Global 0.25° Gridded 6-Hourly and Daily Sea Surface Winds from Multiple Satellites



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1. Introduction

Advances in understanding the coupled air-sea system and numerical modelling of the ocean and atmosphere demand increasingly higher resolution data over the global ocean surface, as documented in several WMO programs (e.g., WMO/TD-No. 1036, 2000; Curry *et al*. 2004). Some applications require that fluxes be computed at temporal and spatial resolutions of up to 3 hours and 50 km, respectively. Observationally, these requirements can only be met by utilizing multiple satellite observations of sea surface wind (SSW), sea surface temperature (SST), and sea surface air temperature and humidity (Ta and Qa). The above four variables are the necessary components to compute the turbulent (latent and sensible) air-sea heat fluxes through empirical bulk formulae. Efforts are being made at the U.S. National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center to produce globally gridded high resolution datasets for the above four parameters from multiple-satellite and in-situ observations on an operational basis. Here, we describe the feasibility and production of high resolution global sea surface wind speed. The SSW, Ta and Qa have higher frequency variability than SST in general.

2. Data Coverage

Sea surface wind has been observed from both in-situ platforms and multiple satellites. In the satellite era, in-situ observations play a critical role in calibrating and validating satellite observations. However, with the dense satellite sampling, in-situ observations play a minor role in reducing random and sampling errors in blended analyses using both in-situ and satellite observations (e.g., Zhang *et al.* 2006).

The time line of the long-term US sea surface wind speed observing satellites is shown in Figure 1. The coverage is sparse in early years, and the number of satellites gradually increased to about three in mid 1990s and to six since mid 2002.

The individual satellite data used in this study were obtained from the Remote Sensing Systems, Inc. (e.g., Wentz 1997) for their uniformity of the retrieval algorithms for the multiple satellites over the whole time period, and for their wide use in producing various air-sea turbulent fluxes (e.g., Chou *et al.* 2003 and citations therein). Using these datasets, we explore the possibility of producing blended global products on a 0.25° grid for various temporal resolutions. The 0.25° grid approximates the high resolution of the above satellite observations. This 0.25° grid resolution also marginally resolves oceanic boundary currents such as the Gulf Stream where large turbulent fluxes and large flux gradients frequently occur.

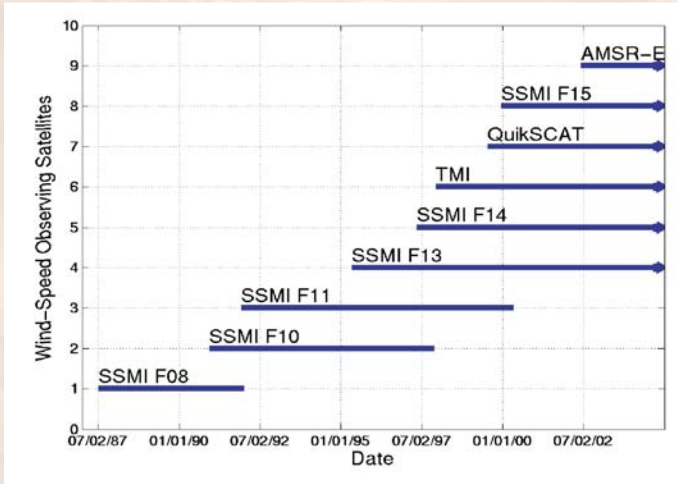

Figure 1. Timeline of the long-term US sea surface wind speed satellites used in this study.

Over the years, the ocean has become sampled in more detail as indicated in Figure 1 and quantified in Figure 2. The averaged sampling time interval decreased rapidly from late 1987 to mid 1990s, from more than 14 hours to less than 8 hours. Further decreases from mid 1990s were more moderate and eventually converged from tropics to high latitudes in early 2000. This is a simplified view on average; detailed global sampling distribution patterns are available from the authors.

3. Globally Gridded Products

On global average, 6-hourly products on the global 0.25° grid have become feasible since 2000. A simple objective analysis method (Zeng and Levy 1995) was used to generate our gridded and blended products on the 0.25° grid and 4 times per day at 00, 06, 12 & 18Z (UTC or GMT). Additionally, daily fields were generated by averaging the 4 snapshots of the day, and monthly fields were computed by averaging the daily fields. Climatological monthly means were then computed from the monthly data for certain chosen base time periods (e.g., 1995—2005); earlier data were not used in this climatology because there were limited early satellites. The blended data for all the above resolutions (6-hourly, daily and monthly) are processed from 9 July 1987 to present. However, caution must be exercised when using the 6-hourly data for the early time period, for which time aliases may be large due to the data under-sampling (c.f. Figs. 1 and 2). All of

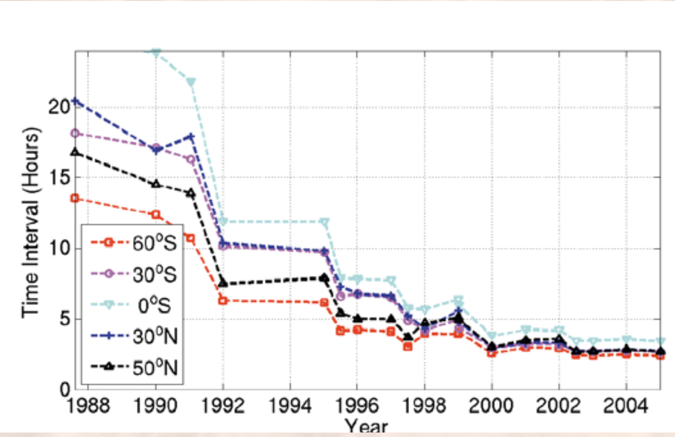

Figure 2: Averaged sampling time intervals in the 0.25° bins and as functions of time and latitude, using the satellites shown in Figure 1. Values are zonal averages along five latitude circles and averaged over 1-week periods at the beginning of selected months, for which there were new satellite additions or reductions.

these data and supporting MATLAB, FORTRAN and GrADS routines are freely available to the research community through the links at the website http://www.ncdc.noaa.gov/oa/rsad/blendedseawinds.html. Wind directions corresponding to the above resolutions will be added soon. Future products on SST, Ta and Qa will also be linked to this site.

An example of the analyzed global winds at 12Z, 28 August 2005 is shown in Figure 3, on which simultaneous Hurricane Katrina and Typhoon Talim are clearly shown. Remember that the satellite-retrieved winds may still underestimate the maximum winds in regions with heavy precipitation.

Acknowledgements:

The individual satellite data were downloaded from the website of the Remote Sensing System (RSS), Inc. (http://www.remss.com/). We thank Debra Smith at RSS for answering our detailed questions. Mention of a commercial firm does not constituent endorsement by the U.S. government.

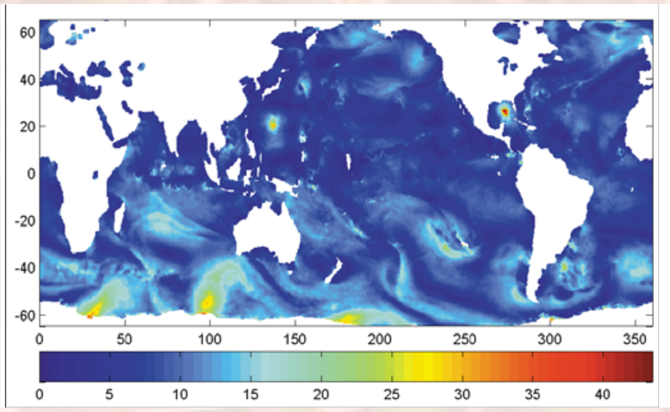

Figure 3: An analysis of the global sea surface winds at 12Z, 28 August 2005, reconstructed from observations of the six satellites shown in Figure 1.

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