



# Ground validation of instantaneous satellite rainfall estimates

## Combination of a dynamical interpolation technique with geostatistical simulations to generate an ensemble of reference high resolution rain fields in West Africa.

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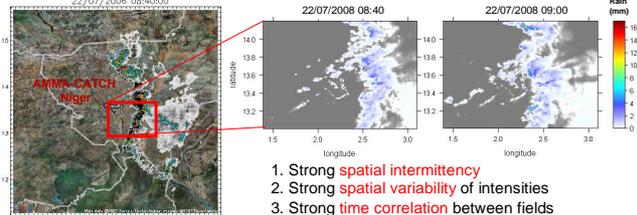
### INTRODUCTION

#### CONTEXT

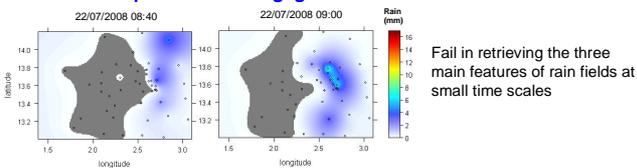
Evaluating the reliability of instantaneous rain rate satellite estimates at ground level for the Megha-Tropiques satellite mission.

#### ISSUE: Limitation of classical interpolation techniques

A typical Mesoscale Convective System (MCS) over the Sahel (viewed by radar)



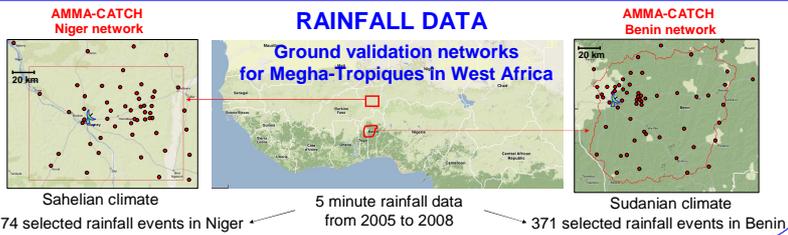
#### Classical interpolation of rain gage measurements at small time scales



#### OBJECTIVE

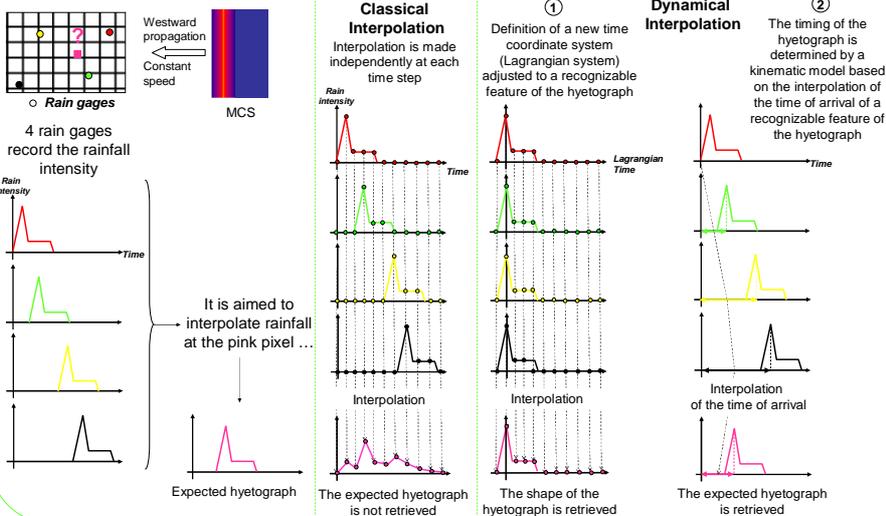
Creating **ground reference high resolution rain fields** (5 min/1km resolution) by combining:

- Dynamical interpolation** technique used to model the spatial variability and the intermittency of the rain rates as well as the space-time correlation between rain fields, by taking into account the kinematic of the rainy systems.
- Geostatistical simulations** used to generate an ensemble of high resolution rain fields by taking into account the uncertainty of interpolation.



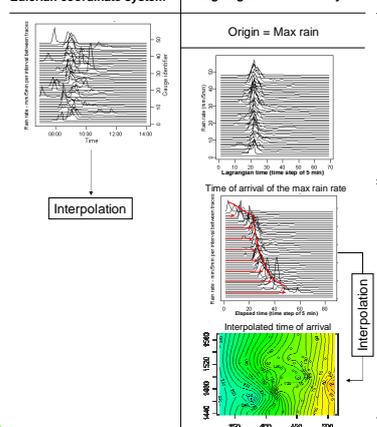
### CLASSICAL VS DYNAMICAL INTERPOLATION

#### AN IDEAL CASE STUDY TO UNDERSTAND THE INTERPOLATION METHOD

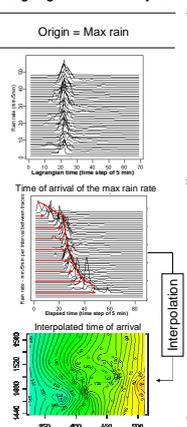


#### A REAL CASE STUDY: Event Niger 2006/07/22

**Classical interpolation**  
Eulerian coordinate system

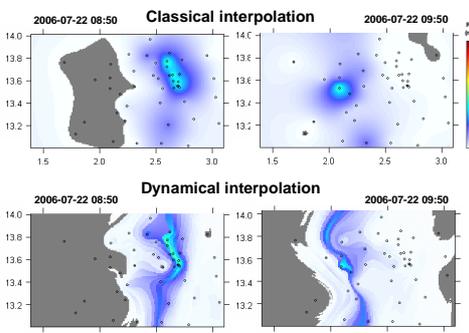


**Dynamical interpolation**  
Lagrangian coordinate system



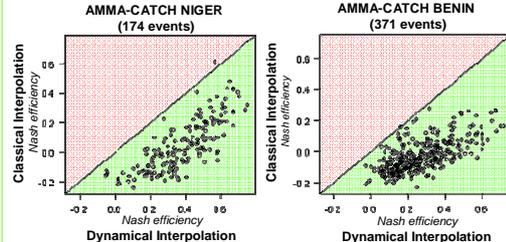
① Adjustment of the hyetographs in the Lagrangian coordinate system

② Definition of the kinematic model



The spatial variability and intermittency of the rainfall and the temporal correlation of rain fields between two instants of time are retrieved.

#### CROSS VALIDATION FROM 2005 TO 2008 OVER THE NIGER AND THE BENIN



The cross validation consists of (i) hiding a rain gage, (ii) interpolating the rain at the hidden rain gage location, (iii) comparing the predicted rainfall with the observed rainfall. This process is applied for all rain gages for each event.

The Nash efficiency is a quantitative criterion used to compare the prediction vs the observation. The best value is 1. A mean value is computed for each event.

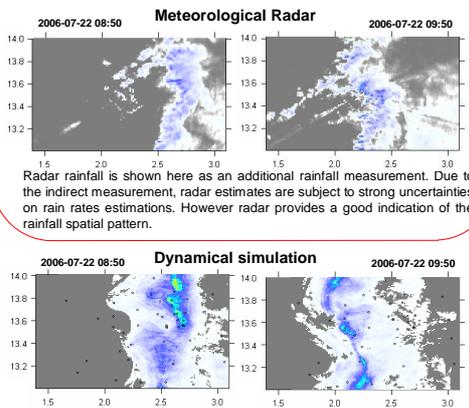
**Dynamical interpolation always performs better than classical interpolation over both Niger and Benin areas**

### COMBINATION OF DYNAMICAL INTERPOLATION AND GEOSTATISTICAL SIMULATIONS

Usually geostatistical interpolation techniques (e.g. Kriging) provide a suitable framework to assess the uncertainty of interpolation. However due to the switch between the Eulerian and the Lagrangian coordinate systems, the assessment of the uncertainty associated with the dynamical interpolation technique is not straightforward and would necessitate specific theoretical studies.

However when interpolation is carried out at the event time step, for which no kinematic model is required, the interpolation uncertainty is easily assessed. Knowing this interpolation uncertainty at event time step, a geostatistical method has been developed to generate stochastic event rain fields conditioned by point values (Vischel et al., 2009). The generated fields reproduce correctly both point distribution and spatial correlation of rainfall at the event time step.

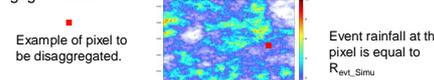
- Dynamical interpolation and geostatistical simulations are combined by:
- Stochastically simulating the rain rates at the event time step conditioned by the rain gage values
  - Disaggregating the stochastic rain fields from event time step to 5 minute time step by using at each grid pixel the hyetograph obtained by dynamical interpolation



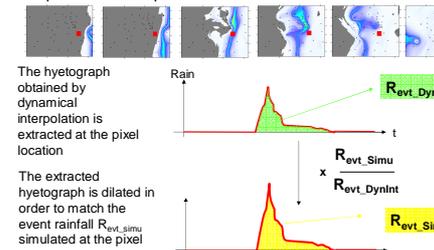
The stochastic rain fields are characterized by a more erratic and more realistic rainfall pattern. Rain cells are more clearly identified than in the smooth pattern obtained by dynamical interpolation only.

For each event, several realizations can be simulated in order to provide an ensemble of reference high resolution rain fields that take into account the interpolation uncertainty.

① Simulation of a stochastic event rain field conditioned by rain gage values



② Disaggregation to 5 minute time step by using the dynamical interpolation technique



- The process is realized for all simulated grid pixels
- Coming back to ① to simulate another realization of the rainfall event to obtain an ensemble of stochastic rain fields