Ifremer

Large Tropical River Plume Monitoring with SMOS to better estimate Land-Sea Freshwater Fluxes

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Rivers, important variables in oceanography

- Surface freshwater is important to Air-Sea interactions by modifying :
  - open ocean SSS (density)
  - buoyancy of the surface layer & vertical stratification

➡ Rivers : important factors of the Air/Sea interactions

- Sources of organic & inorganic materials which have a key role in many biological, physical & chemical processes.

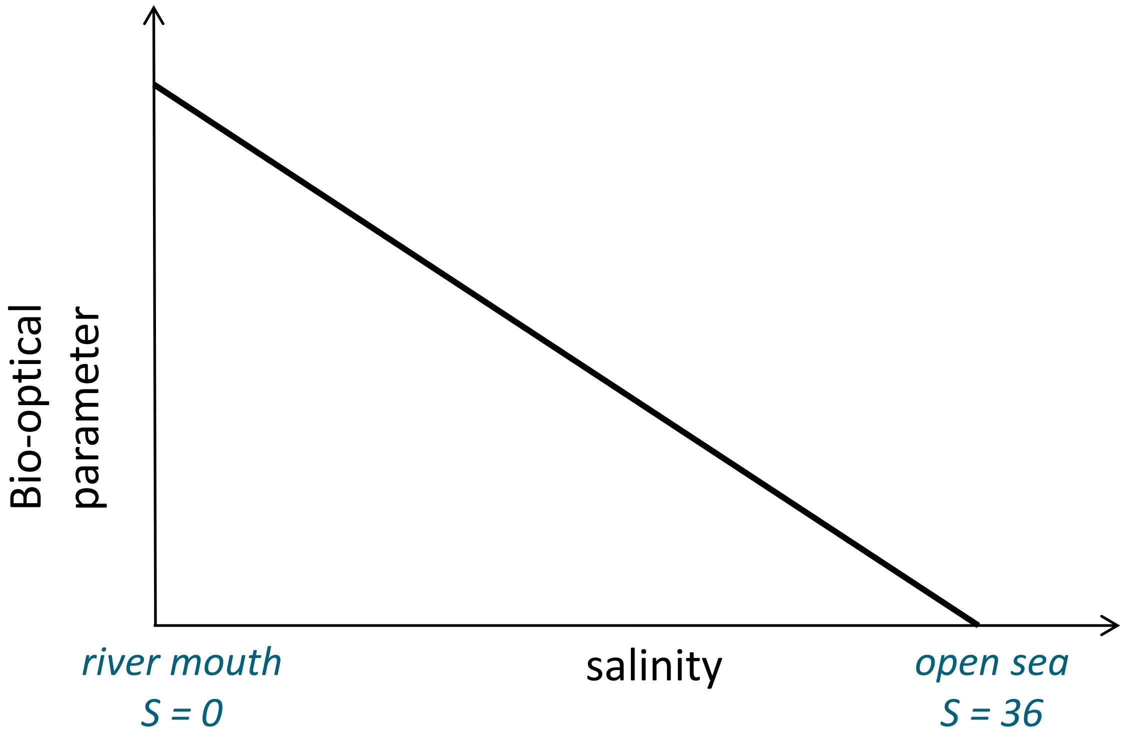
➡ Rivers represent key hydrologic components of freshwater Land/Sea exchanges

- Particularly the Amazon River plume : the world's largest river in terms of discharge levels

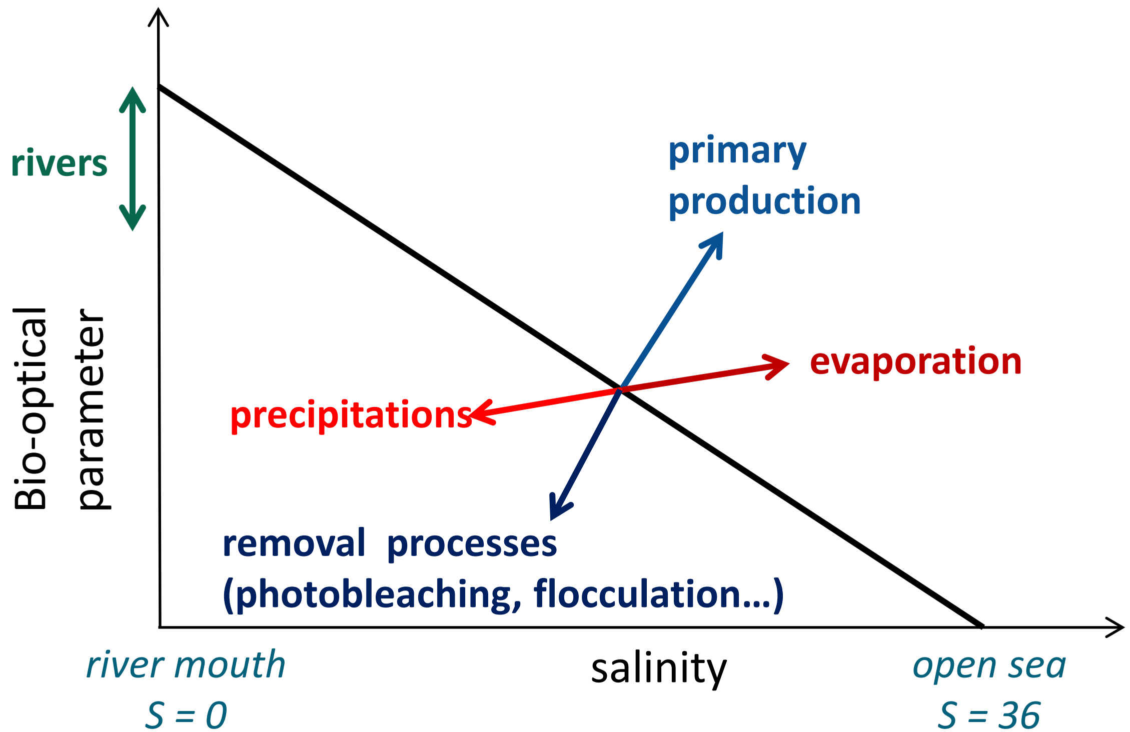
Conservative Mixing in Rivers' plume

- SSS/optical properties ➡ conservative mixing
- A well known inverse correlation SSS/light absorption and SSS/light attenuation

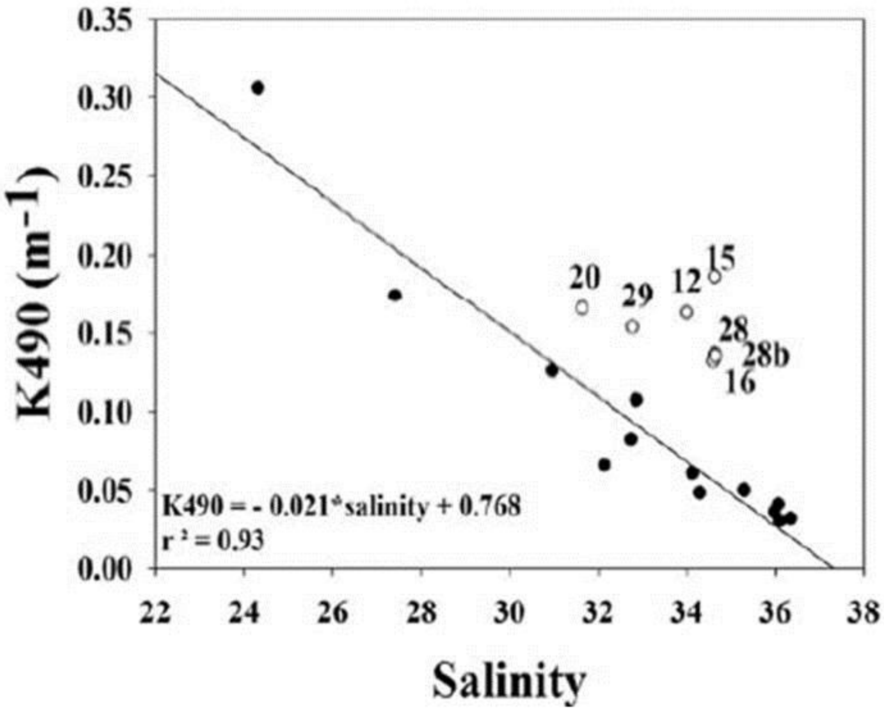
(Hu et al. 2004, Del Vecchio & Subramaniam 2004, Molleri et al. 2010, Salisbury et al., 2010)



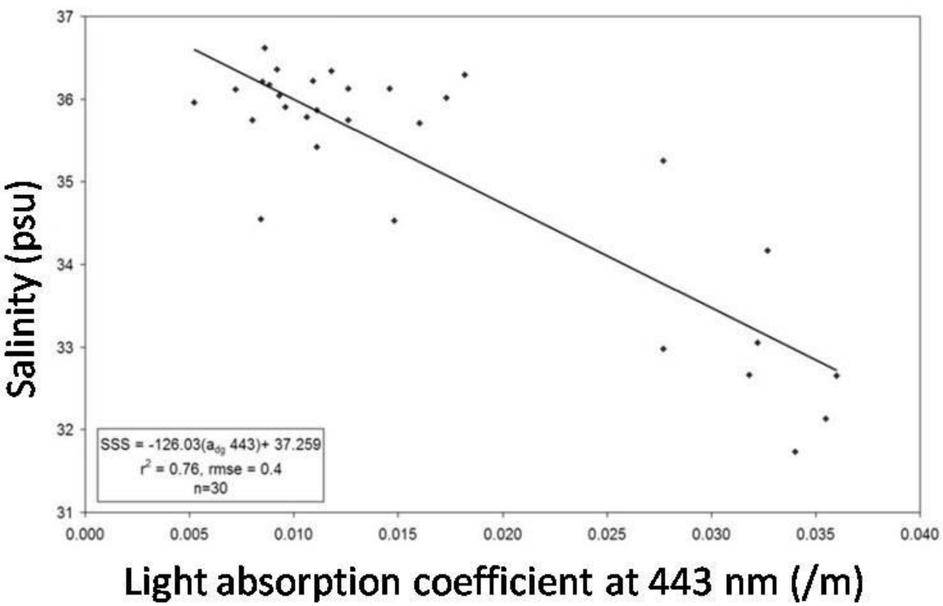
- Deviations from the conservative mixing :
  - Physical processes
  - Bio-optical & bio-chemical processes



- Up to now, the monitoring of the Amazon River plume and of the conservative mixing were limited due to a lack of joint SSS/optical properties observations



Del Vecchio and Subramaniam, 2004

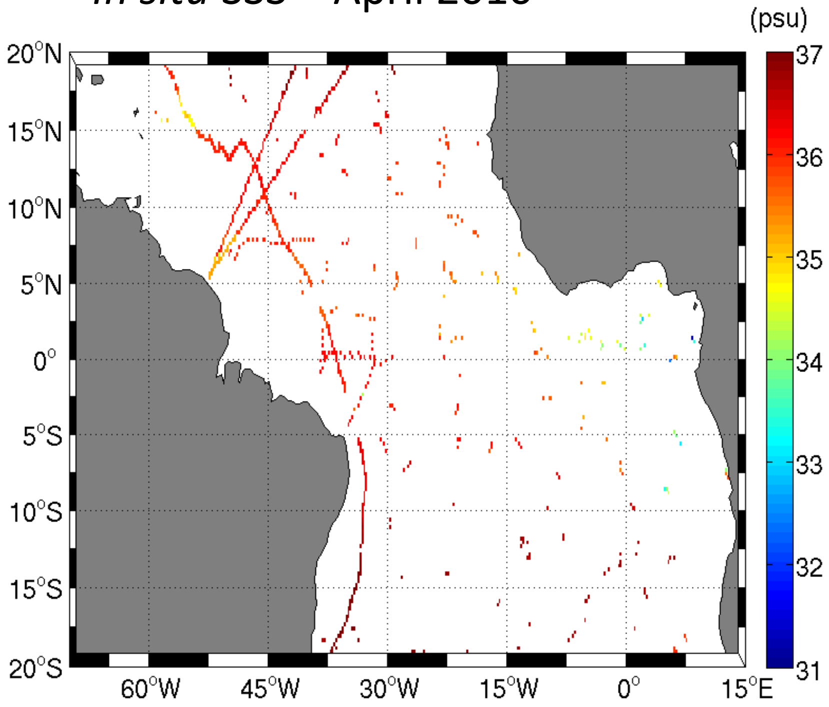


Molleri et al, 2010

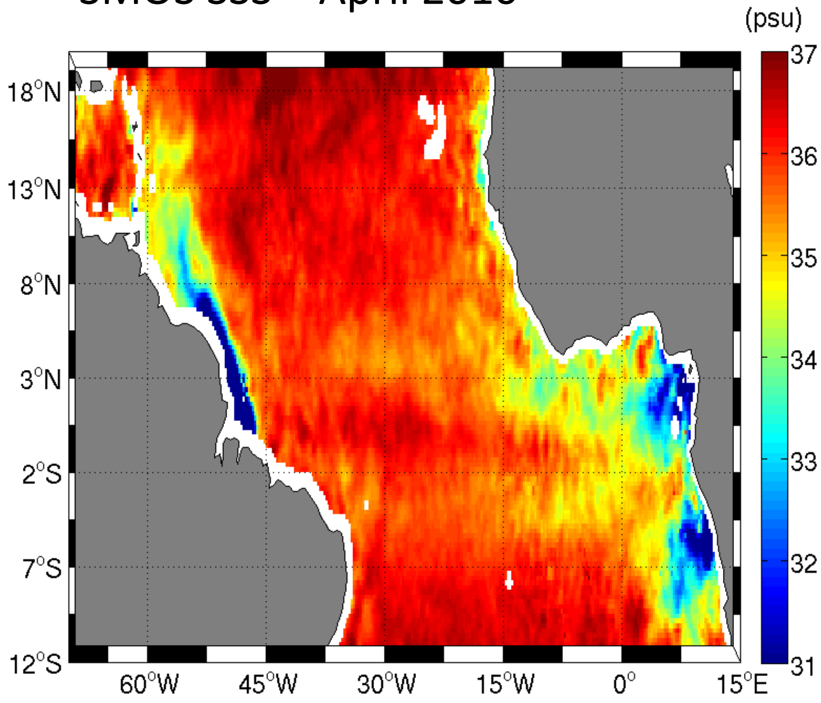
- Since 2010, spaceborne measurements of SSS are available for the first time from SMOS & Aquarius missions

→ unprecedent spatial & temporal resolution

In situ SSS – April 2010



SMOS SSS – April 2010



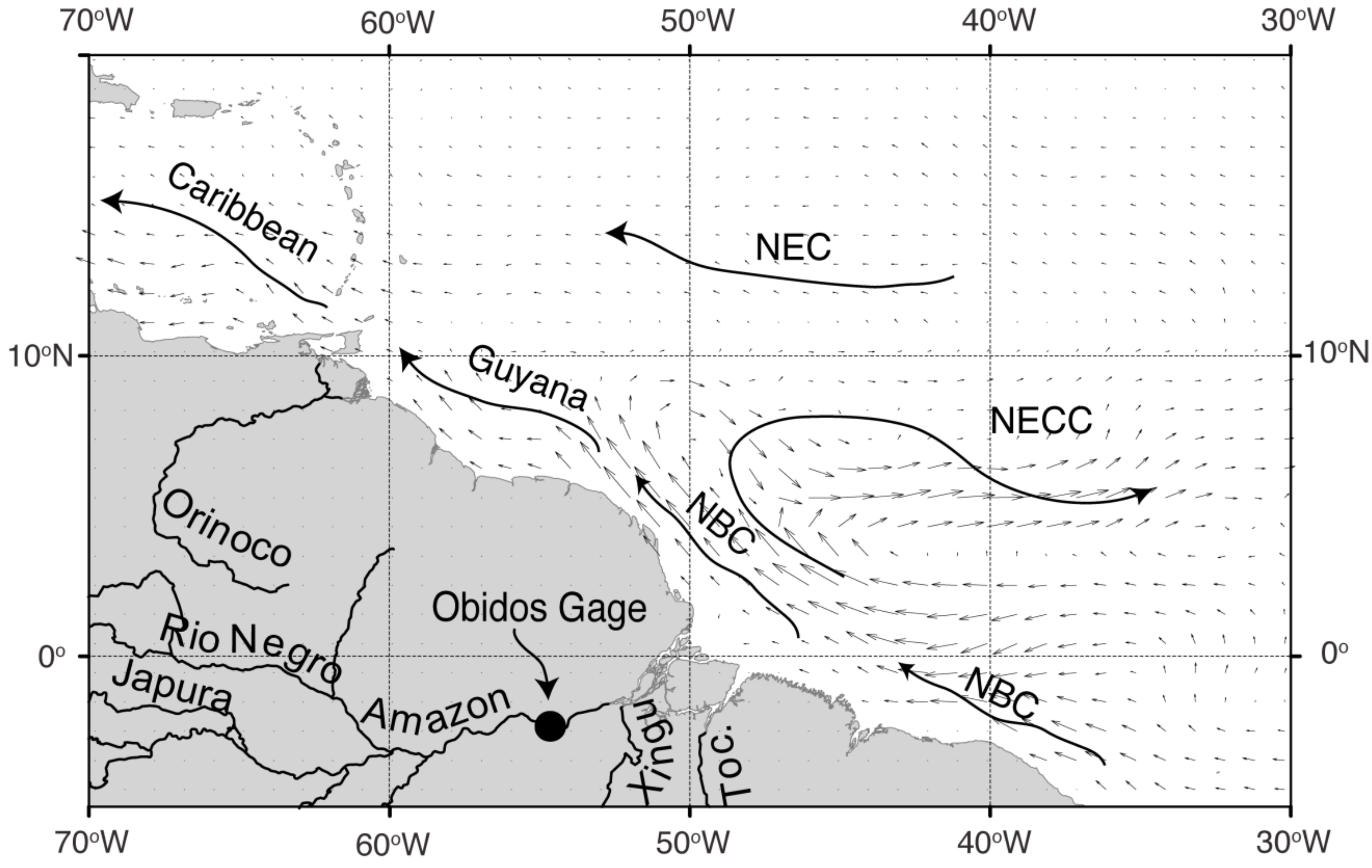
Objectives

- Illustrate the **new monitoring capabilities** for the oceanic freshwater pool generated by the Amazon discharge
- Study the quasi-linear **seasonnally varying conservative mixing** derived from the satellite SSS and Ocean Color properties
- Investigate non conservative behaviours of the conservative mixing
- Estimate the **SSS at high spatial resolution** (4 km) from Ocean Color data

Data

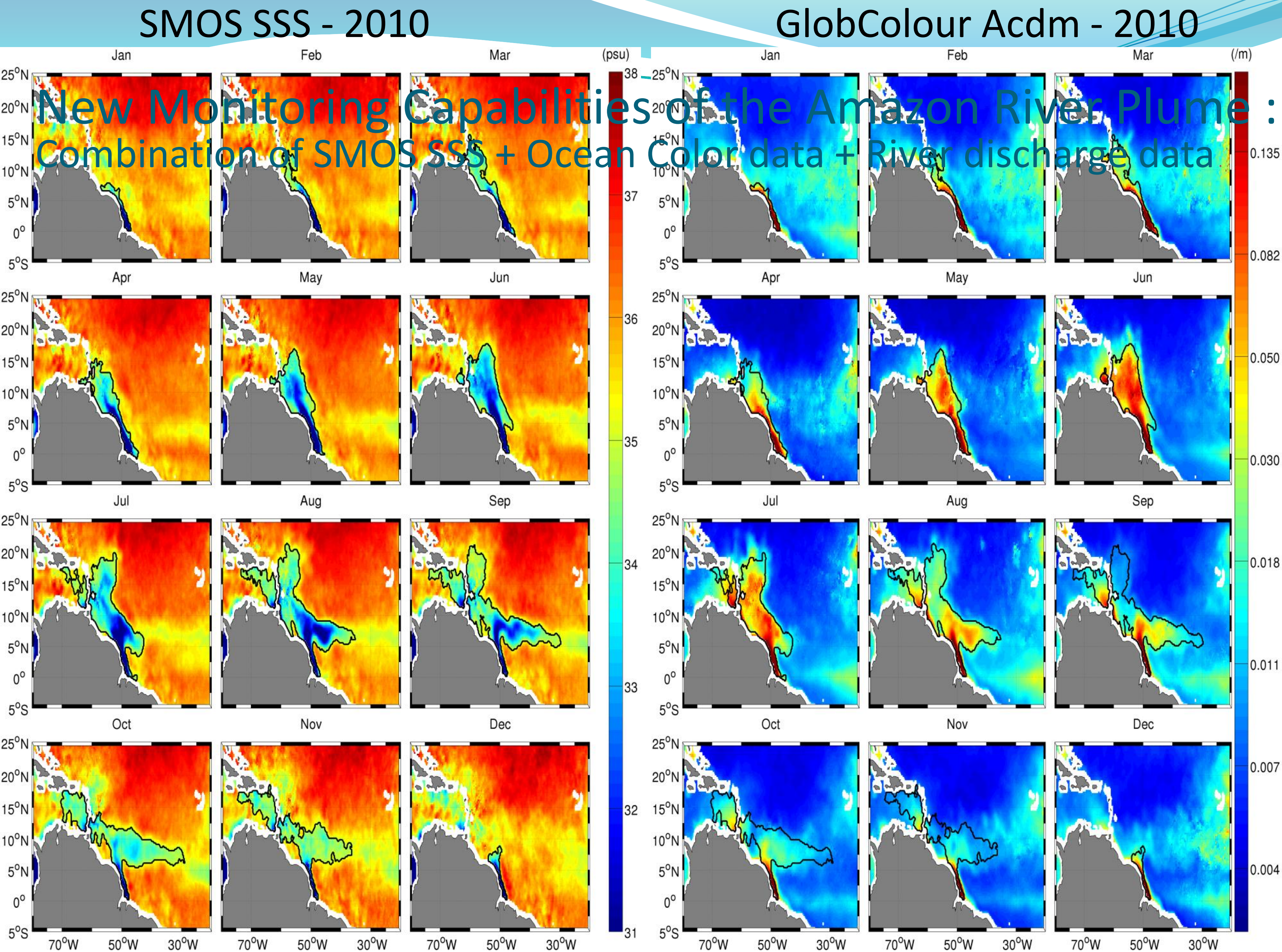
- **SMOS SSS**: 10-day daily running mean, 0.25 degree resolution (CATDS CEC products)
- **MERIS/MODIS/SeaWIFS CDM** absorption: 10-day daily running mean, 4-km resolution (GlobColour ACRI-ST)
- ***In situ* SSS** (Coriolis, IRD, various research campaigns)
- **ORE HYBAM** Amazon & Orinoco discharges at Obidos & Bolivar gauges
- 8-day Carbon based Production Model (CbPM) **Net Primary Productivity** from Ocean Productivity

Amazon Plume - Local Ocean Currents

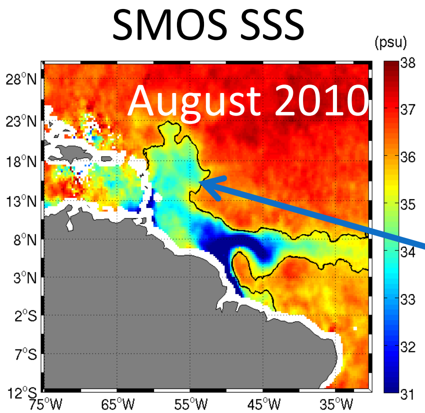


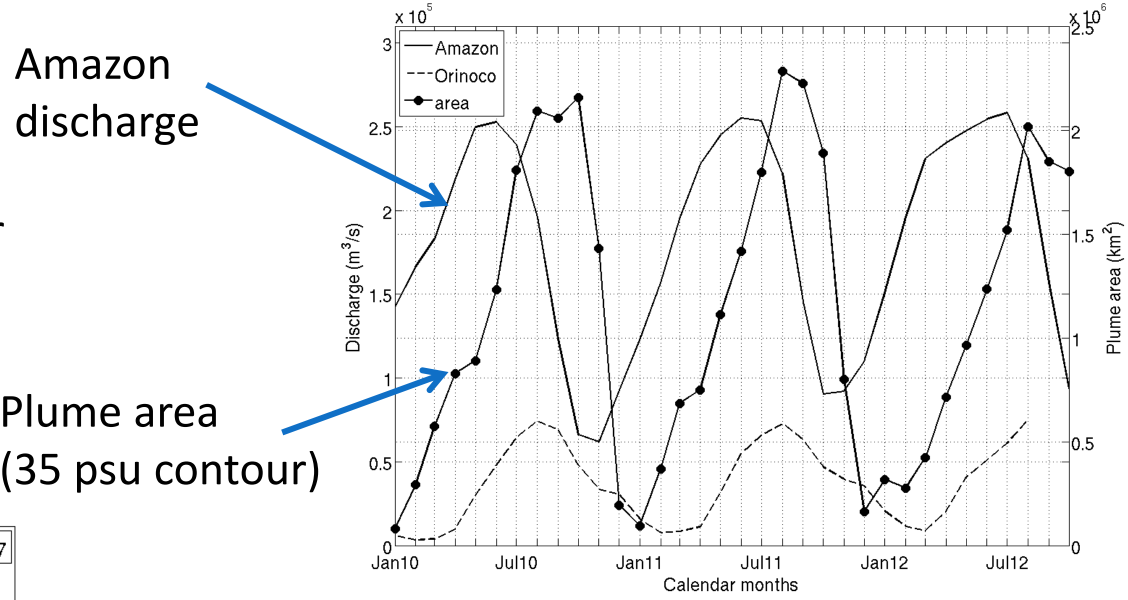
New Monitoring Capabilities of the Amazon River Plume :

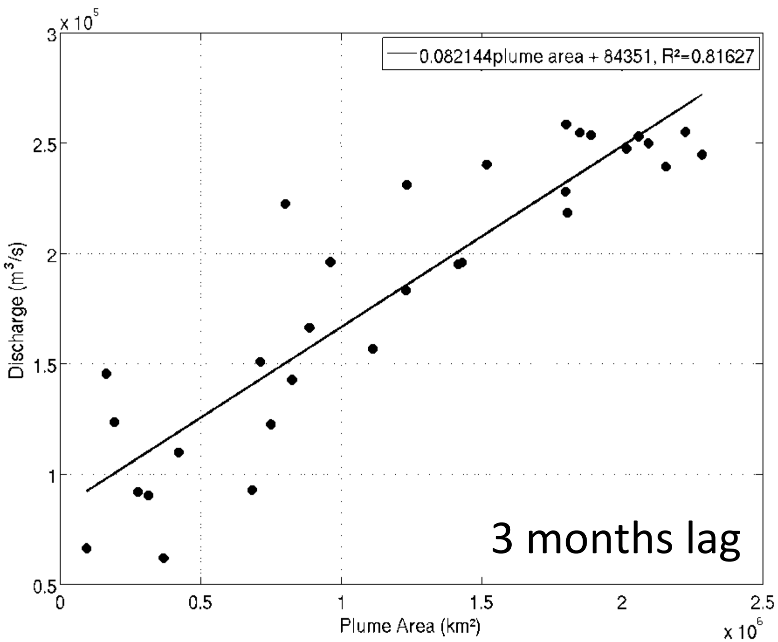
Combination of SMOS SSS + Ocean Color data + River discharge data



SMOS plume monitoring capabilities







Amazon plume extension

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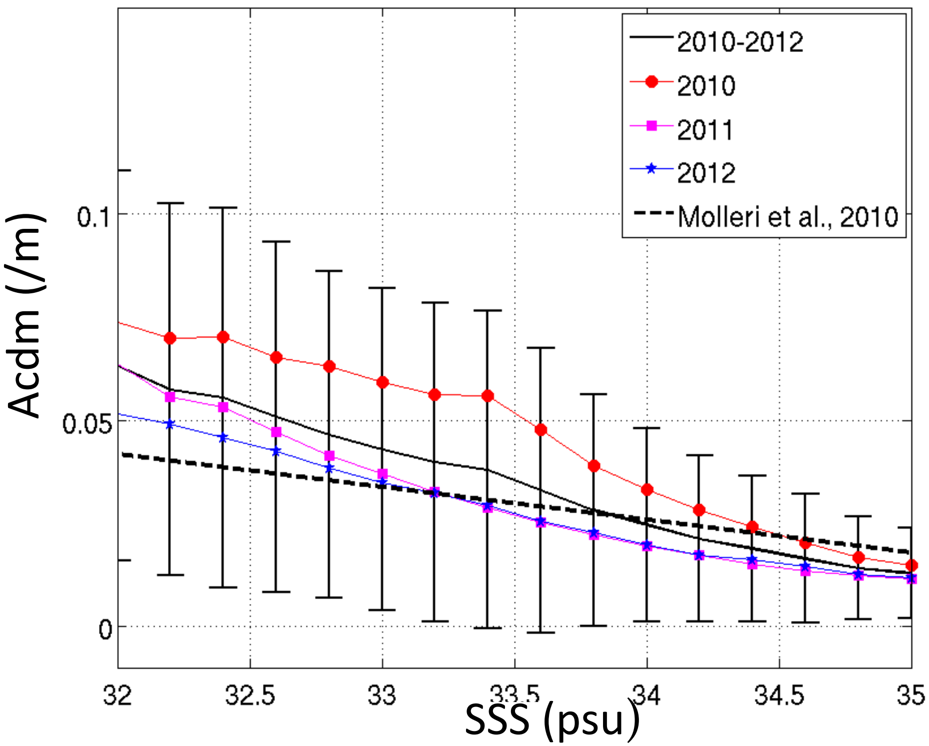
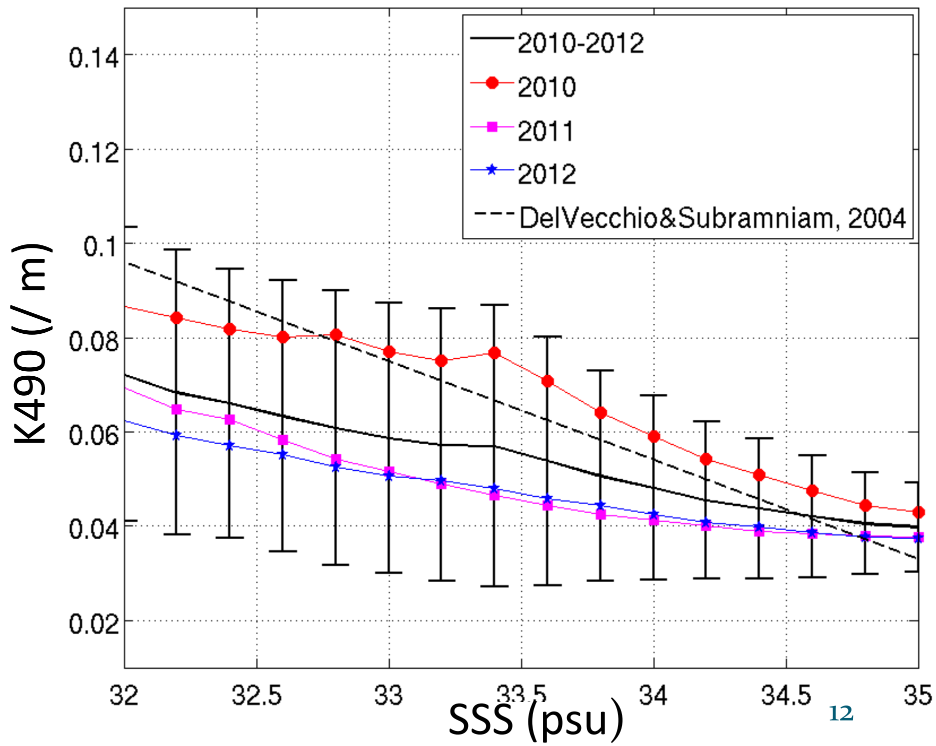
Amazon discharge proxy

The Conservative Mixing seen by SMOS and Ocean Color Sensors

Annual relationships

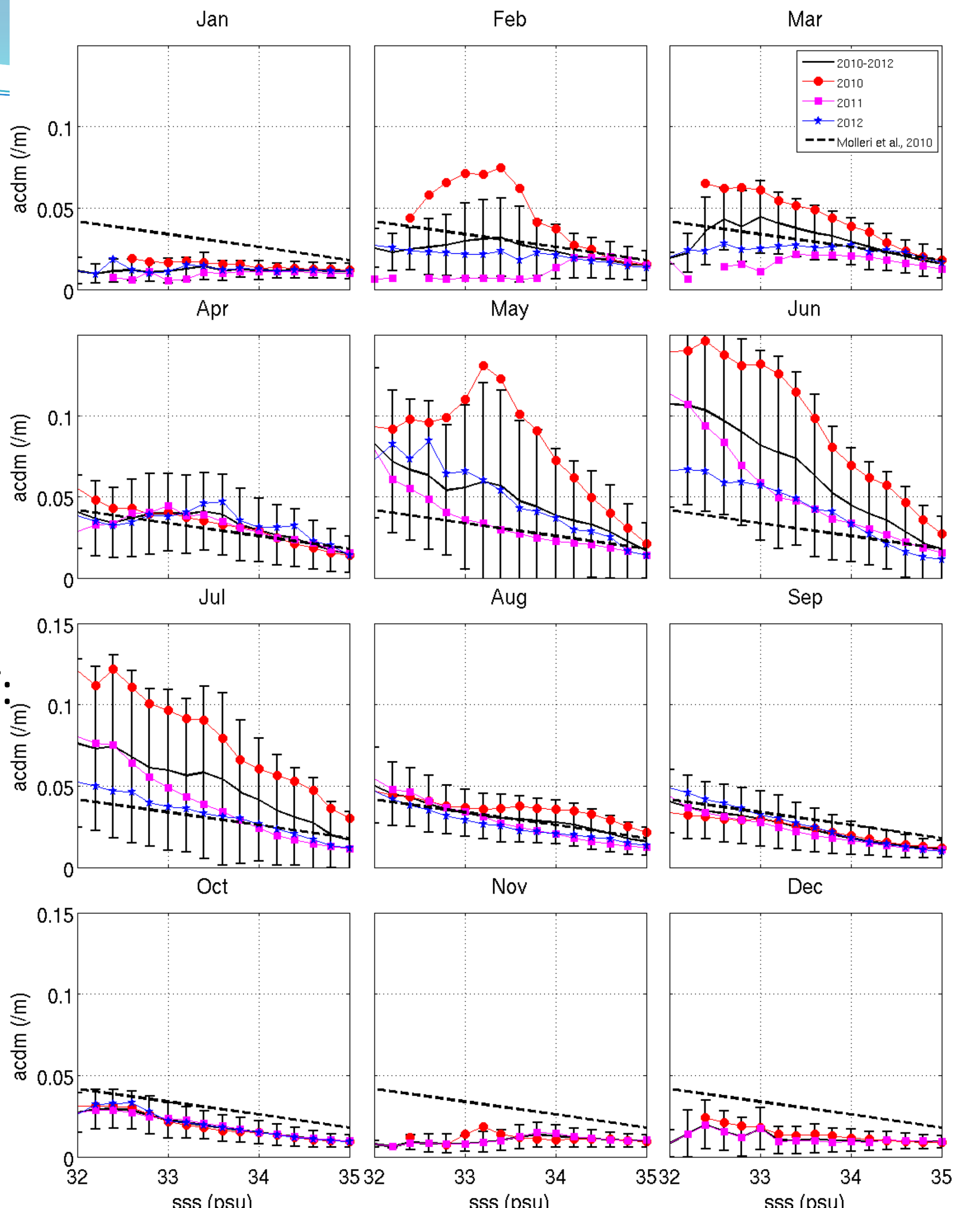




Observed seasonal and interannual variabilities in the SSS/ACDM relationship

Sources of these variabilities have to be explored in terms of:

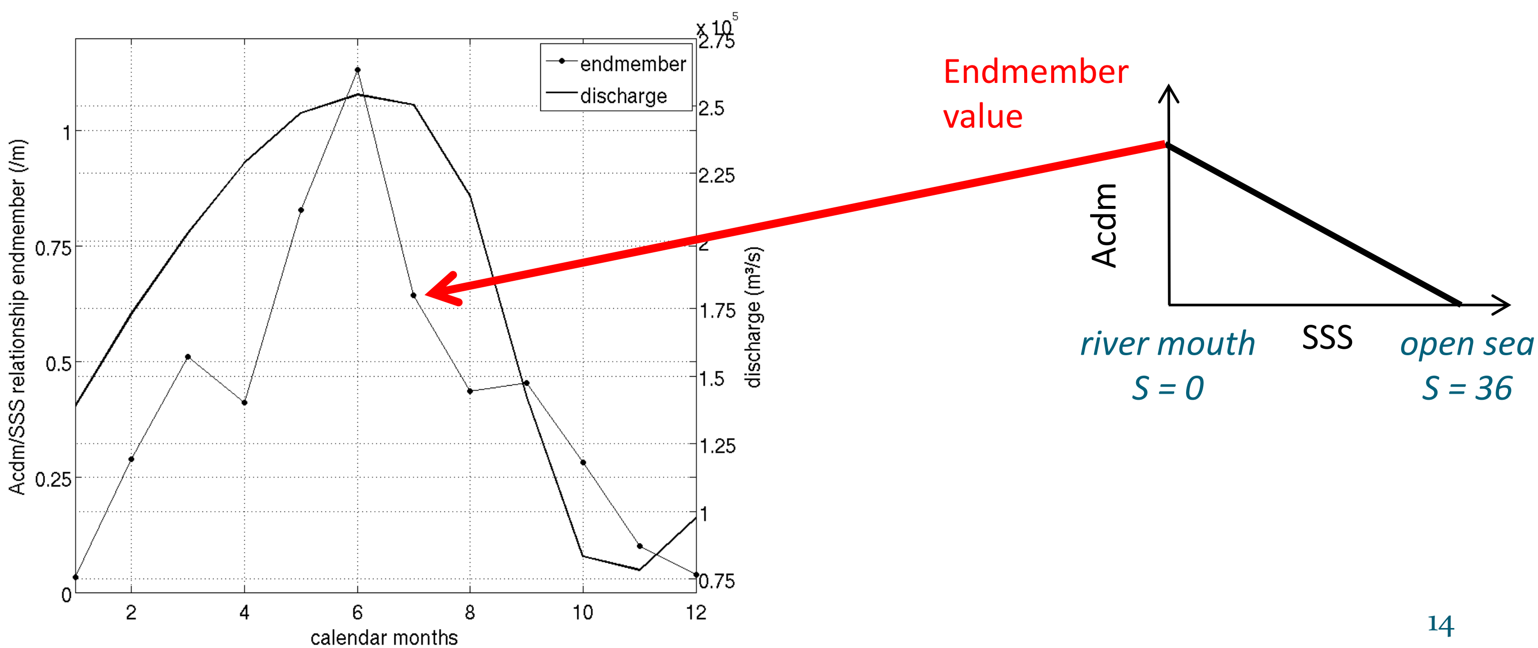
- River cycle (endmember variations, Amazon tributaries)
- Biogeochemical processes (photobleaching, primary production)
- Physical processes (advection, wind, rain)



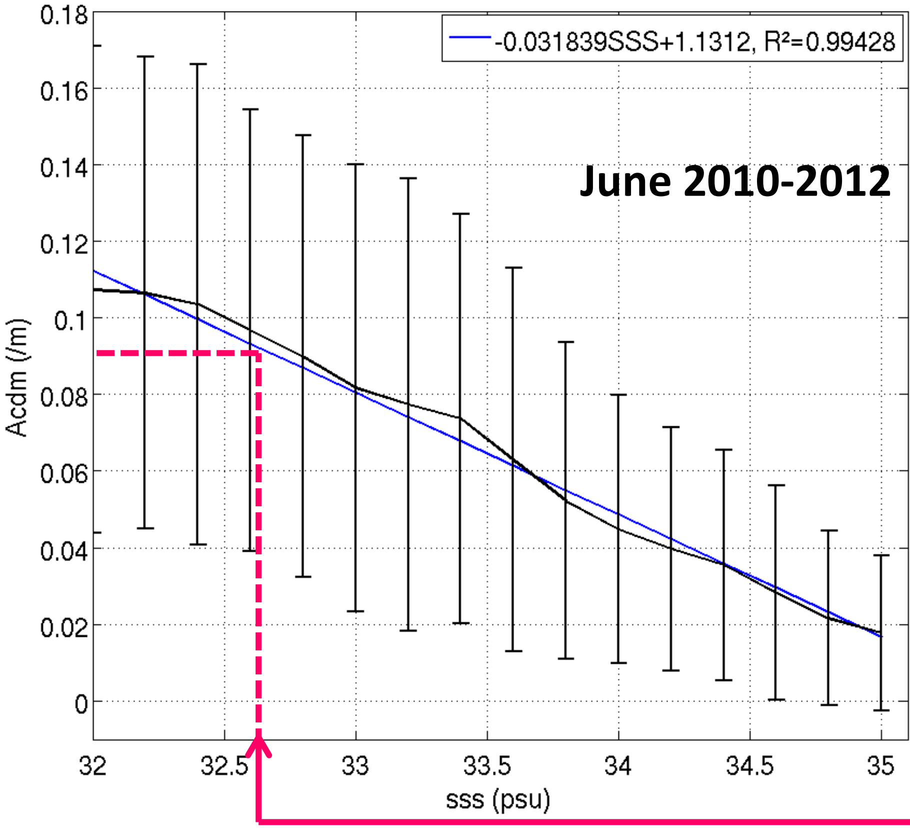
Observed seasonal and interannual variabilities in the SSS/ACDM relationship

- Amazon discharge in phase with the endmember of the SSS/Acdm relationship

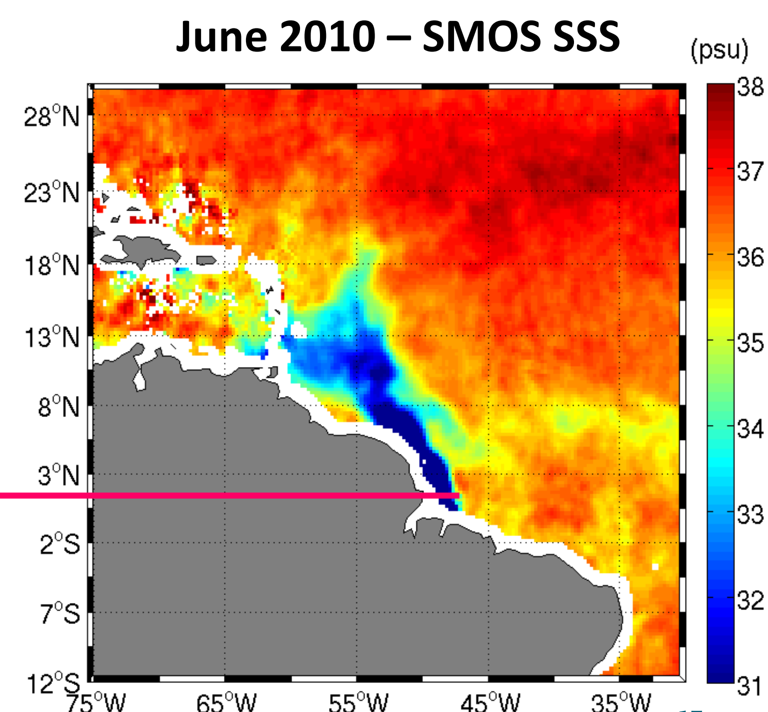
→ discharge = main source of the conservative mixing seasonal cycle



Deviations from the conservative mixing



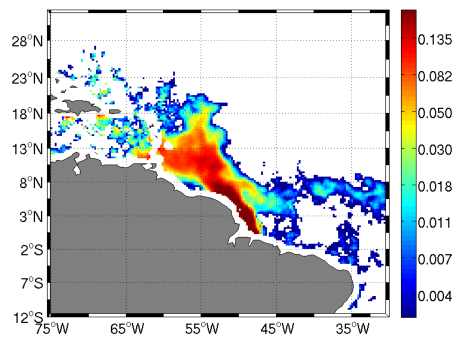
Estimation of Acdm from SMOS SSS and the monthly 2010-2012 SSS/Acdm relationship



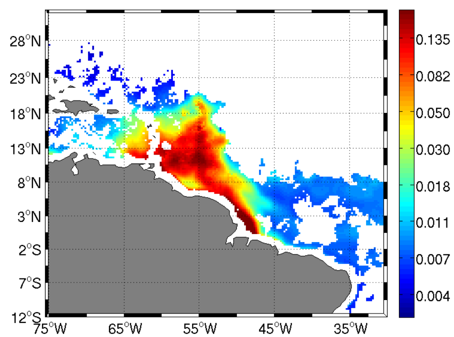
Deviations from the conservative mixing

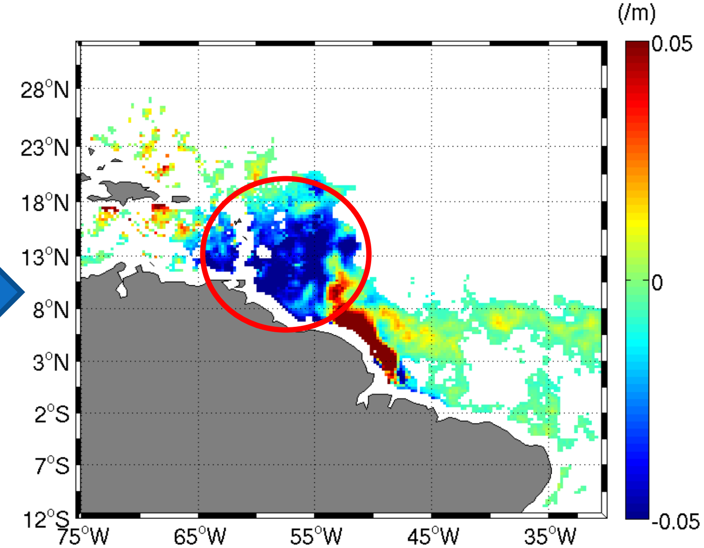
June 2010

Synthetic Acdm



GlobColour Acdm





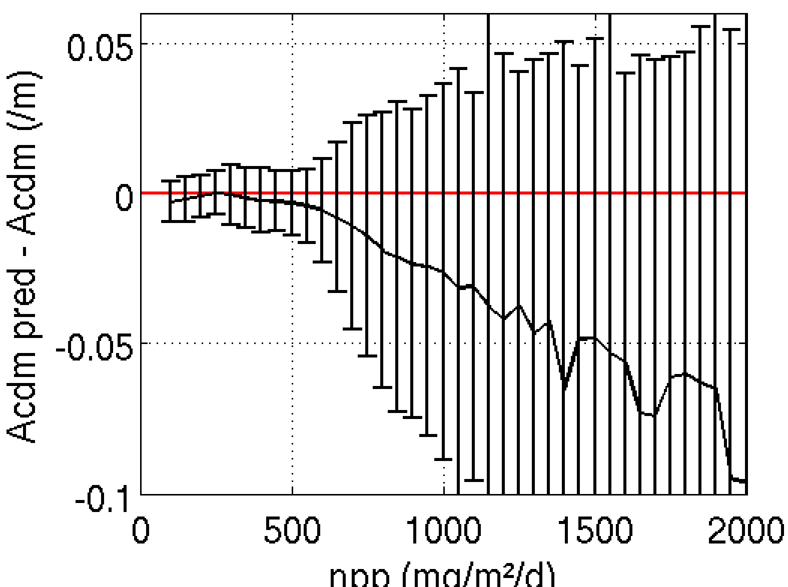
Observe

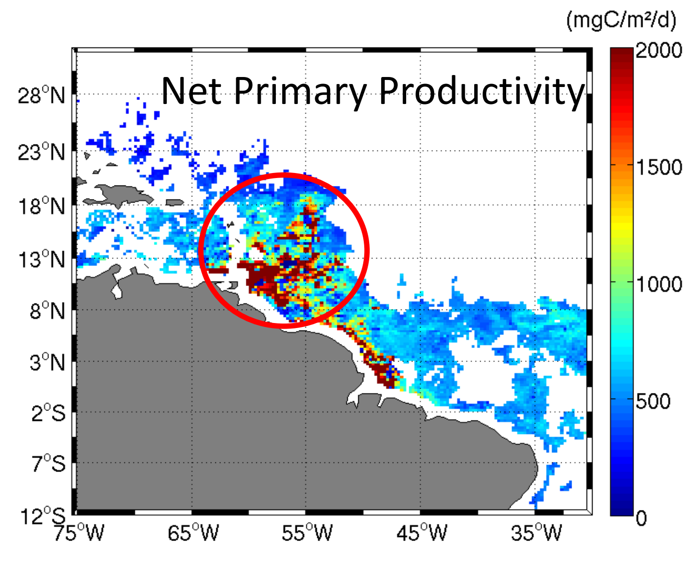
Anoma

Synthetic

Anom

Observe



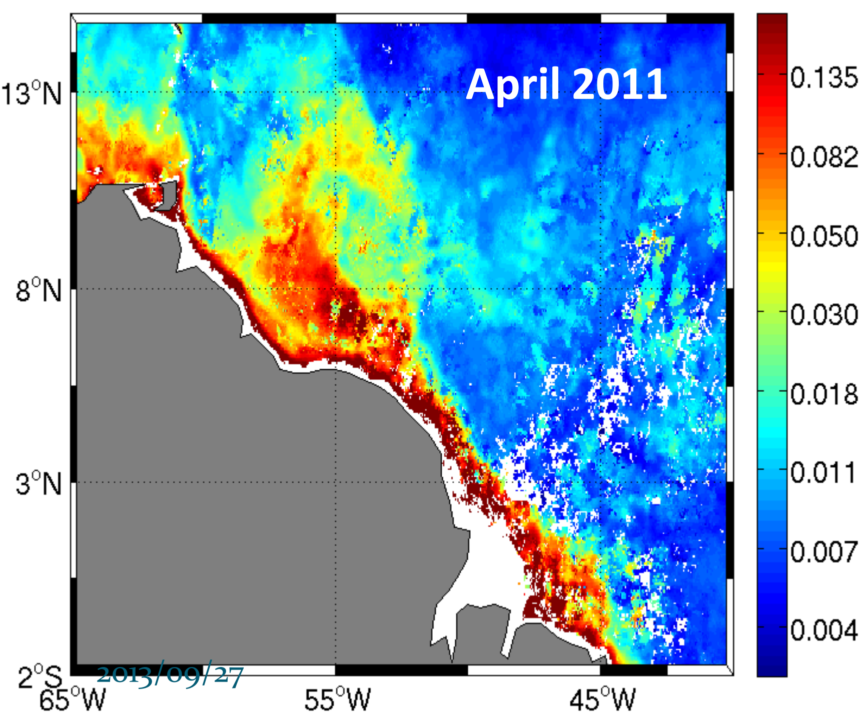


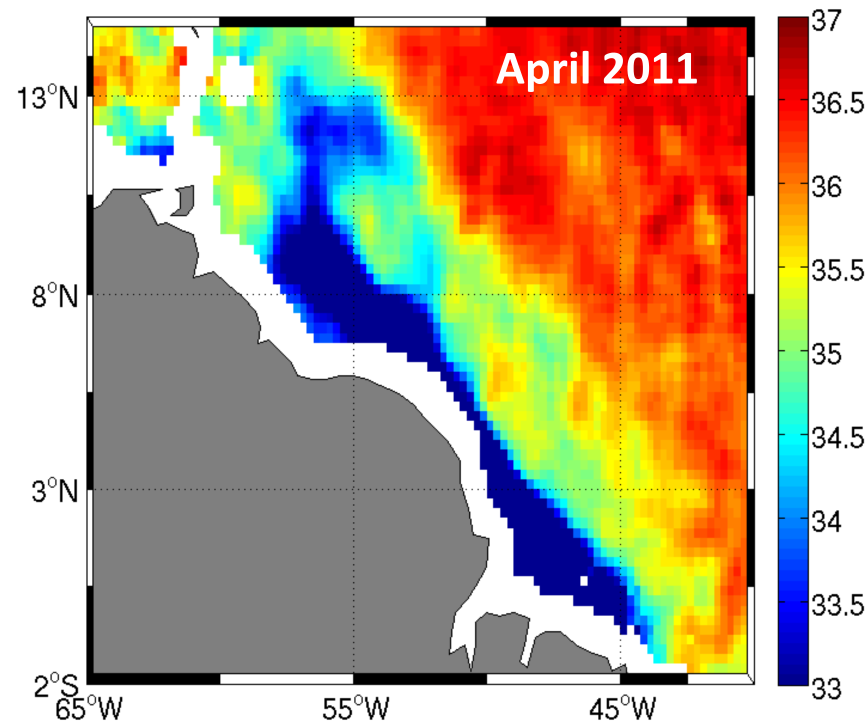
High resolution SSS from Ocean Color

- Ocean Color sensors : 4 km – SMOS : 25 km

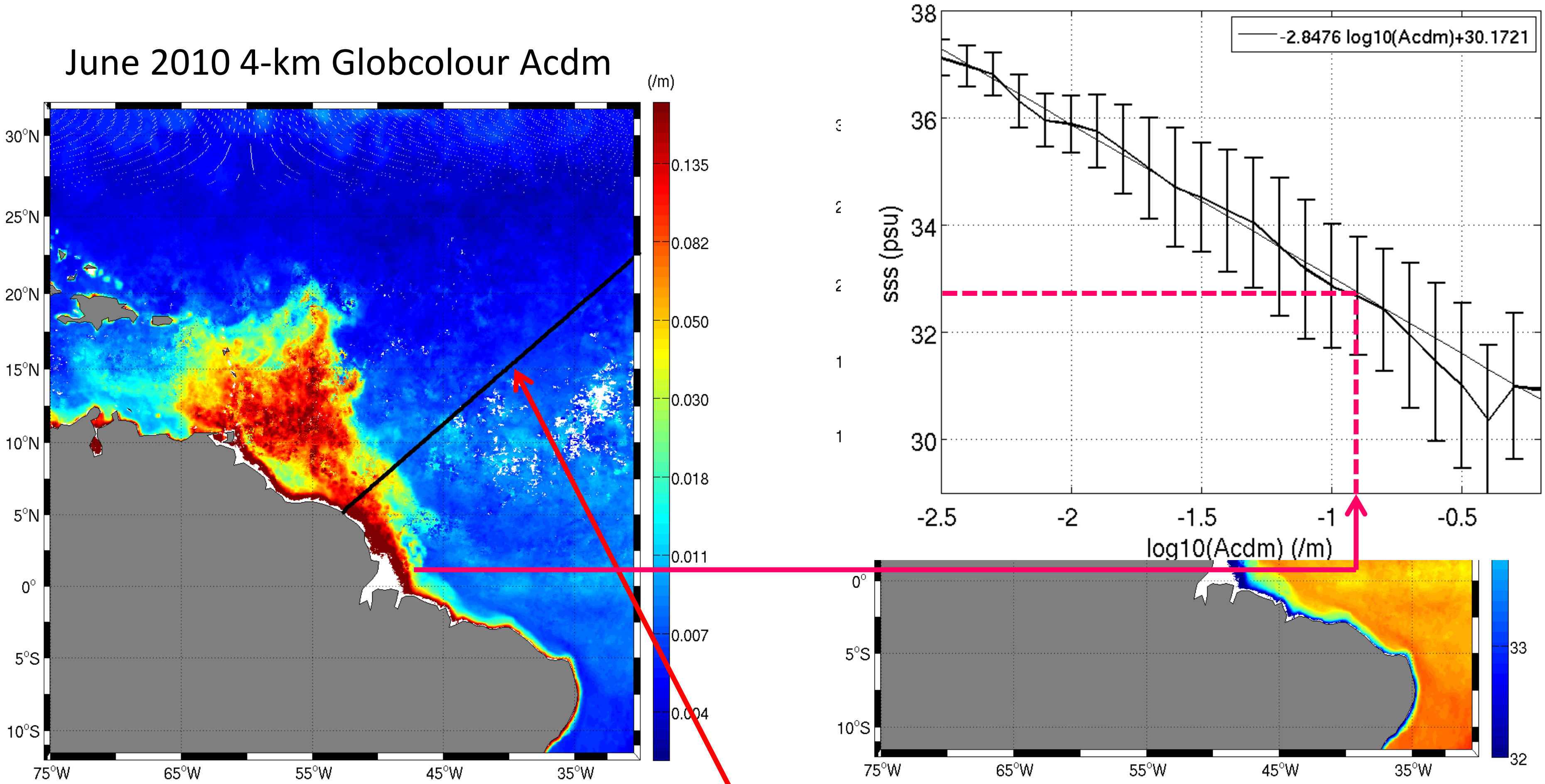
  ➡ distinguish structures not well-resolved by microwave SSS sensors

- Data available from 2002
- Coastal observations



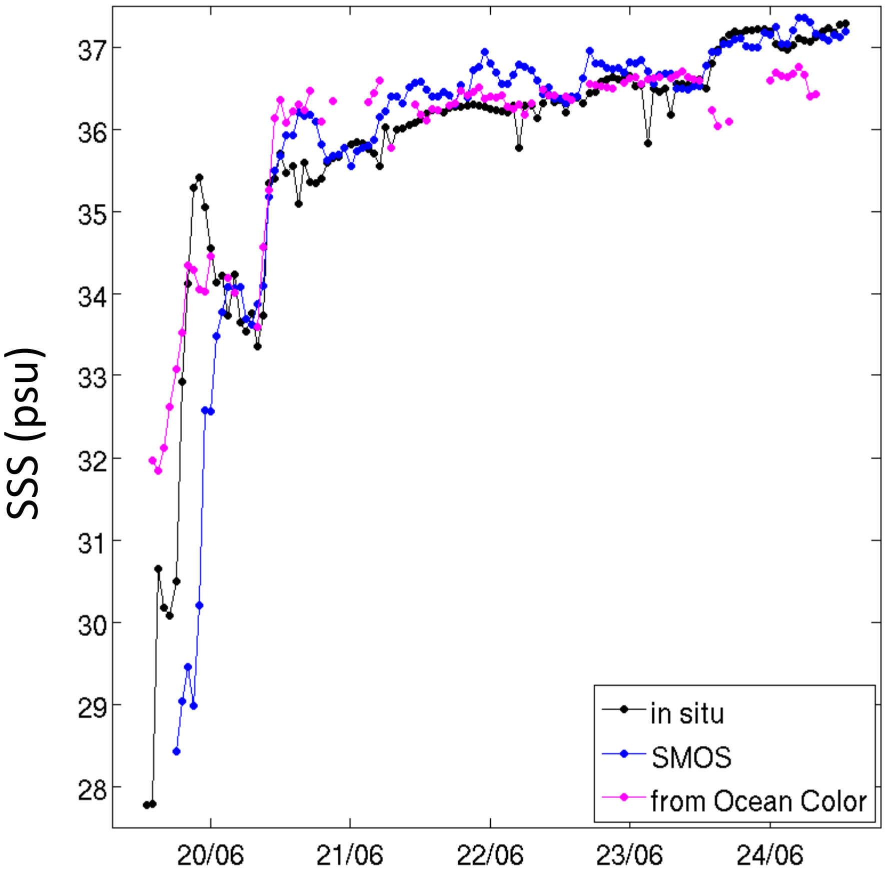


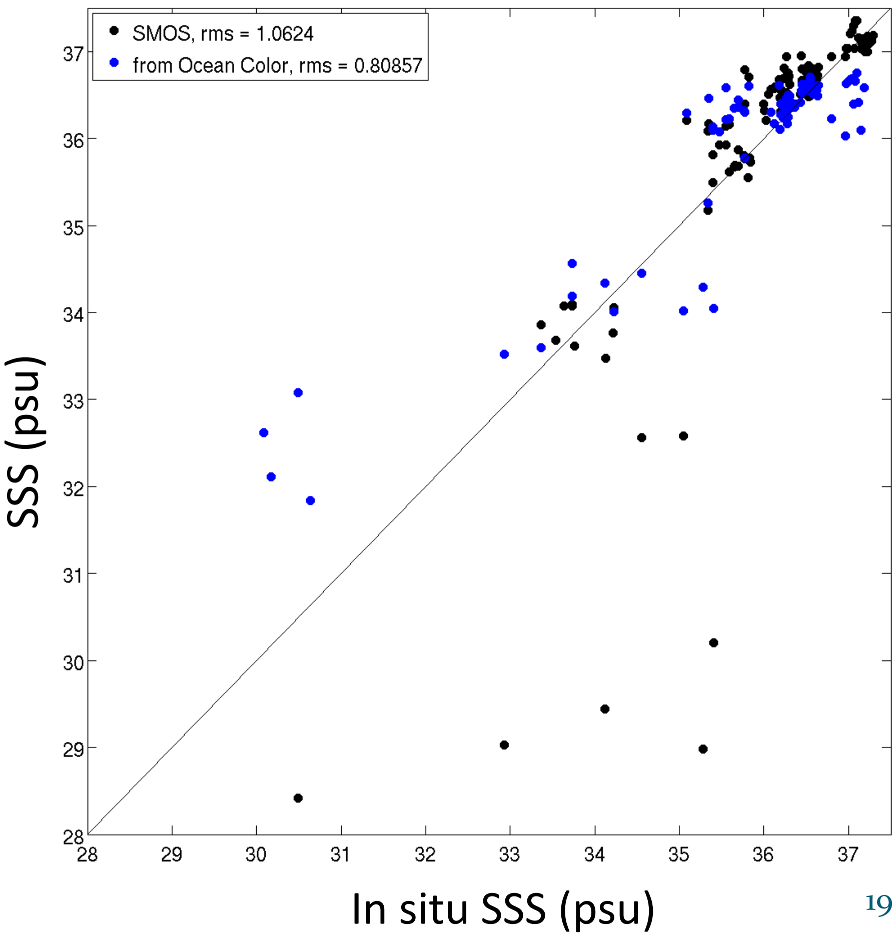
High resolution SSS from Ocean Color

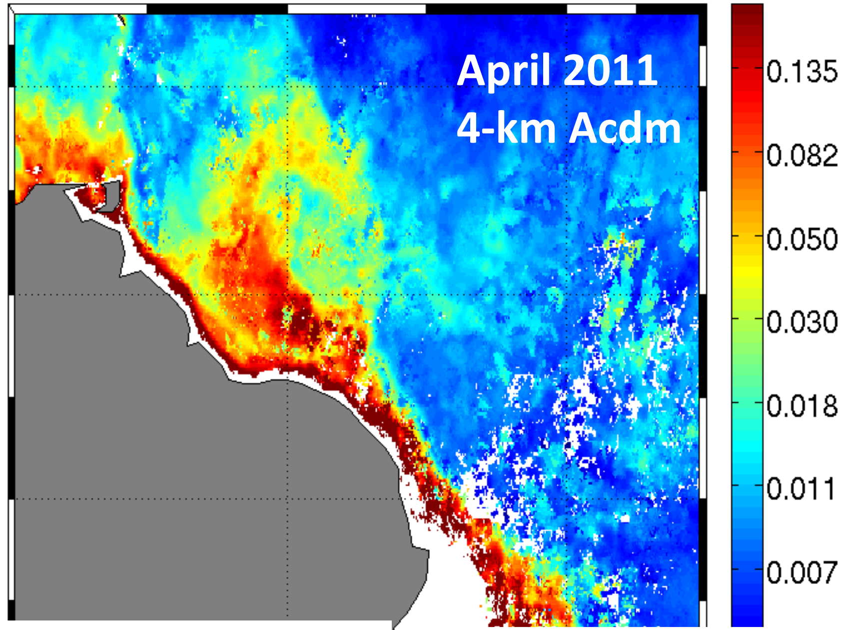


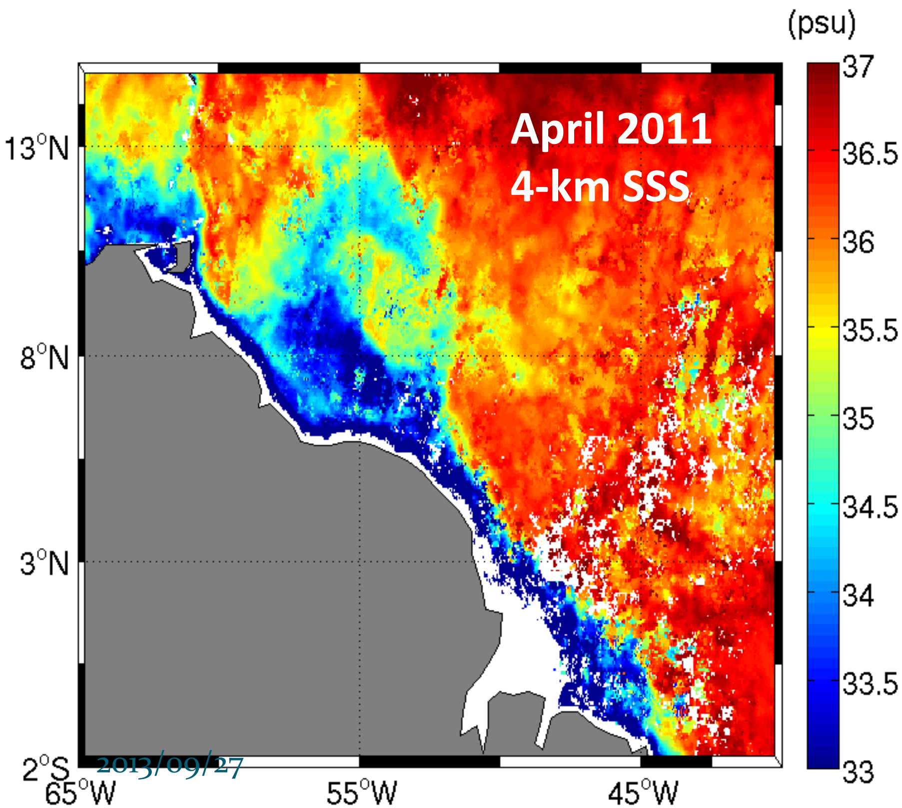
Colibri TSG transect - June 2010

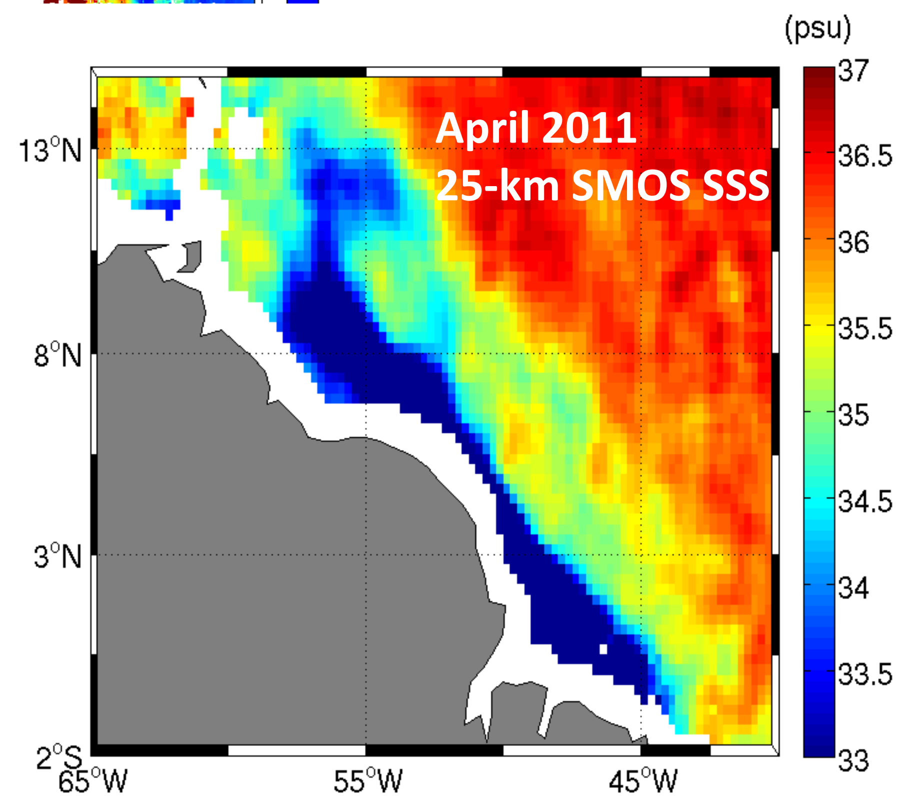
High resolution SSS Validation

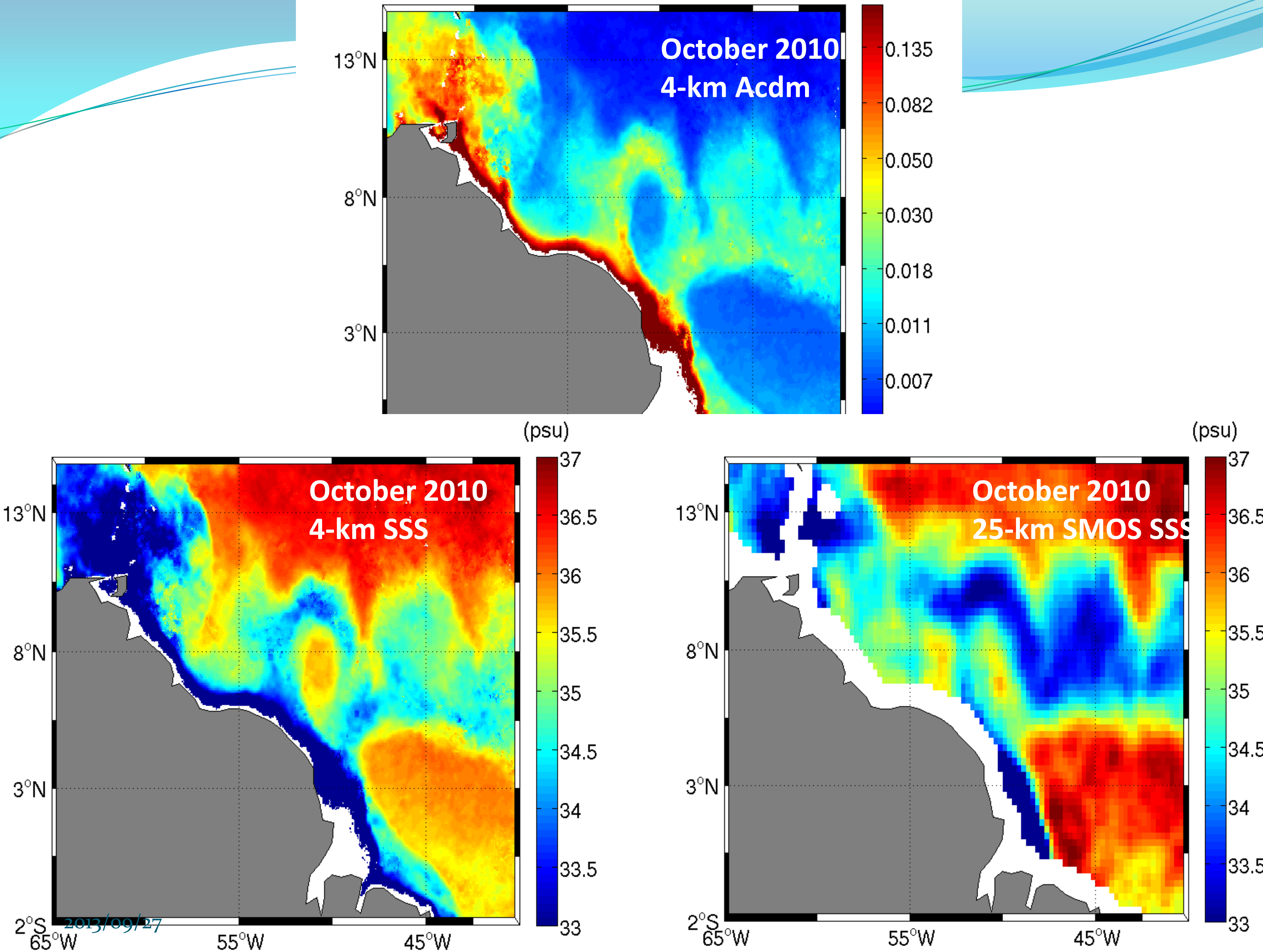





April 2011
4-km Acdm
13°N
8°N
3°N
0.135
0.082
0.050
0.030
0.018
0.011
0.007


April 2011
4-km SSS
(psu)
13°N
8°N
3°N
2°S
65°W
55°W
45°W
37
36.5
36
35.5
35
34.5
34
33.5
33


April 2011
25-km SMOS SSS
(psu)
13°N
8°N
3°N
2°S
65°W
55°W
45°W
37
36.5
36
35.5
35
34.5
34
33.5
33


October 2010
4-km Acdm
13°N
8°N
3°N
0.135
0.082
0.050
0.030
0.018
0.011
0.007
October 2010
4-km SSS
(psu)
37
36.5
36
35.5
35
34.5
34
33.5
33
13°N
8°N
3°N
2°S
65°W
55°W
45°W
October 2010
25-km SMOS SSS
(psu)
37
36.5
36
35.5
35
34.5
34
33.5
33
13°N
8°N
3°N
2°S
65°W
55°W
45°W

Conclusions

- Consistency between SMOS SSS (microwave instrument) & Ocean Color (optical instrument)
- New approach of the SSS/Acdm relationship thanks to remote sensing : largely improved spatio-temporal monitoring
- For the first time, the seasonal and interannual variabilities of the conservative mixing are highlighted
- Study of the deviations from the conservative mixing
- High Resolution SSS estimates can be retrieved

Thank you for your attention

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