Impact study of AMSU-A/B data over sea-ice in the Météo-France global assimilation system

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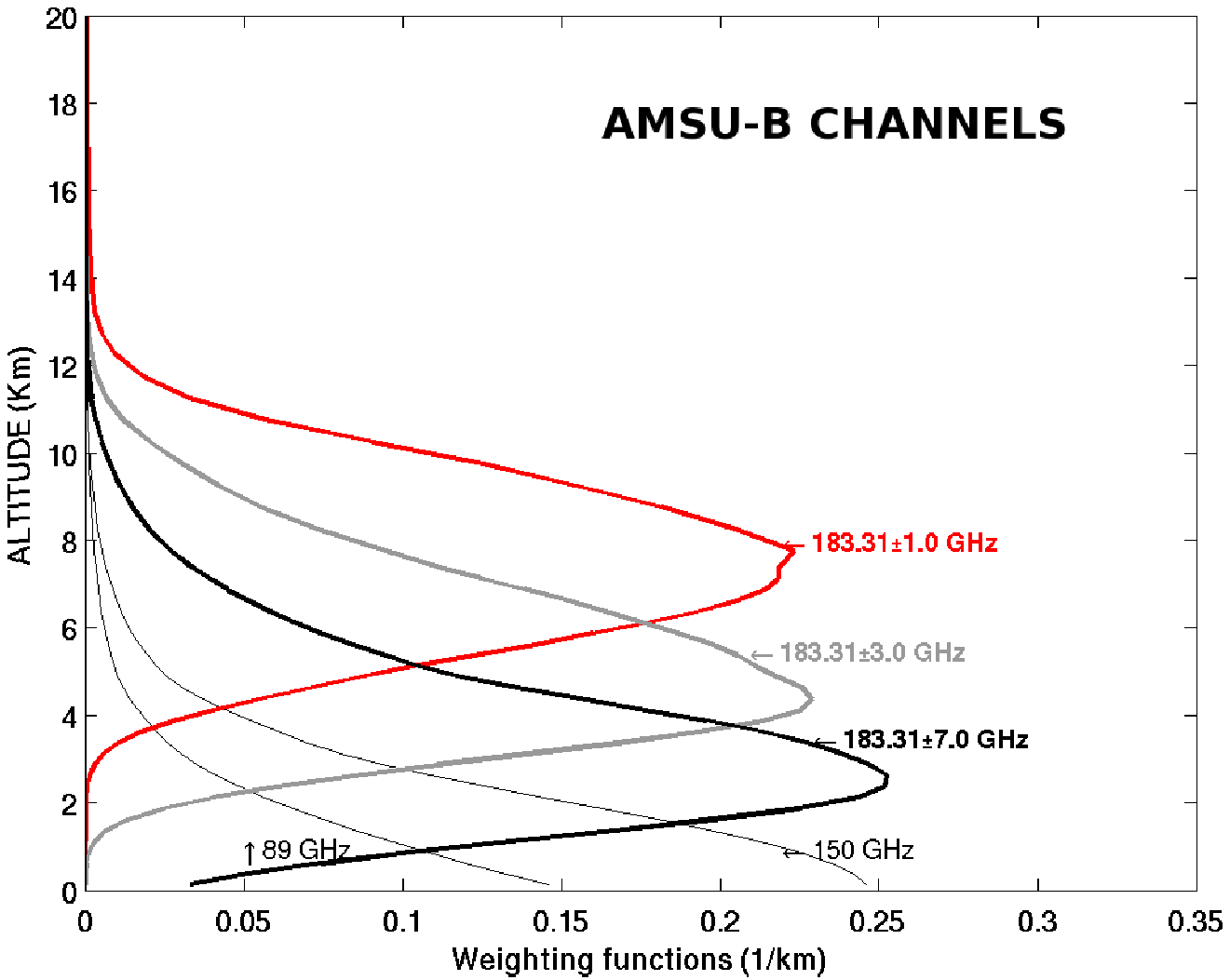
CNRM-GAME, Météo-France & CNRS

(1) AMSU-A & AMSU-B observations

Indirect measurements of temperature and humidity



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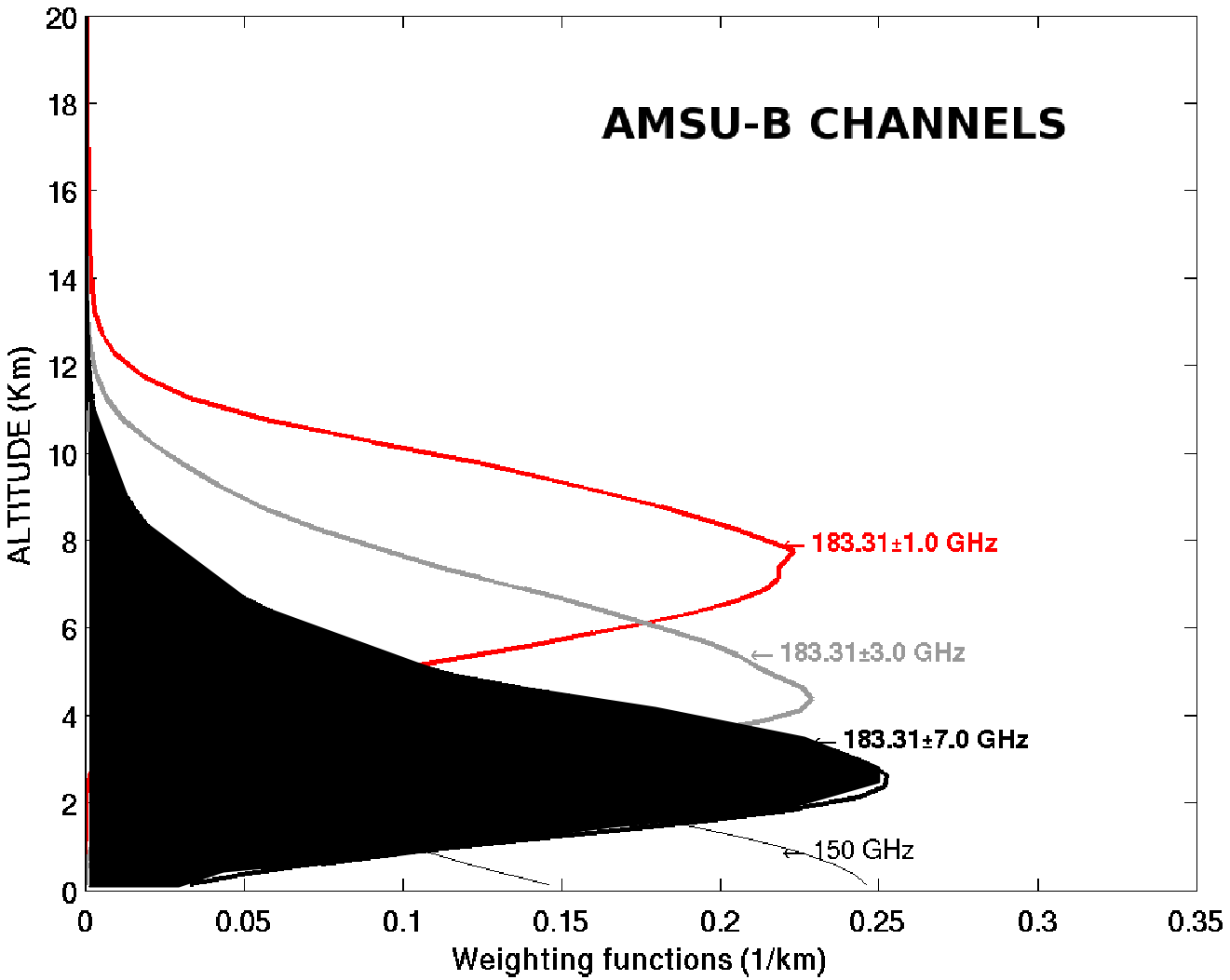
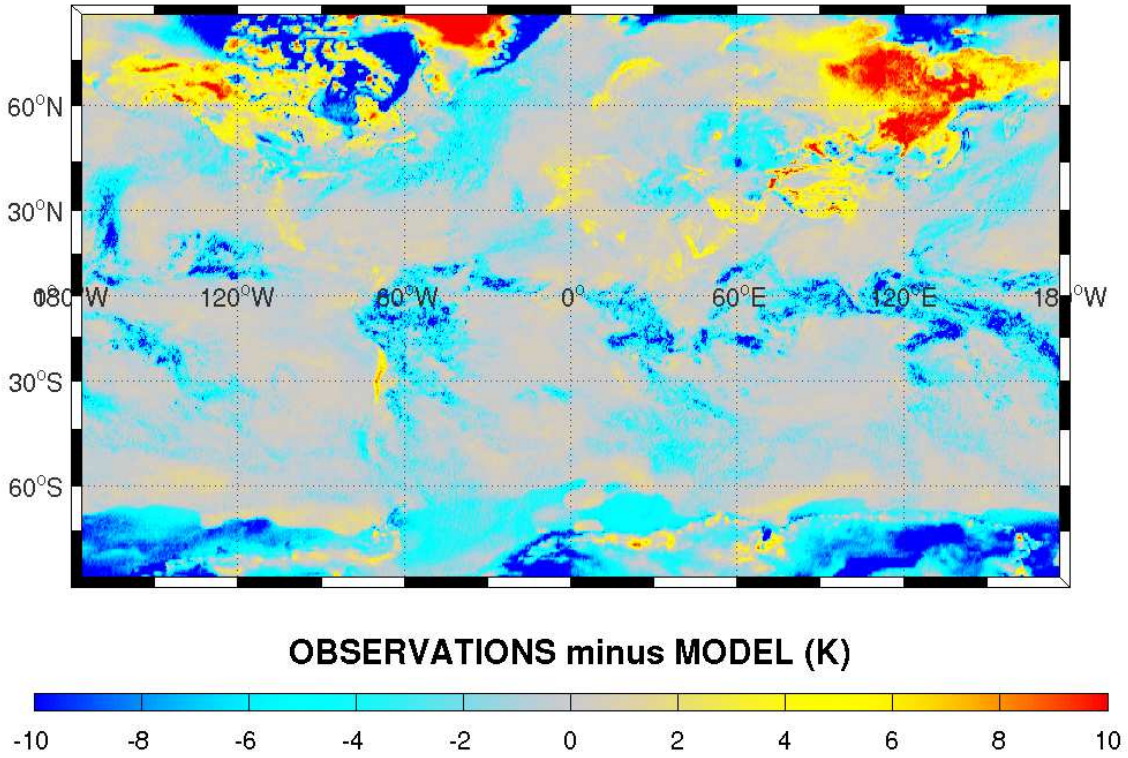


(1) AMSU-A & AMSU-B observations

Current usage of AMSU-B channel 5 (183.31 ± 7.0 GHz) in ARPEGE



December 2008

One of the limitations: large uncertainties about the surface description (emissivity and surface temperature) over snow and sea-ice

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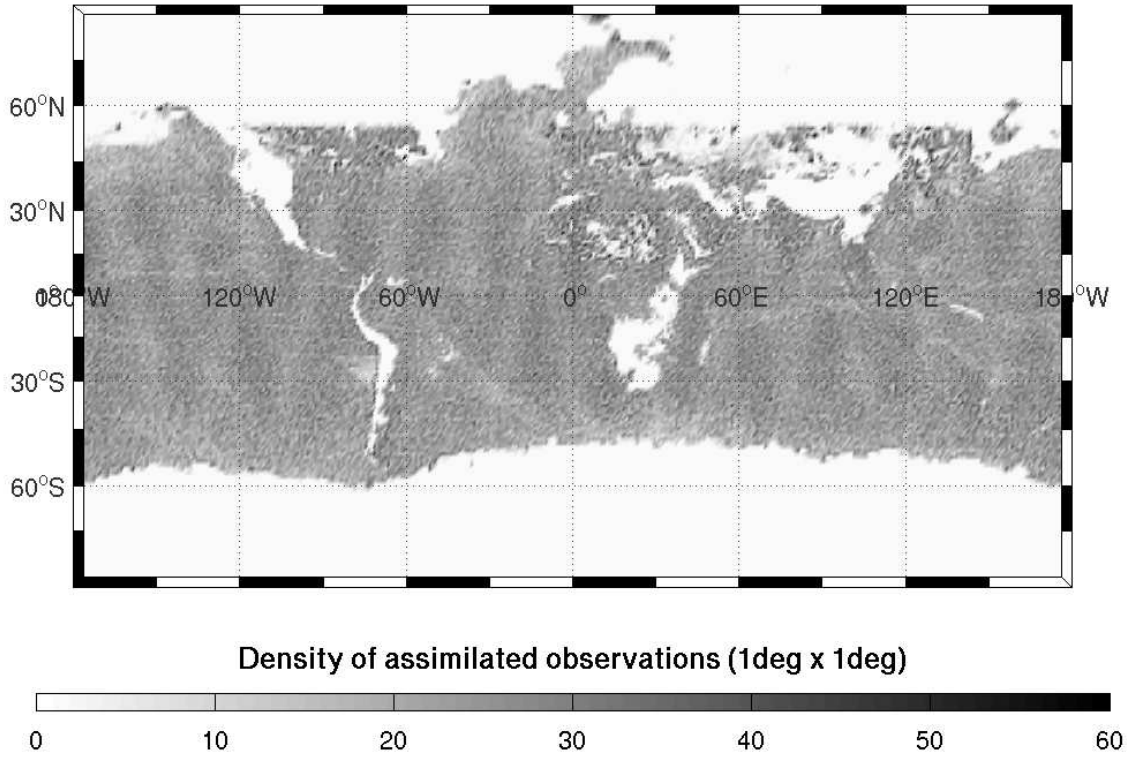

December 2008

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(2) Emissivity for AMSU-A & AMSU-B over sea-ice

Since July 2008, a “dynamical retrieval method” is used in ARPEGE to estimate the land surface emissivity at microwave frequencies (Karbou et al. 2006):

• Instantaneous emissivity retrieval at one surface surface channel (89 GHz for AMSU-B and 50 GHz for AMSU-A)

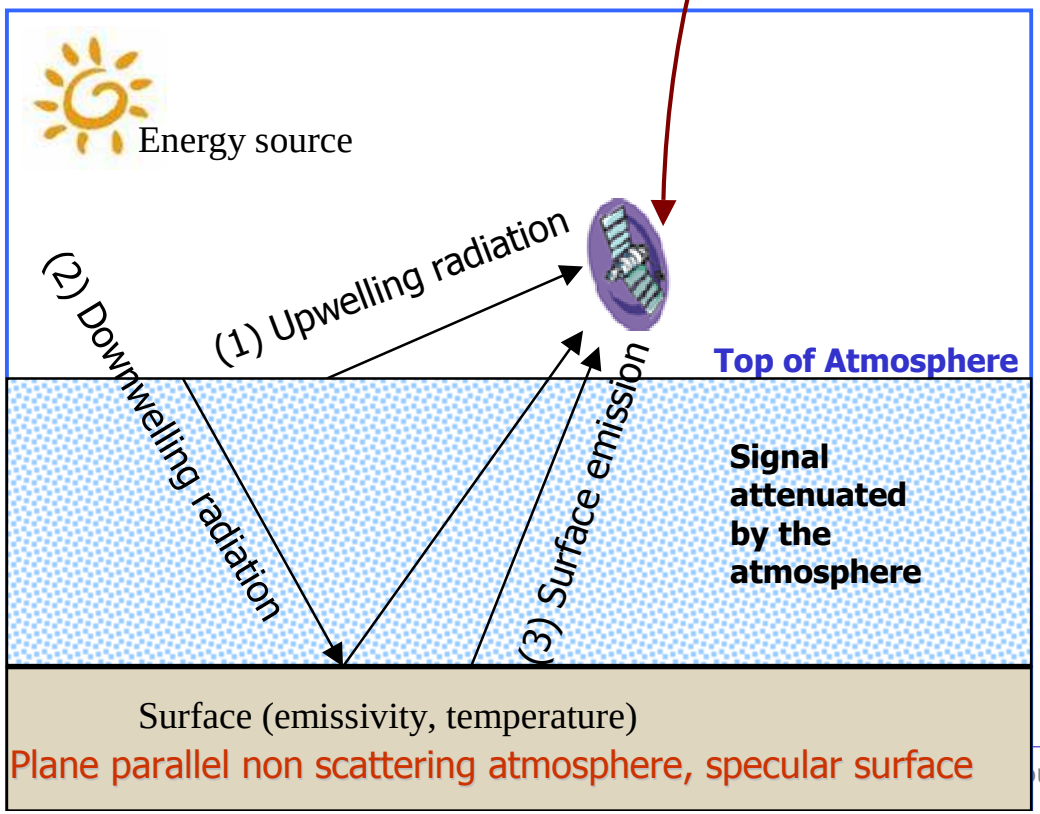
• The emissivity is then given to sounding channels (with no frequency dependency)

• Limitations: ± 55 deg (avoid sea ice, snow)

• Bouchard et al. 2010: it is possible to better assimilate AMSU data over Antarctica and surrounding sea ice using this emissivity parameterization

(2) Emissivity for AMSU-A & AMSU-B over sea-ice

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

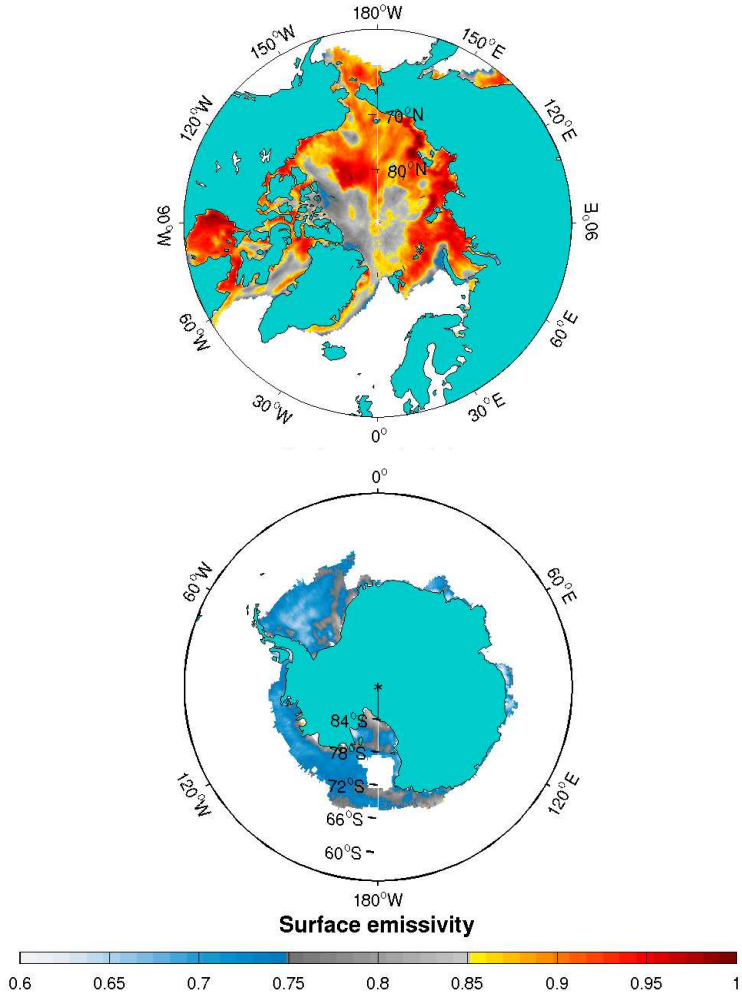


$$\varepsilon(p,\upsilon)=\frac{T(p,\upsilon)-T(\upsilon,\uparrow)-T(\upsilon,\downarrow)\times\tau}{\tau\times(Ts-T(\upsilon,\downarrow))}$$

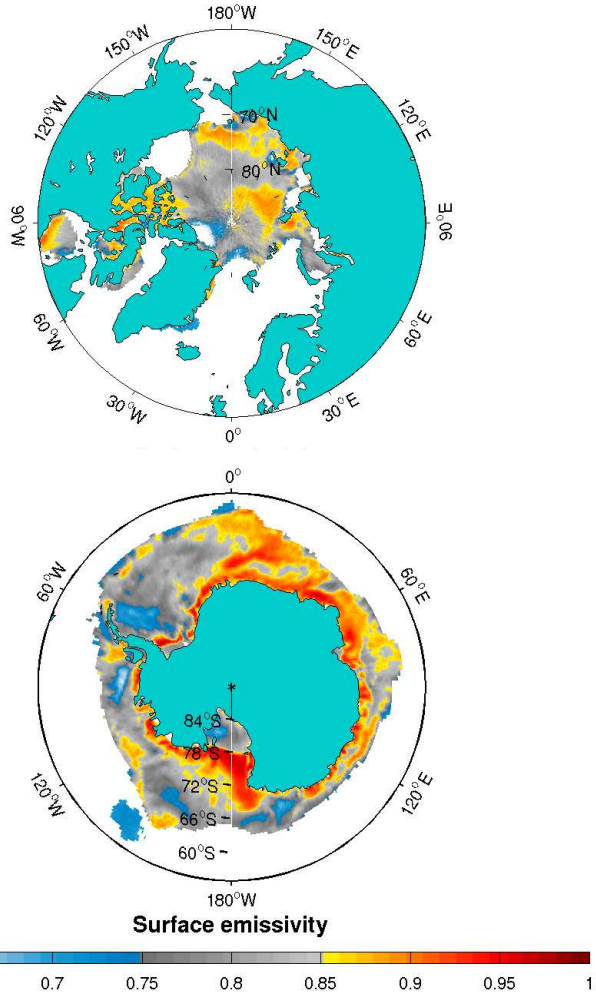
(2) Emissivity for AMSU-A & AMSU-B over sea-ice

Surface emissivity at 89 GHz

January 2009

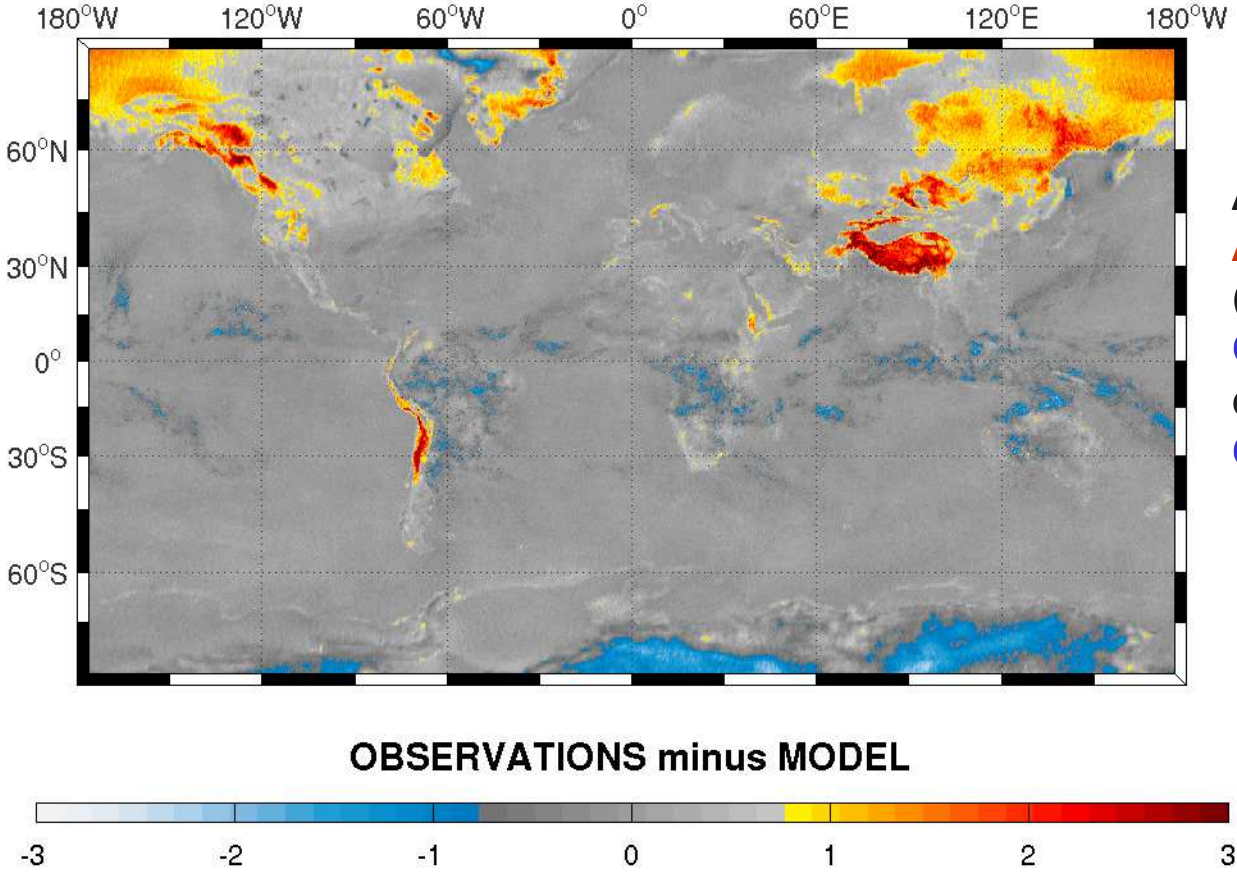


July 2009



(2) Assimilation of AMSU-A & AMSU-B over sea-ice

For AMSU-A: we can safely use the 50 GHz emissivity for temperature sounding (52-60 Ghz) over sea ice;
Over snow, the specular assumption can introduce biases (Talk of S. Guedj)



AMSU-A channel 5 (53 GHz)
All observations
(One week of data)
Over land & sea-ice: retrieved emissivity at 50 GHz
Over sea: FASTEM model

(2) Assimilation of AMSU-A & AMSU-B over sea-ice

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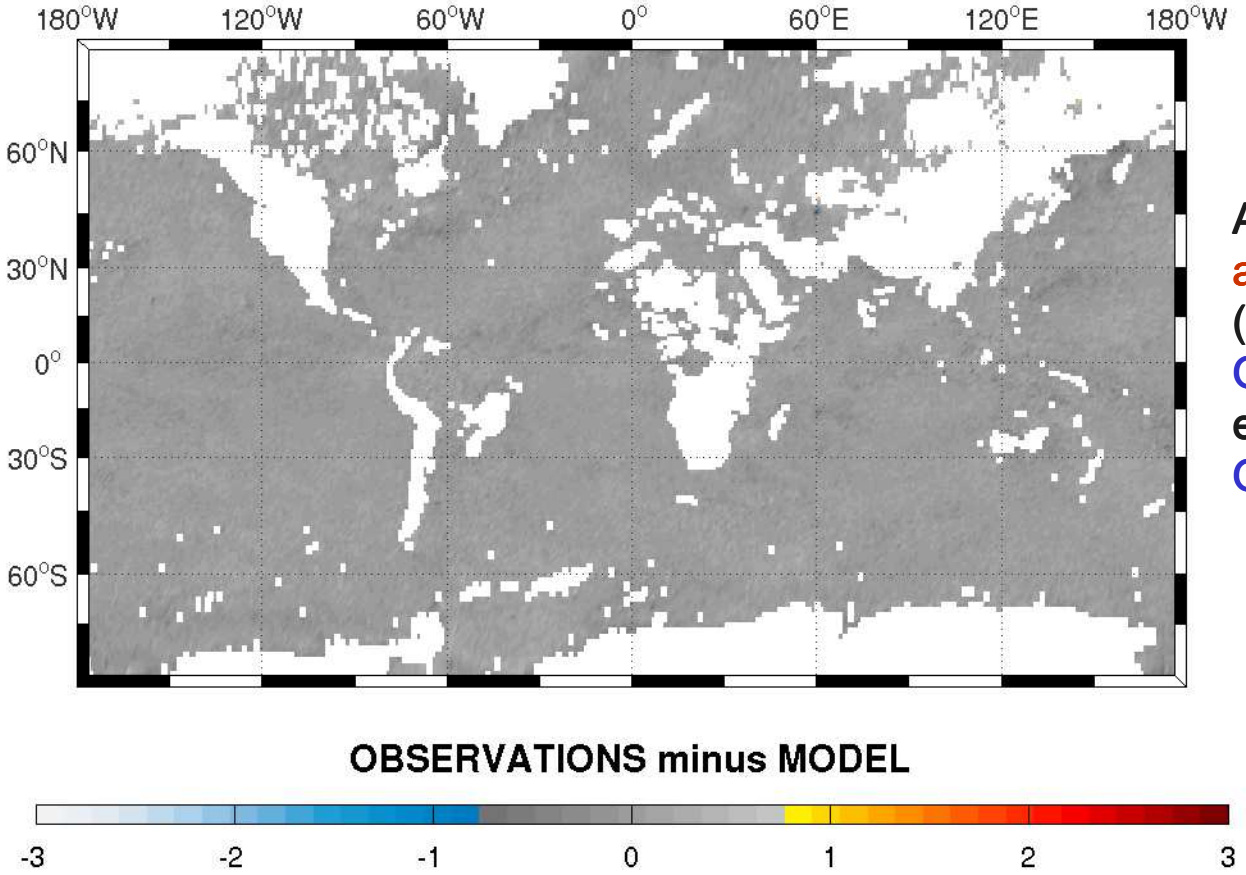

AMSU-A channel 5 (53 GHz) assimilated observations (One week of data)
Over land & sea-ice: retrieved emissivity at 50 GHz
Over sea: FASTEM model

(2) Assimilation of AMSU-A & AMSU-B over sea-ice

For AMSU-B: in particular, can we still use the 89 GHz emissivities for sounding channels near 183 GHz without any frequency dependence parameterization ?

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For AMSU-B in particular, can we still use the 89 GHz emissivities for sounding channels without any frequency dependence parameterization ?

Bouchard et al. 2010: it is possible to better assimilate AMSU data over Antarctica and surrounding sea ice using this emissivity parameterization

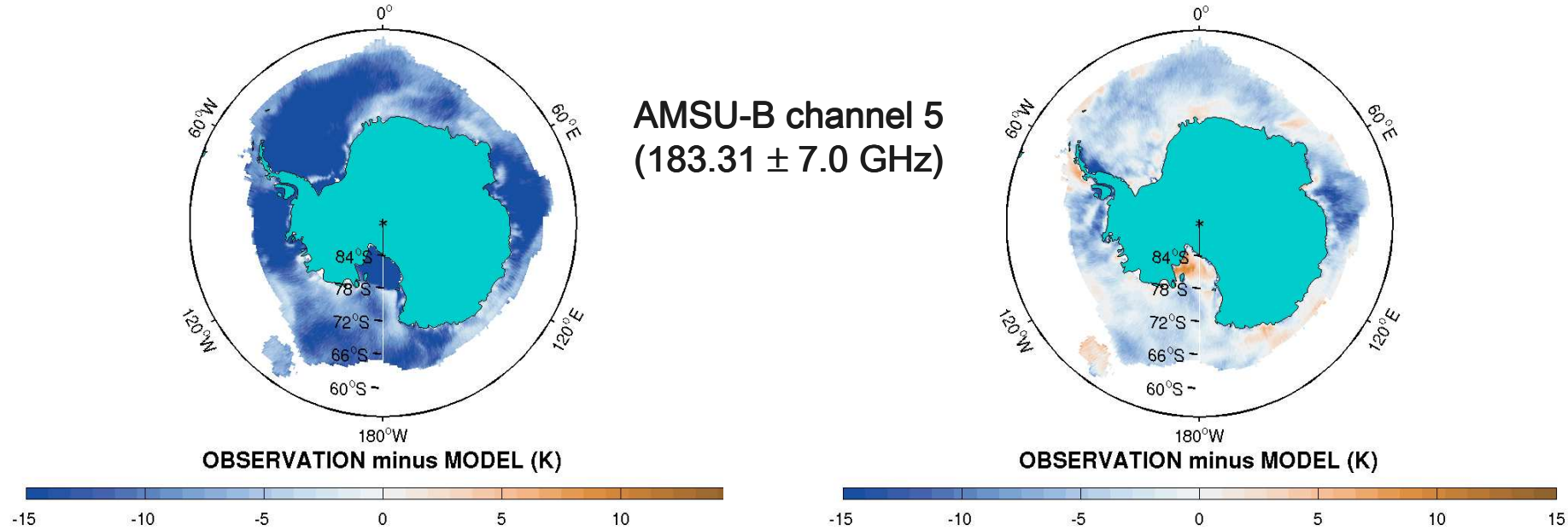
Better results if an emissivity parameterization is introduced (to describe the emissivity change between 89 GHz and 183 GHz)

(2) Assimilation of AMSU-A & AMSU-B over sea-ice

For AMSU-B in particular, can we still use the 89 GHz emissivities for sounding channels without any frequency dependence parameterization ?

Current system

89 GHz emissivity without frequency parameterization



AMSU-B channel 5
(183.31 ± 7.0 GHz)

(2) Assimilation of AMSU-A & AMSU-B over sea-ice

For AMSU-B in particular, can we still use the 89 GHz emissivities for sounding channels without any frequency dependence parameterization ?

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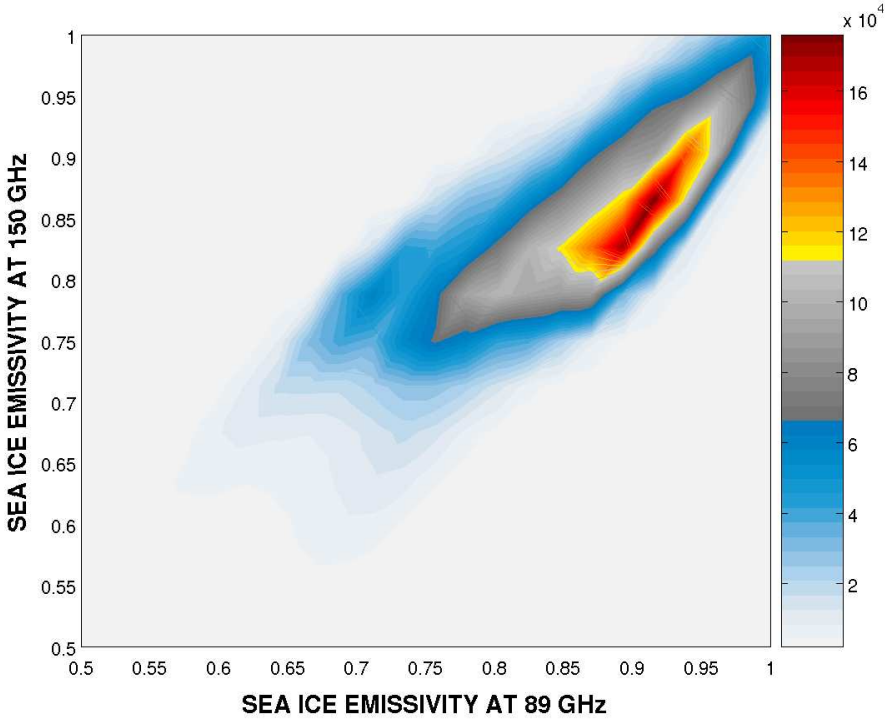
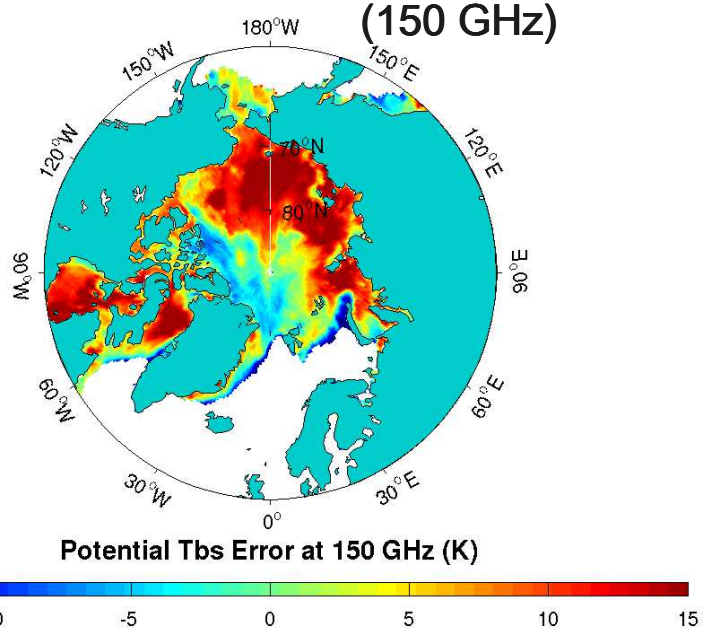


AMSU-B channel 2 (150 GHz)



(2) Assimilation of AMSU-A & AMSU-B over sea-ice

For AMSU-B in particular, can we still use the 89 GHz emissivities for sounding channels without any frequency dependence parameterization ?

Use of frequency parameterization for sea ice: to describe the emissivity change from 89 GHz to 183.31 GHz

Emissivity (~183 GHz) = Emissivity at 89 GHz + f (Tb 89, Tb150, Ts)

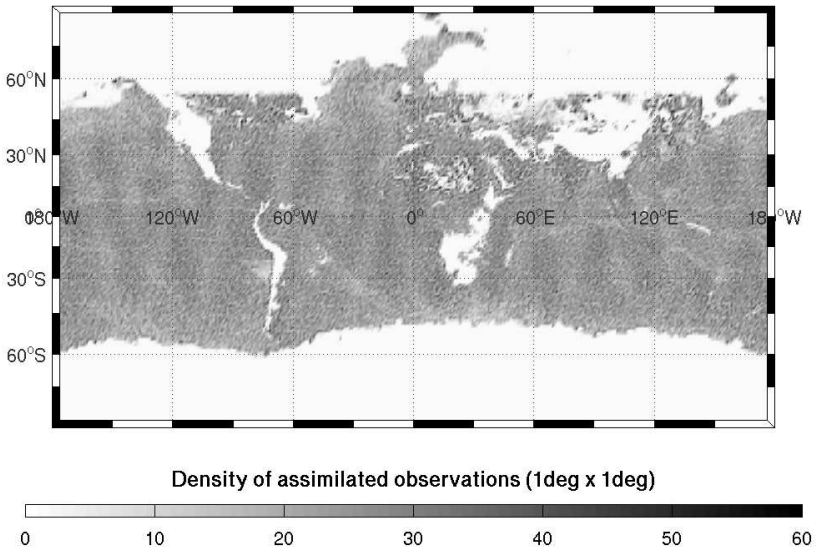
Data impact studies for evaluation:

- Period: 15/12/2009 to 04/02/2010
- CTL: the current operational system
- EXP: CTL + emissivity model over sea ice + assimilation of AMSU-A/-B over sea ice

(3) Data impact results

Usage of AMSU-B channel 5 (183.31 ± 7.0 GHz) in ARPEGE

CTL



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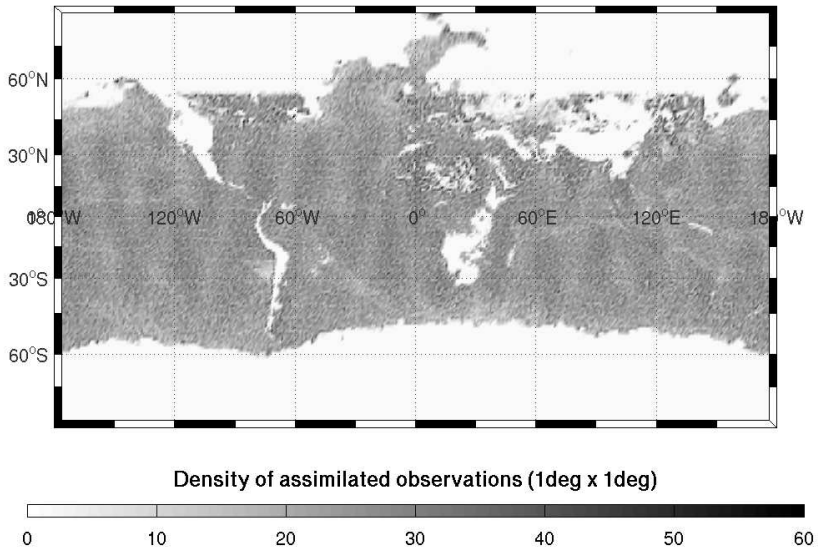
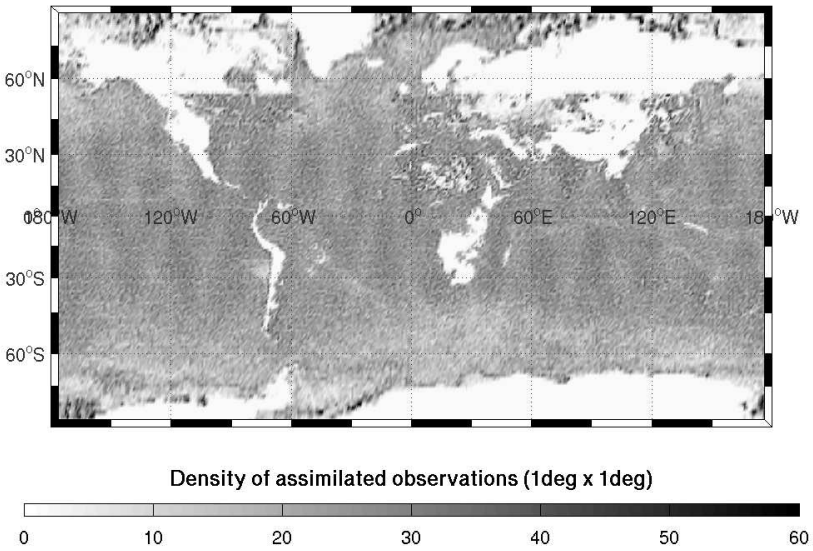


EXP



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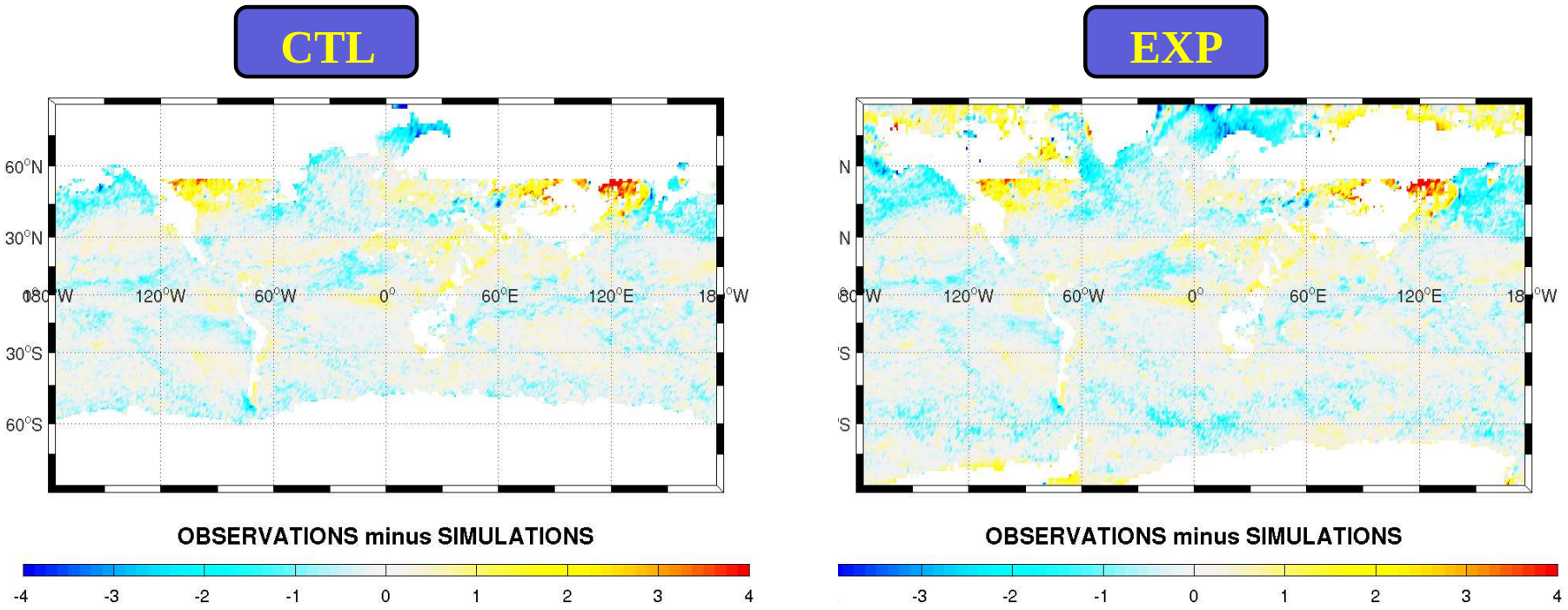
"OBSERVATIONS minus SIMULATIONS" for AMSU-B channel 5 (183.31 ± 7.0 GHz)



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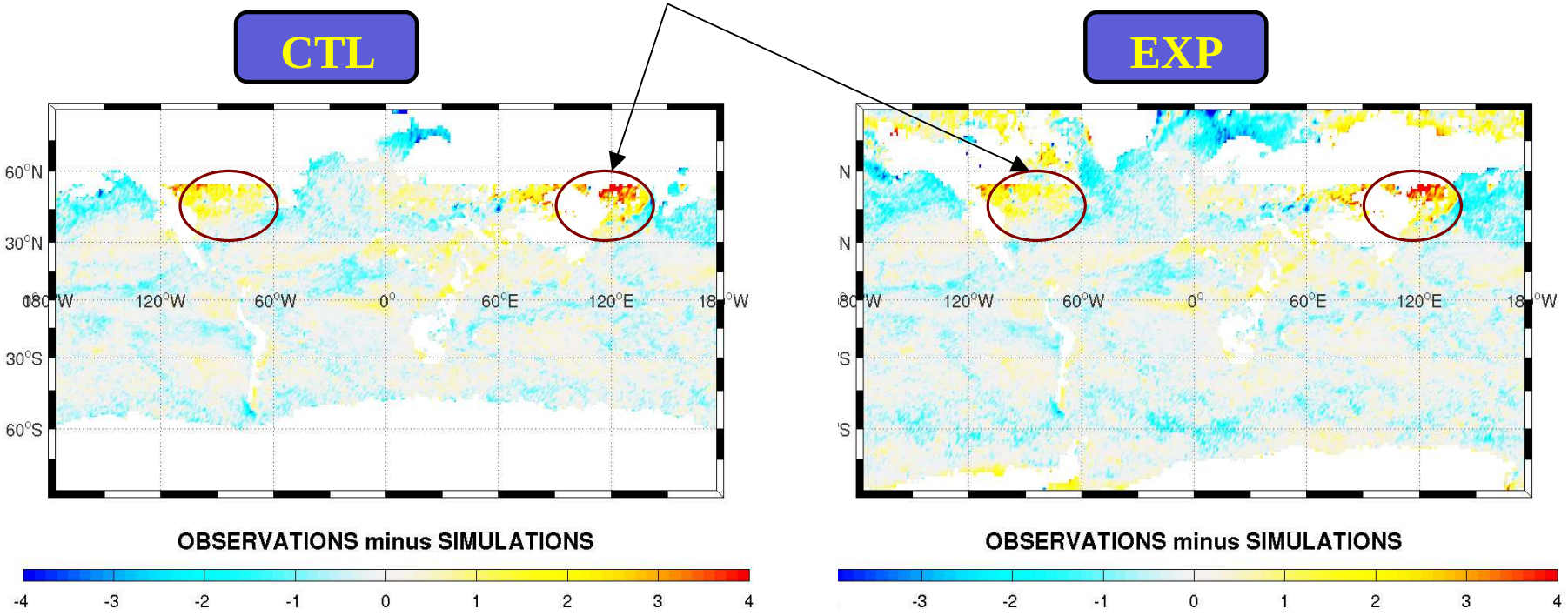
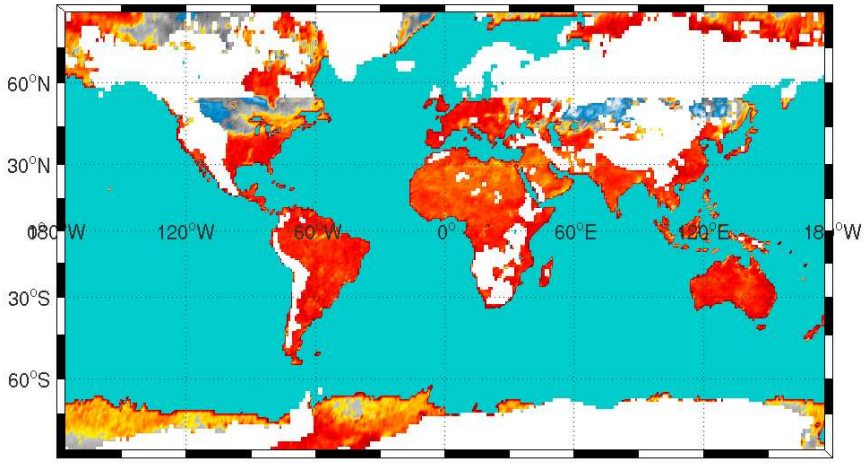
"OBSERVATIONS minus SIMULATIONS" for AMSU-B channel 5 (183.31 ± 7.0 GHz)

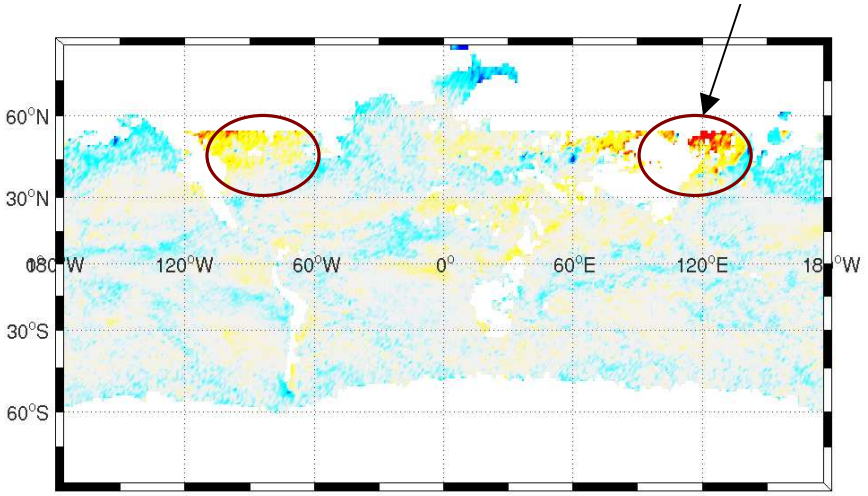
Snow (effect of specular approximation ? Or need for a frequency dependency over snow ?, Harlow, 2009, Guedj et al. 2010)





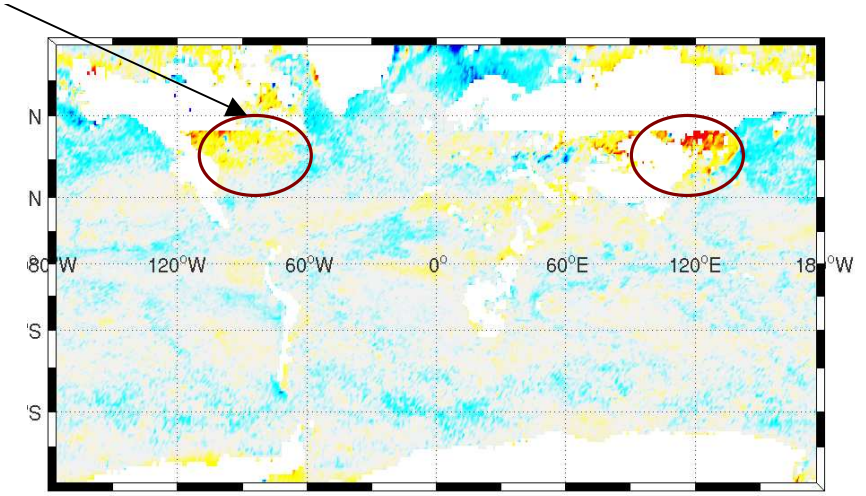
SURFACE EMISSIVITY

0.65 0.7 0.75 0.8 0.85 0.9 0.95 1



OBSERVATIONS minus SIMULATIONS

-4 -3 -2 -1 0 1 2 3 4



OBSERVATIONS minus SIMULATIONS

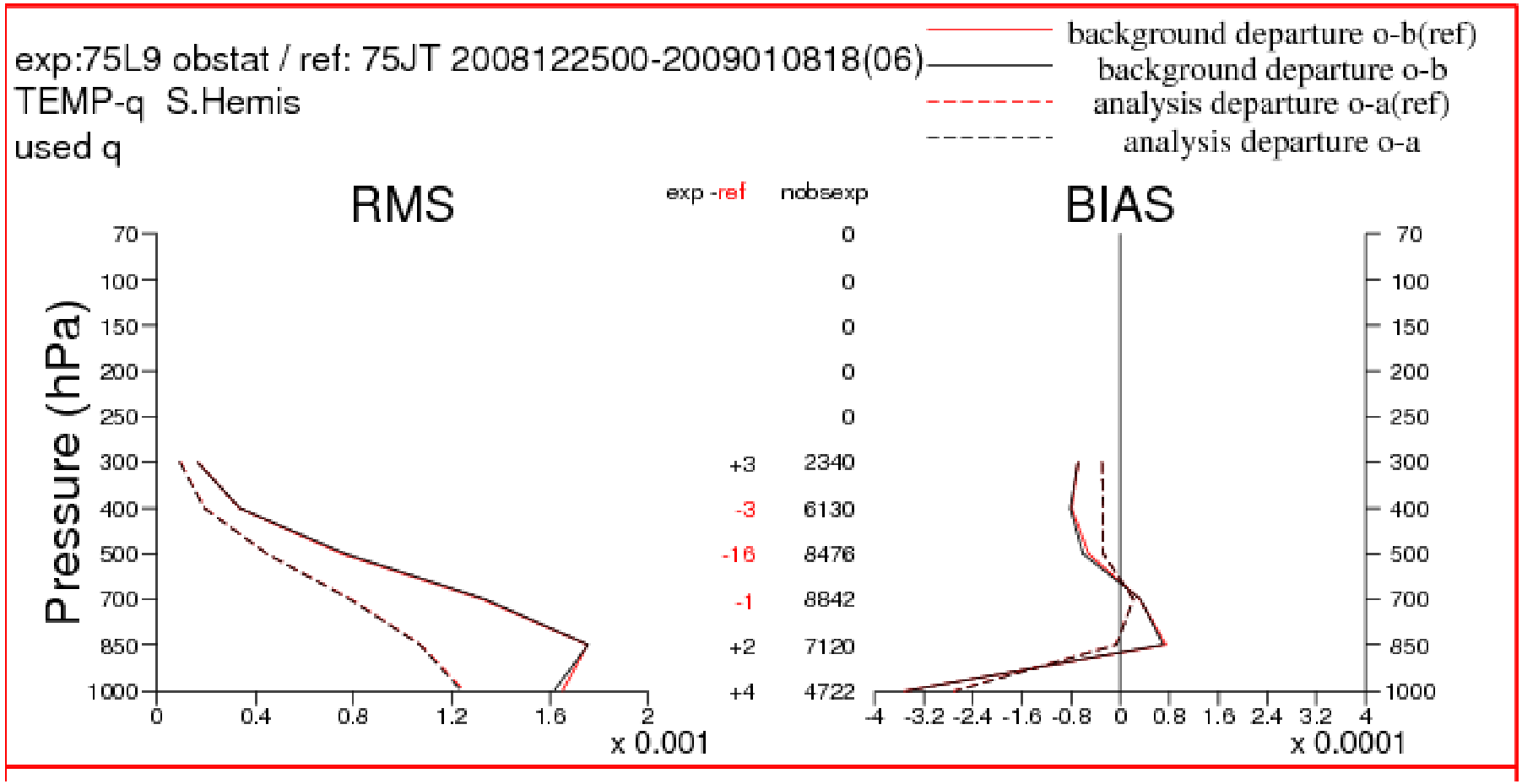
-3 -2 -1 0 1 2 3 4

(3) Data impact results

CTL --- Analyses
__ First-Guess

Fit to all observations: improvement or neutral effect

EXP --- Analyses
__First-Guess



(3) Data impact results

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__ First-Guess

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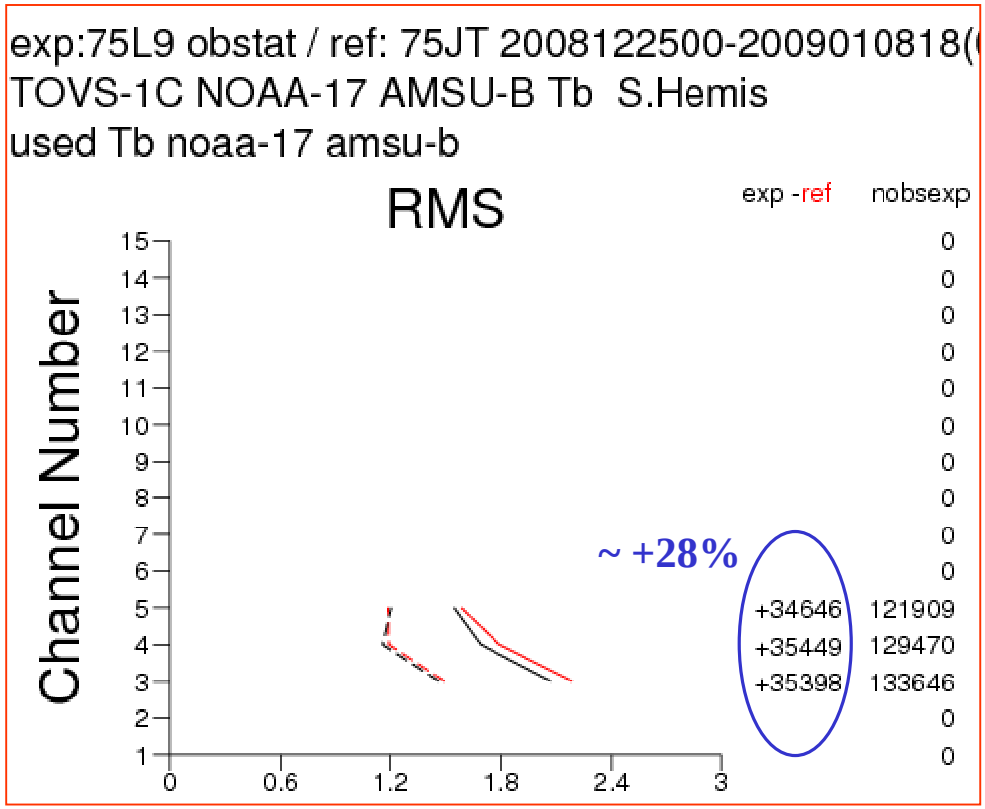
Fit to all observations: improvement or neutral effect
RMS errors of AMSU-B departures from Analyses and First-guess (NOAA-17), S. Hemisphere



(3) Data impact results

Forecast errors wrt ECMWF ANALYSES

Wind speed (m/s), 96 hr

20 samples, from 20081229 to 20090117

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__ RMSE

EXP --- BIAS
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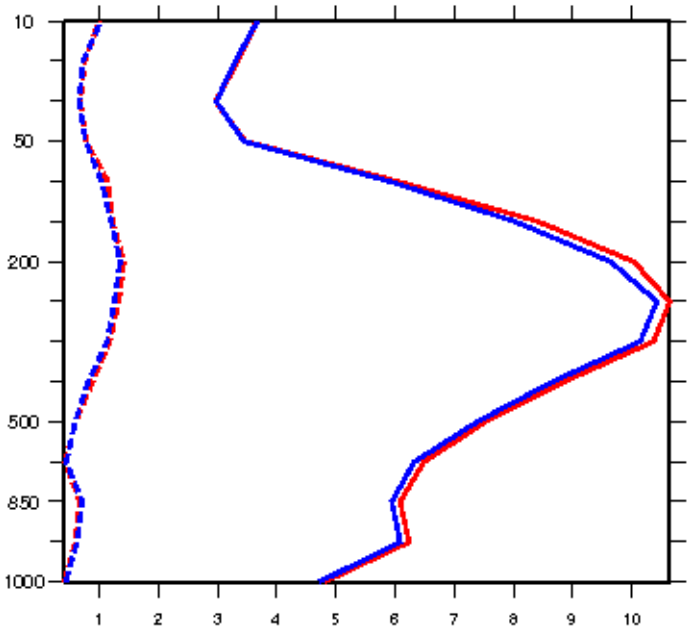
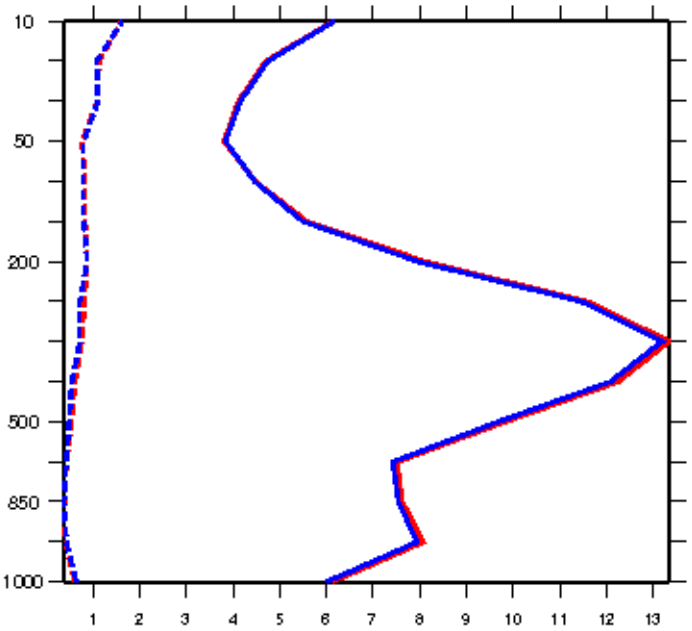
AUS-NZ



EURATL



(3) Data impact results

Forecast errors wrt Radiosondes

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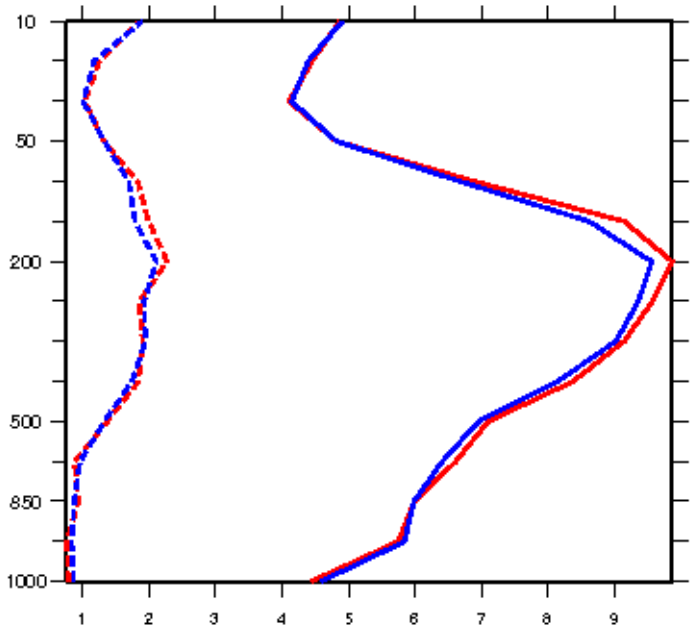
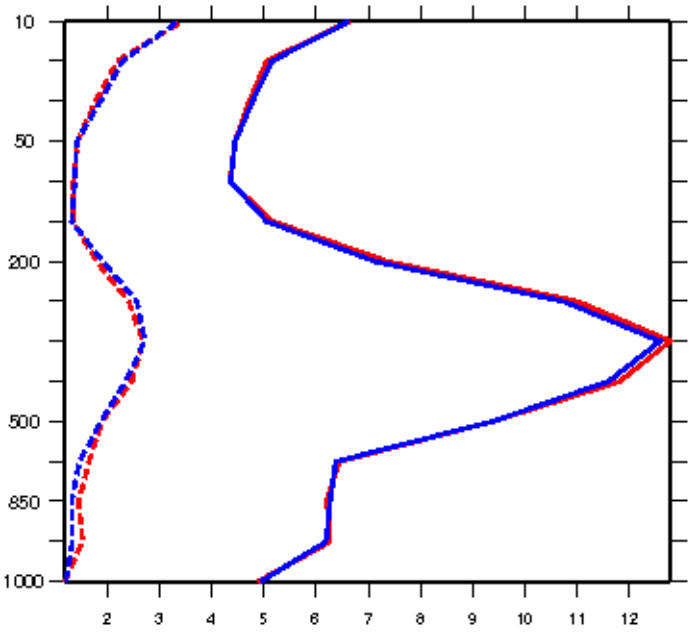


EUROPE



Summary

Objective: extend the use of AMSU observations over sea ice

Method to calculate the sea ice emissivity to be used to assimilate humidity and temperature observations

Beneficial for ARPEGE: data usage, RTTOV performances, Fit to all available observations, quality of analyses/forecasts

Data impact study on a contrasted season (for instance July 2009)

Issues: the use of AMSU data over snow surfaces