Title: A potential-vorticity perspective on the motion of mid-latitude surface cyclones: theory and real case studies

Authors: **G. Rivière (1),** J.-B. Gilet, L. Oruba, P. Arbogast, G. Lapeyre, K. Maynard

(1) CNRM/GAME, CNRS and Météo-France, Toulouse, France
(gwendal.riviere@meteo.fr / Fax : 33 561078453 / Phone : 33 561079870)

Mid-latitude surface cyclones are commonly observed to move across the mean flow from the equator to the pole. Some of them undergo a strong and rapid deepening when they cross the axis of the low-frequency jet stream that may lead to damaging winter storms.

The purpose of the present study is first to describe a recent theory that may explain this cross-jet motion which is a generalization of the so-called beta drift in the mid-latitude baroclinic context. According to this theory, the key parameter controlling the movement of a surface cyclone across the mean tropospheric jet is the vertical-average potential vorticity (PV) gradient associated with the jet. The basic mechanisms will be presented within the framework of the two-layer quasi-geostrophic model.

The second part of the study consists in validating this theoretical result by analyzing the real case of the European storm Xynthia (26–28 February 2010). To do so, numerical sensitivity experiments using the Météo-France global operational forecast model ARPEGE-IFS were performed. The control forecast, starting from the operational analysis almost 2 days before the storm hit France, represents the trajectory of the storm quite well, together with the deepening during the crossing of the low-frequency upper-level jet axis. A PV-inversion tool is used to modify the vertical-average PV gradient at the initial time. As expected from the theory, when the PV gradient is intensified, there is a quicker displacement of the surface cyclone toward the jet axis and the jet-crossing phase occurs earlier than in the control forecast. The opposite occurs for a reduced PV gradient. A dynamical interpretation in terms of PV anomalies generated by Rossby wave radiation is provided in accordance with the above theoretical results.