The Atmospheric Distribution of Molecular Hydrogen (H_2) and Related Species Observed During the HIPPO Project

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The goal of the HIAPER Pole-to-Pole Observations (HIPPO) of Carbon Cycle and Greenhouse Gases project was to measure a large set of trace gases and black carbon aerosols as a function of altitude and latitude in different seasons in order to better understand their sources, sinks, and atmospheric transport, and to use these measurements to compare with a variety of chemical transport models. This should ultimately lead to improvements in the models. The National Science Foundation/National Center for Atmospheric Research Gulfstream V (GV) aircraft (formerly known as HIAPER) was equipped with a suite of instruments for carbon cycle and greenhouse gases, ozone and a few other reactive gases, aerosols, and meteorological parameters. The GV flew a set of five transects in 2009-2011 from Colorado to Anchorage, AK, to near the north pole, then south to Christchurch, NZ, toward the edge of Antarctica, and back to the northern hemisphere high latitudes, with intermediate stops at different locations in the Pacific Ocean. On each leg of the journey, the GV carried out a series of profiles from the marine (or continental) boundary layer to the stratosphere, generating a set of altitude/latitude slices of the atmosphere in different seasons (January 2009, October-November 2009, March-April 2010, June-July 2011, and August-September 2011).

In this presentation, results are shown that were obtained from the UAS Chromatograph for Atmospheric Trace Species (UCATS) instrument and other sensors on board the GV, and from whole air samples analyzed in the laboratory post-flight. UCATS was configured to measure N_2O, SF_6, H_2, CH_4, CO, water, and ozone during HIPPO. The focus here is on the distribution of molecular hydrogen (H_2), which has a diverse set of atmospheric and terrestrial sources, and a sink term that is dominated by soil uptake. Results are broadly consistent with previous studies, showing a slight maximum in the southern hemisphere, much greater variability with altitude in the northern hemisphere, and overall stability in the global average mixing ratio in recent years. Tracer-tracer correlation plots of H_2 with methane and CO allow details of the distribution of hydrogen to be elucidated. There appears to be a local maximum in H_2 at northern hemisphere midlatitudes in spring and early summer. Low values of hydrogen persist at high northern latitudes long after the soil sink should have decreased with the onset of winter.

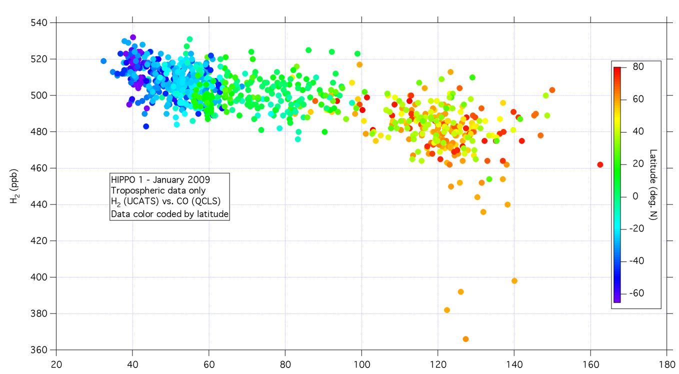

Figure 1. Tracer-tracer correlation plot of tropospheric H_2 vs. CO color-coded by latitude in January 2009, at the time of the maximum in the southern hemisphere H_2 seasonal cycle.