Possible semi-circumglobal teleconnection along polar front jet over the Northern Hemisphere driven by deep convection over the Sahel

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The Sahel region, located between the tropical rainforests of Africa and the Sahara Desert, has rainfall that varies widely from year to year, associated with extremely deep convection. This deep convection, strongly heated by water vapor condensation, suggests the possibility of exerting a remote influence on mid- and high-latitude extreme weather similar to the well-known influences of tropical oceanic convective clouds on global climate. Here we investigate the possibility that deep convection over the Sahel initiates a semi-circumglobal teleconnection extending to eastern Eurasia.

We performed a linear regression analysis of large-scale atmospheric fields with the Sahelian Outgoing Longwave Radiation (OLR) index in September of each year from 1979 to 2016. That suggested the interannual variability of the Sahelian convection drives a semi-circumglobal teleconnection across Eurasia (Fig. 1). In addition, numerical experiments supported the possible existence of this teleconnection.

We propose that the anomalous heat source due to deep convection over the Sahel in the late monsoon season influences meandering of the mid-latitude jet stream over Europe through the combination of a Matsuno-Gill response (Matsuno 1966; Gill 1980) and advection of absolute vorticity (e.g., Sardeshmukh and Hoskins 1988). This European jet meander may in turn drive an eastward propagation of a Rossby wave across Eurasia as far as East Asia. Thus, the teleconnection might rely on a causal link between two atmospheric waves, one a wave from the subtropics to mid-latitudes, the other a Rossby wave propagation along the polar front jet.

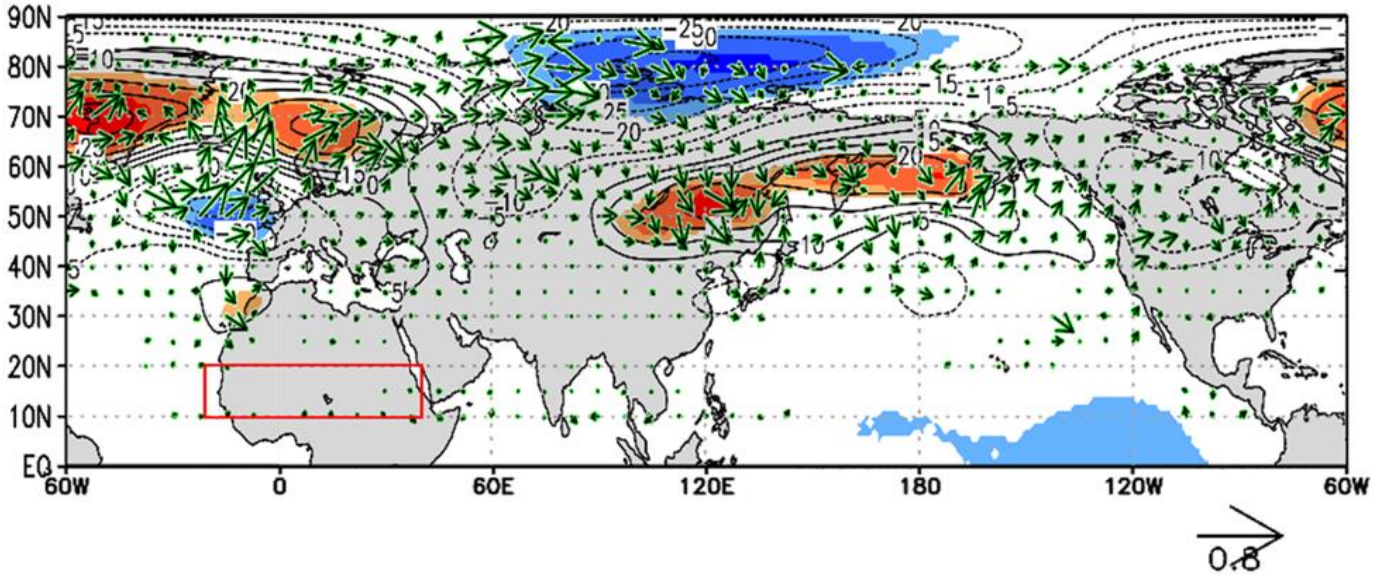

Figure 1. Northern hemisphere map showing contours of anomalies in geopotential height at 300 hPa (m) regressed against the Sahelian OLR index in September, when convective cloud activity over the Sahel is especially strong. Color shading indicates regions where values satisfy less than 10% 5%, and 1% levels of statistical significance by t-test. Vectors indicate wave activity flux ($m^2\ s^{-2}$; Takaya and Nakamura 2001). The red rectangle outlines the area where the Sahel OLR index is calculated.

References

Gill A., Some simple solutions for heat-induced tropical circulation. *Q J R Meteorol Soc*, **106**, 447-462, 1980.

Matsuno T., Quasi-Geostrophic Motions in the Equatorial Area. *J Meteorol Soc Japan Ser II*, **44**, 25–43, 1966.

Sardeshmukh P. D., Hoskins B. J., The Generation of Global Rotational Flow by Steady Idealized Tropical Divergence. *J Atmos Sci*, ***45***, 1228–1251, 1988.

Takaya K., Nakamura H., A formulation of a phase-independent wave-activity flux for stationary and migratory quasigeostrophic eddies on a zonally varying basic flow. *J Atmos Sci*, **58**, 608–627, 2001.