National Aeronautics and Space Administration

Monitoring the biophysical properties along Lagrangian advection pathways in the Amazon River plume

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MOTIVATIONS :

- **The Amazon River** is the world's largest river in terms of discharge. It can influence both air-sea and land-sea interactions.
- By discharging huge amounts of **riverine suspended & dissolved matter**, it can have an impact on several **biological, physical & chemical processes**.

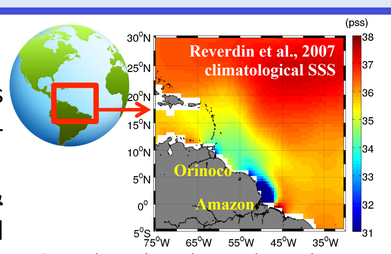


Fig 1 *: Climatological SSS in the northwestern tropical Atlantic ocean*

OBJECTIVE :

Monitoring the spatial and temporal variability of the Amazon River plume is important to biophysical interactions at local and regional scales. We study here the **upper ocean mixing induced by the Amazon outflow along key pathways.**

METHOD :

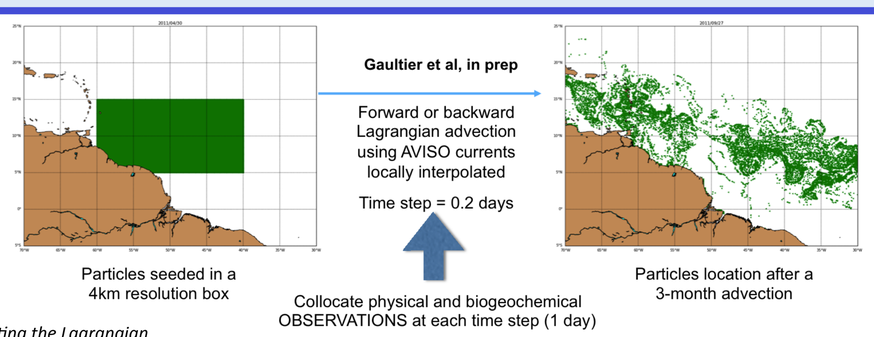


Fig 5 *: Scheme presenting the Lagrangian advection method used in this analysis*

CONTEXT :

Spring-Summer : Amazon waters are carried **northwestward** by the North Brazilian Current (NBC) along the Brazilian shelf.
Fall-Winter : The North Equatorial Counter Currents (NECC) strengthens, Amazon waters are carried **eastward**.

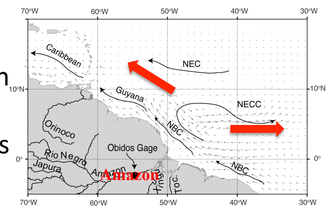


Fig 2 *: Northwestern tropical Atlantic local currents*

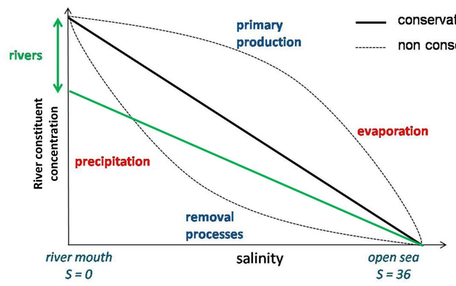


Fig 3 *: Scheme of the mixing line from the mouth of the river to the open ocean*

From the mouth to the open ocean :
- Salinity increases/riverine constituent decreases

Mixing line : riverine constituent concentration versus salinity
- Linear dependence : **conservative** mixing
- Non linear dependence : **non conservative**

Colored Detrital Matter (CDM) :

- from terrestrial sources
- a river water proxy
- key roles in biogeochemical/physical processes
- negatively correlated with salinity in river plume areas

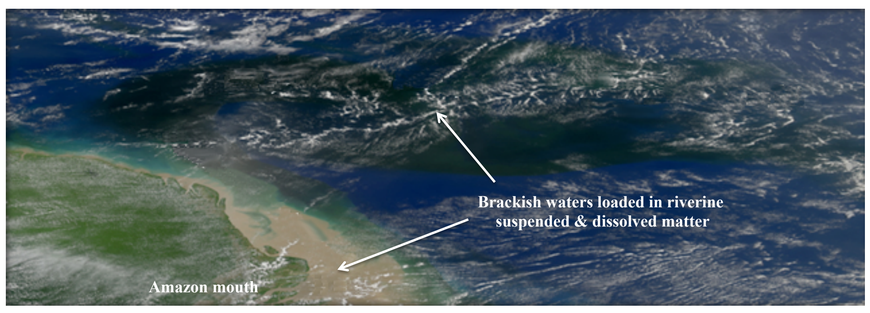


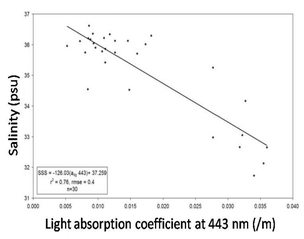
Fig 4 *: MERIS image of the Amazon plume*

WHY DO WE USE A LAGRANGIAN APPROACH ?

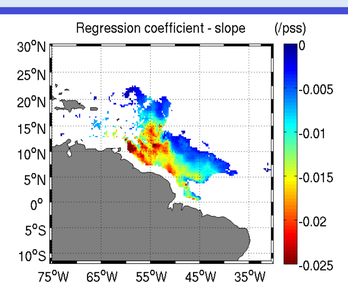
Conservative mixing approximation is well documented (many previous studies), but how applicable here ?

Freshwater masses discharged :

- Different initial characteristics
- Different advection pathways
- Different biogeochemical & physical processes undergone



Molleri et al, 2010



Fournier et al, 2015

Fig 6 *: (Left) Salinity as a function of light absorption coefficient at 443 nm using 30 in situ measurements collected in the Amazon plume (Molleri et al., 2010)*
(Right) Map of the slope of the relationship between SMOS sea surface salinity and colored detrital matter absorption coefficient at each pixel in the Amazon plume (Fournier et al, 2015)

Biophysical properties along Lagrangian advection pathways :

We follow particles using the lagrangian method along 2 different pathways :
- from a box next to the Amazon mouth
- for 120 days

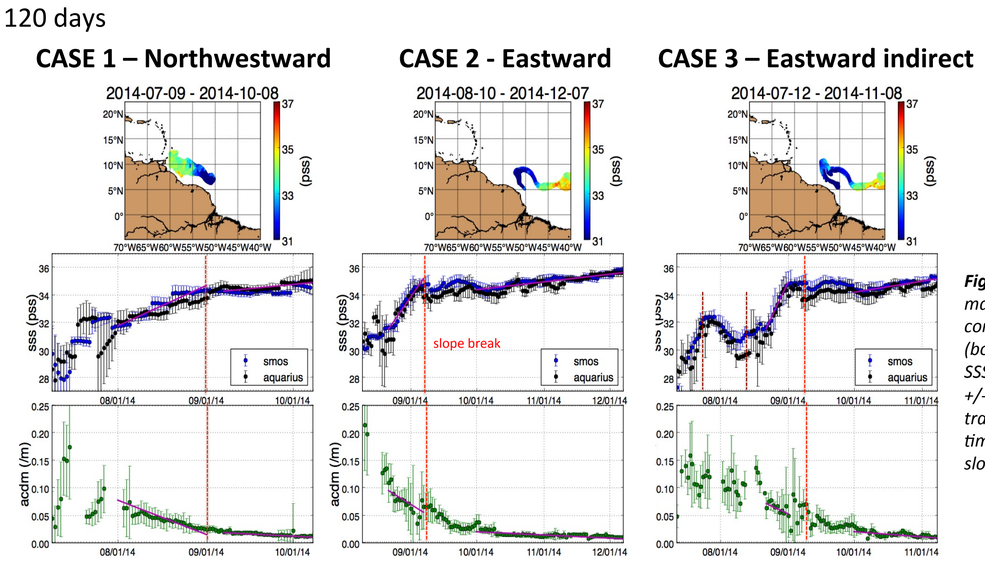


Fig 7 *: 3 cases are presented : (top) maps of particles trajectory with the corresponding SSS at each time step; (bottom) mean SMOS and Aquarius SSS and CDM absorption coefficient +/- 1 standard deviation along the trajectory of the particles (along time). The red dashed lines mark the slope breaks*

From mid July	From mid August	From mid July
Northwestward	Eastward	Northwestward then Eastward
Waters trapped in an eddy	Direct pathway	Indirect pathway

Evolution of mean sea surface salinity and absorption coefficient of CDM along the pathways everyday day :
- Negative correlation between SSS and aCDM, as expected
- A slope break occurs in all 3 cases, 'first' slope steeper than the 'second' slope
- The 'first' slope [32-34 pss] occurs over short time periods compared to the slope that 'holds' for 34-35.5 pss
- Case 1 (northwestward), the 'first' slope occurs over longer time period than in cases 2 and 3 (eastward)

Mixing line – CDM absorption versus SSS :

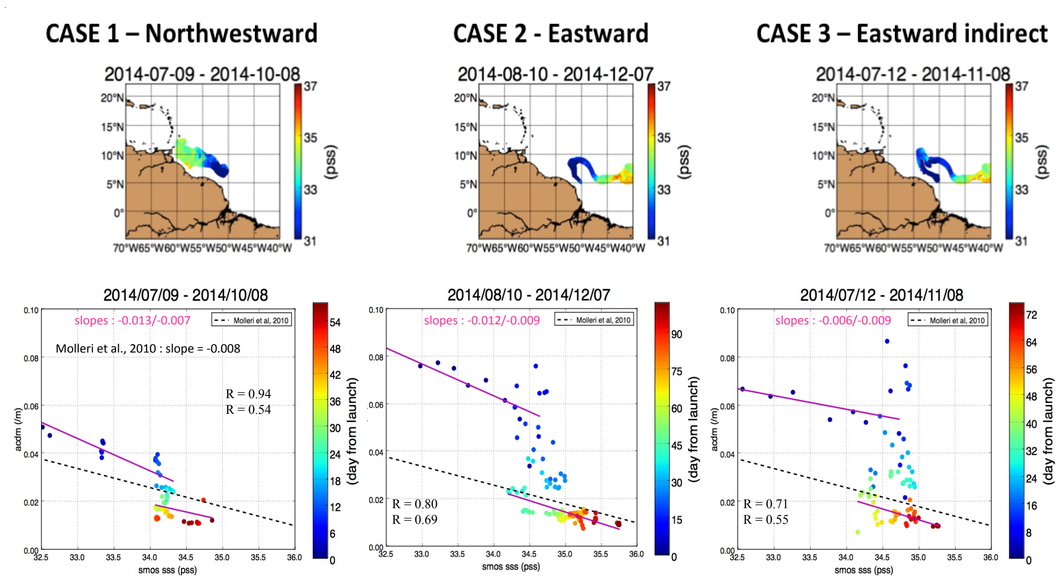


Fig 8 *: 3 cases are presented : (top) maps of particles trajectory with the corresponding SSS at each time step; (bottom) mean SMOS SSS versus mean CDM absorption coefficient along the trajectory of the particles. C-axis represents the day after launch. The black dotted line represents the SSS/aCDM relationship found by Molleri et al, 2010.*

- Slope break in all 3 cases -> 2 different relationships
- Comparable slopes BUT different end-members (aCDM value at the river mouth (SSS=0))
- Relationships at higher SSS comparable to *Molleri et al.*'s
- Complicated processes not controlled at the slope break (productivity, photobleaching ?)

CONCLUSIONS :

The Lagrangian analysis of the mixing line between SSS and CDM absorption coefficient along advective pathways from the Amazon mouth to the open ocean highlights the difficulty to compute such a mixing line in the Amazon plume. The cases studied show that the mixing line depends on space, time, pathways. Our study also shows the existence of multiple SSS/acdm relationships depending on the pathway.

Our perspectives are to use the Lagrangian method to :
- identify different mixing line patterns
- determine whether or not/where/when the mixing line(s) can be established
- locally identify non-conservative processes along advection pathways

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DATA :

ESA SMOS SSS : 7-day, 0.5° resolution (L4, CATDS CEC)
Aquarius/SAC-D SSS : 7-day, 1° resolution (SMI V4, PO.DAAC)
AVISO Sea Surface Currents : daily, 0.25°
MODIS AQUA acdm at 443nm : 8-day running mean, 9km (Ocean Color)