WEATHER CLIMATE WATER
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海洋气象热点方向与北极事务

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WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

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当前，海洋气象的热点:*从满足单一需求向适应多需求发展，实现与多学科领域的融合*

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History of IMO/WMO – Satefy Seas

关注海上安全是海洋气象学诞生原因（到今天167年）

- 海洋气象学对于海洋相关业者的重要性就像空气对于人的生命一样重要，可以说**没有海洋气象学所提供的高质量气象信息，就不可能有各种海上活动的顺利开展。**
- 首届气象大会 ***August 1853 (Brussels布鲁塞尔)*** ：形成共识：
- 需要可靠的、经常可获得的海上气象情报；The need for reliable and regular information about the weather over the sea areas of the world
- 认识到开展国际合作的重要性led to the recognition of the need for international co-operation

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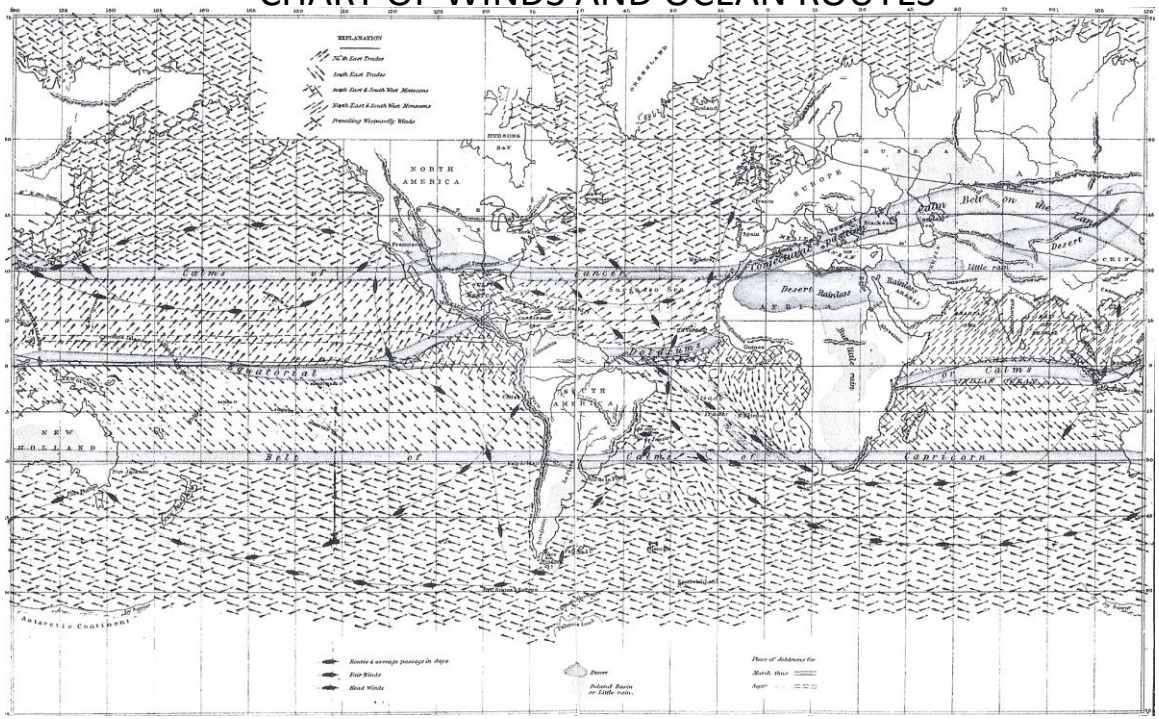
MATTHEW FONTAINE MAURY

马修·方丹·莫里（1806年1月14日－1873年2月1日），美国天文学家、海军军官、历史学家、海洋学家、气象学家、地质学家、教育家。

由MAURY'S (1806-1873) 绘制的海洋气象与海上航行图
CHART OF WINDS AND OCEAN ROUTES



他被誉为“海洋探路者”（Pathfinder of the Seas）、“现代海洋学和海军气象学之父”（Father of Modern Oceanography and Naval Meteorology）。

International shipping 国际船舶运输现状

- About 90% of the world trade volume is transported by the international shipping industry. 世界贸易量中约90%通过海上运输实现。
- Shipping is the cheapest mode to transport bulk goods.海运是大宗商品运输最便宜的方式。
- On a global scale, it was estimated that the marine transport sector has contributed to approximately 60,000 premature deaths each year (Corbett et al., 2007). 据估计，全球海上运输业每年有近6万人因为海上灾难而死亡。
- 海洋气象服务展现出更多地具有商业化服务的趋势。气象与海事部门只是通过联合发布海上航行信息提供公益服务。国际上相关的国际组织有：IMO/WMO/IOC/IHO

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海洋与气候变化

海洋气象更多地参与到气候变化相关的数据获取、分析研究和信息服务之中。

海洋热量

南北极海冰容量

气旋指数

海洋酸化

海平面上升

WMO

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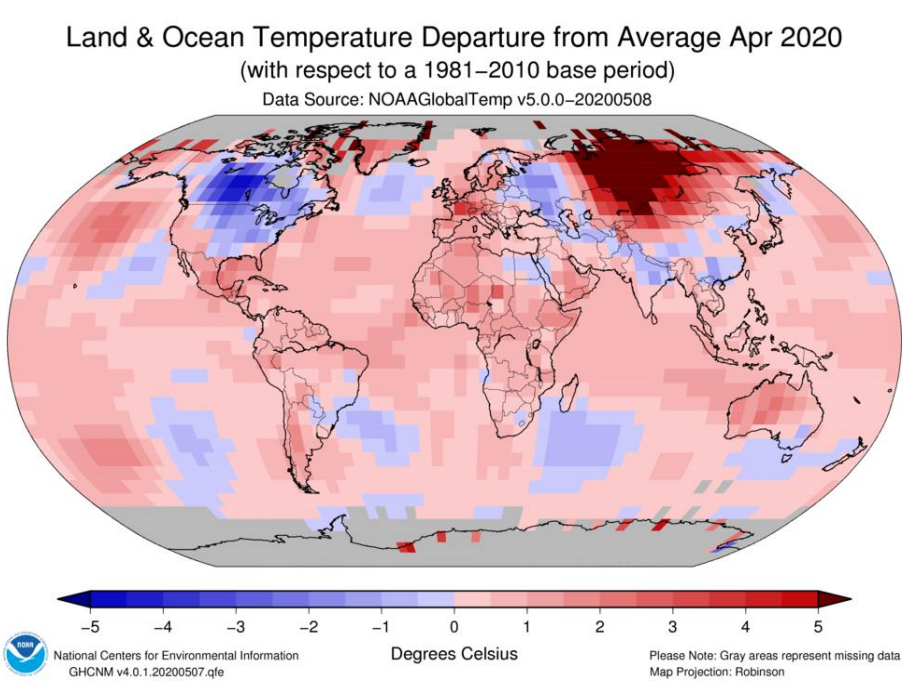

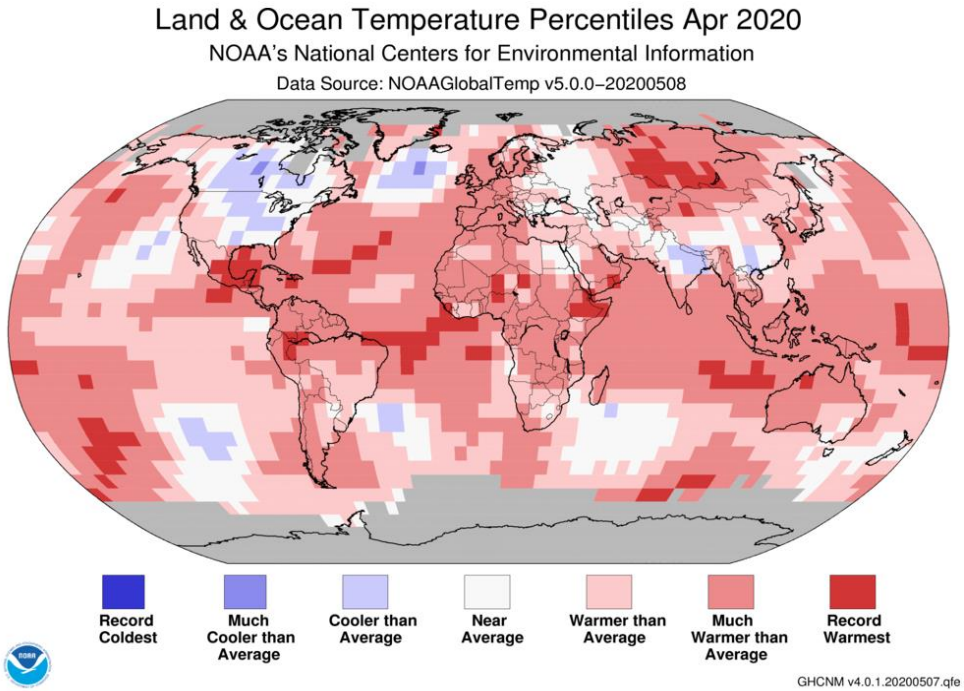

- 亚洲北部（+4 C), 澳洲西部、欧洲中部、墨西哥湾、拉布拉多和白令海、跨越太平洋南南部和北部及南极洲地区 (+2C)；加拿大和美国北部（-2 C）；
- 达到最暖记录的有：大西洋大部、墨西哥（湾）、南美北部、非洲、亚洲北部以及部分印度洋和西太平洋。
- 1965年以来地球表面达到当月（**4月份**）温度极值的比例：2020（6.87%）2016 (14.5%), 2010 (9.7%), and 1998 (7.9%)
- 2019年是有记录以来第二热的年份。 2016是全球128年来陆地海洋表面平均温度最高的一年(图略)

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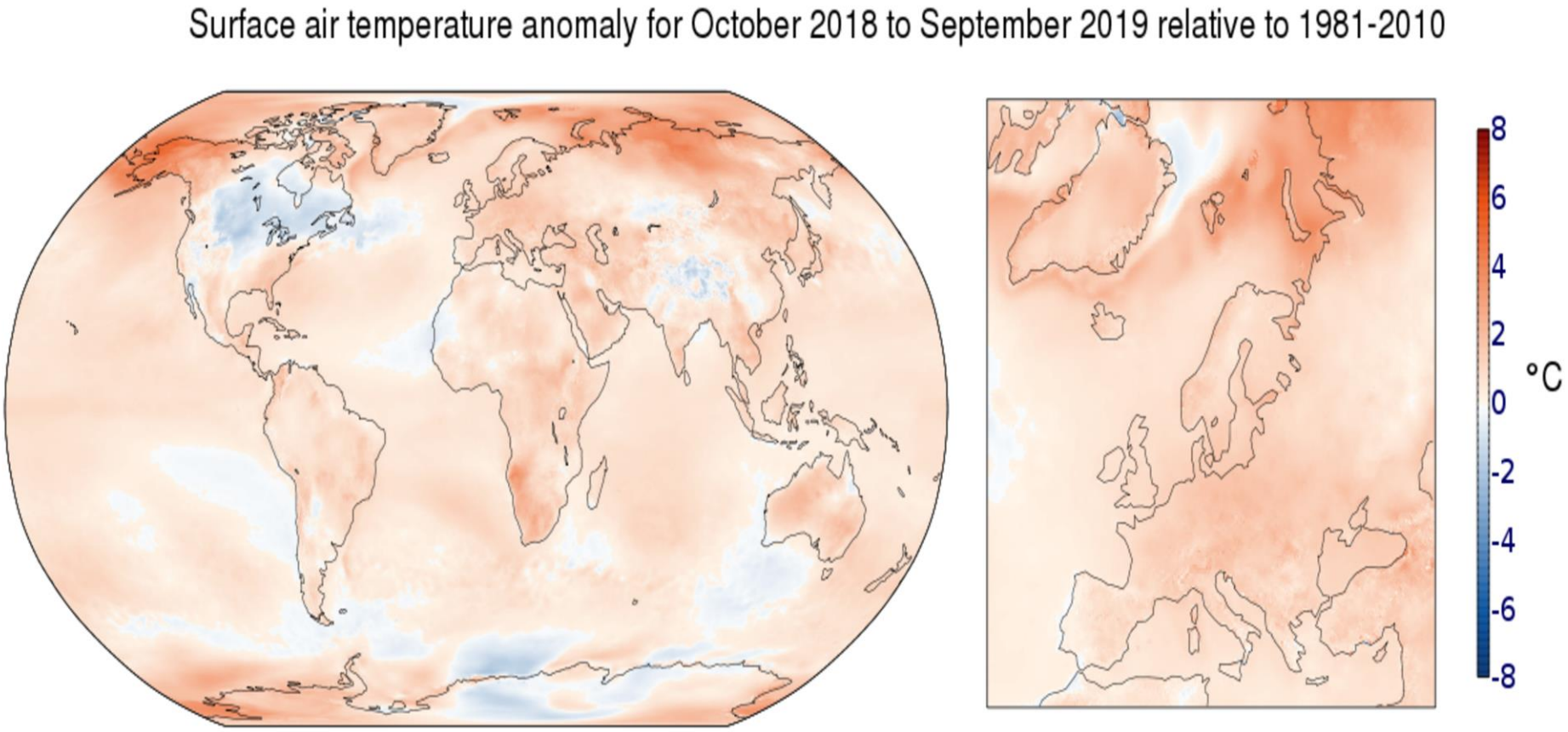
2018年10至2019年9月平均（相对于30年气候）的温度异常大值区。北大西洋部分区域为负值区



European Commission

Copernicus Europe's eyes on Earth

Climate Change Service climate.copernicus.eu

IMPLEMENTED BY ECMWF

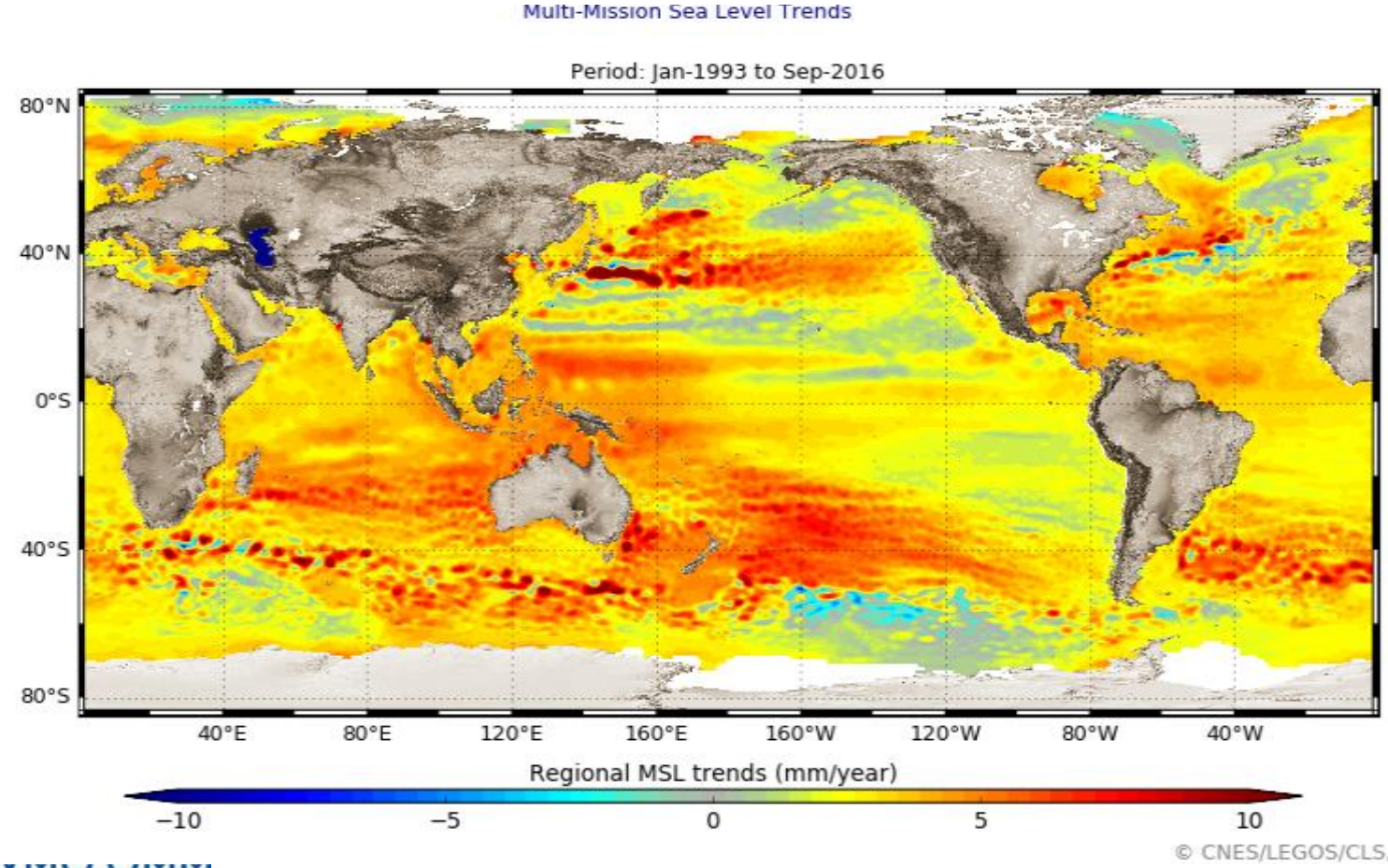
Regional Sea Level changes:

西太、南印度洋和西大西洋热带地区每年海平面上升幅度在**5-10 mm**

not uiform, but more pronouced in ares with rates ranging between 5-10 mm/yr.

欧盟哥白尼海洋服务计划卫星高度计长期（13年）资料分析。

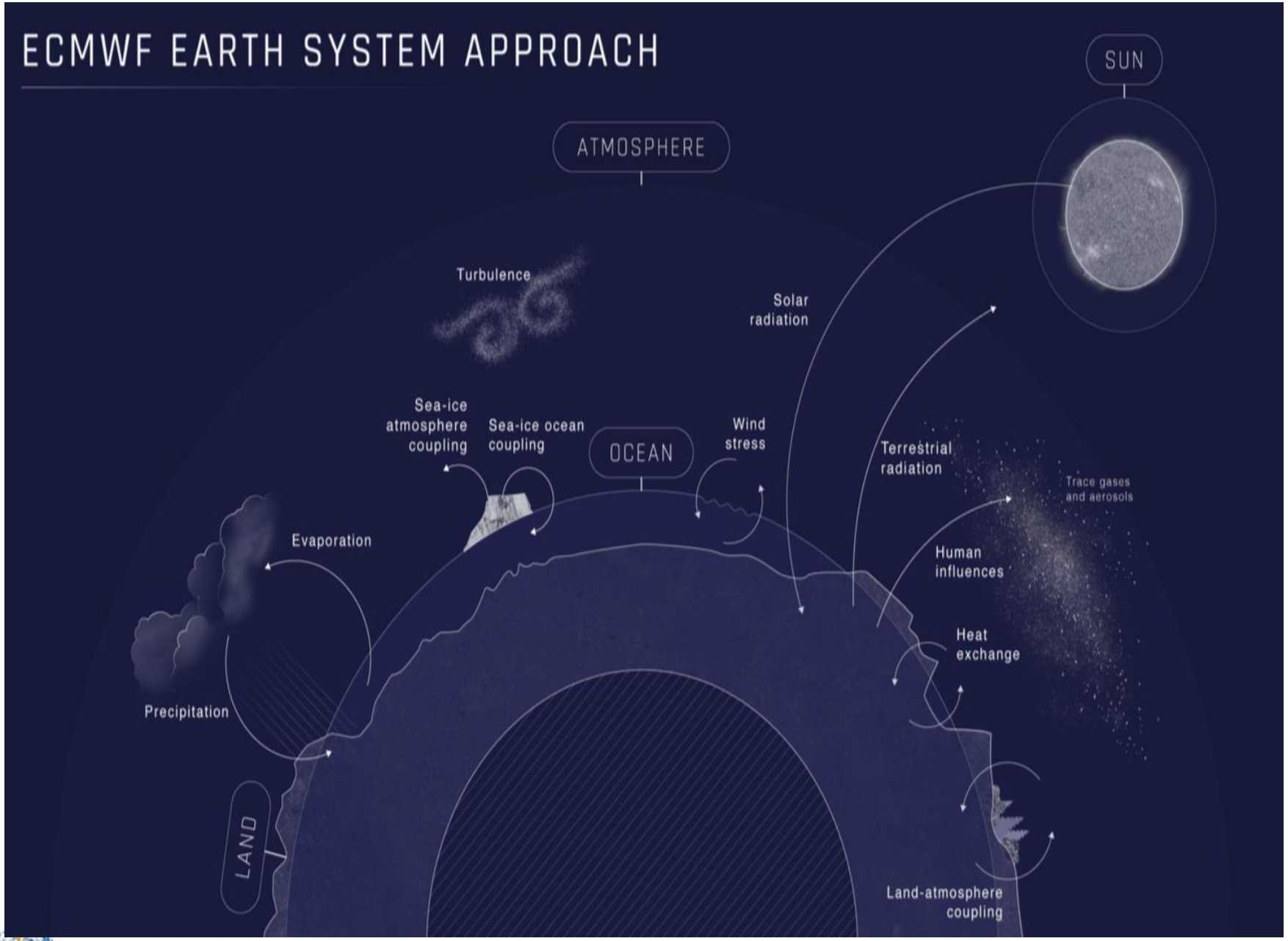
Jan. 1993 - Dec.2016



观测显示全球海平面上升正在加速。自从工业革命以来，海洋酸化增加了**26%** （图略）

Why weather prediction needs an Earth system approach
采取地球系统预报途径是NWP发展的必然也是更好的海洋预报需要(1)

- *太阳为地球生命提供能源。它驱动着天气变化、洋流和水的循环。the Sun delivers the energy that powers all life on Earth and it drives the weather, ocean currents and the hydrological cycle.*
- *太阳在地球表面加热的不均匀性驱动着大气环流，进而影响着地球其他圈层。**Differential heating between the tropics and the poles*** (due to the Sun being higher in the sky in the tropics) ***is the fundamental driver of the large-scale circulation of the atmosphere***.
- 太阳辐射的作用（吸收与反射）。However, *many other factors modulate how the atmosphere reacts to the Sun's heating.* For example, **different surfaces absorb** or **reflect the Sun's radiation to different extents**, with **snow and ice** having a high albedo and reflecting back to space a high proportion of the incoming sunlight,
- 海洋与森林的作用。**oceans and forests** present a much darker surface and absorb more of the energy.
- 云和气溶胶的作用。**Clouds and aerosols** also affect how much sunlight reaches the surface – affecting the temperature and the amount of water which is evaporated – which in turn can affect the further development of clouds and weather systems.


ECMWF EARTH SYSTEM APPROACH
SUN
ATMOSPHERE
Turbulence
Solar radiation
Sea-ice atmosphere coupling
Sea-ice ocean coupling
OCEAN
Wind stress
Terrestrial radiation
Trace gases and aerosols
Evaporation
Human influences
Heat exchange
Precipitation
LAND
Land-atmosphere coupling

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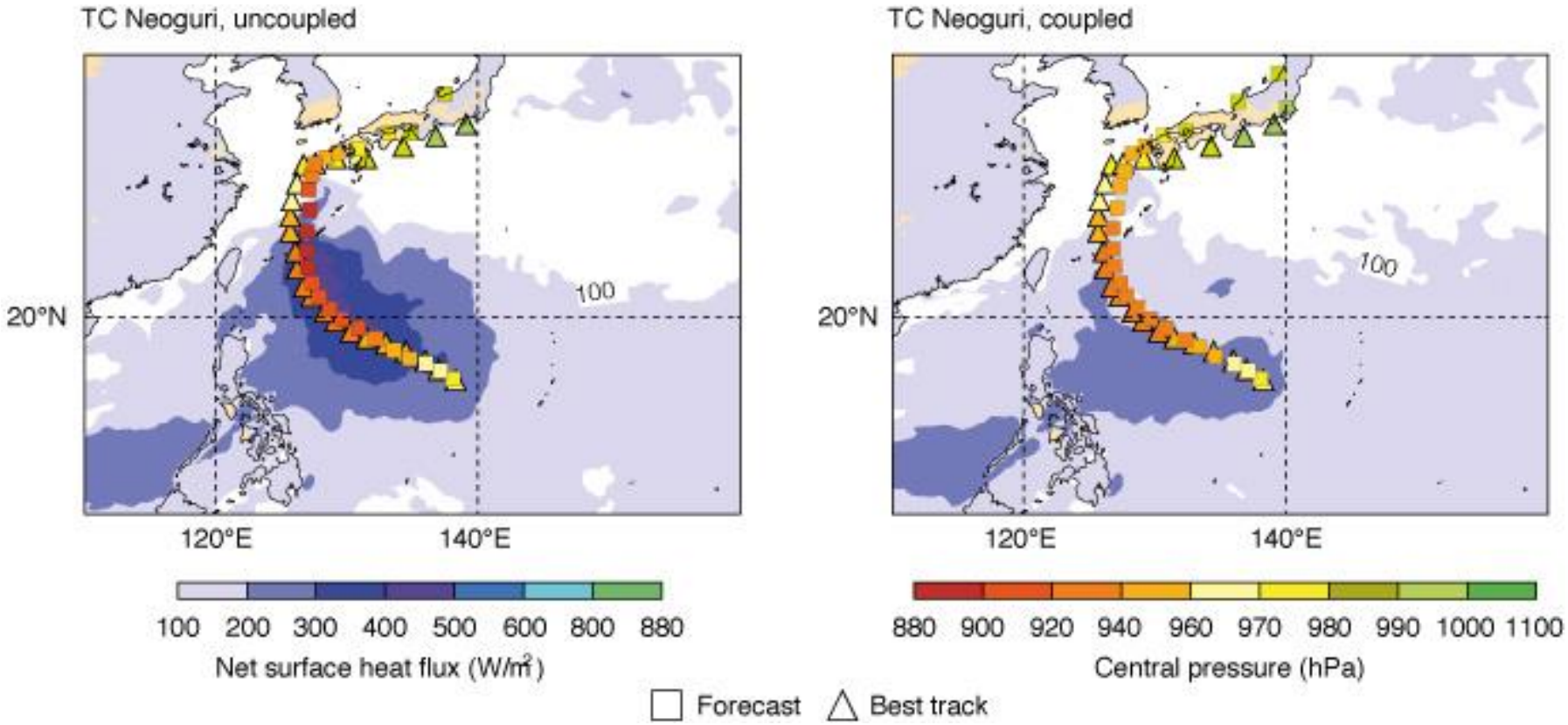
Why weather prediction needs an Earth system approach
为什么要采取以地球系统预报为途径：这是NWP发展的必然(2)

- 要反映这些相互作用的特征，需要我们采取地球系统预报的技术途径。
- 自从2018年6月以来，ECMWF 所有的预报系统，包括中期的和季节预报系统都包括了海洋和海冰的与大气的耦合，尽可能充分地考虑这些相互作用的代表性。特别是，与海洋的耦合极大地提高了特别是包括热带气旋在内的赤道地区中期预报的准确性。通过引入太阳辐射与气溶胶相互作用和更精确的气溶胶场的资料不仅提高了预报的准确性还能够提供化学天气预报信息。这是EU哥白尼计划的一个组成部分。
- 按照计划，ECMWF 将能够更好地改进大气物理的许多方面，其中包括云、对流、辐射和大气化学成分（如O3 和气溶胶)。通过参与WMO 的极地研究年计划， ECMWF正在开展陆面过程在地球系统预报模式中的更好表达，其中包括对雪和冰的更复杂先进的解析。



- 预报试验表明，与没有与海洋耦合的相比，五天的预报会过度预报像2014年7月台风（Neoguri）的中心气压，然而，海气耦合模式的预报表现要好很多（见右图）。 原因是耦合模式更真实地模拟了海气热通量 (blue shading in the charts)。

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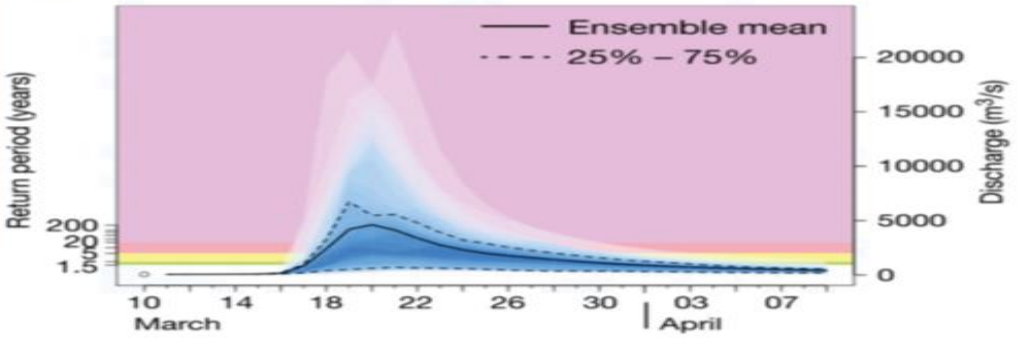
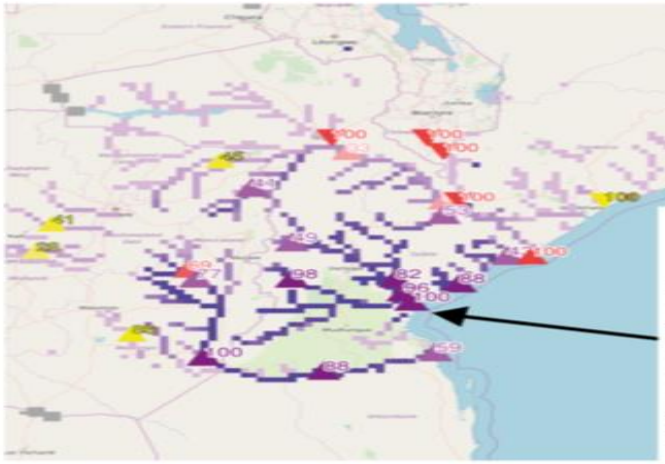
ECMWF's Earth system approach for Hydrological Prediction
地球系统预报中的水文预报

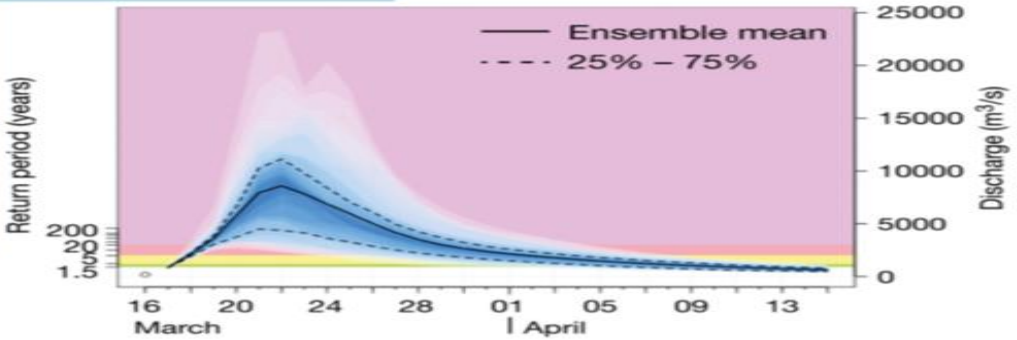
- **ECMWF 的地球系统模式: the Integrated Forecasting System (IFS),** 是所有数据同化和预报的基础。
- 地球系统各圈层相互作用模拟取得的进展构成了ECMWF十年系统发展战略的核心 **the core of the ECMWF 2016–2025 Strategy**.
- **The ECMWF 的愿景是采用地球系统预报的途径作下一代全球水文预报。**
- **在业务模式中水的收支平衡仍然是一项艰巨的科学任务。** (Zsoter et al., 2019).
- 作为早期取得的成果，改进模式中水文因素的代表性会使大气与海洋相互作用的预报大大受益。.
- 然而，在获得水文资料方面的困难，阻碍了这项工作的进展。.
- **采用地球系统模式开展洪水预报是一条清晰的技术路线。全球洪水预警系统** (GloFAS) 是欧盟哥白尼应急管理服务计划（CEMS）的业务化（24/7）的预报内容。

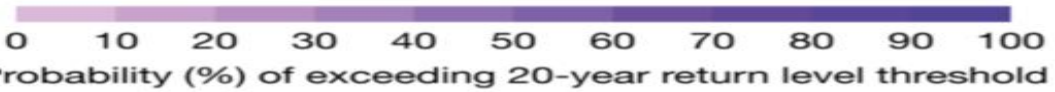
Forecasts issued on 10 March



Forecasts issued on 16 March







GloFAS 对热带气旋“Idai”引发的洪水的预报 。
（2019年3月10日至16日）

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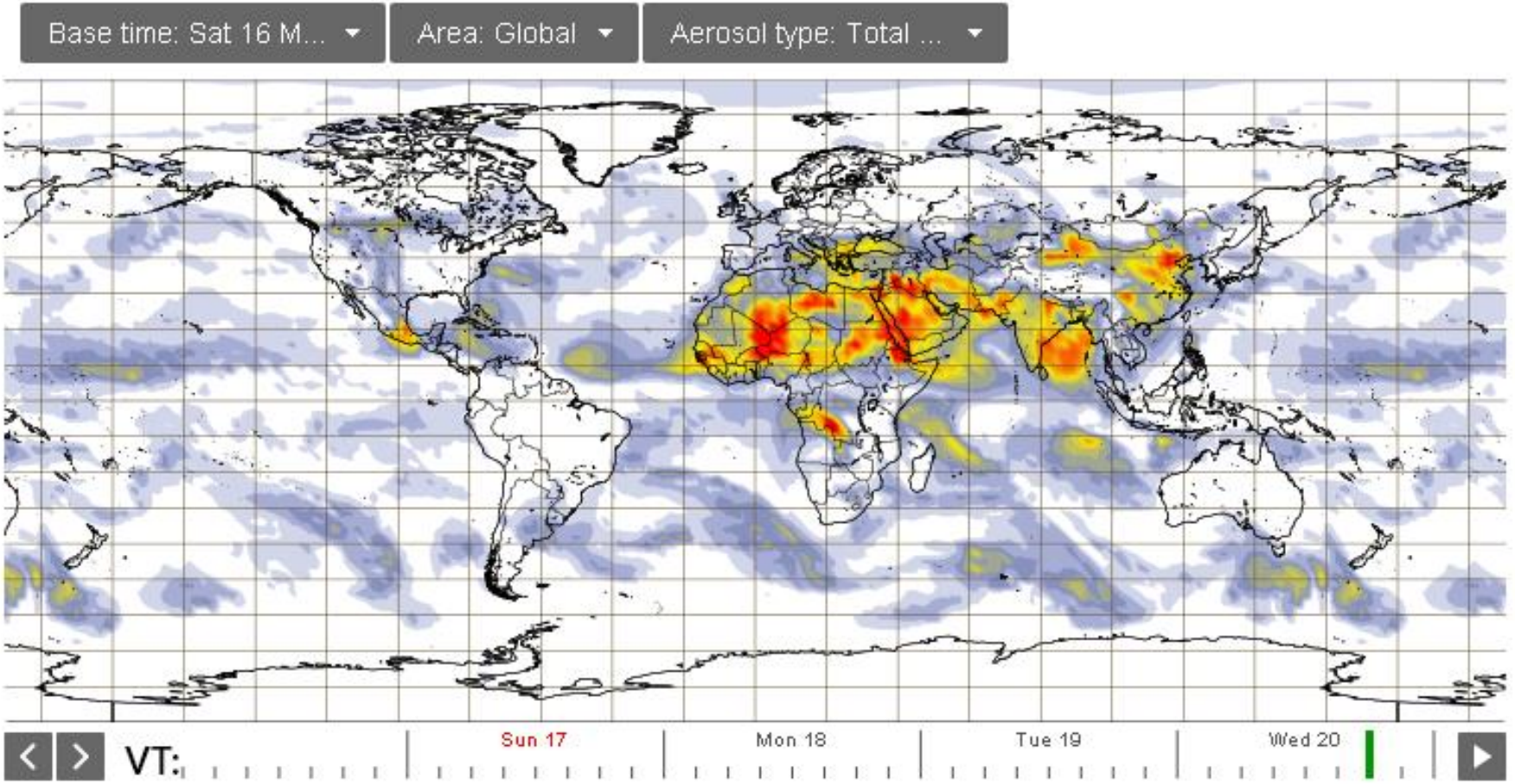
全球逐日气溶胶光学厚度AOD预报

（也分别提供有机物、黑碳和硫酸盐等气溶胶的预报)



https://atmosphere.copernicus.eu/global-forecast-plots

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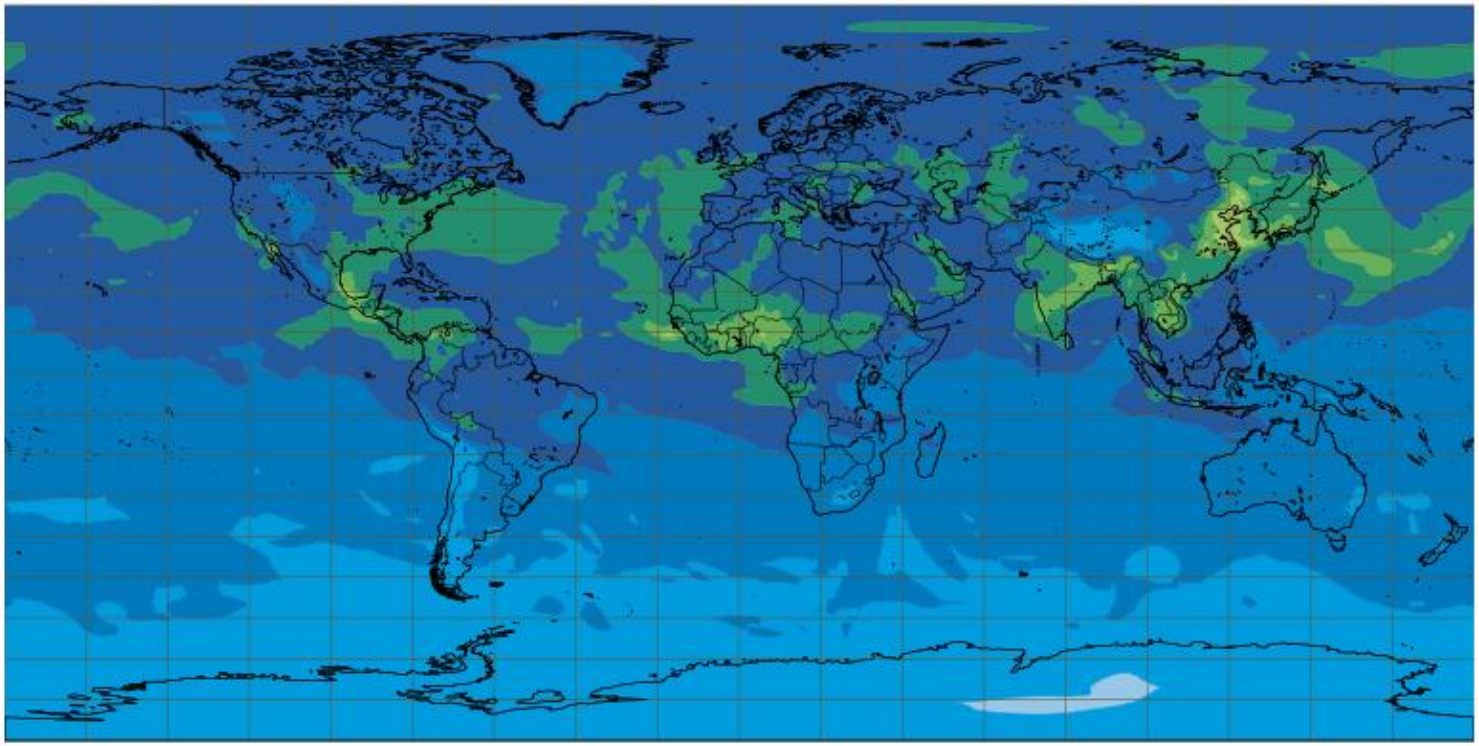
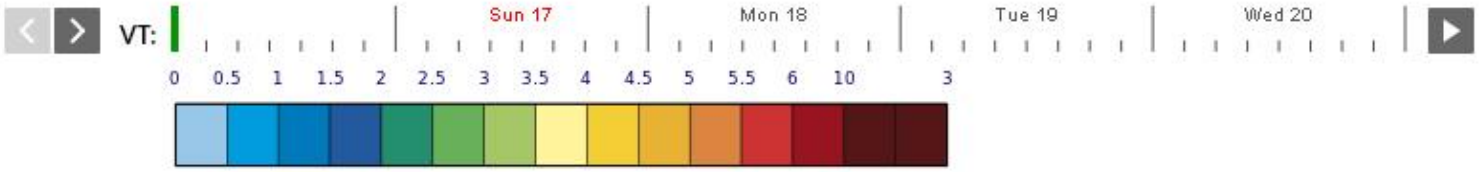
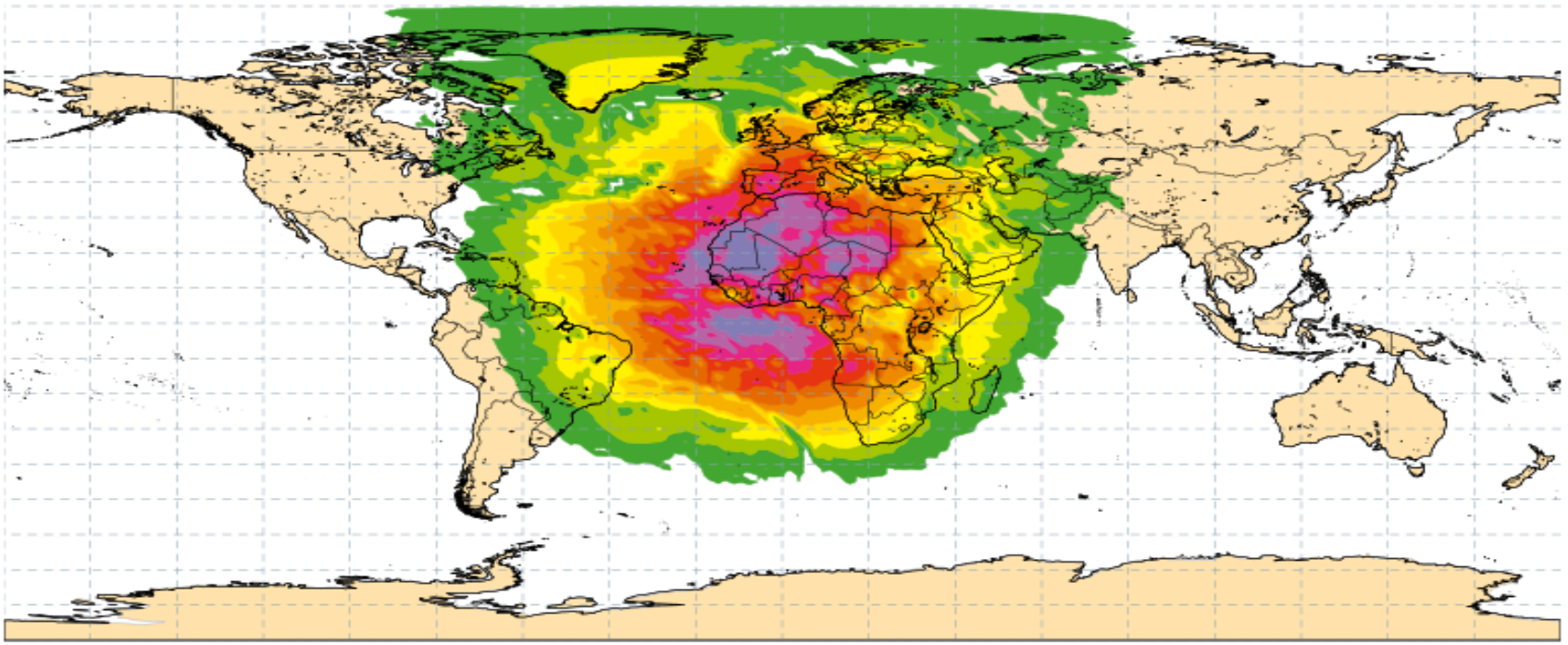
全球逐日一氧化碳浓度预报





Total column of carbon monoxide [10^18 molecules / cm2] (provided by CAMS, the Copernicus Atmosphere

全球逐日紫外线指数预报



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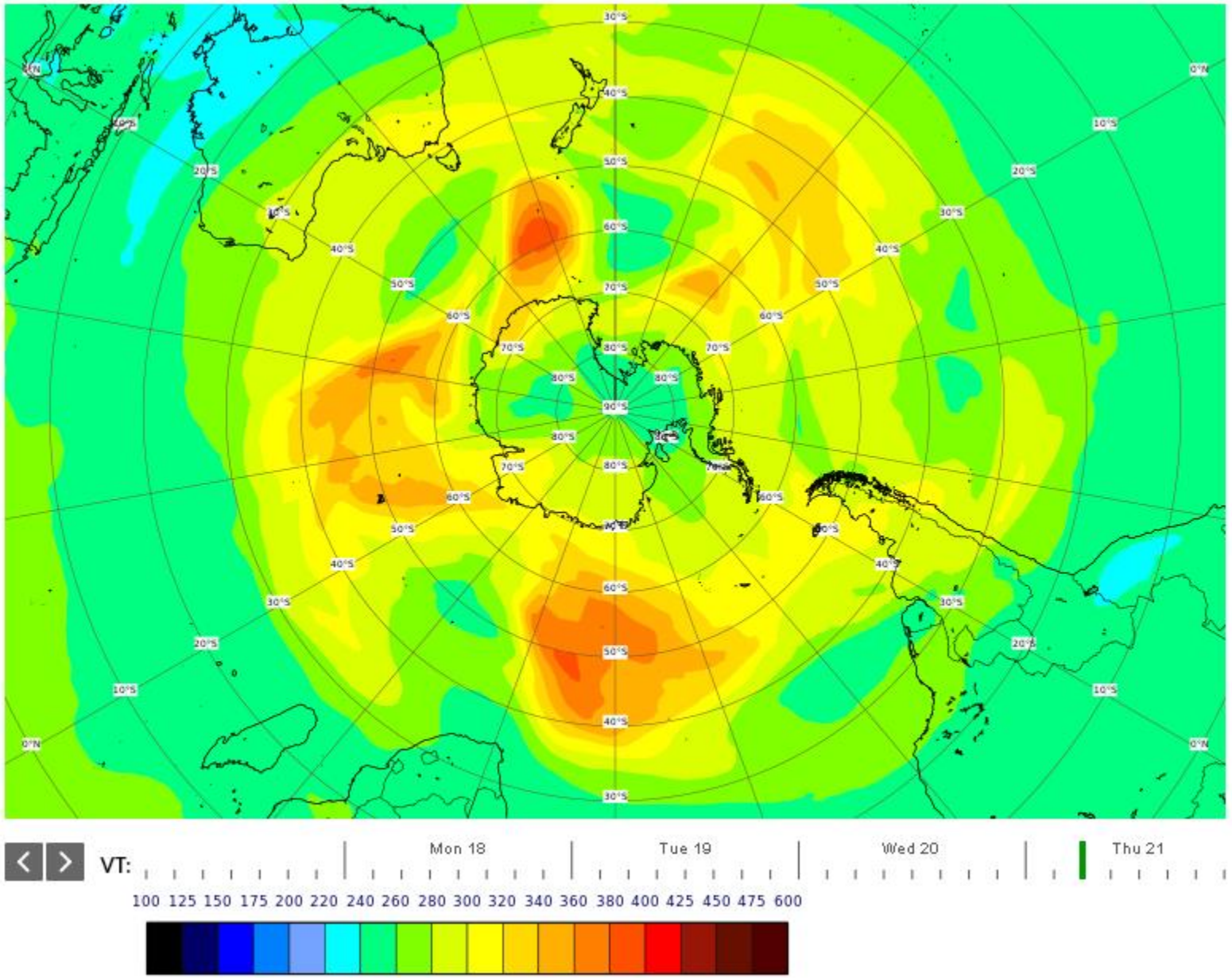
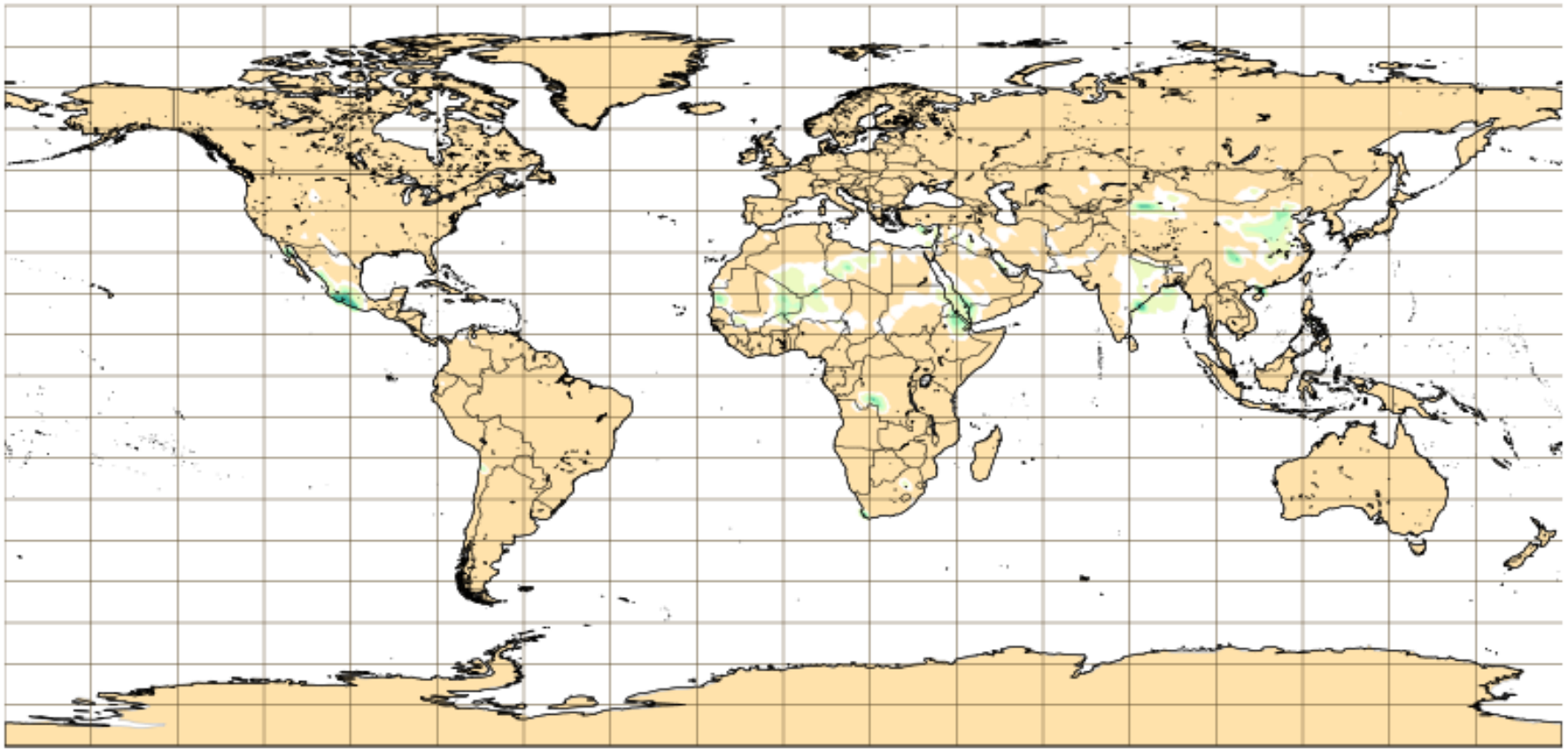
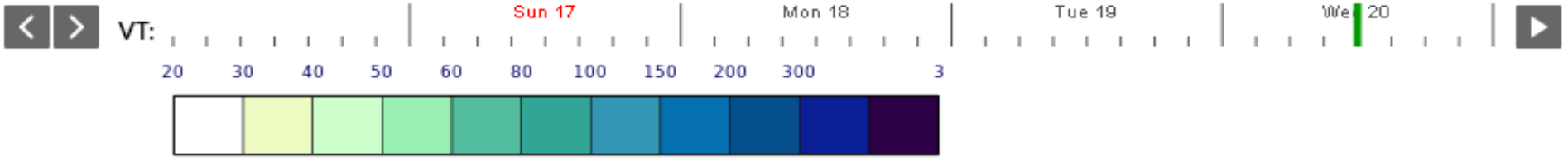
南极上空逐日臭氧浓度预报



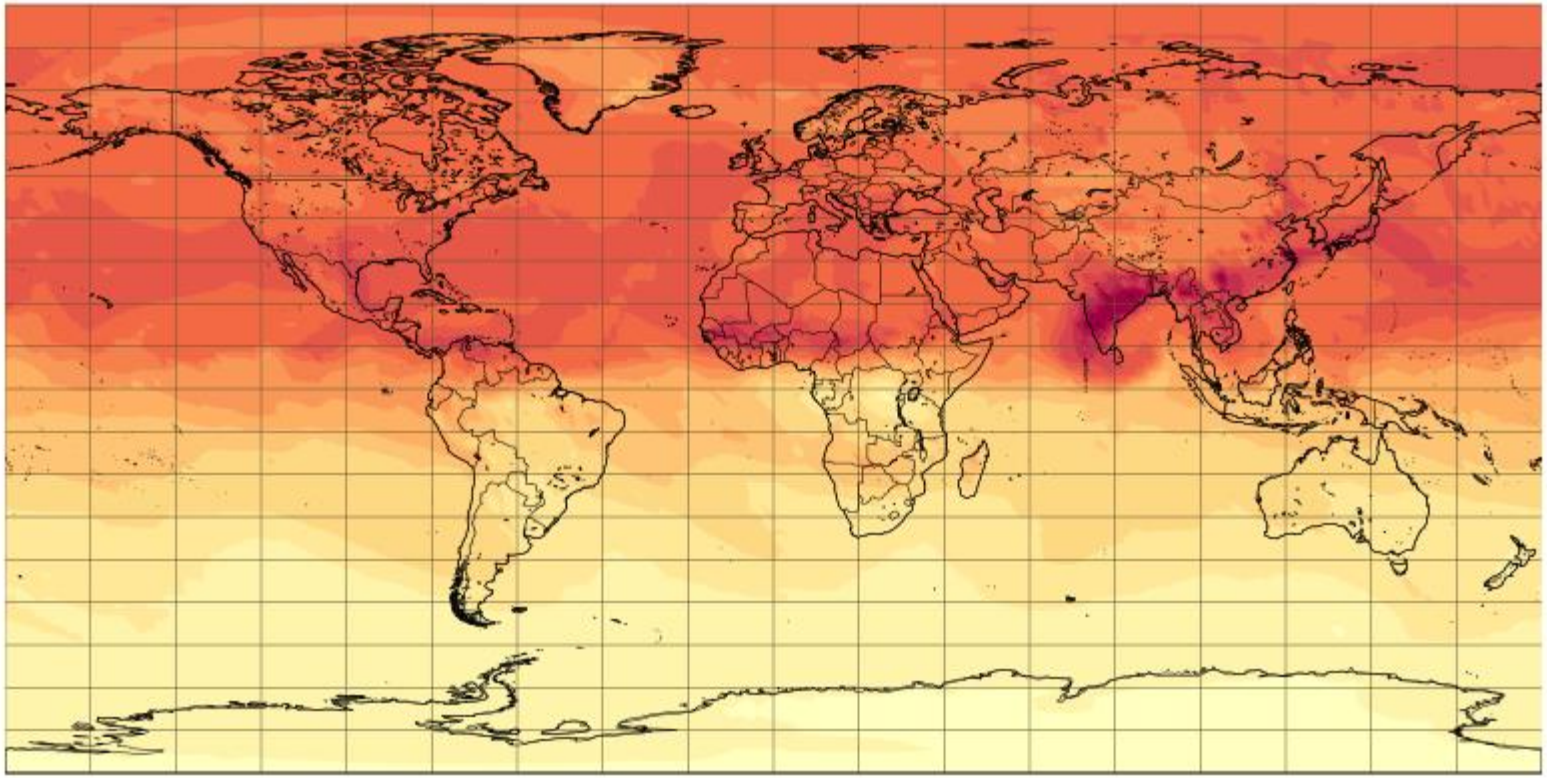
全球逐日PM2.5浓度预报

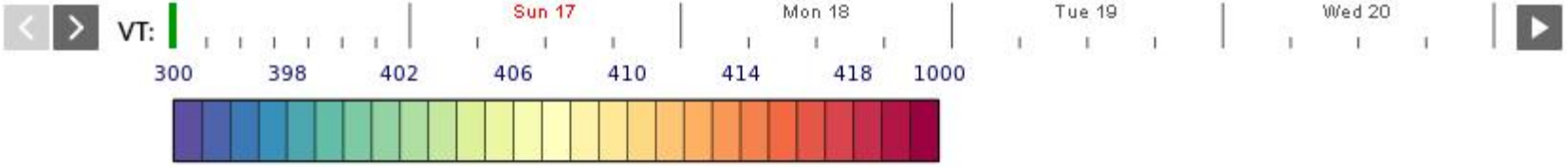




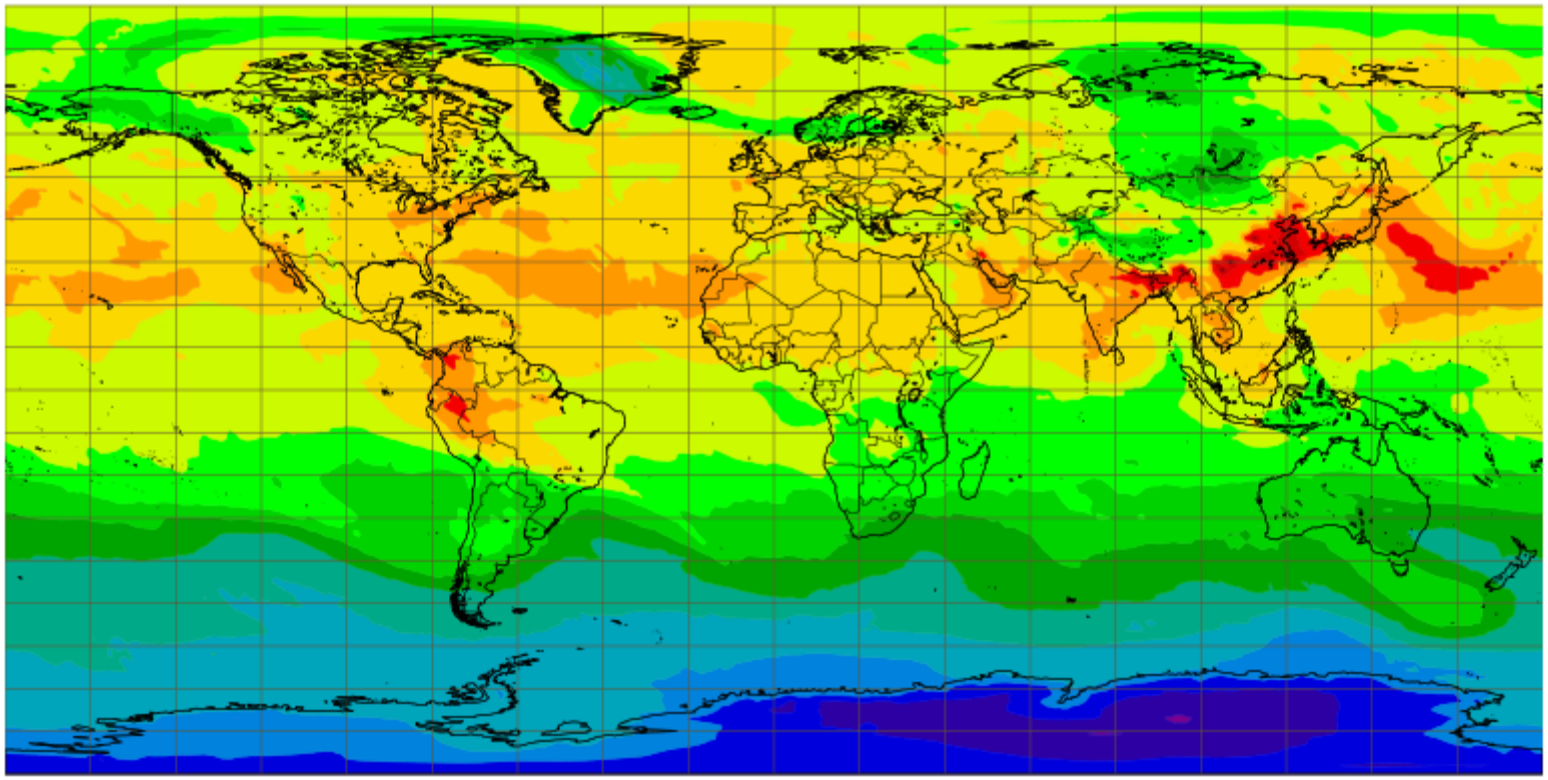
PM2.5 - fine particulate matter [ug / m3] (provided by CAMS)

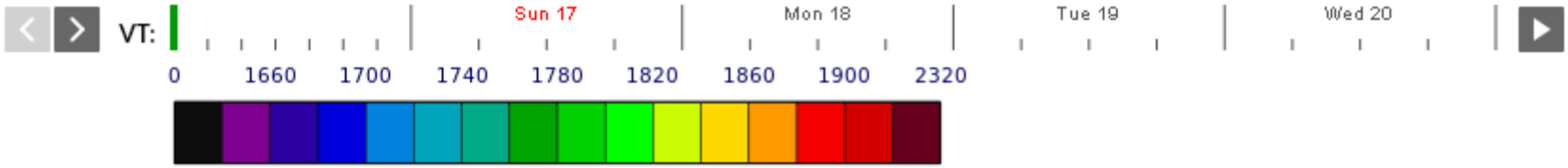
全球逐日CO2浓度预报





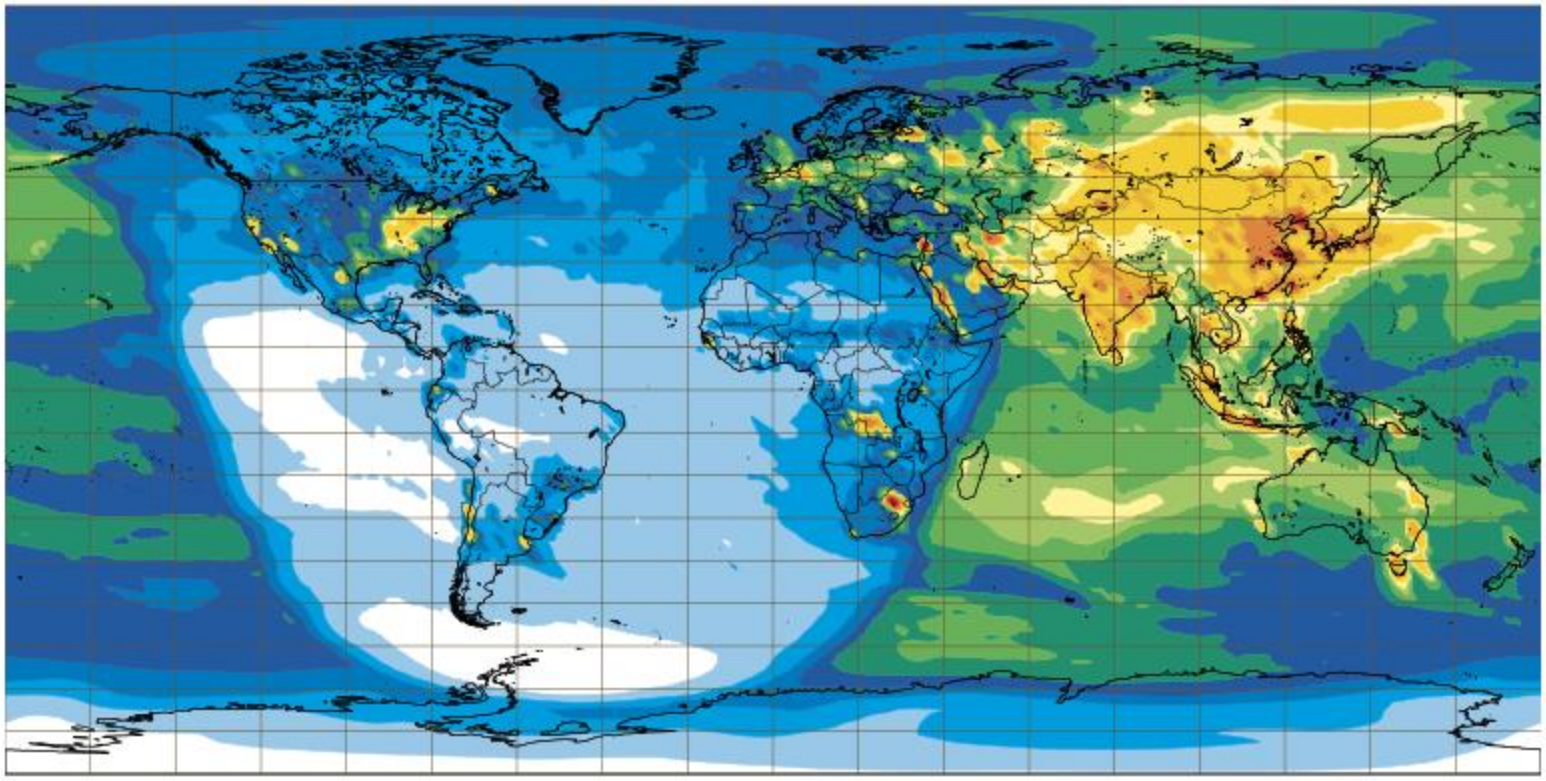
全球逐日CH4浓度预报

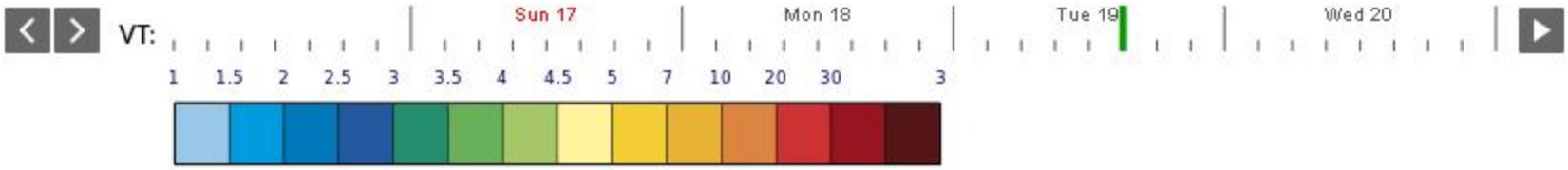




Total column of methane [ppbv] (provided by CAMS, the Copernicus Atmosphere Monitoring Service)

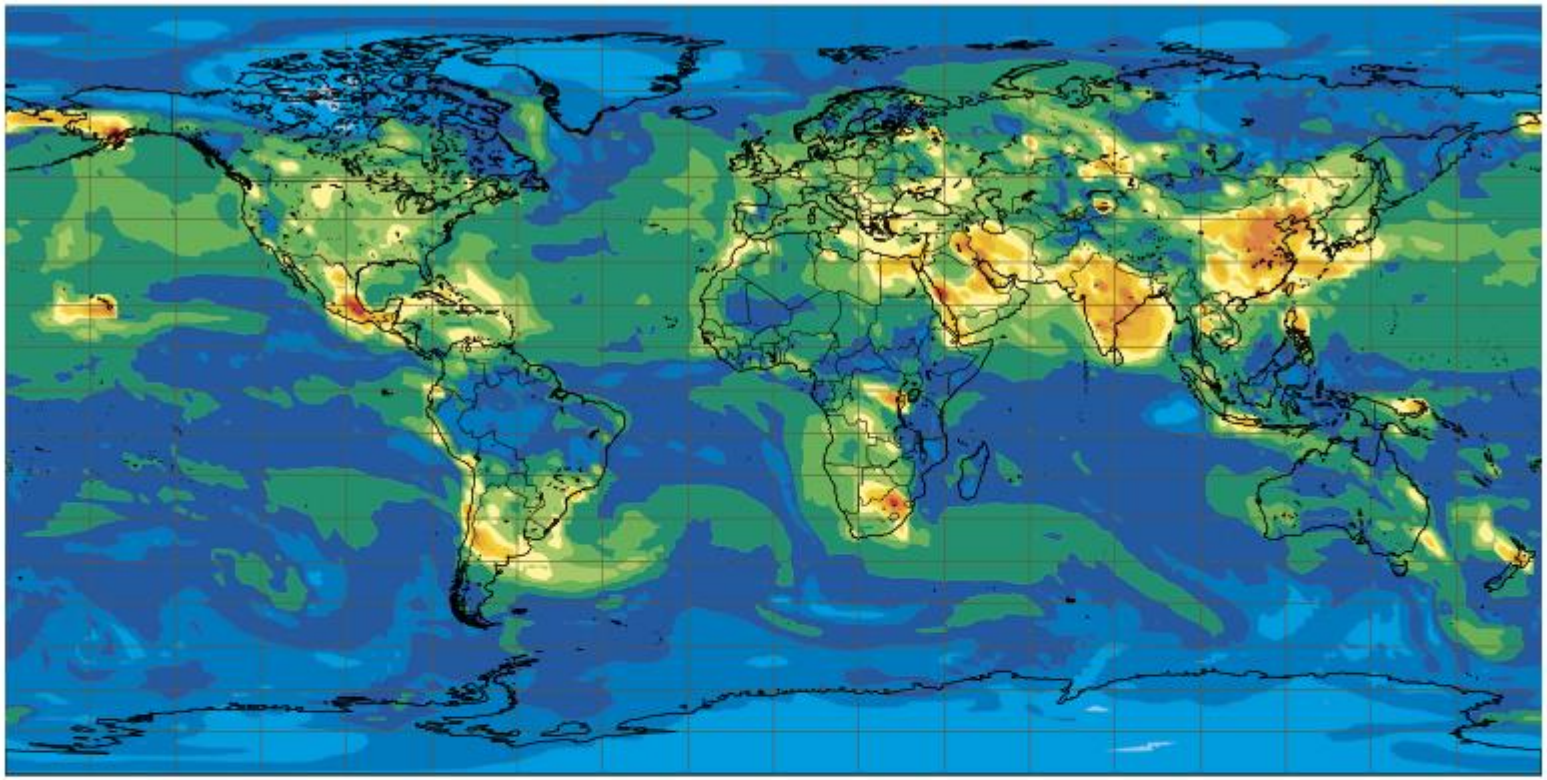
全球逐日NO2浓度预报

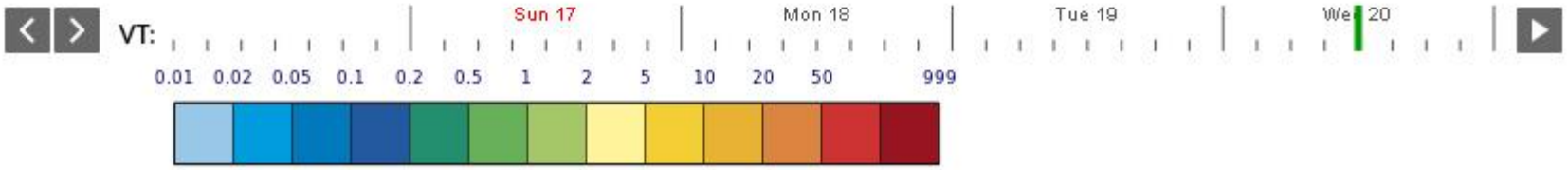




Total column of nitrogen dioxide [10^15 molecules / cm2] (provided by CAMS, the Copernicus Atmosphere

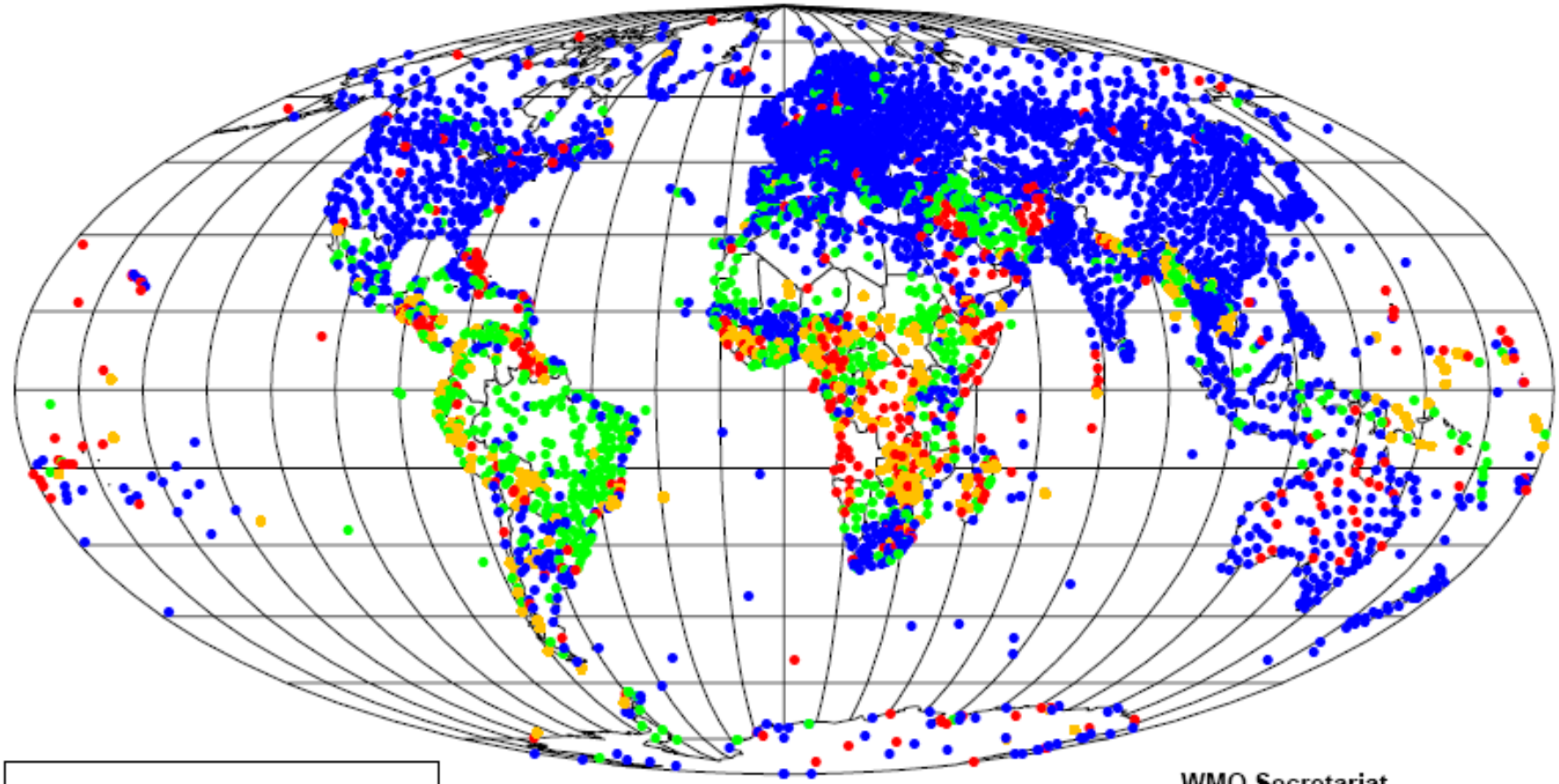
全球逐日SO2浓度预报





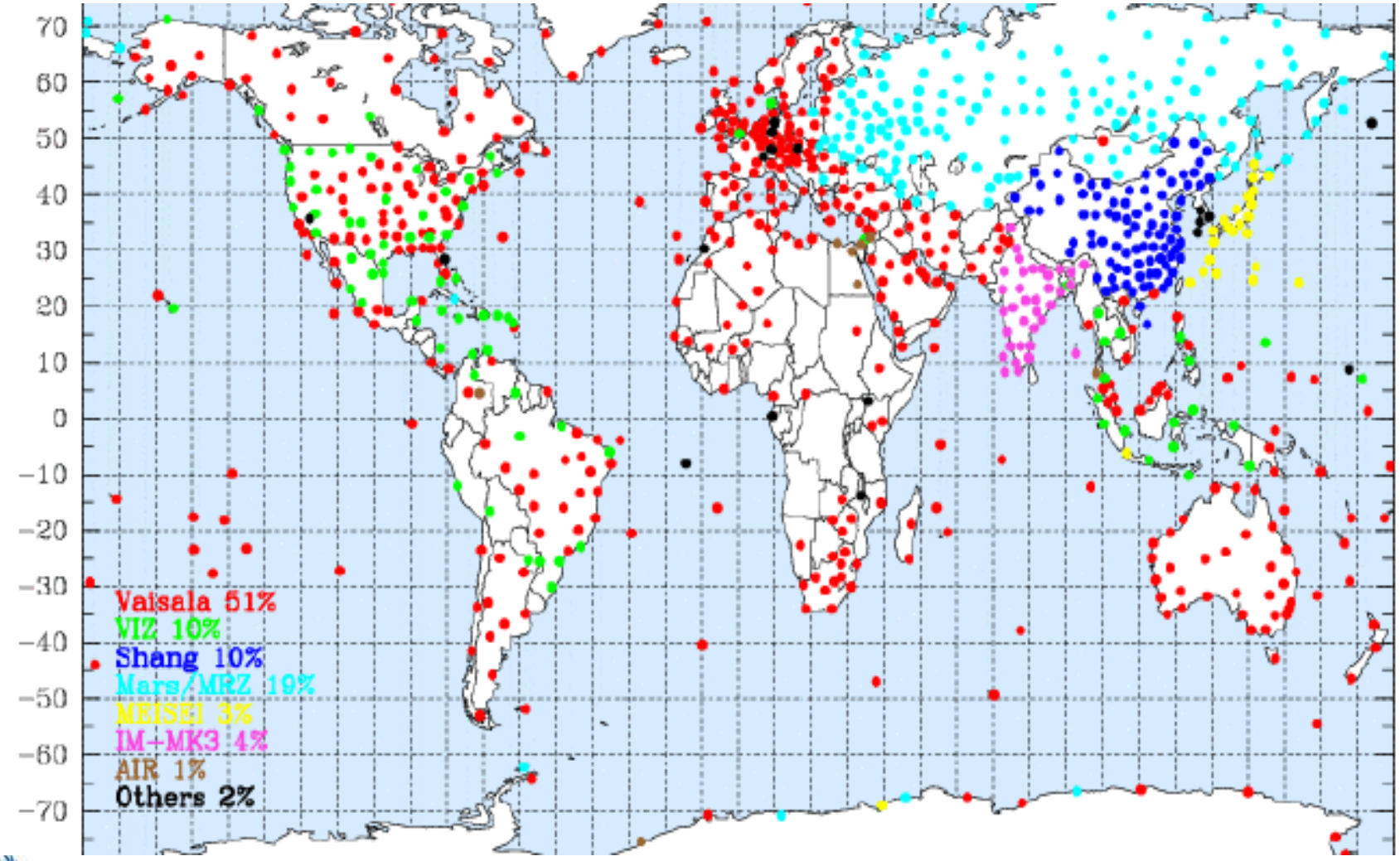
Total column of sulphur dioxide [10^15 molecules / cm2] (provided by CAMS, the Copernicus Atmosphere Monitoring

WMO Global Observing Network with routine data exchange (10,000 stations)

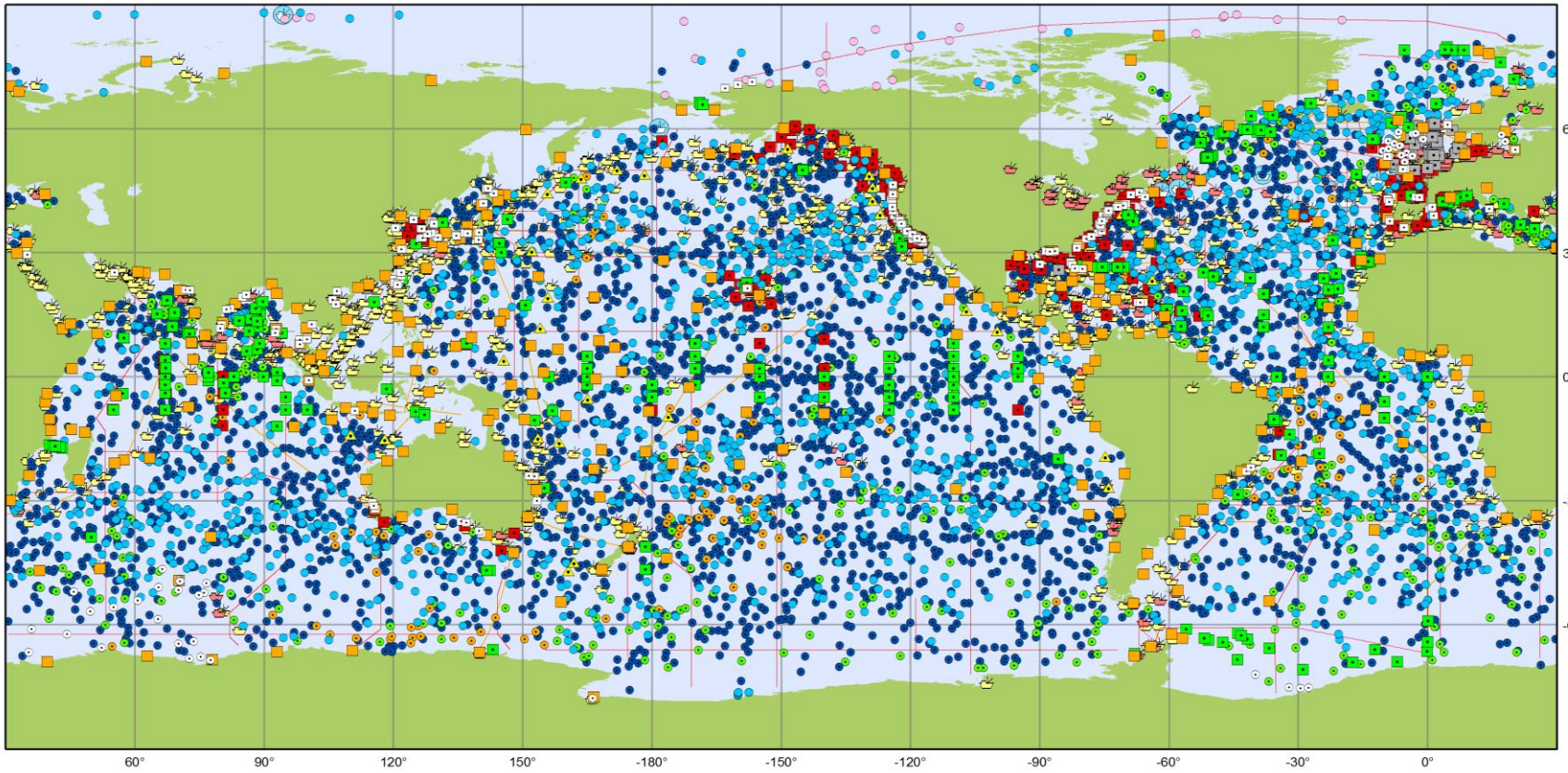


WMO OMM

WMO Global Observing Network with routine data exchange (1,000 upper air stations)



Global Ocean Observing System的主要观测平台（浮标、船舶、岸基等：https://www.jcommops.org/board）



Main in situ Elements of the Global Ocean Observing System

March 2020

Profiling Floats (Argo)
- Core (4056)
- Deep (138)
- BioGeoChemical (399)

Data Buoys (DBCP)
- Surface Drifters (1473)
- Offshore Platforms (94)
- Ice Buoys (28)
- Moored Buoys (325)
- Tsunameters (29)

Timeseries (OceanSITES)
- Interdisciplinary Moorings (357)

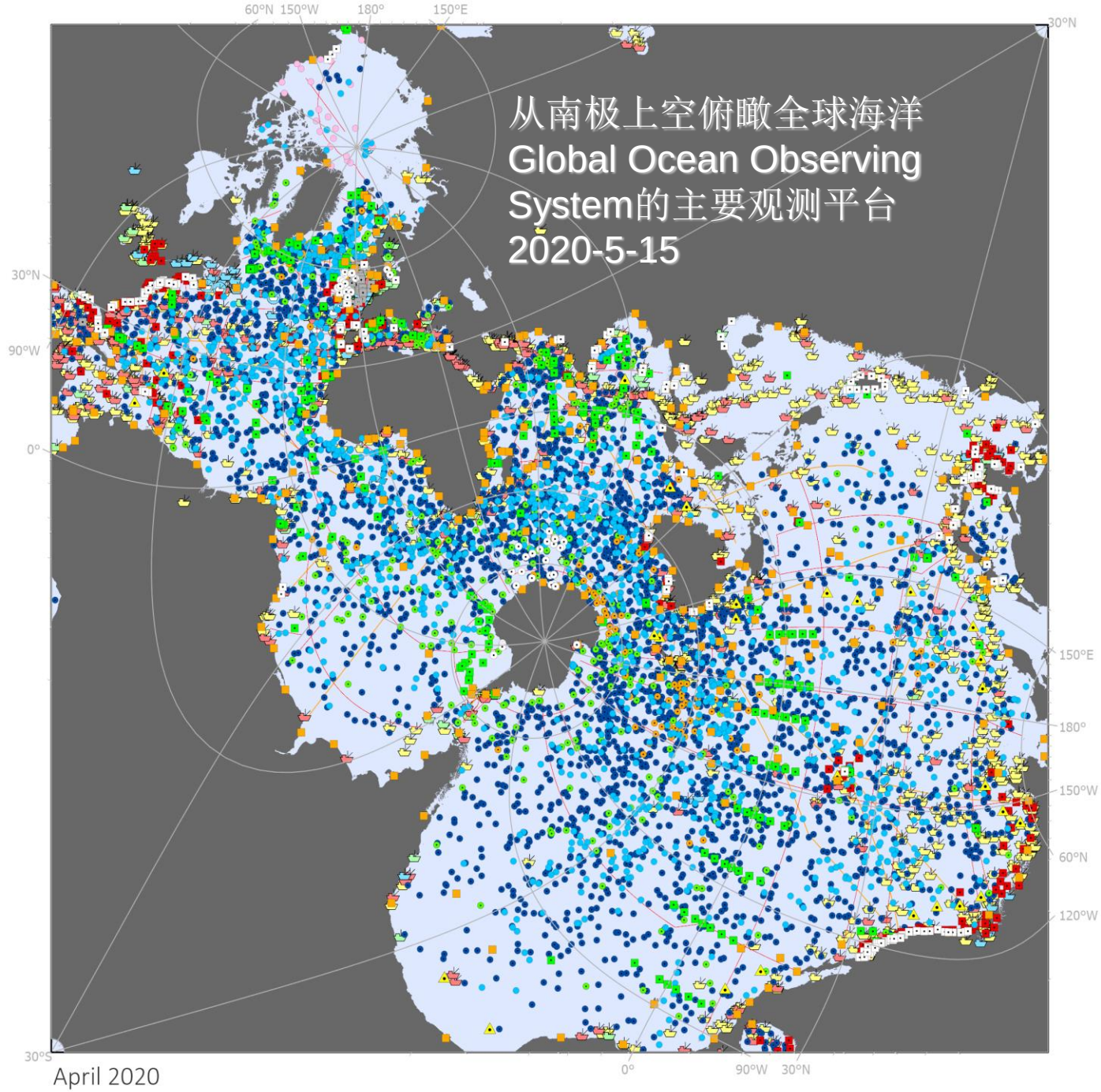
Repeated Hydrography (GO-SHIP)
- Research Vessel Lines (63)

Sea Level (GLOSS)
- Tide Gauges (290)

Ship based Measurements (SOT)
- Automated Weather Stations (254)
- Manned Weather Stations (1274)
- Radiosondes (11)
- eXpendable BathyThermographs (32)

Other Networks
- HF Radars (270)
- Animal Borne Sensors (53)

Generated by www.jcommops.org, 09/04/2020



April 2020

Main in-situ Elements of the Global Ocean Observing System

Argo

- Argo (3953)
- Deep-Argo (113)
- BGC-Argo (396)

DBCP

- Surface Drifters (1464)
- Fixed Platforms (94)
- Ice Buoys (25)
- Moored Buoys (368)
- Tsunameter (29)

OceanSITES

- Platforms (345)

GO-SHIP

- GO-SHIP (63)

GLOSS

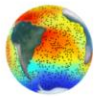
- Tide Gauges (290)

SOT

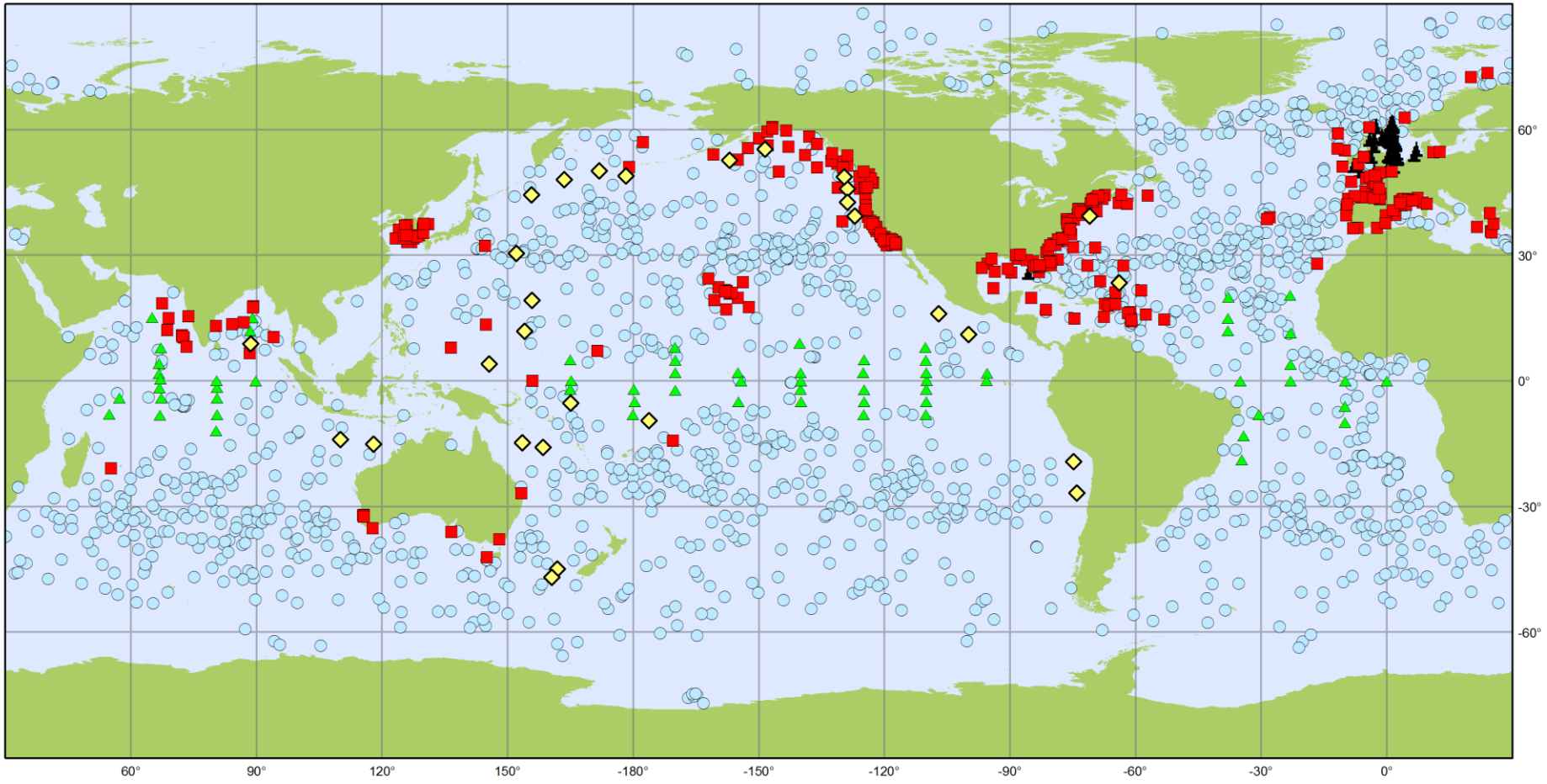
- VOSClim-Automated (70)
- VOSClim-Manned (340)
- VOS-Automated (151)
- VOS-Manned (903)
- ASAP Radiosondes (11)
- SOOP XBTs (32)

Other Networks

- HF Radars (270)
- Animal Borne Sensors (53)



Generated by www.jcommops.org, 15/05/2020
Projection: WGS 1984 Spilhaus Ocean Map in Square



Data Buoy Cooperation Panel

Operational Platforms

March 2020

Platforms operational during the month. GTS data as received by Meteo France.

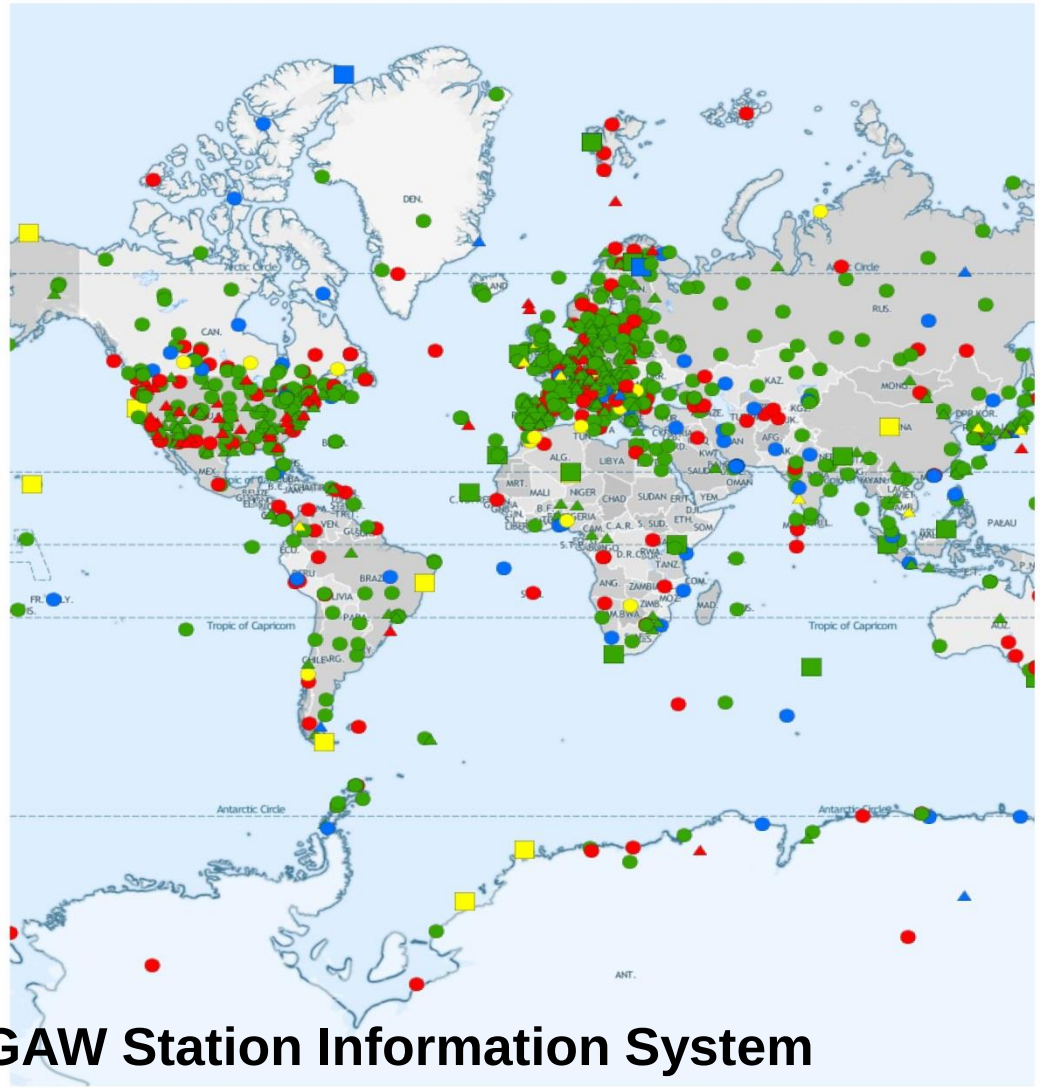
- Tsunameters (29)
- Coastal/National MB (291)
- Tropical MB (67)
- Fixed Platforms (94)
- Drifting Buoys (1 554)

2020年3月正常运行中的海洋观测平台

Generated by www.jcommops.org, 06/04/2020

WMO OMM

“Health”（全球大气成分） of the observational network



GAW Station Information System (GAWSIS)

Procedures for stations and networks are in place

The observational network evolution follows the **Rolling Review of Requirement** process

GAW observational network comprises:

- Global stations (31)
- Regional stations
- Local stations
- Mobile platform
- Contributing networks (10)

Very few measurements over the oceans!

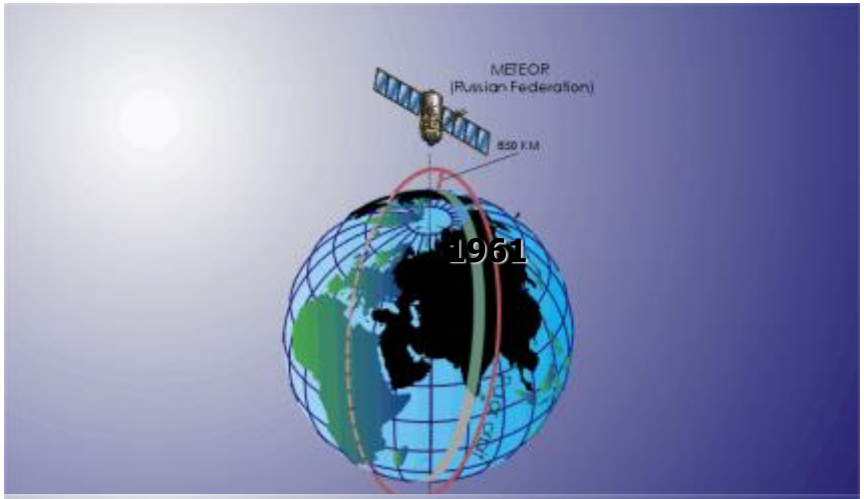
World Meteorological Organization

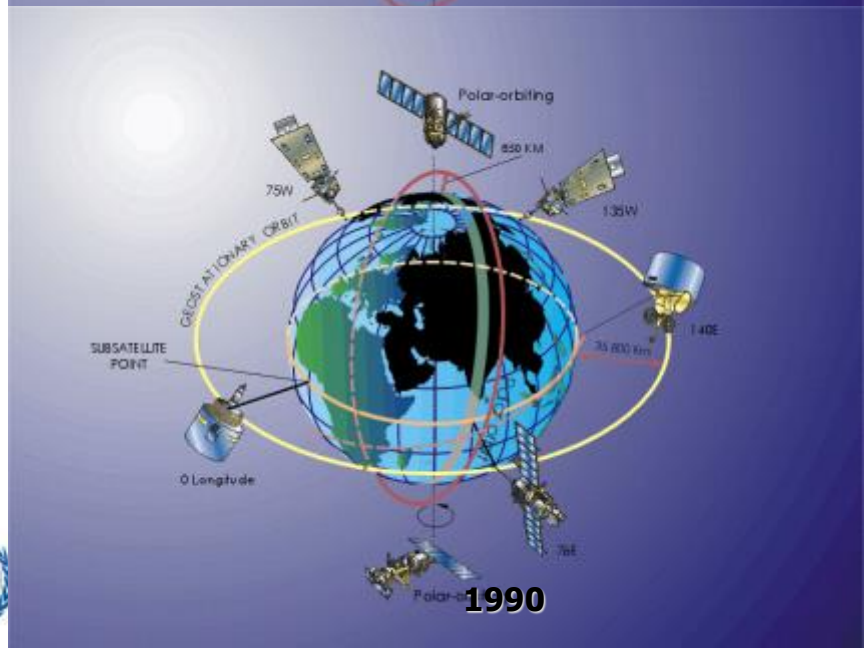
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

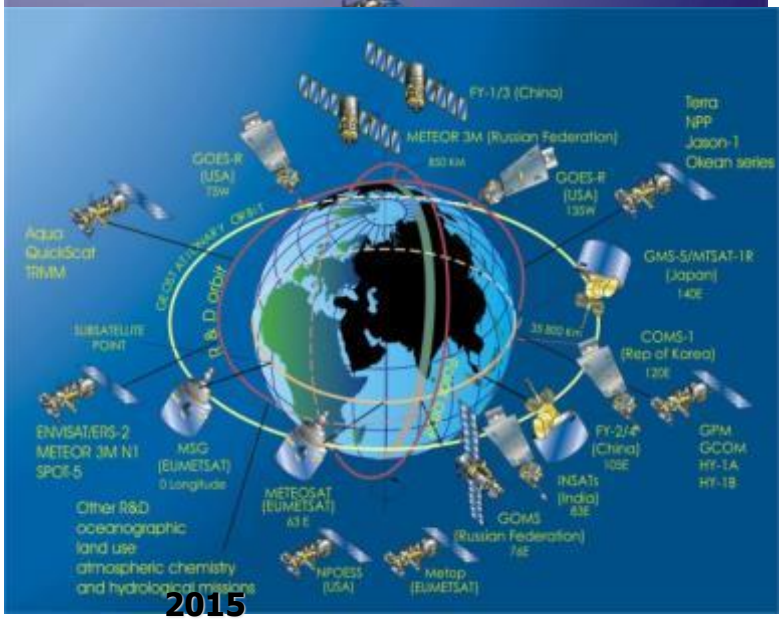
Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

Global	■	Reporting	●
Regional	●	Partly Reporting	●
Contributing	▲	Non-reporting	●
Local	★	Closed	●
		Planned	●
		Pre-operational	●

WMO Global Observing Network with global satellite constellations (GEO and LEO)

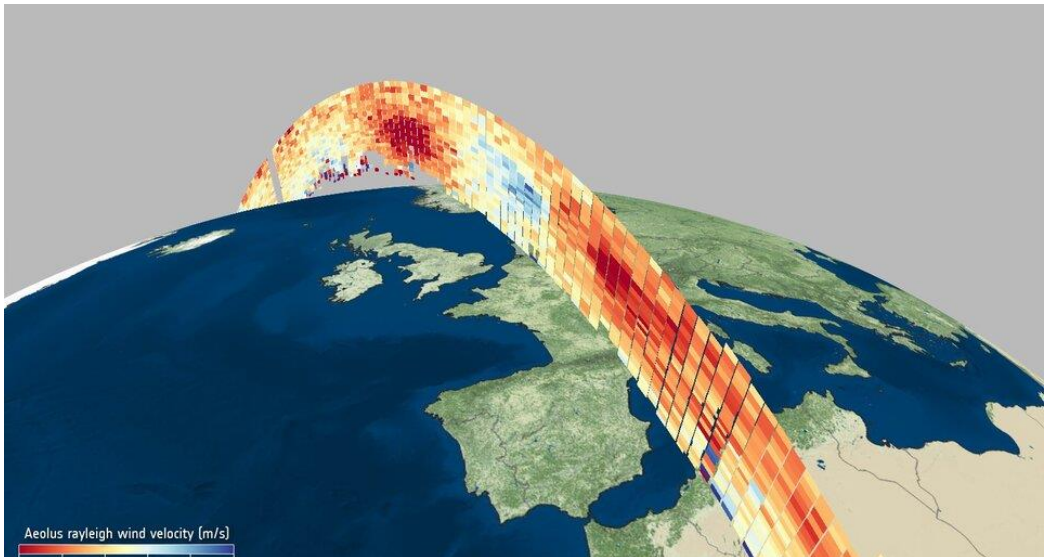


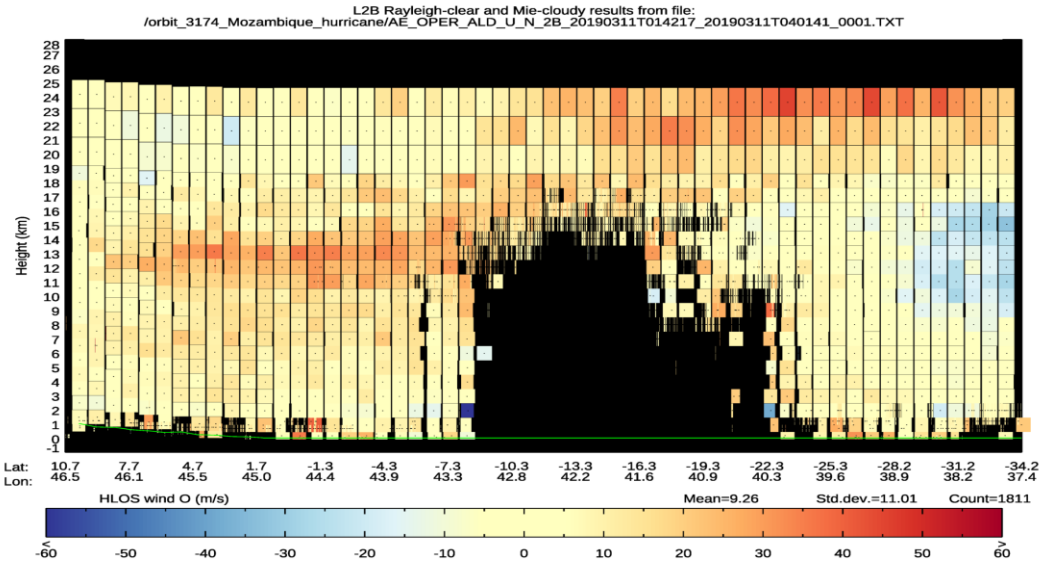




Aeolus （2018.08发射）大气风垂直扩线探测；ECMWF 及法德英和挪威等气象部门已经评估了对全球数值天气预报的积极作用

- Aeolus的Aladin是有史以来唯一能从太空提供风垂直扩线的仪器。它通过发出激光紫外脉冲测量在不同层之间反向散射的多普勒频移信号。给出30km下无云、薄云内和厚云顶各层的风。
- Aeolus准实时数据（3小时内的）通过ESA 网站和EUMETCast及GTS向4,000个欧洲用户以及整个WMO成员提供（19 May 2020）。https://aeolus-ds.eo.esa.int/oads/access/
- https://www.eumetsat.int/website/home/News/DAT_5009311.html?lang=EN

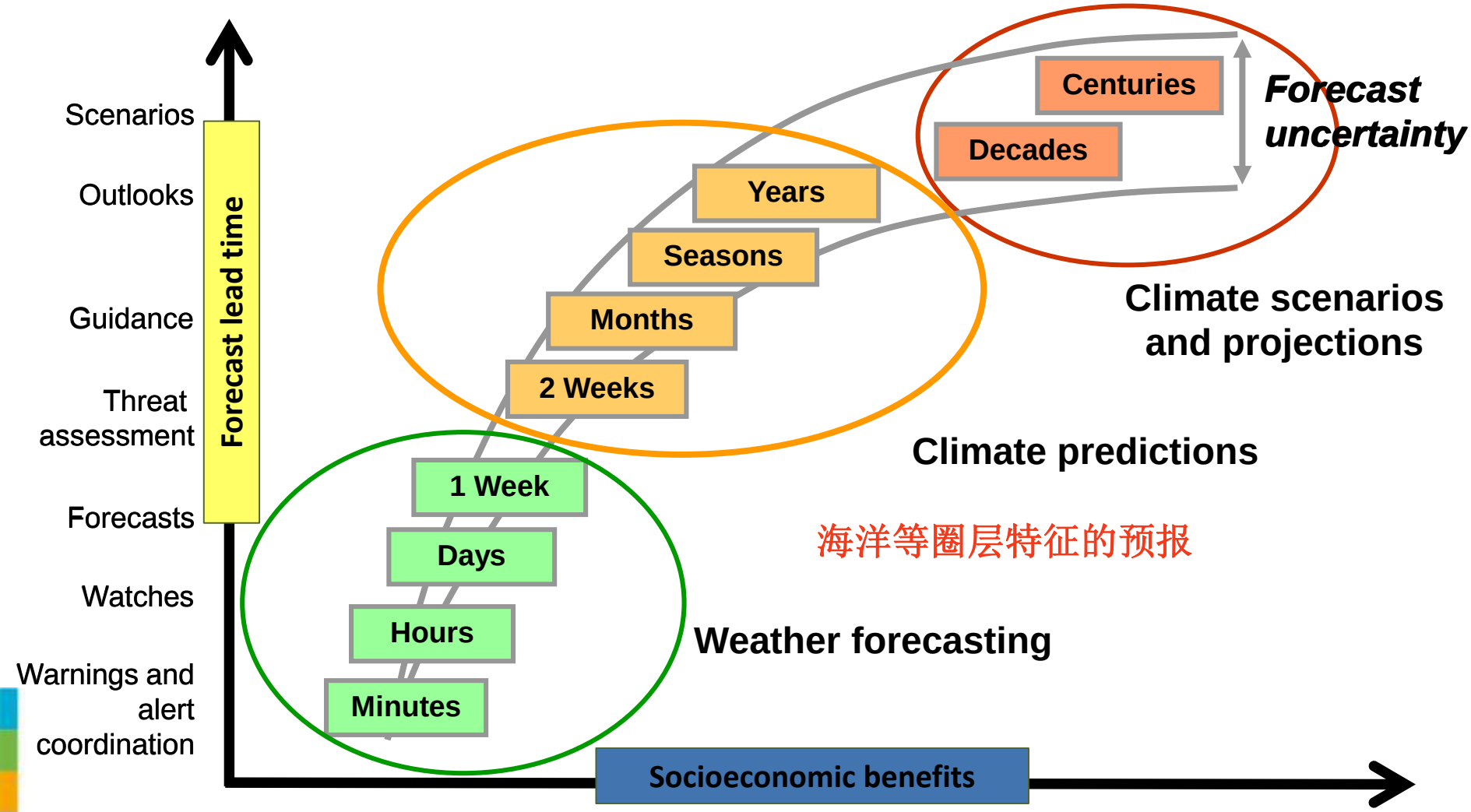




WMO OMM

地球系统预报支撑的无缝隙预报应用

Weather-to-climate: seamless framework

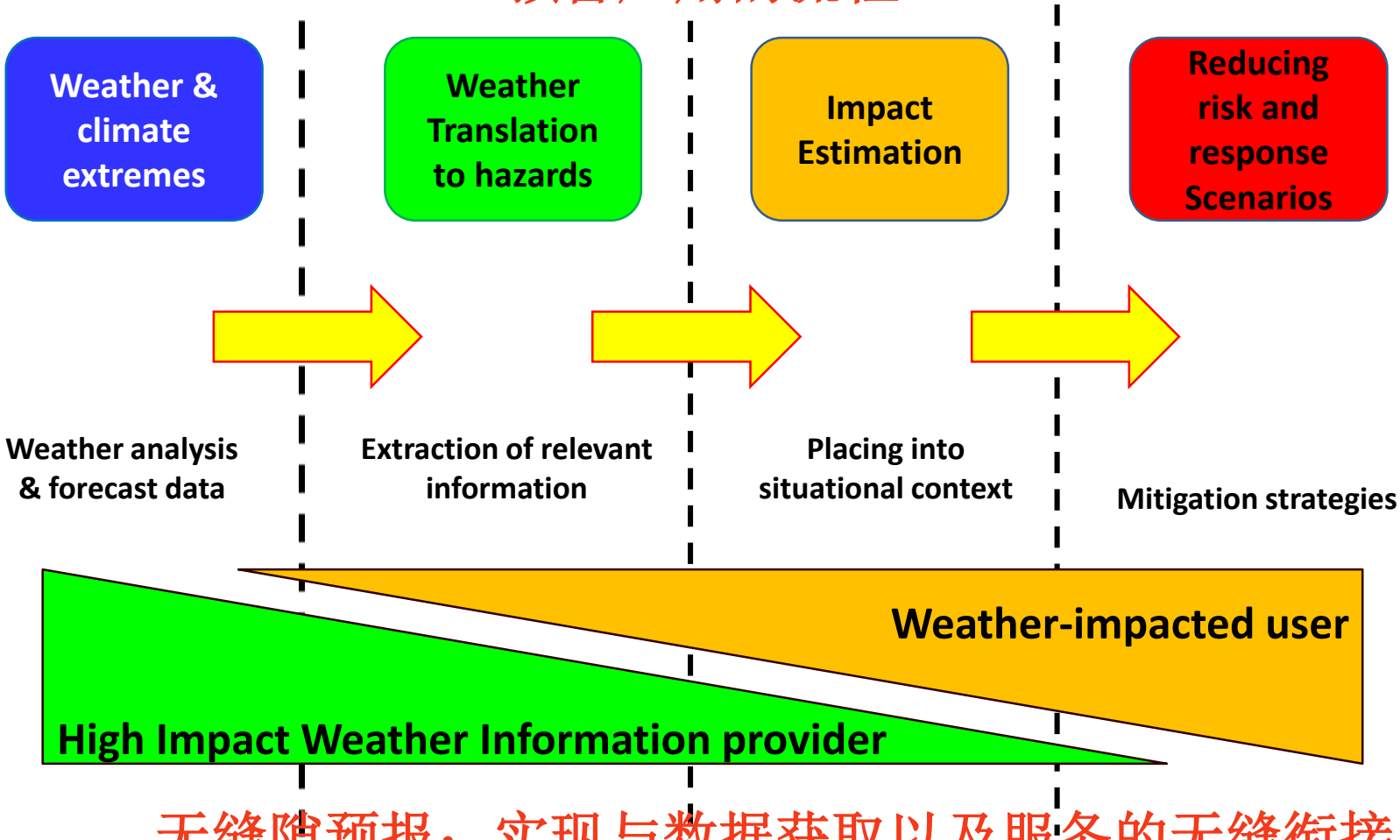


融入海洋预报的无缝隙预报的技术路线

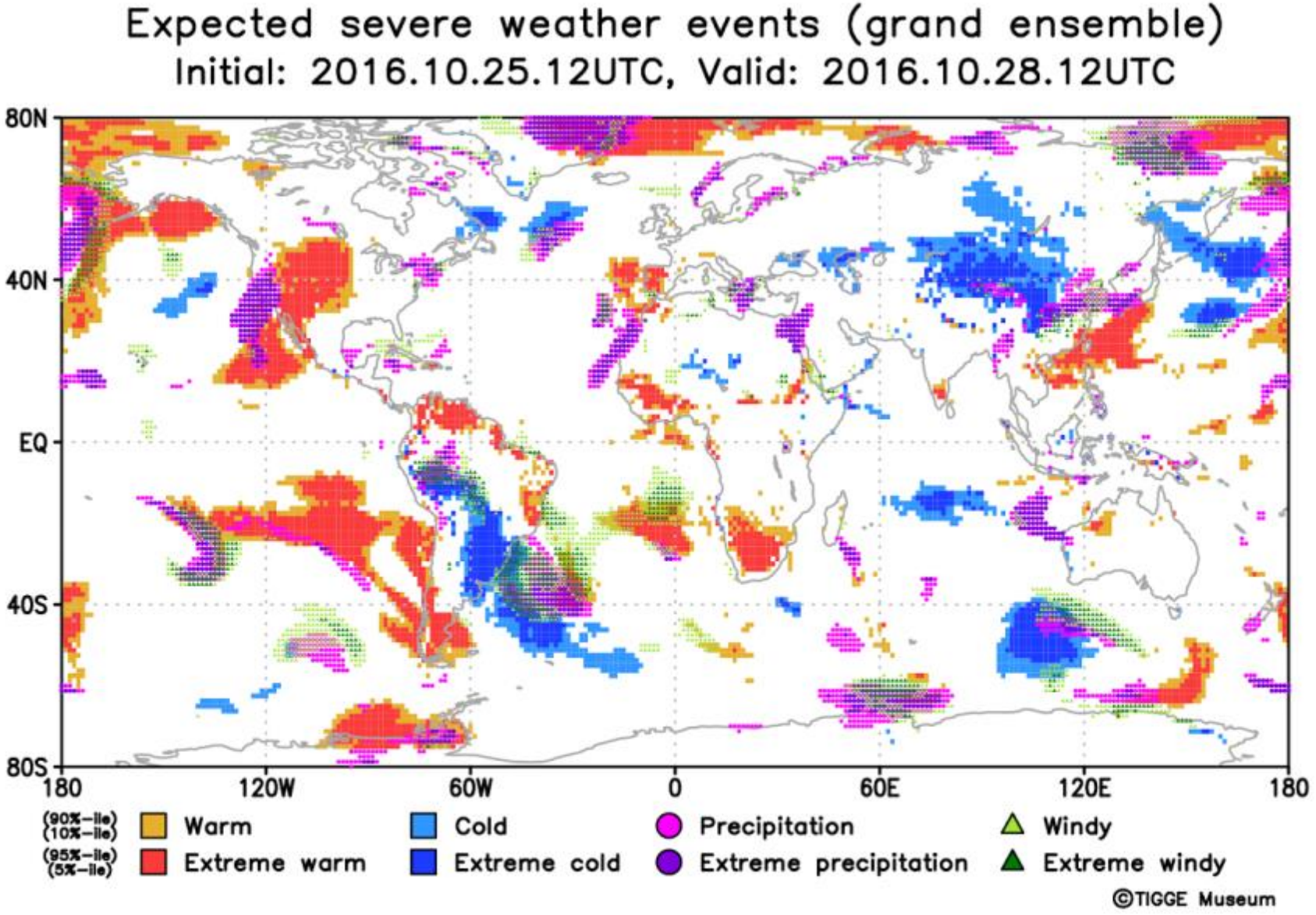
Adapted from NOAA 2011

Seamless information towards impacts: seamless between provider and user

连接从天气气候事件到用户的决策应用的基于影响的预报和预警应用的流程



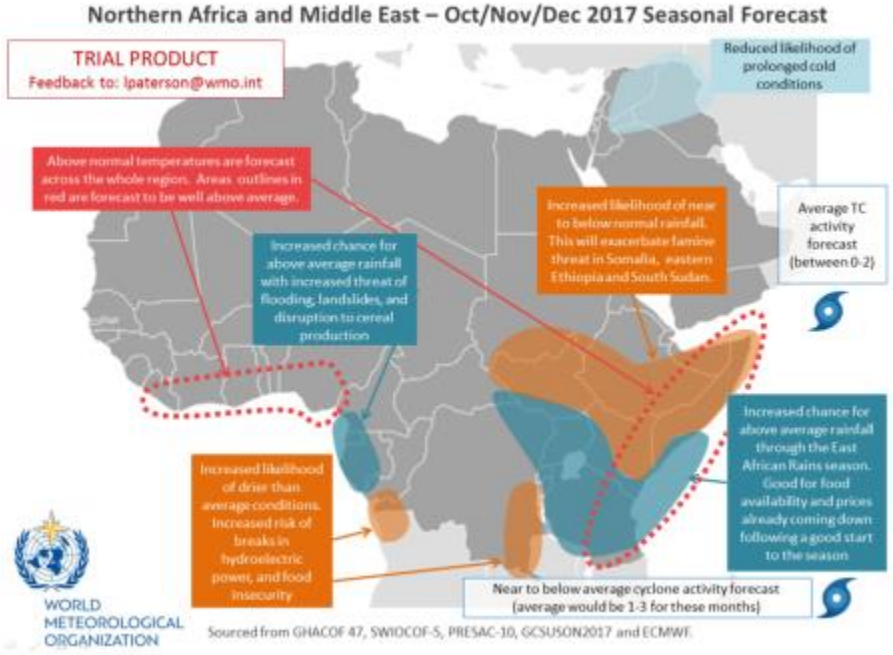
无缝隙预报：实现与数据获取以及服务的无缝衔接影响的分析、评估和预估也是无缝隙的。



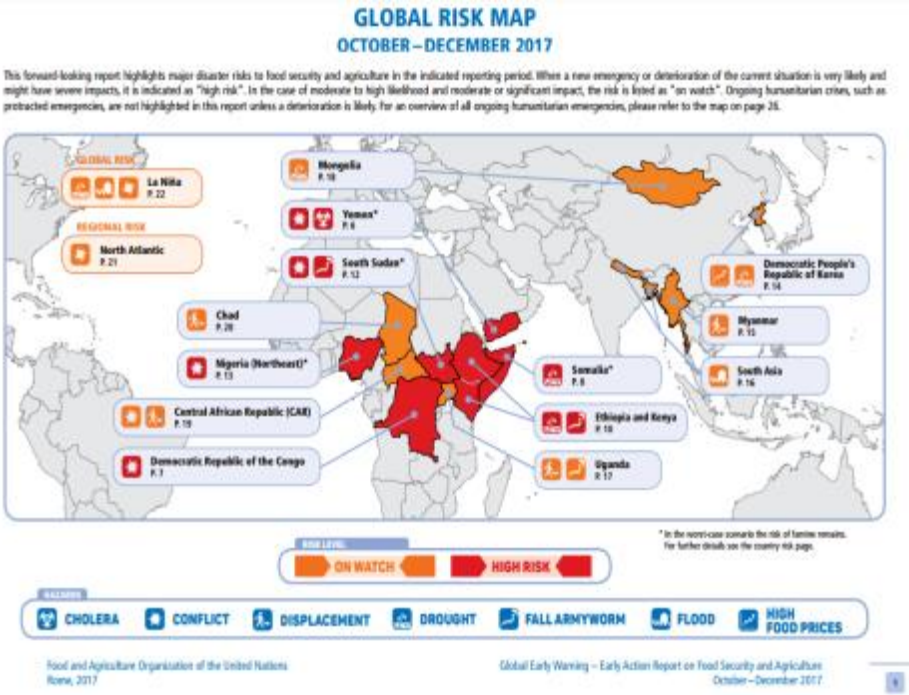
3 days prediction on expected extreme events: i.e. extreme warm, and precipitation in Artic region

Risk mapping and assessment: Weather and climate products for reducing disaster risk (from Laura Paterson)

- Value added products can then be made by combining weather predictions and seasonal forecasts with other data – based on likelihood of hazard, vulnerability, exposure, coping capacity and ongoing issues affecting UN operations.
- Needs close relations with customer to learn sensitivities appropriately.



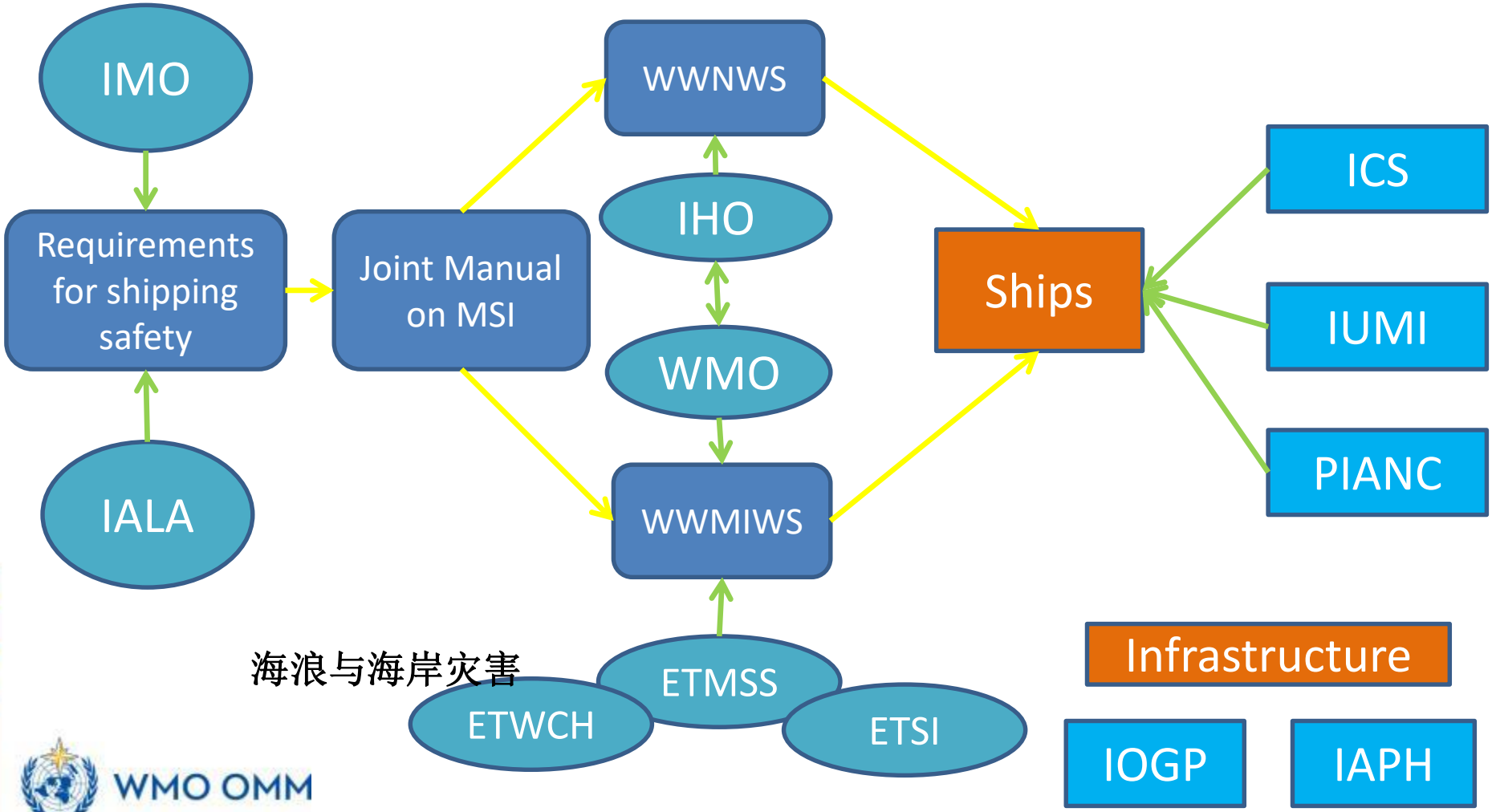
Trial WMO product to UNOCC



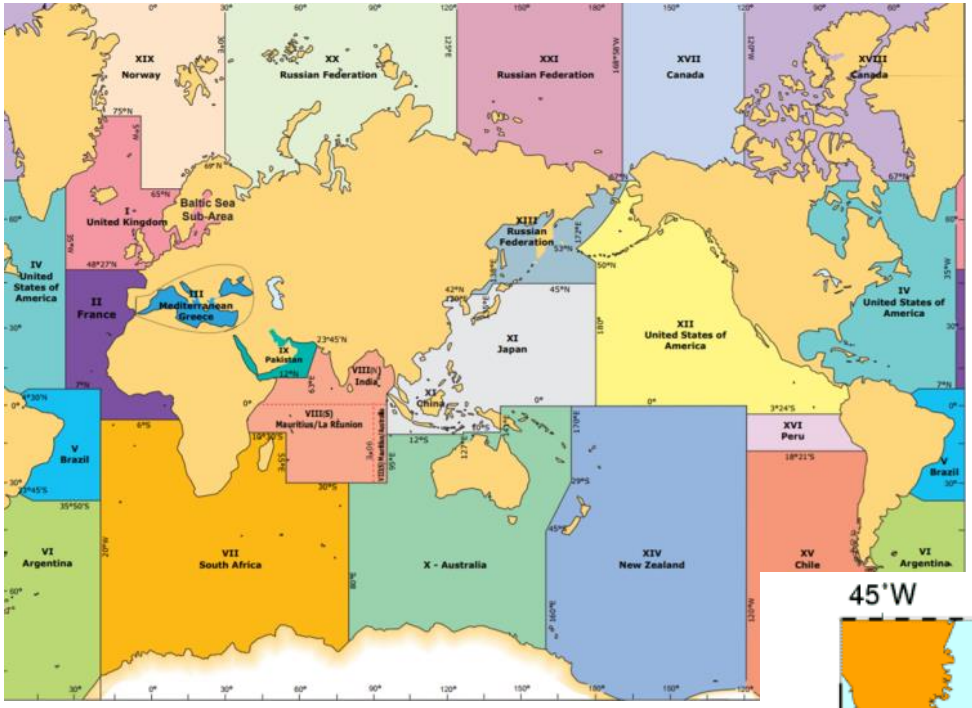
Existing FAO monthly multi-hazard report

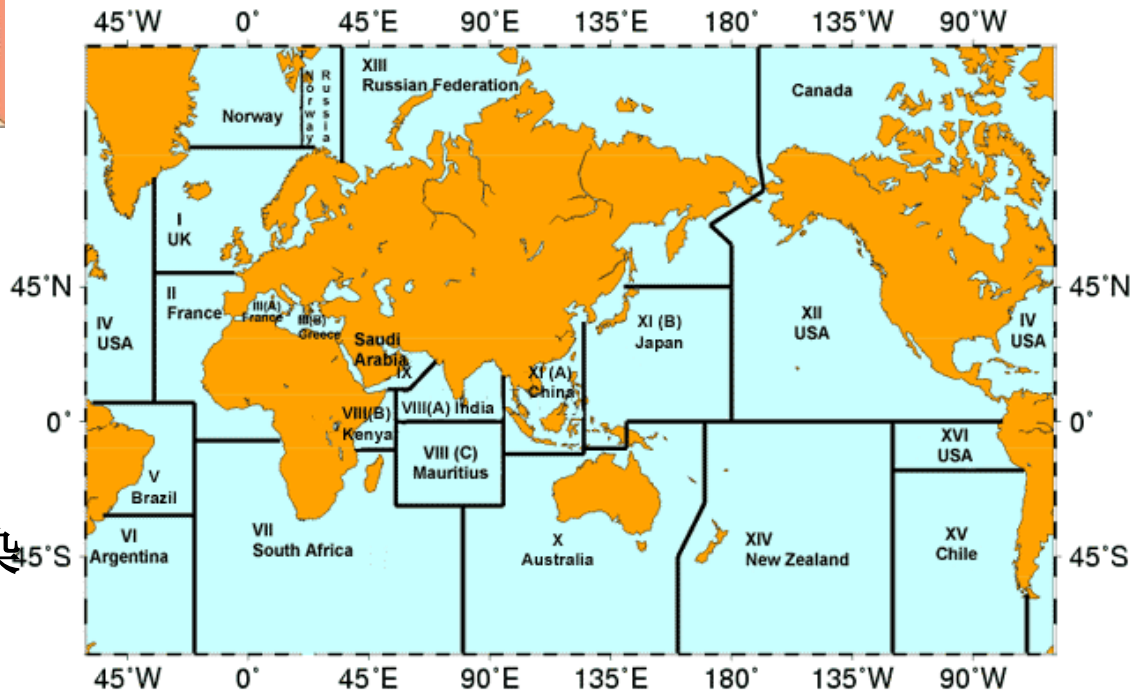
WMO OMM

Partnership landscape for Maritime Safety
海洋气象服务业务系统与合作伙伴网络



IMO/WMO Worldwide Met-Ocean Information and Warning Service (21)





MPERSS Marine Pollution Emergency Response Support System for the high seas 海上污染应急响应支持系统

WMO OMM

IMO/WMO **International Symposium on Extreme Maritime Weather - Towards Safety of Life at Sea and a Sustainable Blue Economy** (23-25 October 2019）

加强海洋气象计划与海上运输界合作的努力

PURPOSE: Identifying ways to reduce the loss of life and property, damage to the environment, as well as disruptions to the economy from extreme maritime weather.

Outcomes of the Symposium: The met-ocean, shipping and other relevant maritime communities are working together :

- To optimize and improve the value chain ranging from met-ocean observations to forecasts, products and services, to minimize risks of adverse weather to vessels and property at sea
- Impact based supporting services
- Effective and efficient delivery to the end-users such as industry, shipping, freight and passenger companies, trans-oceanic route planning, as well as weather avoidance and environmental emergency response.
- Better understanding of the opportunities and challenges between those delivering met-ocean information.
- Assistance to countries to respond to SDGs, SFDRR including UNDOS.

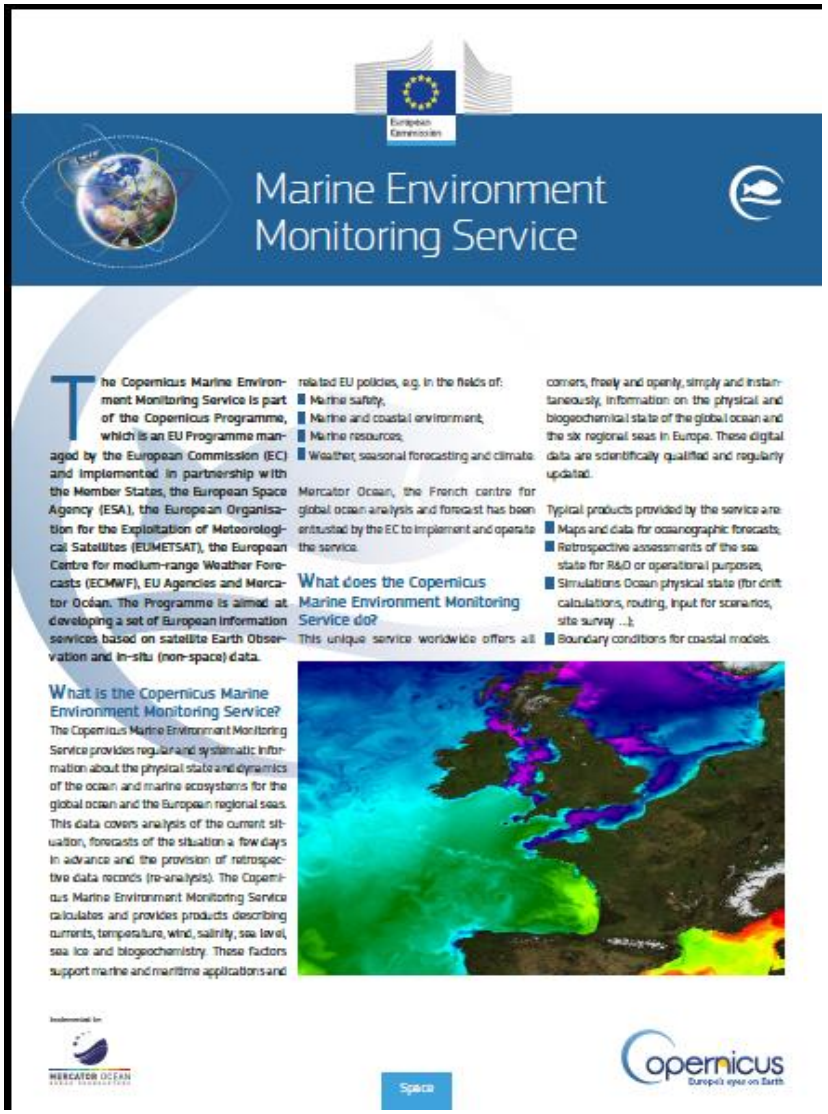
International Symposium

WEATHER CLIMATE WATER
WORLD METEOROLOGICAL ORGANIZATION
Supporting the global maritime community to access metocean products and decision support services
IMO
INTERNATIONAL MARITIME ORGANIZATION

WMO OMM

The Copernicus Marine Environment Monitoring Service (CMEMS) 区域海洋知识与信息服务范例

- provides regular and systematic reference information on the physical and biogeochemical state, variability and dynamics of the ocean and marine ecosystems for the global ocean and the European regional seas.
- The observations and forecasts produced by the service support all marine applications, including:
- Marine safety;
- Marine resources;
- Coastal and marine environment;
- Weather, seasonal forecasting and climate.
- Mercator Ocean International (5 France, the Norwegian NERSC , UKMO, Italian CMCC , Spanish Puertos Del Estado)



Marine Environment Monitoring Service

The Copernicus Marine Environment Monitoring Service is part of the Copernicus Programme, which is an EU Programme managed by the European Commission (EC) and implemented in partnership with the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for medium-range Weather Forecasts (ECMWF), EU Agencies and Mercator Océan. The Programme is aimed at developing a set of European information services based on satellite Earth Observation and in-situ (non-space) data.

related EU policies, e.g. in the fields of:
- Marine safety,
- Marine and coastal environment,
- Marine resources,
- Weather, seasonal forecasting and climate.

Mercator Ocean, the French centre for global ocean analysis and forecast has been entrusted by the EC to implement and operate the service.

What does the Copernicus Marine Environment Monitoring Service do?

This unique service worldwide offers all corners, freely and openly, simply and instantaneously, information on the physical and biogeochemical state of the global ocean and the six regional seas in Europe. These digital data are scientifically qualified and regularly updated.

Typical products provided by the service are:
- Maps and data for oceanographic forecasts,
- Retrospective assessments of the sea state for R&D or operational purposes,
- Simulations Ocean physical state (for drift calculations, routing, input for scenarios, site survey ...),
- Boundary conditions for coastal models.

What is the Copernicus Marine Environment Monitoring Service?

The Copernicus Marine Environment Monitoring Service provides regular and systematic information about the physical state and dynamics of the ocean and marine ecosystems for the global ocean and the European regional seas. This data covers analysis of the current situation, forecasts of the situation a few days in advance and the provision of retrospective data records (re-analysis). The Copernicus Marine Environment Monitoring Service calculates and provides products describing currents, temperature, wind, salinity, sea level, sea ice and biogeochemistry. These factors support marine and maritime applications and

MERCATOR OCEAN

Space

Copernicus
Europe's eyes on Earth

WMO OMM

当前，海洋气象的热点:*从满足单一需求向适应多需求发展，实现与多学科领域的融合*

- **传统的海洋气象定义：**海洋气象学是气象学的一个分支，主要研究海洋上的各种大气现象，这些大气现象对海洋深处和浅处的影响以及海洋表面对大气现象的影响 。海洋气象学也包括海洋气象知识及信息的应用。
- **海洋气象与多学科融合热点：（1）海洋与气候变化**（如冰雪圈信号和海洋热容量的监测、海平面升高、海洋生物多样性等）、（2）**海洋与防灾减灾**（**海岸带积涝、海啸**等多灾种早期预警、海上灾害性天气**WWMIWS**等）、（3）海洋环境预报与**地球系统模拟与预报**、（4）海洋观测与**全球气候系统监测**、（5）海洋**数据与综合信息管理**、（6）海洋**知识与能力建设**。
- **学科知识支撑重大国际发展议程：**（1）气候与气候变化与海洋科学基础数据系统（WMO/IOC/**IPCC/WCRP/UNFCCC/PA-COP**）；（2）海洋**灾害**风险管理与多灾种早期预警（**海上生命安全公约**SOLAS/**仙台减灾框架协议**SFDRR/IMO/IHO/WMO/UNDRR）；（3）健康海洋与可持续发展（**联合国海洋法公约 UNCLOS /SDG14/UNFCCC-Ocean Pathway/Blue Economy/UN Ocean Science Decade)**;**
- **海洋气象与海洋学计划的结合JCOMM及再结合 JCB：现在与未来;**
- **支撑可持续发展目标的联合国《海洋科学十年》**以及气候变化缔约方大会《海洋实施道路》与《蓝色海洋》经济等。

JCOMM由WMO/IOC联合建立（1999年）

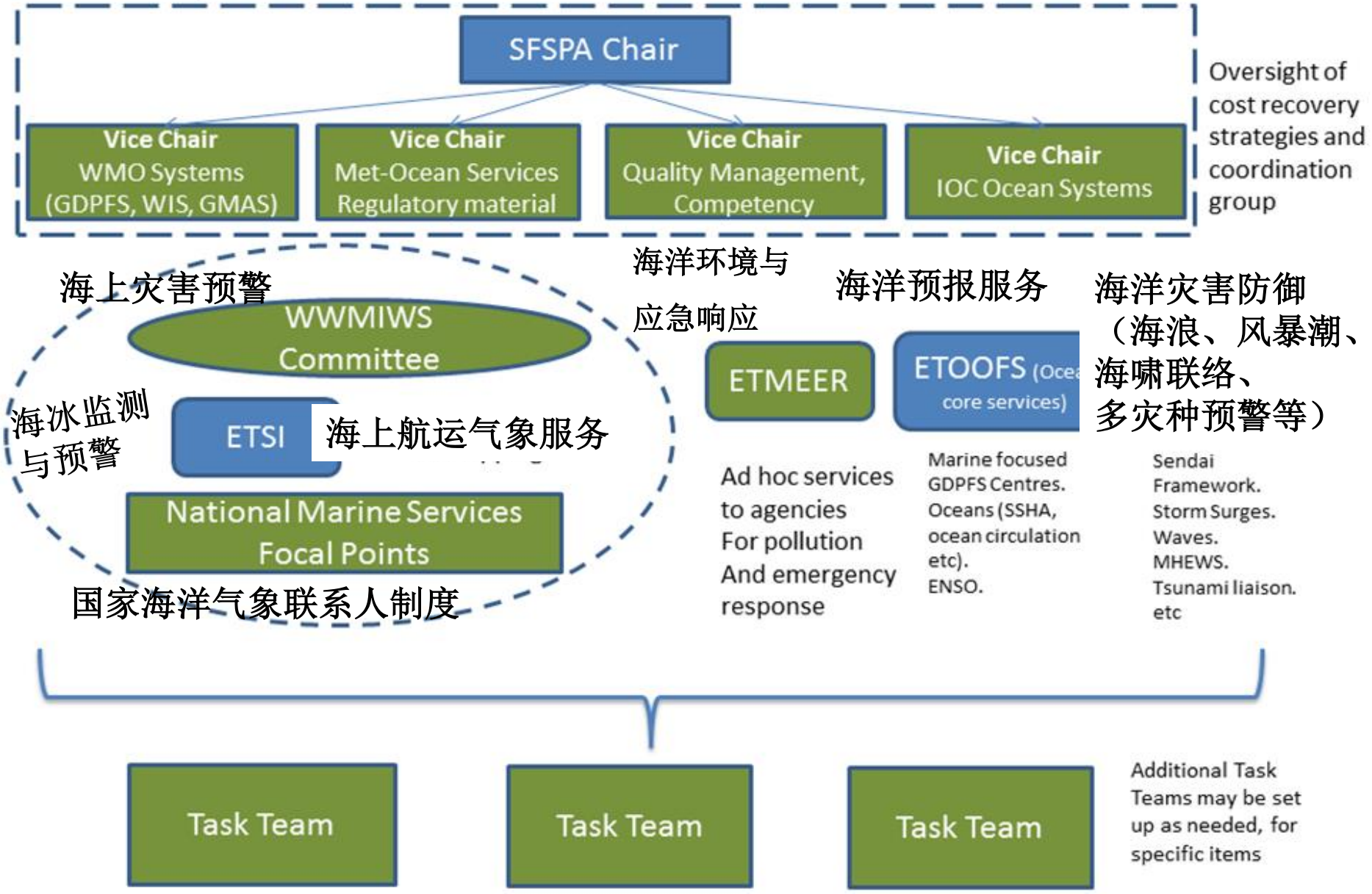
- 共同的技术标准Common standards and interoperability
  of observations, infrastructure and information management systems
- 注重观测-研究-服务价值链的实现Strengthening value chain from observations and research to services

- 海洋模拟与预报Ocean modelling and forecasting systems
- 海洋大气研究与气候服务Science combining ocean and atmosphere that has relevance in developing climate services
- 强化合作，服务各国More strategic collaboration to support Members in implementing international commitments

WMO OMM

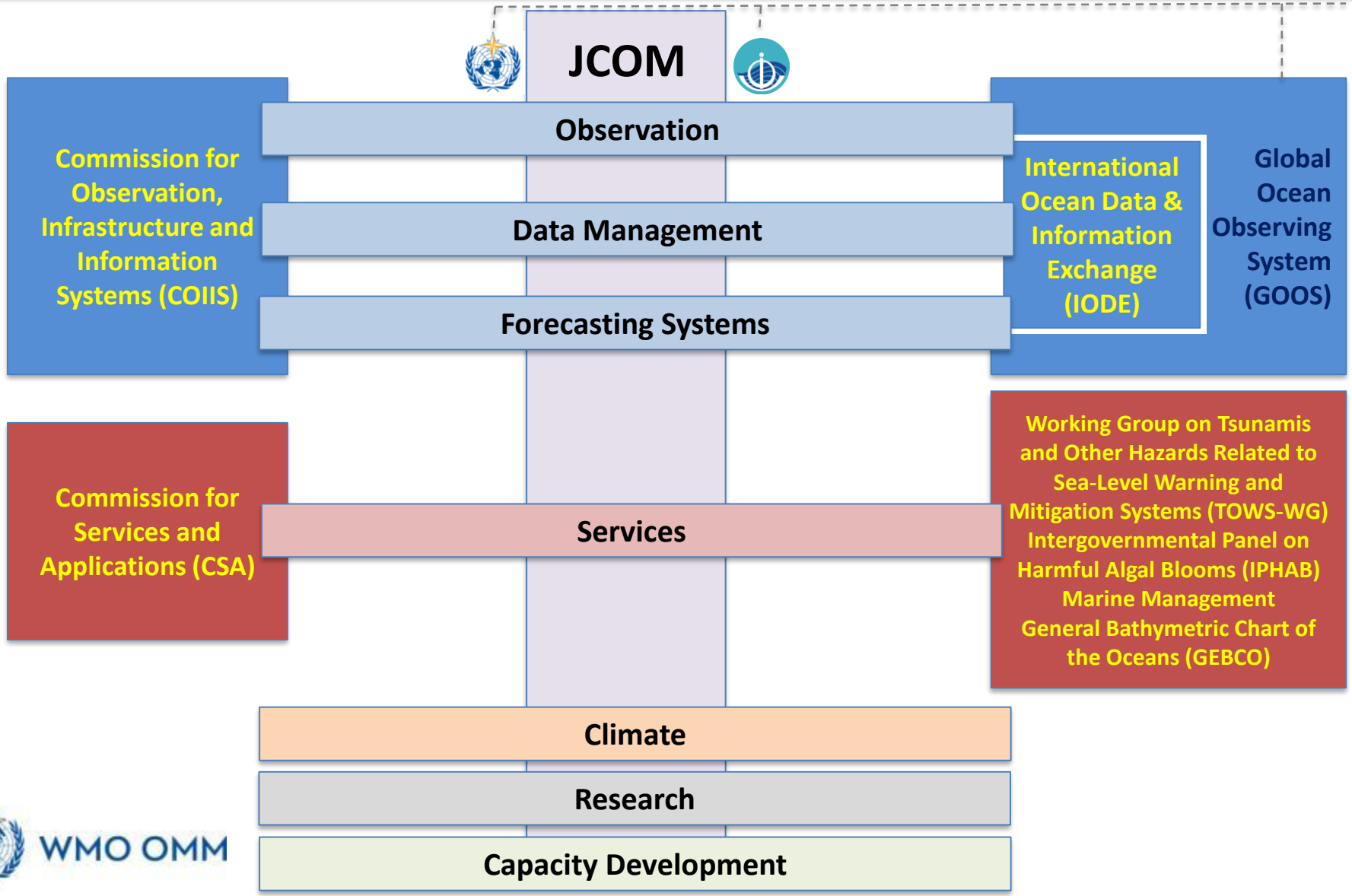
JCOMM 海洋气象预报服务计划与专家组结构

Green = Ne
Blue = Existing



Suggested coordination and integration role of JCOM

(To be further defined by the joint WMO-IOC consultation group)



WMO OMM

当前，海洋气象的热点:*从满足单一需求向适应多需求发展，实现与多学科领域的融合*

- **传统的海洋气象定义：**海洋气象学是气象学的一个分支，主要研究海洋上的各种大气现象，这些大气现象对海洋深处和浅处的影响以及海洋表面对大气现象的影响 。海洋气象学也包括海洋气象知识及信息的应用。
- **海洋气象与多学科融合热点：（1）海洋与气候变化**（如冰雪圈信号和海洋热容量的监测、海平面升高、海洋生物多样性等）、（2）**海洋与防灾减灾**（**海岸带积涝、海啸**等多灾种早期预警、海上灾害性天气**WWMIWS**等）、（3）海洋环境预报与**地球系统模拟与预报**、（4）海洋观测与**全球气候系统监测**、（5）海洋**数据与综合信息管理**、（6）海洋**知识与能力建设**。
- **学科知识支撑重大国际发展议程：**（1）气候与气候变化与海洋科学基础数据系统（WMO/IOC/**IPCC/WCRP/UNFCCC/PA-COP**）；（2）海洋**灾害**风险管理与多灾种早期预警（**海上生命安全公约**SOLAS/**仙台减灾框架协议**SFDRR/IMO/IHO/WMO/UNDRR）；（3）健康海洋与可持续发展（**联合国海洋法公约 UNCLOS /SDG14/UNFCCC-Ocean Pathway/Blue Economy/UN Ocean Science Decade)**;
- **海洋气象与海洋学计划的结合**JCOMM及**再结合 JCB：现在与未来**;
- **支撑可持续发展目标的联合国《海洋科学十年》**以及气候变化缔约方大会《海洋实施道路》与《蓝色海洋》经济等。

改变世界的SDG17项目标及十年行动

改变世界的17项目标 （2015--2030）

- 可持续发展目标呼吁全世界共同采取行动，消除贫困、保护地球、改善所有人的生活和未来。17项目标于2015年9月由联合国所有会员国一致通过，作为2030年可持续发展议程的组成部分。该议程为世界各国在15年内实现17项目标指明了方向。

- 目前，许多地方的行动正取得进展，但总体而言，进展的速度和规模尚未达到实现可持续发展目标所需的水平。自2020年起的十年内，我们必须采取有力的行动，才能在2030年之前实现可持续发展目标。

行动十年(全球、国家、地方和个人层面) （2020-2030）

- 实现可持续发展目标的期限仅剩十年，世界各国领导人在2019年9月的可持续发展目标峰会上呼吁开展行动十年、实现可持续发展，并承诺调动资金、提高国家行动力、增强机构能力，在2030年目标日期前实现可持续发展目标，不让任何一个人掉队。

- 联合国秘书长呼吁社会各界在三个层面上开展行动十年：**在全球层面**，采取全球行动，为实现可持续发展目标提供更强的领导力、更多资源和更明智的解决方案；**在地方层面**，政府、城市和地方当局的政策、预算、制度和监管框架应进行必要的转型；**在个人层面**，青年、民间社会、媒体、私营部门、联盟、学术界和其他利益攸关方应发起一场不可阻挡的运动，推动必要的变革。

WMO OMM

SUSTAINABLE DEVELOPMENT GOALS SDG -14 目标

保护和可持续利用海洋和海洋资源，促进可持续发展

Conserve and Sustainable Use Oceans, Seas and Marine Resources for Sustainable Development

1. Reduce marine pollution 海洋污染
2. Manage & protect of marine & coastal ecosystems **(by 2020) (Ind.)海岸带生态系统保护与管理**
3. Address impacts of ocean acidification **(Indicator Tier III, +progress)海洋酸化的影响**
4. Eliminate overfishing, manage stocks scientifically **(by 2020)消除捕捞过渡，科学管理存量**
5. Conserve > 10% of coastal and marine areas **(by 2020)保护超过10%的海岸带地区**
6. Prohibit harmful fisheries subsidies **(by 2020)禁止有害的渔业补贴**
7. Ensure economic benefits to SIDS & LDCs from sustainable use of marine resources (e.g. fisheries, aquaculture, tourism) **支持发展中国家**

a. **Build science capacity through IOC Criteria and Guidelines on the Transfer of Marine Technology 科学能力建设**
b. **Access of artisanal fishers to resources and markets 帮助普通渔民**
c. **Conventions, UNCLOS 履行公约与联合国海洋法公约;**

THE OCEAN CONFERENCE

UNITED NATIONS, NEW YORK, 5-9 JUNE 2017

- 为聚焦SDG-14, 推动SDGs， 推动实施可持续发展议程，**2017年5月召开了联合国海洋大会，确立推进重点，加强伙伴合作，落实各类承诺。**
- Seeking ways to support and implement SDG 14: Conserve and sustai the oceans, seas and marine resources for sustainable development
- Polar areas highlighted: risks of melting sea ice, increased hazards
- WMO's voluntary commitments launched, including Year of Polar Prediction (YOPP) – mid 2017 to mid 2019: fostering observations and forecasting capabilities in polar regions, which are changing rapidly due to climate change

YOPP YEAR OF POLAR PREDICTION

WMO OMM

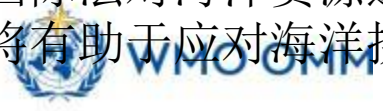
+ PA

+ Ocean Pathway（UNFCCC海洋行动计划：海洋议题在联合国气候变化框架进程中的贡献）

+

BBNJ：国家管辖权外的生物多样性进程

可持续发展目标设立了一套框架持续管理海洋和沿海生态系统，保护其免受陆地污染影响，同时应对海洋酸化带来的影响。加强对话交流，并通过国际法对海洋资源进行可持续管理，
将有助于应对海洋挑战。**SDG-14:** 水下生物及全球海洋生态系统

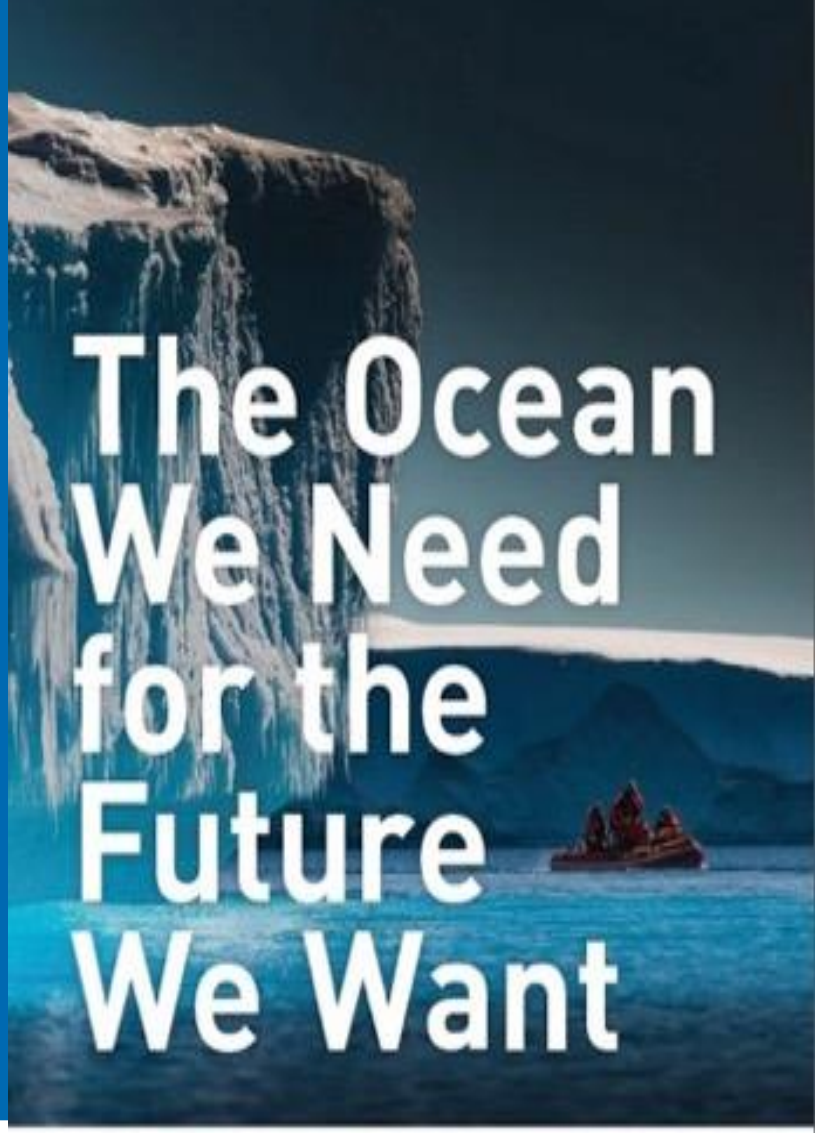


The UN Decade of Ocean Science for Sustainable Development (2021-2030)

Omnibus Resolution for Oceans and the law of the sea

联合国大会通过了开展海洋科学十年行动（2021-2030），实现可持续发展目标的决定（决议A/RES/72/73的第292页）。

（6 December 2017， 72nd UN General Assembly Resolution）



United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission · Sustainable Development Goals

Proposal for an International Decade of Ocean Science for Sustainable Development (2021-2030)

One Planet, One Ocean

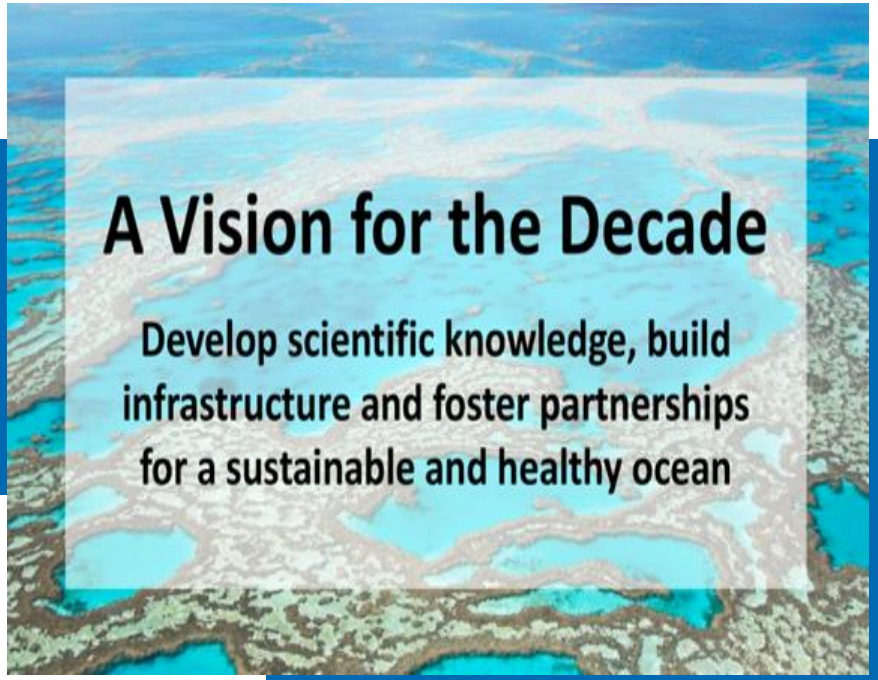
INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO)

Fifty-first Session of the Executive Council
UNESCO, Paris, 3–6 July 2018

十年愿景：发展科学知识，推动基础设施建设，强化伙伴关系，促进海洋可持续和健康发展。　　制定了十年行动路线图

ROADMAP

Item **4.1** of the Revised Provisional Agenda



2021 2030 United Nations Decade of Ocean Science for Sustainable Development

The United Nations
Decade of Ocean Science
for Sustainable Development
(2021-2030)

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Implementation Plan （五大子计划）

Between 2018 and 2020, the UNGA tasked IOC with preparing the Decade and coordinating the development of an Implementation Plan, which will include:

- Science Plan
- Capacity Development Plan
- Resource Plan
- Communications & Engagement Plan
- Monitoring & Reporting

Principles: Inclusive & transformative, focused on solutions 聚焦问题的解决（7）

Science breakthroughs –> top-down designed

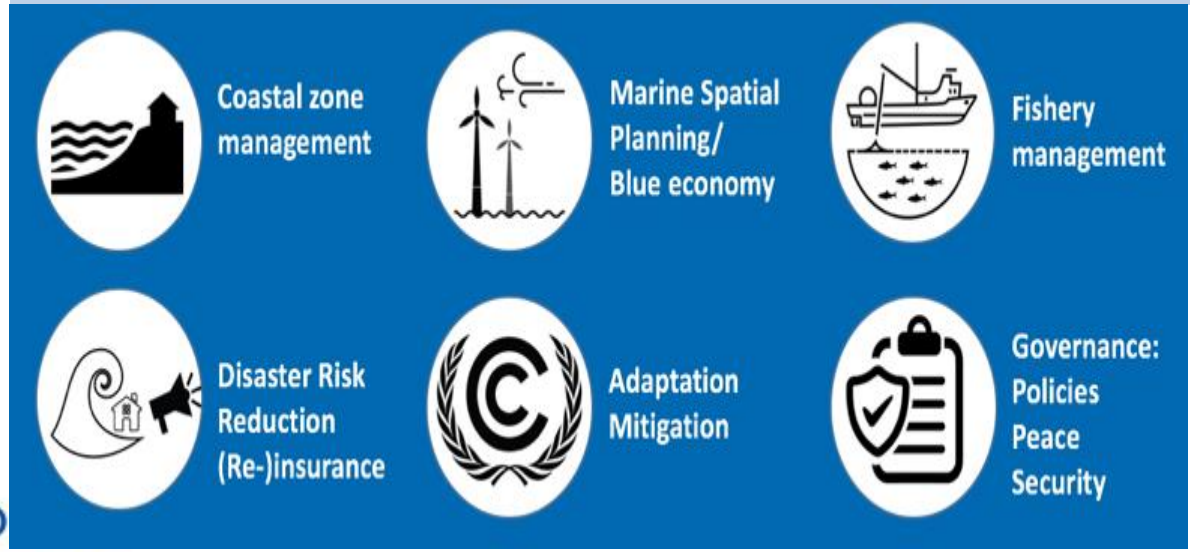
- Mapping 数字海洋地图
- Observations 观测
- Eco-systems生态系统
- Data and Information 数据与信息提供

- Multi-Hazard Warning Systems 多灾种预警系统
- Ocean in Earth System Science 海洋与地球系统科学
- CD, Education, Ocean Literacy 能力建设、教育与文化

Solutions

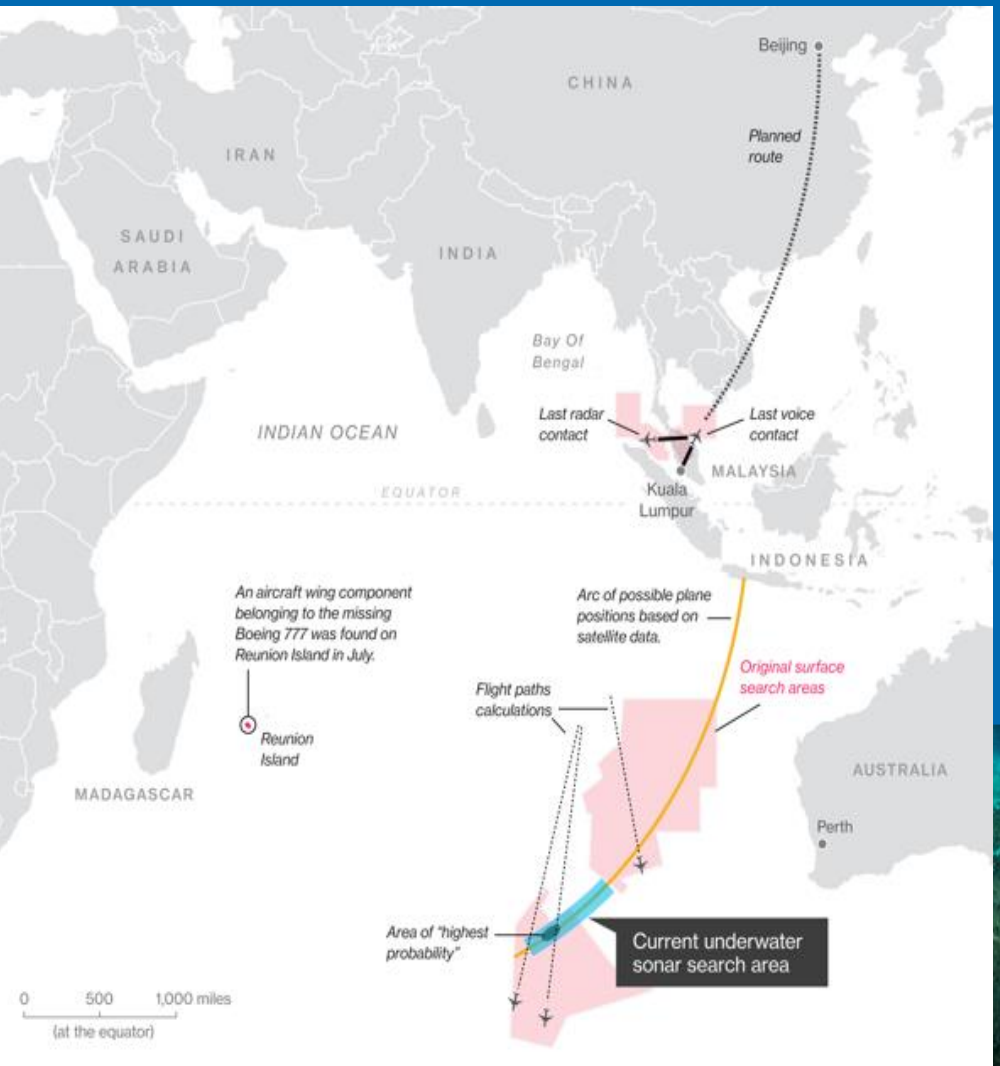
Resources

Pickup by practice –> stimulated



WMO

UN Decade of Ocean Science for Sustainable Development
Priority Research and Development Areas



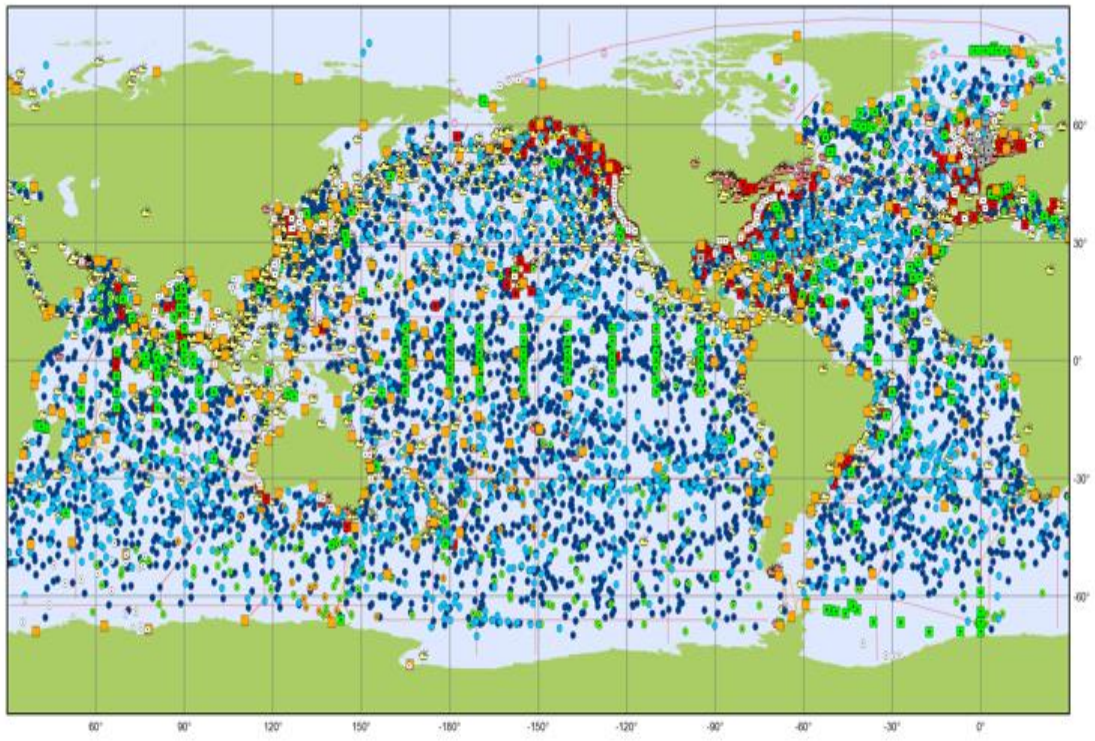
优先研发领域R&D

Priority Area 1:

Comprehensive map (digital atlas) of the ocean 数字海洋

(Scope: well beyond topography)

UN Decade of Ocean Science for Sustainable Development
Priority Research and Development Areas



Main in situ Elements of the Global Ocean Observing System — April 2018

Profiling Floats (Argo)
- Core (3815)
- Deep (57)
- BioGeoChemical (305)

Data Buoys (DBCP)
- Surface Drifters (1408)
- Offshore Platforms (96)
- Ice Buoys (11)
- Moored Buoys (387)
- Tsunameters (32)

Timeseries (OceanSITES)
- Interdisciplinary Moorings (338)

Repeated Hydrography (GO-SHIP)
- Research Vessel Lines (61)

Sea Level (GLOSS)
- Tide Gauges (252)

Ship based Measurements (SOT)
- Automated Weather Stations (248)
- Manned Weather Stations (1767)
- Radiosondes (8)
- eXpendable BathyThermographs (37)

Other Networks
- HF Radars (270)
- Animal Borne Sensors (53)
- Ocean Gliders (31)

Generated by www.jcommops.org, 14/05/2018

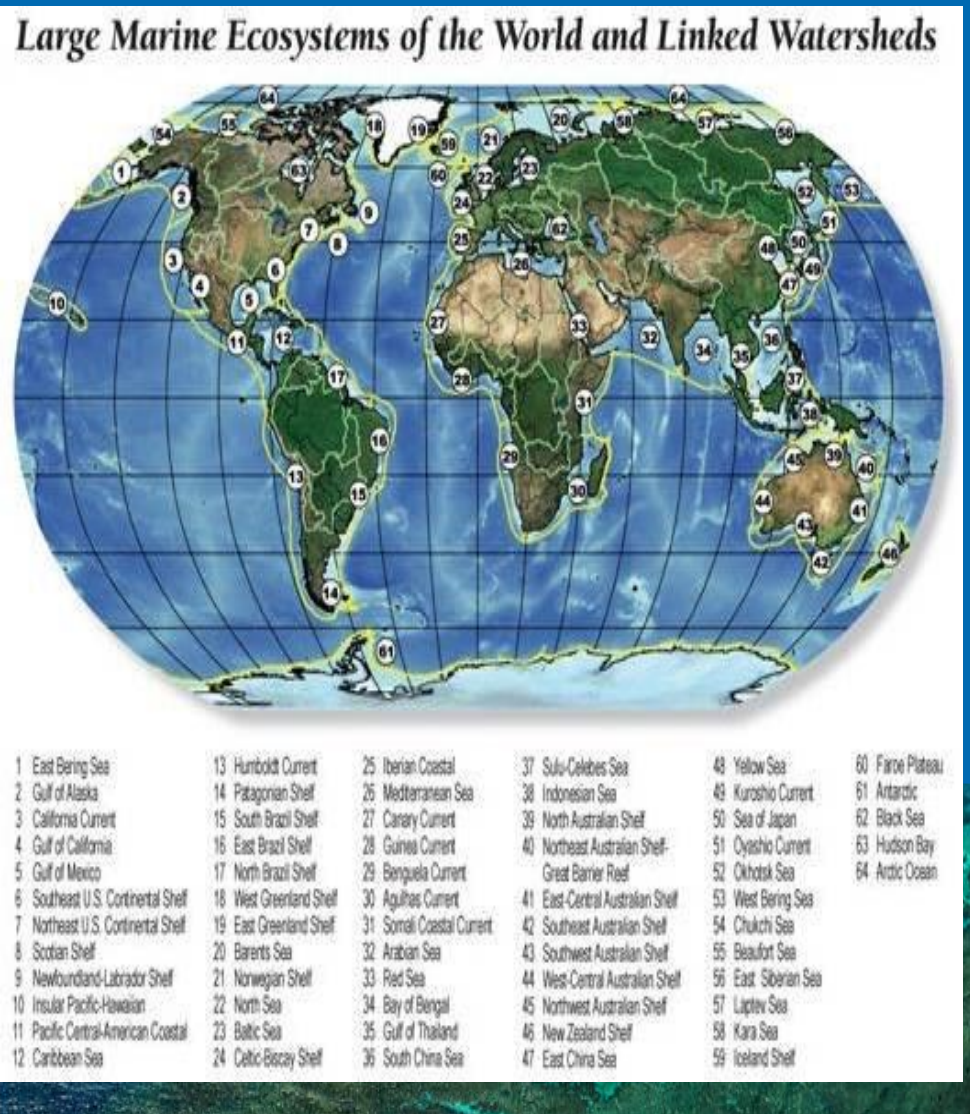
R&D Priority Area 2:

A comprehensive ocean observing system

海洋观测

(polar, bio, eco, BGC, eDNA, deep ocean, +)

UN Decade of Ocean Science for Sustainable Development
Priority Research and Development Areas



R&D Priority Area 3:

A quantitative understanding of ocean ecosystems定量化的海洋生态系统 as the basis for their integrated ocean management

(multiple stressors, deep ocean, bottom, predictive, assisted adaptation, e.g. of coral reef ecosystem)

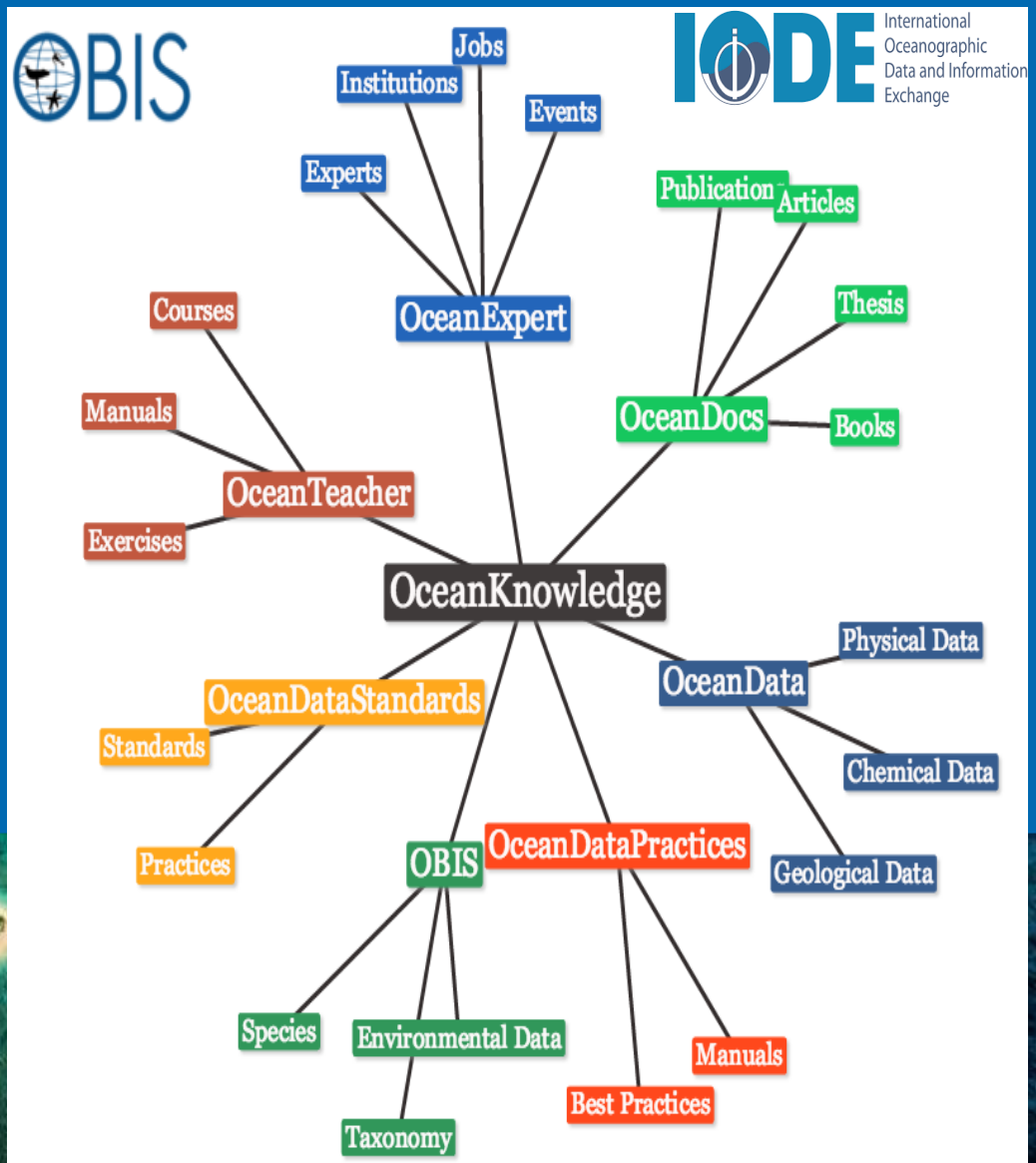
Vavau © Stuart Chape

UN Decade of Ocean Science for Sustainable Development
Priority Research and Development Areas

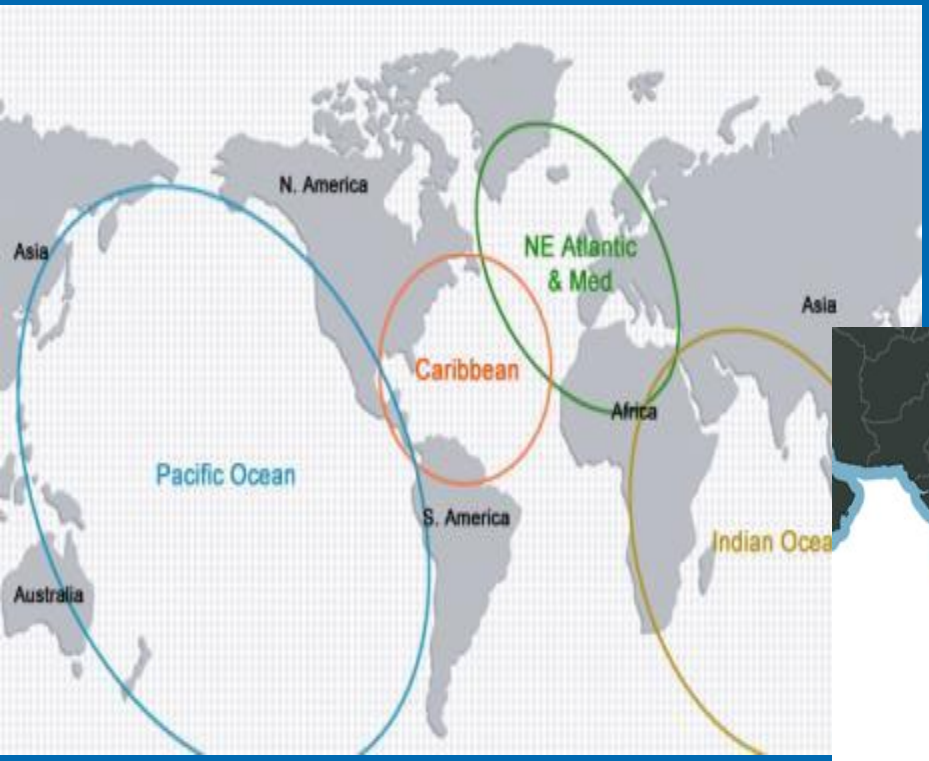
R&D Priority Area 4:

Data & information System

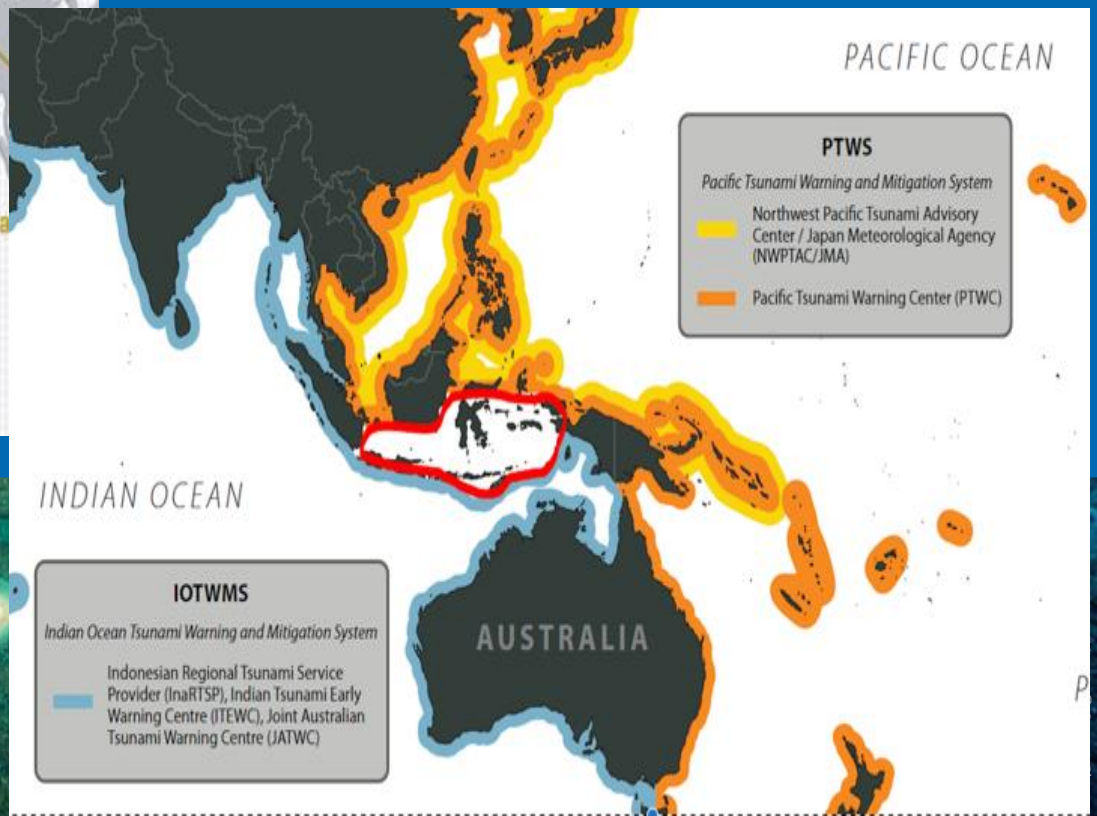
数据与信息系统 (依托国际海洋数据信息交换计划和生物多样性信息系统)



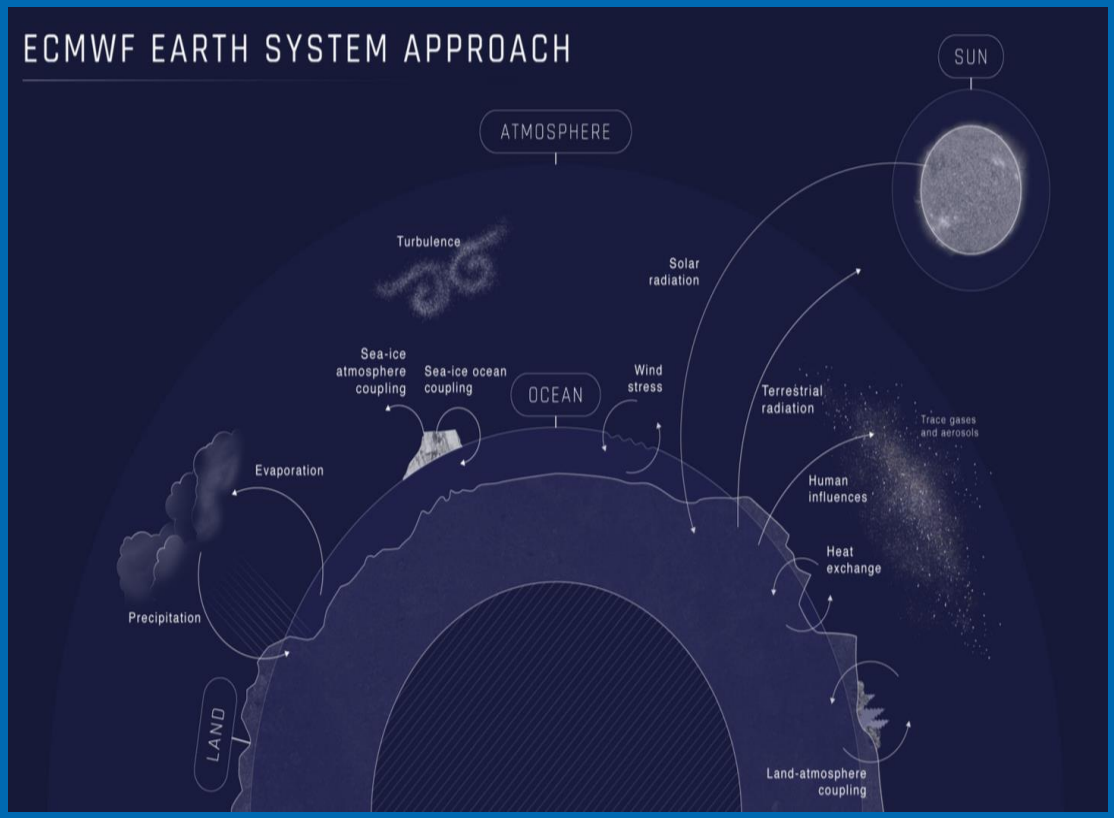
UN Decade of Ocean Science for Sustainable Development
Priority Research and Development Areas



R&D Priority Area 5: Ocean dimension in an integrated multi-hazard warning system多灾种预警系统中的海洋预警系统



UN Decade of Ocean Science for Sustainable Development
Priority Research and Development Areas



R&D Priority Area 6:

Ocean in Earth System Science
海洋与地球系统科学

UN Decade of Ocean Science for Sustainable Development
Priority Research and Development Areas

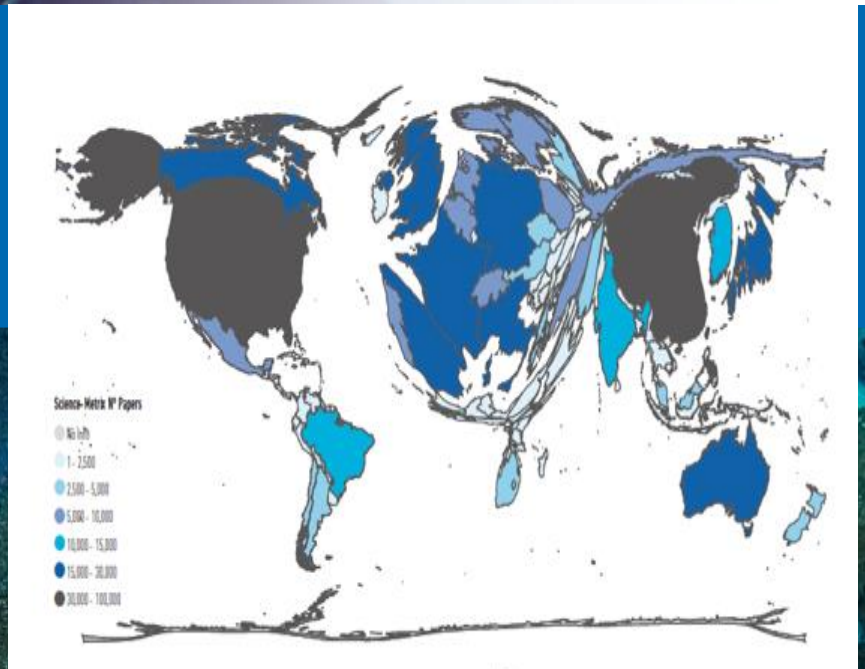
R&D Priority Area 7:

Capacity Development

Education and Training

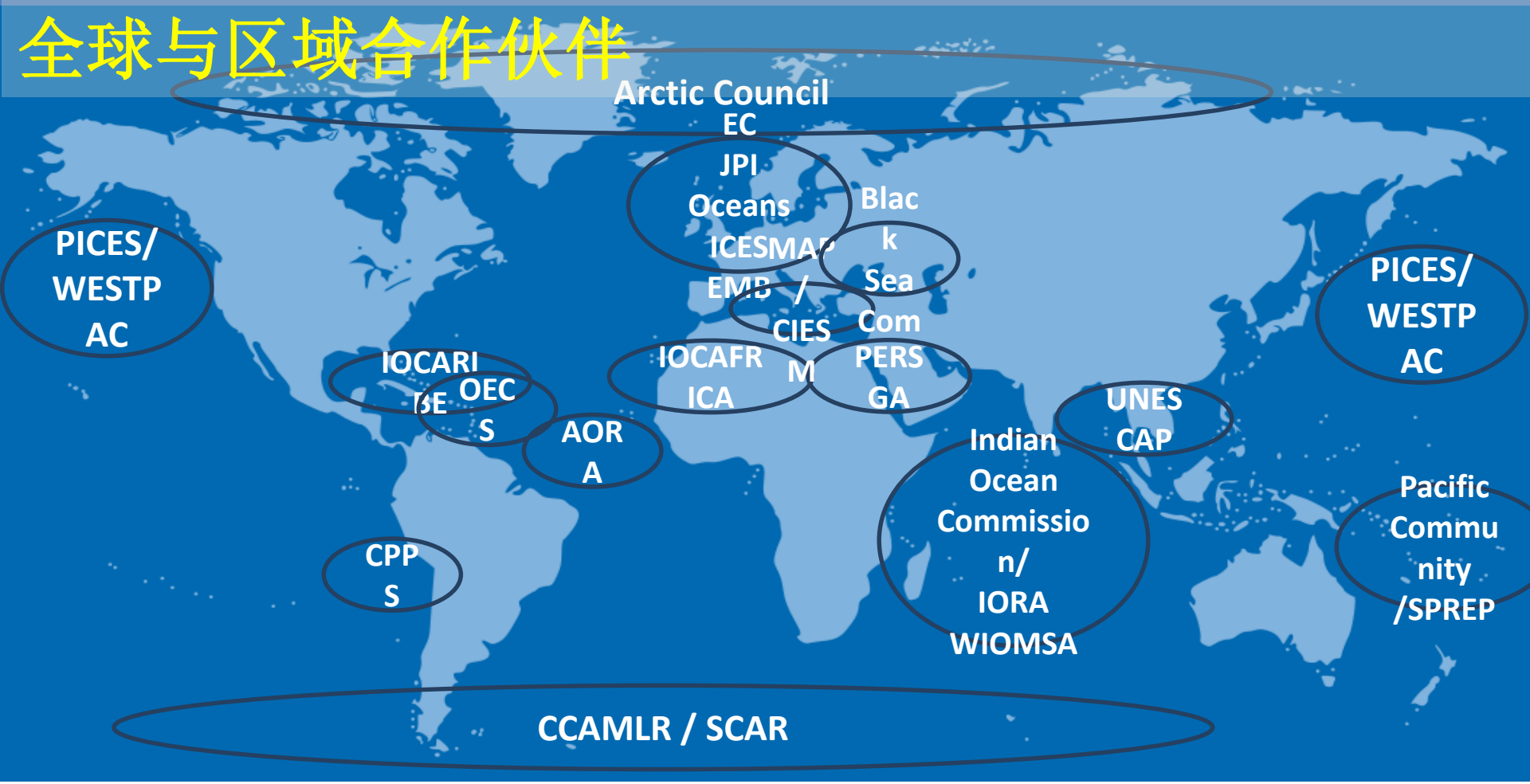
海洋能力建设

Ocean Literacy



Vavau © Stuart Chape

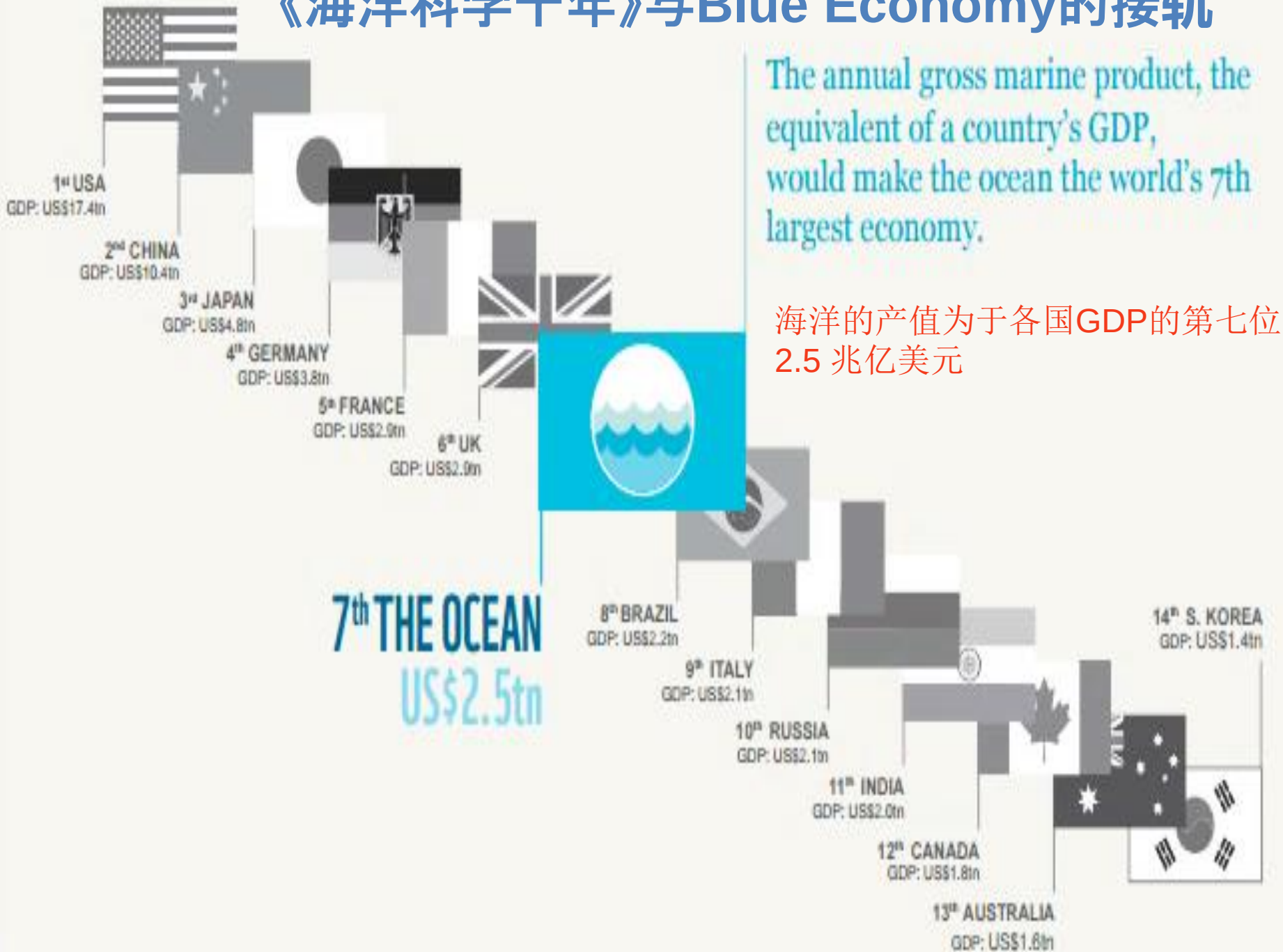
全球与区域合作伙伴



CBD CTED ESCAP FAO IAEA ILO IMO IOC ISA DESA DOALOS ODA

OHRLLS UNCTAD UNDP UNEP UNESCO UNHCR UNIDO UNITAR UNU UNWTO WMO World Bank

《海洋科学十年》与Blue Economy的接轨



海洋的产值为于各国GDP的第七位
2.5 兆亿美元

Blue Economy发展趋势

Near-term growth:（近期增长领域）

Shipping, shipbuilding and repair, port activity, 船运、造船、修船及港口建设

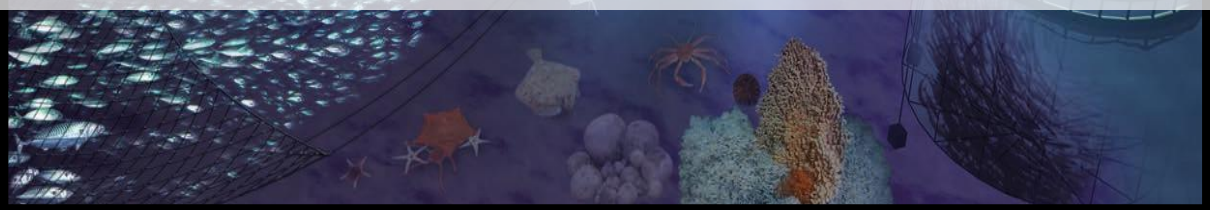
marine aquaculture, offshore wind, and marine tourism水产养殖、沿岸风能、海上旅游

Later:（后期发展潜力）

Renewable energy, biotechnology and CCS可再生能源、生物技术和碳捕集与封存

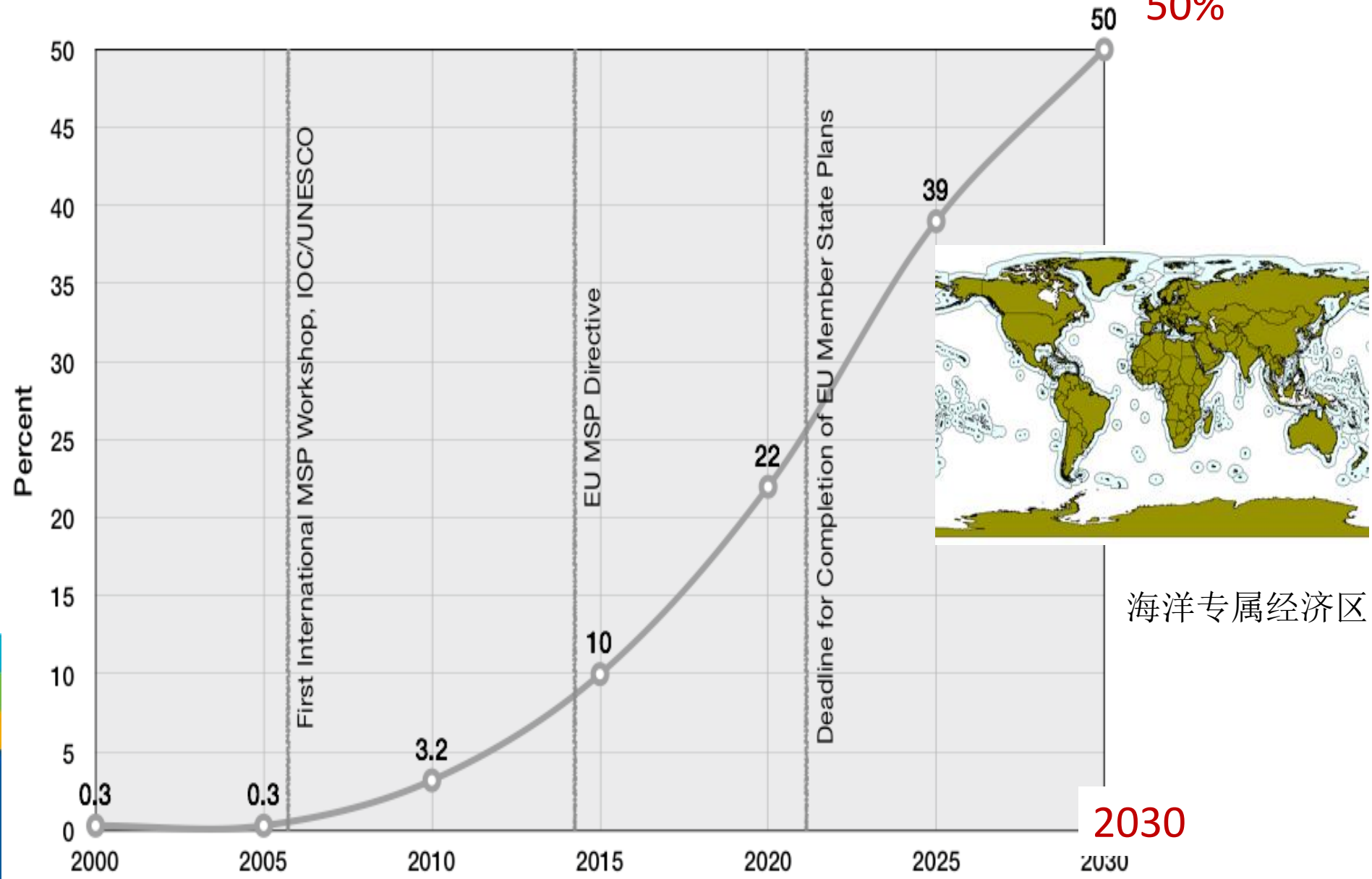
Less strong growth: (不太强劲增长的方面)

Oil and gas, capture fisheries油气开采与海洋捕捞



Percent of Surface Area of World's Exclusive Economic Zones Covered by Approved Marine Spatial Plans

50%



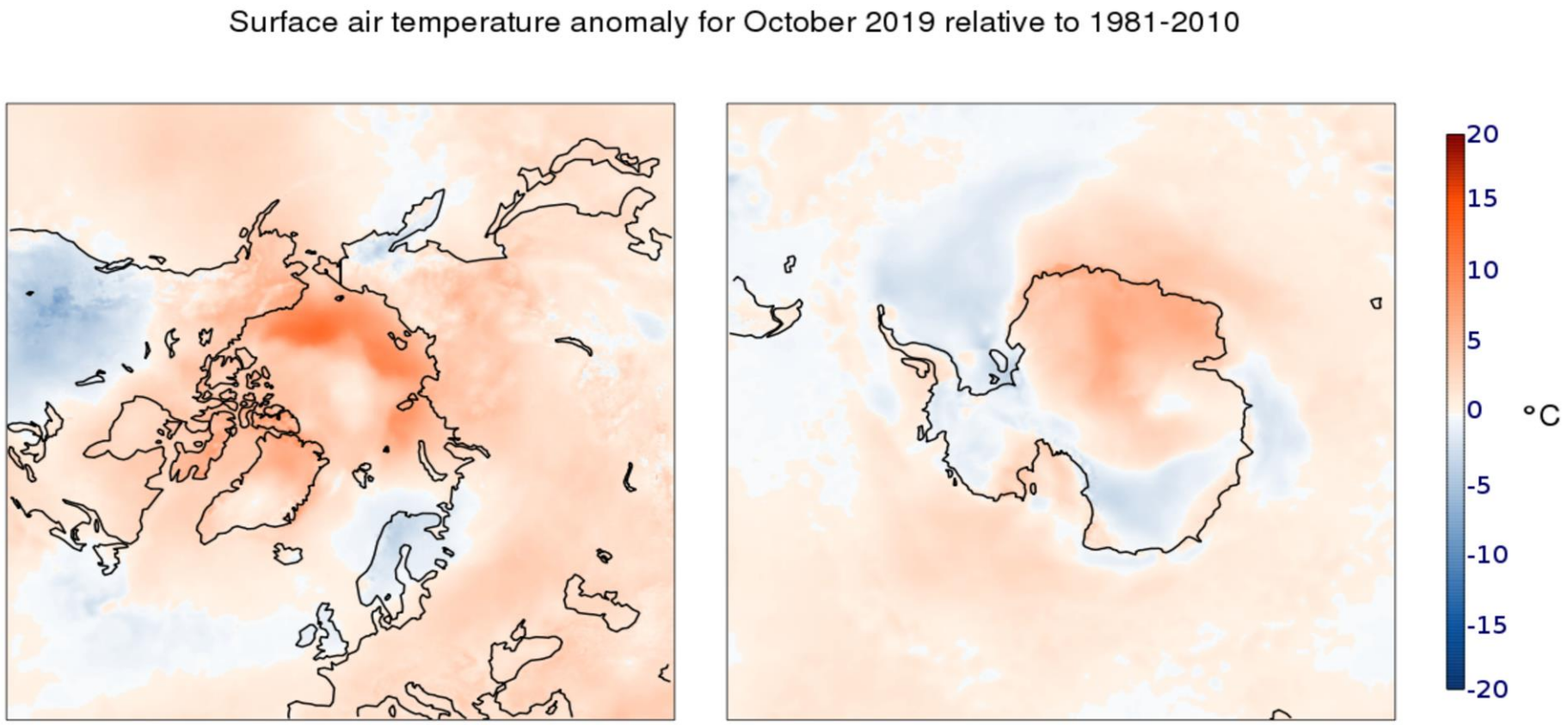
海洋专属经济区

2030

海洋气象与北极事务

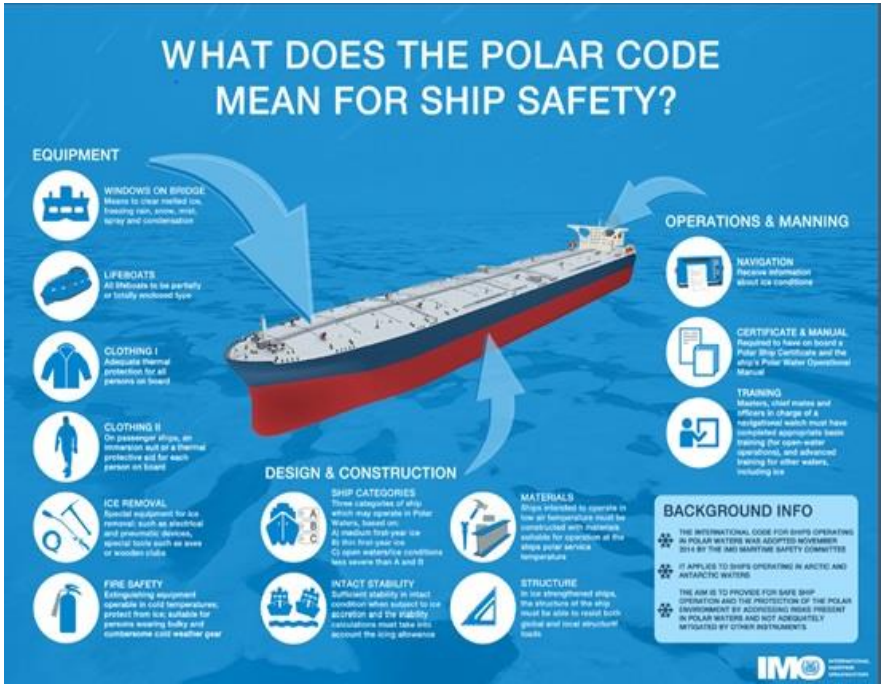
- 极地气候现状与极地航运潜力与发展趋势
- 业务服务能力与国际合作（如与IMO关于《国际极地船舶及运行规则》的合作）
- 科学研究（如PPY研究计划）
- 极地事务参与（工作组与特别任务组）

2019年10月相对于1981-2010年的气温距平



《国际极地水域操作船舶规则》

- IMO颁布了《国际极地水域操作船舶规则》， 并分别通过《国际海上人命安全公约》（SOLAS）新增的第 XIV 章“极地航行船舶安全措施” 和《防止船舶造成污染公约》（MARPOL）附则 I、II、IV 和 V 修正案，于 2017 年 1 月 1 日实施，适用于所有极地水域操作的客船和 500 总吨及以上船舶（以下简称“极地船舶”）。
- 极地规则主要目的是保护极地地区脆 弱的生态环境，尽最大可能免受日益增长 的极地航运活动的影响，以降事故促环保 为原则，采用风险方法，针对极地水域特 殊风险，提供了覆盖极地船舶构造、设备、 操作、培训、搜救、环保等所有方面的目 标和功能要求，以补充现有 IMO 公约规则 要求。所有北极地区港口的船舶、穿越北 极航行的船舶、以及在南极区域航行的船 舶将受极地规则约束。
- 该准则适用的对象为生效后建造的新船舶。生效之前建造的船舶被要求在2018年1月1日之后，通过首次中期检验或换证检验来满足该规则有关要求。



WMO支持升级操作船舶规则（Polar Code）行动

- 极地严重缺乏观测资料，极地资料对数值预报和其他应用十分重要。要努力推动极地过往船舶开展指令性观测，获取冰雪圈和天气资料
- **WWMIWS is an important contributor to compliance with the Polar Code.**

- 需要WMO 与IMO 合作修改《规则》，将这些观测需求纳入《规则》。JCOMM国际海冰工作组(IICWG)负责对接：

- 在40届南极协议磋商会议ATCM（2017年6月，北京）上，WMO 邀请各缔约方接受这一建议；WMO也要求北极理事会的海洋环境工作组（PAME）争取北极航运最佳实践论坛对修改这一《规则》的支持；

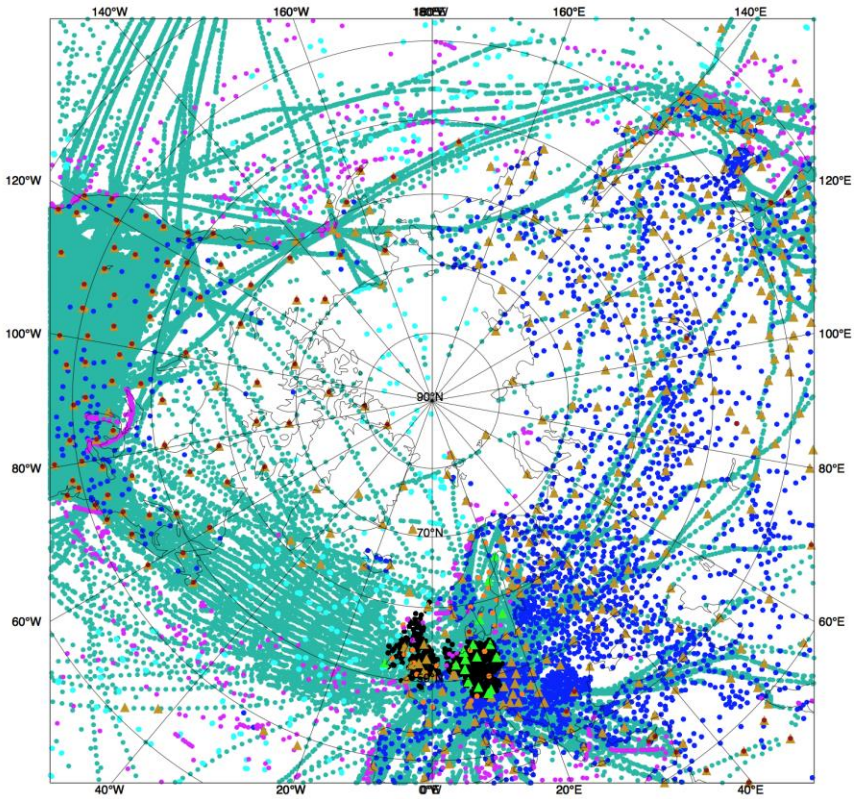
- WMO与其他相关组织（如IHO、IALA等）一道共同推动《规则》的修改与相关服务的开展；WMO 将与IMO及其他组织（如英国航海学会 ）一道推进海冰规避航海能力建设。

Why are we interested?

Relative poor observational coverage

- Synop
- Ship
- Pilot
- Radiosonde
- Radiosonde
- Profiler
- Aircraft
- Drifting buoys
- Synop B

- METAR



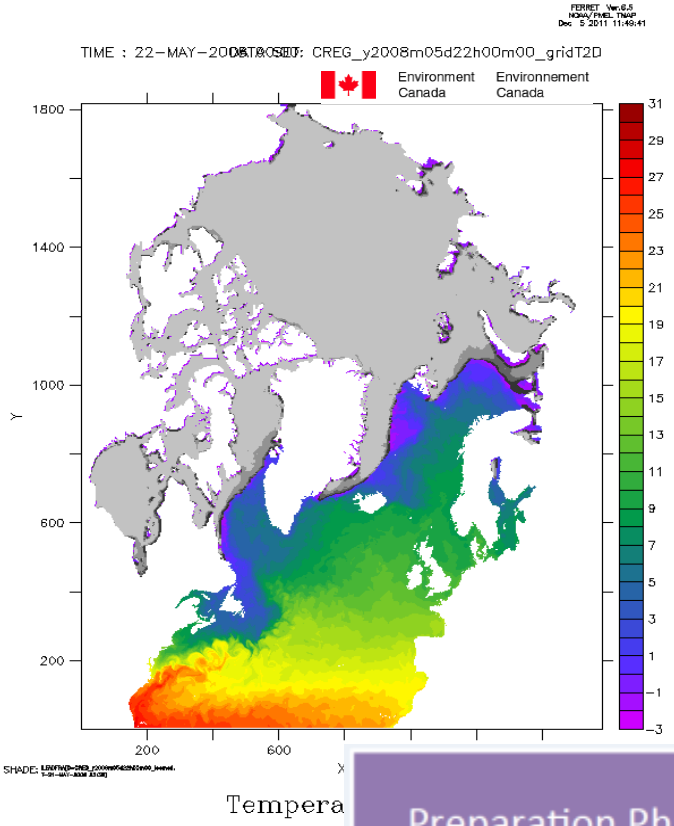
ECMWF analysis: Conventional observations on 15 April 2015

Jung et al. (2016), BAMS

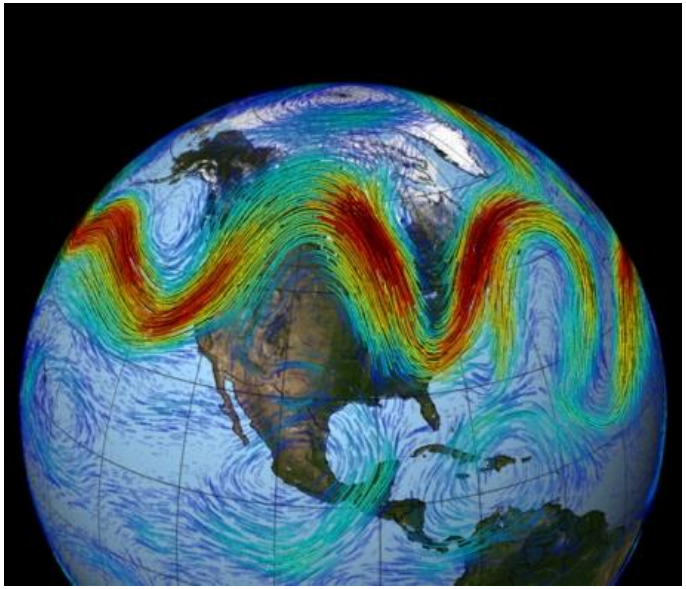
Designing an Arctic Prediction System

The Year of Polar Prediction WMO

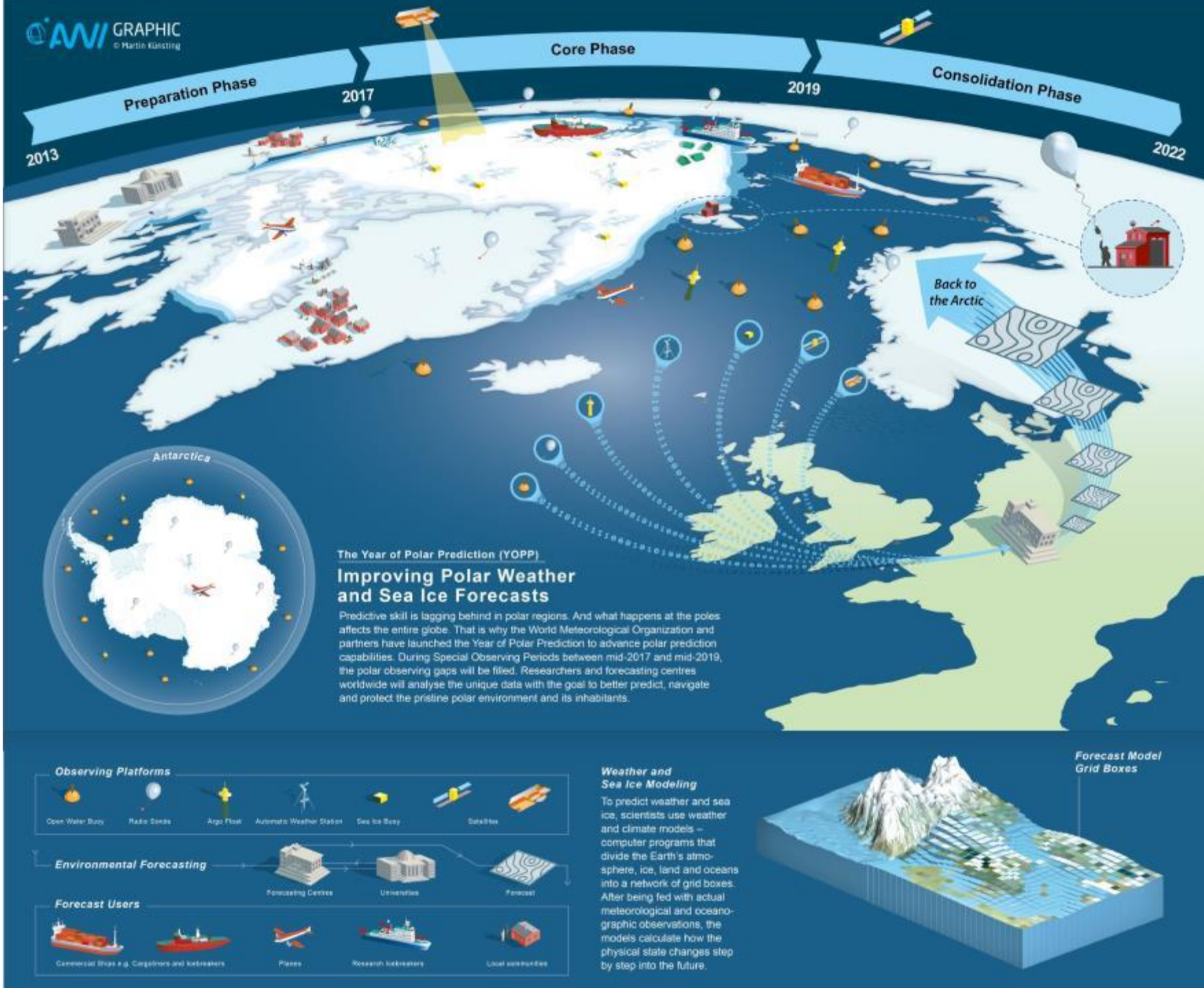
极地预报年活动（2017-2019）极地预报项目，野外观测与模拟



WMO Polar Prediction Project is launching a modelling and field campaign (Year of Polar Prediction, mid-2017 to mid-2019) assist planning an Arctic observational network for improving predictive capabilities



The field campaign



Operational Support by Met Services

Operational centers services offer their support for YOPP-endorsed campaigns 确认的支持WMO 极地预报年计划的业务中心

- Environment and Climate Change Canada
- European Centre for Medium-range Weather Forecasts
- Finnish Meteorological Institute
- National Marine Environmental Forecasting Center (China)
- Icelandic Meteorological Office
- Norwegian Meteorological Institute (MET Norway)
- Federal Service for Hydrometeorology and Environmental Monitoring (Russian Federation)
- Swedish Meteorological and Hydrological Institute
- Met Office, UK
- NOAA National Weather Service Alaska Region, US
- USGS Sea Ice Email Service （美国地调局海冰email服务计划）
- U.S. Naval Research Laboratory

http://www.polarprediction.net/yopp-activities/operational-support/

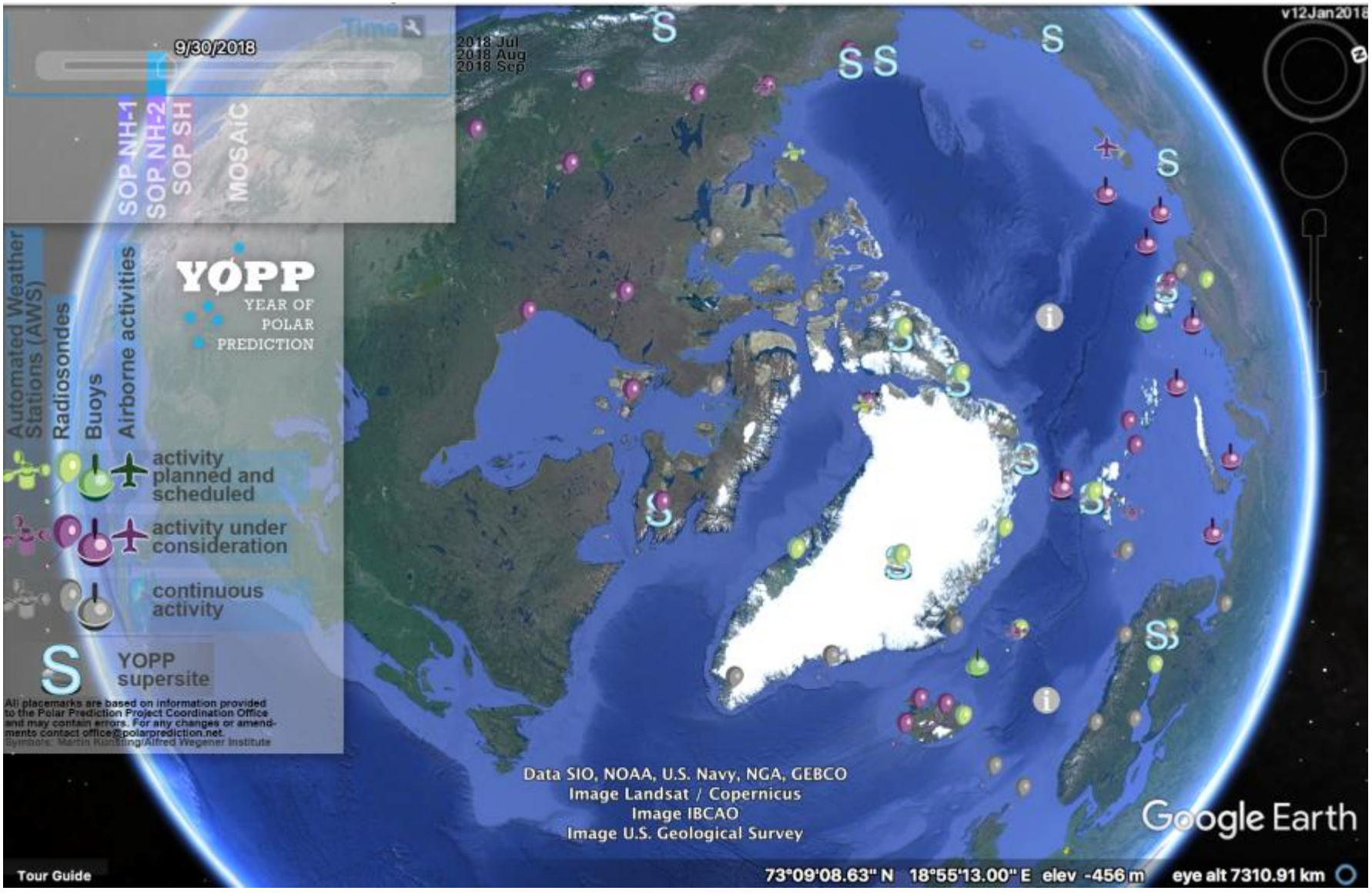
Arctic Winter Special Observing Period (SOP)
极地预报计划的北极冬季特别观测期
(1 Feb–31 Mar 2018)

- The Year of Polar Prediction (World Weather Research Programme) is boosting the improvement of observations and science in Polar Regions through Special Observing Periods (1Feb-31March 2018, SOP1 and Jul-Sep 2018 SOP2)
- 1,990 extra radiosondes from 17 Arctic stations including field work (7 nations involved)
- Major addition of buoys for SOP2 in collaboration with Russian Met Service and EUMETNET

Radio sonde launch at French-German AWIPEV station in Ny Alesund, Svalbard
(Photo: Christoph Ritter/AWI)

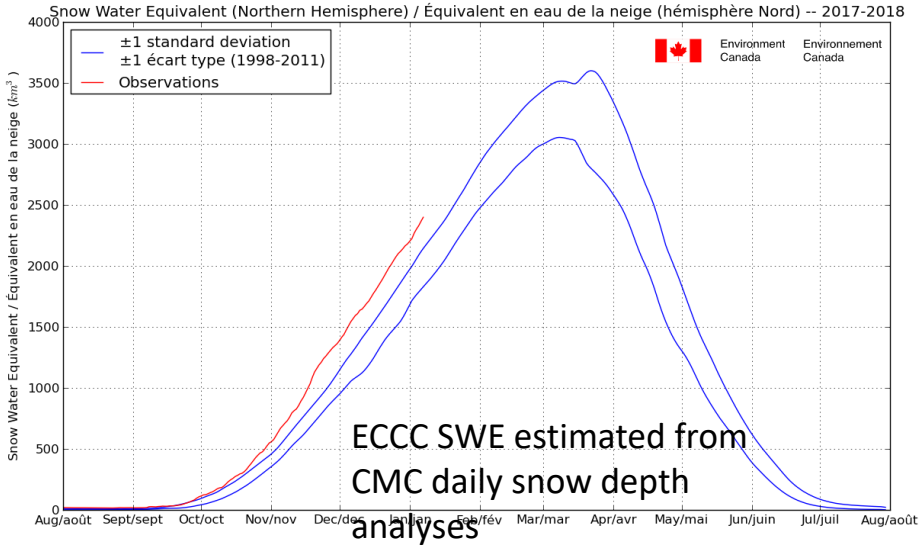
Arctic Summer SOP (1 Jul–30 Sept 2018)
极地预报报计划的夏季加强观测

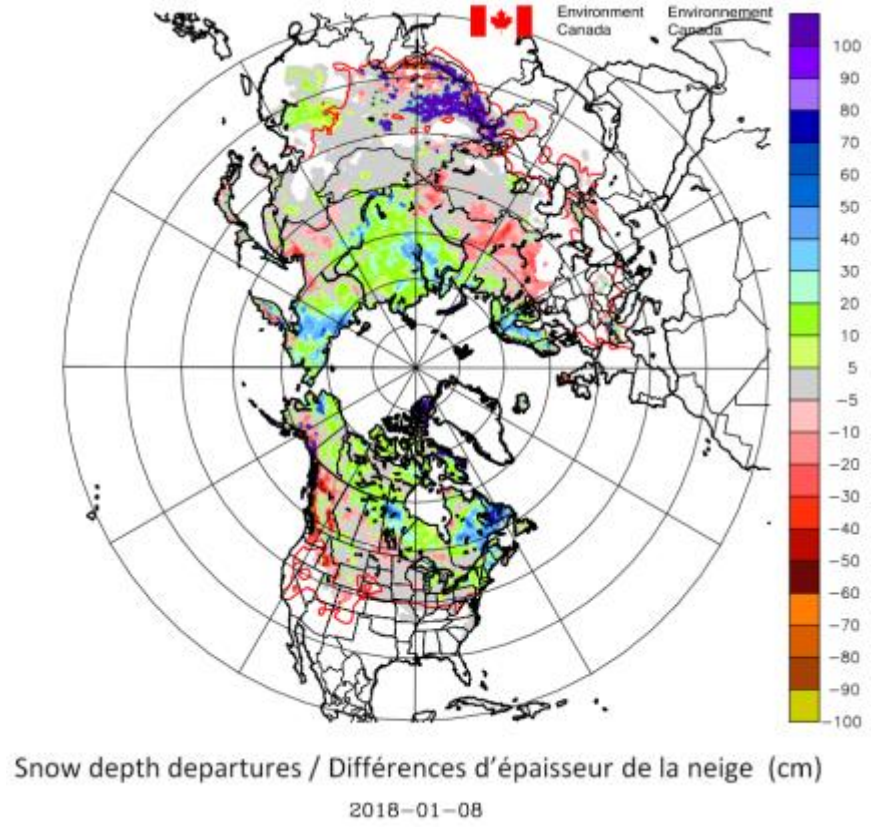
YOPP YEAR OF POLAR PREDICTION

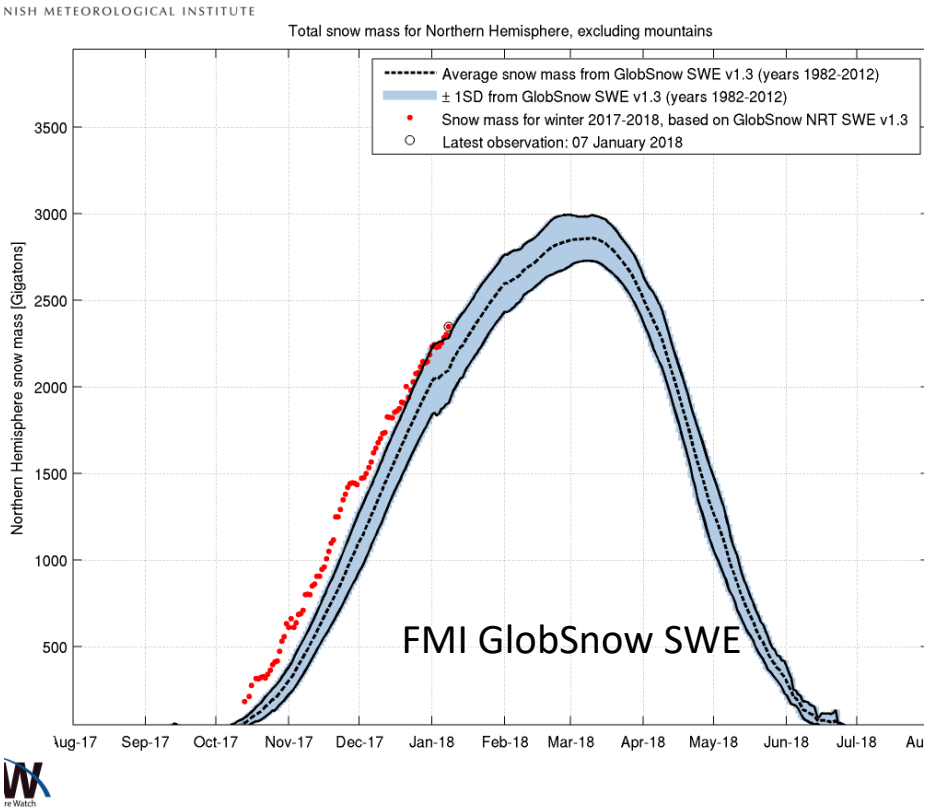


Hemispheric "snow anomaly trackers" for SE and SWE

- Near real-time tracking of NH SWE from GlobSnow (FMI) and the CMC daily snow depth analysis (ECCC) in place since 2014: available through Global Cryosphere Watch
- 形成了准实时的全球雪盖监测与跟踪分析能力

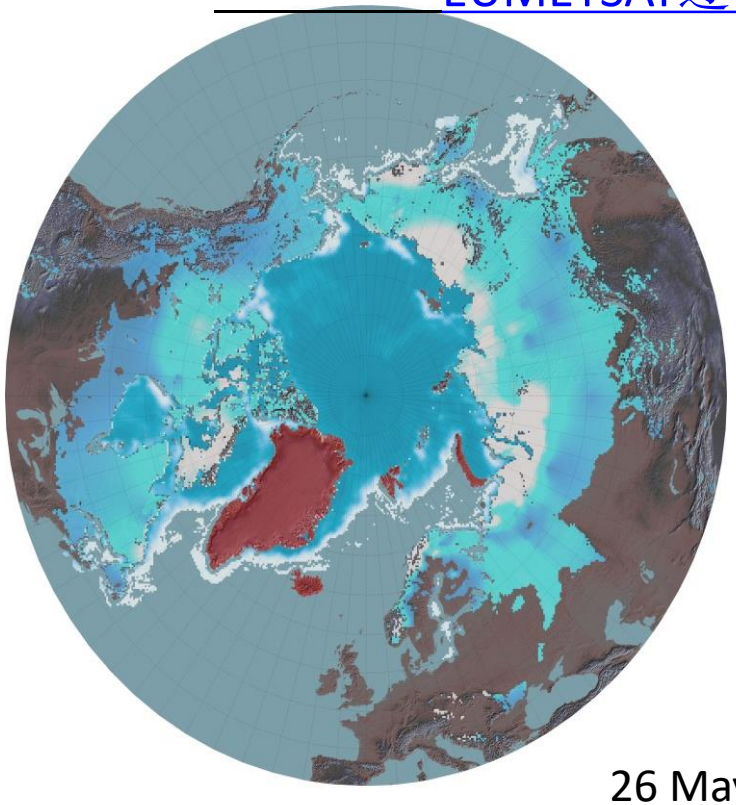




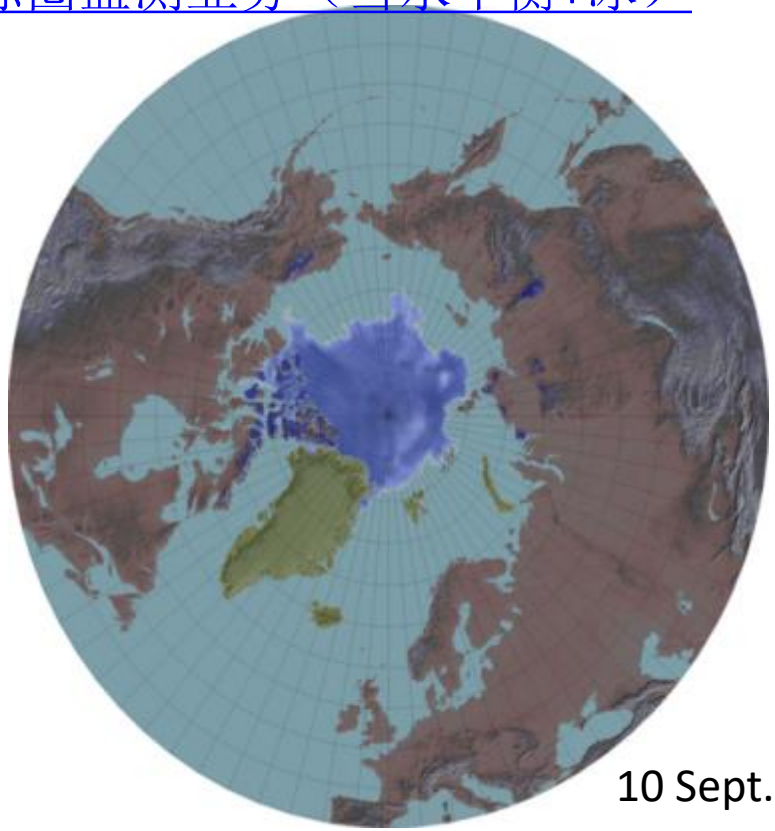


Daily ”snapshot” of the Cryosphere (terrestrial SWE + Sea Ice)

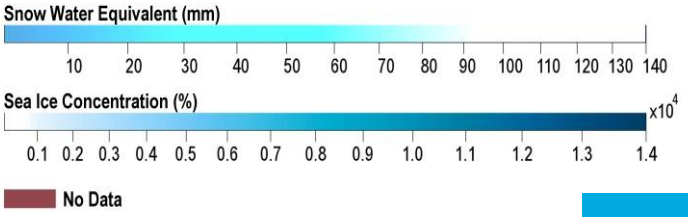
EUMETSAT逐日的冰冻圈监测业务（雪水平衡+冰）



26 May 2017



10 Sept. 2017



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

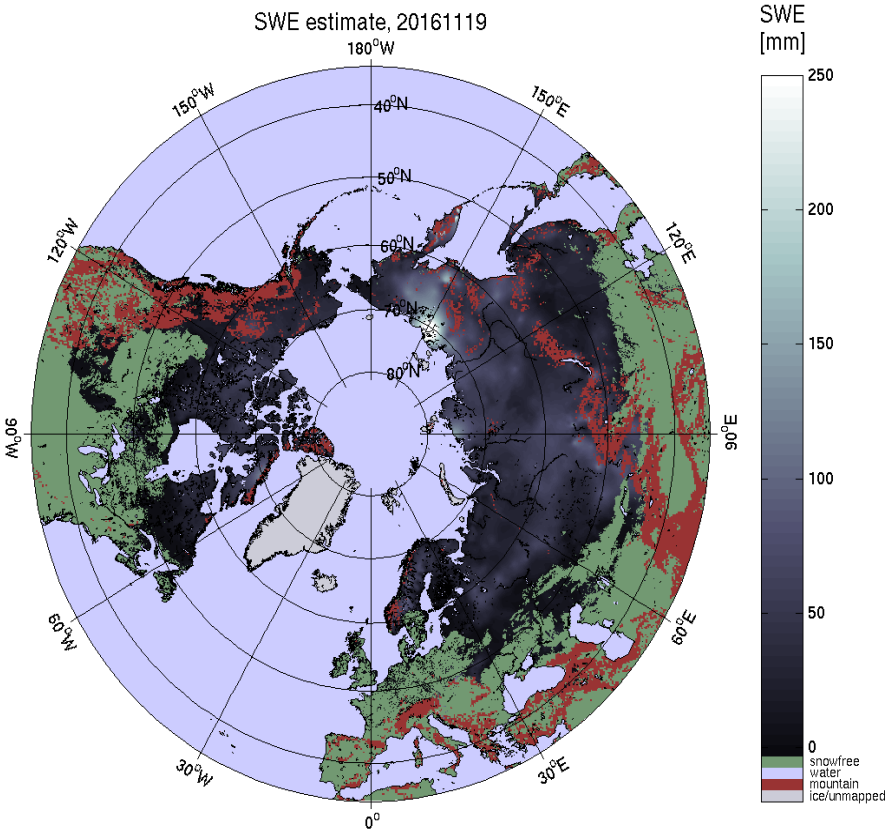
EUMETSAT
OSI SAF
OCEAN AND SEA ICE

EUMETSAT
H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

35 year-long CDR time-series on snow conditions of Northern Hemisphere

可以从下列网站获得EUMETSAT北半球35年长时间序列雪况气候资料

- First time reliable daily spatial information on SWE (snow cover):
  - Snow Water Equivalent (SWE)
  - Snow Extent and melt (+ grain size)
  - 25 km resolution (EASE-grid)
  - Time-series for 1979-2016
- Passive microwave radiometer data combined with ground-based synoptic snow observations
  - Variational data-assimilation
-
- Available at open data archive (www.globsnow.info)
- Daily NRT production since 2010
- Operational within EUMETSAT HSAF



Takala, M., Luojus, K., Pulliainen, J., Derksen, C., Lemmetyinen, J., Kärnä, J.-P, Koskinen, J., Bojkov, B., "Estimating northern hemisphere snow water equivalent for climate research through assimilation of spaceborne radiometer data and ground-based measurements", Remote Sensing of Environment, Vol. 115, Issue 12, 15 December 2011, doi: 10.1016/j.rse.2011.08.014

Arctic Regional Climate Centre Network (ArcRCC-Network)
极地区域气候中心网络实施计划

(Implementation Plan approved by WMO Executive Panel of Experts on Polar and High-mountain Observations, Research and Services, EC-PHORS)

North American Node

- Consortium: Canada (Lead), USA

Northern Europe/Greenland Node

- Consortium: Norway (Lead), Denmark, Iceland, Finland, Sweden

Eurasian Node

- Lead: Russian Federation

- **Cross-node operations in LRF, monitoring and data to provide pan-Arctic coverage**
- develop temperature, precipitation and sea-ice products for the circumpolar Arctic:
  - Descriptions of the previous month/season conditions
  - Monthly and seasonal (Winter/Summer) outlooks/forecasts
  - Bulletins updating the monthly and seasonal (Winter/Summer) outlooks/forecasts

- Demonstration phase to commence in May 2018
- Norway : overall coordinator for 3 years
- Several institutions within the consortia countries to join forces
- RA VI RCC-Network as well as other GPCLRFs are expected to contribute

http://www.wmo.int/pages/prog/wcp/wcasp/RCC-Polar_Regions.html

Proposed content for pan-Arctic bulletin 泛北极气候监测公报

1 Meteorological conditions in the Northern Polar Region

1.1 Large-scale atmospheric processes

1.2 Meteorological parameters

2. Ice conditions and processes in the Arctic Ocean

3 Hydrological and hydrochemical conditions in the Arctic Ocean

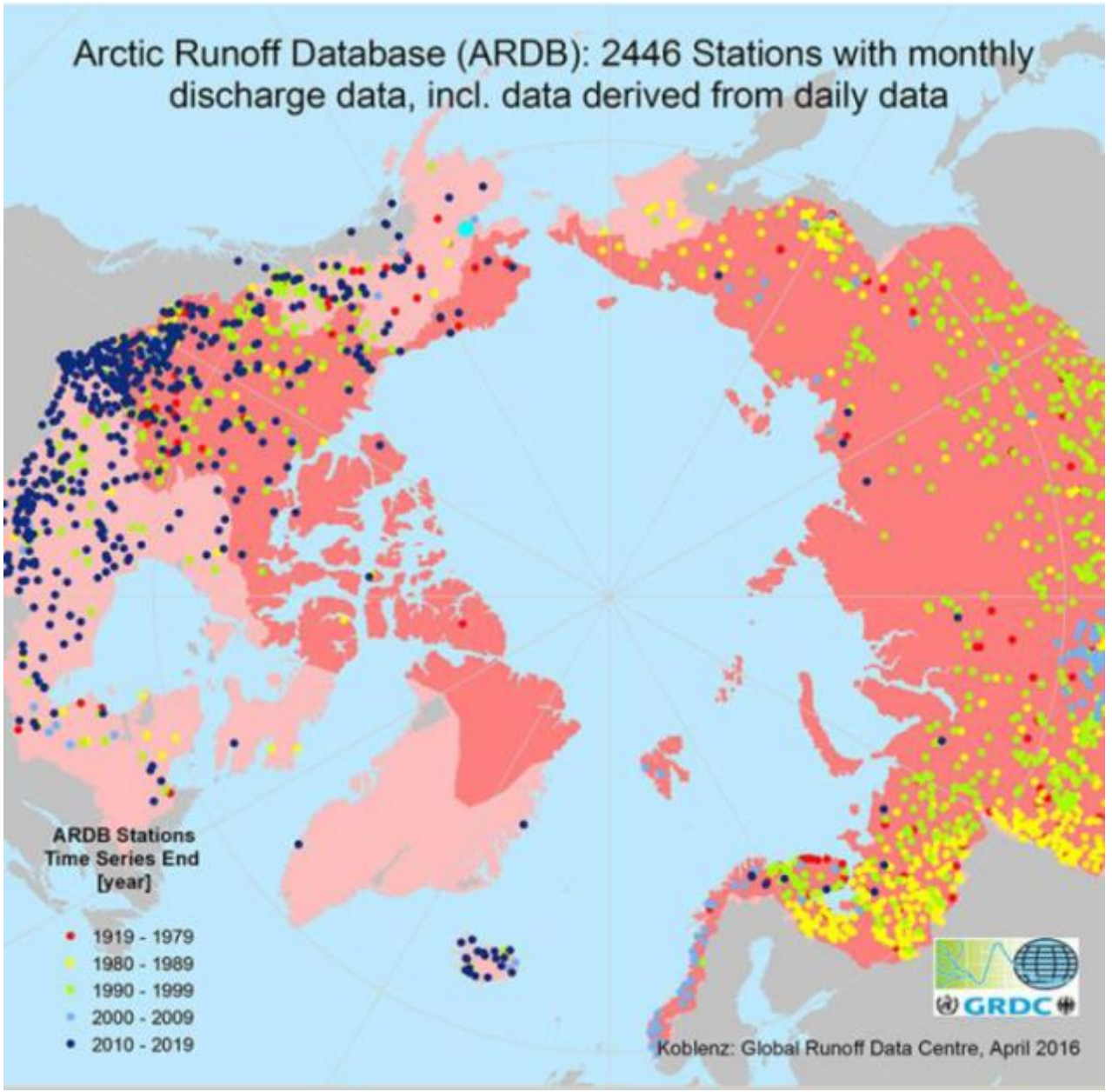
3.1 Thermohaline conditions

3.2 Sea level

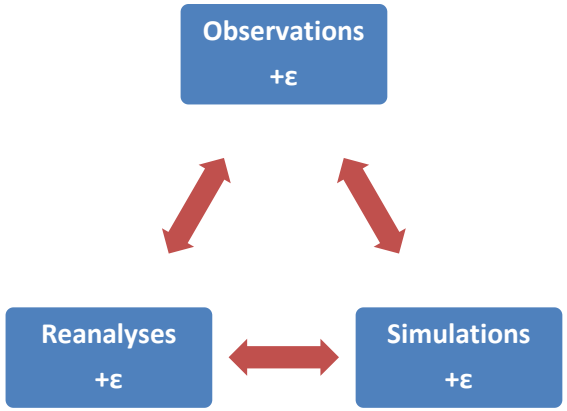
3.3 Wind waves

Arctic – HYCOS北极水文观测系统：北极区域水文资料

- Monitoring of freshwater fluxes and pollutants into the Arctic Ocean
- Database and Data sharing
- Develops common methodology for e .g., under ice measurements and water temperature, …)
- Applications (forecasts,…)

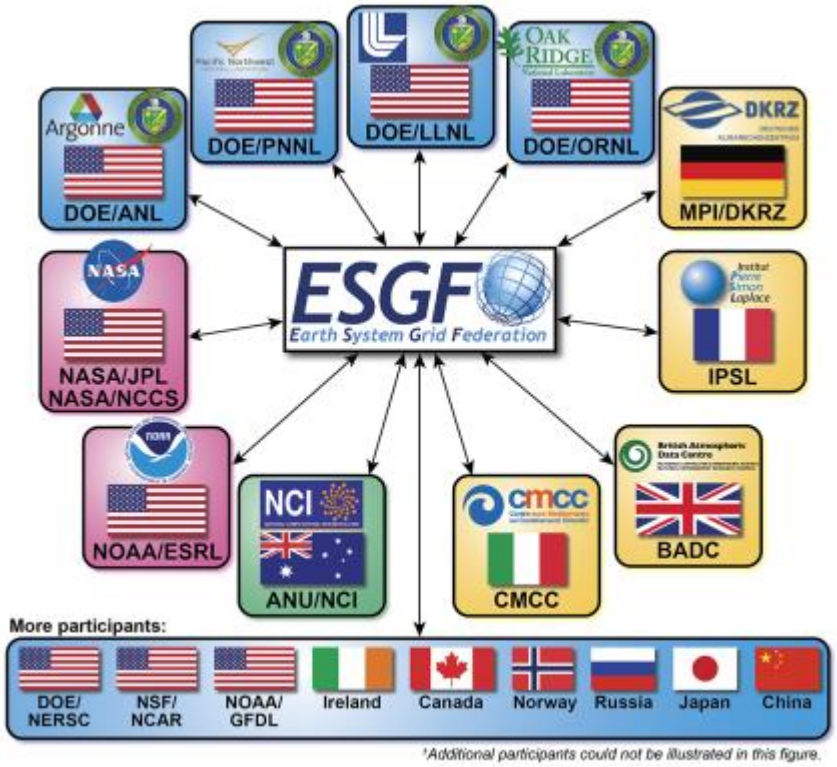


Strategy on data accessibility:
地球系统网格联盟ESGF（耦合模式比较计划）



Earth System Grid Federation (**ESGF**) used for CMIP (many observations, reanalysis, predictions and projections at global and regional scale.

obs4MIPs/ana4MIPs: data records with contributions from : ESA, EUMETSAT, ECMWF, NASA, NOAA, JMA, etc.



WCRP World Climate Research Programme

PRINCE ALBERT II OF MONACO FOUNDATION

POLAR CHALLENGE

500 000 SWISS FRANCS

Be the first to complete a 2000 km continuous mission with an Autonomous Underwater Vehicle (AUV) under the sea ice.

Compete for the Prize!

Become a co-sponsor!

www.wcrp-climate.org/polarchallenge

Co-sponsors: WMO, Environment Canada, Environnement Canada, WWRP, esa, GCOS

GEO GROUP ON EARTH OBSERVATIONS, SCOR, Endorsed by: IASC, SCAR

Industry partner: WILDLIFE COMPUTERS

POLAR CHALLENGE

CONTEXT

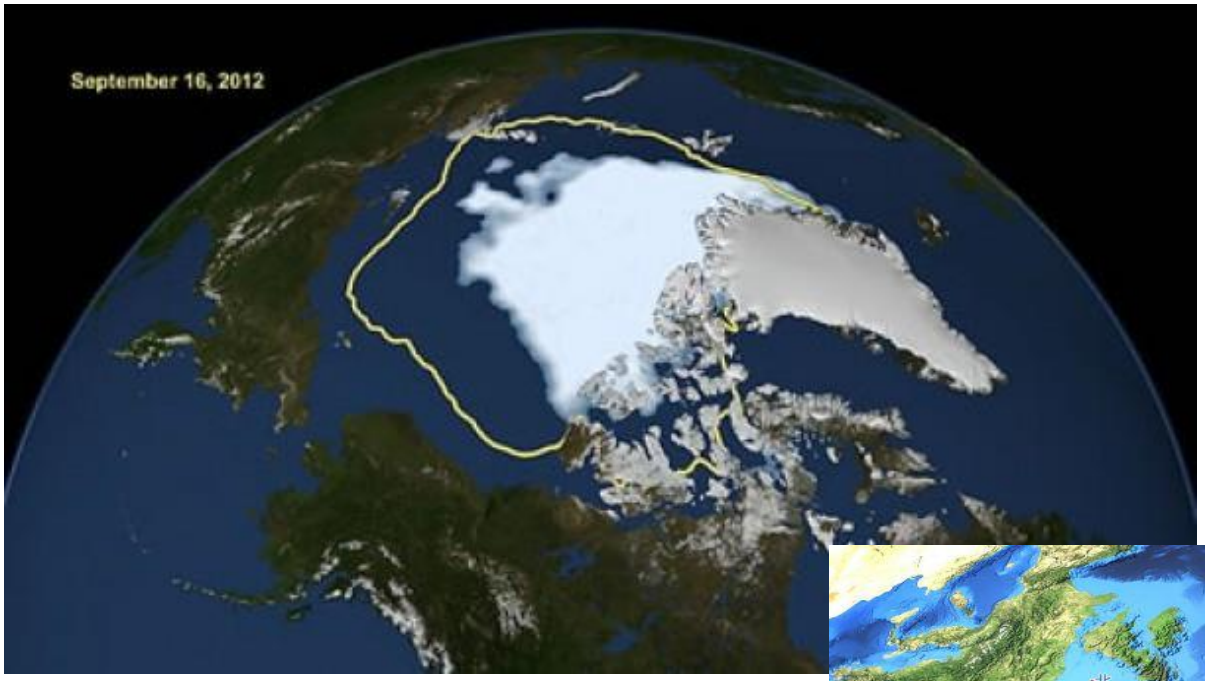
The cryosphere plays a fundamental role in the climate system. We need much better monitoring and prediction capabilities for the polar regions.

CHALLENGES AND OPPORTUNITIES

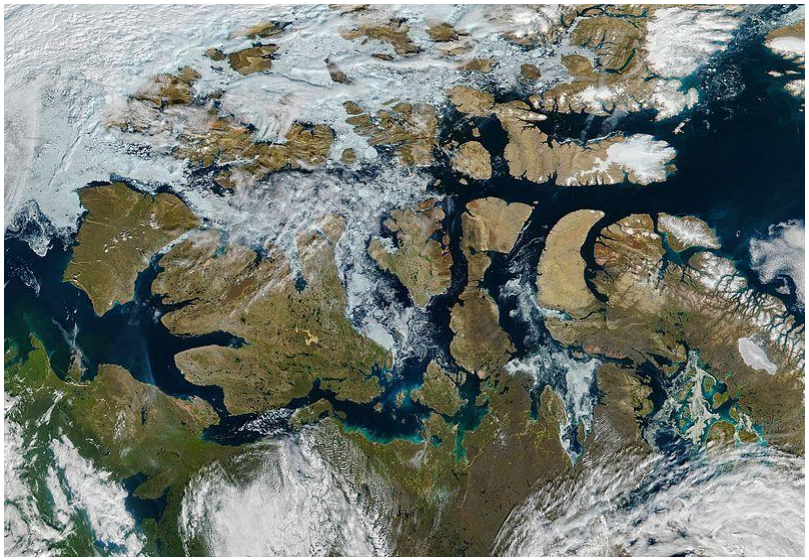
Polar observations are expensive, risky and sparse. We can expand AUVs' endurance, navigation and communication capabilities to operate under the sea ice.

VISION

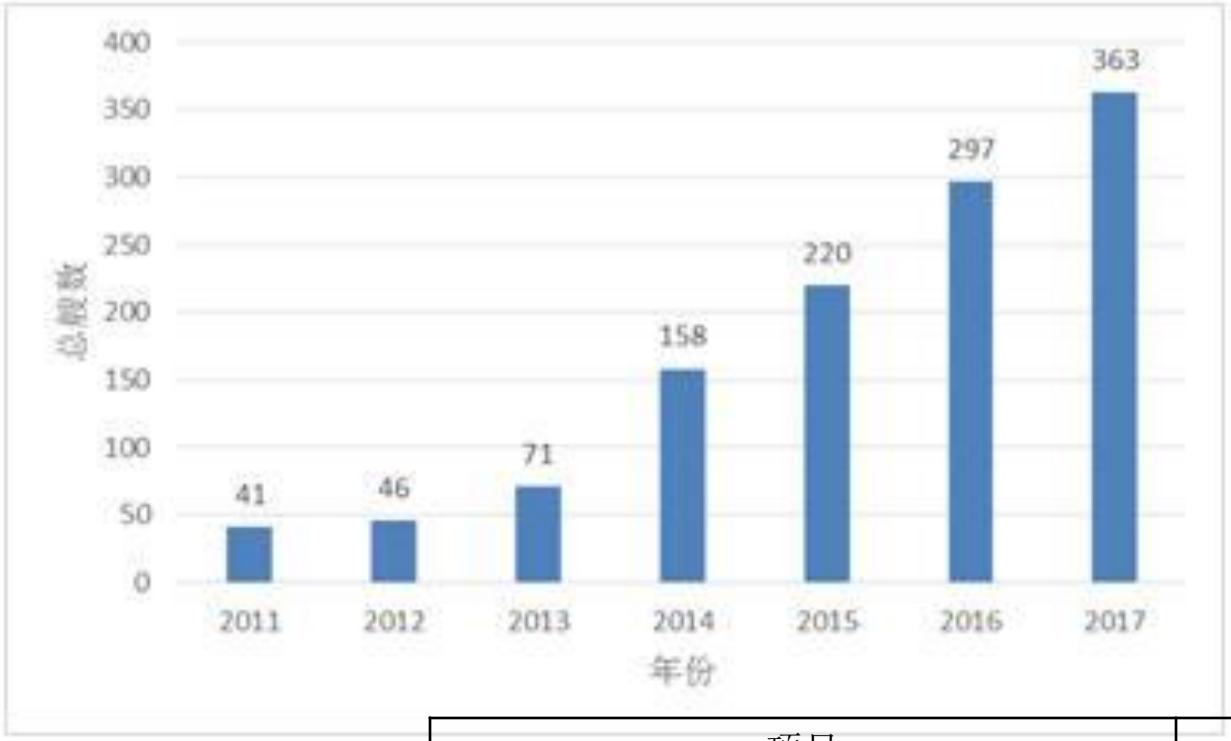
A cost-effective, sustainable and autonomous polar ocean monitoring system to drive a new era for climate research and services.



2016年9月北极的冰层融化情况已经远远超过2012年的卫星图片



机遇与风险并存，西北航道卫星图，峡湾中连片的浮冰，给船只带来隐患



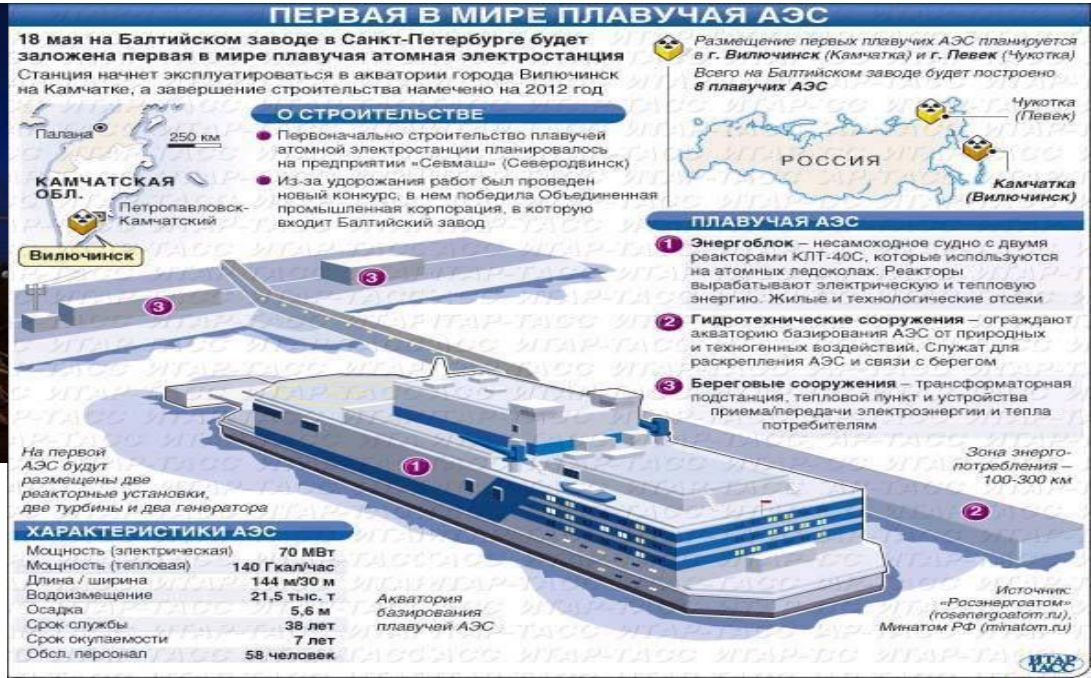
2011-2017年东北航道船舶通过数量

北极航线和常规航线经济性分析

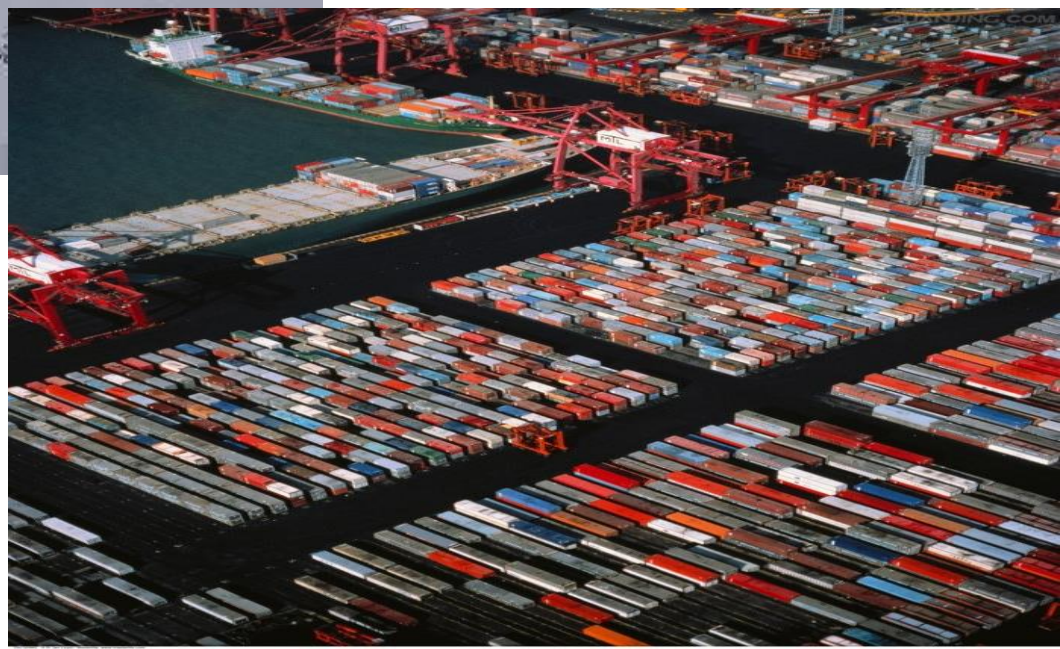
项目	北极航线	常规航线
船员成本（美元）	252450	323000
通行费用（美元）	140000	180000
燃油日消耗（吨）	23	23
总燃油消耗（吨）	625	874
燃油价格（美元/吨）	260	260
燃油成本（美元）	162500	227240
润料费（美元）	16250	18179
总成本（美元）	571200	748419
成本对比（美元）	177219（可省约18万美元）	

俄罗斯在北极滨海亚马尔半岛的超大型天然气项目工地

如图介绍，这种浮动式发电站将是北极航线 的沿途海岛 、沿途海港城市和海上作业平台的重要 电力来源



认识北极、保护北极、利用北极和参与治理北极，维护各国和国际社会在北极的共同利益，推动北极的可持续发展。



这样繁荣的港口会给经济带来多么大的拉动，谁都能想明白

WORKING GROUPS (6)

- ARCTIC CONTAMINANTS ACTION PROGRAM (ACAP): 极地污染物行动计划
- ARCTIC MONITORING AND ASSESSMENT PROGRAMME (AMAP): 极地监测与评估计划
- CONSERVATION OF ARCTIC FLORA AND FAUNA (CAFF): 极地植物和动物保护工作组
- EMERGENCY PREVENTION, PREPAREDNESS AND RESPONSE (EPPR): 应急保护、备灾和响应工作组
- PROTECTION OF THE ARCTIC MARINE ENVIRONMENT (PAME) 极地海洋环境保护工作组
- SUSTAINABLE DEVELOPMENT WORKING GROUP (SDWG): 可持续发展工作组

TASK FORCES AND EXPERT GROUPS

（13）

Expert Groups:

- **BLACK CARBON AND METHANE EXPERT GROUP** （2015-now）
- **ECOSYSTEM-BASED MANAGEMENT**

Task Forces on

- **Arctic Marine Cooperation (TFAMC)**
- **Improved Connectivity in the Arctic (TFICA)**
- **Telecommunications Infrastructure in the Arctic (TFTIA)**
- **Enhancing Scientific Cooperation in the Arctic (SCTF)**
- **Arctic Marine Oil Pollution Prevention (TFOPP)**
- **Black Carbon and Methane (TFBCM)**
- **Facilitate the Creation of a Circumpolar Business Forum (TFCBF)**
- **Institutional Issues (TFII)**
- **Search and Rescue**
- **Arctic Marine Oil Pollution Preparedness and Response**
- **Short-Lived Climate Forcers (SLCF)**

2019年5月的北极理事会以未达成联合声明而告终（美国：反对减少黑碳排放条款、散布中俄威胁论）；芬兰外长声明（主题：气候变化挑战与维护地区和平）

结束语

- 关注海洋气象学从何处来、向何处去，促进其在融合中发展壮大；
- 在可持续发展、减灾和气候变化适应以及蓝色经济发展议程中，体现海洋与海洋气象教学、科研、业务和人才培养的定位与作用；
- 采用地球系统预报的视野，把握海洋观测数据、海洋过程在地球系统各圈层相互作用融合中的价值实现；
- 面对极地等海洋事务的机遇和挑战，建立包括极地区域的海洋知识科创支撑能力，把握科研人才培养服务社会的发展方向；
- 依托国家海洋发展战略及上海国际航运中心建设，联合国内科研、教学和服务的专家团队，打造海洋科技创新国际合作网络。

Working together in weather, climate, ocean and water

WMO

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

Thank You

Contact: 汤 绪

tangxu@fudan.edu.cn

WMO OMM

World Meteorological Organization

Organisation météorologique mondiale