Rainfall fields estimation by data fusion based on a variational 4DVAR assimilation technic of rain gauges and microwave links

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Rainfall is a complex process which is highly variable both in time and space. Accurate measurement at small scale of rain fields is an important task for the study of the water cycle, and it is also a major element of the physics of climate. Rain gauges networks are usually used to estimate rain fields, however due to the necessary limited number of rain gauges they cannot catch all the variability of the rain field. Consequently, kriging methods generally used to build the rainfall fields from rain gauges networks, produces too smoothed fields and tend to underestimate high rain rates. This is particularly damageable for hydrologic studies and it is problematic for accurate calibration of devices embedded onboard satellites dedicated to rainfall observation.

The method proposed here to retrieve rainfall fields uses two types of observation: a classical rain gauge network and commercial Satellite to Earth microwave links. The later allow to estimate rain integrated attenuation along links of 5-6 km long at high temporal resolution (10 second in our case). These links give some additional information about the precipitations over the whole area and not only on a limited number of points. The fusion of these two kinds of data is made by a 4D-Var assimilation method using a simple advection numerical scheme. The first part will present results obtained from the assimilation of attenuations observations collected during HYMEX campaign. The second part will compare on synthetic rain maps the retrieved fields obtained when only rain gauges are used and when the fusion algorithm is used.

With a 100km² simulated field with rainfalls from 0 to 85mm/h and with a 8 rain gauges network randomly placed around the microwave links, we get, by running the assimilation model only with the rain gauges, only around 40% of the real total rainfall over the area (because some extreme parts of the event are not seen by the rain gauges), while we get around 98% of the total rainfall by using both the rain gauges and the microwaves links. Moreover, by using both the microwaves links and the rain gauges, the maximum value of the rebuilt field is equal to 90% of the real maximum value, while it is only equal to 85% when only the microwaves links are used.