Impact of satellite surface-wind data on weather prediction

Robert Atlas

Microwave remote sensing of ocean-surface winds from space enables improved quantification of their impact on weather analyses and forecasts.

Accurate observations of surface-wind velocity over the oceans are required for a wide range of meteorological and oceanographic applications. Surface-wind data is needed to drive ocean and surface-wave models, as well as to provide initial conditions and verification for numerical weather prediction (NWP). In addition, this type of data serves as a basis for calculations of surface fluxes of heat, moisture, and momentum, and for nowcasting weather and wave conditions at sea.

Prior to the launch of satellites capable of determining surface-wind properties from space, such observations were provided primarily by ships and buoys. Although the latter are important components of the global observing system, they are limited in coverage and accuracy. Since the 1970s, satellites have offered an effective alternative to fill data voids at higher resolution. Satellite surface-wind data (obtained from both microwave radiometry and scatterometers) can improve NWP in two ways. First, they contribute to improved analyses of the surface-wind field and the data-assimilation process. (They can also provide an improved representation of the atmospheric mass and motion fields above the surface.) Second, surface-wind data, in conjunction with other satellite observations, can provide the information necessary to improve model formulations of the planetary boundary layer and other aspects of model physics. By using satellite surface-wind data, two of the major sources of error could thus be reduced, yielding improved short-range forecasts over the oceans.

We conducted data-impact studies to evaluate the importance of satellite surface-wind data for NWP. We first performed a ‘control’ data-assimilation cycle, followed by one or more experimental assimilations in which we added the satellite surface winds to the control. We then compared the analyses and forecasts from each assimilation to determine its impact.

In our most recent experiments, we used both global and regional models to evaluate the impact of the two most recent scatterometers in space, Quikscat and the Advanced Scatterometer (ASCAT: see Figures 1 and 2). Figure 1 and the accompanying table present an illustration and a summary of the impact of Quikscat data on analyses of cyclones using the current NASA global data-assimilation system, the Goddard Earth Observing System model (version 5), as well as its counterpart of the National Centers for Environmental Prediction. In nearly every analysis cycle, Quikscat adds cyclones that would otherwise go undetected, deletes spurious cyclones, and modifies cyclone positions and intensities as measured by either their vorticity (rate of rotation) or maximum wind. Figure 2 presents an example of significant impact on the prediction of hurricane Hannah, resulting from assimilation of ASCAT-based surface-wind data. Use of ASCAT data improves the five-day...
In conclusion, satellite surface-wind measurements over the oceans can reveal the precise locations and structures of significant meteorological features, such as cyclones and fronts. This data is routinely used by operational forecasters and in numerical model and data-assimilation systems to improve weather analyses and forecasts over the oceans, as well as air-sea fluxes and the forcing of ocean models. We continue to perform research and data-impact experiments to optimize the use of this data and assess its impact. Current work focuses on use of ASCAT and on preparing for future operation of ocean surface-wind and 3D wind sensors from both aircraft and space.

**Figure 2.** Five-day forecasts of hurricane Hannah. (bottom) With and (top) without assimilation of Advanced Scatterometer (ASCAT) data. The observed location of Hannah is given by the red hurricane symbol.

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Robert Atlas is the director of the Atlantic Oceanographic and Meteorological Laboratory. He has been performing research based on satellite data since 1973 and was the first to demonstrate the beneficial impact of quantitative satellite data on NWP.

**References**