NOAA National Climate Model Portal

NCMP

NOMADS

The NOAA Operational Model Archive and Distribution System

NOMADS and the National Climate Model Portal

NCMP

NOAMDS

NWS RITT Forum
May 18, 2011

Glenn K. Rutledge
NCMP/NOMADS Project Manager
NOAA's National Climatic Data Center
Asheville, NC 28801

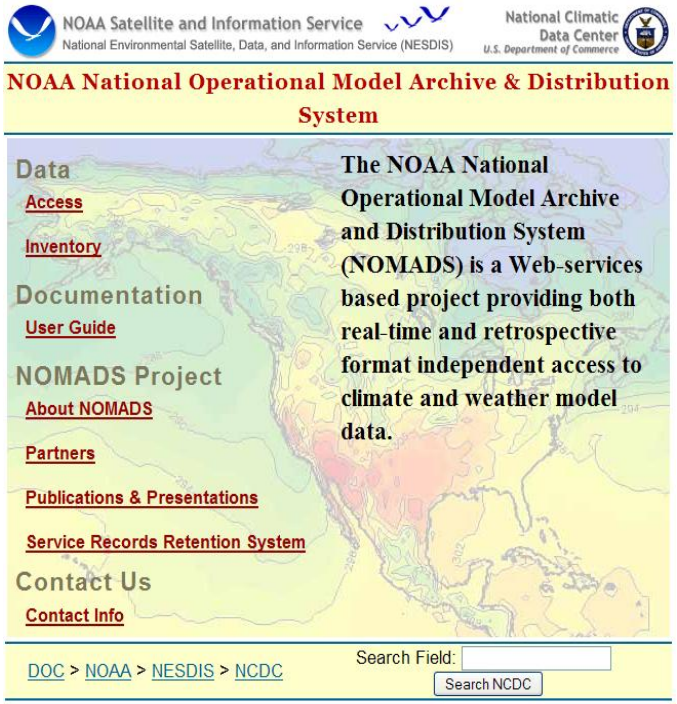
Member GO-ESSP

NOAA National Climate Model Portal

NCMP

NOMADS - NCMP Outline

- Project Staff
- Background: NOMADS
- Mission, Goals, and Objectives
- User Statistics and Data Availability
- Spin-up Plan and System Design
- User Requirements and Science Tools
- Program Support and Next Steps



NOMADS
The NOAA Operational Model Archive and Distribution System

Member GO-ESSP

NOAA National Climate Model Portal

NCMP

NOMADS Operations
NCMP Development Staff

Jay Hnilo CICS
Boulder, CO.

Rear (L-R):
Dan Swank
Jeff Budai
Danny Brinegar

Front (L-R):
Phil Cogbil
Glenn Rutledge
Mike Grogan

Not shown: **NOMADS Extended Team members**: Scott Stephens and Jeff Robel
Web Admin & App Dev: Georgi Petov

NOMADS - NCMP Mission Statement

- *Supporting NOAA's Science, Service, and Stewardship mission, the mission of the National Climate Model Portal (NCMP) is to aid in the understanding, sharing, and improvement of climate and weather models and associated information via innovative applications of web-based technology*

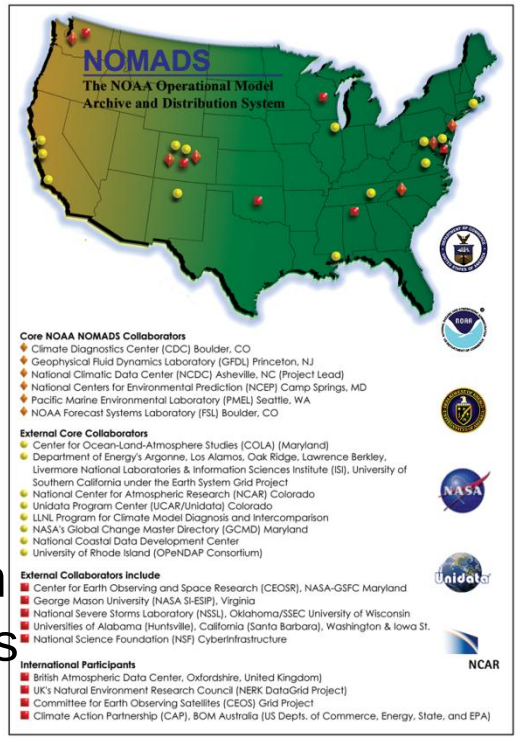
Background: NOMADS

- 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- operational in 2002.

- NOAA's NCDC initiated NOMADS with NCEP and GFDL. The collaboration grew quickly.

- Founding member of GO-ESSP. Focus has been on weather models. NCMP will address reanalysis and climate models and associated observational data.

- Users can have access to data as input to their decision making processes this information is useful on time scales from days (weather) to months (El Nino) to decades (global climate change).



NOMADS
The NOAA Operational Model Archive and Distribution System

10 Years OLD !

NOMADS Benefits

- In 2009 NWS systems engineers informally studied the bandwidth "cost savings" obtained via the NOMADS vs. traditional "gateway" servers.
- In a nutshell, they found an overall savings of 80% of the volume by using NOMADS for the same services.
- "NOMADS" services (OPeNDAP, GDS, LAS, TDS, ftp4u) being considered for "NOAA NexGen".

NOMADS
The NOAA Operational Model Archive and Distribution System

NOMADS - NCMP
OCIO Recommendation

- **NOAA Office of the CIO**
  - **Strategic Information Technology Plan 2010-2017, March 2010**
  - **IT Strategic Objectives (one of nine):**

"Continue development/implementation and maintenance of operational archive and user access capabilities for the National Climate Services Portal and National Climate Model Portal (NCMP) to provide access to the next generation of NOAA climate and weather models and analyses products."

NOMADS - NCMP
NAS Recommendation

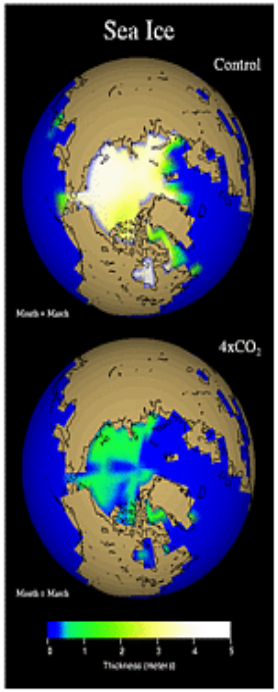
- **National Academies of Sciences, National Research Council, Board of Atmospheric Sciences and Climate**:

  "Completing the Forecast: Characterizing and Communicating Uncertainty for Better Decisions Using Weather and Climate Forecasts"

The NOAA National Operational Model Archive and Distribution System (NOMADS) should be maintained and extended to include (a) long-term archives of ***global and regional ensemble forecasting systems and their native resolution, and (b) re-forecast datasets to facilitate post-processing"***[1]

NCMP will be built on top of NOMADS as a suite of Services and Tools. It is an **extension** and an **expansion** of NOMADS

NOMADS Goals



- Establish a unified 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
The NOAA Operational Model Archive and Distribution System

NOAA National Climate Model Portal

NCMP

NCMP Objectives

Objective: Reliable, Consistent, Long-Term Public Access and Interoperability and Inter-comparison of Models and Observational Data sets for all levels of expertise.

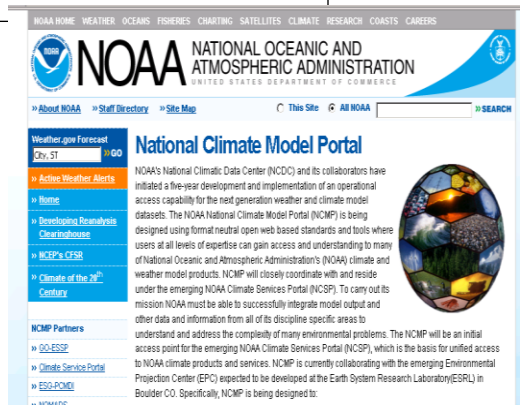
a. NCMP will be an Initial access point for models and associated data under the NOAA Climate Services Portal (NCSP).

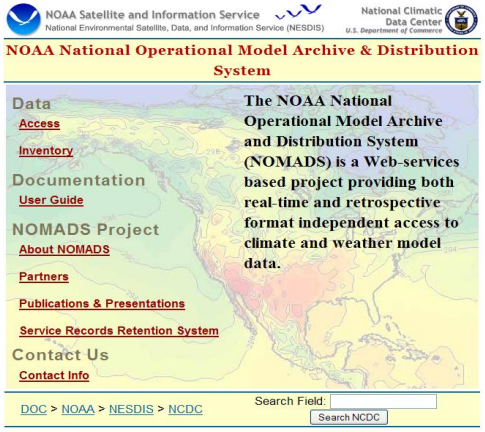
b. Access capability to NOAA's next suite of Climate reanalysis products: "Explaining Climate to Improve Predictions" (ECIP) approaching 1.2 Petabytes:
   a. CFS-RR (reanalysis and reforecast) (Saha, et al.)
   b. Twentieth Century Reanalysis Project (20CR, Compo)
   c. CFSR- 'Lite' (CPC, tbd)

c. In support of IPCC Assessment Report (AR5) activities NCMP will advance CMIP with a suite of both derived products and data and on-line diagnostic tools designed to support Stakeholders and improve access to climate information.

d. Regional & Local Modeling support; Downscaling

e. Engage and support stakeholders from functional requirements of their needs; Societal Benefit Areas; and NCDC "Sectorial" Teams. Initial requirements based on need of Water and Energy.





NCMP Deliverables

- While NCMP has a number of goals and objectives, it will ultimately be judged by it success in meeting the Deliverables and Performance Measures outlined in NOAA's FY 2012 Presidential Budget Request. NCMP's activities will be prioritized toward meeting those success factors.

- ***Deliverables***
  - NOAA Reanalysis Web Page for collection of User requirements
  - Access to the next generation reanalysis datasets; & derived CMIP
  - Model-to-Observational inter-comparison capability
  - Prototype Customer Service support capability and a research quality help desk supporting NCMP users
  - A reanalysis clearinghouse to host consensus datasets for the next series of NOAA reanalysis. (Reanalysis.Org)

GO-ESSP
A Primary Collaborator

Global Organization for Earth Systems Science Portals

- **British Atmospheric Data Centre**
  - Bryan Lawrence – Director, British Atmospheric Data Centre
- **Geophysical Fluid Dynamics Laboratory**
  - V. Balaji, Head, Modeling Group, Princeton/GFDL
- **The German Climate Computing Centre**
  - Michael Lautenschlager (NeRC Grid)
- **Lawrence Livermore National Laboratory**
  - Dean Williams, PCMDI, Chief Archive Services/CMIP5 , ESGF
- **National Center for Atmospheric Research**
  - Don Middleton, Senior Manager, Enabling Technologies, ESGF
- **Pacific Marine Environmental Laboratory**
  - Steve Hankin (Unified Access Framework, DMIT)
- **NOAA/Earth Systems Research Laboratory**
  - Cecelia Deluca (ESMF, National Climate Projection and Prediction NCPP prototype)
- **NOAA/National Climatic Data Center**
  - Glenn Rutledge, NOMADS/NCMP, DMIT

NOMADS hosted the 2011 GO-ESSP Workshop

May 9-10, Asheville NC
>90 participants !

http://go-essp.gfdl.noaa.gov/

Primary Collaborators (cont.)

Programs, Agencies, Academia

- Lawrence Livermore National Laboratory
  - Program for Climate Model Diagnostics and Intercomparison (PCMDI)
  - CMIP and AR International partners via the Earth System Grid (ESG): ORNL, PCMDI, NCAR, BADC, etc,
- Earth System research Laboratory (ESRL)
  - Environmental Projection Center
  - CIRES Climate Diagnostics Center NOAA PSD
- Pacific Marine Environmental Research Laboratory (PMEL)
  - Unified Access Framework UAF
- NOAA Climate Services Portal (NCSP)
- National Weather Service
  - Operational R/T NOMADS; WOC
- Geophysical Fluid Dynamics Laboratory via NOMADS
- Open Geospatial Consortium (OGC)
- Group on Earth Observations (GEO)
  - AIP-4
- U.S. Integrated Drought Information System (NIDIS)
- U.S. National Assessment Program (NCDC/NCS)
- UCAR / Unidata
- Center for Ocean-Land-Atmosphere (COLA)
- CEOS WGISS

NOAA National Climate Model Portal

NCMP

NOMADS Archive

NWP Model and Climate Reanalysis

Global Forecast System (GFS), 1 and ½ degree	March 2004 – Present, October 2006 - Present
NCEP Climate Forecast System Reanalysis (CFSRR) Global 32km	January 1979-Present
NCEP Climate Forecast System Reforecast (CFSRR) Global 32km	January 1979 – Present
NCEP North American Regional Reanalysis (NARR) 30 years 32km	January 1979 - Present
NCEP/NCAR/DOE R1 & R2 Global Reanalysis	Jan 1948 – Present, Jan 1979 - Present
NCEP Global Ensembles (GENS) / TIGGE (w/ NCAR)	December 2007 - Present
ESRL Twentieth Century Reanalysis Project (20CR) (2011)	January 1850-Present
NCEP Spectral Statistical Interpolation (SSI) Global Data Assimilation System (GDAS) w/ model restart	January 2001 - Present February 2002-Present
North American Mesoscale (NAM, formally Eta) 12km	February 2005 - Present
Rapid Update Cycle (RUC) 20km and 13km	January 2006 – Present, March 2007 - Present

Climate Data / Coupled AOGCM

Limited GFDL CM2.0 and CM2.1 Climate Experiments	Limited AR4/5
Paleoclimate Model Intercomparison Project (PMIP)	POR
CMIP3/5 multi-model suite via ESGF (2011)	AR4/5

In-situ

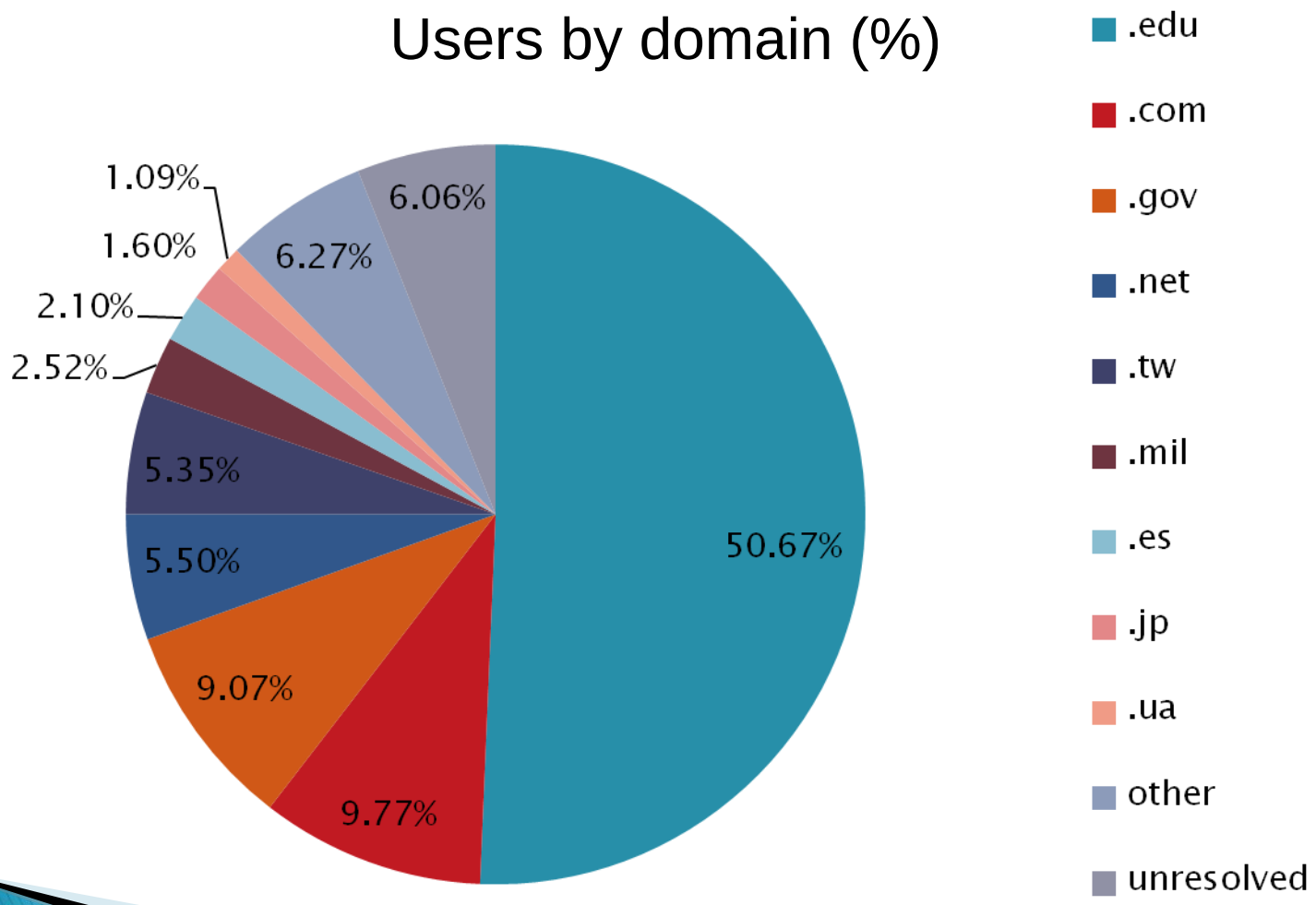
NCDC Global Historical Climate Network (GHCN) Temp/Precip	Jan 1880 – Present, Jan 1900 - Present
NCDC Integrated Global Radiosonde Archive (IGRA) upper air	Varies by station
NCDC Smith-Reynolds Extended Reconstructed and OI ¼ SST's	Jan 1854 – Present, Jan 1985 – Present
Service Records Retention System (SRRS)	April 2001 - Present

NOMADS
The NOAA Operational Model Archive and Distribution System

NOAA National Climate Model Portal

NCMP

NCDC NOMADS
User Statistics FY2010 (1/3)



NOAA National Climate Model Portal

NCMP

NCDC NOMADS
User Statistics FY2010 (2/3)

Education (.edu)

User	% Tot. Vol.
ucar.edu	32.55%
fsu.edu	5.33%
iastate.edu	1.97%
princeton.edu	1.30%
psu.edu	1.30%

Commercial (.com)

User	% Tot. Vol.
wunderground.com	3.30%
ceinetworks.com	1.09%
windlogics.com	1.01%
vestas.com	0.82%
boeing.com	0.69%

Government (.gov)

User	% Tot. Vol.
nasa.gov	4.75%
noaa.gov	2.33%
aftac.gov	0.66%
pnl.gov	0.64%
nersc.gov	0.46%

Networks (.net)

User	% Tot. Vol.
comcastbusiness.net	2.35%
comcast.net	0.63%
verizon.net	0.58%
optonline.net	0.50%
windstream.net	0.38%

% of total volume

NOAA National Climate Model Portal

NCMP

NCDC NOMADS
User Statistics FY2010 (3/3)

FY10

Distinct hosts served: 83,370

Successful requests: ~125 million

1 day record: 4.9TB

Data Type	Volume (TB)
CFSR -Reanalysis	218.89
NARR	64.11
GFS	56.64
NAM	15.6
RUC	10.46
NCEP/EDAS	1.38
GDAS	0.79
GENS	0.49
Tape Orders	97.27
Total	**465.19 TB**

With NOMADS/NCMP sub-setting capabilities performance metrics based solely on data volume downloaded misses the point entirely!

FY11

user requests will exceed 2010 significantly due to the addition of:

- CFS Reforecast
- CFSv2 Operational runs
- 20th Century Reanalysis Project

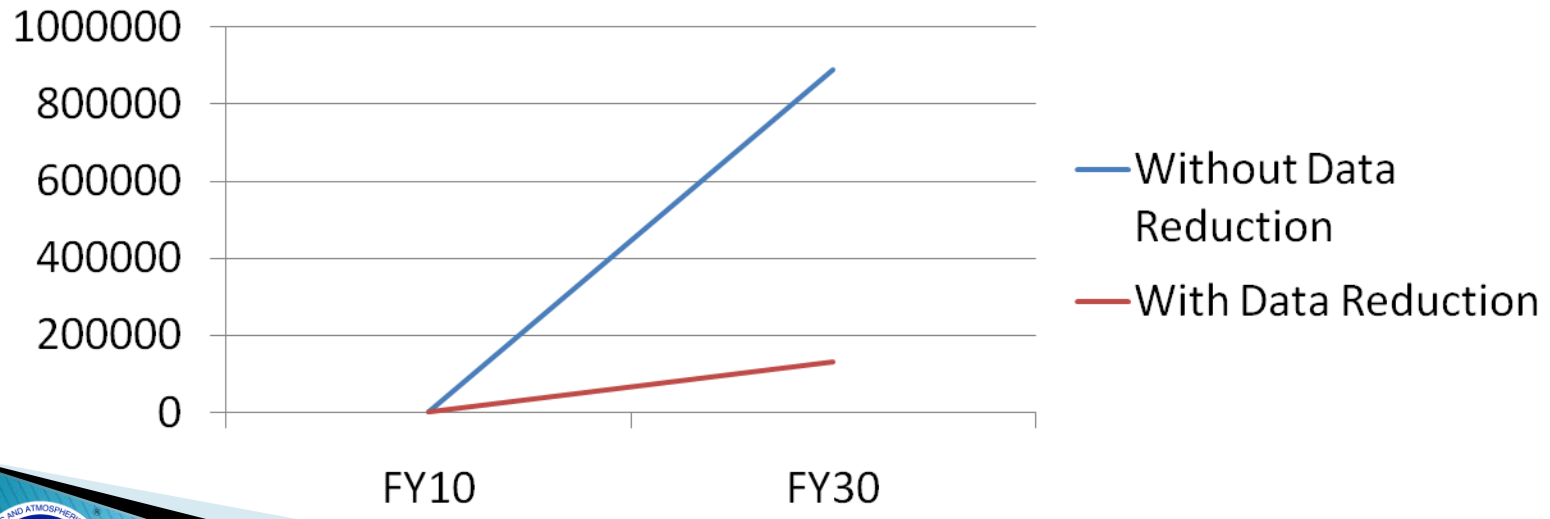
How best to scale to meet ever increasing data volumes and user demand

Model Archive Growth Exebyte (EB)

- Since 1966, model output volume closely mirrors "Moore's Law":
  - a doubling of volume (CPU processing speed) approximately every two years*.

•Derived estimates below show existing archive storage requirements without data reduction practices. Volumes approach 1 Exabyte (1 Billion Gigabytes).

- Simple data reduction policies to remove forecast products, and outdated reanalysis reforecasts, and Atmospheric-Ocean General Circulation Models (AOGCM's) at the Archive level greatly reduces archive and stewardship requirements.



* unpublished results (Rutledge, Alpert 2004)

NOAA National Climate Model Portal

NCMP

Model Data Volume by Type

Data Type	Volume Growth Rate	Data Reduction	Compression	Total Volume * (PB) FY10	FY30
NWP and Ensembles[1]	Doubling /2yr**	Yes: Del. Fcst fields	GRIB/NetCDF	1.3	~49
AOGCM's Climate[2]	Step function	Yes: Maintain Two IPCC AR cycles	NetCDF (4)	0.1	~40
Reanalysis[3]	Step function	Yes: 2 Reanal cycles	GRIB/NetCDF (4)	.3	~36
Regional Downscaled[4]	Linear	Yes 10 years	NetCDF (4)	0.002	5
Reanalysis Clearinghouse Observations[5]	Linear	No WCRP/ WOAP/other	various	0.005	1
Totals				1.7 PB	131 PB

Notes:

1.NWP forecasts removed after 5 years. Only Analysis and Initial conditions retained.

2.Climate Models increasing as stewardship and user access requirements increase under NOAA.

3.NOAA reanalysis once performed only every 10 years. New IT resources and NOAA "Clearinghouse" will allow on-going reanalysis of the climate system.

4.Only critical Regional and Local scale downscaled analysis retained at NCDC. Regional offices can maintain as req'ed.

5.NOAA recommendation to create a database of in-situ obs avbl for on-going reanalysis of the climate system. Multi-Agency involvement: NOAA, NASA, ESCMF, EPA, NCAR, USGS, et al., : "Reanalysis.org".

* Volumes in Peta bytes (1,000TB).

* * NWP Estimates based on verified linear to log exponential growth using empirical data since 1966 (J. Alpert 2004).

NOMADS
Data Management Philosophy

- Different combinations of community assets will solve different problems
- Can be tailored to current near-term solutions
- Effective use of existing portals for data access and distribution, and for existing transport technologies will increase chances of success.
- NOMADS participates in a broader NOAA-wide and Agency-wide framework for a comprehensive suite of modeling services (e.g., GO-ESSP, ESGF, NCPP, etc.)

NOAA National Climate Model

U.S. GEO Modeling Infrastructure Vision of the Future

Reanalysis and Climate Clearing-house
Community vetted observational database

Public and private catalogue

Search tools

Metadata

Ontologies

Workflow generation tools

Private virtual workspaces

Shared virtual workspaces

NOMADS & National Climate Model Portal

NOAA Climate Services Portal

Users

Middleware, access protocols, secure data transport

User authentication, access control logic

Metadata vocabularies, ontology standards

Education and training, user support

Monitoring & control services

Event detection

Adaptive

Observing System Simulation Experiments

Pre / Post Processing

Real-time data streams

Datasets

Modeling Systems

Analyses

Other (e.g. Unique Instrumentation)

Observing Systems

Task

D D D

Earth Systems Modeling Framework

Workflow orchestration engine

Q A M

DOE Earth System Grid & iRODS

Private or published results

CLASS and NCDC Long-term archives

Compute servers

Digital libraries

GEO US-GEO

D data
Q Q/A
M model
A analysis

Rutledge/Meacham/Fontaine 2006

NCMP Model Infrastructure

NOAA National Climate Model Portal

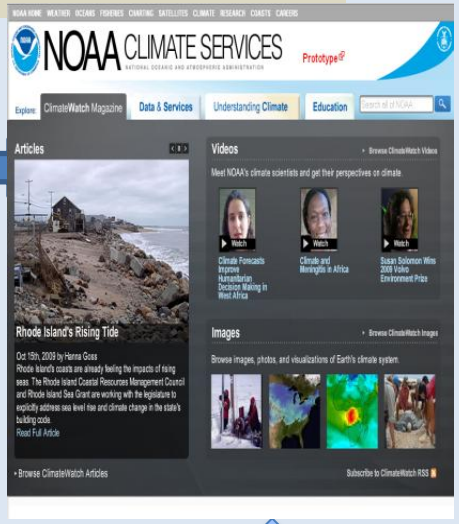
NCMP

Reanalysis.Org
Climate Clearing-house
Community vetted observational database

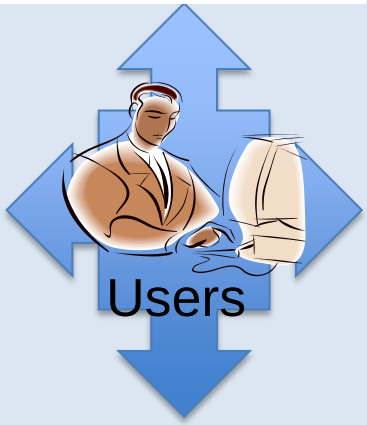
NWS | NODC | GFDL | NCDC

GDS | Search tools | LAS | ESG iRODS | CDAT | TDS

NOAA NOMADS



- Global Interoperability Framework
- National Climate Predictions and Projections Center



NOAA Cooperative Institute Climate and Satellites
CICS-NC Asheville

NOAA Climate Assessment Services

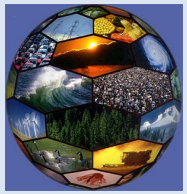
Private or Unpublished results

LLNL / ORNL Collaborations

Earth System Grid Framework

NCDC

NOAA Archive Services / CLASS

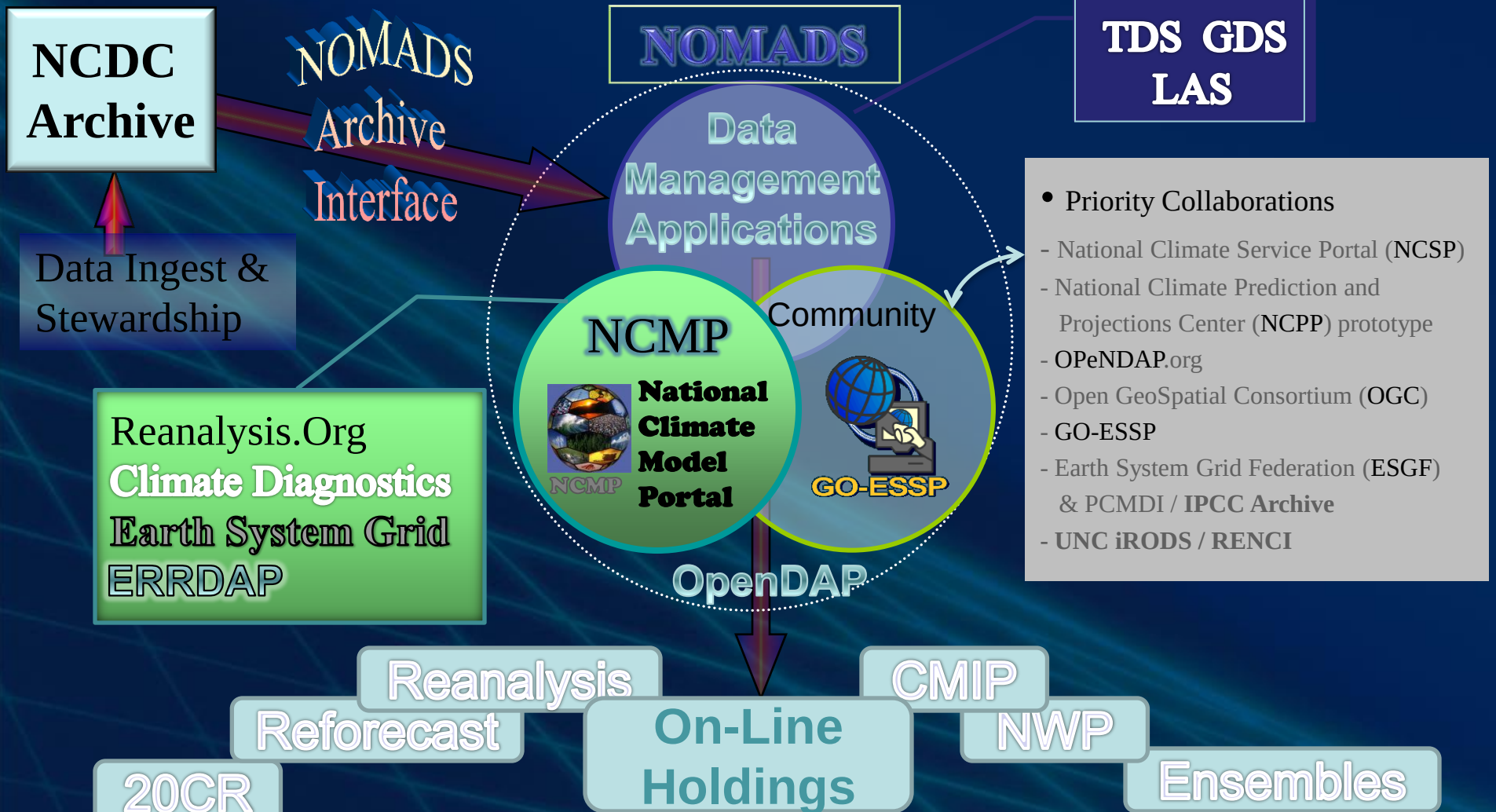


Rutledge/ 2011

Multiple paths to format independent data access

NOMADS
The NOAA Operational Model Archive and Distribution System

The NOMADS/NCMP System



- Priority Collaborations
  - National Climate Service Portal (NCSP)
  - National Climate Prediction and Projections Center (NCPP) prototype
  - OPeNDAP.org
  - Open GeoSpatial Consortium (OGC)
  - GO-ESSP
  - Earth System Grid Federation (ESGF) & PCMDI / **IPCC Archive**
  - **UNC iRODS / RENCI**

The NOMADS/NCMP System

NOMADS
The NOAA Operational Model Archive and Distribution System

NOMADS

The Back-end {1.0}
Where the Applications and Work is performed

Back

Clients & Processes {1.1}
- Ferret
- Grads
- Ingest
- N-HAS
- others

Scripts & System Processes {1.2}
- System Monitoring
- Clean-up
- Ingest & Post-Processing
- others

Applications {1.3}
- GDS
- TDS
- LAS
- ERRDAP (here?)

Grid Technologies {1.4}
- ESGF
- iRODS (tbd)

Hi-Volume Transfer and Broadcast {1.5}
- redot his...
- LDM
- NCDC ftp
- CLASS
- others

NCMP

The Dashboard {2.0}
This is the entry page for the NOMADS user. A 3-tier approach

- **Simple Presentation Mode {2.1}**

Simple Access for Teachers, Students, the General Public. "What impact will Global Warming have on me in 25 years?"

- **Targeted Presentation Mode {2.2} User Engagement Secto**
  - Agriculture {2.2.1}
  - Litigation {2.2.2}
  - Travel {2.2.3}
  - Energy {2.2.4}
  - Transportation {2.2.5}
  - Water Resources {2.2.6}
  - Civil Infrastructure {2.2.
  - Coastal Hazards {2.2.8}
  - Health {2.2.9}
  - Insurance {2.3.0}
  - Commerce {2.3.1}
  - Modelers {2.3.2}
  - Climate Impacts (2.4.0)

{2.3} US Assessments
{2.4} Climate Service Port

- **Expert and Advanced Mode {2.5}**
  - Modeler Access {2.5.1}
  - Ensemble Diagnostics {2.5.2}
  - Climate Diagnostics (2.5.3}

Sub-setting data, & datasets for targeted orders: model diagnostics and uncertainty generation.

User Capabilities {3.0}
This section describes the user components as functions and capabilities. This section of components defines system requirements based on user needs.

High Level Inventory & Browse {3.1}
→ Browse / Catalogs / Metadata Archive & ISO

uest Selection .2}
→ Selection of Data: subset / simple aggregation / two-way interactions

ilities
s
zation
Forum
Desk
nostics Tools
nomalies
NAO, AO, etc.
re repository

- {3.3.1} **Advanced User Capabilities** Format Conversion / Re-gridding / re-projection 5-D sub-setting / advanced aggregation
- {3.3.2} **Direct File Access** ftp2u / http-wget / TDS / partial http
- {3.3.3} **Existing Services and Tools** Ensemble Probability / Reanalysis / NCEP Charts / GDS / TDS / LAS / SRRS / OPeNDAP / IOSP /
- {3.3.4} **Visualization** Weather & Climate Toolkit pdisp / new

Admin / Monitoring {3.6}
→ {3.7.1} stats / backup / system availability

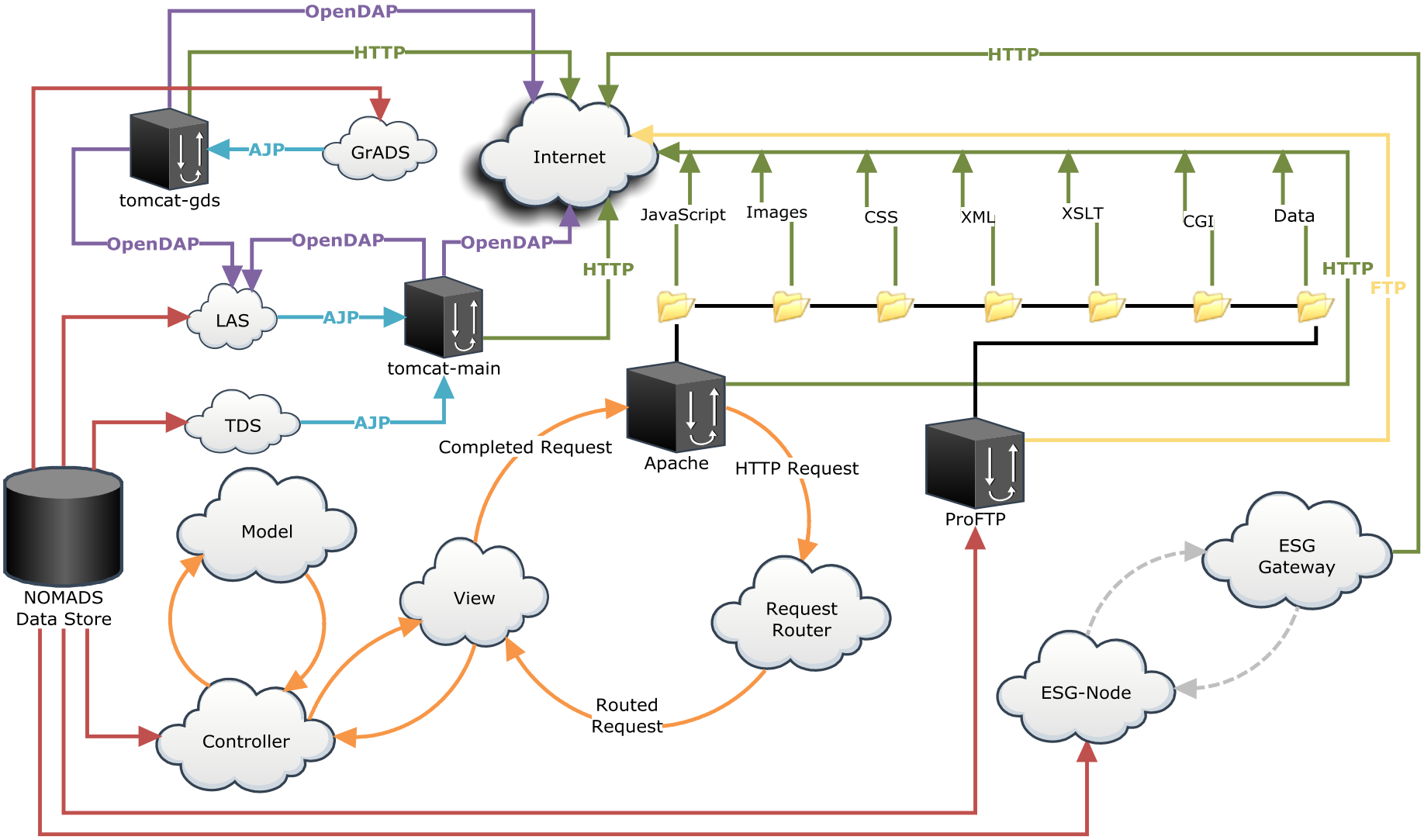
NCMP
National Climate Model Portal

- 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.

NOAA National Climate Model Portal

NCMP

Current NOMADS Architecture



NOAA National Climate Model Portal

NCMP

Existing NOMADS-NCMP Servers

- **Archive** services supported by NCDC is available at http://nomads.ncdc.noaa.gov/. This server provides
  - access to most of NCEP's operational data sets
  - a long-term archive for all data sets
  - many other data sets (see http://nomads.ncdc.noaa.gov/data.php?name=inventory)
  - A non-operational research and development server (and developing ESG node) managed by NCDC is available at http://nomads6.ncdc.noaa.gov/ncep_data/index.html

- **Near real-time services** supported 24x7 by NWS is available at http://nomads.ncep.noaa.gov/. This server provides
  - access to NCEP's operational data sets as they are being generated
  - a short-term archive of up to a month for most data sets
  - 24x7 operational monitoring by NCEP staff
  - a geographically-diverse backup server to insure operational availability
- Four non-operational **research and development** servers used for customer testing of new products and services prior to operational implementation
  - These servers are not guaranteed to have current data and their content are supported only during business hours and on the basis of staff availability. Three non-operational research and development servers managed by NCEP are available at
    - http://nomad1.ncep.noaa.gov/ncep_data/index.html
    - http://nomad3.ncep.noaa.gov/ncep_data/index.html
    - http://nomad5.ncep.noaa.gov/ncep_data/index.html

- **Ocean-NOMADS** at http://edac-dap2.northerngulfinstitute.org/ocean_nomads/. This server provides most NCEP and some Navy Ocean Models.

Existing NOMADS Services

- **Data Access Services**
  - THREDDS Data Server
    - OPeNDAP access form
    - NetCDF Subset service
    - GIS/WCS and WMS capabilities
    - Raw data file server
    - Limited aggregation capabilities
  - Grads Data Server
    - OPeNDAP access for GrADS compatible data
    - Full aggregations to ease access
  - Web applications
    - Ensemble probability tool: Easy interpretation of GFS ensembles
    - SRRS archive / NCEP charts access application
- **Raw/Scriptable data access**
  - Partial-HTTP subsetting
  - Anonymous FTP for select datasets
  - Bulk access through wget scripts
- **Archive Access**
  - N-HAS offline data request system within NOMADS web interface
  - Bulk FTP access through N-HAS
  - OPeNDAP enabled offline cache.
  - CLASS bulk and OPeNDAP access proxy
- **Requirements and Outreach**
  - User requirements
  - “Sectoral” engagement (energy, water, transportation, Ag, etc.)
  - NCMP Charter & Program Plan

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 21 member GFS ensemble dataset located on the NCEP NOMADS High Availability server. The data is passed via OpenDAP back to the application, where it is read using the Java NetCDF library, and then the probabilities are calculated.

For more information, please see our help page.

Where

Station ID: Asheville, Asheville Regional Airport, NC, United States

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

When

Latest model run (2009 Oct. 23 06z)

Year Month Date Model Run 00z

What

- [x] Air Temperature at 2 meter height
  - [x] 6 hour Highest temperature: greater than 65 °F
  - [ ] 6 hour Lowest temperature: greater than °C
- [ ] Precipitation
- [ ] Wind at 10 meter height
- [ ] Cloud Cover
- [ ] Air Temperature at 850 millibar pressure level
- [ ] Convective Available Potential Energy (CAPE)

Submit

PDF's on the fly

NOMADS Ensemble Probabilities on the fly:

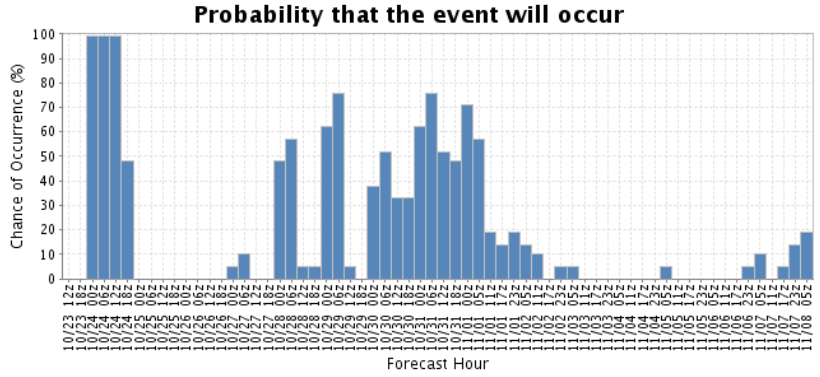
- 20 model runs
- 30 fcst projections
- 10 days of forecast

Request

Location:
Asheville, Asheville Regional Airport, NC, United States (35-25-55N, 082-32-15W)
Time:
Oct 23, 2009 06z
Event:
where the highest temperature is greater than 65 degrees F.

Progress [show]

Results




```
                    NOMADS Ensemble Probability Tool
================================================================================
Probability that the following event will occur:
   Where the highest temperature is greater than 65 degrees F.
At the location:
   Asheville, Asheville Regional Airport, NC, United States (35-25-55N, 082-32

For the GENS model run at the given time:
   Oct 23, 2009 06z
```

http://nomads.ncdc.noaa.gov/EnsProb/

NOAA National Climate Model Portal

NCMP

NOMADS - NCMP Reanalysis.Org

Reanalyses.org collaboration to:

- Facilitate comparison between reanalysis and obs datasets
- Evaluative content provided by reanalysis developers
- Provide links to detailed data descriptions;
- Describe and provide data access
- Wiki format to promote discussions of the recovery of observations to improve reanalysis

NOAA, NASA, ECMWF, UKMET, JMA…

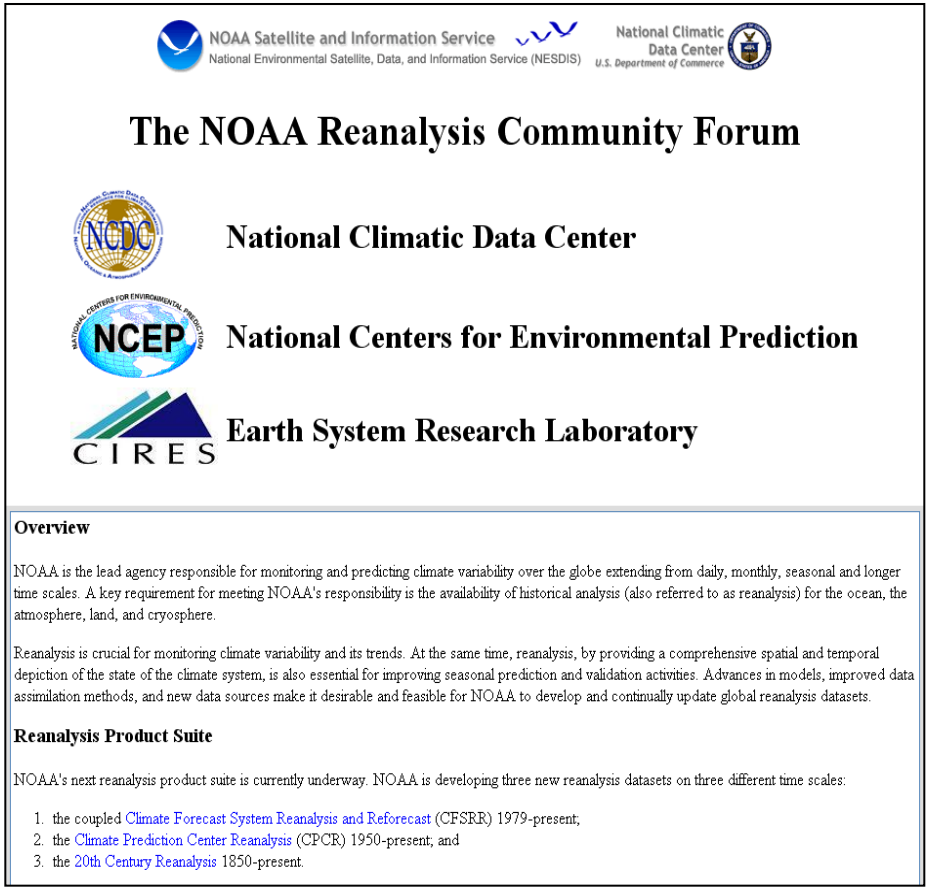
NOAA National Climate Model Portal

NCMP

NCMP
NOAA's Reanalysis Community Forum

NCMP hosts a community feed-back and information page. Used for requirements. Provides info for:

1) Climate of the 20th Century (Compo et al.,)
   - 1850 to present.
2) Climate Forecast System Reanalysis and Reforecast (CFSRR) Project (Saha et al.) 1978-2009 modern era Reanalysis and Seasonal Reforecast
3) tbd: CFSR 'Lite" reanalysis (NCEP/CPC)



http://nomads.ncdc.noaa.gov/NOAAReanalysis/

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NOAA National Climate Model Portal

NCMP

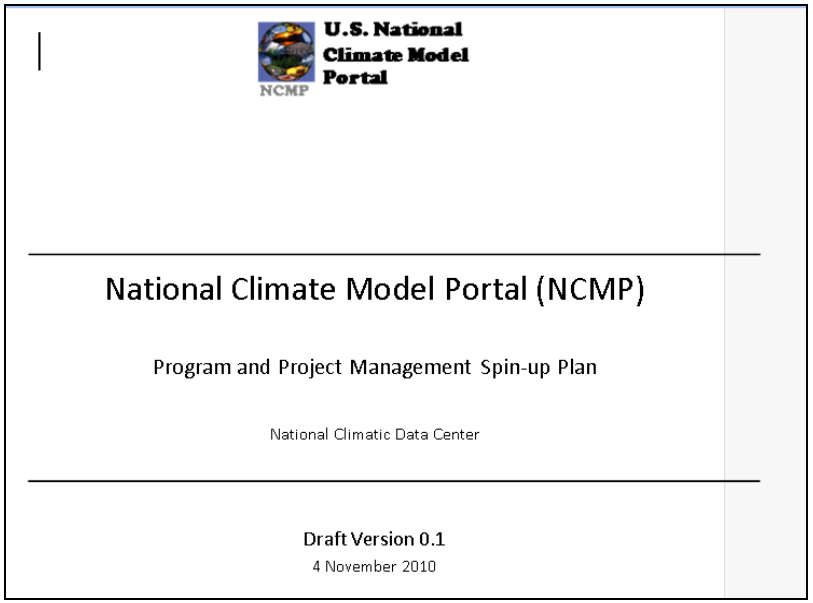
NCMP Architectural Design by Functional Areas

- Project Management
- Planning & Engineering
- Climate Science Applications
- Application Development
- Sector Engagement
- Systems Technology
- Dataset Management
- Model Data Dissemination Support

NCMP
Spin-up Plan and Charter

- NCMP Project Management Spin-up Plan, Charter and Program Plans in development gathering stakeholder requirements, and leveraging and community efforts.

- To reach its broad goals, NCMP will focus its work on five key functional areas:
  1) dataset availability
  2) scientific tool development
  3) sector engagement
  4) general tool development
  5) climate data dissemination and support


U.S. National Climate Model Portal
NCMP

National Climate Model Portal (NCMP)

Program and Project Management Spin-up Plan

National Climatic Data Center

Draft Version 0.1
4 November 2010

U.S. National Climate Model Portal

NCMP

NCMP Initial Capabilities

Architectural Fit: An Earth System Grid Federation Node

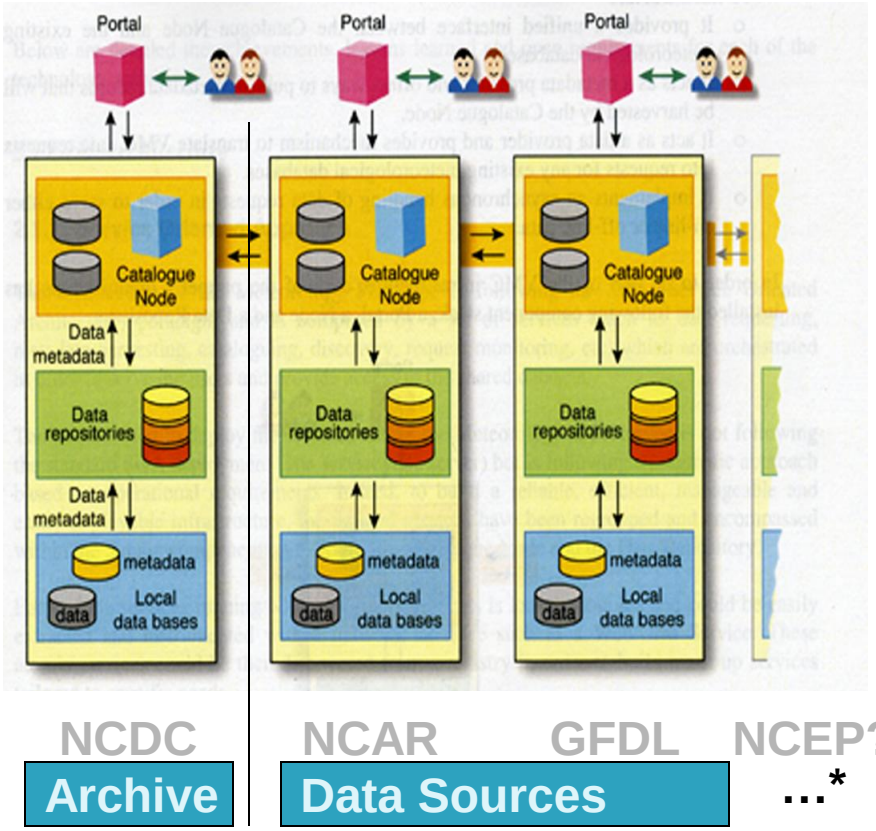
The initial NCMP architecture is based on NOMADS and on the DOE ESG: a (advanced) Portal, the ESG/TDS Catalog Node, and the (local) Data Repository.

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 advance and leverage ESG/ TDS. Heart of collaboration 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, advancements to CLASS and will also use the NOAA Data Center IT infrastructure for long term storage and access**

Generalized Schematic



Pilot w/ RENCI / DICE iRODS underway

U.S. National Climate Model Portal

NCMP

NCMP
Science Tools for Users (1/3)

- Support for assessments, downscaling, diagnostics, calibration of NWP ensembles and model-to-obs inter-comparisons, and aggregations of commonly used variables of NOAA reanalysis datasets.

- Regridding: Preserving the monthly mean, from high res to low res and back and forth.

- Format Conversions, Transformations & Geo-rectification: Grib1,Grib2 to CF complaint NetCDF; and from NetCDF3 to NetCDF4.

- More general simpler tools for dumping data (of all formats) to CF compliant NetCDF

- Extraction of a pseudo-station location (ARM site for example) from gridded model data using a Cressman analysis

NCMP
Science Tools for Users (2/3)

NCMP ADVANCED / INTERMEDIATE USERS

• Incorporate first look diagnostic capabilities. These could be both a thumbnail plot, brief description, resultant data in NetCDF form and (initially) python source code and OGC compliant (ESRI) plots.

• Average Annual cycles, diurnal cycles, annual averages, examination of anomalies, measures of extreme events, climate sensitivity, decadal trends, ratio of variances, Empirical Orthogonal Functions and where applicable comparisons to observations.

• Examination of tropical variability, calculation of ENSO indices, simulation of satellite measures from both models and observations

NOAA National Climate Model Portal

NCMP

NCMP
Science Tools for Users (3/3)

PROFESSIONAL USERS- Diagnostics & Model-to-Obs Inter-comparisons

- On-line access to Climate Model Analytical Egines
  - Climate model Data Analysis Tool (CDAT) for advanced model diagnostics and model-to-obs intercomparisons.
  - other tools such as NCDC's SPEC (Ansari et al) will be leveraged to a help develop thumbnail plots generated from CDAT python code as to be extensible with CDAT to accurately geo-locate non-discrete points to grids.

- Variability (identification of regions of climate sensitivity)
  - Tools will be developed to find a simple ratio of variances for (projected model results) / (observations)
  - e.g., Twentieth Century Reanalysis Project, or Climate of the 20th Century run or, 2x or 4xCO2 GFDL IPCC CM.x runs

- Decadal Temperature Trends and Average Annual Cycles

Anomalies can be pre-staged. Average annual cycle differences between a control run and a doubled CO2 would infer that presently precip maximums are in June – but in a 2xCO2 run precip maximizes in January. These are important direct measures appropriate for an advanced audience.

NOAA National Climate Model Portal

Simple Measures of sensitivity/indices:

- Ratio of variances of (surface temperature)/(skin temperature)
- Radiative flux measures: TOA and surface SW and LW
- Examination of vertical structure of simulated Cloud fraction
- Investigate quantification of surface albedo and change
- Quantification of extreme events from models compared to observations (frequency and magnitude)
- Derived ENSO, NAO, indices compared to observations, emphasize timing of reoccurrence and magnitude.
- Simulation of satellite measures from model data

  ratio of variance of skin temp and simulated measure

NOAA National Climate Model Portal

NCMP

NOMADS - NCMP
Eg. Science Tools for Users

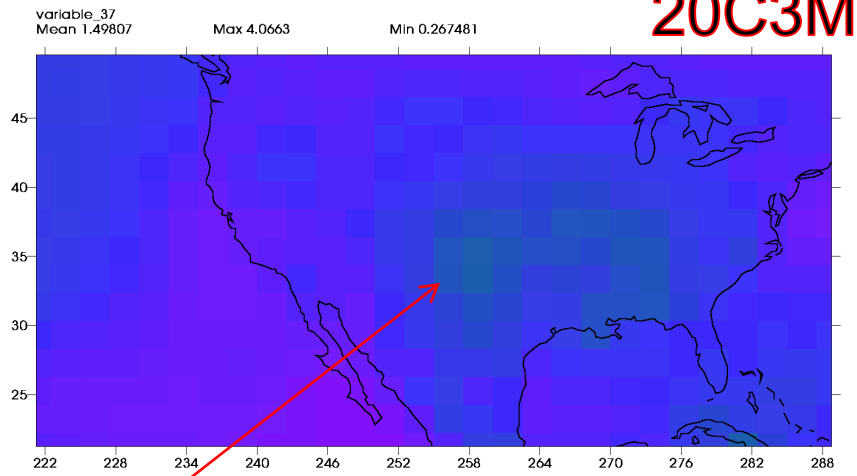
Climate of the 20th century runs (Annual averages):
Global variance of surface temperature (C).

NCEP/NCAR R2 reanalysis (1948-2000) = 0.064
GFDL 2.1 (1948-2000) = 0.071

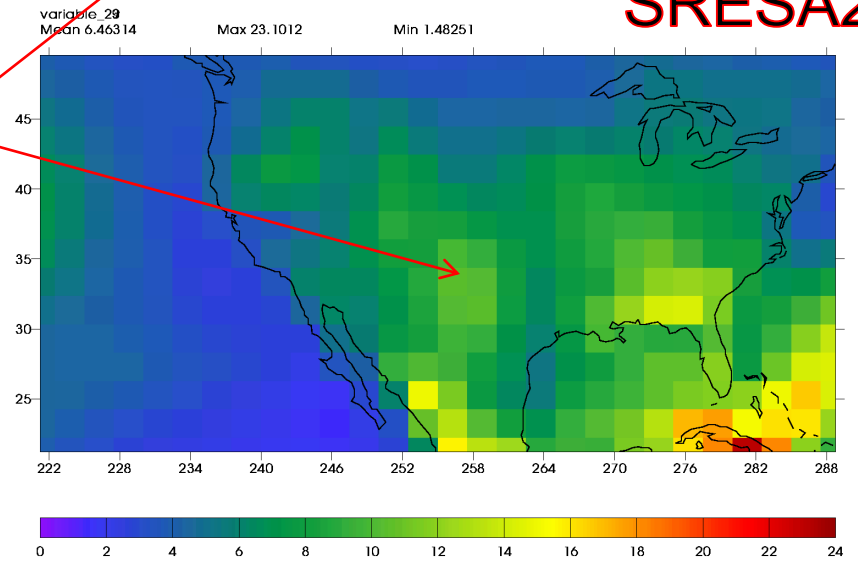
GFDL 2.1 (2000-2099) A2 = 0.841
GFDL 2.1 (2000-2099) A1B = 0.553
GFDL 2.1 (2000-2099) B1 = 0.193

A ratio of variance of annually averaged surface temperature (same scale)

20C3M



SRESA2



NOAA National Climate Model Portal

NCMP

National Climate Model Portal Downscaling

NCMP CICS DOWNSCALING
Close Coordination with U.S. National Assessment Program at USGCRP

Dynamical:
Initially use NCAR WRF for downscaling of global reanalysis, climate of the 20th century runs and 2xCO2 model runs. Output initially will emphasize state variables and those appropriate for study of the hydrological cycle and alternative energy production (e.g., wind, solar isolation).

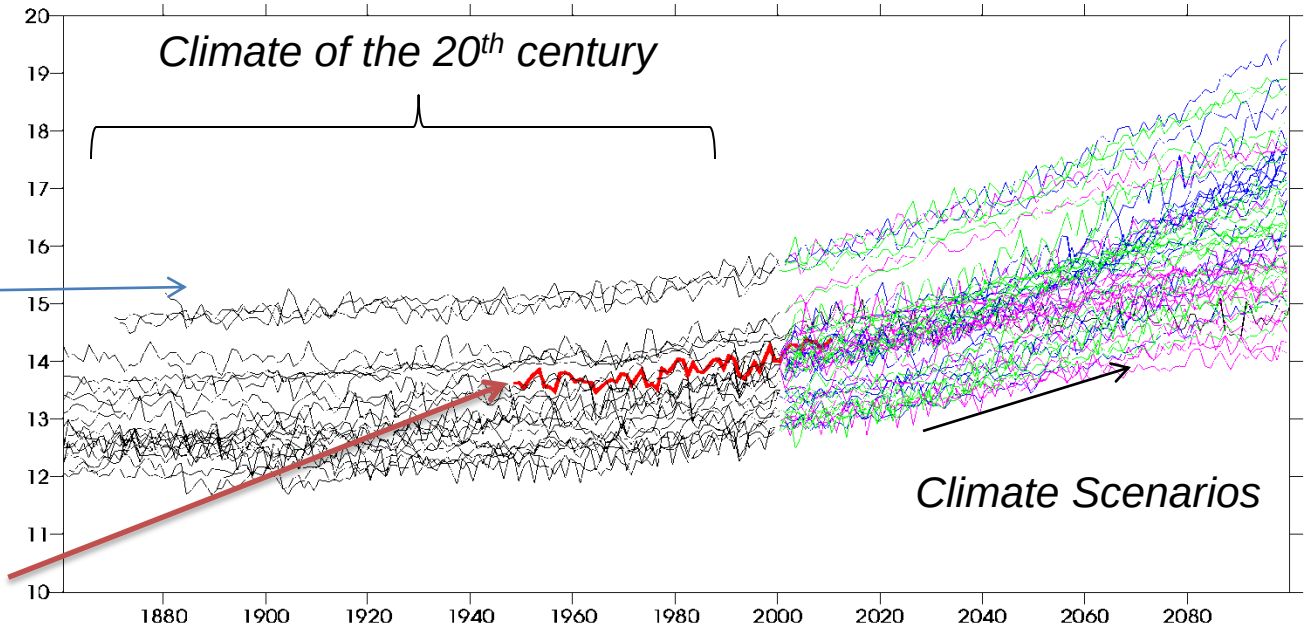
Statistical:
NCMP will advance existing NCDC Sector Teams and work with mitigation, economic, and private sector researchers to formulate appropriate methods for application of this approach. We will emphasize tools to perform the calculations on the server side or give access to monthly-mean model output for data generation by the researchers themselves. It is thought ASCII text output would be sufficient for this method in the short term. (Heyhoe and Boyle guidance)

NOAA National Climate Model Portal

Modeling, NWP, and Intercomparison Projects

Global Surface Temperature ^{0}C

INGV_ECHAM4
CSIRO3.5
GISS_E_H



R2 reanalysis

This plot is dynamically generated from CMIP3 and requested by NCSP

A2 Scenario:: Average of 19 different models and average of last ten annual values = 17.00 ^{0}C

A1B Scenario:: Average of 24 different models and average of last ten annual values = 16.45 ^{0}C

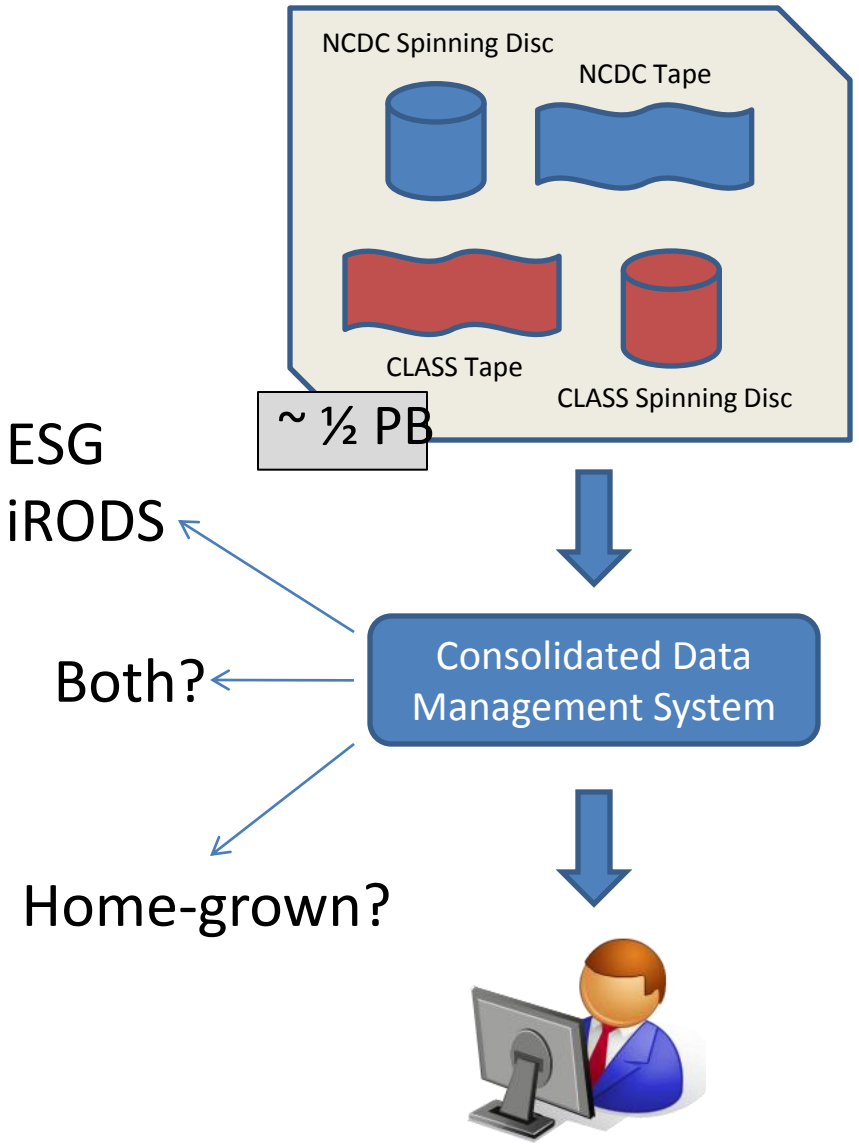
B1 Scenario:: Average of 20 different models and average of last ten annual values = 15.51 ^{0}C

NOAA National Climate Model Portal

NCMP

Improved Data Management

- NOMADS' holdings continue to grow, especially with additions of new data as part of NCMP
- Holdings now spread across 4 different NOAA/NCDC media
- NCMP will leverage/create and/or select a data management system to abstract the handling of these media
- NOMADS/NCMP users will gain a more consistent user experience across all datasets



NOAA National Climate Model Portal

NCMP

NOMADS as data store → NCMP as data discovery

- Metadata-based search and discovery
- Extending distributed access mechanisms
- Technology & tools such as
  - ncISO
  - ESGF
  - ERDDAP / GI-cat / GI-go
  - UAF
  - esri GeoPortal

ESGF Earth System Grid Federation

NOAA

unidata

GI cat

esri

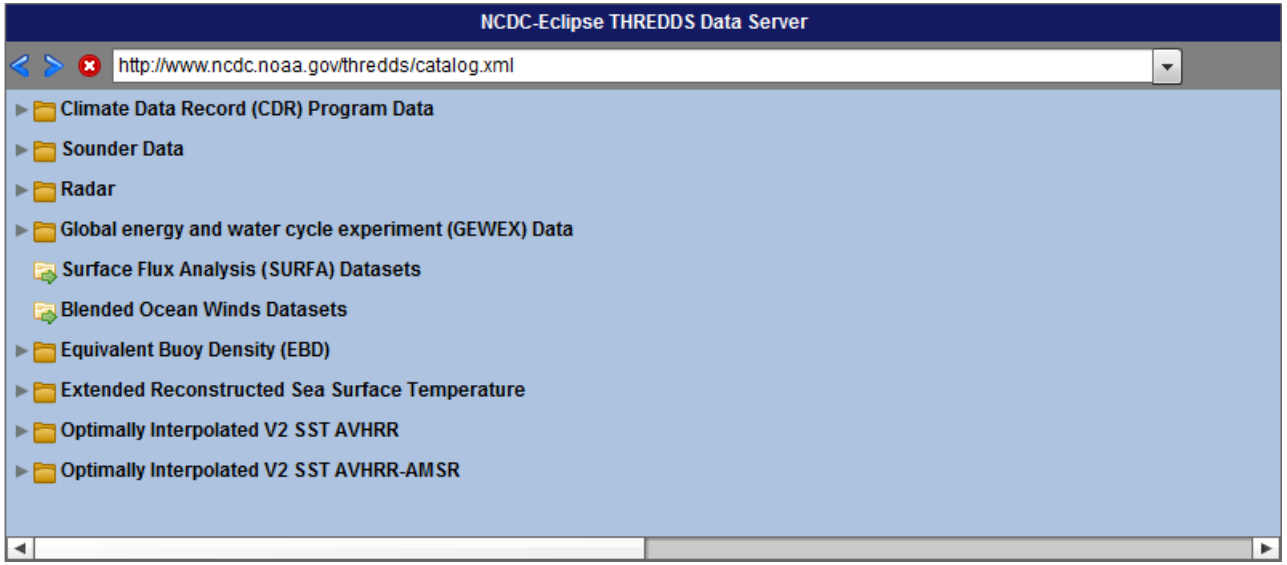
NOAA National Climate Model Portal

NCMP

NCMP / NOMADS Technology Enhancements

- Extending NOMADS into interactive and sector-utilized formats and technologies

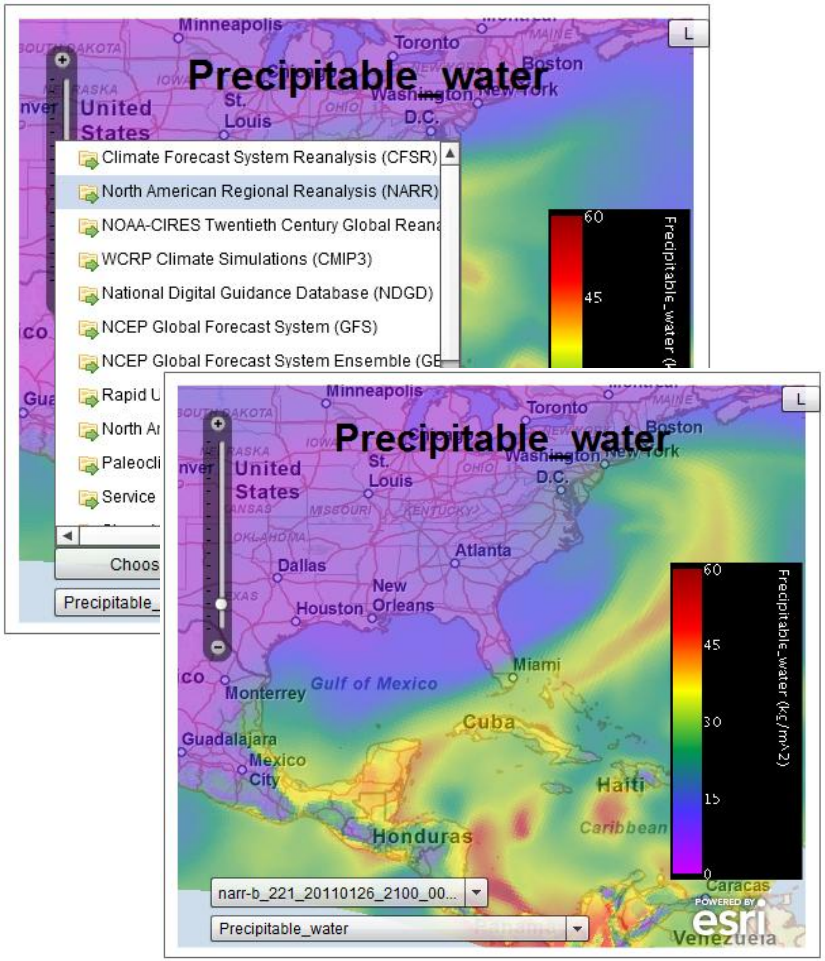
Example: THREDDS Catalog Navigation in Adobe® Flash®



NOAA National Climate Model Portal

NCMP

NCMP / NOMADS Technology Enhancements (cont.)

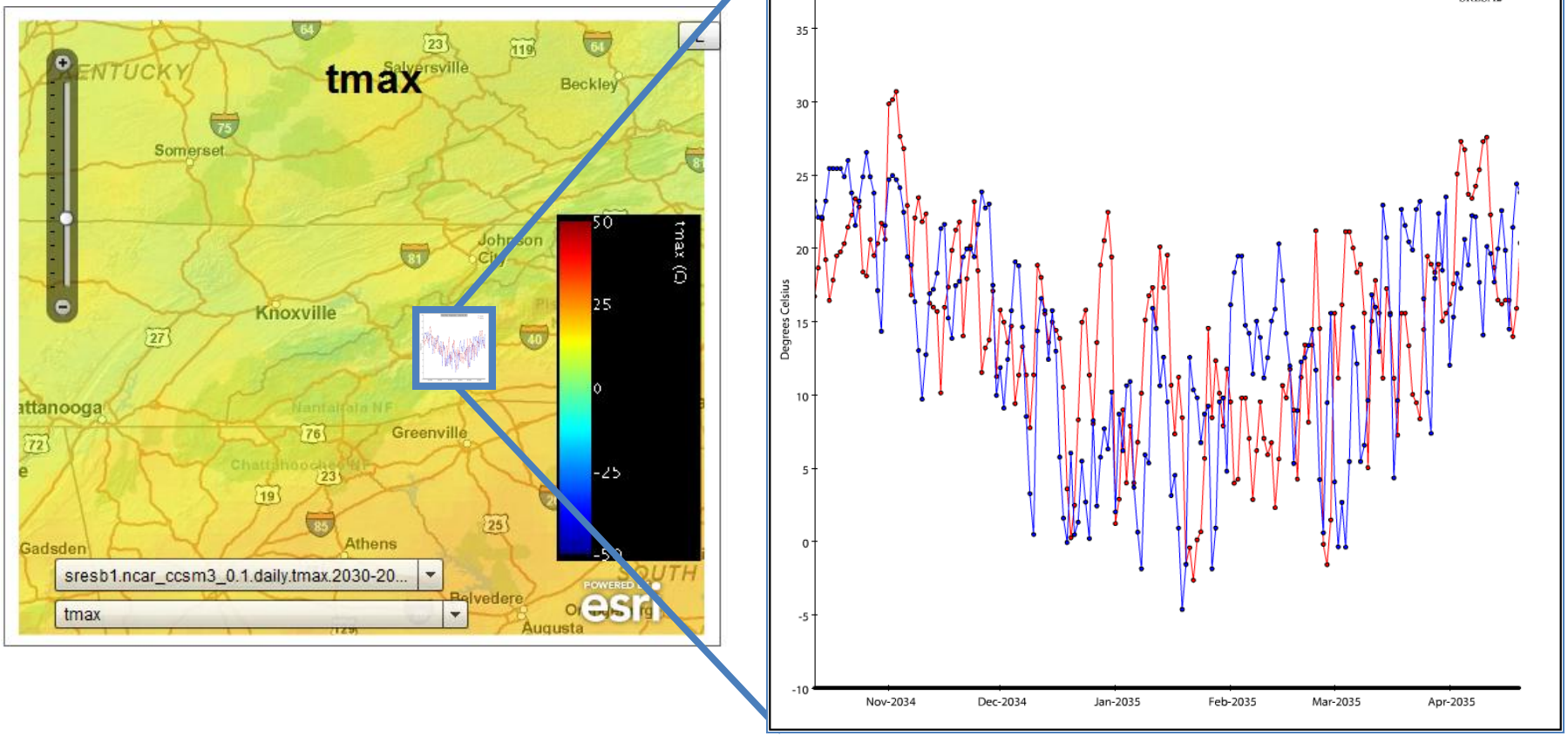


- Incorporating THREDDS-based data into interactive mapping applications
- Utilizing OGC components from THREDDS (WMS, WCS, etc.)

NOAA National Climate Model Portal

NCMP

NCMP / NOMADS Technology Enhancements (cont.)

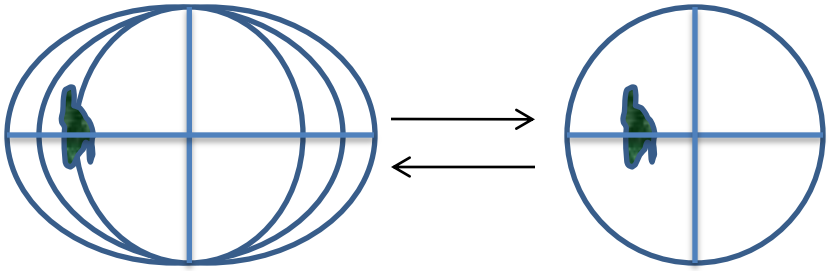


Interactive experiences: CMIP3 data in a web-based mapping application with multi-scenario timeseries comparisons via Multigraph

NOAA National Climate Model Portal

NOMADS - NCMP
Support for GIS Users

Oblate spheroid (aka, Earth) to sphere

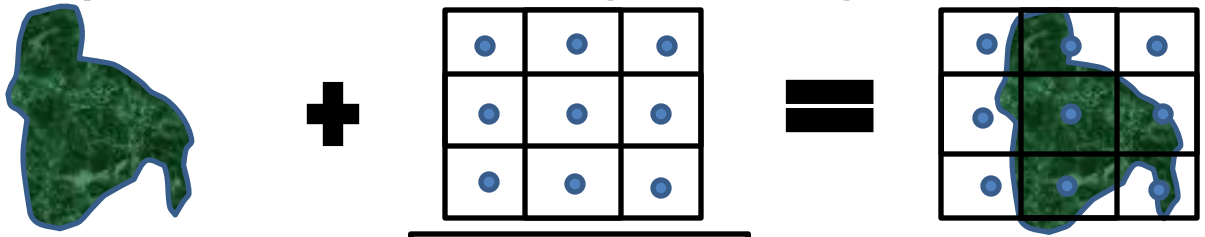


EARTH MODEL

At present there are no commonly used transformations when going from one to the other

No Datums included in datasets

Shapefile defined region to gridded data



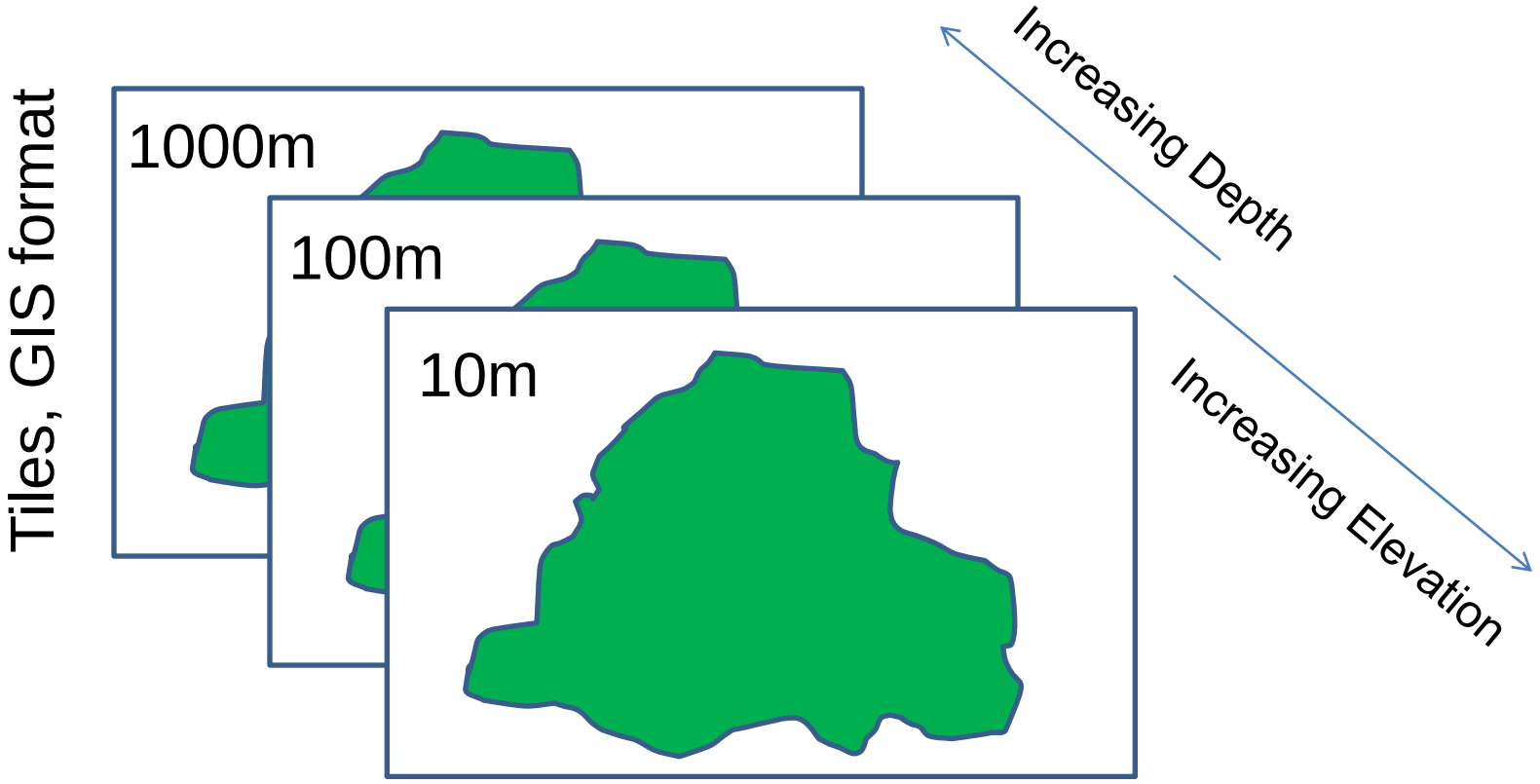
Shapefiles: Bound Regions

Grids defined by Lat & Lon Bounds

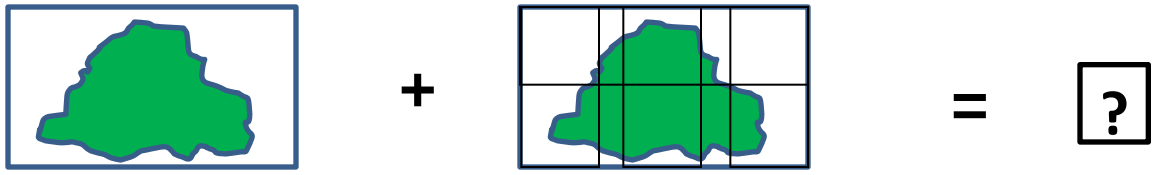
?

NOAA National Climate Model Portal

Advanced Tasks: GIS to NetCDF



Gridding high/deep topography to netCDF



GIS geometries

Tiles at different scales

NOAA National Climate Model Portal

NCMP

NOMADS – NCMP
Next Steps

- Finalize Charter & Program Plans.
- Codebase re-write (java/python). Improved tape access.
- Implement requirements process: evolving Climate Service coordination; sector engagement: Water and Energy themes
- NOAA Climate Model Portal Governance and Science Teams being established
- Fill gaps in existing architecture identified in NOMADS
- Capabilities nearing completion:
  - ESGF; Model Reanalysis Observational Clearinghouse: (Reanalysis.Org); pre-aggregations of most requested data
- Initiate Data Reduction processes
- Prototype downscaling and diagnostics capabilities
- 2011 GO-ESSP Workshop; Climate Service Workshops

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

Select Bibliography

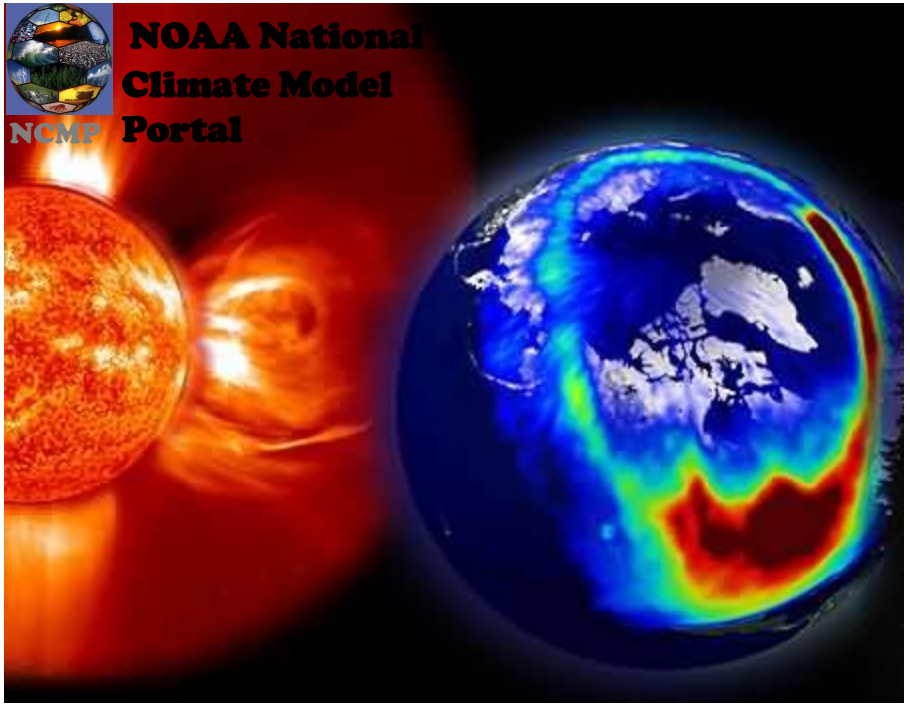
- Rutledge, G.K., J. Alpert, and W. Ebisuzaki, 2006: NOMADS, a climate and weather model archive at the National Oceanic and Atmospheric Administration. *Bulletin of the American Meteorological Society*, 87 (3), 327-341.
- Saha, Suranjana, and Coauthors, 2010: The NCEP Climate Forecast System Reanalysis. *Bull. Amer. Meteor. Soc.*, **91**, 1015–1057.
- Compo GP, et al., 2011. The Twentieth Century Reanalysis Project. *Q. J. R. Meteorol. Soc.* **137**.
- 2010 BAMS Global State of the Climate Report, 2011: (in press)

NOAA National Climate Model Portal

NCMP

Glenn.Rutledge@noaa.gov

http://nomads.ncdc.noaa.gov



Questions?

NOAA — National Oceanic and Atmospheric Administration — U.S. Department of Commerce