Institut National de la Météorologie

Impact of an improved Backgrund-error covariance matrix with AROME 3Dvar system over Tunisia

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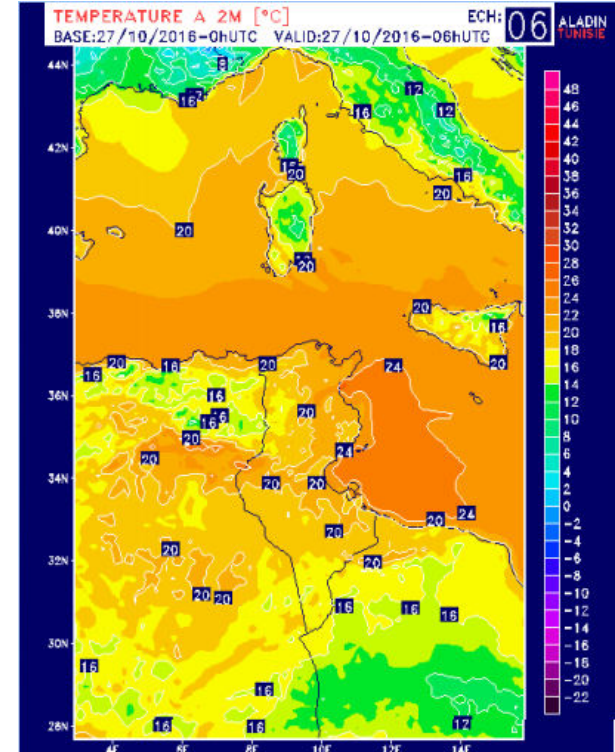* PNT / DRDM / INM

** GMAP / CNRM / Meteo-France

1. **NWP at INM :** general framework

2. **AROME-Tunisie Configuration :** next operational Model

3. **Data Assimilation at INM :** Scheme & observations ?

4. **AROME-3DVAR Configuration :** B Matrix computation and diagnostics

5. **Impact of AROME-3DVAR over convective situations:** Case Studies of September 2016 & October 2017 Floods

6. **Summary & Outlook**

Operational & Parallel Suites

▪Models implemented on Ashtarte Server

	ALADIN operational	AROME	HARMONIE
Model version	CYCLE 40	CYCLE 40	CYCLE 40
Spatial Resolution	7.5 km	2.5 km	2.5 km
Vertical Levels	70	60	65
Boundaries	ARPEGE 10km	ARPEGE 10km	ALADIN 7.5km
Time step	450 s	60 s	60 s

▪ Configuration of **AROME-Tunisia 1.3 km**
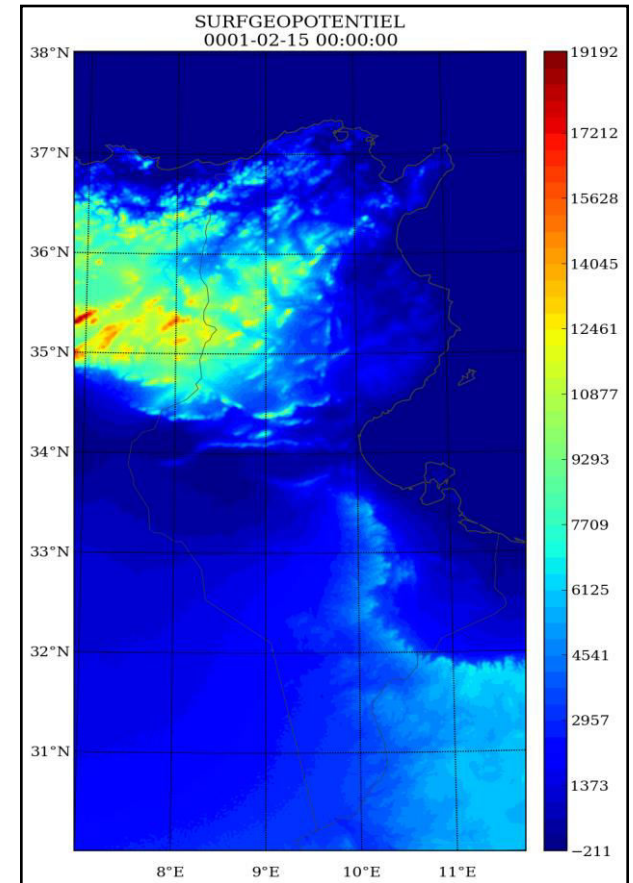(CY42, Coupled to ARPEGE 10Km, Time step 45s,90 vertical levels

▪ HPC Project: Enhancement of the computing capacity:

On going project: 2sd call of tender

AROME-TUNISIE Configuration

	AROME-TUNISIE 1.3 km
Version	CYCLE 42
Resolution	1.3 km
Number of Points NLON*NLAT	384 X 720
Vertical Level	90
Coupling Model	ARPEGE 10km
Time step	45 s

AROME-Tunisie Domain

- **HPC Project**: Enhancement of the computing capacity:

On going project: 2sd call of tender

AROME-MEDJERDA: a small domain over Medjerda catchment

	AROME-MEDJERDA
Model version	**CY40**
Resolution	**1.3 km**
Vertical Levels	90
Boundaries	ARPEGE 10km
Time step	45 s
Center	(8.75,36.5)
N° Points	128*85

▪The catchement of Medjerda, located in the north-western region of Tunisia, is an area at risk that suffers from severe flooding every year.

▪As it holds the biggest river in Tunisia and several dams around it, Medjerda watershed represents an important hydrometeorological study area.

24H Accumulated precipitations of 25/02/2015 - from left to right : Observation, AROME-Medjerda 1,3km and ALADIN 12.5 km
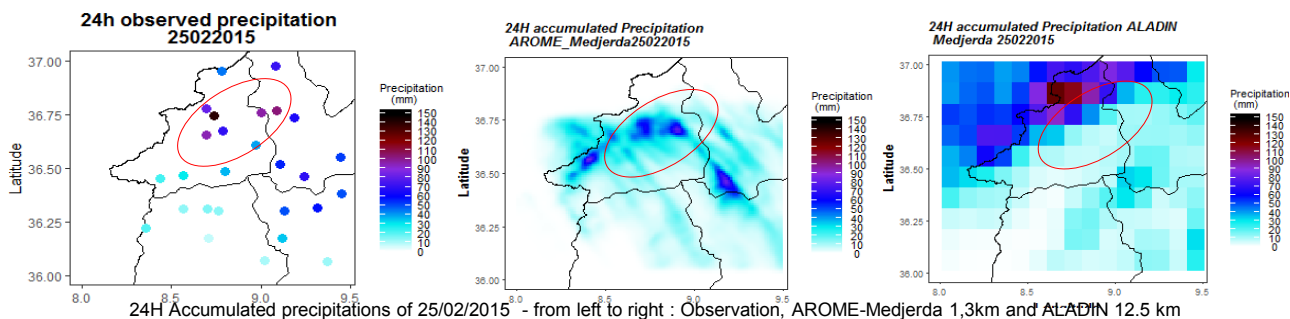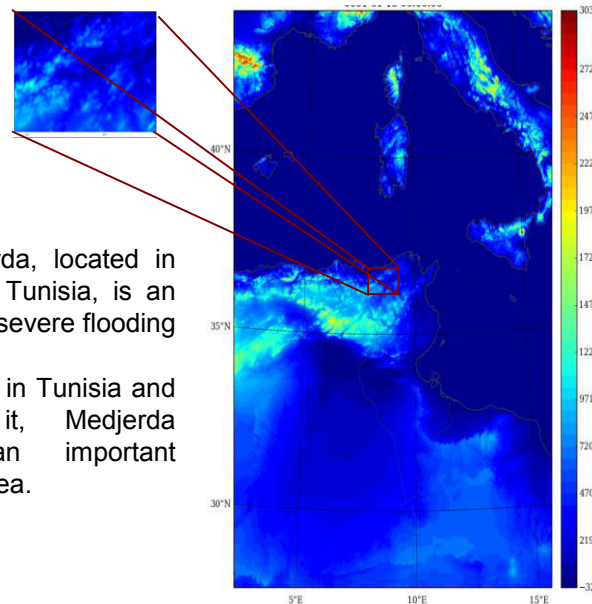
→ Hydrology Application: **Watersum** Project : **Early Warning System** over Medjerda

In Collaboration with General Directorate of Water Resources (Tunisia) and the Regional Environmental Center (REC) and funded by Swedish International Development Cooperation Agency
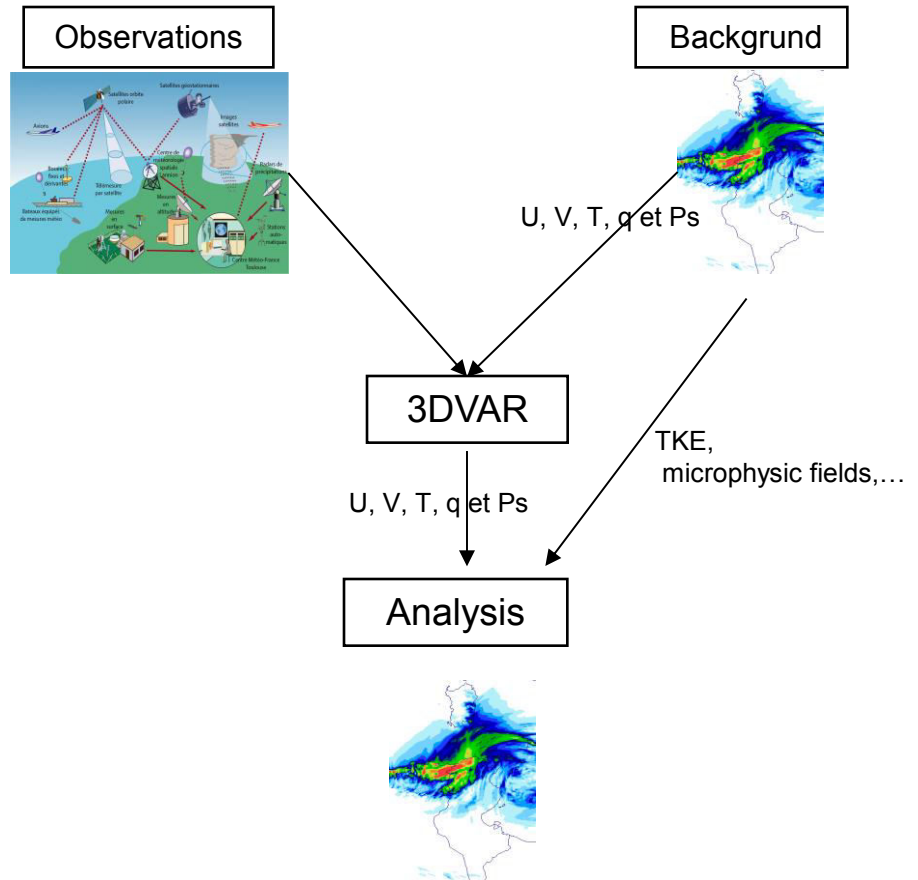
ALADIN-Tunisie DA Configuration

- 3DVAR scheme
- 3H cycling
- OPLACE observations
- Local: Synop, Amdar

AROME-Tunisie DA Configuration
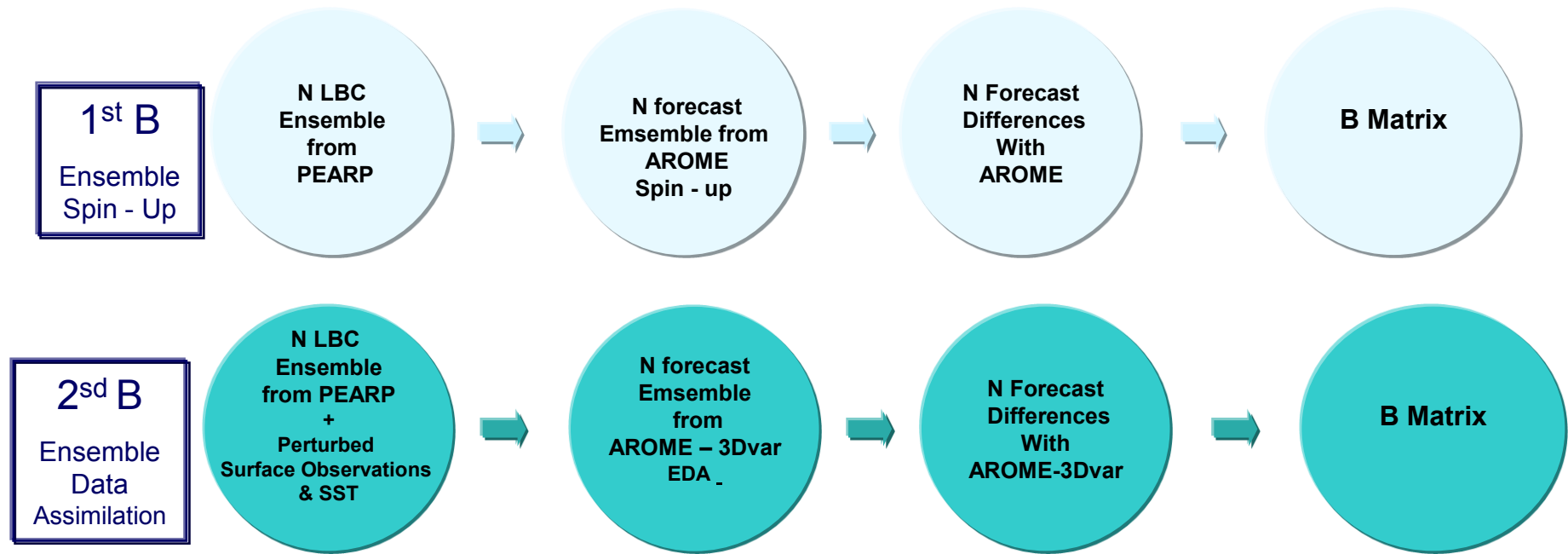
Tested on Meteo-France

- 3DVAR scheme
- 3H cycling
- Synop, Temp, Amdar, Buoy
- Satellite: Seviri, AMSU-A, AMSU-B, IASI

Data Assimilation Scheme

Observations

Backgrund

U, V, T, q et Ps

3DVAR

U, V, T, q et Ps

TKE, microphysic fields,…

Analysis

1st B — Ensemble Spin - Up

N LBC Ensemble from PEARP → N forecast Emsemble from AROME Spin - up → N Forecast Differences With AROME → B Matrix

2sd B — Ensemble Data Assimilation

N LBC Ensemble from PEARP + Perturbed Surface Observations & SST → N forecast Emsemble from AROME – 3Dvar EDA → N Forecast Differences With AROME-3Dvar → B Matrix

Perturbed Surface Observations & SST

Perturbed SST: (following Y. Michel's works)

- OSTIA files

- As the Sea ~ 1/6 of Tunisian domain -> fixed perturbation

▪B matrices are the average of 3 B matrices calculated over 3 periods: winter (rainy season), summer (Hot & humid) and Fall (convective systems) → take on consideration all the Regimes that influence Tunisian Weather

▪ In order to have a positive definite B matrix, we must have the number N of differences equal to or greater than the number of vertical levels of the model (60 for Arome 2.5 km et 90 for Arome 1.3 km) :

Winter-Time 07-16 February:

 6 members ensemble * 10 days at 00H → **60**

Fall-Time ''Off season'' 25September – 04October 2015:

6 members ensemble * 10 days at 00H → **60**

Summer-Time 16-20 August 2016:

6 members ensemble * 5 days * 2 runs 00H & 12H (to integrate convective phenomena) → **60**

▪Same periods for B matrix - EDA and B matrix Spin-up → compare the matrices
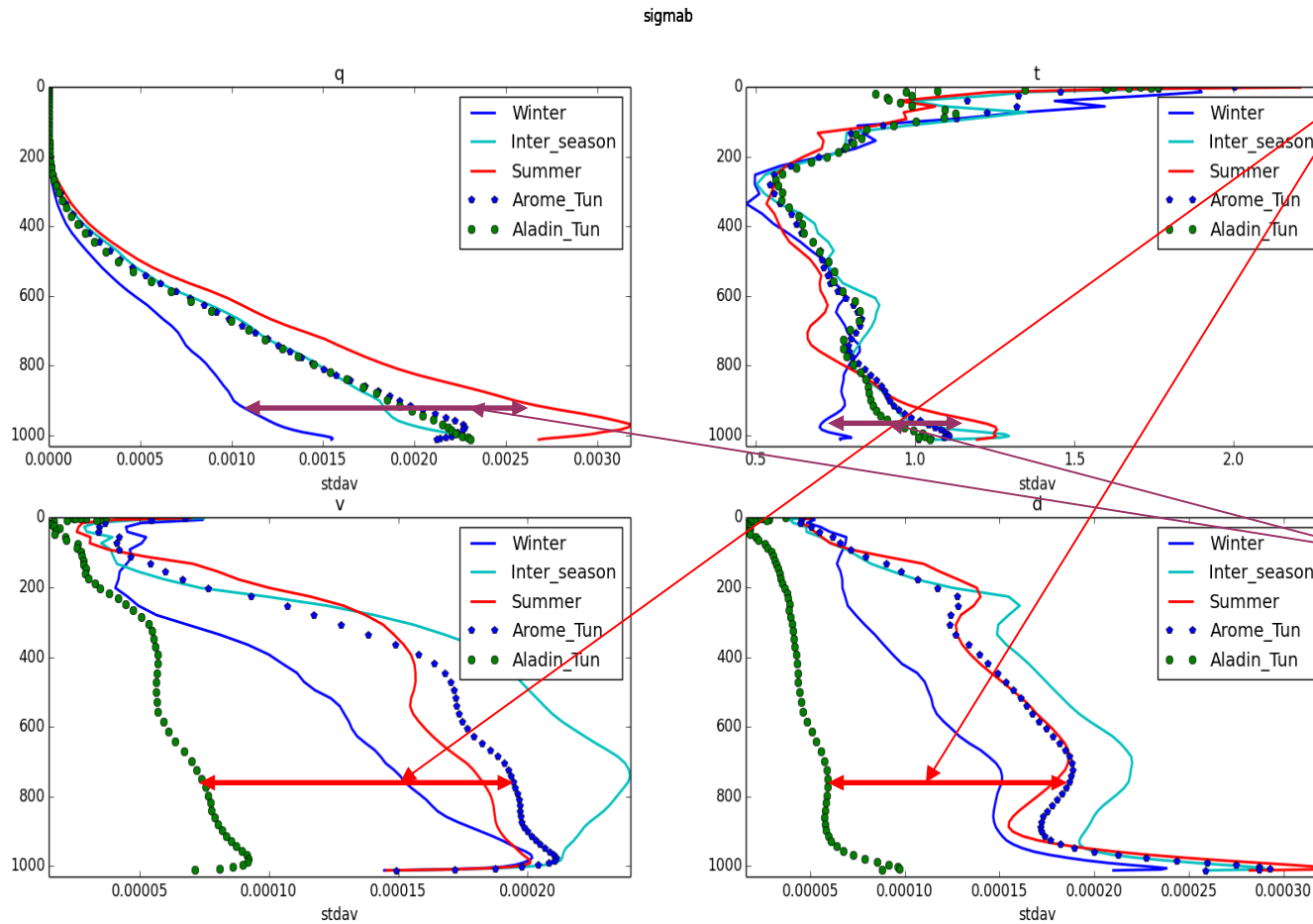
Increase in standard deviation of vorticity and divergence of Arome compared to Aladin

Differences between Summer & Winter

→ limit of the « climatologic » B matrix

Vertical profile of the standard deviation of specific humidity (q), temperature (t), vorticity (v) and divergence (d) for AROME-TUNISIE during winter (blue line), inter-season (cyan line) and summer (red line) periods; AROME–Tunisie (mean of the 3 periods) (blue dot) and ALADIN-TUNISIE (green dot).
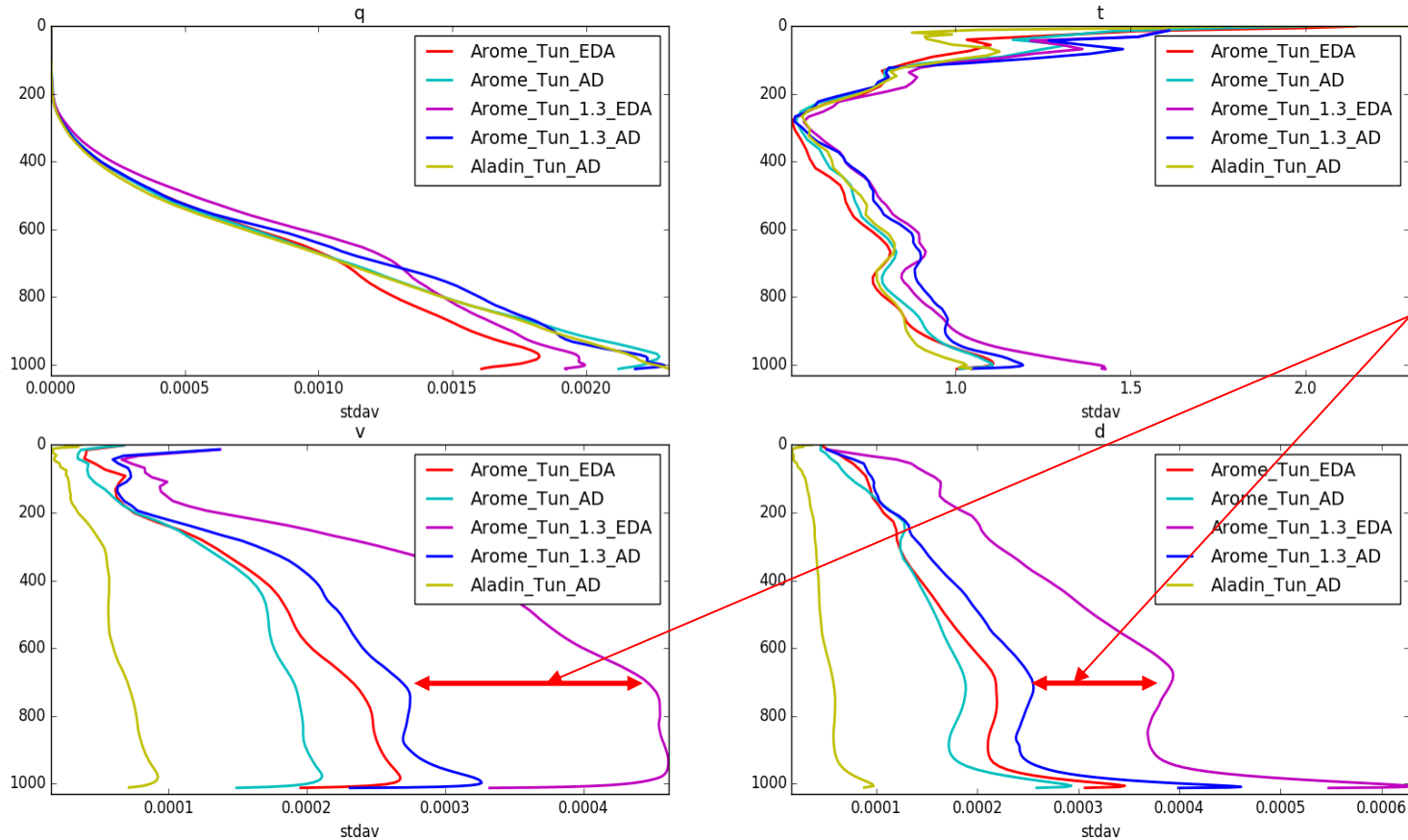
Increase in standard deviation of vorticity and divergence of Arome EDA versus Arome Spin up

Vertical profile of the standard deviation of specific humidity (q), temperature (t), vorticity (v) and divergence (d) for AROME-TUNISIE Spinup; AROME–Tunisie EDA and   ALADIN-TUNISIE (green dot).

Horizontal variance spectra at 800 hPa of specific humidity (q) temperature (t), vorticity (v) and divergence (d) for AROME–Tunisie (blue) and ALADIN-TUNISIE (green)
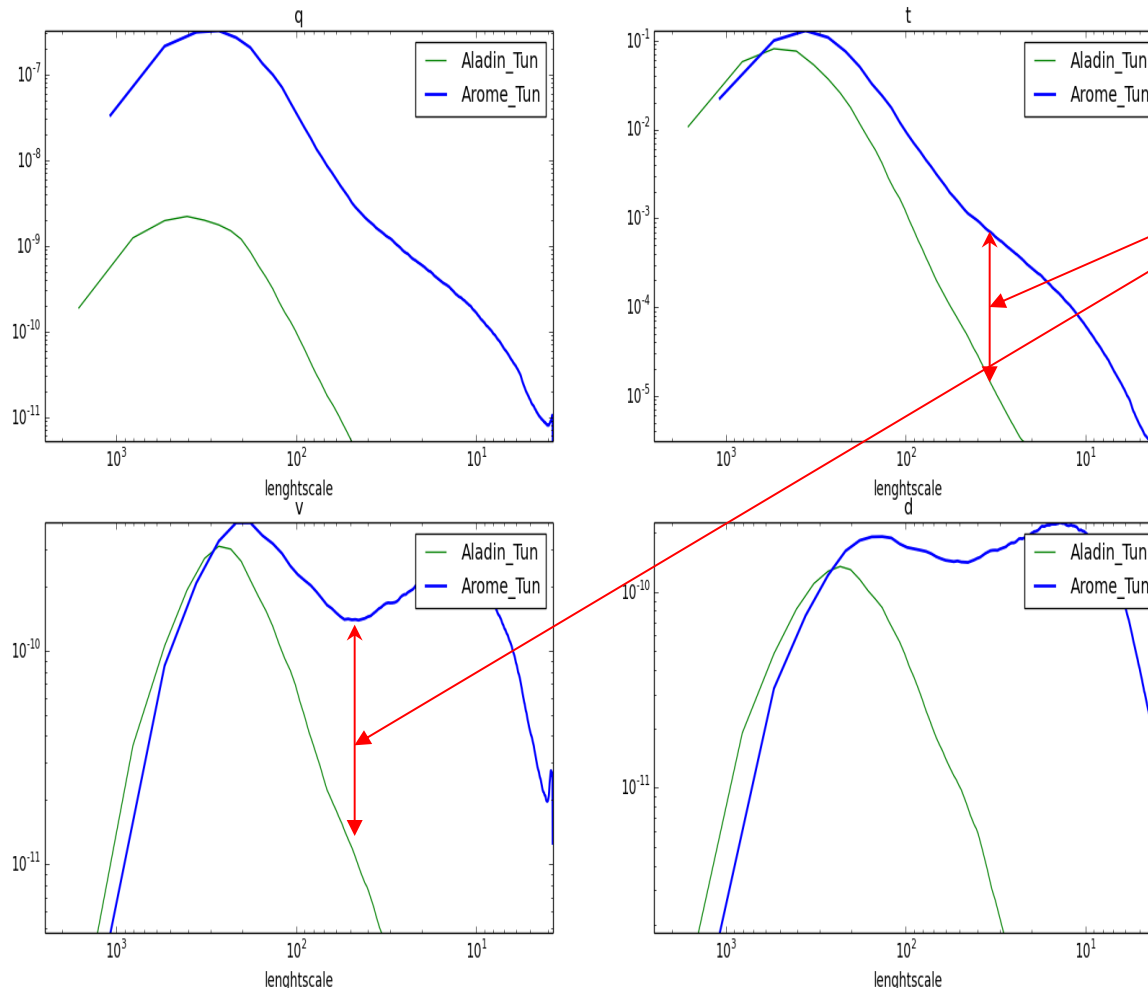
Difference between Arome and Aladin for short wavelengths as Arome represents better small scale structures

Arome DA will put less weight on background fields than Aladin

→ **For the same innovation, Arome increment will have larger amplitude then Aladin**
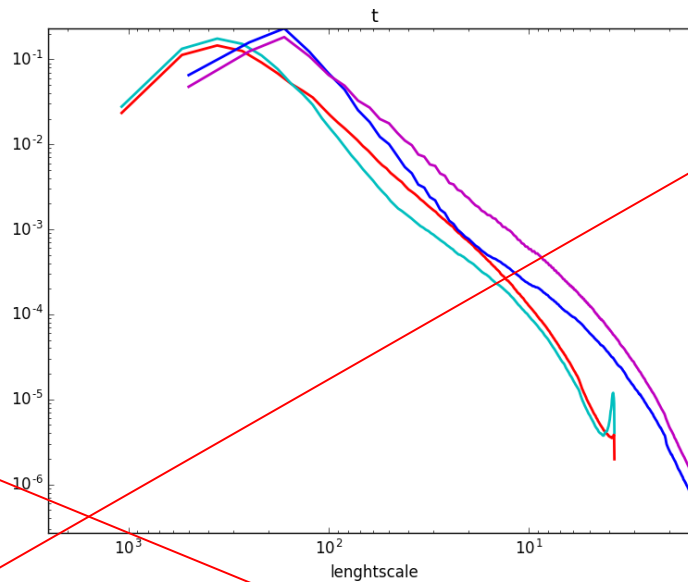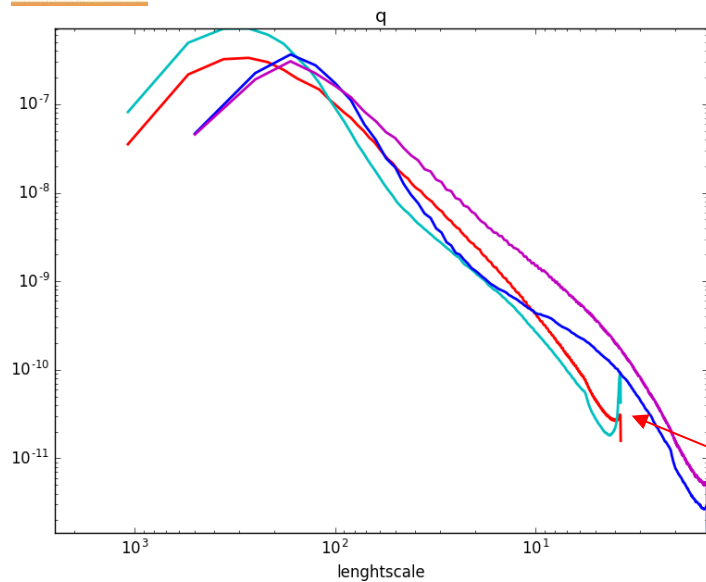
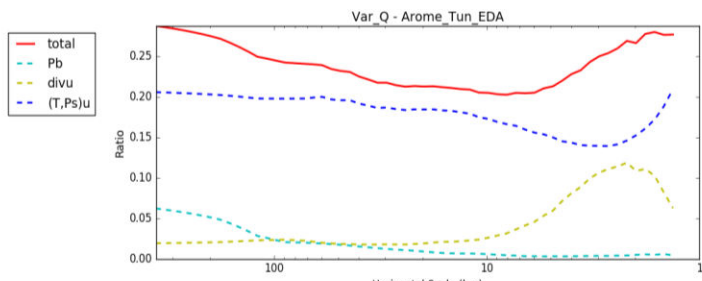Arome EDA horizontal variance are bigger than Arome Spin up for short wavelengths

Evolving of small scale background perturbations due to EDA Cycling Effect
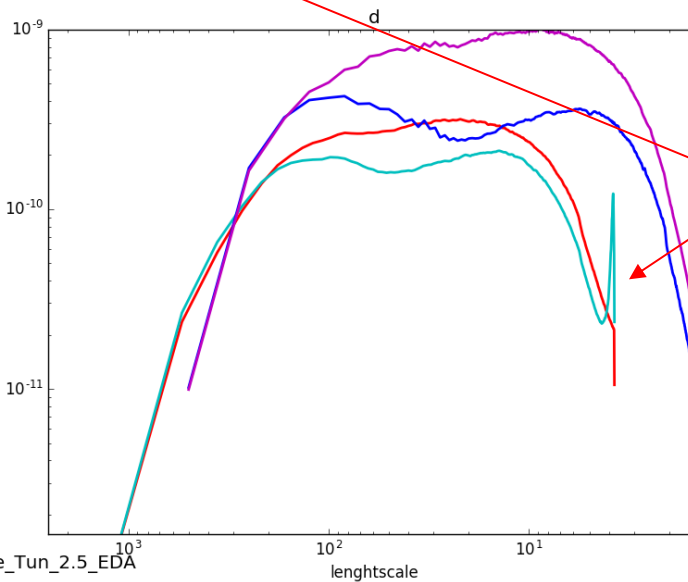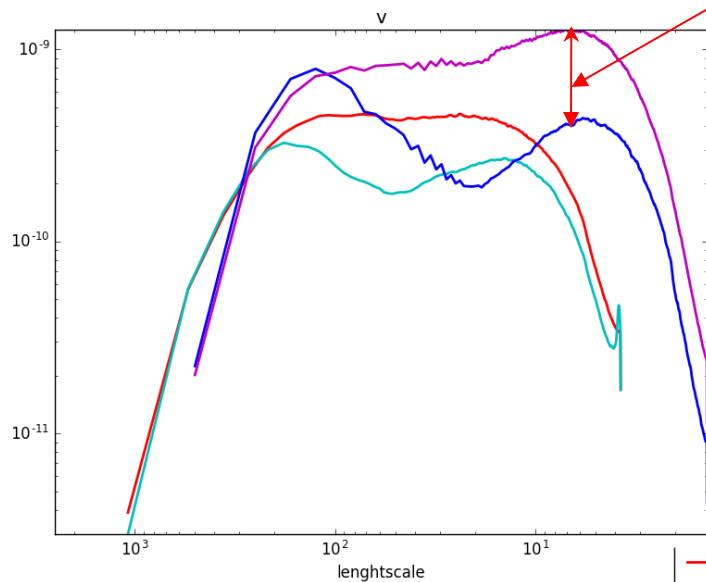
Noise with B matrix Spin-up

-> reduced due to DA cycling with B matrix EDA

Arome_Tun_2.5_EDA
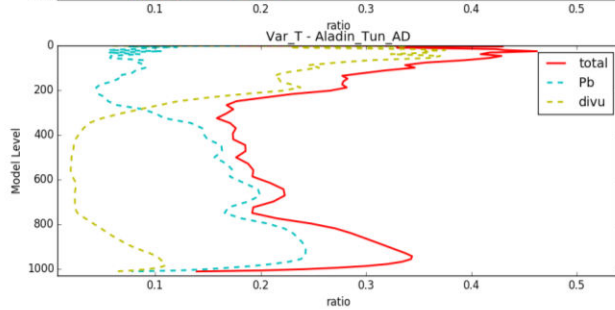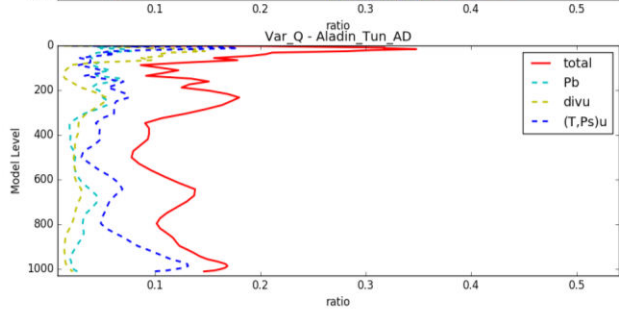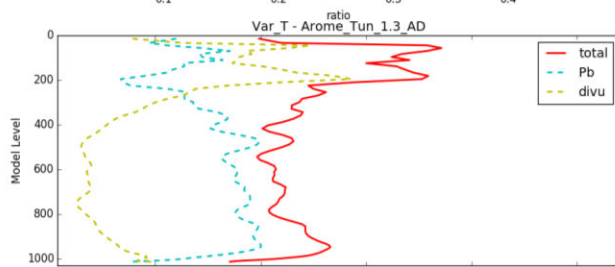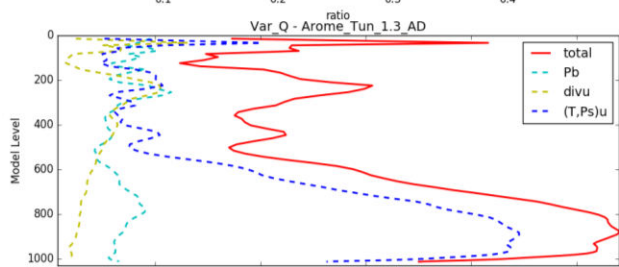Arome_Tun_2.5_AD
Arome_Tun_1.3_AD
Arome_Tun_1.3_EDA
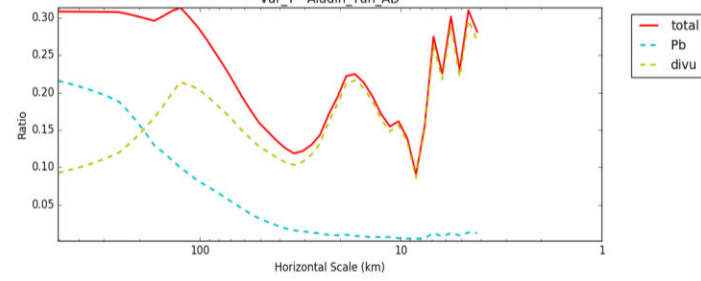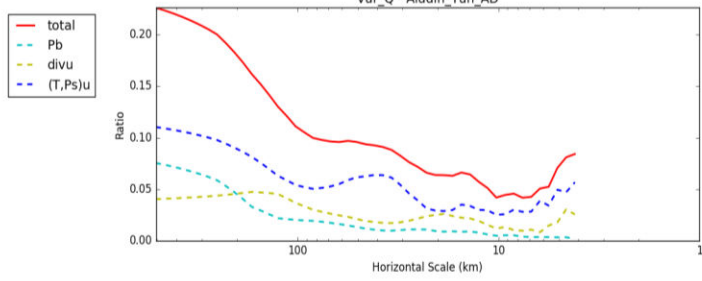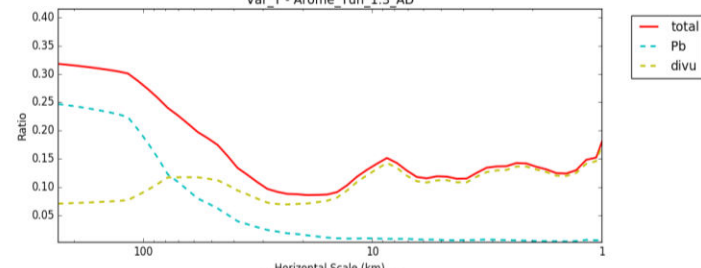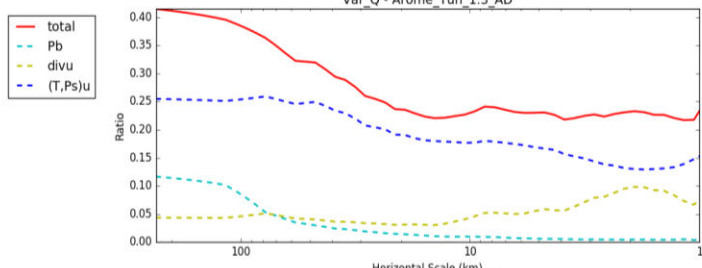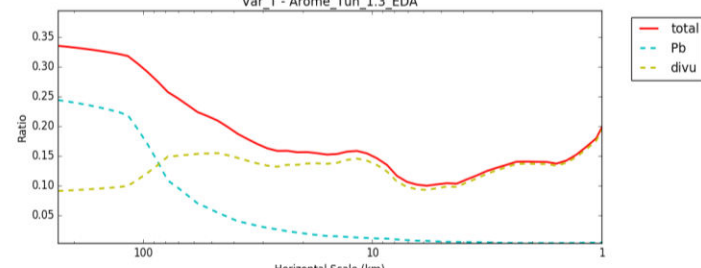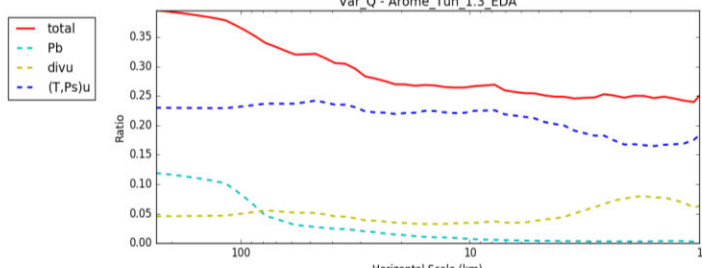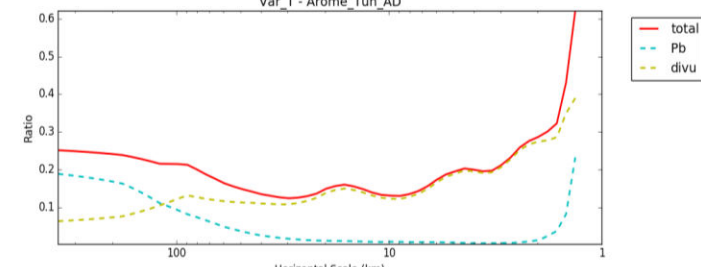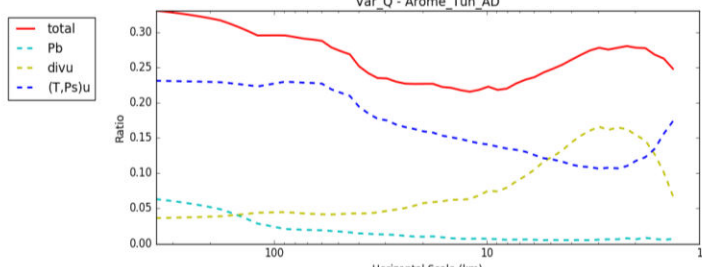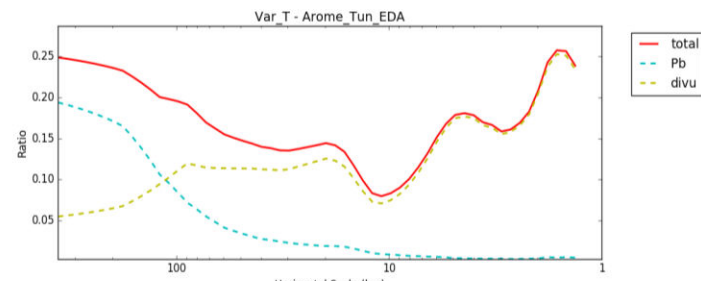
Explained Variance %
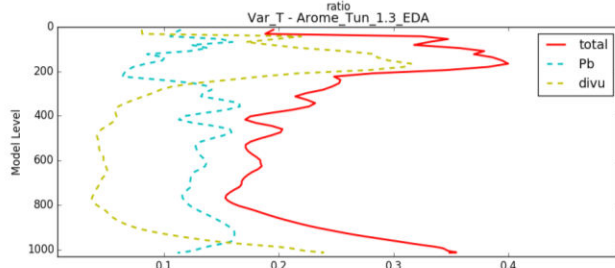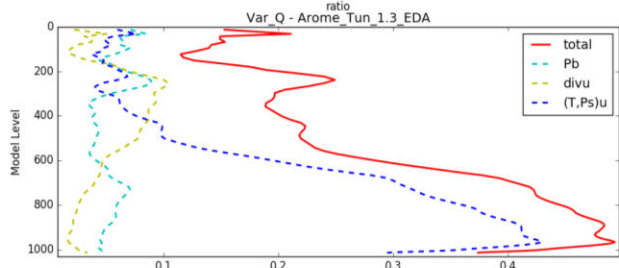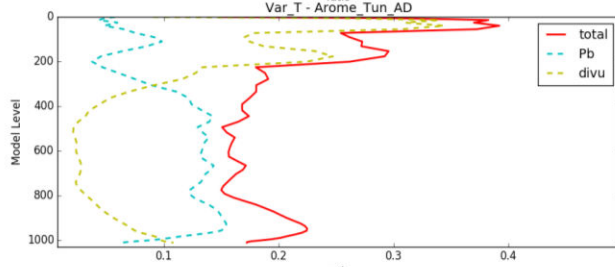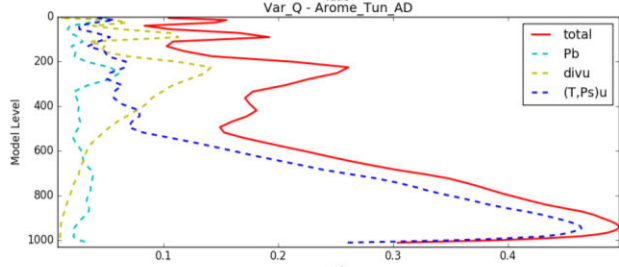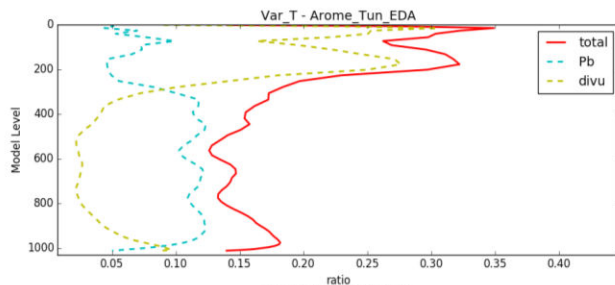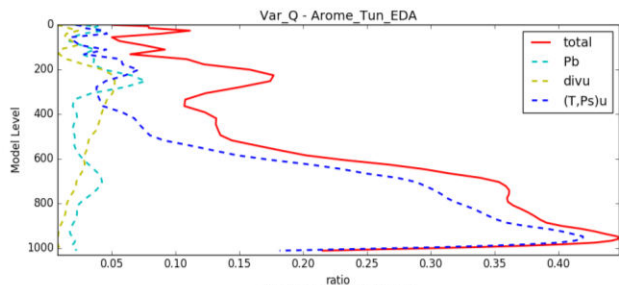
Pb unbalanced
Geopotentiel

Divu unbalanced
Divergence

T unbalanced
Temperature

Explained Variance %

Pb unbalanced
Geopotentiel
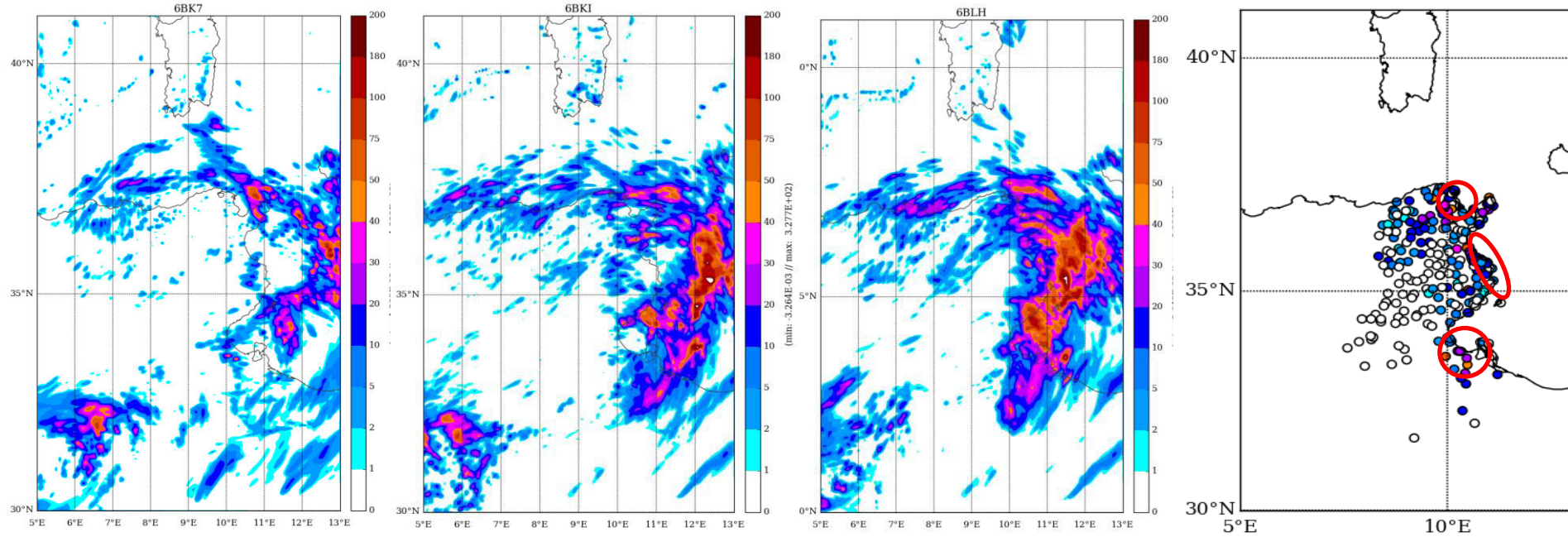
Divu unbalanced
Divergence

T unbalanced
Temperature

AROME Spin-up

AROME 3DVAR – Bmatrix Spin up

AROME 3DVAR – Bmatrix EDA

Observations

Scores du :2017100300

Case Study - 03 October 2017

Better Prediction for the cell localization and intensity

▪ 3 typical systems: North-East, East Cost, South-East Cells

▪Better Prediction for the cell localization and intensity for Arome 3DVAR compared to Spin up

▪Better scores for Arome 3DVAR EDA Bmatrix compared to Bmatrix Spin up

Convective Situation causing heavy rain & flood

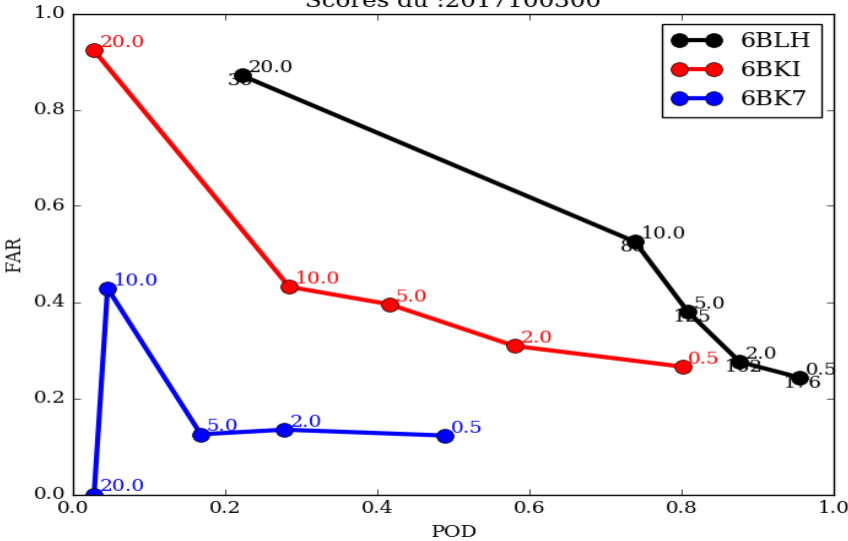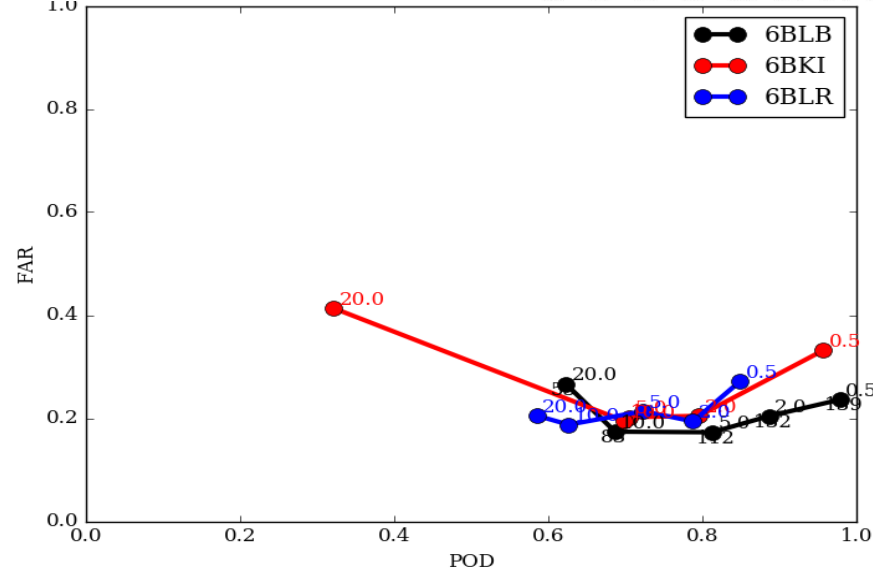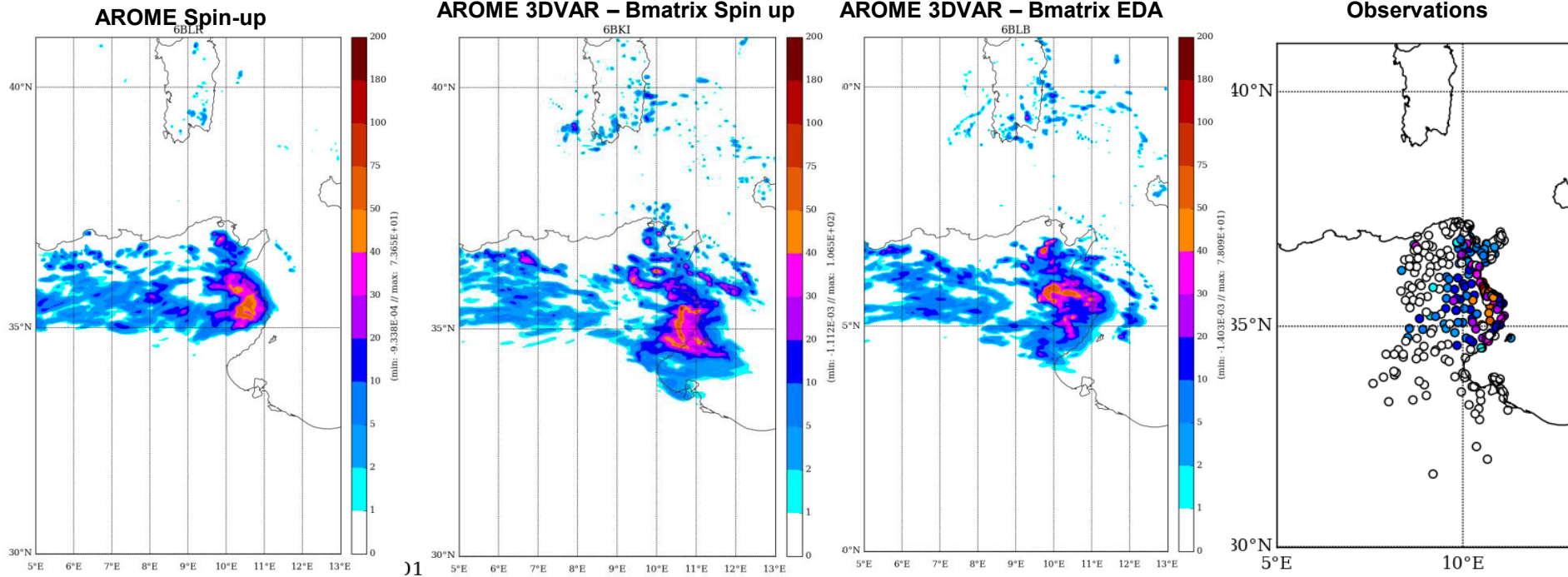AROME Spin-up   AROME 3DVAR – Bmatrix Spin up   AROME 3DVAR – Bmatrix EDA   Observations

Case study - 23 September 2016

Better Prediction for the cell localization and intensity:

- Better Prediction for the cell localization and intensity for Arome 3DVAR compared to Spin up

- Better scores for Arome 3DVAR EDA Bmatrix compared to Bmatrix Spin up

Convective Situation causing heavy rain & flood

- Encouraging results with AROME-Tunisie 3dvar

- Despite the computational cost, B matrix with EDA is worth pursuing

- Next Challenge: Observations

  Work on our Local Data Base Observation for DA

Acknowledgment :

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Thanks to all the GMAPers for the support

Thank you ☺

Question ?

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