ECMWF update on assimilation of SMOS data

- Global, bias sensitivity to CMEM,
- Bias correction → CDF matching,
- DA impact experiments,
- SMOS-SM-v1.0

ECMWF

Bias correction

SMOS reproc TB archive (ECFS)

Convert to grib
Superobing
Reduced Gaussian grid
Resolution T255-T511

QC:
Water Fraction < 5%
Altitude <1500m,
Slope<4%
Radio. Accuracy < 4K

Output
TBxx, TByy
Angles: 10, 20, 30, 40, 50

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CMEM Offline
Reduced Gaussian grid
Resolution T255, interpol T511

Input:
ECMWF operational SM, ST, Tair

QC:
No snow
T2m > 273K
Faraday Rotation

Output:
TBxx, TByy, Teff
Angles: 10, 20, 30, 40, 50

CDF matching coefficients (a,b)
For TBxx, TByy (30°, 40°, 50°)

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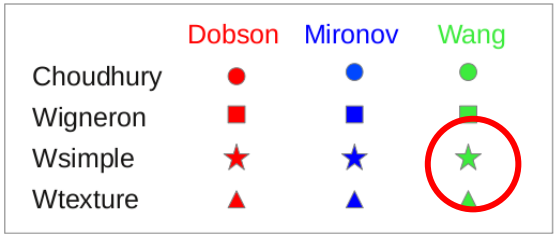
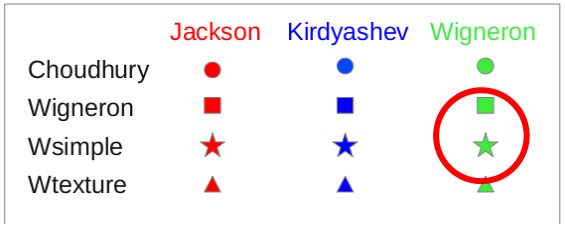
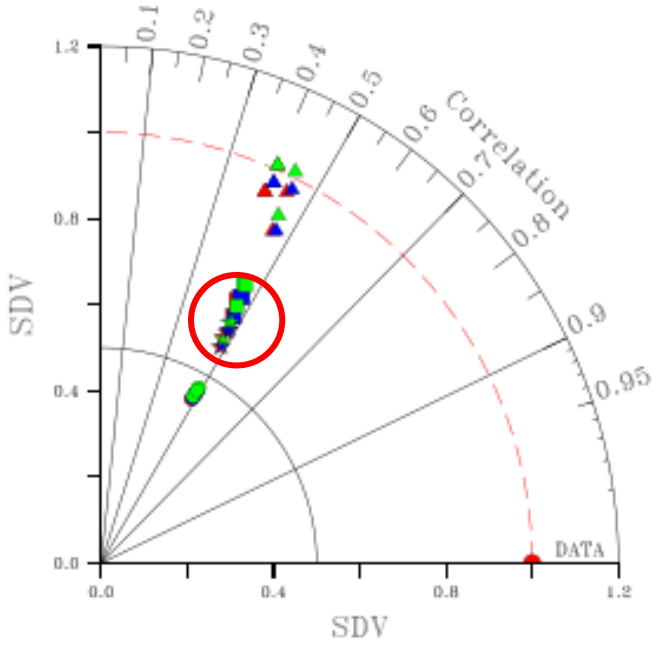
Bias sensitivity to CMEM

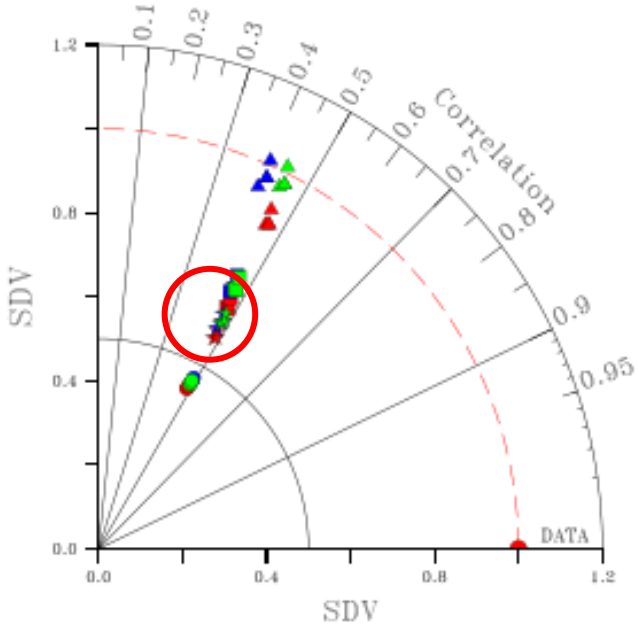
36 CMEM configurations:
- 3 dielectric models (Wang, Dobson, Mironov)
- 3 vegetation models (Jackson, Wigneron, Kirdyashev)
- 4 Roughness models (Wigneron 2001, Wigneron 2007, Choudhury)
- 36 CMEM * 2 pol * 1 year * 4 times per day, compared to SMOS

Metrics: RMSE, R, Bias, SDV, uRMSE → Taylor diagrams









Wtexture good for SDV, but not for R

Best correlation and uRMSE with Wang, Wigneron, Wsimple

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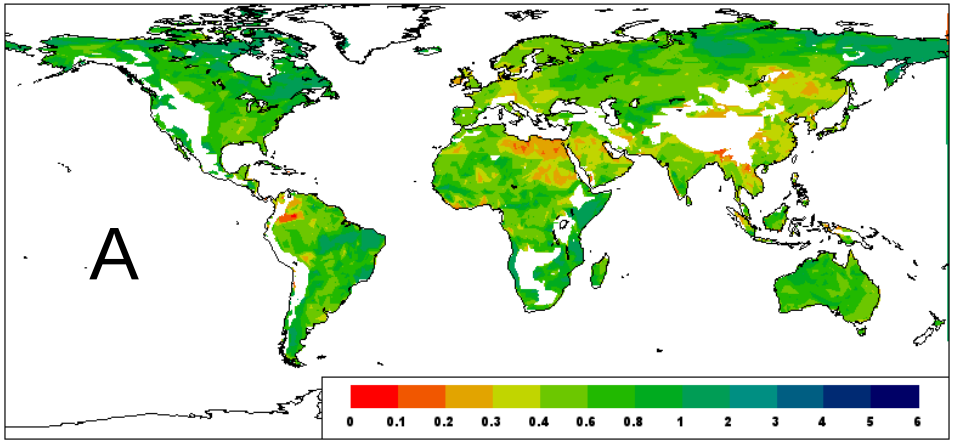
Bias correction

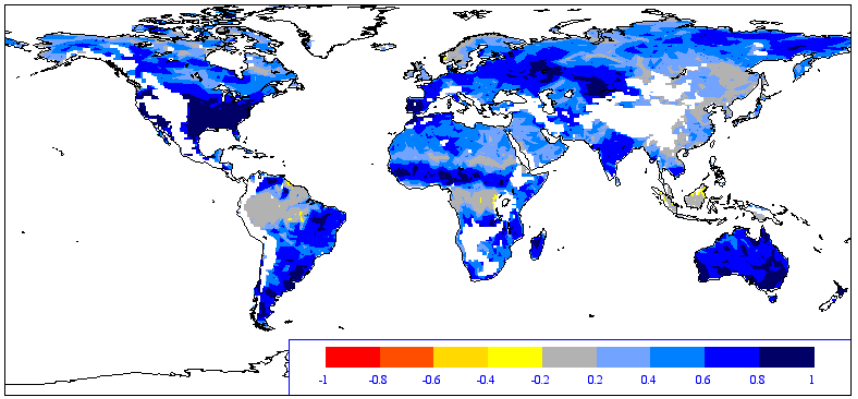
Corrected $\underline{T_B} = A^* \underline{T_B^{SMOS}} + B$

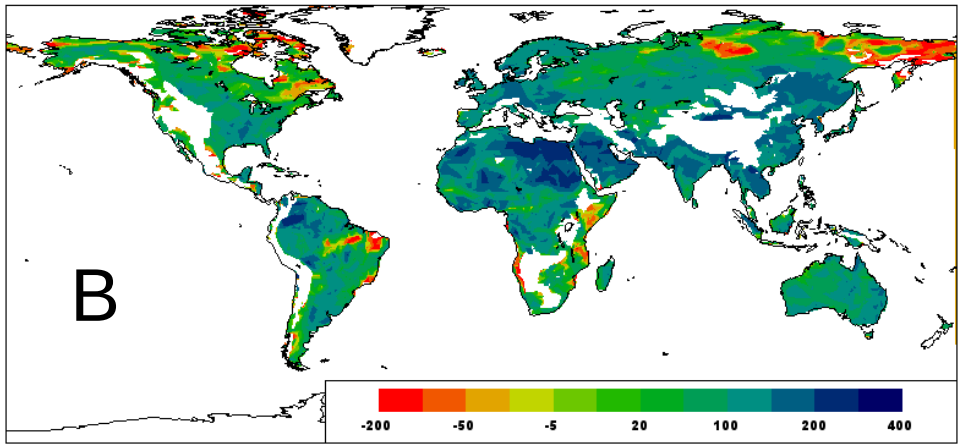
with A = std_cmem/std_smos

B = cmem – smos (std_cmem/std_smos)

R [SMOS vs. CMEM]







Std_cmem < std_smos → A<1

→ B positive values

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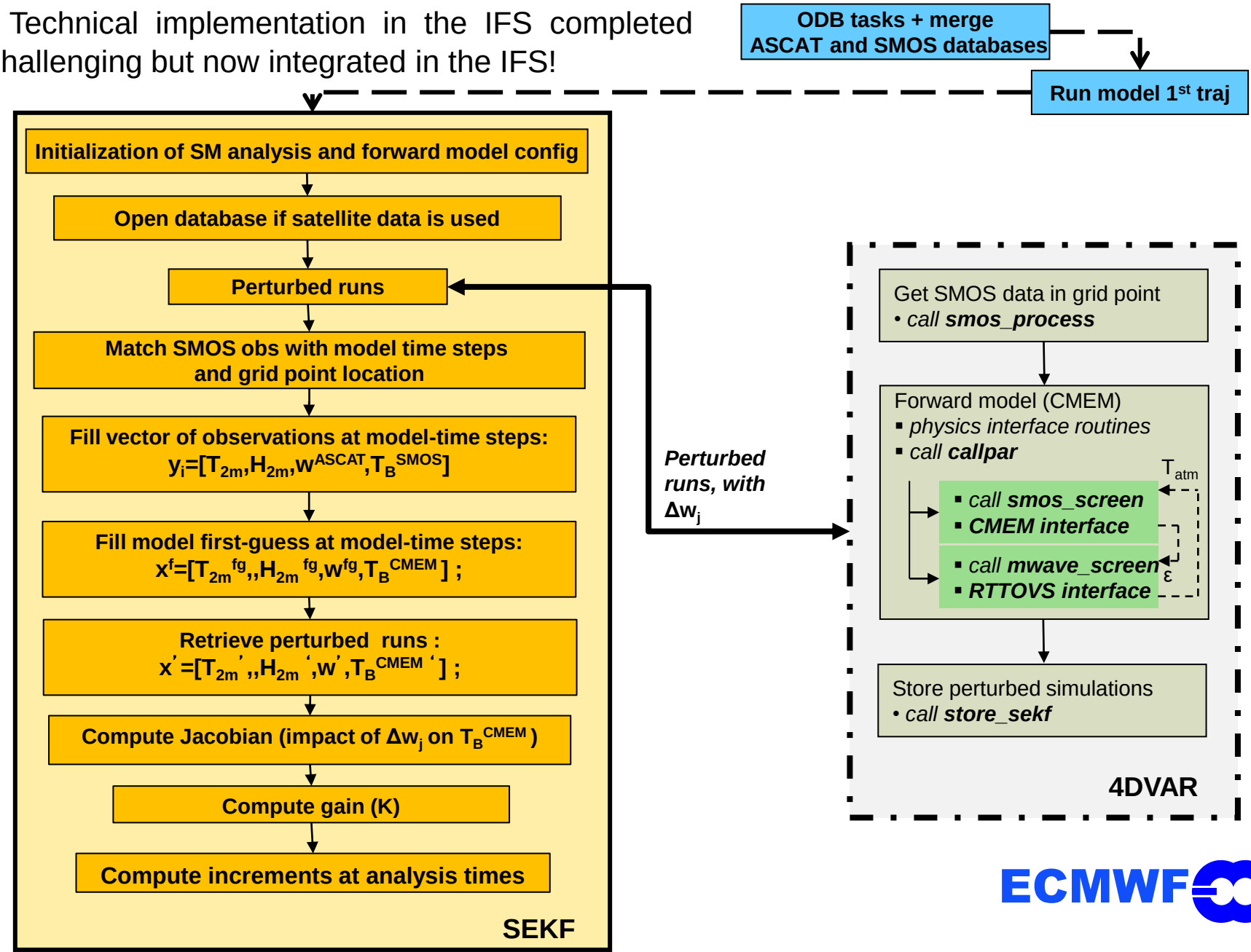
Assimilation - Overview progress

➢ Technical implementation in the IFS completed
Challenging but now integrated in the IFS!



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Experimentation in CY37R3 & CY38R1

EXPT	PERIOD	DATA	REGION	BC	OBJECTIVE
foeu	4-10 Apr 2011	T^{2m},RH^{2m} (SYNP)	N.Amer	-	Technical
foeq	4-10 Apr 2011	SYNP, T_B(40XX,40YY)	N.Amer	$T_B(bc)=T_B+avg(bias)$	Technical
foew	4-10 Apr 2011	SYNP	Australia	-	Technical
foev	4-10 Apr 2011	SYNP, T_B(40XX,40YY)	Australia	$T_B(bc)=T_B+avg(bias)$	Technical
frjm	April 2011	SYNP	Australia	-	Technical + cal
frm1	April 2011	SYNP, T_B(40XX,40YY)	Australia	$T_B(bc)=T_B+avg(bias)$	Technical + cal
frmx	April 2011	SYNP, T_B(20XX,50XX)	Australia	$T_B(bc)=T_B+avg(bias)$	Technical + cal
fskc	July 2011	SYNP	N.&SAmer	-	DA- impact
fska	July 2011	SYNP, T_B(20XX,50XX)	N.&SAmer	$T_B(bc)=T_B+avg(bias)$	Technical + cal
fshy	July 2011	SYNP, T_B(30-40-50-XX-YY)	N.&SAmer	$T_B(bc)=T_B+avg(bias)$	Test CONV
fsth	July 2011	SYNP, T_B(30-40-50-XX-YY)	N.&SAme	$T_B(bc)=T_B+avg(bias)$	DA- impact
fstg	July 2011	SYNP, T_B(30-40-50-XX-YY)	N.&SAme	CDF-matching	DA- impact
fted	Feb 2011	SYNP	Australia	-	DA- impact
ft48	Feb 2011	SYNP, T_B(30-40-50-XX-YY)	Australia	$T_B(bc)=T_B+avg(bias)$	DA- impact
ft53	Feb 2011	SYNP, T_B(30-40-50-XX-YY)	Australia	CDF-matching	DA- impact
ftec	May10- Oct12	SYNP	Global	-	SMOS-DA-v1.0
fsx2	May10- Oct12	SYNP, T_B(30-40-50-XX-YY)	Global	CDF-matching	SMOS-DA-v1.0

DA impact studies – N. & S. America case

- Assimilation of SMOS T_B (SEKF) in the antenna reference frame
  - July 2011
  - Resolution: **T511** (~40 km)
  - Observations:
    - NRT brightness temperatures,
    - **30, 40, 50** degrees ± ΔT_B=0.5 K
    - **XX & YY** polarisations
    - Only AF-FOV
  - CMEM configuration; best for R (Wang(DIEL), Wsimple(RGH), Wigneron(VEG))
  - **Jacobians calibrated** ($\Delta\theta j$=0.01m^3m^{-3}, $/H^-_{max}/ = /H^+_{max}/$ =250 K/m^3m^{-3})
  - **STD of observations error** → radiometric accuracy
  - Degraded observational system for the atmosphere → only conventional and geostationary data sensitive to winds,

- **CTRL:** assimilation of T^{2m}, RH^{2m}
- **EXPT-1:** assimilation of T^{2m}, RH^{2m} + SMOS T_B (~BC)
- **EXPT-2:** assimilation of T^{2m}, RH^{2m} + SMOS T_B CDF

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Analysis vs SCAN network: Layer 1 (0-7 cm) vs. in-situ (~5cm)

	CTRL	SMOS + poor syst	SMOS + ~BC	SMOS + CDF
R	0.53	0.54	0.54	0.55
RMSD	0.13	0.13	0.13	0.13
Bias	-0.07	-0.07	-0.07	-0.07

p-value < 0.05 → N=76

- Little quality control applied to measurements from NRCS-SCAN !
- *Dharssi et al. (2011)*; reject if R<0.3, RMSD>0.2 m^3m^{-3} and SD>0.1 m^3m^{-3}

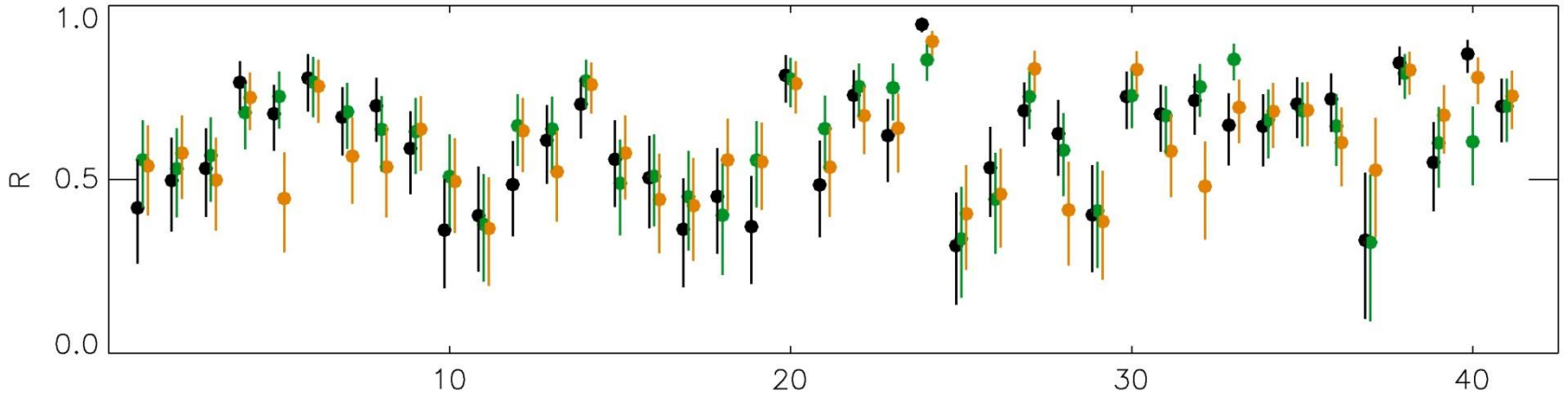
	CTRL	SMOS + poor syst	SMOS + ~BC	SMOS + CDF
R	0.59	0.59	0.59	0.60
RMSD	0.13	0.13	0.13	0.14
Bias	-0.08	-0.09	-0.09	-0.09

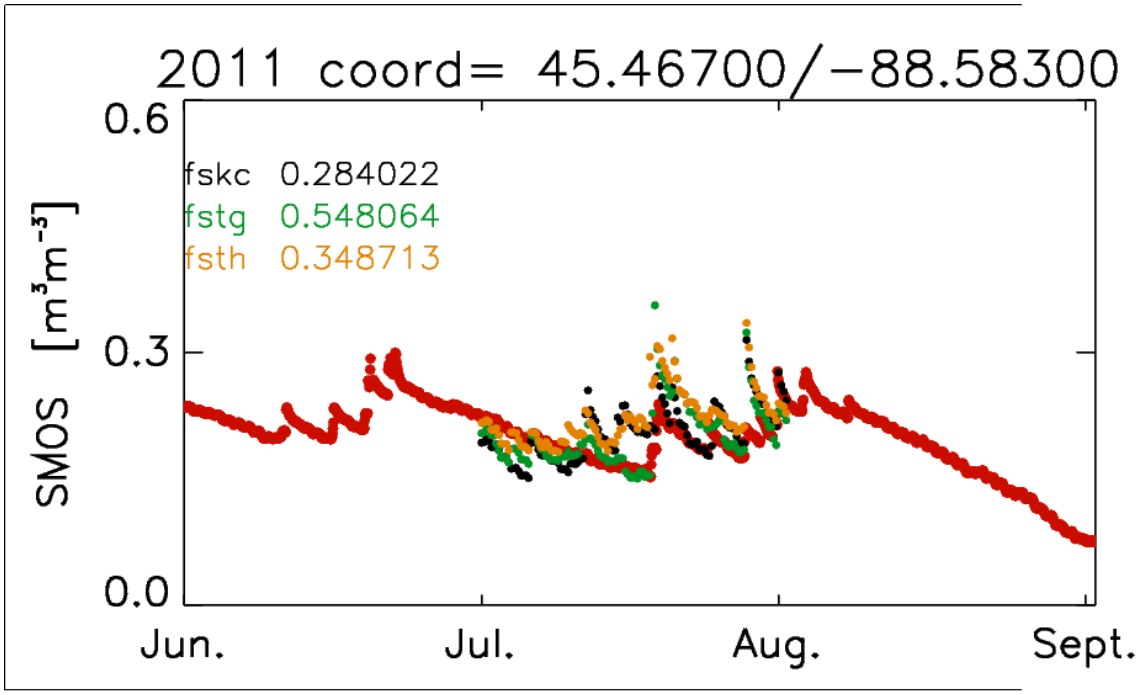
p-value < 0.05 & R>0.3 (Albergel et al., 2012)→ N=58

	CTRL	SMOS + poor syst	SMOS + ~BC	SMOS + CDF
R	0.60	0.61	0.60	0.63
RMSD	0.08	0.08	0.08	0.09
Bias	-0.03	-0.04	-0.04	-0.04

p-value < 0.05 & R>0.3 & RMSD<0.2 & SD<0.1 → N=41

SCAN network: Layer 1 (0-7 cm) vs. in-situ (~5cm)





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SMOS–SM–v1.0

- Assimilation of SMOS T_B in the antenna reference frame at **global** scale (SEKF)
  - Period: **1 May 2010** 00UTC – **31 October 2012** 12UTC analysis
  - Resolution: **T511** (~40 km)
  - Observations:
    - NRT brightness temperatures (**Second reprocessed dataset 2010-2011**),
    - **30, 40, 50** degrees ± ΔT_B=0.5 K
    - **XX & YY** polarisations
    - Only AF-FOV
    - RFI flag used (BUFR info flag, bit-1)
    - Bias corrected using a point-wise CDF matching
  - CMEM configuration; best for R (Wang(DIEL), Wsimple(RGH), Wigneron(VEG))
  - **Jacobians calibrated** ($\Delta\theta j$=0.01m^3m^{-3}, $/H^-_{max}/ = /H^+_{max}/$ =250 K/m^3m^{-3})
  - **STD of observations error** → radiometric accuracy
  - Full observational system used for the atmosphere,

- **CTRL:** assimilation of T^{2m}, RH^{2m}
- **SMOS-DA-v1.0**: assimilation of T^{2m}, RH^{2m} + SMOS T_B CDF

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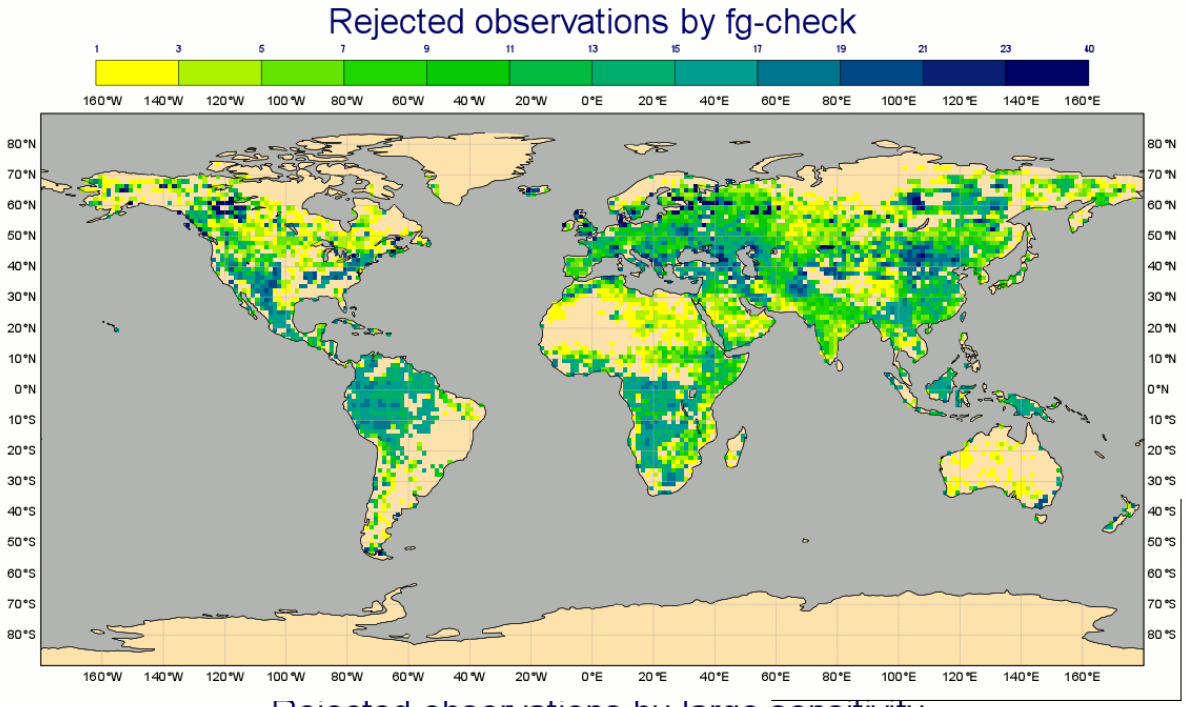
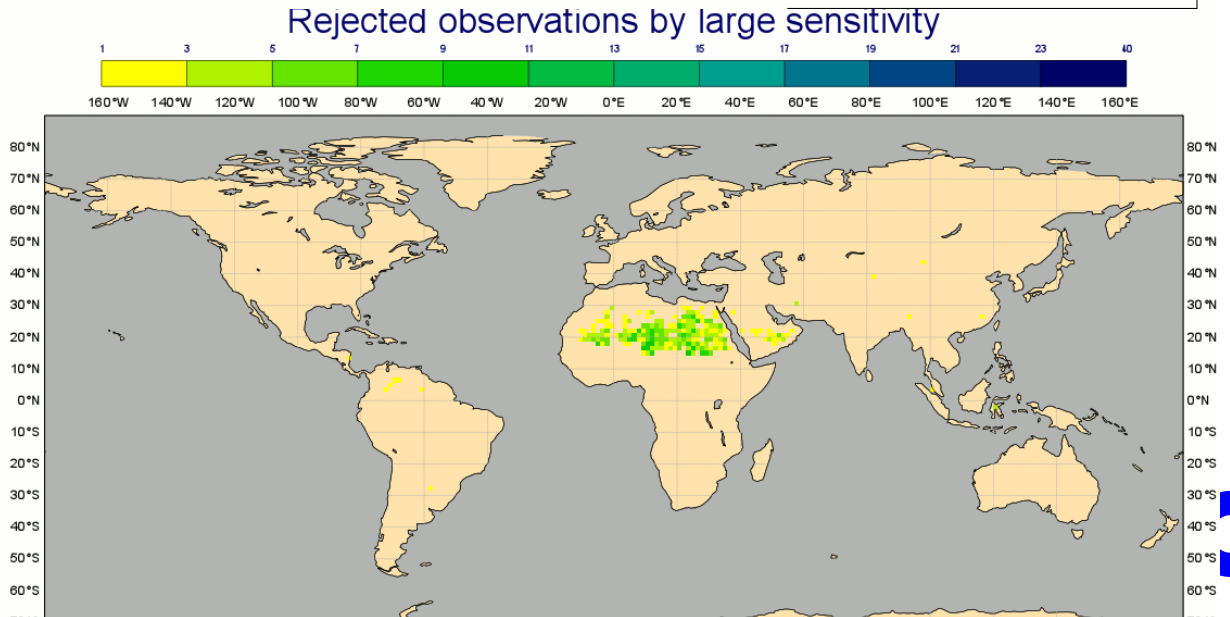
SMOS–SM–v1.0 - Overview

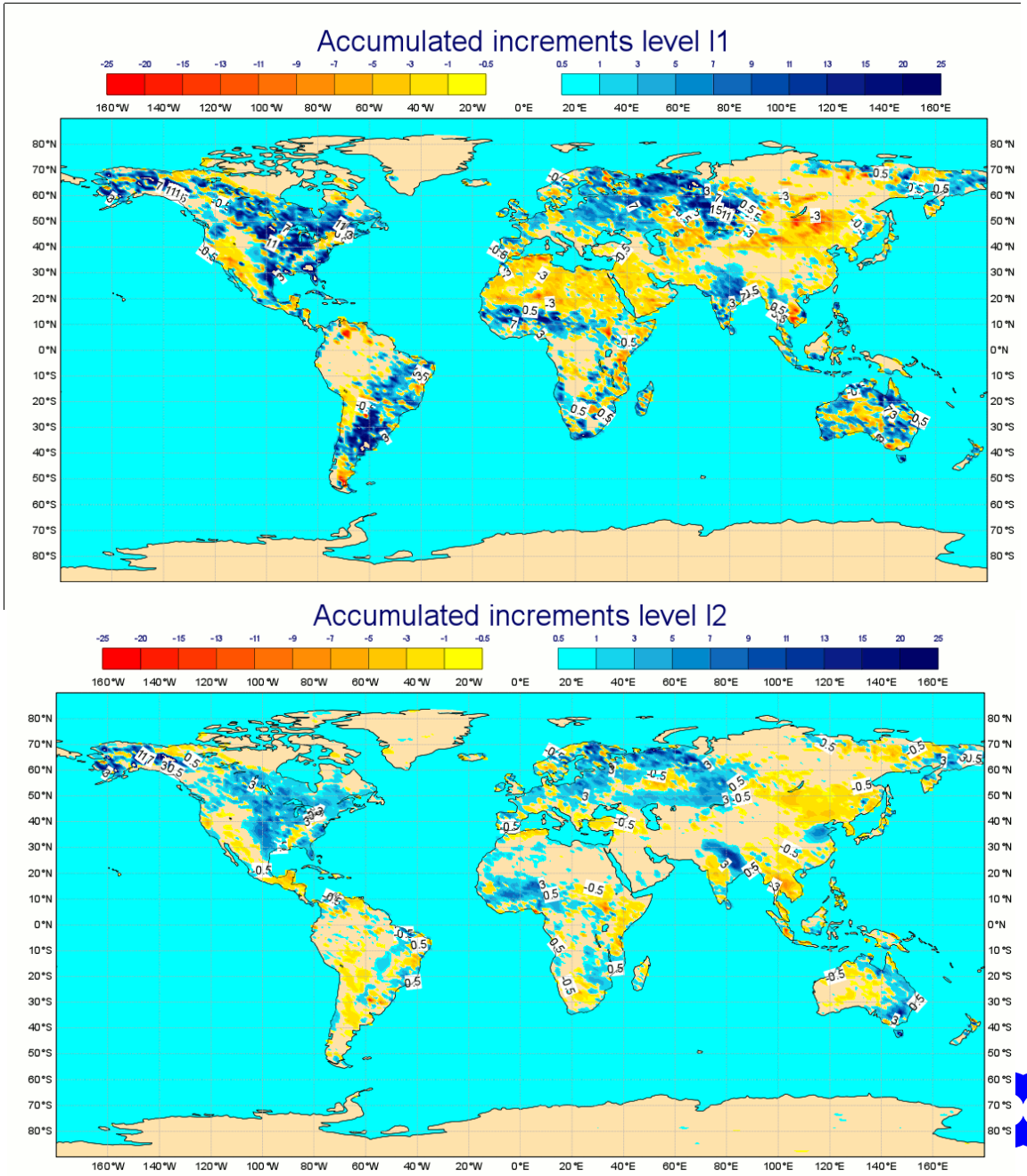
- Quality control for May-2010;
- Most of the rejections in the SEKF are produced by the first-guess check.
- Only a few observations rejected by large too large sensitivity of the model to small perturbions.





SMOS–SM–v1.0 - Overview

- Accumulated increments for May-2010 (in mm)



Summary and next

- DA impact experiments started. Currently being analysed
  - First results show a positive impact on the SCAN network in July 2010,
  - Longer periods are needed to obtain robust and significant results,
- SMOS-SM-v1.0 product. Currently 4 months of analysis.
- Can results be improved? YES, this is just the beginning
  - error matrices improvement, in particular cross-correlation terms,
  - binning implementation,
  - first-guess threshold based on experimentation,
  - CDF-matching for more angles, including seasonal correction
  - etc.
- Impact analysis on the forecast skill → First results of SMOS-SM-v1.-0 show neutral impact, although slightly positive over certain located regions.
- Impact on the CO2 fluxes → Reduction of the global NEE CO2 sink by 14.7%. First order reduction in GPP, then on respiration.

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Other slides (RFI flag)

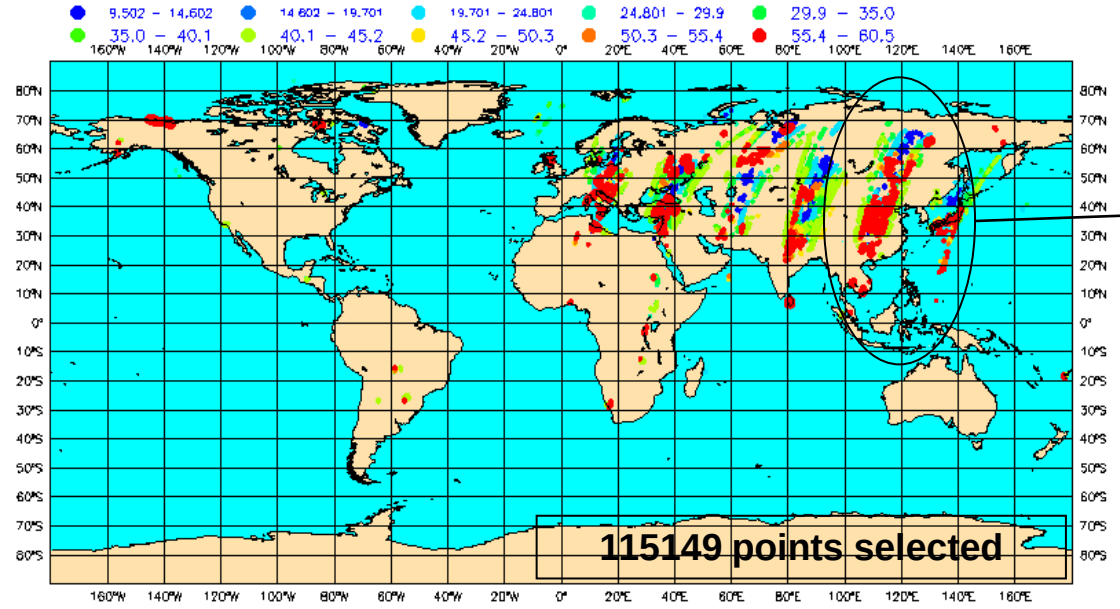
RFI flag in BUFR product

- Use of RFI flag at ECMWF:
  - RFI flag information in BUFR since deployment of NRT v5.05 the 7 March 2012.
  - Also RFI flag info available in the last reprocessing (2010-2011),
  - BUFR product, SMOS information flag, two bits interesting for ECMWF:
    - Bit-1: Pixel is affected by RFI effects as identified in the AUX_RFILST or it has exceeded the BT thresholds
    - Bit-4:Measurement is affected by the tails of a point source RFI as identified in the AUX RFI list (tail width is dependant on the RFI expected BT defined in the AUX RFILST. → no RFI information was found here.

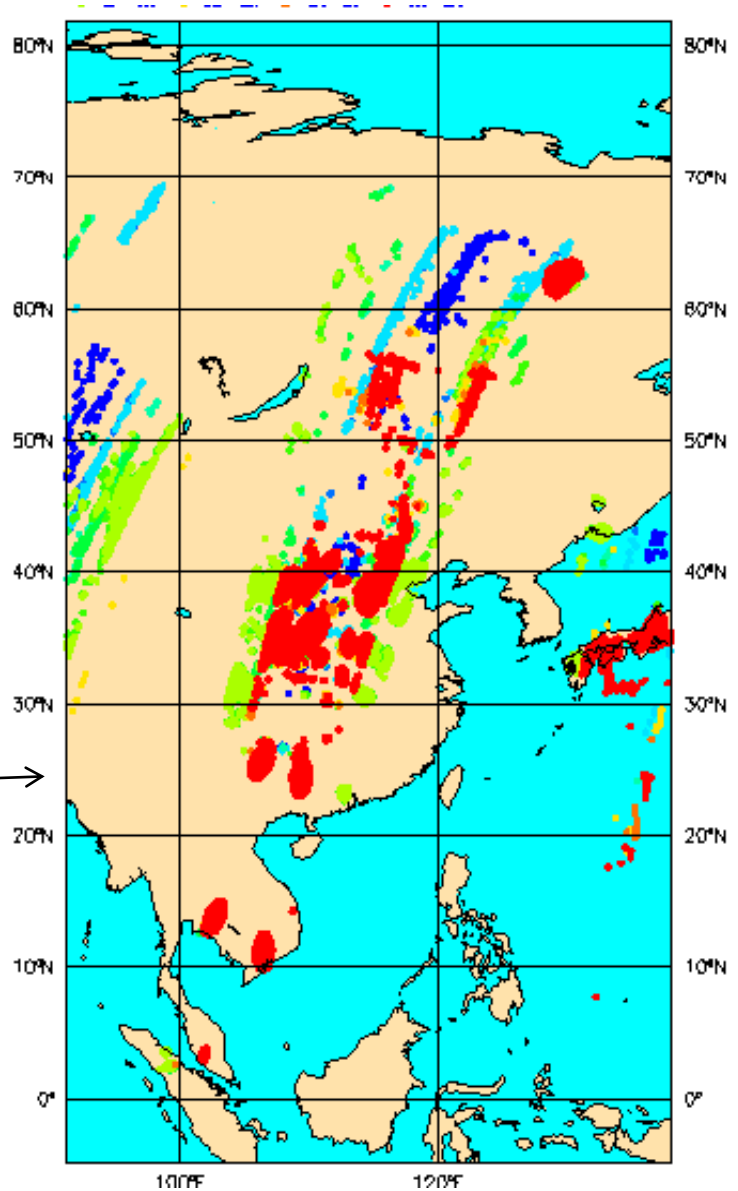
SMOS info flag (bit-1) – all data

- SMOS database in IFS the 9 May 2012 (data from 2100UTC to 0900UTC) with current monitoring suite.
  - Basic quality control,
  - Selected angles: 10, 20, 30, 40, 50, 60 (± 0.5),
  - Selected polarisations: XX, YY

Incidence angle



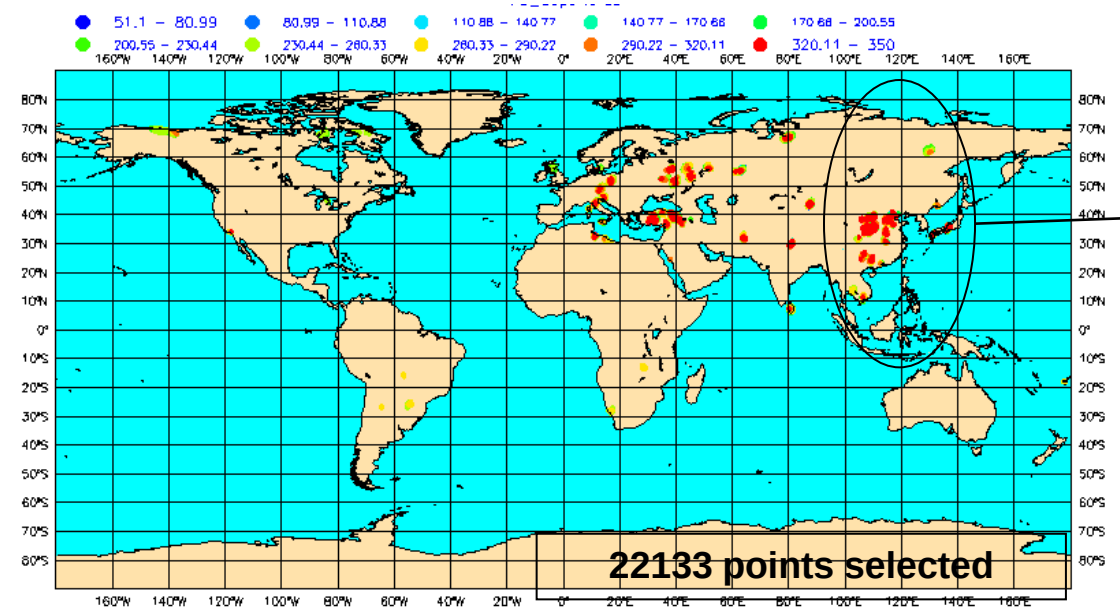
EAFOV



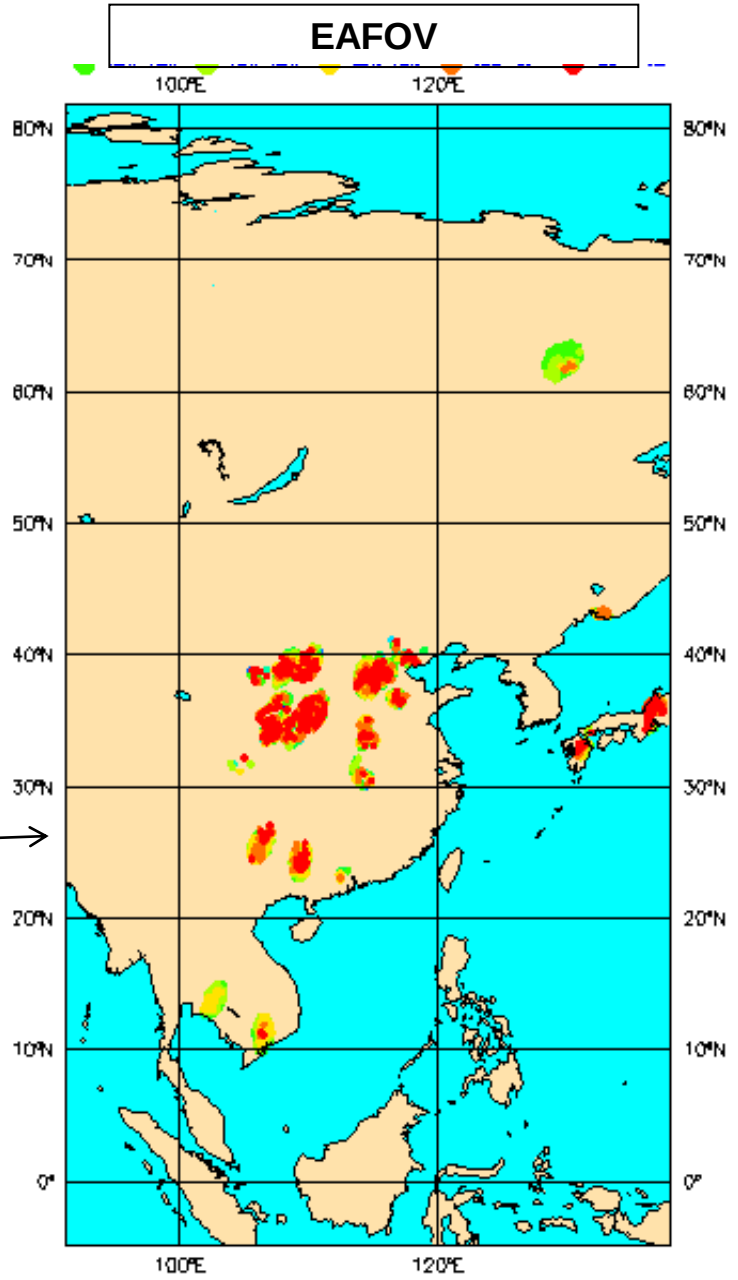
SMOS info flag (bit-1) – active data

- On top of previous thinning/screening, only active data will be assimilated → guarantee to pick only the nearest observation to the model grid (per angular bin), where the analysis are carried out.
- RFI flagged areas are dramatically reduced → keeps only the most heavily contaminated areas?

Incidence angle



EAFOV

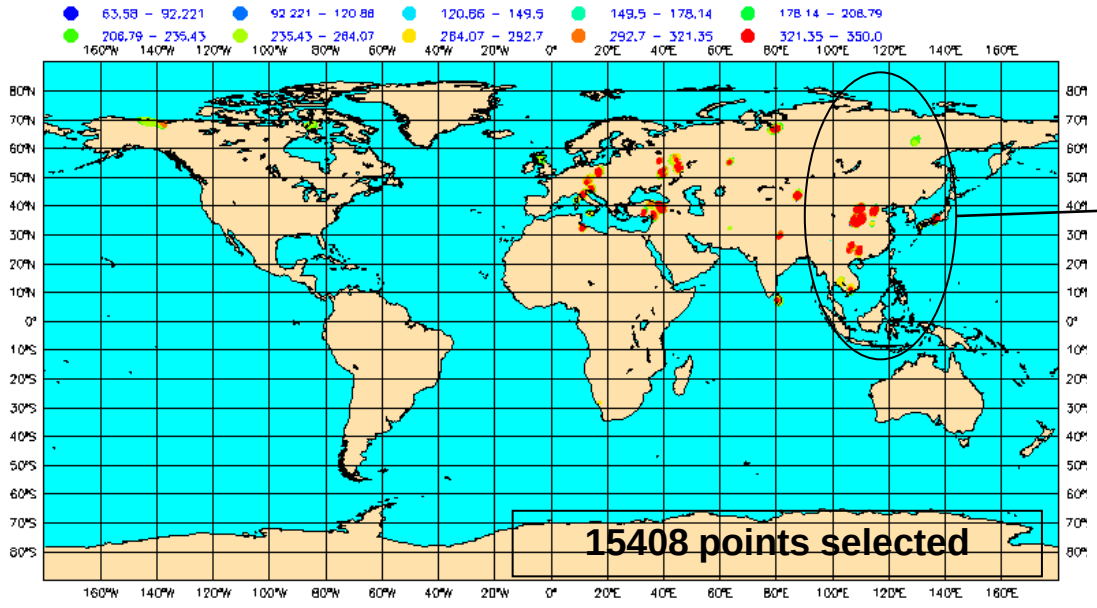


SMOS info flag (bit-1) – active data + AFOV

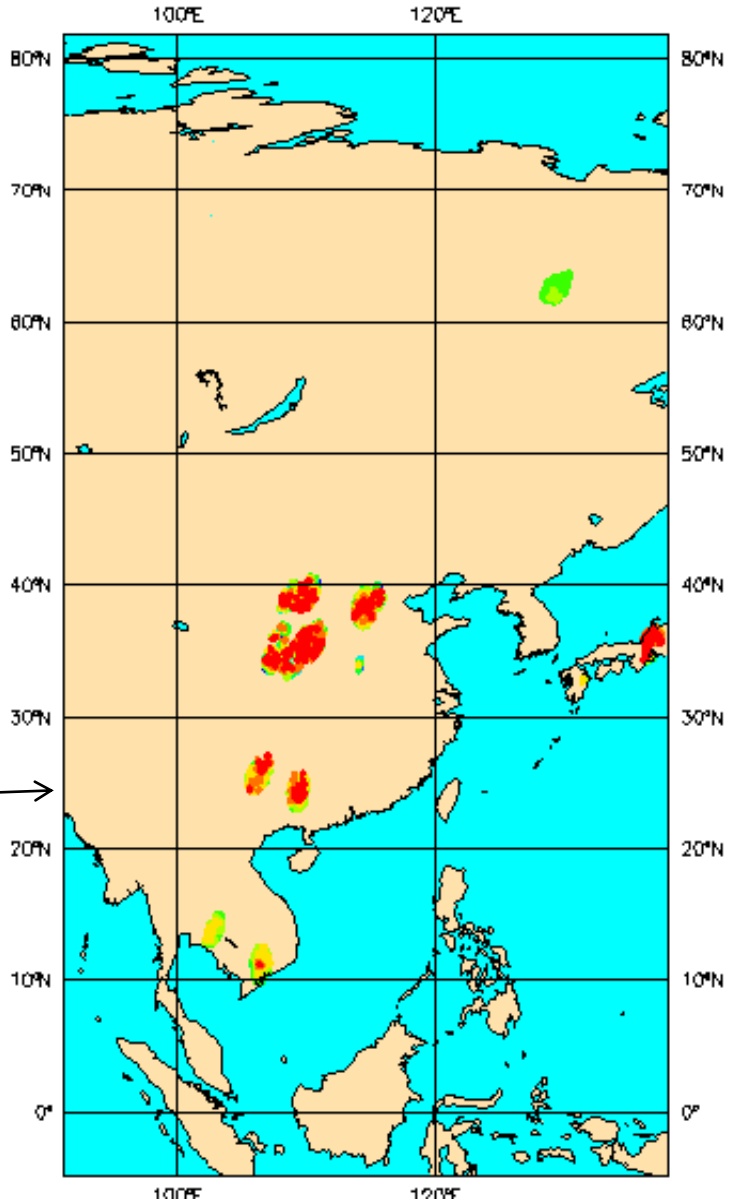
- For assimilation purposes, better assimilate data in the AFOV → further, modest, reduction of data.

- Based on this filter, which data is still left to be assimilated?

Incidence angle

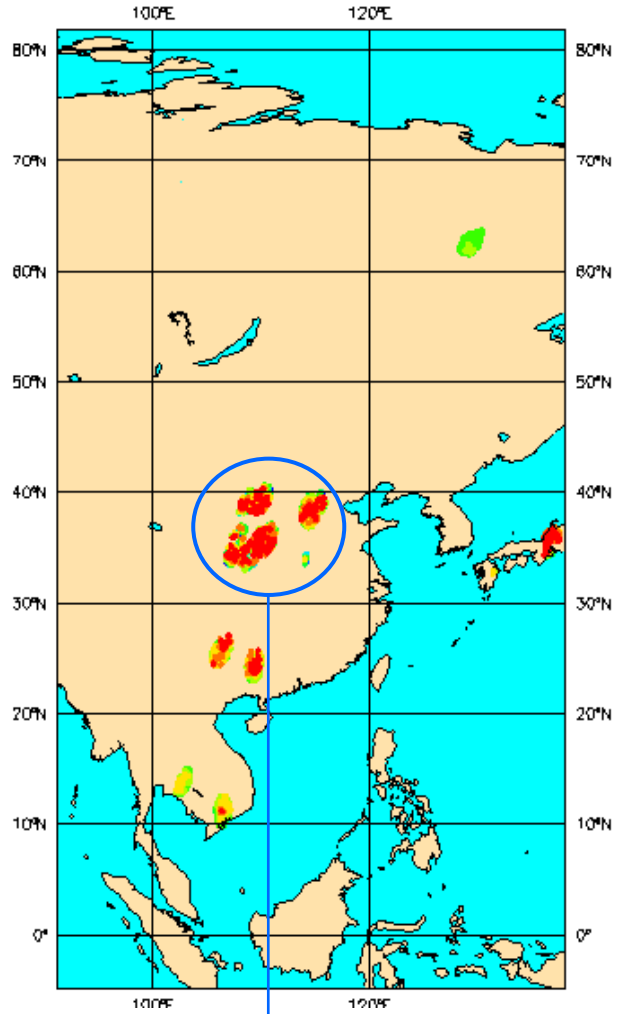


AFOV

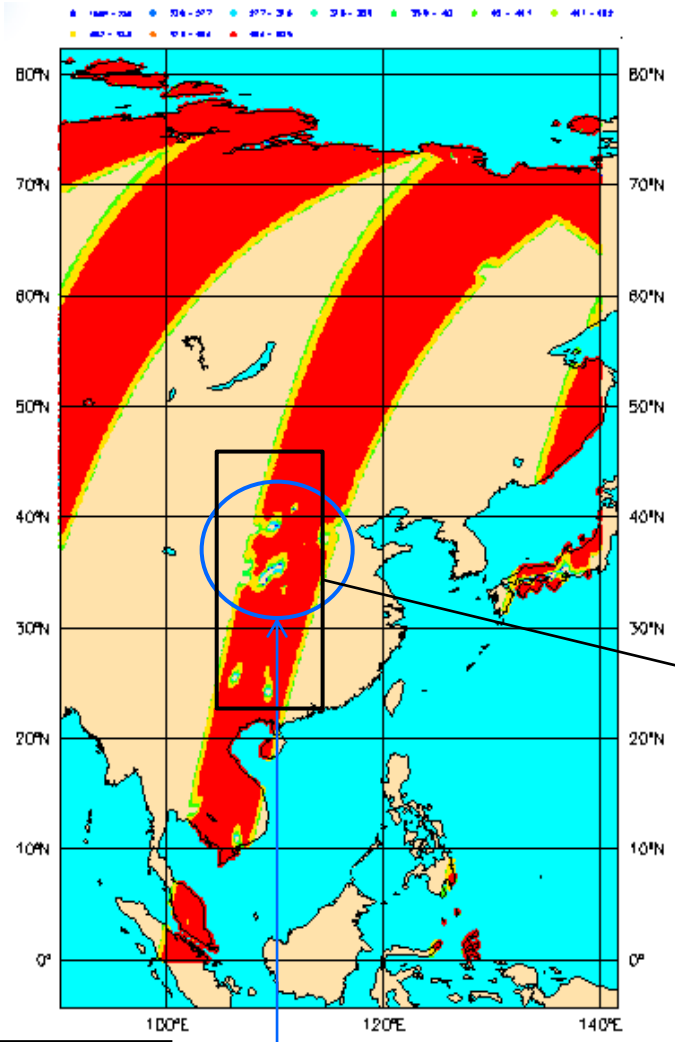


SMOS info flag (bit-1)

Active data at T1279 filtered based on thinning, screening, SMOS flag and radiometric accuracy



Active data at T1279 still available to be assimilated



Data which potentially could be assimilated still in areas suspicious of being contaminated (perhaps SMOS flag not effective yet to filter data contaminated by tails of the source?) → further filters are required for assimilation

Data filtered

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