MkIV Balloon VMR Trends

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Retrieved MkIV profiles from 23 flights were analyzed by the program: vmr_n2o_trend.f which fits a straight line to the Gas-N$_2$O relationship for each retrieved profile. This straight line is then interpolated to the desired N$_2$O value to yield a Gas vmr value.

It does this four times, with a weighting function that peaks at four different N$_2$O levels: 100, 150, 200, and 250 ppb of N2O. In this way, if there is any curvature in the Gas-N$_2$O relationship, then the local gradient will be used to compute the intercept since the distant points will be strongly de-weighted.

The weighting function is a Lorentzian of 50 ppb N$_2$O half-width, in conjunction with the usual 1/Gas_error$^2$ least-squares weighting.

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Notes

Balloon flights between 1997 and early 2003 were all from high latitude, following two launches from Fairbanks Alaska in May 1997 and 4 launches from Esrange, Sweden. The 1997 flights were out of the vortex. The Esrange flights (1999, 2000, 2002, 2003) were all inside the winter polar vortex, but the Dec 1999 flight occurred before any heterogenous chemistry.

The Sep 1992 flight had so much aerosol remaining from the Jne 1991 Pinatubo eruption that the limb path became opaque below 22 km, which meant that the 250 ppm N₂O isopleth was never encountered on this flight. So no red point.

The last two plots show N₂ trends and N₂O trends. The latter show values that are exactly at the reference N₂O values without any trend, representing a self-consistency check of the method. The N₂ trend is essentially zero. The N₂ data are noisy because there are only half a dozen usable N₂ lines and these are weak being quadrupole transitions.

Of course, N₂O has been increasing steadily from 308 ppb in 1989 to 328 in 2014, so the apparent trends seen in the gases all all relative to the 0.25%/year trend in N₂O.
Summary

Trend data have been extracted from MkIV balloon vmr profiles. The effects of dynamical variability have been largely removed by interpolating the retrieved gas vmrs to reference N$_2$O isopleths, allowing the underlying trend to be more clearly seen.

This is especially important because of the large range of latitudes covered by the MkIV balloon flights from 33N to 69N.

The next step is to account for the known 6% increase in N$_2$O from 1989 (308 ppb) to 2014 (328 ppb).