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Emissions of Iodine and its Impact on Tropospheric Ozone: A Global 3-D Model Study

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Iodinated compounds are potentially of high importance in atmospheric chemistry. They have the potential to destroy ozone in catalytic cycles and thereby alter the oxidising capacity of the atmosphere. In addition to emissions of organic precursors, recent research has highlighted the importance of oceanic HOI/I2 emissions as a result of ozonolysis of seawater. These organic and inorganic flux terms have been included in the TOMCAT 3-D chemical transport model and their impact on the tropospheric iodine and ozone budget assessed.

We use the TOMCAT 3-D CTM coupled to the GLOMAP-Mode size-resolved aerosol microphysics module. The model has a detailed tropospheric chemistry scheme and was used at a horizontal resolution of 2.8o x 2.8o forced by ECMWF ERA-Interim reanalyses. We present model simulations to diagnose the impact of organic and inorganic iodine emissions and the key chemical/physical processes which determine the tropospheric iodine loading. We evaluate the simulated IO using observations in the marine boundary layer and free troposphere. By including the emission of HOI/I2 the CTM can capture the observed levels of IO globally ($\sim$ 0.5-1 ppt in the daytime). HOI is the dominant iodine species at the surface, with mixing ratios typically $\sim$3 ppt and reaching >10 ppt in 'hotspot' locations. The complex coupling between iodine and ozone chemistry in the troposphere is highlighted in these comparisons, with a negative model feedback between ozone deposition, iodine emission and subsequent ozone depletion.

The simulated IO and HOI is highly dependent on modelled wind speed, sea-surface temperature (SST) and surface ozone concentration, i.e. the variables used in the parameterisation of the emission of HOI/I2 from the ocean surface. We present a number of sensitivity simulations to determine the impact of these variables on the simulated IO, against observations made during the HaloCAST-P campaign. Wind speed is the dominant driver for HOI/I2 emission and has a significant, non-linear impact on the simulated IO. At low wind speeds (3 – 5 m s-1), IO sensitivity to modelled wind speed is $\sim$0.2 pptv (m s-1)-1, decreasing to 0.09 pptv (m s-1)-1 at higher speeds (5-10 m s-1). In contrast, deposited ozone and SST have a smaller impact on modelled IO across the cruise. Therefore, the accuracy of using the large-scale grid-box wind in the current formulation of the parameterised HOI/I2 flux needs further consideration to better constrain the importance of iodine on tropospheric chemistry.