Long-term changes in ozone over Europe since the early 1990s – analysis of ozone measurements from sondes, regular aircraft (MOZAIC) and alpine surface sites.

J. A. Logan (jlogan@seas.harvard.edu), J. Staehelin, J.-P. Cammas, V. Thouret, H. Claude, H. Debacker, C. Hueglin, H. E. Scheel, R. Steubi, and R. Derwent

Summary:
Ozone data from MOZAIC, alpine sites (both UV absorption) and most sonde stations are self-consistent since ~1998. Problems with sondes in earlier years.


1. MOZAIC time series are usually self-consistent. Monthly Means Monthly Anomalies

These two layers, ~2 km thick, avoid the boundary layer and the tropopause (mostly).

2. Sonde time series are less self-consistent. Sonde time series are not always coherent with each other, or with MOZAIC, before 1997 or after 2006. Problem with recent Uccle data.

3. Alpine time series are usually self-consistent: 3 sites at 3-3.5 km Highly coherent after 1996, some differences earlier. No increase since ~1996


5a. Alpine site and Mace Head data Monthly anomalies
Mace Head baseline data give a larger increase in ozone than Zugspitze data

5b. Mace Head – baseline vs. all data The method for assigning baseline conditions changed. Pollution filtering included southerly airflow, later method does not. This causes an artificially high trend, relative to all the data.


Analysis details: Sonde and MOZAIC data are averaged in the same layers, equally spaced in pressure altitude, ~1 km apart. The analysis uses monthly means of these time series. The period 1997-2003 is used to form monthly anomalies. The sondes and MOZAIC analysis uses ~2 km layers, except when comparing to alpine sites.

Payern has used EEC sondes since Sept. 2002, Uccle since April 1997. The mean MOZAIC time series is the weighted average of monthly means from the four airports, weighted by the number of profiles per month. The trend model fits the seasonal cycle and four seasonal trends. The annual trend is the average of the seasonal trends, and uses the covariance matrix of seasonal trends to compute the standard error of the annual trend.

Acknowledgements: funded by NASA.