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THE PLAN TO ACCESS REAL-TIME NWP OPERATIONAL MODEL DATA SETS USING NOMADS

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A major transition in weather and climate prediction is now occurring, one in which real-time availability for weather information is critical to serve our society's needs and in which numerical weather prediction research is spreading from a handful of national centers to dozens of groups across the country. At a recent "NWS Next" workshop, (NWS Technology Infusion Plan, October 2001) the highest priority need for both NWS customers and science technology infusion was for complete access to NWS numerical forecast system output. The rapid growth of local scale NWP capability and global model development is now possible due to: availability of multiprocessor workstations; the availability of regional and local scale models that run on these workstations (e.g., the Workstation Eta model); and the availability of analysis and forecast grids from NCEP.

The scientific community, external to NCEP, is an intellectual resource which can be harvested to accelerate improvements in NWS products through technology infusion. To provide this technology infusion, the community needs to obtain NCEP products, both in real-time and for historical cases, for operational and research purposes.

There are, however, no tools for users to 1) pare down the generally large file sizes of real-time high resolution data files, 2) group and compose different data sets to create unique products, and 3) access the immense and ever-growing NCEP observations data base. Access to these data will be the catalyst for an environmental prediction partnership whose resources would be the world's largest. The first attempt to provide Internet-based, flexible source of NCEP products has been through a partnership called the **NOAA Operational Model Archive and Distribution System (NOMADS)** (Rutledge, G., et al, 2002, 2001). The Geophysical Fluid Dynamics Laboratory (GFDL), the National Center for

Atmospheric Research (NCAR), the National Climatic Data Center (NCDC), and the National Centers for Environmental Prediction (NCEP) have partnered to provide the research community with a substantial amount of grid data and has develop community-based software tools to allow Internet access and many of the above tools.

NOMADS is primarily concerned with the archival of official weather service records and the distribution of research data, therefore, NCEP will provide real time access to the NWS suite of products using the NOMADS technology. The present official dissemination of these products is through the Family of Services and operational ftp servers provided by the Office of Operational Systems (OOS), which holds real-time copies of NCEP model and observation files. This access is currently sufficient for a wide class of research, general public, and government use of NCEP real time data but, in a future world where the volume of NWS products is expanding rapidly, the need for customized access in which users can specify limited domains, time resolution and desired output variables is increasingly important.

The NWS Strategic Plan emphasizes community-based modeling partnerships and broad distribution of operational products. One major example is the National Digital Forecaster Database (NDFD) being developed by the NWS Meteorological Development Laboratory. The NDFD will contain collections of official NWS forecasts which can be accessed in real time and which will be transferred to NCDC for archival.

Technologies for collaboration and model development is exemplified by the contribution of the scientific community to the Weather Research and Forecasting (WRF) model now under development (see for example <http://www.wrf-model.org/documentation/main.html> for more information). The technology for

implementing flexible access to NWS digital products is now available and is exemplified by the NOMADS capabilities. This project will enable real time access to the current operational suite of digital products to commercial users, university scientists and others outside the NWS. These products provide real-time forecast information for model comparison and supplies operational level initialization for forecast models. An example of this is the great demand of real time operational Coastal Ocean Forecast System (COFS) analyses (see for example <http://polar.wwb.noaa.gov/COFS/Welcome.html> for more information on COFS) analysis. These fields are not available in real time on any operational site.

Following the NOMADS lead, the real time data server will distribute the NCEP data base in a format independent methodology. NOMADS supports international standards and makes it possible to accept geographical information system (GIS) formats through client software. A wide variety of formats will be supported, included WMO standard GRIB2 Binary (GRIB), and BUFR (Binary Universal Form for the Representation of meteorological data). GIS formats are supported by third parties and applicable on the client side of the NOMADS server. GIS is a computer system capable of assembling, storing and manipulating geographical referenced information and NOMADS, DODS and Live Access Server (LAS) can provide information to the GIS client in a form that the client understands. For example, one of the software services that NOMADS servers will provide is a cracking program for BUFR files and GRIB2 standards. In this way the NOMADS system can be used by other communities. Since NOMADS technology enables customized, on-the-fly subsetting of the full digital data base, users will be able to tailor their own output in terms of formats, domain, product and transmitted volume. This will also enable scientific collaboration between the operational NWP community at NCEP and the University research community never before considered. This will enable a feedback mechanism to tie the university research directly back to the NWP quality control and diagnostics processes at NCEP. Additionally, this proposal will lay the groundwork for a global climate model collaboration server since the methods to be used in this effort are applicable to other model outputs as well, and will be addressed in future years.

NOMADS software will enhance NWS operational server flexibility and capability through standard Internet communications. High bandwidth communications from NCEP to NOAA and NWS operational servers including Internet II connectivity are planned under separate projects ensuring successful implementation of a real time service. Prototyping of this process is necessary and the NOMADS project is underway to implement an operational archive and distribution process. The real time data distribution will leverage software programming developments and standards from NOMADS.

Currently, NCEP NWP products are available in real-time through a number of different channels but none of them have met the challenge to provide researchers, the public, scientific modelers at universities and federal agencies, national and

international, with the real time data, and the ability to pare down "slice and dice" the data base with capability for example to subset over space, time, or combine and compare with other models present and past. The real time files from the official OOS server have some selected records such as precipitation but most data sets are presented "as is" without the ability for users to get the records they need. The large data sets are difficult to locate and it is difficult to sustain long file transfers. International users, in particular, have problems with data access under current conditions. In addition, no catalog and search capability is available and there is no software to unpack, request time periods or space parameters selected by the user, making the existing OOS data base accessible to a handful of in-house users. NOMADS will be used to "slice and dice" the NCEP real time data base using DODS, Live Access Server (LAS) and GrADs-DODS Server (GDS). Traditional on-line data services through web based ftp and ftp are also available. In addition the model code of NCEP operational models configured for standard platforms is available as a package including ancillary programs with documentation and test data.

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