15b.1 A COMPARISON OF SEA LEVEL PRESSURE ANALYSES DERIVED FROM QUIKSCAT WINDS TO MANUAL SURFACE ANALYSES PRODUCED IN THE NOAA OCEAN PREDICTION CENTER

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1. INTRODUCTION

The main responsibility of the NOAA Ocean Prediction Center (OPC) is 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 including the offshore waters of the continental United States. The SeaWinds scatterometer onboard the NASA QuikSCAT satellite has provided OPC forecasters with Near-Real Time (NRT) ocean vector wind retrievals over large ocean areas since 1999 and have since become fully integrated into the OPC warning and analysis process. Prior to QuikSCAT, OPC forecasters had to rely on buoy and ship observations to make their warning decisions. These obs ervations are often sparsely distributed. Since ships avoid areas of strong wind and high seas, observations in the vicinity of strong synoptic scale weather systems cannot be relied upon. The impact of QuikSCAT winds on OPC operations has been significant. Each day, QuikSCAT covers 90% of the world's oceans providing two looks at a particular location thereby eliminating much of the data gap. The wide swath width (1800km) enables forecasters to see entire storm systems. Since QuikSCAT retrieves winds speeds greater than 32.6 ms^{-1} (HURRICANE FORCE (HF) strength) forecasters can now differentiate between all wind warning categories, in particular between common STORM force winds and extreme HF conditions. In addition to making warning decisions, QuikSCAT winds are routinely used to locate and position frontal features and high and low pressure centers. Never before have the OPC forecasters' assessment of conditions over vast open areas been more accurate.

Although the data gap has been reduced for surface winds, the same cannot be said for surface pressure observations. Forecasters depend on the six-hour surface pressure forecasts from the latest National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) model as the primary guidance for their analyses. In many instances in areas where QuikSCAT indicates strong winds, the GFS forecasts weaker winds. After some discussion OPC forecasters are hesitant to stray too far from numerical model short-term forecasts of sea level pressure. There is a tendency for forecasters to not strengthen cyclones as much as QuikSCAT winds would indicate. Accurate representation of the Sea Level Pressure (SLP) field remains a problem. A solution would be a QuikSCAT based SLP field.

The Planetary Boundary Layer (PBL) Research group of the Department of Atmospheric Sciences at the University of Washington has developed a planetary boundary layer model (UWPBL4.0) to calculate various PBL quantities (reference). The inverse or pressure retrieval model s ubroutine estimates the surface pressure field using Level 2B Science Level winds from QuikSCAT. With the help of the PBL groups the model was adapted to generate surface pressure fields using near real time Merged Geophysical Data Record lite (MGDR lite) data from NOAA/NESDIS. Dynamically consistent surface pressure fields of various North Atlantic and North Pacific extratropical cyclones were produced in near real time. A comparison of the QuikSCAT derived SLP fields with the OPC manual analyses and the numerical analyses from the GFS revealed that in most cases the central pressures of oceanic extratropical cyclones were not analyzed to be deep enough either by the numerical analyses and forecasts or the manual analyses. The procedure used to produce the pressure fields for the case studies is described in section 2. Section 3 provides detailed case studies. Results and conclusions are summarized in section 4.

2. PROCEDURE

OPC forecasters produce surface analyses for the North Atlantic and North Pacific four times daily at 0000, 0600, 1200, and 1800 UTC using the 6hr surface pressure forecast from the GFS model as a first guess. Modifications are then made using the most recent ship and buoy observations, QuikSCAT ocean vector wind data and satellite imagery. Forty extratropical cyclones (20 in the Atlantic, 20 in the Pacific) of various intensities and locations were chosen for this study. The UWPBL model was run for each cyclone using the QuikSCAT pass closest in time to the analysis time. Ship and buoy observations of sea level pressure that fell within the pass were used to seed the pressure gradient field to produce a surface pressure analysis. For each case, the UWPBL surface pressure analysis was compared to the corresponding OPC manual surface analysis and GFS model analysis or forecast and the difference in central pressure between UWPBL

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and OPC (UWPBL – OPC) and UWPBL and GFS (UWPBL – GFS) was computed.
In the majority of the cases, the UWPBL produced lower central pressures than either OPC manual analyses or the model generated pressure fields. The average difference in central pressure for each ocean was then computed and is shown in table 1. In the Atlantic, the average difference was - 2.7 hPa for UWPBL – OPC and - 3.3 hPa for UWPBL – GFS. In the Pacific the average differences was slightly less - 1.3 hPa for UWPBL – OPC

	OPC-GFS	UWPBL – OPC	UWPBL - GFS
Atlantic	**-0.8**	**-2.7**	**-3.3**
Pacific	**-0.7**	**-1.3**	**-2.0**

Table1. Average difference between the central pressure from UWPBL model and the OPC manual analyses and the UWPBL model and the GFS numerical guidance.

and - 2 hPa for UWPBL- GFS. It is believed that the larger difference in the Atlantic is due to several cases where the difference in central pressure was significant (greater than 7 hPa). Upon examination of the surface observations from ships and buoys for these cases, it appears that the UWPBL model did not "draw" for the observations and the pressures were analyzed too deep. The reason for this is not clear and this must be further investigated before the model can be used operationally with confidence. For the remainder of the cases the model generated pressures were consistent with the observations. Although the central pressures of the UWPBL model were not always lower than either the OPC or GFS analyses, the resulting pressure fields did appear to be dynamically consistent with the synoptic situation.

3. CASE STUDIES

The initial intent of this study was to evaluate the performance of the UWPBL boundary layer model. Several of the cases generated for this study provide excellent examples of how the SLP analyses produced by this model could be used operationally by OPC forecasters as an analysis and forecasting tool.

The first example is from 0600 UTC 10 January 2005. In this case, numerical guidance from the 0600 UTC GFS model run indicated a 999 hPa low at 43N, 162E (Fig.1b). There were no ship or buoy observations available in the vicinity of the low, however the 0709 UTC QuikSCAT pass showed an area of HF winds to the southwest of the low center (Fig.1d). The strongest winds forecast by the GFS model were GALE FORCE In this situation since there were no surface pressure observations available, the forecaster was hesitant to stray too far from the model, even though QuikSCAT winds indicated a significantly stronger low. A 997 hPa low at 42N, 163E was analyzed (Fig.1a) The UWPBL model using the QuikSCAT pass from 0709 UTC as input (Fig. 1d) resulted in a 982 hPa low at 42N, 164E. The resulting pressure field is consistent with the available observations and appears to be a realistic representation of the synoptic situation.

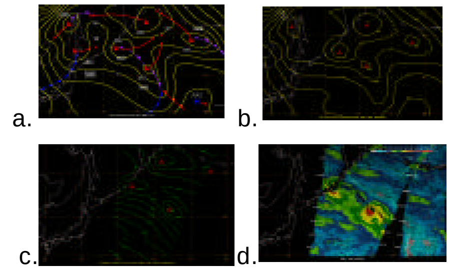

Fig.1: a) OPC surface analysis for 0600 UTC 10 January 2005. Surface pressure drawn with yellow isobars in 4 hPa intervals. The red letter L indicates low centers. b) GFS surface analysis for 0600 UTC 10 January 2005. Surface pressure drawn with yellow isobars in 4 hPa intervals. Low centers are indicated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

In this example the SLP analysis retrieved from QuikSCAT winds would have given the forecaster confidence to deepen the low on the manual surface analysis.

In the second example the 3 hr forecast from the 0600 UTC run of the GFS model for 01 April 2005 (valid at 0900 UTC) indicated a 991 hPa low at 39N, 53W (Fig 2b). The 0900 UTC OPC position was low was 39N, 52W with a central pressure of 991 hPa. (Since OPC only produces analyses every 6 hrs, the OPC 0900 UTC position and intensity of the low was derived from the average position and intensity from the 0600 UTC and 1200UTC OPC surface analyses.) Using the QuikSCAT pass from 0830 UTC (Fig 2d), the UWPBL model generated a 987 hPa low at 39N, 51W (Fig.2d.)

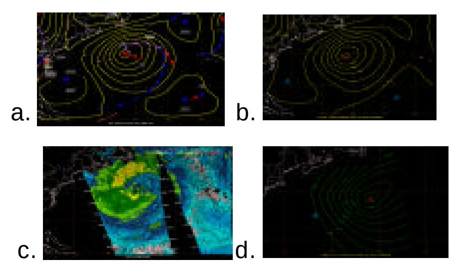

Fig.2: a) OPC surface analysis for 0600 UTC 01 April 2005. Surface pressure drawn with yellow isobars in 4 hPa intervals. The red letter L indicates low centers. b) 3 hr surface analysis forecast from the 0600UTC 01April 2005 GFS model run valid for 0900 UTC 01April 2005. Surface pressure drawn with yellow isobars in 4 hPa intervals. Low centers are indicated by a red Surface pressure c) QuikSCAT pass from 0830 UTC 01 April 2005. d) Surface analysis generated by UWPBL model for 0830 UTC 01 April 2005. Surface pressure drawn in green for 4 hPa intervals. The red letter L indicates low pressure centers.

The third case is an example of a situation where the GFS guidance did not correctly capture the structure of the cyclone. On the surface analysis for 0000 UTC 08 July 2005, the OPC forecaster analyzed a dual low system with a 996 hPa low at 49N 134W and a second low center low at 57N, 139 W with a central pressure of 1003 hPa. GFS model guidance for 0600 UTC indicated a single 996 hPa low at 49N, 132W. Using the 0300 UTC QuikSCAT pass the UWPBL model produced a dual low system with a 991 hPa low at 50N, 133W and a second at low at 56N, 140W with a central pressure of 1001 hPa. In this case where the GFS model guidance only hinted at a second low, the SLP analysis generated by the UWPBL did produce a definite second low center.

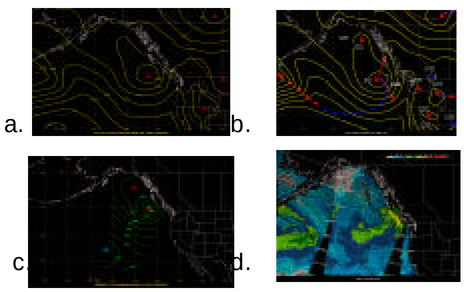

Fig.3: a) GFS surface analysis for 0300 UTC 08 July 2005. Surface pressure drawn with yellow isobars in 4 hPa intervals. The red letter L indicates low center. b) OPC surface analysis for 0000 UTC 08July 2005 Surface pressure drawn with yellow isobars in 4 hPa intervals Low centers are indicated by a red. c) Surface analysis generated by UWPBL model for 0300 UTC 08 July 2005. Surface pressure drawn in green for 4 hPa intervals. Low pressure centers are indicated by a red L. d) QuikSCAT pass from 0300 UTC 08July 2005

4. CONCLUSIONS

The inclusion of QuikSCAT winds in the OPC has indeed improved the analysis and warning process. The issuance of short-term wind warnings increased by 10% as a direct result of using QuikSCAT wind observations (Von Ahn et al, in review). Forecasters can now assess wind conditions over the open oceans more accurately than ever before. However, the accurate representation of the surface pressure field still remains a problem. With only sparse surface observations of sea level pressure from ships and buoys forecasters are often hesitant to stray too far from the model guidance in analyzing the surface pressure field. The UWPBL was originally developed to produce a sea level pressure field using QuikSCAT level 2B wind as input. Although this model was valuable for examining past cases, it was of no use operationally in NRT. With help from the PBL group at the University of Washington, the OPC adapted the model to use the near real time MDR Lite QuikSCAT data as input so that the model could be run operationally. The forecasters could then use the resulting sea level pressure analyses generated by the model as an additional observational tool for preparation of their manual surface analyses.

For an observational tool to be incorporated into the operations at OPC it must meet certain requirements. It must be available in a timely manner right at the forecasters workstations. Optimally the data should be able to be overlaid over other parameters for ease of comparison. The resulting output must be realistic and meteorologically correct. Overall, the UWPBL model has met these criteria. The output from the model has been converted to GEMPAK for display on the N-AWIPS workstations. The model is available in a timely manner and can be used, along with QuikSCAT and any ship and buoy observations to analyze the surface pressure field at a given time. Overall, the performance of the model was encouraging .The model was reliably able to produce dynamically consistent fields of surface pressure. There were a few situations, however, where the resulting pressures were considered to be too deep. The reason for this appears to be related to the assimilation of the surface pressure observations into the model. This must be evaluated before the model can become fully operational.

5. References

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