SMOS and hydrology

Yann H. Kerr, Al Bitar Ahmad, Delphine Leroux, Thierry Pellarin, Beatriz Molero, Audrey Choné, Marie Parrens, Jean-Pierre Wigneron

▶ **To cite this version:**

Yann H. Kerr, Al Bitar Ahmad, Delphine Leroux, Thierry Pellarin, Beatriz Molero, et al.. SMOS and hydrology. ESA-ESRIN Earth Observation for Water Cycle Science 2015, Oct 2015, Frascati, Italy. hal-02743524

HAL Id: hal-02743524

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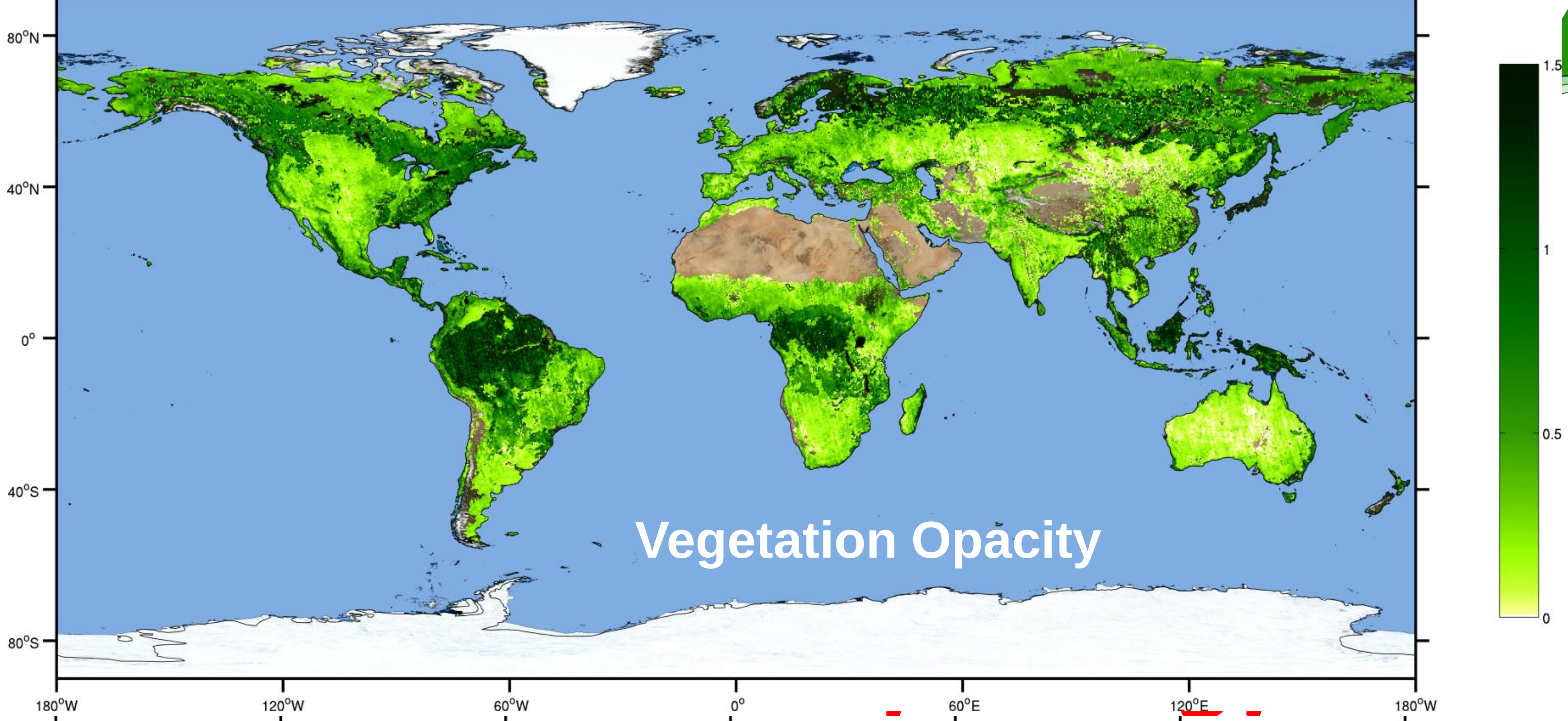
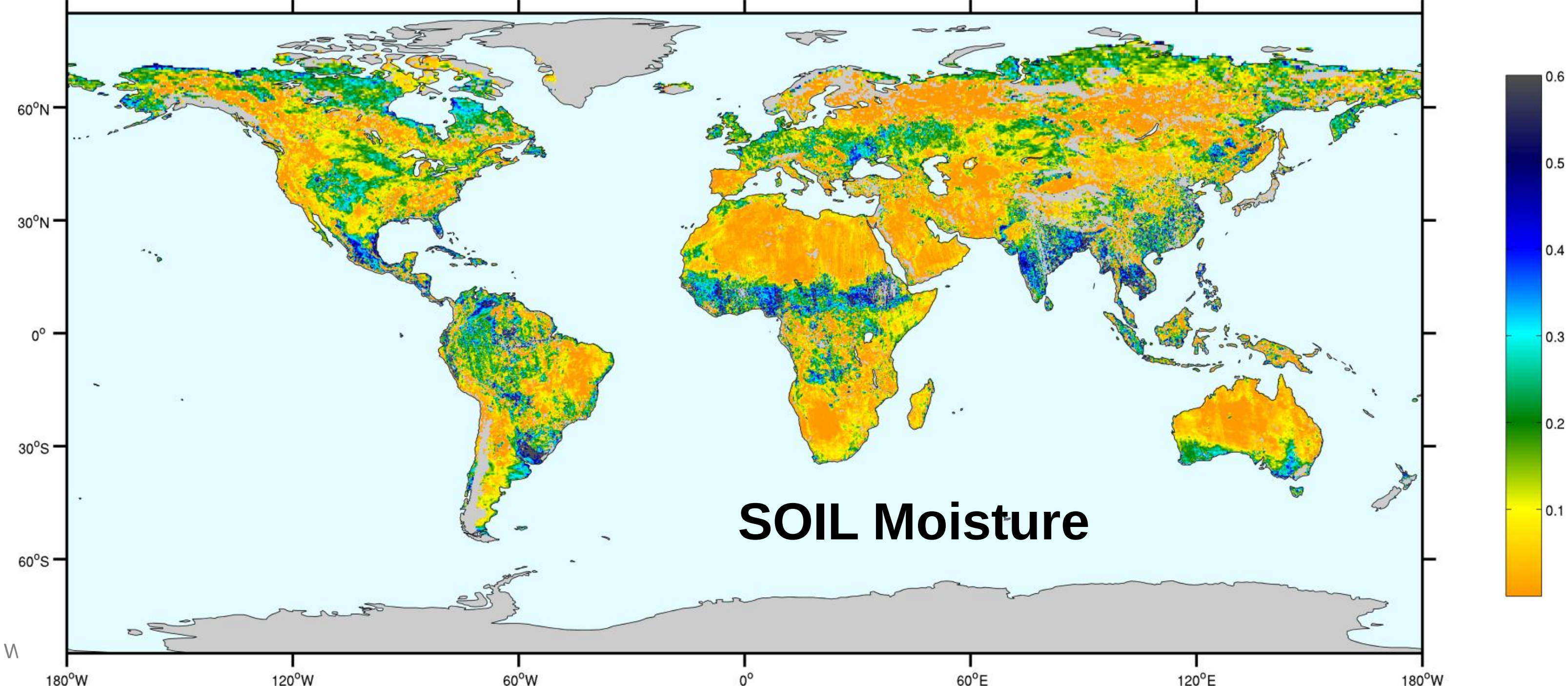

Vegetation Opacity
80°N
40°N
0°
40°S
80°S
180°W
120°W
60°W
0°
60°E
120°E
180°W
1.5
1
0.5
0


SOIL Moisture
60°N
30°N
0°
30°S
60°S
180°W
120°W
60°W
0°
60°E
120°E
180°W
0.6
0.5
0.4
0.3
0.2
0.1

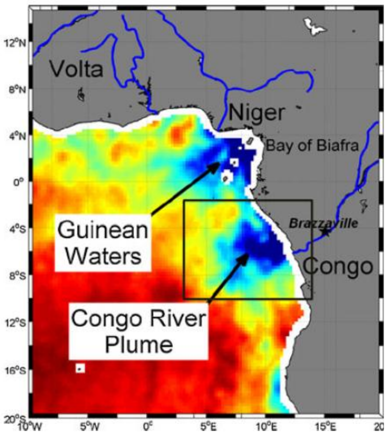
Layout

- Some examples
  - Over oceans (se yesterday's talks)
  - From high to low resolution over land
  - Streamflow
  - Water bodies
  - Rain estimates
  - Flood risks mapping
  - Snow properties
- Way forward

Ocean … reminder

AIR-SEA INTERACTIONS: FRESH WATER OUTFLOW, RAIN, …

Seasonal cycle of Congo and Niger rivers



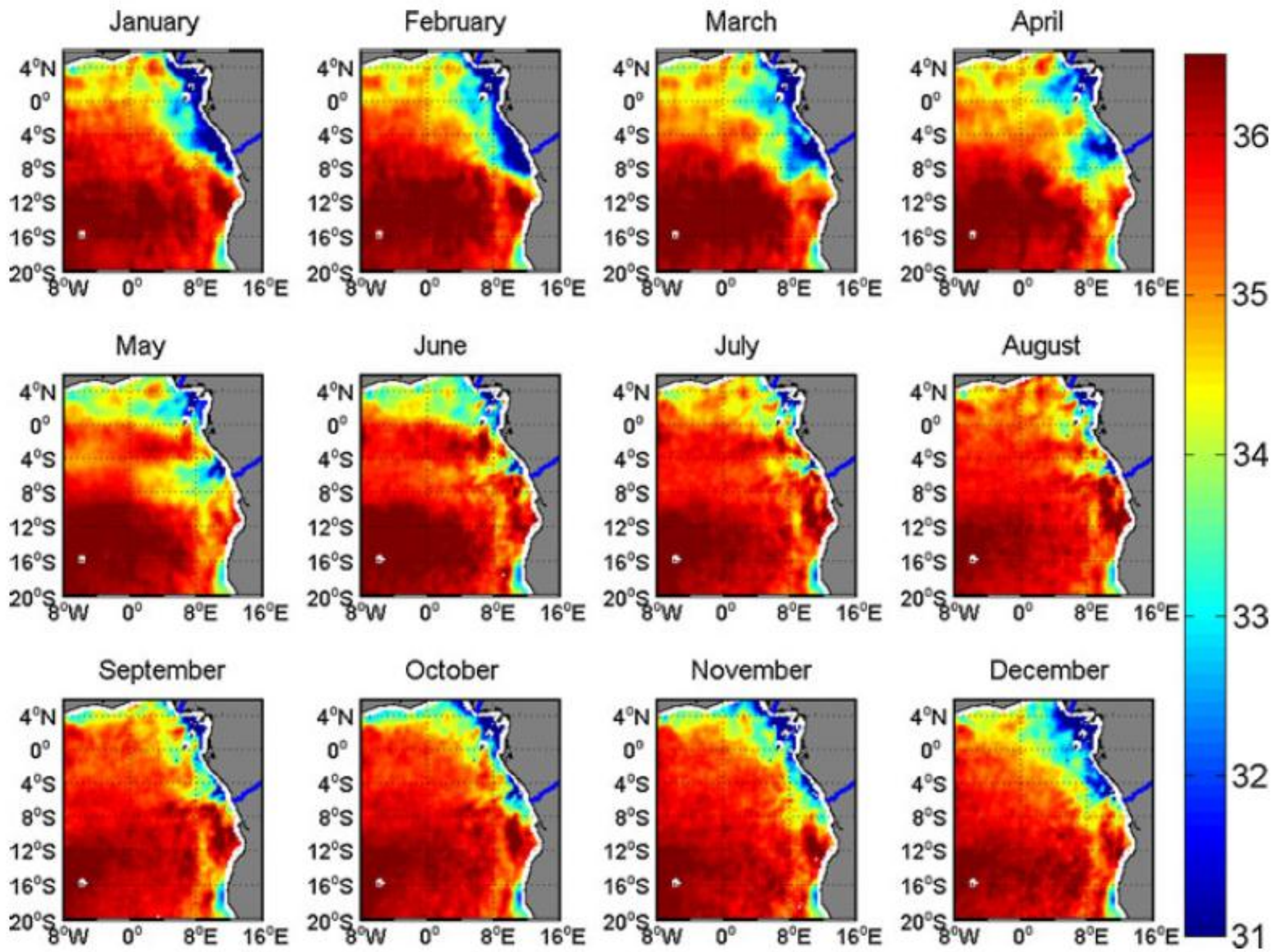
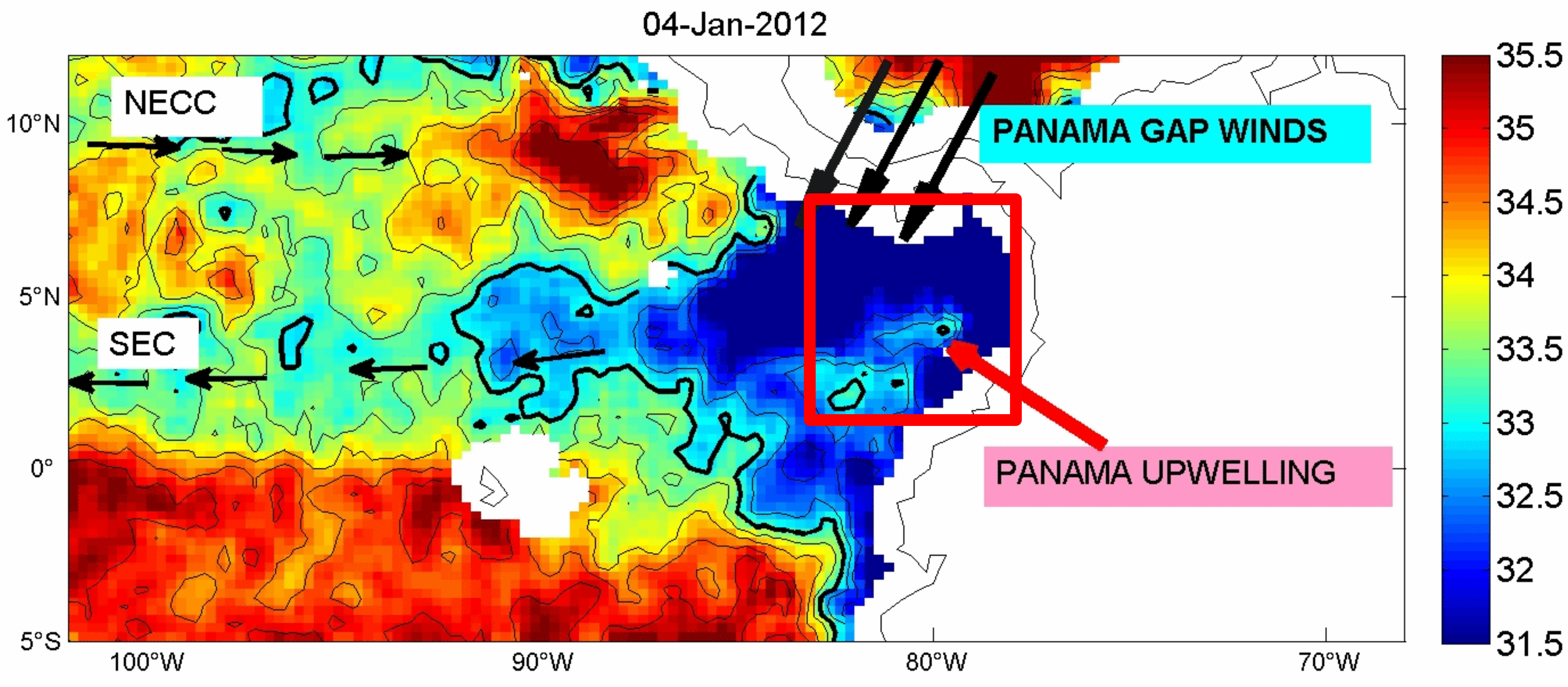


Fig. 10 2010–2012 Monthly averaged seasonal cycle of surface salinity in the eastern tropical Atlantic derived from SMOS observations

N. Reul

Seasonal behaviour of SSS in the Panama area

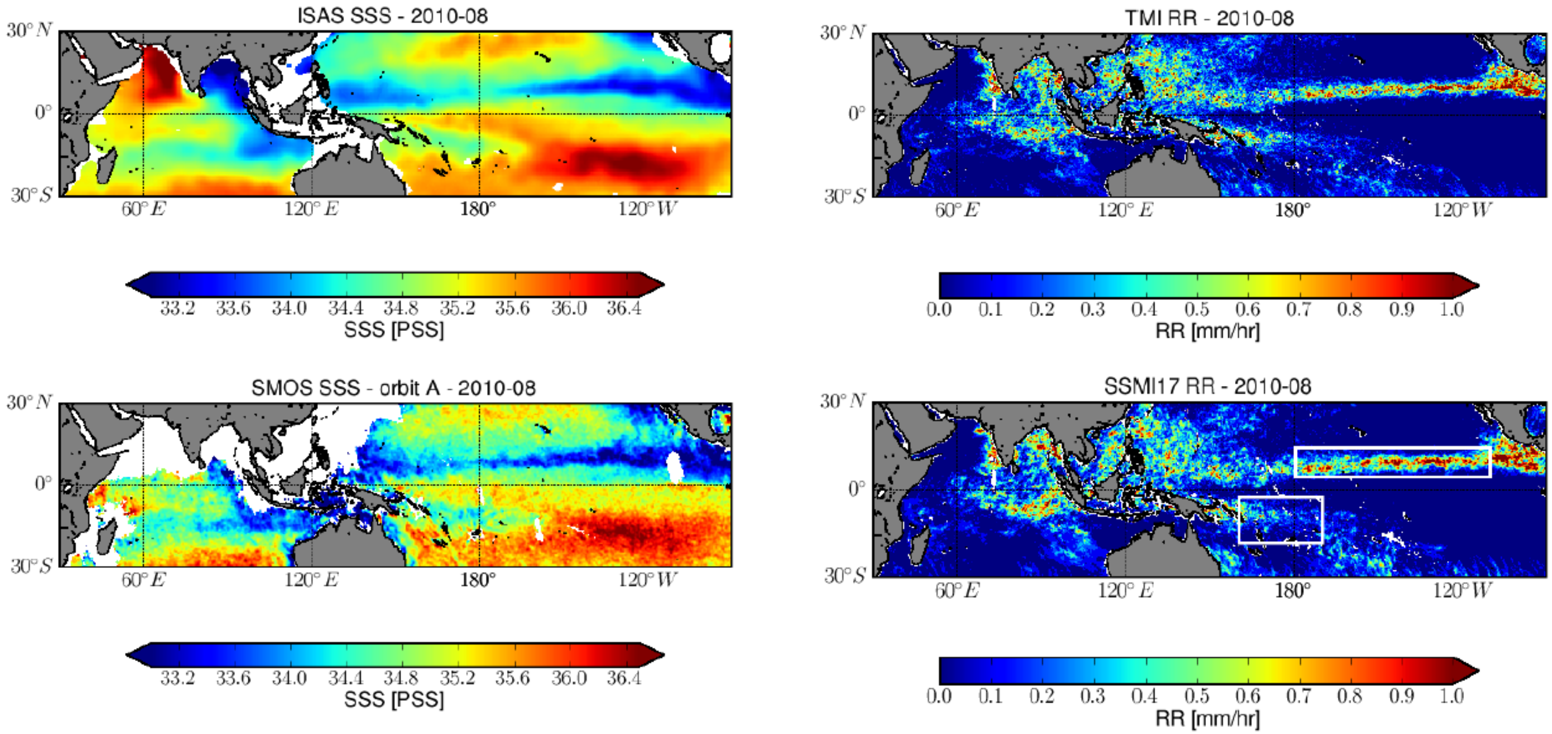


First observed with SMOS

smos+ sos
support to science element

CESBIO

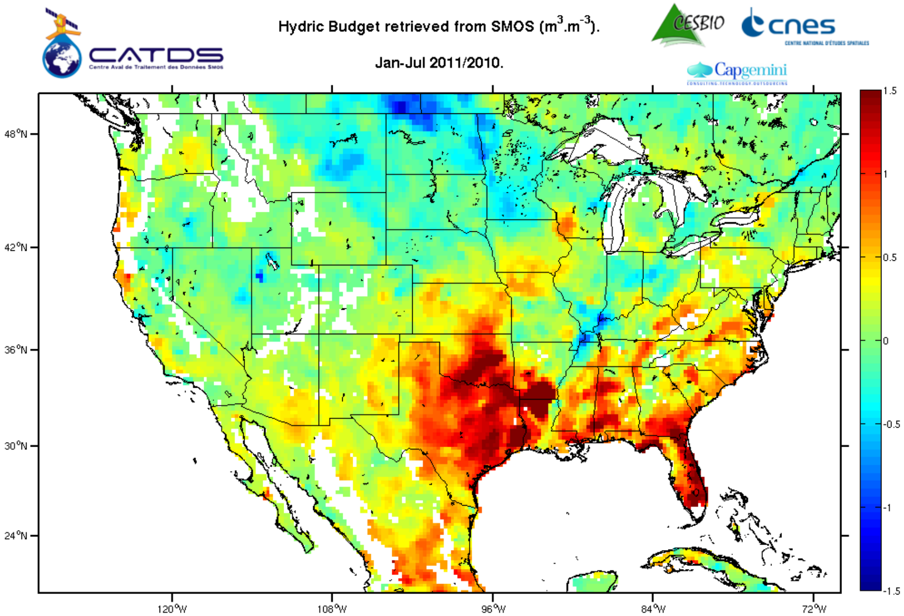
Impact of Rain on SMOS SSS

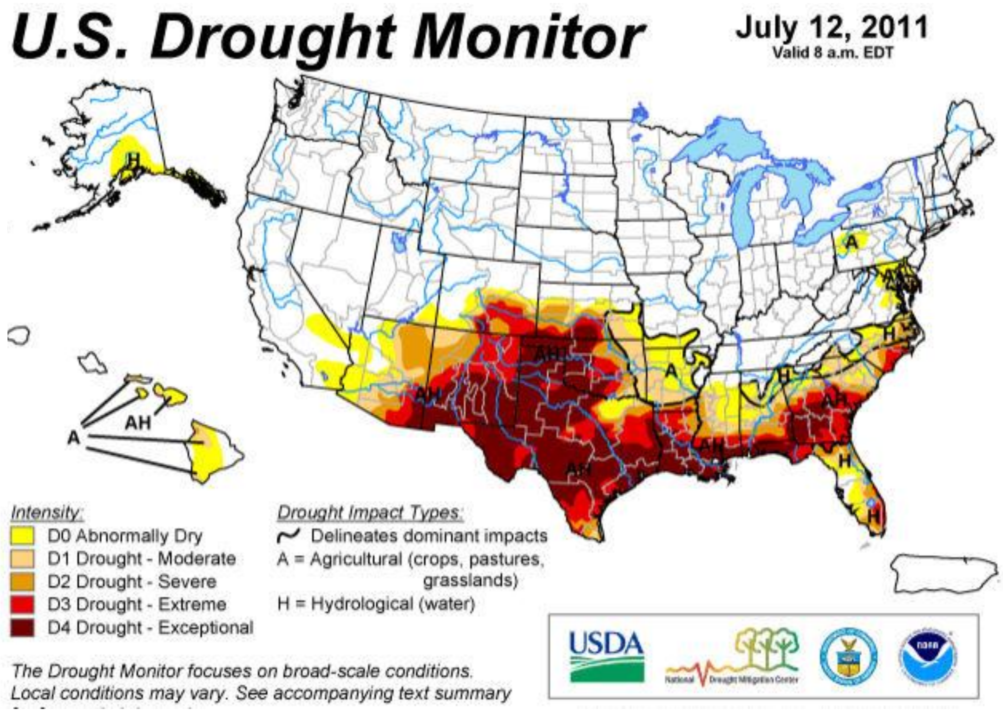


Boutin et al. (2014), JGR Oceans

Through its links with Precipitations, SMOS salinity data provide a new tool to better characterize the increase in the marine tropical hydrological cycle strength

Root zone soil moisture and Drought: which scale?





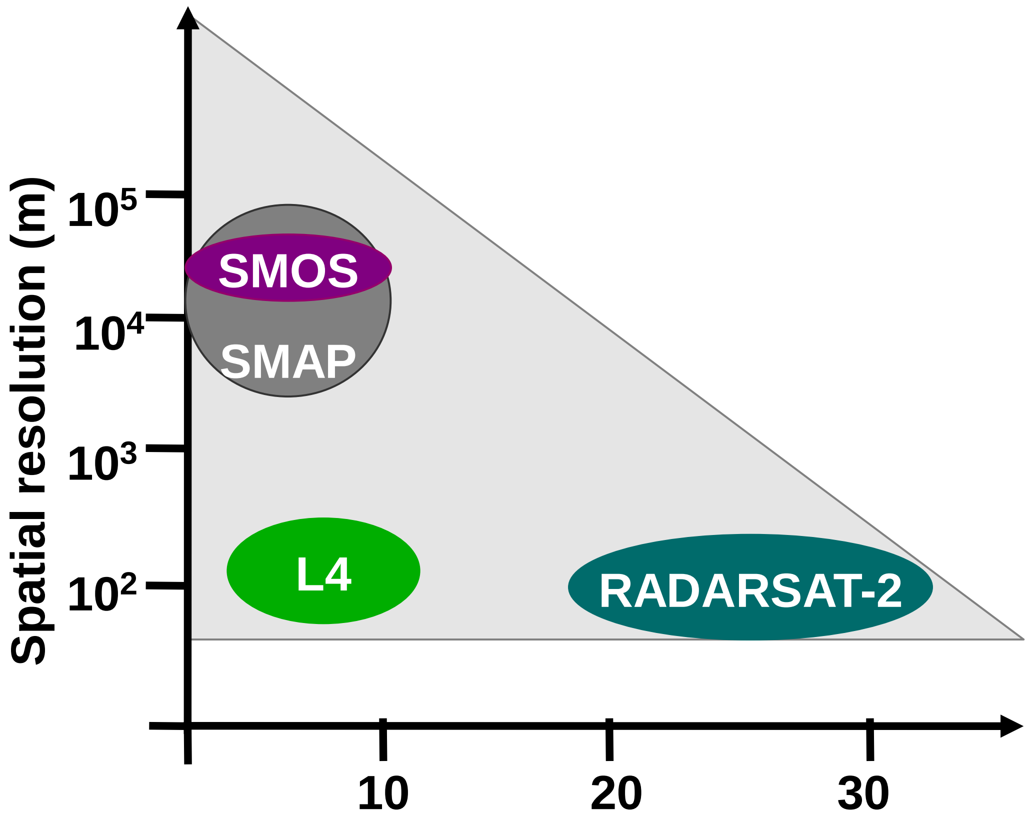
A. Quesney, L. Berthon

SMOS

L4 – HIGH RESOLUTION SURFACE SOIL MOISTURE: IRRIGATION, STRESS, PHYTOSANITARY

Active – Passive microwave merging – 1/3

- **L4: Combined high resolution active and passive Microwave soil moisture product**



Passive (SMOS)

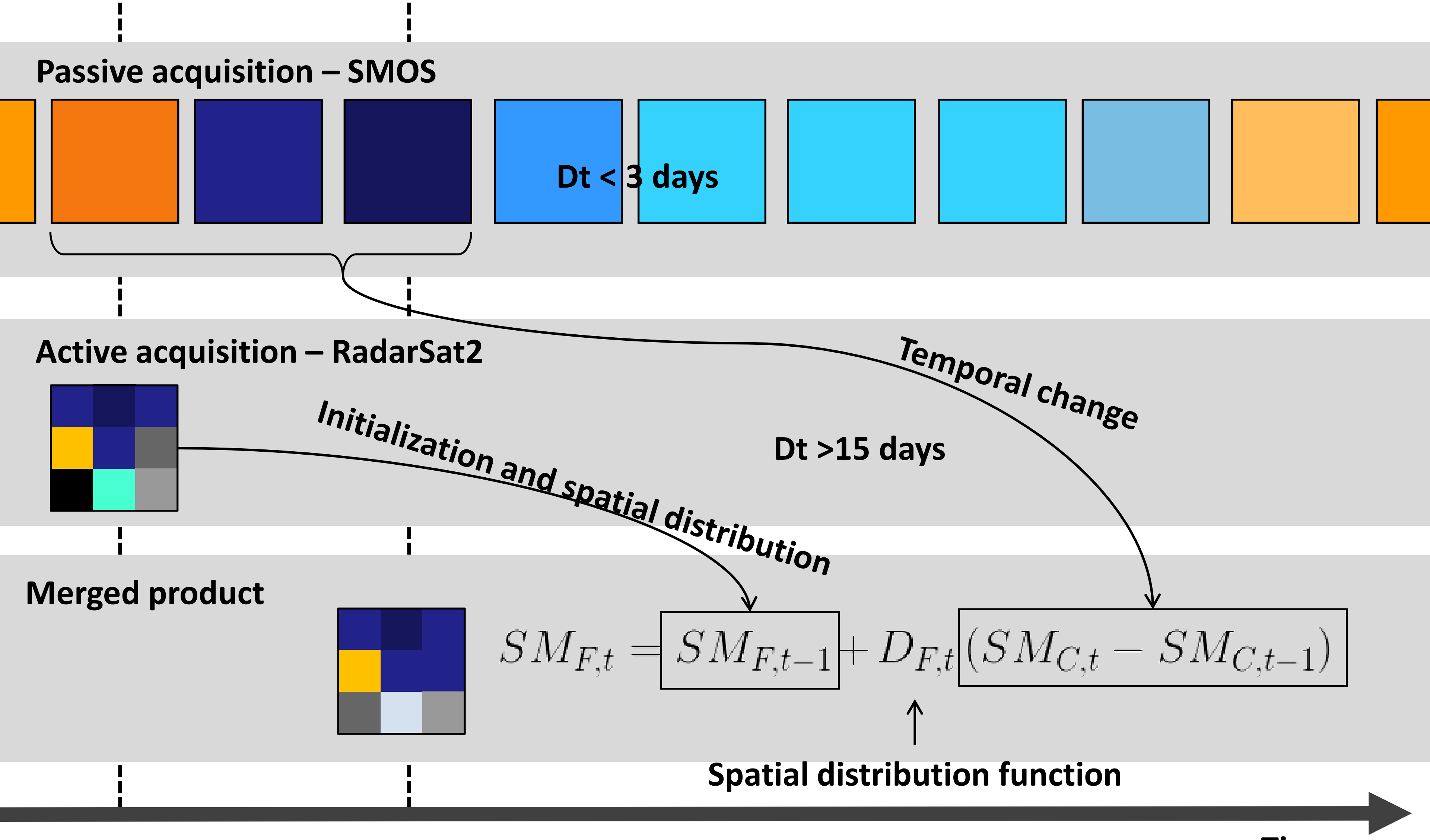
Spatial res. --> ~25 km
Temporal res. --> ~3 days

Active (RADARSAT-2)

Spatial res. --> ~100m
Temporal res. --> ~24 days

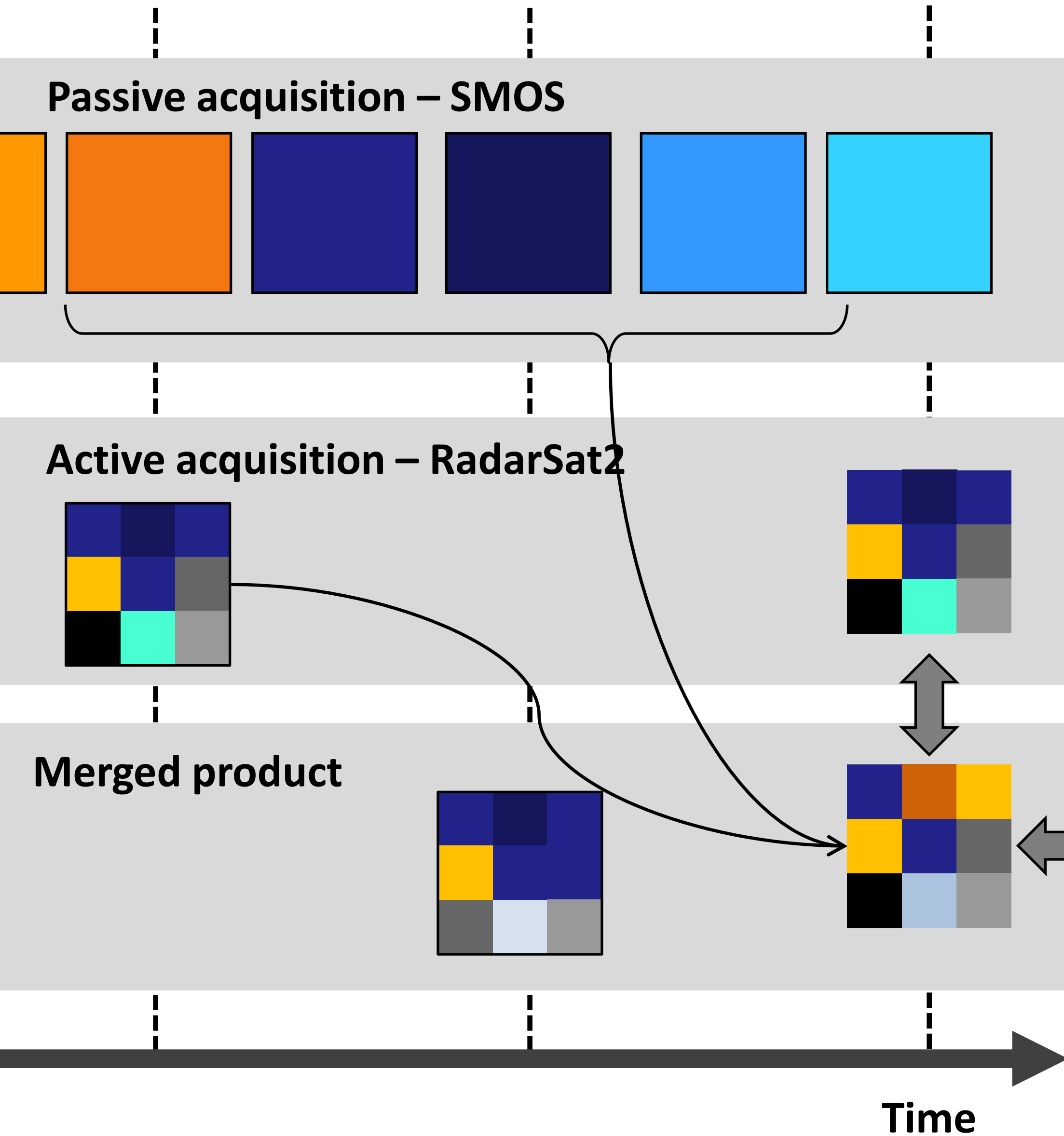
S. K. Tomer, CESBIO & IISc

Active – Passive microwave merging - 2/3



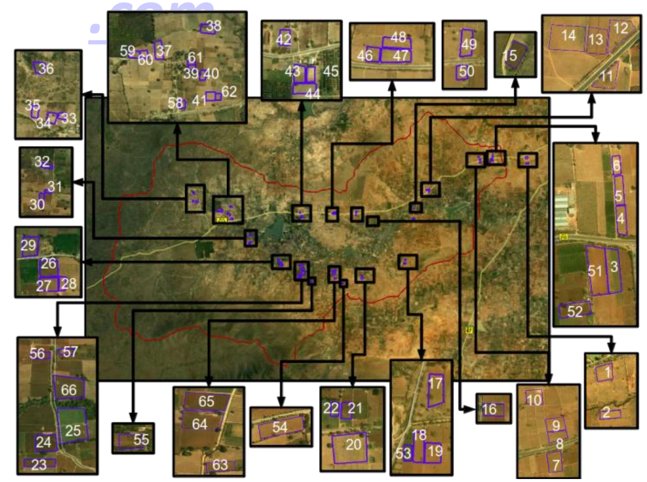
Tomer S. K., Al Bitar A, Sekhar M., Merlin O., Corgne S., Bandyopadhyay S., Sharma, Mehrez Z., Kerr Y.
MAPSM: A conceptual spatio-temporal algorithm to merge active and passive soil moisture (in-prep)

Active – Passive microwave merging - 2/3



Cal/val site:
RISAT
Mega-Trop.
SMAP
SMOS

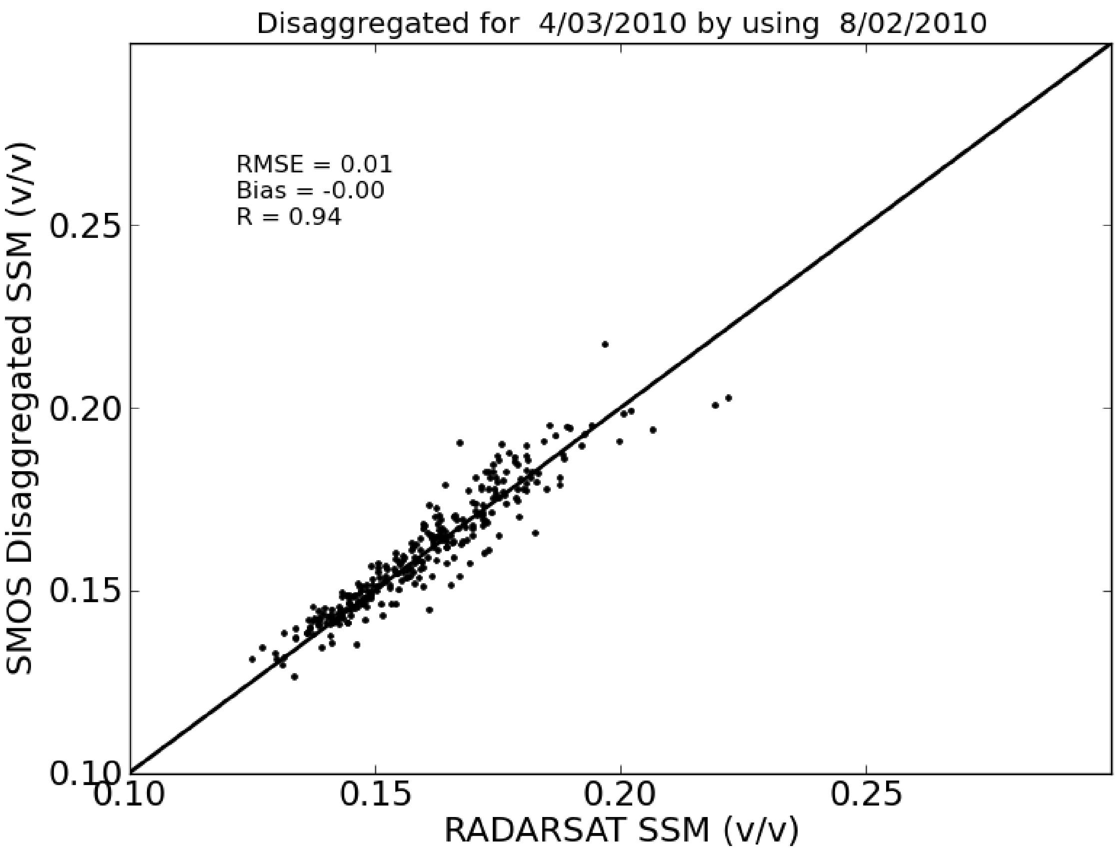
www.ambhas.com

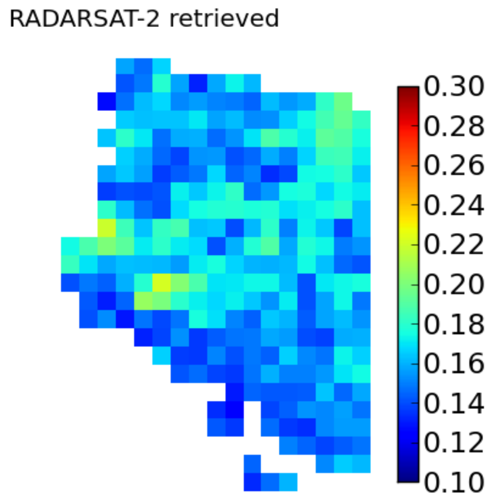


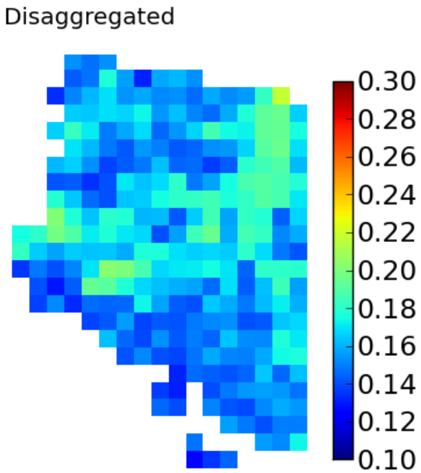
50 monitored plots

S. K. Tomer, CESBIO & IISc

Validation of downscaled SMOS soil moisture with respect to RADARSAT-2 soil moisture



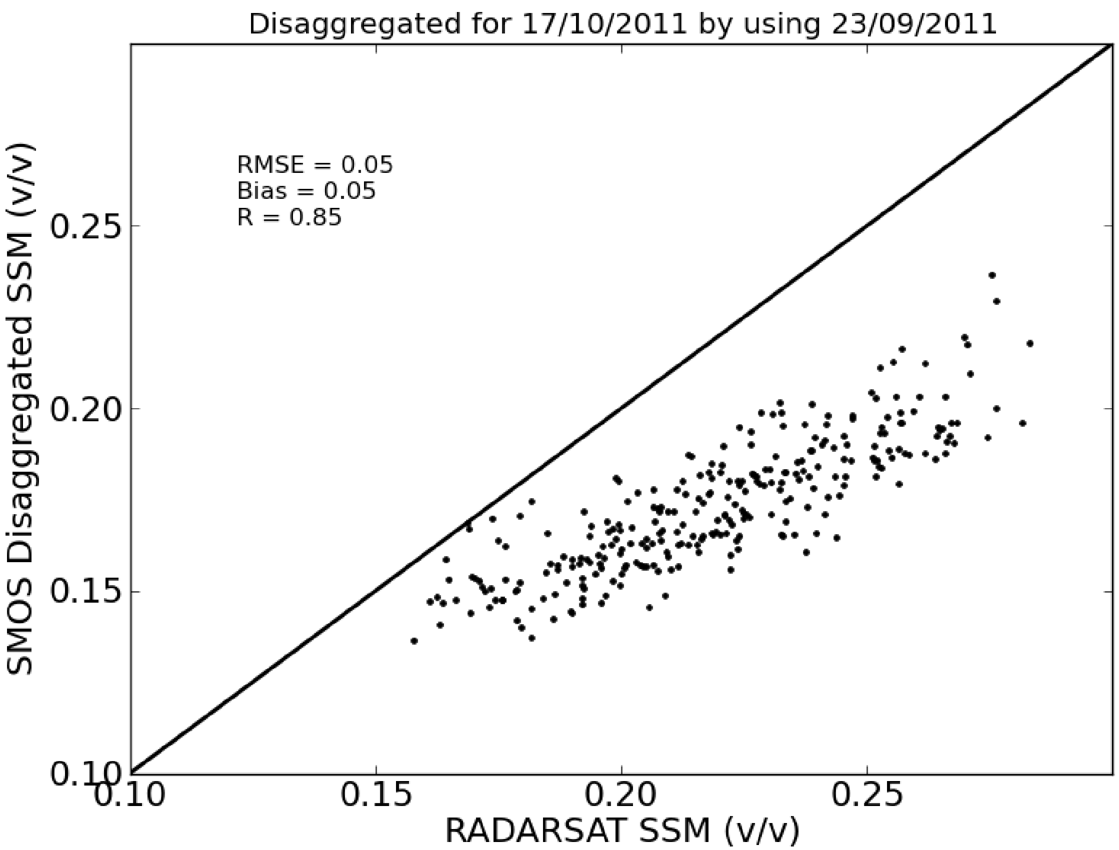


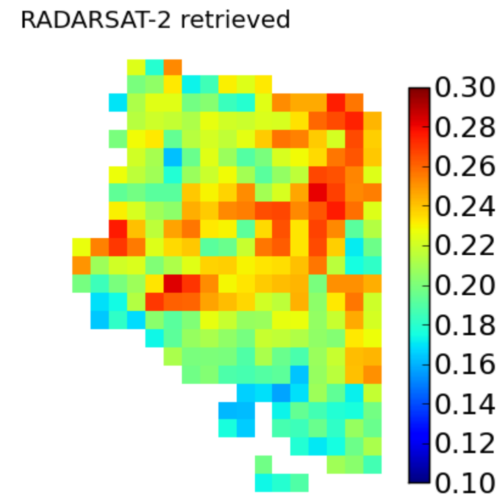


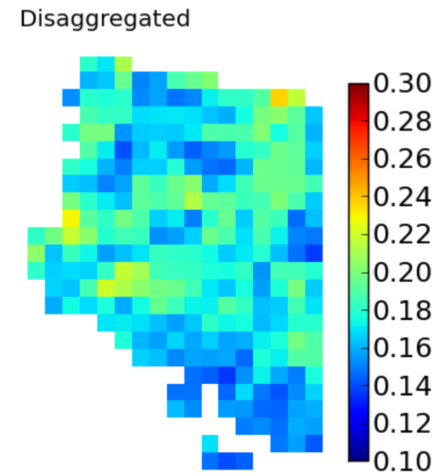
➢ **Disaggregation is not performed for the forest land use**

S Kumar

Validation of downscaled SMOS soil moisture with respect to RADARSAT-2 soil moisture







S Kumar

streamflow

ASSIMILATION IN STREAM FLOW MODELING

→ SEE H. LIEVENS' PRESENTATION

SMOS data can improve stream flow modeling

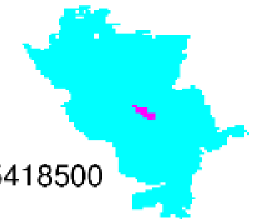
Results

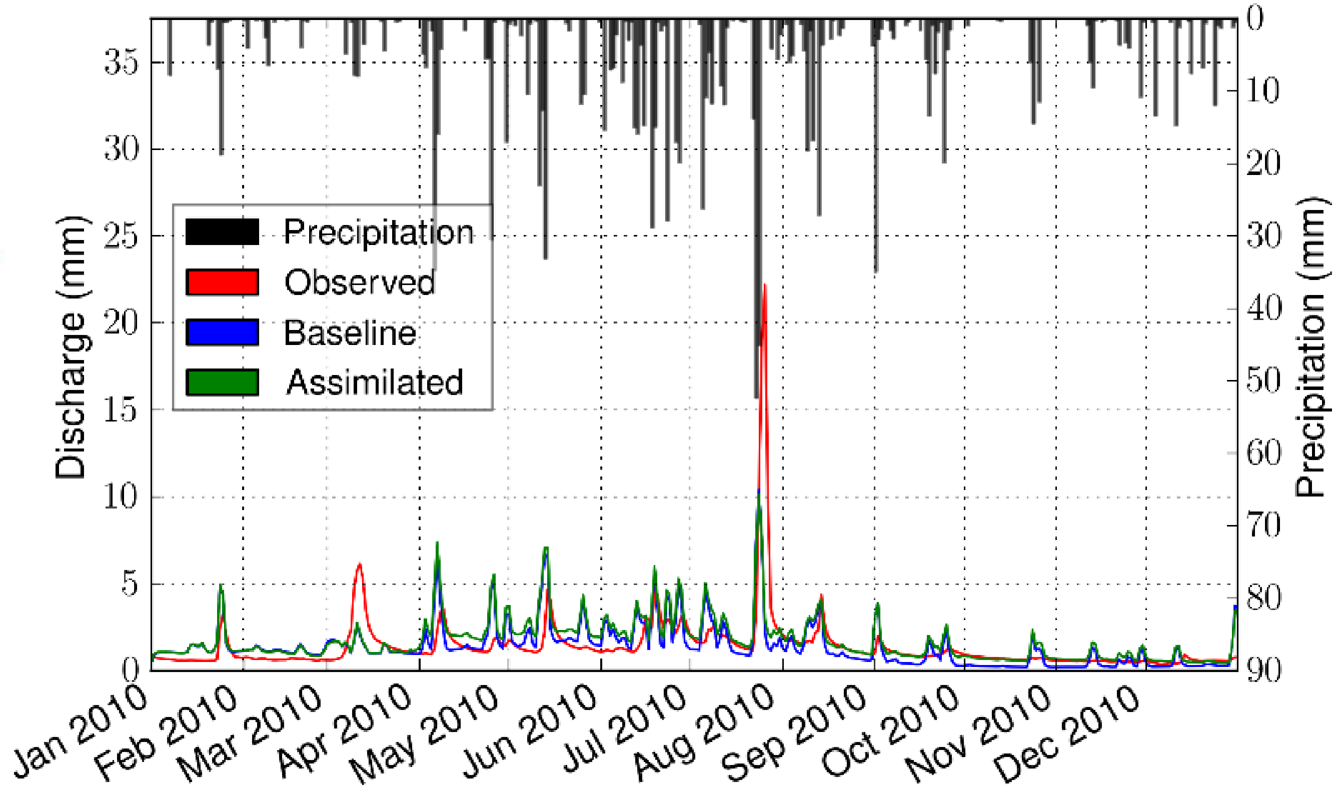
Over

Upper Mississippi Basin

	Baseline	Assimilation
KGE	0.41	0.49
Ratio of std	1.45	1.37
Bias	-0.17	0.20
Correlation	0.66	0.73

Gauge Site No. = 5418500





smos+hydrology

Lievens H. et al

and

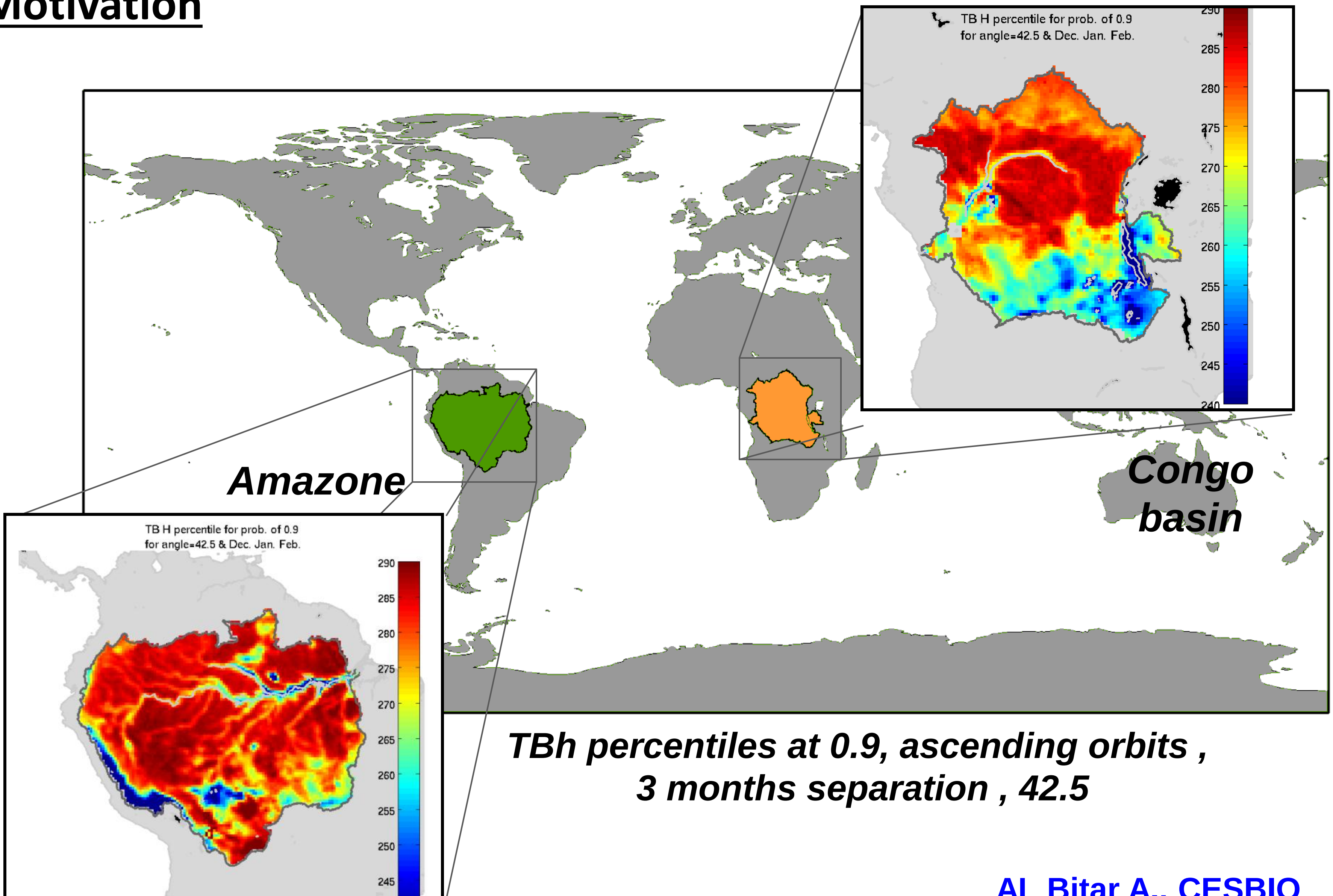
Tomer S. K. et al.

SMOS

WATER BODIES:
WATER FRACTION, RIVER DISCHARGE, RAINFALL

Seasonal dynamics in tropical watersheds

Motivation

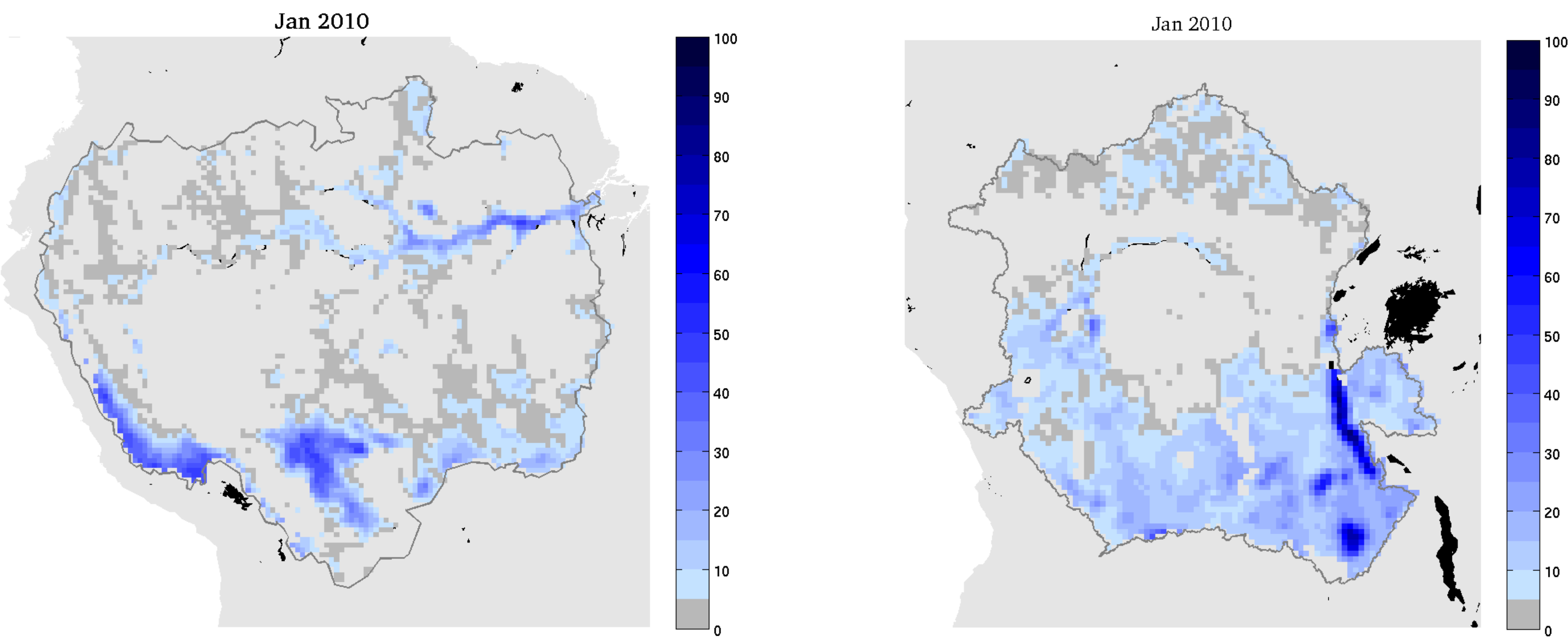


TBh percentiles at 0.9, ascending orbits ,
3 months separation , 42.5

AL Bitar A., CESBIO

SWaF: SMOS Water Fraction in tropical watersheds

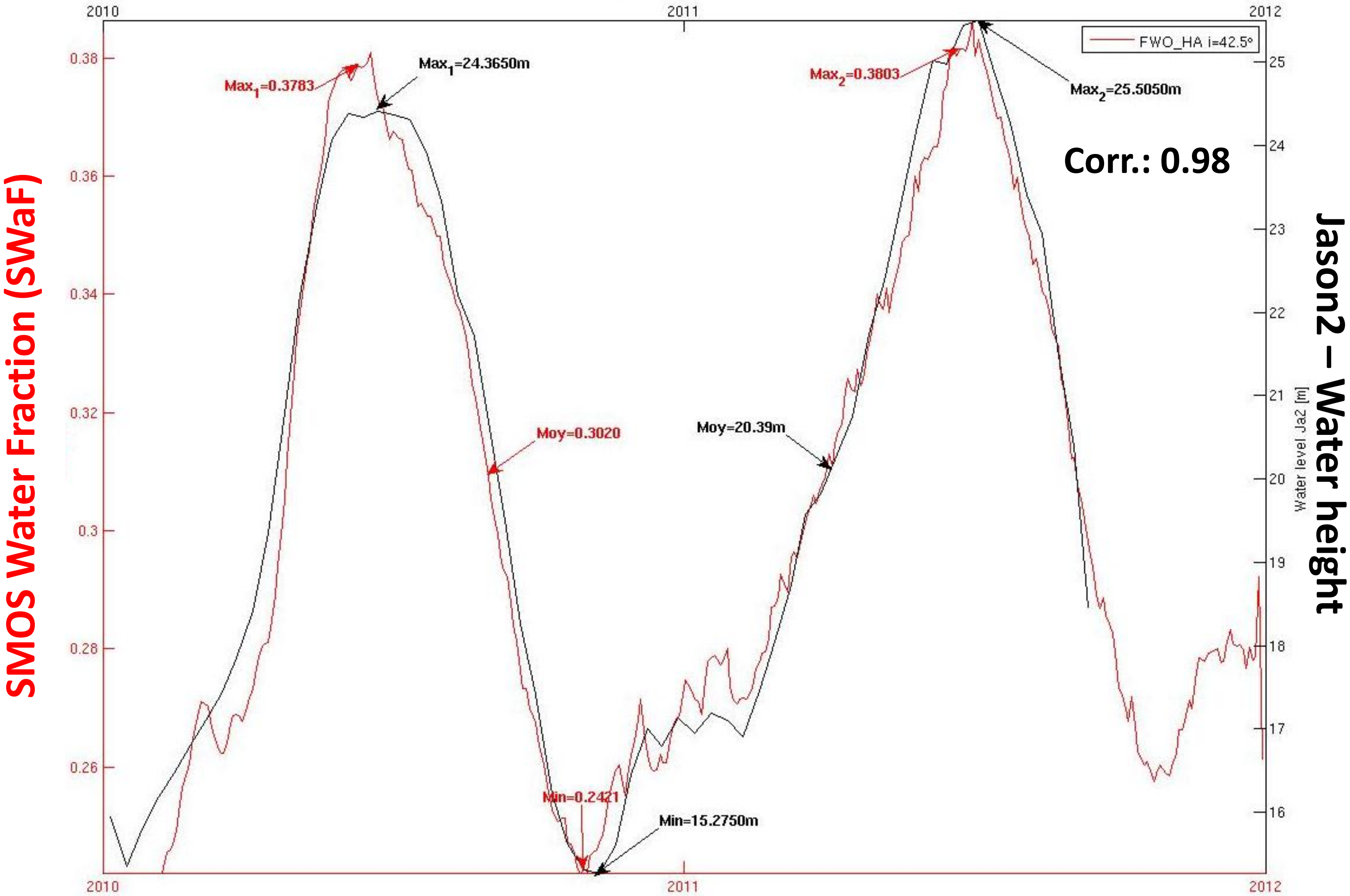
Results



Al Bitar A., Parrens M., Wigneron J.P., Cote R., Cretraux J.-F., Selma C., Kerr Y. H., Water fraction in tropical watersheds from SMOS L-band radiometer, *in prep.*

SMOS Water Fraction & Jason2 Water Height

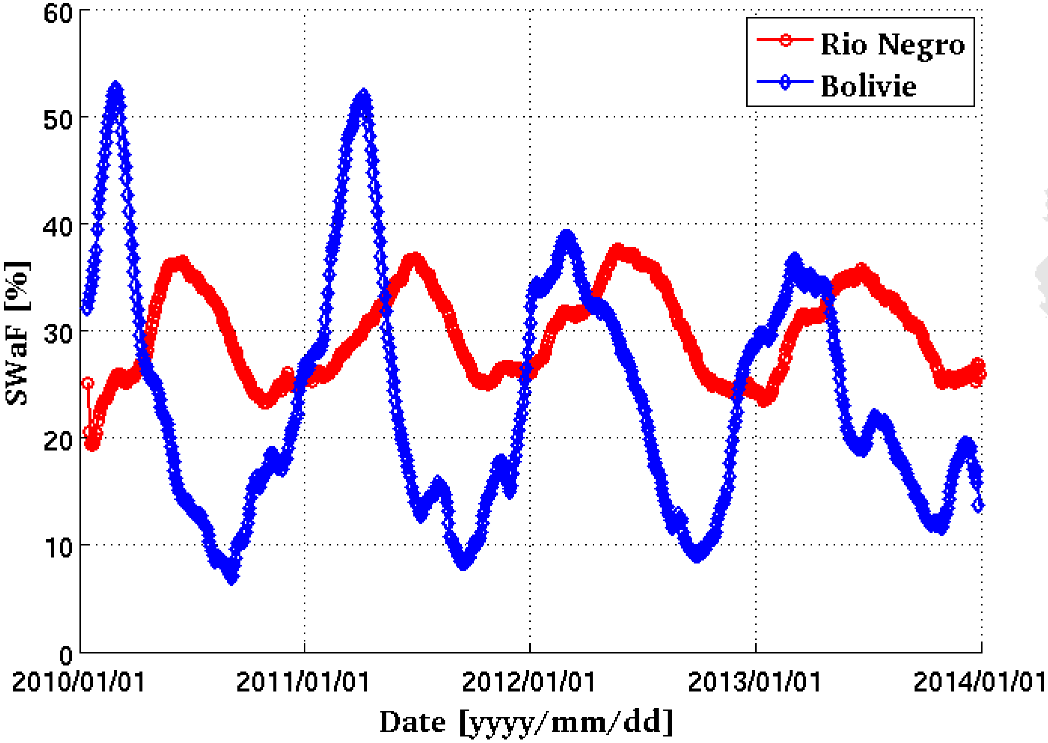
Results :

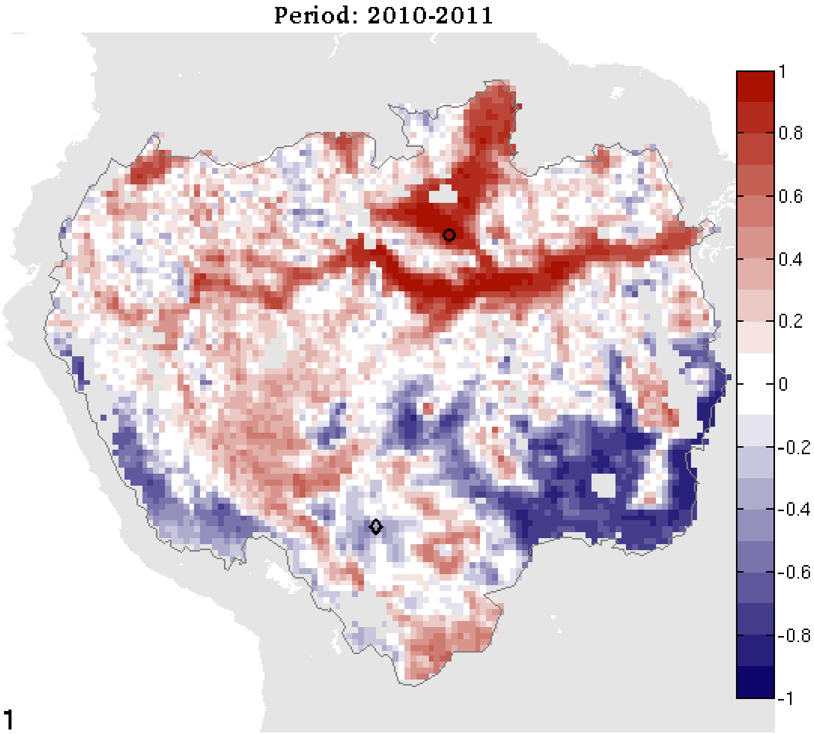


Jason2 river height from Hydroweb Legos (J.F. Creteaux)

Comparison between the SWaF temporal series in the North and in the South

Results :





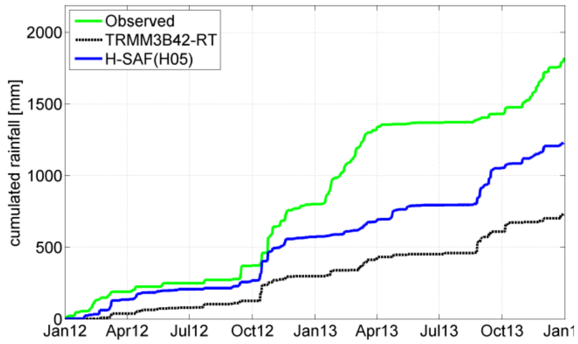
Rain

ENHANCING RAINFALL PRODUCTS

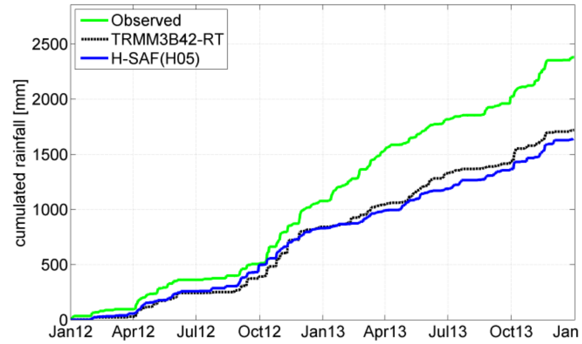
→ SEE L. BROCCA'S PRESENTATION

The issue

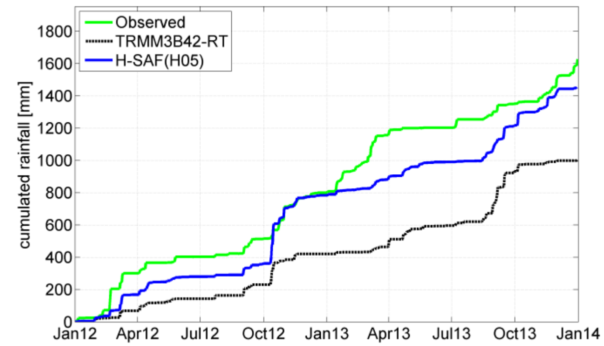
Northern Italy

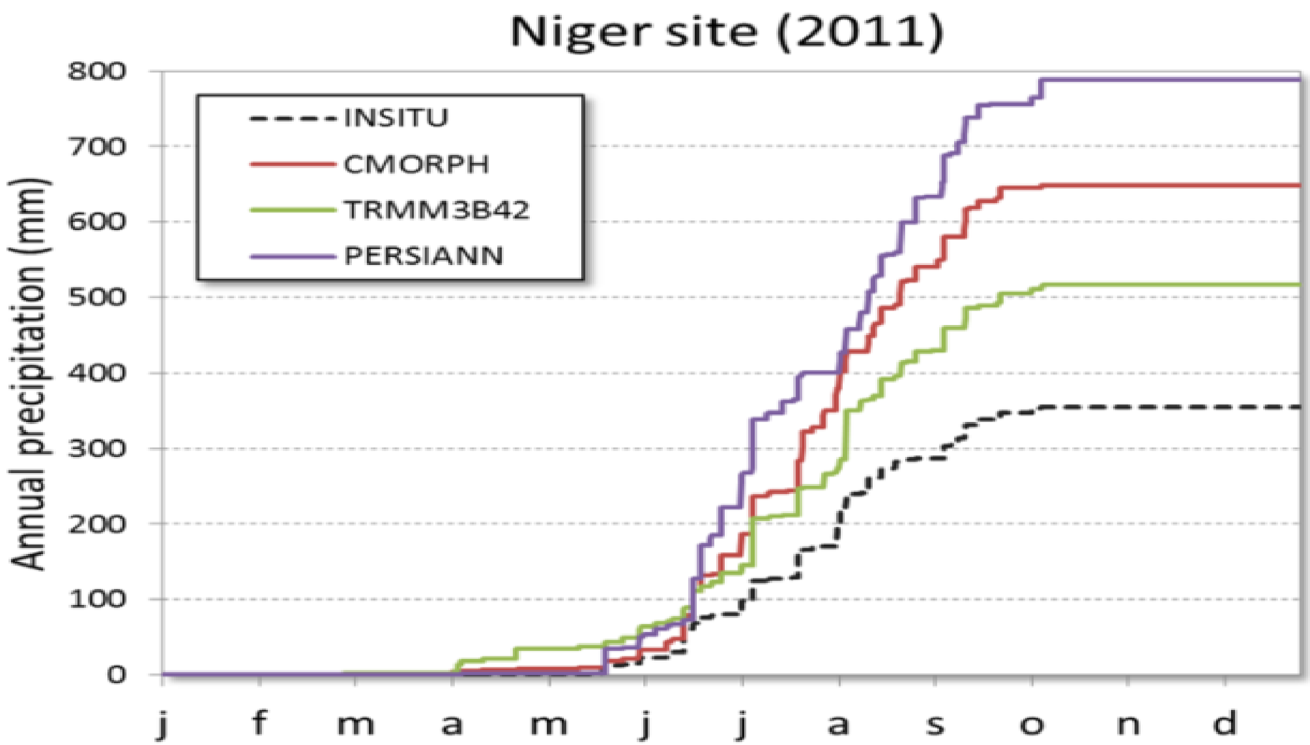


Central Italy



Southern Italy

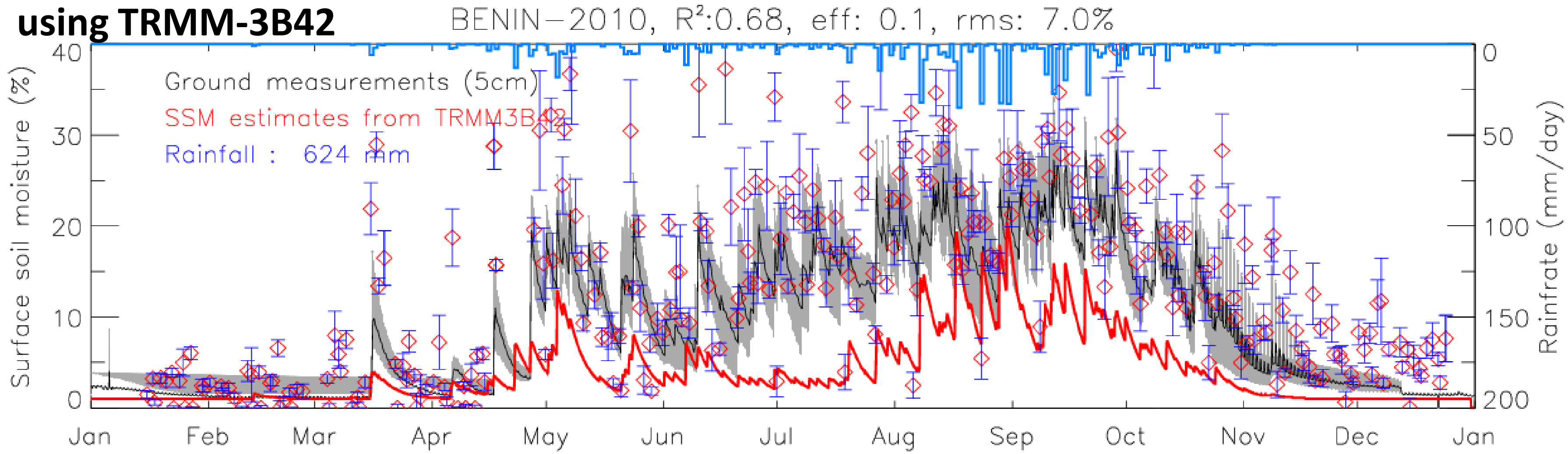




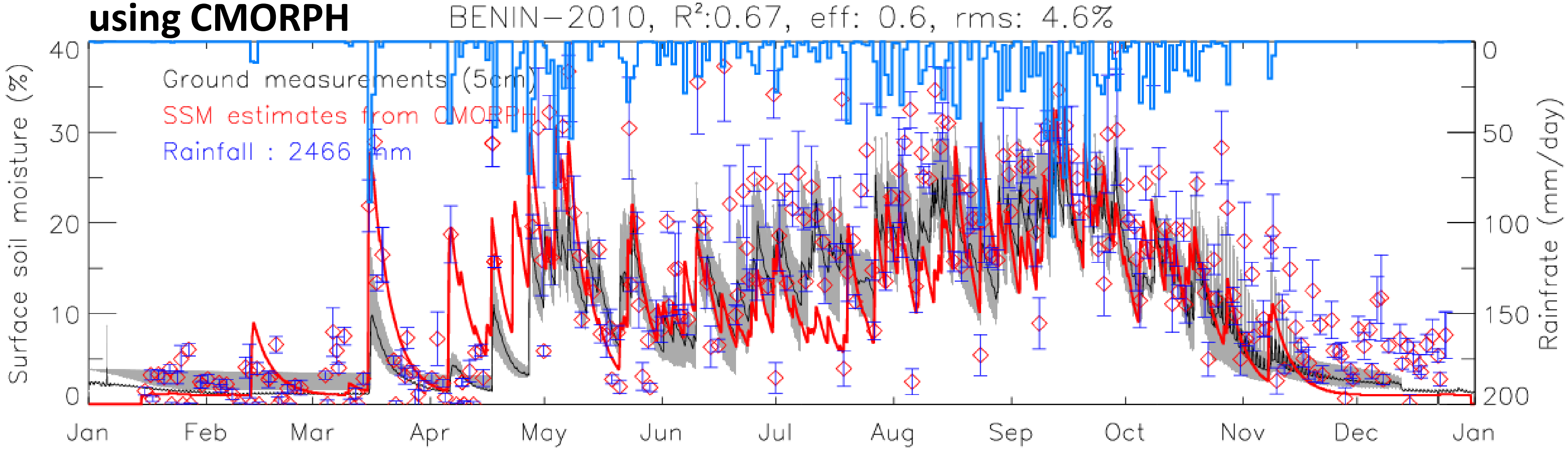
Estimated SSM without SMOS assimilation

Motivation:

using TRMM-3B42



using CMORPH

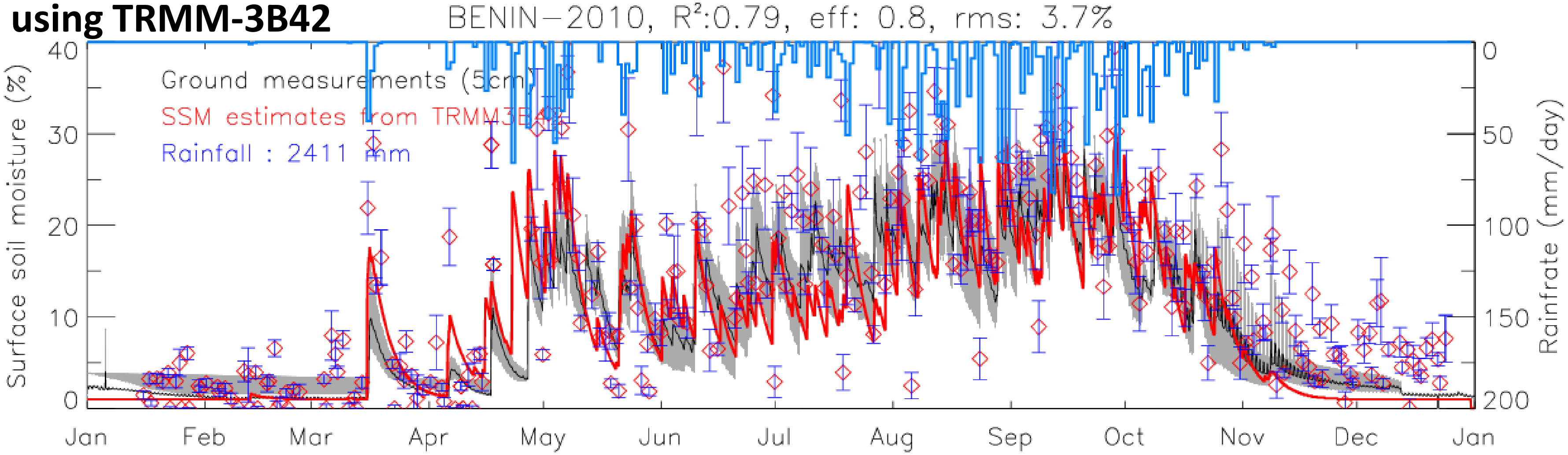


Pellarin T., Louvet S., Quantin G., Legout C., Al Bitar A., Kerr Y., Correcting Satellite Based Precipitation Products Using SMOS Measurement, 2014

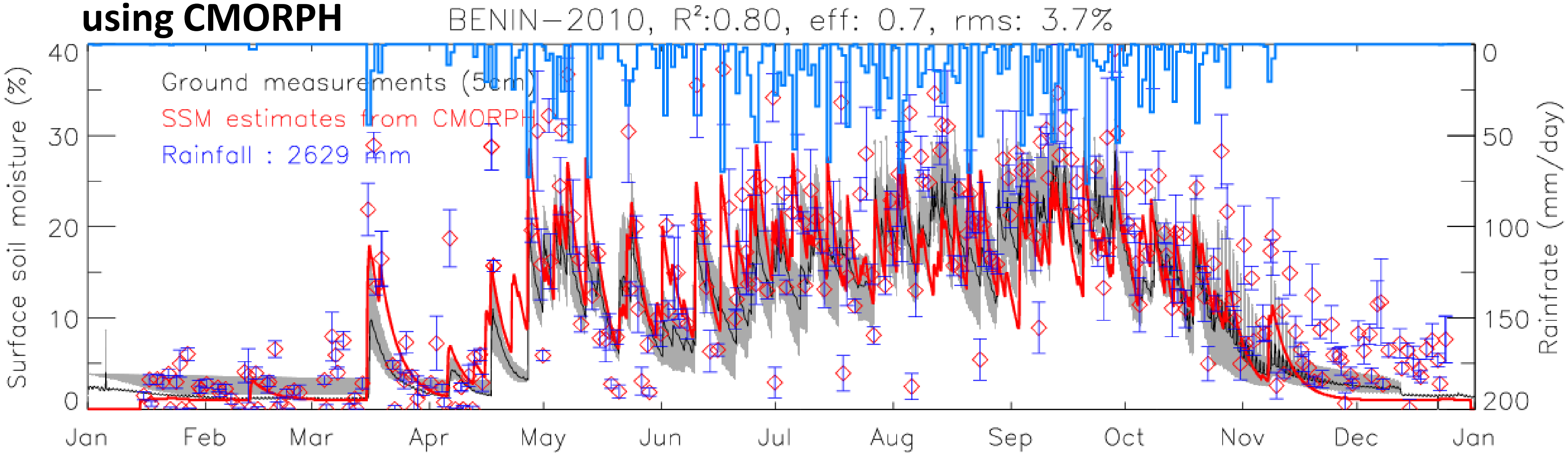
Estimated SSM with SMOS assimilation

Results:

using TRMM-3B42



using CMORPH



Pellarin T., Louvet S., Quantin G., Legout C., Al Bitar A., Kerr Y., Correcting Satellite Based Precipitation Products Using SMOS Measurement, 2014

SMOS

L4 – RISK MITIGATION: FLOOD RISK MAPPING

SMOS Flood Risk Forecast

Methodology

Leveraging inundation risk based on SMOS soil moisture prior knowledge

Rainfall probabilities

SMOS Soil moisture probabilitie s

SMOS SM L3 produ cts

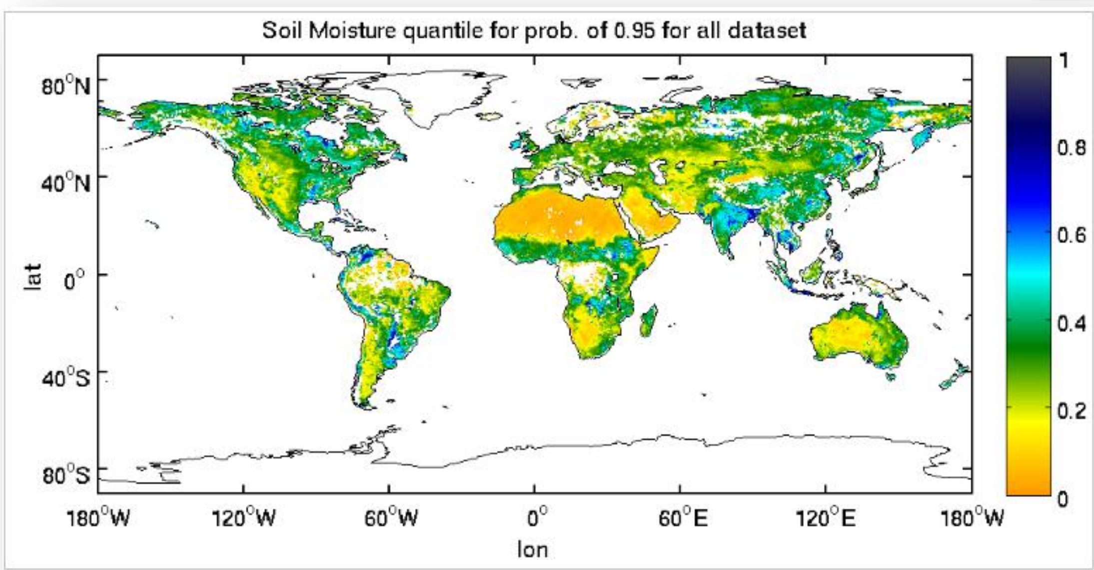
Rainfall forecas t

Precipitation Flood Risk

Precipitation Inundation risk

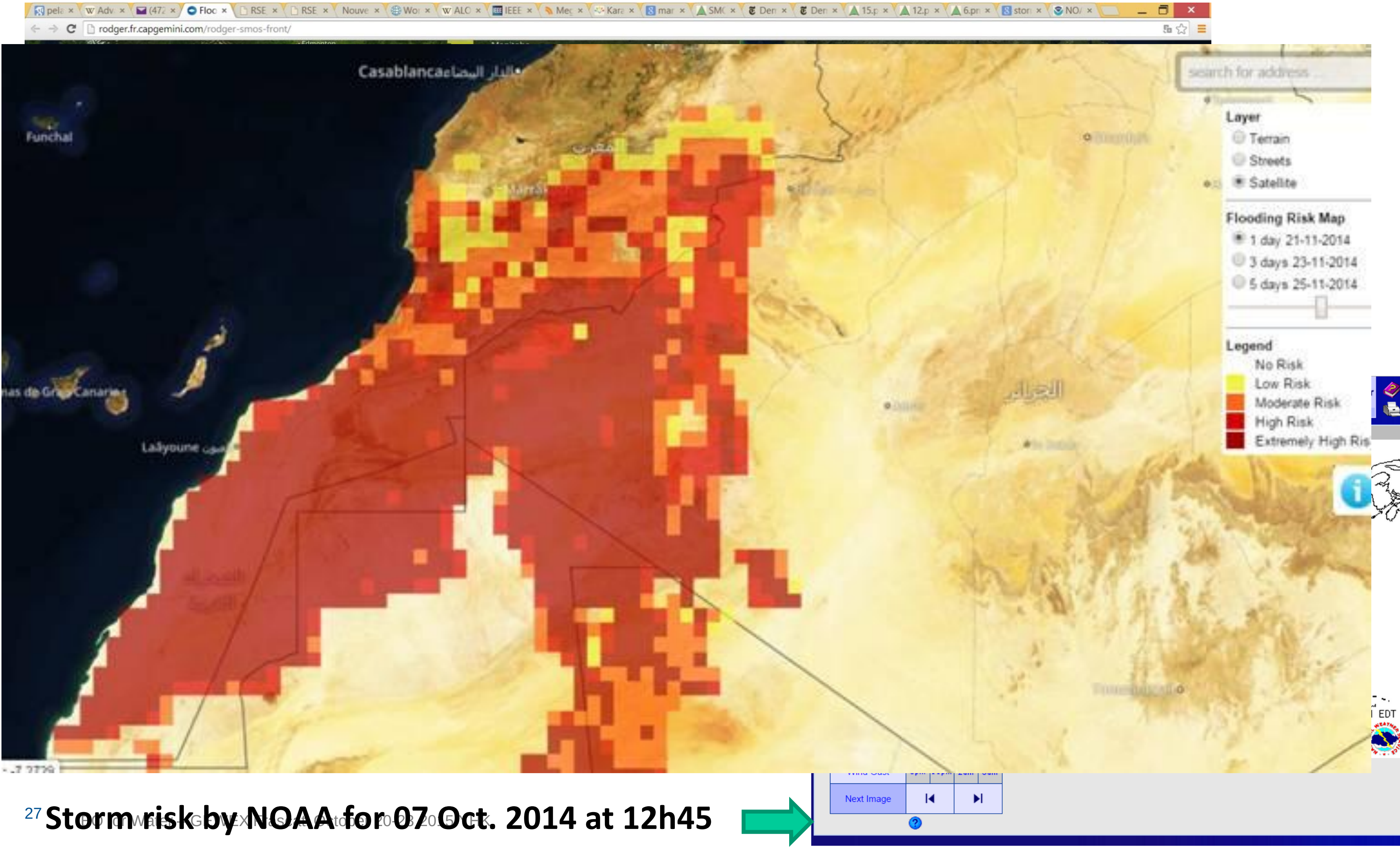
Flood Risk (Precip + SMOS)

SMOS Innundatio n Risk



Al Bitar A., Chone A., S. K. Tomer, Kerr Y. CESBIO

Operational implementation by CapGemini and CESBIO



Storm risk by NOAA for 07 Oct. 2014 at 12h45

Cryosphere

SNOW DENSITY

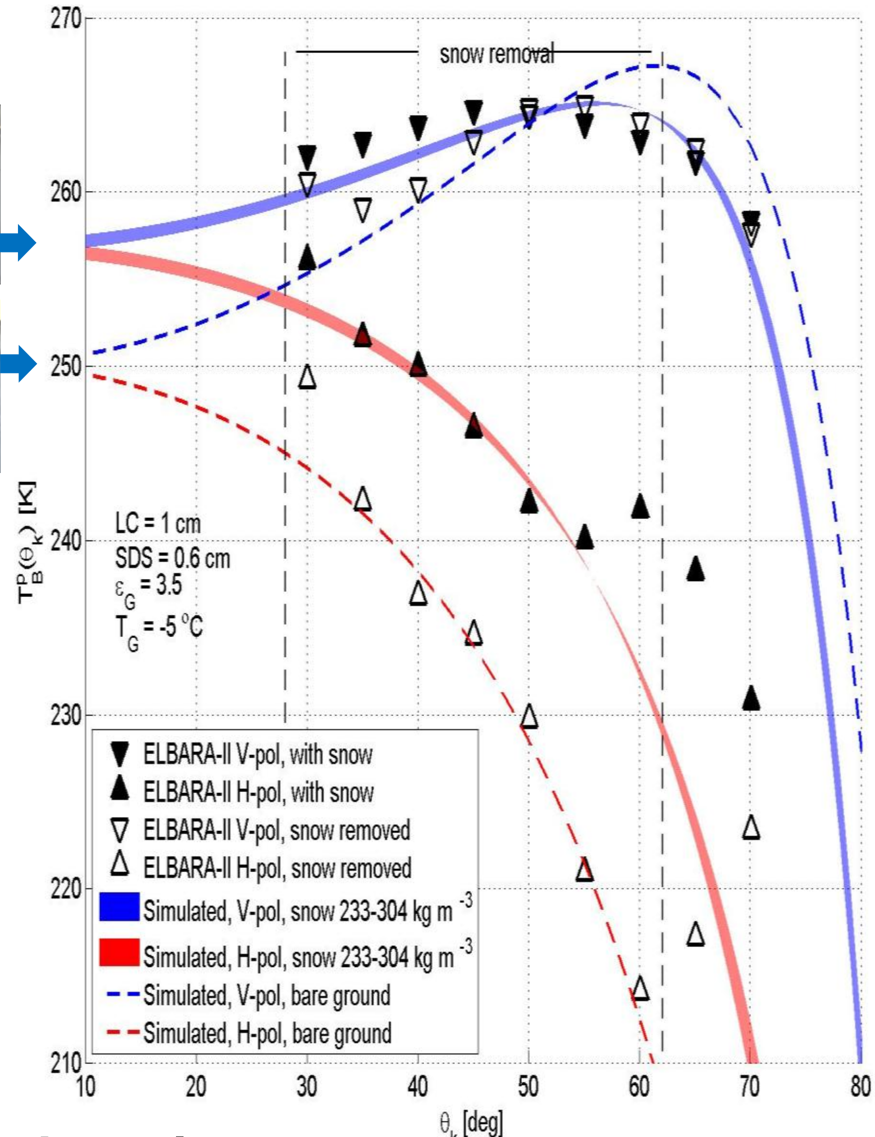
J. Lemmetyinen, M. Schwank, K. Rautiainen, A. Kontu, T. Parkkinen, C. Mätzler, A. Wiesmann, U. Wegmüller, C. Derksen, P. Toose, A. Roy, J. Pulliainen, "Snow Density and Ground Permittivity Retrieved from L-Band Radiometry: Application to experimental data", submitted to RSE special SMOS issue.

Snow Removal Experiment

Experimental proof that L-band $T_B{}^p(\theta)$ are affected by dry snow even it is transparent!

On Feb. 12 2015, snow was removed from the area covered by ELBARA-II observations (FMI-ARC wetland site, observed since 2012)

ELBARA-II measurements performed before (solid triangles) and after (hallow triangles) snow-removal.
⇒ Reasonable match with forward model predictions.

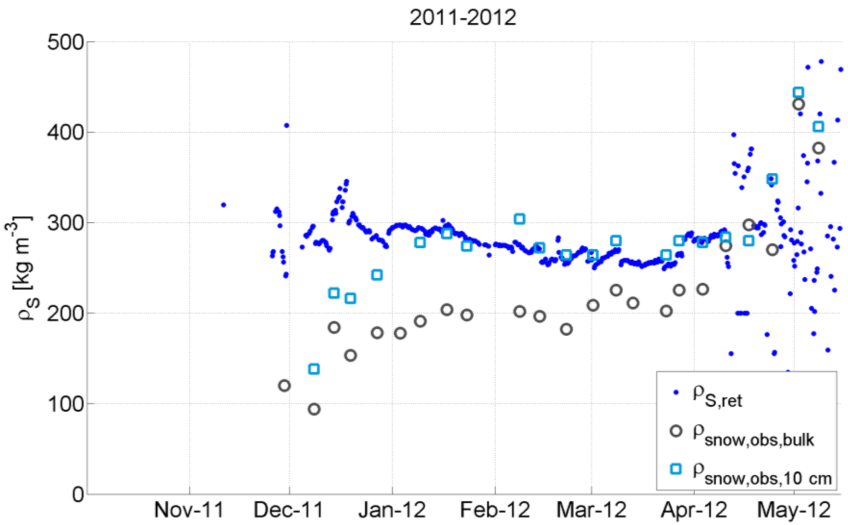


M. Schwank et al

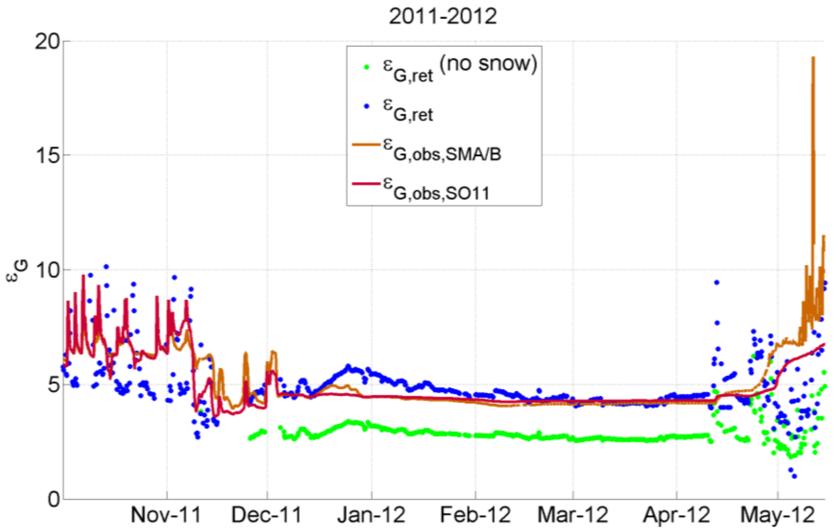
$P = (\rho_S, \varepsilon_G)$ Retrieved from Experimental T_B

Three winter seasons (only 2011-2012 is shown) at the FMI-ARC forest clearing site show consistent retrievals $P = (\rho_S, \varepsilon_G)$ of snow density (ρ_S) and ground permittivity (ε_G).

Time-series of retrieved and *in situ* ρ_S



Time-series of retrieved and *in situ* ε_G



Retrieved ρ_S show good correlation with *in situ* bottom layer snow density.

$\Rightarrow$ Potential novel SMOS product useful to enhance SWE estimates.

Retrieved ε_G without consideration of snow propagation underestimates *in situ* measurements by $\approx$ 30 %

Retrieved ε_G with consideration of snow propagation matches *in situ* measurements better.

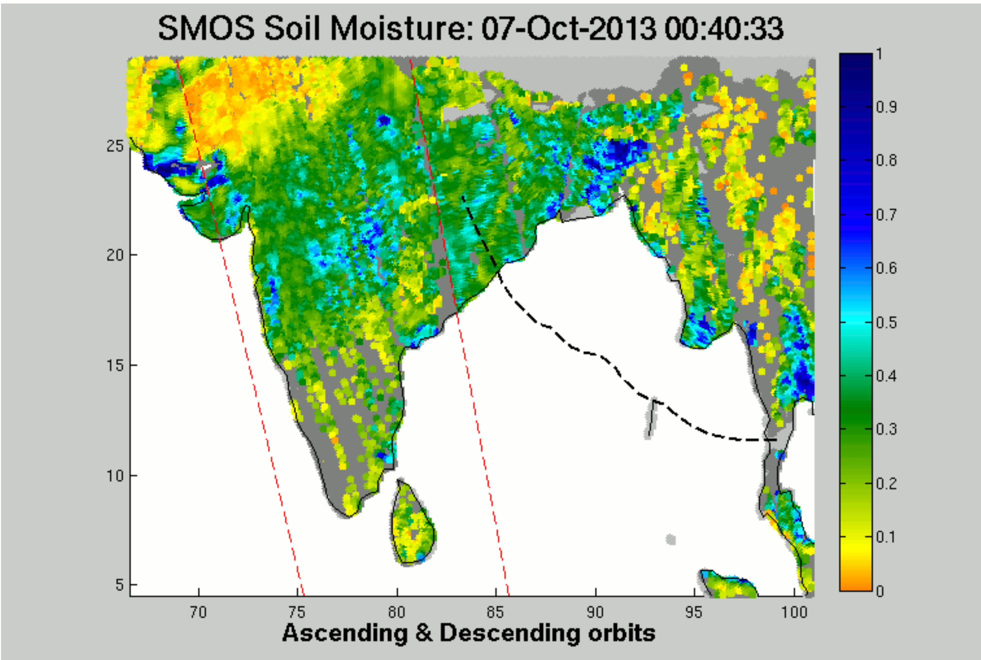
$\Rightarrow$ Implications for SMOS permittivity retrievals under dry snow cover.

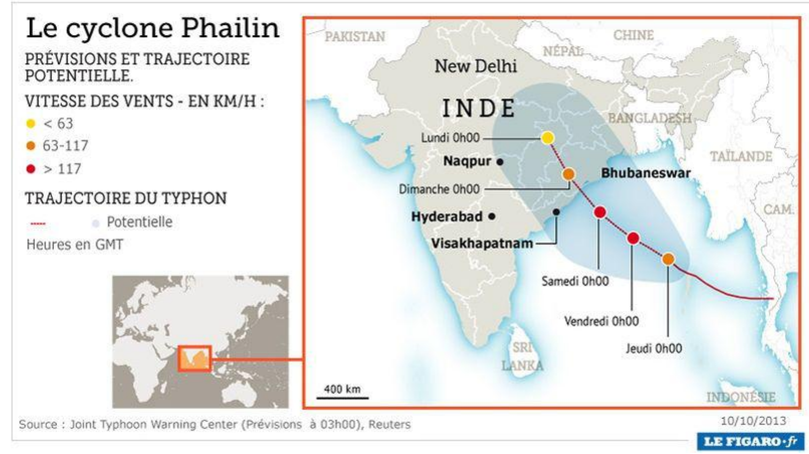
M. Schwank et al

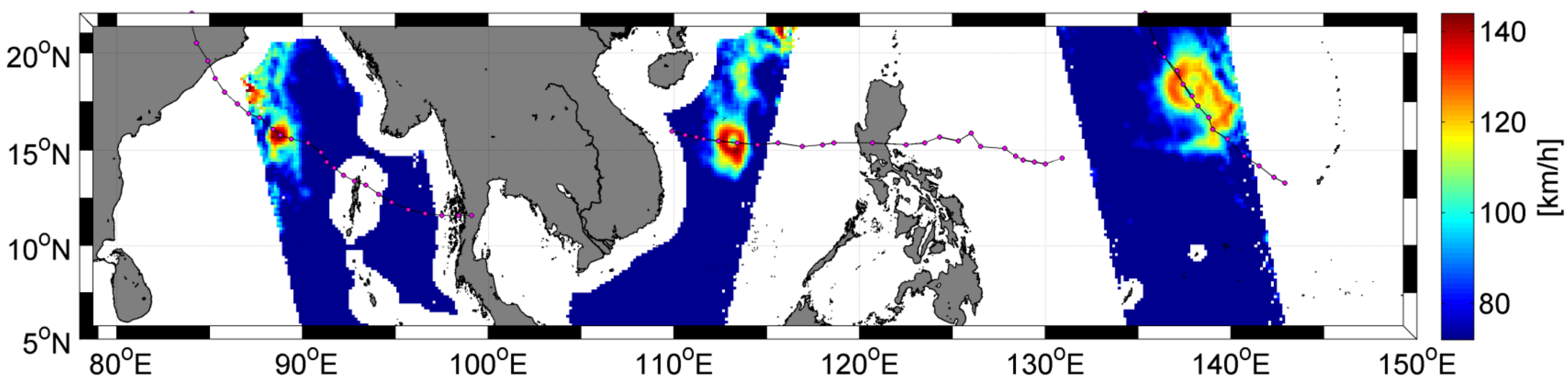
Summary

- A wealth of uses in hydrology were identified using SMOS which demonstrates the power of real soil moisture fields in a variety of uses
  - Extreme events
  - Risk mitigation (floods, fires, etc…)
- Many very meaningful synergies with other sensors and models
- SMOS enhances several products:
  - Rainfall fields
  - Sea ice
  - Freeze thaw…;
  - Wind over oceans
- With SMAP higher temporal sampling can be achieved increasing the impact

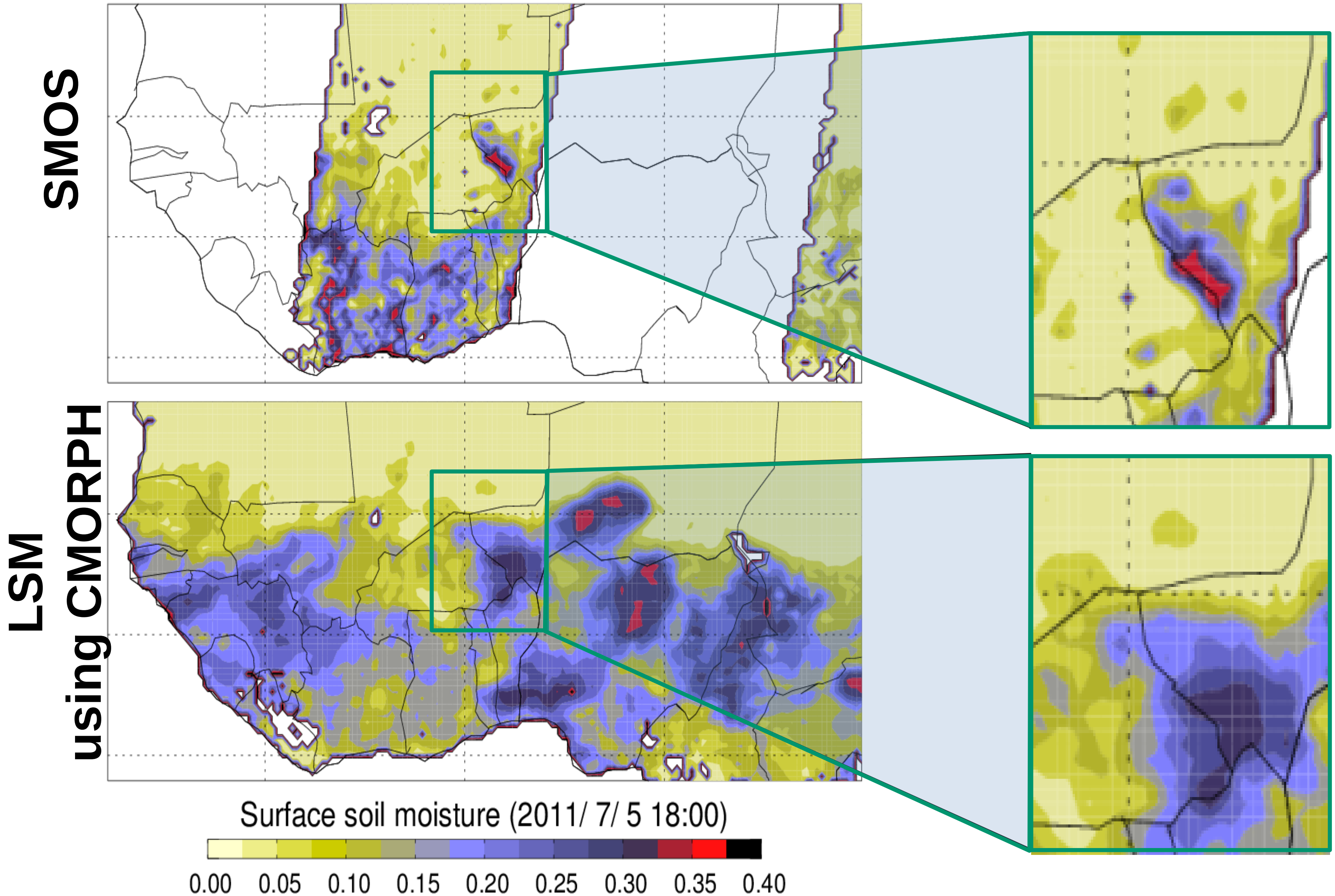
Cyclone Phailin Octobre 2013







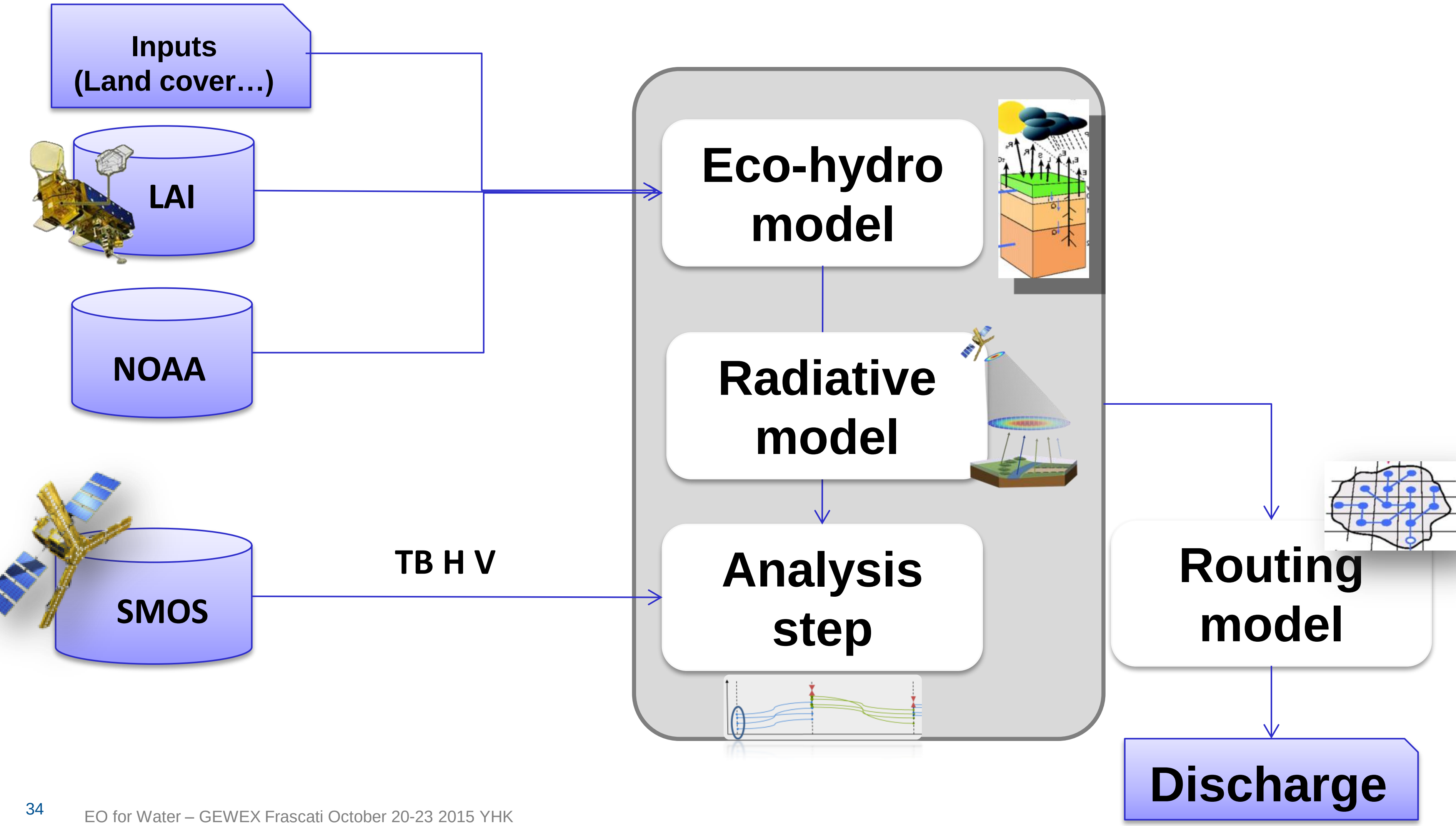
Soil moisture from SMOS and from models (T Pellarin)



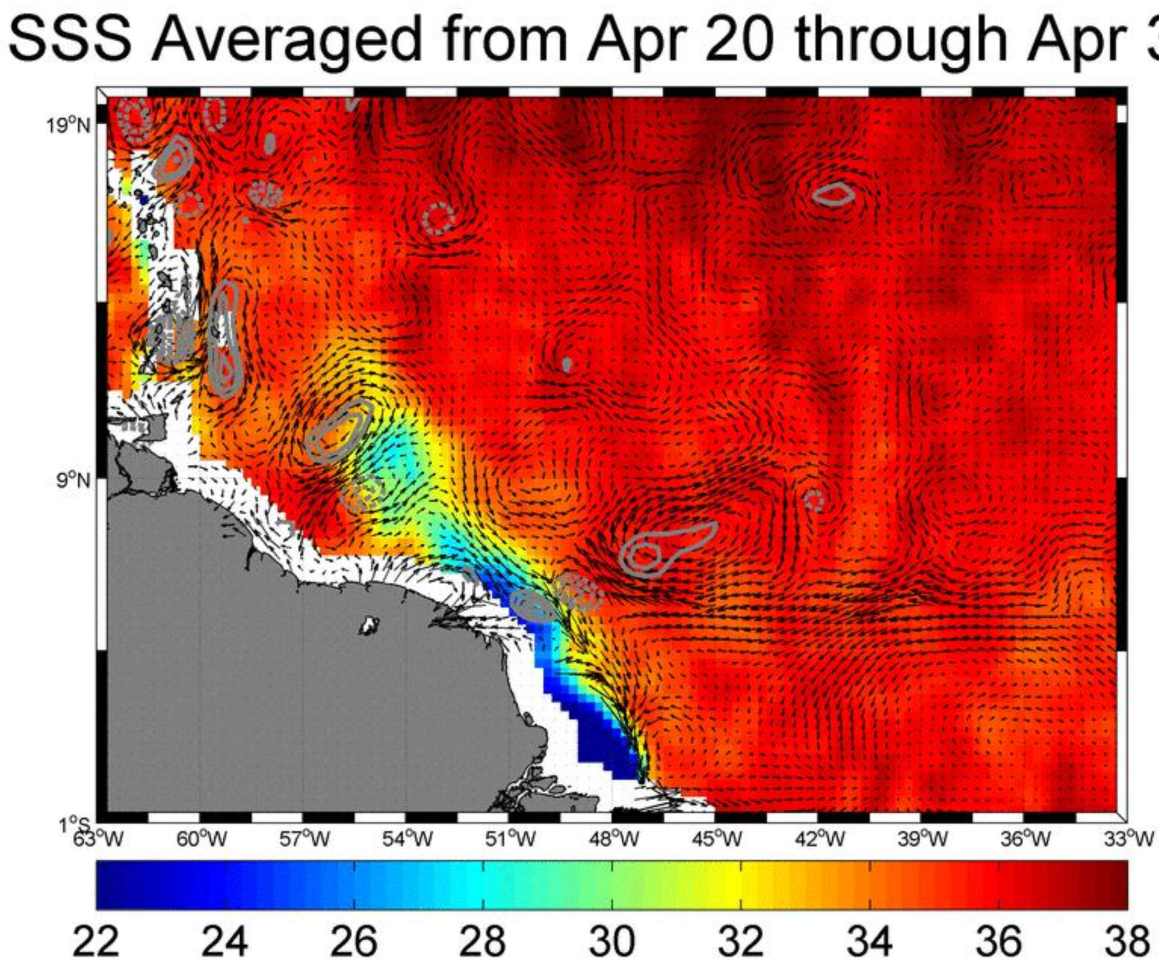
SMOS+Hydro Assimilation system

Methodology

Assimilation of surface soil moisture into eco-hydrological modeling

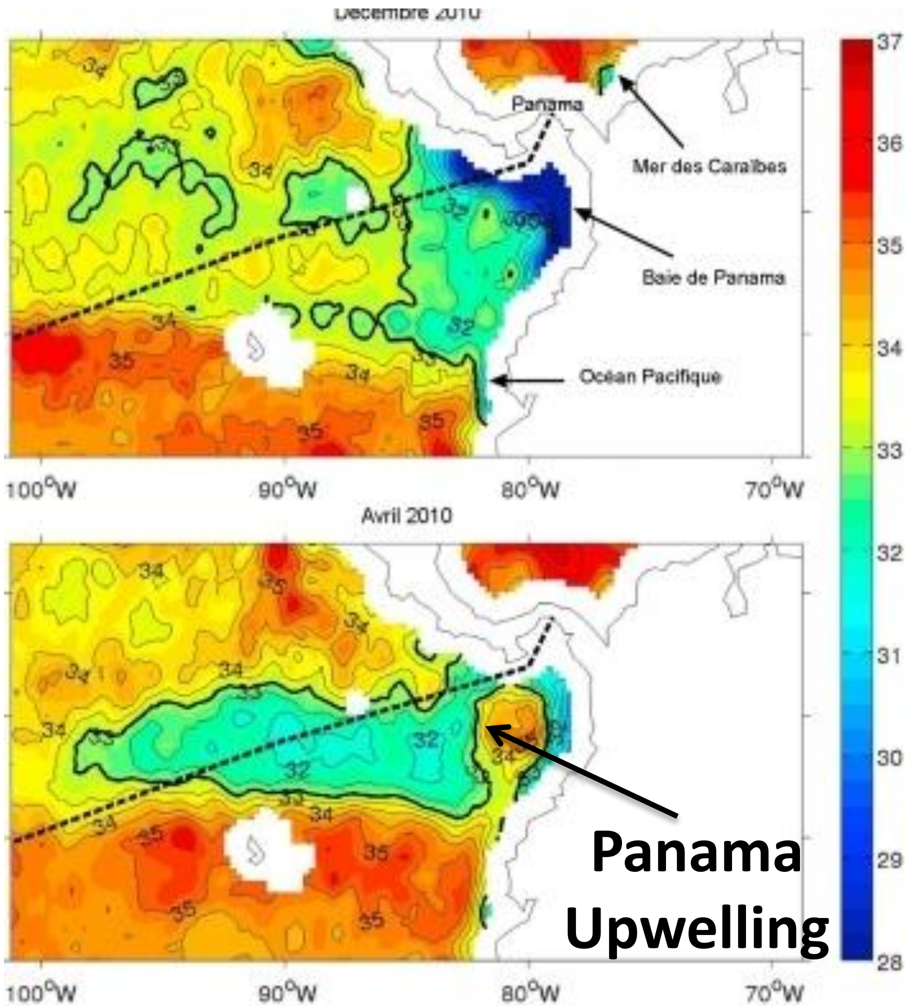


Monitoring fresh water outflow (Amazon and Orinoco plumes (SMOS) with curents (altimeter)

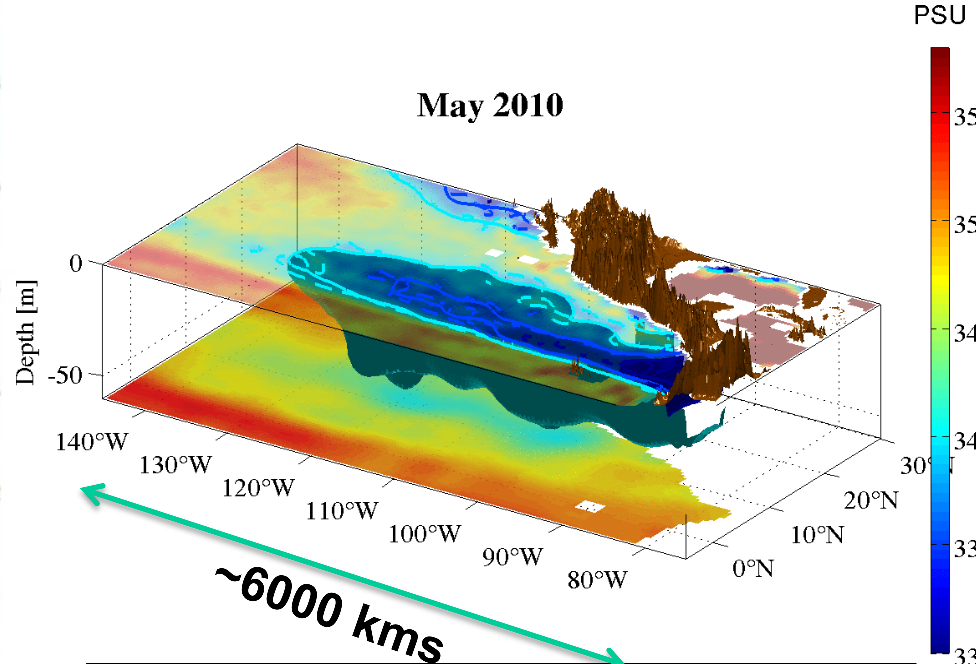


N. Reul

SSS signal of the Panama Upwelling in the Eastern Pacific Freshpool & 3D monitoring of the pool



Alory et al, JGR, 2012



Seasonal & Interannual variability of the East Pacific Freshpool

Surface=SMOS
Subsurface=ARGO OI

S. Guimbard 2015