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QUIKSCAT SEAWINDS OCEAN SURFACE WIND PROCESSING AND DISTRIBUTION

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1. INTRODUCTION

The SeaWinds is a scatterometer instrument carried by the Quick Scatterometer satellite (QuikSCAT) in a Sun-synchronous near-polar orbit, circling the Earth every 100 minutes. It operates by sending radar pulses to the ocean surface and measuring the backscattered radar pulses bounced back to the satellite. The winds near the ocean's surface cause ripples, which are sensed by radar pulses. By analyzing the echoed radar pulses, wind speed and direction are determined. SeaSpace Corporation collaborates with the Center for Ocean-Atmospheric Prediction Studies (COAPS), Florida State University and several other academic and government organizations to provide enhanced SeaWinds-derived products to operational users. The SeaWinds data are processed to derive wind speed, wind direction, rain flag, vorticity, and surface pressure, customized to meet individual users' specifications, and distributed to operational centers.

2. SEAWINDS DERIVED PRODUCTS

The distributed data contain three groups of files: (1) ocean surface wind vector and rain flag, (2) vorticity, and (3) surface pressure. The vorticity and surface pressure are secondary products derived based on the wind field. The derivation of surface pressure requires an initial guess dataset such as data from a numerical model output.

The horizontal resolution of the wind data is 25 km. There are 76 measurements across the satellite swath, which is approximately 1900 km wide. Rain flag data are included in the same wind data file as an indication of the rain contamination. As described in Sharp et al. (2002), rain influences radar returns through three processes: backscatter off the rain, attenuation of the signal passing through the rain, and modification of the surface shape by rain drop impacts (Bliven et al. 1993; Sobieski and Bliven 1995; Sobieski et al. 1999). The rain flags are determined by a multidimensional histogram technique (Huddleston and Stiles 2000).

The vorticity field is calculated using the methodology given by Sharp et al. (2002). Individual vorticity values are calculated at the center of each 2 by 2 box of wind observations by determining the circulation around the box and then dividing by the area. This approach allows the vorticity to be calculated at the same spatial density as the wind observations. All wind vector data, including rain-flagged data, are used in these calculations. The noise that results by including rain-flagged data is determined to be small compared to the signal. The average vorticity of 7-point (175 km) by 7-point box is then calculated from the individual vorticity values.

A vorticity field calculated by the above procedure is shown in Fig. 1. This figure displays the wind field and derived vorticity field of Hurricane Alma on May 30, 2002. The unit of the overlaid wind barbs is m/s. Wind speed of 20-30 m/s are observed around the Hurricane center, which is associated with vorticity values of greater than $10x10^{-5}$/s. Around the hurricane center the vorticity values reach to a maximum of $30x10^{-5}$/s. A time series of Alma's vorticity fields from May 25 to May 31, 2002 is shown in Fig. 2. During this time frame, Alma developed from a tropical storm on May 25, to a hurricane in May 27-29, then down-graded to a tropical storm on May 31. The intensity of Alma is indicated by both the maximum vorticity value and the area extension of vorticity values greater than $10x10^{-5}$/s. In general, when the average vorticity exceeds a threshold vorticity of $10x10^{-5}$/s and the wind speed exceeds a minimum wind speed of 10 m/s for at least 25

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times within a 350 km x 350 km area, the condition signals a potential tropical cyclone development. The vorticity field provides a useful tool in the early detection of tropical cyclones.

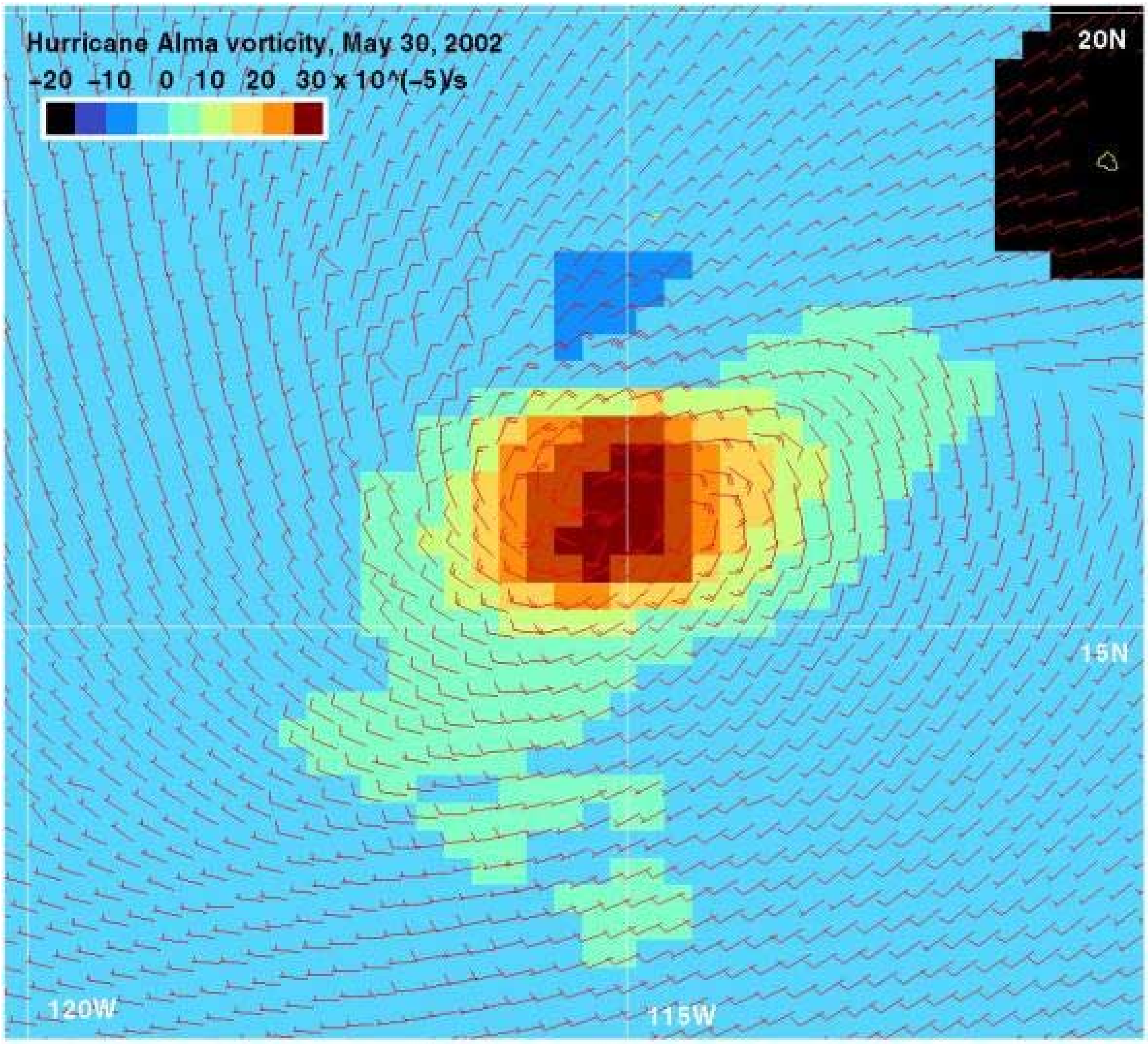

Fig. 1. Vorticity field of Hurricane Alma. The overlaid ocean surface wind barbs are in m/s.

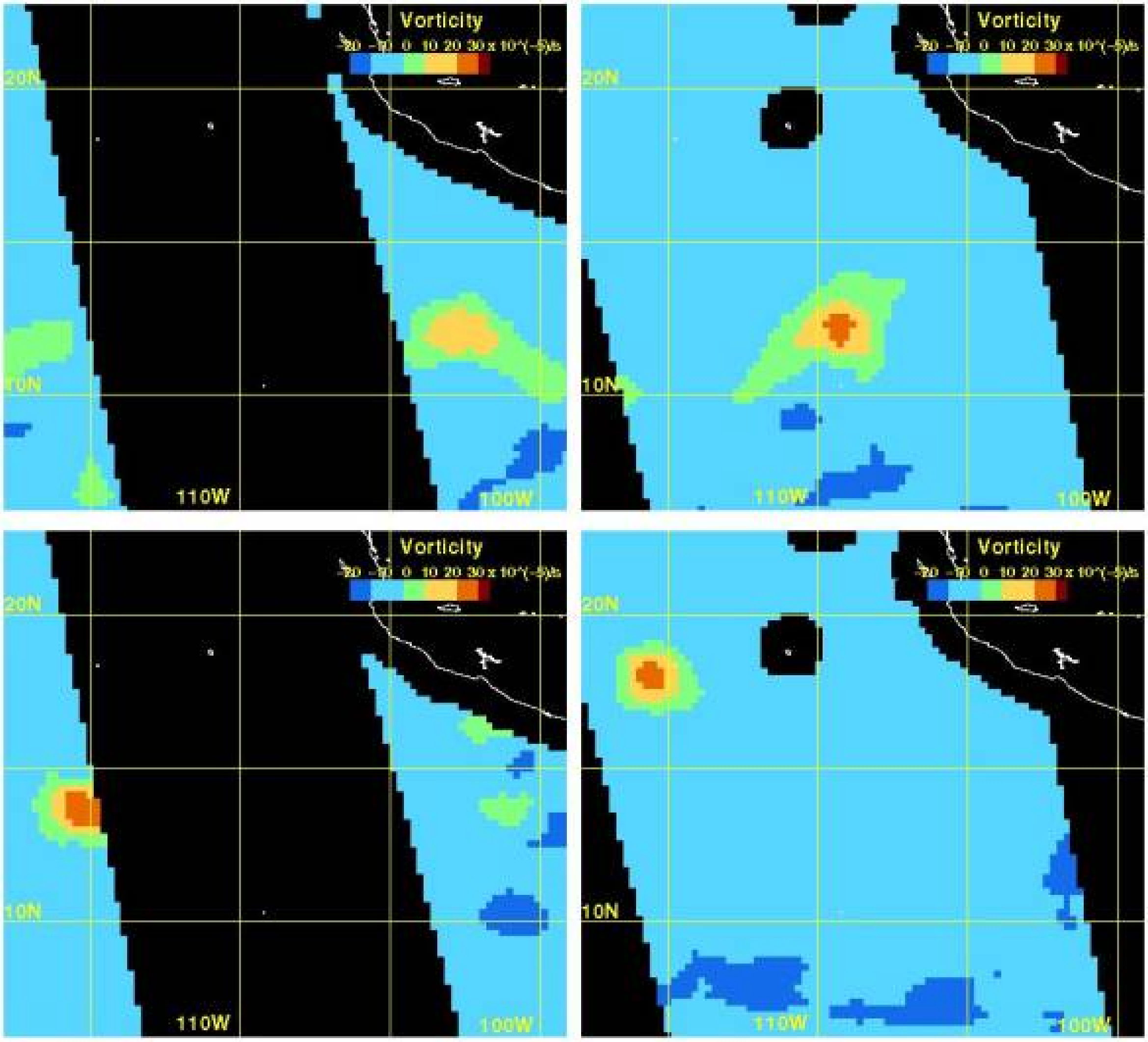

Fig. 2. Time series of Hurricane Alma's vorticity fields. (a) May 25, (b) May 27, (c) May 29, and (d) May 31, 2002.

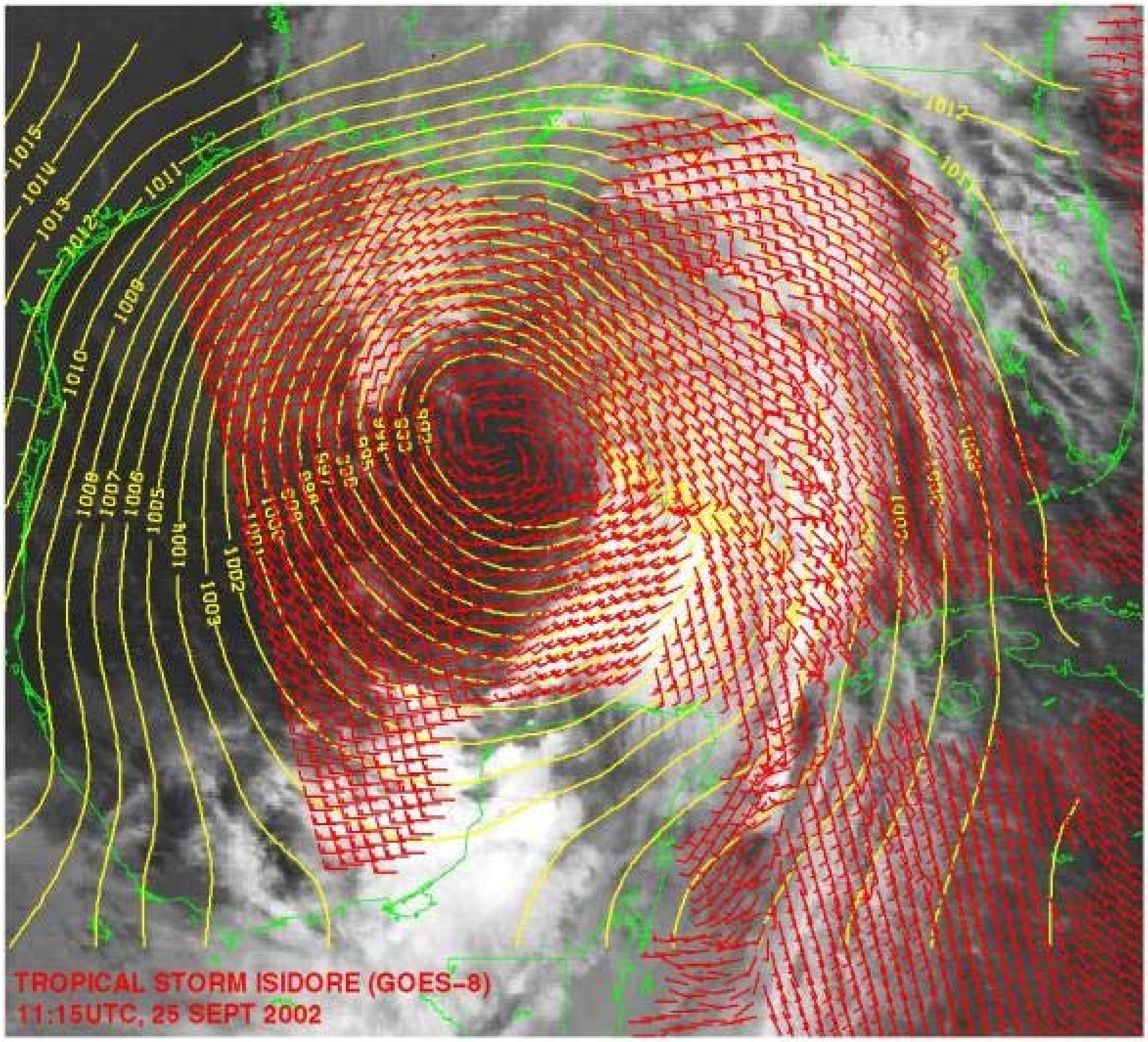

Fig. 3. Tropical Storm Isidore. The wind barbs are SeaWinds derived ocean surface winds (m/s). The contours are surface pressure (mb).

Fig. 3 shows the wind field and surface pressure field of Tropical Storm Isidore in the Gulf of Mexico. The background in the figure is a GOES-8 channel 4 infrared image, taken at 11:15 UTC, September 25, 2002. Upon entering the Gulf of Mexico, Isidore was down-graded to a Tropical Storm from its previous hurricane intensity. At the time of this image, the ocean surface wind speeds in the deep convective area around the center are approximately 20 m/s, with gusts to 30 m/s. The surface pressure minimum is at 988.5 mb. The intensity and structure of Tropical Storm Isidore are well defined by the surface wind field and pressure gradient.

3. SUMMARY

The QuikSCAT SeaWinds scatterometer measurement provides a global coverage of both wind speed and wind direction at the ocean surface. Based on the wind field, surface vorticity and pressure can be derived. These datasets contain valuable information for the study and forecasting of tropical weather systems. It has been shown that the SeaWinds derived vorticity presents a new tool for identifying systems that have the potential to develop into tropical cyclones. Through collaboration of SeaSpace Corporation, COAPS, and other academic and government organizations, these SeaWinds derived products are routinely generated and available to operational users in a near-real-time basis.

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