ICCP 2016
- ref 424 -

Evaluation of the Microphysics of Precipitation with Multifrequency Radar Observations (EMPORiuM): a prospective study

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Objectives

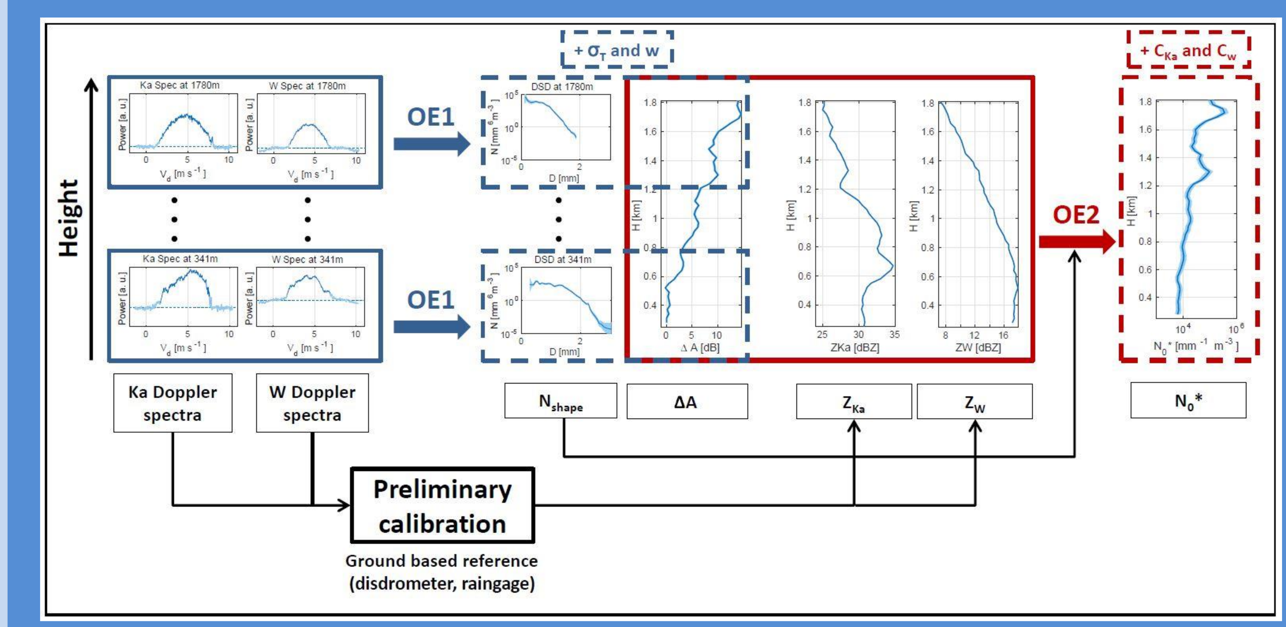
This project investigates how new multi-frequency radar observations can be used to improve the representation of precipitation microphysics in a mesoscale model, such WRF.

In order to improve the parameterization for drop size distributions (DSDs) and microphysical processes, especially with respect to evaporation and breakup, observations of the DSDs profiles are needed.

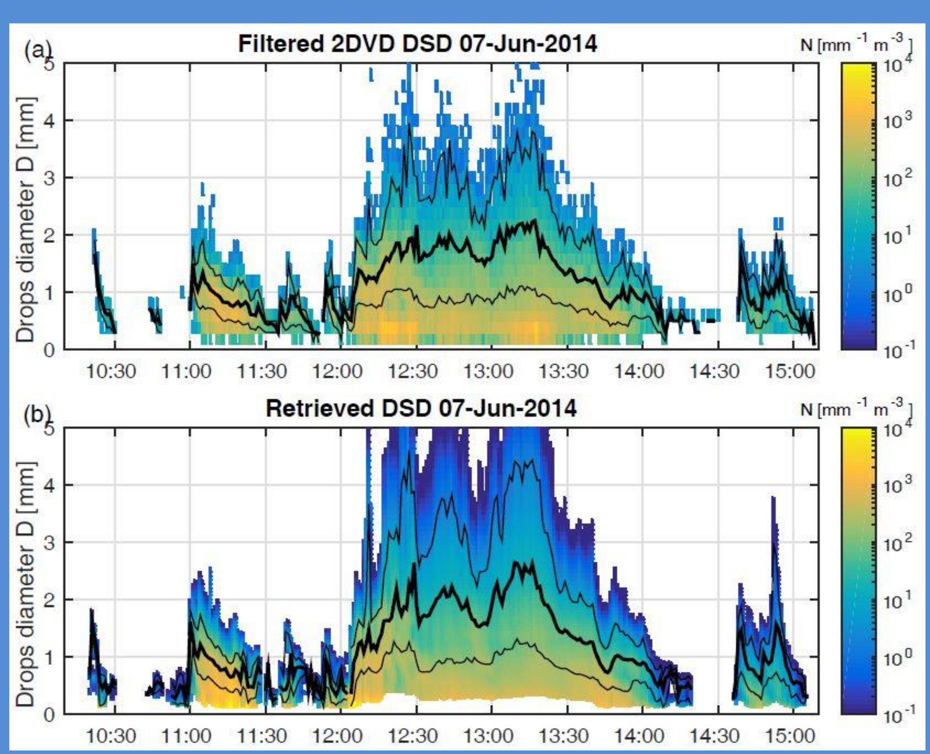
This poster presents in a first part a new retrieval technique and its validation by field observations. In a second part, modeled DSD parameters (D_m, N_0*) are compared with the retrieval results for a squall line observed over Oklahoma in June 2011.

Multi-frequency retrieval (35, 94 GHz)

- Exploits the dependence of rain drop scattering properties with radar frequency
- Optimal matching of radar Doppler spectra to retrieve profiles of the DSD and vertical air motion



→ The successful operation of the above retrieval technique has been shown during the "Biogenic Aerosols Effects on Clouds and Climate" (BAECC) campaign which took place in summer 2014 in Finland. The figure below shows the comparison of the retrieved DSD with 2DVD disdrometer measurements at the ground.

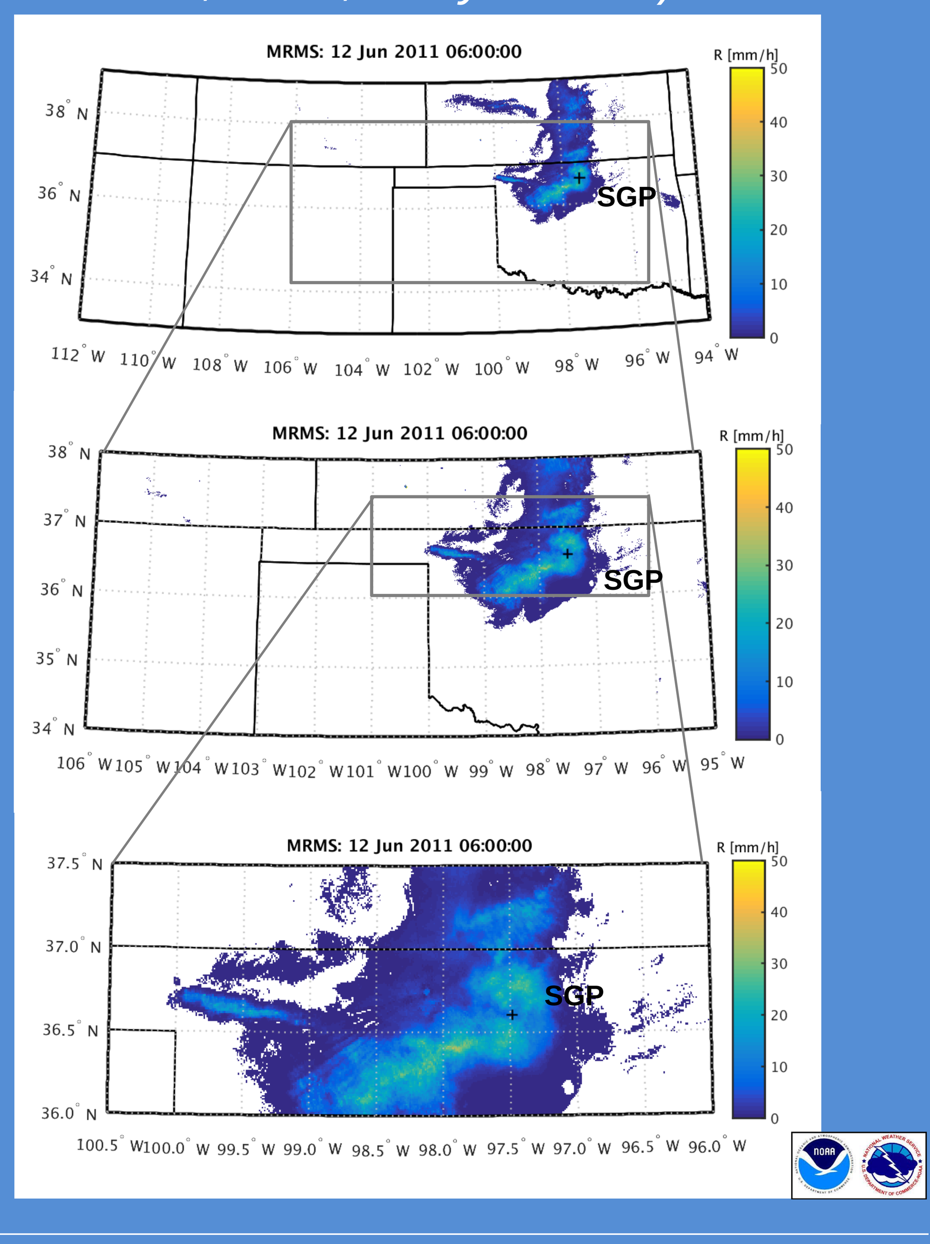


Tridon et al., 2016, QJRMS, under review

Case Study

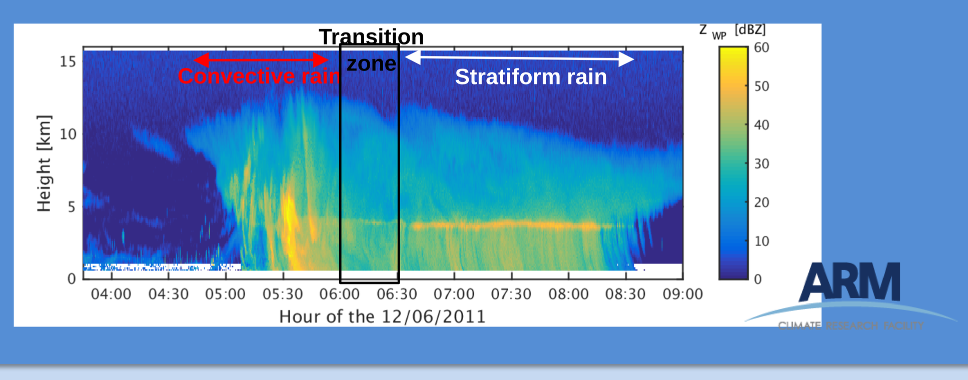
NEXRAD observations

- The squall line developed over North Oklahoma on the 12th of June 2011 and was observed by the US NEXRAD operational network
- Rainfall estimation from the MRMS product (*Kirstetter et al., 2013, J. Hydromet.*)



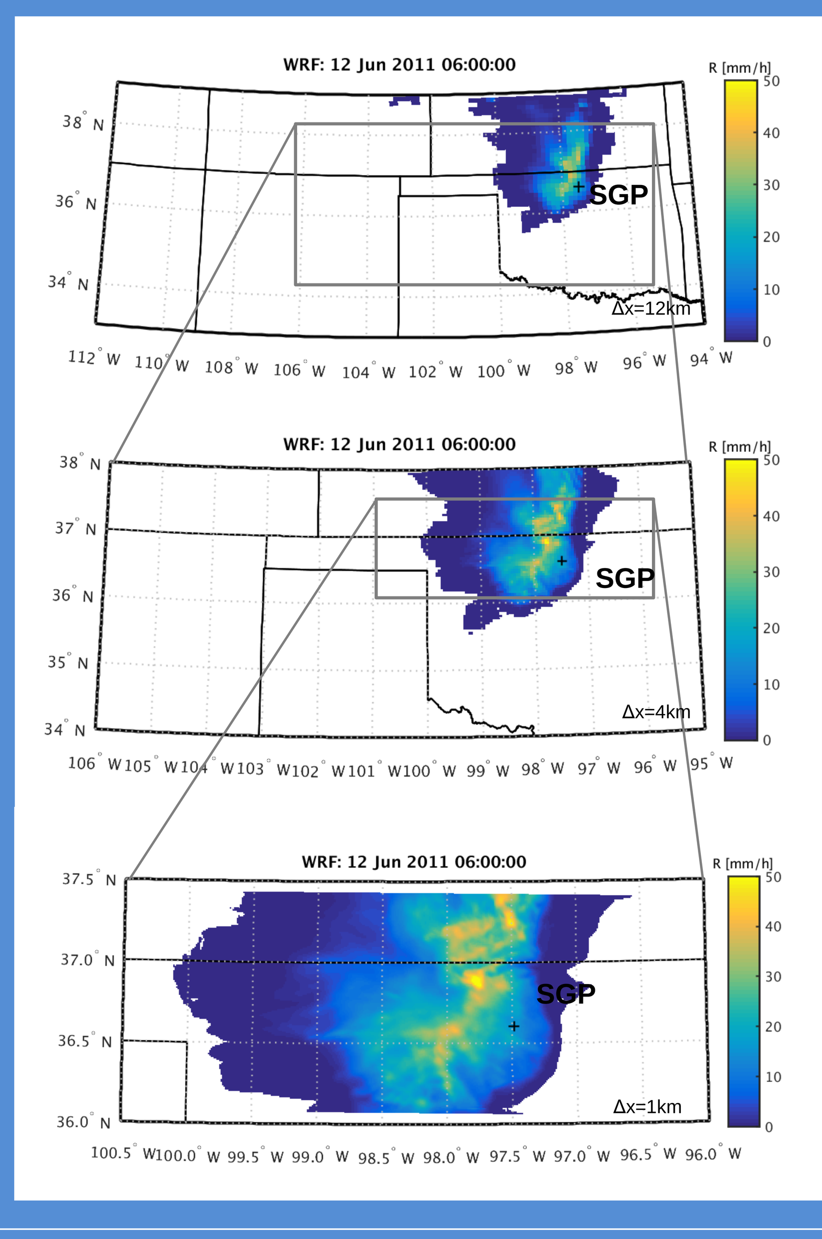
ARM SGP vertical observations

UHF (Rayleigh scat.) profiler in precipitation mode



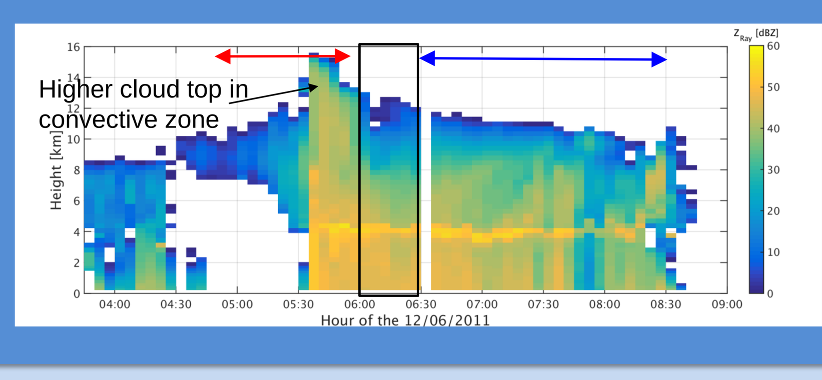
WRF: mesoscale simulations

- Initiation: ECMWF Era-Interim 00:00 UTC data on 11th June 2011
- 3 nested domains with increasing resolution
- 2 moment bulk microphysics scheme of *Morrison et al. (2009, MWR)* where the rain DSD is represented with an exponential function.

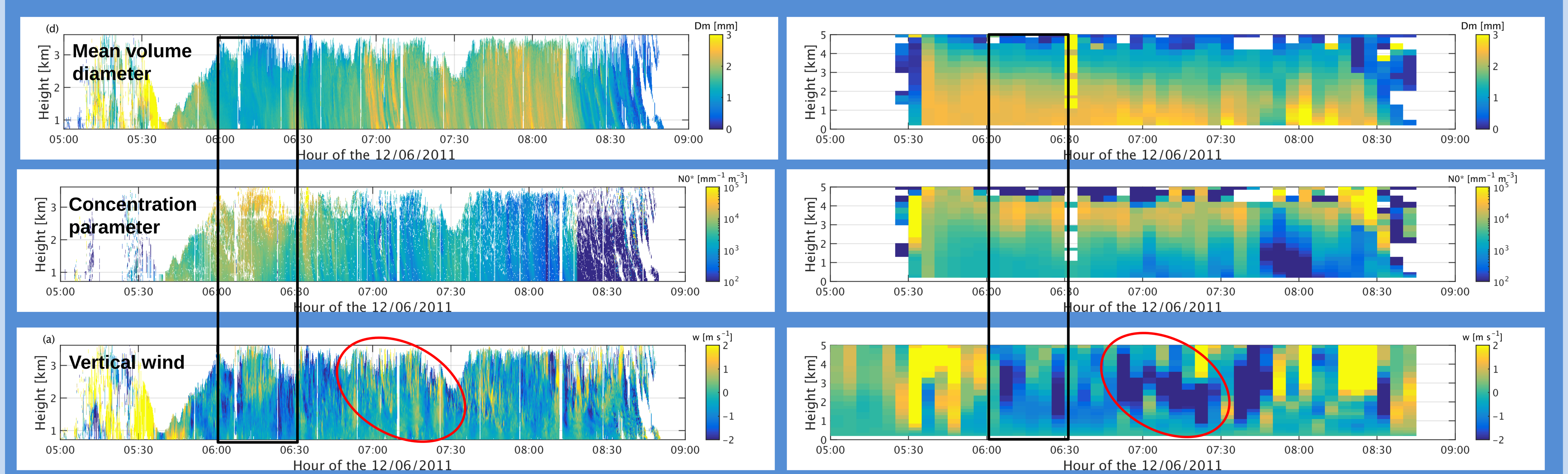


Simulated vertical structure

10 cm radar reflectivity (Rayleigh scat.)



Retrieval results vs. WRF simulations



- The typical **transition zone** (lower reflectivity, lower D_m, higher N_0* and enhanced subsidence (w < 0) than in stratiform region) is not reproduced by the model. According to *Biggerstaff and Houze (1993)*, these contrasting properties originate from the ice phase with a combination of size sorting of hydrometeors (smallest ice crystals ejected from highest levels of the convective region), and a reduced aggregation efficiency in the transition zone due to the lack of small ice crystals.
- **Vertical trend:** Several reasons can explain the excessive D_m and N_0*: excessive evaporation below cloud base, too efficient collision-coalescence, condensation due to a possible low-level cloud (not seen in the observations), or the well known problem of drop sorting effect for 2-moment schemes with a fixed shape parameter (*Milbrandt et al., 2010*). More work is necessary to explore these possibilities.

Conclusions and Perspectives

The first step of this project was to evaluate the model results with different types of observations. Overall, the simulation shows reasonable performances in terms of accumulated precipitation, its localization and timing. On the other hand, the variability of the DSD is not well reproduced.
As a next step, the project will compare the performances of different microphysical schemes against the DSD observations.

References

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Acknowledgements:
This project was made possible through the financial support of the French LEFE programme of the CNRS-INSU. The calculations for this study have been done on computer facilities of the 'Institut du Développement des Ressources en Informatique Scientifique' (IDRIS),CNRS at Orsay and the 'Centre Informatique National de l'Enseignement Supérieur' (CINES) at Montpellier under the project 940180. The French team acknowledges with gratitude the hours of computer time and the support provided. The UK team acknowledges the use of the SPECTRE and ALICE High Performance Computing Facilities at the University of Leicester.