出國報告（出國類別：開會）

參加「氣候變遷風險資訊 (International Workshop on Risk Information on Climate Change)」暨「區域波譜模式(RSM2014)」工作坊

服務機關：行政院環境保護署
姓名職稱：
翁特約環境技術師婉珊
邱特約高級環境技術師美璇
派赴國家：日本－橫濱市
出國期間：民國 103 年 11 月 24 日至 11 月 28 日

報告日期：民國 104 年 2 月 24 日

摘要

本案係參加於日本橫濱舉行之「氣候變遷風險資訊 (International Workshop on Risk Information on Climate Change)」暨「區域波譜模式(RSM2014)」工作坊，藉由參與本會議，吸取國際對氣候變遷及相關風險資訊之應用與作法，了解亞洲國家因應氣候變遷現況，並精進我國因應氣候變遷的能力與經驗。

日本因其國土狹長、地形多樣，對不同區域的溫度與降水既存有明顯差異，同時夏秋兩季亦經常受到颱風侵襲，近年更因氣候變遷與極端天氣事件，使其遭受到的氣候風險明顯增加。為強化極端天氣與災害應變能力，日本並於 2012 年起進行「氣候變遷風險資訊計畫 (Program for Risk Information on Climate Change)」，又稱「創生計畫(SOUSEIProgram)」，著重推展氣候變遷及全球暖化預測的基礎技術，並應用於災害風險評估等面向。本「氣候變遷風險資訊工作坊」即是由該計畫所支持，除了發表 SOUSEI 計畫成果外，其辦理目的即為探討模式建構的關鍵因素，綜整出影響氣候變化的影響因子，完成可靠的氣候預測工具，進而建立出對社會實質有用模擬結果。同時，「2014 區域波譜模式」工作坊亦於同一時間合併舉行，透過工作坊的形式推廣區域波譜模式，並提供學術單位實機操作機會，及進行相關研究之經驗交流。

本「氣候變遷風險資訊暨「區域波譜模式」工作坊，所分享之內容聚焦在科學理論與情境假定的討論、運用、解讀及未來的研究發展及走向。透過工作坊的分享，我們可得知 SOUSEI 計畫較過去更著重於風險評估的研究，並且期望於未來協助日本政府進行氣候變遷相關策略規劃與措施擬定。然而科學研究的結果及對應之風險分析與管理，應與政府及民間進行良好的溝通，才能將其研究成果能充分應用於國家政策規劃、決定、推動與評估。

目錄

壹、 背景說明及目的

氣候變遷堪稱人類所面對的最嚴峻挑戰之一，涉及科學、經濟、環境、社會、文化乃至國家安全、文明存續等多層面議題，影響甚廣；如何妥善因應氣候變遷已是各國政府首要的公共政策議題。西元（下同）2013 年聯合國氣候變遷政府間專家委員會(IPCC)發表第五次評估報告(AR5)中指出針對氣候變遷的現象與變化趨勢，AR5 評估結果更加確認由人類造成氣候變遷氣候變遷高度可信度(95%)，而氣候變遷整體變化趨勢則大致相同。

為因應氣候變遷，臺灣目前係以科學、策略及教育三方向著手進行因應，科學界負責環境觀測與科學數據的演繹和預測，而政府部門再依此科學結果擬定政策與策略，並藉由教育提升我國國人自身之氣候變遷素養。

本次「氣候變遷風險資訊 (International Workshop on Risk Information on Climate Change)」暨「區域波譜模式(RSM2014)」工作坊，即配合日本推展推展氣候變遷之「創生計畫(SOUSEI Program)」，探討氣候變遷及全球暖化預測及應用。藉由參與本會議，吸取國際對氣候變遷及相關風險資訊之應用與作法，了解亞洲國家因應氣候變遷現況，並精進我國因應氣候變遷的能力與經驗。

貳、 會議過程及內容

本次參與以「氣候變遷風險資訊」工作坊為主，其次則是「區域波譜模式」工作坊，相關工作行程如下：

日期	工作內容概要
103.11.24	啟程，出發至日本橫濱
103.11.25 ~ 103.11.27 上午	參加「國際氣候變遷風險資訊工作坊」 **1.** 開幕 **2.** 主題 A「氣候變遷預測與判斷(Prediction and Diagnosis of Climate Change)」 **3.** 主題 B「地球系統模擬及其對減緩政策之意義(Earth System Modeling and Its Implication for Mitigation Policy)」 **4.** 主題 C「區域性氣候變遷風險預測之挑戰(Challenges toward Regional Climate Change Risk Prediction)」 **5.** 主題 D-1「氣候變遷影響評估(Climate Change Impact Assessment)」 **6.** 主題 D-2 「如何應用風險資訊於全球氣候變遷調適(How to Use Risk Information to the Global Climate Change)」 **7.** 綜合討論與閉幕
103.11.27 下午	「區域波譜模式(RSM2014)工作坊」
103.11.28	資料彙整及返程

➢ 「國際氣候變遷風險資訊工作坊(International Workshop on Risk Information on Climate Change)」

一、會議緣起及目的

日本因其國土狹長、地形多樣，對不同區域的溫度與降水既存有明顯差異，同時夏秋兩季亦經常受到颱風侵襲，近年更因氣候變遷與極端天氣事件（如集中強降雨與熱浪），使其遭受到的氣候風險明顯增加。為強化極端天氣與災害應變能力，在日本文部科學省(Ministry of Education, Culture, Sports, Science and Technology, MEXT)資助下，自 2002 年展開連續的階段性研究計畫，每項計畫為期五年。

2002-2006 年(FY2002)執行「人類、自然與地球永續共存計畫(Project for the Sustainable Coexistence of Humans, Nature and the Earth)」，又稱「共生計畫 (KYOUSEI Program)」，以全球暖化預測技術為計畫目標；2007-2011 年(FY2007)執行「21 世紀氣後遷預測創新計劃(Innovative Program of Climate Change Projection for the 21st Century)」，又稱「革新計劃(KAKUSHIN Program)」，旨在利用預測技術的結果進行影響評估；而目前執行中的 2012-2016 年 (FY2012) 「氣候變遷風險資訊計畫 (Program for Risk Information on Climate Change)」，又稱「創生計畫(SOUSEI Program)」則著重進一步推展氣候變遷及全球暖化預測的基礎技術，使之應用在規劃方法及災害風險評估等面向上。

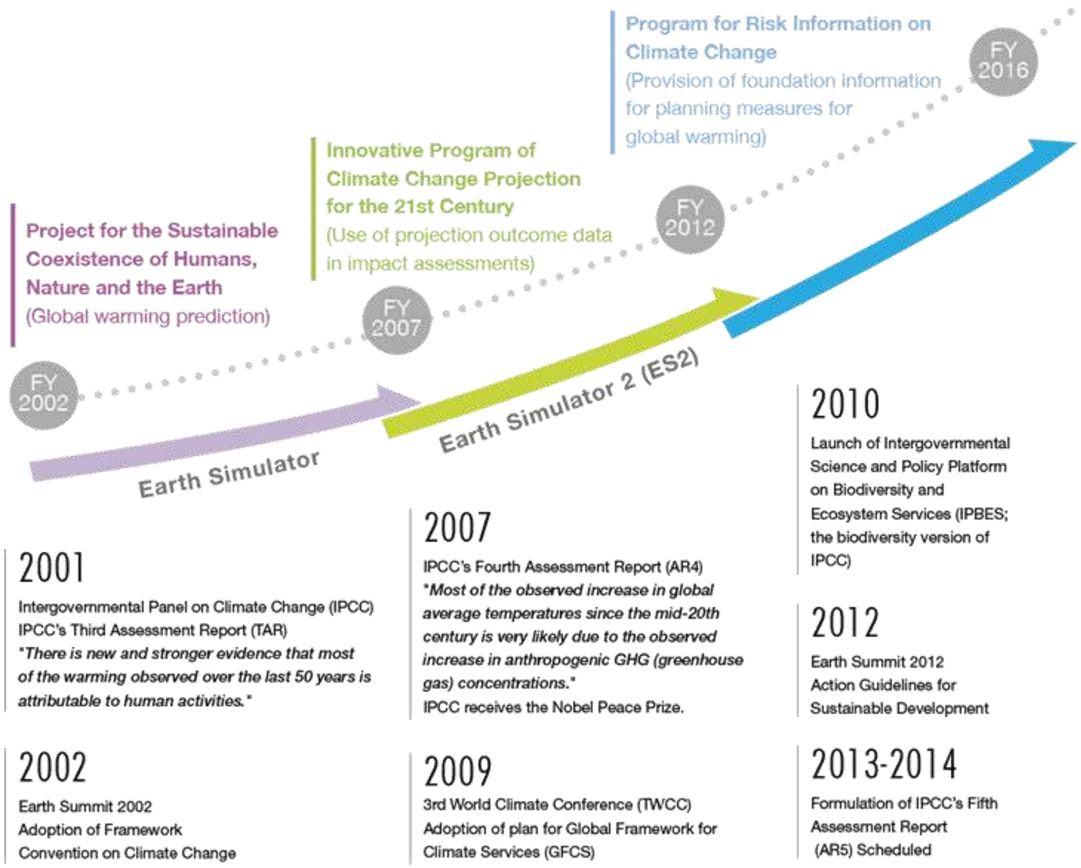


圖1 日本氣候變遷研究進展

SOUSEI 計畫執行將氣候變遷及極端氣候事件的發生，運用模式評估各種損害之風險，將與氣候預估及情境模擬有關的研究，進行進一步的創新與發展，完善既有的模式，使人類對氣候變遷衝擊在環境、經濟與社會各層面可做出最適合因應策略。

「氣候變遷風險資訊工作坊」係由「創生計畫(SOUSEI Program)」所支持，由東京大學大氣海洋研究所(The Atmosphere and Ocean Research Institute, AORI)、筑波大學(University of Tsukuba)、京都大學防災研究所(Disaster Prevention Research Institute, DPRI-UK)與獨立行政法人海洋研究開發機構(Japan Agency for Marine-earth Science and Technology, JAMSTEC)共同主辦，工作坊舉辦期間為 2014 年 11 月 25 日至 27 日，活動地點為 JAMSTEC 橫濱地球科學研究所。

本工作坊除了發表 SOUSEI 計畫成果外，其辦理目的即為探討模式建構的關鍵因素，綜整出影響氣候變化的影響因子，完成可靠的氣候預測工具，進而建立出對社會實質有用模擬結果。因此，會議將研討的重點將放在全球氣候變遷的新興議題，包括氣候模式的改進、地球生物化學模型、數據同化、氣候事件的歸因、氣候敏感、模擬數據的學科應用等。

本工作坊開幕時，並由 SOUSEI 計畫主任 Akimasa Sumi（住　明正）同時也是日本國立環境研究所理事長，就日本氣候變遷研究進展及 SOUSEI 計畫發展內容進行簡介。SOUSEI 計畫內含 5 個子計畫，主題 A「全球氣候變遷預測與判斷(Prediction and diagnosis of imminent global climate change)」負責最基礎層次的模式與技術研究，作為 SOUSEI 計畫的根基，其次是主題 B「氣候變遷預測促進穩定目標的設定(Climate change projection contributing to stabilization target setting)」作為主題 A 的輔助，就地球環境生化循環進行研究，以瞭解如何創造穩定之社會及經濟環境。主題 C「氣候變遷風險資訊之基礎技術發展(Development of basic technology for risk information on climate change)」就氣候事件進行研究，產出氣候變化之數據資料；主題 D「氣候變遷之準確影響評估(Precise impact assessments on climate change)」則運用各主題研究結果進行進一步的風險評估與策略分析，最後由主題 E「推展氣候變遷研究及相關合作(Promotion for climate change research and linkage coordination)」將各主題產出之研究成果，加以進行交流及推廣，以確保研究成果可於其他組織或機構運用。

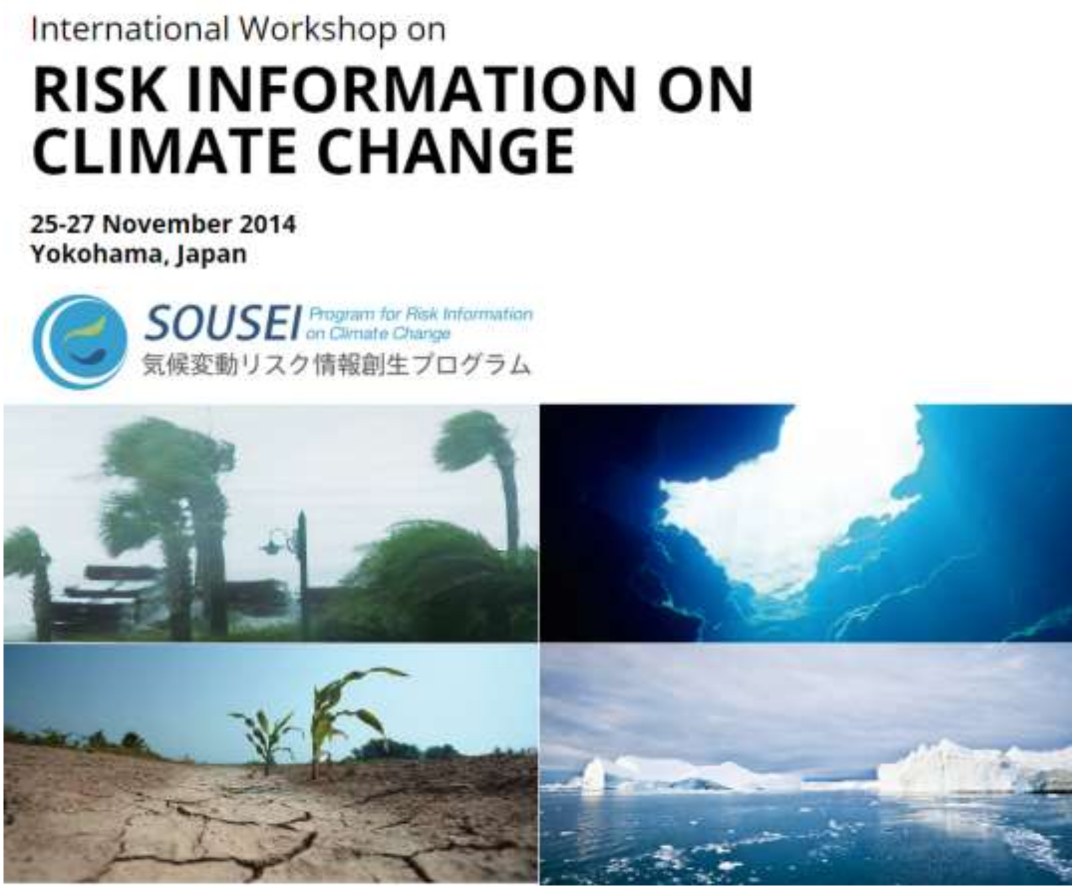


圖2 「氣候變遷風險資訊工作坊 (International Workshop on Risk Information on Climate Change)」主視覺

表1 SOUSEI 子計畫主題

主題	主辦單位及研究內容
Theme A: Prediction and diagnosis of imminent global climate change 全球氣候變遷預測與判斷	東京大學大氣海洋研究所(AORI)
	開發與氣候變遷相關的模式與技術，做為 SOUSEI 計畫的基礎 ➢ 瞭解氣候變遷的機制 ➢ 開發全球氣候之綜合預測系統

主題	主辦單位及研究內容
Theme B: Climate change projection contributing to stabilization target setting 氣候變遷預測促進穩定目標的設定	海洋研究開發機構(JAMSTEC) 針對各類地球環境生化循環進行研究，特別是二氧化碳濃度改變對上述循環的影響，以瞭解如何創造穩定之社會及經濟環境。 ➢ 不同情境之長期氣候變遷預測 ➢ 大規模變動及氣候改變之科學研究
Theme C: Development of basic technology for risk information on climate change 氣候變遷風險資訊之基礎技術發展	筑波大學(University of Tsukuba) 利用大氣模型就日本地區氣候事件進行數據研究，產出氣候變化之數據資料，並進行危害分析。 ➢ 氣候預測機率之風險分析 ➢ 運用超解析模型進行氣候情境之研究
Theme D: Precise impact assessments on climate change 氣候變遷之準確影響評估	京都大學防災研究所(DPRI-UK) 運用其他主題產出之氣候預測成果做出進一步之風險評估，並提出對應之策略與措施。 ➢ 氣候變遷對天然災害的影響 ➢ 氣候變遷對水資源的影響 ➢ 氣候變遷對生態系統及生物多樣性的影響
Theme E: Promotion for climate change research and linkage coordination 推展氣候變遷研究及相關合作	海洋研究開發機構(JAMSTEC) 將其他主題產出之研究成果進行管理、交流及推廣，以確保研究成果可於其他組織或機構運用。

二、會議內容

「氣候變遷風險資訊工作坊」議程配合 SOUSEI 子計畫結構，分為主題 A、B、C、D-1 與 D-2 等場次（議程如下，詳如附件一）。

表2 「氣候變遷風險資訊工作坊」議程

日期	內容
103.11.25	開幕
	主題 A「氣候變遷預測與判斷(Prediction and Diagnosis of Climate Change)」 主題 B「地球系統模擬及其對減緩政策之意義(Earth System Modeling and Its Implication for Mitigation Policy)」
103.11.26	主題 C「區域性氣候變遷風險預測之挑戰(Challenges toward Regional Climate Change Risk Prediction)」 主題 D-1「氣候變遷影響評估(Climate Change Impact Assessment)」
103.11.27	主題 D-2 「如何應用風險資訊於全球氣候變遷調適(How to Use Risk Information to the Global Climate Change)」
	綜合討論與閉幕

（一） 主題 A「氣候變遷預測與判斷」

工作坊中分享相關研究進程，包括氣候或天氣事件的可預測力、過去氣候變遷發生的歸因與機制(Attribution of Climate-related extreme Events, ACE)、天氣事件之歸因、雲和氣候的敏感度(Clouds and climate sensitivity)，及發展新的氣候模式。

其中一項研究提出近 10 年的氣候變化中，運用不同模型解讀暖化間斷(warming hiatus)與長期暖化趨勢間的影響因子；另外一項研究，則提出從極端氣候事件中尋找人為與自然的影響因子，探討人為活動造成溫室氣體排放與全球溫度變化間的相互作用。另外，尚有研究發展出新的 MIROC6 氣候模式，以取代現有的模式，並嘗試建立過去 150 年大氣及海洋分析分析數據等研究內容。

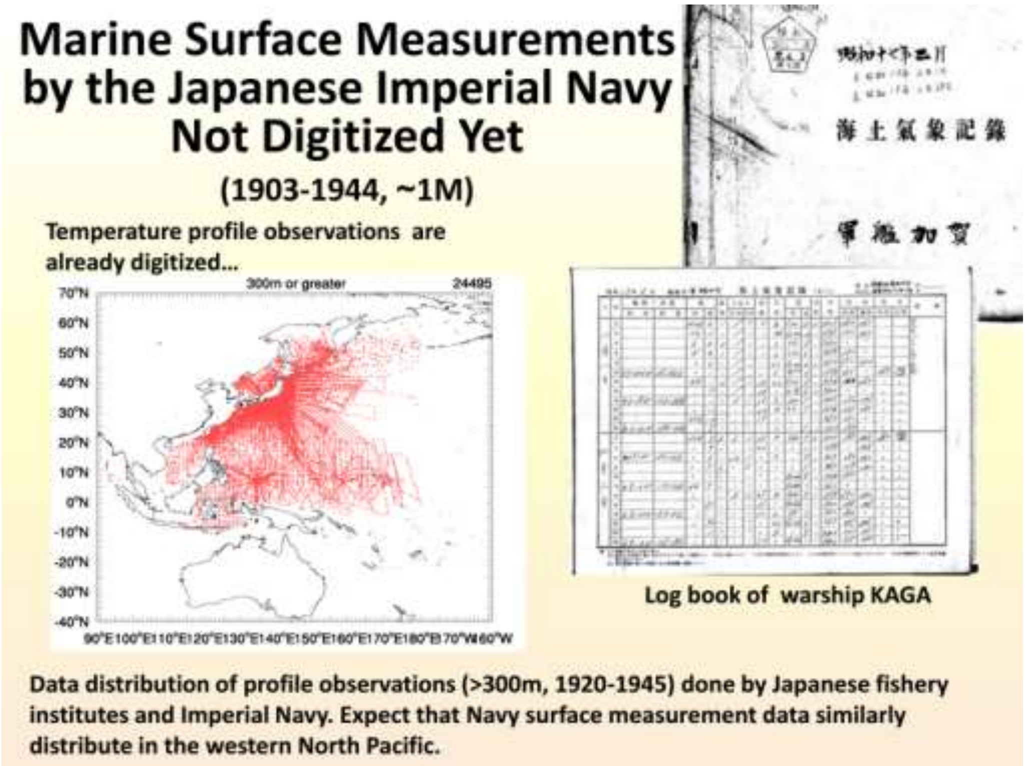


圖3　運用海軍的紀錄重新建構過去百年的氣候數據資料(Masayoshi Ishii, Meteorological Research Institute, Japan Meteorological Agency, Japan.)

（二）　主題 B「地球系統模擬及其對減緩政策之意義」

主題 B 分享相關研究領域的階段性成果，包括：

1. 利用不同情境模擬全球氣候變遷與相關指數之關係，如建立二氧化碳的肥料效應(CO_2 fertilization effect)預估模式，瞭解其對葉面積指數(Leaf area index, LAI) 之作用及緩和大氣碳濃度的效果等。
2. 運用氣候機(HadGEM2)瞭解地球系統及氣候變遷，包括雲與氣膠偶合模式、土地覆蓋改變與地表氣候之影響及碳循環研究等相關應用。

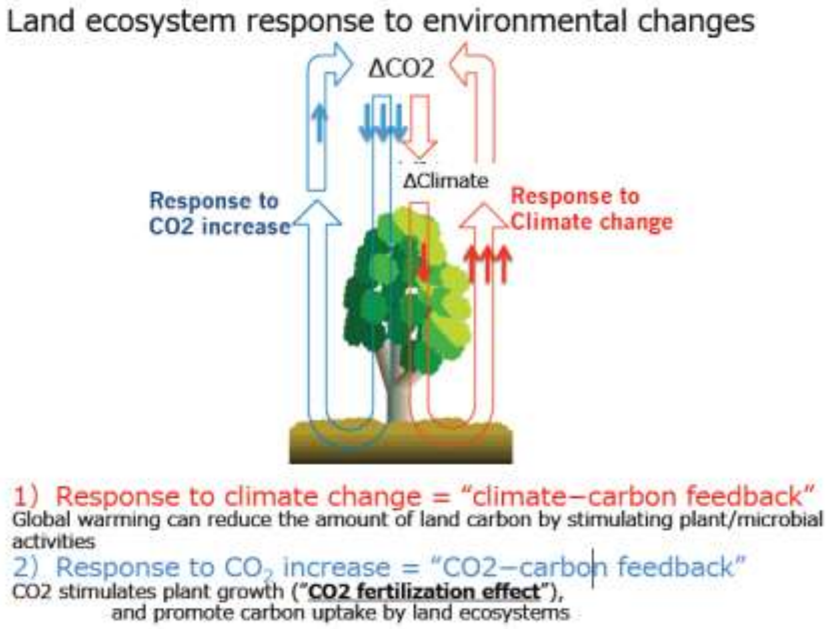


圖4　說明二氧化碳的肥料效應對氣候改變的回饋(Tomohiro Hajima, Japan Agency for Mrine-Earth Science and Technology, Japan.)

3. 將二氧化碳排放量及非二氧化碳之氣膠對暖化的影響，作獨立的情境之目標設定，發現長期的暖化仍取決於二氧化碳的累積排放量，而暖化的最大值則會受到非二氧化碳之氣膠及生命週期較短之溫室氣體的減量速率所影響。以全球升溫控制在 2 度 C 以內目標下，未來全球的碳排放將受到更多的限制，並且應將二氧化碳以外的潛在因素考量在內，才可能達成。
4. 強化對氣候大尺度變化與變異的科學解釋力，研究各種臨界要素(tipping element)、不可逆的環境變遷(如：冰層崩塌)和地理工程學等議題。

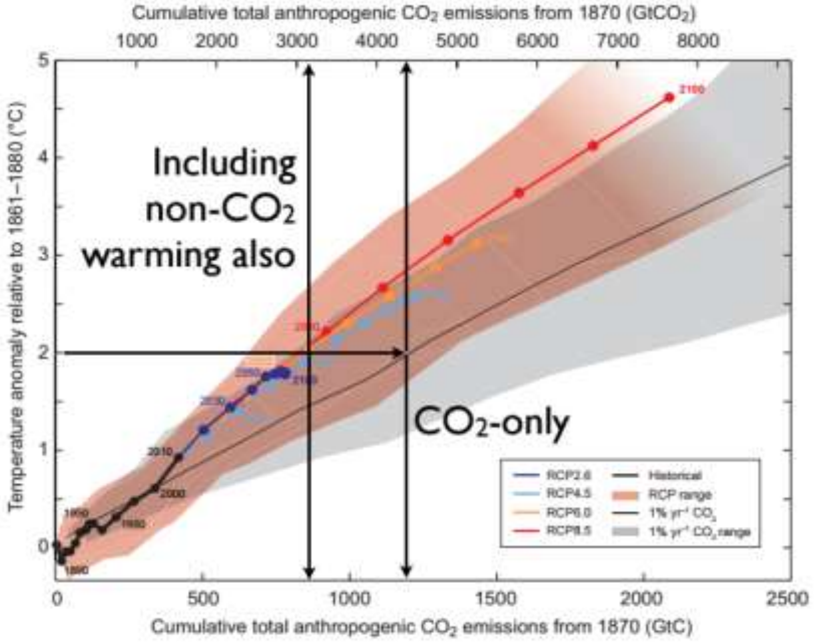


圖5　二氧化碳及非二氧化碳的累積排放量對全球暖化的影響(Damon Matthews, Geography, Plannning and Evironment, Concordia University, Canada.)

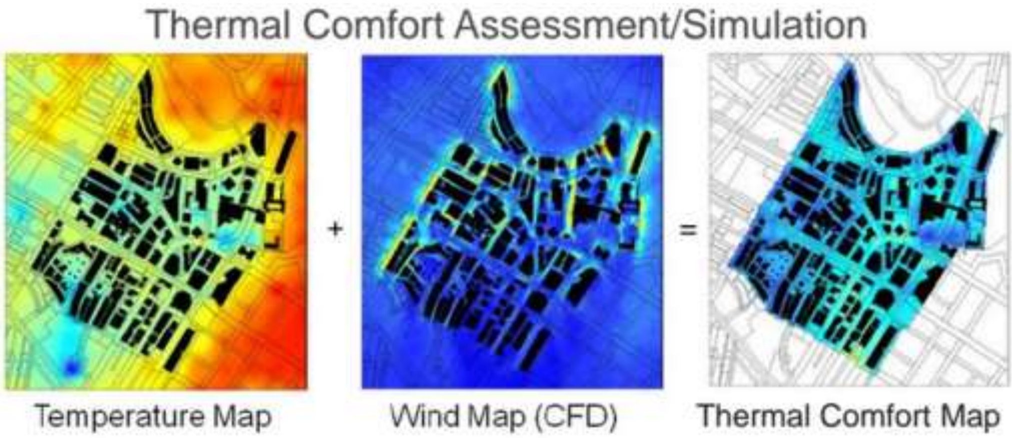
（三）　主題 C「區域性氣候變遷風險預測之挑戰」

人類活動對氣候變遷的影響在減緩措施的效果顯現之前，仍會進行持續，因此必須立即建立調適的機制。運用平均氣溫及降雨等基礎氣候變遷資訊，進行包括風災、水災等風險評估，已在國際間受到關注，然而對於亞洲地區，與季風相關的資訊仍有不足之處;同時低發生率但造成高衝擊的事件，更需要加強研究。

主題 C 主要提出氣候變遷災害評估與水文氣象災害相關的資訊，重點研究目標為氣候預測的風險評估，以增進氣候系統及測試的效能，減少預估模式的誤差值，並已應用於改善全球氣候模式(GCM)、區域氣候模式(RCM)和颱風預估模式上，相關研究亦強調動力降尺度及不確定性的分析工作，對於未來的氣候預測將更為重要。

此外，也有針對全球暖化情況，運用氣候模型配合城市

模型，評估城市面對全球暖化的壓力，探討城市結構、社會行為等影響因子，如何提出有效的適應規劃及措施。



TSV range	Ta range (°C)	Perception (reference to ASHRAE 7-point scale)
-3～-2	Not applicable	cold to cool
-2～-1	22.4～25.4	cool to slightly cool
-1～0	25.4～28.5	slightly cool to neutral
0～1	28.5～31.6	neutral to slightly warm
1～2	31.6～34.7	slightly warm to warm
2～3	34.7-37.7	warm to hot

圖6　以模型討論適應暖化情況之城市規劃(Tian Kuay Lim, National Environment Agency, Singapore.)。

（四）　主題 D-1「氣候變遷影響評估及主題 D-2 「如何應用風險資訊於全球氣候變遷調適」

主題 D-1 以建立更具有精確度的區域模型，以及運用風險機率擬定合適之減緩及調適策略為研究主軸。本工作坊中提出氣候變遷對自然資源（如：水資源、生態系統、生物多樣性）之衝擊與對自然災害之影響，過度的二氧化碳排放不僅造成暖化問題，同時亦造成海洋酸化問題，未來若不採取合適的對策，生態系統將受到諸多影響。

而日本狹長的國土，則提供了各種緯度生物變化的研究機會，並藉由監測方式瞭解生態系統分布及改變，進而歸納出對應的機制與因子，並建立預估模式。

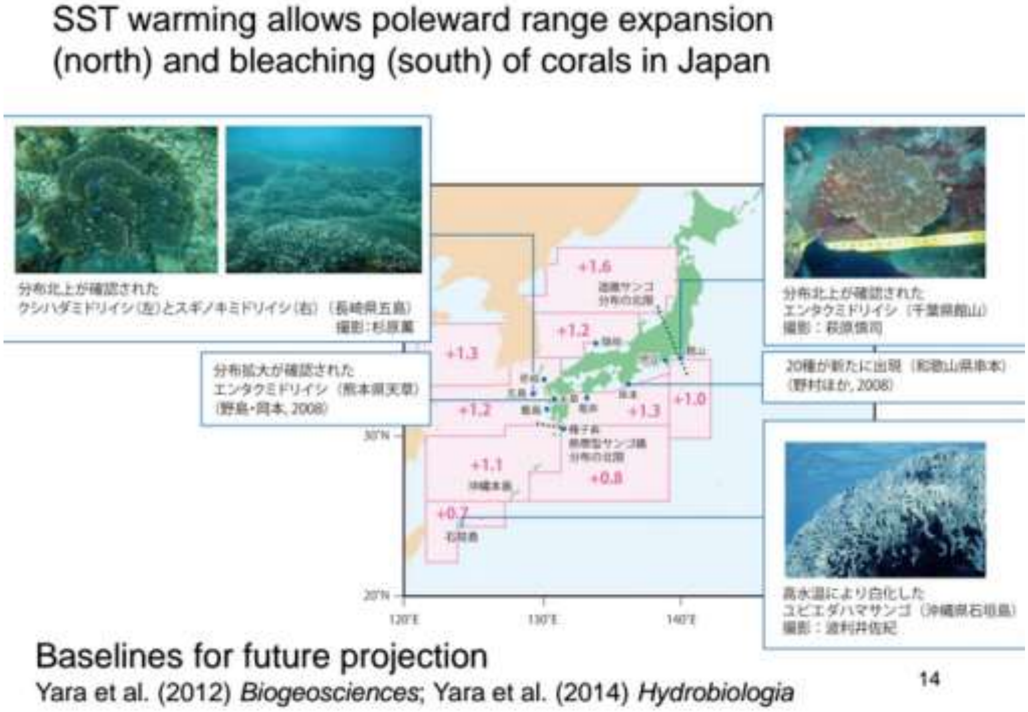


圖7　日本海岸海溫變暖對於珊瑚生長區域的改變 (Hiroya Yamano, Center for Environmental Biology and Ecosystem Studies, National Institute for Environmental Studies, Japan.)

主題 D-2 則強調，若以全球升溫小於 2 度 C 為目標，則意味著要付出較高的減量成本，應將社會、經濟、氣候等多面向的因子納入評估措施，規劃合適之減緩及調適措施。此外，我國「臺灣氣候變遷推估與資訊平台計畫(TCCIP)」與 SOUSEI 計畫及 KAKUSHIN 計畫（SOUSEI 之前期計畫）有密切合作，故本研討會亦邀請我國國家災害防救科技中心代表分享 TCCIP 相關研究成果。

（五）　會議討論與總結

1. SOUSEI 計畫的挑戰

(1)研究成果不僅提供給科學界，同時應讓大眾所周知：如何將研究的結果傳達給民眾，仍需進一步的思考。

(2)對於尚無法精確的資訊，需要加強溝通的工作，例如使用高解析度不一定代表高度精確性。

(3)在風險分析與管理方面，對於發生頻率低但會造成高衝

擊的事件應加強研究量能。

(4)在組織內部，應有專責單位將相關研究結果作進一步的整理及歸納。

2. SOUSEI 計畫的成果

(1)預期未來 SOUSEI 計畫所產出的成果，可被廣泛的運用於日本各項衝擊與調適研究。

(2)對於日本將於 2015 年夏天頒布「國家調適計畫(National Adaptation plan)」，SOUSEI 計畫所完成的氣候模式將可協助該政策推展。

(3)SOUSEI 計畫預定於 2015 年 2 月提交 1 份摘要總結，包含提出短程（10 年之內）、中程（10-30 年）、長程（30-100 年）不同時期優先重視的領域或議題，可作為日本政府未來氣候變遷決策與施政之重要參考。

圖8　參與「氣候變遷風險資訊工作坊」人員合影

- 「區域波譜模式(RSM2014)」工作坊

一、會議緣起及目的

區域波譜模式(RSM)工作坊從 1999 年起，每年於不同國家辦理一次工作坊，2014 年於日本橫濱由東京大學主辦，其辦理之目的為透過工作坊的形式推廣 RSM，提供學術單位操作 RSM，及進行相關研究之經驗交流。

二、會議內容

本工作坊期程為 2014 年 11 月 26 日至 29 日，其部分議程與「氣候變遷風險資訊工作坊」合併舉辦，另外於同一活動地點進行 RSM 研究成果分享及實機操作活動（議程如下，詳如附件二）。

表3 「區域波譜模式(RSM2014)」工作坊議程

日期	內容
103.11.26	「區域性氣候變遷風險預測之挑戰(Challenges toward Regional Climate Change Risk Prediction)」(與「氣候變遷風險資訊工作坊」合併舉辦 RSM 研究成果分享
103.11.27	RSM 研究成果分享 實機操作講座
103.11.28	RSM 研究成果分享 地球模擬網站簡介 實機操作講座
103.11.29	技術參訪

工作坊中，就美國內陸海的模擬研究成果進行分享，比較不同解析度的全球模式，結果顯示大尺度的全球模式可以分析整體的海洋狀況，但透過區域模式使我們對於海洋較小尺度的洋流和渦漩有更多的瞭解。此外，未來 100 年的氣候變遷模擬，研究結果顯示未來的亞洲冬季季風會變弱，但日本北部的降雨和水氣會增加，並利用區域波譜模式針對過去的個案進行分析，以了解日本相關災害的狀況。

參、 心得與建議

一、學習心得

（一） 「氣候變遷風險資訊工作坊」，主要以 2012 至 2017 年的「創生計畫(SOUSEI Program)」所支持，並就其四大研究計畫主軸（包括氣候變遷預測、生物地球化學循環對地球氣候影響、氣候模式運用於極端天氣等氣候風險預估及風險管理等面向）進行不同氣候模式應用與影響因子進行成果分享。本工作坊聚焦在科學理論與情境假定的討論，大多在說明大氣模式運用，以及各種模式如何解讀氣候變遷的問題，與其未來的研究發展及走向。

（二） 透過工作坊的分享，我們可得知 SOUSEI 計畫較過去更著重於風險評估的研究，如發生頻率較低卻存在高衝擊的氣候事件更應投入研究，並且將評估的結果與社會及經濟等條件，納入減緩與調適策略的考量，同時致力於更實質的運用，其研究成果將對於日本相關政策發展，提供重要的參考。

（三） SOUSEI 計畫也發現將其研究結果與大眾溝通的重要性，期待未來能將氣候變遷的情境與風險，運用更容易讓外界瞭解的方式傳遞出去，以減輕未來氣候事件對全民造成的損害。

（四） RSM 工作坊，較「氣候變遷風險資訊工作坊」更專精於模式模擬的研究內容，提供學生增進其對研究的思考及實機操作的經驗。

二、建議

（一） 氣候變遷調適策略規劃與措施推動內含跨領域的資源與議題，中央政府扮演非常關鍵的領導角色。SOUSEI 計畫直接獲得環境省與文部科學省的資源支助，並納入日本中央政策「國家調適計畫」的推動藍圖中，其研究成果能充分應用於國家政策規劃、決定、推動與評估。

（二） 氣候變遷是一個動態的過程，因此氣候模擬方法必須能夠適時地滾動式修正。SOUSEI 計畫以 IPCC AR5 的情境模擬結果為基礎進行相關研究，子計畫之間氣候模式與情境設定亦相互共享，使其研究可建立於共同基礎與定義，並可與國際接軌。

（三） RSM 工作坊提供模式的使用者互相交流及學習，並提供學生參加，透過建教合作讓更多對環境議題有興趣的人員也能參與研究，可增強國內未來環境政策推動之能量。

（四） 臺灣目前係以科學、策略及教育三方向著手進行因應，在科學研究部分，我國「臺灣氣候變遷推估與資訊平台建置」計畫結合國家災害防救科技中心、中央氣象局與中央研究院環境變遷研究中心與及國內氣候變遷研究學者，運用日本氣候變遷 SOUSEI 計畫氣候模式及 IPCC AR5 不同情境研擬「2014 臺灣氣候變遷科學報告」，以作為我國氣候變遷調適計畫推動之參考依據。

（五） 氣候變遷影響層面甚廣，科學研究有助於了解氣候變遷的成因及未來可能產生的衝擊，惟科學研究的結果及對應之風險分析與管理，應與政府及民間進行良好的溝通，透過工作坊之舉辦，可增進溝通管道之形成，以達到全面強化國家適應氣候變遷能力之目標。

肆、 附件

附件一、國際氣候變遷風險資訊工作坊議程

附件二、「區域波譜模式(RSM2014)」工作坊議程

附件三、會議摘要資料

附件四、SOUSEI 計畫簡介

附件一、國際氣候變遷風險資訊工作坊議程

國際氣候變遷風險資訊工作坊議程

DAY 1 (NOVEMBER 25, TUE.)	
9:00-9:30	Registration
WELCOMING REMARKS	
9:30-9:40	• AkimasaSumi (Special Advisor to MEXT, President, National Institute for Environmental Studies Japan.)
SESSION 1 (THEME A): PREDICTION AND DIAGNOSIS OF CLIMATE CHANGE 氣候變遷預測與判斷 Convener: Masahide Kimoto (Atomosphere and Ocean Research Institute, The University of Tokyo, Japan.)	
9:40-10:05	北太西洋震盪的季節預測到年代際預測:最新的能力和未來的展望 Seasonal to decadal prediction of the winter North Atlantic Oscillation:emerging capability and future prospects • Doug Smith (Met Office Hadley Centre, UK.)
10:05-10:30	了解最近十年的氣候變遷和其歸因分析 Understanding and attributing climate changes in the last decade • Masahiro Watanabe (Atomosphere and Ocean Research Institute, The University of Tokyo, Japan.)
10:30-10:55	人類活動對於極端氣候和氣象事件的影響 Anthropogenic influence on weather and climate extremes • Nikolaos Christidis (Met Office Hadley Centre, UK.)
10:55-11:10	Break
11:10-11:35	氣候預報模式的初始場 Obsevation-model-ensemble initialization for climate prediction • Masayoshi Ishii (Meteorological Research Institute, Japan Meteorological Agency, Japan.)
11:35-12:00	試驗模式中不同物理過程開關的影響 SPOOKIE:The Selected Process On/Off KlimaIntercomparison Experiment

	• Mark Webb (Met Office Hadley Centre, UK.)
12:00-12:25	雲的反饋和氣候敏感度對於不確定性的影響 Factors contributing to the uncertainty in cloud feedback and climate sensitivity • Tomo'o Ogura (National Institute for Environmental Studies, Japan.)
12:25-14:00	Lunch
SESSION 2 (THEME B): EARTH SYSTEM MODELING AND ITS IMPLICATIONS FOR MITIGATION POLICY 地球系統模擬及其對減緩政策之意義 Convener: MichioKawamiya (Japan Agency for Marine-Earth Science and Technology, Japan.)	
14:00-14:25	氣候波譜模式中人為二氧化碳排放對全球碳循環的影響 CO2 fertilization effect on global carbon cycle evaluated by ESMs • Tomohiro Hajima (Japan Agency for Mrine-Earth Science and Technology, Japan.)
14:25-14:55	探討東亞的氣候狀態- 韓國國家氣候研究中心氣候變遷研究 Understanding climate process in East Asia - Climate change research in NIMR • Kyung-On Boo (Climate Reasearch Laboratory, National Institute of Meteorological Research, Korea Meteorological Administration, Republic of Korea.)
14:55-15:20	人為氣溶膠強迫力對 20 世紀北太平洋的溫度變化的影響 Effect of anthropogenic aerosol forcing on temperature change of the North Pacific Ocean in the 20th Century • Manabu Abe (Japan Agency for Marine-Earth Science and Technology, Japan.)
15:20-15:35	Break
15:35-16:05	在氣候減緩目標下累積的二氧化碳收支 Cumulative carbon budgets for climate mitigation targets • Damon Matthews (Geography, Plannning and Evironment, Concordia University, Canada.)
16:05-16:25	累積碳排放和全球平均溫度變化的明顯比例關係 Robustness of the proportionality of global mean temperature change to cumulative carbon emissions

	• Kaoru Tachiiri(Japan Agency for Mrine-Earth Science and Technology, Japan.)
16:25-16:50	從社會經濟的觀點評估不同排放路徑下固定的累積二氧化碳排放量 Evaluating multiple emission pathways for fixed cumulative CO2 emissions from socioeconomic perspectives • Ken'ichi Matsumoto (The University of Shiga Prefecture, Japan.)

DAY 2 (NOVEMBER 26, WED.)	
SESSION 3 (THEME C): CHALLENGES TOWARD REGIONAL CLIMATE CHANGE RISK PREDICTION 氣候變遷風險區域預測的挑戰 Conveners: IzuruTakayabu (Meteorological Research Institute, Japan Meteorological Agency, Japan.) Koji Dairaku (National Research Institute for Earth Science and Disaster Prevention, Japan.)	
9:00-9:20	利用氣候情境發生機率進行風險評估 Probalistic Climate Scenarios for Risk Assessment • Koji Dairaku (National Research Institute for Earth Science and Disaster Prevention, Japan.)
9:20-9:45	為何區域氣候模式在氣候變遷的推估中很重要 Why is reginal climate modeling critical for climate change projections? • Vasu Misra (Florida State University, US.)
9:45-10:00	高解析度的大尺度模式對於未來情境推估的模擬與應用 High-resolution AGCM Modeling and Application for Future Projection • Ryo Mizuta (Meteorological Research Institute, Japan Meteorological Agency, Japan.)
10:00-10:25	CWRF 在區域氣候預測上最佳的物理系集上的改進 CWRF Optimized Physics Ensemble Improving Regional Climate Prediction • Xin-Zhong Liang (University of Maryland, US.)
10:25-10:40	利用高解析度區域氣候模式推估日本未來氣候變遷情境 Projection of future climate change over Japan using a high-resolution regional climate model • Akihiko Murata (Meteorological Research Institute, Japan Meteorological Agency, Japan.)

10:40-11:00	Break
11:00-11:25	氣候科學的改善以及美國國家氣候評估報告的發表 Deliver and Improve Climate Science for National Climate Assessment in the United States • Liqiang Sun (National Climatic Data Center, National Oceanic and AtomosphericAdminidtration, US.)
11:25-11:40	探討未來情境下水資源管理的影響 Study on impact of the water resources management on projectd future • Kei Yoshimura (Atomosphere and Ocean Research Institute, The University of Tokyo, Japan.)
11:40-12:05	新加坡地區在城市尺度下的熱壓力和水資源對氣候敏感度設計的評估 Urban-scale assessment of thermal comfort stress and water resources risk in support of a climate-sensitive design for Singapore • Tian Kuay Lim (National Environment Agency, Singapore.)
12:05-12:20	非靜力大氣海洋波浪耦合模式在颱風的模擬 Typhoon simulations using a coupled atomosphere-wave-ocean non-hydrostatic model • Kazuhisa Tsuboki (HydrosphericAtomospheric Research Center, Nagoya University, Japan.)
12:20-13:30	Lunch 午餐
SESSION4 (THEME D-1): CLIMATE CHANGE IMPACT ASSESSMENT 氣候變遷衝擊的評估 Conveners: Eiichi Nakakita (Disaster Prevention Research Institute, Kyoto University, Japan.) TohruNakashizuka (Graduate School of Life Science, Tohoku University, Japan.)	
13:30-13:40	自然災害、水資源和生態系統的衝擊評估 On the Impact Assessments on Natural Disaster, Water Resource and Ecosystem • Eiichi Nakakita (Disaster Prevention Research Institute, Kyoto University, Japan.)
13:40-14:05	日本陸地生態系統在全球氣候變遷下將受到的衝擊和新的變化 Emerging and future effects of global climate change on terrestrial ecosystems

	in Japan • TohruNakashizuka (Graduate School of Life Science, Tohoku University, Japan.)
14:05-14:35	氣候變遷對森林覆蓋的流域生態系的影響:現在和潛在的風險 Effects of changing climate on forested watersheds: current and potential new risks to these ecosystems • Myron Mitchell (Department of Environmental and Forest Bilogy, College of Environmental Science and Forestry, State University of New York, US.)
14:35-15:05	透過監測海岸生態系了解氣候變遷的影響 Monitoring coastal ecosystems to reveal the effects of climate change • HiroyaYamano (Center for Environmental Biology and Ecosystem Studies, National Institute for Environmental Studies, Japan.)
15:05-15:20	Break
15:20-15:50	兩倍二氧化碳下所造成的的全球暖化和海洋酸化海洋生態系的反應 Future projection of marine ecosystems in response to two CO2-caused global phenomena: global warming and ocean acidification • Masahiko Fujii (Faculty of Environmental Earthe Science, Hokkaido University, Japan.)
15:50-16:20	氣候變遷的速度和未來海洋生物多樣性的分布 The velocity of climate change and the future global distribution of marine biodiversity • Jorge Garcia-Molinos (Department of Ecology, Scottish Association for Mariine Science, Scottish Marine Institute, UK.)
16:20-16:55	氣候變遷和生物多樣性: 整合的過程 Climate change and biodiversity: integration approach • ShunsukeManagi (Graduate School of Environmental Studies, Tohoku University, Japan.)
16:55-17:20	自然資產和碳損失 Natural capital accounts and carbon damages • Pablo Muñoz (International Human Dimensions Programme on Global Environmental Change (IHDP), Germany.)

DAY 3 (NOVEMBER 27, THU.)	
SESSION 5 (THEME D-2): HOW TO USE RISK INFORMATION TOWARD THE ADAPTATION TO THE GLOBAL CLIMATE CHANGE 如何使用風險的資訊針對氣候變遷做調適 Convener: Eiichi Nakakita (Disaster Prevention Research Institute, Kyoto University, Japan.)	
9:30-10:00	日本對自然災害和水資源的氣候變遷衝擊分析中的重要觀點 Some important points in climate change impact assessment on natural disaster and water resources in Japan • Eiichi Nakakita (Disaster Prevention Research Institute, Kyoto University, Japan.)
10:00-10:30	氣候變遷對台灣自然災害的衝擊: 利用 JMA 高解析度全球模式 Climate change impacts study on natural disasters in Taiwan-using JMA/MRI high resolution AGCM data • Lee-Yaw Lin (National Science and Technology Center for Disaster Reduction, Taiwan (ROC))
10:30-10:40	Break
DISCUSSION Chairman: AkimasaSumi (Special Advisor to MEXT, President, National Institute for Environmental Studies, Japan.)	
10:40-10:50	日本在氣候變遷的研究和評估上跨領域合作的作為 Interdisciplinary cooperation initiative of scenarios for climate change research and assessment in Japan • Junichi Tsutsui (Central Research Institute of Electric Power Industry, Japan.)
10:50-11:00	SOUSEI 計畫對日本調適和衝擊研究的貢獻 Contributions of the SOUSEI Program for impact and adaptation studies in Japan • Kiyoshi Takahashi (National Institute for Environmental Studies, Japan.)
11:00-11:15	建議

	Comments • Timothy Carter (Co-Chairs, Task Group on Data and Scenario Support for Impacts and Climate Analysis (TGICA), Finnish Environment Institute (SYKE) Research Professor, Finland)
11:15-12:15	Discussion 討論
CLOSING REMARKS	
12:15-12:20	• AkimasaSumi (Special Advior to MEXT, President, National Institute for Environmental Studies Japan.)
Closing	

附件二、「區域波譜模式(RSM2014)」工作坊議程

「區域波譜模式(RSM2014)」工作坊議程

November 26			
	9:00-12:15 RSM plenary session in SOUSEI symposium “Challenges toward Regional Climate Change Risk Prediction”		
	Venue: Miyoshi Hall		
	9:00	Koji Dairaku	利用氣候情境發生機率進行風險評估 Probabilistic Climate Scenarios for Risk Assessment
	9:20	Vasu Misra	為何區域氣候模式在氣候變遷的推估中很重要 Why is regional climate modeling critical for climate change projections?
	9:45	Ryo Mizuta	高解析度的全球大尺度模式對於未來情境推估的模擬與應用 High-resolution AGCM Modeling and Application for Future Projection
	10:00	Xin-Zhong Liang	CWRF 在區域氣候預測上最佳的物理系集上的改進 CWRF Optimized Physics Ensemble Improving Regional Climate Prediction
	10:25	Akihiko Murata	利用高解析度區域氣候模式堆估日本未來氣候變遷情境 Projection of future climate change over Japan using a high-resolution regional climate model
	10:40	BREAK	
	11:00	Liqiang Sun	氣候科學的改善以及美國國家氣候評估報告的發表 Deliver and Improve Climate Science for National Climate Assessment in the United States
	11:25	Kei Yoshimura	探討未來乾旱的變化下對水資源管理的影響 Study on impact of the water resources management on projected future change of drought
	11:40	Tian Kuay Lim	新加坡都會尺度下的熱壓力和水資源對氣候敏感度設計的評估 Urban-scale assessment of thermal comfort stress and water resources risk in support of a climate-sensitive design for Singapore
	12:05	Kazuhisa Tsuboki	非靜力大氣海洋及波浪耦合模式對颱風的模擬 Typhoon simulations using a coupled atmosphere-wave-ocean non-hydrostatic model
	12:20	LUNCH BREAK in Guest House	
	13:30-17:00 Dynamical Downscaling for Climate (Chair: Liqiang Sun)		
	Venue: Seminar Room in 2F of Exhibition Square		
	13:30	Kei Yoshimura	Opening Remark

1	13:45	Nikolaus H. Buenning	21 世紀水同位數推估和其對風和降雨型態模擬的關係 Water isotope projections of the 21st century and how they relate to simulated changes in wind and precipitation patterns
2	14:00	Xuejie Gao	區域模式在中國的應用 Application of RegCM over China
3	14:15	Suryun Ham	利用氣候波譜模式進行降尺度分析未來不同氣候情境(RCP)的東亞氣候變遷的特徵 Assessment of Future Climate Changes over the East Asia due to the RCP scenarios downscaled by Regional Spectral Model
4	14:30	LinhLuu-Nhat	NCEP 區域波譜模式對越南地區的氣候預測 Climate prediction using NCEP Regional Spectral Model (RSM) for Vietnam
5	14:45	Mehwish Ramzan	南亞氣候探究和對高解析度區域波譜模式(RSM)的價值 Study of South Asian Climate and Added value of High Resolution Regional Spectral Model (RSM)
6	15:00	Abdoulaye SARR	利用模式探討在 RCP8.5 的情境下西非撒哈拉地區的重要氣候指標 Assessing Critical Climate Indices over West Africa Sahel under RCP8.5 Scenario from a Nesting Approach RCM/GCMs
	15:15	BREAK	
7	15:30	Liqiang Sun	巴西東北部的氣候降尺度預報:最新進展 Climate Downscaling Forecasts over Northeast Brazil: An Update
8	15:45	Asuka Suzuki-Parker	利用多個區域及全球模式動力降尺度實驗分析日本地區的不確定性歸因分析 Uncertainty attribution in the multi GCM/RCM ensemble dynamical downscaling experiments for Japan
9	16:00	Tomohito J. Yamada	多個全球大氣模式和區域模式對未來極端降雨強度分析 Extreme precipitation intensity in future climates based on the multi-GCMs with multi-RAMs
10	16:15	Yao Yao	以衛星觀測資料評估 WRF 模式對南極氣候的模擬 An evaluation of WRF model’s simulation on the Antarctic climate with satellite observations
11	16:30	Fumiaki MORIYAMA	區域氣候模式在東亞地區的敏感度實驗 Several scheme sensitivity experiments in Eastern Asia by a regional climate model
12	16:45	Panduka Neluwala	高解析度海洋大氣耦合模式對斯里蘭卡的降尺度預報表現 Performance of High Resolution Ocean Atmosphere Coupled Model Downscaling over Sri Lanka

13	17:00	Hiroaki Kawase	NHRCM 系集模式對冬季降雨未來變化模擬的不確定性 Uncertainty of future changes in winter precipitation simulated by NHRCM ensemble experiments in Japan
November 27			
	Venue: Seminar Room in 2F of Exhibition Square		
	9:00-12:30 Model Development and Process Studies (Chair: Henry)		
14	9:00	Hann-Ming Henry Juang	深大氣動力發展 Developing Deep Atmospheric Dynamics
15	9:15	Song You Hong	利用波譜和有限差分法比較兩個區域模式的靜力和非靜力的動力模組 Comparison of Nonhydrostatic and Hydrostatic Dynamical Cores in Two Regional Models with Spectral and Finite-Difference Methods
16	9:30	LIM Tian-Kuay	新加坡都市熱島效應與風的風險評估的整合分析和模擬系統 AN INTEGRATED ANALYSIS AND SIMULATION SYSTEM FOR URBAN HEAT ISLAND EFFECT AND WIND RISK ASSESSMENT IN SINGAPORE
17	9:45	HyodaeSeo	海溫度對季內震盪的日夜變化變化的影響 Coupled impacts of the diurnal cycle of sea surface temperature on the Madden-Julian Oscillation
18	10:00	Shyh Chen (on behalf of Chih-Hui Shiao)	中央氣象局動力降尺度區域氣候預報系統的改進 Zoning Scheme Improvement for the Dynamically Downscaled Regional Climate Forecast System of CWB
19	10:15	Chenglai Wu	利用 WRF/chem 模擬東亞地區沙塵排放和輸送:不同沙塵排放的敏感度實驗 Modeling dust emission and transport over East Asia by WRF/Chem: sensitivity to dust emission schemes
	10:30	BREAK	
20	10:45	Din AmadUd	利用區域同位波譜模式進行 1986 年大風雪模擬並與 Cosmosiso 模式比較 1986 Snow Storm Simulation Using Regional Isotope Spectrum Model (IsoRSM) and Its Comparison with Cosmosiso Model
21	11:00	Mohan Kumar Das	比較雷達、衛星和模式模擬裡中尺度對流系統的特徵 Composite Characteristics of Mesoscale Convective Systems Observed by Radar, TRMM and Simulated by Model

22	11:15	Noriko N. ISHIZAKI	日本大雪區因全球暖化帶來的極端降雨變化 Precipitation extreme change due to global warming over the heavy snow region in Japan
23	11:30	FRANKLIN JOSEPH OPIJAH	系集 WRF 模式在 GHA 區域年代際降雨預測的相關性 RELEVANCE OF THE EMS-WRF MODEL IN DEKADAL RAINFALL PREDICTION OVER THE GHA REGION
24	11:45	Masahiro Tanoue	利用區域波譜模式模擬日本降雨和水氣來源 Precipitation and water vapor origins throughout Japan in winter by isotopes-incorporated Regional Spectral Model
25	12:00	MIDHUN MADHAVAN	比較 SWING2 模式和觀測對於印度夏季季風降雨的模擬 Stable Water Isotopologues in Indian Summer Monsoon Rainfall: A comparison between SWING2 model simulations and observations
	12:15	GROUP PHOTO	
	12:30	LUNCH BREAK in Guest House	
	14:00-17:00 Hands-On Lecture 1		
	18:00-20:00 Reception in Guest House		
November 28			
	Venue: Seminar Room in 2F of Exhibition Square		
	9:00-10:45 Application Studies (Chair: Kei Yoshimura)		
26	9:00	Xu Ying	利用 CMIP5 推估中國未來的洪水風險 Projected Flood Risks in China based on CMIP5
27	9:15	KinyaToride	重建歷史天氣的資料分析:利用重分析資料做現在的模擬 Toward Reconstruction of Historical Weather with Data assimilation: Present Day Experiments using Reanalysis Data
28	9:30	Vasu Misra	灌溉對美國東南氣候的影響 The impact of irrigation on the southeastern US climate
29	9:45	Shyh Chen	易發生火災的天氣預報 Fire Busting Weather Forecast
30	10:00	Kenshi Hibino	氣候變遷評估在時間和空間平均尺度的影響 The Effect of Temporal and Spatial Averaging Scales in Climate Change Assessments
31	10:15	Yoshikazu Kitano	全球暖化下極端事件和阻塞高壓出現頻率的空間變化 Spatial Change of Blocking Frequency and Extreme Events with Global Warming
32	10:30	IzuruTak	氣候模式具預報能力的時間尺度

		ayabu	Skillful time scale of climate model
	10:45	BREAK	
	11:00-12:30 Tropical Cyclones (Chair: Hironori Fudeyasu)		
33	11:00	Shota Yamasak i	熱帶氣旋的路徑如何影響強降雨和強陣風的分布 How do tracks of tropical cyclone affect the distribution of heavy rainfall and strong winds?
34	11:15	Hiroaki YOSHIO KA	利用觀測資料和系集降尺度模擬分析大尺度環流對颱風麗琵生成的影響 Large-scale influences on the formation of Typhoon LEEPI using observational data and ensemble downscale experiments
35	11:30	SachieKa nada	以 2 公里高解析非靜力模式探討 IDA 颱風快速增強的三度空間發展過程 Three dimensional evolution of an extremely intense tropical cyclone with the extraordinarily rapid intensification simulated by a 2-km mesh non-hydrostatic model: Numerical experiments of Typhoon IDA (T5822)
36	11:45	Tetsuya Takemi	未來最壞情境下以區域模式評估颱風帶來的災害 Regional-Scale Simulations of High-Impact Tropical Cyclones for the Assessments of Meteorological Hazards from a Worst-Case Scenario
37	12:00	MASAY A KATO	非靜力海氣耦合波浪模式針對 2012 年和 2013 年颱風的數值模擬 Numerical study of typhoons in 2012 and 2013 using a coupled atmosphere-wave-ocean non-hydrostatic model
38	12:15	Yunfei Zhang	西北太平洋颱風海氣波浪耦合模式模式的模擬 Numerical Simulation of Typhoons in the Northwestern Pacific using a Coupled Ocean – Atmosphere – Wave Modeling System
	12:30	LUNCH BREAK in Guest House	
	13:30-15:00 ES2 Site Visit		
	15:00-18:00 Hands-On Lecture 2		

附件三、會議摘要資料

SOUSEI

INTERNATIONNAL WORKSHOP ON RISK INFOMATION ON CLIMATE CHANGE

25-27 November 2014

Yokohama Japan

東京大学 大気海洋研究所
Atmosphere and Ocean Research Institute, The University of Tokyo

JAMSTEC 独立行政法人 海洋研究開発機構
JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY

筑波大学
University of Tsukuba

DPRI 京都大学 防災研究所
Disaster Prevention Research Institute, Kyoto University

Contents

[page left intentionally blank]

Outline of the Workshop

Workshop Objectives:

Sciences for projecting future climate are entering a new era triggered by the Intergovernmental Panel on Climate Change (IPCC) fifth Assessment Report (AR5). Scientists are now realizing the necessity of being more collaborative than ever across different disciplines in order to disseminate information including societal impacts of climate change estimated based on simulation data.

Developing and improving general circulation models (GCMs) and Earth system models (ESMs), which are primary tools for climate change projection, is undoubtedly important and have to be continuous. Developing basic technologies for obtaining risk information on climate change by using statistical and dynamical methods is essential to devise countermeasures for future disasters. In order to provide scientists from worldwide with an opportunity to exchange ideas for confronting and overcoming the above turning point, "International Workshop on Risk Information on Climate Change" is to be held in Yokohama, Japan, on 25-27 November, 2014.

The purpose of the workshop is to discuss key factors for advancing modeling activity, achieving credible climate projection, attributing climate change signals, and translating simulation results into information useful for society. Particular emphases will be put on emerging issues in the field of global change projection, such as climate model improvement, biogeochemical modeling, data assimilation, event attribution, climate sensitivity, high-resolution time-slice simulation, and multi-disciplinary applications of simulation data for impact assessment on natural disasters, water resources, and ecosystem and its diversity.

The workshop is co-organized by the Atmosphere and Ocean Research Institute (AORI) of the University of Tokyo, Japan Agency for Marine-earth Science and Technology (JAMSTEC), University of Tsukuba, and the Disaster Prevention Research Institute (DPRI) of Kyoto University. The organizers are sponsored by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) through the Program for Risk Information on Climate Change (SOUSEI Program) embarking in FY 2012.

Date: November 25-27, 2014

Venue: Miyoshi Memorial Hall, Yokohama Institute for Earth Sciences, Japan Agency for Marine-Earth Science and Technology(JAMSTEC), 3173-25, Showa-machi, Kanazawa-ku, Yokohama-city, Kanagawa, Japan

Conveners:

Masahide Kimoto (AORI, University of Tokyo)
Michio Kawamiya (JAMSTEC)
Izuru Takayabu (MRI, Japan Meteorological Agency)
Eiichi Nakakita (DPRI, Kyoto University)

Organizers:

Atmosphere Ocean Research Institute (AORI) / University of Tokyo
Japan Agency for Marine-earth Science and Technology (JAMSTEC)
Tsukuba University
Disaster Prevention Research Institute (DPRI) / Kyoto University

Language: English

International Workshop on
Risk Information on Climate Change

Program

Day 1 (November 25, Tue.)	
9:00-9:30	Registration
Welcoming remarks	
9:30-9:40	Akimasa Sumi (Special Advisor to MEXT, President, National Institute for Environmental Studies Japan.)
Session 1 (Theme A) : Prediction and diagnosis of climate change **Convener:** **Masahide Kimoto(Atomosphere and Ocean Research Institute, The University of Tokyo, Japan.)**	
9:40-10:05	**Seasonal to decadal prediction of the winter North Atlantic Oscillation: emerging capability and future prospects** Doug Smith (Met Office Hadley Centre, UK.)
10:05-10:30	**Understanding and attributing climate changes in the last decade** Masahiro Watanabe (Atomosphere and Ocean Research Institute, The University of Tokyo, Japan.)
10:30-10:55	**Anthropogenic influence on weather and climate extremes** Nikolaos Christidis (Met Office Hadley Centre, UK.)
10:55-11:10	Break
11:10-11:35	**Obsevation-model-ensemble initialization for climate prediction** Masayoshi Ishii (Meteorological Research Institute, Japan Meteorological Agency, Japan.)
11:35-12:00	**SPOOKIE:The Selected Process On/Off Klima Intercomparison Experiment** Mark Webb(Met Office Hadley Centre, UK.)
12:00-12:25	**Factors contributing to the uncertainty in cloud feedback and climate sensitivity** Tomo'o Ogura (National Institute for Environmental Studies, Japan.)
12:25-14:00	Lunch
Session 2 (Theme B) : Earth system modeling and its implications for mitigation policy **Convener:** **Michio Kawamiya (Japan Agency for Marine-Earth Science and Technology, Japan.)**	
14:00-14:25	**CO2 fertilization effect on global carbon cycle evaluated by ESMs** Tomohiro Hajima(Japan Agency for Marine-Earth Science and Technology, Japan.)
14:25-14:55	**Understanding climate process in East Asia - Climate change research in NIMR** Kyung-On Boo (Climate Reasearch Laboratory, National Institute of Meteorological Research, Korea Meteorological Administration, Republic of Korea.)
14:55-15:20	**Effect of anthropogenic aerosol forcing on temperature change of the North Pacific Ocean in the 20th Century** Manabu Abe (Japan Agency for Marine-Earth Science and Technology, Japan.)
15:20-15:35	Break
15:35-16:05	**Cumulative carbon budgets for climate mitigation targets** Damon Matthews (Geography, Plannning and Evironment, Concordia University, Canada.)
16:05-16:25	**Robustness of the proportionality of global mean temperature change to cumulative carbon emissions** Kaoru Tachiiri (Japan Agency for Marine-Earth Science and Technology, Japan.)
16:25-16:50	**Evaluating multiple emission pathways for fixed cumulative CO2 emissions from socioeconomic perspectives** Ken'ichi Matsumoto (The University of Shiga Prefecture, Japan.)
18:00-20:00	Welcome Reception

Day 2 (November 26, Wed.)	
Session 3 (Theme C) : Challenges toward regional climate change risk prediction **Convener:** **Izuru Takayabu (Meteorological Research Institute, Japan Meteorological Agency, Japan.)** **Koji Dairaku (National Research Institute for Earth Science and Disaster Prevention, Japan.)**	
9:00-9:20	**Probalistic Climate Scenarios for Risk Assessment** Koji Dairaku (National Research Institute for Earth Science and Disaster Prevention, Japan.)
9:20-9:45	**Why is reginal climate modeling critical for climate change projections?** Vasu Misra (Florida State University, US.)
9:45-10:00	**High-resolution AGCM Modeling and Application for Future Projection** Ryo Mizuta (Meteorological Research Institute, Japan Meteorological Agency, Japan.)
10:00-10:25	**CWRF Optimized Physics Ensemble Improving Regional Climate Prediction** Xin-Zhong Liang (University of Maryland, US.)
10:25-10:40	**Projection of future climate change over Japan using a high-resolution regional climate model** Akihiko Murata (Meteorological Research Institute, Japan Meteorological Agency, Japan.)
10:40-11:00	Break
11:00-11:25	**Deliver and Improve Climate Science for National Climate Assessment in the United States** Liqiang Sun (National Climatic Data Center, National Oceanic and Atomospheric Adminidtration, US.)
11:25-11:40	**Study on impactof the water resources management on projectd future** Kei Yoshimura (Atomosphere and Ocean Research Institute, The University of Tokyo, Japan.)
11:40-12:05	**Urban-scale assessment of thermal comfort stress and water resources risk in support of a climate-sensitive design for Singapore** Tian Kuay Lim (National Environment Agency, Singapore.)
12:05-12:20	**Typhoon simulations using a coupled atomosphere-wave-ocean non-hydrostatic model** Kazuhisa Tsuboki (Hydrospheric Atomospheric Research Center, Nagoya University, Japan.)
12:20-13:30	Lunch
Session 4 (Theme D-1) : Climate change impact assesment **Convener:** **Eiichi Nakakita (Disaster Prevention Research Institute, Kyoto University, Japan.)** **Tohru Nakashizuka (Graduate School of Life Science, Tohoku University, Japan.)**	
13:30-13:40	**On the Impact Assessments on Natural Disaster, Water Resource and Ecosystem** Eiichi Nakakita (Disaster Prevention Research Institute, Kyoto University, Japan)
13:40-14:05	**Emerging and future effects of global climate change on terrestrial ecosystems in Japan** Tohru Nakashizuka (Graduate School of Life Science, Tohoku University, Japan.)
14:05-14:35	**Effects of changing climate on forested watersheds: current and potential new risks to these ecosystems** Myron Mitchell (Department of Environmental and Forest Bilogy, College of Environmental Science and Forestry, State University of New York, US.)
14:35-15:05	**Monitoring coastal ecosystems to reveal the effects of climate change** Hiroya Yamano (Center for Environmental Biology and Ecosystem Studies, National Institute for Environmental Studies, japan.)
15:05-15:20	Break
15:20-15:50	**Future projection of marine ecosystems in response to two CO2-caused global phenomena: global warming and ocean acidification** Masahiko Fujii (Faculty of Environmental Earthe Science, Hokkaido University, Japan.)
15:50-16:20	**The velocity of climate change and the future global distribution of marine biodiversity** Jorge García Molinos (Department of Ecology, Scottish Association for Mariine Science, Scottish Marine Institute, UK.)
16:20-16:55	**Climate change and biodiversity: integration approach** Shunsuke Managi (Graduate School of Environmental Studies, Tohoku University, Japan.)
16:55-17:20	**Natural capital accounts and carbon damages** Pablo Muñoz (International Human Dimensions Programmme on Global Environmental Change (IHDP), Germany.)

Day 3 (November 27, Thu.)	
Session 5 (Theme D-2) : How to use risk information toward the adaptation to the global climate change **Convener:** **Eiichi Nakakita (Disaster Prevention Research Institute, Kyoto University, Japan.)**	
9:30-10:00	**Some important points in climate change impact assessment on natural disaster and water resources in Japan** Eiichi Nakakita (Disaster Prevention Research Institute, Kyoto University, Japan.)
10:00-10:30	**Climate change impacts study on natural disasters in Taiwan-using JMA/MRI high resolution AGCM data** Lee-Yaw Lin (National Science and Technology Center for Disaster Reduction, Taiwan (ROC))
10:30-10:40	Break
Discussion **Chairman:** Akimasa Sumi (Special Advisor to MEXT, President, National Institute for Environmental Studies, Japan.)	
10:40-10:50	**Interdisciplinary cooperation initiative of scenarios for climate change research and assessment in Japan** Junichi Tsutsui (Central Research Institute of Electric Power Industry, Japan.)
10:50-11:00	**Contributions of the SOUSEI Program for impact and adaptation studies in Japan** Kiyoshi Takahashi (National Institute for Environmental Studies, Japan.)
11:00-11:15	**Comments** Timothy Carter (Co-Chairs, Task Group on Data and Scenario Support for Impacts and Climate Analysis (TGICA), Finnish Environment Institute (SYKE) Research Professor, Finland)
11:15-12:15	**Discussion**
Closing remarks	
12:15-12:20	Akimasa Sumi (Special Advisor to MEXT, President, National Institute for Environmental Studies, Japan.)
Closing	

Session 1: Prediction and diagnosis of climate change

Convener: Masahide Kimoto,

Atmosphere and Ocean Research

Institute, The University of Tokyo, Japan.

Morning, November 25, 2014

Seasonal to decadal prediction of the winter North Atlantic Oscillation: emerging capability and future prospects

D. M. Smith[1], A. A. Scaife[1], R. Eade[1] and J. R. Knight[1]
[1] Met Office Hadley Centre, FitzRoy Road, Exeter, EX1 3PB, UK

European and North American winter weather is dominated by year to year variations in the North Atlantic Oscillation (NAO) which controls the direction and speed of the prevailing winds. An ability to forecast the time-averaged NAO months to years ahead would be of great societal benefit, but current operational seasonal forecasts show little skill. However, there are several elements of the climate system that potentially influence the NAO and may therefore provide predictability for the NAO. We review these potential sources of skill, present emerging evidence that the NAO may be usefully predictable (with correlations exceeding 0.6) on seasonal timescales, and discuss prospects for improving skill and extending predictions to multi-year timescales.

Understanding and attributing climate changes in the last decade

M. Watanabe[1] and team MIROC
1. Atmosphere and Ocean Research Institute, University of Tokyo

Supported by the Japanese Program for Risk Information on Climate Change (SOUSEI program), we have worked on several research issues such as the prediction and diagnosis of global climate change, developments of a global climate model called MIROC and coupled data assimilation system using it, both towards CMIP6. The former includes researches of the ENSO and near-term climate predictability, attribution and mechanisms of past climate changes, and clouds associated with the climate sensitivity. In this presentation, I first overview the above activity and then focus on our recent research outcomes.

Targets of attributing past climate changes can be classified into individual weather events and long-term aspects of the climate system. The probabilistic attribution of weather events is often called event attribution (EA), which is a new area of research. We have performed 100-member AGCM ensemble experiments with various boundary conditions in order to estimate possible anthropogenic contribution to the occurrence frequency of heatwave and heavy rain events occurred after 2010. We identified the global warming acting to increase risk of potential frequency of some events, the mechanism of which differ from one to another. For long-term climate changes, we combined the above EA experiments, AGCM sensitivity experiments, and partially assimilating coupled model experiments. Examples are the attribution of global warming hiatus and increasing frequency of cold winters over Eurasia.

Anthropogenic Influence on Weather and Climate Extreme

N. Christidis[1], P. A. Stott[1], and A. Ciavarella[1]
[1] Met Office, FitzRoy Road, Exeter, Ex1 3PB, United Kingdom

Detection and attribution studies have identified significant large-scale changes in extremes and have shown, for example, that increases in warm and cold daily temperature extremes are mainly driven by human influences on the climate. In smaller sub-continental regions enhanced internal variability makes the detection of the effect of external forcings more difficult. A new methodology has been developed that uses constraints from a global attribution analysis to construct regional temperature distributions with and without the effect of human influences. Estimates of the change in the odds of extremely warm years and seasons can then be pre-computed and are readily available whenever a new extreme is observed. Attribution of specific extreme weather and climate events is another major focus of attribution research and a lot of progress has been done in that area in recent years. The first formal event attribution study investigated the human contribution to the European heatwave of 2003 and found that it at least doubled the chances of the event. European summers have warmed by more than 0.8 ^{0}C since this analysis was published and a new study was recently carried out to estimate the current odds of having another severe summer heatwave event in Europe. A new system for attribution of extreme events has also been developed in the Hadley Centre, based on large ensembles of simulations with the HadGEM3-A atmospheric model. The system has been employed to study a number of high-impact extreme events, including the catastrophic heatwave in Moscow in July 2010, recent consecutive cold winters and the 2013 cold spring in the UK, the severe floods in eastern Australia in March 2012 and the African drought in 2011. A new European initiative aims to work towards the integration of the attribution system into an operational framework that will provide timely attribution assessments produced on a regular basis.

Observation-model-ensemble initialization for Climate Predictions

M. Ishii[1]
[1] Meteorological Research Institute/JMA
1-1, Nagamine, Tsukuba, Ibaraki, 305-0052

A new system for climate predictions with MIROC is introduced. The climate model under development is a minor revision of MIORC version 5. Some of physical schemes in the atmospheric, oceanic, and land components have been updated. With these replacements, model biases reduced and the reproducibility of El Nino and Southern Oscillation (ENSO) becomes better. The initialization scheme that makes model close to observed states have also been updated. The former scheme which relaxes ocean temperature and salinity to gridded observations was rather simple and its computational cost is very cheap. By contrast, the new one is one realization of ensemble Kalman filter (EnKF) that requires ensemble model integration for inferring errors in model fields at every analysis interval.

Using the above model and initialization scheme, we are planning to produce 150-year long climate analysis from 1850 onward. Here historical surface observations are used mainly, that is, they are sea surface temperature (SST) and surface pressure. These observations are rich in time and space, compared to vertical profile observations. In the first trial, the EnKF scheme developed successfully produces three dimensional atmospheric structures and oceanic ENSO variations near the equator. Once we would have the 150-year climate analysis, the data base could be utilized for understanding more details of the climate system and for improvement of climate prediction systems. Needless to say, this will contribute to refined risk assessments of future climate changes and to policy making.

The success of the above plan largely depends on observational data for past hundreds years. The data must be qualified and more data are needed particularly for a period before the 1950s. There do exit many data under exploration at present. By international efforts, such data have been salvaged from lapse of memory and digitized for climate studies. We are collaborating with several such international projects getting active in recent years.

Please be sure to complete the information of the corresponding author in the next page.

SPOOKIE: The Selected Process On/Off Klima Intercomparison Experiment

M.J. Webb[1], A.P. Lock[1], S. Bony[2], C.S. Bretherton[3], T. Koshiro[4], H. Kawai[4], T. Mauritsen[5], T. Ogura[6], R. Roehrig[7], S. Sherwood[8], M.Watanabe[9], J. Vial[2] and M. Zhao[10]
[1] Met Office, Exeter, United Kingdom
[2] Laboratoire de Météorologie Dynamique, IPSL, CNRS, Paris, France
[3] Department of Atmospheric Science, University of Washington, Seattle, U.S.A
[4] Meteorological Research Institute, Tsukuba, Japan
[5] Max Planck Institute for Meteorology, Hamburg, Germany
[6] National Institute for Environmental Studies, Tsukuba, Japan
[7] Centre National de Recherches Météorologiques, Toulouse, France
[8] Climate Change Research Centre and ARC Centre of Excellence for Climate System Science, University of New South Wales, Sydney, Australia
[9] Atmosphere and Ocean Research Institute, University of Tokyo, Japan

SPOOKIE is a recent initiative building on the experimental protocol of the Cloud Feedback Model Intercomparison Project (CFMIP). Its aims are to establish the relative contributions of different areas of model physics to inter-model spread in cloud feedback. The approach is to perform "mechanism denial" sensitivity experiments where specific model processes are removed or simplified.

Pilot amip/amip4K "ConvOff"experiments with parametrized convection switched off are presented. We find that models are able to run without parameterized convection at current climate model resolutions. The six models (MRI-CGCM3, MIROC5, HadGEM2-A, MPI-ESM-LR, CNRM-CM5 and IPSL-CM5A-LR) show strong convergence in the longwave cloud feedback in strongly precipitating areas of the tropics and a more moderate reduction in inter-model spread in the cloud feedback associated with shallow clouds in the most stable subtropical regimes. Inter-model spread in the intermediate trade cumulus regime increases however, and the range of global cloud feedbacks across the models increases slightly. This, along with the fact that the global cloud feedbacks with and without parametrized convection are strongly correlated suggests that process other than parametrized convection are responsible for the inter-model spread in global cloud feedback in the models examined.

In their control simulations the Convoff experiments generally have more low level cloud and larger ice and liquid water paths. Models with less low level cloud in heavily precipitating regions of the tropics have stronger tropical cloud feedbacks. This relationship is present in standard and ConvOff experiments. Other processes which may potentially contribute to inter-model spread in cloud feedback will be discussed, along with future plans to develop the SPOOKIE approach.

Factors contributing to the uncertainty in cloud feedback and climate sensitivity

T. Ogura[1], Y. Kamae[1], H. Shiogama[1], M. Watanabe[2], T. Yokohata[1], H. Tatebe[3], M. Satoh[2,3], C. Kodama[3], Y. Yamada[3], A.T. Noda[3], Y.-W.Chen[3], Y. Tsushima[4] and M. Kimoto[2]
[1] National Institute for Environmental Studies, Tsukuba, Japan
[2] Atmosphere and Ocean Research Institute, University of Tokyo, Japan
[3] Japan Agency for Marine-Earth Science and Technology, Japan
[4] Met Office, Exeter, United Kingdom

To better understand the uncertainty in the estimated climate sensitivity, we conducted a Multi-Parameter Multi-Physics Ensemble (MPMPE) experiment with a climate model, MIROC. MPMPE is an ensemble constructed by changing both uncertain parameter values and structure in a climate model. We used 8 variants of MIROC5 with low resolution (T42L40), in which parameterizations of cloud, convection, and turbulence are swapped for those in MIROC3. For each variant, we perturbed uncertain parameter values to create 136 ensemble members in total. Six year AMIP-type experiments were conducted for each member with perturbed SST, sea ice, and CO2 concentration to estimate radiative forcing, climate feedback, and climate sensitivity. The estimated climate sensitivity ranged from 2.2 to 10.4K, which was related to shortwave cloud feedback. The cloud feedback resulted from changes in middle-top as well as low-top clouds, whose strength could not be explained by a single observable metric in the present climate. In subsets of the ensemble members, however, we found statistical relationship between the cloud feedback and such variables as cloud albedo, cloud cover, and lower tropospheric mixing intensity. Such metrics suggest that high climate sensitivity as much as 10.4K is not supported by observations. To further discuss the relation between lower tropospheric mixing and cloud feedback, we implemented a parameterization for shallow convection in MIROC5 and estimated its impact on the cloud feedback with AMIP-type experiments. We found that the implementation made the cloud feedback less negative by suppressing the increase in middle-top clouds in the global warming simulation. At the workshop, we will discuss the potential roles which middle-top clouds may play in the cloud feedback, and also lessons we learn from output of the cloud system resolving model, NICAM.

[page left intentionally blank]

Session 2: Earth system modeling and its implications for mitigation policy

Convener: Michio Kawamiya,
Japan Agency for Marine-Earth Science and Technology, Japan.

Afternoon, November 25, 2014

CO_2 fertilization effect on global carbon cycle evaluated by ESMs

Tomohiro Hajima[1]
[1] Japan Agency for Marine-Earth Science and Technology, 3173-25, Showa-machi, Kanazawa-ku, Yokohama, Kanagawa, 236-0001, Japan

CO_2 increase in the atmosphere stimulates plant growth, and hence promote carbon uptake by land ecosystems (so called "CO_2 fertilization effect"). This process can reduce the future global warming, by forming a negative feedback loop between atmospheric CO_2 concentration and terrestrial carbon amount (CO_2 – land carbon feedback), but the strength is still uncertain. In this research, the impacts of the CO_2 fertilization effect on global land carbon feedback is evaluated, and the mechanisms how the feedback magnitude is determined in earth system models (ESMs) is analyzed.
By examining the simulation results from an ESM, the CO_2 fertilization is found to increase global LAI during 1850-2005 and the effect was found to be nearly ubiquitous, but the LAI increase is offset by human perturbations of the carbon cycle through land-use change and climate-change. We also confirmed that multiple ESMs driven by a common scenario show a large spread of the feedback strength among models, and found that the sensitivity of plant productivity to elevated CO_2 is the dominant factor to determine the strength of the CO_2–carbon feedback, although increasing CO_2 stimulates other carbon cycle processes. Simulations with a single ESM driven by different CO_2 pathways demonstrated that carbon accumulation increases in scenarios with slower CO_2 increase rates. We confirmed by numerical and analytical methods that the difference among CO_2 scenarios is a time-lag of terrestrial carbon pools in response to atmospheric CO_2 increase. These results demonstrate that the importance of adequate incorporation of CO_2 fertilization effect (CO_2 – land carbon feedback) into ESMs.

Climate Research in NIMR/KMA for the Understanding Climate Process in East Asia

Kyung On Boo, Sungbo Shim, MH Cho, C Lee and TK Heo
National Institute of Meteorological Research/ Korea Meteorological Administration

For the historical period, human activities give significant impacts on climate system by the radiate forcing changes due to greenhouse gases and aerosols. As fundamental atmospheric constituents, GHGs and aerosols induce significant influences on the radiative balance and hydrological cycle of climate system. While most aerosols originate from natural sources, increase from emissions arising from anthropogenic sources during the historical period, are thought to have played an important role in 20^{th} century climate change.

East Asia is densely populated region over 60 percentile of the world's population and economically rapid developed regions. GHGs emission increases and the climate change appear significantly. The rapid economic development during the last several decades has caused a dramatic increase in aerosol emissions as well. Unlike the long-live greenhouse gases, which are distributed uniformly over the globe, aerosols show different lifetime and regionally different distribution of concentration. Therefore aerosol impacts are important issue in regional climate over East Asia. In this presentation, the research status in NIMR to address the issue will be introduced.

The NIMR/KMA was jointly participating in the CMIP5 long term experiments with the Met Office Hadley Centre using the HadGEM2-AO climate model. In this study, we analyze the historical run and single forcing experiments using HadGEM2-AO.

In order to understand aerosol direct and 1^{st} indirect effects, we investigate influences in multi-decadal SST variability simulation over the North Pacific during the 20^{th} century. A comparison between historical simulations with and without anthropogenic aerosols changes shows a number of important temporal and spatial characteristics of the observed multi-decadal SST variability from the 1920s to 1990s, which is not found in experiments without aerosol changes. This paper explores both direct and indirect aerosol influences, and finds that in this model the aerosol-cloud interactions dominate the total aerosol forcing of the surface energy budget.

Every spring, the East Asia region is frequently affected by Asian Dust. Therefore, NIMR has an interest in mineral dust emissions and the direct radiative impacts in present-day run and future projection. Dust emissions are related with land surface area change of bare soil. In the study, we compare the land cover difference impact between HG2-ES and HG2-AO and found that more dust loading due to excessive bare soil fraction induces an amplified dry bias over Asia. In future projection, as vegetation area expands, replacing bare soil area, dust loading is expected to reduce. The subsequent changes in atmospheric circulation gives effects on future projected precipitation amount over the South China Sea.

Besides, we analyze climate response to aerosol-cloud interaction on East Asian Summer Monsoon and future projection of dust emissions using CMIP5 ensemble mean. The results also will be shortly included in this presentation.

Acknowledgements *This study is supported by NIMR-2012-B-2 and performed with the collaboration with B. Booth and G. Martin in MOHC.*

Effect of anthropogenic aerosol forcing on temperature change of the North Pacific Ocean in the 20th Century

Manabu Abe[1], Shingo Watanabe[1], Michio Kawamiya[1] and Toru Nozawa[2]
[1]Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokohama, Kanagawa, 236-0001, Japan
[2]Okayama University, Okayama-shi, Okayama, 7000-8530, Japan

Aerosol in the atmosphere affects climate through change in solar radiation into land and ocean surface. Previous studies have reported increase in aerosol in late 20th century weaken the solar radiation into the surface; that is famous as the global dimming (Wild 2011). However, most of the results are restricted to the land observations, because of less data observed in the ocean region. The effect on the ocean temperature change has not been clear.
We investigate an effect of the increase of anthropogenic aerosol on sea surface temperature (SST) change in the North Pacific Ocean (NPO) with the 20th Century historical simulations by MIROC-ESM (Watanabe et al. 2011). We firstly compare the historical simulation with full external forcing (Full) to that without realistic increase in aerosol forcing (piAero). Negative SST trends from 1950 to 1980 are found over the NPO in the Full experiment, consistent with that in the observations. However the positive SST trends in the NPO are seen in the piAero experiment. Thus the negative SST trend is likely to be attributable to increase of aerosol. In the NPO, the aerosol increase makes solar radiation into sea surface decrease mainly through the indirect effect of aerosol, and then SST decreases. In addition, historical simulation with only natural forcings such as volcanic eruption and solar variability denies an effect of the volcanic eruption on the negative SST trend. A result from CMIP5 multi-model data supports that the aerosol indirect effect is important for the negative SST trend in the NPO.

Reference

Watanabe, S., and Coauthors, 2011: MIROC-ESM 2010: model description and basic results of CMIP5-20c3m experiments. Geosci. Model Dev., 4, 845-872.
Wild, M., 2011: Enlightening Global Dimming and Brightening. Bulletin of the American Meteorological Society, 93, 27-37.

Cumulative carbon budgets for climate mitigation targets

H. Damon Matthews[1]
[1] Concordia University, Montreal, Quebec, Canada

The idea of measuring climate change as a function of cumulative CO_2 emissions has emerged in the past five years as a simple and effective tool to understand and quantify how global temperatures respond to human emissions. In particular, the finding that climate warming responds linearly to cumulative carbon emissions is a powerful way to frame the climate problem, and opens avenues for both changing how we approach climate mitigation, as well as better predicting the climate impacts associated with a given emission pathway. In the IPCC Fifth Assessment Report, the ratio of warming to cumulative CO2 emissions was termed the "Transient Climate Response to cumulative carbon Emissions" (TCRE)'', and was assessed to be approximately 1.5 (range 0.8 to 2.5) °C per 1000 PgC emitted. This TCRE relationship also formed the basis of the idea of cumulative "global carbon budgets" to represent the allowable emissions for a given climate mitigation target.

In this presentation, I will review the theoretical basis of the TCRE and discuss the range of emissions scenarios over which the TCRE can reasonably represent the climate response to cumulative CO_2 emissions over time. I will then show how the TCRE framework can be used to estimate the cumulative carbon budgets for a range of global temperature targets, focusing in particular on the best estimates and uncertainty range for 2 °C of climate warming. Finally, I will discuss some strategies for how the cumulative carbon budget for 2 °C could be allocated to individual nations in a manner that both respects the need for a finite cap on future cumulative emissions, and also addresses some of the fundamental global inequities associated with national contributions to climate change.

Robustness of the proportionality of global mean temperature change to cumulative carbon emissions

K.Tachiiri[1]
[1] Japan Agency for Marine-Earth Science and Technology
3173-25 Showa-machi, Kanazawa-ku, Yokohama, 236-0001, Japan

The constancy of the transient climate response to cumulative carbon emissions (TCRE) greatly facilitates the development of future emission scenarios. However, the TCRE has unfortunately been defined only while temperatures are increasing. We used the earth system model MIROC-ESM to examine the proportionality between global mean temperature changes and cumulative carbon emissions for decreasing, stable, and increasing CO2 scenarios. Results showed that the proportionality was maintained for the stable concentration scenario (with temperature gradually increasing), but for overshooting scenarios, the proportionality constant increased by 20–50%. In those scenarios, ocean heat content became large once atmospheric CO2 concentration (pCO2) had become high and changed very little after pCO2 decreased, post-warming air-to-sea heat fluxes were suppressed, and atmospheric temperatures became higher than expected based on the TCRE and cumulative carbon emissions. This result suggests that accumulation of ocean heat uptake might cause post-warming mitigation policies to be less effective than expected.

Please be sure to complete the information of the corresponding author in the next page.

Evaluating multiple emission pathways for fixed cumulative CO2 emissions from socioeconomic perspectives

K. Matsumoto[1]
[1] School of Environmental Science, The University of Shiga Prefecture
(2500 Hassaka, Hikone, Shiga, 5228533, Japan)

Cumulative CO_2 emissions are good indicators for the climate stabilization level. Some studies use this indicator, instead of using CO_2 concentration targets in 2100, to analyze the relationship between emission reduction in the short term and technological/economic feasibility of achieving a climate target in the long term. Those studies, however, did not focus on socioeconomic impact of taking different emission pathways for fixed cumulative CO_2 emissions, although understanding such impact is important since capacity of reducing CO_2 emissions might be different by year. This study analyzes socioeconomic feasibility and impact to achieve various emission pathways under a constraint that the cumulative CO_2 emissions are unchanged, using a CGE model. We develop and examine five emission pathways that start declining from the reference level in 2040 and finally attain zero emissions in 2100 (quick-slow-quick reduction, slow-quick-slow reduction, and three emission pathways in between). The cumulative emissions from 2040 to 2100 are 434 GtC (447 GtC in RCP4.5 and 60 GtC in RCP2.6 in the same periods).

Calculated carbon prices indicate that the smaller the emissions, the higher the carbon prices in each period. In 2100 when emission levels are same among the pathways, however, the price of the quick-slow-quick pathway is slightly higher than the others. It might be due to its larger emission reduction from 2090 to 2100 than the others. The differences in the calculated global GDP among the pathways are small. In 2100, the global GDP for the five pathways is between US$206.5 trillion and US$208.3 trillion. In addition, the difference in the cumulative GDP among the pathways is less than 1% (discount rate = 3%). The differences in the global primary energy demand among the pathways are more noticeable than those in the GDP. The largest difference in the cumulative primary energy demand among the pathways is about 4%. However, such larger differences in energy demands do not seem to affect the GDP significantly.

Session 3: Challenges toward

Regional Climate Change Risk Prediction

Conveners:

Izuru Takayabu,

Meteorological Research Institute,

Japan Meteorological Agency, Japan.

and

Koji Dairaku,

National Research Institute for Earth

Science and Disaster Prevention, Japan.

Morning, November 26, 2014

Probabilistic Climate Scenario Information for Risk Assessment in Japan

K. Dairaku[1], G. Ueno[2], and I. Takayabu[3]
[1] National Research Institute for Earth Science and Disaster Prevention
3-1 Tennodai Tsukuba Ibaraki 305-0006 Japan
[2] Institute of Statistical Mathematics
10-3 Midori-cho, Tachikawa, Tokyo 190-8562, Japan
[3] Meteorological Research Institute
1-1 Nagamine, Tsukuba, Ibaraki 305-0052, Japan

Climate information and services for Impacts, Adaptation and Vulnerability (IAV) Assessments are of great concern. In order to develop probabilistic regional climate information that represents the uncertainty in climate scenario experiments in Japan, we compared the physics ensemble experiments using the 60km global atmospheric model of the Meteorological Research Institute (MRI-AGCM) with multi-model ensemble experiments with global atmospheric-ocean coupled models (CMIP3) of SRES A1b scenario experiments. The MRI-AGCM shows relatively good skills particularly in tropics for temperature and geopotential height. Variability in surface air temperature of physical ensemble experiments with MRI-AGCM was within the range of one standard deviation of the CMIP3 model in the Asia region. On the other hand, the variability of precipitation was relatively well represented compared with the variation of the CMIP3 models. Models which show the similar reproducibility in the present climate shows different future climate change. We couldn't find clear relationships between present climate and future climate change in temperature and precipitation.

We develop a new method to produce probabilistic information of climate change scenarios by weighting model ensemble experiments based on a regression model (Krishnamurti et al., Science, 1999). The method can be easily applicable to other regions and other physical quantities, and also to downscale to finer-scale dependent on availability of observation dataset. The prototype of probabilistic information in Japan represents the quantified structural uncertainties of multi-model ensemble experiments of climate change scenarios.

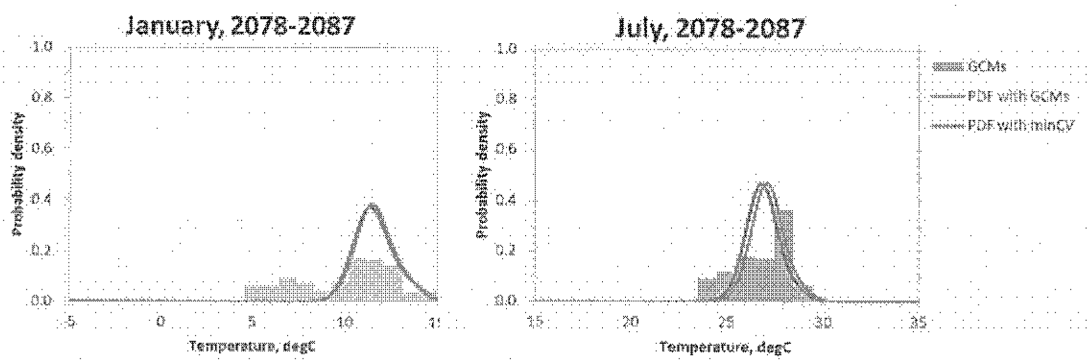


Figure. Estimated probability distribution function of 2m temperature in future climate in Tokyo

Acknowledgments
This study was supported by the SOUSEI Program, funded by Ministry of Education, Culture, Sports, Science and Technology, Government of Japan.

Why is regional climate modeling critical for climate change projections?

Vasu Misra[1]
[1] Florida State University

With constant questions being asked about the validity of dynamic downscaling from erroneous and uncertain global model simulations, there is some skepticism in pursuing very high resolution climate change projections from regional climate models. In this talk we will present examples from dynamic downscaling simulations over the southeastern US, which provides evidence of the benefits of downscaling. These examples will be shown to be highly relevant for a region like Japan.

High-resolution AGCM Modeling and Application for Future Projection

R. Mizuta[1], O. Arakawa[1,2], K. Yoshida[1], T. Ose[1], T. Nakaegawa[1]
[1] Meteorological Research Institute, Japan
[2] University of Tsukuba, Japan

Time-slice experiments using MRI-AGCM3.2 with horizontal grid sizes of 60 and 20 km have been performed to investigate detailed and localized changes as a consequence of global warming. Future (2075–99) climate experiments, in which the change in sea surface temperature (SST) derived from the Coupled Model Intercomparison Project phase 5 (CMIP5) is added to observed SST, are compared with present-day (1979–2003) climate experiments.

When quantifying uncertainty of the climate projections, existence of many factors of uncertainty should be considered; for instance, (1) uncertainty from scenario of greenhouse gas emission, (2) uncertainty from physical parameterization scheme of the model, and (3) uncertainty from different climate models. We are conducting many (~25) ensemble experiments with the 60-km model and four ensemble experiments with the 20-km model in order to cover the width of the uncertainties.

Ensemble experiments for four scenarios (RCP2.6, RCP4.5, RCP6.0, and RCP8.5) are used to consider (1). Ensemble experiments for three different cumulus convection schemes (Yoshimura: Yukimoto et al. 2011, Arakawa-Schubert: Randall and Pan 1993, and Kain-Fritsch: Kain Fritsch 1993) are used to consider (2). Different geographical patterns of SST change in the CMIP5 models are considered for (3). The patterns of SST change in the CMIP5 models have been categorized into three types by applying cluster analysis. The averages of the patterns for each cluster, in addition to the average of all models, are used for the ensemble experiments with the 60-km and 20-km models.

CWRF Optimized Physics Ensemble Improving Regional Climate Prediction

Xin-Zhong Liang[1,2]
[1]Department of Atmospheric & Oceanic Science, University of Maryland
[2]Earth System Science Interdisciplinary Center, University of Maryland

The CWRF is developed as a Climate *extension* of the Weather Research and Forecasting model (WRF) by incorporating numerous improvements in representation of physical processes and integration of external (top, surface, lateral) forcings that are crucial to climate scales, including interactions between land–atmosphere–ocean, convection–microphysics and cloud–aerosol–radiation, and system consistency throughout all process modules. As a result, the CWRF has demonstrated great capability and excellent performance in simulating the regional climate (including extreme events) over U.S. This presentation will focus on the development of CWRF representation of physical processes at regional scales and its added values over the driving general circulation model outputs for seasonal-interannual climate prediction and possible impacts of the present-day model fidelity on future climate projection. It will discuss the capability of the CWRF optimized physics ensemble to further improve climate prediction and uncertainty estimation at regional-local scales.

Projection of future climate change over Japan using a high-resolution regional climate model

A. Murata[1], H. Sasaki1, H. Kawase[1], M. Nosaka[1], M. Oh'izumi[2], T. Kato[1], T. Aoyagi[1], F. Shido[1], K. Hibino[3], S. Kanada[4], A. Suzuki-Parker[3], and T. Nagatomo[3]

[1] Meteorological Research Institute, Tsukuba, Japan
[2] Meteorological College, Kashiwa, Japan
[3] University of Tsukuba, Tsukuba, Japan
[4] Nagoya University, Nagoya, Japan

Future changes in surface air temperature and precipitation over Japan at the end of the 21st century are projected by a well-developed non-hydrostatic regional climate model (NHRCM) with a grid spacing of 5 km under the RCP8.5 scenario. Uncertainties in the projected temperature and precipitation are also evaluated using the results obtained from ensemble simulations using the high-resolution model.

First, the performance of NHRCM in the present climate for each region in Japan is evaluated based on observations and the results of previous simulations. Bias and root-mean-square errors from observations in the annual-mean temperature and the annual precipitation, comparable to those in the previous simulations, are small, indicating that temperature and precipitation in the present climate are reasonably well reproduced by NHRCM in this study.

Projected future climate shows robust increases in surface air temperature for all regions in Japan. The magnitude of the changes, however, depends on locations and tends to be larger over northern regions compared with southern regions. The noticeable increase in temperature over the northern regions is consistent with the previous studies, in which decrease in sea ice over the Sea of Okhotsk in the future climate has a strong impact on temperature increase.

In contrast, projected precipitation has no systematic relationship between future change and region. In some region, the annual precipitation in a member of ensemble simulations shows statistically significant decrease or increase. However, the annual precipitation simulated with other members does not show statistical significance. In conclusion, there is no region where the annual precipitation has robust increase or decrease.

Deliver and Improve Climate Science for National Climate Assessment in the United States

Liqiang Sun[1], Kenneth E. Kunkel[1], and Laura E. Stevens[1]
[1] Cooperative Institute for Climate and Satellites (CICS)
North Carolina State University (NCSU) and NOAA's National Climatic Data Center (NCDC)

In support of the development of the Third National Climate Assessment (NCA3) report, extensive analyses of historical trends and future projections, including dynamical and statistical downscaling data, were undertaken. The dynamical downscaling data are primarily from the North American Regional Climate Change Assessment Program (NARCCAP). Key impacts-relevant findings are summarized in a series of NOAA technical reports.

20th century trends in temperature and precipitation will be shown for each U.S. region, with a focus on extreme climate conditions, such as heat and cold waves, which have trended in opposite directions, as well as heavy precipitation events, which have tended to increase during recent years in most of the United States.

Projections of 21st century climate under various emissions scenarios will also be presented. Such simulations indicate a shift towards warmer conditions across the U.S., including both an increase in the number of hot days and nights, and a decrease in the number of cold days and nights. Projections of annual average precipitation do not provide a robust signal of either increases or decreases for most regions, however, simulations of extreme rainfall indicate future increases of 20% or more in the magnitude of the largest rainfall events under a high emissions scenario. Also, the length of dry spells is projected to increase in most areas.

Confidence of the future climate changes and actionable information will be also discussed at the workshop.

Typhoon simulations using a coupled atmosphere-wave-ocean non-hydrostatic model

Kazuhisa TSUBOKI
Hydrospheric Atmospheric Research Center (HyARC)
Nagoya University
Furo-cho, Chikusa-ku, Nagoya, 464-8601 Japan,
tsuboki@rain.hyarc.nagoya-u.ac.jp

Typhoons are one of the most intense weather systems in the western North Pacific and their landfall occasionally causes huge disasters. The purpose of our research is more accurate simulation of typhoons and estimation of the maximum possible intensity of typhoon in the future climate using a numerical model. We have developed a coupled atmosphere-wave-ocean non-hydrostatic model, CReSS (Cloud Resolving Storm Simulator)-NHOSE (Non-hydrostatic Ocean model for the Earth Simulator) with a wave model (Figure 1). The exchange of momentum between the atmosphere and the ocean is performed by the wave model. Consequently, the maximum surface wind region is not necessary to coincide with the region of maximum wave height and the wind direction is not always the same as the direction of wave propagation. We also incorporated the ocean mixing layer model which was developed by the Hibiya's group in the Kakushin Program. Using the coupled mode, daily simulation experiment is performed for the domain including the main part of the Kuroshio current in the western North Pacific. We performed nine typhoons in 2012 and 2013 to examine the effect of coupling the ocean model for typhoon simulation. The maximum difference between the coupled model and the atmospheric model was 10 hPa. The simulation results using the coupled model were compared with an ocean observation to verify the model performance. The results show that the modification of the ocean mixing layer due to the passage of a typhoon and the Kuroshio current to the northeast of Taiwan were successfully simulated. The atmospheric part of typhoon simulation was compared with drop-sonde observations. The thermodynamic structures such as temperature and moisture around the typhoon center showed a good agreement with the observations. In the simulation experiment of typhoon Choi-Wan (2009) which moved over the western North Pacific to the north. The simulation result showed that low frequency waves along the typhoon track lasted more than several days. A periodic change in water temperature in the sea was associated with the waves. Such detailed variation of water temperature with the typhoon passage was successfully simulated by the coupled model.

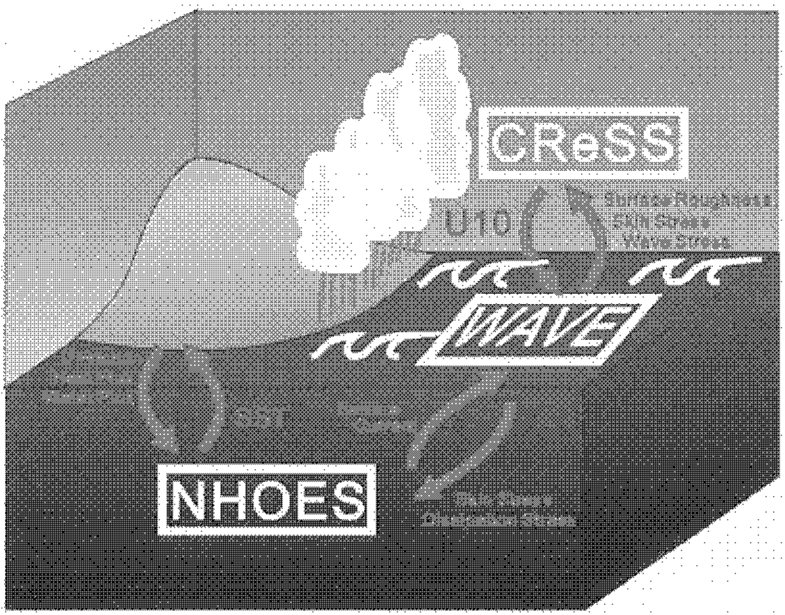


Figure 1: Schematic representation of the Coupled Atmosphere-Wave-Ocean Non-hydrostatic Model (CReSS-NHOSE).

Session 4: Climate change impact assessment

Convener: Eiichi Nakakita

Disaster Prevention Research Institute,

Kyoto University, Japan

and

Tohru Nakashizuka

Graduate School of Life Science,

Tohoku University, Japan

Afternoon, November 26, 2014

On the Impact Assessments on Natural Disaster, Water Resource and Ecosystem

E. Nakakita[1],
[1] Disaster Prevention Research Institute, Kyoto University, Uji 611-0011, Kyoto, Japan

Not long ago, there was a great deal of careful discussion on whether or not global warming is related to extreme weather phenomena such as the large typhoons and localized heavy rainfall that have been increasing recently. However, Japan experienced any number of close brushes with, and direct hits from, large typhoons and frequent occurrence of strong winds, floods, overflowing rivers, high tides, high waves, and landslides. Concern has spread that these disasters may intensify as global warming progresses.

Theme D, precise impact assessments on climate change, aims to scientifically demonstrate the connection between the aforementioned increase in natural disasters and global warming and to look 100 years into the future to see how serious it may become. The research results are to be presented as "actual figures" and are expected to be used as data for the government and municipalities to consider how to protect the lives of people in urban and rural areas, coastal areas, and river areas. A "100 year impact assessment" was proposed by this program's antecedent, KAKUSHIN, but this is the first attempt to produce an actual figure for "the maximum predicted amount of future rainfall." To generate this kind of specific figure, detailed data with a high degree of precision is required. Even with all the data that we can collect, the sample size and precision are still inadequate. So, in Theme D, we take on the challenge of developing an assessment model that can produce predictions even given the data limitations, and we endeavor to assess extreme phenomena Broadly speaking, there are three specific research sub-themes. They are "climate change impacts on natural hazards," "climate change impacts on water resources," and "climate change impacts on ecosystems and biodiversity.

The first sub-theme, climate change impacts on natural hazards, is handled by DPRI-KU, together with Global Centre of Excellence for Water Hazard and Risk Management (ICHARM/PWRI). We aim to produce predictions for scenarios including worst-case particularly in the case of typhoons, which cause the most serious weather-related damage in Japan, concerning the frequency, scale, accompanying precipitation, strong winds, high tides, and high waves, including during the Baiu season.

The second sub-theme, climate change impacts on water resources, is handled by DPRI and IIS. When the climate changes due to global warming, the rain amount and rain patterns change significantly. It is also possible that what formerly fell as snow will change into rain. In Japan which has many mountainous regions, it is anticipated that this would cause a great change in the "pattern of water flowing into rivers." So, the Kyoto University team of this group will predict and assess the changes in the flow and supply of water in the main rivers in Japan, the impact on rice farming, etc., and the need for flood control such as dams, etc. Similar prediction and assessment will be pursued for the world's major rivers, including in Asia. The University of Tokyo team will predict and assess how the actual water cycle will change on a global scale with the addition of artificial modifications. This team will also study the effectiveness of adaptation strategies.

The third sub-theme, climate change impacts on ecosystem and biodiversity, is supervised primarily by Graduate School of Life Sciences at Tohoku University, and other participants include Nagoya University, Hokkaido University and NIES. We aim to predict and assess whether ecosystems are capable of changing abruptly due to global warming, taking as models the forests of northeastern Japan and the marine life in the ocean near Japan. The Tohoku University team will conduct predictions and assessments concerning whether global warming will cause the extinction of alpine plants, the impact of strong wind on forests, the purification effects of forests, and changes in tourism resources. The Nagoya University team will conduct predictions and assessments on how climate change alters forest vegetation and then whether the altered forest vegetation affects the climate. The main research sites will be Asian rainforests and the eastern boreal Siberia. The team will study the changes in the major forests in the world, such as the tundra forest. The team composed of Hokkaido University and NIES focus on ocean acidification which occurs when more anthropogenic carbon dioxide dissolves in seawater. The team will predict and assess what sorts of changes will occur in coastal marine ecosystem such as coral reefs and seaweed forests due to global warming and ocean acidification.

Emerging and future impacts of global climate change on terrestrial ecosystems in Japan

Tohru Nakashizuka[1], Masaya Shimazaki[1], Ayaka Numata[1], Koji Yamaguchi[1], Yukari Abe[1], Miki Nomura[1], Kohei Iwai[1] and Kohei Takano[1]

[1] Graduate School of Life Sciences, Tohoku University, Sendai, 980-8578 Japan

Several impacts of climatic change on terrestrial ecosystems are predicted to be serious in the area of high latitude and altitude in Japan. Since the mean temperature in Japan has become higher by about 1 C in recent century, distributional shifts of some plants have already been conspicuous. We have been studying the impacts of climatic change on bamboo, beech (*Fagus crenata*) and subalpine (mostly *Abies* spp.) forests, alpine plants, and moorland ecosystems at mountains in northern Japan by aerial photographs together with field survey.

We studied the distribution of bamboos has shifted to north or high elevation areas in recent 30 years. Bamboo spp. used to have utilized for foods or crafts, though they are not so much recently. Therefore, their forests tend to be left without management to cause some ecological problems recently. It is predicted to expand in northern area in Honshu islands and even in Hokkaido in the future.

Beech trees also had the tendency to shift to higher elevation by tree ring analyses; the growth rates of trees in low elevation have been decreasing while those in high elevation have been increasing. Carbon budget and nutrient cycling will also be affected by such change in local conditions. We also found that the fir forests have been shifting to higher elevation by analyzing the past and present aerial photographs. Its habitat was predicted to decrease greatly if the temperature rises in 2-3 C by using habitat model. The sites close to moorland were suggested to be some refuges for this species, and the predicted habitat distribution depended on the scenarios assuming the decrease of mires or not. The tree lines in many mountains have also shifted to higher elevation in many mountains in northern Japan. Since the alpine vegetation located at relatively lower elevation than continental mountains, the impacts of climatic change on habitat loss and extinction of alpine plants are predicted to be very serious. Moorlands have been decreasing in recent 30 years by the analyses of aerial photographs. In particular those in upper slopes are decreasing remarkably, suggesting some influence of remaining snow covers in spring or summer season.

Since northern mountains in Japan are characterized as the area of heavy snow, snow cover has impacts on many ecosystems. Deep snow cover might have made the tree lines lower, and made habitats for alpine plants, kept humid conditions in moorlands, and made the dominance of beech trees high. Thus, other than rising temperature, decreasing in snowfall seems to greatly affect vegetation, though total amount of rainfall may not change greatly in this area. Getting these findings, we are now making the prediction model and going to predict the future impacts on these ecosystems applying the climatic change scenarios.

Effects of Changing Climate on Forested Watersheds: Current and Potential New Risks to these Ecosystems

by

Myron J. Mitchell

SUNY-Environmental Science and Forestry
1 Forestry Drive
Syracuse, New York 13210 USA

ABSTRACT

Climate change is currently affecting the forests of southeastern Canada and the northeastern United States in many different ways. Various models predict that climate change will accelerate during the current century and hence the effects of climate on these forests will likely be amplified. To show how climate is affecting nutrient cycling in forest ecosystems, this presentation will focus on nitrogen as an important element. The results will demonstrate how climate change may have very different effects that depend on nitrogen's biogeochemical form and behavior. Most of the nitrogen (as nitrate) export in forested watersheds of this region occurs during winter and spring snowmelt when uptake by vegetation is minimal. Thus, nitrogen is strongly influenced by winter conditions, such as the soil thermal environment and rain on snow events. The overall patterns of drainage water inorganic nitrogen concentrations and fluxes within some watersheds of the region show strong temporal synchronization, suggesting the potential importance of climate as a regulating factor. As atmospheric deposition of inorganic nitrogen decreases in concert with declining atmospheric emissions, the relative importance of climate on the cycling on nitrogen will likely increase. Predicting the effects of climate change on nutrient cycling is complicated by other factors affecting forest ecosystems, some of which are directly influenced by climate change. These factors may include more ice storms, increased role of herbivory, changes in forest tree species composition and structure, increases in tree pathogen impacts, and the introduction of exotic plant, microbial and animal species.

Monitoring Coastal Ecosystems to Reveal the Effects of Climate Change

H. Yamano[1]
[1] National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305-8506, Japan

Sea surface temperatures (SSTs) are one of the primary factors determining the distribution of marine organisms. SST warming may have causing significant change in coastal ecosystems. Monitoring and data mining could help reveal the changes.

Japan provides an ideal setting to examine the changes caused by SST warming, because it covers a wide latitudinal range, stretching from subtropical to temperate areas. For examile, latitudinal limits of coral reefs and coral distributions are observed around the Japanese islands (Yamano et al., 2012b). Seas around Japan showed significant sea surface temperature (SST) rises in winter (January–March) (1.1°C–1.6°C) (after Japan Meteorological Agency), which is critical for corals to survive at the latitudinal limits of their distribution. This means that Japan provides a unique opportunity for examining baselines of species range shifts and/or expansions due to climatic warming over a large spatial scale. In this presentation, I present our results from field evidence of species distributional change in response to SST warming.

In the Ryukyu Islands, located in the southern part of Japan, mass coral bleaching occurred in 1998. A 15-year monitoring revealed this bleaching event has caused significant decrease of coral cover, espceially for *Acropora* corals that contribute to reef building. Further, no recovery of observed in areas with sediment discharge (Hongo and Yamano, 2013). After that, other bleaching events occurred in 2001 and 2007. These events were driven by anomalously high SSTs in summer, which suggests that rising SSTs would cause higher frequency of bleaching. Aerial photographs taken before and after the 2007 bleaching event revealed 2/3 of corals were lost in the Sekisei Lagoon. On the other hand, range expansion of corals was observed in the mainland Japan and Kyushu and Shikoku. We collected records of coral species occurrence from eight temperate regions of Japan along a latitudinal gradient, where past coral occurrence records were available in the form of literature and specimens since the 1930s. After careful examination of the species distribution, we detected four species showed range expansions, with speeds of up to 14km/year (Yamano et al., 2011). Further, not only corals but also other coastal marine organisms are changing. Range shifts/expansions were observed in seaweeds and crustaceans (e.g. Yamano et al., 2012a). These results suggest that coastal ecosystems are changing.

Based on the evidence, we have set up a monitoring of SST and coral species distribution in permanent quadrats at eight regions around Japan. Species-specific tolerance of corals to SST was observed based on the monitoring. Collectively, these results contribute not only to understanding dynamics of coastal ecosystems but also to providing fundamental dataset for future projection of coral habitats.

References

Hongo, C. and Yamano, H. (2013) Species-specific responses of corals to bleaching events on anthropogenically turbid reefs on Okinawa Island, Japan, over a 15-year period (1995-2009). PLoS One, 8, e60952.

Yamano, H., Sugihara, K. and Nomura, K. (2011) Rapid poleward range expansion of tropical reef corals in response to rising sea surface temperatures. Geophys. Res. Lett., 38, L04601.

Yamano, H., Sugihara, K., Goto, K., Kazama, T., Yokoyama, K., and Okuno, J. (2012a) Ranges of obligate coral-dwelling crabs extend northward as their hosts move north. Coral Reefs, 31, 663.

Yamano, H., Sugihara, K., Watanabe, T., Shimamura, M. and Hyeong, K. (2012b) Coral reefs at 34°N, Japan: Exploring the end of environmental gradients. Geology, 40, 835-838.

Future projection of marine ecosystems in response to two CO_2-caused global phenomena: global warming and ocean acidification

Masahiko Fujii[1]
[1] Faculty of Environmental Earth Science, Hokkaido University

Observational data and future projection results show that the oceans have already experienced tremendous influences of global warming, especially due to rise in the temperature and that the influences are considered to be even accelerated in next decades. Many previous studies predict northward migration of aquatic habitats in the northern hemisphere and enhanced fish catches in higher latitudes caused by global warming. However, recent studies have suggested that the influences would be much more complicated if ones take other multiple phenomena such as ocean acidification into account. Ocean acidification is a phenomenon that the alkalinity of surface oceans is weakened by injection of the atmospheric CO_2 that is acidulous in the water. Ocean acidification has recently been concerned because the phenomenon presumably affects sea creatures, especially calcifies of which bodies are partly made of calcium carbonate such as shellfish and pteropods can be dissolved. Even non-calcifiers such as fishes are anticipated to be affected by ocean acidification through changes in food webs. Although there are several sorts of procedures proposed to mitigate global warming, such as geoengineering, reducing anthropogenic CO_2 emission is considered to be the only way to mitigate ocean acidification and its effects on marine ecosystems. In this presentation, recent future projection results of combined effects of global warming and ocean acidification on marine ecosystem will be introduced.

The velocity of climate change: projecting shifts in species distributions under future climate change

J. García Molinos[1, 2], and M.T. Burrows[1]
[1] Scottish Association for Marine Science, Oban, Argyll PA37 1QA, UK
[2] National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305-8506, Japan

Climate change is expected to become the greatest driver of change in global biodiversity over the next decades and is unequivocally related to contemporary changes in marine species distributions, abundance, phenology, demography and physiology. In particular, distribution shifts are one of the most frequently reported responses to ocean warming, which is likely to become increasingly important given the expected intensification of current rates of climate change. However, forecasting climate-driven distribution shifts is challenging because they depart frequently from expected patterns of simple poleward movement and the mechanistic understanding required is often lacking. Nevertheless, recent evidence suggests that the velocity of climate change (VoCC), representing the speed and direction of isotherm shifts, is a good predictor of observed distribution shifts and differences in rates of movement at leading and trailing edges across different taxa. Further, the velocity of climate change can be used to derive spatial trajectories for climatic niches, which can then be used to infer related changes in species distributions. This approach emphasizes connectivity and accounts for the effect of geographic features (e.g., the relative orientation and configuration of coastlines) on the movement of species tracking their climate niches. We have applied the velocity trajectory approach to project global patterns of marine biodiversity (12,796 taxa, 23 phyla) under the IPCC Representative Concentration Pathways (RCPs) 4.5 and 8.5. Globally, range expansions prevail over contractions under both scenarios up to 2100, suggesting a redistribution rather than loss of current biodiversity. High coupled species invasions and extirpations are nevertheless expected regionally (e.g., Central Indo Pacific) under the RCP8.5, leading to strong decreases in richness and the anticipated formation of novel communities via species replacement. The velocity trajectory approach offers a simple yet useful and intuitive tool to model expected global changes in biodiversity in response to ocean warming.

Climate change and biodiversity: integration approach

Shunsuke Managi [1]
[1] Graduate School of Environmental Studies
Tohoku University
6-6-20 Aramaki-Aza Aoba, Aoba-Ku
Sendai 980-8579, Japan

Climate change is identified in policy community by successful example of caution encouraged with large scale model. The model is diverse but possible to model globally including future zero emission. Evidence based policy, on the other hand, is more applied in biodiversity studies. This study discuss how biodiversity can include the caution with some evidence based policy. Road ahead might need to analyze ad hoc large scale but simple model with detailed evidence based policy direction.

Measuring nations' social progress: the Inclusive Wealth Report

Pablo Munoz[1] and Shunsuke Managi[2]
[1]International Human Dimensions Programme – United Nations University
[2]Tohoku University

There is a need of using broader measures of economic performance and human well-being. Current indicators such as Gross Domestic Product (GDP) largely ignore biophysical changes to environmental systems caused by economic activities, yet those changes often affect long-term production and social welfare.

In this context, the Inclusive Wealth Report (IWR) project proposes wealth accounting as a complementary indicator of social progress, since this concept factors in the changes on the environment and provides information on the long-run economic development. In wealth accounting, the temporal preservation of a nation's capital base is the source of inter-temporal opportunities for fulfilling the needs of present and future generations. The wealth indicator in the IWR tracks particularly the changes in the value of three capital asset categories: human, produced and natural capital.

This presentation elaborates on the construction of the Inclusive Wealth measure in the IWR project, and presents empirical evidence for several nations over the last two decades.

[page left intentionally blank]

Session 5: How to use risk information toward the adaptation to the Global Climate Change

Convener: Eiichi Nakakita,

Disaster prevention Research Institute

Kyoto University, Japan

Morning, November 27, 2014

Some important points in climate change impact assessment on natural disaster and water resources in Japan

E. Nakakita[1],
[1] Disaster Prevention Research Institute, Kyoto University, Uji 611-0011, Kyoto, Japan

We have been harvesting mutual understanding and respect among Japanese civil engineers, meteorologists and climatologists under the Kakushin Program, by hot discussions. (2007-2011). Sousei Program (post Kakushin) is the stage to take impact assessment as an issue of the first priority under the mutual understanding among Japanese researchers.

The AGCM and RCM with super-high spatio-temporal resolutions (20 km-1 hour) made it possible to evaluate extreme hazard (ex. Max. discharge) in Japan. We can get approximate projection on changes of return values of extreme events. However, there is a risk that the return period does not have enough accuracy because there is no guarantee that quite extreme events could be properly projected within the limited number of ensembles. (Single time series output from the AGCM20 and RCM) In this sense, it may be difficult to project correct design hazard for water management and flood control so on.

On the other hand, the risk management should deal with phenomena beyond design hazards. In this sense, it is very important to take into account the result from a worst case scenario as one of the forcing hazard for disaster risk management under climate change. Taking into consideration above items, I think, it is very important for climate change adaptation to discriminate more between planning with an uncertain design level and risk management with a worst case scenario.

Based on these ways of thinking, climate change impact assessment on natural hazard and water recourses, keeps several sub teams as followed; (numbers on right hand side indicate participating researchers' number)

i Climate change impacts on natural hazards	
i-a Metrological risk (rof. Takemi, Kyoto University)	12
i-b River risk (Prof. Tachikawa, Kyoto University)	25
i-c Coastal risk (Prof. Mori, Kyoto University)	18
i-d Risk management (Prof. Tatano, Kyoto University)	6
i-e River risk in global scale (Suzuki, PWRI)	15
ii Climate change impacts on water resources	
ii-a Social-economic risk (Prof. Tanaka, Kyoto University)	18
ii-b Anthropogenic effects (Oki, U Tokyo)	

Also we are keeping Important issues are as followed in mind.

- Generating PDF of extreme values with higher accuracy
  - Generating of PDF using a lot of 60km ensemble
  - Converting extreme values in 60km-scale into values in regional-scale using RCM5 and RCM2 dynamically downscaled from GSM20.
- Worst case senario
  - Worst case typhoon
  - Multi-hazard
  - Social Senario
- Proposing adaptation philosophy consistent with mitigation philosophy
  - Developing decision making methodology under high uncertainty of risk
  - Developing decision making methodology under no information on probability of a worst case

We are taking these issues as our backbone.

Therefore, keeping fundamental collaborations with Theme C and other Themes is very crucial for theme D. Also discussions with policy makers and providing them our new findings are very important for supporting them in building up adaptation strategies.

Climate change impacts study on natural disasters in Taiwan-using JMA/MRI high resolution AGCM data

Lee-Yaw Lin[1], Yung-Ming Chen[2], Chao-Tzuen Cheng[2], Yun-Ju Chen[2], Jung-Lien Chu[3], Jun-Jih Liou[3] and, Yuan-Fong Su[3]

[1] Deputy director, National Science and Technology Center for Disaster Reduction, 9F., No.200, Sec. 3, Beisin Rd., Sindian District, New Taipei City 23143, Taiwan (R.O.C.).

[2] Associate Researcher, National Science and Technology Center for Disaster Reduction, 9F., No.200, Sec. 3, Beisin Rd., Sindian District, New Taipei City 23143, Taiwan (R.O.C.).

[3] Assistant Associate Researcher, National Science and Technology Center for Disaster Reduction, 9F., No.200, Sec. 3, Beisin Rd., Sindian District, New Taipei City 23143, Taiwan (R.O.C.).

In recent years, extreme weather/climate events caused large-scale disaster in Taiwan. For example, typhoon Morakot (2009) and Fanapi (2010), torrential rainfall (over 100mm/hr and lasting several hours) makes severe flood and landslide events. According to Scientific Report of Climate Change in Taiwan (Ministry of Science and Technology, MOST, 2011), the numbers of typhoons with extreme rainfall have increased during the time span of 2000-2009 compared with the last three decades. Moreover, many studies also show that the frequency and intensity of extreme weather/climate events is projected to increase under climate change.

Taiwan and Japan have similar geographical environments and climate systems and are facing the similar issues which typhoons and mei-yu caused floods and landslides, especially on disaster prevention or adaptation topics. Through the collaboration with SOUSEI program in Japan these years, Taiwan Climate Change and Information Platform project (TCCIP, National project supported by MOST, Taiwan) uses MRI - AGCM3.2S super-high resolution climate projection data to assess climate change impacts on disasters over Taiwan area. Currently, Top ten torrential rainfall typhoon events are selected to simulate impacts of water-related disasters in basins. Dynamical downscaling and bias correction techniques are used to generate 5 km resolution typhoon precipitation data.

The results show that climate change will trigger much larger landslide areas by increasing extreme rainfall events, leading to serious sedimentation in rivers, and causes 3 more meters deep flooding in downstream urban cities. The damage of disasters is much serious compared to Typhoon Morakot. Storm surges of all typhoon events provided by MRI-AGCM3.2S were also simulated to evaluate the largest storm surge of different areas, which were coupled with inundation model to assess the largest flooding impacts. Furthermore, the result of storm surge simulation and the projection of dynamical downscaling data were used to calculate hazard indices for coastal, flooding, landslide and drought disaster risk maps of present-day and future. Based on the disaster risk maps, it is found that the impacts of climate changes on disasters related to extreme precipitation events are significant but the impacts of climate changes on drought and water resources issues are insignificant.

International Workshop on RISK INFORMATION ON CLIMATE CHANGE

Convener / Speaker

Name	Country	Session
Akimasa Sumi	Japan	Opening & Disscussion
Masahide Kimoto	Japan	1
Doug Smith	UK	1
Masahiro Watanabe	Japan	1
Nikolaos Christidis	UK	1
Masayoshi Ishii	Japan	1
Mark Webb	UK	1
Tomo'o Ogura	Japan	1
Michio Kawamiya	Japan	2
Tomohiro Hajima	Japan	2
Kyung-On Boo	Korea	2
Manabu Abe	Japan	2
Damon Matthews	Canada	2
Kaoru Tachiiri	Japan	2
Ken'ichi Matsumoto	Japan	2
Izuru Takayabu	Japan	3
Koji Dairaku	Japan	3
Vasu Misra	US	3
Ryo Mizuta	Japan	3
Xin-Zhong Liang	US	3
Akihiro Murata	Japan	3
Liqiang Sun	US	3
Kei Yoshimura	Japan	3
Tian Kuay Lim	Singapore	3
Kazuhisa Tsuboki	Japan	3
Eiichi Nakakita	Japan	4,5
Tohru Nakashizuka	Japan	4
Myron Mitchell	US	4
Hiroya Yamano	Japan	4
Masahiko Fujii	Japan	4
Jorge García Molinos	UK	4
Shunsuke Managi	Japan	4
Pablo Muñoz	Germany	4
Lee-Yaw Lin	Taiwan (ROC)	5
Junichi Tsutsui	Japan	Disscussion
Kiyoshi Takahashi	Japan	Disscussion
Timothy Carter	Finland	Disscussion

[page left intentionally blank]

Participants (As at November 14, 2014)

Name	Country
Abdoulaye SARR	Senegal
Akinori Ito	Japan
Akio Kitoh	Japan
Akira Noda	Japan
Alessandro Damiani	Japan
Asuka Suzuki-Parker	Japan
Atsushi Suzuki	Japan
Chihiro Kodama	Japan
Dai Yamazaki	Japan
Das Kumar Mohan	Bangladesh
Fen Yi Liao	Taiwan
Hideaki Shibata	Japan
Hiroaki Tatebe	Japan
Hirokazu Endo	Japan
Hiroki Kashimura	Japan
Hironori Fudeyasu	Japan
Hsuan Mei Chiu	Taiwan
Hyungjun Kim	Japan
Kai Po Jenny Law	Japan
Katsuhiro Nakao	Japan
Katsumasa Tanaka	Japan
Kenji Tanaka	Japan
Kohei Takano (Takenaka)	Japan
Kumiko Takata	Japan
Lan Yen Wang	Taiwan
Masato Mori	Japan
Michio Watanabe	Japan
Osamu Arakawa	Japan
Shan Wan Weng	Taiwan
Shintaro Takao	Japan
Shinya Kakuta	Japan
Shoji Kusunoki	Japan
Song-You Hong	Korea
Takashi Mochizuki	Japan
Takuya Yazaki	Japan
Tatsuya Seiki	Japan
Tokuta Yokohata	Japan
Toshinori Aoyagi	Japan

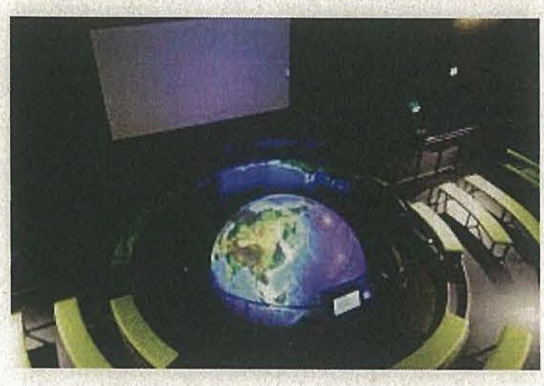
Name	Country
Yohei Yamada	Japan
Yoko Shibutani	Japan
Youichi Kamae	Japan
Yukiko Imada	Japan
Yukio Tanaka	Japan

SOUSEI Program for Risk Information on Climate Change

気候変動リスク情報創生プログラム

13th International Regional Spectral Model Workshop

Abstracts



JAMSTEC, Yokohama, Japan

November 25 - 29, 2014

Water isotope projections of the 21st century and how they relate to simulated changes in wind and precipitation patterns

Nikolaus H. Buenning[1*], Lowell Sott[1], Kei Yoshimura[2]

1. Department of Earth Sciences, University of Southern California, Los Angeles, California, USA
2. Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba, Japan

* presenter (email: buenning@usc.edu)

Increases in greenhouse gas concentrations through the 21st century are projected to increase global temperatures and change circulation and precipitation patterns globally. However, there remain many uncertainties in how the general circulation of the atmosphere will change and how it will impact regional hydroclimates. In the low and middle latitudes the isotopic composition (δ) of atmospheric moisture could potentially be useful at tracing these changes in precipitation and wind patterns. In this study sea surface temperatures and sea ice conditions from 21st century climate projections (RCP8.5 scenario) were used to force the isotope-enabled Global Spectral Model (IsoGSM). This ensemble of IsoGSM simulations provides insight as to how and where water isotopologues will change globally as a result of 21st century climate change. In general, δ values increase in the subtropics and middle latitudes and decrease in the southern tropics. Changes to horizontal winds suggest that the isotopic changes are likely due to changes in the strength of the Hadley Cell, rather than the poleward expansion of the descending branch of the cells. Regionally, the simulations project consistent increases in δ values through the 21st century over central and southern Africa, the Tibetan Plateau, and the eastern Australia. Decreasing δ values were found over the eastern tropical Pacific and the western margins of South America. A comparison with a present-day IsoGSM simulation reveals similar regional changes in δ values over the last 60 years. The similarities between recent changes and 21st century projections of δ values suggest that certain hydrological aspects of 21st century climate change are already taking place in some regions. Central Africa stands out as a region where IsoGSM simulates robust rises in precipitation and vapor δ values for both the 21st century and the late 20th century. The recent rise in δ values over central Africa is validated against δ variations from a Lake Bosumtwi sediment archive. Through vapor tagging simulations, it was found that both the present-day and 21st century isotopic trends were a result of shifts in the position of the ITCZ and subsequent changes to wind patterns. These simulated shifts, in turn, caused a drying throughout Central Africa. The present-day increase in regional δ values could be a precursor of worsening drought conditions as the Earth warms through the 21st century.

Application of RegCM over China

Xuejie Gao[1]

Climate Change Research Center, Chinese Academy of Sciences (CCRC/CAS), Beijing 100029

Abstract

We have been using the Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climate Model, RegCM series of models over China domain since the late 1990s. In general we focus more on climate change simulations and projections. In the mean time, investigation on effects of landuse and land cover change on climate, modeling of dust events, modeling of aerosols and their climate effects, and seasonal prediction experiments have also been carried out. To validate the high resolution RCM simulations, we constructed a gridded daily scale observation dataset over China. A lot was learned from the studies. For example, we found model resolution is very important in the simulation of present-day climatology, in particular the monsoon precipitation, over the region. The high resolution RegCM not only introduces a fine scale topographically-induced structure in the climate change signal, but it also project some significantly different change patterns compared to the driving GCMs, due to the stronger and more realistic topographic forcing and the resulting circulation changes. These work, as well as model deficiencies over the region, will be briefly introduced in the talk.

[1] gaoxj@cma.gov.cn; gaoxuejie@mail.iap.ac.cn

Assessment of Future Climate Changes over the East Asia due to the RCP scenarios downscaled by Regional Spectral Model

Suryun Ham* **and Kei Yoshimura**

Atmosphere and Ocean Research Insititute, The University of Tokyo, Kashiwa, Japan
E-mail: suryun01@gmail.com

Abstract

This study assesses future climate change over East Asia using the Regional Spectral Model (RSM). The RSM is forced by three-types of future climate scenarios produced by the Hadley Center Global Environmental Model version 2 (HG2); the representative concentration pathways (RCP) 2.6, 4.5 and 8.5 scenarios for the intergovernmental panel on climate change fifth assessment report (AR5). Analyses for the current (1980-2005) climate are performed to evaluate the RSM's ability to reproduce precipitation and temperature. Three different future (2020-2100) simulations are compared with the current climatology to investigate the climatic change over East Asia. The RSM satisfactorily reproduces the observed seasonal mean and variation of precipitation and temperature. The spatial distribution of the simulated large-scale features and precipitation by RSM shows generally improved pattern compared to that is given by the HG2. In addition, their inter-annual variations and probability distribution for intensity of precipitation in Japan are better captured by the RSM. Assessment of future climate changes over the East Asia will be discussed.

Climate prediction using NCEP Regional Spectral Model (RSM) for Vietnam

Author: **Linh Luu-Nhat**
Institution: Vietnam Institute of Meteorology, Hydrology and Climate change (IMHEN)
Address: 23/62 Nguyen Chi Thanh, Dong Da, Hanoi, Vietnam
Email: linhln.imhen@gmail.com and/or linhln@imh.ac.vn

Abstract:

The Viet Nam Institute of Meteorology, Hydrology and Environment (now is Viet Nam Institute of Meteorology Hydrology and Climate change) is a functional organization for science under jurisdiction of the Ministry of Natural Resources and Environment with mandates for research and development of science and technology on meteorology, hydrology, oceanography, water resources, environment and climate change (http://www.imh.ac.vn).

Since 2011, we have been studying Regional Spectral Model (RSM) following the assisstants from Dr. Henry Juang (National Center for Environmental Prediction - NCEP). Currently, the NCEP RSM model has been compilied on the IMHEN's HPC system and run two times per month for providing real-time forecasts of next consecutive 6 months using CFSv2 s the input data. The model not only run for real-time forecasts, but also for simulations using the NCEP Reanalysis - II input data.

Our study running NCEP RSM model for 1991-1995 simulations showed that, temperature was higher than observation data. In which, model showded the less skill in temperature simulation over the high mountain area. However, the skill of model in simulating temperature was quite good over others. Referring rainfall simulation, model simulated much lowerly through rainy season and slighly higher through dry season than observations.

The results showed that, model performed well spatial distribution of temperature compared with obervation. Especially, the model successfully forecasted the trend of temperature variation over climate regions of VietNam, in particular with the cold surge in the winter. The spatial and temporal rainfall forecasts were quite similar to the obervation distribution.

In the coming, to improve RSM's forecasts in Vietam, we concentrate deeply in studying physical shemes, chosing domain and resolution. Especially, one of our activities is application model to extreme climate events forecasts.

Study of South Asian Climate and Added value of High Resolution Regional Spectral Model (RSM)

*Mehwish Ramzan[1,2], Suryun Ham[1], Muhammad Amjad[3],
Eun-Chul Chang[1] & Kei Yoshimura[1,2]

1. *Atmosphere and Ocean Research Institute, The University of Tokyo, Japan*
2. *Institute of Industrial Science and Technology, The University of Tokyo, Japan*
3. *Global Climate Change Impact Study Centre, Islamabad, Pakistan*

The study of Climate change featuring South Asia was conducted using Regional Spectral Model (RSM) at 50 km resolution following the protocol of Coordinated Regional Downscaling Experiment (CORDEX) for South Asia. The time period for this analysis was divided into Evaluation phase (1980-2005) and Projection phase (2020-2100). Two Representative Concentration Pathway's scenarios (RCP) such as RCP4.5 and RCP8.5 were used for the projections phase. The evaluation and projection phase simulations of RSM were driven by HadGEM2-AO coupled GCM of National Institute of Meteorological Research, Korean Meteorological Agency (Baek et al., 2013). The intense study of evaluation phase showed the better performance of RSM over HadGEM2, highlighting the added value features of high resolution RSM in terms of capturing complex topography, meso-scale atmospheric circulation over South Asian monsoon region, inter-annual and intra-seasonal variations of precipitation outperforming GCM. Based upon the better performance of RSM for evaluation phase the projections for future will be considered important, giving robust information for future climate of the region.

Presenters Name: Mehwish Ramzan
Presenter's email: mehwish@rainbow.iis.u-tokyo.ac.jp

Assessing Critical Climate Indices over West Africa Sahel under RCP8.5 Scenario from a Nesting Approach RCM/GCMs

Author: Abdoulaye Sarr*

* ANACIM, Aeroport LSS de Dakar B.P.: 8257 Dakar-Fann, Dakar-Senegal E-mail: layesarr@voila.fr

Abstract:

Rainfed agriculture is dominant in West Africa, and is highly dependent on rainfall. To better assess the impacts of climate change on this sector, regional studies and in-depth analyses of key climate parameters and/or indicators were conducted. In this study, we used the Coordinated Regional Downscaling Experiment (CORDEX-AFRICA) to assess climate indices that affect agricultural activities over West Africa. The SMHI-RCA3.5 regional climate model is used to downscale the Global Spectral model MIROC and 3 others GCMs at a resolution of 50km horizontal resolution for a domain covering the whole Africa. We assess the model over West Africa for an historical period (1981-2005) and two future time frames, 2031-2055 for the intermediate term (IT) and 2071–2095 for the far term (FT), under the Representative Concentrations Pathway 8.5, (RCP8.5) (Riahi and Nakicenovic, 2007).

Climate Downscaling Forecasts over Northeast Brazil: An Update

Liqiang Sun[1], Marcelo Rodrigues[2], and Eduardo Martins[2]

[1]Cooperative Institute for Climate and Satellites (CICS), North Carolina State University (NCSU) and NOAA's National Climatic Data Center (NCDC)
[2]Ceara Institute for Meteorology and Hydrology (FUNCEME), Brazil

The operational dynamical downscaling forecast was first issued over northeast Brazil in 2001. The Regional Spectral Model (RSM), with horizontal resolution of 60 km, was used to downscale the ECHAM4.5 AGCM (T42) forecasts. Since then the downscaling forecast system has been continuously evolving: implementation of the regional Atmospheric Modeling System (RAMS) with 40 km resolution in 2005, the Climate Prediction Tool (a statistical downscaling tool) with resolution of 60 km in 2010, and global models of ECHAM4.6 (T42) and CESM (T62) in 2011. Forecasts have been issued monthly for four upcoming running 3-month periods. Forecast ensembles of up to 405 members are postprocessed and merged into final probability forecasts. Verification of the past 12 years of forecasts reveals that the overall rainfall forecast skill, measured by the ranked probability skill score, is positive over a majority of northeast Brazil. Skill levels are generally higher for the rainy season than the pre-rainy season, and in northern region than the southern region of northeast Brazil. Over a period of as brief as 12 years, the variability in the amplitude of ENSO extremes is likely to govern forecast skill more strongly than incremental improvements in models or forecast methodology. The skill of the downscaled forecasts is generally higher than that of the driving global model forecasts, indicating the added values of the regional models. However, the downscaling forecasts do not capture the observed shifts in the rainfall climatology.

Uncertainty attribution in the multi GCM/RCM ensemble dynamical downscaling experiments for Japan

Asuka Suzuki-Parker, Izuru Takayabu, Hiroyuki Kusaka, Koji Dairaku, Suryun Ham, Sachiho A. Adachi, and Noriko N. Ishizaki

Dynamical downscaling (DDS) is an important tool for climate change assessment at fine-scale. Yet it has inherent uncertainties arising from selections regional climate model (RCM) and their configurations, as well as the driving data and others. For better understanding of DDS outcome, it is important to quantitatively assess the uncertainty contributions from each of the source of uncertainty. In this study, we utilize a 12-member ensemble DDS downscaling experiments for Japan at 20km horizontal resolution, comprised of three GCMs (MIROC5, MRI-CGCM3, and CCSM4, under historical and RCP4.5 scenarios) and four RCMs (MRI-NHRCM, NIED-RAMS, Tsukuba-WRF, and AORI-RSM). Ensemble spread is attributed to GCM and RCM differences using analysis of variance (ANOVA). The results using seasonal mean temperature indicate that ensemble spread is primarily attributable to GCM differences. Statistically significant RCM contributions are also noted, especially for winter season. In summer season, RCM contribution is less compared to winter, but its significance appears in areas where surface physics treatment is vastly different among RCMs (e.g., usage of urban canopy model, etc). Greater RCM contribution during winter may be associated with different representation of topography in the RCMs.

Extreme precipitation intensity in future climatesbased on the multi-GCMs with multi-RAMs

Tomohito J. Yamada*, M. A. Farukh, Taiki Fukushima, M. Inatsu, Tomonori Sato, Yadu N. Pokhrel, Taikan Oki

*: Faculty of Engineering, Hokkaido University, N13-W8, Kita-ku, Sapporo, Hokkaido 060-8628, Japan (tomohito@eng.hokudai.ac.jp)

This study introduced a method named as 'hybrid-downscaling' to estimate the future extreme hourly precipitation intensity based on observational evidence of the 99th percentile precipitation intensity against air temperature, as well as the future air temperature projected by dynamical downscaling (RSM, JMA, and WRF by giving three different lateral boundary conditions such as MIROC, MPI, and NCAR GCMs).
We analyzed the 99th percentile of 1-h precipitation intensity against each air temperature range for both in Sapporo and Tokyo. The 99th percentile precipitation intensities tended to have an approximate equation in which the rate of precipitation intensity increment was similar to the Clausius-Clapeyron rate of change in the saturation water vapor. This study also showed that both 99th percentile precipitable water and the vertical instability indices followed the Clausius-Clapeyron rate of change.

An evaluation of WRF model's simulation on the Antarctic climate with satellite observations

Yao Yao, Yong Luo, Jianbin Huang, and Zongci Zhao
Center for Earth System Science, Tsinghua University

The Antarctic acts as an import part in the global climate system, but the simulation of Antarctic climate remains a huge challenge for current climate models. The complicated terrain and strong katabatic wind make it necessary to perform high-resolution simulation over the Antarctic through the regional climate model (RCM). We have performed different types of simulations based on the latest version of WRF model and its polar version (Polar WRF) which is maintained by Byrd Polar Research Center in the Ohio State University. Since the cryosphere processes such as sea-ice thickness and the snow on sea-ice have already been incorporated into the standard WRF, the two versions of WRF models might have similar capability as demonstrated from our evaluations. We have also driven the RCM through outputs of different reanalyses (FNL and ERA-Interim) and global climate models (CAM3, CAM5 and WACCM) to study the sensitivity of boundary conditions and the possible added value through the dynamical downscaling. Due to the higher resolution, WRF model shows generally better simulation than CAM and WACCM on the surface temperature. The bias mainly exists over the ice shelf region, which may be resulted from the impropriate description of surface energy transport. Our study also reveals that the bias can be reduced through the approach of spectral nudging. Finally, we employed the COSP simulator so as to compare our simulations of the cloud over the Antarctic with satellite observations (CloudSat, CALIPSO and ISCCP) directly.

Presenter: Yao Yao, yaoyao13@mails.tsinghua.edu.cn

SEVERAL SCHEME SENSITIVITY EXPERIMENTS IN EASTERN ASIA BY A REGIONAL CLIMATE MODEL

Fumiaki MORIYAMA[1], Hironori FUDEYASU[1]
Kei YOSHIMURA[2], Suryun HAM[2]
1 Yokohama National University, Yokohama, Japan
2 University of Tokyo, Kashiwa, Japan
Email: moriyama-fumiaki-dv@ynu.jp

The main aim in this study is to validate the performance of a fully coupled regional downscaling system based on the Regional Spectral Model (RSM) for atmosphere and the Regional Ocean Modeling System (ROMS) for the ocean. The system is developed for the purpose of downscaling observed analysis or to provide regional details for the Global Spectral Model (GSM). The two models share the same grid and resolution with efficient parallelization through the use of dual message passing interfaces.

In our experiments, the coupled downscaling is performed using historical Simple Ocean Data Assimilation (SODA) oceanic reanalysis and NCEP/DOE (R-2) atmospheric reanalysis in order to study the impact of coupling on the regional scale atmospheric analysis. The model domains cover the Japan Islands with 28 vertical atmospheric sigma levels for RSM and 30 vertical ocean sigma levels for ROMS. The integration times were several years from 00 UTC on 1 January 1980. For the control (CTL) run, the SAS scheme (Arakawa and Schubert 1974) was used as the parameterization of cumulus convection and SLINGO scheme (Slingo 1987) used as cloud water scheme. The convergence component has been nudging (Hong and Chang 2012).

We conducted the sensitivity experiment without spectral nudging scheme (EX1). The precipitation from EX1 is increased compare to that from CTL, especially over the Japan Sea on January, February and March. And the sea surface temperature from the EX1 is decreased compared to that from CTL. Using the results of the sensitivity experiments, we can detect the performance of a fully coupled regional downscaling system.

PERFORMANCE OF HIGH RESOLUTION OCEAN ATMOSPHERE COUPLED MODEL DOWNSCALING OVER SRI LANKA

Panduka Neluwala[1] (Presenting Author), Kei Yoshimura[2], Suryun Ham[3]

[1] Department of Civil Engineering, The University of Tokyo, Japan.
E-mail: neluwala@hydra.t.u-tokyo.ac.jp

[2,3] Atmosphere and Ocean Research Institute, The University of Tokyo, Japan.

Abstract

Ocean behavior influences the atmosphere considerably, which influence the performance of regional climate models (RCMs). Variables such as sea surface temperature (SST) and currents affect atmospheric circulation, surface heat fluxes and winds which cause considerable effect on the water cycle. But RCMs usually derives SST data from observations or global circulation models (GCMs) with a very course resolution less than 100 km. Recent studies have showed application of high resolution atmosphere-ocean coupled model downscaling can reproduce the regional atmosphere and ocean behavior successfully due to accurate representation of air-sea interaction effects. In this study a fully coupled regional atmosphere-ocean model by [Li et al., 2012] which is developed to couple downscaling of observed analysis or global model outputs is used. In this model Regional Spectral Model (RSM) would provide the atmosphere forcing to Regional Ocean Model (ROMS) and ROMS would provide the ocean forcing to RSM.

To investigate the air-sea interaction effect on the regional downscaling, this study compares the performance of coupled RSM-ROMS with the RSM over Sri Lanka. Both coupled and uncoupled models downscaled the initial and lateral boundary condition from the National Centers for Environmental Prediction-Department of Energy Atmospheric Model Inter comparison Project II Reanalysis (NCEP-DOE Reanalysis 2) and uncouple model downscale SST from NCEP optimum interpolation (OI) SST while couple model use monthly Simple Ocean Data Assimilation (SODA) for initial conditions. The model was run for a period of one year with 20 km resolution. Simulated SST, precipitation and surface net heat fluxes are compared with observed satellite products. SST is compared with Optimum Interpolation 1/4 Degree Daily Sea Surface Temperature Analysis (OISST) from AVHRR and AMSR. Net surface heat flux from Objectively Analyzed air-sea Fluxes for the global oceans (OAFlux) and precipitation are compared with Asian Precipitation - Highly-Resolved Observational Data Integration evaluation of water resources (APHRODITE), Tropical Rainfall Measuring Mission (TRMM) products and observed rain gauge station. Interestingly coupled model could give better performance than the uncoupled model in precipitation and surface flux. However there was some bias in the see surface temperature even though it nicely reproduce the spatial distribution of SST which may be due to the imperfect air-sea interaction in the model which have to be addressed in the next step.

Key words: *RSM, ROMS, SST, air-sea interaction*

Uncertainty of future changes in winter precipitation simulated by NHRCM ensemble experiments in Japan

Hiroaki Kawase*[1], Hidetaka Sasaki[1], Akihiko Murata[1], Masaya Nosaka[1], and Noriko N. Ishizaki[2]

1: Meteorological Research Institute

2: Japan Agency for Marine-Earth Science and Technology

In Japan, winter precipitation is strongly affected by the East Asia Winter Monsoon (EAWM), extra-tropical cyclones activity, and sea surface temperature (SST) in the Sea of Japan. We investigate the uncertainty of future changes in winter precipitation using the non-hydrostatic regional climate model with 20km resolution (NHRCM20) based on the AMIP-type global climate projection (AMIP-type run). The AMIP-type runs are conducted by MRI-CGCM given three SST clusters which include three different types of SST anomaly in CMIP5 experiments. In addition, three cumulus parameterizations, which is Yoshimura scheme (YS), Kain-Fritsch scheme (KF), and Arakawa-Schubert scheme (AS), are applied in each run with the SST cluster. Therefore, we have 3x3 AMIP-type runs and conduct nine dynamical downscalings from them.

The ensemble mean of nine NHRCM20 experiments in RCP 8.5 shows the decreases in winter precipitation in the Sea of Japan side and over the south of Japan Island with a 95 % significance level according to the Mann-Whitney U test. On the other hand, winter precipitation increases over the inner area of Hokkaido, which is the most northern part of Japan. The decrease in precipitation in the Sea of Japan side and the increase in Hokkaido show the robust signals since they are simulated in the most ensemble members. The former is strongly related to the weakened winter monsoon and the latter is corresponds to the increase in precipitable water vapor in the warmer condition. In contrast, the decrease in precipitation over the south of Japan Island seems to be related to the changes in the extratropical cyclone activity around Japan, while they have a large uncertainty.

Developing Deep Atmospheric Dynamics

Hann-Ming Henry Juang
Environmental Modeling Center
NOAA/NWS/NCEP, Washington, DC

We are not only in the stage to prepare cloud-resolvable for high-resolution weather/climate forecast but also in the requirement to have deep-atmospheric capabilities in order to couple with space weather model in NCEP GFS (National Centers for Environmental Prediction Global Forecast System). The primitive equation set with deep-atmospheric dynamics has been adapted, so that the equation set used has capability to cover all scales of atmospheric motion. Based on conservative principles; such as momentum conservation, energy conservation, mass conservation and entropy conservation, the deep atmospheric primitive equation set has no approximation and covers nonhydrostatic system with three dimensional momentum equations, three-dimensional Coriolis force, vertical varied gravitational force, and height varied momentum.

The deep-atmospheric equation set provides non-approximated dynamic fields for atmospheric circulation, especially for precise/correct deep atmospheric circulation to couple with space weather and prolong its predictability. This set of equation has been discretized into difference equation set to be used for numerical modeling, which can be found in Juang (2014). An alternative form of this discretized equation set to use existed GFS routines without altering too much will be presented in the meeting. This ready-to-code discretized equation has been coded into NCEP GFS including spectral transform, spectral derivative, semi-Lagrangian and semi-implicit with two-time-level scheme. It is under testing and debugging, we hope to present its preliminary results in the meeting.

Comparison of Nonhydrostatic and Hydrostatic Dynamical Cores in Two Regional Models with Spectral and Finite-Difference Methods

Jihyeon Jang[1] and Song-You Hong[1*]

[1]Korea Institute of Atmospheric Prediction Systems, Seoul, South Korea

[*]E-mail: songyouhong@gmail.com

ABSTRACT

This study demonstrates the characteristics of the nonhydrostatic spectral regional model program (RMP) of the Global/Regional Integrated Model system (GRIMs) for representing a downslope windstorm case and a heavy rainfall event over Korea, relative to the hydrostatic simulation using the same model. This kind of comparison is also executed for the Weather Research and Forecasting (WRF) finite-difference model, which has been widely used in research and operational communities. The 1-km nonhydrostatic simulations of the windstorm from both models reproduce the downwind propagation of mountain waves that are originated over the eastern flank of the Korean peninsula, with a longer eastward propagation in the WRF than in the RMP. For the heavy rainfall case near Seoul, it is found that differences in simulated precipitation are not discernible at 27-km and 9-km grids for both dynamical cores. At a 3-km grid, the RMP with nonhydrostatic core does not influence the distribution of the simulated rainfall, but improves the local maximum, which is exaggerated in the hydrostatic simulation. Improvement is also achieved in the WRF in the distribution of rainfall. The hydrostatic simulation of the WRF produces spurious rainfall over the mountainous region along the east coast of the peninsula, which is alleviated in the nonhydrostatic simulation.

Keywords: Nonhydrostatic model, Dynamical core, WRF, GRIMs, heavy rainfall

AN INTEGRATED ANALYSIS AND SIMULATION SYSTEM FOR URBAN HEAT ISLAND EFFECT AND WIND RISK ASSESSMENT IN SINGAPORE

Tian Kuay Lim [a,] *, Haiyan Miao [b], Geoffery Davidson [c], Daniel Lee [d]

[a] National Environment Agency, Singapore
[b] Institute of High Performance Computing, Agency of Science, Technology and Research, Singapore
[c] National Parks Board, Singapore
[d] Urban Redevelopment Agency, Singapore

KEY WORDS: Downscaling, Geographic Information System (GIS), computational fluid dynamic modeling, UHI, wind channel, risk assessment

ABSTRACT:

The IPCC Climate Change Assessment Reports recognised the potential impacts of climate change on cities. These impacts include an increased frequency of heat waves, rising sea levels and increase risk of storm surge, changes in the timing, frequency and severity of urban flooding associated with more intense precipitation events. With global warming, an increased frequency of heat waves and severity will certainly amplify the current problems associated with urban heat island (UHI) effects and wind channels which can enhance local wind speeds dramatically in a highly urban environment with densely aggregated, tall buildings.

With the motivation for sustainable development and to better adapt to climate change in mitigation planning for UHI and urban wind risks, the objective of this work is to develop an integrated analysis and simulation system, based on coupled atmospheric and urban model and geospatial information, to conduct a case study for UHI and urban wind channels assessment in highly urbanized Singapore. Urban weather cannot be modelled without detailed understanding of the urban landscape and cities cannot plan for climate change and sustainable development without knowledge of atmospheric hazards and potentials.

A very high resolution mesoscale spectral model (MSM), based on the National Centers for Environmental Predictions (NCEP) Regional Spectral Model, has been adapted and calibrated for Singapore to downscale hourly weather fields at 1km spatial resolution for Singapore. The downscaled weather fields are fed into a Computational Fluid Dynamics (CFD) urban model as the initial and boundary conditions for the urban domain. Leveraging on the CFD modeling, a full wind and pressure 3D gridded field can be obtained in the chosen area. Inputs of building geometry in Geographic Information System (GIS) form are required, and the two-dimensional outlines are then extruded based on the building heights to form three dimensional buildings. Information regarding temperature and wind were tuned using the MSM can then be identified at localized levels. To demonstrate the robustness of the MSM, we conducted studies on the performance of the MSM in simulating the various tropical weather conditions, ranging from monsoons to squalls, in Singapore. With the hourly weather fields at 1 km spatial resolution, the coupled MSM-CFD model is then used to study UHI and wind channels such as for urban biodiversity, particularly on tree failure, in the urbanized Garden City, Singapore.

* Corresponding author - simbalam@singnet.com.sg. This is useful to know for communication with the appropriate person in cases with more than one author.

Coupled impacts of the diurnal cycle of sea surface temperature on the Madden-Julian Oscillation

Hyodae Seo
Associate Scientist at Physical Oceanography Department,
in Woods Hole Oceanographic Institution

This study quantifies, from a systematic set of regionalocean-atmosphere coupled model simulations employing various coupling intervals, the effect of sub-daily sea surface temperature (SST) variability on the onset and intensity of Madden-Julian Oscillation(MJO) convection in the Indian Ocean. The primary effect of diurnal SST variation (dSST) is to raise time-mean SST and latent heat flux (LH) prior to deep convection. Diurnal SST variation also strengthens the diurnal moistening of the troposphere by collocating the diurnal peak in LH with those of SST. Both effects enhance the convection such that the total precipitation amount scales quasi-linearly with pre-convection dSST and time-mean SST. A column integrated moist static energy (MSE) budget analysis confirms the critical role of diurnal SST variability in the buildup of column MSE and the strength of MJO convection via time-mean stronger mean LH and diurnal moistening. Two complementary atmosphere-only simulations further elucidate the role of SST conditions in predictive skill of MJO. The atmospheric model forced with the persistent initial SST, lacking enhanced pre-convection warming and moistening, produces a weaker and delayed convection than the diurnally coupled run. The atmospheric model with prescribed daily-mean SST from the coupled run, while eliminating the delayed peak, continues to exhibit a weaker convection due to the lack of strong moistening on a diurnal basis. The fact that time-evolving SST with diurnal cycle strongly influences the onset and intensity of MJO convection is consistent with previous studies that identified an improved representation of diurnal SST as a potential source of MJO predictability.

Title: Fire Busting Weather Forecast

Shyh Chen[1]*, John Benoit[1], Jack Ritchie[2], Yunfei Zhang[3], and H. Juang[4]

[1] Pacific Southwest Research Station, US Forest Service, Riverside, California
[2] Scripps Institution of Oceanography, University of California, San Diego
[3] National Marine Environment Forecasting Center, State Oceanic Administration, China
[4] National Centers for Environmental Prediction, Camp Springs, Maryland
[*] Presenter, e-mail: schen@fs.fed.us

Abstract

Wind and weather informaion in mountainous areas are critical in wildland fire-fighting. The variables are complex because of the underlaid complex terrain. Since Weather Service does not provide such detailed forecasts, regional computer models have to be used to enhance the official coarse resolution forecasts. However this high-resolution weather information is not readily available national-wide due to its immense computational requirement, and usually can only be available over a small region when a severe fire event was long over. Thus the advantage of using high-resolution weather model for fire management was limited. We have developed an experimental system called FireBuster designed to streamline and automate many intermediate processes. We are routinely producing forecasts at 5 km (~3 mile) resolution over southern California. A field forecaster can then select any part in the domain to request a special 1 km (~0.6 mile) resolution 72-hour forecast with only a few clicks on a google-map. All computations are done on high performance computers at PSW Riverside. The resulting fire weather variables can be retrieved in a reasonable time through a web interface as each 6-hour increment is done. Near surface weather from the Meso-West observational network are also available for display, as soon as they become available, for future validation. In addition, 72-hour weather forecast time series at any given location in the domain can be retrieved simply by a click on the map. This feature provides firefighters with detailed weather forecasts, including winds, at their location and could potentially be of life or property saving value in the event of wildfires. Future enhancements will include actual fire perimeters and economic data layer so that FireBuster can truly be part of an integrated fire management tool.

Submitted to: The 13th International RSM Workshop, Yokohama, Japan.

Modeling dust emission and transport over East Asia by WRF/Chem: sensitivity to dust emission schemes

Chenglai Wu*, Zhaohui Lin
International Center for Climate and Environment Sciences, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China, 100029

Mineral dust aerosol plays an important role in the earth system and affects the climate directly and indirectly at regional to global scale. Currently, the dust processes have been incorporated into many regional and global models to represent the dust aerosol-climate interactions. However, there exists considerable uncertainty in the dust cycle simulation, along with the climate effect from dust aerosol, and this uncertainty could be closely related with the parameterizations of dust emission processes. In this study, the impact of dust emission schemes on the dust cycle simulation will be investigated using the Weather Research and Forecasting with Chemistry (WRF/Chem) model.

Firstly, five different dust emission schemes are implemented to the WRF/Chem model, and then the WRF/Chem model with different dust emission schemes has been applied to simulate the specific dust storm episodes occurred during 14-25 March 2002 over East Asia. Comparison of dust cycle simulation shows that, WRF/Chem with six different emission schemes (including the original scheme) can all reasonably reproduce the observed spatial distribution of surface dust concentration; however, the simulated total dust budget differs significantly with different emission schemes, and the uncertainties in the simulated dust budget are found to vary among regions. Generally, the dust emission scheme affects the regional dust budget directly through its impact on the total emitted dust amount; it can also have indirect influence on the inflow and outflow of dust aerosol through its impact on the geographical location of the dust emission regions. Furthermore, the size distribution of dust particles for a specific dust emission scheme has proven to be important for dust budget calculation due to the dependence of dust deposition amount on dust size distribution. Finally the factors associated with the uncertainties in dust emission simulation are examined and further improvements of dust emission parameterizations for regional models are discussed.

1986 Snow Storm Simulation Using Regional Isotope Spectrum Model (IsoRSM) and Its Comparison with Cosmos$_{iso}$ Model

Din Amad Ud[1], Kei Yoshimura[2]

[1]Masters Student at Oki Laboratory, IIS Institute of Industrial Science (IIS) in University of Tokyo

[2]Associate Professor at Atmosphere and Ocean Research Institute (AORI) and Institute of Industrial Science (IIS) in University of Tokyo

ABSTRACT

Models are quite useful for detecting the phase, geographical and biological variations in the isotopic composition, mainly by fractionation. Stable water isotopes are spaciously used as an indicator of different weather related phenomena. IsoRSM is a regional model developed by [Yoshimura et al.] in which stable water isotopes like HDO and $H_2{}^{18}O$ were integrated with the regional spectrum model. To investigate the performance of IsoRSM, a 1986 winter snow storm is analysed which occurred on the eastern side of United States followed by intense precipitation. The model temporal duration was 9 days with 20km spatial resolution, however the results were examined and compared for three days i.e. from 19-21 Jan in which heavy frontal precipitation occurred. Temperature and Precipitation distribution results are well captured on spatial scale and the modelled isotopic ratios from IsoRSM of precipitation and water vapour are then validated with the observation values (Precipitation from NOAA, Temperature and $\delta^{18}O$ values are taken from [Geldzmen and Lawrence 1990 etc.] GALE experiment. The results obtained are quite realistic even on temporal scale at Avoca Pennsylvania (AVP) and Raleigh-Durham, North Carolina (RDU). But to further asses the performance of $\delta^{18}O$ distribution both in precipitation and water vapor, results are further compared with cosmos$_{iso}$ model made by Stephan et al. (which includes complex cloud microphysics, boundary layer turbulence scheme for water vapour, grid scale and moist advection schemes) and ERA-40 reanalysis data. Comparison is mainly done by visual inspection however the results are validated with the observation values in the form of time series, correlation and also on the synoptic scale as well. IsoRSM successfully reconstructed and shows the precipitation and isotopic behaviour although there are some overestimations and a bit of a time lag especially in precipitation maybe because of more simplified cloud microphysics however for water vapour results are much better. In general results from IsoRSM are overall good and almost comparable to Cosmos$_{iso}$ which has a complex cloud microphysics, more fine resolution along with different microphysical schemes. This analysis shows the importance and usefulness of IsoRSM that, it successfully captured the isotopic behaviour of a snow storm with relatively coarse resolution and in future it can be effectively used for detection of other similar kinds of events.

KEYWORDS

Isotope Fractionation, Water isotopes, 1986 Snow Strom, IsoRSM, Cosmos$_{iso}$, GALE

Email : Amad_400@yahoo.com

Composite Characteristics of Mesoscale Convective Systems Observed by Radar, TRMM and Simulated by Model

Mohan K. Das[1]*, Someshwar Das[2], Abhijit Sarkar[3], and Md. Nazrul Islam[4]

[1]SAARC Meteorological Research Centre, Dhaka, Bangladesh
[2]India Meteorological Department, New Delhi, India
[3]National Centre for Medium Range Weather Forecasting, NOIDA, India
[4]Department of Meteorology/CECCR, King Abdulaziz University, Jeddah, Saudi Arabia

*Presenting Author Email: mohan28feb@yahoo.com

ABSTRACT

Mesoscale Convective Systems (MCSs) that form over northeast India and adjoining Bangladesh region during the pre-monsoon season are studied employing observations from ground based radar, Tropical Rainfall Measuring Mission (TRMM) and synoptic stations. Subsequently, an attempt is made to simulate the storms using Weather Research and Forecasting (WRF) model at 9 km horizontal resolution, and 28 vertical levels. Studies of Radar data for 15 cases showed that the Nor'westers (severe thunderstorms) propagate in the form of parallel bow shaped squall lines having typical horizontal length of about 150 km, reaching more than 350 km on some occasions. They propagate at typical speeds of about 50 km hr^{-1} from northwest to southeast direction. Several sensitivity experiments were conducted with different combinations of cumulus parameterization schemes, cloud microphysics schemes, and planetary boundary layer schemes to examine the root mean square errors (RMSE) of forecasts. The RMSE values were calculated for rainfall, wind speed at surface and time of occurrence of the storms in the model simulations. The model underestimated the strength of the squall lines in terms of wind speed and precipitation. The simulated results showed presence of strong vertical wind shear and an advection of warm moist southerly wind from the Bay of Bengal during the formation of MCSs. Low level positive vorticity in combination with moist southerly wind from the Bay of Bengal and strong surface heating resulted in the formations of the MCSs in all the cases. Cloud tops reached as high as 15-18 km in some of the cases of the severe storms. The altitude of core precipitation was located between 2-8 km. Average cloud hydrometeor content of the MCSs was estimated from model simulation.

Keywords: MCS, Nor'westers, Radar, TRMM, WRF model.

Precipitation extreme change due to global warming over the heavy snow region in Japan

Noriko N. ISHIZAKI*[1], Hiroshi G. TAKAHASHI[2], Hiroaki KAWASE[3], Hidetaka SASAKI[3], and Fujio KIMURA[1]

1: Japan Agency for Marine-Earth Science and Technology

2: Tokyo Metropolitan University

3: Meteorological Research Institute

** nishizak@jamstec.go.jp*

Under a constant relative humidity condition, precipitable water in the troposphere increases at the rate of change in saturation water vapor pressure (6.5-7% K^{-1} in the lower troposphere) as described by the Clausius-Clapeyron (CC) relation. Change in the precipitation is constrained by this water availability in the atmosphere. However, studies have shown that the extreme precipitation increases rapidly than that of the moisture content. In this study, change in the precipitation extreme in a warmer climate is investigated using observation and numerical simulation performed by a regional climate model over Japan Sea side, that undergo the abundant precipitation including much snow during winter monsoon season. Increase of the 99.9th percentile of the hourly precipitation is larger than that of precipitable water in the global warming simulation, while the total precipitation in the winter season shows small change although the weak (intense) precipitation decreases (increases). Extremes for liquid precipitation considerably increase (up to 14% K^{-1}), although that for solid precipitation is less than CC relation. The numerical simulation show that extreme precipitation would rather increase in the warming condition and much precipitation would occur as liquid precipitation instead of snowfall even in the high altitude area. This results indicate the necessity of reconsideration for the effective countermeasures to prevent changing disaster associated with the global warming.

RELEVANCE OF THE EMS-WRF MODEL IN DEKADAL RAINFALL PREDICTION OVER THE GHA REGION

Franklin J. Opijah[1], Joseph N. Mutemi[1], Laban A. Ogallo[2]

[1] University of Nairobi; [2] IGAD Climate Predictions and Applications Centre

CORRESPONDING AUTHOR

Franklin J. Opijah

University of Nairobi, Department of Meteorology, PO Box 30197 00100 Nairobi
Email: fopijah@gmail.com or fopijah@yahoo.com Tel: +254733822702

Abstract

Forecasting on dekadal (ten-day) timescales is critical because it is the bridge that links short term scales, called the Numerical Weather Prediction (NWP) range, and seasonal scales. This bridge, often referred to as the extended NWP range, is important in the provision of early-warning products and information, particularly concerning recurrent drought episodes and localized flooding over the Greater Horn of Africa (GHA) region. This study seeks to assess the validity of the dynamically-downscaled GCM rainfall outputs by the Environmental Modelling System's Weather Research and Forecasting (EMS-WRF) model in 2011. The results reveal that the EMS-WRF model, by and large, performs well over the region, but the excellence of the forecast products varies temporally and spatially. Nonetheless, the model exaggerates rainfall amounts over certain areas, particularly that forced by mesoscale systems. Moreover, the model generally underestimates the rainfall amounts arising from unexpected storms, and displaces the areas of the highest rainfall intensity in several respects. The EMS-WRF model is useful for predicting the distribution of dekadal rainfall over the GHA, but may perform better through improving the ocean-atmosphere interactions and feedback processes and employing multi-model ensemble forecasting techniques. The model should be used cautiously in tandem with other forecasting techniques.

Key words: EMS-WRF model, rainfall, prediction, forecasting, dekad, dekadal, ICPAC

Precipitation and water vapor origins throughout Japan in winter by isotopes-incorporated Regional Spectral Model

Masahiro Tanoue[1*], Kimpei Ichiyanagi[2], Kei Yoshimura[3], and Jun Shimada[2]
[1]Institute of Engineering Innovation, School of Engineering, The University of Tokyo
[2]Graduate School of Science and Technology, Kumamoto University
[3]Atmosphere and Sea Research Institute and Institute of Industrial Science, University of Tokyo

In this study, precipitation and water vapor origins throughout Japan in winter were estimated by regional spectral model with stable isotopes in water (δ^{18}O and δD). Model simulation was conducted from 2001 to 2010. Simulated spatial distributions of δ^{18}O and d-excess of precipitation in winter reproduced observational data well with correlation R=0.823 and R=0.532, respectively. However, high RMSE was recognized on δ^{18}O (2.31‰) and d-excess (6.83‰). Simulated daily sea-level pressure patterns were divided into two types: winter monsoon (WM) type and extratropical cyclone (EC) type. In the WM type, precipitation rates were high (more than 4 mm/day) and low (less than 4 mm/day) along the Japan Sea side of Japan and the Pacific Ocean side of Japan, respectively. The latitude effect (values decrease with increasing latitude) was recognized over the Pacific Ocean and the Japan Sea. Spatial distributions of d-excess (=$\delta D-8\times\delta^{18}O$) in precipitation and evaporation were more than 15‰ around Japan. Water vapor evaporated from the Japan Sea was predominant throughout Japan in the WM type, except for the southwestern islands of Japan. Interestingly, a portion of this moisture moved eastward to the Pacific Ocean; however, the moisture did not contribute to the total amount of precipitation along the Pacific Ocean side of Japan where precipitation rates was small. In contrast, precipitation rate was high throughout Japan in the EC type. Spatial distribution of δ^{18}O in precipitation showed the latitude effect in the Pacific Ocean and the Japan Sea, and it also showed the amount effect (values decrease with increasing precipitation) throughout Japan. Spatial distributions of d-excess in precipitation and evaporation were below 12‰ around Japan, except for the western part of the East China Sea. In the simulations, water vapor evaporated from the Pacific Ocean was predominant throughout Japan. Along the Japan Sea side of Japan, we found that δ^{18}O was 2‰ higher and d-excess was 9‰ higher in the WM type than in the EC type.

* *Corresponding author address*: 2-39-1, 2-11-16 Bunkyo-ku, Tokyo, 113-8656 Japan
E-mail: masatano.dx@gmail.com

Stable Water Isotopologues in Indian Summer Monsoon Rainfall: A comparison between SWING2 model simulations and observations

M.Midhun* and R.Ramesh

Geosciences Division, Physical research Laboratory, Ahmedabad, India

*Presenting author (midhun@prl.res.in)

Stable isotope based climate proxies (ice core, tree ring, speleothem etc.) are used to reconstruct the past rainfall variation over tropics. In Indian Summer Monsoon (ISM) region, due to the lack of sufficient observations, the major control of stable isotopes in precipitation ($H_2{}^{18}O$, HDO) are poorly quantified. We analyze multi-model simulations from the Stable Water Isotope iNtercomparison Group 2 (SWING2) project, to understand the major factors that control sptaio-temporal variability of rainfall isotopologues. In SWING2 project, apart from the free GCM simulations (forced by observed SST), a few of them are nudged with reanalysis dynamical fields (NCEP/ECMWF). All the model simulations produce the annual cycle of precipitation over Central Indian region with higher rainfall during ISM (June-September). The magnitude of monsoon rainfall and its spatial pattern simulated by the nudged Global Spectral Model (GSM) is more consistent with the observation compared to other SWING2 models. The spatial pattern of ISM rainfall $\delta^{18}O$ produced by different models show certain common features such as latitudinal gradient, depletion trend along the low level jet stream etc. Most of the models simulations show strong amount effect (inverse relation between amount of rainfall and its $\delta^{18}O$) over the ocean, whereas it show a large heterogeneity in amount effect over Indian subcontinent. Model produces stronger amount effect compared to GNIP observations. Though the correlation between observed $\delta^{18}O$ and amount of rainfall is weaker over Indian subcontinent, rainfall $\delta^{18}O$ of New Delhi show good correlation with regional rainfall and it is also seen in SWING2 simulations.

Projected Flood Risks in China based on CMIP5

Xu Ying (Emial: xuying@cma.gov.cn)

National Climate Center, China Meteorological Administration, Beijing 100081, China

Abstract

Based on the simulations from 22 CMIP5 models and in combination with data on population, GDP, arable land, and terrain elevation, the spatial distributions of the flood risk levels are calculated and analyzed under RCP8.5 for the baseline period (1986–2005), the near term future period (2016–2035), the middle term future period (2046–2065), and the long term future period (2080–2099).

(1) Areas with higher flood hazard risk levels in the future are concentrated in southeastern China, and the areas with the risk level III continue to expand. The major changes in flood hazard risks will occur in the middle and long term future.

(2) In future, the areas of high vulnerability to flood hazards will be located in China's eastern region. In the middle and late 21st century, the extent of the high vulnerability area will expand eastward and its intensity will gradually increase. The highest vulnerability values are found in the provinces of Beijing, Tianjin, Hebei, Henan, Anhui, Shandong, Shanghai, Jiangsu, and in parts of the Pearl River Delta. Furthermore, the major cities in northeast China, as well as Wuhan, Changsha and Nanchang are highly vulnerable.

(3) The regions with high flood risk levels will be located in eastern China, in the middle and lower reaches of Yangtze River and stretching northward to Beijing and Tianjin. High-risk flood areas are also occurring in major cities in Northeast China, in some parts of Shaanxi and Shanxi, and in some coastal areas in Southeast China.

(4) Compared to the baseline period, the high flood risks will increase on a regional level towards the end of the 21st century, although the areas of flood hazards show little variation.

In this paper, the projected future flood risks for different periods were analyzed under the RCP8.5 emission scenarios. By comparing the results with the simulations under the RCP 2.6 and RCP 4.5 scenarios, both scenarios show no differences in the spatial distribution, but in the intensity of flood hazard risks, which are weaker than for the RCP8.5 scenarios.

By using the simulations from climate model ensembles to project future flood risks, uncertainty exists for various factors, such as the coarse resolution of global climate models, different approaches to flood assessments, the selection of the weighting coefficients, as well as the used greenhouse gas emission scheme, and the estimations of future population, GDP, and arable land. Therefore, further analysis is needed to reduce the uncertainties of future flood risks.

Key words： RCP8.5 scenario; flood risk; projection

Toward Reconstruction of Historical Weather with Data assimilation: Present Day Experiments using Reanalysis Data

Kinya Toride[1] (Presenting Author), Kei Yoshimura[2]

[1] Department of Civil Engineering, University of Tokyo, Japan.

E-mail: ktoride@hydra.t.u-tokyo.ac.jp

[2] Atmosphere and Ocean Research Institute, University of Tokyo, Japan.

The worlds concern of global warming has been increasing recently. Understanding historical weather is one of the important matters for understanding future climate changes. To understand historical weather, we need to reconstruct weather from historical meteorological data. However, there is less meteorological data in Japan compared with Europe or America before 1870s because the official meteorological network in Japan started in 1870s [Zaiki et al., 2006]. Old diaries record historical weather are considered to have a high potential to recover this. The ultimate goal of this study is to reconstruct historical weather by deriving total cloud cover (cloudiness) from old weather records and assimilate that by using General Spectral Model (GSM) and ensemble Kalman filter. Since this is quite a new approach to reconstruct historical weather, we conducted some experiments for the primary step. In this study, a cloud assimilation scheme is inserted to LETKF-IsoGSM [Yoshimura et al., 2014] and then weather is reconstructed by using NCEP DOE reanalysis data. We assume 18 observation stations in Japan according to Historical Weather Data Base [Yoshimura, 2007]. In the experiments, first, virtual observation of total cloud amount is made by giving random noise to NCEP DOE data. The random noise is sampled from the normal distribution with given observational error standard deviations. The observational standard error of total amount of cloud is set as 30% and observations are assumed to be taken once a day. Second, open loop simulation is done from Jan. 1, 2005 to Jan. 1, 2006 to make an initial condition. Third, total cloud amount is assimilated from Jan. 1, 2006 and results is compared with the open loop case. The results show great improvements in total cloud amount, and also other variables (e.g. humidity, precipitation, precipitable water, wind, pressure) are improved. In addition, an idealized experiment using 400 observation stations distributed all over the world was done to reveal benefits when we could use many old diaries in the world.

Key Words: weather reconstruction, cloud data assimilation, ensemble Kalman filter

The impact of irrigation on the southeastern US climate

Vasu Misra and C. Selman

Dept. of Earth, Ocean, and Atmospheric Science,

Florida State University, Tallahassee, FL 32306

Email: vmisra@fsu.edu

Abstract

We show the sensitivity of the simulated southeastern US climate from RSM to different levels of irrigation. These sensitivity experiments are decade long integrations forced by the NCEP-R2 atmospheric reanalysis and OISSTv2. Each of the 4 independent integrations involved keeping the root zone soil moisture at 100%, 75%, 50%, and 25% of the field capacity in the crop grid cells during the growing season from May to October. The fifth experiment was the control, in which no irrigation was applied. The seminar will discuss the relative differences between the experiments and also the amount of soil water added during the integration in each of the experiments.

Title: Fire Busting Weather Forecast

Shyh Chen[1]*, John Benoit[1], Jack Ritchie[2], Yunfei Zhang[3], and H. Juang[4]

[1] Pacific Southwest Research Station, US Forest Service, Riverside, California
[2] Scripps Institution of Oceanography, University of California, San Diego
[3] National Marine Environment Forecasting Center, State Oceanic Administration, China
[4] National Centers for Environmental Prediction, Camp Springs, Maryland
[*] Presenter, e-mail: schen@fs.fed.us

Abstract

Wind and weather informaion in mountainous areas are critical in wildland fire-fighting. The variables are complex because of the underlaid complex terrain. Since Weather Service does not provide such detailed forecasts, regional computer models have to be used to enhance the official coarse resolution forecasts. However this high-resolution weather information is not readily available national-wide due to its immense computational requirement, and usually can only be available over a small region when a severe fire event was long over. Thus the advantage of using high-resolution weather model for fire management was limited. We have developed an experimental system called FireBuster designed to streamline and automate many intermediate processes. We are routinely producing forecasts at 5 km (~3 mile) resolution over southern California. A field forecaster can then select any part in the domain to request a special 1 km (~0.6 mile) resolution 72-hour forecast with only a few clicks on a google-map. All computations are done on high performance computers at PSW Riverside. The resulting fire weather variables can be retrieved in a reasonable time through a web interface as each 6-hour increment is done. Near surface weather from the Meso-West observational network are also available for display, as soon as they become available, for future validation. In addition, 72-hour weather forecast time series at any given location in the domain can be retrieved simply by a click on the map. This feature provides firefighters with detailed weather forecasts, including winds, at their location and could potentially be of life or property saving value in the event of wildfires. Future enhancements will include actual fire perimeters and economic data layer so that FireBuster can truly be part of an integrated fire management tool.

Submitted to: The 13th International RSM Workshop, Yokohama, Japan.

The Effect of Temporal and Spatial Averaging Scales in Climate Change Assessments

Kenshi Hibino[1] and Izuru Takayabu[2]

1: University of Tsukuba
2: Meteorological Research Institute

Many studies try to detect the climate change signal in the future, such as warming or precipitation change. It is well known that the feasibility of the detection largely depends on the temporal and spatial averaging scales as well as the location of the target place and the season. For example, global warming or annual-mean precipitation change is more easily detected than local warming or monthly-mean precipitation change, respectively. The present study analyzes surface-air temerature and precipitation data from MRI-AGCM with a spatial resolution approximately 60km and investigates their changes between present (1979-2003) and future (2075-2099) climate. The feasibility of the detection of the climate change signal is quantified by signal to noise ratio (SNR) which is often used in statistical tests. The aim of the study is to clarify the dependence of SNR on temporal and spatial averaging scales. The trade-off relation between these two scales for the variation of SNR is estimated, which has to be useful information for climate change risk assessments using various spatial and temporal scales. The trade-off relation is obtained in various latitudes from tropics to mid-latitudes and the characteristics of the relation are found to differ qualitatively between tropics and mid-latitudes. This difference reflects the difference of spatio-temporal structure of temperature (precipitation) distribution in each latitude. This work was supported by the SOUSEI programs of the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) of Japan.

Spatial Change of Blocking Frequency and Extreme Events with Global Warming

Yoshikazu Kitano※, Tomohito J. Yamada

Faculty of Engineering, Hokkaido University

※ Presenter

appukin@gmail.com

Atmospheric blocking is one of the most crucial phenomena leading to extreme events such as heat wave, cold wave and heavy precipitation, and so on. In this study, the frequency of winter blocking and their changes between end of twenties and twenty-first centuries are examined utilizing Coupled Model Intercomparison Project Phase 5 (CMIP5) datasets and the European Centre for Medium-Range Weather Forecasts Reanalysis Dataset (ERA-40). Blocking is diagnosed using a two dimensional blocking index based on the method of Pelly and Hoskins (2003). The distribution of blocking frequency is calculated by 9 GCM dataset and almost all of them showed the tendency that the Pacific high-latitude blocking are shifted northeastward but huge model bias is found over other region. The ratio of extreme events with blocking events also calculated in twentieth and twenty-first centuries. As an extreme event, the top 10 % of heat, cold and heavy precipitation days in analysis period are defined. It is confirmed that the distribution of extreme events changes the location following the blocking shift especially on north Pacific. To analyze the physical mechanism causing the change of blocking location, energy balance is analyzed. Resulting from temperature rising over the low latitude, westerly wind shift poleward and affected the blocking location.

Skillful time scale of climate model

Izuru Takayabu[1], Kenshi Hibino[2]

1: Meteorological Research Institute
2: University of Tsukuba

Dynamical downscaling has been performed to supply information for various end-users who need detailed information on climate change. In such a case, it has long been a main interest to what scale could climate model produce useful information. We call this scale as “skillful scale”. It is suggested in Pielke (2002) that the smallest wavelength we could represent accurately is four times larger than the grid point interval. However, as shown in Castro et al. (2005) or Rockel et al. (2008), the skillful scale is much larger than that scale. Recently, needs for information of extreme events increased, and for that purpose, discussion of skillful time scale become also useful. Though there are already many studies which has shown the relation between model grid size and their representativeness of daily or hourly precipitation intensity (e.g. Kimoto et al., 2005, Sasaki et al., 2011), there is still no analysis done on the cause of the relation. In this paper, we try to discuss the cause of the difference in representing short time scale precipitation intensity owing to their horizontal grid size by comparing their power spectrum with that of a station data.

This work was supported by the SOUSEI programs of the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) of Japan.

HOW DO TRACKS OF TROPICAL CYCLONE AFFECT THE DISTRIBUTION OF HEAVY RAINFALL AND STRONG WINDS?

Shota YAMASAKI[1], and Hironori FUDEYASU[1]

1 Yokohama National University, Yokohama, Japan
Email: fude@ynu.ac.jp

The purpose of this study is to examine the distribution of rainfall and surface winds associated with tropical cyclones (TCs) over the Japan Island, based on a series of numerical experiments. The heavy rainfall and strong winds were observed over the Japan Island, although those distribution was very complex because of local effects such as mountainous terrain. The topography effect resulting in the heavy rainfall and strong winds associated with TCs were intimately linked to the TC tracks. Using numerical experiments with several TC tracks, we can detect the particular TC track which results in the highest amount of rainfall and/or wind speed at the each location in Japan. Thus, an understanding of the variability in the distribution of surface winds speed and precipitation over the Japan Island depend on TC tracks may be useful for reducing risk and improving water resource management.

Numerical experiments were performed using the Mesoscale Model 5 (MM5) jointly developed by Pennsylvania State University and the National Center for Atmospheric Research. MM5 is a non-hydrostatic model developed as a community mesoscale model (Dudhia 1993; Grell et al. 1995). In this study, the simulation used two modeling domains: the outer grid (D1) was comprised of 190 x 210 grid cells with a grid resolution of 18 km, and an inner domain (D2) had a finer resolution of 6 km with 550 x 540 grid cells. The simulation of Typhoon Vera (1959) was performed utilizing the typhoon bogus schemes incorporated in MM5.

Heavy rainfall associated with Vera caused several flooding that results in heavy losses of life and widespread damages in Japan. MM5 successfully simulated Vera in 2.5 days long simulation from 12 UTC 24 September 1959. Especially the simulated Vera’s track was in good agreement with the observed track. In the numerical experiments, tracks of Vera changed with westward or eastward sift of the location of Japan Islands. The distribution of heavy rainfall and strong winds changed drastically due to the changes of the topography effect.

LARGE-SCALE INFLUENCES ON THE FORMATION OF TYPHOON LEEPI USING OBSERVATIONAL DATA AND ENSEMBLE OWNSCALE EXPERIMENTS

Hiroaki YOSHIOKA[1], Hironori FUDEYASU[1], Masaki KATSUMATA[2],
Akira YAMAZAKI[2], Satoru YOKOI[2], Satoki TSUJINO[3],
Ayumi MASUDA[1] and Ryuichi SHIROOKA[2]

1 Yokohama National University, Yokohama, Japan
2 Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan
3 Hydrospheric Atmospheric Research Center, Nagoya University, Nagoya, Japan
Email: yoshioka-hiroaki-bp@ynu.jp

This study focused on the large-scale influences on the tropical cyclogenesis, growing Typhoon Leepi (T1304) observed by a field project named the Pacific Area Long-Term Atmospheric Observation for Understanding of Climate Change (PALAU2013) over the northwest Pacific Ocean in 2013 conducted by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). The initial disturbance of Leepi which occurred at 3N, 175W in 03Z June 10, 2013, passed through the observation point R/V MIRAI MR13-03 at 12N, 135E.

We analyzed how large-scale environment affected the genesis and development processes of Leepi derived from re-analysis ensemble data, ALERA2 (Enomoto et al. 2013). The horizontal resolution of this ensemble data of the pressure level is 1.25 ×1.25 degree. Using first guess ensemble mean and ensemble member (63 members), we determined differences in the environments and strength (tangential wind) of the initial disturbance.

Finally, the ensemble downscale experiments were performed using the nonhydrostatic meso-scale numerical model, WRF with horizontal resolution of 20 km. The initial date were derived from 63 ensemble members and 17 initial times from 00UTC 13 Jun to 00UTC 17 Jun 2013. Some experiments successfully simulated Leepi, whereas disturbance could not be simulated in others. Therefore the ensemble downscale experiments can detect the important factor in the large-scale environment, resulting in the formation of Typhoon Leepi.

Three dimensional evolution of an extremely intense tropical cyclone with the extraordinarily rapid intensification simulated by a 2-km mesh non-hydrostatic model: Numerical experiments of Typhoon IDA (T5822)

#Sachie Kanada[*1] and Akiyoshi Wada[*2]
[*1] HyARC, Nagoya University
[*2]Meteorological Research Institute/Japan Metrological Agency
skanada@rain.hyarc.nagoya-u.ac.jp

We numerically investigated extraordinarily rapid intensification (ERI) of Typhoon Ida (T5822) and its three-dimensional structural change using a 2-km mesh non-hydrostatic models (NHM2) developed by the Japan Metrological Agency (JMANHM). According to the Regional Specialized Meteorological Center Tokyo best track data, Ida was an extremely intense TC with the minimum central pressure (MCP) of 877 hPa and underwent ERI with the maximum pressure drop (MPD) of 93 hPa day^{-1}. The initial and boundary conditions were provided from results of the numerical experiments calculated by a 5-km mesh JMANHM nested from the Japanese 55-year Reanalysis data. NHM2 included 2-moment bulk-type microphysics with an ice-phase, a 1.5-order turbulence closure scheme and no cumulus parameterization scheme. This study used three different initial times for numerical experiments: 12Z (hereafter, 2112) and 18 Z (hereafter, 2118) on 21 and 00Z on 22 (hereafter, 2200) September in 1958.

Among the three, 2118 and 2200 experiments reproduced the extraordinarily MPD greater than 60 hPa with MCPs of 887 hPa (2118) and 877 hPa (2200). As for the successful ERI cases, the initial conditions were characterized with more intense convections within a radius of 100 km (hereafter, the inner-core) where the axis of the lowest pressure was upstanding. Intense updrafts moistened the inner-core upper layer and relatively weak subsidence outside the inner-core warmed the boundary-layer top, reducing the thickness of inflow boundary layer. Meso-γ-scale updrafts occurred around the thin layer formed continuously from the heads of near-surface inflow and downdraft in the inner-core. We found that the eyewall updraft abruptly developed when the meso-γ-scale updrafts appeared around the eye where the region was moistened and warmed due to the preceding convection. ERI was initiated just a few hours after the eyewall updraft was established. (286 words)

Regional-Scale Simulations of High-Impact Tropical Cyclones for the Assessments of Meteorological Hazards from a Worst-Case Scenario

Tetsuya Takemi
Email: takemi@storm.dpri.kyoto-u.ac.jp
Disaster Prevention Research Institute, Kyoto University
Uji, Kyoto, 611-0011, Japan

Tropical cyclones (TCs) are one of the severe weather events that have high impacts to our society. In regions that are affected by tropical cyclones, we face a common threat by meteorological hazards due to TCs. Therefore, the assessment of the hazard and the resulting impacts by TCs is important for preventing and mitigating induced disasters. In this study, we use a mesoscale meteorological model to perform regional-scale simulations of TCs and apply the simulated data for use in hazard/impact assessment studies. We here focus on typhoons which are TCs over the western North Pacific region. We have conducted numerical simulations of some of the high-impact typhoons in a recent year and in the history. Under the framework of a SOUSEI program, a Japanese activity in climate-change studies, called Precise Impact Assessments on Climate Change, we have been collaborating with colleagues involved in the impact assessment project in order to apply a regional-scale meteorological simulation technique for the quantitative assessments of typhoon hazards/impacts to river basins, coastal areas, and forest areas. In this talk, we will demonstrate some of the results of regional-scale simulations of severe typhoons. By investigating typhoons that caused disasters, we propose an approach to assess a high-impact typhoon as a worst-case scenario.

Numerical study of typhoons in 2012 and 2013 using a coupled atmosphere-wave-ocean non-hydrostatic model

MASAYA KATO[1),*] , kato@rain.hyarc.nagoya-u.ac.jp, Hidenori Aiki[2)], Taro SHINODA[1)], Akihiko MORIMOTO[1)], Mayumi YOSHIOKA[3)], Kazuhisa TSUBOKI[1)]

1) Hydrospheric Atmospheric Research Center, Nagoya University
2) Japan Agency for Marine-Earth Science and Technology
3) Center for Atmospheric and Oceanic Studies, Tohoku University

We have been developing a coupled atmosphere-wave-ocean non-hydrostatic model called CReSS-NHOES since 2010. We use Cloud Resolving Storm Simulator (CReSS) developed by Nagoya university for an atmospheric model and Non-Hydrostatic Ocean model for Earth Simulator (NHOES) developed by JAMSTEC for ocean and wave models. To develop and evaluate CReSS-NHOES, we have conducted the daily atmosphere-ocean coupling simulation since 2012. The horizontal grid resolution is 0.05 degree for both latitude and longitude (approximately 5km). The domain includes almost Kuroshio Current and its extension. GSM provided by JMA and JCOPE2 provided by JAMSTEC are used as the initial and the boundary condition for the atmosphere and the ocean, respectively. The initial time of each simulation is 18 UTC and the integration time is for 5 days. We analyzed 10 typhoons in 2012 and 2013. To evaluate an effect of the atmosphere-ocean interaction, non-coupled simulations (CReSS) were conducted. CReSS predicts SST using a one dimentional heat transfer model in the skin layer. The differences of the path and the moving speed were small. The central pressure difference increased from about 24 hour integration. Some simulated typhoons of CReSS-NHOES were stronger than that of CReSS. The track of T1217 (Jelawat) was the east side along Kuroshio Current. SST decrease from the initial over the Kuroshio region of CReSS-NHOES was small compare to the result of CReSS. Horizontal advection of the warm current had an important role to maintain SST. The central pressure of T1307 (Soulik) was about 4hPa lower of CReSS-NHOES for the first 2 days. Ocean heat content (OHC) which defined as heat content above the depth of 26 degree Celsius was larger than 100 kJ/cm2. When Soulik moved into the region where OHC was less than 30 kJ/cm2, simulated typhoon of CReSS-NHOES was about 10 hPa weaker than that of CReSS.

Numerical Simulation of Typhoons in the Northwestern Pacific using a Coupled Ocean–Atmosphere–Wave Modeling System

ZHANG Yunfei, LING Tiejun, LI Xiang, LIU Na

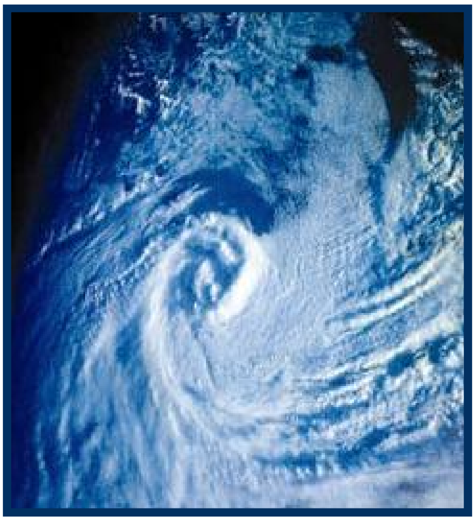
Key Laboratory of Research on Marine Hazards Forecasting, National Marine Environmental Forecasting Center, Beijing, 100081, China

A newly developed Coupled Atmosphere-Ocean-Wave modeling system, based on the COAWST model (Warner et al., 2010), is used to simulate the landfall typhoons in the northwest Pacific and explore the heat fluxes exchanged between the atmosphere model WRF, ocean model ROMS and wave model SWAN. The ocean model and wave model have 15km uniform resolution, which matched the horizontal resolution of the atmosphere model in its grid. We modify the typhoon initialization scheme of HWRF (Liu et al., 2006) and apply it into the coupled system. Specifically, to suitable for the high resolution model data and ensure the vortex dynamical and physical compatible with the model, some improvements are taken into the new scheme: the method to fix the vortex center, the method of spatial filter, the vortex generation and the vortex modification. We applied the spectral nudging (von Storch et al., 2000) on temperature, horizontal winds and geopotential height at upper layer (k>10) towards global data to remain large-scale reasonable atmospheric characters.

附件四、SOUSEI 計畫簡介

SOUSEI

Program for Risk Information on Climate Change



MEXT

MINISTRY OF EDUCATION,
CULTURE, SPORTS,
SCIENCE AND TECHNOLOGY-JAPAN

Progress of the Climate Change Research Projection

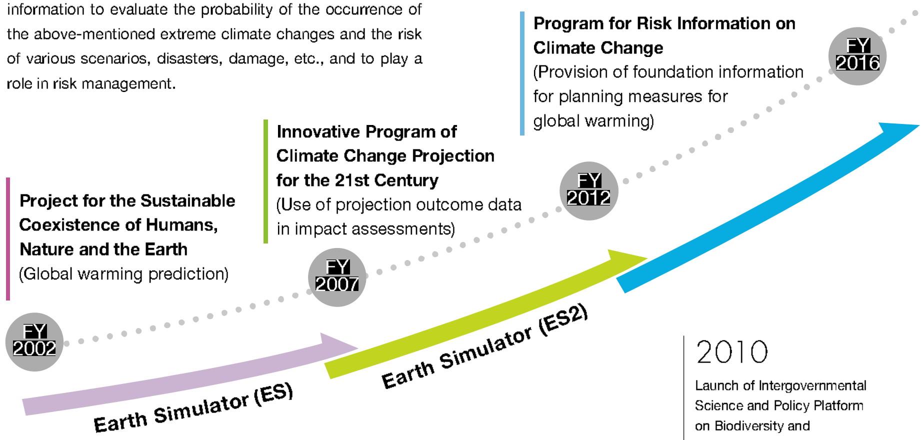
A project is underway to prepare for the conceivable scenario and to enable risk evaluation at the highest level!

On the Japanese archipelago which is mountainous and long north to south, there is significant variation among the regions in temperature, precipitation, and wind. Since the islands are surrounded by the ocean, they are often hit by typhoons during the summer and fall. Moreover in recent years, extreme weather phenomena have become frequent occurrences, including concentrated heavy rainfall, unusually high temperatures near 40 degrees Celsius (104 degrees Fahrenheit), and tornadoes strong enough to destroy houses. These types of abnormal weather phenomena threaten our daily lives and are capable of causing immense damage to society and the economy.

The Program for Risk Information on Climate Change (SOUSEI) carries on the work of the Innovative Program of Climate Change Projection for the 21st Century (KAKUSHIN) (FY2007-FY2011). The aim of this program is to generate information to evaluate the probability of the occurrence of the above-mentioned extreme climate changes and the risk of various scenarios, disasters, damage, etc., and to play a role in risk management.

This project began in FY2012 and will continue for five years. The project's specific research is divided into five themes which are being pursued concurrently, as follow. Theme A: Prediction and diagnosis of imminent global climate change, Theme B: Climate change projection contributing to stabilization target setting, Theme C: Development of basic technology for risk information on climate change, Theme D: Precise impact assessments on climate change, and Theme E: Promotion for climate change research and linkage coordination.

By developing the highest level of research technology in the world, we expect to play a role in climate change risk prediction not only in Japan but also in countries around the world including Southeast Asia.



2001
Intergovernmental Panel on Climate Change (IPCC)
IPCC's Third Assessment Report (TAR)
"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

2002
Earth Summit 2002
Adoption of Framework Convention on Climate Change

2007
IPCC's Fourth Assessment Report (AR4)
"Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG (greenhouse gas) concentrations."
IPCC receives the Nobel Peace Prize.

2009
3rd World Climate Conference (TWCC)
Adoption of plan for Global Framework for Climate Services (GFCS)

2010
Launch of Intergovernmental Science and Policy Platform on Biodiversity and Ecosystem Services (IPBES; the biodiversity version of IPCC)

2012
Earth Summit 2012
Action Guidelines for Sustainable Development

2013-2014
Formulation of IPCC's Fifth Assessment Report (AR5) Scheduled

Introduction

Reduction of the uncertainty of climate change projection and usage of "risk information" in the real world

A quarter of a century has already passed since global warming due to industrial activities was noted. The response heretofore has been mainly to hold discussions on saving energy and on regulating emissions of greenhouse gases such as carbon dioxide. Now we are beginning to see the frequent occurrence of concentrated heavy rainfall, large typhoons, and the flooding that goes along with those. We have reached the point where it is necessary to devise specific answers to questions such as "how high should the levees be?" and "how strong should houses and high-rise buildings be to withstand the wind?," for the adaptation strategies for global warming.

The major mission of the Program for Risk Information on Climate Change is to further boost the basic technology for climate change projection, predict the probability of the occurrence of extreme concentrated heavy rainfall, etc., and conduct the risk evaluation research of the associated damage.

Themes constructed in a nested fashion

This research program is arranged with a multilayered structure. Theme A is the lowest-level layer. On top of that is Theme B, followed by Theme C and Theme D.

Theme A focuses on the development of the basic model that is the basis of this program. In this program's precursor, the Innovative Program of Climate Change Projection for the 21st Century, research on the basic model was also driving the overall program, but in the current program, we aim to strengthen the basic model itself and to add more advanced functions.

Theme B has a sibling relationship with Theme A. It adds elements such as the environmental biogeochemical cycles and biological activity to the basic model, develops a more detailed earth system model, and studies target levels for stabilization of the climate.

The aim of Theme C is to extract more detailed prediction information and to describe the "conceivable scenario" including the probability of a particular scenario occurring, such as Isewan Typhoon (Typhoon Vera). In response, Theme D aims to produce risk projections and assessments to provide adaptation to minimize the impact to natural hazards, water resources and ecosystem and biodiversity under climate change.

What are needed are scientific grounds and reliability

We are already at the point of no return with regard to global warming, but when it comes to "climate change risk," its perceived seriousness varies greatly depending on one's generation and location. For instance, having experienced the tsunami and the nuclear accident following the Great East Japan Earthquake, we in Japan understand that even a disaster with the extremely small probability of "once in 1,000 years" causing exceedingly massive damage may actually occur.

In order to take specific action under the current difficult circumstances which include a declining birthrate, an aging society, and less-than-abundant funds, we must have reliable risk assessments based on scientific grounds. Those of us involved in this project intend to scientifically question and ascertain the matters which seem certain and the matters which are still not well understood. We are pushing forward with research to obtain reliable results that will serve as grounds for every person to think and make decisions.

Program Director (PD) Akimasa Sumi (special advisor to MEXT)

President, National Institute for Environmental Studies (NIES)

Outline

Akimasa Sumi, PD (Program Director)

Special Advisor to MEXT
President
NIES

PD supervises the program so that it is carried out efficiently and effectively, and he handles the overall coordination of the program. A PO (program officer) is assigned to each theme to assist the PD in managing the progress of research topics and adjusting research plans, etc.

Tatsushi Tokioka, PO

Special Advisor to MEXT
Team Leader
Research Institute for Global Change, JAMSTEC

Fujio Kimura, PO

Special Advisor to MEXT
Program Director
Research Institute for Global Change, JAMSTEC

Hideo Harasawa, PO

Special Advisor to MEXT
Vice President
NIES

Theme A: Atmosphere and Ocean Research Institute, the University of Tokyo (AORI)

Prediction and diagnosis of imminent global climate change

Representative: Masahide Kimoto
Vice Director/Professor, AORI, the University of Tokyo

The coming global warming is unavoidable, and all segments of society are seeking ways to adapt to it. In an effort toward providing climate change risk information and contributing to building a society highly adaptive to climate change, this theme develops a climate prediction system that enables verification using observation data on various timescales and provides climate projection information with high reliability. We aim to improve the reliability of projections of future climate changes through analyzing major contributing factors, verifying hindcasts, and assessing the impacts of anthropogenic factors associated with past climate changes involving severe weather and extreme events. In addition, we attempt to reduce the uncertainty in climate projection due to physical processes controlling climate sensitivity through verification using observation data, which is a yardstick of climate system responsiveness to external forcing such as that caused by changes in concentration of carbon dioxide.

【Research Topics】

Understanding mechanisms of climate variability and change

■Studies on prediction and predictability of climate variability from interannual to decadal time scales (AORI)

■Towards reducing uncertainty in model-based estimation of climate sensitivity (National Institute for Environmental Studies: NIES)

■Reduction of uncertainty in climate models relevant to climate sensitivity (JAMSTEC)

Development of an integrated prediction system for global climate studies

■Development of a seamless prediction system for seasonal-to-decadal time scales (Meteorological Research Institute JMA: MRI)

■Development of data assimilation technology for optimizing initial and boundary conditions (JAMSTEC)

Theme B: JAMSTEC

Climate change projection contributing to stabilization target setting

Representative: Michio Kawamiya
Project Manager, JAMSTEC

Uncertainty in the projection of carbon dioxide concentration, together with uncertainty concerning climate sensitivity, is a major obstacle to predicting the future climate. In this research theme, we are developing an earth system model that handles the environmental biogeochemical cycles including the carbon cycle and the nitrogen cycle as well as changes in land use. These are critical for more accurately predicting changes in the balance of carbon dioxide and changes in ecosystems and agriculture, etc. When developing our research, we study, from a scientific standpoint, the socio-economic scenarios that form the preconditions on which the projection experiment is premised. In studying targets for carbon dioxide, it is important to understand phenomena that may occur in the future but must be avoided as well as the impact of methods we could use to avoid them. This is why we work to create new scientific knowledge concerning the impact and effects of violent changes (tipping elements) which may arise when the degree of anthropogenic environmental changes exceed a certain threshold as well as methods to lower the average temperature of the earth artificially so as to suppress the damage due to warming (geoengineering).

【Research Topics】

Long-term global change projection based on diverse scenarios

■Development of an earth system model dealing with variations of greenhouse gases, land use change, etc. (JAMSTEC)

■Information gathering and examination on socio-economic scenarios toward stabilization target setting (JAMSTEC)

■Integrated assessment on climate projection experiments and socio-economic scenarios (Central Research Institute of Electric Power Industry:CRIEPI)

Obtaining scientific perceptions on large-scale variations and modifications of climate

■Development of technologies for numerical investigations on tipping elements and irreversibility of environmental changes (ice sheet collapse, etc.) (JAMSTEC)

■Development of technologies for numerical investigations on geoengineering (stratospheric aerosol injection, etc.) (JAMSTEC)

Theme C: University of Tsukuba

Development of basic techno-logy for risk information on climate change

Representative: Izuru Takayabu
Head of the Second Laboratory, Atmospheric Environment and Meteorology Research Department, Meteorological Research Institute (MRI)

In recent years, climate change impact assessments and development of countermeasures have been undertaken around the world. However, there is currently no standard downscaled data that can simultaneously address various demands (from changes in the mean field to hazard analyses). In this research theme, we aim to produce probability data that enables hazard analyses related to both high-frequency phenomena and low-frequency phenomena (typhoons, heavy rainfall, etc.) in the region of Japan. For this purpose, we are further refining the existing super high-resolution atmospheric model and applying statistical methods on model results to generate data on the probability of climate change predictions in the Asian monsoon region, including Japan. We aim to prepare a standard dataset (climate scenarios) together with data concerning the uncertainty in basic variables in climate prediction, which can be used in different applications of prediction data.

【Research Topics】

Probabilistic climate prediction for risk assessment

■Efficient approach for climate ensemble experiment (National Research Institute for Earth Science and Disaster Prevention: NIED)

■Development of statistical methodology of ensemble data on climate change (The Institute of Statistical Mathematics:ISM)

■Improvement in cost-efficiency of dynamical downscaling for ensemble data (AORI)

Producing a standard climate scenario by using super high resolution models

■Development of quantification method for reliability and uncertainty of climate change information (University of Tsukuba)

■Downscaling of the change in future weather extremes by using high-resolution models (MRI)

■Development of a coupled ocean-atmosphere non-hydrostatic model for typhoon research (Hydrospheric Atmospheric Research Center, Nagoya University: HyARC)

Theme D: Disaster Prevention Research Institute, Kyoto University (DPRI-KU)

Precise impact assessments on climate change

Representative: Eiichi Nakakita
Professor, DPRI, Kyoto University

To generate information that contributes to climate change risk management, it is important to perform a more detailed assessment of the impact, together with specifying the risks and understanding the probabilities. In this research theme, we are performing a quantitative impact assessment from a variety of perspectives including natural hazards, water resources, and ecosystems and biodiversity, using climate change prediction information as well as prediction information produced in this program. We are also performing a variation estimate of the expected risk value, an estimate of the uncertainty of that estimate, and an impact assessment on the worst-case scenario of a natural hazard. Next, using these figures, we perform a variation estimate of the socio-economic risk and aim to compile the basic information for adaptation strategies. With regard to natural hazards, in conjunction with proposing various basic approaches to the adaptation strategies, we aim to study assessment methods for comprehensive disaster mitigation measures that can alleviate a disaster to some degree when external forces occur that exceed the existing facilities plan, as part of the worst-case scenario. We also aim to construct a methodology for the economic assessment.

【Research Topics】

Climate change impacts on natural hazards

■Risk assessment of meteorological disasters under climate change (DPRI-KU)

■Risk assessment of water-related disasters under climate change (Kyoto University Graduate School of Engineering)

■Risk assessment of coastal disasters under climate change (DPRI-KU)

■Measuring socio-economic impacts of climate change and effectiveness of adaptation strategies (DPRI-KU)

■Development of risk assessment and adaptation strategies for water-related disaster in Asia (Public Works Research Institute:PWRI)

Climate change impacts on water resources

■Assessment of socio-economic impacts on water resources and their uncertainties under changing climate (DPRI-KU)

■Assessment of climate change impacts on the social-ecological systems of water resources and hydrological cycles (Institute of Industrial Science, University of Tokyo:IIS)

Climate change impacts on ecosystem and biodiversity

■Assessment of climate impacts on ecosystem and biodiversity (Tohoku University)

■Economic evaluation of ecosystem science (Tohoku University)

■Eco-climate system in northeastern Eurasia and southeastern Asian tropics: impacts of global climate change (Nagoya University)

■Assessment of multiple effects of climate change on coastal marine ecosystem (Hokkaido University)

Theme E: JAMSTEC

Promotion for climate change research and linkage coordination

Representative: Michio Kawamiya
Project Manager, JAMSTEC

Promotion for effective researches on climate change

■Support for program implementation and outreach

■Support for forming common recognition on climate change risk information

■Establishment of a system required for providing information and advice on climate change risk

Theme A: Prediction and diagnosis of imminent global climate change

We provide a research basis for climate prediction so that we can perform prediction experiments over various spatiotemporal scales

We develop a system that can predict climate changes over broad timescales, from El Niño over a half year to global warming over 10 years or 100 years. We aim to provide to the world "more specific prediction levels" that can be used for risk assessment.

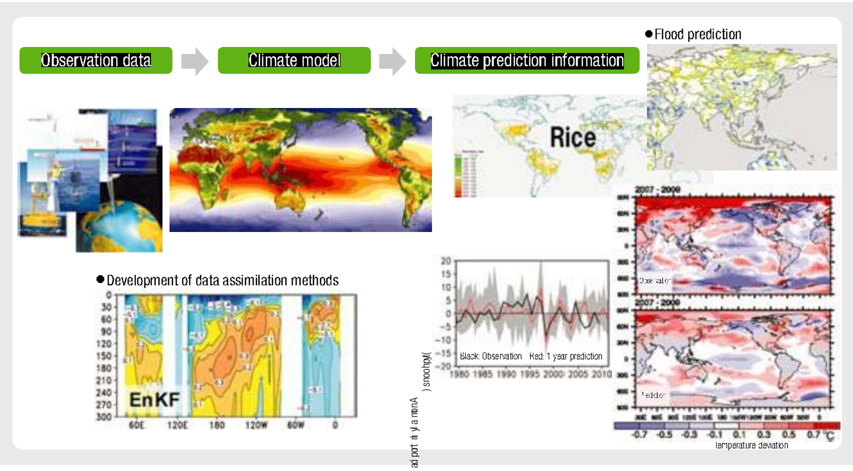
Weather forecasts and precipitation probabilities, which are indispensable in our daily lives, have been remarkably improved in the past few decades. This is due to the appearance of supercomputers capable of rapidly performing massive and complex calculations and the development of atmospheric models that can reproduce the atmospheric circulation, precipitation, and the generation and extinction of clouds. Recently, a "coupled atmosphere-ocean general circulation model" which is composed of an ocean model together with the atmospheric one has been developed, and it is used to predict the occurrence of El Niño a half year to one year in advance and to predict global warming 10 years in the future. In general, we face a larger uncertainty in longer term climate predictions, and actually, the present climate change predictions contain such a large uncertainty that we cannot estimate adequate levels for the height of levees and the strength of buildings.

Theme A, prediction and diagnosis of imminent global climate change, aims to develop the models and the technology to serve as the research basis for the Program for Risk Information on Climate Change. We are endeavoring to improve the present models and the prediction systems so that we can more reliably verify the past extreme events and apply them to future predictions.

Seamless prediction, from weather to El Niño and global warming

Theme A is divided into two sub-themes: (1) understanding mechanisms of climate variability and change and (2) development of an integrated prediction system for global climate studies.

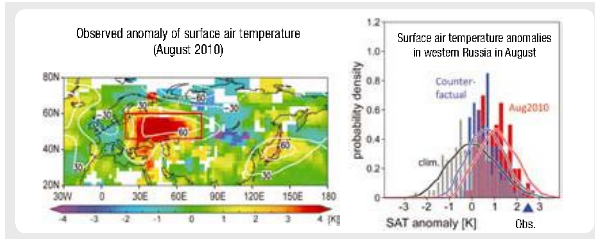
In the former, i.e., understanding mechanisms of climate variability and change, we have three goals. The first goal is to further develop the "near-term climate prediction system with initialization" that was developed by KAKUSHIN and to provide information for seamless prediction, from the occurrence of El Niño up to a half year in advance to the prediction of global warming 30 years in the future. "Initialized prediction" is regarded here as making forecasts by starting with the realistic atmospheric, oceanic, and land conditions, based on observation data. In addition to the long-term tendency of global warming, we predict the future natural changes in the atmosphere and oceans.



Theme A aims to develop a system capable of seamless climate prediction from weather fluctuations a few months ahead to global warming several decades ahead. For this, not only will we improve the accuracy of climate models, but we will also develop data assimilation methods that initialize the model using the observation data. We will verify hindcast skills for the past climate changes and provide prediction information for applied studies.

The second goal is to estimate the contribution from anthropogenic warming to the past extreme events such as heat waves and abnormally low temperatures.

The third goal is to clarify the factors that cause the wide range of predictions, such as "a temperature increase of 1.5 degrees to 4 degrees in 100 years" to improve the present prediction models. In particular, we aim to reduce the uncertainty of climate sensitivity by focusing on what approach to employ for "cloud behavior" in the models.

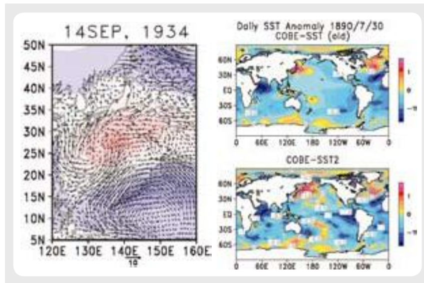


The prediction system is also used to estimate the contribution of global warming to the past extreme events toward risk assessment. Our simulation using the observed ocean condition revealed that the heat wave over Russia in August 2010 appeared to be a rare natural fluctuation (event probability 3.3%) (left panel). In a counterfactual simulation that removed the contribution of global warming, the event probability was less than one-fifth.

Improving prediction accuracy for the world

In the latter, i.e., development of an integrated prediction system for global climate studies, we aim to develop the optimization technology for applying analysis methods simultaneously to various spatiotemporal scales, obtaining initial and boundary values and improving computer processing.

To enhance the case studies and verify the prediction system, it would be desirable to compile reanalysis data of the atmosphere and ocean states for the past 100 years, yet this is difficult even with the supercomputer Earth Simulator which is the pride of Japan. Since the capacity of the supercomputer places a major limit on research progress, Theme A poses challenging goals. More accurate prediction of near-term climate changes will enable us to provide "more specific figures" for risk assessments to the world. In other words, it will become possible to calculate where we should place priority, how much budget is necessary and where it is necessary, and how many years will be required until preparations are complete.



At present, observation data for only 50 years are available to verify the prediction of decadal climate changes and extreme events. We attempt to reconstruct climate variability during the recent 100 years by using advanced data assimilation methods. The left panel represents a reconstructed weather chart at the time of the 1934 Muroto typhoon, and right panel represents the reconstructed sea surface temperatures at the end of the 19th century.

Key phrases	Reduction of uncertainty in climate predictions, detection and attribution of anthropogenic climate changes, seamless prediction of climate change, development and improvement of climate models, improvement of data assimilation system

Structure

JAMSTEC → AORI ← NIES

and others

Representative: Masahide Kimoto

Vice Director/Professor, AORI, the University of Tokyo

Representative: Masahide Kimoto

We have developed MIROC, the Model for Interdisciplinary Research on Climate, and have contributed not only to research on climate systems and climate changes but also to provision of prediction data for IPCC. In this regard, we aim to provide better climate prediction data on seasonal to interannual changes, and further, on interdecadal timescales, so that more effective risk management for climate changes can be practically conducted. To achieve this, through verifying the reconstruction of the past climate changes, we will improve climate models, develop assimilation systems using observation data, and engage in research to reduce the uncertainty in predictions.

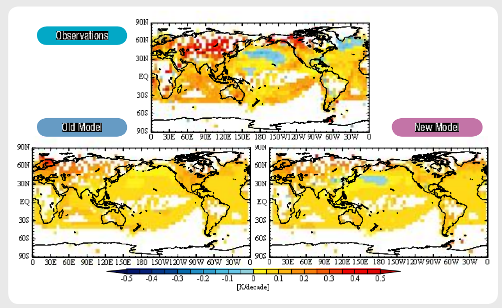
We are building a high-precision earth system model to contribute to global warming countermeasures and socio-economic scenarios

We aim to contribute to the setting of target levels to stabilize the climate and the building of more reliable socio-economic scenarios by constructing a climate system model that incorporates biological activities such as photosynthesis and environmental biogeochemical cycles for carbon dioxide and methane, etc., on a global scale.

Starting in the latter half of the 20th century, emissions of greenhouse gases including carbon dioxide surged due to industrial activities, and now attention is being called to the risks of global warming. It is clear from the observation data that the average temperature increased by 0.74 degrees Celsius (1.33 degree Fahrenheit) in the past 100 years, and there is no doubt that the earth is undergoing a warming trend.

The rise in temperature will cause negative effects including a rise in ocean levels due to melting ice sheets, an increase in massive typhoons and concentrated heavy rainfall, and extinction of living things, but the problem is that it is not easy to predict the climate change and the impact that will actually occur. Global warming has occurred repeatedly during the earth's 4.6 billion year history, but this is the first time that the human element has played a role.

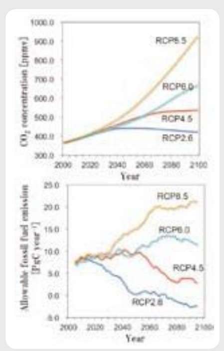
Four major themes spanning diverse research areas



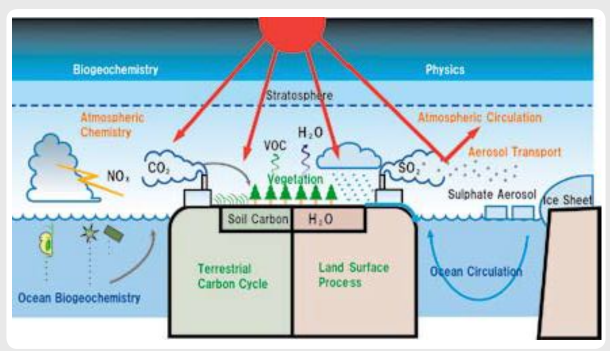
Improvement of the climate model: We are pursuing efforts to improve the climate model, which is the foundation for the earth system model. We are also improving the reproducibility of past climate changes.

Given these conditions, the four sub-themes under Theme B are "development of an earth system model," "study of socio-economic scenarios," "development of prediction models for tipping elements (sudden climate changes)," and "development of technologies for numerical investigations on geoengineering (climate engineering)" which should enable achievement of Theme B's objective, "climate change prediction contributing to stabilization target setting."

In charge of "development of an earth system model" are JAMSTEC, AORI, and NIES. We aim to enable dynamic analysis of the entire planet by incorporating environmental biogeochemical cycles and biological activity in the existing "earth system model," and to apply it to the issues at hand in this project. Researchers from a variety of backgrounds are participating in this project, not only those who specialize in meteorology and physical oceanography but also those in ecology and chemistry.



CO_2 emission path calculation: We can use the earth system model to answer the question of "How much do we need to reduce emissions to bring CO_2 concentration below 450 ppm in order to restrain global warming?"

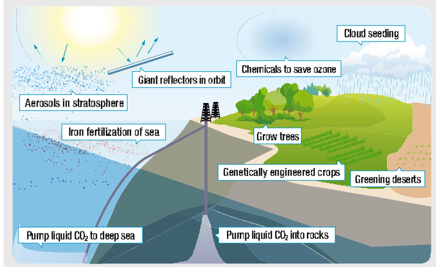


Structure of the earth system model. We are developing this model by adding biological and chemical processes to the atmospheric and ocean general circulation models that have been used for conventional global warming predictions.

Participating in the "study of socio-economic scenarios" are economics researchers who specialize in global warming countermeasures from the University of Shiga Prefecture and CRIEPI, in addition to researchers from AORI and from NIES. Heretofore, development of socio-economic scenarios was in the category of economics, but in this project, we have arranged for collaboration with the field of climate change analysis with the aim of building a future image of the world that is based on scientific data.

"Development of prediction models for tipping elements (sudden climate changes)" and "development of technologies for numerical investigations on geoengineering" are both handled by JAMSTEC, AORI, and NIES. In the former, our activities include the building of a prediction model for "changes in the outermost edges of the south polar ice sheet as it collapses," which has not been studied until now as well as verification with mathematical models of "how suddenly the melting of permafrost could occur" and "the volume of organic carbon that will melt and decompose."

In the latter, we carry out numerical investigations on development of technology to artificially control the climate and also calculate the expense, predict the effects, and predict the side effects of that. For example, we use Earth Simulator to "chill the earth by spraying fine particles in the stratosphere" and "promote photosynthesis by scattering iron in the ocean and increasing the plankton."

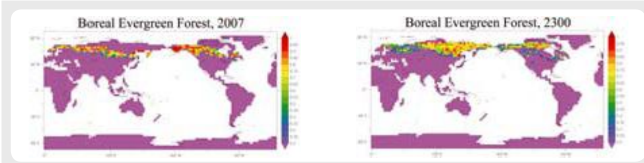


Proposed methods of geoengineering. Of these, in this program, we are working to verify the feasibility of "aerosols in stratosphere" and "iron fertilization of sea."

Producing results that contribute to society

Development and verification of a climate model depend largely on the development of supercomputer technology, but in Theme B overall, we would like to achieve an improved version of our earth system model by the fourth year of the project. Moreover, when building emission scenarios for carbon dioxide, not only do we plan to have researchers in the field of socio-economics produce estimates as has been done heretofore, but also to fully integrate knowledge and information from the natural science fields, such as the carbon cycle.

Prediction of changes in vegetation distribution: As global warming continues, the distribution of vegetation may change significantly. By using the earth system model, we can gain information about the changes in vegetation distribution.



Key phrases	Development of an earth system model, study of socioeconomic scenarios, tipping elements, geoengineering

Structure

CRIEPI

The University of Shiga Prefecture

JAMSTEC

and others

Representative: Michio Kawamiya

Project Manager, Research Institute for Global Change, JAMSTEC

Representative: Michio Kawamiya

While the question of "How much should we reduce carbon dioxide emissions in the future so that the earth is not massively harmed?" is a socio-economic question, it is also a natural science question that we need to tackle using an earth system model. We believe that we must engage in generating the future image of society while encouraging communication, which has been sparse, between researchers in both fields and taking on issues that have not been researched to a large extent until now, such as verification of achievability of geoengineering.

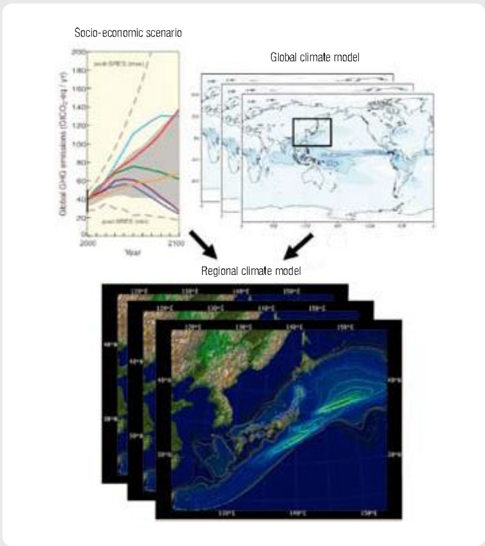
Theme C: Development of basic technology for risk information on climate change

We aim for technological development that will enable us to employ a statistical approach for everything from inter-annual variability to extreme climate phenomena and to produce detailed evaluations for each region

Our objective is to develop statistical methods for analyzing and evaluating, for instance, the inter-annual variability of seasonal changes which affects the timing of the northward movement of the cherry blossom front (“Sakura-Zensen”) or the southward movement of the autumnal-colored front (“Kouyou-Zensen”), or extremely rare weather phenomena such as the Isewan Typhoon (Typhoon Vera). We also aim to create a picture of the “conceivable scenarios,” including the probability of a particular scenario occurring. The research results will be useful when devising countermeasures for future disasters, etc., of the nation and municipalities.

The Isewan Typhoon made landfall at Cape Shionomisaki in September 1959 and wreaked tremendous damage in almost all regions of Japan. Approximately 5,000 people lost their lives, and the economic damage due to high tides and floods was 551.2 billion yen, equivalent to three times the annual national budget at the time. This type of extreme weather event occurs only rarely, about “once in 20 to 50 years.” However, when it does occur, many people’s lives are endangered, and significant social and economic damage and chaos ensue.

Theme C, development of basic technology for risk information on climate change, will focus on these types of extreme weather conditions that rarely occur. Ultimately, we aim to achieve detailed regional evaluations by employing a statistical approach to extreme precipitation, ocean wave height, and wind speed. Broadly speaking, there are two specific research sub-themes. One is “probabilistic climate projection for risk assessment,” and the other is “producing a standard climate scenario by using super high resolution models.”



Ensemble numerical experiments to generate probability data for weather scenarios

Here, in addition to assessment of the uncertainty in a global climate model by using ensemble experiments, etc., we use downscaling techniques to obtain detailed climate information for each region. Downscaling is a method for obtaining the distinctive changes in each region in Japan from low resolution information such as the computation results from a global coupled atmosphere-ocean general circulation model. Here, we employ a dynamical downscaling method that uses various regional climate models like those used for daily weather prediction.

Probabilistic climate prediction for risk assessment

The first sub-theme, probabilistic climate prediction for risk assessment, is handled by NIED, ISM, and AORI. Here, for the purpose of climate change risk assessment, we study the statistical expression of uncertainty in detailed regional climate change scenarios using a climate model, and we study how to sample efficiently and evaluate statistically the extremely rare weather phenomena.

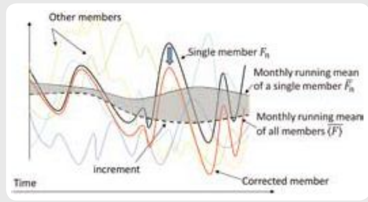
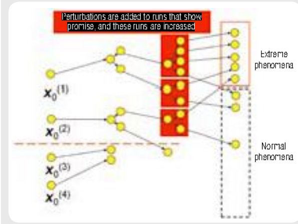


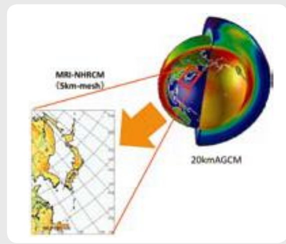
Illustration of the single member correction method which is an efficient method of dynamical downscaling from the ensemble prediction results. This figure shows the correction using the same method for forecast variables (from black line to red line).



Sampling of extreme phenomena. We simultaneously begin multiple runs with different initial conditions or initial values (the four ◯ arranged vertically on the left). If a run is determined to have no chance of reaching an extreme phenomena by a given point in time (i.e., it is below the red dotted line), then the time integration is halted. If the run is considered to have a chance (◯ above the red dotted line), we continue the time integration after adding perturbations to that value, assigning new tasks to the computing unit which has already halted the time integration before. Through these operations, it is possible to prioritize the assignment of computation resources to extreme phenomena.

Producing a standard climate scenario by using super high resolution models

The second sub-theme, producing a standard climate scenario by using super high resolution models, is handled by University of Tsukuba, MRI, and HyARC. Using a super high-resolution atmospheric model, we generate detailed climate change scenarios for Japan that are useful in assessing climate change risk. A coupled model will be developed to assess accurately the interaction between ocean and typhoon and will be used to quantitatively project the typhoon intensity in the future climate.



Schematic diagram of a dynamical downscaling experiment using 5-km mesh regional climate model (lower left) from a 20-km mesh general circulation model (upper right)

A super typhoon in a global warming climate predicted by a cloud resolving atmospheric model with a 2km horizontal resolution. The clouds of the simulated typhoon are shown in 3D. When this typhoon is over the Pacific Ocean, it maintains a central pressure of 870 - 860 hPa and a maximum wind speed of 70 - 80 m/s for four days, and it makes landfall at nearly the same intensity.

Key phrases	Climate scenario, ensemble experiments for climate change, downscaling, statistical evaluation, typhoon intensity estimate

Structure

University of Tsukuba

ISM

HyARC, Nagoya University

NIED

MRI

AORI

and others

Representative: Izuru Takayabu

Head of the Second Laboratory, Atmospheric Environment and Meteorology Research Department, MRI

Representative: Izuru Takayabu

The key to the success of this theme is “collaboration” across a variety of fields although the dynamical downscaling technique used in this theme is based on a field of meteorology. This time, experts in statistics are also involved for the first time, and we are pursuing research together with scientists from various applied fields. To communicate smoothly with researchers from different fields, including agreeing on definitions of basic terminology, a number of years are required. We believe that we must strive, at times with perseverance, for good communication.

How will global warming change typhoons and ecosystems? We tackle oncoming problems that affect all of us

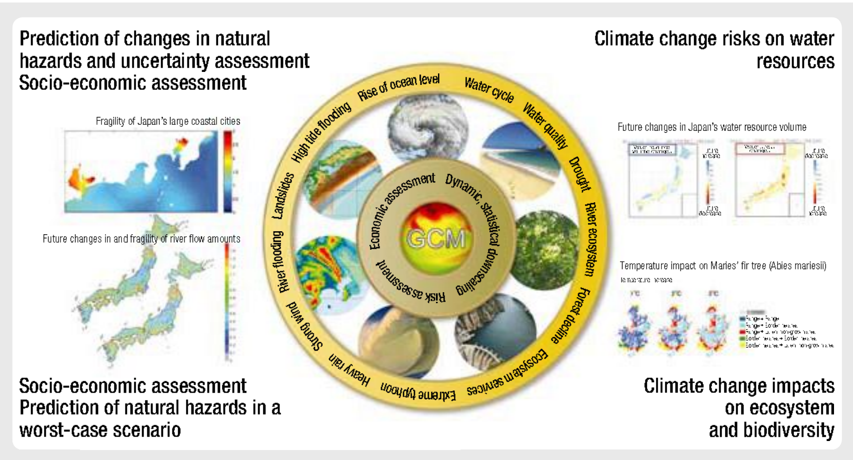
How will global warming change typhoons, floods, landslides, and river flows as well as the forests and oceans? By producing specific predications, we promote adaptation to oncoming problems that affect all of us.

Not long ago, there was a great deal of careful discussion on whether or not global warming is related to extreme weather phenomena such as the large typhoons and localized heavy rainfall that have been increasing recently. However, Japan experienced any number of close brushes with, and direct hits from, large typhoons and frequent occurrence of strong winds, floods, overflowing rivers, high tides, high waves, and landslides. Concern has spread that these disasters may intensify as global warming progresses.

Theme D, precise impact assessments on climate change, aims to scientifically demonstrate the connection between the aforementioned increase in natural disasters and global warming and to look 100 years into the future to see how serious it may become. The research results are to be presented as “actual figures” and are expected to be used as data for the government and municipalities to consider how to protect the lives of people in urban and rural areas, coastal areas, and river areas.

A “100 year impact assessment” was proposed by this program’s antecedent, KAKUSHIN, but this is the first attempt to produce an actual figure for “the maximum predicted amount of future rainfall.” To generate this kind of specific figure, detailed data with a high degree of precision is required. Even with all the data that we can collect, the sample size and precision are still inadequate. So, in Theme D, we take on the challenge of developing an assessment model that can produce predictions even given the data limitations, and we endeavor to assess extreme phenomena.

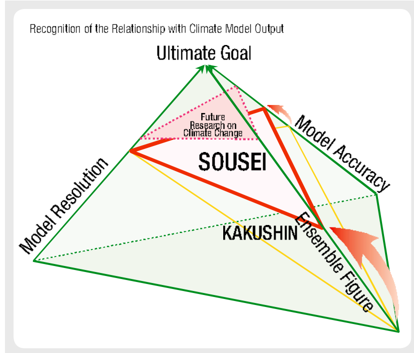
Broadly speaking, there are three specific research sub-themes. They are “climate change impacts on natural hazards,” “climate change impacts on water resources,” and “climate change impacts on ecosystems and biodiversity.”



Climate change impacts on natural hazards

The first sub-theme, climate change impacts on natural hazards, is handled by DPRI-KU, together with Global Centre of Excellence for Water Hazard and Risk Management (ICHARM/PWRI). We aim to produce predictions for scenarios including worst-case particularly in the case of typhoons, which cause the most serious weather-related damage in Japan, concerning the frequency, scale, accompanying precipitation, strong winds, high tides, and high waves, including during the Baiu season.

There are approximately 25 typhoons annually, and around 10 of those approaches or make landfall in Japan. The number of typhoons is not large, but it is known that a small alteration in the path of a typhoon can have an extremely large impact on the amount of wind and rain Japan receives, and as a result, cause immense damage. We will predict and assess how the frequency of “once in 100 years” type disasters and worst-case damage will change during the coming 100 years, and we will use this information to understand the impact on society and for national planning.



When generating impact assessments and adaptation strategies, the ultimate ideal is to boost the model’s accuracy and to generate many possibilities (ensembles) with finer time and space resolutions, but this ideal is not achievable. So, what can be done? This challenge is one of the highlights of climate change impact assessment.

Climate change impacts on water resources

The second sub-theme, climate change impacts on water resources, is handled by DPRI and IIS. When the climate changes due to global warming, the rain amount and rain patterns change significantly. It is also possible that what formerly fell as snow will change into rain. In Japan which has many mountainous regions, it is anticipated that this would cause a great change in the “pattern of water flowing into rivers.”

So, the Kyoto University team of this group will predict and assess the changes in the flow and supply of water in the main rivers in Japan, the impact on rice farming, etc., and the need for flood control such as dams, etc. Similar prediction and assessment will be pursued for the world’s major rivers, including in Asia. The University of Tokyo team will predict and assess how the actual water cycle will change on a global scale with the addition of artificial modifications. This team will also study the effectiveness of adaptation strategies.

Key phrases	Assessment of impact 100 years in the future, application to the East Asian region, actual condition of global warming and impact assessment as well as countermeasures, prediction of climate on a regional scale

Structure

DPRI Kyoto University

NIES
National Agriculture and Food Research Organization (NIRE/NARO)
Tohoku University
Nagoya University
IIS, the University of Tokyo
Tokyo Institute of Technology
ICHARM / PWRI
Hokkaido University
and others

Representative: Eiichi Nakakita

Professor, DPRI, Kyoto University

Representative: Eiichi Nakakita

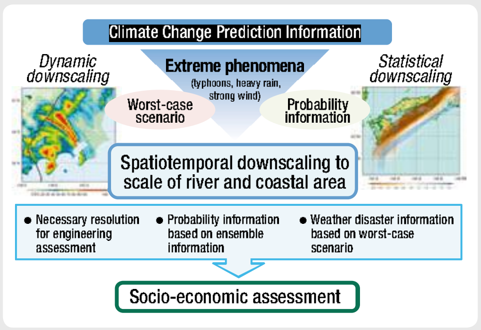
This area deals with a wide field. It focuses on phenomena that are the entryway for the research project (from natural hazards and water resources to ecosystems) and the exit target (adaptation strategies). It is extremely important to understand the entry phenomena as well as to know the society, people, and living things involved in the exit. Consequently, I believe that, compared to the other areas, we will be able to pursue our research with many researchers in an enjoyable and lively manner.

Climate change impacts on ecosystem and biodiversity

The third sub-theme, climate change impacts on ecosystem and biodiversity, is supervised primarily by Graduate School of Life Sciences at Tohoku University, and other participants include Nagoya University, Hokkaido University and NIES. We aim to predict and assess whether ecosystems are capable of changing abruptly due to global warming, taking as models the forests of northeastern Japan and the marine life in the ocean near Japan.

The Tohoku University team will conduct predictions and assessments concerning whether global warming will cause the extinction of alpine plants, the impact of strong wind on forests, the purification effects of forests, and changes in tourism resources. The Nagoya University team will conduct predictions and assessments on how climate change alters forest vegetation and then whether the altered forest vegetation affects the climate. The main research sites will be Asian rainforests and the eastern boreal Siberia. The team will study the changes in the major forests in the world, such as the tundra forest.

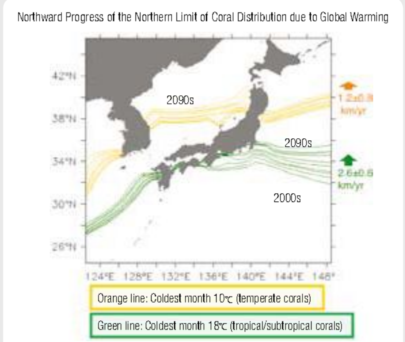
The team composed of Hokkaido University and NIES focus on ocean acidification which occurs when more anthropogenic carbon dioxide dissolves in seawater. The team will predict and assess what sorts of changes will occur in coastal marine ecosystem such as coral reefs and seaweed forests due to global warming and ocean acidification.

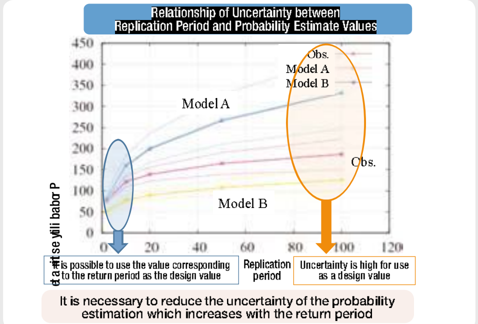


Prediction of Future Changes in Natural Hazards

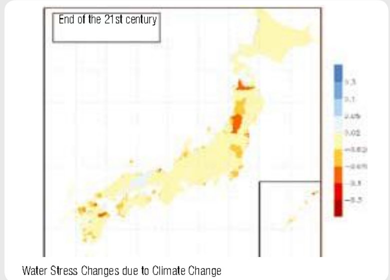
Specific results for input into policy

Of all the themes in this project, the issues examined in Theme D are the most specific and the closest to us. Naturally, work on this theme will enable more accurate prediction of "how climate and meteorological phenomena will change," but the theme will also explore how to utilize the research results in society in order to minimize the lives and assets lost in natural hazards. We look forward to results that enable proposals that will cause a paradigm shift among policymakers.





Relationship between Replication Period and Uncertainty of Probability Estimate



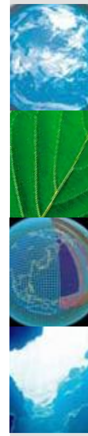
Water Stress Changes due to Climate Change

Theme E : Promotion for climate change research and linkage coordination

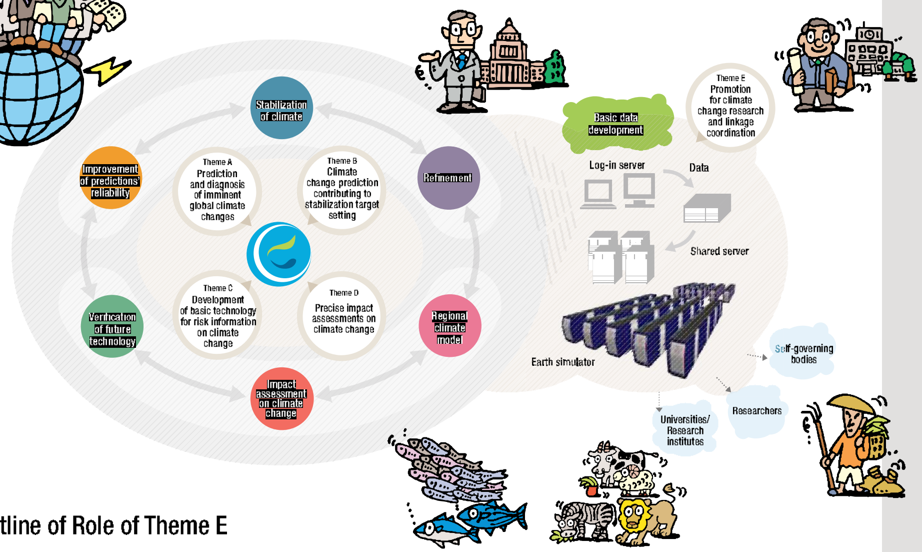
Summarizing the research result of SOUSEI Program overall and connecting it to society

Theme E plays the role of coordinator

To derive maximum utilization from the results of the Generation Program, we will connect them to the practical aspects of all sorts of disaster-related and preparation-related situations. The role of Theme E is to provide support for coordination, liaison, and information exchange for this purpose.



Theme E will coordinate the linkage of themes A through D and manage the research results in a database in a unified manner. Then, the results will be edited and organized so they can be put to practical use, and using an information network of all the teams and related institutions, a foundation for opportunities to utilize the research results in the real world will be created.



Outline of Role of Theme E

■To fulfill the role of coordinator so as to ensure the utilization of the research results of SOUSEI Program for more accurate and precise weather prediction and disaster prevention.

■To centralize the research results of all the teams in a database and to classify, organize, and provide technological support for efficient utilization of the data.

■To spearhead liaison conferences and information exchanges among themes A through D and to contribute toward the mutual sharing and multilayered utilization of research results.

■To conduct public relations activities so that the this Program becomes widely known, such as holding public symposiums and issuing newsletters.

Related Organizations

Theme A

Atmosphere and Ocean Research Institute, the University of Tokyo

http://www.aori.u-tokyo.ac.jp/english/

- Japan Agency for Marine-Earth Science and Technology
- Center for Global Environmental Research, National Institute for Environmental Studies

Theme B

Japan Agency for Marine-Earth Science and Technology

http://www.jamstec.go.jp/e/

- The University of Shiga Prefecture
- Central Research Institute of Electric Power Industry

Theme C

University of Tsukuba

http://www.tsukuba.ac.jp/english/

- Atmosphere and Ocean Research Institute, the University of Tokyo
- Hydrospheric Atmospheric Research Center, Nagoya University
- Research Organization of Information and Systems, the Institute of Statistical Mathematics
- National Research Institute for Earth Science and Disaster Prevention
- Meteorological Research Institute, Japan Meteorological Agency

Theme D

Disaster Prevention Research Institute, Kyoto University

http://www.dpri.kyoto-u.ac.jp/web-e/

- Hokkaido University Graduate School of Environmental Science
- Field Science Center for Northern Biosphere, Hokkaido University
- Graduate School of Life Sciences, Tohoku University
- Graduate School of Environmental Studies, Tohoku University
- Institute of Industrial Science, the University of Tokyo
- School of Engineering The University of Tokyo
- Graduate School of Information Science and Engineering, Tokyo Institute of Technology
- Hydrospheric Atmospheric Research Center, Nagoya University
- National Agriculture and Food Research Organization
- International Center for Water Hazard and Risk Management under the auspices of UNESCO, Public Works Research Institute
- Center for Environmental Biology and Ecosystem Studies, National Institute for Environmental Studies

Environment and Energy Division
Research and Development Bureau
Ministry of Education, Culture, Sports, Science and Technology-JAPAN

3-2-2 Kasumigaseki, Chiyoda-ku,
Tokyo 100-8959, Japan
URL:http://www.mext.go.jp/english/

Contact Point

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

3173-25 Showa-machi, Kanazawa-ku
Yokohama, Kanagawa, 236-0001, Japan
Email : sousei_info@jamstec.go.jp
URL:http://www.jamstec.go.jp/sousei/english/

2013.12

VEGETABLE OIL INK