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The differing impact of air stagnation on near-surface ozone across Europe

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Daily maximum temperature is known to be the meteorological variable that mostly controls the afternoon near-surface ozone concentrations during summer. Air stagnation situations, characterised by stable weather conditions and poor ventilation, also lead to the accumulation of pollutants and regional ozone production close to the surface. This work evaluates the joint effect of daily maximum temperature and a simplified air stagnation index on surface ozone observations in eight regions of Europe during summer 1998-2015.

As expected, the correlations of MDA8 O_3 (maximum daily 8-h running average ozone) with temperature are higher than with stagnation for most regions. Nevertheless, stagnation can also be considered as a good predictor of ozone, especially in the regions of central/southern Europe, where the correlation coefficients between MDA8 O_3 and the percentage of stagnant area are within the range 0.50–0.70. MDA8 O_3 consistently increases over central/southern Europe under stagnant conditions, but this is not always the case in the north. Under non-stagnant conditions and daily maximum temperatures within 20-25 ºC (typical temperatures of fair weather conditions that allow photochemical production), northern Europe is affected by southerly advection that often brings aged air masses from more polluted areas, increasing the MDA8 O_3 mixing ratios.

We have also found that the ozone diurnal cycles in the central/southern regions exhibit large amplitudes, with above-average daytime and below-average night-time concentrations, when stagnation occurs. Stagnant nights are often associated with stable shallow planetary boundary layer and, presumably, enhanced dry deposition and chemical destruction of ozone. After sunrise, mixing with air from air from the residual layer, accumulation of ozone and precursors, and photochemical production seem to be the main mechanisms involved in the build-up of daytime ozone.

According to previous studies, some of the central/southern European regions where stagnation has a clear impact on ozone have undergone significant upward trends in air stagnation in the past and are also likely to experience increases in the future. However, our study has identified other regions with unclear responses of summer ozone to the occurrence of stagnation. This indicates that climate model projections of increases in stagnation should not directly be

translated into enhanced summer ozone pollution if the sensitivity of this pollutant to stagnation has not been proved for a particular region.