ACCENT
ATMOSPHERIC COMPOSITION CHANGE
THE EUROPEAN NETWORK OF EXCELLENCE

Sustainable atmosphere; transport and transformation of pollutants

ATMOSPHERIC COMPOSITION CHANGE AS A CONSEQUENCE OF CLIMATE CHANGE? SURFACE OZONE IN THE EUROPEAN SUMMER 2003 AS AN EXAMPLE

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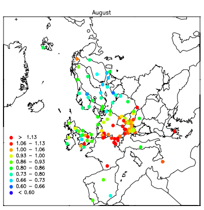
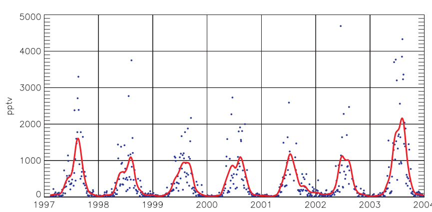
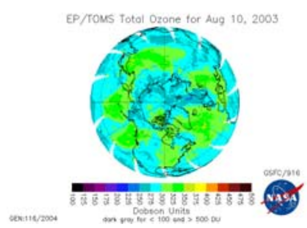
- The European summer of 2003 was exceptionally warm.
- The surface ozone concentrations in central Europe were the highest values since the end of the 1980s. The concentrations were particularly high in June and August 2003.
- Measurements of other trace species suggest that the ozone concentration levels were enhanced by a number of positive feedback effects.
  - Extensive boreal forest fires in Siberia lead to an elevated background level of ozone and CO at northern latitudes thereby increasing the ozone levels that peaks are superimposed upon.
  - Direct measurements and increased temperature and solar radiation suggest that biogenic isoprene emissions in Europe were increased during summer 2003 and further increased the peak ozone episodes.
  - In the anticyclone characterizing the ozone episodes the residence time of air parcels in the atmospheric boundary layer increased, and the total ozone column and the cloud cover were reduced, all favouring ozone formation.
  - In the drought conditions that developed during the heat wave ozone dry removal was weakened due to stomata closure of the plants under drought stress.
- Such situations can come at a higher frequency under continued climate change and may gradually overshadow the effect on ozone as well as PM of reduced emissions from anthropogenic sources of VOC and NO_x.



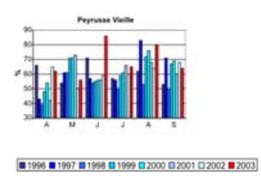
Monthly means of daily maximum ozone observed in August 2003 relative to the maximum of the monthly means of daily maximum ozone during the years 1991-2002.



EMEP canister samples of isoprene at Donon during 1997-2003. Individual samples (twice a week) are shown as blue marks and the corresponding smoothed running average as a red curve.



Column ozone map from TOMS Earth Probe on August 10, 2003.



The percentage residence time inside the European planetary boundary for air masses arriving at six sites given as monthly averages (April-September) during 1996-2003. The data are based on 7 days Flextra 3-D back trajectories.

Climate change feedbacks on atmospheric composition can be sorted according to

- **emission regulators** (both anthropogenic and biogenic, including demography, shift in seasonal temperatures and the effect on energy consumption, plant and forest species, atmosphere-ocean interaction)
- **transport regulators** (wind, convection, mixing properties in the ABL)
- **transformation regulators** (rh, q, cloud cover and type, T, albedo and its effect on photolysis rates)
- **removal regulators** (precipitation frequency and amount, surface properties, bidirectional effects)

Estimates of climate change feedback on atmospheric composition:

- Summer ABL ozone up to a factor of 2 over Continental Europe
- Biogenic emissions feedback of the order of 10%
- Acid dep and eutrophication change of the order of 10%
- Summer PM up to a factor of 2

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Reference: European surface ozone in the extreme summer 2003, S. Solberg, P. Coddeville, Ø. Hov, Y. Orsolini, D. Simpson, K. Uhse, 2005. Submitted for publication

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