Coordinating Earth Observations to Better Understand, Mitigate and Adapt to Climate Change

Espen Volden
GEO Secretariat

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OBJECTIVES

• Improved scientific understanding, modelling and prediction of climate

• Availability of Essential Climate Variables (ECVs) needed by WCRP, IPCC, UNFCCC

• Accessibility of all the observational data needed for climate monitoring and services in support of adaptation to climate variability and change

• Global carbon observing and analysis system
Architecture for Climate Monitoring

‘Strategy Towards an architecture for Climate Monitoring from Space’
Joint effort CEOS, CGMS and WMO, Published 2013
Foundation for the Observation and Monitoring Pillar of GFCS

- Architecture explicitly traceable to GCOS Guidelines and Climate Monitoring Principles
- Provides a basis for a systematic end-to-end approach: sensing, data records, applications, policy/decision making
- Could address and link
  - observational requirements (i.e. GCOS)
  - fitness-for-purpose of applications & “services”
Architecture for Climate Monitoring

User driven requirements

Feasibility

Feedback
The ECV concept

CLIMATE SYSTEM VARIABLES
- Observation is feasible
- Observation is cost-effective
- Observation is relevant

ECVs

FOUNDATIONS
- Climate science
- Climate data
- Observational capability and infrastructure

GUIDANCE
- User requirements
- Observing principles and standards
- Guidelines for dataset generation

Sensing
Climate Record Creation
Applications
Decision Making
From sensing to climate record

Proxies

AD 0 1000 2014

Data Recovery, Digitizing, ...

Reanalysis up to last 100 years

Sensing Observations

Climate Record Creation

High quality data records for ECVs
From climate data records to modeling
Modeling

Weather, Climate and Earth-System Prediction Systems *(USA, ECMWF, WCRP, WMO)*

- Tropical Convection (YOTC)
- Subseasonal to Seasonal Prediction (S2S)
- Polar Prediction

Satellite Analysis & Dissemination
Portal to ECMWF Analysis/Forecasts
Easy Access to, and Use of, Climate Information (US, EC & EU, WMO, …)

- Trying to link with more national activities
- Practical guidance for understanding climate data
- Eumetsat/WCRP Symposium

Climate Record Creation  Applications  Decision Making
Carbon Assessments & Budgets
(Australia, China, EC, France, Germany, Italy, Japan, Netherlands, UK, USA, CEOS, ESA, GTOS, WMO)

* Coordinated global carbon observation/analysis system
* Assessment of regional/global carbon budgets
* Ground/space CO2/CH4 measurements
* GEO Carbon strategy
* CEOS Carbon Strategy
The Global Forest Observations Initiative
GFOI ensures the acquisition of core satellite data for 11 countries in 2013 rising to global coverage in 2016.

GFOI reviews and promotes research and development needed to implement national forest monitoring.

GFOI provides capacity building in coordination with others such as UN-REDD. It supports the use of satellite and ground data to monitor forests, estimate carbon stocks and greenhouse gas emissions.

GFOI Methods and Guidance report:
Use of Satellite and Ground data for national forest monitoring and estimation of carbon stocks and greenhouse gas emissions.
Consistent with IPCC Guidelines and UNFCCC requirements as agreed in November 2013 in Warsaw.
Taking Earth's temperature

Like thermometers in the sky, satellite instruments can measure the temperatures of Earth's surfaces. ESA's new GlobTemperature project is merging these data from a variety of spaceborne sensors to provide scientists with a one-stop shop for land, lake and ice temperature data.
Thank you!

evolden@geosec.org

http://www.earthobservations.org
1. Reanalysis projects (ERA-CLIM)
2. 2000-year regional climate reconstruction (IGBP PAGES)
3. GCOS Assessment of the Adequacy of the Global Observing System for Climate
4. Develop physical architecture for Climate Monitoring from Space via ECV inventory population (incl. in-situ data records), gaps analysis and agreed actions & maturity matrix, ESA CCI, WMO SCOPE-CM
5. Subseasonal to Seasonal Prediction (S2S) (improved forecasts, quantified uncertainties, societal applications) & Polar Prediction & YOTC
6. GFCS & Copernicus Climate Service
7. Easier access to, and use of, climate data records and derived information products
8. Eumetsat/WCRP Symposium
GEO Climate: Challenges and issues

- CL-01 Task Team a functioning team
- Clarify WMO-GEO collaboration on GFCS
- Requirements for ECVs need to be revised in order to better address mitigation & adaptation needs at national & local scales
- Requirements for in-situ climate data records to be better specified
- More national climate adaptation activities to be contributed
- Key climate datasets more visible and accessible
- Cross-SBA activities, e.g. Water, Health, Agriculture, Disasters, Energy, Blue Planet, Cold Regions, GEO-GNOME
Bridging Ocean Communities

*(Canada, UK, CEOS, GOOS, IOC, POGO, WMO)*

* “Blue Planet” Initiative*

* GOOS implementation*

* Global/region ocean forecasting systems*

* Ocean-color networks (ChloroGIN, FARO)*

* Applications to fishery and aquaculture*
Advanced Land-Cover Products
(Canada, China, EC, Greece, Japan, Netherlands, Nigeria, Spain, Sweden, UK, USA, Spain, EEA, ESA, GTOS, ISPRS)

* Global 30m products
* Major land cover types (eg. wetland)
* Independent validation databases
* Global Land Cover Portal
* Growing int’l consensus
Cold Regions Monitoring

(Canada, China, Denmark, Germany, Norway, India, Italy, Japan, Spain, USA, ICIMOD, IEEE, WCRP, WMO)

- CryoClim climate monitoring service
- Svalbard Integrated Arctic Earth Observing System
- Sea-ice ECV for Arctic/Antarctic snow-cover
- Focus on Tibetan Plateau
- Glacier dynamics mapping
GEO Climate Target 2015

Achieve effective and sustained operation of the global climate observing system and reliable delivery of climate information of a quality needed for predicting, mitigating and adapting to climate variability and change, including for better understanding of the global carbon cycle.

GEO Members and Participating Organisations should contribute national/international activities related to climate and carbon information production, use, and access; align data policies with the GEOSS Data Sharing Principles; and make the data accessible through the GEOSS Portal.
Free and open data policies

Example: Copernicus Sentinels

Sentinel-1A launched 3 April 2014
C1 Improvement and Extension of the Climate Record. Thorsten Kiefer (thorsten.kiefer@pages.unibe.ch)

• Compilation of proxy data covering the last two millennia
• Systematic comparisons between proxy-data based reconstructions and model simulations.

C2 Accelerated Implementation of GCOS. Carolin Richter (crichter@wmo.int)

• Enhanced capabilities to access, develop, implement and use integrated and interoperable Earth- and space-based observation systems for weather, climate and hydrological observations
• Advance GCOS and Essential Climate Variables (GCOS ECV’s) e.g. building upon feedback from IPCC AR5
C3 Weather, Climate and Earth-System Prediction Systems. Jim Caughey (jim.caughey@gmail.com)

- Completing YOTC in 2014. Project a success, databases established.
- MJO Task Force on-going, also supports Sub-seasonal to Seasonal.

C4 Easy Access and Use of, Climate Information. Glenn Rutledge (glenn.rutledge@noaa.gov)

- Leverage SBA’s, GFCS and others for practical guidance for understanding climate data.
- Advance Middleware Applications and Services to subset, visualize, and access climate adaptation datasets (in-situ, models, and satellite).
- User Engagement development. Develop processes and Use Cases to better define and build requirements to better satisfy users.
Earth is entering a new era

Paleocene?

IPCC Assessment: very likely by 2100

Holocene

Marcott et al. reconstruction
Mann et al. reconstruction
Lacking: Middleware applications to interrogate models; and practical guidance, Use Cases and specific requirements for and from users that are not necessarily climate or computer scientists. For example:

• Climate, Seasonal, and Inter-annual models are readily available yet practical information and use of climate information is lacking¹.

• Practical guidance for the use of: seasonal forecast information (statistical and dynamical models, global historical datasets, ensemble prediction), validation, probabilities, and assessing skill.

• Linkages to, and developing capabilities for accessing and analyzing the utility of historical climate information (observations, reanalysis products, remote sensing and merged analyses) and how they are useful in a decision making context.

¹. Jacobs/Zebiak; 2014: “Online Climate Information Guidebook” Proposal. Board on Global Strategies, AMS USA
Key Requirements

FUTURE REQUIREMENTS FOR OBSERVATIONS AND INFORMATION

• Requirements to be generated to coordinate access to available or developing reference information on approaches to decision-making under uncertainty (e.g. with less than perfect information – how to avoid analysis “paralysis” and focus on what we know, including what we know about extreme events)¹

• Linkages to knowledge of longer term climate projections (IPCC products, indicators, scenario generation and decision applications thru GEOSS.

• Development of user community partnerships and specific use cases and leverage the work of SBA’s and the WMO Global Framework for Climate Services.

• Assist in the development of the GEOSS “Community Portals White Paper” and applications development (IN-05 and AIP-7)

• User access through GEOSS Portal to existing Earth System Grid Federation (ESGF) IPCC model data access networks in coordination with WCRP.
Practical Guidance is needed for the use of Climate data for Stakeholders, e.g.,

- “Guide to Climatological Practices WMO No. 100”

- Board on Global Strategies American Meteorological Society “Online Climate Information Guidebook” (Proposal) 2014: Jacobs/Zebiak

- ODU Mitigation and Adaptation Institute (MARI) (Hans-Peter Plag)

- CEOS WGISS Liaison to GEO
Advance and promote GEOSS User Requirements Registration (URR) (Hans-Peter Plag/ S. Natavi)
Key 2014 Outputs Session 5
FUTURE REQUIREMENTS FOR OBSERVATIONS AND INFORMATION

Advance interactions with GFCS and WCRP

Global Framework for Climate Services (GFCS)

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
Model Output to Decision Making. An Example

Ensemble Probabilities on the fly:
- 21 members (model runs)
- 16 days of forecast
- 6 hrly increments
- Restful based PDF’s in real-time.

NOAA NOMADS Ensemble Probability Tool
Cross-Task Activities (and actions)

• Ensure delivery of the climate information needed for adaptation through the GEOSSWeb Portal.
  – Action: Strengthen linkages between CL-01 and GEOSS Community Portals effort thru SBA’s, IN-05, ID-05 and AIP-7

• Build upon existing “Climate Services” portals.
  – Action: Leverage European Clearinghouse, and USclimate.gov
  – Action: Develop Earth System Grid Federation and WCRP

• Build upon existing frameworks for Climate Services
  – Action: Develop use cases with GFCS, MARI, others
  – Action: Develop access to practical information for adaptation users; identify process to determine key user groups in GEOSS
Challenges, Issues, and Gaps Hindering Progress

- **Revitalized CL-01 Team**
  - Learning curve for C4 Lead (monthly mtgs)

- **Gap between Data and Application of Data**
  - Understandings and Knowledge base and Use Cases lacking

- **User needs- needs addressing**
  - Develop coordinated USER requirements process for models, data, and knowledge thGEOSS
  - Utilize existing efforts to develop climate adaptation Guidance products: U.S. AMS, CFCS, Regional level offices
  - Leverage requirements generation processes: GCOS
ECVs must not be understood as a select group of stand-alone variables; they are part of a wider concept. ECVs are identified based on the criteria of:

- **Relevance**: the variable is critical for characterizing the climate system and its changes;
- **Feasibility**: observing or deriving the variable on a global scale is technically feasible using proven, scientifically understood methods; and
- **Cost-effectiveness**: generating and archiving data on the variable is affordable, mainly relying on coordinated observing systems using proven technology, taking advantage where possible of historical datasets.
Existing Observational Requirements for Climate

GCOS Essential Climate Variables

<table>
<thead>
<tr>
<th>Domain</th>
<th>Essential Climate Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmospheric (over land, sea and ice)</td>
<td>Surface wind speed and direction; precipitation; upper-air temperature; upper-air wind speed and direction; water vapour; cloud properties; Earth radiation budget (including solar irradiance); carbon dioxide; methane and other long-lived greenhouse gases; and ozone and aerosol properties, supported by their precursors.</td>
</tr>
<tr>
<td>Oceanic</td>
<td>Sea-surface temperature; sea-surface salinity; sea level; sea state; sea ice; ocean colour.</td>
</tr>
<tr>
<td>Terrestrial</td>
<td>Lakes; snow cover; glaciers and ice caps; ice sheets; albedo; land cover (including vegetation type); fraction of Absorbed Photosynthetically Active Radiation (FAPAR); Leaf Area Index (LAI); above-ground biomass; fire disturbance; soil moisture.</td>
</tr>
</tbody>
</table>

- Specific requirements for climate observations already exist - Mature
- Process: i.e. periodic update/adequacy cycle is critical
- Includes both Satellite and in-situ
- Includes both “variable” specific requirements and cross-cutting Guidelines & Climate Monitoring Principles
C1 Improvement and Extension of the Climate Record: Thorsten Kiefer (thorsten.kiefer@pages.unibe.ch)

- Local compilation of proxy data covering the last two millennia, to be archived at the World Data Center (WDC) for Paleoclimatology at NOAA in Boulder, Colorado, USA.
- Regional reconstructions of the spatial and temporal variability of climate parameters temperature, precipitation, and pressure over the last 2000 years.
- Systematic comparisons between proxy-data based reconstructions and model simulations.
- Publications (papers) on regional climate variability over the last 2000 years and on methodological issues such as calibrations, data-model comparison, and spatial climate reconstruction.
Key 2014 Outputs C2: Session 5

FUTURE REQUIREMENTS FOR OBSERVATIONS AND INFORMATION

Accelerated Implementation of the Global Climate Observing System

C2 Accelerated Implementation of GCOS CL-01-C2 is Carolin Richter (crichter@wmo.int) and John Bates (NOAA, USA)

• Enhanced capabilities to access, develop, implement and use integrated and interoperable Earth- and space-based observation systems for weather, climate and hydrological observations

• GEOSS Portal access to related environmental and space weather observations, based on world standards set by WMO.

• GCOS, Climate Monitoring Architecture.
FUTURE REQUIREMENTS FOR OBSERVATIONS AND INFORMATION

Weather, Climate and Earth-System Prediction Systems

Lead and POC Jim Caughey (jim.caughey@gmail.com)

• Advance the Year of Tropical Convection (YOTC) programme.- completes in 2014.
• Improvement of the representation of organized tropical convection in models and its effects on the global circulation.
• Development of diagnostics/metrics for robust simulation of the Madden Julian Oscillation (MJO)
• Multi-model diabatic heating experiment and the associated model runs and analysis
• Analysis of specific A-train collocated/CloudSat data sets
• MJO Task Force metrics for global climate models and boreal summer forecasts
• The Subseasonal to Seasonal Prediction (S2S) programme main database for forecasts is now established at ECMWF
• Improved representation of subseasonal to seasonal processes and model physics in Earth System models.
• Better understanding of systematic errors, biases and uncertainties in the subseasonal to seasonal forecast range
• Improved skill and use of subseasonal to seasonal forecasts
Easy Access to, and Use of, Climate Information

Lead and POC Glenn Rutledge (Glenn.Rutledge@noaa.gov)

Key Outputs include Practical Guidance for accessing climate information; and Middleware Applications and Services to subset, visualize, and access climate adaptation datasets (in-situ, models, and satellite).

- Climate, Seasonal, and Inter-annual models are readily available yet practical information and use of climate information is lacking\(^1\).
- Practical guidance for the use of: seasonal forecast information (statistical and dynamical models, global historical datasets, ensemble prediction), validation, probabilities, and assessing skill.
- Linkages to, and developing capabilities for accessing and analyzing the utility of historical climate information (observations, reanalysis products, remote sensing and merged analyses) and how they are useful in a decision context.
- Access to information on Monitoring of climate (remote sensing products, global analyses; their uses and limitations).

FUTURE REQUIREMENTS FOR OBSERVATIONS AND INFORMATION

Lead and POC Glenn Rutledge (Glenn.Rutledge@noaa.gov) P. 2

Key Outputs include Practical Guidance for accessing climate information; and Middleware Applications and Services to subset, visualize, and access climate adaptation datasets (in-situ, models, and satellite).

• Reference information on approaches to decision-making under uncertainty (e.g. with less than perfect information — how to avoid analysis “paralysis” and focus on what we know, including what we know about extreme events)¹

• Linkages to knowledge of longer term climate projections (IPCC products, indicators, scenario generation and decision applications thru GEOSS.

• Provide access to satellite, observations, and model output for users on all skill levels.

• Advance interactions and collaborations the WMO Global Framework for Climate Services and WCRP

• Develop, and Advance the GEOSS Community Portals paper — collaboration with IN-05 and AIP-7.

• User access to existing and developing Earth System Grid Federation (ESGF) IPCC model output data in coordination with WCRP.