Impact of the river numerical implementation on the plume dynamics

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MOTIVATION and MAIN RESULTS

- 2 approaches to represent rivers in OGCMs:
  - Salinity flux (relaxation)
  - Mass flux (true open boundary, reference)
- What is the impact of these numerical implementations on the dynamics of the plume?
- Mixing and estuary geometry define the potential vorticity structure which then determines the plume dynamics and shape
- A vertically distributed relaxation approach is similar to the mass flux approach (for this configuration)

METHODS

▪ **Model:**

1) Using the Hybrid Coordinate Ocean Model (HYCOM) for an academic river outflow configuration based on ***Schiller et al.*** (2010): Flat bottom (20 ***m***), ***Δx***=2.5 ***km***, ***Δz***=1.25 ***m***, temperature passive, ***f***-plane, KPP, closed basin, mass added, 1000 ***m³/s*** discharge

2) Salinity relaxation algorithm is:

$$S_1^{n+1} = S_1^n - \alpha_{river}\frac{S_1^n \delta t}{h_1^n} \text{ with } \alpha_{river} = \frac{h_1^n \delta h_1}{\delta t (h_1^n + \delta h_1)} \approx \frac{\delta h_1}{\delta t}\left(1 - \frac{\delta h_1}{h_1^n}\right) \approx \frac{\delta h_1}{\delta t}$$

LIMITATIONS:
- no added mass
- if first layer is thin, approximation is not valid

EXPERIMENT NAME	LOCATION of FORCING
SURF	Baroclinic - 1st point
SURF - VERT	Barotropic - 1st point
SURF - VERT - HALF	Barotropic - half estuary
SURF - VERT - FULL	Barotropic - full estuary
FLUX	Barotropic - 1st point

▪ **Diagnostics:**

1) Flow divided in 2 layers(at the isohaline 34.9)

$$\mathrm{PV} = \frac{\zeta_n + f}{h_n}, \text{ où } \zeta_n = rot(\mathbf{U}) = \partial_x v - \partial_y u$$

$$\mathrm{PVA} = \frac{\zeta_n + f}{h_n} - \frac{f}{H_{n_{rest}}},$$

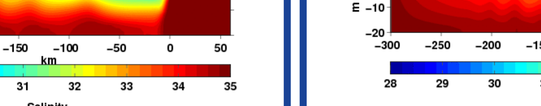
où $H_{n_{rest}}$ est l'épaisseur initiale de la couche n

$$\mathrm{PH} = \frac{h_n}{\zeta_n + f}$$

$$\mathrm{PHA} = \frac{h_n}{\zeta_n + f} - \frac{H_{n_{rest}}}{f}$$

PV is conserved if adiabatic conditons

Mass removed: PVA > 0 ↔ PHA <0
Mass added: PVA < 0 ↔ PHA >0

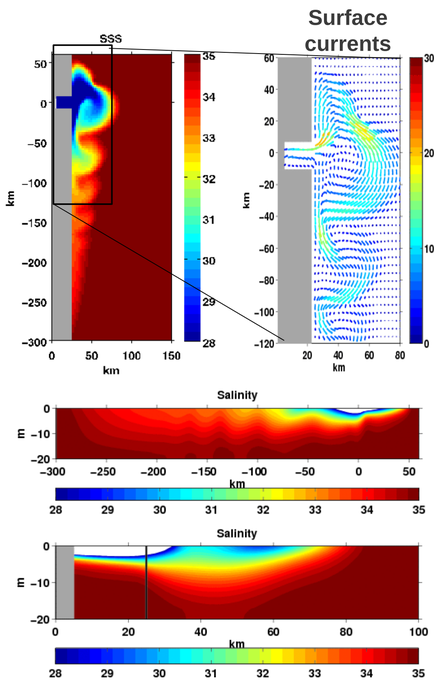


If the vorticity field is known, the dynamic is known

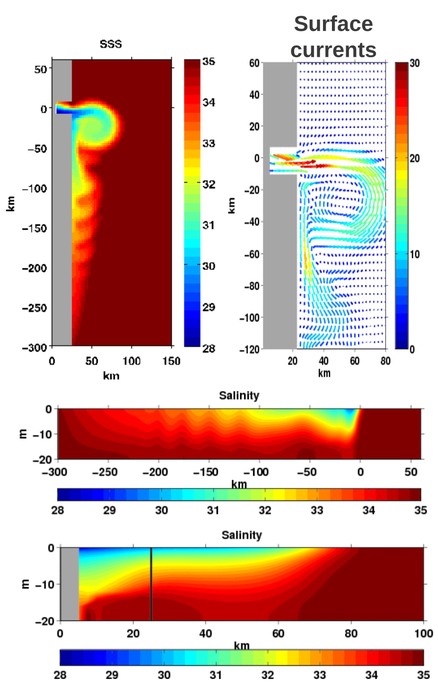
SALINITY RELAXATION APPROACH WITH ADDED MASS

MASS FLUX APPROACH

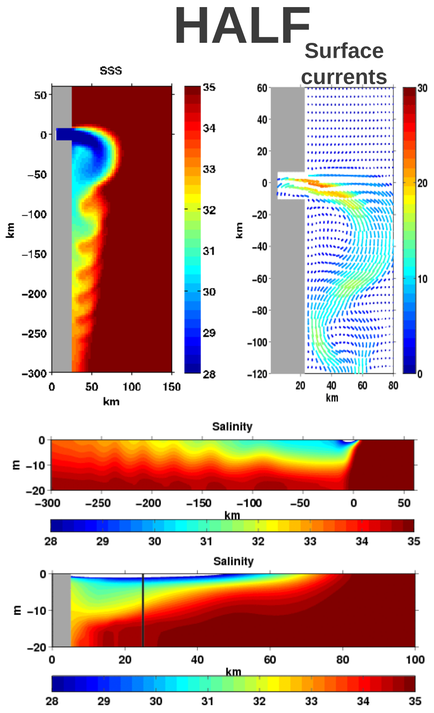
SURF



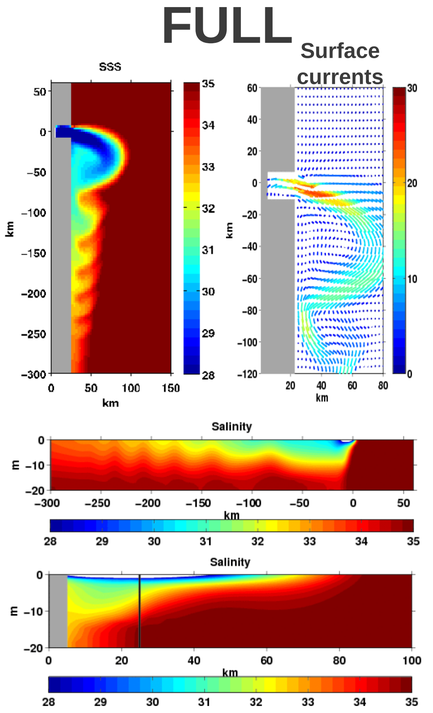
SURF - VERT



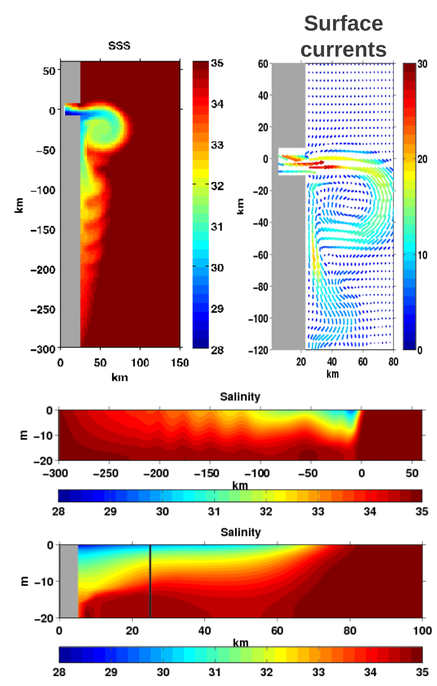
SURF - VERT - HALF



SURF - VERT - FULL



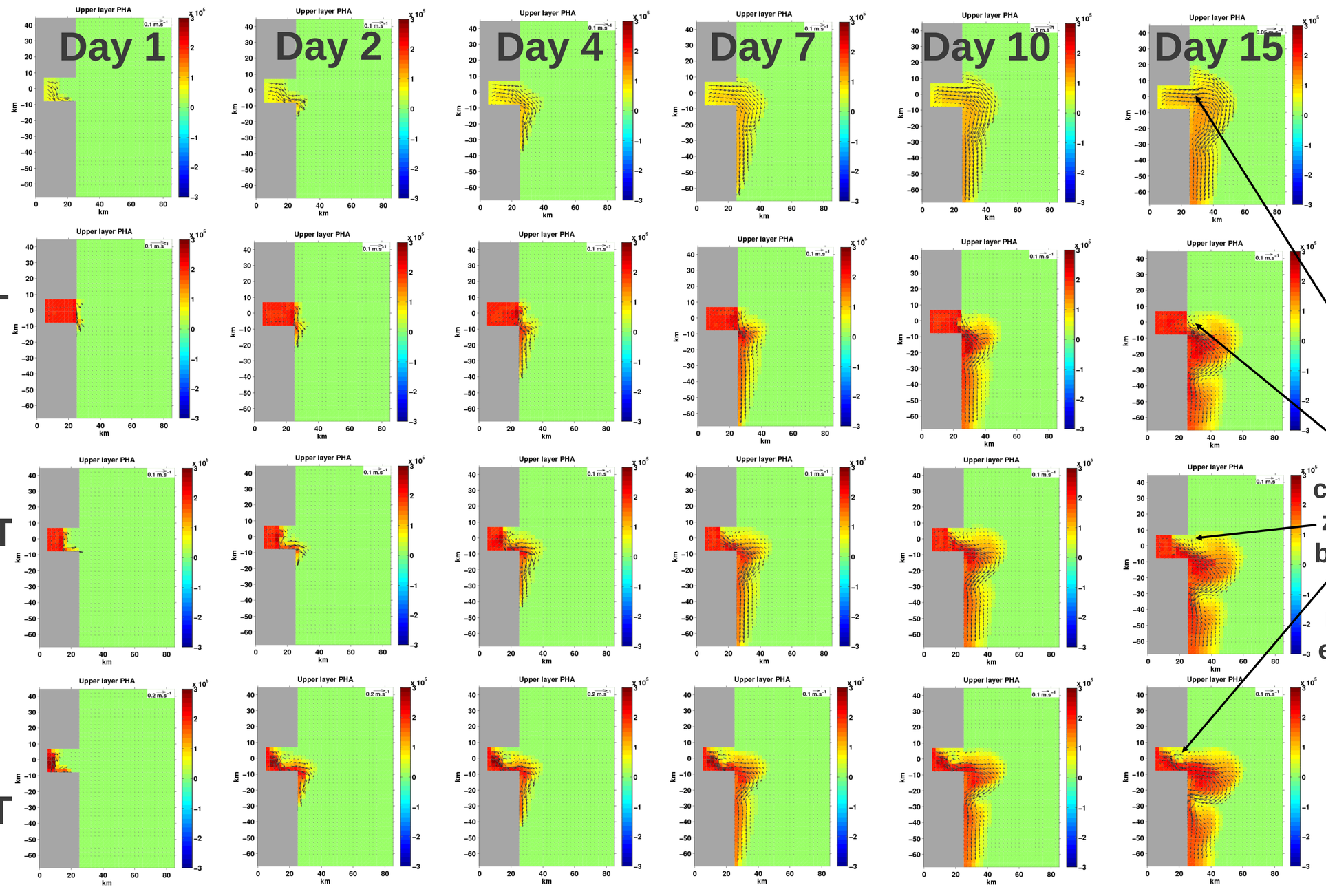
FLUX



- Buoyancy fluxes are different
- No impact of the unresolved river momentum
- Estuary mixing and circulation different

Considered as the reference experiment

POTENTIAL HEIGHT DIAGNOSTICS



No re-circulation

Re-circulation zone that blocks the plume northern extension