RHOAPS

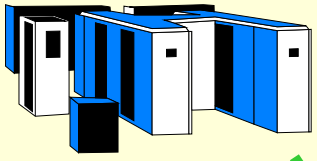
Real-time **H**ydrology **O**cean **A**tmosphere **P**rediction **S**ystem

Pronunciation: “Ropes”

Motto: *More than just THREDDS*

Key Aspects

- Integrated real-time data systems
  - Atmospheric
  - Hydrologic
  - Coastal oceans
  - Societal impacts
- Coupled forecast systems
- Analysis and display alternatives
  - Atmospheric and oceanographic “5D” numerical analysis
  - GIS and database management decision support



National forecast model output

Region of Interest (ROI) Identifier

Area of Interest

Local Model Output

Area of Interest

Data Assimilation

Hi Res. *Coupled* Local Forecast Model

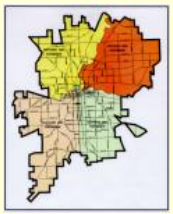
Radar

Dataset Concentrator

Streamflow

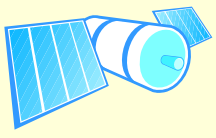
High res. local forecast, radar, streamflow, satellite weather obs, etc. **for Region of Interest**

Local Model Output



Infrastructure

Event/ROI Dataset and Catalog Collection



Satellite images, weather obs.., etc.

Analysis and Visualization for researchers, educators, students, decision-makers, general public

Data interactive publications

Unidata Focus

- Real-time, event-driven, “subscription-based” push data delivery to user sites (IDD, LDM)
- Data transformation for use at sites (Decoders)
- Desktop applications for data analysis and visualization (McIDAS, GEMPAK, IDV)
- Standards-based, web services technology to enable remote catalog, metadata, data access (netCDF, THREDDS, OPeNDAP, ADDE, OGC WCS)
- Expertise in community of more that 100 university departments

Atmospheric Data Sources and Modeling Tools

- NCEP (Global and National Forecasts)
- NWS (Radar)
- NASA (Modis?)
- NCDC and NCAR (Archives)
- Unidata IDD and THREDDS technology
- WRF local weather forecast model
- Local data assimilation module for WRF

Hydrological Focus

- Hydrological data systems (CUAHSI Hydrological Information Systems)
- Streamflow data
- Hydrological observatory datasets
- Drainage basin topological datasets
- GIS analysis and display systems

Hydrological Data Sources and Modeling Tools

- Local Governments: utilities, planning, tax, engineering, stormwater, and GIS departments
- State Governments: natural resources, transportation, and environmental agencies
- Federal Government:
  - USGS: Digital Elevation Models (DEMs), Digital Orthophoto Quadrangles (DOQs), hydrography, stream gaging stations, land-use/land cover
  - EPA: streams and monitoring data
  - NRCS: soils (both state STATSGO (State Soil Geographic database) and county-level 'SSURGO' (Soil SURvey Geographic database)
- CUAHSI HIS data systems
- Coupled Hydro – meteorological models

Coastal Oceans Focus

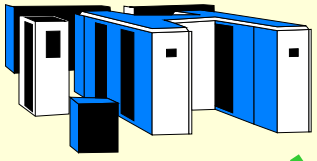
- SCOOP (SURA Coastal Oceans Observing Program)
- Near-shore bathymetry
- Storm surge models
- Hydrologically correct Digital Elevation Maps
- GIS and oceanographic analysis and display systems.

Recent Joint Efforts

- Support tools for cataloging and serving data at sites (THREDDS, OPeNDAP, ADDE, WCS)
- Transform datasets for access in Grid environment (LEAD, TACC, NCAR ESG)
- Connect datasets to real-time processing (LEAD WRF model, ADAS assimilation, ADAM mining)
- Integrate datasets into RDBMS and GIS systems (CUAHSI, TACC, ESRI, OGC)

Coastal Oceans Data Sources and Modeling Tools

- NOAA National Geodetic Survey: Coastal Survey Maps
- NOAA Ocean Service: Estuarine Bathymetry
- USGS: DEMs
- National Federation of Regional Coastal Ocean Observing Systems (RCOOS)
- Surge, wave, inundation models
- Coupled Surge – meteorological models



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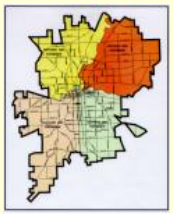

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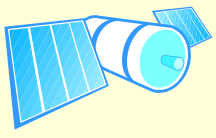

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Data interactive publications

Interoperability Issues

- **Green items represent slowly changing datasets of discrete objects that tend to be available in GIS or other DBMS-based systems (e.g., land use, infrastructure, digital elevation model)**
- **Blue items represent rapidly changing, real-time continuous-function datasets often delivered via IDD push and typically stored in local file systems (e.g., radar, satellite, local weather observations)**

Local Weather Forecast Data Needs

- National forecast model output for boundary conditions and possibly for initialization
- Data assimilation
  - Local weather station observations
  - Full 3D radar scan observations
  - Satellite imagery (e.g. Modis)
  - Local topography
  - Local land characteristics

Hydrological Model Data Needs

- DEM
- Hydrologically correct drainage paths:
  - Topographic relief
  - Culverts
  - Stream channels
- Land characteristics (permeability)
- Streamflow
- Soil moisture
- Precipitation

Coastal Waves, Surge, Inundation Model Data Needs

- Near-shore bathymetry
- Hydrologically correct Digital Elevation Model
- Wind field
- Precipitation
- Ensemble modeling approach under development

Impacts and Decision Support Data Needs

- Infrastructure
- Demographics
- Communication systems
- Contact information
- Digital Flood Insurance Rate Map (DFIRM) – measure of vulnerability
- Forecast of Probably Threatened Areas

Primary Datasets Needed for Coupled System

- National forecast model output
- Radar observations
- Streamflow
- Hydrologically correct DEMs
- Near shore bathymetry
- Infrastructure
- Demographics

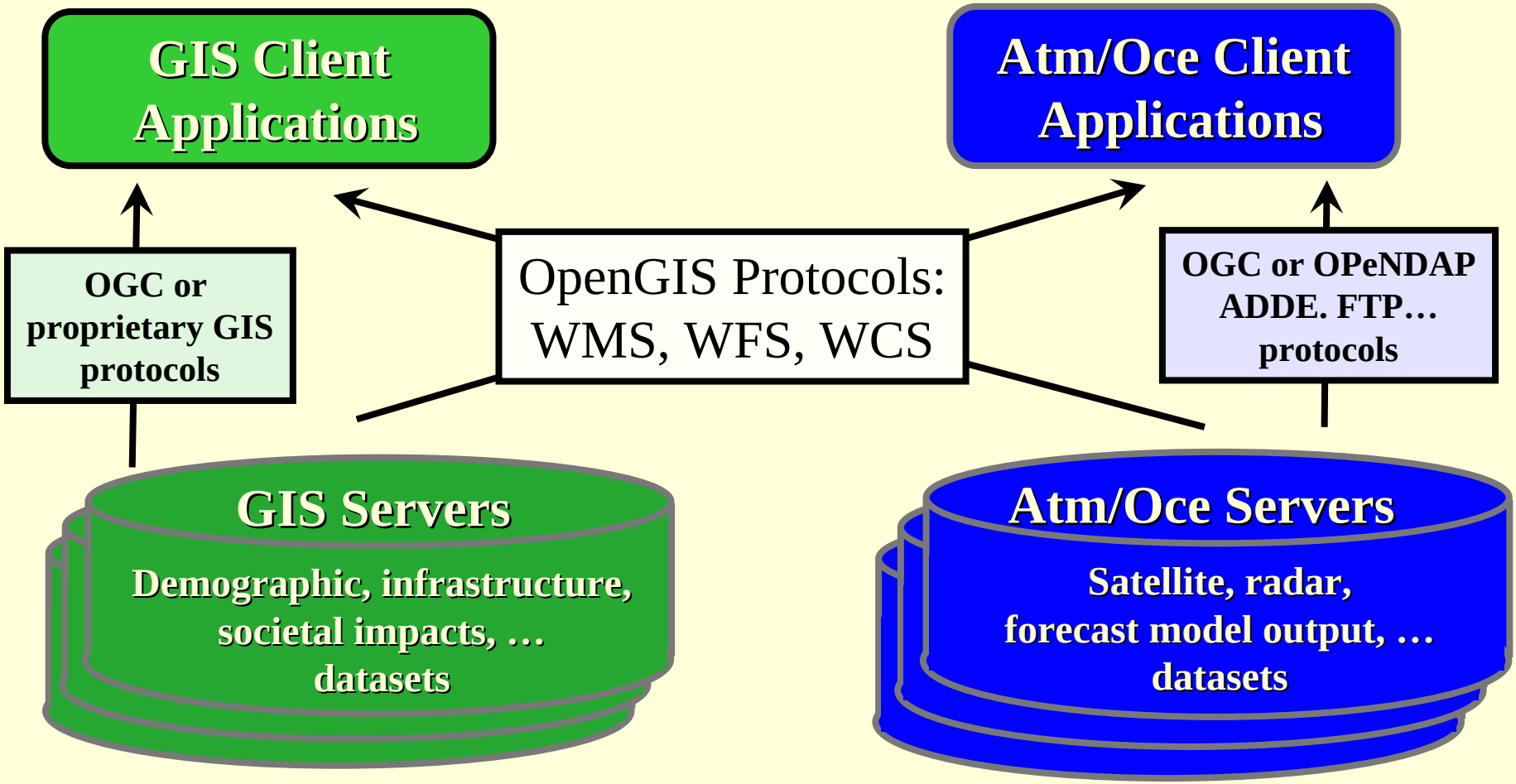
Primary Tools for Coupled System

- IDD/LDM
- THREDDS (incl. netCDF,OPeNDAP, WCS)
- WRF local model
- Data assimilation module for WRF
- Coupled WRF-Hydro Model
- Coupled WRF-Surge Model
- ArcHydro
- GIS Database systems
- Integrated Data Viewer
- Grid Technologies
- Other ???

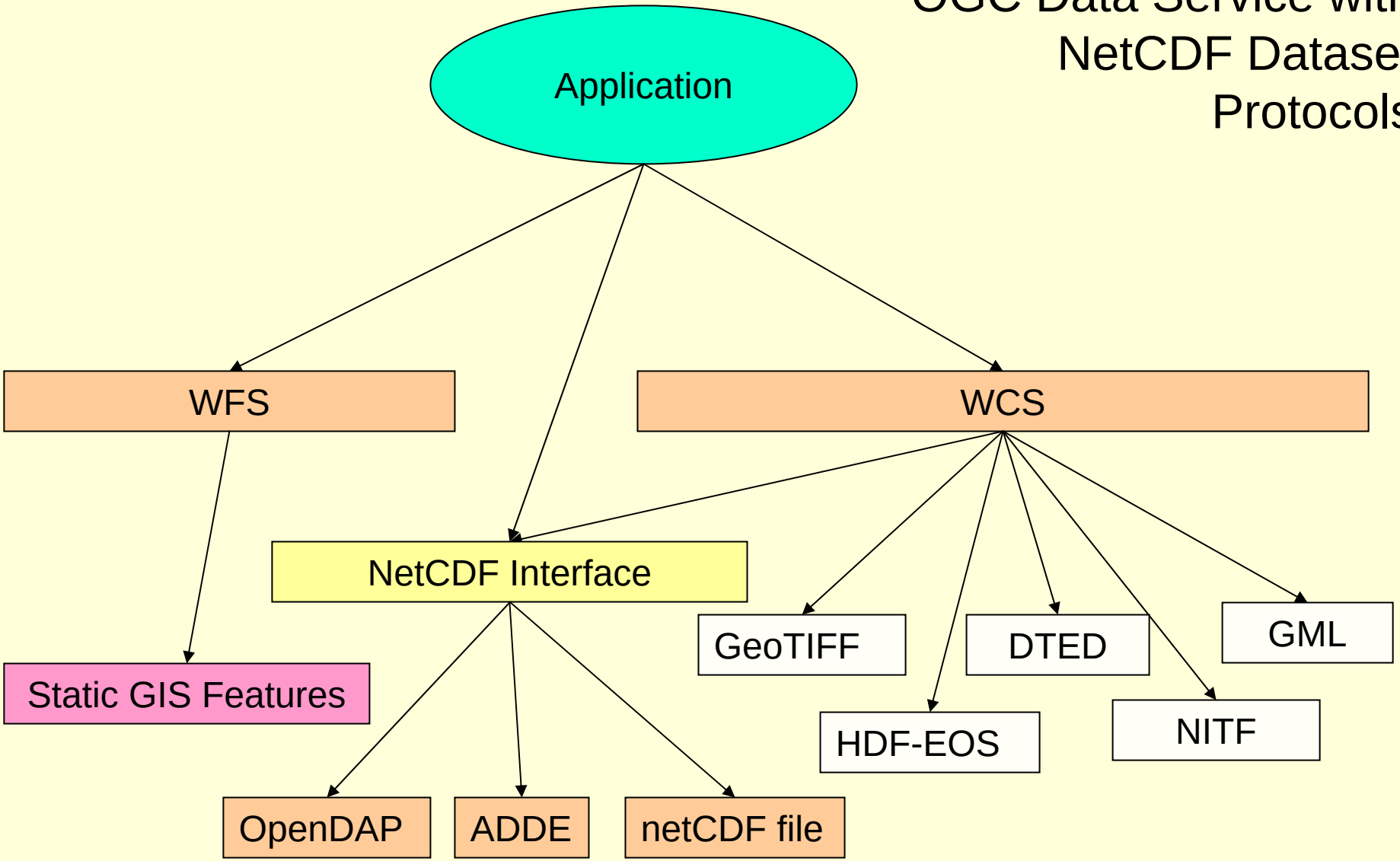
Interoperability Issues Summary

- Traditional atmospheric and oceanographic data systems – continuous, rapidly changing datasets
- GIS and RDBMs systems employed in hydrology, infrastructure and societal impacts realms – discrete features
- Integration of data from both fields needed
- Analysis and display capabilities of both communities needed

Web Services for Data System Interoperability



OGC Data Service with NetCDF Dataset Protocols



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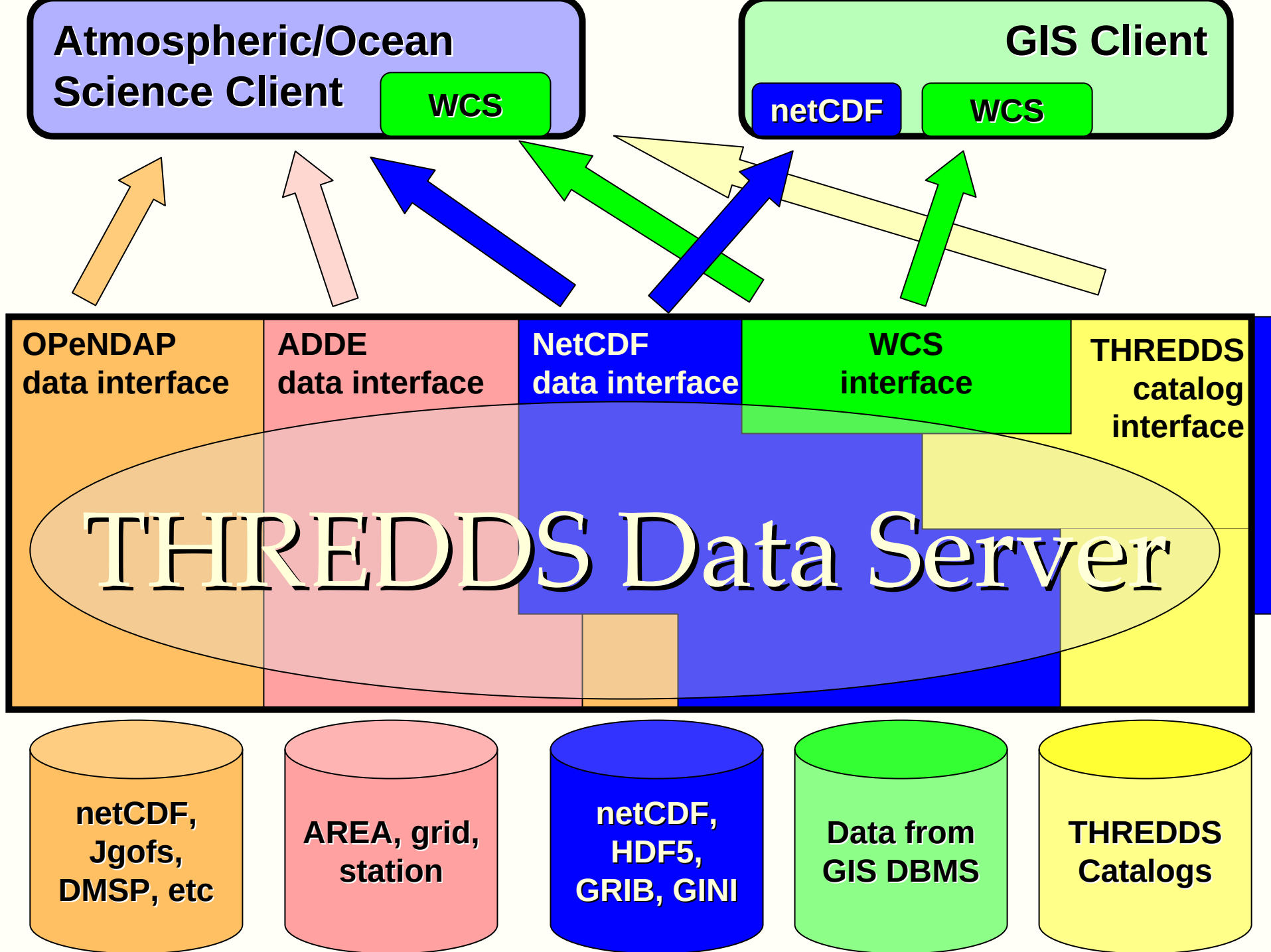
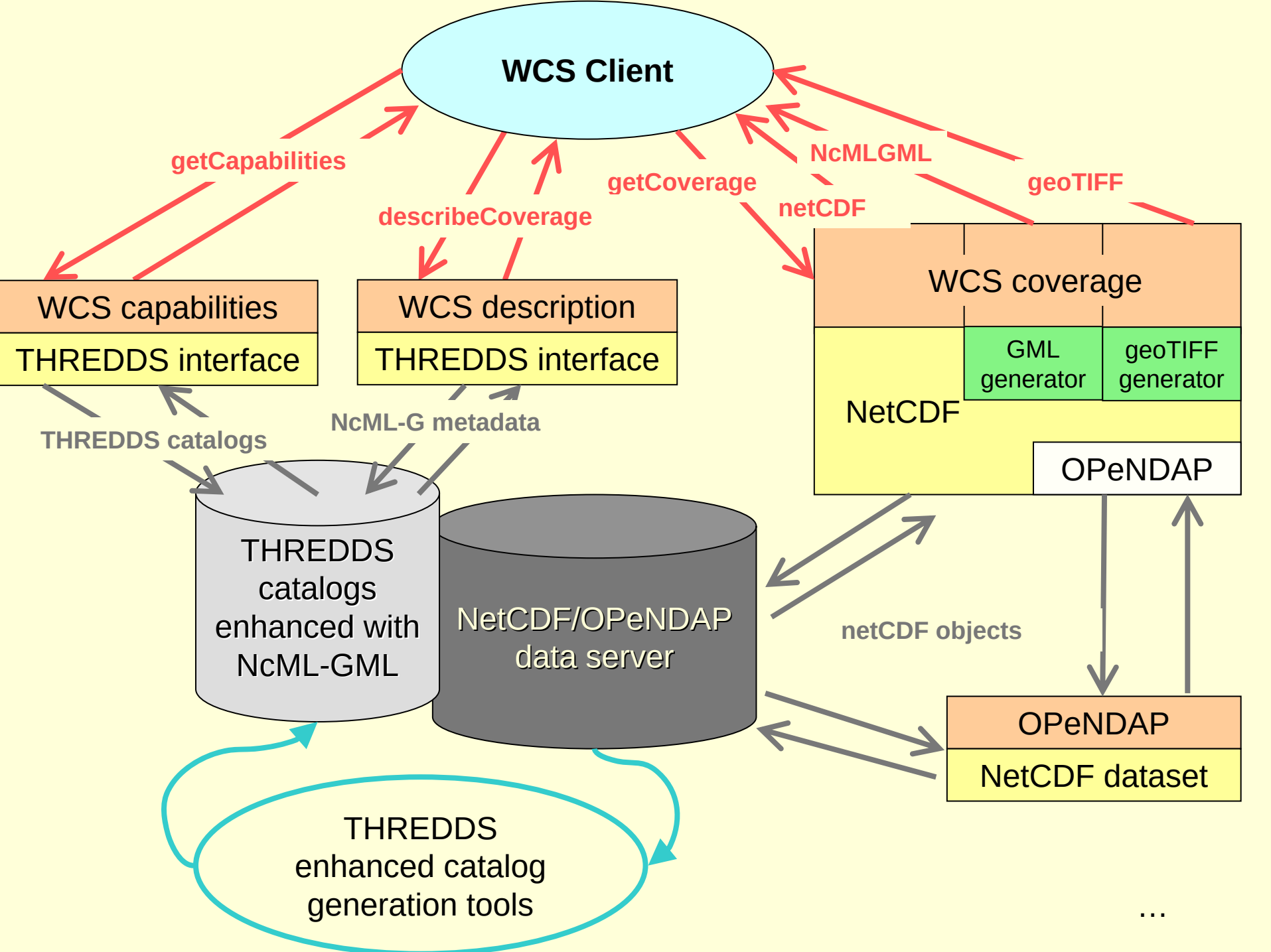

Atmospheric/Ocean Science Client
WCS
GIS Client
netCDF
WCS
OPeNDAP data interface
ADDE data interface
NetCDF data interface
WCS interface
THREDDS catalog interface
THREDDS Data Server
netCDF, Jgofs, DMSP, etc
AREA, grid, station
netCDF, HDF5, GRIB, GINI
Data from GIS DBMS
THREDDS Catalogs


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

Overarching Goal

- **NOT to solve** the many scientific issues in the field
- But to **develop the infrastructure** to facilitate innovative interdisciplinary research and education