Towards the use of SSM/I observations over land in the French global and limited-area models

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Advancement @ Météo-France
What about SSM/I over land ?

- Is it possible to assimilate SSM/I data over land ?
- How to account for land in the bias correction ?
- Research in the global model (ARPEGE)
  - On-going experiments during AMMA (Jul-Aug-Sep 2006) to test the dynamic retrieval of emissivities (Karbou et al., 2006)

1st part of the presentation

- Surface emissivity is an issue, but skin temperature too !
- Research in the limited area model (ALADIN)
  - Estimation of T_{skin} for each channel (Karbou et al., 2006)
  - Validation with synoptic and radiosonde station T_{2m} data

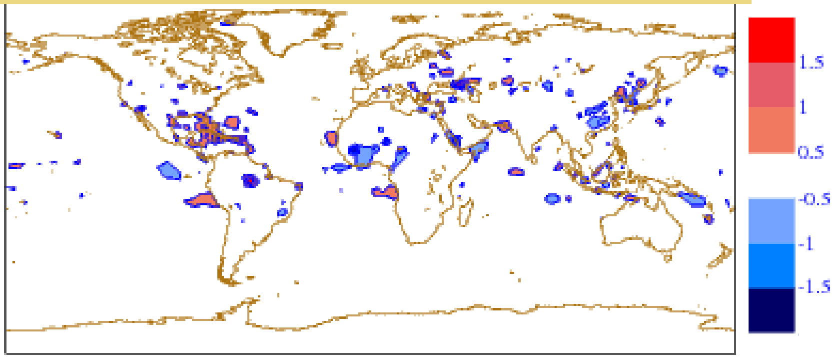
2nd part of the presentation

Assimilation of SSM/I data over land in the global model ARPEGE

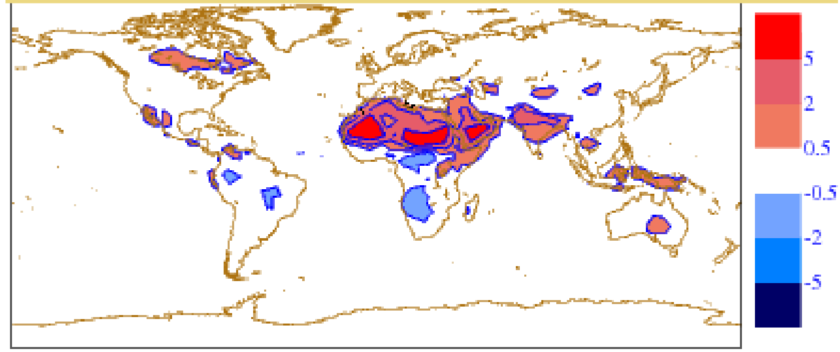
- Control CTR: SSM/I over sea only (oper Sep'06)
- Experiment EXP: CTR + SSM/I over land
  - Quality control
    - no coastal point, no land point with | lat | > 60°
  - Dynamic estimation of surface emissivity
    - 19V/19H emissivities assigned (with a frequency parameterization) to other channels of same polarization
    - 19V/19H discarded from assimilation
  - Variational bias correction (VarBC)
    - "eTs" instead of "Ts" as one of the predictors
    - Emissivity taken from dynamic method @19V
- Run period: 15 Jul – 14 Sep 2006

Water vapour (TCWV & specific humidity profile) Average over the period 15 Jul-13 Sep'06

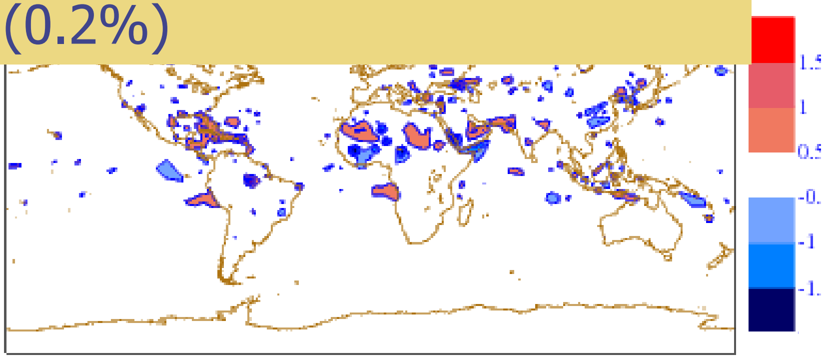
Control TCWV increments
Mean= 0.027 $kg.m^{-2}$ (0.1%)



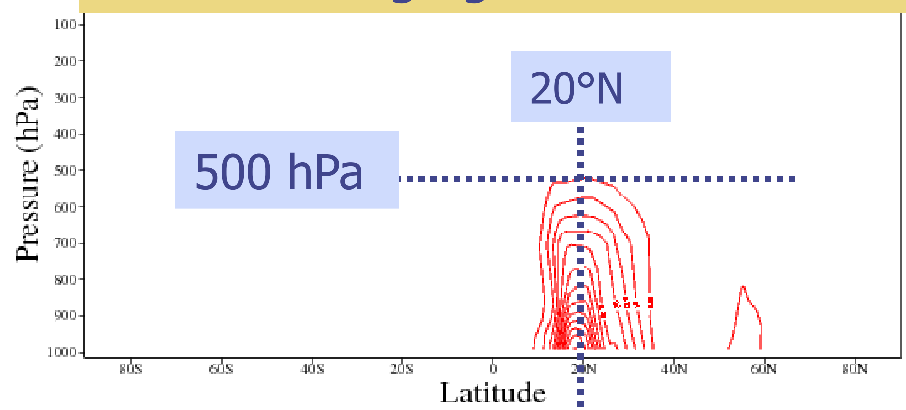
Exp-Ctr TCWV analysis difference
Mean= 0.165 $kg.m^{-2}$ (0.6%)



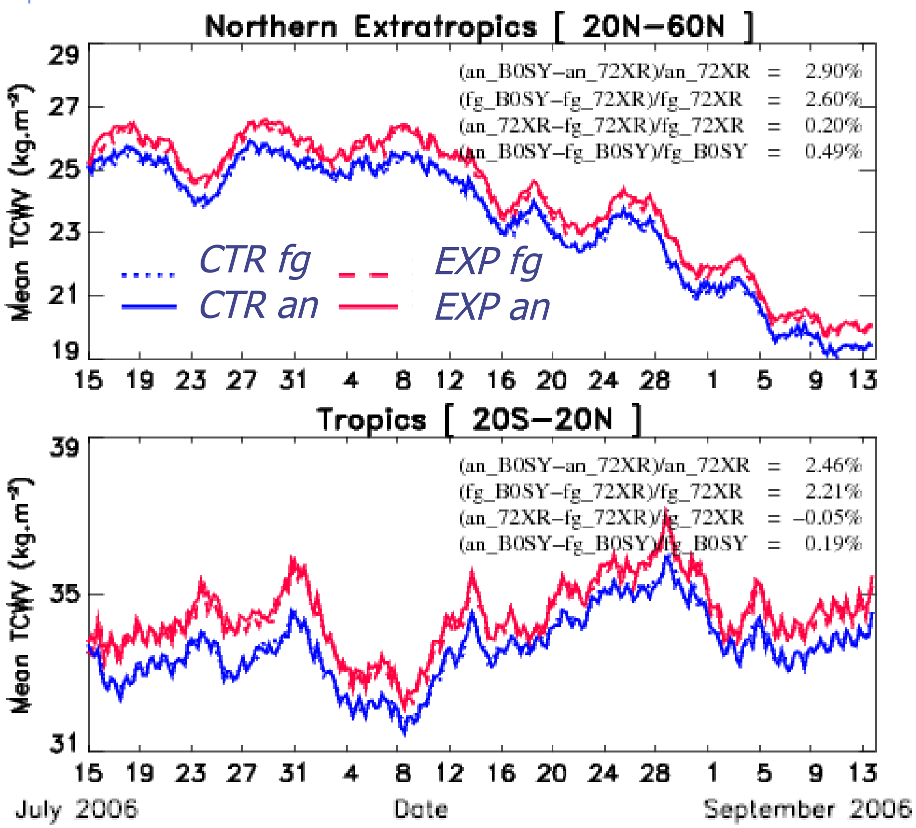
Experiment TCWV increments
Mean= 0.041 $kg.m^{-2}$ (0.2%)

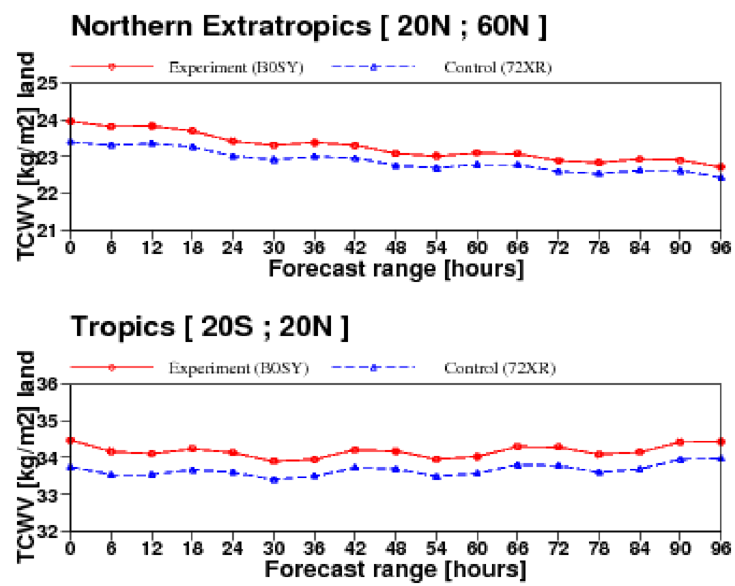


Exp-Ctr q analysis difference
iso = 0.05 $g.kg^{-1}$



TCWV evolution over land





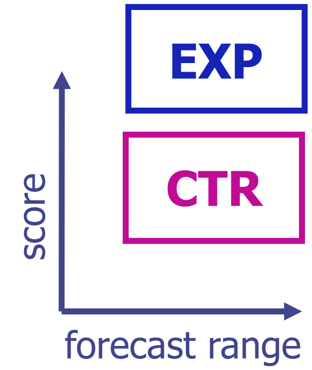
Time series (first guess, analysis)

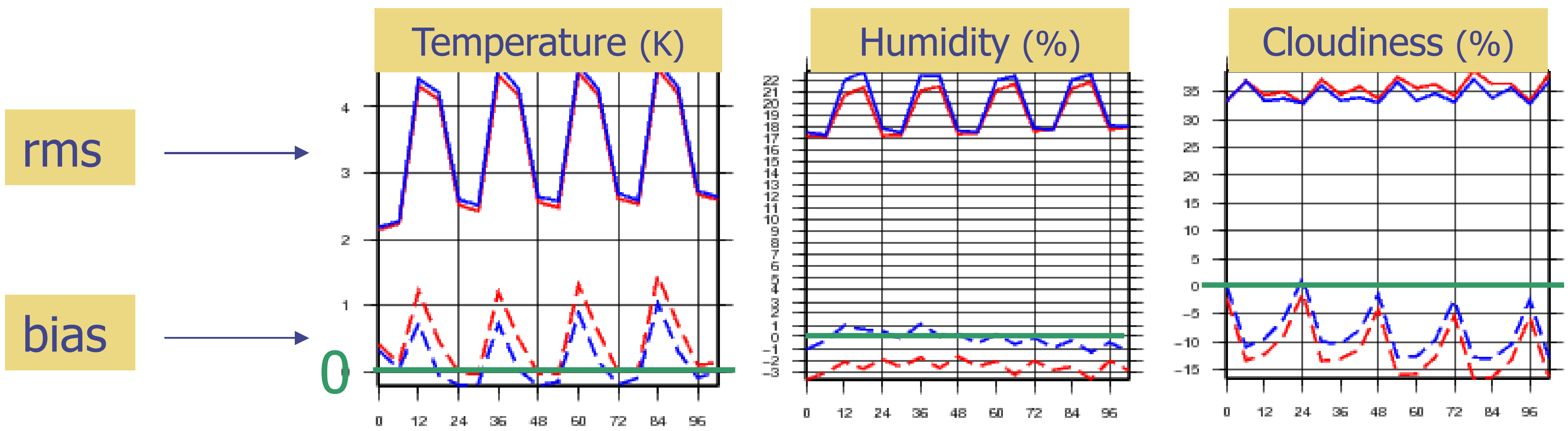
Forecast range (forecast)

Forecast scores wrt synop data

forecast-observation

North of Africa (lat > 0°)

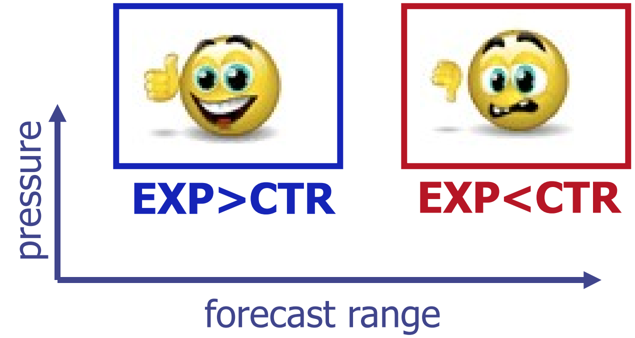




Forecast scores wrt radiosondes

Geopotential (forecast-observation)

Difference between EXP and CTR

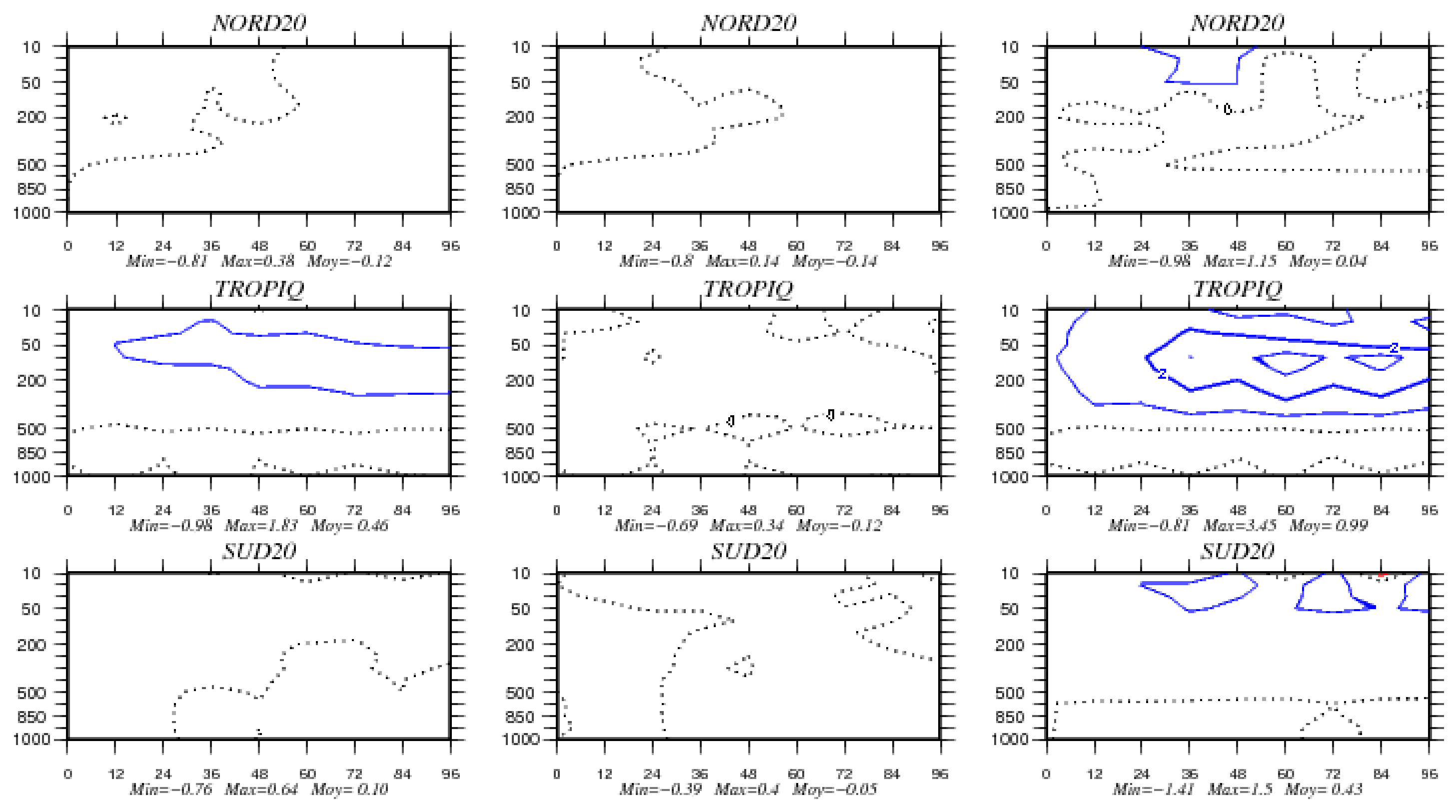


rms | std dev | bias

Northern Extratropics

Tropics

Southern Extratropics



Estimation in ALADIN of T_{skin} retrieved from SSM/I over land

For a plane parallel non scattering atmosphere and a specular surface

$$T_{skin} = \frac{Tb - (T_{\downarrow} \times (1 - \varepsilon_{atlas}) \times \Gamma) - T_{\uparrow}}{\varepsilon_{atlas} \times \Gamma}$$

T_{skin} retrieved from

- RT model + meteorological fields
- Observation
- Atlas

… with their own errors …

Experimental framework

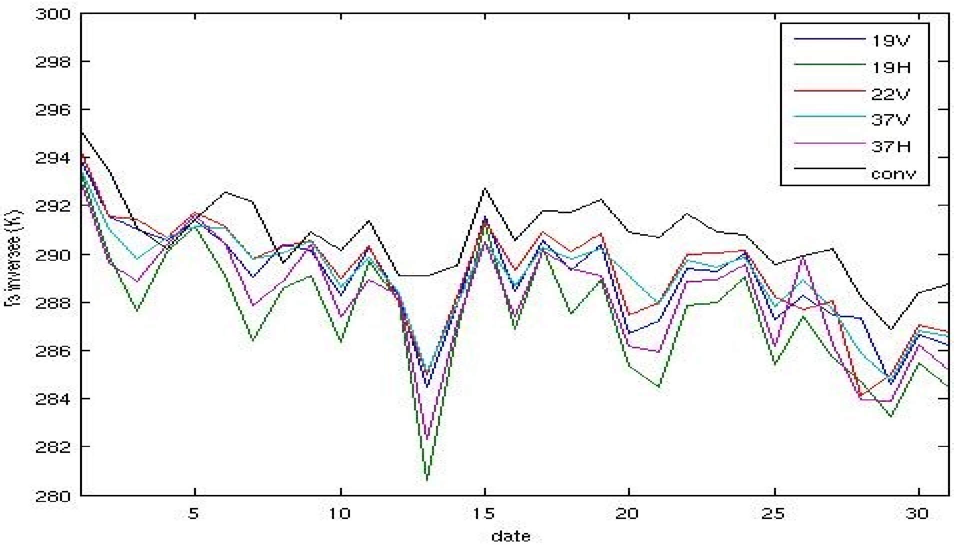
- Emissivity atlas obtained over a 2-month period (Jun-Jul 2006)
- Screening over a 1½-month period (1 Aug-15 Sep 2006)
- T_{skin} estimated for each channel
- Comparison to "interpolated" T_{2m} (conventional data averaged within a radius of 0.5° around the satellite observation)

Statistics T_{skin} versus T_{2m}

Instrument-Channel	Bias $T_{skin}-T_{2m}$	Std $T_{skin}-T_{2m}$	Correlation (T_{skin},T_{2m})
SSMI-1 (19V)	-2.05	10.2	0.72
SSMI-2 (19H)	-3.6	17.7	0.61
SSMI-3 (22V)	-1.66	8.3	0.75
SSMI-4 (37V)	-1.89	8.4	0.72
SSMI-5 (37H)	-2.92	15.2	0.63
SSMI-6 (85V)	-0.97	9.5	0.68
SSMI-7 (85H)	-1.52	12.5	0.63

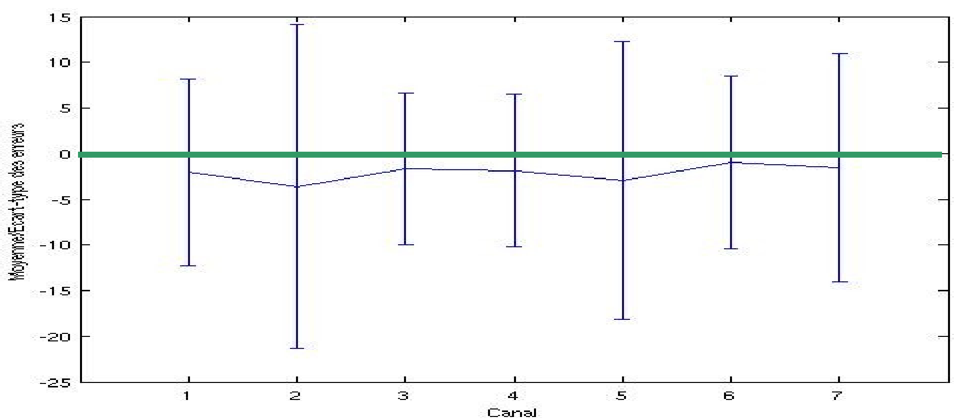
cold bias, V better than H, best performance with 22V & 37V

Time series of T_{skin} & T_{2m}

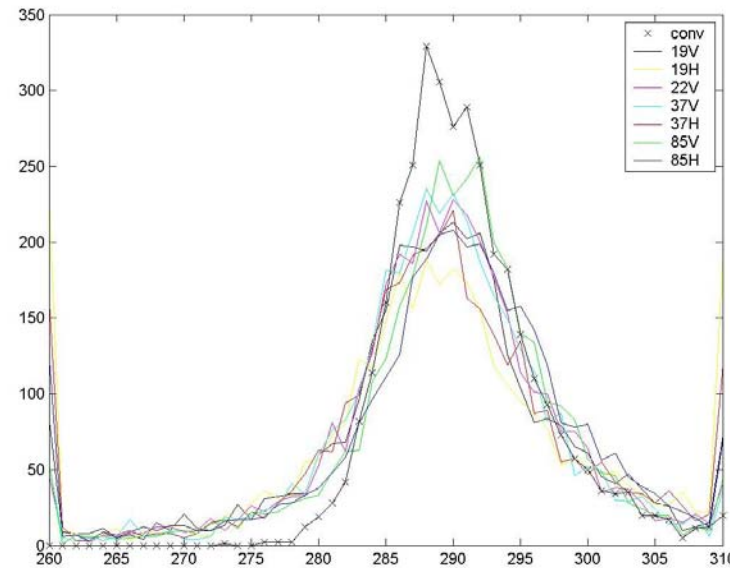


On average over Aug'06

Mean and std of T_{skin}-T_{2m}



Histograms of T_{skin} & T_{2m}



V better than H, best agreement with channels 3 & 4 (22V & 37V)

Conclusion

- With a dynamic retrieval of emissivity over land, useful information can be retrieved from SSM/I over land
- Using SSM/I channels over land with a predictor adapted to land surface in the variational bias correction has a positive impact on the analysis performance and the forecast scores
- When compared to conventional T_{2m} temperatures, the performance of the T_{skin} retrieval is better with V than with H and the best agreement is found with channels 22V & 37V

Future work and issues

- Assimilation of SSM/I over land
  - Validation of TCWV field with AMMA GPS data & with MERIS data
  - Evaluation of the impact on the African Monsoon hydrological cycle
  - Intercomparison of the impact of SSM/I and AMSUB over land
- T_{skin} retrieval
  - T_{skin} vs $T_{2m:}$ which depth is sounded ? Dependence on frequency
  - T_{skin} vs SEVIRI retrieved $T_{s:}$ microwave versus infrared
  - T_{skin} vs $T_{s\ first\ guess}$
  - Choice of the channel for T_{skin} retrieval (discarded from assimilation)
  - How to assign T_{skin} to other channels ?
- How to improve the assimilation over land ?
  - Improve the use of emissivity (in the control variable ?)
  - Combination of dynamic retrieval of emissivity & T_{skin} ?

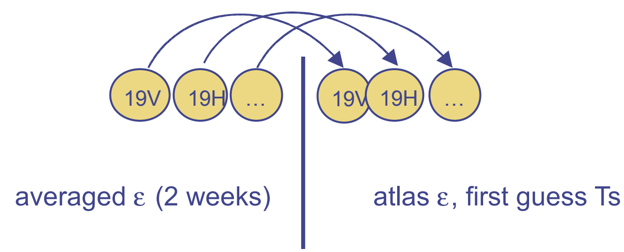
SPARE SLIDES

Context
Assimilation of microwave data over land

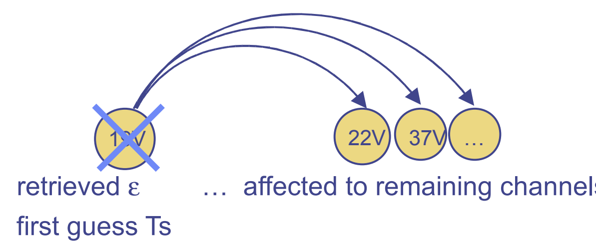
Three land surface parameterizations with increasing complexity (Karbou et al. 2006)

Adapted to SSM/I

– ***Averaged emissivity (atlas)***
  - Averaged ε (2 weeks)
  - ε estimates for SSM/I channels
  - Ts from first guess

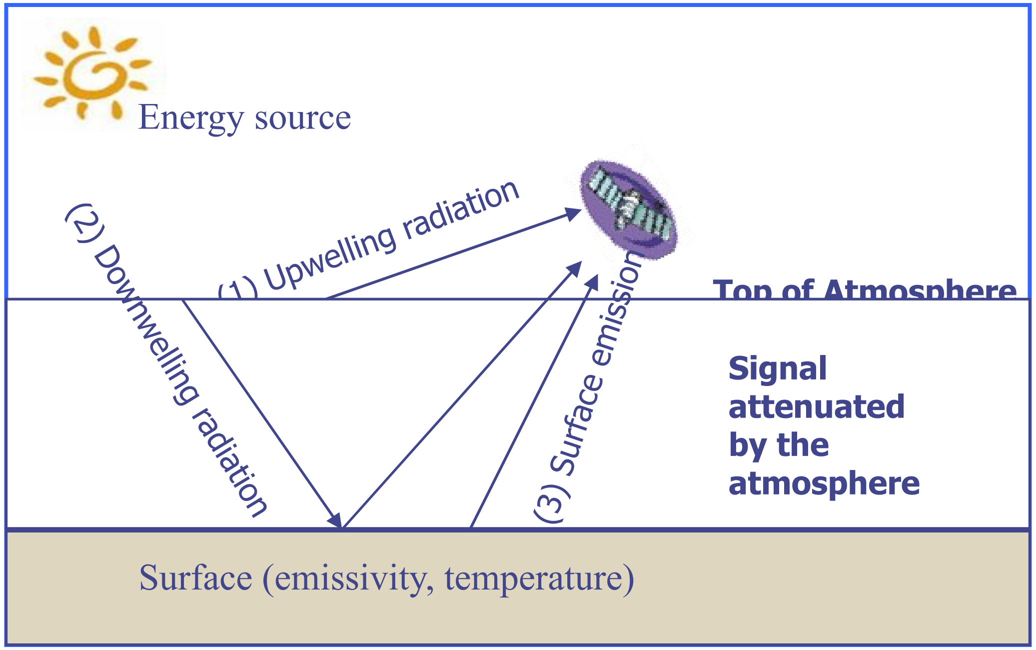


– ***Dynamically estimated emissivities***
  - ε estimated at SSM/I 19 V&H channels
  - ε calculated at 19 GHz (V or H) affected to SSM/I channels
  - Ts from first guess



– ***Emissivity from atlas and dynamically estimated skin temperature***
  - ε given by an atlas
  - Ts estimated at SSM/I 19 V&H channels
  - Calculated Ts as a guess for other channels

Estimation in ALADIN of T_{skin} retrieved from SSM/I over land



For a plane parallel non scattering atmosphere and a specular surface:

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Experimental framework

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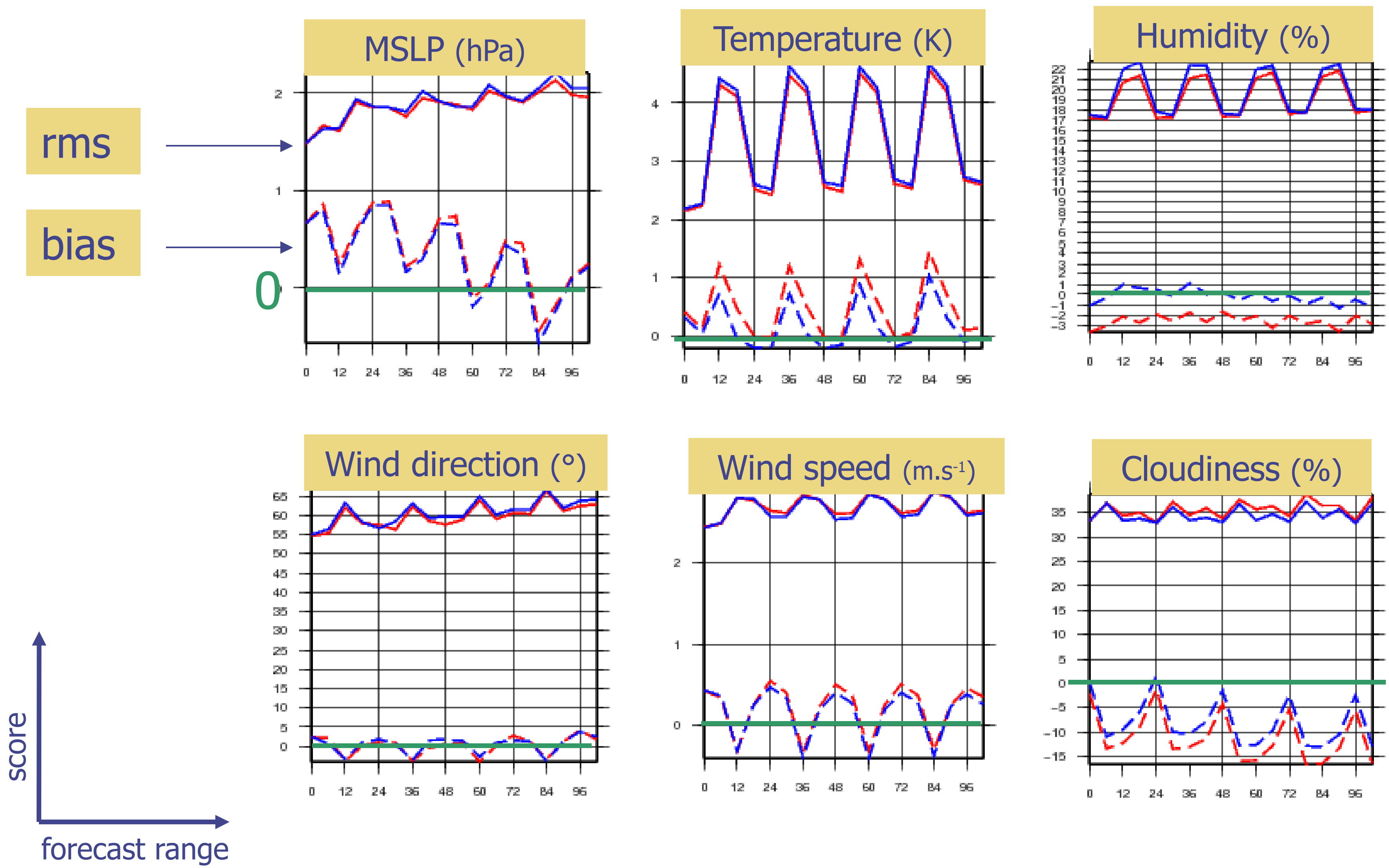
Tskin retrieved from RT model, observation and atlas

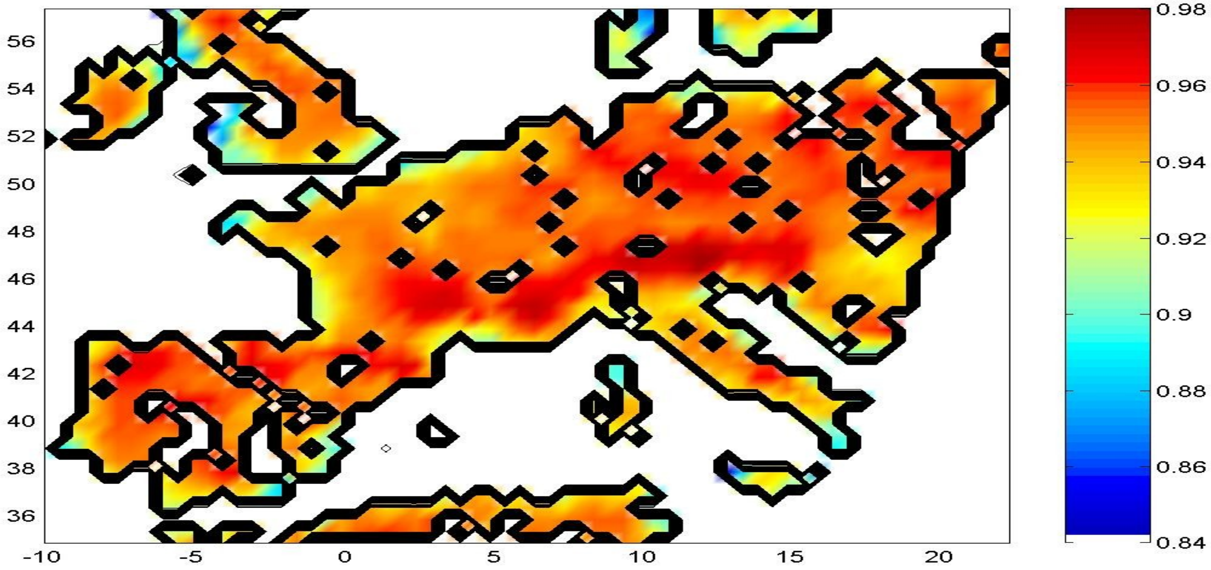
Forecast scores wrt synop data
forecast-observation

EXP

CTR

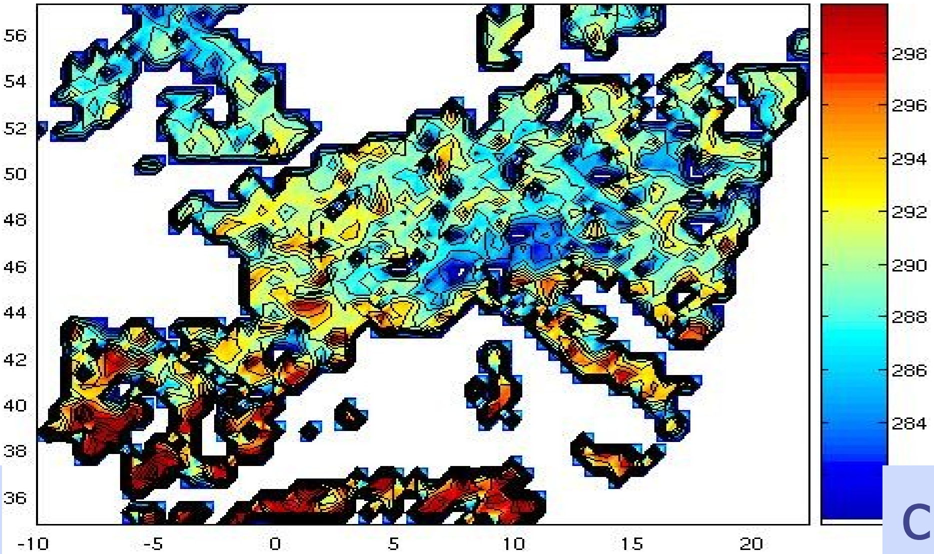


Emissivity atlas over the ALADIN France domain



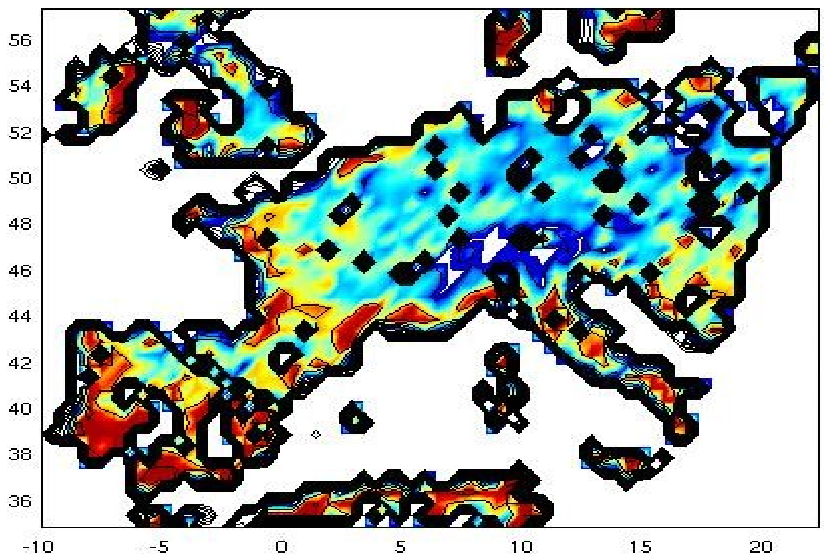
SSM/I channel 4 (37V) land surface emissivity on average over a 2-month period (Jun-Jul 2006)

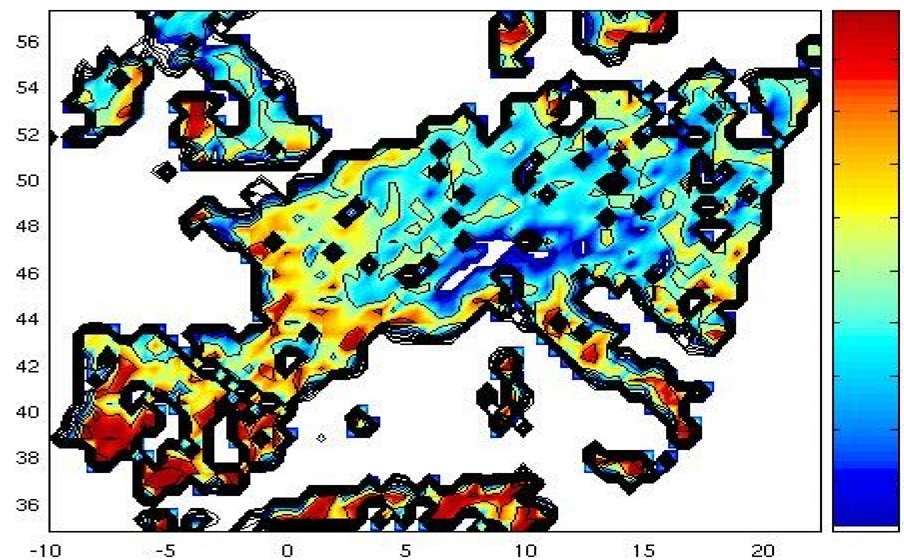
T_{2m}



channel 2 T_{skin}

channel 3 T_{skin}





worse performance, stronger cold bias (East of France, Alps)

best performance