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Long term variability of O3 in the UTLS as measured by MOZAIC since 1994 and its link to NAO indices

Valérie Thouret (1,2), Jean-Pierre Cammas (1,2), Christophe Cassou (3), Philippe Nédélec (1,2), Gilles Athier (1,2), Damien Boulanger (1,2), and Fernand Karcher (4)

(1) Université de Toulouse, UPS, LA (Laboratoire d'Aérologie), 14 avenue Edouard Belin, 31400, Toulouse, France, (2) CNRS, LA (Laboratoire d'Aérologie), 31400 Toulouse, France, (3) CNRS, CERFACS, Global Change and Climate Modelling Project, 42, Avenue G. Coriolis, 31057 Toulouse, France , (4) GAME/CNRM (Météo-France, CNRS) Centre National de Recherches Météorologiques, Toulouse, France

The MOZAIC program (http://mozaic.aero.obs-mip.fr) measures O3 and thermodynamical parameters since August 1994 on board 5 commercial aircraft operated by European airlines. Thus, most of the sampling data have been recorded at northern mid-latitudes, between 9 and 12 km altitude, in the upper troposphere – lower stratosphere (UTLS). To better assess the O3 distribution and its seasonal and regional behavior, measurements have been referenced to the tropopause altitude. The tropopause is defined as being a transition zone 30 hPa thick centered on the surface PV=2 pvu. Two other layers are defined on either side of the tropopause to encompass all the cruise levels of the MOZAIC flights, as fully described in Thouret et al., (2006). Then, we have access to the upper tropospheric and lower stratospheric ozone distributions independently of any ozone threshold and regardless of the seasonal variations of the tropopause. We will present a climatology of O3 in the UTLS for different regions of the northern mid-latitudes, from Western US to Japan, via North Atlantic and Europe. We will focus on the seasonal and regional differences to better highlight the ozone behavior in this critical region. Given the availability of 15 years of data (up to 2008), we also aim to further assess the interannual variability and "trends". The first analysis presented in Thouret et al., (2006) showed an increase of O3 of about 1%/year between 1994 and 2003 in both the UT and the LS over a large North Atlantic area. This time period was actually characterized by the so-called (positive) anomaly 1998-1999. O3 time series and anomalies have been correlated with the atmospheric teleconnections indices (NAO and NAM), showing thus the coupling between the stratosphere and the troposphere and the role of the variations in large scale dynamics, through wave-driven stratospheric circulation influencing down to the middle and upper troposphere. Later on, Koumoutsaris et al., (2008) have also shown the role of the strong El-Nino event in 1997 in the positive ozone anomaly in 1998-1999 observed at hemispheric scale. In this present study, thanks to a longer time series now available (up to 2008), we go a step further. We will show that recent data actually reveal a leveling off of O3 since 2000 over the US and Europe while it is still increasing over Asia. More over, to further understand the leading processes of such "trends" and to attribute them to various forcing, we will show a more detailed analysis of the links between O3 anomalies and the teleconnections indices.