Impact studies towards the use of SSM/I observations over land in the French global model

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OBJECTIVE	Check the ability of the French global 4D-Var system to assimilate SSM/I observations over land
MEANS	Sensitivity studies and experimental assimilation of SSM/I over land to the best of our knowledge
BASELINE	Dynamic retrieval of land emissivity adapted to SSM/I observations (first developed to assimilate AMSU-A and AMSU-B/MHS surface sensitive channels over land, Karbou *et al.*, 2006)

SENSITIVITY STUDIES to elaborate constructive alternatives

❶ LAND SURFACE EMISSIVITY ASSIGNMENT

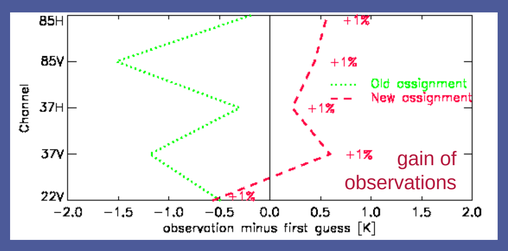
Dynamically retrieved emissivity from 19 GHz is assigned with an adaptation to channels of same polarization

Channel	19V	19H	22V	37V	37H	85V	85H
Old assignment	19V	19H	19V	19V	19H	19V	19H
New assignment	19V	19H	19V +0.005	19V -0.012	19H -0.001	19V -0.021	19H -0.006
(New-Old)/Old	0	0	+0.5%	-1.2%	-0.1%	-2.2%	-0.6%

19 GHz channels discarded from any further use

Bias (obs-guess) 15-25 Jul 2006

LAND



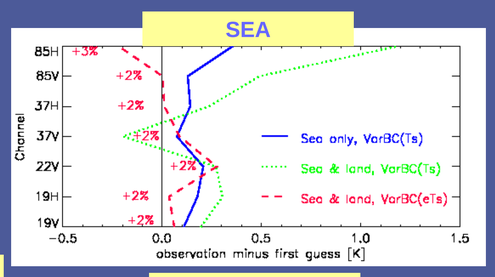
➥ Biases lower than 0.5 K instead of 1.5 K in absolute value with new emissivity assignment

❷ BIAS CORRECTION PREDICTOR CHANGE

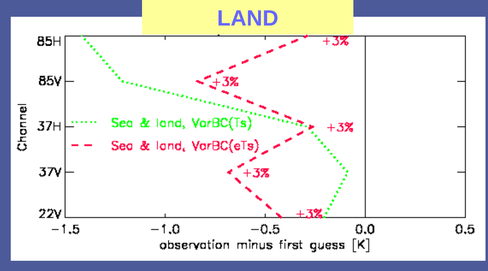
"e(V,19) T_s" is used instead of "Ts" as a predictor for bias correcting SSM/I data through VarBC (Auligné *et al*., 2007)

Bias (obs-guess) 25 Jul – 25 Aug 2006

SEA



LAND



➥ Over sea: biases within [-0.5 K ; 0.5 K] with or without land points guaranteed if "eTs" is used as a predictor

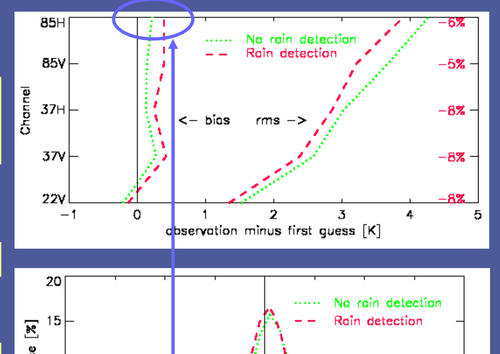
➥ Over land: smaller biases when "eTs" is used as a predictor

❸ QUALITY CONTROL THROUGH RAIN DETECTION

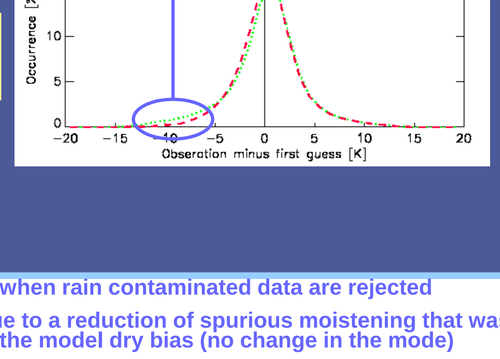
Rain contaminated SSM/I data are rejected through a regression based on SSM/I data at 37V and 85V (Conner and Petty, 1998)

Bias & RMS (obs-guess) 15 Jul – 14 Sep 2006

LAND



85V density function (obs-guess) 15 Jul – 14 Sep 2006



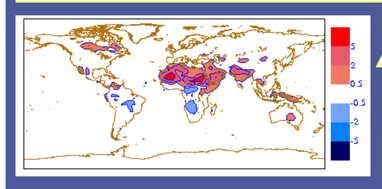
➥ Reduction of RMS when rain contaminated data are rejected

➥ Increase of bias due to a reduction of spurious moistening that was partly compensating the model dry bias (no change in the mode)

IMPACT OF ASSIMILATING SSM/I RADIANCES OVER LAND with the synergy of ❶ ❷ ❸ components (15 July – 14 Sep 2006)

IMPACT ON HYDROLOGICAL CYCLE

TCWV (Total Column Water Vapour) analysis difference EXP – CTR

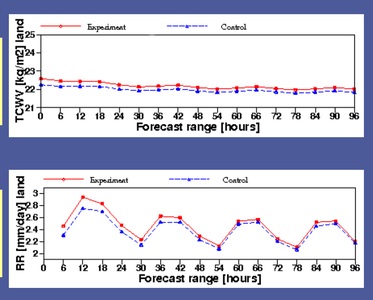


More humidity in EXP

TCWV as a function of forecast range

LAND

Precipitation rate as a function of forecast range



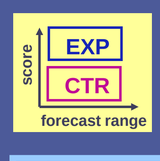
➥ Global moistening of the model in EXP, massively over North Africa, below 500 hPa

➥ Persistence of this signal in EXP throughout the forecast range up to at least 4 days

➥ Precipitation spin-down, already present in CTR, is reinforced in EXP under the effect of additional moisture, resulting from an imbalance between the assimilation and the forecast systems

FORECAST PERFORMANCE

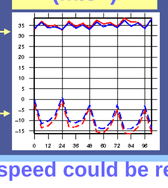
Forecast scores wrt synop data
forecast-observation, North Africa (latitude > 0°)



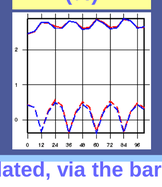
RMS

bias

Wind speed ($m.s^{-1}$)

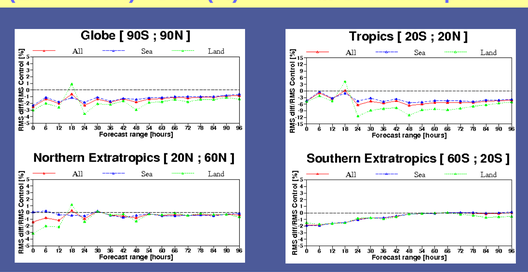


Cloudiness (%)



200 hPa geopotential RMS error wrt ECMWF analysis

(EXP – CTR) / CTR (%) **All** Sea Land points



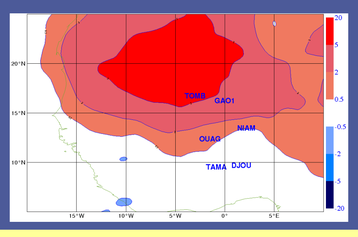
➥ Improvement of wind speed could be related, via the baroclinic force, to the increase of greenhouse effect

➥ Positive effect on cloudiness over Africa (latitude > 30°N), in a region where model suffers from a lack of clouds

➥ Reduction of the forecast error in all areas particularly over land but also, to a lesser extent over sea

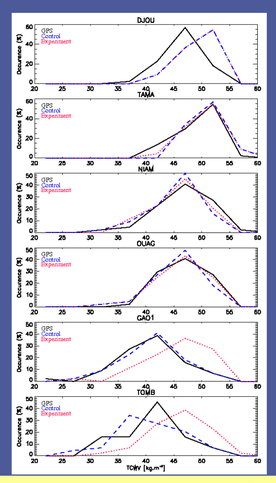
➥ Largest improvements in geopotential are to be found at night time (decrease of convection over Africa)

MODEL FIT TO GPS OBSERVATIONS



Towards larger moistening

TCWV analysis difference EXP – CTR
+ GPS stations over the AMMA region
(African Monsoon Multidisciplinary Analysis, see Bock *et al*., 2008 for the GPS network, Redelsperger *et al*., 2006 for an overview of the AMMA project)



➥ Similar behaviour

➥ EXP better than CTR

➥ EXP too moist

TCWV distribution (bin size of 5 $kg.m^{-2}$) GPS CTR EXP

CASE STUDY 16 August 2006 at 12 UTC

Global overreaction of convection over North Africa when SSM/I observations are used over land

➥ BUT locally convection often happens to be much better represented in EXP (intensity, occurrence)

CTR obviously misses a large portion of deep convection

➥ convection cells occur in EXP over Guinea and Burkina Faso

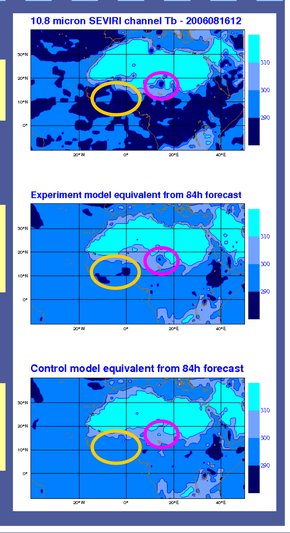
➥ convection cells occur in EXP over Chad

Cells maintained in EXP throughout the day in good agreement with SEVIRI observations

MSG SEVIRI 10.8 μm Tb

EXP 84-hour forecast 10.8 μm Tb

CTR 84-hour forecast 10.8 μm Tb



KEY MESSAGES (more results to be found in Gérard *et al*., 2010)

FEASIBILITY	Extraction of useful information from observations very sensitive to the surface such as SSM/I data
DIFFICULTY	Opposed effects once together can lead to some residual biases (combined effects)
INVESTIGATION	Some further sensitivity studies on land surface description, rain detection, bias correction
FUTURE	Effort ought now to be focused on SSMI/S and future microwave sounders

CTR: Control (no SSM/I over land)

EXP: Experiment (with SSM/I data assimilated over land)

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Redelsperger, J-L., Thorncroft, C. D., Diedhiou, A., Lebel, T. , Parker, D. J. and Polcher, J., 2006: African Monsoon Multidisciplinary Analysis: An International Research Project and Field Campaign *Bull. Am. Met. Soc.*, 87, 1739-1746