Large mesoscale salinity features detected by SMOS and perspectives for next generation missions

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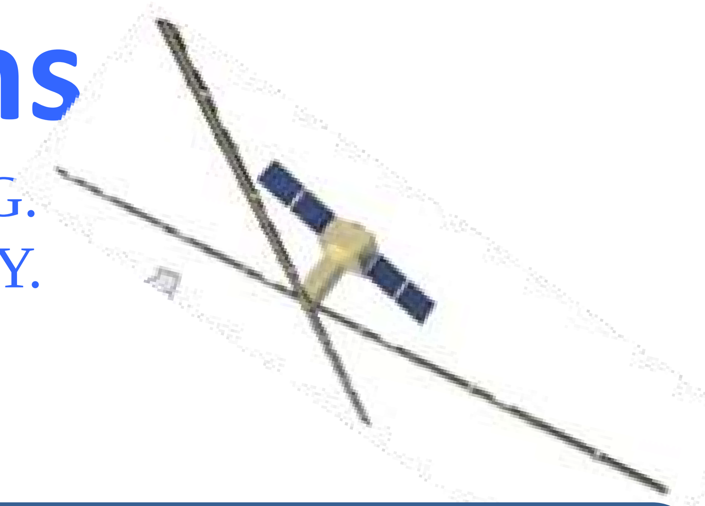
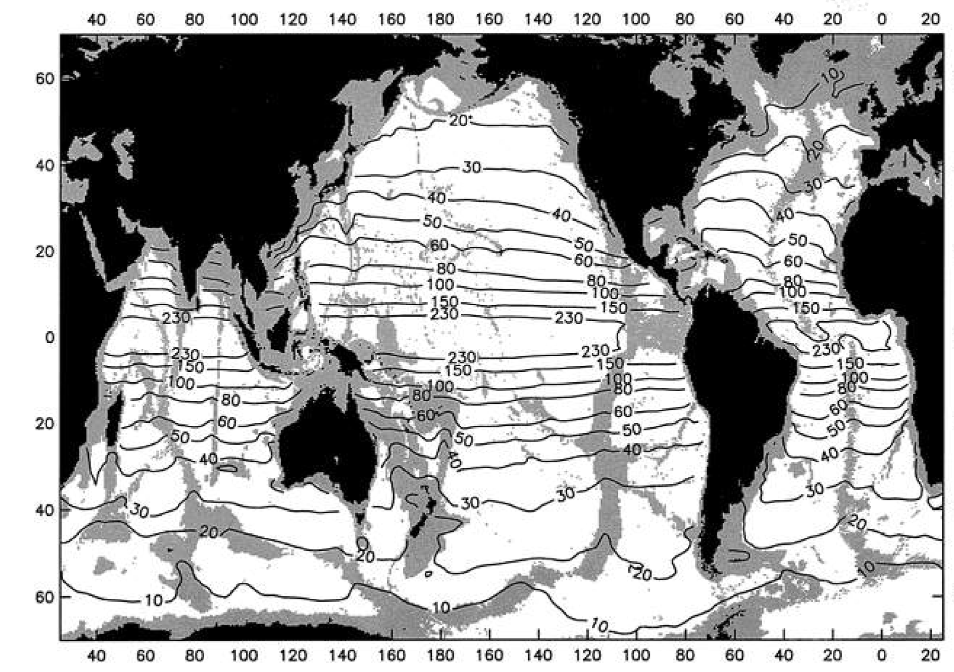


Introduction

SMOS provides the longest satellite sea surface salinity (SSS) time series (2010-ongoing). Its averaged spatial resolution of ~45km allows to detect large mesoscale structures, density-compensated structures, the influence of freshwater fluxes (rainfall, river plumes) on salinity and, by extension, on the density of sea water. We illustrate them with SMOS results which show the scientific interest of increasing the spatial resolution of satellite salinity measurements. This supports the development of the new SMOS high resolution (SMOS-HR) concept (~10km resolution, see posters/presentations by Cheymol et al. , Rodriguez-Fernandez et al., Kallel et al., this conference).

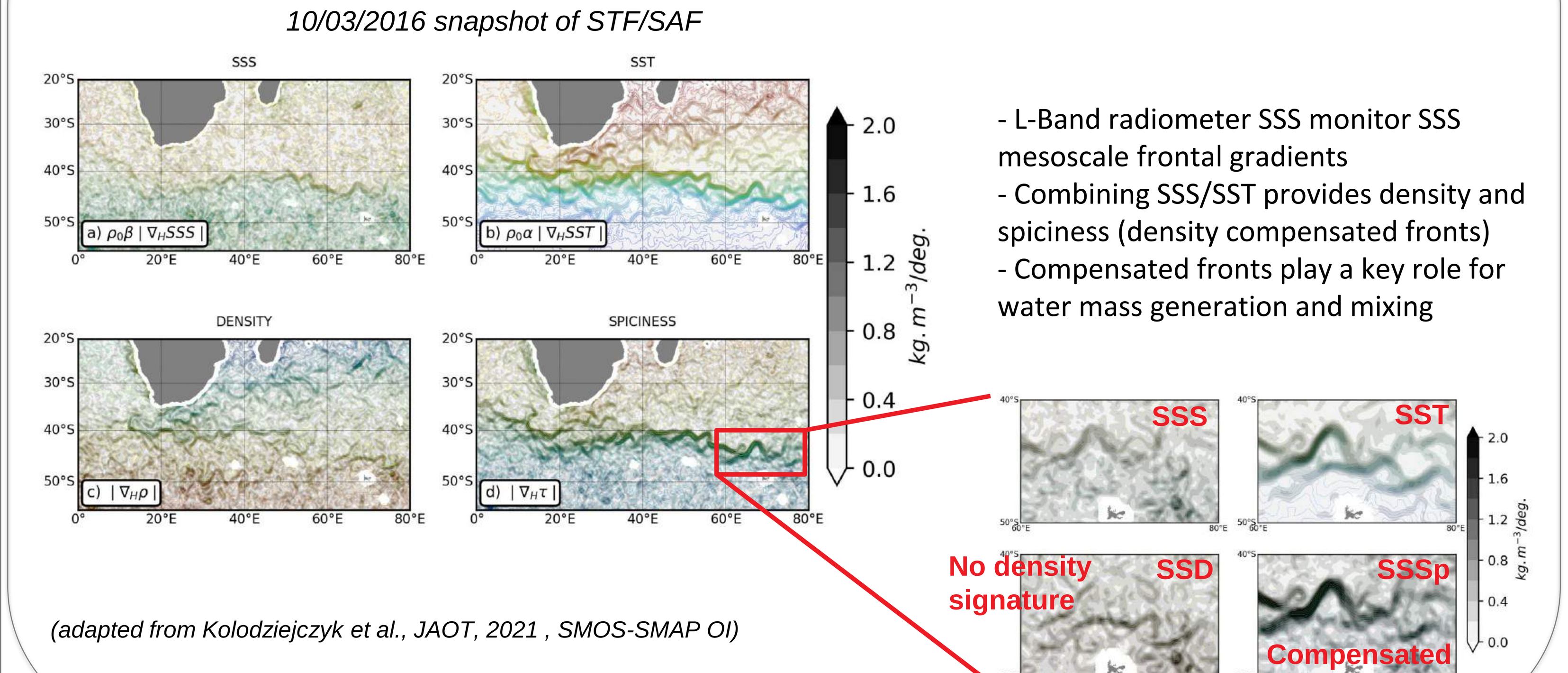


Scales of mesoscale eddies (1st baroclinic Rossby radius of deformation (km); Chelton et al. 1998). SMOS-HR => mesoscale features at much higher latitude than SMOS.

Open Ocean

Density compensated fronts in Southern Ocean

10/03/2016 snapshot of STF/SAF

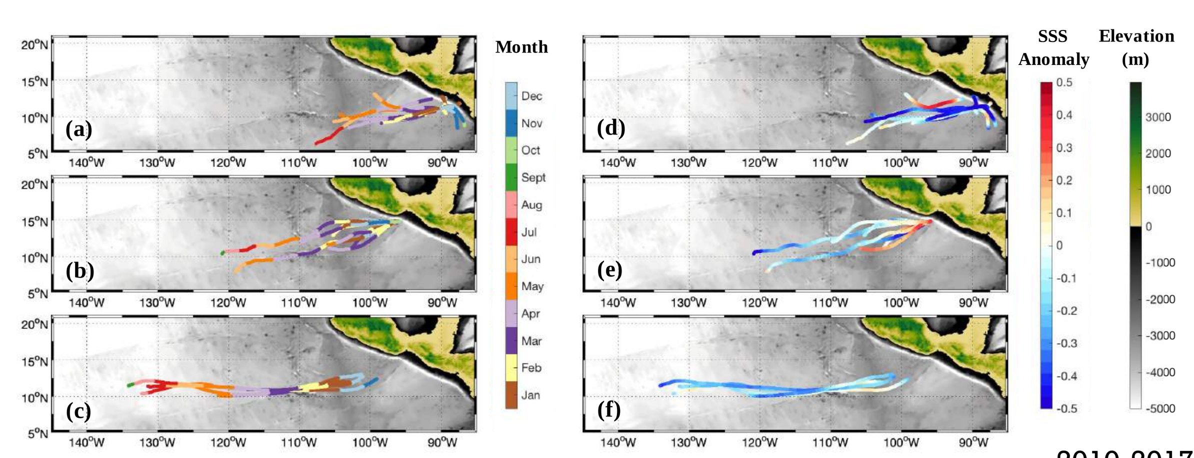


- L-Band radiometer SSS monitor SSS mesoscale frontal gradients
- Combining SSS/SST provides density and spiciness (density compensated fronts)
- Compensated fronts play a key role for water mass generation and mixing

(adapted from Kolodziejczyk et al., JAOT, 2021 , SMOS-SMAP OI)

Eddies from NE tropical Pacific Ocean

-Eddies redistribute a large part of freshwater input (precipitations, rivers) in the ocean.
-They travel over large distances, long periods of time.
-SMOS allows to follow corresponding S anomalies over more than 6 months.



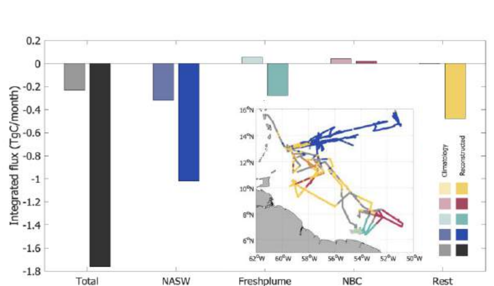
+ Majority of anticyclonic eddies (20 out of 22)
+ 3 eddies families (timing & trajectories)
+ export of continental water mass towards center Pacific (mean speed of .05 m.s^{-1})

Hasson et al. JGR, 2019

SMOS monitors relatively well large mesoscale (eddies, fronts) in low & mid latitudes.
SMOS-HR 10km resolution needed to well caracterize mesoscale at high latitudes (See Rossby deformation radius, introduction).

Tropical river plumes

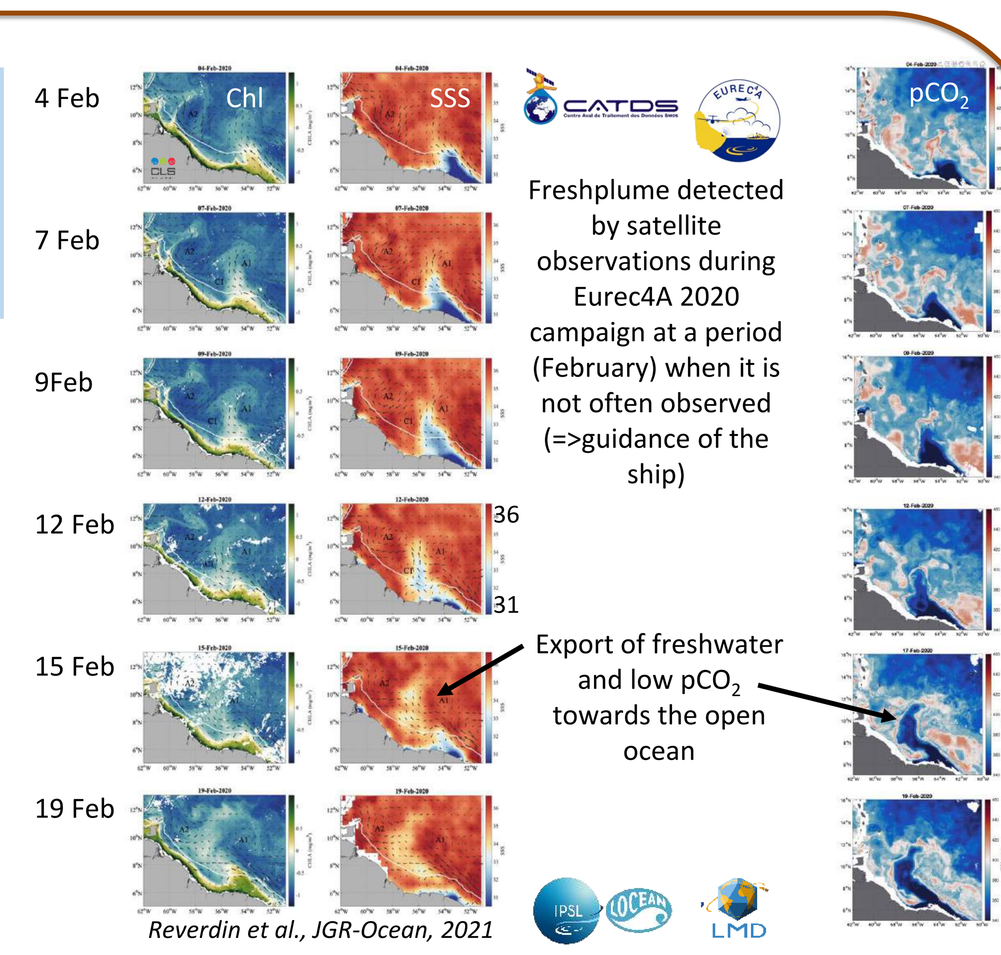
Wintertime process study of the Amazon river plume & North Brazil Current rings reveals the northwestern tropical Atlantic region as a larger sink for CO_2 than expected



In February 2020, the region [50° W-59° W – 5° N-16° N] is a CO_2 sink from the atmosphere to the ocean (-1.7 TgC.month^{-1}), a factor of 10 greater than previously estimated.

Olivier et al. Biogeosciences 2022

See more on Wednesday 16:25, session A8.03.1, talk 63461

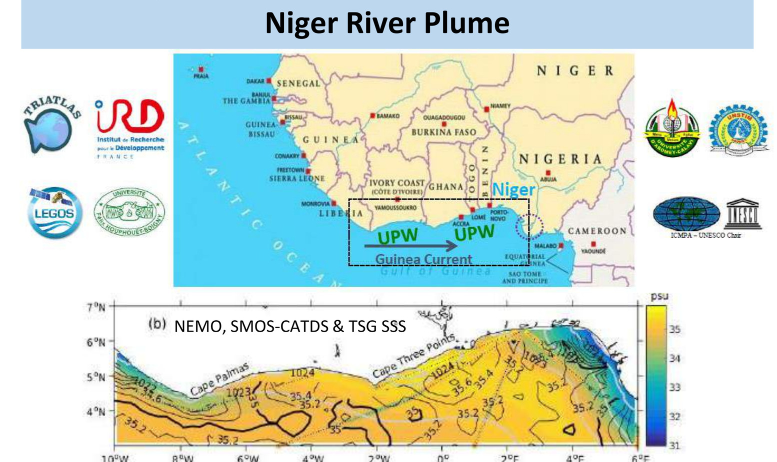


Freshplume detected by satellite observations during Eurec4A 2020 campaign at a period (February) when it is not often observed (=>guidance of the ship)

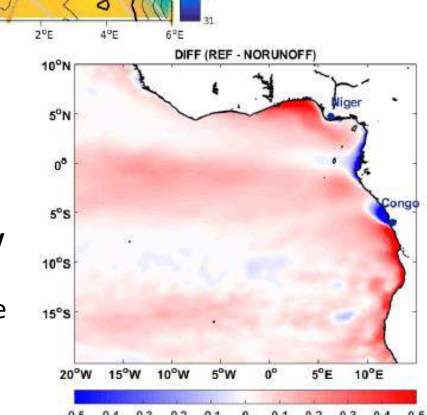
Export of freshwater and low pCO_2 towards the open ocean

Reverdin et al., JGR-Ocean, 2021

Coastal Upwelling Limitation by Onshore Geostrophic Flow in the Gulf of Guinea around the Niger River Plume



- Coastal upwelling weakened by about 50% due to onshore geostrophic flow in its eastern part
- Surface geostrophic flow due to coastline curvature and **equally controlled by steric effects related to temperature and salinity**
- **Niger river** enhances geostrophic currents and stratification with no effect on onshore flow, but **warms by 1° C the upwelling tongue**, through stratification that reduces vertical mixing.



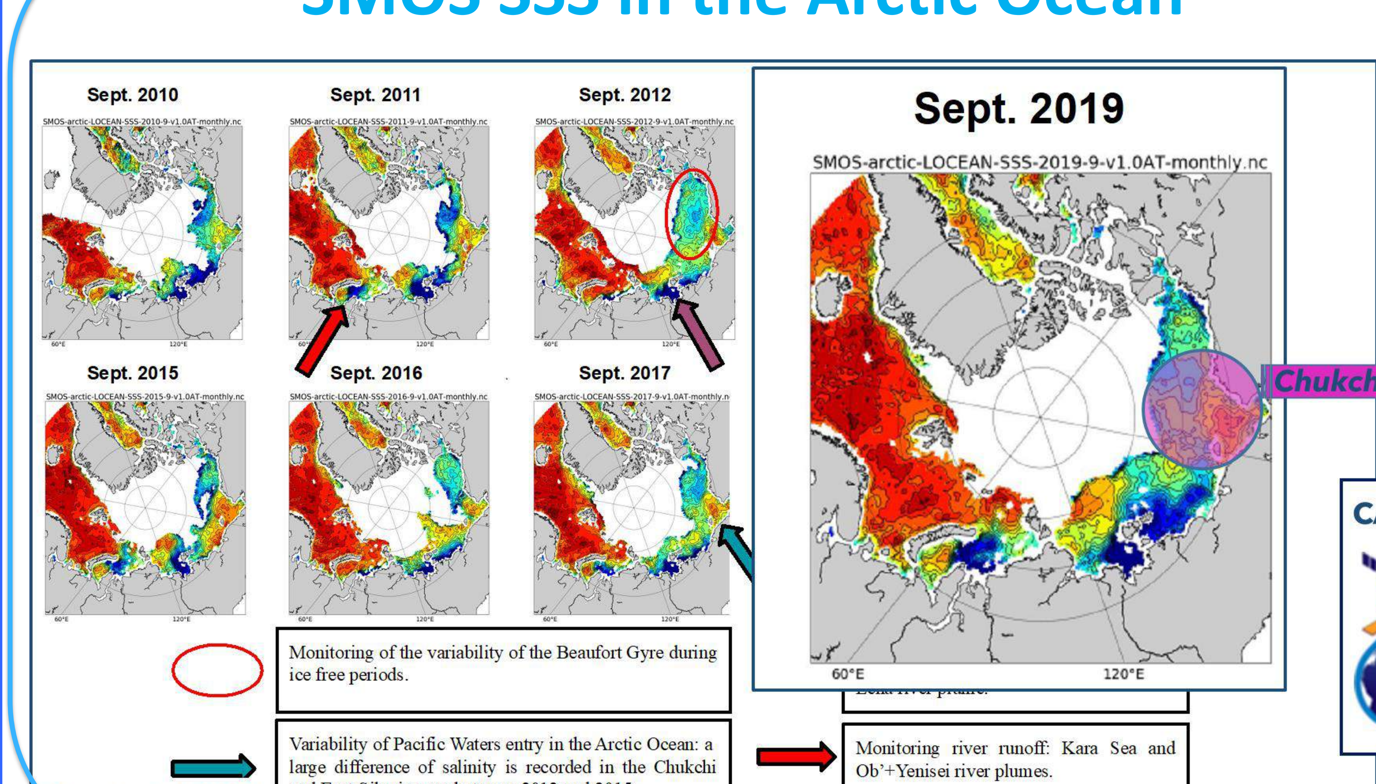
Alory et al., Frontiers, 2021

SMOS monitors eddies, fronts, related to river plumes, surface currents, upwellings. They redistribute heat, biogeochemical compounds (e.g. CO_2), from coast to open ocean, between ocean surface and subsurface, between ocean and atmosphere.

SMOS-HR 10km resolution => closer to coast, detection of small scale features, filaments.

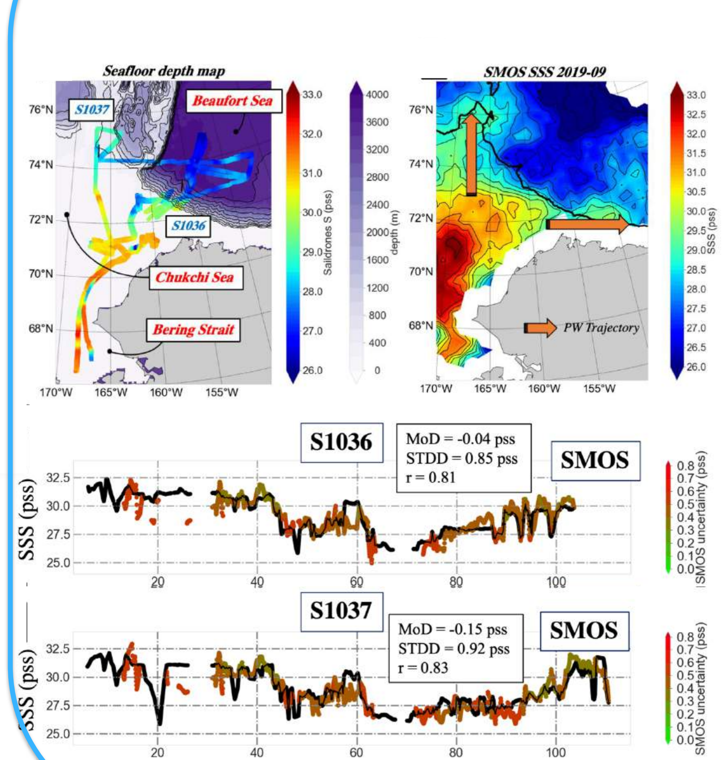
Polar regions

SMOS SSS in the Arctic Ocean



(Supply et al, 2020)

SMOS & Saildrones in the Chukchi Sea



- Two saildrones crossed the Chukchi Sea during summer 2019 measuring SSS at 53 cm and 60 cm from the surface (Gentemann et al. 2020).
- During June and July, saildrones follow the sea ice retreat. Two major freshening events are recorded on the shelf.
- Saildrones measure low SSS in the Beaufort Gyre.

Supply et al., in revision JGR 2022
See poster on Thursday

SMOS monitors the evolution of freshwater from melting ice and from the great high latitude rivers, then transported by ocean currents. Salinity shapes the density of sea water which in turn drives heat exchanges between ocean, atmosphere and ice.
SMOS-HR 10km resolution => monitoring closer to ice, of large mesoscale structures.

Poster pdf

References
Alory, et al. (2021), Frontiers in Marine Science, 7(1116); Chelton, et al. (1998), JPO, 28(3), 433-460; Hasson et al. (2019), JGR-Oceans, 124(4), 2861-2875; Kolodziejczyk et al. (2021). JAOT, 38(3), 405-421; Melnichenko, et al. (2021), Remote Sensing, 13(2), 315; Olivier et al. (2022), Biogeosciences, in press; Reverdin, G., et al. (2021), JGR-Oceans, 126(4); Supply, et al. (2020), RSE, 249, 112027.

Acknowledgements
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