Interannual ozone variability at the NCO-P WMO/GAW global station: influence of stratosphere-to-troposphere exchange

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Background

The tropospheric ozone (O3) is an atmospheric key compound, being the third most important greenhouse gas. Acting as short-lived climate forcer, it can influence the oxidative capacity of the troposphere and affect the population health, the ecosystem integrity and the crop yields. A large part of the produced O3 derives from anthropogenic emissions, although a not negligible contribution is provided by lightning and stratosphere-to-troposphere exchange (STE). This latter process is a topic of ongoing research, especially for what concerns the quantification of where and how often the stratospheric intrusions (SI) take place.

South Asia and the Himalayas are a crucial zone for what concerns O3 levels. For this reason, the Nepal Climate Observatory-Pyramid (NCO-P) WMO/GAW global station is operative since March 2006 in the high Khumbu Valley, Nepal, at 5079 m a.s.l. As previously investigated (Cristofanelli et al., 2010), NCO-P is strongly affected by SI events, thus the development of tools to assess and analyze the variability of such events is of particular importance, especially for what concerns the climatological perspective.

STE climatology and the steflux tool

In this study, the STE climatology presented in Škerlak et al. (2014) is used. This makes use of the ERA-Interim reanalysis dataset from the ECMWF, as well as a refined version of a well-developed Lagrangian methodology. Basically, it selects, from a large set of trajectories available each day, only the ones for which the tropopause (2 pvu/380 K) crossing occurs, according to a minimum residence time; then, following a 3-D labelling algorithm, it distinguishes between points of stratospheric or tropospheric nature.

By using this climatology as input, the steflux tool has been developed, in order to obtain a fast and reliable estimation of the SI occurring at a specific location, over a chosen time period. As input, it is possible to select several parameters, such as coordinates and height (given as a specified pressure level, or PBL height) for the search location.

Validation dataset

Method shown in Cristofanelli et al. (2010), developed to assess the influence of SI to the O3 variability at NCO-P. It makes the combined use of different in situ measurements (such as O3, P and RH), satellite observations (total column O3 retrieved by OMI product, TCO), and modelling back-trajectory outputs (by using LAGRANTO model, see Sprenger et al., 2015). Basically, a specific day was considered as influenced by SI if at least one of the following criteria was satisfied:

- Significant variations of daily P value and presence of back-trajectories with PV>1.6 pvu
- Significant daily TCO increases and presence of back-trajectories with PV>1.6 pvu
- Significant variations of daily P values and TCO daily increases
- Presence of RH>80% and significant negative correlation O3-RH and daily O3 maximum higher than the seasonal value and significant variation of daily P, PV or TCO values

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References

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