Extreme events in total ozone: Spatio-temporal analysis from local to global scale

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Recently tools from extreme value theory (e.g. Coles, 2001; Ribatet, 2007) have been applied for the first time in the field of stratospheric ozone research, as statistical analysis showed that previously used concepts assuming a Gaussian distribution (e.g. fixed deviations from mean values) of total ozone data do not address the internal data structure concerning extremes adequately (Rieder et al., 2010a,b). A case study the world's longest total ozone record (Arosa, Switzerland – for details see Staehelin et al., 1998a,b) illustrates that tools based on extreme value theory are appropriate to identify ozone extremes and to describe the tails of the total ozone record. Excursions in the frequency of extreme events reveal "fingerprints" of dynamical factors such as ENSO or NAO, and chemical factors, such as cold Arctic vortex ozone losses, as well as major volcanic eruptions of the 20th century (e.g. Gunung Agung, El Chichón, Mt. Pinatubo). Furthermore, atmospheric loading in ozone depleting substances led to a continuous modification of column ozone in the northern hemisphere also with respect to extreme values (partly again in connection with polar vortex contributions). It is shown that application of extreme value theory allows the identification of many more such fingerprints than conventional time series analysis of annual and seasonal mean values. Especially, the extremal analysis shows the strong influence of dynamics, revealing that even moderate ENSO and NAO events have a discernible effect on total ozone (Rieder et al., 2010b). Overall the extremes concept provides new information on time series properties, variability, trends and the influence of dynamics and chemistry, complementing earlier analyses focusing only on monthly (or annual) mean values. Findings described above could be proven also for the total ozone records of 5 other long-term series (Belsk, Hohenpeissenberg, Hradec Kralove, Potsdam, Uccle) showing that strong influence of atmospheric dynamics (NAO, ENSO) on total ozone is a global feature in the northern mid-latitudes (Rieder et al., 2010c). In a next step frequency distributions of extreme events are analyzed on global scale (northern and southern mid-latitudes). A specific focus here is whether findings gained through analysis of long-term European ground based stations can be clearly identified as a global phenomenon. By showing results from these three types of studies an overview of extreme events in total ozone (and the dynamical and chemical features leading to those) will be presented from local to global scales.

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