Transport of Microplastics in San Francisco Bay and Coastal Waters

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5 GYRES
Microplastics in San Francisco Bay and Coastal Waters

• 2 year investigation on microplastic and nanoplastic pollutions
  • Loading in pathways to the Bay
  • Transport and fate in SF Bay and adjacent National Marine Sanctuaries

• Funded by
  • Gordon & Betty Moore Foundation
  • Grants and in-kind support from:
    SF Bay Regional Monitoring Program, Patagonia, EBMUD and SF Baykeeper
San Francisco Bay and adjacent National Marine Sanctuaries

- 40% of California drains into Bay
- Tidal – 2 m range, 0.5-1 m/s current
- Shallow – average 5 m
- Wet season / dry season
- CA Coastal Current / upwelling
Microplastics Conceptual Model
Modeling

Goals

• Link pathways (stormwater, wastewater) to ambient plastics

• Fill gaps in the regional MP budget

• Highlight additional areas to sample, point to missing sources or sinks
Hydrodynamic Model
San Francisco Bay

Delft Flexible Mesh
- Seamless transition from 10 m to 2km
- 3D
- Wind
- Tidal elevation
- Stormwater
- California Delta inflow
- Wastewater/refinery discharges
Hydrodynamics Validation

Sample of salinity validation

Cruise 2013-04-23

- Observed (USGS)
- Model
Modeling Microplastics

• As a scalar
  • Scales to many diffuse sources
  • Fewer numerical issues
  • Trade-offs with tracking source identity

• As particles
  • Natural representation
  • Resolve trajectories
  • Age of particles is unambiguous

• Wide range of terminal velocities
  • Sinking 10mm/s
  • Neutral
  • Rising 10mm/s

No deposition yet!
Wet Weather Distributions

Wastewater

- Buoyancy + circulation ➞ strong gradients
- Large difference in export to coastal ocean
Wet Weather Distributions

Stormwater

- Greater magnitude (in wet season)
- Similarity at scales > 20 km controlled by buoyancy, circulation
- Differences at scales of 1s – 10s km controlled by source location
Wet vs Dry Conditions

Buoyant tracers

- Stormwater: strongly seasonal
- Wastewater: roughly constant in time
- Estuarine circulation in wet weather
- Modulates coastal exchange
Extending to the Coastal Ocean

- Capture transport from SF Bay to adjacent Marine Sanctuaries

- Linking small-scale estuarine dynamics to shelf dynamics
Coupling with the Coastal Ocean

Challenging!

• Model platforms typically target a particular range of scales

• Coupling between models often introduces transport or stability problems

• Approach under development:
  • Delft Flexible Mesh
  • Borrow coastal grid from existing regional ocean model (CA-ROMS)
  • Water level, salinity, temperature from global model (HYCOM)
  • Barotropic tides from Oregon Tidal Predictions.
Work-in-Progress
Coastal Hydrodynamics

Salinity

Temperature
Summary

• Distributions strongly controlled by water-column behavior

• Sinking tracers have a confined range, least dilution (even w/o deposition)

• Neutral tracers mix quickest

• Buoyant tracers travel farthest

• Complex Bay geometry, complex coastal dynamics = a challenge