UTLS Workshop

Quantifying the ozone distribution and variability in the UTLS in relation to thermal and circulation features

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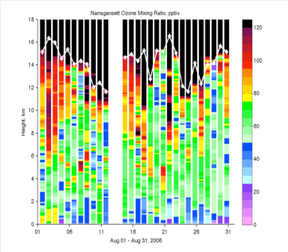
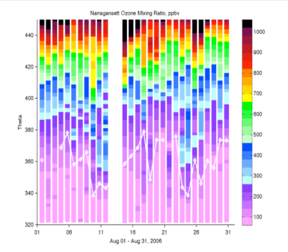
Introduction Sonde profiles provide valuable *in situ* data on the distribution and variability of ozone. Here I highlight some observed features, noting in particular their relation to the tropopuase, using data from Narragansett, RI. I also summarize an approach to deal with the impact of the modest temporal response of the commonly-used ECC ozonesonde.

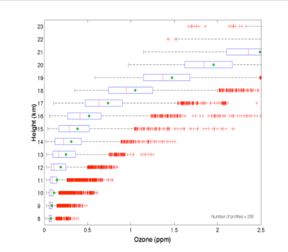
Elevated mixing ratios below the tropopause (here using the WMO criterion) are often associated with ST exchange. Analysis of related events in INTEXB indicated contributions from distant biomass burning events as well.

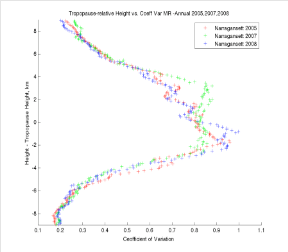




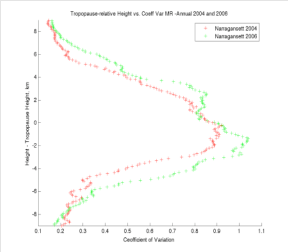
With θ as the vertical coordinate and an expanded mixing ratio range the variability above the tropopause becomes evident. Note variations across 200 ppbv (purple over blue) in over 30% of the profiles. This at a midlatitude site in summer.

Note that the mean mixing ratio value (dot) is at or close to the 75th percentile (box edge) at 10 - 11 km altitudes, close to the average tropopause height. Also notable is the significant variability throughout the lower stratosphere. The peak variability is apparently greater at this site than at some higher-latitude sites.

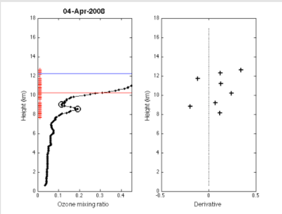




The coefficient of temporal variability (σ/mean) is plotted here *vs*. height relative to the WMO tropopause, using data from weekly profiles over three years. The maximum variability in the UT is broadly consistent with results from other sites. Of course the variability increases again near the surface.

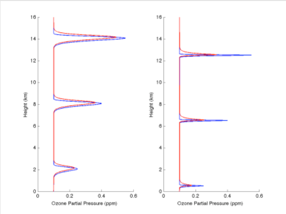


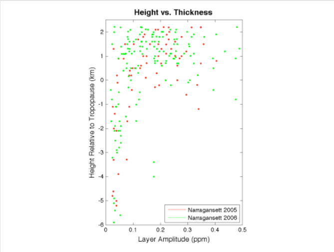
Intensive summer observation campaigns in 2004 and 2006 added close to 30 profiles in each year. In 2004 the UT/LS variability was typical of other years, despite the relative absence of surface ozone outbreaks (Thompson *et al*. 2007). We have not determined whether the summer profiles strengthen or weaken the higher CofVa in 2006.

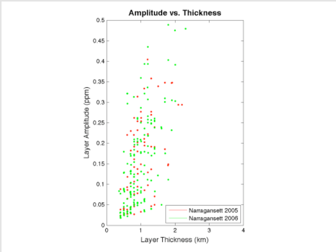


In an analysis of layers, we identify layer edges as they cross constant mixing ratio lines. Paired edges of opposite slope make up a layer. Distributions of layers from two years are shown (above, right). The impact of the modest response time of the ECC sonde is significant.

The response of the ECC sonde was simulated using a single pole Butterworth low pass filter. Trials using laboratory Response Time data confirmed the accuracy of the filtering; differences between the step-up and step-down behavior verified that the cell does not have a strictly first order response. Shown here are assumed (blue) and estimated instrumental response profiles. The amplitude of layers is reduced by 15-50%. In contrast, the height of the peak is offset relatively little, < 150 m.







The occurrence of layers and their amplitudes are shown in the left panel; the height is relative to the thermal (WMO) tropopause for each profile. The increased amplitude of the layers above the tropopause is as expected. In the right panel the distribution of amplitude *vs*. thickness (vertical extent of the layer) is shown for the same period. As noted, below left, the amplitude of layers is always underestimated, with the most significant discrepancy for layers that are thin. Note that more than 50% of the layers have thicknesses < 1 km. However, the majority of these have moderate amplitude, < 150 ppbv.

Discussion An obvious next step is to estimate the extent to which the overall variability of the ozone distribution is underestimated by profile observations, given the occurrence and characteristics of layers. A check on these results will be made using data from vertical profiles using fast-response instruments on aircraft operating in the vicinity of sonde profiles (e.g. in the INTEX campaigns). In the Response Time trials the step-down cases fit the ideal exponential less well than in the step-up cases - the time for the instrument to return to its background value is much longer than the RT itself. This asymmetry, which is inherent in the ECC cell (Komhyr, 1969) may make a full deconvolution of the response challenging or impossible. However, the estimated RT values are sufficiently close together that an approximate correction should be possible because an approach to background seldom occurs in field conditions.

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