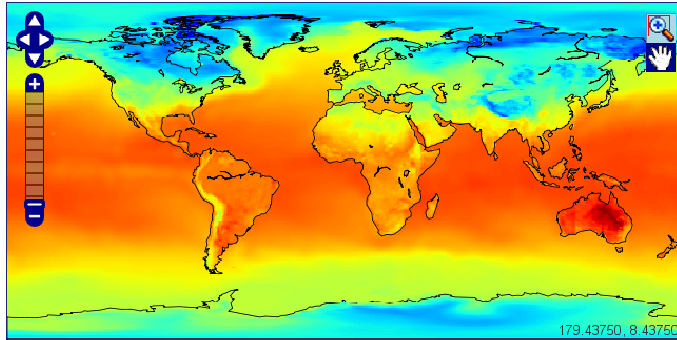# Delivering Multiple OGC Service Types from a Single Climate Science Domain Model

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2nd workshop on the use of GIS/OGC standards in meteorology, Toulouse,
23rd - 25th November 2009

Also: Phil Kershaw, Bryan Lawrence, Stephen Pascoe (BADC), Andrew Woolf (STFC E-Science Centre).

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Overview

- CSML: Climate Science Modelling Language
- COWS: CEDA OGC Web Services Framework
- Mapping CSML to OGC

CEDA = Centre for Environmental Archival

Motivation behind CSML
Climate Science Modelling Language

- "A key goal of Grid technologies is to facilitate virtualisation of resources."

- "Essential semantic behaviour and content is abstracted from low-level implementation."

- "Heterogeneous platforms and implementations should be encapsulated behind interfaces with common syntax and semantics."

- "Low-level resources may then be composed into higher-level services."

CSML Feature Types

Set of 13 Feature Types for the Climate Sciences developed at STFC/BADC

Weakly typed: e.g. Profiles, PointSeries, GridSeries. Not: "TemperatureProfile"

UML model
GML
Application
Schema

csml:ProfileFeature
(e.g. RadioSonde OR CTD cast)

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

+ **operation**ExtractProfile(...)
+ **operation**ExtractPoint(...)

Oceanography

Atmospheric Science

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Feature type	Description	Example
PointFeature	Single point measurement.	raingauge measurement
PointSeriesFeature	Time-series of single datum measurements at a fixed location in space.	tidegauge, rainfall timeseries
TrajectoryFeature	Measurement along a discrete path in time and space.	surface salinity along a ship's cruise track; atmospheric aerosols along an aircraft's flight path
PointCollectionFeature	Collection of distributed single datum measurements at a particular time	2m temperatures measured at weather stations across the UK at 0600z.
ProfileFeature	Single 'profile' of some parameter along a vertical line in space.	wind sounding, XBT, CTD, radiosonde
ProfileSeriesFeature	Time-series of profiles on fixed vertical levels at a fixed location	vertical radar timeseries, thermistor chain timeseries
RaggedProfileSeriesFeature	Time-series of unequal-length profiles, but on fixed vertical levels, at a fixed location	repeat daily balloon soundings of atmospheric temperature from the same location
SectionFeature	Series of profiles from positions along a trajectory in time and space.	shipborne ADCP
RaggedSectionFeature	Series of profiles of unequal length along a trajectory in time and space	marine CTD measurements along a ship's cruise track
ScanningRadarFeature	Backscatter profiles along a look direction at fixed elevation but rotating in azimuth	weather radar
GridFeature	Single time-snapshot of a gridded field.	gridded analysis field
GridSeriesFeature	Time-series of gridded parameter fields	numerical weather prediction model, ocean general circulation model
SwathFeature	Two-dimensional grid of data along a satellite ground-path	AVHRR satellite imagery

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CSML Storage Descriptors

- Inline XML not practical for large datasets

- CSML defines Storage Descriptors

```
<NetCDFExtract id="FQnsm5Gg">
 <arraySize>24</arraySize>
 <fileName>/badc/sw/data/SeaWiFS_2009001.nc</fileName>
 <variableName>time</variableName>
</NetCDFExtract>
```
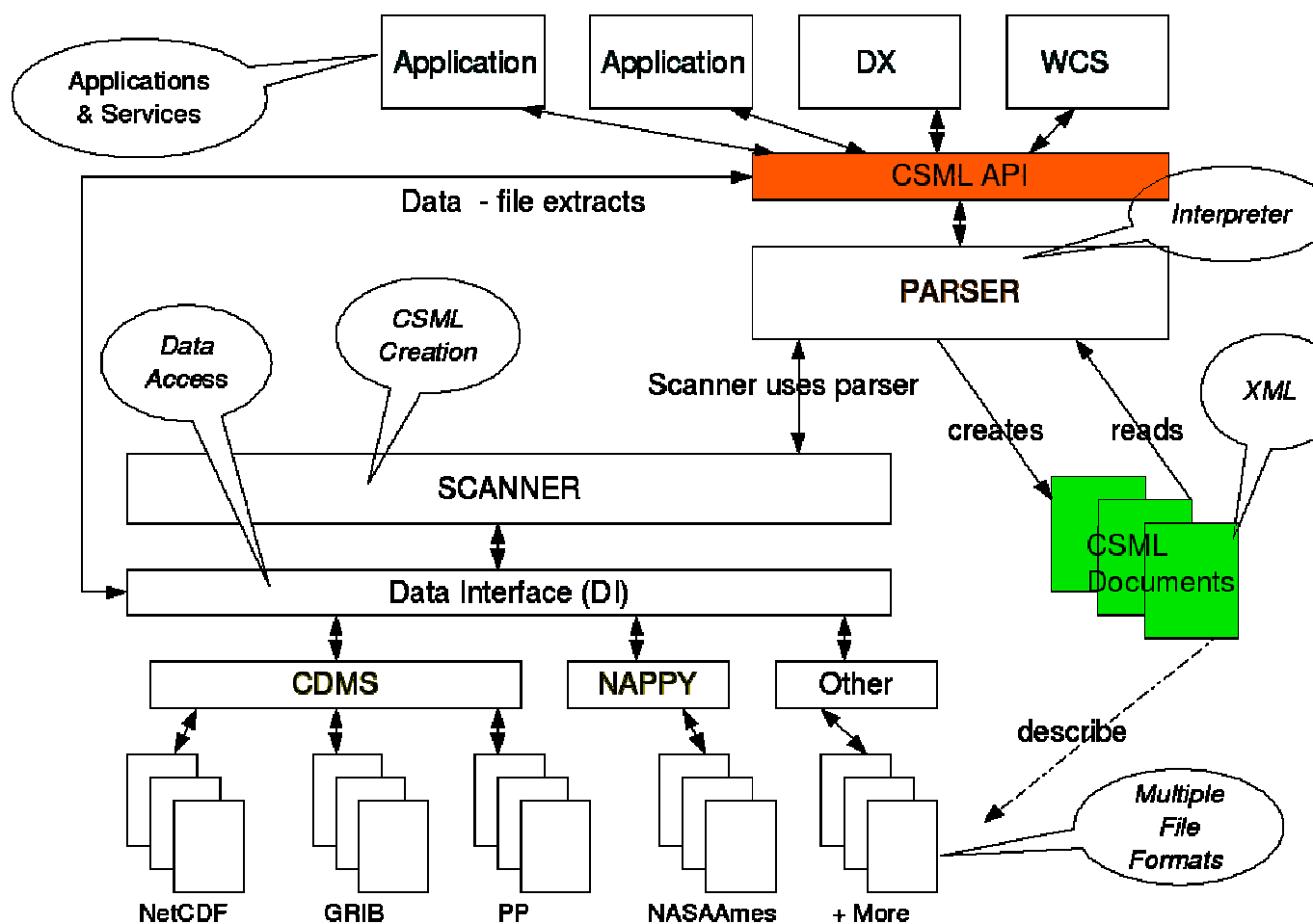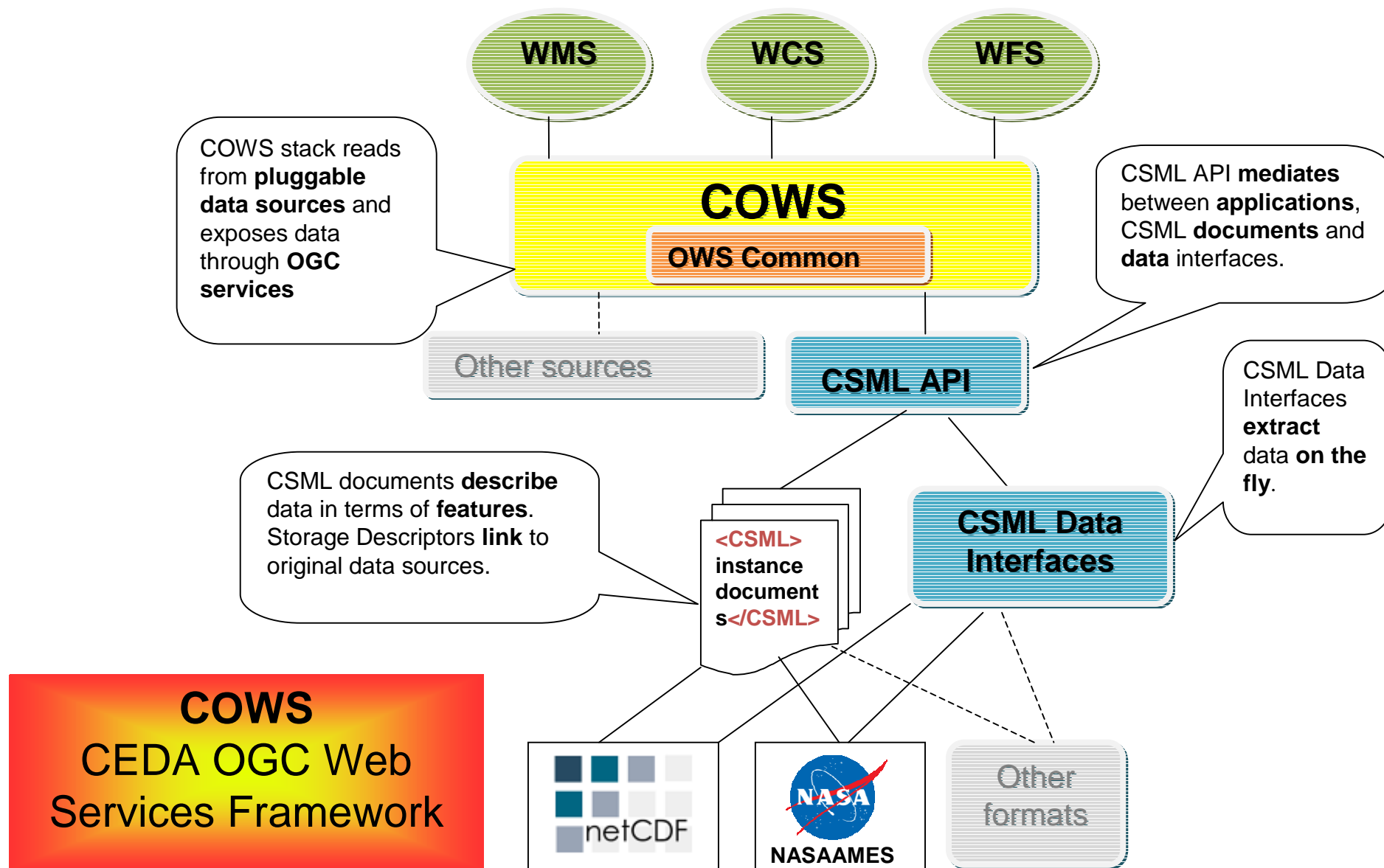
- Also supports aggregated arrays

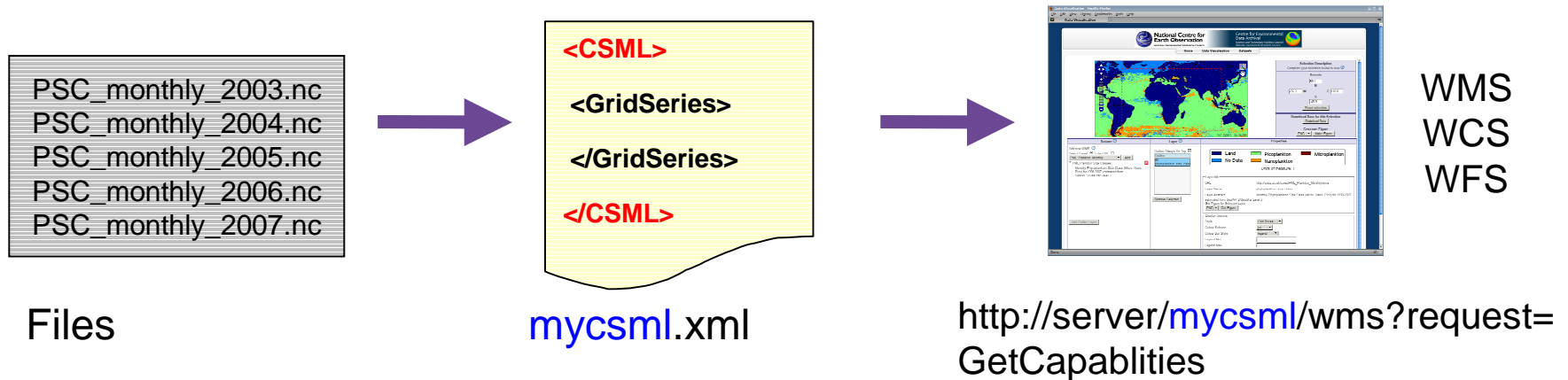# CSML Tools – Virtualising data

COWS (CEDA OGC Web Services) Framework

- Open Source Python (Installed as Python Eggs)
- Uses Pylons Web Framework.
- Supports WSGI (Python Web app interfaces)
  - Enables integration with security layer
  - Security filters OGC requests and request authorisation (via OpenID or organisational login)
- OGC URLS and Capabilities documents are built on the fly from backend (CSML or other)
- Defines interfaces to backend data sources.
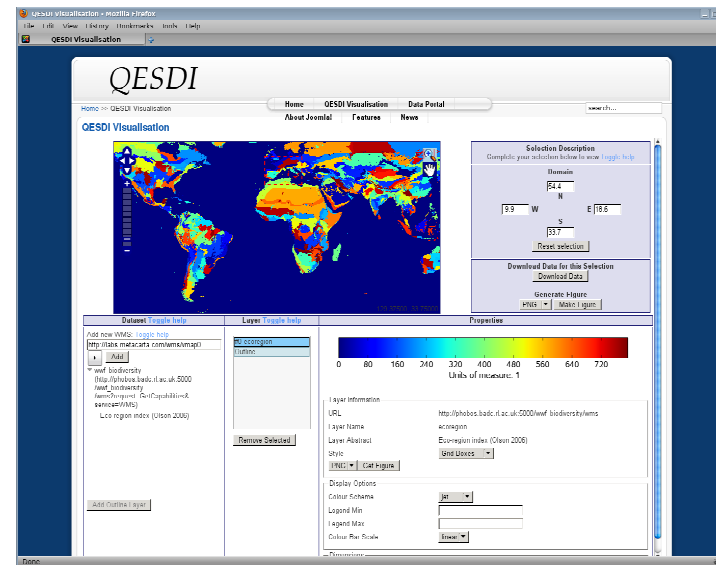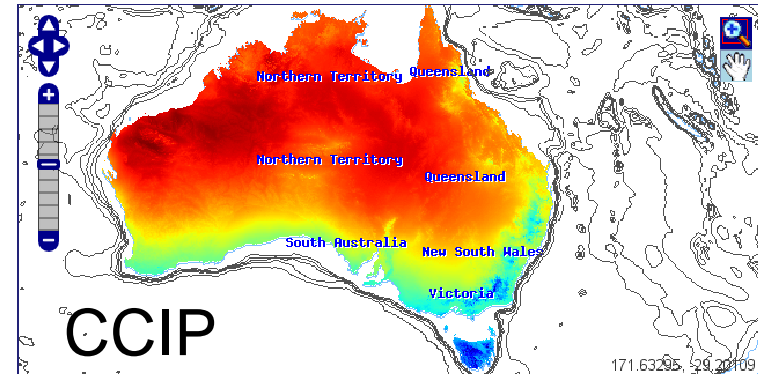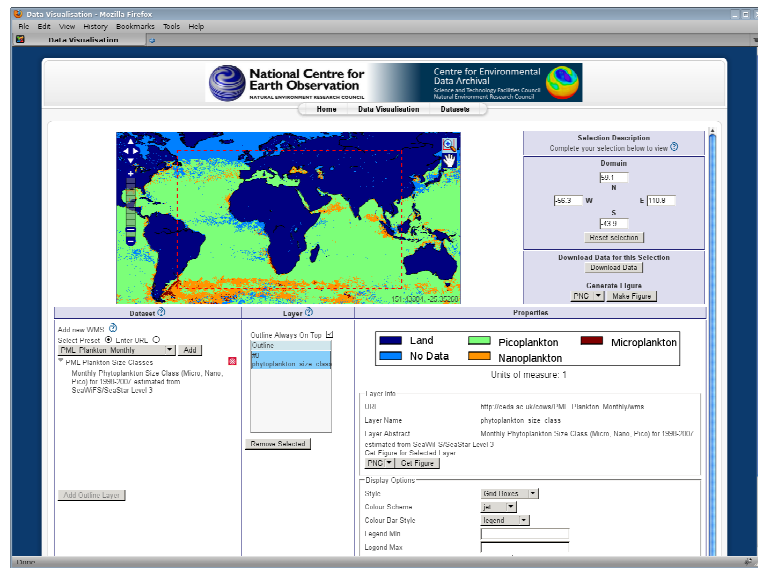
OGC services on the fly

1. Run 'csmlscan' tool on dataset.

2. Expose CSML file to COWS application.

3. OGC capabilities generated on the fly from CSML documents. (Semantics help here!)

Files	mycsml.xml	

PSC_monthly_2003.nc
PSC_monthly_2004.nc
PSC_monthly_2005.nc
PSC_monthly_2006.nc
PSC_monthly_2007.nc

Files

\<CSML\>

\<GridSeries\>

\</GridSeries\>

\</CSML\>

mycsml.xml

WMS
WCS
WFS

http://server/mycsml/wms?request=
GetCapablities

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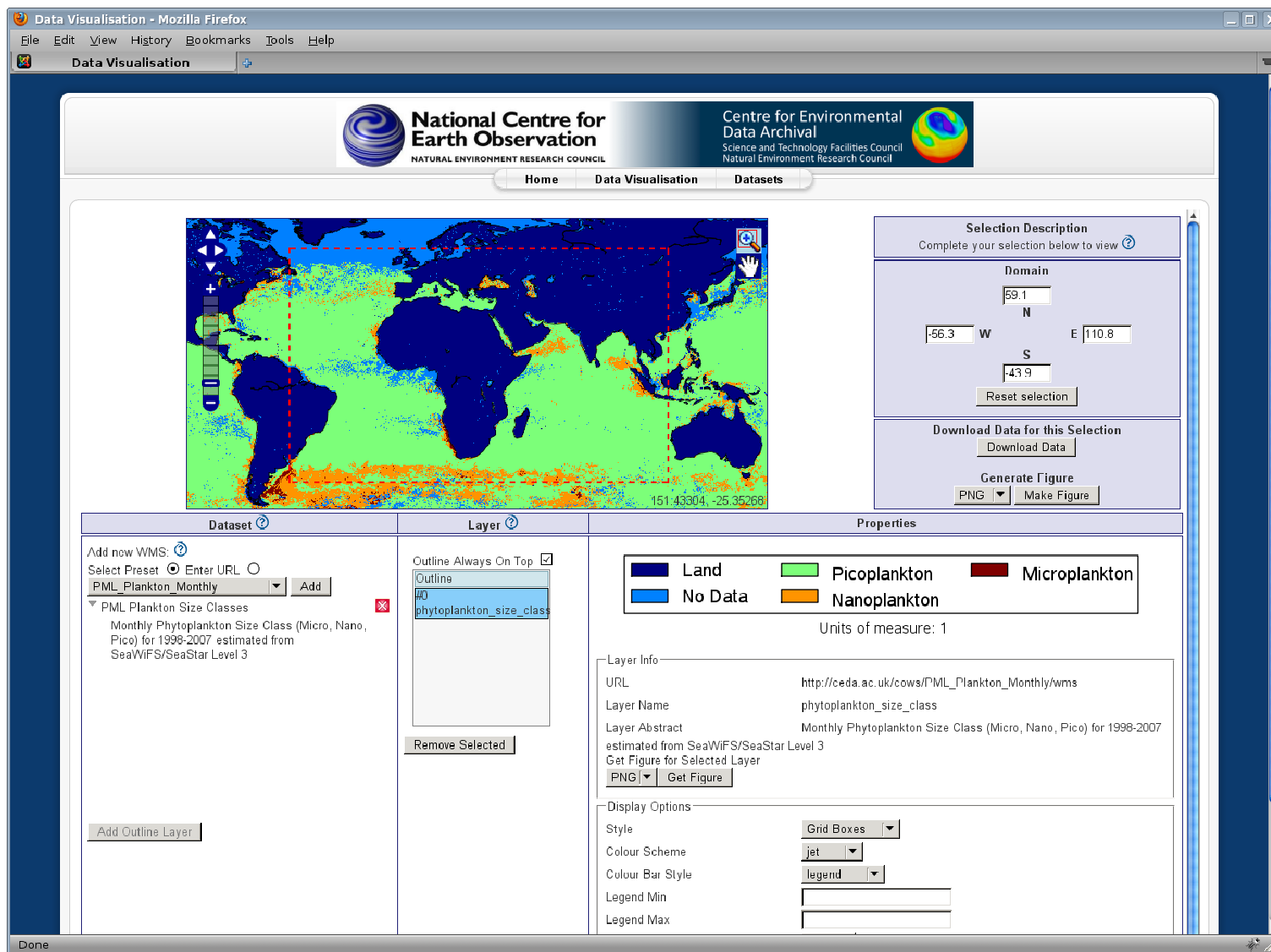
CSML to WMS mapping

- Dataset
  - Features
  - Coverage Info
- GridSeries.subsetToGridSeries()
  - Render the result
- Other feature types could be supported

- GetCapabilities (endpoint)
  - Layers
  - Bbox/Temporal info
- GetMap()

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WMS – client & server

CCIP

QESDI

Open mechanism:

http://cowsclient?endpoint=http://yourwms?request=...

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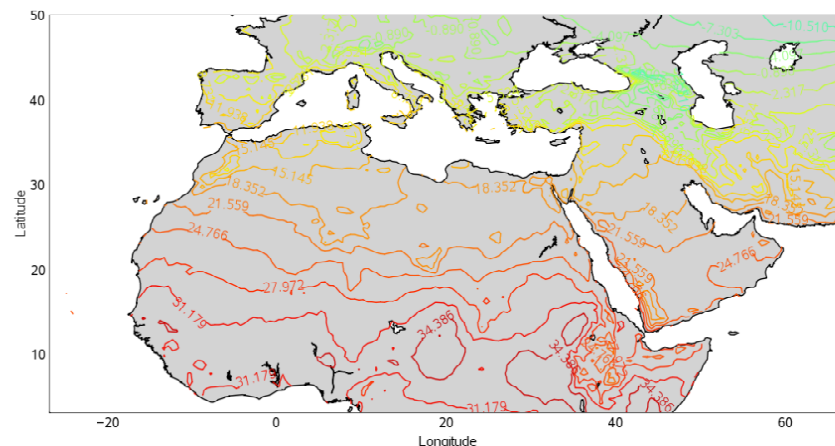NATURAL ENVIRONMENT RESEARCH COUNCIL

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WMS server & client have configurable 'extras'
(that don't break the core standard)

- Legend styles
- Legend min max
- Climatology time selections
- Colour maps
- Line thicknesses
- Logarithmic Scales
- Contour Maps
- Publication Plots

Dimensions

time

Climatology, 1998-2007 April

Display Options

Style	Grid Boxes
Colour Scheme	bone
Legend Min	
Legend Max	
Colour Bar Scale	linear
	linear
	log

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CSML to WCS mapping

- Dataset
  - Features
  - Coverage Info

- More feature info...

- GridSeries operation
  - subsetToGridSeries()

- GetCapabilities() (endpoint)
  - Coverages
  - Bbox/Time info

- DescribeCoverage()
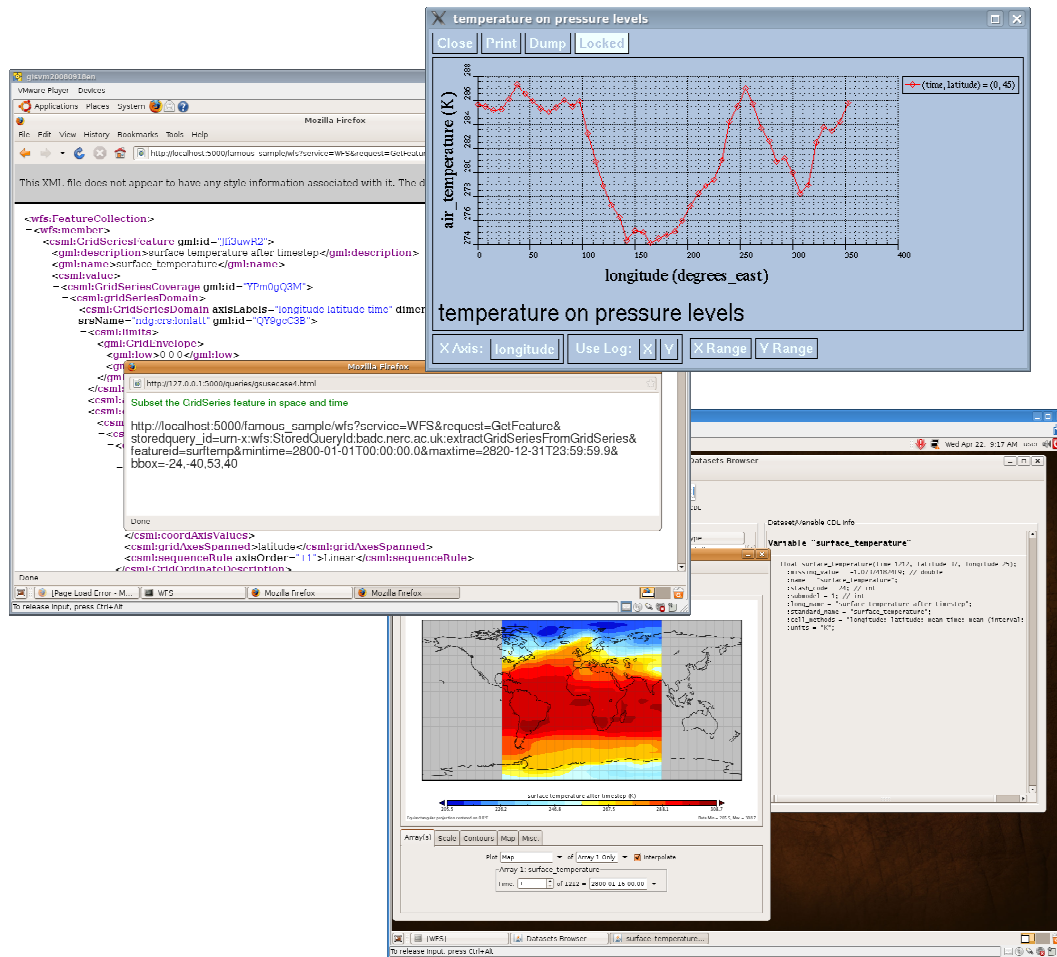
- GetCoverage()

WCS

- WCS Server
- Generic WCS Client
- GUI built on OWSLib

- Large datasets?
  - CMIP5 == 1PB
- WPS integration?

WFS 2.0

- WFS 2.0 (ISO 19142)
- WFS endpoints from CSML docs
- AdditionalObjects >> Binary
- StoredQueries:
  - Feature Operations
  - e.g. ExtractPointSeries()
  - Defined in Domain Model

To Do

Write a WFS client app

http://epubs.cclrc.ac.uk/bitstream/3245/WFS-CSML.ppt

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CSML to WFS 2.0 mapping

- csml:FeatureCollection
  - Feature Types
- Bbox/temporal cvg info
- feature.operations
- FileExtract
  - NetCDFExtract

- wfs:FeatureCollection
  - available types
- Spatial Temporal FILTER
- StoredQuery
- AdditionalObjects

Summary

- **Agreed domain model:**
  - Provides consistent interfaces at data level
  - Defined operations (e.g. subsetting)
  - Removes complexity from end use applications
  - Simplifies adding new data to frameworks
- **COWS builds OGC services on domain model concepts:**
  - GridSeries (WMS, WCS)
  - Other Feature Types (WFS)
    - Can now link to binary (or other objects) through WFS.
  - OGC Services built on the fly
  - CSML greatly simplifies mapping to service endpoints
- **Future COWS work: WFS Client development**
  - WFS 2.0 Stored Queries very flexible - mirrors domain operations
  - CSML-aware WFS client: better, tailored interface