



World Meteorological Organization

Weather • Climate • Water

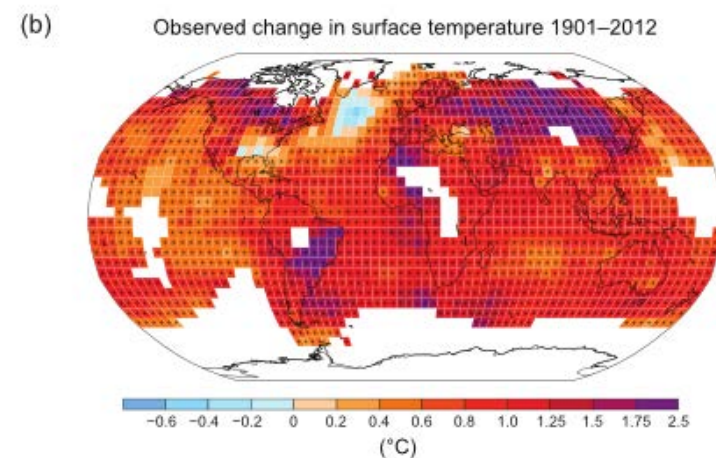
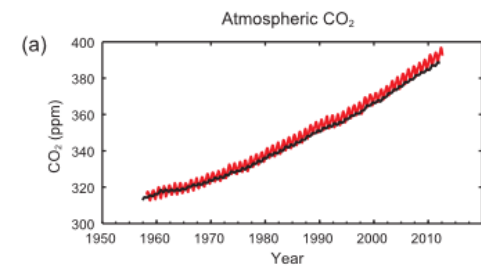
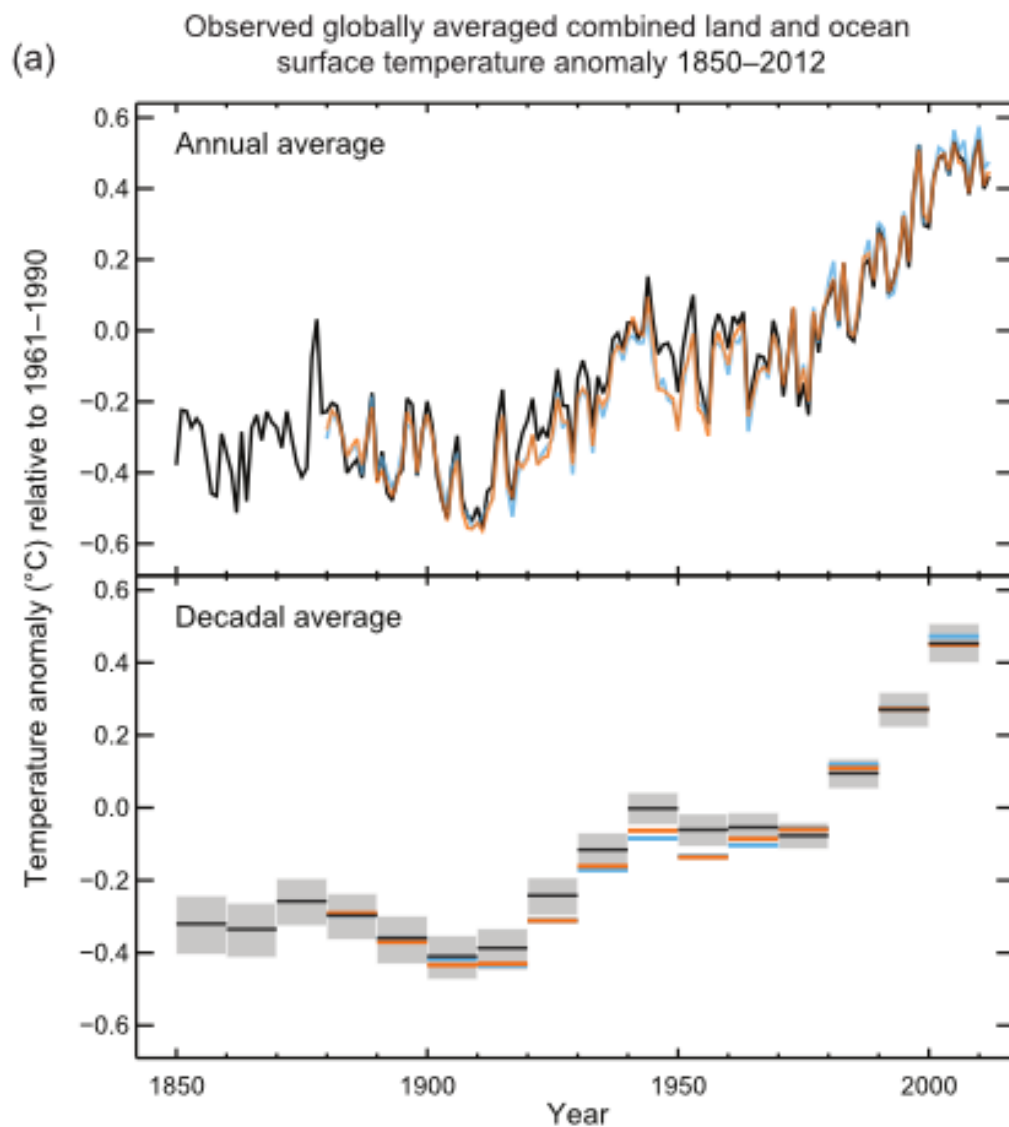
Introduction to WMO and its support to climate change science

Stephan Bojinski

COSPAR/WMO Capacity Building Workshop
Satellite remote sensing, water cycle, and climate change

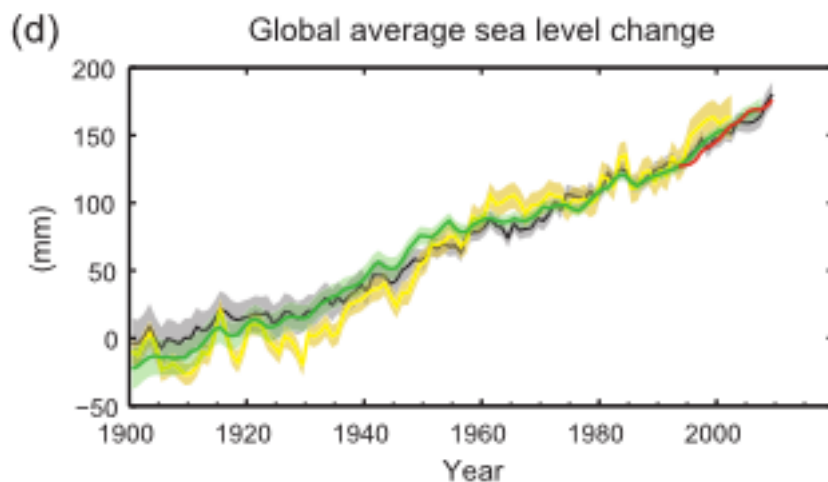
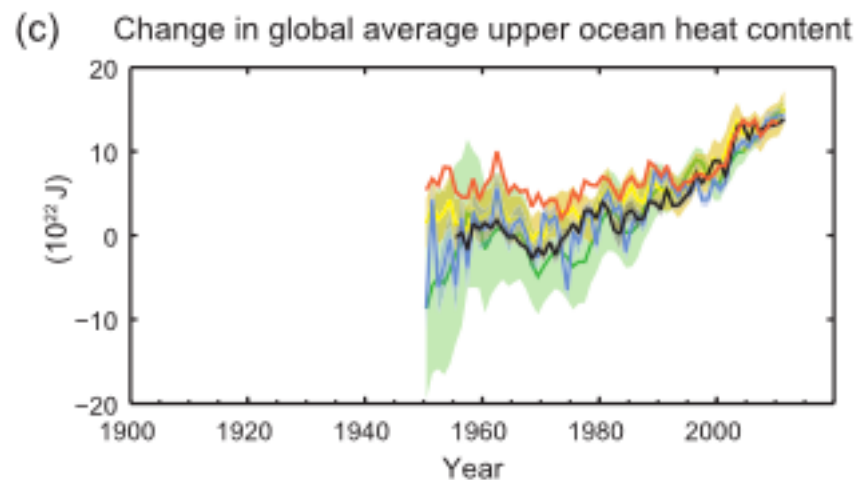
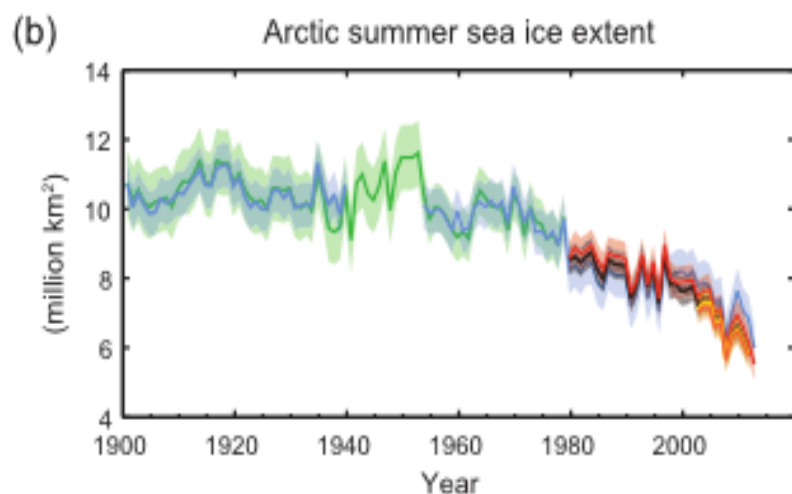
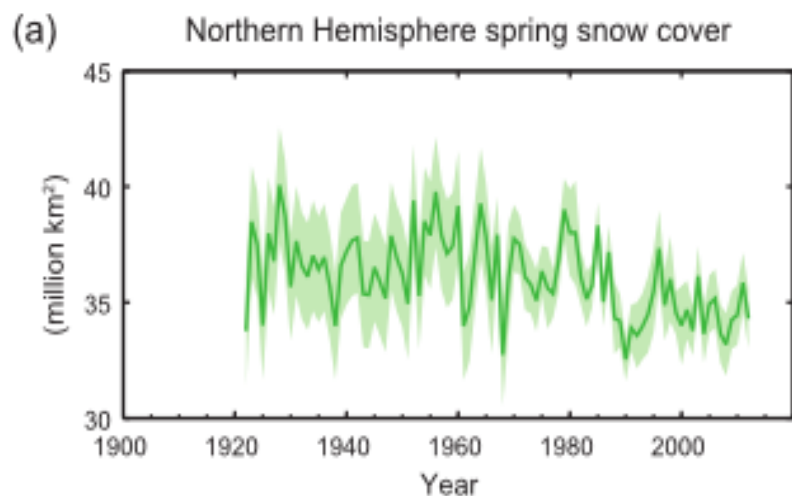
21 July – 1 August 2014, Tver', Russian Federation





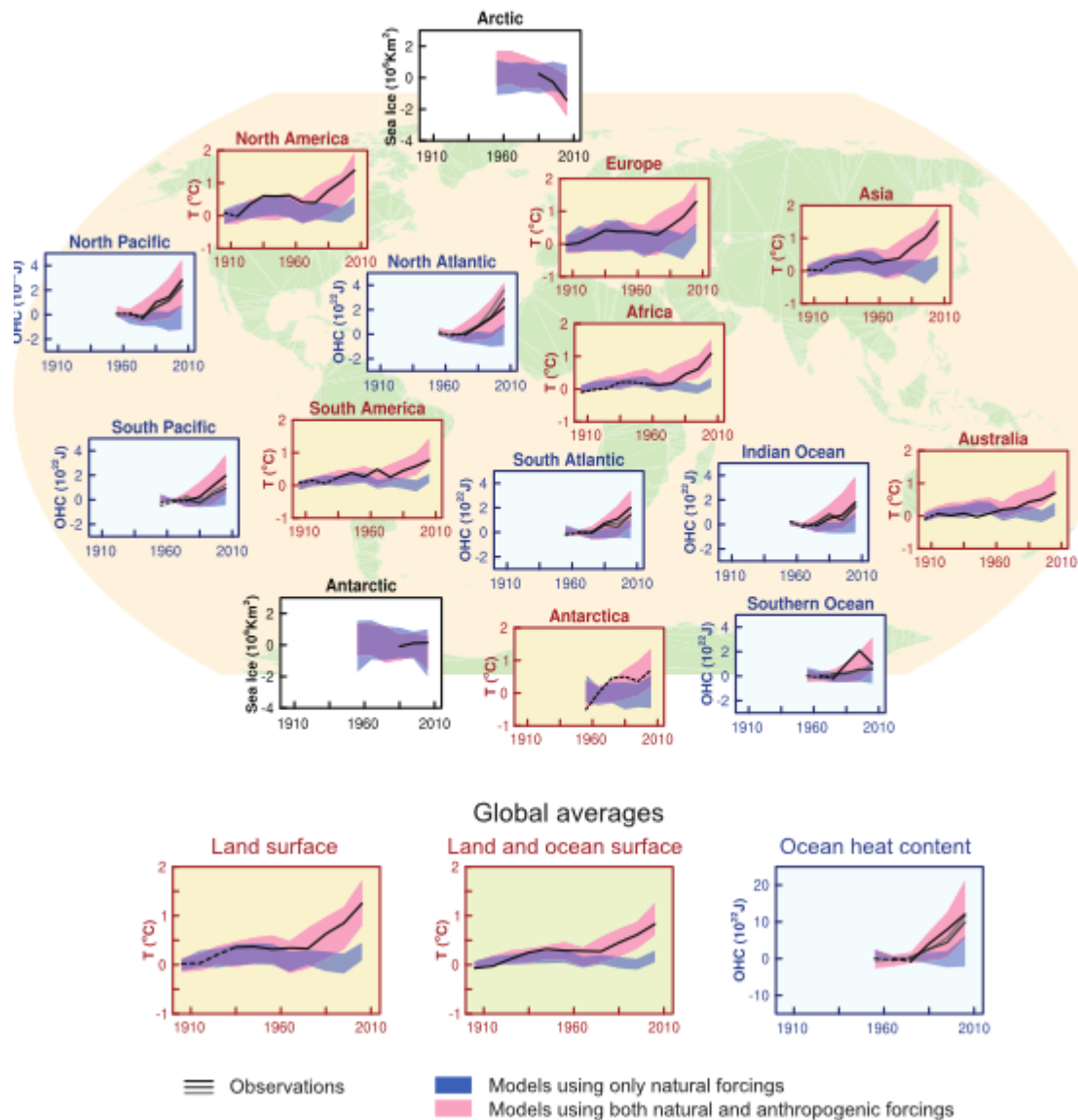
Source: IPCC AR5, WG I





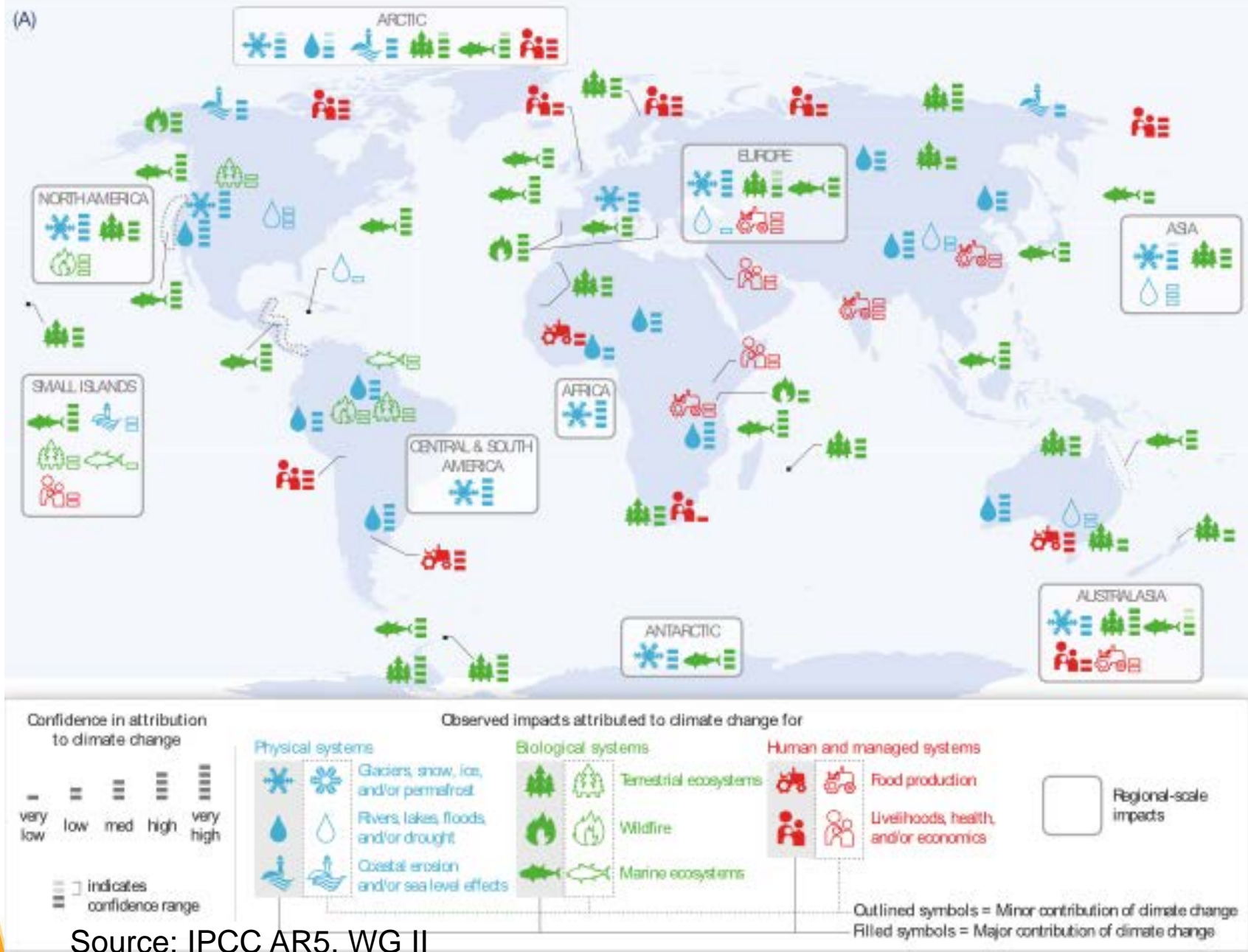
Source: IPCC AR5, WG I





Source: IPCC AR5, WG I





Source: IPCC AR5, WG II

МГЭИК

МЕЖПРАВИТЕЛЬСТВЕННАЯ ГРУППА ЭКСПЕРТОВ ПО ИЗМЕНЕНИЮ КЛИМАТА

ИЗМЕНЕНИЕ КЛИМАТА, 2013 г.

Физическая научная основа

Резюме для политиков

РГ I

ВКЛАД РАБОЧЕЙ ГРУППЫ I В ПЯТЫЙ ДОКЛАД
ОБ ОЦЕНКЕ МЕЖПРАВИТЕЛЬСТВЕННОЙ ГРУППЫ
ЭКСПЕРТОВ ПО ИЗМЕНЕНИЮ КЛИМАТА



ВМО



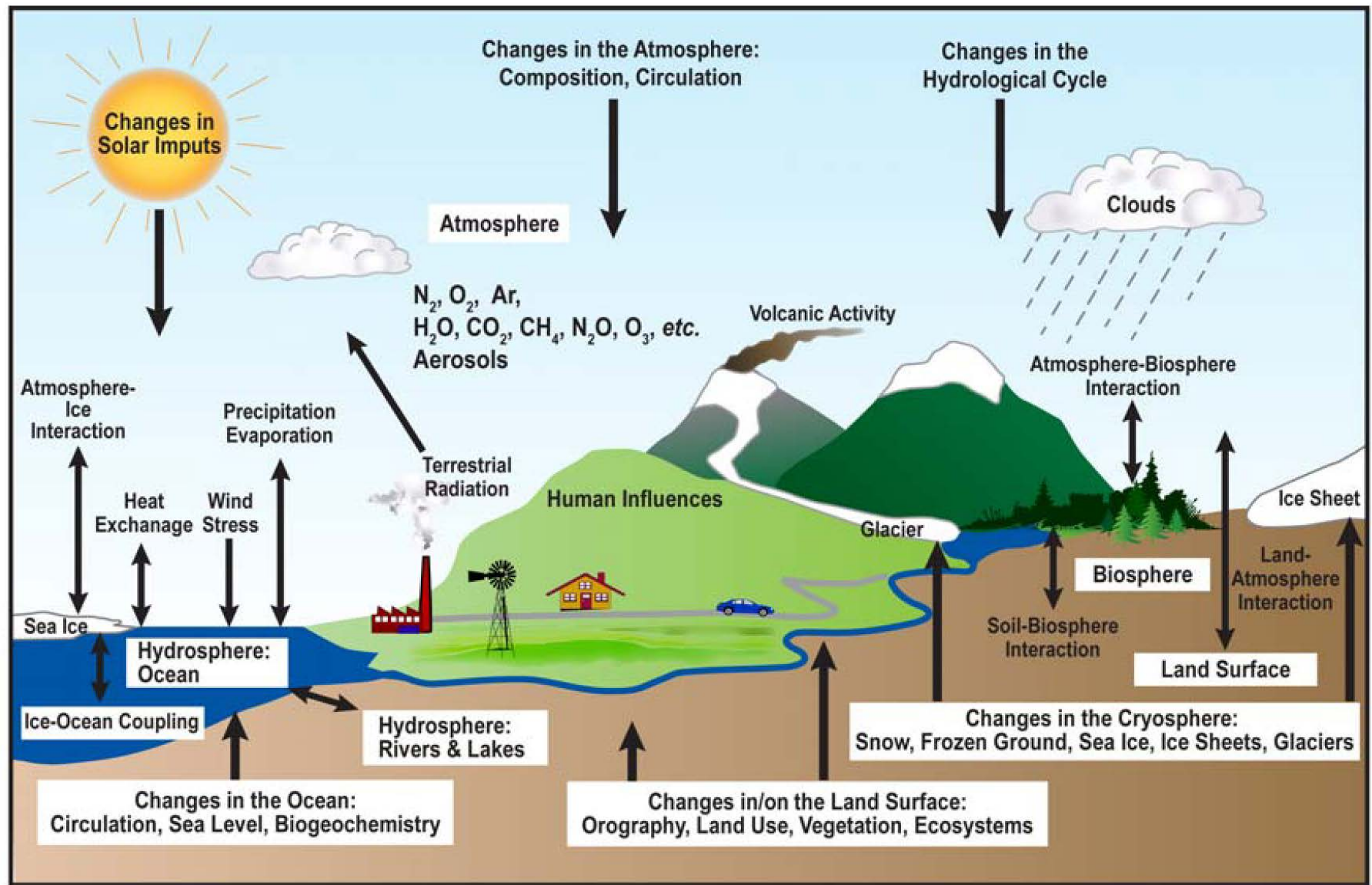
ЮНЕП



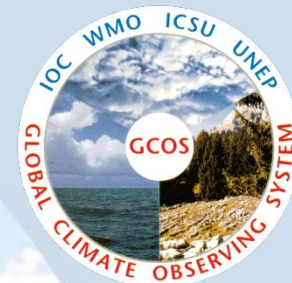
COSPAR/WMO

Weather • Climate • Water

Observing a changing climate system...



GCOS Essential Climate Variables (50 ECVs)

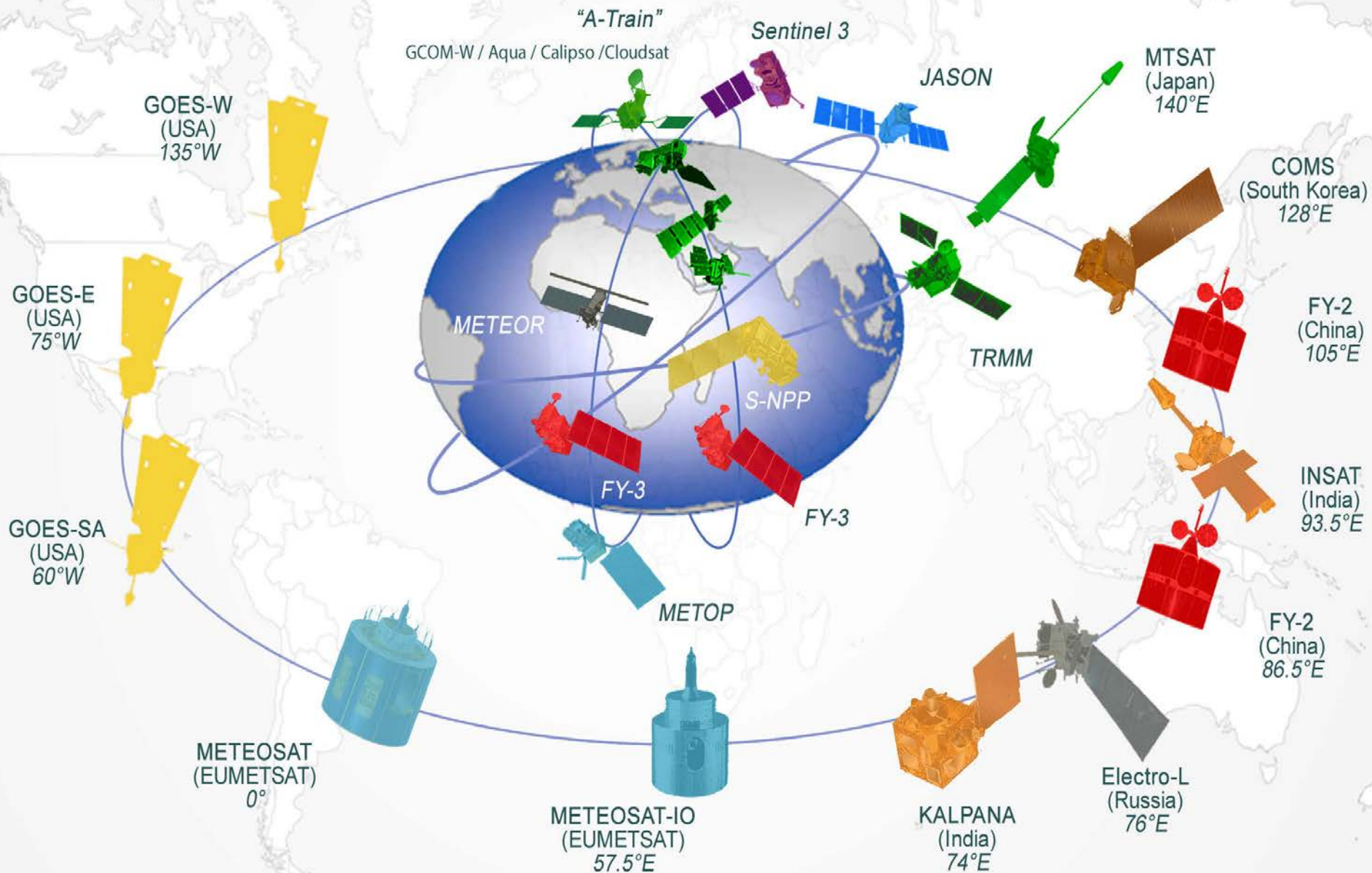


- **Priority list of variables to be observed systematically (Status: 2011)**
- **Criteria:**
 - Global observations **feasible** (practical, cost-effective)
 - **Highest impact** on needs of UNFCCC, climate research (WCRP), climate change assessments (IPCC)

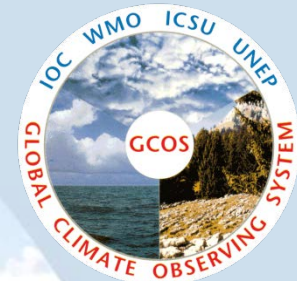
Source: <http://www.wmo.int/pages/prog/gcos/Publications/gcos-138.pdf>

Domain	Essential Climate Variables	
Atmospheric (over land, sea and ice)	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, Wind speed and direction, Water vapour, Cloud properties.
	Composition:	Carbon dioxide, Methane, Other long-lived greenhouse gases, Ozone and Aerosol, supported by their precursors.
Oceanic	Surface:	Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea Ice, Current, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton
	Sub-surface:	Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers.
Terrestrial	River discharge, Water use, Groundwater, Lakes, Snow cover, Glaciers and ice caps, Permafrost, Ice sheets, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture.	

Space-based observations



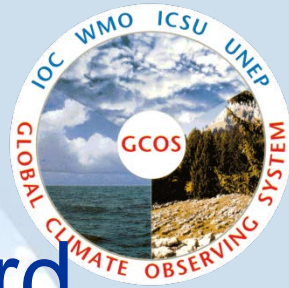
GCOS Essential Climate Variables: Significant contribution by satellites to 29 ECVs (orange)



Source: <http://www.wmo.int/pages/prog/gcos/Publications/gcos-154.pdf>

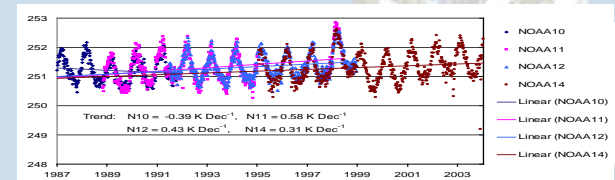
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What is an ECV product / FCDR?



■ Fundamental Climate Data Record (FCDR)

Consistent timeseries of calibrated level 1 data (eg., radiances)



■ “ECV” or “ECV products”

Derived timeseries of (bio)geophysical variables

Which satellite can contribute to which ECV?

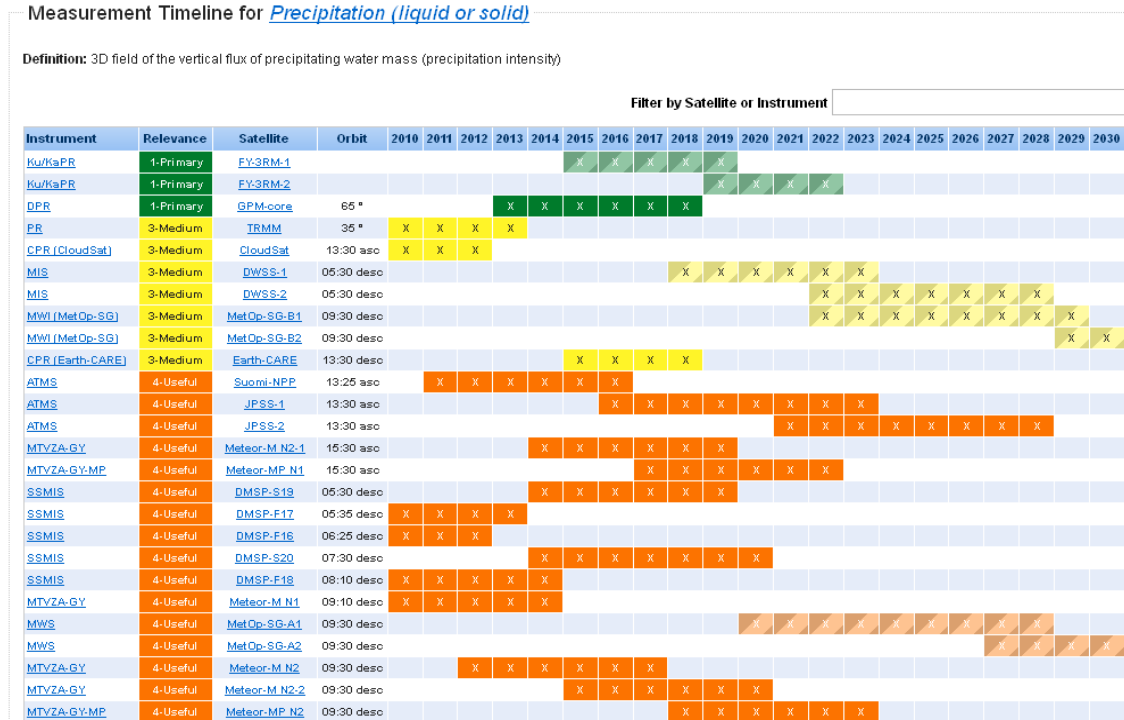
- WMO Observing Systems Capability Analysis and Review Tool -“OSCAR”
- Repository of
 - Satellite EO systems and instruments (~870)
 - Observation requirements

(www.wmo.int/oscar)

Example: Satellite Instruments for deriving Precipitation

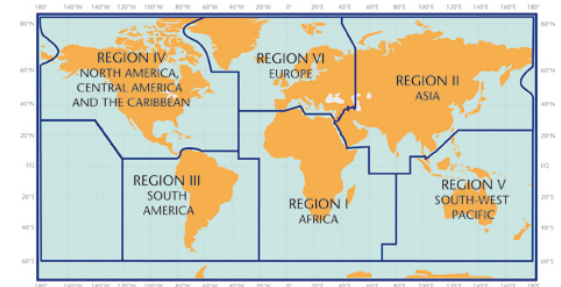
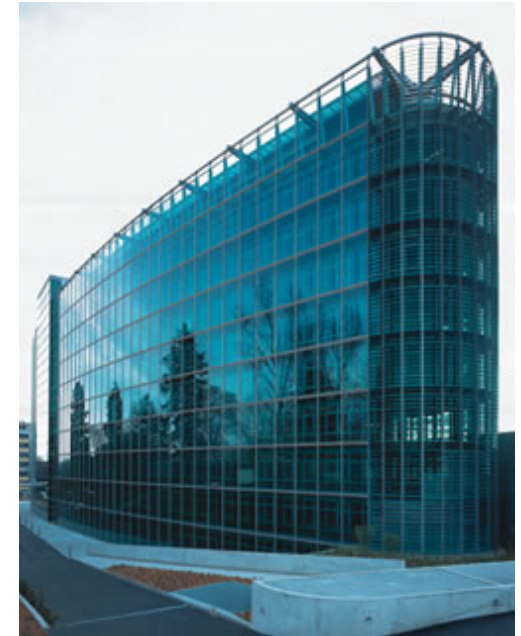


COSPAR/WMO CBW, Tver', Russian Fed



WMO at a glance

- Specialized agency of the U.N. for meteorology (weather and climate), operational hydrology and related geophysical sciences
- Established in 1950
- Membership of 191 states/territories
- Governed by the Members
 - Represented through National Meteorological Service
- Regional Associations
- Secretariat (Geneva, Switzerland) with ~270 staff



WMO at a glance



Cooperation between:

- national meteorological and hydrological services, global modelling centres, research institutions, satellite operators, development agencies and banks, UN agencies, other national and international partners

In the areas of:

1. Observations
2. Applications
3. International standards
4. Data exchange
5. Research
6. Training and capacity building



WMO Programmes

World Meteorological
Organization



A United Nations Specialized Agency
Working together in Weather, Climate and Water

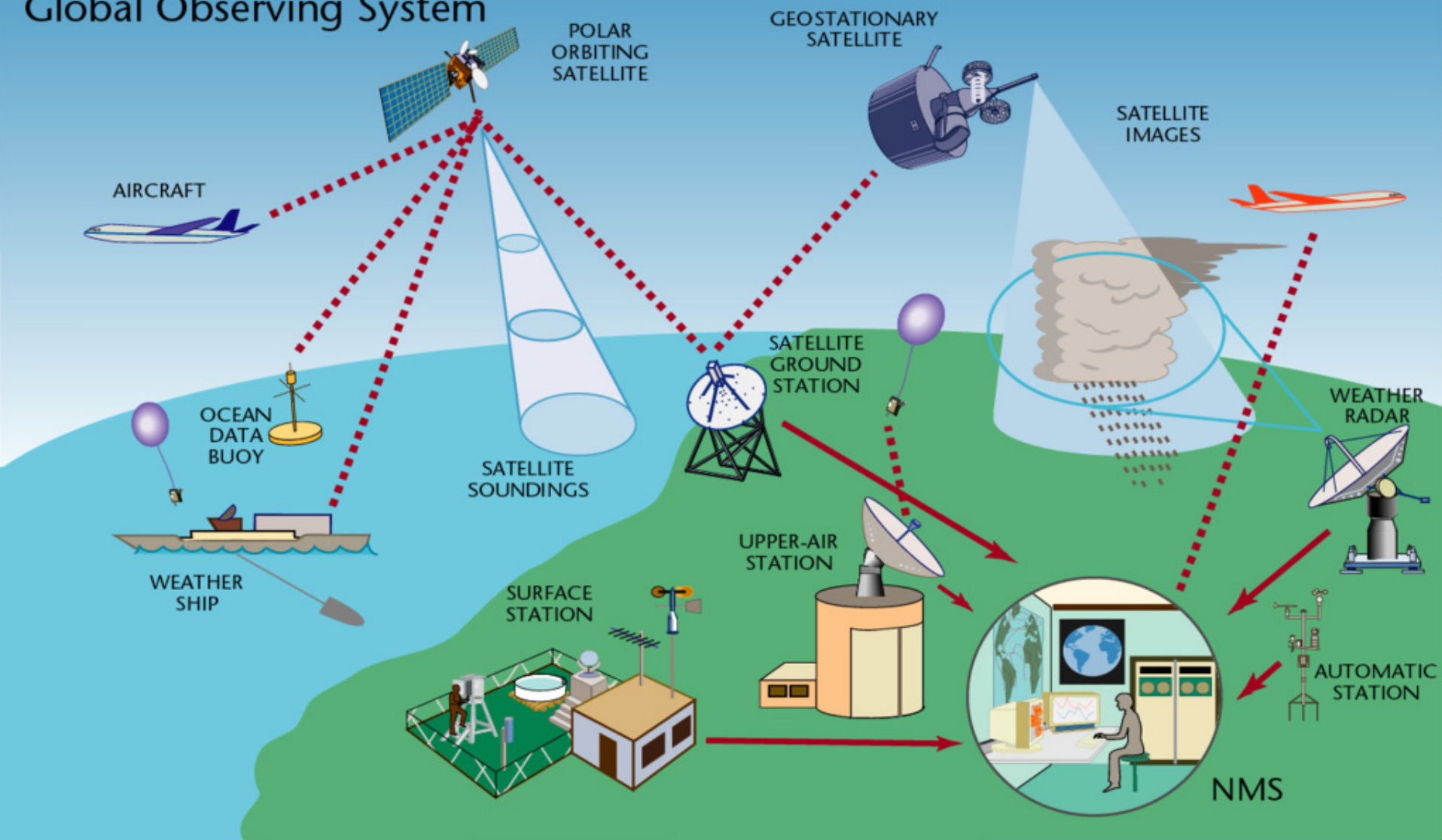


World Weather Watch Programme	Marine Meteorology and Oceanography Programme
Global Atmosphere Watch Programme	WMO Quality Management Framework
World Weather Research Programme including THORPEX	Information and Public Affairs Programme
Hydrology and Water Resources Programme	Voluntary Cooperation Programme
World Climate Programme	Education and Training Programme
World Climate Research Programme	WMO Programme for the Least Developed Countries
WMO Space Programme	Regional Programme
Public Weather Services Programme	Disaster Risk Reduction Programme
Agricultural Meteorology Programme	Aeronautical Meteorology Programme
Tropical Cyclone Programme	

+ Co-sponsored Programmes: GCOS, GOOS, GTOS, IPCC, ...



Global Observing System



WMO-CGMS VLab: Education and Training, Capacity building



WMO-CGMS Virtual Laboratory
for Education and Training in Satellite Meteorology



A network of Centres of Excellence sponsored by satellite operators

- To provide training on meteorological and environmental satellite systems, data, products and applications;
- To foster research and the development of applications for societal benefit at the local level by the NMHS.





Resources

IPCC 5th Assessment Report: <http://www.ipcc.ch>

WMO Space Programme: <http://www.wmo.int/sat>

WMO OSCAR Tool: <http://www.wmo.int/oscar/space>

Online training resources:

<https://www.meted.ucar.edu/>

(Free registration; ~300 000 int'l users)

WMO-CGMS VLab: <http://vlab.wmo.int>





**World
Meteorological
Organization**

Weather • Climate • Water

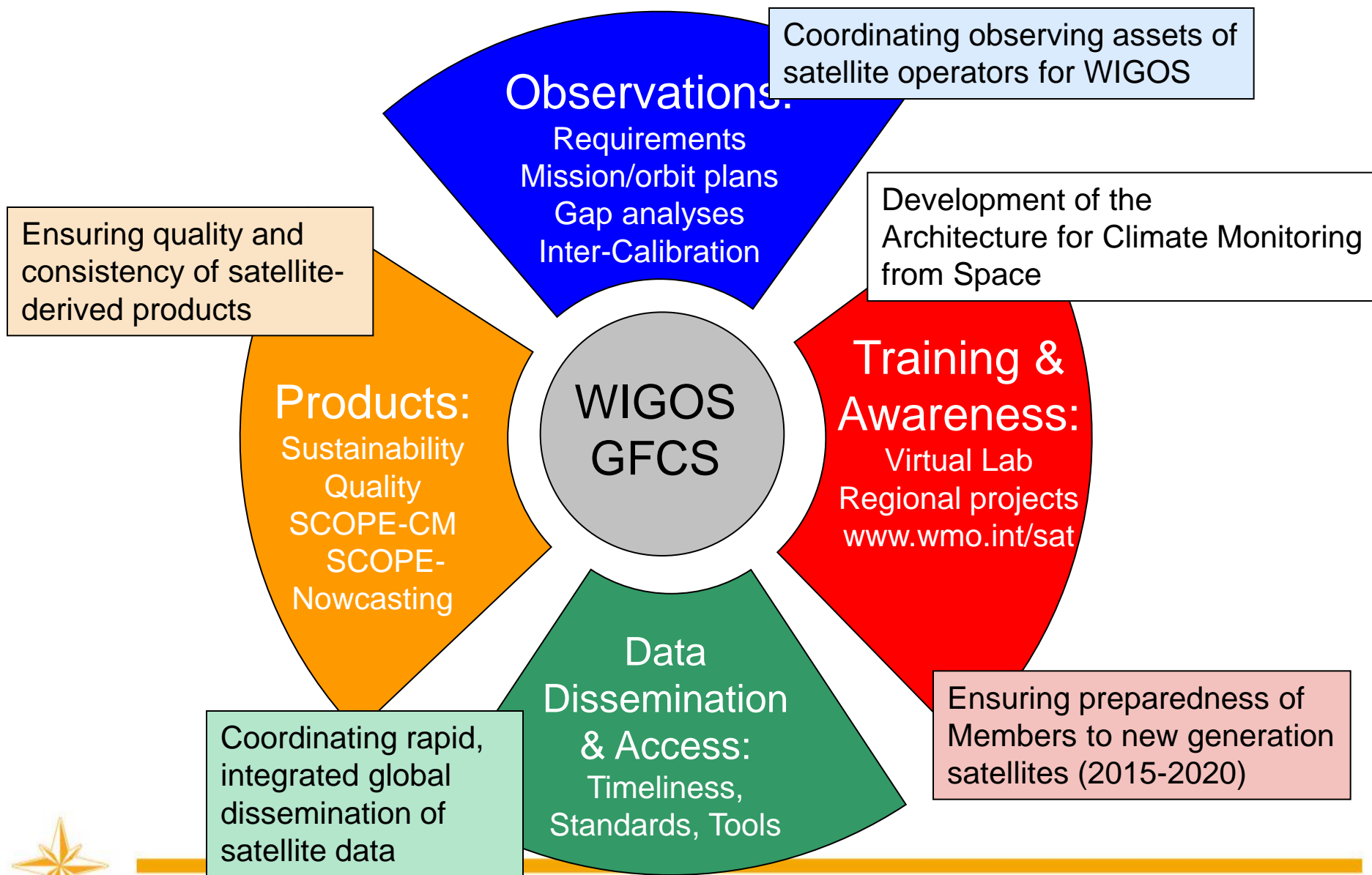
Thank you for your attention

Stephan Bojinski
sbojinski@wmo.int

Backup slides



WMO Space Programme Activities



WMO Strategic Priorities

- Global Framework for Climate Services (GFCS)
- Integration of observation/information systems (WIGOS/WIS)
- Disaster risk reduction
- Support to Aviation
- Capacity building

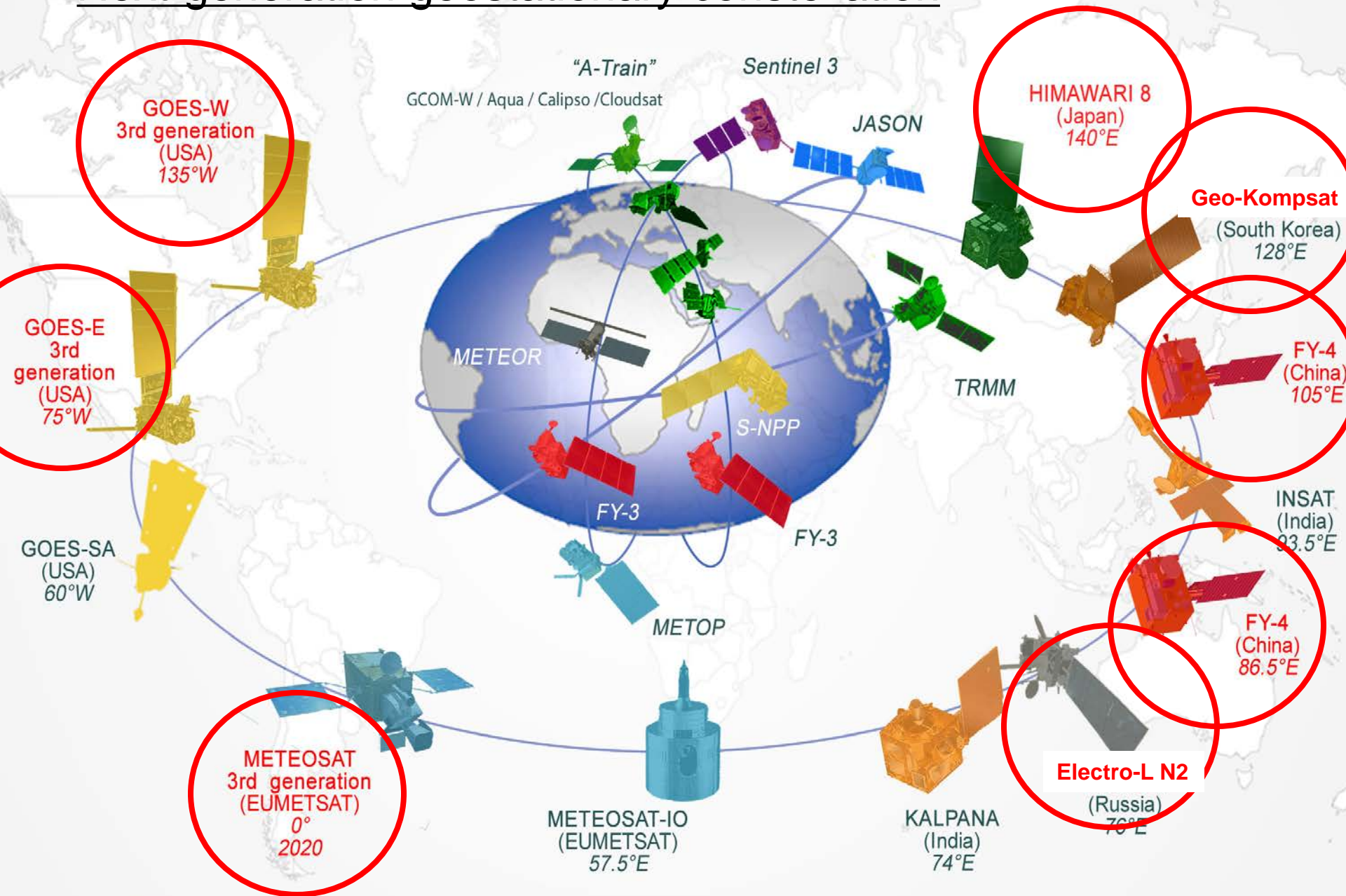
EC-66 (2014) discussed priorities for next financial period 2015-2019



New generation of satellites



Next-generation geostationary constellation


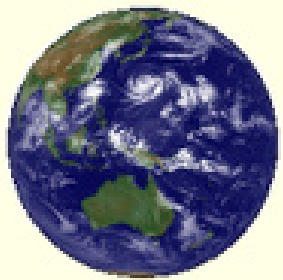

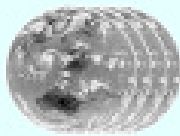
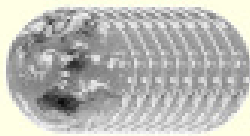


Enhancement of Himawari-8/9's observation function over that of MTSAT-1R/2

Higher spatial resolution

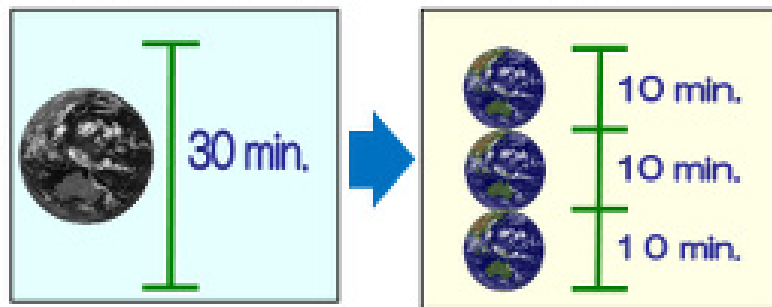
MTSAT-1R/2	Himawari-8/9
VIS 1km	VIS 0.5 - 1km
	NIR 1 - 2km
IR 4km	IR 2km

More spectral bands

MTSAT-1R/2	Himawari-8/9
VIS 1 band (black/white image) 	3 bands (color image) 
NIR N/A	3 bands 
IR 4 bands 	10 bands 
5 bands	16 bands

More frequent observation

Full disk observation with 10-minute intervals



Rapid scan observation

New
Every **2.5 minutes**
around Japan



The case for Members to prepare

- Satellites widely used by WMO Members in support of weather, climate, water applications
- New generation of geostationary meteorological satellites to enter operations in 2015-2019, including:
 - Himawari-8 (JMA)
 - FY-4 (CMA)
 - GOES-R (NOAA)
 - GEO-KOMPSAT-2 (KMA)
 - MTG (EUMETSAT)
 - Electro-L N2 (ROSHYDROMET)
- Capabilities improve (e.g., sampling rate, spatial resolution, spectral channels)
- Leading to more accurate and timely forecasts
- Data rates increase drastically, by factors of 10-100
- Affecting all WMO Regions
- Need for training highlighted in WMO 2012 Survey

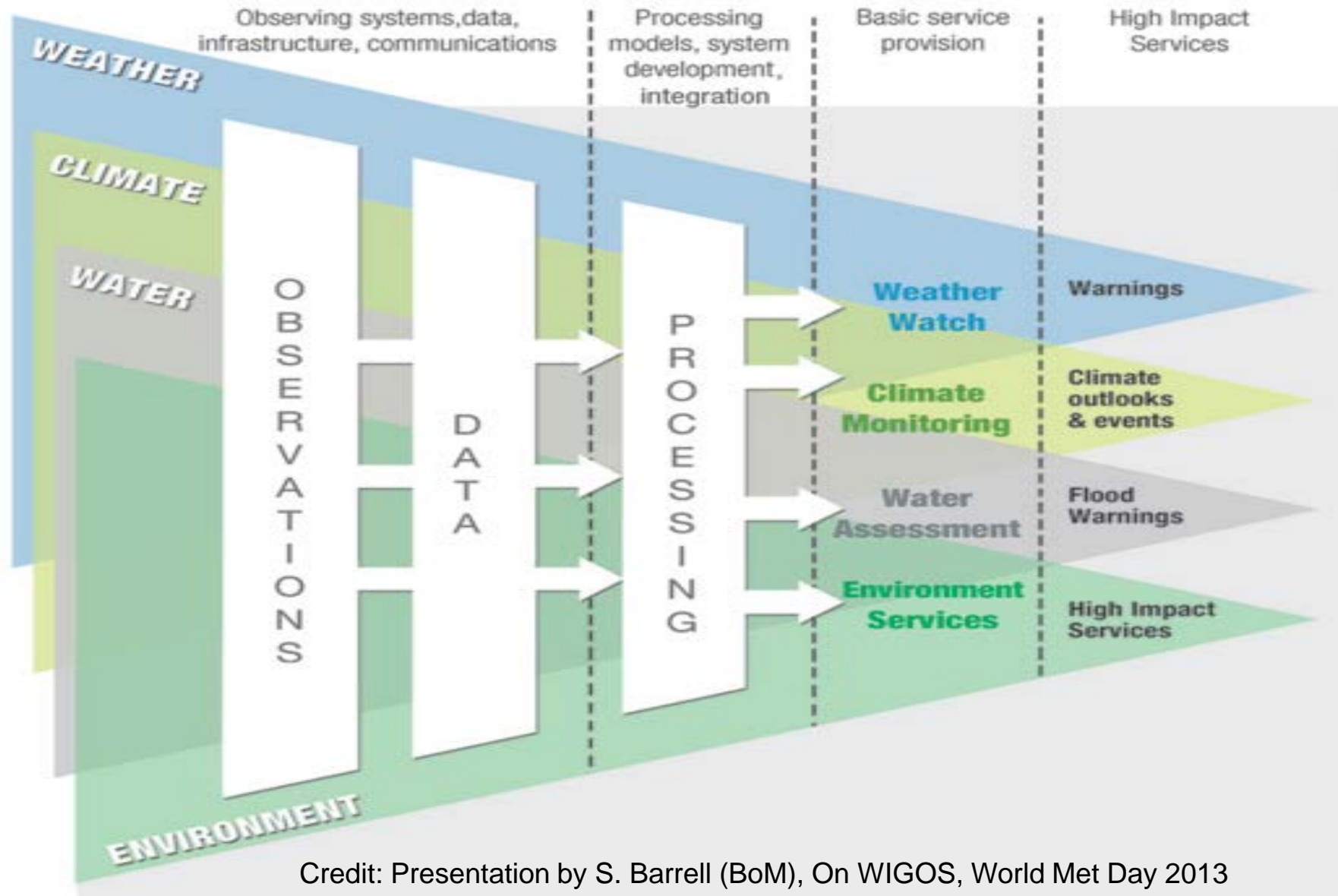


Global Framework for Climate Services



Integrated service model

Composite/integrated observations underpinning service outcomes



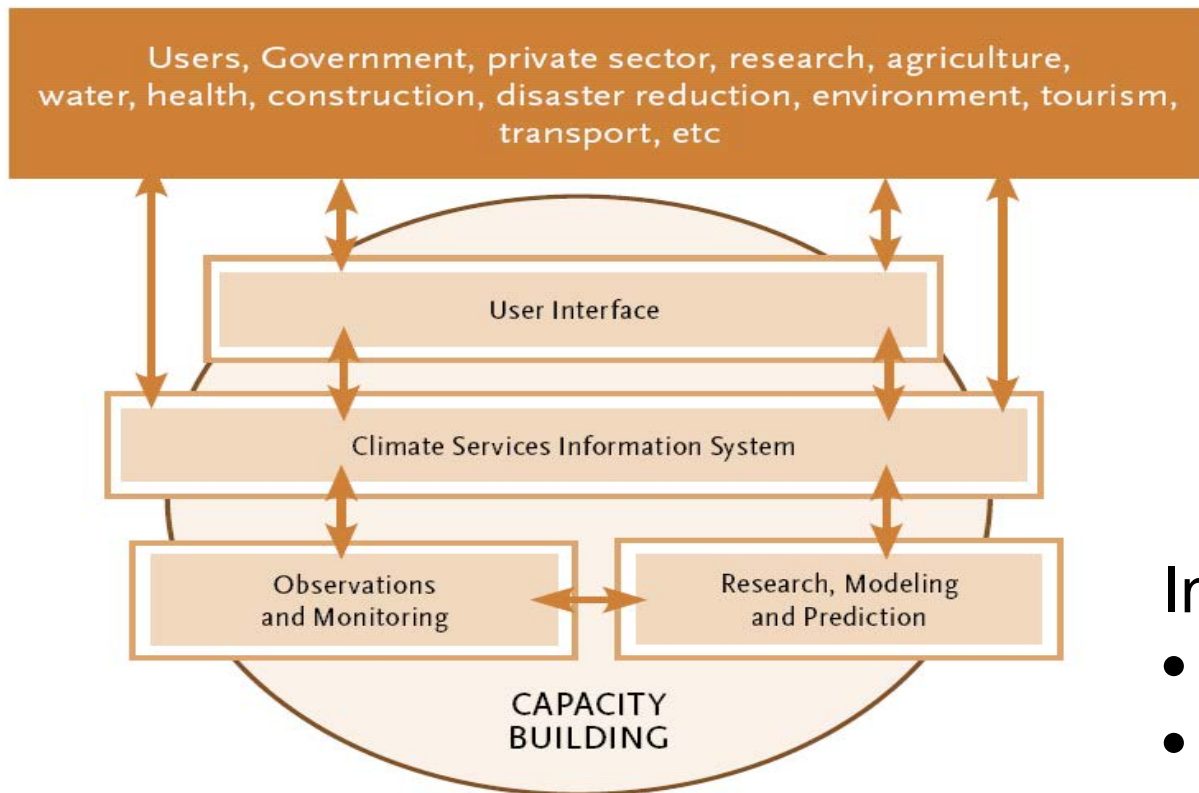
Credit: Presentation by S. Barrell (BoM), On WIGOS, World Met Day 2013



COSPAR/WMO CBW, Tver', Russian Federation, 21 July – 1 August 2014

Weather • Climate • Water

Global Framework for Climate Services: Coordinate to be prepared to adapt



Initial priority areas:

- Health
- Water
- Agriculture
- Disaster risk reduction

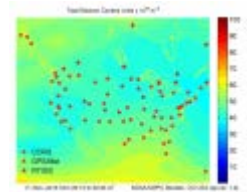
Space weather



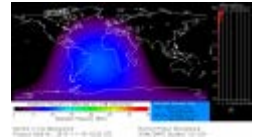
Space Weather

Four domains:

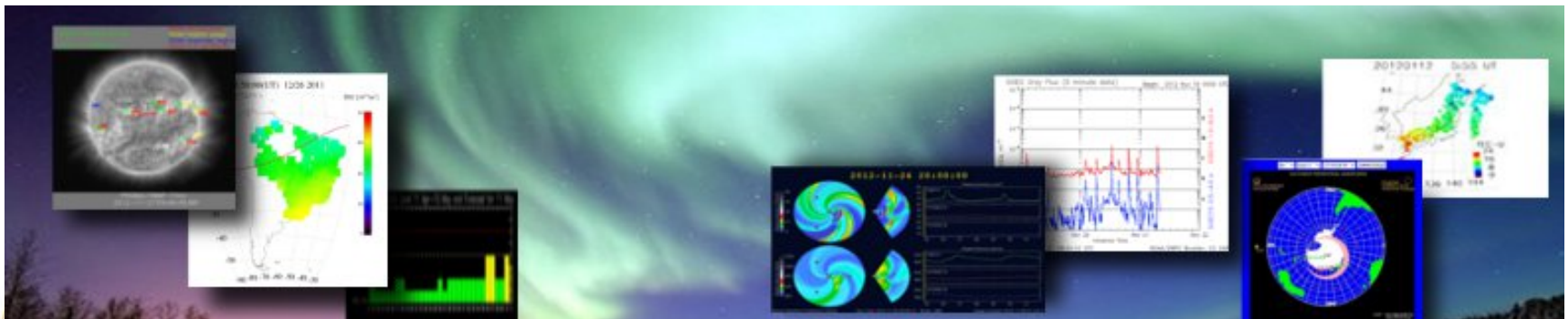
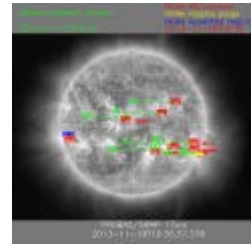
- Ionospheric phenomena
(Total Electron Content, HF comm's)
- Geomagnetic activity, Auroral activity
- Solar and interplanetary phenomena
(Solar wind, cycle, activity)
- Energetic particles



TEC



X-Ray and
Proton forecast



Space weather

Space Weather is important for WMO

- Impact on radio-communications
- Impact on meteorological satellites
- Space Weather-climate linkage
- Potential coupling with Numerical Weather Prediction models

WMO can support Space Weather activities

- Meteorological satellites are flying space weather instruments
 - WMO's 60-year experience in global operational coordination
 - Synergy with met services to aviation, hazard warning, energy ...
- WMO Members decided to engage in « International coordination of **operational** Space Weather observation, products and services, in particular to protect against global Space Weather hazards »
... as part of the WMO Space Programme



SCOPE-Nowcasting



Objectives of SCOPE-Nowcasting

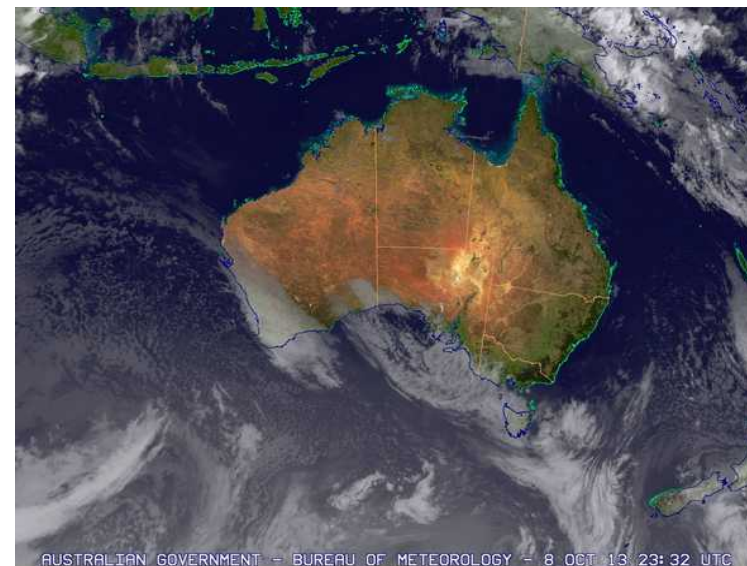
- Continuous and sustained provision of consistent, well-characterized satellite products for nowcasting
- Supporting the forecasting range zero to six hours where current NWP capability is limited.
- Demonstrated by pilot projects
- Achieved through a collaborative network among experts, user institutions and satellite operators, to sustain product generation, dissemination and facilitate user uptake.



User Requirements

Pilot 1: Harmonized basic product suite
in Asia-Oceania

- 4 geostationary operators (to be 5 soon)
 - Multiplicity of products and formats
 - Multiple dissemination mechanisms
- (Needs of Severe Weather Forecasting
Demonstration Projects: SWFDP)



Pilot 2: Quantitative volcanic ash products
(for aviation : VAACs)

Pilot 3: Quantitative precipitation estimates
(High relevance for all WMO applications)

Pilot 4: Sand dust events in Asia



Pilot Project 1: Basic Nowcasting

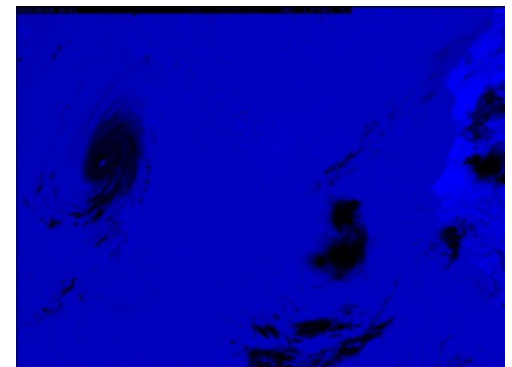
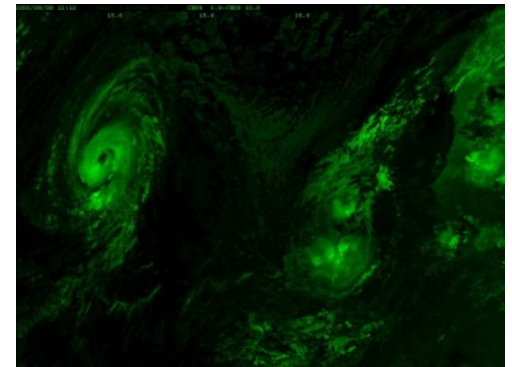
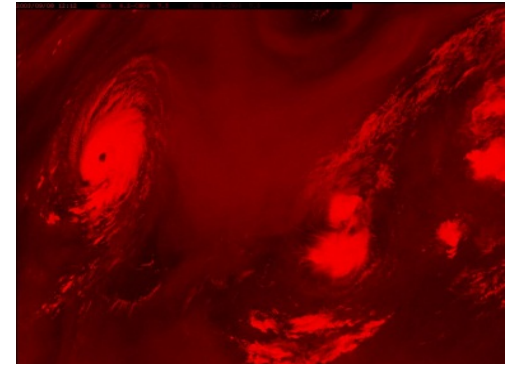
Regionally-consistent RGB composites :

- i. a de facto standard for RGBs has been generated by EUMETSAT and endorsed by WMO
- ii. None of the satellite operators in RA II and RA V currently delivers RGB products in real time
- iii. The next generation of geostationary satellites in the region - Himawari-8, FY-4A and Geo-KOMPSAT-2A – will provide appropriate sources for such products.

SWFDP Project SW Pacific:

- identified key satellite product requirements
- prefer dissemination through internet (SWFDP Project intranet)
- high interest in using RGBs airmass and convection

 **Training required on the use of satellite data**



Responses:

New VLab Strategy 2015-2019



VLab 5-year strategy (2009-2013)

- Initial focus on education and training for satellite meteorology
- To expand to:
 - Climate, Disaster support (e.g., Fires), Marine applications, Land applications, Hydrology, Atmospheric chemistry, air quality, dust, Environment
- Taking advantage of:
 - Technical progress, use of satellite data in combination with radar, NWP, lightning, in-situ obs, Shared resources, New satellite systems, (operational, R&D), Partnerships with other institutes
- Implementation Plan



New VLab Strategy

- Timeframe 2015-2019
- In line with evolving WMO ETR strategy
- Responding to drivers (and more..)
- New strategy required by January 2015, for submission to World Meteorological Congress 2015
- Drafting team required; first draft by Oct 2014

Q:

- Which drivers? More of the same? Consolidation?
- Be more specific (milestones, metrics, maturity)?
- Implementation Plan?



Responses:

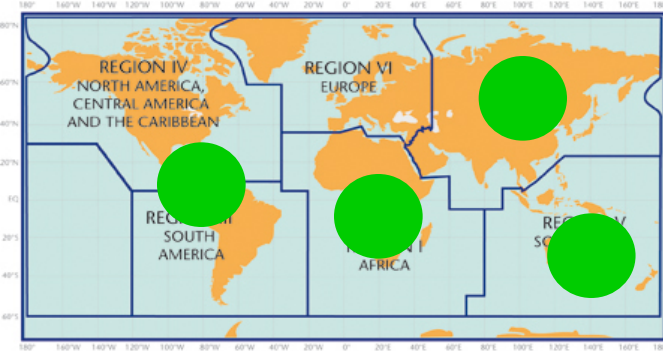
Regional mechanisms



Regional activities

Requirements for Satellite Data Access and Exchange

- ✓ Regional approach to maintaining requirements for satellite data access and exchange
- ✓ In support of all WMO applications
- ✓ Builds on:
 - RA I (Africa): Dissemination Expert Group
 - RA II (Asia): WIGOS Project Coordination Group
 - RA III/IV (Americas): Coordination Group;
 - RA V (SW Pacific): Task Team Sat Utilization
- ✓ Membership: Operational users, Satellite providers, Training centres (VLab CoEs), Scientific users, others



Regional Training Events

- ✓ EUMETSAT 2012 Conf: Training session; follow-up?
- ✓ 4th Asia-Oceania Met Sat Conference: VLab Training Event
- ✓ NOAA Satellite Conference 2013: WMO-NOAA “Train the Trainer” workshop
- ✓ Plans for AOMSUC-5, NSC-2015
- ✓ Must be led by VLab CoEs**

Input?



ET-SUP-7 (2013)

TRAINING EVENT PLANNING

Recommendation 7.3: Regional mechanisms fostering coordination of requirements for satellite data access and exchange should be strengthened by collocating, where possible:

- ***region-based satellite user conferences [NSC, EUM MSC, AOMSUC, UFA];***
- ***regional training events covering current and upcoming satellite systems, enabling users to utilize data from these systems, practical information on data access, visualization and analysis tools, and***
- ***meetings of Regional Satellite Data Requirements Groups.***



Responses:

Online Product Access Guide



Product Access Guide: Motivation

- Many WMO Members have identified the need for guidance on how to access EO satellite product collections online (WMO user survey, 2012)
- Should be based on existing online resources
- Should be in line with the WIS
- Should satisfy user needs for metadata
To assess fitness-for-purpose for applications
- Should include information on:
Expert groups and Training material relevant to products



Product Access Guide

- Links to product collections documented on the internet by providers
- Documentation (metadata) criteria, to optimize guidance for users:

Point of contact	Applicability domain
Product identifier	Geographical region
Providing organization	Resolution
Data source	Update frequency
Access information	Quality indication / documentation

- Developed by WMO in partnership with satellite operators, and other providers
- Maintenance, documentation, data distribution, data policy remains responsibility of providers



Product Access Guide

<http://www.wmo-sat.info/product-access-guide>

Q:

Your feedback regarding the inclusion of training material?



Responses:

New generation of satellites:

COSPAR/VLab Training events

Satellite User Readiness Navigator
(SATURN)



ET-SUP-8 (2014)

COSPAR-VLab collaboration

Possible themes of future COSPAR-WMO workshops

2015: Soil moisture in Africa (considering SMOS, GPM, SMAP, ASCAT, AMSR-2); Include Asia/ Middle East participants? Hosted by Morocco?

2015: Space weather (UKMO taking the lead?)

2016: Ocean dynamics (considering SMOS, Jason, Sentinel-3, Aquarius)

2017: Atmospheric chemistry (considering SAGE III, OCO-2, GOSAT-2, Sentinel 5P)

For each event, it is necessary to identify a champion and a host country (a developing country, as a general COSPAR rule). A one year effort is required for the organization. Also consider new-gen GEOs.

RECOMMENDATION 8.35: VLab to support recording and archiving of workshop material from COSPAR/VLab events.



New generation of satellites: Guidance

- Satellite User Readiness Navigator (SATURN) online portal, with information on :
 - Satellite systems and instruments
 - Products, datasets, distribution methods
 - Test and proxy data, tools
 - Training material
- Developed together with satellite operators/CGMS (as a collaborative blog)
- Currently includes only geostationary satellites
- Regularly updated, work in progress



New generation of satellites: Guidance

CBS Guideline for Ensuring User Readiness for New Generation Satellites (Report CBS-15, 2012)

“operational users [NMHSs] to establish user readiness projects 5 years prior to launch”

“satellite operators to assist users in introduction of new data streams into operations”



New generation of satellites: Guidance

Reference User Readiness Project

- Generic structure to support user readiness planning
- Generic timeline with respect to launch date (-5/-4/-3 years etc.)
- Deliverables for users and satellite operators

Users	Satellite operators
Budget planning, R&D	Operation plans & schedules
Data reception & handling	Instrument characterization
Data processing & visualization	Data access specifications
Training and capacity building	Test data and tools; Software
Contributions to cal/val	User dialogue channels
...	...



Satellite User Readiness Navigator (SATURN)

Online Demo:

<http://www.wmo-sat.info/satellite-user-readiness>

