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

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Abstract

Rainfall is a complex process which is highly variable both in time and space. Rain field accurate measurement at small scale is an important task for the study of the water cycle. 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 necessarily limited number of rain gauges, all the variability of the rain field cannot be accounted for. Consequently, kriging methods, generally used to build the rainfall fields from rain gauges networks, produce too smoothed fields and tend to underestimate high rain rates. This is particularly damageable for hydrologic studies. Concerning the calibration of rainfall observation satellites with on-board embedded devices, it has a crucial impact on the accuracy of the sensor.

We propose a method to retrieve rainfall fields using two types of observations: a classical rain gauge network and a set of Satellite to Earth commercial microwave links. The later allows estimating integrated rain attenuation along 5-6 km long links with a high temporal resolution (10 seconds in our case). These links give some additional information on the precipitations over the whole area and not only on a limited number of points. These two kinds of data are merged with 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 focus on synthetic rain maps. The impact of the fusion algorithm is assessed through the comparison of its results with rain fields retrieving from rain gauges alone.

To test our algorithm we spread, randomly, 8 rain gauges around a set of microwave links to cover a 100km2 simulated rain field with rain rates from 0 to 85mm/h. By running the assimilation model with the rain gauges alone, only around 40% of the total rainfall is retrieved over the area (mainly because some extreme events are not seen by the rain gauge network). When using both, the rain gauges and the microwaves links, we get around 98% of the total rainfall. Moreover, it also allows rebuilding a field whose maximum is equal to 90% of the original (expected) maximum. When using only the microwaves links only 85% of the maximum value is restored.

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