Validation of a new SMOS Salinity L3 product

M. Sena Martins, Julia Köhler, D. Stammer

CEN
(Center für Erdsystemforschung und Nachhaltigkeit)
Hamburg University
SMOS Validation

- Bias estimate and consequent correction of SMOS Salinity data from August 2010 – July 2011 >> a new L3 product
- Validation with in situ data, salinity from Argo and surface drifters
- Salinity variability: what can we expect from SMOS?
- First assimilation runs with GECCO
- Reprocessed data
- Future plans
First SMOS SSS Retrievals

Sea surface salinity (S1) from ascending (upper panel) and descending swaths (middle panel) as well as averaged data (lower panel) in March 2011 (left figure) and September 2010 (right figure).

Data were selected (theoretical error < 1.5) and weighted by their inverse theoretical error.
SMOS SSS Bias evolution

SMOS salinities suffer from
• Land- or Ice contamination
• RFI
• Roughness influence
• Long term and short term drift
• Sunglint effects...

Processing is continuously improving, however data set until March 2012 was incoherent. Reprocessed data will be validated.

Figure: Global daily mean differences SMOS SSS to uppermost Argo salinities (above: ascending orbits, below descending orbits)
SMOS SSS Bias estimate

SMOS SSS were selected by the following criteria:

- Range: $28 < SSS < 40$
- theoretical error < 1.5
- difference to climatological values < 1

Differences to climatological values were computed for all swaths in each month.

Correction functions were developed having the best fit to the differences.

Figure: Global salinity differences between SSS1 and WOA09 (thin lines: zonally averaged) before any “corrections”. Bars show the standard deviation of the zonal average.

**Thick lines:** Polynomials best fitting the differences.

*Blue: ascending swaths, red: descending swaths.*
Improvement of the SMOS SSS

“Corrected” SSS (SMOS S1) from ascending (upper panel) and descending orbits (middle panel) as well as averaged data in September 2010

Differences of SMOS SSS before and after correction (here the example for Sep 2010)
Validation by Argo salinity

**Upper panel:** Salinity differences SMOS S1 to Argo from global data during the period August 2010 to July 2011 from ascending and descending orbits.

**Middle panel:** Salinity differences of the corrected SMOS S1 to Argo from global data during the same period from ascending and descending orbits.

**Lower panel:** Differences of Argo to climatological data.
**Validation by Drifter salinity data**

*Salinity* in the southwestern Pacific, near to the *Pacific Warm Pool* from corrected SMOS S1 and surface drifters’ data (Mar 2010-Oct 2011)

*Figure*: SMOS S1 salinity corrected, gridded on 1°x1° and monthly averaged. Superposed are the sections of trajectories of surface drifters in the corresponding month (daily values).
Salinity variability signal

- Salinity signal is small in most part of the ocean (< 0.4)
- Number of Argo measurements in the last decade per box of 1° x 2° is still small (< 40).

Fig. above: RMS Differences between Argo data (2000 to 2010) and climatology (WOA01)

Fig. right: Number of Argo measurements per grid box
Seasonal and interannual salinity variability

At Station M (right: from Holliday et al. 2009)
Seasonal Amplitude at Atlantic moorings PIRATA, CIS, PAP, M (below: Martins et al, in preparation)
Amplitude of salinity seasonal variability in the Atlantic

Amplitude of the annual harmonic LSQ fit in uppermost salinity observations (<10 m, from WOCE, EN3, Argo, 1980-2010), gridded to 2°x 3° boxes

Explained variance of the SSS variability by the seasonal signal from left

Martins et al. (2012) in preparation
Amplitude of salinity seasonal variability

From “corrected” SMOS S1 (above)

From WOA09 climatology (below)
Assimilating 2010 SMOS DATA in a global model

A. Köhl, GECCO

- Resolution: $1/3^\circ - 1^\circ$
- Input Data: Argo and CTD T/S, XBT, Altimeter SLA, SST (HadISST, AMSR/E), mean SSH
- and SMOS SSS from CATDS/CEC-OS SMOS Level 3 SSS
- Forcing: fluxes via bulk formulae from NCEP 6h atm. state
- Optimized parameters include T/S initial conditions, wind, air temperature, humidity, precipitation (~12 iterations).
- Results from 4 runs:
  - Reference: iter00
  - Salinity - in situ and SMOS: SMOS
  - Salinity - only SMOS: SMOSonly
  - Salinity - only in situ: noSMOS
First assimilation results: RMS SSS Residuals
First assimilation results: Precipitation changes

- Ideal for merging salinity data from various in situ and satellite sources.
- Results are plausible, but very preliminary.
- Biggest impact on surface freshwater forcing (E-P, run-off), but also on FW transport and heat transport.

RMS Precipitation Changes: SMOS – no SMOS

Mean Precipitation Changes (mm/d)
First comparison to climatological salinity (WOA09) still reveals a bias with

- values > 0.5 g/kg in the subtropical band
- Latitudinal dependence
- Seasonal dependence
- High values at land and ice transitions

SMOS S1 – WOA09 SSS: Monthly averages of ascending (upper panel) and descending (middle panel) orbits and of both (lower panel) in January 2011 (left) and October 2011 (right)
SMOS SSS: Reprocessed data

- Reprocessed data still have large differences between ascending and descending orbits, which seem to be dependent on latitude and season.
First images of the SMOS Reprocessed S1 asc+des orbits averaged, gridded and displayed for the southwestern Pacific. Salinity along surface drifter trajectories of the corresponding month are overlaid:

- Several flags are set, and have to be investigated further
- Statistics still have to be calculated
- Validation still has to be carried out
Future plans

• Reprocessed data will be validated, also here a latitude and time dependent bias seems to exist, a similar correction has to be applied
• Do surface drifter salinities serve as “calibration points”?
• Relation of salinity from SMOS and in situ measurements (differences due to surface effects)?
• Development of a new L3 Product, with actual uncertainties, taking into consideration spatial and temporal decorrelation scales
• Comparison to Aquarius data
• GECCO Assimilation