Mixing and the potential vorticity structure of the quasi-biennial oscillation

B. H. BURGESS[1], L. A. HATFIELD[1], and R. K. SCOTT[1]

[1] *University of St Andrews, St Andrews, United Kingdom*

We study the potential vorticity (PV) structure of the quasi-biennial oscillation (QBO), with applications to mixing out of the tropical pipe and dynamical coupling between the QBO and the polar vortex. Our focus is on observational data, and we use PV fields from the ERA-Interim reanalyses encompassing the time frame 1979-2015. Potential vorticity provides a natural framework within which to study mixing because strong PV gradients form at the edges of critical layers and act as barriers to mixing and transport. We consider two main questions that can be illuminated by the structure of the PV fields; firstly, we study the dynamical coupling between the QBO and the polar vortex. In particular, we develop an alternative account of the Holton-Tan effect in terms of the PV structure. Secondly, we study how the 'leakiness' of the tropical pipe is conditioned by the phase of the QBO. Mixing in the stratosphere is highly localised within the surf zone, but with strong vertical variations at the subtropical edge: on vertical levels where the QBO winds are westerly, mixing may extend deep into the tropics (Dunkerton & O'Sullivan 1996), while on levels where the QBO winds are easterly, mixing is more confined to the extratropics. To gain more insight into the vertical structure of mixing, we study the influence of the QBO phase on the height-latitude structure of the PV field in the vicinity of the equator. Analysis of the ERA-interim data indicates that the meridional PV structure differs significantly between the two phases of the QBO: in the easterly phase there are sharp PV gradients at the equator around 70 hPa and 10 hPa, with strong gradients at 20N and 20S on intermediate levels. In the westerly phase, sharp PV gradients at the equator extend up to 20 hPa, with strong PV gradients in the northern hemisphere subtropics. Preliminary modelling suggests that mixing out of the tropical pipe is inhibited on levels where the QBO winds are easterly, so that on these levels the tropical pipe is well-defined and protected from mixing. On levels where the QBO is westerly, mixing occurs over a broad critical layer between the polar vortex edge and the equator. The degree to which the tropical pipe is 'leaky' thus has strong vertical dependence, which is correlated with the phase of the QBO.

Key words: QBO, PV, tropical pipe, polar vortex

References:

Dunkerton, T. J., and D. J. O'Sullivan, 1996: *GRL*, **23**, 2497-2500.