News in This Quarter

NRL Atmospheric Variational Data Assimilation System (NAVDAS)

Following six years of development and testing, NAVDAS became operational on 1 October 2003 at Fleet Numerical Meteorology and Oceanography Command. The system is the brainchild of the late Dr. Roger Daley, who was among the world's most esteemed experts in data assimilation, and was a distinguished visiting scientist at NRL, Monterey for six years. The successful deployment of NAVDAS marks the beginning of modern analysis methods for the U.S. Navy. The methods used in NAVDAS can optimally determine the most likely state of the atmosphere from observations, numerical forecasts, error statistics, and atmospheric dynamics. The ability to directly assimilate brightness temperatures from satellites was one of the main motivations for this development, as the variational theory used in NAVDAS allows the use of observations that are related indirectly (and possibly nonlinearly) to the model and analysis state variables of temperature, wind, and humidity.

NAVDAS is designed to work with both the Navy Operational Global Atmospheric Prediction System (NOGAPS), and the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS^{TM}). The new NAVDAS system is truly a DoD system, capable of deployment for use onboard ships, at regional centers, or at central site. It functions on work stations as well as massively parallel computers, and is designed especially for performance on the globally relocatable nested grids of COAMPS^{TM}.

NAVDAS contains a complete data assimilation system, including the software to process observations. The design makes it easy to add new observation types as they become available, and improved data visibility for monitoring the quality of the analysis input. The data processing infrastructure was built with the next generation of NAVDAS in mind, which will analyze data in space and time (four-dimensional assimilation), vs. the space only version (three dimensional assimilation) currently implemented in NAVDAS. In the future four-dimensional data assimilation, the optimal state will be derived from flow-dependent error statistics and be coupled to the model's dynamics. Recent research results from NAVDAS running with the accelerated representer method, a first step toward four-dimensional assimilation, are very promising. This first operational implementation of NAVDAS is a giant step toward that eventual goal.

Since becoming operational, significant improvement in FNMOC's prediction accuracy has been achieved. This is only a beginning, however, as more improvement is expected as NAVDAS evolves. Among the immediate items on the list for implementation into NAVDAS are:

- direct assimilation of AMSU-A/B satellite brightness temperatures,
- assimilation of MODIS/TERRA winds,
- assimilation of QuikScat and ERS-2 scatterometer winds,
- assimilation of SSM/I wind speed retrievals,
- operational deployment of NAVDAS into COAMPS^{TM},
- implementation of a very high resolution marine wind analysis,
- more accurate specification of the forecast error statistics, and
- more sophisticated data quality control procedures.

Numerous smaller additions and improvements are constantly being implemented, as necessary, to keep the system up to date with the ever-changing world's weather observing network. This transition could not have taken place without the dedicated effort of NRL scientists, which totaled over thirty work years. In addition to Roger Daley, the following NRL scientists helped to make this transition a success: Edward Barker, Pat Pauley, Jim Goerss, Keith Sashegyi, Tom Rosmond, and Tim Hogan. The radiance assimilation, which will soon become operational, is due to: Nancy Baker, William Campbell, Clay Blankenship, Steve Swadley and Jim Clark.

COAMPS^{TM} is a trademark of the Naval Research Laboratory, Monterey (E. H. Barker and N. L. Baker, Navy).

Update on Fast Radiance Calculations

Recent advances in the OPTRAN model are leading to more accurate and faster simulations of satellite observed infrared radiances for clear atmospheres. OPTRAN 7, an improved version of the current operational OPTRAN 6, produces brightness temperatures that agree with the "gold standard" of computationally intensive, line by line (LBL) values to better than 0.2 K in independent data tests (see figure). Current work is focused on including the effects of atmospheric aerosols and variable Earth surfaces (through surface emissivity models) on

the radiances. Future plans call for including more atmospheric gases (e.g., CH_4, oxides of nitrogen) in the calculations.

Errors in Simulated AIRS Radiances
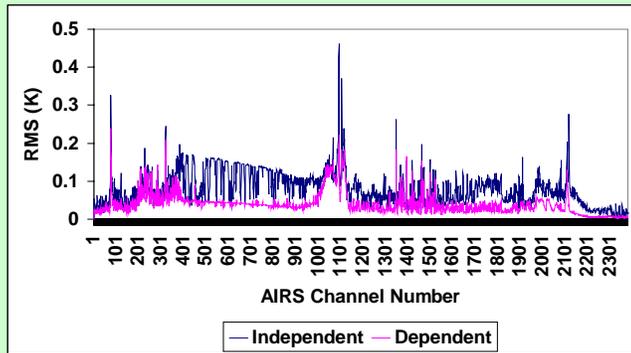
Faster calculations are being realized through minimizing the needed computer memory by reducing the number of coefficients that have to be stored. This is being achieved without loss of accuracy by using optimized polynomials to represent the vertical axis. Fast calculations are critical for assimilating the huge volume of data from hyperspectral instruments such as NASA's Atmospheric Infrared Sounder (AIRS). Even the reduced volume AIRS data sets currently being evaluated by JCSDA represent significant challenges. For each forecast, about 75,000 observations, each with some 300 spectral channels of information, must be checked and assimilated within 20 minutes. OPTRAN coefficients have also been generated for AIRS "super channels". "Super channels" are a reduced number of channels created by combining channels with similar absorption properties. The super channels retain most of the information content of the full channel set and have less noise than the individual channels. Calculation of radiance for a super channel is similar to that for a single channel, thus greatly reducing the computational time required in the assimilation process. In this way, the 2000+ AIRS channels can be reduced to an "equivalent" 300 super-channels (L. McMillin, NESDIS).

Meet Lidia Cucurull

Lidia joined the JCSDA in October 2003 as a University Corporation for Atmospheric Research (UCAR) Visiting Scientist, a position sponsored by the National Science Foundation. Lidia's primary responsibility is to facilitate the use of COSMIC (Constellation Observing System for Meteorology, Ionosphere, and Climate) radio occultation sounding data in operational data

assimilation systems, through a collaborative project between the JCSDA and the UCAR COSMIC Office. COSMIC is a joint US/Taiwan funded project to launch a constellation of six low earth orbit satellites in 2005 carrying advanced GPS (Global Positioning System) occultation receivers. These are expected to provide ~2500 globally distributed GPS radio occultation atmospheric (GPS/RO) soundings daily. The purpose of her project is to develop, test, and optimize procedures to ingest atmospheric profiles retrieved from GPS radio occultation data into operational data assimilation systems. GPS radio occultation data have been shown to be of high accuracy, and have the potential to improve the quality of global analyses and operational numerical weather prediction forecasts.

Recent Seminars

After a summer break, JCSDA seminars resumed in the fall. In a seminar on October 15 co-sponsored by the NESDIS/ORA seminar series, Kostya Vinnikov, U. Maryland, and Norm Grody, NESDIS, discussed their recent Science paper on Trend of Mean Tropospheric Temperature Observed by Satellites. Michael McAtee, Air Force Weather Agency, reviewed Data Assimilation Activities at the Air Force Weather Agency on November 19. Bill Rossow, NASA Goddard Institute for Space Studies, presented on Clouds and the General Circulation on December 17. In a Special JCSDA seminar on Dec. 18, Nancy Baker, Naval Research Laboratory, spoke on Assimilation of Satellite Observations in U.S. Navy Operational NWP Models. During their visits, all the out of town speakers met with JCSDA scientists for discussions of mutual interest.

Outlook for Next Quarter

JCSDA will Approves Announcement of Opportunity Proposals for FY04 Funding

Upcoming Seminars

2/18/04	Fuzhong Weng	NESDIS/ORA	Radiative Transfer Modeling Supports Advanced Satellite Data Assimilation
3/17/04	Gregg Jacobs	Naval Research Laboratory	Ocean Models and Assimilation at the Naval Research Laboratory
4/21/04	Ron Errico	NASA Goddard Global Modeling and Assimilation Office	Issues in Assimilation of Precipitation Observations