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Simulation of X-band Co-polarized backscattering from Oil-covered sea surfaces

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1. Introduction

Mineral oil films appear on SAR image plane as spots darker than the sea surface background because of their suppression of capillary waves. However, mono-molecular biogenic surfactants give rise to radar signatures similar to that of mineral oil films. Hence, to fully understand the link between the actual oil slick and the dark patch observed in the SAR image plane, it is necessary to analyze the underlying scattering process from theoretical aspects.

This study focuses on the analysis of the joint role played by the scattering model and the damping model in predicting the co-polarized NRCS due to a slick-covered sea surface. Simulated NRCSs are compared with actual measurements collected by X-band TerraSAR-X (TSX) SAR over oil slicks and biogenic films of known origin.

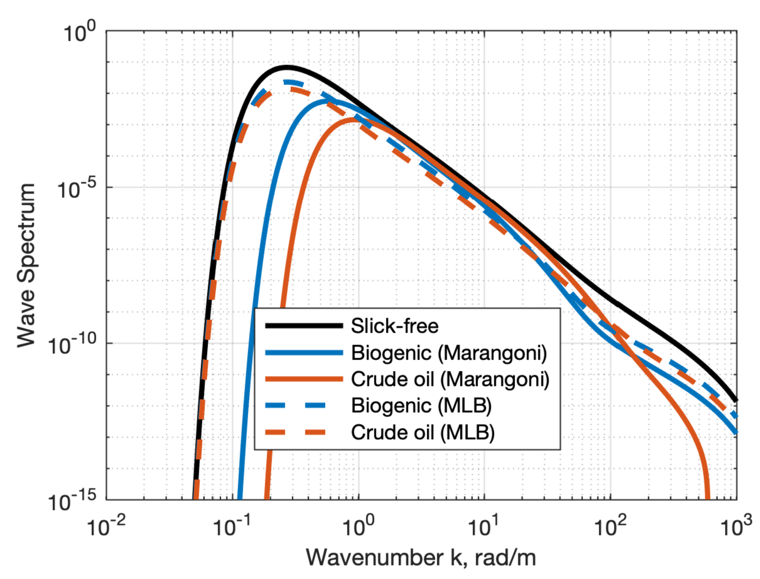
2. Methodology

(1) Viscous Damping Model: Marangoni effect

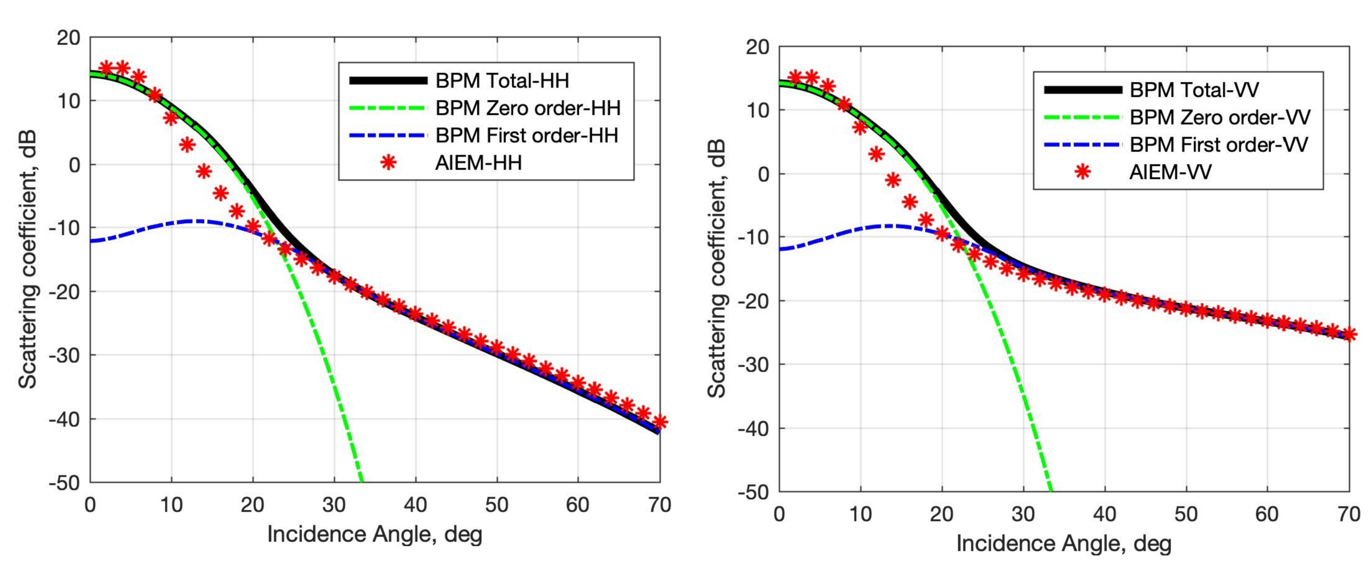
$$y_{\mathrm{Mar}}(K;|E|,\theta) = \frac{1 + X(\cos\theta - \sin\theta) + XY - Y\sin\theta}{1 + 2X(\cos\theta - \sin\theta) + 2X^2}$$

(2) Roughness Damping Model: Model of Local Balance

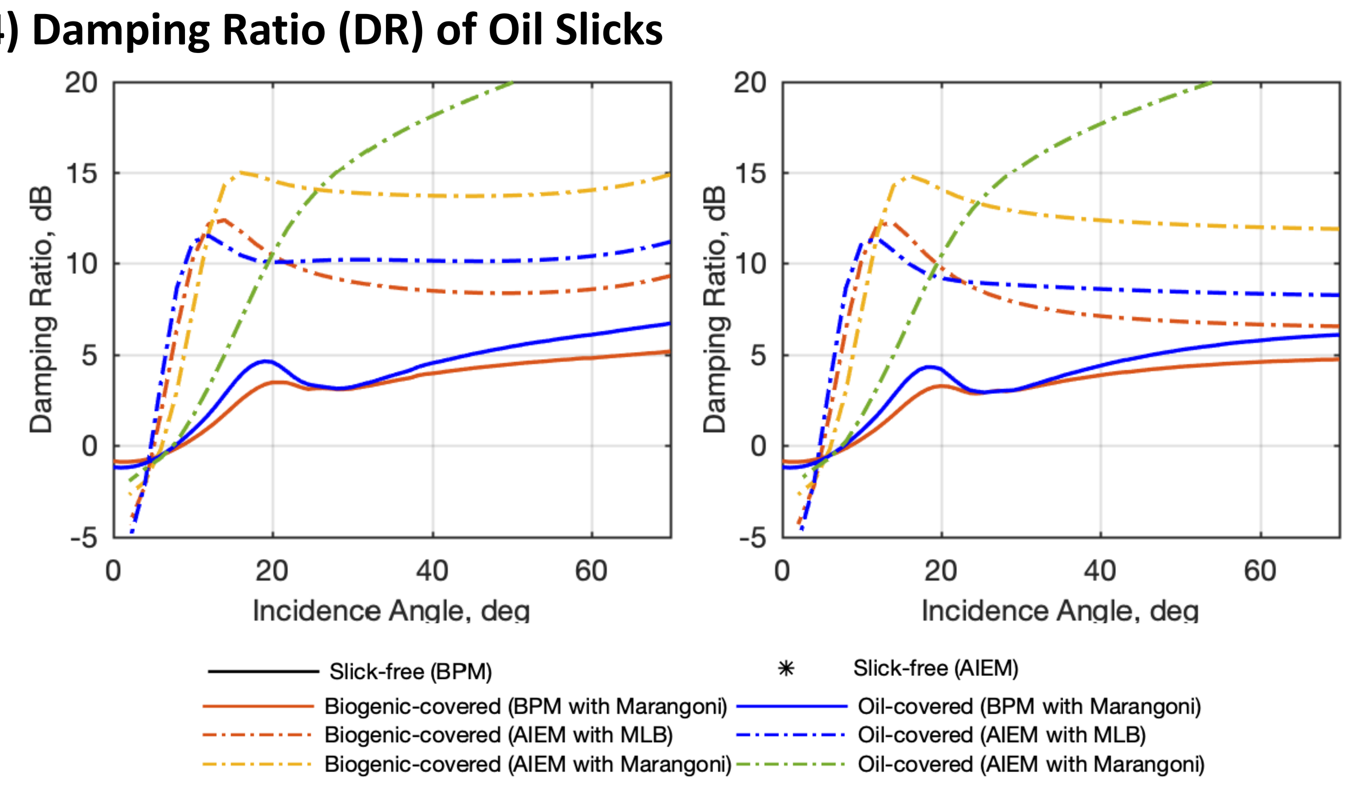
$$y_{\mathrm{MLB}}(K, u_{*,s}, y_{\mathrm{Marg}}) = \frac{\beta(u_{*,s}) - 2(\Delta\cdot y_{\mathrm{vis}})c_g + (\alpha + \Delta\alpha)}{\beta(u_*) - 2\Delta c_g + \alpha}$$



(3) Sea Surface Scattering Models: AIEM and BPM

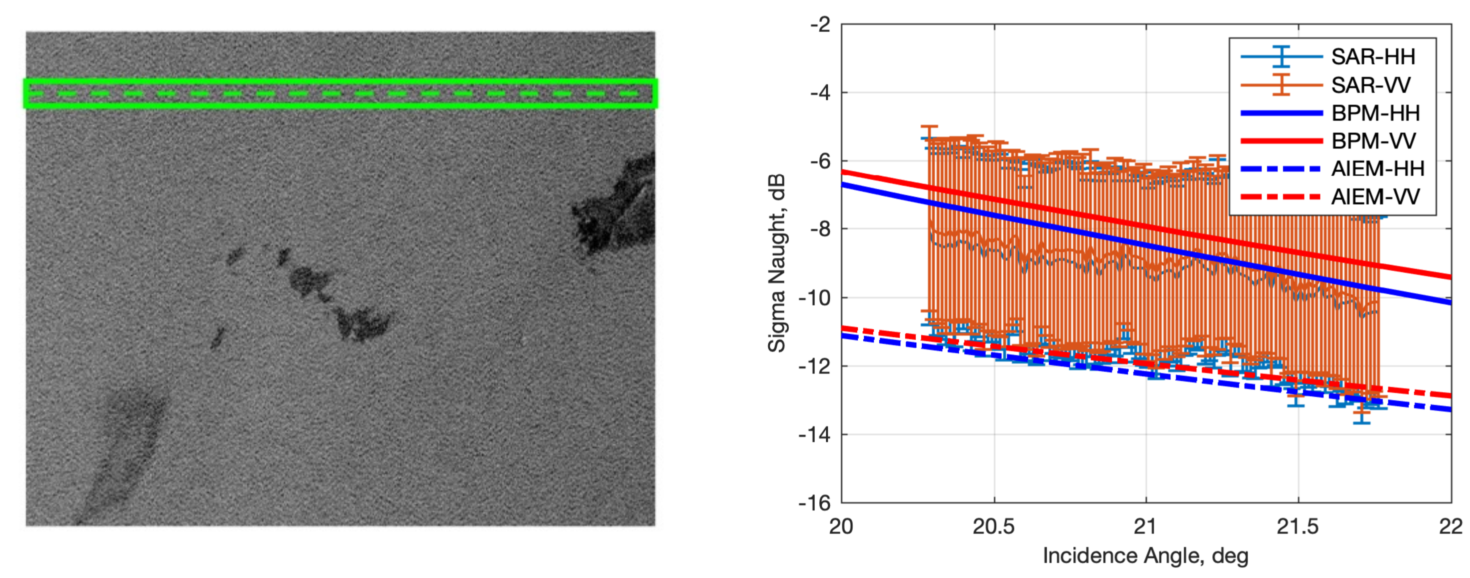


(4) Damping Ratio (DR) of Oil Slicks

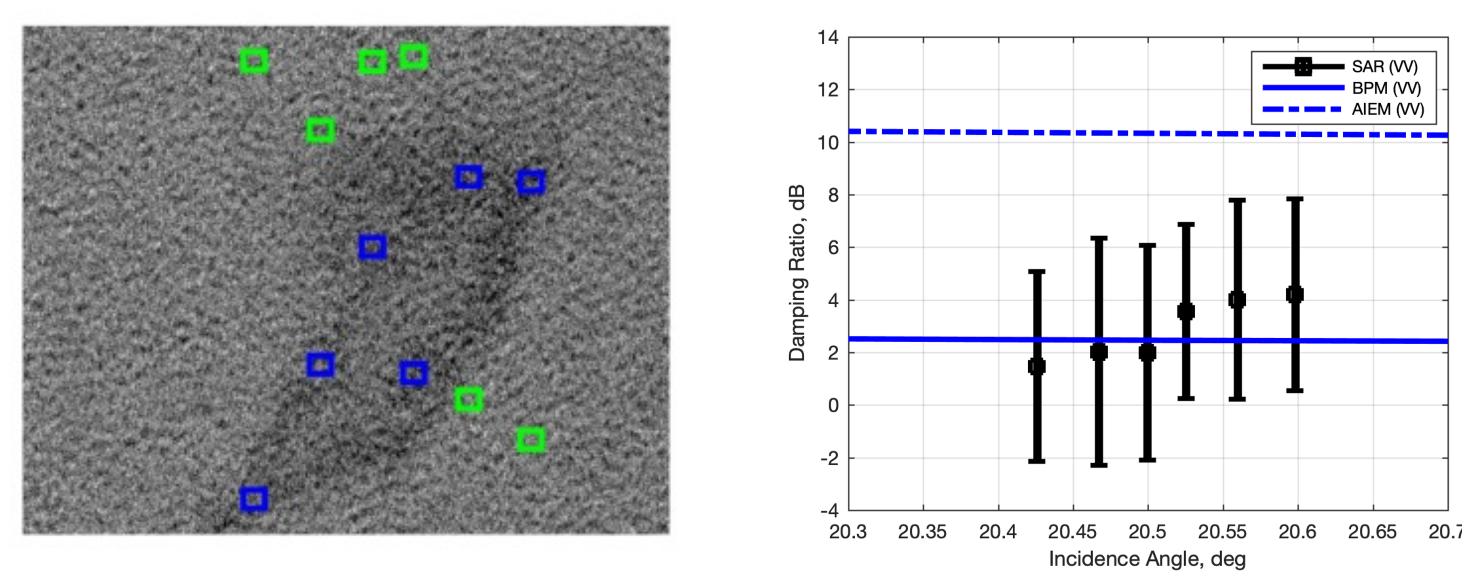


3. Simulation Results with TSX measurements

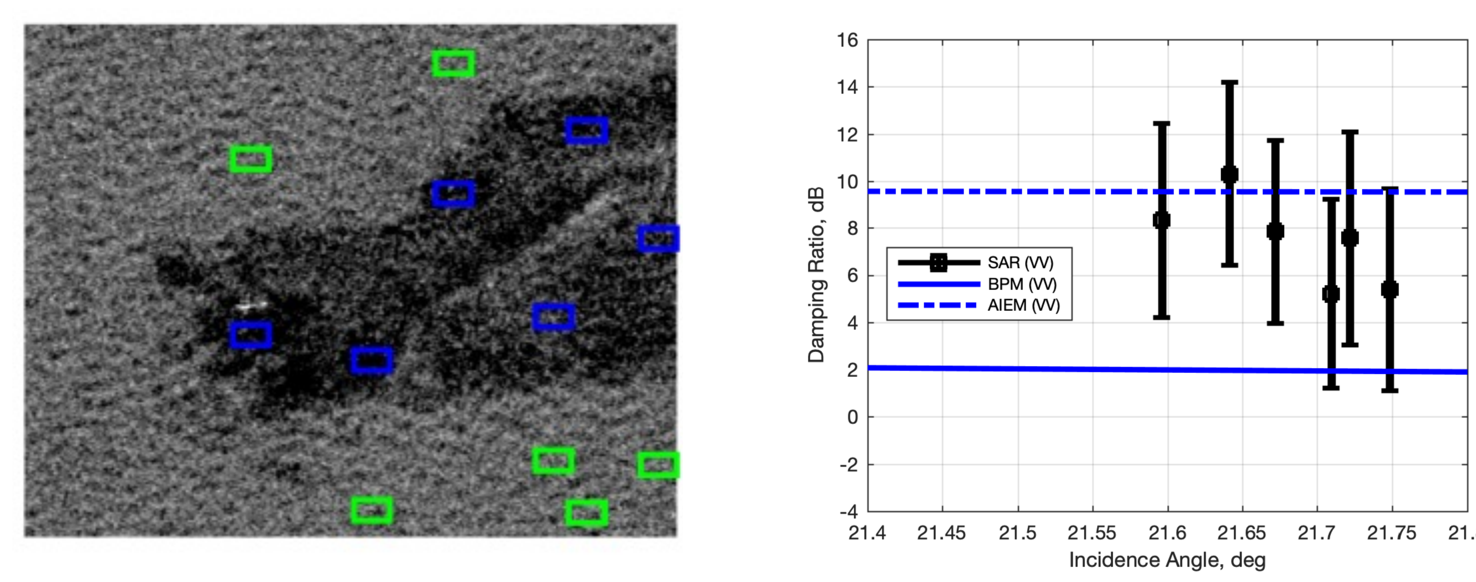
(1) Slick-free Sea Surface (NRCS)



(2) Biogenic Slick-covered Sea Surface (DR)



(3) Mineral Oil-covered Sea Surface (DR)



4. Conclusion

- When dealing with slick-free sea surface, the two-scale BPM and AIEM result in predicted NRCS values at both polarizations that exhibit non-negligible differences up to an incidence angle of about 40° . The NRCS predicted by BPM results in the best agreement with the measured one at low incidence angles. Their differences are negligible at larger incidence angles.
- The two-scale BPM augmented with the Marangoni damping model is more suitable for predicting the NRCS and the damping ratio of biogenic slicks;
- The AIEM combined with the damping MLB results in a better agreement with SAR measurements collected over oil slicks.

References

1. W. Alpers and H. Hühnerfuss, "The damping of ocean waves by surface films: A new look at an old problem," J. Geophys. Res., Oceans, vol. 94, no. C5, pp. 6251-6265, 1989.
2. F. Nunziata, P. Sobieski, and M. Migliaccio, "The two-scale BPM scattering model for sea biogenic slicks contrast," IEEE Trans. Geosci. Remote Sens., vol. 47, no. 7, pp. 1949-1956, 2009.
3. A. Montuori, F. Nunziata, M. Migliaccio, and P. Sobieski, "X-band two-scale sea surface scattering model to predict the contrast due to an oil slick," IEEE J. Sel. Topics Appl. Earth Obs. Remote Sens., vol. 9, no. 11, pp. 4970-4978, 2016.