Assimilating the infrared data from geostationary satellites within the Météo-France models

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Assimilation of GEO satellites data in Météo-France models

Two models and three different sensors

- Global model ARPEGE. 4DVar assimilation system. Three different sensors on board three different series of satellites :
  - SEVIRI on board MSG
  - AHI on board Himawari
  - ABI on board GOES 3rd generation
- Local Area Model AROME. 3DVar assimilation system. Only one sensor :
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Different ways to assimilate the radiance of infrared imagers

- Raw radiances (ABI in ARPEGE, SEVIRI in AROME)
- Clear Sky Radiances which are an average of clear radiances present over a spatial grid (SEVIRI and AHI in ARPEGE)

Focus on ARPEGE : denial of IR data from GEO satellites

An OSE (Observing System Experiment) had been conducted at Météo-France to assess the relative importance of each observing system (Chambon et al 2022). To complete this study, an additional experiment was carried out where all IR data from GEO satellites were removed.

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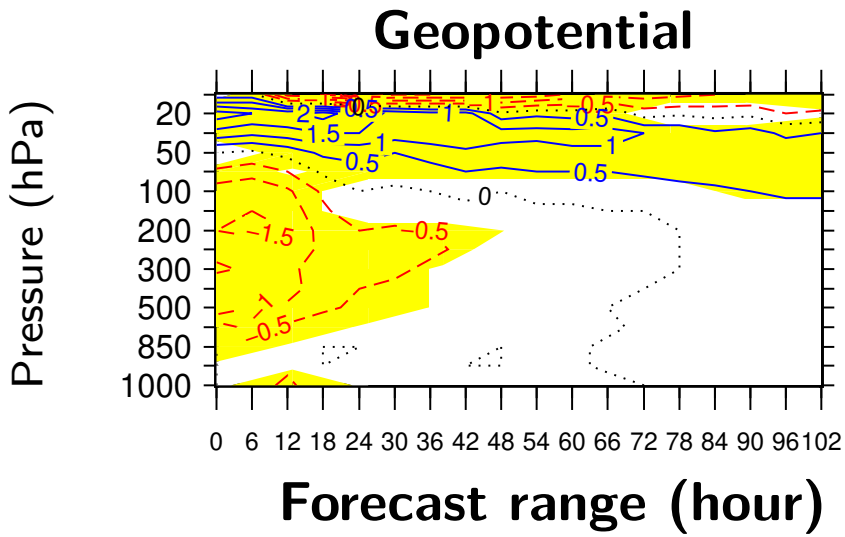
Scores computation and representation



Relative difference of std (forecast - analysis) between the experiment and a reference.

- blue line : positive impact
- red line : negative impact
- yellow area : significant at 99%

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Experiment : same framework but no assimilation of IR data from GEO satellites.
Length : six month from 2019/10/01 to 2020/04/04

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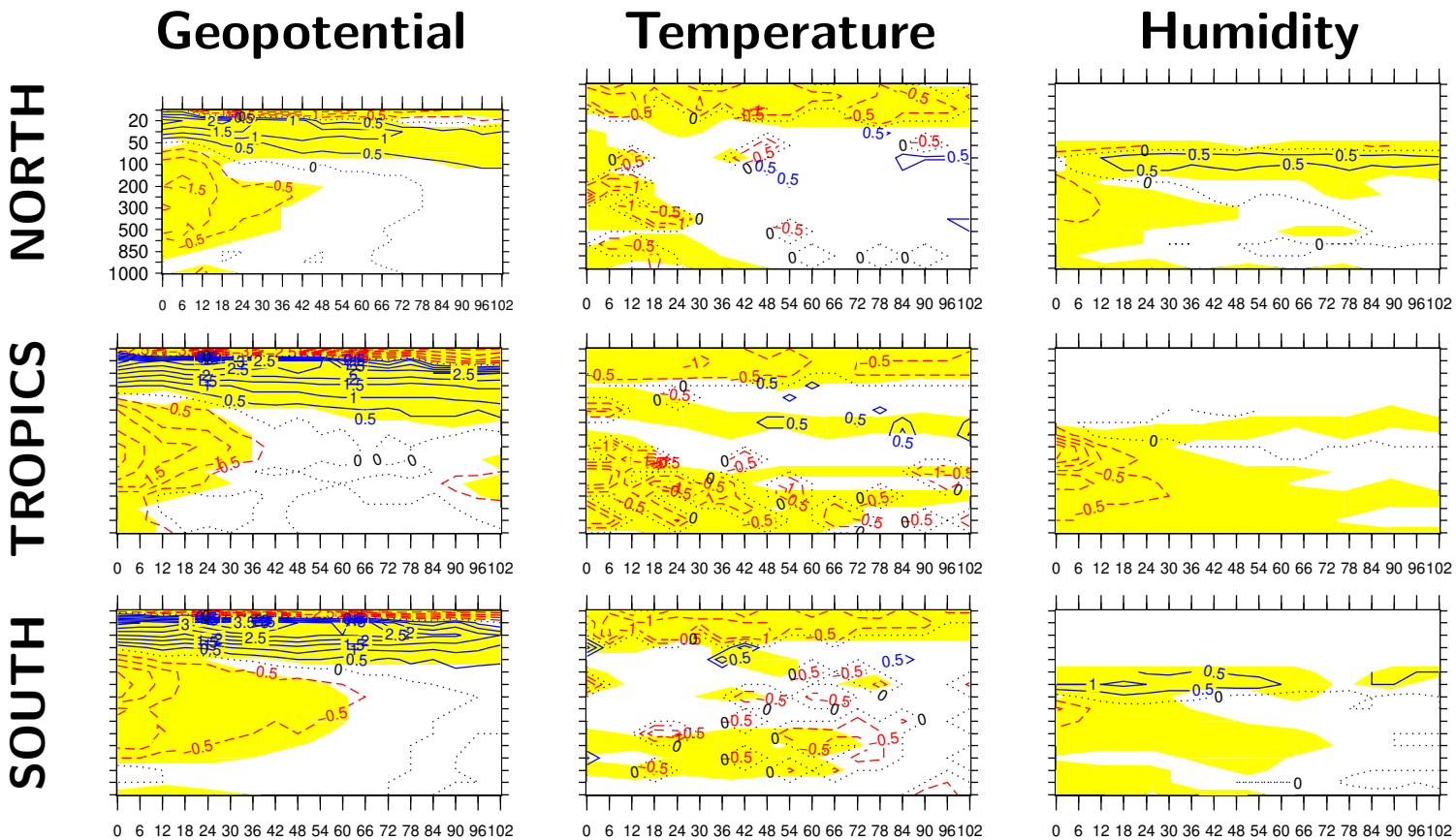

Importance of data from geostationary satellites in ARPEGE

To sum up

- Great impact of radiances from geostationary satellites on the forecast performance in ARPEGE
- Impact lasts throughout the forecast up to 96 hours
- Still work to do to fully understand the detrimental effect in the highest part of the atmosphere

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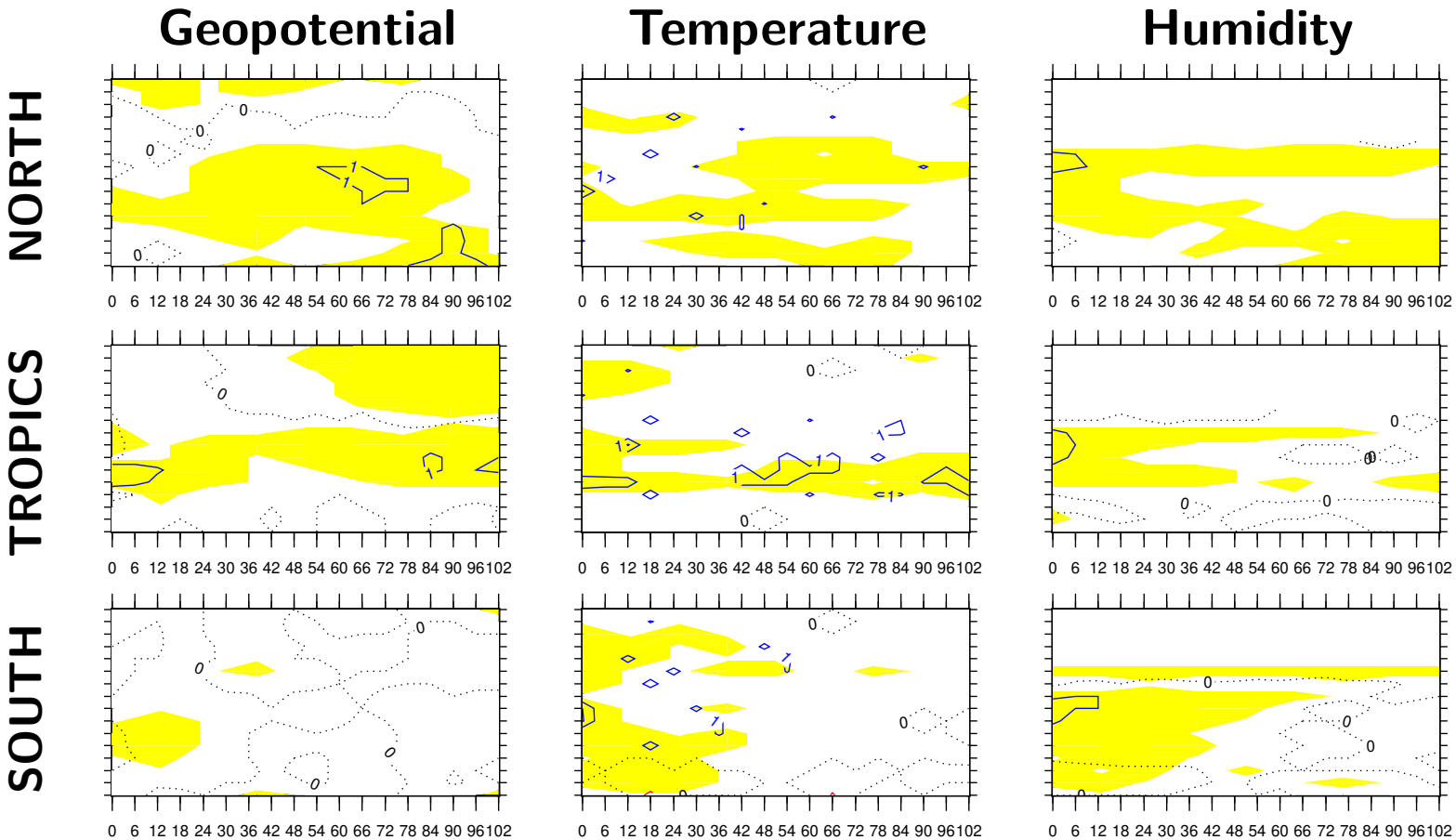
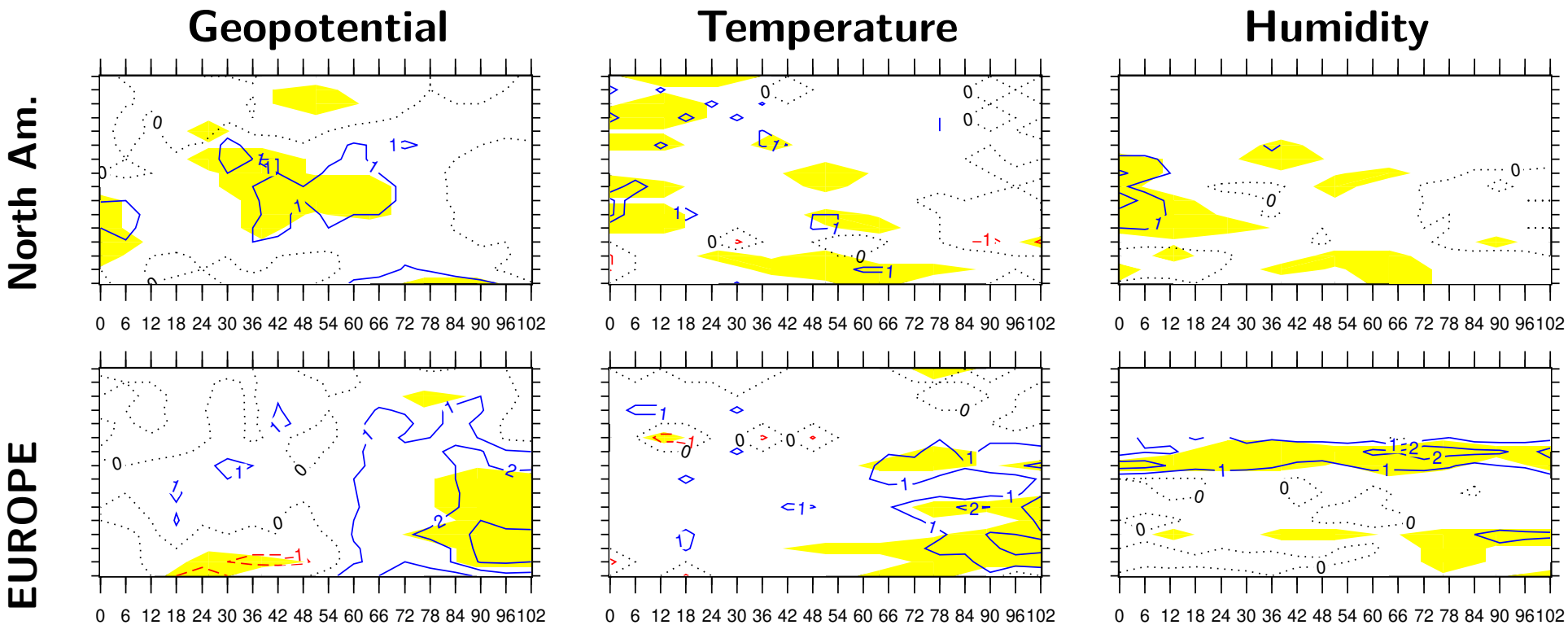
GOES16 ABI channels assimilated in ARPEGE

	Sea		Land	σ_O
Channel	clear sky	low clouds	clear sky only	
2 - 6.150 μm (WV 300hPa)	Yes	Yes	$Z \leq 1000$ m	2.5 K
3 - 7.000 μm (WV 450hPa)	Yes	Yes	$Z \leq 1000$m	2.6 K
4 - 7.400 μm (T 600hPa)	Yes	No	No	2.6 K

Scores compared to IFS Analysis (2021/07/20 2021/10/31)

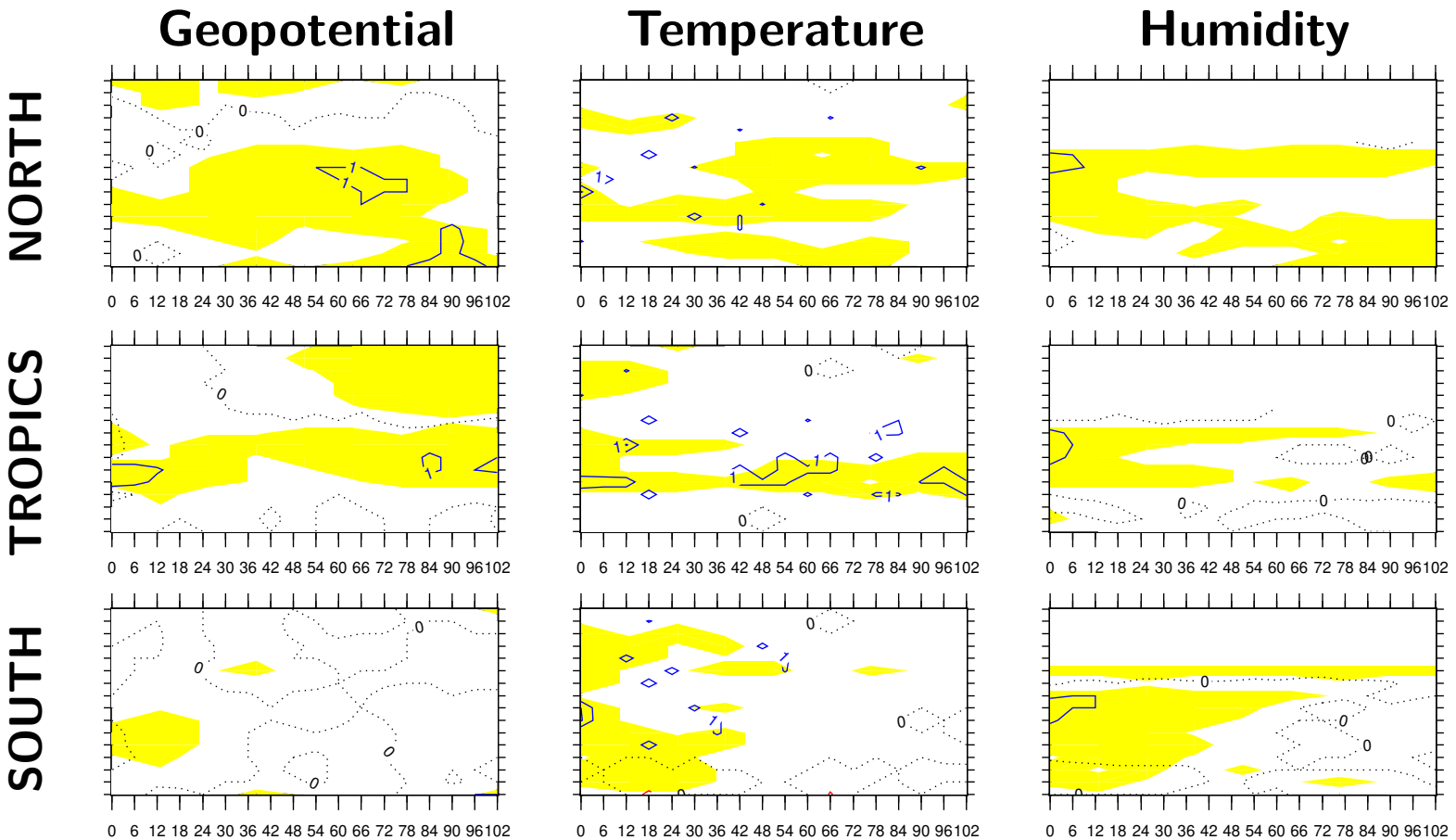


And over North America and Europe



And GOES-18

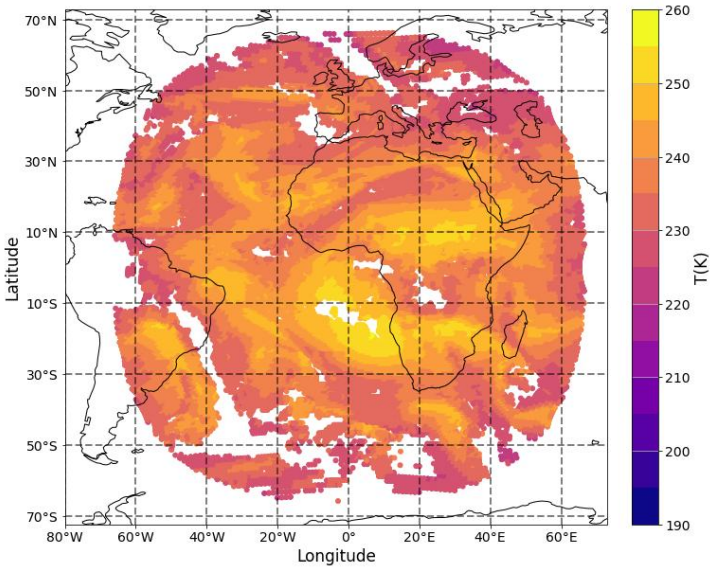
- Should be monitoring with the update of the operational chain
- Experiments have already been conducted with good results



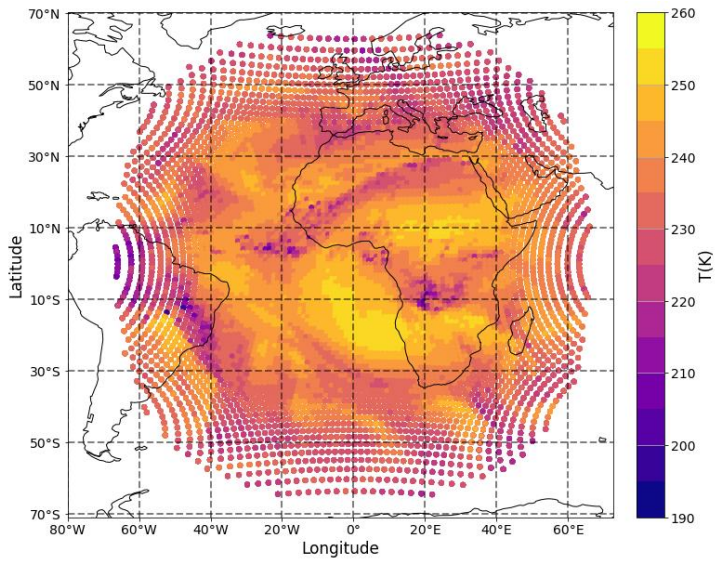
What is the best strategy to assimilate IR data from geostationary satellites ?

- An ongoing internship (Antoine Chemouny) on the subject
- Data from MSG4 for almost three months this winter (2022/11/11 $\rightarrow$ 2023/01/31)
- Two experiments that mimic the operational version of ARPEGE :
  1. Meteosat-11 data assimilated as CSR
  2. Meteosat-11 data assimilated as raw radiances

Clear Sky Radiances



Raw radiances



A. Chemouny

Conclusions and perspectives

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Perspectives

- 2023-24 : MTG-I and assimilation of FCI
- 2024- ? ? : MTG-S and IRS (see O. Coopman presentation)
- Taking account in AROME of the spatial correlation of observation errors (O. Guillet et al 2019)
  - PhD thesis should start in next automn (or spring 2024)
  - Better representation of the statistic of the observation error that leads to a better representation of the small scale of the model
  - First an "easy part" with SEVIRI (or FCI)
  - Ultimate goal : with IRS

Guillet, O., A. T. Weaver, X. Vasseur, Y. Michel, S. Gratton, and S. Gürol, 2019 : Modelling spatially correlated observation errors in variational data assimilation using a diffusion operator on an unstructured mesh. Quarterly Journal of the Royal Meteorological Society.

Thank you for your attention