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Field validation of wave-wind-dependent sea spray generation functions

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Recent studies stress the importance of considering sea surface wave characteristics in sea spray generation functions (SSGFs). To this end, the effect of interacting winds and waves on sea spray generation was studied using data collected during the Marine Aerosol Tunnel Experiments (MATE2019) conducted at the OSU-Pytheas large wind-wave tunnel facility at Luminy, Marseille (France) (Study detailed in Bruch et al., in review). A total of 20 wind and wave combinations were tested, with wind speeds between 8 and 20 m s^{-1} combined with pure wind waves and waves generated by a wavemaker, allowing for a range of wave characteristics and wave ages. Similar wind speed profiles and whitecapping behavior between the laboratory and the field suggest that the laboratory is appropriate for the study of sea spray production. The sea spray generation flux was estimated from logarithmic vertical sea spray concentration profiles using a flux-profile method using Monin and Obukhov (1954) theory. Results show that the production of larger droplets at 20-35 μm radius is well correlated with the wave slope variance $<S^2>$, whilst the wind friction velocity cubed u_*^3 performs best over 7-20 μm. Two SSGFs are proposed.

The original work presented here is an assessment of the validity of the two SSGFs in the field. The two laboratory-derived SSGFs are tested in two numerical models; the stationary Marine Aerosol Concentration Model (MACMod) (used in Laussac et al., 2018), and the non-hydrostatic mesocale atmospheric model Meso-NH (jointly developed by the LA - UMR 5560 - and the CNRM - UMR 3589). The $<S^2>$ necessary required by both SSGFs is estimated using a wind-dependent formulation (Cox and Munk, 1956) and a spectral spectral model (Elfouhaily et al., 1997). Results show that the numerical simulations offer good results relative to sea spray measurements obtained in the North-West Mediterranean in fetch-limited conditions (Laussac et al., 2018), as well as other existing SSGFs in the literature. These results suggest that wind-wave tunnel facilities present an interesting alternative for determining the sea spray generation flux, especially in high wind speed conditions in which deployment in the field is difficult.

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