Recent and ongoing developments in surface data assimilation for NWP at Météo France

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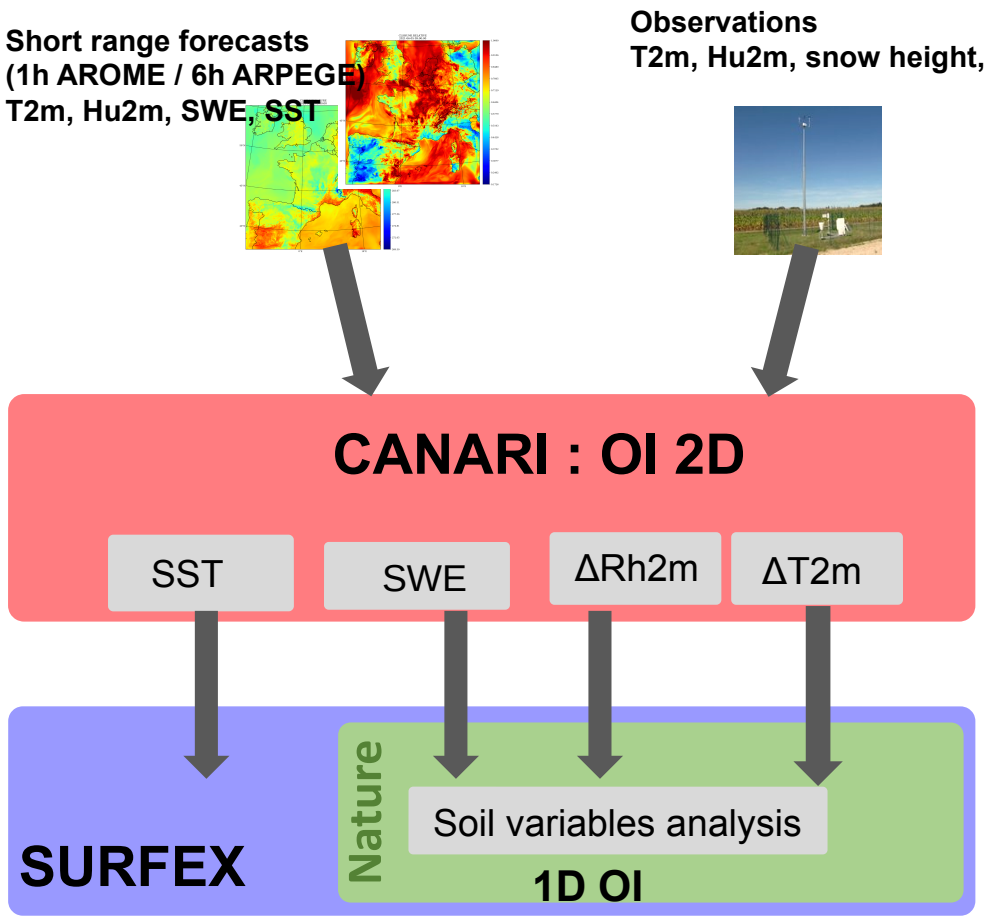
Introduction



- Same surface analysis for ARPEGE global model and AROME limited-area model
- 2 steps for surface analysis
  - 2D OI for 2m variables
  - 1D OI for soil variables
- Outdated system and lack of flexibility for analysing more variables or assimilating different types of observations
- Ongoing work
  - On the 2D part in AROME (Sophie Marimbordes's talk)
  - On the assimilation of satellite observations in ARPEGE (Zied Sassi's talk)

Outline

- Assimilation of satellite snow cover product for snow analysis in ARPEGE global model
- Ongoing work:
  - Development of a 2DEnVar in AROME (Sophie Marimbordes's PhD): adding snow and SST analyses into the 2DEnVar
  - Assimilation of satellite land surface temperature in ARPEGE (Zied Sassi): updating IASI surface emissivity atlas
- Future plans: towards coupled surface-atmosphere analyses: use of coefficients of the day (computed from EDA) in the soil analysis

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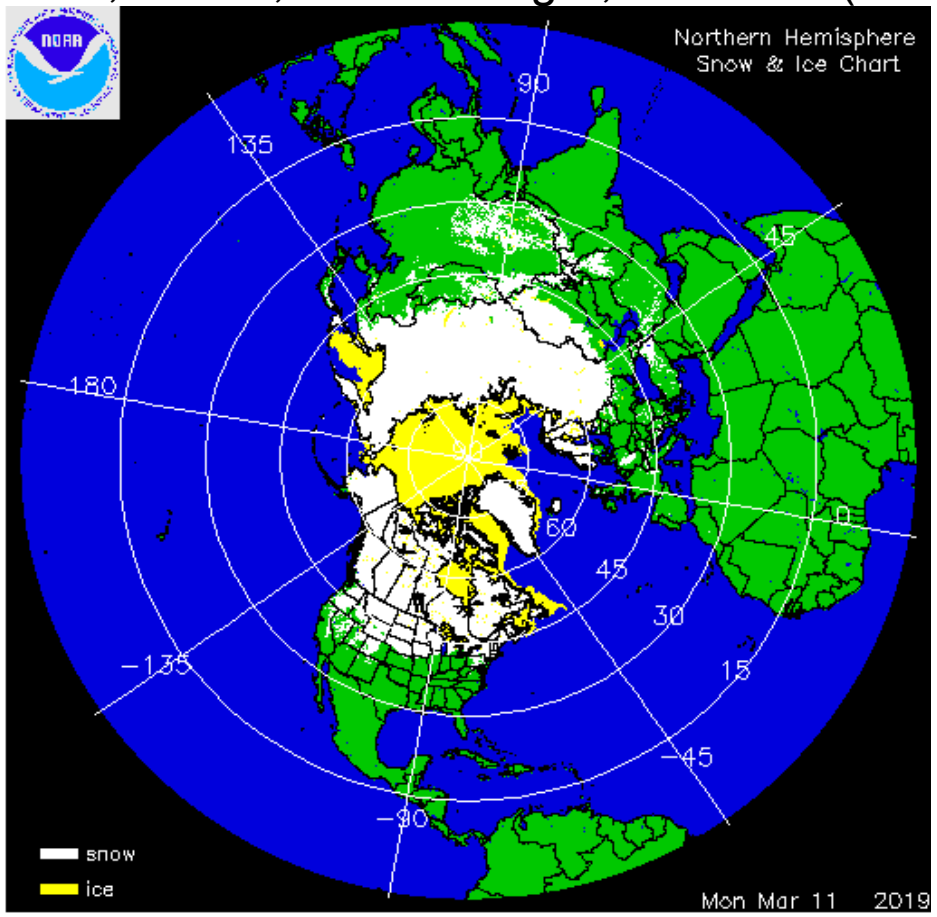
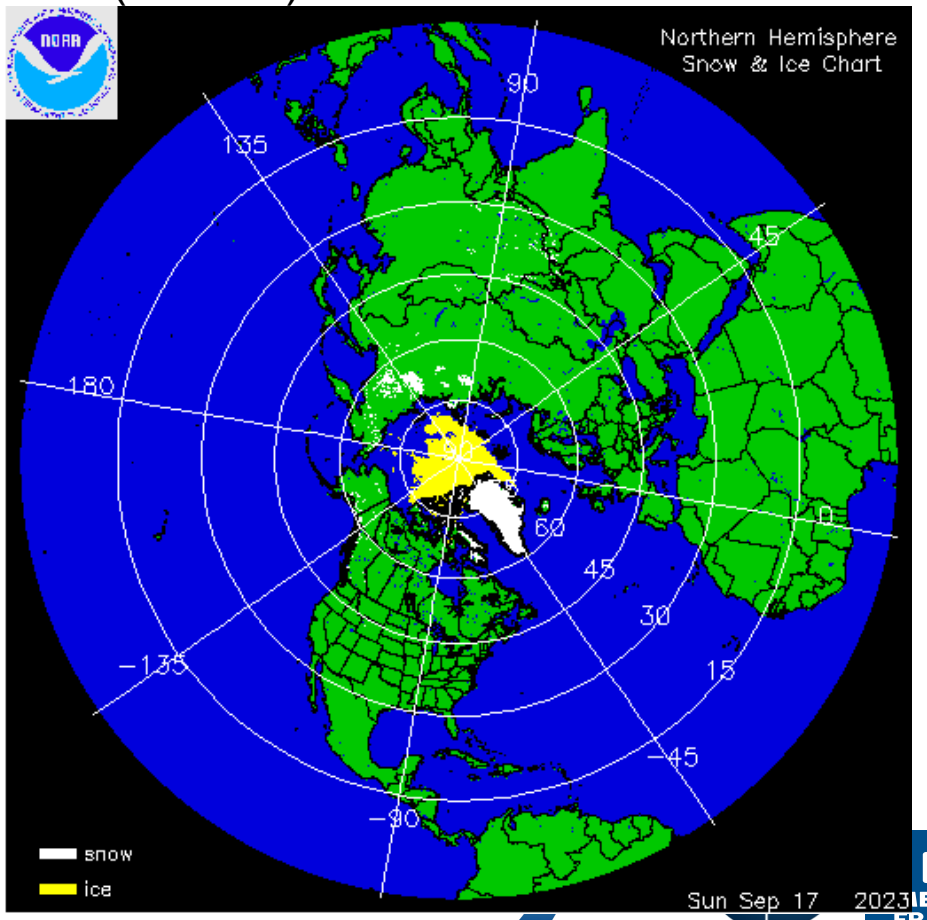
Assimilation of satellite snow cover product for snow analysis

- Satellite observations to fill in gaps of the in-situ network
- IMS NOAA-NESDIS product over Northern hemisphere, daily product, 4 km resolution, observations from AVHRR, AMSU, GOES/Imager, Himawari (AHI), Meteosat (SEVIRI)





IMS product over Northern hemisphere on March, 11 2019 (left) and September, 17 2023

Assimilation of satellite snow cover product for snow analysis

- Snow cover (0 or 1), to be convert into snow water equivalent for assimilation:

  0 kg/m² if no snow (0), 5 kg/m² if snow (1)

- Spatial thinning of observations

- Tunning of observation and background error standard deviations and correlation length

  σ_b = 5 kg/m²

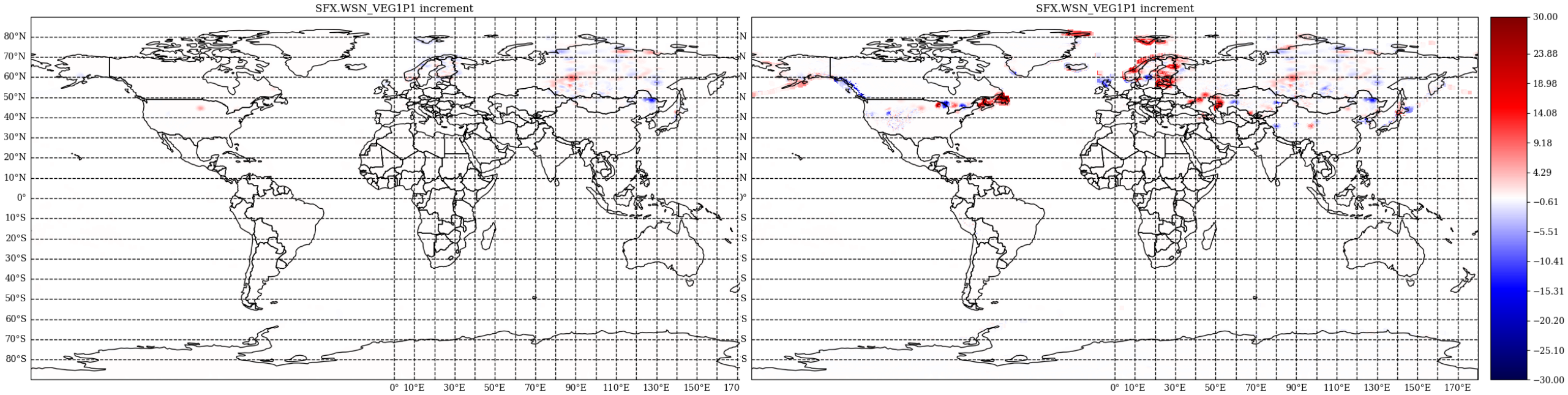
  σ_o = 8 kg/m² (5 kg/m² for in-situ obs)

  d = 10 km (100 km for in-situ obs)

		Snow cover observation	
		0	1
Background	SWE = 0 kg/m²	Assimilated: 0 kg/m²	Assimilated: 5 kg/m²
	SWE > 0 kg/m²	Assimilated: 0 kg/m²	Not assimilated

Assimilation of satellite snow cover product for snow analysis

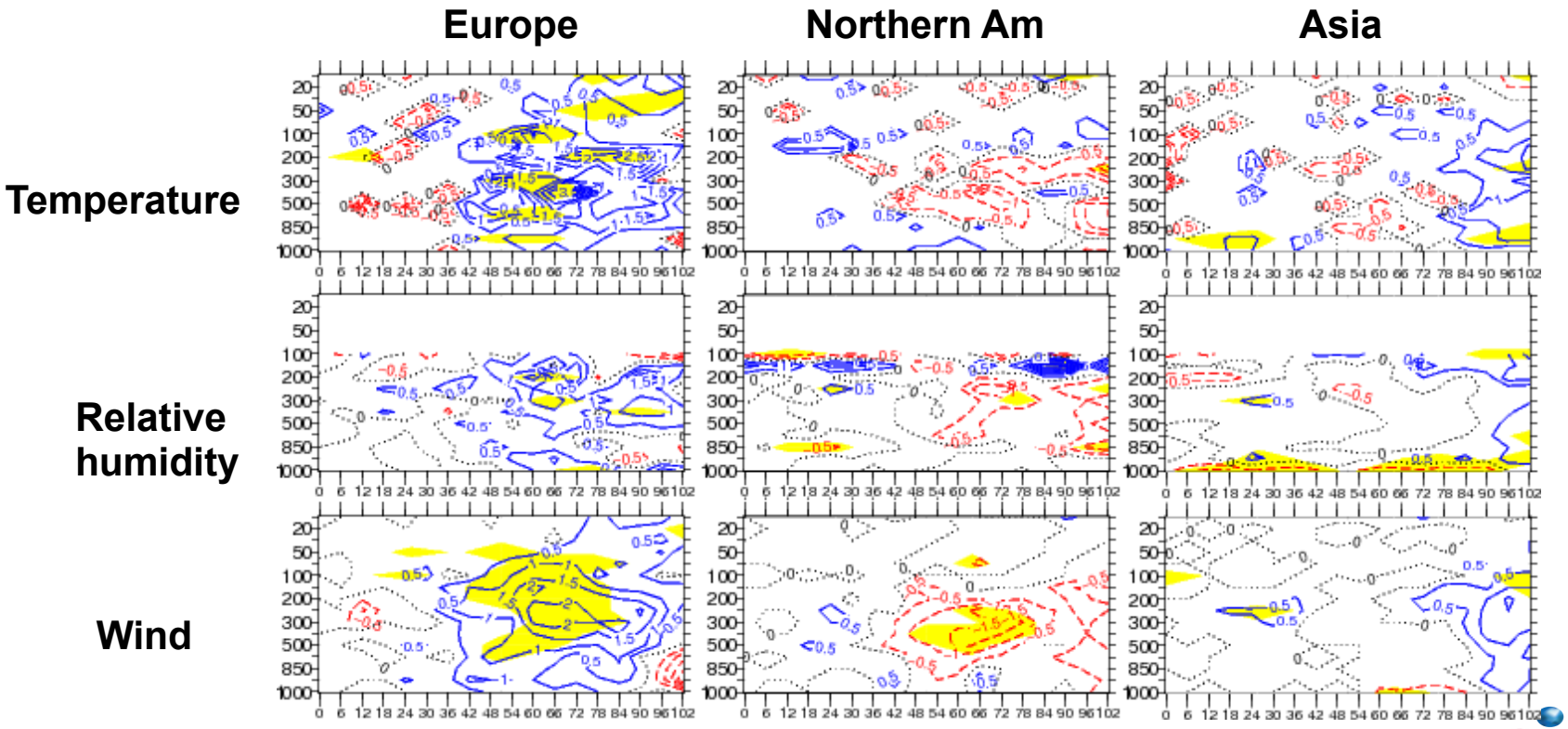
- Snow increments: assimilation of IMS product at 0 UTC each day



Snow water equivalent increments without (left) and with (right) IMS data assimilation on January 3 2023 at 0 UTC.

Assimilation of satellite snow cover product for snow analysis

- Forecast scores: RMSE reduction (%) of forecasts up to 102h of an experiment assimilating IMS snow cover product vs no assimilation of IMS with respect to **ECMWF independant analysis**, over the period 20230101-20230216 (x-axis: forecast range, y-axis: pressure level) (blue: improvement with IMS, yellow shade: significant according at 95 % confidence level to bootstrap test)



Assimilation of satellite snow cover product for snow analysis

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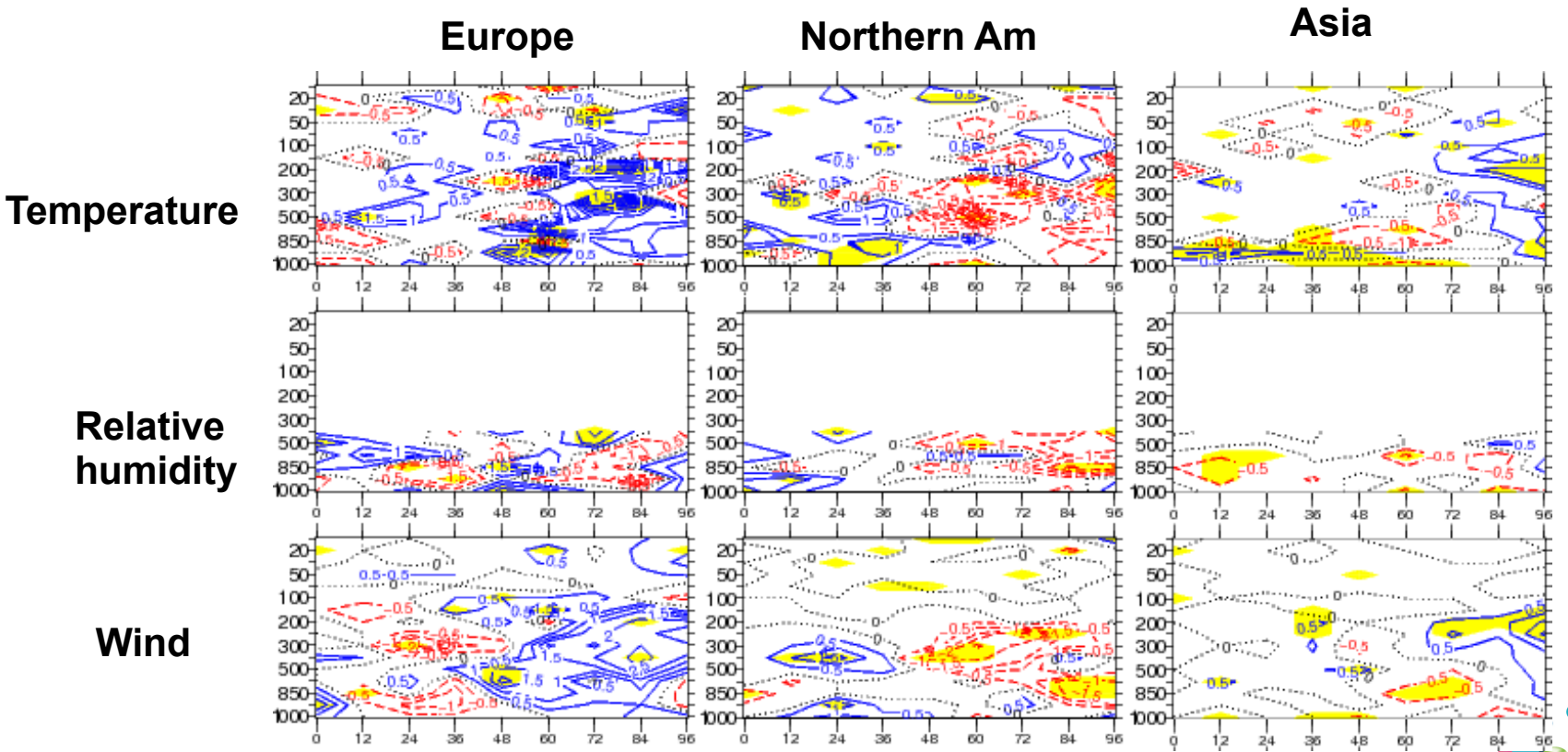

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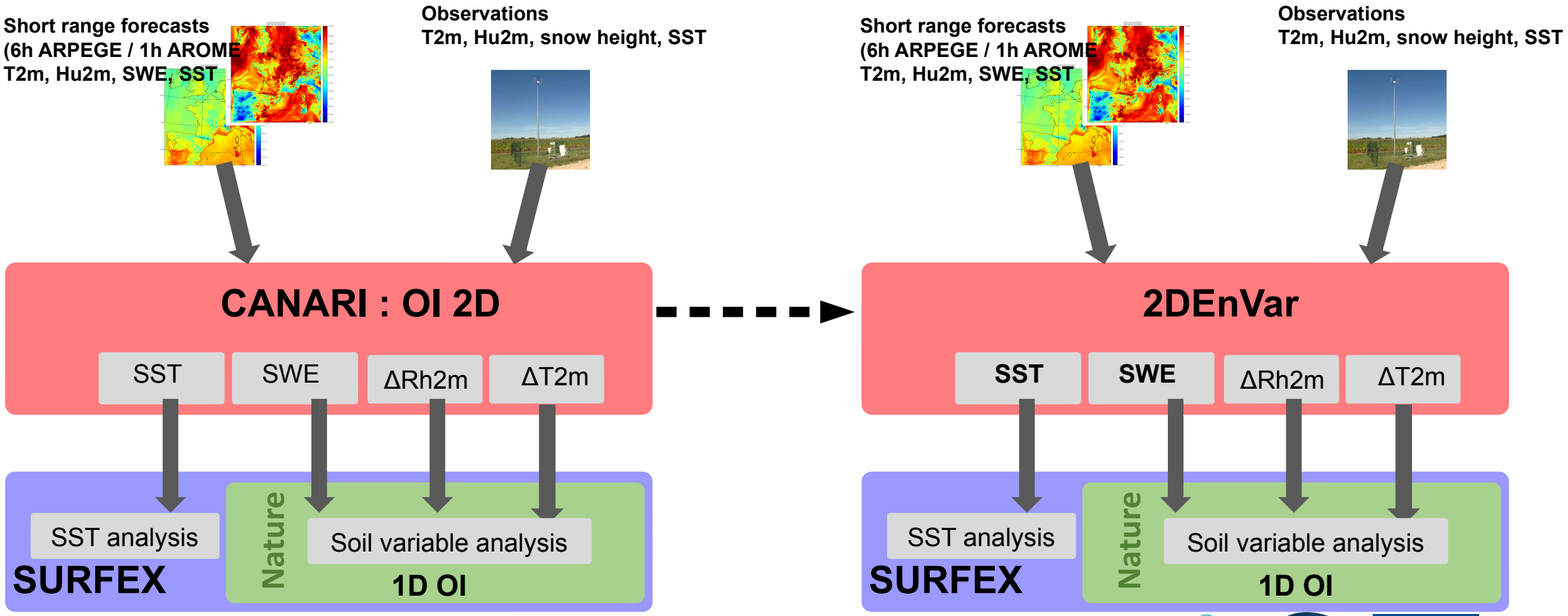
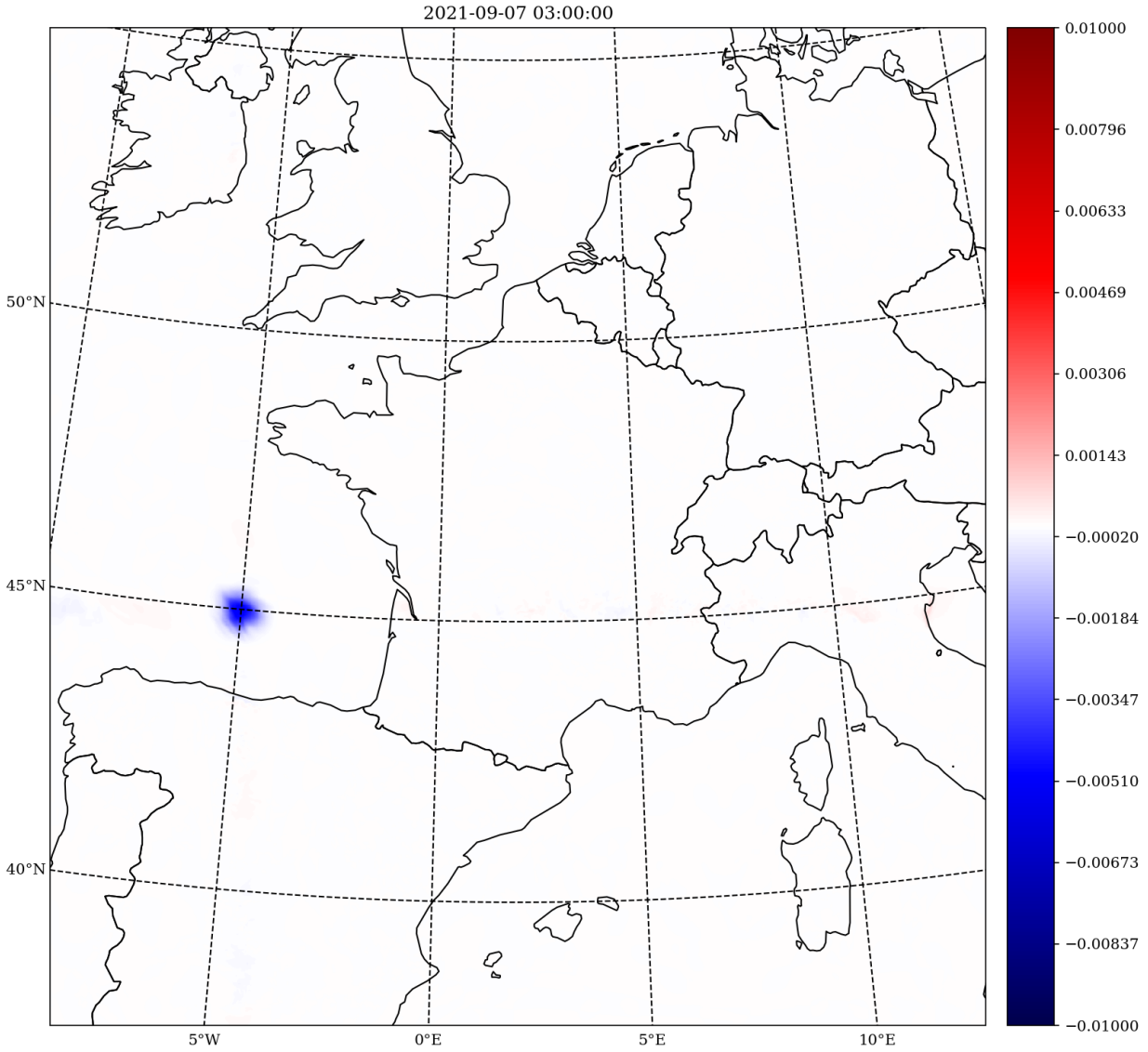
Development of a 2DEnVar for surface analysis

- AROME EDA 3.2 km, 50 membres



Development of a 2DEnVar for surface analysis

- Reminders on the development of a 2DEnVar (Sophie Marimbordes's presentation)
  - R and H similar as in a 2DVar
  - B computed from an EDA, fully flow-dependant for T2m and RH2m
  - EDA: 3h forecasts from 50 membres at 3.2 km
  - Localization length: 25 km to filter spurious long distance correlations
- Extension of 2DEnVar to SST and SWE to replace the whole 2D part of surface analysis



Error covariances for SST and RH2m on 07/09/2021 at 3 h

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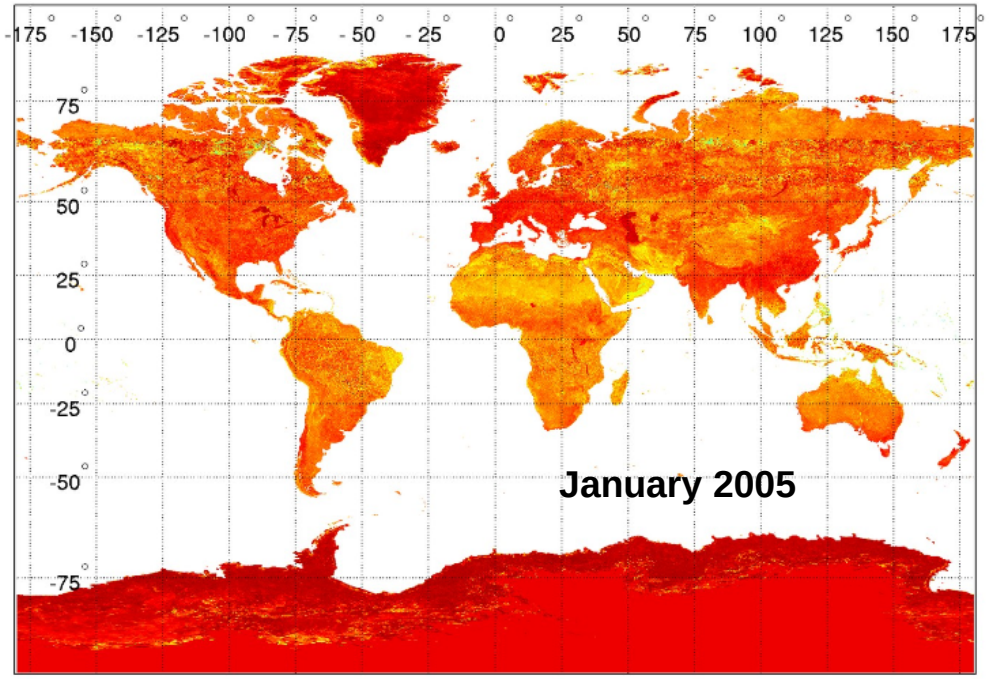
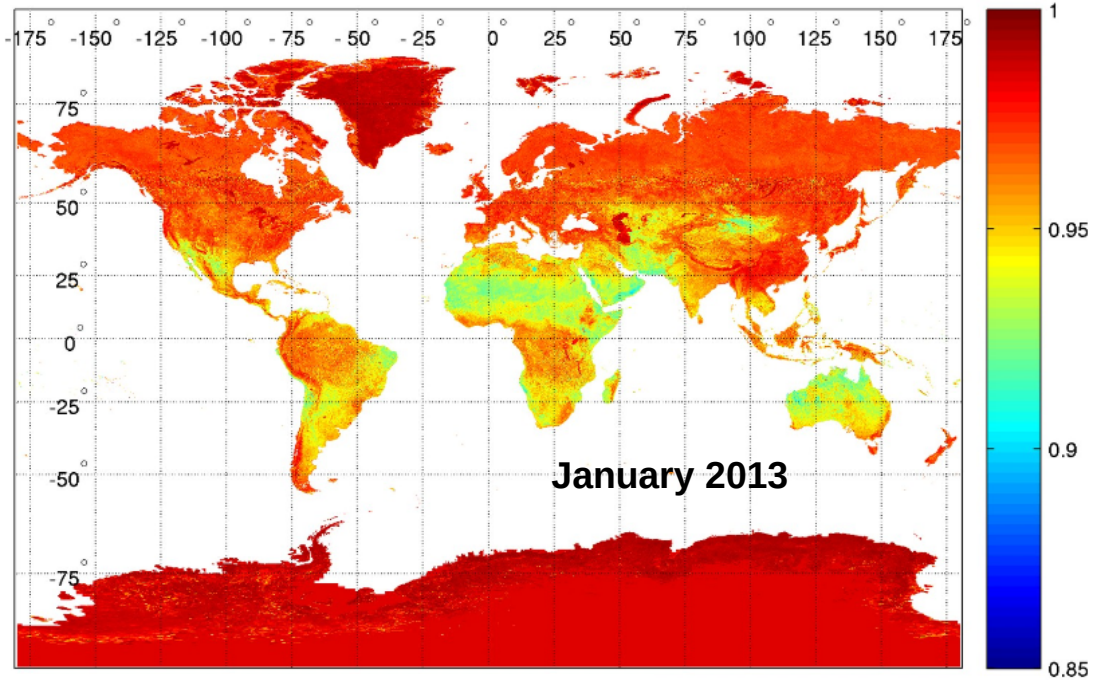
Updating IASI surface emissivity atlas

- Zied Sassi's work: assimilation of land surface temperature retrieved from infrared sounder IASI into ARPEGE global model
  - IASI LST retrieved in the screening step of upper air assimilation
  - Use of consistent LST for surface and atmospheric assimilations
  - Update of the emissivity atlas

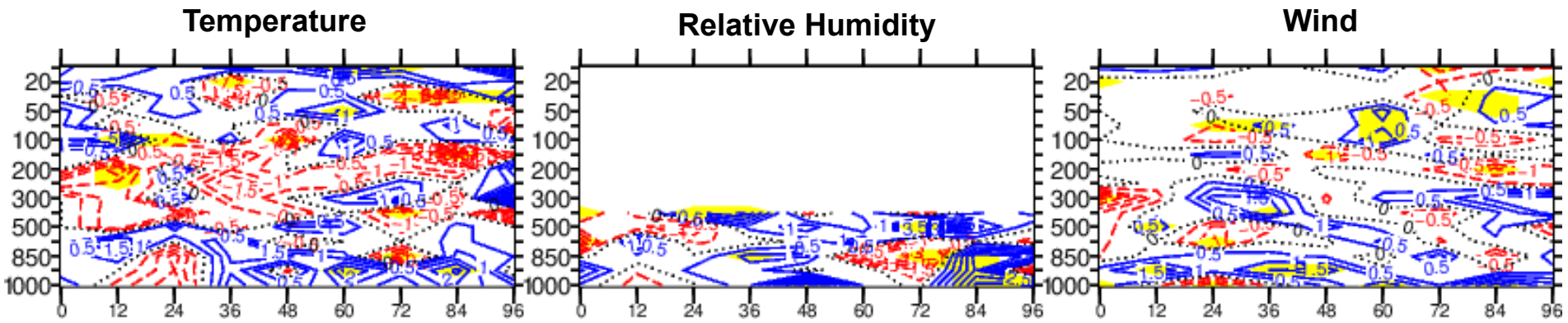




Global emissivity atlas from University of Wisconsin et 10.8 µm

Updating IASI surface emissivity atlas

- Update of the emissivity atlas: first results: impact on forecast scores



RMSE reduction of forecasts up to 96h on the **Southern Hemisphere** with recent atlas vs oper atlas with respect to radiosounding data over a one-month period (20230118-20230218) (x-axis: forecast range, y-axis: pressure level) (blue isoligns: improvement with new atlas, yellow shades: significant with a 95 % confidence level according to the bootstrap test)

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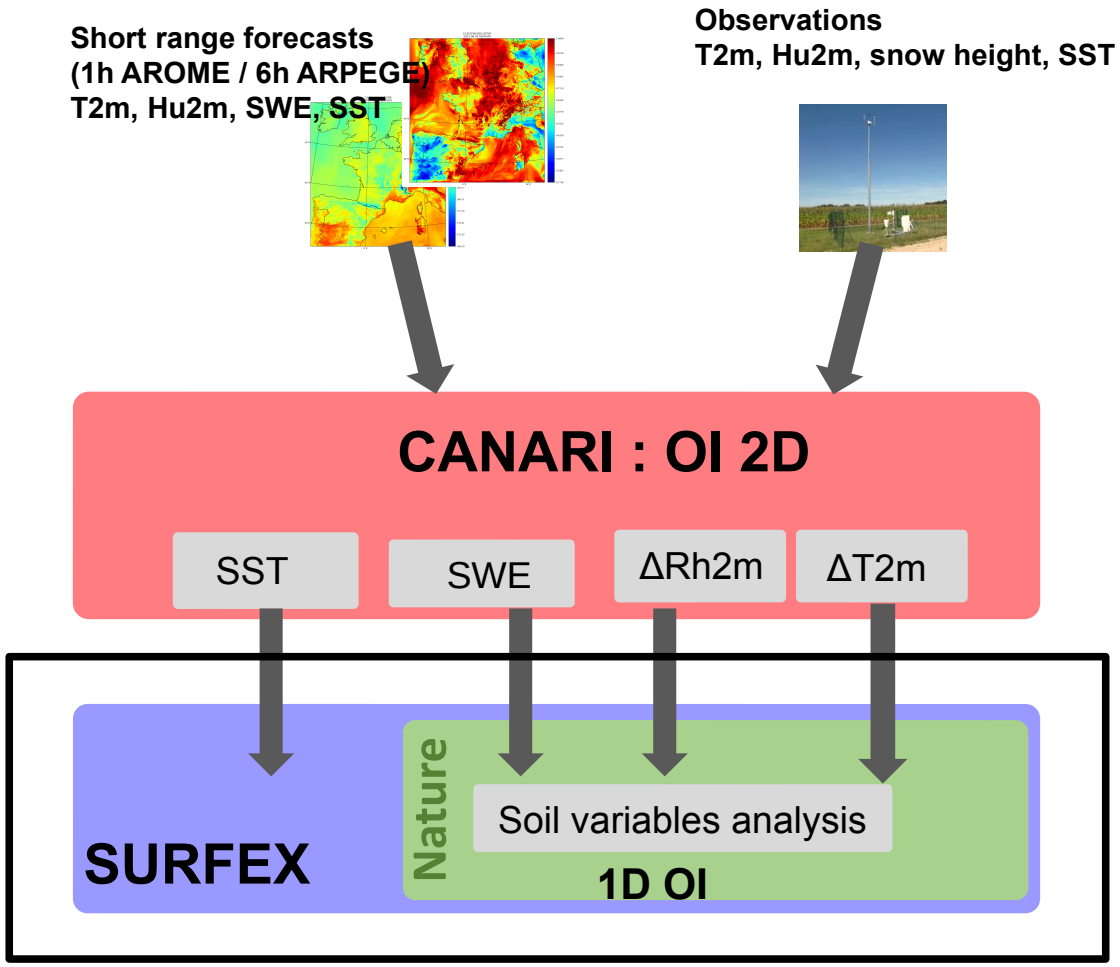
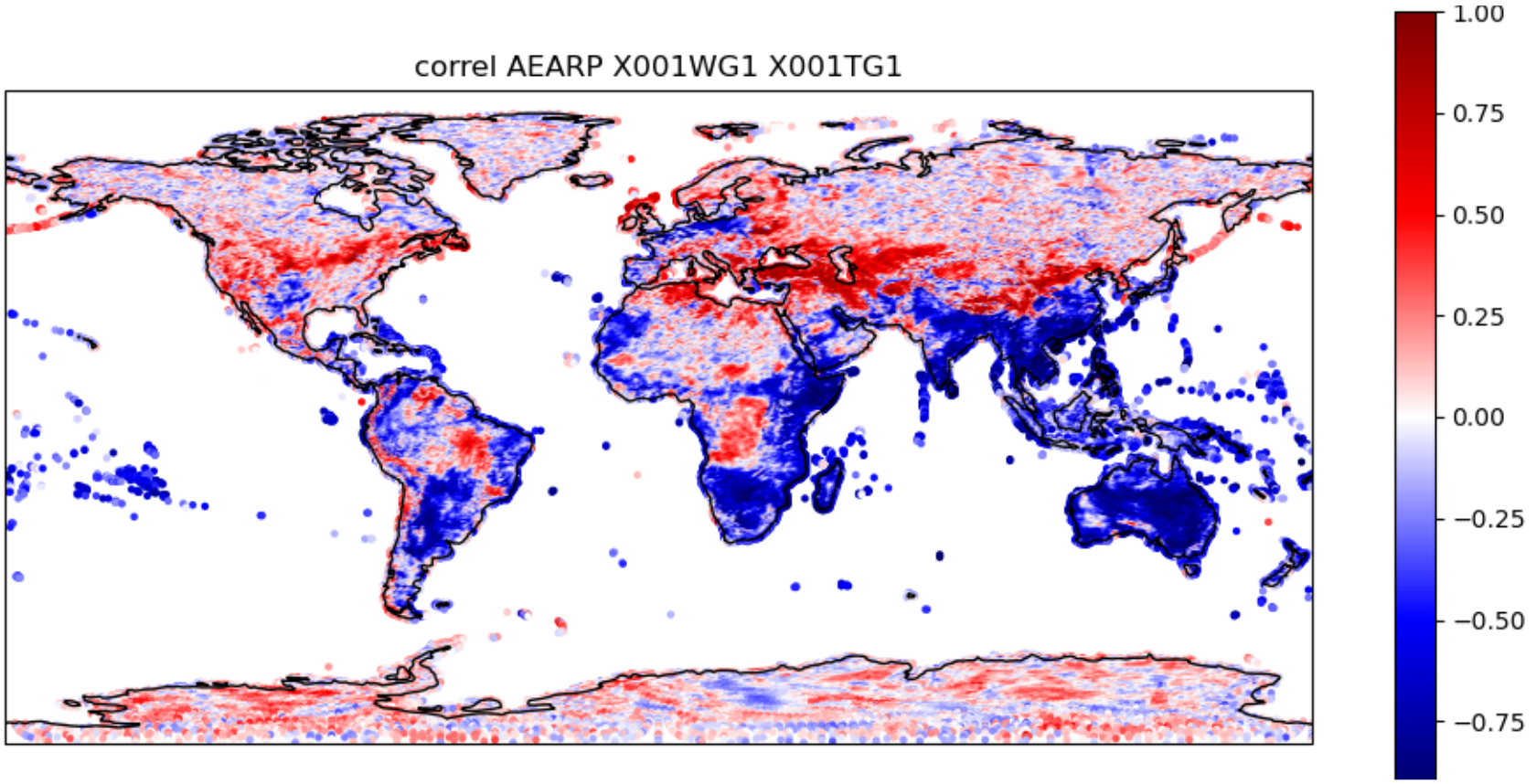
Use of coefficients of the day in the soil analysis



- 1D OI to analyse soil variables
- Development of an ensemble approach for the analysis of soil variables using short range forecasts from EDA to compute flow-dependant coefficients

Use of coefficients of the day in the soil analysis

- Computing correlations between variables using ARPEGE EDA
- ARPEGE EDA: 50 membres, T499, perturbation of observations, inflation applied to forecast to increase dispersion



Correlations between surface temperature and superficial soil moisture on January 1st 2023 at 0 UTC

Conclusion and future work

- Current work on the 2 steps of surface assimilation
- 2D Optimal Interpolation: to be replaced by a 2DEnVar
- 1D OI: improvement using information of the day provided by EDA
- Assimilation of different types of observations, in particular satellite observations