JP1.4 AN EVALUATION OF THE APPLICATION OF SEA LEVEL PRESSURE ANALYSES DERIVED FROM NEAR REAL TIME QUIKSCAT WINDS AS AN OPERATIONAL TOOL WITHIN THE NOAA OCEAN PREDICTION CENTER

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1. INTRODUCTION

The NOAA Ocean Prediction Center (OPC) is responsible for the issuance of short-term wind warnings for the North Atlantic and North Pacific high seas waters from 35 degrees W to 160 degrees E longitude. This area includes the offshore waters of the continental United States. Prior to the availability of remote sensing instruments, OPC forecasters had to rely on sparsely distributed ship and buoy observations to make their warning decisions. Since ships avoid areas of strong wind and high seas, the availability of observations in the vicinity of strong synoptic scale weather systems is undependable. The SeaWinds scatterometer on board the NASA QuikSCAT satellite has provided OPC forecasters with Near-Real Time (NRT) ocean vector wind retrievals over large ocean areas since 1999. Each day, QuikSCAT covers 90% of the world's oceans, giving forecasters two passes over a particular location. The wide 1800km swath enables forecasters to look at an entire storm system. This has significantly reduced much of the data void over the open oceans. Since QuikSCAT can retrieve wind speeds greater than 32.7 ms^{-1} (hurricane force intensity) forecasters now have the ability to identify areas of hurricane force conditions and to differentiate among all wind waning categories. Since QuikSCAT wind retrievals have become fully integrated into OPC operations, forecasters routinely use the QuikSCAT winds in their analysis and forecast process to locate and position frontal features, centers of high and low pressure and to determine the extent of wind warning areas. The assessment of wind conditions over the open oceans is more accurate than ever before.

Although QuikSCAT has had a significant impact on the short-term wind warning process in the OPC, this impact has not carried over to the forecasters' analysis of sea level pressure (SLP). To improve the SLP analysis the OPC has begun to use the University of Washington Planetary Boundary Layer model (UWPBL) (Patoux et al. 2003) to derive SLP fields from QuikSCAT wind retrievals. The UWPBL model derives SLP through the inverse process using QuikSCAT Level 2B (L2B) winds from the NASA Physical Oceanography Distributed Active Archive Center (PO.DAAC) servers. The Ocean Application Branch (OAB) of the OPC ran the UWPBL model to generate surface pressure fields for a number of North Atlantic and North Pacific extratropical cyclones. A comparison of the SLP fields from the UWPBL model with the manual OPC surface analyses and the Global Forecast System (GFS) surface pressure fields revealed that in most cases the central pressure of the storms was not analyzed to be deep enough by either OPC manual analyses or the GFS model. (Von Ahn et al., 2005) Since the L2B winds are not available in real time the use of the UWPBL model in an operational setting is limited. OAB, with help from the University of Washington (UW) Planetary Boundary Layer Group (PBL) has modified the UWPBL model to derive SLP fields using the NRT Merged Geophysical Data Record Lite (MGDR Lite) 25 km QuikSCAT winds from NOAA/NESDIS. The resulting SLP fields are now available in NRT on the forecasters' National Centers Advanced Weather Interactive Processing System (N-AWIPS) workstations for use as an additional observational aid to prepare their manual surface analyses. This version of the UWPBL model has been running in NRT in a quasi-operational mode since June 2005. In August 2005 an updated version was released and has replaced the earlier version. This paper evaluates the use of the UWPBL model SLP fields as an analysis aid for OPC forecasters. Section 2 describes the UWPBL model and details the procedure used to generate the NRT SLP analyses. Section 3 presents case studies that illustrate the usefulness of the model as an analysis aid. Results and conclusions are presented in section 4.

2. BACKGROUND AND PROCEDURE

The UWPBL Model was developed by the PBL group at the UW to solve the PBL and to calculate various PBL quantities (Patoux et al. 2003.) For each grid point, the PBL model uses the QuikSCAT wind vector to calculate the geostrophic wind and through an inversion of the geostrophic equation derives a pressure gradient. The resulting pressure gradient field is then seeded with surface pressure observations to produce a SLP analysis. The UWPBL 4.0 Model has been running operationally in NRT in the OPC since June 2005 using the MGDR-Lite winds from NOAA/NESDIS as input. In August 2005 this version was replaced with an updated version (UWPBL4.1). The UWPBL model runs upon receipt of each new QuikSCAT pass. The most recent

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pressure observations from ships and buoys that fall within the QuikSCAT pass are used to seed the pressure gradient fields. The resulting SLP analysis is converted to a General Environmental Meteorological Package (GEMPAK) file for display on the operational N-AWIPS workstations. On average 15 SLP analyses are produced for each ocean each day.

OPC forecasters produce surface analyses for the North Atlantic and the North Pacific daily at 0000, 0600, 1200, and 1800 UTC. Using the 6hr SLP forecast from the GFS model as a first guess, modifications are made using the most recent ship and buoy observations, QuikSCAT ocean vector wind data and satellite imagery. With only sparse SLP observations from ships and buoys, forecasters are often hesitant to stray too far from model guidance in analyzing the SLP field even though satellite imagery and/or QuikSCAT may indicate a stronger cyclone. In situations such as this, a dynamically consistent SLP field such as the ones produced by the UWPBL model would be invaluable.

3.0 Case Studies

In a study of 40 extratropical cyclones, Von Ahn et al (2005) compared the SLP analyses derived from the UWPBL model with the SLP analyses produced by the GFS model and the SLP analyses manually prepared by OPC forecasters. This results of this study revealed that the UWPBL reliably produced dynamically consistent SLP analyses. In the majority of cases, the central pressures from the UWPBL were lower than the central pressures from the GFS and the OPC SLP analyses. The following cases are examples of how the SLP fields from the UWPBL model can be used as an analysis aid within the OPC.

In the first example from 0600 UTC 10 January 2005, numerical guidance from the 0600UTC GFS model run indicated a 999 hPa low at 43N, 162E (Fig.1b). A QuikSCAT pass from 0709 UTC showed an area of hurricane force winds to the south west of the low center (Fig. 1d.) The strongest winds indicated by the GFS model were only Gale Force. Because there were no surface pressure observations from ships or buoys observations available within the vicinity of the low center, the forecaster chose not to deviate too far from model guidance even though QuikSCAT indicated a stronger cyclone and analyzed a 997 hPa low at 42N, 163 E on the OPC 0600UTC manual SLP analysis (Fig.1a.) The SLP field derived from the UWPBL model using surface winds from the 0709 UTC QuikSCAT pass (Fig.1d) produced a significantly deeper 982 hPa low at 42N, 164E. The pressure field was consistent with the SLP observations that were available and the pressure gradient better represented the stronger wind field. In this situation, the UWPBL SLP analysis would have given the forecaster the confidence to deepen the low on the OPC manual surface analysis and to warn for the hurricane force conditions.

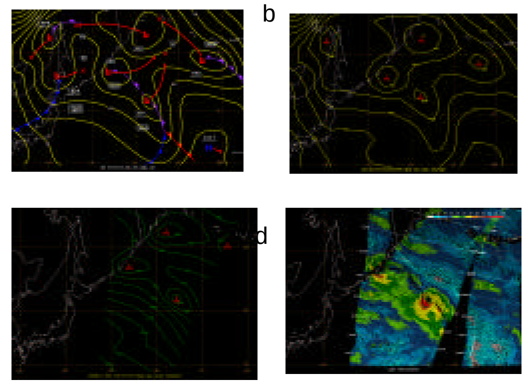

Fig.1: a) OPC surface analysis for 0600 UTC 10 January 2005. Surface pressure is drawn with yellow isobars in 4 hPa intervals. The red letter L indicates low centers. b) GFS surface analysis for 0600 UTC January 10 2005. Surface pressure is drawn with yellow isobars in 4 hPa intervals. Low pressure centers are indicated by a red L. c) Surface analysis generated by UWPBL model for 0709 UTC 10 January2005. Surface pressure is drawn in green for 4 hPa intervals. The red letter L indicates centers of low pressures. d) QuikSCAT pass from 0709 UTC 10 January 2005. Hurricane force winds are plotted as red wind barbs.

The second case is an example of a situation where the GFS model guidance did not correctly capture the structure of the cyclone. On the 0000UTC analysis for 08 July 2005, the OPC forecaster analyzed a dual low system with a 996 hPa w at 49N, 133W and a second low at 57N, 139W with a central pressure of 1003 hPa.

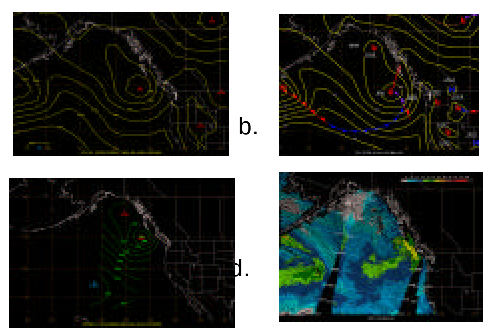

Fig.2: a) GFS surface analysis for 0300 UTC 08 July 2005. Surface pressure drawn with yellow isobars in 4hPa intervals. The red letter L indicates the low center. B) OPC surface analysis for 0000UTC 08 July 2005. Surface pressure drawn with yellow isobars in 4 hPa intervals. A red L indicates low centers. c) Surface analysis generated by UWPBL model for 04300 UTC 08 July 2005. Surfac e pressure drawn in green for 4 hPa intervals. A red L indicates low pressure centers. d) QuikSCAT pass from 0300 UTC 08 July 2005.

The GFS model guidance for 0300 UTC indicated a single 996 hPa low at 43N, 132W. The SLP analysis derived from the UWPBL model using a QuikSCAT pass from 0300UTC produced a dual low system with a 991 hPa low at 50N, 133W and a second low at 57N, 139 W with a central pressure of 1001 hPa. In this case, while the SLP analysis from the GFS model only hinted at a secondary low, the analysis generated by the UWPBL model produced a definitive secondary low pressure center. This is an instance where the UWPBL SLP analysis would have reinforced the forecaster's decision to deviate from model guidance.

4.0 Summary and conclusions

The UWPBL Model has been running operationally in NRT in the OPC since June 2005 using the MGDR-Lite winds from NOAA/NESDIS as input. For an observational tool to be used operationally within the OPC it must meet stringent requirements.
The data must be available in NRT at the forecasters workstations and must be realistic and meteorologically correct. Ideally the data should be able to be overlaid over other observational parameters for comparison. The UWPBL model has met these criteria. The output from the model has been converted to GEMPAK format so that it is now displayed right at the forecasters' N-AWIPS workstations. The SLP analyses are available in NRT in a timely manner so that they can be used along with QuikSCAT winds and ship and buoy observations to produce the manual OPC SLP analyses.

Overall, the performance of the UWPBL model has been encouraging. Daily comparison of the SLP fields derived from the UWPBL model with the GFS model guidance and the manually produced OPC SLP analyses has shown that the UWPBL model reliably produces dynamically consistent analyses of SLP. However, there have been instances where the resulting pressure field was considered to be too deep and were not consistent with the available ship and buoy pressure observations. The reason for this appears to be twofold. First, it appears that the method OAB has developed to assimilate the surface pressure observations from ships and buoys into the model may be partly responsible for this. The second reason seems to be related to stability issues. The UWPBL model is currently running using a constant sea surface temperature (SST) and surface air temperature resulting in neutral stability. The OAB has begun running (in parallel) a version of the UWPBL model that accounts for the air sea temperature difference. It is believed that once these factors have been thoroughly evaluated the UWPBL derived SLP analysis will prove to be an extremely valuable observational tool.

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5.0 References

Patoux, J., R.C. Foster, R. A. Brown, 2003: Global Pressure Fields from Scatterometer Winds. *J. Appl. Meteor.,* **42,** 813-826**.**

Von Ahn, J., J.M. Sienkiewicz, J. Patoux, 2005: A Comparison of Sea Level Pressure Analyses Derived From QuikSCAT Winds to Manual Surface Analyses Produced in the NOAA Ocean Prediction Center, preprint, 21st Conference on Weather Analysis and Forecasting, AMS, Washington, D.C.