Usage of L2 soundings in the data assimilation and numerical weather prediction system at the Argentinian NMS: present implementation and experiments.

ITSC-25

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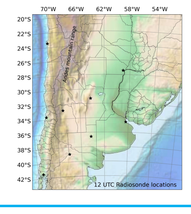
1. Motivation

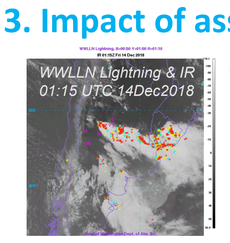
- Very few radiosondes launched operationally over the region
- Limitation in both computational and human resources for regional data assimilation of satellite radiances



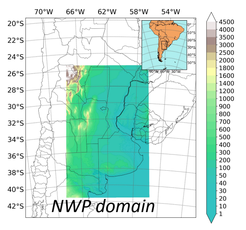
2. Objective

This work aims to provide an overview of the current usage of L2 soundings in the **data assimilation and numerical weather prediction system at the National Meteorological Service of Argentina (SAP.SMN)**, along with sensitivity experiments to evaluate the impact of the humidity and temperature retrievals assimilation.

3. Impact of assimilating L2 soundings in a case study (14th Dec 2018)



A mesoscale convective system (MCS) developed over central Argentina.



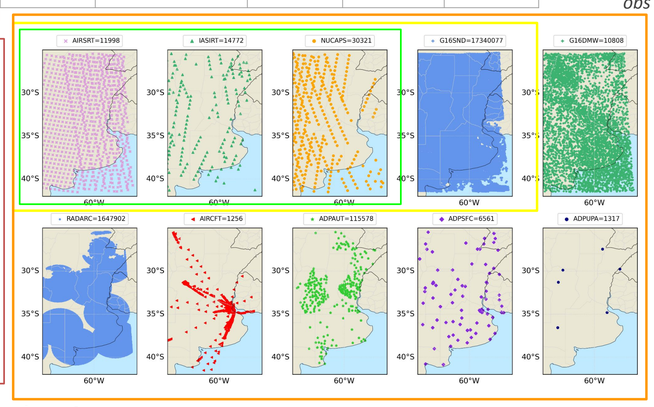
System characteristics:

- 4D-LETKF-WRF DA system: Local Ensemble Transform Kalman Filter coupled with the Weather Research & Forecasting model
- 4 km horizontal resolution, 60 vertical levels
- 40 ensemble members
- Boundary conditions: 0.25° GFS perturbed using 0.5° GEFS forecasts
- Multi-physics scheme: WSM6 and Lin for microphysics (1-moment); YSU, MYJ and SH for PBL
- Hourly analyses from 19 UTC 13 Dec to 18 UTC 14 Dec (24 cycles) using 10 minutes slots for DA
- RTPS inflation (alpha 0.95)
- Localization: 180km (H) and 0.4 ln P (V) (for radar: 25km (H) and 2km (V))
- Vertical S.O. (25 hPa) applied to IASIRT, NUCAPS, G16SND, G16DMV
- S.O. for radar: 6km (V) and 1km (H)

Experiment	IASIRT	NUCAPS	AIRSRT	G16SND	G16DMV	ADPAUT/ADPSFC	AIRCFT	ADPUPA	RADAR
POL	T, Q	T, Q	T, Q						
POL+G16SND	T, Q	T, Q	T, Q	T, RH					
ALL	T, Q	T, Q	T, Q	T, RH	U, V	U, V, T, RH, PSFC	U, V, T	U, V, T, Q	Z, dV

Total assimilated obs

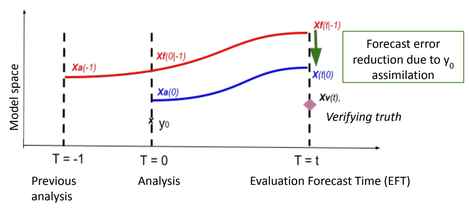
- **IASIRT:** the Infrared Atmospheric Sounding Interferometer on board the European MetOp satellite series
- **NUCAPS:** the Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) onboard the Joint Polar Satellite System, using the NOAA Unique Combined Atmospheric Processing System
- **AIRSRT:** the Atmospheric Infrared Sounder on board the National Aeronautics and Space Administration (NASA) Aqua polar-orbiting satellite
- **G16SND:** the Legacy Vertical Temperature and Moisture Profiles from GOES-16

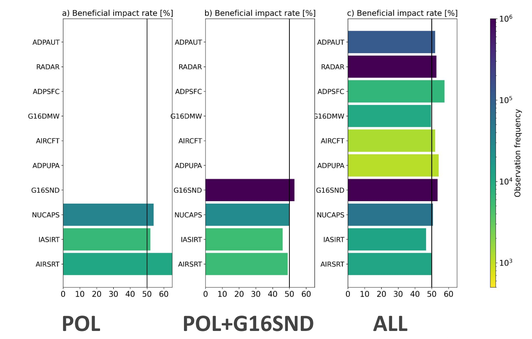


Ensemble Forecast Sensitivity to Observations Impact

*What is **EFSOI**?* An objectively quantification of the impact of each assimilated observation.

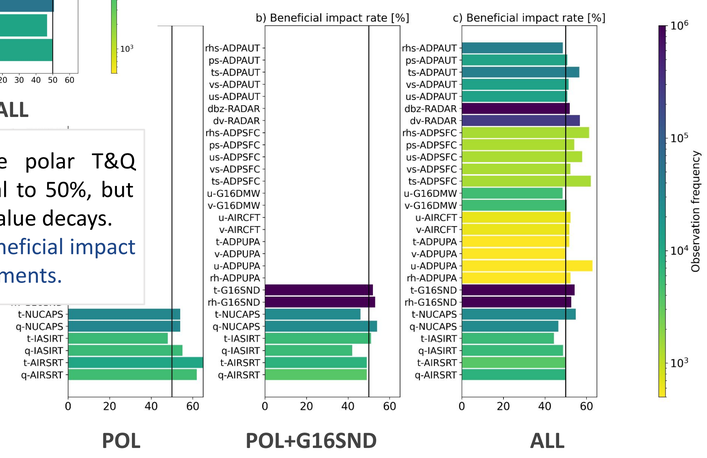
The difference between the errors of the forecast initialized from the analysis with the assimilated observation versus the forecast without that observation, is calculated.





EFSOI was calculated for 1-h Evaluation Forecast Time (EFT), considering the own DA analyses as the verifying truth

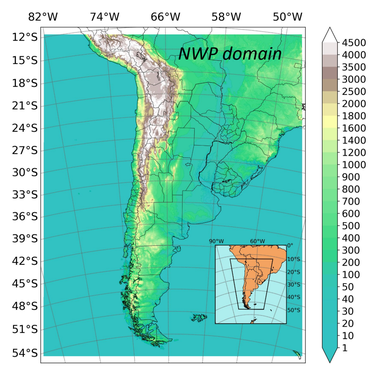
Beneficial impact rate [%] =
# of obs beneficial / # of total obs

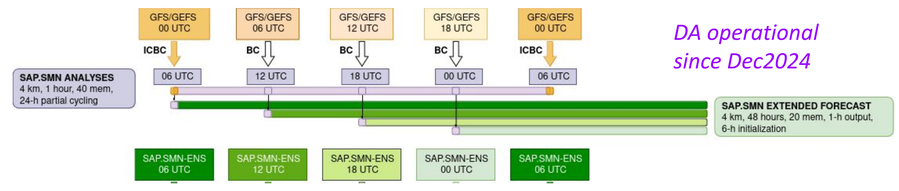


The beneficial impact rates of the polar T&Q retrievals are general greater or equal to 50%, but when more sources are included the value decays. Geostationary T&Q retrievals show beneficial impact rates greater than 50% for both experiments.

It is remarkable that the radiosondes profiles (ADPUPA) show similar (or better) beneficial impact rates to L2 retrievals, although the observation frequency is at least one order of magnitude smaller.

4. Operational usage of L2 soundings for regional analyses (SAP.SMN-ANA)



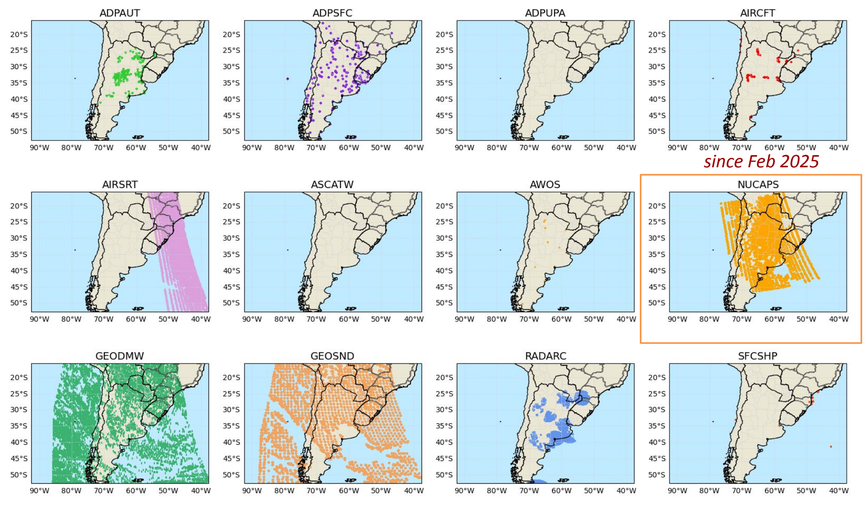


DA operational since Dec2024

System characteristics

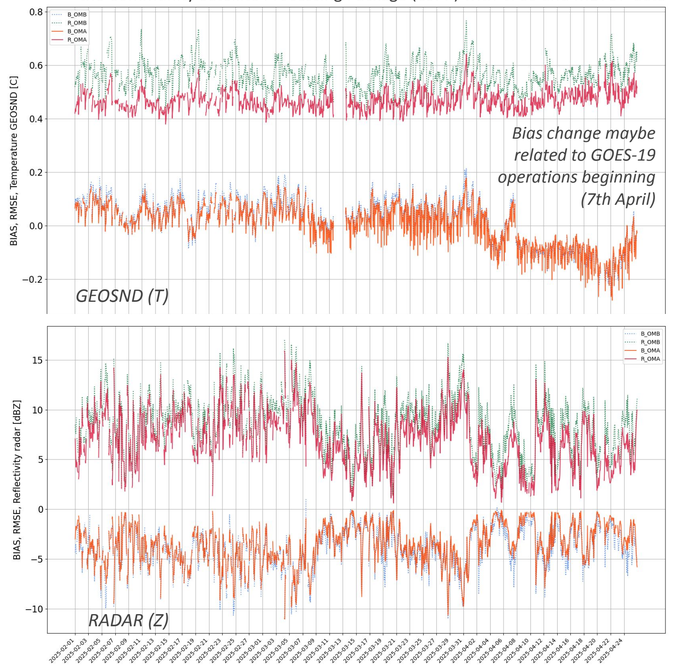
- The same as the experiments in Section 3, but with 45 vertical levels and some differences in assimilated observations (see table)
- Partial cycling: DA reinitialized everyday at 12 UTC
- NUCAPS obtained through DBNet from CONAE (Argentina space agency)
- Observation cut off: 60 minutes

Eg. 2025/03/06 18 UTC Assimilated observations



Source	Variables	S.O./TH
ADPAUT ADPSFC	U, V, T, RH, PSFC	-
ADPUPA	U, V, T, Q	-
AIRCFT	U, V, T	SO 30km, 25hPa
AIRSRT	T, Q	-
ASCATW	U, V	-
AWOS	U, V, T, RH, PSFC	-
NUCAPS	T, Q	SO 5km, 25hPa
GEODMW	U, V	SO 30km, 25hPa
GEOSND	T, RH	TH 100km, 50hPa
RADARC	Z	SO 6km, 1km
SFCSHP	U, V, T, RH, PSFC	-

NUCAPS: CONAE Earth Observation Satellite Direct Broadcast (EOS-DB) products using the Community Satellite Processing Package (CSPP) with JPSS and METOP data



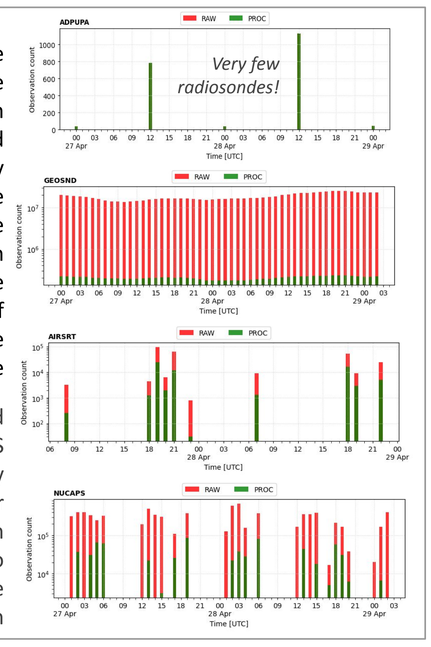
The OMA and OMB statistics from 2025/02/01 to 2025/04/25 for GEOSND T and radar Z show a properly behaviour of the DA system.

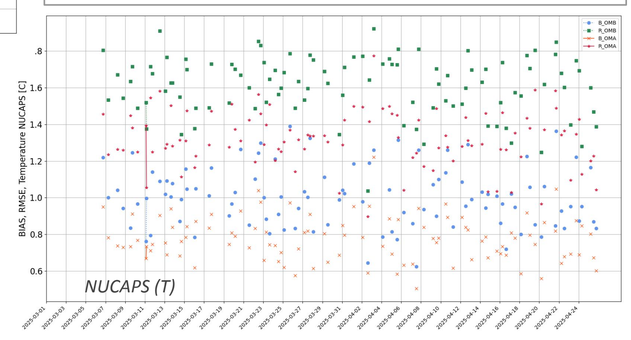
The negative reflectivity bias suggests an overestimation of the intensity of the convective systems simulated, result which is also encountered in higher resolution simulations over the region and is worth to study.

The OMA and OMB statistics from 2025/03/01 to 2025/04/25 for NUCAPS T also show a reduction in the analysis error

Temperature and moisture retrievals from both polar and geostationary satellites are very valuable tools for fill in gaps in the description of the atmosphere

GEOSND and NUCAPS retrievals may be better exploited in the future to retain more information





5. Concluding remarks and future perspectives

- The assimilation of thermodynamic profiles retrievals showed positive impacts in the forecasts according to EFSOI
- **L2 T&Q retrievals (from AIRS, NUCAPS, GOES) are successfully assimilated in the operational high resolution hourly 4D-LETKF-WRF system at the Argentinian Meteorological Service**
- More sensitivity studies should be conducted to adjust S.O. and TH. parameters of each L2 sounding source to better exploit the data for operational DA purposes
- L2 T&Q retrievals, radar data and automatic surface weather station observations represent valuable information to include in regional NWP models
- Operational implementation of EFSOI is planned to monitor the assimilated observations

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