MIC-346

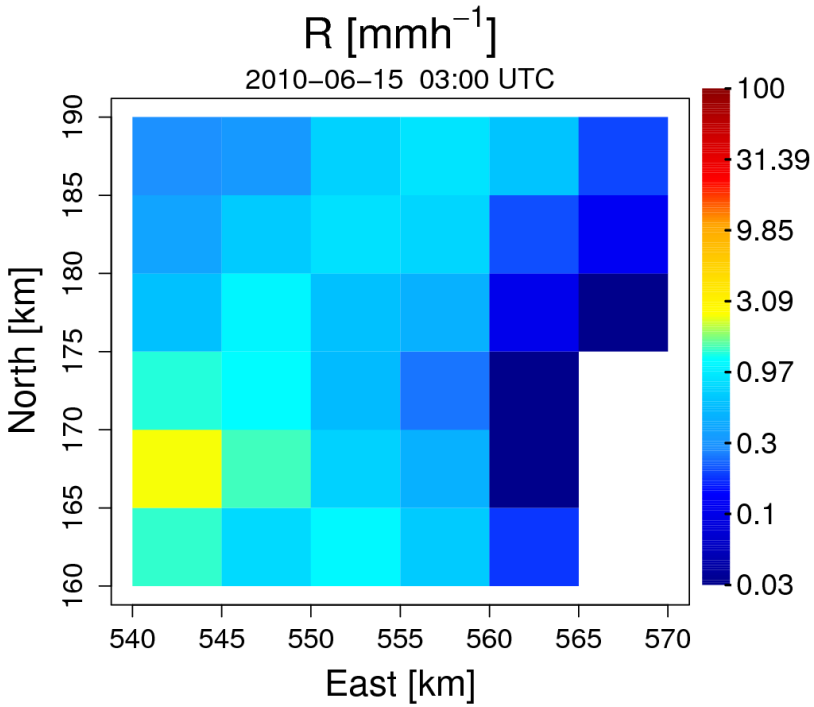
Stochastic space-time disaggregation of rainfall into DSD fields

Marc Schleiss and Alexis Berne

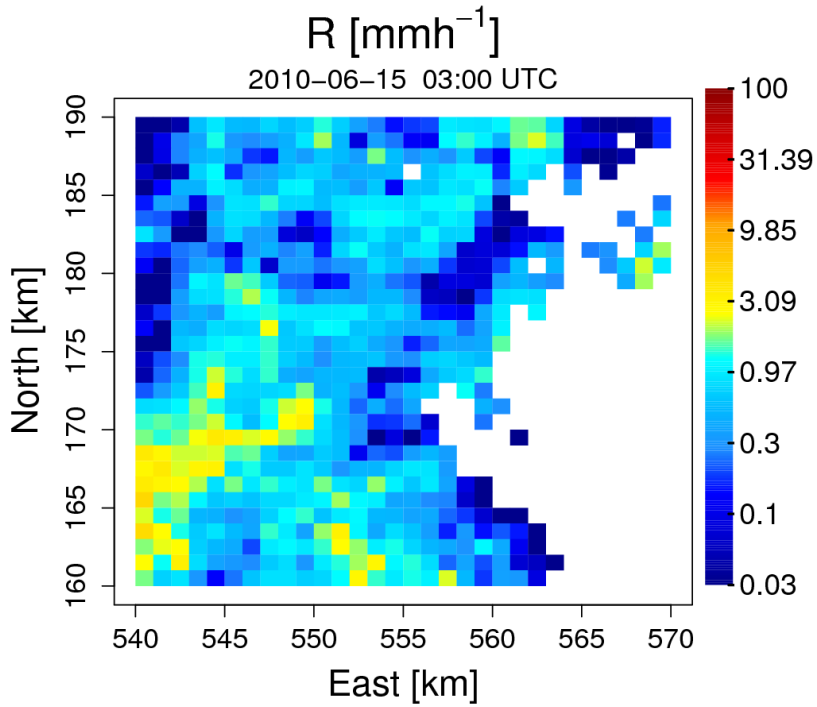
Laboratoire de Télédétection Environnementale (LTE), EPFL, Switzerland

ERAD 2012, 25-30$^{\text{th}}$ June, Toulouse, France

What is rainfall disaggregation?

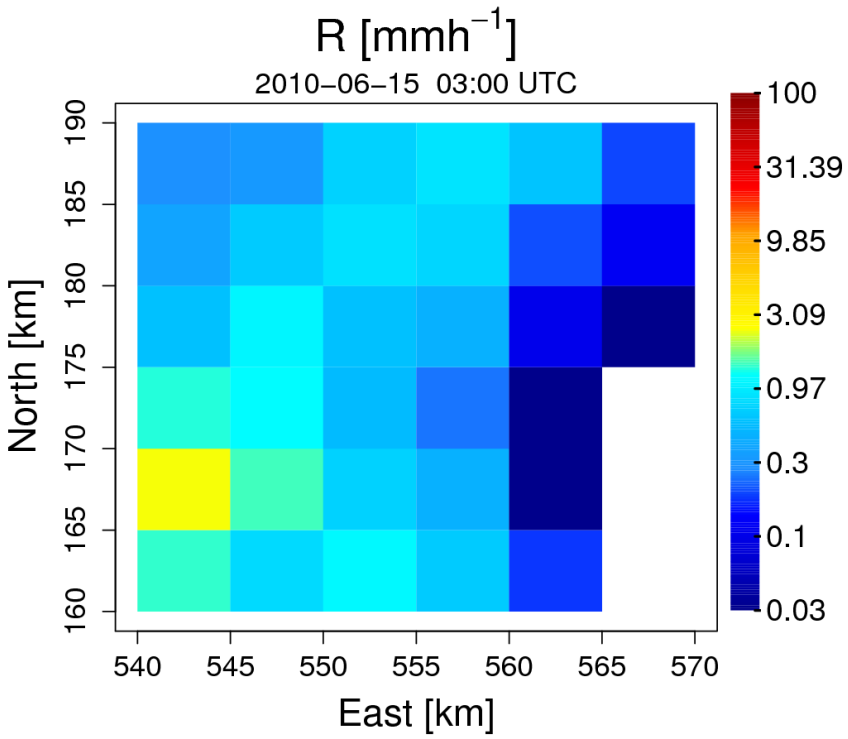


Low resolution

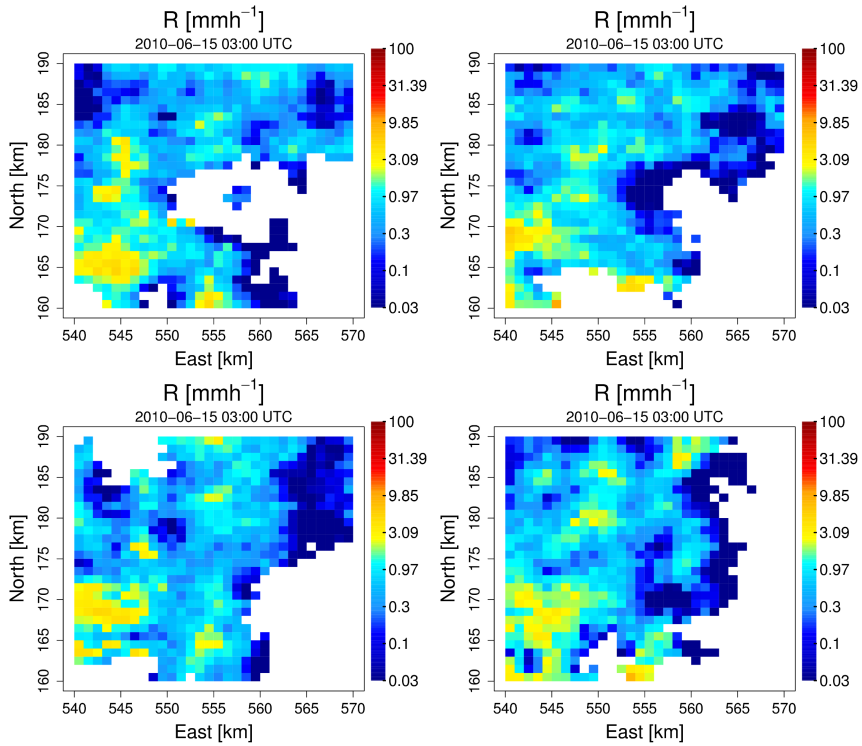


High resolution

No unique solution!



→



Constraints:

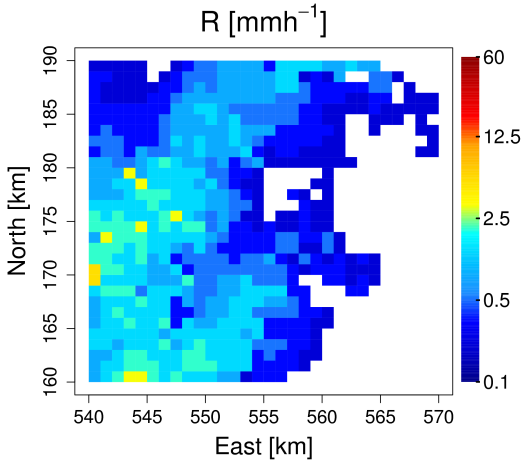
- block-averaged rain rates
- spatial and temporal structures
- intermittency

Why is disaggregation important?

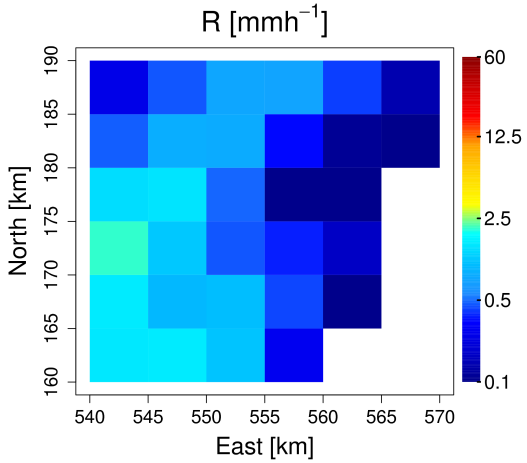
- Many hydrological applications require high resolution rainfall data.

  $\rightarrow$ flash floods, landslides, urban water management

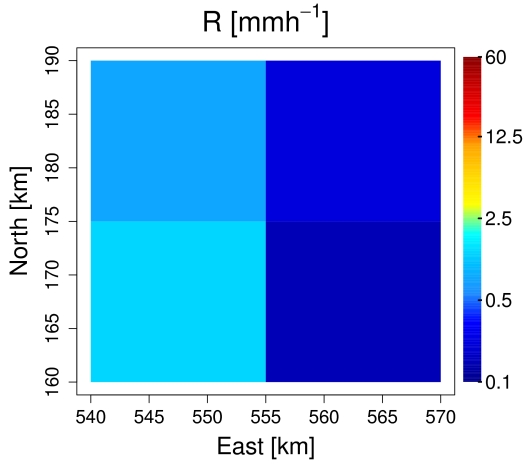
- Rainfall is not a linear process.
- Rain rates and intermittency are scale dependent.



1×1 km^2



5×5 km^2



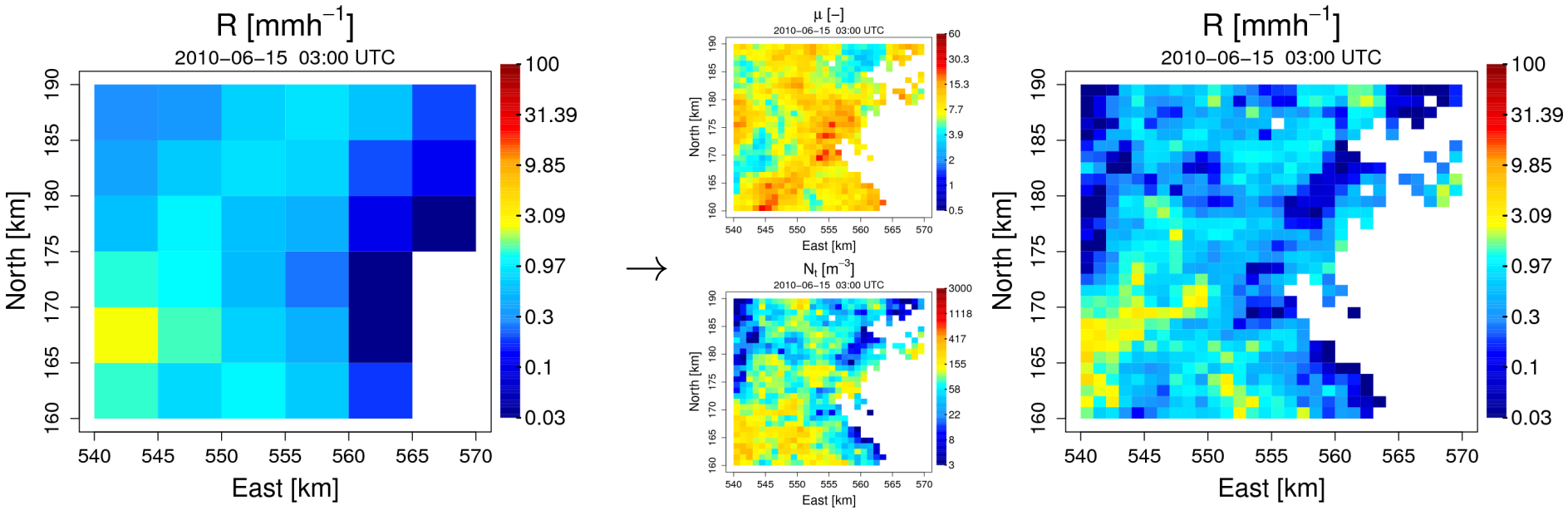
15×15 km^2

Why is this contribution original?

Previous work on rainfall disaggregation mostly focused on rain rates.

$\rightarrow$ The present disaggregation method is based on the DSD.

The rain rates are derived from the simulated DSD fields.



Modeling

The proposed disaggregation method is based on Geostatistics.

Space-time structures

Climatological variograms estimated using radar and disdrometer data:

- $\gamma_I(h, \tau)$ (intermittency)
- $\gamma_\mu(h, \tau)$ ($\sim$ drop size)
- $\gamma_{N_t}(h, \tau)$ ($\sim$ drop concentration)

Intermittency

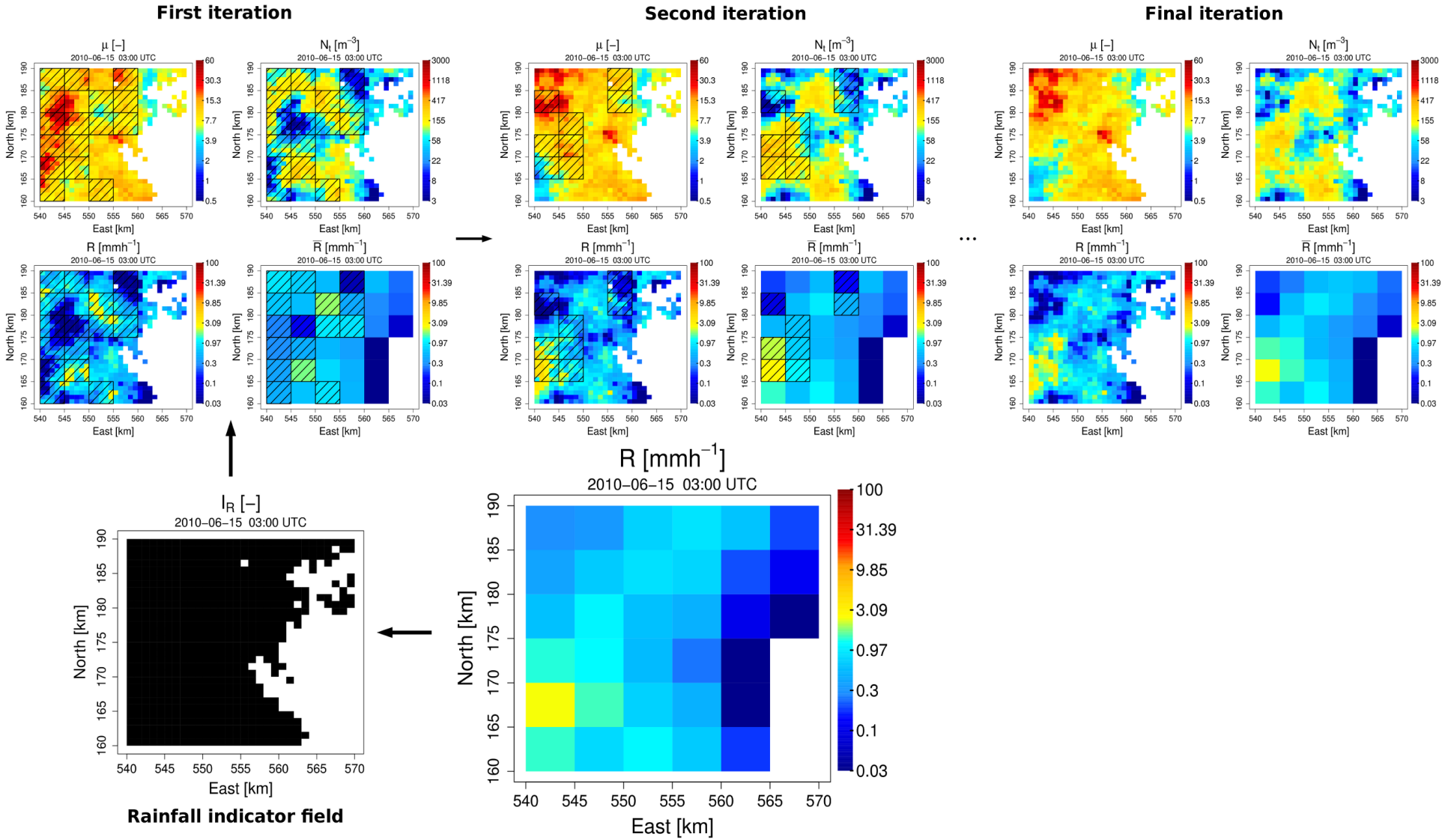
Climatological scaling laws are used to estimate the percentage of rainy locations at the fine scale:

$\rightarrow$ Schleiss et al. 2011, Geophys. Res. Lett., vol.38

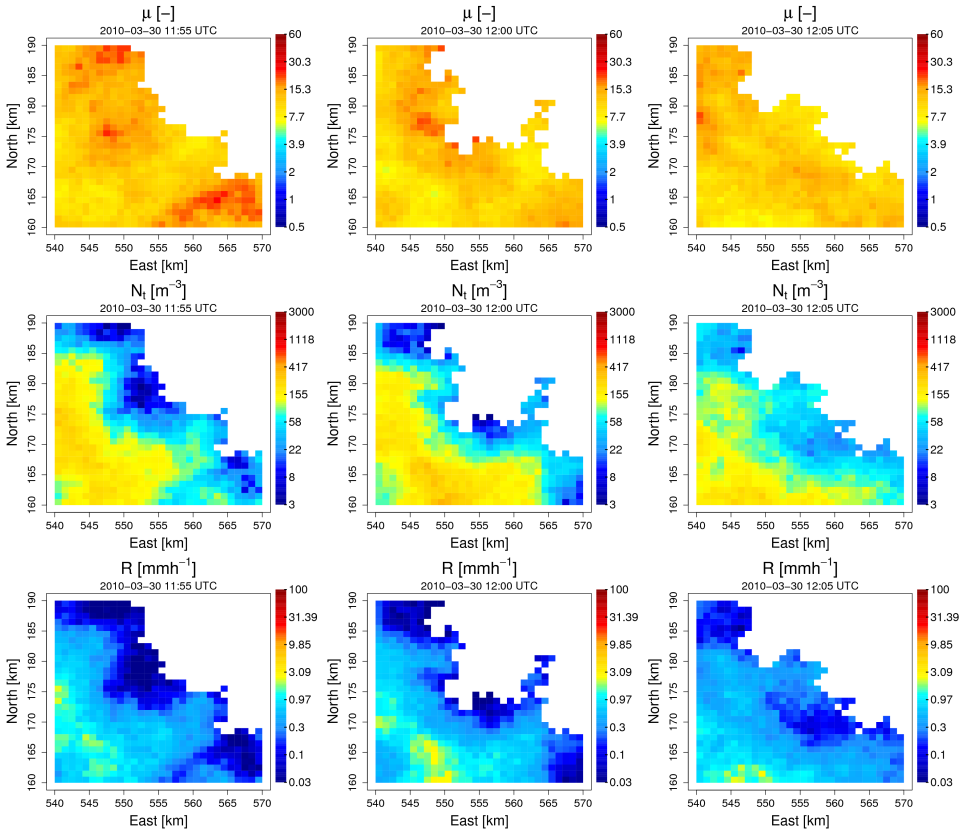
Simulation algorithms

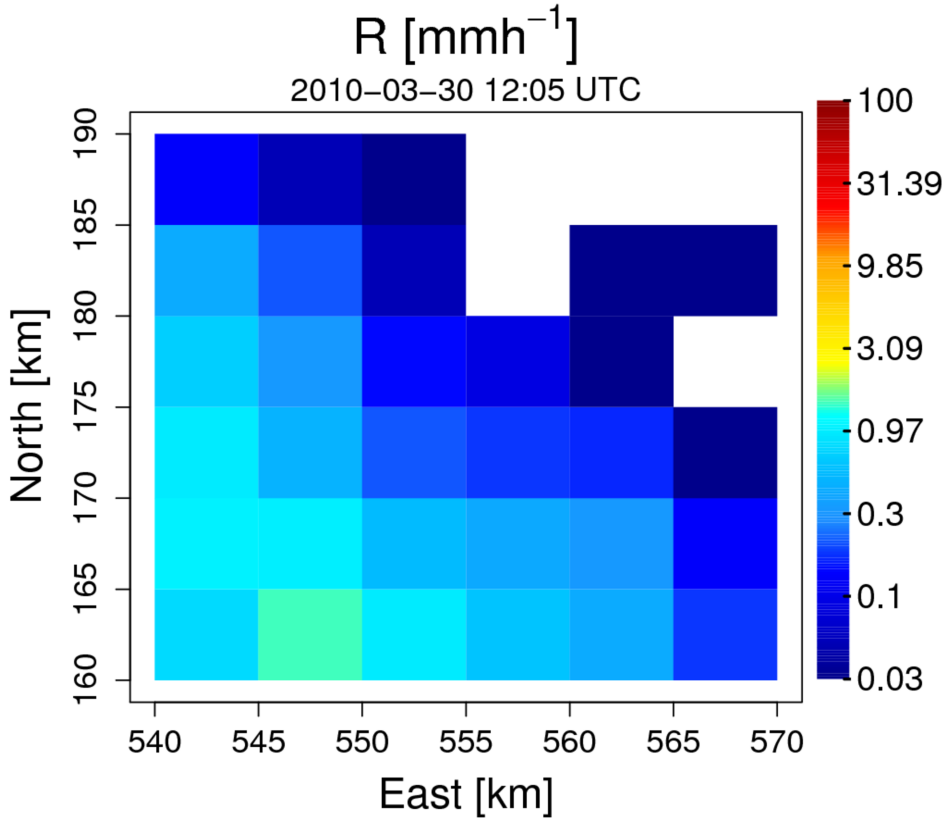
- Sequential Indicator Simulation (SIS) for rainfall intermittency
- Sequential Gaussian Simulation (SGS) for DSD parameters
- Multivariate Gaussian transformation technique

The disaggregation procedure



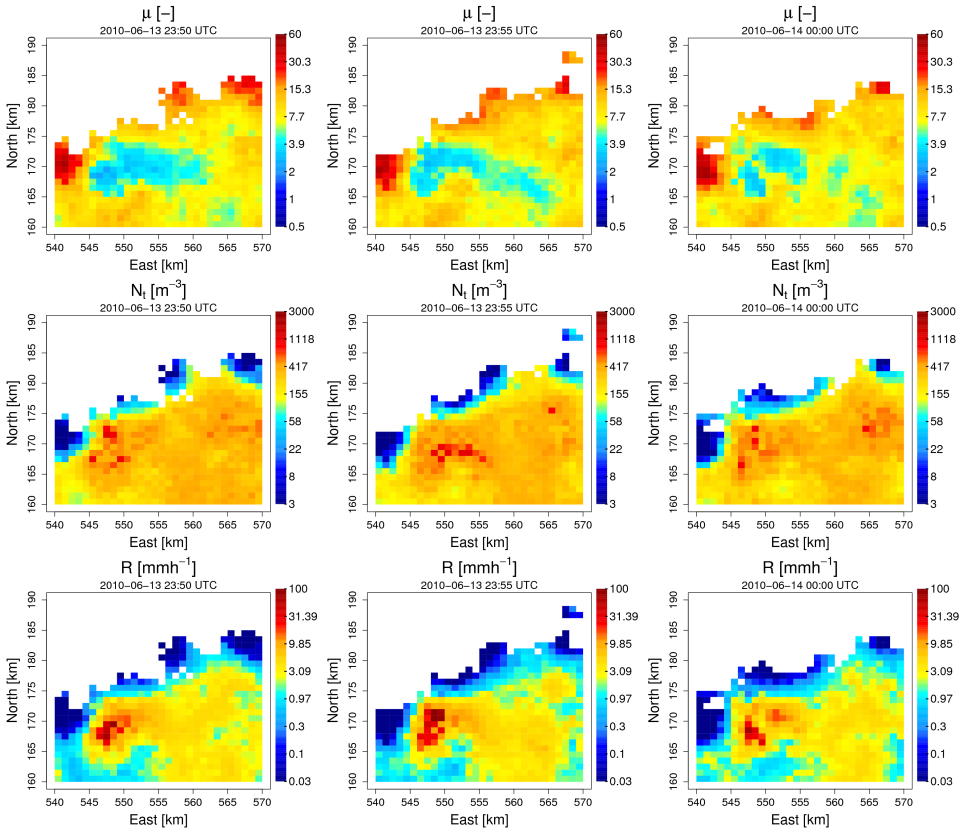
Example 1: Stratiform event

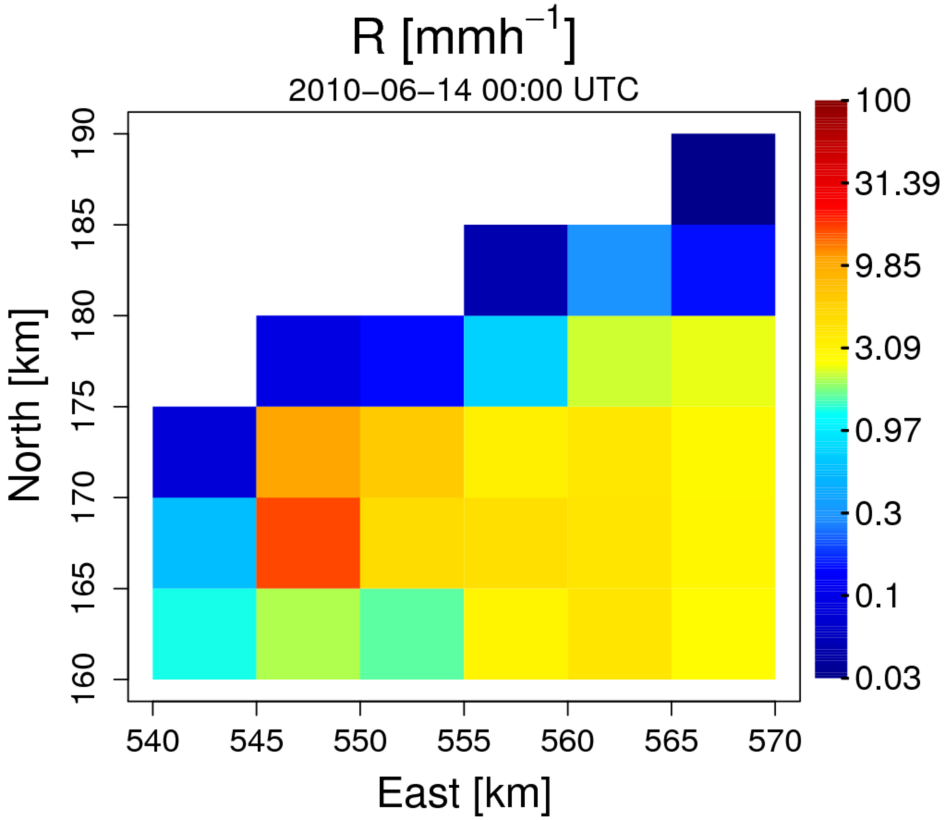




The simulated rain rate distributions and space-time structures are consistent with radar data at the same scale.

Example 2: Convective event





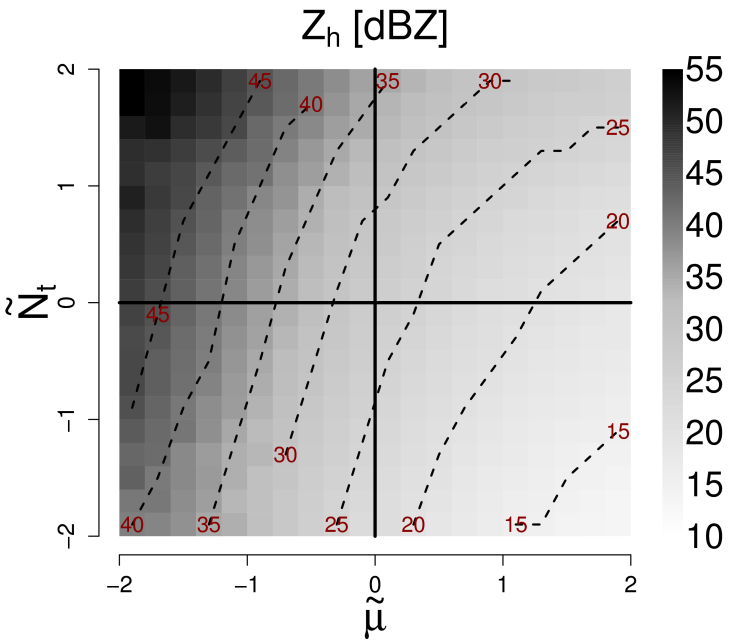
The simulated rain rate fields are slightly too smooth compared to radar data at the same scale.

Perspectives

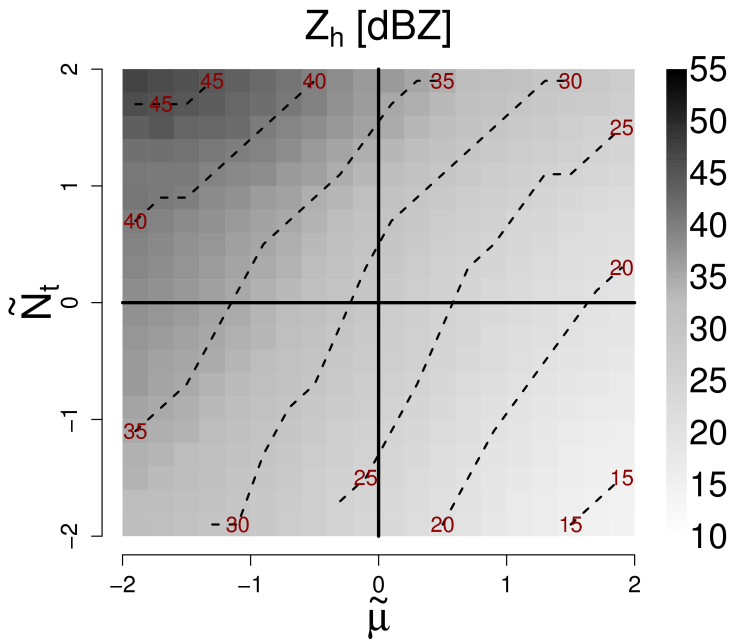
Many bulk variables (R, Z_h, Z_{dr}) can be computed from the DSD.

Idea: use Z_h at 2 frequencies to drive the disaggregation process!

$$Z_{h|v} = C(f) \int_D \sigma_{B_{h|v}}(D, f) N(D) dD$$



35.5 GHz



13.6 GHz

Perspectives

Possible input sources for disaggregation:

- ground-based weather radar
- satellite data
- numerical weather models
- point measurements...

$$Y = \int_D f(D)N(D)dD$$

Conclusions

Summary:

- New rainfall disaggregation technique based on DSD
- Geostatistical framework (variograms)
- Possibility to generate multiple realizations
- The disaggregation procedure can be driven by the rain rate, the reflectivity or any other DSD-related bulk variable.

Limitations:

- Space-time structures difficult to parameterize
- No vertical structure (so far)

Thank you for your attention!