The Importance of Atmospheric Rivers in the development of Explosive Cyclogenesis.

Jorge Eiras-Barca[1], Alexandre M. Ramos[2] Margarida L.R. Liberato[3],
Gonzalo Miguez-Macho[1], Ricardo M. Trigo[2], Daniel Garabo-Paz[1] and Joaquim G. Pinto[4,5]

[1]Non-Linear Physics Group, Universidad de Santiago de Compostela, Spain.
[2]Instituto Dom Luiz, Facultade de Ciências, Universidade de Lisboa, Portugal.
[3]Escola de Ciências e Tecnologia, Universidade de Trás-os-Montes e Alto Douro, Vila Real, Portugal.
[4]Department of Meteorology, University of Reading, UK.
[5]Institute for Geophysics and Meteorology, University of Cologne, Germany

Extratropical cyclones and particularly explosive cyclogenesis are one of the major natural hazards in mid-latitudes and are responsible for socioeconomic impacts. Explosive cyclogenesis result from different mechanisms that includes upperlevel cyclonic vorticity advection, low-level warm air advection, and latent heat release. Several studies confirm the occurrence of a maximum of latent and sensible heat availability in the lower troposphere, near the warm sector, supporting the contribution of moist diabatic processes, such as latent heat release by cloud condensation processes, results in the intensification of extratropical cyclones.Cyclones with deepening rates of at least $(24 \cdot \sin\varphi/\sin(60^\circ))$ hPa in 24 hours, where φ represents latitude in degrees of the cyclone center position, are referenced in the literature as explosive cyclogenesis / developments or simply as “bombs”.

ARs are identified as narrow plumes of enhanced moisture transport that are usually present in the core section of the broader warm conveyor belt occurring over the oceans along the warm sector of extra-tropical cyclones. They are usually W-E oriented steered by pre-frontal low level jets along the trailing cold front and subsequently feed the precipitation in the extra-tropical cyclones. The large amount of water vapor that is usually transported in ARs can lead to heavy precipitation and also to latent heat release along its path [1,2,3,4]. The main objective of this work is to analyze systematically the importance of the ARs on the development of extratropical cyclones, with special emphasis on the explosive cyclogenesis. The two different databases (explosive cyclogenesis and ARs) are analyzed simultaneously in order to study the importance of the ARs in the different stages of the explosive cyclogenesis in the North Atlantic and North Pacific basins. Results confirm the link between these two phenomena, with no significant differences between both regions.

[1] Ferreira et al. (2016). On the relationship between atmospheric water vapour transport and extratropical cyclones development.

[2] Trigo (2006). Climatology and interannual variability of storm-tracks in the Euro-Atlantic sector: a comparison between ERA-40 and NCEP/NCAR reanalyses.

[3] Eiras-Barca et al. (2016). Seasonal Variations in North Atlantic atmopsheric river activity and its association with anomalous precipitation over the Iberian Atlantic Margin.

[4] Guan et al. (2015). Detection of Atmospheric Rivers: Evalueation and application of an algorithm for global studies.

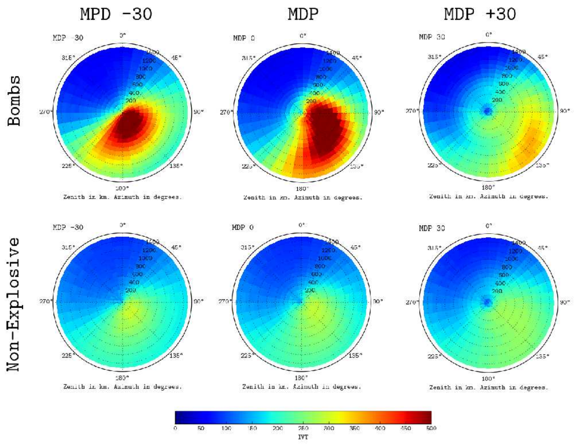

Figure 1: Integrated Vapor Transport (IVT) composites surrounding the cyclone center in a 24h time-frame from the Maximum Deepening Point (MDP), for the North Atlantic basin.

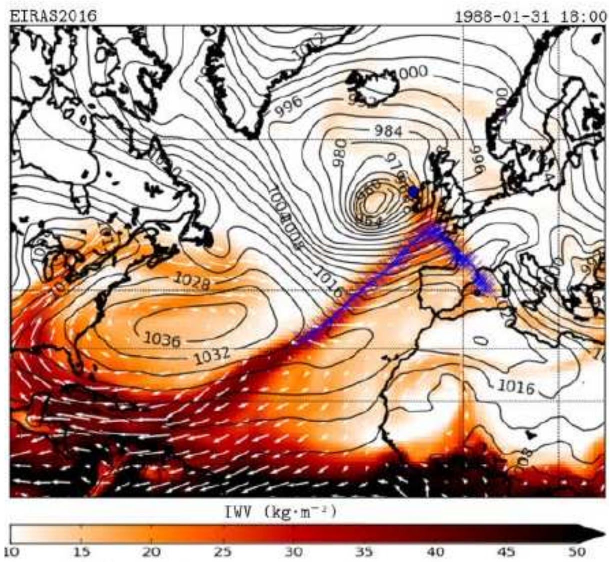

Figure 2: Example of interaction between a very well defined AR and an EC. Blue crosses identify the central axis of the Atmospheric River detected by the EIRAS2016 algorithm.