April 30, 2025

Wind-induced residual currents as a driver of sediment flux intensification in a shallow, micro-tidal bay

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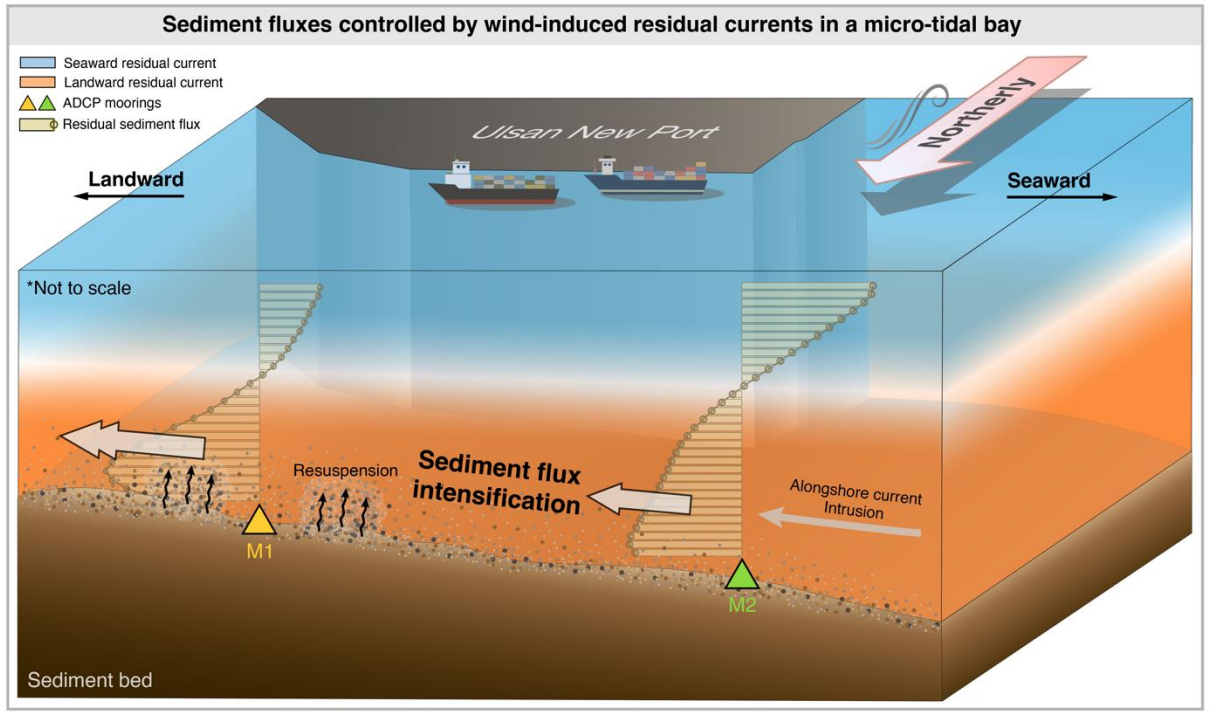

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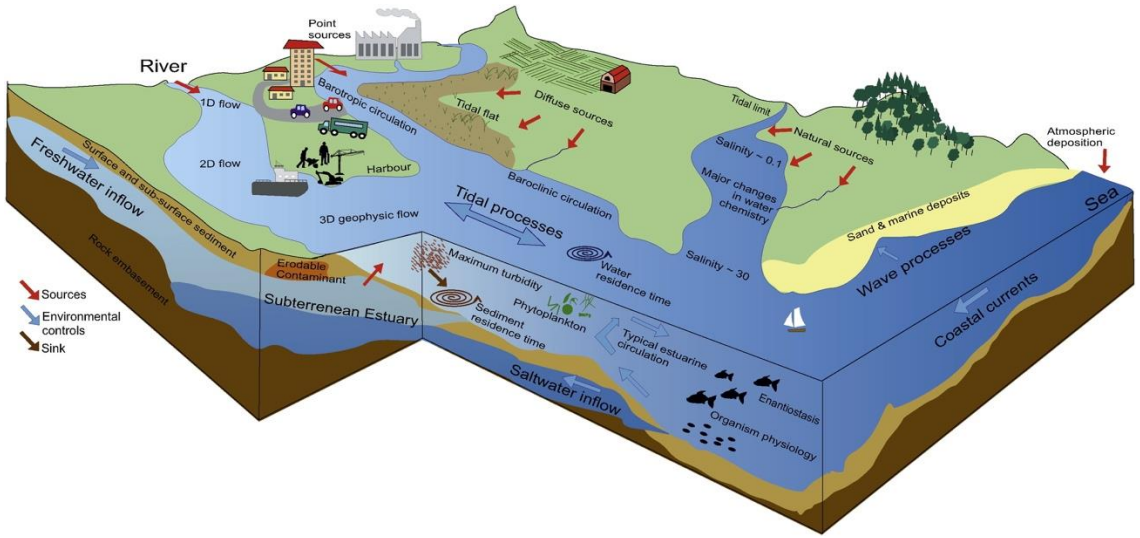
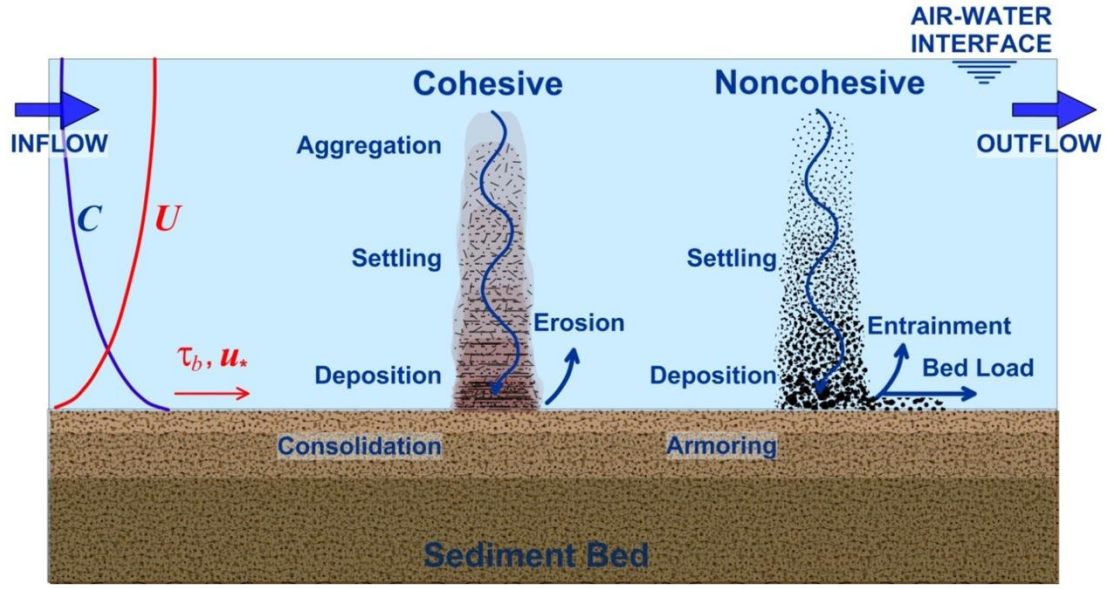
Sediment dynamics in microtidal bay



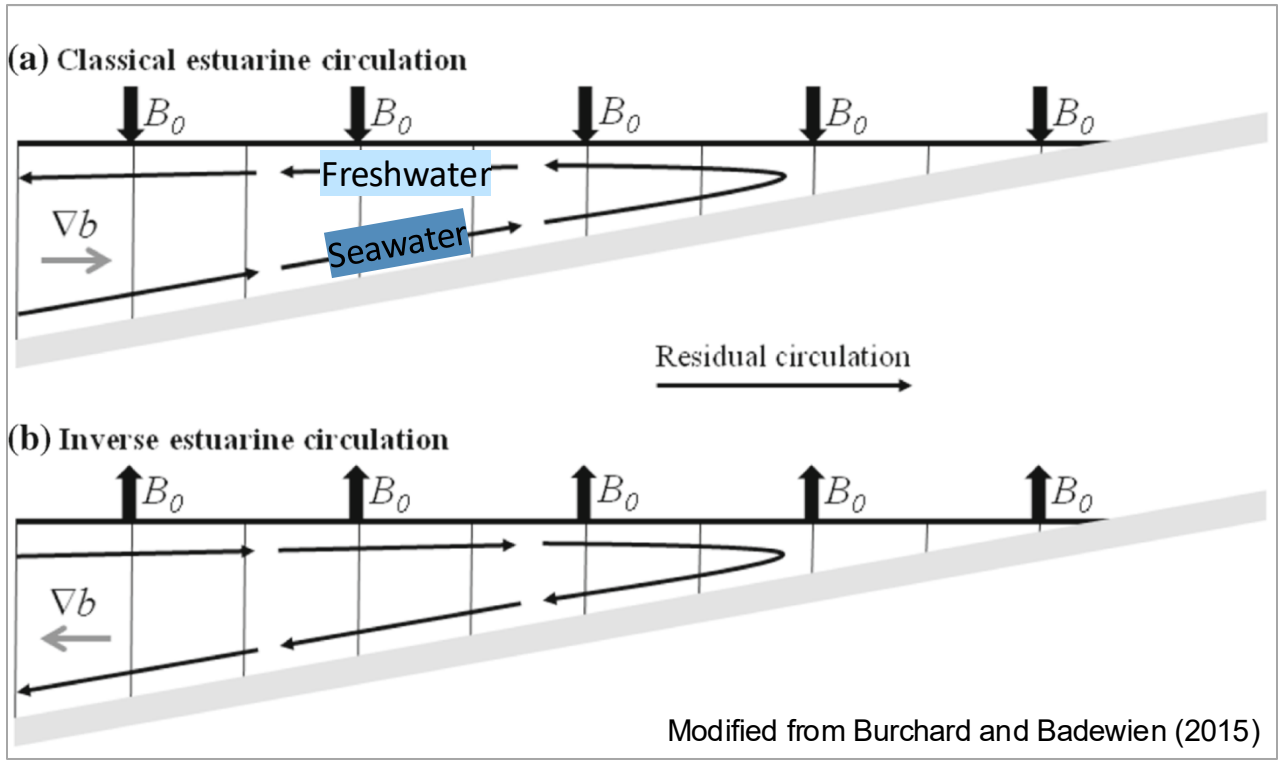
Machado et al. (2016)



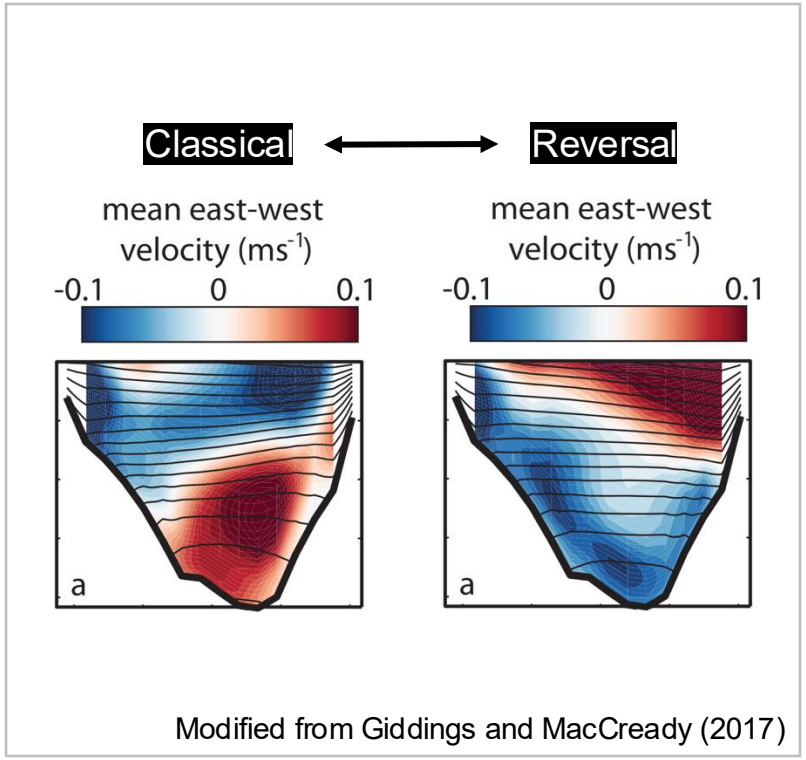
Shrestha et al. (2014)

- Bed sediments can be resuspended by various shear stresses, which are closely related to the hydrodynamic conditions
- **In shallow, microtidal bays, estuarine circulation plays a more dominant role in sediment transport** than tidal pumping

Estuarine circulation and Wind forcings



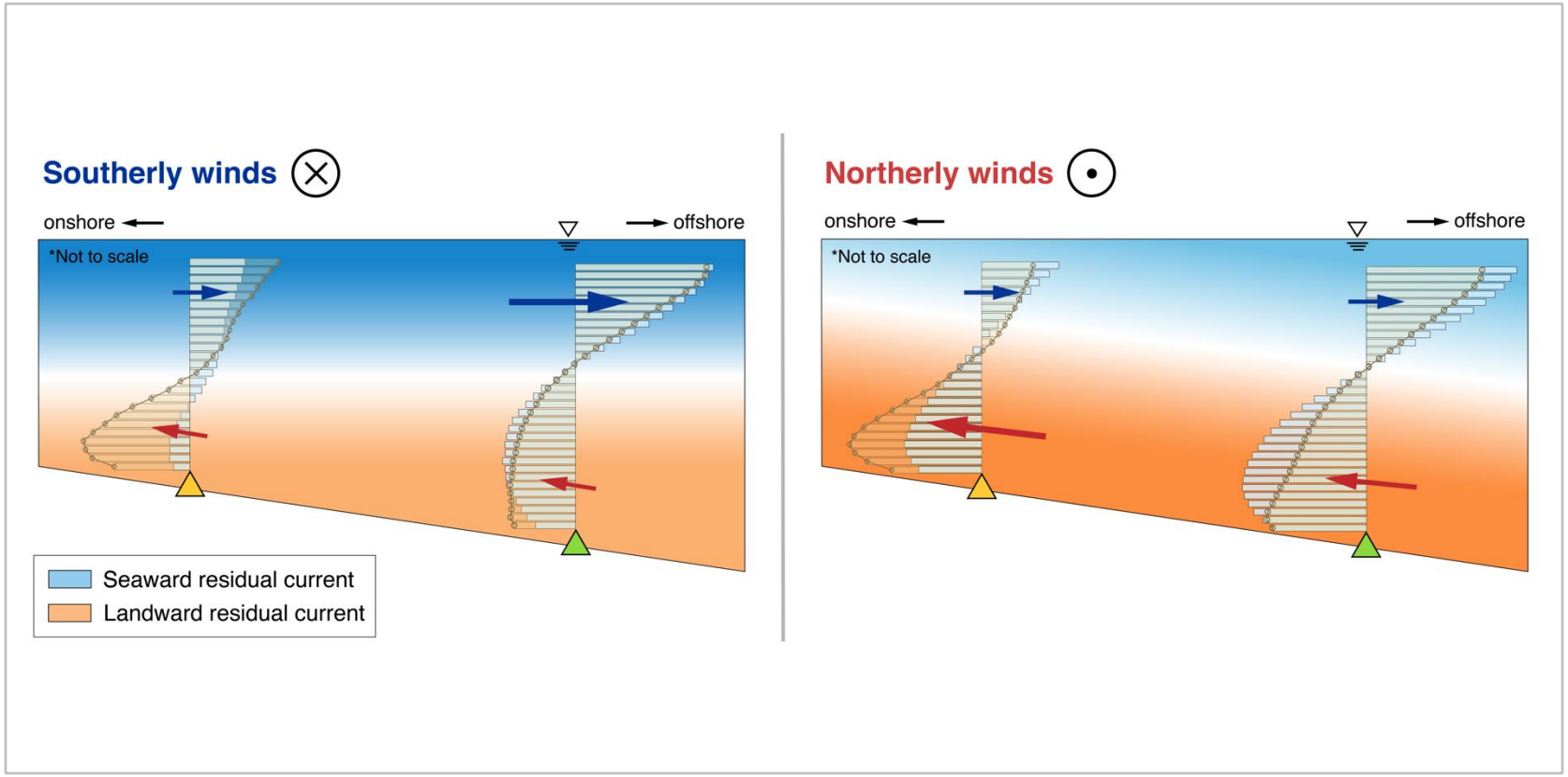
Modified from Burchard and Badewien (2015)

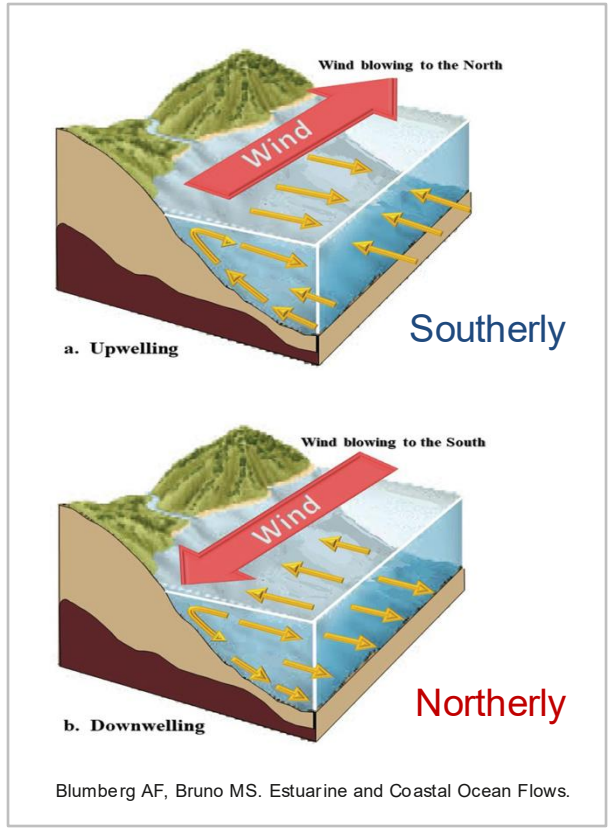


Modified from Giddings and MacCready (2017)

- **Classical estuarine circulation**, which drives landward seawater intrusion in the bottom layer and seaward freshwater outflow in the surface layer, is controlled by various forcings (e.g., tidal straining/asymmetry, wind, freshwater discharge)
- Wind forcing can induce switch between classical and reversed estuarine circulations

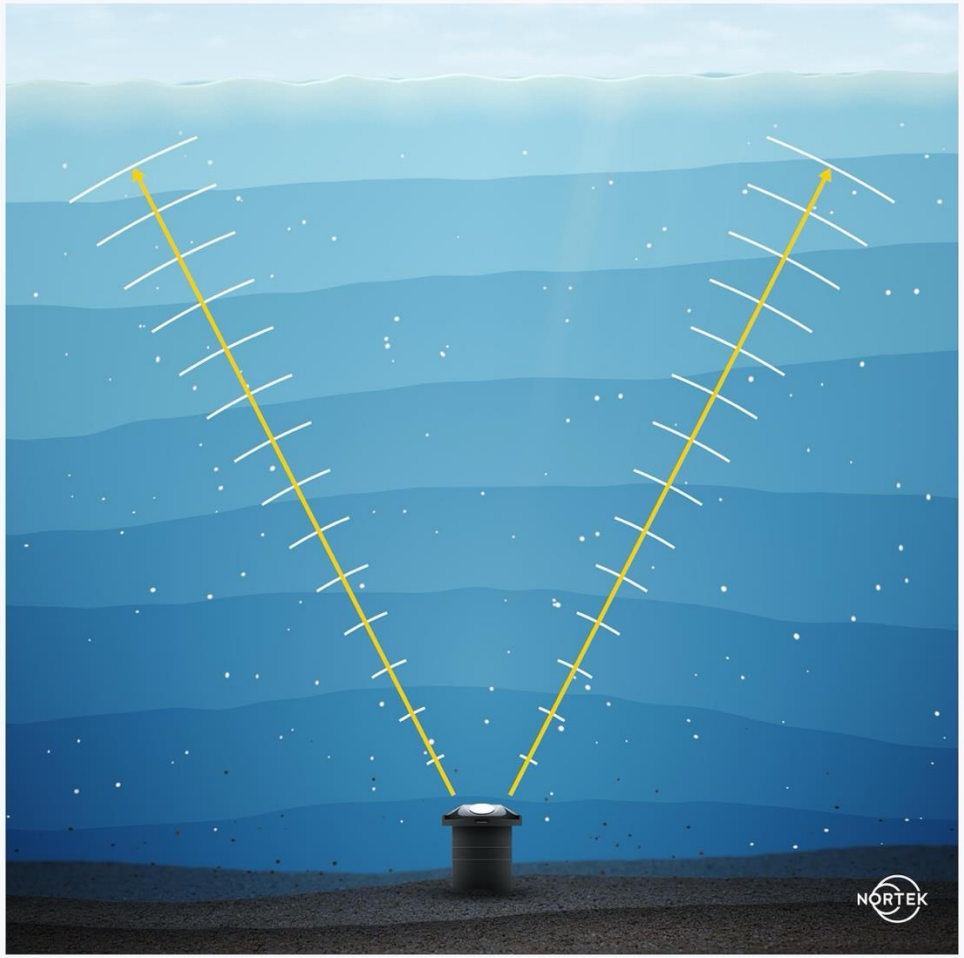
Wind-driven onshore mechanisms





Blumberg AF, Bruno MS. Estuarine and Coastal Ocean Flows.

Suspended sediment concentration



www.nortekgroup.com/knowledge-center/wiki/guide-to-understanding-adcps

Suspended sediment concentration (SSC)

$$SSC_v = 10 \cdot log_{10}(SSC_{OBS}) - 10 \cdot log_{10}R^2 - 2 \cdot \alpha \cdot R + L_{DBM} + P_{DBW} \quad (1)$$

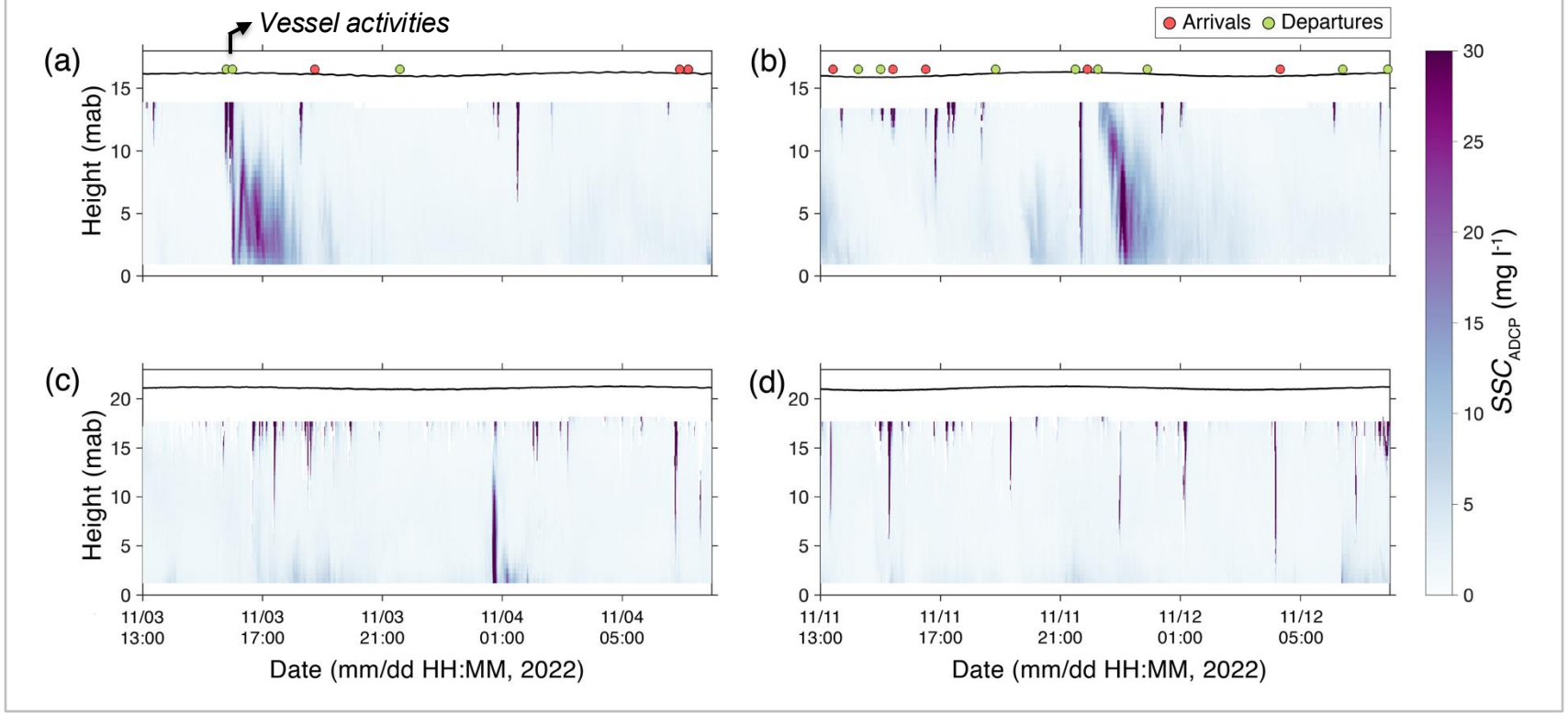
$$SSC_v = K_c \cdot (E - E_r) + C \quad (2)$$

$$SSC_{ADCP} = 10 \cdot exp\left(\frac{C + 20 \cdot log_{10}R + 2 \cdot \alpha \cdot R - L_{DBM} - P_{DBW} + K_c \cdot (E - E_r)}{10}\right) \quad (3)$$

- SSC_v: volume scattering strength (dB)
- SSC_{OBS}: SSC calculated by OBS calibration
  (SSC from water samples – NTU from CTD casting)
- R: slant range along the ADCP beam (m)
- α: sound attenuation coefficient of water (dB m^{-1})
- L_{DBM}: transmit pulse length
- P_{DBW}: transmit pulse power
- E: echo intensity from ADCP
- E_r: reference level of the echo intensity

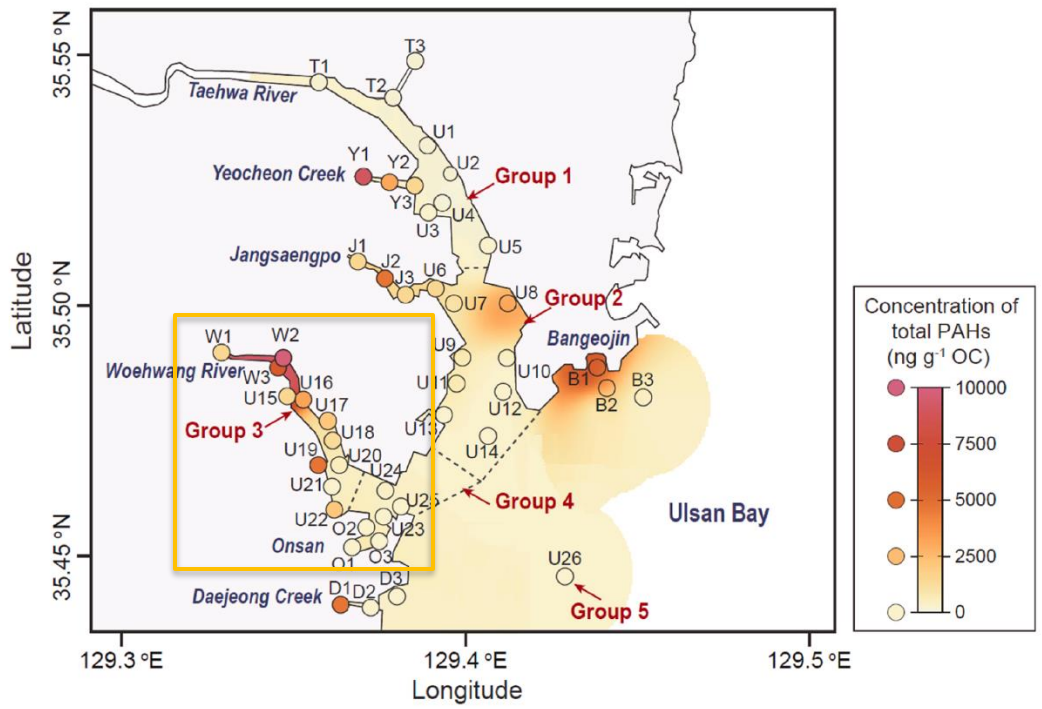
- *Equation (1):* SSC_v is converted from the SSC_{OBS}
- *Equation (2):* SSC_v and echo intensity from ADCP were fitted by the calibration coefficients (K_c and C)
- *Equation (3):* Derived K_c and C were used to convert echo intensity into SSC_{ADCP}

Potential data contamination

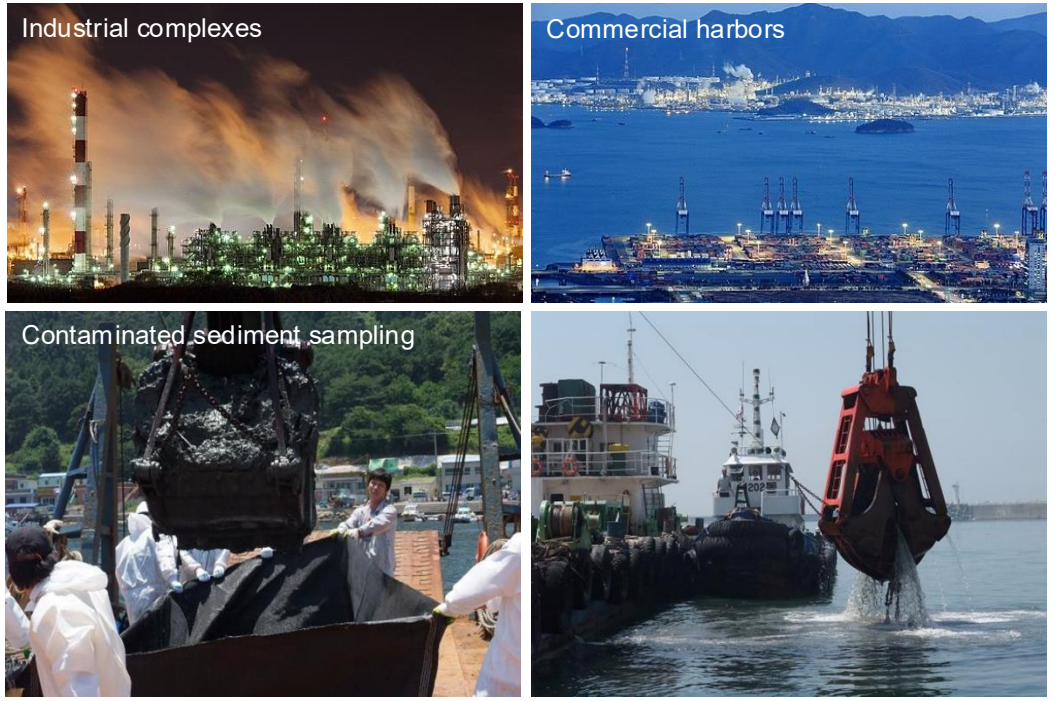


- Undesirable sudden increase in SSC_{ADCP} was observed: likely resulting from vessel activities at the adjacent harbor
- In this study, the overestimated data suspected of being certainly influenced by vessel activities were intentionally excluded from the analysis

Contaminants in bed sediments



Modified from Kim et al. (2023)



Images: Gettyimages/Ministry of Land, Transport and Maritime Affairs

- The study area is known that the **trace metal contamination in bed sediments is most serious** in Korean coastal areas
- Sediment transport patterns could provide valuable information to manage the contaminated bed sediments