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Iodine Emissions from Seaweeds: Species-dependent and Seasonal Differences

Thomas Adams (1), Stephen Ball (1), Catherine Leblanc (2), and Philippe Potin (2)

(1) Department of Chemistry, University of Leicester, United Kingdom (tja10@le.ac.uk), (2) UMR 8227, CNRS-UPMC, Integrative Biology of Marine Models, Station Biologique, Roscoff, France

Emissions of iodine from macroalgae into the marine boundary layer (MBL) significantly impact tropospheric chemistry and the biogeochemical cycling of iodine. Gas-phase iodine chemistry perturbs the usual HO_x and NO_x radical cycles, provides additional sink reactions for tropospheric ozone, and modifies atmospheric oxidizing capacity. Iodine oxides ($I_xO_y$with $x \geq 2$) formed through the reaction of iodine atoms with ozone nucleate new aerosol particles which, if they grow sufficiently, can act as cloud condensation nuclei (CCN) and so influence the local climate in coastal regions.

Some seaweeds, such as brown algae, are important bio-accumulators of iodine. They specifically induce iodine metabolism to protect themselves against oxidative stress, both as a defence mechanism and when exposed to air around low tide. Indeed the dominant emission source of iodine into the atmosphere in coastal regions comes from intertidal macroalgal beds, particularly those of kelp species.

We present results from an extensive laboratory study of molecular iodine (I_2) emissions from five seaweed species (two Fucales, *Ascophyllum nodosum* and *Fucus vesiculosus,* and three kelp species, *Laminaria digitata*, *L. hyperborea* and *Saccharina latissima*). Eighty-four incubation experiments were performed at the Station Biologique in Roscoff (Brittany, France) between September 2012 and June 2013 to quantify species-dependent I_2 emission rates in response to progressive air exposure, mimicking low tide, and to investigate any seasonal differences. Measurements were conducted on "fresh" biological samples: *Ascophyllum* and *Fucus* thalli were collected whilst still submerged on an ebbing tide, transported in seawater to the laboratory and analysed immediately; kelp samples were collected by boat, stored in an outside aquarium in running seawater and analysed within a few days. I_2 emissions were quantified at high time resolution by broadband cavity enhanced absorption spectrometry (1σ detection limit = 12 parts per trillion by volume in 5 seconds). Experiments exposed samples to air for between 1 and 6 hours, depending on the typical period that the seaweeds were exposed by tides while growing in their local habitats.

This large-scale study provides detailed information on the variability in the emission profiles and total I_2 amounts from multiple samples of the same species. We also consider how the emission profiles and I_2 amounts change with species, season, and total iodine content of the algal samples. Our results have applications for quantifying iodine fluxes into the atmosphere and for investigations into the physiology of macroalgae.

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