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SIMULATIONS OF ROUGHNESS-SALINITY-TEMPERATURE ANOMALIES AT S-L-BANDS

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Introduction. During the last two decades, it was demonstrated the value of passive microwave technique for diagnostics of oceanic processes and fields. Indeed, S-L-bands radiometers provide day/night monitoring of ocean dynamics practically at any weather conditions. At these bands, atmospheric effects, contributions from clouds, precipitations, and rain/snow can be neglected in most environmental situations. Therefore, S-L-bands radiometers (imagers) have good potential capabilities to observe sophisticated ocean surface phenomena directly. Because at S-L-bands the thickness of the electromagnetic skin layer of seawater can reach several centimeters dependent on temperature and salinity, it is possible to monitor a variability of the ocean skin layer as a whole. As shown experiences, surface roughness, foam/whitecap, subsurface bubbles, spray/aerosol, water salinity, and temperature are the main factors affected on ocean emissivity. These issues have been reported in [1], [2], [3]. Detailed analyses show that thin ocean skin layer responsible for S-L-bands radiometric signals, usually is unstable and nonuniform; it is formed under the influence of a number of environmental factors: thermohaline (i.e. joint salinity and temperature) circulations, double-diffusive and convective processes, turbulent mixing, hydrodynamic interactions, surface wave modulations, and currents. To describe properly ocean microwave emission characteristics, we create a physics-based composite model allowing computer simulations of different scenarios, features, and/or localized disturbances. In this study, we present new model data related to so-called “roughness-salinity-temperature anomalies” (RSTA) which occur in oceans due to simultaneous variations of surface roughness (induced by wind speed (v)), salinity (s), and temperature (t). We suppose that diagnostics of RSTA can be made successfully using advanced S-L-bands microwave techniques.

Basic description. A composite model is a model that contains several model partitions. In our case, the selected partitions are connected stochastically using certain statistical rules. We apply this concept for simulations of ocean emissivities at variable surface conditions taking into account joint impacts of many factors. Statistical approach seems to be the most realistic way to deal with dynamical databases. The key point here is to assign model (and experimental) data to specified hydrodynamic phenomena and/or patterns having mostly stochastic character. This will require of multiresolution observations.

Technique. An algorithm provides the generation of both 1-D and 2-D radiometric signals including discrete digital stochastic mapping and a spatial averaging of the brightness temperature depending on an observation process and pixel resolution. For digital imaging we employ the fundamental mathematical models:

1) Brownian motion random field (BRF)
2) Gaussian random field (GRF)
3) Markov random field (MRF)
4) Self-similar, fractal (FRF)

Actually, we develop a multiscale representation which is composed of a series of random fields at varying scales or resolutions. This option allows us to perform extraction of relevant radiometric features among stochastic image background through texture-based criteria and segmentation methods.

Demonstration. Here we are focusing on numerical results obtained concerning emissivities, radiometric signals, and images related to different oceanic phenomena and situations. As reported earlier in [4, 5], radiometric features are usually observed in the form of monotonic brightness-temperature trends, short-term spikes (in 1-D signals), and distinct spots (in 2-D images); these features are distinguished by the brightness-temperature contrast as well. Theory and experiment show that low-contrast features ~ 1-3 K correspond to surface roughness change and high-contrast features ≥10-15 K correspond to foam/bubble/spray activities depending on coverage fractions. To provide more adequate descriptions especially at S-L-bands, we incorporate gradients of surface temperature and salinity into a composite microwave model. In this case, considerable changes in radiometric signals and images occur due to stochastic *intermittency* of different microwave contributions. Measurable radiometric signals depend on an observation process and instrument resolution considerably. Particularly, we demonstrate a great variety of simulated RSTA (signatures) having specific mosaic gradients of brightness (Fig. 1). Properties and the observability of RSTA are defined by many hydro-physical parameters, their statistical characterizations, and variability. Corresponding model data will be presented and discussed.

Conclusion. In this study we apply a composite ocean microwave emission model to predict and evaluate stochastic radiometric features induced by many environmental factors. For this goal, we perform numerical simulations of emissivity, radiometric signals, and images based on random field models. Particularly, we claim a novel class of remote-sensing stochastic features, e.g., RSTA which occur in localized ocean areas due to multiple interactions between different hydrodynamic phenomena. As shown our modeling, such events cause the changes in ocean emissivity. We believe that in certain conditions (at resolutions ~ 10-20 km, $v < 5$ m/s, $t = 10\text{-}20°C$, and $s = 25\text{-}35$ psu) RSTA could be registered using advanced S- and L-band radiometers (imagers). Our model data can also be considered for the retrieval purposes in connection with AQUARIUS-NASA and SMOS-ESA missions dedicated to the global monitoring of sea surface salinity from space using L-band radiometers.

References

[1] Raizer V., "Modeling L-band emissivity of a wind-driven sea surface," *IGARSS'2009*, Cape Town, South Africa July 13 - 17, 2009.

[2] Raizer V., "Modeling of L-band foam emissivity and impact on surface salinity retrieval," *IGARSS'2008*, Boston, MA 6 -11 July 2008.

[3] Raizer V., "Macroscopic foam-spray models for ocean microwave radiometry," *IEEE Trans. Geosci. Remote Sens*., vol. 45, no. 10, pp. 3138 - 3144, October 2007.

[4] Raizer V., "Texture models for high-resolution ocean microwave imagery," *IGARSS'2005*, Seoul, Korea, 25-29 July, 2005.

[5] Raizer V., **"**High-resolution passive microwave-imaging concept for ocean studies," *OCEANS, 2005. Proceedings of MTS/IEEE***,** vol. 1, pp. 62-69, 2005. ISBN: 0-933957-34-3.

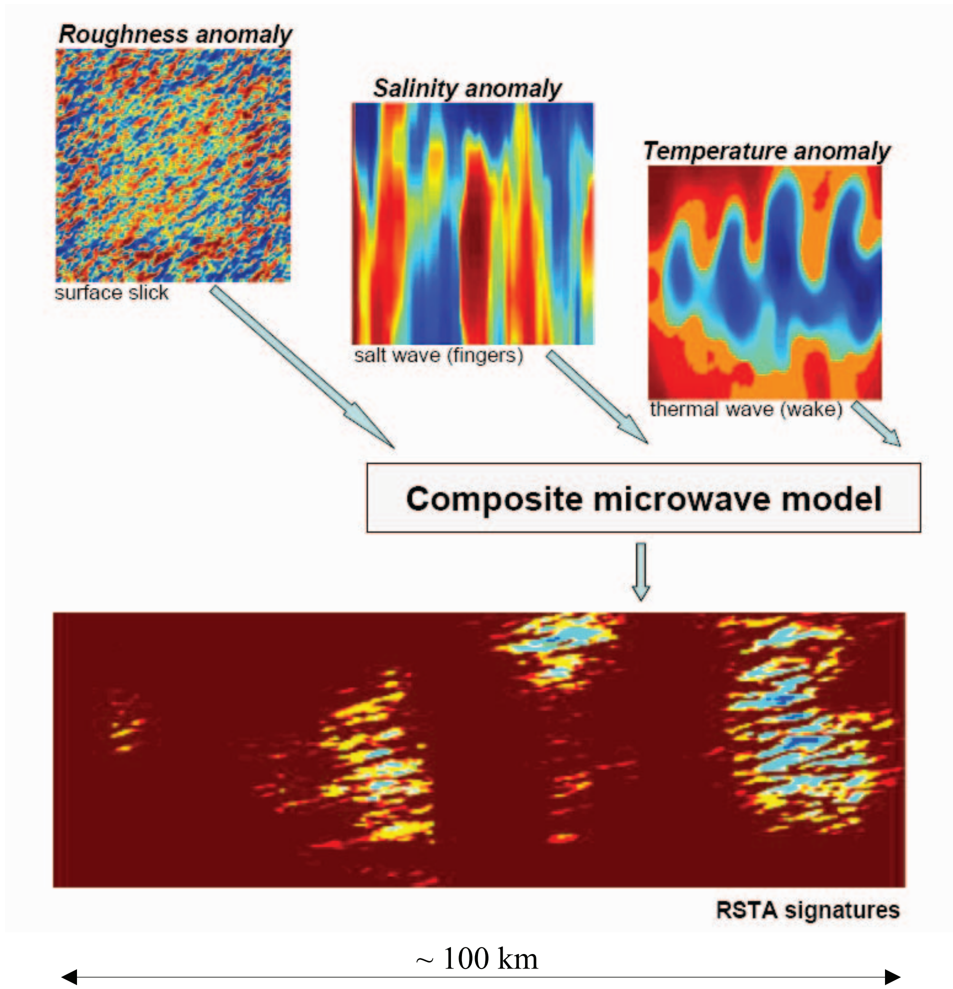

Figure 1. Schematic illustration of stochastic RSTA simulations. Radiometric features (for foam-free surface at L-band) are revealed in the form of distinct objects with variable texture and mosaic gradient. Observability of such RSTA depends on pixel resolution.