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STEFLUX: a tool for investigating stratospheric intrusions

Davide Putero (1,2), Paolo Cristofanelli (1), Michael Sprenger (2), Bojan Škerlak (2), and Paolo Bonasoni (1)
(1) CNR-ISAC, Bologna, Italy (d.putero@isac.cnr.it), (2) IAC-ETH, Zurich, Switzerland

Stratosphere-to-Troposphere Exchange (STE) represents one of the natural processes that have substantial impacts on atmospheric chemistry and is an important aspect of global change. In particular, stratospheric intrusions (SI) are capable of changing the oxidation capacity of the troposphere and their contribution to ozone (O_3) levels in the troposphere was estimated to be as large as the net photochemical production. SI is a topic of ongoing research, especially for what concerns its possible impact on long-term trends of tropospheric O_3. In this work, a new tool called STEFLUX is presented. The main purpose of STEFLUX is to obtain a fast and reliable identification of the SI occurring at a specific location and during a selected time window, by using a set of Lagrangian trajectories. The database used as input is a compiled STE climatology, which makes use of the ERA-Interim reanalysis dataset from the ECMWF, as well as a refined version of a well-developed Lagrangian methodology. In this work, STEFLUX outputs were compared to the observations from two high-mountain stations in the Himalayas and in the Mediterranean basin, i.e. the Nepal Climate Observatory-Pyramid (NCO-P, 5079 m a.s.l.) and Mt. Cimone in the Italian northern Apennines (2165 m a.s.l.), which represent a suitable place for the occurrence of SI events. The STEFLUX performance was assessed by observing that it well represented the seasonal- and inter-annual variability of the frequency of SI events at the two measurement sites; then, by following both a “backward” and a “forward” approach, it was demonstrated that the tool is especially powerful in capturing long-lasting SI events (i.e. longer than one day). Then, by exploiting the fact that the ERA-Interim reanalysis extends back to 1979, STEFLUX was used to obtain a SI occurrence climatology for the two sampling sites. A trend evaluation study was performed for both cases, indicating no significant trends, except for the winter season.