Climate Data for Non-experts: Standards-based Interoperability

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Working Together on A Mosaic for Atmospheric Data

Acronym Glossary

- GALEON (Geo-interface for Air, Land, Environment, Oceans NetCDF)
- FES (Fluid Earth Systems, aka “metoceans” mainly the data systems of the atmospheric and ocean sciences)
- http://www.unidata.ucar.edu/content/publications/acronyms/glossary.html

Outline

- Challenge: make climate data understandable beyond the climate science community
- Weather data lessons learned: different ways of thinking about data
- Interoperable data systems enable use of familiar and appropriate tools
- Model output: multi-dimensional grids
- Verifying models with observations
- Existing tools in different communities
- Transformations: data are often not available in the right form
- References

Other Communities

- Experts in other disciplines
- Impacts on society and infrastructure
- Decision makers
- Educators at all levels
- The general public
- The GIS (Geographic Information System) community in general

Organizations and Projects Addressing Interoperability for Climate Data

- OGC (Open Geospatial Consortium -- establishing netCDF data model, encoding, Climate and Forecast Conventions as international standards
- GEOSS (Global Earth Observing System of Systems): Climate and Biodiversity focus
- MetOceans Domain Working Group within the OGC defining climate data use cases
- CCLI (Climate Challenge Integration Project) associated with the Free and Open Software for Geosciences (FOSS4G)
- Looking to NCAR, UCAR, Unidata for contributions and sometimes leadership

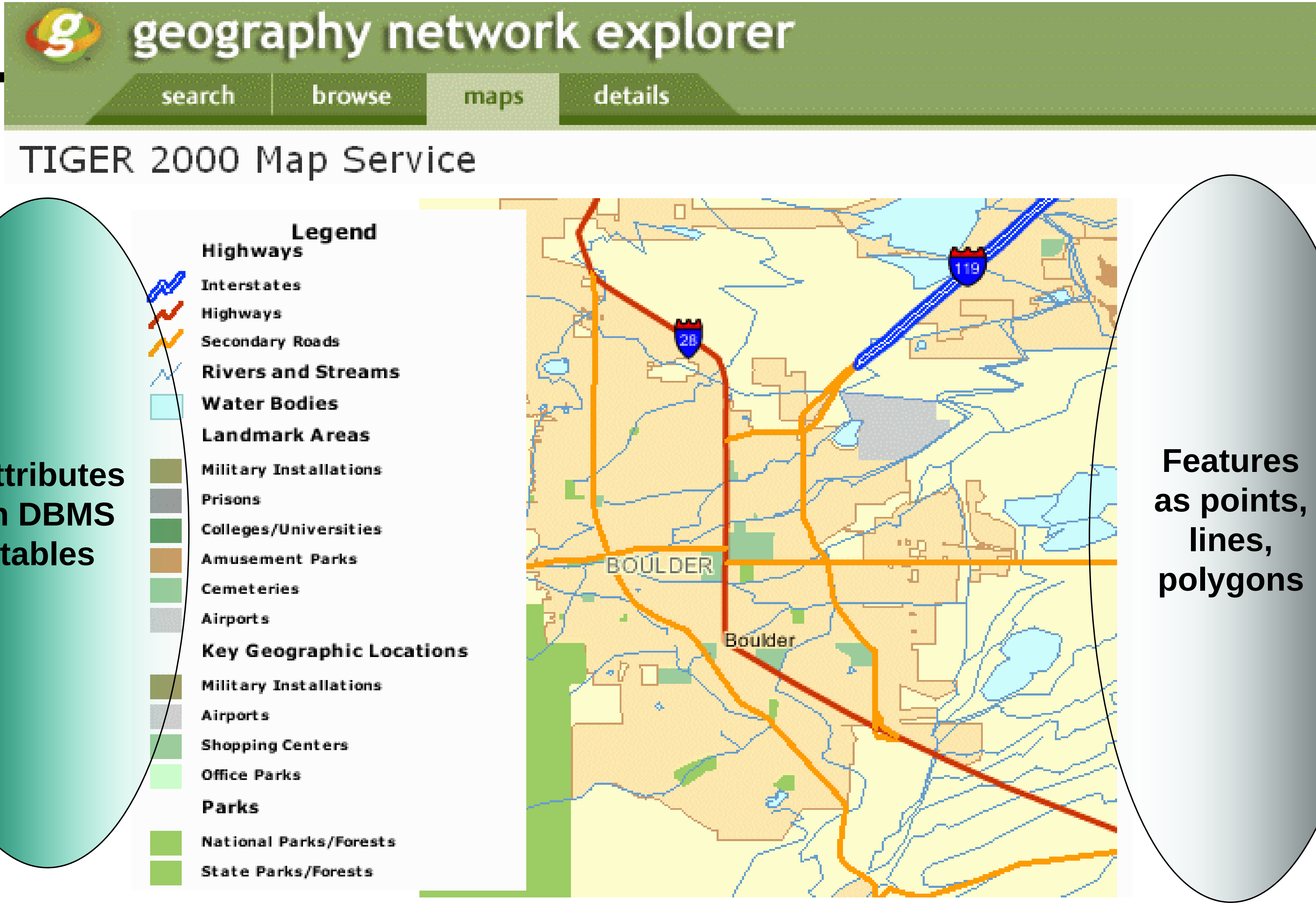
The Challenge of Disparate Data Models: Different Ways of Thinking about Data

- To the GIS (includes solid earth and societal impacts) community, the world is:
  - A collection of static *features* (e.g., roads, lakes, plots of land) with geographic footprints on the Earth (surface).
  - The *features* are discrete objects with attributes which can be stored and manipulated conveniently in a **relational database.**

- To the fluids (atmosphere and oceans) communities, the world is:
  - A set of *parameters* (e.g., pressure, temperature, wind speed) which vary as continuous functions in 3-dimensional space and time.
  - The behavior of the *parameters* in space and time is governed by a set of **equations.**
  - Data are simply discrete points in the mathematical function space.
- Each community is making progress in understanding and adapting to needs and strengths of the other. Progress areas will be highlighted

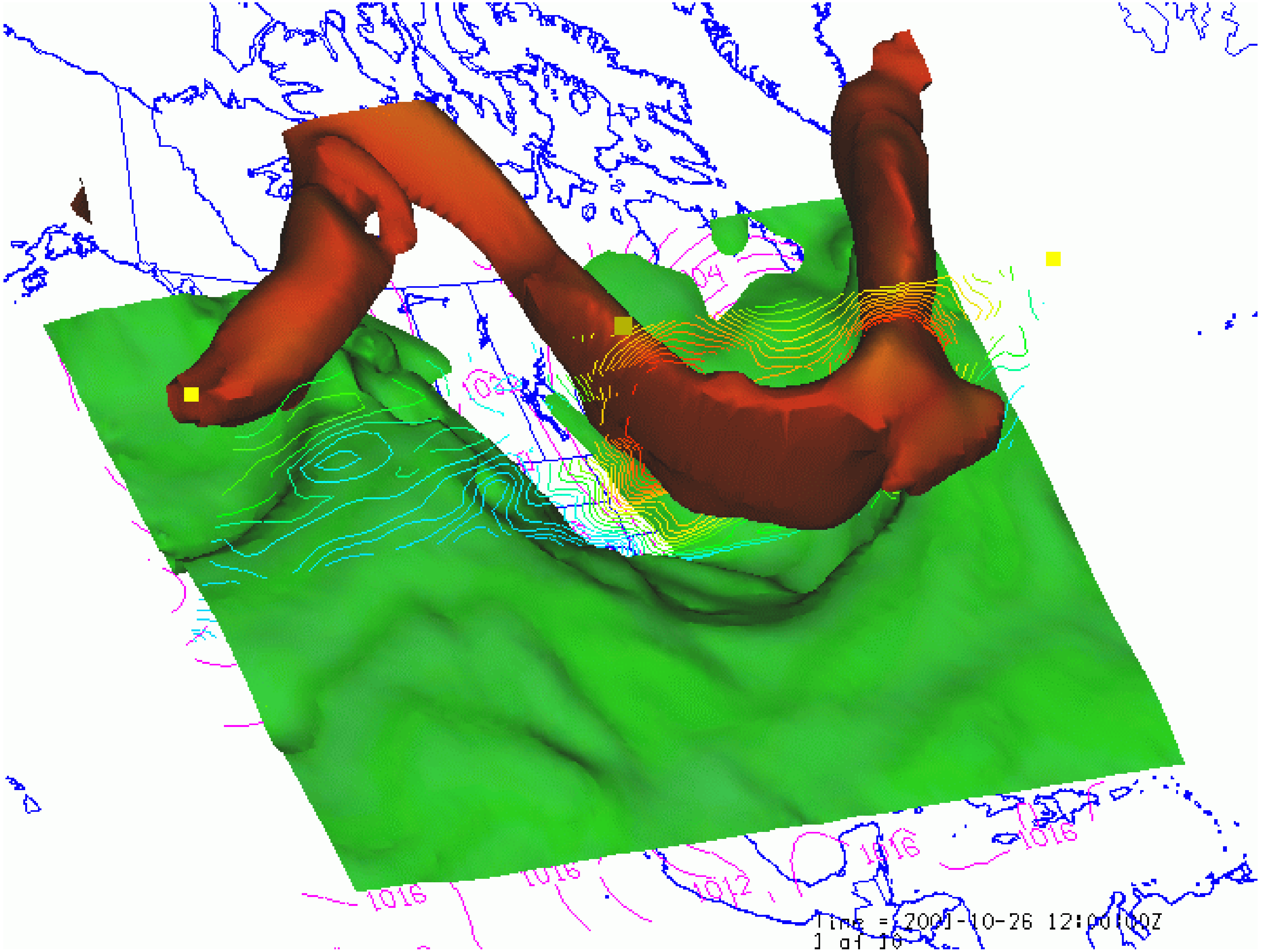
Traditional GIS view

Attributes in DBMS tables

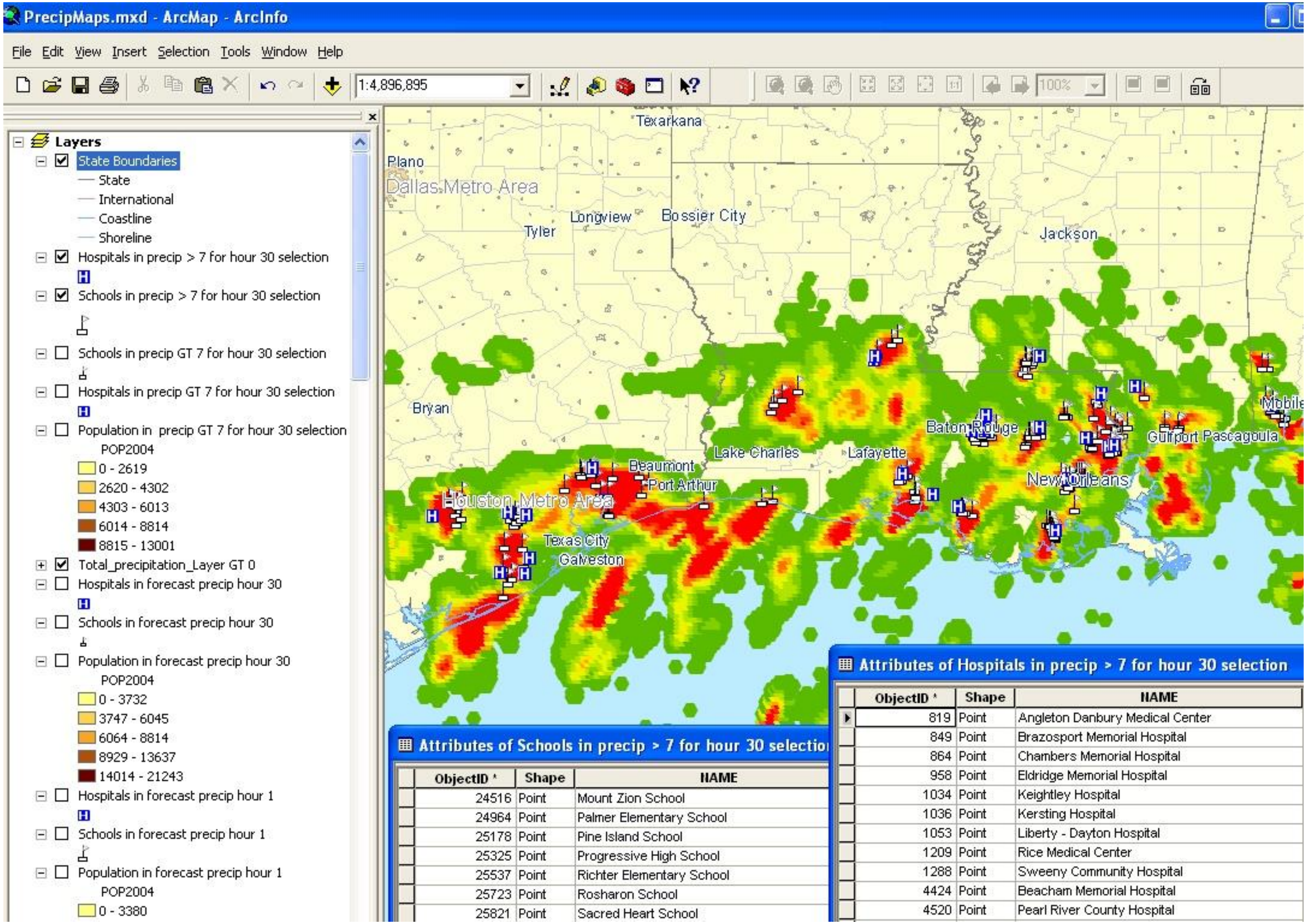


Features as points, lines, polygons

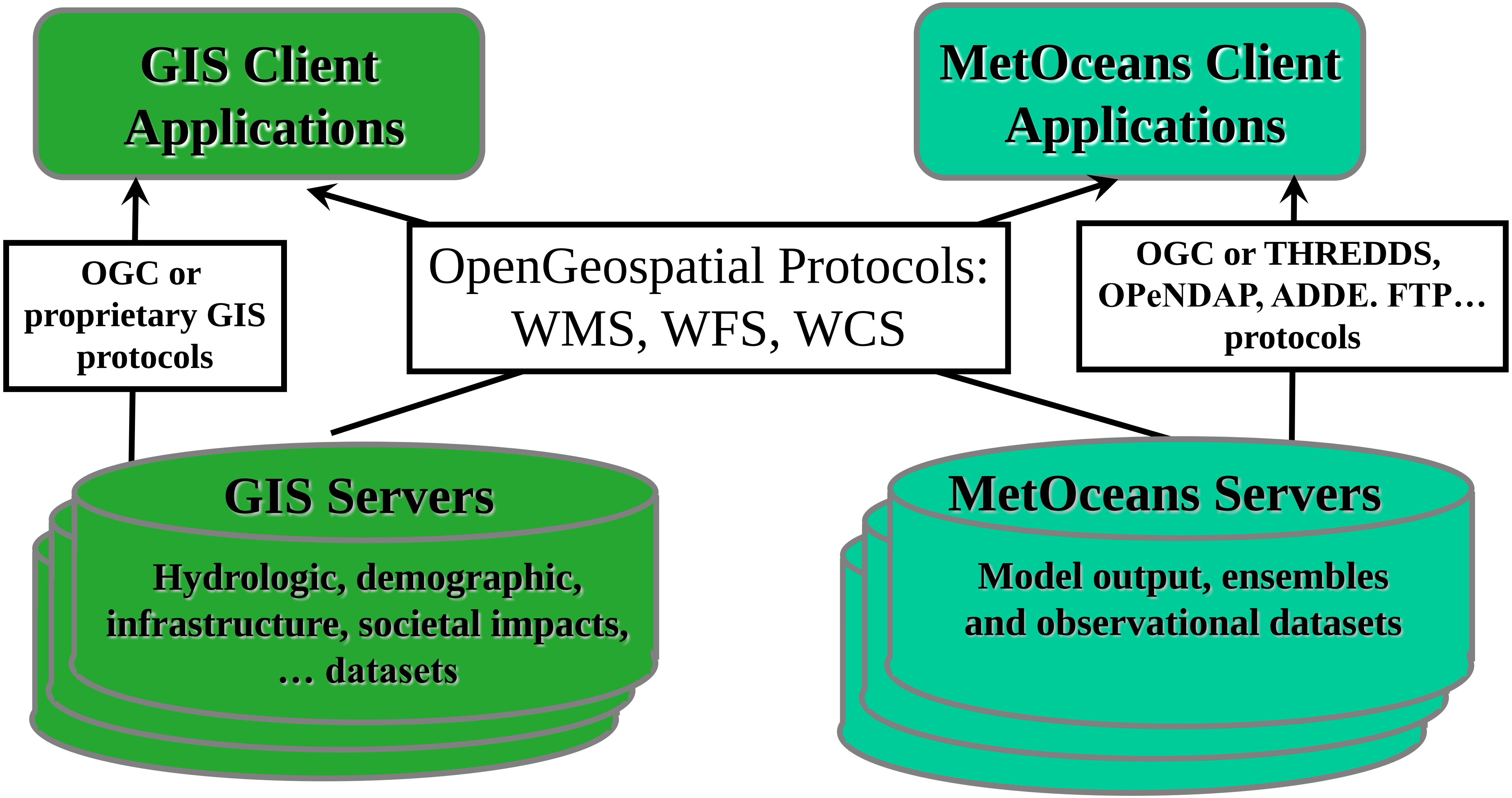
Atmospheric Data Visualization



Apply GIS Tools To Atmospheric Science Data



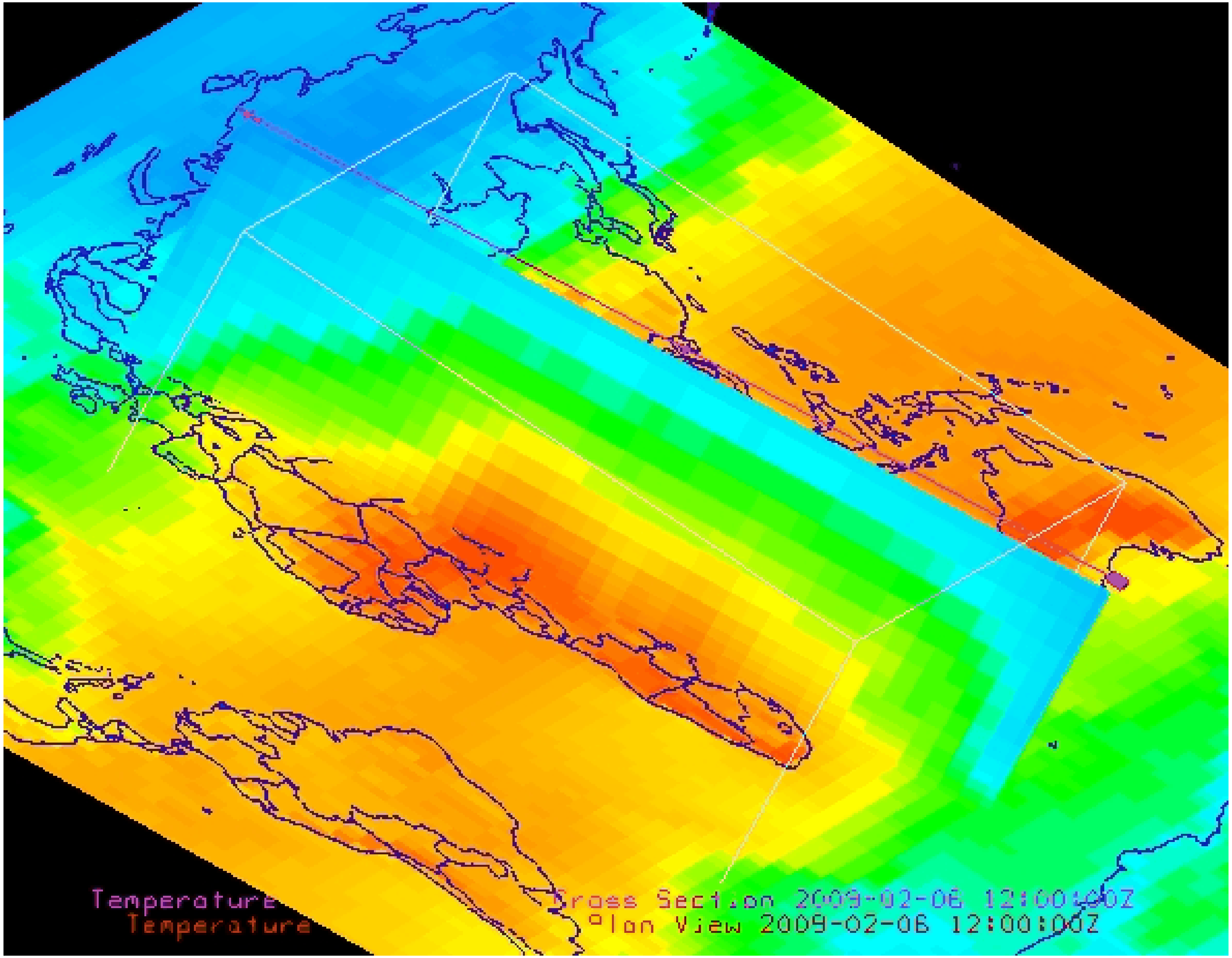
Taking Advantage of Web Services for Data System Interoperability



Special Characteristics of Atmospheric Data

- full 3D in space
- multiple times (forecast run time and valid time)
- time relative to the present (e.g., latest)
- non-regularly-spaced grids
- observational datasets that are not gridded at all
- non-spatial elevation (e.g. pressure) coordinate
- Data interpolation depends on physics (and data) whereas GIS world is concerned mainly with geometry
- agreement on Coordinate Reference System specifications

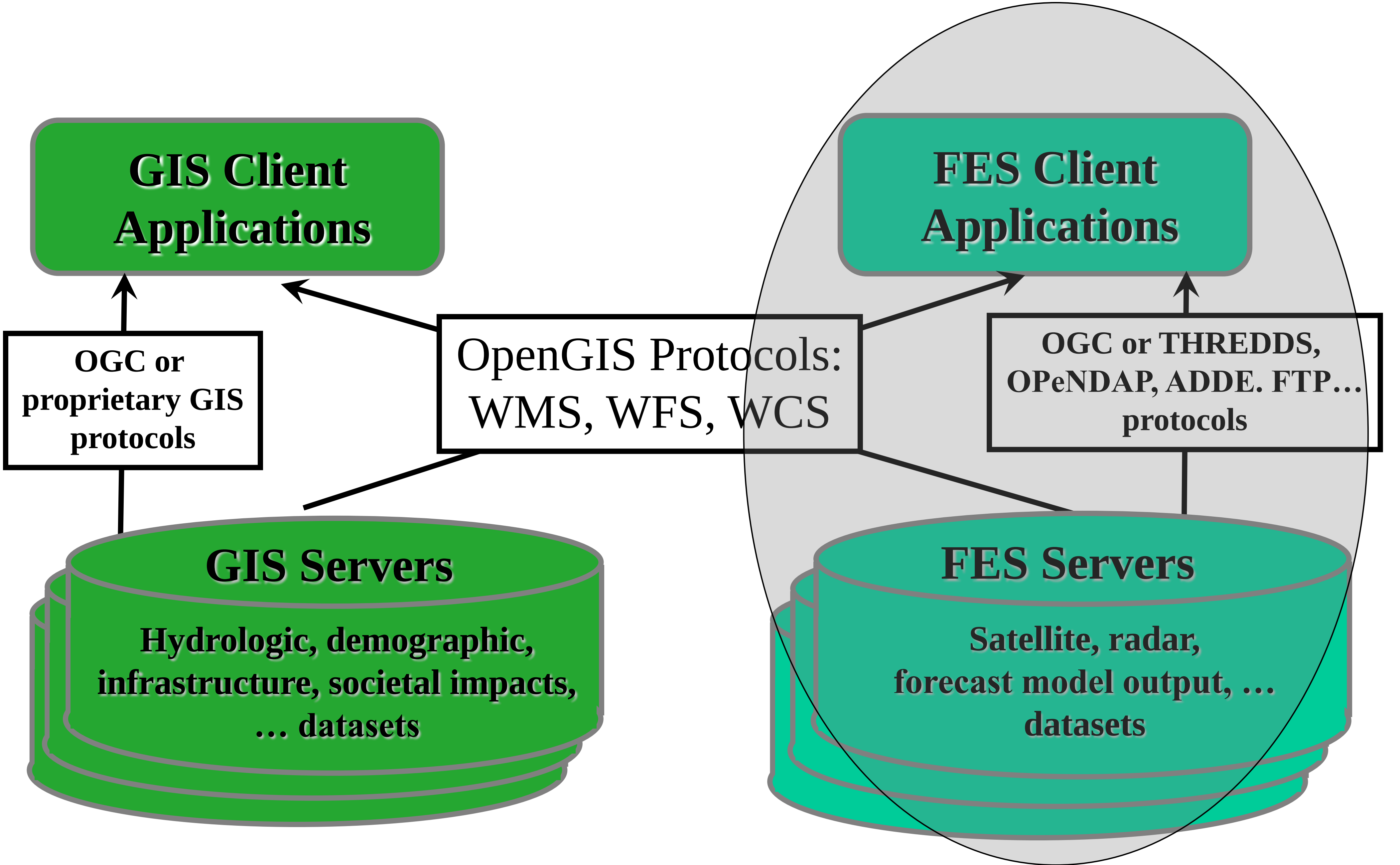
Output of Forecast Models: Time-varying, Multi-dimensional



Building on Existing Systems that Work

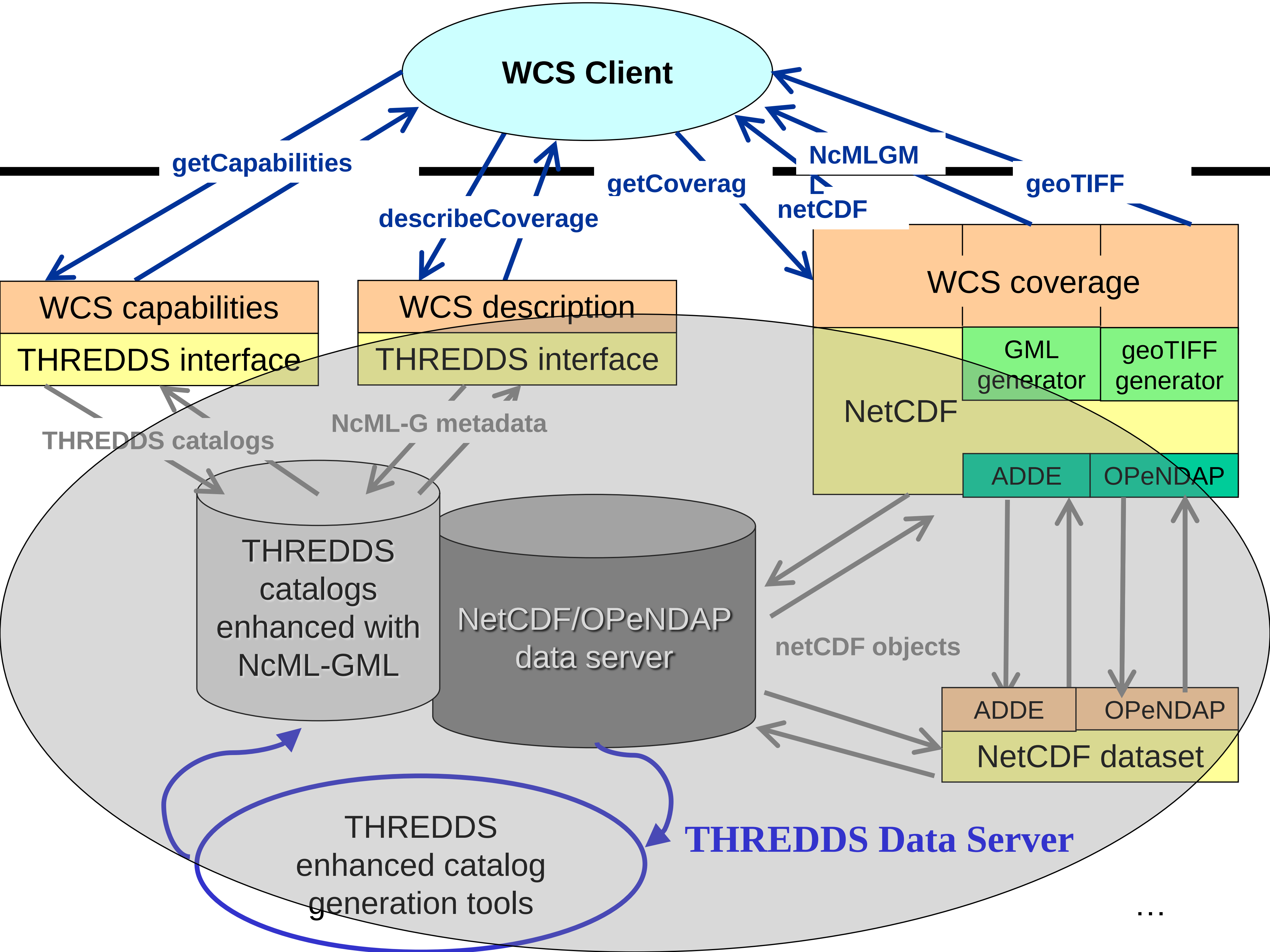
- Solid set of established data systems serving the MetOceans community
- Many of these data systems and tools can serve climate sciences as well
- Climate data systems have many of the same interoperability issues

Taking Advantage of Web Services for Data System Interoperability



Working Systems in MetOceans Community

- Unidata IDD/LDM “pushes” many GB/hr of real-time data to hundreds of sites 24x7
- netCDF provides common interface to many file formats (HDF5, GRIB, and many others via TDS)
- OPeNDAP delivers many dataset types via client/server pull interface
- THREDDS provides catalog data framework for its own community
- THREDDS Data Server (TDS) integrates service interfaces and on-the-fly conversion to netCDF objects
- CF conventions:
  - available for gridded data, coordinate system specs are more explicit now
  - proposed for point, station, trajectory -- including means for specifying locations for non-gridded data collections.



WCS Client
getCapabilities
describeCoverage
getCoverag
NcMLGM
netCDF
geoTIFF
WCS capabilities
THREDDS interface
WCS description
THREDDS interface
WCS coverage
NetCDF
GML generator
geoTIFF generator
ADDE
OPeNDAP
THREDDS catalogs
NcML-G metadata
THREDDS catalogs enhanced with NcML-GML
NetCDF/OPeNDAP data server
netCDF objects
ADDE
OPeNDAP
NetCDF dataset
THREDDS Data Server
THREDDS enhanced catalog generation tools
…

Datasets Not in Convenient Form: NCAR GIS Climate Science Examples

- Have: netCDF files with daily min / max temperature
- Need to find: hottest 3 consecutive daily min temperatures over a period of years
- With GIS tools, this necessitated exporting each time as a separate GIS “layer.”
- This is not convenient as we are working with 365 layers for each year

More Climate Examples:

- Using the daily temperature data we want to find all occurrences of when a threshold is exceeded
  - Currently working with scripts to extract each time as a layer is very cumbersome
- We have 20 years of daily data and need to find the 97th percentile temperature
  - In order to get a percentile you first need to get the min and max values then calculate the percentile

Need Processing Services

- Interoperable data services are a good beginning
- Re-usable, web processing services are a next step
- Examples of automated processing needs, e.g.,
  - Gridding/assimilation
  - Forecast models themselves
  - Transformations between pressure and height
  - Basic climate examples from previous slide

Summary

- MetOceans datasets fully 3D in space with multiple time dimensions and special coordinate systems
- Many data types: grids, station/point, profile, trajectory, radar, swath, irregular grids
- Internal systems and community standards: IDD, THREDDS, OPeNDAP, NetCDF, CF Conventions
- Standards-based web services for serving and processing data for use in other communities.
- NetCDF and OGC standard interfaces bridge community data systems

References

- GALEON document with more details
- GALEON Wiki
- Unidata NetCDF
- CF Conventions
- OGC WCS Specification
- OGC Observations and Measurements:
- ISO 19123 Coverage Specification
- GML
  - CSML
  - NcML-GML
- ISO 19111: Geographic Information: Spatial Referencing by Coordinates
- CS-W
- Interoperability Day Presentations
  - Andrew Woolf
  - Stefano Nativi
  - Wenli Yang
  - Stefan Falke
  - ESIN Paper
- Proposed CF conventions for non-gridded datasets