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Interactive comment on "European surface ozone in the extreme summer 2003" *by* S. Solberg et al.

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Solberg et al. discuss various reasons for the elevated O3 during Europe's hot summer of 2003, all of which are plausible. There is one important additional factor: the impact of temperature-dependent chemistry on ozone formation rates.

Cardelino and Chameides (1990) and Sillman and Samson (1995) both found that ozone formation is affected by temperature-dependent photochemical reaction rates. Specifically, the temperature-dependent decomposition PAN and other organic nitrates affects ozone formation. Formation of PAN during pollution episodes can be a significant sink for both NOx and the family of odd hydrogen radicals (OH, HO2 and RO2). At low temperatures this removal of NOx and Hx slows the rate of ozone formation.

At risk of being self-promoting I want to refer to my earlier results (Sillman and Sam-

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son, 1995), which were based on the extreme summer of 1988 in the eastern U.S. Results from measurements at an ensemble of rural sites showed that daily maximum O3 increased 3 ppb (6 mcg/m3) for every 1-degree rise in daily maximum temperature, for temperatures from 300-310 K. Ozone increased more slowly with temperature (or not at all) for maximum temperatures below 300 K. Similar rates of increase have been reported in Europe (Wunderli and Gehrig, 1991).

Results from a coarse 3-d simulation suggested that half of the observed increase in rural ozone (1.5 ppb per degree K) can be explained solely by the decomposition rate of PAN and related species. The impact of the PAN decomposition rate was somewhat less in a VOC-sensitive urban area than in NOx-sensitive rural areas, but was still significant.

Increases in isoprene associated with temperature had little effect on ozone. The effect of isoprene was limited because ozone formation in rural locations in the U.S. was sensitive to NOx rather than VOC, and VOC-sensitive urban areas had relatively little isoprene. Seasonal changes in photolysis rates and increased water vapor associated with temperature had a significant effect on O3 in VOC-sensitive environments.

Jacob et al. (1993) found that stagnant meteorology could also explain approximately half the observed increase of ozone with temperature in the U.S. This result is consistent with Solberg's finding that residence times of air parcels in the boundary layer were longer during events with high temperatures.

Solberg et al. addressed meteorological transport patterns, photolysis rates, isoprene and dry deposition as possible causes of increased ozone during high-temperature periods. Each of these is plausible as a contributing factor. The effect of temperature-dependent chemistry should be added to this list. It may be the most important factor.

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