4.2 THE IMPACT OF QUIKSCAT ON WEATHER ANALYSIS AND FORECASTING

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1. INTRODUCTION

Scatterometer observations of the ocean surface wind speed and direction improve the depiction and prediction of storms at sea. These data are especially valuable where observations are otherwise sparse—mostly in the Southern Hemisphere and tropics, but also on occasion in the North Atlantic and North Pacific.

The SeaWinds scatterometer on the QuikScat satellite was launched in June 1999 and it represents a dramatic departure in design from the other scatterometer instruments launched during the past decade (ERS-1,2 and NSCAT). More details on the SeaWinds instrument can be found in Atlas *et al.* (2001) and Bloom *et al.* (1999). This presentation shows the influence of QuikScat data in data assimilation systems both from the NASA Data Assimilation Office (GEOS-3) and from NCEP (GDAS).

2. SEAWINDS EXPERIMENTS

The strategy for assessing the impact of SeaWinds in NWP was largely described in Bloom *et al.* (1999), and parallels the approach used for the geophysical validation of NSCAT data (Atlas *et al.*, 1999). Given here are two tables that summarize the early experiments run using data assimilation systems from both the Data Assimilation Office (DAO) and NCEP using early data from SeaWinds.

3. ANALYSIS RESULTS

Figures 1-4 show the short-term impact of SeaWinds data on the GEOS data assimilation system. These results are taken from runs that employed an updated model function (time period: 12-27 January, 2000). While the 6 h vector and slp impacts are localized to the satellite swaths, the assimilation system spreads the wind information considerably in the vertical (figure 4). After 18 h from the initial time, the vector differences are spread over all the oceans.

Figure 5 gives a detailed view of the influence that SeaWinds data can have on the positioning of a surface low pressure area in an analysis. The sea level analysis used in GEOS is multivariate; thus wind data can directly affect the analysis of sea level pressure.

EARLY SEAWINDS EXPERIMENTS: GEOS

- GEOS DATA ASSIMILATIONS USED
  GEOS-1, GEOS-2, GEOS-3
- SPINUP: 10 DAYS
- ASSIMILATION PERIOD
  19 JULY - 19 SEPTEMBER 1999
- EXPERIMENTS
  - CONTROL – ALL CONVENTIONAL DATA + TOVS + CTW
  - QUIKSCAT – CONTROL + THINNED QUIKSCAT WIND VECTOR
  - SSMI – CONTROL + SSMI WIND SPEED
  - ERS-2 – CONTROL + ERS-2 WIND VECTORS
  - SPEED – CONTROL + QUIKSCAT WIND SPEED
- FORECASTS 11 FORECASTS FROM EACH

EARLY SEAWINDS EXPERIMENTS: NCEP

- SPINUP: 10 DAYS
- ASSIMILATION PERIOD
  19 JULY - 12 SEPTEMBER 1999
- EXPERIMENTS
  - CONTROL – ALL CONVENTIONAL DATA + TOVS + CTW
  - QUIKSCAT – CONTROL + THINNED QUIKSCAT WIND VECTORS (Sweet Spot Only)
  - NCEP_OP – CONTROL + SSMI + ERS-2
  - NCEP_OP_Q – NCEP_OP + THINNED QUIKSCAT WIND VECTORS (Sweet Spot Only)
  - NCEP_OP_A – NCEP_OP + THINNED QUIKSCAT WIND VECTORS (Full Swath)
- FORECASTS 10 FORECASTS FROM EACH
- ADDITIONAL EXPERIMENTS: VARIABLE OBSERVATION ERRORS

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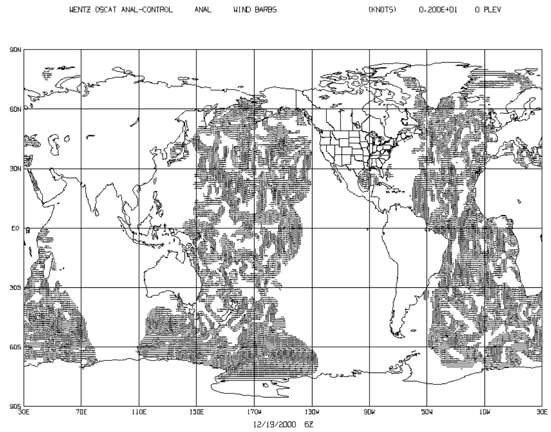

Figure 1 Impact on ocean surface wind vectors after 6 hours of SeaWinds assimilation. Note residual pattern from the orbits.

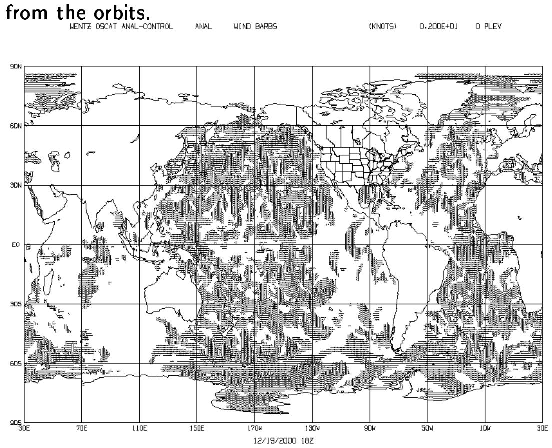

Figure 2 Impact on ocean surface wind vectors after 18 hours of QuikScat assimilation. Now the difference patterns cover all the oceans over the globe.

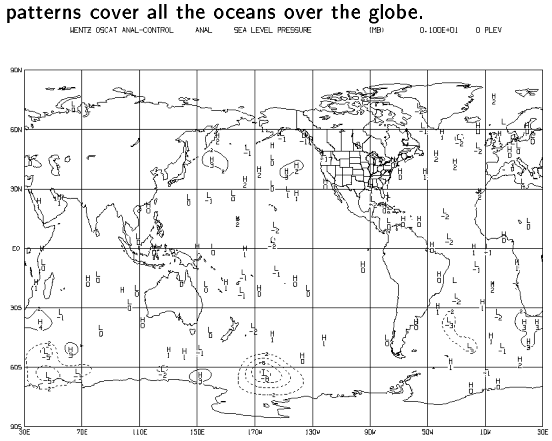

Figure 3 Differences in Sea Level Pressure Analyses after 6 hours of assimilation.

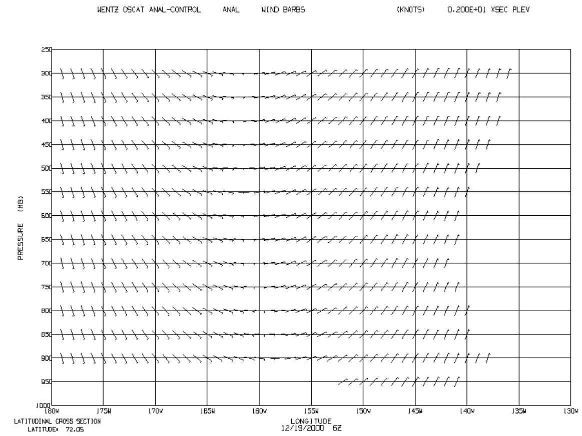

Figure 4 Vertical cross-section of vector wind differences, showing vertical influence of QuikScat data during the assimilation process.

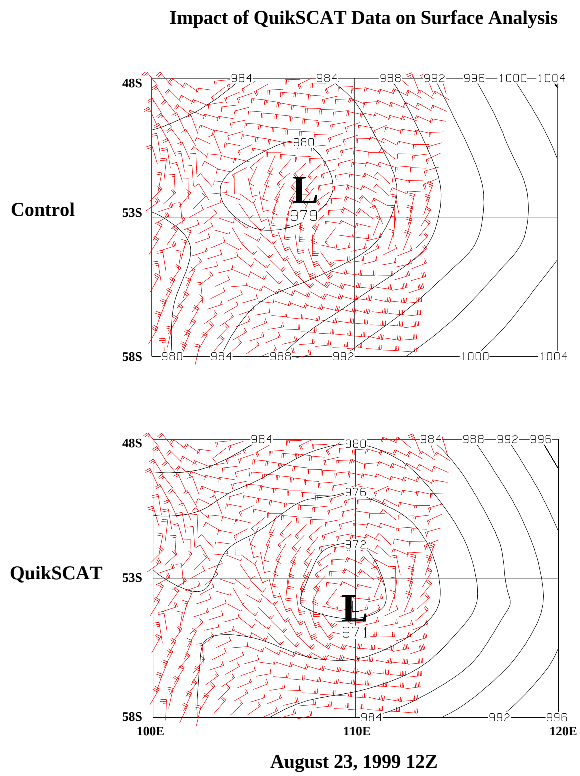

Figure 5 Top: Control Sea Level Pressure analysis, which does not conform to the QuikScat wind data. Bottom: Sea Level Pressure analysis using QuikScat data, showing a much improved agreement.

4. FORECAST IMPACTS

A limited sample of 5-day forecasts were made from initial conditions taken from assimilations made with and without SeaWinds data during the period 12-27 January, 2000. Figure 6 shows the impact these data made on 500 hPa geopotential height anomaly correlations of forecast skill. There was a slight positive impact on forecast skill in the Northern Hemisphere, and there was a somewhat larger improvement in forecast skill in the Southern Hemisphere.

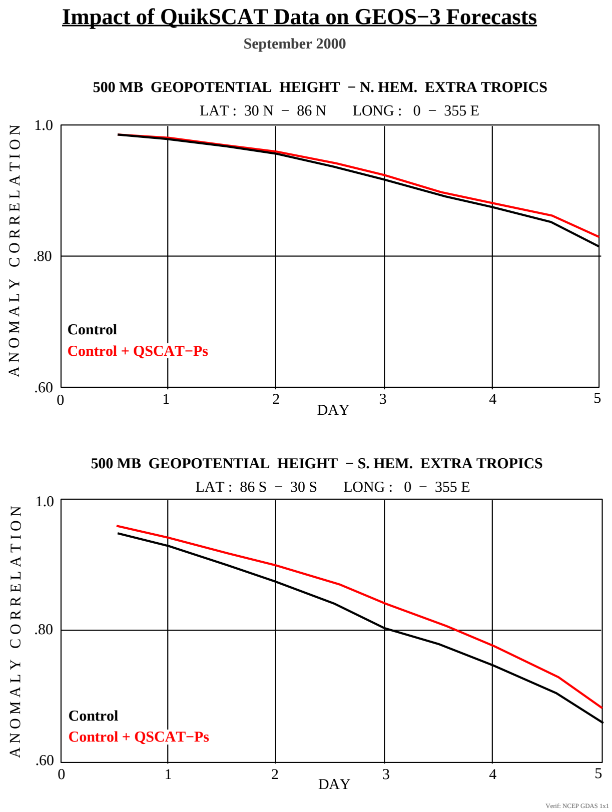

Figure 6 Anomaly correlation measures of forecast skill. QSCAT-Ps refers to the Sweet-Spot swath subset of SeaWinds data using a newer model function ("prime").

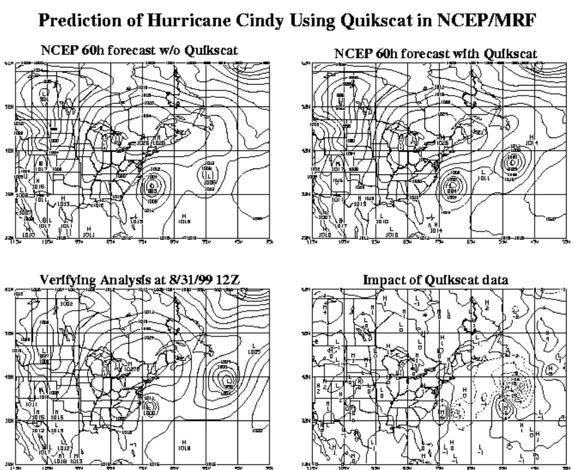

Figure 7 Impact of QuikScat data in a test version of the NCEP operational environment. Verifying analysis is the lower left panel. Note the greatly improved position and depth of the mid- Atlantic storm. The magnitude of the impact is shown in the lower right panel.

5. HURRICANE CINDY CASE STUDY

The impact of QuikScat data have also been examined in a version of the NCEP operational environment. Figure 7 shows SeaWinds data having an enormous beneficial influence on the amplitude and positioning of a mid-Atlantic hurricane in a 60 hour forecast.

Figure 8 shows the magnitude and position errors of the mid-Atlantic storm shown at 60 h in figure 7 – Hurricane Cindy. This experiment shows that the assimilation of QuikScat data results in a substantial reduction of both magnitude and displacement errors with respect to the control run. The 60 h forecast with QuikScat data is more accurate than the 24 h forecast without QuikScat data. It should be noted, however, that the current NCEP operational system includes ATOVS data which were not used in the experiment described here. As a result, the expected impact of QuikScat data in the current operational system would be smaller.

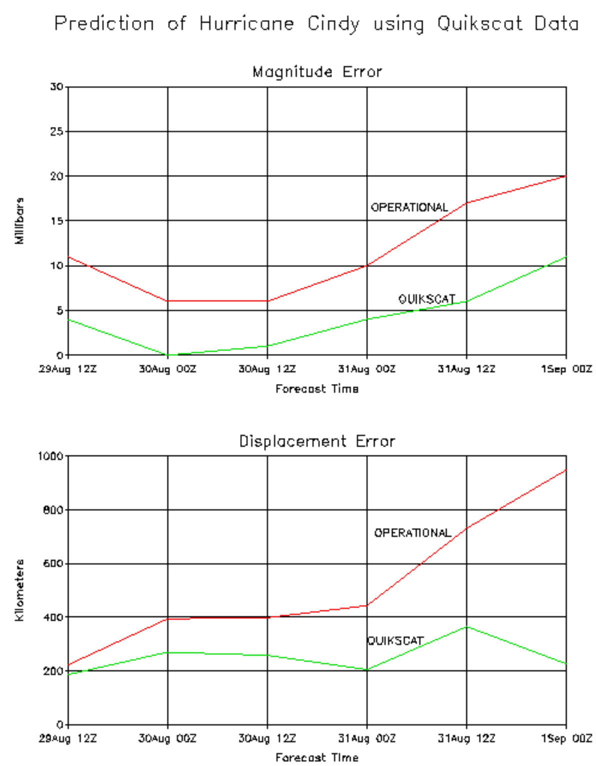

Figure 8 Magnitude and displacement errors of Hurricane Cindy in the NCEP system over a 60 hour period.

6. PLANNED SEAWINDS EXPERIMENTS

- NEW DAS CONFIGURATIONS
  - GEOS/Stretched Grid: (0.5°x0.5°, 0.25°x0.25°)
  - fvDAS: Based on Finite Volume (NASA/NCAR) GCM
- NEW DATA SETS FOR ASSIMILATION
  - SeaWinds retrievals generated with improved model functions and quality flags
  - SeaWinds Backscatter

7. SUMMARY

- SeaWinds (like NSCAT and ERS) shows unequivocal signatures of meteorological features including cyclones, fronts, anticyclones, easterly waves and other precursors of hurricanes and typhoons.
- Through collaborative efforts between NASA and NOAA, National Weather Service marine forecasters are using SeaWinds data to improve analyses, forecasts and significant weather warnings for maritime interests. This results in substantial economic savings as well as the reduction of weather related loss of life at sea.
- The impact of SeaWinds on Numerical Weather Prediction models is on average modest but occasionally results in significant forecast improvements.

8. REFERENCES

Atlas, R., R.N. Hoffman, S.M. Leidner, J. Sienkiewicz, T.-W. Yu, S.C. Bloom, E. Brin, J. Ardizzone, J. Terry, D. Bungato, and J.C. Jusem , 2001: The effects of marine winds from scatterometer data on weather analysis and forecasting. *Bull. Amer. Meteor. Soc.*, in press.

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