

Sensor network technology in support of aquatic microbiology

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Challenges of Sensing in Aquatic Environments

Water Does Not Stand Still!

- Spatial and temporal variation create challenges to sensing and monitoring for microorganisms in aquatic environments
- Need for distributed systems, with various, scalable sensing capabilities

Why study aquatic microorganisms?

- Main primary producers
 - Implications for food webs, global climate change
- Coastal Harmful Algal Blooms (HAB's)
 - May release toxins to the environment, kill fish
 - Affect human and marine animal health
 - Economic and social impacts
 - Annual US losses ~ \$50 million

Factors controlling HAB's still largely unknown

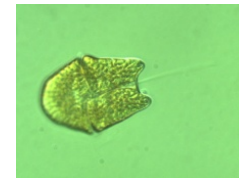
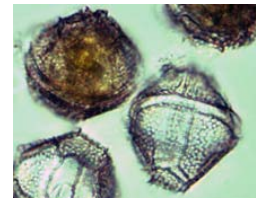
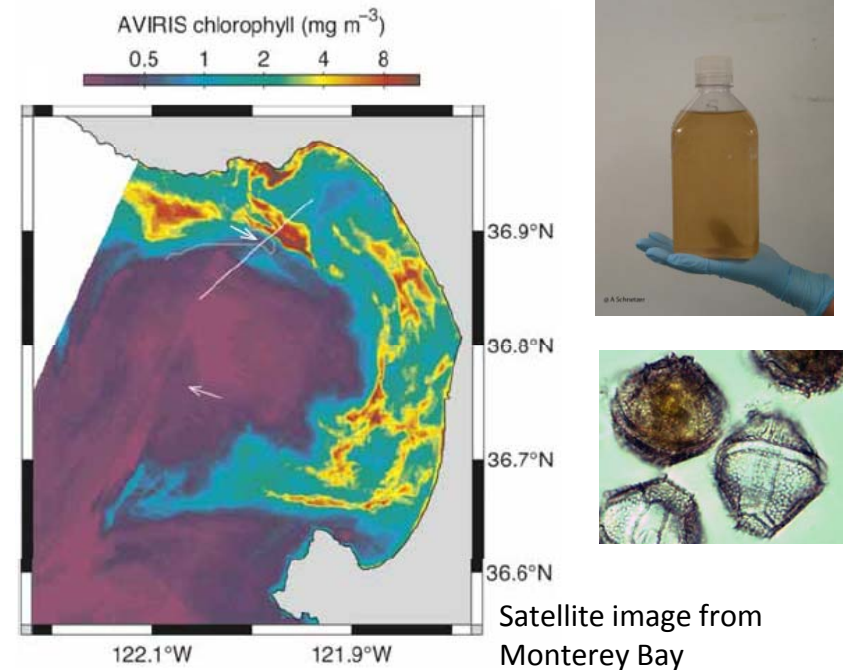


Photo by Miriam Godfrey

Networked Aquatic Microbial Observing System NAMOS Coastal Marine Research



King Harbor, Redondo Beach

- Site of red tides followed by fish kills in June, Sept 2005
- Shallow, semi-enclosed harbor
 - Large tidal range (1.5m, 5m total depth)
- High level of recreational use
- Diverse phytoplankton community
 - Many bloom-forming species
 - Several potentially toxic species



Dead fish against seawall in King Harbor



NAMOS Approach

Multiple modes of sensing

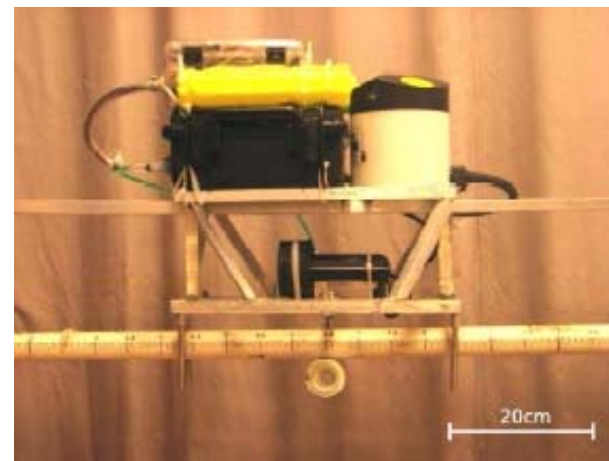


Multi-parameter sondes hung from docks in 3 locations in King Harbor, Redondo Beach



Vertically profiling QBoat can navigate to many parts of harbor to collect data

Dock-based winch system obtains vertical profiles of many basic parameters



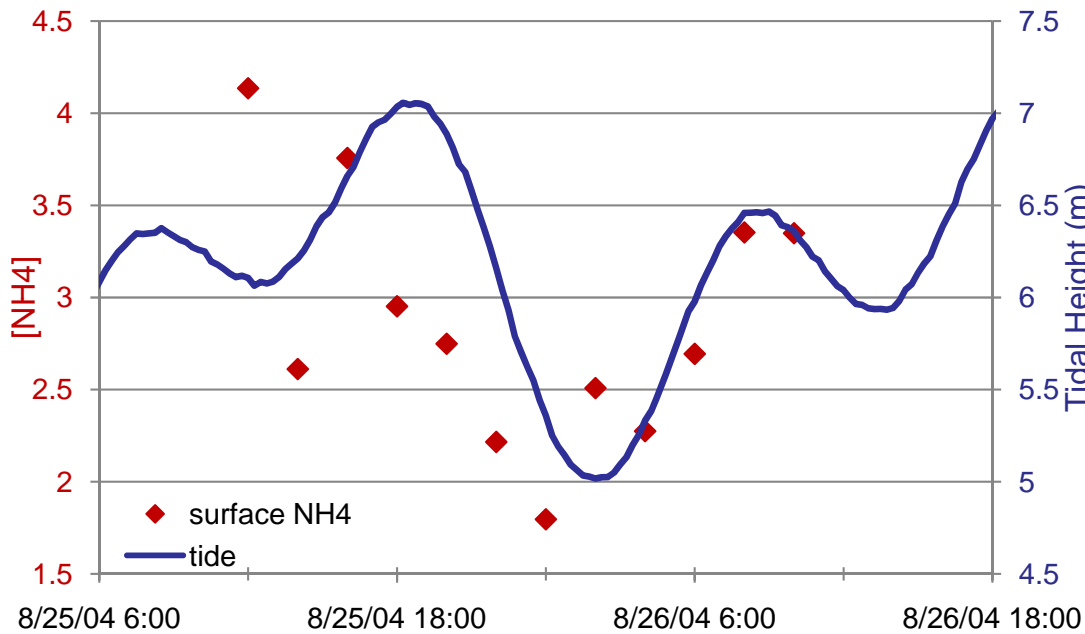
Robotic Benthic Sampler carries scientific payload, obtains upward-looking data along an underwater transect

Hypothesis-driven field studies rely on NAMOS system

- 2007 field work in King Harbor suggested a relationship between tidal cycle and nutrient availability in surface waters
- Coordinated NAMOS approach (+ a bunch of people!) allows for an intensive and comprehensive investigation of this phenomenon and its potential effects that would not have otherwise been possible



Tidal forcing of nutrients and phytoplankton population in King Harbor



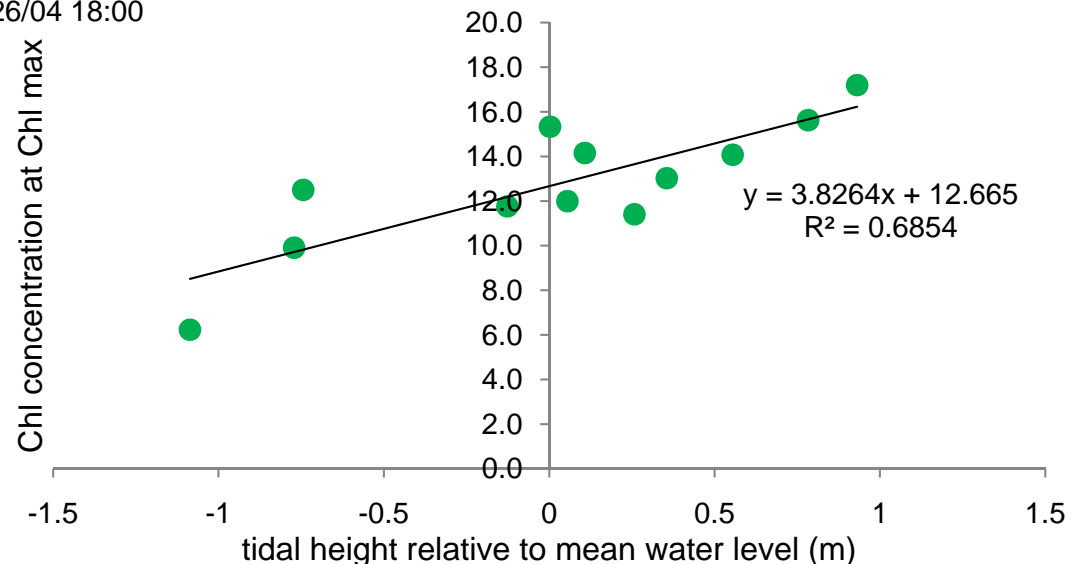
Data from 2-week study and 2 24-h cycles suggest relationship between tidal cycle and surface nutrient concentrations (NH_4^+)

- Require tidal data (ADCP), nutrient samples

Also an apparent relationship between tidal cycle and the amount of chlorophyll at subsurface maximum

- Require ADCP data, chlorophyll values from water samples, vertical sensor profiles

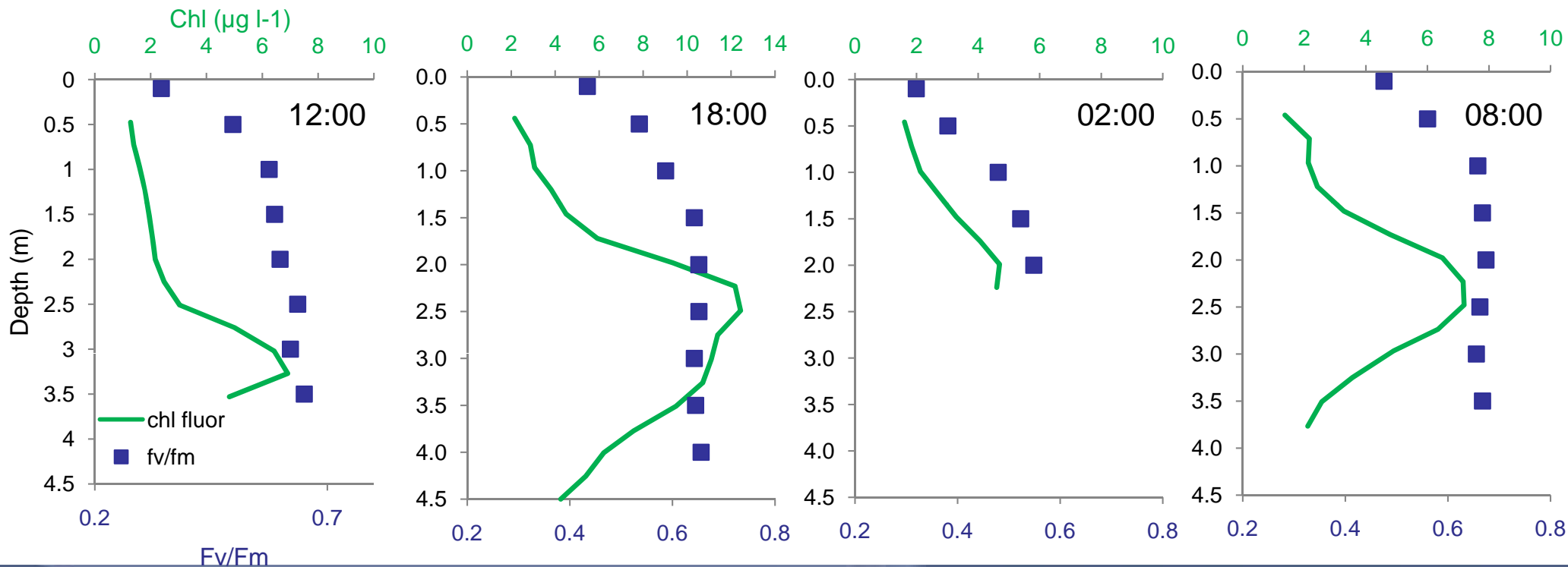
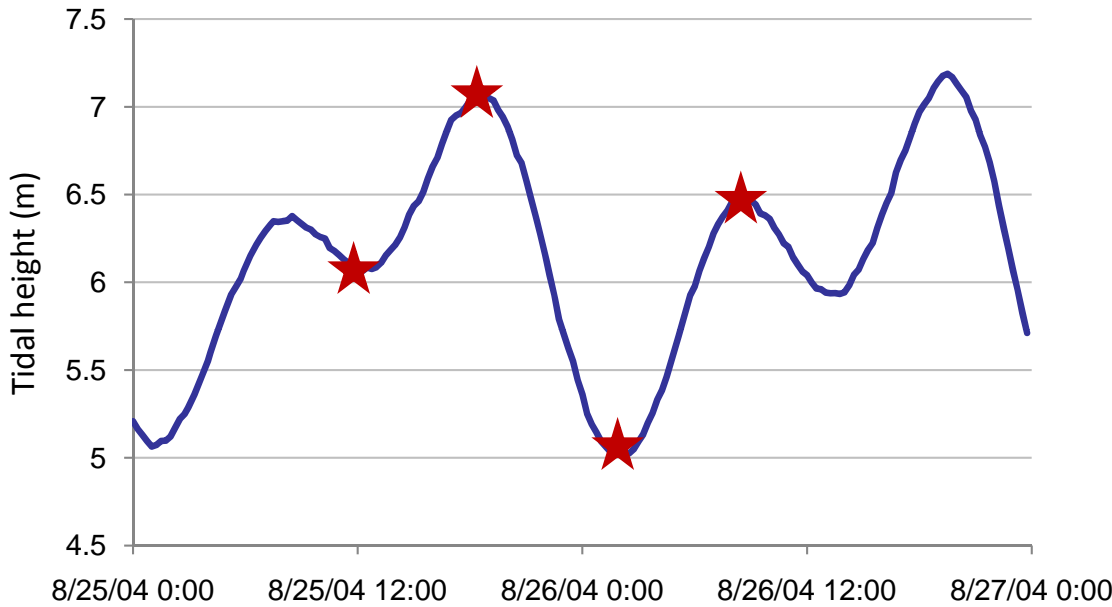
diel 1 rel tide v. chl max



A developing story...

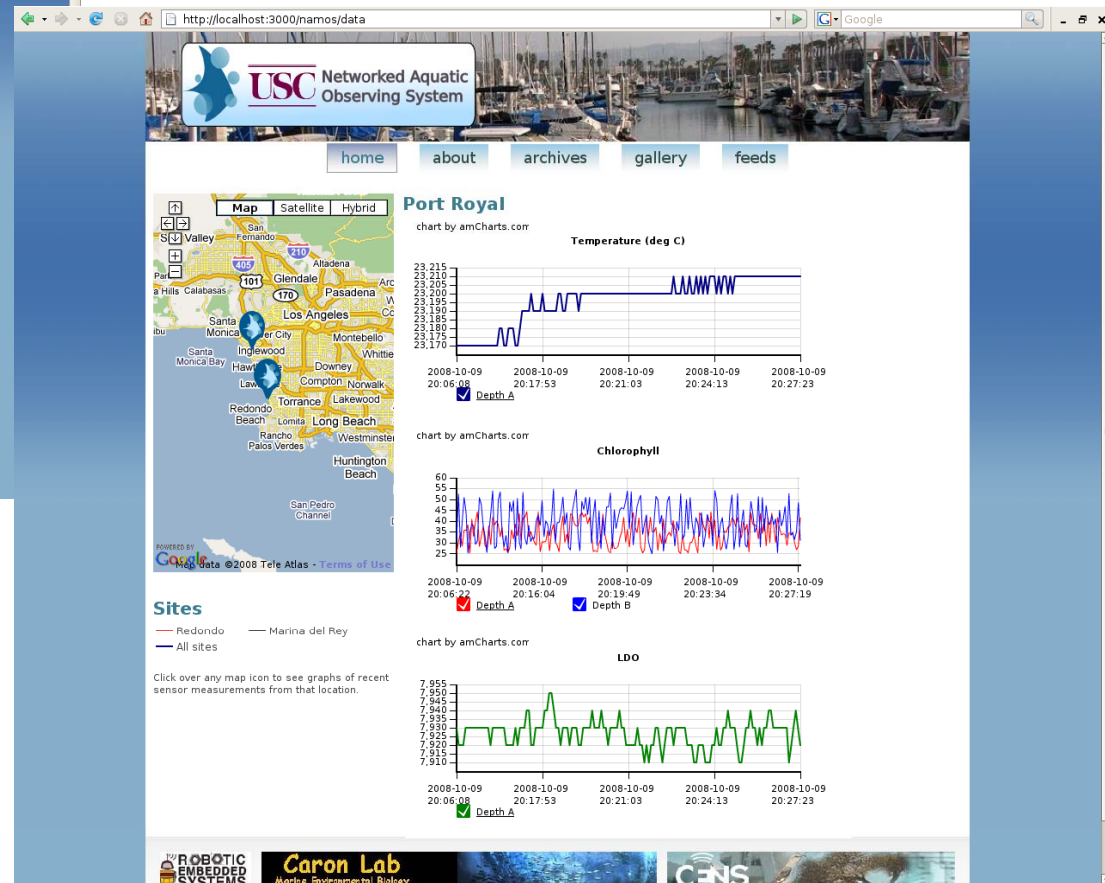
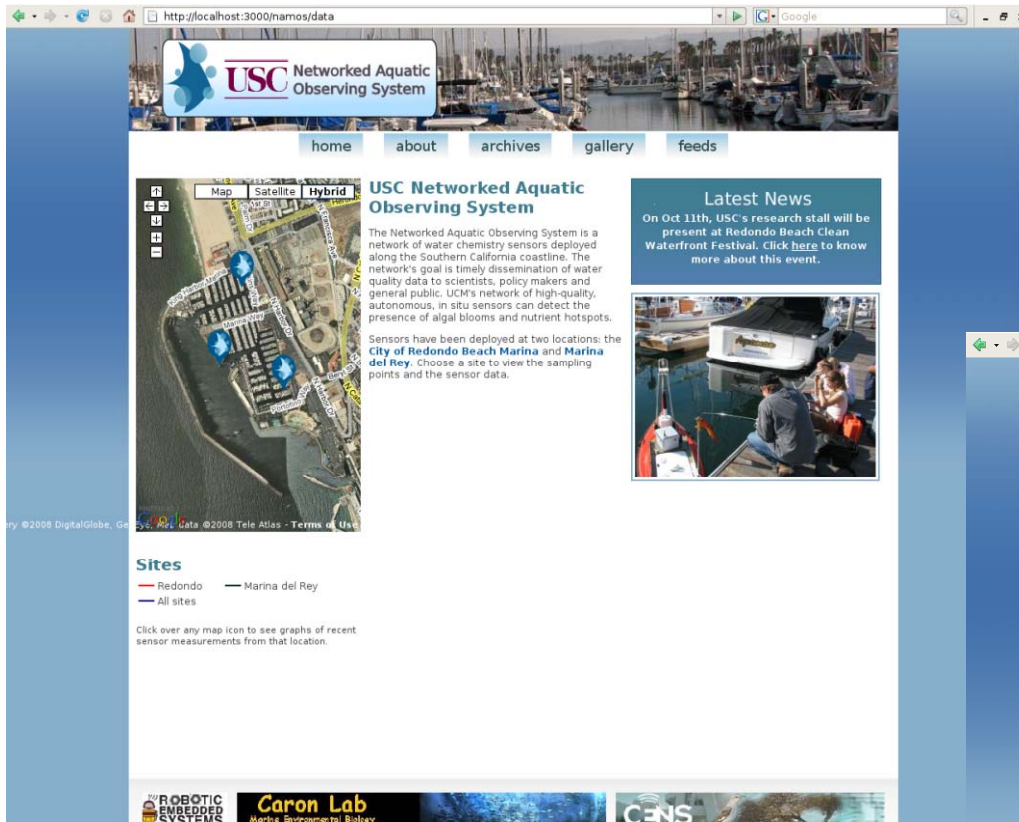
Changes in chlorophyll distribution, photosynthetic yield (Fv/Fm) over tidal cycle.

- Purely physical?
 - Probably not; chl changes only at 'deep max'
- Or potentially a response to short-term nutrient influxes?



Real-time data coming online

Help city officials keep tabs on harbor health, anticipate red tide events as they occur



<http://robotics.usc.edu:3000/namos/data>

Trends and data available to the public; query-able database for more in-depth analyses.

2008 - Expansion to Marina del Rey



- One of the largest small-boat harbors on the west coast
- Potential for water quality issues, given land-based inputs from Ballona Creek
- 2 sites proposed - challenges for NAMOS system on larger scale

Challenges of Sensing in Aquatic Environments

Water Does Not Stand Still!

Aquatic microorganisms have highly variable compositions and distributions.

Factors controlling HAB's still largely unknown, but with ENS technology we can start addressing the multiplicity and variability in the system.

****We still need biologically-relevant sensing abilities, to target species and/or toxins**

Acknowledgements

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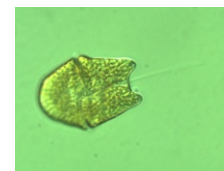
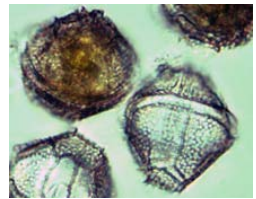
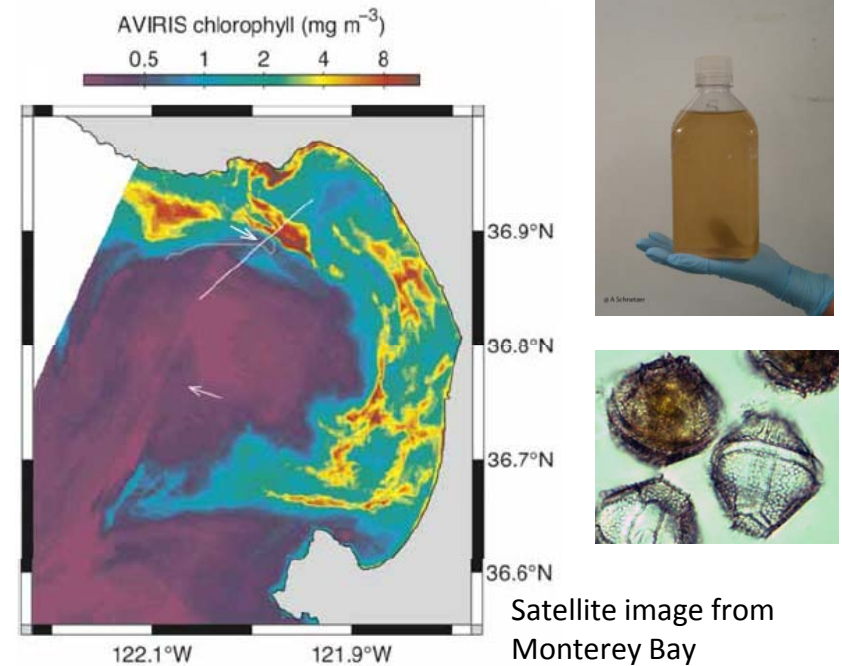


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