Characterisation of Niger and Congo rivers plumes in the Gulf of Guinea (GG)

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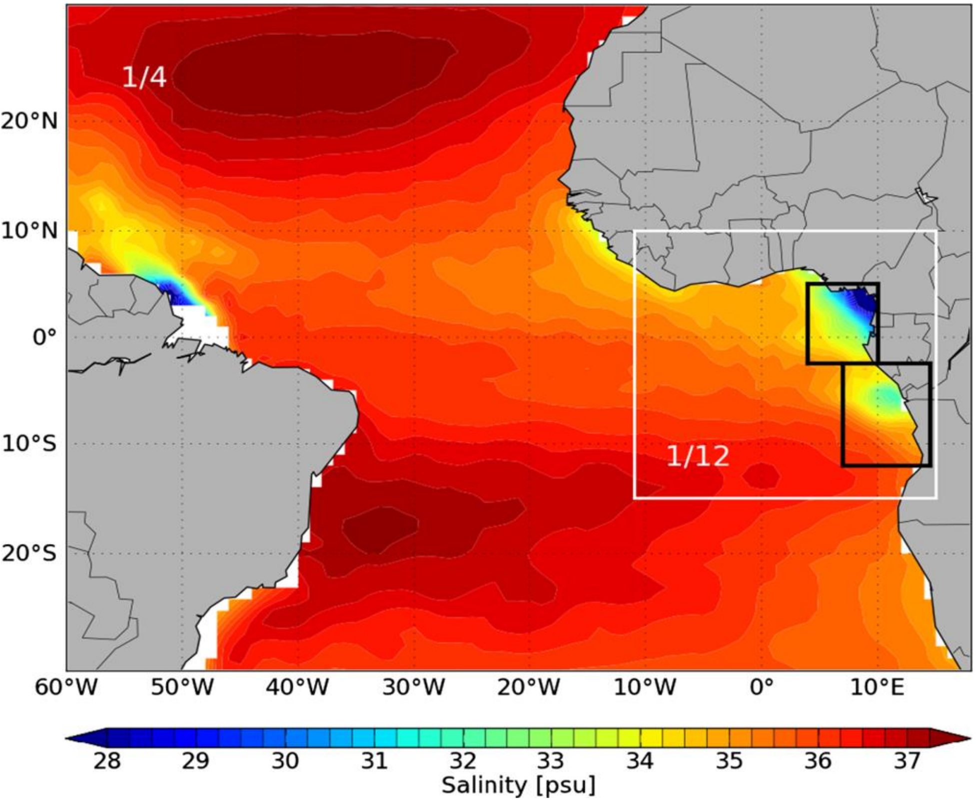
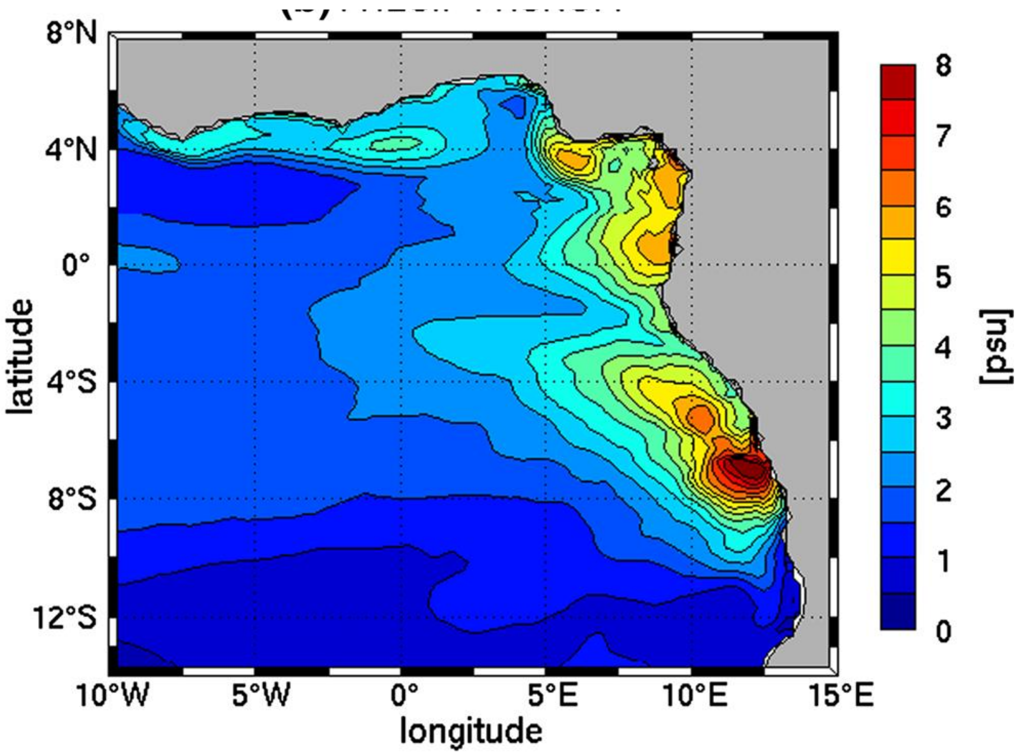
Introduction

Mean SSS for the tropical Atlantic from Reverdin et al. (2007) climatology.



Gulf of Guinea: SSS seasonal variability amplitude from Berger et al (2014)
Numerical model, 1995-2006



Strong variability of SSS in the Gulf of Guinea.

1.1 – Scientific questions

- **Is it possible to observe GG fresh water plumes from SMOS?**
- **What is the variability of fresh water plumes in GG?**
- **What is the vertical structure of fresh water plumes?**

- Evaluation of SSS SMOS CATDS data.

- Observation of seasonal to interannual SMOS SSS variability

- Examination of stratification off Congo from *in situ* data

CATDS = « Centre Aval de Traitement des Données SMOS »

2.1 - Data

❑ *in situ data*

. Profiles **Argo** (116) : Δt = 2days; ΔZ = 1m (0-50m)

. Profiles **CTD** PIRATA FR26 (8): ΔZ = 1m

❑ *in situ Product* **ISAS**: (2011 to 2016) [Gaillard et al. 2016]

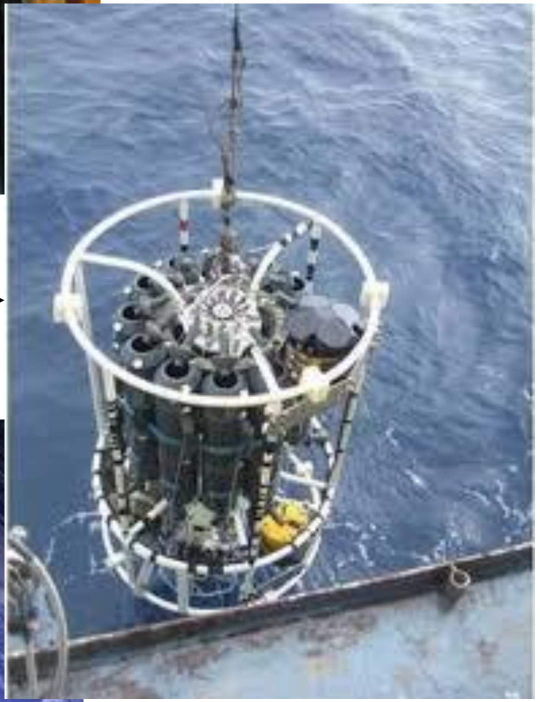
❑ *Satellite Product* (2011 to 2016)

. **SSS SMOS** (CATDS): ΔX*ΔY = 25*25km

(Boutin et al. RSE 2018)

Argo

CTDO2



SMOS

2.2 - Methodology

- **Superficial structure:**

 - Validation of SSS SMOS estimations with RMSD

 - Analysis of seasonal cycle

- Analysis of seasonal / interanual time series

$$N^2 = N_S^2 + N_T^2 \quad (1)$$

- **Vertical structure:**

- Brunt Vaïsälä frequency analysis

- Turner angle (Tu_v) analysis

$$Tu_v = \arctan\left(\frac{\alpha\Delta\theta + \beta\Delta S}{\alpha\Delta\theta - \beta\Delta S}\right) \quad (2)$$

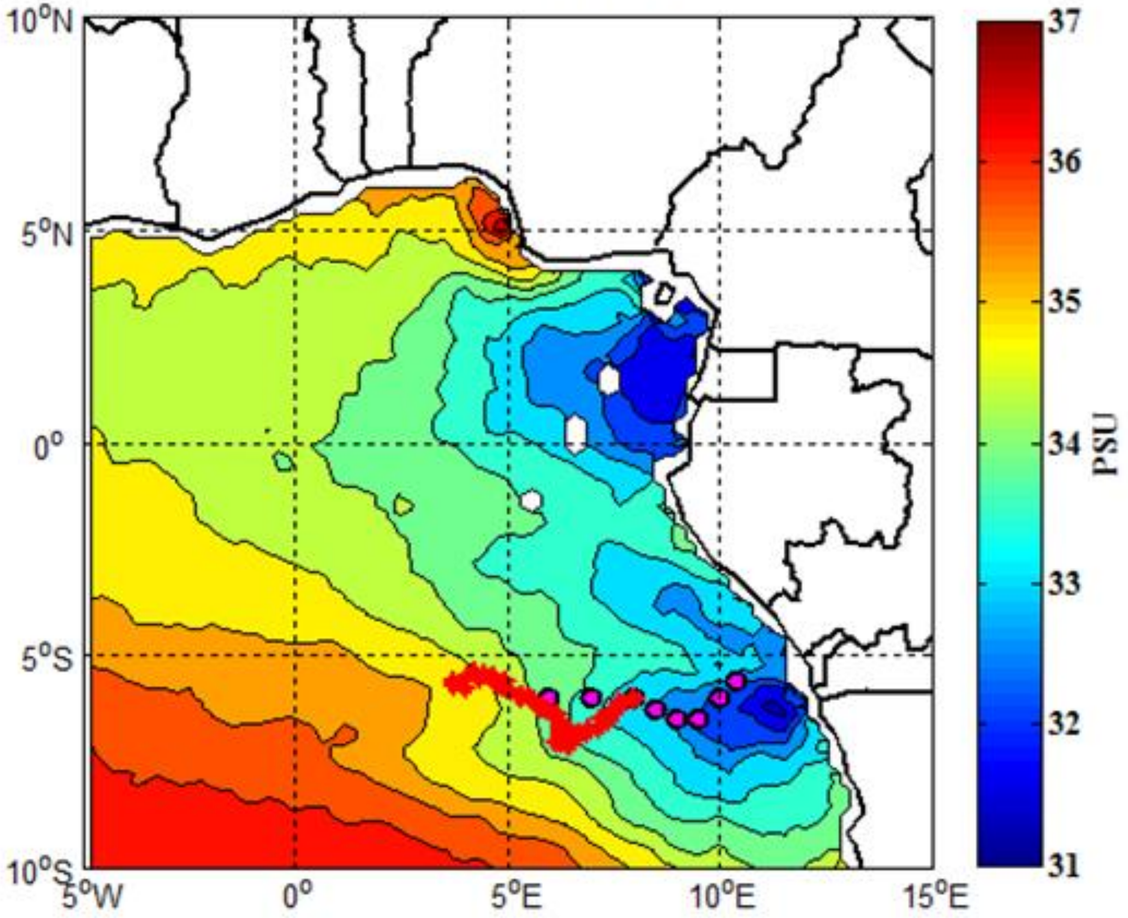
3.1- Results – SSS SMOS Evaluation :

- **Comparison with a single Argo float (WMO 6901611) from April to November 2016 (red) and CTD from PIRATA FR26 cruises (purple circle).**

SSS RMSD

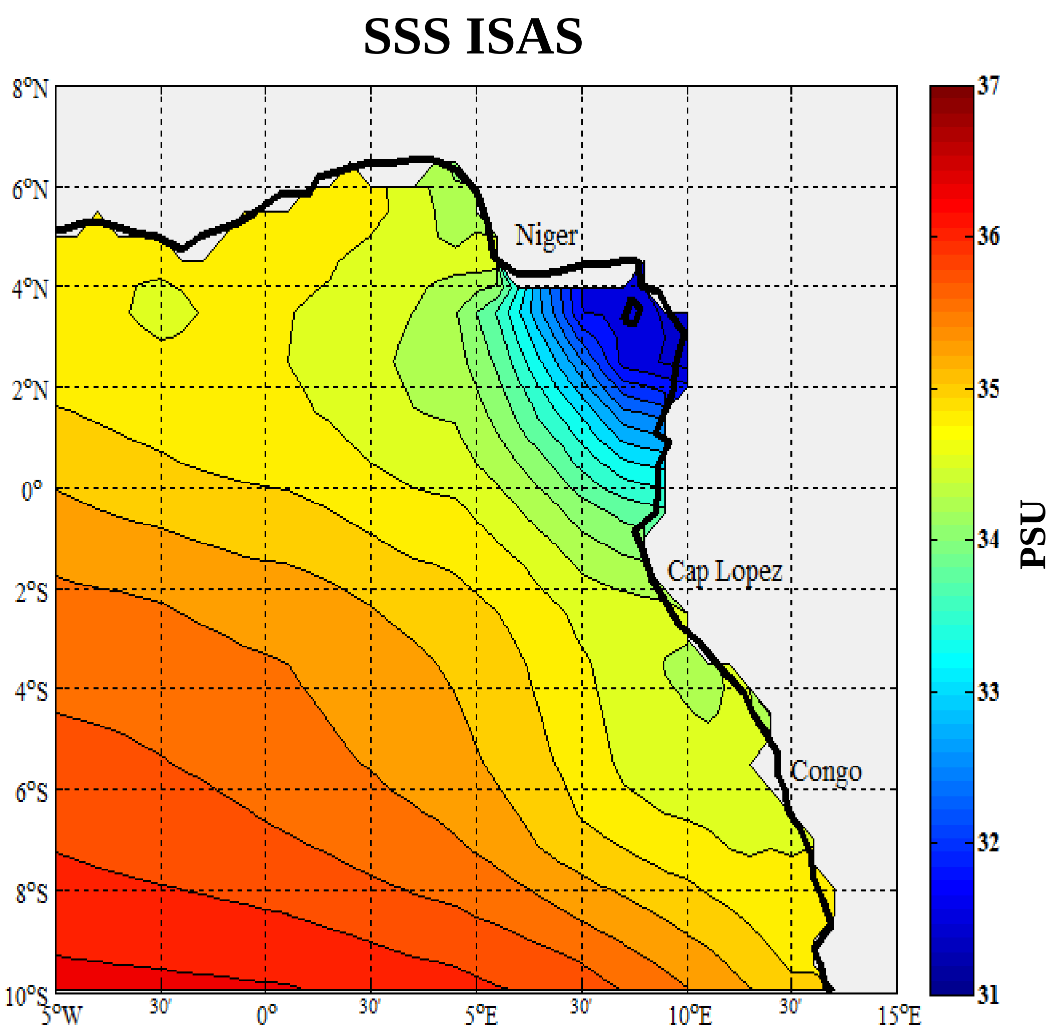
Data	Argo	
	ISAS	SMOS_CATDS
RMSD (psu)	0,69	0,47
Data	CTD PIRATA FR26	
	ISAS	SMOS_CATDS
RMSD (psu)	1,93	1,19

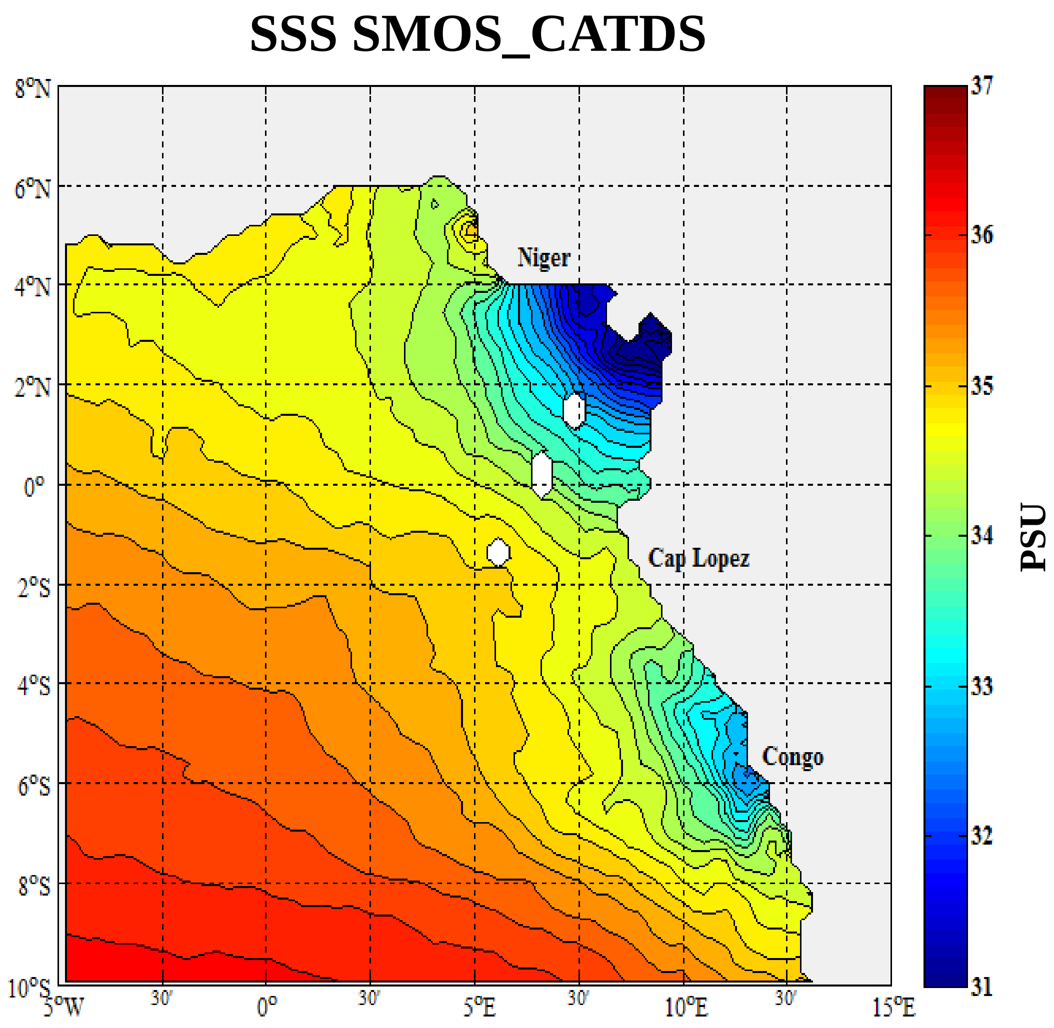
SSS_SMOS CATDS (April 2016)



SSS SMOS (CATDS) is adequate for detecting coastal freshwaters

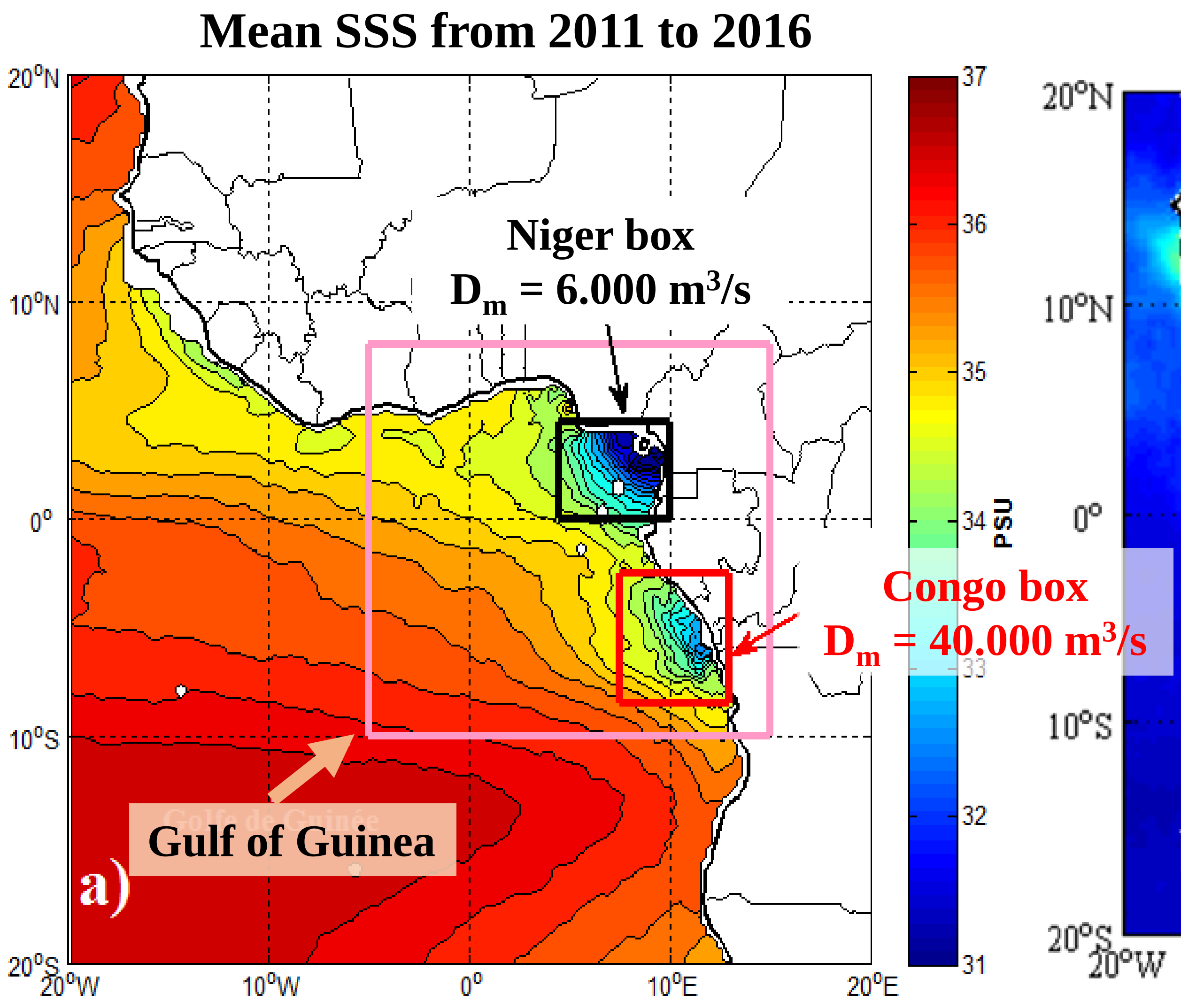
3.2 – Mean state of SSS in GG (2011-2016)

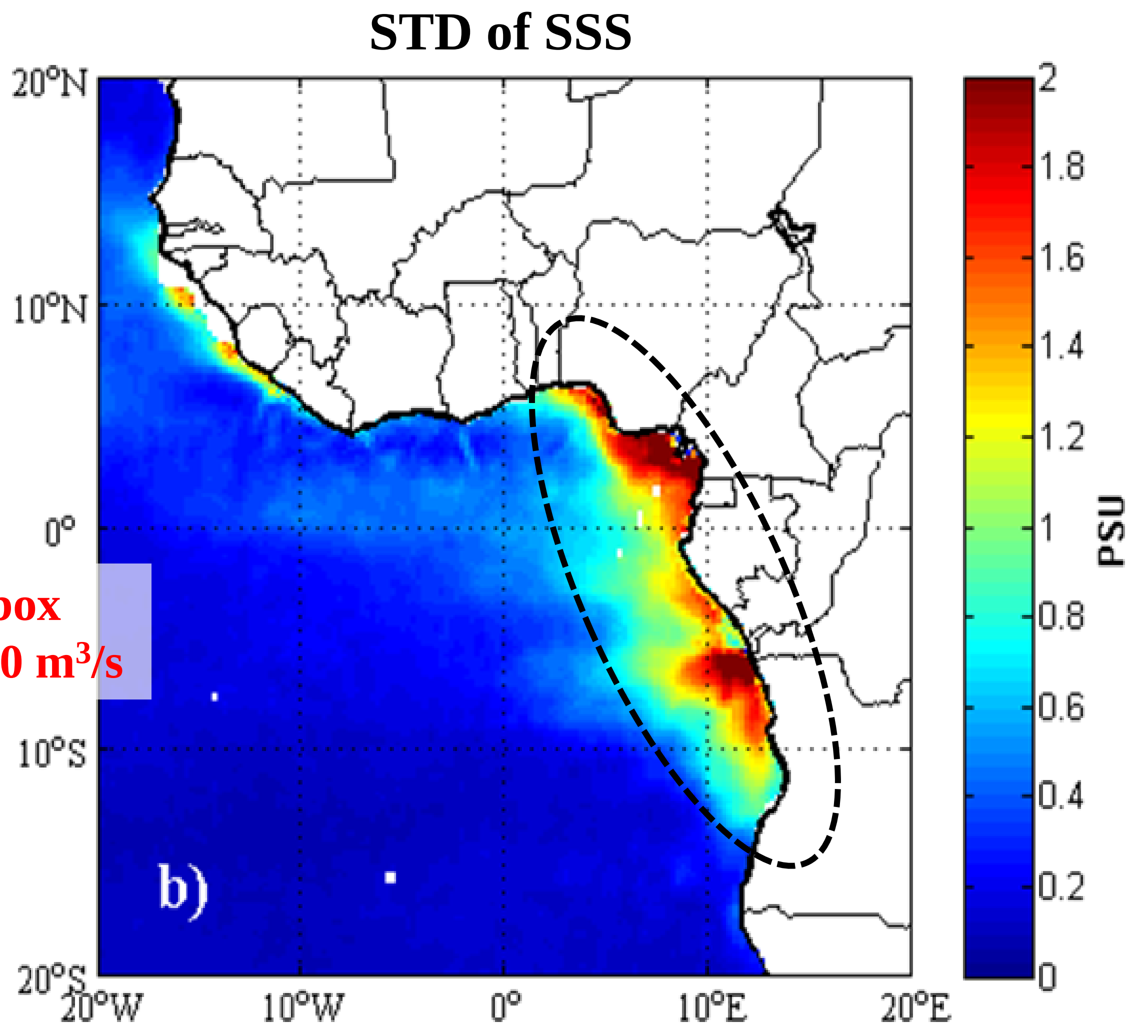




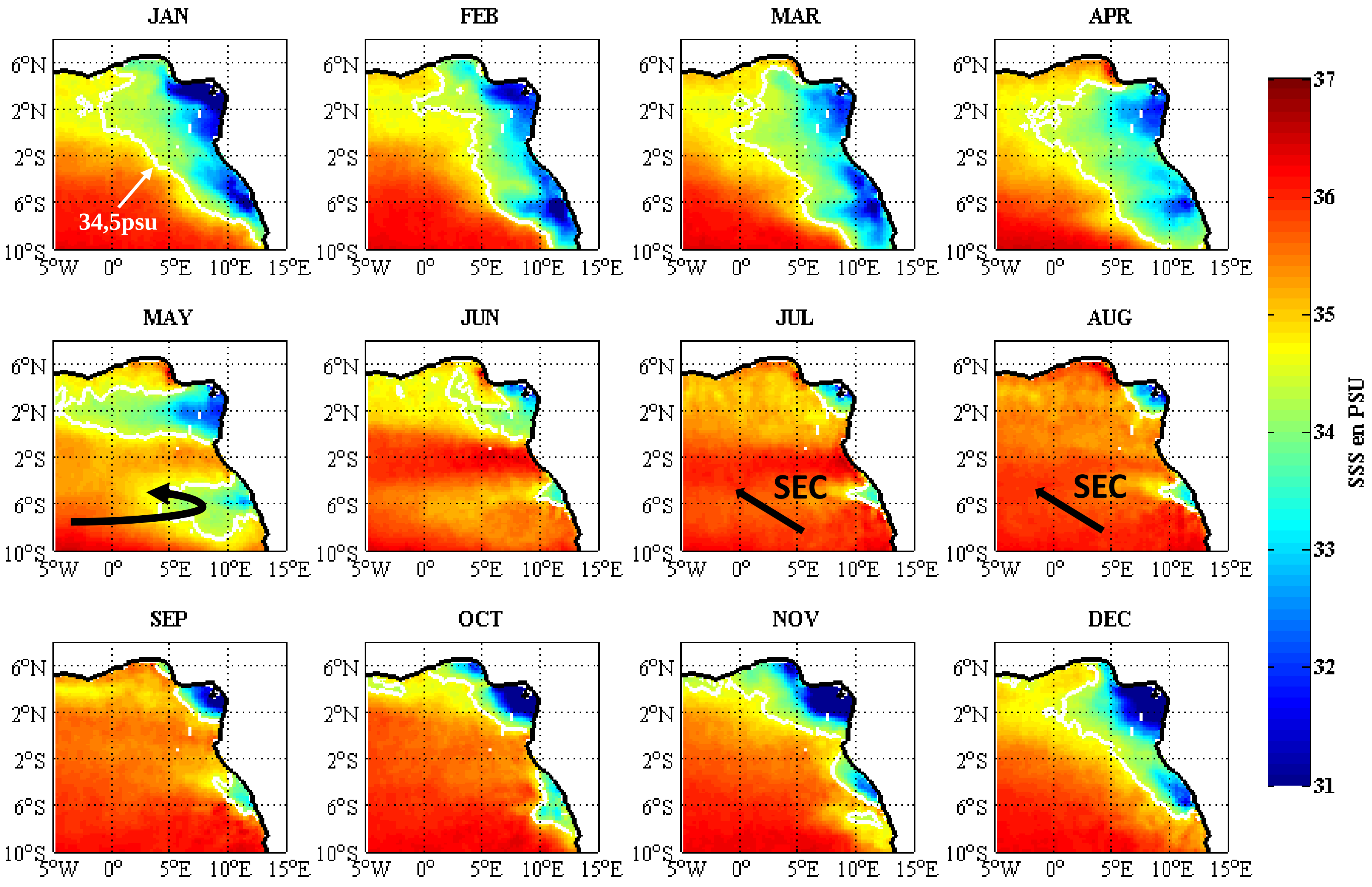
➡ **Better view of Congo freshwater plume from SSS SMOS CATDS product.**

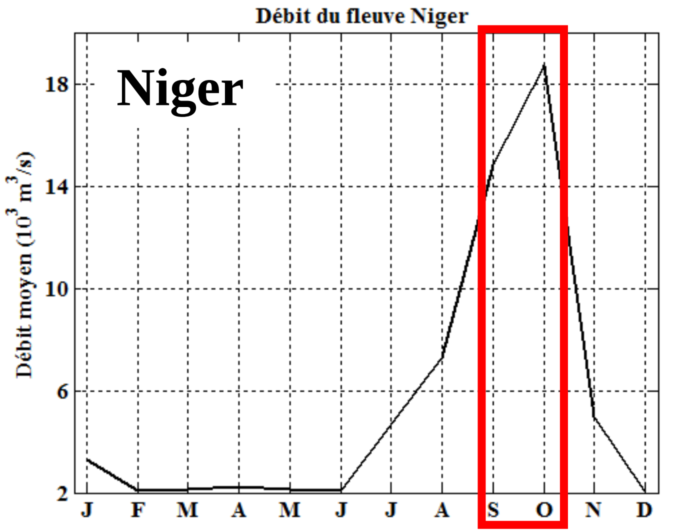
Strong variability of SSS observed from SMOS CATDS product.

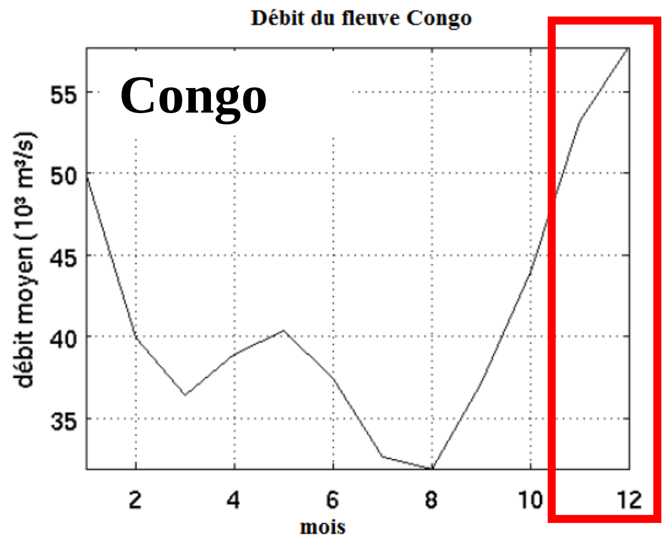




3.3 – SSS Seasonal variability from SMOS (CATDS).

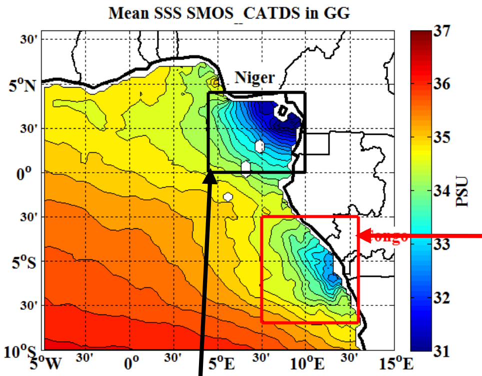




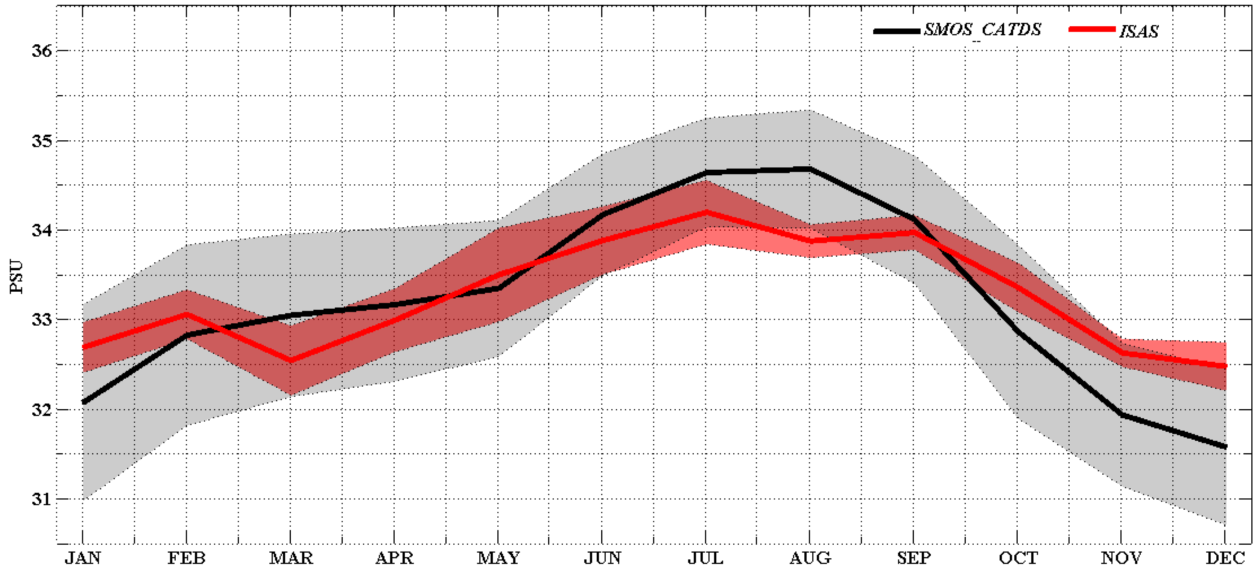


N. Dossa et al. 2017
C. Vic et al. 2013
Kolodziejczyk et al. 2014b

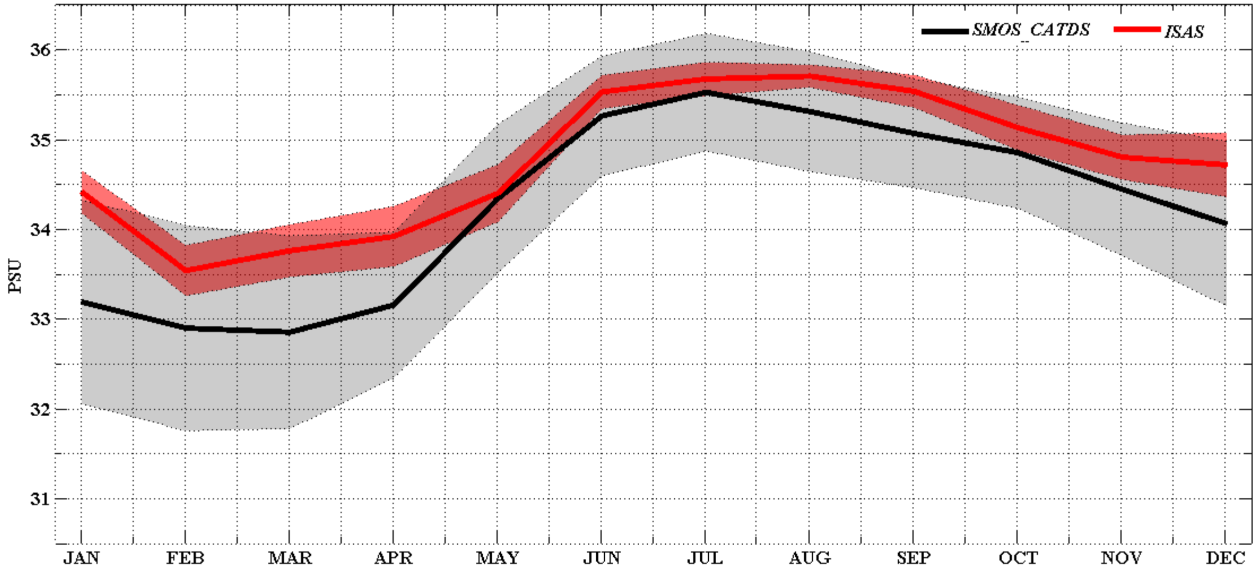
3.4 - Mean seasonal time series.



Niger box [4.5-10°E; 0-4.5°N]

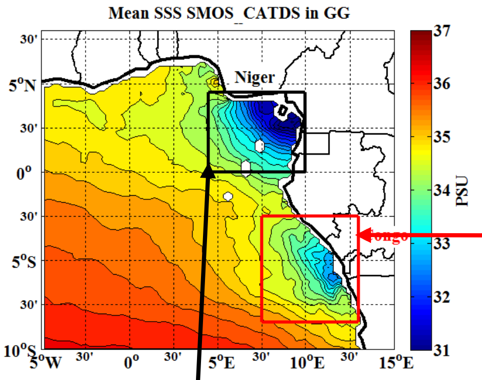


Congo box [7.5-15°E; 2.5-8.5°S]

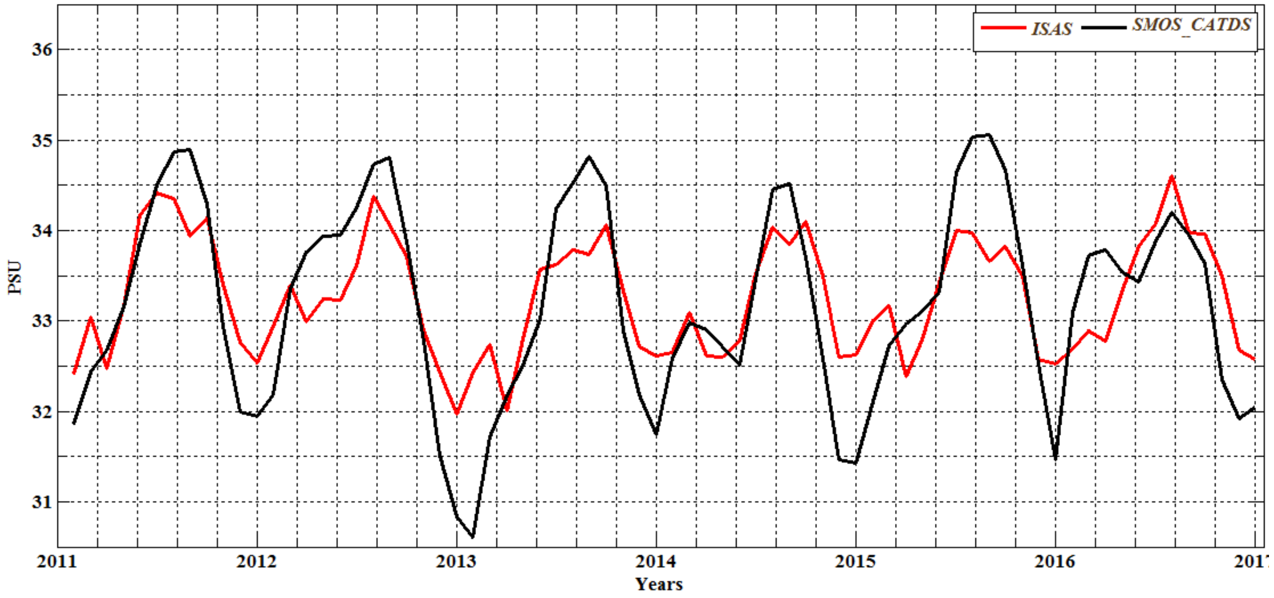


➡ **Substantial annual seasonal cycle in both regions**

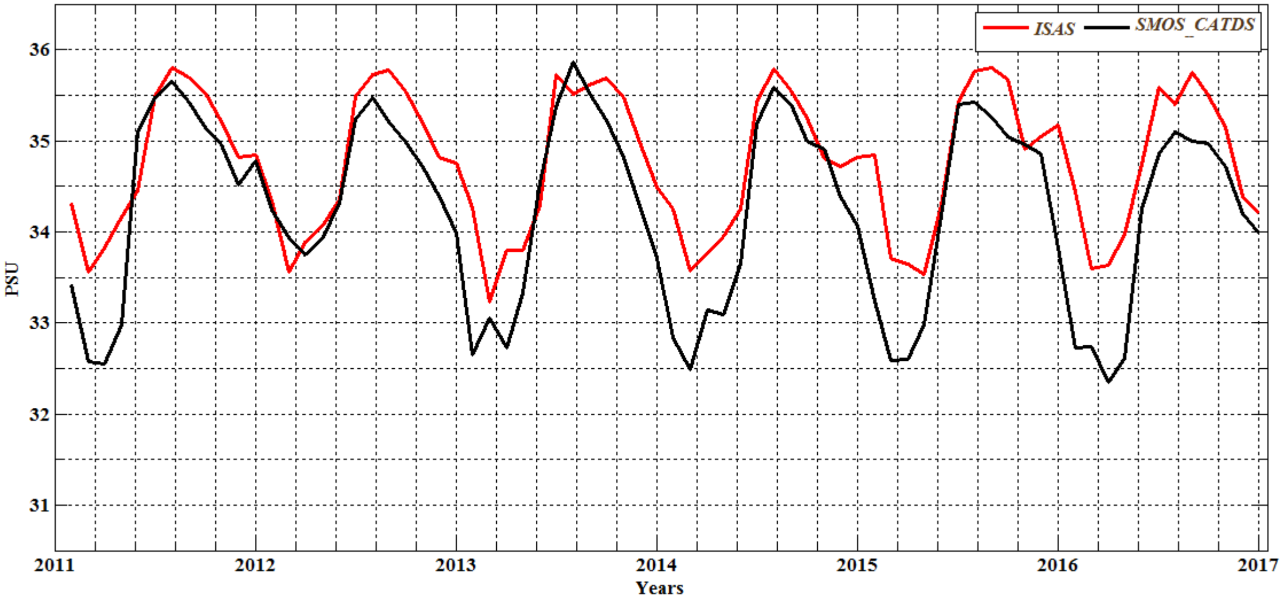
3.5 - Interannual time series.



Niger box [4.5-10°E; 0-4.5°N]



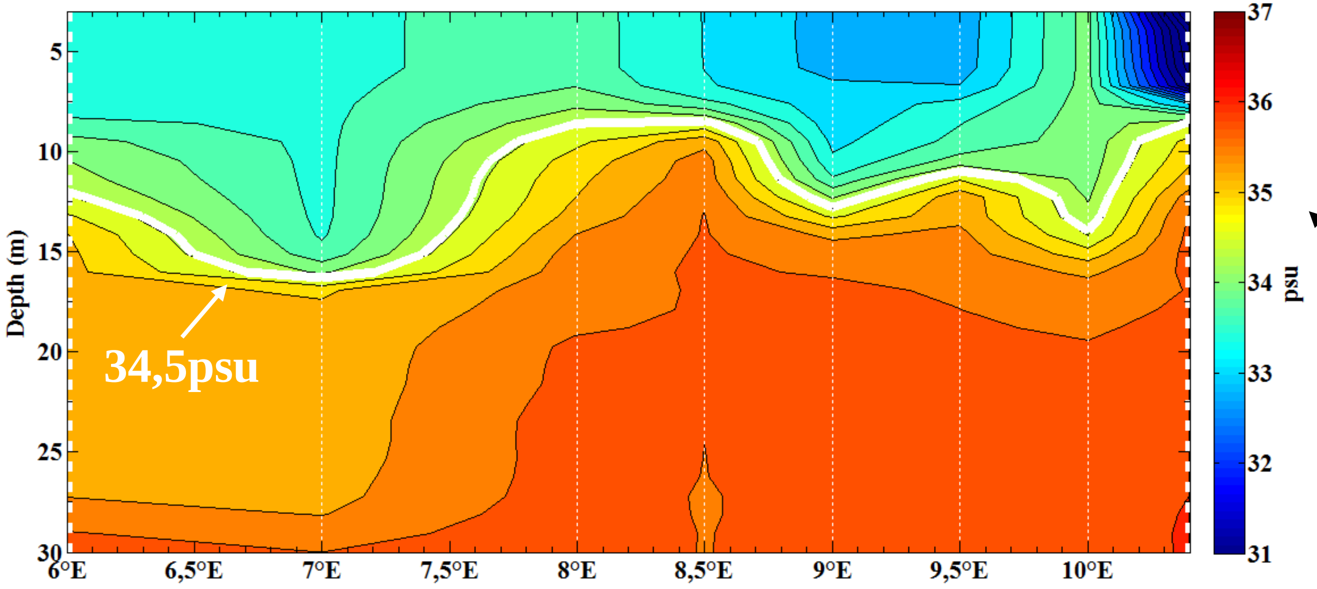
Congo box [7.5-15°E; 2.5-8.5°S]



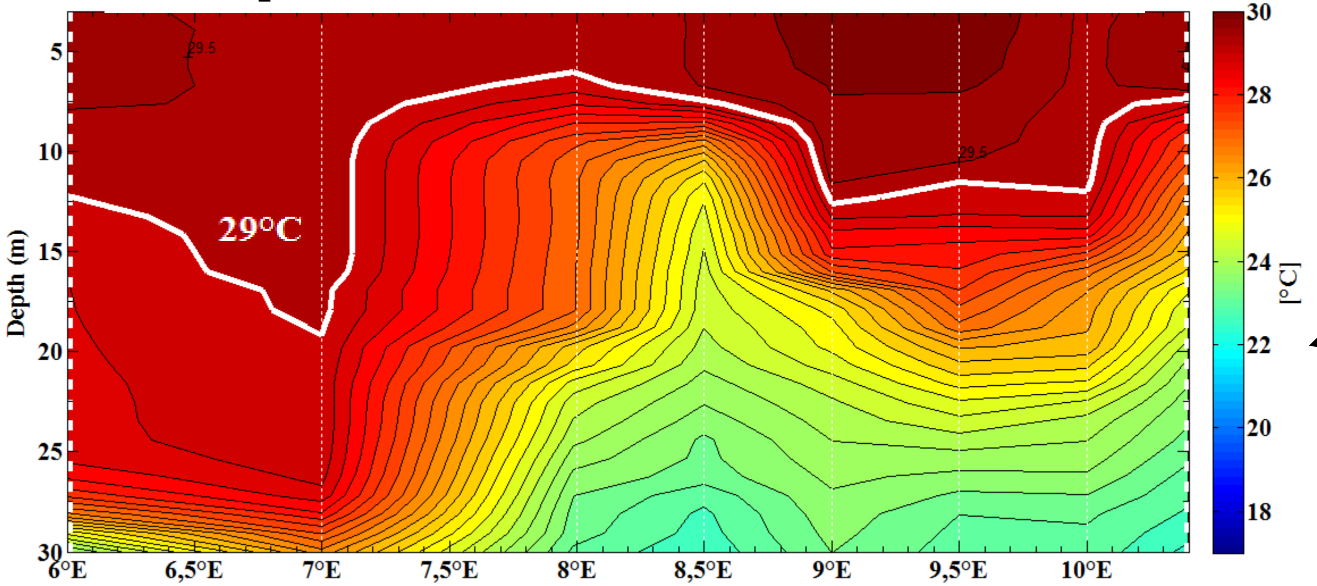
➡ **Repetition of seasonal cycle on interannual scale in both regions**

3.6 - Section of S and T in Congo river plume.

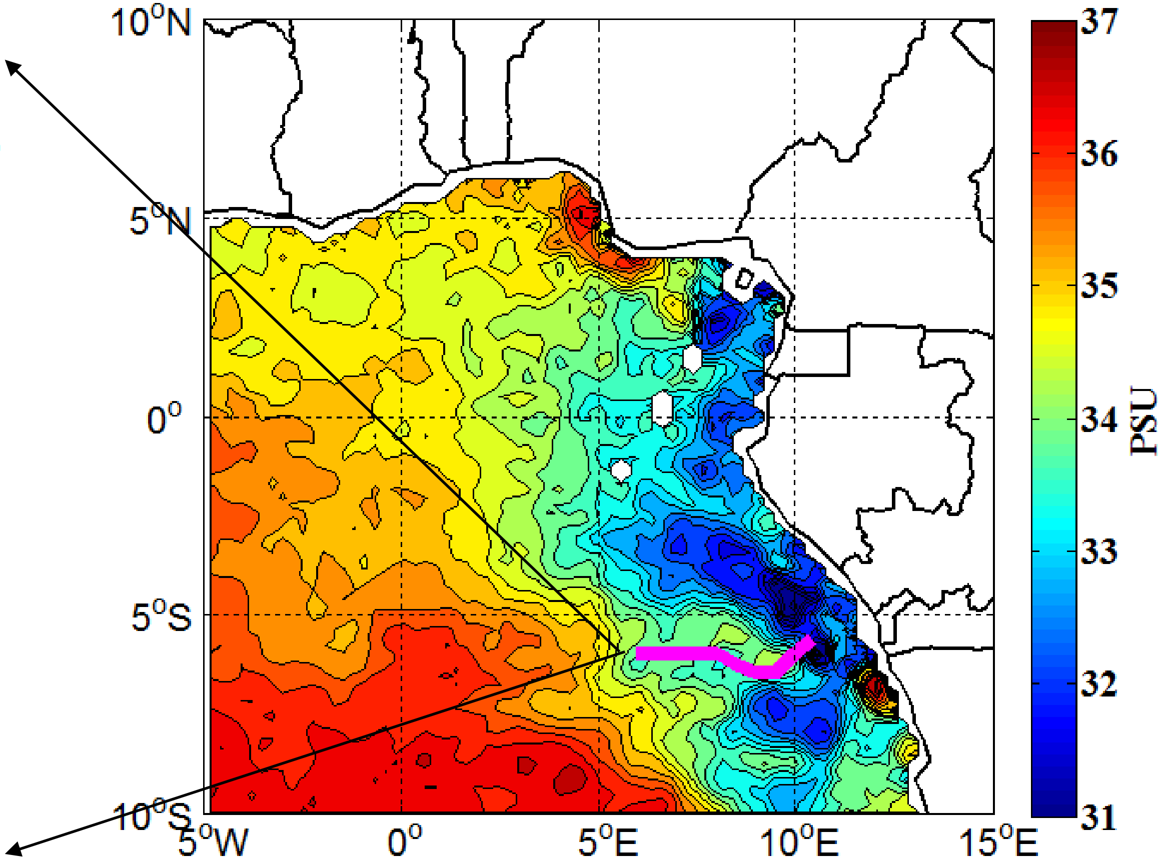
Salinity section from CTD PIRATA FR26



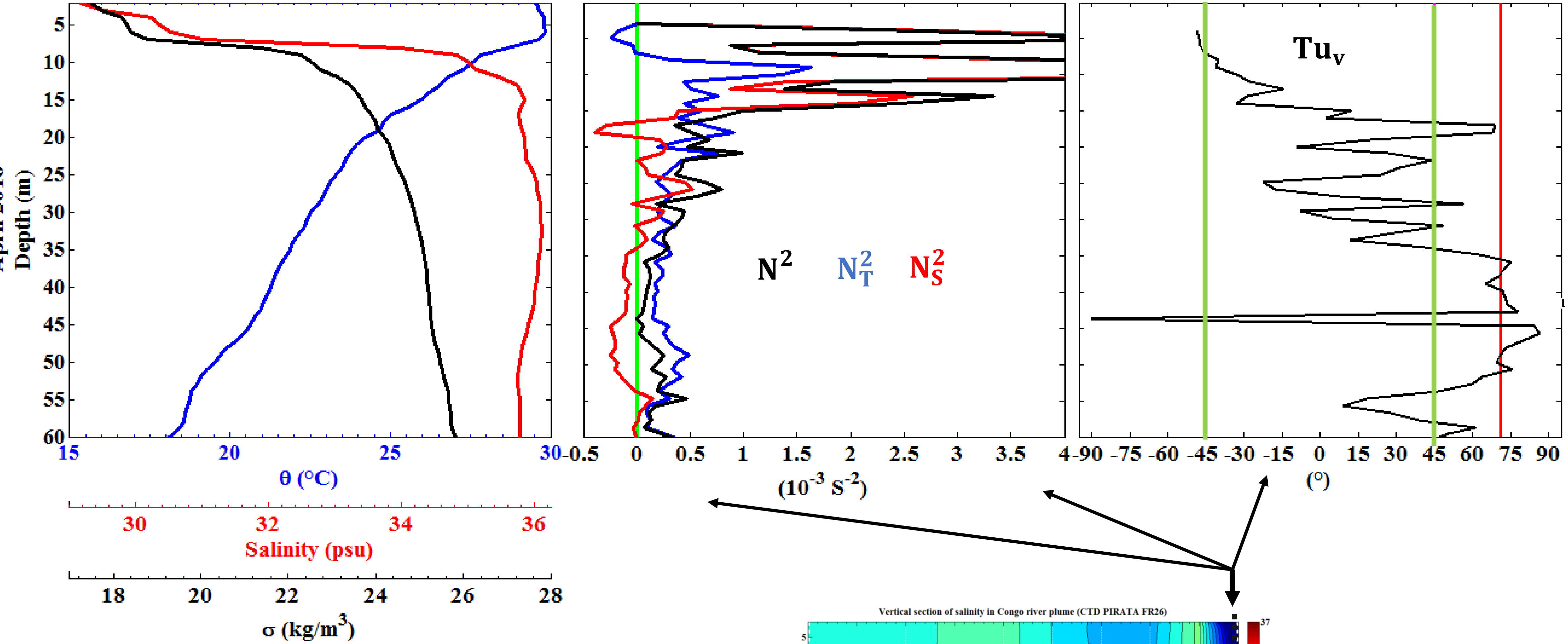
Temperature section from CTD PIRATA FR26

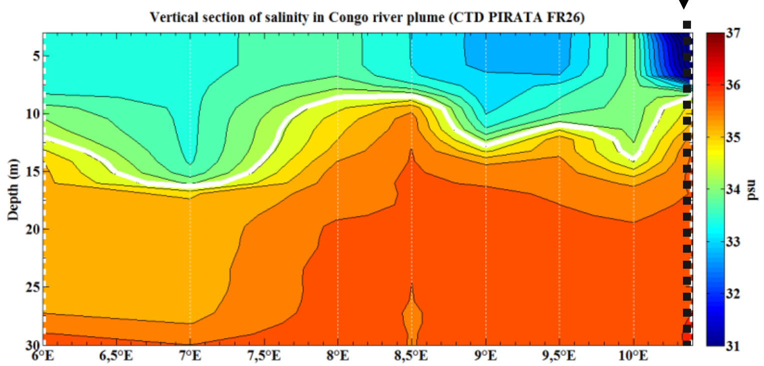


SSS SMOS_CATDS (2 April 2016)

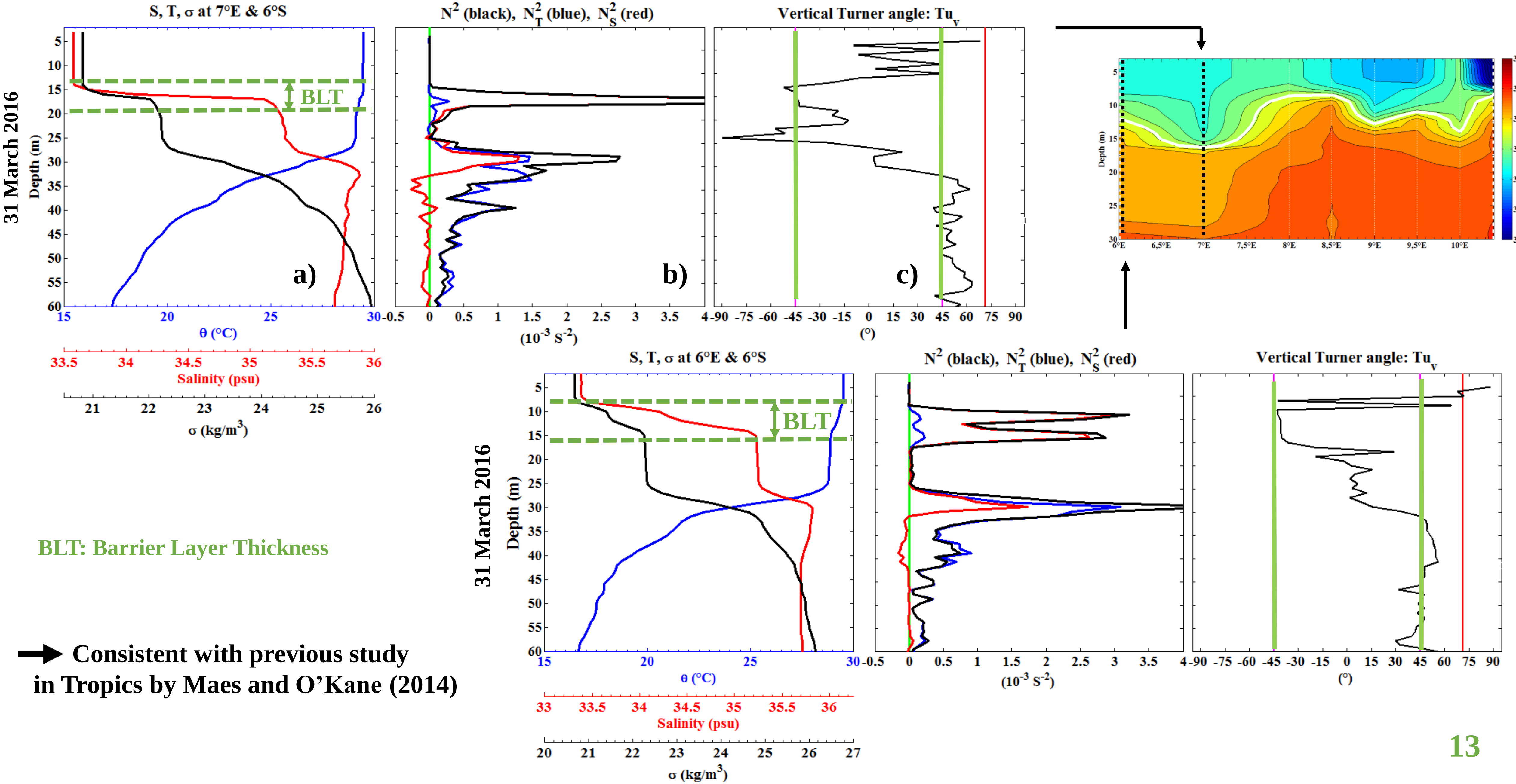


3.7 – Stratification in Congo river plume (1/2)





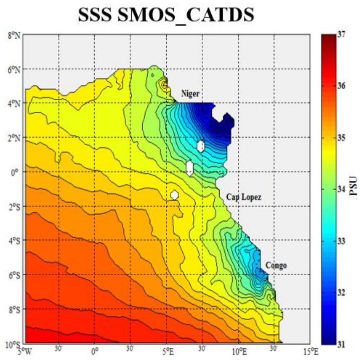
3.8 - Presence of BL in Congo river plume (2/2)



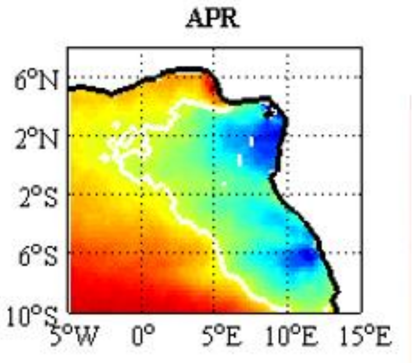
BLT: Barrier Layer Thickness

➡ **Consistent with previous study in Tropics by Maes and O'Kane (2014)**

Preliminary conclusion

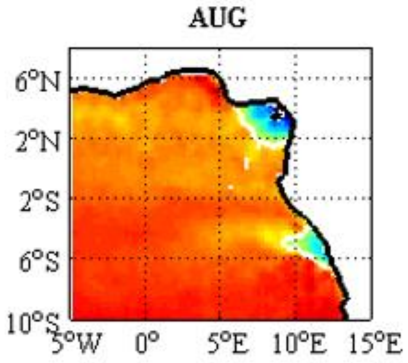


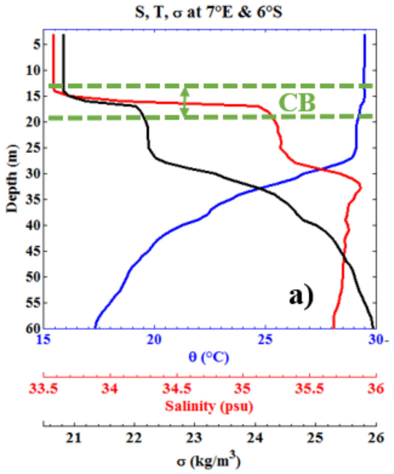
SSS SMOS (CATDS) → Valid for detecting freshwater plumes, especially in the Gulf of Guinea.



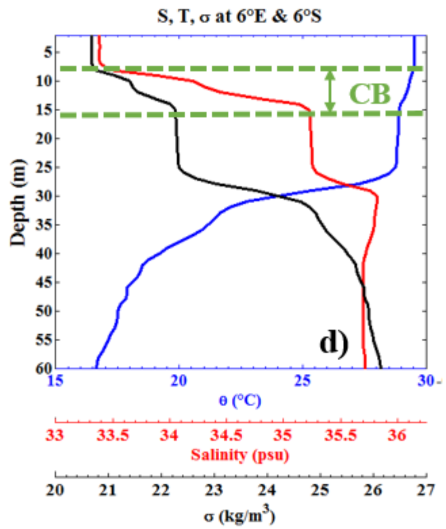
← Maximal extension in April

Minimale extension in August →





← Complex horizontal and vertical structure off Congo →



Perspectives

- Study the superficial dynamics of freshwater plumes in the GG.
- Study the stratification in freshwater plume in the GG, especially in Congo river plume.


Thank you for your nice attention

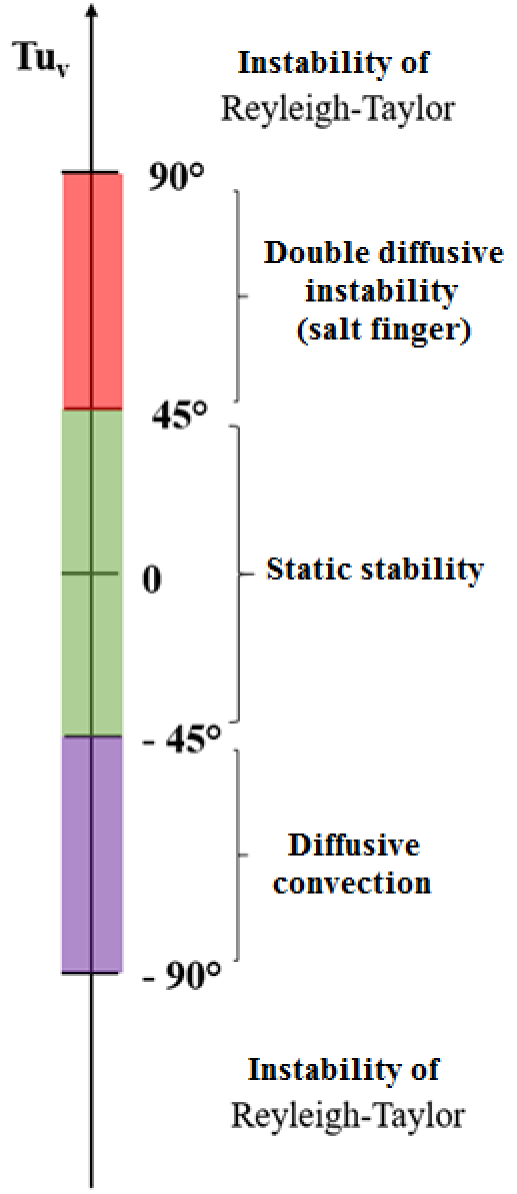
○ Brunt Vaïsälä frequency and Turner angle (Tu_v)

$$N^2 = -\frac{g}{\rho_0}\frac{\partial \rho}{\partial z} \Rightarrow N^2 = g.\alpha\frac{\Delta\theta}{\Delta z} - g.\beta\frac{\Delta S}{\Delta z} \quad (2)$$

$$N_T^2 = g.\alpha\frac{\Delta\theta}{\Delta z} \quad (3)$$

$$N_S^2 = -g.\beta\frac{\Delta S}{\Delta z} \quad (4)$$

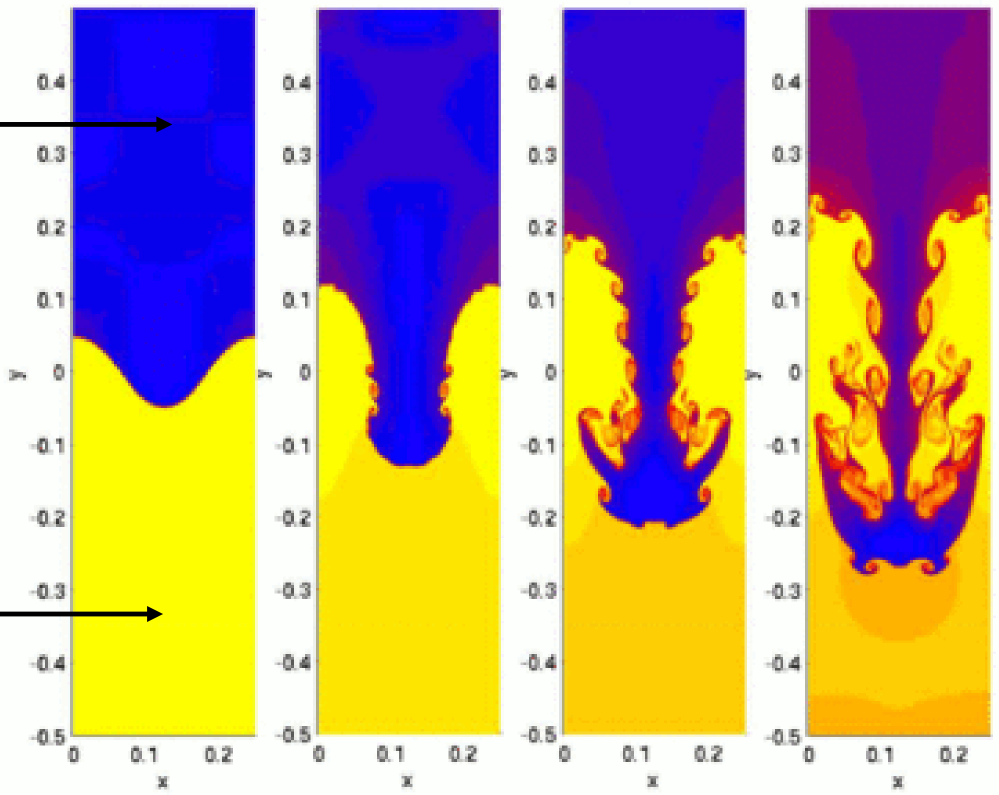
$$Tu_v = \arctan\left(\frac{\alpha\Delta\theta + \beta\Delta S}{\alpha\Delta\theta - \beta\Delta S}\right) \quad (5)$$



○ Reyleigh – Taylor Instability

Light fluid

Heavy fluid



https://fr.wikipedia.org/wiki/Instabilit%C3%A9_de_Rayleigh-Taylor

○ Double diffusive instability: salt finger

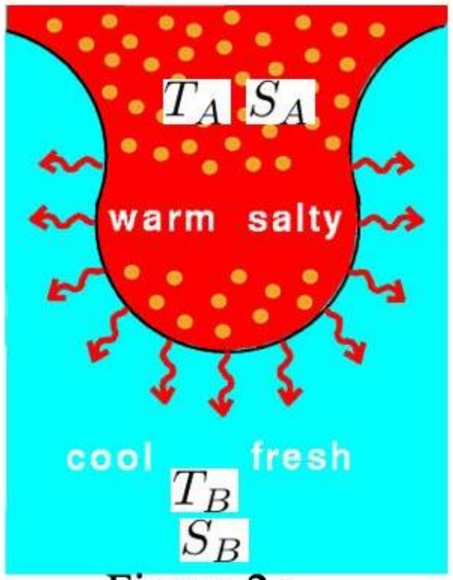


Figure 2a

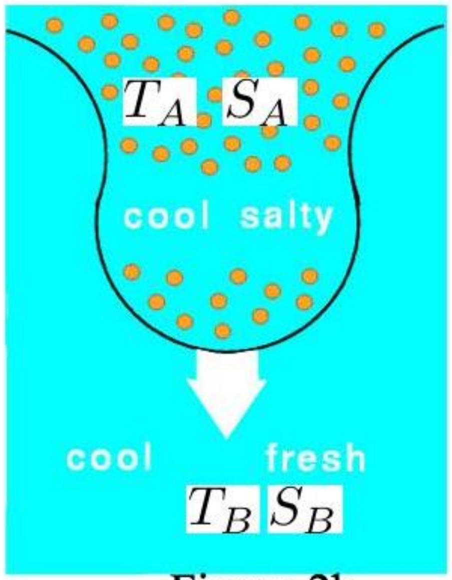


Figure 2b