EVALUATION OF SATELLITE-DERIVED INFORMATION AS AN ANALYSIS TOOL AND TO IMPROVE PREDICTABILITY OVER CONVENTIONAL DATA-SPARSE REGIONS

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LONG TERM GOALS

The lack of adequate tropospheric observations over marine areas adversely affects the forecast skill of numerical weather prediction systems, and can therefore pose a threat to fleet operations. Clearly, space-based remote sensors must be employed to derive high-quality observations to help fill these data voids. In addition, it is important to marry these data with assimilation systems that can incorporate effectively the information provided in order to ameliorate the forecast skill degradation problems. It is the overarching mission of the Cooperative Institute for Meteorological Satellite Studies (CIMSS) located at the University of Wisconsin to forward the development and application of satellite-based information towards solving meteorological problems and observational deficiencies.

OBJECTIVES

This study is being supported by ONR Marine Meteorology and is being carried out through a cooperative research program involving scientists from CIMSS, the Naval Postgraduate School, and the Naval Research Lab in Monterey. The project goals and objectives can be broken down into four areas: 1) Product development. To show that multisensor information from geo and polar satellites can be fused to derive fields/products for use in fleet operations, for input into data assimilation, and for diagnostic studies. 2) Product demonstration. To evaluate the above products in a simulated operational setting (FASTEX field program) through real time dissemination to the operations center, and also through post-analysis studies related to adaptive and targeted observations. 3) Science applications. To apply the satellite-derived products to issues related to forecast degradation such as oceanic cyclogenesis, and to better understand the dynamic triggers of such events. 4) Data assimilation. To examine the usefulness of effectively incorporating the satellite radiance and wind information into global and regional data assimilation and forecast systems.

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APPROACH

The two month FASTEX field experiment (Joly et al. 1997) was used as a focus for intensive data collection, processing, and product development. Observations from GOES and NOAA satellites were collected and processed into meteorological variables on a continuous basis during this period. The data sets were made available in near real time via the Internet to the FASTEX operations center in Ireland, and also archived at CIMSS. The collection and processing routines were fully automated and based on algorithms developed at CIMSS.

The primary variables derived for demonstration and applications were multispectral wind fields from GOES sequential imagery, and upper-tropospheric thermal and advection fields derived from NOAA satellite microwave brightness temperatures combined with the GOES winds. These datasets, along with the raw radiances, are now being used in data assimilation and forecast impact studies.

WORK COMPLETED

Datasets were successfully collected and processed during FASTEX (about 90% success rate in near real time). Some post-processing was involved to fill in missed periods of interest to FASTEX. Case study datasets were identified by the FASTEX community for further investigation, and these were carefully analyzed, packaged and made available for easy use by colleagues/collaborators. A Web site home page was set up with an on-line catalog of processed datasets.

Selected datasets were disseminated to the NPS and NRL-MRY collaborators for data assimilation experimentation and evaluation. Published results from this evaluation are expected in the second year of the proposed effort under this award.

RESULTS

GOES multispectral winds (from water vapor, IR and visible imagery; Velden et al. 1997, Velden et al. 1998) were disseminated to the NRL-MRY numerical modeling group for a selected number of IOPs (Intensive Observational Periods). The winds were tested as part of adaptive observing experiments designed to identify critical initial analysis deficiencies (meteorological variables and location). The model adjoints were employed to identify the regions of perturbations in the initial analysis suspected of leading to subsequent model forecast errors. The GOES winds were assimilated to assess the data impact on forecasts, and to confirm the adjoint-determined perturbations as viable indicators of forecast error.

Results of model forecast impact tests run with data collected during FASTEX IOP #18 showed that the assimilation of the high-density GOES winds could account for much of the deficiency in the initial analyses. The forecasts of a target storm were significantly improved by the incorporation of the satellite data (Langland et al. 1998). Additional sensitivity studies were conducted to assess the relative impact of the data over two key regions: 1) at upper levels just upstream of the developing cyclone (potential vorticity anomaly), and 2) in mid levels over the

baroclinic zone/warm sector just ahead of the developing storm. The model adjoints pointed to the baroclinic development as the prime dynamic trigger mechanism in this case. While the GOES winds lead to analysis increments (changes) in both regions, it was clearly shown by partitioning of the dataset and independent forecast trials that the majority of the forecast impact (improvement) resulted from the additional information in the mid-level baroclinic zone. Further tests are underway to assess the impact of the winds assimilated over a 48 hour period prior to the key forecast time, and the inclusion of multispectral radiance information from the GOES sounder.

IMPACT

The significance of the preliminary results to date are twofold: 1) the GOES winds can in some cases lead to a significant reduction in forecast error, and 2) the adjoint strategy is a viable candidate for targeting critical areas of importance for forecast improvement. Many more cases need to be evaluated before conclusions can be drawn, but the preliminary results are encouraging on both fronts.

The ramifications of these findings can help mold the design of effective strategies for targeted sampling. If the initial condition uncertainties in numerical predictions can be properly identified in real time, adaptive sampling can be employed to focus on these regions with enhanced observations. In some cases, remote sensing from satellites may negate the need for deployment of expendables and other resources that may be costly.

The above combination of targeted sampling strategies, enhanced data from space-borne platforms, and effective assimilation has been demonstrated to have the potential to reduce forecast errors. This will benefit fleet operations.

TRANSITIONS

The automated algorithms designed to produce the high-density, multispectral GOES winds are being transitioned into Naval operations via a collaborative effort with NRL-MRY (ONR award # N00014-95-C-6017). The completion of this transition is expected in late 1998 or early 1999. NOAA/NESDIS is now producing the datasets in a demonstration mode, and it is expected the datasets will be operational in the last quarter of 1997. The NCEP numerical modeling team is evaluating the data and will begin assimilation into their global system in 1998. The Navy has been incorporating elements of the GOES datasets (produced under contract by CIMSS) successfully into NOGAPS since 1996 (Goerss et al. 1998).

RELATED PROJECTS

In addition to the collaborations with NRL-MRY cited above, additional data impact experiments are being carried out with NOAA/ETL (Dr. Mel Shapiro and colleagues). In this project, variational assimilation methodologies are being employed to incorporate the winds and also the GOES radiances.

The impact of the GOES winds on hurricane trajectory forecasts is also being assessed in collaboration with groups at NRL-MRY and GFDL (Princeton). Preliminary indications are the data are having positive impacts on track forecasts (Rohaly et al. 1998).

REFERENCES

Web site: http://cimss.ssec.wisc.edu/fastex/fastex.html

Goerss, J.S., C.S. Velden and J.D. Hawkins, 1998: The impact of multispectral GOES-8 wind information on Atlantic tropical cyclone track forecasts in 1995. Part II: NOGAPS forecasts. To appear in Mon. Wea. Rev. in early 1998.

Joly, A., and co-authors, 1997: The Fronts and Atlantic Storm-Track Experiment (FASTEX): Scientific objectives and experimental design. Bull. Amer. Meteor. Soc., 78, 1917-1940.

Langland, R.H., R. Gelaro, G.D. Rohaly and M. Shapiro, 1998: Adjoint-based adaptive observations in FASTEX. Symp. on USWRP Research Foci, Phoenix, AZ, January, 1998.

Rohaly, G.D., R.H. Langland and R. Gelaro, 1998: Identifying regions where the forecast of tropical cyclone tracks is most sensitive to initial condition uncertainty using adjoint methods. 12th AMS Conf. Num. Wea. Pred., Phoenix, AZ, January 1998.

Velden, C.S., T.L. Olander and S. Wanzong, 1998: The impact of multispectral GOES-8 wind information on Atlantic tropical cyclone track forecasts in 1995. Part I: Dataset methodology, description and case analysis. To appear in Mon. Wea. Rev. in early 1998.

Velden, C.S., and co-authors, 1997: Upper-tropospheric winds derived from geostationary satellite water vapor observations. Bull. Amer. Meteor. Soc., 78, 173-195.