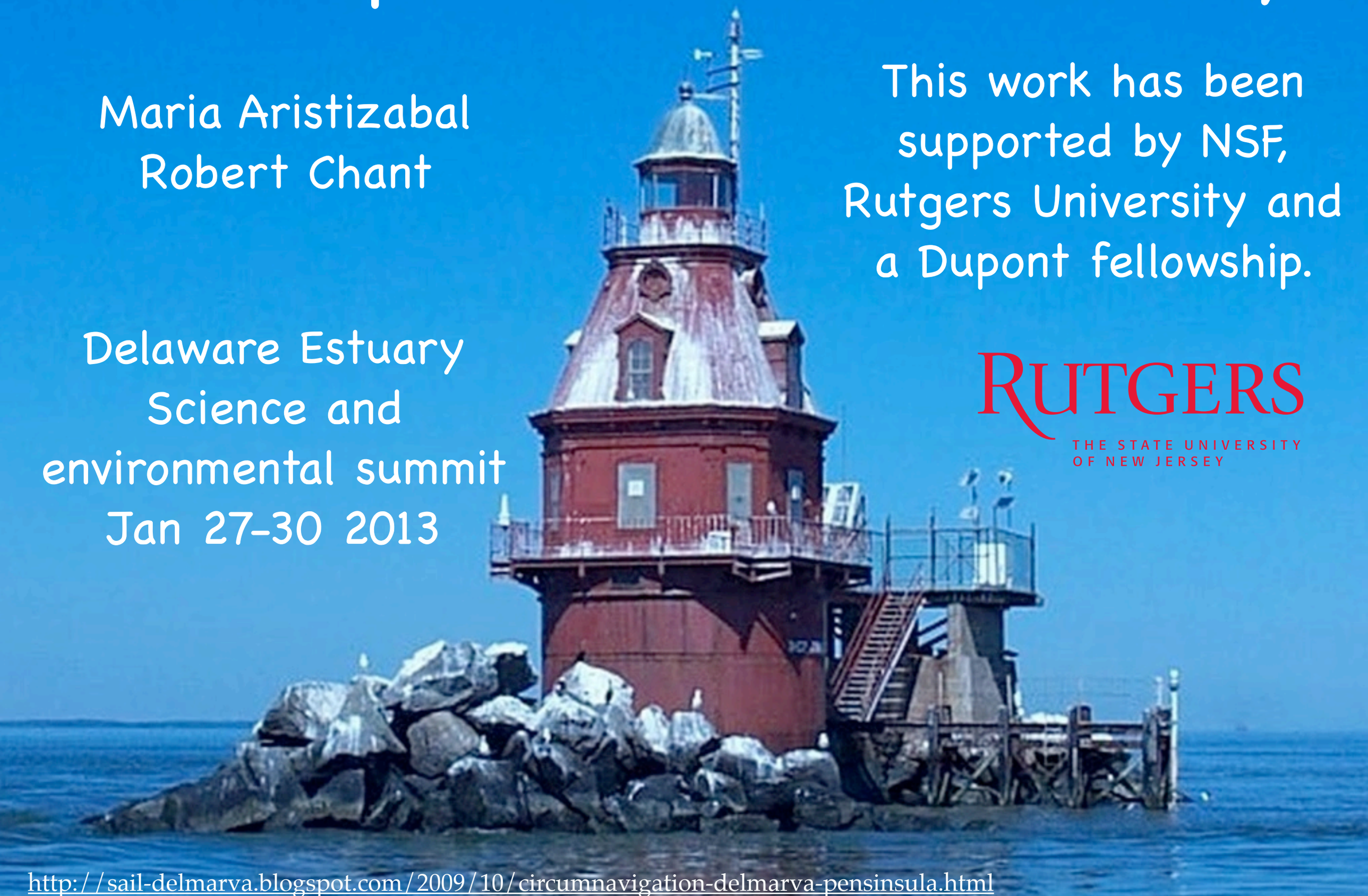
Salt Dispersion in Delaware Bay

Maria Aristizabal
Robert Chant

This work has been supported by NSF, Rutgers University and a Dupont fellowship.

Delaware Estuary Science and environmental summit Jan 27-30 2013

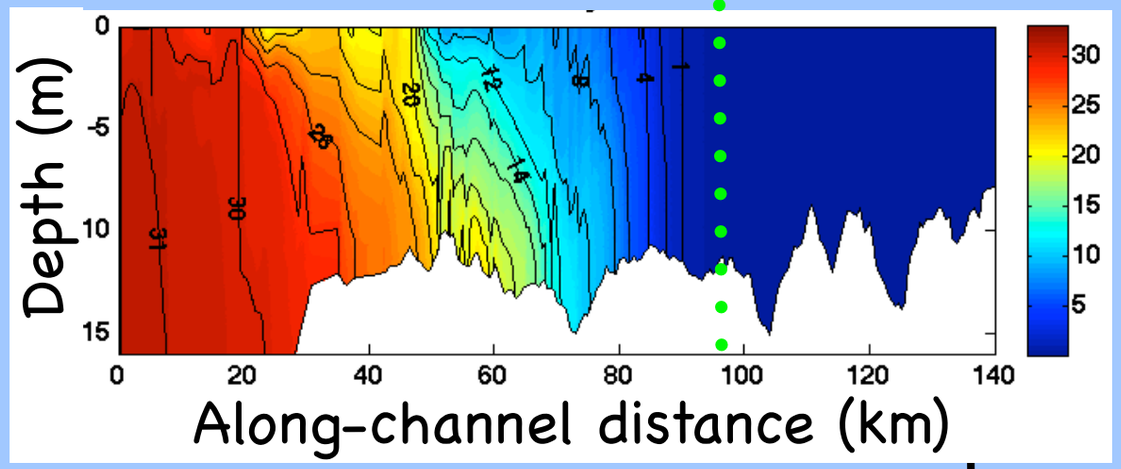
RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY



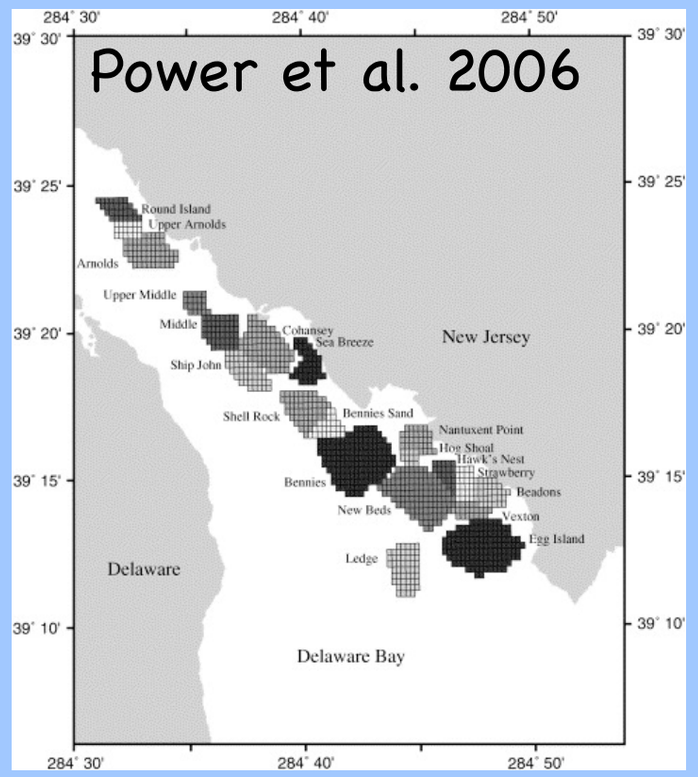
http://sail-delmarva.blogspot.com/2009/10/circumnavigation-delmarva-pensinsula.html

Why is salt dispersion important?

Salt dispersion determines the observed along-channel salinity structure in estuaries



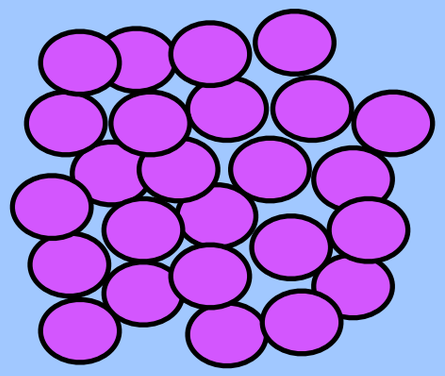
salt intrusion length



Easter oyster beds

Dispersion

t=0

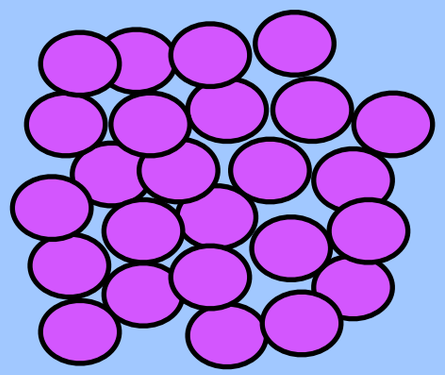


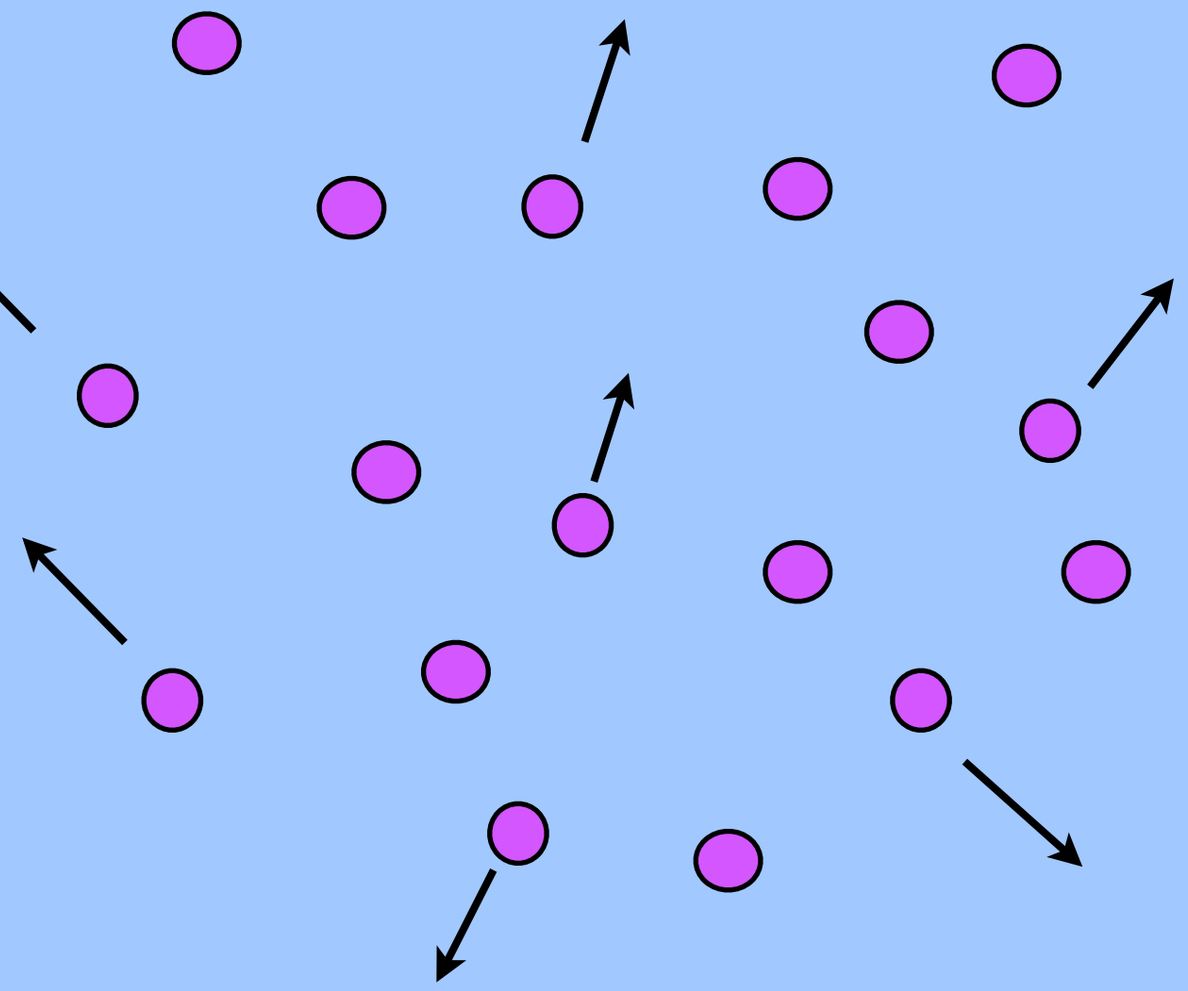
Number of particles per second = Dispersion rate = Flux

Dispersion

t=0

t=later time





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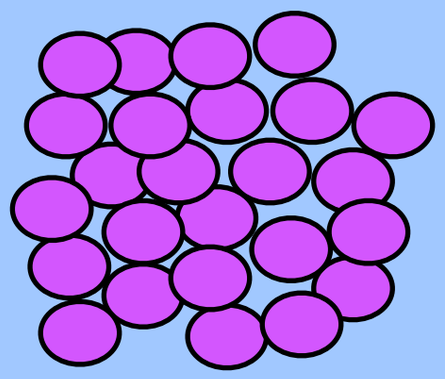
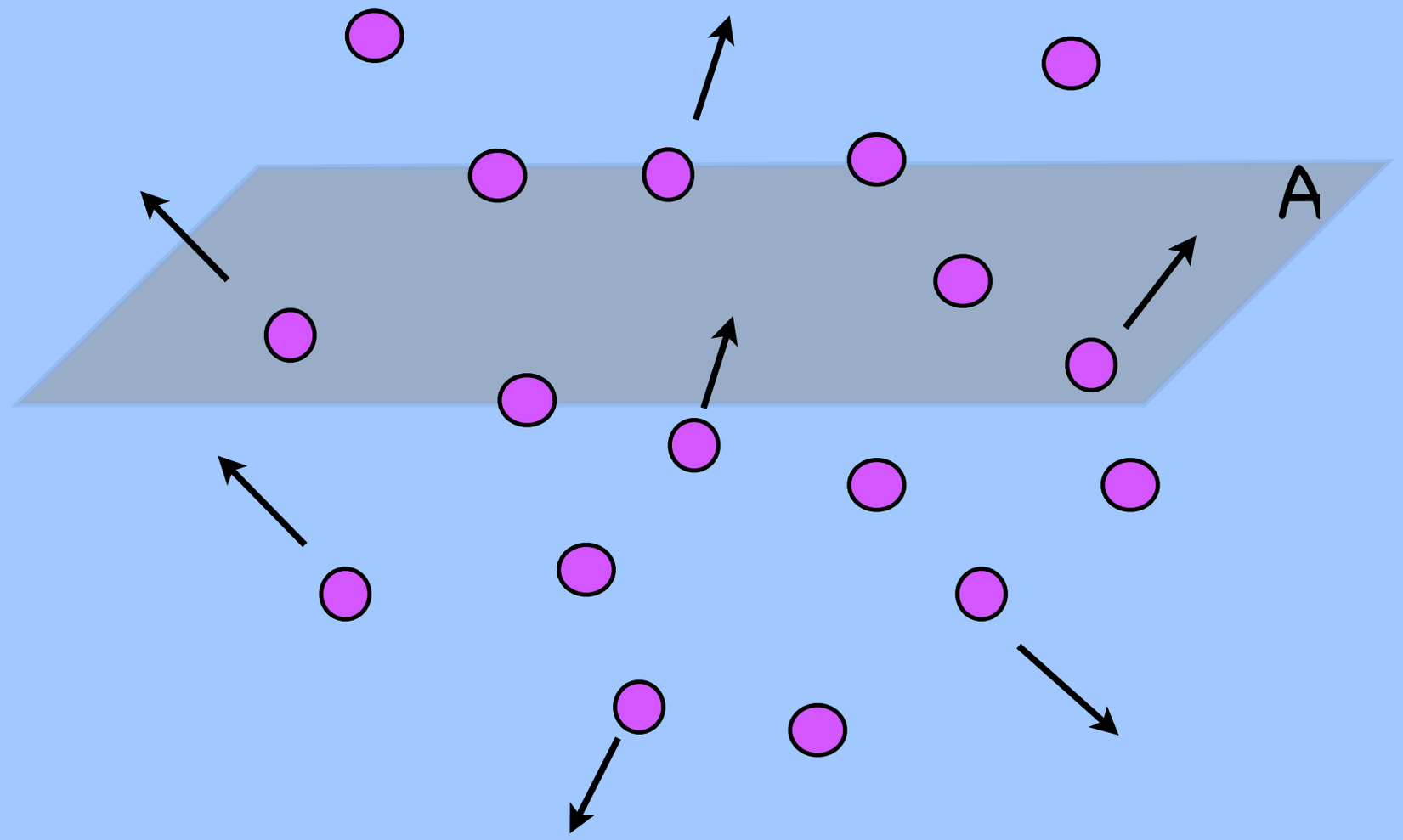
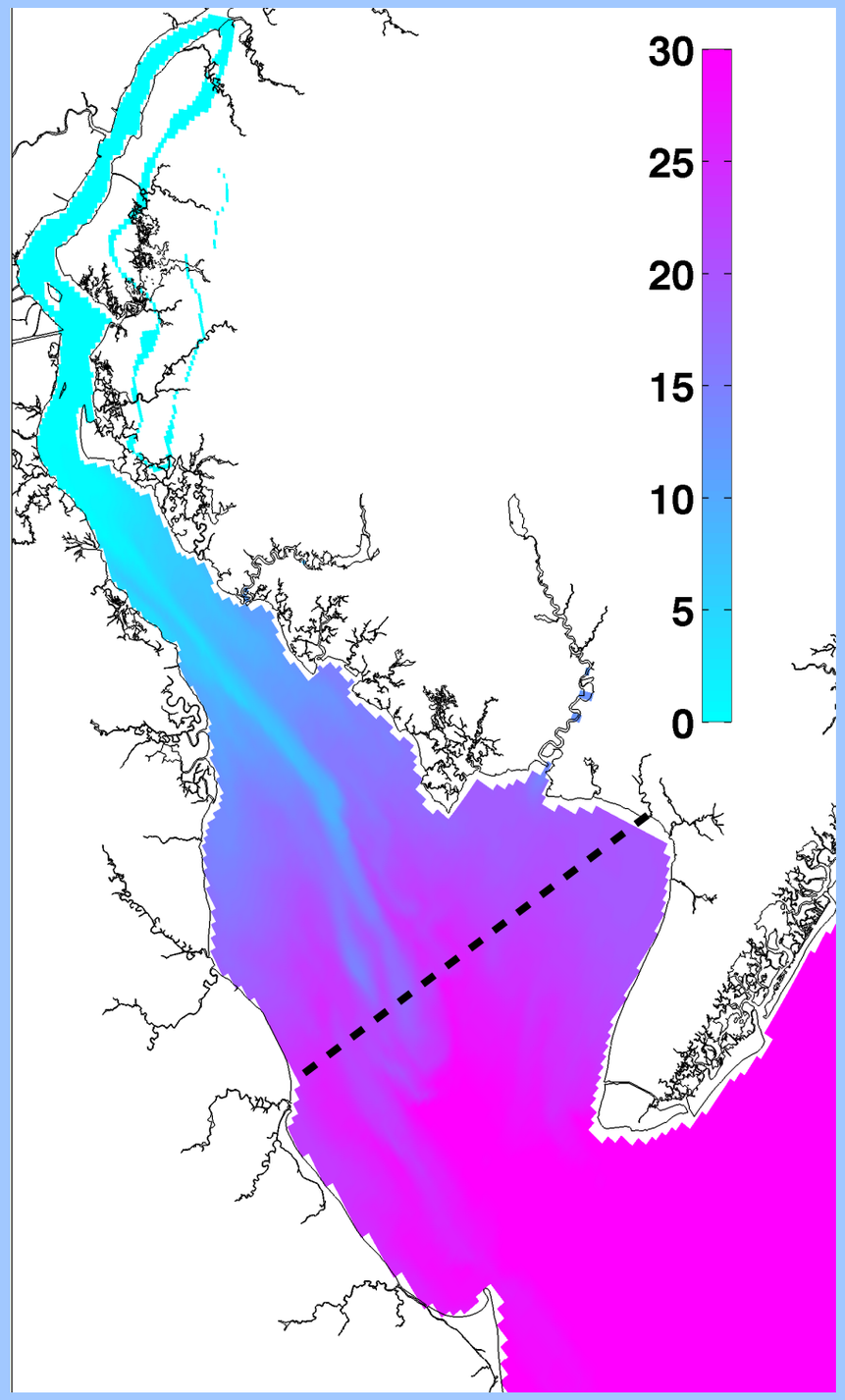




Number of particles per second = Dispersion rate = Flux

Salt flux mechanisms



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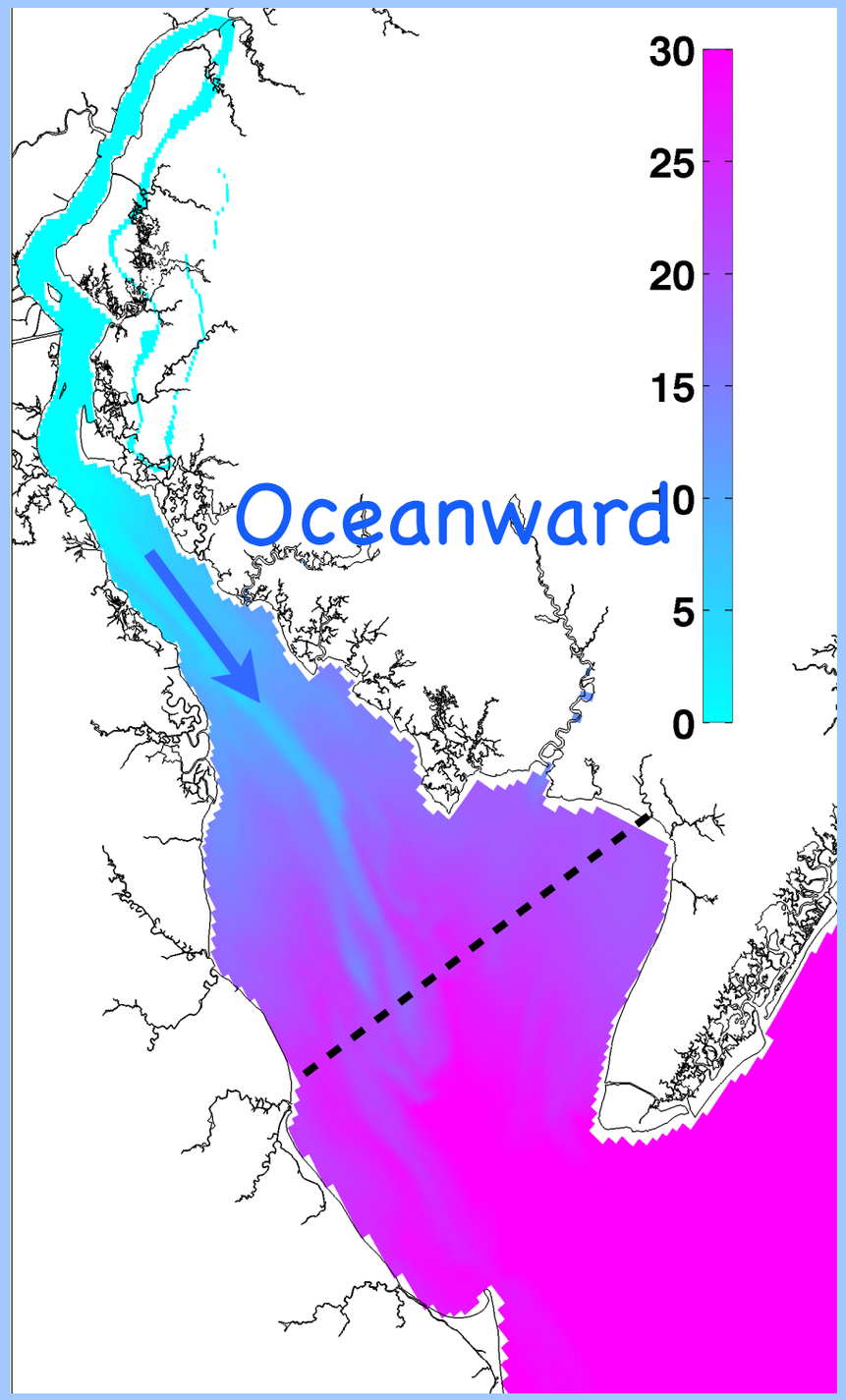
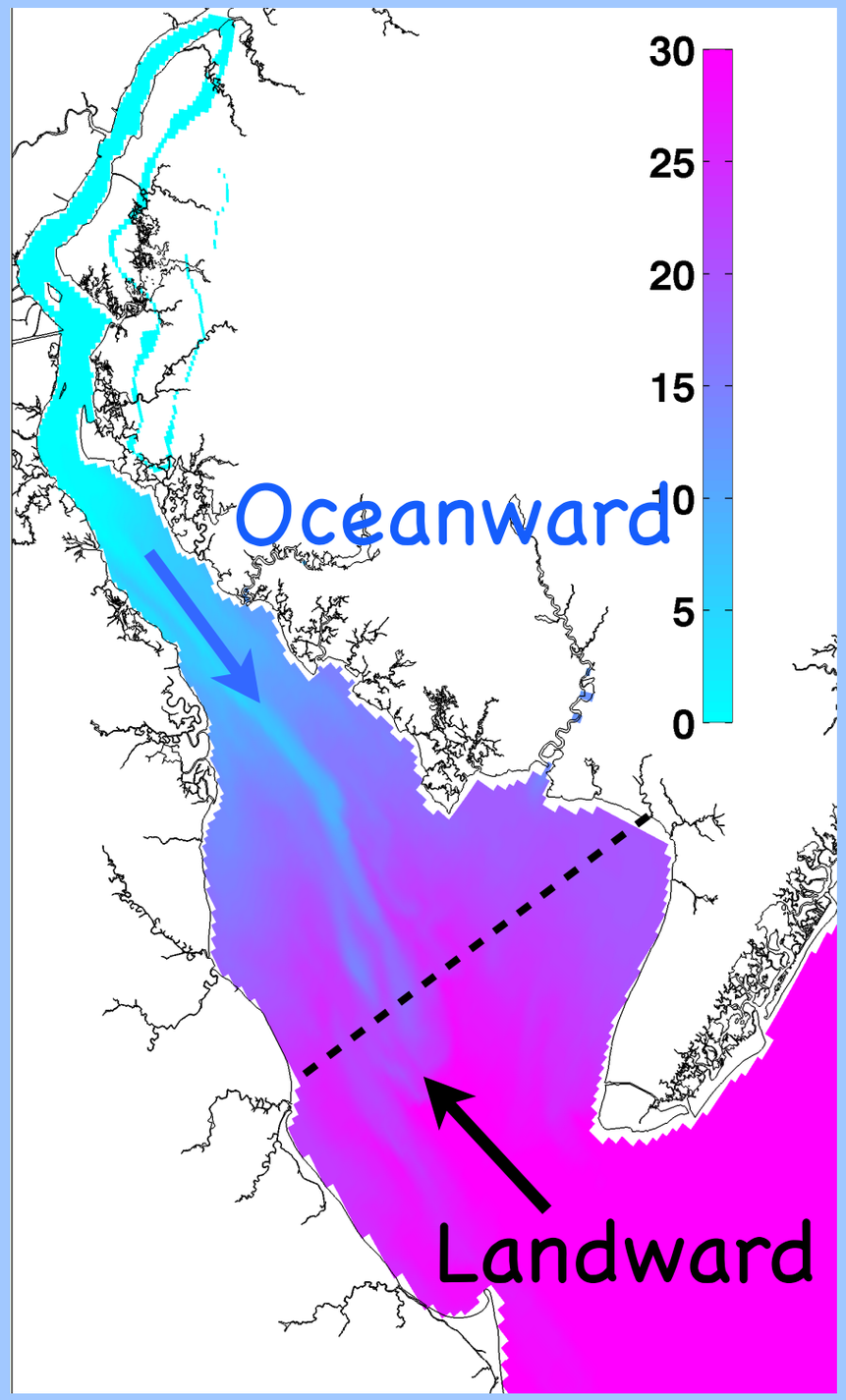


Oceanward salt flux by the river outflow

$$F_0 = Q_0 S_0$$

Salt flux mechanisms



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Landward salt fluxes

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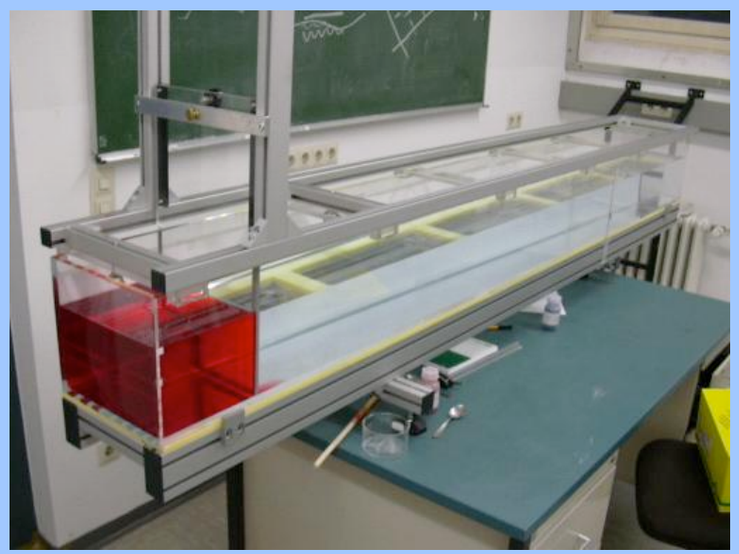

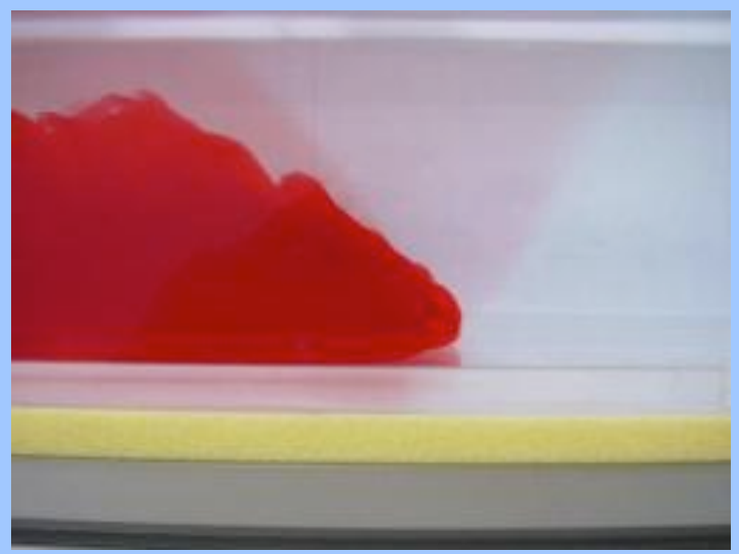

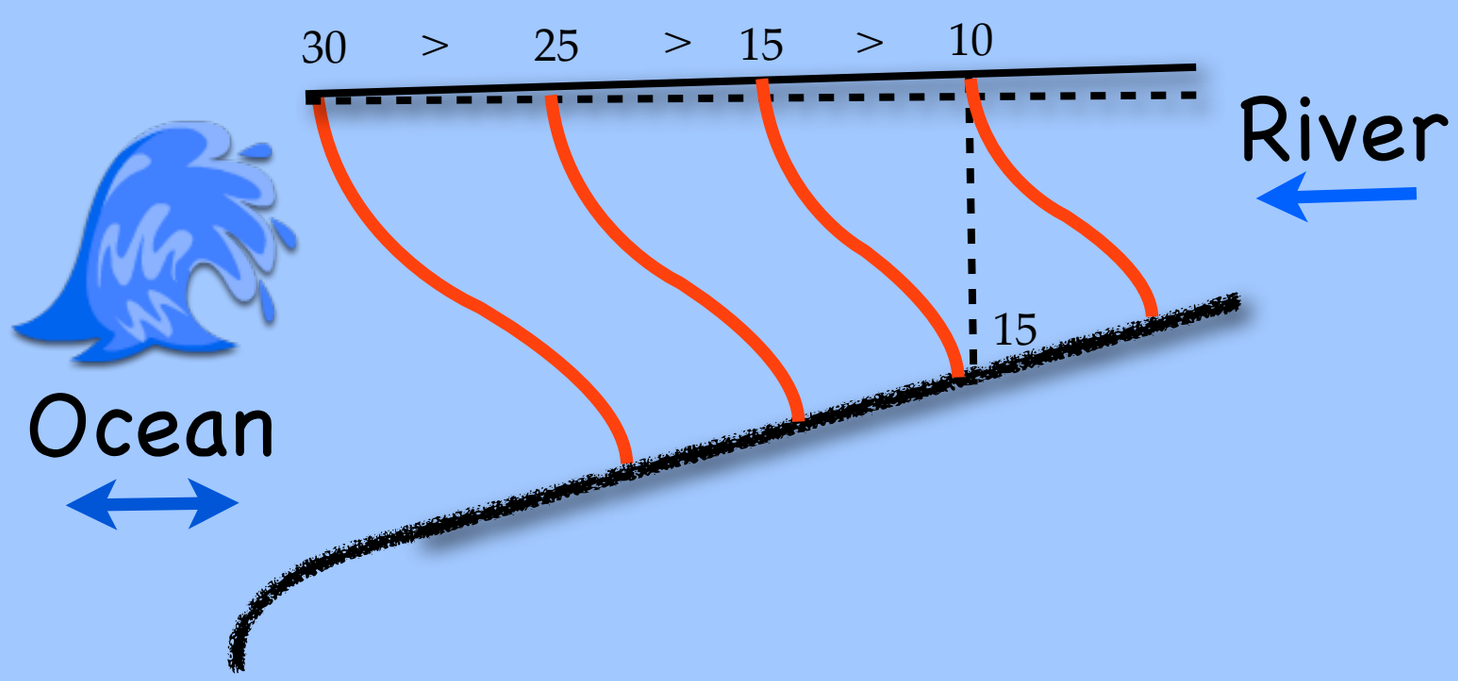

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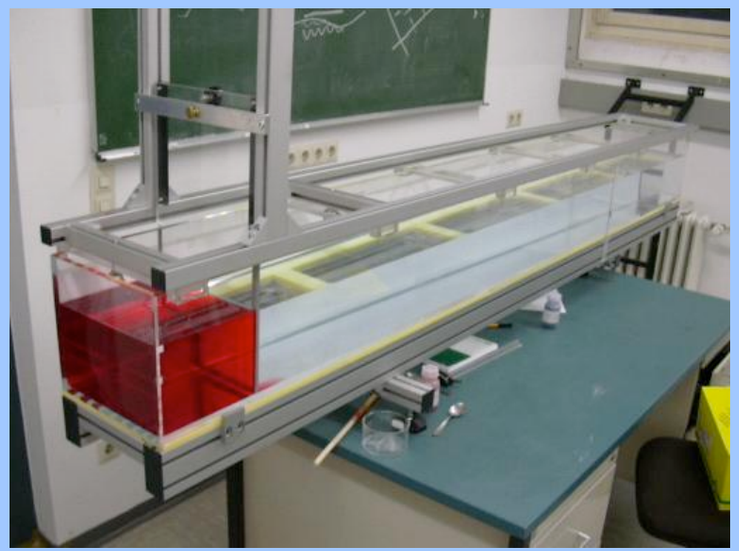

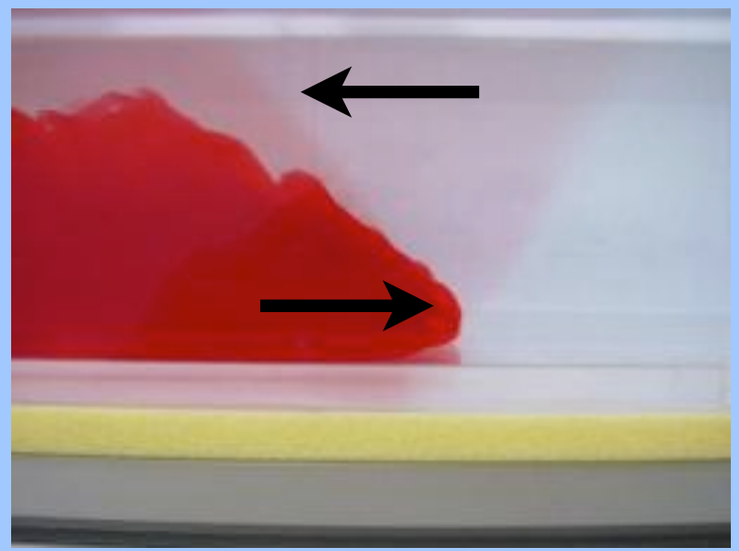

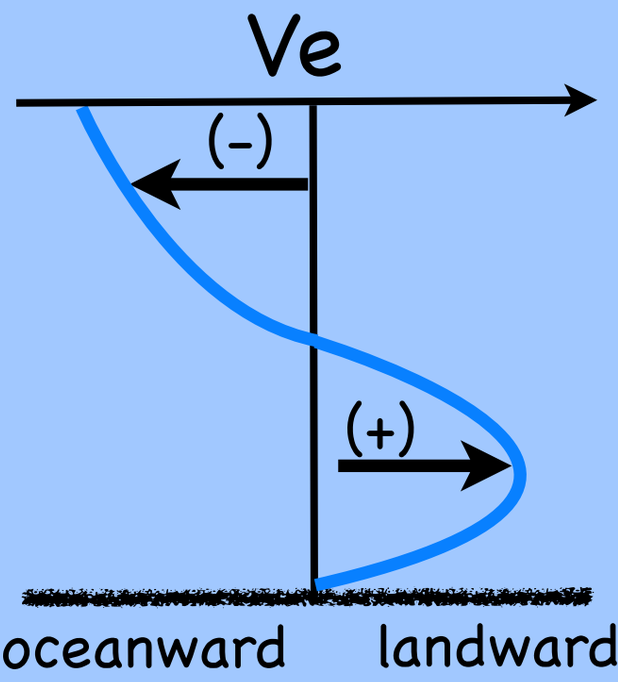

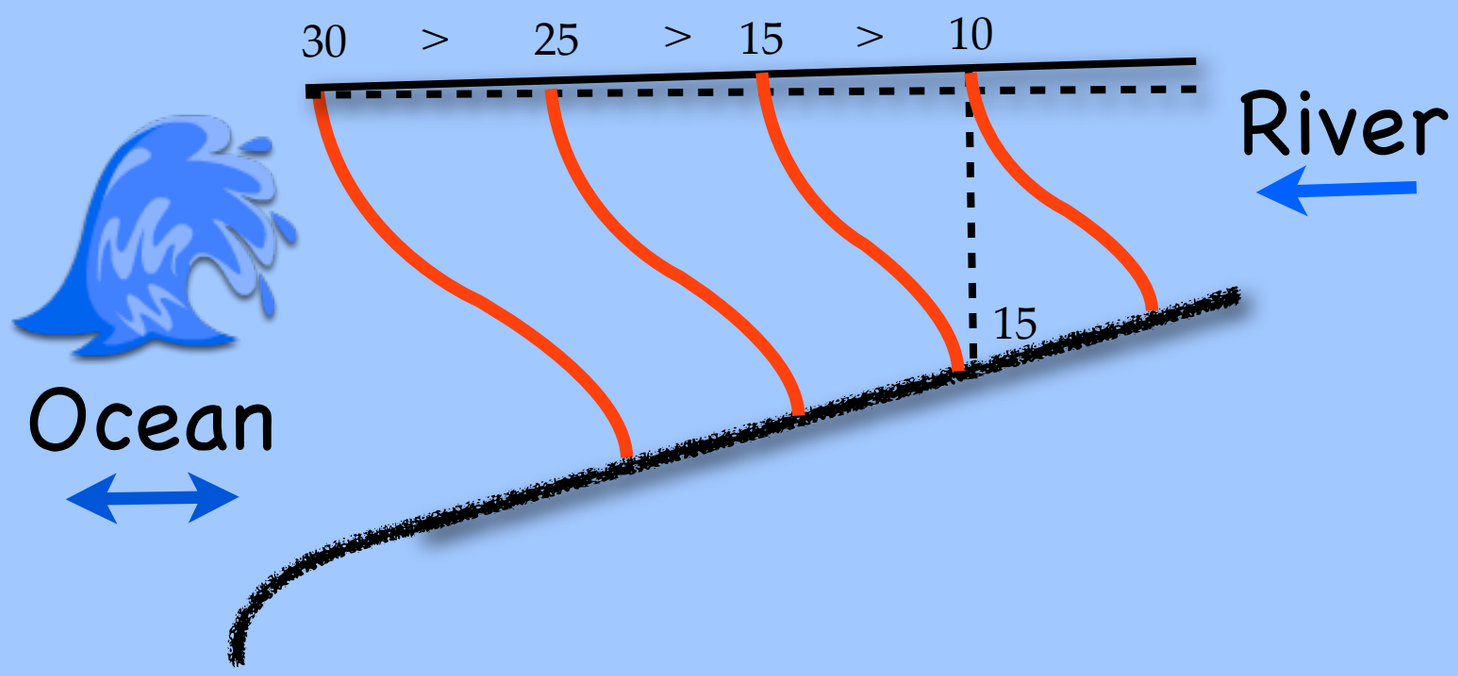

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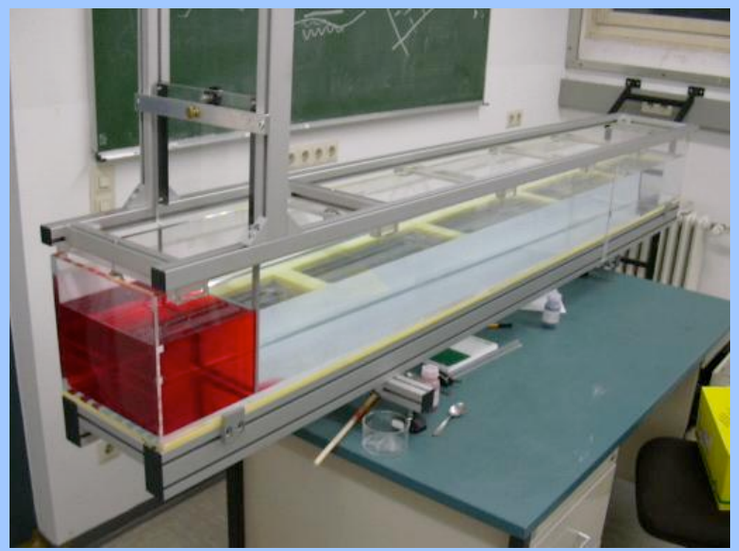
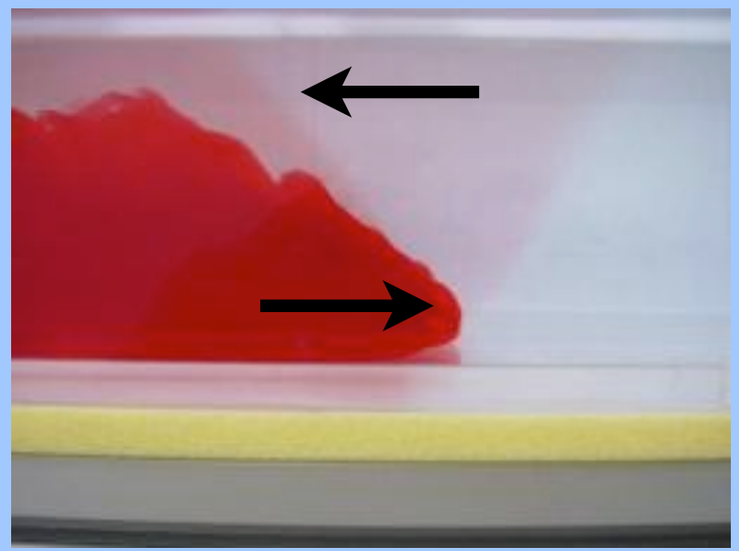
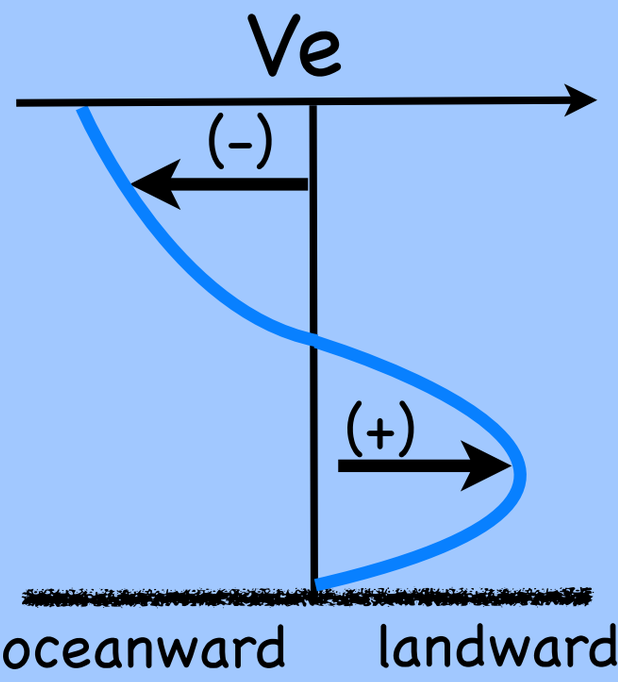
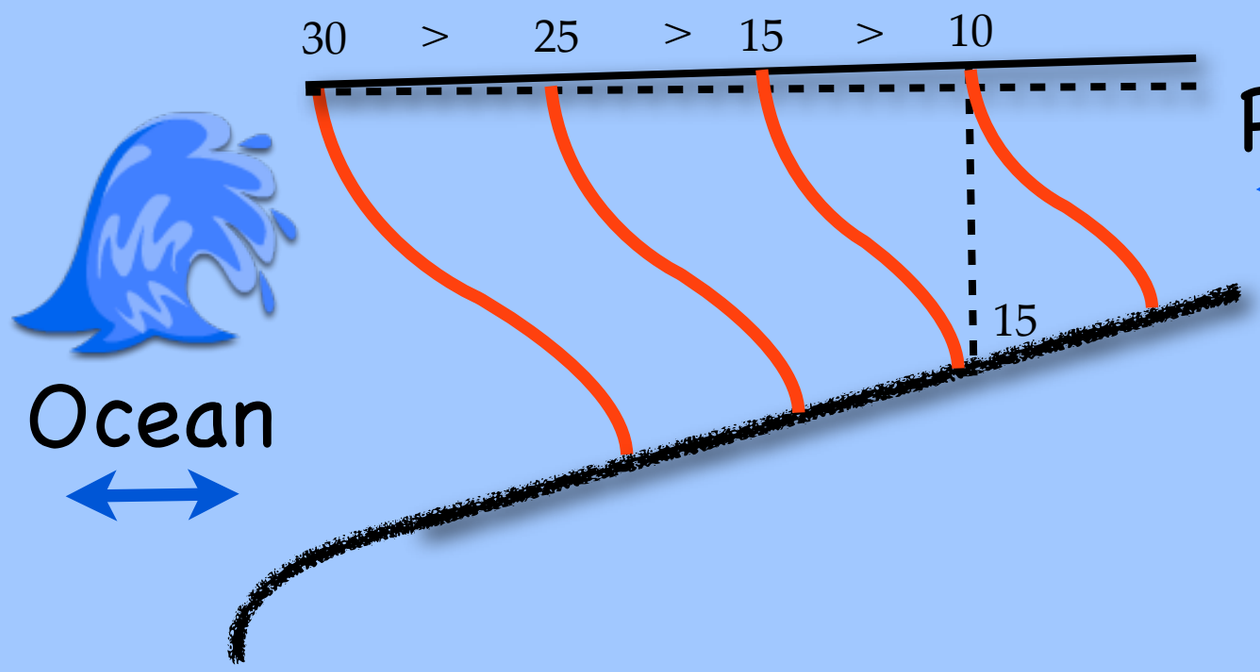




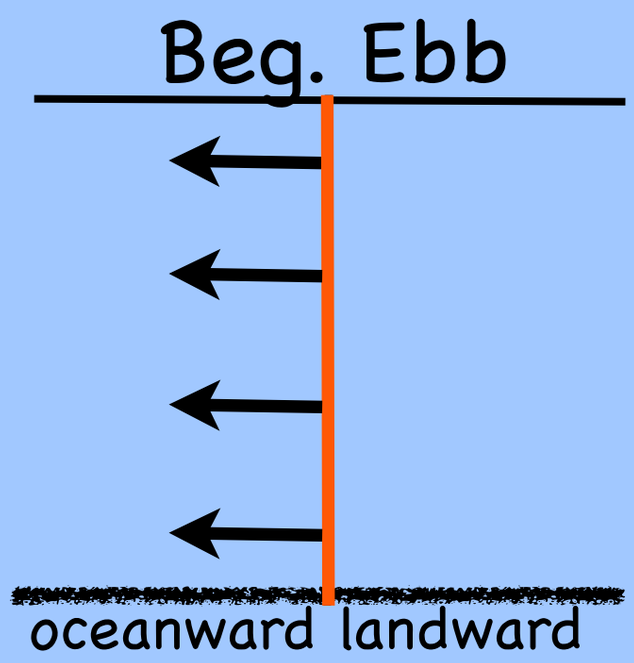




Net salt flux > 0

Landward salt fluxes

2) Tidal salt flux:



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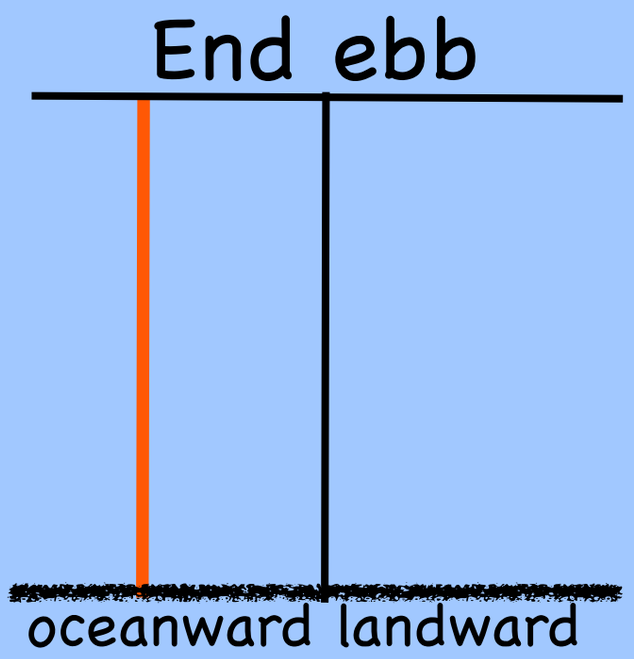

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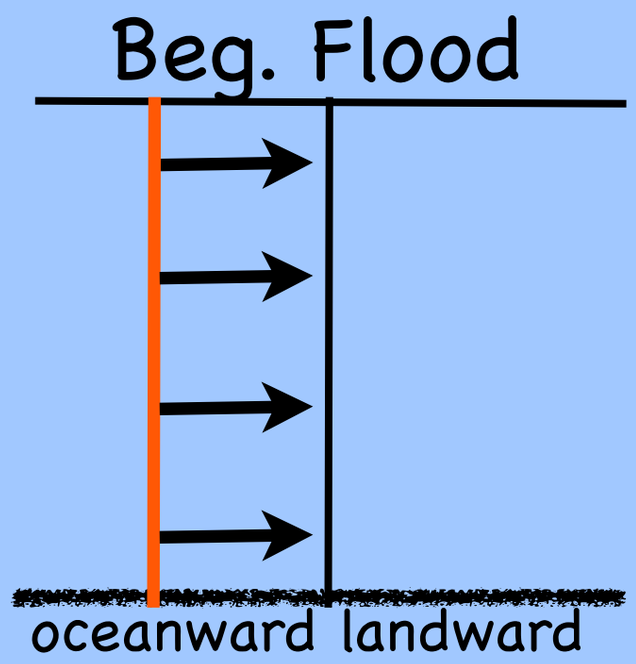

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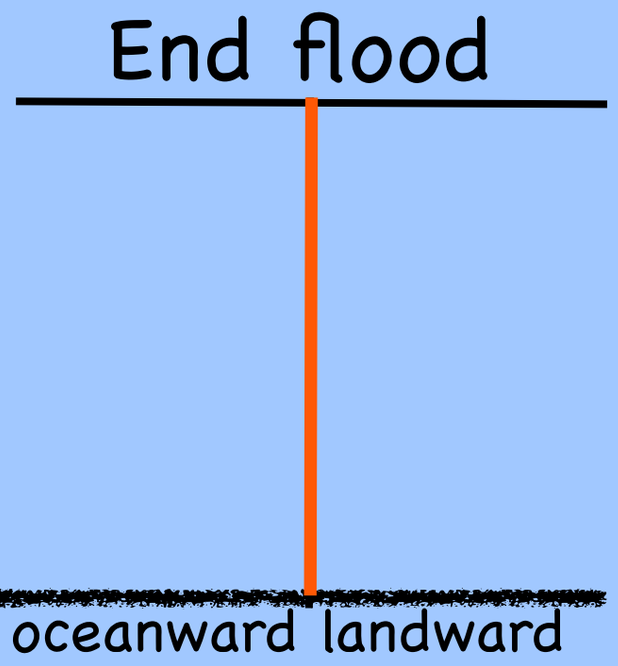

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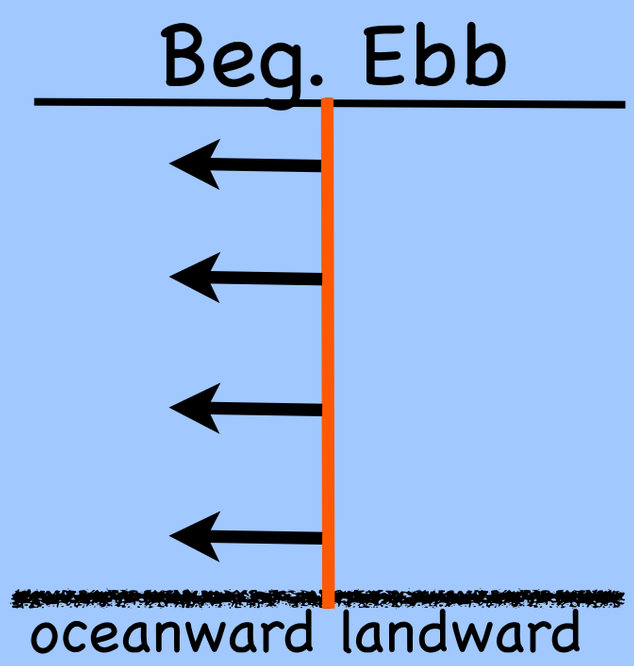

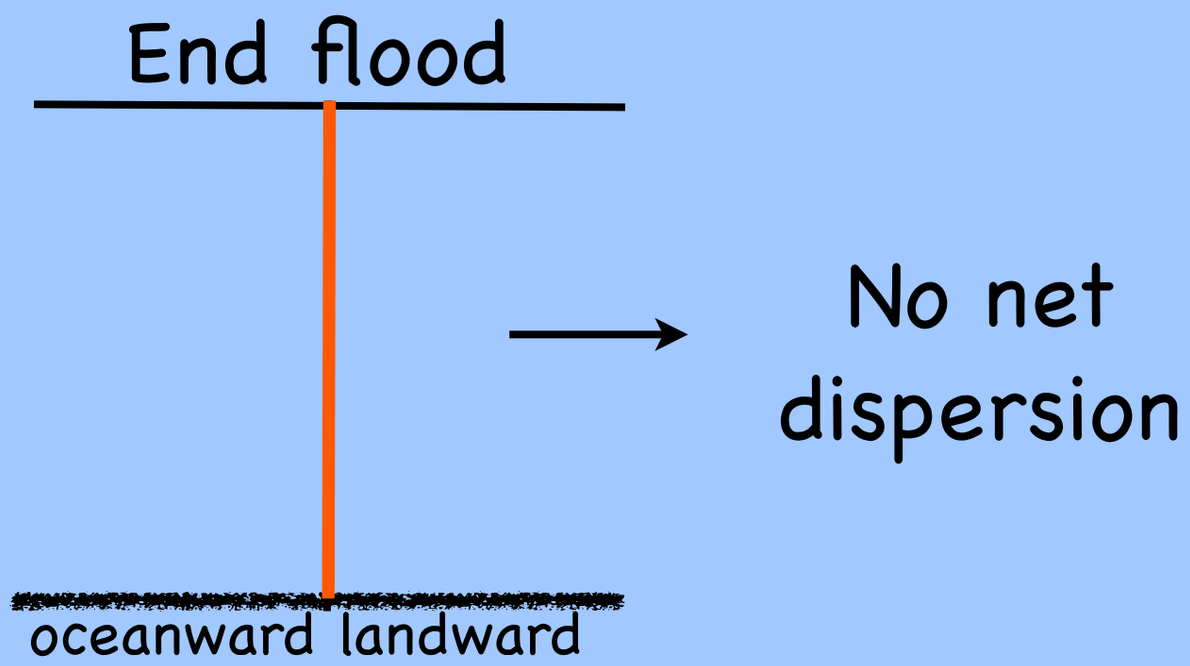

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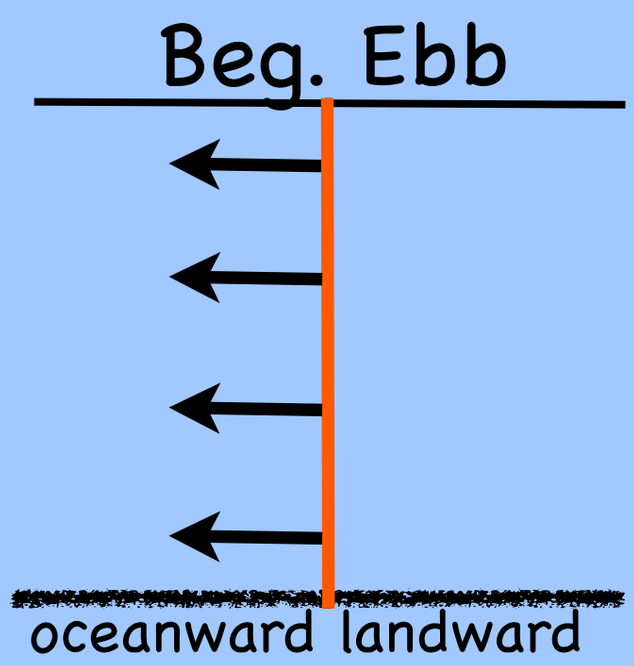

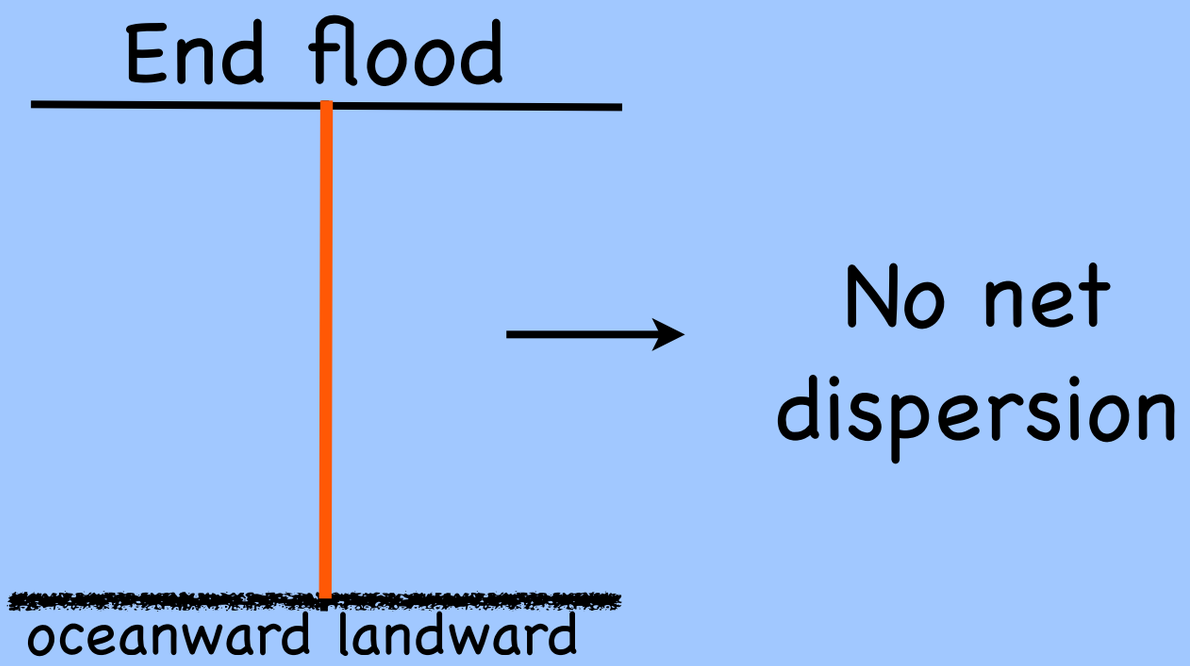

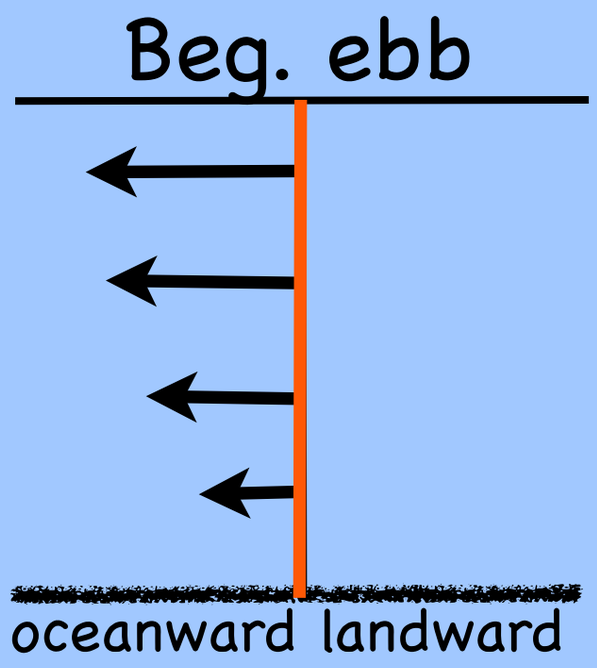

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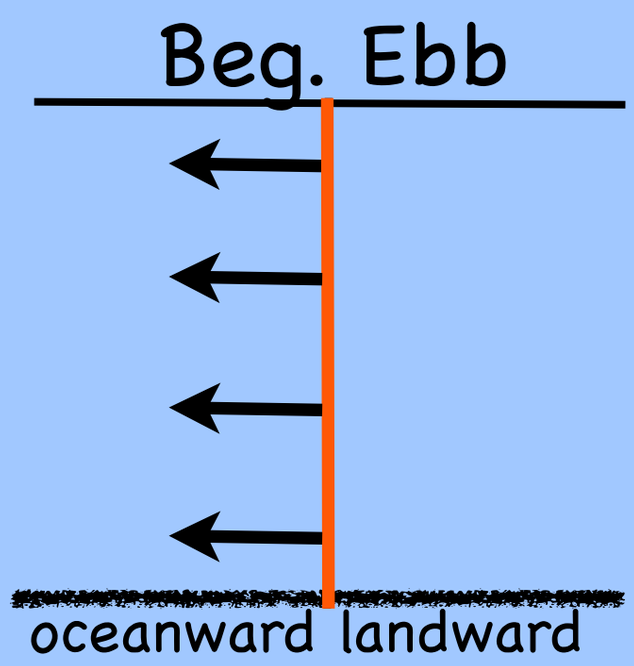
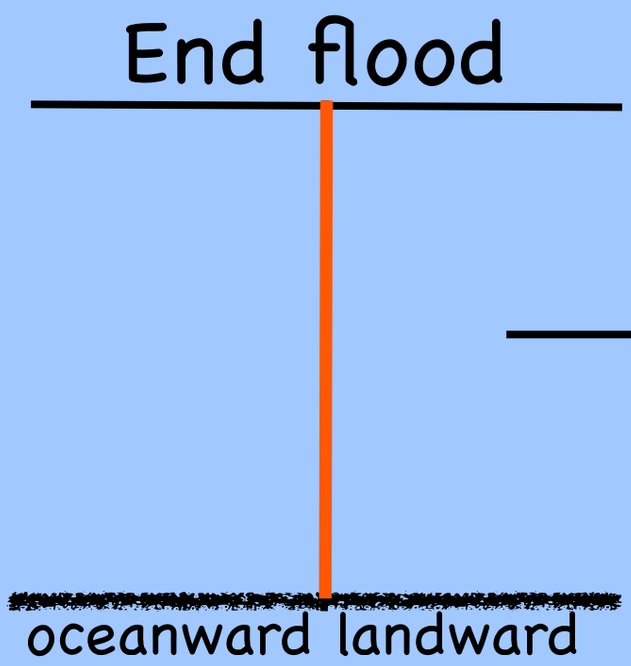
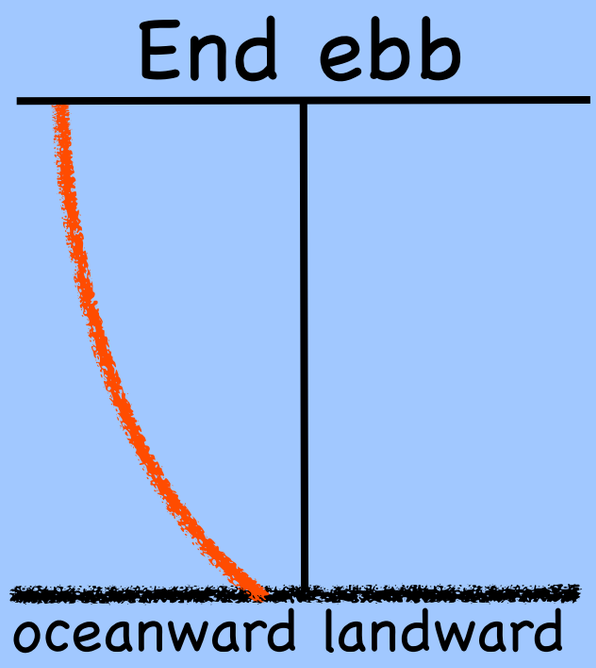




No net dispersion



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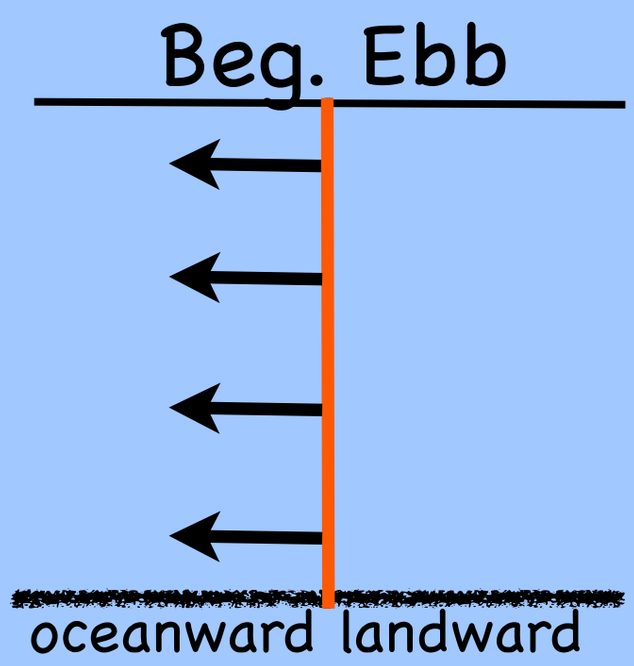

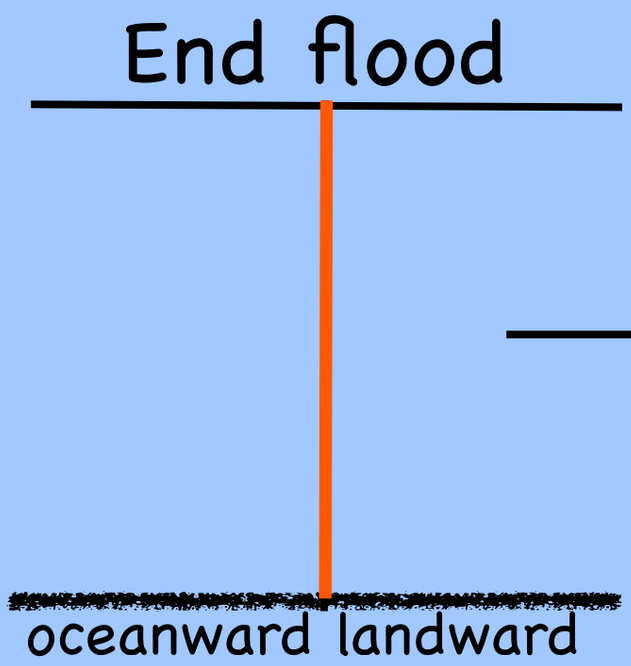

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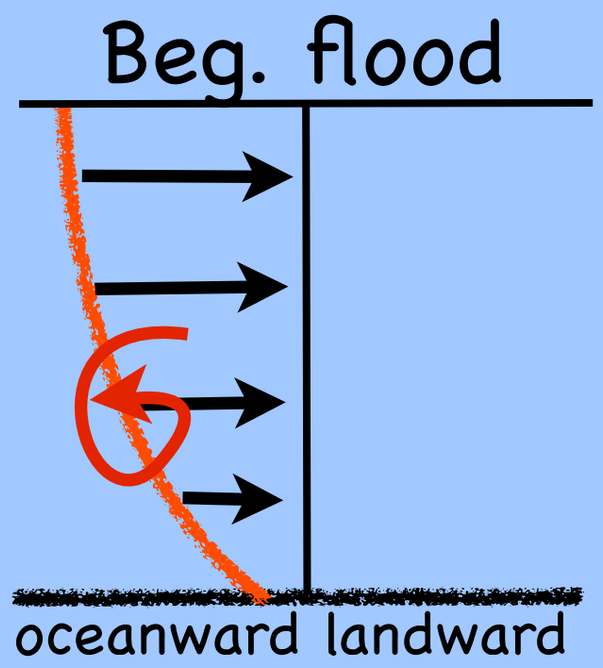

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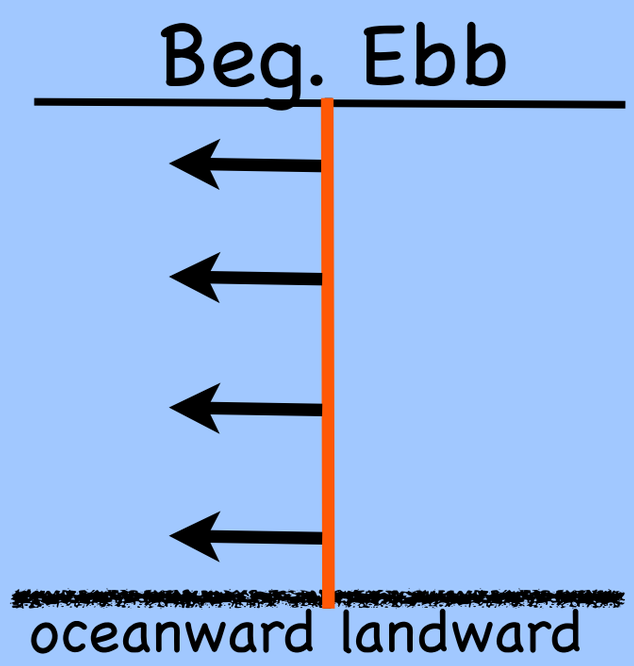

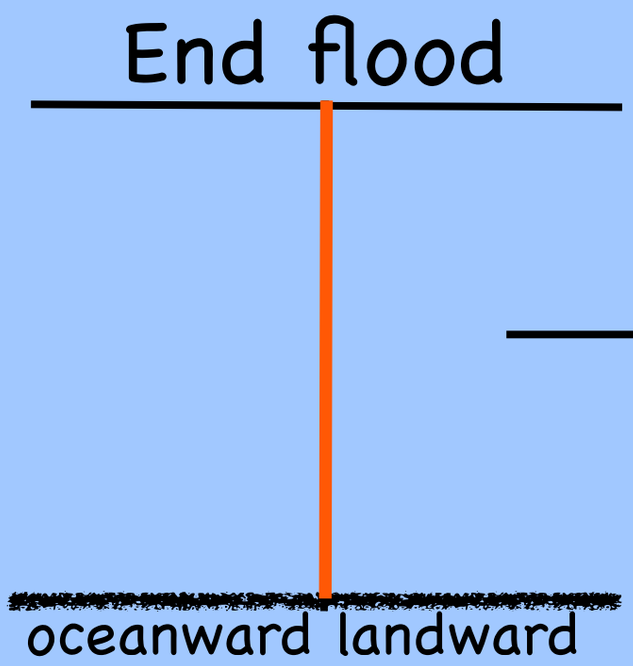

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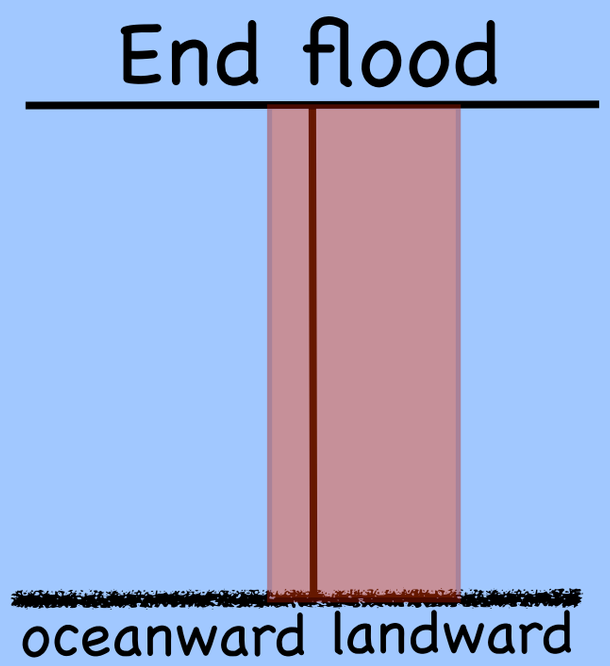

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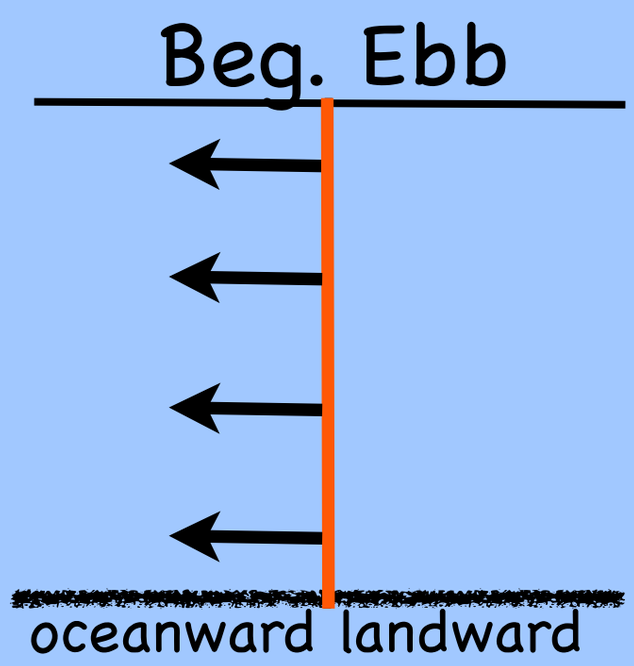

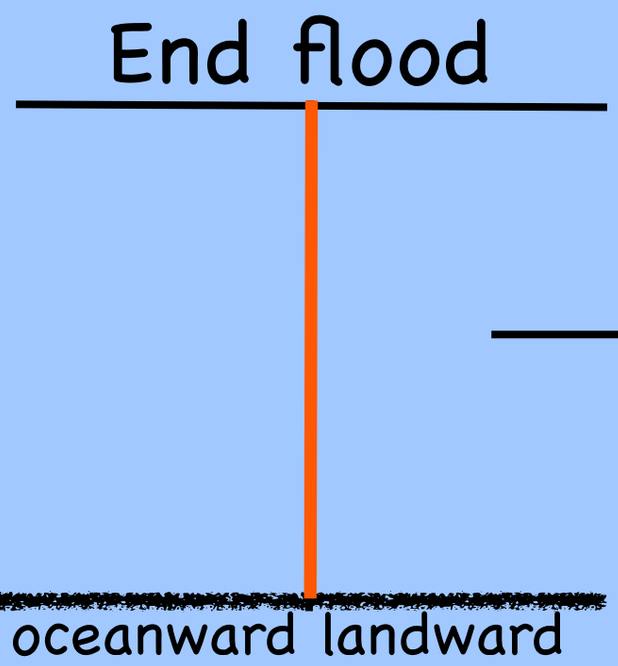

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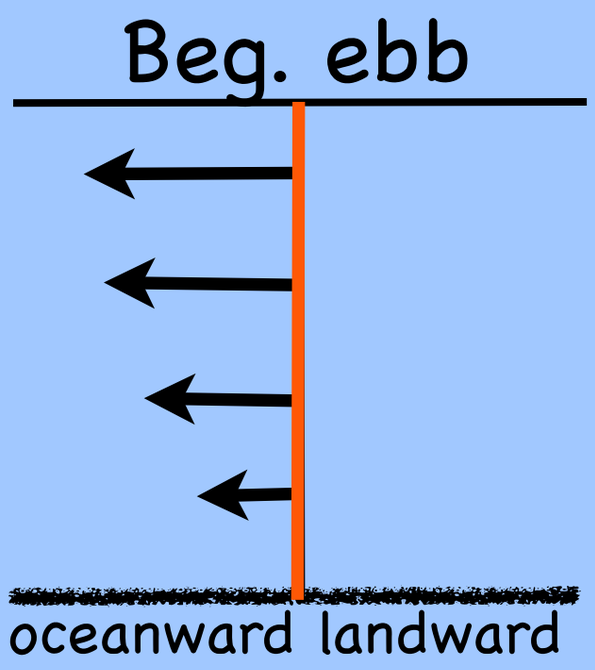
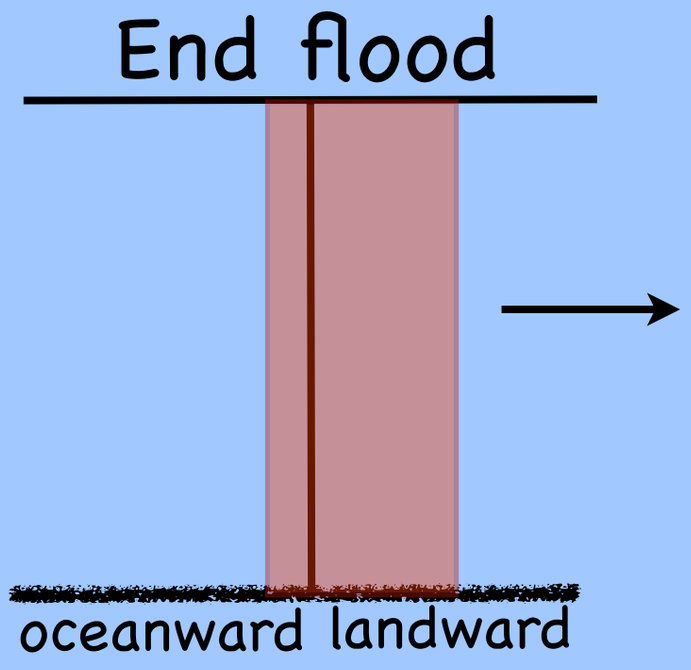
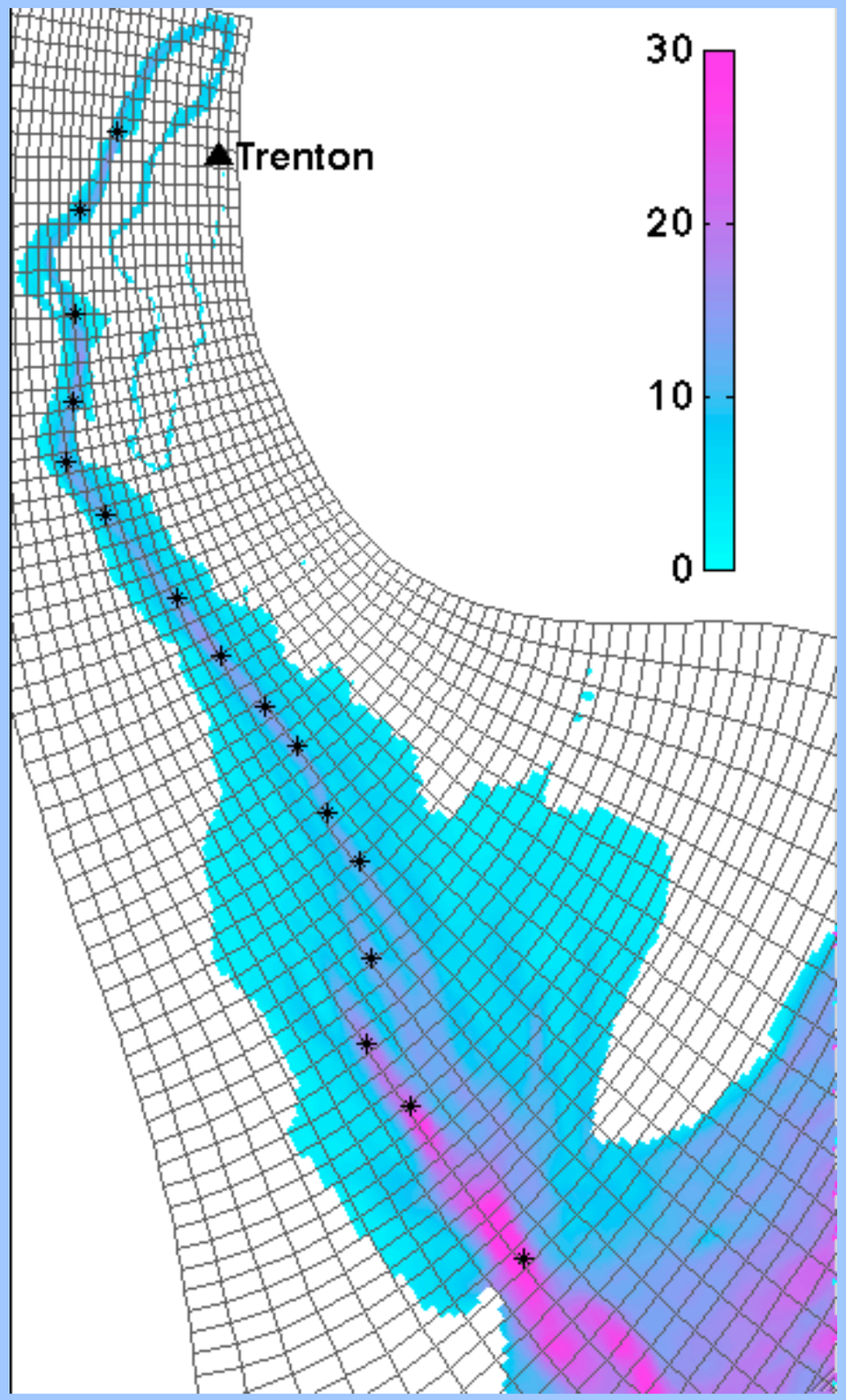


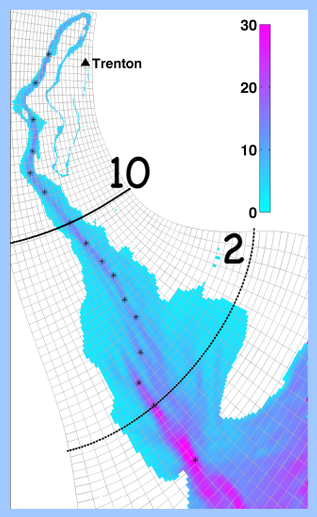


Net dispersion

Methods



- Regional Ocean Modeling System (ROMS).
- Grid horizontal resolution:
  - 1200 m at the shelf break.
  - 400 m at the upper river.
- 20 vertical terrain following levels.
- Forcing:
  - M2 and S2 tides at the boundaries.
  - River input at Trenton from 350 to 3000 m^3/s.
- 16 stations along the estuary.



Results

Area integrated salt fluxes

Total Salt fluxes

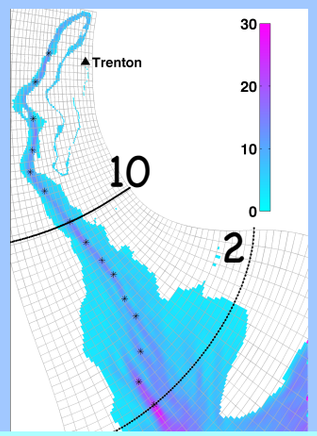
River outflow

Exchange flow

Tidal currents

$$F_s = F_0 + F_e + F_t$$

Landward salt fluxes are enhanced during neap tide therefore the system gains salt during neap and looses salt during spring tide



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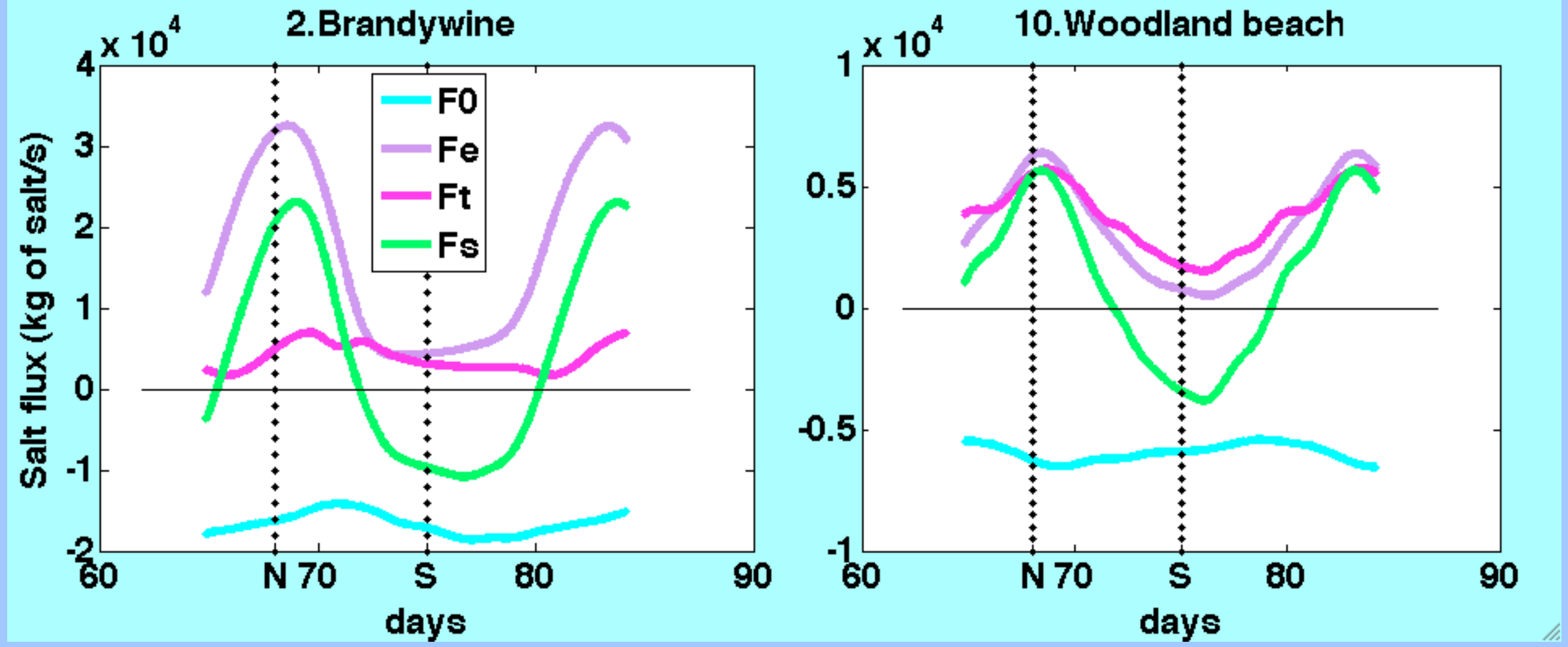

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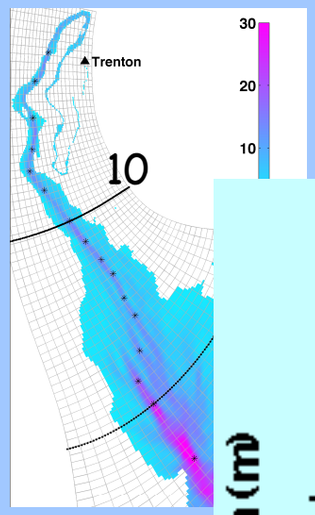
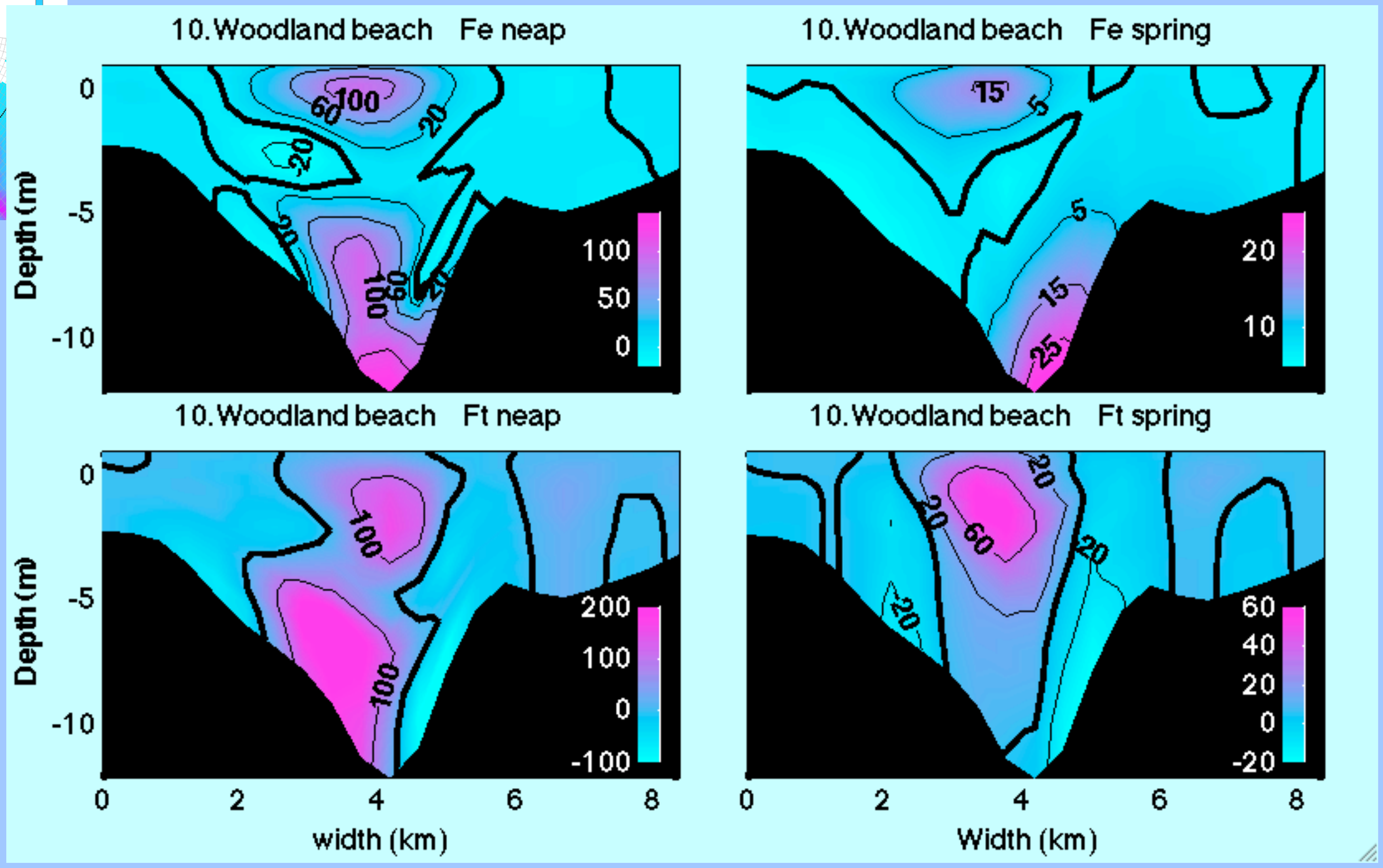
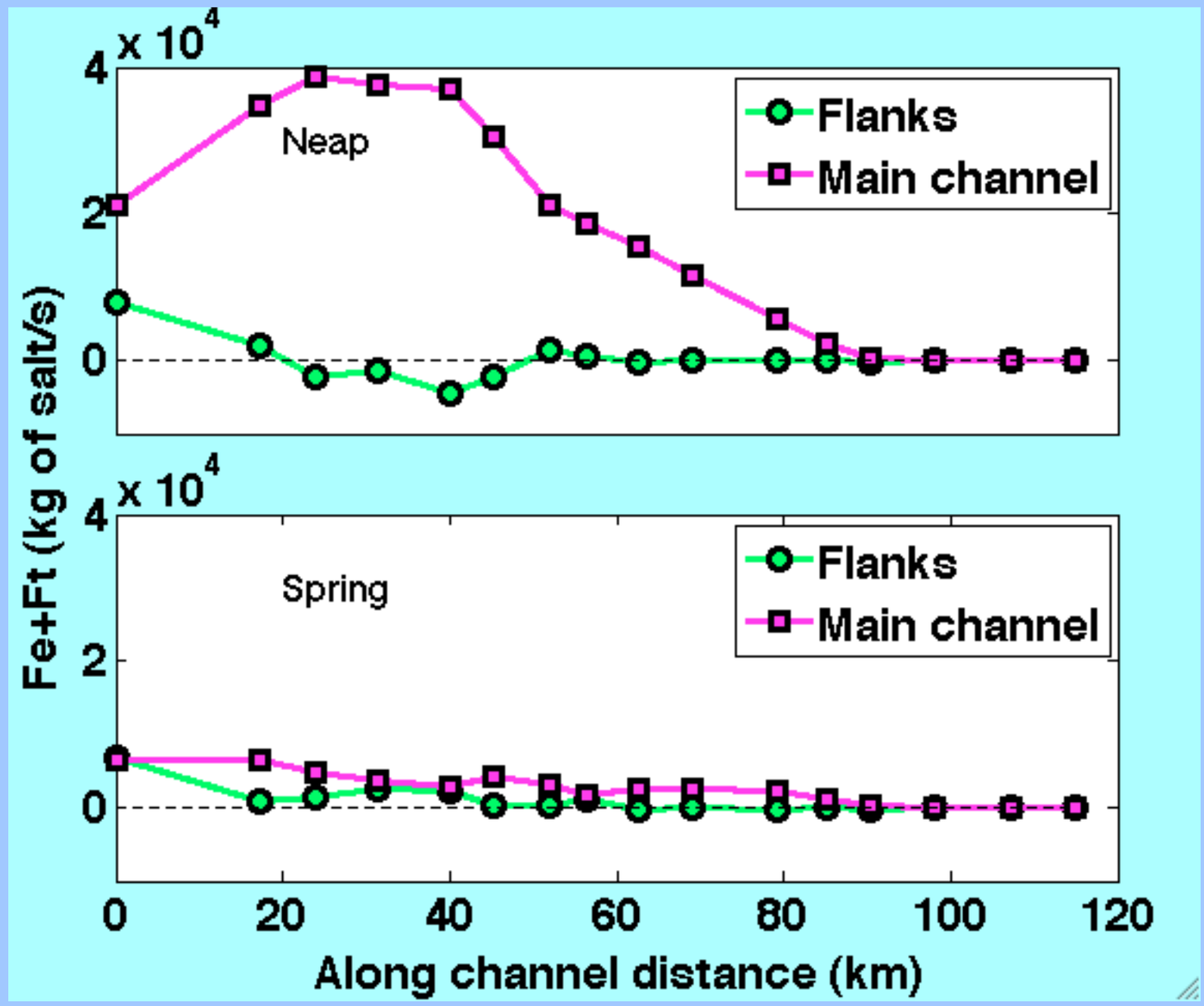




Landward salt fluxes occur mainly in the main channel during neap tide. The deepening of the main channel can change the salt fluxes in the system.

Landward salt flux



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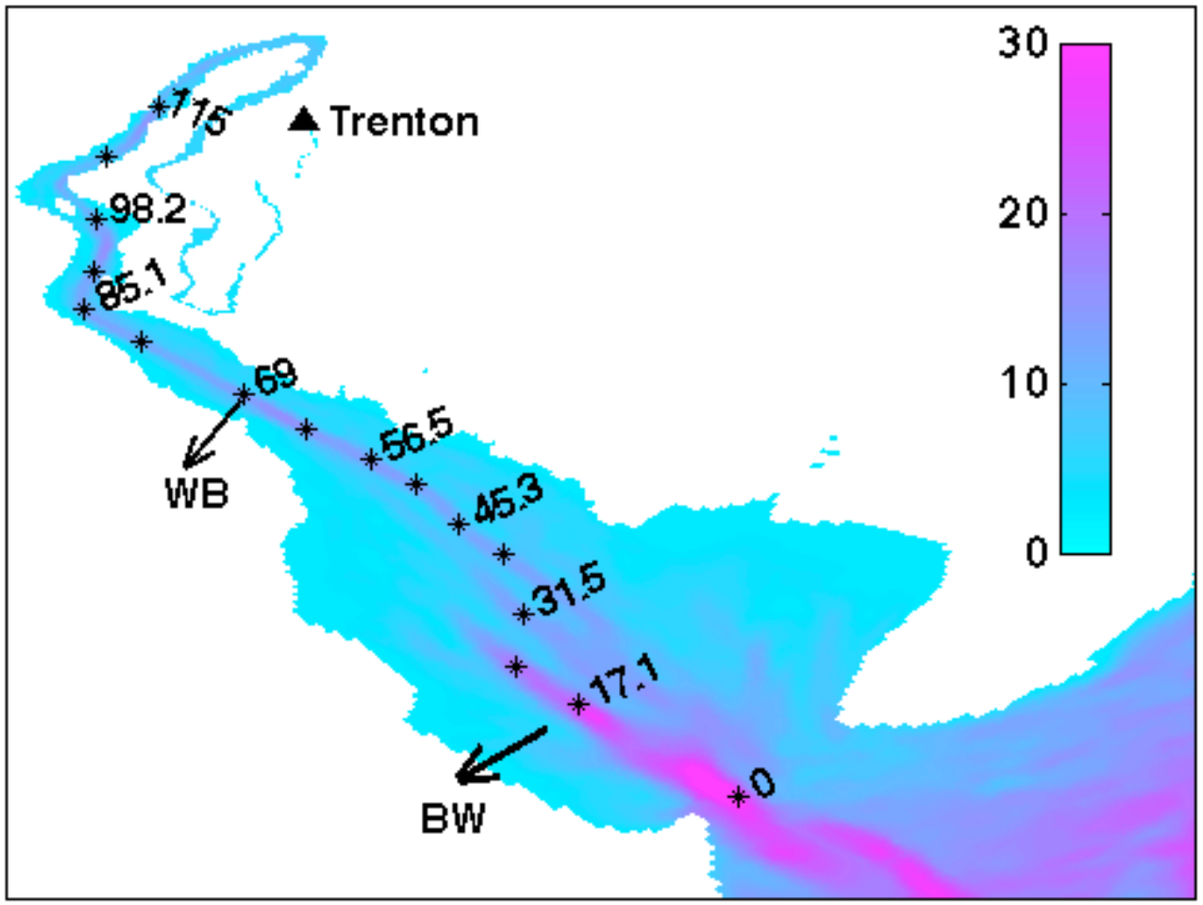
Response of salt intrusion length with river discharge



Salt intrusion length (Lo) in Delaware Bay is quite insensitive to river discharge.

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Paulson 1970 and Garvine et al. 1992

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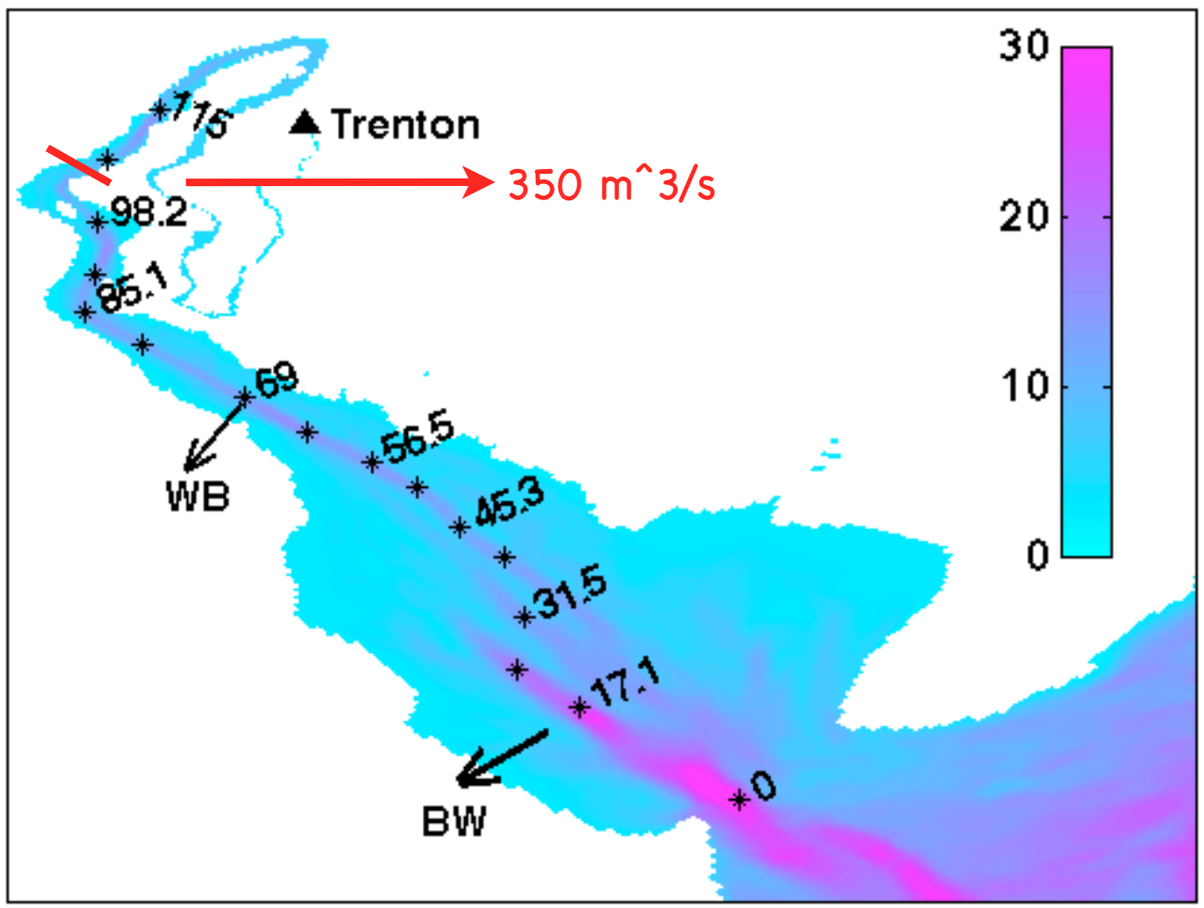

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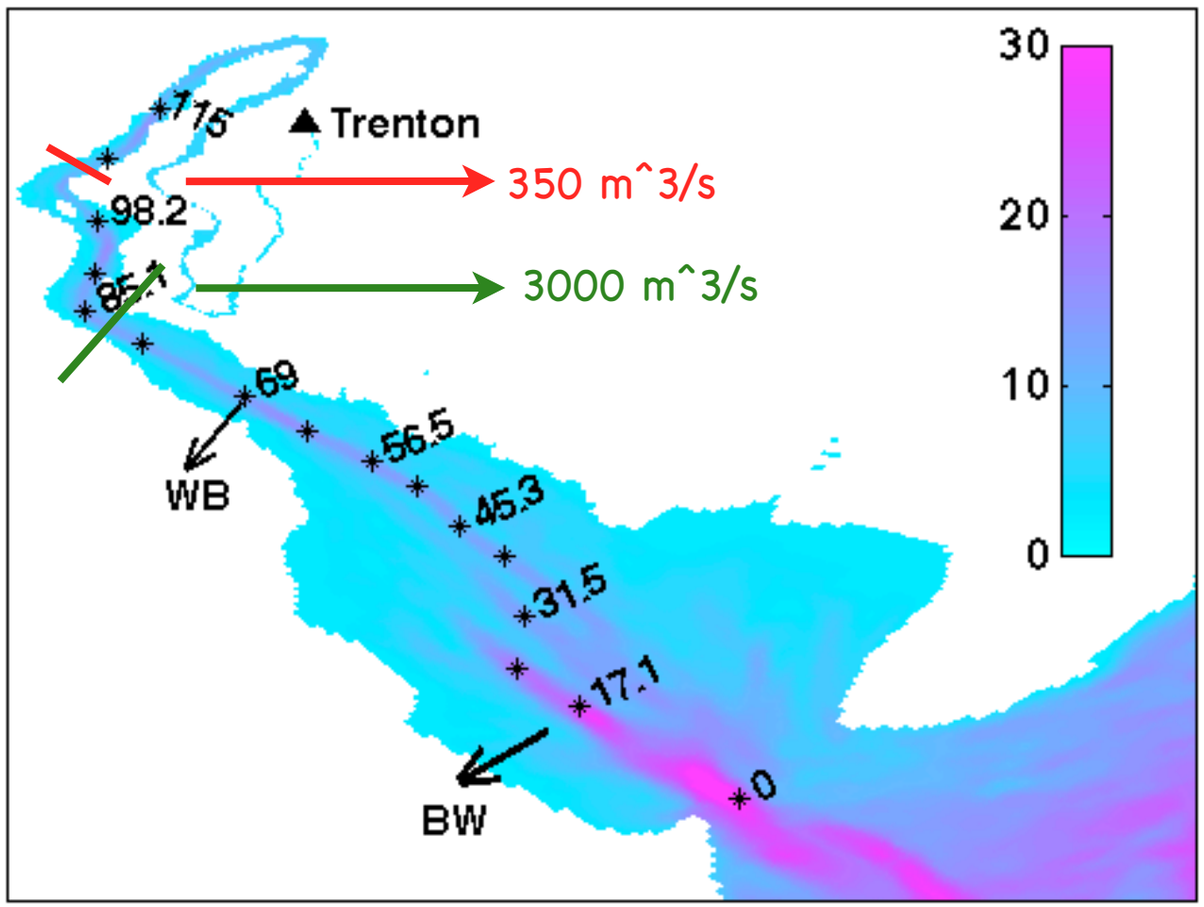

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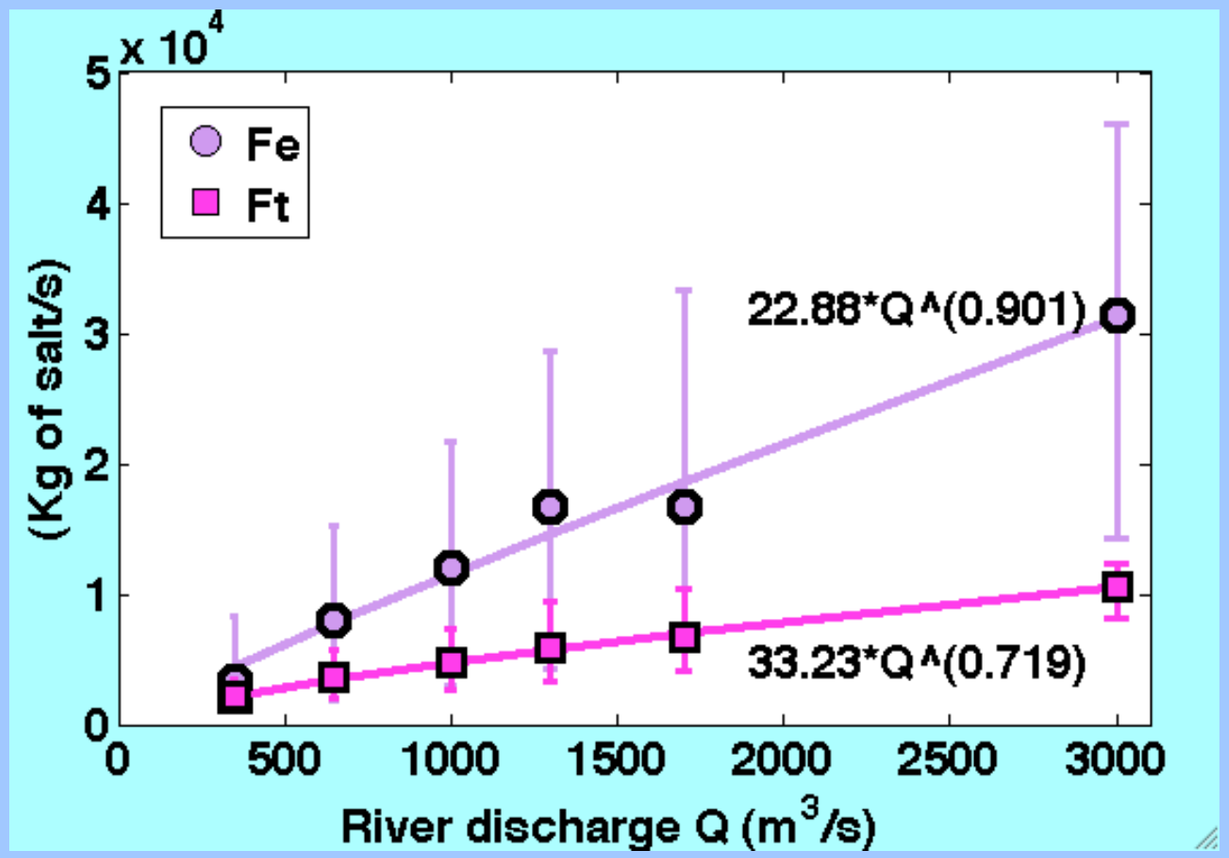
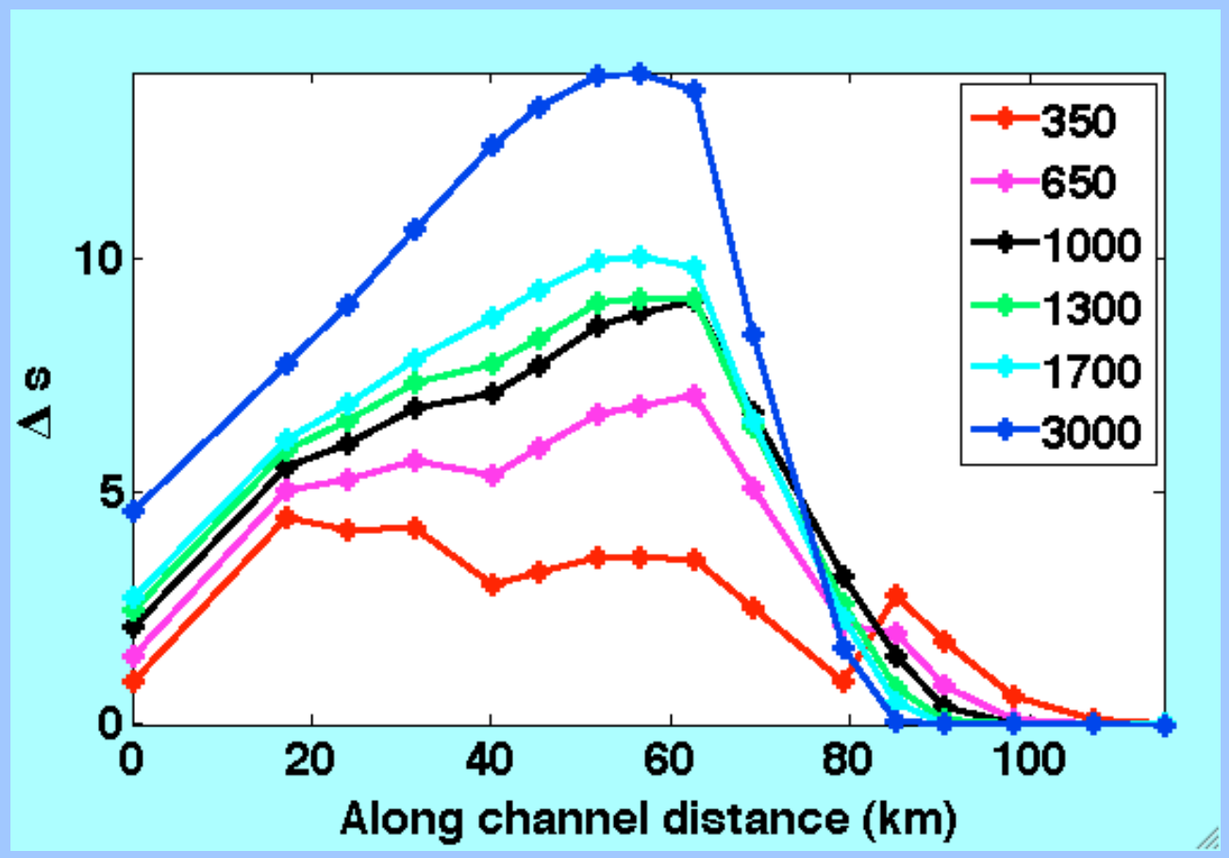
Why causes this insensitivity of Lo with Q?





- Both Fe and Ft depend on Q. For low Q Fe and Ft have a similar magnitudes. For high Q Fe dominates.

- For high Q stratification is enhanced which allows the salt to travel further upstream and then L0 stiffens.

Conclusions

- The system gains salt during neap tide and loses salt during spring tide.
- Landward salt fluxes occur mostly in the main channel during neap tide. This is due to increased stratification.
- Salt intrusion length is quite insensitive in Delaware Bay. This is because for high Q Fe dominates and at the same time stratification is enhanced (mixing is suppressed). This allows the salt to migrate further upstream.