



Can topographic blocking be diagnosed using deformation?

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Mountain ranges, such as the Rocky Mountains, the Himalayas, the Andes as well as Greenland's ice sheet, contribute significantly to the observed asymmetry of the atmospheric general circulation between the two hemispheres. The linear effect of topography on the mean circulation is relatively well understood whereas our understanding of the non-linear impact is still incomplete. This study focuses on topographic blocking, an effect that is not included in linear theories. As a first step, the relative importance of blocking compared to the linear and other non-linear effects is examined for some major mountain ranges.

There are several possible diagnostics to assess the relative importance of blocking, e.g. the Froude number. The Froude number suggests the existence of a critical layer that separates the blocked from the non-blocked flow regime. Below that layer the flow is primarily deflected around the mountain, whereas the flow is primarily directed over the mountain above. These diagnostics are, however, indirect in the sense, that they rely on additional parameters to those of the flow itself to infer blocking. Typically, information such as temperature stratification is used for these diagnostics. Furthermore, it is assumed that the mountain is embedded in an otherwise homogeneous flow by using parameters of the upstream flow. Those parameters are hard to determine because of the heterogeneity of the approaching flow.

In order to avoid the ambiguity in the choice of those parameters, we construct a new diagnostic for blocking, relying only on the flow field itself. The new diagnostic is based on the deformation of the flow field, as the flow field of pure (stretching) deformation is similar to the expected diffluent/confluent flow upwind/downwind of the mountain in the blocked regime. We present a climatology of deformation around major mountain ranges based on the ERA Interim reanalysis from 1979–2010. In the climatology, we put special emphasis on the determination of a critical layer, that separates the blocked from the non-blocked flow regime. The hypothesised relation of deformation to blocking is analysed, and we discuss to which extent deformation is a suitable indicator of blocking.