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Upper ocean degassing during a summer storm south of Iceland

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A summer storm south of Iceland during the ACSOE campaign in June, 1998 caused a large-scale degassing of the upper ocean. Vertical profiles of dimethylsulphide, methyl iodide, methyl bromide, ethene, propene, and isoprene all showed evidence of surface outgassing and downward transport as the mixed layer deepened in response to the high winds during the storm. Production/loss profiles for each compound were formulated using a Greens function approach based on a series of upper ocean transport models to take account of wind-forced mixed layer deepening. In addition to outgassing, most of the profiles show evidence of near-surface ingrowth during the interval after the highest winds when the water column restratified. Interestingly, the profiles suggest that the volatile compounds did not outgas in the same way, even after taking account of the different diffusion effects. Species with a moderate solubility in water and 1- to 3-day atmospheric lifetime (dimethylsulphide, methyl iodide, and methyl bromide) appeared to reach equilibrium across the sea-air interface during the highest winds. This was unexpected because concentrations measured in fair-weather conditions suggest that the ocean is almost always supersaturated. Calculations showed that the amounts lost from the ocean were mixed over the depth of the atmospheric boundary layer and that this limited subsequent net surface outgassing. This behavior was quite different from the other species (ethane, propene, and isoprene) with low solubility in water and very short atmospheric lifetimes. In this case, the compounds were being lost from the upper ocean continuously throughout the period of the storm and being destroyed in the atmosphere on a time scale of minutes to hours. Surface outgassing was not strong enough to overcome the rate of atmosphere destruction to achieve equilibrium across the air-sea interface.