THE OPERATIONAL USE OF SSM/I WIND SPEED DATA OVER OCEANS

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1. INTRODUCTION

Wind speed data derived from the Special Sensor Microwave/Imager (SSM/I) are being used by the meteorologists of at the National Meteorological Center (NMC) to enhance their routine operational ocean surface wind analyses for the NW Atlantic, and NE Pacific. The SSM/I data are transmitted from the DMSP satellite to a ground station where they are processed into wind speed data (Goodberlet, Swift, & Wilkerson, 1990) and sent to NMC computers in near real time (within of 3-5 hours). The satellite is polar-orbiting with a 102 minute orbit, with areal coverage about twice a day over a given area, one ascending orbit, and one decending orbit. The satellite data covers a swath of 1400km, with a footprint of near 25km. This satellite sensor is a passive microwave instrument which can measure wind speeds at the ocean surface (19.5m) with an accuracy close to 2 m/s (or 10%) under rain-free conditions, for a wind speed range of 3-25m/s. Further, there are two DMSP satellites (F-10 and F-11) with the SSM/I sensor although F-10 is considered the primary system, and F-11 is a backup which is ahead by about 4 hours.

It is evident that such a data coverage over the ocean would be of great value, since observational data are very sparce from conventional platforms (i.e. ships, buoys and coastal platforms). Thus, even though this data set does not provide wind direction, or wind speeds in excess of 25m/s or winds over rainy areas, there still is valuable information because of its wide swath and its global ocean coverage that can be used by the operational meteorologist for immediate use for ocean surface wind analyses. The F-10 data are being routinely used by the NMC global data assimialtion system by averaging (super-obing) the wind speeds by 1 degree quadrangles. These data could also be used in their full resolution for application to regional analysis and forecasting problems.

2. DISCRIPTION OF WIND PRODUCTS

It was decided that while charts of wind speeds would be of value by themselves, directional information would also be of value to give the sense of flow patterns. The directions are obtained by interpolating the directions from the lowest level (at about 45 m) wind field of the global operational analysis system (Derber et al. 1991) to the location of the SSM/I wind speeds. These wind directions represent the ocean surface wind field fairly well for synoptic scale resolutions. Wind charts are generated for the central Pacific (25°N to 60°N, 180°W to 140°W, and NE Pacific (25°N to 60°N, and 160°W to the U.S. West coast), and the NW Atlantic (25°N to 65°N, and 40°W to the U.S. East coast) with the satellite data time window being +/- 3 hours centered on the appropriate analysis.

The SSM/I wind products are now being routinely made available in real-time by Marine Prediction Branch to the Satellite Marine Section which produces the operational forecasts. These products are in the form of two sets of charts, 1) a color coded plot, (by wind speed categories) of all the wind speed data, and 2) a chart that plots color coded wind barbs. As mentioned above, the direction is obtained from the global surface wind analysis (global forecast model run at +3:20), but only every fourth data point is plotted because of the density of the data for the F-10 satellite. A similar set of wind speed plots for the F-11 satellite are also made available.

3. EVALUATION

An objective evaluation of the SSM/I wind data is being made by comparisons with NOAA fixed bouy wind data. The buoy winds are not, unfortunately, measured at the same height as the satellite winds. These buoy anemometers range from 3m to 14m. For this comparison, the buoy wind data have been adjusted to a common height of 20m, assuming the neutral log profile, to match the height of the satellite data. Satellite data that are within 3 hours of a buoy observation time (taken at 00, 06, 12, and 18 UTC) and within 1 degree (110km) are averaged and then compared with the adjusted speed and direction at the buoy. The SSM/I wind statistics are presented in Table 1 which compares the satellite data with NOAA fixed buoy data. Although the sample of data is small, the results do suggest that SSM/I wind speeds are more accurate than conventional ship wind measurements, whose poor quality has been documented by Pierson (1990).

TABLE 1

Comparison of wind data for period of 93/04/09 through 93/05/09. Values of speed are given in m/s.

	Adjusted Buoys Speed Mean	Satellite Speed Mean	Speed Bias, RMS
F-10	7.6m/s	6.9m/s	-0.7, 2.2
F-11	7.9m/s	7.4m/s	-0.5, 2.1

BUOY VS SATELLITE COMPARISON

Additional charts are being made to compare spacial patterns of the satellite wind speeds along the swaths with the appropriate wind speeds from analyses and their differences using color coded plots. This preprint article presents one example in black and white, but the full complement of color view graphs will be presented during the oral presentation. An example of all SSM/I wind speeds with model assigned directions is presented in Figure 1 and the corresponding surface analysis is presented in Figure 2.

Some quality control problems have been identified over the past several months, i.e. the first pixel adjacent to land or ice boundaries may have a wind speed much higher than surrounding areas futher off-shore, occasionally an entire scan lines is in error (usually with an obvious jump in wind speeds) but the winds are not rejected because speeds are in the acceptable range. Dispite the limitations and problems with this wind data set, it is clear that there is reliable information for use in numerical prediction models, especially, high-resolution regional models.

REFERENCES:

Derber, J.C., D.F. Parrish and S.J. Lord (1991): The New Global Operational Analysis System at the National Meteorological Center. Wea. Forecasting 6, 538-547.

Goodberlet, M. A., C. T. Swift and J. C. Wilkerson (1990): Ocean Surface Wind Speed Measurements of the Special Sensor Microwave/Imager (SSM/I). IEEE Transactions on Geoscience and Remote Sensing. Vol. 28, No. 5, 823-827.

Pierson, W.J. (1990): Examples of, Resons for, and Consequences of the Poor Quality of Wind Data From Ships for the Marine Boundary Layer: Implications for Remote Sensing. J. Geophys. Res. 95(C8), 13313-13340.

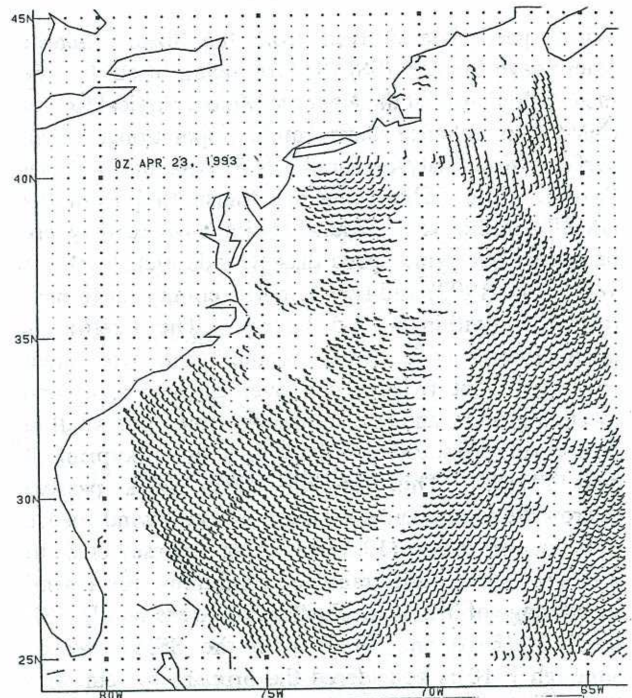

Figure 1: SSM/I wind speed data with analysis model directions.

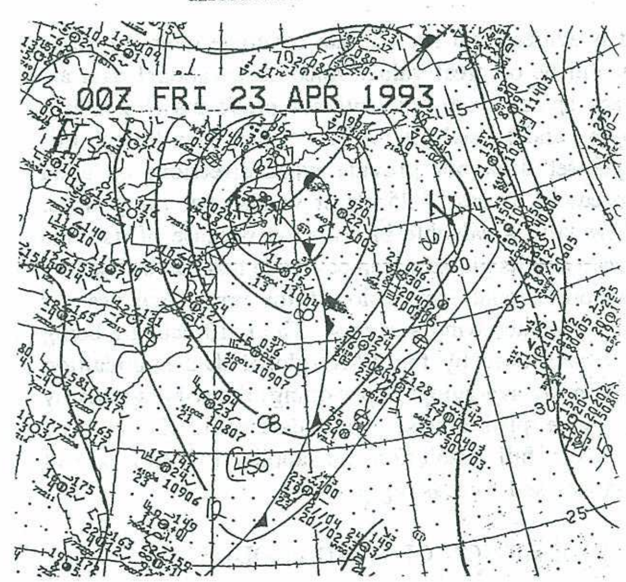

Figure 2: Surface Weather Map