出國報告（出國類別：考察）

獨立行政法人海洋研究開發機構考察（日本）

服務機關：國立海洋科技博物館
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派赴國家：日本
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壹、目次

貳、摘要

日本獨立行政法人海洋研究開發機構（Japan Agency for Marine Science and Technology：JAMSTEC）本部位於横須賀，並設有むつ(舊名大湊田名部市)研究所（位於青森縣）、東京事務所、横濱研究所、高知コア研究所、國際海洋環境中心（位於沖繩縣）等其他 5 個分部，組織分成「役員」、「研究部門」、「開發及運用部門」、「經營管理部門」。其中，役員設有理事長 1 人，理事 3 人，監事 2 人；「研究部門」設有戰略研究開發領域（下轄 8 個中心、實驗室及計畫團隊）、基幹研究領域（下轄 11 個研究領域）、むつ研究所、高知コア研究所、研究推進部；「開發及運用部門」設有海洋工學中心（下轄海洋技術開發部等 4 個研究船管理室）、地球情報基盤中心（下轄 6 個研究開發部）、地球深部探查中心（下轄運用部等 5 個單位）；「經營管理部門」設有經營企劃部、總務部、人事部等 8 個單位，全機構人員約 1000 位，年度預算約 400 億日幣。重要的研究設施包括 8 艘研究船、8 搜載人與無人潛水載具、地球模擬設備（超級電腦）、岩心庫等設施。本館首次拜訪該機構，商討雙方交流及合作模式，並請該機構持續提供本館最新海洋科學、技術、資源、生物等相關研究成果與資訊，供本館做為展示、教育、研究或蒐藏等目的使用。海洋研究開發機構雖係以研究為主要發展業務，辦理海洋相關學術研討及交流會。然為將海洋最新研究訊息傳遞給一般民眾，仍設有各式教育推廣活動，有一般民眾參觀導覽活動、研究人員至高、國、中、小學上課、培育種子教師、與大學合作共同指導研究生等等，與本館未來發展的方向一致。能與該機構持續合作與交流，是本館努力成為國際級博物館的重要發展業務之一。

一、出國目的

日本為全球先進海洋大國之一，有關海洋科學與技術之相關研究、產業、教育領域均優於臺灣。本次考察對象為獨立行政法人海洋研究開發機構（簡稱該機構），該機構為日本最重要的海洋研究與技術發展的研究機構。本館於 2014 年 1 月正式開館營運前，在常設展示發展與建構過程當中，許多有關深海相關之影片與照片，均為該機構無償提供本館做為常設展示用，這些資料已運用在深海展示廳、深海影像廳、船舶與海洋工程廳的常設展示項目。

本次出國考察的目的除為感謝與維繫該機構對本館的協助與支持外，並將現地考察該機構本部與橫濱研究所設施，初步了解該機構的環境、設施與相關營運狀況。

二、出國過程

本次出國行程安排（原 2013 年提案計畫）預定考察海洋研究開發機構及北海道大學厚岸臨海實習場，上述兩單位均是熱心提供本館有關深海及昆布林相關影片、照片與資料的機構。為持續獲得最新海洋研究成果與資訊，進行與兩機構的合作與交流，以便發展本館相關之研究與教育推廣活動，因而有安排有兩機構的考察行程，參與考察人員為 2 人，預算編列新台幣 23 萬，8 天行程。惟出國預算經核定為新台幣 4 萬元整，已無法支應上述考察計畫。因而修改行程，優先安排考察海洋研究開發機構本部及橫濱研究所，參與人員限縮為 1 人。原預定日期為 5-7 月，亦因計畫調整而改為 11 月進行，出國日期修正為 11 月 4 日至 11 月 7 日。

本次行程簡要說明如下：11 月 4 日從台北出發至東京，然後移動至橫濱；11 月 5-6 日考察海洋研究開發機構及橫濱研究所，11 月 7 日從橫濱出發回臺灣。

（一）橫須賀本部考察過程

橫須賀本部位於神奈川県橫須賀市夏島町 2 番地 15，位於東京灣的西南側，靠近海邊。灣區及附近地區均為日本大企業如日產、住友重工等公司之研究與技術發展中心，建築物主要形式均為工廠式建築。從橫濱車站搭乘京浜東北縣在追浜車站下車後，再轉乘公車在該機構門口下車，交通不算便利，搭乘計程車會比較方便，特別是穿梭在該工業區域內。該機構主要設施包含「本館」、「海洋科學技術館」、「深海總合研究棟」、「海洋研究棟」、「深海總合研究棟」、「潛水訓練池棟」、「潛水模擬器棟」、「海洋工學實驗棟」、「超音波水槽棟」、「波動水槽」、「高壓實驗水槽棟」、「潛水調查船整備場」、「無人探查機整備場」、「海洋技術研究棟」、「海洋生態研究棟」等 19 座建築物，以及碼頭一座，水深 8 公尺，長約 200 多公尺。當日考察時，研究船「橫須賀號」正停泊在碼頭邊進行整備作業。

重要考察紀要如下：

「橫須賀號」考察行程：該船全長 105.2 公尺，總噸數 4,439 噸，1990 年下水，可搭載 60 名乘員。該船為深海（しんかい）6500 及浦島（うらしま）深海巡航探查機的作業母船。該船特色是有前、後兩座鑑橋，係為配合操作有人及無人載具下海時，控制母船航行用。另有與深海 6500 聯繫之控制室，這是有別於國內研究船的特有空間。船齡雖有 24 年，但是環境乾淨、設備也維護得很好，船身的除銹作業做得也很確實，行走在船艙間，感覺非常舒服。人員在船上進行維護作業時，一律穿戴安全帽與制服，紀律非常良好。

「潛水調查船整備場」：考察當日停留在整備場的水下載具有深海 6500（有人載具）及浦島深海巡航探查機（無人載具），由於載具經常出海作業，本日能夠同時

看到兩部載具同時現身，我們的運氣算是相當好。為提升深海 6500 在水中的靈活度，該載具已經完成了修改作業，從原本一個推進器，更改為兩個推進器，其他構造也做了一些小幅的變動。整備場裡，並設有簡易解說牌及相關控制浮力的材料，係提供一般參觀民眾有關載具使用與構造相關訊息，並可供參觀者動手觸摸及了解載具浮沉的原理。一如以往在日本居住時的深刻印象，整齊乾淨的整備場地，工作動線與參觀動線間的清楚區隔，實在臺灣值得學習與努力的地方。

「海洋科學技術館」：是本部對外進行科普教育活動最大的場地，是一個展示館。該館陳列許多深海探測儀器、深海生物、研究船模型等展示品。就展示觀點而言，並不像一般博物館一樣，刻意營造出神秘、令人感動的展場氣氛，來吸引民眾的目光。可是整個展示場地除了部分展項是模型外，其他展品都是貨真價實的展覽品或是典藏品，充分顯現該機構的海洋科學與科技的研究水平與能力，實在是臺灣目前無法跟上的水平。

「高壓實驗水槽棟」：除了兩座高壓實驗水槽外，設有讓民眾體驗壓力與體積關係、深海高壓如何摧毀物品等相關的展示項目，以及可讓民眾動手操作的互動單元。因為是工作場地，見學場域不是本館科教教室的氛圍，是一處真實的做實驗場地。本次展出的項目中，令人感到最新奇的是，玻璃在深海高壓的環境下，最後被壓毀成為一堆粉沫，而不是破裂成塊的樣子。

本次主要拜訪對象為白山義久理事，也是一直給與本館默默協助的最重要人物，由於該理事的熱忱幫忙，使得本館得以獲得深海相關照片與影片資料，運用在本館常設展示項目，目前使用到該機構資料的展示廳為深海展示廳、深海影像廳以及船舶與海洋工程廳。白山義久理事亦相當關心臺灣研究船沉沒的事情，站在同樣是研究海洋的立場，他也感覺到有些遺憾。

（二）橫濱研究所考察過程

橫濱研究所位於神奈川県横浜市金沢区昭和町 3173-25，大約介於橫濱車站與追浜車站之中間，面積比位於橫須賀本部的土地小。與橫須賀本部比起，橫濱研究所相對位於市區內，周邊為住宅區，離杉田車站或是新杉田車站也比較近，徒步即可到達。該所主要的研究主題大多屬於和地震、氣象或是使用電腦分析方面的研究與技術開發工作。

重要考察紀要如下：

「地球模擬器」：設於 2002 年 3 月，開始係為分析地球溫暖化後所產生的氣候變動、預測氣候、地震及地球內部變動等作業。該系統實際上是一座獨一無二的大型超級電腦，處理速度曾經是世界第一，用來分析有關地震、地球內部變動、海流、大氣、降雨、颱風、地震、海水溫度、海中浮游動植物活動等即時數據，並將之轉化為模擬影像，以作為災害防制、警告、預警等研究分析及運用，並將這些電腦置於一棟有減震功能的建築物。在阪神大地震發生時，橫濱的震度是 5，然而該棟建築物的震度只有 1，緩震效果極佳。另一個令人印象深刻的是，該建築物使用了許多可以反射光源的裝置（非光纖），藉由光線的散射將建築物外的光源引入室內，降低的燈管的使用數，也達到節能的效果。

另一訊息是，日本政府曾花了不少錢投資超級電腦，之後行政單位亦提出下一代電腦的更新預算申請。不過據稱當時亦引起國會議員的關注，議員曾經質問投資這麼大的金額更換電腦設備，維持世界第一的時間有多長？當行政單位回覆可維持半年的優勢時，國會議員認為花這麼多錢沒有價值，並把預算刪減掉。

「地球情報館」：與橫須賀本部最大不同的是更重視展示廳裝修氛圍及一般民

眾的公共服務，因此看起來較像博物館，或是具有科學教育中心的功能，常常辦理科學教育活動，除每日開放給民眾免費參觀外，每月亦有一次的周休假日服務民眾入館參觀。而且設有專門導覽解說人員，穿著制服為參觀民眾服務。該館另外設有民眾可以使用的圖書室、視聽室、實驗教室，餐廳，提供禮品、紀念品及模型販賣服務，圖書室內並有販賣該機構或是其他出版社出版之有關海洋研究的出版品。該館最大的展示項目為地球劇場，是一個大型的球型投影銀幕，將監測的海洋資料轉化成影片投影在球面上，民眾可藉由操作面板上的觸控按鍵，選擇想要看的影像節目。

三、出國心得

本次考察海洋研究開發機構橫須賀本部及其橫濱研究所的心得如下：

1.該機構的海洋科學與科技研究設施及成果遠在我國之上，從該機構的研究論文發表數、展示物件大多為真品的實例上便可觀之。在成為一個名正言順的「海洋國家」之前，我國還有一大段路要走。

2.該機構在設施的維護保養作業上，遠較我國來的仔細與確實。例如，研究船雖然已使用超過 20 年，設施或有些使用刮痕，但是整艘船仍非常乾淨，船身的除銹作業也做得非常確實。我國在研究設備的維護作業上，要更加細心才行。

3.研究雖為該機構主要核心業務，然為讓更多民眾了解海洋相關知識，該機構仍辦理一般民眾、高、國、中、小學生之參觀活動，冬季及夏季的夏令營，研究人員到校進行推廣教學，接受實習生來機構實習，訓練種子教師，與大學合作共同指導研究生等活動，這一點和本館在教育推廣活動之作法相同，基本上雙方面差異不大。。

4.就服務民眾的展示場地設施設計而言，海科館的展示場地氛圍營造與展示手法，絕對優於該機構的參觀設施。

四、建議事項

有關本次海洋研究開發機構考察行程之建議事項如下：

1.應與該機構密切聯繫與交流，對海科館及我國獲取最新海洋研究成果之訊息極為重要，有助於提升海科館與我國的海洋研究水平與國際觀，亦有助於未來常設展示主題更新、特展主題內容充實等作業。

2.海洋研究開發機構對於研究船與設備的維護水平，均在臺灣之上，這一點是我國應該檢討與學習的地方。所謂「工欲善其事，必先利其器」，從小地方的維護狀況就可以看到大地方研究成果，我國在這一方面仍有許多成長空間。

3.該機構亦知我國最新研究船「海研五號」觸礁沉沒乙事，深深表達遺憾之意。對身為臺灣海洋研究領域成員的一員，面子上實在掛不住。我們應確實檢討原因，並改正後，建造新的研究船，持續支持海洋研究。

4.本次旅費編列 4 萬元，實無法完成兩人同赴海洋研究開發機構及北海道大學的考察活動，因而不得不調整原本計畫，讓計畫經費的缺口變少。期望下次出國旅費審查時，能多參照實際訪問行程及地點，核實編列充足預算。

五、考察照片

<table>
<tr><td colspan="2">海洋研究開發機構---橫須賀本部</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>橫須賀主館
為該機構主要行政中心，除了主館外，另有 18 棟建築物。</td><td>橫須賀碼頭
碼頭很乾淨、整齊，碼頭拓寬工程已經完成。</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>無人探查機整備場
位於碼頭旁，水下載具下船後，即可在旁進行維護作業，相當方便。</td><td>港灣汙染防止用具倉庫
防止港灣汙染相關設備儲存處</td></tr>
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<tr><td colspan="2">海洋研究開發機構---橫須賀本部</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>橫須賀號船頭
該船當日停泊港口整補中，雖為 24 年的船齡，但船體及設施維持的相當好。</td><td>橫須賀號船尾
碼頭經過浚深後深度為 8 公尺，除地球後無法停泊外，其他 7 艘研究船皆可停泊該碼頭。</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>橫須賀號艦橋
該船有前後兩處艦橋，係為配合水下載具下水時控制母船所設置。</td><td>深海 6500 控制室
該控制室位於艦橋後方的獨立空間，負責與深海 6500 載具通訊。</td></tr>
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<tr><td colspan="2">海洋研究開發機構---橫須賀本部</td></tr>
<tr><td>  </td><td> 
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<tr><td>潛水調查船整備場
深海 6500 的維修基地</td><td>深海 6500
進行維修作業中的深海 6500</td></tr>
<tr><td>  </td><td> 
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<tr><td>深海 6500 正面
正面有 3 個壓克力的觀景視窗,載具乘員可同時觀看艇外狀況。</td><td>深海 6500 尾部
為增加在海中的靈活度，該載具推進器已由 1 個改為 2 個</td></tr>
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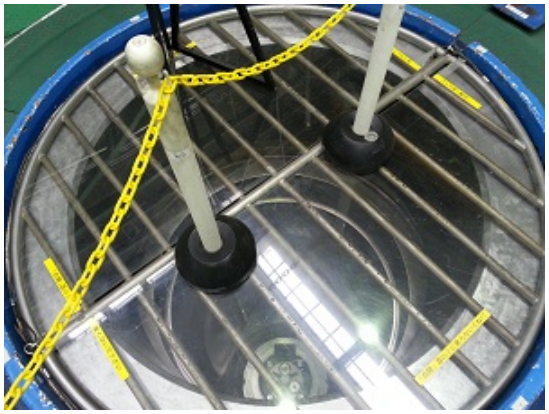
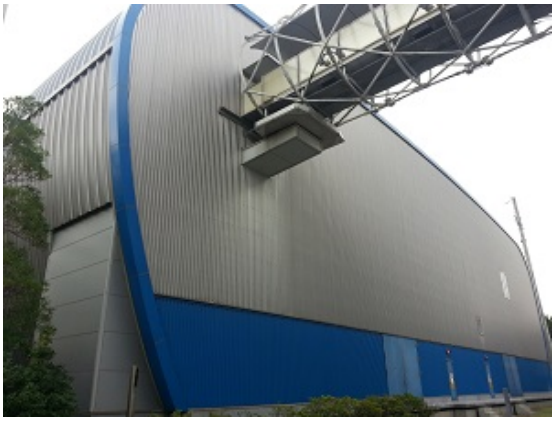
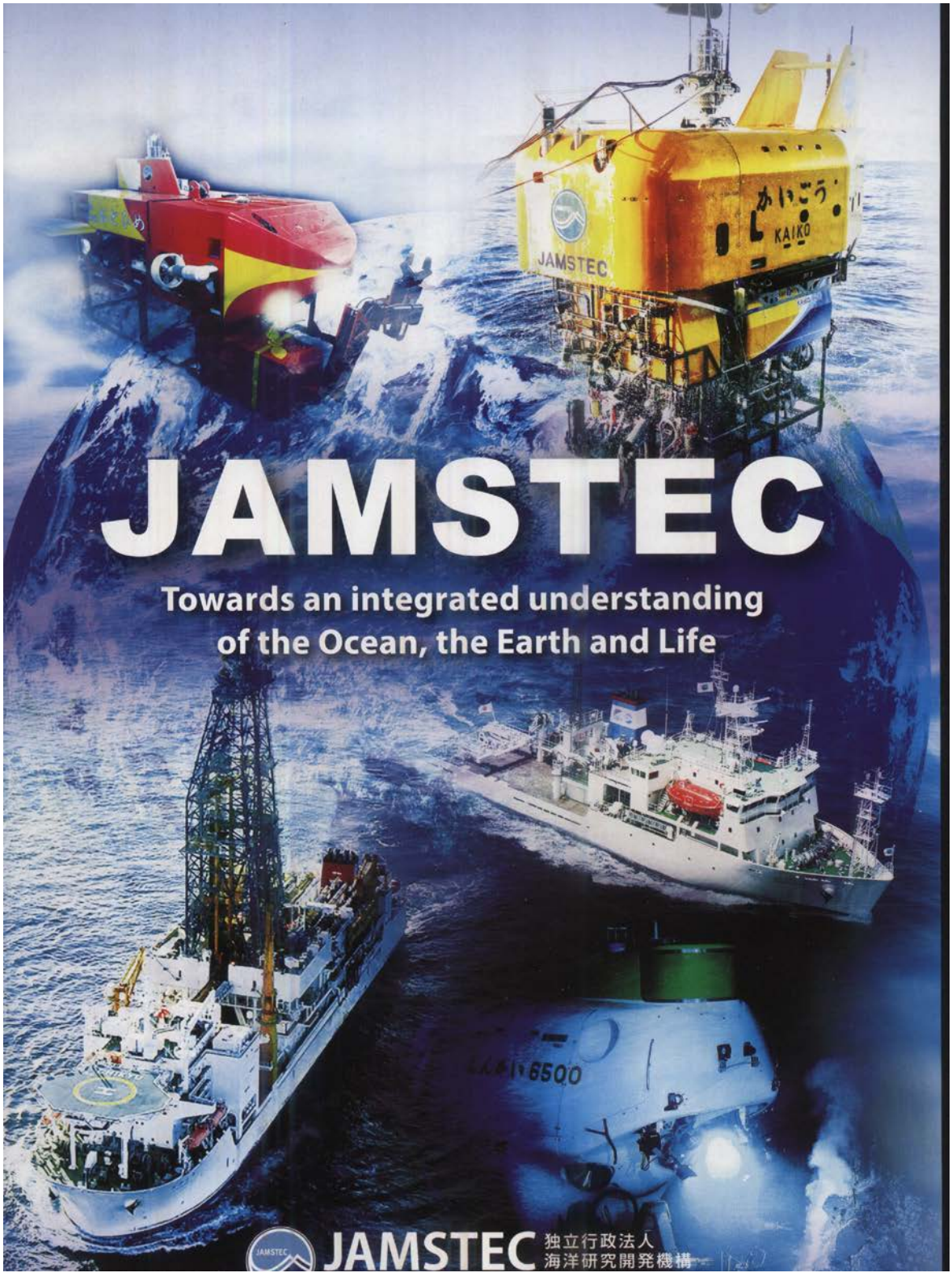
海洋研究開發機構---橫須賀本部	
	
海洋科學技術館 1:1 的深海 6500 模型展項，可進入艙體間體驗艙內狹窄的壓迫感。	海洋科學技術館 8 艘該機構所屬研究船模型展項，讓民眾觀看不同船隻的功能。
	
海洋科學技術館 深海生物標本展項亦為館內展示項目，蒐藏許多珍奇深海生物標本。亦有深海熱泉生態造景展項，製作精細度與本館差不多。	海洋科學技術館 該機構設有一般民眾參觀導覽活動，由於不是假日，參加者均是老人，約略可見國家人口老化的情況。

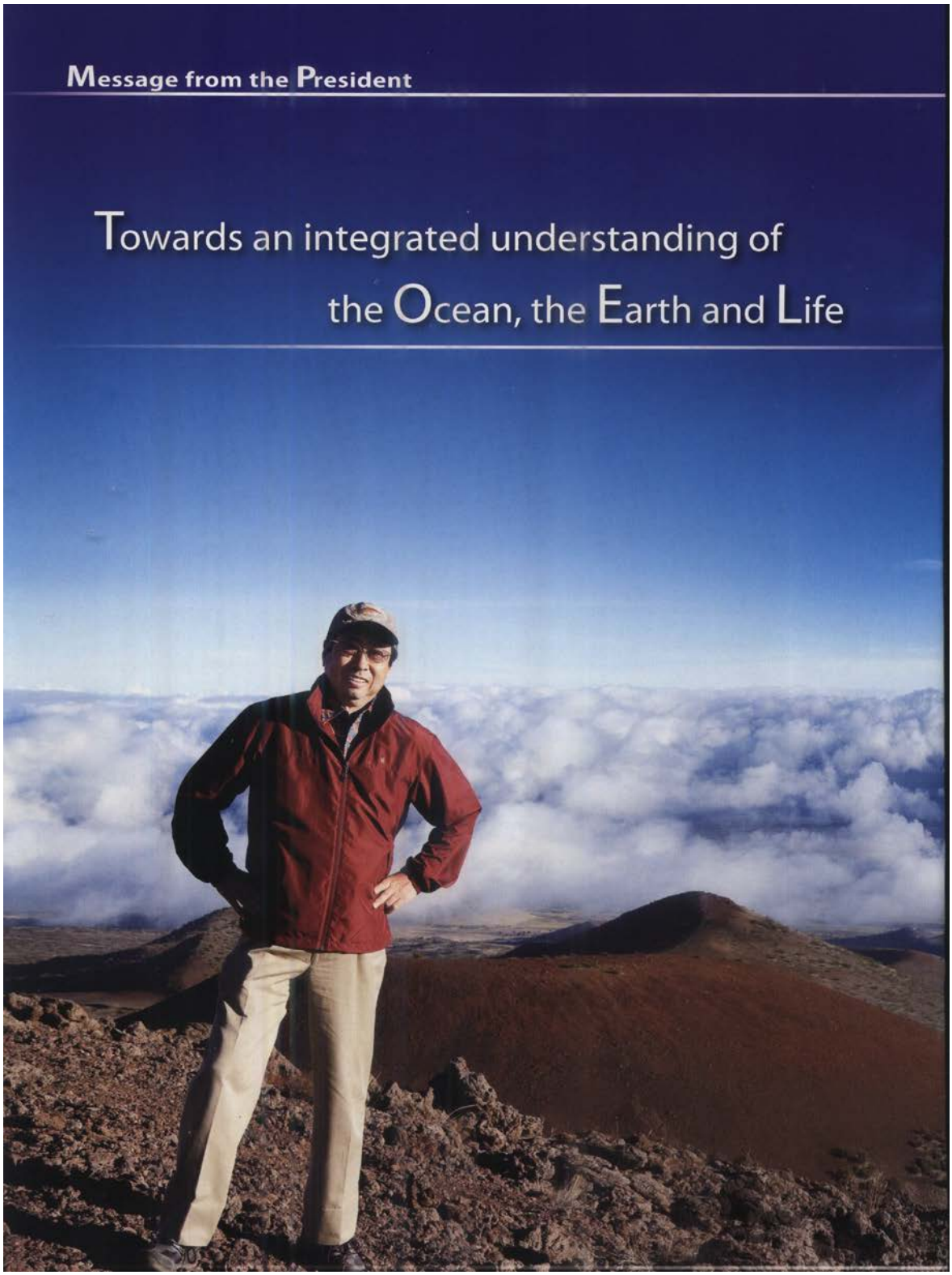
海洋研究開發機構---橫須賀本部	
	
高壓實驗水槽棟 高壓實驗水槽，深度 3 公尺。	高壓實驗水槽棟 高壓水槽蓋子。
	
高壓實驗水槽棟 受高壓後，金屬產生之形變。	高壓實驗水槽棟 玻璃受高壓後，呈現粉末狀。

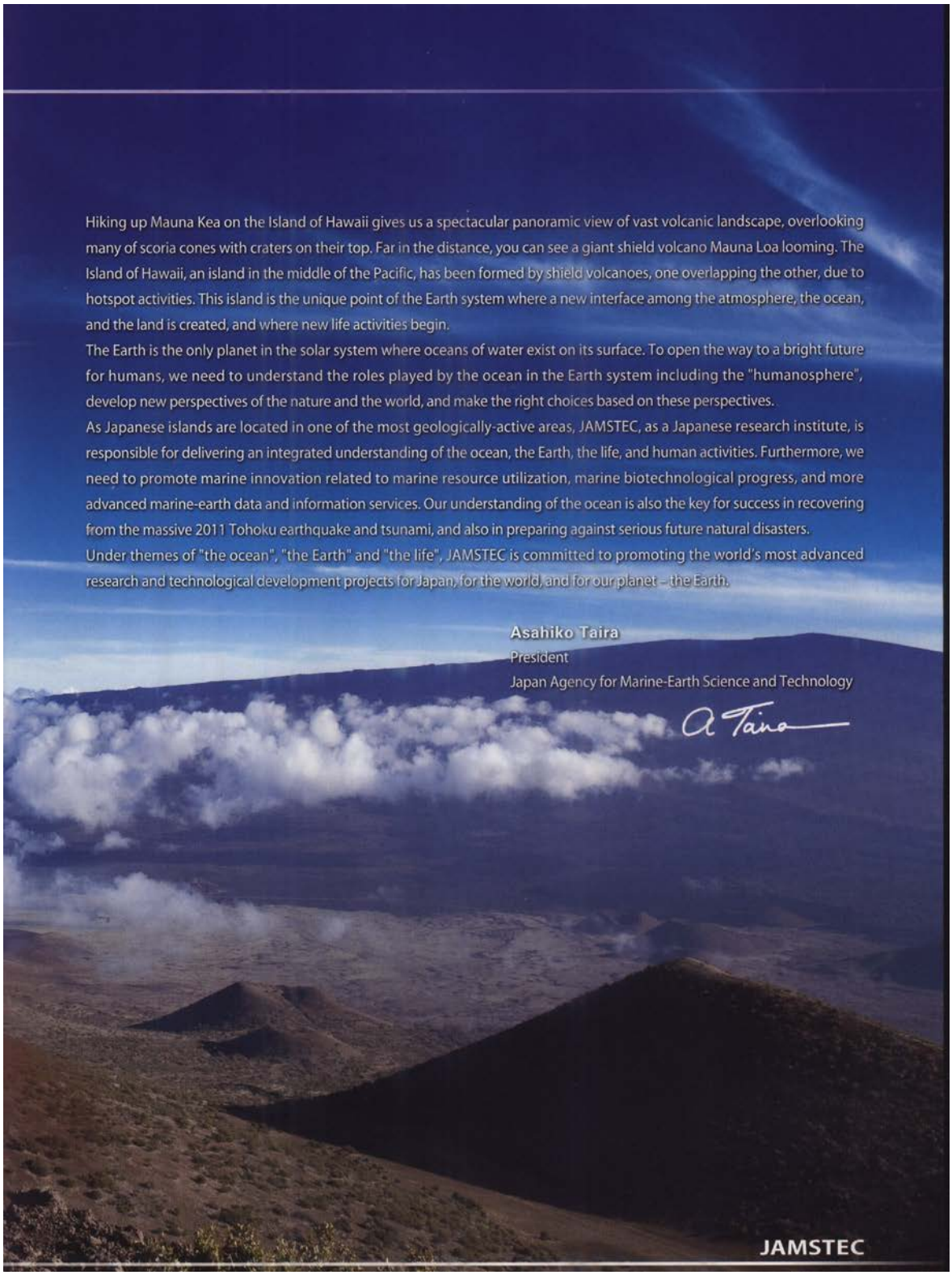
海洋研究開發機構---橫濱研究所	
	
橫濱研究所主館	地球模擬器大樓 存放地球模擬器的建築物
	
地球模擬器大樓中的超級電腦 有關地震、颱風、海中動植物浮游生物群聚等資料，均可經快速計算。	節能照明設施 地球模擬器大樓之電腦存放位置，其照明為自然採光，不用電燈等燈具作照明，非常環保。

<table>
<tr><td colspan="2">海洋研究開發機構---橫濱研究所</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>地球情報館內最大展項
模擬大氣、地震、地球暖化相關資訊，展示效果佳</td><td>地球情報館二樓
主要以相片展示為主，包含各式深海生物、生態、環境等照片</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>地震情報模擬器（一樓）
該展項可由民眾在面板上任點一處模擬地震發生後，模擬器就會進行推斷震央及預測影響範圍之展演</td><td>地球情報館二樓圖書室
開放給一般民眾閱覽，擺放有關海洋相關書籍，其中一個架上陳列該機構出版之書籍相關資料。</td></tr>
</table>

肆、附錄


JAMSTEC
Towards an integrated understanding
of the Ocean, the Earth and Life
JAMSTEC
独立行政法人
海洋研究開発機構


Message from the President
Towards an integrated understanding of
the Ocean, the Earth and Life


Hiking up Mauna Kea on the Island of Hawaii gives us a spectacular panoramic view of vast volcanic landscape, overlooking many of scoria cones with craters on their top. Far in the distance, you can see a giant shield volcano Mauna Loa looming. The Island of Hawaii, an island in the middle of the Pacific, has been formed by shield volcanoes, one overlapping the other, due to hotspot activities. This island is the unique point of the Earth system where a new interface among the atmosphere, the ocean, and the land is created, and where new life activities begin.
The Earth is the only planet in the solar system where oceans of water exist on its surface. To open the way to a bright future for humans, we need to understand the roles played by the ocean in the Earth system including the "humanosphere", develop new perspectives of the nature and the world, and make the right choices based on these perspectives.
As Japanese islands are located in one of the most geologically-active areas, JAMSTEC, as a Japanese research institute, is responsible for delivering an integrated understanding of the ocean, the Earth, the life, and human activities. Furthermore, we need to promote marine innovation related to marine resource utilization, marine biotechnological progress, and more advanced marine-earth data and information services. Our understanding of the ocean is also the key for success in recovering from the massive 2011 Tohoku earthquake and tsunami, and also in preparing against serious future natural disasters.
Under themes of "the ocean", "the Earth" and "the life", JAMSTEC is committed to promoting the world's most advanced research and technological development projects for Japan, for the world, and for our planet – the Earth.
Asahiko Taira
President
Japan Agency for Marine-Earth Science and Technology
A Taira
JAMSTEC

Towards an integrated understanding of the Ocean, the Earth and Life

Research and development of submarine resources

Exploring untapped submarine resources

For Japan's economy, and also for the future of the human race, it is important to harness the submarine resources as yet untapped in Japan's vast territorial waters and Exclusive Economic Zone (EEZ). However, how these resources were formed and their exact distribution remains a mystery. At JAMSTEC, we aim at contributing to utilization of submarine resources through leading-edge exploration and research with our considerable experience and accumulated technologies. Specifically, We research the origin of sea-floor hydrothermal deposits, cobalt-rich crust, deep-sea mud rich in rare earths and yttrium (REY-rich mud) and methane hydrate, and develop efficient survey techniques and environmental assessment methodologies.

- Researching the origin of sea-floor hydrothermal deposits, and developing techniques to survey it
- Researching the origin of cobalt-rich crust and REY-rich mud, and developing techniques contributing to discovery of high quality ores
- Researching the origin of seabed hydrocarbon resources, and developing the continuous carbon energy cycle
- Development of methodologies to assess environmental impacts

Sulfide ores rich in metal components harvested from artificial hydrothermal vents

Artificial hydrothermal vents are man-made jet holes in active deep-sea hydrothermal vent environments, the aim of which is to continuously observe changes in the hydrothermal fluid venting patterns, and the chemical compositions of the delivered hydrothermal fluid.

Hydrothermal fluid venting through the seabed

Hydrothermal fluid venting exists in places where there is submarine volcanic activity. The hydrothermal fluids interact with the crust they pass through and become enriched in metals. When the submarine hydrothermal fluids are quenched by surrounding seawater, the metals precipitate as sulfides, forming sea-floor hydrothermal deposits. These deposits include metals such as copper, lead, and zinc, as well as rare metals such as gold, silver and minor metals, and are expected to become an important resource of these economically valuable metals in the future.

Submarine Resources

Submarine mud volcanoes
A submarine mud volcano is formed when highly viscous mud wells up from deep below the surface, and erupts into the seabed.
Methane hydrate was collected in the first mud volcano drilling around Japan.

Methane hydrate sampling off Joetsu

Methanogenic archaea collected from beneath the ocean floor
Methanogenic archaea are thought to be the main producers of microbial origin hydrocarbon resources (methane).

REY-rich mud expected to be utilized as a resource

Ferromanganese crust sampling
Ferromanganese crust contains many kinds of minor metals. Crust containing a large amount of cobalt is referred to as cobalt-rich crust.

Distribution of submarine recourses around Japan

Hydrothermal vents · Ferromanganese crust *1 · Methane hydrate *1,2 · Mud volcanoes · REY-rich mud

JAMSTEC

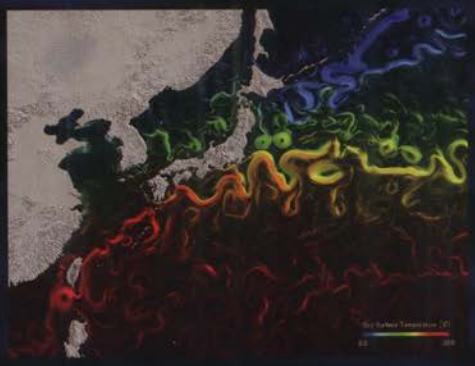
Towards an integrated understanding of the Ocean, the Earth and Life

Research and development on marine and global environmental change

Detecting signals of global environmental change

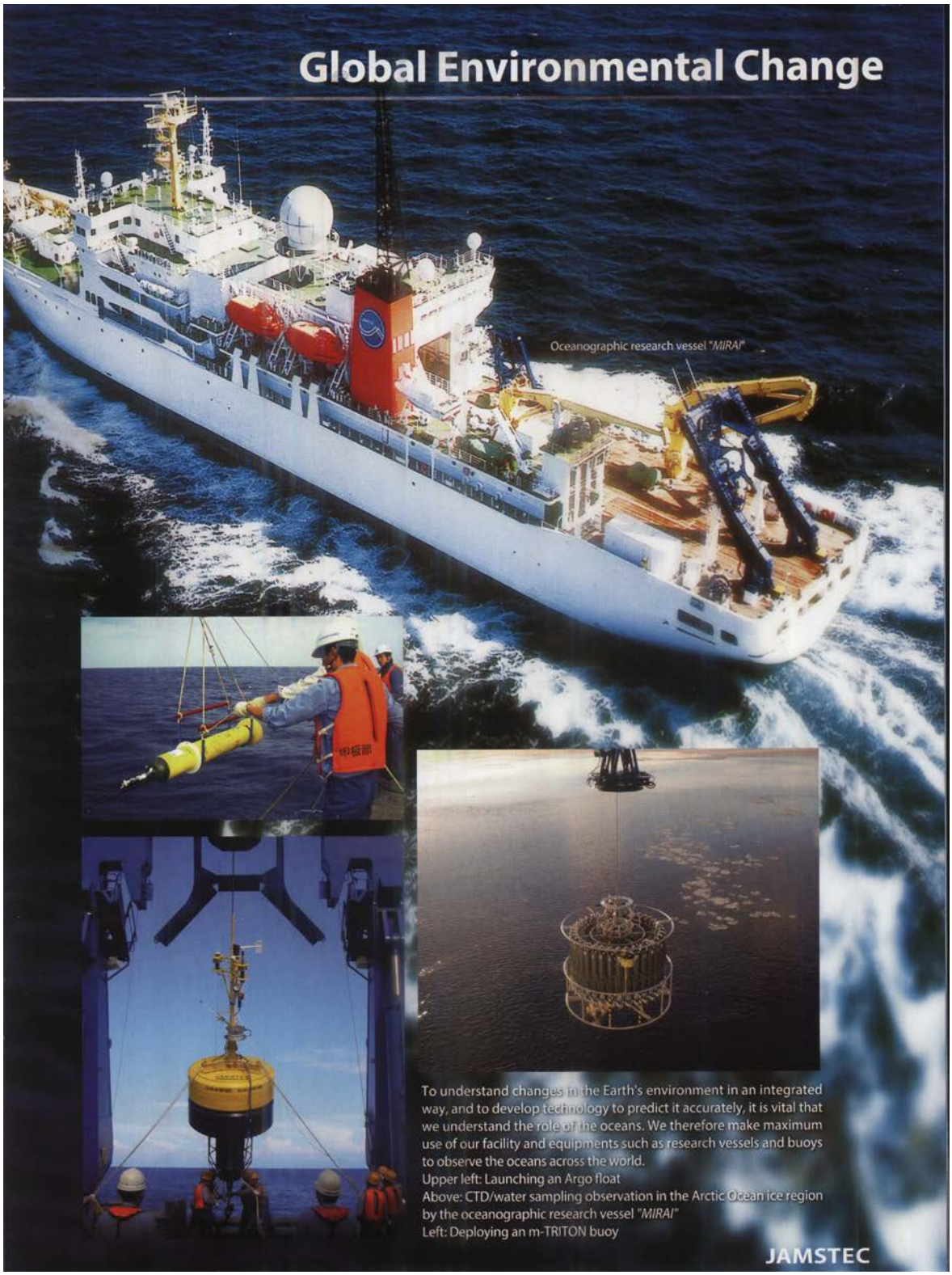
Exchange of energy and elements between the ocean and atmosphere, between the sea and land, and between the tropical and the polar regions, has a major impact not only on short-term weather and climate variations, but also on long-term global environmental change, such as global warming. At JAMSTEC, we are pursuing observation-driven technical development in order to understand this process and actual conditions in an integrated way, and to make accurate predictions of global environmental change. By capturing global changes such as global warming and ocean acidification due to increased CO_2 levels in the atmosphere, their impact on the ecosystem, and changes in thermal and element distribution patterns accurately, we contribute to planning of adaptation plans, and disseminate information to the public to make it useful for disaster prevention and mitigation.

- Observational research for understanding and predicting global environment change
- Research on environmental geochemical cycles
- More advanced prediction of global environmental change based on observational research, and its application



At JAMSTEC, we are developing a numerical simulation model to predict global environmental change accurately.
Upper left: Ocean currents around Japan calculated by the ocean general circulation model OFES
Upper right: We are improving prediction reliability by a more advanced version of the "Nonhydrostatic ICosahedral Atmospheric Model (NICAM)", in order to develop a seamless environmental prediction system that will allow us to make practically useful predictions.

In order to understand the global environment, we need to unlock the secrets of the geochemical cycle, for example, CO_2 which is exchanged among the oceans, the atmosphere and terrestrial ecosystems. JAMSTEC has built research towers for continuous in situ observation to understand the exchange of CO_2 and water vapor between the atmosphere and the land surface, and the role of the ecosystem.
Left: A black spruce forest in Alaska covered by snow, and a research tower built in it


Global Environmental Change
Oceanographic research vessel "MIRAI"
To understand changes in the Earth's environment in an integrated way, and to develop technology to predict it accurately, it is vital that we understand the role of the oceans. We therefore make maximum use of our facility and equipments such as research vessels and buoys to observe the oceans across the world.
Upper left: Launching an Argo float
Above: CTD/water sampling observation in the Arctic Ocean ice region by the oceanographic research vessel "MIRAI"
Left: Deploying an m-TRITON buoy
JAMSTEC

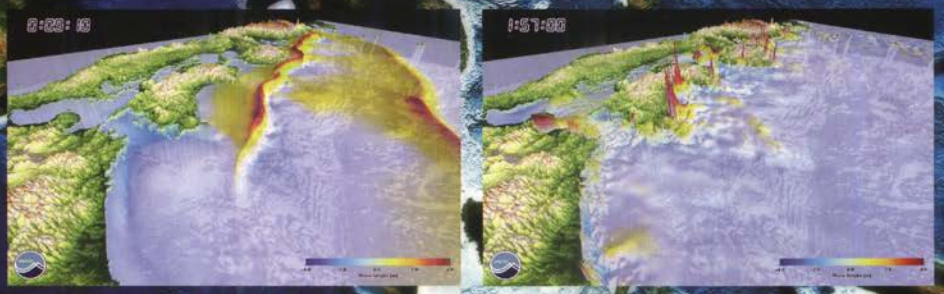
Towards an integrated understanding of the Ocean, the Earth and Life

Research and development on seismogenic zones

Understanding seismogenic zones, and contributing to disaster mitigation

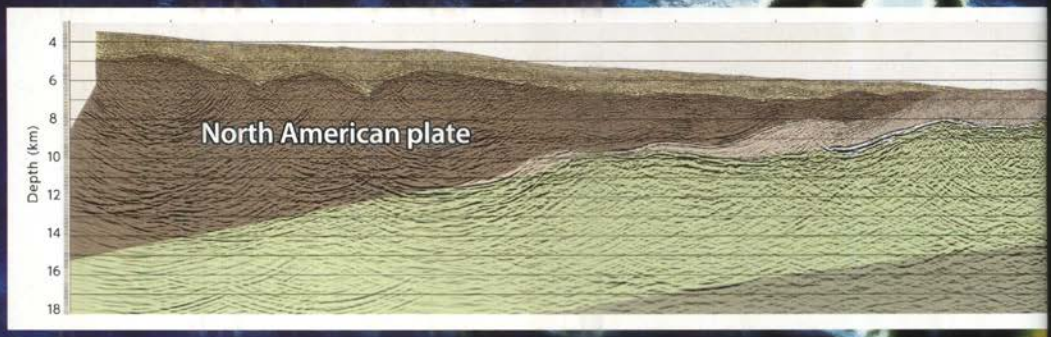
In recent years, many disasters due to earthquake and tsunami occurred in various countries across the world including Japan. At JAMSTEC, we work to clarify the nature of earthquake and tsunami, making full use of state-of-the-art marine observation technologies and advanced simulation and monitoring research, and provide the observed data and the research results to the society for contributing to disaster mitigation. We also accumulate scientific knowledge about the impacts of earthquake and tsunami on the marine ecosystem and its recovery process to make a contribution to disaster recovery.

- Investigation into the seismogenic zones around the plate boundary regions
- Comprehensive disaster potential evaluation of earthquakes and tsunamis
- Study of the damage to the ecosystem by earthquakes and tsunamis and its recovery

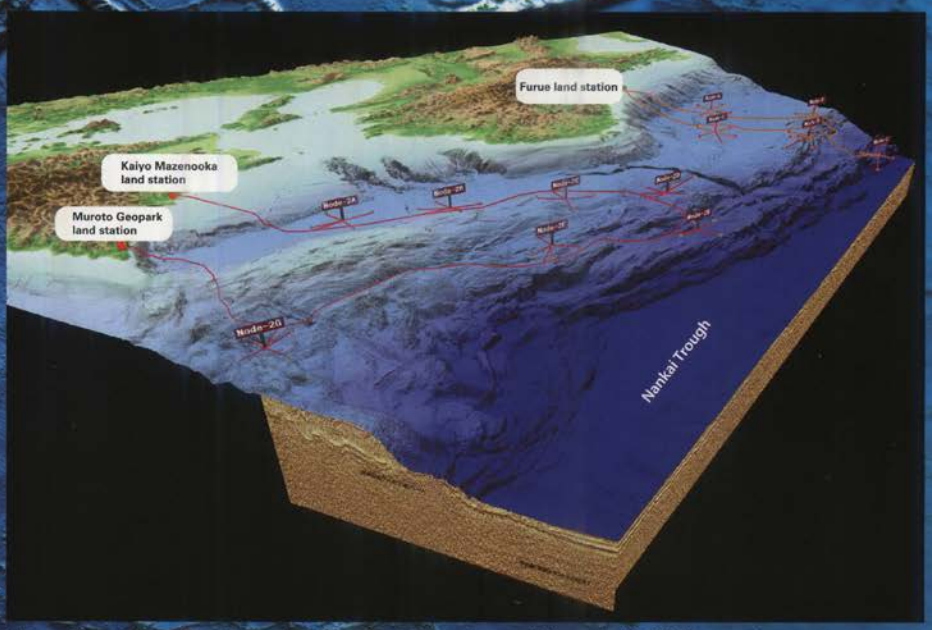


Simulation of a tsunami caused by a hypothetical massive earthquake around the Nankai Trough

We make a contribution to disaster mitigation through reality-based simulations of earthquakes and tsunamis and disaster potential evaluation.



Seismogenic Zones



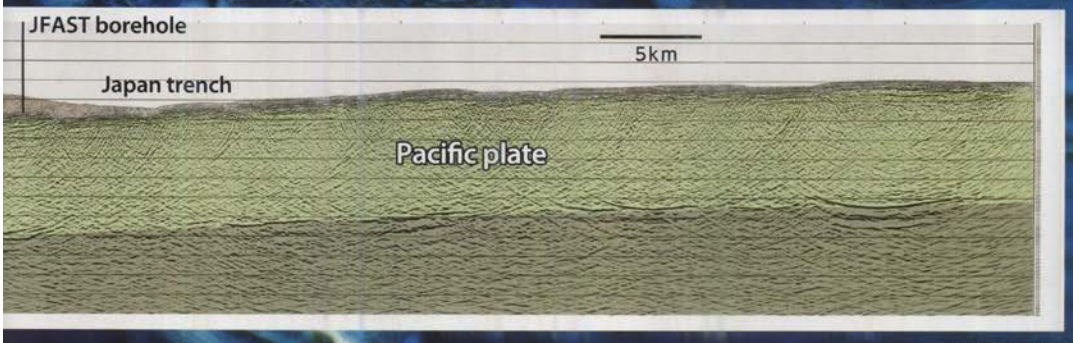
Above: Dense Oceanfloor Network System for Earthquakes and Tsunamis (DONET)

DONET has been deployed on the seabed from off Kii Peninsula to off Shikoku to monitor the expected fault zones of the Tonankai and Nankai earthquakes in real time. We carry out system development and maintenance, operation, and data analysis of earthquake, tsunami and crustal change.

Preparing to install ocean bottom seismographs

Below: Seismic reflection image of the rupture zones of the 2011 Tohoku Earthquake (Based on the figure in Nakamura et al. submitted)

In this figure, boundaries of geological layers and faults are imaged.
It is shown that the Pacific plate (oceanic plate) is sinking beneath the North American plate with keeping its undulated structure and the upper part of the North American plate (continental plate) was deformed by small-scale normal faults.
The survey line passes through very close to the drilling site of the Japan Trench Fast Drilling Project (JFAST) conducted in 2012 by *CHIKYU* and this survey data provide important information for understanding of the drilling results and integrating data obtained by the drilling and the seismic reflection survey.



JAMSTEC

Towards an integrated understanding of the Ocean, the Earth and Life

Research and development on marine biosciences and engineering

Exploring the unknown extreme biosphere to solve the mystery of life

The waters surrounding Japan are one of a few hot spots of biodiversity in the world. The deep ocean is still a frontier full of unsolved mysteries. At JAMSTEC, using *SHINKAI 6500* and Remotely Operated Vehicles to investigate extreme environment biospheres beneath the deep ocean floor or seabed, we carry out research and development for understanding the structure of the ecosystem and its evolution.
Organisms living in extreme environment biospheres have a tolerance for high pressure and low temperatures. It is expected that mankind will be able to exploit their useful functions and genes. JAMSTEC is also doing applied research to create innovations that will utilize the functions peculiar to marine organisms living in this extreme environment.

- Analyzing marine ecosystem functions
- Exploring extreme environment biosphere functions, revealing their functions and its application

Discovery of the unique ecology of a deep-sea amphipod from the Mariana Trench, the deepest ocean area in the world, and discovery of new cellulose

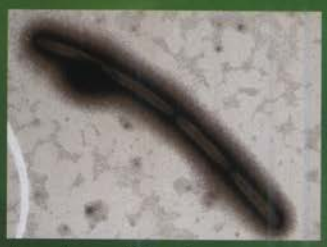
Above is the result of dripping digestive enzymes extracted from *Hirondellea gigas* onto various substrates, and reacting them at room temperature. The substrates contain blue or red pigments. When there is enzyme activity, the substrate is decomposed and the periphery turns white from the margin, which shows high enzyme activity.

In order to understand the mechanism giving rise to the diversity of marine organisms, and how the ocean biosphere and oxygen-deficient environment were formed, we perform various studies on this ecosystem of unique marine organisms, their evolutionary processes, and their diverse structures and functions.

A species of *Osedax*

From "QUELLE 2013", the around-the-world voyage of the

Extreme Biosphere

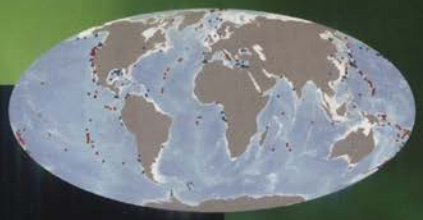


Hyperthermophilic methanogen isolated from Kairei field in the Indian Ocean that can grow at high temperature at 122°C

Thermococcales isolated from Kairei field in the Indian Ocean

Many of extremophiles, such as thermophilic bacteria and halophilic bacteria, belong to the genus *Archae*. Some bacteria are also thermophilic, but many of the hyperthermophilic bacteria that live under elevated temperatures over 90° C are archaebacteria.

A hydrothermal vent being crowded with *Shinkaia crosnieri*



Distribution of chemosynthetic ecosystems discovered so far Sites of hydrothermal vents (red dots) and cold seeps (blue dots) (modified ChEss/CoML data)

We are exploring as yet uncharted extreme biospheres, gaining new knowledge about the structure of microbial ecosystems, various symbiotic systems, and the evolution of life. We also do research on the functions of and techniques for extracting useful enzymes produced by marine organisms, and putting useful new substances from living things into practical use.

Many creatures like scaly-foot gastropods inhabit Kairei Field of the Indian Ocean.

Cow shark

Although they play an important role in maintaining the whole ecosystem, knowledge of the top predators in the deep ocean is very limited. We are attempting to understand the diversity and ecology of the top predators in deep-sea regions to draw a new picture of the ocean ecosystem.

JAMSTEC

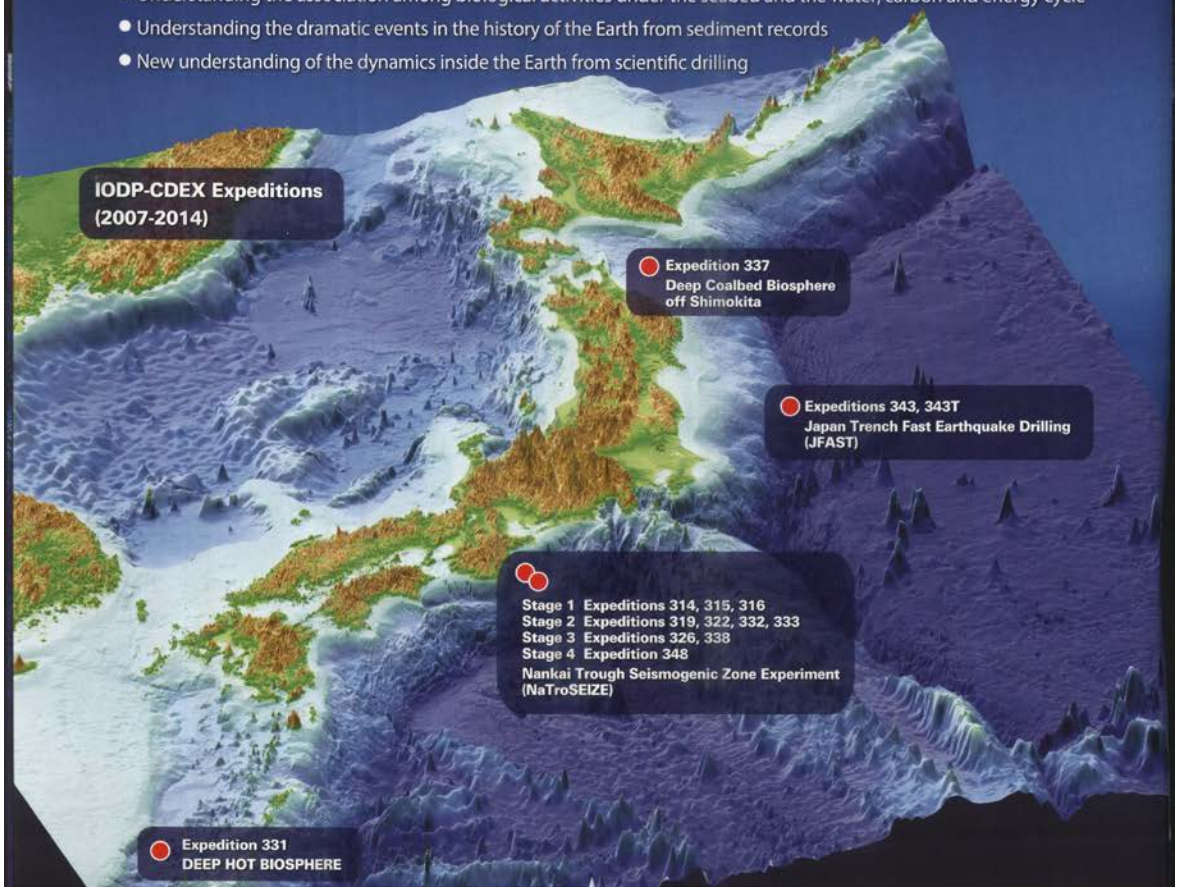
Towards an integrated understanding of the Ocean, the Earth and Life

Promotion of comprehensive ocean drilling science

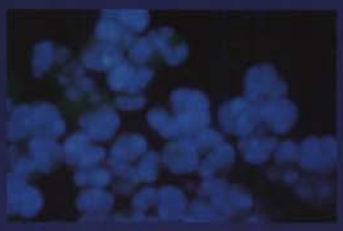
Getting to know the Earth from beneath the seabed

The deep-sea drilling vessel "CHIKYU" has enabled us to gain fresh knowledge about the behavior of the plates, the biosphere beneath the seabed, and the Earth's history, and new research objectives have now emerged. To answer these newly arisen scientific questions, we are promoting the international project called International Ocean Discovery Program (IODP). We also perform direct extraction and analysis on the substances forming the Earth's interior, conduct borehole observations, and attempted to build an earth internal dynamics model by linking the ocean, the Earth and life by means of numerical analysis and modeling techniques. This kind of research and development are opening up new possibilities in scientific drilling.
Contributing to the development of ultra-deep drilling techniques, based on the experience obtained so far, is also important.

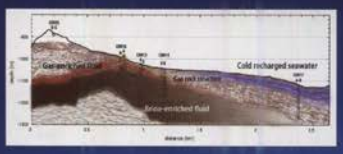
- Understanding the dynamics of crustal activity and the geochemical cycle using core samples and boreholes
- Understanding the evolution of oceanic/continental plates and magma, and their transition process
- Understanding the association among biological activities under the seabed and the water, carbon and energy cycle
- Understanding the dramatic events in the history of the Earth from sediment records
- New understanding of the dynamics inside the Earth from scientific drilling



Deep-sea Drilling

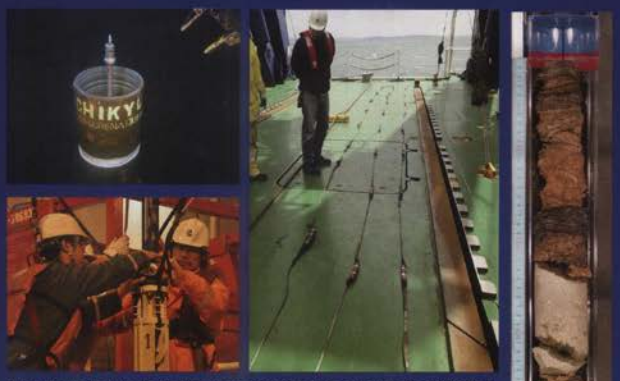


Methanogenic archaea separated and cultured from under the seabed off Shimokita, Aomori Prefecture.



Through the drilling in Okinawa hydrothermal sea bottom life zone, a huge sub-seafloor hydrothermal fluid reservoir was discovered.

Spanning about 4 billion years since the birth and evolution of life and the Earth, the water, carbon and energy cycle is considered to have taken an important role in the birth of life and its early stage of evolution.
Moreover, the water, carbon and energy cycle under the seabed may be linked with the ecosystem on the Earth's surface or the subsurface by plate motion or mantle convection. We therefore promote research on the relationship between the environment under the seabed and the biological activities, and the evolution of microorganisms beneath the seabed, using core samples.



Long-term borehole thermometer installed in a borehole drilled by "*CHIKYU*" in the Japan Trench Fast Drilling Project (right), and its installation and its recovery (two photos on the left)

A sample of plate boundary fault in the Japan Deep extracted by "*CHIKYU*" in the Japan Trench Fast Drilling Project (right)

From the data obtained by seabed observation and wide-area geophysical surveys, and from data obtained in boreholes, we can visualize the detailed, 3-dimensional structure and materials underneath the seabed, and enhance a better understanding of changes occurring in them. We also design high accuracy, high-resolution techniques to analyze samples and data of different scales, do research and development on the latest drilling technology and measurement techniques, conduct technology development for drilling at great depths, and carry out research and development related to processes and transitions such as crustal movements and the geochemical cycle by means of numerical simulations.

Deep-sea drilling vessel "*CHIKYU*"

JAMSTEC

Towards an integrated understanding of the Ocean, the Earth and Life

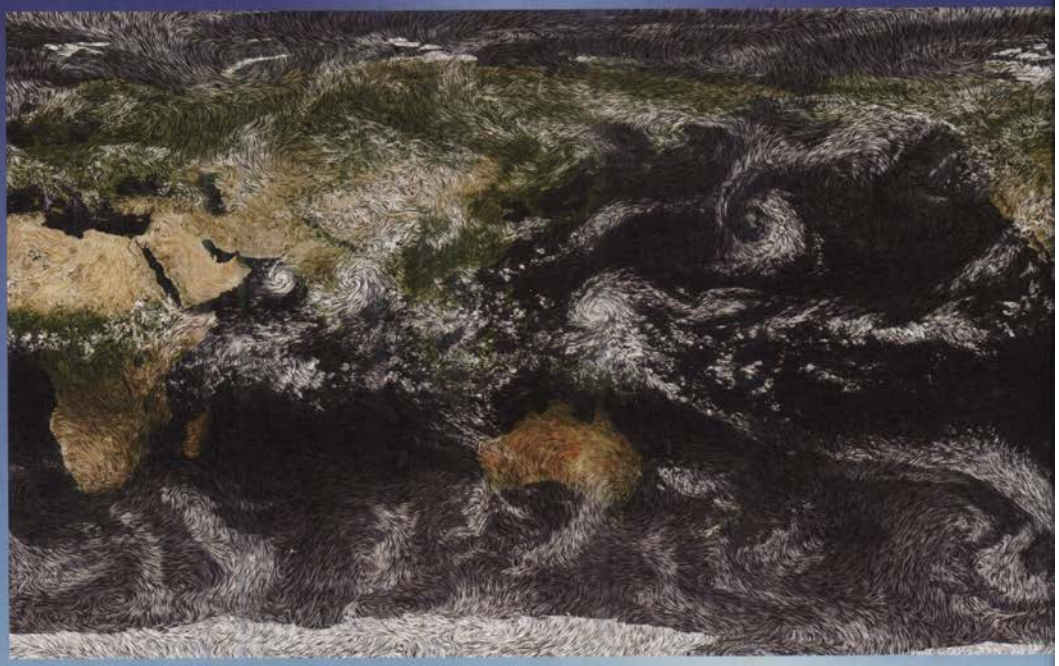
Research and development on advanced synthetic information science

Predicting the Earth's future by simulations

Earth Simulator

Simulation science and technology is a vital technological resource to ensure people's safety and reassurance. We therefore make maximum use of the "Earth Simulator", and also apprehend the obtained knowledge in a cross-cutting perspective. We target to draw actions and resolutions for the future and promote advanced synthetic information science in marine earth science.
Moreover, to synthesize observational data and simulated prediction data, and to create value-added information which can be utilized by society, we perform research and development required for products for operational use, including data assimilation techniques. In order to return this information to society widely and effectively in a comprehensible fashion, we are enhancing construction of infrastructure of the global environmental information.

- Research and development on advanced process models
- Designing high performance computing simulation technology to obtain cutting-edge information
- Total integrated research and development on data and information, and its transmission to society



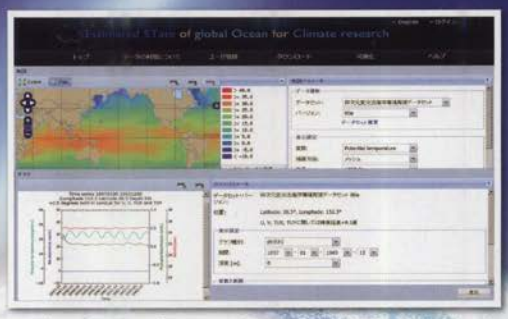
Clouds (deep white) and low-level motions in the atmosphere (thin white lines) on 1st June, 2004, reproduced by NICAM

To develop models required for marine and earth science, and generate climate change and environmental predictions which are useful for public service, we promote large-scale numerical simulation techniques, making use of observational data and models.

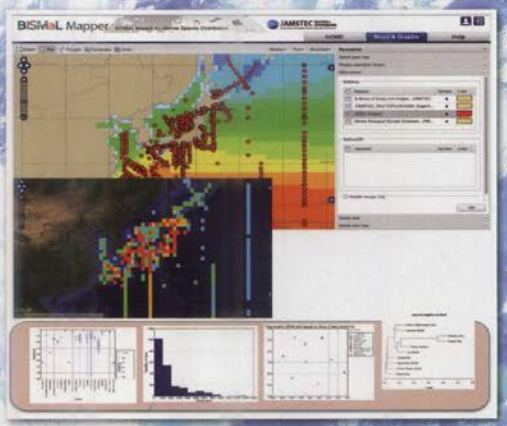
Information Science

We promote development of highly advanced mathematical and physical models and simulation techniques to understand processes on various scales, and make accurate predictions of various phenomena. The figure above is a simulation of the seismic wave which propagated across the globe excited by the 2011 Tohoku Earthquake.

Above is a simulation of wind currents and air temperature near Tokyo Station using the MSSG model developed by JAMSTEC.



On the webpage of "Estimated State of Global Ocean for Climate Research (ESTOC)", the data set for reproducing marine environment using a 4D-variational method is open to the public, which is used for climate change research.



BISMaL, "Biological Information System for Marine Life" is a data system for handling information about marine biodiversity, in particular biogeographic data. The aim is to collect and provide information mainly on marine life around Japan, and to contribute to an understanding of its diversity.

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Towards an integrated understanding of the Ocean, the Earth and Life

Construction of a research and development base for opening up ocean frontiers

Opening up the future by technological development

Technology for the basis of national existence, and technology required for a total understanding of the vast ocean, are being developed from the aspects of both hardware and software. In order to promote this, we are developing fundamental technology to build an innovative research infrastructure for opening up unexplored domains, and doing basic research and development which would be instrumental to build new systems.

- Research and development on advanced ocean technology
- Developing a highly accurate and highly efficient observation system
- More advanced, higher efficiency operation technology

To more efficiently and effectively promote observation, exploration and survey, we are improving the functionality of the Autonomous Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs), developing more sophisticated application techniques, and carrying out high-tech research and development at the same time. We are also engaged in the efficient construction of seafloor cable networks using these vehicles, and development of their operation and maintenance technology, as well as establishment of more sophisticated basic techniques for efficiently operating integrated survey and observation systems using underwater gliders and new profiling floats.


Technological Development
Tsunami-Observation Buoy
Research Vessel
ROV
Electromagnetic Survey System
Full-Depth Manned Submersible
(1)
(2)
(3)
(4)
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(7)
Satellite "KIZUNA"
Antenna
Research Vessel KAIYO
Land station
Autonomous Underwater Vehicle OTOHIME
(1) Developing autonomous underwater vehicles (AUVs)
(2) New fuel cell systems for operation in the sea
(3) Application technology for manned research submersibles
(4) Acquisition of submarine surface 3D data by underwater laser scanning
(5) Development of underwater gliders
(6) DONET system installation by remotely operated vehicles (ROVs)
(7) Remote control technology of ROVs from land using a super high-speed Internet satellite
JAMSTEC

Towards an integrated understanding of the Ocean, the Earth and Life

Research Facilities

Deep Sea Drilling Vessel *CHIKYU*

Joining JAMSTEC's fleet in July 2005, the deep-sea drilling vessel *CHIKYU* has the most advanced drilling capabilities in the world (10,000m from the sea surface, and 7,500m below the seafloor where the water depth is 2,500m if the Riser Drilling system is used). *CHIKYU* allows us to drill down to the mantle where we human-beings have not reached yet, and into the seismogenic zones. Acting as the principal vessel of the International Ocean Discovery Program (IODP), the main objective of *CHIKYU* is to facilitate a wide range of activities that will contribute to our future. Success of these activities may lead us to reveal the mechanisms causing massive earthquakes, discover the origin of life, predict the environmental change on our planet, and find new submarine resources.

Length:	210 m
Beam:	38 m
Height from hull:	130 m
Complement:	200 persons
Gross tonnage:	56,752 tons
Maximum drilling depth:	2,500 m
Length of drill strings:	10,000 m
Commissioned:	2005

Manned Research Submersible *SHINKAI 6500*

SHINKAI 6500 is a manned submersible that can dive to depths of 6,500 meters. *SHINKAI 6500* is among the deepest diving manned submersible in operation for scientific purposes. The number of dives has reached 1390 since she started her missions in 1991. *SHINKAI 6500* has dived not only in the seas around Japan, but also in the Pacific, Atlantic and Indian Oceans.

Depth capability:	6,500 m
Complement:	3 persons
Length:	9.5 m
Weight in the air:	26.7 tons
Pressure hull diameter:	2.0 m
Normal dive duration:	8 hours
Life support duration:	129 hours
Payload:	150 kg (in air)


Research Vessel
NATSUSHIMA
Length: 67.3 m
Gross tonnage: 1,739 tons
Complement: 55 persons
Commissioned: 1981
Remotely Operated Vehicle (ROV)
KAIKO
Depth capability: (launcher)11,000 m
: (vehicle Mk-IV)7,000 m
Length/ Weight in the air
: (launcher)5.2 m/5.8 tons
: (vehicle Mk-IV)3.0 m/5.5 tons
Research Vessel
KAIYO
Length: 61.5 m
Gross tonnage: 3,350 tons
Complement: 60 persons
Commissioned: 1985
Remotely Operated Vehicle (ROV)
HYPER-DOLPHIN
Depth capability: 3,000 m
Length: 3.0 m
Weight in the air: 4.3 tons
Support Vessel
YOKOSUKA
Length: 105.2 m
Gross tonnage: 4,439 tons
Complement: 60 persons
Commissioned: 1990
Autonomous Underwater Vehicle (AUV)
URASHIMA
Depth capability: 3,500 m
Length: 10.0 m
Weight in the air: 7.0 tons
Deep Sea Research Vessel
KAIREI
Length: 106.0 m
Gross tonnage: 4,517 tons
Complement: 60 persons
Commissioned: 1997
Autonomous Underwater Vehicle (AUV)
JINBEI
Depth capability: 3,000 m
Length: 4.0 m
Weight in the air: 1.7 tons
Oceanographic Research Vessel
MIRAI
Length: 128.5 m
Gross tonnage: 8,706 tons
Complement: 80 persons
Commissioned: 1997
Autonomous Underwater Vehicle (AUV)
OTOHIME
Depth capability: 3,000 m
Length: 2.5 m
Weight in the air: 0.85 tons
Research Vessel
HAKUHO MARU
Length: 100 m
Gross tonnage: 3,991 tons
Complement: 89 persons
Commissioned: 1990
Autonomous Underwater Vehicle (AUV)
YUMEIRUKA
Depth capability: 3,000 m
Length: 5.0 m
Weight in the air: 2.7 tons
Research Vessel
SHINSEI MARU
Length: 66 m
Gross tonnage: 1,629 tons
Complement: 41 persons
Commissioned: 2013
Remotely Operated Vehicle (ROV)
ABISMO
Depth capability : 11,000 m
Length/ Weight in the air
: (launcher) 2.7 m/3.0 tons
: (vehicle) 1.3 m/0.35 tons
Earth Simulator
(Yokohama Institute for Earth Sciences)
Number of processors: 1280
Number of nodes: 160
Peak performance: 131 teraflops
Main memory capacity: 20 terabytes
Core Repository
(Kochi Institute for Core Sample Research)
JAMSTEC

Institutes and Offices

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Global Oceanographic Data Center (GODAC)
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JAMSTEC
Japan Agency for Marine-Earth Science and Technology

SHINKAI
しんかい
6500

有人潜水調査船「しんかい6500」

「しんかい6500」は、6,500mの深さまで潜る事が出来る世界有数の有人潜水調査船で、1989年に完成しました。その活動範囲は日本近海だけでなく、太平洋やインド洋、遠くは大西洋にまで及び、これまでに延べ1380回を越える潜航を行ってきました。そして、「しんかい6500」は、日本のみならず世界の深海調査研究の中核を担う重要な役割を果たしています。2012年3月、「しんかい6500」は、建造以来最大となる改造を終えました。船尾の主推進装置を、旋回式大型1台から固定式中型2台に変更し、また水平スラスタを後部に1台増設して回頭性能を向上させました。また、全てのプロペラのモーターをよりレスポンスの良いものに換装し、加速・制動性能も向上させました。

人を乗せて六、五〇〇mのフロンティアを探る

「しんかい6500」の支援母船「よこすか」

「しんかい6500」が光をあてた深海底の世界


大西洋中央海嶺の熱水マウンドに群がるエビ


伊豆・小笠原海域で発見した鯨骨


東北地方太平洋沖地震震源海域で発見した亀裂


熱水チムニー　東太平洋海膨

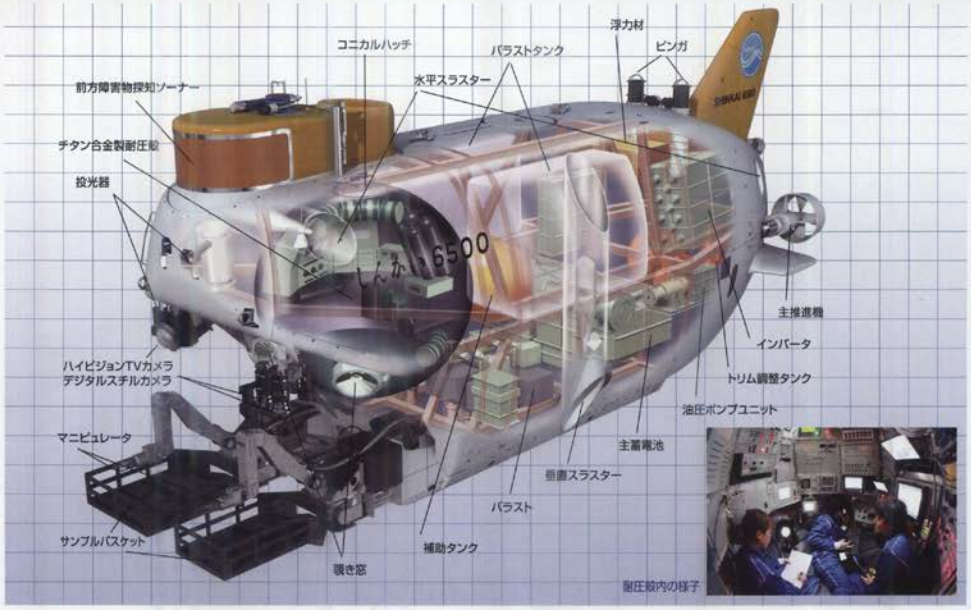

インド洋中央海嶺熱水チムニーと生物群集


枕状溶岩　東太平洋海膨

水深6,500mの脅威の世界に挑む
最先端技術の結晶。

巨大地震を発生させる6,200m～6,500mの地質構造を調べることができるようにつくられた「しんかい6500」にはさまざまな最新技術が取り入れられています。水深6,500mでは1cm²あたり約680kgという水圧がかかるので、人が乗る耐圧殻はチタン合金を使って、高い水圧に耐える強度を持っています。また、カラー画像を音波を使って母船に送る音響画像伝送装置など、最新の技術を使って、さまざまな研究に取り組んでいます。

しんかい 6500



水中音響技術

地上での通信などには電波が使われていますが、水中では電波がとどかないので、音波を使います。音波を使って周りの地形や自分の位置を確かめたり、電話をしたりすることができます。また、画像をデジタル処理した通信技術でカラー画像を送ることにも成功しました。これらの技術を使って、さまざまな調査や研究がなされています。

潜ってから浮くまで

「しんかい6500」の通常潜航時間は8時間です。水深6,500mの潜航では、行き帰りにかかる時間はそれぞれ2時間半です。ですから、実際に海底で調査ができる時間は3時間ほどになってしまいます（浅い場所では調査時間が長くなります）。朝、潜航を開始し、海底についたら調査をして、夕方までに浮上してきます。夜間は翌日の調査に備えて電池の充電などを行います。

主要目							搭載機器
	全長	9.7m	最大潜航深度	6,500m	通常潜航時間	8時間	・ハイビジョンテレビカメラ(2台)
	幅	2.8m	乗員数	3名	ライフサポート時間	129時間	・塩分、水温、圧力計、溶存酸素の測定器
	高さ	4.1m		（パイロット2名／研究者1名）	ペイロード	150kg(空中重量)	・デジタルカメラ(1台)
	空中重量	26.7トン	耐圧殻内径	φ2.0m	最大速力	2.7ノット	・マニピュレータ(7関節2台)
							・可動式サンプルバスケット(2台)
							・その他航海装置等

深海巡航探査機「うらしま」

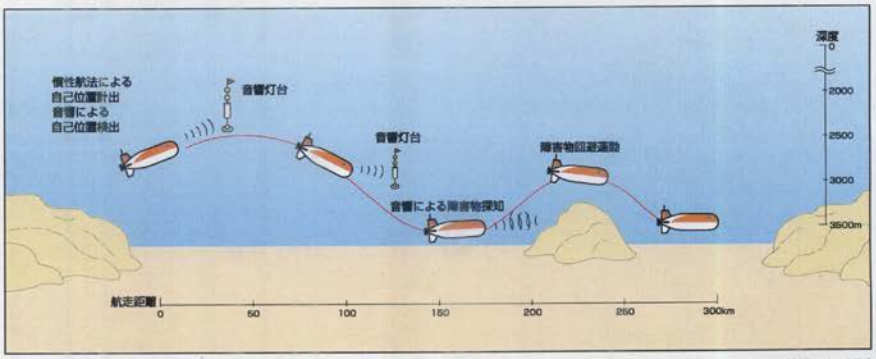
ミッションに従い自ら位置を計算して航行する海洋探査ロボット

「うらしま」は大きな機体を活かし、多くの調査観測機器を搭載することができます。また、プログラムされた調査測線に沿って制御することができる、海底調査の自由度が非常に高い自律航行型の海洋探査ロボットです。海底地形・地質調査や、近年では熱水鉱床等の海底資源調査での活躍も期待されています。

（写真：図1うらしま）

「うらしま」の調査潜航

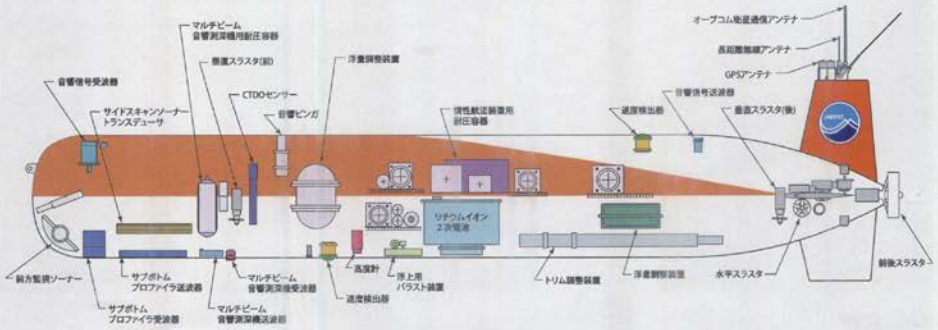
「うらしま」は、より海底に近い場所の調査を行うことで、高解像度の海底地形や海底下構造のデータを取得することが可能です。プログラムされた調査測線に沿って運動を制御できるため、同一地点の調査や広い範囲を往復させる調査なども行います。



（図2　うらしまの航行のしくみ）

自律航行によって、より効率良く、広い範囲の海底地形や海底下のデータ取得が可能

「うらしま」は全長10mの大きな機体を活かし、観測機器をたくさん載せることができるため、研究者からの様々な要望に応えることができます。また、安定した姿勢で航行できるため、高解像度の海底面の地形観測や海底下の地層構造の観測を得意としています。



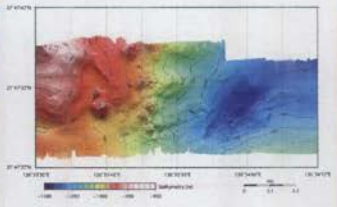
主要目

最大潜航深度	3500 m
航続距離	約30 km 日中(日出から日没まで)
水中速力(最大)	3ノット(1ノット=1.852km/時)
空中重量	7t

「うらしま」の主な観測機器

地形地質・海底資源調査には欠かせないサイドスキャンソーナーやマルチビーム測深機などの調査機器を常備しており、慣性航法装置により自律航行し、観測を行っています。その他にも、大型の機体を活かして、様々な観測機器を搭載することができます。

慣性航法装置
宇宙ロケットにも使われているシステムを改良してつくられた慣性航法装置。1時間まっすぐ進んでも目標から0.025度の誤差という精度を持っています。



マルチビーム測深機(Multi-Beam Echo Sounder:MBES)
海底地形のデータを数値として取得するマルチビーム測深機(MBES)を常備しています。400khZの高い周波数の音波を使用して海底面近くで探査を行うため、水上船舶からのMBES探査に比べ、より高い精度の海底地形を得ることができます。

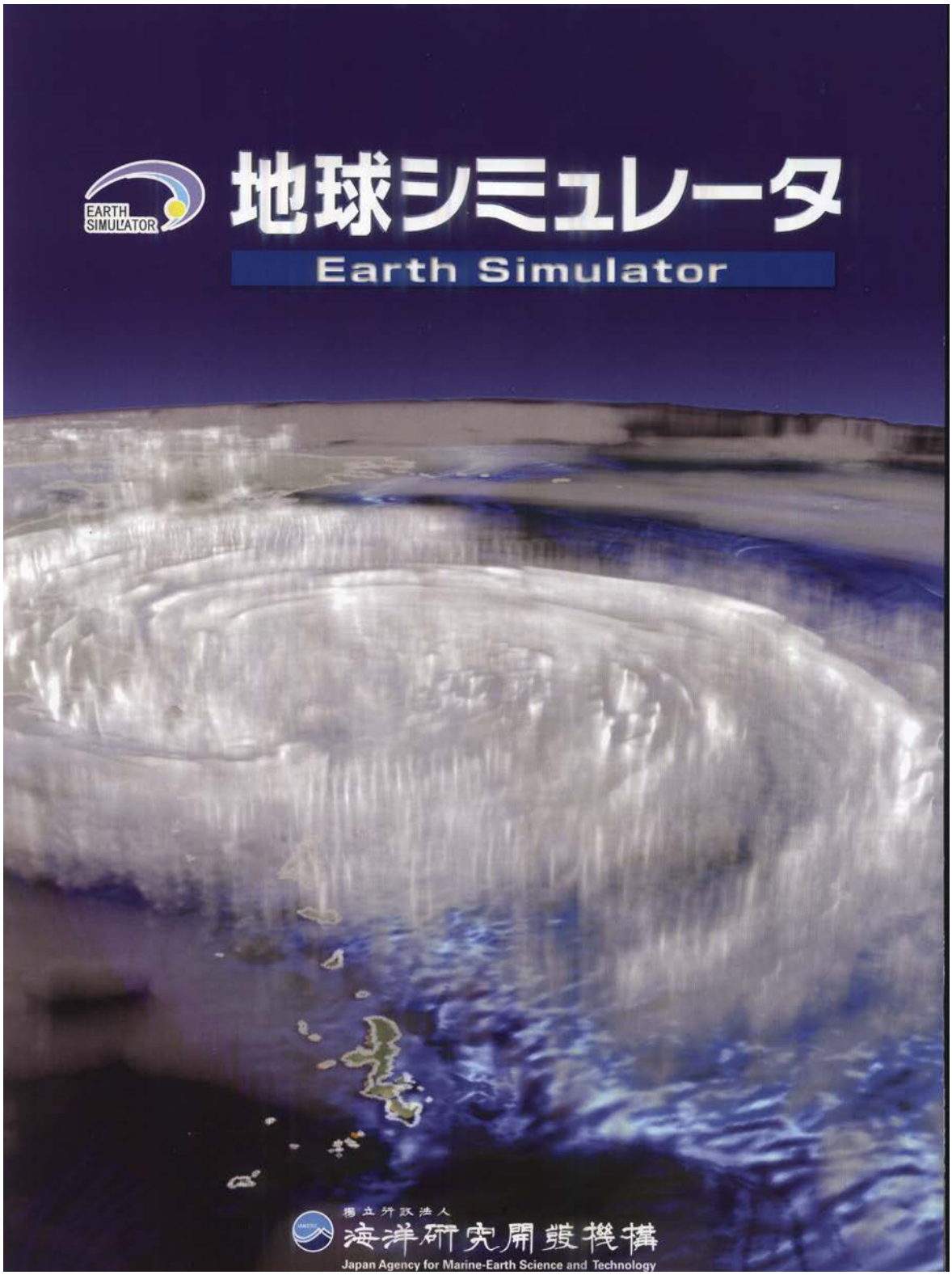
サイドスキャンソーナー
船の下ではなく横に音波を照射して、海底の凹凸から反射して帰ってきた信号を画像にする装置。写真は探査で明らかになった泥火山の表面です。

経緯

2000年	深海巡航探査機「うらしま」完成。駿河湾水深1753mに潜航し、自律型無人探査機として世界最深記録を更新。
2003年	燃料電池搭載の無人探査機として、世界で初めて水深300mの潜航に成功。最大潜航深度1,507m、連続航続距離30ｋｍ、潜航時間７時間を記録。

主要諸元

全長	10m
幅	1.3m
全高	1.5m
空中重量	7.0 トン


EARTH SIMULATOR
地球シミュレータ
Earth Simulator
独立行政法人
海洋研究開発機構
Japan Agency for Marine-Earth Science and Technology

地球シミュレータの概要
Outline of the Earth Simulator

地球シミュレータは 2002 年 3 月に、地球温暖化を始めとする気候変動の解析・将来予測、地震や地球内部変動の解明等、世界に類を見ない「人類的課題に挑戦できる世界最速のスーパーコンピュータ」として運用を開始しました。

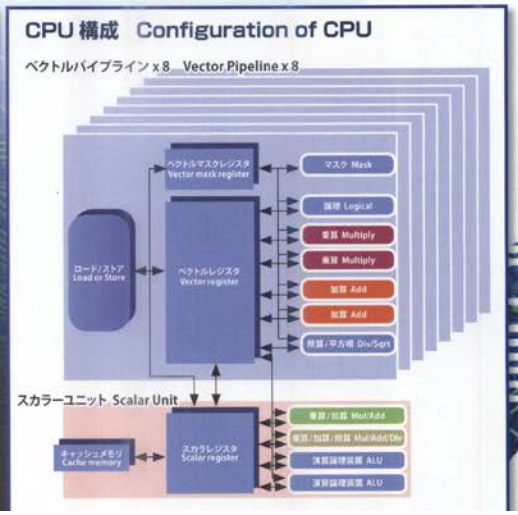
特に気候変動研究分野では、文部科学省の事業である「人・自然・地球共生プロジェクト」と、それに続く「21 世紀気候変動予測革新プログラム」向けの高解像度地球温暖化予測モデルの開発・温暖化予測実験に広く利用され、IPCC 第 4 次報告書作成に大きく貢献しました。また、その高い計算能力は、材料開発、輸送機器改良、ディバイス開発、そして医薬品開発など、最先端の産業分野にまで広がり、従来のシミュレーション研究では到達出来なかったレベルの成果が発表されました。

地球シミュレータは、運用開始後2年半もの間、リンパックというベンチマークテストで世界最速のコンピュータでしたが、スーパーコンピュータは、その性能が 10 年間で 100 倍に達するとも言われるほど日進月歩の世界であり、また利用者からの膨大な演算処理要求によってフル稼働している状況が常に続いていました。そこで、更なる性能向上を計るため、2009 年 3 月に新システムへの更新を行い、3.2 倍の計算能力向上、使用電力量の約 3 割低減に成功しました。

これからも地球シミュレータを使い、より信頼のおける、より実用にかなった未来予測が可能なシミュレーション技術を世界に先駆けて開発し、安全・安心な社会の実現と、人類の持続的な豊かさに貢献していきたいと考えています。

■ ハードウェア仕様 Hardware Specifications

		地球シミュレータ Earth Simulator
CPU	クロック Clock	3.2GHz
	ベクトル性能 Peak performance of each CPU	102.4GF
	メモリ転送性能 Memory bandwidth	256GB/s
Node	CPU 数 Number of CPU for each node	8
	ベクトル性能 Peak performance of each node	819.2GF
	メモリ容量 Shared memory / node	128GB
	ノード間転送性能 Inter-node transfer speed	128GB/s (64GB/s×2)
System	ノード数 Total number of processor nodes	160
	演算性能 Peak performance of system	131TF
	メモリ容量 Main memory	20TB
	NW トポロジー	



地球シミュレータ利用課題
Earth Simulator Research Projects

地球シミュレータ利用の枠組みは大きく「公募課題」、「特定課題」、「機構課題」に分かれています。

There are basically three categories of Earth Simulator projects consisting of "Proposed Research Projects", "Contract Research Projects" and "JAMSTEC Research Projects".

■ 公募課題

先端大型研究施設として広く利用に供することにより、我が国の科学技術レベルの向上に資するため、地球科学分野について課題を公募しています。公募は年に１回行われます。

■ 特定課題

国等からの委託もしくは補助により地球シミュレータを利用して進めるプログラムについては、「地球シミュレータ特定課題」として受け入れています。

この枠組みは、気候変動リスク情報創生プログラム、地球シミュレータ産業戦略利用プログラムに利用されています。

■ 機構課題

海洋研究開発機構が主導する研究課題および国際・国内共同研究、自然災害等に関連する緊急ジョブの実行など社会貢献につながる活動に地球シミュレータを利用しています。また、地球シミュレータの有償利用についてもこの枠組の中で行っています。

Proposed Research Projects

In order to facilitate the wider use of the Earth Simulator as an advanced large-scale research facility and improve Japan's science and technology, a public application process is held every year with applications being received for earth science research fields.

Contract Research Projects

Projects using the Earth Simulator based on commissioned research or grants by public organizations such as the central government are accepted as Contract Research Projects.

These include "the Program for Risk Information on Climate Change (SOUSEI)" and "the Program for Strategic Industrial Use of Earth Simulator".

JAMSTEC Research Projects

The Earth Simulator is also used for research projects organized by JAMSTEC, international and domestic collaboration projects and the execution of urgent jobs in the time of natural disasters.

In addition, fee-based usage of the Earth Simulator is conducted under this category.

地球シミュレータの計算資源配分
Earth Simulator Resource Allocation

The Earth Simulator

地球シミュレータの産業利用について
Industrial Use of the Earth Simulator

地球シミュレータは、産業界の先進的な研究開発にもその利用を開放しています。利用方法には、利用成果を公開するもの（成果公開型有償利用）と、非公開とするもの（成果専有型有償利用）の2つの利用制度があります。

成果公開型は、「地球シミュレータ産業戦略利用プログラム」として文部科学省の先端研究基盤共用・プラットフォーム形成事業の補助を受けて実施しており、利用者情報や利用成果はシンポジウム、印刷物、ウェブページ上で一般公開されます。成果専有型は、利用成果だけでなく利用者の情報も非公開として利用する事が出来ます。

どちらも事前にプログラムの実行確認などのために無償で利用できるトライアルユース制度を設けており、プログラムの移植、高速化などの技術支援も実施しています。詳しくは、ウェブページ（http://www.jamstec.go.jp/es/jp/）をご覧ください。

The Earth Simulator is available for the industrial world. There are two ways to use the Earth Simulator: 'Open-type' and 'Confidential-type'.

The Open-type is being carried out under "Program for Industrial Strategic Use of Earth Simulator" supported by MEXT (the Ministry of Education, Culture, Sports, Science and Technology). Then user's information and results are opened to public in symposiums, publications, web sites, etc. Under the Confidential-type, users can make their information and results confidential.

Both types have a Trial-use system in which users can use the simulator free of charge in order to test the execution of programs in advance. In addition, we offer technical support for porting and optimization of application programs. For more details, see the web site. http://www.jamstec.go.jp/es/en/

	成果公開型有償利用 Open-type	成果専有型有償利用 Confidential-type
募集 Call for research proposals (for Japanese corporation, only)	年1回～2回の公募 Once or twice a year	随時 Any time
利用成果の扱い Handling of results	公開 Open	非公開 Confidential
利用成果の帰属 Attribution of results	利用者 Users	利用者 Users
トライアル期間 Trial period	最大2年間 Maximum of 2 years	最大3ヶ月 Maximum of 3 months
トライアル資源量 Amount of trial computer sources	補助事業の枠内で配分 Allocated within the supported program	100ノード時間 100 Node-hour
ノード時間当たりの単価*1 Unit cost per Node-hour*1	下表を参照 See the table below	￥4,110

成果公開型有償利用単価*2 Unit cost for Open-type*2		
有償利用年数 Year of usage	負担率 Charge ratio	ノード時間当たりの単価 Unit cost per Node-hour
1年目 1st year	10%	￥411
2年目 2nd year	20%	￥822
3年目 3rd year	30%	￥1,233
4年目 4th year	40%	￥1,644
5年目以降 5th year and later	50%	￥2,055

※1 ノード時間とは、1ノードを1時間利用した場合を表現する単位です。
*1 Node-hour is a unit where one unit of Node-hour means that a single node is used for one hour.

※2 大学・独立行政法人等が成果公開型を利用する場合は、初年度から50%の負担率となります。
*2 When universities and independent administrative institutions use the Open-type, the charge ratio is 50% from the first year without Trial-use.

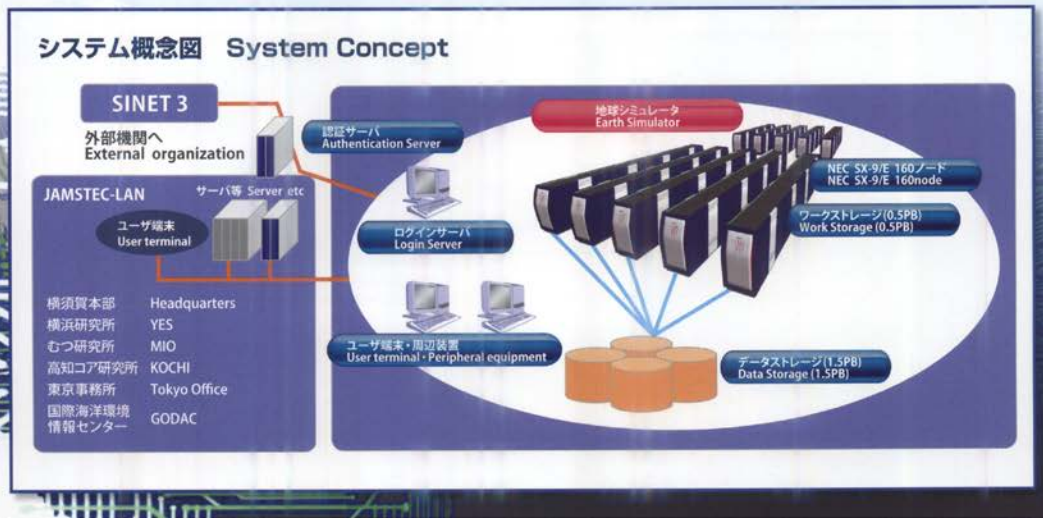
The Earth Simulator

The Earth Simulator started to operate in March, 2002 as "the fastest supercomputer in the world that was able to take on solving problems facing humankind," such as the climate change including global warming, the earthquakes and changes in the earth' s interior, and so on.

In the climate change, in particular, the Earth Simulator has been widely used for developing the high-resolution global warming prediction model and experiments in the projects of the Ministry of Education, Culture, Sports, Science and Technology – the "Project for Sustainable Coexistence of Humanity, Nature and the Earth" and the subsequent "Innovative Program of Climate Change Projection for 21st Century" – and significantly contributed to the 4th IPCC report. Moreover, the utilization of its high computing performance has spread to cutting-edge industrial projects including material development, transport machine improvement and device and drug development etc. As a result, the outcome of the Earth Simulator has reached to a level beyond conventional simulation research.

According to the Linpack benchmark test, the Earth Simulator has been the world's fastest computer for two and a half years since it started operation. Under the situation where the performance of supercomputers has been rapidly advancing as is said that their performance are improved a hundred times faster every ten years, the Earth Simulator has continued fully operating to respond to the massive processing requests of users. To improve its performance, we upgraded the simulator to a new system in March, 2009 and succeeded in improving computing performance by 3.2 times and reducing electric power consumption by approximately 30 percent.

We would like to continue utilizing the Earth Simulator to develop simulation technologies for more reliable and practical prediction as a global pioneer, support realization of the safe societies and contribute to the continuous fulfillment of human welfare.



お知らせ General Information

地球シミュレータのご利用・お申し込みに関して

産業各分野での利用も推進しております。ご利用をお考えの方はお問い合わせください。

E-mail: es_apply@jamstec.go.jp

We are pleased to make The Earth Simulator available for not only scientific, but also industrial use. Please contact the following address if you are interested.

E-mail: es_apply@jamstec.go.jp

お問い合わせ

地球シミュレータに関するご質問は、下記へお問い合わせください。

E-mail: esc-contact@jamstec.go.jp

If you have any questions, please contact us at the following address.

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見学・取材については、海洋研究開発機構のホームページの「お問い合わせ」より、お問い合わせください。なお、横浜研究所地球情報館では、地球シミュレータによる研究成果や開発当時の資料を展示しております。

JAMSTECホームページ：http://www.jamstec.go.jp/j/index.html

If you are interested in a tour, a media interview or filming, please click on "Contact Us" on the JAMSTEC webpage. In addition, original research results and documents of the ES development period are displayed at the Earth Science Museum of Yokohama Institute for Earth Sciences.

JAMSTEC Webpage：http://www.jamstec.go.jp/e/index.html

アクセスマップ Access Map

最寄り駅

JR 根岸線 新杉田駅　徒歩 10 分
京浜急行線 杉 田 駅　徒歩 13 分

Nearest Train stations:
Shin-Sugita Station of the JR Negishi Line
(10min on foot)
Sugita Station of the Keikyu Line
(13min on foot)

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