April 30, 2025

Typhoon-induced sediment dynamics: Effects of extreme winds on resuspension and transport in Yeosu Bay, Korea

Su In Kim[1], Sun Min Choi[1,2], Seong Woon Jeong[1], Jae-Hun Park[1], Pyeong Joong Kim[2], Ho Kyung Ha[1,*]

NASA earth observatory

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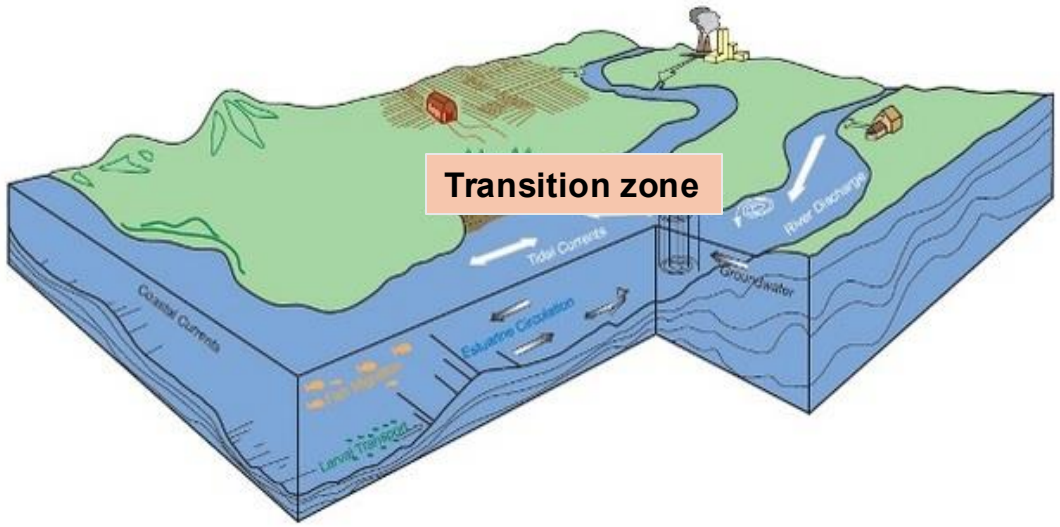
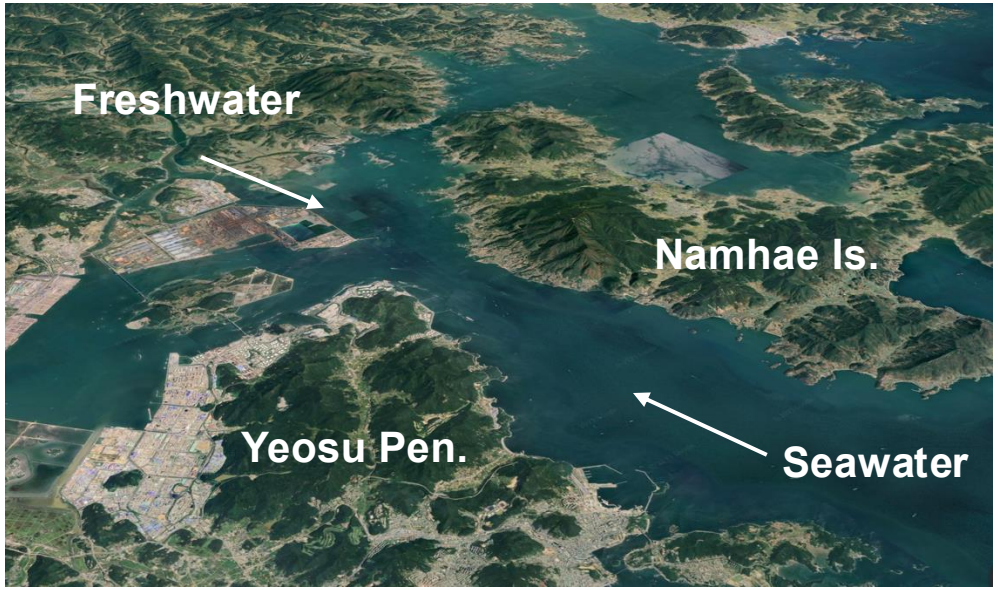
Coastal Ocean Observation Laboratory
INHA UNIVERSITY, KOREA

Definition of Bay

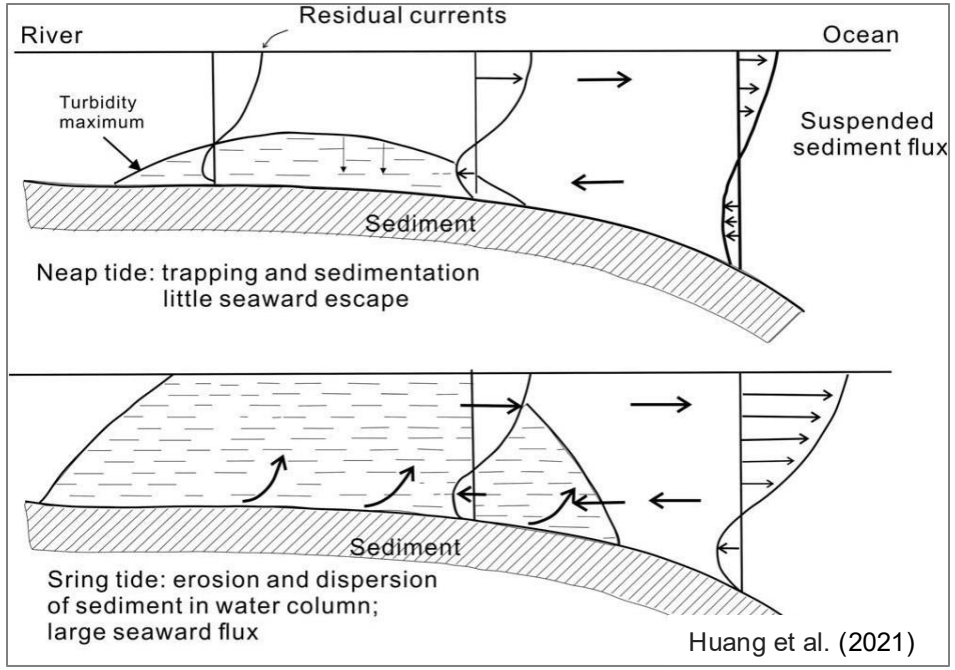


2013 Nature Education Modified from Geyer et al. (2000)

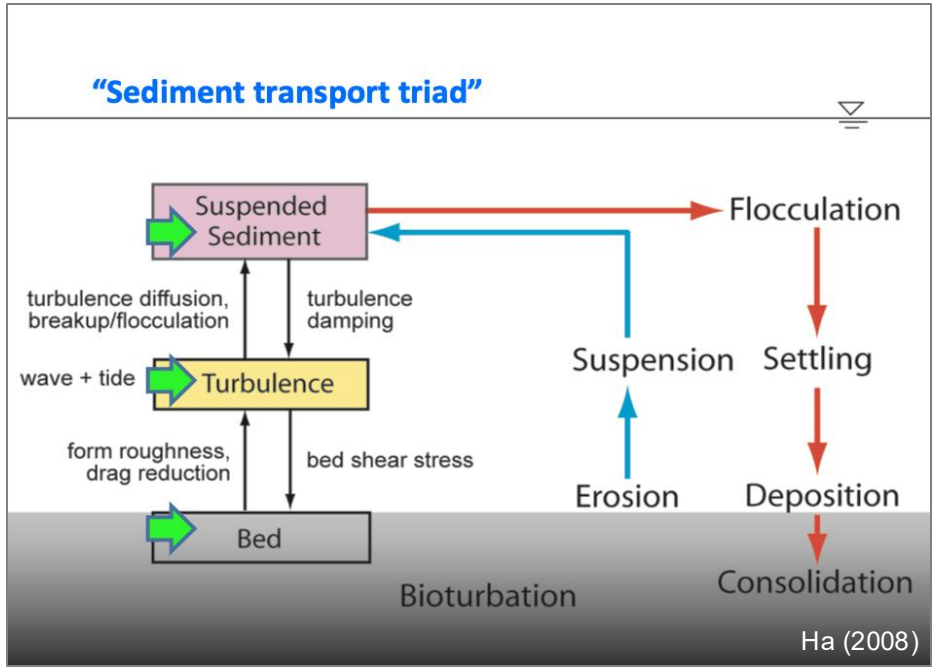


- **Bay** is a partially enclosed body of water that is connected to a larger body of water
- It is subject to marine (tides, waves, intrusion of saline water) and riverine (flows of freshwater and sediment) effects
- Mixing of freshwater and seawater creates a nutrient-rich **transition zone** that supports high productivity

Mechanisms driving sediment transport



Huang et al. (2021)



Ha (2008)

- **Tidal asymmetry** results from nonlinear tidal propagation, causing shorter flood or longer ebb periods (or vice versa)
- **Estuarine circulation** causes sediment transport to be landward in the bed and seaward in the surface
- **Stratification** is more pronounced during ebb due to convective overturning when saline water is carried over less den se water during flood

Issues in study area

광양만과 여수해만의 표층퇴적물에서 Nonylphenol의 오염에 관한 연구

조 현 서 · 김 용 욱* · 설 순 우 · Horiguchi Toshihiro**

여수대학교 해양시스템학부 · *한국해양오

(2004년 3월 11일 접수; 20

여수해만 주변해역 퇴적물의 물리적 및 음향학적 성질

김길영 · 성준영 · 김대철 · 김정창*

부산수산대학교 응용지질학과 · *부산수산대학교 실습선

광양만 및 여수해만 표층퇴적물의 지화학적 특성과 중금속 오염

현상민* · 이태희 · 최진성 · 최동림 · 우한준[1]

한국해양연구원 남해연구소

[1]한국해양연구원 지구환경연구본부

낭만의 '여수바다'…해양오염 위험 가장 높다

머니투데이 | 남형도 기자

머니투데이

여수해경, 기름·유해액체물질 저장시설 등 집중점검

광주 · 호남본부 김도형 기자 | 승인 2023.04.14 11:49 | 댓글 0

보다빠른뉴스 KOREA NEWS TONGSIN

대한 뉴스통신

여수 앞바다 정박지 기름 이적 작업 중 기름 유출

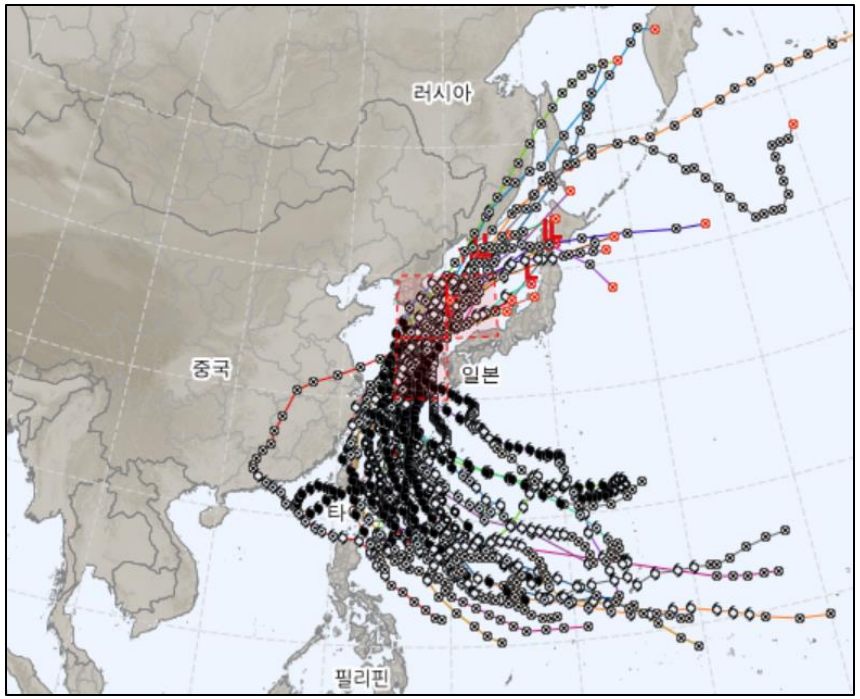
조승화 기자 | 입력 2022.11.03 10:42 | 댓글 0

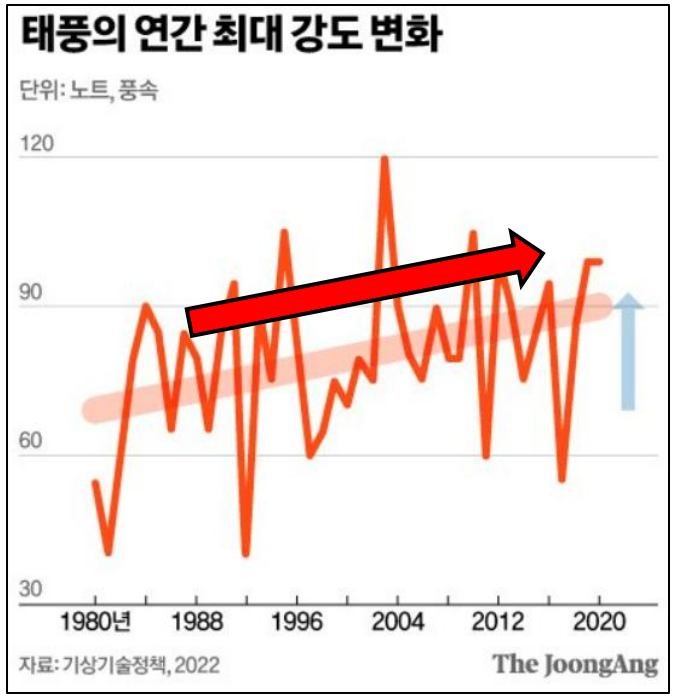
NBN 남도방송 Namdo Broadcasting Network

광양만권 환경오염 심각

- Typhoons can intensify sediment transport, affecting both ecosystems and pollutant dispersion.
- These bays already face deteriorating environmental conditions that require close monitoring.
- Imbalance in sediment dynamics can disrupt ecological and socioeconomic systems.
- Typhoon-driven sediment processes in this region need focused research.

Typhoon Patterns and Impacts on Korea





- The map (left) shows typhoon tracks affecting Korea since 1997 (KMA).
- Typhoons typically follow a parabolic path, heavily impacting the southeastern coast.
- The annual maximum typhoon intensity has increased from the 1980s to 2020.
- Korea is vulnerable to typhoons — continued research is essential.

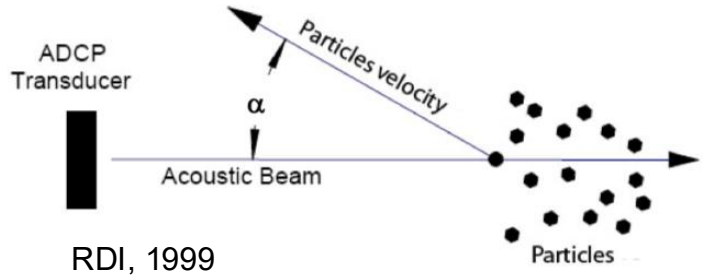
Suspended sediment concentration (SSC) from echo intensity

Calibration of acoustic backscatter was performed using ***"sonar equation"*** (Deines, 1999; Kim et al., 2004; Ha et al., 2011)

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

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

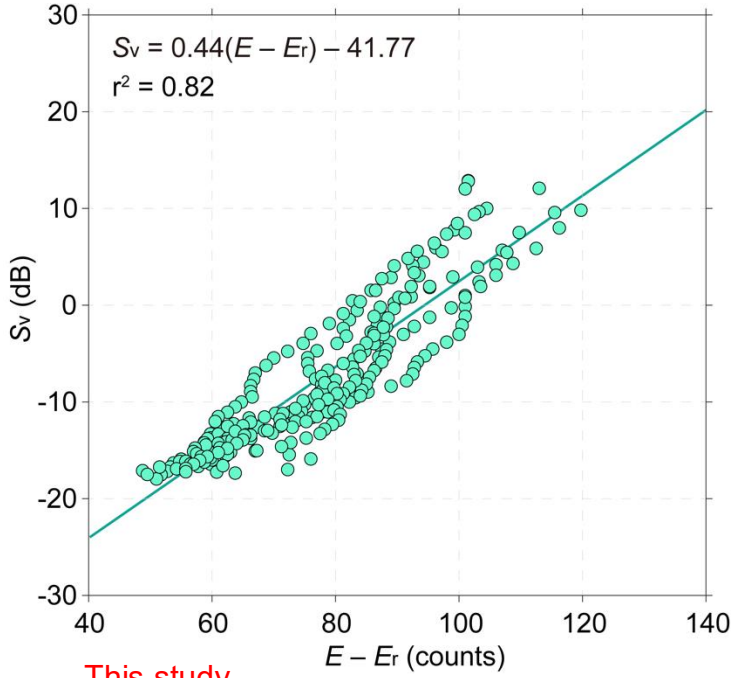
$$SSC_{ADCP} = 10 \cdot exp\left(\frac{C + 20 \cdot \log_{10} R + 2 \cdot \alpha \cdot R - L_{DBM} - P_{DBW} + K_c \cdot (E - E_r)}{10} \right) \quad (3)$$



RDI, 1999

SSC_{ADCP}: suspended sediment concentration measured by ADCP (mg l^{-1})
R: range along the beam (slant range) to the scatterers (m)
α_w: absorption coefficient of water (dB m^{-1})
L_{DBM}: $10 \cdot \log_{10}$(transmit pulse length) (m)
Kc and C: signal calibration coefficients

P_{DBW}: $10 \cdot \log_{10}$(transmit power) (W)
E: echo intensity
E_r: reference echo intensity (= 40 count)
SSC_{OBS}: SSC calculated by the OBS calibration

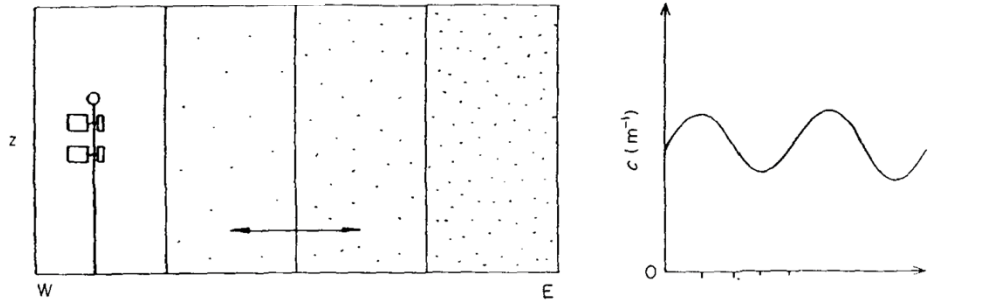


This study

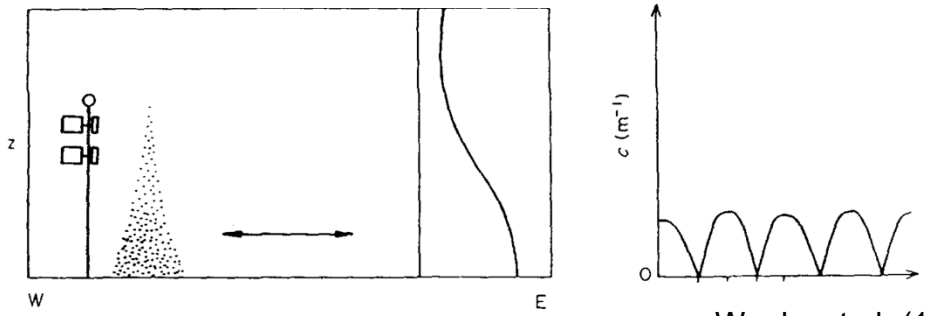
- Intensity of the sound that is backscattered off particles is related to suspended sediment concentration (SSC).
- SSC was derived from turbidity (NTU) using OBS calibration with *in-situ* filtered samples.
- ADCP echo intensity was converted to SSC using the sonar equation and calibration coefficients (K_c, C).

Controlling mechanisms for SSC variability

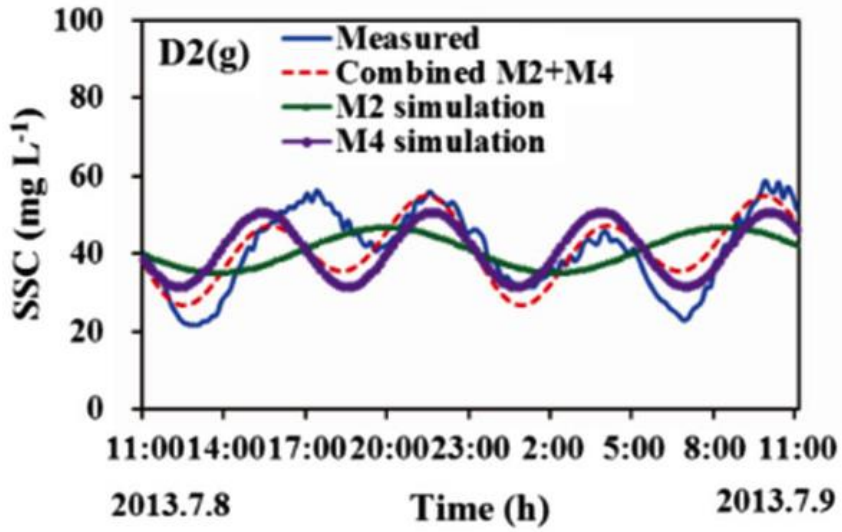
Horizontal gradient



Tidal resuspension of sediment



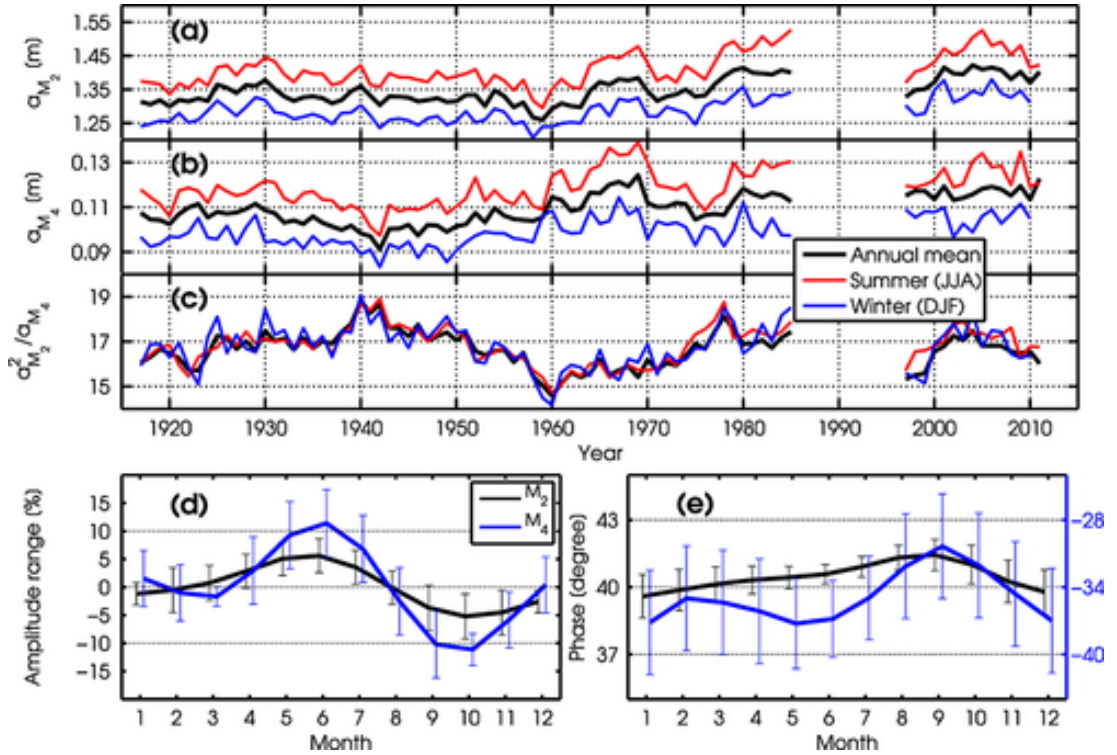
Weeks et al. (1993)



Yang et al. (2016)

- Theoretically, there are two potential sources for SSC variations: "local resuspension" and "horizontal advection"
- The semi-diurnal variation of SSC was due to advection by semi-diurnal tide imposing on SSC gradient, whereas quarter-diurnal variation in SSC was caused by local resuspension

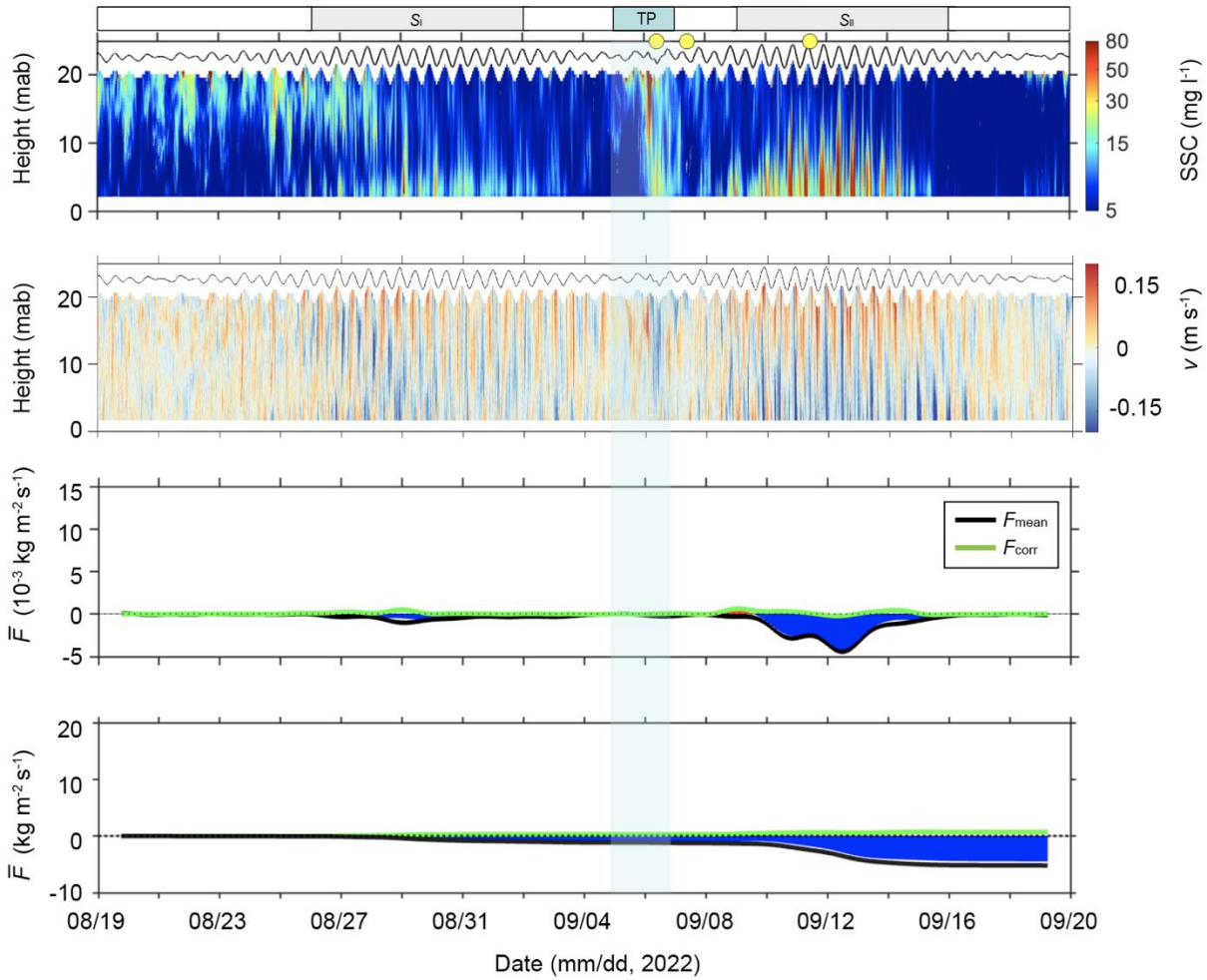
Seasonal variability of M2 and M4 tides in controlling sediment transport



Gräwe et al. (2014)

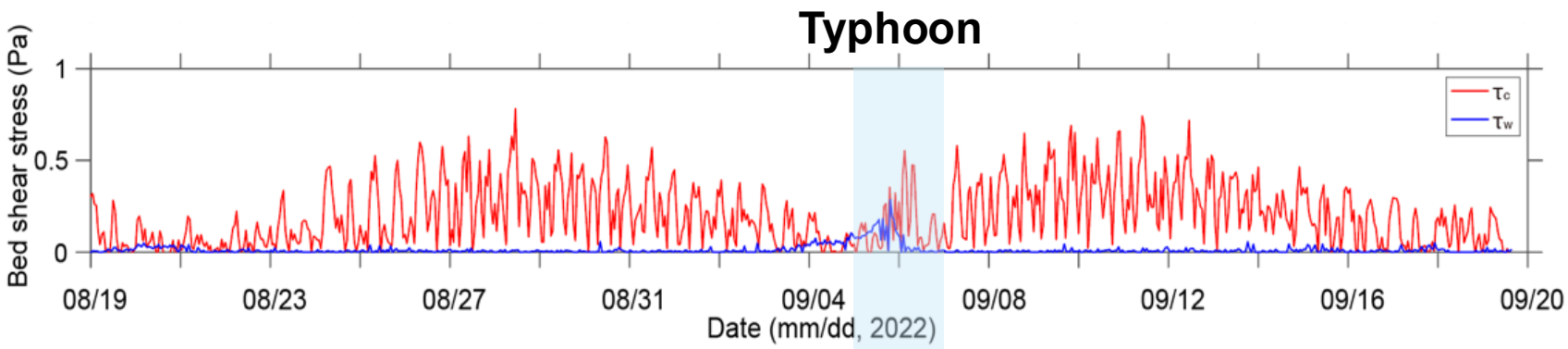
- The interaction of the M2 and M4 tides is one of the main drivers of the residual sediment transport
- Annual phase variations of M2 and M4 are in the range of 3–15°
- Residual sediment transport can vary by 10–50%

Across-channel sediment fluxes



- The across-channel sediment flux near the bed also increased during the S_{II}, with higher sediment flux corresponding to the intensification of westward-directed *v*.
- Over the entire observation period, the cumulative across-channel sediment fluxes near the bed exhibited displacements of 4.4 kg m s^{-1} westward.

◆ *Bed shear stress*



◆ *Temperature & salinity*