ON-SCENE ANALYSIS/FORECAST SYSTEM

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LONG TERM GOALS:

Develop and demonstrate an end-to-end on-scene analysis/forecast system for real-time data fusion, analysis, and forecasting. This system will be used to produce tactical atmospheric parameters which affect weapon and sensor systems and will be designed to use a local area network interfaced to automated instruments, a modern database, and supporting software.

OBJECTIVES:

Develop the framework for an analysis, nowcast, and short-term forecast system that can be used at on-scene locations. This development will include optimal objective analysis methods that blend all observations and dynamical constraints into a 3-dimensional depiction of the atmosphere, methods to include new data sources (e.g., radar, in-situ, remotely sensed observations) into existing analysis methods, incorporation of transformation algorithms that convert instrument measurements into atmospheric state measurements, quality control methods for on-scene observations to insure time and space continuity, and a hierarchy of physical parameterizations that allow a choice between computational time and sophistication. The performance of the system will be evaluated, and studies will be performed to determine the impact of simplification of model physics and/or optimization of code to meet time constraints.

Develop the capability to perform REA nowcasts using data available on-scene. Develop automated data quality control methods and user-friendly interfaces to allow a non-expert to control the system. Incorporate algorithms into the system to compute tactical atmospheric parameters, such as refractivity, and develop interfaces for decision aid connectivity. Study the value-added by utilizing the on-scene observational data.

APPROACH:

Use the atmospheric component of the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS) as the framework for the on-scene system. Within this system, build an atmospheric data assimilation system that will be able to analyze mesoscale weather by applying sophisticated analysis procedures capable of ingesting the information from doppler radar, conventional observations, and remote sensors. One component of this data assimilation system will be to design a system that optimally utilizes the SPY-I doppler radar information. This effort will be accomplished by combining the newly developed 3DVAR analysis with a simplified adjoint application for the SPY-I radar.

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Develop general algorithms to allow for portability of COAMPS between hardware platforms, including both shared and distributed memory systems while maintaining high performance on each platform within one single-code version of the system.

Link the analysis and forecast model output to METOC decision aids via the Tactical Environmental Data Subsystem (TEDS) data base, a component of the Tactical Environmental Support System/Next Century (TESS/NC), that provides the network interface to tactical computer systems. Develop a "warm start" capability for COAMPS to begin the local data assimilation cycle from COAMPS forecast products produced at another remote center. Use the developed system to conduct case studies of relevant meteorological phenomena.

WORK COMPLETED:

COAMPS has been interfaced with the Multivariate Optimum Interpolation (MVOI) objective analysis, univariate objective analyses of temperature and moisture, and a system-independent database. This system has been run in a data assimilation mode using a triply-nested grid configuration over numerous limited-area domains over the earth.

COAMPS was used as the framework in establishing a simulated advanced shipboard METOC operations center at NRL Monterey. In this capacity, COAMPS was used as an analysis/nowcast/short-term forecast system on a routine daily basis. Analyses and forecasts have been prepared twice daily for Bosnia, the California coast, the Antarctic, and SHAREM (Arabian Gulf) areas and the results have been made available on a WWW server.

Some tests on the MVOI version of the COAMPS data assimilation system have been conducted using the WSR-88D doppler winds and surface meosnet observations. These tests determined the added value of all data types for predicting mesoscale convective precipitation patterns. Doppler winds plus conventional data gave large improvements to the forecast, and when the mesonet surface observations were added, even more improvements were demonstrated. NRL acquired a data set of SPY-I and WSR-88D doppler winds, and visited Lockheed-Martin in New Jersey to study the SPY-I Doppler radar capability.

A Graphical User Interface (GUI) was developed which consolidates the information necessary to run the system and creates the run control script. In coordination with a NRL 6.2 visualization project (BE-35-2-31), a set of standard graphical products have been developed that include diagnostic comparisons of forecasts with observations and satellite imagery. Automated techniques have been developed to link COAMPS output with the Radio Physical Optics (RPO) electromagnetic propagation model.

A prototype operational system to analyze local atmospheric data on-scene and make tactically relevant forecasts was transitioned to 6.4 and fielded on the USS NIMITZ while on a transit down the west coast of the U.S. The six 36 hour forecasts produced marked the first time fully three-dimensional numerical weather predictions were ever made on board ship. The COAMPS forecast area was moved in coordination with the intended position of the ship so the forecast continuously covered its primary operating area. COAMPS results were disseminated over the network from the USS NIMITZ to a WWW server on shore. In coordination with the Naval Postgraduate School (NPS), the unique data set from SHAREM 110, containing aircraft data, ship soundings, rocketsondes, and COAMPS forecasts,

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was used to study the evolution of the mesoscale boundary layer and the impact on propagation conditions during two significant events.

RESULTS:

A new input/output scheme was developed and implemented in COAMPS that dramatically reduces compile time, improves debugging, and allows the user to run any number of nested grid meshes simultaneously. The upgraded COAMPS was successfully ported to a variety of workstations and the results have been verified against the operational FNMOC version of the code. The improved portability assures code consistency and maintainability across platforms.

The ability to run idealized simulations with COAMPS has been improved by restructuring the code and improving the surface parameter data base and processing techniques. Idealized simulations are particularly useful for testing physical parameterizations. To gain a better understanding of complex physical phenomena, simplification of the land use and/or environmental data used to initialize a full-physics simulation is insightful.

Results from COAMPS simulations and analysis of data, including those provided by the British Meteorological Research Flight (MRF), showed the temporal and spatial evolution of the boundary layer in the Arabian Gulf preceding a SHAMAL event was related to local along-barrier wind flows and moisture advection, which had a significant impact on the elevated trapping layer. The low-level moisture over the Gulf was strongly modified by the diurnal heating cycle that led to a moist density current over the interior regions of southern Saudi Arabia and the formation of a narrow trapped coastal surge containing a low-level jet that formed ahead of the cold front over the eastern Gulf.

The tests using NEXRAD data illustrated the added value of all data types for predicting mesoscale events. Doppler winds plus conventional data gave large improvement to the short-term forecast, while the mesonet surface observations also contributed to the forecast improvement. Three time levels of SPY-1 data (15:41-46 UT, August 21, 1996) were used to retrieve the two-dimensional wind field on the conic surface of the radar scan. The retrieved winds were compared reasonably well with the dual winds obtained from the SPY-1 and KDIX NEXRAD radars.

The USS NIMITZ demonstration showed the feasibility of running and maintaining a sophisticated atmospheric data analysis and forecast system on-scene. Although a success, the experience has led to initiatives for several improvements, in particular making the data handling techniques more robust under real-world communications scenarios; simplifying the COAMPS user interface; and developing a user interface for the output product dissemination capability.

IMPACT:

The success of COAMPS in the on-scene environment is significant and has been recognized by CDR David G. Markham as "… a monumental achievement that will undoubtedly have a far reaching impact on our future METOC CONOPS."

TRANSITIONS

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Developments from this program transition to an existing 6.4 program (PE 0603207N) for applications within TESS/NC and, via the TESS/NC - JMCIS link, with the tactical applications supporting on-scene decision makers.

RELATED PROJECTS:

Related 6.2 projects within PE 0602435N are BE-35-2-18, for the development of atmospheric mesoscale models, BE-35-2-19, for the development of data assimilation techniques, BE-35-2-21, for the development of advanced visualization techniques, and T045-99, an effort to understand and develop better moisture, cloud, and precipitation forecasting techniques. The related 6.4 project under PE 0603207N is X2343-10, which focuses on the transition of the 6.2 development to the STAFC demonstration project.

REFERENCES:

None.

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