Microwave Emissivity of a Vertically Inhomogeneous Sea-Foam Layer: Application to the WindSat Retrieval Algorithm

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Accurate, physically based, retrievals of the wind vector over the ocean from radiometric measurements depend on a complete and realistic physical model for ocean surface emissivity. An ocean surface emissivity model has three major components: microwave emissivity of foam-free water (both specular and roughness component), emissivity due to foam, and the foam (or whitecap) coverage controlling the relative importance of these two components. Within the framework of the WindSat mission at the Naval Research Laboratory (NRL), a physical ocean surface emissivity model is under development. In this paper we concentrate on the foam emissivity aspect of the NRL model.

A comprehensive physical model of foam emissivity has to consider the following features of sea foam. First, the amount of air within the foam changes continuously with depth and establishes vertically inhomogeneous foam properties, which affect foam emission. Second, foam emission is a result of the cumulative effect of various contributions, such as up-welling and down-welling emissions within the foam layer, diffuse scattering within the foam, emission of seawater beneath the foam, reflection of down-welling atmospheric emission from the air-foam interface, and the multiple reflections of all these components at the foam layer interfaces. Finally, foam patches covering the ocean surface have various thicknesses, which affect the magnitude of these contributions to foam emissivity. We report results from our foam emissivity model, which accounts for these features.