Measurements of Bromine Oxide, Iodine Oxide and Oxygenated Hydrocarbons in the Tropical Free Troposphere from Research Aircraft and Mountaintops

R. Volkamer[1], E. Apel[2], B. Pierce[3], M. Kanakidou[4] and The TORERO Science Team[5]

[1]Cooperative Institute for Research in Environmental Sciences (CIRES), Department of Chemistry and Biochemistry, University of Colorado, Boulder, CO 80309; 303-492-1843, E-mail: rainer.volkamer@colorado.edu
[2]National Center for Atmospheric Research (NCAR), Atmospheric Chemistry Division, Boulder, CO 80307
[3]NOAA National Center for Environmental Prediction, Camp Springs, MD 20746
[4]University of Crete, Crete, Greece
[5]University of Colorado, Boulder, CO 80309

The Tropical Ocean tRoposphere Exchange of Reactive halogen species and Oxygenated voc (TORERO) field experiment deployed an innovative payload of optical spectroscopic-, mass spectrometric-, and remote sensing instruments aboard the National Science Foundation (NSF)/NCAR Gulfstream V (GV) aircraft (HIAPER). 17 research flights were conducted, 6 above NOAA RV Ka'imimoana cruise KA-12-01 from Hawaii to Costa Rica (TAO program). We have measured small oxygenated hydrocarbons (glyoxal, methyl ethyl ketone, propanal, butanal etc), volatile organic compounds (some 50+ species), bromine oxide and iodine oxide radicals, methyl iodide, bromoform, dibromomethane, and other organohalogen precursors, aerosol size distributions, photolysis frequencies and other parameters from the sea surface to 15km altitude between 40N to 40S latitude over the eastern tropical Pacific Ocean. The project was motivated by our recent observations of very short-lived and very water soluble oxygenated hydrocarbons, like glyoxal, in the remote marine boundary layer (Sinreich et al., 2010, ACP) that remain as of yet unexplained by atmospheric models. Further, the project extended first measurements of of iodine oxide radicals in the tropical free troposphere over the Central Pacific Ocean in the Northern Hemisphere (Dix et al., 2013, PNAS) towards measurements of iodine oxide and bromine oxide in the Southern Hemisphere. Organic carbon and halogens are relevant in the atmosphere because they influences the reactive chemical removal pathways of climate active gases (i.e., ozone, methane, dimethyl-sulfide), and can modify aerosols (e.g., secondary organic aerosol, secondary organic aerosol). This presentation provides a comprehensive field evidence of vertical distributions of small oxygenated molecules and halogen oxide radicals that are found to be widespread in the tropical free troposphere, where 75% of the global tropospheric ozone and methane destruction occurs, and mercury oxidation rates are accelerated at low temperatures. A mountaintop Multi AXis Differential Optical Absorbtion Spectroscopy (MAX-DOAS) instrument to measure tropospheric bromine oxide and iodine oxide vertical profiles was recently installed at Mauna Loa Observatory (MLO), and the capabilities of this instrument to observe the composition of the upper tropical free troposphere from the ground are discussed.

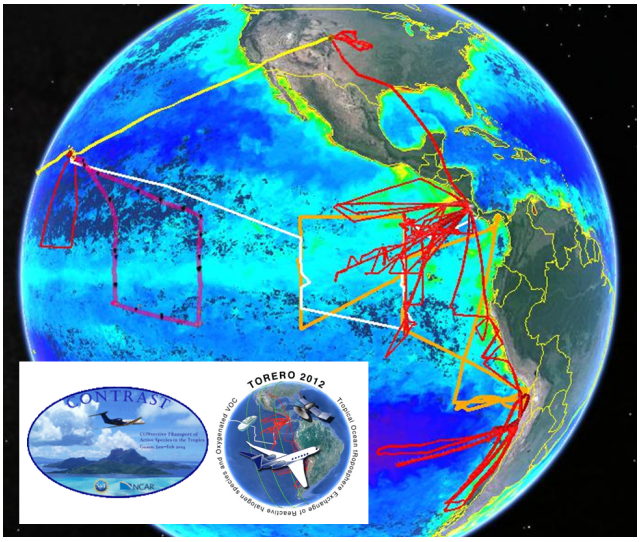

Figure 1. Flight tracks of the NSF/NCAR GV aircraft (red) and ship tracks of RV Ka'imimonana cruise KA-12-01 (white) during the TORERO Project (Jan/Feb 2012). Two flights were further conducted above the mountaintop MAX-DOAS setup at MLO as part of the CONvective TRansport of Active Species in the Tropics (CONTRAST) Project (Jan/Feb 2014).