The Global Observing System for Climate

IMPLEMENTATION NEEDS

With a focus on the Ocean Chapter.

Katy Hill, Scientific Officer, Ocean Observations (GCOS, GOOS, JCOMM)

WMO UNESCO IOC ICSU International Council for Science UNEP

Improved observations lead to significant benefits

ECV Requirements, Adequacy Reports, Plans

Observations, Products, Open Data

Science, Assessments, Policy

Climate Services, Risk Assessments, Early Warning & Disaster Risk Reduction Policies

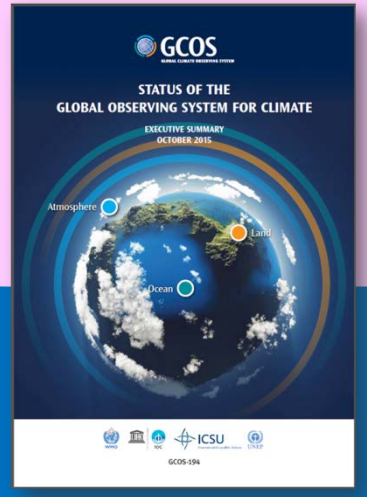
Successful adaptation and mitigation, reduced climate risks, enhanced livelihoods, and food & water security.

GCOS Reports and Plans

Status

2015

United nations conference on climate change
COP21/CMP11



New Plan

2016

Adaptation & Mitigation

I

Water, Energy and Carbon cycles

II

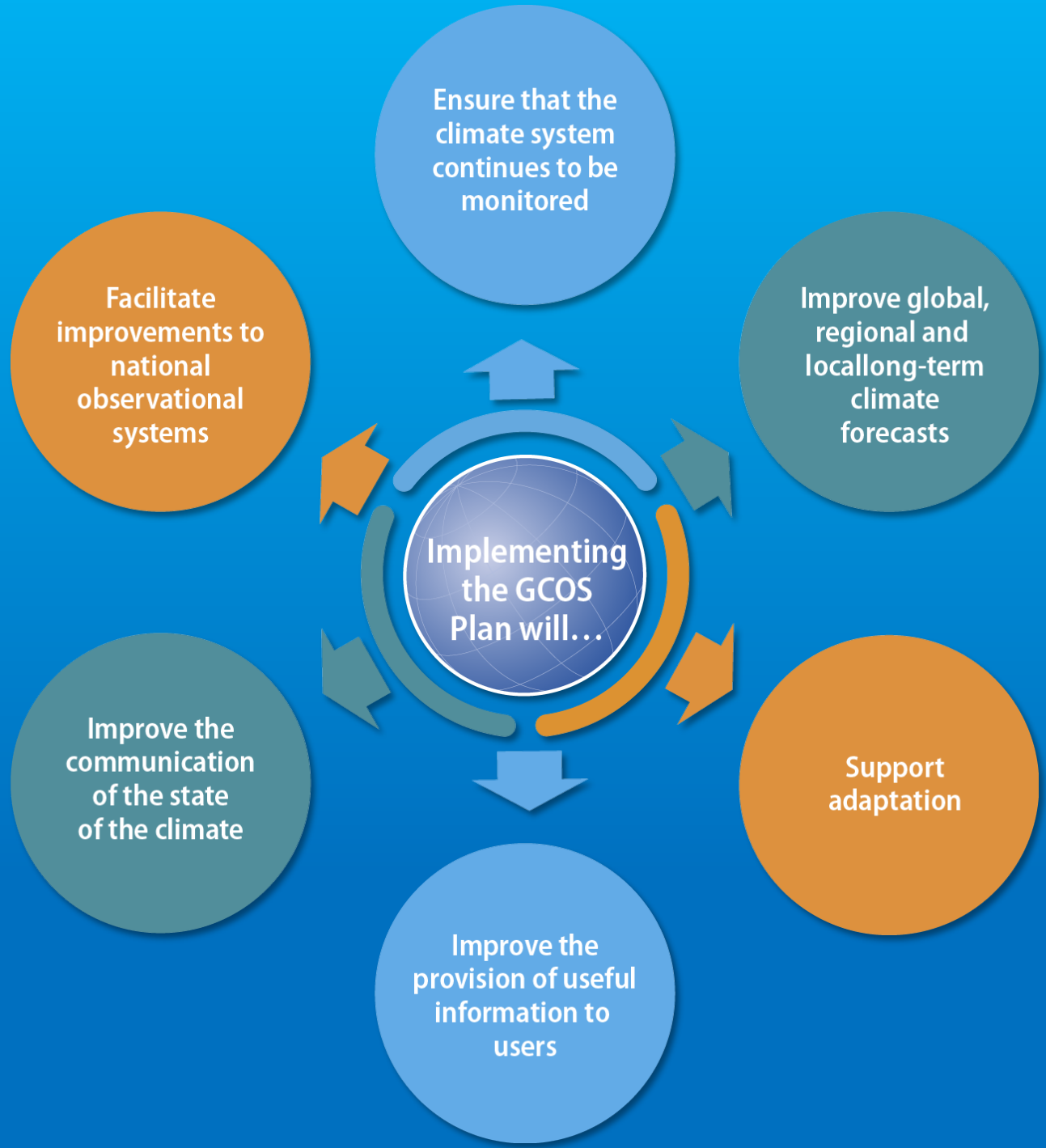
Additional Essential Climate Variables

III

Emphasis on more help for networks in developing countries

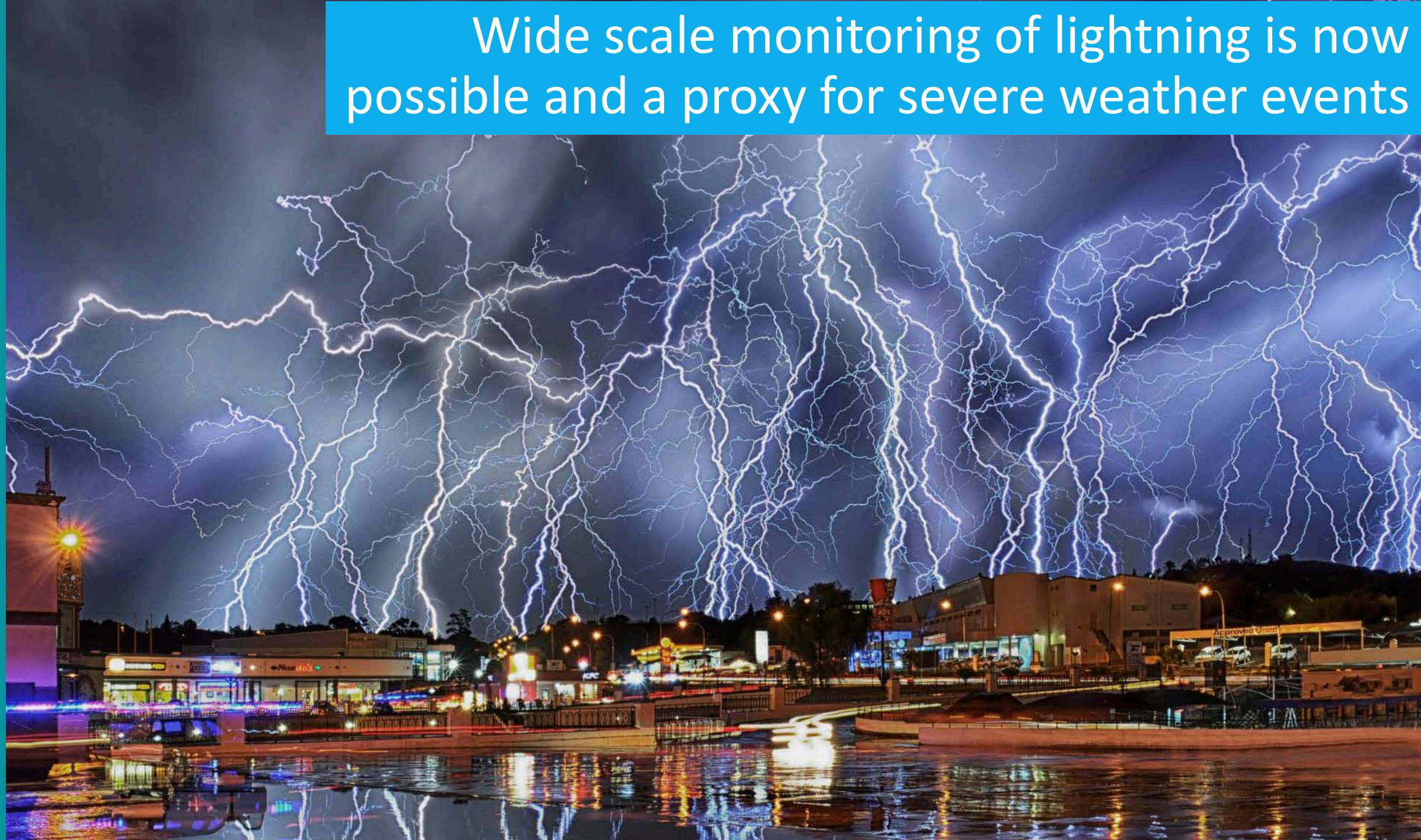
IV

6 Implementation Aims



Adaptation, mitigation and climate indicators

Wide scale monitoring of lightning is now possible and a proxy for severe weather events



Monitoring of ecosystems is important for adaption (coastal protection, fisheries and biodiversity) as well as understanding changes in the carbon cycle

Essential Climate Variables (ECVs)

Atmospheric

- Surface: Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget.
- Upper-air: Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget, Lightning. Composition: Carbon Dioxide (CO2), Methane (CH4), Other long-lived greenhouse gases (GHGs), Ozone, Aerosol, Precursors for aerosol and ozone.

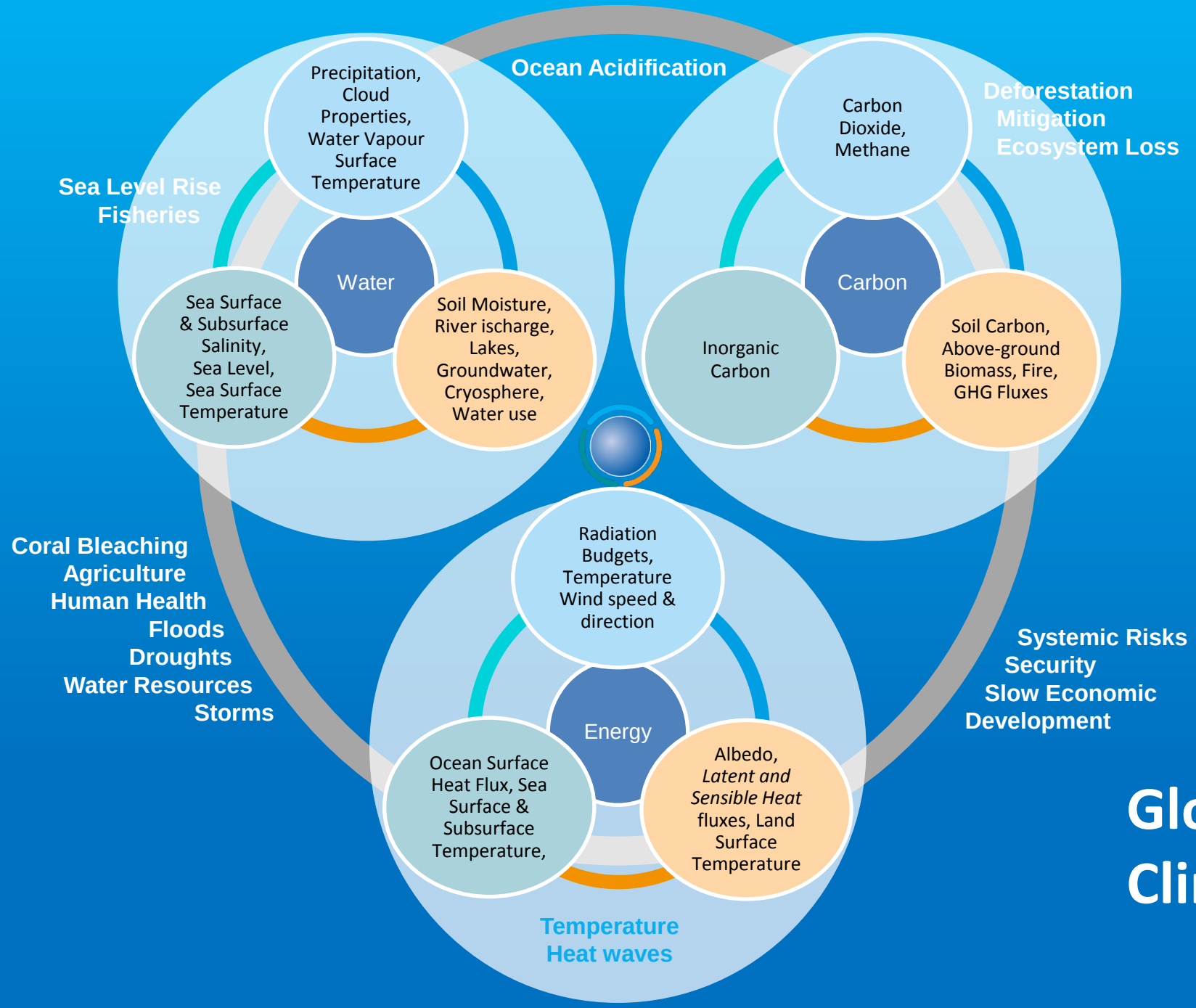
Oceanic

- Physics: Temperature: Sea surface and Subsurface, Salinity: Sea Surface and Subsurface, Currents, Surface Currents, Sea Level, Sea State, Sea Ice, Ocean Surface Stress , Ocean Surface heat Flux
- Biogeochemistry: Inorganic Carbon, Oxygen, Nutrients, Transient Tracers, Nitrous Oxide (N2O), Ocean Colour
- Biology/ecosystems: Plankton, Marine habitat properties

Terrestrial

- Hydrology: River discharge, Groundwater, Lakes, Soil Moisture Cryosphere: Snow, Glaciers, Ice sheets and Ice shelves, Permafrost
- Biosphere: Albedo, Land cover, Fraction of absorbed photosynthetically active radiation, Leaf area index, Above-ground biomass, Soil carbon, Fire, Land Surface Temperature
- Human use of natural resources: Water use, GHG fluxes

Global Climate Cycles



Closing the Carbon Budget

- Quantify fluxes of carbon related greenhouse gases to +/- 10% on annual time-scales
- Quantify changes of in carbon stocks to +/- 10% on decadal time-scales in the ocean and on land, and to +/- X% in the atmosphere on annual time-scales
- Who: Operators of GCOS related systems, including data centres.
- Time-Frame: Ongoing
- Performance Indicator: Regular assessment of uncertainties in estimated fluxes and inventories

Closing the Global Water Cycle

- Close water cycle globally within 5%
- Who: Operators of GCOS related systems, including data centres.
- Time-Frame: Ongoing
- Performance Indicator: Regular assessment of the uncertainties in estimated turbulent flux of latent heat

Closing the Global Energy Balance

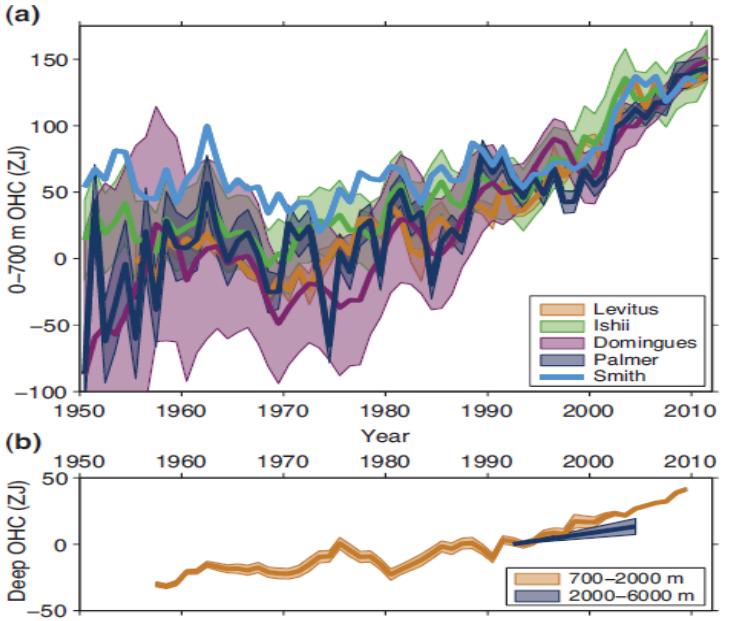
- Balance energy budget to within 0.1 Wm-2
- Who: Operators of GCOS related systems, including data centres.
- Time-Frame: Ongoing
- Performance Indicator: Regular assessment of imbalance in estimated global energy budget

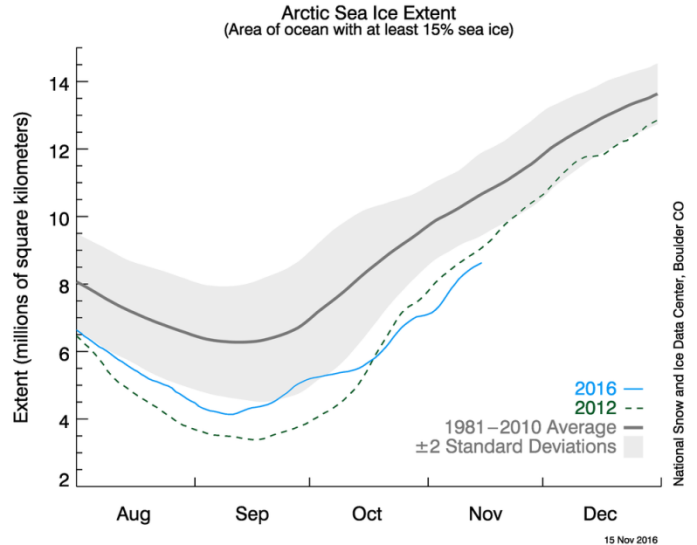
Target 4: Explain Changing Conditions to the Biosphere

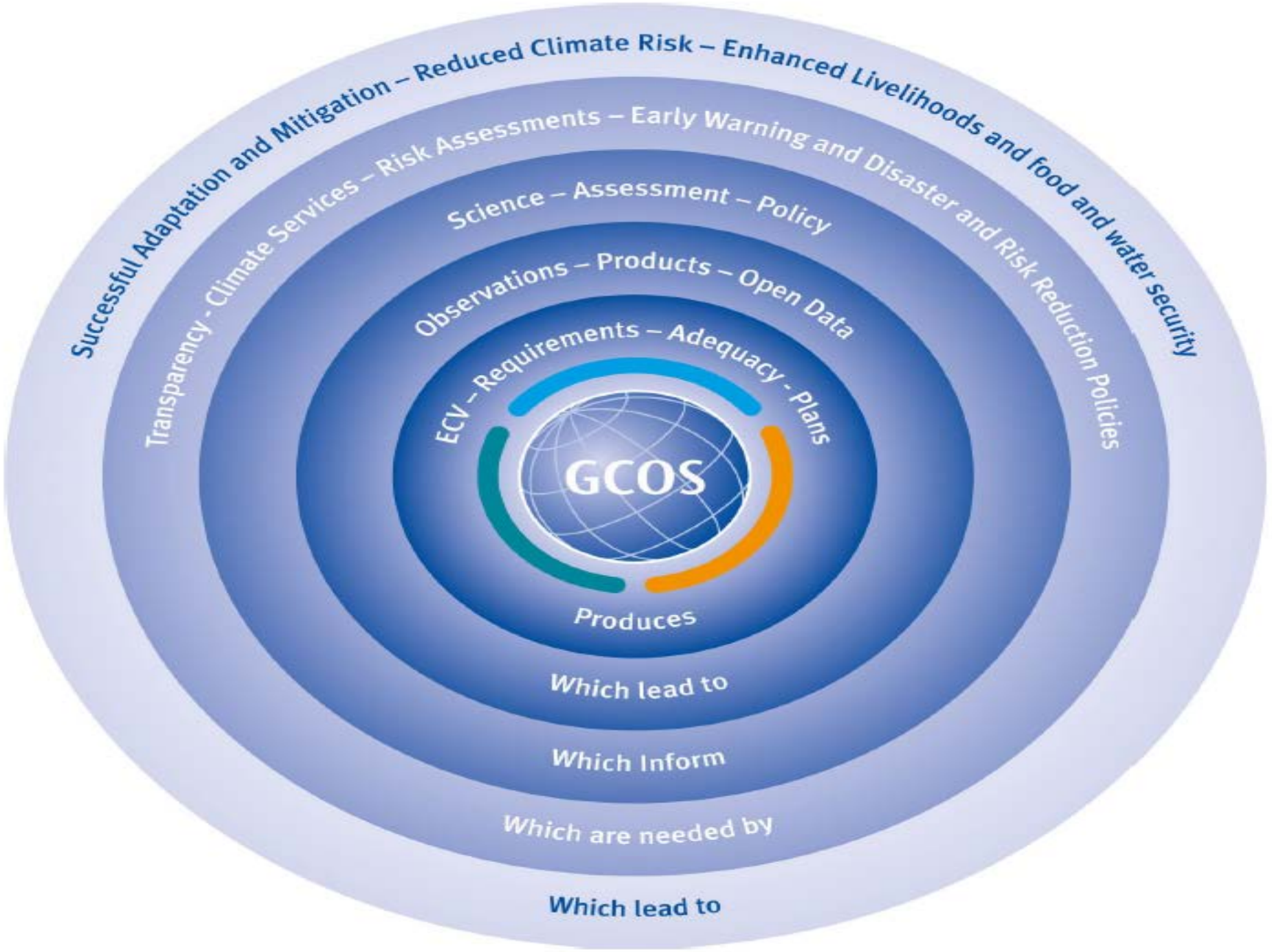
- Measured ECVs that are accurate enough to explain changes to the biosphere (for example, species composition, biodiversity etc.)
- Who: Operators of GCOS-related systems, including data centres.
- Time-Frame: Ongoing
- Performance Indicator: Regular assessment of the uncertainty of estimates of changing conditions as listed above

Climate Indicators

- Aim to be able to communicate a more complete picture of climate change (beyond surface temperature
- Will agree on a small set that covers different aspects of the system.
- Ensure they are regularly computed.
- Work with the community to communicate/display
- OOPC already works with NOAA to deliver state of the ocean indices. OOPC has been considering options for further expansion into subsurface.
- GCOS Workshop likely next year.

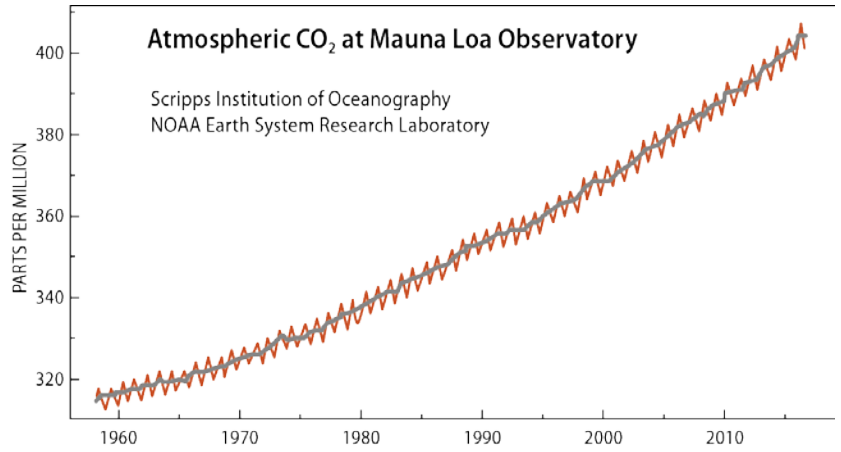


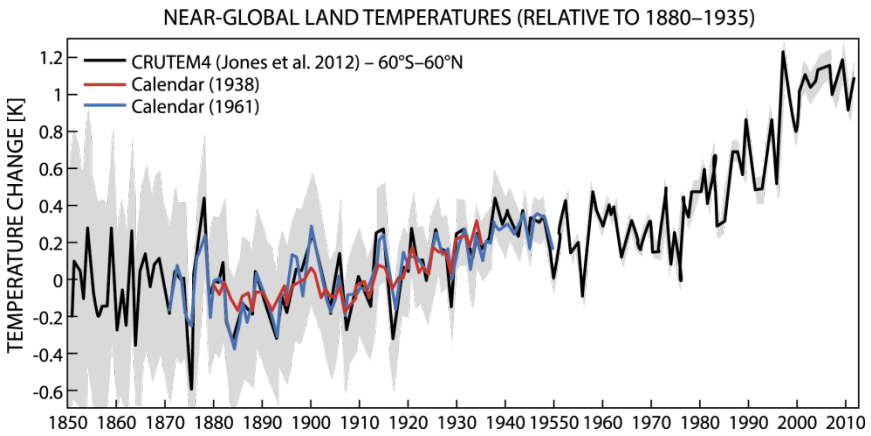



Successful Adaptation and Mitigation – Reduced Climate Risk – Enhanced Livelihoods and food and water security
Transparency - Climate Services – Risk Assessments – Early Warning and Disaster and Risk Reduction Policies
Science – Assessment – Policy
Observations – Products – Open Data
ECV – Requirements – Adequacy - Plans
GCOS
Produces
Which lead to
Which Inform
Which are needed by
Which lead to

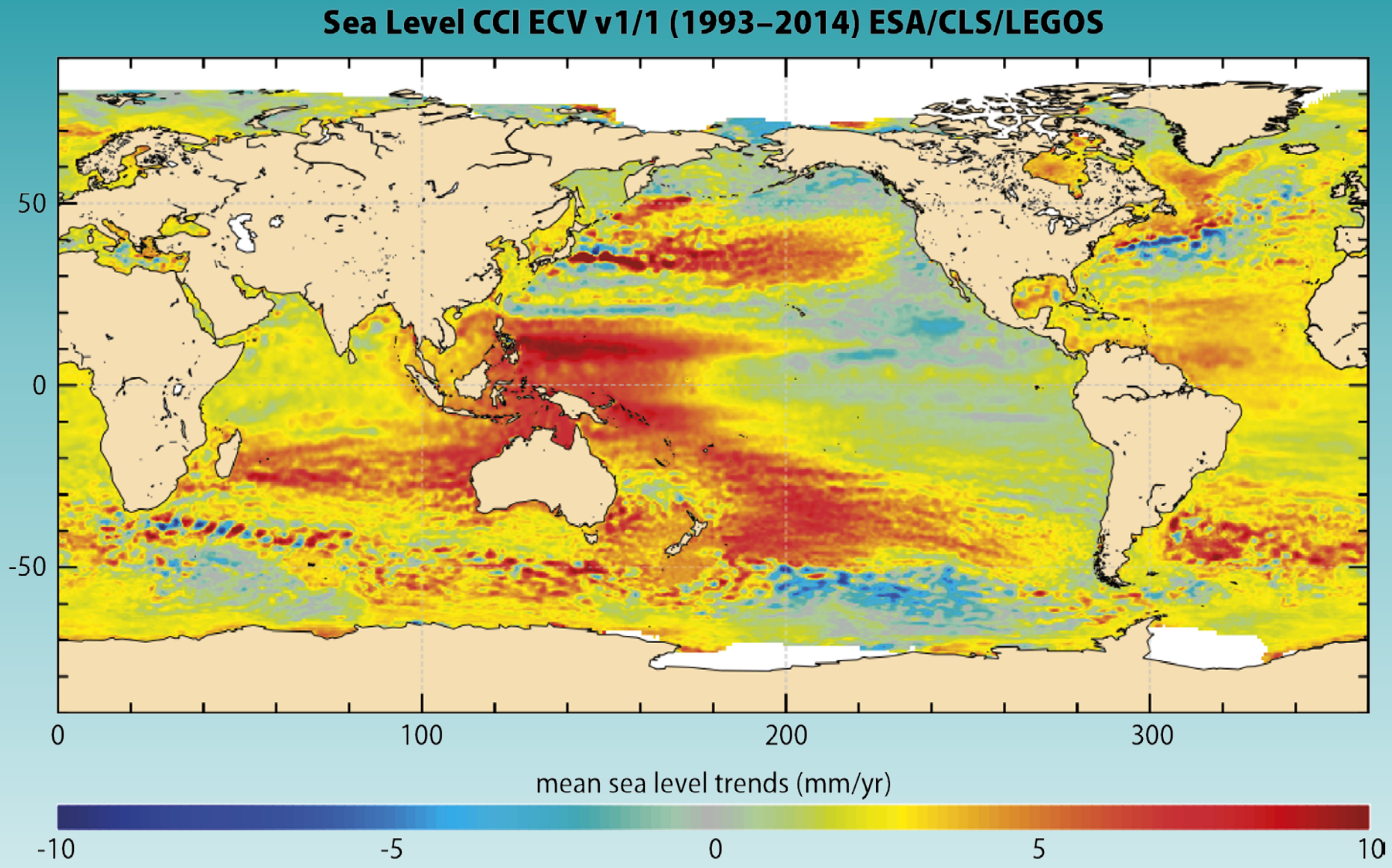
Atmosphere Key Messages

- Fewer changes than other panels: reflection of maturity/operational nature of atmospheric observing systems
- Addition of lightening ECV
- The need to complement satellite observations with in situ
- increasing generally the availability of observations and data products to meet climate needs,
  - in terms of frequency, measurements on remote locations but
  - also in terms of reporting and exchange.



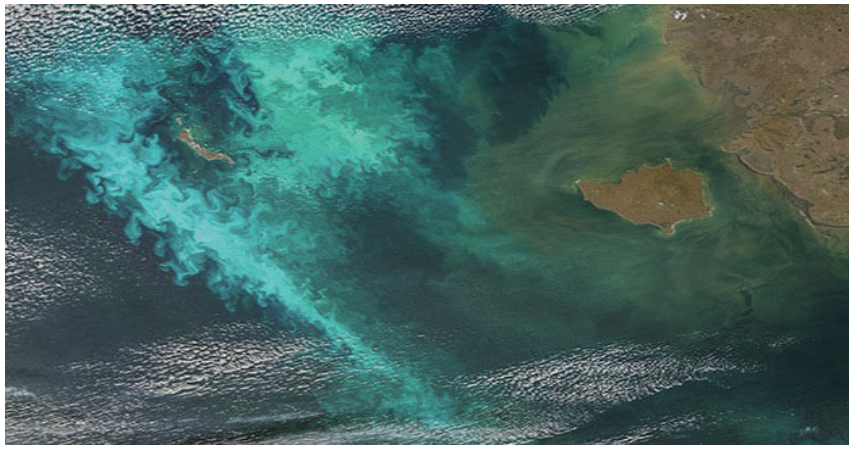


Regional distribution of many ECVs:
Satellites + in situ = global picture



Ocean Chapter. What's new.. (I)

- Focus on development activities
- Stronger multidisciplinary flavour:
  - Driven by need to understand climate impacts, adaptation, climate cycles
  - Expansion into the coast.
  - drawing on expertise from 3 GOOS panels,
  - Enabled by new sensor technologies
- ECV based actions.
  - Drawing on EOV Specifications, need to connect climate cycles
  - Focussed on what we need the observing system to enable us to do
  - Highlights the multiplatform mix/observing system interdependancies needed.
  - Performance evaluations for ECV based actions a priority for OOPC.



GOOS separation of responsibility for disciplines (ocean variables)

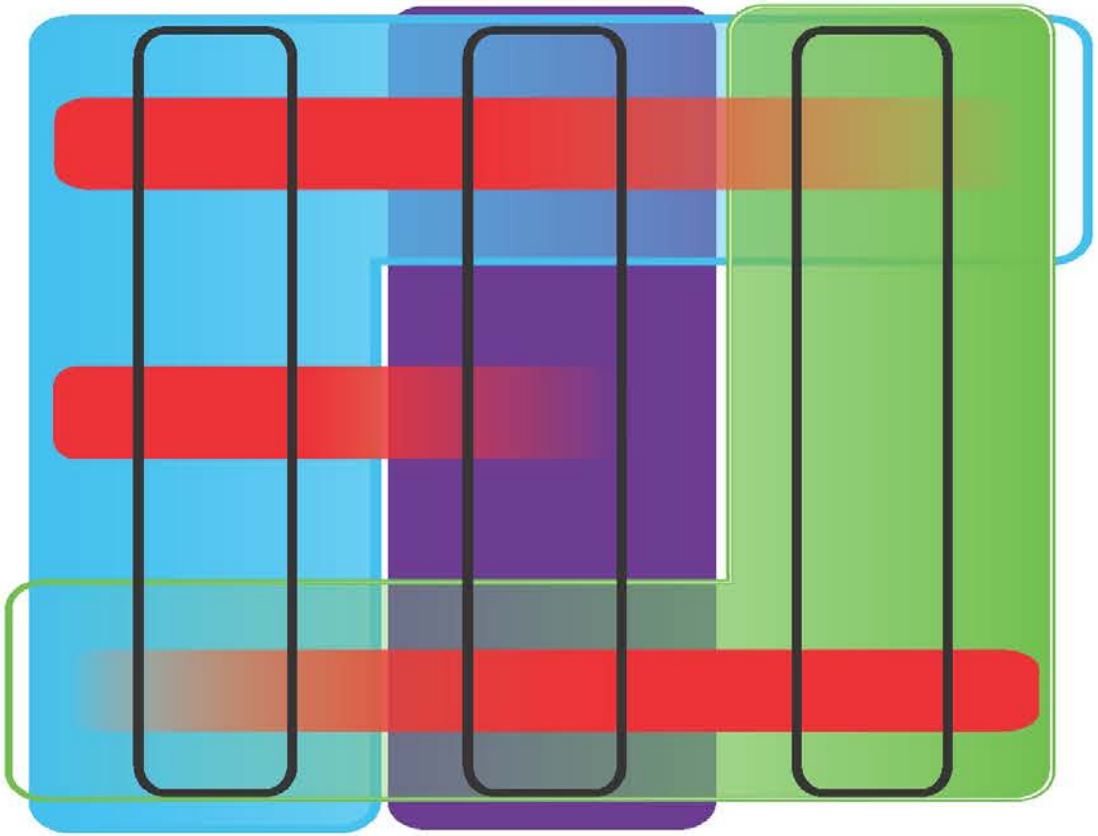
Physics **Biogeochemistry** **Biology**

GOOS Application Areas

Climate
(through **GCOS** for IPCC, UNFCCC, GFCS and national monitoring, mitigation, adaptation)

Real-time Services
(through JCOMM services, GODAE OV to specific benefit areas)

Ocean Health
(with GEO BON and others for IPBES, WOA, CBD, and national applications)



Strength of disciplinary contribution to application area

GCOS-GOOS-WCRP
OOPC: Panel for Physics variables, and
Climate Theme Lead
RT Services Theme Lead.
Ocean Health Theme Support

GOOS **Biogeochemistry**: Panel for Biogeochemical Variables and
Climate Theme Support
Ocean Health Theme Support

GOOS **Biology**: Panel for Biology Variables, and
Ocean Health Theme Lead
Climate Theme Support

EOVs and readiness level

CONCEPT PILOT MATURE

Physics

- Sea State
- Ocean surface stress
- Ocean Heat Fluxes
- Sea Ice
- Sea level
- SST
- Subsurface temperature
- Surface currents
- Subsurface currents
- Sea Surface Salinity
- Subsurface salinity

Biogeochemistry

- Oxygen
- Inorganic macro nutrients
- Carbonate system
- Transient tracers
- Suspended particulates
- Nitrous oxide
- Carbon isotope (^{13}C)
- Dissolved organic carbon

Biology and Ecosystems

- Phytoplankton biomass and productivity
- HAB incidence
- Zooplankton diversity
- Fish abundance and distribution
- Apex predator abundance and distribution
- Live coral cover
- Seagrass cover
- Mangrove cover
- Microalgal canopy cover

EOVs mapping to ECVs

Physics

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Plankton

- Apex predator abundance and distribution
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Marine Habitat Properties

Design and evolution of the observing system

Action O6:

- **Technology development:** Continued support for development of satellite capabilities, autonomous platforms and climate-quality sensors, through pilot-phase to mature stage.

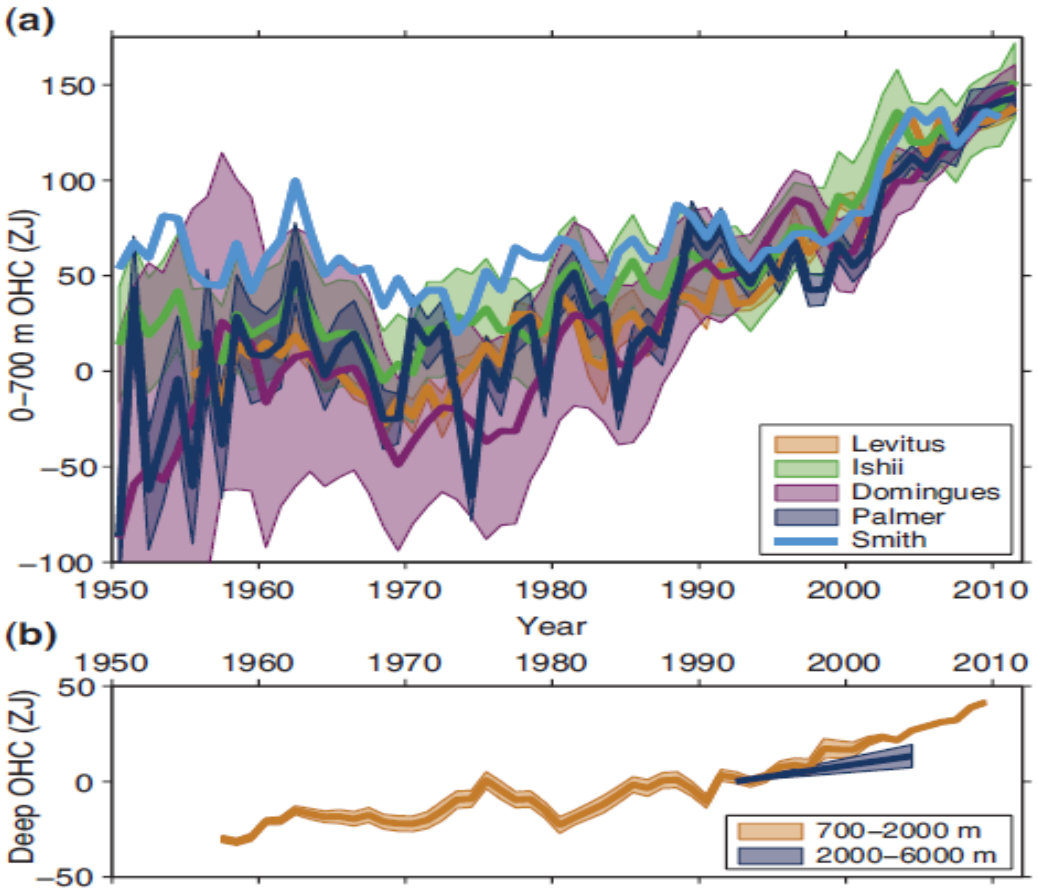
Action O7:

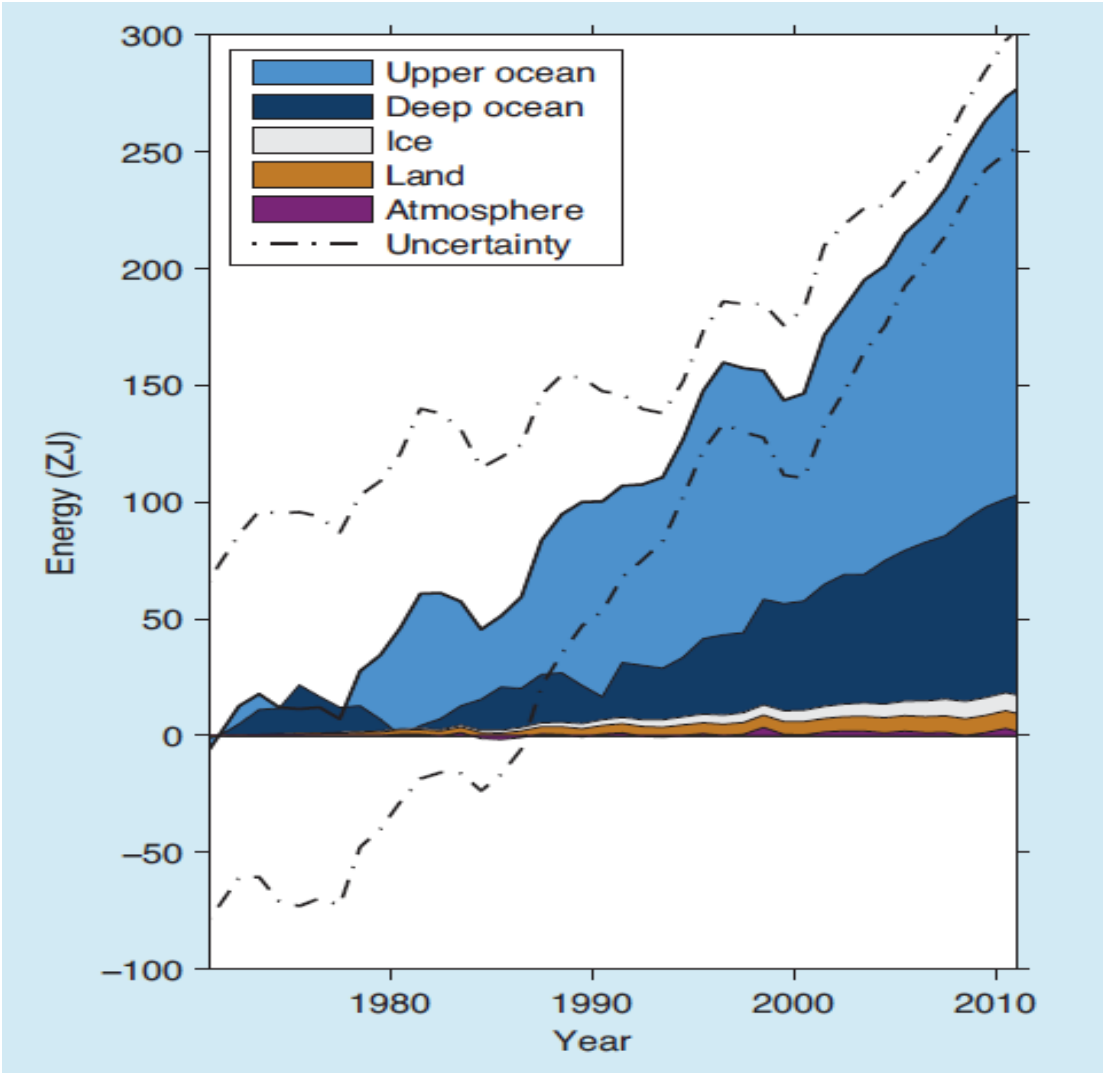
- **Observing system design and evaluation:** Support and engage in systems based observing system development projects established through GOOS as detailed in this plan, and efforts for the ongoing evaluation of the observing system.

TPOS 2020
Tropical Pacific Observing System

AtlantOS

Global Energy Budget and Ocean Heat Content: The Ocean store ~93% of excess heat





Actions: Ocean Temperature

Action 08: Sea Surface Temperature

- Continue the provision of best possible SST fields based on a continuous coverage-mix of polar orbiting (including dual view) and geostationary Infra-Red measurements, combined with passive microwave coverage, and appropriate linkage with the comprehensive in situ networks.

Action 09: Upper Ocean Temperature:

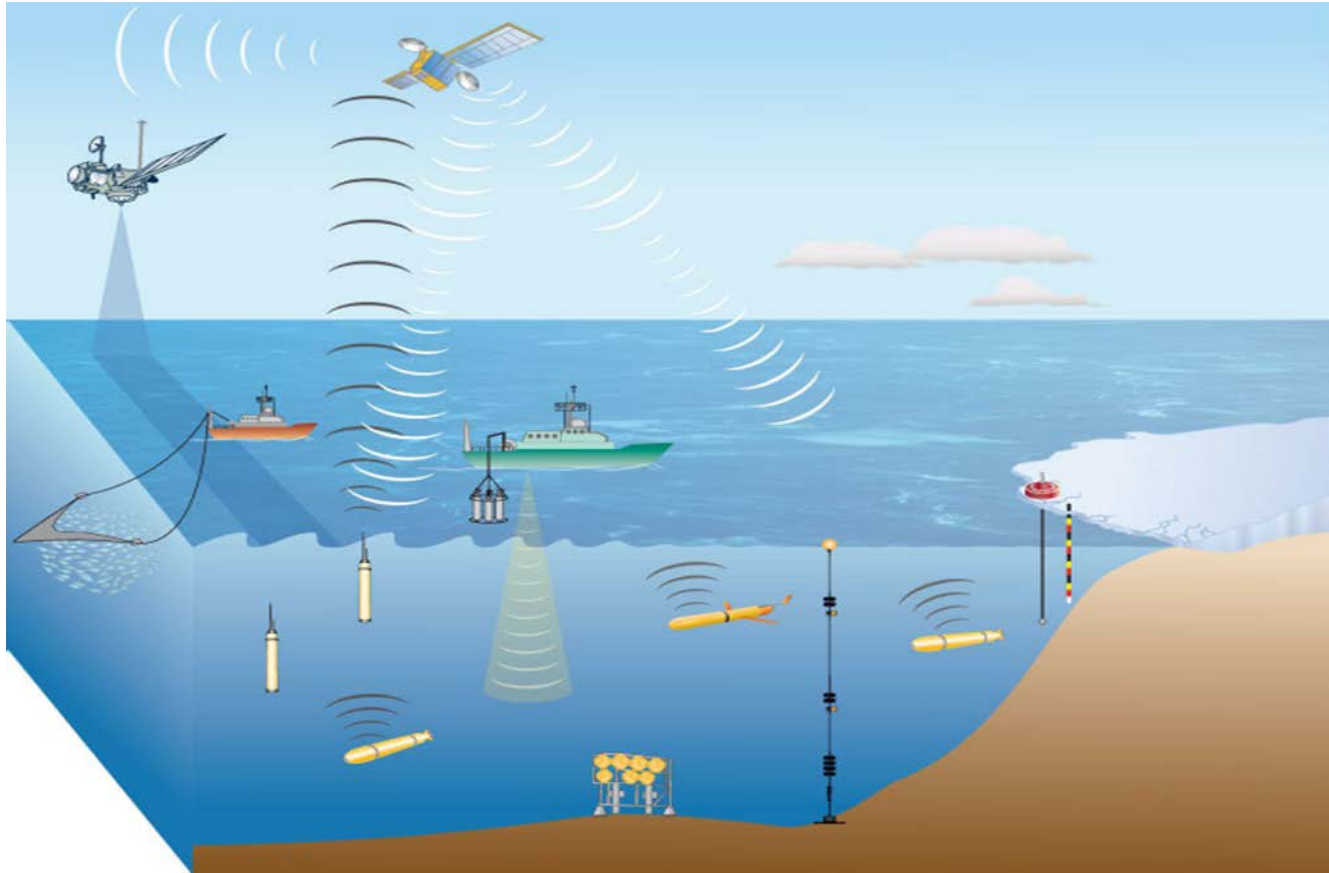
- Maintain a global upper ocean (0-2000 m) temperature observing system for the assessment of ocean temperature and heat content change and its contribution to sea level rise.

Action 10: Full depth ocean temperature:

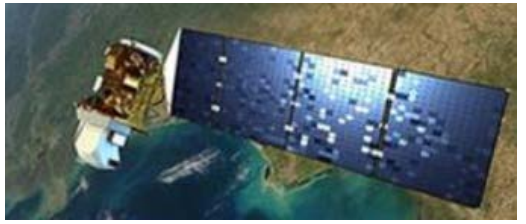
- Develop and begin implementation of a full depth ocean temperature observing system to support the decadal global assessment of the total ocean heat content and thermosteric sea level rise.

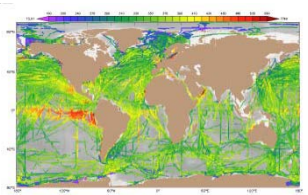
Ocean Chapter. What's new.. (II)

- Constellation/Network based actions
  - Refined observing system targets/level of effort needed.
  - For in situ, aligned with Network KPIs, tracked by JCOMMOPS.
- Focus on Platform/Network Interdependencies
- Focus on delivery of data, products.



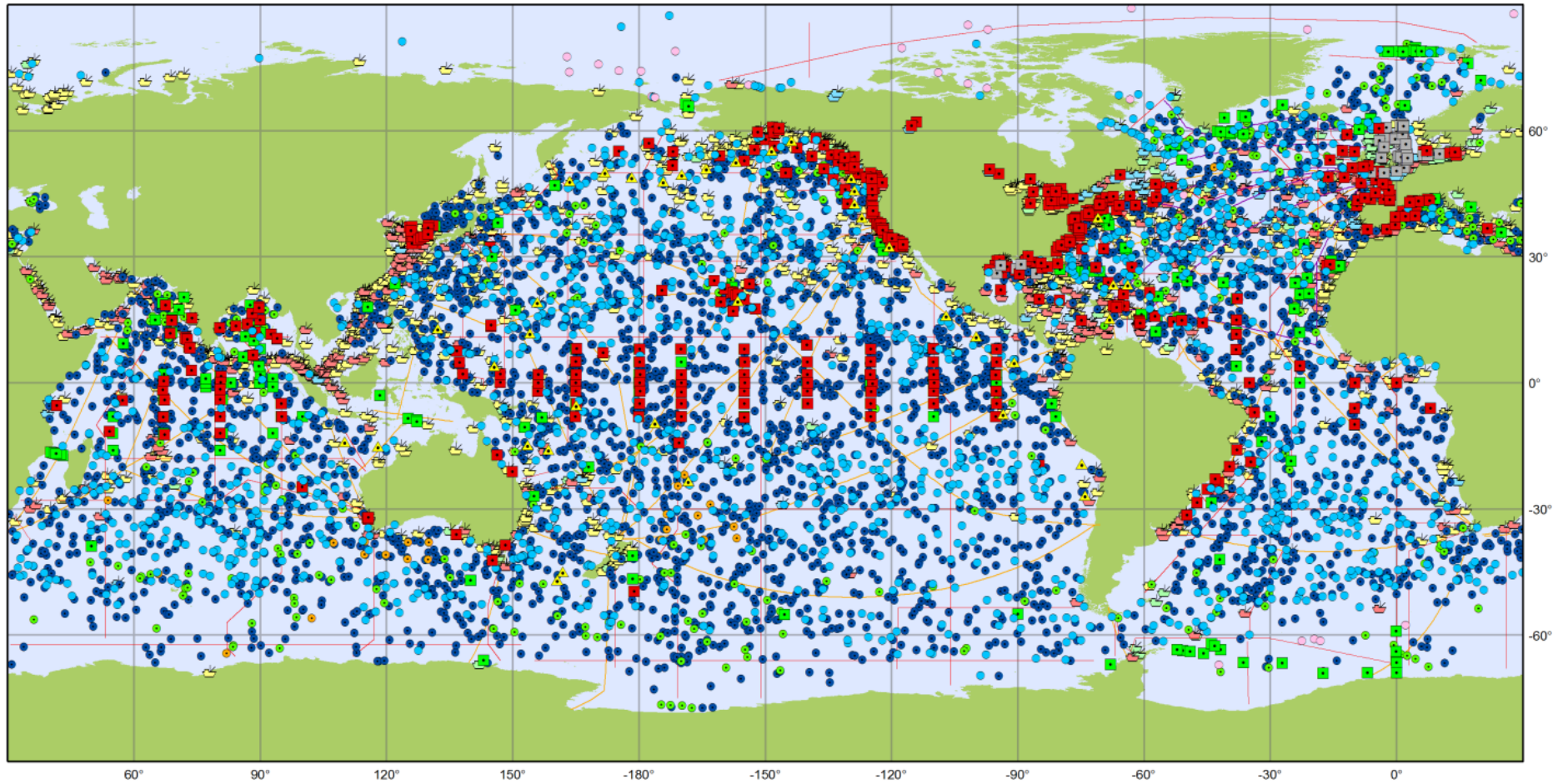
Constellation/Network Actions





- **Action O34: Satellite Ocean Surface Stress:** Continue to improve the delivery and quality of ocean surface stress fields based on satellite missions with the comprehensive in situ networks (e.g. metocean moorings). (1) improve resolution with the benefit of near coastal data (2) improved coverage of the diurnal and semi-diurnal cycles.

- **Action O37: Argo Array:** Sustain and expand the Argo profiling float network of at least 1 float every 3x3 degrees in the ocean including regional seas and the seasonal ice zone (approximately 3800 floats).



Main in-situ Elements of the Global Ocean Observing System

October 2016

Argo
- Argo (3836)
- Deep-Argo (23)
- Bio-Argo (295)

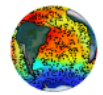
DBCP
- Surface Drifter (1456)
- Fixed Platform (103)
- Ice Buoy (26)
- Moored Buoy (422)
- Tsunameter (38)

OceanSITES
- Platforms (331)

GO-SHIP
- GO-SHIP (61)

SOT
- VOSClim-Automated (105)
- VOSClim-Manned (363)
- VOS-Automated (151)
- VOS-Manned (1111)

- ASAP Radiosondes (7)
- SOOP XBTs (46)



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Key Messages: General

- Connection to other conventions, SDGs
- Focus on climate indicators
  - Communication on the climate system changes, observations that underpin them (future workshop)
- Focus on Major Climate Budgets and Cycles.
  - Future effort needed on atmosphere/ocean, land/ocean interfaces (likely focus of future workshops
- Stronger focus on observing biosphere.
- Requirements for adaptation, mitigation (higher resolution)
  - Higher resolution obs requirements, products/information (likely addressed through regional workshops).

Key Messages: Ocean

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- Focus on Platform/Network Interdependencies
- Focus on delivery of data, products.

Future challenges.

- Developing a multidisciplinary multicustomer Observing System:
  - Expanded drivers for sustained observing (climate, ocean services, ecosystem health),
  - Climate requirements increasingly multidisciplinary
  - One observing system for range of requirements, potential and challenge to broaden funding base.
- Embracing new technology:
  - New technology provides opportunities to fill gaps, observe more variables, lower cost for observation.
  - Focus on climate record needs to be paramount (c.f. individual platform based timseries).
- Focus on evolution with stability.
  - Need to continue to drive innovation in observing system: continued need to prove we are getting more impact for investment (not simply asking for everything we are doing + more).