Identification and Climatology of COLs near the Tropopause from two different kind of physical approaches

R. Nieto[1,2] (rnieto@uvigo.es), *M. Sprenger[3], H. Wernli[4], R. Trigo[2,5]* and *L. Gimeno[1]*

[1]Universidad de Vigo, Ourense, Spain ; [2]CGUL-IDL, University of Lisbon, Portugal ; [3]Institute for Atmospheric and Climate Science, ETH Zürich, Switzerland ; [4]Institute for Atmospheric Physics, University of Main, Germany; [5]Universidade Lusófona, Departamento de Engenharias, Lisbon, Portugal.

Cut-off low pressure systems (COLs) are defined as **closed lows in the upper troposphere** that have become completely detached from the main westerly current.

COLs are important as a mechanism of **stratosphere troposphere exchange** (STE). In COLs, the **tropopause is anomalously low**, thus contributing to produce STE. The STE associated with COLs is essential to explain **anomalous values of tropospheric ozone**.

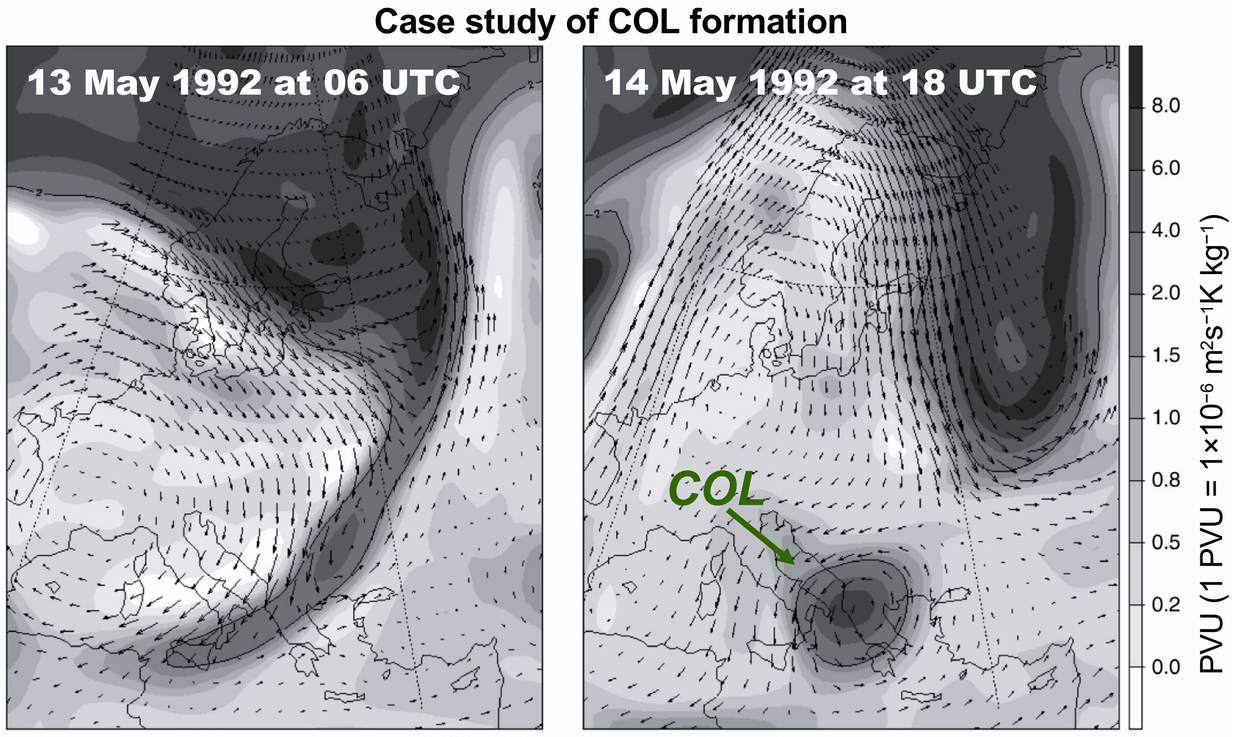
Here we present 3 upgraded climatologies of COLs developed by Nieto et al. (2005, hereafter NAL) and by Wernli and Sprenger (2007, here after WS), and a comparison between the results, for the whole extratropical Northern hemisphere (from 20ºN to 70ºN) from January 1958 to December 2002.

We use reanalysis datasets available every 6-hours from NCAR-NCEP and ERA-40 from the ECMWF, checking the area of COL occurrence, seasonal and monthly cycle.

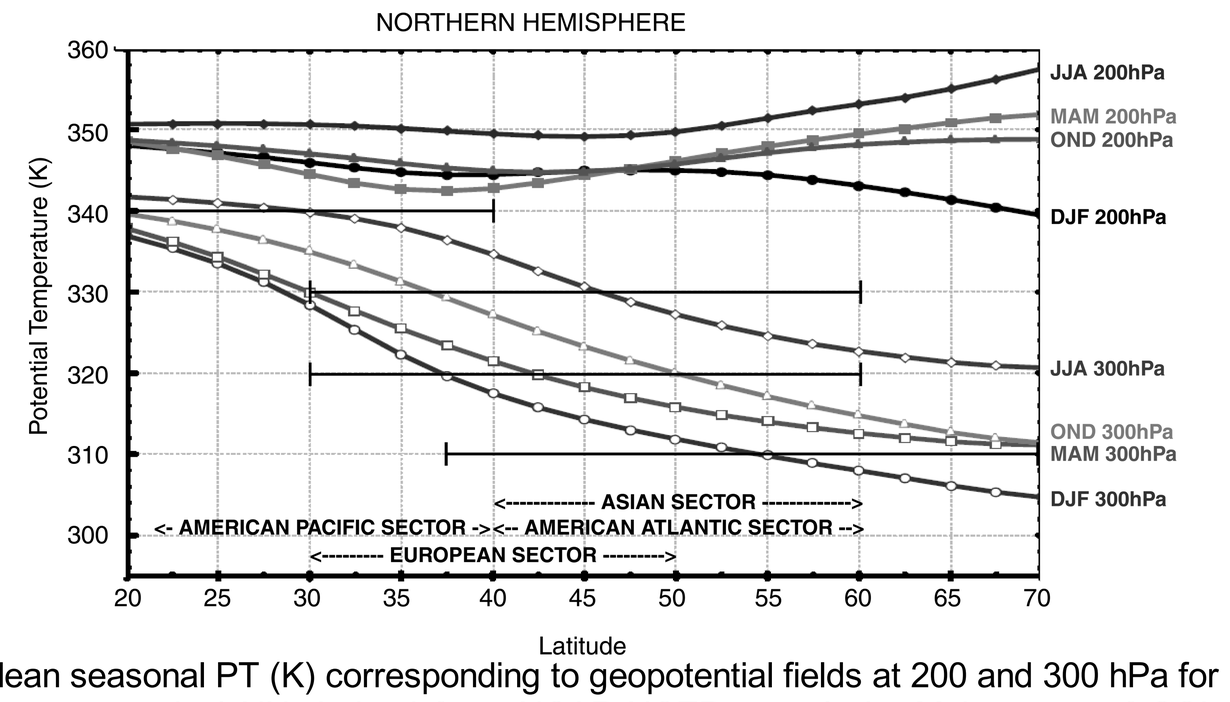
The first two climatologies are built from both reanalysis based on the conceptual model of COL developed by Nieto et al (2005) using geopotential, u-wind, and T from 200, 300 hPa onto a 2.5°x2.5° grid.

The third climatology was developed using potential vorticity (PV) as the physical parameter of diagnosis following the previous methodology by Wernli and Sprenger (2007) using ERA-40. U-wind components, T and geopotential fields are onto a 1ºx1º grid. Potential temperature and PV have been calculated on the original hybrid model levels. Finally, the PV field was interpolated to a stack of isentropic levels from 300 to 350K, separated by 10K.

Case study of COL formation

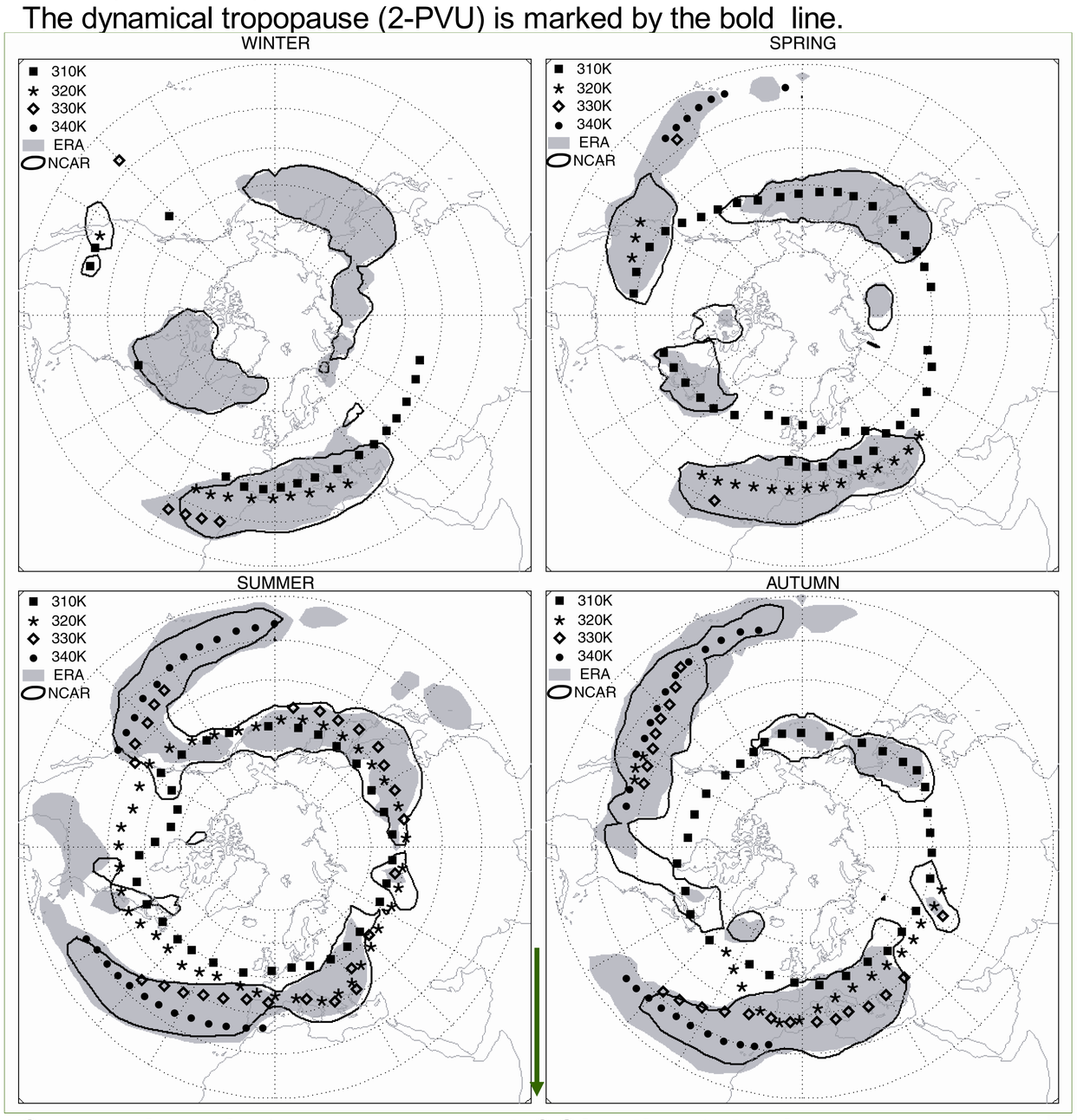


Isentropic PV map on the 320 K isentrope. The wind vectors are overlaid. The dynamical tropopause (2-PVU) is marked by the bold line.



Mean seasonal PT (K) corresponding to geopotential fields at 200 and 300 hPa for the extratropical NH derived from NCAR-NCEP reanalysis. Main areas of COL occurrence are plotted over the latitude axis. Continuous black segments indicate the isentropic level where COLs are identified for different latitudes.

In general, the most appropriated isentropic levels to analyze each latitude band are: from 30ºN to 60ºN, 320 and 330 K; for latitudes lower than 40ºN, 340 K; and for latitudes higher than 40ºN, 310 K.



Comparison between seasonal COL climatologies.

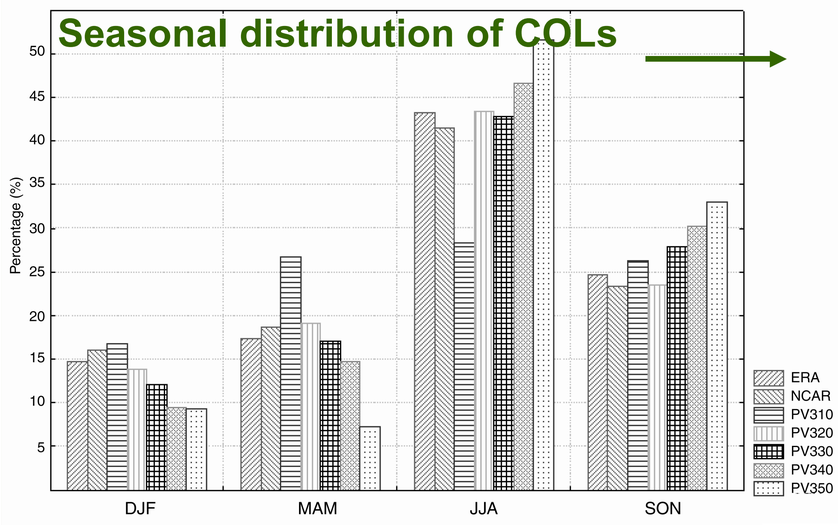
Gray areas and black line denotes NAL climatologies, and symbols mark the longitudinal axes of main areas of occurrence from WS climatologies.

The higher the latitude of the COL region, the lower the isentropic level that is appropriate for the comparison.

Asian and North American Atlantic sectors: COLs at 310 & 320 K

European and North American Pacific areas: 330 and 340 K for all seasons with the exception of winter (310, 320, and 330 K)

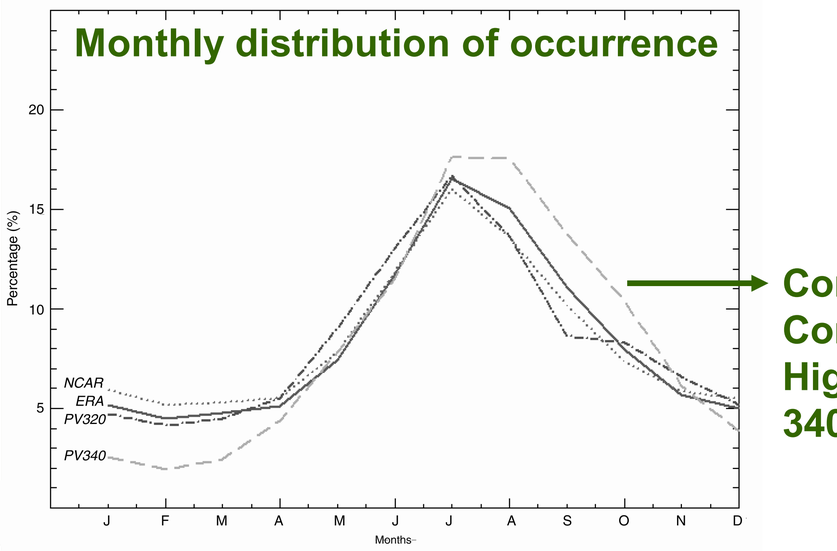
In summary: for each season and for different areas, different isentropic levels must be used to obtain a good representation of the main areas of COL occurrence.



Max. during summer and min. during winter, with some differences in the amplitude of the seasonal cycle.

Best agreement: ERANAL, NCARNAL and WS 320 K.

Of all the seasons, the best agreement occurs in DFJ and the worst in JJA when higher relative differences are found.



Common maximum in July. Common minima in D or J. Higher amplitude for the 340K level.

The two methodologies are complementary and each contributes to a better characterization of the physical properties of COLs.

Nieto R et al 2005. Climatological features of COLs in the Northern Hemisphere. J. Climate 18, 2805-2823.

Wernli, H. & M. Sprenger. 2007. Identification and ERA-15 climatology of PV streamers and COLs near the extratropical tropopause. J. Atmos. Sci. 64: 1569–1586.

Nieto R, Sprenger M, Wernli H, Trigo R and Gimeno L. 2008. Identification and Climatology of COLs near the Tropopause. ANYAS, in press.