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Ocean surface wind and stress vectors as essential climate variable

W. Timothy Liu[†]; Naoto Ebuchi; Xiaosu Xie
[†] Jet Propulsion Laboratory, USA
Leading author: w.t.liu@jpl.nasa.gov

Wind is air in motion and is a vector quantity with a magnitude (speed) and a direction. Ocean surface stress is the turbulent transfer of momentum between the ocean and the atmosphere; it is another vector quantity closely related to wind. Ocean wind is strongly needed for marine weather forecast and to avoid shipping hazard. Surface wind is responsible for the dynamics and transport in the atmosphere and convergence brings moisture and latent heat that drive deep convection and fuel hurricanes. For oceanographers, it is stress more than wind that drives ocean circulation. The two-dimensional stress field is needed to compute the divergence and curl (vorticity) that control the vertical mixing. The mixing brings short-term momentum and heat trapped in the surface mixed layer into the deep ocean, where they are stored over time. It also brings nutrients and carbon stored in the deep ocean to the surface, where there is sufficient light for photosynthesis. The horizontal currents, driven in part by stress, distribute the stored heat and carbon in the ocean. While the general public knows and feels the wind, very few people know what stress is. Even for oceanographers, the concept of stress distribution is largely derived from that of wind, because there was no large-scale measurement of stress over the ocean until the launch of the first scatterometer. Because there is much more wind information than stress information and the public is more familiar with wind than stress, an equivalent neutral wind is used as the geophysical product of the scatterometer. By definition, the equivalent neutral wind is uniquely related to stress, while the relation between stress and the actual wind depends on atmospheric stability, which generates turbulence. Although scatterometers have been known to measure surface stress, they have been used and promoted as wind measuring instruments and equivalent neutral wind has been used as the actual wind, particularly in operational weather applications. The characteristics of wind vector derived from space-borne scatterometers, as a essential climate variable will be discussed. The principles of geophysical retrieval will be summarized. The history, current availability and sustainability of the data set will be described. The strengths, weakness, maturity, and uncertainties of the data sets will be discussed. The sub-daily sampling of wind and stress by a constellation of sensors to mitigate the aliasing of long time series by high frequencies variations will be presented with a comparison among these sensors.