Assimilation of satellite retrieved land surface temperature in AROME

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Outline

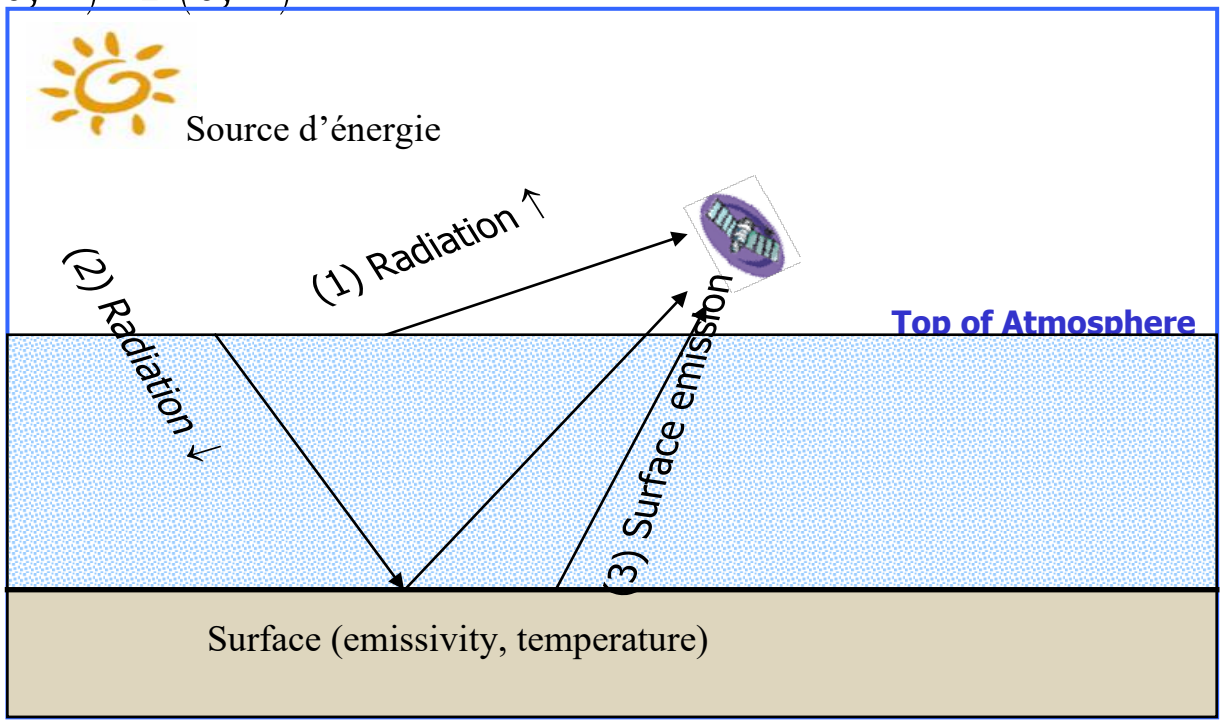
- Introduction
- Land surface temperature assimilation: implementation
- Land surface temperature assimilation: results
- Conclusions and future work

Introduction

- Near surface atmospheric layers are crucial in NWP to modelize heat and water fluxes between surface and atmosphere
- Satellite radiances are informative on surface and near surface atmosphere, but are not assimilated in surface model
- The assimilation of satellite radiance needs realistic surface conditions:
  - Surface temperature retrieval for infrared sensors (surface emissivity for microwave sensors)
  - Retrieval at each assimilation time

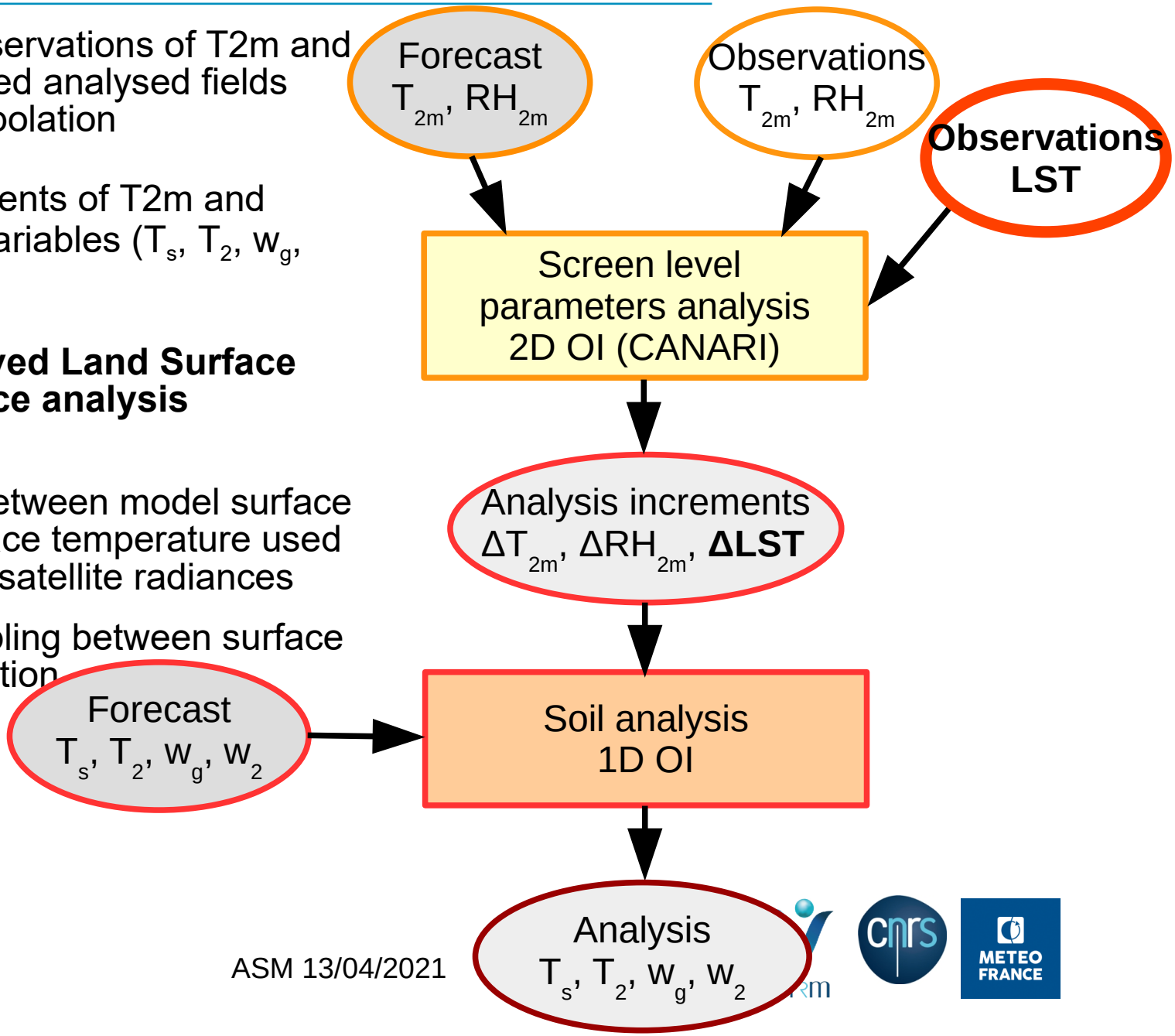
$$T(p,\upsilon)=\varepsilon(p,\upsilon).Ts.\tau+(1-\varepsilon(p,\upsilon)).\tau.T(\upsilon,\downarrow)+T(\upsilon,\uparrow)$$

$T(p,v)$: brightness temperature
$\varepsilon(p,v)$: surface emissivity
Ts: surface temperature
τ: atmospheric transmittance
$T(v,\downarrow)$: downward radiation
$T(v,\uparrow)$: upward radiation



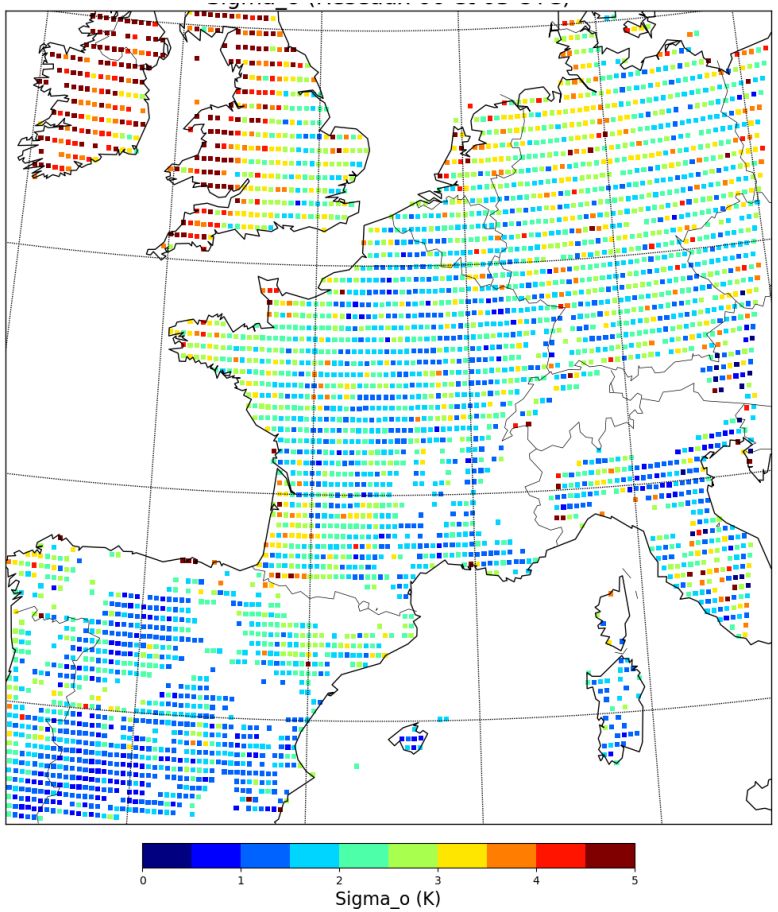
Introduction

- Use of screen level observations of T2m and Hu2m to compute gidded analysed fields using 2D Optimal Interpolation
- 1D OI using the increments of T2m and Hu2m to analyse soil variables (T_s, T_2, w_g, w_2)
- **Use of satellite retrieved Land Surface Temperature in surface analysis**
  - Better consistency between model surface temperature and surface temperature used for the assimilation of satellite radiances
  - Improvement of coupling between surface and upper air assimilation

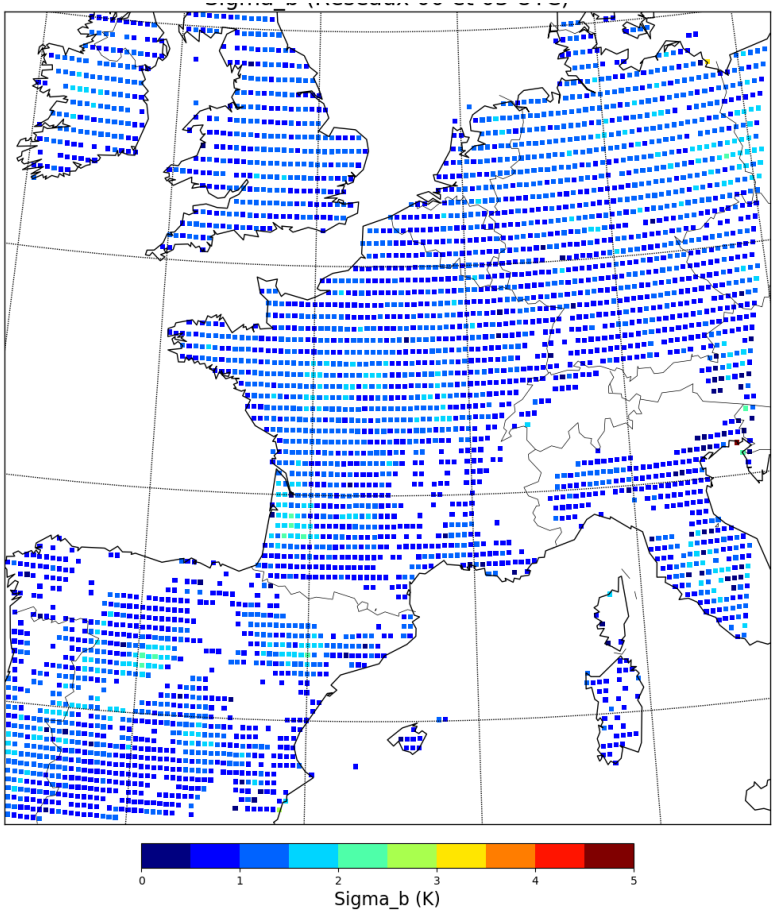


Land surface temperature assimilation: implementation

- Assimilation of SEVIRI retrieved land surface temperature in AROME model
- Assimilation of LST at 0h and 3h assimilation times
- Diagnostics of observation and background errors using Desroziers diagnostics
  - σ_o = 3 K, σ_b = 1.8 K, correlation length = 30 km



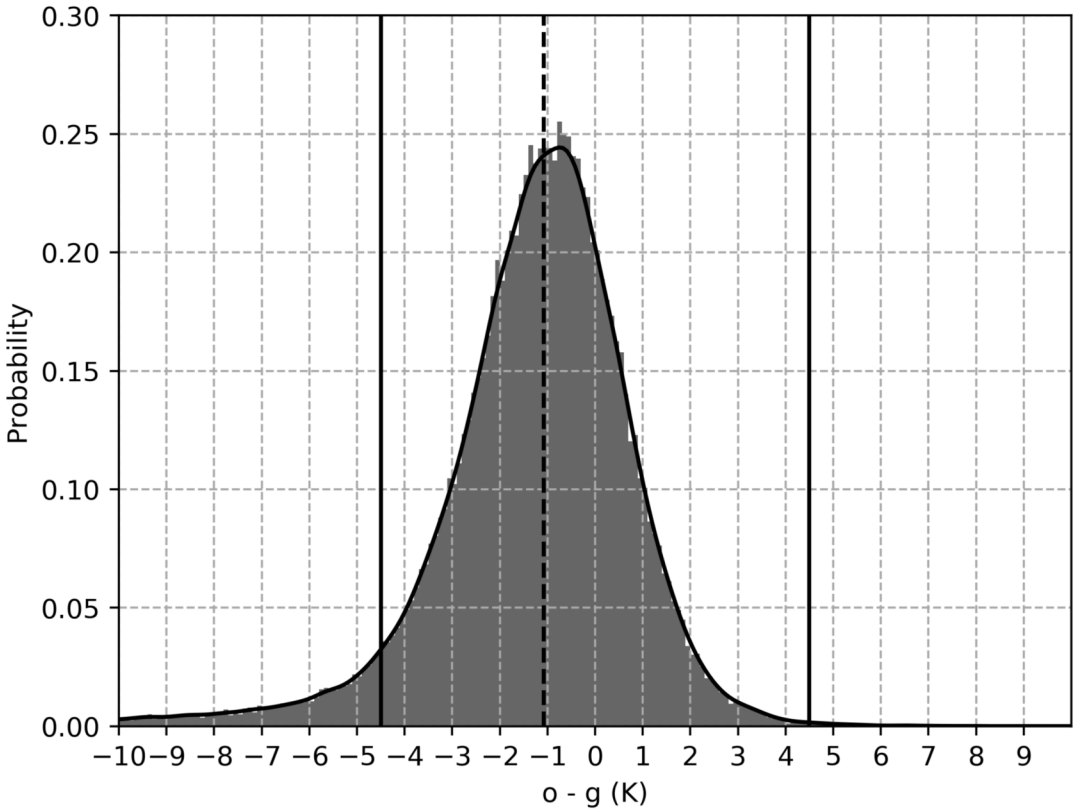
Observation standard deviations



Background standard deviations

Land surface temperature assimilation: implementation

- Case studies
  - Threshold on innovation: obs – guess lower than -4.5 K removed to avoid undetected clouds

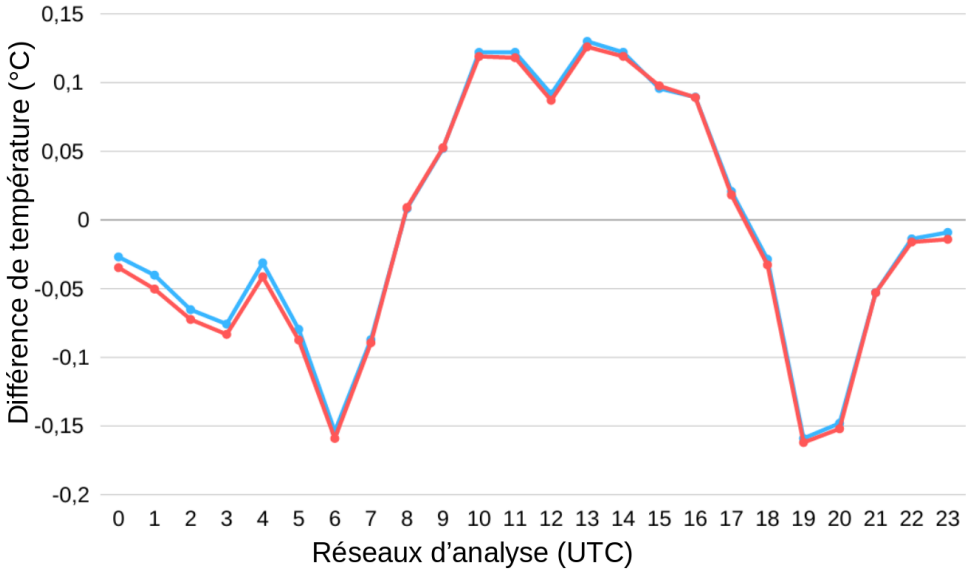


Obs LST – guess LST distribution

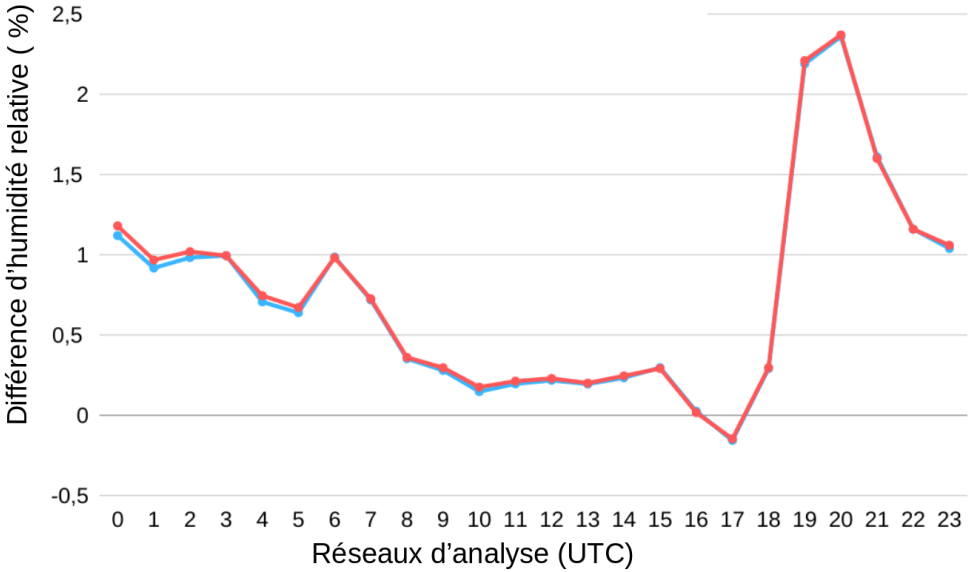
Land surface temperature assimilation: results

- Assimilation of SEVIRI LST at 0h and 3h in an AROME experiment over 2 months in 2019 (July and August)
- Evaluation of land surface temperature assimilation on assimilation

Obs T2m – Guess T2m EXP-ARO REF-ARO



Obs Hu2m – Guess Hu2m EXP-ARO REF-ARO



Mean differences between observations of T2m (left) and Hu2m (right) and background for each analysis time, for EXP-ARO and EXP-REF experiments

Smaller differences between observations and background for the first assimilation times (up to 6h)

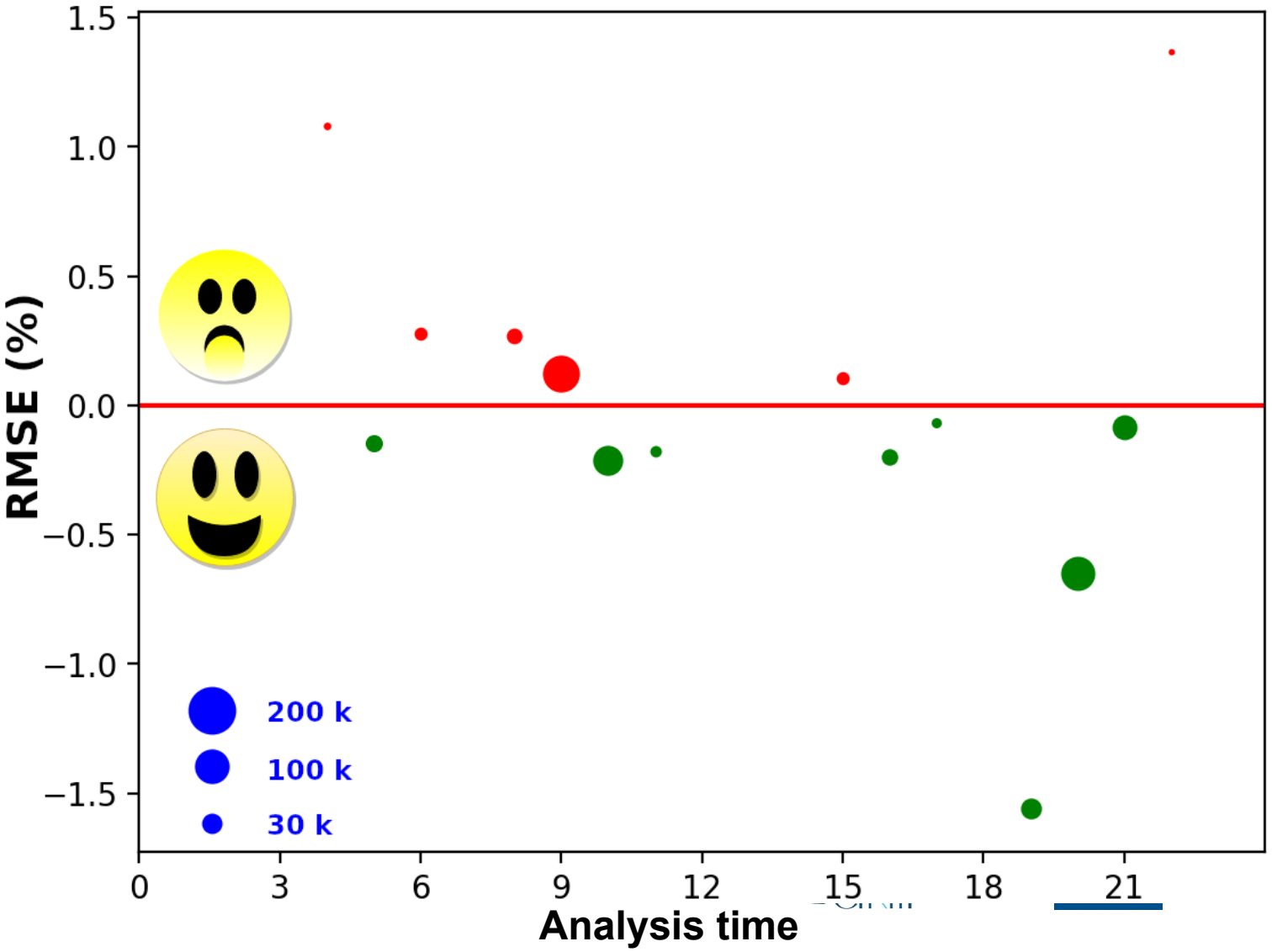
Land surface temperature assimilation: results

- Evaluation of land surface temperature assimilation on assimilation

Differences of RMSE for MHS channel 5 between observed and simulated radiances for EXP-ARO and EXP-REF

Impact on emissivity retrieval for MW sensors

Average decrease of RMSE: 0.29 %



Land surface temperature assimilation: results

- Evaluation of land surface temperature assimilation on AROME forecasts against Synops

Forecast ranges	0h	6h	12h	18h	24h	30h	36h	42h	48h
T2m (K)	**-0.01**	0	0	0	**0.01**	0.01	0	0.01	0.01
Hu2m (%)	-0.02	0.01	0.04	0.08	0.06	0.06	-0.02	0.01	0.07

Relative difference of mean quadratic errors for T2m and Hu2m with respect to observations for forecast ranges up to 48h
0.01: significant with 99.5 % confidence
0.01: significant with 95 % confidence

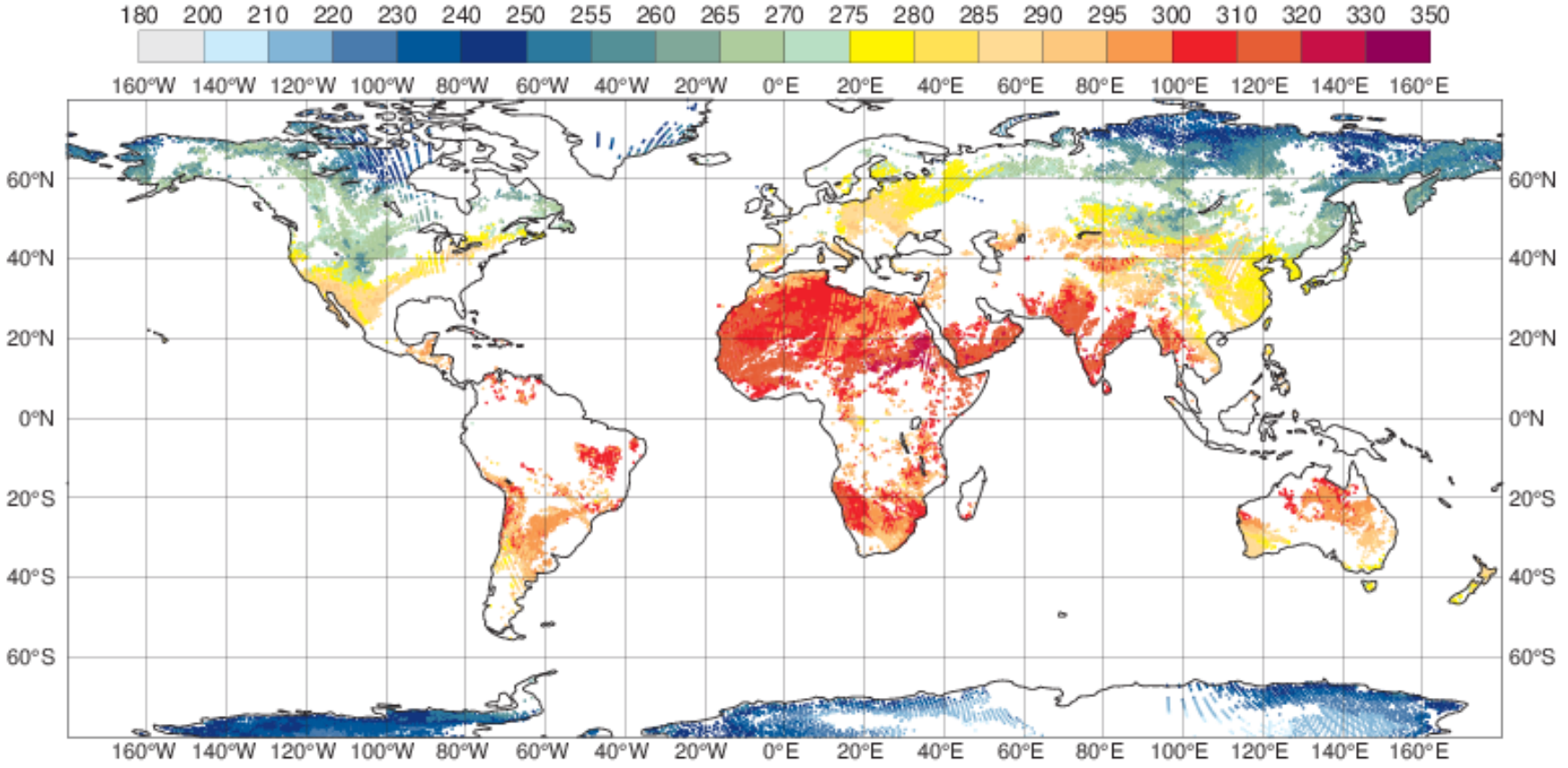
- Improvement of forecasts of T2m and Hu2m up to 48h, with significant impact by nighttime
- Improvement of forecasts of temperature and specific humidity below 400 hPa up to 24h

Conclusions and futur work

- First experiments of assimilation of satellite land surface temperature in AROME model
- The assimilation of SEVIRI land surface temperature improves the assimilation of 2 metre and satellite observations
- Improvement in temperature and humidity forecasts up to 36h in low atmospheric layers
- **Sassi et al, 2021**: Assimilation of satellite retrieved land surface temperature in AROME NWP model, *in preparation*
- Experiments of assimilation of land surface temperature at all analysis times, and over different periods in AROME
- Future work: contribution of coupled surface and atmosphere assimilations for the representation of fluxes between surface and atmosphere in AROME model
  - Use of ensembles of data assimilation for T2m and Hu2m analyses
  - Evaluation on other kinds of observations: precipitation, land surface temperatures retrieved from SEVIRI

Conclusions and future work

- Application of the methodology to IASI observations: land surface temperature retrieval and assimilation in ARPEGE for land surface analysis



Land surface temperatures retrieved from IASI instrument (canal 10.8 µm)