Fate of Tributary Loads to Lake Michigan

Luke Gloege

Galen McKinley, Pete McIntyre, Rob Mooney

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

60th IAGLR 2017
From Cities to Farms:
Shaping Great Lakes Ecosystems

DETROIT
MAY 15-19

Previous work

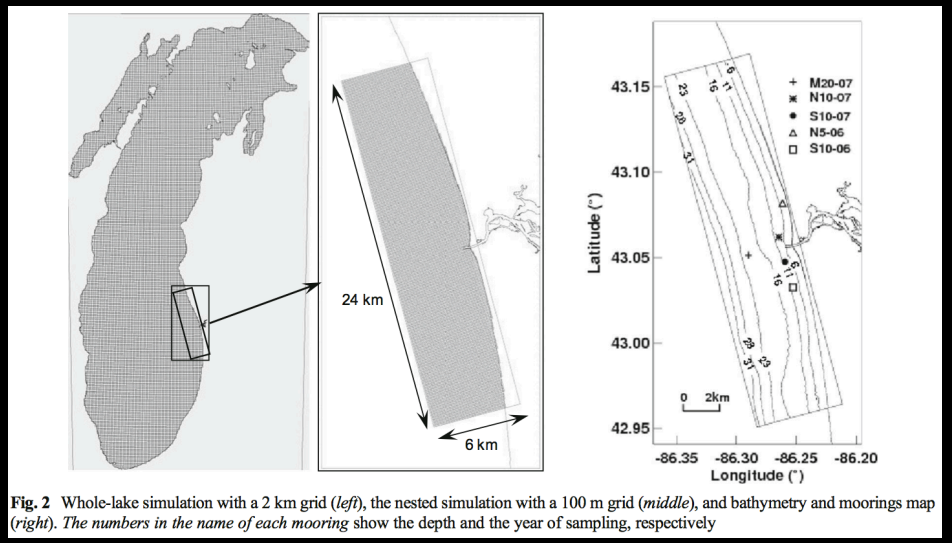
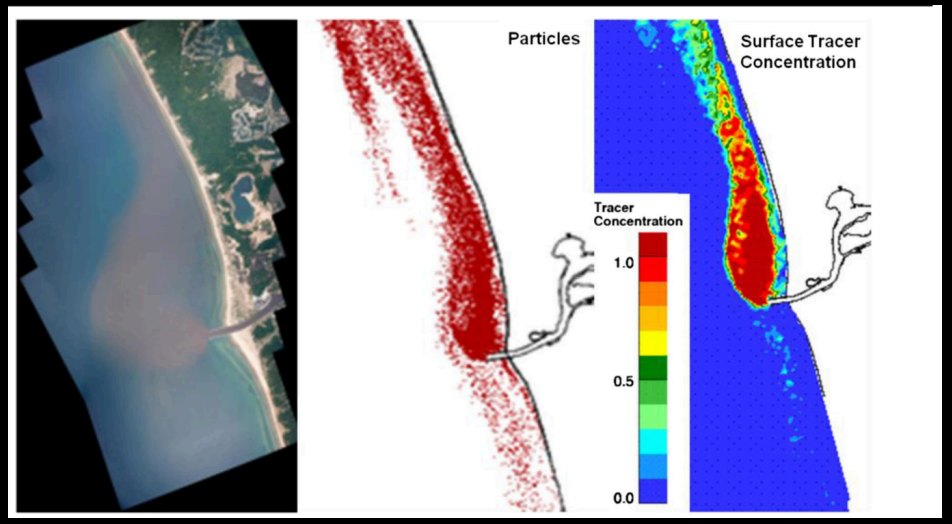


Fig. 2 Whole-lake simulation with a 2 km grid (*left*), the nested simulation with a 100 m grid (*middle*), and bathymetry and moorings map (*right*). *The numbers in the name of each mooring* show the depth and the year of sampling, respectively



Nekouee et al. 2015 Water Air Soil Pollut.

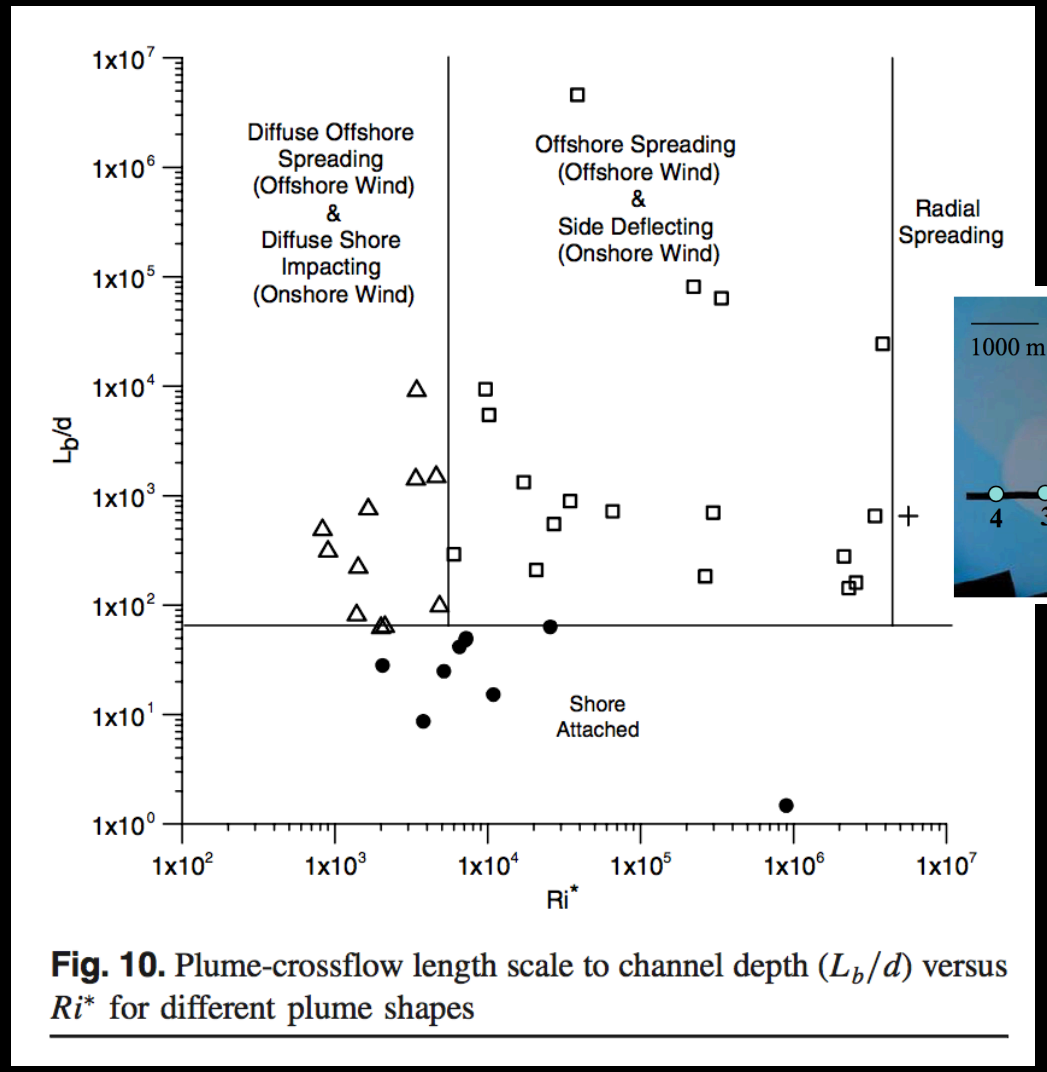
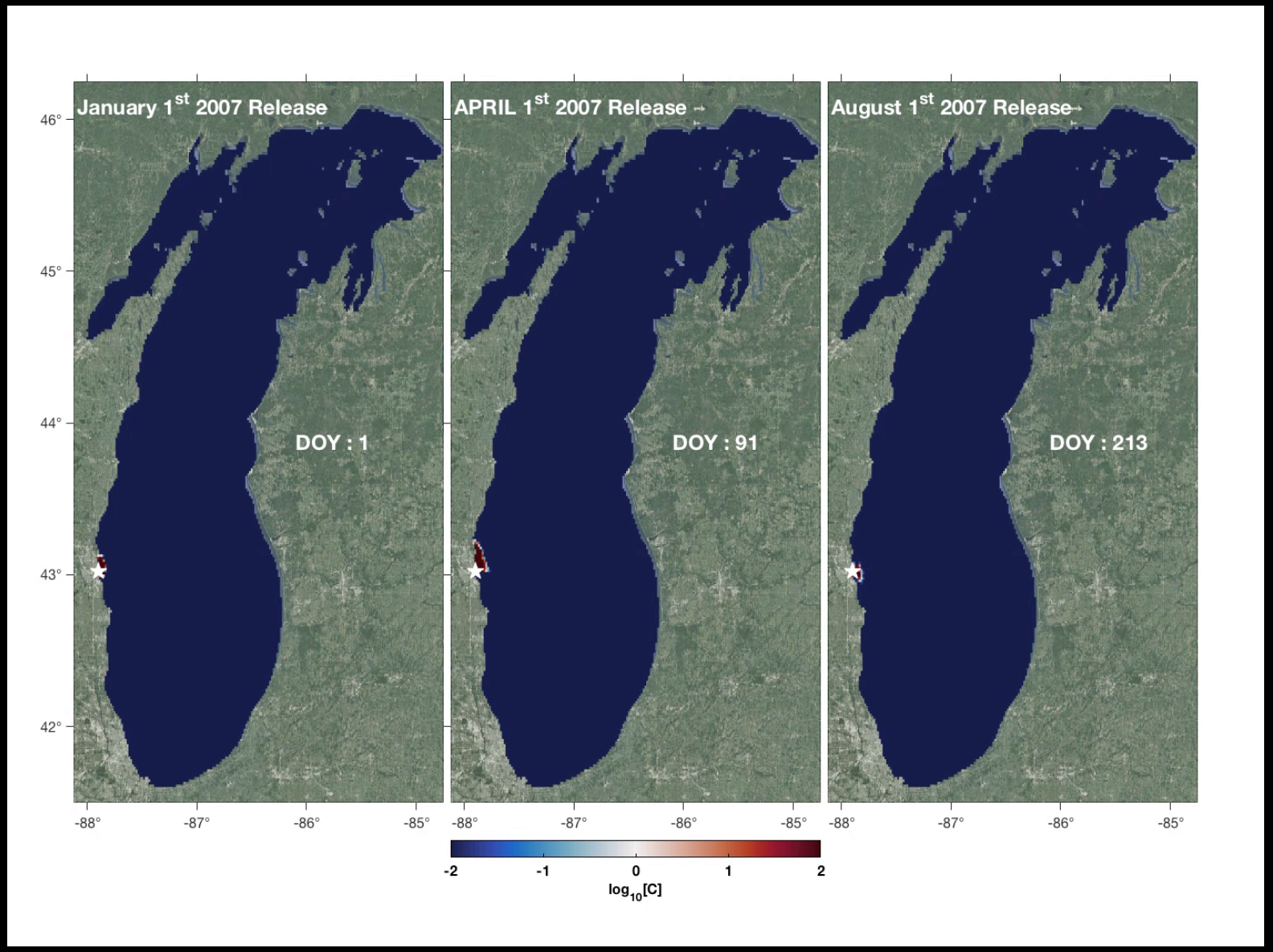


Fig. 10. Plume-crossflow length scale to channel depth (L_b/d) versus Ri^* for different plume shapes

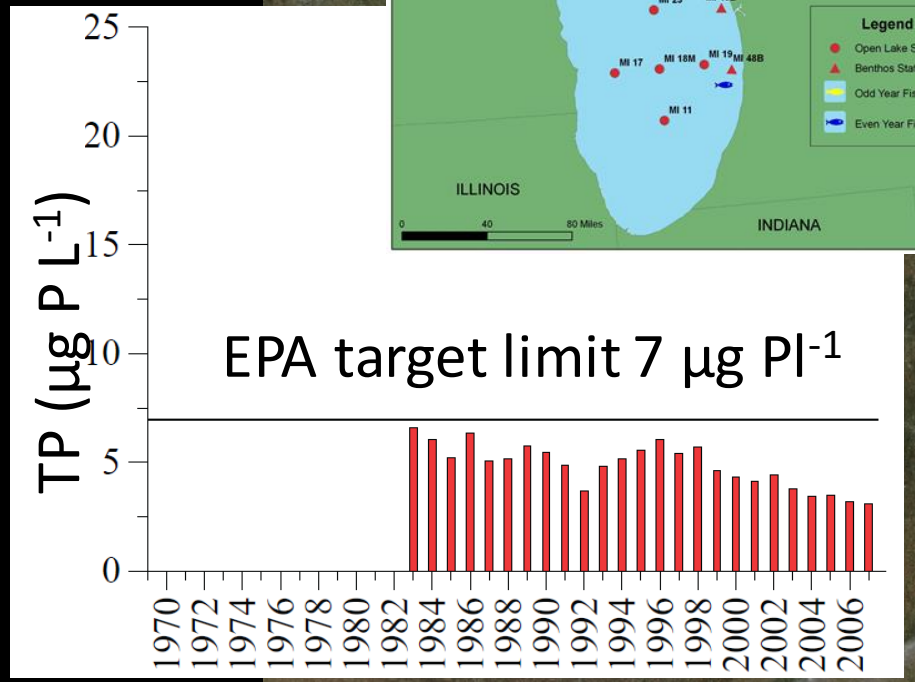
Nekouee et al. 2013 JGLR.

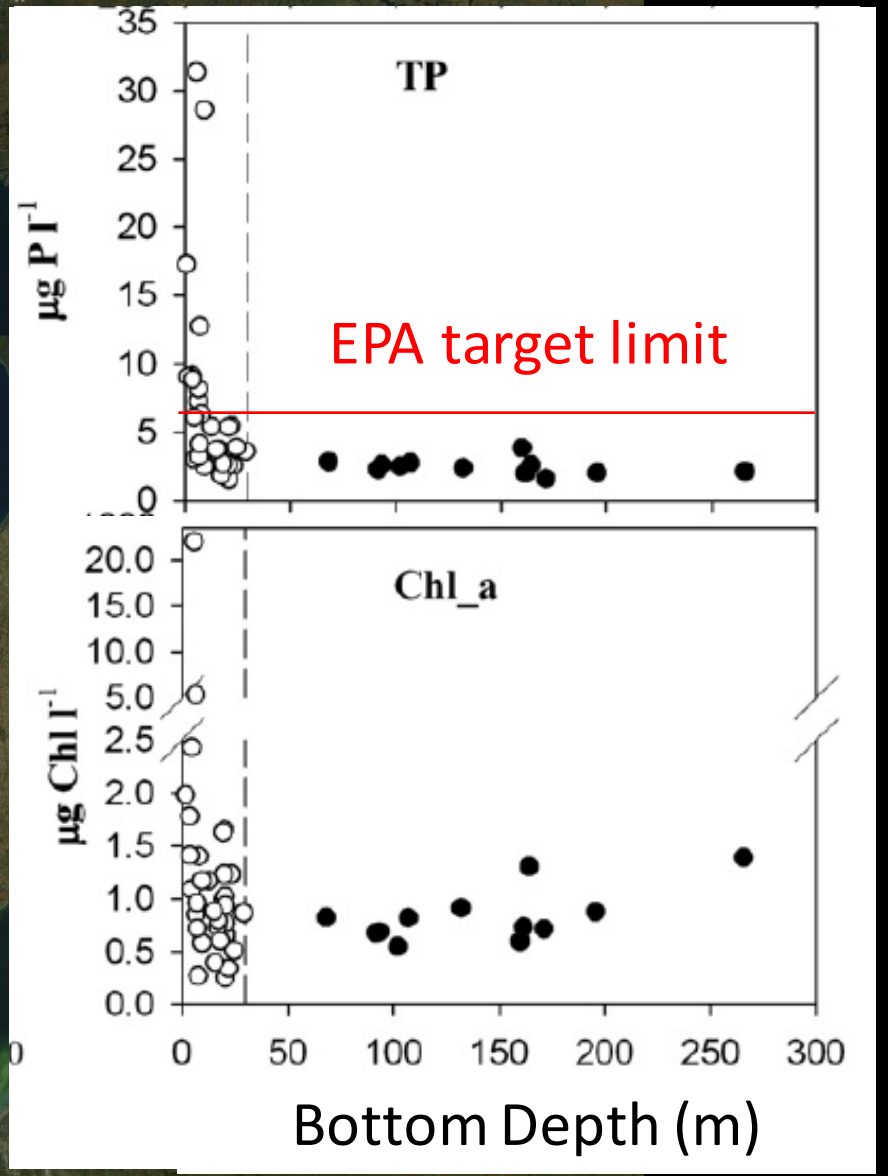
Dye Release Animation



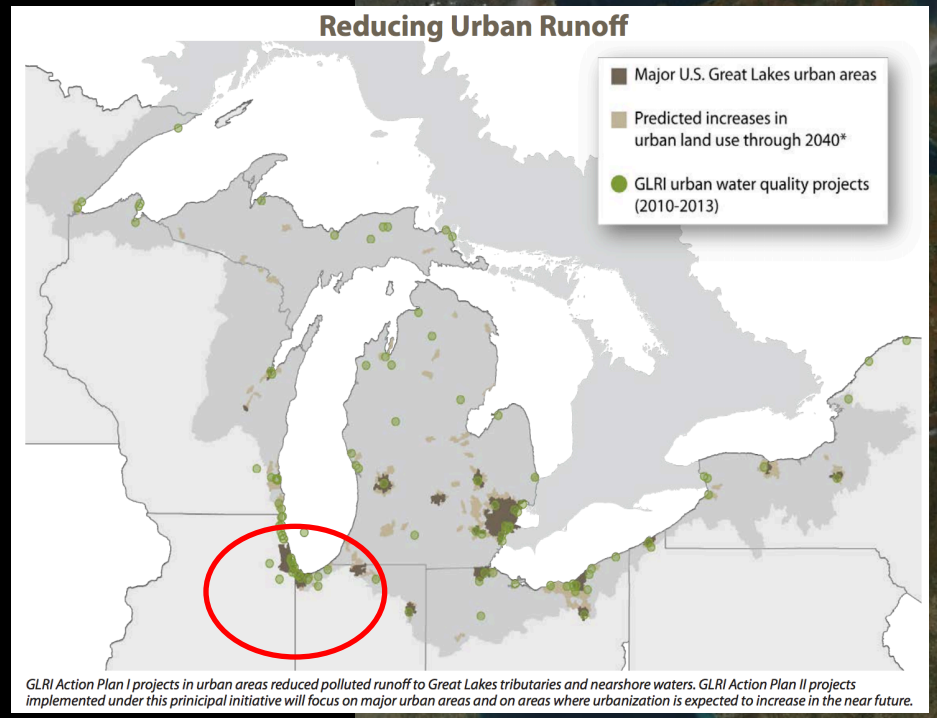
Great Lakes Eutrophication

NOAA Earth Observatory

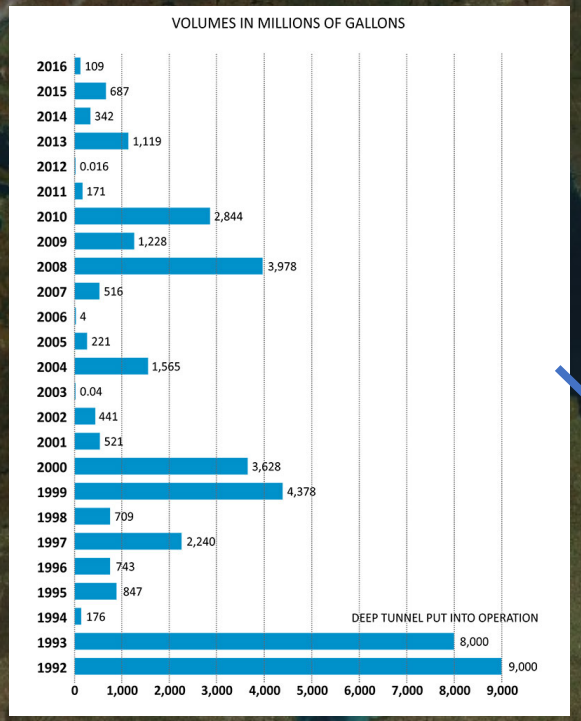




Yurista et al. 2015 JGLR



GLRI Action Plan



MMSD

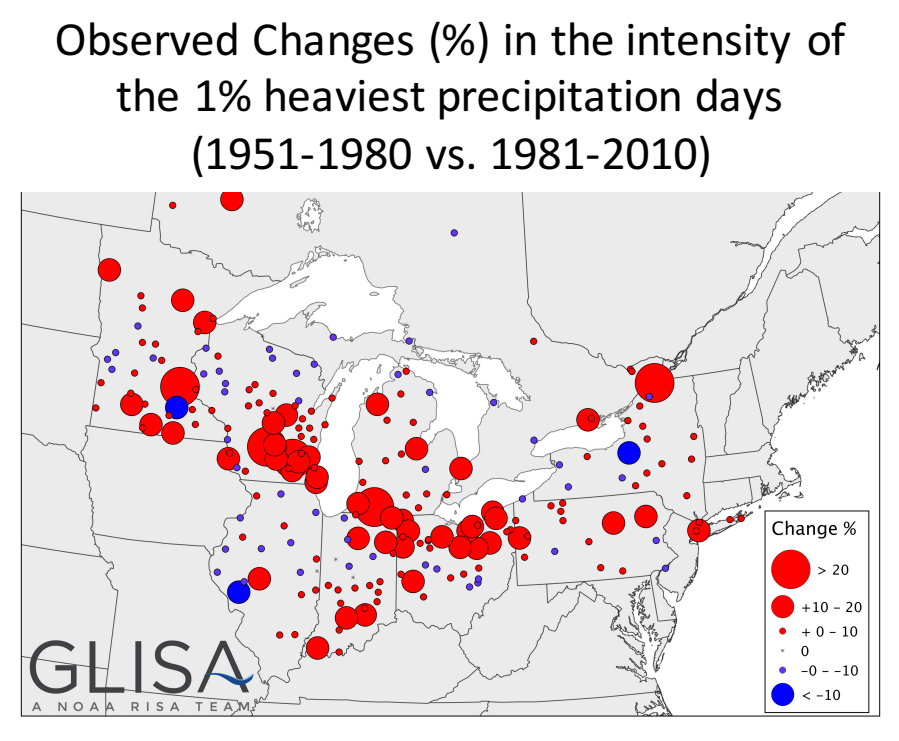
Record rainfall leads MMSD to dump wastewater, stormwater into Lake Michigan, Milwaukee River

POSTED 4:39 PM, APRIL 13, 2015, BY KATIE DELONG

NOAA Earth Observatory

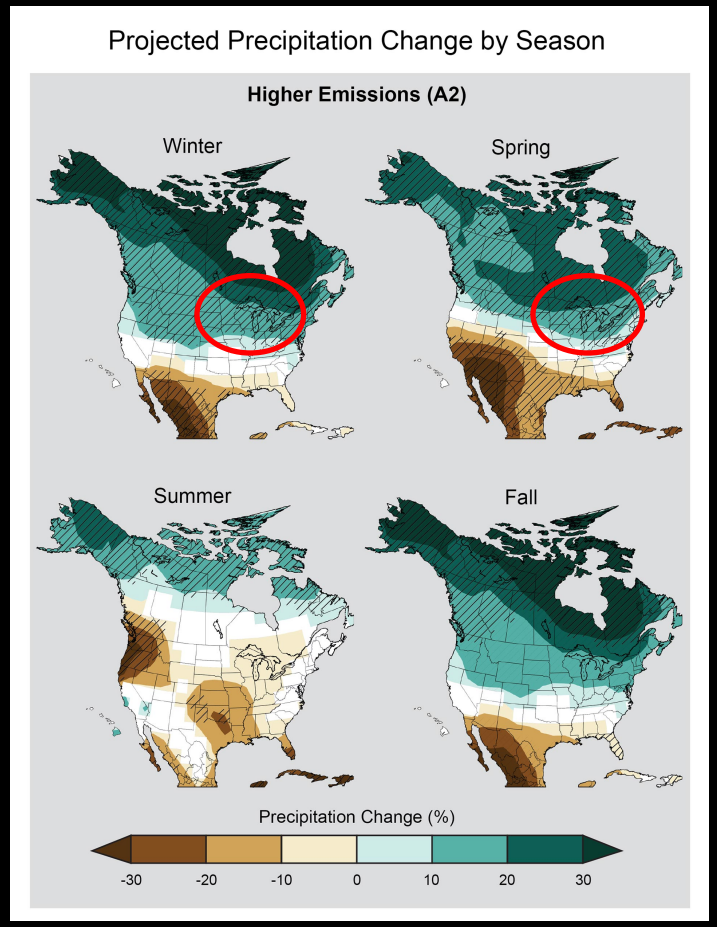
Midwest Precipitation Changes

Historical



Change in intensity of the heaviest 1% of daily precipitation events at GLISA climatology stations in the Great Lakes region.

Projected



Third National Climate Assessment

Model Experiment

- MIT general circulation model
- Closed basin
- 1/60 degree (~2km) horizontal res.
- 28 vertical layers (5 m -31 m)
- Forced at surface with meteorological and radiative fields every 3 hours
- Dye release at mouth of Milwaukee River

Instantaneous Release on …

January 1st , April 1st , and August 1st

Analysis

Target concentration

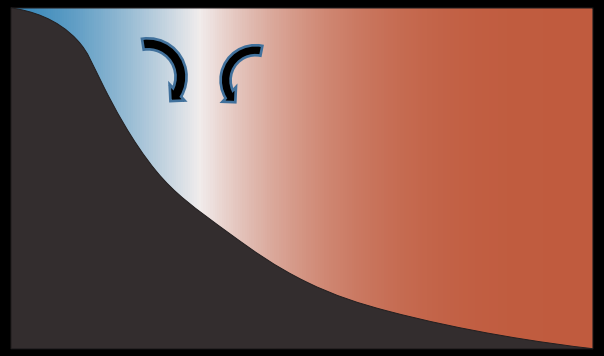
Concentration equivalent to tracer well-mixed throughout basin

1. **Time of arrival**
   Elapsed time until “target concentration” observed

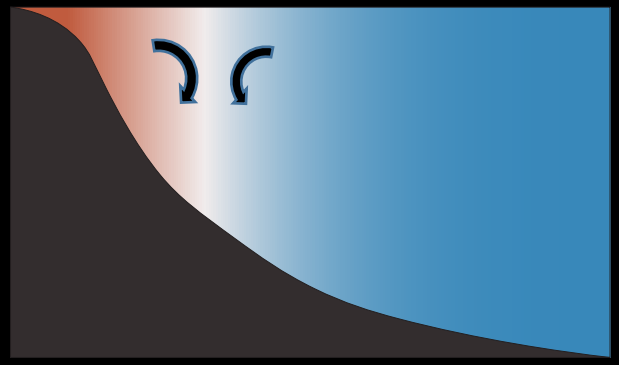
Analysis Times

January release	April release	August release
DOY: 1 - 60	DOY: 91 - 151	DOY: 213 - 273

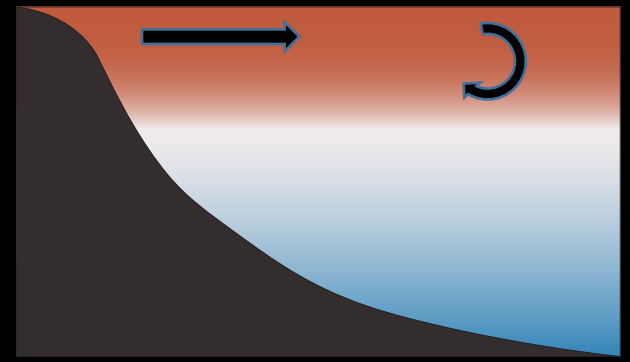
Winter thermal bar



Spring thermal bar



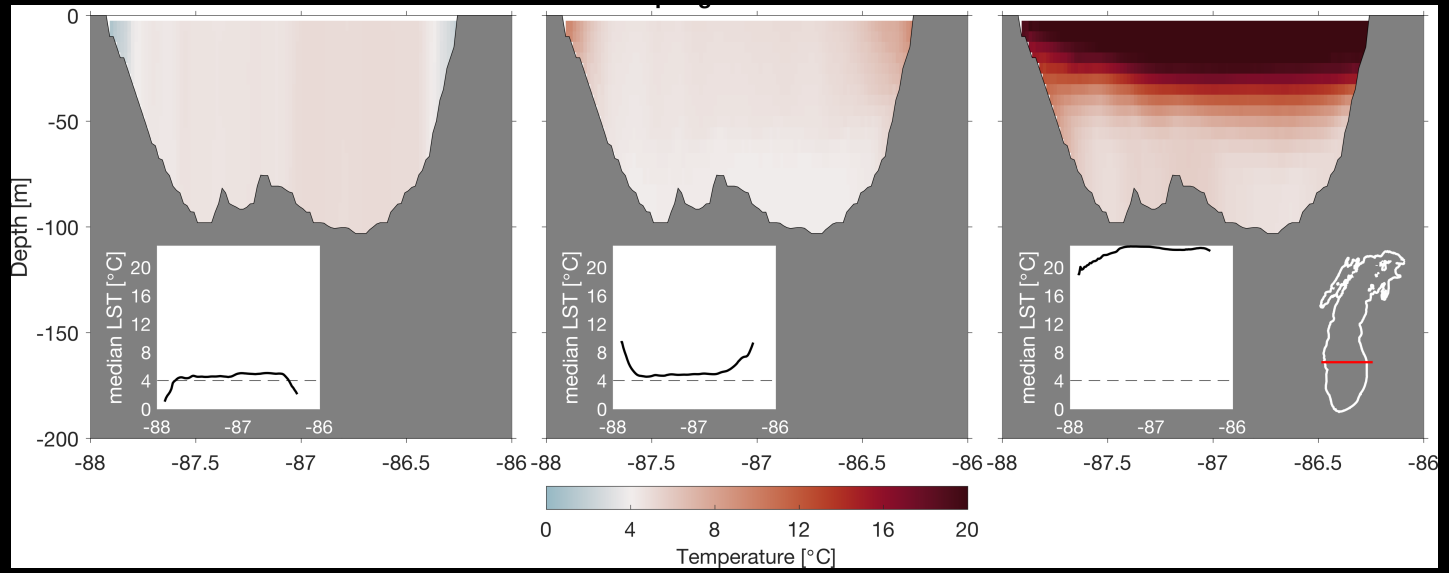
Summer stratified



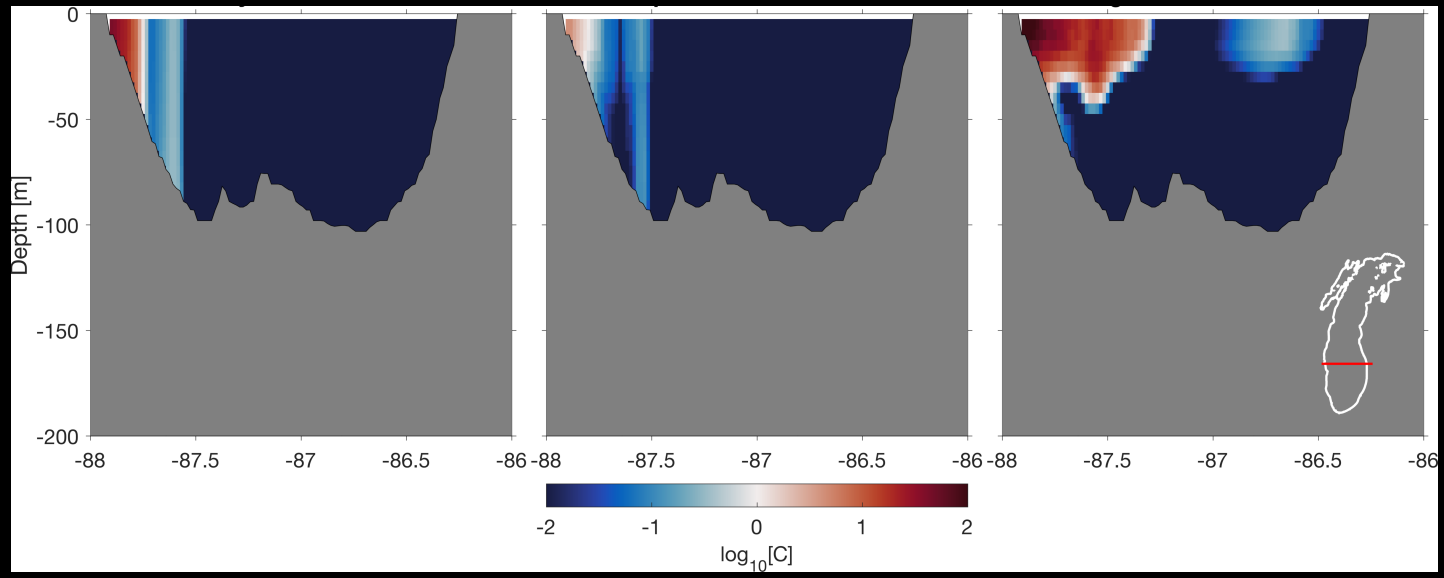
Thermal bar :
Strong horizontal gradient in temperature during transition to vertical stratification

Tracer concentration

Median temperature
(Note the thermal bars)



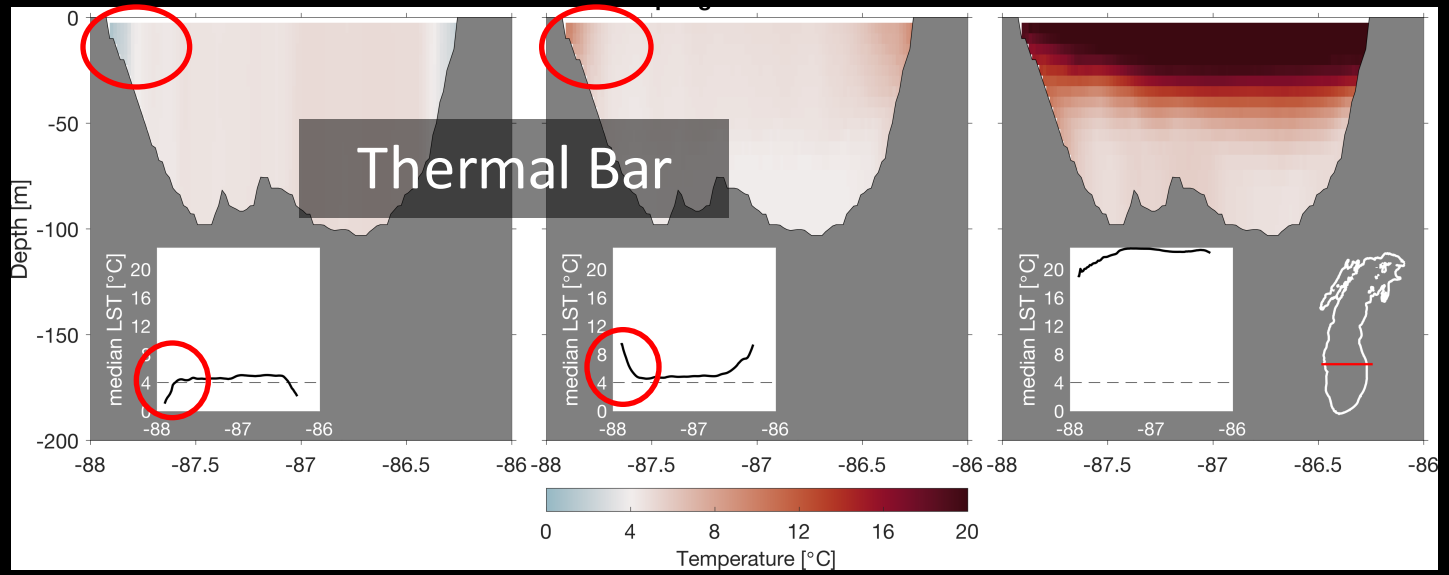
Median tracer concentration



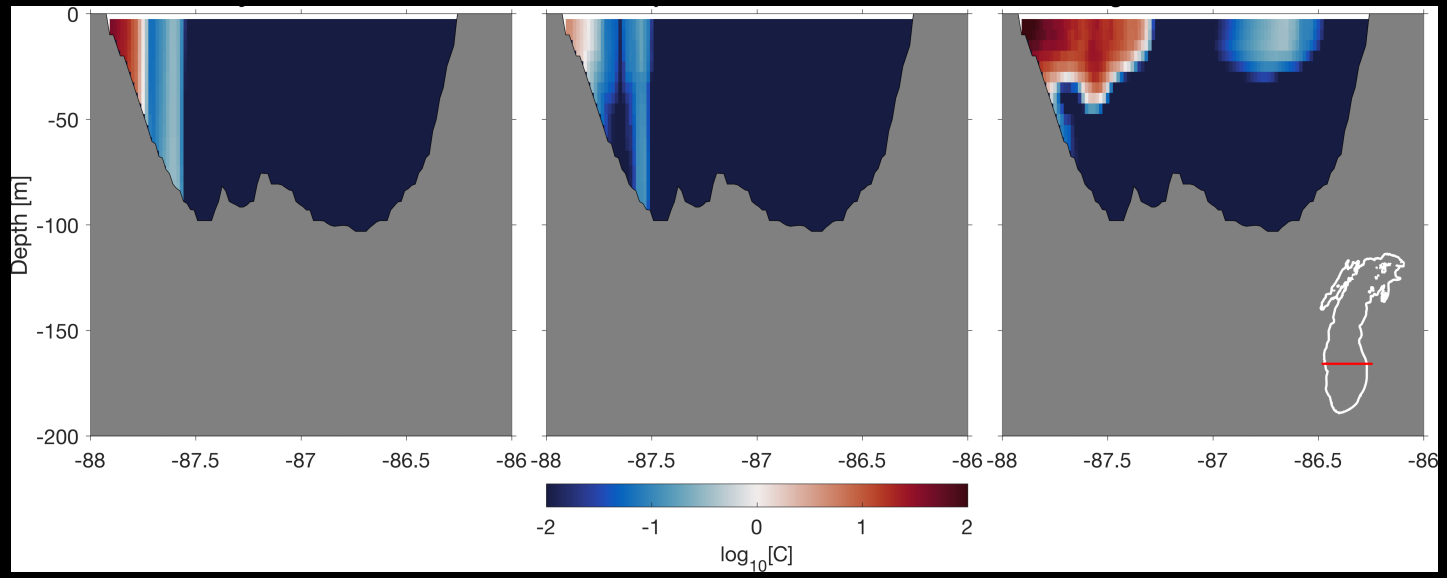
January April August

Tracer concentration

Median temperature
(Note the thermal bars)



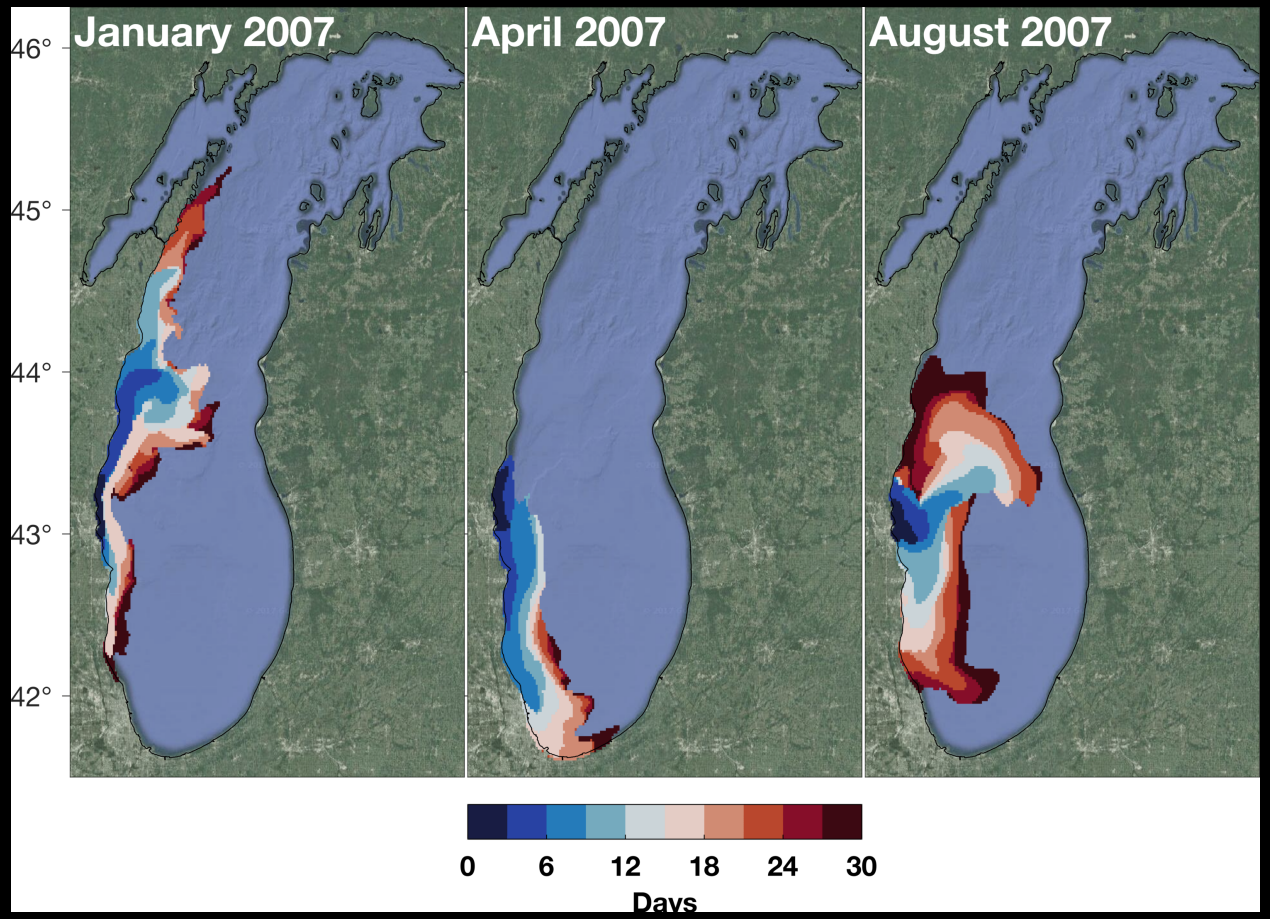
Median tracer concentration



January April August

Time of Arrival

January April August



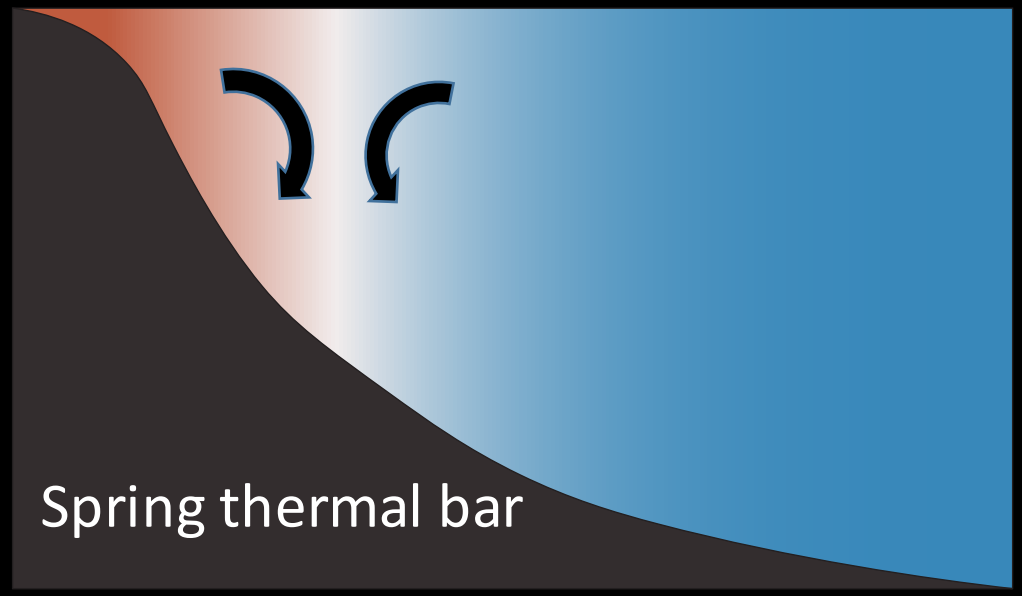
January / April

Plume remains coastal

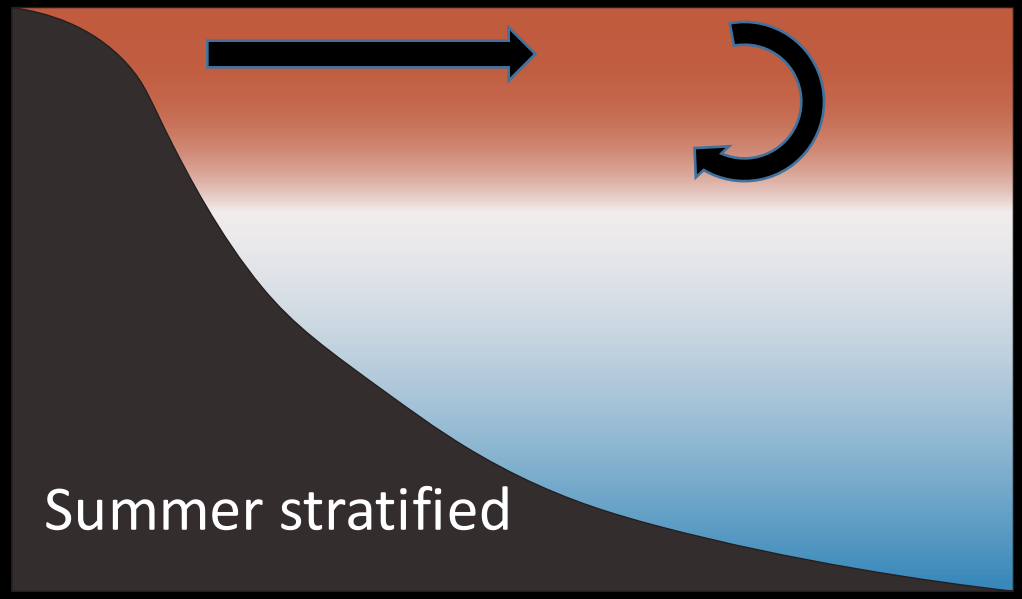
August

Plume moves offshore

Why do we see this pattern?

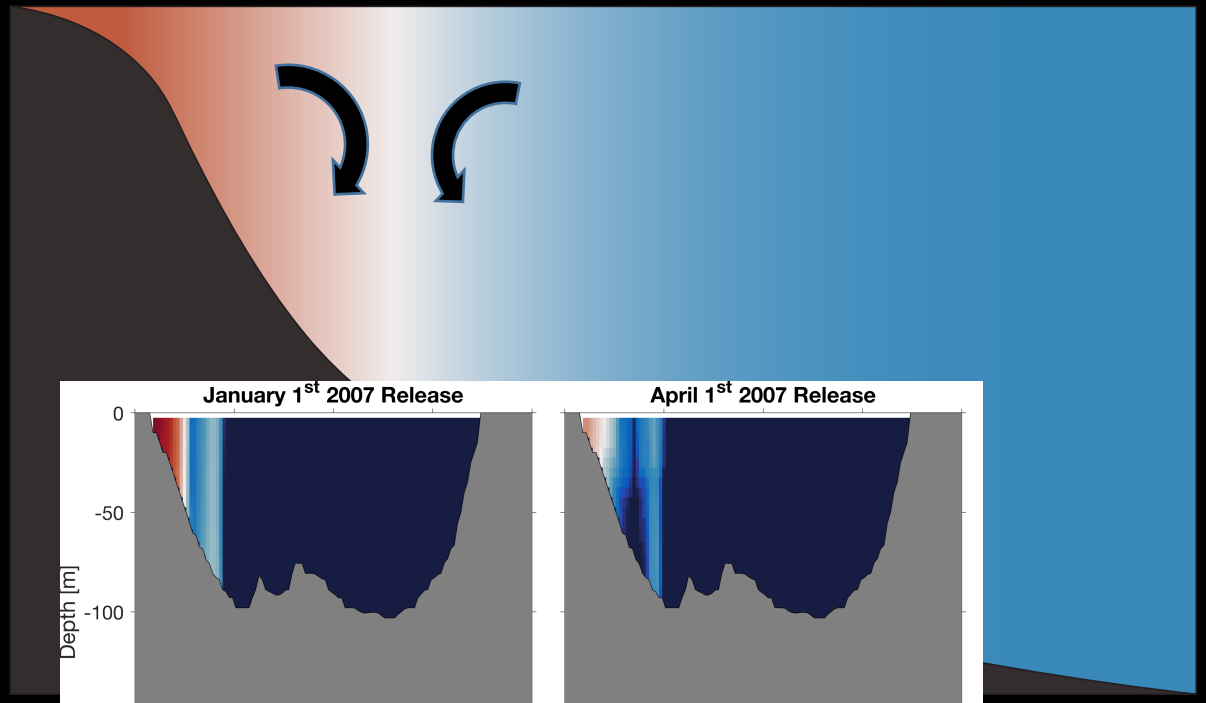


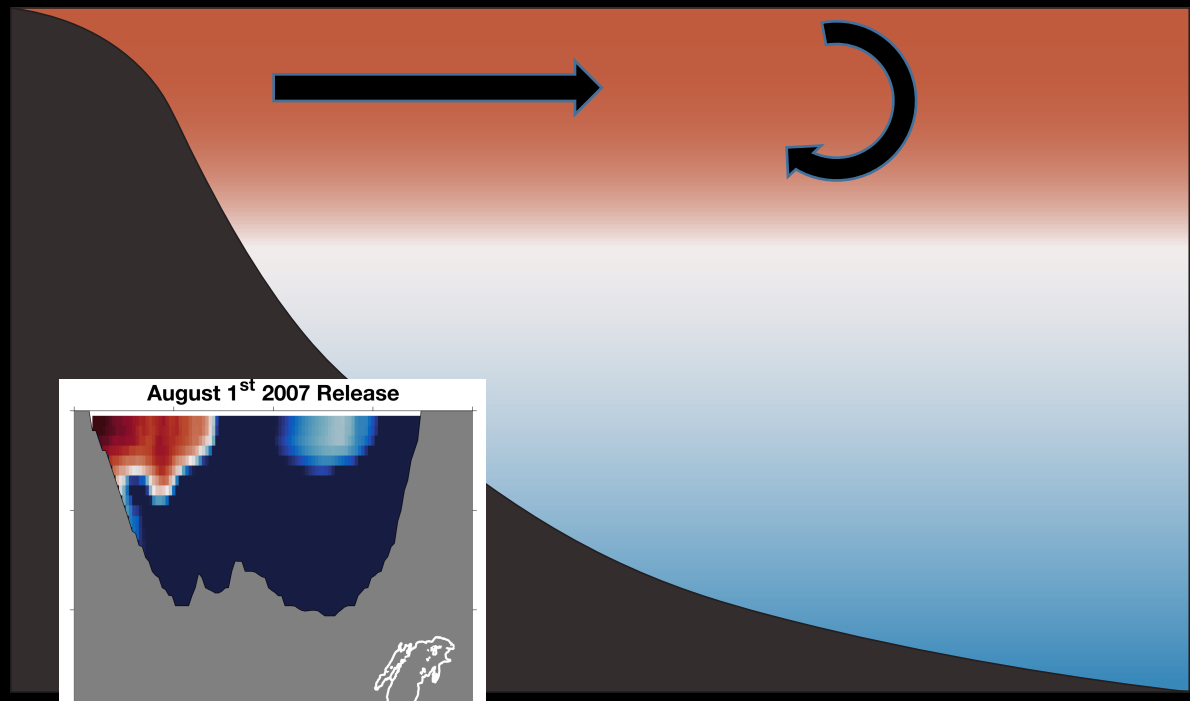
- Strong horizontal density gradient inhibits offshore transport
- Uniform temperature in vertical allows mixing throughout water column



- Weak horizontal density gradient allows offshore transport
- Thermocline acts as a barrier to mixing

Why do we see this pattern?





Conclusions

Timing of release release has potential to trap pollutants near the coast

Timing of the release has potential to exacerbate local impacts

Location of release determines location of impact

Acknowledgements

Galen McKinley

Pete McIntyre

Rob Mooney