Can we simply predict maximum turbidity in tidal estuaries?

(i.e., can we classify estuarine turbidity maximum within an estuarine parameter space?)

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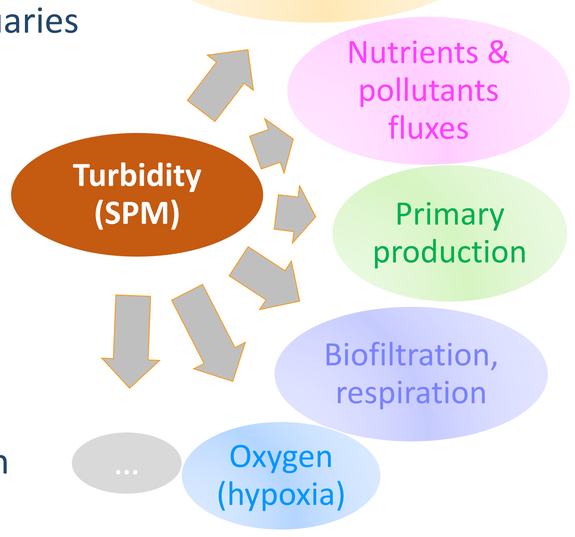
CONTEXT

Why looking at turbidity in estuaries?

- Strong impacts on ecosystems
- High variability between estuaries
  From low (mg/l) to high (g/l) Supended Particulate Matter (SPM) concentrations
- No '*simple*' tools to estimate maximum turbidity
  Costly measurement networks and realistic numerical models
- Need of turbidity information in uninvestigated estuaries



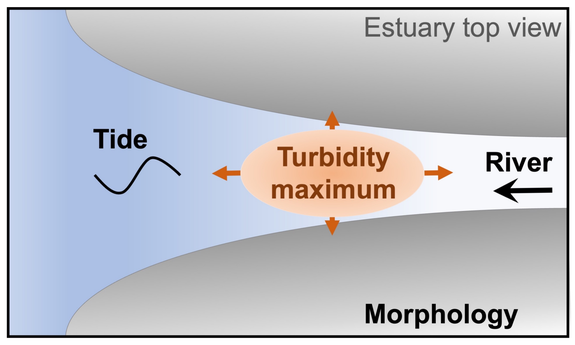
OBJECTIVES

We hypothesize that…

Estuarine turbidity maximum is related to a limited number of forcing parameters (e.g., tidal range, river discharge, morphology)

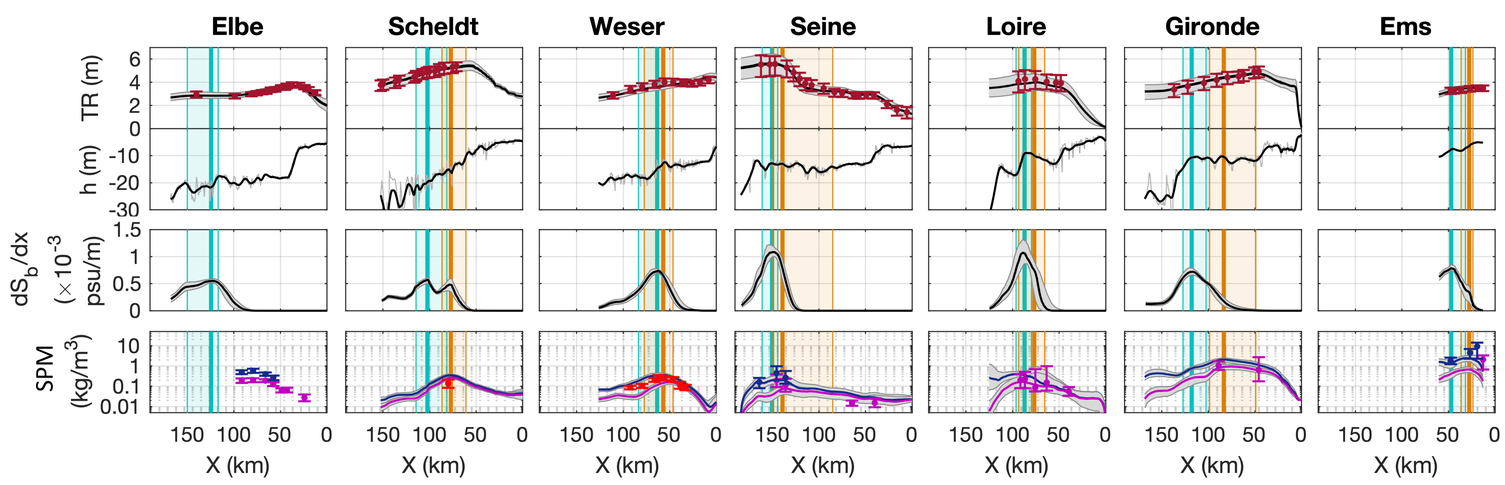
We aim at…

- Developing a method for estimating estuarine turbidity maximum from integrated and easily accessible variables
- Providing a tool for helping stakeholders managing ecological issues in estuarine ecosystems
  (+) A generic method to estimate potential estuarine turbidity maximum
  (–) A less accurate method than site-specific numerical modeling



RESULTS

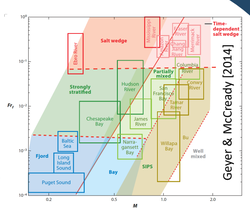
Yearly-average along-estuary profiles of hydrodynamics and sediment dynamics



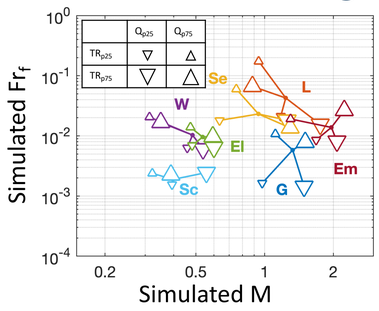
$$Fr_f = \frac{U_R}{N_0}$$

$$M = \sqrt{\frac{C_D U_T^2}{\omega N_0 H^2}}$$

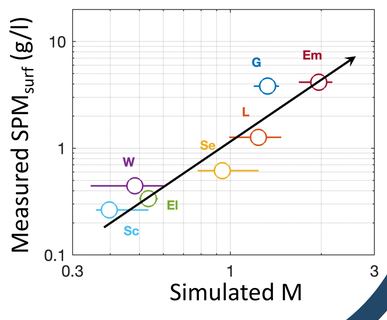
$$N_0 = \sqrt{\beta g s_{ocean} H}$$



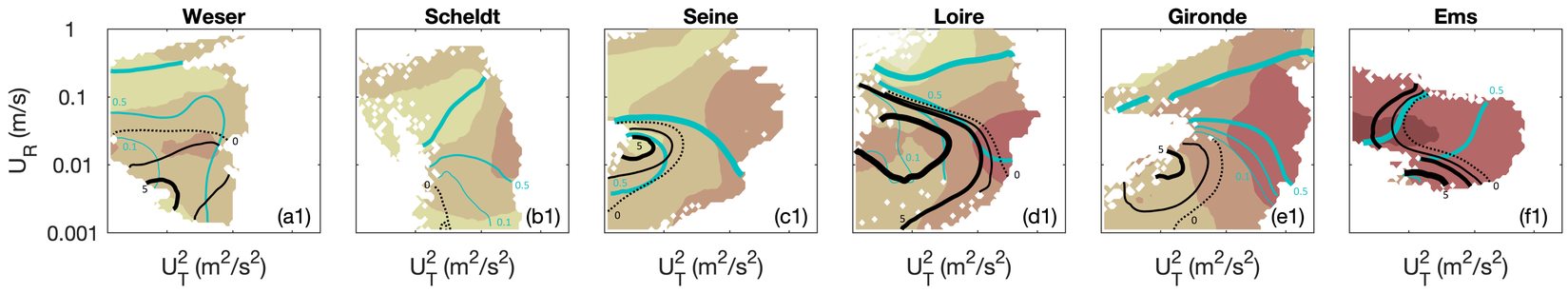
River *vs* tidal forcing



SPM *vs* tidal forcing



An explanatory parameter space for estuarine sediment dynamics



- SPM increases with tidal current, asymmetries, and estuarine circulation

U_T: Max. bottom velocity (/tide)
U_R: River velocity (/tide)
$\overline{U}$: Mean bottom velocity (/tide)

$SSC_{d\text{-}a}$ sim (kg/m³): 0.001 | 0.01 | 0.1 | 1 | 10

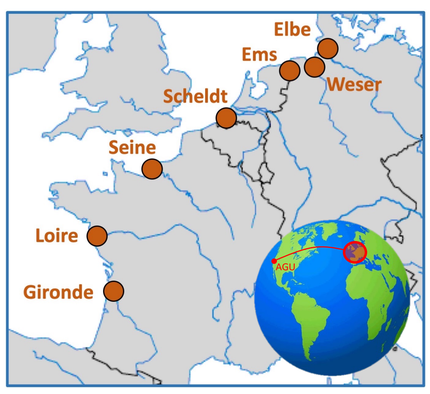
$\overline{U}$ (10^{-2} m/s): 0 | 2.5 | 5 | 10

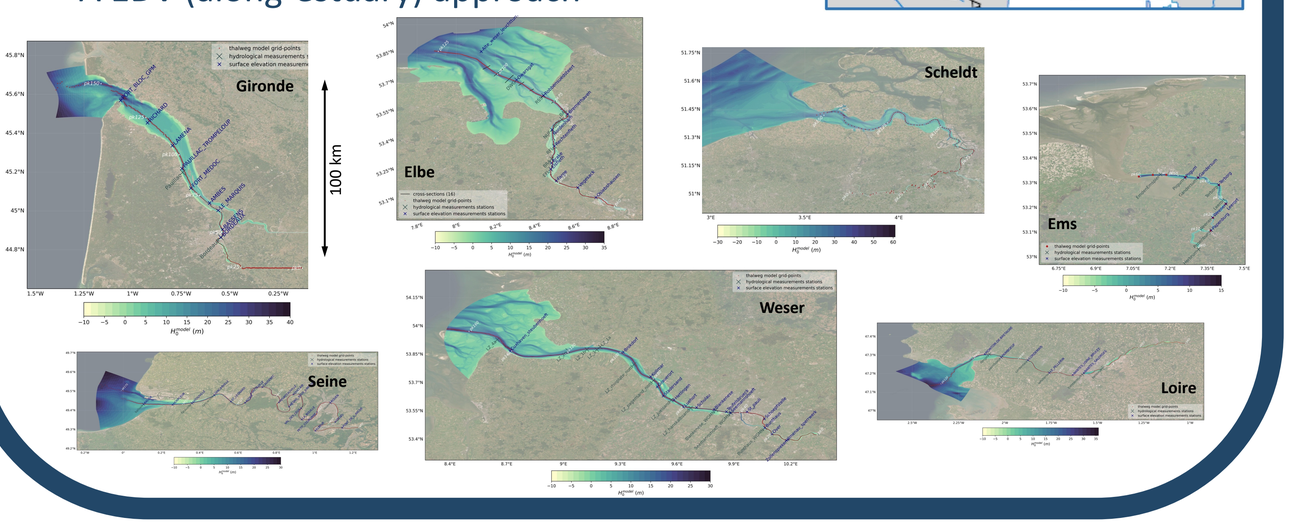
Tide asymmetry (-): 0.1 | 0.25 | 0.5 | 1

METHOD

We used…

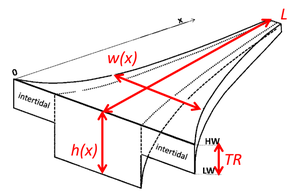
- An inter-estuary comparison
  7 meso- to macro-tidal NW European estuaries
- *In situ* measurements + numerical models
  1-year-long high-frequency dataset (water level, velocity current, salinity, SPM concentration)
- A 1DV (along-estuary) approach



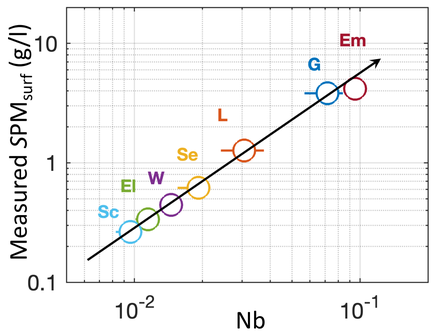


OUTCOMES

Take away messages…



$$Nb = \frac{TR}{h_m} w_{int} \left(\frac{L}{\lambda}\right)^{0.5} \left(\frac{w_m}{h_m}\right)^{0.5} \frac{1}{{h_m}^2}$$



- The turbidity maximum observed in tidal estuaries can be related to a limited number of integrated variables
  (e.g., tidal range *TR*, mean length *L*, tidal length λ, mean depth h_m, mean width w_m, mean intertidal width w_{int})
- The potential maximum turbidity can be used to derive ecological variables (e.g., light attenuation for primary production limitation, potential hypoxia conditions, etc.)

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