Jet Propulsion Laboratory
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Monitoring and understanding seasonal and interannual variations of sea surface salinity associated with the Mississippi River plume

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Motivations

- **Rivers : important factors of the Air/Sea interactions**
  - open ocean Sea Surface Salinity (SSS) (density)
  - buoyancy of the surface layer & vertical stratification

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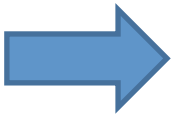
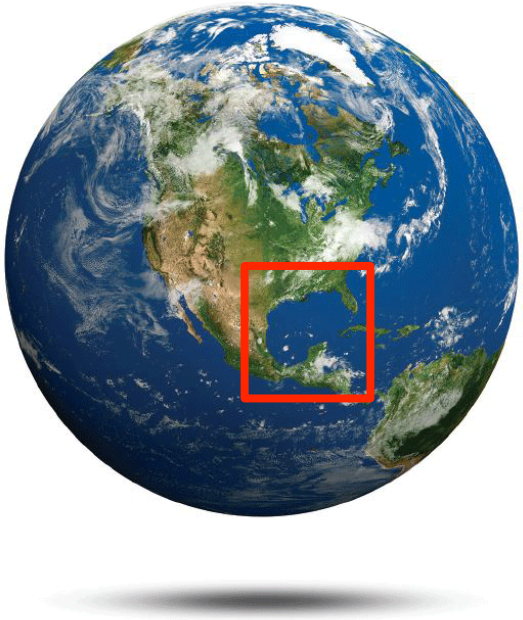
  - key role in many biological, physical & chemical processes
- Mississippi River : the largest river in North America



Importance of monitoring the spatial and temporal variability of the Mississippi River plume

Objectives

- Investigate seasonal and interannual variations of SSS :

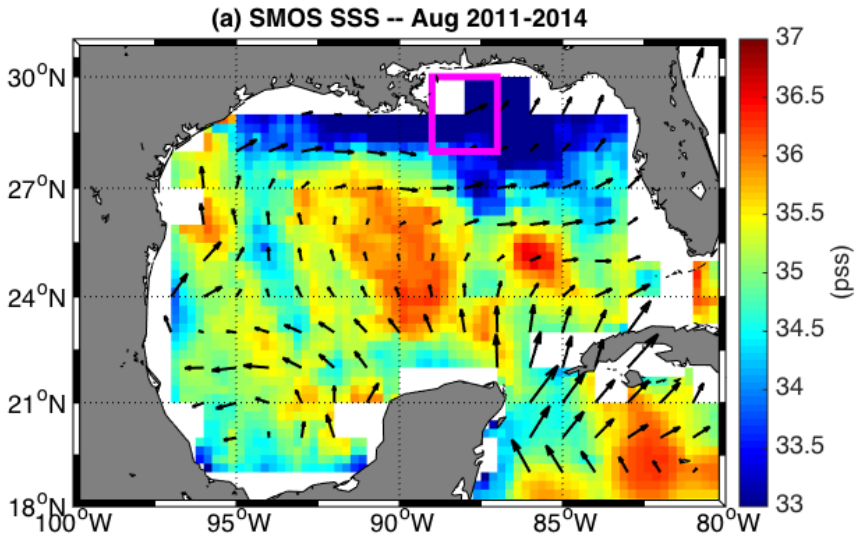


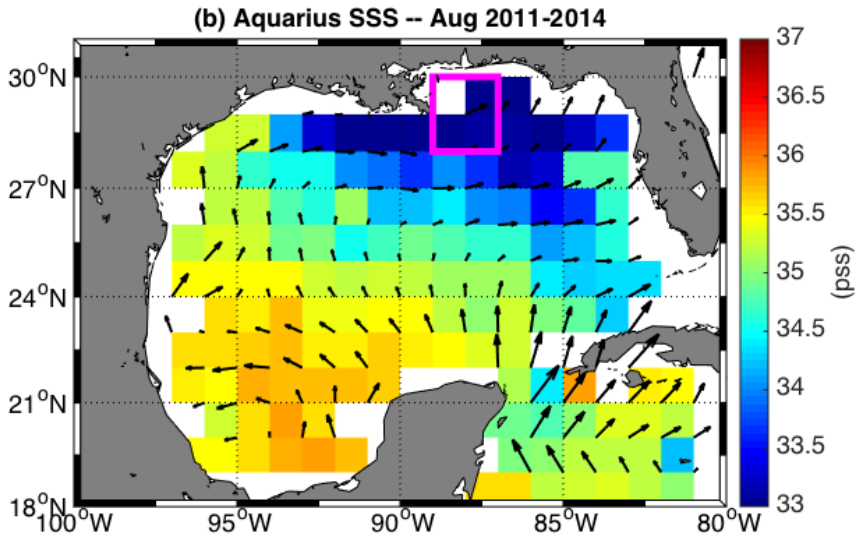
- Gulf of Mexico - Mississippi River plume
- 2010-2014
- Aquarius/SAC-D and SMOS SSS

Data

- **AQUARIUS/SAC-D SSS**: 7-day, 1° (SMI V4, PO.DAAC)
- **SMOS SSS**: 10-day, 0.25° (L3, LOCEAN)
- **ERA-Interim E and P** (evaporation and precipitation) : 3-hourly, 0.5°
- **OSCAR currents** : 5-day, 1° (L4)
- **USGS** Mississippi River **discharge** at the Baton Rouge gauge
- **HYCOM SSS** (global ocean data assimilation run, 1/12° equatorial resolution grid) : monthly, 0.25°
- **MODIS AQUA acdm** (absorption coefficient of Colored Detrital Matter at 443 nm) : 10-day running mean, 0.25° (OceanColor)

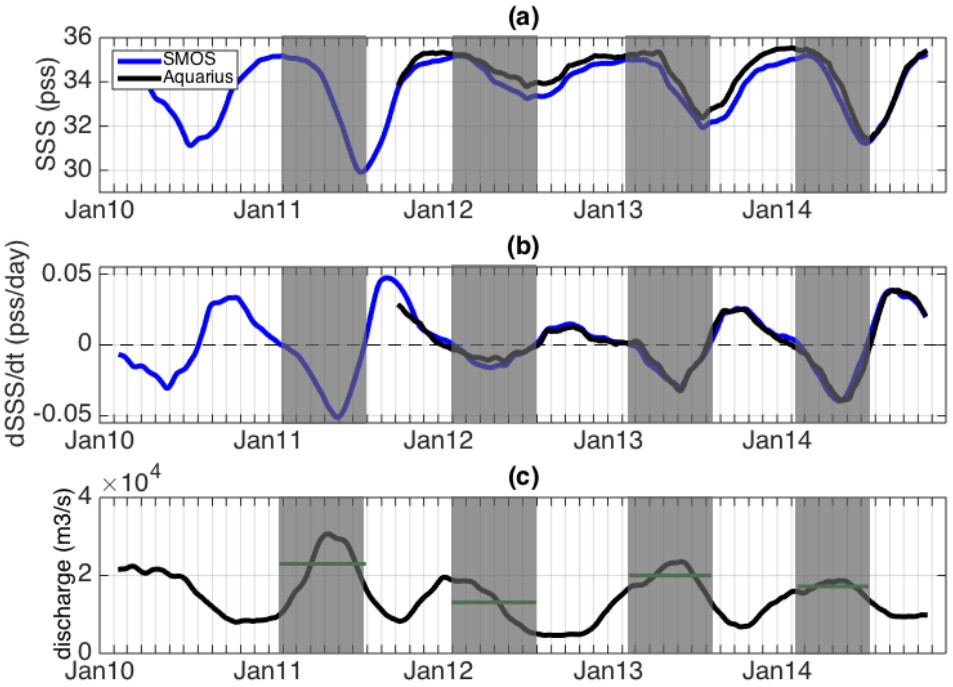
Mississippi River freshwaters





August : about 3 months after the maximum of discharge
a maximum freshening associated with the river plume

SSS variability near the mouth



- SSS minimum/acdm maximum in August, 3 month after maximum discharge

- SSS seasonal cycle magnitude: 4 pss

- **Summer 2011** : SSS is a record minimum (flooding event)

- **Summer 2012** : highest SSS minimum (3 pss) comparable to the seasonal variation magnitude

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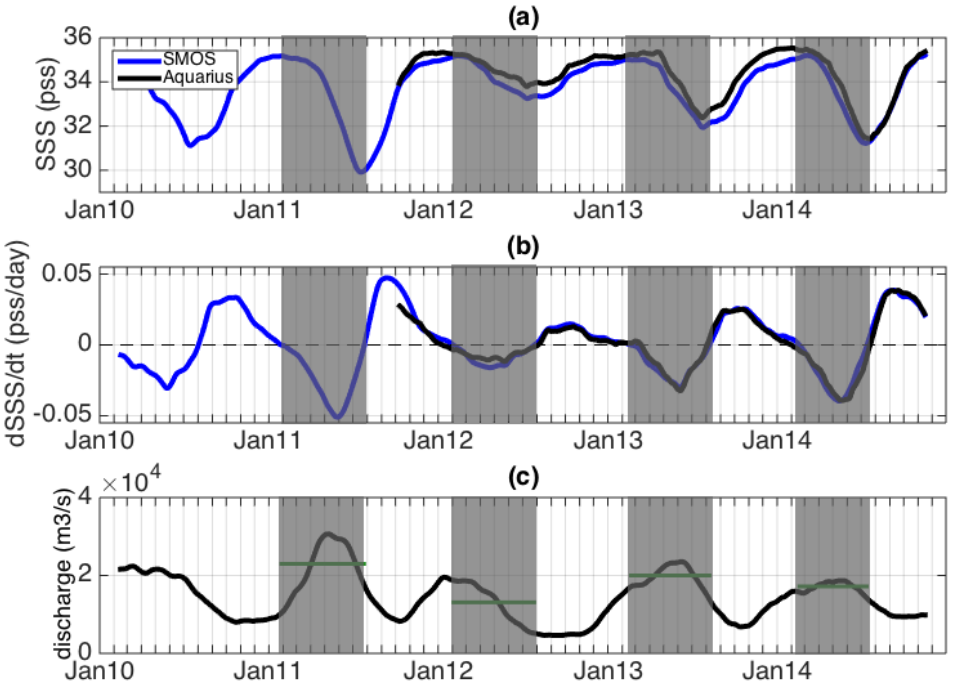

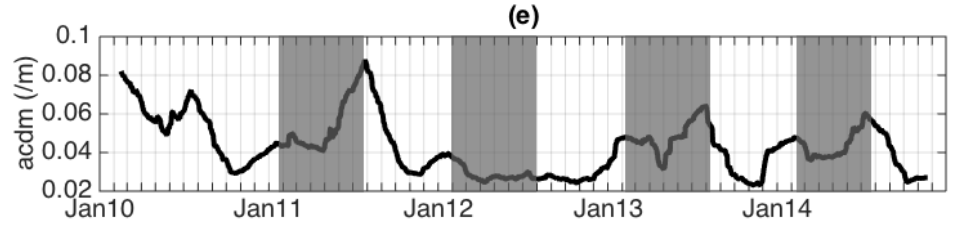

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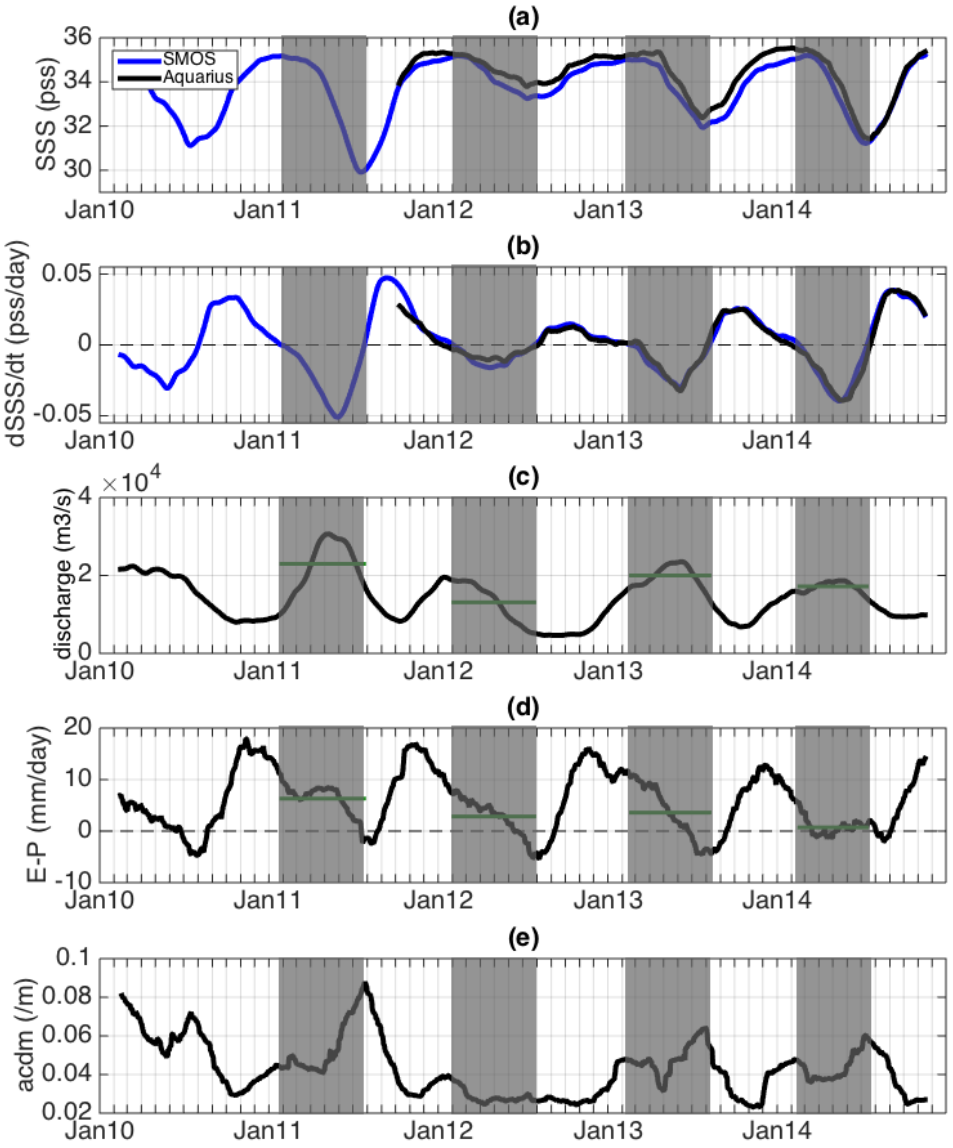

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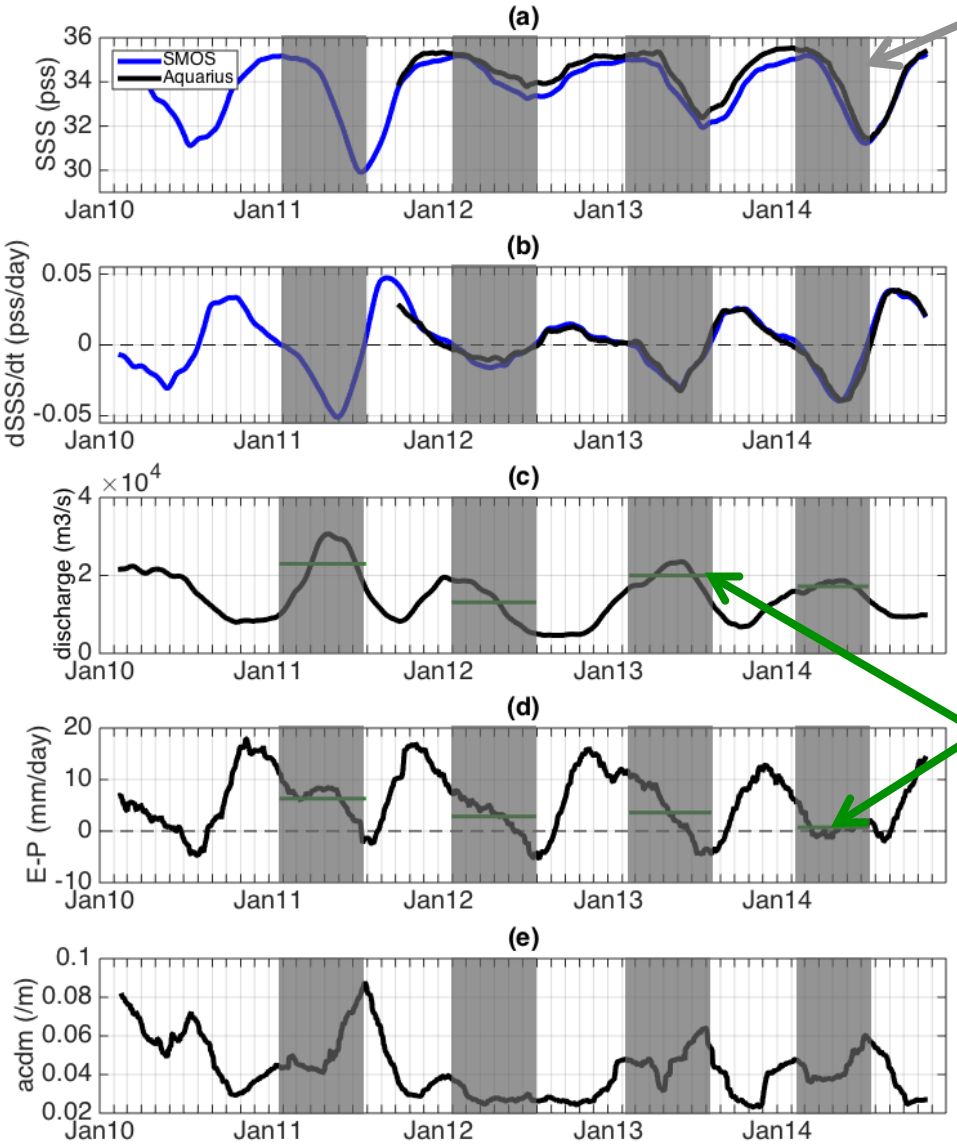

dSSS/dt < 0
(approximately January-August)

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Averaged river discharge and E-P

- SSS variation consistent with the river discharge forcing

- SSS variation inconsistent with the E-P variations

Estimation of the salinity budget

$$dS/dt = S\,(E-P)/H - S\,R/V - u\,dS/dx - v\,dS/dy + RES$$

evaporation - precipitation — **river** — **horizontal advection** — **vertical advection** — **Horizontal/vertical mixing**

(in the box next to the Mississippi mouth / H=10m)

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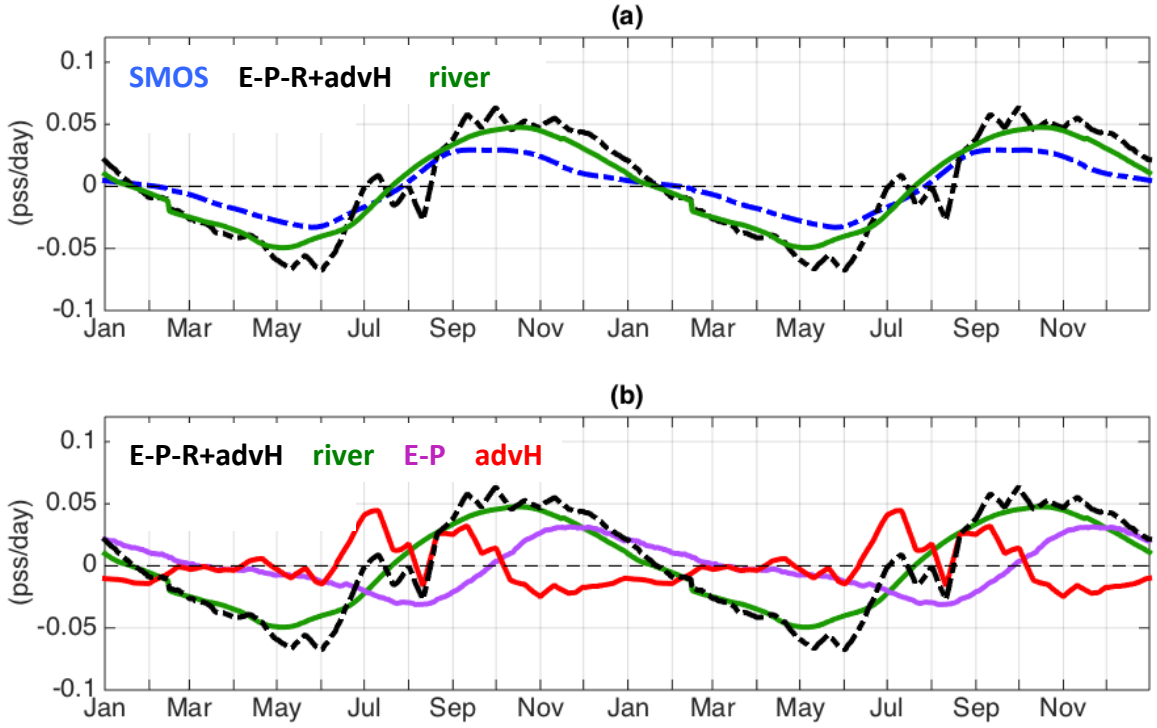
Seasonal variability of the budget and its components



Major contribution of the river term in the seasonal variation of the budget :

➡ comparable phase and amplitude

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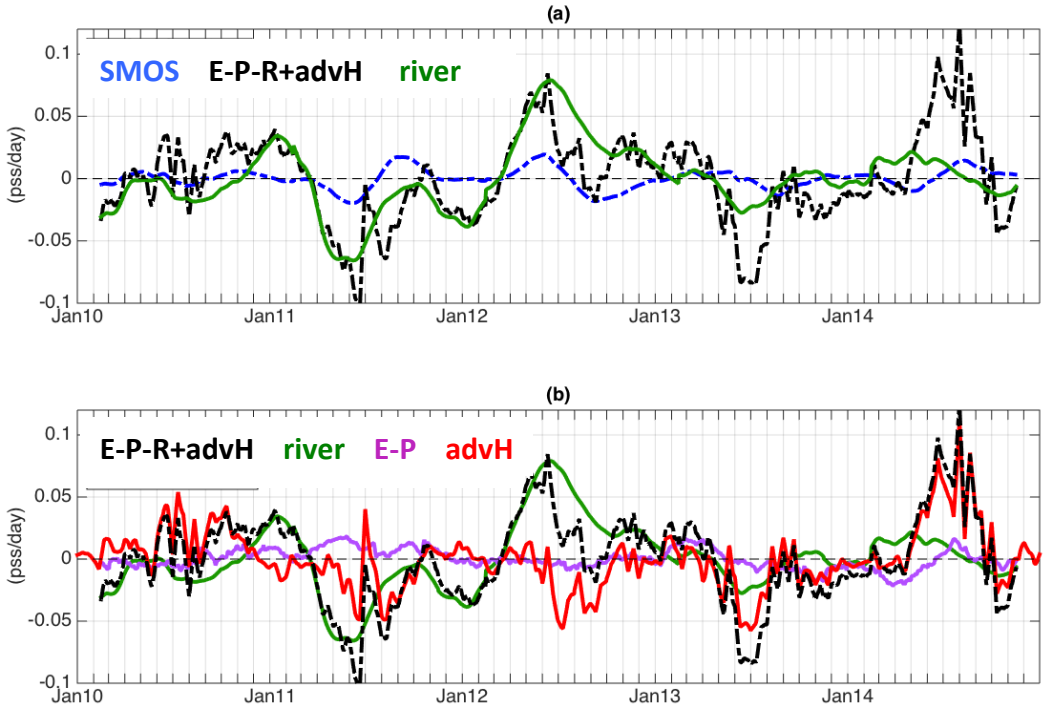
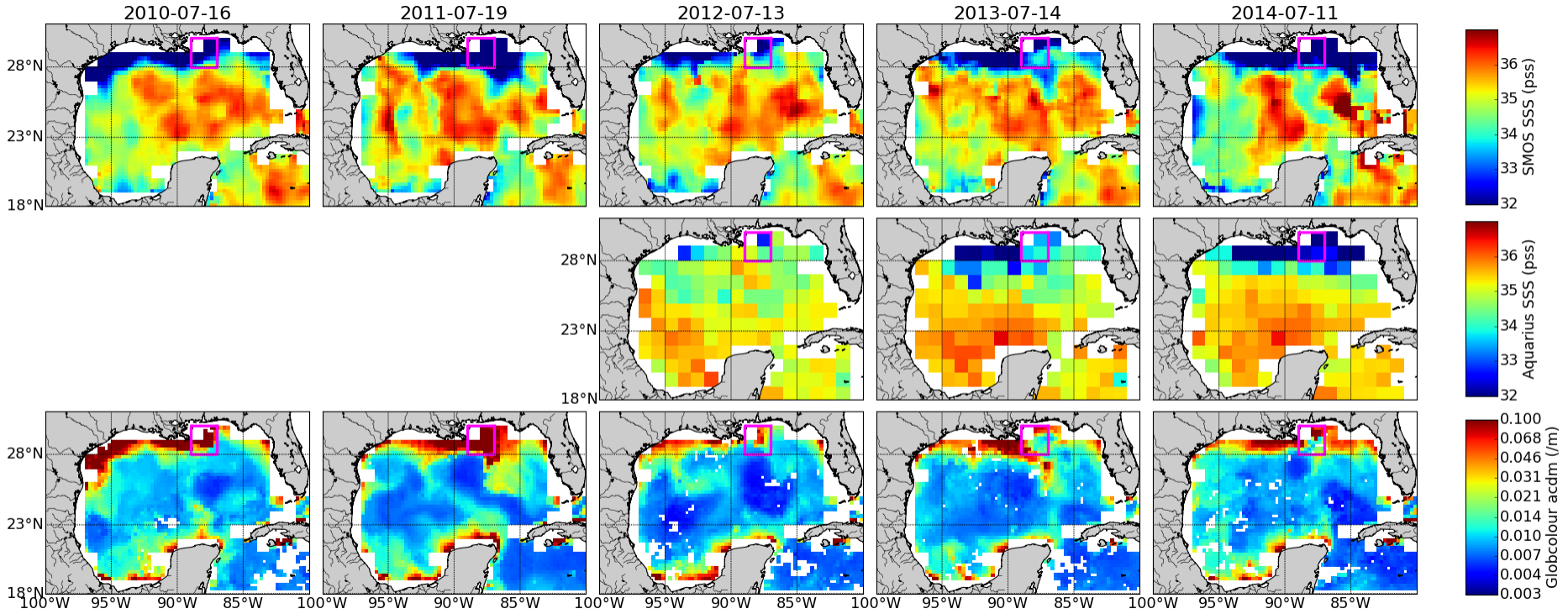
Interannual variability of the budget and its components



- **Summer 2011**: budget/SMOS SSS tendency/river component minimums
- **Summer 2012**: budget/SMOS SSS tendency/river component maximums

➡ major contribution of the river discharge term in 2011 and 2012

Spatial extent of the impacts of the interannual river discharge

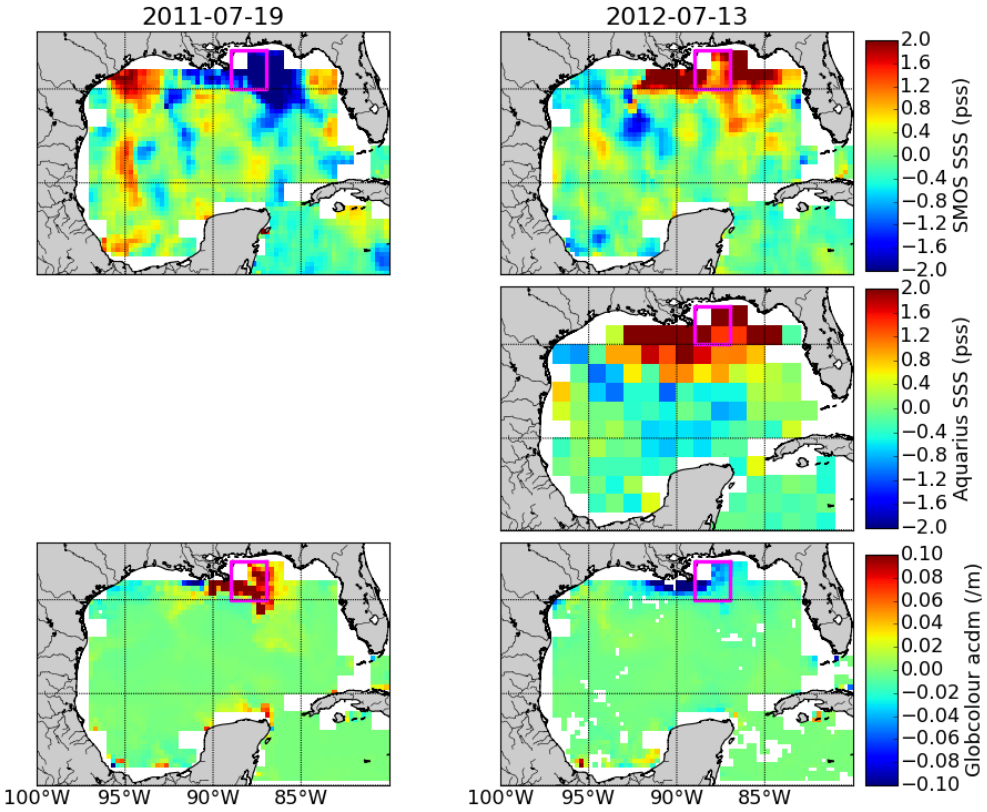


Maps within a 10-day time window when SSS minimum is reached in different years

⇒ Smaller extension of the Mississippi River plume in July 2012

Spatial extent of the impacts of the interannual river discharge

Anomaly maps from July 2010-2014 within a 10-day window around SSS minimum



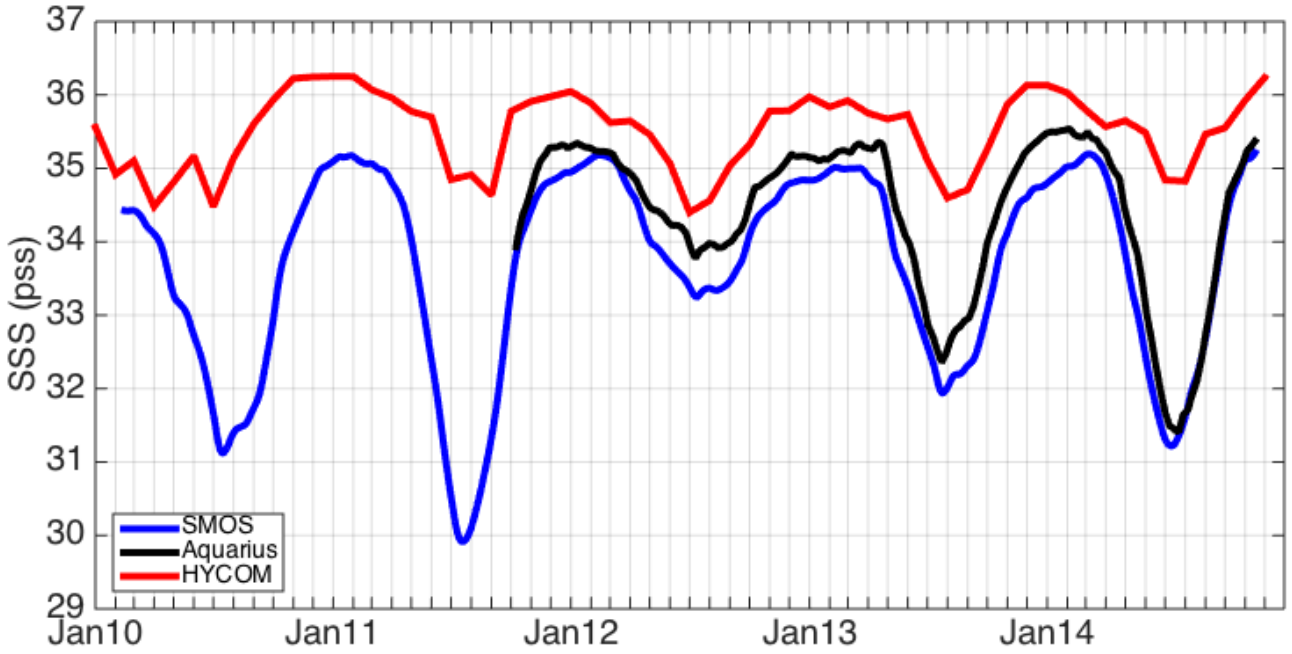
2011 :

- SSS lower in the Mississippi Plume compared to the 2010-2014 July composite
- acdm higher

2012 :

- SSS higher
- acdm lower

Implication to ocean model circulation



Ocean models :

- climatological river runoff forcing
- SSS often relaxed to climatology

⇒ suppressing interannual changes as observed.

Conclusions

- Interannual changes in the SSS minimum, comparable to the magnitude of the seasonal cycle (3 pss)
- Seasonal and interannual SSS variations consistent with the river component of the budget but not with E-P or horizontal advection components
- Implications to ocean model simulation and forecast
- Implications to marine ecosystems :
  - GoM, the largest hypoxic zone affecting the US (<0.2 mg O2/l)
  - satellite SSS measurements can be used to monitor and predict the extent of hypoxic zone

Thank You