Oxygenated Volatile Organic Compounds (OVOCs) in the Remote Marine Troposphere: Results from the Cape Verde Atmospheric Observatory (CVAO)

L.J. Carpenter[1], K.A. Read.[2], S.R. Arnold[3], R. Beale[4], P.D. Nightingale[4], A.C. Lewis[2], J.R. Hopkins[2], J.D. Lee[2] and L.M. Neves[5]

[1]Department of Chemistry, University of York, York YO10 5DD, United Kingdom; +44 1904 434588, E-mail: lucy.carpenter@york.ac.uk
[2]National Centre for Atmospheric Science, University of York, York, United Kingdom
[3]University of Leeds, Leeds, United Kingdom
[4]Plymouth Marine Laboratory, Devon, United Kingdom
[5]Instituto de Nacional de Meteorologia and Geofisica (INMG), Mindelo, Cape Verde

OVOCs in the atmosphere are precursors to peroxy acetyl nitrate (PAN), affect the tropospheric ozone budget, and in the remote marine environment represent a significant sink of the hydroxyl radical (OH). The sparse observational database for these compounds, particularly in the tropics, contributes to a high uncertainty in their emissions and atmospheric significance. Here we show multi-annual measurements of acetone, methanol and acetaldehyde in the remote marine boundary layer made between October 2006 and September 2010 at the CVAO (16,848°N, 24.871°W), a subtropical marine boundary layer global Global Atmosphere Watch Station situated on the island of São Vicente. All three OVOCs show similar seasonal cycles with higher values observed in March and September and lowest in December and January. Simulations of OVOCs at Cape Verde using the CAM-Chem global chemical transport model show reasonable agreement with acetone concentrations (mean observed:model ratio of 1.23) but large discrepancies with acetaldehyde (model underestimation of a factor of 25) and methanol (model underestimation of a factor of 3). The model predicts a strong summer minimum in acetaldehyde and a broad summer maximum in methanol, whereas the observations showed much less pronounced seasonal cycles although with spring and autumn peaks. The standard CAM-Chem model was adapted to include a two-way sea-air flux parameterisation based on seawater measurements made in the Atlantic Ocean and these measurements suggest that the tropical Atlantic region is a net sink for acetone but a net source for methanol (contrary to many previous assessments) and acetaldehyde. The "ocean model" resulted in improved simulations of atmospheric methanol and acetaldehyde, although still with a four-fold underestimation in acetaldehyde concentrations. However, these simulations produced a poorer agreement with acetone (new observed:model ratio of 1.88) and no improvement in the predicted seasonal variability of the OVOCs. We suggest that terrestrial biogenic African and North American primary and/or secondary OVOC sources are also underestimated by the model, and that this may explain the very pronounced model underestimation of OVOC concentrations in autumn and spring, respectively. The secondary production of OVOCs from higher alkanes produced biogenically from plants or from the ocean may also play an important part in model uncertainties.
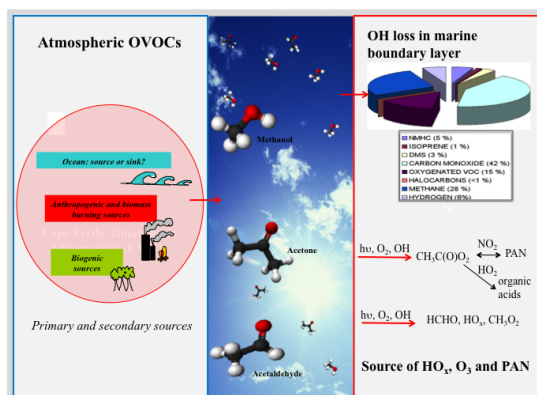

Figure 1. Atmospheric OVOCs.