

Final scientific report for the Exchange Grant:  
“Study of climatological features and  
mechanisms of multiple tropopauses  
on the Mediterranean area“

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## **1. Purpose of the visit**

The aim of the visit as described in the application for the grant was the collaboration with Prof. José M. Castanheira from the Department of Physics of the Universidade de Aveiro, recognized specialist in the field of stratospheric processes. Our intention was to make valuable research in order to give an explanation of the physical mechanisms leading to the fact of the Mediterranean region as a global centre of MT events. Three main research lines were explored: analysis of the troposphere-stratosphere exchange of ozone for MT events, study of the possible relationship with Jet Stream variations and variations in the temperature profile. Data from radiosonde stations existing in the Mediterranean region will be used, which let us to obtain the best vertical resolution. The possibility of using data obtained using GPS/RO techniques is a plus.

## **2. Description of the work carried out during the visit**

With the logical adjustments during the advance of the research in the Universidade de Aveiro we have performed a first approach to the analysis of cut-off low systems and its relevance for the multiple tropopause events. We have compared the existing databases of cut-off low systems obtained

from ERA-40 reanalysis with MT over the Mediterranean obtained using radiosonde data for a 40 years period (1965-2005). Moreover this radiosonde data has been homogeneized during the stay to obtain more reliable results. A first approach on the study of the ozone influence on MT events is being performed using several kind of data as for example the JRA-25 reanalysis. It was not possible to expand the work to the use of GPS/RO techniques because of time limitations.

The first results obtained are described below and were presented during the General Assembly of 2008 of the European Geosciences Union in Vienna.

### 3. Description of the main results obtained

The most relevant result obtained is that over the Mediterranean region the MT tropopause events seems not to be connected with the existing cut-off low systems, at least for the same time.

#### RESULTS - ANNUAL -

	ST	DT	TT
STRATOSPHERIC CUT-OFF LOW	70.63	23.61	5.75
TROPOSPHERIC CUT-OFF LOW	60.55	31.56	7.79
WITHOUT CUT-OFF LOW	67.47	26.26	6.19

**Table 2:** Percentage of cases with simple, double and triple tropopause (ST, DT and TT respectively) respect to the number of soundings coincident with tropospheric (upper), stratospheric(middle) and without cut-off lows (lower) respectively.

	ST	DT	TT
STRATOSPHERIC CUT-OFF LOW	3.91	1.31	0.32
TROPOSPHERIC CUT-OFF LOW	6.56	3.42	0.85
WITHOUT CUT-OFF LOW	56.42	21.96	5.17

**Table 3:** Percentage of cases with simple, double and triple tropopause (ST, DT and TT respectively) respect to the total number of soundings.

## RESULTS - DJF -

	ST	DT	TT
STRATOSPHERIC CUT-OFF LOW	69.54	24.39	6.02
TROPOSPHERIC CUT-OFF LOW	67.30	26.42	6.16
WITHOUT CUT-OFF LOW	66.61	26.92	6.39

**Table 4:** Similar to Table 2 but for DJF.

	ST	DT	TT
STRATOSPHERIC CUT-OFF LOW	5.09	1.78	0.44
TROPOSPHERIC CUT-OFF LOW	6.44	2.53	0.59
WITHOUT CUT-OFF LOW	55.37	22.38	5.31

**Table 5:** Similar to Table 3 but for DJF.

However based on results from other studies we are studying the relationship with time gaps. That is, our current hypothesis is that the MT events are influenced by cut-off low systems in a 24 to 48 hours basis. In this way our computations has been multiplied by eight to assess the cut-off low systems during the previous 48 hours to MT events in a six hours time basis. By the way the computations are now heavier and slower.

This hypothesis seem to be reasonable and well supported by the recent results obtained by Dr. Sprenger from the ETHZ in Zurich about maximum time of influence of the synoptic conditions. That is, as the coincident of the spatial distribution over the Mediterranean region for MT events and cut-off low systems is clear and given the recent results, it is possible that a cut-off low drives to a MT event 24 hours after its occurrence.

Some relevant references to evaluate the rationale about this topic are:

- Randel WJ, DJ Seidel, and LL Pan. 2007. Observational characteristics of double tropopauses, *J. Geophys. Res.*, 112: D07309. DOI:10.1029/2006JD007904.
- Wernli H, Sprenger M. 2007. Identification and ERA-15 Climatology of Potential Vorticity Streamers and Cutoffs near the Extratropical Tropopause, *J. Atmos. Sci.*, 64: 1569-1586.

## **4. Future collaboration with the host institution**

Both the host and the visiting researcher have planned to continue our collaboration on this research topic and discussed about other different. We have planned after finishing the study of the topic studied during the exchange grant to expand the study for the whole globe.

Other topic relevant and which we would like to develop is the simulation using climate models of the situations observed and here studied of MT events. The usual radiative-convective models with baroclinic adjustments for extratropics could not be able to reproduce MT events in a correct way and it should be studied.

## **5. Projected publications/articles resulting or to results from the grant**

We work on a paper containing the obtained results and other which we process at this moment. A tentative reference for this paper is:

J. A. Añel, L. de la Torre, J. M. Castanheira, L. Gimeno (2008) Study of the relationship between Cut-Off Low Systems and Multiple Tropopause events.