

The NOAA Operational Model Archive and Distribution System (NOMADS)



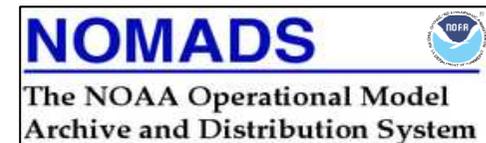
and plans for

NOAA's National Climate
Model Portal
- NCMP -

Glenn K. Rutledge
NOAA National Climatic Data Center
8th GO-ESSP Community Workshop
October 6-8, 2009 Hamburg, Germany



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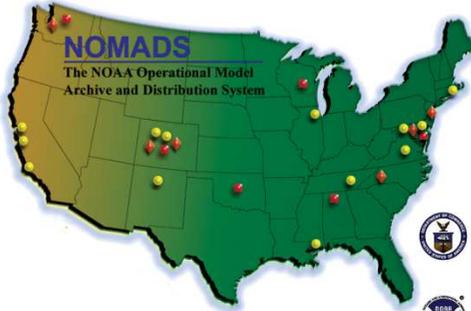
Outline

- NOMADS Background and Status Report
- NOMADS “Next” Design
- The National Climate Model Portal (NCMP)
 - conceptual architecture
 - a community approach
 - call for collaboration



NOMADS: 10 years old?

- NOMADS is a distributed data access project for access to real-time and retrospective high volume numerical weather prediction and climate models. Conceived in 1999 and supported and advanced by GO-ESSP.
- NOAA's NCDC initiated NOMADS with NCEP and GFDL.
- NOMADS provides access to data as input for decision-makers, on time scales from days (weather) to months (El Nino) to decades (global warming).



NOMADS
The NOAA Operational Model
Archive and Distribution System

Core NOAA NOMADS Collaborators

- ◆ Climate Diagnostics Center (CDC) Boulder, CO
- ◆ Geophysical Fluid Dynamics Laboratory (GFDL) Princeton, NJ
- ◆ National Climatic Data Center (NCDC) Asheville, NC (Project Lead)
- ◆ National Centers for Environmental Prediction (NCEP) Camp Springs, MD
- ◆ Pacific Marine Environmental Laboratory (PMEL) Seattle, WA
- ◆ NOAA Forecast Systems Laboratory (FSL) Boulder, CO

External Core Collaborators

- Center for Ocean-Land-Atmosphere Studies (COLA) (Maryland)
- Department of Energy's Argonne, Los Alamos, Oak Ridge, Lawrence Berkeley, Livermore National Laboratories & Information Sciences Institute (ISI), University of Southern California under the Earth System Grid Project
- National Center for Atmospheric Research (NCAR) Colorado
- Unidata Program Center (UCAR/Unidata) Colorado
- LLNL Program for Climate Model Diagnosis and Intercomparison
- NASA's Global Change Master Directory (GCMD) Maryland
- National Coastal Data Development Center
- University of Rhode Island (OPENDAP Consortium)

External Collaborators include

- Center for Earth Observing and Space Research (CEOSR), NASA-GSFC Maryland
- George Mason University (NASA SISEP), Virginia
- National Severe Storms Laboratory (NSSL), Oklahoma/SSEC University of Wisconsin
- Universities of Alabama (Huntsville), California (Santa Barbara), Washington & Iowa St.
- National Science Foundation (NSF) Cyberinfrastructure

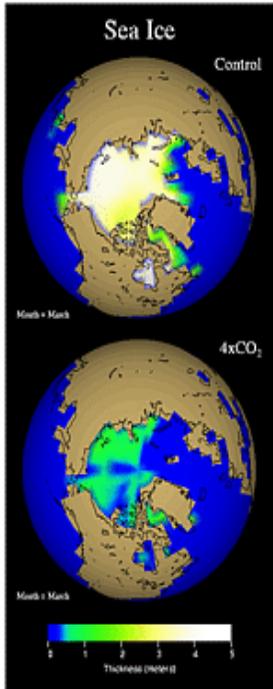
International Participants

- British Atmospheric Data Center, Oxfordshire, United Kingdom
- UK's Natural Environment Research Council (NERC DataGrid Project)
- Committee for Earth Observing Satellites (CEOS) Grid Project
- Climate Action Partnership (CAP), BOM Australia (US Depts. of Commerce, Energy, State, and EPA)

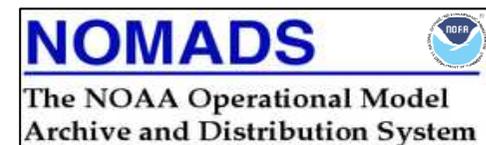
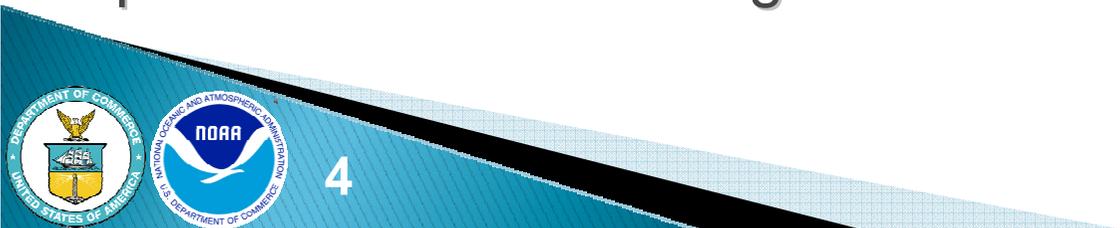
Logos for participating organizations: NOAA, NCEP, GFDL, NCDC, PMEL, FSL, COLA, Argonne, Alamos, Berkeley, ISI, NCAR, LLNL, NASA, Unidata, CEOSR, NSSL, University of Wisconsin, Alabama, California, Washington & Iowa St., NSF, British Atmospheric Data Center, NERC, CEOS, CAP, BOM Australia.



NOMADS Goals



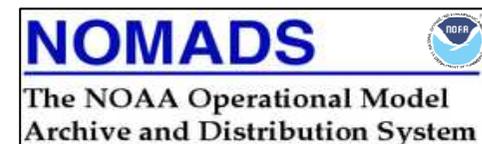
- Establish a distributed climate and weather model archive providing format independent access to retrospective models
- promote model evaluation and community feedback
- foster research within the geo-science communities (ocean, weather, and climate) to study multiple earth systems using collections of distributed data
- develop institutional partnerships and access via distributed open standard technologies



NOMADS Adopted for both Archive and Real-Time Services

- Archive and limited real-time services:
 - National Climatic Data Center (NCDC) Asheville, NC
 - National Ocean Data Center (NODC) Charleston, SC
 - the new “Ocean-NOMADS”

- New (2008) operational National Weather Service (NWS) real-time (R/T NOMADS) services:
 - Fort Worth, TX
 - Boulder, CO
 - Silver Spring, MD

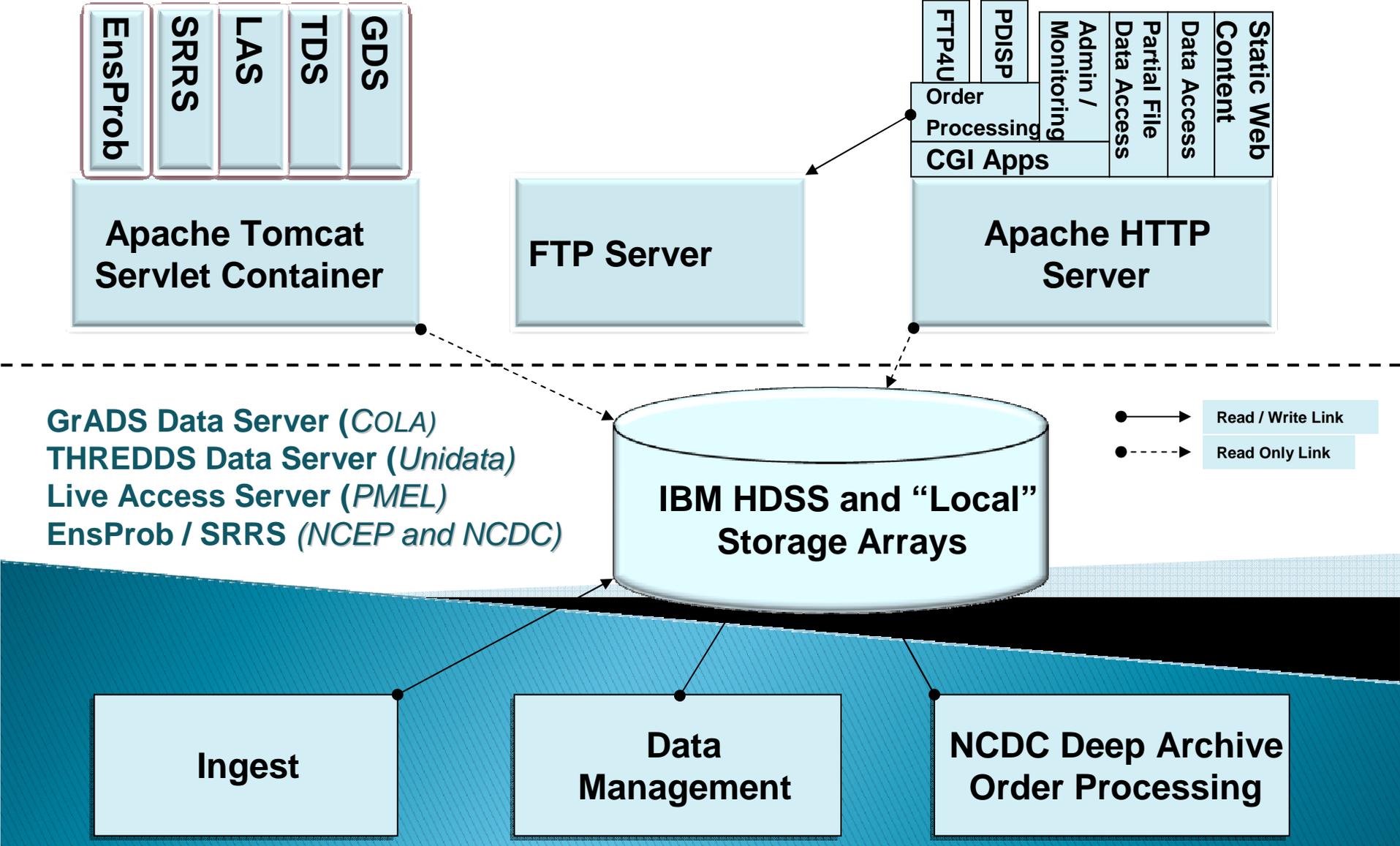


Some NOMADS Benefits

- NWS systems engineers recently studied the bandwidth “cost savings” obtained via NOMADS vs. their traditional “gateway” servers.
- In a nutshell, they found an overall savings for users up to 80% of the volume by using NOMADS for the same services.
- “NOMADS” services (OPeNDAP, GDS, LAS, TDS, <ftp4u>) being considered for “NOAA NexGen”.



NOMADS Architecture



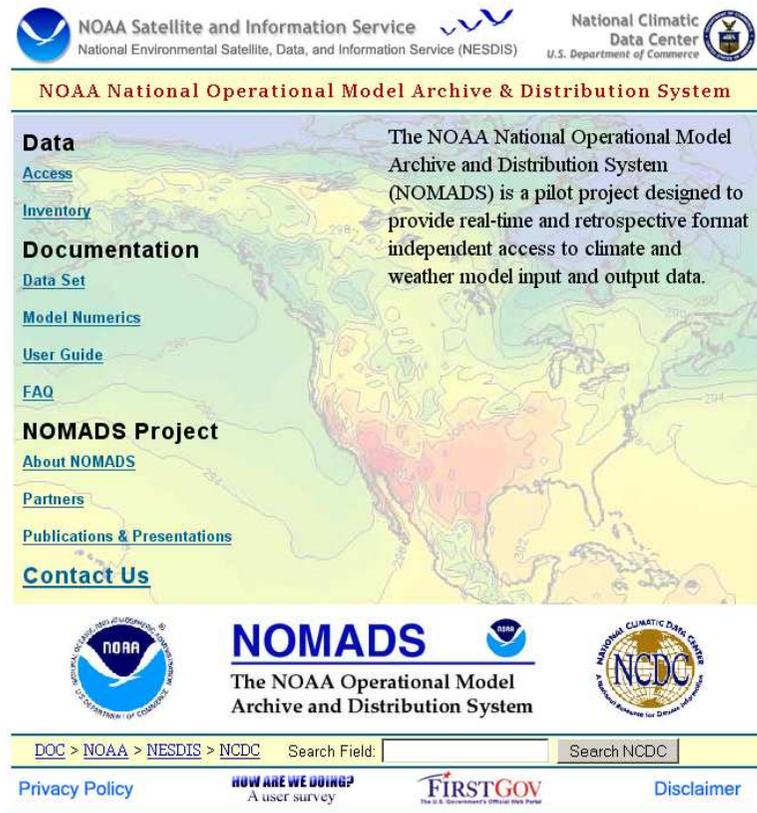
NOMADS Data

NWP Model

- ▶ Global Forecast System (GFS), 1 and ½ degree
- ▶ NCEP Spectral Statistical Interpolation (SSI) Global Data Assimilation System (GDAS) w/ restart files
- ▶ North American Mesoscale (NAM, formally Eta) 1 and 3 hourly
- ▶ Rapid Update Cycle (RUC) 13km and 20km
- ▶ NCEP North American Regional Reanalysis (NARR) 30 years 32km
- ▶ NCEP/NCAR R1/R2 Reanalysis / CDAS)
- ▶ NCEP Regional Special Model (RSM)
- ▶ NCEP Global Ensembles and SREF
- ▶ NCEP Climate Forecast System (CFS) coupled climate model.
- ▶ NCEP Ocean Wave models and NCEP Sea Ice Models

In situ

- ▶ NCDC Global Historical Climate Network (GHCN)
- ▶ NCDC Integrated Global Radiosonde Archive (IGRA) upper air
- ▶ NCDC Smith-Reynolds Extended Reconstructed and OI ¼ SST's
- ▶ Service Records Retention System (SRRS)
- ▶ [Climate Models / Coupled AOGCM](#)
- ▶ Limited GFDL CM2.0 and CM2.1 Climate Experiments
- ▶ Paleoclimate Model Intercomparison Project (PMIP)



NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)

National Climatic Data Center
U.S. Department of Commerce

NOAA National Operational Model Archive & Distribution System

Data
[Access](#)
[Inventory](#)

Documentation
[Data Set](#)
[Model Numerics](#)
[User Guide](#)
[FAQ](#)

NOMADS Project
[About NOMADS](#)
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Contact Us

The NOAA National Operational Model Archive and Distribution System (NOMADS) is a pilot project designed to provide real-time and retrospective format independent access to climate and weather model input and output data.

NOMADS
The NOAA Operational Model Archive and Distribution System

DOC > NOAA > NESDIS > NCDC Search Field: Search NCDC

Privacy Policy **HOW ARE WE DOING?** A user survey **FIRSTGOV** The U.S. Government's Official Web Portal Disclaimer

<http://nomads3.ncdc.noaa.gov/develop/index.php>

Created by NOMADS.ncdc@noaa.gov

Last updated 08/8/05

Please see the [NCDC Contact Page](#) if you have questions or comments.



NOMADS Ensemble Probability Tool



NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)



National Climatic
Data Center
U.S. Department of Commerce

NOMADS Ensemble Probability Tool

The NOMADS Ensemble Probability Tool is a tool that is designed to allow users to interrogate the NCEP Global Ensemble model. The tool allows the user to describe a set of conditions and determine the probability that that set of conditions will occur at a given location.

The NOMADS Ensemble Probability Tool queries the Ensemble Datasets located on NCEP's NOMADS servers. The data is passed via OpenDAP back to the application, where it is read using the Java NetCDF library and then calculates the probability of occurrence.

For more information, please see our [help page](#).

Where

Station ID
 Lat (-90 to 90) Lon (-180 to 180)

When

Latest model run (2007 May. 02 18z)
 Year Month Date Model Run

What

Temperature
 Precipitation
 Wind

[DOC](#) > [NOAA](#) > [NESDIS](#) > [NCDC](#)

Search Field:

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HOW ARE WE DOING?
A user survey

[USA.gov](#)

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NOMADS Ensemble Probabilities on the fly:

20 model runs

30 fcst projections

10 days of forecast

ONE OPeNDAP request

New: World Bank a User w/
SMS Texting via SMS
messaging: parameter
thresholds for improved
agriculture in developing
regions.

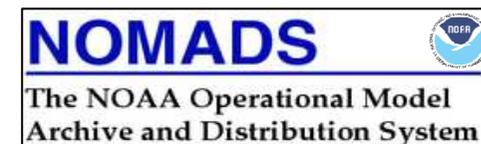
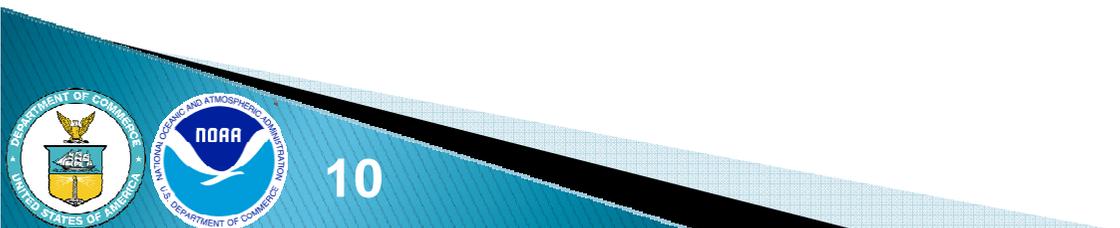


WMO WWRP THORPEX Interactive Grand Global Ensemble

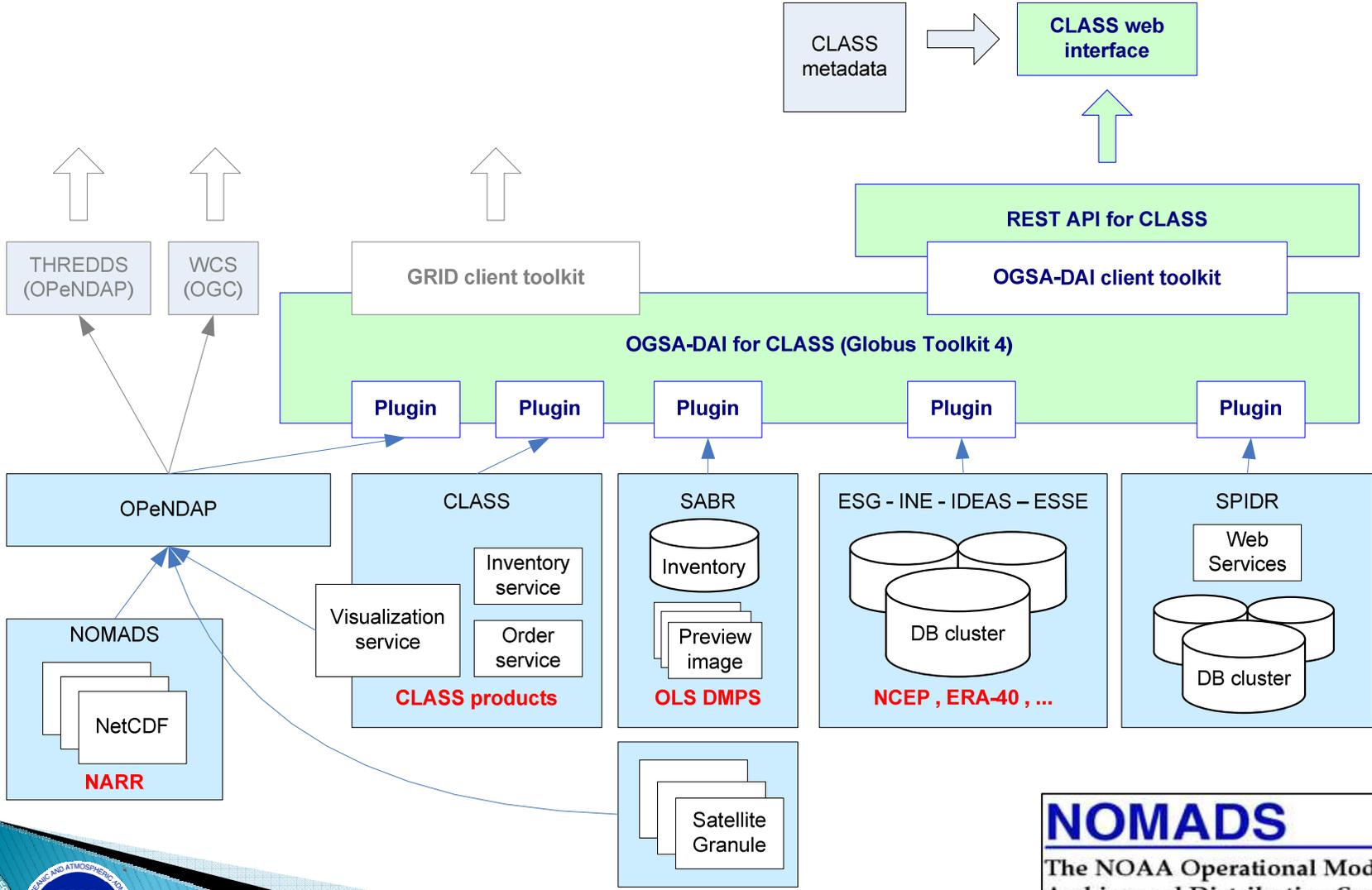
TIGGE Archive



- ▶ A joint US (NCEP, NCDC and NCAR) activity
 - NOMADS producing 11 variables for the US TIGGE archive at NCAR
 - Lends distributed nature of NOMADS to data problems of TIGGE
 - NCDC NOMADS involved in the planning stages for the WMO WWRP THORPEX Global Interactive Forecast System (GIFS).

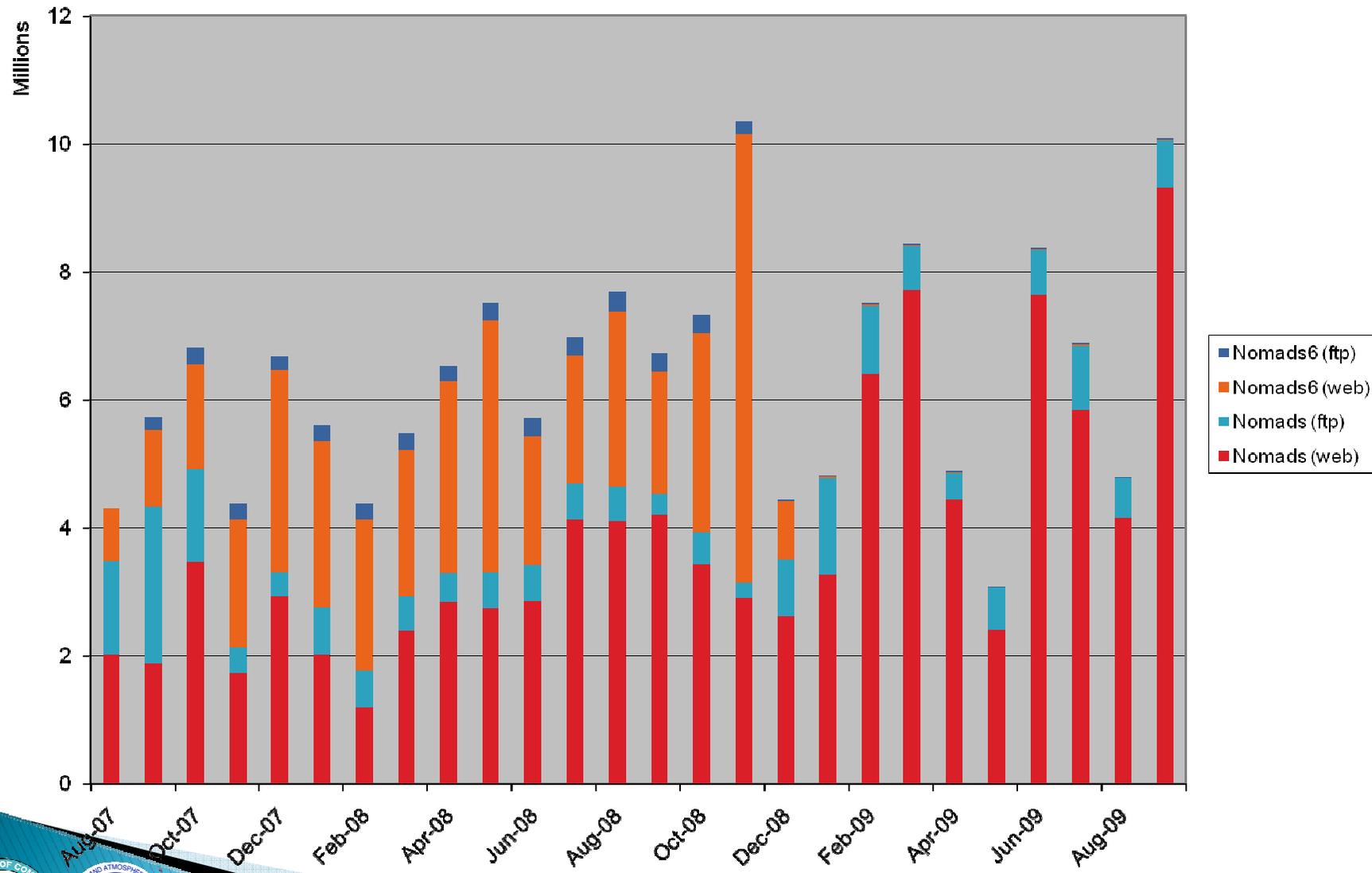


CLASS API architecture SNAPP



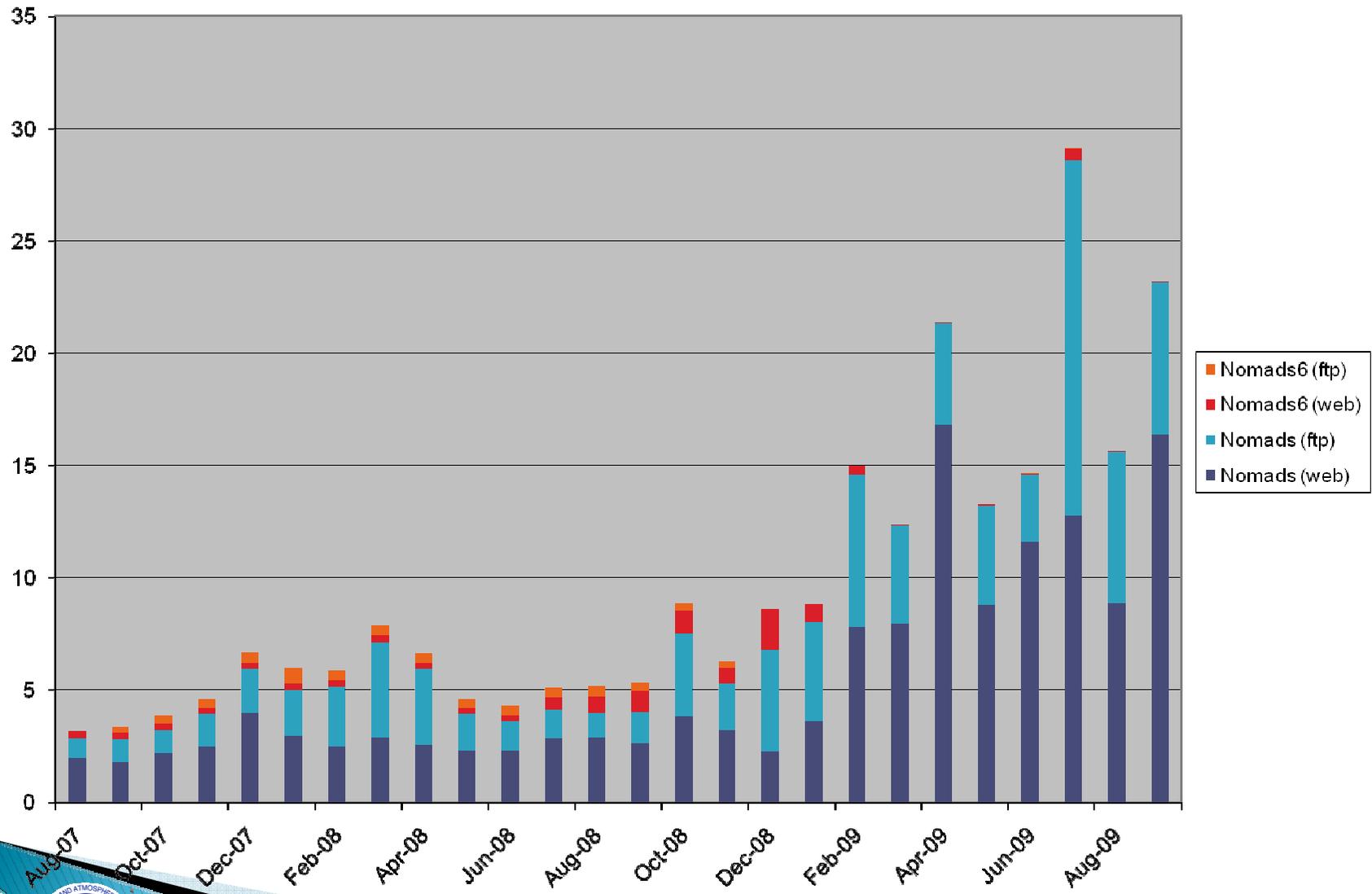
NCDC

NOMADS Model Data Requests



NCDC

NOMADS Model Data Downloads (TB)



The NOMADS WorkPlan

- ▶ NOMADS (FY09/10)
 - Bulk order customer access for the NOAA Reanalysis
- ▶ NOMADS-Next (FY10)
 - New front end, catalogs/inventory, fast access cache; New Java based codebase
- ▶ National Climate Model Portal NCMP (FY10-14)
 - System Requirements Specification, CF metadata support, ESG, iRODS
 - “Climate Model HelpDesk” at NCDC in collaboration with GFDL, NCAR, PCMDI, CPC, CDC, ...
 - NCMP accessible thru the National Climate Portal



Priorities for NOMADS Development at NCDC

- ▶ Prepare for servicing NOAA's suite of Reanalysis efforts (1.5 Petabytes)!
- ▶ New Data and Models:
 - Development of a reanalysis clearinghouse capability for an "on-going analysis of the climate system"
 - AR5 subsets, Regional Climate Models, TIGGE, YOTC
- ▶ User Engagement Workshops
- ▶ New or renewed collaborations
 - Oak Ridge National Lab;
 - PCMDI, NCAR, GFDL, others....



Priorities for NOMADS Development at NWS/NCEP*

- New Data Sets
 - 4km NAM
 - T878 GFS
 - Calibrated ensembles; observations
 - CFSRRWOC bandwidth increases
- Improve Web GUI and System Documentation
- System and Functionality Priorities:
 - TDS and Catalogs
 - Harden capability at the NOAA Gateway
 - BUFR files for operational conventional and non-conventional observations served in a similar way to the way NOMADS serves gridded fields



New NOAA Reanalysis Projects

- 1) Historical SFC Reanalysis
(Compo et al.)
 - 1850 to present. ~60TB
- 2) Post WW-II Reanalysis
(NCEP/CPC)
 - 1944 to present. ~235TB
- 3) Climate Forecast System
Reanalysis and Reforecast
(CFSRR) Project (Saha et al.).
 - 1978-2008 Reanalysis and
Seasonal Reforecast
~450TB



NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)



National Climatic
Data Center
U.S. Department of Commerce

The NOAA Reanalysis Community Forum



National Climatic Data Center



National Centers for Environmental Prediction



Earth System Research Laboratory

Overview

NOAA is the lead agency responsible for monitoring and predicting climate variability over the globe extending from daily, monthly, seasonal and longer time scales. A key requirement for meeting NOAA's responsibility is the availability of historical analysis (also referred to as reanalysis) for the ocean, the atmosphere, land, and cryosphere.

Reanalysis is crucial for monitoring climate variability and its trends. At the same time, reanalysis, by providing a comprehensive spatial and temporal depiction of the state of the climate system, is also essential for improving seasonal prediction and validation activities. Advances in models, improved data assimilation methods, and new data sources make it desirable and feasible for NOAA to develop and continually update global reanalysis datasets.

Reanalysis Product Suite

NOAA's next reanalysis product suite is currently underway. NOAA is developing three new reanalysis datasets on three different time scales:

1. the coupled [Climate Forecast System Reanalysis and Reforecast \(CFSRR\)](#) 1979-present,
2. the [Climate Prediction Center Reanalysis \(CPCR\)](#) 1950-present; and
3. the [20th Century Reanalysis](#) 1850-present.

...to be serviced by NOMADS Jan 2010

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NOMADS-Next Proposed GUI

Presentation Layer

3) Expert Modeler Access {1.3.1}

Ensemble Diagnostics {1.3.2}

Observation System Simulation Experiment (OSSE) capability (1.3.3)

Sub-setting data, & datasets for targeted orders {1.3.4}
model diagnostics, uncertainty PDF's generation, downscaling, Regional
Climate users; impacts, initialization access, etc.

{4.4}

- Provide **simple**, predefined weather information (reports, charts, visuals, etc.) for general public consumption. Provide little or no options while requesting the data.
- Provide **targeted**, predefined weather information (reports, charts, visuals, etc.) for specific educational and industry requirements such as agriculture and insurance. Provide access to only a few sub-setting options.
- Provide **expert** access to the full range of NOMADS capabilities for scientists and meteorologists. Allow sub-setting along 5 dimensions: longitude, latitude, level, time (2), and variable.

Broadcast
{4.5}

- LDM
- NCDC ftp
- CLASS
- others

The National Climate Model Portal NCMP

- ▶ The National Climate Model Portal (NCMP) will:
 - Ensure readiness of access to NOAA's next generation Climate and Weather Models and Data using NOMADS*
 - Increase capacity to handle large data volumes and high user demand for these products
 - Provide long term stewardship and climate information records
 - Develop and staff a model "HelpDesk" capabilities to ensure climate model data output is used appropriately to reduce errors and public expectation of model results.
 - Develop enhanced access trees for public and NOAA Operational and Research Centers
 - Leverage Existing NOAA Service Orientated Architecture efforts under GEO-IDE and community efforts such as GO-ESSP

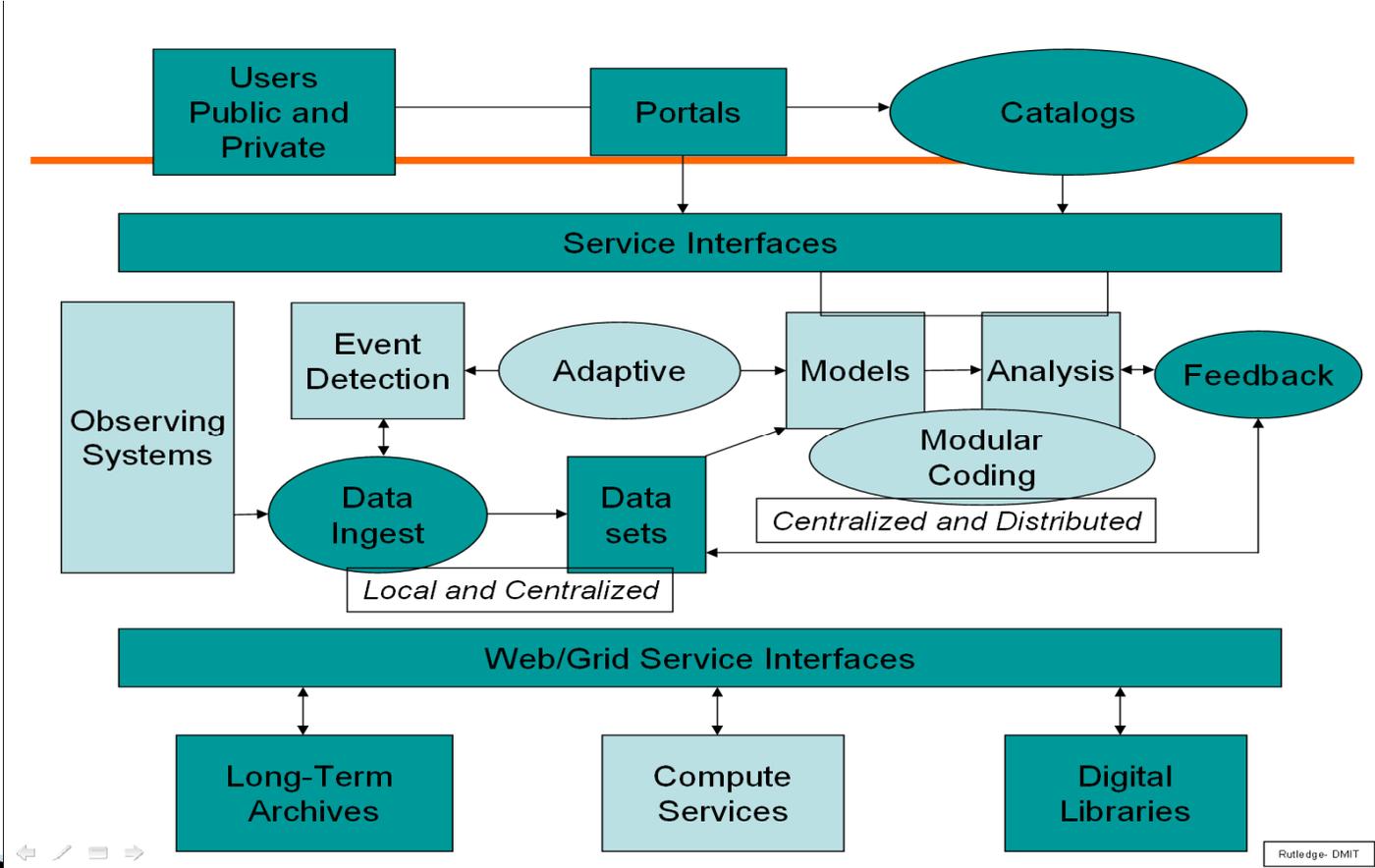
- ▶ NCMP will be developed between technical portal architecture development and data portal user services access capabilities.

** National Academies of Sciences, National Research Council
Board of Atmospheric Sciences and Climate*



NCMP Conceptual Design

NCMP addressing a gap for model services in NOAA*
 (dark boxes indicate scope of NCMP)



Rutledge-DMIT

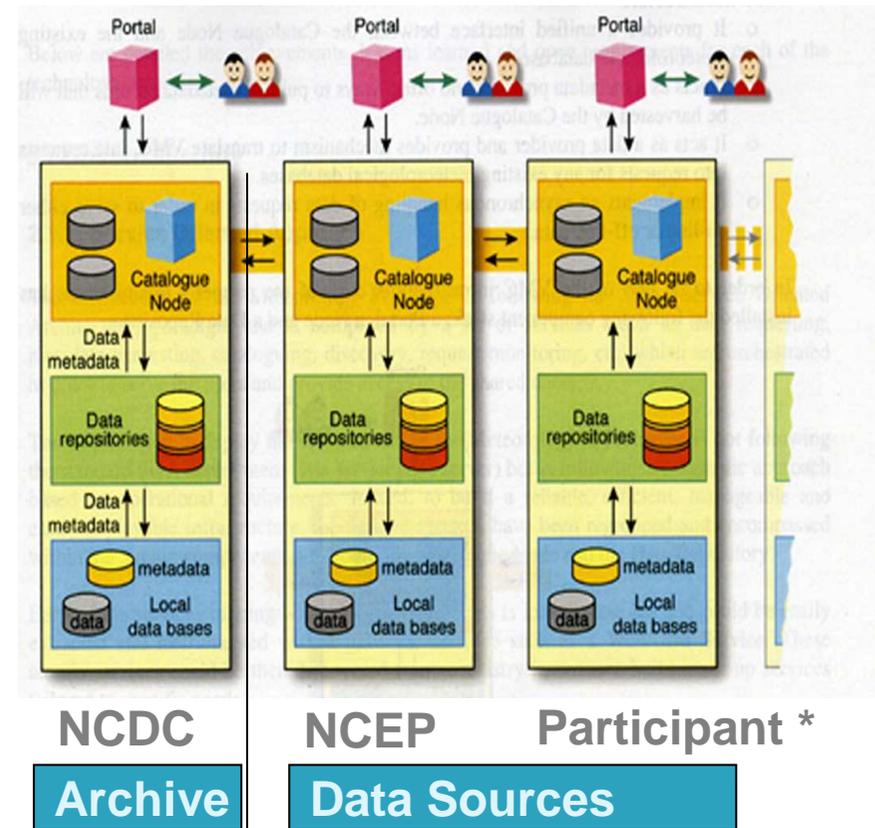


* from NOAA DMIT and GEO-IDE CONOPS

NCMP Distributed Vision

The NCMP architecture is based on three (3) main components; the Portal, the Catalog Node, and the Data Repository:

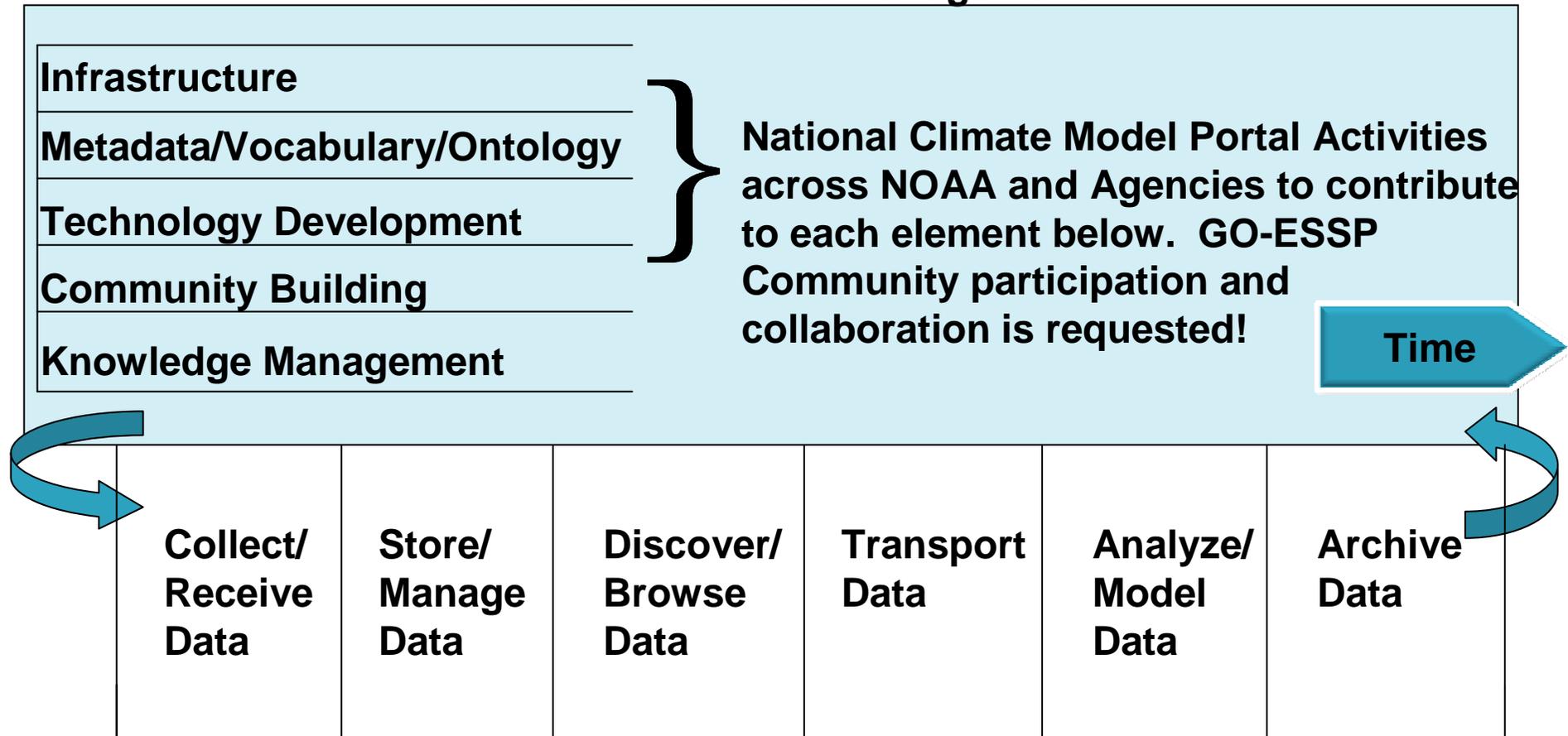
- 1) The Portal is the user's real-time interface to the system, manage requests, download data, receive user input and catalog browsing.
- 2) the Catalog Node is the heart of the system and concentrates on connecting partners, metadata, search and discovery and secure peer-to-peer connectivity.
- 3) the Data Repository will be based on advanced real-time access components, and will also use the Data Center IT infrastructure for long term storage and access



* participants may include GFDL, NCAR PCMDI, EPA, other DOE, & US-GEO

NCMP Proposal for Collaboration Coordination

Value Chain for Data Management *



Functions

Functions add value to the raw material (in this case, data) to produce a product for Policy and Management Decisions

It is an iterative spiral approach



* Value Chain Construct (M. Porter, 1998 Competitive Advantage)

NOMADS: Collaborations a Priority

- ▶ Community building and collaborations are required in the era of 150PB model output data streams- digital libraries, distributed data access and processing.
- ▶ Adaptation of exiting efforts into the CLASS infrastructure also priority. May include:
 - Earth Systems Modeling Framework (ESMF);
 - the Earth Systems Grid (ESG);
 - iRODS and other community based distributed access technologies.



Next Steps

- ▶ Pending Congressional approval in the Presidents budget in FY10 NCMP will begin Spring 2010.
- ▶ An Open Invitation to Collaborate with NCMP.
- ▶ GO-ESSP is seen as critical to the success of NCMP. (as in the early NOMADS collaboration).
- ▶ Some initial activities is data set sharing for distributed access:
 - IPCC AR5 at NCDC NOMADS
 - CFSRR Reanalysis at NCAR
 - Model “HelpDesk” coordination across NCDC and GFDL
 - others



Thank you !! but finally...

Asheville NC USA: 2010 10th GO-ESSP Workshop?

Fall GO-ESSP Workshop
2010 Proposed

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QUESTIONS?

