Observing the Earth and Its Environment:

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS) Imperative

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World Meteorological Organization

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Outline

I. WIGOS Background

II. WIGOS Imperative

III. WIGOS Concept Development

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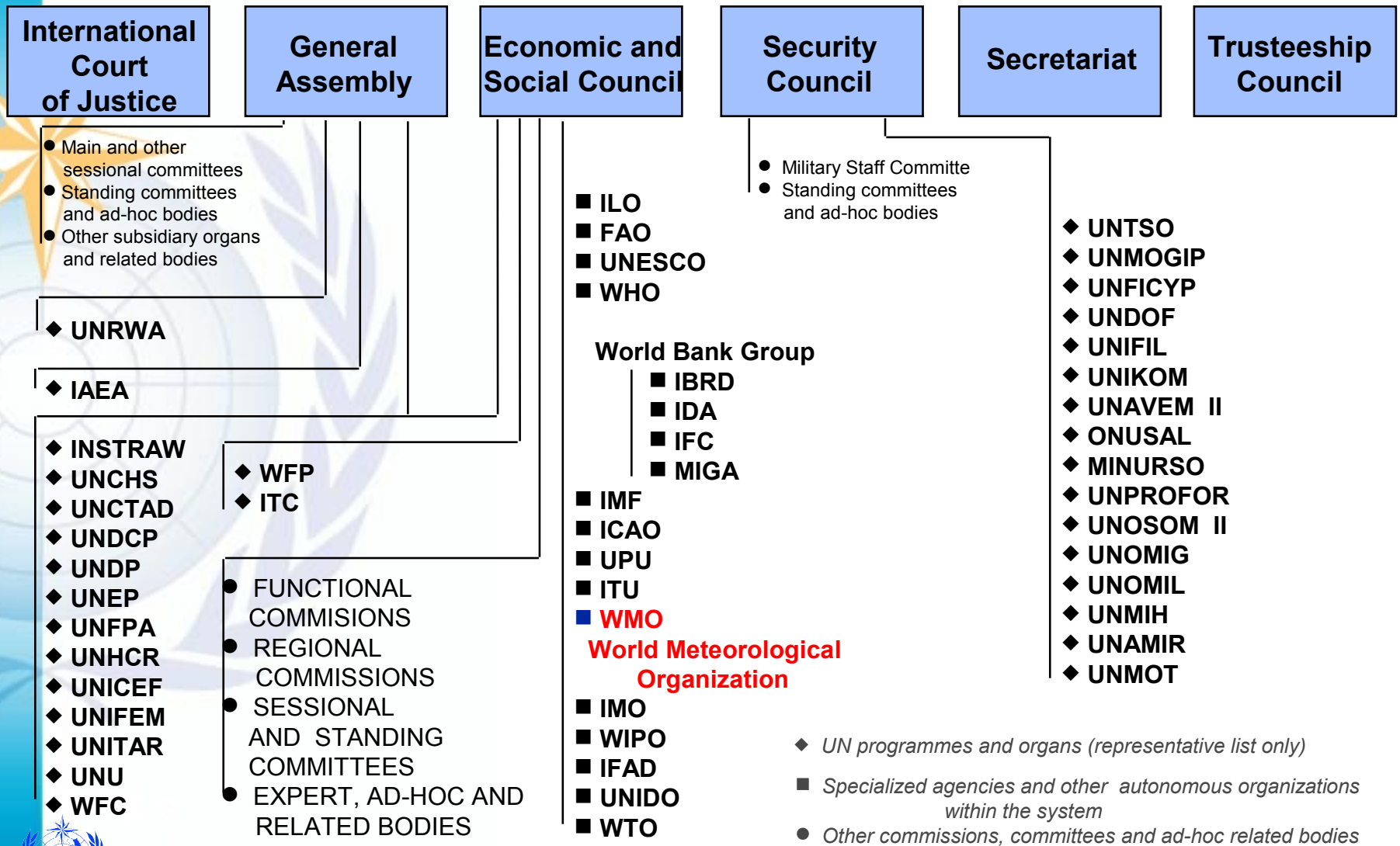
WMO in The United Nations System



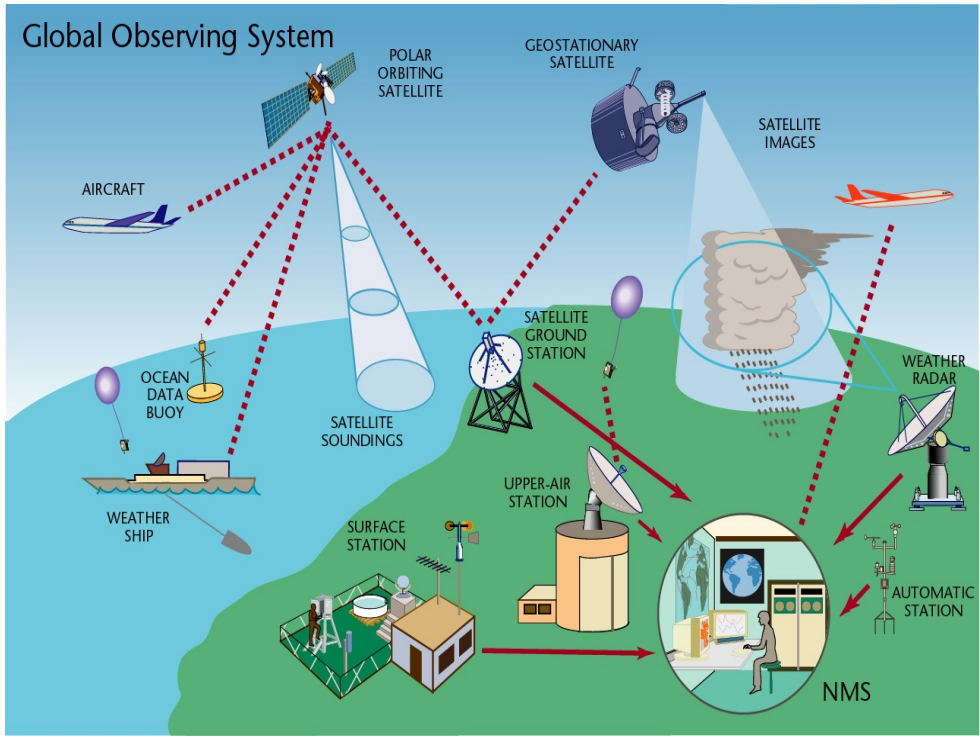
Organizational Structure of WMO (*189 Members*)

Key Values of the Organization

- **The Global Nature of the Weather, Climate and Water issues**
- **International Collaboration and Cooperation to solve key problems which one single country can not solve:**
  - **Global coordinated standardization of meteorological observations and real time data exchange for meteorological services**
  - **International cooperation on Disaster Risk Reduction (weather, climate and water related)**
  - **Joint efforts contribute to the better life, economic sectors and sustainable development.**

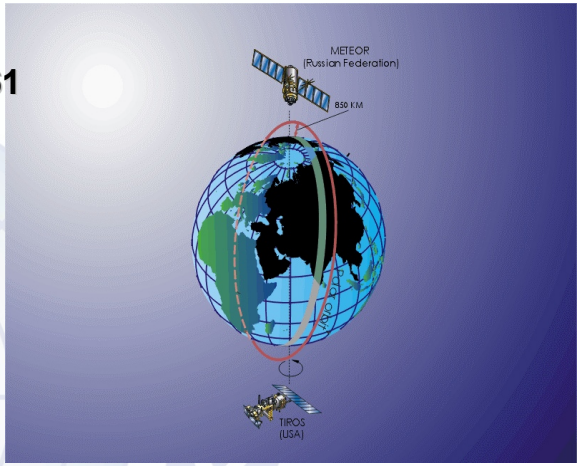
One of the greatest achievements of WMO: WWW (GOS, GTS and GDPFS)

- WMO Global Observing System: the benchmark observation progress :
  - Surface networks
  - Upper-air networks
  - Ocean observations
  - Radars networks
  - Airborne observations
  - Satellite constellations

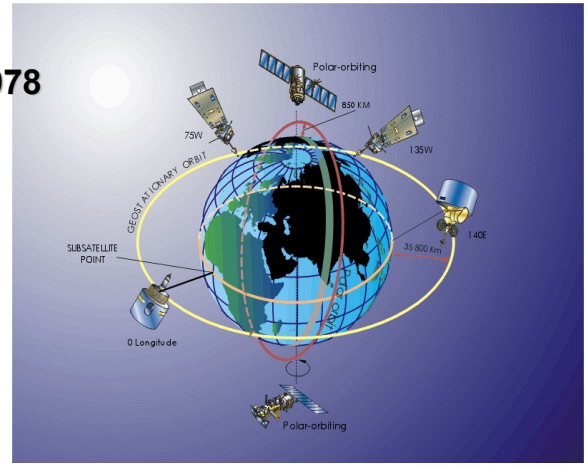


GOS Space-based development

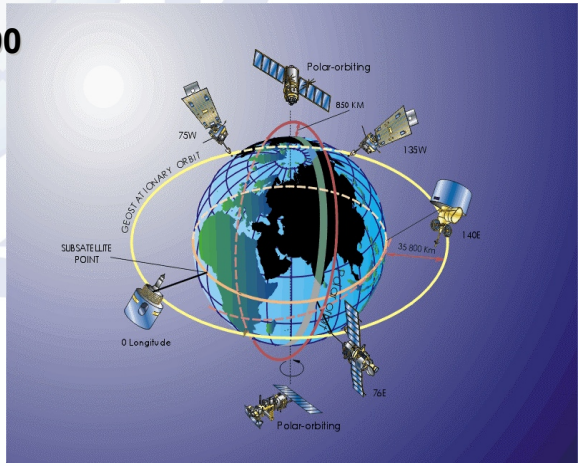
1961



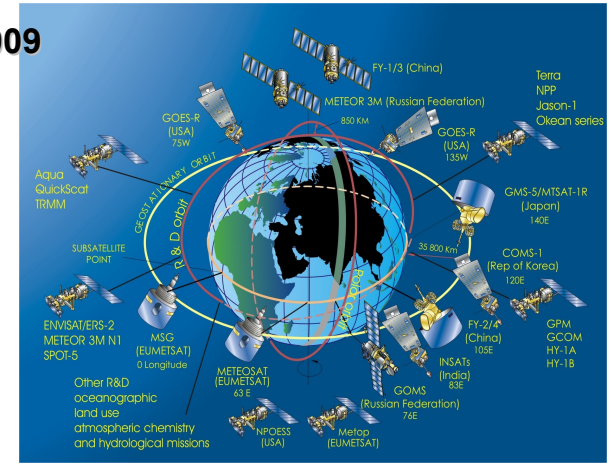
1978



1990



2009



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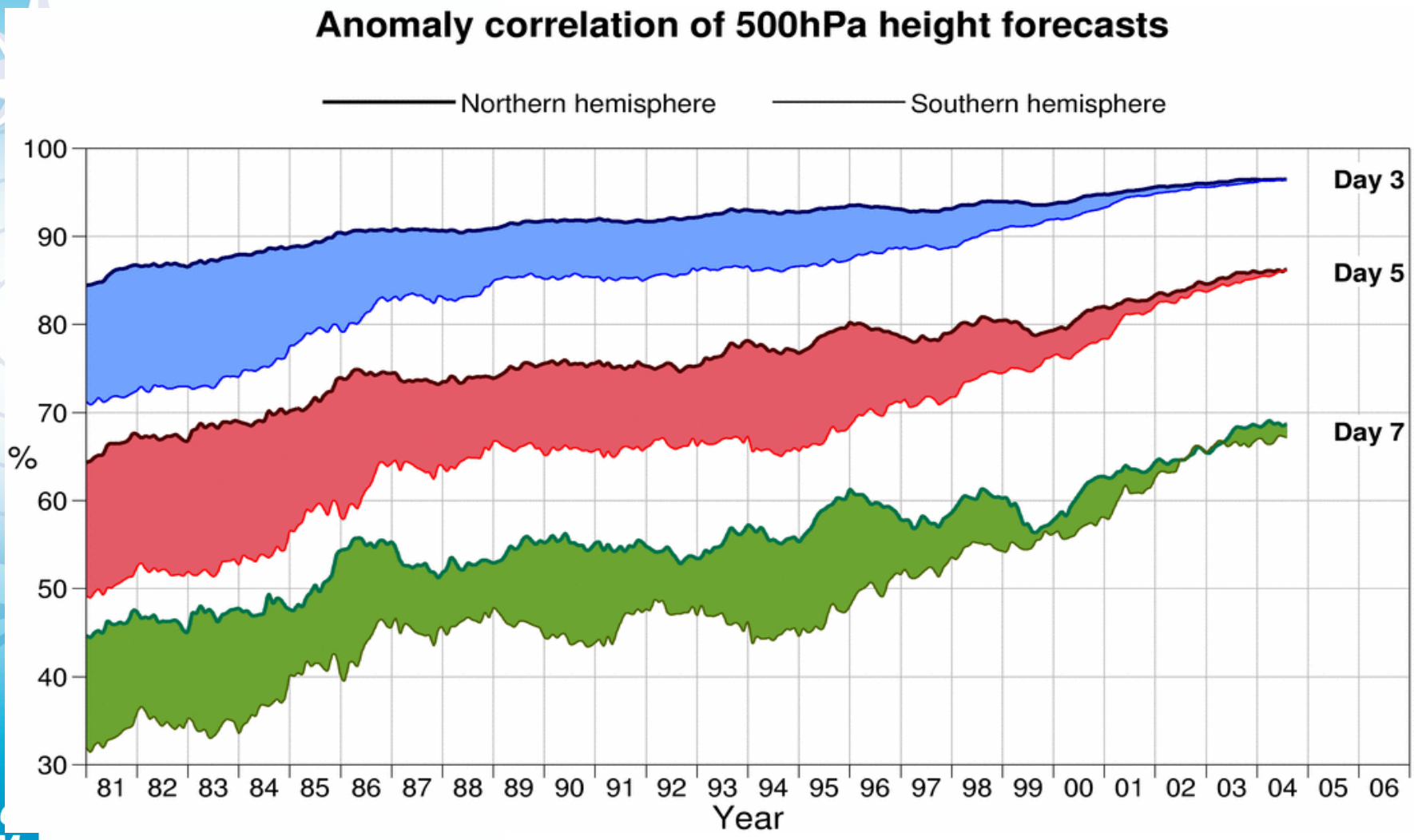
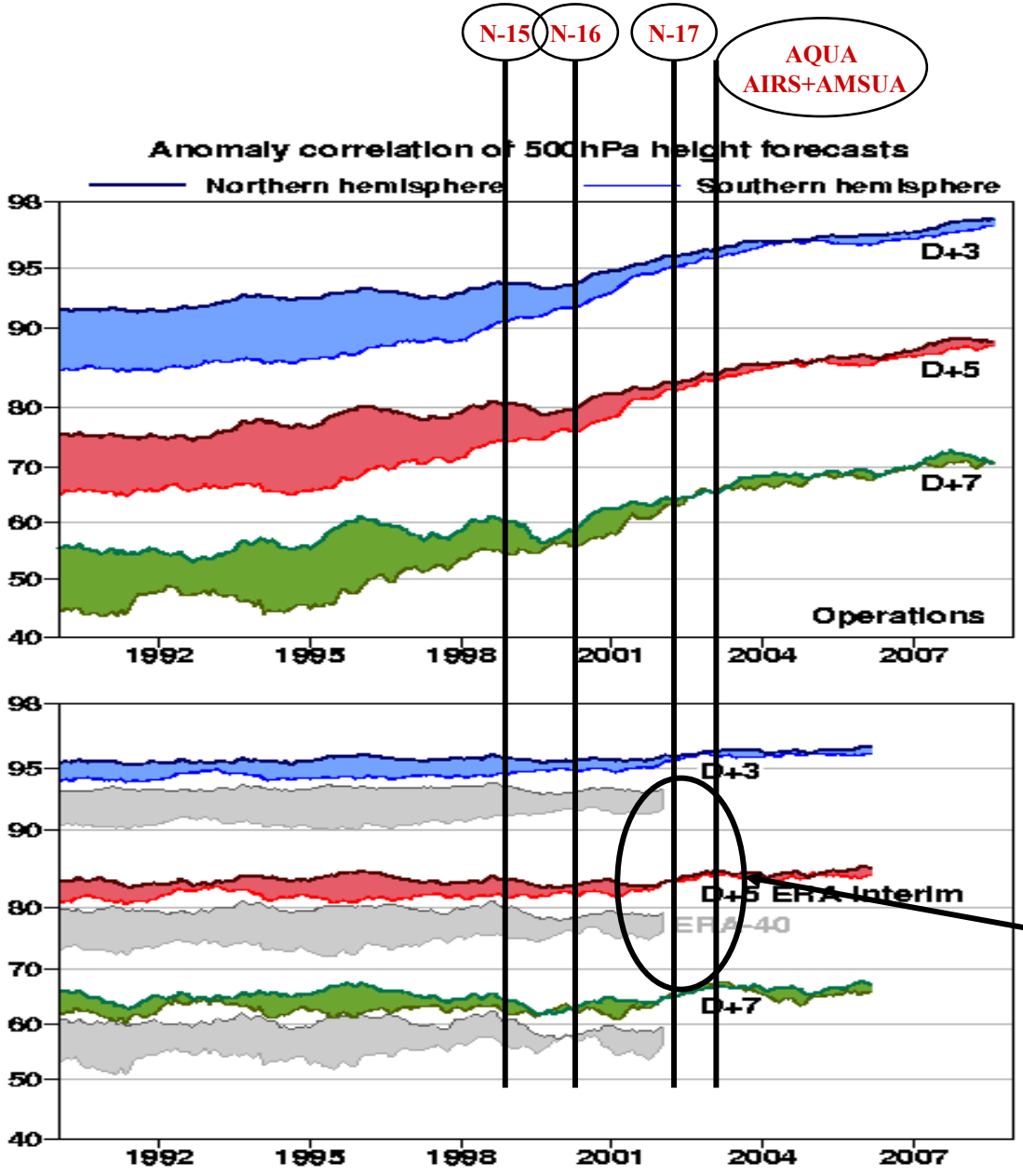
Convergence of N.Hem and S.Hem Medium Range Forecast skill 1981 – 2004



Impact of satellite observations on reanalyses



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Challenges: Climate Change and severe disasters, increasing society needs for improved services

El Niño

Hot & cold spells

Droughts

River basin flooding

Tropical cyclones

Heavy precipitations (rain or snow)

Storm surges

Ice Storms

Storm (winds)

Dust storms

Wildland fires & haze

Hail&Lightning

Mud & landslides

Flash floods

Avalanches

Tornadoes

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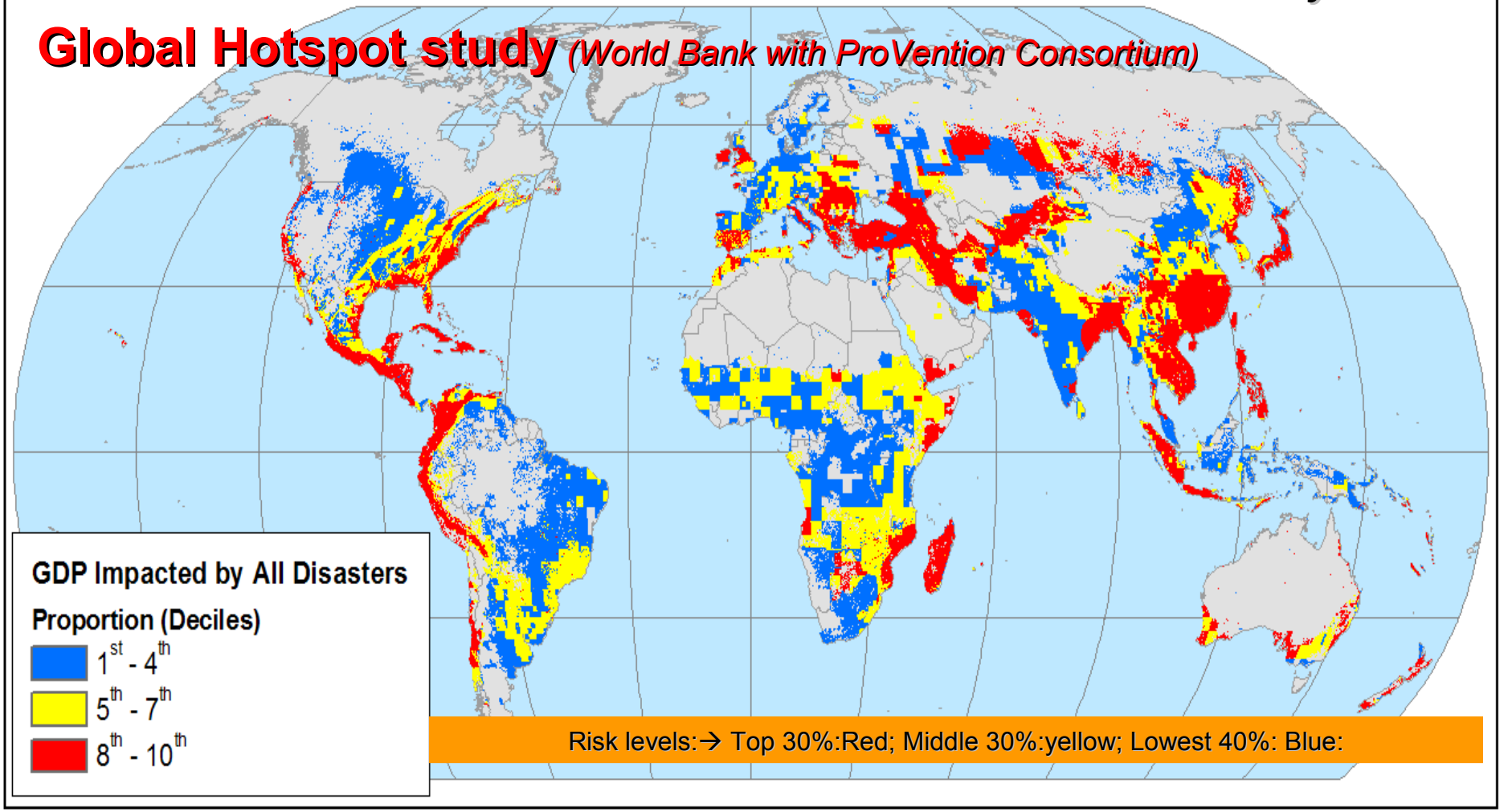
Global Challenges We Share

As society becomes more complex we become more sensitive to natural and human induced variability.

Global Hotspot study *(World Bank with ProVention Consortium)*



35 countries have more than 5% pop in areas at risk from three or more hazards
96 countries have more than 10% pop in areas at risk from two or more hazards
160 countries have more than 25% pop in areas at risk from one or more hazards

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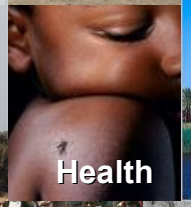
Increasing Risks under a Changing Climate



Strong Wind

Coastal Marine Hazards

Tropical Cyclones

Heavy rainfall / Flood

Heatwaves

Intensity

Frequency

Hazards' intensity and frequency are increasing

Exposure is increasing !

Climate observations Are critical for better services

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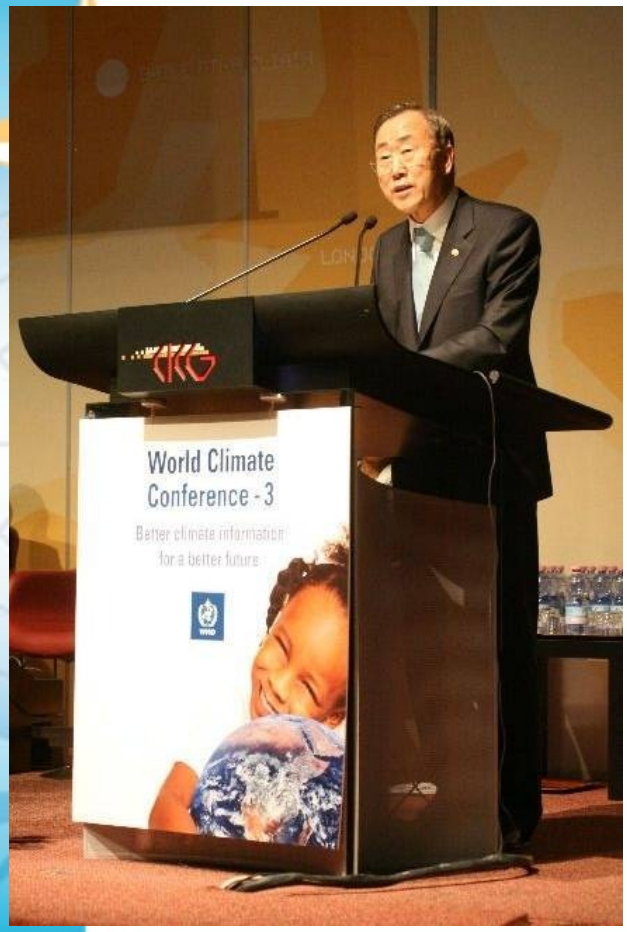
World Climate Conference-3



Aug 31 – Sept 4, 2009, GENEVA

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WCC-3 High-level Declaration
(approved on 3 September 2009)

DO 1 We, Heads of State and Government, Ministers and Heads of Delegation present at the High-level Segment of the World Climate Conference-3 (WCC-3) in Geneva, noting the findings of the Expert Segment of the Conference;

OP 1 Decide to establish a Global Framework for Climate Services (hereafter referred to as "the Framework") to strengthen production, availability, delivery and application of science-based climate predictio

Decide to establish a Global Framework for Climate Services

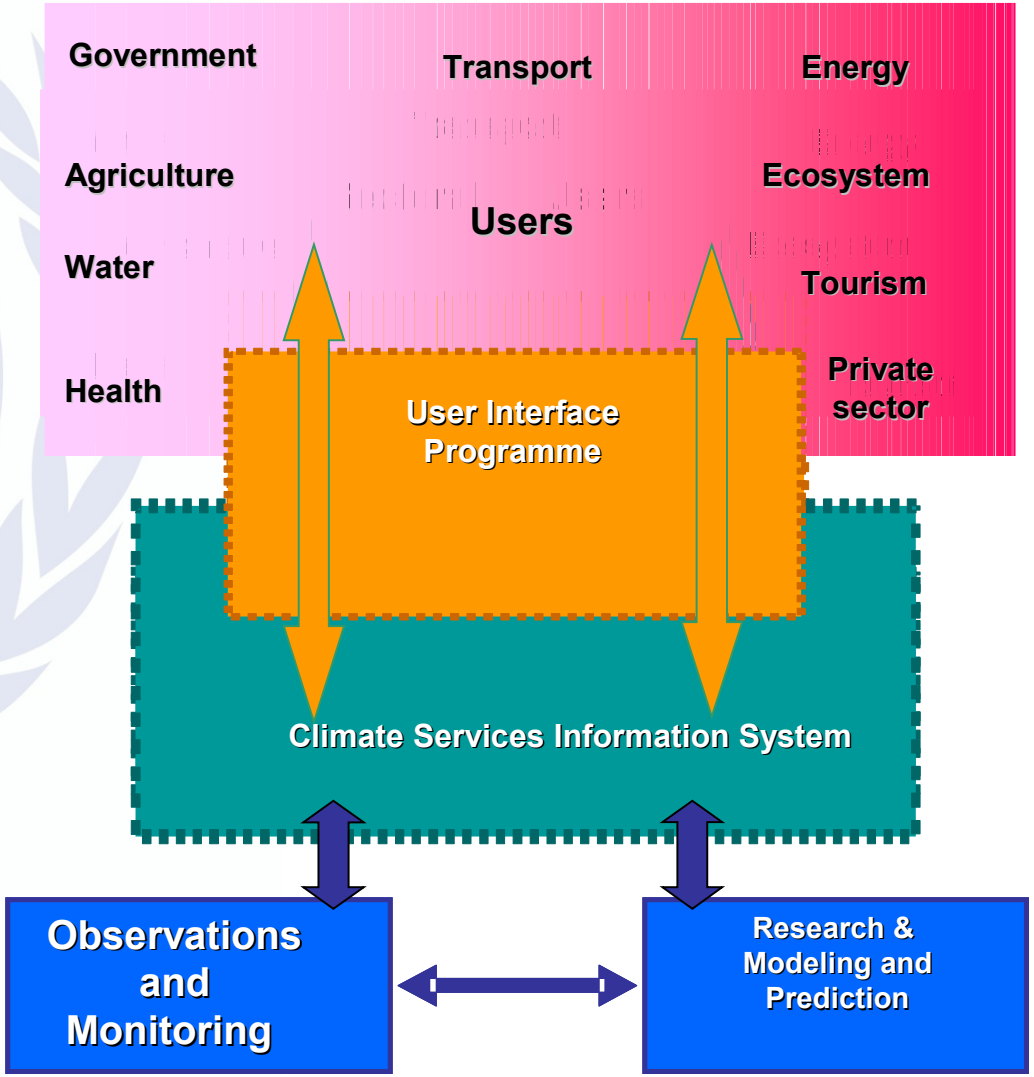
OP 2 Req **on of the Declarati** **rms of reference** **ors to be appointed by the Secretary-General of the WMO with due consideration to expertise, geographical and gender balance;**

OP 3 Decide that the task force will, after wide consultation with governments, partner organizations and relevant stakeholders, prepare a report, including recommendations on proposed elements of the Framework, to the Secretary-General of WMO within 12 months of the task force being set up. The report should contain findings and proposed next steps for developing and implementing a Framework. In the development of their report, the taskforce will take into account the concepts outlined in the annexed Brief Note;

OP 4 Decide further that the report of the task force shall be circulated by the Secretary-General of WMO to Member States of the WMO for consideration at the next WMO Congress in 2011, with a view to the adoption of a Framework and a plan for its implementation; and

OP 5 Invite the Secretary-General of WMO to provide the report to relevant organizations, including the UN Secretary-General.

Components of Global Framework for Climate Services



WIGOS: Overview

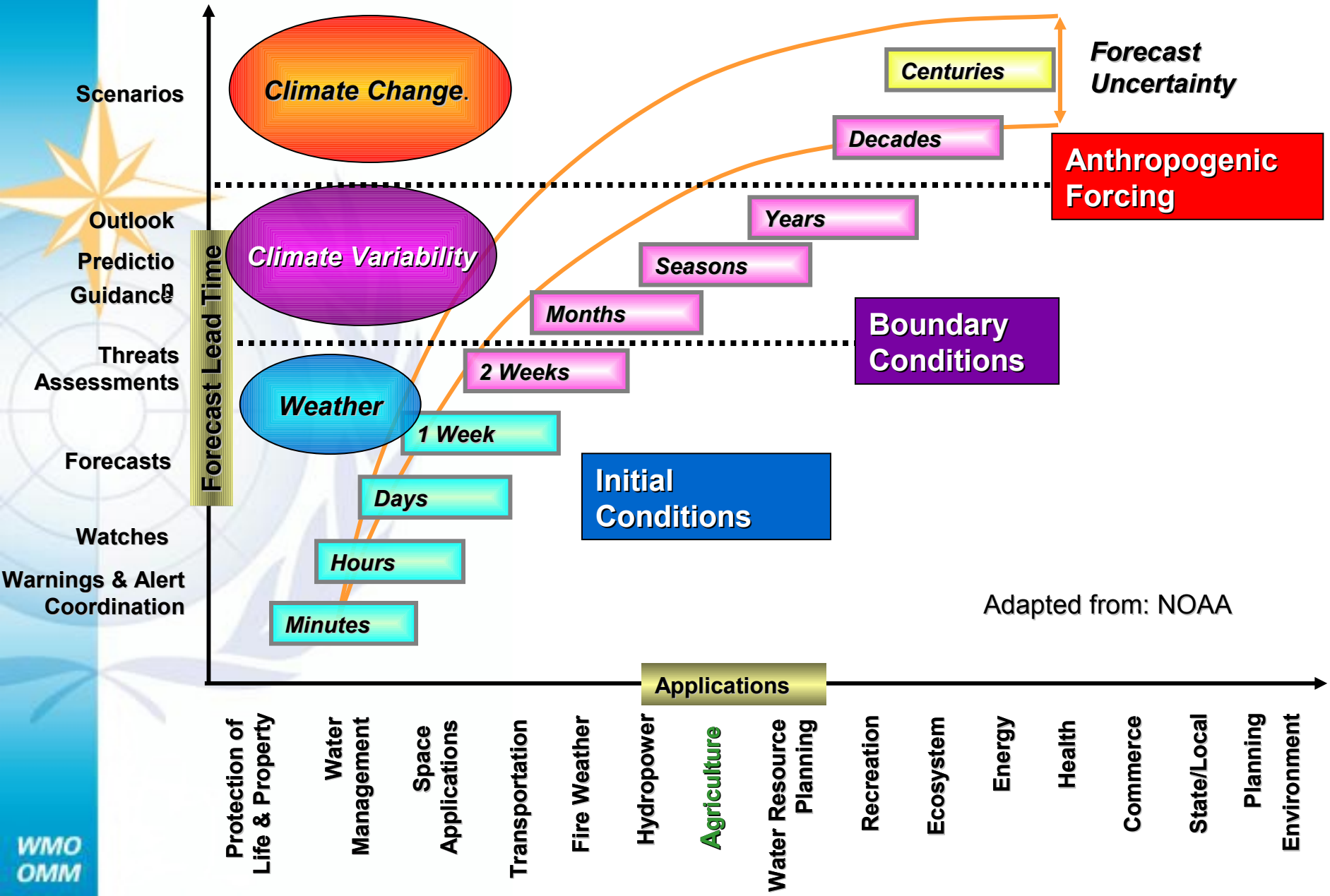
CONGRESS XV (2007)

- High priority -- “Towards Enhanced Integration between the WMO Observing Systems” (WIGOS) to support weather, climate, water and related environmental services

WMO Executive Council

- Established a WG on WIGOS-WIS
  - Develop an WIGOS Implementation Plan
  - Refine the WIS-Implementation Plan
  - Monitor the Progress of the Pilot and Demo projects

A Seamless Prediction Framework: Challenges to the observing systems



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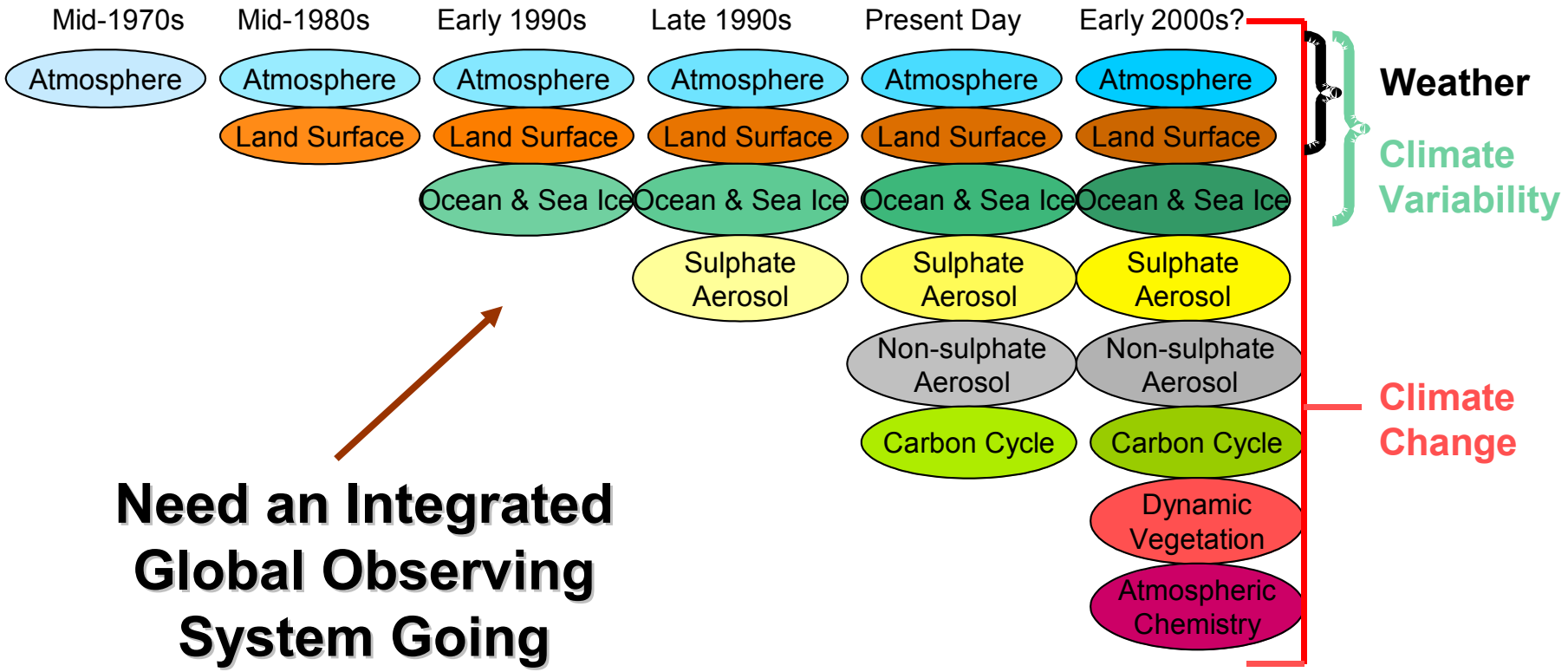
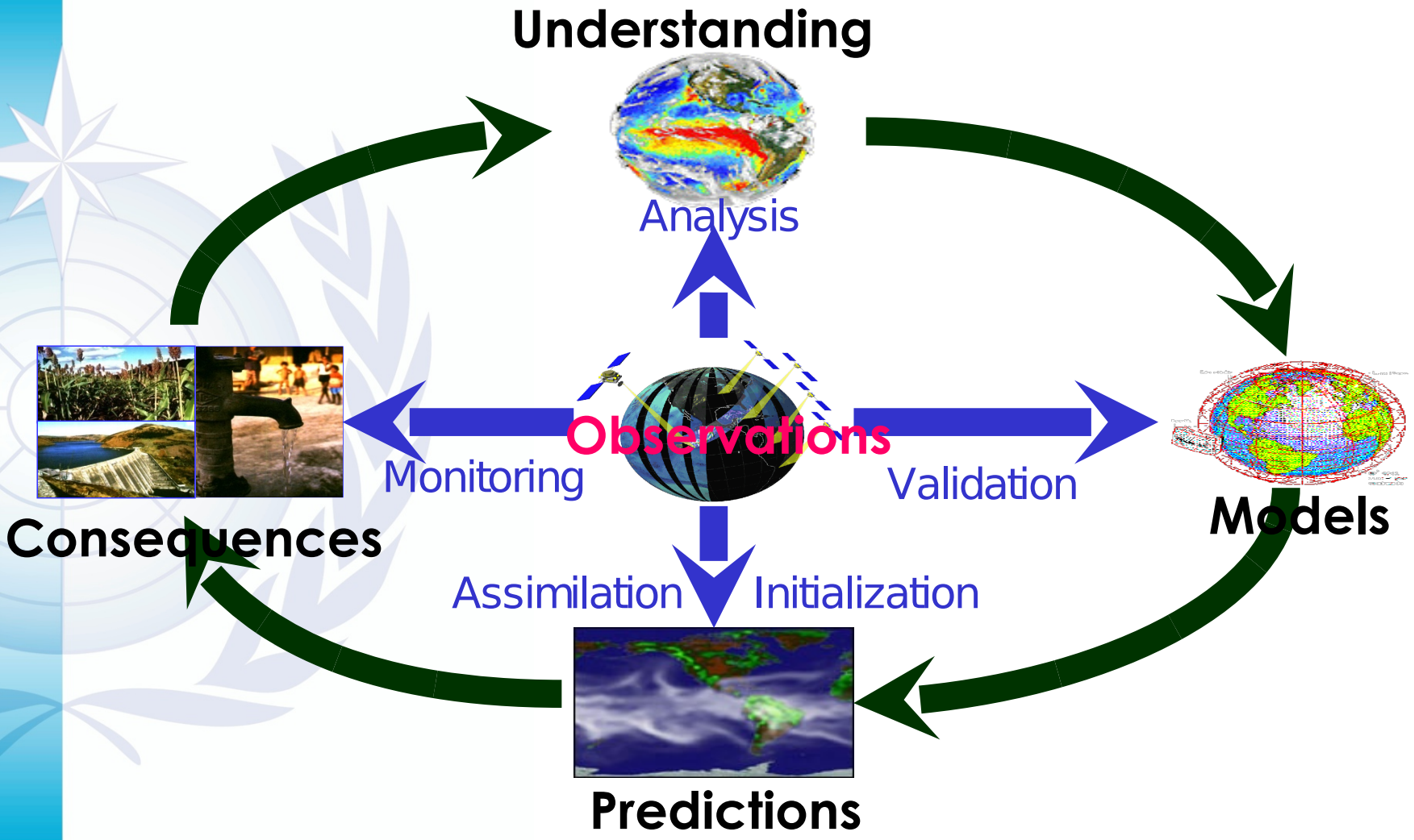
Overview of Weather and Climate Models and the Required Observations



Need an Integrated Global Observing System Going Beyond the WWW

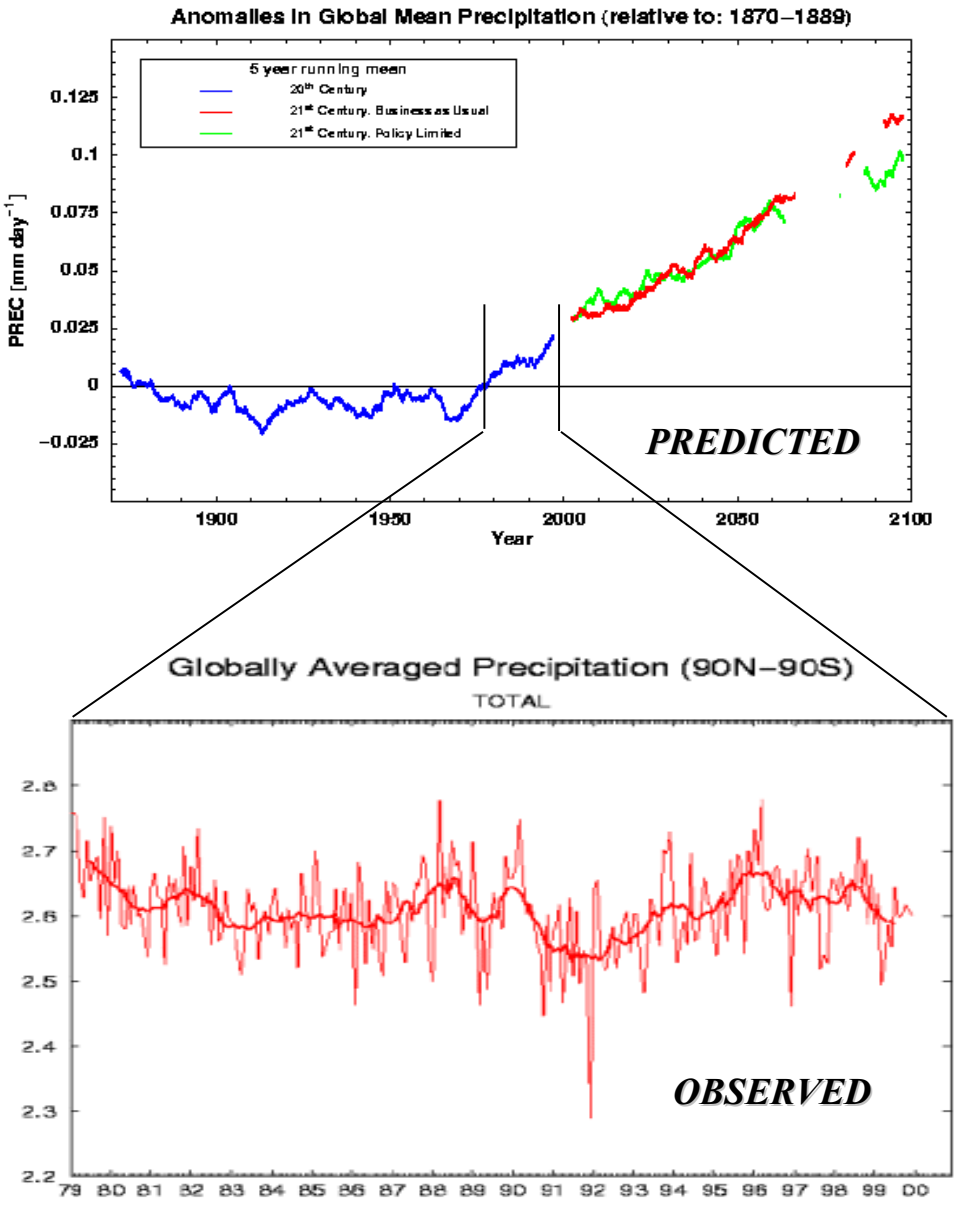
Importance of observations : From Observations to Consequences



The availability of new observations strongly motivates advances in understanding, prediction, and application.

Climate Model vs Observed Precipitation

- Global Intensification of the hydrological cycle ?
- Models indicate trend -- observations don't confirm
- Errors don't allow proof



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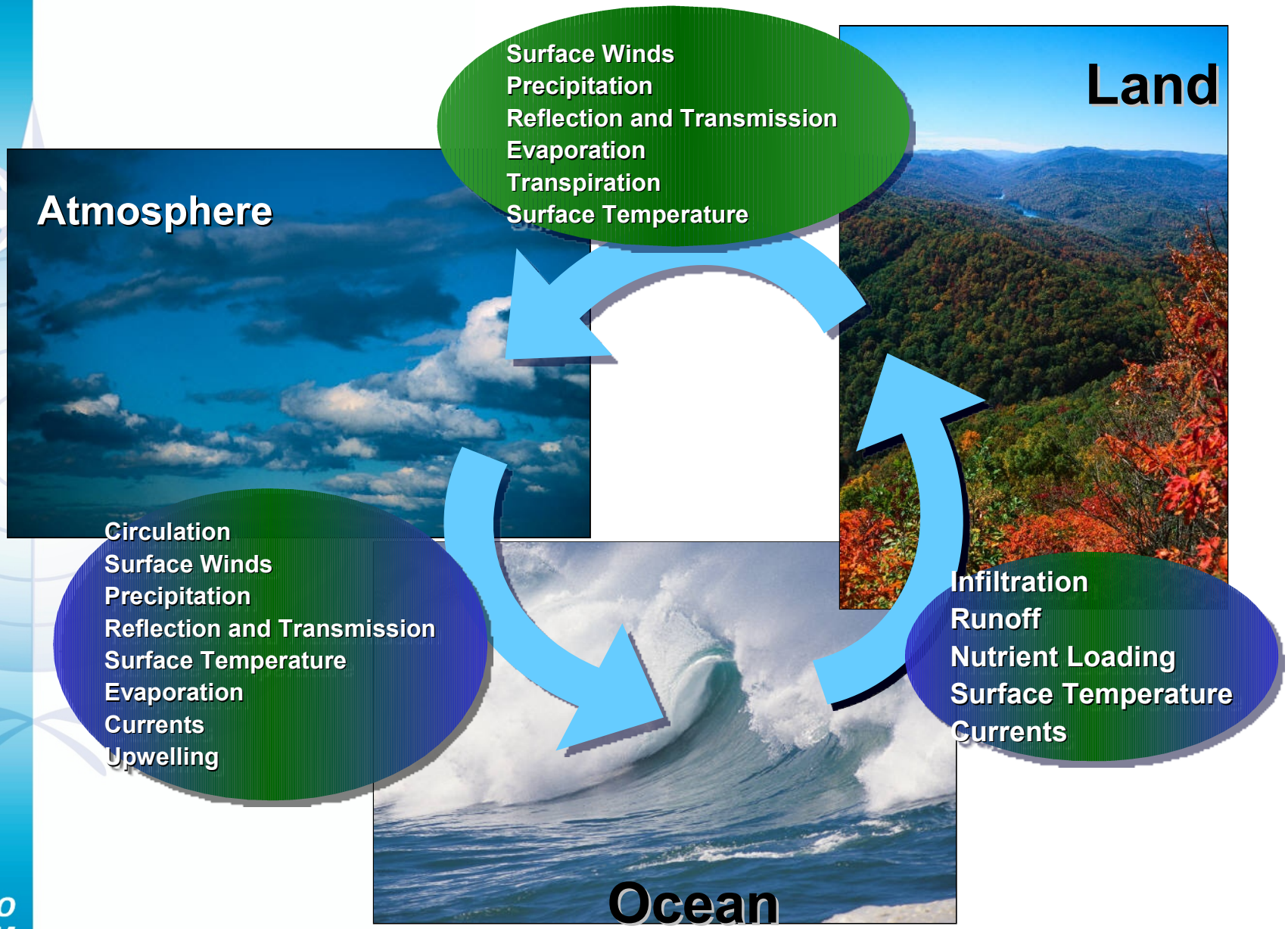
Studying Earth as a Complex System



No.1 Priority: Completeness

Fill-in critical observation gaps in 5 dimensions

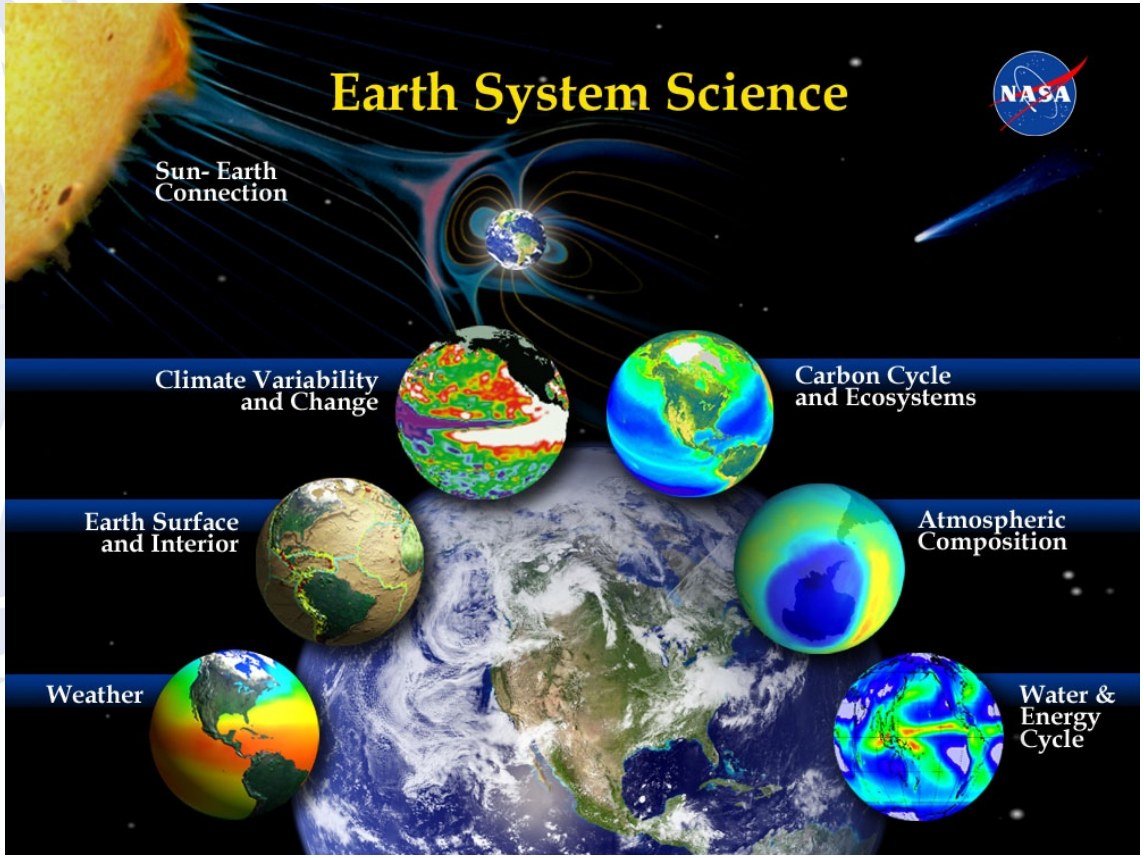
- Space
- Time
- Variables

Space & time

- Oceans (incl sub-surface, regularly)
- Land (incl polars and cyrosphere)
- High atmosphere

New variables ??

Earth System Science: Foundation for Climate, Weather and Environmental Observations, Research, Prediction and Services in 21st Century

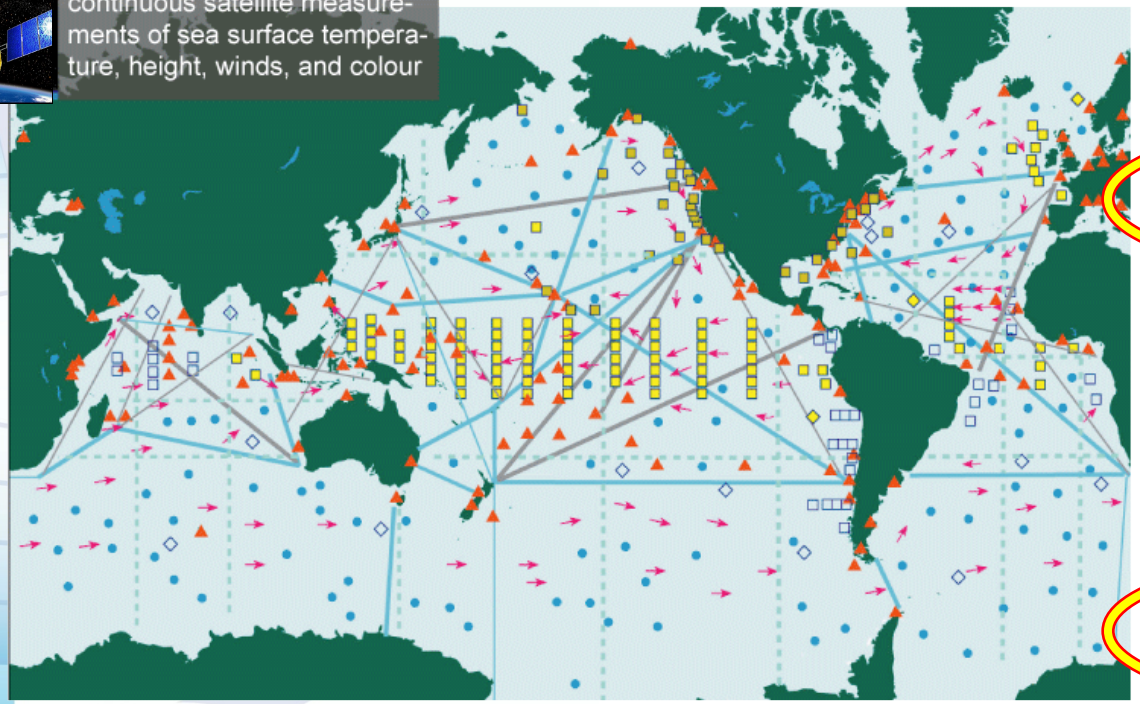


Initial Global Ocean Observing System for Climate

Status against the GCOS Implementation Plan and JCOMM targets

Total *in situ* networks **61%** March 2009

continuous satellite measurements of sea surface temperature, height, winds, and colour



87% **Surface measurements** from volunteer ships (VOSclim)

200 ships in pilot project

100% Global **drifting surface buoy** array

5° resolution array: 1250 floats

66% **Tide gauge** network (GCOS subset of GLOSS core network)

170 real-time reporting gauges

81% **XBT** sub-surface temperature section network

51 lines occupied

100% **Profiling float** network (Argo)

3° resolution array: 3000 floats

59% Repeat **hydrography** and **carbon** [illegible]

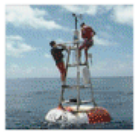
Full ocean

Reference time series 54%

58 sites

48% Global **reference mooring** network

29 moorings planned



79% Global tropical **moored buoy** network

119 moorings planned

Milestones

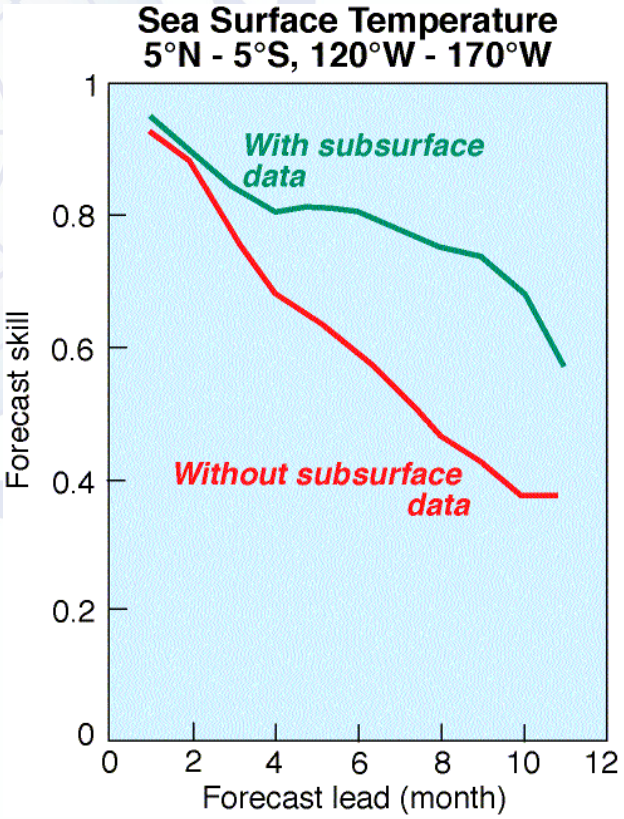
Drifters 2005

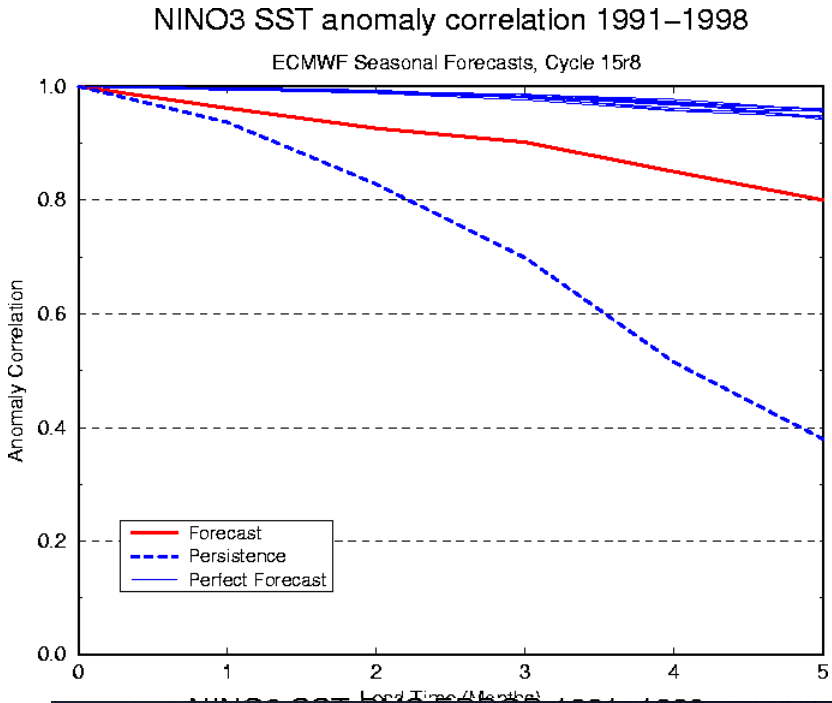
Argo 2007

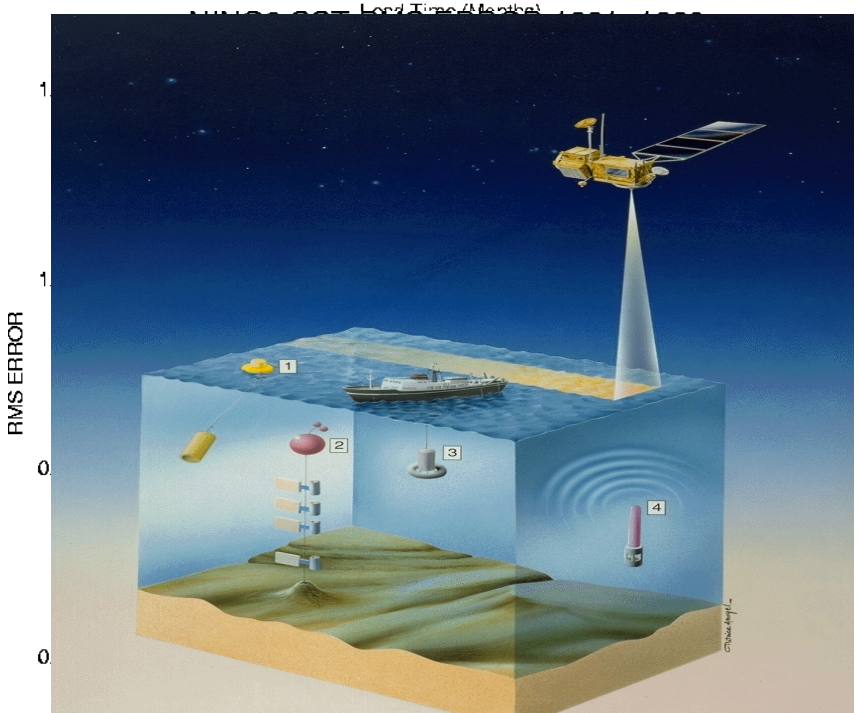
WMO OMM GCOS GOOS jcomm OCEANOGRAPHY & MARINE METEOROLOGY

The ENSO

- The predictability rely on sub-surface data
- Satellite can not observe sub-surface now







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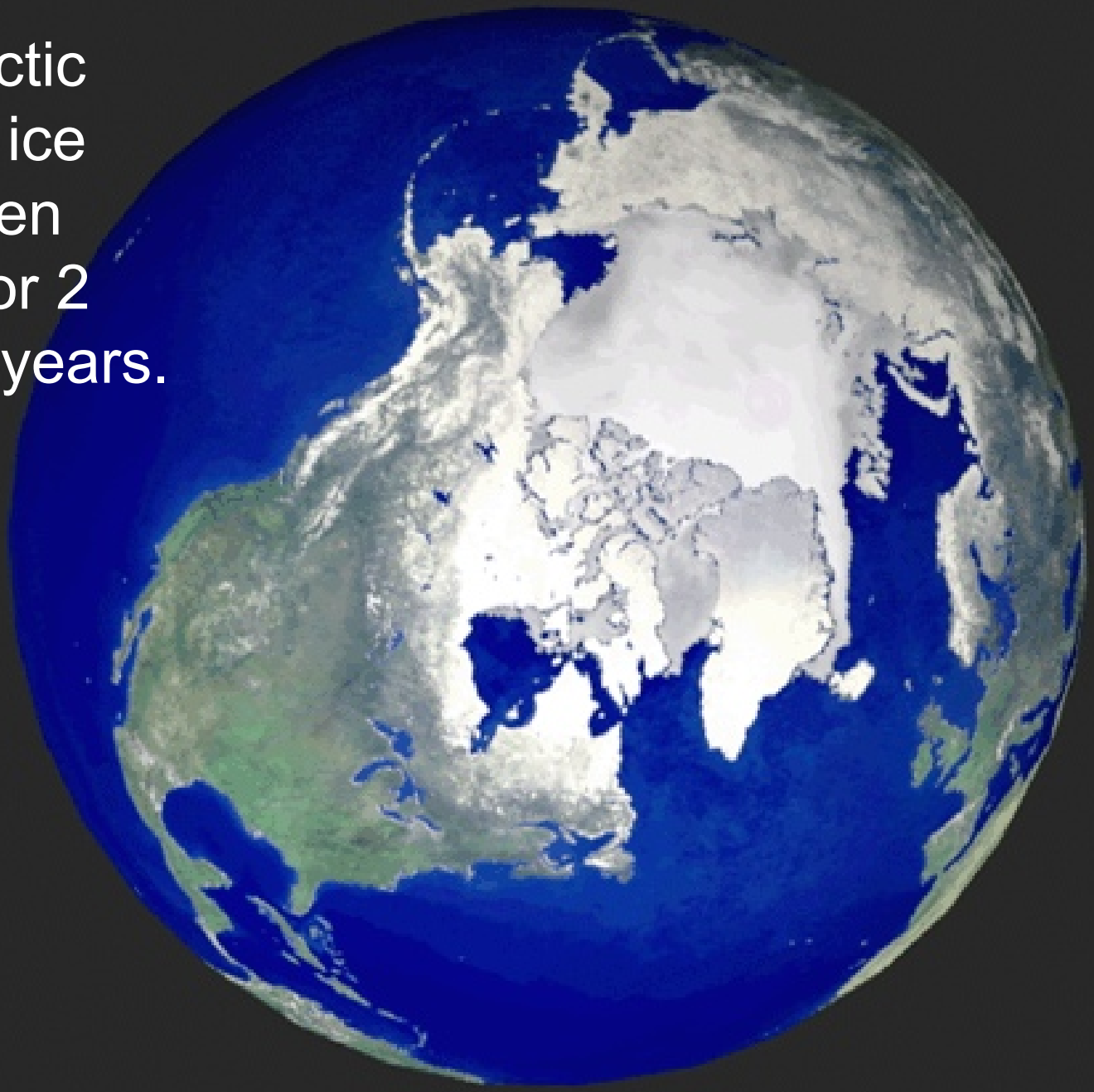
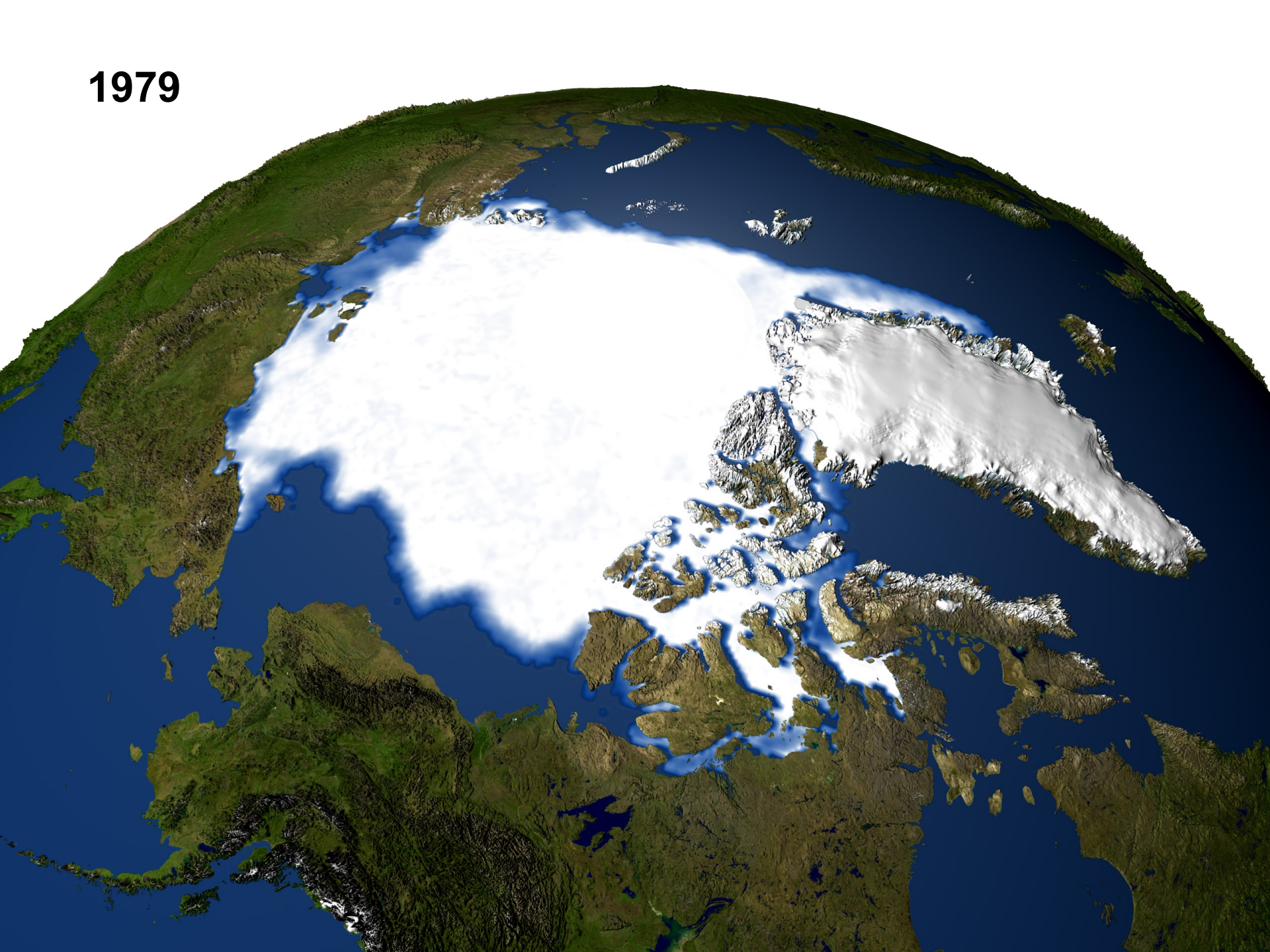
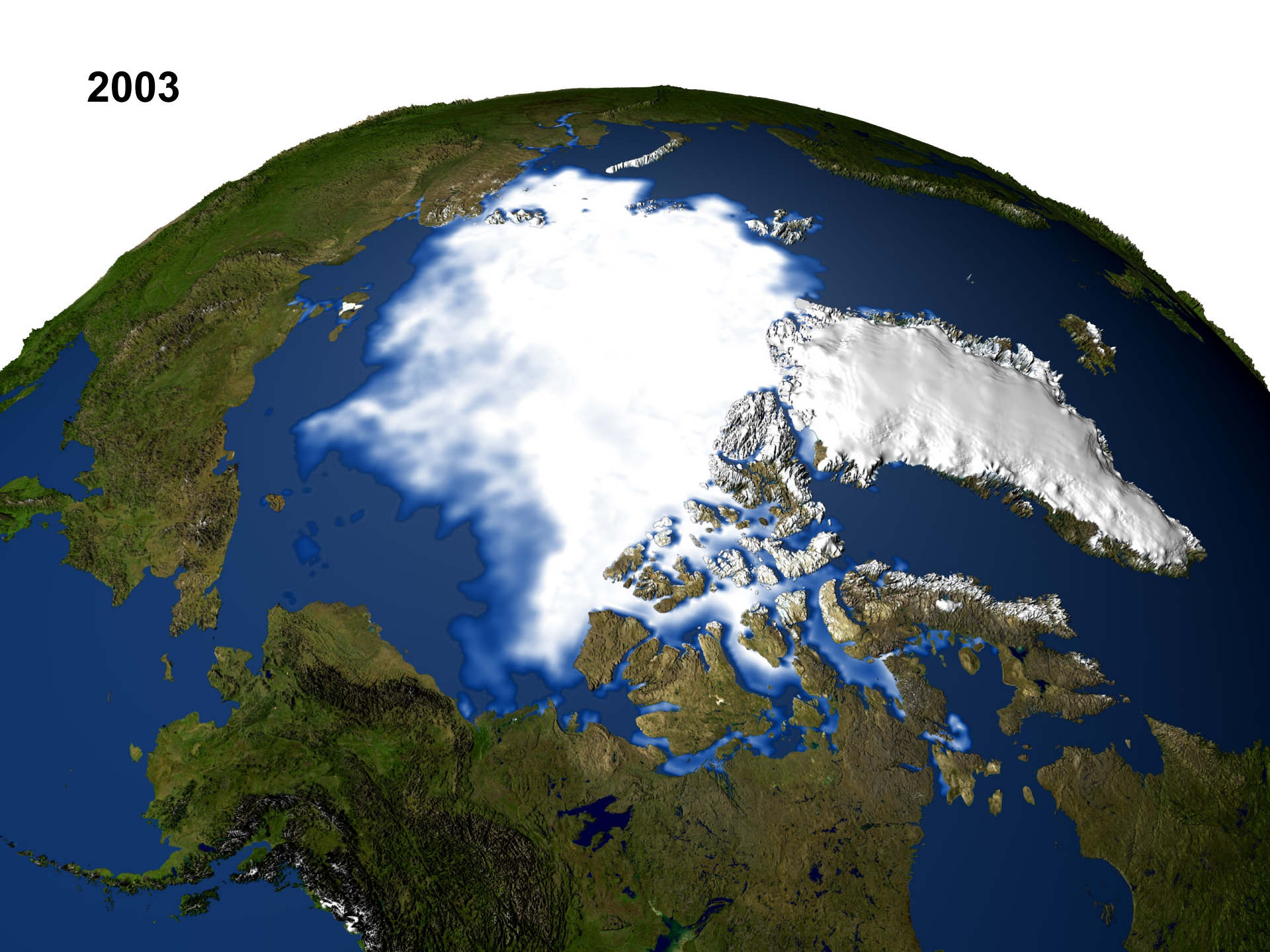
The Arctic Ocean ice has been there for 2 million years.

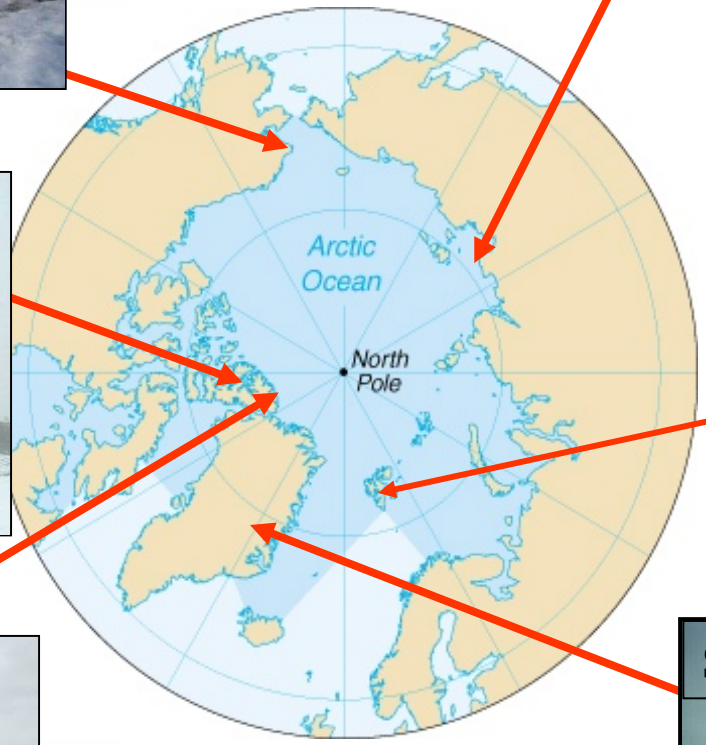



1979


2003

Barrow, Alaska

Tiksi, Russia



Eureka, Canada

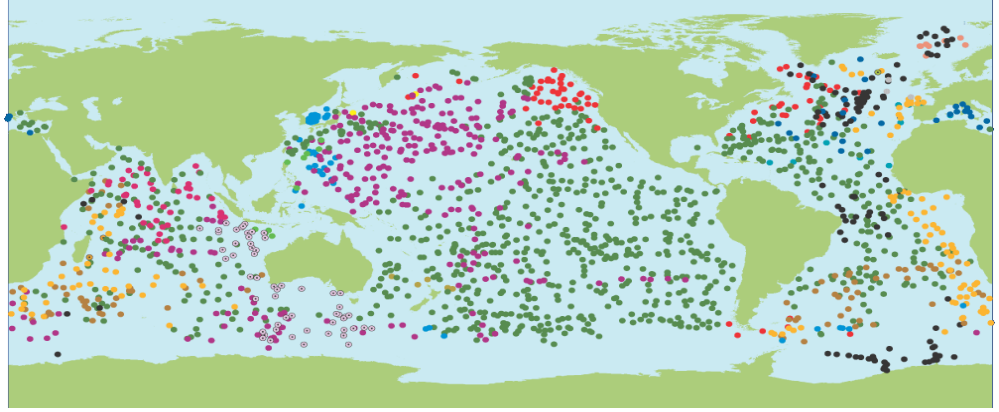
Ny-Alesund, Svalbard

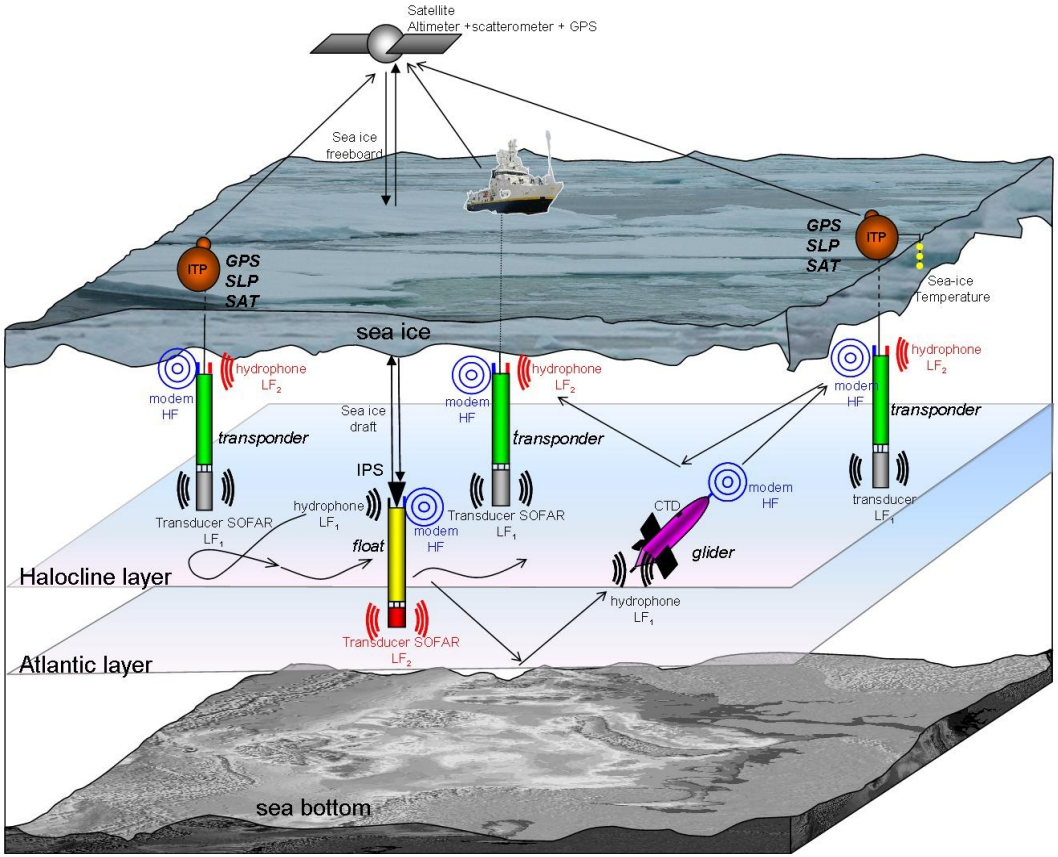
Alert, Canada

Summit, Greenland

Establishing Intensive Atmospheric Observatories In the Arctic is the component of NOAA/SEARCH being directed by ESRL

Temperature-salinity observations under ice





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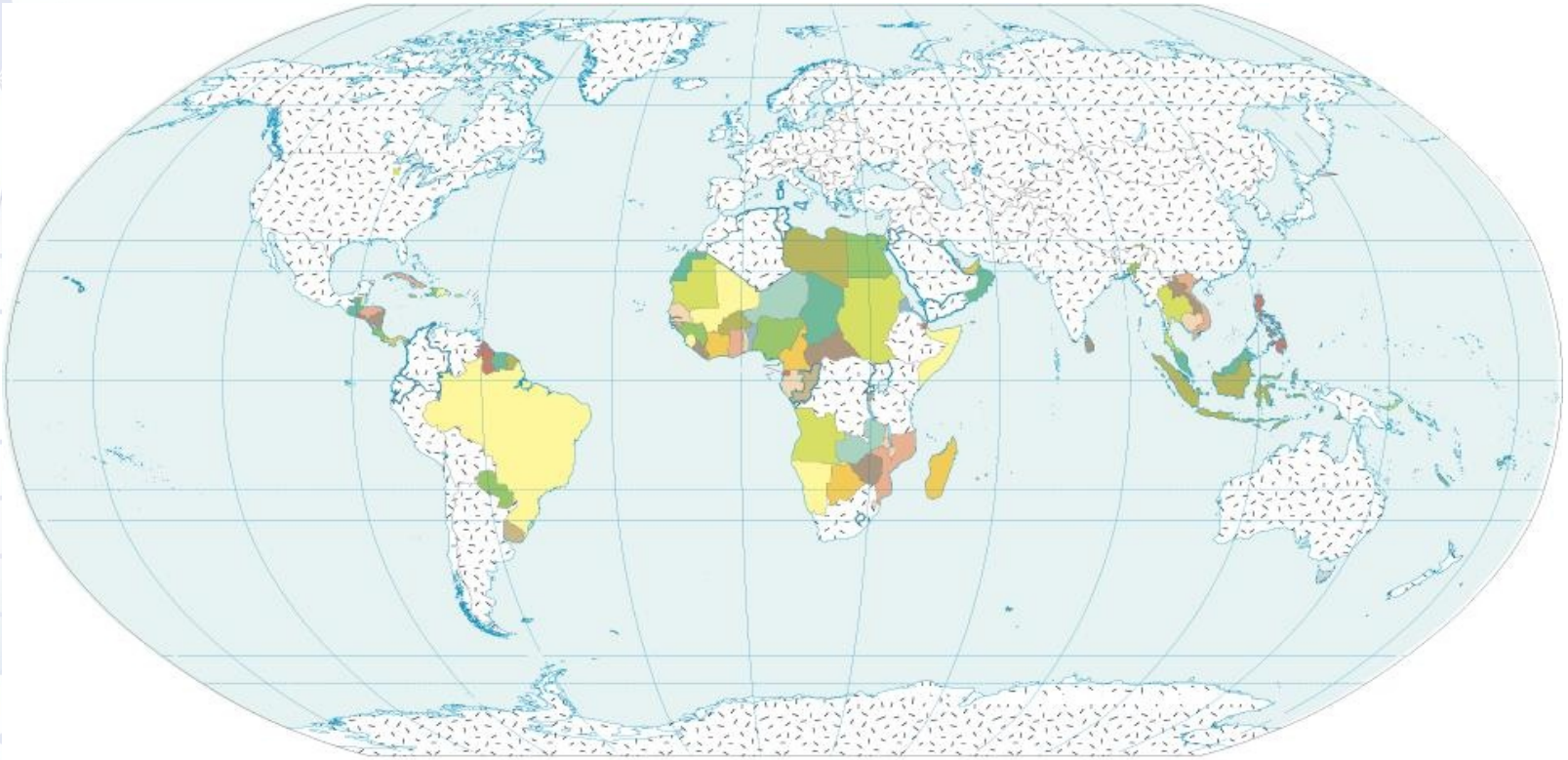
Countries Where Cryosphere Occurs

95 countries identified with cryospheric components

Cryosphere truly is global



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GCOS: 45 Essential Climate Variables

- **Atmospheric (16)**
  - **Surface –** Air temperature, **Precipitation**, Air pressure, Surface radiation budget, **Wind speed and direction**, Water vapour
  - **Upper Air – Earth radiation budget (including solar irradiance), Upper-air temperature (including MSU radiances), Wind speed and direction, Water vapour, Cloud properties**
  - **Composition – Carbon dioxide, Methane, Ozone, Other long-lived greenhouse gases, Aerosol properties**.
- **Oceanic (15)**
  - **Surface – Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Current, Ocean colour (for biological activity)**, Carbon dioxide partial pressure
  - **Sub-surface:**Temperature, Salinity, Current, Nutrients, Carbon, Ocean tracers, Phytoplankton
- **Terrestrial (14)**
  - River discharge, Water use, Ground water, **Lake levels, Snow cover, Glaciers and ice caps**, Permafrost and seasonally-frozen ground, **Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Biomass, Fire disturbance, soil moisture**

Blue (26) = largely space-based

- **ECVs a priority list! (GCOS Second Adequacy Report, 2003)**
- **Criteria:**
  - Global observations feasible (practical, cost-effective)
  - High impact on needs of UNFCCC, IPCC, climate monitoring

No. 2 priority: how to ensure the quality of the observations to meet climate operation and services requirements

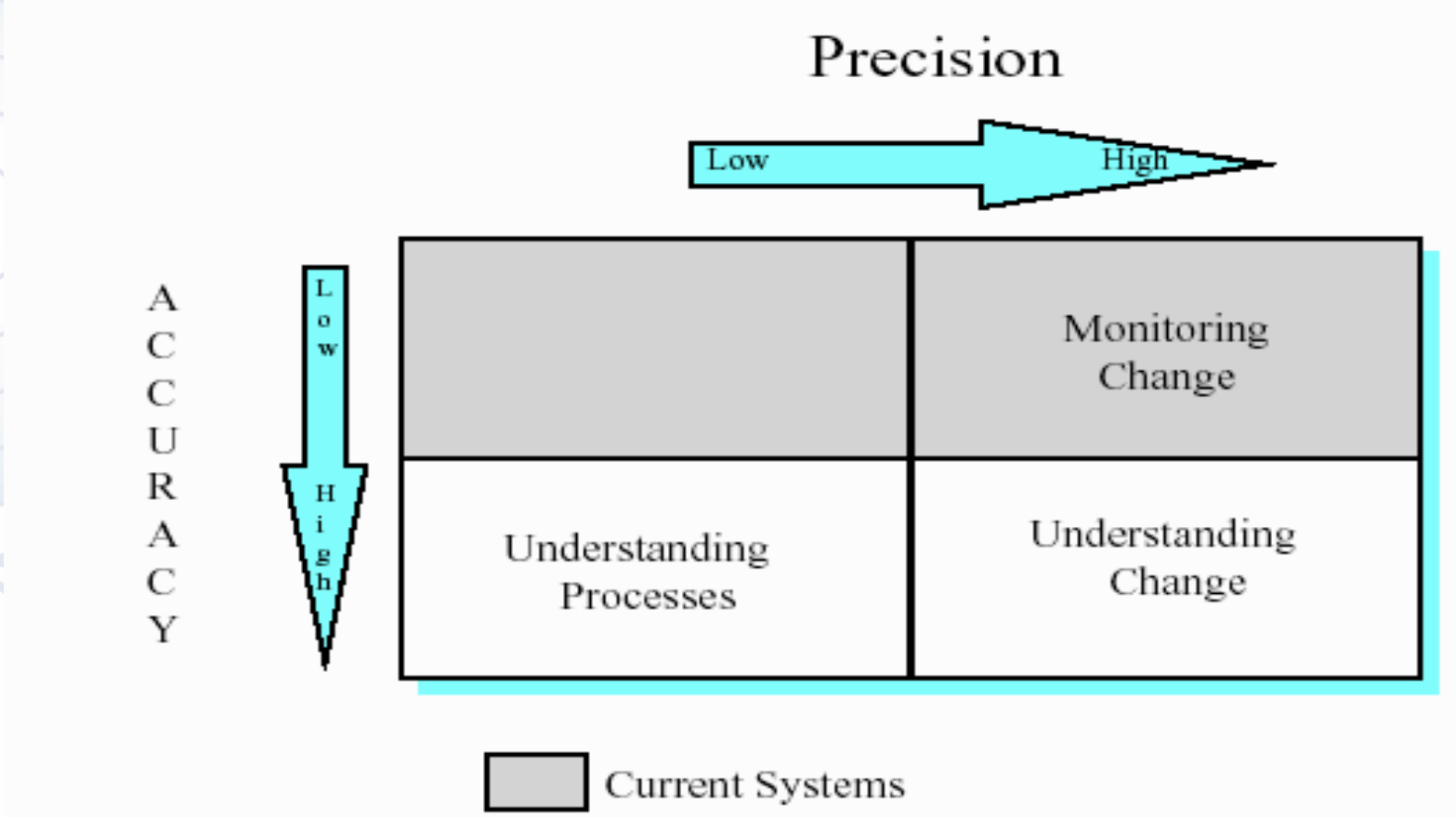

Fig. 1 The climate measurement problem - understanding climate

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WIGOS Vision

- **WIGOS will establish an integrated, comprehensive and coordinated observing system to satisfy in a cost-effective and sustained manner the evolving observing requirements of WMO Members and enhance coordination with partners for the benefit of society.**

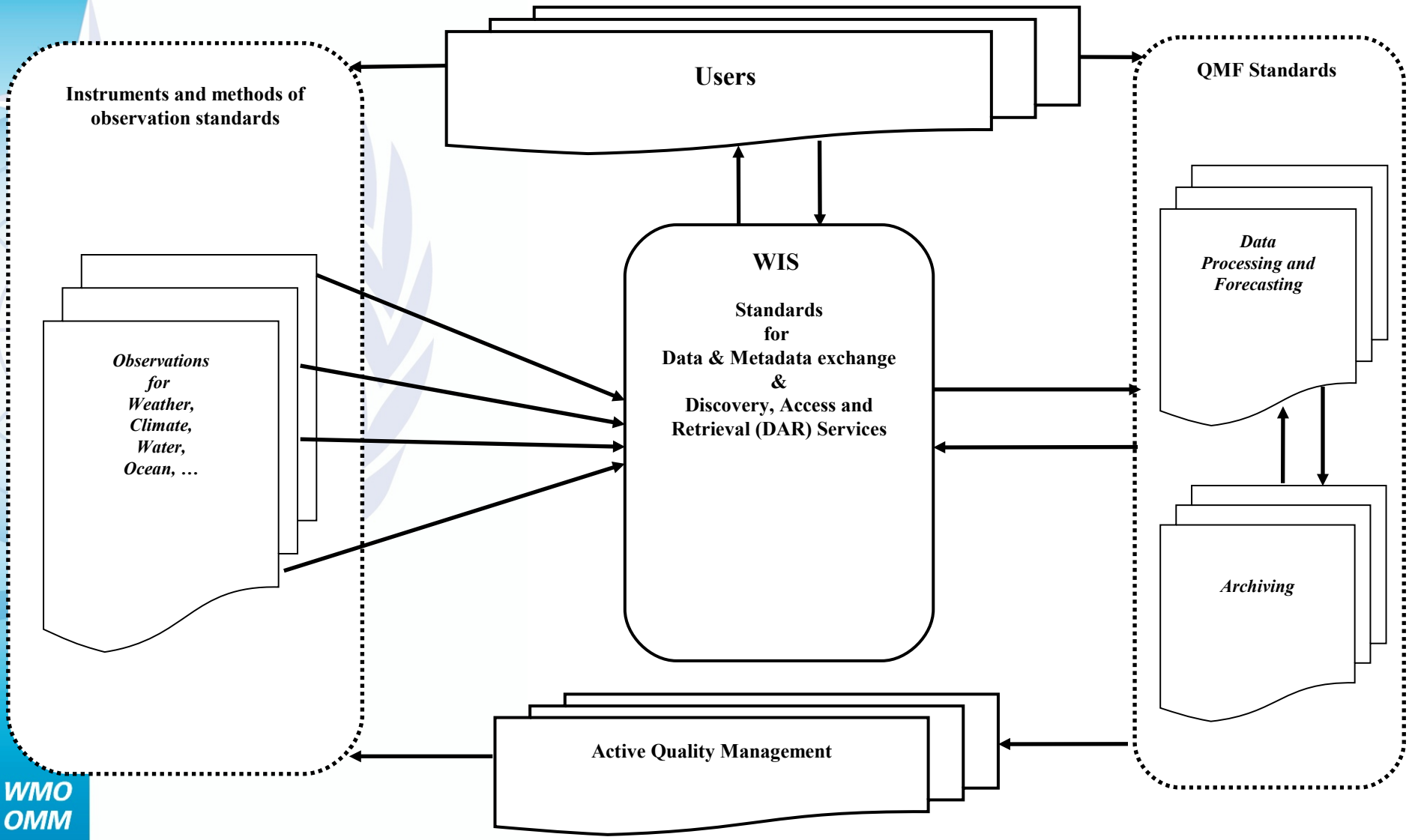
WIGOS SCOPE (What)

- *Requirements:*
  - Provide a mechanism to meet new observational requirements of WMO Members and Partners by building on the existing Rolling Review of Requirements (RRR) process; (GFCS, etc)
- *Interoperability:*
  - Build upon and add value to the existing WMO observing components of:
    - **WWW Global Observing System (GOS)**
    - **Global Atmospheric Watch (GAW)**
    - **World Hydrological Cycle Observing System (WHYCOS)**
  - with emphasis on systematic climate system observations and integration of surface- and space-based observations;

WIGOS SCOPE (What)

- *Standardization:*
  - Enhance observational data quality and homogeneity by introducing improved data quality and data management standards;
- *Access:*
  - Improve access to, and utilization of, observations and products from WMO observing systems as well as from co-sponsored systems such as GCOS, GOOS, and GTOS;
- *Coordination:*
  - Foster research and development activities and coherent planning for future observing systems by working with the all WMO Programmes and Partner organizations.

Three areas of Integrations/Standardizations



Take satellite system as an example

- **Instruments level integration: possible**
  - **Common specification for baseline satellite instruments**
  - **Common hardware and software design for baseline satellite instruments, important: calibrations!**
- **Quality Management level integration**
  - Agreed Scientific algorithm for standard products
  - Agreed common software library for data processing, image processing and products generation
  - Develop and standardized appropriate quality procedures, including validation and inter-comparison
- **WIS level integration**
  - Agree on data and products formats for international exchange
  - Agree on the use of compression methods
  - Establish an archiving strategy for DAR

Integration of different systems

- **Integration of different surface and satellite observing systems**
- **Integration of ground-based and space-based observations (one function of GRUAN)**
- **Integration of observing and information systems**

Global Satellite Inter-Calibration System (GSICS)

-an excellent example and the most important issues for global satellites integration.

- To improve the use of satellite global observations.
- To provide for the ability to create stable long-term climate data sets.
- To ensure instruments meet specification, pre-launch tests are traceable to SI standards.

Simultaneous Nadir Overpass (SNO)

Next step: Global satellite products validation

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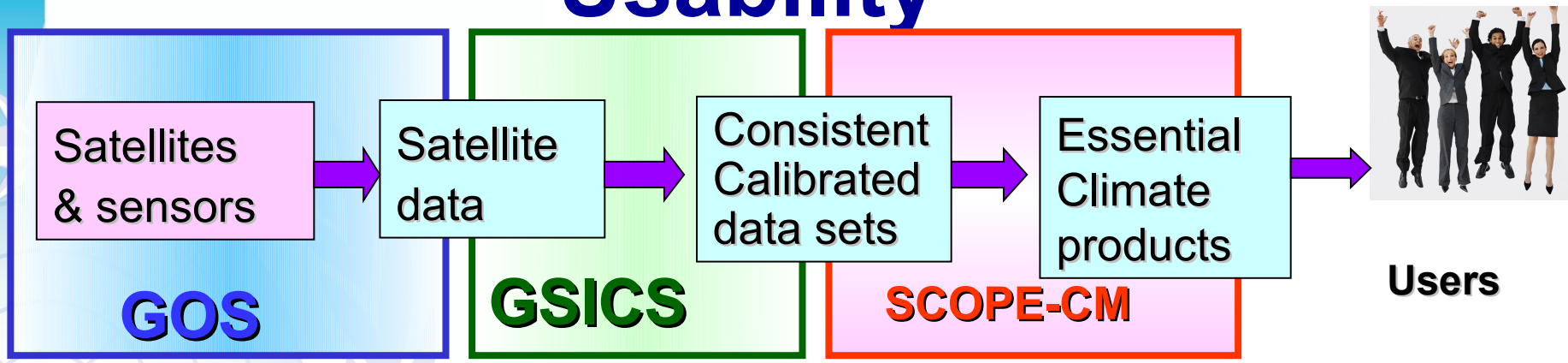
Maximizing Data Quality and Usability



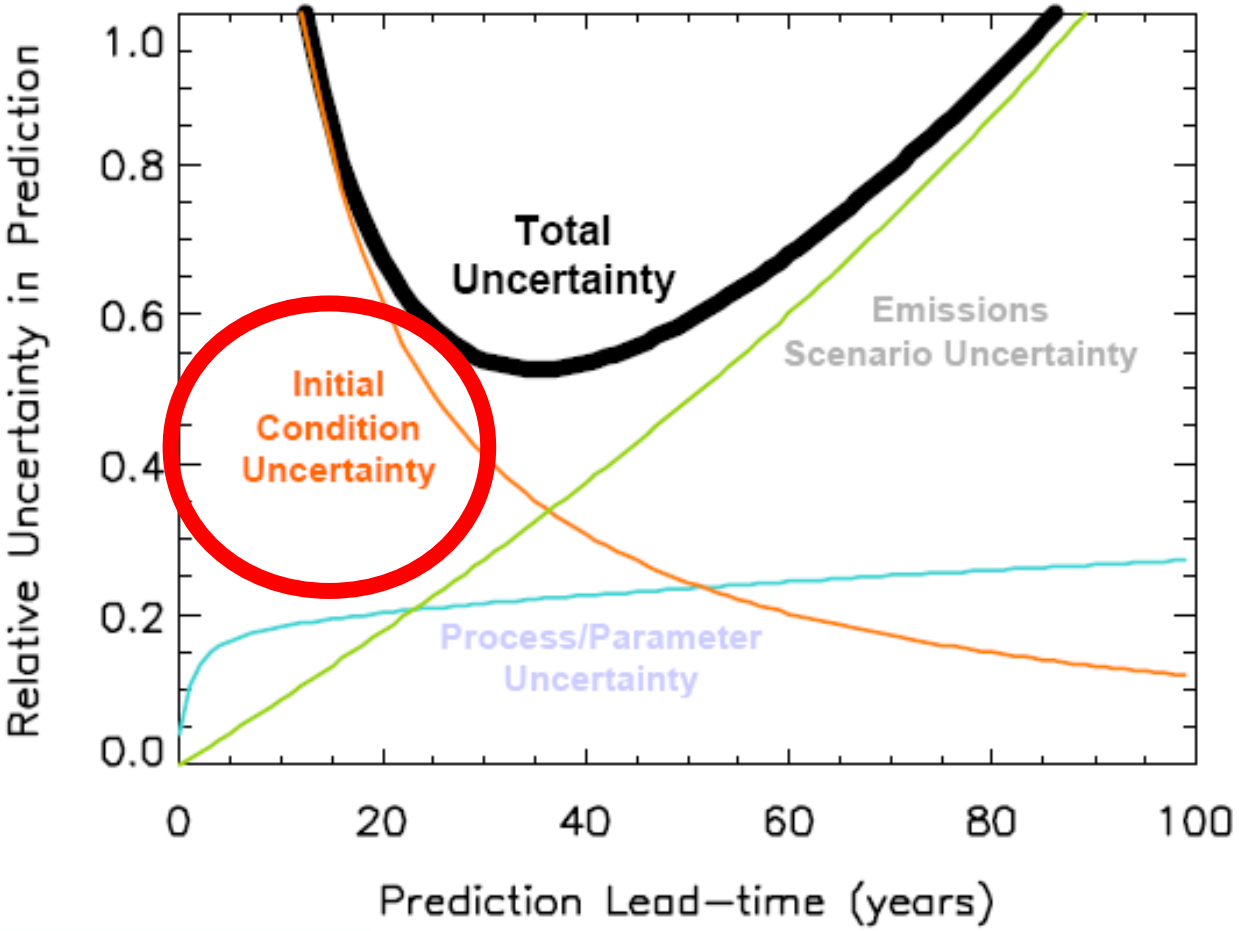
- **Sustained CO-ordinated Processing of Environmental satellite data for Climate Monitoring (SCOPE-CM)**
  - **Global products**
  - **Sustained into the future**
  - **Coordinated globally**

Integration of space-based and ground-based observations: (surface talk with satellites)

- Ground- and space-based system can be complementary and supplementary by design and operation
- Integration with ground observations can remove satellite biases and ensure consistency;
- Ground observations can support process studies, satellite products validation, and algorithm /model development.

Where will space derived ECV's help climate modellers?

Contributions to uncertainty in predicted decadal mean temperature versus the lead-time of the prediction (Cox & Stephenson (2007) *Science, 317, 207.)*



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Priority: WIGOS will enhance system capabilities of Turning Observations into value-added Products, Information and Knowledge

Pay special attention to the remote sensing measurements

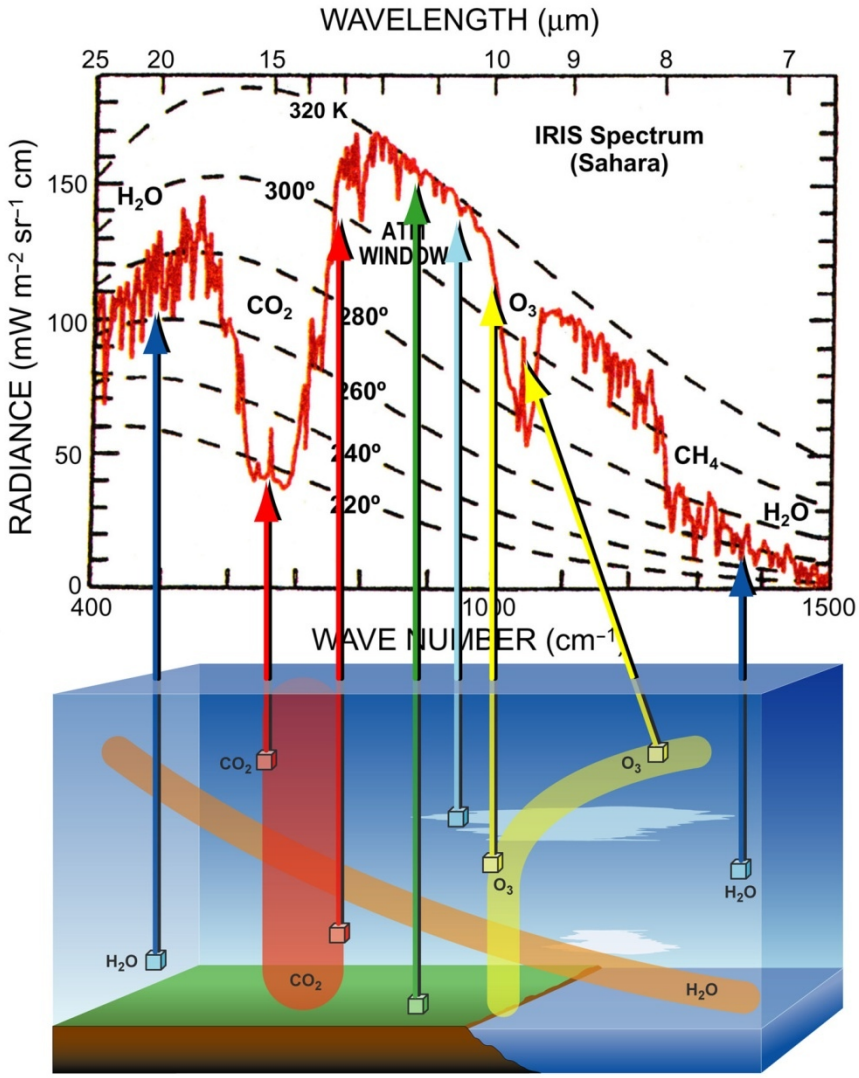
knowledge

information

products

data

- priority: turning observations into products and information
- Great challenges on:
  - Sciences
  - Technologies
  - Coordination
  - Collaboration
  - Cooperation
  - ….



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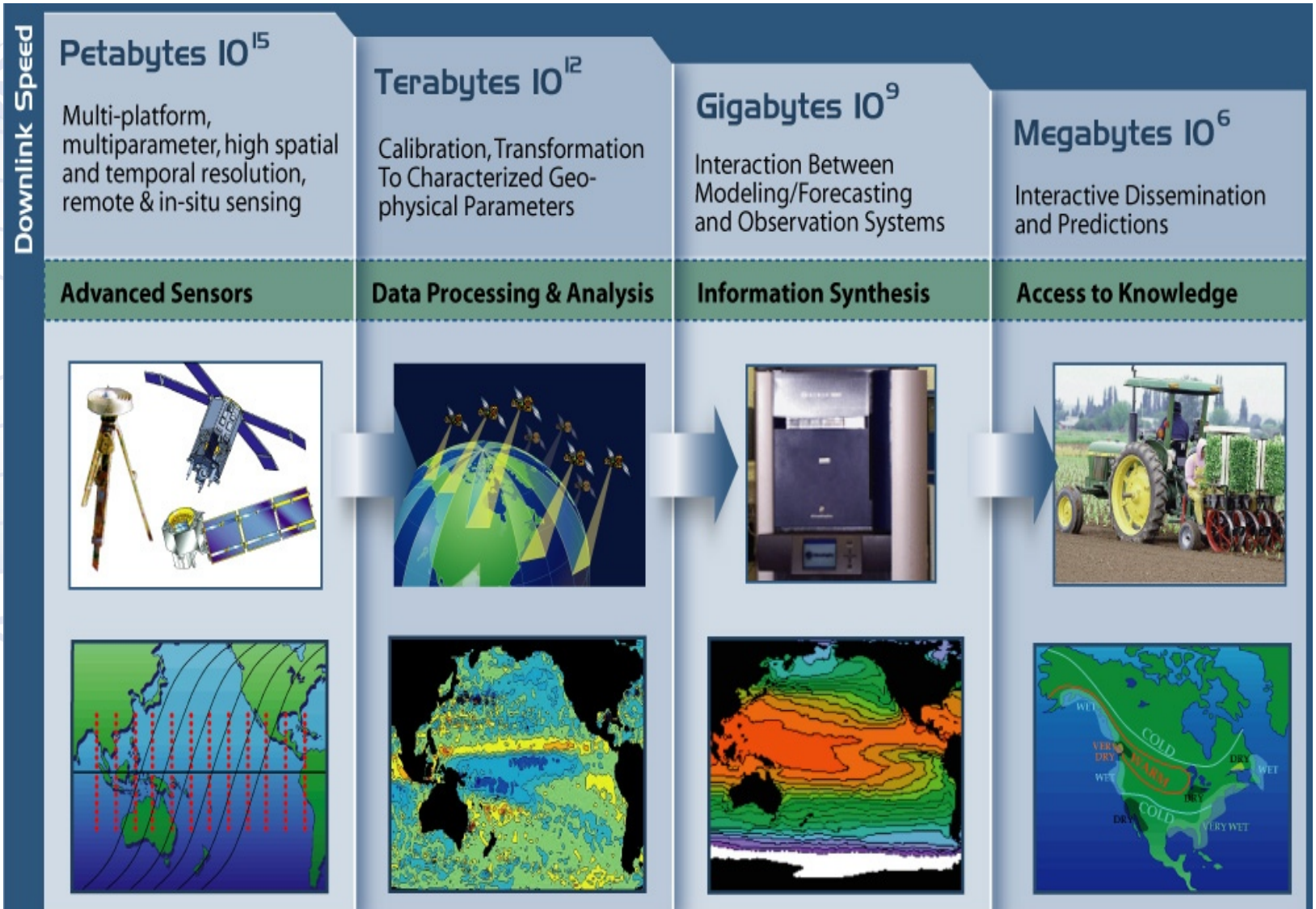
Need Great Global Consolidation Efforts



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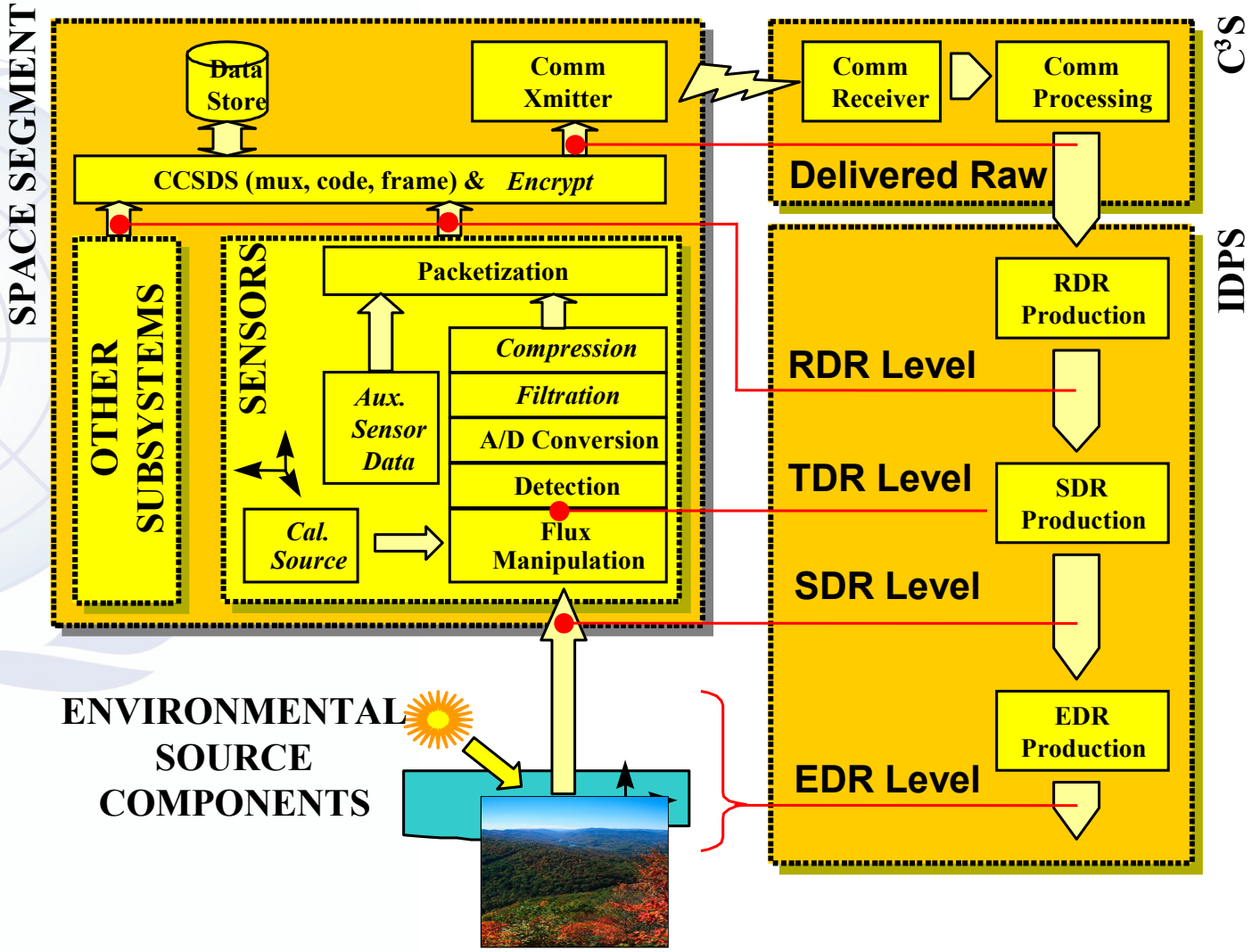
NPOESS products delivered at multiple levels

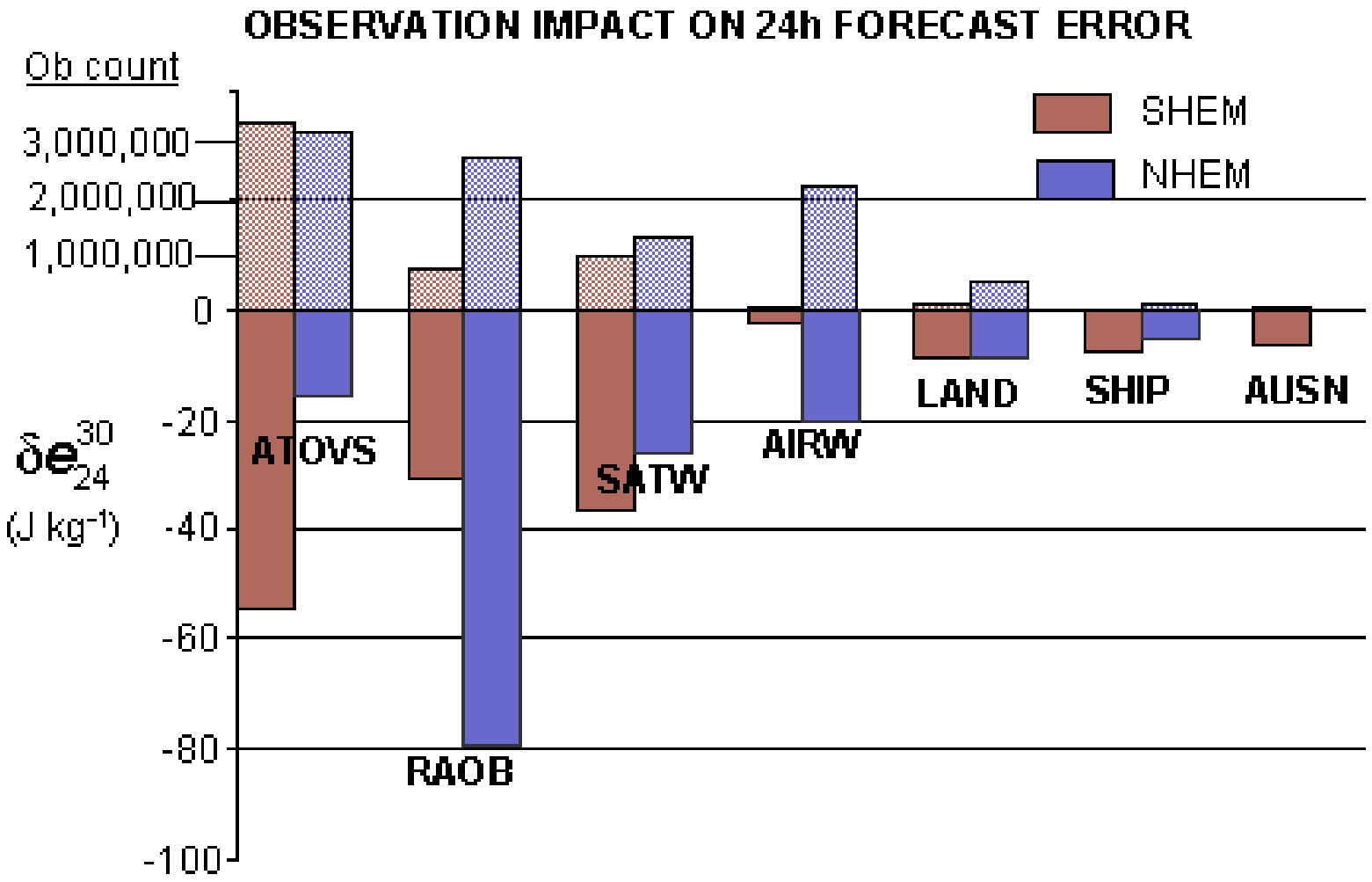


Why Data utilization in NWP so successful ?

- Thanks to NWP community (ECMWF, NCEP,)
  - Fast and robust Observing systems development, esp. Satellites
  - Scientists play important role
  - Science and Technology transfer into operations
- WIGOS need fully engage research (science and technology) community for data utilizations

Observing systems development need guidance from user communities

Impact study from NWP: How about climate



WIGOS Phases

- ***The Test of Concept phase (2007 - 2011)***
  - WDIP development
  - Pilot Projects, by the technical commissions and JCs.
  - Regional Demonstration projects (RAs)
- ***WIGOS Implementation phase (2012 - 2015)***
  - Will focus on implementing an organizational framework for improved governance, management, integration and optimization of the multiple observing systems by WMO and WMO's co-sponsored and partner organizations.
- ***WIGOS Operational phase (2016 onward)***
  - **WIGOS constituent observing systems and networks will continue to evolve and improve the integration, and to improve service delivery.**

Roles and responsibilities

WMO *Members:*

- Develop national observing systems according to the GOS Vision for 2025; GAW development Strategic Plan; WHYCOS guidelines; GCOS, GOOS and GTOS Implementation Plans;
- Implement standards in accordance with WIGOS regulatory material;
- Participate in regional and international cooperation mechanisms;
- Provide adequate resources to WIGOS implementation, either in kind, via secondments and/or through contributions to the Trust Fund.

Regional Associations:

- Regional WIGOS Implementation Plans, including the WIGOS Pilot Implementation Projects;
- Identify priority areas where surface-based and space-based subsystems can be integrated;
- Encourage proactive involvement of Members in regional WIGOS implementation activities.

Roles and responsibilities

Technical Commissions:

- Develop guidance for the design and evolution of observing systems utilizing the RRR Process;
- Develop WIGOS standards in collaboration with partners;
- Provide technical guidance and advice to Members and Regional Associations on WIGOS;
- Review, update and harmonize WMO Regulatory Material.

Partners (UN organizations, co-sponsors and systems, GEO, others)

- Collaborate with WMO in establishing appropriate coordination mechanisms;
- Ensure interoperability with WIGOS;
- Coordinate with WMO on data policy.

WIGOS Pilot & Demo Projects (On-going)

- WIGOS Pilot Projects for:
  - CIMO
  - JCOMM
  - AMDAR
  - GAW
  - Global Hydrological Network
  - Satellite Systems integration (GSICS)
  - **GCOS Reference Upper-Air Network (GRUAN)**
- WIGOS Regional Demonstration Projects

Summary: Towards the reality of WIGOS

- Many challenges remain
  - Clarity of definition – WIGOS scope and value-add
  - Coordination, collaboration, communicationTechnical level, at the management level within WMO and at a structural level – including programmes, TCs
- Achieving ‘reality’ will require WMO to
  - Develop, resource and communicate a coherent and resourced implementation strategy (not just a plan)
  - Confirm and elaborate the composite ‘system of systems’ approach to integration
  - Build confidence and collaboration with Members, partners, and amongst programmes, especially with co-sponsored systems
- RAs and TCs must take a leadership role in all of the above
  - Challenge is how to do this. How much of WIGOS is RAs and TCs level?

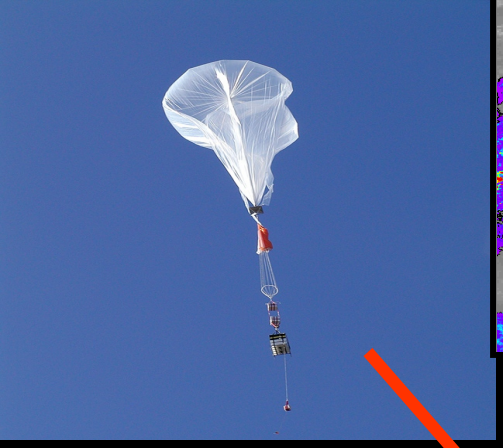
WIGOS Benefits

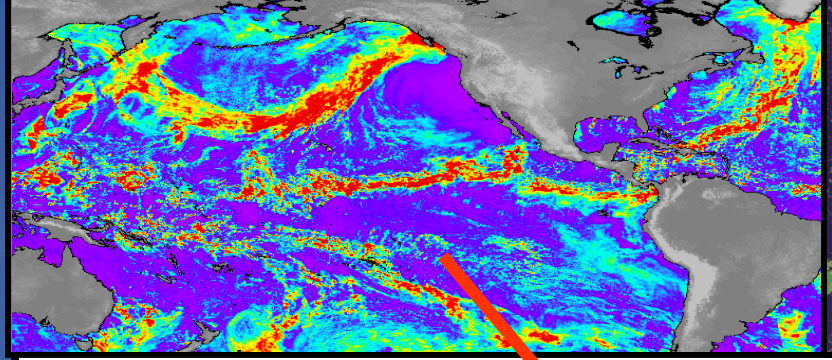
- **Enable WMO Members to meet expanding national mandates which are increasingly calling for greater coordination and integration to better respond to ever-increasing services requirements;**
- **Together with WIS, enhance operational components of WMO Programmes, especially in Developing and Least Developed Countries;**
- **Together with GCOS, GOOS, GTOS and others will be robust components of the future Global Framework for Climate Services (GFCS); and**
- **Provide a basis for sound decision making and enhance delivery of benefits to society. .**

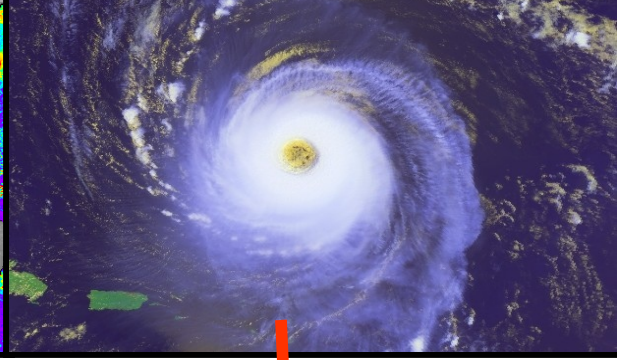
WIGOS Web Page

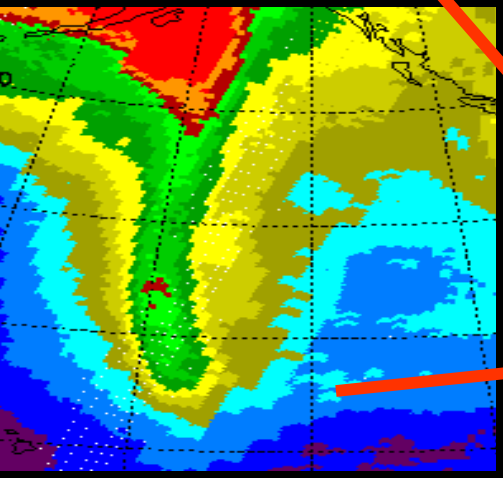
http://www.wmo.int/pages/prog/www/wigos/index_en.html

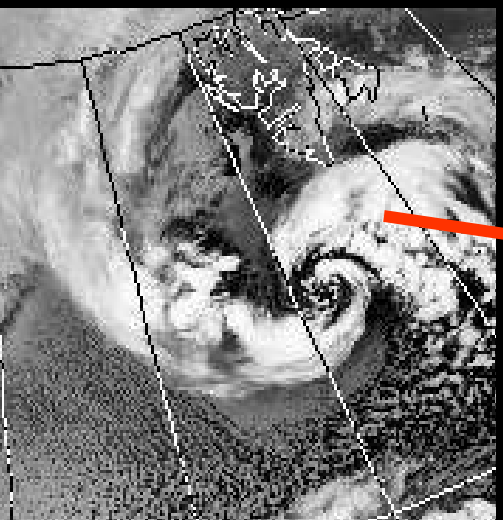
WMO
OMM

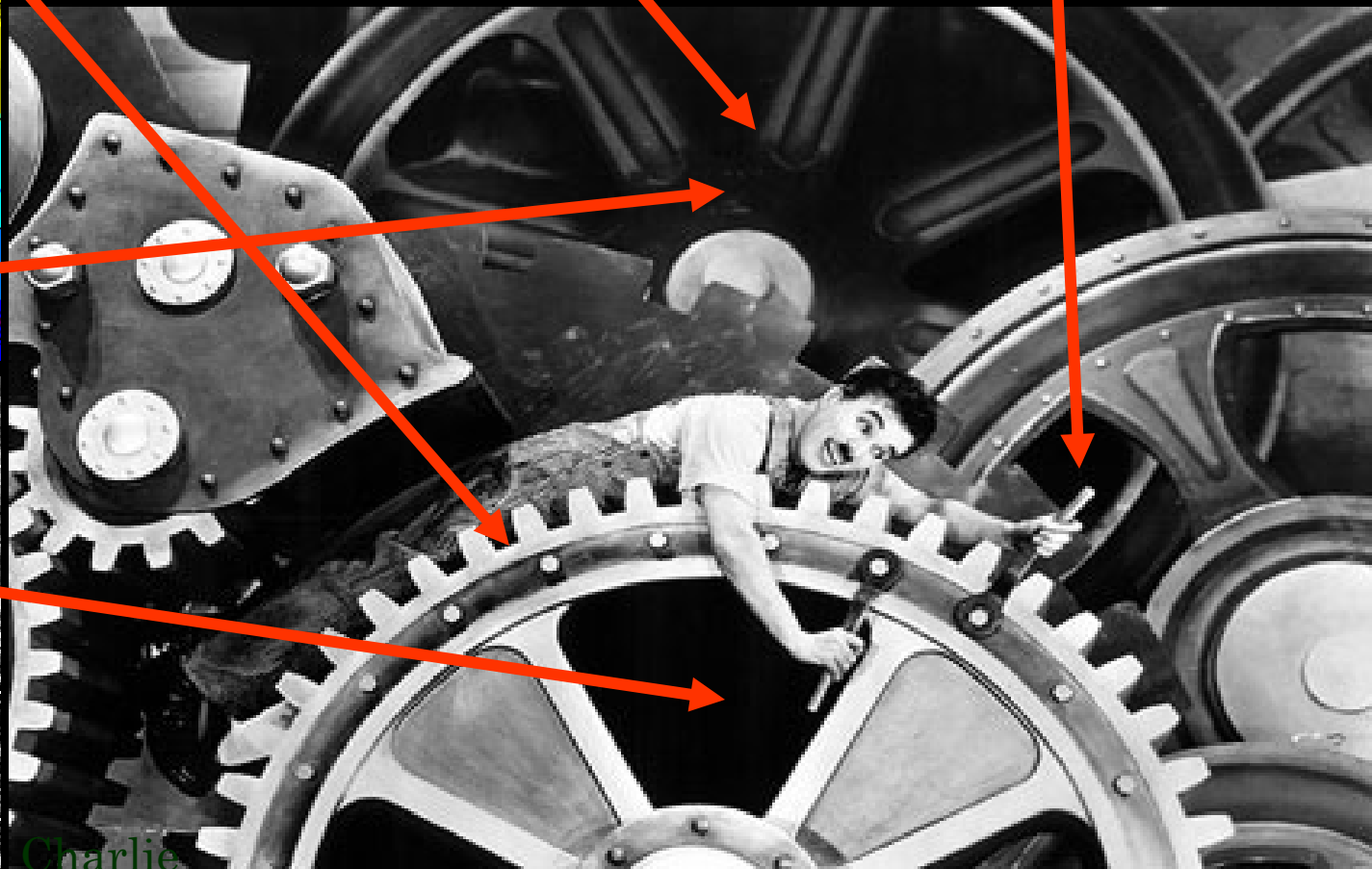












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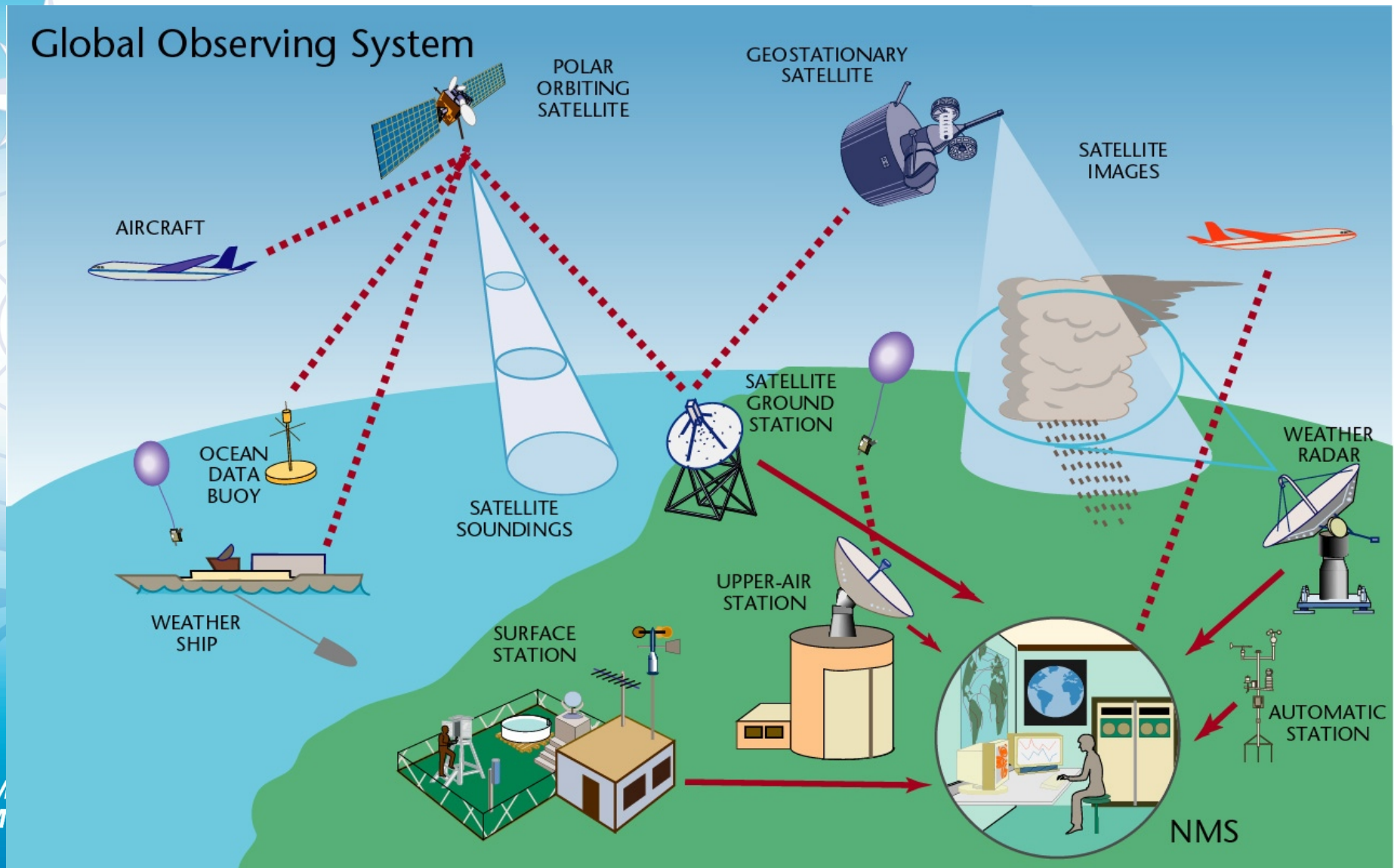
WIGOS: work together from concept to reality



GCOS community

The world's leading community addressing climate observations will play more important role !