SMOS Progress Meeting 5

09:30-09:50  SMOS mission status: Susanne
09:50-10:10  ECMWF-SMOS contract status: Patricia
10:10-10:30  Operational monitoring status: Joaquín
10:30-10:50  coffee break
10:50-11:20  ECMWF LDAS & SMOS bias correction: Patricia
11:20-12:30  SMOS in SEKF dvpts (bugs, impact studies, QC, errors): Joaquín
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14:30-15:00  UK Met Office SMOS/Land analysis status: Brett
15:00-15:20  Conclusions and recommendations: all
15:20-15:30  Coffee break
15:30-16:30  ESA-ECMWF internal discussion
## ESA SMOS Project at ECMWF

**Project Phase-II (28 Months):**
- 01 October 2010 - 31 January 2013
- 11 WPs (13PM ECMWF; 28 PM ESA)

<table>
<thead>
<tr>
<th>WP</th>
<th>ECMWF Funding (Pat &amp; al)</th>
<th>ESA Funding (Joaquín)</th>
<th>Task</th>
<th>Status</th>
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<tbody>
<tr>
<td>WP 1000</td>
<td>1 pm</td>
<td>1 pm</td>
<td>Coordination</td>
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<td>WP 1100</td>
<td>2 pm</td>
<td>3 pm</td>
<td>Continuous monitoring</td>
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<td>WP 1200</td>
<td>3 pm</td>
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<td>Data thinning</td>
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<td>WP 1300</td>
<td>6 pm</td>
<td></td>
<td>Noise filtering</td>
<td>✓</td>
</tr>
<tr>
<td>WP 1400</td>
<td>6 pm</td>
<td></td>
<td>Bias correction</td>
<td>✓</td>
</tr>
<tr>
<td>WP 1500</td>
<td>3 pm</td>
<td></td>
<td>CMEM maintenance</td>
<td>✓</td>
</tr>
<tr>
<td>WP 1600</td>
<td>1 pm</td>
<td></td>
<td>Web Page</td>
<td>✓</td>
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<tr>
<td>WP 2000</td>
<td>6 pm</td>
<td></td>
<td>Data assimilation</td>
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<tr>
<td>WP 2100</td>
<td>3 pm</td>
<td></td>
<td>L3/4 Root zone SM</td>
<td>✓</td>
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<tr>
<td>WP 2200</td>
<td>3 pm</td>
<td></td>
<td>Validation data base</td>
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</tr>
<tr>
<td>WP 2300</td>
<td>3 pm</td>
<td></td>
<td>Hot spot analysis</td>
<td></td>
</tr>
</tbody>
</table>

**Colour code:**
- To do
- Ongoing
- Done
ESA SMOS Project at ECMWF

Reports to do for WPs: 1100, 1400, 2000, 2100, 2300
### ESA SMOS Project at ECMWF

**CCN1 & 2 (14+2 Months):**
- 01 November 2012 - 28 February 2014

<table>
<thead>
<tr>
<th>WP</th>
<th>PM</th>
<th>Task</th>
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</thead>
<tbody>
<tr>
<td>WP 3100</td>
<td>1 pm</td>
<td>Technical Support</td>
</tr>
<tr>
<td>WP 3200</td>
<td>3 pm</td>
<td>QC and monitoring</td>
</tr>
<tr>
<td>WP 3300</td>
<td>4 pm</td>
<td>Root Zone SM re-processing</td>
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### Several Options

<table>
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<tr>
<th>WP</th>
<th>PM</th>
<th>Task</th>
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<tr>
<td>WP 3400</td>
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<td></td>
</tr>
<tr>
<td>WP 3401</td>
<td>3 pm</td>
<td>B-matrix</td>
</tr>
<tr>
<td>WP 3402</td>
<td>4 pm</td>
<td>3D error structures</td>
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<td>WP 3403</td>
<td>3 pm</td>
<td>CMEM calibration</td>
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<td>WP 3404</td>
<td>7 pm</td>
<td>SMOS for EDA/EPS</td>
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<tr>
<td>WP 3500</td>
<td>4 pm</td>
<td>Ultra light product</td>
</tr>
</tbody>
</table>

**Colour code:**
- **To do**
- **Ongoing**
- **Done**
ESA SMOS Project at ECMWF

CCN Status in March 2013

SMOS CCN1
(Joaquin)
Extended analyses:
- DA impact (precip feedback, Carbon etc)
- Binning implementation
- Hot Spot analysis continuity
- Revised QC
- Seasonal BC and evaluation
- Bugs tracking and fixing…
Actions Plan until June 2014

Work Packages:

- WPs 3401 and 3402 (B cycling and 3D error structure)
- WP 2000 Impact evaluation (1 month): redo after bug fixes all tools already available
- Root Zone product reproc (3300): need to define characteristics (unit, dissemination grid, cycle time, product name etc…)

Report and publications:

- Peer reviewed (+ report):
  - Noise Filtering (just accepted in IEEE TGRS)
  - SMOS DA impact
  - Forward modelling and BC
  - Hot Spot analysis
- Report only:
  - Monitoring report
  - Root Zone Product
  - B cycling and 3D-error
SMOS Progress Meeting 5

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ECMWF Land Surface Data Assimilation

Recent developments

Current: IFS cycle 38r2  
Next: IFS cycle 40r1 (implementation 19 November)

Improved LDAS in IFS 40r1:

- **Improved snow analysis**, error specification for NOAA/NESDIS IMS and conventional observations, generic snow blacklist
- **Revised surface analysis code and ODB feedback**, EDA surface observations perturbations, impact on ENS (EPS)
- **New land surface obs monitoring (T2M,RH2M,Snow)** and NOAA/NESDIS IMS snow cover
- Glacier mask revised over Iceland
- **ASCAT-B soil moisture monitoring (38r1)**, EDA SST perturbations for 25 members
- SMOS forward operator configuration & bias correction (CDF-matching)

Projects:

- NASA/SMAP SDT, App WG and mission Early Adopter
Positive values mean larger errors with test (no EKF) than CTRL (oper config with EKF)

\[ \rightarrow \text{Positive impact of EKF soil moisture analysis}\]
on humidity & temperature,
Significant at 1000 hPa, day 1-3 (NH)

Experiments (Jun-Jul 2012):
- CTRL: current operational configuration
- Test no EKF: switch off EKF SM analysis
- Evaluation on temperature and humidity forecasts

de Rosnay et al, QJRMS 2013 compared EKF and OI

Now we compare EKF and Open loop (no DA):
Snow data assimilation: further improvements

Next IFS cycle 40r1 (19 Nov 2013)
Improved use and error specifications of the IMS product

Impact on FC Temperature

<table>
<thead>
<tr>
<th>IMS \ FG</th>
<th>Snow</th>
<th>No Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow</td>
<td>x</td>
<td>DA 5cm</td>
</tr>
<tr>
<td>No Snow</td>
<td>DA</td>
<td>DA</td>
</tr>
</tbody>
</table>

IFS cycle 40 errors:
BG: $\sigma_b = 3$ cm
SYNOP: $\sigma_{\text{synop}} = 4$ cm
IMS: $\sigma_{\text{ims}} = 8$ cm

RMSE forecast temperature
Future (40r1)–current (38r2)

Improved use of NOAA/NESDIS IMS snow
$\rightarrow$ Small but significant
Error reduction in IFS 40r1 compared to IFS 38r2
NOAA/NESDIS IMS snow cover Monitoring

IMS monitoring North America (esuite 40r1)

IMS Snow Cover Hit rate (esuite 40r1)

IMS SNOW COVER
HIT RATE (ALL)
DATA PERIOD = 2013-11-12 21 - 2013-11-13 09
EXP = 0063, CHANNEL = 1
Min: 0.048 Max: 1.000 Mean: 0.904
GRID: 1.00x1.00

IMS SNOW COVER
CHANNEL = 1, ALL DATA [TIME STEP = 24 HOURS]
Area: lon_w = 189.0, lon_e = 255.0, lat_s = 20.0, lat_n = 76.0 (over All_surfaces)
EXP = 0063

false alarm rate  correct-nulls

total non snow event

27 30 6 9 12 15 18 21 24 27 30
Nov

27 30 6 9 12 15 18 21 24 27 30
Nov

27 30 6 9 12 15 18 21 24 27 30
Nov
ASCAT-B SM Monitoring

- ASCAT-B soil moisture acquisition since 23 November 2012
- ASCAT-B Soil moisture monitoring operational since 06 December 2012
- Consistent ASCAT-A and ASCAT-B soil moisture

ASCAT SM – Model
(First guess departure, m³.m⁻³)
23-24 Nov 2012

ASCAT-A

ASCAT-B

<table>
<thead>
<tr>
<th></th>
<th>Nb</th>
<th>Mean m³.m⁻³</th>
<th>Std m³.m⁻³</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCAT-A</td>
<td>64893</td>
<td>0.0152</td>
<td>0.0645</td>
</tr>
<tr>
<td>ASCAT-B</td>
<td>65527</td>
<td>0.0149</td>
<td>0.0663</td>
</tr>
</tbody>
</table>

Operational monitoring:
http://www.ecmwf.int/products/forecasts/d/charts/monitoring/satellite/slmoist/

2013
ASCAT SM Operational Monitoring

ASCAT-A

SCATTER PLOT OF FIELD OF VIEW VERSUS FG_DEPAR
SLM FROM METOP-A, CHANNEL 1
EXP = 0001; PERIOD = 2013100700 - 2013110500
ALL - GLOBE

ASCAT-B

SCATTER PLOT OF FIELD OF VIEW VERSUS FG_DEPAR
SLM FROM METOP-B, CHANNEL 1
EXP = 0001; PERIOD = 2013100700 - 2013110500
ALL - GLOBE

07 October - 05 November 2013
Consistent in terms of
Obs value, FG departure, number of observations
Root Zone Products validation

Based on Triple Collocation
HSAF CDOP2 VS12 02: Pellarin et al. 2013

Four root zone soil moisture products (2 TC):
- GL-SWI (Copernicus Global Land service Soil Wetness Index based on ASCAT SSM)
- SMOS level-4
- MERRA-Land re-analysis
- H-SAF H14 (SM-DAS-2)

Validation RZSM with in situ data: Limited by vertical sampling

Annual mean root-zone soil moisture maps for MERRA, H14, GL-SWI and SMOS
Root Zone Products validation

Based on Triple Collocation: 2 triplets

TC1: MERRA / SMOS / H14
TC2: MERRA / SMOS / GL-SWI

TC1 Error maps (soil moisture index RMSE)

Error distribution (% of pixels)

<table>
<thead>
<tr>
<th></th>
<th>TC1</th>
<th></th>
<th>TC2</th>
</tr>
</thead>
<tbody>
<tr>
<td>lowest</td>
<td>35%</td>
<td>Err&lt;0.2</td>
<td>31%</td>
</tr>
<tr>
<td>MERRA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMOS</td>
<td>29%</td>
<td>38%</td>
<td>39%</td>
</tr>
<tr>
<td>H14</td>
<td>39%</td>
<td>43%</td>
<td>-</td>
</tr>
<tr>
<td>GL-SWI</td>
<td>-</td>
<td>-</td>
<td>30%</td>
</tr>
</tbody>
</table>

- Identify areas of larger errors
- Differences between products definition (liquid vs total water content)
Root Zone Products validation
Based on Triple Collocation (TC)

Comparison of error estimates using ground validation and triple collocation

→ Good estimates of error from the TC approach
Summary recent LDAS dvpts

- From IFS cycle 40r1, all the land surface observations used at ECMWF are:
  - In the ODB
  - Monitored operationally
- Land surface observations:
  - Conventional (new): Rh2m, T2m, snow
  - Satellite: ASCAT-A, ASCAT-B, SMOS (Joaquin) and NOAA/NESDIS IMS,
- Others: snow analysis significant improvements, EKF further improvements (in 40r2), EDA surface observations perturbations, impact on ENS (EPS)
- Extensive Validations activities of soil moisture and temperature (Clement)
- H-SAF VS: first investigations of triple collocation for root zone validation
ECMWF SMOS forward operator and Bias Correction

- Data preprocessing (BUFR2GRIB converter)
- TB simulations for 36 CMEM configurations
- CMEM global scale Intercomparison (for 2010) at 40° incidence angle
- Bias correction multi-angular (2010-2012) using best CMEM configuration, following Drusch et al., 2007 and Scipal et al., 2008

CMEM v4.1: (http://www.ecmwf.int/research/data_assimilation/land_surface/cmem/cmem_index.html)

On each grid point:

\[
TB^*_{SMOS} = a + b \ TB_{SMOS}
\]

with \( a = \overline{TB}_{CMEM} - \overline{TB}_{SMOS} \left( \frac{\sigma_{CMEM}}{\sigma_{SMOS}} \right) \)

\( b = \frac{\sigma_{CMEM}}{\sigma_{SMOS}} \)

\( \rightarrow \) Matches mean and variance
ECMWF SMOS forward operator and Bias Correction

SMOS reproc TB archive (ECFS)

Convert to grib (ECFS)
Superobing
Reduced Gaussian grid
Resolution T255, T511

QC:
Water Fraction < 5%
Radio. Accuracy < 4K
AFOV
RFI flag (reproc2)

Output
TBxx, TByy, Faxx, ...
Angles: 30, 40, 50

ECMWF input:
SM, ST, Tair, Tskin
Land cover, LAI, texture

CMEM Offline
Reduced Gaussian grid
Resolution T255

QC:
No snow
T2m > 273K
Slope < 4%

Output:
TBh, TBv → Fraday rotation
TBxx, TByy
Angles: 30, 40, 50

1- CMEM Intercomparison at 40° and dynamic parameterization
2- Maps of CDF matching coefficients (a,b)
For TBxx, TByy (30°, 40°, 50°)
SMOS BUFR2GRIB

Offline BUFR decoder also available at the ECMWF SMOS web pages:
- http://www.ecmwf.int/research/ESA_projects/SMOS/tools/smos_tools.html

BUFR for 6h: 2.0 GB

Grib files: 7MB
(14 grib files of 0.5MB each)

0.25°x0.25° grid TBxx,TByy, Faraday rotation, Geometric angles & flags

-SMOS grib archived on ECFS (DCDA, reproc2)
-SMOS GRIB files now produced NRT.
CMEM Simulations

ECMWF  TB (K) ori WaWsWi_TOA H 2010010106 at angle 30

January 2010
TOA TBH

Before QC

On snow, Temp, Topography
LSM

After QC
CMEM Simulations

ECMWF TB (K) ori WaWsWi_TOA H 2010070106 at angle 30

July 2010
TOA TBH
Before QC

After QC
On snow, Temp, Topography LSM
CMEEM Simulations

For each date, each time, each pol, each and each CMEEM configuration:
Match in space/time obs and model
Rotate ECMWF simulation to the antenna frame of the corresponding date and time

ECMWF TB (K) WaWsWi xx 2010070106 at angle 30

July
2010

TBxx
ECMWF comparison with SMOS

Monthly mean difference SMOS-ECMWF: May 2010 (Wang, Wigneron Jackson)
CMEM simulations

CMEM_ECMWF comparison with SMOS TB:
- 3 dielectric models
  (Dobson, Mironov, Wang)
- 3 vegetation opacity models
  (Jackson, Kirdyashev, Wigneron)
- 4 roughness models
  (Choudhury, Wigneron, Wsimple, Wtexture)

→ 36 configurations

Global Evaluation (2010) of CMEM against SMOS data

Evaluation Metrics:
RMSE, R, Bias, SDV, uRMSE, E (normalized uRMSE)

Results for TBx, TBy, 00, 06, 12, 18 UTC, for each month and yearly

<table>
<thead>
<tr>
<th>E TBx 06 utc</th>
<th>Dobson</th>
<th>Mironov</th>
<th>Wang</th>
<th>Ro</th>
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<tr>
<td>Jackson</td>
<td>0.90 0.89</td>
<td>0.89 0.88</td>
<td>0.89 0.89</td>
<td>Ch Wi</td>
</tr>
<tr>
<td></td>
<td>0.88 0.96</td>
<td>0.87 0.97</td>
<td>0.87 0.99</td>
<td>Ws Wt</td>
</tr>
<tr>
<td>Kirdyashev</td>
<td>0.88 0.90</td>
<td>0.88 0.90</td>
<td>0.88 0.91</td>
<td>Ch Wi</td>
</tr>
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<td>0.87 1.06</td>
<td>0.88 1.08</td>
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</tr>
<tr>
<td></td>
<td>0.87 0.99</td>
<td>0.86 1.01</td>
<td>0.86 1.03</td>
<td>Ws Wt</td>
</tr>
</tbody>
</table>

Best CMEM:
Dielectric: Wang and Schmugge
Vegetation opacity: Wigneron 2007
Roughness: Wigneron et al. 2001 (Wsimple)
Bias correction updates

Done for the best CMEM configuration (Wang, Wigneron, Wigneron)

Bias correction follows the SMOS TB reprocessed versions

CDF-Matching version December 2012 (CDF_v0):
• Version used so far for DA experiments
• Yearly CDF-matching, based on first reprocessed data, 2010 → based on 12 months of Obs

CDF-Matching version July 2013 (CDF_v1):
• Based on second reprocessed data, obtained with NRT proc 505 for 2010 and 201101-201107, as well as NRT 2012 (also NRT v505). Hybrid SMOS data including DCDA and reproc2, but consistent in terms of version of the processor used → 31 months of obs
• 1: yearly CDF-matching (CDF_v1_yearly):
  • Improved treatment of areas with low var and low corr (correct only for bias)
  • CDF param for TBxx and TBxx, at 30, 40, 50 incidence
• 2: Monthly CDF-matching (CDF_v1_monthly): Seasonal Bias correction
  • Same as yearly for improved low var areas
  • 5-month moving window used
  • CDF param for TBxx and TBxx, at 30, 40, 50 incidence, for each month

→ Seasonal and multi-angular point-wise CDF-matching used for DA
SMOS_matched = A + B*SMOS_data

Yearly CDF-matching param
40 degrees incidence
Bias correction parameters: CDF_v1_monthly June

\[ \text{SMOS\_matched} = A + B \times \text{SMOS\_data} \]

JUNE Monthly CDF-matching param
40 degrees incidence
Bias correction parameters: CDF\_v1\_monthly December

December Monthly CDF-matching param

40 degrees incidence

SMOS\_matched = A + B*SMOS\_data
SMOS Bias correction yearly evaluation

2012

Mean Bias (K)
TBxx, 40 degrees

Before SMOS BC
(-3.3K)

Note that ECMWF Bias in Amazonia:
< 10K before bias correction
< 1K after BC

After SMOS BC CDF_v1_yearly
(0.7K)

- Low residual bias, except in RFI affected areas (Poland in 2012 and Asia)
SMOS Bias correction yearly evaluation

2012

- Low residual RMSD, except in RFI affected areas (Poland in 2012 and Asia)

Before SMOS BC (16.9K)

After SMOS BC CDF_v1_yearly (8.1K)

RMSD (K)
TBxx, 40 degrees
SMOS Bias correction yearly evaluation

2012

Before SMOS BC

(-3.3K)

After SMOS BC CDF_v1_monthly

(0.7K)

- Low residual bias, except in RFI affected areas (Poland in 2012 and Asia)
SMOS Bias correction yearly evaluation

2012

Before SMOS BC
(-16.9K)

After SMOS BC CDF_v1_monthly
(7.7K)

- Low residual bias, except in RFI affected areas (Poland in 2012 and Asia)
SMOS Bias correction yearly evaluation

2012

Before SMOS BC (0.52)

After SMOS BC CDF_v1_monthly (0.56)

Monthly CDF → improves correlation
SMOS Bias correction yearly evaluation

2012

Before SMOS BC
(0.49)

After SMOS BC CDF_v1_monthly
(0.53)

Monthly CDF → improves correlation
## SMOS Bias correction yearly evaluation

### 2012

Evaluation at pol xx and yy, for monthly_v1 CDF  
Bias is SMOS-ECMWF

<table>
<thead>
<tr>
<th>Angle</th>
<th>R</th>
<th>RMSE(K)</th>
<th>Bias (K)</th>
<th>Var (K²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>XX YY</td>
<td>XX YY</td>
<td>XX YY</td>
<td>XX YY</td>
</tr>
<tr>
<td>30</td>
<td>0.53</td>
<td>0.55</td>
<td>16.4</td>
<td>14.8</td>
</tr>
<tr>
<td>40</td>
<td>0.52</td>
<td>0.49</td>
<td>16.9</td>
<td>13.9</td>
</tr>
<tr>
<td>50</td>
<td>0.46</td>
<td>0.46</td>
<td>19.1</td>
<td>13.0</td>
</tr>
<tr>
<td>30</td>
<td>0.56</td>
<td>0.59</td>
<td>7.7</td>
<td>7.3</td>
</tr>
<tr>
<td>40</td>
<td>0.56</td>
<td>0.53</td>
<td>7.7</td>
<td>7.7</td>
</tr>
<tr>
<td>50</td>
<td>0.50</td>
<td>0.50</td>
<td>8.6</td>
<td>8.1</td>
</tr>
</tbody>
</table>

- Before BC, larger RMSE for xx than yy; fixed after BC.  
- After BC, RMSE lower than 8K except in RFI affected areas  
- Seasonal BC improves mean, var, rmse and corr.  
- FG_depar Stdev after BC ~ 8K  
→ Suitable for data assimilation
## SMOS Bias correction yearly evaluation

### 2012

Evaluation at pol xx and yy, for **yearly_v1** CDF

Bias is SMOS-ECMWF

<table>
<thead>
<tr>
<th>Angle</th>
<th>R</th>
<th>RMSE(K)</th>
<th>Bias (K)</th>
<th>Var (K^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>XX YY</td>
<td>XX YY</td>
<td>XX YY</td>
<td>XX YY</td>
</tr>
<tr>
<td>30</td>
<td>0.53</td>
<td>0.55</td>
<td>16.4</td>
<td>14.8</td>
</tr>
<tr>
<td>40</td>
<td>0.52</td>
<td>0.49</td>
<td>16.9</td>
<td>13.9</td>
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<tr>
<td>50</td>
<td>0.46</td>
<td>0.46</td>
<td>19.1</td>
<td>13.0</td>
</tr>
<tr>
<td>30</td>
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<td><strong>8.0</strong></td>
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<td>0.51</td>
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<td><strong>8.1</strong></td>
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</tr>
<tr>
<td>50</td>
<td>0.45</td>
<td>0.47</td>
<td><strong>8.9</strong></td>
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</tr>
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</table>

- Yearly CDF matches variance at yearly scale
- Lowest RMSD with monthly CDF
SMOS Bias correction monthly evaluation

TBxx, 40 degrees

- Low residual bias, except in RFI affected areas (Poland in 2012 and Asia)
SMOS Bias correction monthly evaluation

Statistics for July 2012

Bias is SMOS-ECMWF

<table>
<thead>
<tr>
<th>Angle</th>
<th>R</th>
<th>RMSE(K)</th>
<th>Bias (K)</th>
<th>Var (K²)</th>
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<td>8.0</td>
<td>7.4</td>
</tr>
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</table>

Before BC

After BC (CDF_v1_monthly)

After BC (CDF_v1_yearly)

→ Best match at monthly scale with v1_monthly
- CMEM intercomparison (2010)
  - Best CMEM configuration: Wang (diel), Wigneron 2001 (roughness),
    Wigneron 2007 (vegetation)
- NRT processing and ECFS archiving of SMOS grib files (T255 and T511)
- Bias correction matches SMOS TB range and variance to ECMWF TBs

- First BC version (2010): old reprocessed version 2010: v1_yearly
- Revised BC (2010-2012) based on 2\textsuperscript{nd} reprocessed NRT product (V505)
- V1_yearly and v1_monthly (5 months moving window)
- Extensive evaluation for 2012 of CDF\textsubscript{monthly} and CDF\textsubscript{yearly}
  - Multi-angular and seasonal bias correction is the best
  - Before BC, larger RMSE for xx than yy; similar score after BC.
  - After BC, RMSE lower than 8K except in RFI affected areas
  - Seasonal BC improves mean, var, rmse and corr.

- FG\_depar Stdev after BC ~ 8K
→ Suitable for data assimilation
CMEM intercomparison and Bias Correction

Complex topography → affect the emission (Pellarin et al. 2006)

Use ECMWF sub-grid scale orography

SMOS data used when Slope < 4%

Slope of Sub-grid scale orography
Last PM:
IFS TBxx
First guess departure
(SMOS-CMEM)

Reference:
CMEM TBxx
First guess departure
(SMOS-CMEM)

- IFS TB not consistent with CMEM
- Evidence of an implementation issue ...
  → Bug tracking in the IFS started in September; fixed early October (cf Joaquin’s presentation)