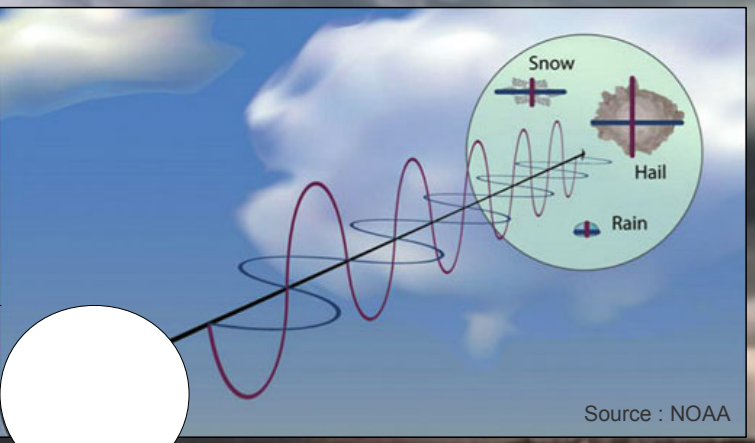
Assimilation of Dual-Polarization Observations into Météo-France Convective Scale model AROME

AMS 38th Conference on Radar Meteorology

C. Augros,
O. Caumont, V. Ducrocq, N. Gaussiat



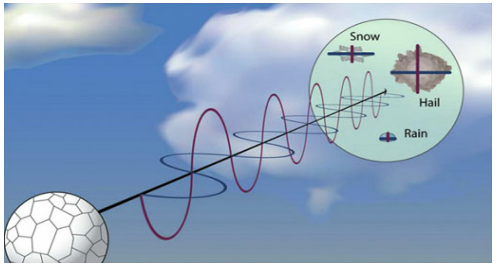
August 30, 2017

B. Vié

Dual Pol observations and convective-scale NWP models

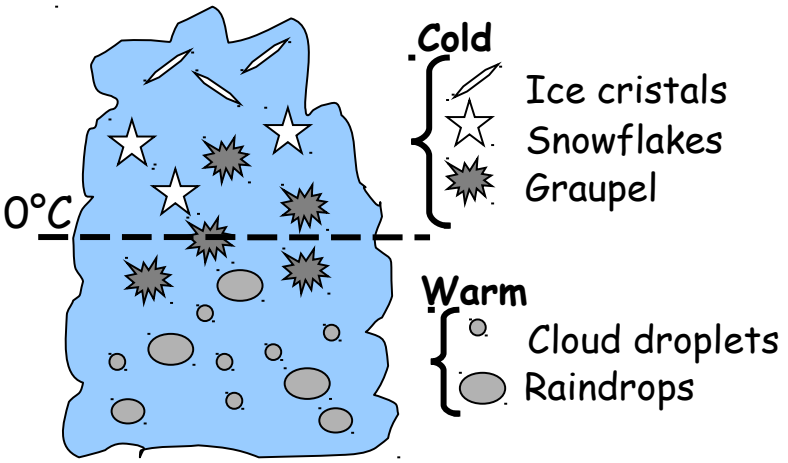
Dual Polarization observations

- High spatial/temporal resolution
- Increase the quality of radar observations
- More information about microphysics



Convective-scale NWP models

- horizontal kilometric resolution
- rich microphysics



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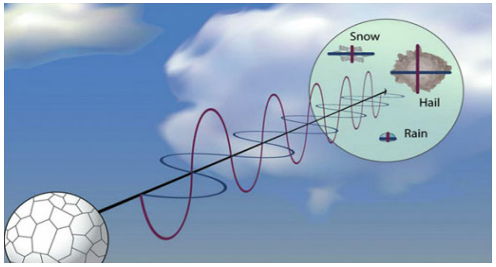

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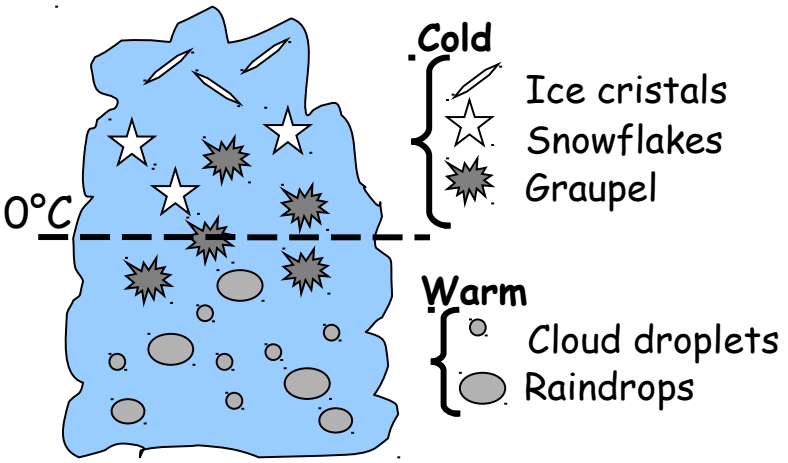
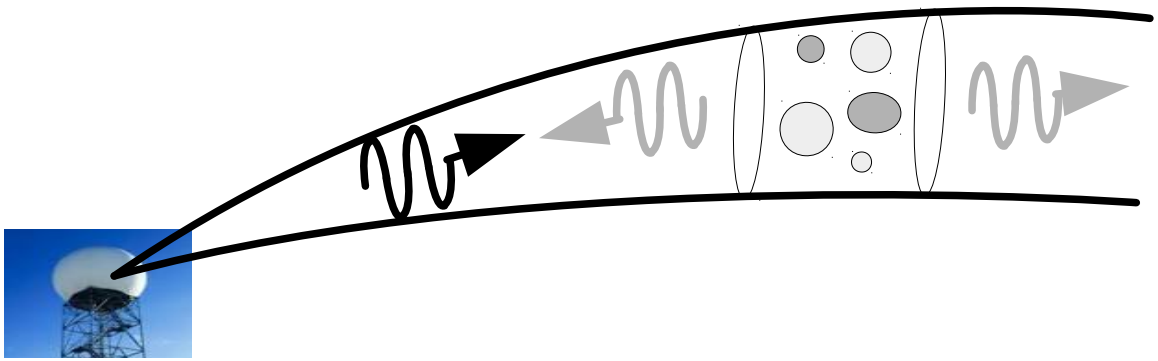


➢ What is the potential of polarimetric variables to improve the initial state and short term forecast of convective scale models?

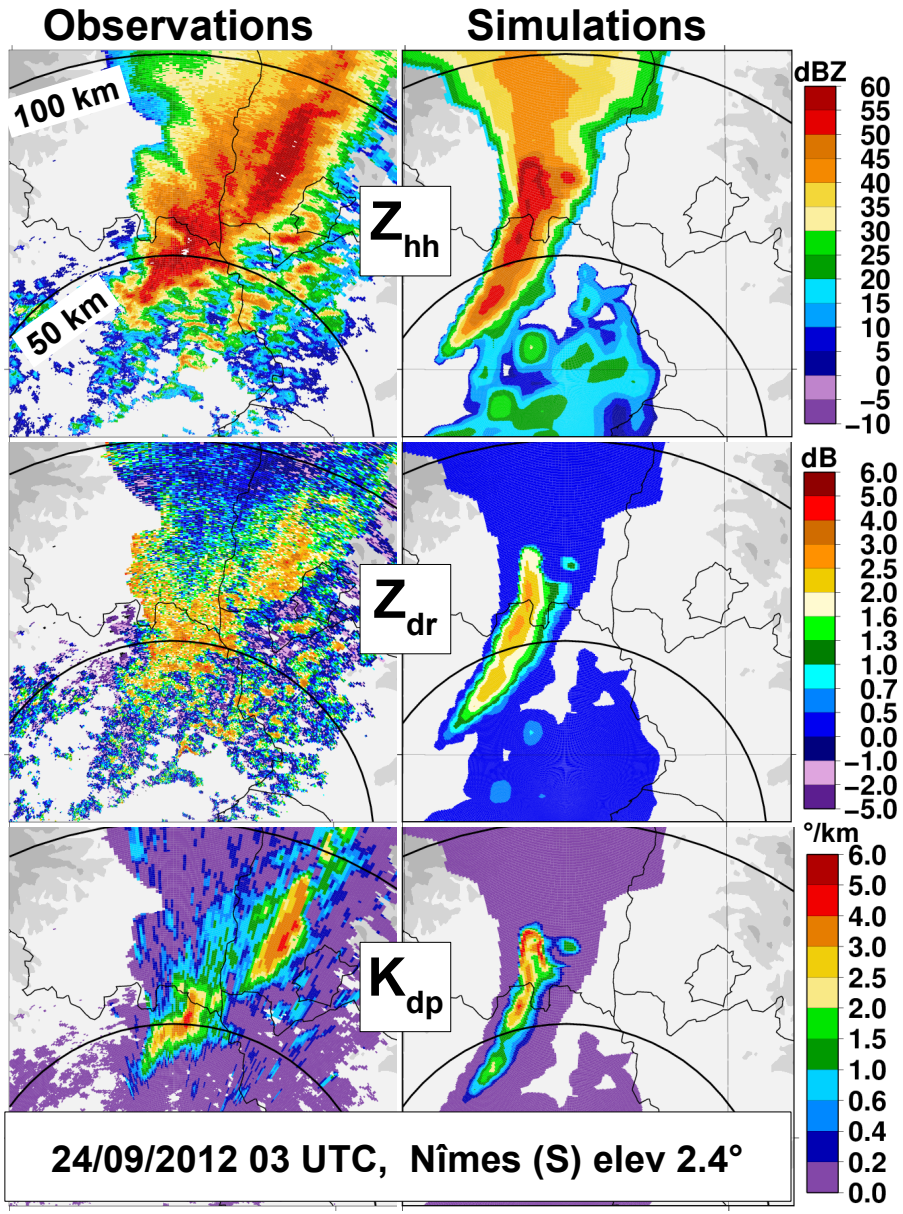
Dual-Polarization radar observation operator



Hydrometeor mass, T, P → **Scattering** spheroids : T-matrix → V_r, Z_{hh}, Z_{dr}, ρ_{hv}, Φ_{dp}, K_{dp}

- **Adapted to AROME 1 moment microphysics scheme**
- **PSD :** Exponential laws (rain, snow, graupel / Gamma law for ice)
- **Shape, orientation, dielectric constants**
  - ➔ From litterature and after a sensitivity study
- **Melting model parameterization**
  - ➔ following Jung et al (2008)

Comparison between observations and simulations

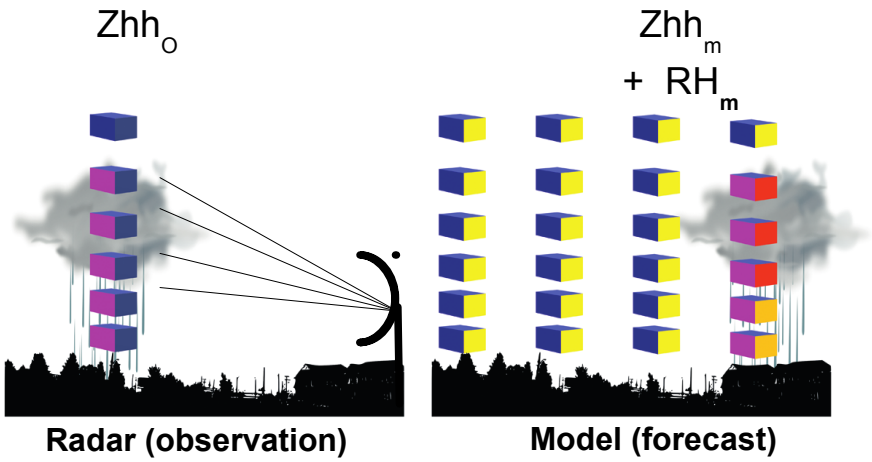


- Convective system well reproduced
- Simulated/observed variables : same order of size
  - ➔ Evaluation of the forward operator in Augros et al (2016)

Augros, C., O. Caumont, V. Ducrocq, N. Gaussiat, and P. Tabary, 2016 : Comparisons between S, C, and X band polarimetric radar observations and convective-scale simulations of HyMeX first special observing period. Quarterly Journal of the Royal Meteorological Society 142, Issue S1: 347-362, doi :10.1002/qj.2572, URL http://dx.doi.org/10.1002/qj.2572.

1D+3D-Var assimilation method in AROME

First step : Bayesian retrieval of relative humidity profiles (RH)



- Comparison between observed and simulated Zhh profiles

1D+3D-Var assimilation method in AROME

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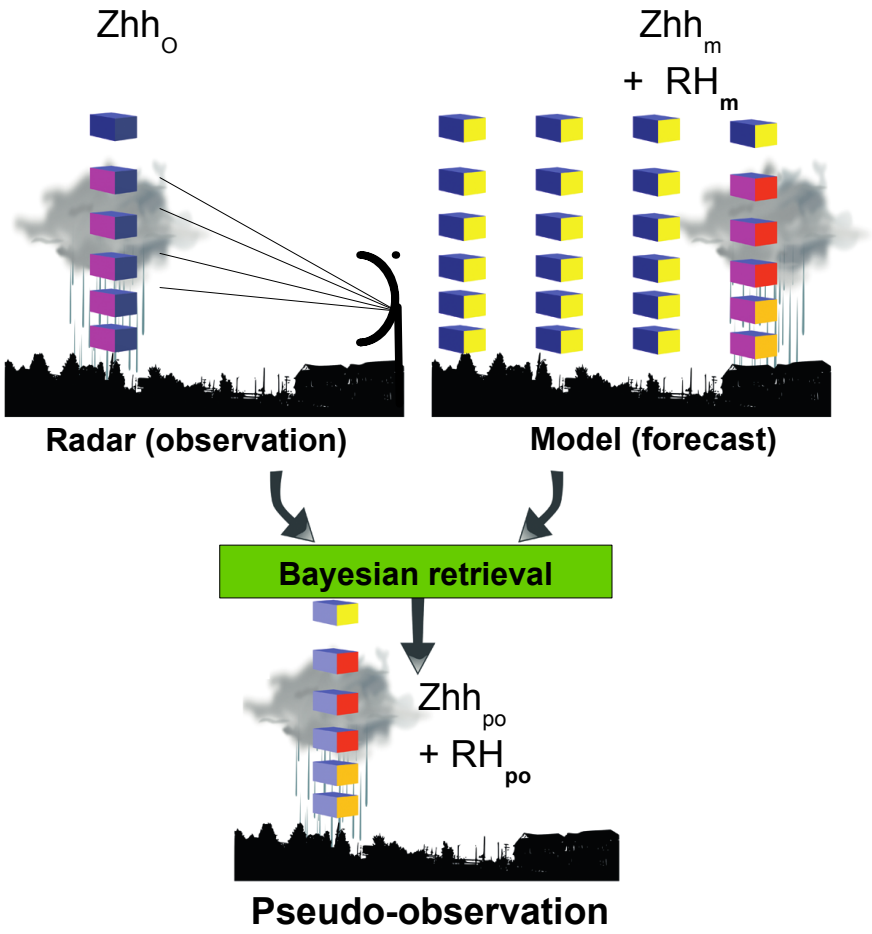

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- Retrieval of a combination of the model profiles that most resemble the observation

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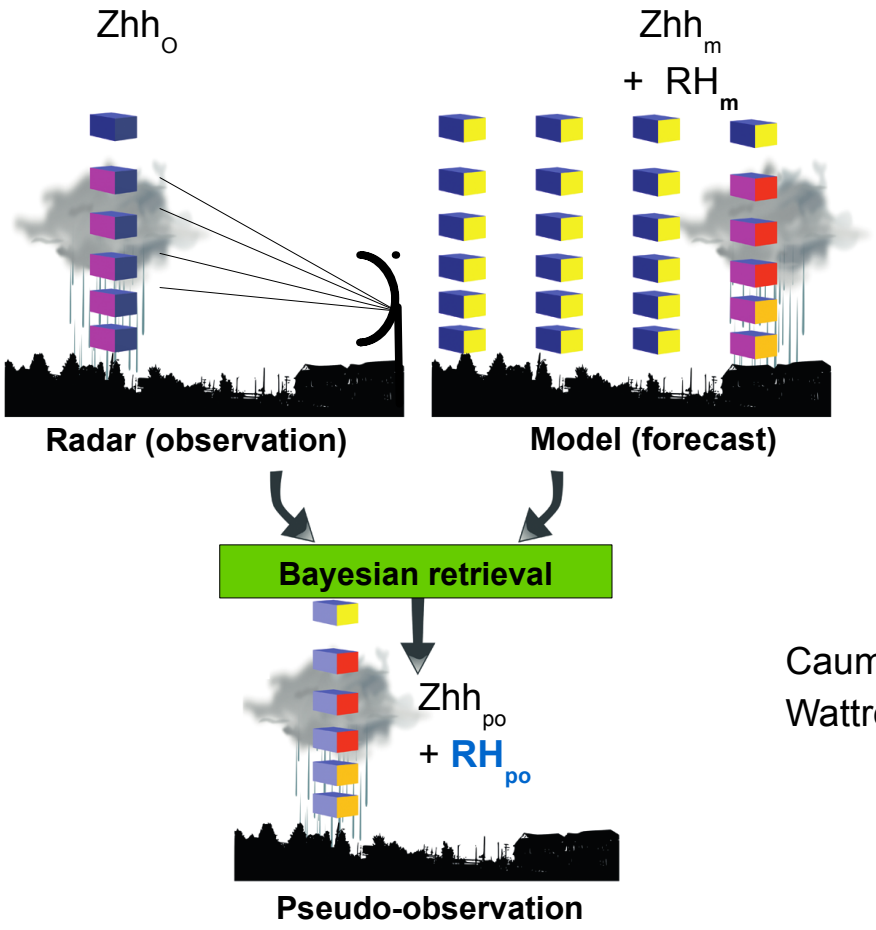

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Caumont et al (2010)
Wattrelot et al (2014)

Second step : Assimilation of the RH profiles in the 3D-VAR

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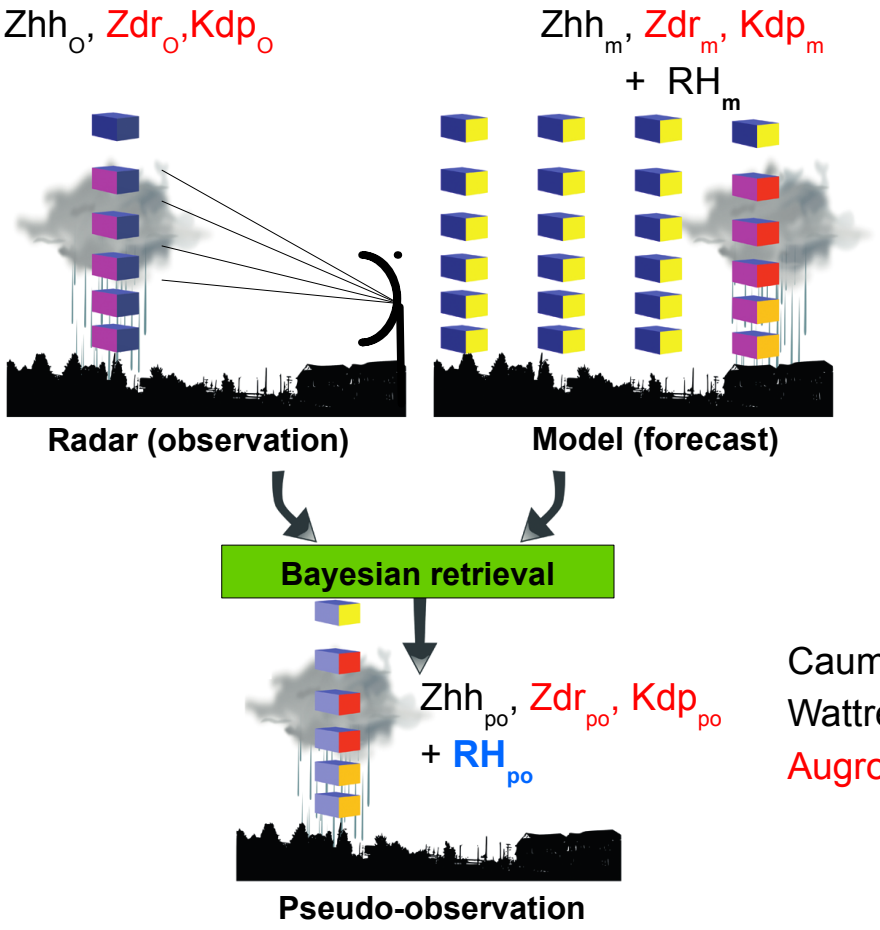

- Comparison between observed and simulated Zhh, Zdr and Kdp profiles
- Retrieval of a combination of the model profiles that most resemble the observation

Caumont et al (2010)
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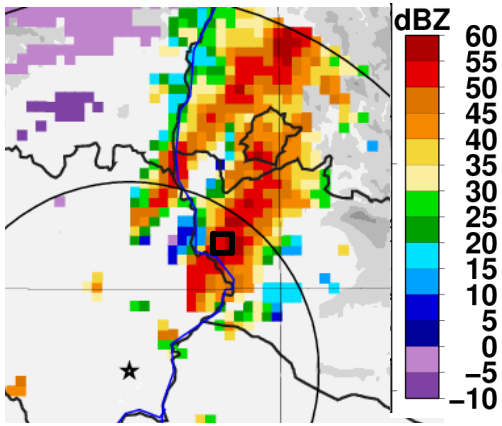
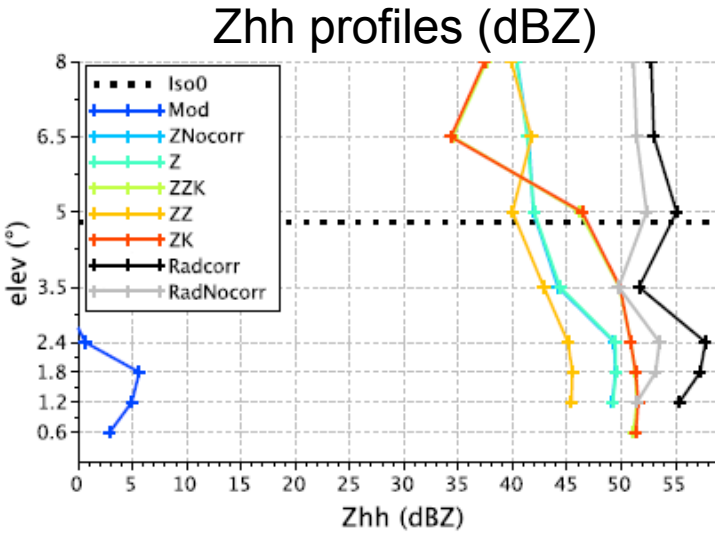
Augros et al 2017 (in review for QJRMS)

Second step : Assimilation of the RH profiles in the 3D-VAR

Illustration of the Bayesian retrieval





Radar with no att. corr.

Radar with att. corr

Model

ZNocorr: use of Zhh without att. corr.

Z: use of Zhh with att. Corr.

ZZK: use of Zhh, Zdr and Kdp

ZZ: use of Zdr mainly (and Zhh)

ZK: use of Kdp mainly (and Zhh)

Pseudo-observations

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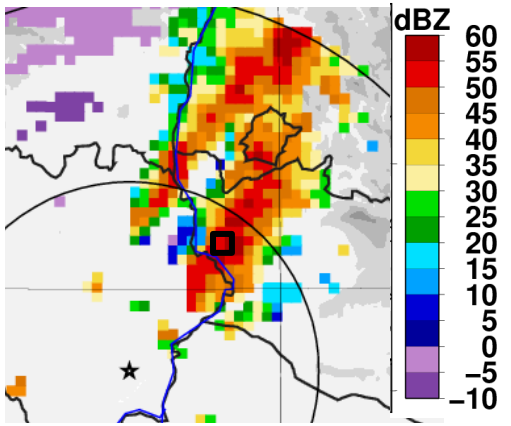

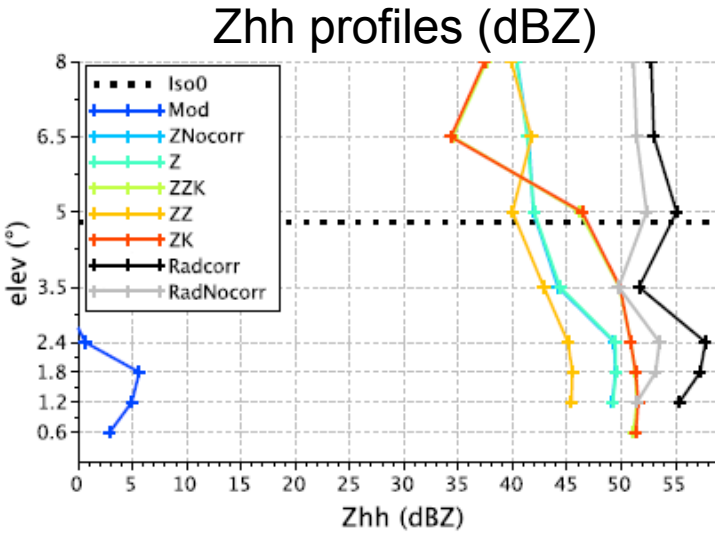

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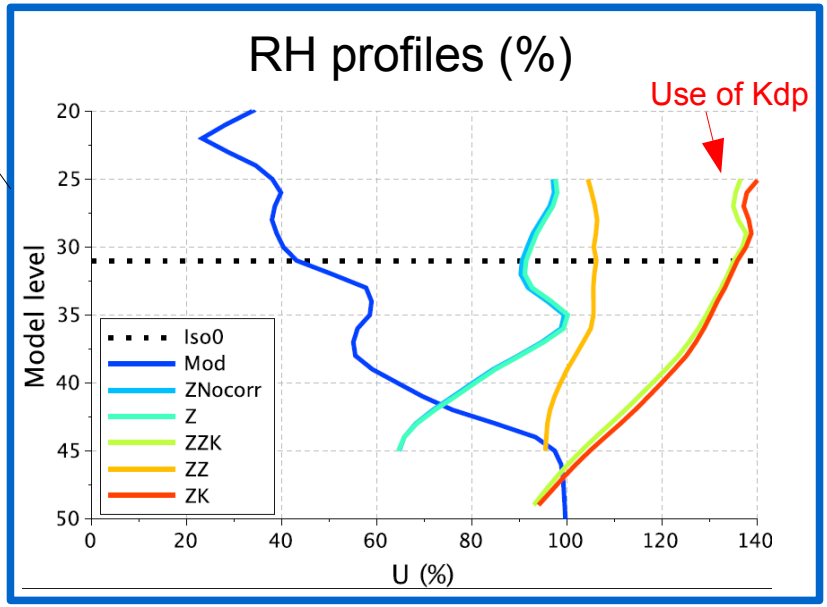
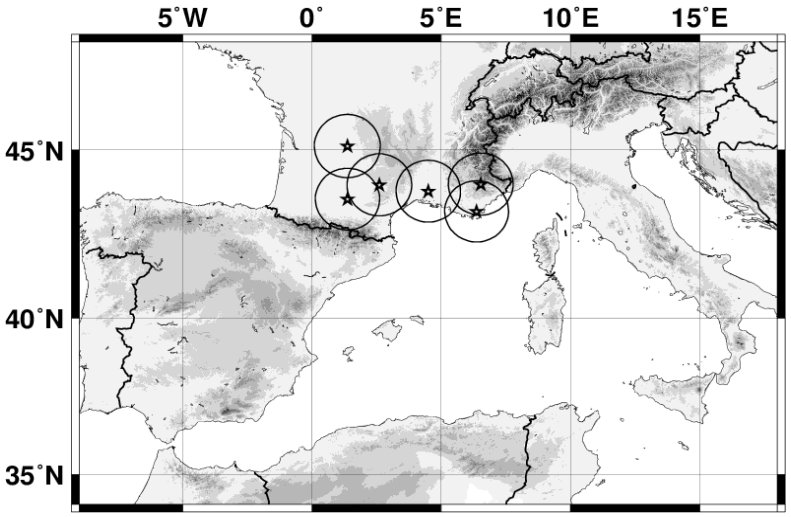


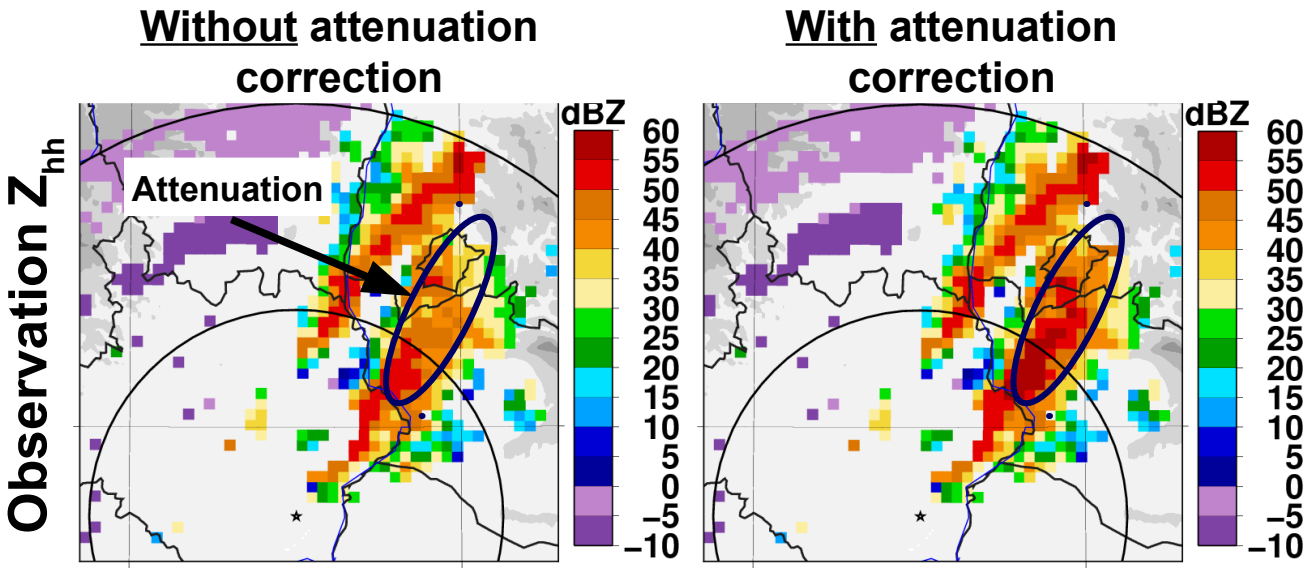
Assimilation experiments characteristics



Expe	Assimilated Observations
CTRL	All except radar reflectivities
ZNocorr	CTRL + RH_{po} from Zhh without att. corr.
Z	CTRL + RH_{po} from Zhh corrected
ZK	CTRL +RH_{po} from Kdp (or Zhh)

- **2 convective cases** studied: 24/09/2012 and 26/10/2012
- AROME model : 2.5 km resolution
- 3 hour assimilation cycle, 3D-VAR

Impact of attenuation correction on the analysis



24/09/2012 06 UTC , Nîmes radar (S band), elev 1.8°

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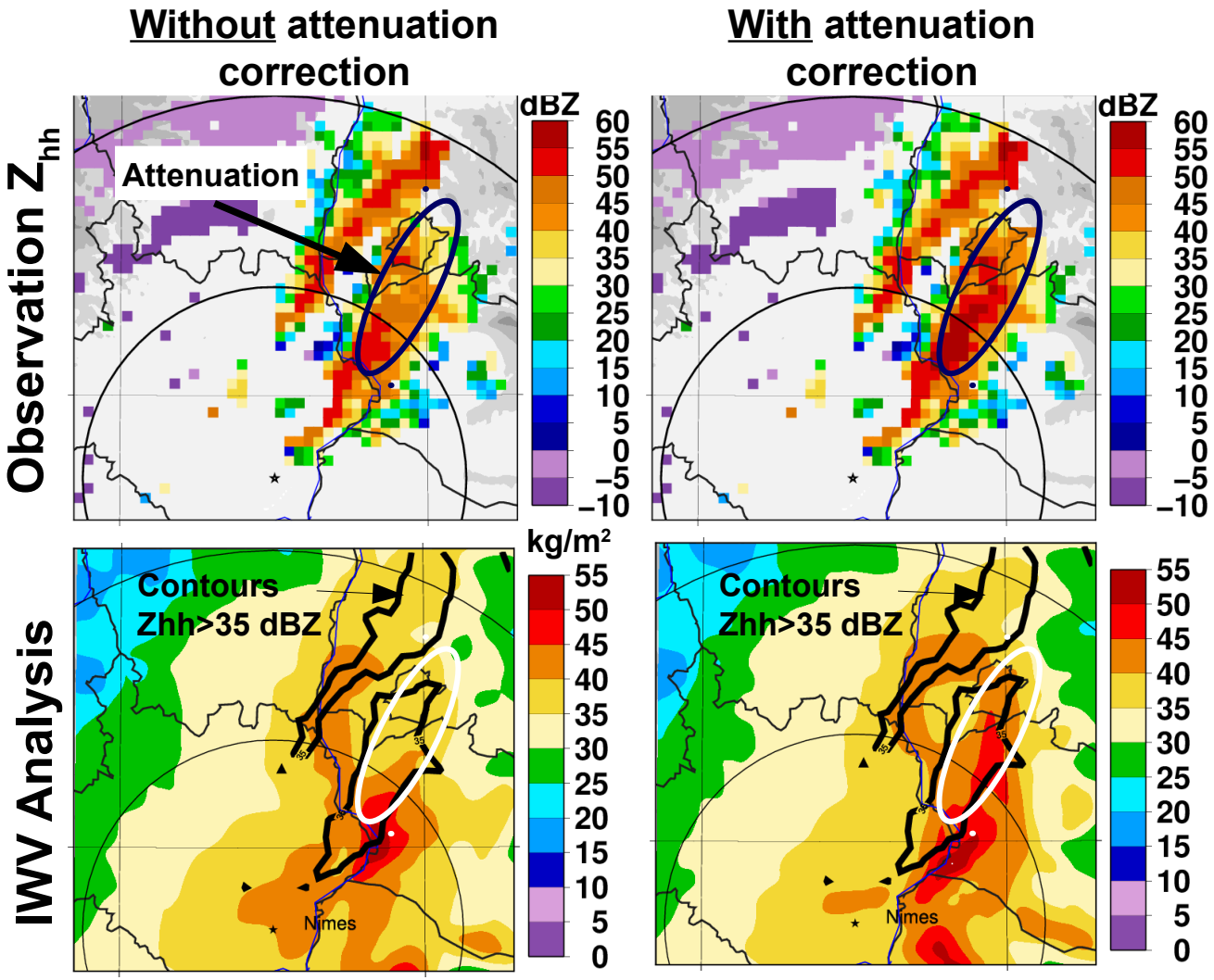


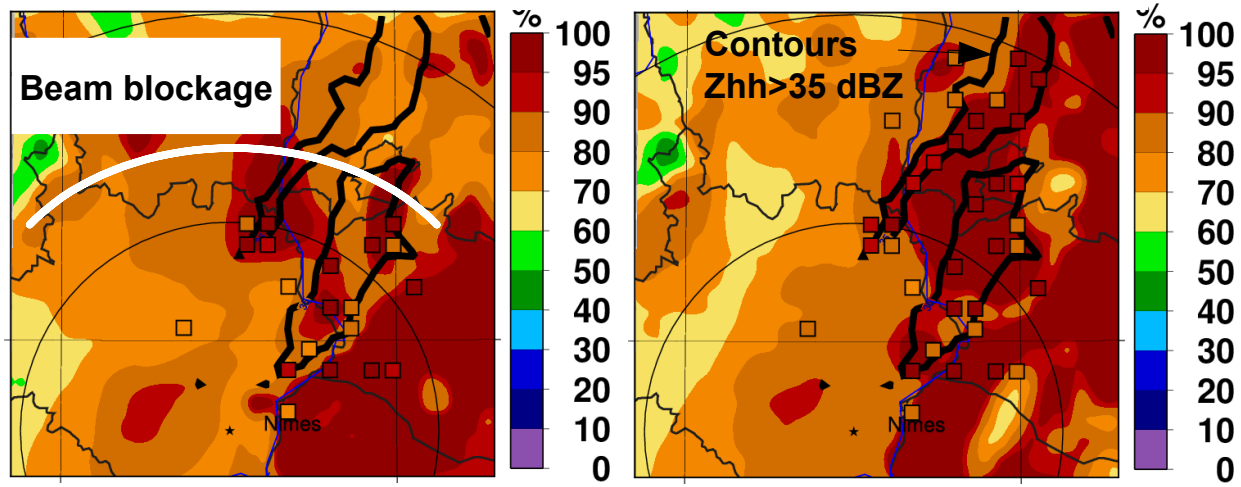
➔ Increase of IWV in analysis with attenuation correction

IWV = Integrated Water Vapor (kg/m2)

24/09/2012 06 UTC , Nîmes radar (S band), elev 1.8°

Impact of assimilating Kdp on the analysis

With Zhh only



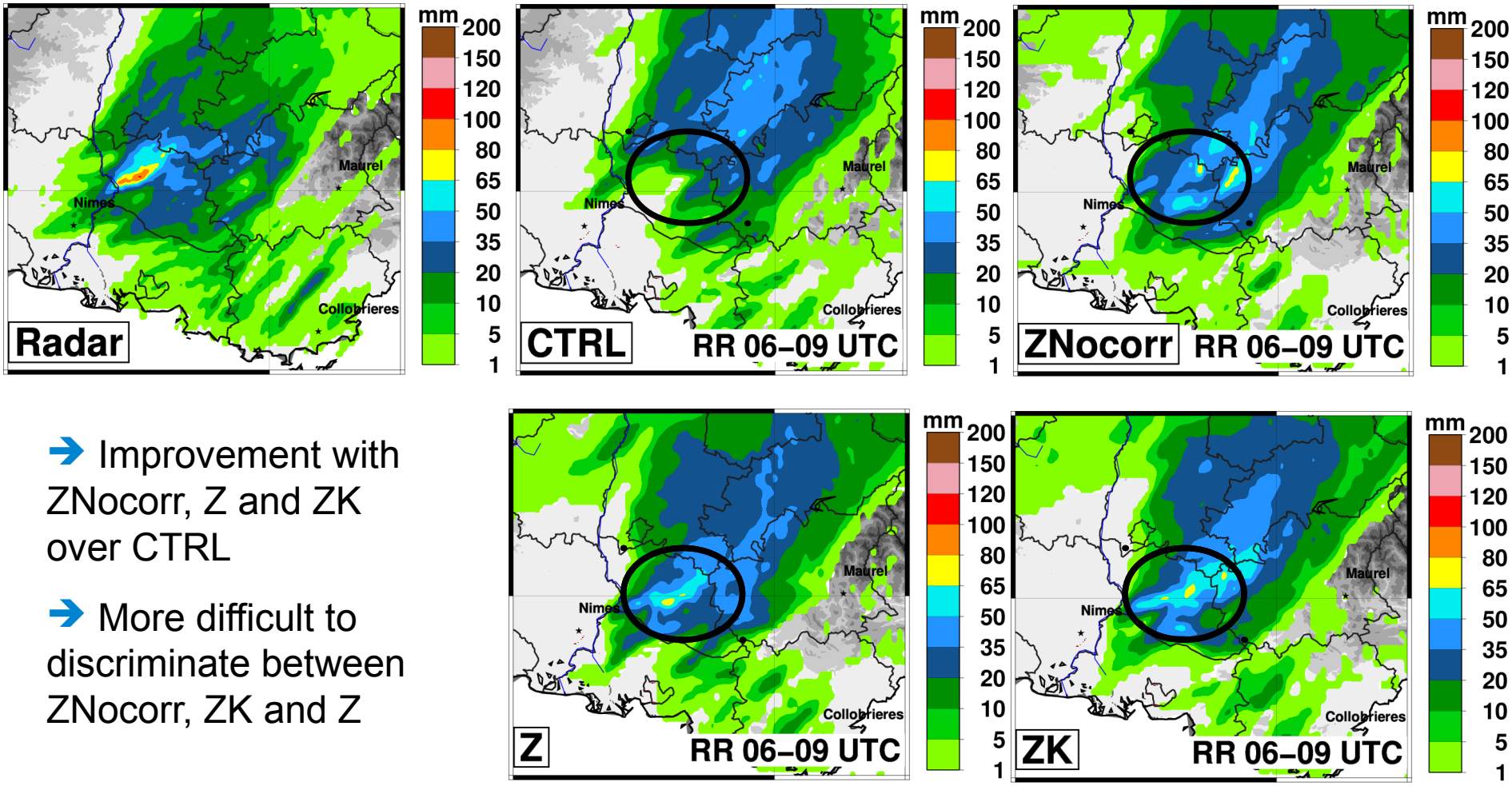
With Kdp mainly

➔ Increase of humidity in analysis thanks to Kdp in partially attenuated areas

24/09/2012 06 UTC , humidity analysis ~ ***1600 m***

Impact on rainfall accumulation forecasts

24/09/2012

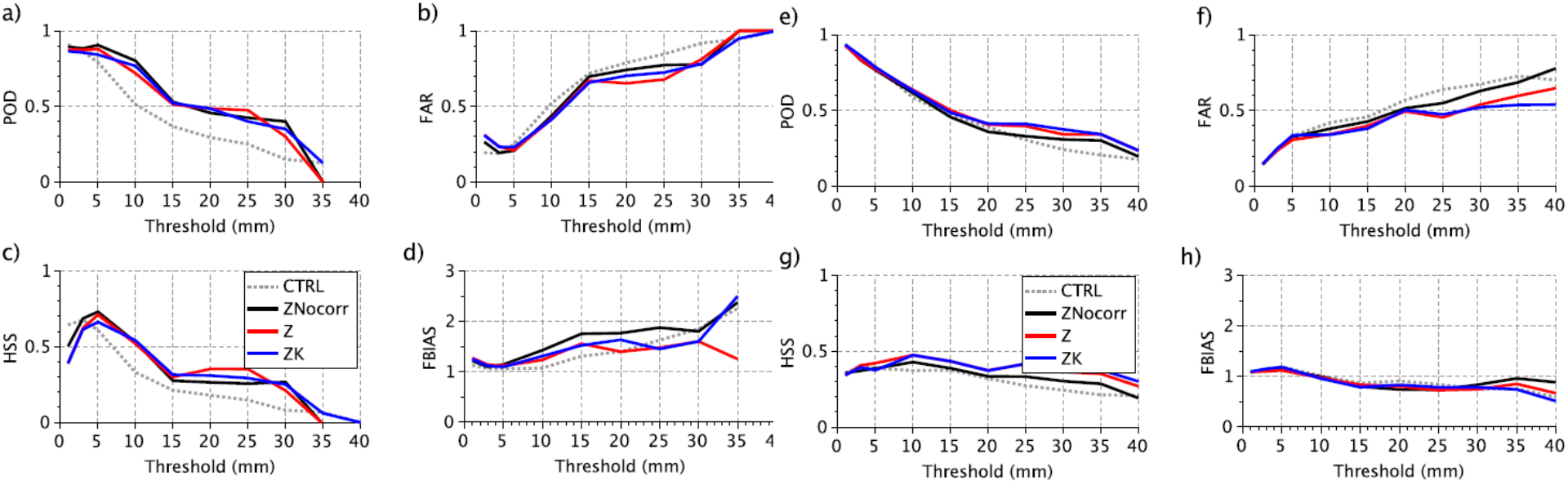


➔ Improvement with ZNocorr, Z and ZK over CTRL

➔ More difficult to discriminate between ZNocorr, ZK and Z

Impact on rainfall accumulation forecasts

Comparisons with radar QPE : contingency scores



IOP6, 5h accumulation

IOP16, 8h accumulation

- Improvement with ZNocorr, Z and ZK over CTRL
- More difficult to discriminate between ZNocorr, ZK and Z

Conclusions and outlook

Conclusions

- Conception and evaluation of an assimilation method well adapted to the current assimilation system in AROME

➔ Improvement of the quality of the assimilated observations (in case of beam blockage, attenuation)

➔ Improvement of the humidity analysis in case of attenuation/beam blockage

➔ Limited impact on short term forecast

Outlook

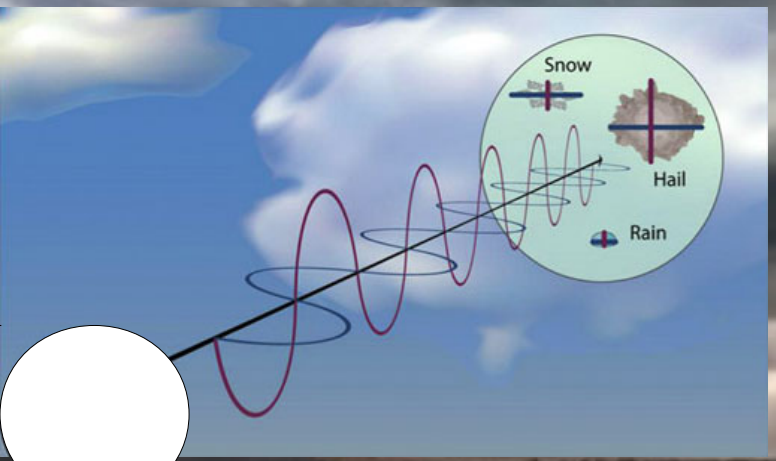
- Assimilation experiments with a new version of AROME (two-moment microphysics scheme LIMA: Vie et al 2016)
- Direct assimilation experiments (1D Var) of polarimetric variables

➔ impact on analysed hydrometeors ?

- Addition of hydrometeors in the control variable of the future assimilation system EnVar in AROME

Thanks !

Questions welcomed !



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