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Observations of iodine monoxide (IO) over the Eastern Pacific using scattered sunlight at low solar zenith angle have found significant IO in the tropical tropopause layer (TTL): 0.13±0.04 ppt in the northern hemisphere and 0.15±0.04 ppt in the southern hemisphere (Dix et al., 2013, 2016; Volkamer et al., 2015; Wang et al., 2015). Chemical transport modeling which reproduces these observations infers that between 0.25 to 0.70 ppt of total inorganic gas-phase iodine (Iy) is injected into the lower stratosphere (LS), a factor of approximately 2 to 5 more than the WMO upper limit of <0.15 ppt (Saiz-Lopez et al., 2015). At these levels, Iy is responsible for 30% of ozone destruction in the LS, an effect comparable to or greater than that of very short lived brominated species. WMO estimates currently do not account for iodine because quantitative evidence of iodine in the lower stratosphere is lacking.
Previous measurements of iodine in the LS have been conducted at twilight (Bösch et al., 2003; Butz et al., 2009; Pundt et al., 1998; Wennberg et al., 1997). These have found upper limits of <0.1 ppt IO, and have informed the WMO upper limit on Iy. Iodine has been detected but not quantified in aerosol in the LS (Murphy et al., 2006, 2014; Murphy & Thomson, 2000).
We present daytime scattered-sunlight limb observations of IO in the TTL and LS the University of Colorado Airborne Multiaxis Differential Optical Absorption Spectroscopy (CU AMAX-DOAS) instrument during the Convection Transport of Active Species in the Tropics (CONTRAST) campaign over the Western Pacific in 2014 (Pan et al., 2017). These include the first quantitative detection of IO in the LS. Utilizing a chemical box-model, we infer Iy from the measured IO. We also present the first quantification of iodine in submicron aerosol in the LS by the High Resolution Aerosol Mass Spectrometer (HR-AMS) from the Atmospheric Tomography Mission (ATom) over the Pacific and Atlantic in 2016 and 2017. Finally, the implications for iodine injection and ozone destruction in the LS from gas-phase and multi-phase catalytic cycles involving inorganic iodine are discussed.