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05/07/2022 - PREVENIR project

-

EFSOI applied to regional data assimilation system over southern South America

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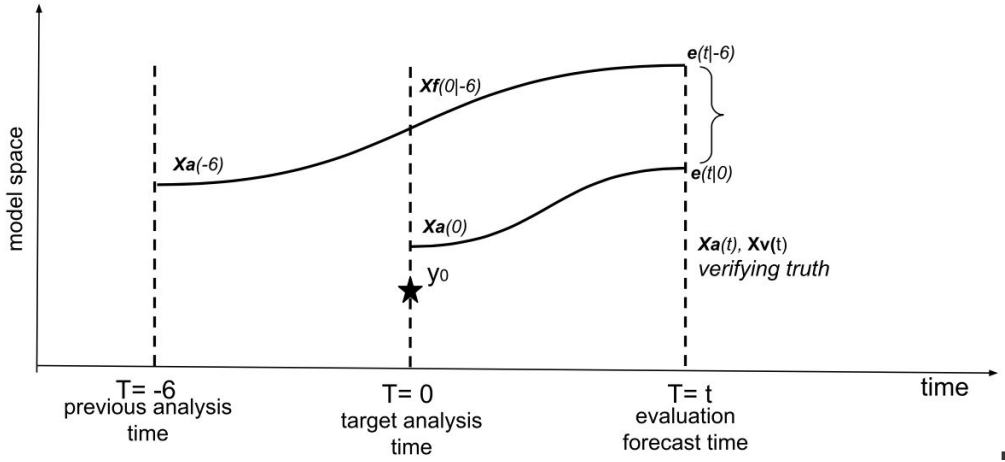
What is EFSOI?

Ensemble **F**orecast **S**ensitivity to **O**bservations **I**mpact

What is EFSOI?

EFSOI is a formulation applied to quantify the contribution of **each** observation assimilated at the time *t=0* to the **reduction** (or **increase**) of the error of the forecast time *t* hours later(evaluation forecast time).

As shown in the conceptual diagram the impact of assimilating an observation (y_0) at *t=0* is quantified by the difference of two forecast errors at the evaluation forecast time. The error of the ensemble mean forecast initialized at *t=0* and *t=-6 (previous analysis) hours* are verified against the analysis at the time. *(Kalnay et al 2012)*.



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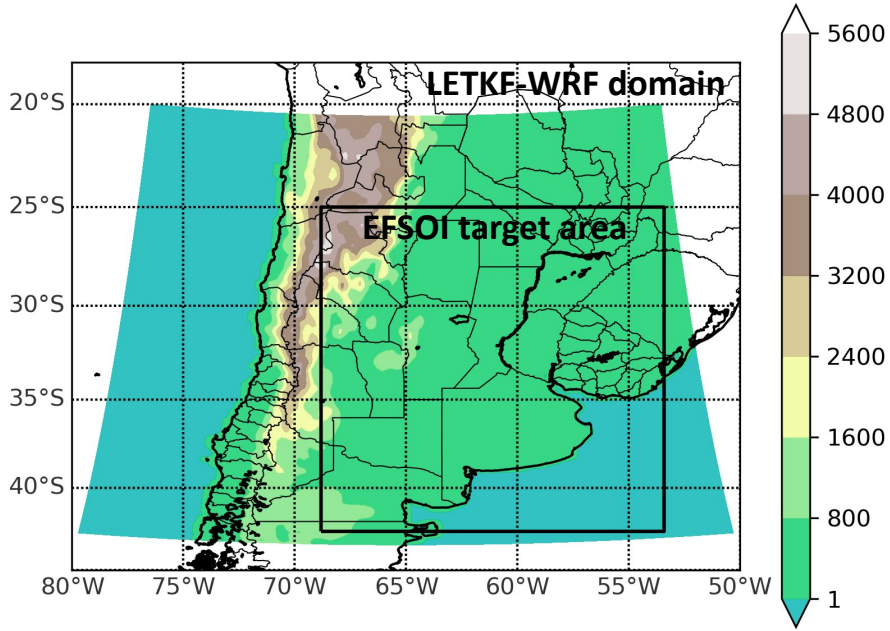
Model configuration



- Assimilation system LETKF-WRF
- GEFS as boundary conditions
- Resolution 20 km (124x130x40 grid points)
- Analysis every 6 h
- 20 multiphysics members (***boundary layer****: YSU,MYJ,SH,MYNN2,MYNN3 ;* ***cumulus****: K-F, Grell;* ***microphysics****: WSM6,Lin*)
- Period: from November 5th 2018 to December 10th 2018 (30 days analyzed)
- Evaluation forecast time 6 hours

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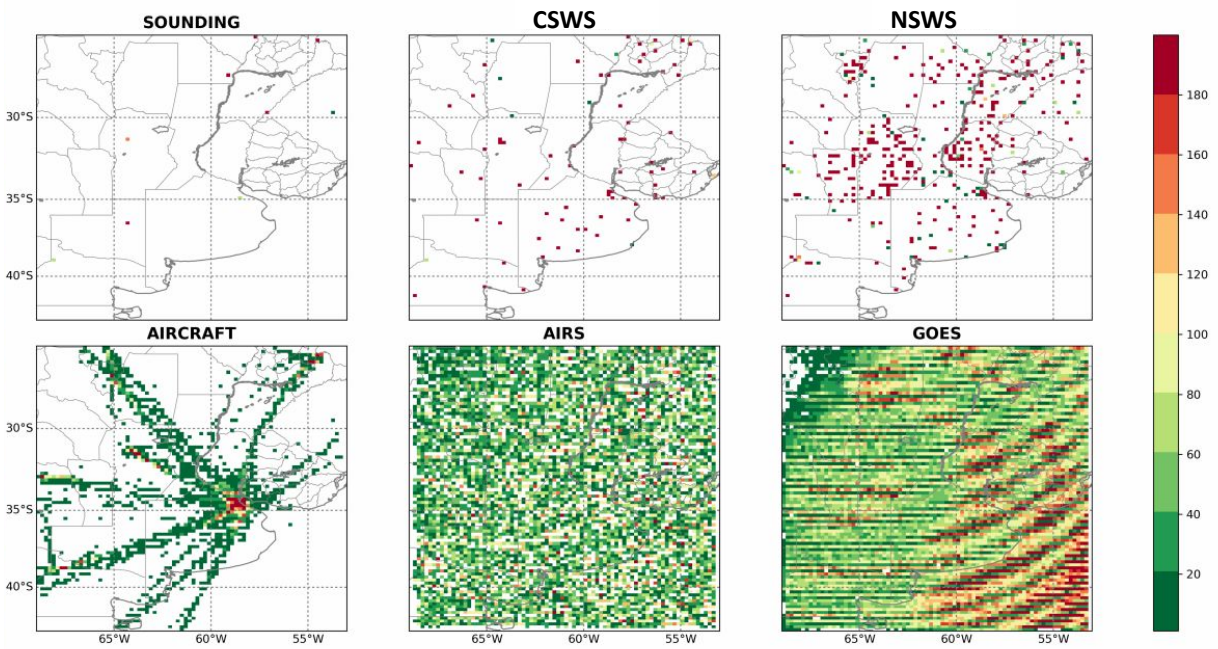
Observational Network

Observation type	Variables
Radiosondes	*RH,T,U,V*
Conventional Manual Surface Weather Stations (CSWS)	*RHS,PS,TS, US,VS*
Non-conventional Surface Weather Stations (NSWS)	*RHS,PS,TS, US,VS*
Aircraft	*U,V*
NASA Atmospheric Infrared Sounder Retrieval	*T,Q*
GOES Derived Motion Winds	*U,V*

Observation frequency during the 30 days analyzed



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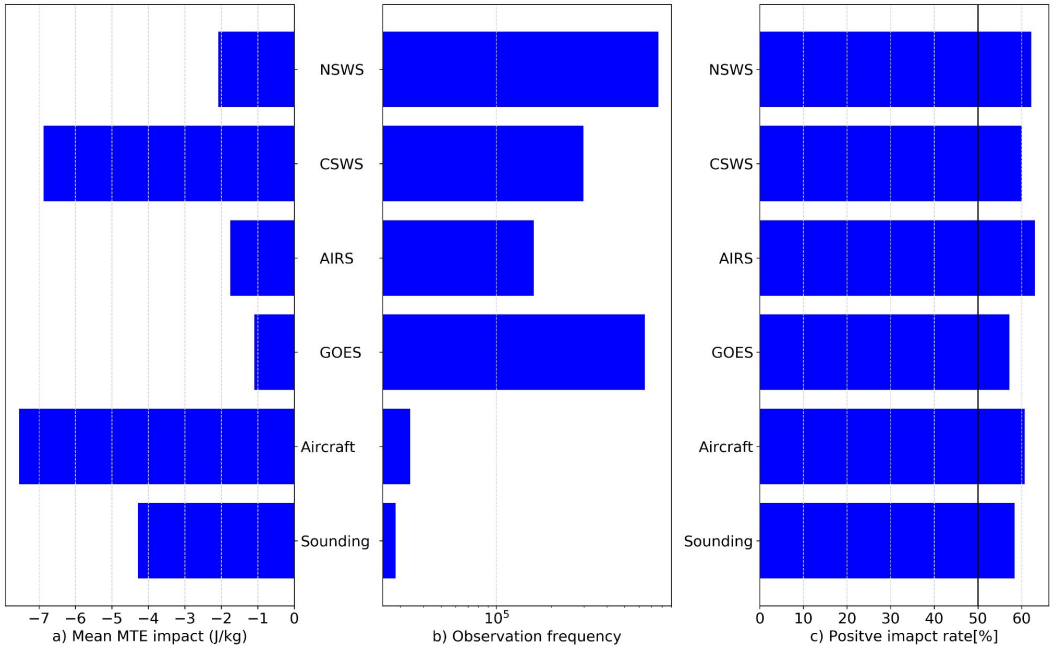
EFSOI results



Different norms: kinetic energy (KE), potential energy (PE), and moist energy (ME).

Moist Total Energy is defined as

MTE=KE+PE+ME

- NEGATIVE (blue) quantitatives indicate forecast **benefit/reduction** of the forecast error.

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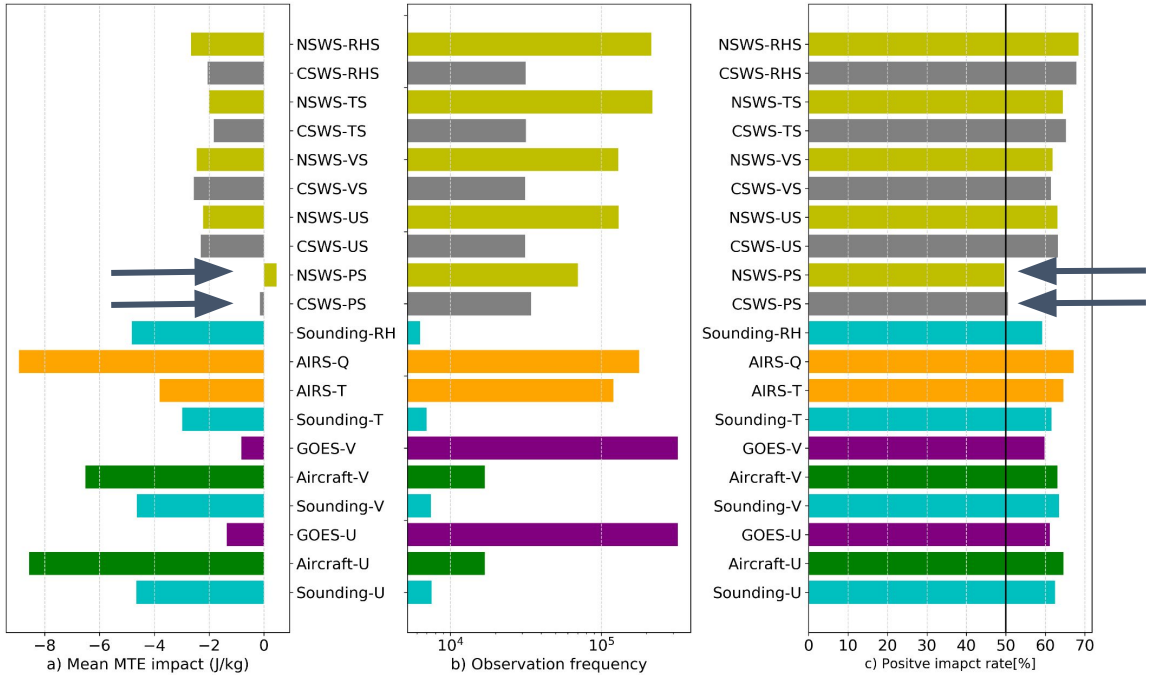
EFSOI results



- **NSWS-PS** has a **POSITIVE** mean MTE → only set with a detrimental impact on average and with a **positive impact rate < 50%**.
- **CSWS-PS** has a positive impact ~ 52%, and mean MTE impact close to zero, being the second "worst" observation set.

Q and **RHS** have the greater positive impact rate values closer to 70%, while the remaining variables range between 55% and 65%

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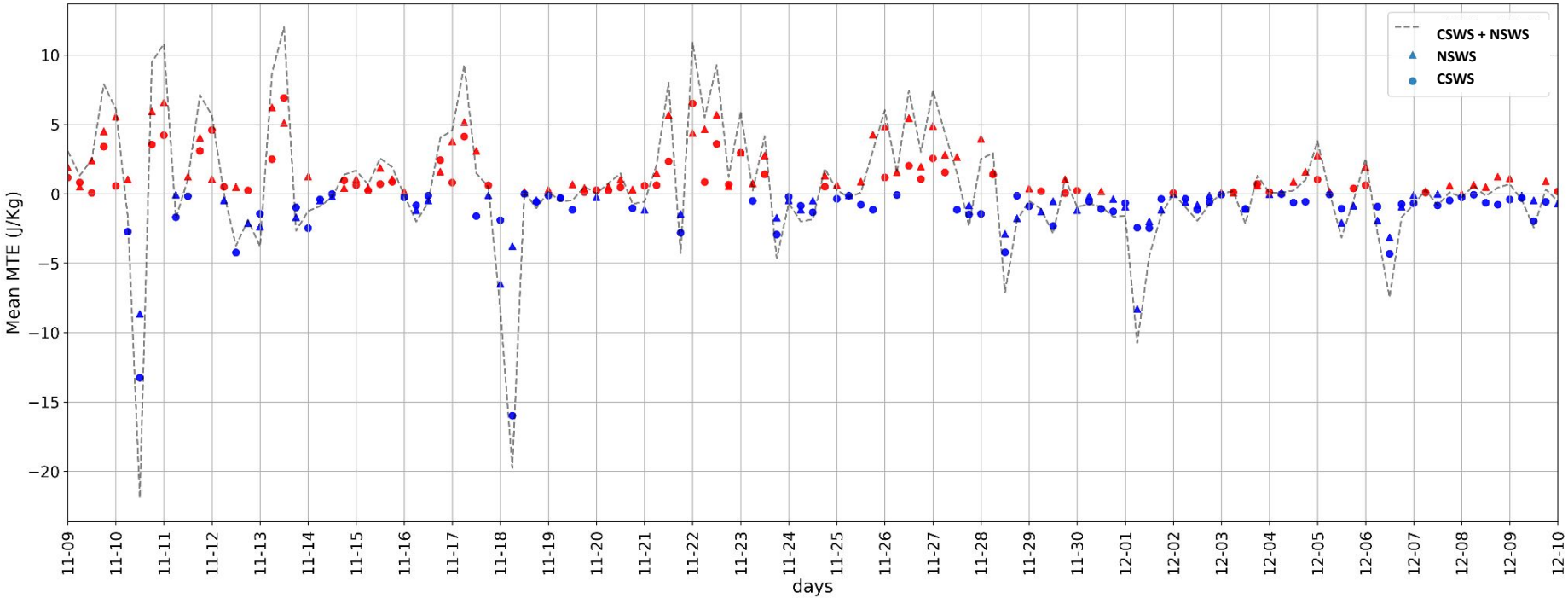
EFSOI results

Timeline of surface pressure mean MTE spatially averaged.



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Verification

Experiments	*Observations Assimilated*
EXP1	*ALL available*
EXP2	*PS variable removed from CSWS and NSWS*

Both experiments have the same model configuration.

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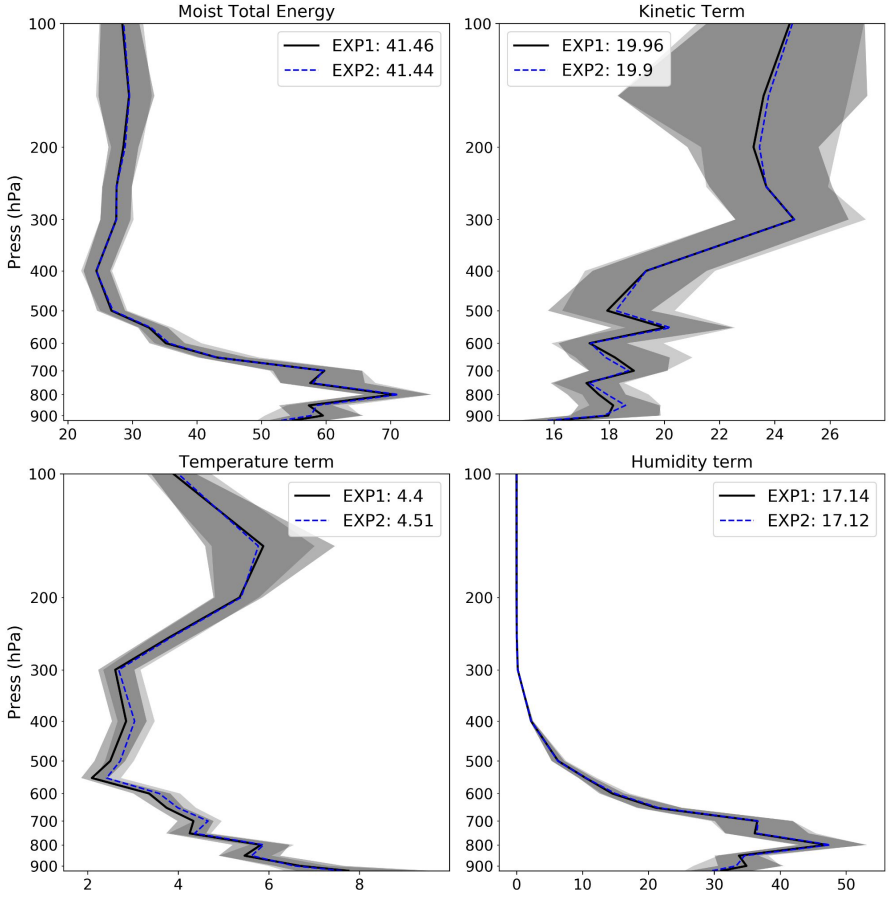

Verification

$$TE_{i,j,k,t} = 0{,}5\left(u'^2_{i,j,k,t} + v'^2_{i,j,k,t} + \frac{C_{pd}}{T_r}T'^2_{i,j,k,t} + \frac{L^2}{C_{pd}T_r}q'^2_{i,j,k,t} + \frac{R_d T_r}{P_r^2}Ps'^2_{i,j,k,t}\right)$$

Moist total energy error *(TE, Ehrendorfer 1999)* is calculated with:

- Forecast initialized at 6 UTC with a 6 hours lead time
- Atmospheric profiles from the fixed sounding measurements at 12 UTC.

Forecast were interpolated using a closest neighbor approach to the location of the sounding. (x' is the difference between state and reference)

- <u>Moist Total Energy:</u> No big differences. Mean value **EXP2<EXP1**.

The results depend on the term and the pressure level.

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Conclusions

- EFSOI method application can efficiently suggest data selection criteria. Was the first approximation to objectively quantify the impact of each individual observation on the forecast over the region.
- EFSOI help identify observation data sources detrimental for the DA assimilation system, such as PS, in order to assess improvements in the regional DA systems applied in south-eastern South America.
- Results showed that both weather surface observational data sources – conventional and nonconventional – were equally beneficial in all the variables considering reduction of the forecast errors.
- Importance of assimilating NSWS observations, besides being an underutilized dataset, for a region such as south-eastern South America with data sparseness of CSWS.

Thank you!

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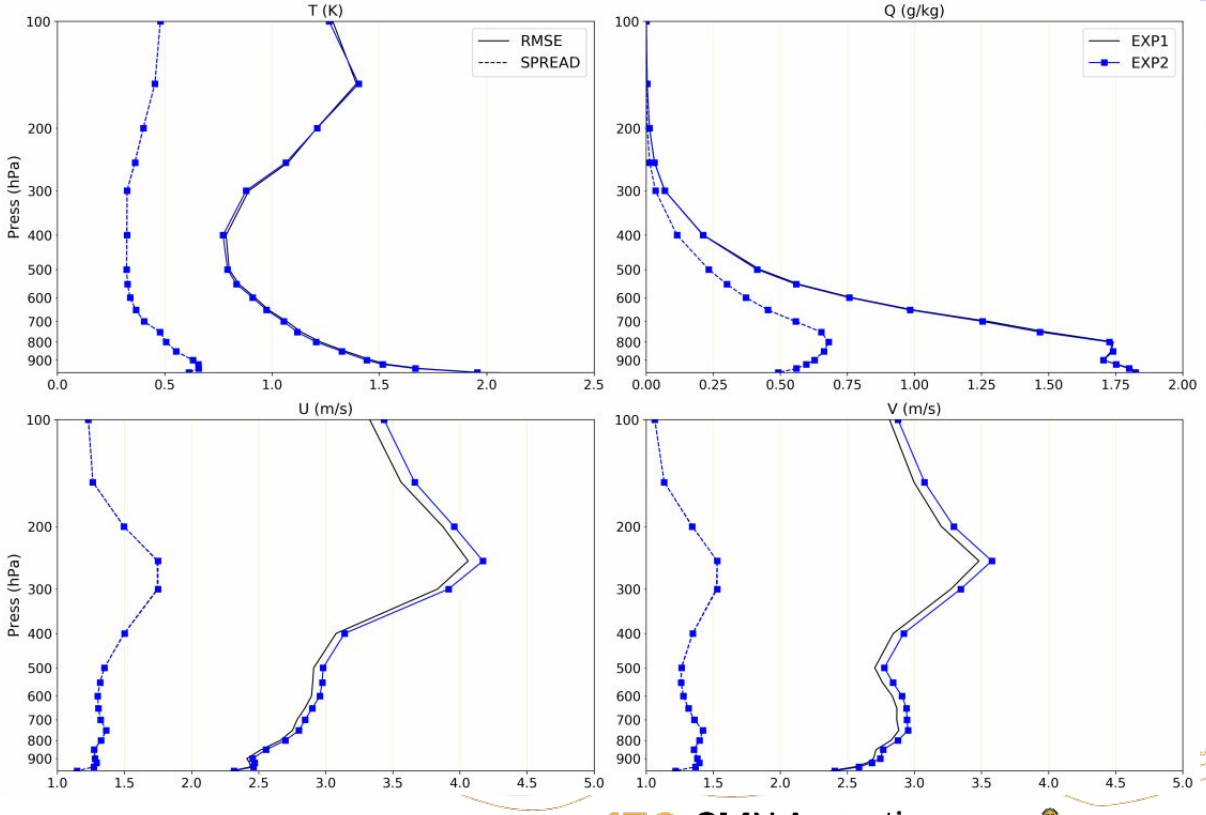
Verification



RMSE and SPREAD calculated with:

- Hourly ERA5 reanalysis of 0.25 degree resolution
- Analyses (00,06,12,18 UTC) linearly interpolated to reanalysis regular grid

U,V components: RMSE EXP1<EXP2

Specific humidity, T: No differences are found between experiments.

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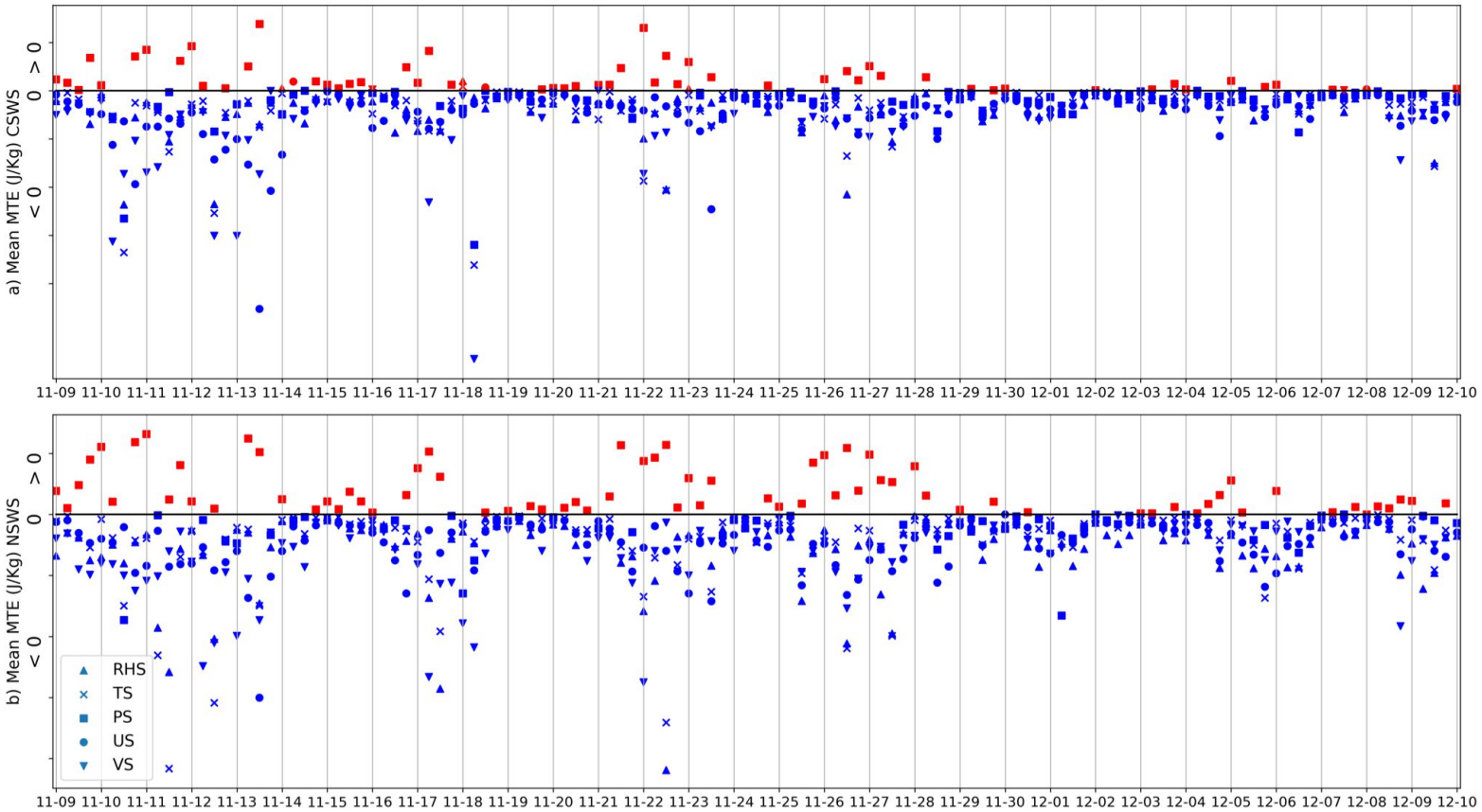

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