RMP
REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN SAN FRANCISCO BAY
sfei.org/rmp

The Virtual Bay

Modeling Nutrients & Transport In San Francisco Bay

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Why Model?
Role of Models in Decision-making

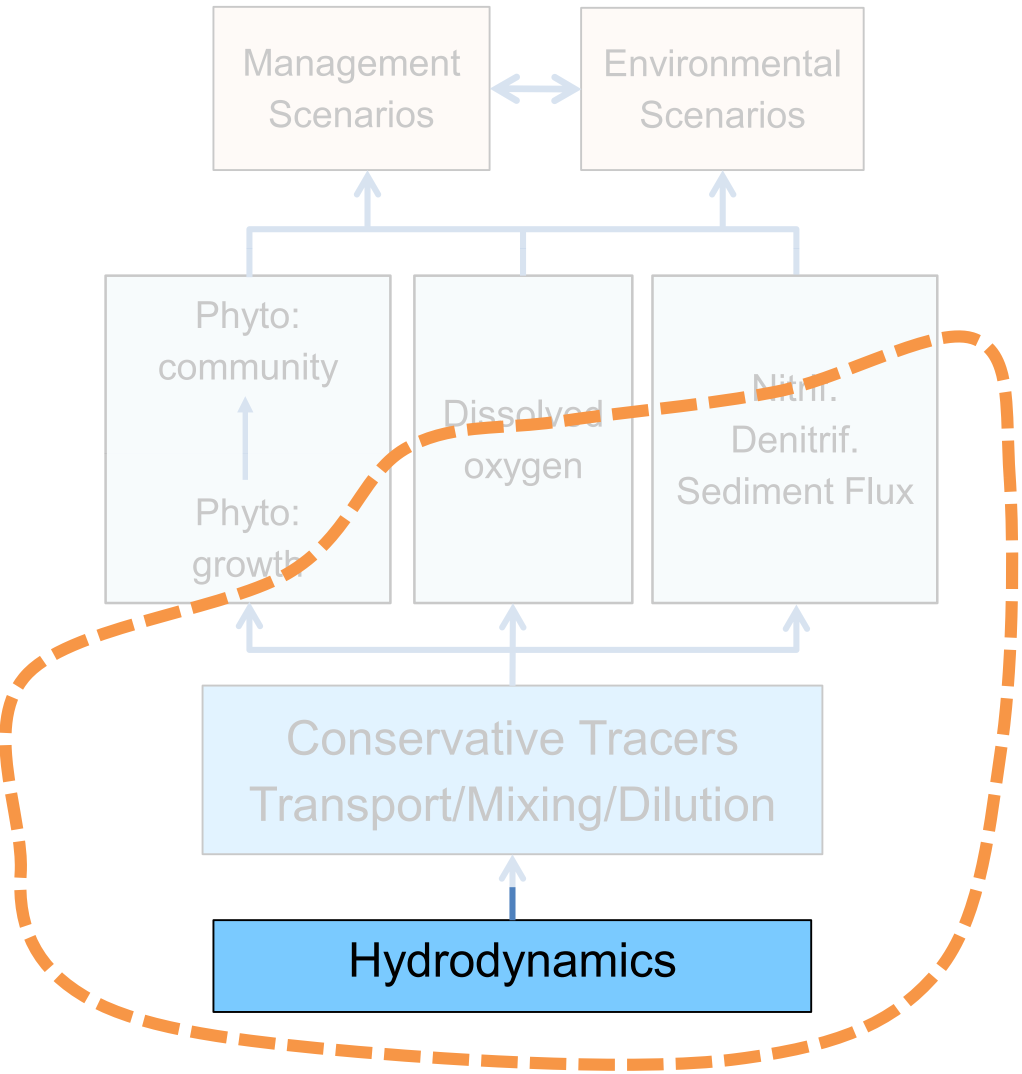
Models as tools that synthesize our collective knowledge of…

biogeochemical processes,

physical processes,

and the **observed state** of the system.

Coupled Hydrodynamic and Water Quality Modeling



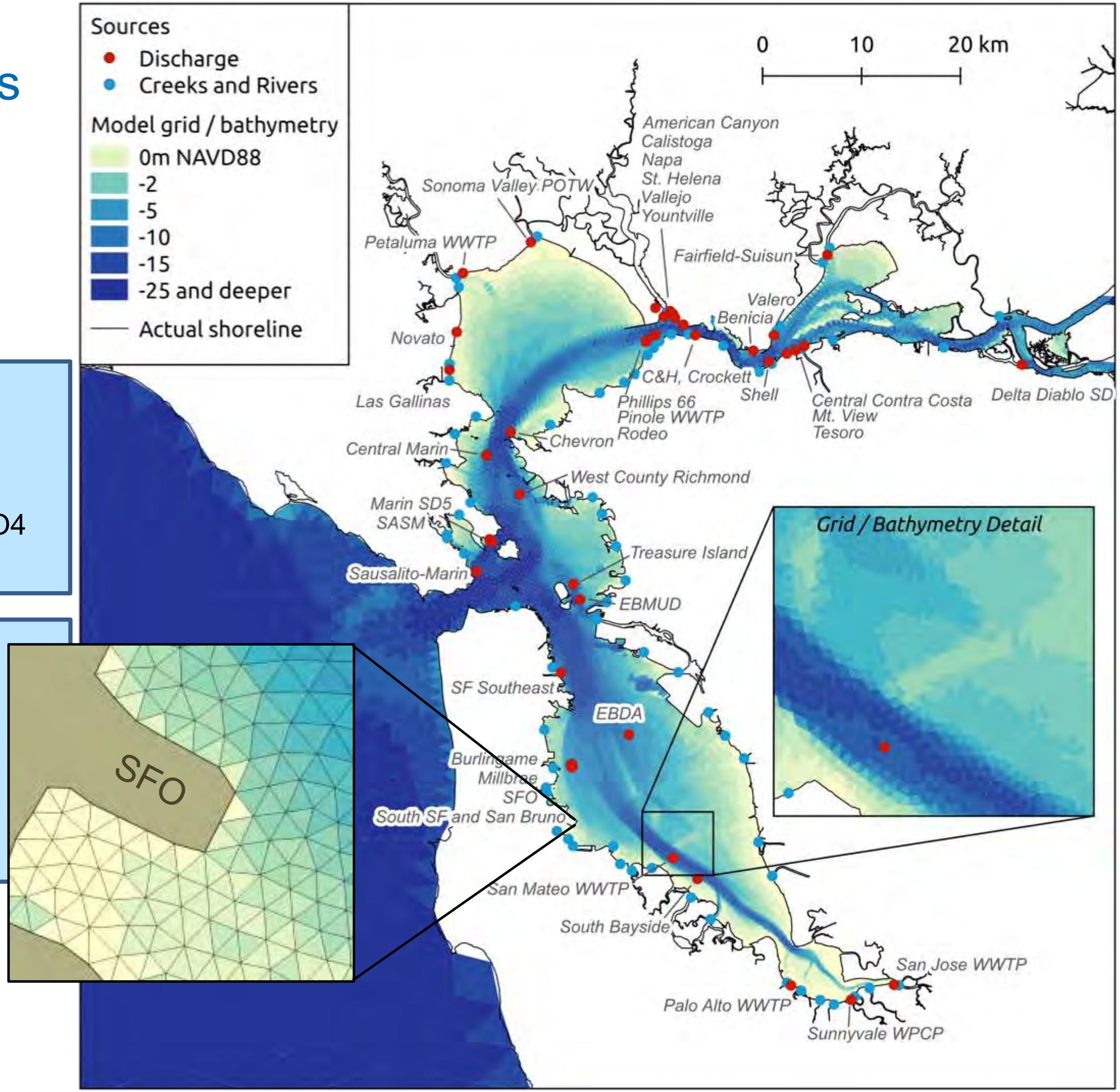
Roughly where we are today

Hydrodynamics

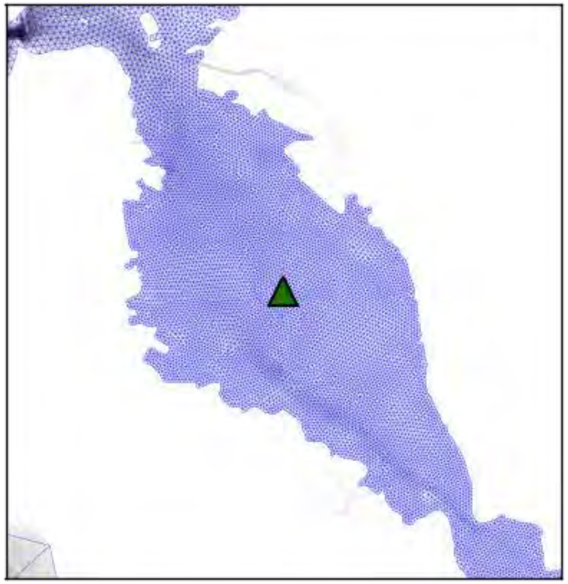
WY2013
36 POTWs
5 refineries
73 rivers & creeks
Est. flows, NO3, NH4, PO4
Wind, tides, evaporation

SUNTANS Domain

31 z-layers, (0.5m+)
25k 2D cells
200k 3D cells
70x real-time on 1 core
4km to 200m resolution

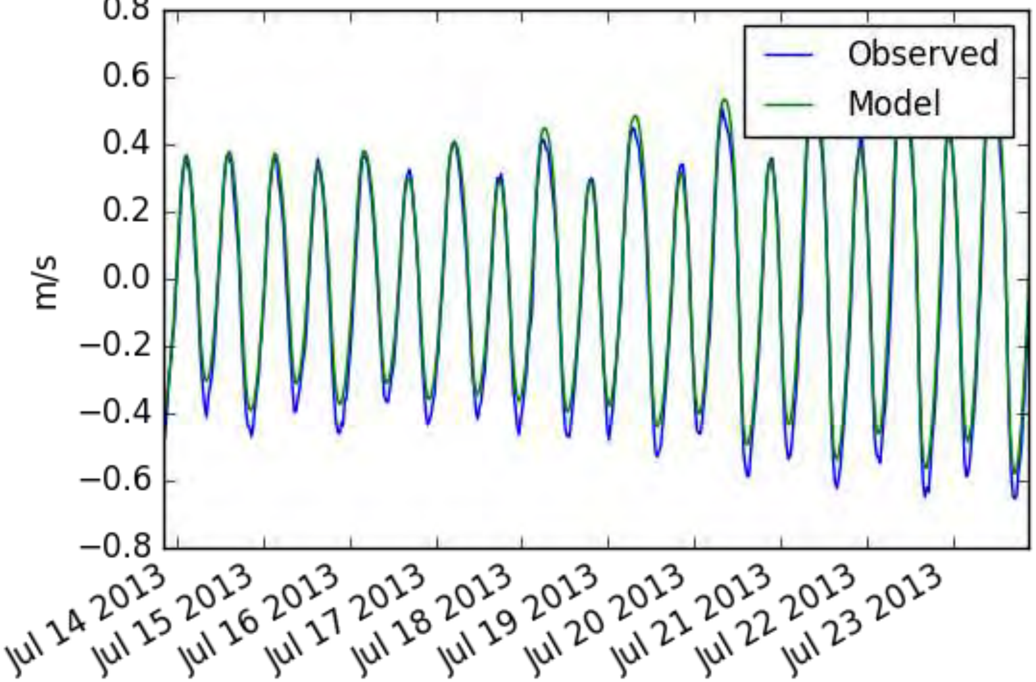


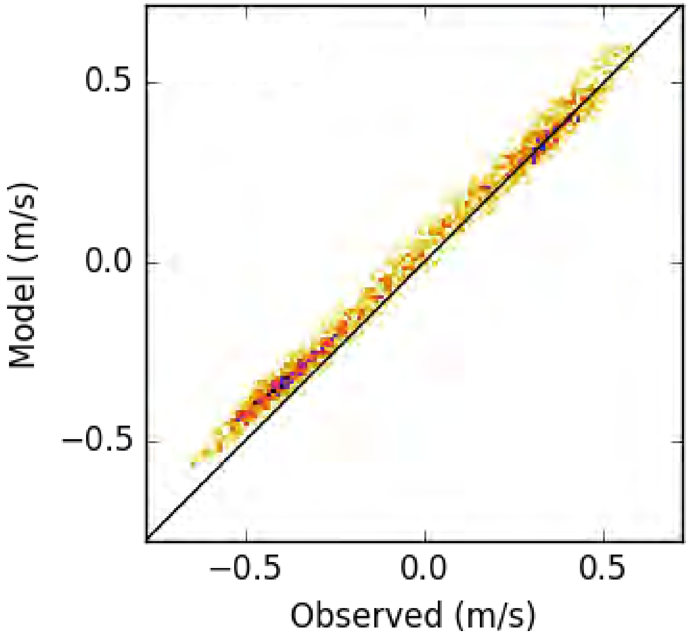
Test of Hydrodynamics: Velocity



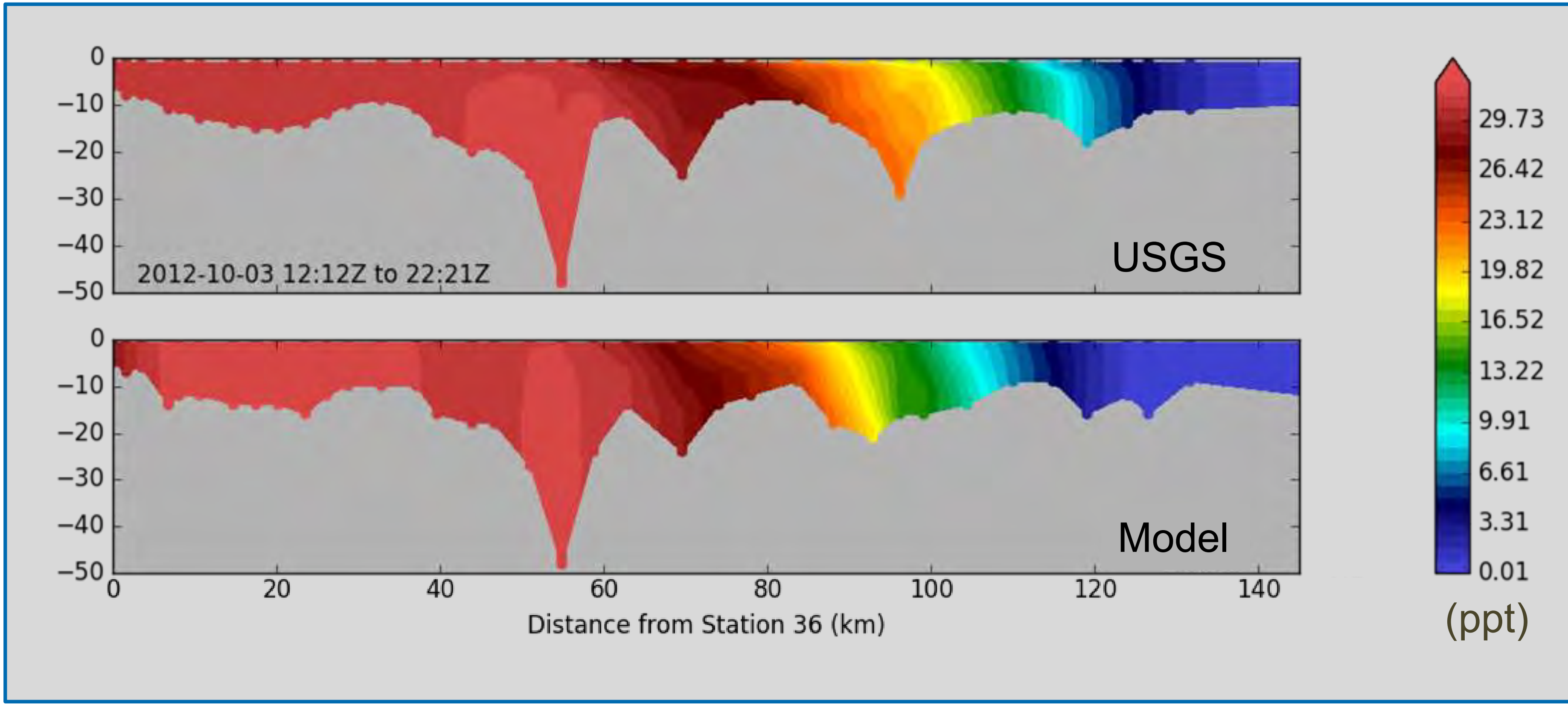
Model-observation comparisons are good in many parts of the Bay

Velocity Along Principal Axis of Tides





Test of Hydrodynamics: Salinity



Dry-weather salinity, stratification generally good

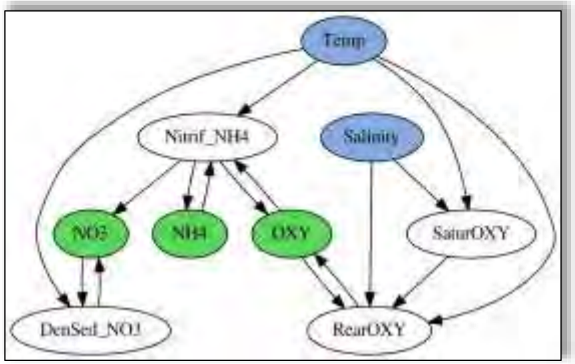
North Bay salt intrusion under-represented

Water Quality Model: *Delft Water Quality*

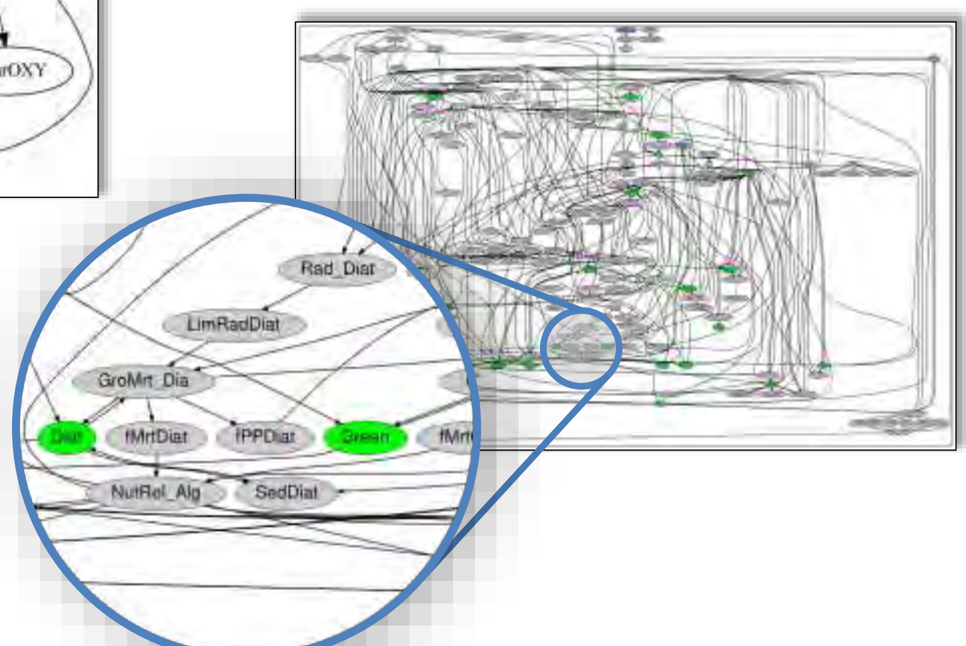
In collaboration with USGS-CASCADE II and Deltares

- Hydrodynamics, loads as input
- Highly configurable for wide range of studies

Simple
transport
de/nitrification
reaeration



Complex
Phytoplankton, sediment, …



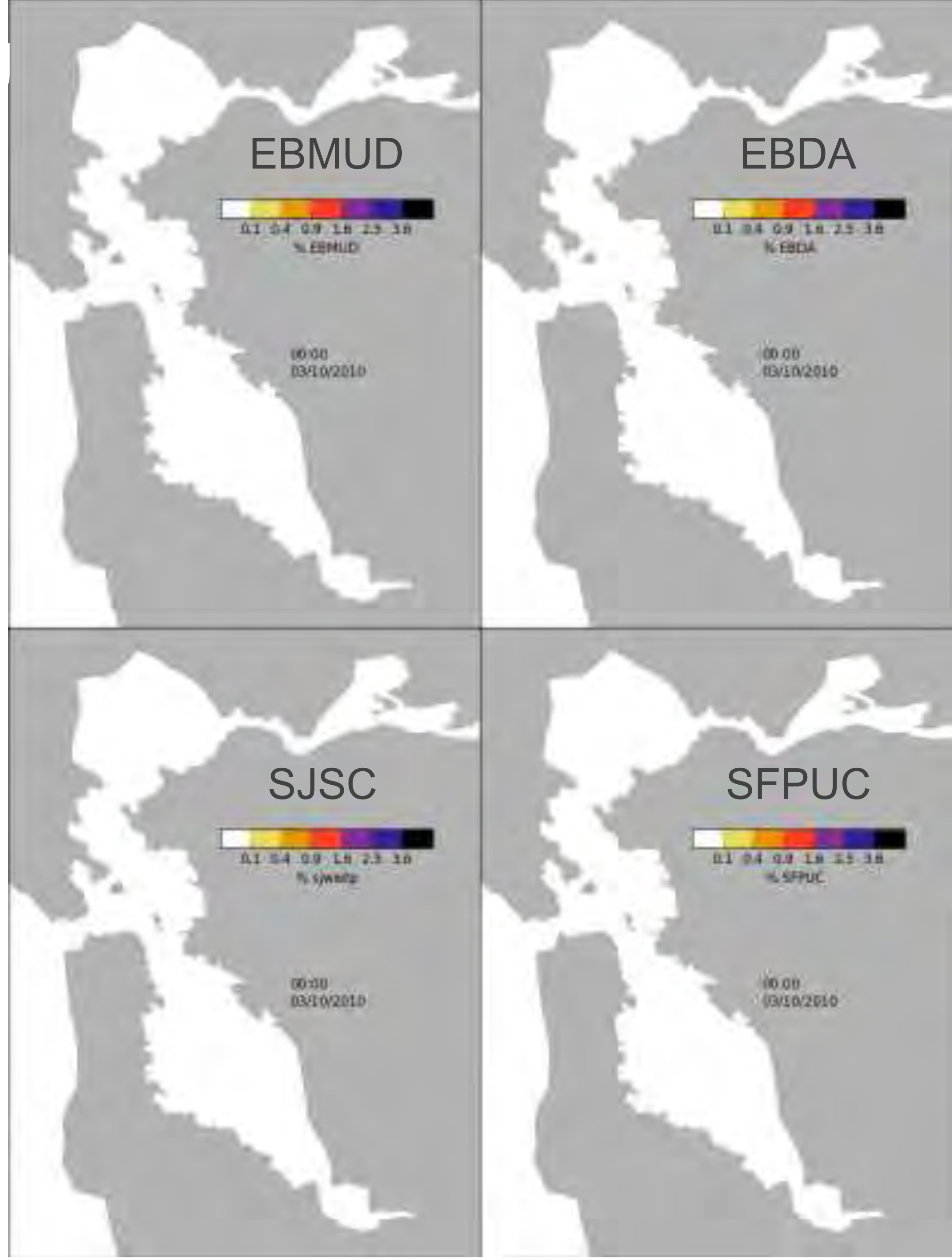
Necessitates a step-wise approach
Balance completeness vs complexity

Year 1 Applications
Transport Modeling

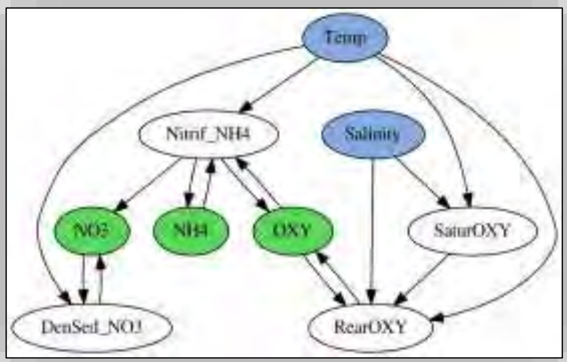
Conservative tracers for various discharges.

Depth-averaged: includes dilution by increased depth

Many applications:
e.g. CEC sampling strategies

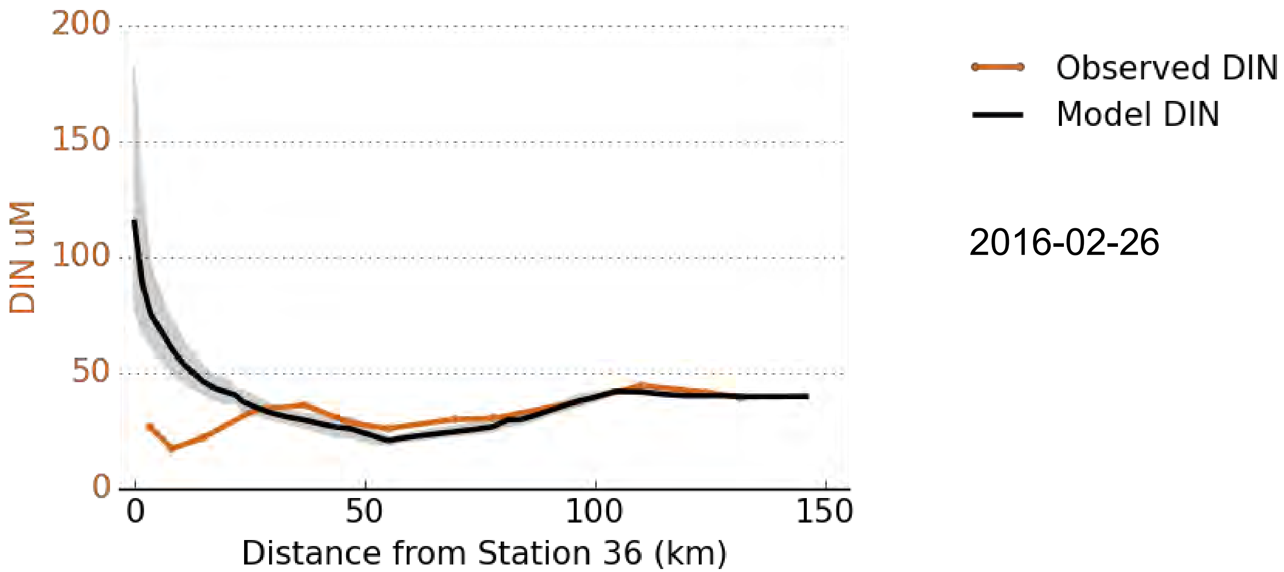


Model-observation Comparison: Dissolved Inorganic Nitrogen

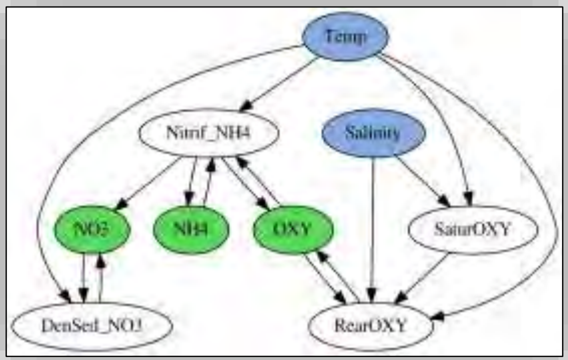


Limited set of nitrogen processes, estimates of NO_3 and NH_4 loads

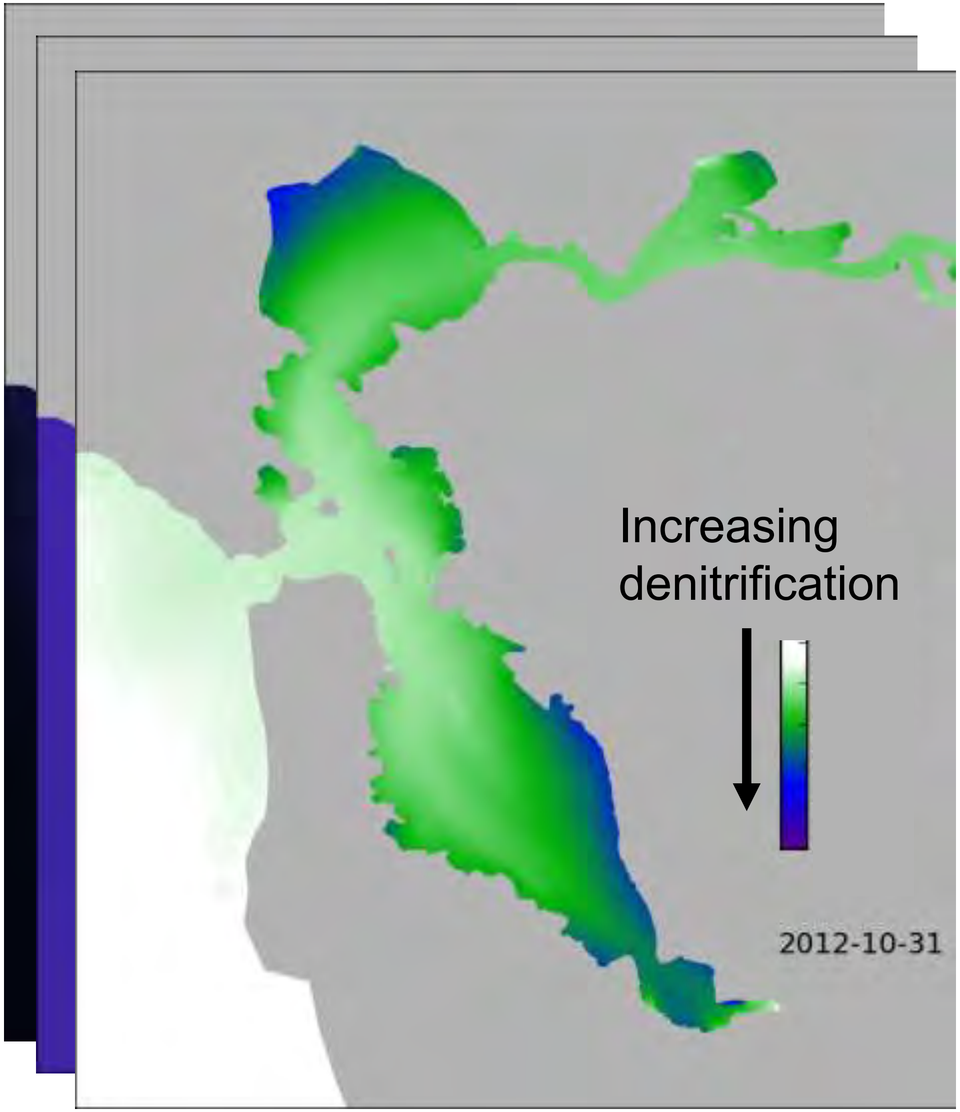
→ Modeled concentrations often quite close to observations



Nutrients: Spatial View



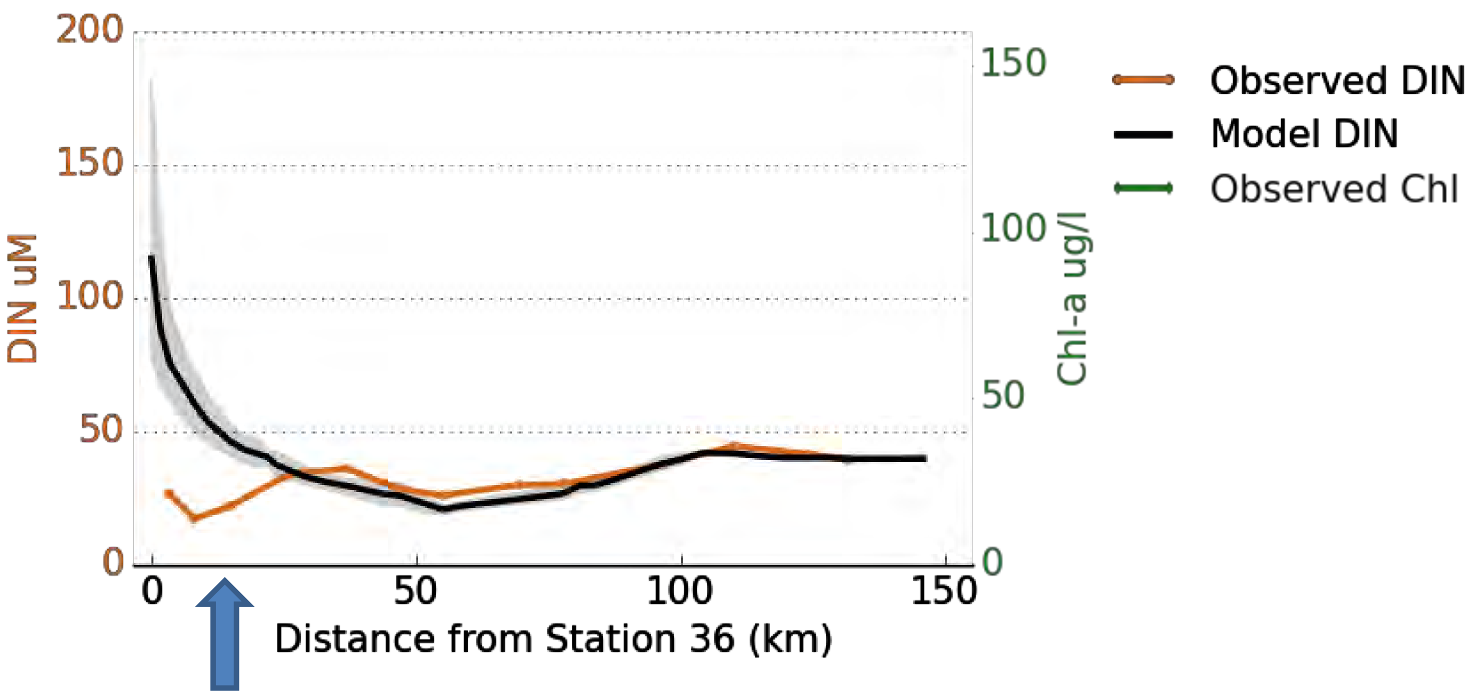
- Provides spatially explicit predictions
- Includes variability in loss terms



Model-observation Comparison: Dissolved Inorganic Nitrogen

Despite the limited set of processes, modeled nutrient concentrations are often quite close to observations

Suggests that dilution and denitrification are significant if not dominant in setting ambient levels.



Missing processes: Drawdown by phytoplankton

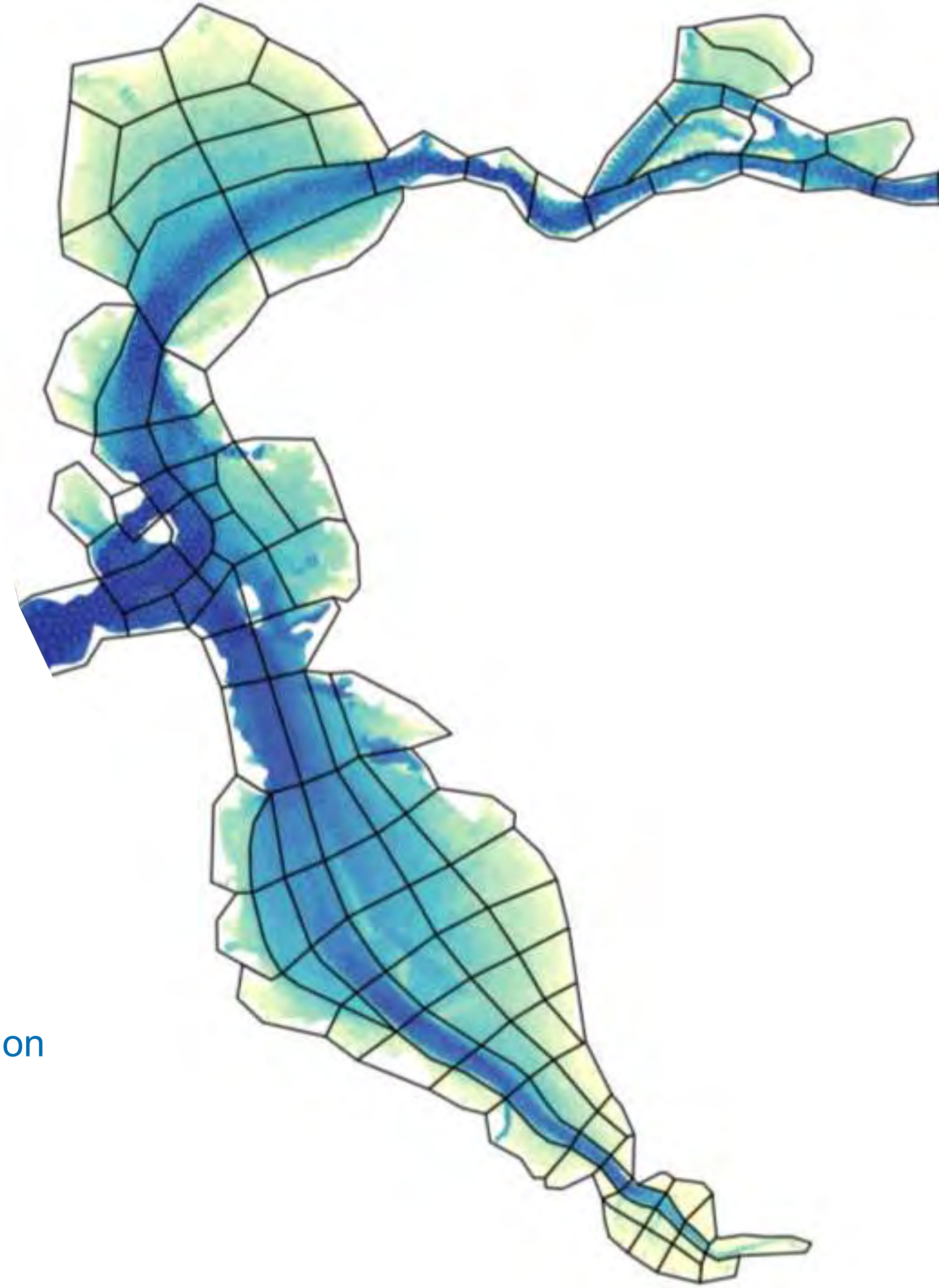
Adding Phytoplankton

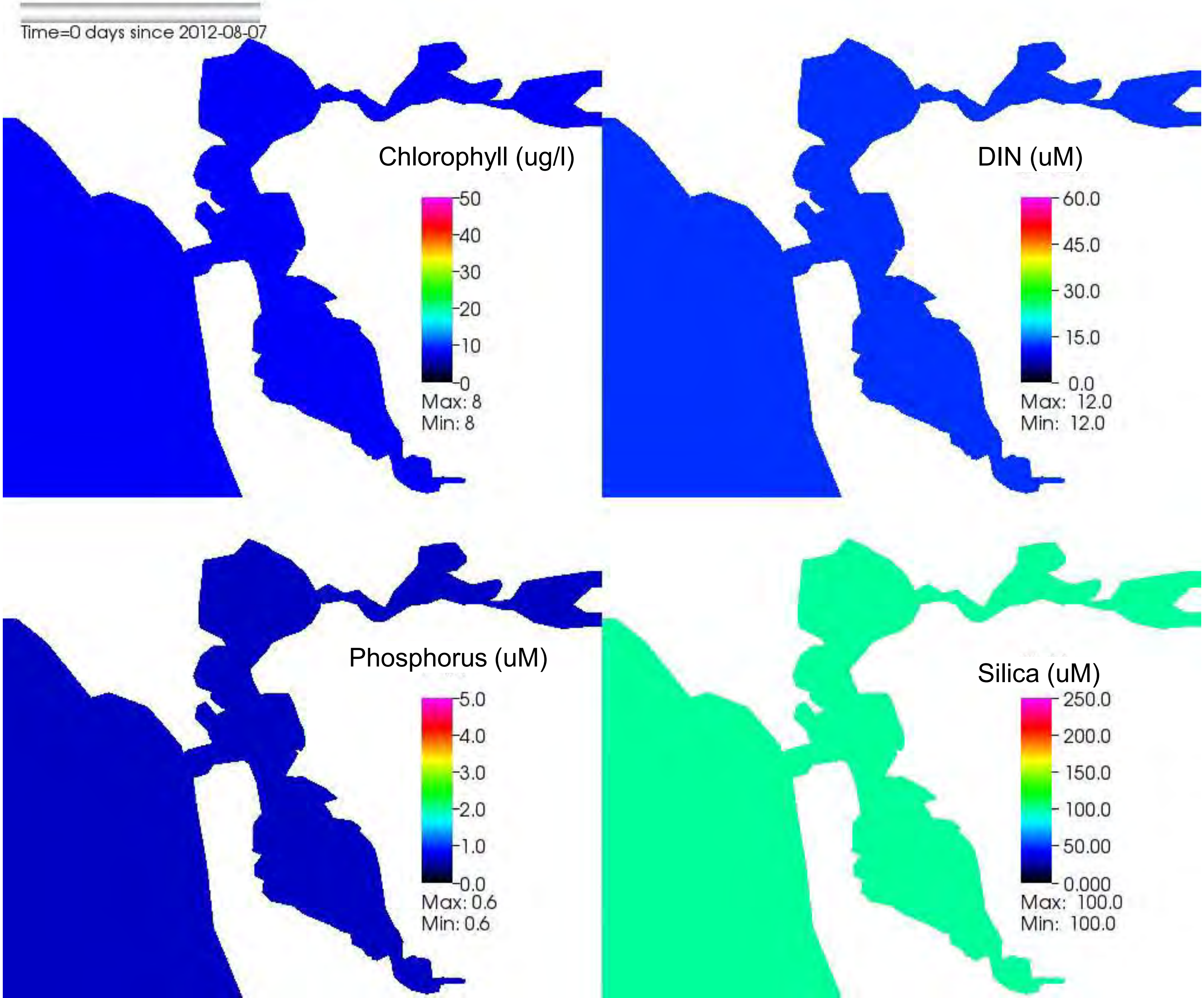
High-res…

- 5-10 days to simulate 1 year
- 100+ GB per run

Low-res…

- 5–20 minutes to simulate 1 year
- Practical for sensitivity analysis, exploration

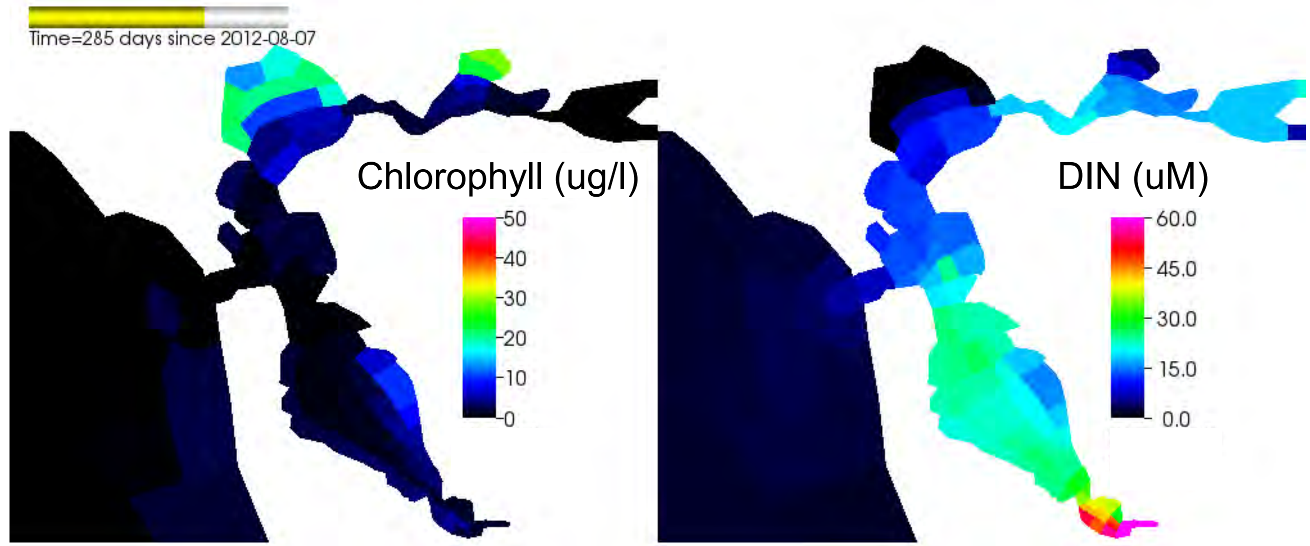




Time=0 days since 2012-08-07
Chlorophyll (ug/l)
50
40
30
20
10
0
Max: 8
Min: 8
DIN (uM)
60.0
45.0
30.0
15.0
0.0
Max: 12.0
Min: 12.0
Phosphorus (uM)
5.0
4.0
3.0
2.0
1.0
0.0
Max: 0.6
Min: 0.6
Silica (uM)
250.0
200.0
150.0
100.0
50.00
0.000
Max: 100.0
Min: 100.0

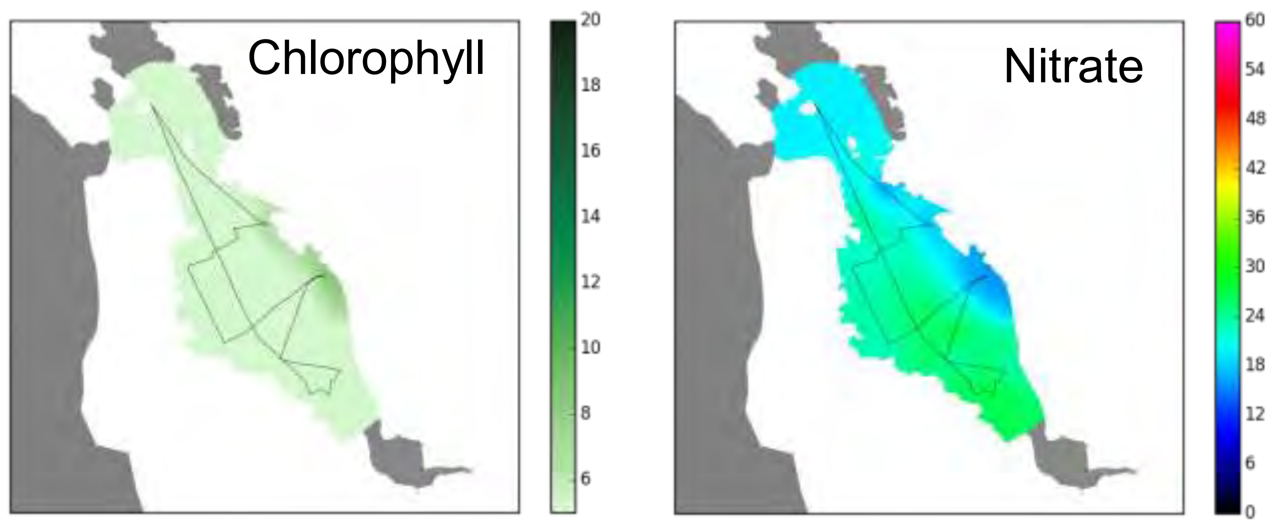
Low Res Water Quality

Snapshot of model
April, 2013



Not a 1:1 comparison… but reasonable features and numbers

April 2016
RTC El Niño Cruises



Broader Applications

Coast ⇔ Bay linkages for nutrient and contaminant transport

Assessing monitoring program designs

Dilution estimates to inform CEC sampling

Supporting first-cut analysis of transport in Emeryville Crescent

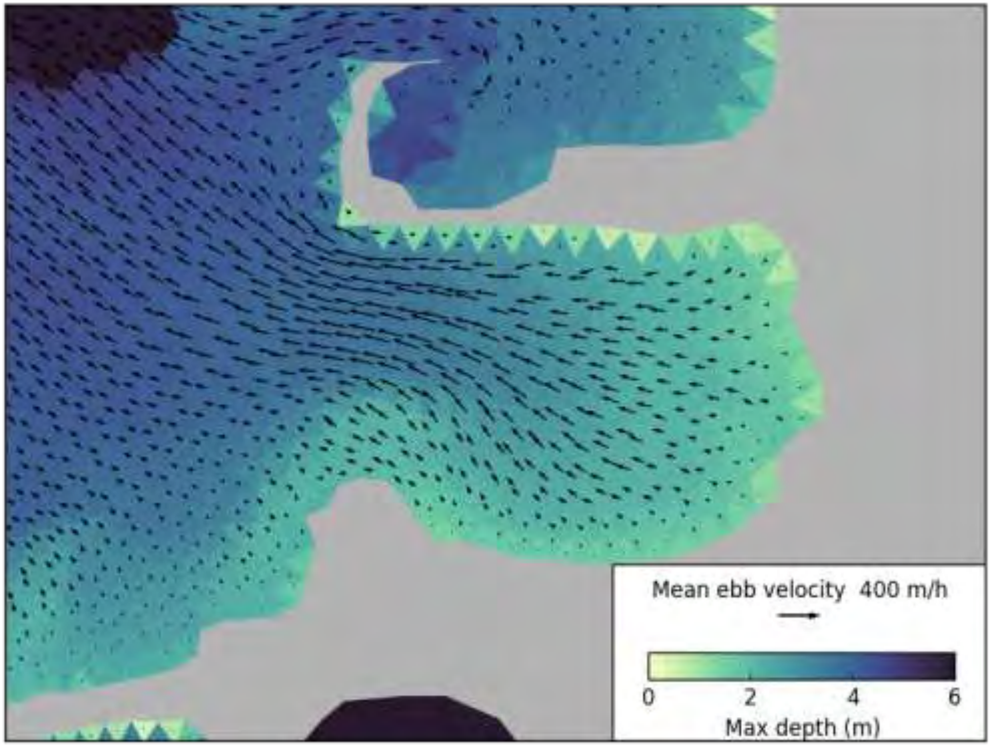
Emeryville Crescent

Part of PCB PMU Study

How far do water parcels move in a single tide?

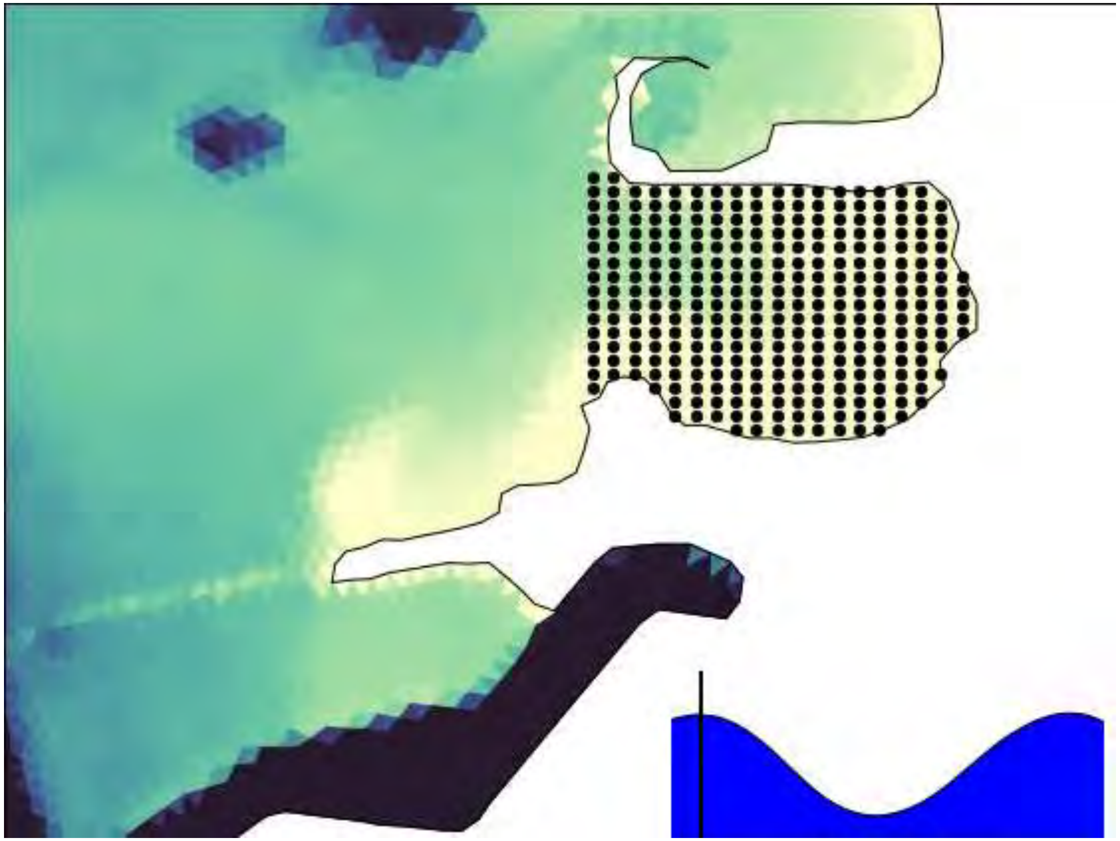
What fraction of the water is flushed out on each tide?

➔ Use modeled velocity field in Emeryville Crescent to place bounds on transport.



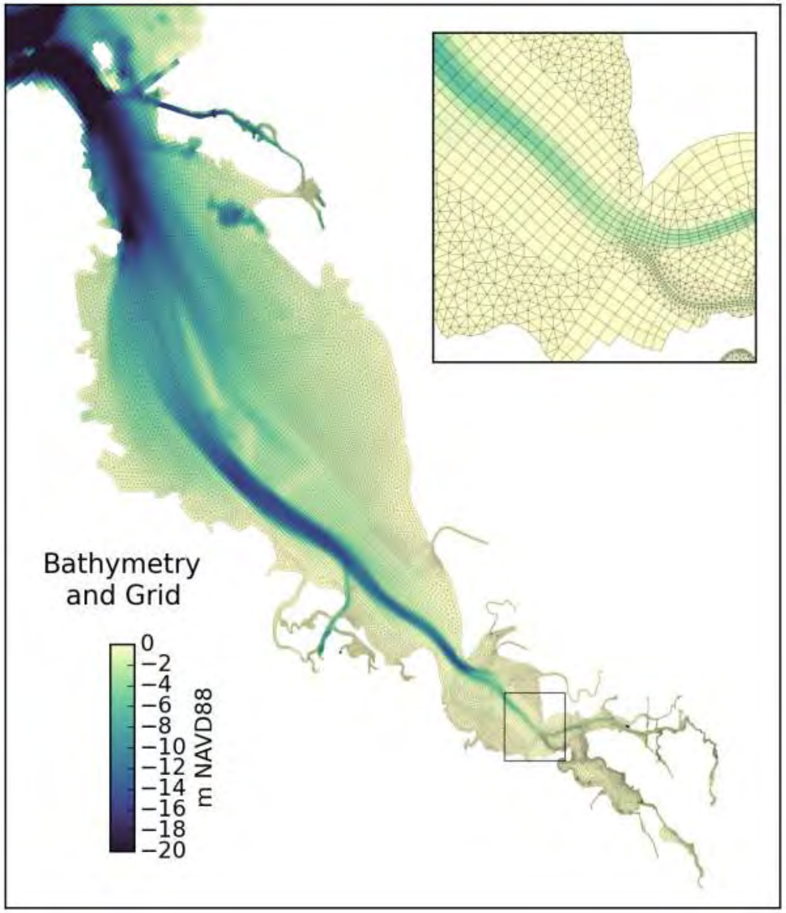
Emeryville Crescent

How much of the water in the Crescent at high tide leaves and does not return on the following high tide?



Next Steps - FY17

- Continued development, calibration, and testing
- Integration of new hydrodynamics including improved South Bay
- Expand beyond South Bay
- Support range of studies for nutrients, monitoring, and beyond



In collaboration with CASCaDE II, Deltares, TU Delft, RMA