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Effect of coastal ocean on suspended particle dynamics in a southern California urban estuary during the dry season

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Why Particle Size is Important?

- Urban **estuaries** frequently have elevated **sediment pollutant** levels due to runoff from the surrounding areas
- Before developing a **management** strategy, it is necessary to characterize particle behavior:
  - If particles are relatively **immobile**, **dredging** and removal would be an appropriate management approach
  - Conversely, **mobile** contaminated sediments would be best managed through **source control**

Goals

- Use a novel technology (laser scatterometer LISST-100X) to continually monitor **size spectra** of total suspended material (TSM) in the **Ballona Creek Estuary** in southern California

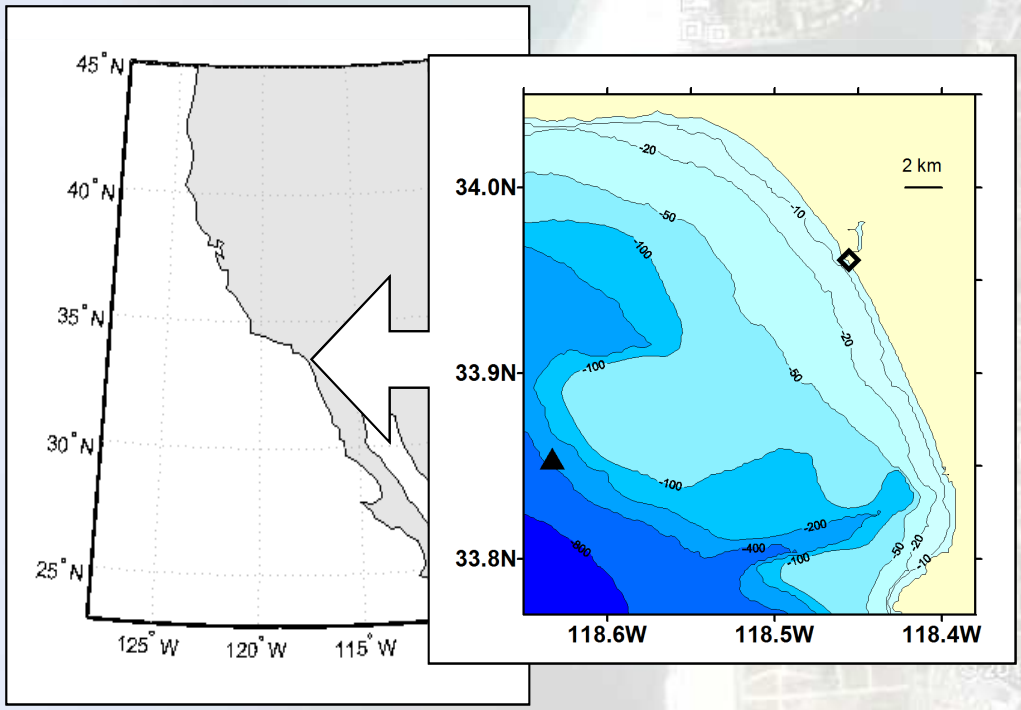
- Correct observations for **biofouling** using novel **detrending** method

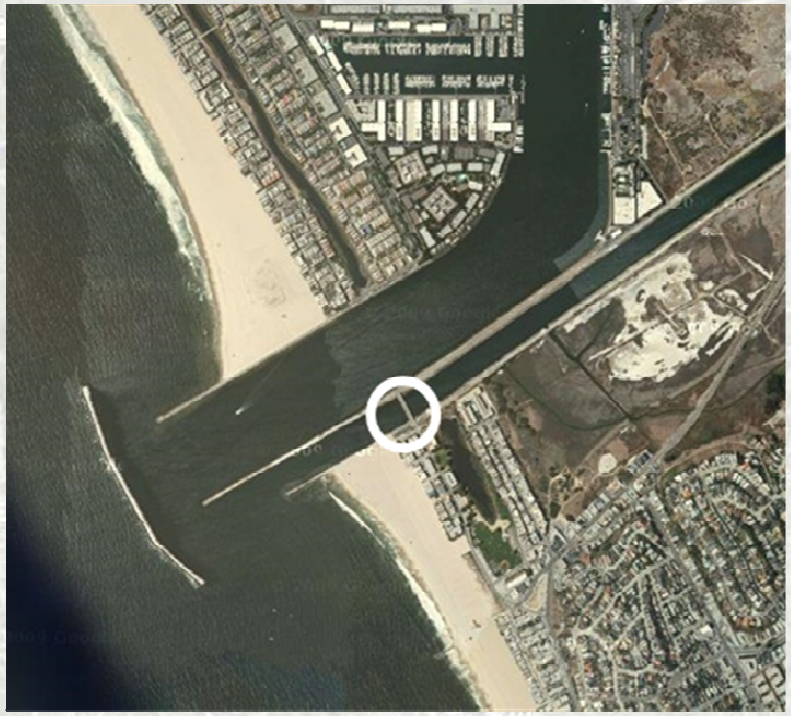
- Characterize those particle dynamics using **multivariate statistics** (PCA) and wavelet transform

- Analyze **physical** (tides) and **biological** (phytoplankton) effects of **coastal ocean** on suspended particle dynamics

Ballona Creek Estuary (BCE)

- Ballona Creek is a heavily urbanized estuary in southern California
- 100 m wide and 3 m deep at the seaward boundary
- Watershed drains 335 km^2
- Dry weather flows <1 $m^3\ s^{-1}$



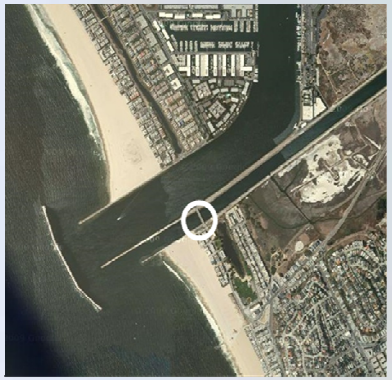


Data Collection: TSM

LISST-100X (Laser In-Situ Scattering and Transmissometry, Sequoia Scientific, Inc.)

http://www.sequoiasci.com

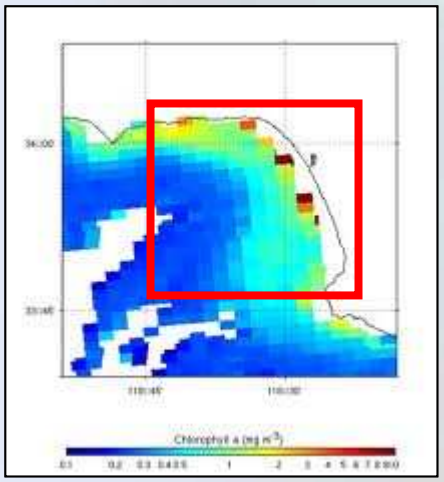
The LISST uses laser refractometry to measure volumetric concentrations (in microliters per liter) for particles in 32 size classes based on log-spaced diameters ranging from 2.72 to 462 µm.



- Deployed near the mouth of the BCE from May 29 to August 27, 2008
- 10 cm above the channel bottom sediment surface
- A HOBO U20-001-01 pressure transducer was co-deployed with the LISST to measure pressure and temperature

Data Collection: Waves and Phytoplankton Biomass

Wave conditions and water **temperature** in Santa Monica Bay (SMB) were characterized by a stationary buoy 46221 (33°51'16" N; 118°37'59" W; water depth: 365 m) 20 km southwest of the BCE mouth

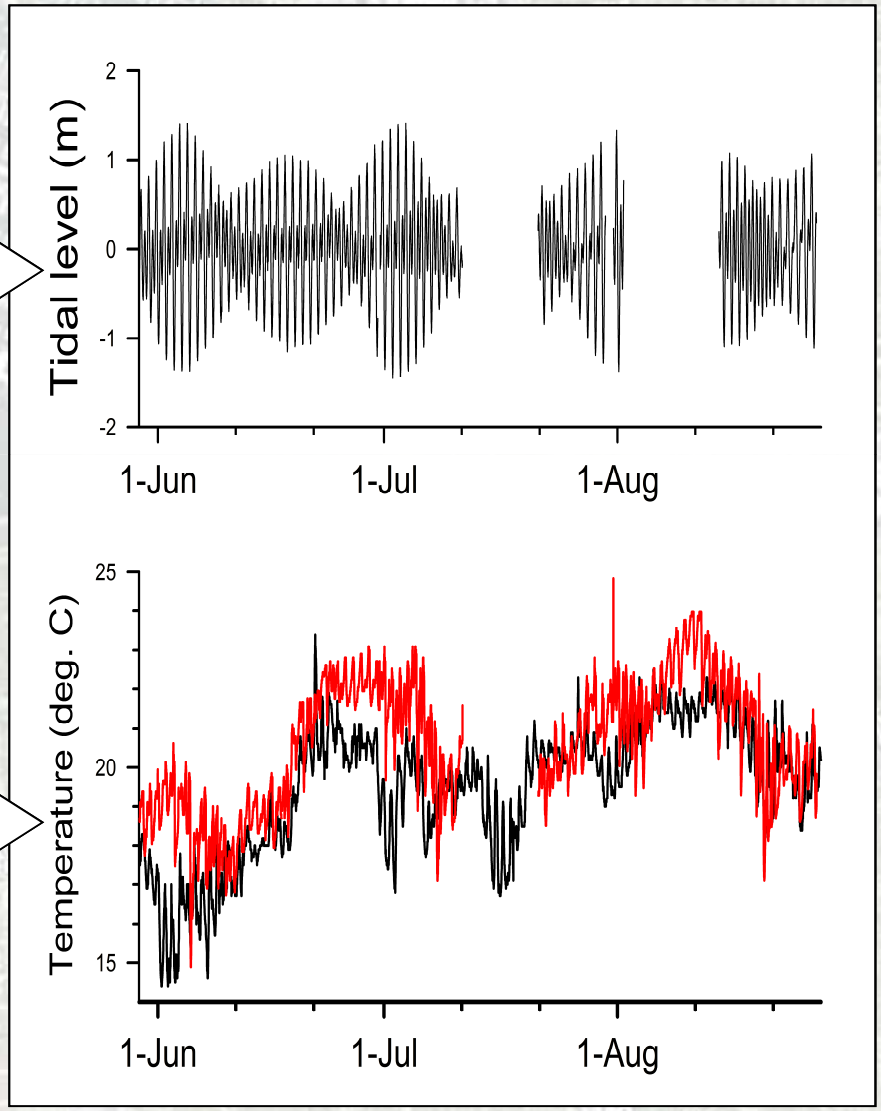


Phytoplankton biomass assessments in the SMB were derived from the **ocean color** satellite measurements collected by MODIS-Aqua.

Strong Tidal Ventilation in BCE

High Tidal Range in BCE

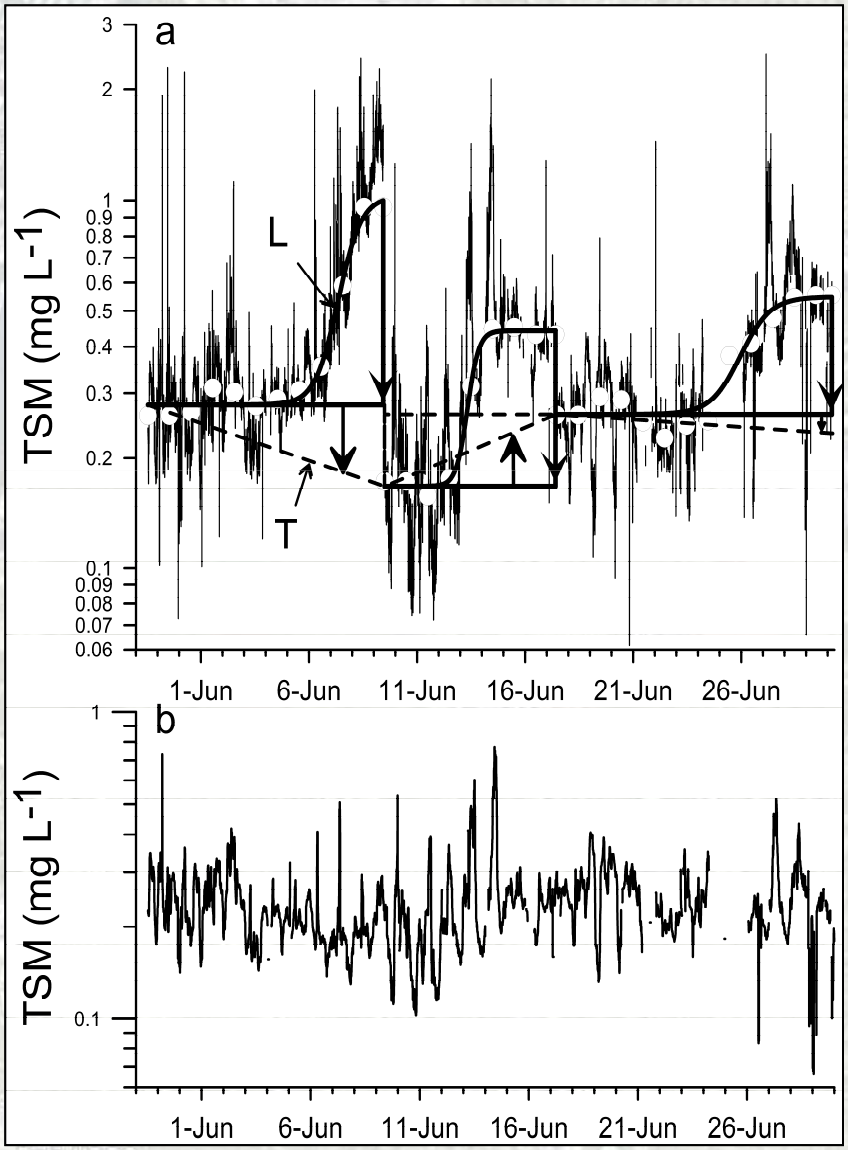
High correlation between water temperature in BCE and SMB



TSM Data Detrending

Biofouling - the growth of algae and other living materials changing detector sensitivity

- TSM measurement error was approximated by a **logistic curve** and subtracted
- **Linear trend** (positive or negative) resulting from differences in TSM concentrations and detector sensitivity after successive maintenance events was calculated and subtracted

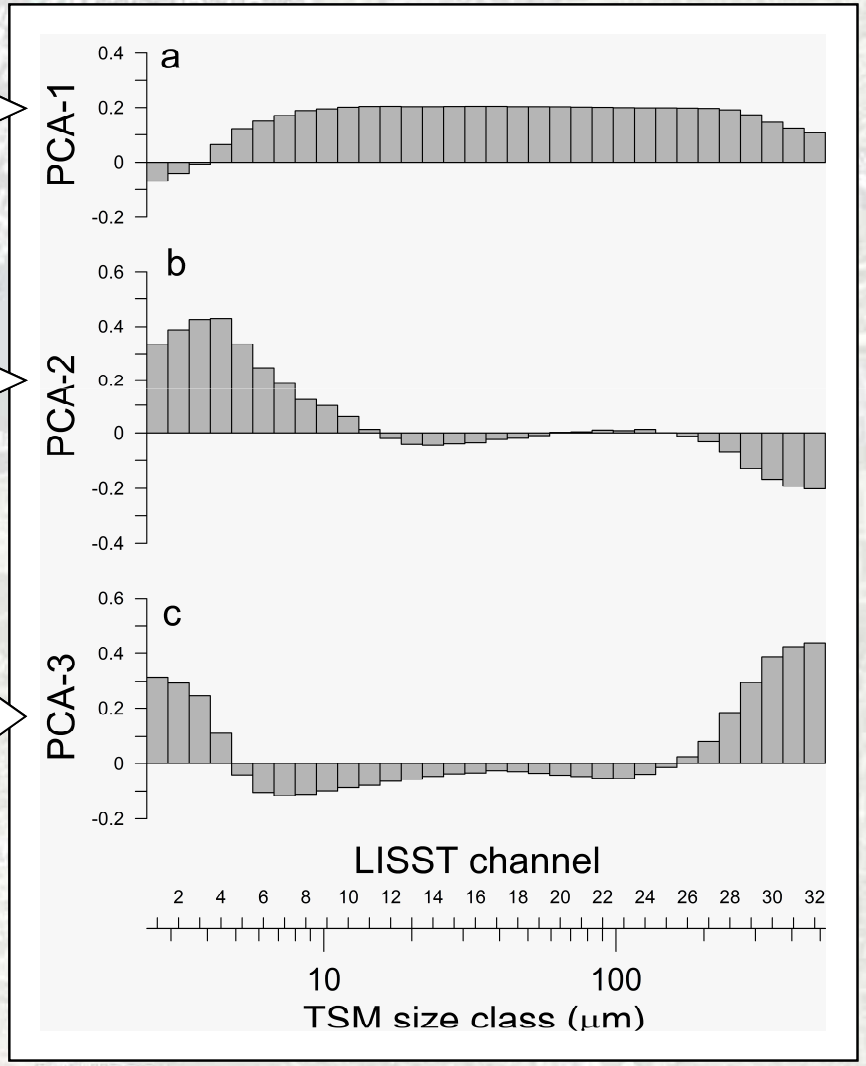


Principal Component Analysis of 32 Particle Size Classes

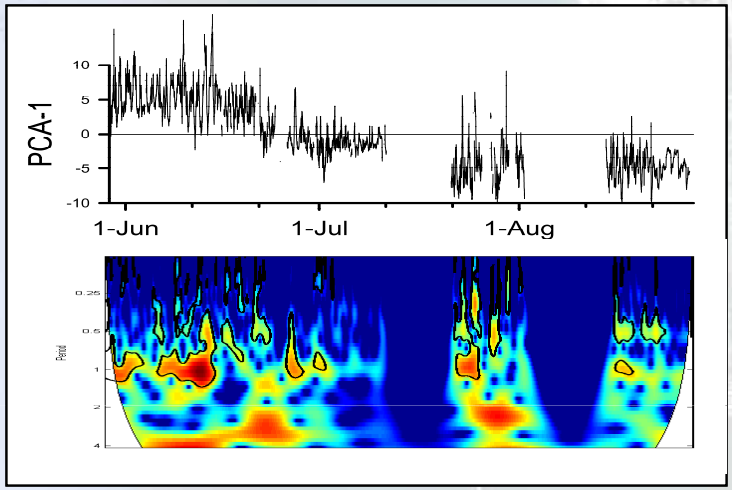
First mode (71%)
– mid-size particles

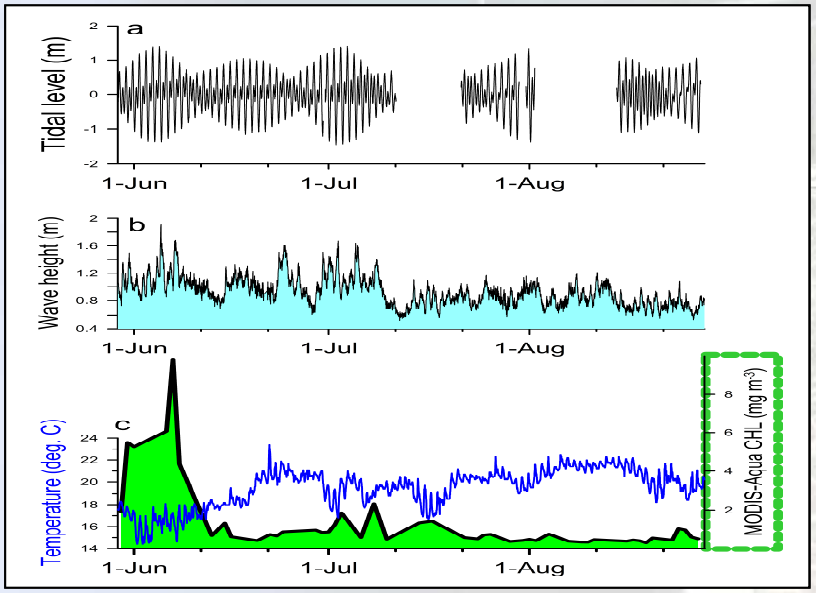
Second mode (14%)
– small-size particles

Third mode (7%)
– mostly large-size particles



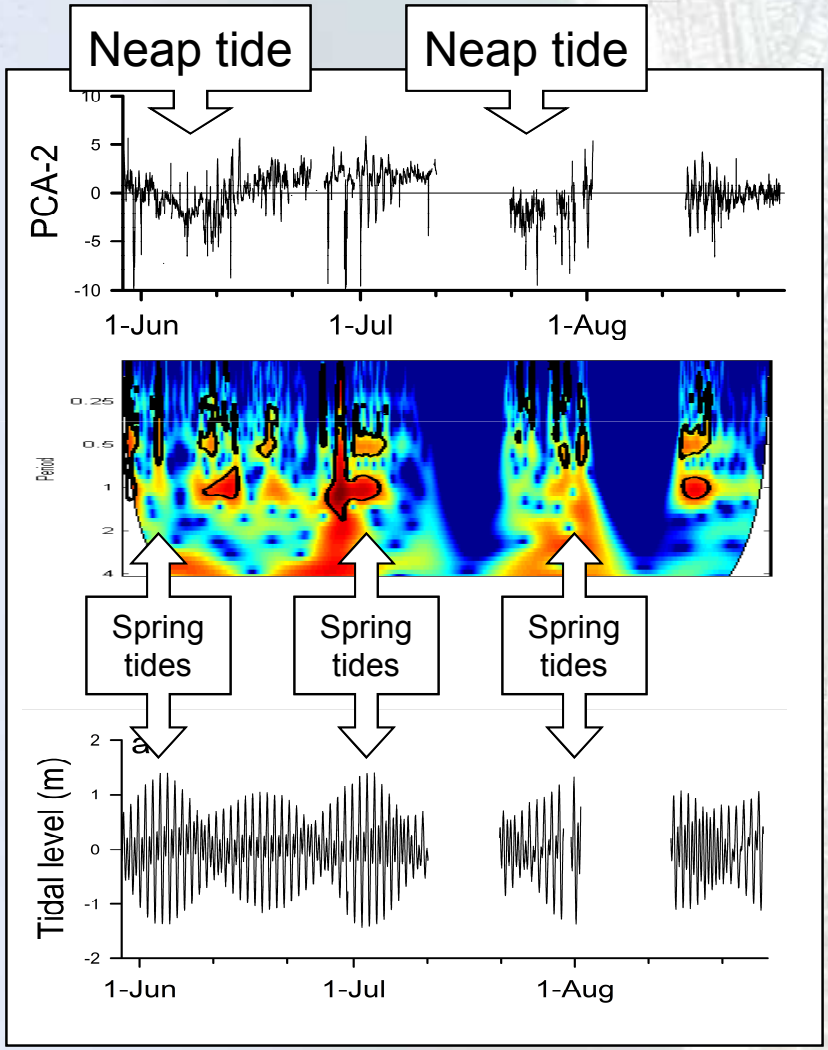
Mid-size Particles (PCA-1) – Ocean Phytoplankton





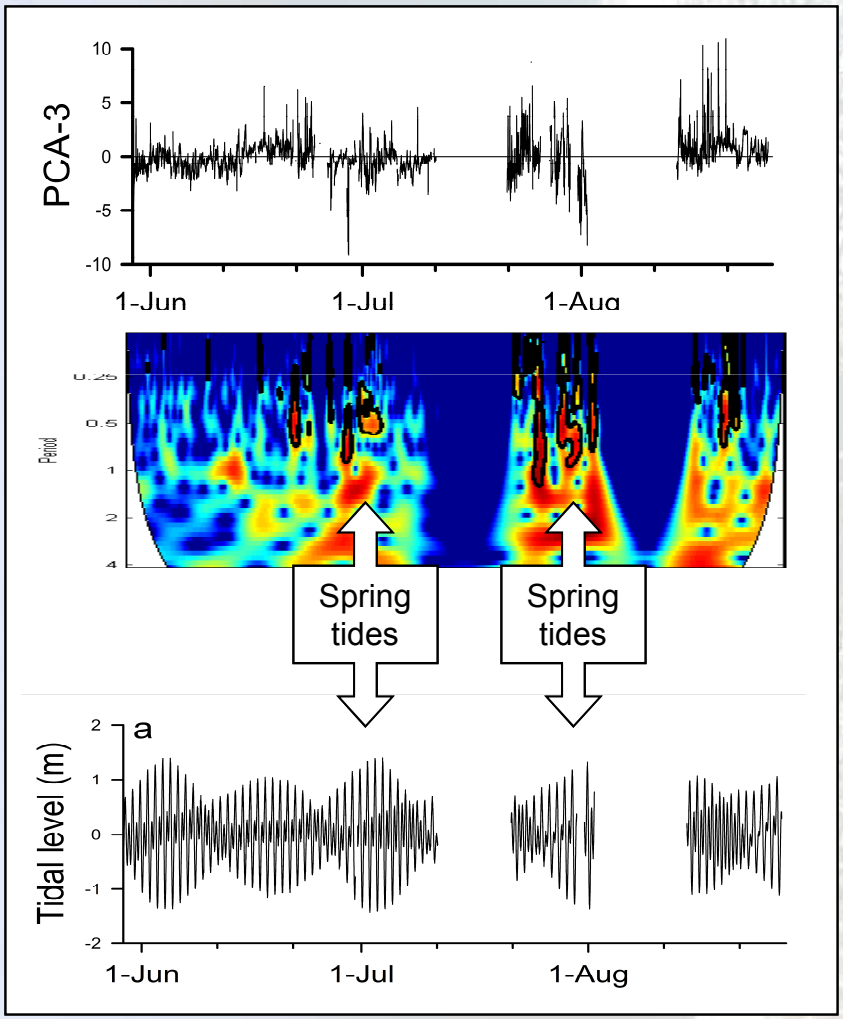
- Decreasing trend similar to CHL in Santa Monica Bay
- No correlation with tides and waves
- Strong diurnal variability (photosynthesis and diel vertical migration)
- Weak semi-diurnal (tidal) variability

Small-size Particles (PCA-2) - Sediments Suspended by Tides



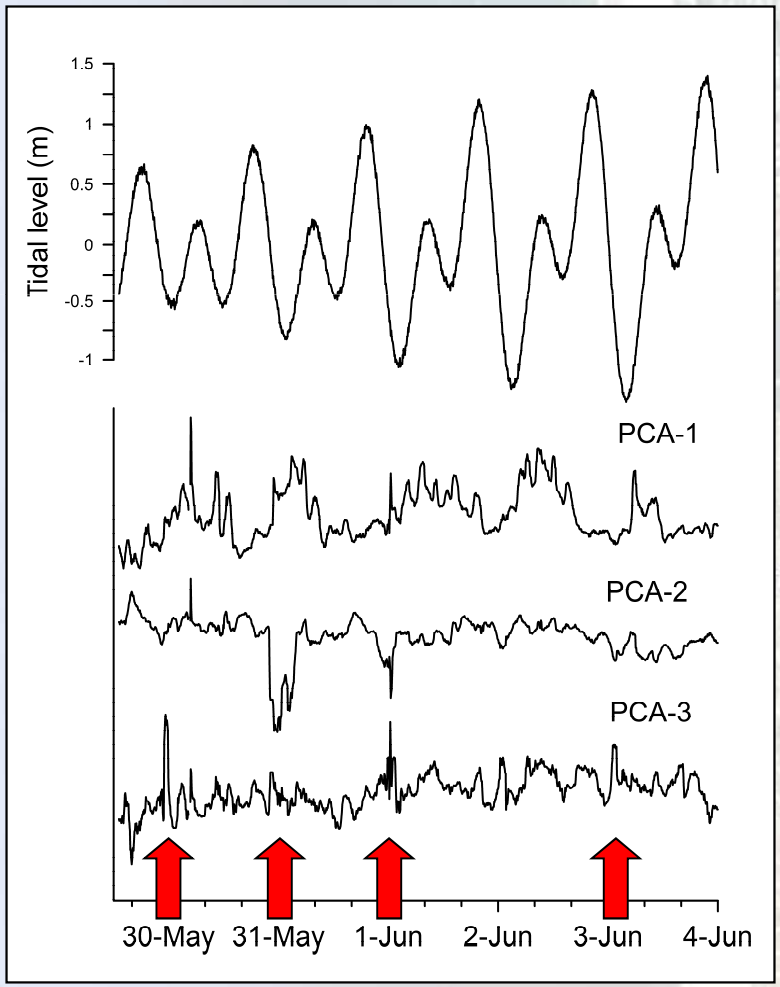
- Strong diurnal and semi-diurnal (tidal) variability
- Maximum variability during spring tides
- Minima during neap tides
- No correlation with CHL and waves

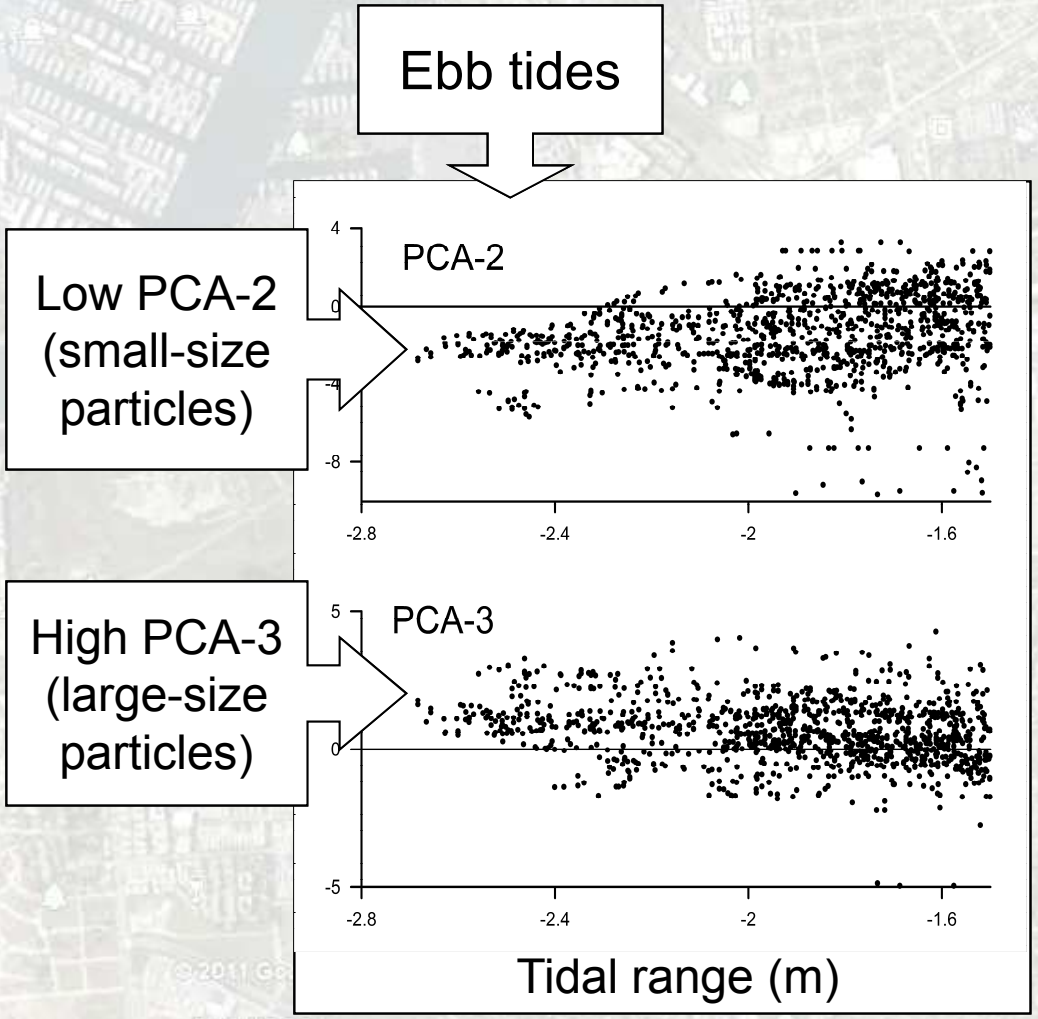
Large-size Particles (PCA-3) - Associated with Tidal Flows



- Strong semi-diurnal (tidal) variability
- Maximum variability during spring tides
- No correlation with CHL and waves

Ebb Tides Transport Down-estuary Water with High Concentration of Large-size and Low Concentration of Small-size Particles





Conclusions

- Most TCM variability in BCE was associated with biological particles (offshore phytoplankton)
- Correlation with offshore phytoplankton indicates that nutrient flux from the sediments in the BCE has minimal impact on phytoplankton biomass
- Because TSM levels in the BCE did not show an increase during flood tides, the majority of sediments in the BCE are likely from terrestrial sources
- Lowest small particle concentrations were associated with neap tides, supposedly when tidal flats become dry and no source of fine particles remain
- Larger particles were correlated with ebb tidal extremes and net export of sediments

Thank you!