Global assessment of Level 3 SMOS and Aquarius salinity measurements using Argo and an operational ocean model

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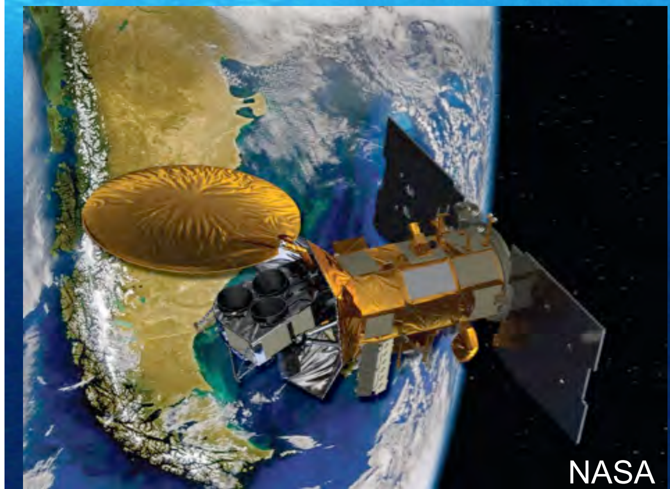

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Aim

- Produce level 3 (gridded) satellite products suitable for scientific exploitation
- Validation against Argo and model output
- Start with monthly…

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Measuring SSS from space: basics

- L-band (23 cm), natural emissivity of ocean surface depends on SSS and SST (dielectric properties)
- Brightness temperature at L-band has strongest sensitivity to SSS
- “Protected” radio-frequency (for radio-astronomy)
- Atmosphere is transparent

Measuring SSS from space: challenges

- Requires very large antenna to measure SSS with sufficient spatial resolution and accuracy
- Sensitivity of T_B to SSS is poor even at L-band
- Many factors affect T_B
  - temperature and SALINITY; directional surface roughness; incidence angle, polarisation; foam/whitecapping; other sources of radiation (sun, moon, galactic noise); **land and ice**

Calibration/validation is tricky because

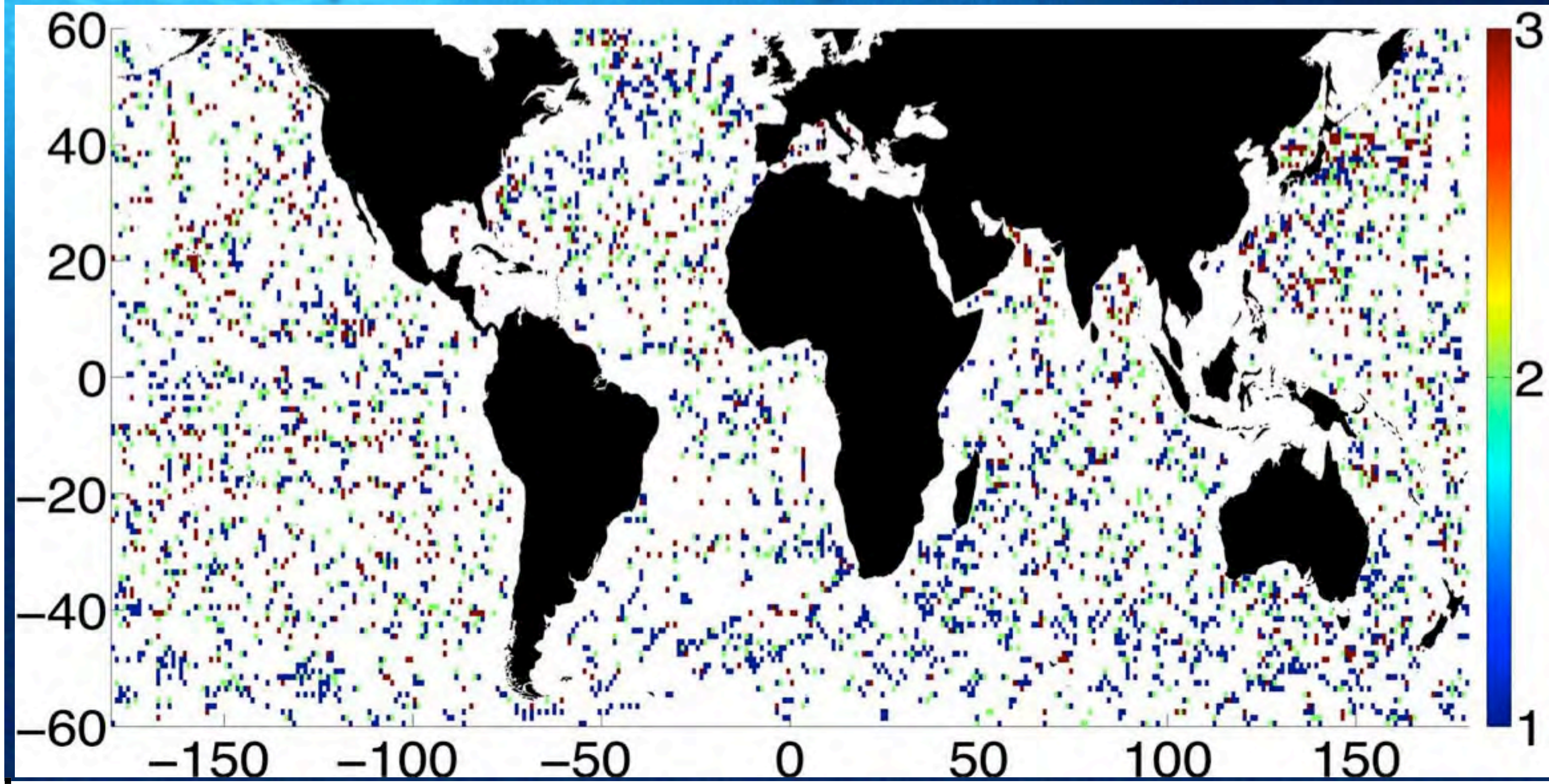
- Single-pass vs multi-pass:
  - Accuracy of single-pass SSS measurements with SMOS is ~1 psu
  - multi-pass averaging is required
- Sea state effects:
  - Quality of SST and surface roughness info? Which forward model(s)?
- Haline skin effect ?
  - **Penetration depth at L-band (35 psu) is ~1 cm**
  - *in situ* measurements of SSS typically at depths of 1-10 m
  - Differences in high precipitation/evaporation areas ?

Argo data

- Coriolis data centre
- Any profile with one valid measurement of salinity at depth <10 m
- Median salinity of each profile
- Median of 1° grid cells by month
- All near real time QC

Why do we need model data?

- Shallowest salinity data ~ 5-10 m
- >3000 floats worldwide, vertical profiles of salinity & temperature every 10 days

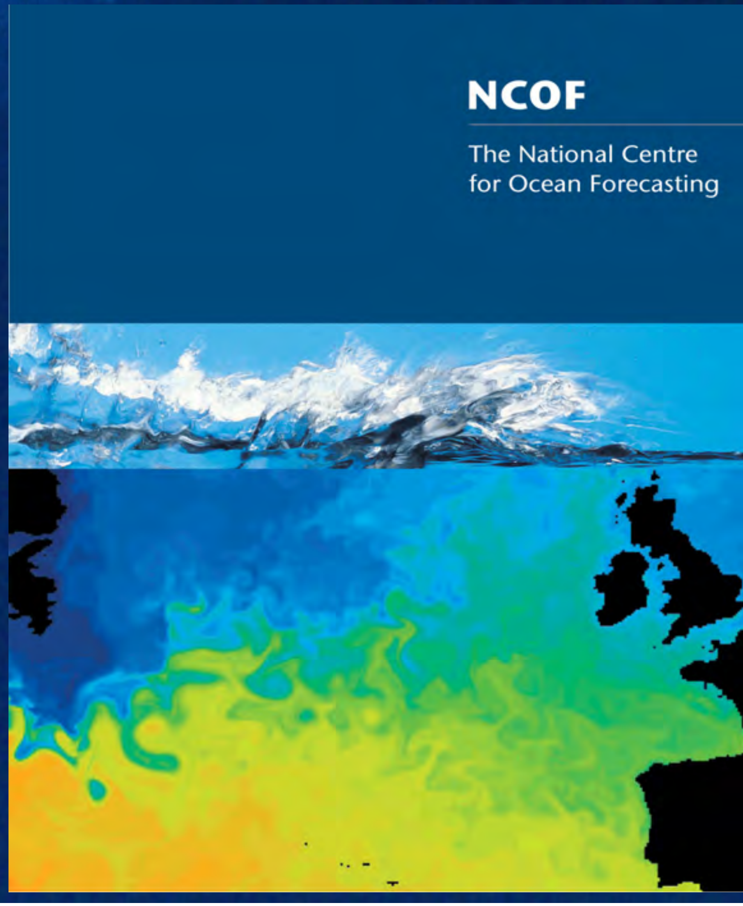


Number of Argo profiles in November 2011

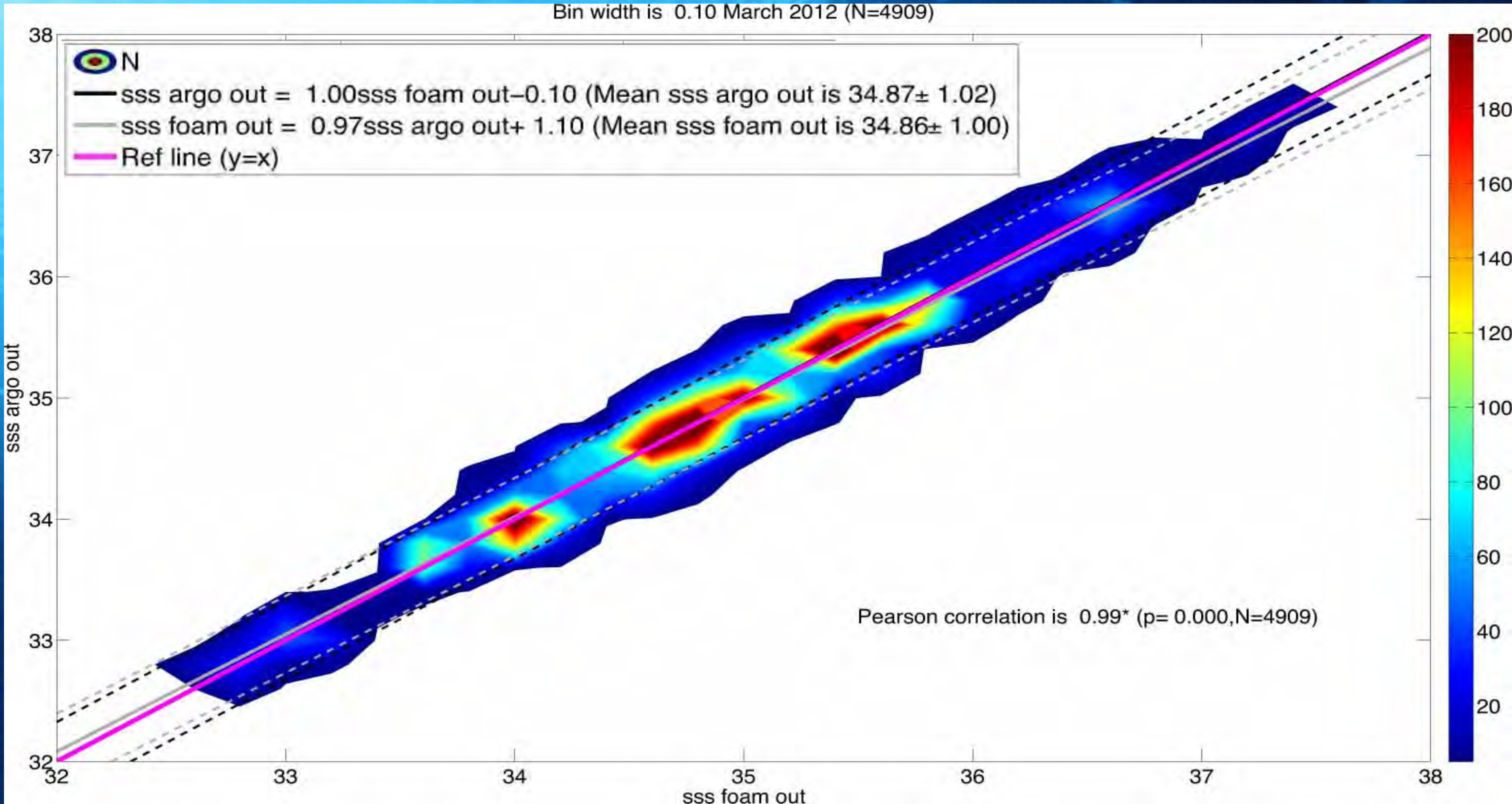
Model Output – FOAM/NEMO

Forecasting **O**cean **A**ssimilation **M**odel based on **N**ucleus for **E**uropean **M**odelling of the **O**cean

- ¼° resolution daily
- Averaged (mean) to 1° and then monthly
- Assimilates **Argo** data, as well as satellite SST, SSH and sea ice data



Is FOAM/NEMO suitable for validation?



Argo SSS

Model SSS

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L3 SSS
Sept 2011 –> Aug 2012

Median SSS in 1°x1° monthly grid

separately for asc and descending passes

ESA SMOS L2 v5.50

Only keep SSS where:

- L2 retrieval error < 1
- > 40 km from land
- summary flag for geophysical issues is OK (e.g. glint)
- summary flag for retrieval is OK (e.g. convergence)
- N_{obs}>25
- PLUS weighted mean version using error

Aquarius L2 v1.3

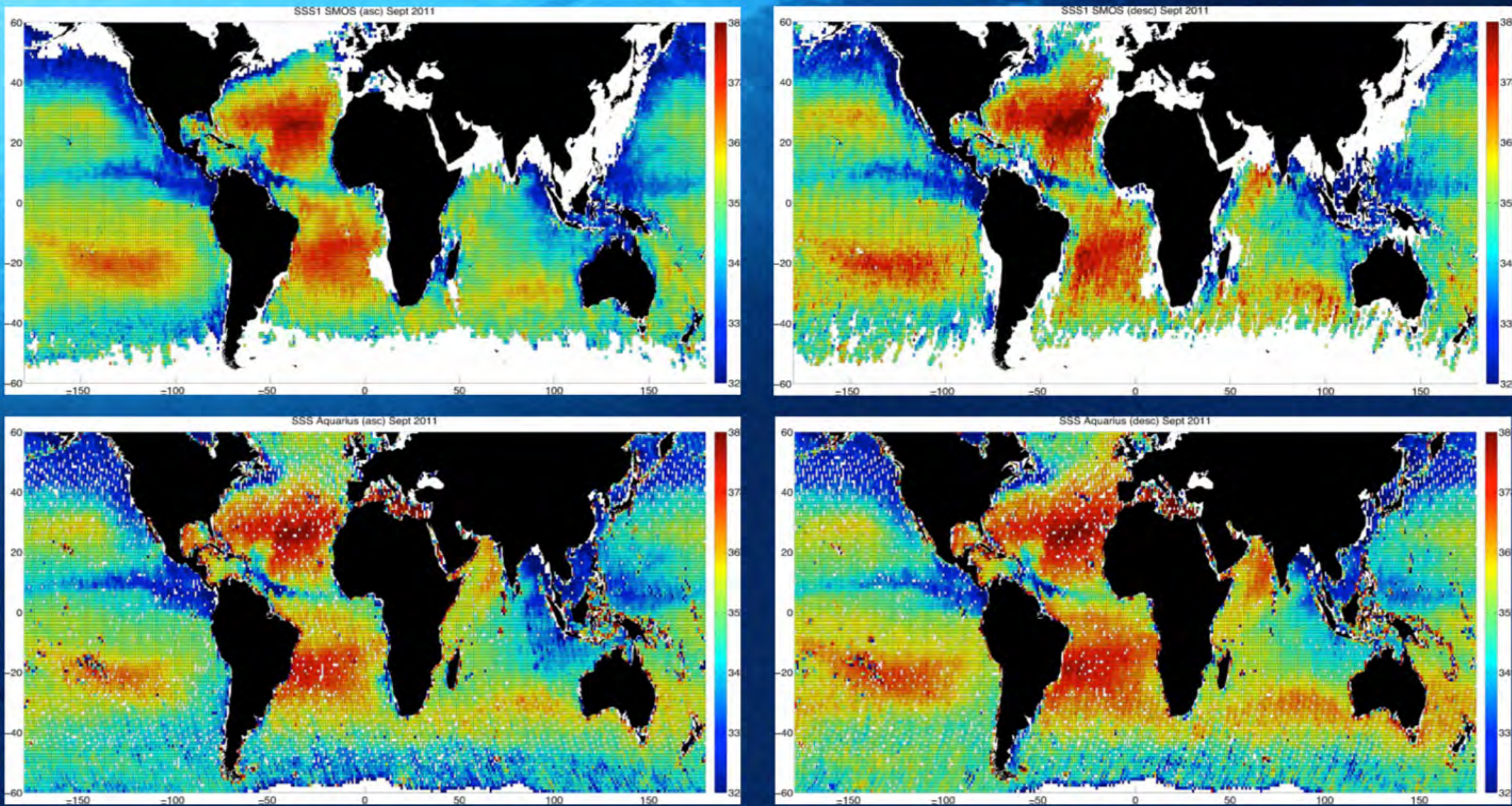
Only keep SSS where:

- 30 < SSS < 40
- -1.9ºC < SST < 40ºC and
- 0 ms^{-1} < wind speed < 60 ms^{-1}
- N_{obs}>5
- NO FLAGS

L3 SSS September 2011

Ascending | **Descending**

SMOS / **Aquarius**



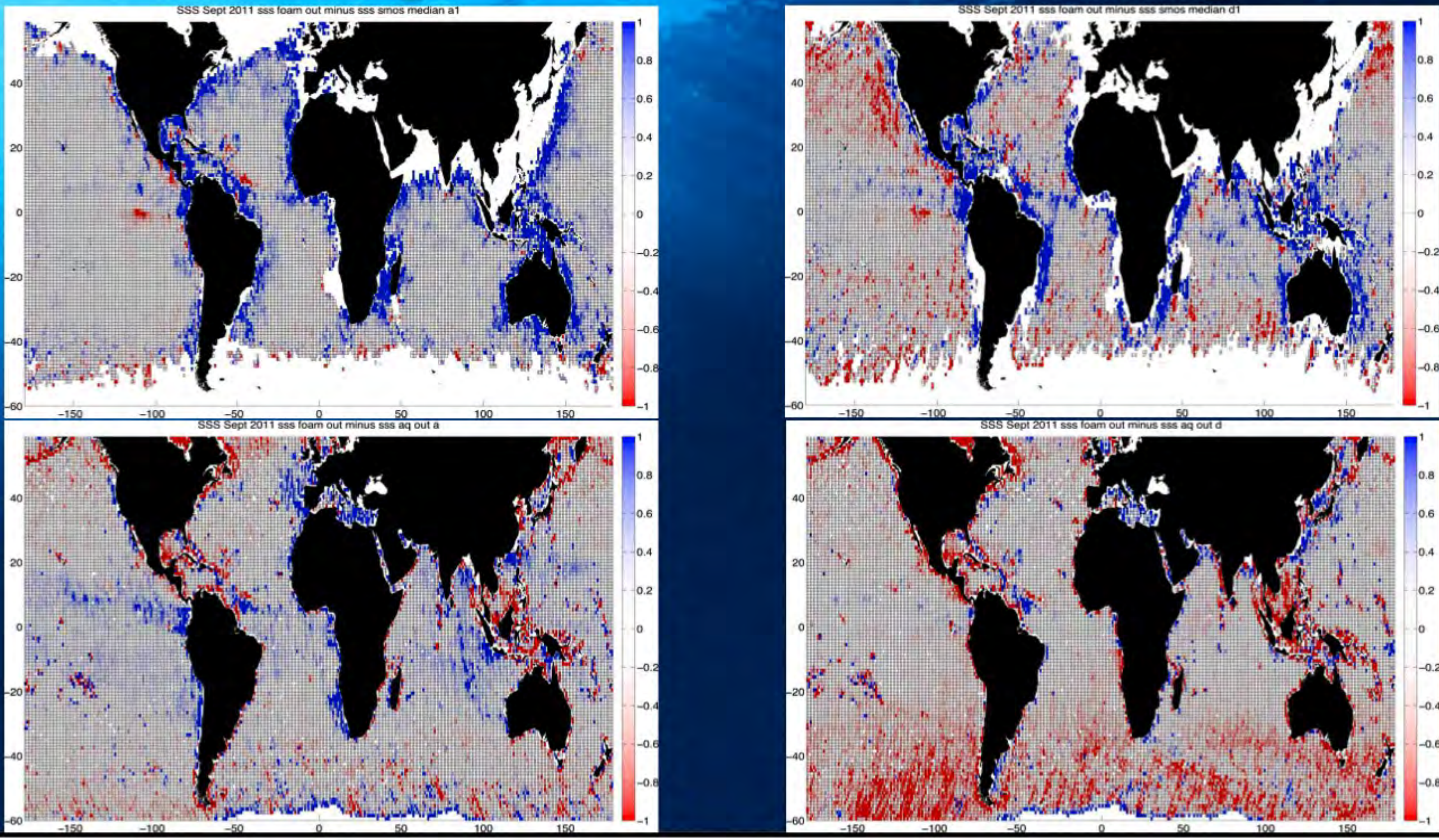
32 38

L3 SSS September 2011 FOAM/NEMO minus…

Ascending | Descending

SMOS

Aquarius



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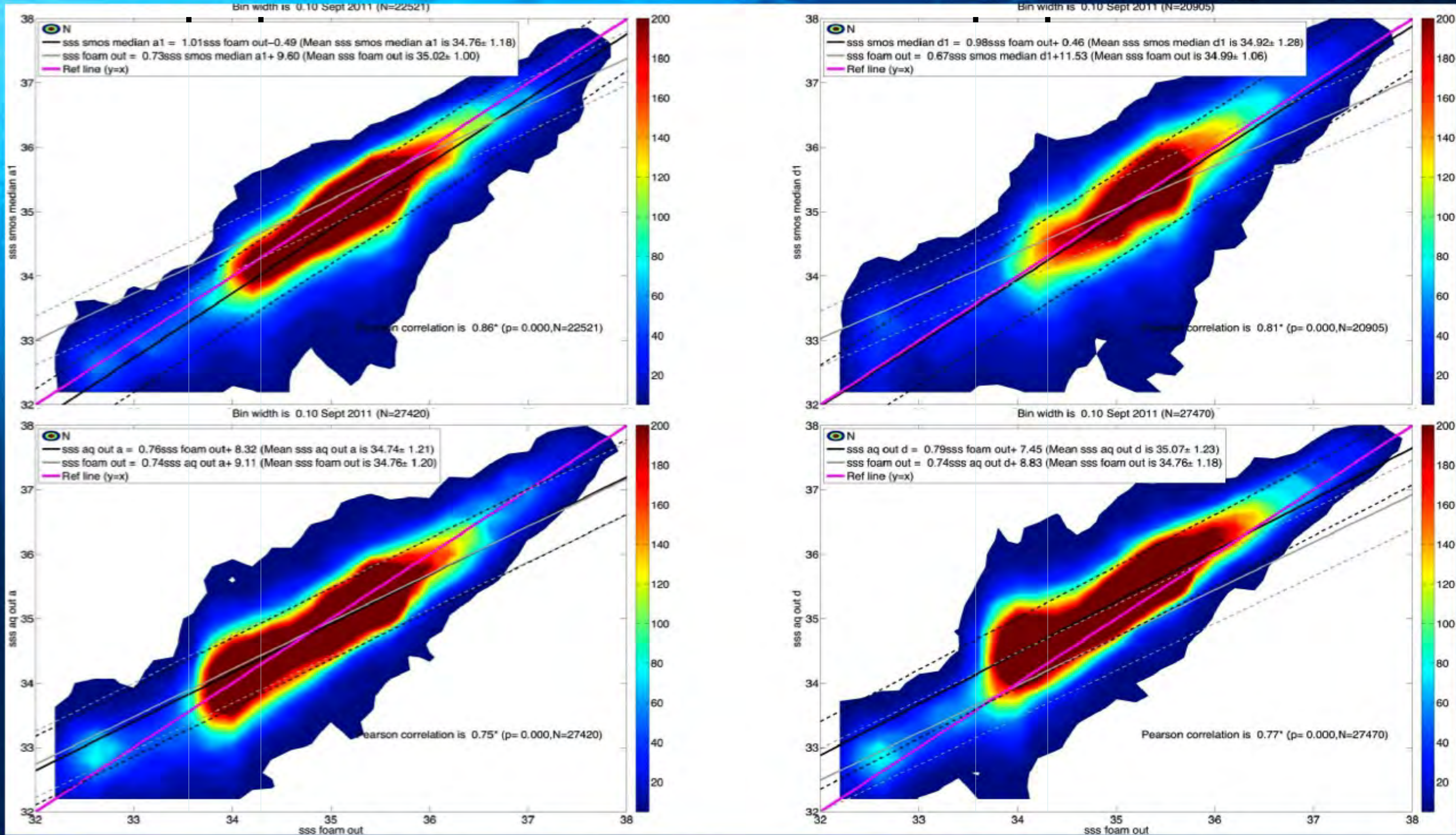
L3 SSS September 2011

Ascending / Descending

SMOS / Aquarius



33.6<SSS FOAM<34.2

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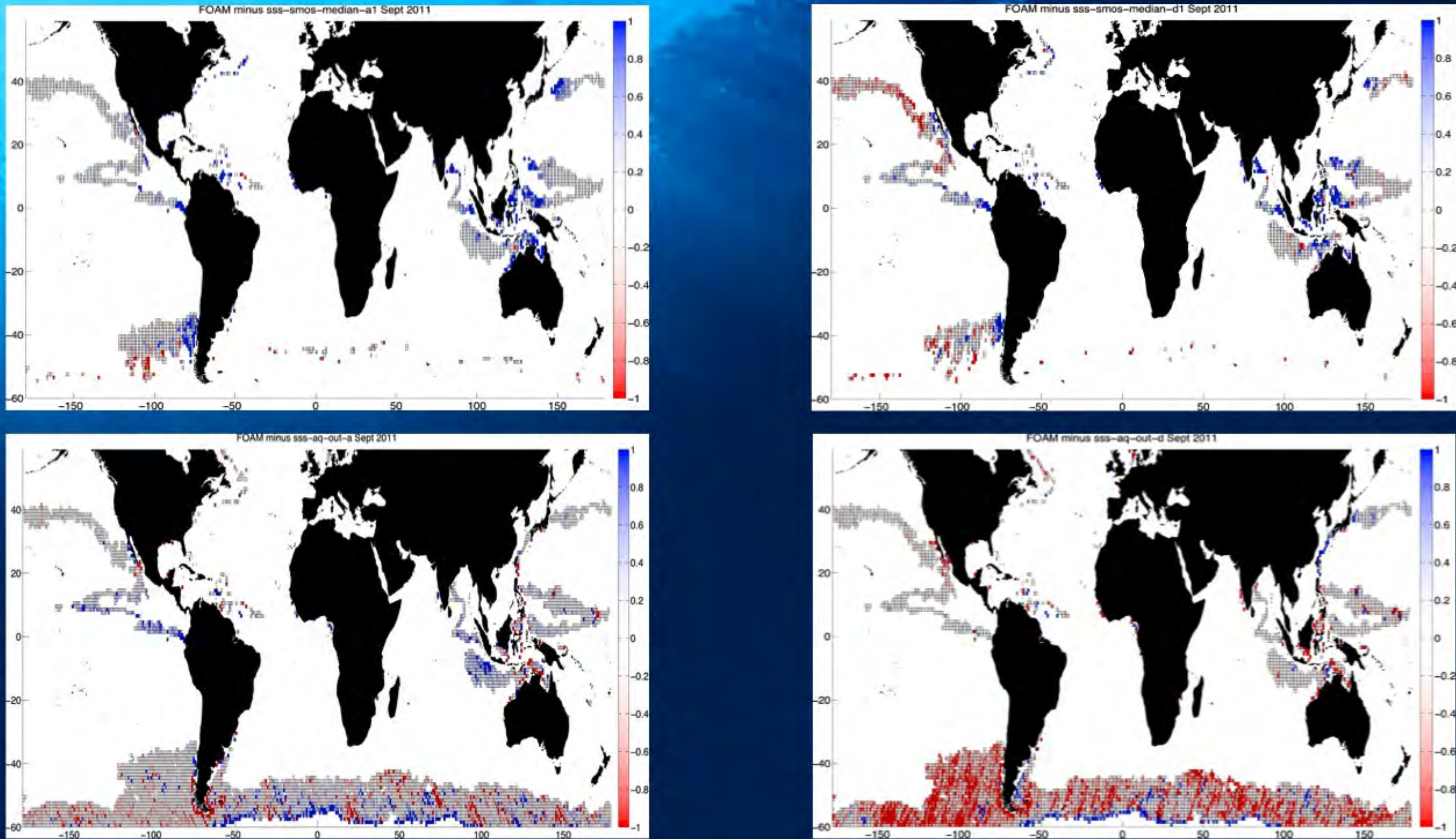
L3 SSS September 2011

Ascending / Descending

SMOS

Aquarius



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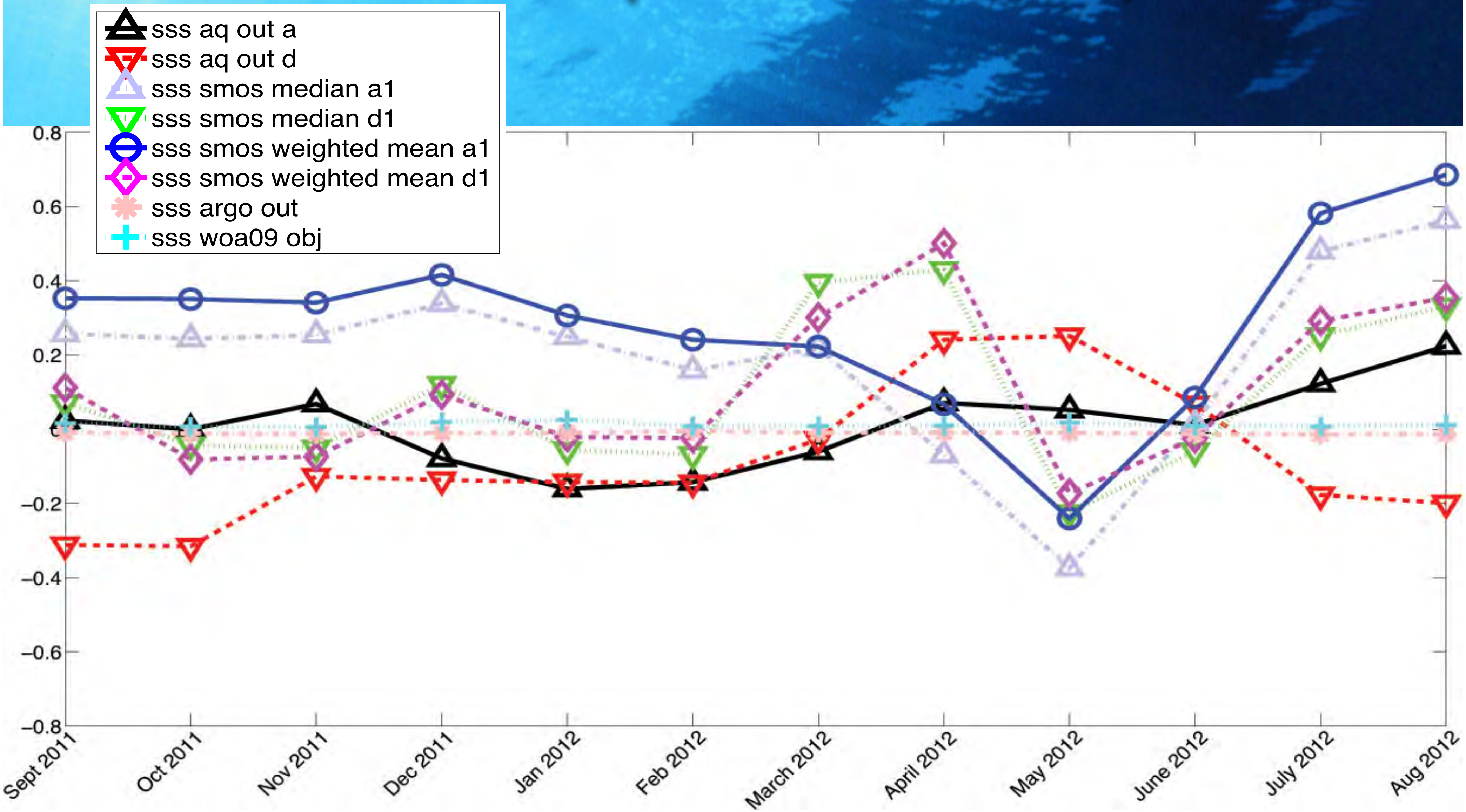
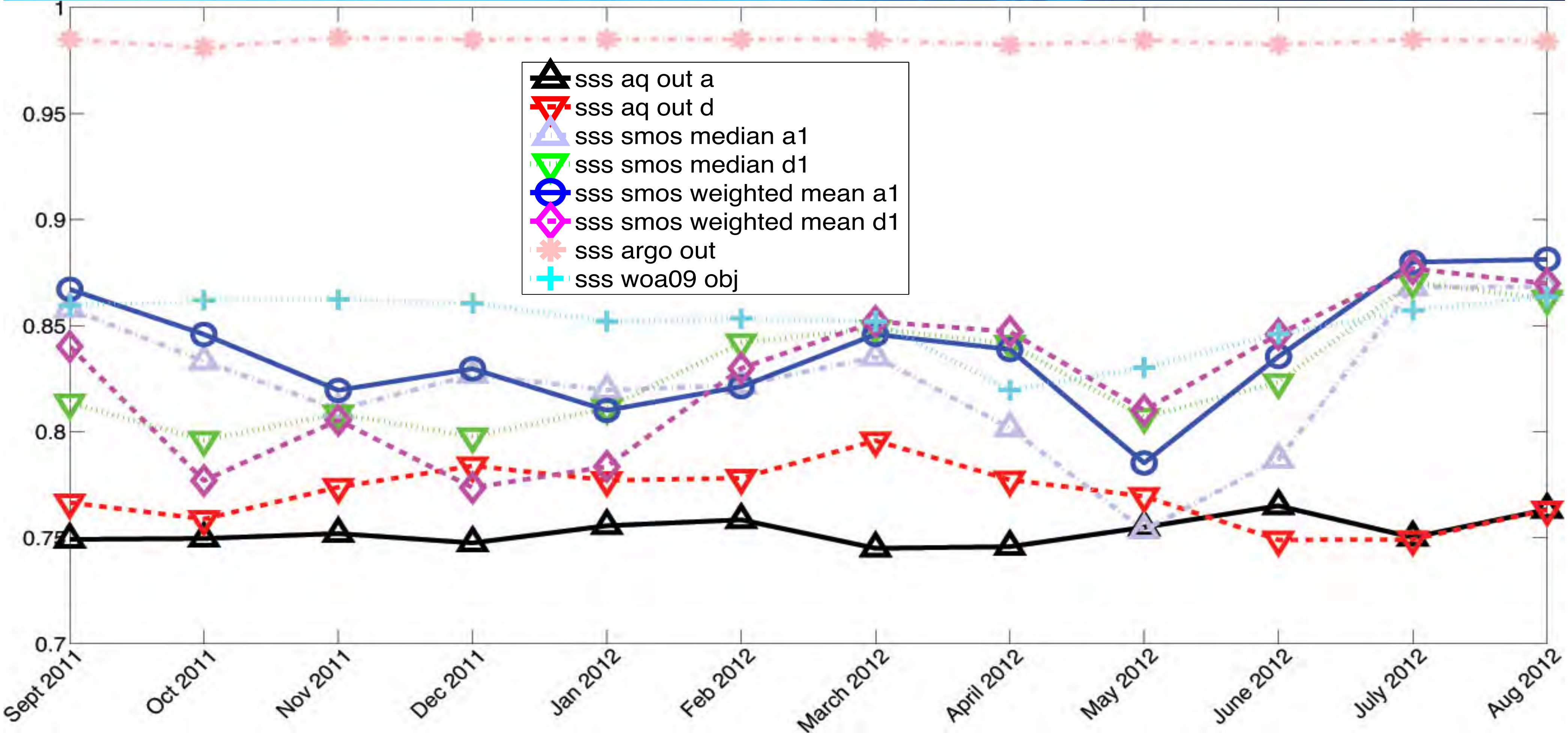
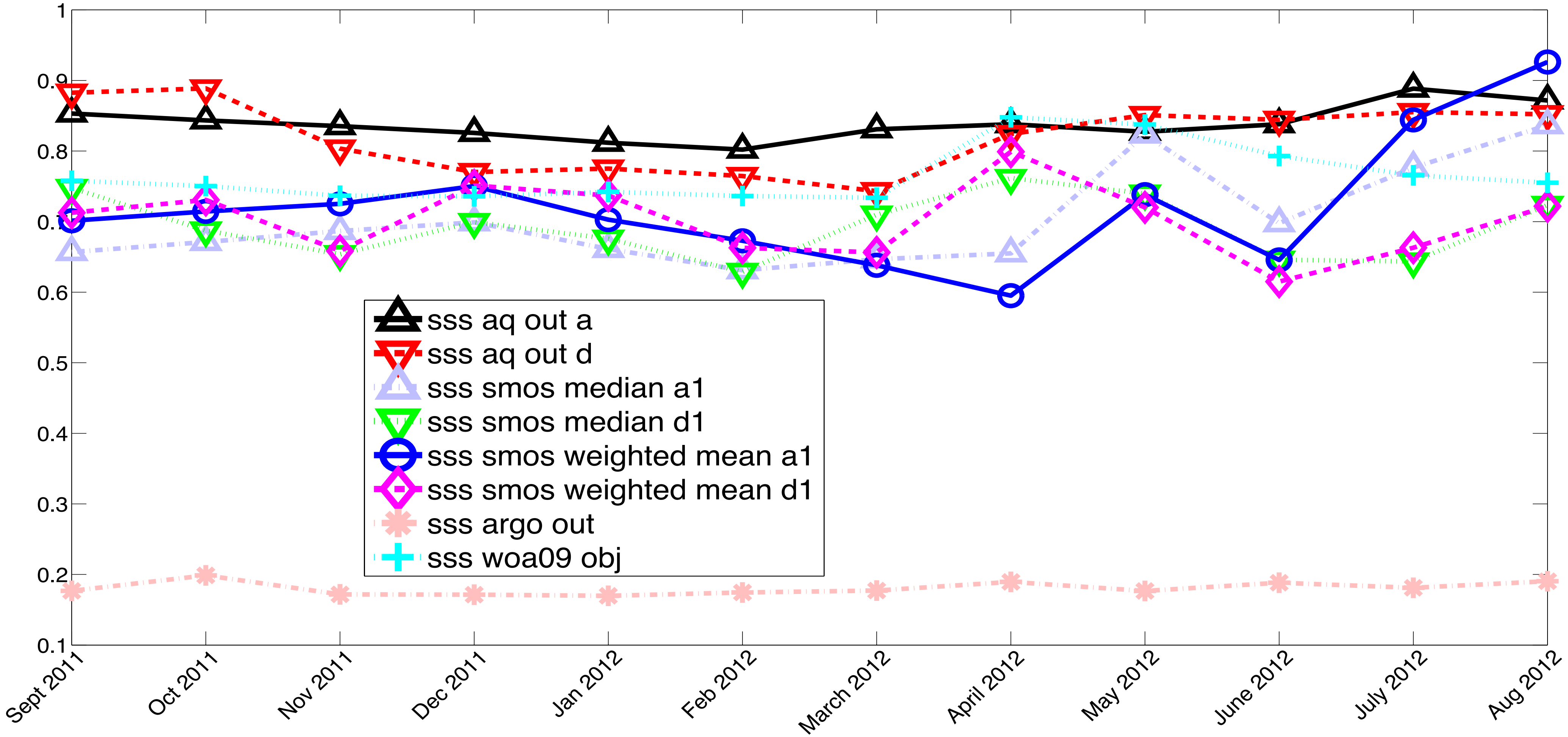
SSS Bias (FOAM - satellite)



SSS Correlation (FOAM & satellite)



SSS RMSD (FOAM & satellite)



Conclusions & Future Work

- Issues at high latitudes in Southern Hemisphere – wind? ice? galactic noise?
- RFI (radio frequency interference) remains a problem but much improved
- Not comparing like with like (SMOS vs. Aquarius filtering high southern latitudes)
  - Next step regional studies (e.g. SPURS)
- Aquarius and SMOS reprocessed data (plus CATDS SMOS data)
- Assimilation…

Thanks to

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www.nceo.ac.uk

SMOS S-MODE

www.smos-mode.eu

smos+ sos

support to science element

www.smos-sos.org

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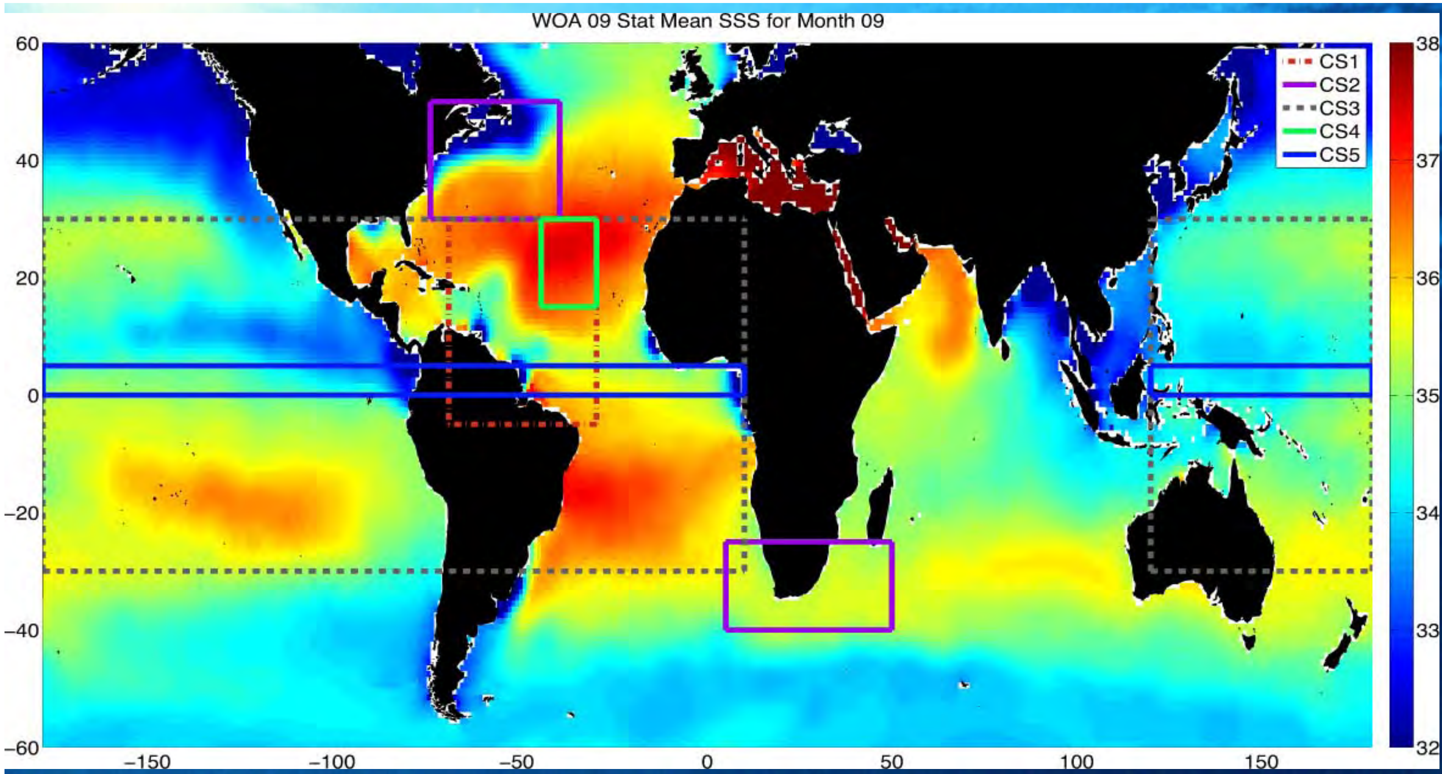
SMOS+SOS Project

- demonstrate the performance and scientific value of SMOS products through 5 well-defined case studies (CS)
- examine and quantify discrepancies between SMOS and *in situ* surface salinity data at various depths in different regions characterised by strong precipitation or evaporation regimes

smos+ sos
support to science element



smos+ sos
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Ref.	Case Study area	Motivation
CS1	Amazon/Orinoco plumes	Freshwater Outflow
CS2	Agulhas, Gulf Stream	Strong water mass boundary region
CS3	Tropical Pacific & Atlantic	Strong precipitation regime
CS4	Sub-tropical North Atlantic (SPURS)	Strong evaporative regime
CS5	Equatorial Pacific	Equatorial upwelling

SMOS and in situ salinity: rain and near-surface vertical stratification effects

J. Boutin[1], N. Martin[1], O. Hernandez[1], G. Reverdin[1], F. Gaillard[2], S. Morrisset[1], N. Reul[3]

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[3] IFREMER/LOS Toulon, France

+ Coll. With T. Delcroix, C. Maes IRD/LEGOS Toulouse, France

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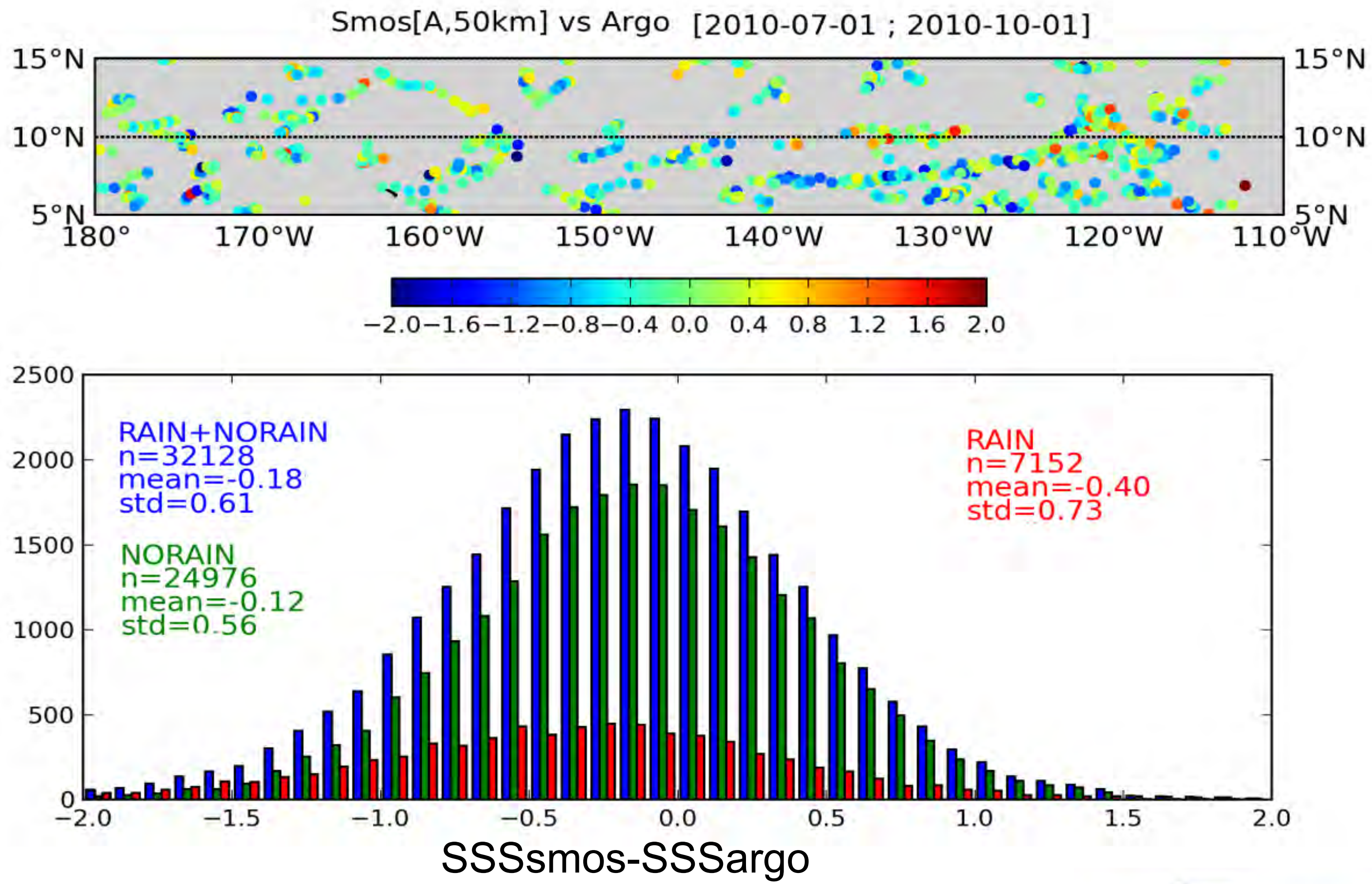
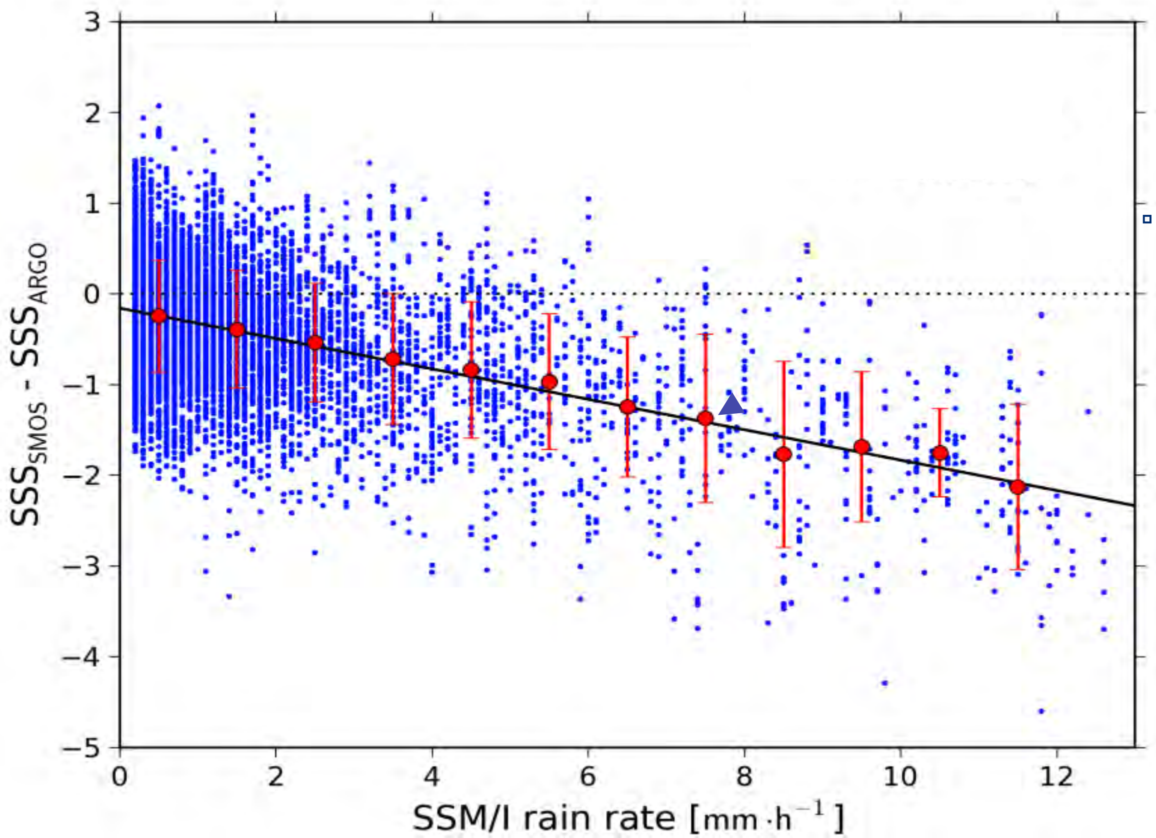
SMOS S_{1cm} – ARGO $S_{\sim 5m}$ & SSMI Rainfall rate SMOS ascending passes (6am) ITCZ (N. Pacific)



Boutin et al., Ocean Science, 2013

SMOS SSS- ARGO SSS vs. SSMI Rainfall Rate Tropical Pacific 5S-5N (July-Sept 2010)



-0.17 pss/ mm/hr
r = -0.5

-0.17 pss/mm/hr
>>
atmospheric contribution
~ - 0.03pss/mm/hr
Rayleigh approximation (e.g., Peichl et al., 2004; Wentz, 2005) **:**

=> slope corrected from atm. ~-0.14pss/mm/hr

Fresher 1cm SSS linked to rain???
Roughness effect ???

Boutin et al, 2013