What Science Have We Learned from Our Combined Airborne and Ground-based Measurements of Halocarbons and other Trace Atmospheric Species?

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The Halocarbons and other Atmospheric Trace Species (HATS) Group ground-based and airborne measurements have complimented each other in scientific discoveries. Ground-based measurements began in 1977 with just 3 molecules (CFC-11 and -12, & N_2O) and has expanded to a total of 64 molecules currently. NOAA and CIRES scientists in the HATS Group started measuring vertical profiles and cruise-altitude levels of atmospheric trace species in 1991, first on high-altitude aircraft (NASA ER-2, 1991–2000; NASA WB-57F, 1999–2016) and balloons (1996–2003), then civilian aviation altitude aircraft [NASA DC-8, 2001–2018; UND Citation, 2003; NCAR GV (2008–2011)], and Unmanned Aircraft Systems (UAS: NASA Altair, 2005–2006, and Global Hawk, 2010–2014). The scope of our observations included many different regional missions and global campaigns, many over or near our baseline stations (Figure 1a). Earlier airborne studies (1990s through early 2000s) had a stratospheric ozone depletion and long-lived greenhouse gases (GHGs) focus, whereas later work included more tropospheric measurements of GHGs and short-lived gases [O_3, H_2O, peroxyacetyl nitrate (PAN), & short-lived halocarbons]. Scientific results include the rate of destruction of ozone in the polar stratosphere during airborne missions [Second Airborned Arctic Stratospheric Expedition (AASE-II), Airborne Southern Hemispheric Ozone Experiment - Measurements for Assessing the Effects of Stratospheric Aircraft (ASHOE-MAESA), Photochemistry of Ozone Loss in the Arctic Region in Summer (POLARIS), & SAGE III Ozone Loss and Validation Experiment (SOLVE)], atmospheric lifetimes of many trace gases including a substantially shorter lifetime for SF_6, due to a mesospheric sink (Figure 1b) observed in 2000 from balloons, stratospheric and tropospheric mean age of the air mass, large-scale transport, and satellite validation. This presentation will focus on the long-term trends of select trace gases over time (Figure 1b), and results from the recent airborne missions National Science Foundation HIPPO and NASA ATom where NOAA flasks [Programmable Flask Packages (PFPs)] were included for the first time.

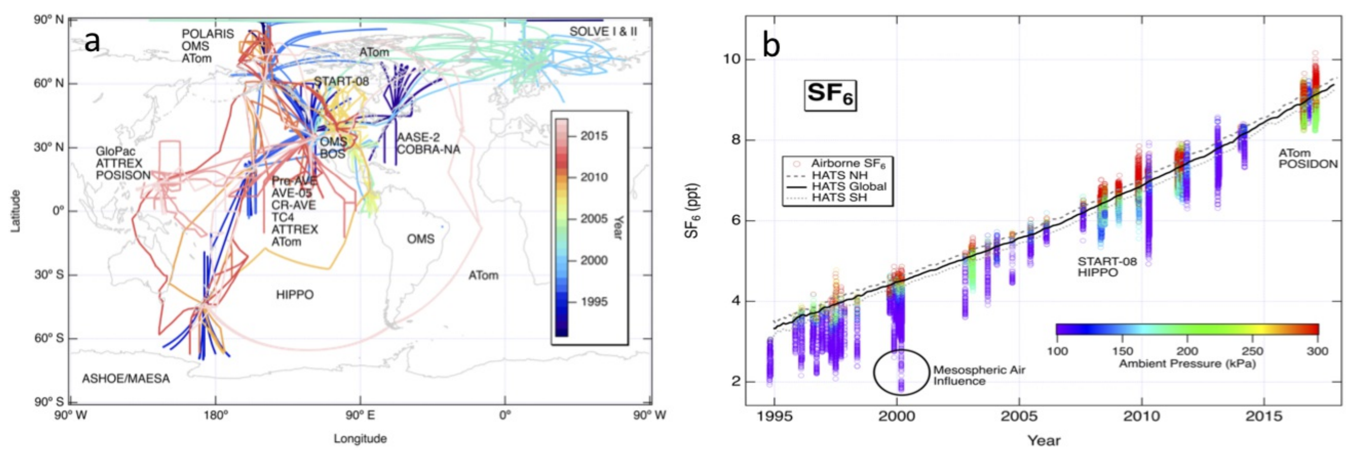

Figure 1. (a) Flight paths from airborne missions (color coded by year, 1991–2018), (b) airborne measurements of atmospheric SF_6 (color coded by ambient pressure), a potent GHG tied to electrical distribution with strong almost constant growth rate of 0.24 ppt per year (2018: ~3% per year) together with our ground-based remote global and hemispheric atmospheric trends.