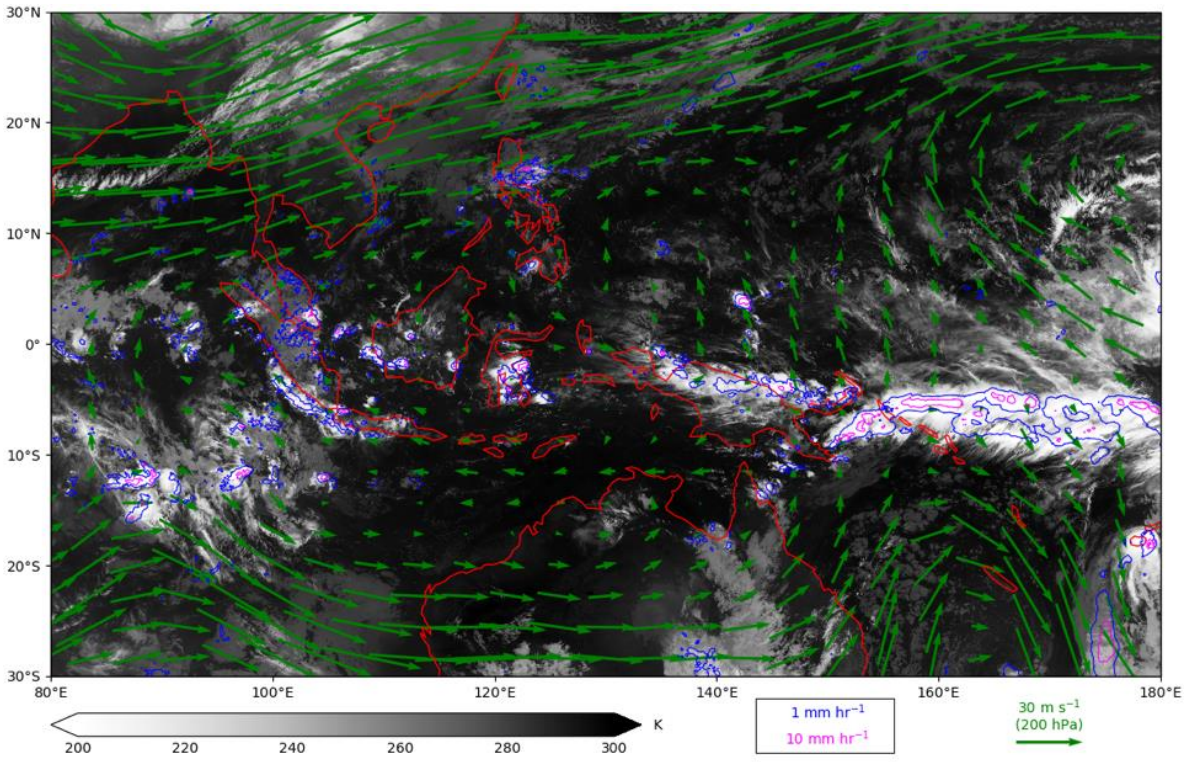
Local Hadley and Walker circulations

Juliane Schwendike (Institute for Atmospheric and Climate Science, University of Leeds)

Abstract

Conceptually, it is useful to partition the three-dimensional tropical circulation into meridional and zonal components, namely, the Hadley and Walker circulations. The averaging involved in their definitions can introduce ambiguities. These problems can be circumvented by first partitioning the total vertical mass flux into components associated with overturning in the meridional and zonal directions, respectively, called here the local Hadley and local Walker circulations. Defining the local Hadley and local Walker circulations this way ensures the pair of two-dimensional overturning circulations can be added to give the original three-dimensional circulation, even when the averages are taken over limited domains.

This presentation investigates: (i) how the local meridional (Hadley) and zonal (Walker) circulations change during ENSO, (ii) in each phase of the Madden-Julian Oscillation (MJO); and the effect of the propagation of the envelope of enhanced and suppressed convection on the poleward extent of the local Hadley circulations and, thus, the strengths and positions of the midlatitude jets. We examine these effects in the ERA-Interim reanalysis data by objectively decomposing the three-dimensional vertical mass flux into a zonal and meridional component, which allows us to investigate regional overturning circulations.



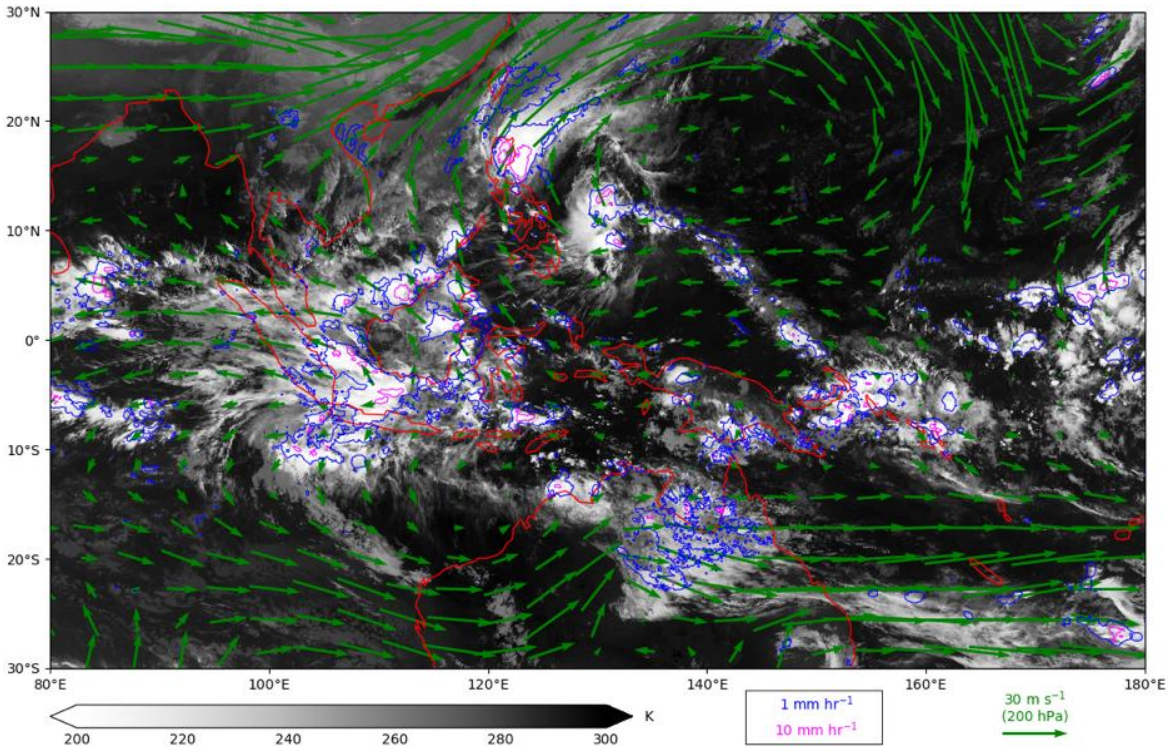


Figure 1: Brightness temperature (Tb, shading) from Himawari's channel 13 (10.4 microns), precipitation (contours) from IMERG, and horizontal wind at 200 hPa (arrows) from ERAI are shown for (a) 16 December 2015 (MJO phase 4) and (b) 31 December 2015 (MJO phase 7) for 19:00 UTC (~03:00 LT). Image courtesy: Simon Peatman.