Rain impact on SMOS SSS in intertropical convergence zone of the Pacific

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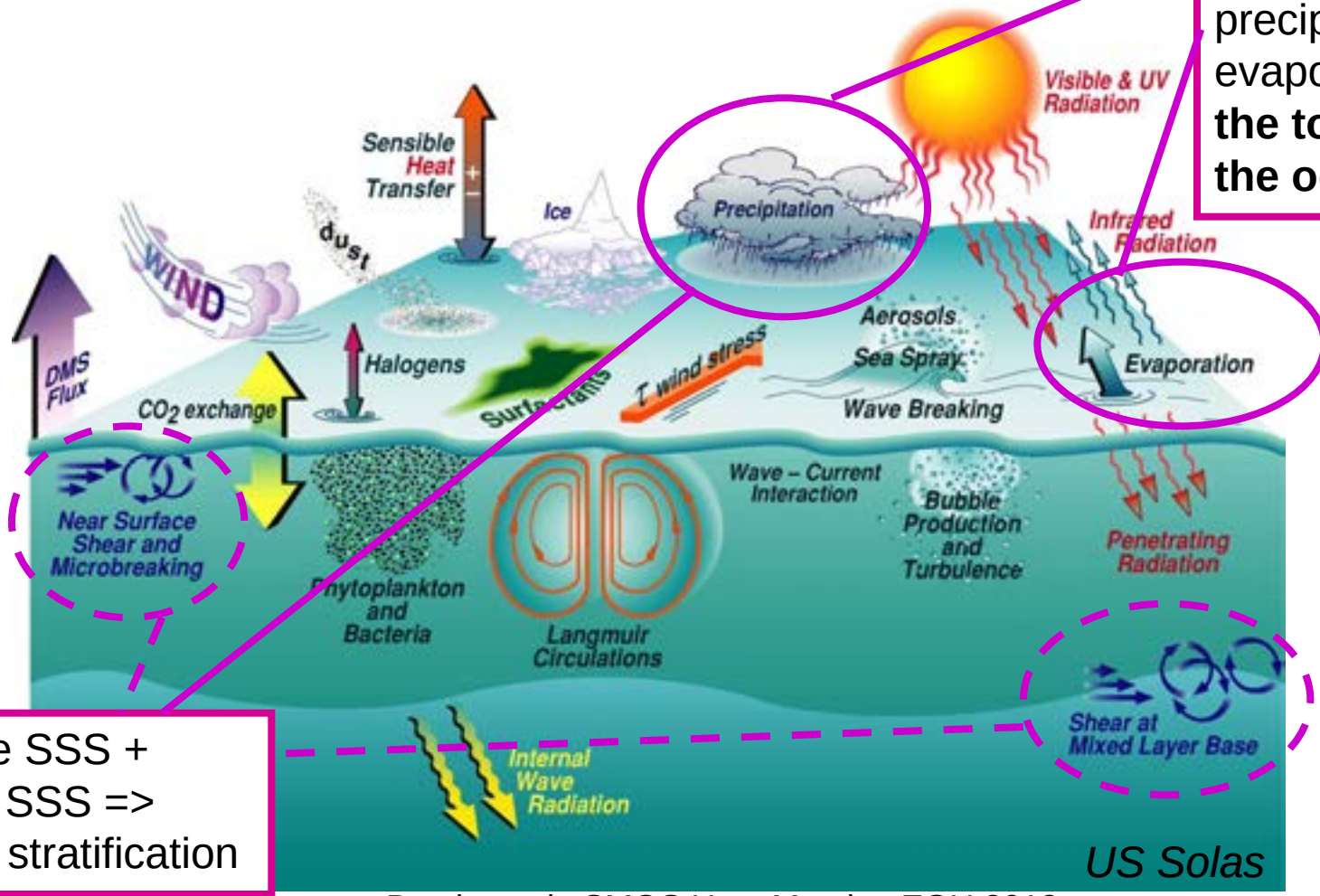
Processes responsible for the air-sea exchange of biogeochemical and physical quantities (mass, heat, momentum)

(Surface Ocean Lower Atmosphere Study (SOLAS))

Satellite SSS: a tracer of precipitation – evaporation **in the top 1 cm of the ocean**

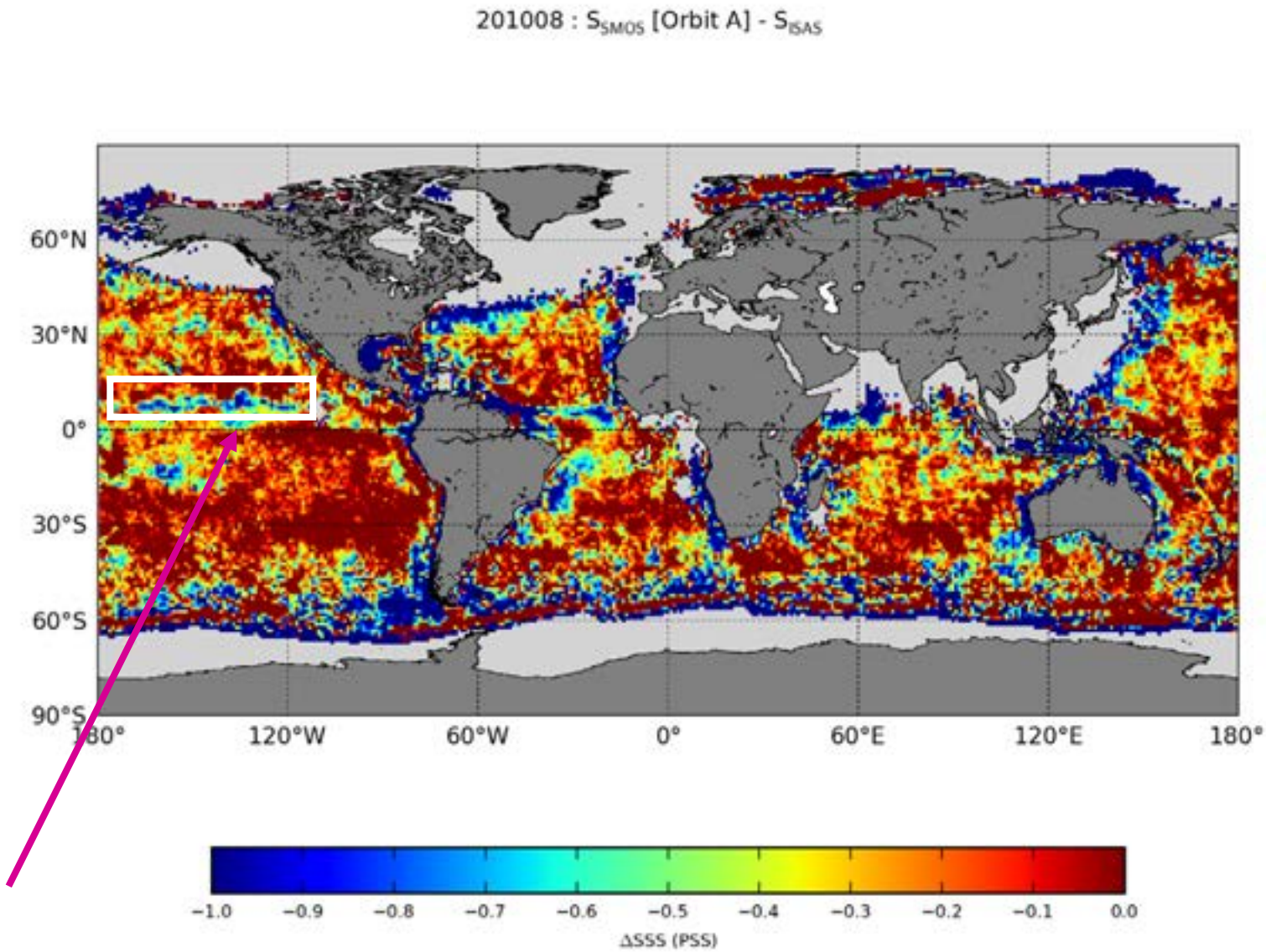


Satellite SSS + deeper SSS => vertical stratification

US Solas

Boutin et al., SMOS User Meeting EGU 2012

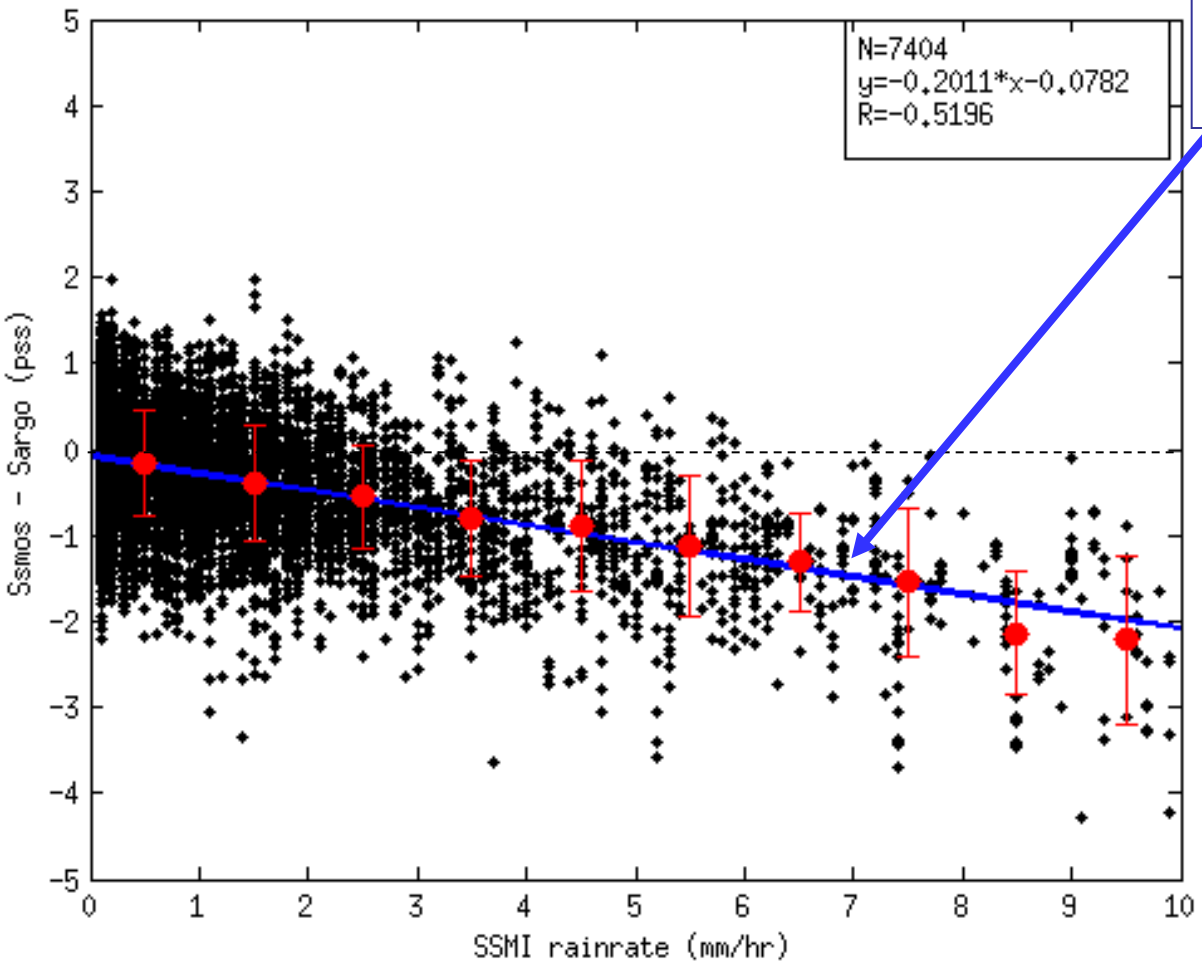
SMOS SSS (v5) – ARGO Optimal Interpolation



SMOS SSS & SSMI Rain Rate colocation in tropical Pacific Ocean (5N-15N)

- **SMOS SSS - 40km resolution**
- Rain Rate deduced from SSMI F16 and F17 (RemSS version 7); 32km spatial resolution
- Colocation of SMOS SSS and SSMI Rain Rate: closest RR within -80mn and +40mn from SMOS time
- **Statistics of SSSsmos-SSSargo depending on SSM/I RR**

SMOS SSS- ARGO SSS versus SSMI RR Tropical Pacific 5S-5N (July-Sept 2010) => 1cm freshening linked to rain

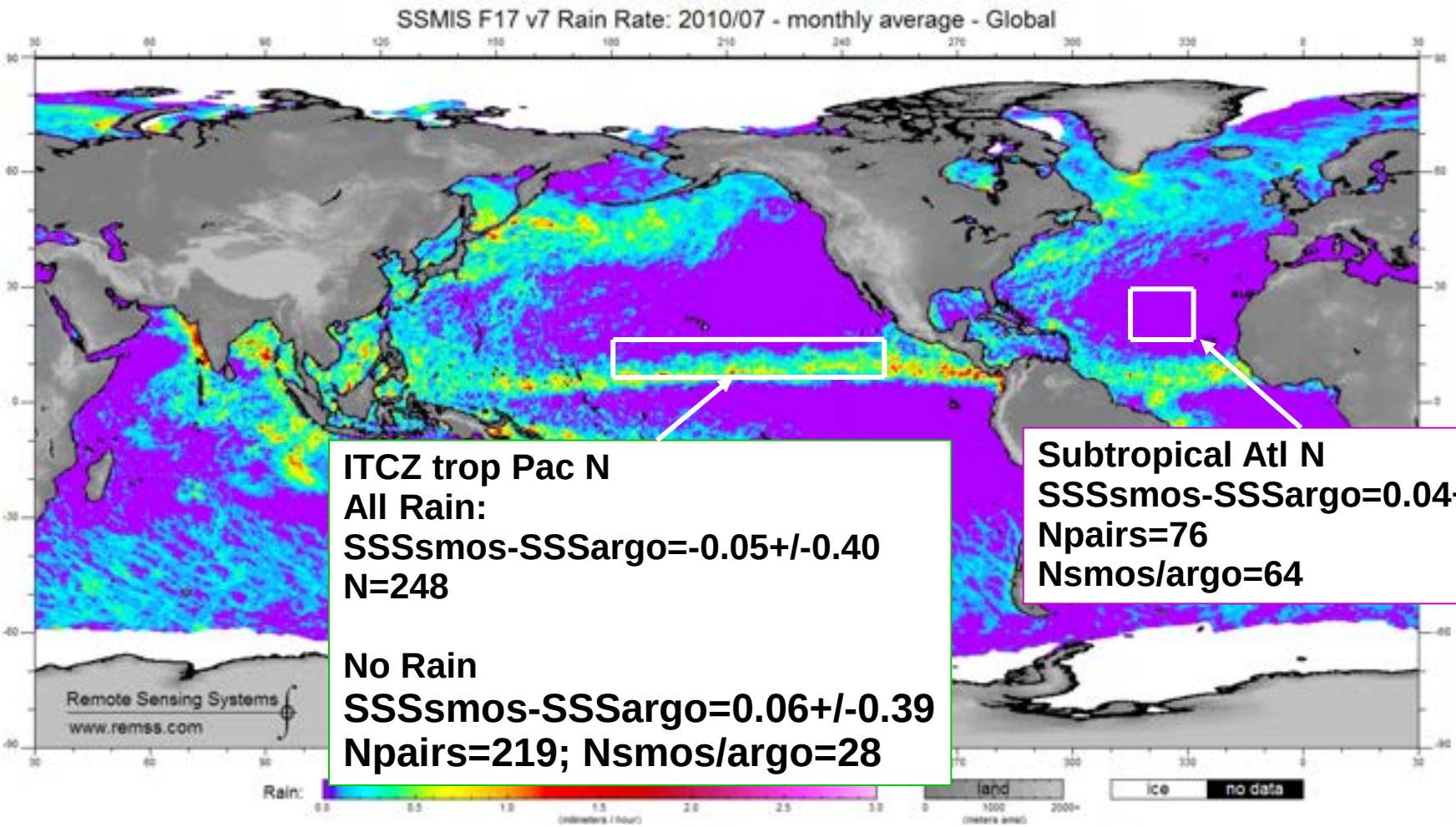


-0.2 pss/ mm/hr
R=-0.5

Boutin et al, 2012, in prep.

Comparison with ARGO:
SMOS averaged over 10 days-100km around ARGO

=> clear impact on SMOS SSS validation



ITCZ trop Pac N
All Rain:
SSSsmos-SSSargo=-0.05+/-0.40
N=248

No Rain
SSSsmos-SSSargo=0.06+/-0.39
Npairs=219; Nsmos/argo=28

Subtropical Atl N
SSSsmos-SSSargo=0.04+/-0.2
Npairs=76
Nsmos/argo=64

Ascending orbits (center of orbit; OTT asc) 3<WS<12m/s
SMOS SSS averaged around ARGO (+/-50km; +/-10days)

Issues

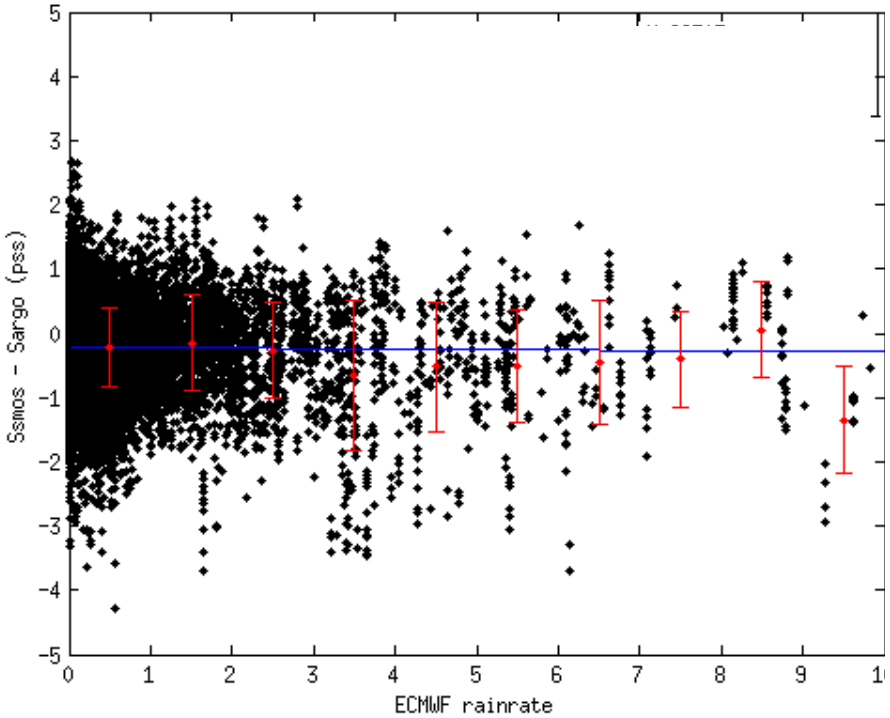
- How to identify rainy measurements
- Is SSS freshening a true signal; Could it be an artefact of SMOS SSS processing?

How to identify rainy measurements?

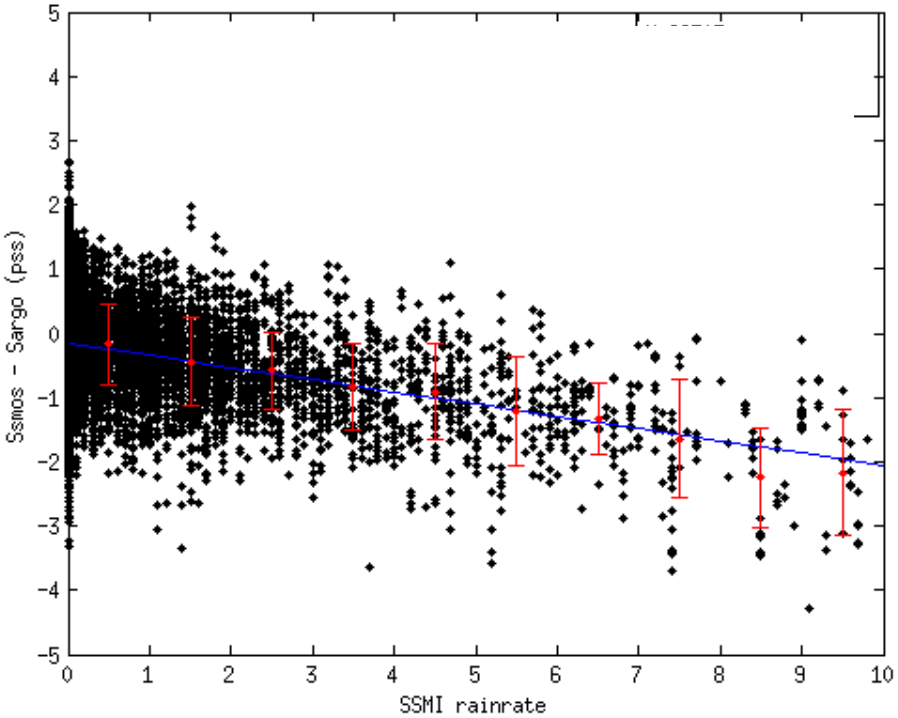
ECMWF Rain Rate not enough precise for monitoring Rain Events in the tropical Pacific

SMOS SSS - ARGO SSS versus

ECMWF RR



SSMI RR



Issues

- **How to identify rainy measurements:**
  - Difficult to flag each SMOS SSS close to rain event
  - Define rainy regions

- Is SSS freshening a true signal; Could it be an artefact of SMOS SSS processing?

Could it be an artefact of SMOS SSS retrieval? (1)

- Atmospheric Rayleigh scattering by rain is neglected in L2 OS processor: At L-band, expected to have a weak impact (e.g. J. Schulz, 2004 for RR<10mm/hr; Wentz, 2005 ~10% of the freshening we observe):

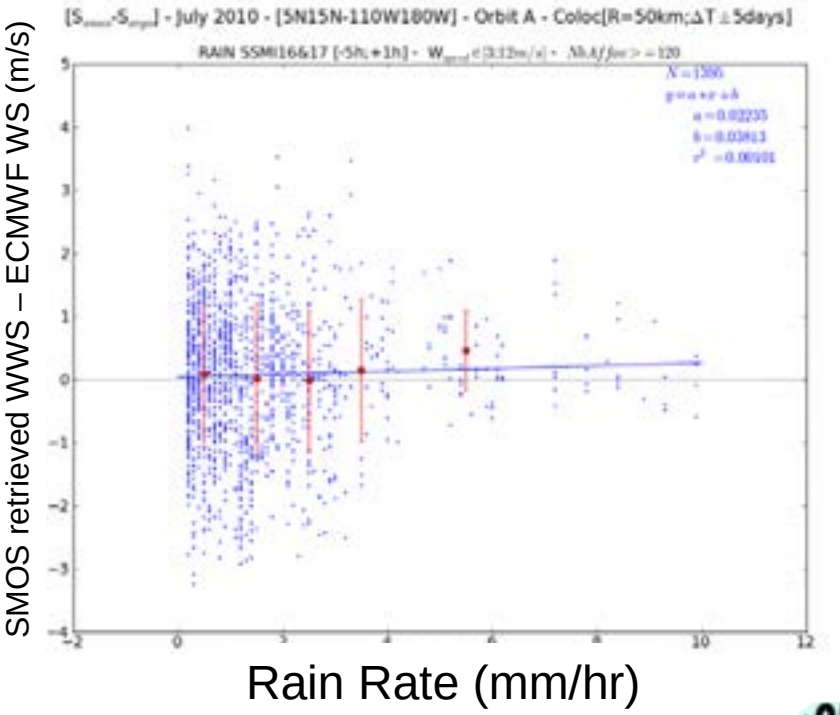
  => it is not an atmospheric effect!

- ECMWF wind speed in rainy conditions?

  => Very unlikely

Differences between ECMWF and SMOS retrieved wind speed are not significantly correlated with RR => probably not an effect of ECMWF wind speed flaw (NB to explain a 2pss freshening, need a 7m/s WS bias)

(Rain events not expected to be systematically associated with an increase of the wind)

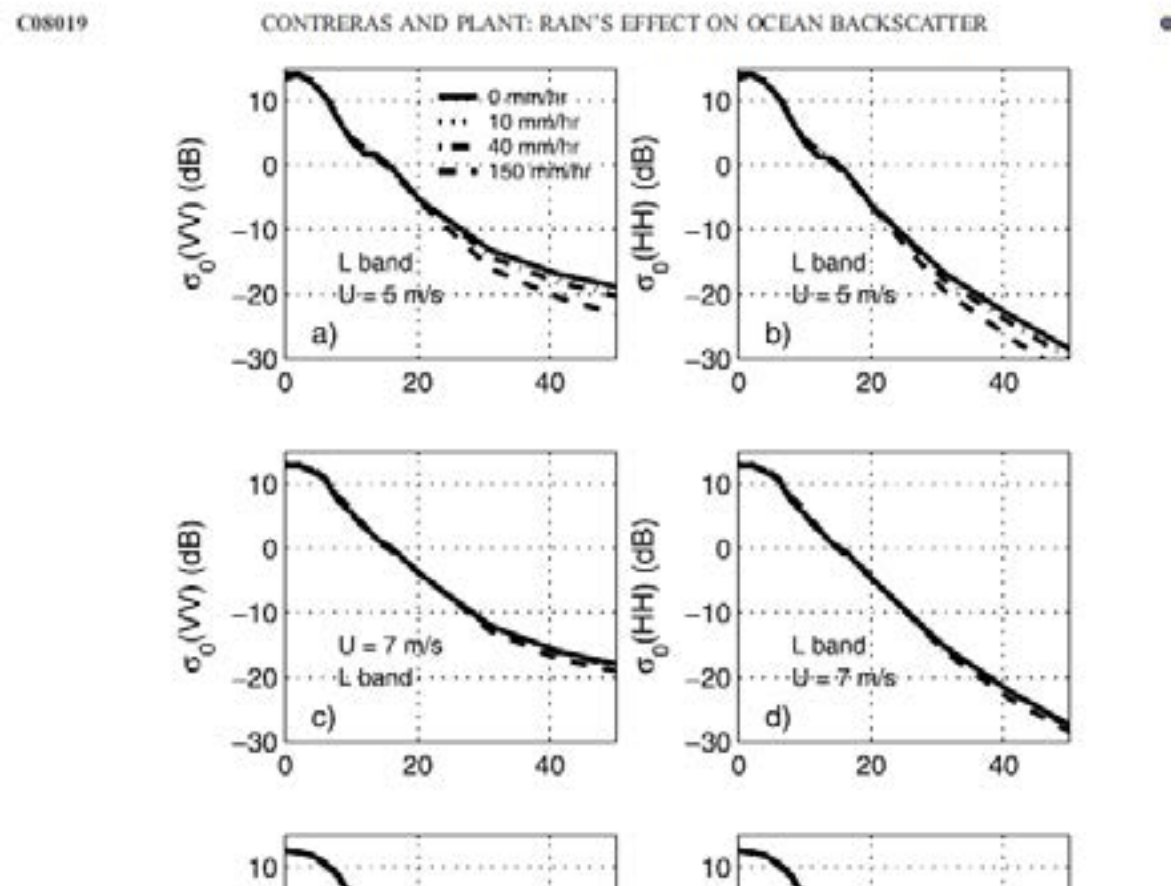


(N.B.: 1psu ⇔ ~0.7K ⇔ ~3.5m/s)

Could it be an artefact of SMOS SSS retrieval? (2)

- Modification of ocean surface waves by rain is expected to have a small (negative) impact on microwave backscatter from the ocean at L-band (Contreras and Plant, 2006)

  => cannot explain the SMOS Tbs increase



Issues

- How to identify rainy measurements:
  - Difficult to flag each SMOS SSS
  - Better to define rainy regions

- **Is SSS freshening a true signal?**

  Yes, very likely
- **Could it be an artefact of SMOS SSS processing?**

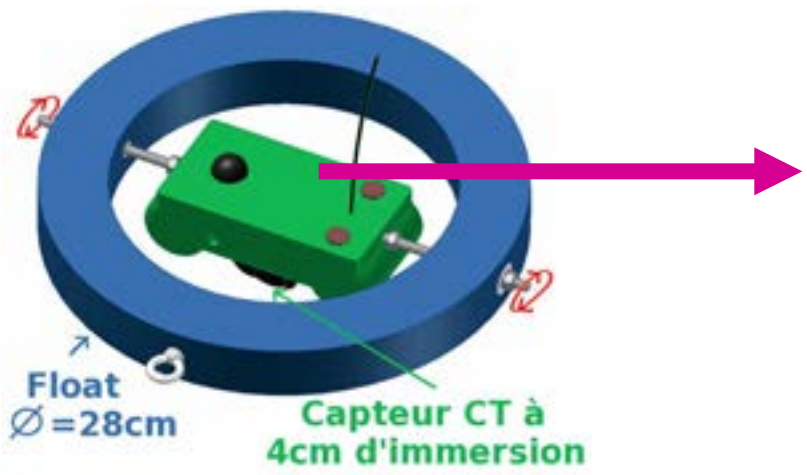
  No, very unlikely

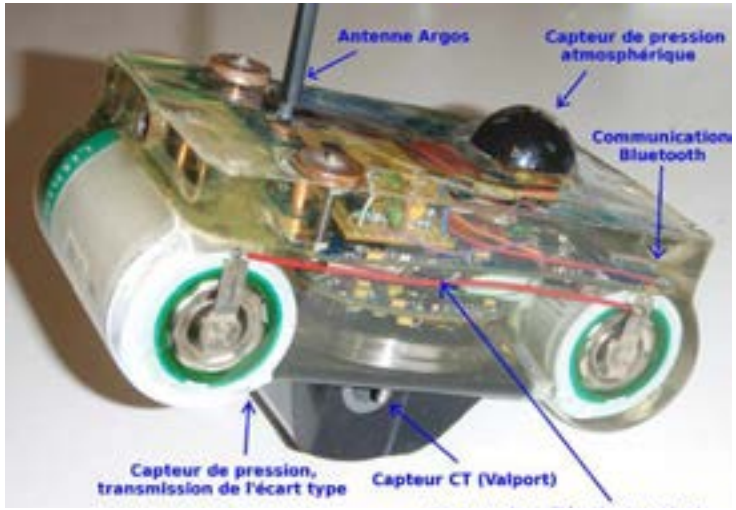
Nevertheless need for in situ validation

-numerous deployments of surface drifters in rainy regions!

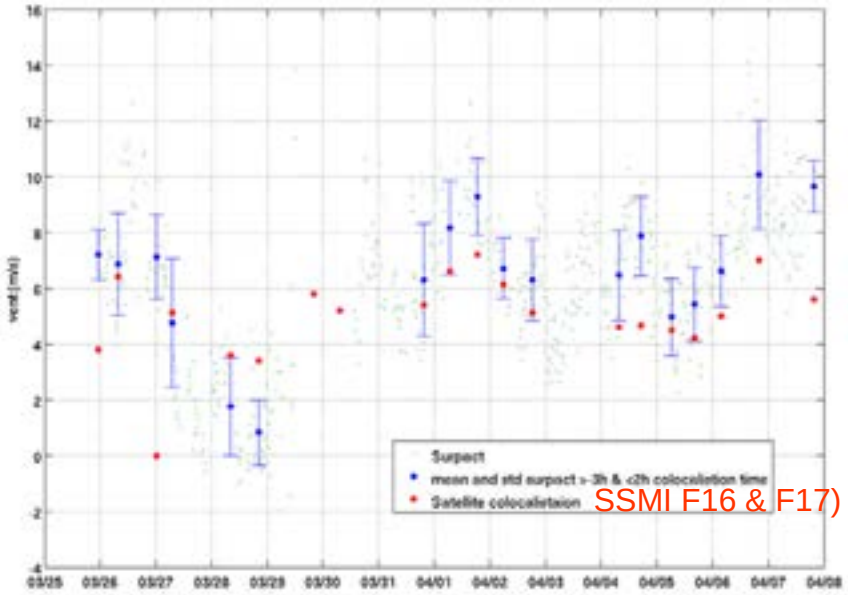
-new development for measuring near-surface salinity and surface waves

Instrumental development in progress (LOCEAN & SMRU): SURPACT => SSS at 4cm depth + wave spectrum





Wind speed inferred from SURPACT wave spectrum in the tropical Atlantic very encouraging



Morrisset, Reverdin et al. 2012

Summary & Perspectives

- The observed correlation between SMOS-SSS freshening and SSMI rain rate is very likely a true effect of ocean surface stratification

=>satellite SSS provides new type of information about surface stratification: a new era for air-sea exchange processes studies…

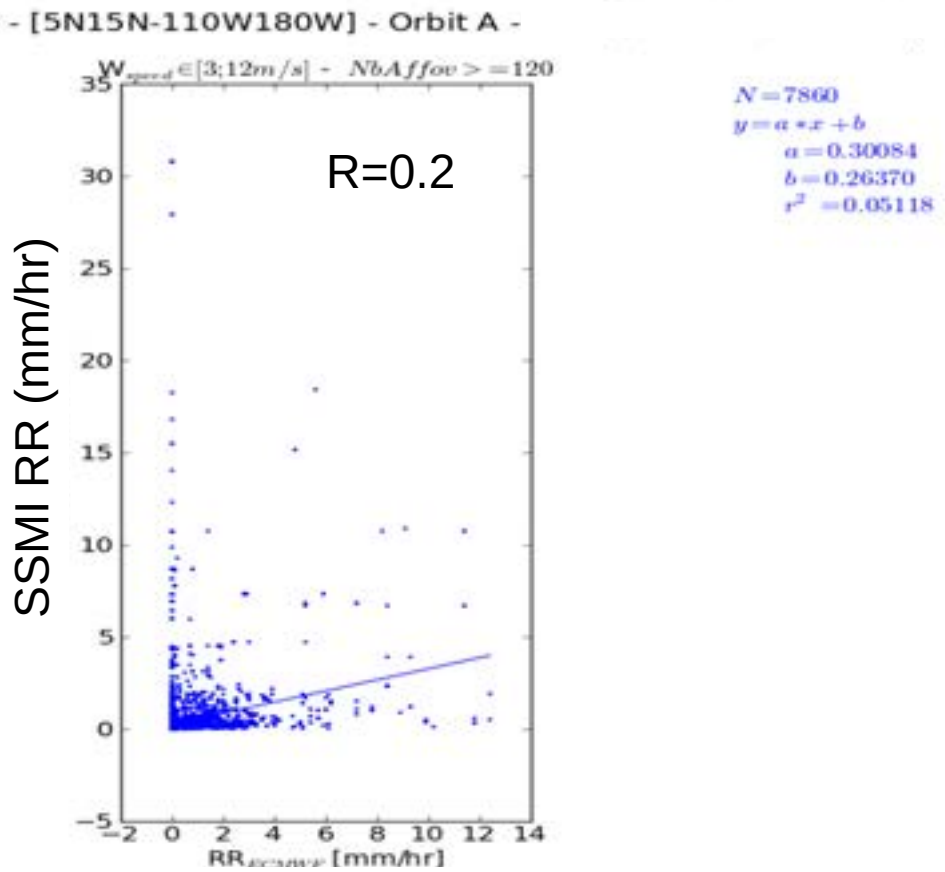
BUT:

=>complicated SMOS-in situ validation in rainy regions

=> are the ocean models ready for assimilating these data? Should we foresee SSS products cleant for rainy conditions? How?

- Efforts from the international community for making measurements closer to the surface (drifters; profilers; argo STS…) should help confirming L-band radiometer observations

Thanks for your attention

How to identify rainy conditions?

ECMWF predicted Rain Rate (in SMOS DAP file) not enough precise for monitoring Rain Events in the tropical Pacific