出國報告（出國類別：國際會議）

出席「Tackling the Air Pollution & Climate Change ： A Science-Policy dialogue」出國報告書

服務機關：行政院環境保護署
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壹、前言

一、「國際地圈/生物圈計畫(International Geosphere-Biosphere Programme，IGBP) 」介紹：

IGBP 於 1982 年由「國際科學聯盟 (International Council for Science, ICSU)」支持成立，專門提倡全球變遷(Global Change)之重要性，其研究地球系統間之生物、化學及物理作用與相互關係，以及人類活動對於全球變遷扮演之角色，據以了解全球變遷衝擊及提出因應對策。IGBP 轄下之大氣化學計畫(International Global Atmospheric Chemistry，IGAC)主要研究範疇則爲大氣化學與氣候變遷。

二、「Rio+20 -- United Nations Conference on Sustainable Development」(Rio 20 年—聯合國永續發展大會，簡稱里約 20 年)介紹：

氣候變遷與人類生活環境、糧食供給及生命財產等息息相關，近一、二十年來更成爲全球關注之議題，聯合國於 1992 年在巴西里約熱內盧(Rio)舉辦「1992 United Nations Conference on Environment and Development (UNCED) 」(1992 年聯合國環境與發展大會)，後續於 2002 年在南非約翰尼斯堡舉辦「2002 World Summit on Sustainable Development (WSSD) 」(2002 年世界永續發展高峰會)，並將在 2012 年 6 月 4-6 日在巴西舉辦「Rio+20 -- United Nations Conference on Sustainable Development 」(Rio 20 年—聯合國永續發展大會，簡稱里約 20 年)，聚集世界各國領袖凝聚永續發展共識，對人類的永續發展，發表重要的宣言。此重要宣言，將代表世界各國政府在處理環境保護與經濟發展議題的政策方向與承諾。

三、IGBP 相關科學家，長期以來即針對全球變遷進行深入研究，IGAC 亦由五位科學家組成「空氣污染與氣候, Air Pollution and Climate, AP&C」小組，研究空氣污染與氣候變遷之關聯，並預定於 2012 年 3 月 26-29 日在英國倫敦舉辦「Planet under Pressure」科學大會，預計將邀請各國重量級學者出席，呈現目前全球變遷的現況，並凝聚科學界共識，提出全球科學家針對永續發展的看法，以期能影響「里約 20 年」各國政府的意向，對永續發展有更正面的態度。

四、「空氣污染與氣候」科學小組主張政府在研擬空氣污染管制策略時，應一併考慮民眾健康與氣候變遷的重要性，該小組規劃在 2012 年 3 月 26-29 日在英國倫敦舉辦「Planet under Pressure」科學大會前辦理 2 次工作討論會(workshop)，邀請各領域專家，從氣候變遷、空氣污染防制、政策擬定等不同角度，進行腦力激盪，以研提出具說服力的學術說帖。

五、本署本(2011)年度委託辦理「空污及海岸地區大城市與全球變遷研究成果彙整」計畫，參與「空氣污染與氣候, Air Pollution and Climate, AP&C」小組討論，今年(2011)6 月 9-10 日該小組在義大利 Arona 舉辦第一次工作討論會－「Tackling the Air Pollution & Climate Change ： A Science-Policy dialogue」，邀請 20 多位各領域專家參與，本署亦派員與會，該小組第二次工作討論會，預定於本年秋季於我國舉辦，屆時，將完成「空氣污染與氣候變遷」說帖，於 2012 年 3 月倫敦舉辦之『Planet under Pressure』科學大會發表，並作爲「里約 20 年」重要學術說帖。

貳、行程及參加人員

日期	行程及地點	工作內容
6 月 7 日(二)	臺北出發至義大利 Arona	啓程
6 月 8 日(三)	轉機抵達義大利 Arona	抵達會議地點
6 月 9 日(四)	義大利 Arona	參加「Tackling the Air Pollution & Climate Change：A Science-Policy dialogue」
6 月 10 日(五)	義大利 Arona	參加「Tackling the Air Pollution & Climate Change：A Science-Policy dialogue」
6 月 11 日(六)	義大利 Arona 出發	返程及轉機
6 月 12 日(日)	轉機抵達臺北	返程

本次討論會參加人員包含 IGAC 之 5 位科學家(其分別來自於法國重要學術機構、英國及美國之耶魯與普林斯頓等著名大學及美國環保署)、國際間從事氣候變遷之學者(來自希臘、義大利、丹麥、英國、美國、日本及南非等)、英國環保署官員等，我國則由本署委託辦理「空污及海岸地區大城市與全球變遷研究成果彙整」計畫協同主持人中央研究院龍世俊博士及本署郭孟芸技士參加，與會人員約 20 餘人。

參、活動地點及內容

「Tackling the Air Pollution & Climate Change ： A Science-Policy dialogue」於 2011 年 6 月 9 日至 10 日於義大利 Arona 舉行。

IGBP 轄下之大氣化學計畫(International Global Atmospheric Chemistry，IGAC)指出，空氣污染物除對人體造成影響外，也對氣候變遷造成衝擊，例如對流層之臭氧、懸浮微粒中碳黑等可能導致大氣暖化，而硫酸鹽卻是造成大氣冷卻，其影

響強度及效應，仍有待釐清；而另一方面，氣候變遷導致之氣溫、水循環變化亦對空氣品質造成影響。空氣污染與氣候變遷有密不可分之關係，關於兩項議題科學證據之建立與管制策略之推動，應同時予以考量。

本次會議 IGAC 針對空氣污染導致之人體健康及氣候變遷影響，嘗試開啓學者專家與決策者對話，其藉由空氣污染物之控制改善，降低對人體健康影響，並減緩氣候變遷。

本次會議討論重點爲：

(一) 確認空氣污染與氣候變遷之挑戰。

(二) 彙整評估目前針對空氣污染及氣候變遷所作之努力及成效，提供政府機關及相關單位參考。

(三) 研提未來針對空氣污染與氣候變遷議題之研究方向。

本次會議討論係由與會者針對上述議題進行腦力激盪，廣泛討論，後續將於本(2011)年秋季於我國舉辦之後續會議，並進一步凝聚重點進行細部修正，做成正式文件，列爲 2012 年 3 月於英國舉辦之 Planet Under Pressure Conference 會議資料；後續並將列入 2012 年 6 月「里約 20 年」地球環境高峰會議評估報告。

肆、與會目的

一、藉由參與本次會議，與國際間學者及其他國家代表交流我國空氣污染管制及因應氣候變遷作爲與成效，並建立聯繫管道，掌握國際間其他先進作爲，可提供本署進一步推動空氣污染管制與氣候變遷因應策略參考。

二、我國並非聯合國成員，無正式管道可參與國際上永續發展議題之討論，藉由參與 IGBP 轄下 IGAC 關於「空氣污染與氣候變遷」之討論，表達我國對於

氣候變遷與空氣污染防制議題之重視及推動之相關管制措施，提高國際能見度；且討論作成之報告後續將提供「里約 20 年」作爲學術說帖，對於全球處理環境保護及經濟發展之影響重要性極高，爲本署在國際交流之一大突破。

伍、會議過程

一、會議進行方式：

本次會議主題爲「空氣污染與氣候變遷(Air Pollution & Climate Change ： A Science-Policy dialogue)」，藉由與會者發表對於空氣污染與氣候變遷議題之見解、分析面臨之挑戰，進行腦力激盪及意見交流。另外，會議中並安排從事氣候變遷及健康影響之學者進行演說，分別從空氣品質改善及氣候變遷減緩之觀點，探討目前科學研究及政策制訂尚有缺漏部分及未來挑戰方向，關於聯合國提出之空氣污染與氣候變遷相關報告，亦請相關學者整理於會議中演說。本次會議最後透過分組討論方式，凝聚對於氣候變遷與空氣污染見解，彙整成會議結論(詳細議程如附錄一)。

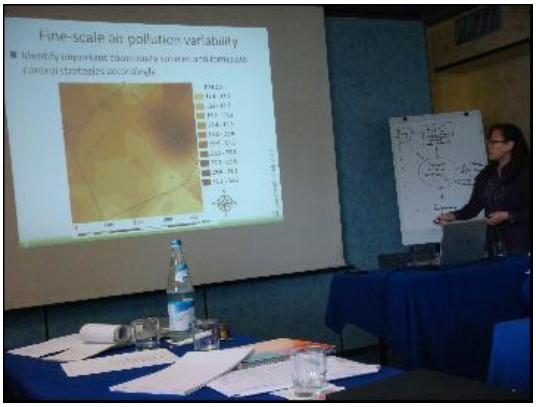
二、我國/本署代表發表內容：

本署委託辦理之「空污及海岸地區大城市與全球變遷研究成果彙整」計畫協同主持人中央研究院龍世俊博士，爲研究空氣污染與人體健康及氣候變遷之專家，龍博士於本次會議提出從對健康及氣候變遷影響之觀點，探討未來空氣污染管制應先進行基礎工具建置及科學研究重點，其指出在空氣污染物排放清冊部分，應加強社區污染源包括餐飲店、寺廟、夜市及汽車美容業等、農業活動(稻草露天燃燒)、建物塗裝、消費性商品揮發性有機物及生物源空氣污染物排放清

冊建置作業；並應進一步掌握空氣污染物大氣化學反應機制，其並提出空氣污染物之區域變化、氣膠粒徑及成分對於健康之影響及複合空氣污染物對於健康影響等，爲科學家未來研究之重點，希望透過科學數據，能尋求在氣候變遷下降低健康損害之方法。

本署代表於會議討論時，表達我國對於氣候變遷與空氣品質關聯議題之重視。基於從事空氣品質保護工作，維護民眾健康之立場，本署已推動各項固定污染源及移動污染源管制措施，以降低空氣污染物之排放量，改善空氣品質。近來，對於氣候變遷影響空氣品質之情形，本署亦觀察出顯著之證據，包括 2009 年 8 月莫拉克風災後，豪大雨造成大量土石沖刷，地表裸露面積增加，導致揚塵污染情形亦變嚴重，而本(2011)年 1 月至 5 月台灣氣溫略低於往年，亦發現臭氧濃度亦有下降趨勢，該些證據都顯示氣候變遷確實與空氣品質有緊密之關聯。爲了解氣候變遷對於空氣品質之影響，本署已規劃辦理相關研究計畫，將初步國際間相關文獻，以提供更多科學證據，作爲本署推動空氣污染管制之參考。

對於研究氣候變遷之學者，在探討控制CO_2等溫室氣體排放量，以減緩氣候變遷之同時，也開始關注空氣污染物造成暖化情形，並提出部分空氣污染物（例如碳黑）減量亦有助於氣候變遷之減緩，在制定管制策略時，應同時考量該些污染物造成污染與氣候變遷影響之觀點，基於推動空氣污染管制工作者之立場，所推動之管制工作具有另一層面之效益，理所當然是相當樂見的，因爲這使我們在推動空氣污染管制工作時，更具說服力。但是，對於關心氣候變遷者而言，從空氣污染物減量著手，其效益如何，應再深入思考。另外關於降溫有正面效益之硫酸鹽($SO4^{2-}$)，由於其對健康有不良影響，倘因其排放對於氣溫上升有減緩作用，即不再管制，是否是正確作法，應仔細依各區域實際污染、溫度與環境狀況，深入評估，方能做出正確決策。


Fine-scale air pollution variability


The Output of the IGBP Air Pollution & Climate Initiative


ific challenges

會議討論情形照片

陸、心得與建議

在本署積極推動各項管制措施下，各種空氣污染物排放量在能源消耗量提高、機動車輛數增加、人口數及經濟持續成長之情形下，已呈現下降趨勢，空氣品質亦呈現改善趨勢， 84 年時，全國測站 PSI>100 百分比爲 6.1%，98 年以降低至 2.87%，99 年更進一步提升至 1.44%，爲歷年來最佳者。

隨著環境負荷持續增加、氣候變遷更加顯著、大陸經濟蓬勃發展所排放之空氣污染物經過長程傳輸日漸加劇等不利因素之影響，空氣品質維護及持續改善之困難度亦隨之增加，如何在既有之空氣污染管制制度外，規劃更有效之空氣污染減量策略，成爲未來空氣品質維護及改善工作必須面臨的挑戰。

空氣污染防制工作面臨的另外一個難處是，長期推動空氣污染管制工作下來，污染較易於控制或改善者，已進行改善，欲使空氣品質再有一點點的提升，需投入的防制成本甚或比過去能獲得大幅改善的成本高，也因爲投入成本高，改善效果不易見，因此，推動空氣污染防制工作講求效益評估，從改善所需投入的成本，與空氣品質改善能獲得的民眾健康改善、生活品質提升等價值比較，能獲得正面效益者，方具有說服污染者從事改善之立基。

參加本次會議，對於以降低民眾健康不良影響爲理念，推動空氣污染防制工作，以改善空氣品質之工作者而言，是有相當衝擊的。科學證據指出，部分空氣污染物例如碳黑及臭氧等，對人體健康有不良影響，且同時導致溫室效應，無庸置疑的，基於保障民眾健康及維持環境永續發展，應予控制減量；但有一些污染物成分，例如硫酸鹽在大氣層中影響人體健康時，卻因會反射陽光，讓氣溫降低，減緩地球增溫情形，美國官方數據顯示，中國大陸用煤量在 2002 至 2007 年從 1 億 3920 萬噸增加到 2 億 8920 萬噸，增加超過一倍，由於燒煤排放更多的硫，硫會形

成水滴及懸浮微粒，生成煙霧雲，把陽光反射回太空，使得過去 10 年，全球氣溫沒像更早的 30 年間上升。對於人體健康有不良影響的空氣污染物卻可減緩地球溫度上升，甚至有人提出，污染管控若僅考慮對當地空氣品質的影響，有可能在短時期內反而加速了氣候變遷的腳步，釀成可怕的氣象災害的想法。因此，在考量對於氣候變遷造成影響之情形下，更加重的空氣污染防制工作之複雜性與困難度。

空氣污染與氣候變遷交互影響之複雜性，已具有明顯不爭之事實依據，爲推動有效及正確之管制措施，建議進行管制措施效益評估除應就污染控制成本及健康提升效應等因子予以評估外，亦應將氣候變遷影響納入考量。

附錄一：議程

Tackling the Air Pollution and Climate Change Challenge: A Science-Policy Dialogue

The aim of the workshop is to produce a draft outline of a briefing document that will:

1. Define the air pollution and climate challenge.
2. Summarize and assess current efforts for policy makers and other stakeholders.
3. Outline a strategy for future research efforts on this topic.

Outline Agenda

Thursday 9th June

9.00am Speakers: Introduction, What is a science–policy dialogue and how can we get it to work? (Paul Monks, Kathy Law)

Session 1: Framing the challenge

9.20am Participant Perspectives: What is the air pollution-climate challenge?

Ninad Bondre – Global Sustainability Science
Sandro Fuzzi – Air Quality-Climate Interaction (thoughts from the ICSU-Belmont Forum)
Jose Jimenez-Mingo – Perspective from the EC Research & Innovation
Kathy Law – AMAP Report on SLCF
Denise Mauzerall – How can we tailor our message to policy makers?
David McCabe: What is the "Air Pollution Climate Challenge"?
Megan Melamed – IGAC/NOAA Bounding BC Report
Hiroshi Tanimoto – Science Policy Interface in Japan
John van Aardenne – Air Pollution and Climate Change at EEA
Erika von Schneidemesser – Science Challenges
Marcus Amann – Creating a Dialoque
Catherine Witherspoon – Integrating Air Quality & Climate Change: The Policy Challenges
Tim Williamson – AQ and Climate Policy: Getting the right outcome
Iyngara Mylvakanam – UNEP Perspective
Tirusha Thambiran – South Africa Perspective
Meng Kuo – Taiwanese EPA Perspective
Frank Raes – Modeling Air Pollution and Climate Change

12.45pm Lunch

2.00pm Rapporteur: What is the challenge from a scientific perspective? (Maria Kanakidou)

2.15pm Rapporteur: What is the challenge from a policy perspective? (Catherine Witherspoon)

Session 2: Arriving at a consensus view of the challenge(s)

2.30pm Roundtable Discussion: Arriving at a Consensus, drafting a summary of the challenge from a science-policy perspective

4.00pm Tea and Coffee

Session 3: Addressing the Challenge

4.30pm Speaker: What are the scientific gaps in addressing the challenge – AQ perspective?
(Candice Lung)

4.50pm Speaker: What are the scientific gaps in addressing the challenge– climate perspective?
(Frank Dentener)

5.10pm Speaker: What are the policy gaps in addressing the challenge?
(Terry Keating)

5.30pm Finish

8.00pm Dinner at Risorante del Barcailolo (Supported by IGBP)

Friday 10th June

9.00am Session 3: Addressing the Challenge - Continued

9.05am Speaker: Lessons from the UNEP BC:O3 report
(Frank Raes)

9.25am Speaker: How to tackle the challenge using a science-policy integrated strategy
(Martin Williams)

Session 4 – Tackling the Challenge

10.00am Breakout Session: IGBP Statement on the Air Pollution & Climate Change Challenge

10.45am Tea and Coffee

11.15am Breakout Session: Strategy for a multi-disciplinary program

12.00pm Reports from the Breakout Sessions

12.45 Speakers: What have we Learned and how do we move forward?
(Paul Monks, Kathy Law)

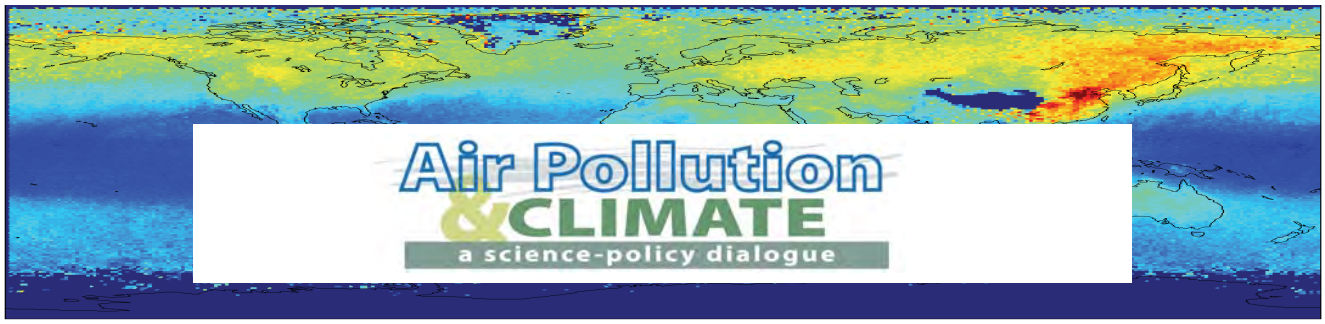
13.00pm Lunch and Close

附錄二：會議紀錄

Air Pollution & CLIMATE

a science-policy dialogue

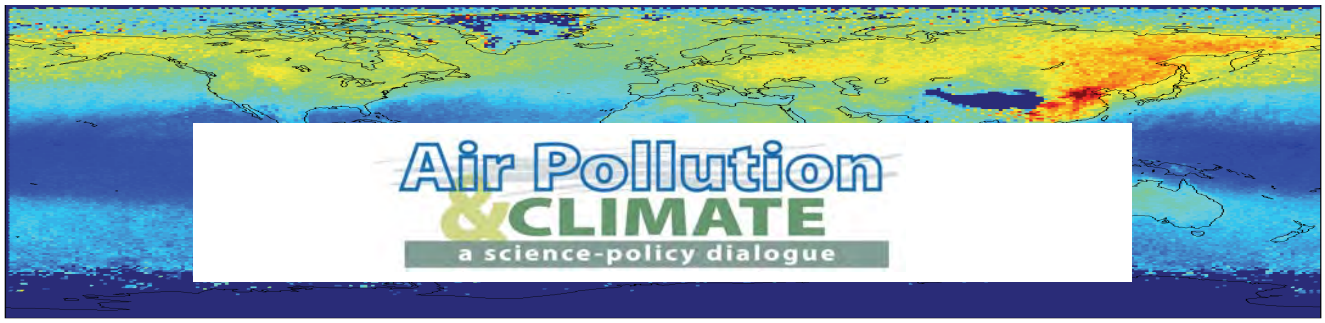
An IGBP Synthesis



The IGBP Air Pollution and Climate initiative aims to:

engage a range of stakeholders (scientists, economists, policy makers, etc.) to assess the status of knowledge with regard to current understanding about air pollution and climate and their interactions in particular with relation to current and proposed mitigation options and policy discussions.

– **Steering Group** – Law/Monks (leads), Mauzerall (Princeton), Keating (US EPA) Unger (Yale), Melamed (IGAC)



AIMS

- Synthesis for policy makers on current state of knowledge on the role and interactions between air pollutants and climate change, including an assessment of uncertainties and identification of gaps.
- Explore and quantify possible mitigation options within socio-economic and scientific context.
- In partnership between policy makers and scientists, assess and develop new metrics to quantify co-benefits/trade-offs of past and future pollutant reduction strategies from different emission sources on air quality, human health, climate, ecosystems, and food and water security (within the context of natural changes in the Earth system).
- Build a new multi-disciplinary research programme to tackle cross cutting issues across traditional science-policy boundaries.

ACCENT *Plus*
ATMOSPHERIC COMPOSITION CHANGE
THE EUROPEAN NETWORK

PI: Fuzzi – Policy topic led

US EPA BC report to congress

AMAP expert group on SLCF

UNEP

UNEP Black Carbon/O_3 "Bounding Black Carbon"

EU
- PEGASOS
- ECLISPE
- ECLAIRE

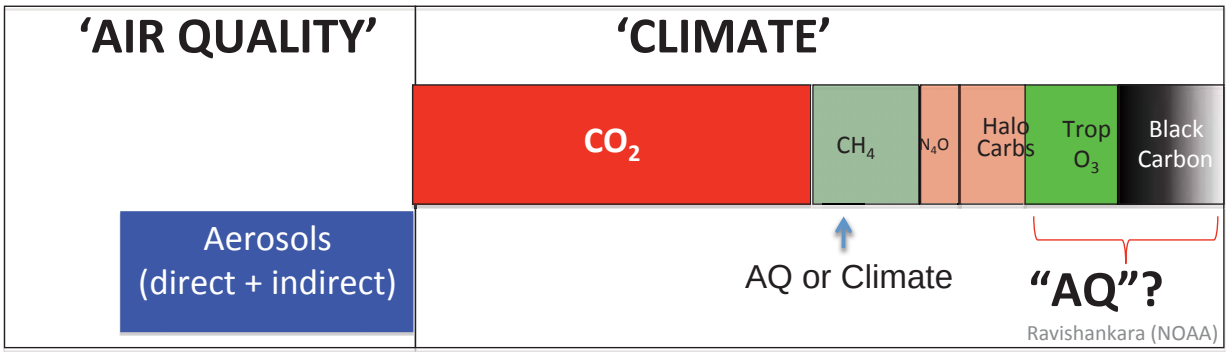
SEVENTH FRAMEWORK PROGRAMME

LRTAP **Task Force on Hemispheric Transport of Air Pollution** HTAP & Climate

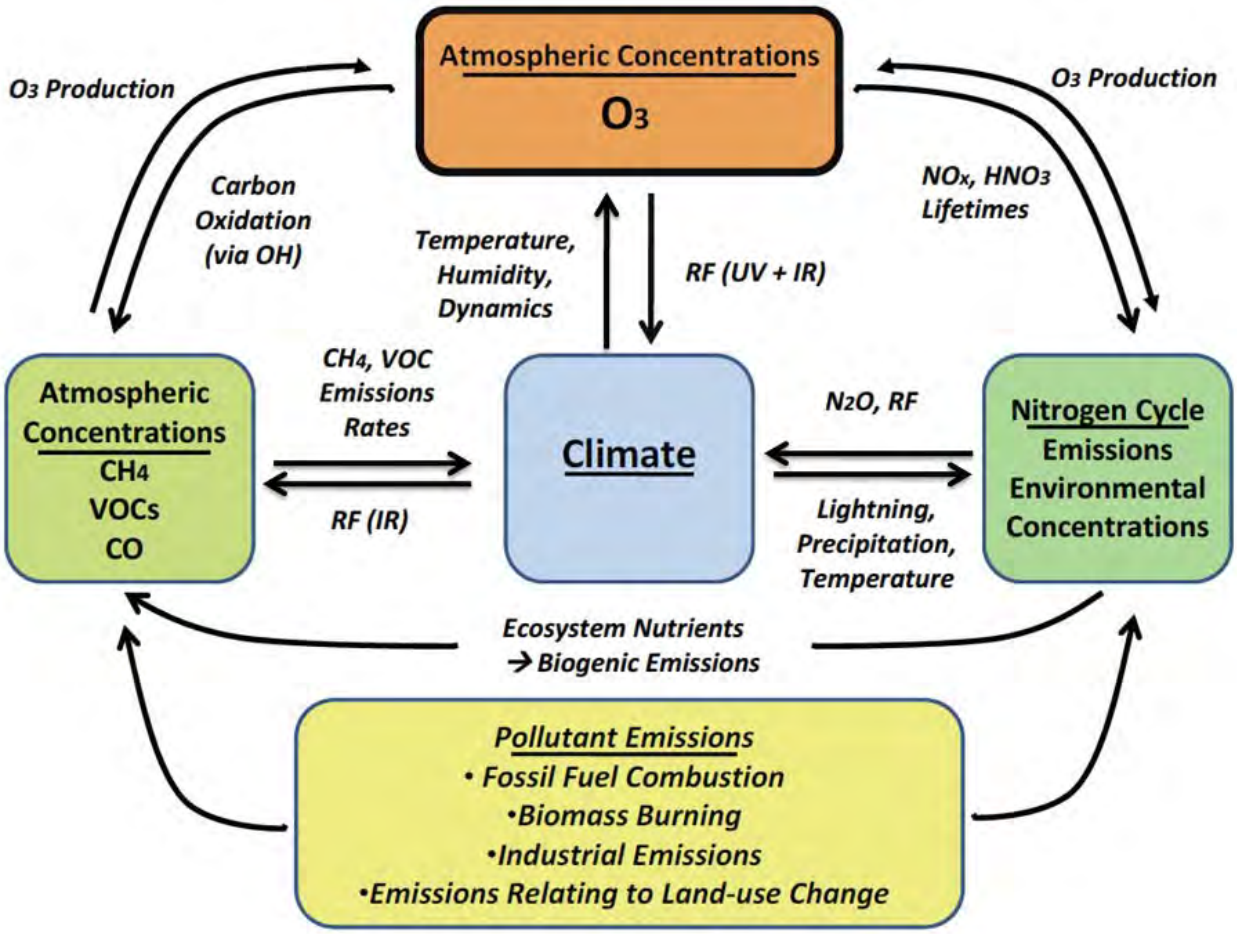
IGBP IS&E – Air Pollution and Climate (Leads: Kathy Law IPSL, Paul Monks ULeic)

GLOBAL CHANGE IGBP International Geosphere-Biosphere Programme ICSU

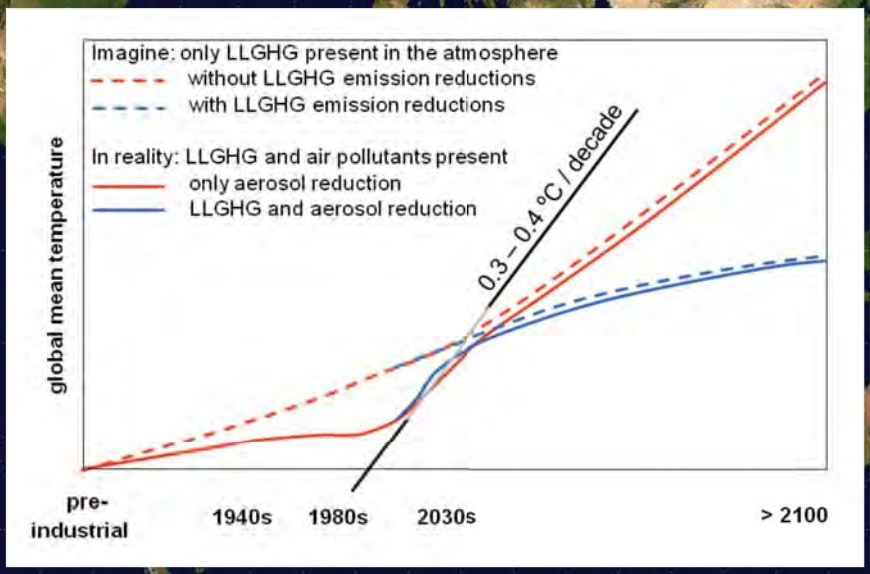
Motivation: Air Pollution & Climate



- Regulation of certain short-lived forcers (or precursors) could provide short-term climate relief (next 5-20 years)
- Co-benefits for health and climate (e.g. black carbon from cook stoves - major source of illness/deaths & emissions)
- AQ and climate policies & their impacts need to be examined together and **based on sound scientific knowledge**



Bumpy Road …



Raes and Seinfeld, AENV, 2009

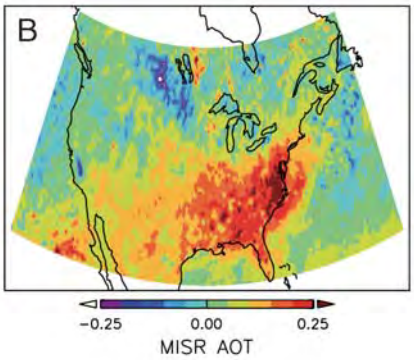
PNAS

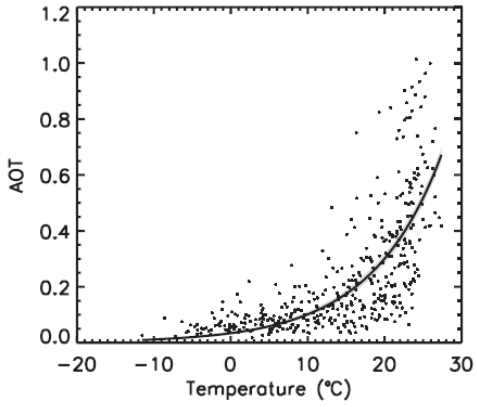
Biogenic carbon and anthropogenic pollutants combine to form a cooling haze over the southeastern United States

Allen H. Goldstein[1], Charles D. Koven[2], Colette L. Heald[3], and Inez Y. Fung[1]

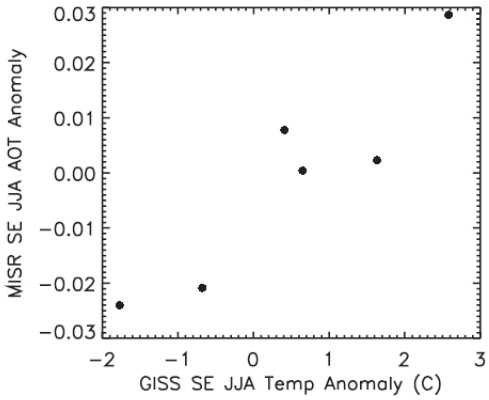
Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720

Contributed by Inez Y. Fung, April 15, 2009 (sent for review July 28, 2008)





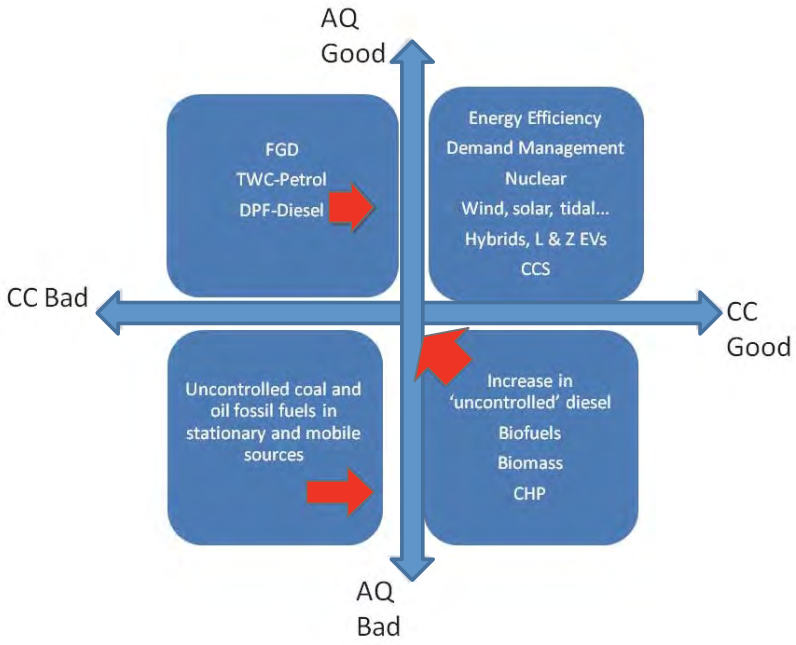
Temporal patterns match BVOC emissions



AOT radiatively important -3.9 W m^{-2} cooling

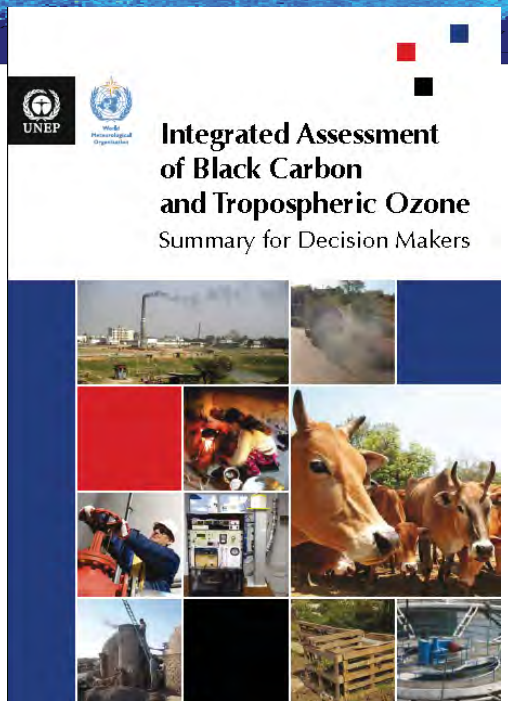
BVOC emissions oxidizing to form SOA, likely modulated by anthropogenic emissions, are responsible for a large fraction of the total column aerosol load in the region

Synergies and trade-off CC & AQ Policy



Monks et al, AENV, 2009

" Scientific evidence and new analyses demonstrate that control of black carbon particles and tropospheric ozone through rapid implementation of proven emission reduction measures would have immediate and multiple benefits for human well-being."



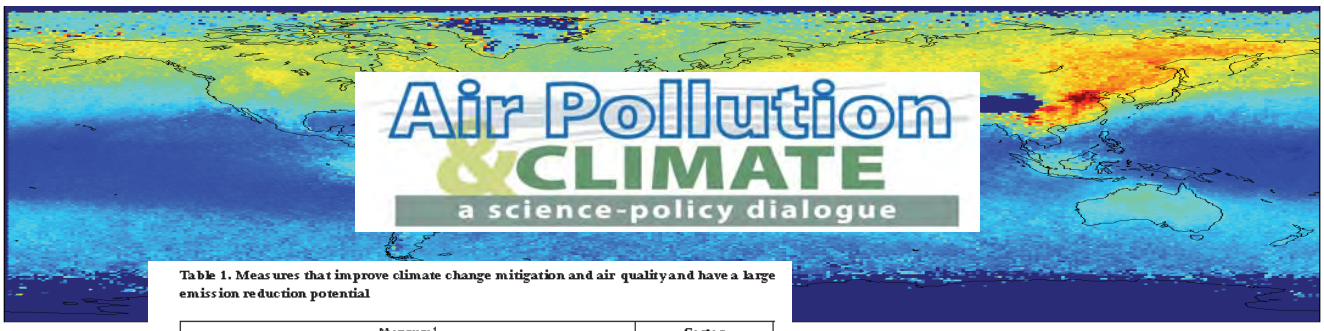
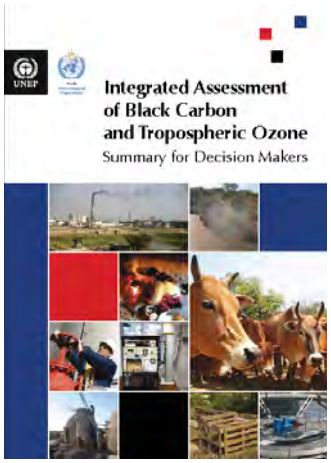


Table 1. Measures that improve climate change mitigation and air quality and have a large emission reduction potential

Measure[1]	Sector
CH_4 measures	
Extended pre-mine degasification and recovery and oxidation of CH_4 from ventilation air from coal mines	Extraction and transport of fossil fuel
Extended recovery and utilization, rather than venting, of associated gas and improved control of unintended fugitive emissions from the production of oil and natural gas	
Reduced gas leakage from long-distance transmission pipelines	
Separation and treatment of biodegradable municipal waste through recycling, composting and anaerobic digestion as well as landfill gas collection with combustion/utilization	Waste management
Upgrading primary wastewater treatment to secondary/tertiary treatment with gas recovery and overflow control	
Control of CH_4 emissions from livestock, mainly through farm-scale anaerobic digestion of manure from cattle and pigs	Agriculture
Intermittent aeration of continuously flooded rice paddies	
BC measures (affecting BC and other co-emitted compounds)	
Diesel particle filters for road and off-road vehicles	Transport
Elimination of high-emitting vehicles in road and off-road transport	
Replacing coal by coal briquettes in cooking and heating stoves	Residential
Pellet stoves and boilers, using fuel made from recycled wood waste or sawdust, to replace current wood-burning technologies in the residential sector in industrialized countries	
Introduction of clean-burning biomass stoves for cooking and heating in developing countries[2,3]	
Substitution of clean-burning cookstoves using modern fuels for traditional biomass cookstoves in developing countries[2,3]	
Replacing traditional brick kilns with vertical shaft kilns and Hoffman kilns	Industry
Replacing traditional coke ovens with modern recovery ovens, including the improvement of end-of-pipe abatement measures in developing countries	
Ban of open field burning of agricultural waste[2]	Agriculture



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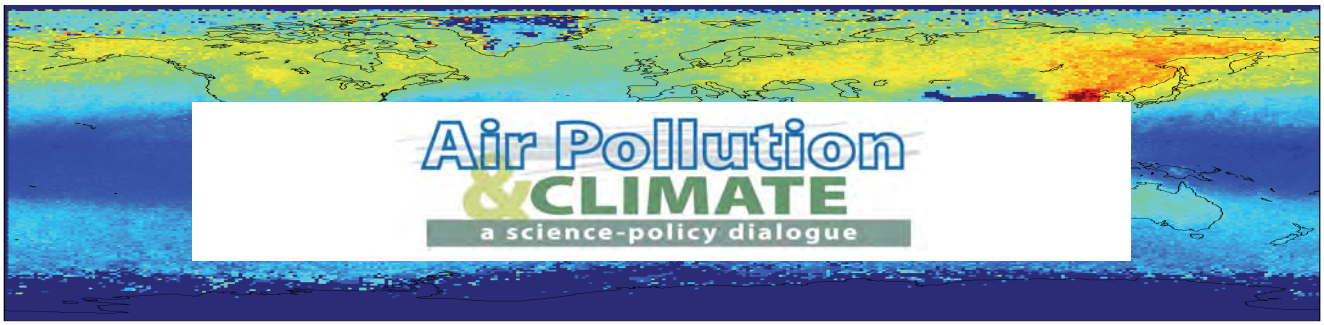


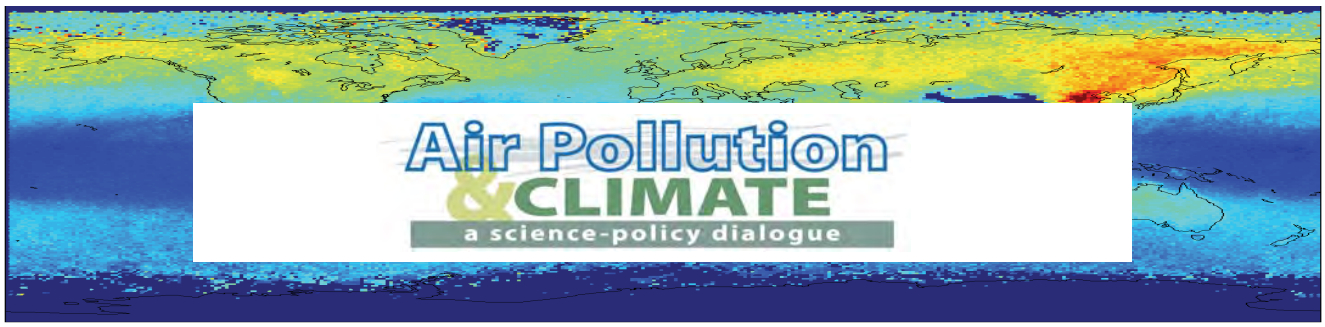
Actions to Date

Tackling the Air Pollution and Climate Change Challenge: A Science-Policy Dialogue

i) **Workshop i.e. this one!!**

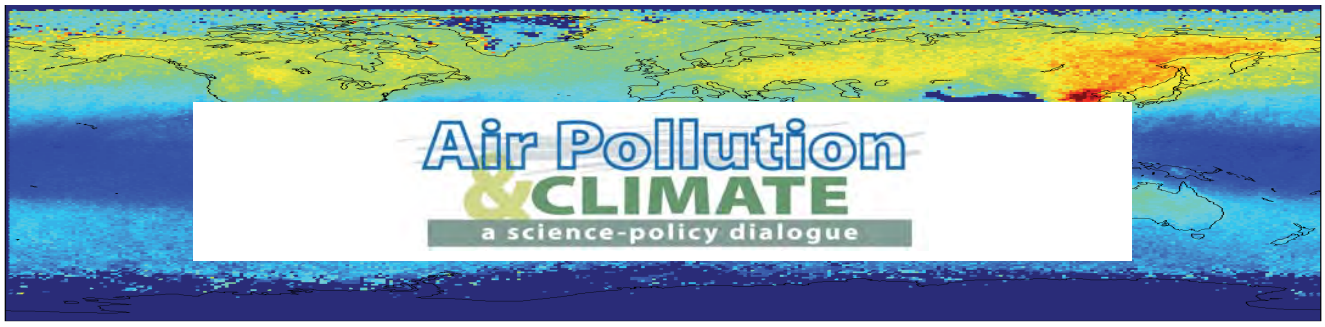
ii) **Agreed co-funding with Taiwanese EPA for future activity to deliver outputs**

iii) **Accepted session at the Planet under Pressure 2012 conference (IGBP, Diversitas, ESSP, IHDP, WCRP), London.**



Summary

- **Workshop represents a significant challenge to represent and focus the breadth of science and policy on the topic area in the global perspective.**
- **We have a framework to structure our thinking – but we are trying to think about the two-way dialogue (listening – understanding).**
- **We hope you enjoy the challenge of the workshop.**

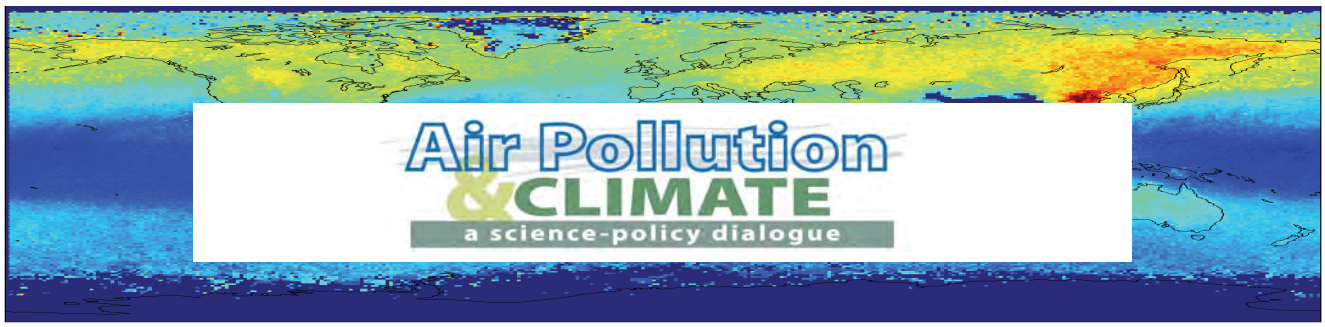


Workshop

Tackling the Air Pollution and Climate Change Challenge: A Science-Policy Dialogue

The aim of the workshop is to produce a draft outline of a briefing document that will:

1. Define the air pollution and climate challenge
2. Summarize and assess current efforts in a meaningful way for policy makers and other stakeholders.
3. Outline a strategy for future research efforts on this topic.

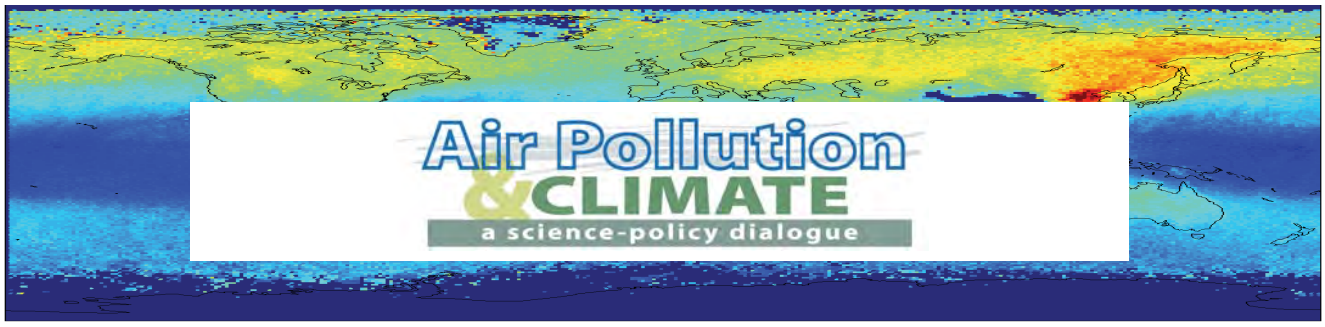


Workshop

Tackling the Air Pollution and Climate Change Challenge: A Science-Policy Dialogue

Elements of workshop

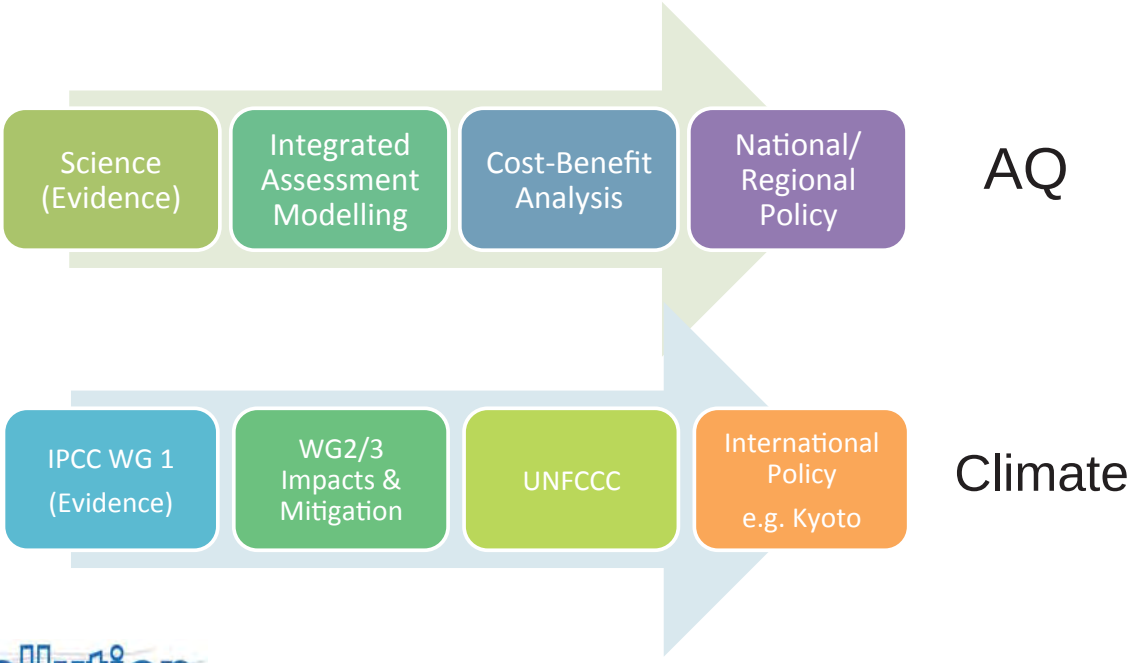
1. Framing the Challenge
2. Arriving at a coherent view on the challenge(s)
3. Addressing the questions – status and gaps of knowledge
4. Tackling the challenge? (a way forward)
5. Drafting outline briefing document



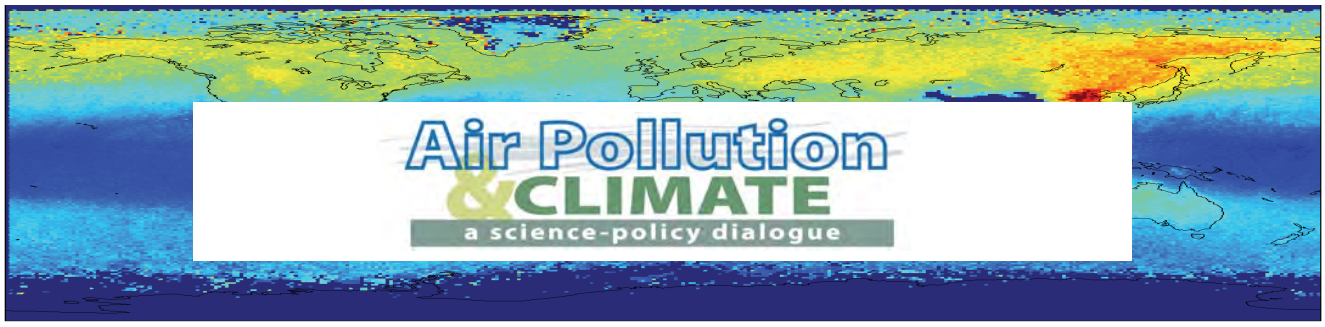
Science – Policy Dialogue

- Engage in ***productive*** 2-way dialogue from the outset
- Define driver influenced policy relevant questions (the challenges)?
- Efficient exchange of information, knowledge, requirements (***both ways***)

Climate & AQ Policy Trails



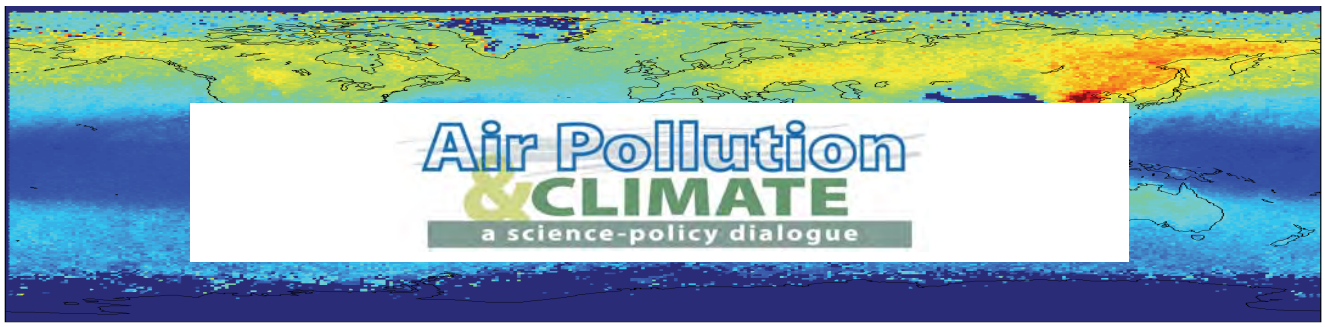
Air Pollution & CLIMATE
a science-policy dialogue



Session 3 - Addressing the questions – filling the gaps

How can we develop a strategy for future research efforts on this topic?

- What's missing - where are the gaps?
- How can we have a more effective dialogue?
- Should we break down the science/policy divide – role for evidence based policy making?
- Definition of the briefing note.



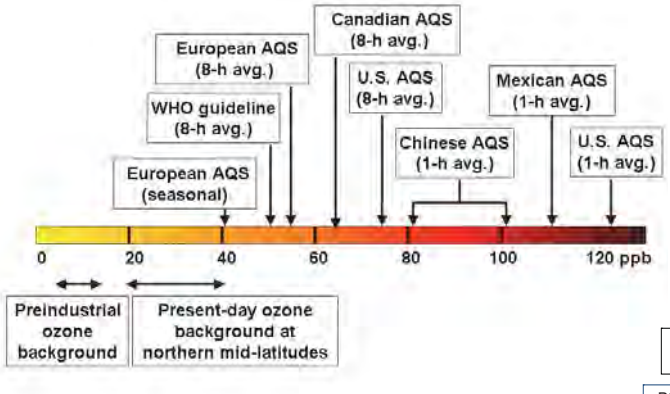
Framing the Challenge

- Different perspectives - science, integrated assessment/ economic modelling, policy, stakeholders
- Drivers – health (AQ), climate change, food security, water
- Targets/thresholds, metrics, time horizons – short/long
- Economics – cost effective measures (technical feasibility)
- **Regional perspectives (importance of different drivers) – international context**

Session Intros

Session 1
Framing the Challenge

Air Quality: Thresholds – O3 and PM2.5 (PM10) – emission controls of precursors (NOx, VOCs, (CO), SO2, … BC?) – large regional variations



US NRC report on Global Pollution (2010)

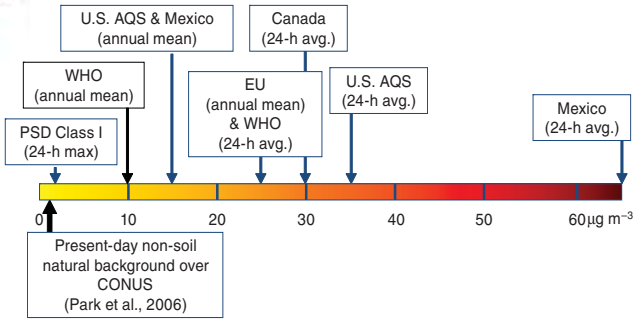


FIGURE 3.4 Comparison of current 24-hr health-based $PM_{2.5}$ standards for the indicated countries, and U.S. allowable 24-hr emissions increment for Class I areas under the Prevention of Significant Deterioration rule.

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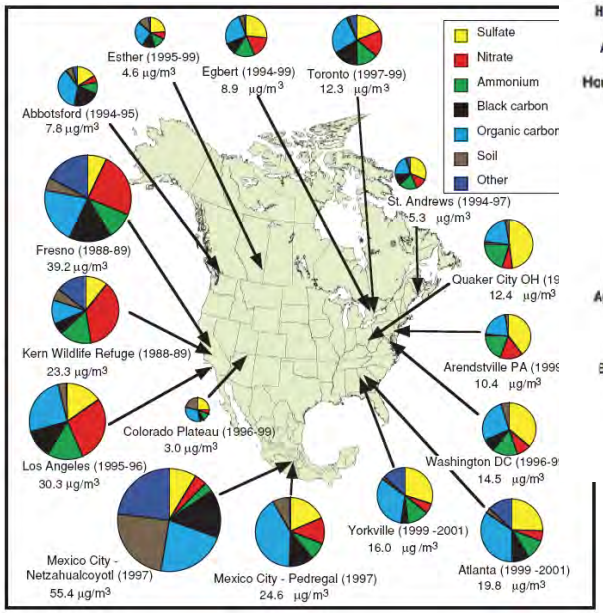
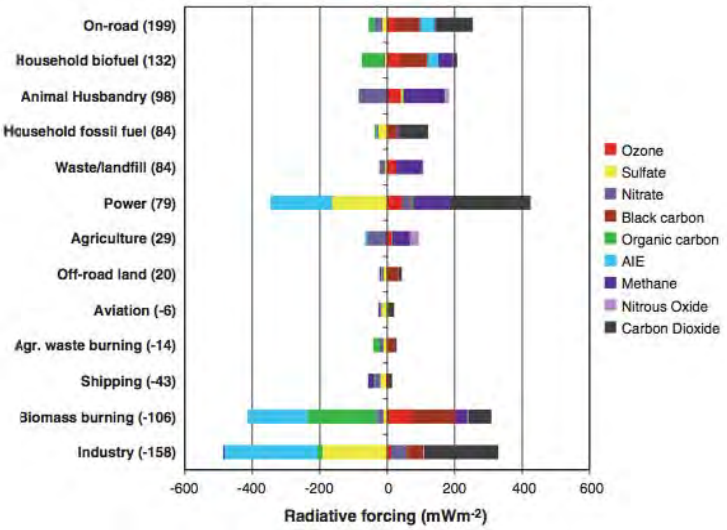
a science-policy dialogue

Climate (aerosols): radiative warming/cooling (GWP, T response) from different components (not PM), emission sectors & regions

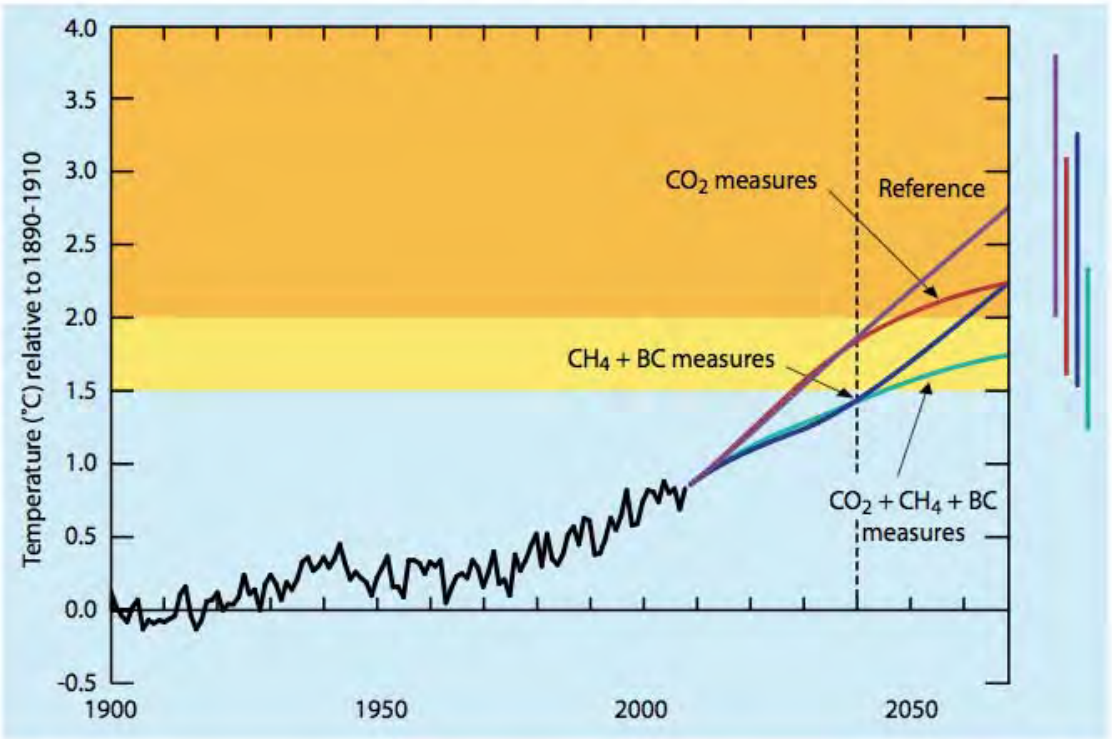


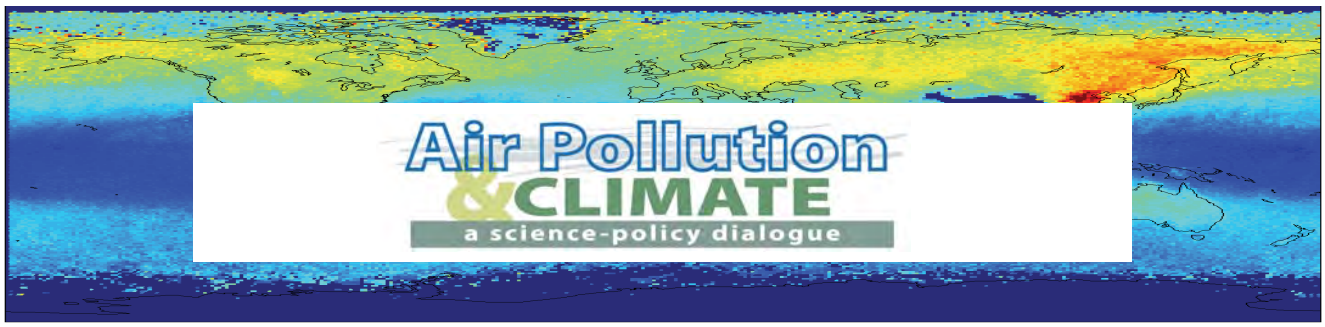
PM2.5 components, NARSTO, 2004



RF in 2020 from constant 2000 emissions, Unger et al., 2010

UNEP BC-O3 report: mitigation of CO2, CH4 and BC (also implicit CO/VOC reductions linked to BC & SO2 linked to CO2)

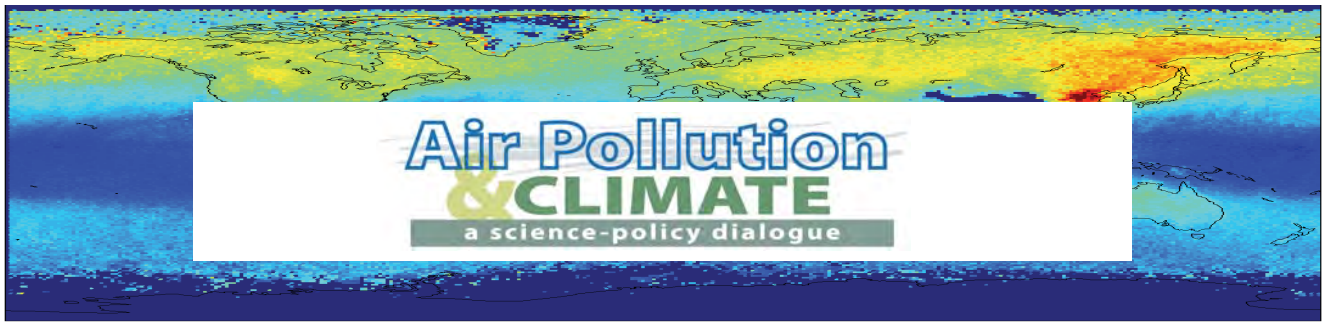




Session 2 - Arriving at a coherent view on the challenges

How do we summarize and assess current efforts in a meaningful way for policy makers and other stakeholders?

- What are the policy and science challenges for air pollution and climate in outline and can we say anything about priorities and gaps?
- What is needed to bridge the policy to science or *vice versa* ?
- What are the barriers to progress?
- *You may have to deal with these from a regional perspective, as they will vary with point of view.*

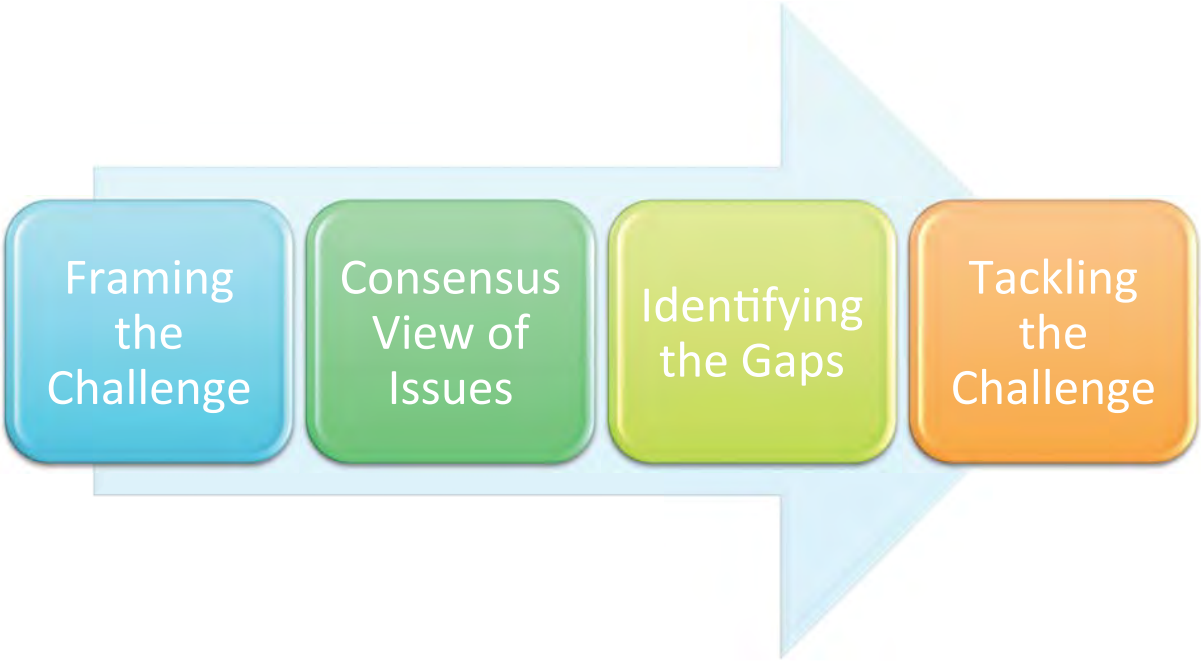


Session 4 – Tackling the Challenge

Defining the briefing document

- The Challenge
- Assessment of current efforts
- Tackling the challenge
  - What are the opportunities for science to inform policy?
  - How do we do it differently?
  - New Perspectives?

Air Pollution & CLIMATE
a science-policy dialogue



Global Sustainability Science

Ninad Bondre
Science Editor

Science for a sustainable planet
GLOBAL CHANGE IGBP International Geosphere-Biosphere Programme
ICSU

IGBP Vision

To provide essential scientific leadership and knowledge of the Earth system to help guide society onto a sustainable pathway during rapid global change

IGBP's second synthesis

Bringing together a diverse group of individuals – scientists, policymakers, industry and other stakeholders – to synthesise knowledge about key policy-relevant areas

Some of the topics

Science Editor, IGBP

ninad.bondre@igbp.kva.se

www.igbp.net

Air Quality-Climate Interaction

- Air pollution and climate change are still treated as if they were two separate problems, when actually they are two sides of the same coin. In fact, emission sources for air pollutants and greenhouse gases coincide.
- In addition, SLGS further complicate the trade-off AQ-climate because of the different time/space scales.
- Needs
  - Improve connection between observations and models
  - Improve and rationalise the observing system
  - Engage with region-specific issues
  - Switch mode between disciplinary science to interdisciplinarity and improve the collaboration between natural sciences and socio-economic sciences
  - Partnership with policymakers needs new expertise
  - Informed public opinion is crucial for building a consensus for wise policy actions

Sandro Fuzzi

Efficient organisation of the science community

- Several Assessment/Planning studies have been/are being performed in this period:
  - IPCC AR5
  - HTAP Report
  - UNEP Assessment of BC and Tropospheric O_3
  - ICSU Grand Challenges
  - …..
- Isn't there a more rationale way of engaging the science community in these highly valuable, but often overlapping tasks?

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a science-policy dialogue

European Commission
Research & Innovation
FP7 - Cooperation - Environment

Jose M. Jimenez Mingo

The European Commission is launching a coordinated effort with the scientific community to address the specific research needs for the Implementation and review of Ambient Air Quality and NEC Directives and the Thematic Strategy on Air Pollution.

Key Players: Research organisations (EU +…)
EC Coordination : DG ENV, DG RTD, DG JRC
Collaboration with EEA

PM_{10} daily limit value exceedances in 2008

NO_2 annual limit value exceedances in 2008

≤ limit value

> limit value

Air Pollution Policy Review - Key elements

- **Review of the current air quality legislation** (including reasons for non-compliance)
- **Review of the current air quality limits and targets**
  - $PM_{2.5}$ as required by Directive
  - Latest scientific evidence of air pollution impacts for ozone, PM_{10}, **UFP**, heavy metals, PAHs, others? (Involvement of CLRTAP/WHO)
  - new targets – long term objectives (2020 – 2030 – 2050?)
- **Possible new measures**
- **Link to climate change** (eg. co-benefits, short lived climate species, black carbon, minimise trade-offs)
- **Integration into sectorial policies** (transport, energy, vehicle emissions, etc.) – already 2011 (White Paper and 2050 roadmaps)
- **Simplification / smart regulation / streamlining**

Air quality and climate change

Major research areas:

- Aerosols and their role on air pollution and climate, (EUCAARI and PEGASOS),
- Environmental impacts of megacities (CITYZEN and MEGAPOLI),
- The nitrogen cycle (NITROEUROPE),
- Effects on European Ecosystems (ECLAIRE-under negotiation),
- Climate and Air Quality Impacts of Short-Lived Pollutants (ECLIPSE-under negotiation)

Air Pollution and Health

Major research areas

- Health effects of ambient air pollution: ESCAPE - increasing knowledge database on the long-term health effects of air pollution exposure (PM10, PM2.5, the soot content of PM2.5 and NOx) by studying 30 European cohorts
- Health impacts of indoor air pollutants: HITEA (microbial pollution) and OFFICAIR (IAQ in offices in view of energy savings initiatives)
- Environmental health impact assessment
  - -FP6: INTARESE/HEIMTSA (health impact of air pollution policies)
  - -FP7: PURGE, URGENCHE (health impact of greenhouse gas reduction policies), TRANSPHORM (integrated assessment of health impacts from road, shipping, rail and aviation emissions)
- Climate change and aeroallergens: ATOPICA - how the spread of aeroallergens will change with climate change; interactions with air pollution (under negotiation)

7/22/11

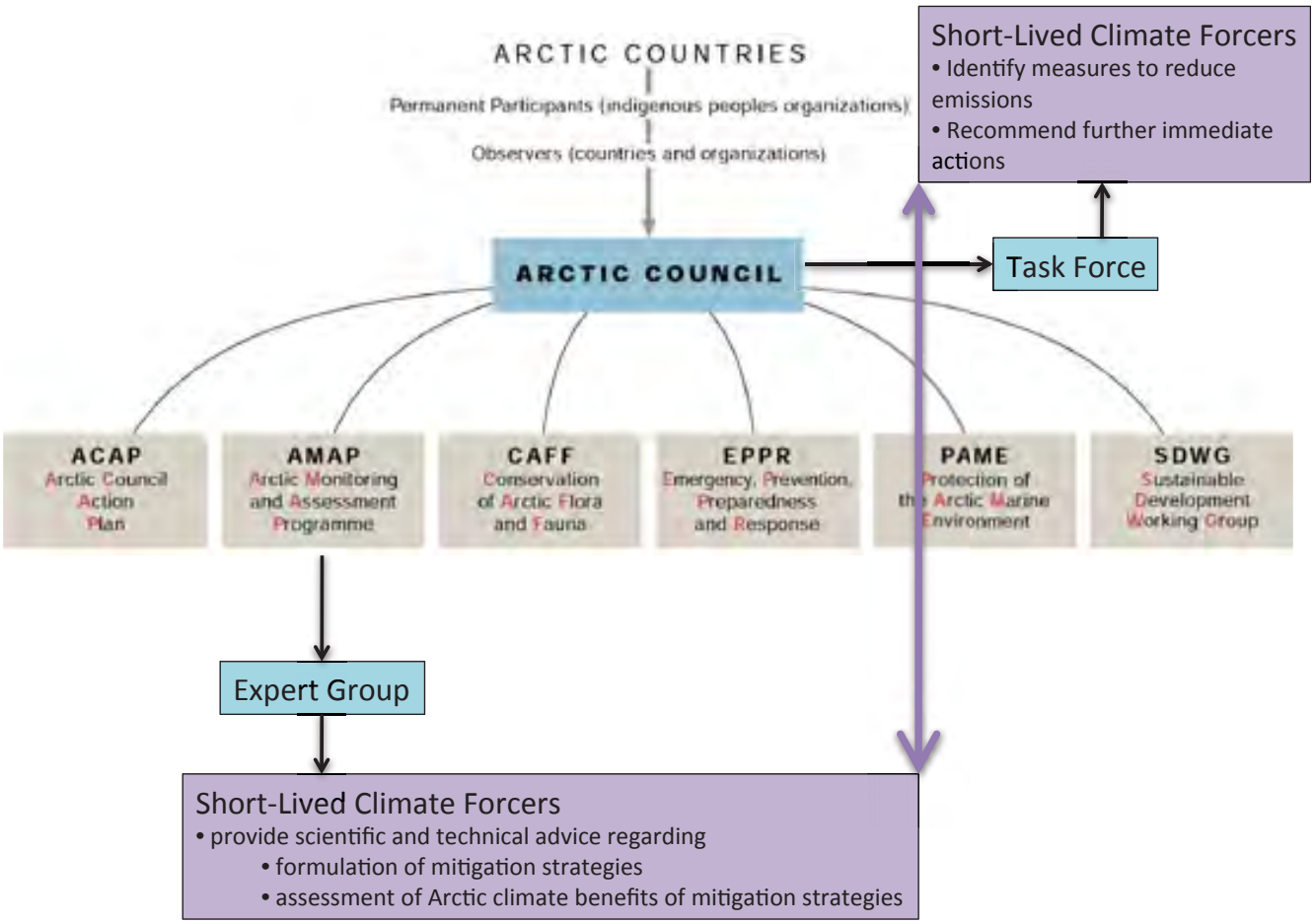
Report of the AMAP Expert Group on Short-Lived Climate Forcers

Chairs:

P.K. Quinn (U.S. - NOAA PMEL) and A. Stohl (Norway - NILU)

Members:

Canada: M. Shepherd (Environment Canada)
Denmark: H. Skov, J. Christensen (Aarhus University)
Finland: H. Lihavainen (FMI), K. Kupianen (SYKE)
Norway: V. Vestreng (NCPA), T. Berntsen (Univ. Oslo)
Russia: V. Radionov (AARI), V. Shevchenko (RAS), A. Klepikov (AARI)
Sweden: A. Arneth (Lund Univ.)
U.S.: M. Flanner (Univ. Mich)
AMAP: J. Calder (NOAA), L. Reiersen (AMAP Secretariat)



Near-final summary findings

General

• Reductions in the emissions of CO_2 are the backbone of any meaningful effort to mitigate climate change. The limited focus of this assessment on BC is not meant to distract from primary efforts on CO_2 reductions or mislead mitigation action toward a sole focus on BC.

• BC deposited to Arctic snow and ice results in a positive radiative forcing.

• G*lobal direct atmospheric forcing* due to BC leads to Arctic warming.

• BC emitted near or within the Arctic will have the greatest impact on Arctic climate and especially on surface temperatures but Arctic climate is strongly coupled with Northern Hemisphere climate and thus sensitive also to extra-Arctic radiative forcings.

Co-emitted species

• Organic carbon species that are co-emitted with BC and that reach the Arctic are unlikely to compensate for the positive radiative forcing due to BC and, over snow and ice covered surfaces, may themselves exert a positive forcing within the Arctic.

• Highly scattering sulfate aerosol exerts a weakly negative forcing over snow. As fresh snow melts over the summer and the surface albedo decreases, sulfate aerosol forcing becomes more negative.

Near-final summary findings (continued)

Geographical location and source types of emissions

• The Nordic countries are associated with the largest *forcing per unit of BC emission* due to emissions occurring at the highest latitudes.

• Within-Arctic BC sources (e.g., shipping, flaring) have a large impact on low-altitude BC concentrations and BC deposition in the Arctic and, thus, likely have a large forcing *per unit emission.*

• Forest, grassland and agricultural fires are the source types in Canada and Russia that dominate BC +OC radiative forcing in the Arctic. Fossil fuel combustion (e.g., diesel engines) is the dominant source in the U.S., Nordic countries and ROW.

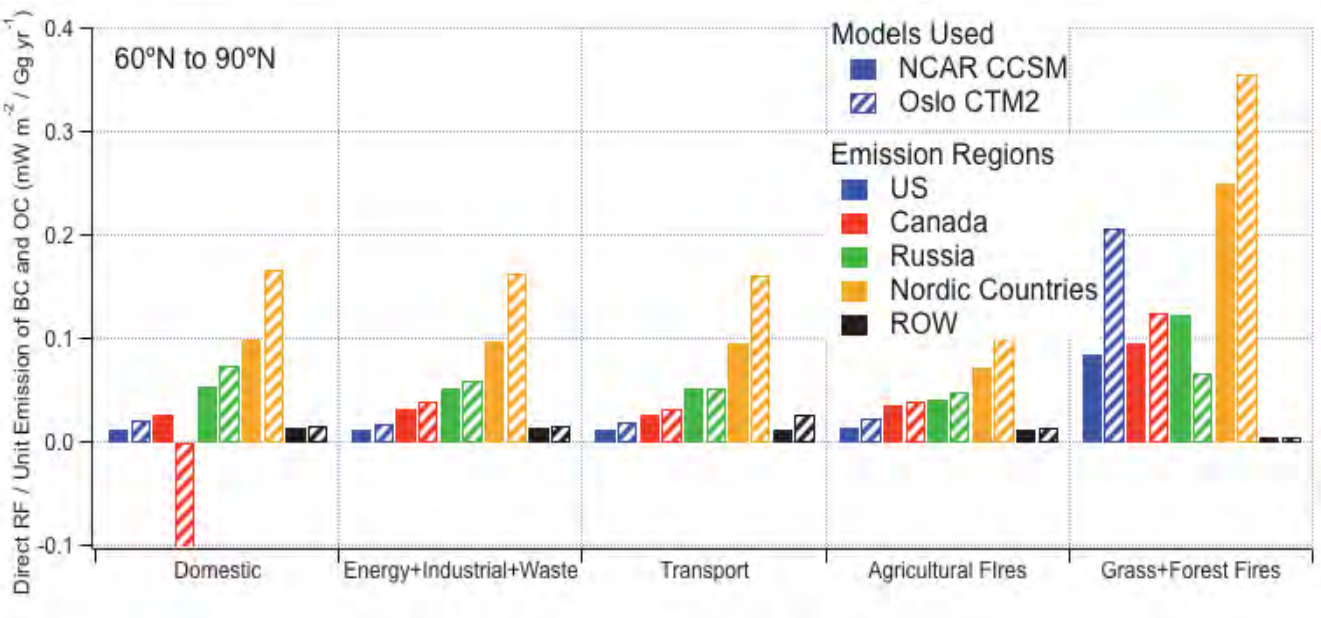
Aerosol indirect effect

• Both the sign and magnitude of aerosol indirect forcing in the Arctic are uncertain. Globally, the indirect and semi-direct effects are negative and lead to a cooling. For the Arctic, however, current studies indicate that the net aerosol indirect and semi-direct effects lead to smaller negative forcing than on the global average, or may even cause positive forcing.

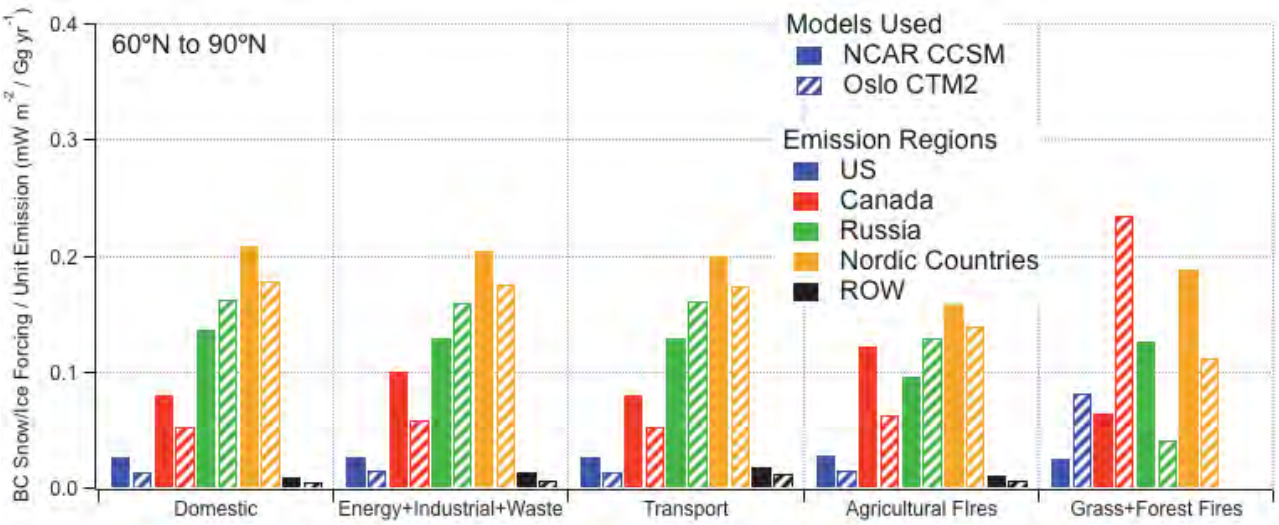
Further science needs

• Currently, there is no single appropriate environmental indicator to assess the Arctic climate response to changes in BC and OC emissions. Hence, an integrated evaluation using observations, reported emissions, and models is required. **We provide a detailed list of recommendations for future studies.**

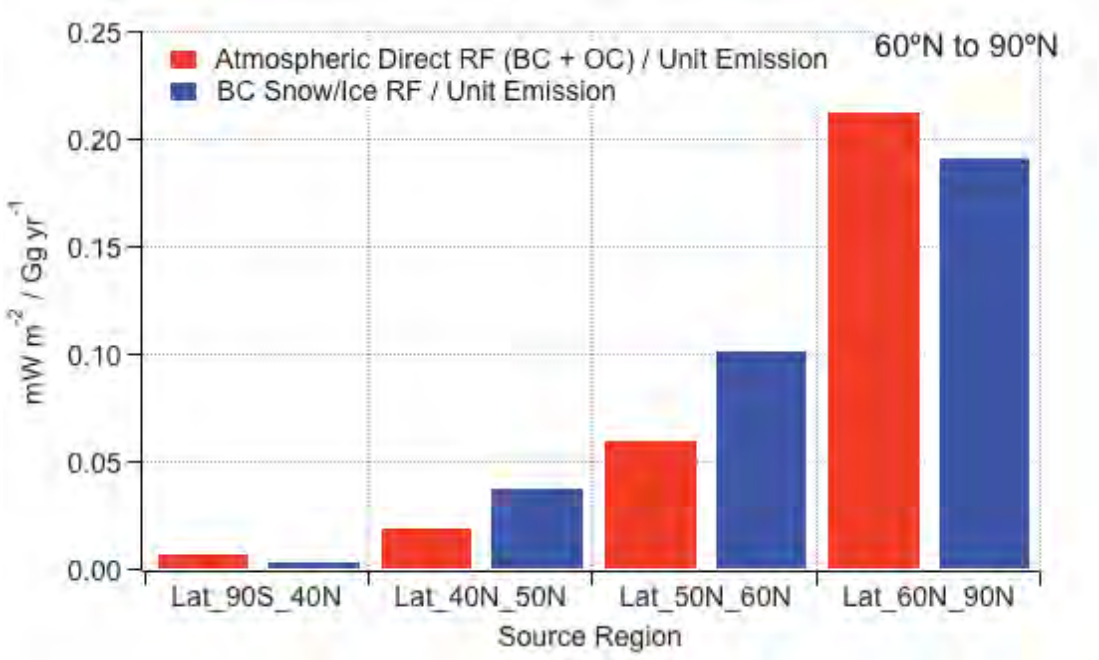
Relative Level of Impact:
Normalized Direct RF for BC + OC as Calculated by the Two Models



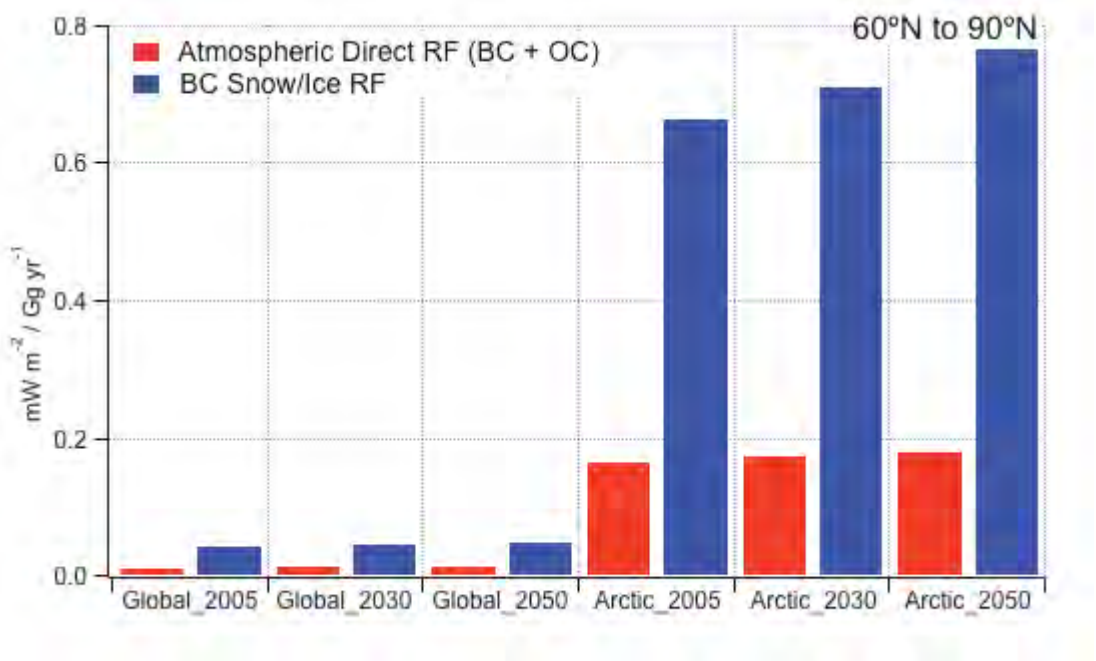
Relative Level of Impact:
Normalized BC-Snow/Ice Radiative Forcing as Calculated by the Two Models



Normalized Direct Radiative Forcing (BC + OC) and BC-Snow/Ice Radiative Forcing due to Emissions from the Considered Latitude Bands (NCAR CCSM)

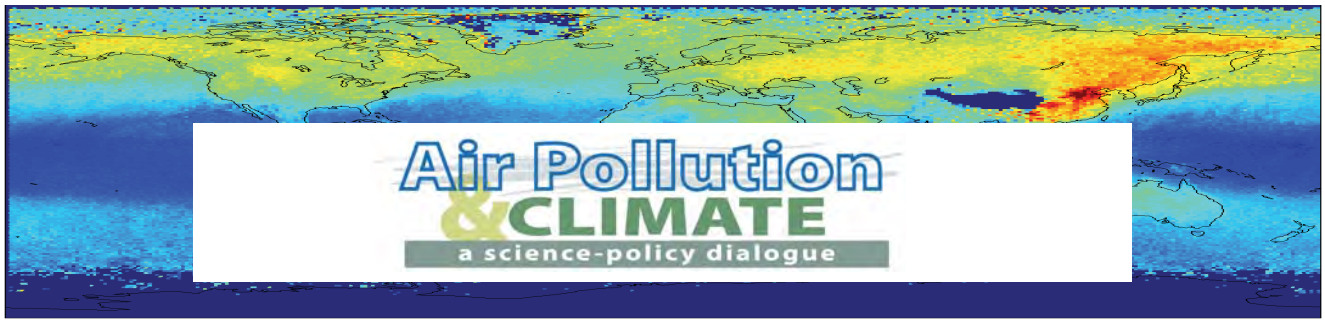


Normalized Atmospheric Direct RF (BC + OC) and BC-Snow/Ice RF due to Projected Increases in Global and Within-Arctic Shipping Emissions
(NCAR CCSM)



Participant Perspective

Denise Mauzerall



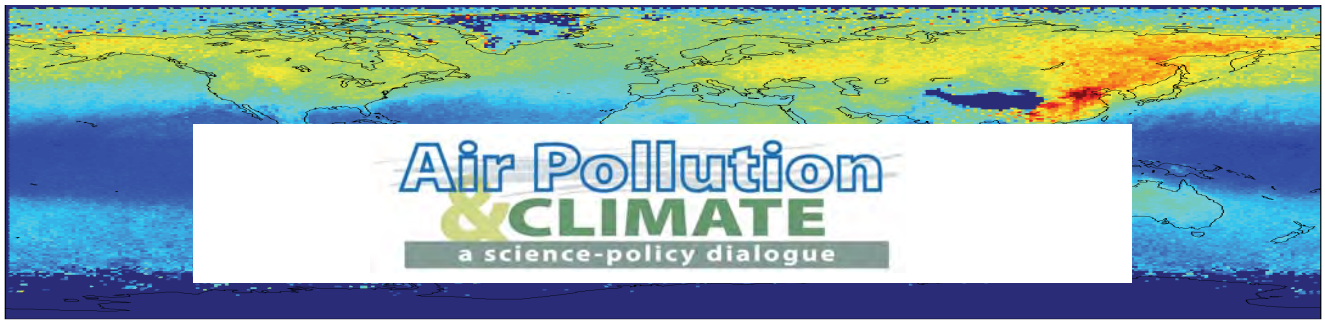
Can we frame current scientific understanding of chemistry-climate interactions in a way that prioritizes mitigation efforts?

a) Where is the science clear that mitigation is a win-win for both air quality and climate? Eg. Methane reductions

b) Where does the science indicate that mitigation is a no-lose situation? Eg. Black carbon mitigation

c) Can we integrate scientific understanding of which mitigation efforts would be most beneficial with existing mitigation cost-curves to make recommendations on where reductions would be most beneficial and cost-effective?

d) Can we do a-c on a regional basis? If not, understanding where the gaps are would be useful.



On a regional and key national basis can we identify key policy makers with whom we can interact?

- Can we develop briefing materials that summarize the key issues for these policy makers?
- Can we determine how mitigation policies are set up for key countries?
- What type of international science-policy cooperation would be helpful in catalyzing desired mitigation?
- What further scientific research would be most salient to policy makers?

What is the "Air Pollution Climate Challenge?"

David McCabe
9 June 2011

CATF: Introduction

US-based NGO, founded in 1996

- Dedicated to reducing atmospheric pollution through research, advocacy, and private sector collaboration
- Solely working on atmospheric issues
- Funded by foundations and individuals

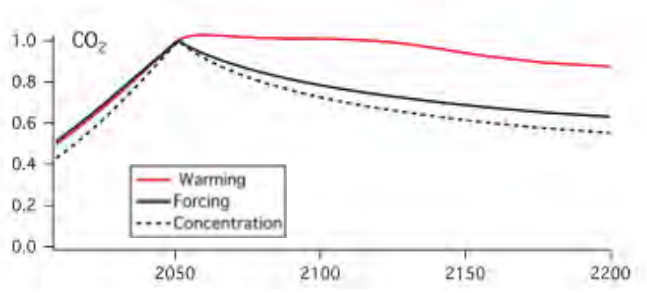
Continuing focus, from beginning, on power plants

  - Early focus on SO_2, NO_x, Hg reductions
- Climate protection is now a major focus

For climate: need LOTS of zero carbon energy

- We will only make serious progress reducing global CO_2 emissions when economically competitive, zero-carbon energy technology is commercially available. We don't believe that public policy will force such technology to be rapidly developed and deployed, so need to facilitate and accelerate development of such technology.

- Even if we were able to to **turn off CO_2**, at best we would be keep warming at ~current rates for a century +



S. Solomon, PNAS, October 2010

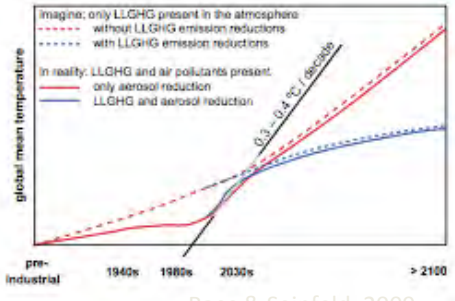
What do we get by cleaning the air?

- **Health, ecology, and crop benefits.**
- Warmer climate from SO_2 reductions.
- Cooling from reductions of black carbon and CO / CH_4 ozone precursors (but not NO_x)

Let's not kid ourselves: cleaning up air pollution (including CH_4) likely warms more than cools. There is a lot of sulfate in the atmosphere and we're cleaning it up rather effectively.

Long lifetime of CO_2 + removal of SO_2:

steep warming ahead….



Raes & Seinfeld, 2009

From a climate perspective, we're in a very tight spot

- In the near-term, targeted reductions of pollutants / sectors where we expect climate benefits is one of the few tools available.
- We participate in these forums with the hope that we can collectively agree upon:
  - Measures, by sector and region, that can be undertaken
  - Quantified impacts of measures, *both positive & negative*
  - Figure out policy routes to get measures implemented
- We have to take the good & bad news and tell an honest story about climate response from reductions and mitigation plausibility.
- Much science progress in past 5 years: better emissions information, more understanding of climate and aerosols, growing confidence about role of methane in formation of tropospheric ozone…but we have a long way to go to see mitigation of SLFs for climate purposes.

"Bounding the Role of Black Carbon in Climate"

By Megan L. Melamed
IGAC Executive Officer
(On behalf of the Bounding BC Authors)

- **An IGAC-AC&C/NOAA supported effort**
- **Coordinating lead authors:**
  - **Tami Bond (U. Illinois)**
  - **Sarah Doherty (U. Washington)**
  - **David Fahey (NOAA)**
  - **Piers Forster (U. Leeds)**
- **International group of 27 lead + contributing authors**
- **For peer-reviewed publication in JGR, 2011**

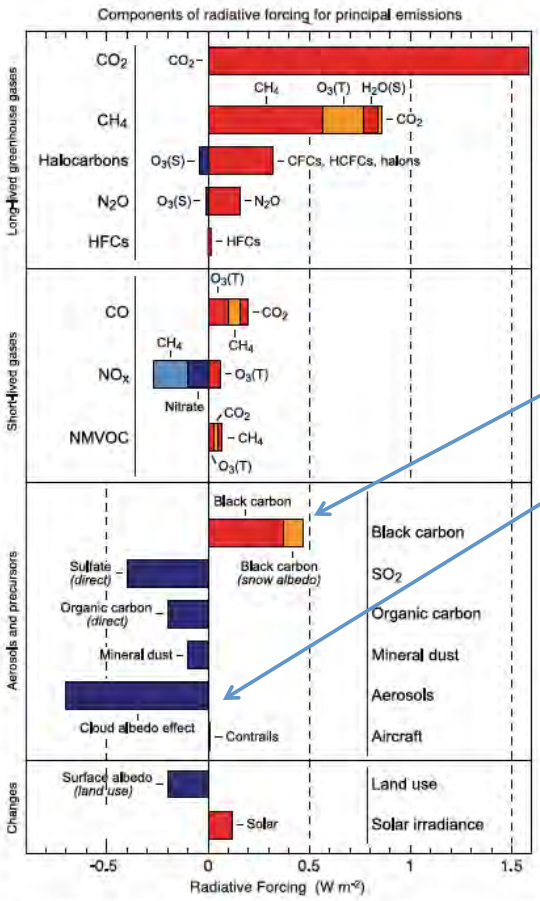


Figure 2.21. *Components of RF for emissions of principal gases, aerosols and aerosol precursors and other changes. Values represent RF in 2005 due to emissions and changes since 1750. (S) and (T) next to gas species represent stratospheric and tropospheric changes, respectively. The uncertainties are given in the footnotes to Table 2.13. Quantitative values are displayed in Table 2.13.*

"Bounding the Role of Black Carbon in Climate"

Black carbon appears here (direct forcing + snow) and here (cloud albedo) and elsewhere

ice + mixed clouds? efficacy?

"Bounding BC" collects and organizes the contribution of <u>all</u> of these effects for the first time from a BC-centric point of view

"Bounding the Role of Black Carbon in Climate"
Guiding principles

- Quantification:
  - provide best estimate and uncertainty bounds of climate forcing
  - where possible, explain differences between current estimates & identify sources of variation and uncertainty
- Comprehensiveness:
  - account for all climate forcing mechanisms
  - account for forcing by species co-emitted with black carbon
- Connection to action:
  - ultimately, source/activity-based answers are desired

<u>Goal 1</u>:

Provide a central estimate and uncertainties for effective forcing by black carbon, including all known mechanisms

"Bounding the Role of Black Carbon in Climate"
Some complexities of the analysis

THE STARTING POINT

Tabulate all published values; average, give range

WHERE POSSIBLE

Sort out:

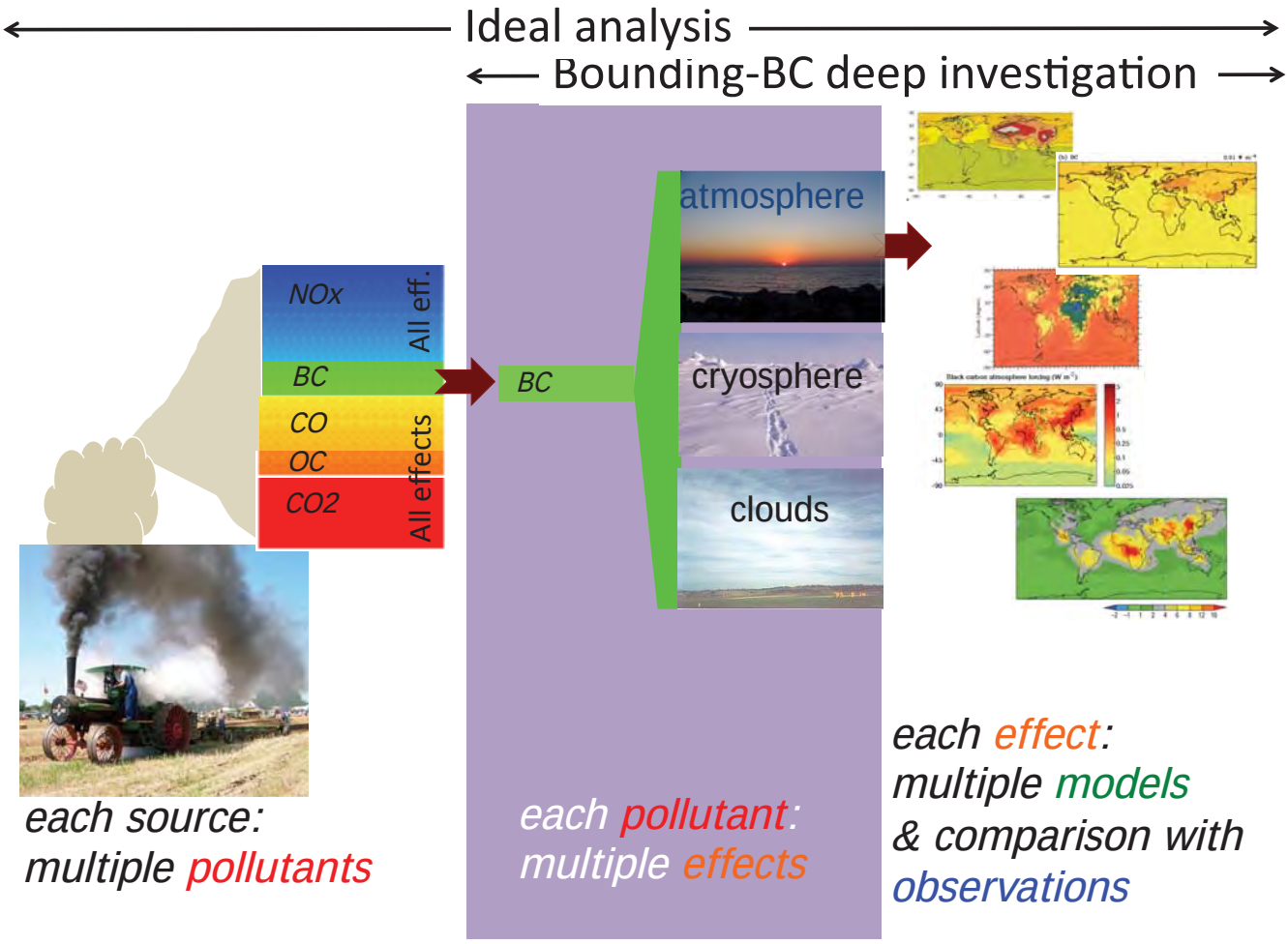
- why values differ and which ones observations support
  - includes new direct forcing estimate constrained by observations
- definition of "forcing"
  - ours includes "fast feedbacks"
- definition of "anthropogenic"
  - 1750-to-present fine for CO_2, but not for BC
  - reported results & observational comparisons often muddled by this distinction

"Bounding the Role of Black Carbon in Climate"
Guiding principles

- Quantification:
  - provide best estimate and uncertainty bounds of climate forcing
  - where possible, explain differences between current estimates & identify sources of variation and uncertainty
- Comprehensiveness:
  - account for all climate forcing mechanisms
  - account for forcing by species co-emitted with black carbon
- Connection to action:
  - ultimately, source/activity-based answers are desired

<u>Goal 2</u>:

Present effective forcing for mitigation actions that target *BC-rich sources*, considering all co-emitted species



Chapters of the Bounding BC Report

1. Introduction
2. Microphysical properties of black carbon
3. Emission magnitudes and source sectors
4. Constraints on atmospheric abundance
5. Direct radiative forcing
6. BC interactions with clouds
7. BC in the cryosphere
8. Climate response to BC forcings
9. Synthesis of BC climate effects
10. Net climate forcing by BC-rich source categories
11. Emission metrics for black carbon
12. Mitigation of BC-rich Sources
13. Conclusions

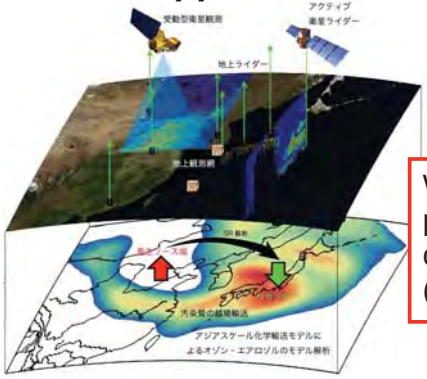
Air Pollution & CLIMATE
a science-policy dialogue

Perspectives from East Asia

- Asia is a large emitter of SLCF to the global atmosphere
  - China, India, Southeast Asia
  - BC from residential sector, open biomass burning, agricultural burning
  - CH_4 from rice fields (=> background O_3)
- Climate change possibly affects Asian monsoon system
  - Is CC good or bad for local/regional air quality?
  - Potential influence on natural emissions
- Politics often conflict in Asia, but activities are in progress
  - EANET (Acid Deposition Monitoring Network in East Asia) by 13 nations
  - TEMM (Tripartite Environment Ministers Meeting) by Japan, China, Korea

Hiroshi Tanimoto
National Institute for Environmental Studies, Japan

Strategic Project: Scientific Analysis of Regional Air Pollution towards Air Pollution Management in East Asia by taking "co-benefit approach" into account (2009-2013), led by H. Akimoto



Atmospheric Science

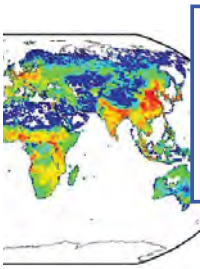
WP-1: Study on regional/hemispheric air pollution by integration of field/satellite observations & chemical transport models (PI: Yugo Kanaya; Hiroshi Tanimoto)

Policymakers (MOE)

環境省 Ministry of the Environment

Social Science

WP-2: Improvement of emission inventories for air pollutants & development of air pollutants reduction scienarios (PI: Toshimasa Ohara)



Policy Science

WP-3: Study on international framework toward promotion of air pollution measures and co-benefit approach (PI: Katsunori Suzuki)

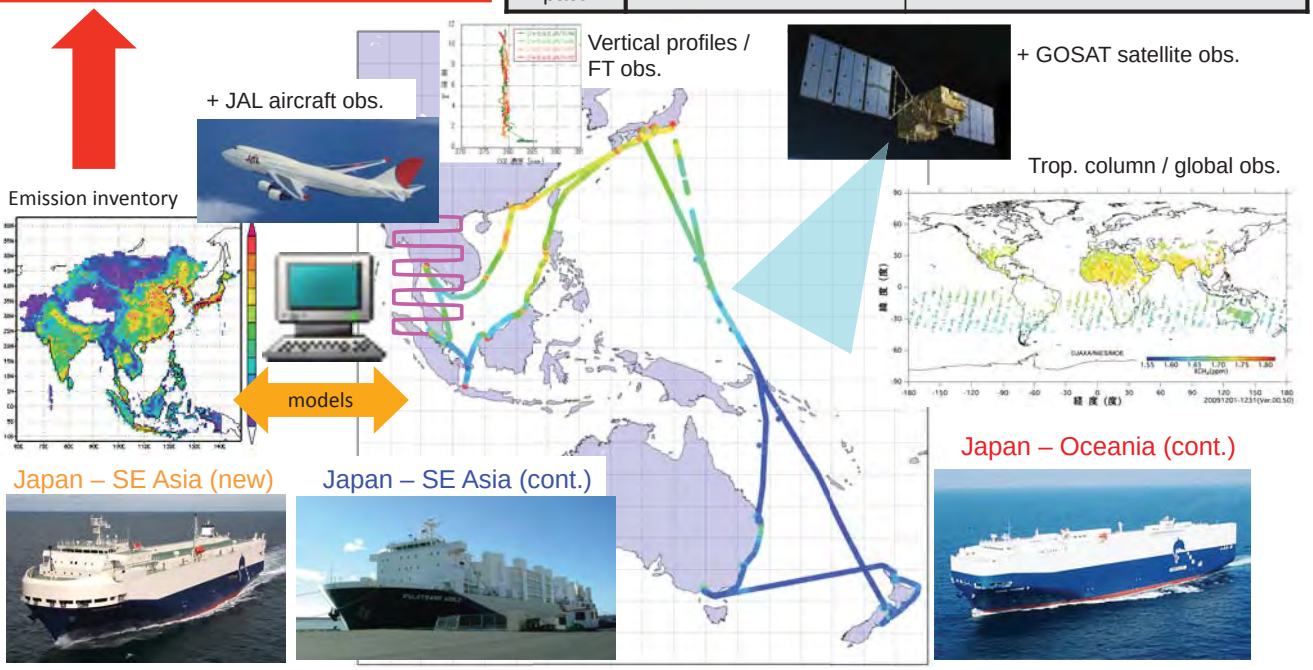
- Understanding the causes of the increase in AQS exceedances for ozone
- Diagnosing the impacts of SLCF (ozone and aerosols) on climate change
- Proposing "co-benefit approach" for regional air pollution and global warming measures

Long-term monitoring of atmospheric trace gases and aerosols in Asia & Oceania using voluntary observing ships

Scientific progress & Policy implication

- Enhancement of obs. capability by satellites, aircrafts, & ships
- Identification of emission sources unique to NE or SE Asia
- Contribution to co-benefit approach for climate change & air pollution

	Long-term							Challenge	
Species	N_2O	SF_6	CO_2	CH_4	O_3	BC	CO	NMVOC	aerosol
Cont.			o	o	o	o	o		
Flask or filter	o	o	o	o			o	o	o
Climatic impact	LLGHG				SLCF				



More efforts required to reduce ozone pollution in Europe

06 Jun 2011

Ground-level ozone is one of the most harmful air pollutants in Europe today. A new report by the European Environment Agency (EEA) shows that despite efforts to reduce ozone pollution, in 2010 levels continued to exceed the long-term objective established in EU legislation to protect human health. EU Member States will also face difficulties in meeting the target value, applicable as of 2010. More »

Taking stock of our resource use on World Environment Day – 5 June 2011

05 Jun 2011

EU to exceed nitrogen oxides emission ceiling, mostly due to road transport

01 Jun 2011

Recession and renewables cut greenhouse emissions in 2009

31 May 2011

New maps give Europeans close-up picture of air pollution from diffuse sources

26 May 2011

Air pollution and climate change challenge at EEA

John van Aardenne(jva@eea.europa.eu)

Challenge 1: complex topic: understanding, flexibility of policies, ensuring environmental integrity, explaining this to member states, citizens and EU policy makers.

1. Reducing cost of air pollution abatement.

Under C&E package costs of implementing future air pollution policy in Europe may be reduced by around EUR 16 billion per year (EC, 2008/SOER 2010)

2. Impact on human health.

JRC (2010): C&E package would reduce loss of statistical life expectancy due to PM in Europe with 2 months (by 2030). In 2000: ~6-8 mnths.

UNEP (2011): implementation of both CH_4 and BC measures will in 2030 and beyond result in annualy 2.5 million avoided premature deaths.

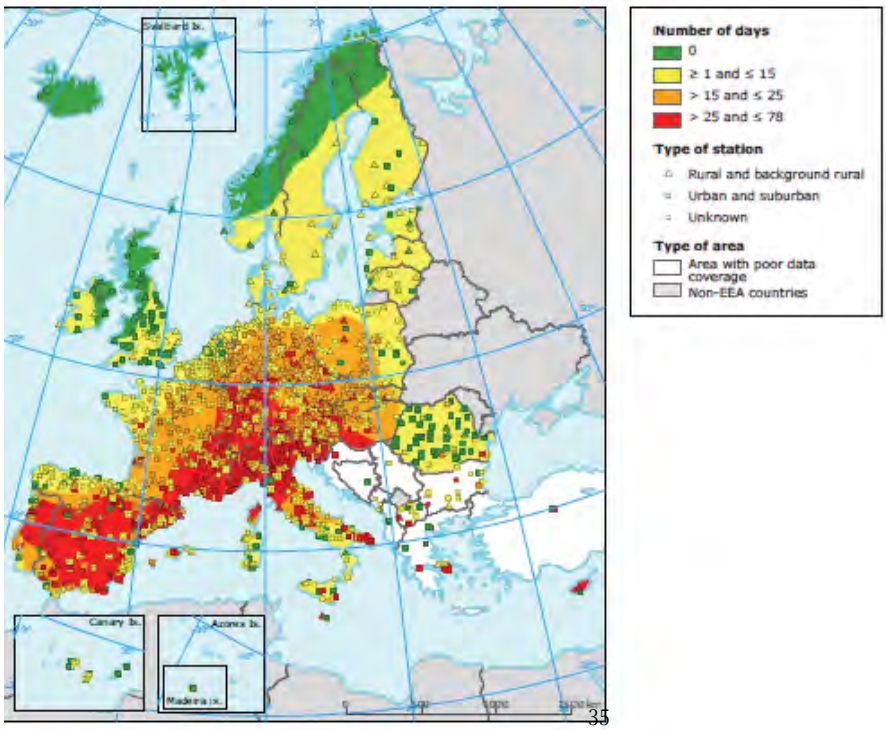
3. Impact of air pollution abatement (HTAP, 2010)

- Decreasing NO_x emissions will increase lifetime of CH_4
- Reduction in PM containing cooling aerosols would increase warming
- Reduction in PM containing BC benefit for both AP and GHG

Challenge 2: Air pollution by ozone across Europe during summer 2010 (Just released)

Is there a climate effect? Situation in 2020-2030-2050 due to CC legislation?

Map 2.2 **Number of days on which ozone concentrations exceeded the long-term objective for the protection of human health during the summer of 2010**



Challenge 3: bring the concept of AP and GHG into environmental assessment studies like the European Environment State and Outlook 2010 (SOER)

1. In order to understand our environmental assessments we need to understand what's in the underlying scenarios (uncertainty in trends but also methods/assumption)

2. Reporting monitoring. Currently focussed on thematic legislation, how to combine/ streamline information on both GHG and AP emissions (metrics)

3. The global vs regional dimension (impact, legislation, mandate of institute)
   - Climate mitigation depends on global action
   - AP both regional and inter-continental and influences climate
   - International shipping/aviation have a global component

Science Challenges

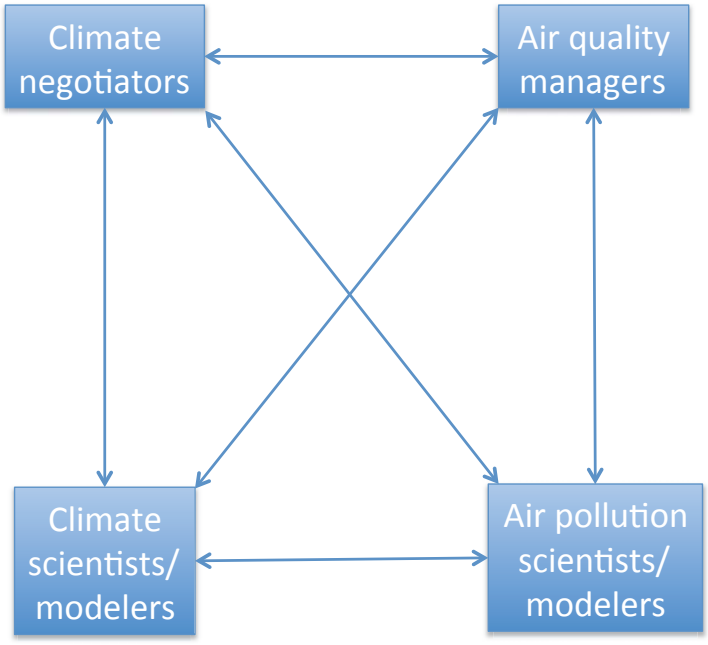
- Feedbacks/co-pollutants/co-benefits
  - SLCFs/AQ pollutants
- Ozone, contribution of background O3
- Land-use change
- Uncertainty
- Increased capacity -> lots of data (observations, monitoring, modeling)

Policy Challenges from the Science Side

- Develop an ongoing two-way dialogue
- Suggest options
- Keep context/value systems in mind
- Simple messages
- Raising public awareness/Dissemination

University of Leicester

Erika von Schneidemesser



Marcus Amann

Integrating Air Quality & Climate Change: The Policy Challenges

Catherine Witherspoon
Program Consultant
ClimateWorks Foundation

#1 Challenge

- Being useful and relevant to policy makers, where they sit, given their pressing concerns, at each moment in time.

#2 Challenge

- Making limited resources (time, people, money) go as far as possible and achieve the greatest benefits possible

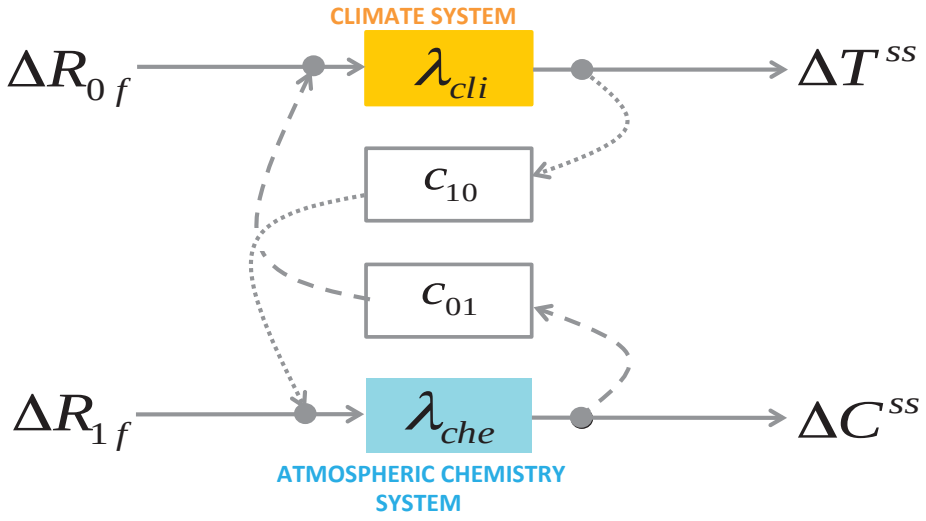
#3 Challenge

- Avoiding tragic, expensive and embarrassing mistakes which are not only negative in their own right, but can set the process back several years

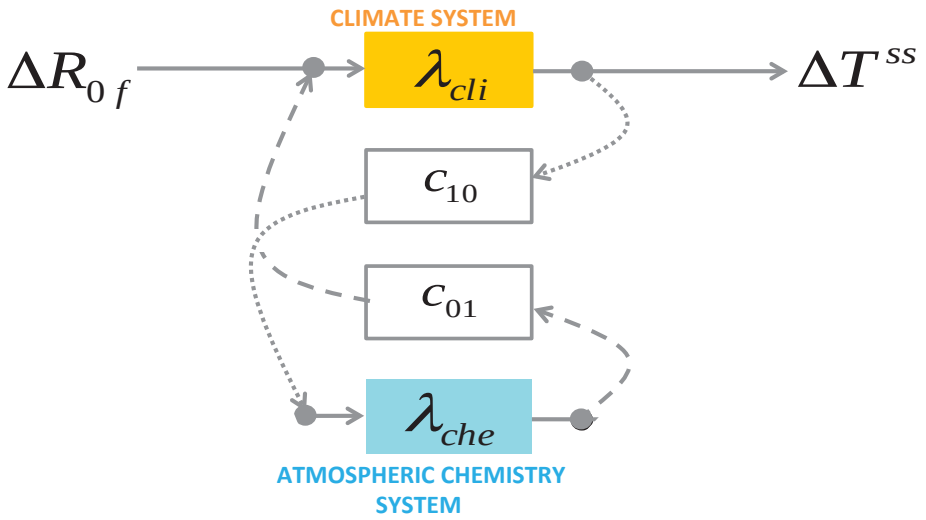
If those are the challenges, how do we overcome them?

- Map significant policy openings
- Identify policy champions
- Tailor messages to the questions being asked
- Make specific recommendations (actions)
- Provide tools that facilitate implementation
- Be honest (but not dreary) about risks

cew@jps.net



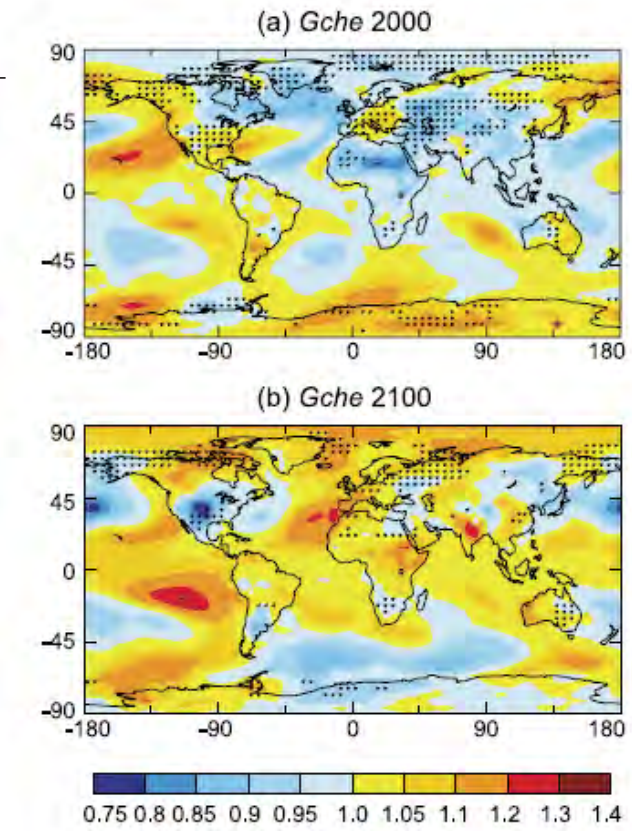
Raes et al., JGR, 2010



$$G_{che} = \frac{\Delta T_{with\_feedback}}{\Delta T_{without\_feedback}}$$

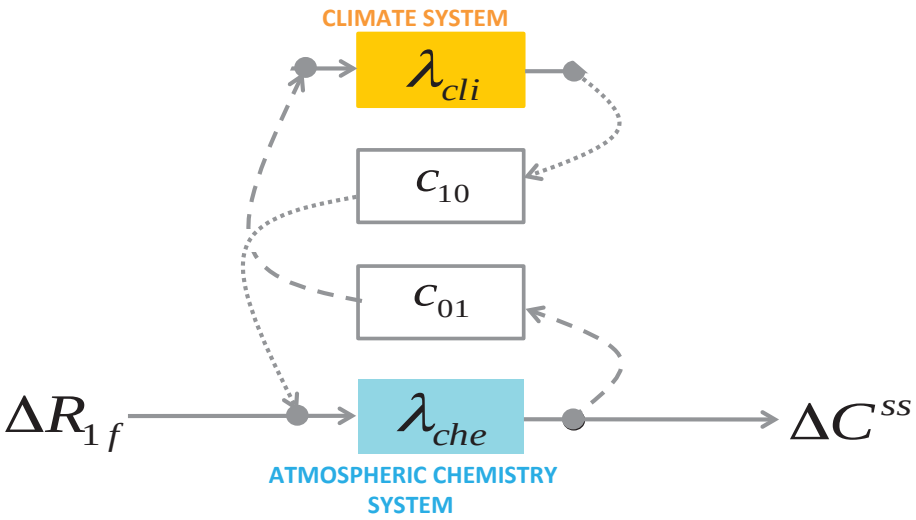
amplification of climate sensitivity due to atmospheric chemistry

$$G_{che} = \frac{\Delta T_{with\_feedback}}{\Delta T_{without\_feedback}}$$



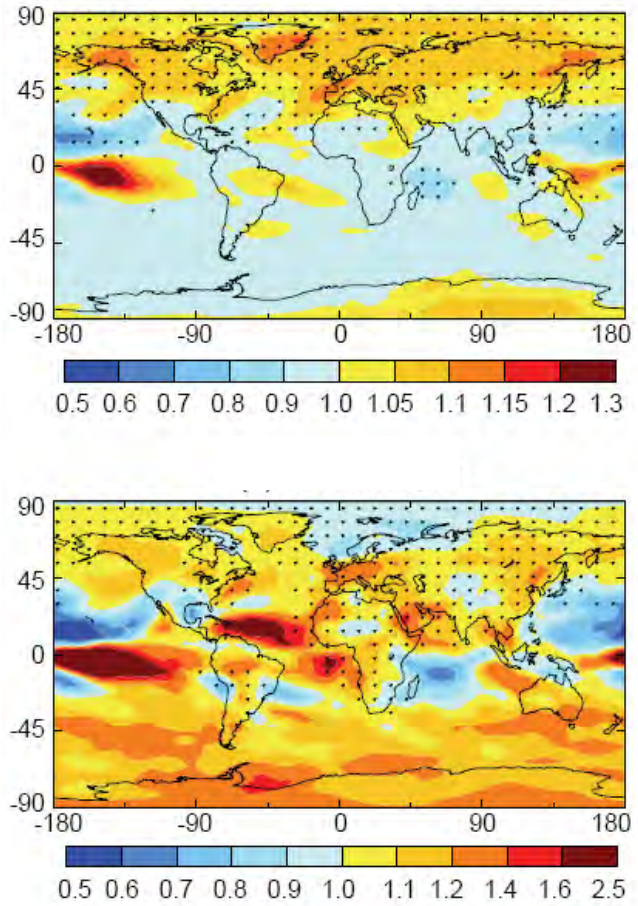
Raes et al., JGR, 2010

$$G_{cli} = \frac{\Delta C_{with\_feedback}}{\Delta C_{without\_feedback}}$$



amplification of atmoscheric chemistry climate sensitivity due to climate

$$G_{cli} = \frac{\Delta C_{with\_feedback}}{\Delta C_{without\_feedback}}$$

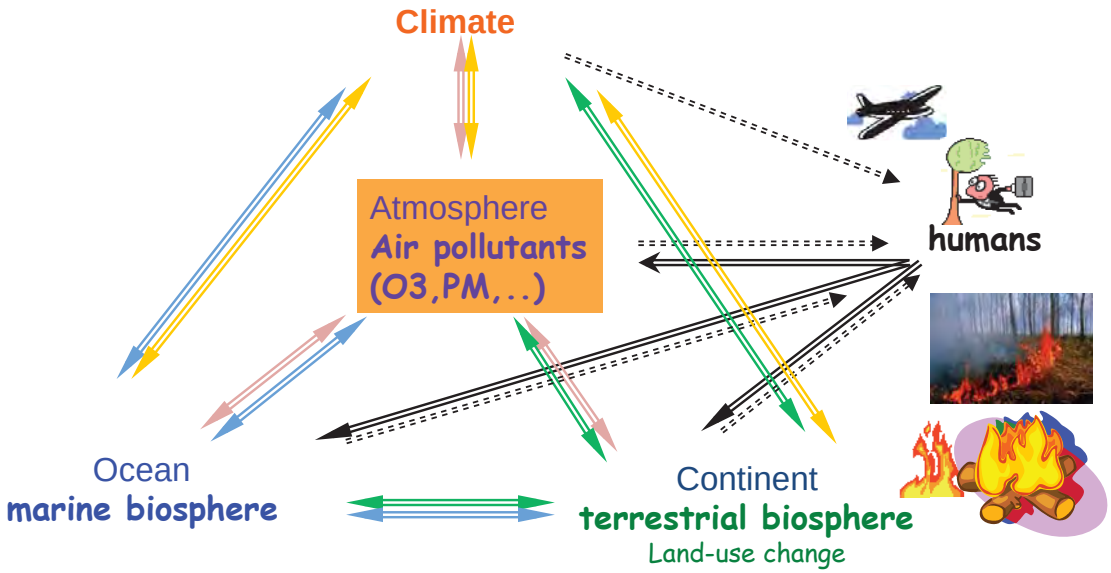


Raes et al., JGR, 2010

Oral Perspectives

- Tim Williamson
- Iyngara Mylvakanam
- Meng Kuo
- Tirusha Thambiran

What is the challenge from a scientific perspective?



Climate feedbacks

Co-emission of pollutants

What is the challenge from a scientific perspective?

The scientific challenge faces the feedbacks (non-linear response) of the earth system to external forces

Climate Change impacts Air Pollution

•Understand and account for emissions and AP response to a changing climate, shift in biomes and land cover/land-use changes, (+ ocean behavior), transport patterns /climate driven chemistry → *increased background levels (more difficult to reach targets)*

• Strong natural component (climate driven) that interacts with anthropogenic (mitigation targeted) emissions

(can be problematic to reach AP/CC targets)

Examples
- SOA enhancement
-BC/OC co-emissions
-CH4 –natural sources → affected by AP

What is the challenge from a scientific perspective?

Global and Regional basis for assessment

Regional basis for implementation

s/r relationship but also for mitigation implementation
different economies, **emission sectors**, LRT patterns

Most developing countries focus on AP issues/low cost measures

Multi-species approach +co-emission → account for and improve scientific understanding

Evaluate Short and long term benefits

Base evaluation on modeling + observational evidence

Enhance and rationalise the observational network to provide observational proof

What is the challenge from a scientific perspective?

Develop complete understanding of AP + CC issues

DEFINE THE REFERENCE POINT for evaluation of the mitigation options

What is in the underlying scenarios for the mitigation options – technology changes to understand the impacts

CO2 mitigation policies and their effect on AP

follow up the effectiveness of policy implementation

→ Understand the role already played by humans with the decisions taken (or not) in changing air quality and climate

Air Pollution & CLIMATE
a science-policy dialogue

What is the challenge from a scientific perspective?

Communicate clear (and the right) messages
provide risks assessment and uncertainties
Evaluate potential of abrupt changes/risks

Sustainable TWO ways dialogue

Message communicated early enough to be digested for discussion by the policy makers

(find the target persons –AQ/CLIM might not be the same

Raise public awareness

What is the Challenge from a Policy Perspective?

&

What Should IGBP Do?

Starting Thesis

- **The Problem:**
- There's a science / policy gap
- Efforts are being made to bridge that gap
- Some work, some don't (or are very risky)
- Process is inefficient
- **IGBP Should…**
- Summarize (and grade?) those efforts
- Identify research priorities
- Aim at global level policy makers

Counter Factuals

- **Re the Problem Statement**
- Multiple reports reinforce messages, aren't inefficient
- Policy makers want best bets not "grades"
- Audience matters (what are their concerns?)
- Timing matters (where is the policy opening?)
- Scale is crucial (policy is made locally, not globally)
- Need ongoing linkages, not just one time report
- Need methodology to link short/long term outcomes

Counter Factuals

- **Re Proposed IGBP Role**
- Other bodies have more access to policy makers (e.g. UNEP); IGBP best on scientific side.
- Policy makers are unlikely to attend Planet Under Pressure conference in March 2012.
- There's no such thing as global policy. All significant decisions happen at the local, regional or national scale.

Other Observations

- People care more about air pollution than global warming. AQ messages will always resonate more.
- Ambition drives trade-offs. To avoid disbenefits have to reach higher.
- Scientists have less appreciation of the policy setting process rather than the other way around.
- Actions have consequences. It's important to identify what those are. (Even activists would agree.)
- Data/studies are suspect and shouldn't be relied upon without understanding underlying facts. Crap = crap.

Possible Way Forward

- Instead of evaluating all SLCF reports, IGBP could identify what we're most confident about and the specific actions that implies.
- IGBP could help translate policy maker needs to the scientific community.
- IGBP could help with linkages between climate and AQ modelers.
- IGBP could frame the short vs. long term issue, which is ***the*** major disjunction between air quality and climate change, and how to bridge those perspectives.

One More Idea

- **<u>If IGBP wants to stay global, it could</u>**
- Focus on sources that are global in nature (marine, aviation) and how best to minimize their climate and air quality impacts.
- Focus on globally significant impact zones (e.g., the Arctic) and what's needed to protect those zones, in ranked priority order.

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Arriving at a Consensus:
Drafting a summary of the challenge from a science-policy perspective:
Roundtable discussion

Group summary of challenges (1)

- Create multi disciplinary global research agenda on AP/ climate
- What is the value added of the IGBP effort? Need to identify what more is needed following UNEP, EPA, etc. reports
- Describe known knowns and known unknowns.
- Want to do an assessment of assessments?
- Start process of analyzing co-benefits at the country scale. This would provide input to local decision makers on mitigation efforts. Need to include economists as well as scientists and policy makers.
- What are air quality implications of LLGHG mitigation strategies? (eg. Biofuel vs. solar or wind)
- Need thoughtful input to EU and Chinese air quality plans.

Group summary of challenges (2)

- UNEP BC O3 report implementation process only just started. There is not yet buy-in from individual countries. Therefore IGBP could help with international buy-in.
- Health risk assessments have a lot of uncertainty but there is still consensus around them. Similarly we should emphasize where there is consensus, not the uncertainties. Synthesize what is common among the reports.
- UNEP efforts started 15 years ago. Need actual emission reductions on the ground.
- Frame air pollution as a unified system – describe what research is needed: interdisciplinary issues, policy relevance. Need research strategy. One atmosphere – same pollutant many effects.
- Need clear broad statement on air pollution - climate connection.

Group summary of challenges (3)

- Policy will be made in an incremental fashion. Science community needs to understand the policy process and be aware of who and when influence is possible. IGBP can help facilitate that interaction in a variety of venues (eg. UNEP report, EPA BC report, China, EU air quality, etc). Think about how to be effective in regional policy settings.

The Output of the IGBP Air Pollutions & Climate Initiative

1. IGBP Statement on the Air Pollution & Climate Change Challenge
   - Clarification of the messages
   - Focus on win-win solutions (from global to regional level)
   - Package message for different audiences
2. Strategy for a multi-disciplinary program

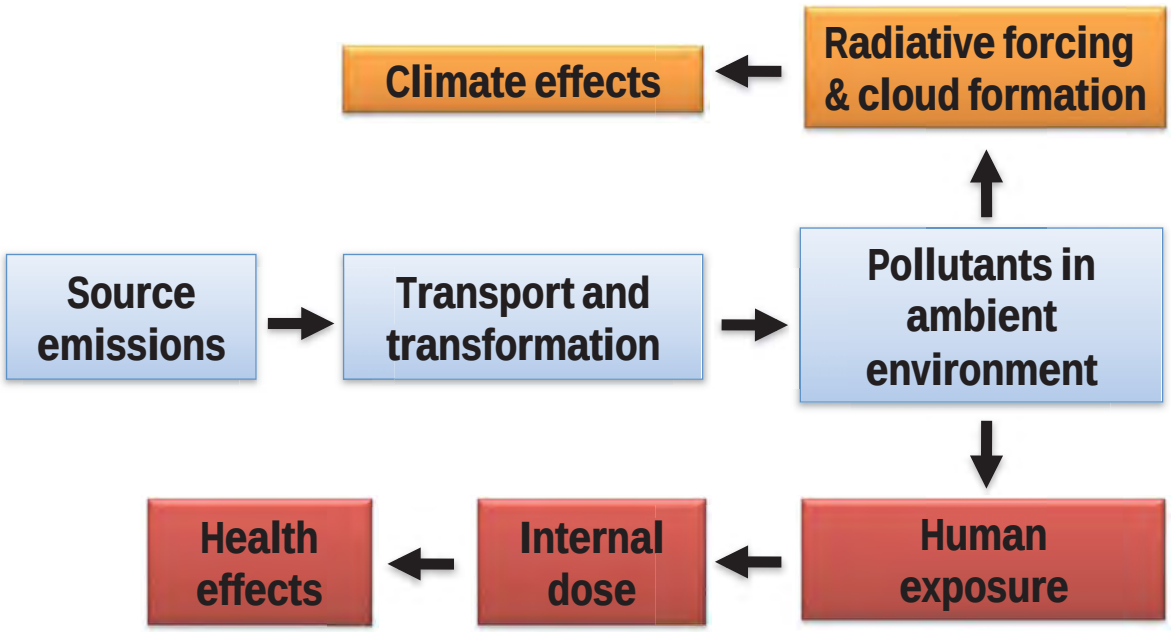
June 9, 2011

What are the scientific gaps in addressing the challenge —**Air Quality Perspective**

Candice SC LUNG

Research Center for Environmental Changes
Academia Sinica, Taiwan

Progression of Pollutants from Emissions to Health/Climate Effects



[Candice SC LUNG, 2011]

2.

Which pollutant to control?

- Health concern
  - Aerosols (BC, OC,…)
  - Tropospheric O_3
  - NOx
  - Volatile Organic Compounds (VOCs)
  - Polycyclic aromatic hydrocarbons (PAHs)
- Long-lived
  - CO_2
  - N_2O
- Short-lived
  - Aerosols (BC, OC,…)
  - NOx
  - Tropospheric O_3
  - Methane
  - CO

[Candice SC LUNG, 2011]

3.

Scientific challenges

- **Challenge 1**: Spatial variability of pollutants
  - Community air quality may be worse than observed in EPA monitoring stations
- **Challenge 2**: Health effects of aerosol sizes and compositions
- **Challenge 3**: Synergic health effects of complex pollution
- Complication: Climate change impacts and country-specific

[Candice SC LUNG, 2011]

4.

Scientific gaps

- **Gap 1**: Source emission inventory
  - Inventory gaps
  - Validation
- **Gap 2**: Mechanisms
  - Surface-atmosphere interactions
  - Physio-chemical transformation of aerosols
- **Gap 3**: Impacts of climate change on air quality

[Candice SC LUNG, 2011]

5.

Pollution Sources

- Uncontrollable
  - Biogenic
- Partially controllable
  - Wild fire
- **Controllable**
  - Industry
  - Transportation
  - Community sources
  - Agriculture practice
  - Personal care products

[Candice SC LUNG, 2011]

6.

Night market

Asian style restaurant

[Candice SC LUNG, 2011]

7.

Hair salon

Car salon

Temple

[Candice SC LUNG, 2011]

8.

Gap 1a — Inventory Gaps

- Actions needed: Source strength and characterization in chamber and field studies
  - Community sources
    - Emissions from cooking sources, religious sources, beauty industry, etc.
  - Agriculture practice
    - Rice straw burning emissions
  - Man-made/human surfaces
    - construction, perfume, etc
    - VOCs or SVOCs emissions
  - Natural sources
    - Biogenic source emission

[Candice SC LUNG, 2011]

9.

Gap 1b —Inventory validation

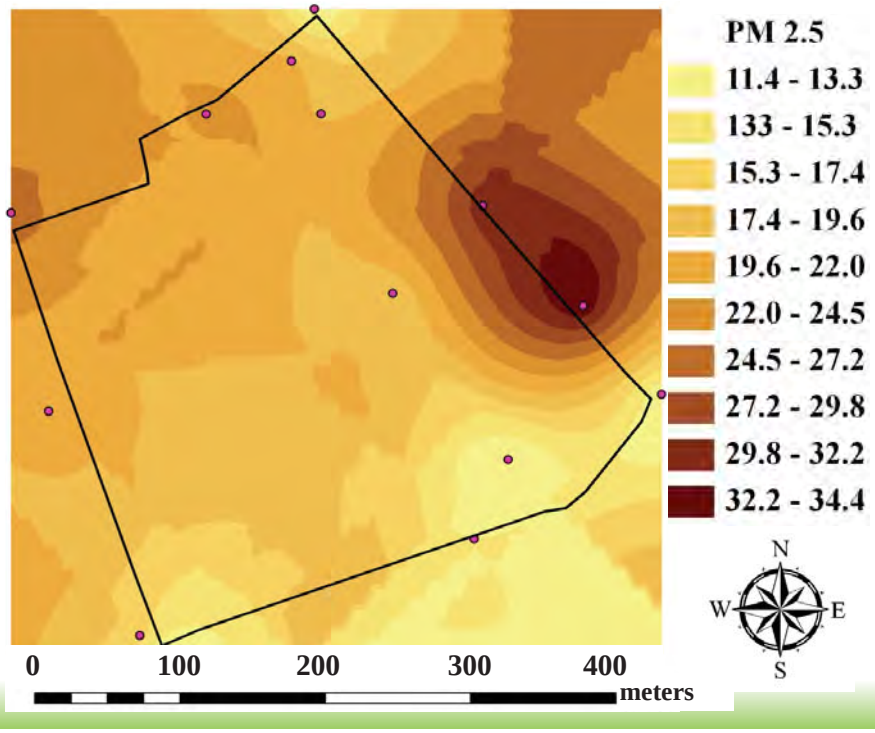
- Actions needed:
  - Source apportionment in field studies
    - Ground-based observations with chemical compositions
    - remote sensing observation with fine-scale resolution and lower detection limits
  - Cross-validation with air quality models
    - Fine spatial resolution

[Candice SC LUNG, 2011]

10.

Fine-scale air pollution variability

- Identify important community sources and formulate control strategies accordingly



[Candice SC LUNG, 2011]

11.

Gap 2a — Mechanisms of surface-atmosphere interactions

- Actions needed: Chamber or in-situ studies for surface-atmosphere interactions
  - Natural surfaces
    - Biogenic emissions interact with other pollutants
  - Man-made surfaces
    - Construction-surface emissions interact with other pollutants
    - Chemical reactions of pollutants with the building materials and surface coatings
  - Human surfaces
    - Personal care product emissions and reactions

[Candice SC LUNG, 2011]

12.

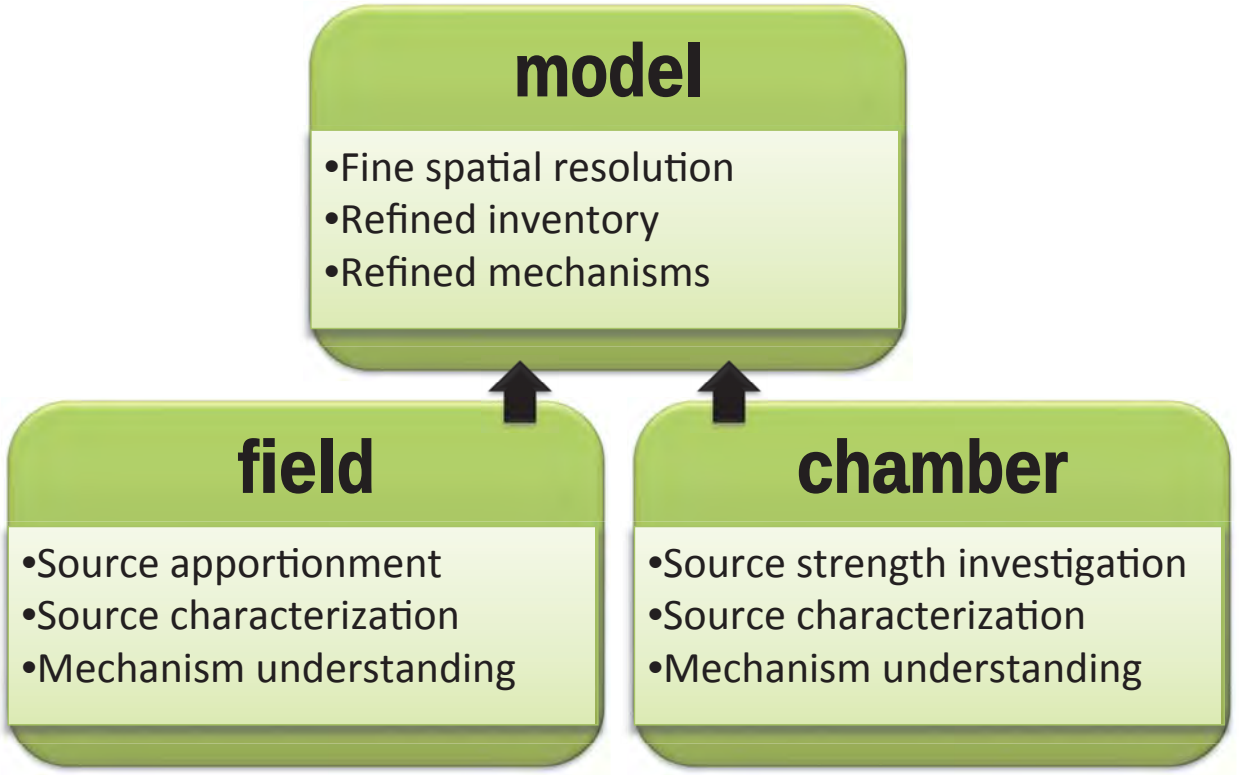
Gap 2b — Mechanisms of physio-chemical transformation of aerosols

- Actions needed: Chamber or in-situ studies to study
  - Physio-chemical property transformation of existing particles with solar radiation and other pollutants
  - Oxidation potentials of important organic aerosol compositions

[Candice SC LUNG, 2011]

13.

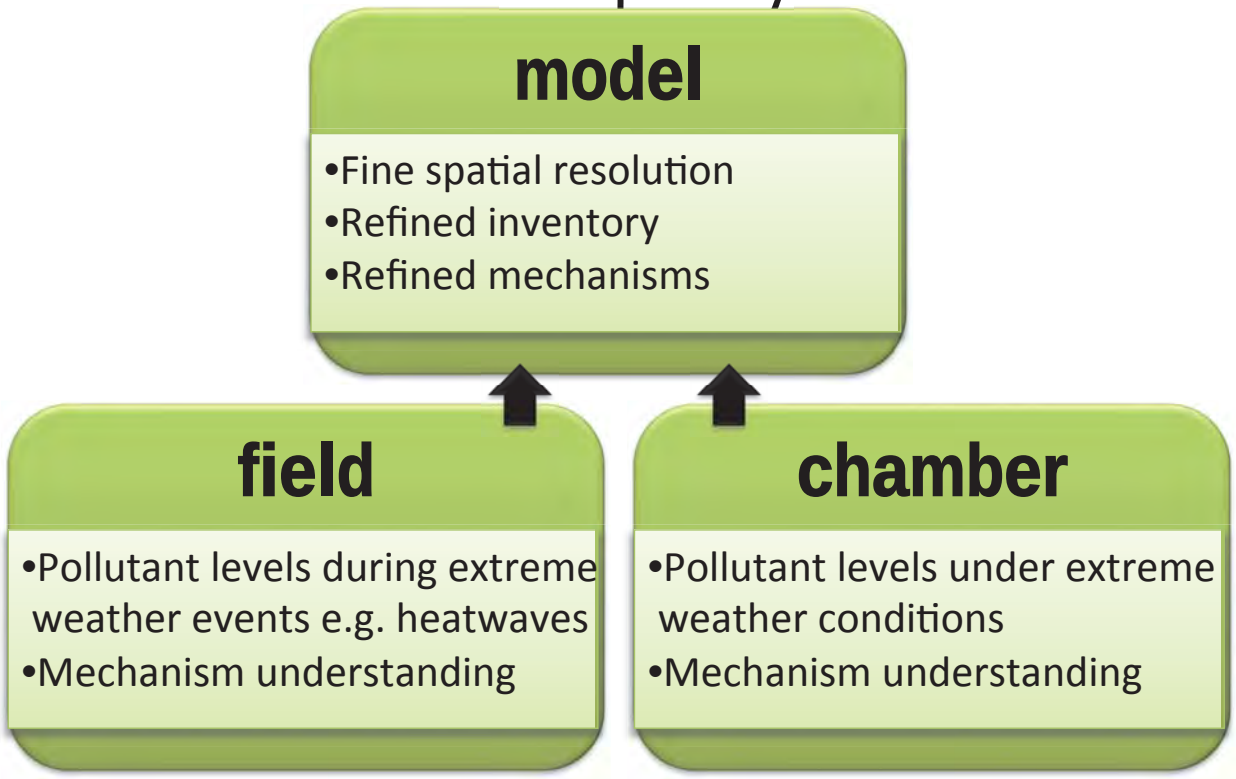
Model refinement



[Candice SC LUNG, 2011]

14.

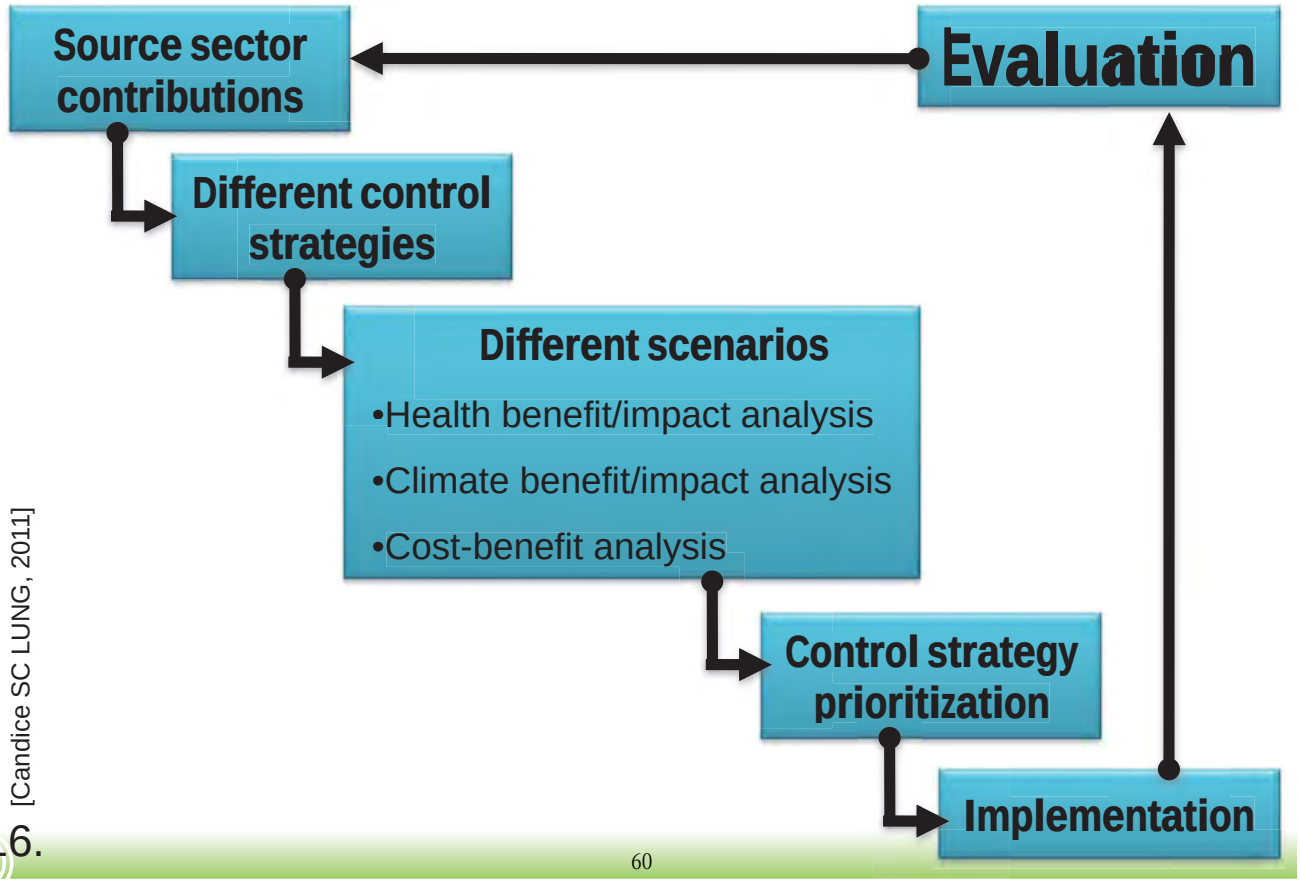
Gap 3 — Impacts of climate change on air quality



[Candice SC LUNG, 2011]

15.

Science-based Air-Quality Control Policy Framework



[Candice SC LUNG, 2011]

16.

Summary

- Scientific gaps
  - source emission inventory
  - mechanisms
  - climate change impacts
- Scientific challenges
  - spatial variability of pollutants
  - health effects of aerosol sizes and compositions
  - synergic health effects of complex pollution
- Reduce health vulnerability under climate change

[Candice SC LUNG, 2011]

17.

What are the scientific gaps in addressing the challenge

—Air Quality Perspective

Any comments and suggestions are welcome!

Candice Shih-Chun LUNG

Academia Sinica, Taiwan

JRC
EUROPEAN COMMISSION

What are the scientific gaps in addressing the air pollution and climate change challenge? - climate

frank.dentener @ jrc.ec.europa.eu

European Commission
Joint Research Centre
Climate Change and Air Quality Unit

How to bring the climate effects of short-lived and long-lived components together in credible metrics for policy making?

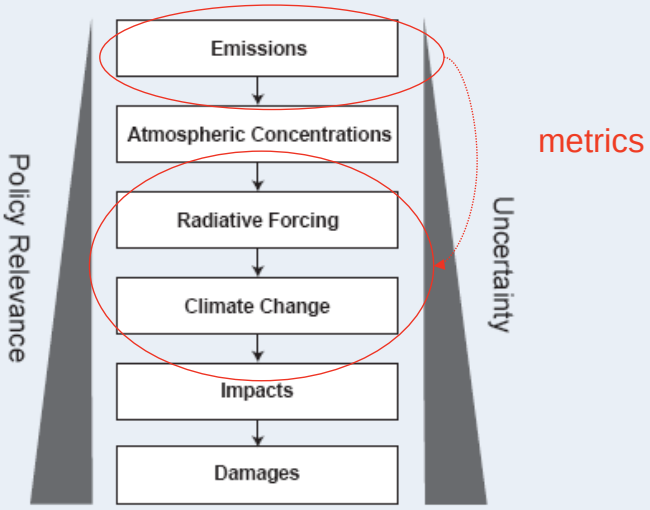


Figure 1. Cause-effect chain from emissions to climate change, impacts and damages (adapted from Fuglestvedt et al., 2003, *Climatic Change*).

Short-lived and long-lived components

- **Climate metrics: instantaneous RF, GWP, GTP**
  - Radiative Forcing is a climate metric
  - Global Warming Potential and Global Temperature Potential are Emissions metrics
  - GWP is integrated RF, GTP includes the surface temperature response, is an end-point metric
- **Current climate policy (Kyoto) uses GWP100: global integrated RF over 100 years. Doesn't include short lived components.**
- **Will future climate policies consider air pollution? How to do it? What role can science play there?**
- **IPCC workshop on metrics (Oslo, 2009)**

IPCC workshop on metrics (Oslo, 2009): General Recommendations

Very useful as a starting point! Downloadable from IPCC

- **Now: keep GWP(100) for policy making: as uncertain as others**
- **Alternative metrics advisable for certain policy goals**
- **GWP very dependent on time horizon (but also GTP), model dependent**
- **Timely interaction of policy and scientific assessments: *2020?***

IPCC Scientific recommendations: Uncertainties

- *Characterize the uncertainties* in Global Temperature Change Potentials (GTPs) stemming from uncertainties in climate sensitivity, climate efficacies, ocean heat uptake
- Develop *Probability Density Functions* (PDFs) for metrics in general, and for GWPs (CO2 absolute GWP (AGWP) and other AGWPs) and GTPs in particular, that encompass all known sources of uncertainties
- Characterize the *uncertainty* associated with ocean heat uptake, climate sensitivity, carbon cycle response and other processes in a hierarchy of climate models. On this basis, understand and communicate the simplifications embedded in reduced complexity models
- Continue to *quantify magnitudes of indirect effects and interactions between different emissions*, not only for long-lived greenhouse gases but also for shorter-lived pollutants
- Better understand and quantify the uncertainty in mitigation costs and climate change damages.

IPCC Scientific recommendations: New and Refined Areas or Metrics

- Develop metrics for policy targets other than limits to temperature change, such as the *rate of temperature* change, the integral of temperature change, and cost-benefit analysis approaches, or other climate variables, etc.
- Develop approaches to account for long-term outcomes such as consideration of *post-target period for GTPs or post-horizon period for GWPs*
- *Comprehensively assess regional differences in emissions-to-impacts* relationships especially for short and very-short lived pollutants
- Determine the degree to which *physical metrics* approximate more *comprehensive metrics that include economics*
- Consider whether existing metrics are appropriate to account for *geo-engineering* proposals, particularly in the context of climate protection at the regional scale.

IPCC Recommendations: Relationship between Policy Frameworks and Metrics

• Study implications of *choice of alternative metrics* for outcomes such as emissions of different gases, climate change outcomes, and costs (especially for specific countries or sectors);

• Investigate the potential for extending the multi-gas strategy to short-lived pollutant emissions.

What about the role for IGBP?

Table A2
GWP values for one-year pulse emissions of black carbon for a 20, 100 and 500 year time horizons and GTP values for 20, 50 and 100 years. The effects of aerosols on clouds (and in the case of black carbon, on surface albedo) are not included. The GTP values are specific to a given value of climate sensitivity – see Appendix 2.

Study	GWP			GTP		
	$H = 20$	$H = 100$	$H = 500$	$H = 20$	$H = 50$	$H = 100$
Koch et al.						
SE ASIA	1700	480	150	500	82	68
N AMER	1900	550	170	560	93	77
EURO	1800	510	150	520	86	72
S ASIA	3200	920	280	940	160	130
S AMER	2200	610	190	630	100	87
AFRICA	1200	340	100	350	57	48
Naik et al.						
Africa	4500	1300	390	1300	220	180
E ASIA	3400	960	290	980	160	140
FSU	2000	580	180	590	98	81
INDIA	5100	1400	440	1500	250	200
N AMER	3200	920	280	940	160	130
S AMER	4900	1400	420	1400	240	200
SE ASIA	4000	1200	350	1200	200	160
Reddy and Boucher						
S. America	1900	550	170	570	94	78
N AMER	1500	430	130	450	74	62
AFRICA	2500	720	220	730	120	100
EUR	1400	380	120	390	65	54
Mid-EAST	2600	740	220	760	130	100
S ASIA	2400	670	200	690	110	95
E ASIA	1500	420	130	430	72	60
Berntsen et al.						
EUR	1500	430	130	440	72	60
China	1200	340	100	350	58	48
S. ASIA	2200	640	190	660	110	91
S AMER	2200	620	190	634	110	88
Bond and Sun	2200	680				
Schulz et al.						
Global mean	1600	460	140	470	77	64

BC GWPs and GTPs

GWP100 for BC:
Africa: 340-1300-720
Europe: 510-380-430
S Asia: 920-620-640

Get this better!

SO2 GWPs and GTPs

Table A4
GWP values for aerosols formed from a one-year pulse emissions of SO_2 for a 20, 100 and 500 year time horizons and GTP values for 20, 50 and 100 years. The indirect effects of sulphate on clouds are not included. (All values are on SO_2 basis. Multiply by 2 to convert from SO_2 to S basis.) The GTP values are specific to a given value of climate sensitivity – see Appendix 2.

Study	GWP			GTP		
	$H = 20$	$H = 100$	$H = 500$	$H = 20$	$H = 50$	$H = 100$
Koch						
SE ASIA	−57	−16	−4.9	−17	−3	−2
N AMER	−89	−25	−7.6	−26	−4	−4
EURO	−42	−12	−3.6	−12	−2	−2
S ASIA	−120	−35	−11	−36	−6	−5
S AMER	−570	−160	−49	−170	−27	−23
AFRICA	−140	−38	−12	−39	−7	−5
Berntsen et al.						
EUR	−100	−29	−8.7	−29	−5	−4
China	−69	−20	−6.0	−20	−3	−3
S. ASIA	−160	−44	−14	−46	−8	−6
S. AMER	−180	−50	−15	−51	−8	−7
Schulz et al.						
Global mean	−140	−40	−12	−41	−7	−6

Fuglestvedt, Atmos. Env., 2010.

GTP20 for SO2:
Africa: -170 -51
Europe: -12 -20
S Asia: -36 -51

Get this better!

IGAC/IGBP

- **Understand and reduce all uncertainties regarding the calculations of GTPs, and GWPs**
- **New or mixed metrics: what are the pros and cons?**
- **Link to metrics to measurements!**
- **Since this is about emission abatement: Endorse verification of reported emission inventories and changes over time (baseline), and monitoring of changes**

… but the story can be even more complicated…

…how to include feedback processes into the metrics, and how far can we go or do we want to go with this?

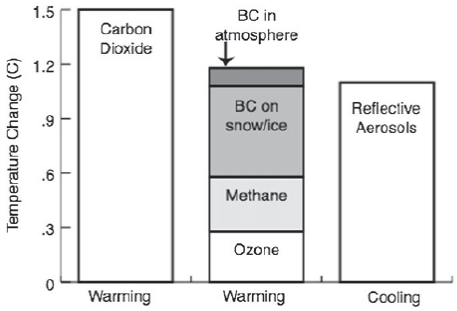
Feedback processes on climate involving pollution

- **Aerosol and clouds**
- **Cryosphere**
- **Terrestrial biosphere**
- **Oceans (nutrient transport, CO2, N2O emissions)**

Aerosol and clouds: linking pollution and climate

- **Should remain top-priorities for IGBP**
- **Endorse critical evaluation of measurement/monitoring capacities (trends!)**
- **Engage with AEROCOM**
- **Linking to metrics: not yet done for indirect effect**

Cryosphere



More in UNEP/IGAC report.

The large uncertainty regarding anything with BC is a challenging for Inclusion in metrics.

Figure 5.26. Estimates of the contribution of particular species to preindustrial to present-day Arctic (60° to 90° N) surface temperature trends. Values are based on the assessment of modelling and observations of Quinn et al., and do not include aerosol indirect effects. Reflective aerosols include sulphate and organic carbon. [Reprinted from Figure 41 of Isaksen, I. S. A., et al. (2009), Atmospheric composition change: Climate-chemistry interactions, *Atmospheric Environment, 43*(33): 5138-5192, with permission from Elsevier.]

Terrestrial Carbon uptake: role of N deposition

Terrestrial uptake of CO_2 2.6 Pg C/yr (0.9-4.2)

of which

Terrestrial uptake due to nitrogen: Literature range of 0.1-2 Pg C/yr

Key uncertainties from:
(1) the magnitude of global N deposition
(2) the partitioning of deposited N among ecosystem loss and retention in various ecosystem pools
(3) the magnitude – and sometimes, direction – of C response of each of these pools.

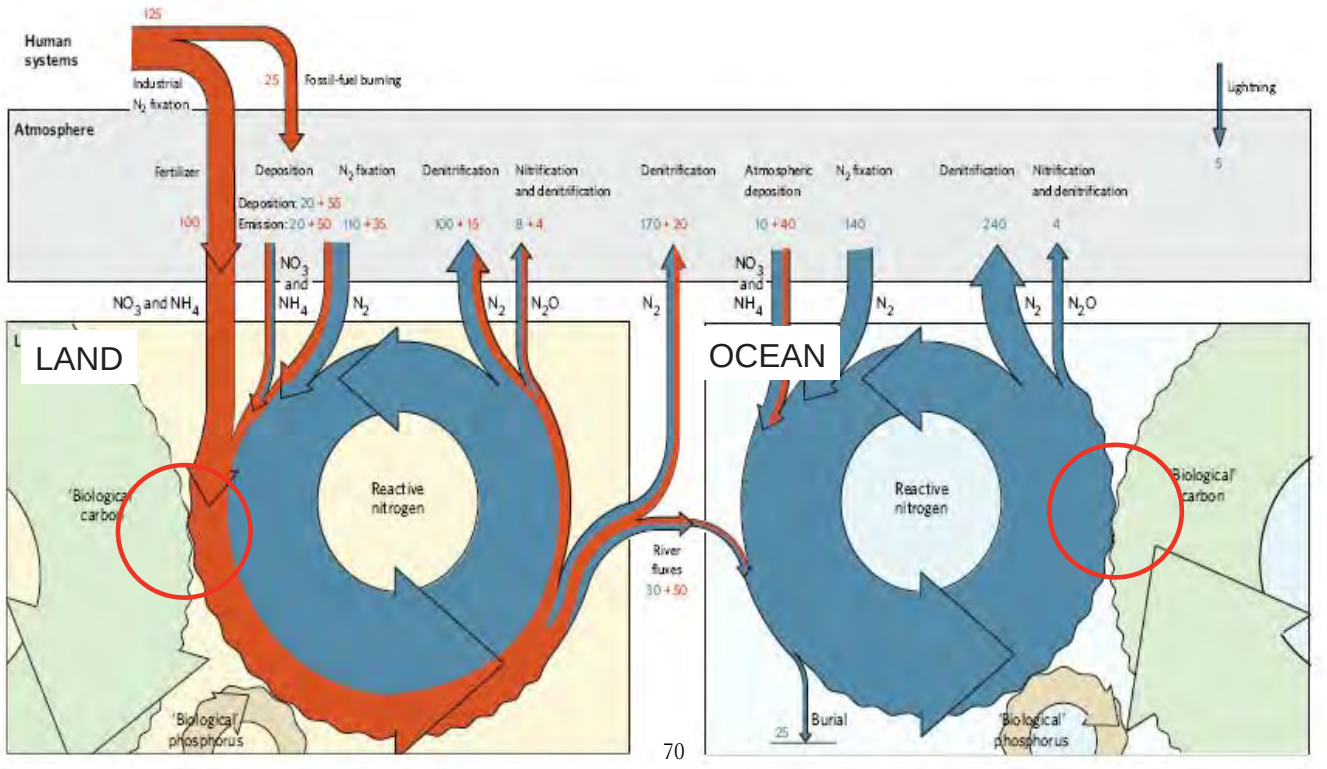
most likely range <0.6 Pg C/yr based on evaluated of 100s of plot scale fertilization experiments (Christine Goodale et al., in review 2011).

Indirect emissions of N2O.

Obviously this is a challenge for 'emission' metrics for N emission.

Interactions of the Carbon and Nitrogen Cycle

Gruber & Galloway, 2008



Impact of diffuse radiation on carbon uptake

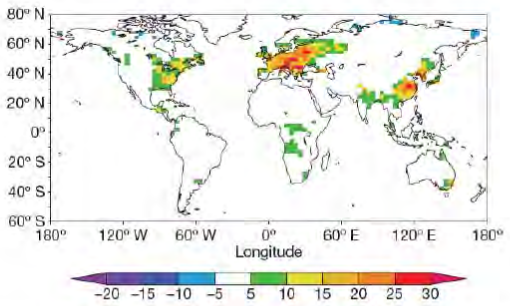


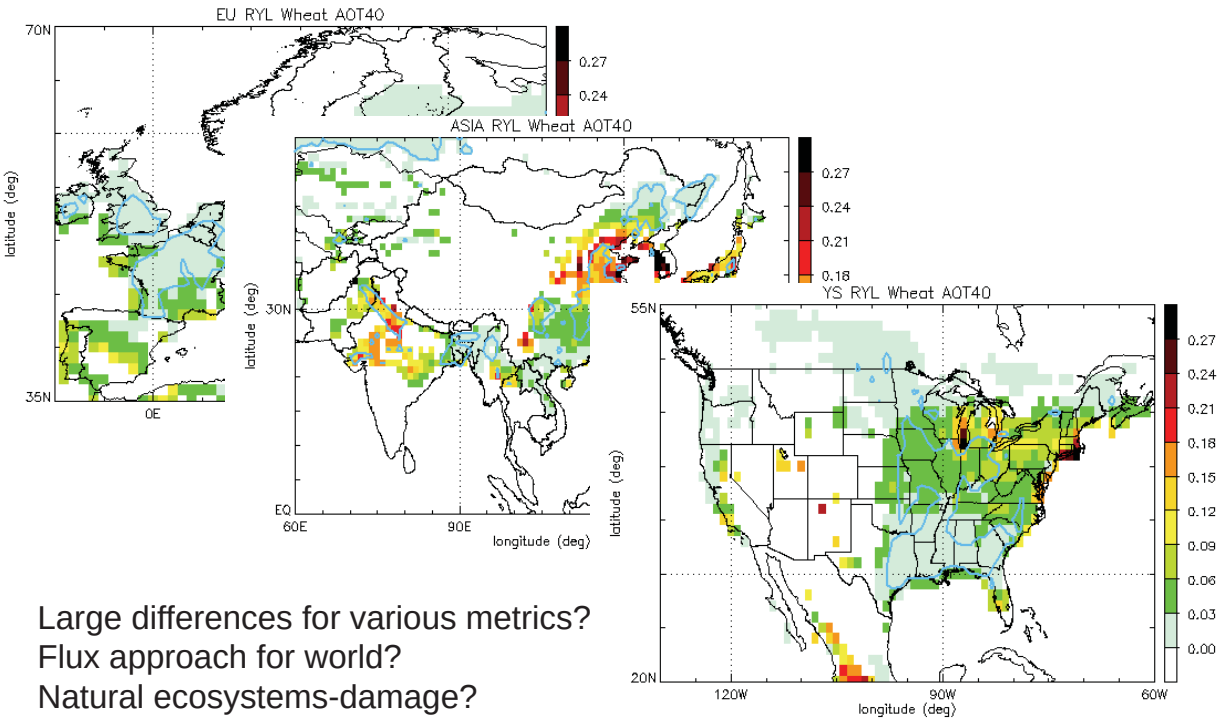
Figure 5.16. Simulated change (colour scale, grams carbon per square metre per year) in diffuse fraction contribution to land carbon accumulation between 1950 and 1980. [Reprinted from Figure 3(d) in Mercado, L. M., et al. (2009), Impact of changes in diffuse radiation on the global land carbon sink, *Nature, 458*: 1014-1017.]

IGBP:

- **Interesting theories: but how are we going to prove them? What processes need to be tested?**
- **What is the role for coordinated experiments measurements and models?**

Interaction of O3 with biosphere

-Damage to agriculture and natural ecosystems;
Van Dingenen (2008)
-Less terrestrial Carbon (CO2) uptake,
and implication for climate metrics (Collins, JGR, 2010)



Large differences for various metrics?
Flux approach for world?
Natural ecosystems-damage?

Van Dingenen et al, 2008

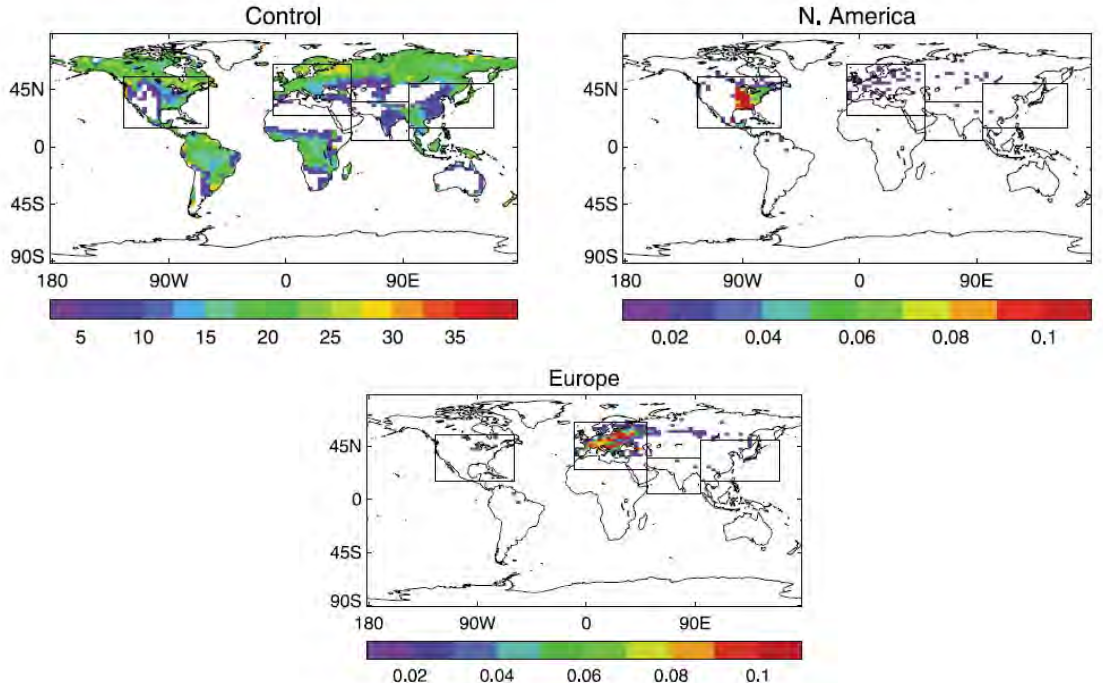
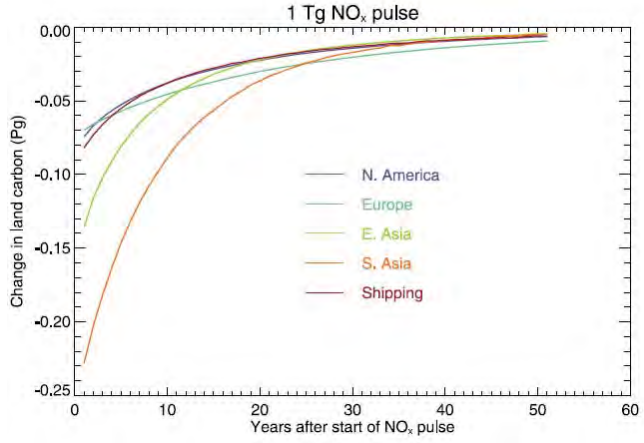
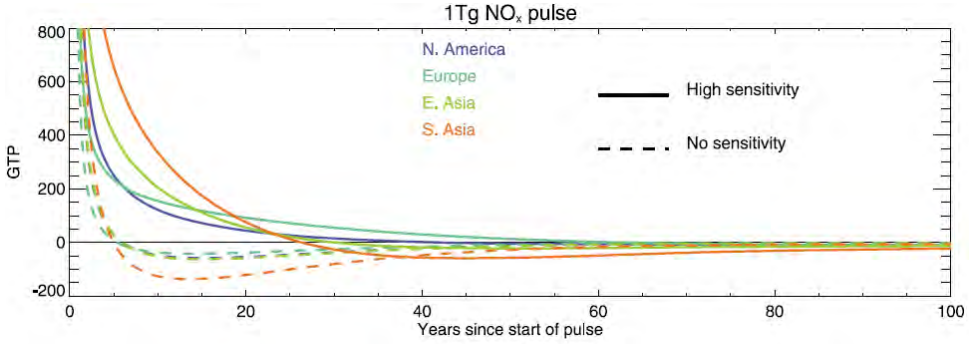


Figure 3. Land carbon store (kg C m^{-2}) for the control experiment and change in land carbon store averaged over year 2 following the regional NO_x emission reductions prescribed in year 1.

NOx ↓ O3 ↑ quasi instantaneous

Collins et al, JGR, 2010





Collins et al, (2010), estimate for NOX emissions a GTP20 of -9 (cooling) to +24 (warming) depending on assumptions of the sensitivity of vegetation types to ozone damage.

Atmosphere-biosphere response directions

NOx ↓ O3 ↑ quasi instantaneous

NOx ↓ OH ↓ CH4 ↑ O3 ↑ longer term

O3 ↓ uptake CO2 ↑

O3 and vegetation

Measurements- especially in tropics

Other feedbacks of vegetation:
- **Role of droughts/fires**
- **Climate dependency of emissions**
- **…we are going to see many more.**

How to bring uncertain processes into meaning metrics, and should we use them?

Summary:

IGBP could:

- Promote discussion on alternative metrics
- Help promoting measurements and model experiment on various feedbacks between pollution and climate and how they influence metrics
- Help in the difficult discussion on weighing uncertainties in climate metrics, and how to communicate uncertain feedbacks

Knowledge to Action

- Knowledge
- Awareness
- Trust/Credibility
- Framing in a Decision Context
- Technology/Management Approach
- Authority/Management Capacity
- Timing (Windows of Opportunity)
- Will
  - Compelling Rationale
  - Political Capital
  - Competing Priorities
- Action

Knowledge to Action

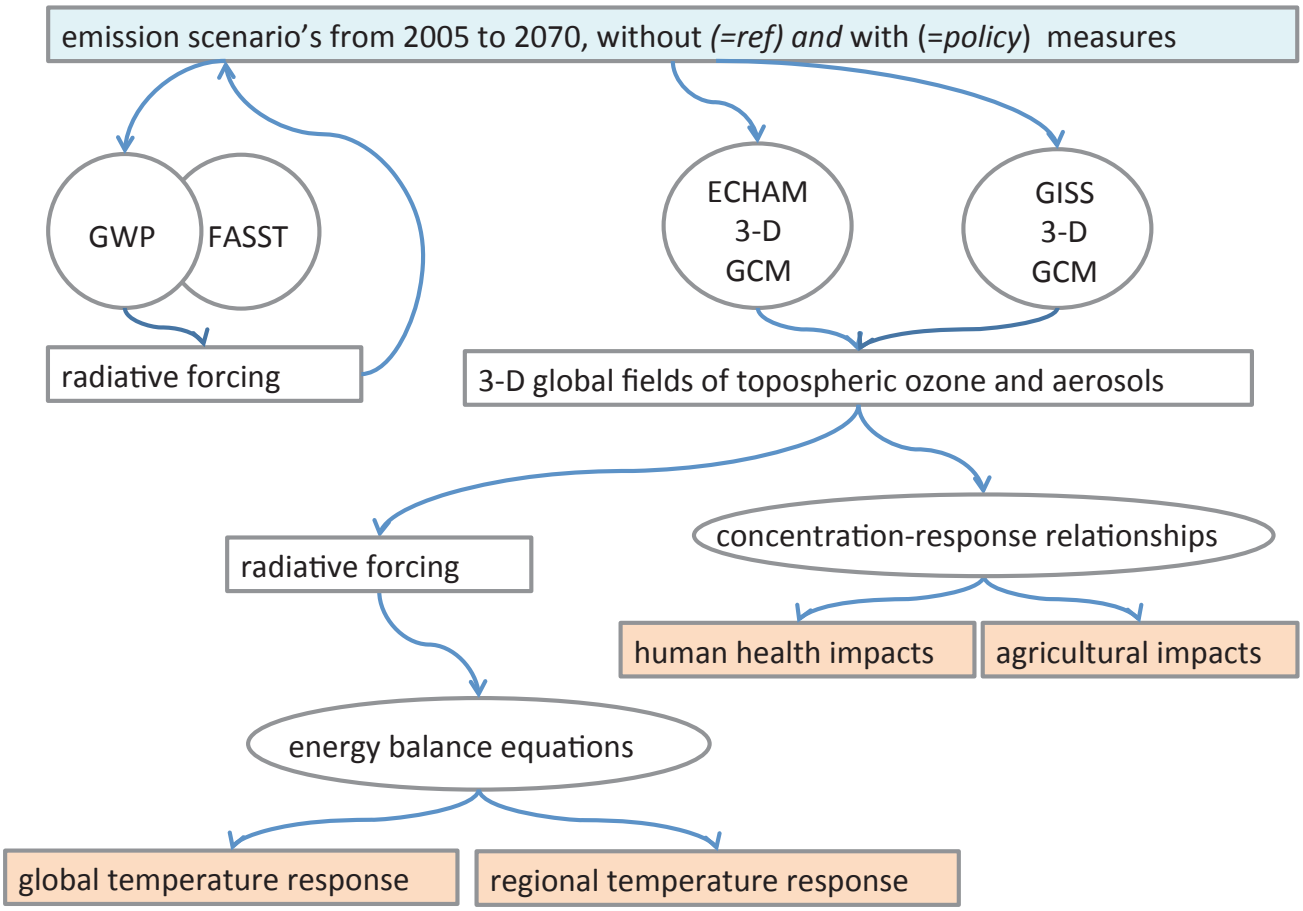
- Knowledge: Target Research, Identify Priorities for Health, Technology, …
- Awareness: Sustained Communication
- Trust/Credibility: Improve Involvement, National Capacity
- Framing in Decision Context: Develop Appropriate Decision Support Systems, Provide Quantification
- Technology/Management Approach: Identify Specific, Appropriate Options, Recognize "Regulatory" System Differences
- Authority/Management Capacity: Support Capacity Building
- Timing (Windows of Opportunity): Have Information Ready, Sustained Messages
- Will
  - Compelling Rationale: Appropriate Framing of Results
  - Political Capital
  - Competing Priorities
- Action

Current Challenges

- Being Directionally Correct
  - E.g. Indirect Aerosol Effects
- Getting Magnitudes Correct
  - Setting Appropriate Expectations
- Appropriately Framing Synergies and Tradeoffs
  - Health, Climate,…Measures of Welfare, Development
- Paralysis by Analysis
  - In what situation do you need detailed analysis?
- Value of Unilateral v. Collective, National v. Global Action
- Competing Priorities
  - Improve the dialogue between the Earth Science Community and the Policy Analysis/International Relations Research Community

Measures to Limit Near-Term Climate Change & Improve Air Quality

Chair:	**Drew Shindell**: NASA Goddard Institute for Space Studies, USA
Vice Chairs:	**Frank Raes:** EC Joint Research Centre, Ispra, Italy **V. Ramanathan:** Scripps Institute, Univ. of California, USA **Kim Oanh:** Asian Institute of Technology (AIT), Thailand **Luis Cifuentes:** Pontificia Universidad Católica ,Chile
Sci. Secretariat:	**Johan Kuylenstierna, Kevin Hicks,** SEI, York, UK
UNEP Coordinator:	**Volodymyr Demkine**, UNEP DEWA, Nairobi, Kenya
Lead Authors:	Emissions: **David Streets**: Aragonne National Labs. USA Atmospheric processes: **David Fowler**: CEH, UK Impacts: **Lisa Emberson**: SEI, UK Policy Measures: **Martin Williams:** Kings College.UK
Lead Modelers:	Emissions: **Markus Amann**: IIASA **Greet Maenhout**:JRC/EC Climate: **Drew Shindell:** GISS. **Elisabetta Vignati** – ECHAM at JRC Health: **Susan Anenberg**: US EPA Crops: **Rita van Dingenen:** JRC Economic Valuation: **Nicholas Muller** Middlebury College



Three groups of promising measures

CH_4 measures

1. Recovery of coal mine gas
2. Production of crude oil and natural gas
3. Gas leakages at pipelines and distribution nets
4. Waste recycling
5. Wastewater treatment
6. Farm-scale anaerobic digestion
7. Aeration of rice paddies

Technical BC measures

1. Modern coke ovens
2. Modern brick kilns
3. Diesel particle filters
4. Briquettes instead of coal for heating
5. Improved biomass cook stoves
6. Pellets stoves and boilers (in industrialized countries)

Non-technical measures

1. Ban of high-emitting vehicles
2. Ban of open burning of agricultural waste
3. Elimination of biomass cook stoves

3 groups of measures

'Methane only': Measures that affect emissions of methane

- Extraction and transport of fossil fuel, waste management and agriculture
- to be implemented centrally by large multi-national and national energy companies, municipalities and through modified agricultural practices

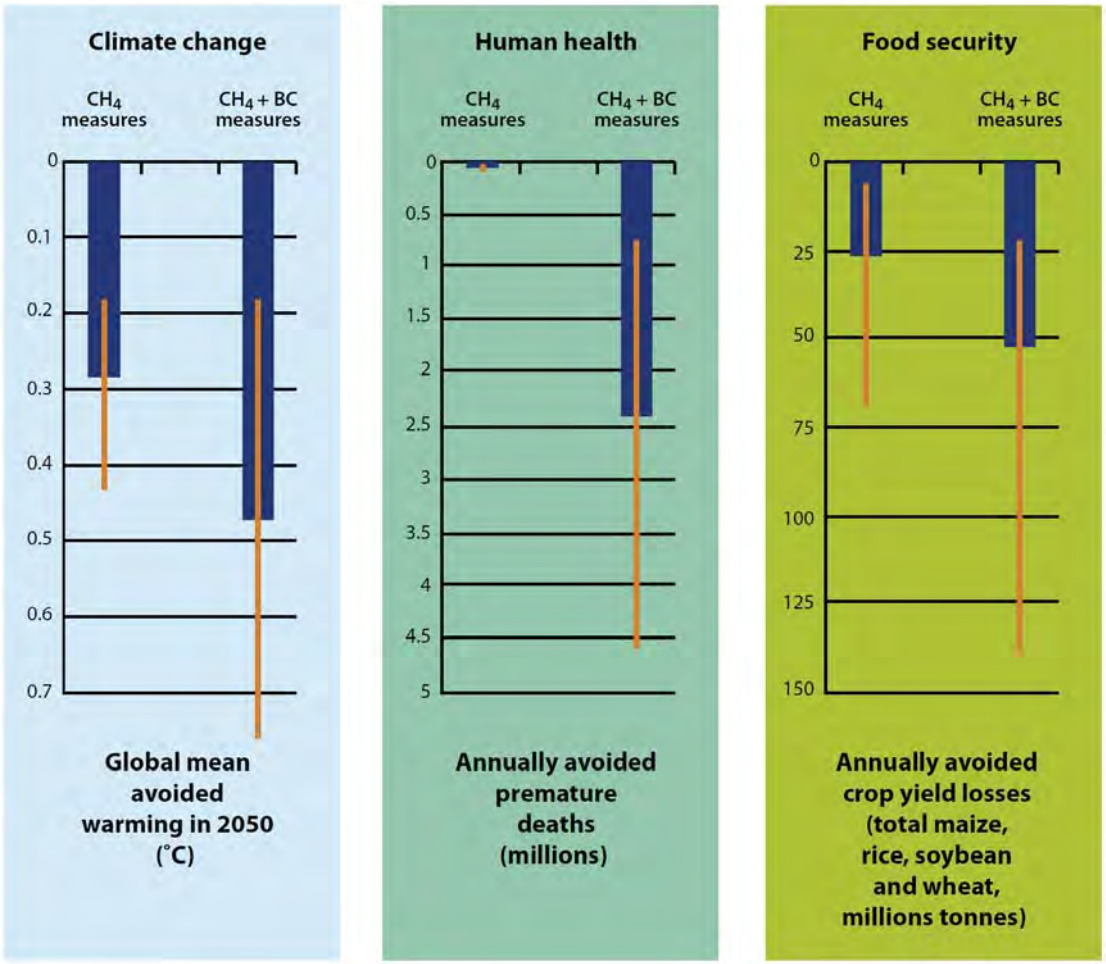
BC Measures that reduce emissions of black carbon and co-emissions (e.g. OC, CO)

- Transport, residential, & industry
- mainly at small stationary and mobile sources;
- biggest BC reduction is from diesel particulate filters

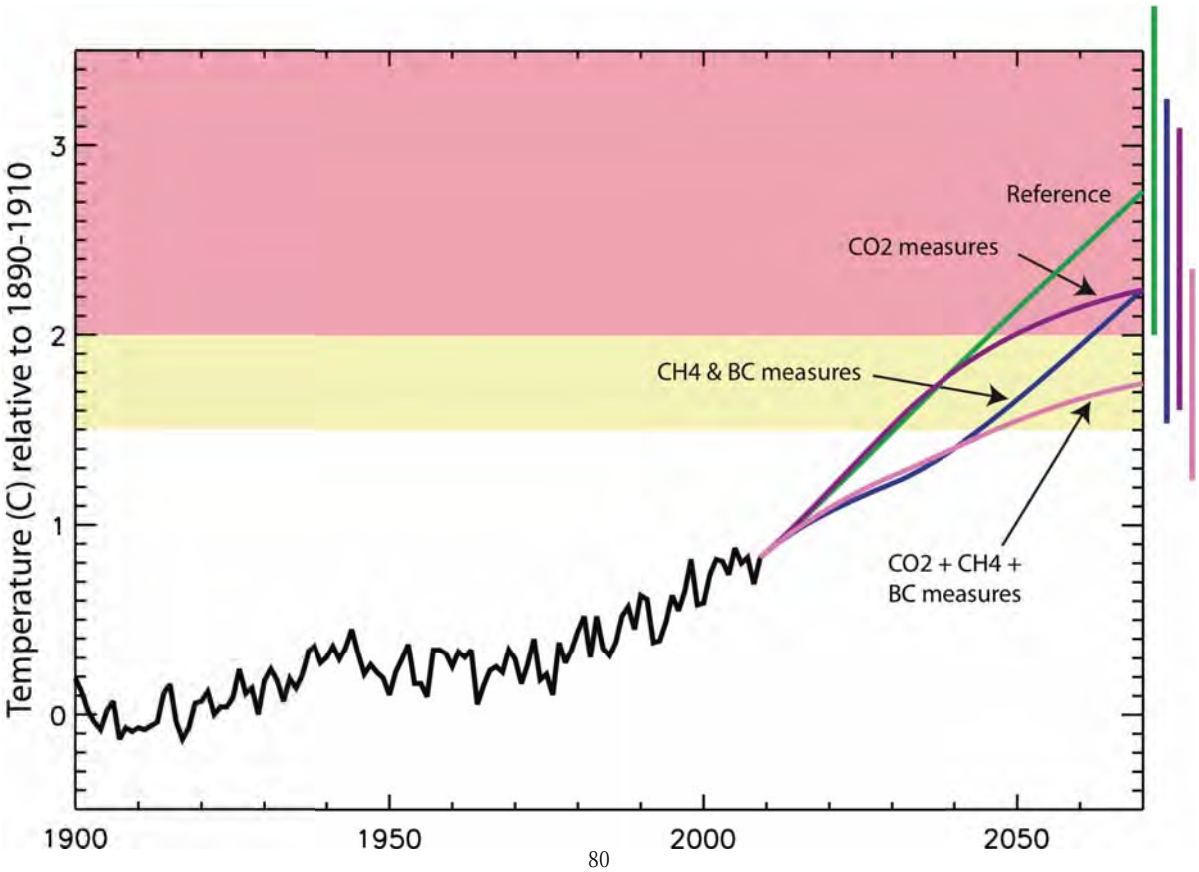
BC Measures to eliminate the most polluting activities

- Transport (high-emitters), cookstove substitution, agricultural waste burning
- Through improved enforcement of legislation or economic and technical assistance to the poorest; biggest BC reduction is from cookstoves

BC, OC and CO reduced by 50-80%, methane by ~40%



Result for Global Temperature Change (hybrid of results from GISS and ECHAM models and assessment of literature) added to the historical record



a focus on solutions
- sectors and measures
- emissions rather than concentration levels

handling uncertainties through a *multi-species* approach
- PM *and* ozone *and* methane (*and* CO2)

handling uncertainties through a *multi-effect* approach
- focus also on regional rather than just global climate impacts
- put them aside impacts on human health and ecosystems

"killing several birds with just 17 stones"

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Tackling Air Pollution and Climate Change
looking for win-win air pollution policies

Frank Raes, Rita Van Dingenen, Frank Dentener

air pollutants as
Short-Lived Climate Forcers

air pollution policies
air pollution

climate
climate change policies

- EU Climate and Energy Package
- Decarbonasation

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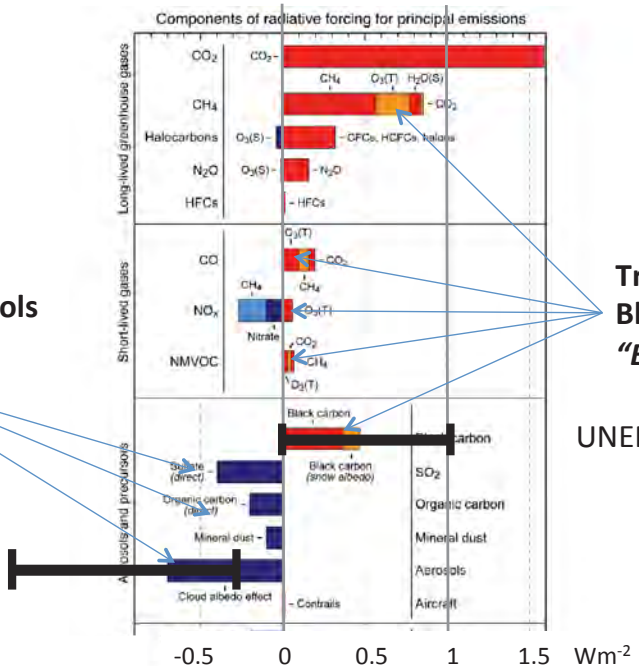
Global radiative forcing of past emissions

Inorganic Aerosols
Organic Carbon Aerosols
"Good" SLFCs



Tropospheric O_3
Black Carbon:
"Bad"SLFCs

UNEP, 2011

IPCC 4AR, 2007

On global climate

Changes in their burdens over the 20th Century has resulted in a global warming that is *potentially* similar to that of CO2

On regional climate

Atmospheric heating by BC disturbs tropical rainfall and regional circulation patterns such as the Asian monsoon.

Black carbon deposition on snow, along with atmospheric heating, leads to faster melting of a.o. the Arctic, the Himalayan and Alpine glaciers.

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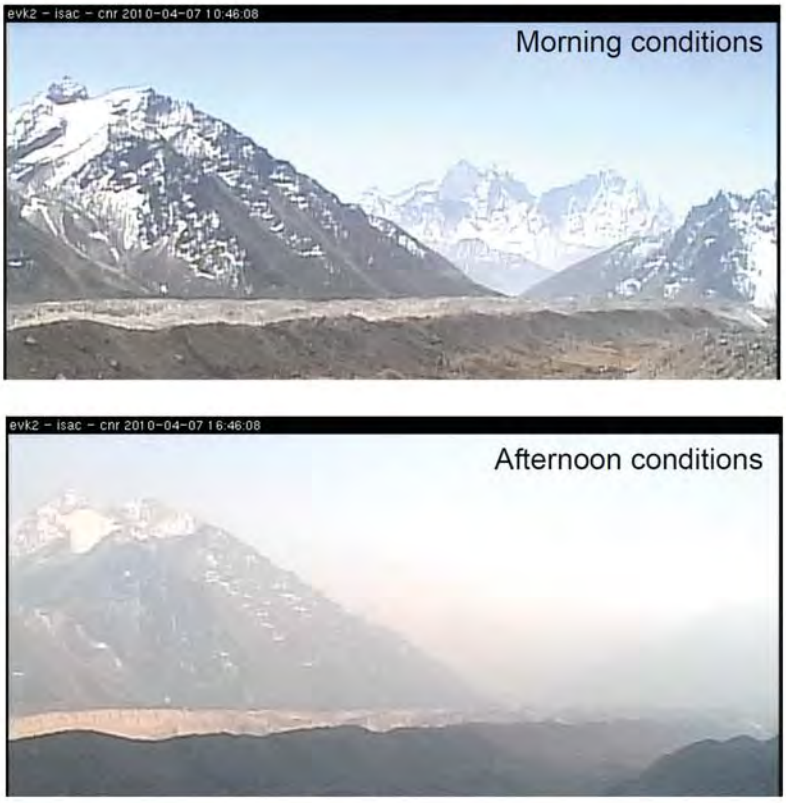
Arctic haze layer over Svalbard, Spitsbergen

Source: Alfred-Wegener Instituite

NCO-P web-cam images of Khumbu valley



Source: CNR ISAC

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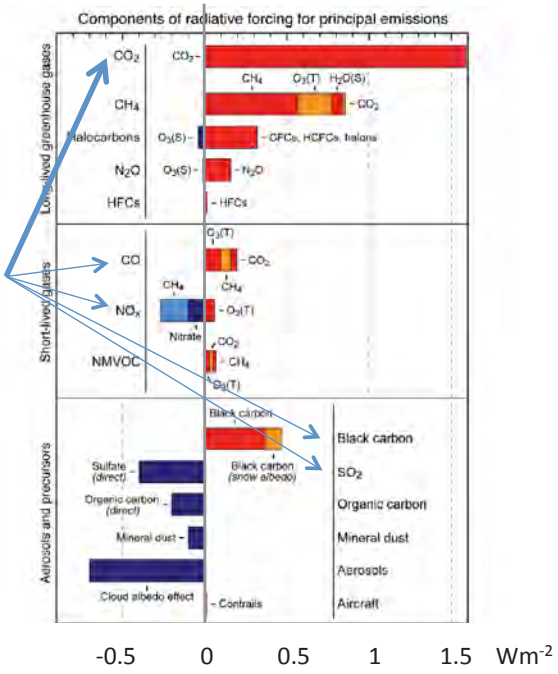
Global radiative forcing of past emissions

Clean ENERGY PRODUCTION
- efficient combustion
- AP emission control



IPCC 4AR, 2007

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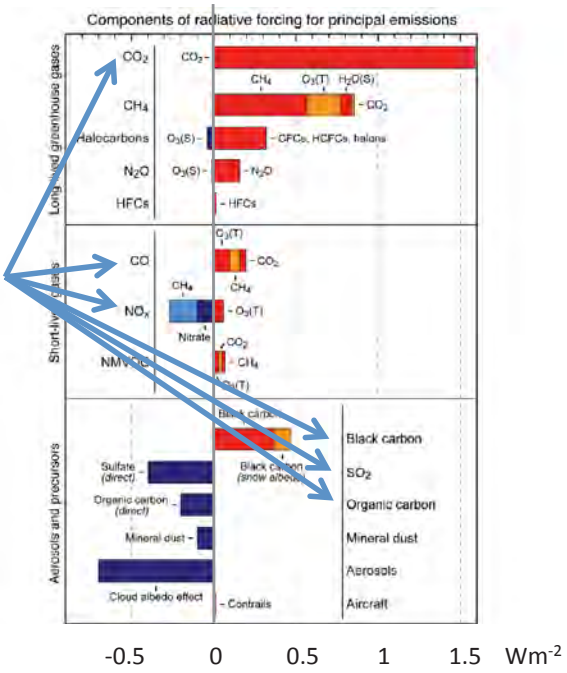
DIRECTORATE-GENERAL
Joint Research Centre

Joint Research Centre

Global radiative forcing of past emissions

Dirty ENERGY PRODUCTION
- inefficient combustion
- little AP emission control



IPCC 4AR, 2007

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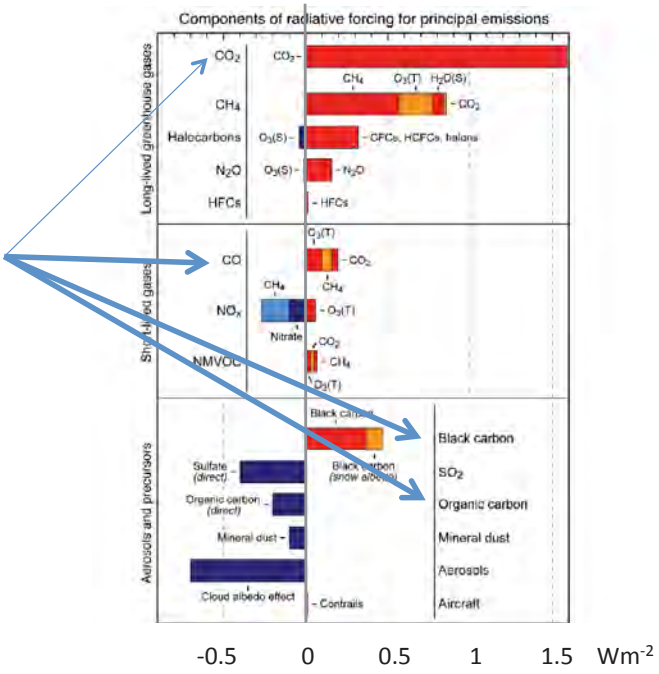
Joint Research Centre

Joint Research Centre

Global radiative forcing of past emissions

DOMESTIC BURNING
- e.g. wood burning



IPCC 4AR, 2007

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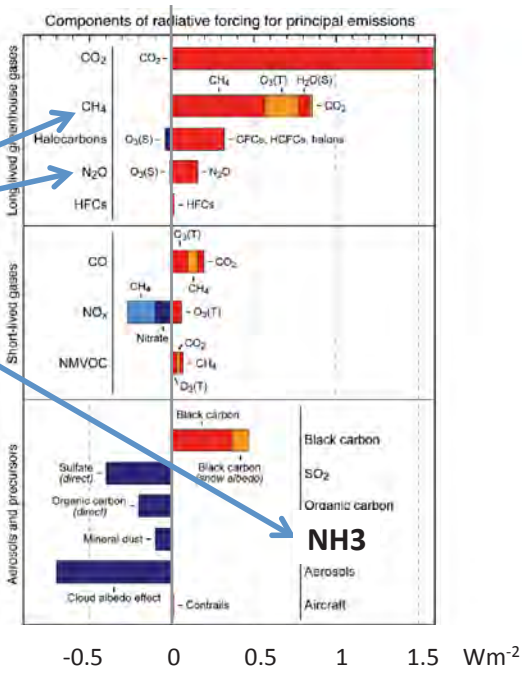
Joint Research Centre

Global radiative forcing of past emissions

AGRICULTURE



IPCC 4AR, 2007

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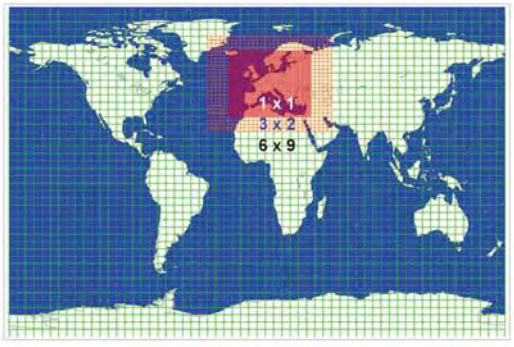
the FAst Scenario Screening Tool TM5-FASST



Based on global source receptor relationships (SRs) calculated with TM5

Calculates the effect of an emission reduction in one grid cell, on various impacts in all other grid cells. Aggregation to SRs between 56 world regions (a.o. WEUR, CEUR)

Emissions considered: SO2, NOx, NH3, Black Carbon, Primary Organic Matter, CH4

Impacts considered:
- PM2.5 impacts on human health,
- O3, impacts on agriculture
- Radiative forcing
- Absolute global warming potential

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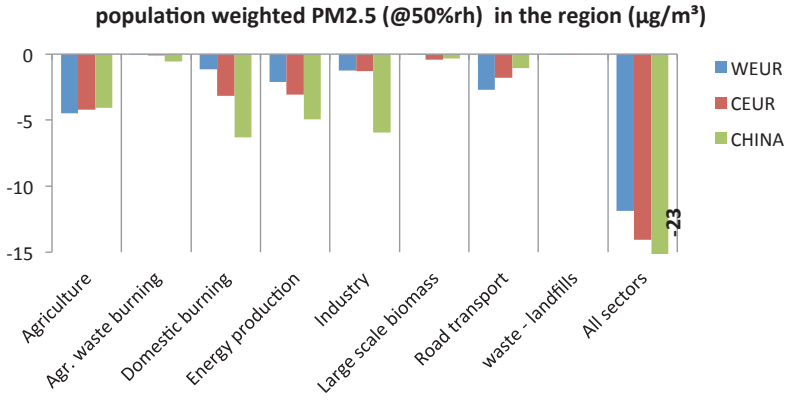
Joint Research Centre

Effect of
100% reduction
of man-made emissions
of CH4 & air pollutants
in individual sectors
and in
individual regions
on:



TM5-FASST, Joint Research Centre, 2011

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Joint Research Centre

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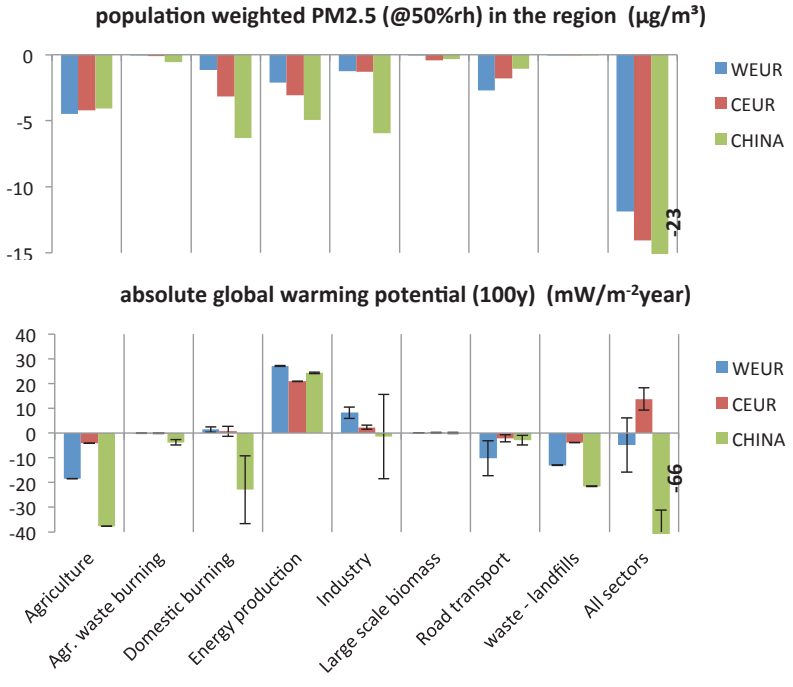

TM5-FASST, Joint Research Centre, 2011

EUROPEAN COMMISSION
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Joint Research Centre

Joint Research Centre

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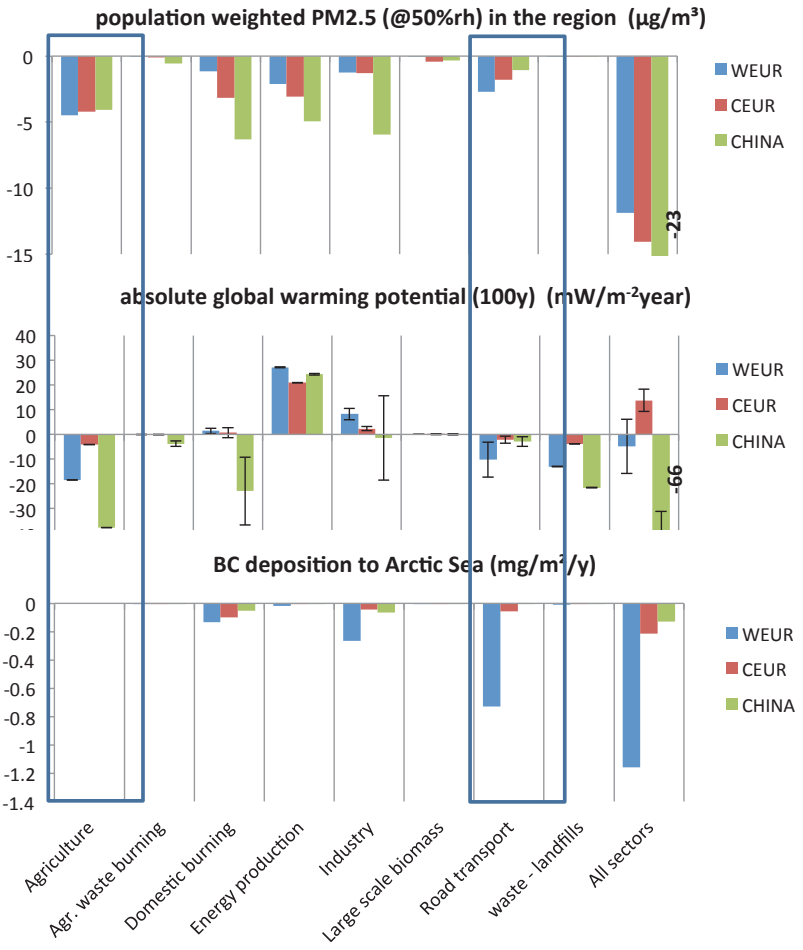


TM5-FASST, Joint Research Centre, 2011

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

conclusions

Joint Research Centre

Reducing emissions of air pollutants will have a fast impact on global mean temperature (GMT) : (80% of expected GMT within 20 yrs)

Favoring reductions in specific sectors or through specific measures (e.g. because of cost) might either lead to a win or a loose for global climate, but will all be beneficial for air quality and “saving the Arctic”. Optimization needed (GAINS)

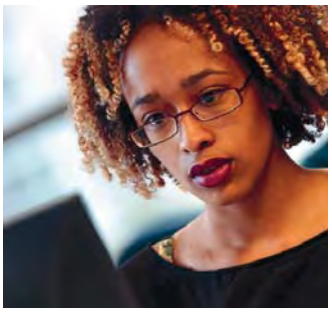
Known climate friendly PM measures (wood pellets, diesel particulate filter, coal brickets) constitute only 10-20% of PM reduction potential

Ozone reduction measures, especially through CH4, are an absolute no-regret policy for air pollution and climate

More information on the chemical fingerprint of individual control measures would be helpful to evaluate more accurately their climate impacts


thanks


Black carbon is the 2nd biggest contributor to global warming.
An EU black carbon strategy today means a cooler planet tomorrow.
THE PARLIAMENT
Come and join a panel debate on this issue.
Paul Henri Spaak Building, European Parliament, June 22nd, 11h30-13h00.
For more information go to www.theparliament.com/blackcarbon

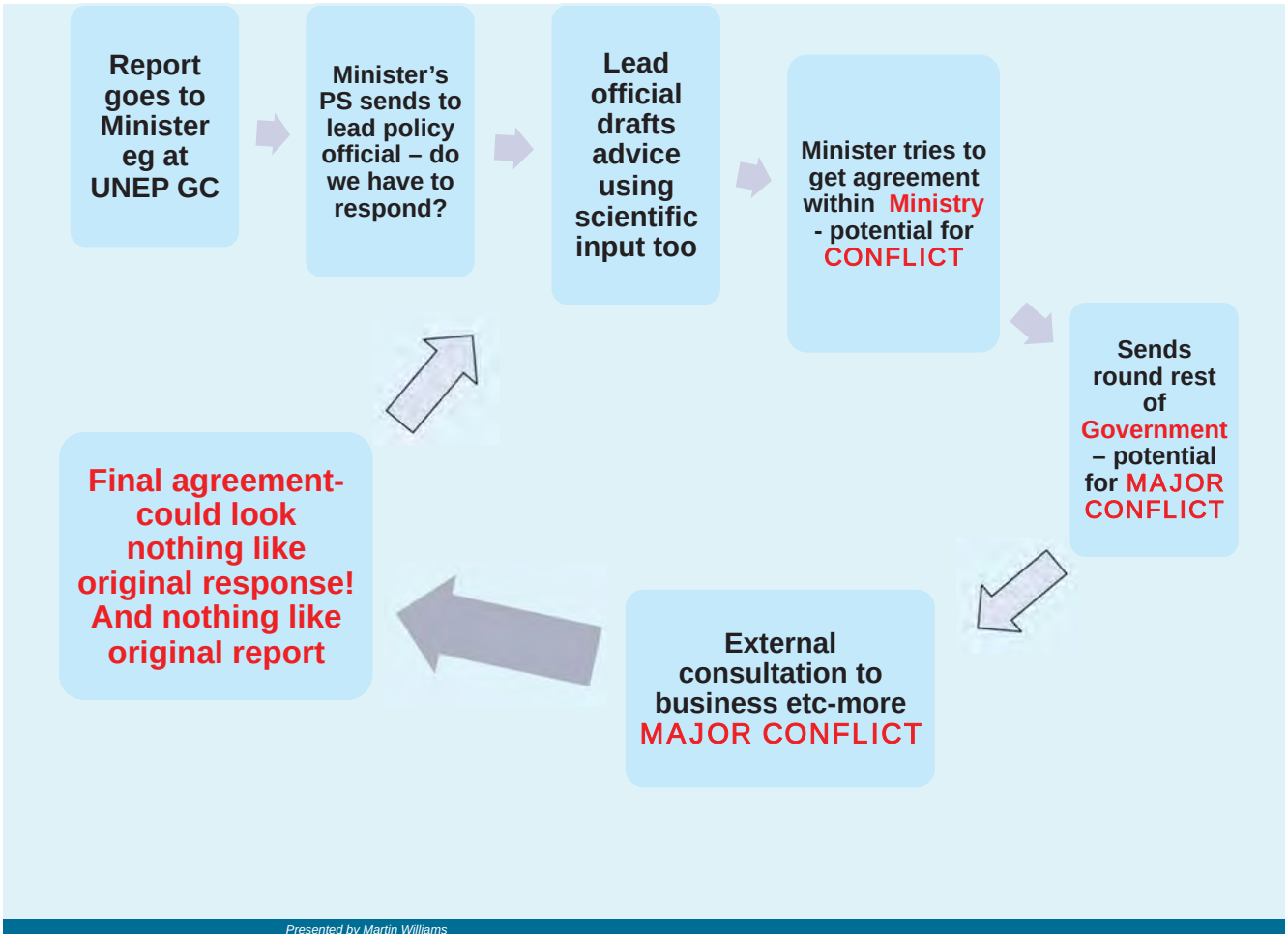




KING'S College LONDON
University of London

How to tackle the air pollution and climate change challenge using a science-policy integrated strategy

Prof. Martin Williams
King's College London & Chair CLRTAP EB

IGBP Workshop:Air pollution & climate – a science-policy dialogue, Arona, 9-10 June 2011



The Stern Report recognised the win-wins and the conflicts

- ‘ Policies to meet air pollution and climate change goals are not always compatible. But if governments wish to meet both objectives together, there can be considerable cost savings compared to pursuing both separately’
  - *Cited studies: European Environment Agency (2006) which showed that the benefits of an emission scenario aimed at limiting global mean temperature increases to 2C would lead to savings on the implementation of existing air pollution control measures of €10 billion per year in Europe and additional avoided health costs of €16-46 billion per year.*
  - *Similarly in China, a recent study (Aunan et al, 2006) showed that for carbon dioxide reductions of 10-20%, the air pollution and other benefits more than offset the costs of action.*

Page ~190 of ~200 page *Technical Annex*

The final key result from this analysis, omitted from the results up to this point, identified the potential consequences of an unmanaged major uptake of residential biomass. The initial analysis indicated that this change alone would outweigh the air quality benefits from all the other changes identified across all the sectors. Taken together the package was estimated to impose a net air quality cost of £112 million in 2012 rising to £2.6 billion in 2022.

Air Quality and Climate Change: a science-policy dialogue?

- Need to think on two fronts
  - UNFCCC 'Kyoto' GHGs
  - SLCFs
- The dialogues are different-UNFCCC is now dominated by foreign and trade policy issues, financial institutions and trading
- *Science plays a smaller role in UNFCCC now (although SLCFs are being addressed by AR5) need to speak the language of economists/policy people/politicians beyond science*
- Discussing AQ co-benefits in UNFCCC context is difficult
- Potentially more chance of success on SLCFs elsewhere?

How to generate a dialogue?

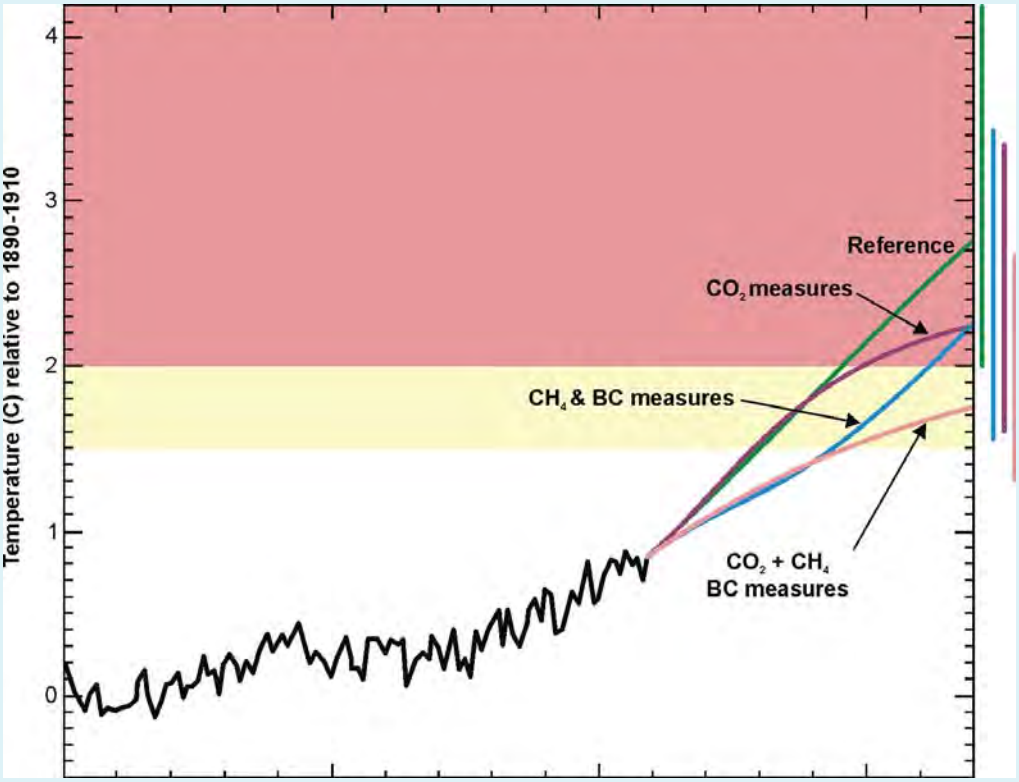
- Go away I'm busy
- Why should I do it?
- Are there votes in it?
- What will the media say?
- Does it cost a lot?
- Will I get big business on my back?

.....oh, and are there any benefits for the public?

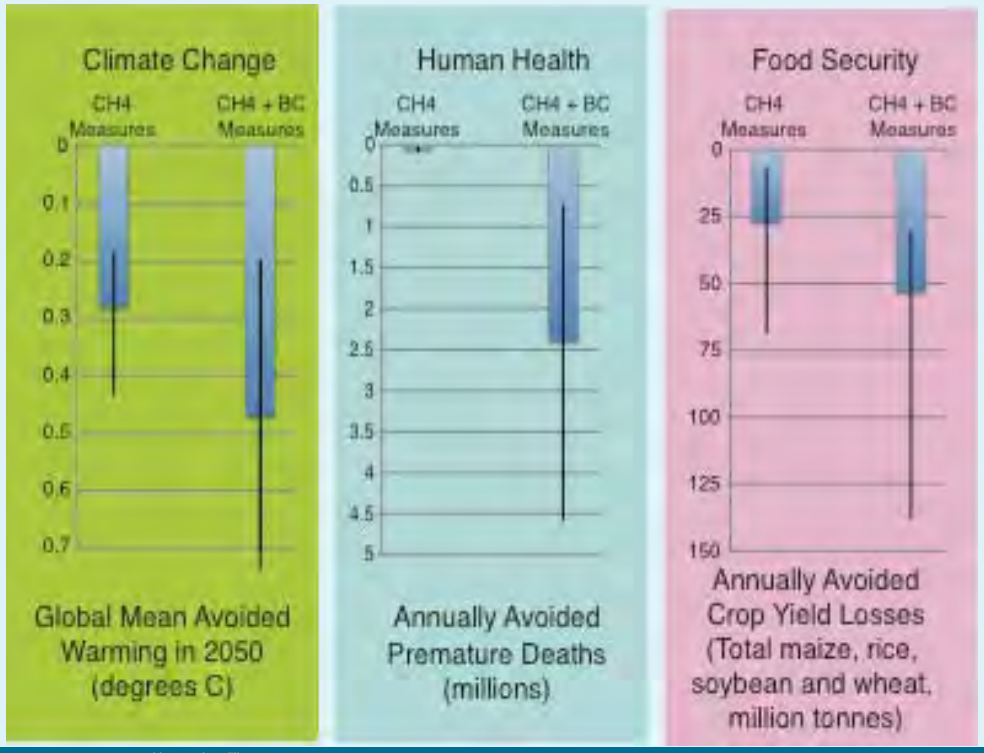
Good example-Main policy messages of the UNEP/WMO Assessment

- There are important public health and food security benefits from tackling SLCFs as well as for climate
- SLCF abatement is complementary to measures on GHGs-both are needed
- Swift action is beneficial
- Abatement of SLCFs is feasible with existing technologies and policies
- ...BUT international governance is lacking

SLCF and CO_2 measures are complementary not mutually exclusive



As well as climate benefits there are also major benefits for health and food security

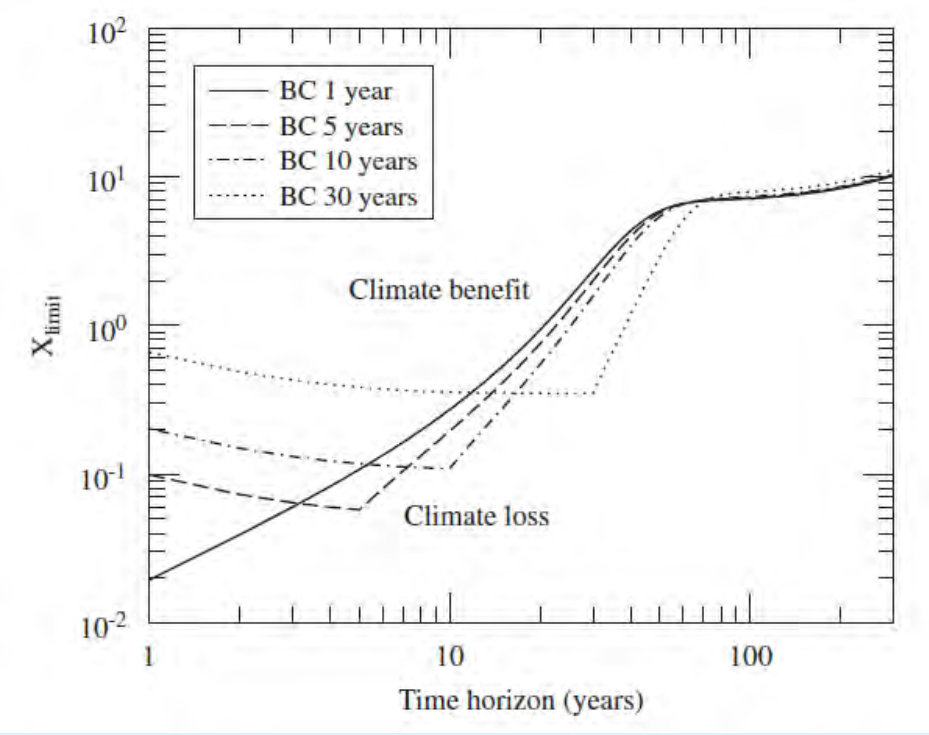


But we also need 'Trade-Off Science'

-there were major problems getting agreement for the UK government to support the EU Directive fitting DPFs to vehicles to reduce PM
-why? Because there was a possible 2-3% fuel (i.e. CO_2) penalty

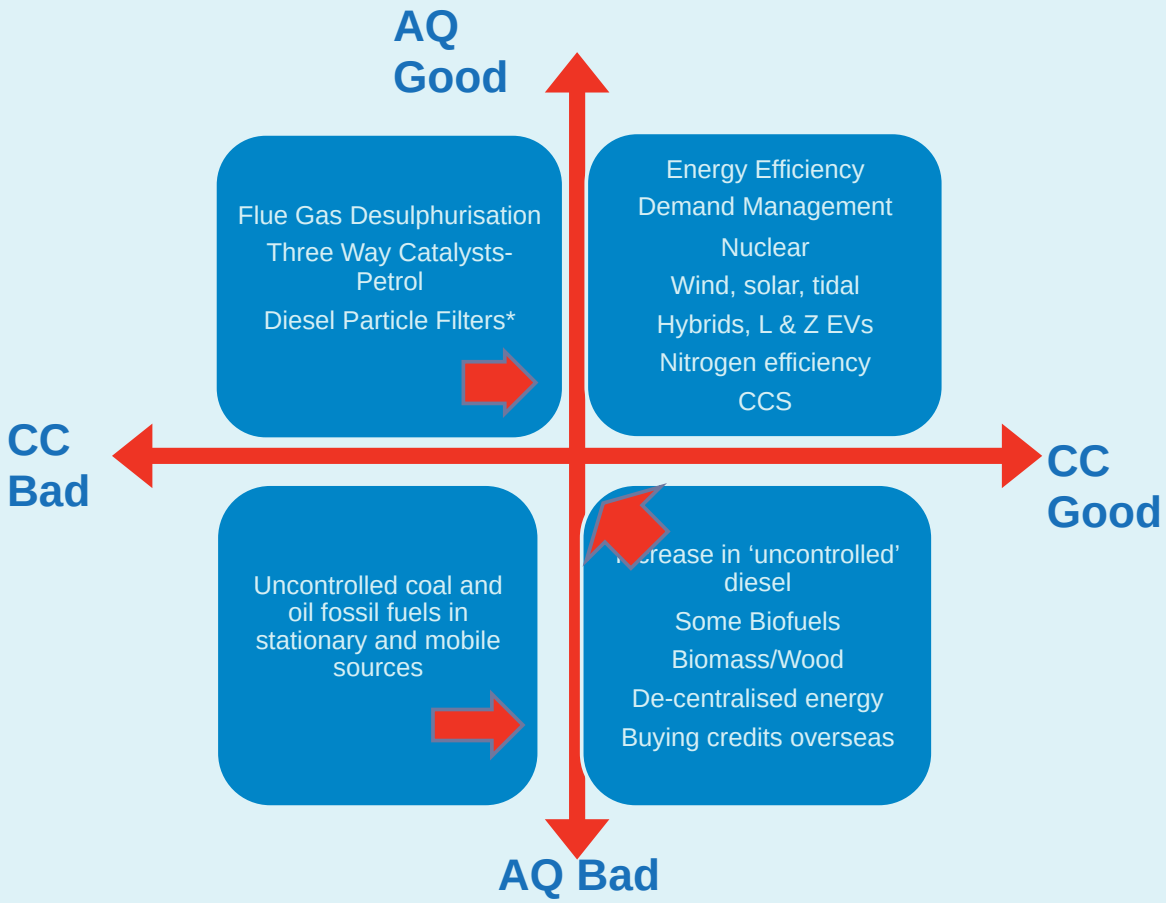
$X = GWP_{BC}(T=100years)\ \Delta BC\ /\ \Delta CO_2$

ΔBC, ΔCO_2 are mass emission changes



Boucher & Reddy, Energy Policy, 2008

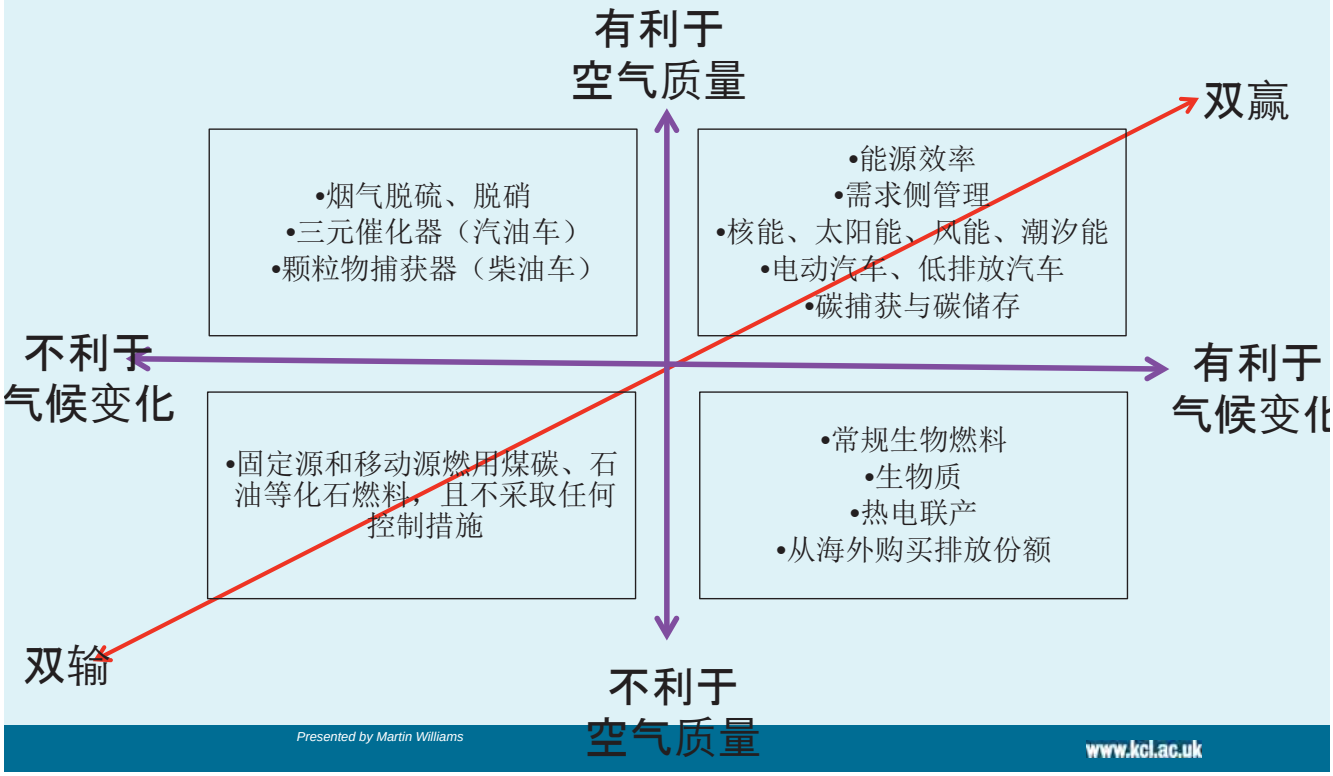
But high ambition means trade-offs are minimised – top right hand square in diagram



气候变化背景下的空气质量管理

Road to Win-Win stratigies

双赢战略



Scientific/economic challenges in incorporating air pollutants/SLCFs in global climate agreements

- Existing agreements use GWP100-not ideal for SLCFs
- Location of emission matters for SLCFs, so controls don't sit comfortably with emission trading
- Knowledge of radiative forcing/climate impacts of SLCFs is less certain than for LLGHGs
- Impacts on health, crops and ecosystems are better quantified-local and regional issues
- Regional impacts of SLCFs are important-Arctic, Himalaya

Policy challenges in linking Air Pollutants/ GHGs/SLCFs

- Policy structures in most countries and regions(EU) are separate
- Including in global instruments would add complexity to an already difficult process
- Comparing short term and longer term impacts is difficult – metrics?
- Local pollution impacts more important for developing countries
- Managing trade-offs (+ve and –ve forcings) in one instrument is difficult
- Global climate mechanisms heavily reliant on trading – not appropriate for SLCFs (but CDM could be incentivised to favour local air quality improvements?)

Current activities on SLCFs

- CLRTAP Task Force on Hemispheric Transport of Air Pollution and Expert Group on Black Carbon both reported in December 2010
- CLRTAP assessing inclusion of BC in Gothenburg Protocol in 2011
- UNEP/WMO Assessment on Agenda of UNEP Governing Council February 2011
- UNEP/WMO Global Assessment of Black Carbon and Tropospheric Ozone report in June 2011
- US EPA report to Congress on Black Carbon (March 2011)
- IPCC AR5 is looking at SLCFs
- UNEP Action Plan
- IGBP Value added?

How do we translate the scientific/ economic conclusions into policies and action?

Possible models for managing SLCFs (1)

- ***Incorporate in UNFCCC?***

  Pros: Single forum for all climate agents

  Cons: ***Added complexity***

  -Compare GHGs and SLCFs – GWPs? Metrics?

  -Takes pressure off GHGs?

  -Less emphasis on air quality damage?

Possible models for managing SLCFs (2)

- ***New global air quality treaty?***

Pros: Offers forum for shared experiences, common standards on technology, products

Cons:- Issues are local and regional so why establish global treaty?

- What would Parties commit to do that was substantive?

Possible models for managing SLCFs (3)

- ***Build on existing regional air quality agreements?***

Pros: Politically more feasible?

Co-benefits of air quality abatement are large

Uses existing structures

Solutions/targets can be 'customised' locally

Could link targets with climate policies

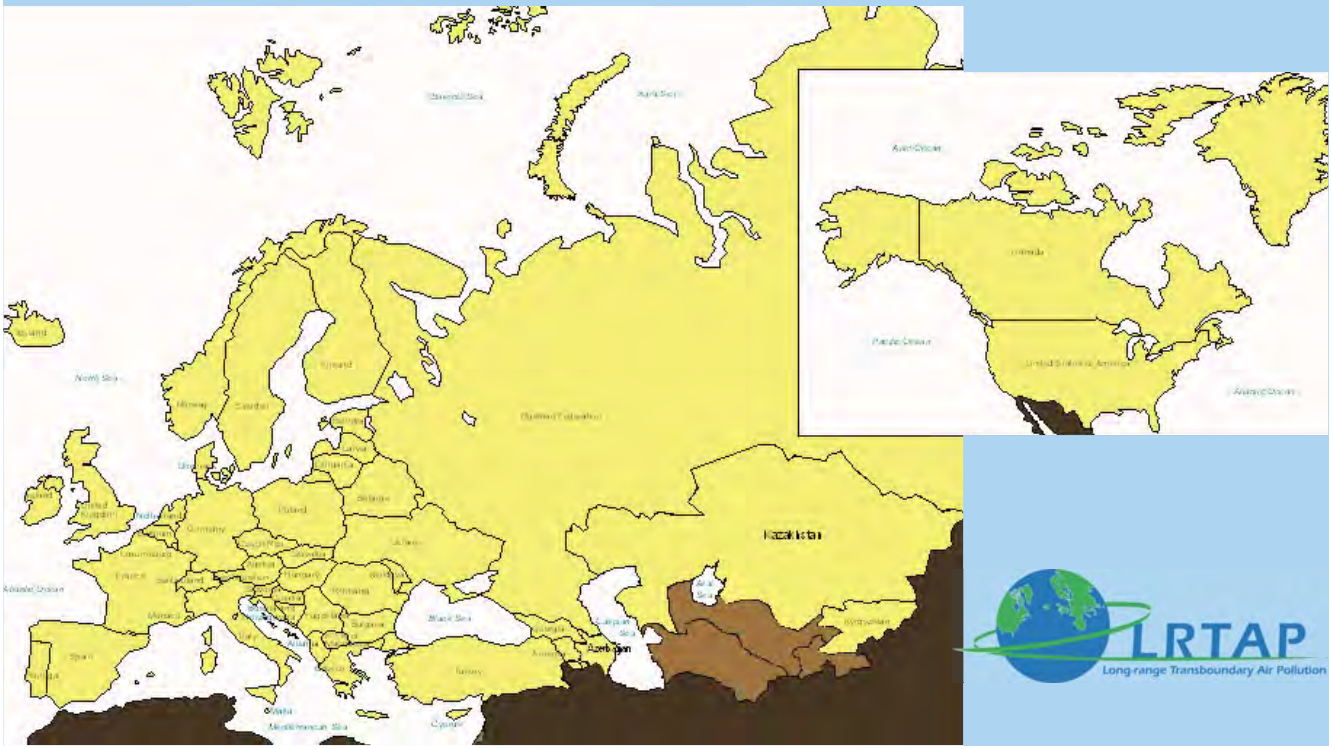
Platforms exist and could be used as exemplars – CLRTAP

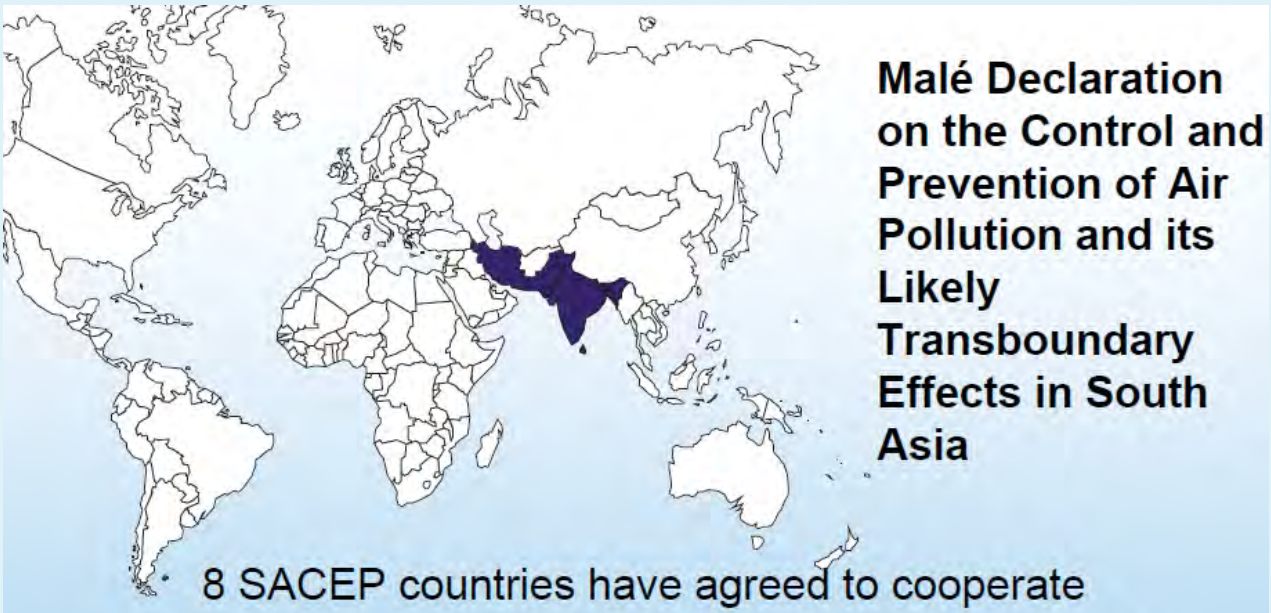
Science is already being 'globalised' HTAP

Cons: Suspicion of negotiating climate 'by the back door'

CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

51 Parties in Europe, North America and Central Asia





Malé Declaration on the Control and Prevention of Air Pollution and its Likely Transboundary Effects in South Asia

8 SACEP countries have agreed to cooperate

Network developed (annual meetings of FPs and NIAs)

Scientific assessment has started (monitoring network set up in 2003/2004)

Clean Air Initiative – Asia (CAI-Asia)

Promoting better air quality management in Asian cities through partnerships and sharing experience since 2001

28 cities, 19 government agencies, NGOs, academic institutions, development agencies and private sector

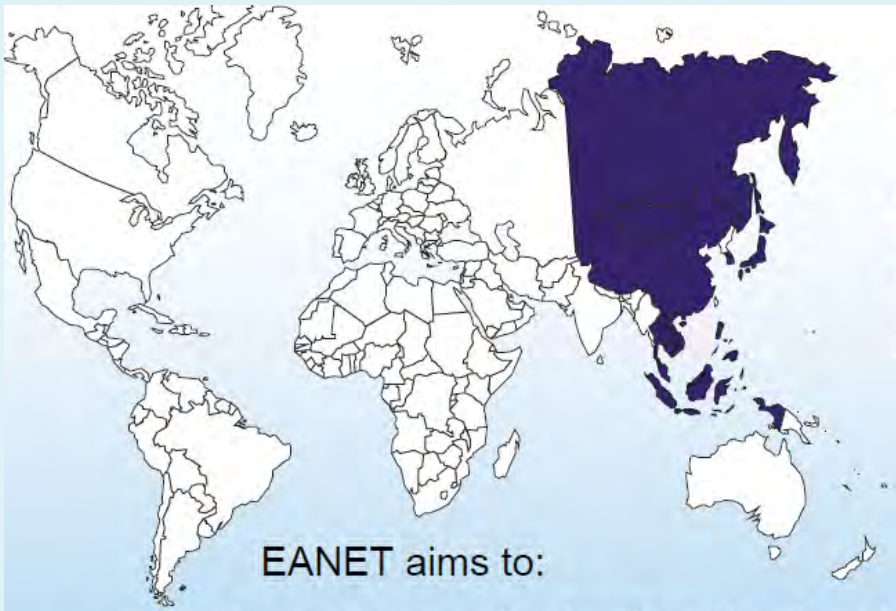
PAPA – Public Health and Air Pollution in Asia

Strategic framework and Benchmarking (with APMA)

Better Air Quality in Asia conferences

Association of South East Asian Nations (ASEAN)

Regional agreement on haze entered into force in November 2003.



EANET

Acid Deposition Monitoring Network in EAST ASIA

EANET aims to:

- Create common understanding about acid deposition in E Asia
- Provide inputs to decision making in the region
- Promote mutual cooperation on issues related to acid deposition

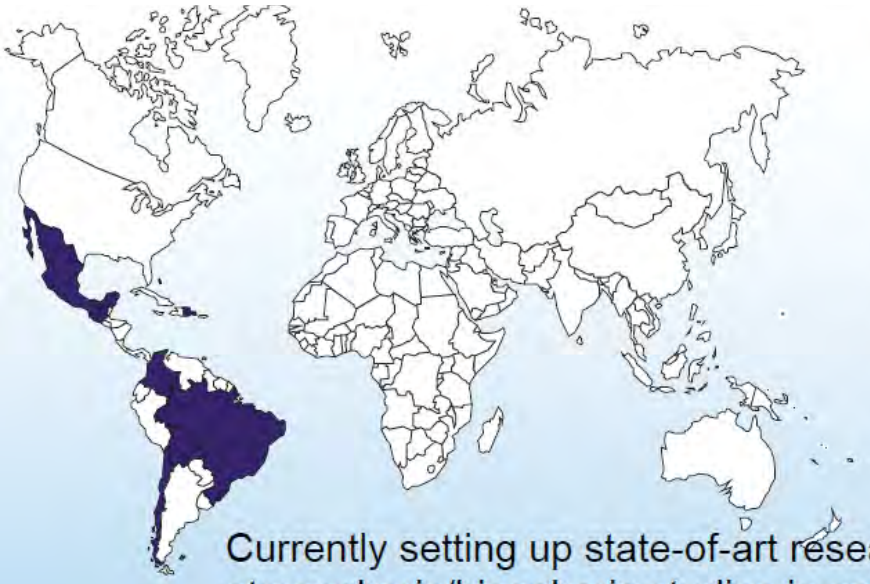
Monitoring network is current focus

APINA

Air
Pollution
Information
Network for
Africa

- Developing science base

Maputo Draft Declaration developed that aims to formally link policy makers in SADC region



IANABIS

'Inter-American Network for Atmospheric / Biospheric Studies'

Currently setting up state-of-art research centres for atmospheric/biospheric studies in countries shown

Aims to develop network to explain changes in regional and global climate, and

Develop regional policies to regulate emissions, air quality and protect the environment

How to translate this into action?

- UNEP Assessment cites many examples of successful implementation of the measures – but not on a sufficiently wide scale
- International governance and funding on SLCFs is lacking
- CLRTAP has taken a lead by incorporating Black Carbon into the revision of the Gothenburg Protocol
- UNEP addressed the SLCF Assessment at the Governing Council in late February 2011-governments still need to consider and respond
- US Congress considers BC report
- EU has a 'roadmap' to decarbonise by 2050
- Where next? UNEP is drafting an Action Plan
- Role of IGBP? Catalyse this process-address National Governments

What can IGBP do?

- What work?
- Interdisciplinary

  -atmospheric science

  -economics

  -technologies

  -governance structures

  -politics/NGOs

  To suggest optimal ways forward for policy and governance on SLCFs and LLGHGs

- Why?
- *to add value and support to other voices in the field*
- *-to make it easier to persuade national governments to act on SLCFs AND on LLGHGs by suggesting optimal solutions*

HOW?

- Need to speak the language of 'Policy makers'
- Get the science/economics etc right but :
- Work round uncertainties – recognise them but come up with clear statements that are (i) scientifically credible and robust

  (ii) useful and useable by the policy process (cf UNEP Assessment)

The Output of the IGBP Air Pollutions & Climate Initiative

1. IGBP Statement on the Air Pollution & Climate Change Challenge
   - Clarification of the messages
   - Focus on win-win solutions (from global to regional level)
   - Package message for different audiences
2. Strategy for a multi-disciplinary program

Breakout Session

A

- Terry Keating
- Iyngara Mylvakanam
- Candice Lung
- Frank Dentener
- Erika von Scheidemesser
- Martin Williams

B

- Kathy Law
- Jose Jimenez-Mingo
- Catherine Witherspoon
- Sandro Fuzzi
- Megan Melamed
- Hiroshi Tanimoto

C

- Paul Monks
- John van Aardenne
- David McCabe
- Meng Kuo
- Maria Kanakidou
- Marcus Amann

D

- Denise Mauzerall
- Frank Raes
- Ninad Bondre
- Tim Williamson
- Tirusha Thambiran

Group A

IGBP Statement on the Air Pollution & Climate Change Challenge

- What is the purpose of the statement?
  - Purpose is to review statements that have been made. Not an assessment of assessments, but an assessment of the high level messages from the assessments.
  - e.g.: UNEP Report: Does IGBP support the basic conclusions? Is there a case where BC reductions will be bad for climate?
- What is the process for getting IGBP/IGAC agreement? Does this go through the science steering committee?
- Who is the audience
  - Policy v. Science Community
  - Packaging Message to Different Levels
    - Summaries for National and Local Level
    - Issues for International Governance
  - Should IGBP make a statement about it?

IGBP Statement on the Air Pollution & Climate Change Challenge

- What is the scope?
  - SLCF v. GHG v. Air Pollution
- What is structure and format?
  - Talking point list?
  - List of Questions, Paragraph Answer, Longer Answer with References
- Possible Topics
  - Health, Ecosystem Effects are more clear. Climate interactions are less well known. Keep quantifying.
  - Implications for metrics, international governance.
    - Two Basket v. One Basket
    - Evaluation criteria for metrics?
    - Qualitative v. quantitative
- Climate impacts on Air Quality
- Air Pollution impacts on Climate effects, precip, …
- Interaction with Nitrogen cycle
  - A set of measures to optimize on CC and Ndep.

IGBP Statement on the Air Pollution & Climate Change Challenge

- Sources
  - UNEP BC/O3 and Action Plan
  - AMAP
  - LRTAP HTAP/BCEG
  - EPA BC Report?
  - ABC Reports
  - CAI-Asia?
  - EPA Climate Penalty
  - UK Assessment of Climate Impacts on Health
  - International Nitrogen Initiative?
- Timing of Statement (What are the implications for process or content?)
  - Is the statement supposed to come out before or after
    - UNEP Action Plan?
    - March Conference
    - Rio+20

Strategies for a multi-disciplinary program

- IGBP can articulate research questions and approaches
- Objectives
  - Awareness and Facilitating Collaboration
- Interdisciplinary Dialogues
  - Health
    - What PM characteristics matter?
  - Other Impacts (Nat and Ag Ecosystems, Materials Damage, …)
    - Biosphere, Land Cover/Land Use Interactions
    - Ecosystem Services
  - Technology
    - What impacts of technology matter? Pollution characteristics, energy efficiency, …
    - Life cycle analysis
  - Economics
    - Valuation of impacts?
  - Governance
    - Need to engage researchers who study governance of air pollution and climate change
    - Implications for Institutional Design (one v. two baskets)
    - Have addressed the issue of which negotiating forum for which pollutants?
    - Implications of Institutional Design (what is possible)
  - Communication
- Research Projects
  - Developing Integrated Modeling Frameworks?
  - Case Studies at the National/Regional Scale
    - Opportunity to Build on ABC Policy Teams
    - Policy Evaluation (What can we learn from where policies have been implemented?)

Group B

One Atmosphere

Climate affects AQ; AQ affects Climate. Cleaning the air means reducing all air pollutants including GHGs.

Scientific evidence shows that immediate, sustained effort, adopting known measures to reduce atmospheric pollution is critical to human health, food security, and stable climate.

- Measures to mitigate atmospheric pollution reduce multiple pollutants with multiple impacts (sometimes in opposite directions).
- A holistic approach is needed: it is essential to consider climate, health, and food security effects of any measure.

To achieve both climate and health goals over the next decades, fast reductions of both CO_2 and PM + O_3 + CH_4 are required.

interdiscipline research priorities

Critical Biosphere-Atmosphere-Climate couplings

- N-C coupling
- atmosphere-biosphere for air pollution-carbon feedbacks
- aerosol-cloud (indirect effects)

Feasibility

- costs, non-economic barriers
- psychology and marketing
- implementation, assessment of efficacy
- considering 'taboo' sources
- **Development & rigorous ex-post testing of integrated assessment models**

Sustainability of megacity trend thru lens of AQ & climate

- physicochemical (ie urban heat island)
- transport & Trans mgmt (mitigation approaches)
- land use implications

Group C

IGBP Statement on the Air Pollution & Climate Change Challenge

- Frame it as the Air Pollution & Climate Change **Opportunity**
  - Air quality (health, food security, water quality) measure are on going and will proceed, the opportunity is to use these measures to impact climate change
  - You get climate benefits that can get short term results that are not covered by the long-term climate policies
  - Long-term climate mitigation are also necessary for climate mitigation
  - In addition air quality protection will be abated by the long-term climate mitigation options

IGBP Statement on the AP & CC Challenge

- The guts of the report
  - IPCC approach using the diagram on the emissions and their AQ/Health vs Climate impacts
  - AQ mitigation option that could be used for short term climate abatement (each bullet with also have a portion on the measures that work for each pollutant)
    - PM emission controls are needed for health, controls should be done in such away that when these controls are implemented, BC is taken out to benefit climate
    - O3 Abatement
      - CH4 should be considered as a measure to reduce O3 because of its impact on climate change mitigation
      - CO and VOCs
    - SOx issue needs to be addressed from AQ side, this will increase warming, therefore GHG mitigation option should be in place to off set the loss of cooling.
    - NOx controls are good for AQ, they do not have a known climate effect, but they do to biogeochemical cycles
    - Ammonia is of concern for AQ, not yet regulated, big with AQ, Climate impact is minimal
  - International emissions, e.g. ships
  - Regional Perspective – different regions are impacted more from different pollutant for both AQ and climate
    - Taking advantage where the greatest opportunities are within regions
  - Mitigation of long-term climate change is still needed and will protect air quality

Strategies for a multi-disciplinary program

- Preparation of new expertise
- One atmosphere approach
- New institutes/centers within universities
- Focus on young scientist
- Integrated metrics
- Coupled models
- First integration needs the biogeochemical and dynamic meteorology communities
- Development of tools that can be used in the developing world
- International collaboration
- Building on the Belmont Forum

Strategies for a multi-disciplinary program

Group D

IGBP Statement on the Air Pollution & Climate Change Challenge

- Focus on the co-benefits, although should describe them as “benefits” without the “co”;
- Should include a menu of benefits which can be tailored, re-ordered, etc. to address different audiences and development needs;
- Focus on timescale of benefits, need to have quick wins to gain political buy-in;
- Include case studies, with health as a major driver;
- Describe any new research needs in terms of reducing risk (i.e. risk of making the wrong decision);
- Note that taking action on climate change could provide a national reputational boost in an international context (important political benefit);
- Include the benefits of land use planning and infrastructure development, e.g. energy efficiency of new buildings, and emphasise their place in the aspirations of the developed world (i.e. the difficulty in improving energy performance with an existing, old urban infrastructure).

Strategy for a multidisciplinary program

- Look to the success of the partnering programme developed under the Montreal Protocol
  - partner countries for form multidisciplinary tams made up of nationals from both countries, to include economists, natural scientists, social scientists, health and financial expertise, technology experts (from target country)
  - Need solutions to be applicable in target country, so need "local" expertise and representation.
  - Look to build local capacity.
  - These teams will need on-going scientific guidance
  - Start with local benefits (ie the co-benefits) not the climate issue.
- Goals need to be realistic and applicable in the target country
  - will need research/risk reduction to back this up
  - mustn't ignore implementation capacity (or not)
- Link to existing development programmes
  - use research knowledge to help direct existing programmes to deliver outcomes for air pollution and climate, i.e. use case studies involving local scientists with collaboration with UNEP scientists to bring home the messages to local governments? Eg. China.
  - Use IGBP to make country-country connections. IGBP has established national contact person in 70 countries. These can be utilized for outreach and connections.

- Need a systematic review of the impact of climate change policies on air pollution, e.g. biofuels/biomass, land use change, etc.
- Develop easily transferable tools for integrated assessment of outputs (as GAINS does) optimized for air pollution and climate
  - need to have local credibility
  - need analysis of the elements needed in such decision support tools, e.g. local, easy to use, reflects local climate, geography, infrastructure, capacity, etc.
- Address perception of low carbon technologies in the developing world
  - "We want what you have"
  - "Why should we carry the burden of saving the world?"
  - "We were lean and green before Western patterns of consumption were introduced through "developing markets" programmes."
- IGBP should examine the impacts of climate change policies on air pollution (eg. CO2 mitigation policies). Examination should go beyond effect of mitigation of methane and BC on climate/health/ag/etc. Eg. Examine impact of increasing use of biofuels on air quality and health. Examine impact of nitrogen fertilizer on climate (production of N2O) as well as air quality (production of NOx and hence O3 production).

附錄三：會議紀錄

Notes from:
IGBP Air Pollution & Climate Initiative's First Workshop
Tackling the Air Pollution and Climate Change Challenge:
A Science-Policy Dialogue
Arona, Italy
9-10 June 2011

9 June 2011

Introductions

Last Name	First Name	Country	Affiliation
Amann	Marcus	Austria	IIASA
Bondre	Ninad	Sweden	IGBP
Dentener	Frank	Italy	EC JCR
Fuzzi	Sandro	Italy	ISAC
Jimenez-Mingo	Jose	Belgium	European Commission
Kanakidou	Maria	Greece	University of Crete
Keating	Terry	USA	U.S. EPA
Kuo	Meng	Taiwan	Taiwan EPA
Law	Kathy	France	LATMOS
Lung	Candice	Taiwan	Academia Sinica
Mauzeral	Denise	USA	Princeton Univ.
McCabe	David	USA	Clean Air Task Force
Melamed	Megan	USA	IGAC
Monks	Paul	UK	Univ. of Leicester
Mylvakanam	Iyngara	Thailand	UNEP
Raes	Frank	Italy	EC JCR
Tanimoto	Hiroshi	Japan	NIES
Thambiran	Tirusha	S. Africa	CSIR Natural Resource & the Envi
van Aardenne	John	Denmark	European Environment Agency
von Schneidemesser	Erika	UK	Univ. of Leicester
Williams	Martin	UK	Kings College London
Williamson	Tim	UK	DEFRA

Welcome (Paul Monks, Kathy Law)

- Paul summarized the initiative in general
    - The IGBP Air Pollution & Climate initiative aime to engage a range of stakeholders to assess the status of knowledge with regard to current understanding about air pollution and climate and their interaction in particular with relation to current and proposed mitigation

options and policy discussions.
    - Steering Group
        - Kathy Law (LATMOS, France)
        - Paul Monks (U. Leeds, UK)
        - Denise Mauzerall (Princeton U., USA)
        - Terry Keating (US EPA)
        - Nadine Unger (Yale U, USA)
        - Megan Melamed (IGAC, USA)
    - The Aims of the Initiative are
        - Synthesis for policy makers on current state of knowledge on the role and interaction between air pollutants and climate change, including an assessment of uncertainties and identification gaps.
        - Explore and quantify possible mitigation option within socio-economic and scientific context
        - In partnership between policy makers and scientists, assess and develop new metrics to quantify co-benefits/trade-offs of past and future pollutant reduction strategies from different emission sources on air quality, human health, climate, ecosystems, and food and water security (within the context of natural changed in the Earth System)
        - Build a new multidisciplinary research programme to tackle cross cutting issues across traditional science-policy boundaries.
    - There are many other efforts on this topic currently underway (ACCENT Plus, US EPA BC Report, AMAP expert group on SLCF, UNEB BC/O3 Assessment, IGAC/NOAA Bounding BC, PEGASOS, ECLISPE, ECLAIRE, HTAP, etc.)
    - Motivation for this initiative
        - Regulation of certain short-lived forcer (or precursors) could provide short-term climate relief (next 5-20 years)
        - Co-benefits for health and climate (e.g. BC from cook stoves)
        - AQ and climate policies & their impacts need to be examined together and based on sound scientific knowledge
    - A One Atmosphere approach
    - Important to mitigate CO2 emission
    - It's really about the synergies and trade-offs
    - UNEP BC/O3 statement brought a lot of discussion
- Kathy introduced the workshop
    - Displayed the UNEP BC/O3 statement
        - "Scientific evidence and new analyses demonstrate that control of black carbon particles and tropospheric ozone through rapid implementation of proven emission reduction measures would have immediate and multiple benefits for human well-being"
        - This statement brought up a lot of discussion - mainly on how effective it is towards policy makers but still scientifically correct
    - Produce a briefing document by London 2012
        - Define what is the air pollution and climate change challenge
        - Summarize and comment on the reports on SLCF
        - How do we move forward from this point
    - How do you form a multi-disciplenary agenda in order to move forward
- Actions to date on this initiative

    - this workshop
    - agreed co-funding with the Taiwan EP for future activity to deliver outputs
    - Accepted session at the Planet Under Pressure 2012 conference
- Summary of this workshop
    - Workshop represents a significant challenge to represent and focus the breadth of science and policy on the topic area in the global perspective
    - We have a framework to structure our thinking - but we are trying to think about the 2-way dialogue (listening-understanding).
- Aim of the workshop is to produce a draft outline of a briefing document that will
    - Define the air pollution and climate change challenge
    - Summarize and assess current efforts in a meaningful way for policy makers
    - Outline a strategy for future research efforts on this topic
- Elements of the workshop
    - Framing the challenge
    - Arriving at a coherent view of the challenge
    - Address the questions, i.e. gaps of knowledge
    - Tackling the challenge, i.e. a way forward
    - Drafting outline briefing document
- Science-Policy dialogue
    - engage in a productive 2-way dialogue from the onset
    - Define driver influences policy relevant questions (the challenges)
    - Efficient exchange of information, Knowledge, requirements (both ways)
- Diagram on policy trails
    - Created a good dialogue
    - John v. - Europe is moving toward the AQ trail for climate
    - Denise - what about the trail the Montreal Protocol did
        - They included the scientist as well as the technology experts on mitigation strategies
    - Marcus Amann - who is the audience for this synthesis?
    - Sandro Fuzzi - this exercise along with other projects within IGBP is also about framing the larger challenge of the Earth System Science in the next 10 years under the reframing from ICSU.
    - Terry Keating - From the beginning of strucuring this effort there are two goals
        - how do we take all the efforts out there and determine what and how to communicate the messages
        - how can the science community better communicate, deliver their science to policy makers
    - Catherine - why do we need to comment on the summary?

Participant Perspectives

- Ninad Bondre - Global Sustainability Science
    - IGBP Vision
        - To provide essential scientific leadership and knowledge of the Earth System to help guide society onto a sustainable pathway during rapid global change
    - IGBP's Second Synthesis
        - Bringing together a diverse group of individuals - scientists, policymakers, industry, and other stakeholder - to synthesize knowledge about key policy-relevant areas
    - Current synthesis topics include:

        - Earth-system impacts from changes in the cryosphere
        - Impacts from changes in the cryosphere on the biota and societies in the arid Central Asia
        - Megacities in the coastal zone
        - Global environmental change and sustainable development: needs of least developed countries
        - Geoengineering impacts
        - Nitrogen and climate
        - Acting on adaptation to global environmental change
        - The role of changing nutrient loads in coastal zones and the open ocean in an increased-CO2 world
        - Impacts of land-use-induced land-cover changes on the functioning of the Earth System
        - Air Pollution and Climate
    - The syntheses will come together at the Planet Under Pressure 2012 conference
- Sandro Fuzzi - Air Quality-Climate Interaction (thoughts from the ICSU-Belmont effort)
    - AQ and climate are still treated as two separate problems, really they are two sides of the same coin
    - Emission sources for air pollutants and greenhouse gasses coincide
    - SLCF further complicate the trade-off between AQ-climate b/c they are on different time/space scales
    - Needs
        - Improve connection between observations and models
        - Improve and rationalize the observing system
        - Engage with region-specific issues
        - Switch to interdisciplinary research, improve the collaboration between natural and socio-economic sciences
        - Partnership with policymakers needs new expertise
        - Informed public opinion is crucial
    - There are currently many assessments/studies that are being performed on this topic, e.g. IPCC AR5, HTAP Report, UNEP BC/O3 Assessment, ICSU GRand Challenges, etc. Is there a more rational way of engaging the science community in these highly valuable, but overlapping tasks?
- Jose Jimenez-Mingo - Perspective from the EC Research & Innovation
    - The EC is launching a coordinated effort with the scientific community to address the specific needs for the Implementation and review of Ambient AQ and NEC Directives and the Thematic Strategy on Air Pollution
    - For the EU, AQ is still a large issue with many areas exceeding the EU daily/annual PM10/NO2 Ambient AQ Directives.
    - The main pollutants of concern regrading HEALTH are PM, NO2, and O3
    - Air Pollution Policy Review in the EU
        - Review of the current AQ legislation
        - Review of the current AQ limits and targets
        - Possible new meassures
        - Link to climate change
        - Integration into sectorial policies
        - Simplefication/ streamline process
    - Major Research areas in AQ & Climate (There are other programs that deal with just

climate)
        - EUCAARI and PEGASOS - Aerosols, Air Pollution, and Climate
        - CITYZEN and MEGAPOLI - Megacities
        - NITROEUROPE - Nitrogen Cycle
        - ECLAIRE (under negotiation) - Effects on Ecosystems
        - ECLIPSE (under negotiation) - Climate and AQ Impact of SLCF
    - Major Research Areas in Air Pollution & Health (Health is still the most important driver)
        - ESCAPE - Health effects of ambient pollution
        - HITEA and OFFICAIR - Health impacts of indoor air pollutants
        - INTARESE/HEIMTSA - Assessment of health impact of air pollution policies
        - PURGE and URGENCHE - Assessment of health impact of GHG reduction policies
        - TRANSPHORM - Integrated Assessment of health impacts from road, shipping, rail, and aviation emissions
        - ATOPICA (under negotiation) - Climate change and aeroallergens
    - Really working at the science-policy interface
- Kathy Law - Presenting Andreas Stohl's Presentation on the AMAP Report on SLCF
    - AMAP is under the Arctic council
        - created an expert group on SLCF
    - In parallel with the Arctic Council AMPA has a project on SLCF and is publishing a report on SLCF and their Impact on the Arctiv
    - Chairs of the Report are P.K. Quinn (U.S. - NOAA PMEL) and A. Stohl (Norway - NILU)
    - Near final conclusion from the report
        - Reduction of BC must be in parallel to reductions of CO2
        - BC on Arctic snow and ice have a positive radiative forcing
        - Global direct atmospheric forcing due to BC warms the Arctic
        - BC emitted near or within Arctic have the greatest impact
        - OC that is co-emitted with BC is unklikely to compensate for the positive forcing of BC
        - Sulfate aerosols have a weakly negative forcing over snow
        - The Nordic countries have the largest forcing per unit of BC emissions (geographical location)
        - BC emissions (e.g. ships, flaring) within the Arctic have large impact on BC deposition and thus likely have large forcing per unit emissions
        - In Canada and Russia, forest, grassland, and agricultural fires dominate BC+OC radiative forcing in the Arctic.
        - Fossil fuel combustion is dominate source in U.S., Nordic Countries, and ROW
        - The sign and magnitude of aerosol indirect forcing in the Arctic are uncertain.
    - Future science needs are presented in report
- Denise Mauzerall - How can we tailor our message to policy makers?
    - Where is the science clear that mitigation is a win-win for both AQ and climate, e.g. methane
    - Where does the science indicate that mitigation is a no-lose situation, e.g. BC mitigation
        - be careful no to push mitigations option that may be incorrect when the science is more conclusive
    - We need to be specific, can we integrate scientific understanding of which mitigation efforts would be most beneficial with existing mitigation cost-curves to make recommendation on where reduction would be most beneficial and cost effective, i.e. get some people involved on the economics of this as part of the initiative

- Can we do a-c on a regional basis?
    - In order to do this with need to identify key policy makers with whom we can interact
    - Summarize the key issues for these policy makers
    - Can we determine how mitigation policies are set up for key countries?
        - Partnerships between developing and developed countries?
        - What type of international science-policy cooperation would be helpful in catalyzing desired mitigation?
        - What scientific research would be most salient to policy makers.
- Frank Raes - commented on the briefing to policy makers on the UNEP report, the policy makers consensus is do more research
- Martin Williams - the UNEP report has made countries go back to start thinking about this in a more socio-economic interdisciplinary discussion, environment ministers from UN countries are the audience for the UNEP report
- Terry Keating - The UNEP report cannot be held up as a "here is the science and now the policy makers haven't done anything about it". The UNEP report should be seen as the starting point of the dialogue. UNEP is the beginning of a long process.UNEP is moving onto the second phase of the process, there is a dialogue going on.
- Paul Monks - the important feature of the UNEP report is a sustainable dialogue between science and policy.
- Marcus Amann - UNEP is very well set to do the policy side of this discussion, so where is this groups time most well spent?

- David McCabe - What is the "Air Pollution Climate Challenge"?
    - Introduction to CATF (Clean Air Task Force)
        - US-based NGO, founded in 1996
        - Dedicated to reducing atmospheric pollution through research, advocacy, and private sector collaboration
        - Works solely on atmospheric issues
        - Funded by foundation and individuals
        - From the beginning focus has been on power plants, i.e. SP2, HOx, Hg reductions
        - Climate now a major focus
    - Need zero-carbon energy to reduce CO2, CATF facilitates and accelerate development of such technology.
    - The Air Pollution & Climate interactions
        - What do we get by cleaning the air?
            - health, ecology, and crop benefits
            - warmer climate from SO2 reductions
            - Cooling reduction of BC and CO/CH4 ozone precursors (but not NOx)
            - Cleaning up air pollution likely causes more warming
        - From a climate perspective, we're in a very tight spot
            - In near-term, targeted reduction of pollutants/ sectors where we expect climate benefits is one of the few tools available.
            - CATF participates in these forums b/c
                - Measures, by sector and region, that can be undertaken
                - Quantified impacts of measures, both positive & negative
                - Figure out policy routes to get measures implemented
        - Tell the honest story
- Megan Melamed - Presenting "Bounding the Role of Black Carbon in Climate" on behalf of the

Bounding BC authors

- This assessment is and IGAC-AC&C/NOAA supported effort
- Lead authors are Tami Bond (U. Illinois), Sarah Doherty (U. Washington), David Fahey (NOAA), and Piers Forster (U. Leeds)
- International group of 27 lead + contributing authors
- Will be submitted to JGR, 2011
- The report collects and organizes the contribution of all radiate forcing effects from BC for the first time - A BC-centric point of view
- Goal 1: Provide a central estimate and uncertainties for effective forcing by BC, including all known mechanisms.
  - Quantification
    - provide best estimate and uncertainty bounds of climate forcing
    - where possible, explain differences between current estimates & identify sources of variation and uncertainty
  - Comprehensiveness
    - account for all climate forcing mechanisms
    - account for forcing by species co-emitted with BC
- Goal 2: Present effective forcing for mitigation actions that target BC-rich sources, considering all co-emitted species
  - Connection to action
    - Ultimately, source/activity-based answers are desired
- Chapters of BC Repot (1. Introduction; 2. Microphysical properties of BC; 3. Emission magnitudes and source sectors; 4. Constraints on atmospheric abundance; 5. Direct radiative forcing; 6. BC interactions with clouds; 7. BC in the cryosphere; 8. Climate response to BC forcings; 9. Synthesis of BC climate effects; 10. Net climate forcing by BC-rich source categories; 11. Emission metrics for BC; 12. Mitigation of BC-rich Sources; 13. Conclusion)

- Hiroshi Tanimoto - Science Policy Interface in Japan
  - Air Pollution & Climate
    - Asia, especially east Asia is a large emitter of SLCF
      - China, India, Southeast Asia
      - BC from residential sector, open biomass burning, agricultural burning
      - Methane from rice fields, contributes to background O3
    - CC possibly affects Asian monsoon system
      - Is CC good or bad for local/regional air quality?
      - Potential influence on natural emissions
    - Politics often conflict in Asia
      - EANET (Acid deposition Monitoring Network in East Asia) by 13 nations
      - TEMM (Tri[artite Environment Ministers Meeting) by Japan, China, Korea
  - Two on going projects in Japan
    - Strategic Project: Scientific Analysis of Regional Air Pollution towards Air Pollution Management in East Asia "co-benefit approach" into account - led by H. Akimoto
    - Long-term monitoring of atmospheric trace gases and aerosols in Asia & Oceania using voluntary observing ships
- John van Aardenne - Air pollution and climate change at EEA
  - More effort required to reduce ozone pollution in Europe
  - Three challenges in day to day life
    - complex topic: understanding, flexibility of policies, ensuring environmental integrity, explaining this to member states, citizens and EU policy makers

            - Reducing cost of air pollution abatement
            - Impact on human health
            - Impact of air pollution abatement
        - air pollution by ozone across Europe during summer 20120 just released, is there a climate effect? Situation in 2020-2030 due to CC legislation?
        - bring the concept of AP and GHG into environmental assessment studies like the European Environment State and Outlooks 2010
            - Need to understand underlying scenarios used in environmental assessments
            - Combine/streamline monitoring of both GHGs and AP emissions (metrics)
            - Global vs. regional dimensions
- Erika von Schneidemesser - Science Challenges
    - Look at AQ and climate as a connected problem
    - Contribution of background ozone
    - Land use change -> how they impact emission and impact mitigation options
    - Bounding the model assessments
    - Increased capacity -> large potential here, take advantage of it
    - Policy challenges from the science side
        - develop a dialogue
        - suggest options
        - keep context/value system in mind
        - simple messages
        - raising public awareness
- Marcus Amann - Creating a dialogue
    - It is one atmosphere, and there are 4 boxes trying to control it
        - Climate negotiators
        - Air quality managers
        - Climate scientists/modellers
        - Air pollution scientists/modellers
    - Some of the links that should occur
        - Climate negotiators <-> Air quality managers
        - Climate scientist <-> Air pollution scientists
        - Spacial and temporal scales are different thus preventing these links
        - Climate is now separated from environment in decision making in many countries
        - Linkage between scientist and policy makers
            - on the climate side there is an up and down communication
            - very difficult to get scientist as an input into international climate negotiations
            - Across linkage is also needed
        - We have the channel to the science community and should focus on two points
            - Communication of uncertainties, how do you effectively do it
            - Communicate what we know, e.g. BC is absolutely beneficial for health, CH4 is a win-win situation
            - Management of the uncertainties
            - Methodology on how to break down people working within their own boxes, i.e. "Think outside the box"
- Catherine Witherspoon - Integrating Air Quality & Climate Change: The Policy Challenges
    - 3 Challenges
        - Being useful and relevant to policy makers, where they sit, given their pressing

concerns, at each moment in time.
        - Making limited resources (time, people, money) go as far as possible and achieve the greatest benefits possible. i.e. greatest bang for the buck
        - Avoiding tragic. expensive and embarrassing mistakes which are not only negative in their own right, but can set the process back several years.
    - How do you overcome these challenges?
        - Is there a policy opening?
        - Identify policy champions
        - Tailor message to the questions being asked
        - Make specific recommendations (actions)
        - Provide tools that facilitate implementation
        - Be honest (but not dreary) about risks (risk-what could wrong, that is the only risk that matters in a political context)
    - Discussion on recommendations from talk
        - What are the limits of recommendations that scientist can make? i.e. telling people to shut down all coal fired power plants is not effective
        - Denise M. - not recommendations, but if you do this, then this will happen options.
        - Frank R. - Scientist, policy maker, politician -> need to make this distinction
        - Terry K. - Need to work on the definition of the division Frank R.
        - David M - We need to change the questions being asked by the policy makers, how do we do that?
        - Paul M. - Marcus and Catherine both are saying that the knowns are where we can make the most benefit and timing is everything
- Tim Williamson - AQ and Climate Policy: Getting the right outcome
    - My position is in the science-policy interface
    - Getting the policy making process into scientist is difficult.
    - Science community needs to be more effective at communicating the risks of certain mitigation options.
    - What are the outcomes we need to achieve.
    - Controlling BC, it is not everything
    - Shipping and biomass don't receive enough attention
    - Message back to scientist, the job doesn't end on just communicating to the policy makers, but to monitor the outcome of the policy to make sure it is working as they thought it would
    - Implementing policy always requires action by people, people relate much better to taking action for regional issues. In this case, that is why air pollution has more weight.
    - AP & Climate is often about trade-offs. Pushing trade-offs to the limits often results in null outcomes
- Iyngara Mylvakanam - UNEP Perspective
    - The need for regional cooperation
    - Scientists from their own country are much more effective when presenting science
    - Need scientific capacity within these countries
    - Sustainability - continual funding is needed to accomplish things in developing countries
    - It is a process.
    - UNEP is developing an action plan to follow the UNEP BC/O3 report
    - The key is the technology side is not part of this conversation, need to start bringing the technology side in.
    - Will be starting a policy and a technology team together for SLCF
    - Need an integrated approach to AQ & climate but then we end up with 3 communities AQ,

climate, and co-benefit. This doesn't help

- Tirusha Thambiran - South Africa Perspective
  - South Africa is still mainly focused on AQ issues
  - Transport sector is a large source of emissions
  - The government has taken action on the sulfur content of fuel
  - The government tried tariffs but there was public outcry and they the tariffs were taken away
  - Decision makers are tackling the low hanging fruit, i.e. industry
  - In a country like South Africa it is really the AQ and health issues that drive the policy
- Meng Kuo - Taiwanese EPA
- Frank Raes - Modeling Air Pollution and Climate Change
  - We have the two communities because we don't have a model that tackles climate change and air pollution from the global to local scale (1 km)
  - We won't have the ideal model for the next 10 years or so
  - Can we use the two separate models to set policy on both issues?
  - It all comes down to feedbacks
    - Climate links a radiative forcing to a change in temperature via the climate system
      - Can look at the amplification of the delta T with and without including the atmospheric chemistry
      - This amplification sensitivity due to atmospheric chemistry is 1, not a big deal at all
    - AQ links a change in emission to a change in composition
      - Can look at the amplification of the delta conc by including the entire climate system
      - The amplification factor for AQ is 1.01
    - Amplification of 1.0 are for a global scale
    - If you do this for regional scale then the story is different
      - the air pollution people need to consider the climate -> can be up to a 30% amplification
    - Read Raes et al., JGR 2010.
  - Do we need a fully couple model to advise policy makers or can it be done with individual climate and then AQ model.

What is the challenge from the scientific perspective? (Maria K.)

- The two challenges are
  - Climate feedbacks
  - Co-emission of pollutants
- Climate Feedbacks
  - Need to understand how emissions and air pollution respond to changing climate
    - Shift in biomes and LCLU
    - Circulation/Transport patterns
  - Strong natural component (climate driven) that interacts with anthropogenic (mitigation targeted) emissons
    - SOA enchancement
    - BC/OC co-emission
    - CH4 - natural sources -> effected by AP
- Global and Regional basis for assessment
  - Regional basis for implentation

        - Most developing countries focus on AP issues/low cost measures
    - Multi-species approach -> account for and improve scientific understanding
    - Evaluate short and long term benefits
    - Base evaluation on modeling + observational evidence
    - Enhance and rationalise the observational network to provide observational proof
- Role of scientist is to develop complete understanding of AP & CC
    - Define the reference point for evaluation of the mitigation options
    - What is the underlying scenarios for the mitigation options, e.g. technology changed to understand the impacts
    - CO2 mitigation policies and their effect on AP
    - FOLLOW UP ON THE EFFECTIVENESS OF POLICY IMPLEMENTATION
        - understand the role already played by humans, e.g. hindcast
- Communicate clear (and the right) messages
    - Evaluate potential of abrupt changes/risks
    - Sustainable TWO way dialogue
        - Message communicated early enough to be digested for discussion by the policy makers
        - find the target person - AQ/CLM might not be the same
    - Raise public awareness
    - National scientific representation is more effective in communicating the message to national policy makers
    - Trust and credibility is important and you need the right people and continuous dialogue to achieve this
    - Policy makers assume the message is coming from some agenda
    - Venue diagrams - show the policy making process for individual policy.

What is the Challenge from the Policy Perspective? What Should IGBP Do? (Catherine Witherspoon)

- This morning - The Starting Thesis
    - The Problem:
        - There's a science-policy gap
        - efforts are being made to bridge the gap
        - Some work, some don't (or are very risky)
        - Process is inefficient
    - IGBP Should
        - summarize (and grade?) those efforts
        - Identify research priorities
        - Aim at global level policy maker
- Counter Factuals
    - The Problem
        - Multiple reports reinforce messages, aren't inefficient
        - Policy makers want best bets not "grades", i.e. policy makers want to know what is known, not uncertainties
        - Audience matters (what are their concerns?)
        - Timing matters (where is the policy opening?)
        - Scale is crucial (policy is never made at the global level)
        - Need ongoing linkages, not just one time report

        - Need methodology to link short/long term outcome
    - Role of IGBP
        - Other bodies have more access to policy makers, IGBP best on scientific side
        - Policy makers are unlikely to attend PuP March 2012 (NOT TRUE according to Ninad)
        - There's no such thing as global policy. All significant decisions happen at the locale, regional, or national scale
- Other Observations
    - People care more about air pollution than CC. AQ messages will always resonate more
    - Ambition drives trade-offs. To avoid disbenefits have to reach higher
    - Scientist have less appreciation of the policy setting process rather than the other way around
    - Actions have consequences. It's important to identify the them.
    - Data/studies are suspect and be relied upon without understanding underlying fact. Crap = crap
- Possible Way Forward
    - Instead of evaluating all the reports, IGBP could identify what we're most confident about and the specific actions that implies
    - IGBP could help translate policy maker needs to the scientific community
    - IGBP could help with linkages between climate and AQ modelers
    - IGBP could frame the short vs. long term issues, which is the major disjunction between AQ and CC, and how to bridge their perspectives
- If IGBP wants to stay global, it could
    - Focus on sources that are global in nature (marine, aviation) and how best to minimize their climate and AQ impacts
    - Focus on globally significant impact zones, e.g. the Arctic, and what's needed to protect those zones, in ranked priority order.
- Terry - You have to bring CC impacts down to the local scale b/c that is why AQ always resonates more than CC
- Raes - What happened to the discussion about the rate of change?
- Tim - Try to estimate the impacts of CC on the UK, showed sea level rise, very effective. Floods came and general public said CC is occurring, then scientist said careful, you can't claim a single event is due to CC.

Arriving at a Consensus, drafting a summary of the challenge from a science-policy perspective, roundtable discussion

- create multi disciplinary global research agenda on AP/climate

- what is the value added of the IGBP effort? Need to identify what more is needed following UNEP, EPA, etc. reports
- Describe known knowns and known unknowns
- An assessment of assessments?
- How do scientist engage in the assessments? Do we know enough about policy process? Was the science communicated effectively? An assessment of HOW the assessments are conducted?
- IGBP can start the process of getting the discussion of the UNEP, etc. report to the local level. Need to include economist if we do this.
- Need thoughtful input to EU and Chinese air quality plans.
- UNEP process has just begun, there is no buy in yet -> IGBP could help with international buy-in

- Health assessments have a lot of uncertainty but they still have a consensus. We should emphasize where there is the consensus, not highlight the uncertainties.
- UNEP efforts started 15 years ago. Need actual emission reductions on the ground.
- Frame the challenge as an atmospheric pollution problem, there are actions that are important to take within that perspective, which can get research focused more on a one atmosphere approach -> what research is needed and its policy relevance. One atmosphere, same pollutants, many effects.
- Integrated One Atmosphere Integrated Effects to informing the incremental policy process. How can the science community help this process?
- Need clear broad statement on air pollution-climate connection
- Policy will be made in an incremental fashion. Science community needs to understand the policy process and be aware of who and when influence is possible. IGBP can help facilitate that interaction in a variety of venues (eg. UNEP report, EPA BC report, China, EU air quality, etc). Think about how to be effective in regional policy settings.
- Conclusion from Paul/Kathy/Megan
    - IGBP Statement on the Air Pollution & Climate Change Challenge
        - Clarification of the message (with a one-atmosphere approach)
        - Focus on win-win solutions (from global to regional level)
            - Focus on the benefits and the risks
        - Package the message for different audiences (is Rio +20 the audience?). Need to frame this statement within how to get the statement into Rio +20 using PuP to launch it.
        - Less than 10 pages
        - Conclusions can be limited by the science -> need for a multi-disciplinary program
    - Strategy for a multi-disciplinary program

Addressing the Challenge

- What are the scientific gaps in addressing the challenge - air quality perspective? (Candice Lung)
    - Challenge 1: Spatial variability of pollutants
        - community air quality may be worse than observed in EPA monitoring stations
        - this factor is not taken into account in setting current standards
        - scientist can help inform the very local sources -> will impact AQ & Climate
    - Challenge 2: Health effects of aerosol sizes and composition
    - Challenge 3: Synergic health effects of complex pollution
    - Complications within these 3 challenges is climate change impacts and country-specific
    - Scientific Gaps
        - Gap 1: Source emission inventory
            - inventory gaps
                - community sources (e.g. cooking)
                - agriculture practice
                - man-made/human surfaces
                - natural source emissions
            - validation
                - Source apportionment in field studies
                - cross-validation with air quality models
        - Gap 2: Mechanisms of
            - surface-atmosphere interactions

                - natural surfaces
                - man-made surfaces
                - human surfaces
            - physio-chemical transformation of aerosols
                - physio-chemiscal property transformation
                - oxidation potentials
        - Gap 3: Impacts of climate change on AQ
            - model refinement
    - Pollution Sources
        - Uncontrollable
            - Biogenic
        - Partially controllable
            - wildfire
        - Controllable
            - Industry
            - Transportation
            - Community sources, e.g. street food, restaurants, hair salons
            - Agriculture
            - Personal care products
    - Summary
        - Scientific Gaps
            - Source emission inventory
            - mechanisms
            - climate change impacts
        - Scientific challenges
            - Spatial variability of pollutants
            - Health effects of aerosol sizes and compositions
            - Synergic health effects of complex pollution
        - Reduce health vulnerability under climate change
- What are the scientific gaps in addressing the challenge - climate perspective? (Frank Dentener)
    - How to bring climate effects of short-lived and long-lived components together in credible metrics for policy making?
    - SL and LL component metrics
        - Climate metrics: instantaneous
            - RF
            - GWP
            - GTP
        - Current climate policy uses GWP100, which doesn't include SLCF
        - Will future climate policy consider air pollutants?
    - IPCC workshop on metrics general recommendations
        - Don't change GWP100 as the metric b/c it is as uncertain as any other metrics
        - Alternate metrics advisable for certain policy goals
        - Timely interaction of policy and scientific assessments, 2020?
            - The IGBP group could stimulate metrics work
        - Uncertainties
            - Characterize the uncertainties in GTP
            - Develop Probability Density Functions (PDFs) for metrics
            - Characterize the uncertainty associated wit ocean heat uptake, climate

sensitivity, carbon cycle response, and other processes
        - Quantify magnitudes of indirect effects and interactions between different emissions, LLGHG and SLCF
        - Better understand and quantify the uncertainty in mitigation costs and climate change damages.
- New and refined areas for metrics
    - Develop metrics for policy targets other than limits to temperature change, such as RATE of temp change, etc.
    - Develop approaches to account for long-term outcomes such as consideration of post-target for GTPs
    - Comprehensively assess regional differences in emissions-to-impacts, especially for SLCF
    - Determine when physical metrics approximate more comprehensive metrics
    - Consider whether existing metrics can account for geoengineering
- Relationship between Policy Frameworks and Metrics
    - Study implications of choice of alternative metrics to a variety of outcomes (emissions of different gases, climate change outcomes, etc.)
    - Investigate the potential for extending the multi-gas strategy to short-lived pollutant emissions
- What is IGBP's Role?
    - Can IGBP help drive work to get metrics better across the board?
    - Understand and reduce all uncertainties regarding the calculation of GTPs and GWPS
    - New or mixed metrics, what are the pros and cons?
    - Link metrics to measurements
    - Since this is about emission abatement: Endorse verification of reported emission inventories and changes over time (baseline, and monitoring of changes).
- How to include feedback processes into the metrics and how far can we go with this?
    - Feedbacks processes on climate involving pollution
        - Aerosols and clouds
            - Should remain top-priority for IGBP/IGAC
            - Endorse critical evaluation of measurement/monitoring capacities
            - Engage with AEROCOM
            - Links to metrics: not yet done for indirect effect
        - Cryosphere
            - BC on snow and ice
        - Biosphere
            - Terrestrial Carbon uptake: role of N deposition
            - This is a challenge for N emission metrics
            - Impact of diffuse radiation on C uptake
            - Interaction of O3 with the biosphere
            - Can relate a NOX reduction to an uptake of C
            - Interesting theories, but how can we prove them? What processes need to be tested?
            - What is the role for coordinated experiments (measurements and models)

            - Need to link all of these to measurement, starting in the tropics?
        - In Summary: IGBP Could
            - Promote discussion on alternative metrics
            - Help promoting measurements and model experiement on various feedbacks between pollution and climate and how they influence metrics
            - Help in the difficult discussion on weighing uncertainties in climate metrics and how to communicate feedbacks
            - Should communicate uncertainties and where the needs are
        - Discussion
            - Metrics are needed for trading purposes
            - Metrics are used to screen measures
- What are the policy gaps in addressing the challenge? (Terry Keating)
    - What are the steps you need to go through from scientific knowledge to action?
        - Knowledge -> Awareness -> Trust/Credibility -> Framing in a decision context -> Technology/Management Approach -> Timing (Window of Opportunity) -> Willing to act (have a compelling story, spend political capital, competes with other priorities) -> Action
    - What are things IGBP can do to address these steps
        - Knowledge: Target research, identify priorities to other communities, e.g. health, technology, etc.
        - Awareness: Sustained communication
        - Trust/Credibility: Improve involvement at the national level, sustained communication
        - Framing in Decision Context: Develop appropriate decision support system, provide quantification, e.g. GAINS model
        - Technology/Management Approach: identify specific, appropriate option, recognize "regulatory" system differences
        - Authority/Management Capacity: support capacity building
        - Timing: Have information ready, sustained messages, have an intermediate to identify when the window of opportunity opens
        - Political Will: Can help make compelling stories
        - Action
    - Current Challenges
        - Being Directionally Correct, e.g. indirect aerosol effects
        - Getting magnitudes correct, i.e. setting appropriate expectations
        - Appropriately framing synergies and tradeoffs, e.g. health, climate, measures of welfare, development, etc.
        - Paralysis by analysis, determine when you do and when you don't need a detailed analysis.
        - Value of unilateral vs. collective, national vs. global action
        - Competing Priorities -> improve the dialogue between the earth science community and the policy analysis/international relation research community

10 June 2011

Frank Raes - Measures to Limit Near Term Climate Change and Improve Air Quality

- UNEP Report on BC
    - The report started from measures: What are the measures that already exist and what impact

will they have on BC/O3
    - The measures were the 200 that the GAINS model has to control air pollutants
    - Out of 200 measures, only 17 were shown to have an impact on climate
    - The 17 measures give you 80-90% reduction options in emissions
    - Based on 100% implementation of the all 17 measures, really an ideal scenario
    - Took all co-emissions into effect
    - 3 groups of promising measures (CH4 measures, technical BC measures, non-technical measures)
    - Then showed the impacts of the implementing the 17 measures on climate change, human health, and food security
    - The SLCF and the LLGHG deal with controls on different sectors, i.e. SLCF transport, LLGHG energy
    - There is a real opportunity to mitigate ~1˚C if CO2+CH4+BC measures are implemented
    - The different approach for the UNEP report
        - A focus on solution
        - handling uncertainties through a mutli-species approach
        - handling uncertainties through a multi-effect approach
        - Killing several birds with just 17 stones
- Tackling to AP & CC Challenge - looking for win-win air pollution policies
    - Showed IPCC graph of components of radiative forcing for principal emissions
    - The impact of BC/O3
        - On global scale - changes in their burdens over the 20th century has resulted in a global warming that is potentially similar to that of CO2
        - On regional climate - atmospheric heating by BC disturbs tropical rainfall and regional circulation patterns such as the Asian monsoon. BC deposition on snow, along with atmospheric heating leads to faster melting in the Arctic, Himalayan's, and alpine glaciers
    - Using the IPCC graph of components of RF for principal emissions, showed how emissions from clean energy production, dirty energy production, domestic burning, and agriculture contribute to RF
    - Showed the effect of 100% reduction of man-made emissions of CH4 & air pollutants in individual sectors (Agriculture, Agr waste burning, Domestic burning, Energy production, Industry, Large scale biomass, road transport, waste-landfills) on PM2.5 and GWP
    - If you look at the AP & CC win-win situation -> focus on the agriculture and road transport
    - Conclusions
        - reducing emissions of air pollutants will have a fast impact on global mean temperature
        - favoring reduction in specific sectors might lead to win or lose for global climate (but there is a regional component to this, e.g. "saving the Arctic"
        - Climate friendly PM measures only constitute 10-20% of reduction potential
        - O3 reduction measures, especially through CH4, are a win:win
        - Need more info on the chemical footprint of individual control measures in order to evaluate more accurately their climate impacts

Martin Williams - How to tackle the air pollution and climate change challenge using a science-policy integrated strategy

- The process of how a report is received by governments to getting the final legislation -> the final

legislation may not be anything like the original report

- The Stern Report recognizes win:wins and conflicts: "Policies to meet air pollution and climate change goals are not always compatible. But if governments wish to meet both objectives together, there can be considerable cost savings compared to pursuing bot separately"
- When targets are set, people do whatever to achieve the target irregardless of that the impacts of it may be. Careful with targets
- The UNFCC
    - Need to think on two fronts (LLGHG and SLCF)
        - LLGHG is dominated by foreign and trade policy issues (UNFCCC)
        - UNFCC is now so much about financial institutions and trading that scientist now play a smaller role in the dialogue
        - It is difficult to discuss AQ co-benefits in the UNFCC context
    - Potential for a new dialogue to be created around SLCF in the AQ context.
- How to generate a dialogue
    - Go away, i'm busy, etc. is the first think you'll likely hear
    - Need to present your message in a 5 floor elevator ride
- UNEP report is a good example of how to enter into this "dialogue"
    - There are important public health and food security benefits from tackling SLCF
    - SLCF abatement is complementary to measures on GHGs
    - Swift action is beneficial
    - Abatement of SLCFS is feasible with existing technologies and policies
    - International governance is lacking
- But we need "trade-off science", e.g. it was difficult to get the UK government to support the EU Directive fitting DPFs to vehicles b/c there was a possible 2-3% fuel penalty
- Synergies and trade-offs diagram - aiming for the top right hand square
- Scientific/economic challenges for SLCF in global agreements
    - Existing agreements use GWP-100
    - Location of emissions matters
    - Knowledge of impacts is less certain than the impacts of LLGHGs
    - Impacts on health, crops, and ecosystems are better quantified regionally or locally
    - Regional impact of SLCFs are important, e.g. the Arctic
- Possible models for managing SLCFs
    - Incorporate in UNFCC
    - Create a new global air quality treating
    - Build on existing regional air quality agreements
- What IGBP Can do
    - What - Adopt an interdisciplinary approach
    - Why - To add value and support other voices in the field, which can make it easier to persuade national governments to act on SLCF AND on LLGHG by suggesting optimal solutions
    - How - Speak the language of policy makers and use clear statements about uncertainties in such a way that the statements are scientifically credible and robust AND useful and useable by the policy process

Outcomes from the breakout session -> get notes from individuals below

Group A
Statement on the Air Pollution & Climate Change Challenge

- What is the purpose of the statement?
    - Purpose is to review statements that have been made. Not an assessment of assessments, but an assessment of the high level messages from the assessments.
        - e.g.: UNEP Report: Does IGBP support the basic conclusions? Is there a case where BC reductions will be bad for climate?
- What is the process for getting IGBP/IGAC agreement? Does this go through the science steering committee?
- Who is the audience
    - Policy v. Science Community
    - Packaging Message to Different Levels
        - Summaries for National and Local Level
        - Issues for International Governance
        - Should IGBP make a statement about it?
- What is the scope?
    - SLCF v. GHG v. Air Pollution
- What is structure and format?
    - Talking point list?
    - List of Questions, Paragraph Answer, Longer Answer with References
- Possible Topics
    - Health, Ecosystem Effects are more clear. Climate interactions are less well known. Keep quantifying.
    - Implications for metrics, international governance.
        - Two Basket v. One Basket
        - Evaluation criteria for metrics?
        - Qualitative v. quantitative
    - Climate impacts on Air Quality
    - Air Pollution impacts on Climate effects, precip, …
    - Interaction with Nitrogen cycle
    - A set of measures to optimize on CC and Ndep.
- Sources
    - UNEP BC/O3 and Action Plan
    - AMAP
    - LRTAP HTAP/BCEG
    - EPA BC Report?
    - ABC Reports
    - CAI-Asia?
    - EPA Climate Penalty
    - UK Assessment of Climate Impacts on Health
    - International Nitrogen Initiative?
- Timing of Statement (What are the implications for process or content?)
    - Is the statement supposed to come out before or after
        - UNEP Action Plan?
        - March Conference
        - Rio +20

Strategies for a multi-disciplinary program

- IGBP can articulate research questions and approaches

- Objectives
    - Awareness and Facilitating Collaboration
- Interdisciplinary Dialogues
    - Health
        - What PM characteristics matter?
    - Other Impacts (Nat and Ag Ecosystems, Materials Damage, …)
        - Biosphere, Land Cover/Land Use Interactions
        - Ecosystem Services
    - Technology
        - What impacts of technology matter? Pollution characteristics, energy efficiency, …
        - Life cycle analysis
    - Economics
        - Valuation of impacts?
    - Governance
        - Need to engage researchers who study governance of air pollution and climate change
        - Implications for Institutional Design (one v. two baskets)
        - Have addressed the issue of which negotiating forum for which pollutants?
        - Implications of Institutional Design (what is possible)
    - Communication
- Research Projects
    - Developing Integrated Modeling Frameworks?
    - Case Studies at the National/Regional Scale
        - Opportunity to Build on ABC Policy Teams
        - Policy Evaluation (What can we learn from where policies have been implemented?)

Group B
Statement on the Air Pollution & Climate Change Challenge

- One Atmosphere
- Climate affects AQ; AQ affects climate. Cleaning the air means reducing all air pollutants, including GHGS
- Scientific evidence shows that immediate, sustained effort, adopting know measure to reduce atmopsheric pollution is critical to human health, food security, and stable climate
    - Measures to mitigate atmospheric pollution reduce multiple pollutants with multiple impacts (sometimes in opposite directions)
    - A holistic approach is needed: it is essential to consider climate, health, and food security of any measure
- To achieve both climate and health goals over the next decades, fast reduction of both CO2 and PM+O3+CH4 are required

Strategies for a multi-disciplinary program

- Critical Biosphere-Atmosphere-Climate coupling
    - N-C coupling
    - atmosphere-biosphere for air pollution-carbon feedbacks
    - aerosol-cloud (indirect effects)
- Feasibility

    - costs, non-economic barriers
    - psychology and marketing
    - implementation, assessment of efficacy
    - considering 'taboo' sources
    - Development & rigorous ex-post testing of integrated assessment models
- Sustainability of megacity trend thru lens of AQ &climate
    - physicochemical (e.g. urban heat island)
    - transport & trans mgmt (mitigation approaches)
    - land use implications

Group C
Statement on the Air Pollution & Climate Change Challenge

- Frame it as the Air Pollution & Climate Change Opportunity
    - AQ (health, food security, water quality) measures are on going and will proceed, the opportunity if to use these measures to impact climate change
    - You get climate benefits that can get short term results that are not covered by the long-term climate policies
    - Long-term climate mitigation are also necessary for climate mitigation
    - In addition air quality protection will be abated by the long-term climate mitigation options
- The guts of the report
    - IPCC approach using the diagram on the emissions and their AQ/Health vs Climate impacts
    - AQ mitigation option that could be used for short term climate abatement (each bullet with also have a portion on the measures that work for each pollutant)
        - PM emission controls are needed for health, controls should be done in such away that when these controls are implemented, BC is taken out to benefit climate
        - O3 Abatement
        - CH4 should be considered as a measure to reduce O3 because of its impact on climate change mitigation
        - CO and VOCs
        - SOx issue needs to be addressed from AQ side, this will increase warming, therefore GHG mitigation option should be in place to off set the loss of cooling.
        - NOx controls are good for AQ, they do not have a known climate effect, but they do to biogeochemical cycles
        - Ammonia is of concern for AQ, not yet regulated, big with AQ, Climate impact is minimal
    - International emission, e.g. ships
    - Regional Perspective – different regions are impacted more from different pollutant for both AQ and climate
        - Taking advantage where the greatest opportunities are within regions
    - Mitigation of long-term climate change is still needed and will protect air quality

Strategies for a multi-disciplinary program

- Preparation of new expertise
- One atmosphere approach
- New institutes/centers within universities
- Focus on young scientist

- Integrated metrics
- Coupled models
- First integration needs the biogeochemical and dynamic meteorology communities
- Development of tools that can be used in the developing world
- International collaboration
- Building on the Belmont Forum

Group D
Statement on the Air Pollution & Climate Change Challenge

- Focus on the co-benefits, although should describe then as "benefits" without the "co-" or a range of benefits
- Should include a menu of benefits that can be tailored, re-ordered, etc. to address different audiences and development needs
- Focus on timescales of benefits, need to have quick wins to gain political buy-in
- Include case studies, with health as a major driver
- Describe any new research needs in terms of reducing risk (i.e. risk of making the wrong decision)
- Note that taking action on climate change could provide a national reputation boost in an international context (important political benefit)
- Include the benefits of land use planning and infrastructure development, e.g. energy efficiency of new buildings, and emphasize their place in the aspirations of the developed world (i.e. the difficulty in improving energy performance with an existing, old urban infrastructure)
- What about HFC and HCFC emissions? They are SLCF without co-benefits

Strategies for a multi-disciplinary program

- Look to the success of the partnering programme developed under the Montral Protocol
    - partner countries for form multidisciplinary tams made up of nationals from both countries, to include economists, natural scientists, social scientists, health and financial expertise, technology experts (from target country)
    - Need solutions to be applicable in target country, so need "local" expertise and representation.
    - Look to build local capacity.
    - These teams will need on-going scientific guidance
    - Start with local benefits (ie the co-benefits) not the climate issue.
- Goals need to be realistic and applicable in the target country
    - will need research/risk reduction to back this up
    - mustn't ignore implementation capacity (or not)
- Link to existing development programmes
    - use research knowledge to help direct existing programmes to deliver outcomes for air pollution and climate, i.e. use case studies involving local scientists with collaboration with UNEP scientists to bring home the messages to local governments? Eg. China.
    - Use IGBP to make country-country connections. IGBP has established national contact person in 70 countries. These can be utilized for outreach and connections.
- Need a systematic review of the impact of climate change policies on air pollution, e.g. biofuels/biomass, land use change, etc.
- Develop easily transferable tools for integrated assessment of outputs (as GAINS does) optimized for air pollution and climate

    - need to have local credibility
    - need analysis of the elements needed in such decision support tools, e.g. local, easy to use, reflects local climate, geography, infrastructure, capacity, etc.
- Address perception of low carbon technologies in the developing world
    - "We want what you have"
    - "Why should we carry the burden of saving the world?"
    - "We were lean and green before Western patterns of consumption were introduced through "developing markets" programmes."
- IGBP should examine the impacts of climate change policies on air pollution (eg. CO2 mitigation policies). Examination should go beyond effect of mitigation of methane and BC on climate/health/ag/etc. Eg. Examine impact of increasing use of biofuels on air quality and health. Examine impact of nitrogen fertilizer on climate (production of N2O) as well as air quality (production of NOx and hence O3 production).

Workshop on Tackling the Air Pollution and Climate Change Challenge
Arona, Italy
9 – 10 June 2011

As part of the International Geosphere-Biosphere Programme's (IGBP) Air Pollution & Climate Initiative, a two-day workshop was held in Arona, Italy on 9-10 June 2011 to discuss the development of an effective science-policy dialogue to address the Air Pollution and Climate Change Challenge.

The workshop had 22 participants across the science-policy spectrum representing 13 different countries. Participants were given the opportunity to present their perspective on the Air Pollution and Climate Change Challenge. Perspectives were varied but the general consensus was there is still a separation between air pollution and climate change in both the policy and scientific communities. This separation is reflected in the temporal and geographic scales of interest: with air pollution efforts focused on the near-term and the local and regional scales, whereas climate change efforts are focused on the long-term and global scale. As with many issues, there also exists a divide between the scientific and policy communities that hinders communication and understanding. The aim of the Air Pollution and Climate Initiative is to break down these divides (Figure 1) and clarify the synergies and trade-offs of research and mitigation efforts across a spectrum of air pollution and climate change policies (Figure 2).

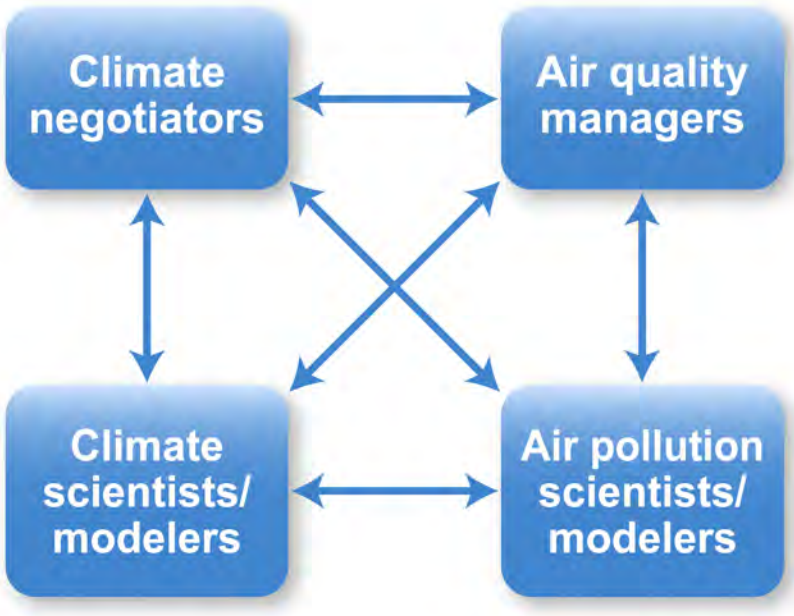


Figure 1. Linkages needed to facilitate simultaneous efforts to address air pollution and climate change in both the policy and scientific communities. Without these linkages opportunities for co-benefits or unintended negative consequences may be overlooked.

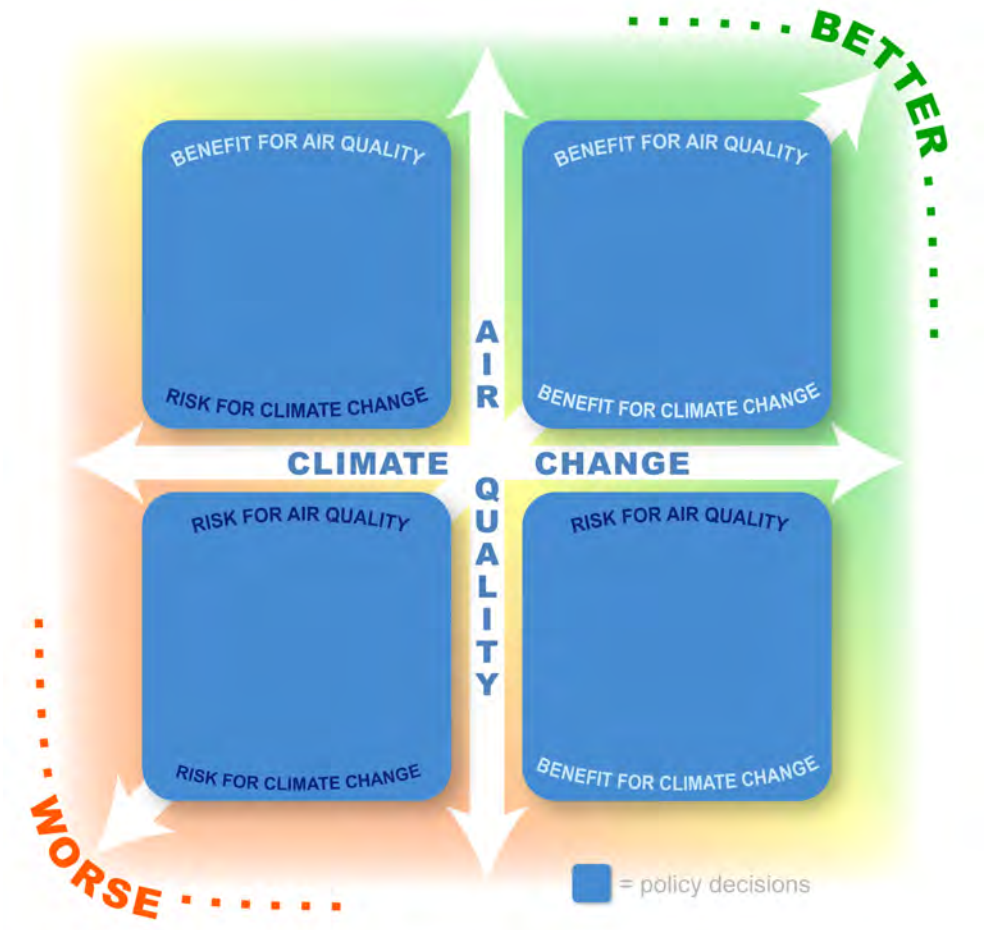


Figure 2. Schematic of the synergies and trade-offs of air pollution and climate change policy decisions.

The Air Pollution & Climate Initiative seeks to build upon current efforts tackling these issues and to provide continuity between present and future efforts. Current efforts include the United Nation Environmental Program (UNEP) *Integrated Assessment of Black Carbon and Tropospheric Ozone*, the Arctic Monitoring and Assessment Programme (AMAP) report on *The Impacts of Black Carbon on the Arctic Climate*, the International Global Atmospheric Chemistry (IGAC) and Stratospheric Processes And their Role in Climate (SPARC) Atmospheric Chemistry and Climate (AC&C) Activity, the US Environmental Protection Agency (EPA) *Black Carbon Report to Congress*, the EU Atmospheric Composition Change the European NeTwork Plus (ACCENT Plus), and the Long Range Transboundary Air Pollution (LRTAP) and European Monitoring and Evaluation Programme (EMEP) Task Force on Hemispheric Transport of Air Pollution (HTAP). By building upon these current efforts, the Air Pollution & Climate Initiative frames the Air Pollution and Climate Change Challenge as a problem comprising one atmosphere, same pollutants, and multiple effects.

Over the next two years, the Air Pollution & Climate Initiative will produce two documents:

1. IGBP Statement on the Air Pollution and Climate Change Opportunity
2. Strategic Plan for a Multi-Disciplinary Program on Air Pollution & Climate Change

The IGBP Statement on the Air Pollution and Climate Change Opportunity will provide a concise assessment of the benefits and risks associated with mitigating air pollutants for human health, agriculture, ecosystems, and climate. The statement will be released as a briefing document at the ICSU Planet Under Pressure Conference March 2012 in London.

At the same time the Air Pollution & Climate Initiative will develop and publish a strategic plan for a multi-disciplinary program on Air Pollution and Climate Change that will engage the international earth system science, social science, and policy communities. This will build on and take account of other international efforts coupling air quality and climate research such as the ICSU-Belmont Earth System Visioning process and provide specific recommendations and methodologies for creating and sustaining such a multi-disciplinary international program.

A follow up workshop on the IGBP Air Pollution & Climate Initiative is scheduled to take place 7-10 November 2011 in Taipei, Taiwan. This workshop will focus on Air Pollution & Climate: A Science-Policy Dialogue in Asia. The Taiwan Environmental Protection Agency (EPA) is sponsoring the workshop.

附錄四：公務出國期間國外人士個人資料彙整表

公務出國期間國外人士個人資料彙整表

會議/活動名稱	姓名	單位及職稱	國別	專長領域	會晤日期	電子郵件	我方接洽者姓名職稱	交流內容	備註
Tackling the Air Pollution & Climate Change ： A Science-Policy dialogue	Kathy Law	LATMOS at the Pierre Simon Laplace Institute	法國	大氣化學與氣候變遷	2011/6/9-6/10	kathy@latmos.ipsl.fr	郭孟芸技士	針對空氣污染與氣候變遷議題進行討論及意見交換。	
同上	Paul Monks	Prof. Univ. of Leicester,	英國	大氣化學與氣候變遷	2011/6/9-6/10	p.s.monks@leicester.ac.uk	同上	同上	
同上	Denise Mauzerall	Prof. at Princeton University in the Woodrow Wilson School of Public and International Affairs	美國	氣候變遷與政策	2011/6/9-6/10	mauzeral@princeton.edu	同上	同上	
同上	Terry Keating	U.S. Environmental Protection Agency, Office of Air and Radiation	美國	大氣化學、氣候變遷與政策擬定	2011/6/9-6/10	keating.terry@epa.gov	同上	同上	
同上	Megan Melamed	IGAC Executive Officer IGAC Core Project Office JISAO, Univ. of	美國	大氣化學與氣候變遷	2011/6/9-6/10	megan@igacproject.org	同上	同上	

會議/活動名稱	姓名	單位及職稱	國別	專長領域	會晤日期	電子郵件	我方接洽者姓名職稱	交流內容	備註
		Washington							
同上	Frank Dentener	European Commission Joint Research Centre	義大利	大氣化學與氣候變遷	2011/6/9-6/10	frank.dentener@jrc.ec.europa.eu	同上	同上	
同上	Sandro Fuzzi	Istituto ISAC-CNR	義大利	大氣化學與氣候變遷	2011/6/9-6/10	s.fuzzi@isac.cnr.it	同上	同上	
同上	David Mccabe	Clean Air Task Force	美國	空氣污染防制	2011/6/9-6/10	dmccabe@catf.us	同上	同上	
同上	Hiroshi Tanimoto	Natl Inst Environ Studies	日本	大氣模式模擬	2011/6/9-6/10	tanimoto@nies.go.jp	同上	同上	
同上	Maria Kanakidou	University of Grete, Department of Chemistry	希臘	大氣化學與氣候變遷	2011/6/9-6/10	mariak@chemistry.uco.gr	同上	同上	