6.007 Using Self-Organizing Map (SOM) Clusters to Create Ozonesonde-based Climatologies and Characterize Linkages among US Ozone Profile Variability and Pollution .

Early Career Scientist

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Abstract:

A typical way to formulate O_3 climatologies is to average ozonesonde profiles on a monthly or seasonal basis, either for specific regions or zonally. However, the variability we are trying to capture in a tropospheric climatology reflects meteorological conditions that may not be confined to a particular season. We demonstrate the advantages of using a statistical clustering technique, self-organizing maps (SOM), over simple averaging, through analysis of more than 4500 sonde profiles taken from the long-term US sites at Boulder, CO; Huntsville, AL; Trinidad Head, CA; and Wallops Island, VA. We apply SOM to O_3 mixing ratios from surface to 12 km (above MSL). At all four sites, profiles in SOM clusters exhibit similar tropopause height, 500 hPa height and temperature, and total and tropospheric column O_3. When profiles from each SOM cluster are compared to monthly O_3 means, near-tropopause O_3 in three of the clusters is double (over +100 ppbv) the climatological O_3 mixing ratio. Large mid-tropospheric deviations from monthly means (-6 ppbv, +7 – 10 ppbv O_3 at 6 km) are found in two highly-populated clusters with a combined 36–39% of profiles. The latter clusters represent both distinctly polluted (summer) and clean (fall/winter, high tropopause) O_3 profiles. In the case of Trinidad Head, SOM clusters of O_3 profile data from the lower troposphere can discriminate background vs polluted O_3 and the conditions linked with each. Two of nine O_3 clusters exhibit thin layers of high O_3, typically between 1 and 4 km, that reside above a subsidence inversion. Ozone in these clusters is upwind of high-altitude surface O_3 monitors at inland locations. Days corresponding to the high O_3 clusters exhibit hourly surface O_3 anomalies at the surface sites of +5 –10 ppbv compared to a climatology; the anomalies can last up to four days.