Assessing Representation Error of In Situ Wind Related Variables for Comparison to Satellite Data

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Motivation

- **Goal**: Accurately determine uncertainty in SeaWinds wind speeds, directions, and vector components
- In situ observations can be used to calibrate and validate SeaWinds wind vectors
  - Ideal in situ observations for comparison are perfectly collocated in both time and space to the satellite overpass
  - To compensate for the lack of ideal in situ observations, observations within a certain distance and time to the satellite overpass are also used
- Applications
  - Improve data assimilation
  - Development of geophysical model functions
  - Creation of gridded products

Figure 1. QuikSCAT satellite.

Background

- A study by Kent et al. (1999) determined the random observational errors for individual variables in the Comprehensive Ocean-Atmosphere Dataset using four months of data by focusing on the error associated with ship separation (spatial)
- Here, we will focus on temporal errors when calculating wind speed, wind stress, and equivalent neutral winds
- SeaWinds responds to wind stress, not actual wind speed
  - Calculated from in situ observations using the BVW model
- Scatterometer winds are calibrated to an equivalent neutral wind speed
  - Assumes neutral stratification, but correct value for friction velocity
  - Calculated from in situ observations using bulk estimates of surface wind stress and roughness length
  - Adjusted to a reference height of 10 meters

Data

The dataset used to complete this study must provide high frequency observations. Also, the observations should not be limited to a specific region. The observations collected through the Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative meet these two requirements.

SAMOS data (Smith et al. 2010) provides ship observations every minute from 2005 through 2009. The data has been visually quality controlled to remove erroneous or suspicious data. The observations include:

- Wind speed
- Air temperature
- Sea surface temperature
- Sea level pressure
- Relative humidity

Figure 2. Research vessel *Knorr* with meteorological instrumentation on a bow mast.

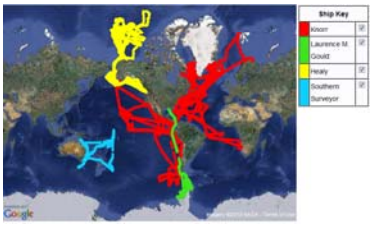

Figure 3. Ship tracks for four of the eight ships from 2005 - 2009

The measured parameters from the SAMOS data allow for wind stress and equivalent neutral winds to be calculated. Data from eight research vessels with different ship tracks (Figure 3 shows four of the tracks) are used to minimize any ship or location biases.

Initial Methodology

- Idealized scenario where only SAMOS data is considered; the satellite is assumed to pass directly over on the hour, every hour
- For each hour, a wind speed dependent averaging window centered on the hour is defined. The averaging window is then shifted away from the hour in one minute increments from 0 to 30 minutes
- The wind speed is then split into different groups to determine the effect of wind speed on the error calculated
- The variance of the difference between the perfectly collocated average and the time shifted average is calculated for each minute shift
- Future steps: Test for a similar distribution between SeaWinds and buoy data

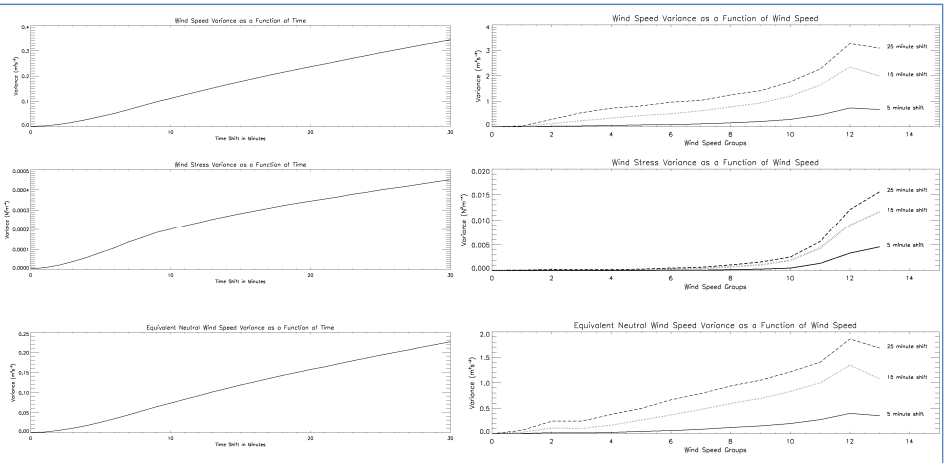

Figure 4 (left) the variance as a function of time, (right) the variance as a function of wind speed and time shift.

Summary

- Error associated with wind speed, wind stress, and equivalent neutral winds are examined in an idealized scenario
- Shifts in time are used to examine the influence of imperfect temporal collocation. The results shown above agree with what is expected:
  - As the shift in time increases, the amount of variance in wind speed, wind stress, and equivalent neutral winds increases
  - The variance associated with equivalent neutral winds is less than that of the in situ measured wind speeds
  - Higher wind speeds are associated with larger variances
  - Higher wind speeds with a large time shift show the greatest amount of variance
- Theoretically, we can now quantify the error associated with a mismatch in time between the in situ observation and satellite overpass as both a function of time and wind speed

Future work

- Taylor's hypothesis can be used to translate shifts in time to shifts in space
- Application of these results to in situ observations used in calibration / validation of SeaWinds measured wind stress and equivalent neutral winds, as well as in the generation of gridded products

References

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