Nowcast for the Next Generation Navy

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LONG-TERM GOALS

This project is one coordinated component of a larger effort to develop a high-resolution data fusion system capable of blending an ensemble of highly perishable, on-scene environmental data together into a consistent, integrated picture of the current, real-time environment. This system will benefit the warfighter by providing a common environmental situational awareness capability that can be accessed directly by decision makers using a Java enabled Internet web browser. The Nowcast system is designed to be globally relocatable to support the Navy's mission, but the "weather view" is easily focused on the high priority battlegroup and target areas. The situational awareness of weather hazard information is intended primarily to support naval aviation in time critical strike missions but may also be used in navigation, cruise missile weaponeering, and for ship self defense. The Nowcast system will be owned, operated, and its quality assurance maintained by the METOC office.

OBJECTIVES

The specific objectives of this project within the larger effort are to design and develop the prototype client / server Nowcast data fusion system, to develop example products using a wide variety of data sources, and to get end-user buy-in through a series of high-level briefings and an Integrated Product Team (IPT) process. The IPT process is designed to ensure that the products developed for Nowcast are useful to the warfighter and that the METOC office can be responsible for Nowcast operations.

APPROACH

Traditionally, the bulk of atmospheric data has been collected at the synoptic times of 00Z and 12Z to support the central site data processing and numerical weather prediction schedule. To meet the challenge of utilizing METOC data available at asynoptic times collected by forward-deployed units, NRL has developed the Coupled Ocean/Atmosphere Mesoscale Prediction System – On-Scene (COAMPS-OS). COAMPS-OS includes the Tactical Environmental Database System (TEDS) and is now being tested operationally at the Navy METOC Regional Centers. In addition to the COAMPS fields and conventional data available in TEDS, and satellite data available from METOC FMQ-17 (shore) and SMQ-11 (shipboard) systems, Nowcast can use data from non-traditional sources and data collection networks focused around the battlegroup and target areas. For example, AEGIS SPY-1 Tactical Environmental Processor (TEP) and other tactical radars of opportunity can provide weather radar around the battlegroup and unmanned aerial vehicles (UAV) can provide a rich set of target area

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14. ABSTRACT

This project is one coordinated component of a larger effort to develop a high-resolution data fusion system capable of blending an ensemble of highly perishable, on-scene environmental data together into a consistent, integrated picture of the current, real-time environment. This system will benefit the warfighter by providing a common environmental situational awareness capability that can be accessed directly by decision makers using a Java enabled Internet web browser. The Nowcast system is designed to be globally relocatable to support the Navy???s mission, but the ???weather view??? is easily focused on the high priority battlegroup and target areas. The situational awareness of weather hazard information is intended primarily to support naval aviation in time critical strike missions but may also be used in navigation, cruise missile weaponeering, and for ship self defense. The Nowcast system will be owned, operated, and its quality assurance maintained by the METOC office.

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weather observations. To use these unconventional data in real-time requires us to adapt machine intelligent feature detection and artificial intelligence (AI) data fusion techniques to create an automatic environmental data fusion engine. In addition, Nowcast uses established web-based product dissemination and display technology to overcome fleet firewall policy limitations and minimize end-user training issues. The Nowcast client software application is configurable to allow the warfighter to tailor the results to their specific requirements. Nowcasting capability will periodically be demonstrated during operational exercises.

Another principal effort in this project is devoted to the development of high-level support and end-user buy-in to Nowcast. In addition to the technical assessment of the environment, it is important not to lose sight of the end-state user needs and requirements (METOC community and warfighters: pilots, ship captains, etc.). To this end, a series of high-level briefings and meetings to senior Navy decision makers in the aviation, surface warfare, and METOC communities have been on going to expose the concept of nowcasting and to generate support. The success of this project is directly related to acceptance by the end-users. Without a feedback mechanism between the S&T process and the end-users, it is possible to be scientifically and technically correct, but produce results that are not useful. To this end, we have a well-defined involvement of selected end-users in the effort through an annual IPT process.

Another key element of our approach is the leverage of other projects at NRL and at other governmental agencies. The NRL base program supports a research project to develop automatic product verification technology for Nowcast and the application of techniques to determine how best to fuse data to support accurate descriptions of the cloud and wind fields to support carrier aviation operations and analyses of electromagnetic (EM) propagation conditions. To improve the diagnosis of the three-dimensional cloud field, this NRL base project has implemented components of the University of Oklahoma's ARPS Data Assimilation System (ADAS) in Nowcast. In a related area not funded by ONR, NRL has a major Ceiling and Visibility (C&V) nowcast product development funded by FAA, NASA, and Navy (N096 through CNMOC and SPAWAR), to provide C&V nowcast products. The products are being tested this year at the Naval Pacific Meteorology and Oceanography Center, San Diego (NPMOC-SD), at the FAA Air Route Traffic Control Center near Los Angeles (Palmdale), and at the National Weather Service Forecast Offices in Oxnard and San Diego.

WORK COMPLETED

A prototype Nowcast system was designed, developed, and demonstrated at NRL Monterey in FY00. Nowcast uses a four-tier internet architecture consisting of a Java applet for an end-user graphical interface (Tier 1), a web server-based servlet engine and database to support the applet and maintain end-user context (Tier 2), a nowcasting product generation engine to provide data sets and products tailored to end-user session requirements (Tier 3), and the COAMPS-OS, TEDS, and ADAS data assimilation system as a back-end (Tier 4). Nowcast leverages software developed for the NRL Atmospheric Variational Data Assimilation System (NAVDAS) for data quality control and the NAVDAS data structures are used to provide a commonality among data handling software.

The effort for FY01 was focused on acquisition of new data types, including 5 minute conventional observations (from the Weather Underground), satellite, and radar data; optimization of real-time data processing; and refinement of the web-based interface. An effort to define radar data requirements for TEDS was coordinated with SPAWAR PMW 155. In cooperation with the NRL base project, a real-time radar data interface and processing capability to NEXRAD data was developed, cycling every 10

minutes, initially from a NOAA ftp site, and later transitioned to a NOAAPORT data feed. This effort was so successful that the capability was transitioned to FNMOC as a new operational product in the Joint METOC Viewer (JMV). A C&V algorithm developed by the National Center for Atmospheric Research (NCAR) in the Tri-Service project was implemented in Nowcast to produce ceiling height and visibility products every 15 minutes. The Navy, FAA, and National Weather Service are currently testing the algorithm in the Southern California area. The ADAS three-dimensional cloud analysis from OU was implemented in Nowcast and used to compute cloud elements every hour. Figure 1 is an example of the Nowcast applet showing the ADAS cloud base height product. Also shown in the figure is an example of the end-user verification display with a drill-down capability to visualize increasingly specific types of color-coded product verification information. The verification system is being developed by the NRL base project.

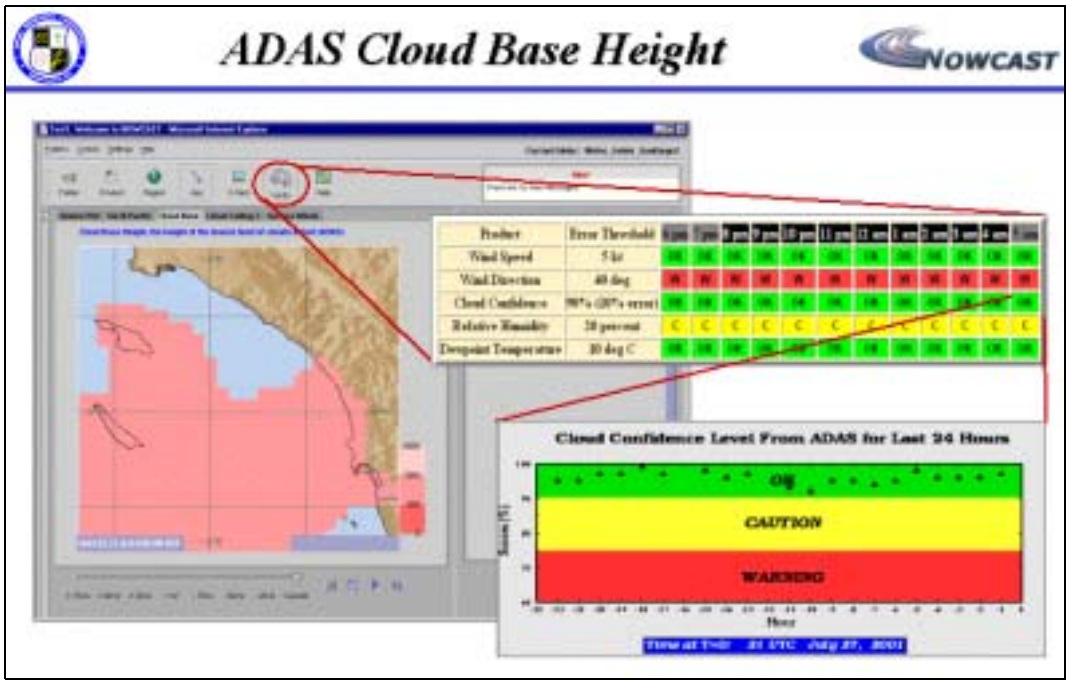

Figure 1. An example Nowcast Java web applet showing ADAS cloud base as a shaded map. The "Verify" button in the applet pops up a "Stoplight" color-coded timeline display with a drill-down capability to visualize individual product verification information.

Work was also accomplished at NCAR and by a Navy Reservist at NRL to process and analyze a large amount of TEP radar data collected onboard the USS Normandy during a Joint Task Force Exercise (JTFX). An interface to satellite data was also developed between Nowcast and the FMQ-17. Figure 2 shows an example of concurrent satellite and TEP radar products for a squall line and severe downburst case during the JTFX that disrupted flight operations on the USS George Washington. The storms formed along a mesoscale air mass boundary within sight of the USS George Washington. The boundary was identifiable on radar and satellite but forecasting exactly when and where the thunderstorms developed was not possible. We speculate the if Nowcast were used to blend the data and automatically forecast the development of thunderstorms, the USS George Washington could have 30 minutes warning and moved about ten miles to the northwest to avoid the adverse weather

conditions. This analysis shows promise that Nowcast can utilize domestic and foreign radar and satellite data to significantly improve automated thunderstorm detection and avoidance at sea. Additionally, this year a series of Nowcast briefings were conducted (some in coordination with TEP) with N70, N78, N765, N76B, N785D1, AIRPAC, Naval Strike and Air Warfare Center, N096 and his National Technical Representative, NPMOC Pearl Harbor, Tactical Training Group Pacific, SPAWAR PMW 155, Naval Postgraduate School, Army Research Laboratory, Aerojet Inc., Australian Bureau of Meteorology, and a poster was given at the Battlespace Atmospheric and Cloud Impacts on Military Operations Conference. The second Nowcast IPT was also held this year at NRL Monterey. The IPT fosters a Nowcast development effort that best matches science and technology with the needs of the warfighter. The IPT was attended by a mix of warfighters, engineers, scientists, managers, and METOC decision makers and resulted in a lively exchange of information, requirements, and concerns about the role, design, development, and fielding of an operational nowcasting capability. At the IPT, the Nowcast web site (http://www.nrlmry.navy.mil/~cook/nowcast) was inaugurated. We hope the on-line presence will help to maintain contact with the IPT members throughout the year.

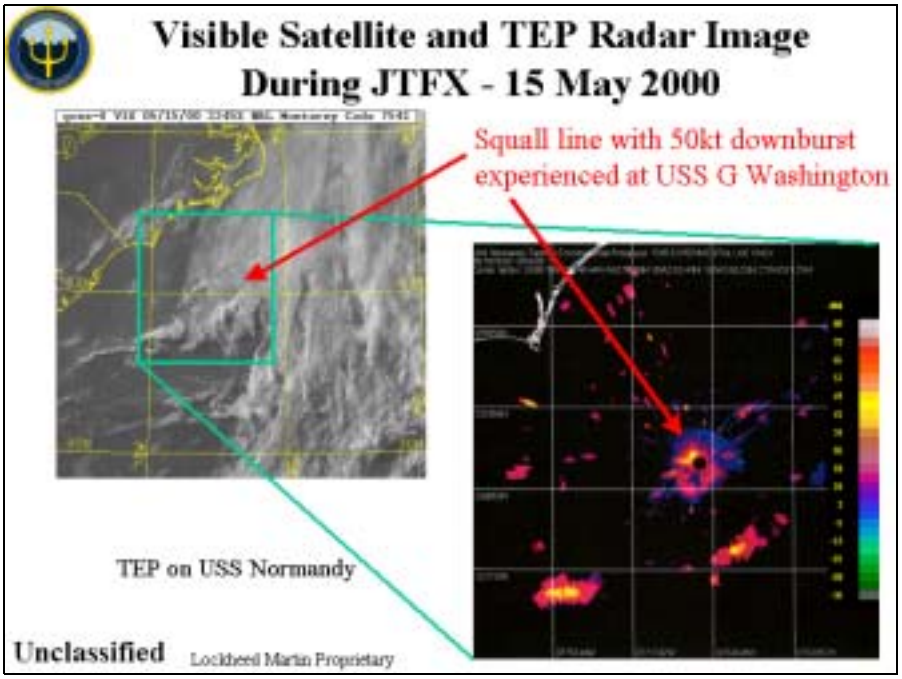

Figure 2. Satellite and radar images showing the squall line of thunderstorms (line of elevated cloud tops and 50 dBZ echoes) that formed near the USS George Washington on May 15, 1999 during a JTFX off the North Carolina coast. At about this time, a 50 knot downburst was experienced during flight operations on the USS George Washington.

RESULTS

The performance of the prototype Nowcast system developed in FY00 was evaluated and several optimizations were made and new technologies introduced. Java software (a "tab" class) was developed to implement the concept of a layered combination of up to two products and data displayed together on a user-selected map region. The end user may adjust the tabs for their specific tactical requirements and collects tabs together into a warfare or region specific folder. The Lightweight Directory Access Protocol (LDAP) database was implemented to store user accounts, folders, tabs, products, and regions; Java Naming and Directory Interface (JNDI) routines were developed to store, retrieve, modify, and delete the entries in LDAP. The applet and applet-to-servlet communications was completely redesigned for greater reliability and efficiency with communications bandwidth. Java beans were implemented to manage user sessions, cache user folders and tab information, and to provide event notification of product generation. Event notification allows Nowcast to automatically re-compute end user products immediately after each algorithm updates the master product. Two new Java servlets were also completed this year and five servlets were enhanced to improve functionality.

The IPT reinforced the warfighter's priorities for data fusion in the target areas, enroute, and in the carrier launch and recovery areas. Nowcast needs to supplement existing METOC forecast assets with an automated capability to continuously assimilate and fuse all-source continuous observations; it needs to include intuitive quality control features so the system is easy to use, operate, maintain, and monitor, and the system needs to be designed to minimize training requirements while maximizing the common situational awareness benefits to the battlegroup.

IMPACT/APPLICATIONS

Nowcast is the focus of a telescoping strategy to provide environmental products tailored to the needs of the warfighter, from the global scale to the tactical scale in both time and space. Nowcast also represents a paradigm shift from products that are briefed and interpreted by METOC personnel to products that are easily accessible, automatically updated, and tailored for interpretation directly by the warfighter. Nowcast enhances the role of METOC support by supplementing the existing forecast capability with automated, short-term (less than 2 hours) products thus freeing the forecaster to concentrate on the longer-range projections for planning and evaluation purposes.

TRANSITIONS

Nowcast is expected to transition in the 2005 time frame to the 6.4 Navy Integrated Tactical Environmental Subsystem (NITES) program at SPAWAR PMW 155. An early transition in FY01 was a stand-alone radar capability implemented at FNMOC.

RELATED PROJECTS

The SPY-1 TEP project at ONR is important to Nowcast as a source of weather radar data at sea.

A major component of Nowcast development is the project in the NRL base program (BE-35-2-56) to develop cloud diagnostic algorithms and verification software for the Nowcast system.

The tri-service (FAA, NASA, and Navy) C&V project has transitioned to an FAA National Ceiling and Visibility Product Development Team.

A proposal to demonstrate a limited Nowcast capability at NPMOC-SD during Fleet Battle Experiment - Juliet (FBE-J) has been submitted to SPAWAR PMW 155.

SUMMARY

Nowcast will provide the Navy METOC operator with an automated system to help monitor and characterize rapidly changing, operationally significant weather situations. By providing information over the web, Nowcast will enable warfighters to consider the impacts of the environment in a common situational awareness framework. This commonality should help to improve coordination and efficiency on the battlefield.

PUBLICATIONS

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