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The effect of wind-generated bubbles on sea-surface back-scattering at 940 Hz

Robbert Van Vossen and Michael Ainslie
TNO Defence, Security and Safety, Oude Waalsdorperweg 63, 2597 AK The Hague, Netherlands

Predictions of sea-surface back-scattering strength are needed for sonar performance modelling. Such predictions are hampered by two problems. First, measurements on surface back-scattering are not available at small grazing angles. These are of special interest to low-frequency active sonar since these mainly contribute to long range propagation. Second, existing theoretical models underestimate the surface back-scattering strength at larger grazing angles. We investigate whether wind-generated bubbles can explain this deficit. Thus, we develop a theoretical description which includes the effect of refraction and scattering of sound by wind-generated bubbles. We compare the theoretical surface back-scattering predictions to Critical Sea Test measurements. These are a set of back-scattering measurements for different wind speeds, and grazing angles are in the range between 5 and 30 degrees. The comparison shows that a good fit can be obtained between the theoretical predictions and the surface back-scattering measurements, depending on the population density of resonant bubbles. This indicates that wind-generated bubbles significantly contribute to rough-surface back-scattering. The bubble back-scattering contribution is dominant at large wind speeds and also at small grazing angles.