Geophysical Research Abstracts
Vol. 13, EGU2011-868, 2011
EGU General Assembly 2011

Aerial Rivers, Subtropical Rainfall and soil Evaporation

Josefina Arraut (1), Carlos Nobre (1), Henrique Barbosa (2), and Jose Marengo (1)

(1) Center for Earth System Sciences, National Institute for Space Research (Brazil) (josefina.arraut@cptec.inpe.br), (2) Physics Institute, University of Sao Paulo

We studied the main pathways of moisture transport to high rainfall regions in the South American subtropics throughout the year, considering the contributions they receive from soil evaporation. We use 22 years of data: specific humidity and wind from the ERA-40 reanalysis and GPCP monthly rainfall. We call all important pathways of moisture flow aerial rivers, because a symmetry can be established with the surface ones: aerial rivers lose water through precipitation and gain through evaporation, while the opposite takes place with surface ones. Furthermore precipitable water is the analogue of the height of a column of liquid, it too can be multiplied by an equivalent column speed to give the column discharge. We recall the equality P-E = $-\nabla$(QV), where P is precipitation, E is evaporation, $-\nabla$(QV) is the two dimensional divergence of the vertically integrated moisture transport (henceforth called divergence) and the variation in time in precipitable water is disregarded as small for our time scales of over a month. The divergence field could in principle be used to determine where the aerial rivers lose or gain water. However, it is considered of low reliability because large cancelation between the two horizontal derivatives can result in a large relative magnitude of the error. We assume that the intense precipitation maxima over the continent, which feed the important river basins with their excess rainfall, coincide to good approximation with the maxima of moisture transport convergence. We then use the long term mean monthly precipitation fields to divide the year according to the position of these maxima in the subtropics and determine the main pathways of moisture flow towards them, which we call seasonal aerial rivers. Four seasons are found: November to March (wet), April to June (cool transition), July to August (dry), and September to October (warm transition). Except for transport directly from the tropical Atlantic to the subtropical portion of the South Atlantic Convergence Zone in the wet season, a north to northwesterly flow close to the eastern flanks of the Andes is the main provider of moisture to the continent's subtropics all year round. In the wet season a continuous pathway can be traced all the way from the tropical Atlantic and over Amazonia to the subtropics. In the other seasons, particularly in the cool transition and dry ones, the contribution from Amazonia is much smaller. We also compare the precipitation maxima to those of moisture transport convergence as a simple means of validation of this last field. The dry and cool transition seasons bear the comparison satisfactorily. We then use the divergence to determine where the atmosphere, and particularly the aerial river, is moistened by evaporation. In the dry season most of southern hemisphere Amazonia shows a net release of water into the atmosphere. Along the aerial river east of the Andes there is net evaporation in both seasons, particularly the dry one. We quantified all contributions to the aerial river in this season: flow from Amazonia, predominantly zonal flow from the Atlantic and net evaporation as a residue, for each of the 44 months in the 22 seasons considered. The two flow contributions are largest and that from Amazonia shows the biggest spread, being most important for the variability in the total discharge. Contribution from net evaporation is 26% on the long term average, an important fraction, it is all due to an increase in specific humidity. In other words moister (and more unstable) air, not more air, is delivered to the high rainfall region. A comparison with other evaporation estimates would be very useful.