The Impact of Wave State and Breaking on Air-Sea Fluxes: Measurements from the HiWinGS Campaign

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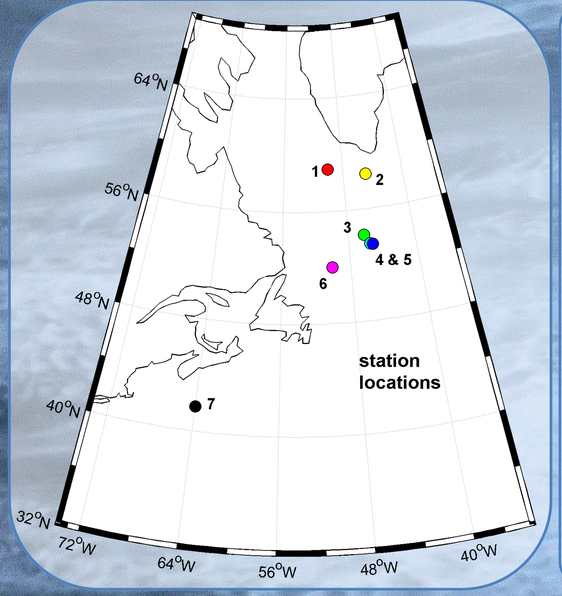
High Wind Gas Exchange (HiWinGS)

Much remains unknown about air-sea interactions during high winds (>10 ms^{-1}), affecting the ability of models to accurately predict the effect of air-sea fluxes on the climate. The aim of the HiWinGS group is to increase understanding of the dependence of air-sea fluxes on sea state under high wind conditions in the Labrador Sea. Fluxes of momentum, heat, moisture, sea-spray aerosol and several trace gases including CO_2, DMS, and methanol were determined using the eddy covariance technique.

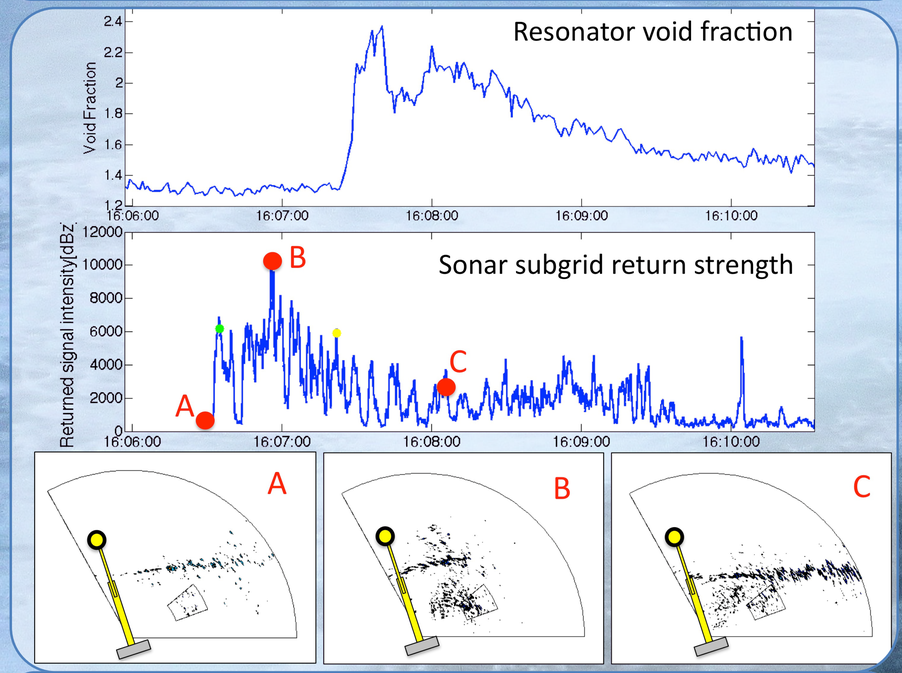


In October 2013, a number of instruments measured gas fluxes, breaking waves and surface displacements (from which significant wave height, H_s, and mean zero up-crossing period, T_z, were calculated). An 11m long National Oceanography Centre spar buoy and Datawell DWR-G Waverider buoy were deployed at seven stations in/near the Labrador Sea.

Breaking Waves and Bubble Plumes

The upward-looking sonar at the base of the buoy provided a 120 degree slice through the water (1.5 degrees wide), and set the context for the other measurements. Bubble size distributions were measured by the acoustical resonators and the bubble camera. The field of view of the foam camera was the area just in front of the buoy, to see the foam patches associated with subsurface bubble plumes.

The overall aim is to understand the lifetime of individual bubble plumes, particularly the relationship between subsurface bubbles and visible surface foam.



4 min 30 s of data from a breaking wave event from resonators and sonar. Top: total void fraction, data from resonator 1. Middle: sonar return strength, with a depth of approximately 5 metres. Bottom: full sonar images for A, B and C.

Comparisons: Spectra and Wind-Sea / Swell Separations

Comparing Waverider and spar spectra justifies observations by the spar; differences potentially show the spar to be more accurate than the Waverider, particularly at frequencies of above 0.15 Hz, due to its high sample frequency (40 Hz), and use of capacitance wires to measure displacements. The Waverider is likely more accurate for waves of <0.15 Hz due to double integration of accelerations.

The spar produces better wind-sea/swell separations than the Waverider using a 1D spectra method. Separations from both buoys, however, seem generally accurate using 60 min spectra. Lots of scatter is seen in calculated separations using 10 min spectra.