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

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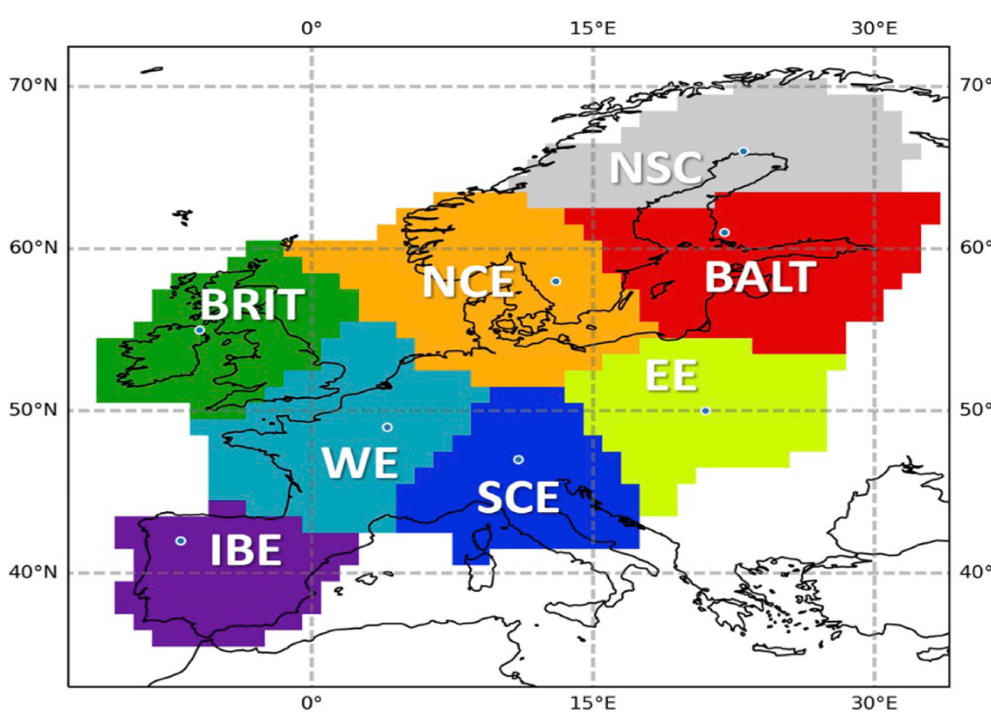
1. Introduction

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.

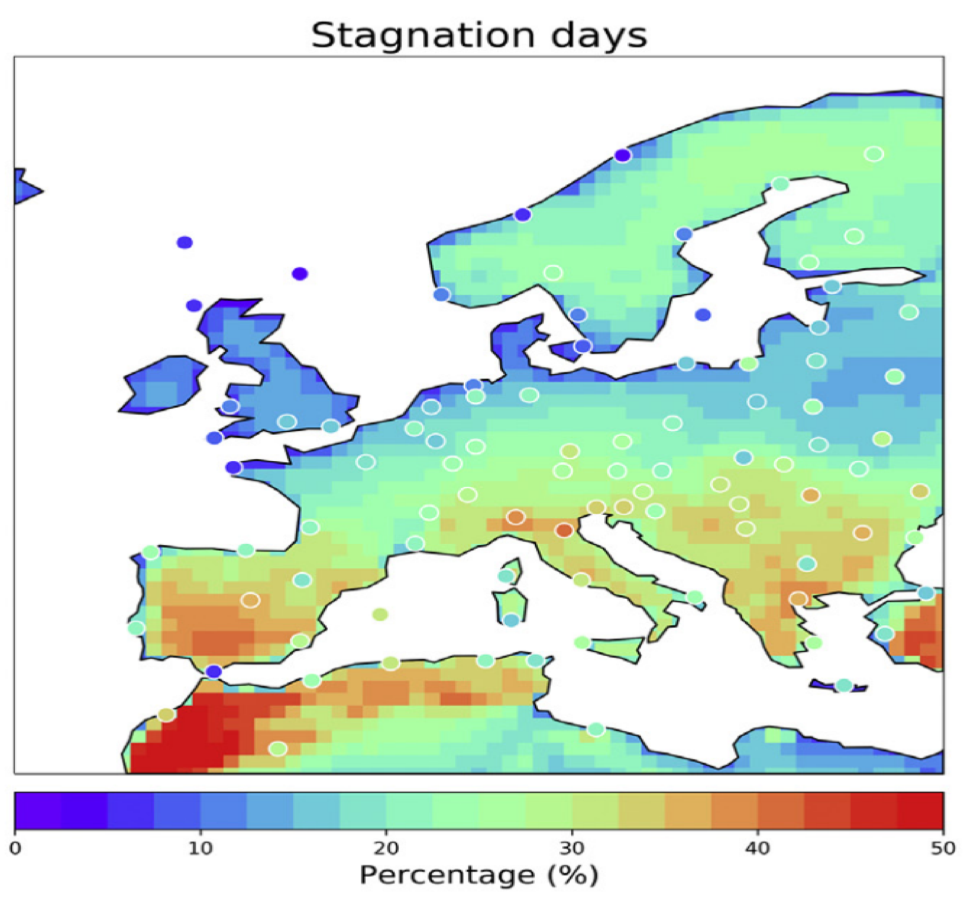
2. Meteorological and ozone data

1. Meteorological fields provided by the ERA-Interim reanalysis at 0.75° x 0.75° horizontal resolution.
2. Interpolated datasets of MDA8 and hourly O_3 over Europe at 1.0° x 1.0° resolution during summer 1998–2015. The regionalizization of these datasets provided by Carro-Calvo et al.(2017) is used:



3. Air stagnation

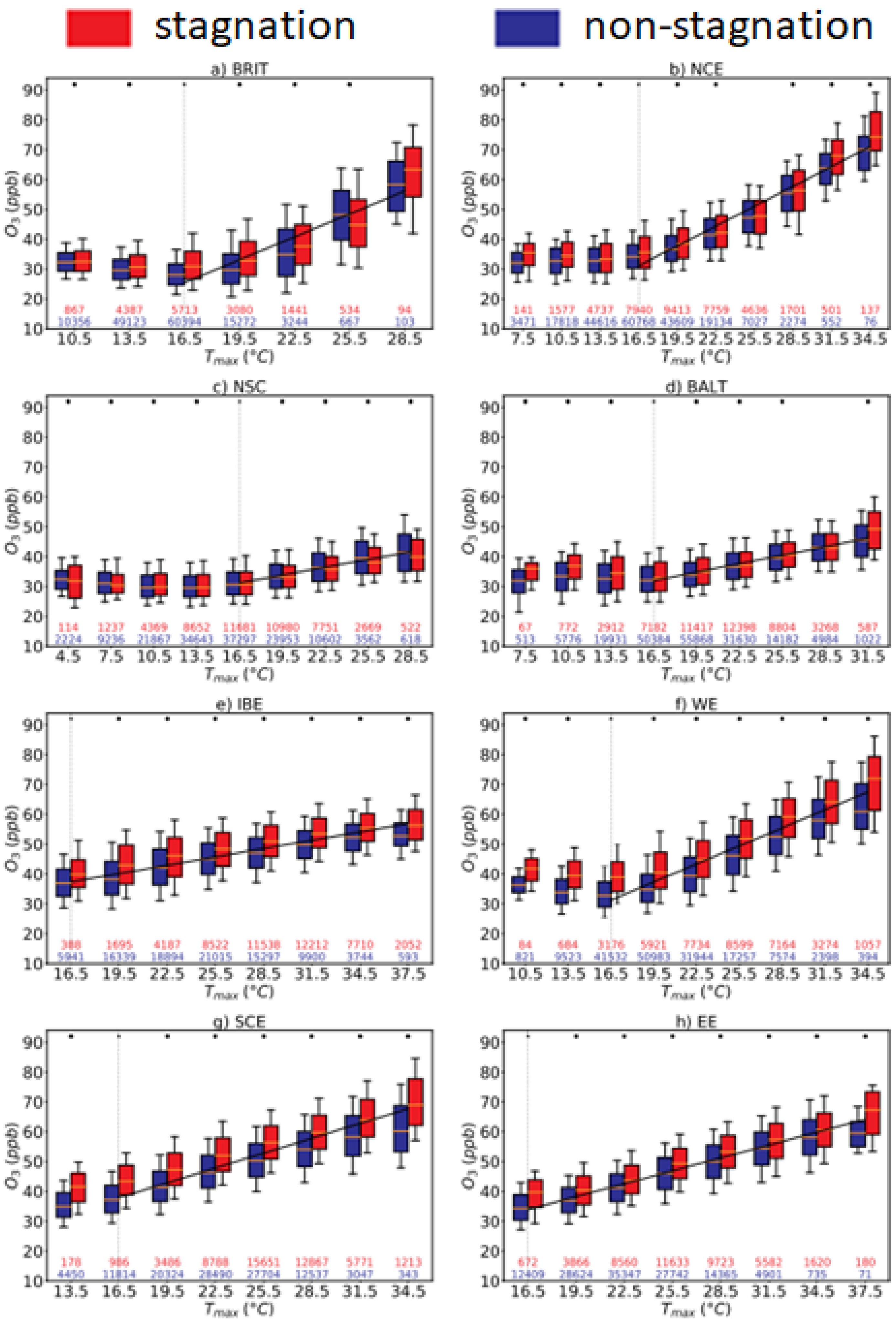
We have used the simplified air stagnation index defined by Horton et al. (2012). A reanalysis grid cell is considered as stagnant if three conditions are simultaneously met on a given day: wind speed at 10m < 3.2 m/s, wind speed at 500hPa < 13.0 m/s and precipitation < 1 mm. This index has recently been used to characterize the spatiotemporal variability of air stagnation in Europe (Garrido-Perez et al., 2018):



4. Relationship between MDA8 O_3, temperature and stagnation

Pearson correlation coefficients (R) between the daily time series of average T_{max}, MDA8 O_3 and the percentage of the area under stagnant conditions (AS) for each region in summer:

R	BRIT	NCE	NSC	BALT	IBE	WE	SCE	EE
$T_{max} - MDA8\ O_3$	0.18	0.52	0.35	0.48	0.42	0.70	0.77	0.73
$AS - MDA8\ O_3$	0.24	0.39	0.06	0.27	0.56	0.62	0.70	0.50
$T_{max} - AS$	0.23	0.47	0.24	0.33	0.51	0.53	0.58	0.44



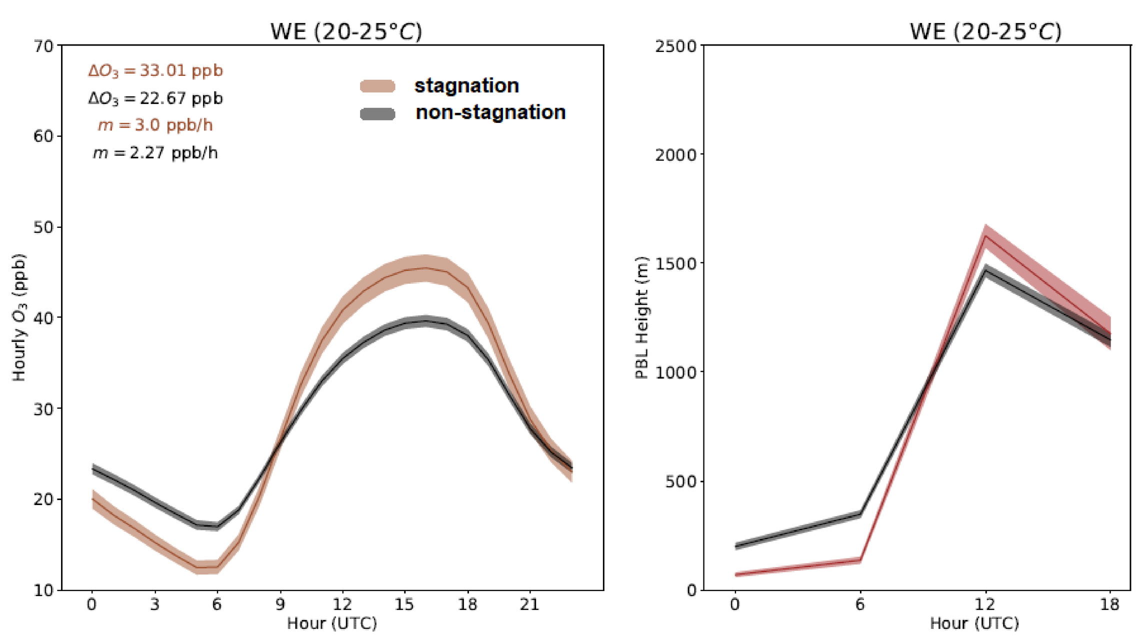
Correlation table

- Considerable spatial heterogeneity across Europe
- The correlations of MDA8 O_3 with temperature are higher than with stagnation for most regions
- Stagnation is also a good predictor of O_3, especially in central/southern Europe (IBE, WE, SCE, EE) and NCE.
- Unclear if the high $AS - O_3$ correlations in the central/southern regions reflect the $O_3 - T$ relationship

O_3 distributions

- MDA8 O_3 consistently increases over central/southern Europe and NCE under stagnant conditions
- Stagnation exerts a minor control on MDA8 O_3 over most of northern Europe (BRIT, NSC, BALT)
- Under non-stagnant situations, northern Europe is affected by southerly advection that often brings more polluted air masses. This mechanism has been related to O_3 extremes there (Carro-Calvo et al., 2017)

5. Impact of stagnation on the O_3 diurnal cycle



- Larger amplitudes of the O_3 diurnal cycle in the central/southern regions and NCE when stagnation occurs
- **Low nighttime** O_3: stable shallow boundary layer and, presumably, enhanced dry deposition and chemical destruction of O_3.
- **High daytime** O_3: mix with air from the residual layer, accumulation of O_3 / precursors and photochemical production.

7. Conclusions

We have been able to identify regions with different responses of summer O_3 to the occurrence of air stagnation. Stagnation has a clear impact on O_3 in central/southern Europe, but this is not always the case for the northern regions. This regional dependency of the O_3 - stagnation relationship across Europe indicates that climate model projections of increases in stagnation should not directly be translated into degraded air quality without a proper assessment of the regional impacts. **For further details see Garrido-Perez et al. (2019).**

References

[1] Carro-Calvo, L. et al., 2017. *Spatial clustering and meteorological drivers of summer ozone in Europe*. Atmos. Environ. 167, 496–510.

[2] Garrido-Perez, J.M. et al., 2018. *Air stagnation in Europe: spatiotemporal variability and impact on air quality*. Science of The Total Environment, 645, 1238-1252.

[3] **Garrido-Perez, J.M. et al., 2019. *The differing impact of air stagnation on summer ozone across Europe*. Atmospheric Environment, 219, 117062.**

[4] Horton, D.E. et al., 2012. *Response of air stagnation frequency to anthropogenically enhanced radiative forcing*. Environmental Research Letters, 7(4), 044034.