Near-Realtime Sea Surface Pressure Fields from NASA's SeaWinds Scatterometer and Their Impact in NWP

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1. Introduction

Spaceborne scatterometers provide marine surface wind vector measurements with unprecedented coverage in space and time. As a result, these instruments can potentially serve as invaluable tools in operational meteorology as well as in the realm of numerical weather prediction. The most recently launched satellite scatterometer, SeaWinds, relays data from over 94% of the planet's ice-free oceans in a 24-hour period. Here the impact of assimilated SeaWinds data upon a numerical weather models performance is examined in a joint collaboration betweent the Center for Ocean and Atmospheric Prediction Studies and NASA's Data Assimilation office at the Goddard Space Flight Center. Particular emphasis devoted to the impact of assimilated scatterometer-derived sea surface pressures. Several experiments are conducted using a new NASA/NCAR finite volume model to separately assess the impact of assimilated sea-surface pressure fields derived from SeaWinds and assimilated SeaWinds winds themselves. The results from these experiments are objectively analyzed and the individual impacts of assimilated SeaWinds variables is compared.

2. Background

This study involving the assessment impact of assimilated scatterometer-derived pressures in addition to assimilated scatterometer winds is a significant departure from many other earlier works. With preliminary impact studies made by Baker et al. (1984) and Duffy et al (1984), it was established that satellite scatterometer wind data (SeaSAT) alone could provide significant improvements in the surface analyses for major synoptic events but less of an impact on the analyses and forecasts for the upper atmospheric levels. In subsequent studies, several initiatives by Duffy and Atlas and more recently by Atlas(2001), demonstrated that the impact of scatterometer surface winds from could be extrapolated vertically by adjusting the mass of upper levels relative to the adjusted features observed at the surface. Here, an alternative technique to enhancement of scatterometer data impact is advanced. Sea-surface pressures derived from the scatterometer data are assimilated into the model in place of the wind data itself. Assuming a relatively hydrostatic state in the atmosphere, surface pressures represent a three dimensional column of the atmosphere rather than the two-dimensional equivalent a the sea surface presented by the wind vectors alone. Surface pressure fields additionally affect the mass fields of the atmosphere directly and thus the impact of their assimilation into the model should be much stronger than that of the winds alone. With the use of pressures, the issues regarding complicated boundary layer physics in a model can be circumvented and so too the need for any vertical extrapolation scheme to adjust the model's upper atmospheric levels.

The calculation of sea-surface pressures from the scatterometer wind vectors in this study is made following the works of Harlan and O'Brien (1986), Brown and Zeng (1994), and ,ost recently Zierdent et. al. (2000). Wind vectors from the SeaWinds instrument are produced along a regularly gridded swath that flows. From these wind vectors observations, relative vorticity is determined following a centered difference scheme and blended via a variational technique with a geostrophic vorticity derived from an initial guess/model pressure field. A new surface pressure field is solved numerically using a method of successive overelaxation.

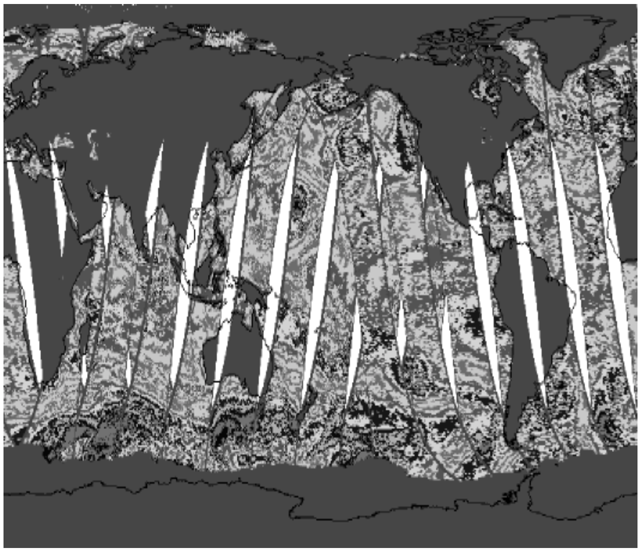
3. Data & Instrument

The SeaWinds instrument was launched by NASA in 1999 aboard the sun-synchronous, polar-orbiting satellite, QuikSCAT. It is a Ku-band scatterometer in the tradition of its predecessors SeaSAT and NSCAT, and functions as an active microwave sensor operating at 13.2 GHz Unlike its predecessors however, SeaWinds employs twin conically rotating pencil beams in its design, thereby improving the quantity and quality of its observations. With an orbital period of 101 minutes, the coverage of SeaWinds is typically 94% of the ice free oceans in one day.

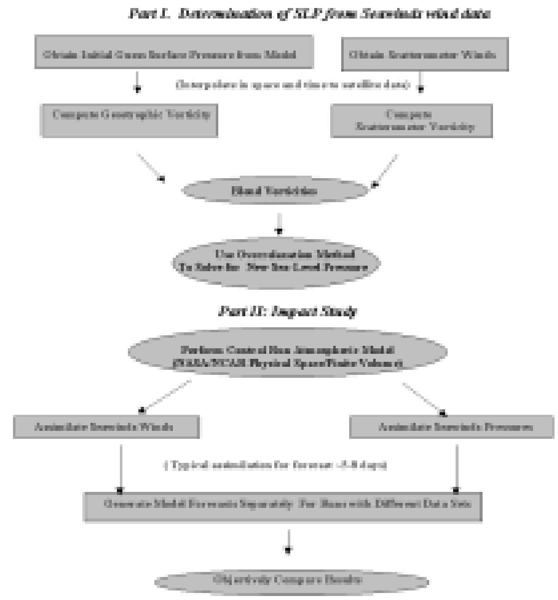
Since its launch several different data sets have been made available to researchers and operational weather centers by NASA-JPL and NOAA-NESDIS. These include processed science quality and near-realtime wind vectors. Both are employed in this study to be consistent with previous impact studies and to suggest the operational viability of using the SeaWinds winds and wind-derived surface pressures.

4. Model

A new Physical Space/ Finite-Volume global circulation model was employed in these experiments This model was developed jointly by NCAR and the NASA Data Assimillation Office. Detailed information about the model is available on the web at:
http://dao.gsfc.nasa.gov/pages/atbd.html



Sample Coverage for one Day By the QSCAT SeaWinds Scatterometer



SeaWinds Pressures and Winds Impact Study Methodology

5. Methodology

A series of individual experiments are conducted to assess and compare the impact of assimilated SeaWinds-derived pressures and assimilated SeaWinds surface wind vectors. The methodology for this impact study follows most closely that established by Atlas et al (2001) and is outlined graphically in Figure 2.

6. Results

Results from the assimilation of one-month of global Seawinds Pressures are presently being generated at NASA's Data Assimilation Office. Impacts of these pressures on the surface analysis alone are shown in figure 3, 4, 5,6, and 7.

7. Acknowledgements

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8. References

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