Information Technology

Estimating Sea Surface Salinity and Wind Using Combined Passive and Active L-Band Microwave Observations

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Several L-band microwave radiometer and radar missions have been, or will be, operating in space for land and ocean observations. These include the NASA Aquarius mission and the Soil Moisture Active Passive (SMAP) mission, both of which use combined passive/active L-band instruments. Aquarius's passive/active L-band microwave sensor has been designed to map the salinity field at the surface of the ocean from space. SMAP's primary objectives are for soil moisture and freeze/thaw detection, but it will operate continuously over the ocean, and hence will have significant potential for ocean surface research.

In this innovation, an algorithm has been developed to retrieve simultaneously ocean surface salinity and wind from combined passive/active L-band microwave observations of sea surfaces. The algorithm takes advantage of the differ-

ing response of brightness temperatures and radar backscatter to salinity, wind speed, and direction, thus minimizing the least squares error (LSE) measure, which signifies the difference between measurements and model functions of brightness temperatures and radar backscatter. The algorithm uses the conjugate gradient method to search for the local minima of the LSE.

Three LSE measures with different measurement combinations have been tested. The first LSE measure uses passive microwave data only with retrieval errors reaching 1 to 2 psu (practical salinity units) for salinity, and 1 to 2 m/s for wind speed. The second LSE measure uses both passive and active microwave data for vertical and horizontal polarizations. The addition of active microwave data significantly improves the retrieval accuracy by about a factor of five. To mitigate the impact of Faraday

rotation on satellite observations, the third LSE measure uses measurement combinations invariant under the Faraday rotation. For Aquarius, the expected RMS SSS (sea surface salinity) error will be less than about 0.2 psu for low winds, and increases to 0.3 psu at 25 m/s wind speed for warm waters (25 ºC).

To achieve the required 0.2 psu accuracy, the impact of sea surface roughness (e.g. wind-generated ripples) on the observed brightness temperature has to be corrected to better than one tenth of a degree Kelvin. With this algorithm, the accuracy of retrieved wind speed will be high, varying from a few tenths to 0.6 m/s. The expected direction accuracy is also excellent (<10°) for mid to high winds, but degrades for lower speeds (<7 m/s).

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A *Posteriori* Study of a DNS Database Describing Supercritical Binary-Species Mixing

Resulting flow models can be used in automotive, aircraft engine, and chemical engineering applications.

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Currently, the modeling of supercritical-pressure flows through Large Eddy Simulation (LES) uses models derived for atmospheric-pressure flows. Those atmospheric-pressure flows do not exhibit the particularities of high density-gradient magnitude features observed both in experiments and simulations of supercritical-pressure flows in the case of two species mixing. To assess whether the current LES modeling is appropriate and if found not appropriate to propose higher-fidelity models, a LES *a posteriori* study has been conducted for a mixing layer that initially contains different species in the lower and upper streams, and where the initial pressure is larger than the critical pressure of either

species. An initially-imposed vorticity perturbation promotes roll-up and a double pairing of four initial span-wise vortices into an ultimate vortex that reaches a transitional state.

The LES equations consist of the differential conservation equations coupled with a real-gas equation of state, and the equation set uses transport properties depending on the thermodynamic variables. Unlike all LES models to date, the differential equations contain, additional to the subgrid scale (SGS) fluxes, a new SGS term that is a pressure correction in the momentum equation. This additional term results from filtering of Direct Numerical Simulation (DNS) equations, and repre-

sents the gradient of the difference between the filtered pressure and the pressure computed from the filtered flow field.

A previous *a priori* analysis, using a DNS database for the same configuration, found this term to be of leading order in the momentum equation, a fact traced to the existence of high-density-gradient magnitude regions that populated the entire flow; in the study, models were proposed for the SGS fluxes as well as this new term. In the present study, the previously proposed constant-coefficient SGS-flux models of the *a priori* investigation are tested *a posteriori* in LES, devoid of or including, the SGS pressure correction term. The present