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Fast time resolution measurements of high concentrations of iodine above a Laminaria Digitata seaweed bed

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We report observations of extremely large concentrations of molecular iodine (I2) measured in situ above a seaweed bed composed of laminaria digitata (90%) and laminaria hyperborea (10%) growing in its natural habitat. Measurements were made off the coast of Roscoff in Brittany, France, during day-time low tides on several days in September and November 2012 with the greatest tidal amplitudes.

Iodine was quantified using a portable, battery-powered broadband cavity enhanced absorption spectrometer (BBCEAS) deployed from the in-shore research vessel "Aurelia" operated by the Station Biologique de Roscoff. For the 5 second integration times used here, the BBCEAS instrument has a detection limit for iodine of 12 pptv (parts per trillion by volume). The boat was anchored above the seaweed bed before it was exposed to air by the ebbing tide; the boat was grounded on the seaweed bed around the tidal minimum, and then refloated as the incoming tide covered the seaweed.

I2 concentrations were strongly anti-correlated with water depth. Initially little I2 was seen above background levels whilst the blades of the seaweed plants were floating on the water surface. However several hundred pptv of I2 was observed within a few minutes of the plants' stipes breaking the surface and first blades coming to rest on rocks out of the water. Iodine concentrations increased further as the tide ebbed, typically peaking around 1500 pptv around the tidal minimum (by which time the seaweed had been exposed for 45 minutes). I2 concentrations decreased rapidly back to background levels as the returning tide submerged the seaweeds. The concentration profiles showed a lot of high frequency structure, with I2 concentrations commonly varying by a factor 2 (or more) within 60 seconds. Additionally the profiles of I2 emitted from the seaweeds immediately below the instrument's inlet typically sat on a smoothly-varying background of approximately 100 pptv, which we attribute to I2 from other more-distant seaweeds whose emissions are better-mixed into the atmosphere.

The peak I2 concentrations observed here are three to five times greater than the maximum amounts recorded above/closeby laminaria beds in previous studies: 350 pptv max in O Grove, Galicia, Spain (Mahajan et al., ACP, 11, 2545, 2011), and 302 and 547 pptv max at Mweenish Bay, near Mace Head, County Galway, Ireland (Huang et al., GRL, 37, L03803, 2010; ACPD, 12, 25915, 2012). In part, the larger peak concentrations seen here are a consequence of deploying a fast response instrument very close to the source, enabling the emission's high temporal variability to be captured with fewer averaging effects. Nevertheless, the I2 concentrations averaged over the 30 minute period around the tidal minimum were still typically 750 pptv, suggesting laminaria beds are even stronger emitters of I2 into coastal atmospheres than previously thought. Some implications for such high concentrations of iodine for the local atmospheric chemistry are considered.

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