



## Extratropical Influence of Upper Tropospheric Equatorial Zonal Wind

Gereon Gollan and Richard J. Greatbatch

GEOMAR, Helmholtz-Zentrum für Ozeanforschung, Kiel, Theorie und Modellierung, Kiel, Germany (ggollan@geomar.de)

Variations in the global tropospheric zonal mean zonal wind ( $[U]$ ) during boreal winter are investigated using Rotated Empirical Orthogonal Functions applied to monthly means. The first two modes correspond to the Northern and Southern Annular Mode and modes 3 and 4 represent variability in the tropics. One is related to El Niño Southern Oscillation and the other has variability that is highly correlated with the time series of  $[U]$  at 150 hPa between  $5^{\circ}\text{N}$  and  $5^{\circ}\text{S}$  ( $[U_{150}]\text{e}$ ) and is related to activity of the Madden-Julian Oscillation (MJO). High amplitude of the MJO with strong precipitation anomalies over the western tropical Pacific (late MJO phases) are associated with the westerly phase of  $[U_{150}]\text{e}$  (and vice versa). The extratropical response to  $[U_{150}]\text{e}$  is investigated using linear regressions of 500 hPa geopotential height onto the  $[U_{150}]\text{e}$  time series. Use is made of reanalysis data and of the ensemble mean output from a relaxation experiment using the European Center for Medium Range Weather Forecasts (ECMWF) model in which the tropical atmosphere is relaxed towards reanalysis data. Both the 45-year ECMWF reanalysis (ERA-40) and the ERA-Interim reanalysis data sets are used for the relaxation experiment as well as for the regression analysis. Therefore the analysis is covering 52 boreal winters from 1960/61 to 2012/13. The regression analysis reveals a robust shift of the Aleutian low and a wave train across the North Atlantic associated with  $[U_{150}]\text{e}$ . It is found that the subtropical Rossby waveguides and the link between the North Pacific and North Atlantic are stronger during the easterly phase of  $[U_{150}]\text{e}$ . The wave train over the North Atlantic is associated with Rossby wave sources over the subtropical North Pacific and North America. Finally, it is shown that a linear combination of both  $[U_{150}]\text{e}$  and the Quasi Biennial Oscillation in the lower stratosphere can explain a substantial fraction of the circulation anomalies of the anomalously cold European winter of 1962/63 when both were in an extreme easterly phase.