Recent DA experiments in Hungary

Gergely Bölöni, Edit Adamcsek, Roger Randriamampianina, Máté Mile, László Kullmann

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Recent activity

- Assess the added value of atmospheric (3DVAR) and surface (OI) DA in ALADIN
- Demonstration of DA in case studies (Wednesday afternoon)
- Background error modeling in ALADIN
- Revision the use of AMSU channels (Roger & Beni)
- First steps towards Arome data assimilation

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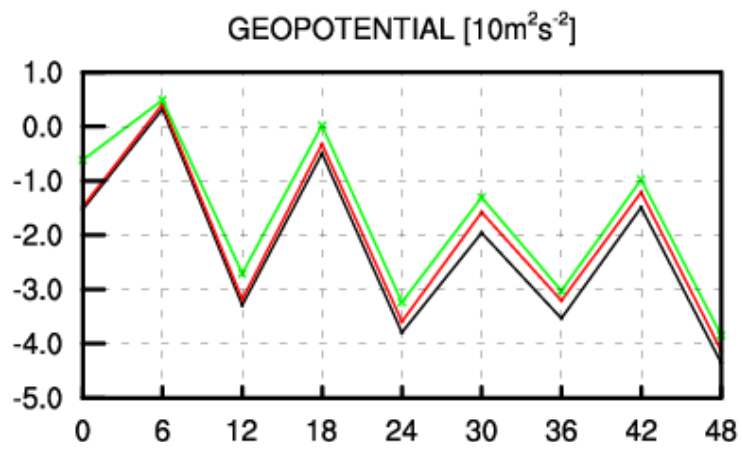
Value of 3DVAR and surf OI

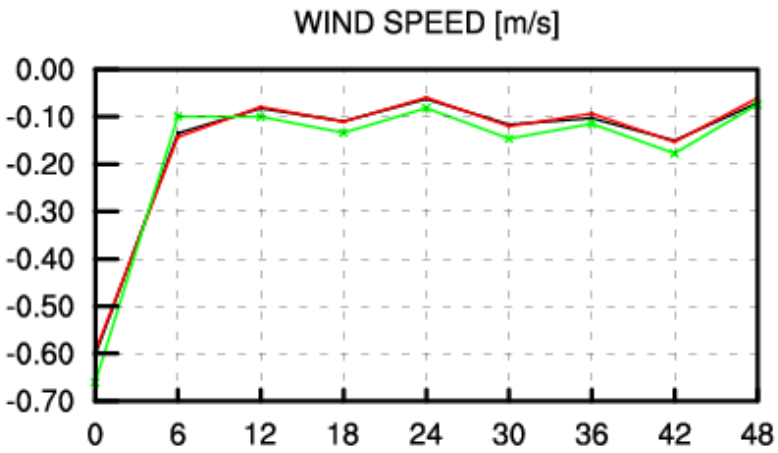
Period: 06/2010
3 experiments coupled to IFS:

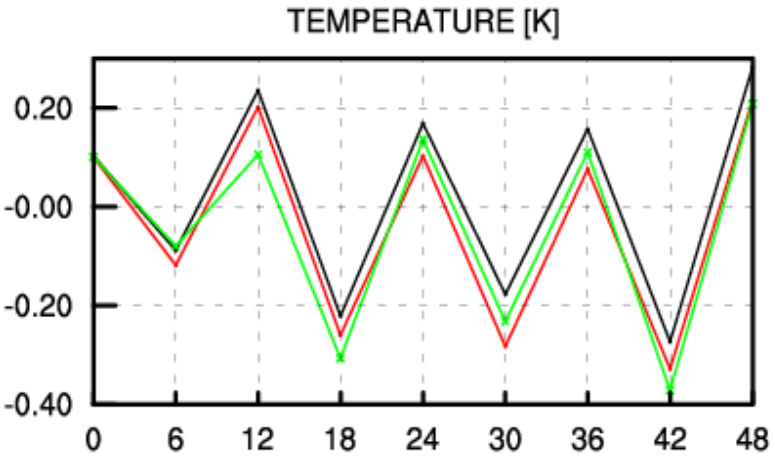
- **DYNA**: dynamical adaptation – no assimilation (surface from ARPEGE)
- **DYCA**: atmospheric IC from IFS + surface OI (CANARI)
- **OPER**: atmospheric

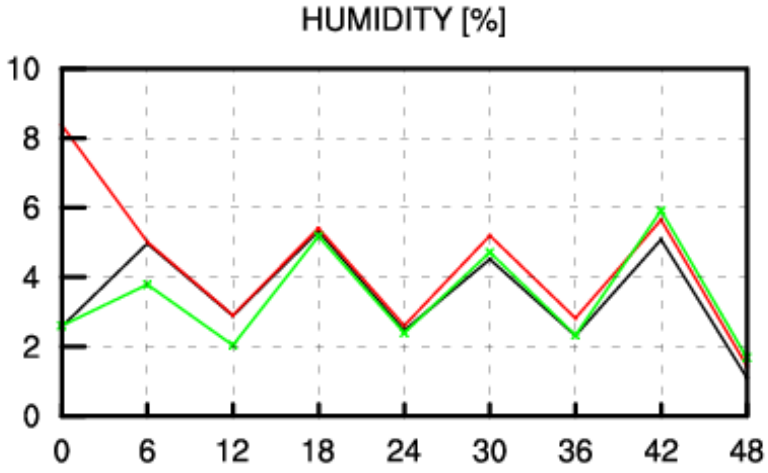
Value of 3DVAR and surf C

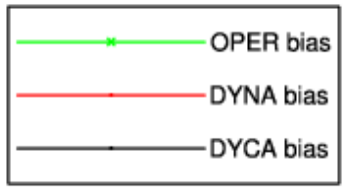
BIAS at 2m





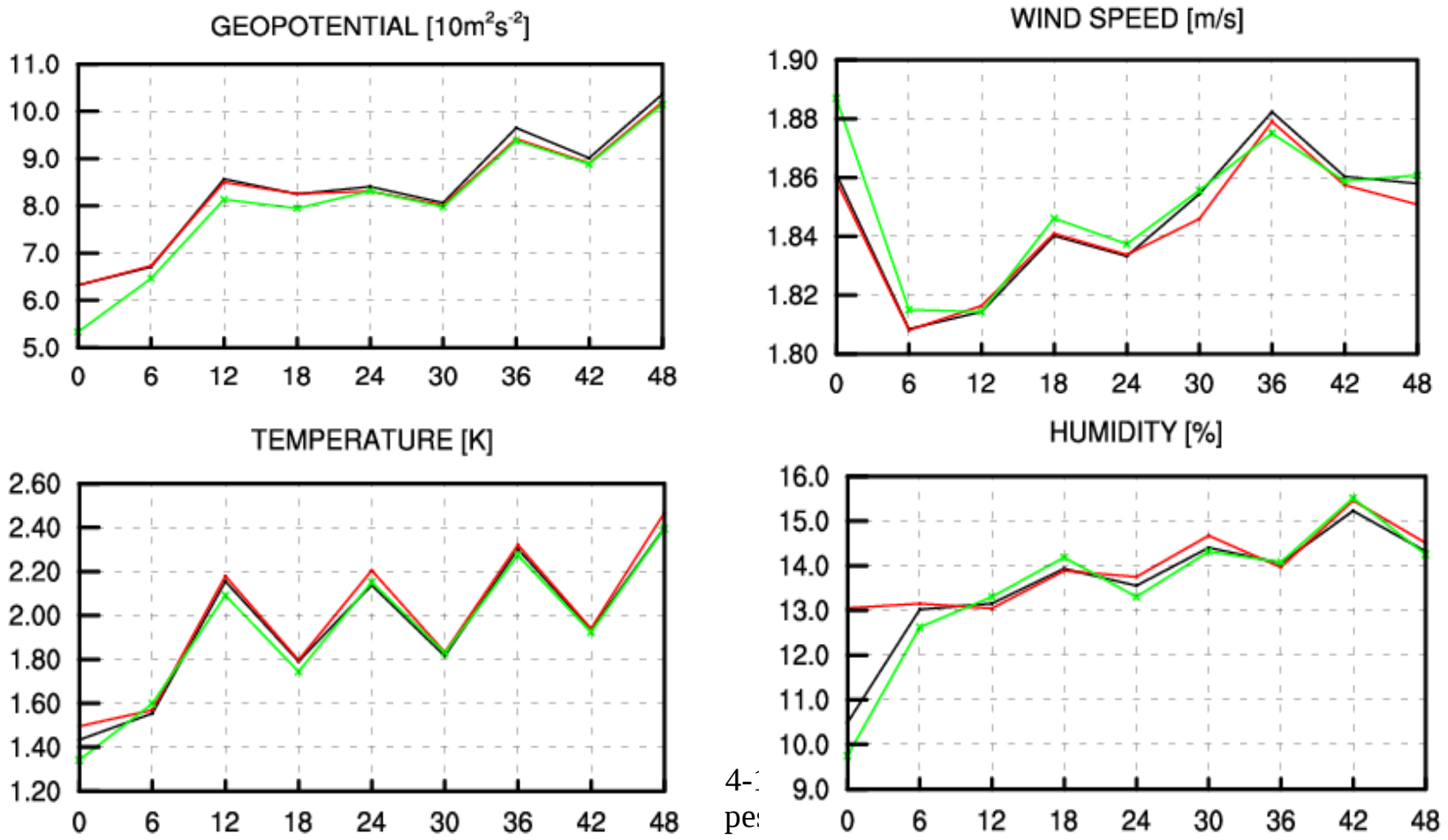






Value of 3DVAR and surf

RMSE at 2m



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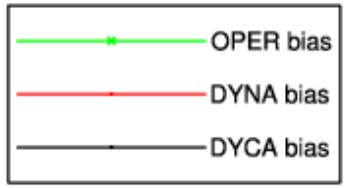
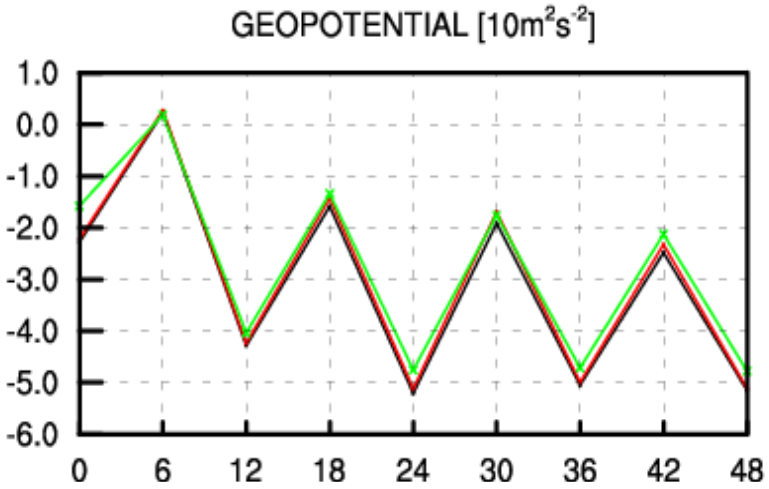
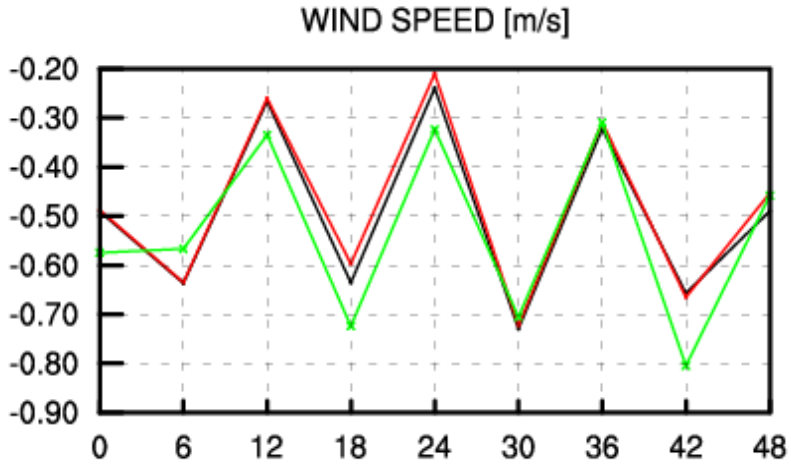
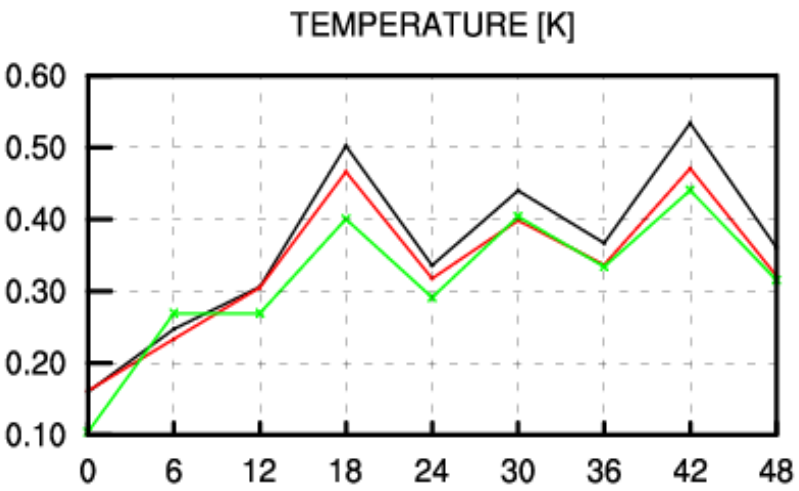
Value of 3DVAR and surf C

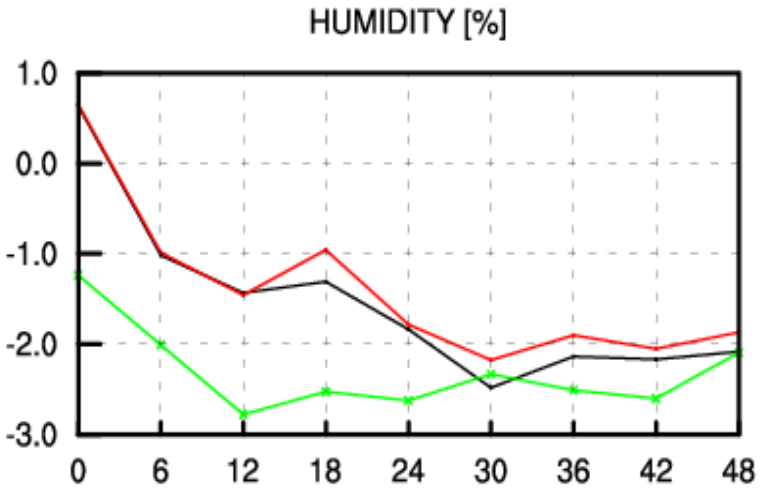
BIAS at 850 hPa





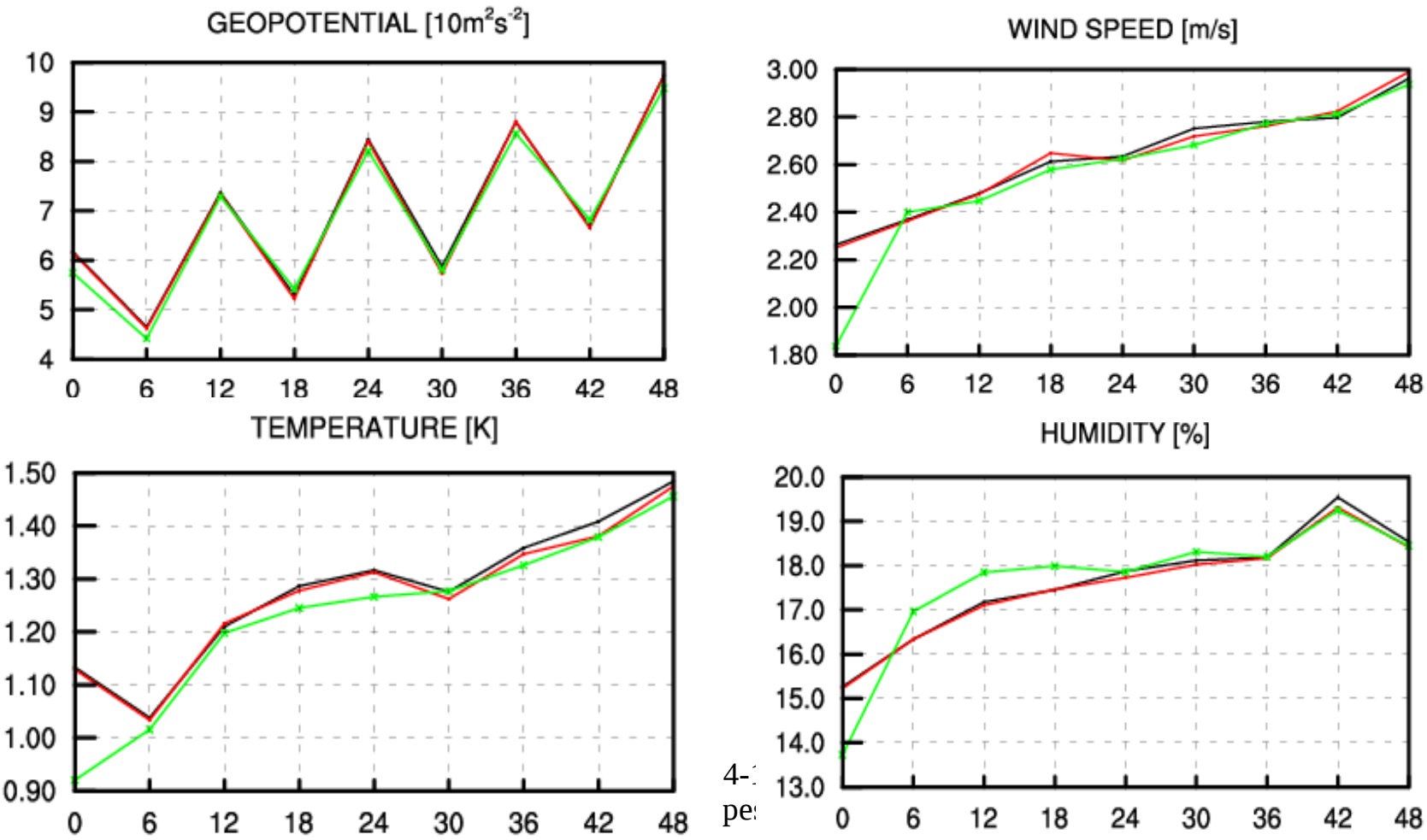






Value of 3DVAR and surf

RMSE at 850 hPa



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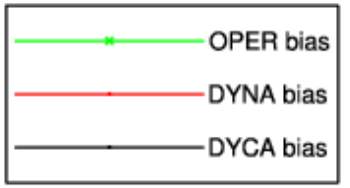
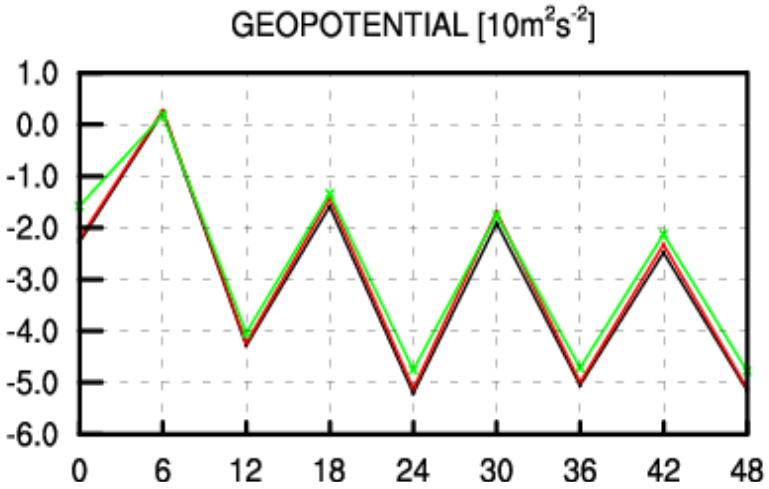
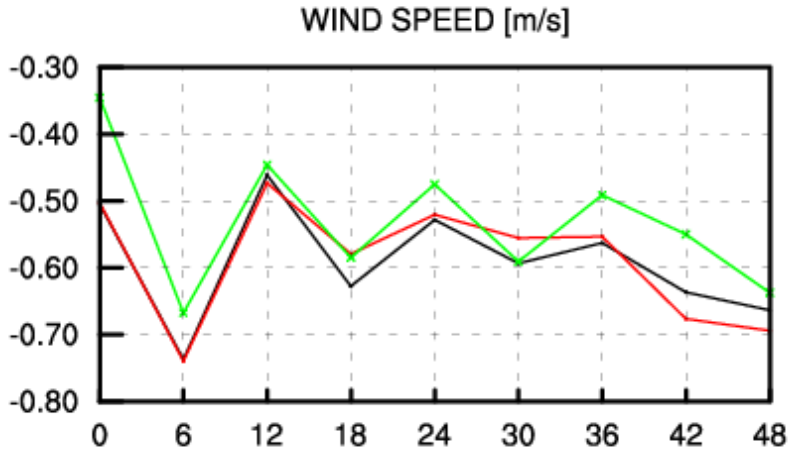
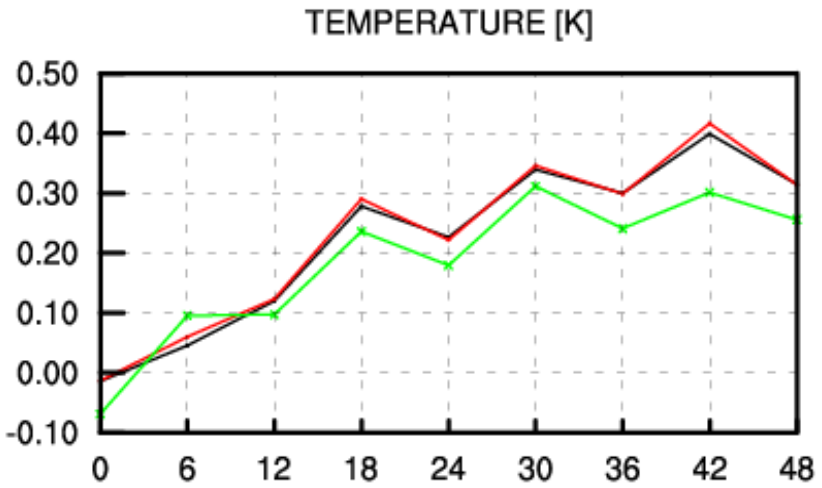
Value of 3DVAR and surf C

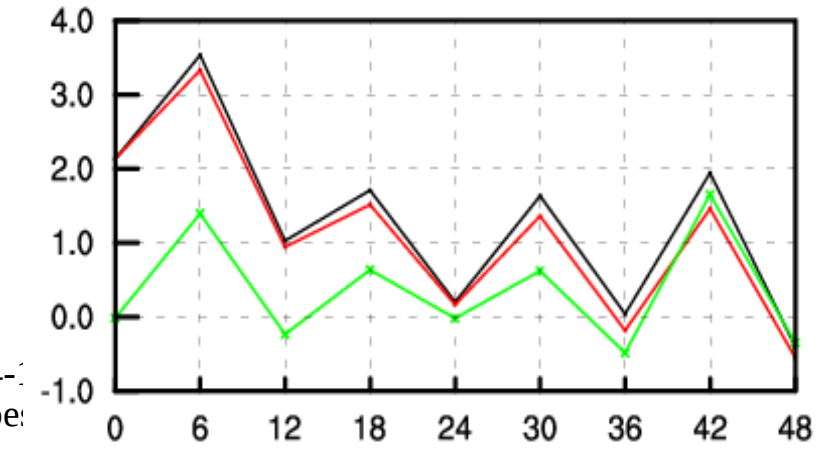
BIAS at 700 hPa





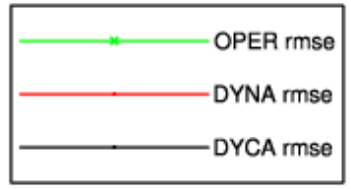


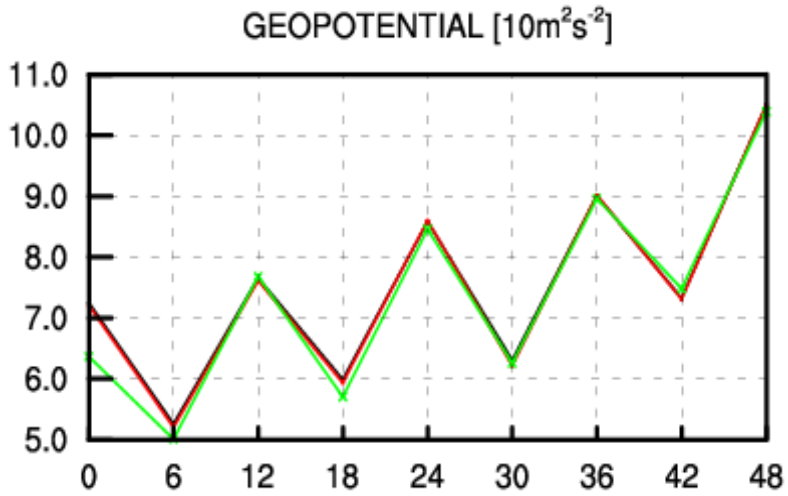


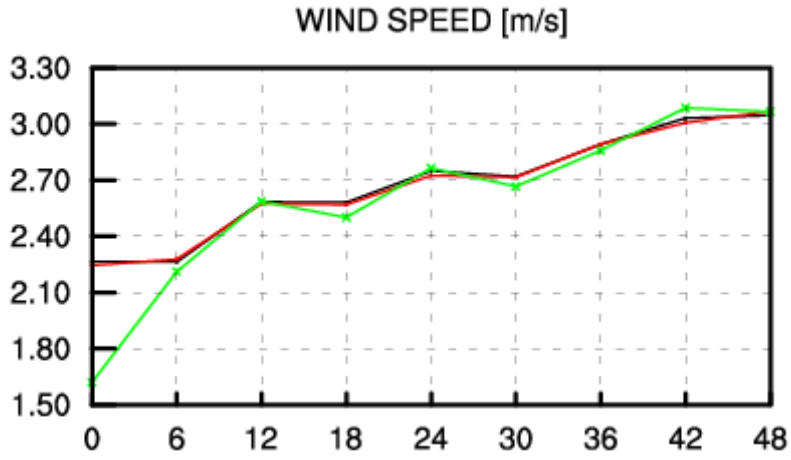


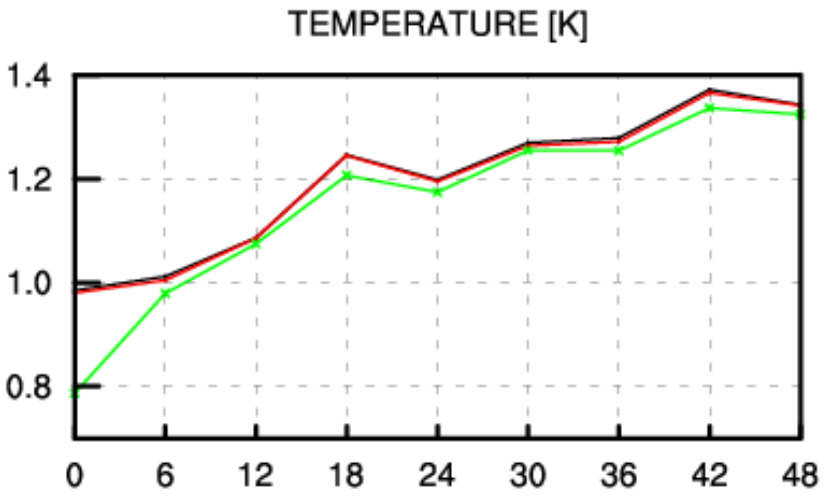
Value of 3DVAR and surf

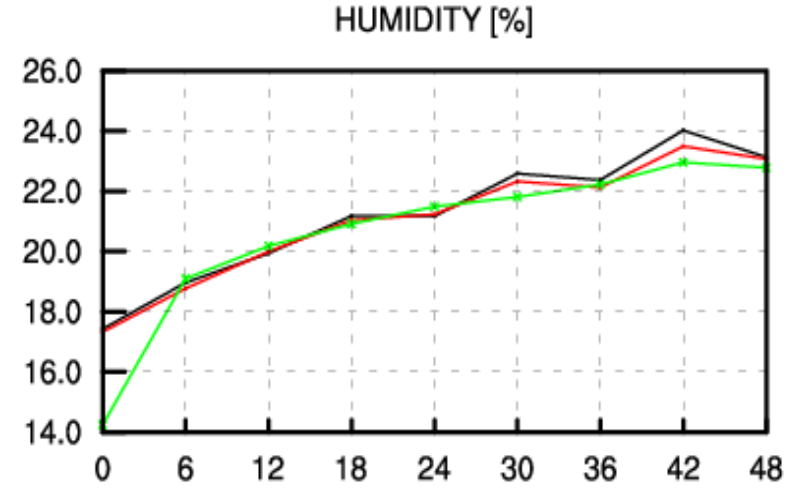
RMSE at 700 hPa











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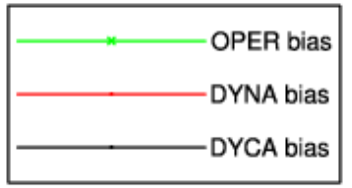
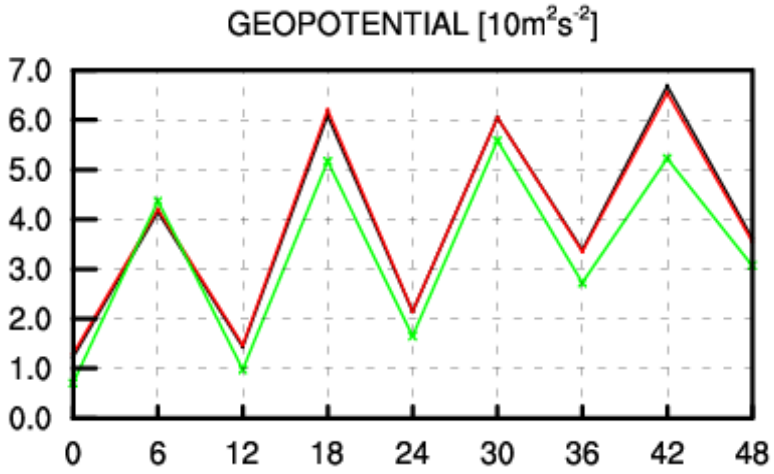
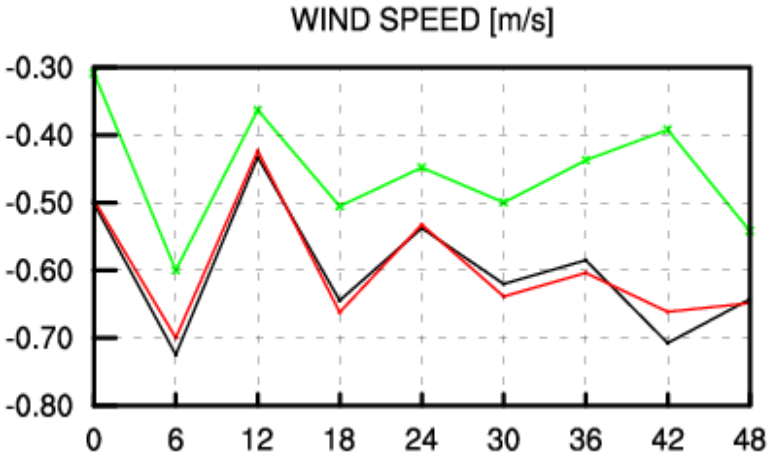
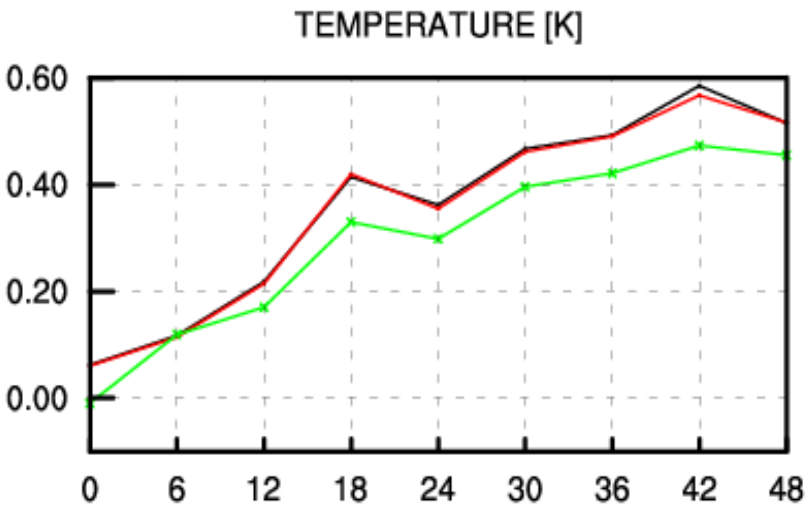
Value of 3DVAR and surf C

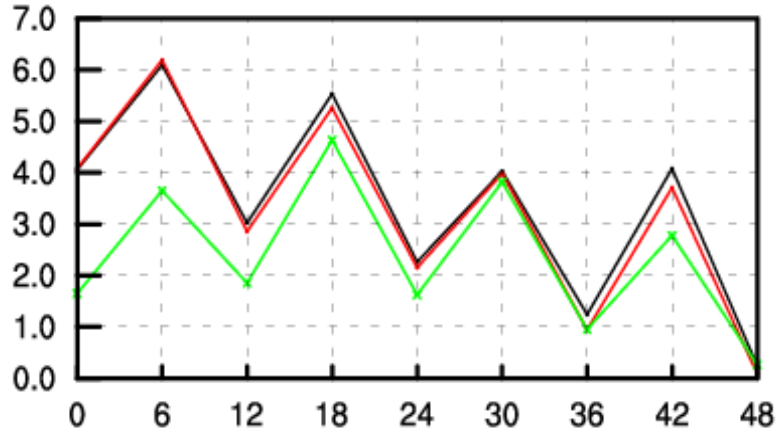
BIAS at 500 hPa





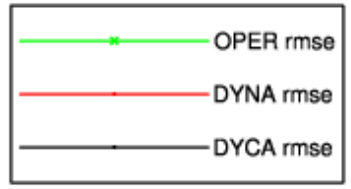


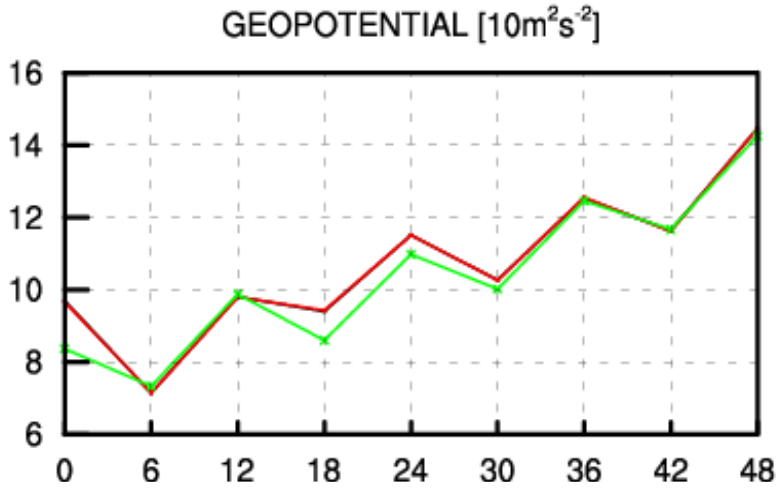


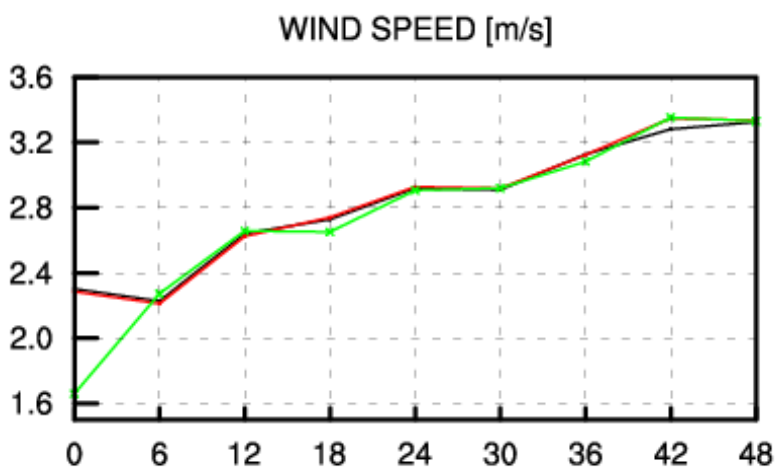


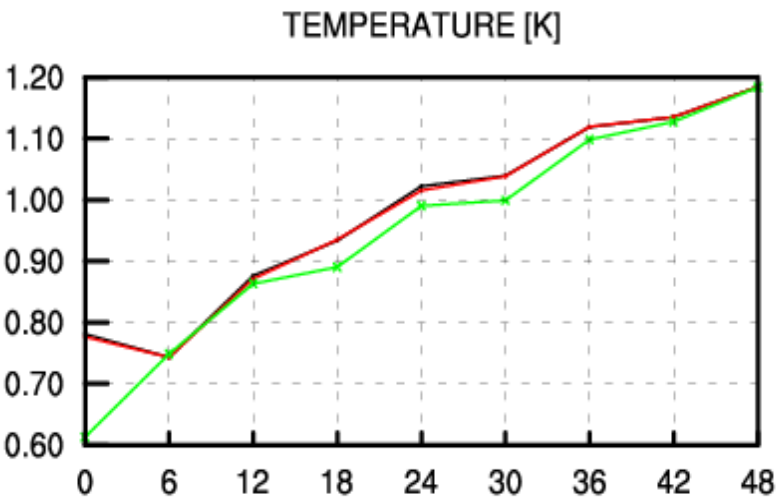
Value of 3DVAR and surf

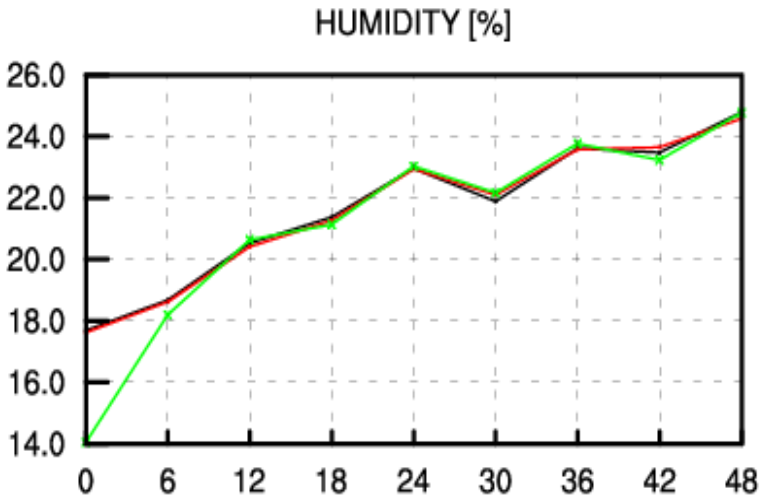
RMSE at 500 hPa











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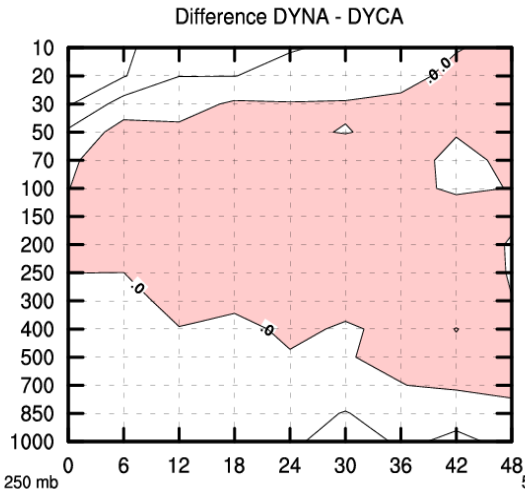
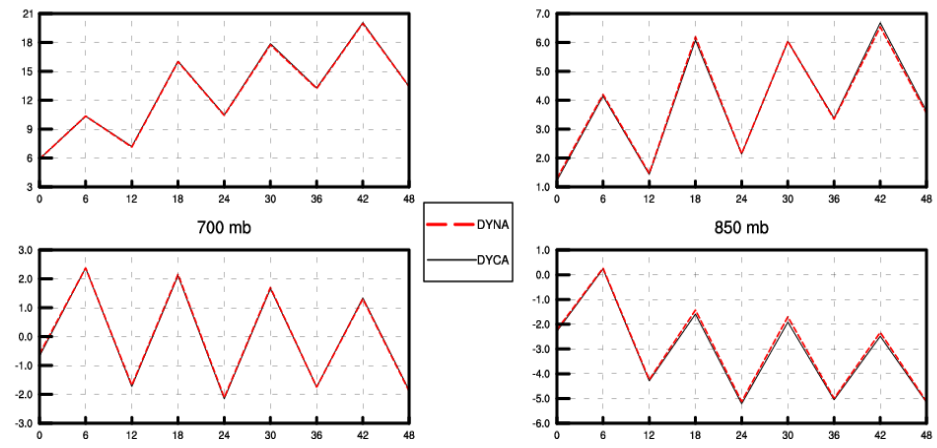
Value of 3DVAR and surf OI

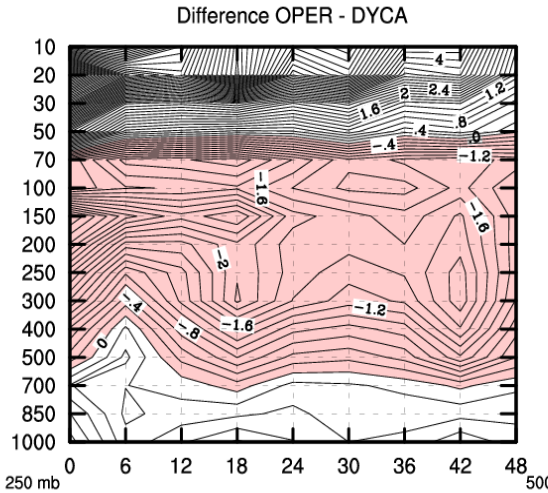
GEO BIAS

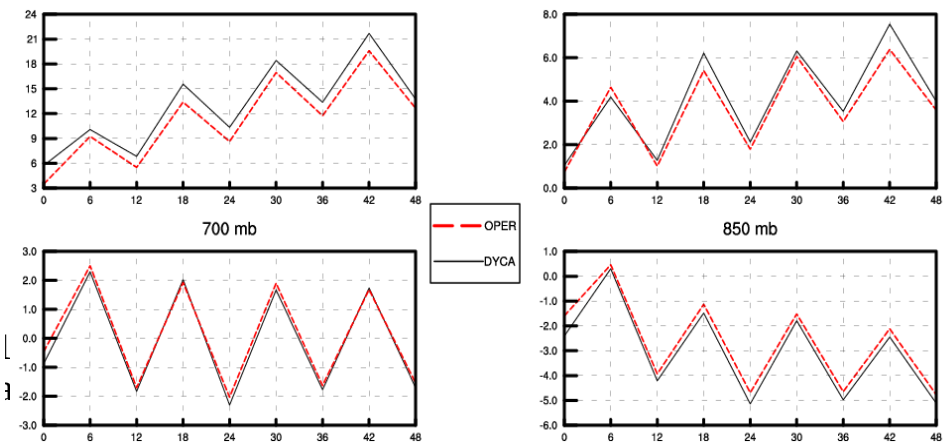
Impact of surface OI





Impact of 3DVAR





Value of 3DVAR and surf OI

GEO RMSE

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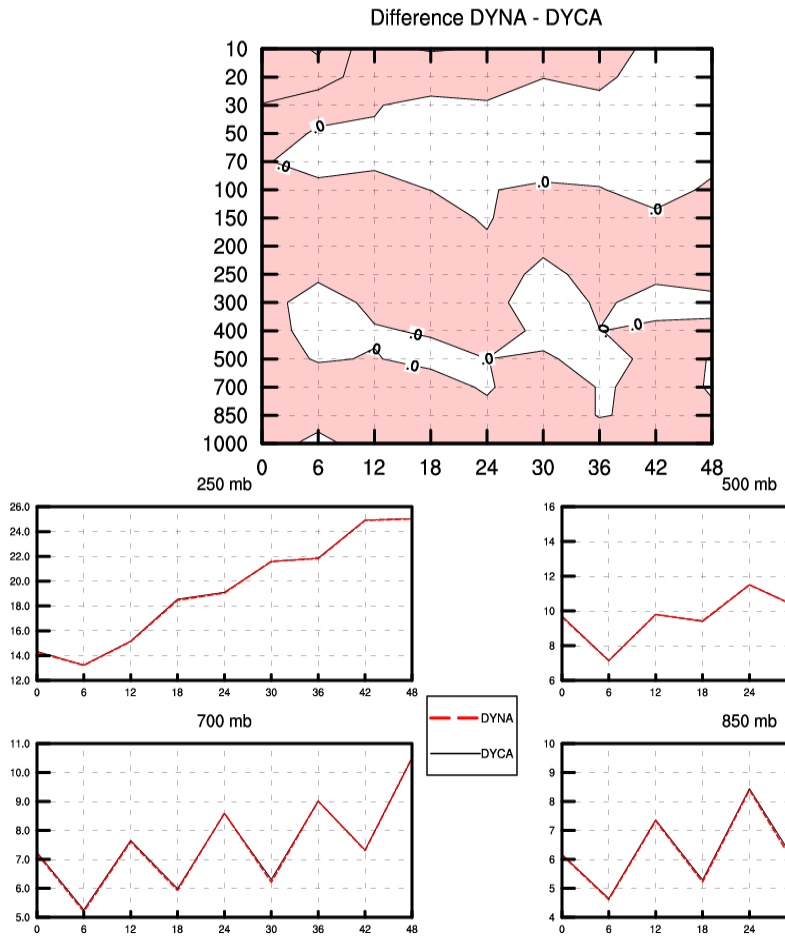
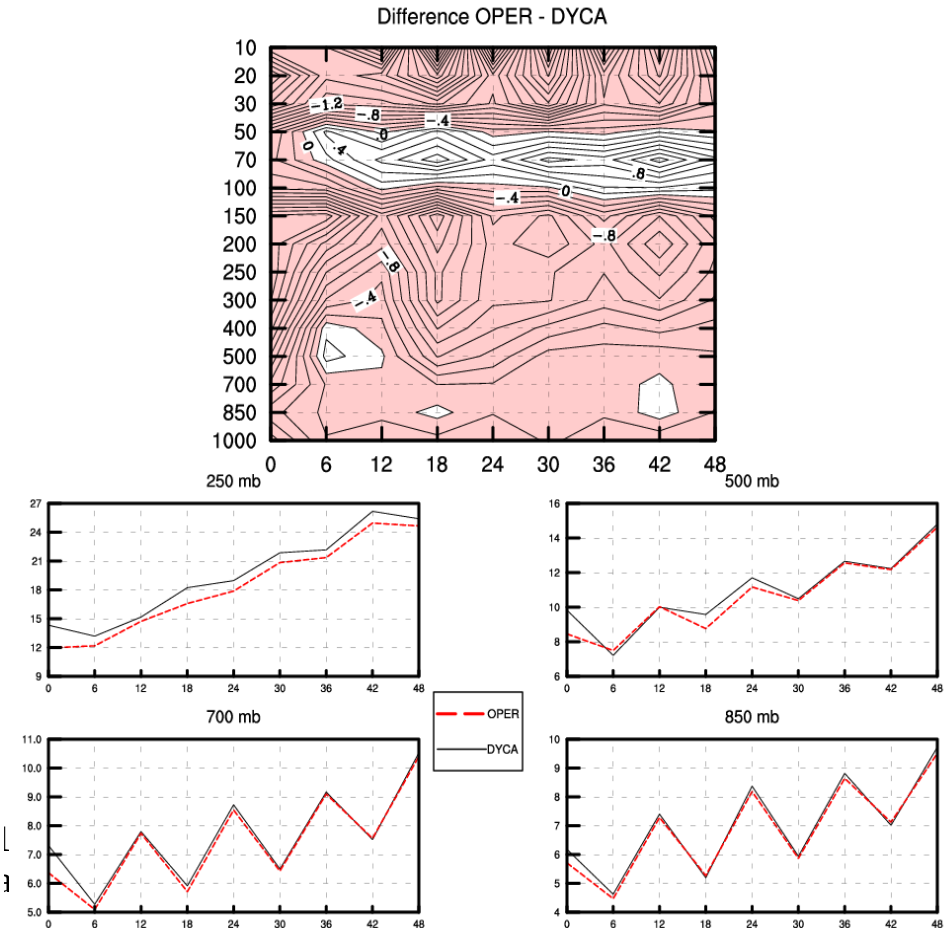


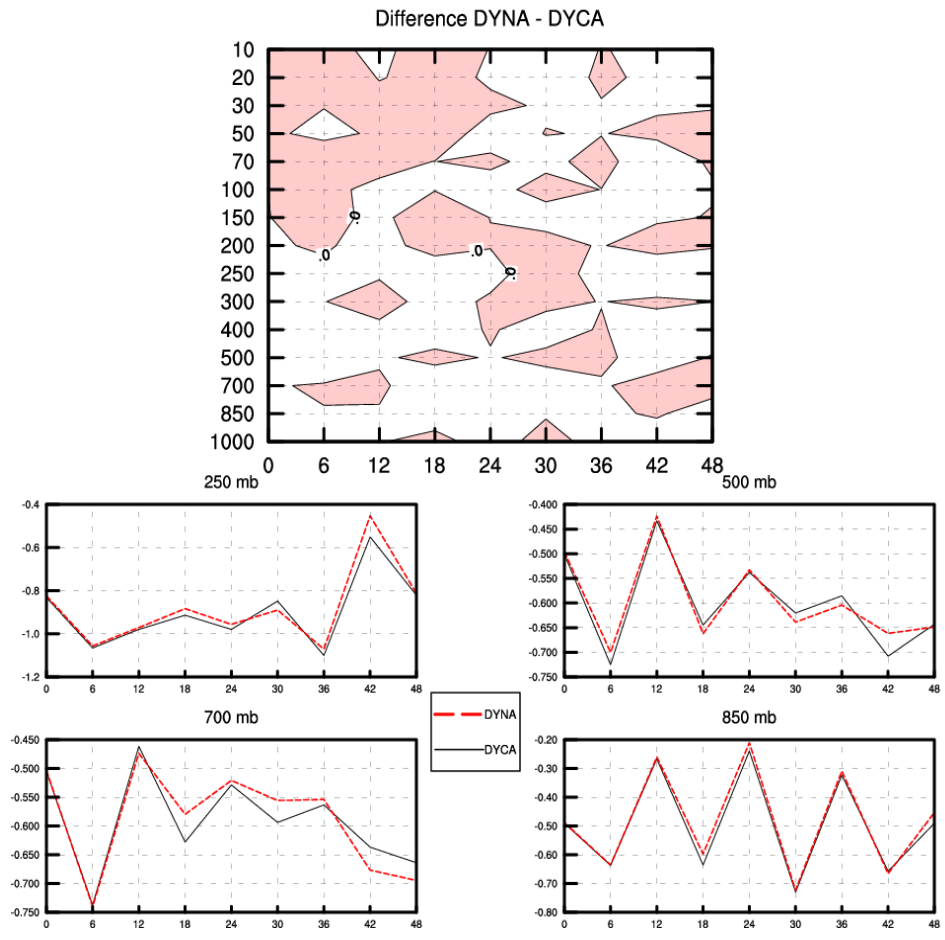
Impact of 3DVAR



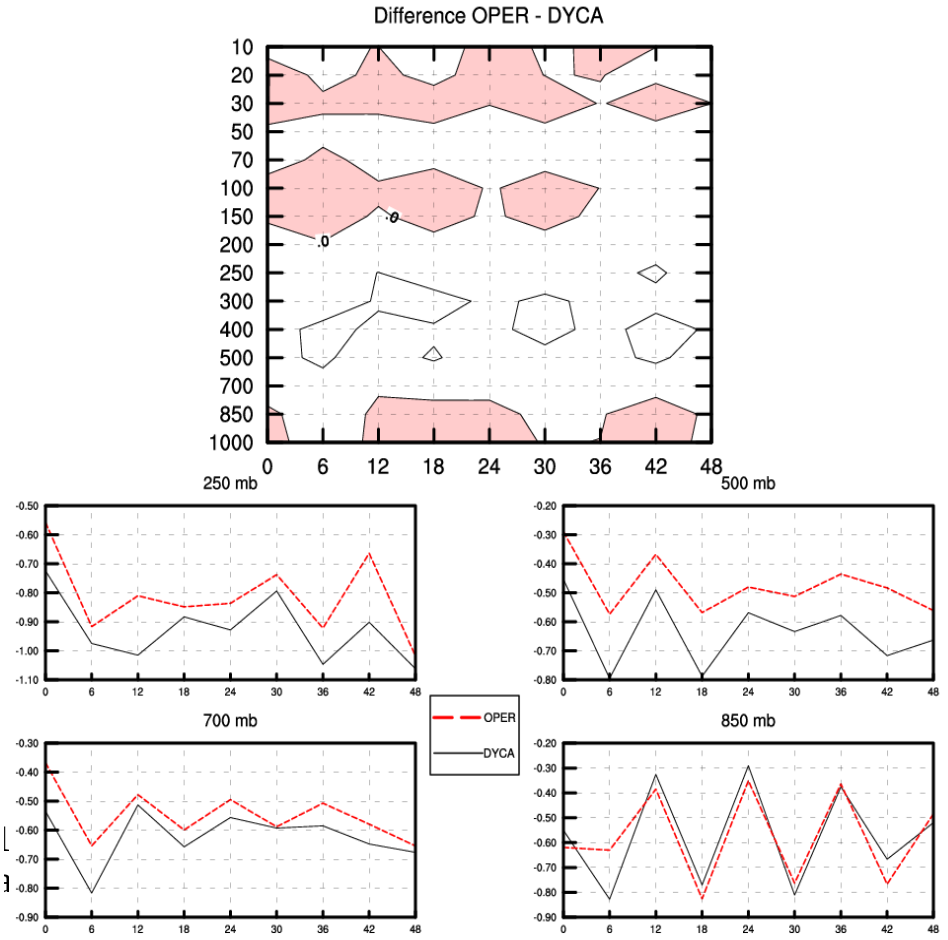
Value of 3DVAR and surf OI

Wind speed BIAS

Impact of surface OI



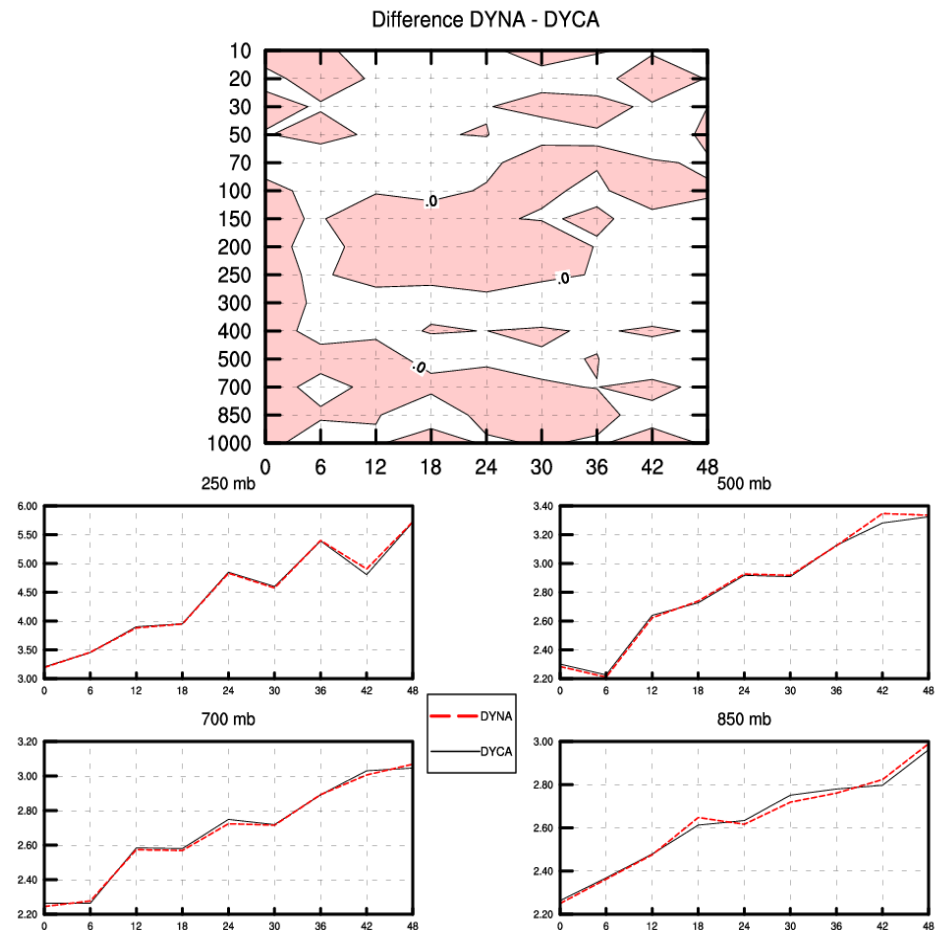
Impact of 3DVAR



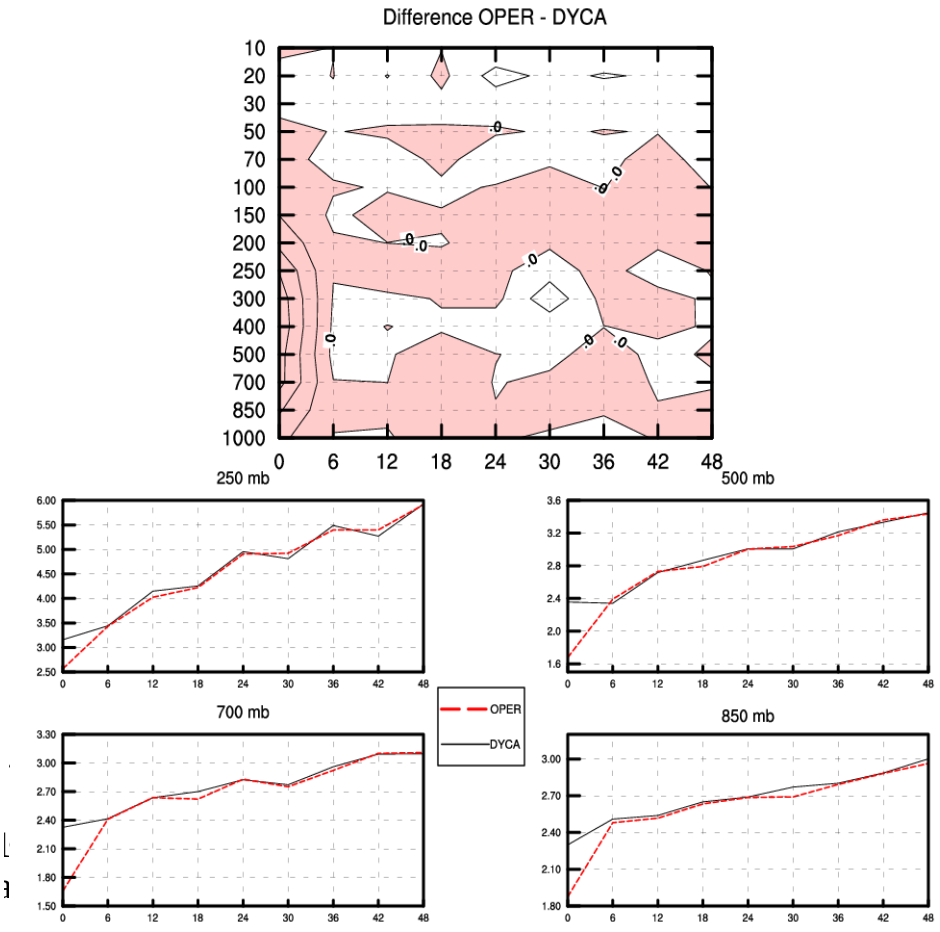
Value of 3DVAR and surf OI

Wind speed RMSE

Impact of surface OI



Impact of 3DVAR

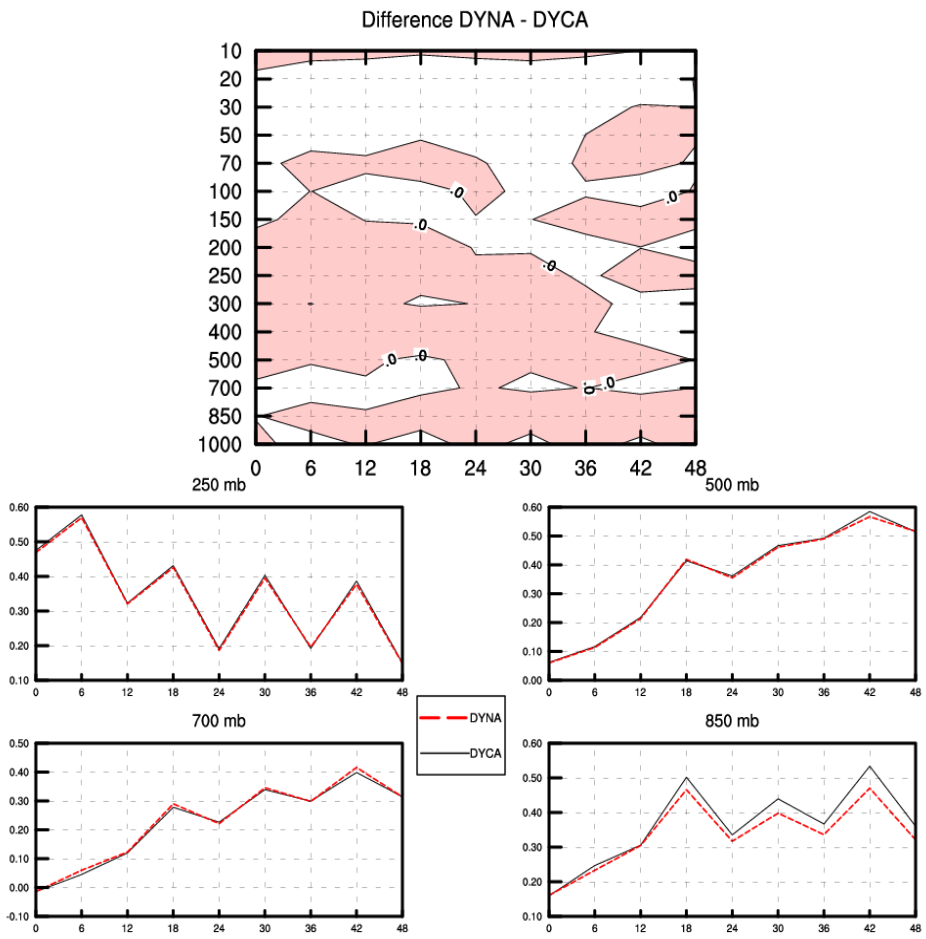


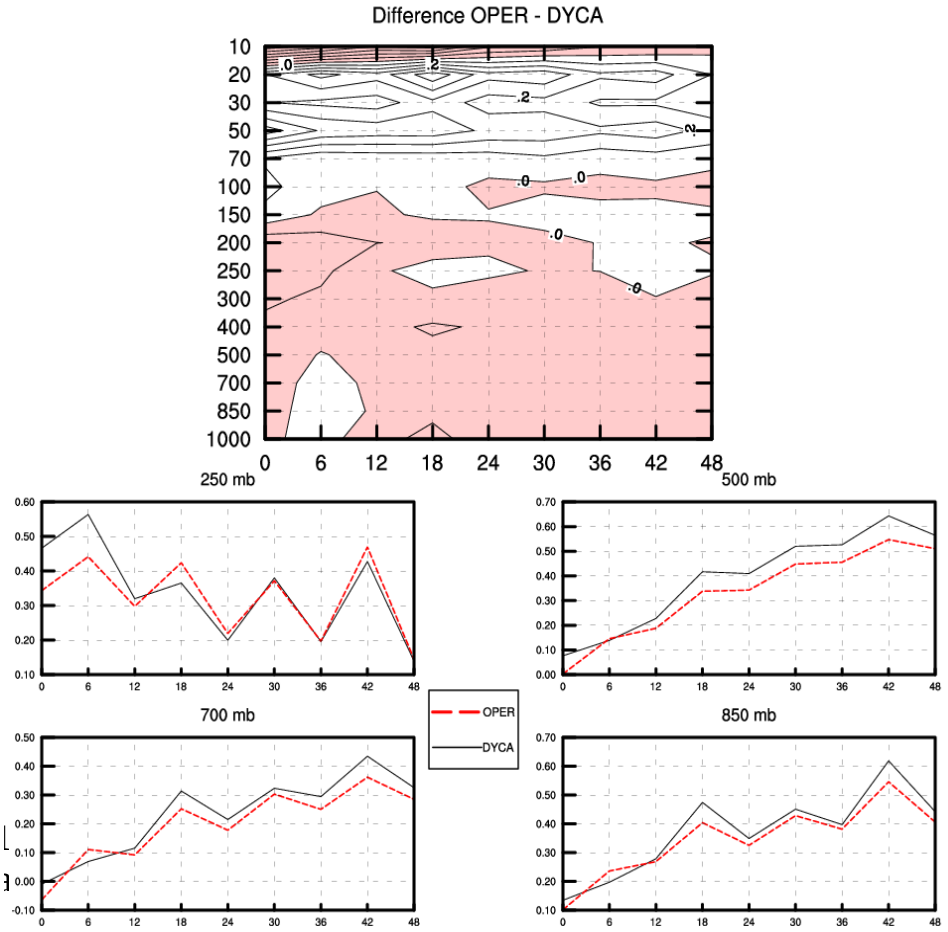
Value of 3DVAR and surf OI

Temperature BIAS

Impact of surface OI

Impact of 3DVAR

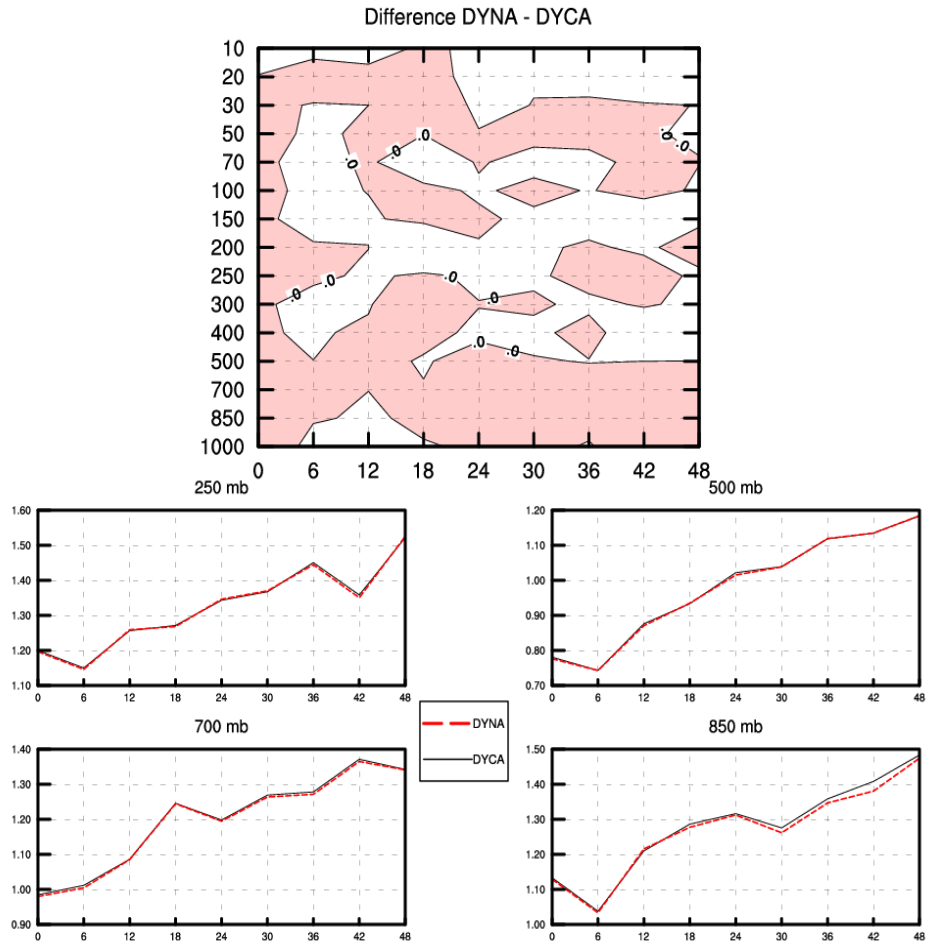




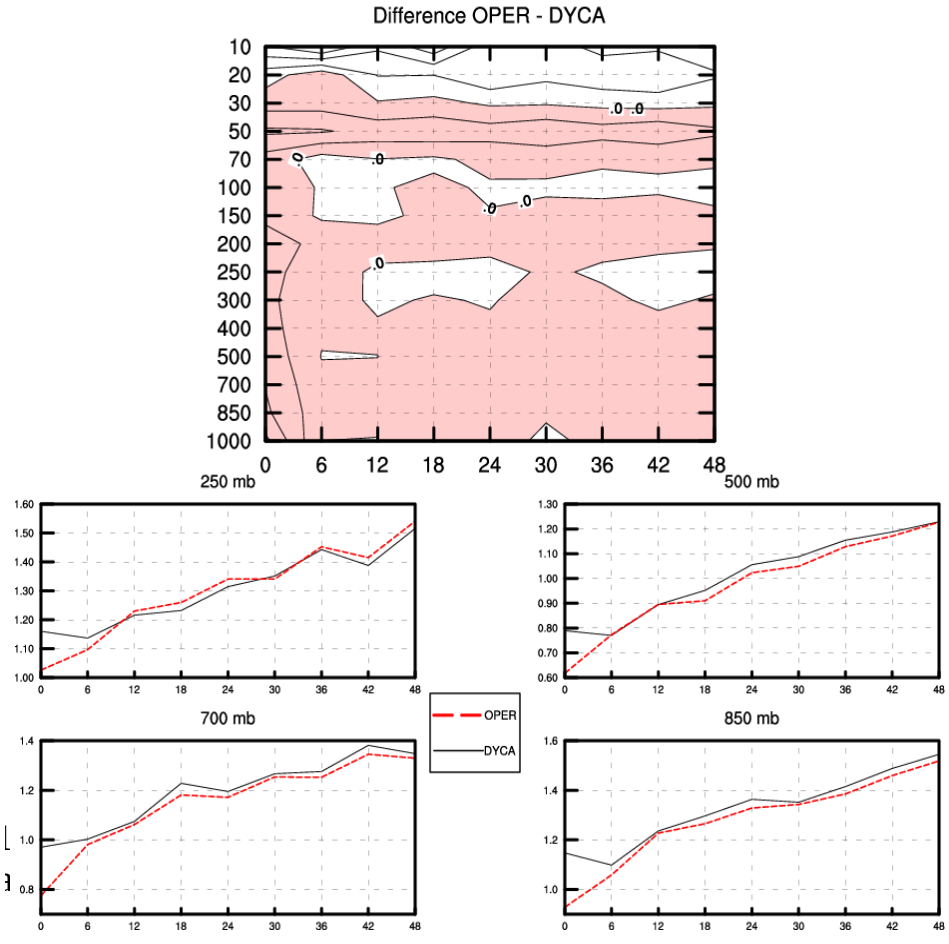
Value of 3DVAR and surf OI

Temperature RMSE

Impact of surface OI



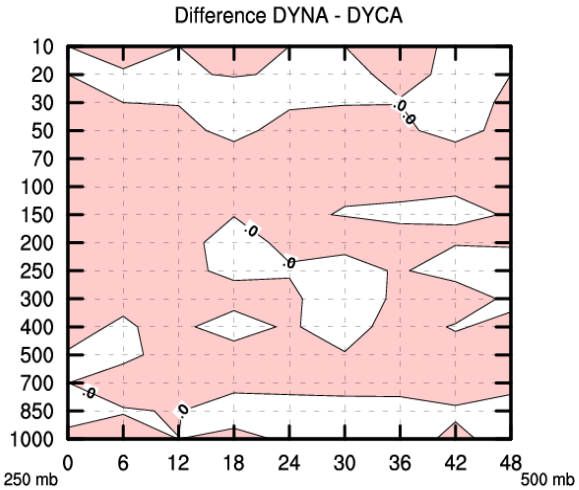
Impact of 3DVAR



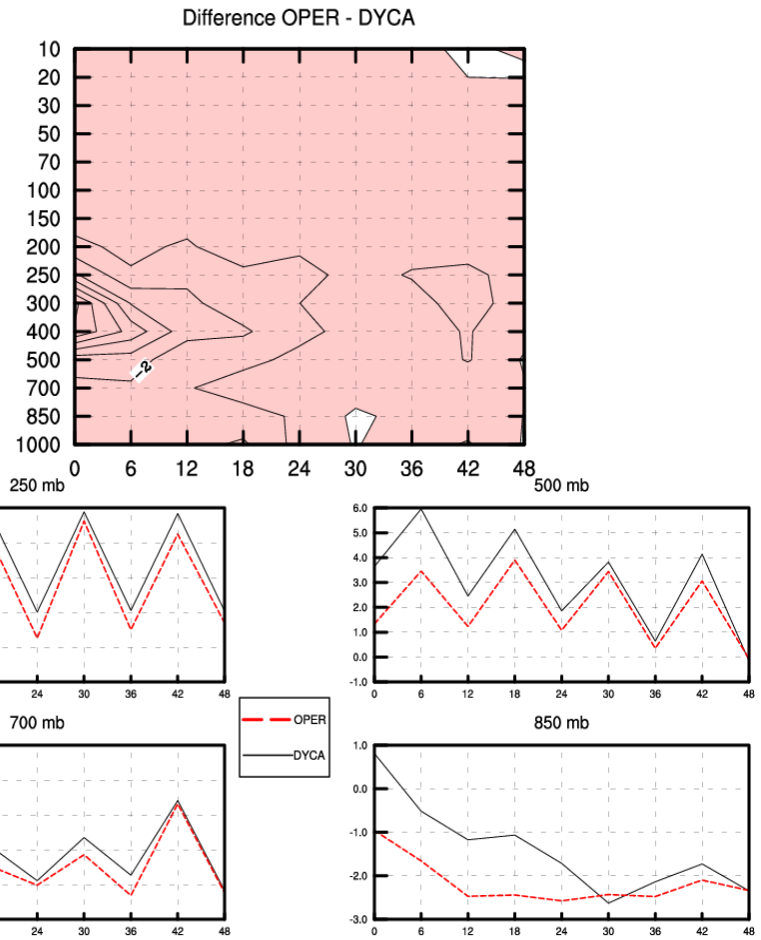
Value of 3DVAR and surf OI

Relative Humidity BIAS

Impact of surface OI



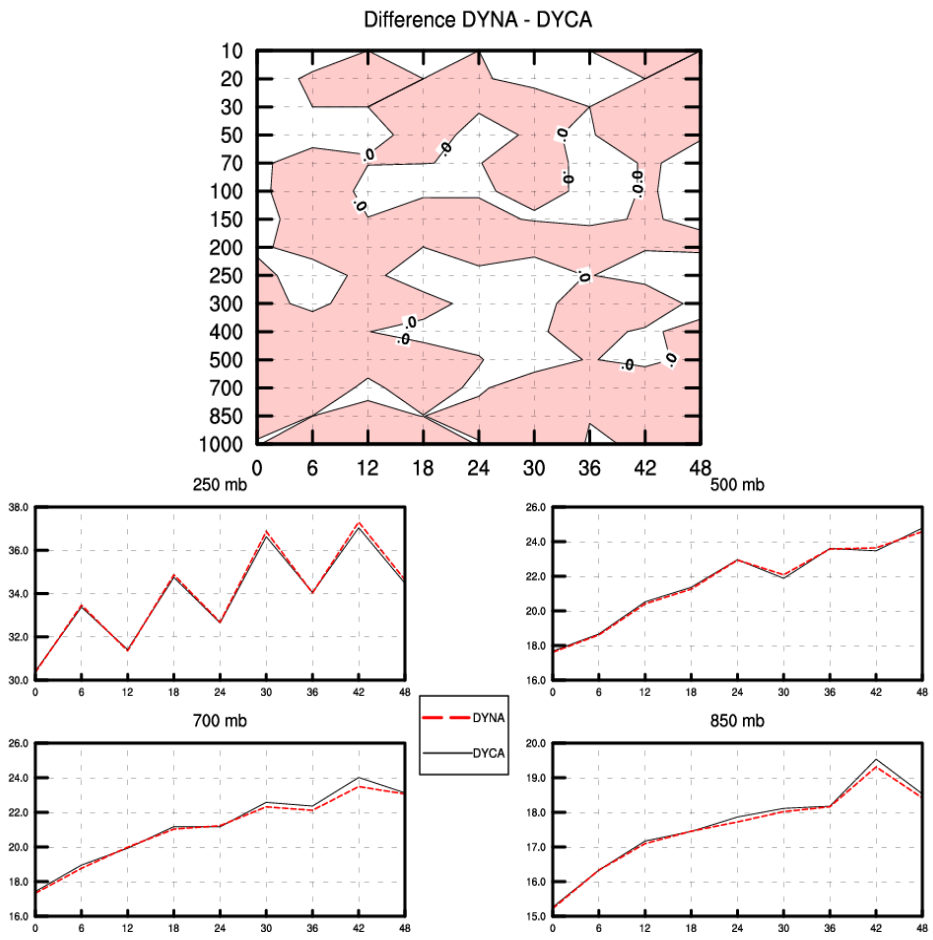
Impact of 3DVAR



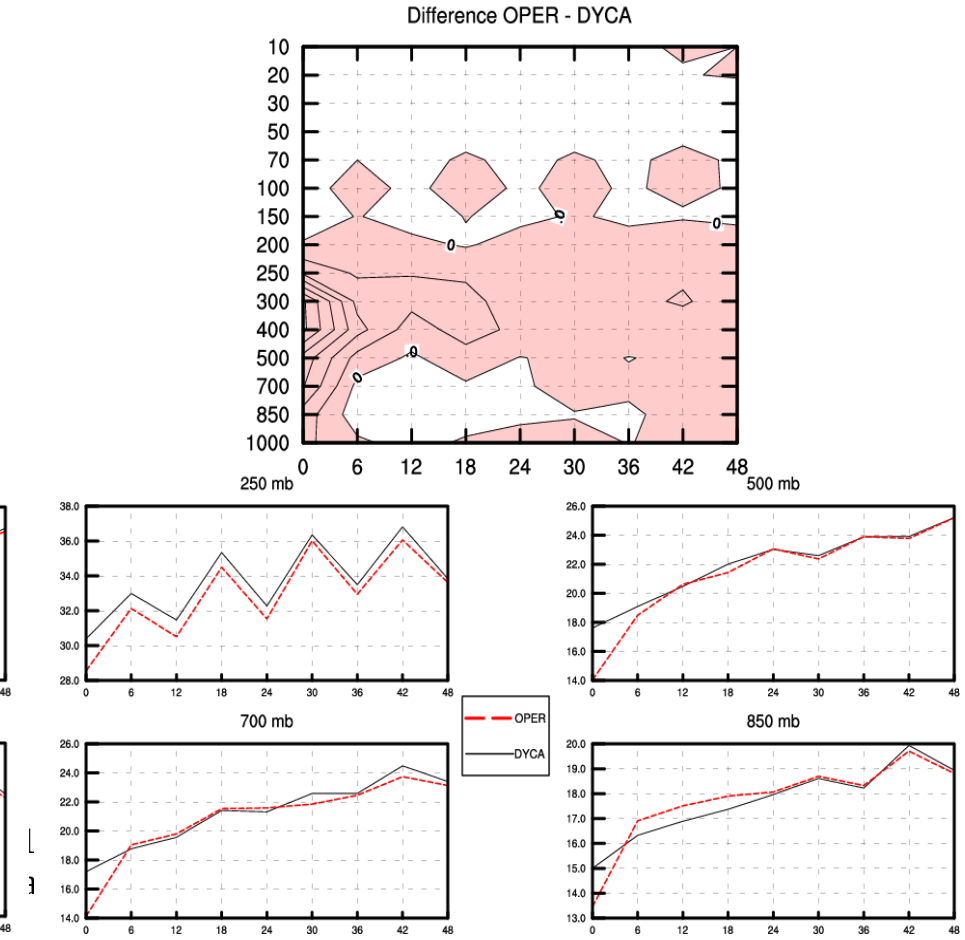
Value of 3DVAR and surf OI

Relative Humidity RMSE

Impact of surface OI



Impact of 3DVAR



B modeling in ALADIN

Aim: simulation of background errors ($\boldsymbol{\varepsilon}_b$) in order to generate a statistical sample for the computation of the background error covariance matrix ($\mathbf{B}$) in the variational analysis:

$$\mathbf{B} = \mathrm{E}\left(\boldsymbol{\varepsilon}_b \boldsymbol{\varepsilon}_b^{\mathrm{T}}\right)$$

$$\mathrm{J}_b(\mathbf{x}) = \frac{1}{2}\left(\mathbf{x}-\mathbf{x}_b\right)^{\mathrm{T}} \mathbf{B}^{-1}\left(\mathbf{x}-\mathbf{x}_b\right)$$

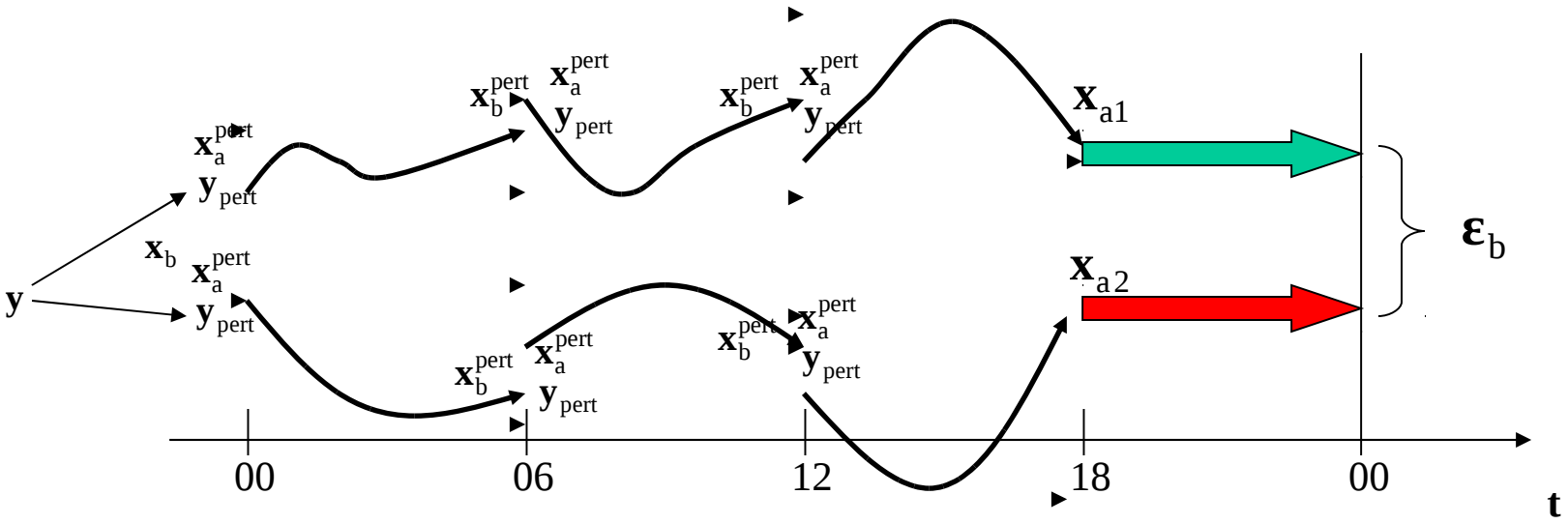
B modeling in ALADIN

Background error simulation with EDA

$$\mathbf{x}_{b1} = M\,\mathbf{x}_{a1}$$
$$\mathbf{x}_{b2} = M\,\mathbf{x}_{a2}$$

$$\boldsymbol{\varepsilon}_b \approx \mathbf{x}_{b1} - \mathbf{x}_{b2}$$

(EDA: Ensemble Data Assimilation)



B modeling in ALADIN

Background error simulation with ET

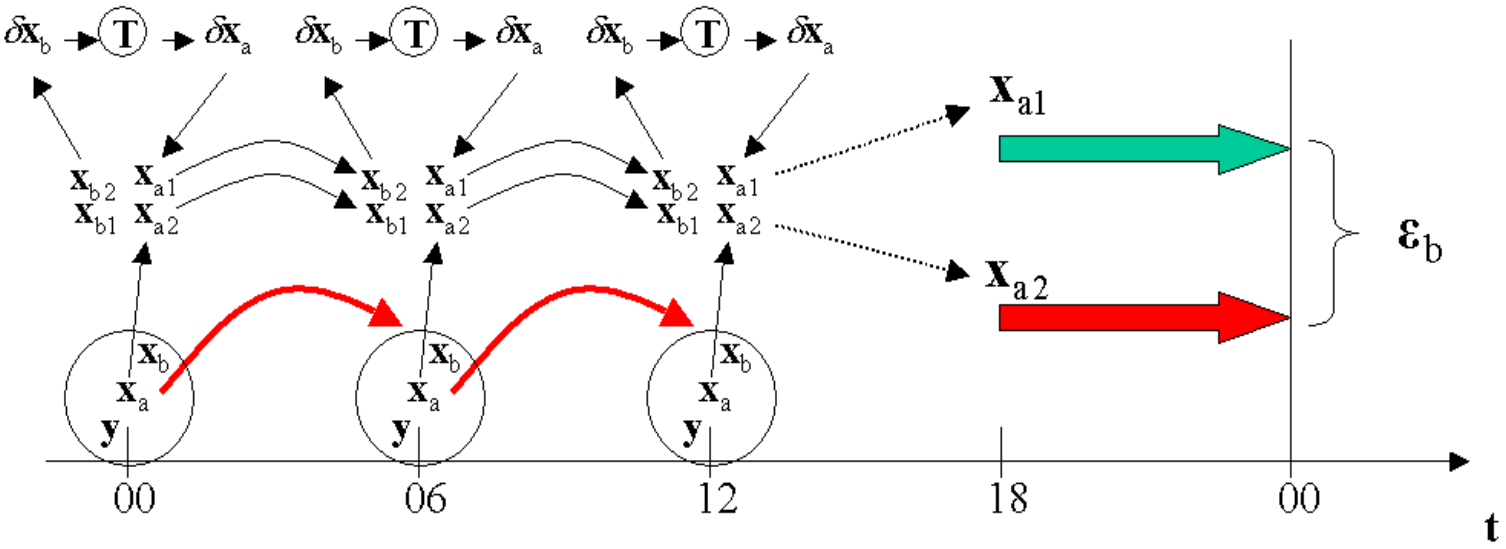
$$\mathbf{x}_{b1} = M\,\mathbf{x}_{a1}$$
$$\mathbf{x}_{b2} = M\,\mathbf{x}_{a2}$$

$$\boldsymbol{\varepsilon}_b \approx \mathbf{x}_{b1} - \mathbf{x}_{b2}$$

(ET: Ensemble Transform)

Transform of perturbations

Assimilation cycle



B modeling in ALADIN

In a LAM:

- we can take the benefit of global error simulations (in the form of LBCs)
- we would like that the $\boldsymbol{\varepsilon}_b$ sample is suitable to represent background errors on the (smaller) spatial scales of the LAM model
- so we go for global (LBC) + local (initial) perturbations

B modeling in ALADIN

LBC petrurbation (coupling) for all experiments:

- IFS EDA (Experiment by Isaksen et al., 07/2007, 4DVAR T255/L91)

Initial perturbation experiments (period 01-31/07/2007):

- **DSC-EDA**: downscaling of the IFS EDA $\boldsymbol{\varepsilon}_{\mathrm{b}} \approx M\,\mathrm{P}\mathbf{x}_{\mathrm{a1}}^{\mathrm{IFS-EDA}} - M\,\mathrm{P}\mathbf{x}_{\mathrm{a2}}^{\mathrm{IFS-EDA}}$

  $\mathrm{P}\mathbf{x}_{\mathrm{a1,2}}^{\mathrm{IFS-EDA}}$: global EDA analyses interpolated to the ALADIN domain

- **LAM-EDA**: local EDA initial perturbations $\boldsymbol{\varepsilon}_{\mathrm{b}} \approx M\,\mathbf{x}_{\mathrm{a1}}^{\mathrm{LAM-EDA}} - M\,\mathbf{x}_{\mathrm{a2}}^{\mathrm{LAM-EDA}}$

  $\mathbf{x}_{\mathrm{a1,2}}^{\mathrm{LAM-EDA}}$: local analyses with perturbed observations

- **LAM-ET**: local ET initial perturbations $\boldsymbol{\varepsilon}_{\mathrm{b}} \approx M\,\mathbf{x}_{\mathrm{a1}}^{\mathrm{LAM-ET}} - M\,\mathbf{x}_{\mathrm{a2}}^{\mathrm{LAM-ET}}$

  $\mathbf{x}_{\mathrm{a1,2}}^{\mathrm{LAM-EDA}}$: local analyses with ET perturbations

B modeling in ALADIN

- **Spectral variance**: variance of the simulated error → diagnoses how the variance is distributed according to spatial scales

- **Spectral spread-skill**: spread and rmse of the ensemble → measures if the error simulation is over or underdispersive (and on which spatial scales)

- **Spectral PECA** (Perturbation vs. Error Correlation Analysis): $\mathrm{corr}\left(|\varepsilon_b|,|\varepsilon_b^{ref}|\right)$

  $\varepsilon_b = \overline{x_b} - x_{b,j}$ simulated background error

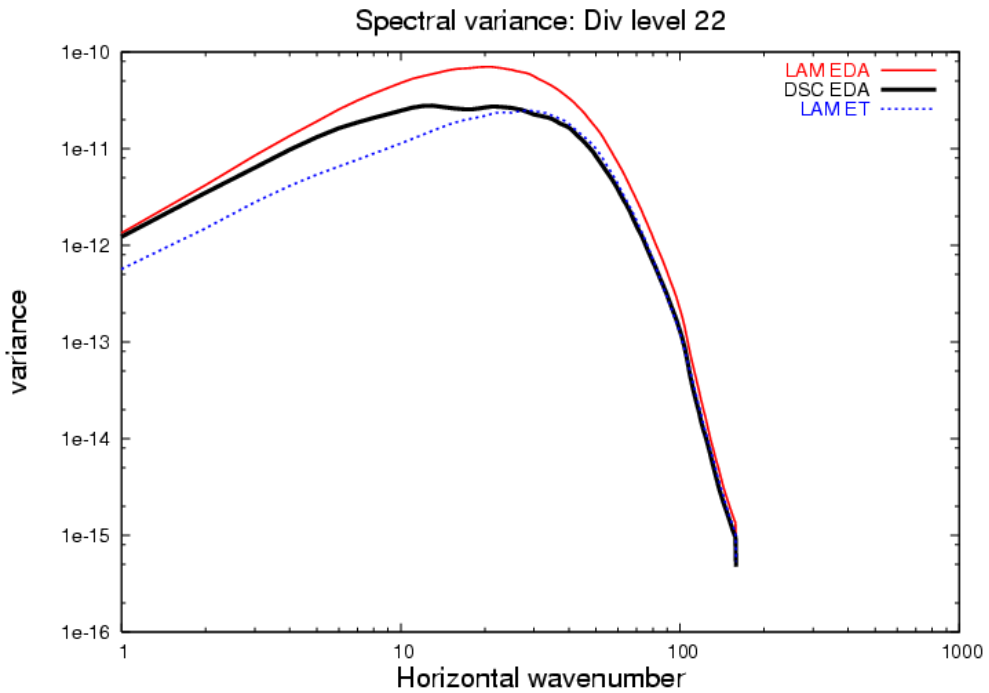
  $\varepsilon_b^{ref} = x_a^{verif} - \overline{x_b}$ „real” background error ($x_a^{verif} = x_a^{Varpack} \approx x_t$)

  → measures how much the „size” of the simulated error is similar to the size of the „real” (!) background error (and on which spatial scales)

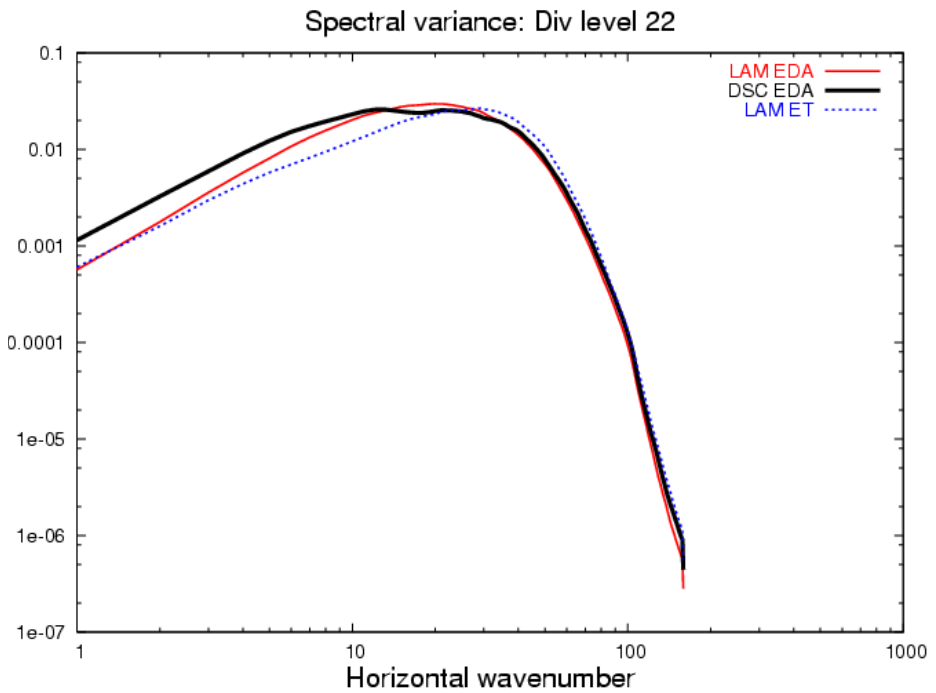
B modeling in ALADIN

Divergence at ~500hPa

Spectral error variance



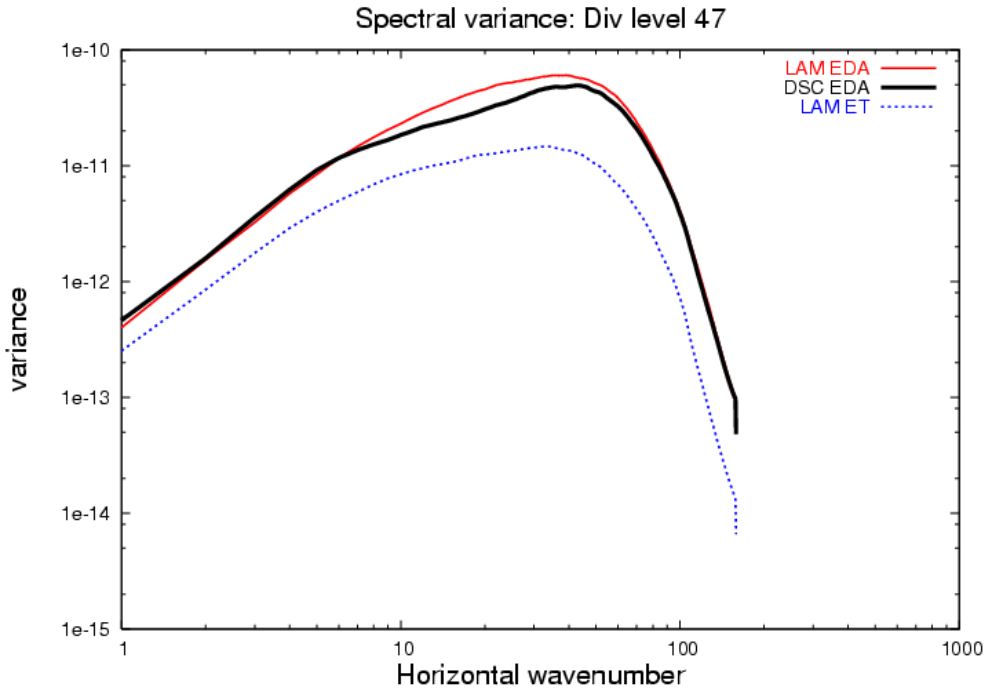
Normalized spectral error variance



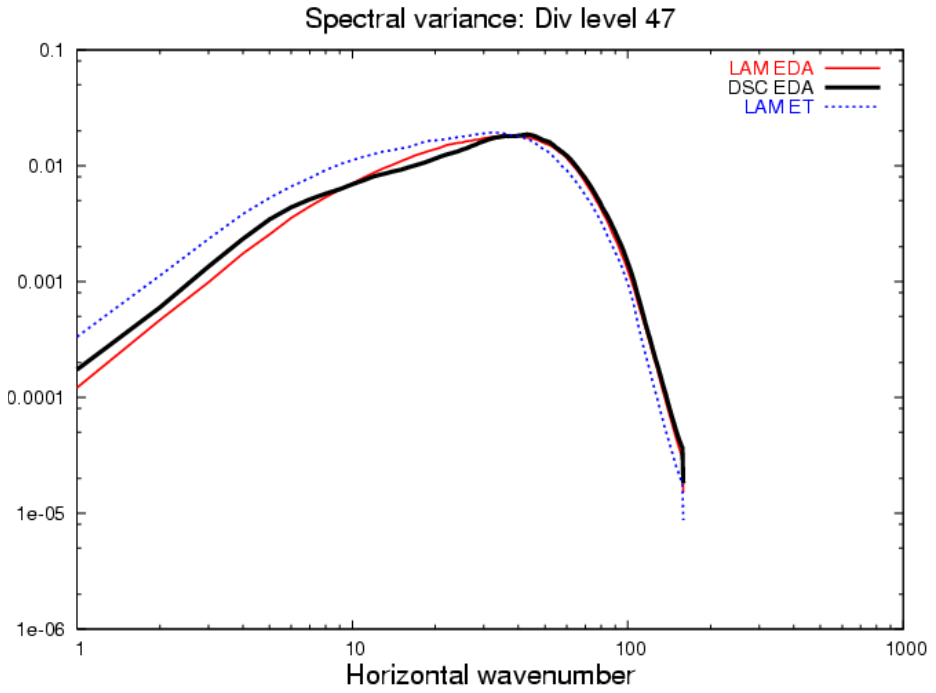
B modeling in ALADIN

Divergence at ~1000hPa

Spectral error variance



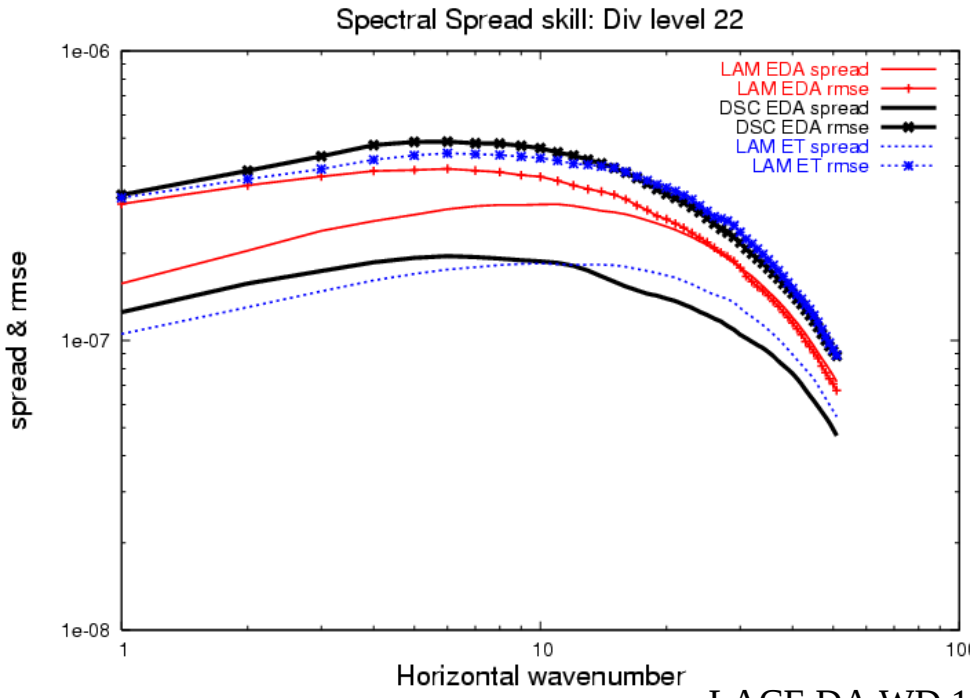
Normalized spectral error variance



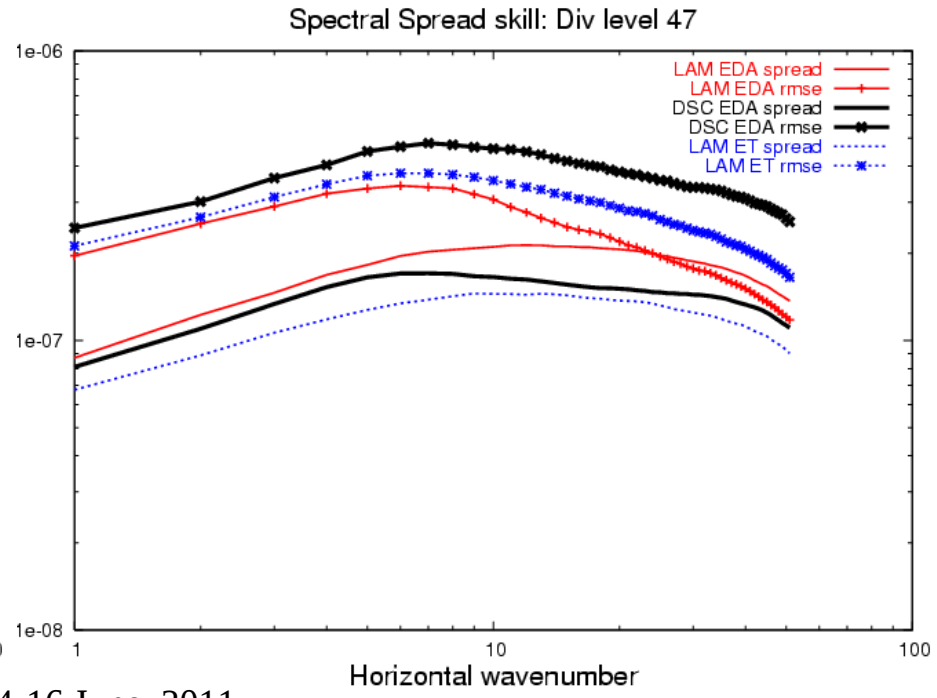
B modeling in ALADIN

Spread-skill (spread-rmse relationship for +6h)

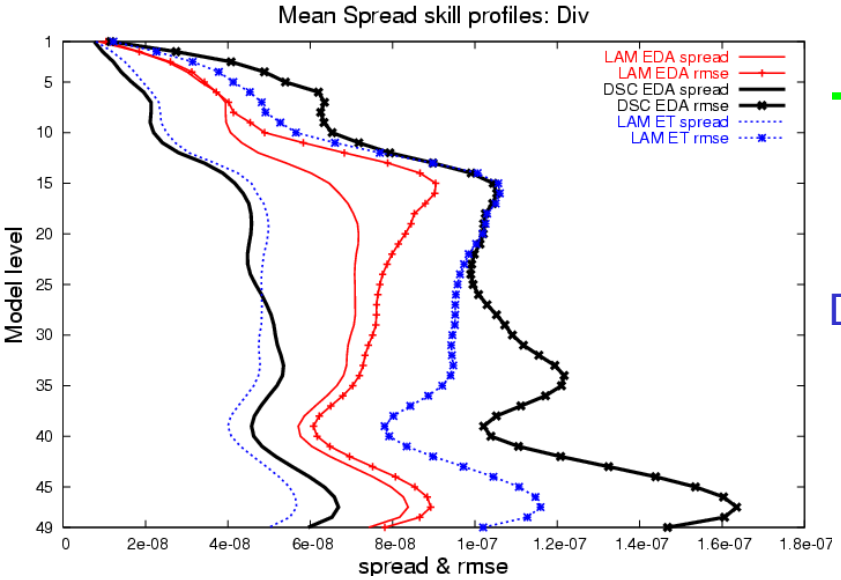
Divergence at ~500hPa



Divergence at ~1000hPa

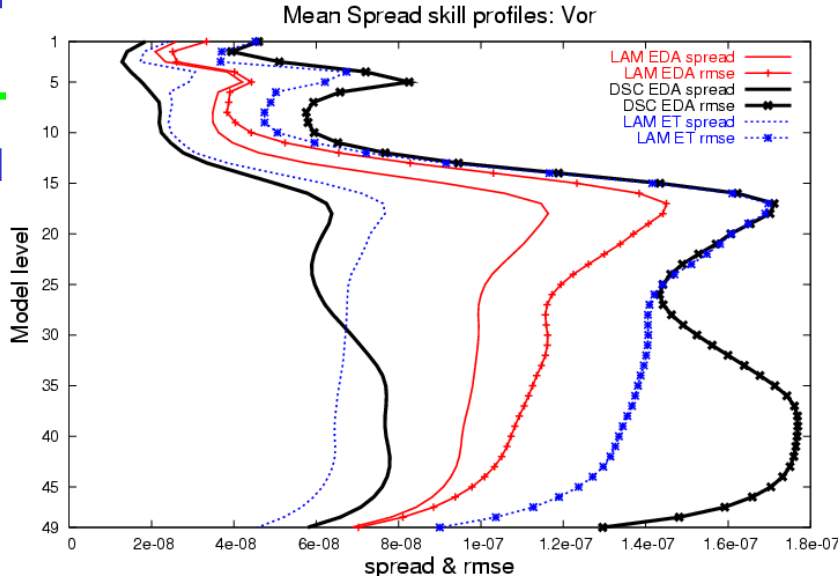


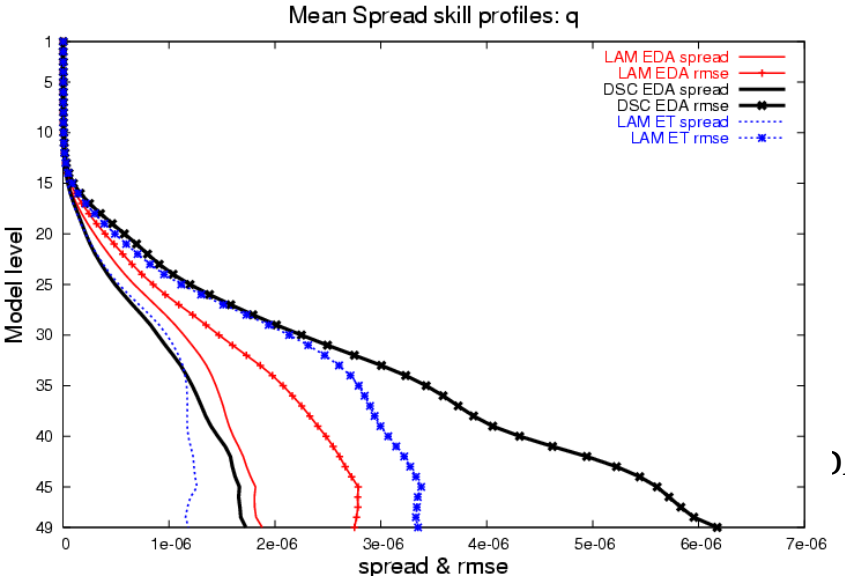
B modeling in ALADIN



Spread-skil profiles

Div Vor





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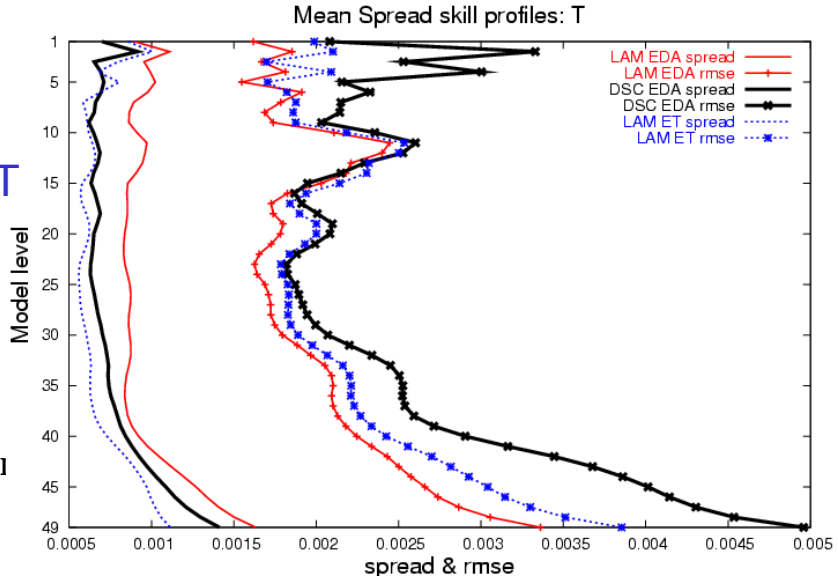
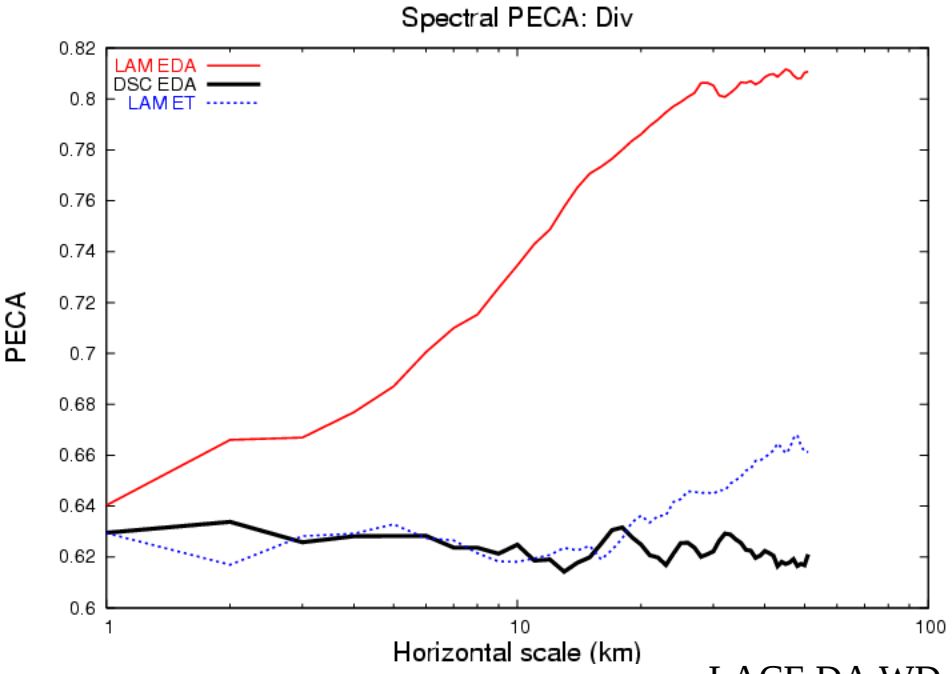


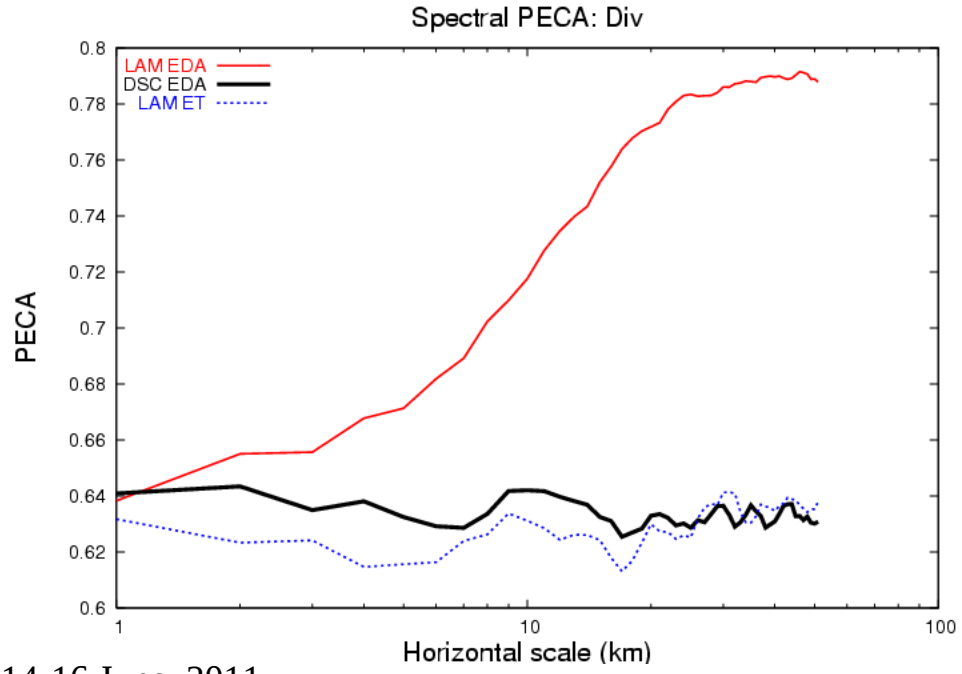
B modeling in ALADIN

PECA: Perturbation versus Error Correlation Analysis

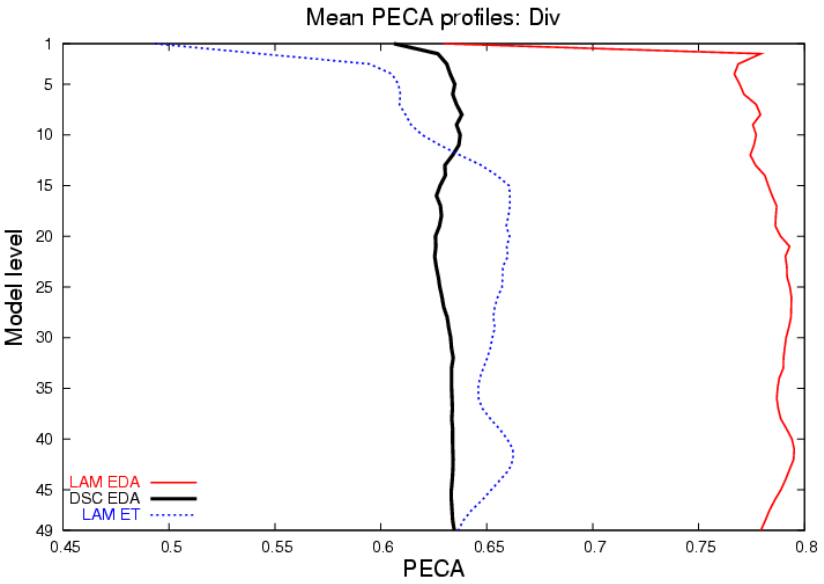
Divergence at ~500hPa



Divergence at ~1000hPa

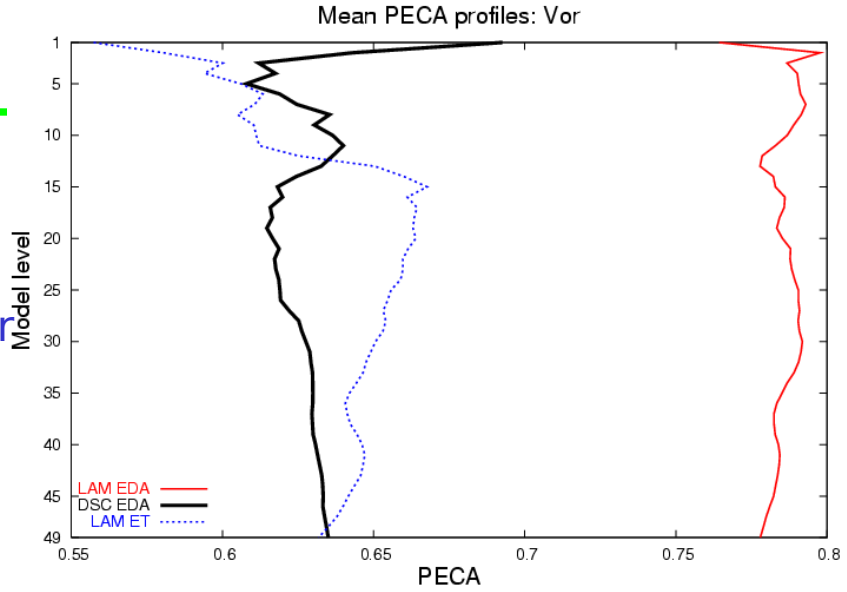


B modeling in ALADIN

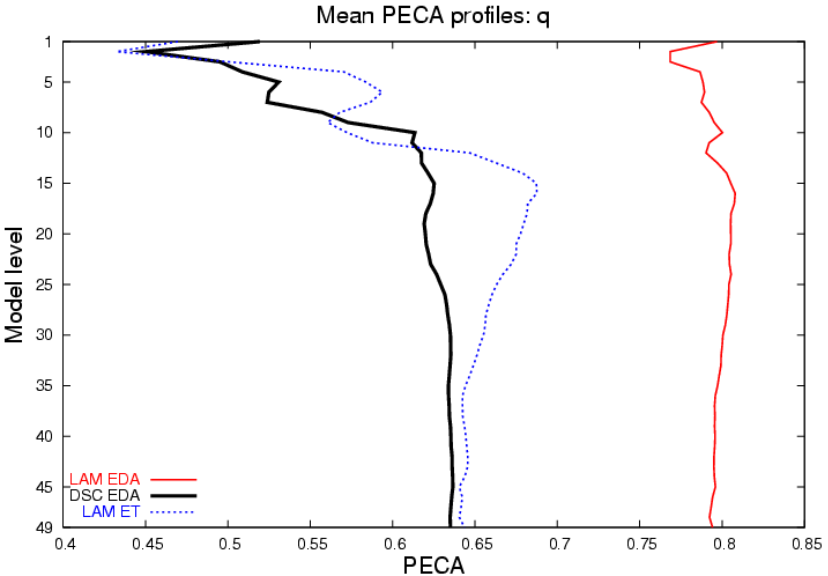


PECA profiles

Div



Vor



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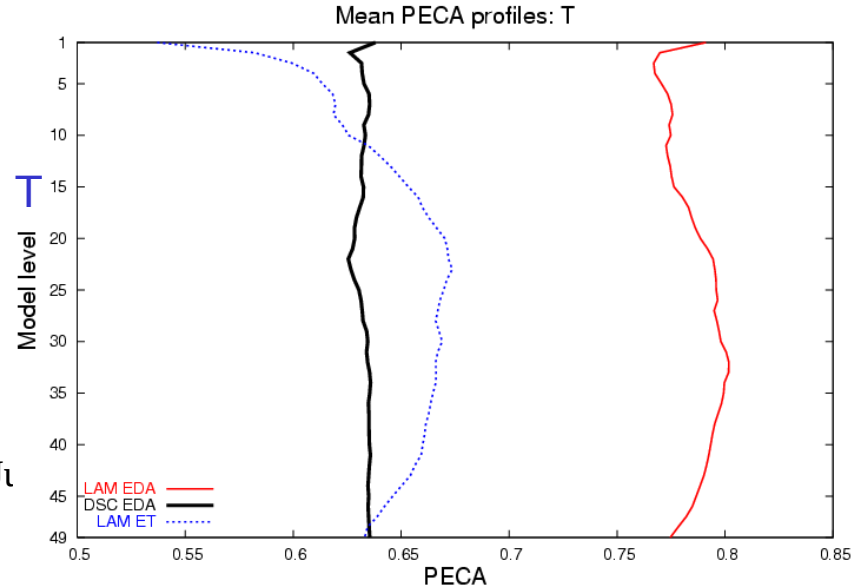

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B modeling in ALADIN

Aim: test the impact of the different error simulation techniques on the analysis/forecast ➔ computation of **B** matrices based on the different error simulations ➔ reinject them into real assimilation experiments and verify the analyses and forecasts

Period: 01-31/07/2007 ➔ idealized experiments (the period is the same as used for the error simulation)

2 data assimilation/forecast **experiments**:

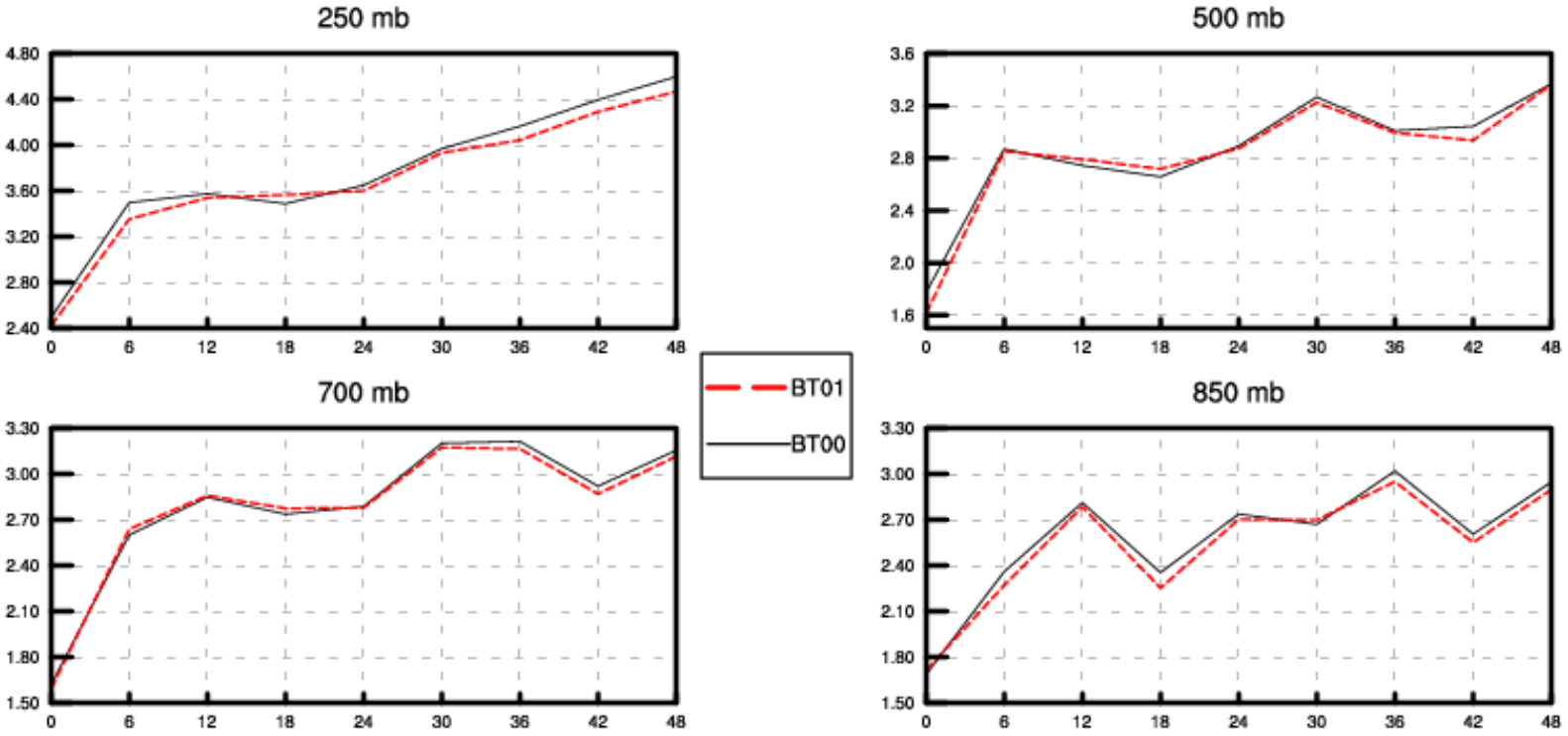
BT00: assimilation cycle using **B** based on the **DSC-EDA** error simulation

BT01: assimilation cycle using **B** based on the **LAM-EDA** error simulation

B modeling in ALADIN

RMSE against TEMPs and SYNOPs

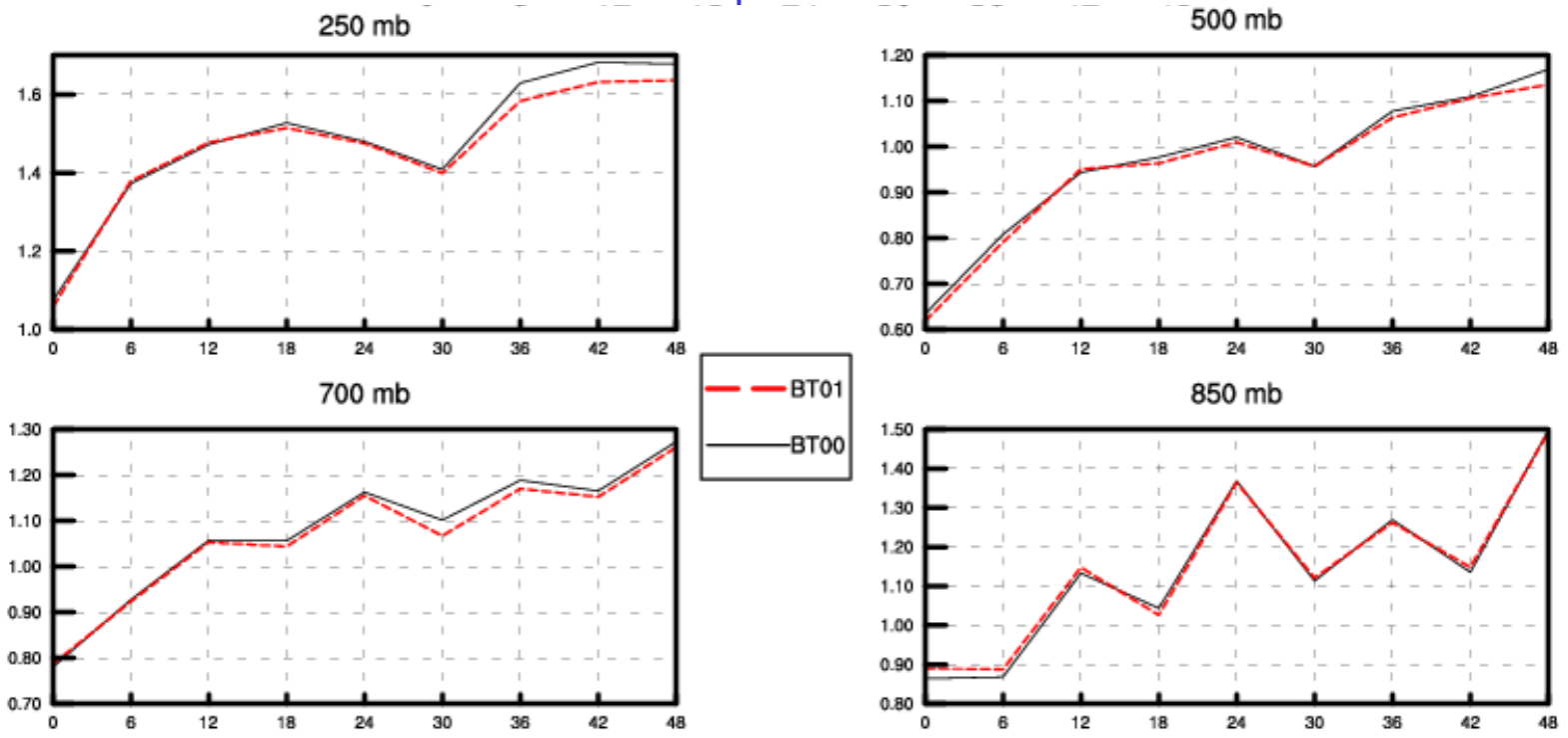
Wind speed



B modeling in ALADIN

RMSE against TEMPs and SYNOPs

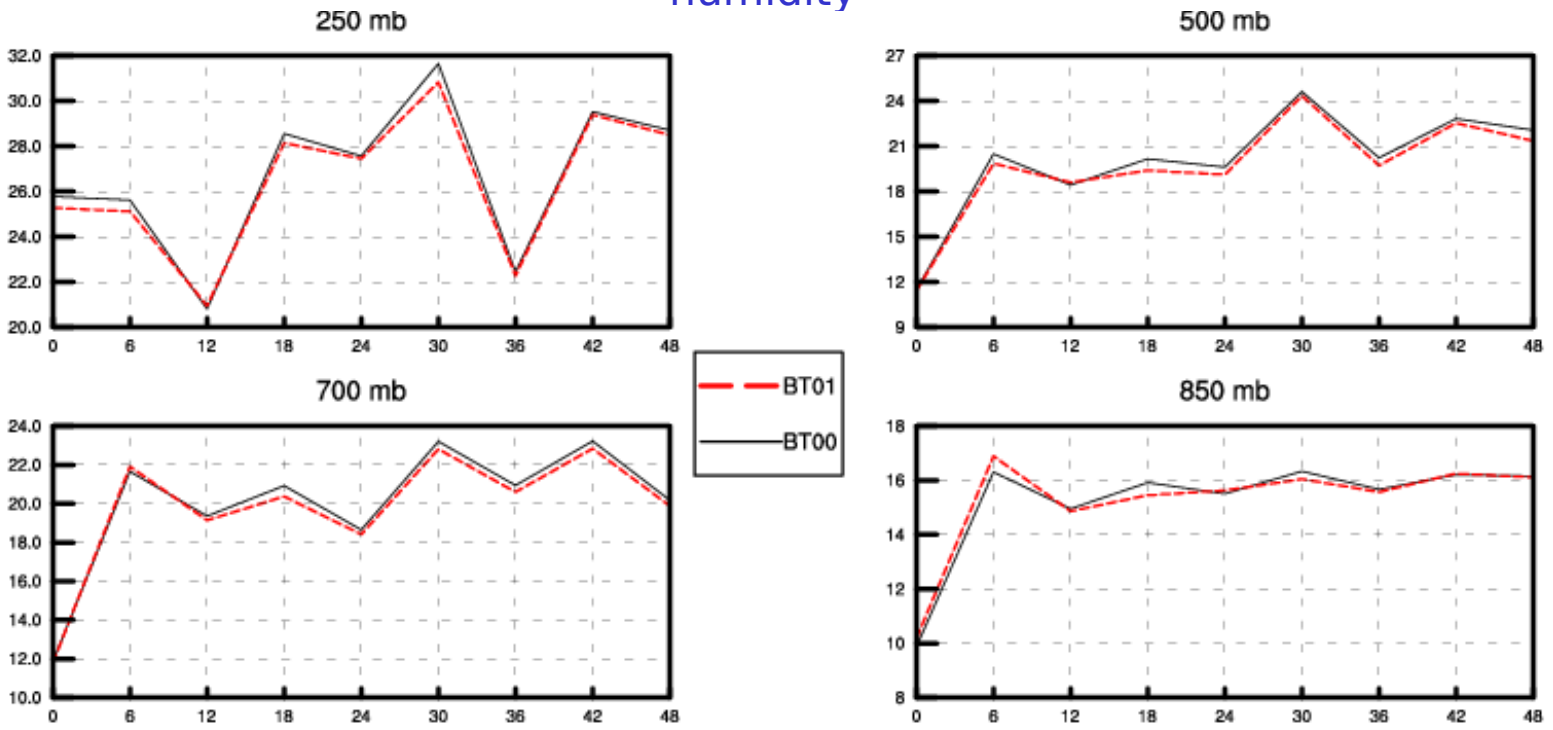
Temperature



B modeling in ALADIN

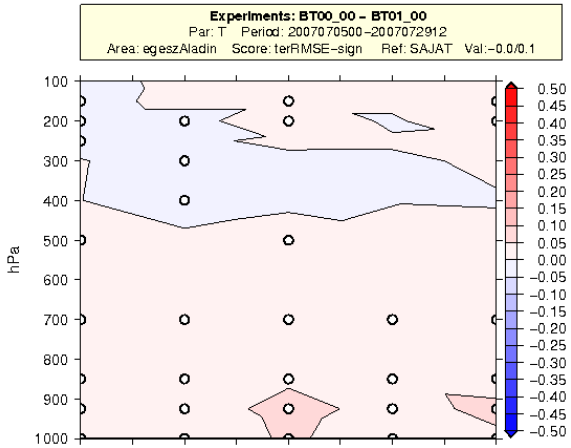
RMSE against TEMPs and SYNOPs

Relative humidity



B modeling in ALADIN

RMSE against analysis (each experiment against its „own”



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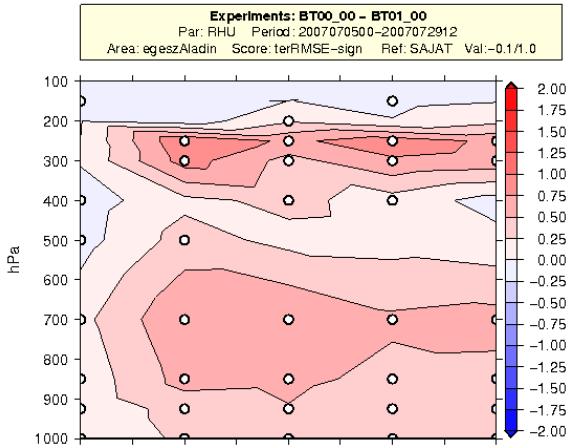
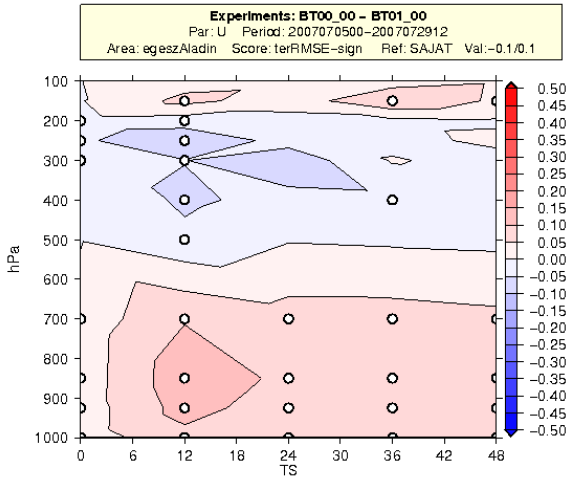
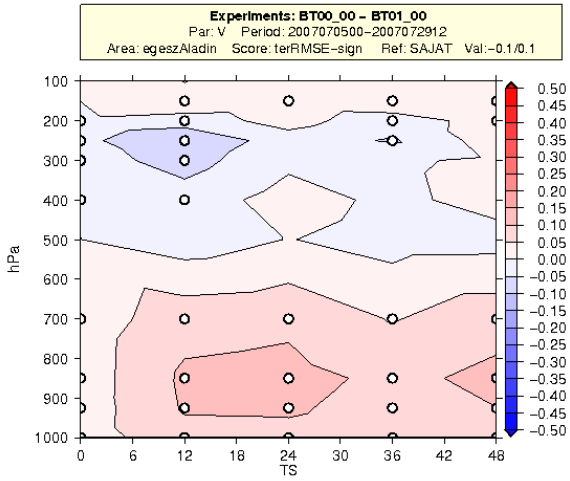


RH



U



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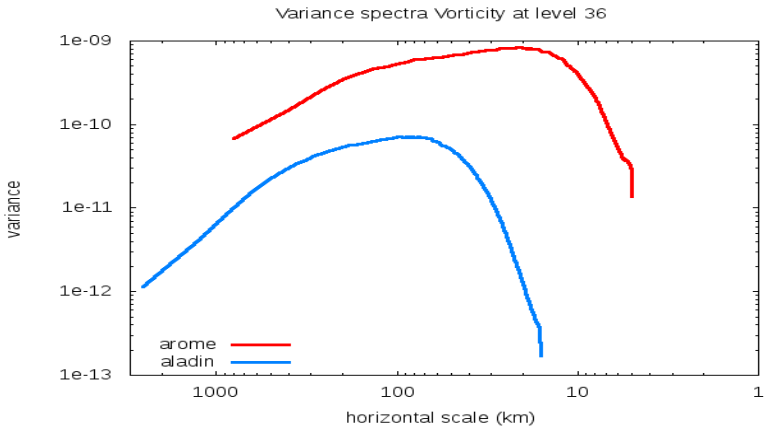
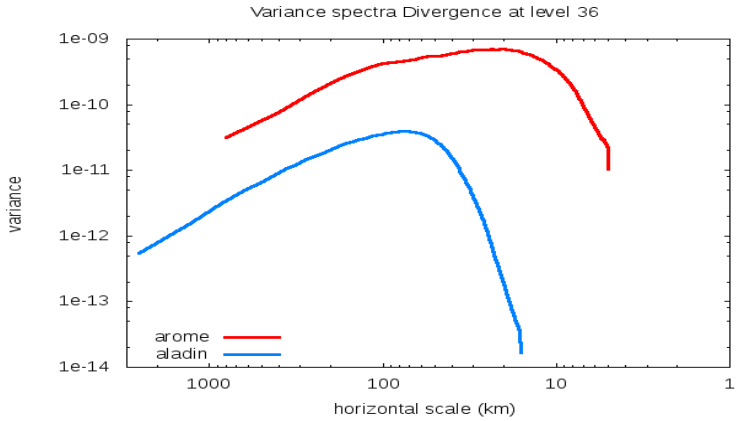
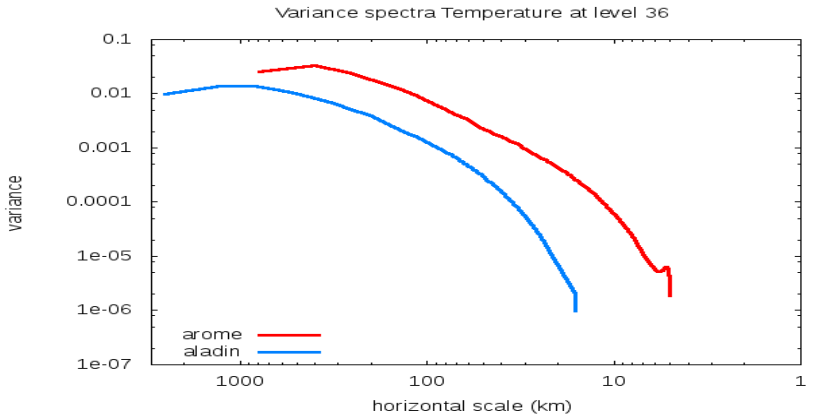
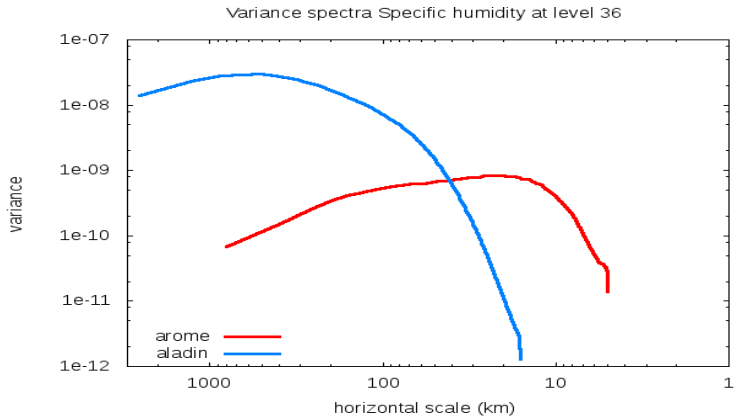
Towards Arome DA

- Background errors computed (Downscaled from ALADIN LAM EDA error simulation)









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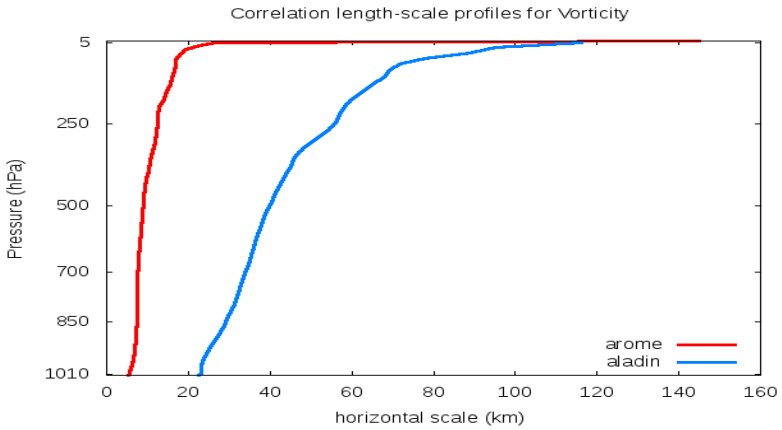
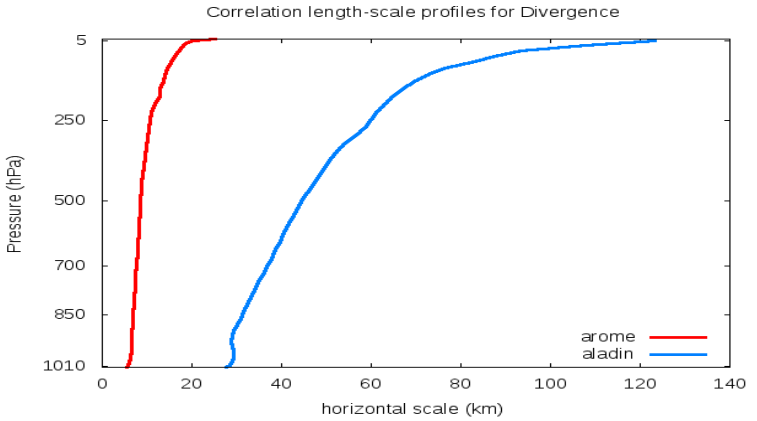
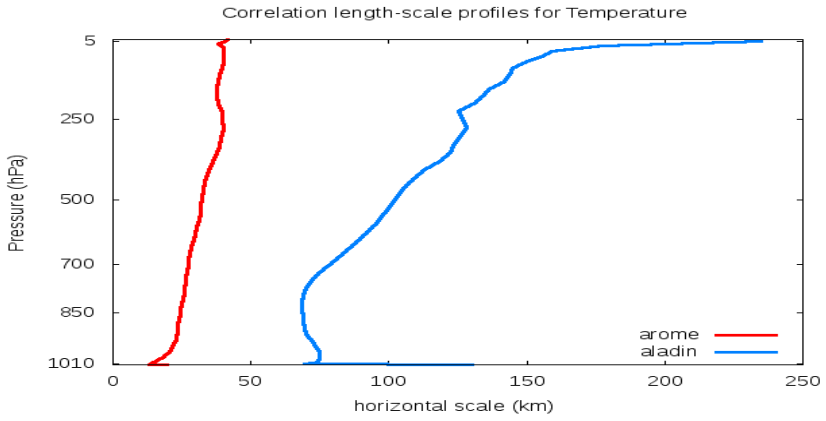
Budapest

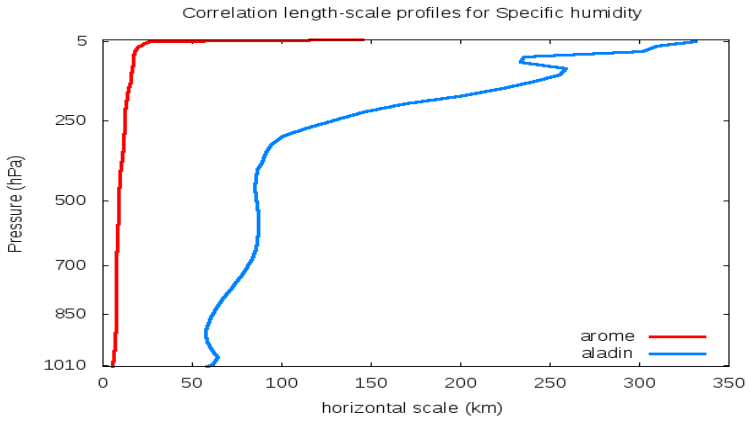
Towards Arome DA

- Background errors computed (Downscaled from ALADIN LAM EDA error simulation)









Towards Arome DA

- Conf. 701, 002, 131 under validation
- First tests by feeding the AROME 3DVAR with operational observations