Data impact studies using observations from AMSU-A & -B over land during the summer 2006

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[◉]IGN

Remote sensing data usage in NWP

Forecast models: propagate in time geophysical parameters (T/Q/U/V/Ps) according to the laws of dynamics of the atmophere

↑

Initiale conditions: compromise between available observations and an apriori information

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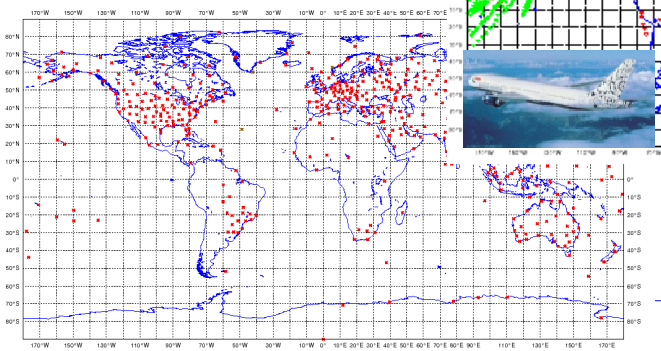
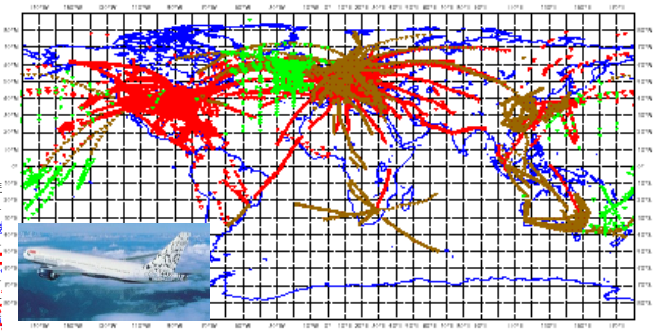
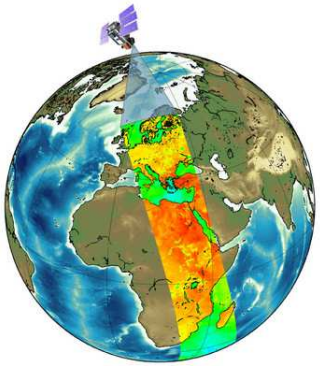
Observations: of different nature, type, unevenly distributed in space and time

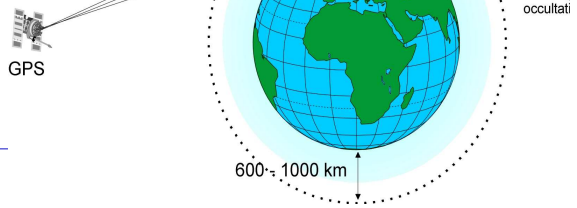
Conventional (in situ or airborne), Satellites

Radiosondes



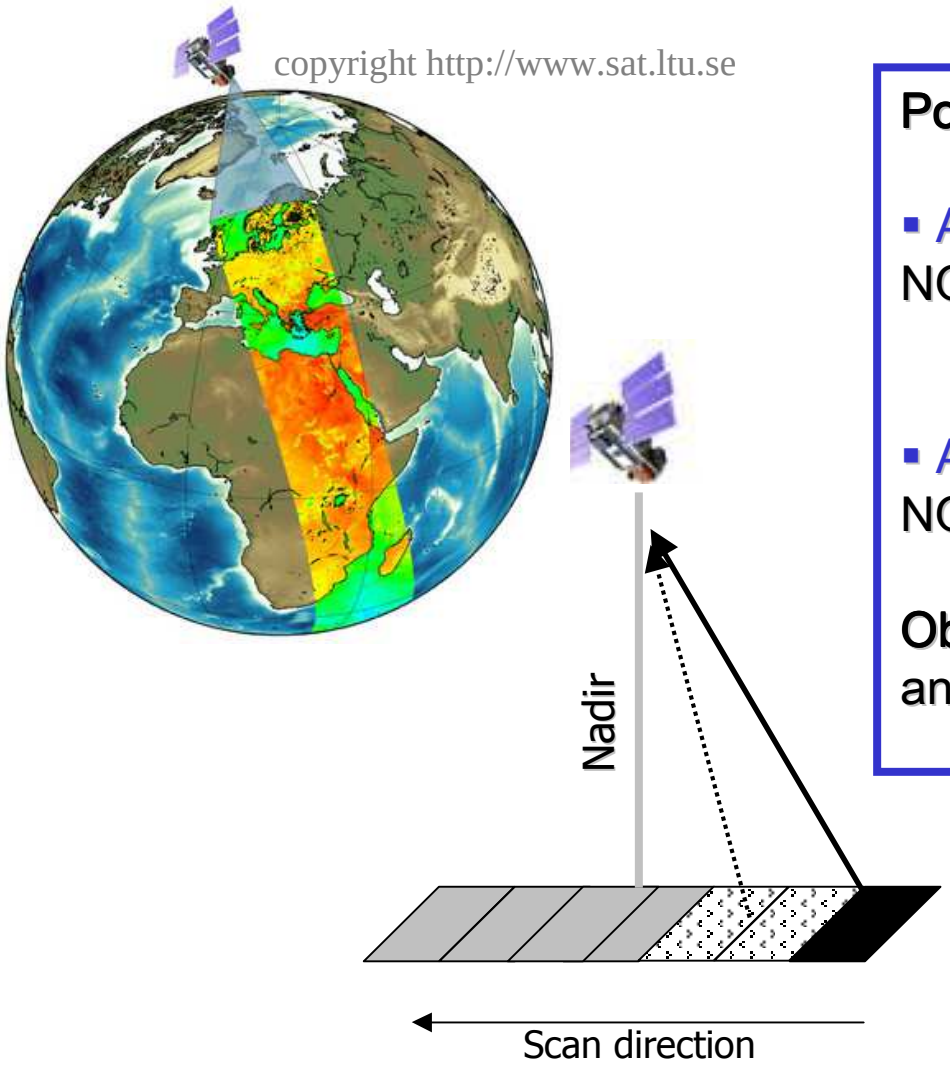






Remote sensing data usage in NWP

AMSU-A et AMSU-B: indirect measurements of humidity and temperature at different levels of the atmosphere



Polar orbiting satellites

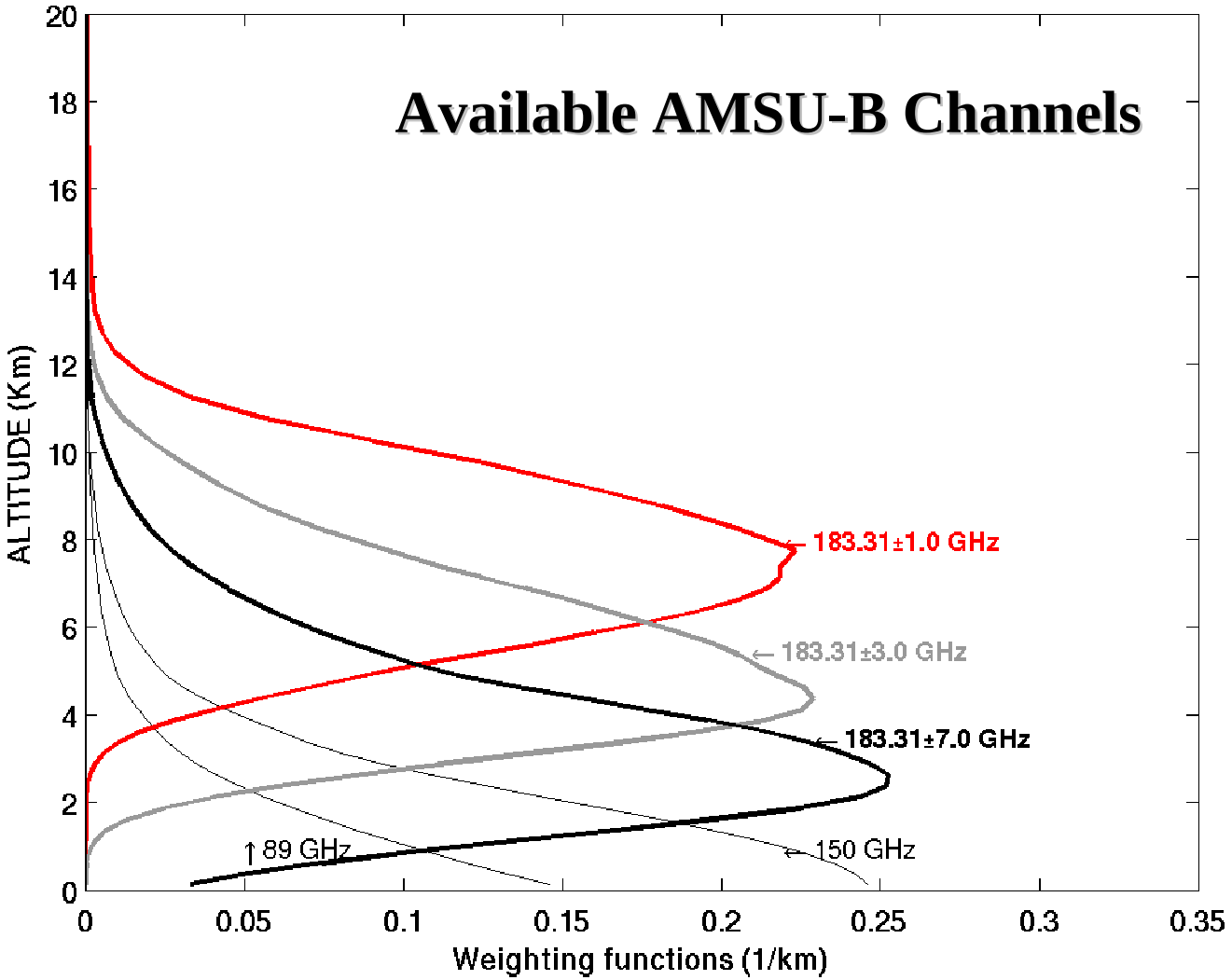
- AMSU-A: NOAA-15, NOAA-16, NOAA-18, NOAA-19, aqua, MetOp

- AMSU-B/MHS: NOAA-16, NOAA-17, NOAA-18, NOAA-19, MetOp

Observation mode: cross track, zenithal angle varies ±58° with respect nadir

Remote sensing data usage in NWP

Indirect vertical measurements of temperature and humidity:



Remote sensing data usage in NWP

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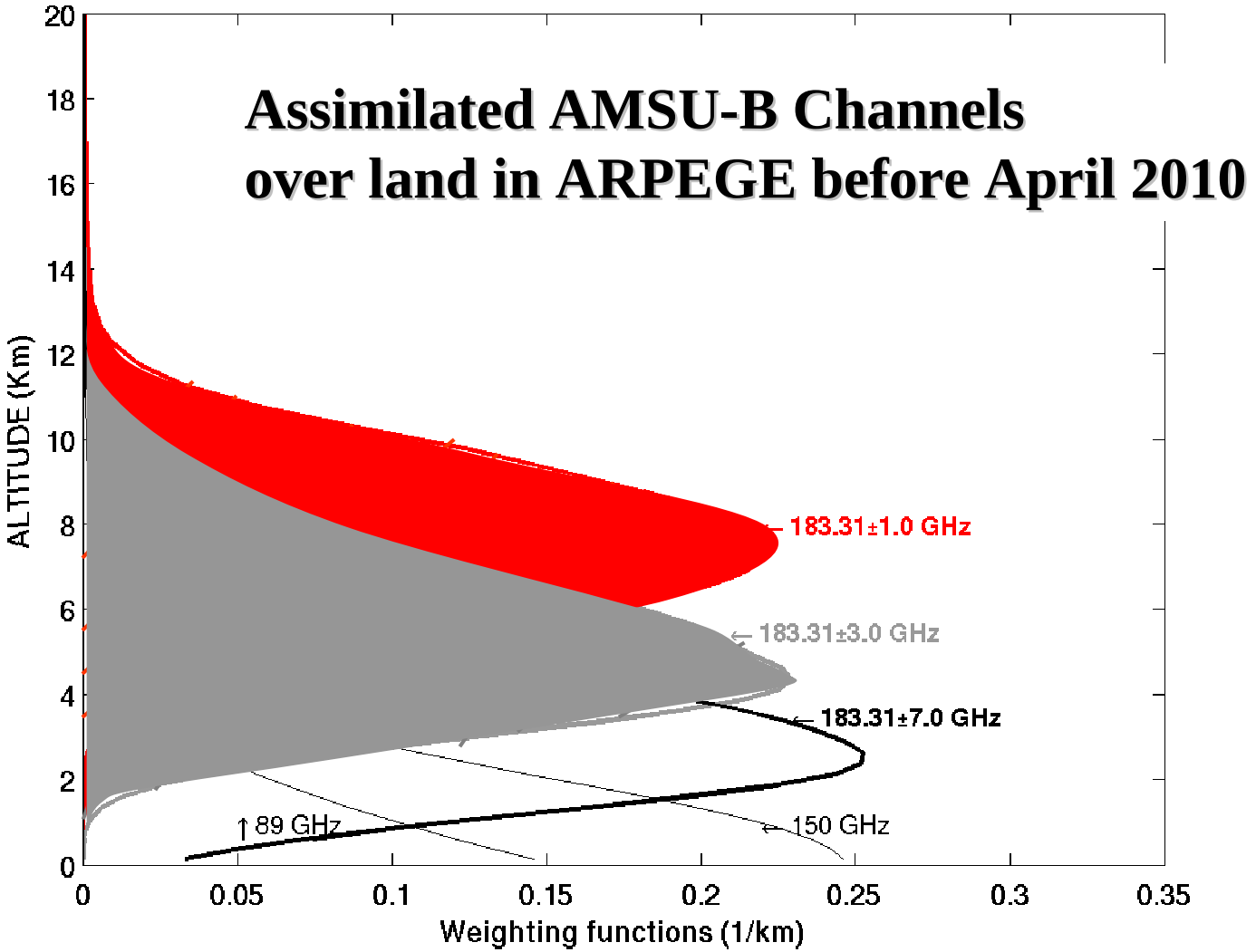
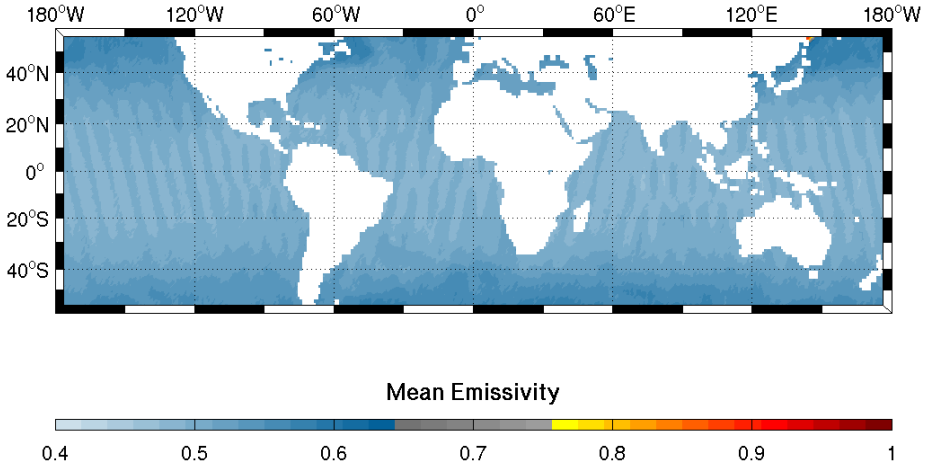


Why the need for a good knowledge of surface emissivity

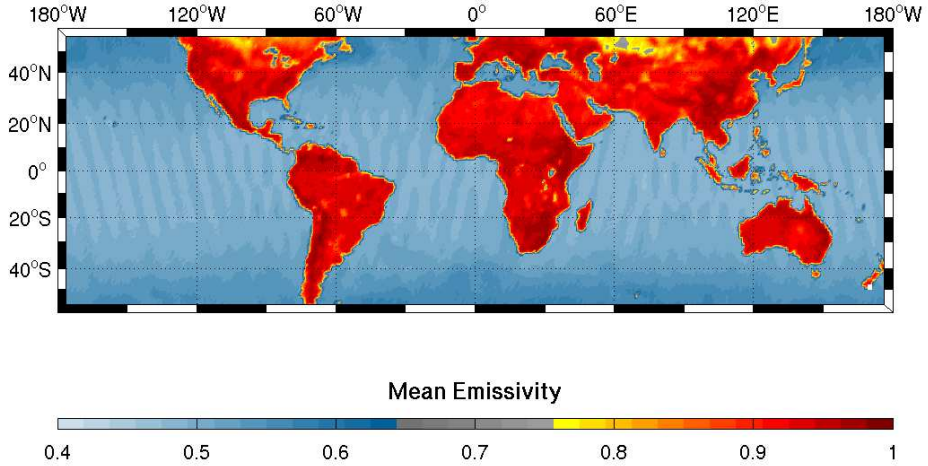
OCEANS



Emissivité ~ 0.5: surface contribution to measured signal < land contribution

Assimilation: effective emissivity models exists : Fastem (English, Hewison [1998], Deblonde, English [2000], Liu et al. [2010]) and meet NWP requirements

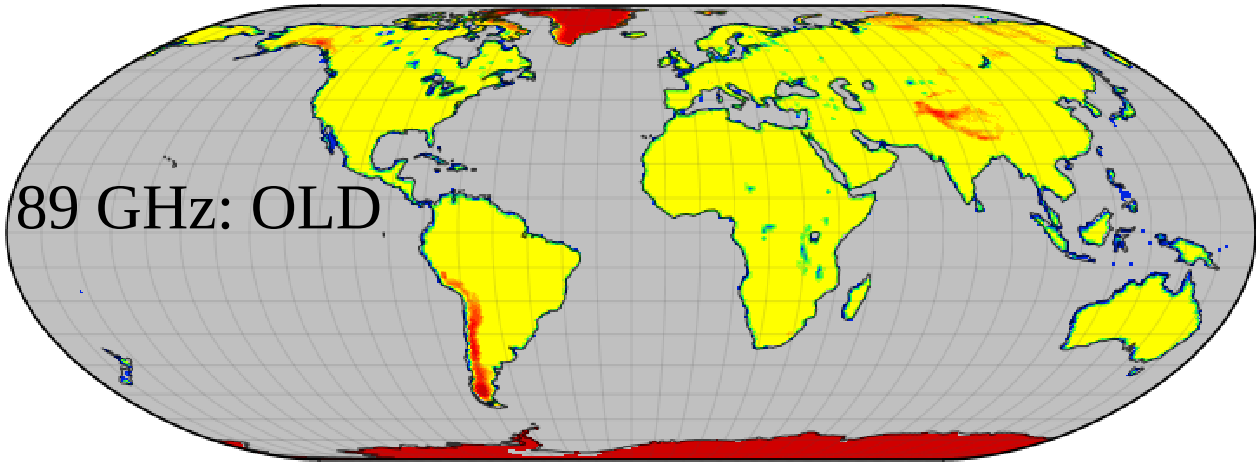
OCEANS LAND

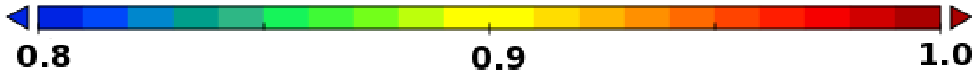


Emissivité ~ 1: higher contribution of the surface to measured radiance

Assimilation: Until recently, no emissivity model effective enough to meet NWP requirements

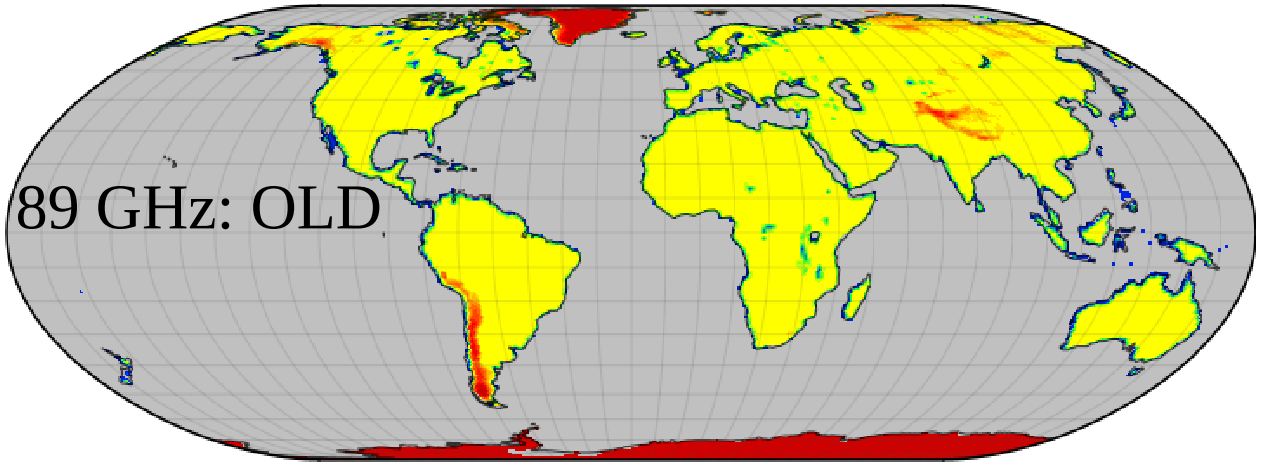
Why the need for a good knowledge of surface emissivity

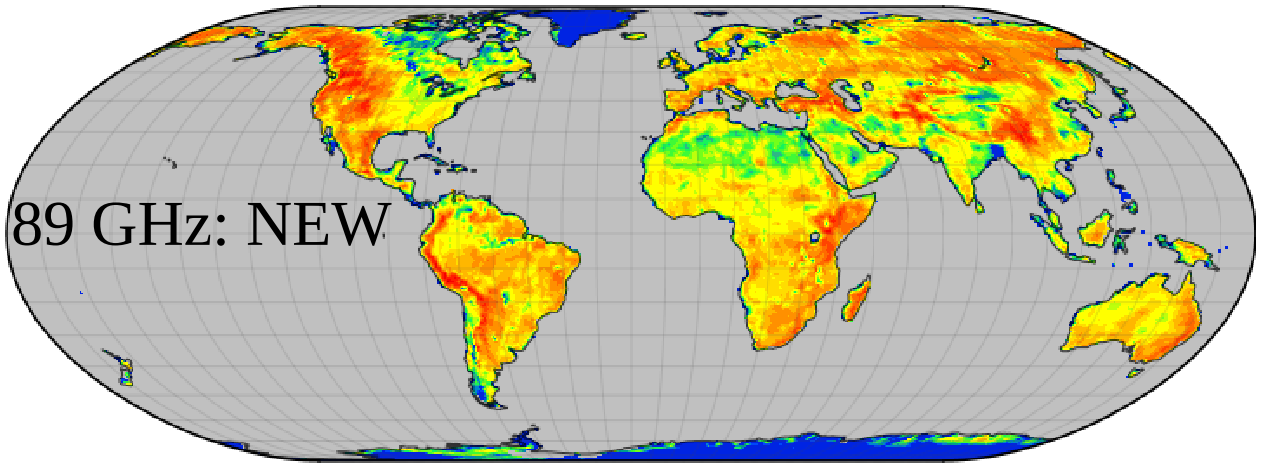




Land surface emissivity : regression version of models ➔ eased the assimilation of sounding channels

Why the need for a good knowledge of surface emissivity

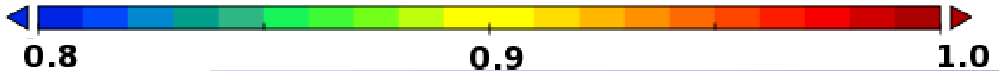




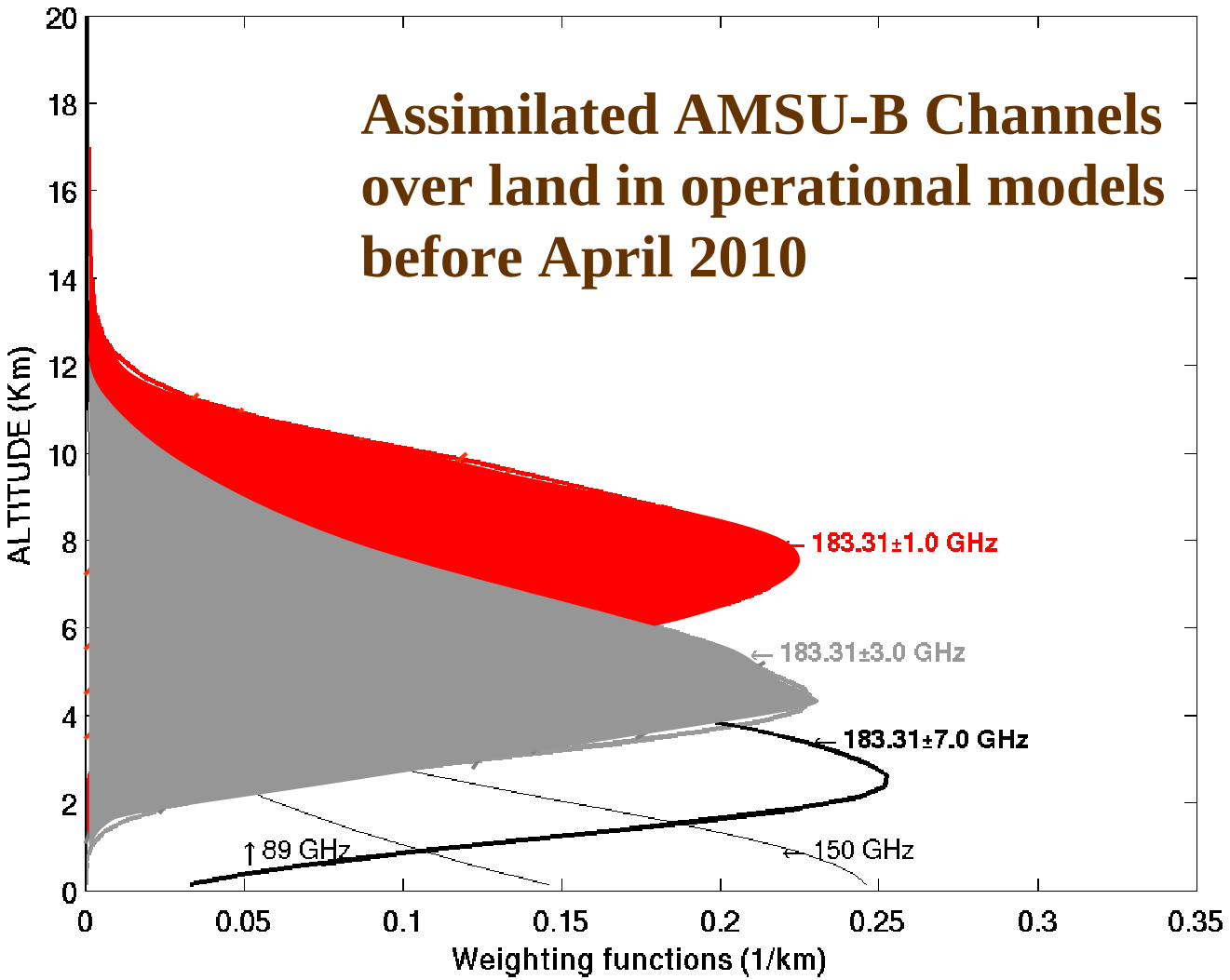
Land surface emissivity : regression version of models ➔ eased the assimilation of sounding channels

Since July 2008, operational implementation of a new land surface emissivity parameterization (Karbou et al. 2006) based on radiative transfer calculations

==> make it possible to assimilate surface sensitive observations over land



Assimilation of surface sensitive channels over land



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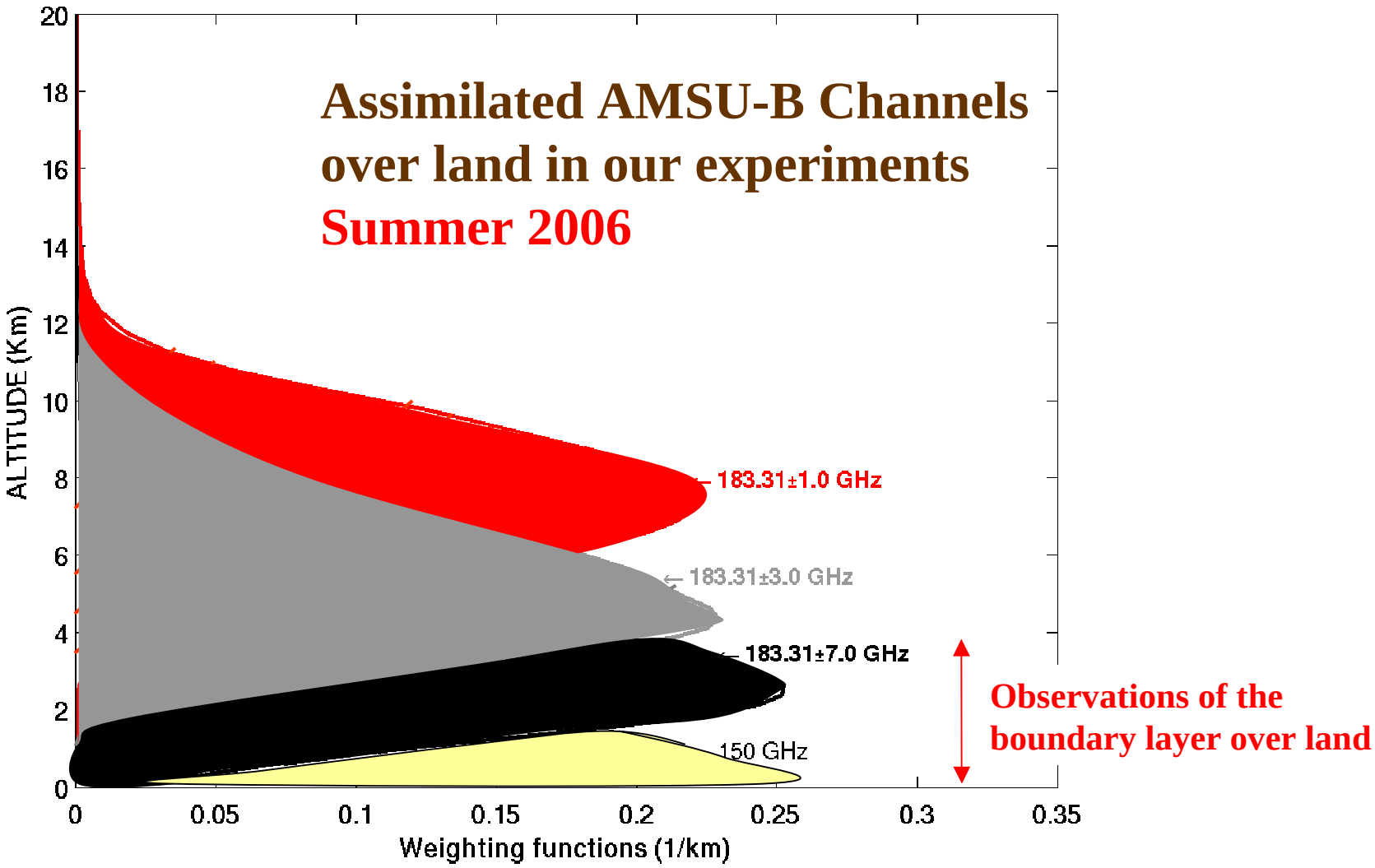


Assimilation of surface sensitive channels over land

Main results when AMSU surface channels are assimilated in 4D-Var:

- Forecast errors with respect to radiosondes and ECMWF analyses
- Impact on analysis of humidity, evaluation against independent GPS measurements from AMMA network

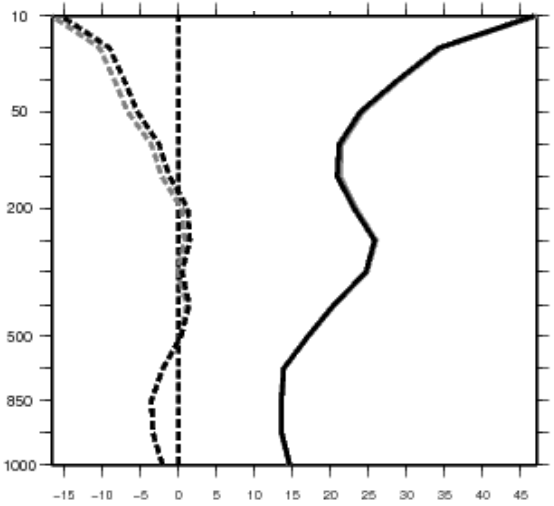
Assimilation of surface sensitive channels over land: Effect on forecasts

Scores geopotential height / Radiosondes, 48h, 1 month

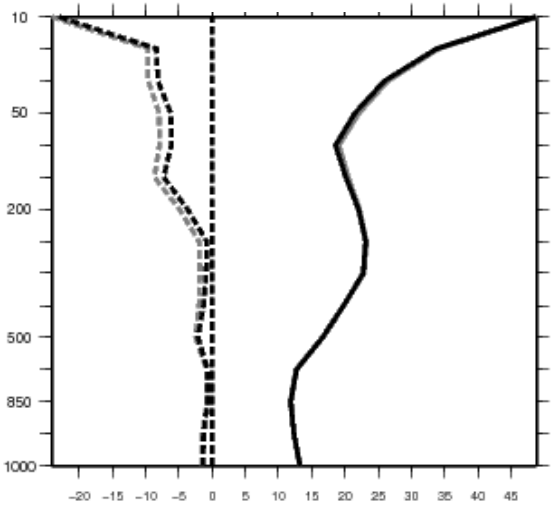
CTL --- BIAS
__ RMSE

EXP --- BIAS
__RMSE

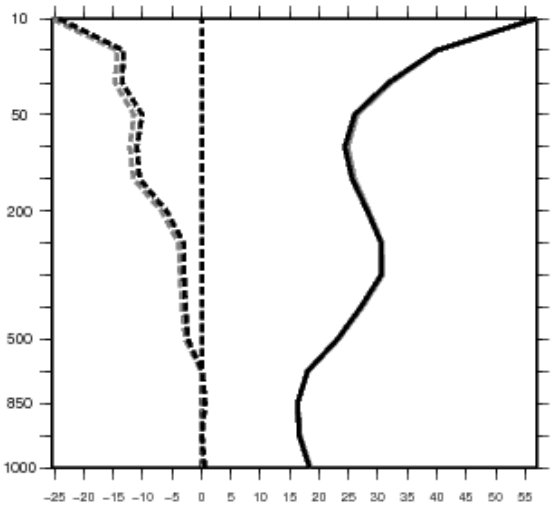
N20



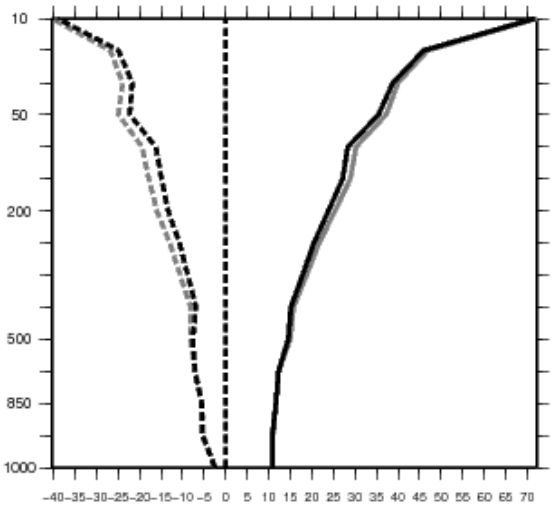
AUS-NZ



S20



TROPIQ



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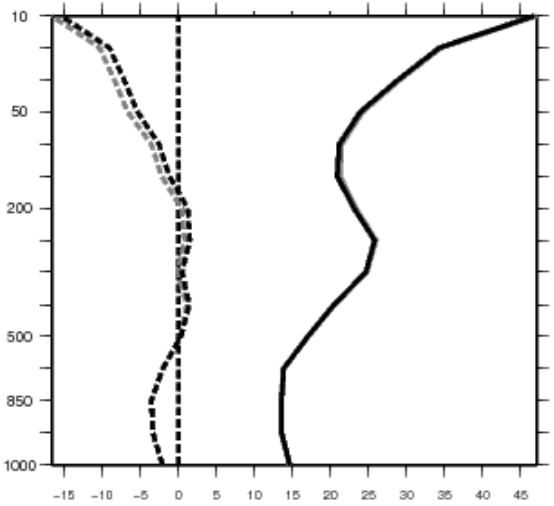

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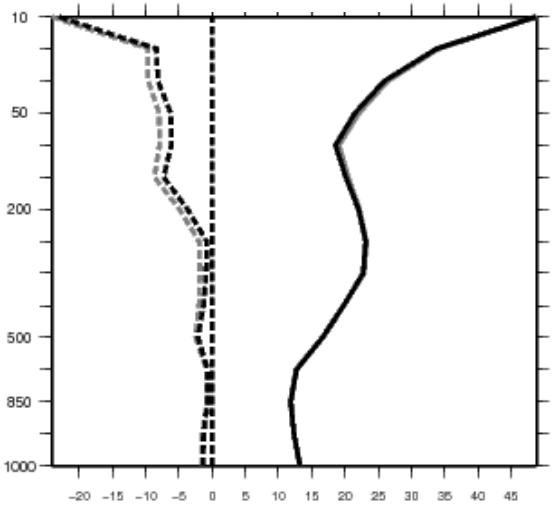

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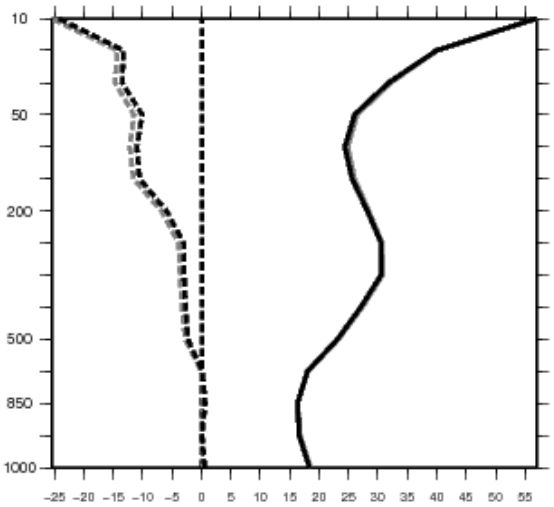

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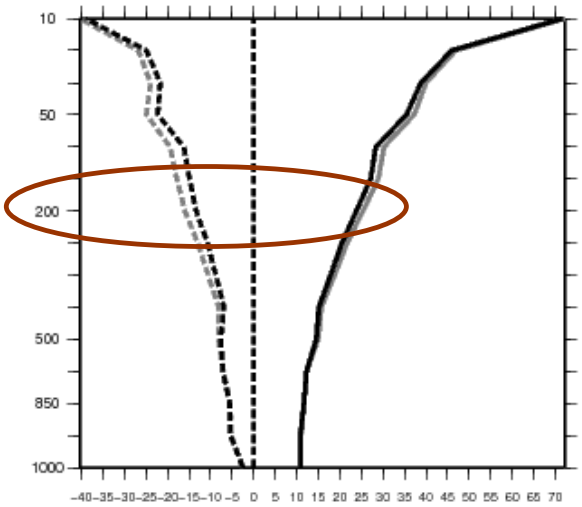
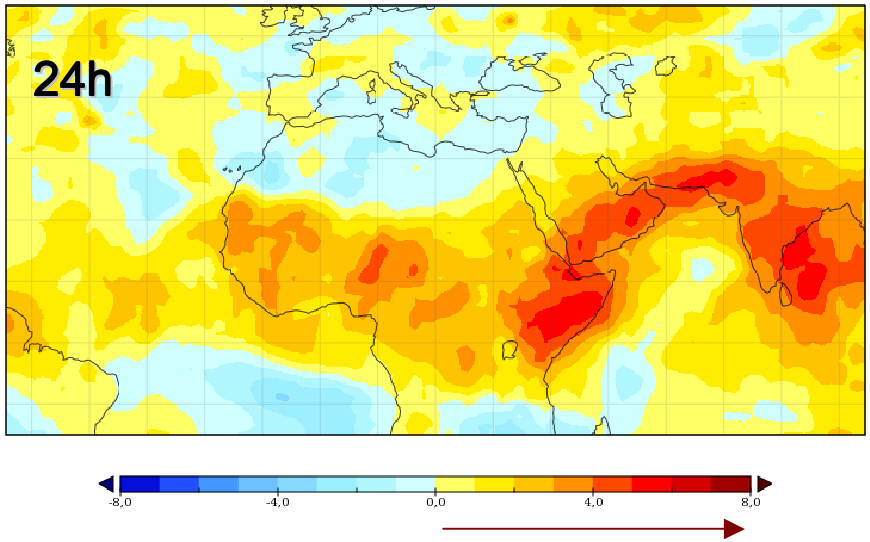


Assimilation of surface sensitive channels over land: Effect on forecasts

Differences of geopotential forecast errors with respect to ECMWF analyses (CTL-EXP), 200hPa, 1month



Smaller errors in EXP

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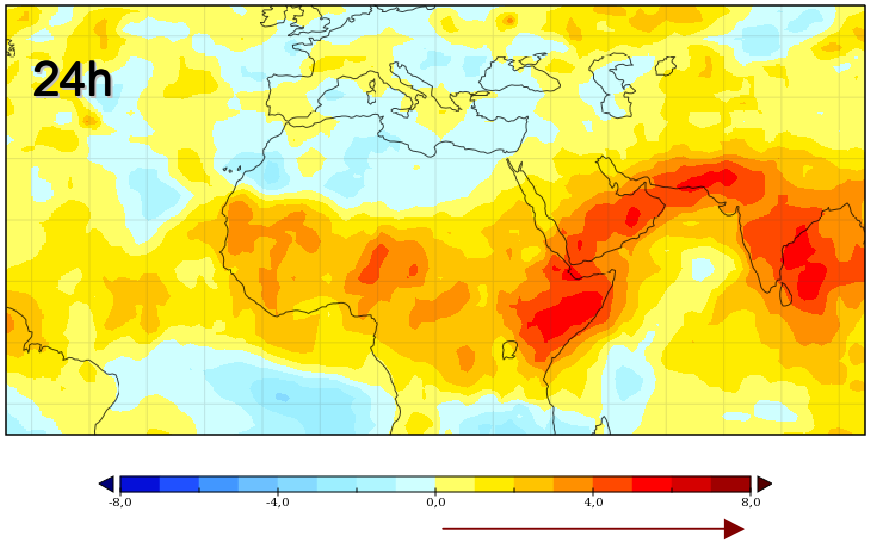

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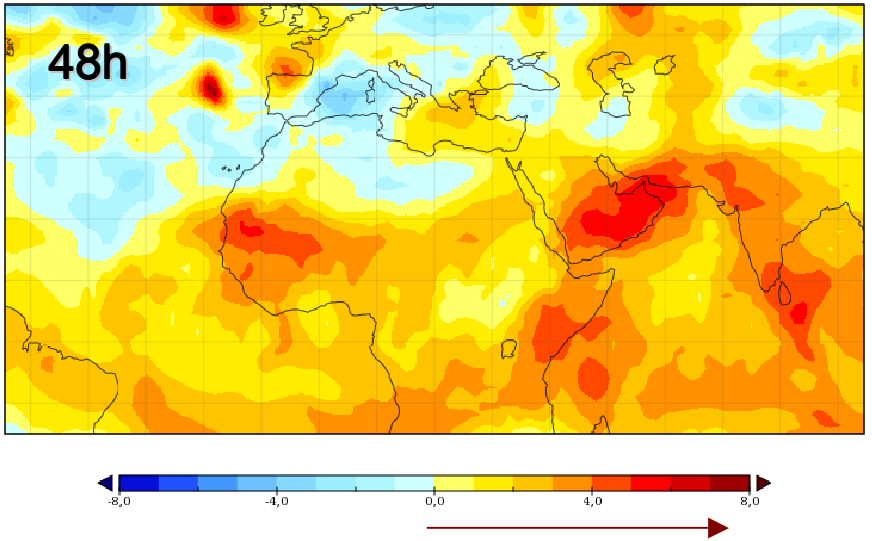

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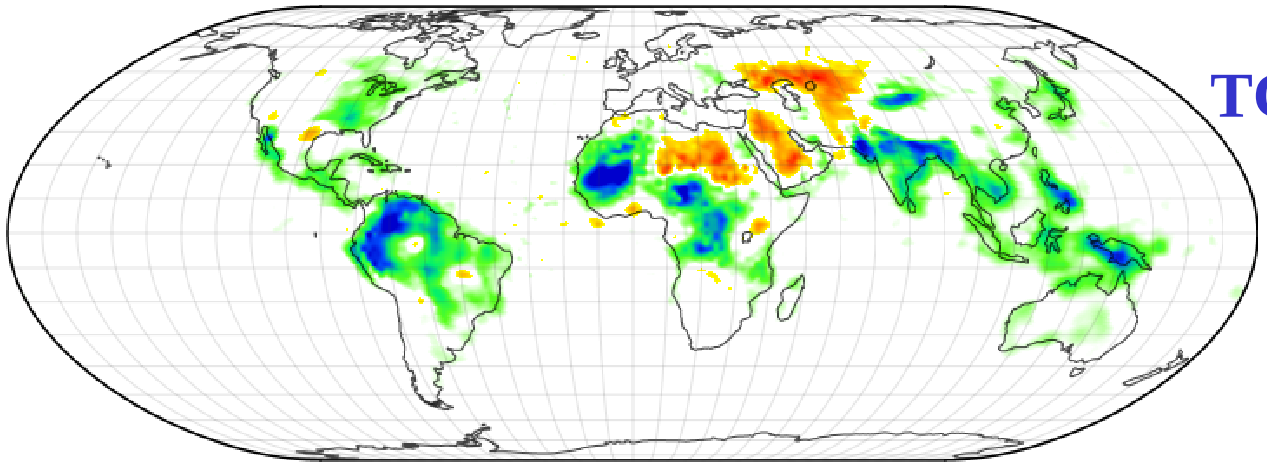
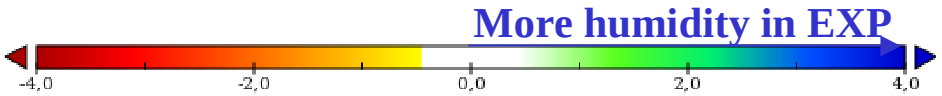
Assimilation of surface sensitive channels over land: Effect on analyses

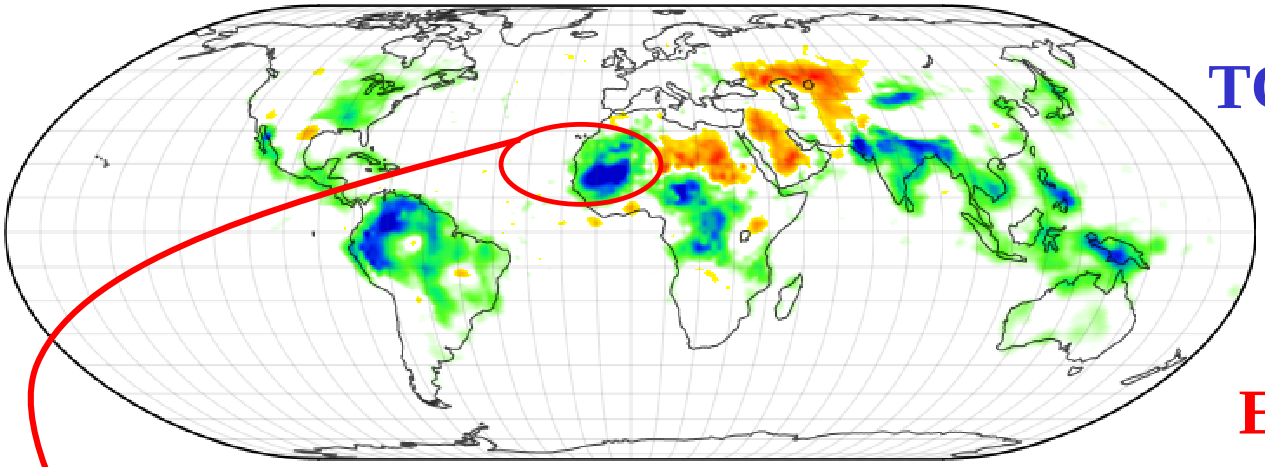


TCWV (EXP-CTL)



Similar humidity features observed when assimilating TCWV from ENVISAT MERIS over land in IFS (Bauer, 2009)

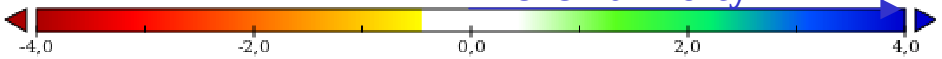
Assimilation of surface sensitive channels over land: Effect on analyses

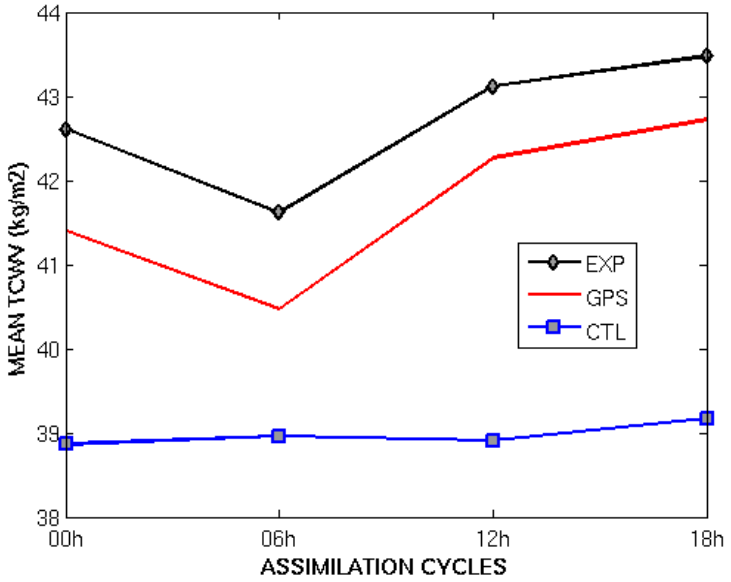


TCWV (EXP-CTL)

Evaluation against GPS measurements

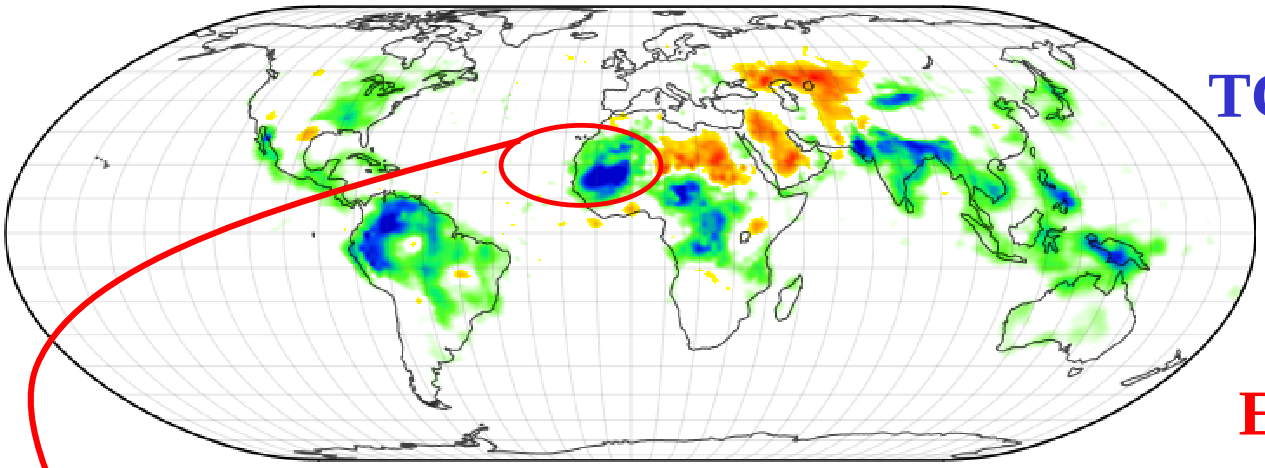
More humidity in EXP





TCWV diurnal cycle, Tombuktu (MALI)

Assimilation of surface sensitive channels over land: Effect on analyses



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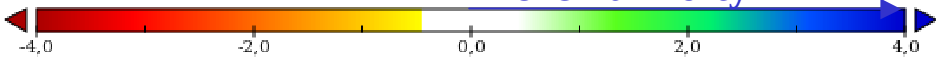
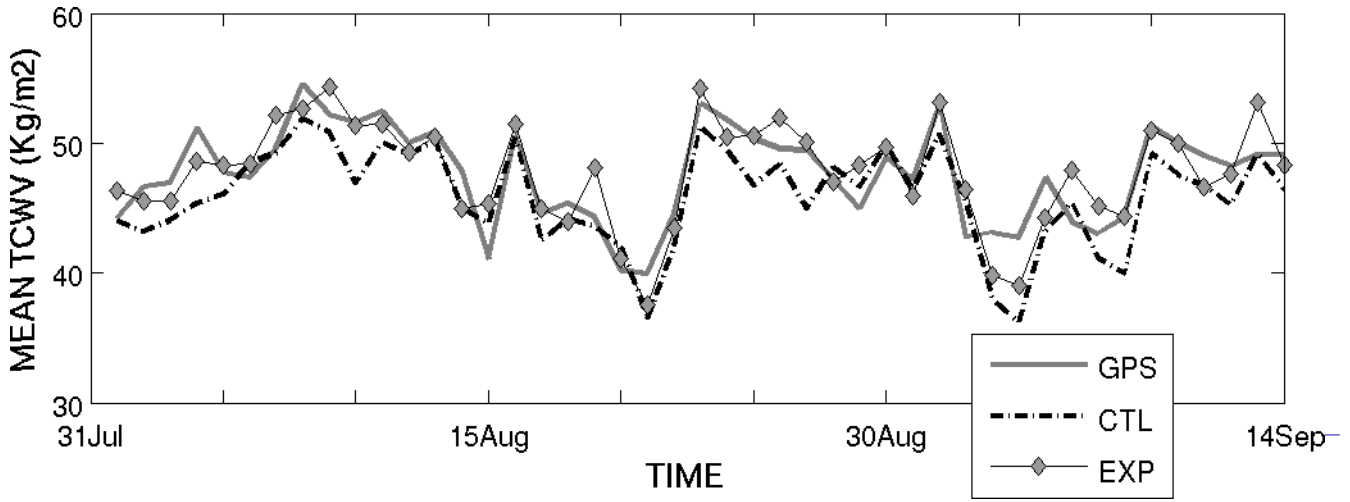
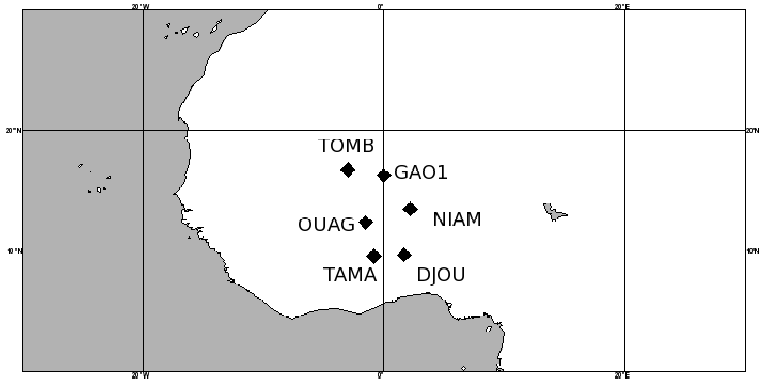


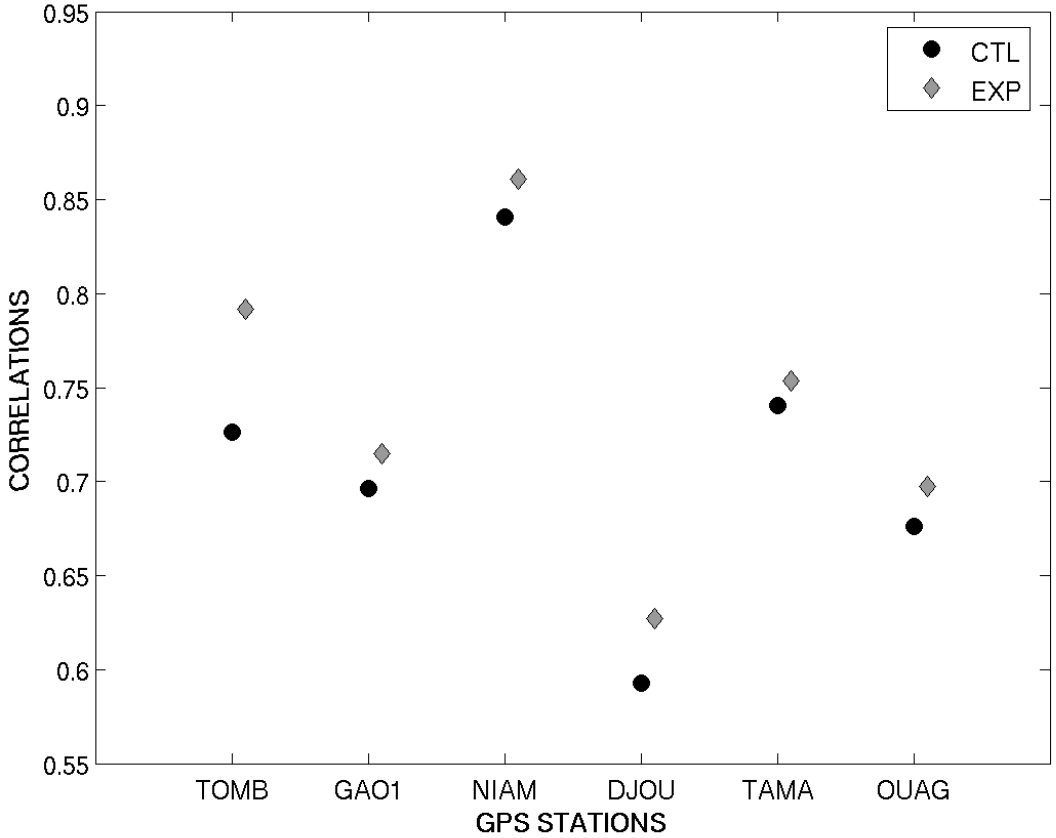
TCWV daily time series, Ouagadougou



Assimilation of surface sensitive channels over land: Effect on analyses

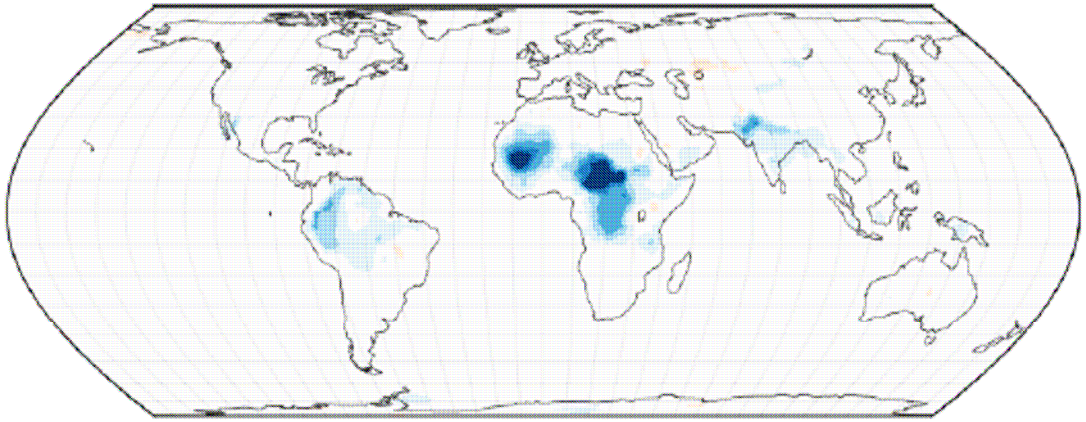


AMMA GPS network



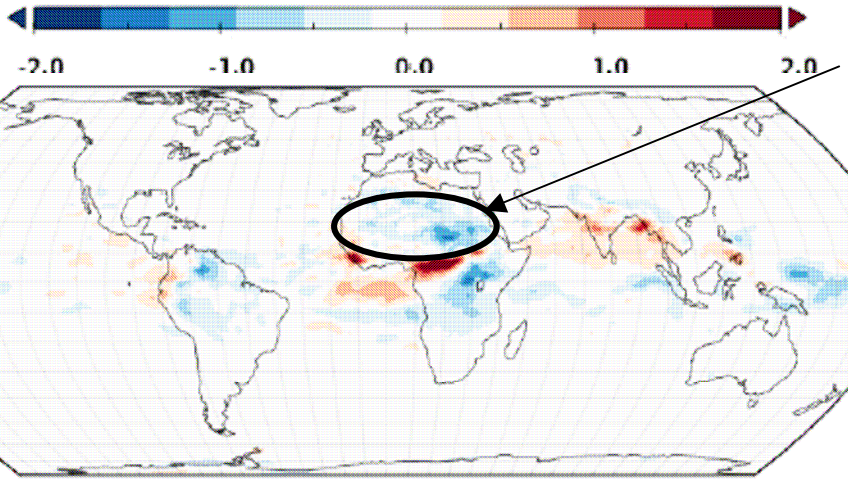
Correlations with GPS, 45 days, synoptic times

Assimilation of surface sensitive channels over land: Effect on analyses



Temperature differences (K), 950 hPa

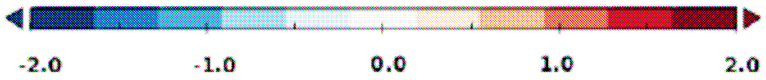
T (EXP-CTL)



AEJ increase

Vz (EXP-CTL)

Zonal wind differences (m/s), 700 hPa

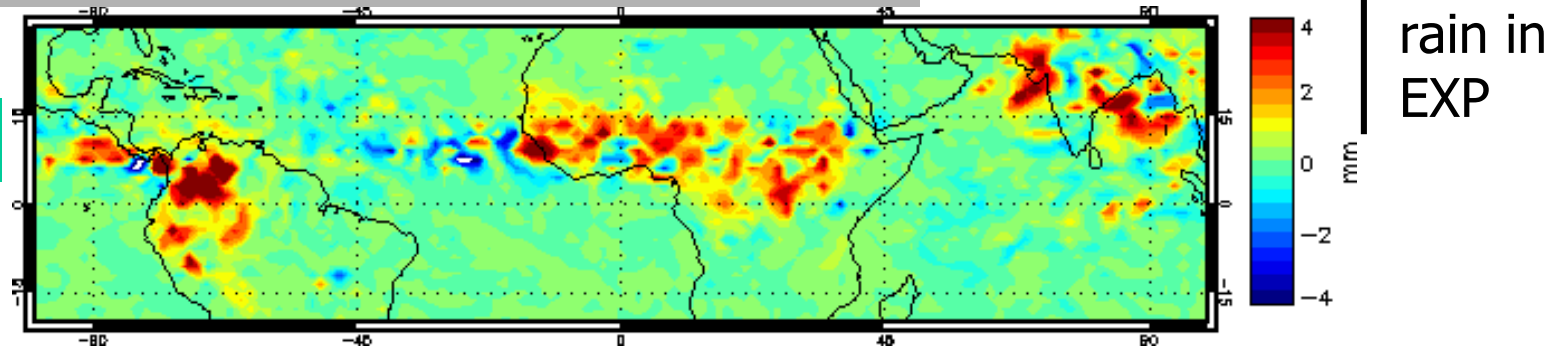


Karbou et al, 2009a, b

Assimilation of surface sensitive channels over land: Effect on forecast

24-hour cumulated precipitation rate

EXP-CTR



Conclusions and Open issues

- A good representation of land surface emissivity motivated assimilation studies to assimilate low level humidity observations (usually blacklisted)
- The assimilation of these channels:
  - Positive impact in scores wrt radiosondes, ECMWF analyses
  - Large impact on humidity analysis (& temp., wind) over the Tropics: low to mid-levels
  - TCWV Change evaluated against independent GPS measurements
- More results in Karbou et al. 2010a-b (Weather and Forecasting)

Surface emissivity model operationally implemented
at Météo-France in July 2008
at ECMWF since September 2009 (Krzeminski et al. 2009)

Assimilation of AMSU surface sensitive observations: operational at Météo-France since 6th April 2010.

Conclusions and Open issues

• Assimilation of humidity observations: need for more in depth studies, inter-comparison studies dealing with different models (connection with moist physic parametrisation)

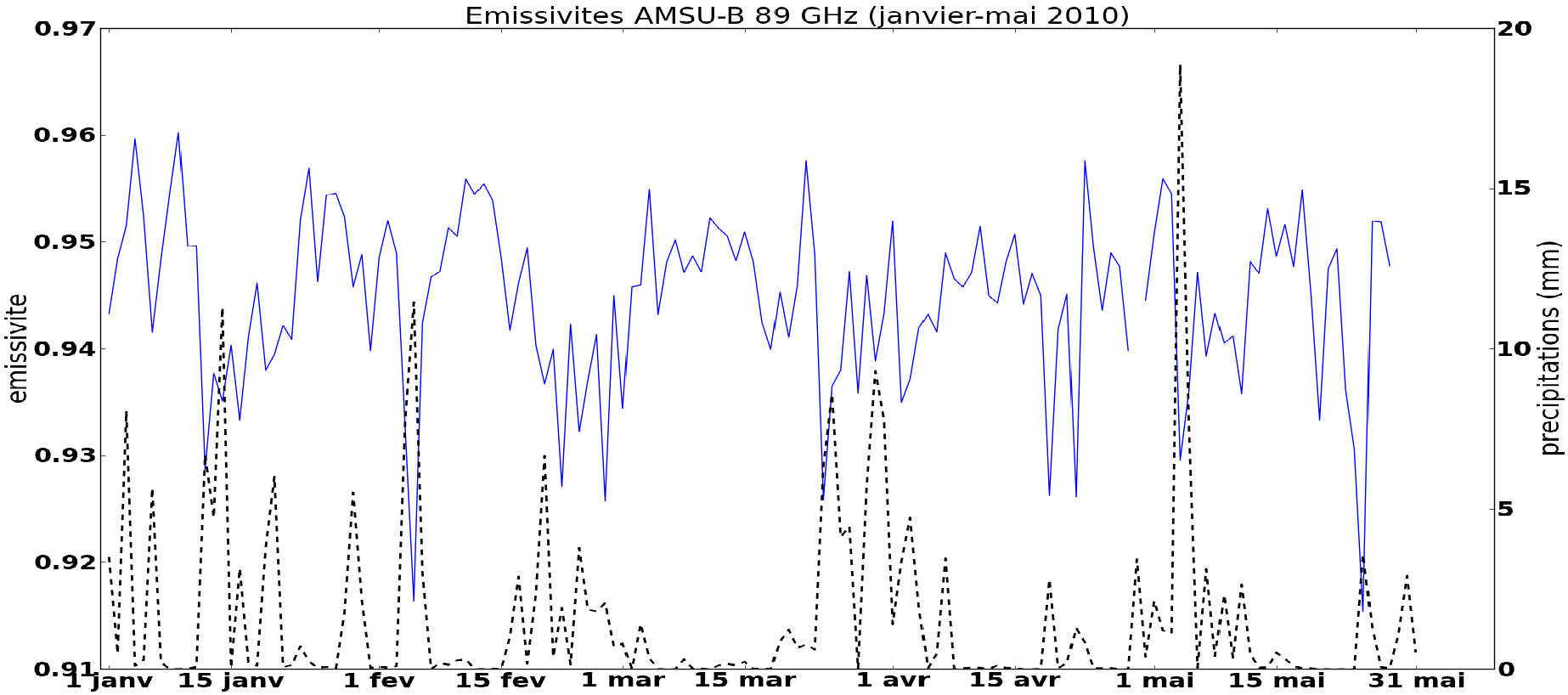
• Need for studies dedicated to the assimilation of MW data under cloudy/rainy conditions

• Potential of meso-scale models: performances of the AROME model using MW based analyses (Florent Beucher)

• Improve the usage of microwave data for other applications (hydrology, physical process studies, ...)

Conclusions and Open issues

- Improve the usage of microwave data for other applications : an example the use of emissivities at 89 GHz to estimate a rain rate *(Camille Birman, Fatima Karbou, Jean-François Mahfouf)*

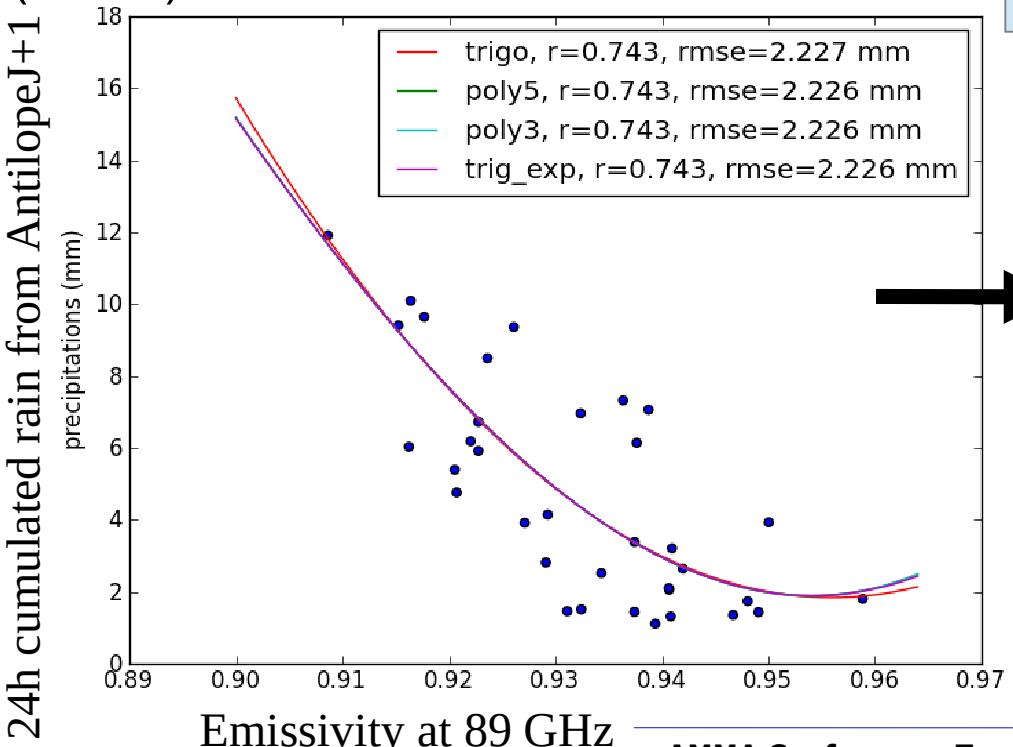


Conclusions and Open issues

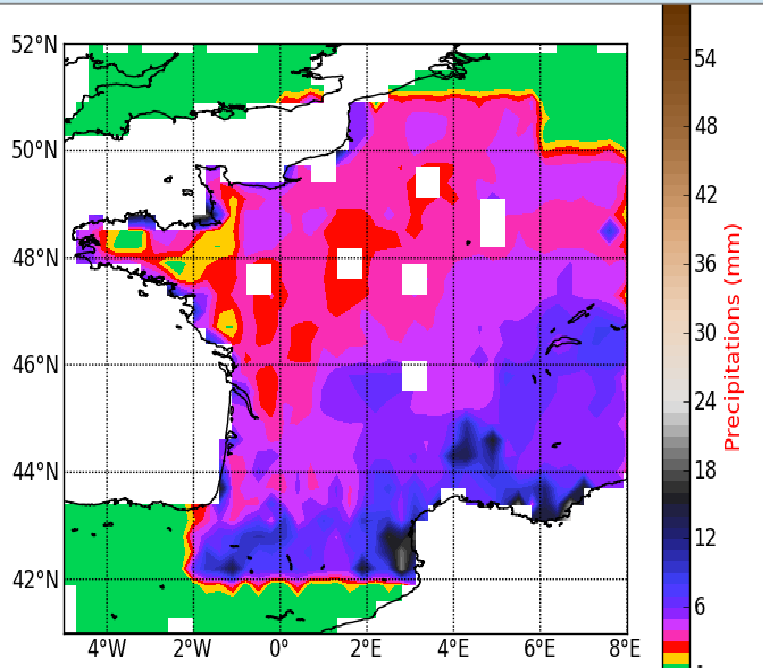
• Improve the usage of microwave data for other applications : an example the use of emissivities at 89 GHz to estimate a rain rate *(Camille Birman, Fatima Karbou, Jean-François Mahfouf)*

• Method evaluated over France, shows a positive bias but correctly reproduce the rain occurrence and variability.

• This approach can be generalised to areas with few in-situ measurements (Africa)



5 May 2010, 24h simulated rain



Some References

Bock, O., Bouin, M.N., Walpersdorf, A., Lafore, J.P., Janicot, S., Guichard, F., Agusti-Panareda, A.: Comparison of ground-based GPS precipitable water vapour to in independent observations and NWP model reanalyses over Africa, *Q. J. R. Meteorol.* Soc., 133, 2011-2027, 2007.

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