First steps in the preparation for the assimilation of the future IRS sounder in NWP models

Olivier COOPMANN (olivier.coopmann@meteo.fr), Nadia FOURRIÉ, Philippe CHAMBON, Pierre BROUSSEAU
CNRM, Université de Toulouse, Météo-France & CNRS

1) The future MTG-IRS (InfraRed Sounder)

- Planned launch in 2024 onboard geostationary sounding satellite **MTG-S**
- Measurement with 4 Local Area Coverage (**LAC**) zones and Earth disc covered with ~ 313 Dwells
- **LAC 4** covering Europe every 30 minutes
- Each Dwell is taken in **10 s** and covers about **640 x 640** km² at nadir with **160 x 160** spatial samples
- Each Pixel covers ~ **6 x 6 km²** over Europe (4 x 4 km² at nadir)
- **1960** channels between **680 - 1210 cm^{-1}** and **1600 - 2250 cm^{-1}**
- Spectral sampling of ~ 0.6 cm^{-1} for both bands

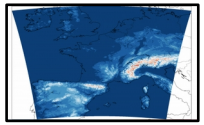
Objectives:

- Preparation of the assimilation of IRS for AROME
- Assessing the impact of IRS on the of the existing observing system including radars.
- To be ready to assimilate real IRS data from day one !

Tools:

- A framework for the assimilation of IRS
- A selection of information for its assimilation

AROME regional model



1,3 km & 90 vertical levels up to 10 hPa

2) IRS sensitivity analysis

The main IRS sensitivities are in the troposphere. The channels the most sensitive in temperature and humidity are observed in the lower troposphere for the first band of the atmospheric window. Ozone band channels are sensitive to temperature and humidity in the lower troposphere.

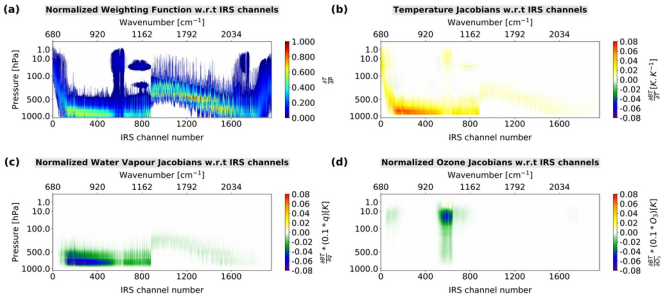


Figure 1: The weighting functions (a) and normalised Jacobians of temperature (b), humidity (c) and ozone (d) as a function of pressure were calculated from the RTTOV radiative transfer model over the 1960 IRS channels.

3) General IRS channel selection for NWP

- Creation of a database of 7500 synthetic IRS observations
- Use of a multi-variate background error covariance matrix (T,q,O_3,Tskin)
- Calculation of a diagnosed observation error covariance matrix taking into account the 1960 inter-channel error correlation
- Channel selection using the information content method (DFS) for T,q,O_3,Tskin over 60 profiles representative of atmospheric variability
- 1D-Var study to select **300 IRS channels** reducing analysis error by up to **48%** in temperature, **65%** in humidity and **17%** in ozone.

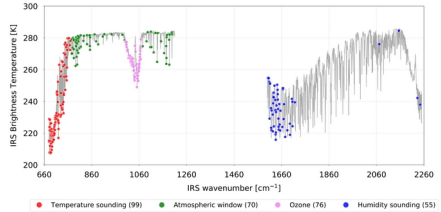


Figure 2: Location of the 300 selected IRS channels on a typical spectrum by main sensitivity.

4) Observing System Simulation Experiment framework

Creation of an **OSSE** to simulate the full observing system for AROME including IRS and to evaluate the impact of IRS in addition to radar observations in the 3D-Var NWP system on weather analysis and forecasts. Implementation of **ARPEGE Nature Run** (5 km horizontal resolution & 105 vertical levels up to 0.1 hPa) to initialise the boundary conditions of **AROME Nature Run** (2.5 km horizontal resolution & 90 vertical levels up to 10 hPa + 15 levels above up to 0.1 hPa from ARPEGE). Two study periods (4 months: **January and February** & **July and August**)

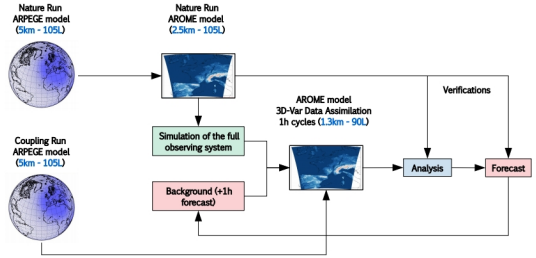
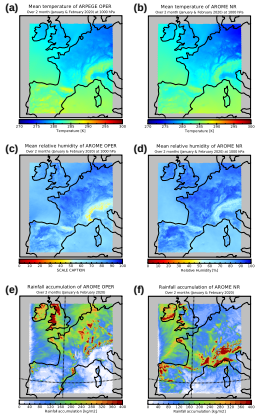


Figure 3: Scheme of the Observing System Simulation experiment (OSSE) framework.

5) Validation of the Nature Runs



- Important check and validation of several meteorological parameters of Nature Runs (temperature, humidity, surface temperature, SST, cloud fraction, rainfall accumulation, etc.).
- No inconsistent structures, time drift or unrealistic effects of the ARPEGE and AROME NRs in relation to the operational. The NRs are validated!
- A 1-month spin-up for the ARPEGE NRs provides a different atmospheric behaviour.
- For the summer period (not shown here) the NRs are globally warmer, less humid and less rainy over France.
- For the winter period, NRs are slightly cooler, wetter and naturally rainy over France.

*Figure 4: Average field over 2 months (from 01 January to 29 February 2020) of the 24 h forecasts of the **operational** AROME model (left) and of the **NR** (right) centred on France for temperature (a, b) and humidity (c, d) at 1000 hPa and rainfall accumulation (e, f) over this period.*

6) Current and future works

- Calibration for an accurate simulation of the observing system for AROME (conventional, radar, infrared, microwave, etc.) is currently underway in order to be closer to the real assimilation system.
- A simulation of IRS pixels (without radiances) has been created for AROME model with a thinning of 1 pixel out of 2 in latitude and longitude (Figure below).
- The next step will be to prepare the AROME system to simulate IRS observations with RTTOV.
- We will adapt the general selection of the 300 IRS channels to be assimilated in AROME to take into account the model top (about 58 sensitive channels above 10 hPa identified).
- Finally, we will evaluate the impact of the new IRS observations in the AROME 3D-Var NWP system in terms of weather analysis and forecasts compared to the Nature Run.

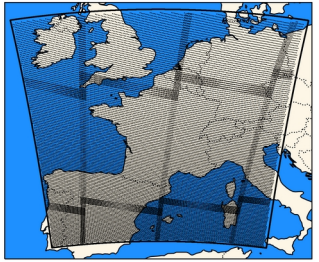


Figure 5: IRS pixels location for simulation in AROME model domain.