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Forecast Intensity & Direction of Tropical Cyclones and Investigating their Impacts on Renewable Energy Power Plants

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ABSTRACT: As one of the biggest vectors on ocean's surface, winds influence a great range of ocean's surface from little waves to great streams. Winds also balance interactions between atmosphere and ocean by stabilizing heat, moisture and gases with ocean's air. In addition, oceanic vector winds can cause devastating forces which are called tropical cyclones. These forces can cause life and property damage. Therefore, it is important to forecast it. It also has a great importance in operation of renewable energy power plants. In this paper, the intensity and direction of tropical cyclones are forecasted and their impacts are analyzed using Matlab software.

KEYWORDS: Dual-Frequency Scatterometer, forecasting, oceanic vector winds, renewable energy, tropical cyclones.

I. INTRODUCTION

Over 70% of Earth's surface comprises from ocean, which makes satellite remote sensing a logical and significant component of an overall effort to meet societal needs for weather and water information; support commerce with information for safe, efficient, and environmentally sound transportation; and provide information for better coastal preparedness. Ocean surface vector winds (OSVW) are crucial pieces of information needed to understand and predict the short-term and longer term processes that drive our planet's environment. As the largest source of momentum for the ocean surface, winds affect the full range of ocean movement, from individual surface waves to complete current systems. Winds along the ocean surface regulate interaction between the atmosphere and the ocean via modulation of air-sea exchanges of heat, moisture, gases, and particulates. With the ocean covering almost three quarters of Earth's surface, this interaction has significant influence on global and regional climate.

Each year hurricanes, typhoons, and other tropical cyclones cause thousands of fatalities and tens of billions of dollars of economic losses throughout the world. Severe examples include the tropical cyclone that killed more than 300,000 people in Bangladesh in 1970, and in the United States: the Galveston Hurricane of 1900, which destroyed the city and killed between 6000 and 8000 people; Hurricane Andrew, which caused monetary losses of 26.5 billion dollars (normalized to 38 billion dollars by inflation, wealth and population changes) in 1992; and, most recently, Hurricane Katrina, which killed more than 1300 people and resulted in losses in excess of 100 billion dollars. Even storms of much lesser intensity can produce significant loss of life and property, presenting a daunting challenge for hurricane forecasters and the communities they serve. Although individual years may vary, the number of hurricanes and the number of major hurricanes (defined as Category 3 or higher on the Saffir-Simpson scale) has been increasing in recent years. The year 2004 was a very active season for the North Atlantic with 15 named storms, nine of which became hurricanes, and six of which became major hurricanes. These included Hurricanes Charlie, Frances, Ivan and Jeanne, which all caused extensive damage and loss of life. The year 2005 continued this upward trend, with 28 named storms, 15 hurricanes, three Category 5 hurricanes, and four major hurricanes hitting the United States.

II. DUAL-FREQUENCY SCATTEROMETER (DFS) DESIGN

The DFS designed by JPL for the GCOM-W2 satellite is a scanning pencil-beam scatterometer with a 360° field of view similar to QuikSCAT. The two incidence angles will be slightly different than those of QuikSCAT to preserve the 1800-km wide swath at the 700-km altitude of GCOM-W. Additional DFS details are:

Table 1 Minimum requirement of DFS sampling and operation

WVC Size	10 km
Coverage	90% of the ocean surface every 24 h
Wind Speed Accuracy (RMS)	3-20 m/s: 2m/s 20-30 m/s: 10% 30-50 m/s: 10% 50-80 m/s: 20%
Wind Direction Accuracy (RMS)	3-30 m/s: 20° 30-50 m/s: 20° 50-80 m/s: 30°
Retrieval in Precipitation	Near all-weather wind retrieval
Product Latency	< 180 min for 85% of the data

III. SCATTEROMETRY

The technique of radar scatterometry is summarized in detail by CF05. Briefly, wind speed and direction are obtained by combining measurements of radar backscatter from a given location on the sea surface at multiple antenna look angles. For QuikSCAT, these multiple viewing angles are facilitated by the movement of the satellite along its orbit that provides forward and aft views from four different measurement geometries within a time interval of 4.5 min. The accuracy of the wind retrievals is best characterized in terms of vector component errors (Freilich and Dunbar 1999); the QuikSCAT accuracy is about 0.75 m s_1 in the along wind component and about 1.5 m s_1 in the crosswind component (CF05). Wind direction accuracy is thus a sensitive function of wind speed at low wind speeds but improves rapidly with increasing wind speed. At wind speeds higher than about 6 m s_1, the QuikSCAT directional accuracy is about 14°. In general, the accuracies of QuikSCAT wind retrievals are degraded when rain significantly contaminates the radar footprint. When the wind speed is sufficiently strong, however, accurate winds can often be retrieved even in raining conditions. Scatterometry provides far more extensive geographical and temporal coverage and higher spatial resolution of ocean vector winds than are obtained by any other means. In the standard processing of the QuikSCAT data, the radar backscatter measurements are binned in 25-km areas for vector wind retrievals (see Fig. 4 of CF05). The high resolution of scatterometer wind observations can be quantified from along track wavenumber spectral analysis (e.g., Freilich and Chelton 1986; Wikle et al. 1999; Milliff et al. 1999, 2004; Patoux and Brown 2001). The heavy solid lines in Fig. 1 are the wavenumber spectra of the QuikSCAT zonal and meridional wind components and the wind speed in the eastern North Pacific. In all three variables, the dependence on wavenumber k drops off as approximately k_2 at low wavenumbers. The wavenumber rolloff is somewhat flatter at wavelengths shorter than about 1000 km (i.e., wavenumbers higher than about 10_3 cycles per kilometer).

The aim of this project is to design a weather-monitoring station that can take measurements of the temperature, air pressure, wind velocity and direction, humidity and save them on a server so that this data may be accessed from anywhere via the Internet. The Raspberry Pi is a low cost, credit-card sized single board computer that has the ability to interact with the outside world by interfacing with various types of sensors. The Raspberry Pi has a number of features such as an ARMv7 processor, GPU, RAM, SD card slot, USB port etc. It's cheap, small and rugged, and it needs a small power supply. The data obtained from this system can then be used for various purposes such as automated irrigation systems, automated temperature control for homes, offices, warehouses and factories, green house climate control, for tracking hazardous materials released into the air is the Biological Identification and Detection System (BIDS), pollution monitoring and many more such applications

Figure 1. Raspberry Pi model B+

The OS most suitable for this project is the Raspbian Wheezy. Raspbian is the most popular RPi operating system because it is easy to use for a Linux beginner. It gives the user a functional desktop. Using Xfce as the desktop environment means the RPI's resources are kept well in hand, and not wasted on inefficient eye-candy. It is an easy-to-use distro that can be set up relatively quickly. The major advantage of Raspbian over the other distros is the selection of educational and teaching material included on the distro. It also supports all the recommended over clocking limits, the Raspberry Pi camera and any future official hardware add-ons as well. A benefit of using Raspbian is that a lot of tutorials, projects and third-party hardware run off are based on it as a standard. It makes it easier to learn coding the distro is quite fast and light. It is essentially the default Linux distribution and this status has given Raspbian a lot of advantages over everything else while still being as flexible as Linux can be

.

IV. CONCLUSION

In this paper, the impact of tropical cyclones on renewable energy power plants are presented. For this purpose, data of weather for a limited time is acquired by QuikSCAT and simulated using mfile part of MATLAB software. Using this software, and identifying assumed date, it is possible to draw characteristics of oceanic vector winds of Scattometre. Acquired algorithm as follow:First, studies associated with this subject is carried out. Afterward, using Matlab software, input data is inserted and simulation is carried out using mfile part of Matlab. The purpose of simulation was predicting short term impact of tropical cyclones on renewable energy power plant. This prediction is finally drew and illustrated in figures.

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