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Study of nocturnal surface ozone enhancement due to vertical mixing from residual layer

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Surface ozone (O_3) is a highly reactive secondary photochemical air pollutant and an important greenhouse gas which contributes to global warming and climate change. It exhibits marked diurnal variability, with high concentration during the day (due to in-situ photochemical production of O_3 in the presence of sunlight, NOX and VOC's) and low concentration during the night (due to removal of O_3 by NO and ground level destruction). Frequent enhancement of the nocturnal surface ozone (NSO) was observed during winter months (November – February) at 6 background ozone monitoring sites (3 urban and 3 suburban) in Portugal during the study period (2000-2010). The reasonable explanation for observed bimodal pattern of surface ozone with second peak around early morning (03 – 05 h) has to be transport processes, as ozone production ceases at nighttime. Simultaneous measurements of surface O_3 at various sites in the region suggest that horizontal advection alone cannot explain the enhancement of NSO maxima. Five major NSO enhancement episodes, when NSO concentration exceeded 80μg/m3, were analyzed to study the role of vertical mixing on NSO. Weather Research and Forecasting (WRF) model simulations were performed to investigate the role of low level jets (LLJs) in generating turbulent mixing and vertical transport of air parcel aloft from residual layer (RL) into the nighttime boundary layer. Further analysis also shows an increasing trend in NSO daily maxima over 5 urban/suburban sites and over another site (Alfragide) which exhibits the same trend but only in the last 7 years of the studied period. Also the non-parametric Mann-Kendall test confirms that the trends are statistically significant.