World Meteorological Organization

Working together in weather, climate and water

Development of an Architecture for Climate Monitoring from Space

--background, challenges & opportunities

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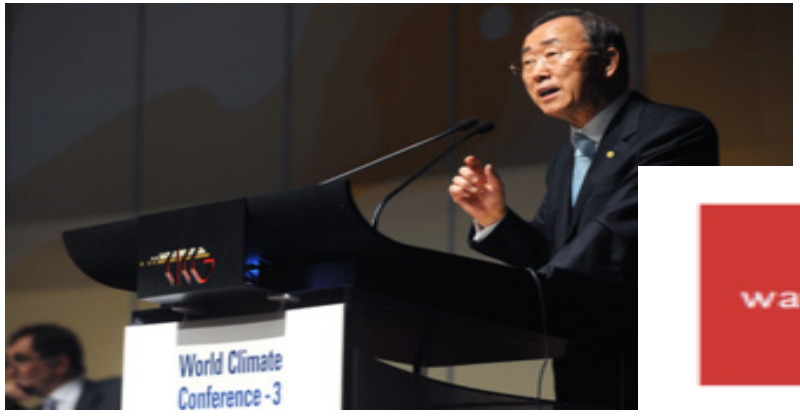
World Meteorological Organization (WMO)

Outline of the Presentation

- Global Framework for Climate Services (GFCS) – A New Partnership Process
- The Concept for An Architecture for Climate Monitoring from Space
- Key Challenges and Opportunities
- Summary

WMO OMM

WCC - 3



Users, Government, private sector, research, agriculture, water, health, construction, disaster reduction, environment, tourism, transport, etc

User Interface

Climate Services Information System

Observations and Monitoring

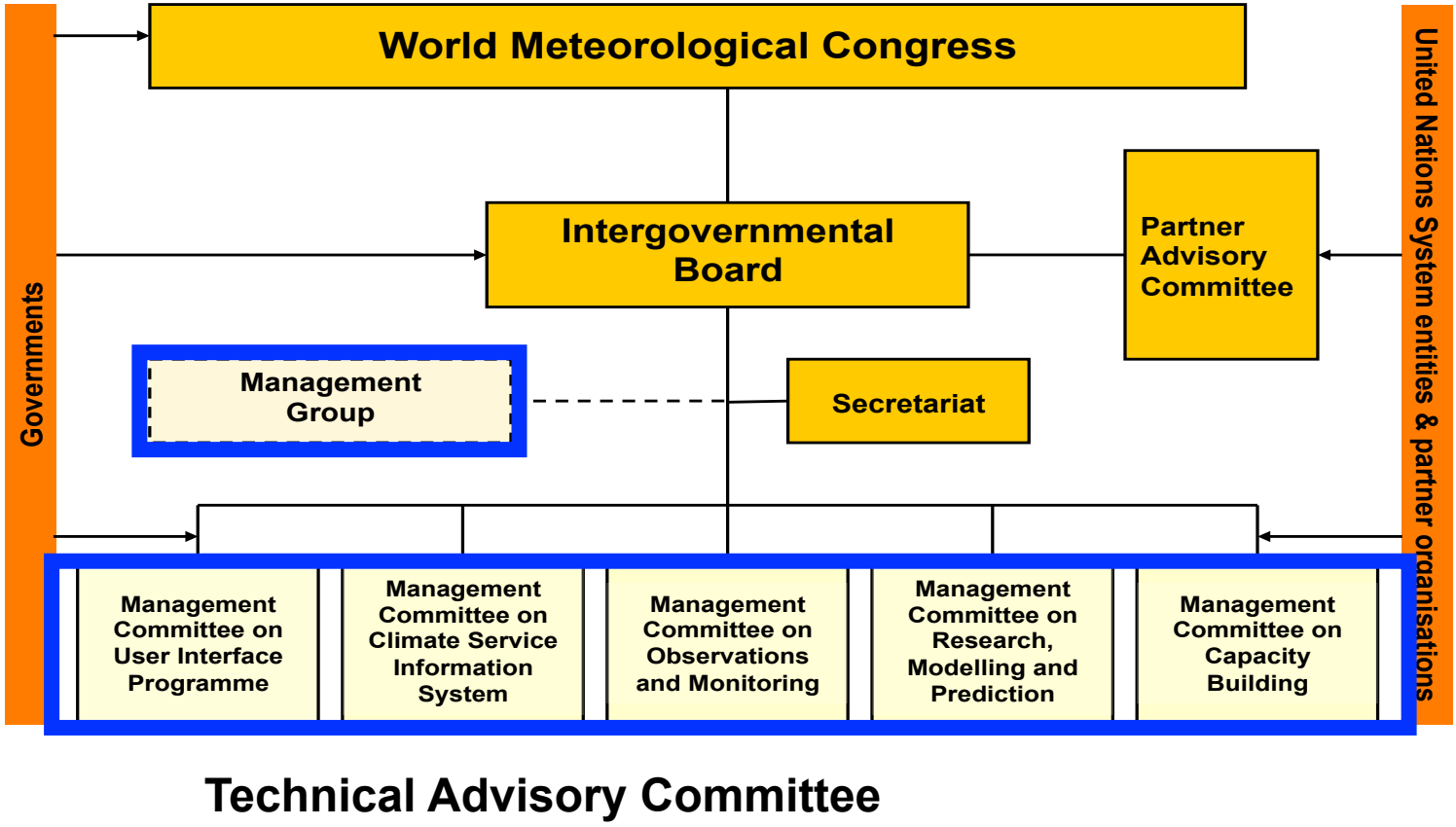
Research, Modeling and Prediction

CAPACITY BUILDING

The first Session of Inter-Governmental Board on Climate Services (IBCS-1, July 1-5, 2013) - Decisions on Governance and Priorites

Monday 1 July:
Dialogue

Tuesday 2 to Friday 5 July
IBCS-1



The GFCS initial priority areas

challenges & opportunities for developing new observing capability to meet new requirements

Agriculture

Water

Health

Disaster Risk Reduction

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Sixteenth WM Congress Resolution 19 (Cg-XVI, 2011)

DEVELOPMENT OF AN ARCHITECTURE FOR CLIMATE MONITORING FROM SPACE

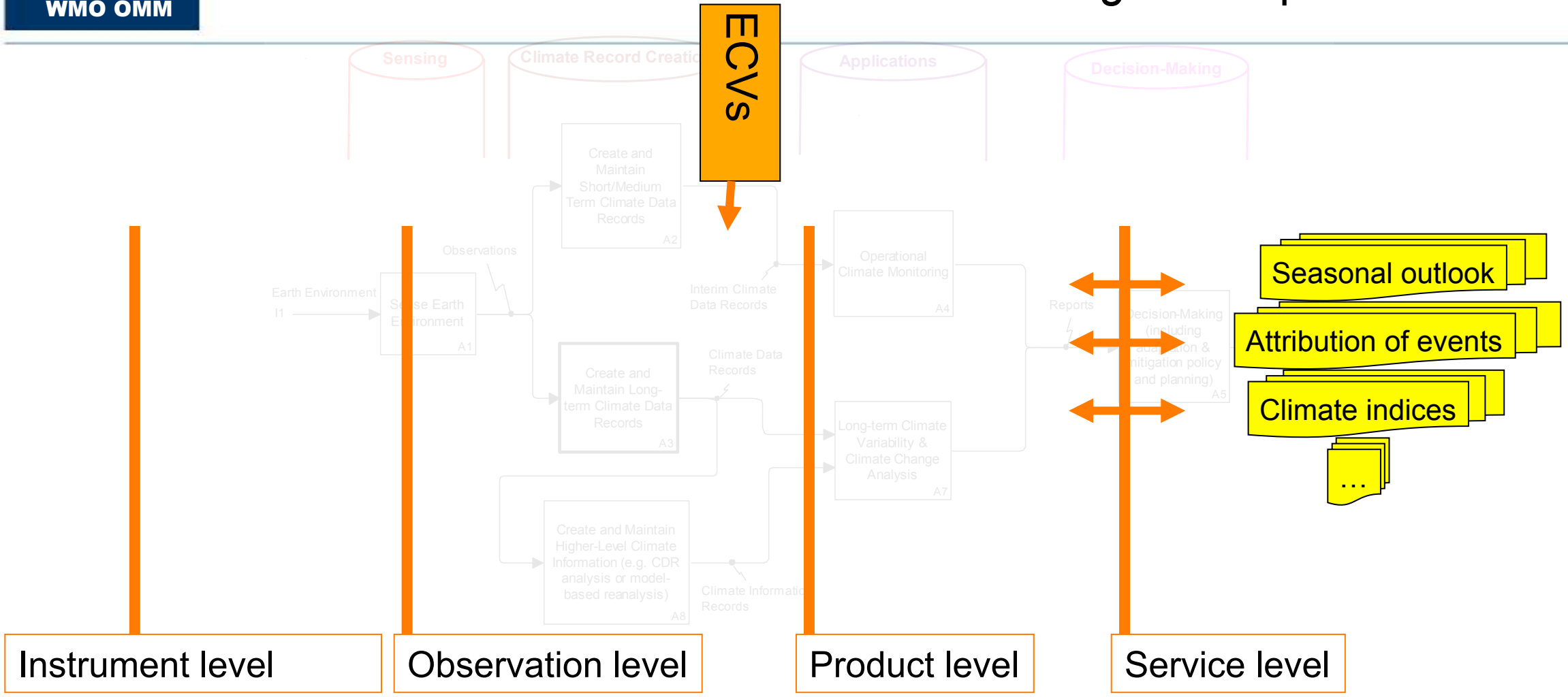
- **Considering:**
  - The increasingly important role that space-based observations are playing in the long-term monitoring.
  - The underpinning role that observations will play in the Global Framework for Climate Services (GFCS),
- **Decides** that **an architecture should be developed, as an important component of WIGOS** , to provide a framework for the sustained and coordinated monitoring of the Earth's climate from space;
- **Invites** CEOS, CGMS, GCOS, GEO & WCRP to collaborate with the WMO Space Programme on the development of an architecture for climate monitoring from space.

A report: Strategy Towards an Architecture for Climate Monitoring from Space

- CEOS-CGMS-WMO ad hoc group on Architecture for Climate Monitoring from Space
- Chair: Mark Dowell (ESA)
- The strategy presents a proposed logical architecture that represents a first step in the development of a physical architecture

- Outline of the report
- Executive Summary and recommendations
- Introduction, Objectives & Targets
- Climate Monitoring Principles, Requirements & Guidelines
- State of the Art
- Beyond research to operations
- Climate Architecture definition
- Mechanisms for Interaction
- Roadmap for way forward
- Recommendations

Climate observations and dataset generation: Architecture for Climate Monitoring from Space



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GFCS IP identified some key challenges

- ***Data:*** *the current availability and quality of climate observations and impacts* data are inadequate for large parts of the globe.
- ***Partnership: interactions between climate service users and providers are not* always well developed, and user requirements are not always adequately understood and addressed.**
- ***Quality:*** *operational climate services are lagging advances in climate and* applications sciences, and the spatial and temporal resolution of information is often insufficient to match user requirements.

Gaps in current scientific and technical capabilities--Observation and monitoring systems

- Some observations (in the land, ocean and **satellite domains**) have not yet been moved to a more operational environment or connected to the existing climate services information systems.
- **Climate monitoring from space does not yet have an internationally-agreed architecture**, although efforts to achieve this are underway.
- Satellite obs have limitations such as in rainfall estimation, The deep ocean is not satisfactorily observed as yet.

GFCS Observations & Monitoring Pillar

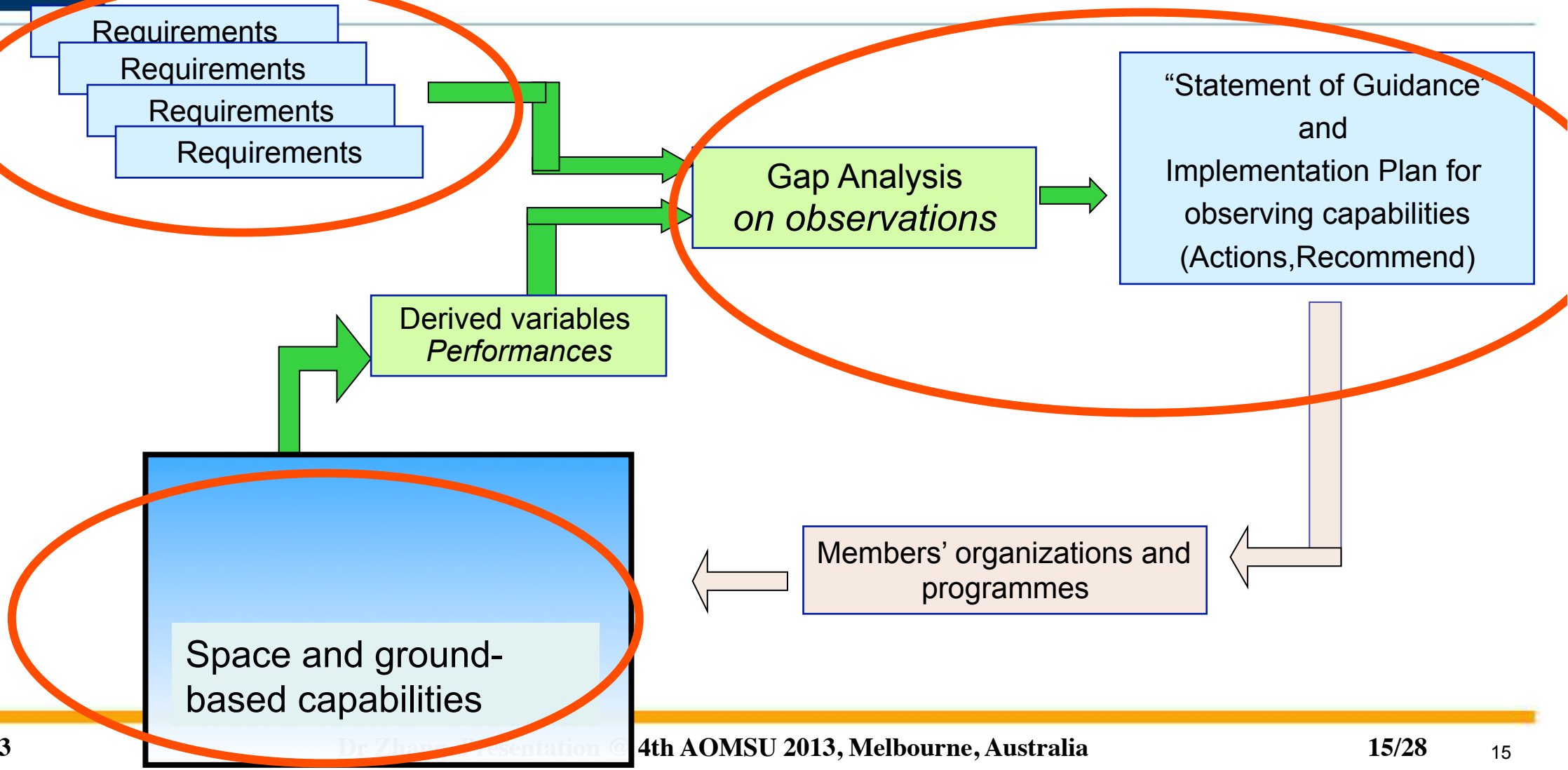
- The GFCS will benefit from **existing surface-based and satellite-based observing systems that already provide a wealth of data**
- The satellite data have contributed very significantly to climate datasets and are the only way to provide global coverage
- **The Architecture for Climate Monitoring from Space has been identified as a key component of GFCS**

Challenge 1. Instruments level

Identify and document broad user requirements is needed before instrumentations– see the report

- **Observing and Data Requirements**
  - **Climate Observations:Essential Climate Variables (GCOS ECV Inventory)** defined by Global Climate Observing System (GCOS-82, 2003)
  - **Fundamental Climate Data Record (FCDR)** denotes a well-characterised, long-term data record, typically calibrated radiances. FCDRs also include the ancillary data used to calibrate them.
  - The Critical Earth Observations Priorities **(GEO-Task)**
- **Modelling Requirements:**
  - *Model initialisation and definition of boundary conditions*
  - *Model development and validation*
  - *Data assimilation for climate models*
- **Assessment Requirements:**
  - **The IPCC's 4th Assessment Report (2007)** underscores the urgent need for critical climate data, and an international architecture supporting them, to observe and monitor the global water cycle and the global carbon cycle.
- **Services Requirements**:
  - The **Global Framework for Climate Services** (GFCS) Implementation Plan (WMO extraordinary Session, October 2012) adds another dimension to the requirements directly link to the user's application areas: agriculture and food security, water resources, health and disaster risk reduction
- **It is clear that the requirements extending beyond the capabilities of one-time research missions and operational satellite systems in existence today.**

WMO Standard Practice: Rolling Review of Requirements -to identify new requirements & gaps to meet GFCS priorities



interpret user requirements for missions

The architecture calls for an end-to-end framework for monitoring both the long-term climate system, and extreme events in real time:

Service requirements:
Content, Presentation, Delivery media, Timeliness, Continuity, User support, Training, ..

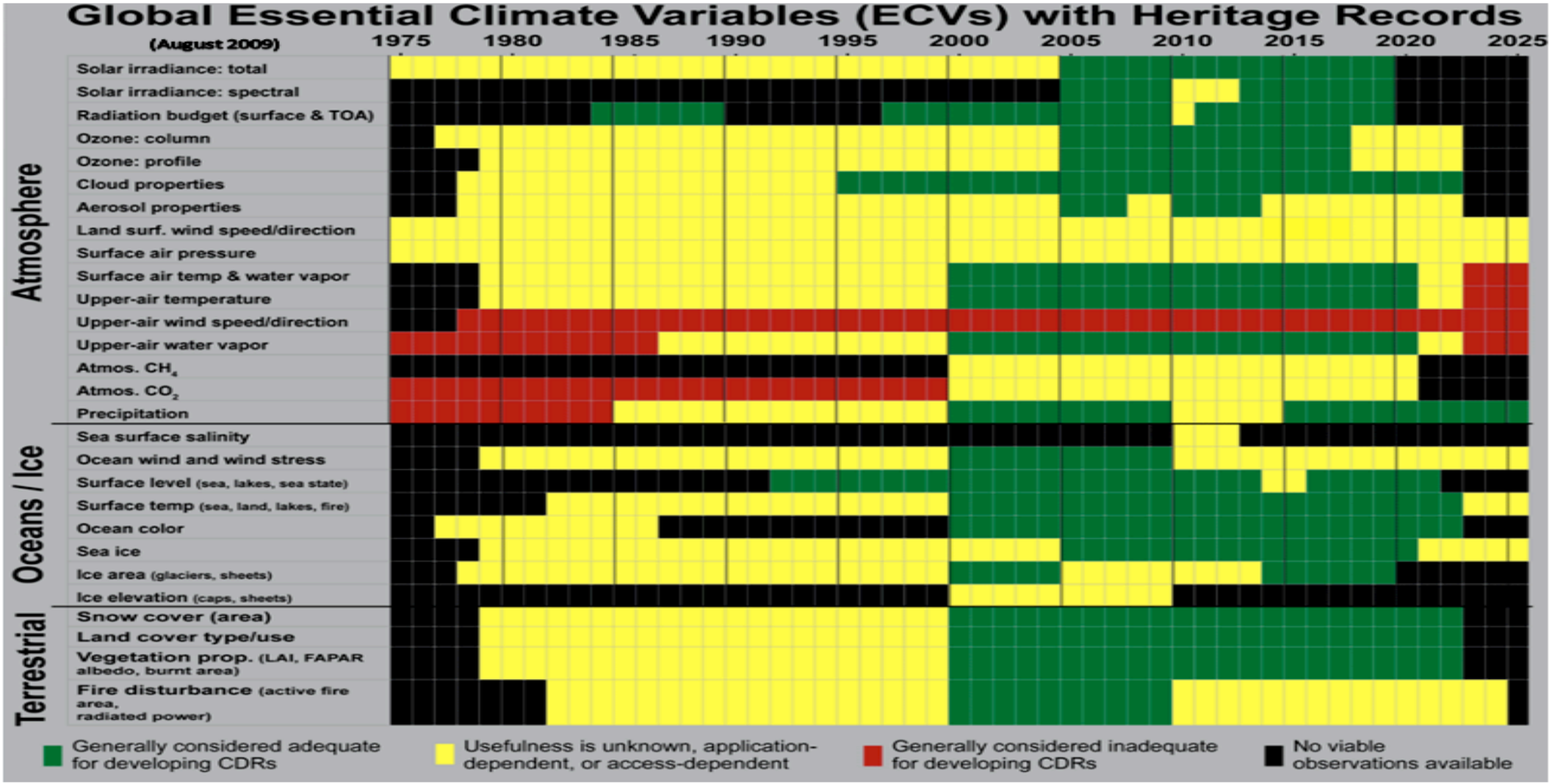
Product requirements:
Type (numerical, graphical, binary, alert), Algorithm, Spatial/temporal resolution, Quality control

Observational requirements:
Geophysical variable, Unit, Domain, Spatial resolution, Temporal resolution, Uncertainty …

Specifications:
Instrument type, Orbit, Scanning mode, Spectral bands, Channel width, SNR, …

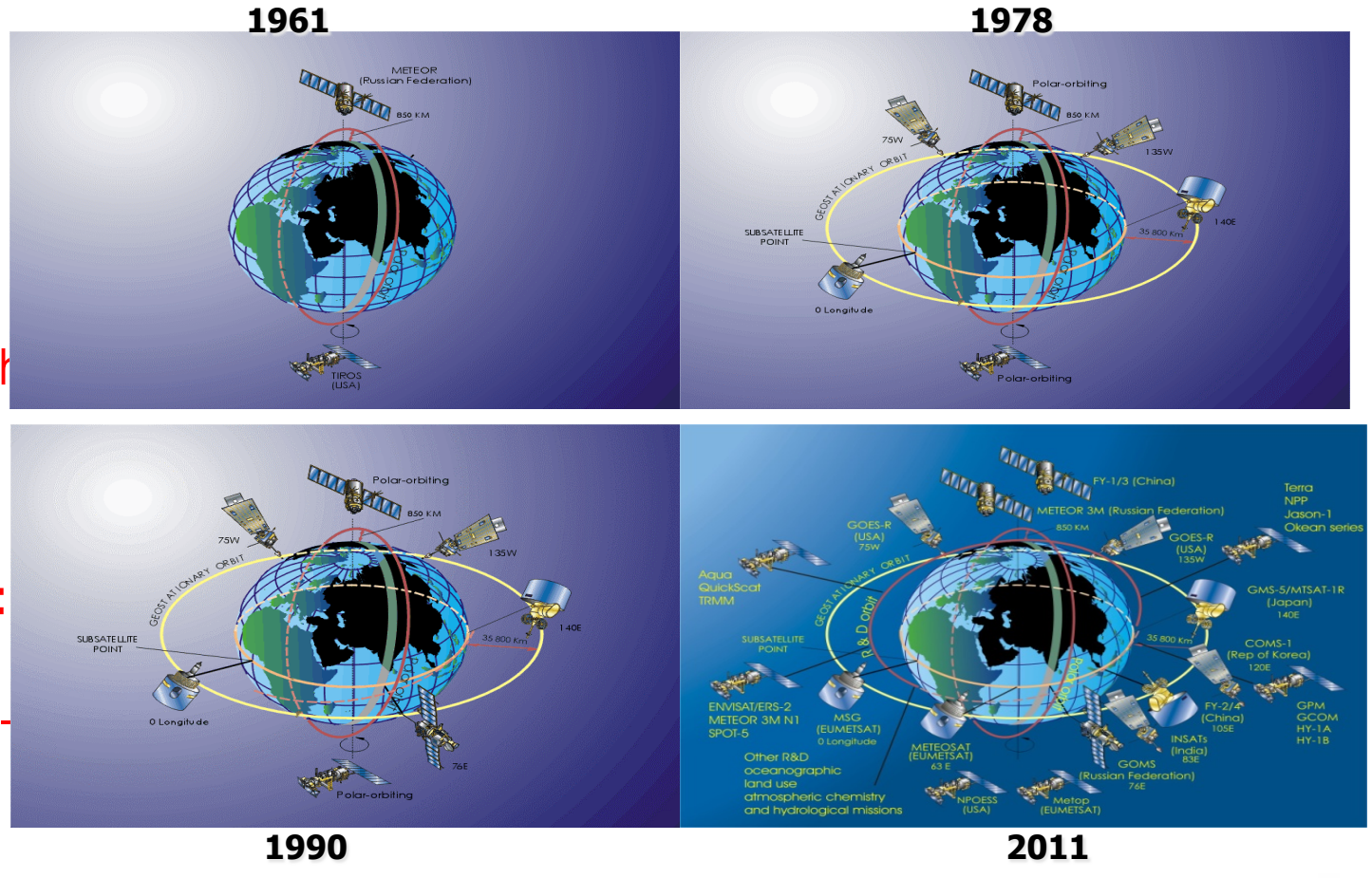
Challenge 2: Climate Record Creation

An architecture to ensure long-term continued climate observations from space — need strong political commitment



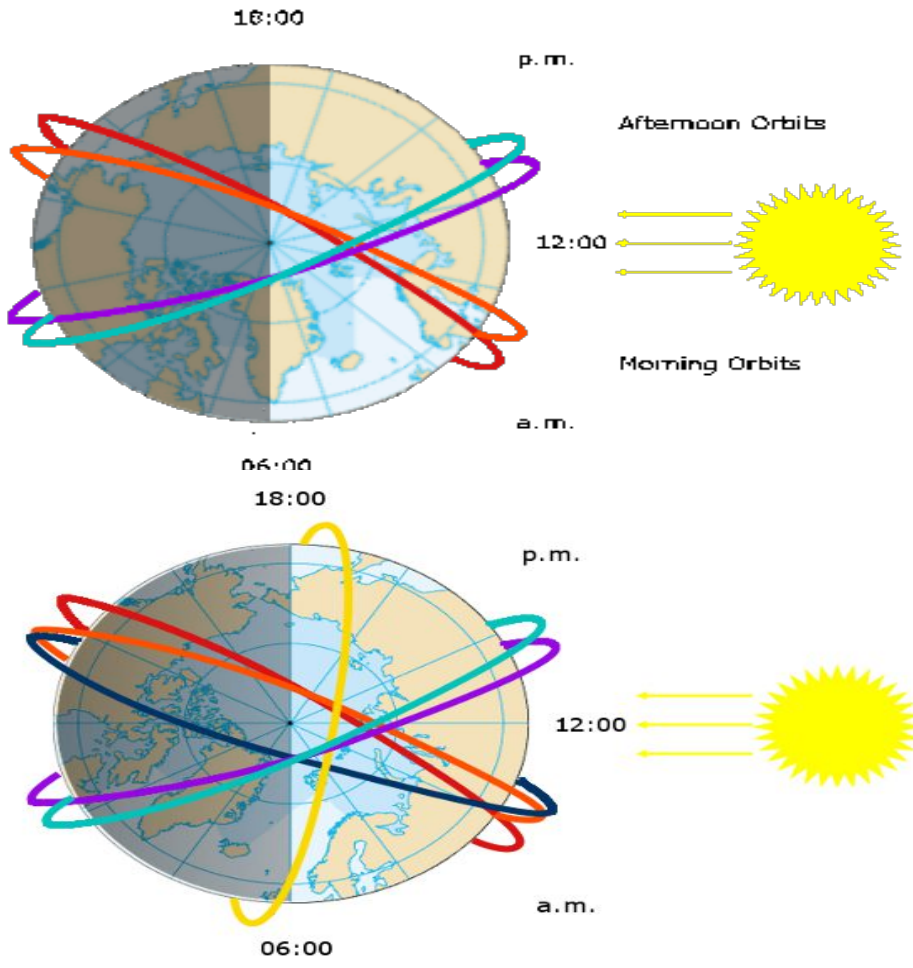
Success of Meteorological satellites 50 years development
-- How to convince political and budget authorities of space agencies & climate services for global investiments

- **Excerpt from President J.F. Kennedy's address to the UN General Assembly, 25 September 1961…, he said:**
- Here, new scientific tools have become available. With modern computers, rockets and **satellites**, the time is ripe to harness a variety of disciplines for a concerted attack th atmospheric sciences require worldwide observations and, hence, **international cooperation.**
- **UN Resolution on World Weather Watch : 1963-2013**
- Global political commitment & coordination! - How ?

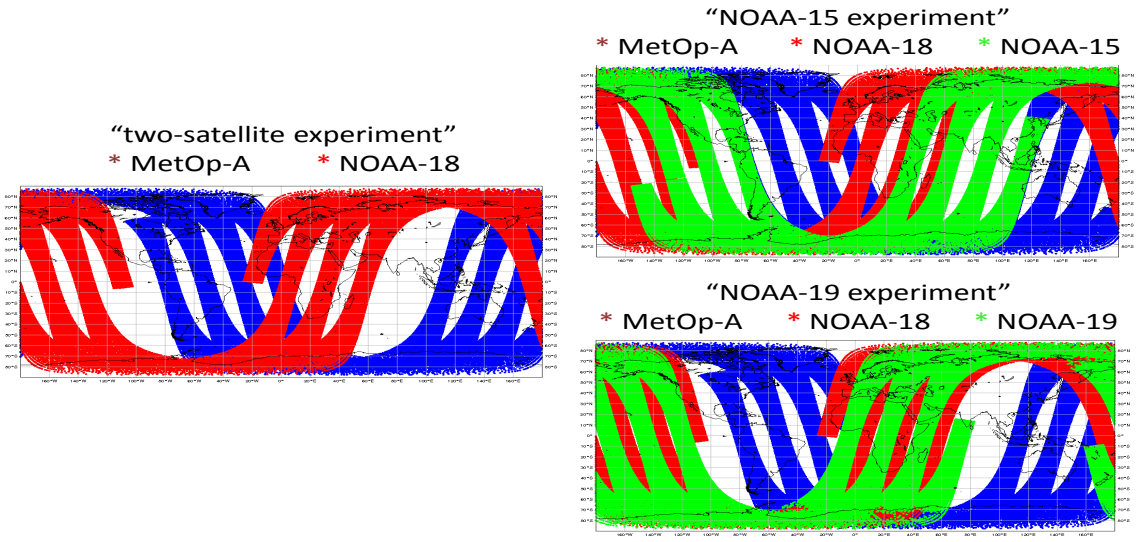


CGMS action and China response: New baseline in the Vision for the Global Observing System in 2025

- The new baseline for the core LEO constellation is to be deployed over three orbital planes around 13:30, 17:30 and 21:30 Equatorial Crossing Time (ECT) in LST for ensuring regular sampling of the atmosphere and earth surface



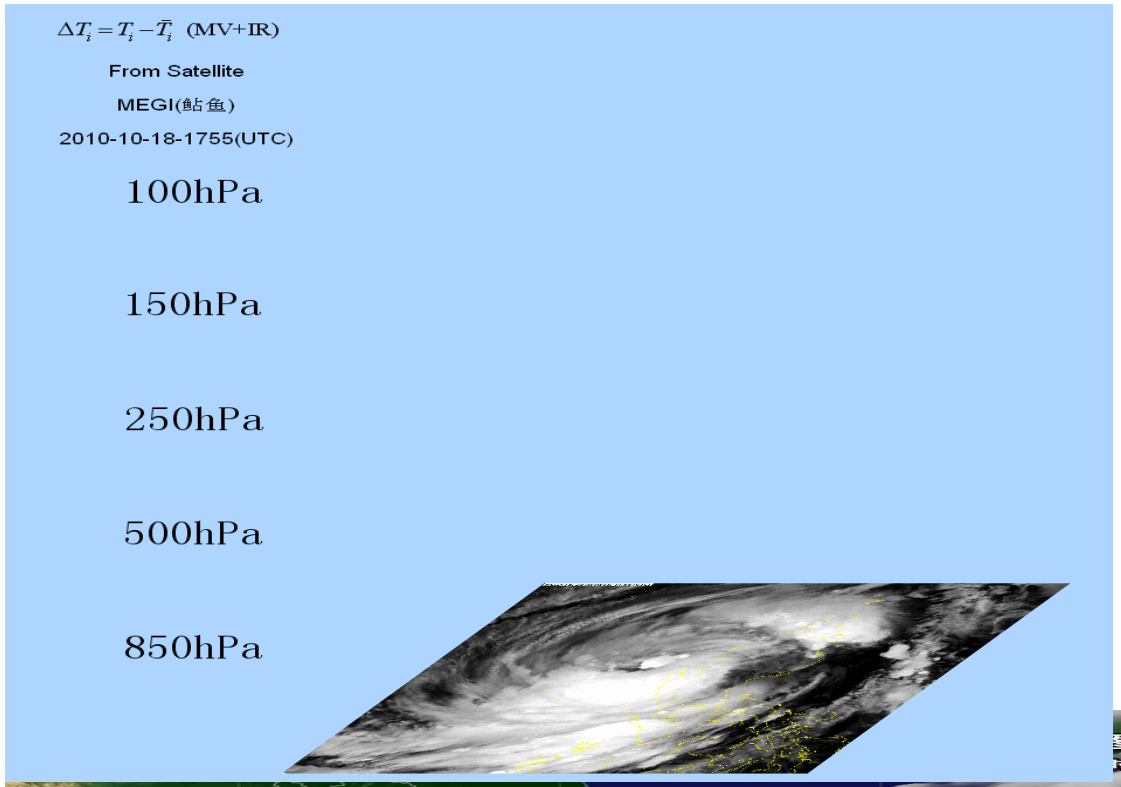
Data coverage



Real time climate monitoring: Three orbital planes will enable more frequent TC structure monitoring-DRR

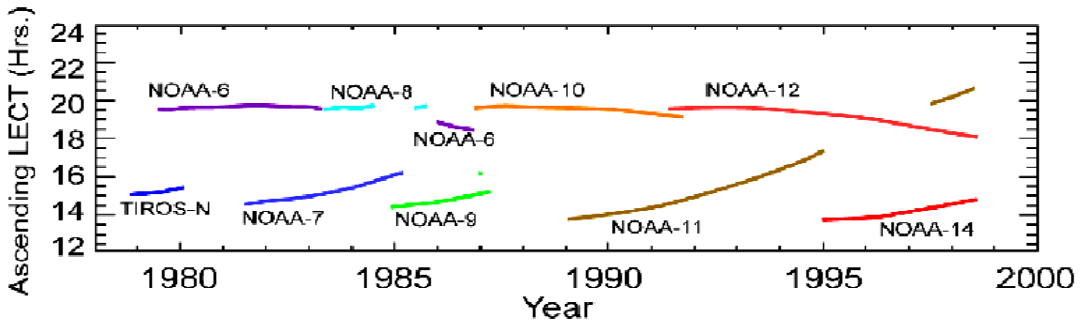
Biggest TC forecast challenge is rapid intensity change

- New 3 LEO constellation for more frequent sounding & better monitoring TC climate extremes by identfying warm core anomaly critical to timing and placement of warnings
- More frequent sounding, better satellite wind and temperature data have potential to improve TC intensity forecast models
- Regular/more frequent high resolution (vs GEO) images sampling can help identify timely disaster regions (convections, floods, fires, etc)

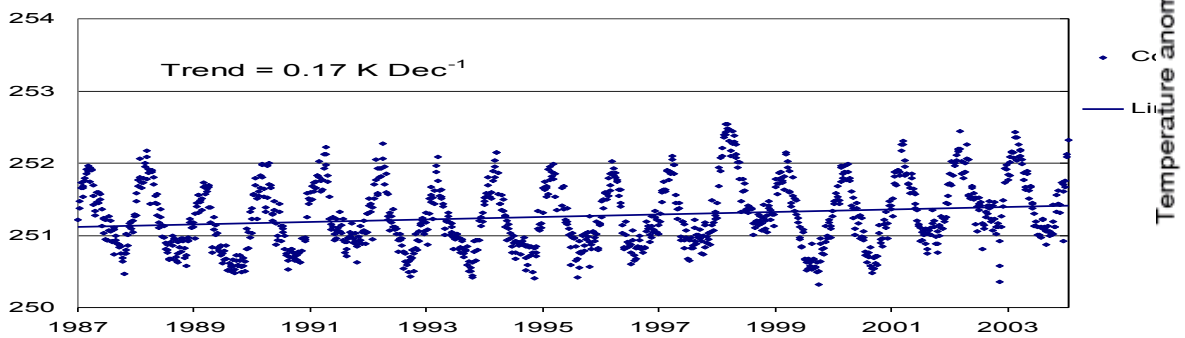


Challenge 2: long-term monitoring- science & technology aspects
Op+ R&D synergies for new capabilities to ensure long-term continued, quality assured climate observations from space

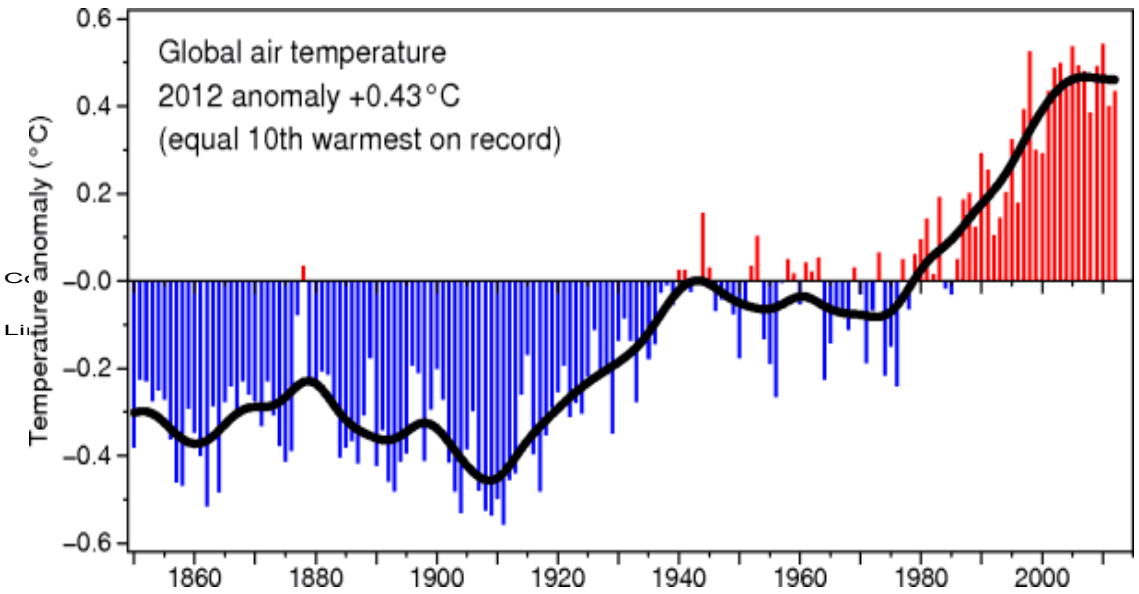
Figure 5



Local equatorial crossing time for NOAA satellites show the long-term drift (from Wentz, 2002).

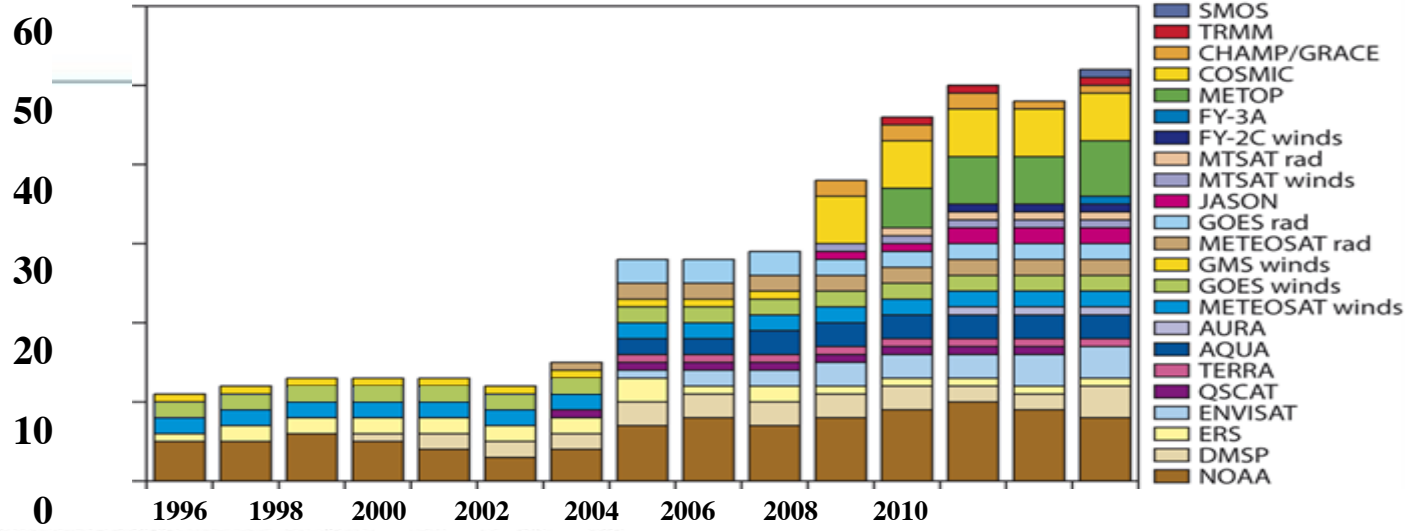


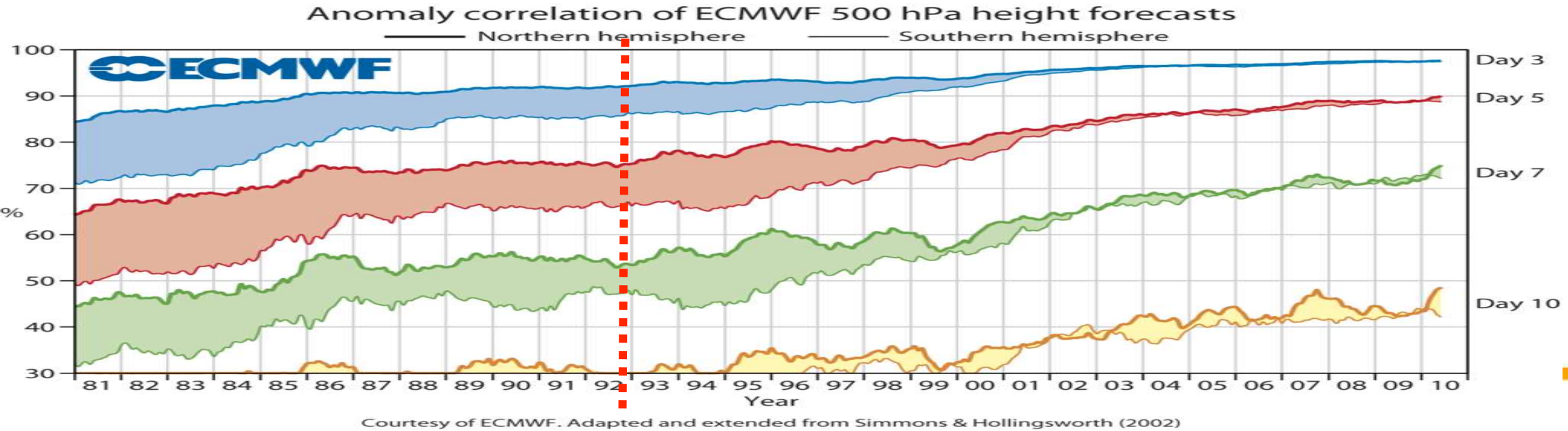
Longest surface T instruments measurements (>140 years)
Against 30 years average (1961-1990)



Challenge 3: Improving satellite data utilizations in Climate – What are the key data for seasonal prediction

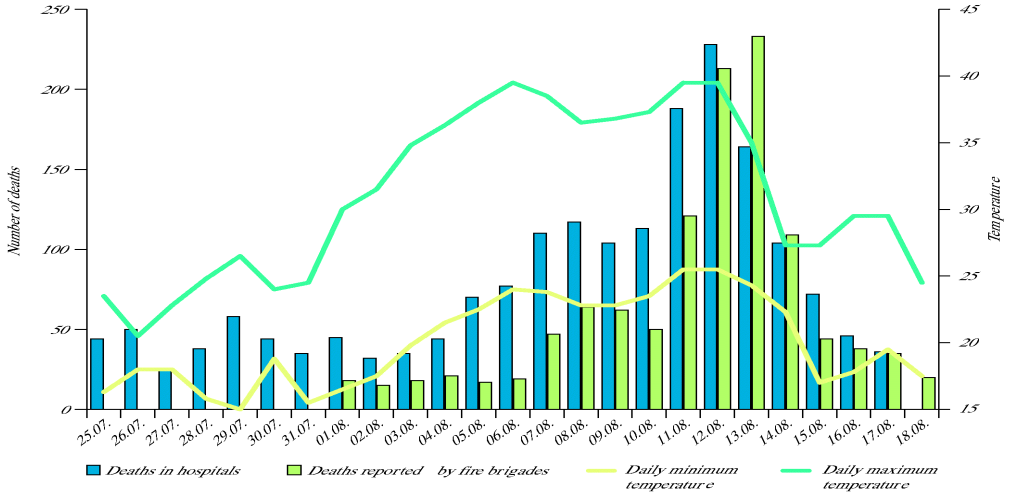
Number of satellite-borne instruments data were assimilated routinely by ECMWF from 1996 to 2010, Expect the similar level of utilization for improving climate model predictions



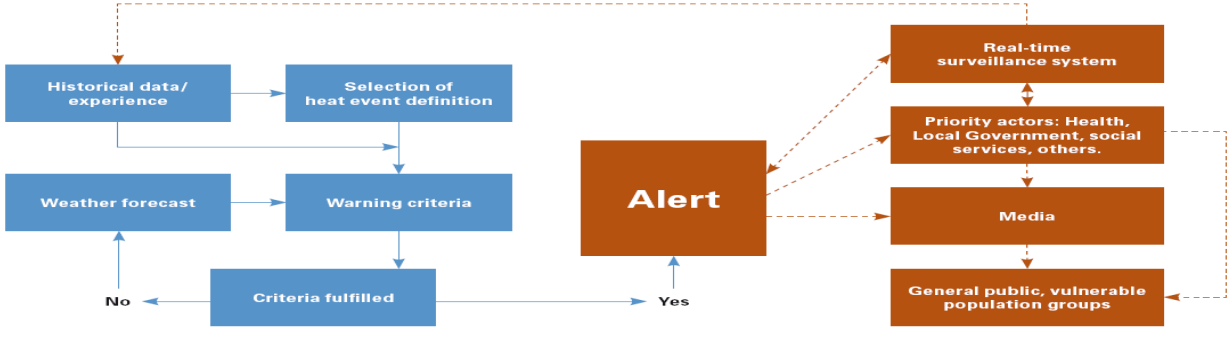


Courtesy of ECMWF. Adapted and extended from Simmons & Hollingsworth (2002)

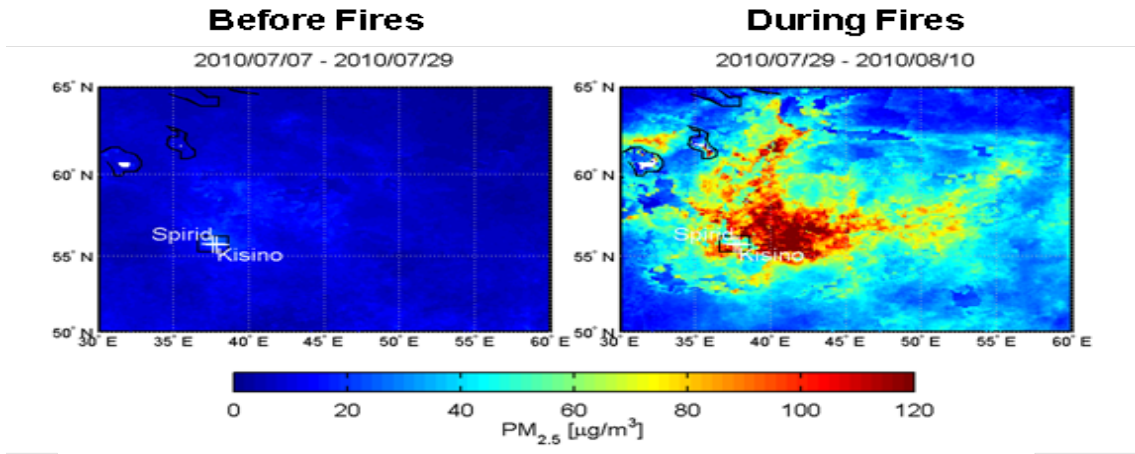
Current uses of met. observations for health: Monitoring/response to weather/pollution events

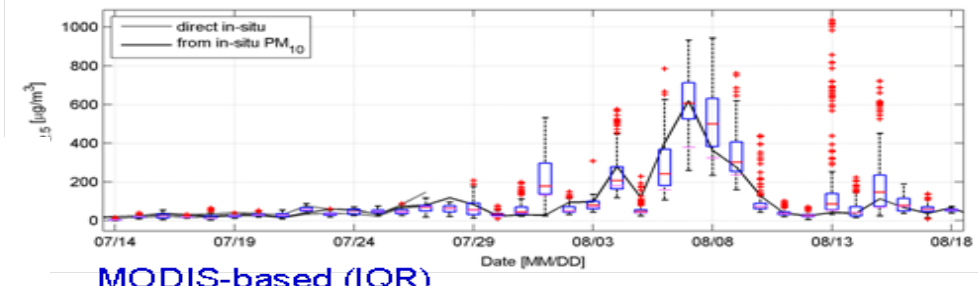


Deaths During Summer Heatwave. Paris Funeral Services (2003)



The information generated by meteorological agencies needs to be connected to preventive actions by health and other sectors to form a heat-health action plan[13]



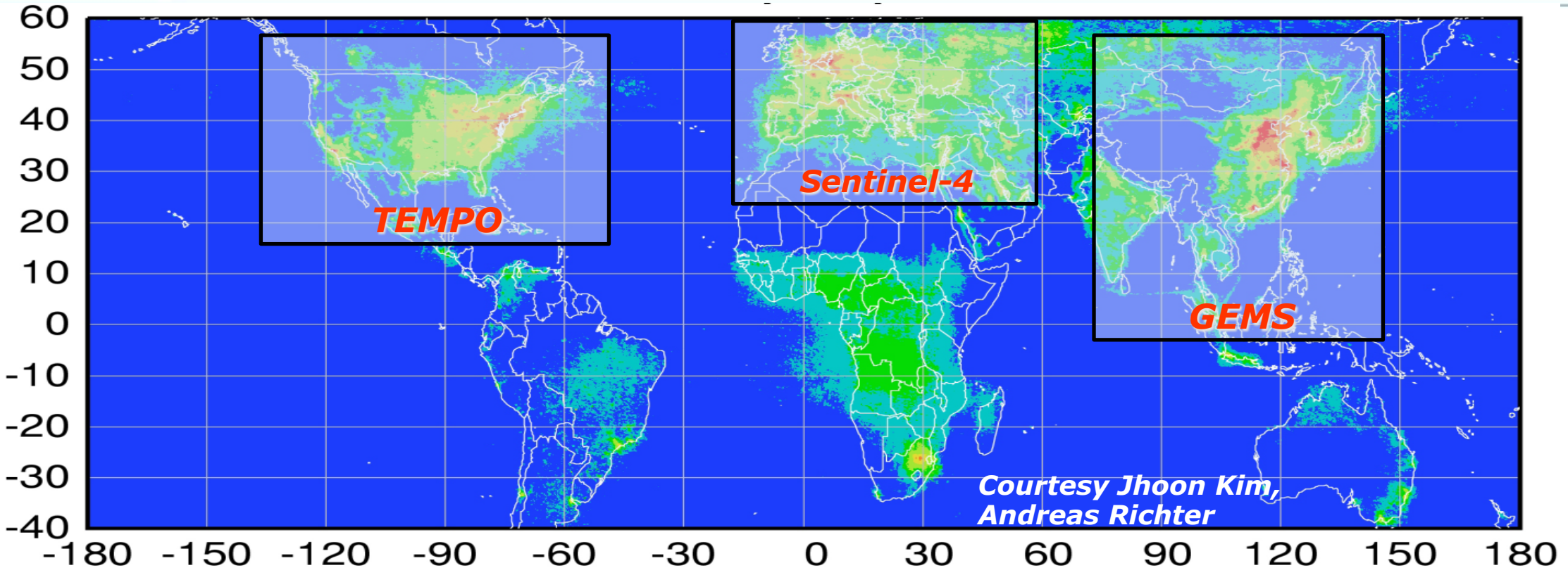


Air pollution levels during Moscow fires in 2010

Example: Geostationary pollution monitoring

Hourly atmospheric pollution observations from geostationary Earth orbit

Spatial coverage of funded spectrometers 2018-2020♪



Policy-relevant science and environmental services enabled by common observations

Challenge 4: Decision–making

New partnership process

---Take Health priority as an example, from user perspective

Space community is the most important partner of WMO from observing stakeholder perspective

WMO OMM

Health sector will make some decisions based on climate information

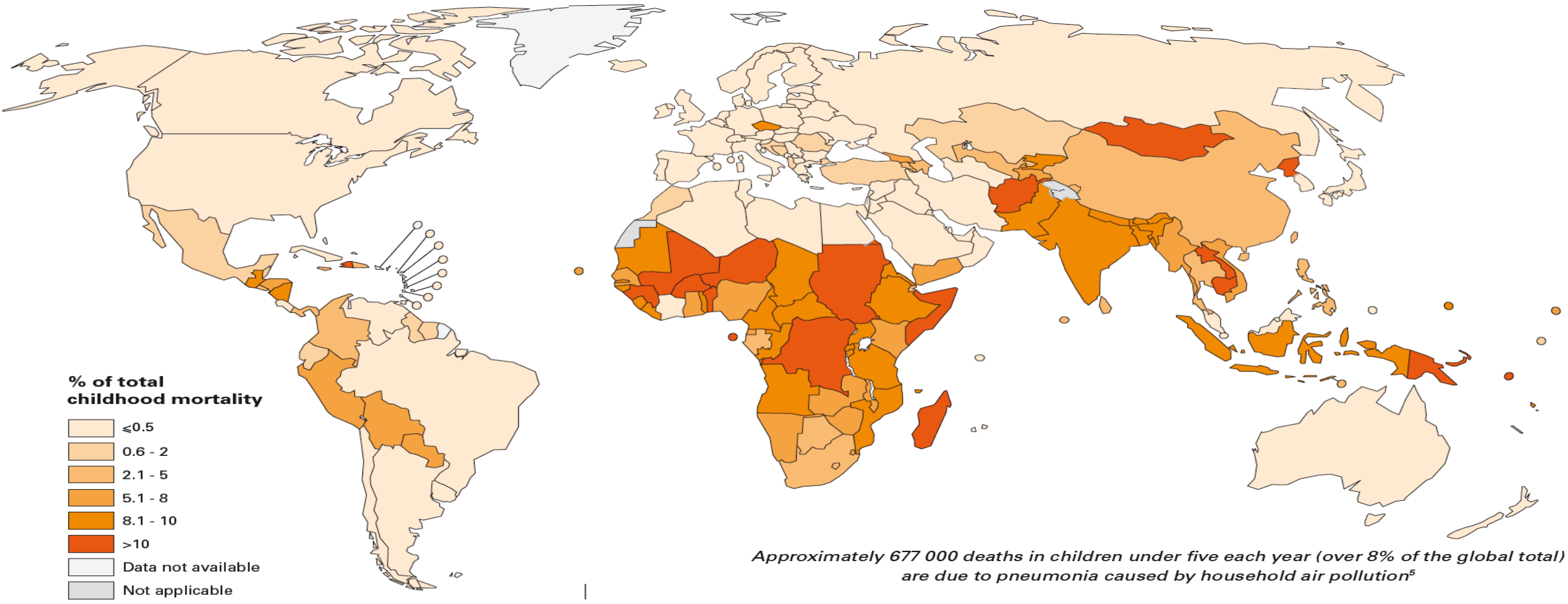
Meteorological conditions affect some of the largest disease burdens:

- Under nutrition kills 3.5 million/yr
- Diarrhoea kills 2.2 million/yr
- Malaria kills 900,000/yr
- Hydrometeorological extremes kill 10s of thousands, and cause multiple other health effects

Director General of the World Health Organization (WHO) Margaret Chan (L) and World Meteorological Organization (WMO) Secretary-General, Michel Jarraud (R)

--Pose with the Atlas of Health And Climate, during a press conference on the extraordinary session of World Meteorological Congress, 2012 in Geneva.
--With droughts, floods and hurricanes like the one bearing down on New York affecting the health of millions of people each year, WMO and WHO health agencies presented an overview of how climate data can help protect public health.

Approximately 677 000 deaths in children under five each year (over 8% of the global total) are due to pneumonia caused by household air pollution



Approximately 677 000 deaths in children under five each year (over 8% of the global total) are due to pneumonia caused by household air pollution[5]

Summary
Key Importance for Space Community

- Meet the Climate observing and monitoring needs by strengthening National and International Programmes and Projects– Opportunities for new development !!
- Active engagement of the development of the physical Architecture to advance climate services !
- Support **free and open exchange policy on climate-relevant space observational data and Products**
- International collaboration: among space agencies and with user communities : If you want go fast, go alone; If you want go far, go together !
- Thank you for your attention !!

Thank You

Strategy for satellite operators to meet Observational Requirements under WMO Integrated Global Observing System (WIGOS) Framework

Inclusion requirements of

- Weather, DRR
- Climate (GFCS, GAW..),
- Water (WHYCOS,..)
- Environment (GAW, Health)
- Co-sponsored observing systems

WIGOS Space component

- From weather satellite to WIGOS space component
- CGMS new baseline with greatly enhanced global satellite constellations to meet WWW, GFCS, GAW, WHYCOS,GCW etc .. Operational requirements.
- Challenges to enhance greatly space and ground capabilities