Preparation for the assimilation of the future IRS sounder @Météo-France

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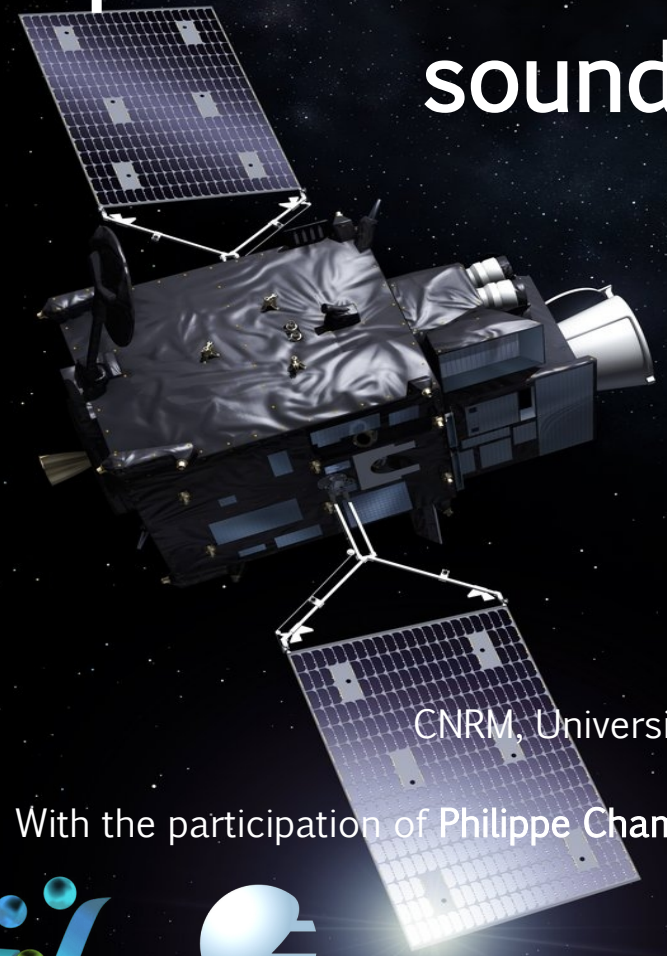
With the participation of **Philippe Chambon, Pierre Brousseau, Maud Martet, Camille Birman and Jérôme Vidot**



IRS MAG 22 January 2022

Evaluation of the impact of IRS in AROME

Olivier Coopmann EUMETSAT Fellowship

Objectives:

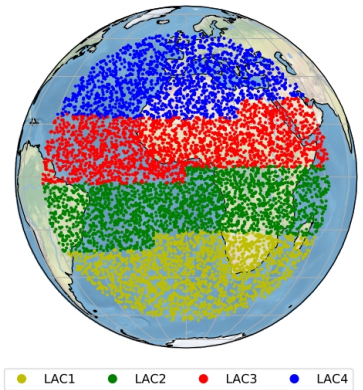
- Preparation of the assimilation of IRS for AROME
- Assessing the impact of IRS in addition to radars
- To be ready to assimilate real IRS data from day one!

Tools:

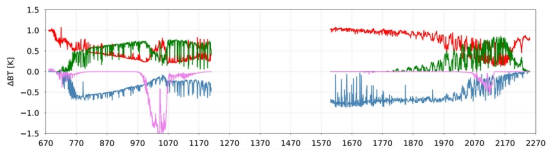
- A framework for the assimilation of IRS : Observing system simulation experiment
- Selection of information for its assimilation

Part 1 : 1D study – IRS analysis & selection of information

Creation of 1D database & sensitivity analysis

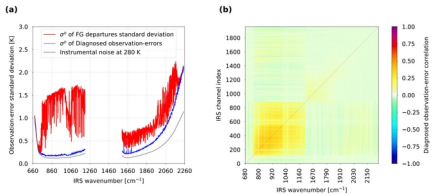


- 7500 synthetic IRS observations & background profiles
- IRS Sensitivity analysis



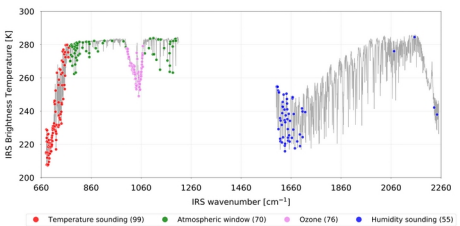
IRS Observation-errors

- Observation errors matrix from the converted NEΔT(T) for the corresponding scene temperature T for each pixel
- Use of 1D-Var data assimilation & Statistical estimation of the full R matrix using the Desroziers method



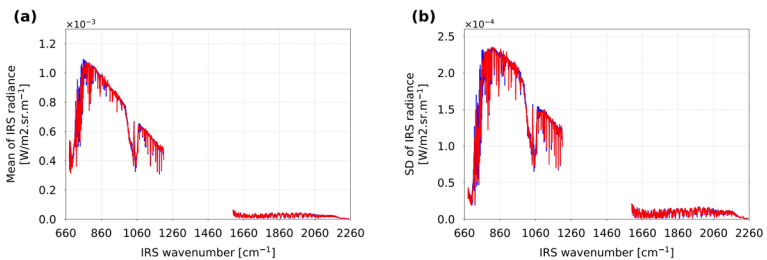
General IRS channel selection for NWP

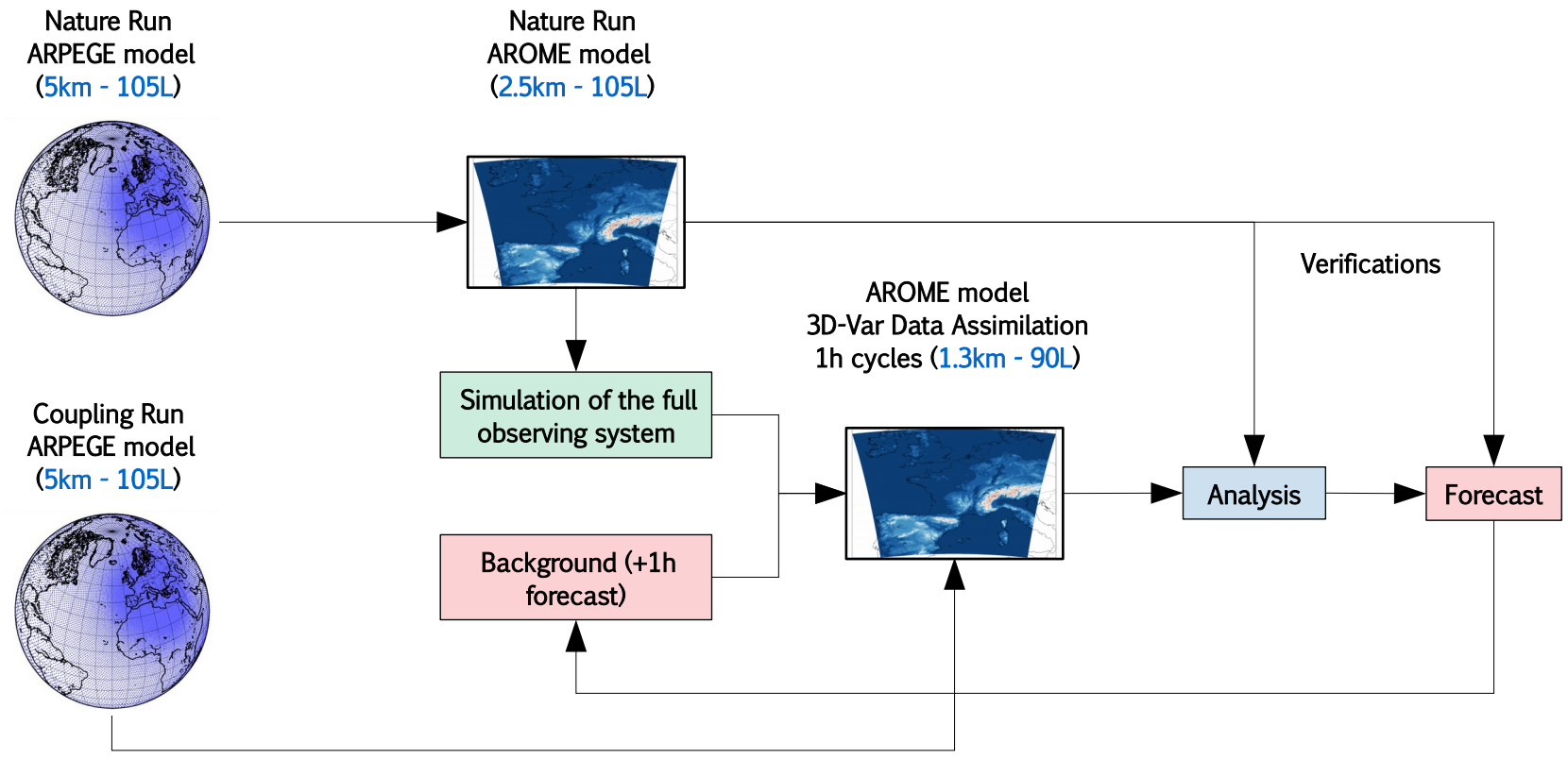
- Use of the information content method (Degree of Freedom for Signal) → DFS = Tr (**I** – **AB**$^{-1}$)
- 1D-Var selection testing with 1700 profiles & 300 IRS channel selection



Principal component study

- Testing the conversion of raw radiances into principal components and then into reconstructed radiances from the new calculation grid (1960 channels for 300 PCs)





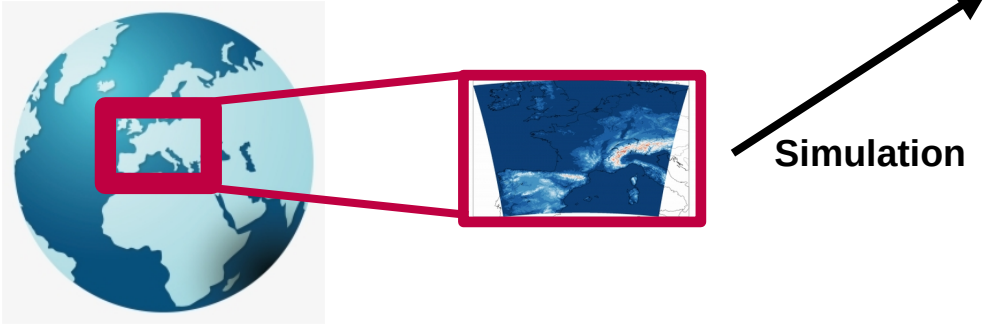
Scheme of OSSE framework for AROME 3D-Var data assimilation system

Calibration of AROME observing system

- Observation values simulated from the AROME NR
- Randomly perturbed to account for instrumental errors
- Calibration by tuning for observation errors for each observation type
- 2 periods: January-February & July-August 2020

ARPEGE NR

AROME NR



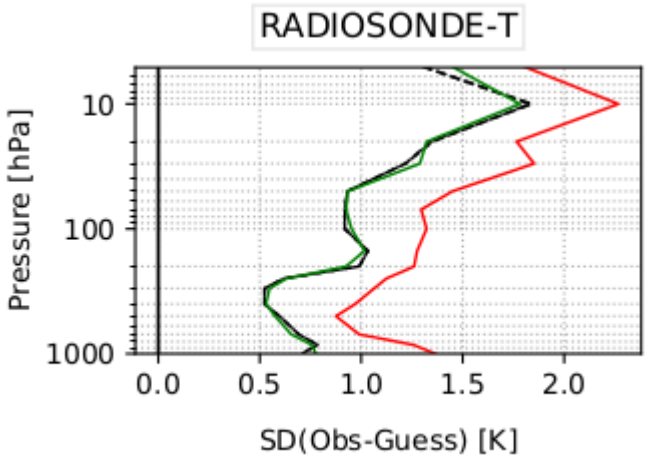
Simulation

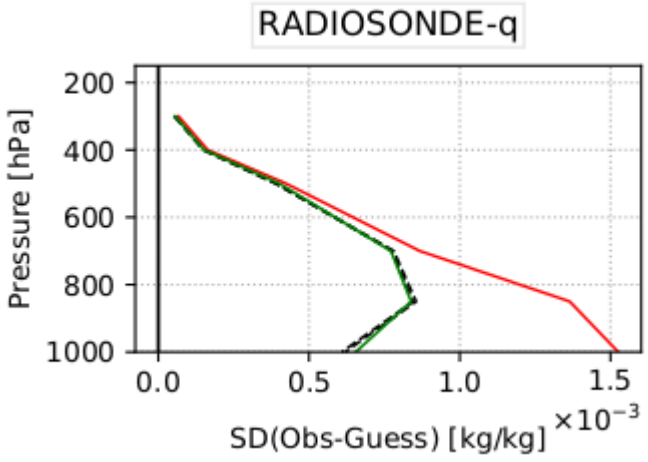
Operational AROME observing system

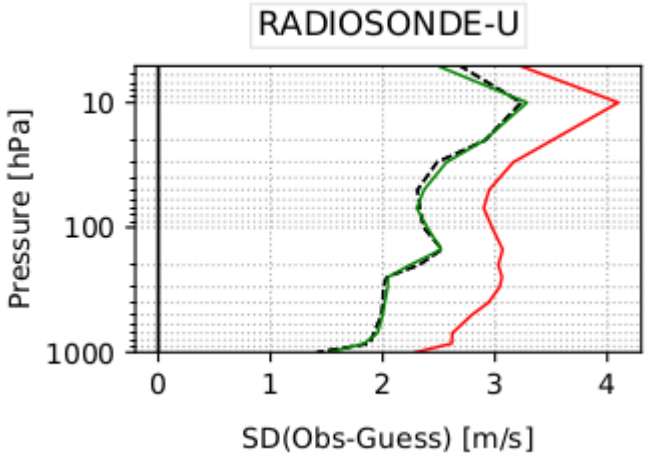
Observation kinds	Instruments
Surface measurements	Surface stations, ships, buoys, ground GPS, wind profilers, **radar humidity, radar wind**
Altitude measurements	Radiosondes (TEMP, PILOT), aircrafts, AMVs
Infra-red satellite data	IASI, SEVIRI
Micro-wave satellite data	AMSU-A, AMSU-B, MHS, ATMS, SSMIS, GMI

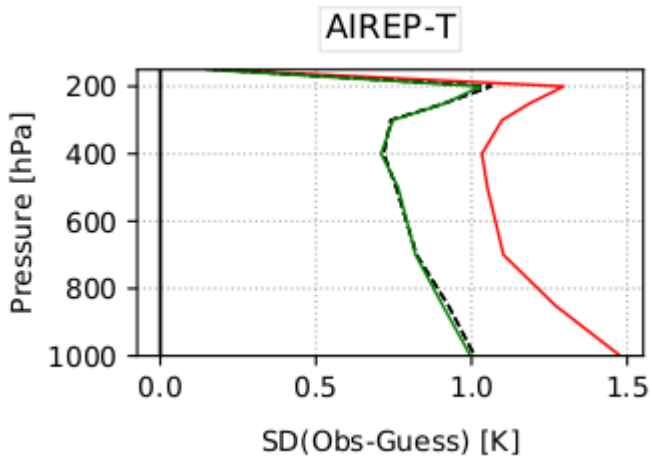
AROME Observing System Simulation calibration

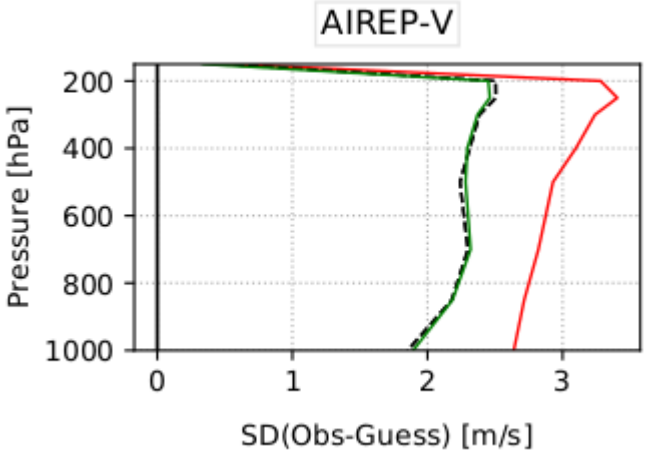
Conventional data ➞ Standard deviation of first-guess departure for 44 days (Summer + Winter)

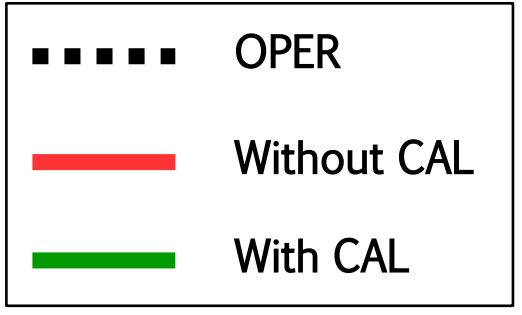




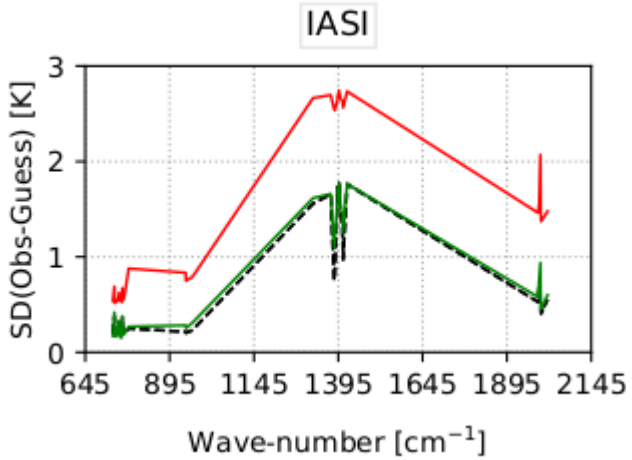


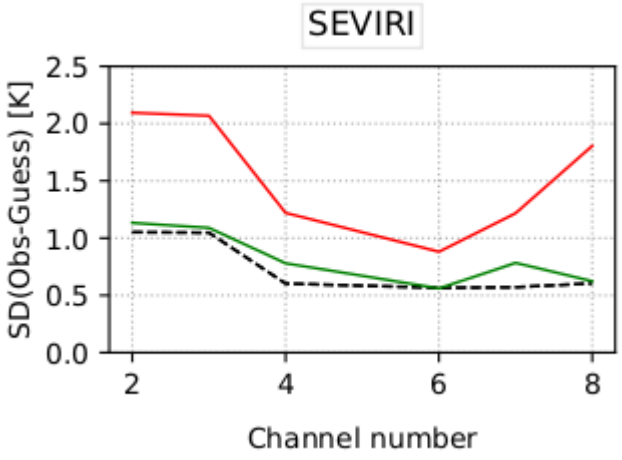


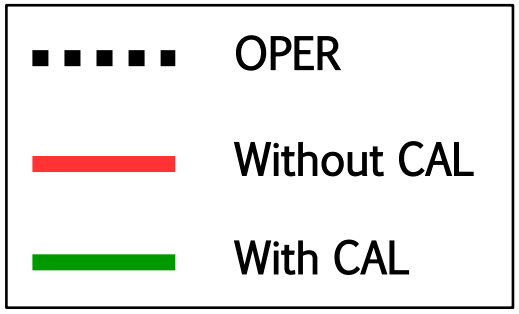




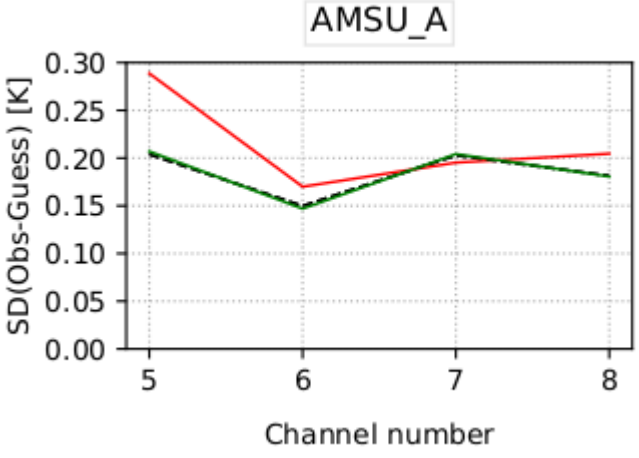
IR data → Standard deviation of first-guess departure for 44 days (Summer + Winter)

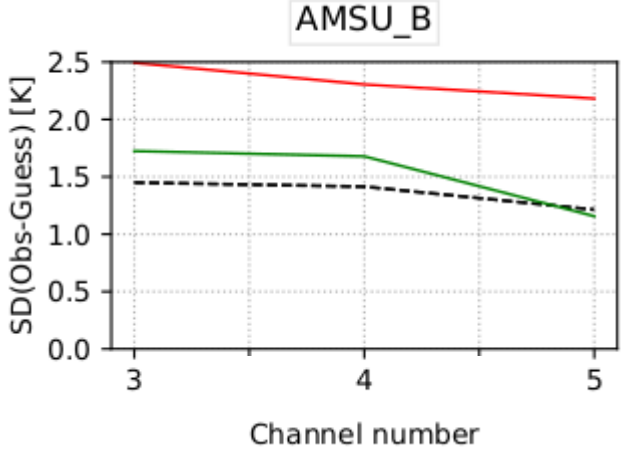


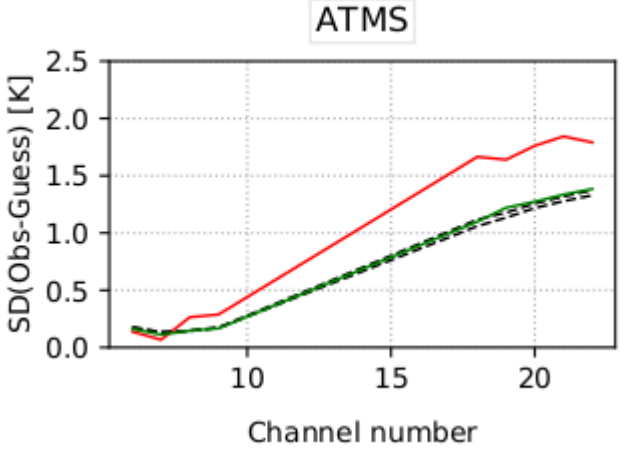




MW data → Standard deviation of first-guess departure for 44 days (Summer + Winter)







Calibration of AROME observing system

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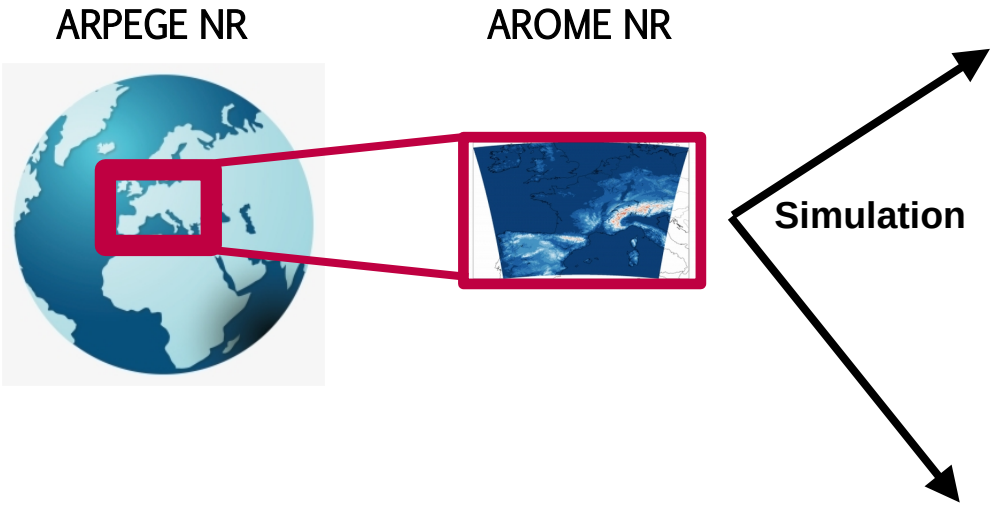

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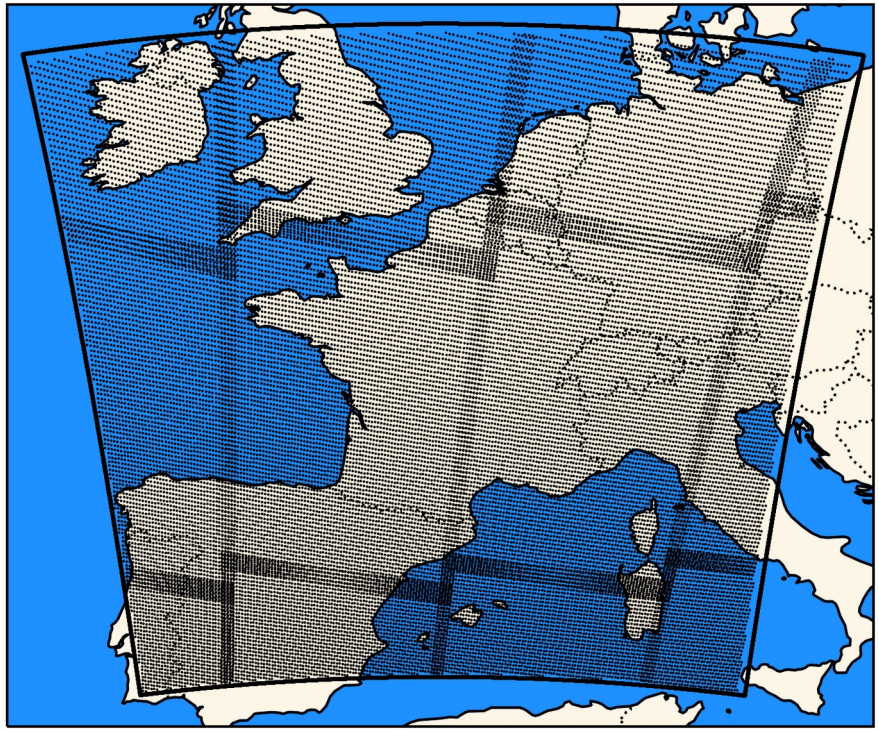
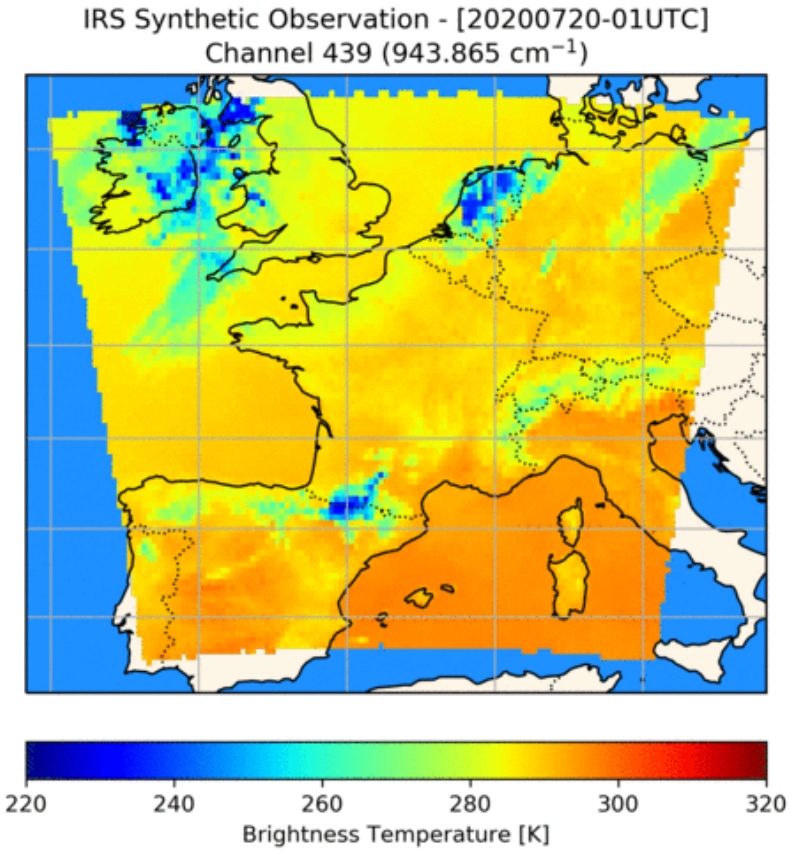
Simulation of IRS brightness temperatures





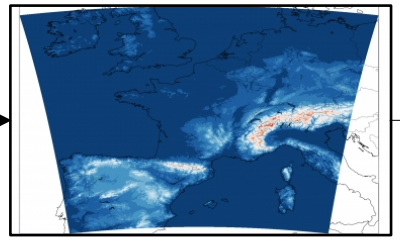
1 pixel out of 4 (32724 observations processed each hour).

First impact of IRS assimilation

Observations **3D-VAR AROME** **Forecast +P24**

AROME observing system

Conv, radars, IR, MW, ...



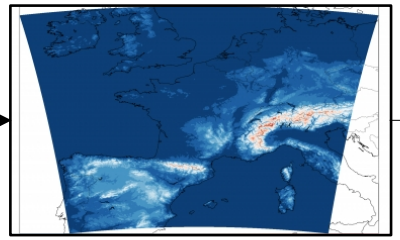
CTL

First impact of IRS assimilation

Observations | **3D-VAR AROME** | **Forecast +P24**

AROME observing system

Conv, radars, IR, MW, ...



CTL

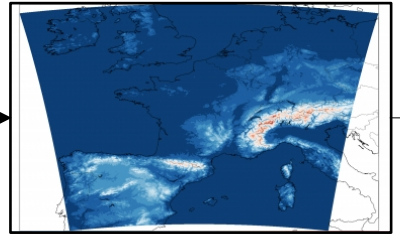
AROME observing system

Conv, radars, IR, MW, ...

+

IRS observations

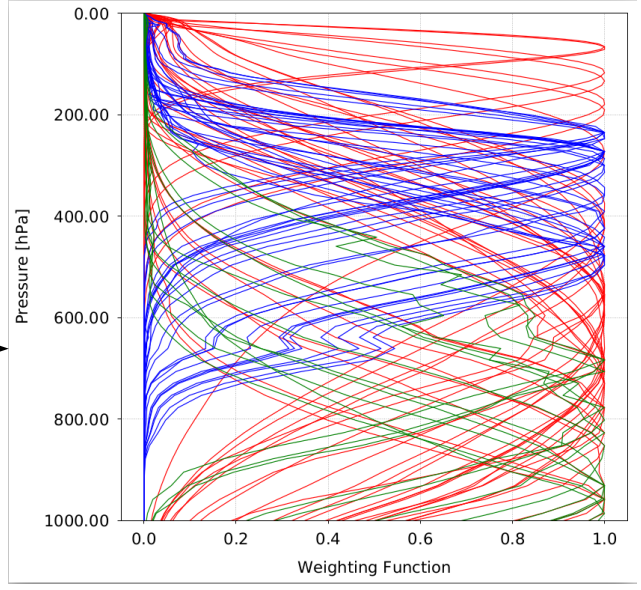
All-Sky, Pseudo-Hamming, NEDT, 1pixel /2



EXP

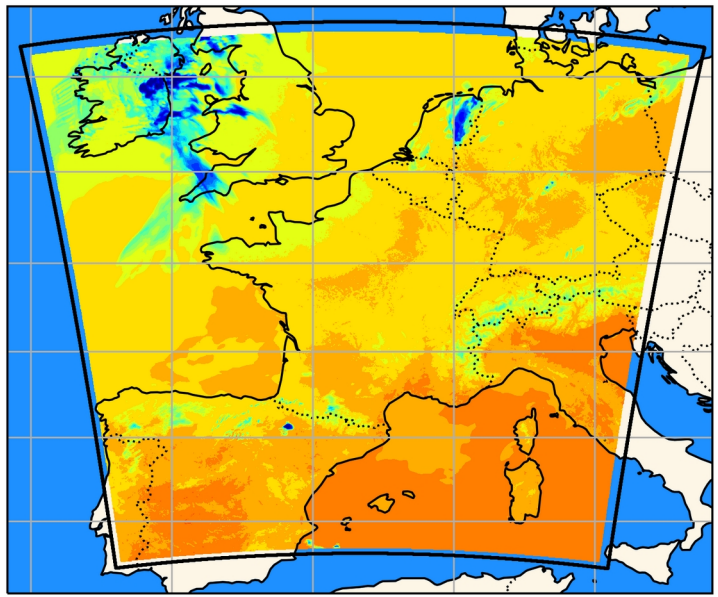
- 75 specific IRS channels (raw radiances)
- Thinning : 70 km
- Obs error diagnosed (no correlation)
- Appropriate Cloud detection

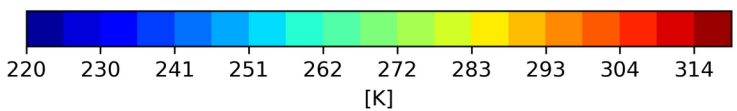
36 T+12 Window+27 WV



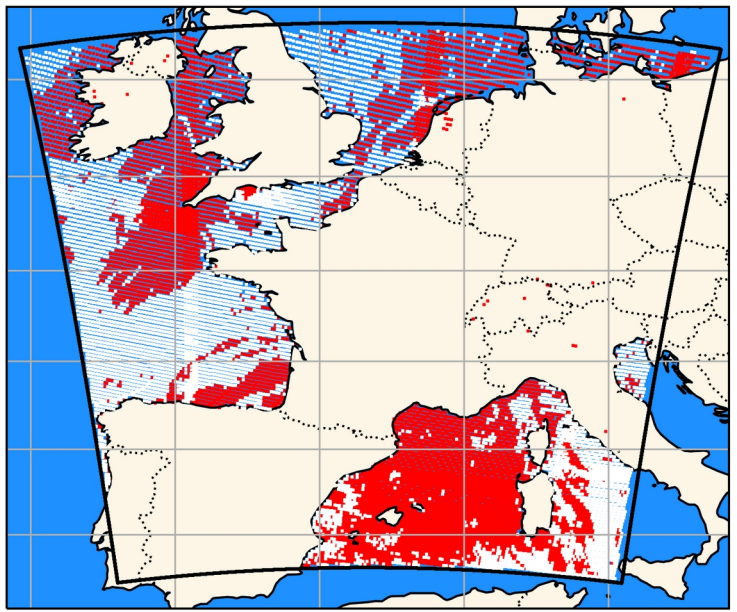
Cloud detection (McNally and Watts detection scheme)

Thermal IR simulation from AROME Guess
[20200720-01UTC] (10.8 μm)





IRS Cloud Flag - [20200720-01UTC]
Channel 514 (989.10 cm^{-1})

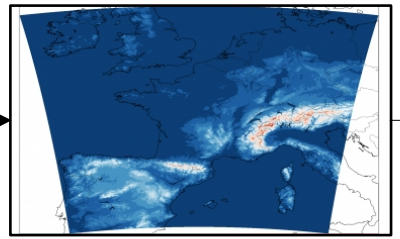


First impact of IRS assimilation

Observations | 3D-VAR AROME | Forecast +P24 | Scores

AROME observing system

Conv, radars, IR, MW, ...



CTL

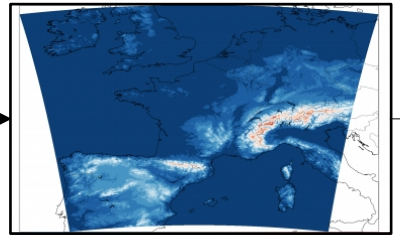
AROME observing system

Conv, radars, IR, MW, ...

+

IRS observations

All-Sky, Pseudo-Hamming, NEDT, 1pixel /2



EXP

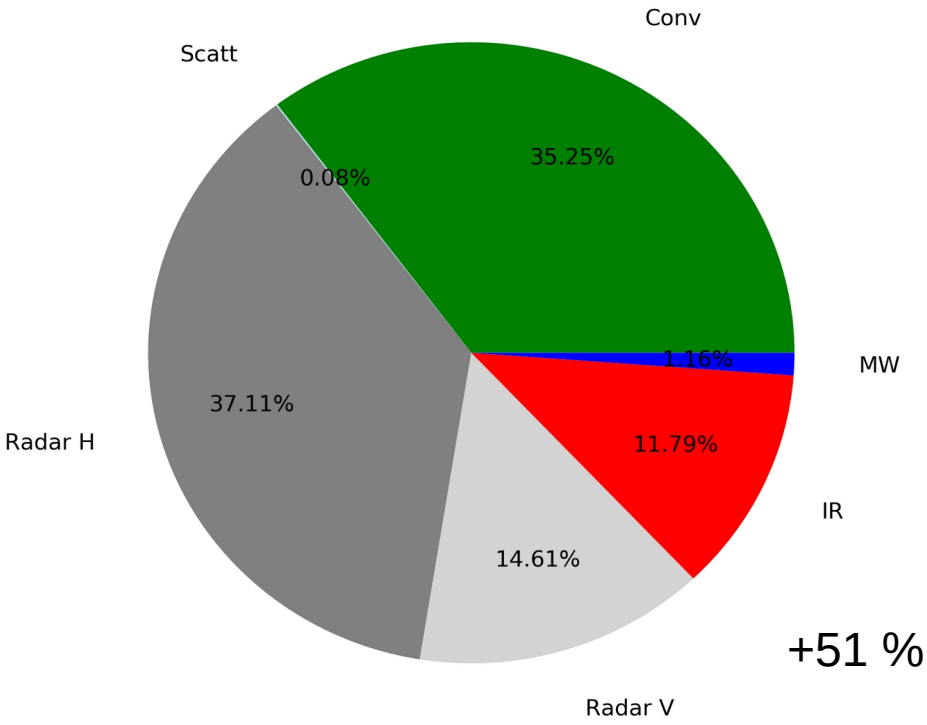
Relative differences / NR
22 forecasts (Summer)
Temperature
Humidity
Wind
Geopotential

- 75 specific IRS channels (raw radiances)
- Thinning : 70 km
- Obs error diagnosed (no correlation)
- Appropriate Cloud detection

Distribution of the observations

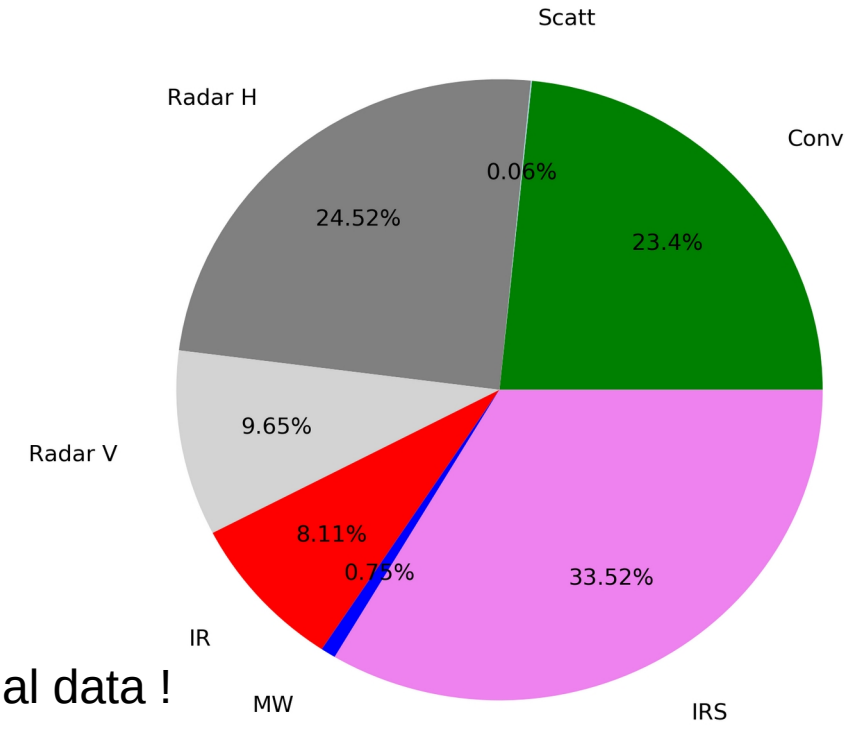
CONTROL 1202187 observations

(a)



EXP 1818648 observations

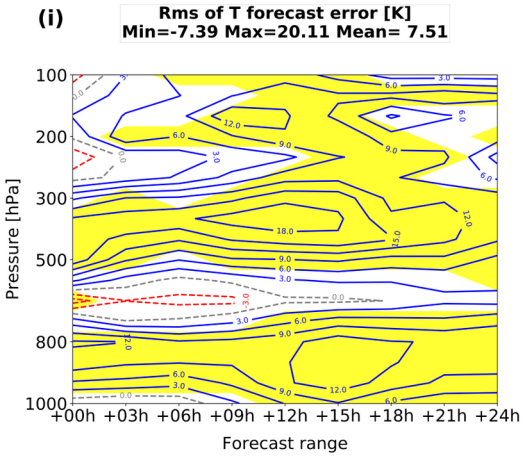
(b)

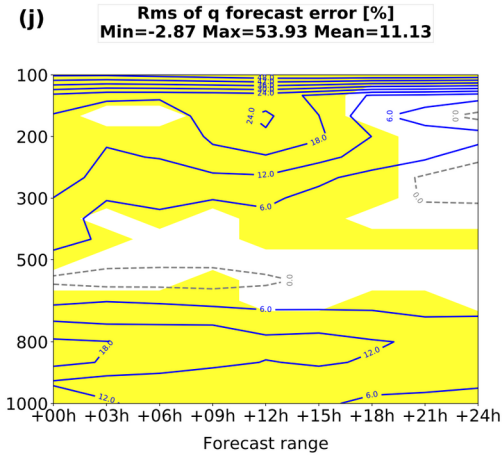


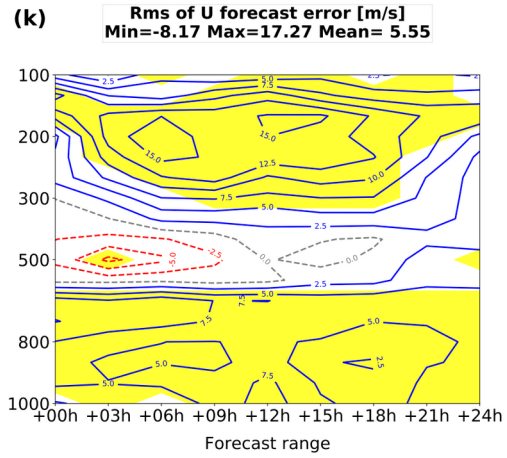
+51 % additional data !

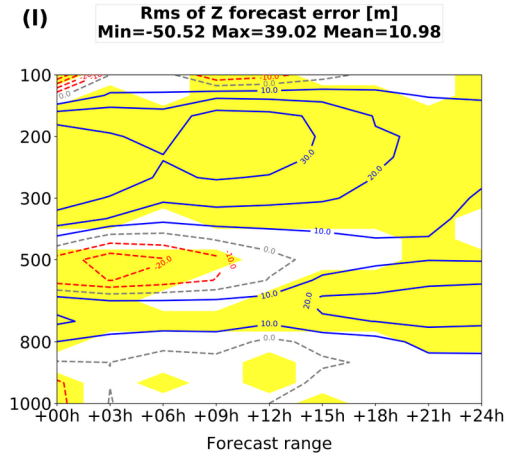
Forecast scores (RMS)

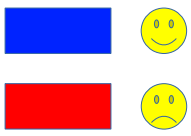
RMS Differences of forecast errors between CTRL and EXP (22 dates only!)











Very encouraging results, to be confirmed.

Conclusion

OSSE framework:

- First assimilation of IRS brightness temperatures in a realistic AROME framework
- Very promising impact of IRS assimilation in AROME even though a very simple channel selection (only over sea, diagonal matrix)

Next work:

- Extend the period of the study (2 months in summer and in winter)
- Use of reconstructed radiances and dedicated observation errors (std+correlation).
- Channel selection dedicated to AROME model + add channel over land