OGC Standards and Climate Monitoring, Modeling, and Data Sharing

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Climate and Weather: Global challenges

Across multiple domains

Use cases:
- wildfires
- severe weather warning service
- hurricanes
- plume forecasting - emergency response
- sustained polar science campaign
- current aviation
- winter highways maintenance
- riverine flooding forecasting
- future aviation
- climate assessment

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Over the next decade the global scientific community must take on the challenge of delivering to society the knowledge and information necessary to assess the risks humanity is facing from global change and to understand how society can effectively mitigate dangerous changes and cope with the change that we cannot manage.
Climate affects us all in many ways!
The Open Geospatial Consortium

Not-for-profit, international voluntary consensus standards organization; leading development of geospatial standards

- 475+ members and growing
- 38 standards
- Hundreds of product implementations
- Broad user community implementation worldwide
- Alliances and collaborative activities with ISO and many other SDO’s
Basic Geospatial Interoperability Challenge Solved

Hundreds of thousands of maps and datasets accessible through close to 10,000 servers running OGC Web Services

OGC Web Services
Web Map Servers (WMS)
Web Feature Servers (WFS)
Web Coverage Servers (WCS)

OpenIOOS.Org
OneGeology.Org
NSDI - India GeoPortal Map Viewer
Skyview2, Eurocontrol

http://www.opengeospatial.org/standards

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OGC Climate Integration Plugfest

• Standards-based interoperability for climate change analysis

• Deployed network of data services (WCS, WFS, SOS), analysis services (WPS, WCPS, WMS), and geospatial client applications that exercise those services

Participants

52 North  Australia Bureau of Meteorology (BoM)  CSIRO

ERDAS  ESRI  OpenGeo  Jacobs University  lat/lon  Lisasoft

UK Science & Technology Facilities Council (STFC)

US National Center for Atmospheric Research (NCAR)


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OGC Standards used in Climate Science, Monitoring, and Modeling
OGC Web Services Standards used in Climate applications

- Catalogue (CSW)
- Geography Markup Language (GML)
- KML
- NetCDF
- Observations and Measurements
- SensorML
- Sensor Observation Service (SOS)
- Web Coverage Service (WCS)
- Web Feature Service (WFS)
- Web Map Service (WMS)
- Web Processing Service (WPS)
Geospatial Processing, Analysis, Workflow

Web Processing Service – WPS
• OGC Web Service access to algorithms
• Change detection, coordinate transformation, modeling and simulation...

OGC®
OGC network Common Data Form (netCDF)

• A data model and a collection of access libraries for array-oriented scientific data.

• Source: University Corp. for Atmospheric Research (UCAR)

• Designed for fluid earth systems (FES)

• A de facto standard used around the world.
  – For example, output datasets from climate models being used for the Fifth Assessment Report of the Intergovernmental Panel on Climate Change must be submitted in netCDF format, using the associated Climate and Forecast (CF) metadata conventions (CF-netCDF).

• Became an OGC standard in 2011.
CF-NetCDF

- FES world is characterized by a set of parameters (e.g., pressure, temperature, wind speed) that vary as continuous functions in 4-dimensional space and time. The behavior of the parameters in space and time is governed by a set of partial differential equations.
OpenMI – a mature standard to integrate models

Models are linked though so called “Linkable Components” with each other.

The “linkable component” can contain temporal and/or spatial (such as point or polygon) structures.

“Linkable components” have bidirectional interfaces, the so called “Exchange Item”

A model chain is executed by its’ last model. The triggered model calls all other models and receives at the end the expected product.
NASA Center for Climate Simulation
Supercomputing Environment

Supported by HQ’s Science Mission Directorate

1 Discover Linux Supercomputer, June 2013:
- Intel Xeon nodes
  - ~3,200 nodes
  - ~42,100 cores
- Peak ~624 TFLOPS general purpose
- 97 TB memory (2 or 4 GB per core)
- Coprocessors:
  - Intel Phi MIC
    - 480 units
    - ~485 TFLOPS
  - NVIDIA GPUs
    - 64 units
    - ~33 TFLOPS
- Shared disk: 7.2 PB

2 Dali and Dali-GPU Analysis
- 12- and 16-core nodes
- 16 GB memory per core
- Dali-GPU has NVIDIA GPUs

3 Dirac Archive
- 0.9 PB disk
- ~70 PB robotic tape library
- Data Management Facility (DMF) space management

4 Data Portal Data Sharing Services
- Earth System Grid
- OPeNDAP
- Data download: http, https, ftp
- Web Mapping Services (WMS) server

5 JIBB
- Linux cluster for Joint Center for Satellite Data Assimilation community

NCCS User Forum, Sep. 24, 2013
NCAR’s GIS portal and Community Climate System Model (CCSM3)

- One of the global climate model included in the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC). Uses NetCDF, WMS, KML, WCS. Model driven by scenarios

SRES scenario B1 is a lower end emissions scenario. Scenario B1 assumes:
- population that peaks in the mid-century and declines thereafter
- rapid changed in economic structures
- introduction of clean and resource-efficient technologies

The map of the winter season's total precipitation anomaly for the near term for scenario B1

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ADAGUC software

- ADAGUC is a geographical information system to visualize netCDF files via the web. Implements OGC WMS, WFS, and WCS.
Infrastructure project of the European Network for Earth System Modelling (ENES)

- climate4impact portal, oriented towards climate change impact modellers, impact and adaptation consultants, as well as other experts using climate change data. Implements OGC WMS, WPS,
Climate Science Markup Language (CSML)

- CSML is a standards-based data model and GML application schema for atmospheric and oceanographic data.

```
csmi:ProfileFeature
  (e.g. CTD cast OR RadioSonde)

+ location
+ time
+ domain (heights, pressure levels)
+ rangeset (measured values)
+ phenomena (salinity, temperature)

+ operationExtractProfile(...) 
+ operationExtractPoint(...) 
```
Not just climate monitoring but modeling of impacts related to climate change
Species Presence with Climate Change
GEOSS Architecture Implementation Pilot

• Observations of pika over the last 20 years, plus modeling systems, to model pika distributions change with climate. Interoperability experiment to determine valuable predictors for the impact of climate change on biodiversity. Area of interest: US Great Basin.
GEOSS Model Web using OGC Services

The Impact of Climate Change on Pikas Regional Distribution

GEOSS Architecture Implementation Pilot Phase 2
Climate Change and Biodiversity Working Group

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US National Snow and Ice Data Center (NSIDC)

- Long time commitment to the use of OGC standards.
  Currently implement WMS, WFS, WCS, GML, NetCDF
GEOSS Demo at GSDI-9, Chile: Effect of drought on poverty

Data/policy analyst monitoring populations that may be at risk from drought
Cross domain use case

• UC11: Riverine Flood Forecasting using Meteorological Ensemble Forecasts

• Few people are interested in weather itself, it’s the impacts of weather that are the concern

• How do we integrate weather and climate information into the hydrology domain?

• Cross-domain engagement with OGC Met Ocean and Hydrology Domain Working Groups

Slides courtesy of Jeremy Tandy, UK Met Office

- Assessing energy production potential for photovoltaic and solar thermal heating. Required investments and achievable CO2 reductions have been computed for each of the 550,000 buildings based on the roof surface segments, and were added to the 3D city model.
ESFRI Environmental Research Infrastructures

- Tropospheric research aircraft
- Upgrade of incoherent SCATter facility
- Multidisciplinary seafloor observatory
- Plate observing system
- Global ocean observing infrastructure

- Aircraft for global observing system
- Integrated carbon observation system
- Biodiversity and ecosystem research infra
- Svalbard arctic Earth observing system

COPAL  EISCAT-3D  EMSO  EPOS  EURO-ARGO

IAGOS  ICOS  LIFEWATCH  SIOS
Increasing pressure to monitor, model, and preserve knowledge

Indian Ocean governments to collaborate on rescuing climate data

Recognizing the need to accelerate the recovery of the region’s large volume of invaluable historical climate records, governments meeting this week in Maputo, Mozambique have decided to establish the Indian Ocean Data Rescue (INDARE) initiative.
Thank you for your participation!

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• http://gosic.org/gcos

• http://www.euro4m.eu/datasets.html
