The unusual merging of the Atlantic and African jet during winter 2009-10

Harnik, N., E. Galanti, O. Martius, and O. Adam, 2014. The anomalous merging of the African and North Atlantic jet streams during Northern Hemisphere winter of 2010. J. Clim. 27, 7319–7334.

The Atlantic and Pacific zonal jet streams differ in character. While the Atlantic jet meanders daily and interannually and is dominanatly eddy-driven, the Pacific jet is relatively fixed at a latitude of around 35N, and is driven both by eddies and thermal forcing from the tropics (Eichelberger and Hartmann, 2007; Li and Wettstein, 2012). In terms of the modified QG model regimes, the Atlantic jet is *an eddy driven jet*, while the Pacific jet is *a merged jet*. The reason we do not categorize the Pacific jet as *a subtropical jet* is that it lies in the middle of the Ferrel cell, and not at the subtropical edge of the Hadley cell (the African-Asian jet, all the way to the Eastern coast of Asia is *a subtropical jet*), as can be seen in the figure below:

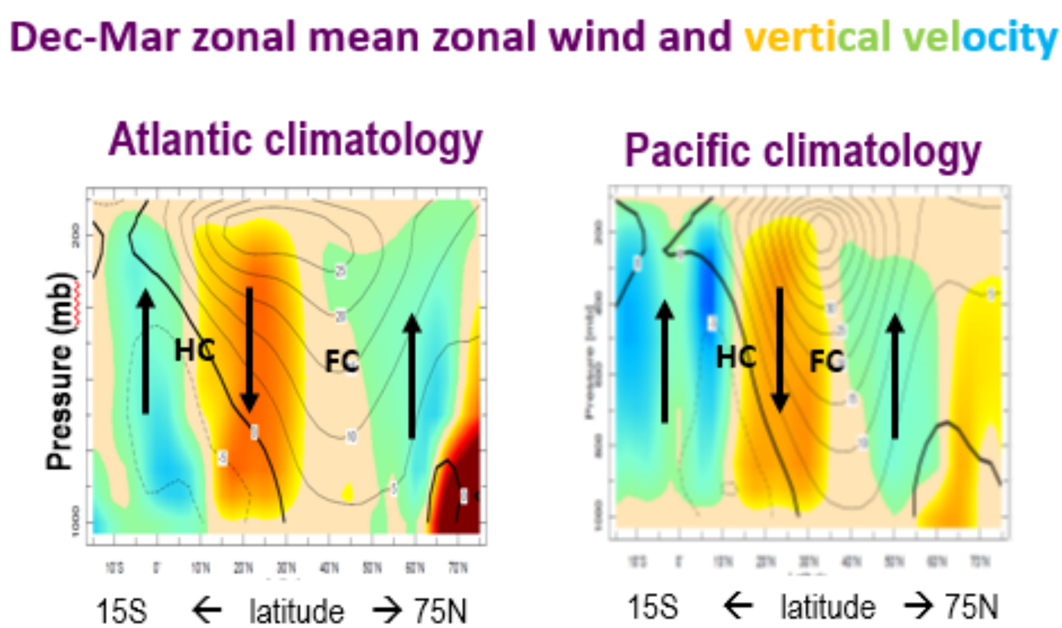

Figure 1: The climatological Dec-Mar mean zonal wind (contours) and vertical velocity (colors) zonally averaged over the Atlantic (left) and Pacific (middle) sectors. The Hadley and Ferrel cells are marked by the letters HC and FC respectively.

The North Atlantic jet stream during winter 2010 was unusually zonal, so that the typically separated Atlantic and African jets were merged into one zonal jet. The latitude-height structure and temporal variability of the North Atlantic jet during this winter were more characteristic of the North Pacific. The above observations suggest that during winter 2009-10, the Atlantic jet underwent a regime change from *an eddy driven jet* to *a merged jet*.

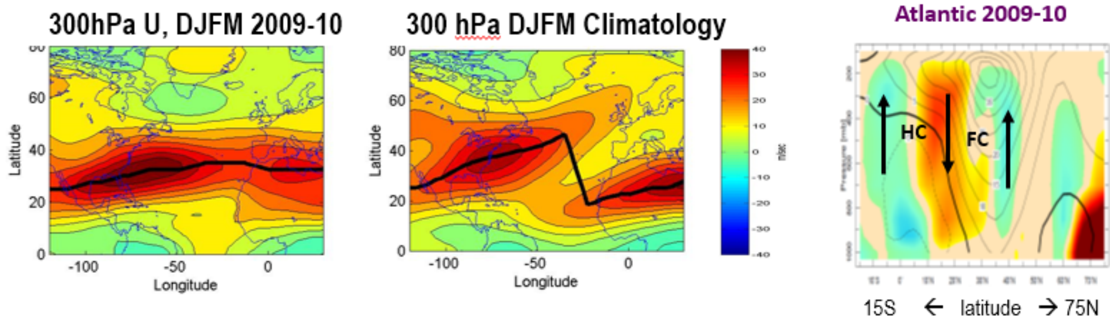

Figure 2: Dec-Mar mean zonal wind at 300hPa over the North Atlantic region. Left- during winter 2010. Middle- Dec-Mar Climatology. Right - the zonal wind (contours) and vertical velocity (colors) zonally averaged over the Atlantic during winter 2009-10.

[Harnik et al (2014)](#) examines this possibility of a regime transition by defining a Zonal Jet Index – ZJI – based on the zonality of the jet axis (the thick black lines in the left and middle plots of Figure 2 above). When the Atlantic and African jets are merged, this line is anomalously zonal, and the ZJI is anomalously negative. The monthly ZJI values are shown in Figure 3 below, with anomalously negative ZJI Dec-Mar months marked by a solid black circle. We see that an anomalously zonal jet state occurred in the past, but the winter of 2009-10 was unusually persistent. Similar persistently zonal winters have occurred in the past at the end of the 1960s.

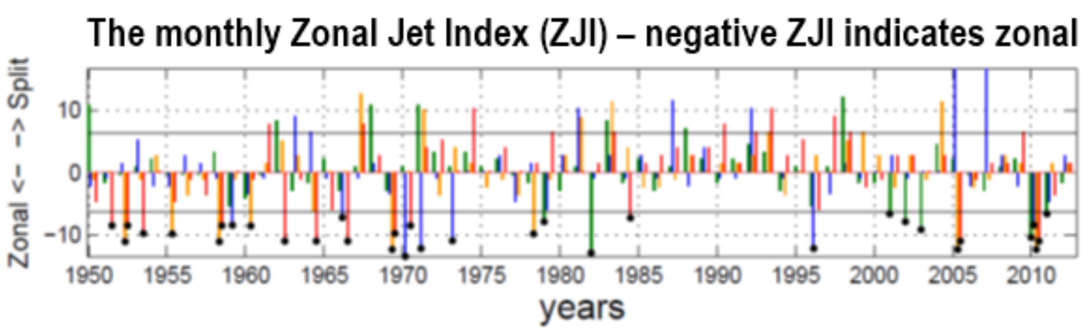

Figure 3: The monthly Zonal Jet Index (ZJI), the with those Dec-Mar months with a ZJI less than minus one standard deviation marked by a solid black circle.

Harnik et al (2014) then examine the characteristics of anomalously zonal jet months using composite analysis. Consistent with the results of the MQG model, the eddy fluxes during the years with a merged jet were anomalously weak. In addition, diabatic heating in the tropical Pacific was unusually strong. This combination of weak eddies in the North Atlantic and strong tropical Pacific heating, act to push the jet towards a merged eddy/thermally-driven state. We also find significant SST anomalies in the North Atlantic, which reinforce the anomalous zonal winds, in particular in the Eastern Atlantic. **This suggests the following picture: while NAO variability during most years is a manifestation of the meandering of an eddy driven jet, a small fraction of the most negative NAO years are a regime transition to a merged jet state.**