Spectral Analysis of Gridded Wind Products

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1. Introduction

Realistic high-wavenumber surface vector wind datasets are needed to both force and validate high-resolution coupled ocean-atmosphere models. Satellites are able to provide such high-wavenumber information, but are spatially and temporally limited by their discrete sampling characteristics and/or rain contamination (Milliff et al. 2004). Reanalysis products are favored due to their global coverage and relatively high temporal resolution (6-hourly). However, past studies (Freilich and Chelton 1986; Chin et al. 1998; Milliff et al. 1999; Wikle et al. 1999; Patoux and Brown 2001; Milliff et al. 2004; Chelton et al. 2006) have shown that scatterometer winds contain more energy at smaller spatial scales than numerical weather prediction (NWP) analyses. In order to overcome said deficiencies surface wind datasets are constructed by objectively blending information from a multitude of sources (e.g., satellites, ships, buoys, and/or NWP reanalysis products). Due to the diversity and number of available gridded wind products along with the continuous development of new datasets it is imperative to establish credibility with the user and provide the essential tools to pick the product(s) best suited for their application. This study compares nine readily available (maybe not familiar outside of the development community) surface wind datasets by computing the power spectral density for the wind speed and curl of the wind.

2. Gridded Wind Products

- AAAA
- BBBB
- CCCC
- DDDD
- EEEE
- FFFF
- GGGG
- HHHH
- IIIII
- JJJJ
- KKKK
- LLLL
- MMMM

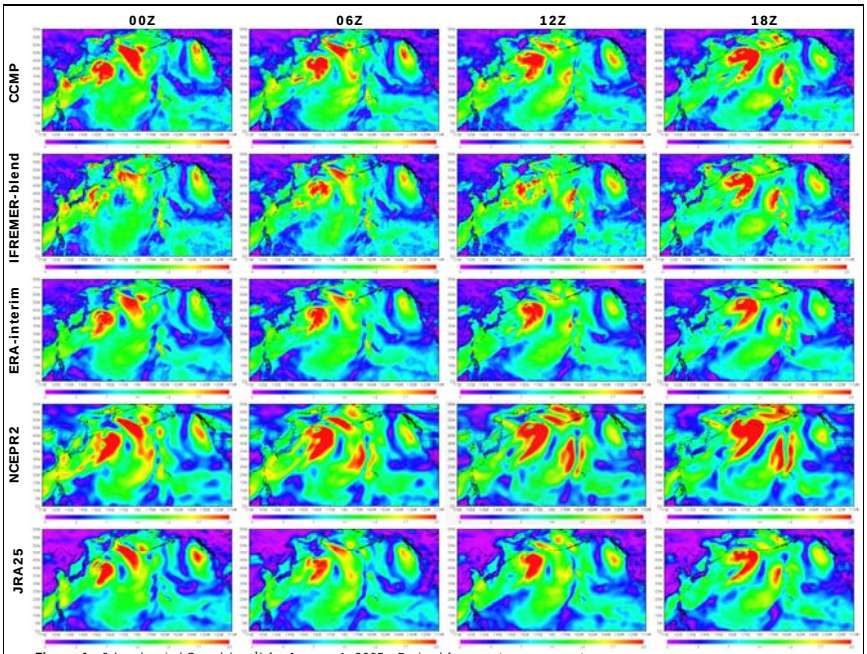

Figure 1. 6-hourly wind Speed (ms^{-1}) for January 1, 2005. Derived from vector components.

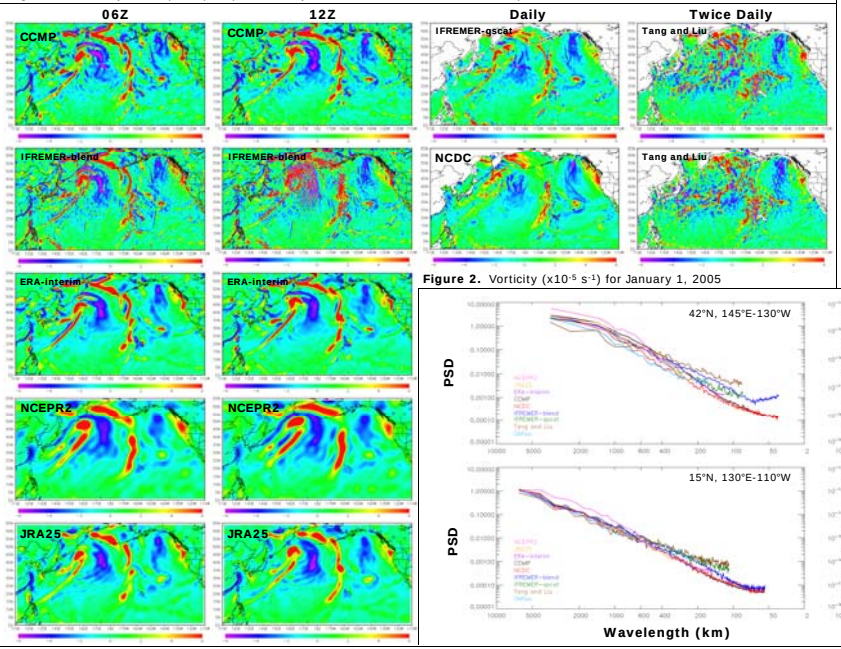

Figure 2. Vorticity ($x10^{-5}$ s^{-1}) for January 1, 2005

3. Establishing Credibility

- Standard validation of gridded wind products
  - Mean fields (e.g., annual, seasonal, monthly, or daily climatologies)
  - Inter-product differences of mean fields
- What is beneath the "good" looks?
  - Derivative fields (curl and divergence)
  - Spectral decomposition
  - An assessment of useful resolution

4. Discussion

- Wind speed looks relatively similar (Figure 1)
  - Satellite tracks are evident in blended products (e.g., IFREMER-blend)
  - Temporal evolution of cyclone is not homogeneous in the IFREMER-blend product
  - Reanalysis products exhibit smoother fields (especially NCEPR2)
- Curl of the wind (Figure 2) reveals unrealistic features (e.g., satellite tracks and noise)
  - Some of the small scale noisy features in the blended products could be true—reality is not smooth
- Wind speed spectra (Figure 3)
  - Largely follow excepted power-law behavior
- Curl of the wind spectra (Figure 3)
  - Reveals vast differences at scales less than 1000km (e.g., slope of spectra)
  - Reveals odd smoothing characteristics
  - Reanalysis products rapidly lose power much quicker than blended products (important for ocean forcing)
- Familiarity and credibility
  - Crucial that the user community be familiar with the available products
  - Imperative that the user community be provided with the essential tools to selects the "best" product(s) for their research needs

Figure 3. Power spectral density (PSD) versus wavelength for wind speed (left) and vorticity (right) for January 2005