# A Universal Model for Near-Nadir Ka-band Radar Backscatter from the Sea

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During the Southern Ocean Waves Experiment (SOWEX), registered ocean wave topography and backscattered power data at Ka-band (36 GHz) were collected with the NASA Scanning Radar Altimeter (SRA) off the coast of Tasmania under a wide range of wind and sea conditions, from quiescent to gale force winds with 9 m significant wave height. Collection altitude varied from 35 m to over 1 km, allowing determination of the sea surface mean square slope (*mss*), the directional wave spectrum, and the detailed variation of backscattered power with incidence angle. For each sea state, data were acquired at 250 m height with the aircraft in a 7° roll attitude while it turned azimuthally through 810°. The small antenna footprint (4 m) allowed determination of the along- and cross-track components of sea surface slope at each measurement point to compute the local incidence angle for each backscattered power value.

Plotting the log of the backscattered power versus the square of the incidence angle tangent produces a straight line for Gaussian scattering. But the SRA data extended far enough off nadir (25°) that the simple Gaussian assumption was not valid and the data were better fit with quadratic curves $ln\,P(S) = -A\,S^2 + B\,S^4$ where $S$ is the incidence angle tangent. In the Gaussian assumption, $B = 0$. The unexpected result was that $B$ was related to $A$ by a power law $B = 0.4182\ A^{1.434}$. Except for the lightest wind day, there was considerable overlap in the $A$ and $B$ coefficients from day to day because they varied significantly azimuthally. But the scatter on any given day spread the coefficients along the general power law representing the entire dataset, indicating that a particular value of $A$ would have the same $B$ coefficient associated with it whether the $A$ coefficient corresponded to the crosswind direction at a high wind speed, or to the upwind direction at a lower wind speed, or to an intermediate wind speed at an intermediate direction relative to the wind.

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