Tropospheric Ozone Assessment Report: Tropospheric ozone observations – How well do we know tropospheric ozone changes?

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From the earliest observations of ozone in the 19th century, measurement methods and the portion of the globe observed by them have evolved and changed. These methods have different uncertainties and biases, and data records differ with respect to coverage and information content. These historical ozone datasets are reviewed, based on relationship of the measurement technique to the modern UV absorption standard, sampling where there is low probability of interfering pollutants, and sampling locations, heights and times such that atmospheric mixing will minimize vertical gradients of ozone near the measurement location.

Spectroscopic methods applied before 1960 may have underestimated ozone by as much as 11% at the surface and by about 24% in the free troposphere, due to the use of differing values of ozone absorption coefficients. There are significant uncertainties with the early chemical measurements related to interference of other gases. There is no firm evidence of very low ozone values in the 19th century, although there is evidence of a modest increase in the 20th century, primarily in the northern hemisphere.

The great majority of validation and intercomparison studies of free tropospheric ozone measurement methods use ECC ozonesondes as a reference. Compared to UV-absorption measurements they show a modest (~1-5%) high bias in the troposphere, with an uncertainty of 5%, but no evidence of a change with time. Umkehr, lidar, and FTIR methods all show modest low biases relative to the ECCs, and so, using ECC sondes as a transfer standard, all appear to agree to within 1σ with the modern UV- absorption standard. Brewer-Mast sondes show a 20% increase in sensitivity to tropospheric ozone from 1970-1995. The Japanese KC sondes show a smaller increase of 5-10%.

Satellite biases and standard deviations are often 2-3 times larger than those of other free tropospheric measurement systems. There is currently little information on temporal changes of bias for satellite measurements of tropospheric ozone. This is an area of concern if satellite retrievals are used for trend studies.
Key words: Tropospheric ozone, climate change, historical measurements, bias, uncertainty