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

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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

- **Cold**
  - Ice crystals
  - Snowflakes
  - Graupel

- **Warm**
  - Cloud droplets
  - Raindrops

Clouds at 0°C
Dual Pol observations and convective-scale NWP models

Dual Polarization observations

• High spatial/temporal resolution
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Convective-scale NWP models

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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

- Adapted to AROME 1 moment microphysics scheme
- **PSD**: Exponential laws (rain, snow, graupel / Gamma law for ice)

- Shape, orientation, dielectric constants
  - From literature and after a sensitivity study

- Melting model parameterization
  - following Jung et al (2008)
Observations

Simulations

Convective system well reproduced

Simulated/observed variables: same order of size


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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Second step: Assimilation of the RH profiles in the 3D-VAR
1D+3D-Var assimilation method in AROME

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

- Comparison between observed and simulated $Z_{hh}$, $Z_{dr}$ and $K_{dp}$ profiles
- Retrieval of a combination of the model profiles that most resemble the observation

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

- Caumont et al (2010)
- Wattrelot et al (2014)
- Augros et al 2017 (in review for QJRMS)
Illustration of the Bayesian retrieval

- ZNocorr: use of Zhh without 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
Illustration of the Bayesian retrieval

- **ZNoCorr**: use of Zhh without attn. corr.
- **Z**: use of Zhh with attn. corr.
- **ZZK**: use of Zhh, Zdr and Kdp
- **ZZ**: use of Zdr mainly (and Zhh)
- **ZK**: use of Kdp mainly (and Zhh)

**Pseudo-observations**

**Zh profiles (dBZ)**

**RH profiles (%)**

Use of Kdp
Assimilation experiments characteristics

- **Expe** | **Assimilated Observations**
- CTRL | All except radar reflectivities
- ZNocorr | CTRL + RH$^\text{po}$ from Zhh without att. corr.
- Z | CTRL + RH$^\text{po}$ from Zhh corrected
- ZK | CTRL + RH$^\text{po}$ 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

Without attenuation correction

With attenuation correction

24/09/2012 06 UTC, Nîmes radar (S band), elev 1.8°
Impact of attenuation correction on the analysis

Without attenuation correction

With attenuation correction

Observation $Z_{hh}$

Contours $Z_{hh}>35$ dBZ

IWV Analysis

Contours $Z_{hh}>35$ dBZ

$\Rightarrow$ 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

- 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!