Ground based and TRMM precipitation radar profiles comparison in West Africa

Matias Alcoba, Marielle Gosset
Laboratoire Géosciences environnement,
GET OMP, 14 av Ed Belin 31500 Toulouse

Xport stratiform/convective profile classification

The physics in a MCS is very rich and complex but we can mainly separate this into two regions where the processes will be strongly different. The convective region of a squall line is visible in general at the front of the line. In this region the vertical fluxes are strong, the air from the column is mixed, and the physical properties are mainly constant with height. To detect this region in the radar images we made an algorithm based on Steiner et al. 1995. The criteria to distinguish convective regions from other regions are based on the horizontal variability of reactivity and the peak of 2° due to very intense rains associated to convective regions. The main problem that we encounter in the implementation of this algorithm for tropical rain is that in the stratiform area behind the convective front, we can have peaks of very strong rain that make the classification ambiguous. The image on the left shows this problem (yellow part surrounded by green). The solution we chose was to take the reflectivity above the melting layer. Due to the vertical fluxes, we can see “cell” convective cells in high levels of the atmosphere, as we see in the figure in the top left, representing the 2 in the S-52km. The convective cells are yellow-red, in the front of the system.

Analysis of the reflectivity profiles

As convective regions involves vertical air movements, the stratiform regions are characterized by stratifications of the atmospheric layers. The hydrometeor physics change with the height. The main characteristics of these regions is the presence on a bright band of reflectivity (BB) under the freezing level (FTC contour). A parallel classification was made to detect stratiform pixels following Sanchez-Ozorna 2000 algorithm. The main criterion is the detection of the BB peak restricted in altitude.

The main problem of this method is the sampling of the radar which skip sometimes the height of the BB, and the more distant are important, the more the reflectivity is smooth due to the increasing vertical averaging.

So the detection of BB is limited to a 70 km area around the radar, as we see in the figure in the left, cyan squares represent pixels with BB.

To extend the classification in the whole area we compare each profile to the average stratiform profile detected thanks to Nash index, and we make a choice. (see in Chapron, 2008)

In the figure in the left present the last step of the stratiform classification. Green zones are classified as stratiform, blue as no classified.

Preliminary comparisons of Ground based and TRMM profiles of precipitation, in Niger, have been presented. The work is now being extended with the aim to provide a compared climatology of profiles, in the Convective and stratiform part of African MCS. Xport is a transportable A-band dual polarimetric radar developed by IRD for field experiments in tropical hydro-meteorology. We carried out the analysis with figure radar data from August 2010. During this period the radar was located in Niamey, Niger (12.17°N, 2.28°E) as part of the Megha-Tropiques microphysics validation campaign. The data used for the comparison of the profiles is calibrated and attenuation corrected. We mainly use the rain events of 6, 7, 10, 13, 17, 18, 22, 26 and 30/08/2010, when an instrumental aircraft was flying in the MCS. The figure on the left shows the reflectivity Z in dBZ of the 0°C layer altitude during the passage of a MS over the radar, the data has been interpolated in a grid of 1km horizontal resolution and 50m vertical resolution.

Comparison

Here we present the results for the comparison of the systems 22/08 (left) and 07,10 and 26/08 (down). TRMM data is plotted in dotted line and Xport in solid line. Blue lines represents quartiles 75% of the profile distribution, red line 25%, and in violet the median. TRMM profiles comes from the average of eleven PR of the radar, with elevation ranges from 1.1 to 40°. The period of analysis was chosen to have a good visibility of the MCS over the radar (averaging classificaion of 2°CV in T61M PART). The range is restricted to 70 km to keep a good enough vertical resolution. TRMM profile correspond to the average of the rain type in the whole system for the considered snapshot. The left figure presents the convective (right) and stratiform profile distribution for both. Concerning the convection it seems that the reflectivity is underestimated for the TRMM radar in the ice layer (S-6km).

We used TRMM PR reflectivity product 2A25 under the satellite track to compare with Xport profiles. We separate convective and stratiform profiles thanks to 2A23 product which gives a classification of rain type. The sampling of the satellite during August do not match exactly with the passage of the systems above the radar. Some systems are sampled before or after their passage through the satellite window (in red in the upper figure). Four orbits were used to compare with the radar events of 07/08, 10/08, 22/08 and 26/08.

The figure above in the left presents a view of the Sahel region with the reflectivity of 2A25 product under the track, and the left figure presents a zoom centered in the system and in the radar window we present the same system five minutes later seen by the radar.

The figure below presents a composite of a vertical section of the reflectivity for satellite (left) and radar (right). We see in the left part of the figure the convective cells rising through the atmosphere. We also can see the BB at 4.5 km, more visible for the radar

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