Correction of the answer to Oreste Reale (R2) in the Interactive comment on "Local and remote moisture sources for extreme precipitation: a study of the two famous 1982 Western Mediterranean episodes" by **Damián Insua-Costa et al.**

In the previous comment, we proposed to modify and extend the first part of the introduction following the reviewer's suggestions. After those changes, the third paragraph of the introduction dealt with the importance of tropical-extratropical interactions for mid-latitudes extreme precipitation:

"Different studies support the aforementioned idea, especially those that point to the interaction with tropical regions as being key in the development of mid-latitude HPEs. The argument is that when extra-tropical baroclinic low pressure systems descend enough in latitude, they have the chance to capture large amounts of moisture generated in the tropics and advect them into the mid-latitudes and beyond. Thus, a high risk of severe rainfall would be induced if that high moisture content is forced upward by some mechanism, such as orographic lift. The phase of the baroclinic wave should be such allowing this moisture to enter the circulation on the eastern side of the cyclone, often funneled along the cold front, and then be transported poleward resulting in well-known structures such as tropical plumes or atmospheric rivers. Tropical moisture exports have been shown to be important contributors to precipitation in mid-latitude regions in both hemispheres, especially relevant for extreme precipitation (Knippertz and Wernli, 2010; Knippertz et al., 2013). Case studies of HPEs in different parts of the planet, such as the west coast of the United States and Europe, conclude that moisture from tropical and subtropical regions can be essential, comprising most of the TPW feeding these severe episodes (e.g. Stohl et al., 2005; Eiras-Barca et al., 2017). The tropical-extratropical connection in the aforementioned cases occurred through an atmospheric river, advecting highly humid air from lower latitudes to the affected areas. In the WMR, studies for different events also evidence the important role that tropical moisture exports can play in the development of HPEs (e.g. Winschall et al., 2014; Krichak et al., 2015). Some even go further and claim that tropical systems, such as Atlantic hurricanes and their extratropical remnants, can be instrumental, by injecting large amounts of moisture into the Mediterranean Basin (e.g. Pinto et al., 2001; Reale et al., 2001). In the Eastern Mediterranean, different research have also shown the importance for heavy precipitation of moisture transport from the tropics, sometimes reflected in the formation of tropical plumes (e.g. Ziv, 2001; Rubin et al., 2007). Another example of how tropical-extratropical interactions can trigger Mediterranean severe rains come from Wu et al. (2013), who found that the interaction of the (6-9 days) African easterly wave with mid-latitude low pressure systems resulted in large moisture exports from the tropics that were fundamental in producing the precipitation inducing floods in 2000 and 2002. All these studies reinforce the need to look at the problem of extreme precipitation in the Mediterranean region from a more global perspective and discard a local or regional view, particularly in the case of moisture origin."

We think it is too early to talk about this now and we prefer to postpone this topic for another article we are working on. In the later article, which we are about to finish, we deal with a much larger number of cases (all major flooding events in the last 35 years), so we hope to draw much more general conclusions. It is at that point that we will attempt to link Mediterranean heavy precipitation events with tropical-extratropical connections, and we will compare the results obtained with those obtained by other authors. In short, we prefer to leave this topic for the closing of our project (my PhD thesis) rather than for the opening. For this reason, we now propose deleting the aforementioned third paragraph.

With this last correction and some other minor modification, the first part of the introduction would read as follows:

"The Western Mediterranean Region (WMR) is characterized by a high frequency in the occurrence of torrential rainfall episodes and floods that cause severe damages, with a very high social and economic impact (Llasat et al., 2010; Jansà et al., 2014). An analysis carried out in the framework of the HYMEX program (Drobinski et al., 2013) showed that 385 flood events (including flash-floods and urban floods) occurred between 1981 and 2010 in north-east Spain, south-east France and south-west Italy (Llasat et al., 2013). The main mechanism generating these heavy precipitation events (HPEs) is the strong instability induced by the warm and moist air at low levels that for most of the year sits over the mild Mediterranean waters and the ensuing vigourous convection is usually triggered by the surrounding mountains or convergence lines (Buzzi et al., 1998; Rotunno and Ferretti, 2003; Llasat, 2009). Jansà et al. (2014) and Reale and Lionello (2013) showed that heavy precipitation in the Mediterranean is usually directly or indirectly related to intense, weak or moderate cyclones. Particularly, they found that in more than 80% of heavy rain cases produced in the Western Mediterranean, a cyclone was situated nearby, in a proper location for organising a warm and moist inflow into the affected area (Jansà et al., 2001; Campins et al., 2011). Most cases occur in autumn, when the combination of a still warm sea surface temperature (after a peak in late summer), and a southward displacement of the jet stream, which usually favours the appearance of Atlantic lows or cut-off-lows (COL's; e.g. Nieto et al., 2005, 2008) affecting the WMR, make this season the most favourable for the development of these extreme events (see Dayan et al., 2015, for a detailed review of the most frequent atmospheric conditions resulting in Mediterranean HPEs).

While factors such as strong instability or the presence of a Mediterranean low in the vicinity are commonly associated with HPEs, as stated in the previous paragraph, the concurrence of these weather features does not ensure the development of extreme precipitation. For example, in autumn, and other seasons too, the presence of Mediterranean cyclones is certainly much more frequent than the occurrence of catastrophic flooding episodes. Similarly, COL's affecting the Iberian Peninsula are more frequent in spring than summer and located west rather than east of Iberia, but heavy rainfall and floods are mainly recorded on the eastern Iberian Mediterranean shore and in autumn. Thus, an important question arises: what is the discriminating factor among many apparently similar weather situations where only one produces an HPE? The starting hypothesis of this work is that the factor setting extreme precipitation situations apart is the existence of a very large moisture supply from remote regions outside the Mediterranean. This very humid external influx, when added to local Mediterranean moisture, would yield the enormous amounts of total precipitable water (TPW) needed to produce the rain accumulations commonly recorded in these episodes, which often remind of the values associated with tropical systems. Once sufficient TPW is present, any mechanism able to concentrate and release this moisture over a small area can cause a flood-producing precipitation event. Under this hypothesis, the configuration of the large-scale circulation would therefore be also critical, since it determines whether an intense moisture transport from remote regions can be established or not.

However, in the ample literature analyzing the different contributors to the genesis of HPEs in the Western Mediterranean, moisture as a key factor is sometimes undervalued or not considered in depth, often assuming that the high values of TPW involved in these events originate locally at low levels from sea evaporation. But, where does such large amount of water vapour really come from? Is it evaporation in the Mediterranean the main source or, on the contrary, does most of the moisture in precipitation originate remotely?

There are, nevertheless, several authors that in the last two decades have used different numerical techniques to answer these fundamental questions. Reale et al. (2001), employing the quasi-isentropic water vapour back-trajectory method (Dirmeyer and Brubaker, 1999), showed that moisture transported by three (westward moving) Atlantic tropical systems and their extra-tropical remnants contributed significantly to the series of floods that affected the north-western and north-central Mediterranean in September and October of 1998. Turato et al. (2004) with the same tool demonstrated that remote moisture sources, mainly the Atlantic Ocean, were crucial in the October 2000 Piedmont flood, and concluded that the contribution of evaporated moisture in the Mediterranean was lower than presumed, at around 20% of the total. Duffourg and Ducrocq (2011) studied the moisture origin and pathways in ten HPEs that took place during the autumn of years 2008 and 2009 in the French Mediterranean region. They also used a water vapour back-trajectory technique, in this case coupled to the Meso-NH atmospheric model (i.e., on-line), concluding that when anticyclonic conditions are dominant during the 3 or 4 days prior to the HPE, the contribution of the moisture from the Mediterranean Sea is clearly dominant, whereas when cyclonic conditions prevail, remote moisture sources have a major role. Pinto et al. (2013), combining a qualitative with a backward trajectory analysis, studied a large number of events (classified in six clusters) ocurred in Northwestern Italy betwen 1938 and 2002, and found that the North Atlantic is a relevant moisture source for precipitation, particularly important in the extraordinary cases. More recently, Krichak et al. (2015) applied a similar method for more than 50 intense cool season HPEs recorded in different parts of the Mediterranean region from 1962 to 2007. Their results highlighted the outstanding role played by tropical moisture reaching the Mediterranean from the Atlantic Ocean and the Arabian Sea. All these studies agree on the importance of the moisture contribution from remote sources, thus supporting our starting hypothesis that a very large moisture supply from regions outside the Mediterranean is often the key factor in these types of episodes. However, practically all of these studies were carried out with Lagrangian models, based on the spatiotemporal tracking of individual fluid particles. This method, despite being very useful for its low computational cost and easy handling, presents a series of simplifications that can introduce important inaccuracies in the calculations, such as errors in particle trajectories (Stohl, 1998) or limitations in the separation between evaporation and precipitation (Stohl and James, 2004). Therefore, further work is needed in this line of research in order to obtain a more complete knowledge about the moisture sources for these extreme rains.”