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Confinement of air in the Asian monsoon anticyclone and pathways of convective air to the stratosphere during summer season

Bernard Legras[1], Silvia Bucci[1], Sivan Chandra[2], and Ajil Kottayil[2]
[1]CNRS / Ecole Normale Supérieure, Laboratoire de Météorologie Dynamique, Paris, France (legras@lmd.ens.fr)
[2]ACARR / Cochin University of Science and Technology, Kochi, India

We study the confinement of the air inside the Asian monsoon anticyclone during summer using both kinematic and diabatic Lagrangian trajectories with ERA5 and ERA-Interim reanalysis, and observed clouds. The improved consistency of ERA5 is demonstrated. It is shown that the escape time from the anticyclone estimated to be 13 days is of the same order as the circulation time which implies weak confinement. Parcels found inside the anticyclone have been mostly detrained by convection above θ =364 K, by about 2.6% of the high clouds over Asia, with a prevalence of continental sources which are located beneath. The Tibetan plateau is found to be the most efficient provider with 10% of its high clouds but this is entirely due to the higher level of cloud tops in this region, and not to any preferred path above. Actually, most parcels escape the plateau to rise. The mean trapping is shown to be described by a 1D model that combines a simple mean ascent and a constant erosion loss, without any need of a “chimney effect”. The vertical dilution is exponential with a e-folding scale of 15 K in potential temperature from 370 K onward. The mean age of parcels with respect to convection exhibits a minimum at the centre of the Asian monsoon anticyclone due to the permanent renewal by fresh convective air and largest values on the periphery as air spirals out.

The variability of the the confinement is strongly linked with the oscillations of the anticyclone between its Tibetan mode and its Iranian mode, and to break and active periods of monsoon rain. We show that this variability modulates also the moisture in the lower stratosphere with wet events following active convection and dry events following the breaks.