The constellation of satellite-based ocean surface wind and precipitation observations since 1999 consists of a diverse collection of both co-synchronous and asynchronous orbiting satellite platforms, both wind vector-capable (RapidScat, QuikSCAT, SeaWinds, ASCAT, OceanSAR2, WindSat, RapidScat) and speed-only radiometers, (TMI, OM5, AMSR, AMSR2, SMOS). These data can be jointly examined for the potential of day-to-day variability over regions where the surface wind varies widely throughout the day, owing to various meteorological forcings, such as landsea temperature differences near coasts, or possible variations associated with tropical convective precipitation. Early results of an analysis are described herein, whereby multiple wind speed and wind vector products were jointly examined to investigate the diurnal (and semi-diurnal, in cases) ocean wind variability.

Theory

The formulation follows the structure of Gill et al. (2005) and later used by Tang et al. (2014), by modeling the diurnal wind using an elliptical variability with the addition of the speed-only radiometers, the sub-diurnal terms, the error variance, and the capability to examine each day over the 2003-2016 period (when at least two scatterometers were jointly operating). Assume we have a wind vector estimate from n wind vector-capable satellite passes, all of them during a given day over a given location. This number varies depending upon the year, month, and the satellites being considered. The daily and sub-diurnally u and v components can be expressed with an elliptical fit using a compact matrix formulation:

\[
\begin{bmatrix}
\mathbf{u} \\
\mathbf{v}
\end{bmatrix}
= \mathbf{A}
\]

For the speed-only (\(\text{s}\)) radiometers, since the relation between \(\mathbf{u}\) and \(\mathbf{v}\) components is non-linear, hypothesis vectors are created by varying the direction one degree at a time (\(\text{e.g.} \), for one radiometer):

\[
\mathbf{u}_n = \mathbf{A} \left( \hat{x} \right)
\]

In either case, these expressions can be expressed in matrix form, where \(\mathbf{A}\) are the matrices with the variance of the \(\mathbf{u}\) \(\text{and} \ \mathbf{v}\) observations.

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References


Examining the Constellation of Scatterometers and Radimeters for Diurnal and Sub-Diurnal Wind Vector Variability

F. Joseph Turk and Svetia Hristova-Veleia
Jet Propulsion Laboratory, California Institute of Technology
Pasadena, CA USA  

jturk@jpl.nasa.gov

Thirteen-Year Analysis (April 2003-Feb 2016)

The maps on the lower left show mean values over limited 7-month periods. To examine the day-to-day variability over a long term, all products listed on the left side were examined for the April 2003-Feb 2016 period (when at least two scatterometers were functional), over specific "target" areas where the major axis exceed 2 m s\(^{-1}\). Both the daily-only (three \(\text{e}\) and three \(\text{f}\) coefficients estimated each day), and daily/sub-dayly analysis (five \(\text{e}\) and five \(\text{f}\) coefficients estimated each day) was done, to examine the presence of the daily-only variability, and to further analyze for the presence of any sub-diurnal variability. Days are included only when the magnitude of the \(\text{e}\) and \(\text{f}\) components sufficiently exceeded the variability (twice the standard deviation) in the estimated regression coefficient terms.

Figures

The figures from this analysis, which were either from daily-only wind speed products or used as a wind speed reference from 1999-2014, and GPM-GMI from April 2014-current, both produced by RSS (eight-month overlap period between TMI and GMI). Per-pass coincidences within ±15 min between TMI (or GMI) and each of the 15 other different wind speed or wind vector (depending upon sensor type) datasets were collected over the 11705-4023616 period - Mean bias correction lookup tables were generated for each 0.5 m s\(^{-1}\) wind speed bin of the reference sensor. These were applied to the speed each of the non-reference sensors, prior to any qualitative analysis.