

**NOAA National
Climate Model
Portal**

NCMP

NOMADS and NCMP Science and Data Management Services

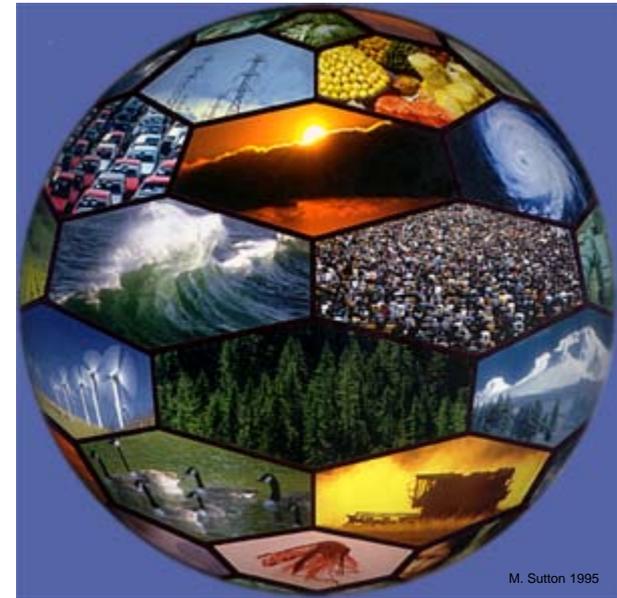
Jay Hnilo

NOMADS/NCMP Senior Scientist

NOAA's Cooperative Institute for Climate and
Satellites (CICS-NC)

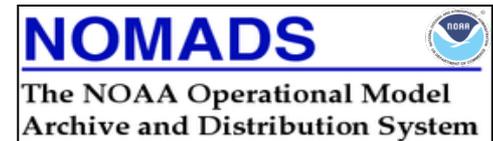
NOAA's National Climatic Data Center

Asheville, NC 28801



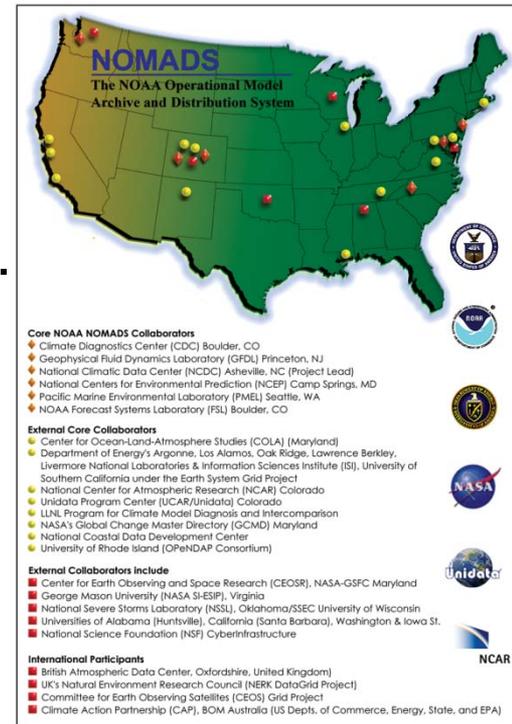
M. Sutton 1995

NCMP

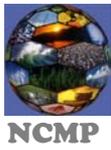


NCMP Background: NOMADS

- 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, GFDL, PCMDI, NCAR.PMEL and others. The collaboration quickly grew under a distributed data access philosophy.
- Founding member of GO-ESSP. Focus on NWP. NCMP will address climate models, diagnostics, and model-to-obs intercomparisons.



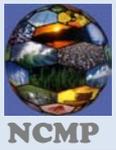
FY10
Distinct hosts served: 83,370
Successful requests: ~125 million
1 day record: 4.9TB



NCMP Benefits

- ▶ In 2009 NWS systems engineers 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.
- ▶ “GO-ESSP” services (OPeNDAP, GDS, LAS, TDS, [ftp4u](#), ...).

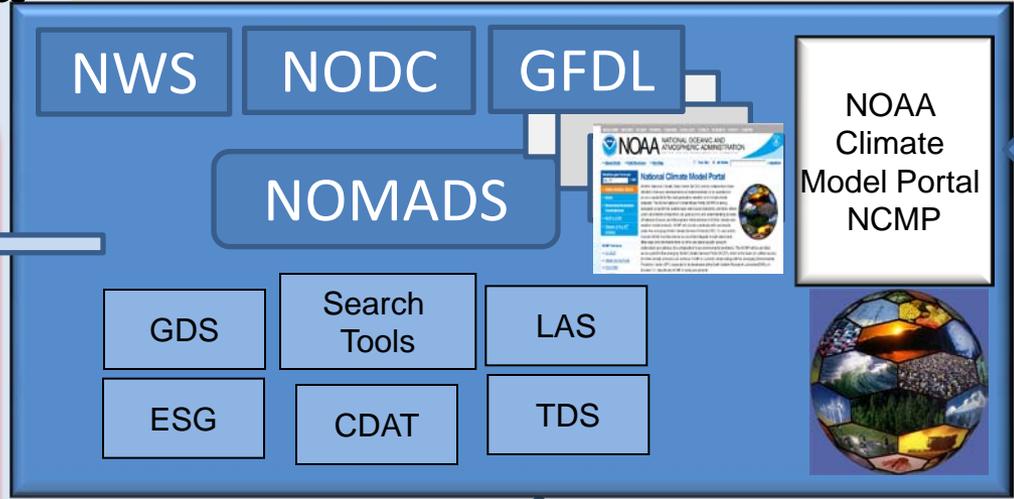




NOAA National Climate Model Portal

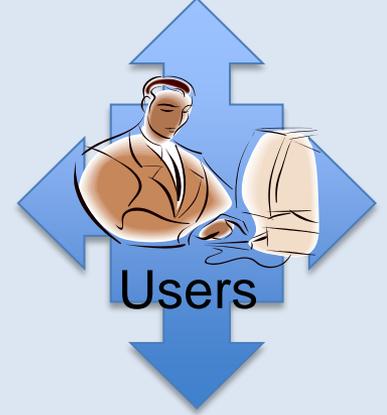
NOMADS Access Infrastructure

Reanalysis.
Org
Climate
Clearing-
house
Community vetted
observational
database



- Global Interoperability Program
- National Climate Predictions and Projections Center

NOAA Cooperative Institute Climate and Satellites
CICS-NC Asheville



NOAA Climate Assessment Services

Private or Unpublished results

Collaborations

Earth System Grid Framework

NCDC

Distributed Archive Services





NOMADS Data Availability

NWP Model and Climate Reanalysis

- ▶ Global Forecast System (GFS), 1 and ½ degree
- ▶ NCEP Climate Forecast System Reanalysis (CFSRR) Global 32km
- ▶ NCEP Climate Forecast System Reforecast (CFSRR) Global 32km
- ▶ NCEP North American Regional Reanalysis (NARR) 30 years 32km
- ▶ NCEP/NCAR/DOE R1 & R2 Global Reanalysis
- ▶ NCEP Global Ensembles (GENS) / TIGGE (w/ NCAR)
- ▶ ESRL Twentieth Century Reanalysis Project (20CR) (2011)
- ▶ NCEP Spectral Statistical Interpolation (SSI) Global Data Assimilation System (GDAS) w/ model restart
- ▶ North American Mesoscale (NAM, formally Eta) 12km
- ▶ Rapid Update Cycle (RUC) 20km and 13km

- ▶ March 2004 – Present, October 2006 - Present
- ▶ January 1979-Present
- ▶ January 1979 – Present
- ▶ January 1979 - Present
- ▶ Jan 1948 – Present, Jan 1979 - Present
- ▶ December 2007 - Present
- ▶ January 1850-Present
- ▶ January 2001 - Present
- ▶ February 2002-Present
- ▶ February 2005 - Present
- ▶ January 2006 – Present, March 2007 - Present

Climate Data / Coupled AOGCM

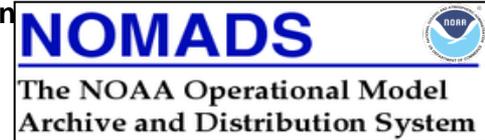
- ▶ Limited GFDL CM2.0 and CM2.1 Climate Experiments
- ▶ Paleoclimate Model Intercomparison Project (PMIP)
- ▶ CMIP3/5 multi-model suite via ESGF (2011)
- ▶ Downscaled CMIP3/5 (2011)

- ▶ Limited AR4/5
- ▶ POR
- ▶ AR4/5
- ▶ AR4/5

Observational In-situ

- ▶ NCDC Global Historical Climate Network (GHCN) Temp/Precip
- ▶ NCDC Integrated Global Radiosonde Archive (IGRA) upper air
- ▶ NCDC Smith-Reynolds Extended Reconstructed and OI ¼ SST's Service Records Retention System (SRRS)

- ▶ Jan 1880 – Present, Jan 1900 - Present
- ▶ Varies by station
- ▶ Jan 1854 – Present, Jan 1985 – Present
- ▶ April 2001 - Present



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
- A **real-time** server supported 24x7 by NCEP 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.

NCMP Recommendation

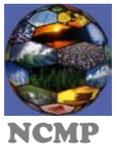
- **National Academies of Sciences, National Research Council, Board of Atmospheric Sciences and Climate:**

“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*

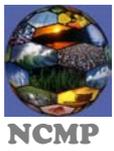
NCMP will be built on top of NOMADS as a suite of Services and Tools. It is an extension and an expansion of NOMADS





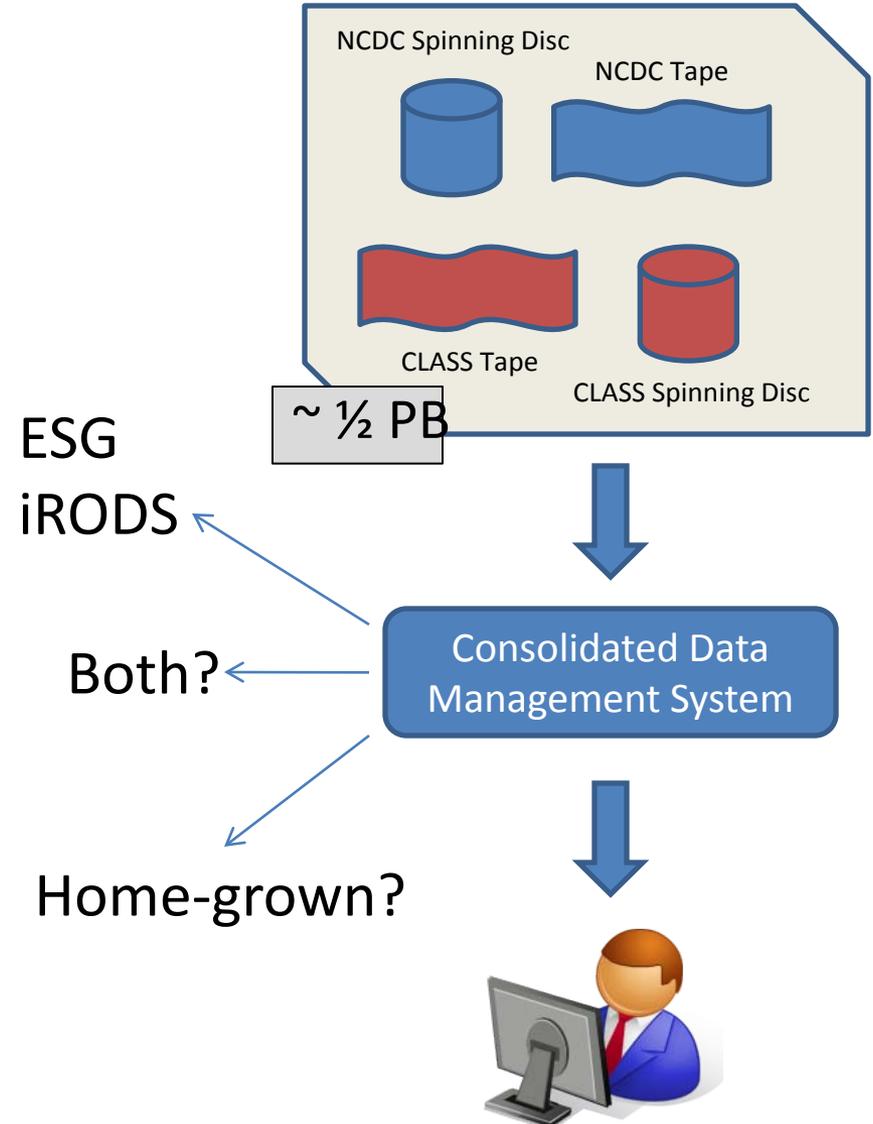
Architectural Design Functional Areas

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



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



NOMADS as data store → NCMP as data discovery



NCDC's Geodata Portal

HOME SEARCH

Search

Reanalysis

Search In: This Site
Additional Options
Clear

WHERE

Anywhere Intersecting Fully within

Search results:

- NCEP Reanalysis version 2
- CDC Derived NCEP Reanalysis Products Tropopause Level
- Climate Forecast System Reanalysis (CFSR)
The NCEP Climate Forecast System Reanalysis (CFSR) was completed for the 31-year period from 1979 to 2009, in January 2010. The CFSR was designed and executed as a global, high resolution, coupled atmosphere-ocean-land surface-sea ice system to provide th...
Web Services Preview Data Access Details Metadata Zoom To
- NCEP Reanalysis Tropopause Level
- NCEP/DOE AMIP-II Reanalysis (Reanalysis-2) Monthly Values
- CPC Merged Analysis of Precipitation Standard
- Climate Prediction Center Global Monsoons

See results through REST API: [GEORSS](#) [ATOM](#) [HTML](#) [FRAGMENT](#) [KML](#) [JSON](#)

This Geoportal was built using the ArcGIS Server Geoportal Extension 9.3.1. Please read the [Disclaimer](#) and [Privacy](#) or [Contact Us](#).

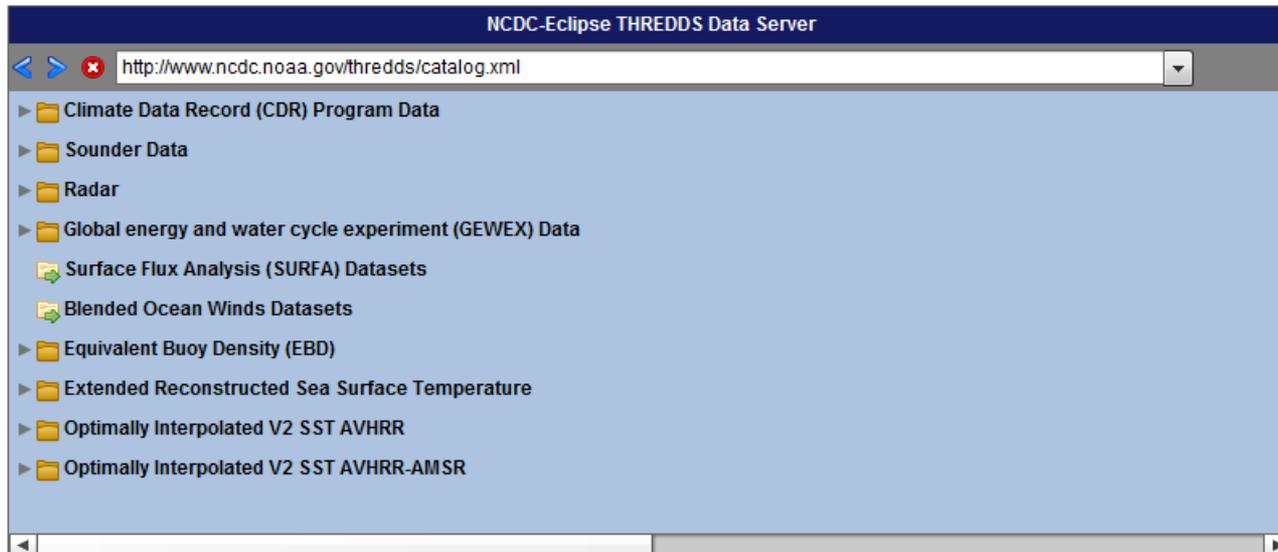
- Metadata-based search and discovery
- Extending distributed access mechanisms
- Technology & tools such as
 - ncISO
 - ESGF
 - ERDDAP / GI-cat / GI-go
 - UAF
 - esri GeoPortal

NCMP / NOMADS

Technology Enhancements

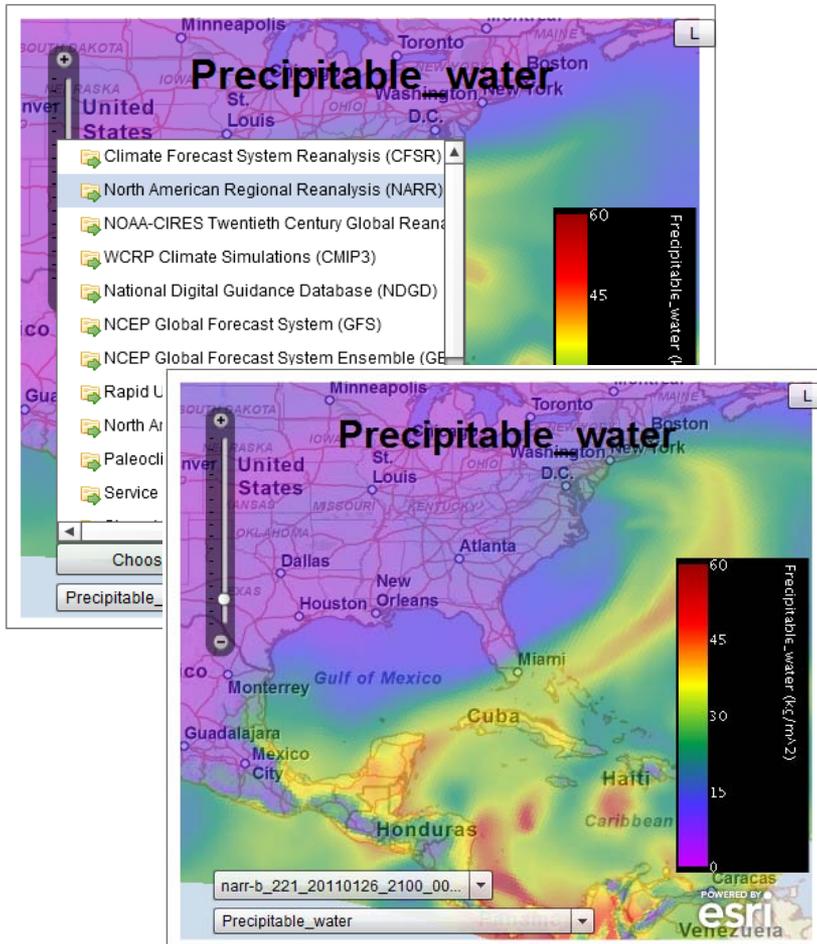
- Extending NOMADS into interactive and sector-utilized formats and technologies

Example: THREDDS Catalog Navigation in Adobe® Flash®



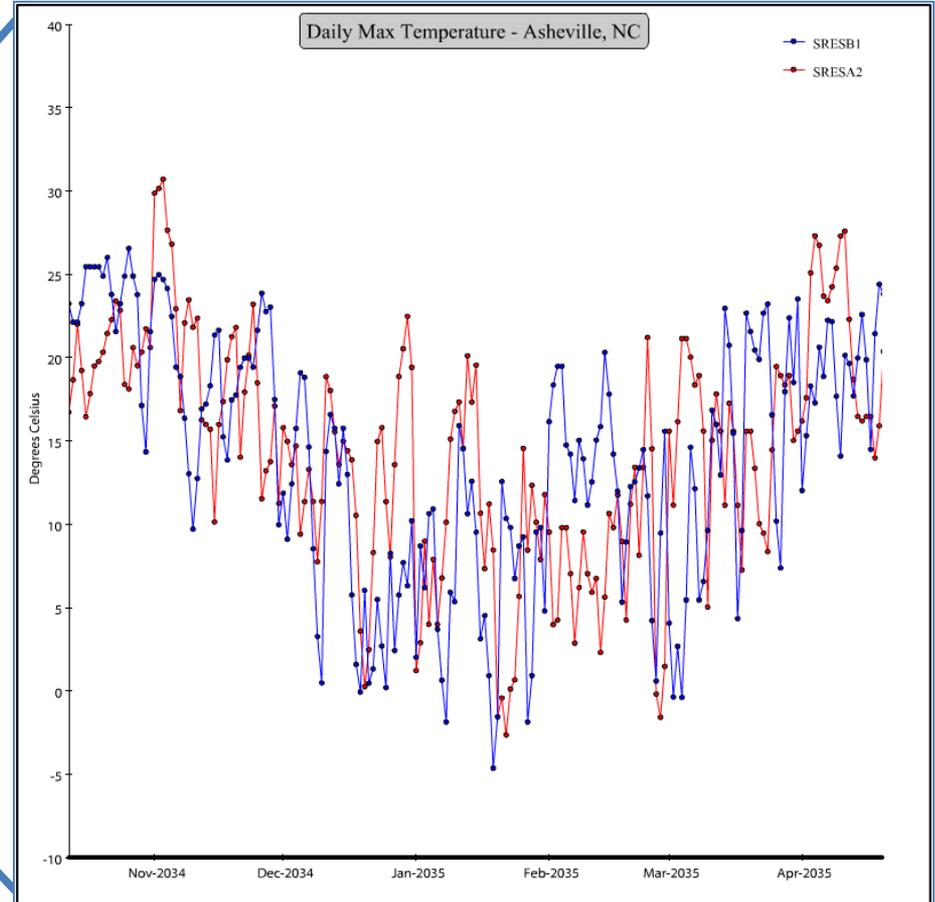
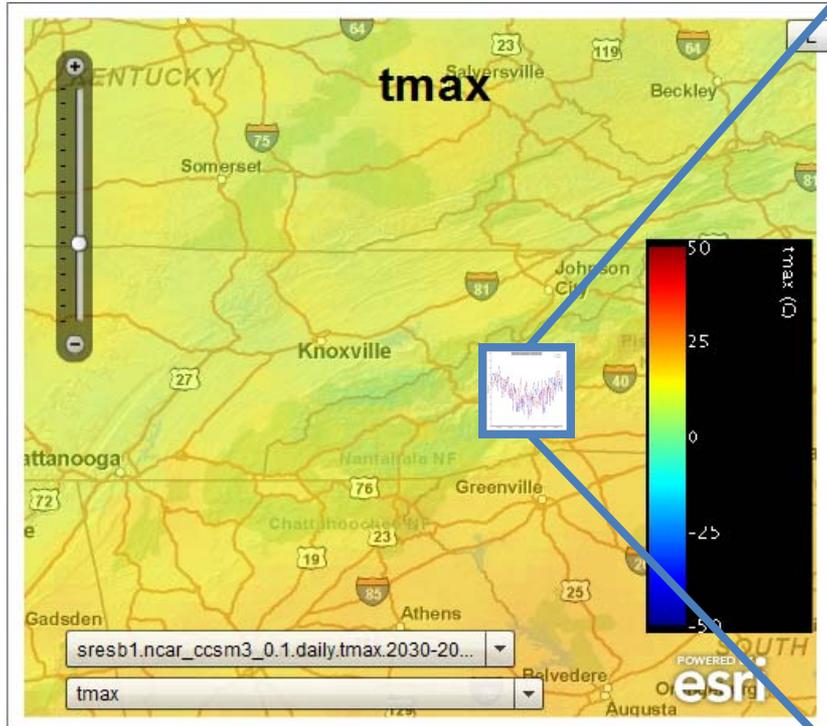
NCMP / NOMADS

Technology Enhancements (cont.)

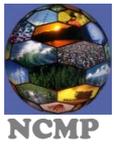


- Incorporating THREDDS-based data into interactive mapping applications
- Utilizing OGC components from THREDDS (WMS, WCS, etc.)

Technology Enhancements (cont.)



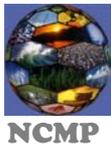
Interactive experiences: CMIP3 data in a web-based mapping application with multi-scenario timeseries comparisons via Multigraph



NCMP Science Tools for Users

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

- On-line access to Climate Model Analytical Engines
 - 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 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.



NCMP Science Tools for Users

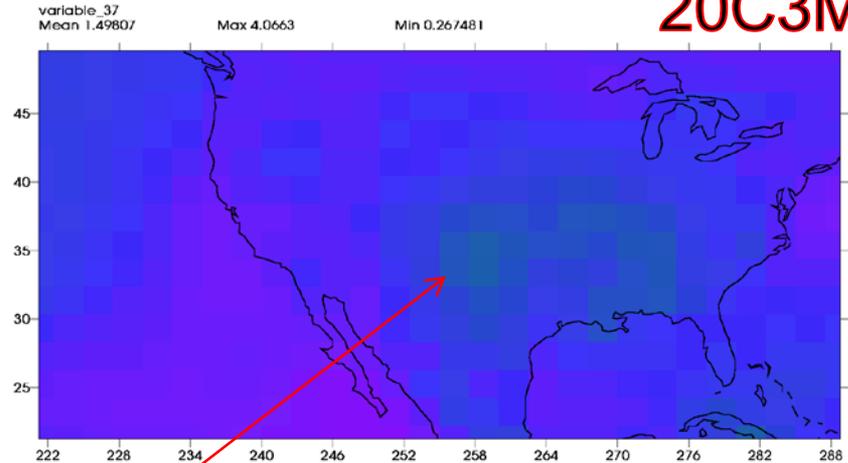
Climate of the 20th century runs (Annual averages):
Global variance of surface temperature (C).

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

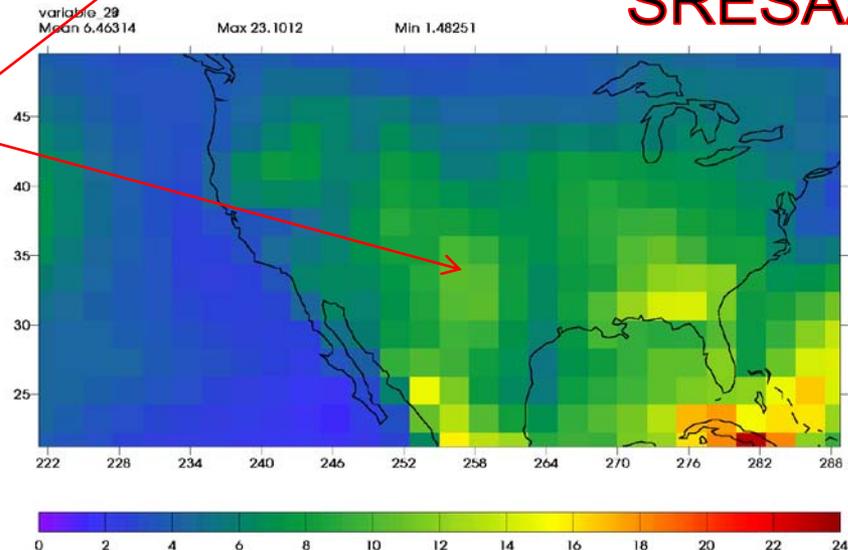
GFDL 2.1 (2000-2099) A2 = 0.841
GFDL 2.1 (2000-2099) A1B = 0.553
GFDL 2.1 (2000-2099) B1 = 0.193

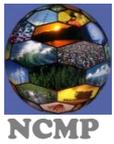
**A ratio of variance of annually
averaged surface temperature
(same scale)**

20C3M



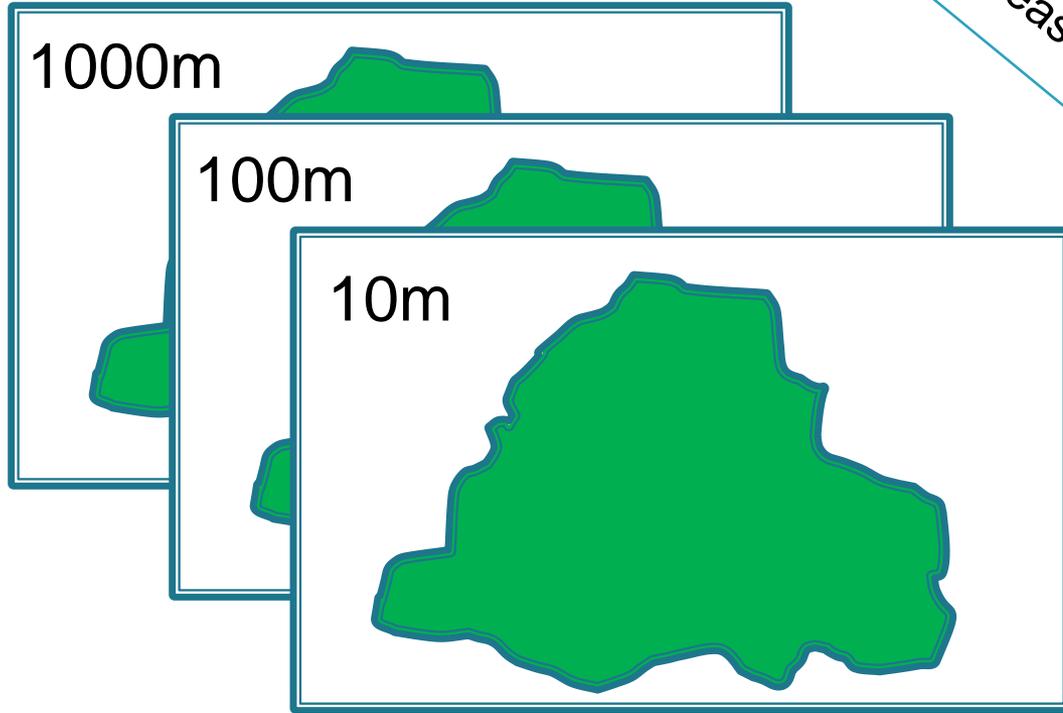
SRESA2





Advanced Tasks: GIS to NetCDF

Tiles, GIS format

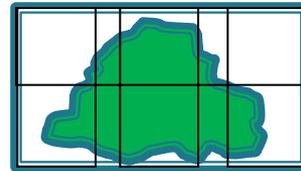


Increasing Depth
Increasing Elevation

Gridding high/deep topography to netCDF



+

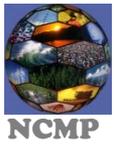


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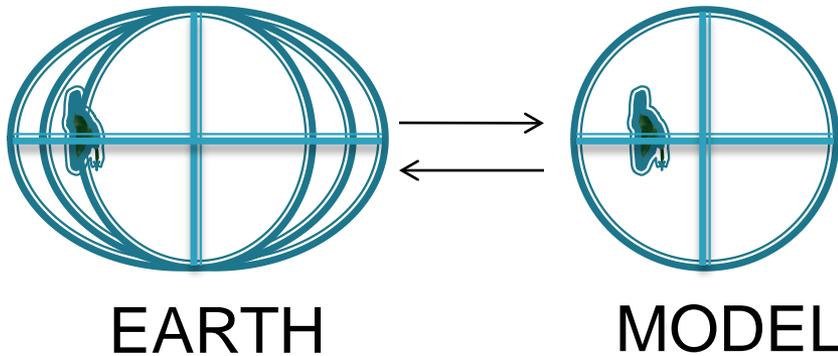
GIS geometries

Tiles at different scales



NCMP Support for GIS Users

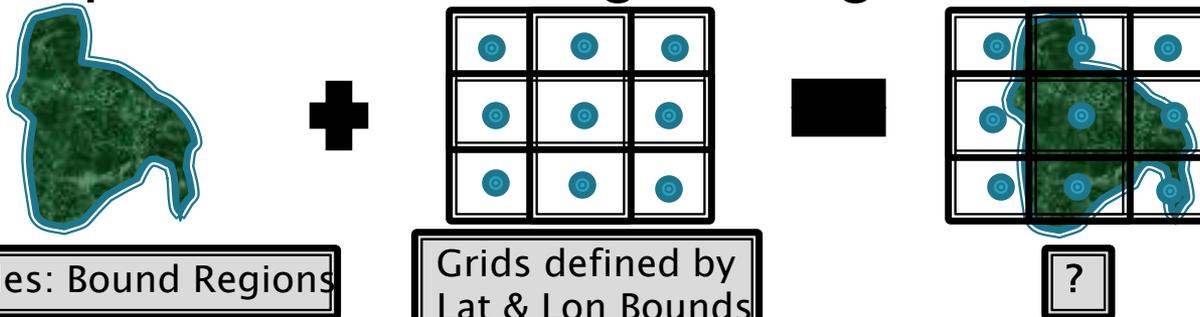
Oblate spheroid (aka, Earth) to sphere

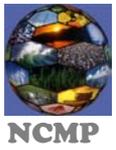


At present there are no commonly used transformations when going from one to the other

No Datums included in datasets

Shapefile defined region to gridded data

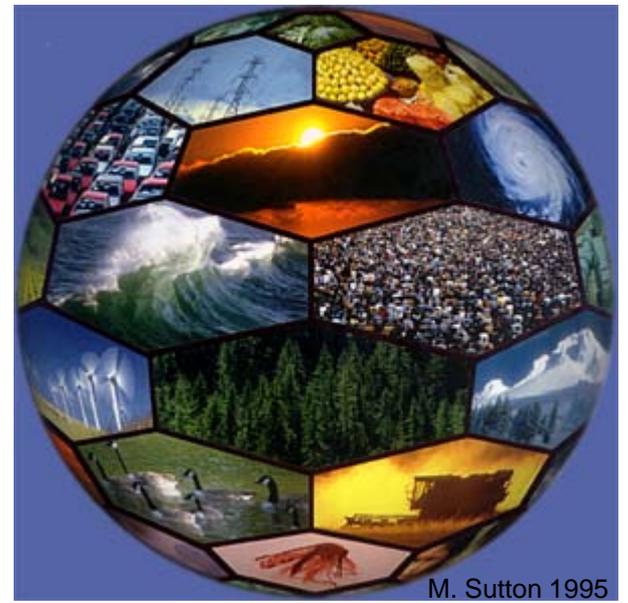




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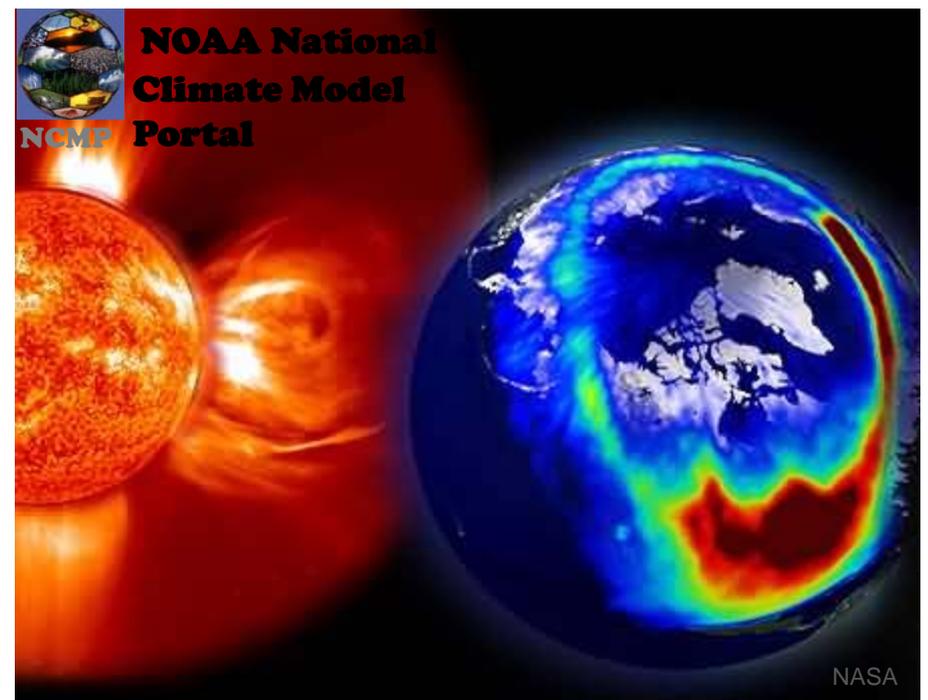


M. Sutton 1995



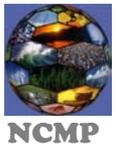
<http://nomads.ncdc.noaa.gov>

Questions?

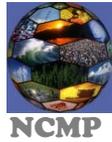


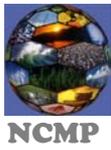
NASA





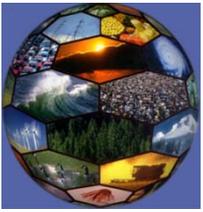
BACKUP





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)

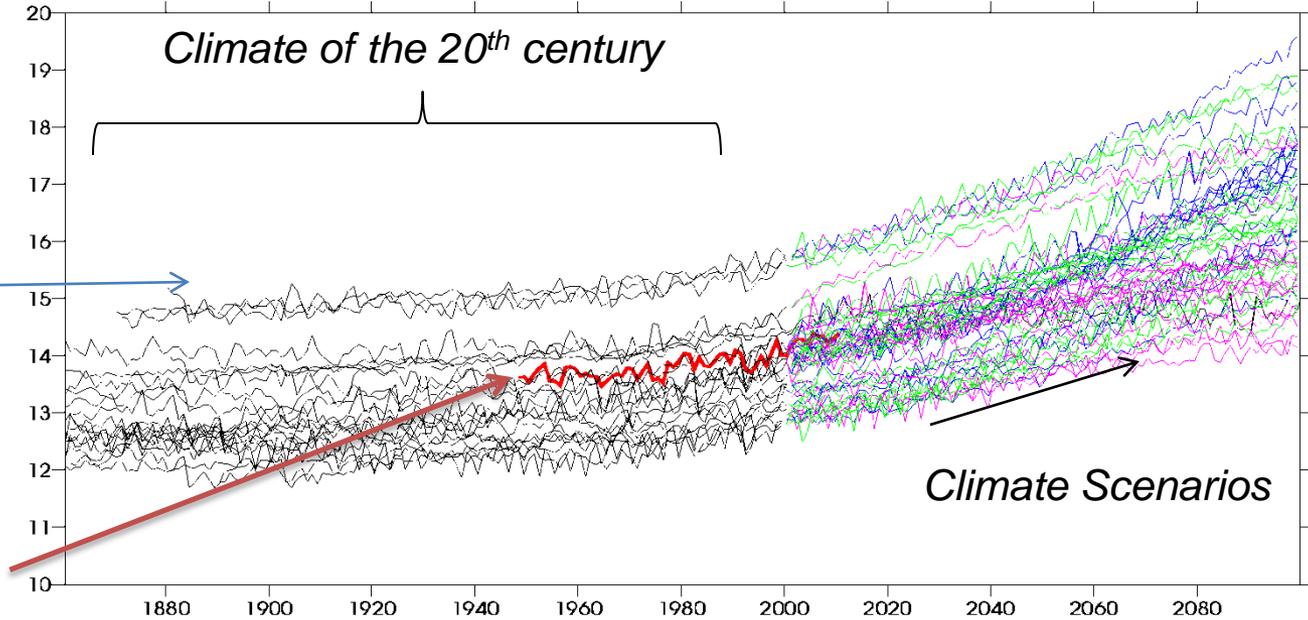


NOAA National Climate Model Portal

Intercomparison Projects

Global Surface Temperature °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 °C

A1B Scenario:: Average of 24 different models and average of last ten annual values = 16.45 °C

B1 Scenario:: Average of 20 different models and average of last ten annual values = 15.51 °C

NOMADS Ensemble Probability Tool

PDF's on the fly

NOMADS Ensemble
Probabilities on the fly:

20 model runs

30 fcst projections

10 days of forecast

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

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

When

Latest model run (2009 Oct. 23 06z)

Year Month Date Model Run

What

Air Temperature at 2 meter height

6 hour Highest temperature

6 hour Lowest temperature

Precipitation

Wind at 10 meter height

Cloud Cover

Air Temperature at 850 millibar pressure level

Convective Available Potential Energy (CAPE)

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

Results

Probability that the event will occur

Forecast Hour	Chance of Occurrence (%)
0	100
1	50
2	10
3	10
4	50
5	60
6	75
7	60
8	40
9	50
10	35
11	60
12	75
13	50
14	70
15	55
16	20
17	15
18	10
19	5
20	5
21	5
22	5
23	5
24	5
25	5
26	5
27	5
28	5
29	10
30	20

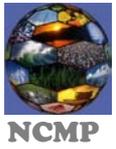
NOMADS Ensemble Probability Tool

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, 082-32-15W)

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





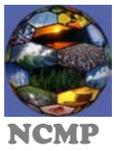
**NOAA National
Climate Model
Portal**

National Climate
Archives

National Climate Model Portal

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 Program Plan



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.

