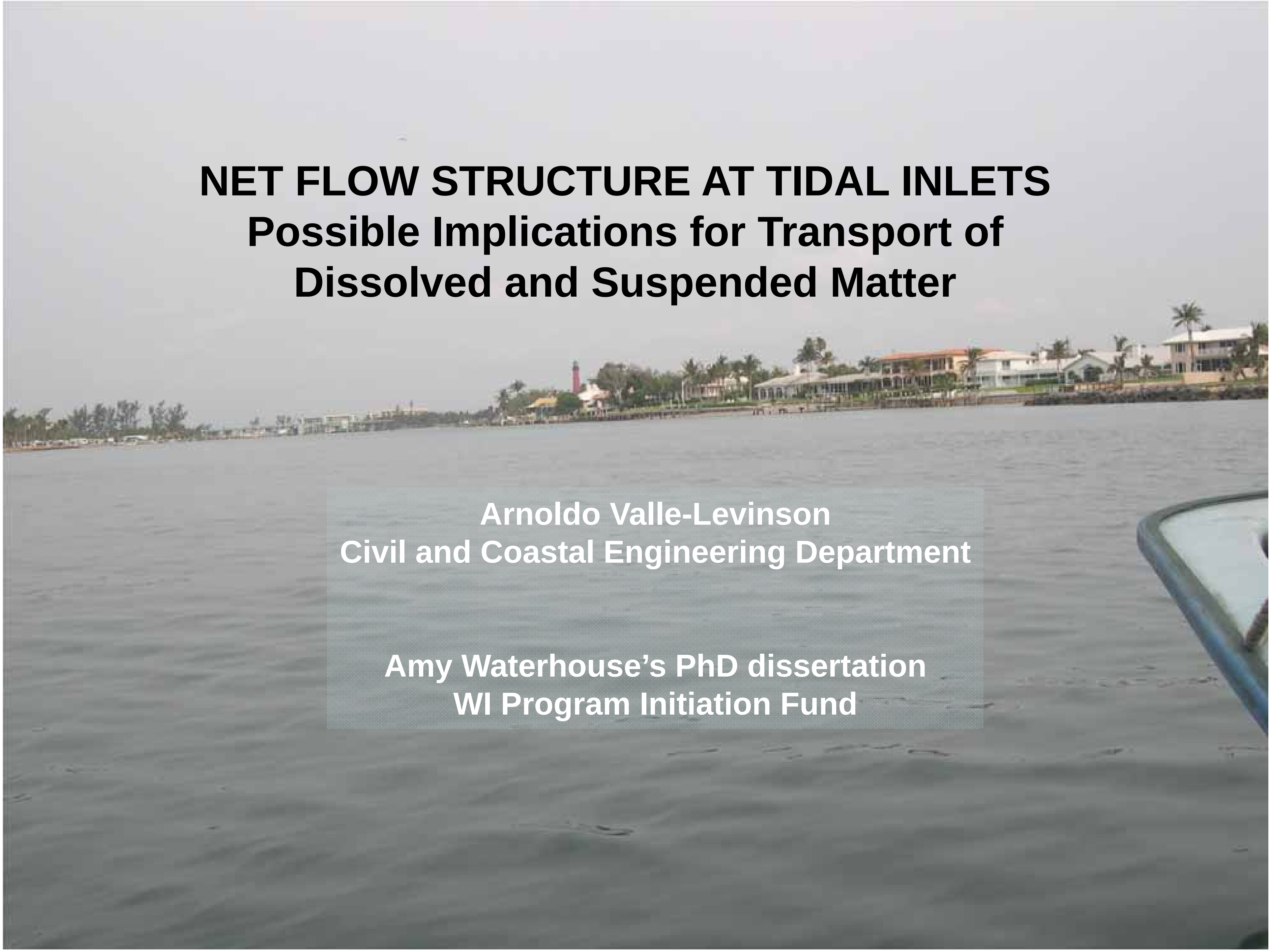
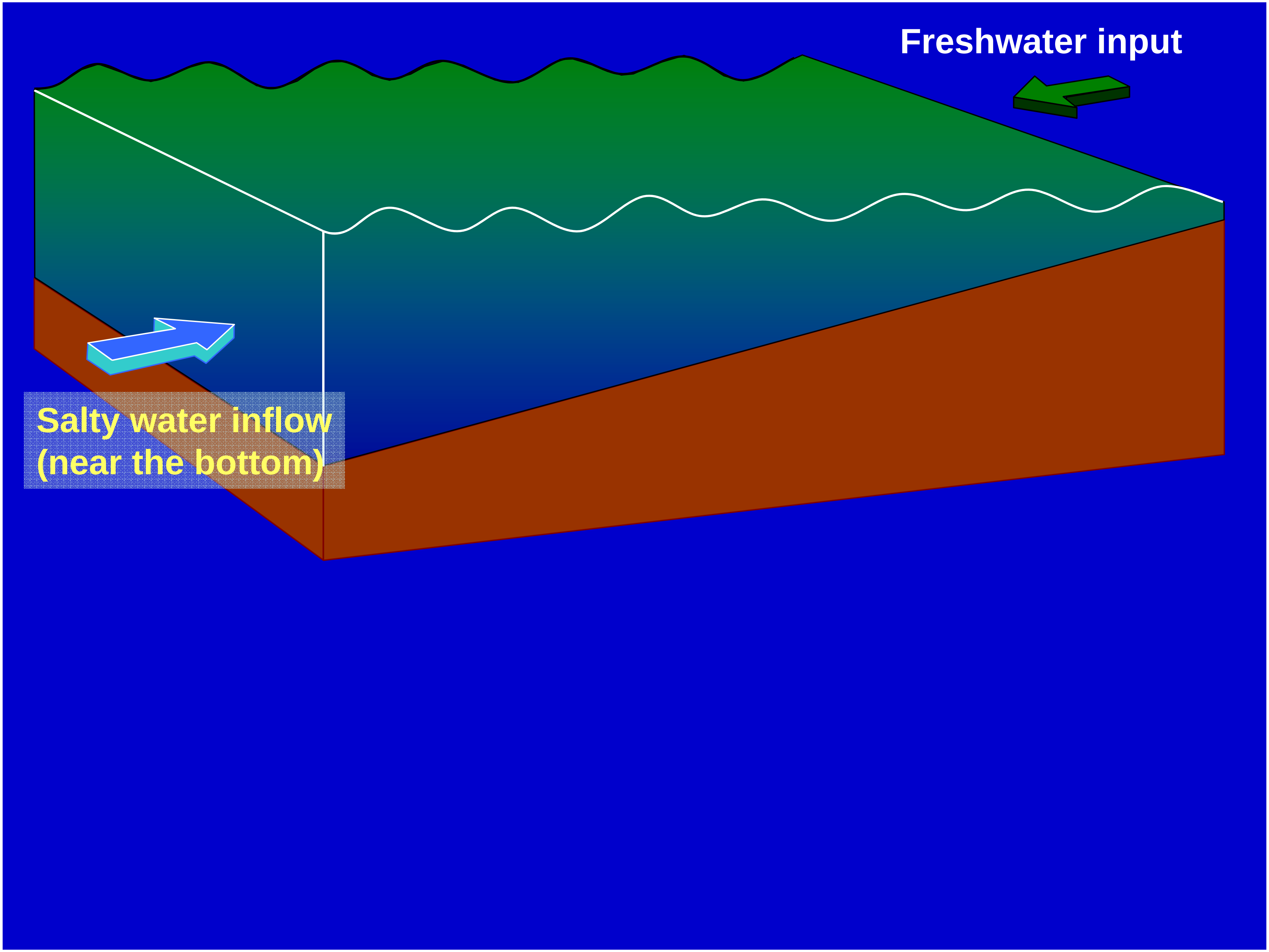
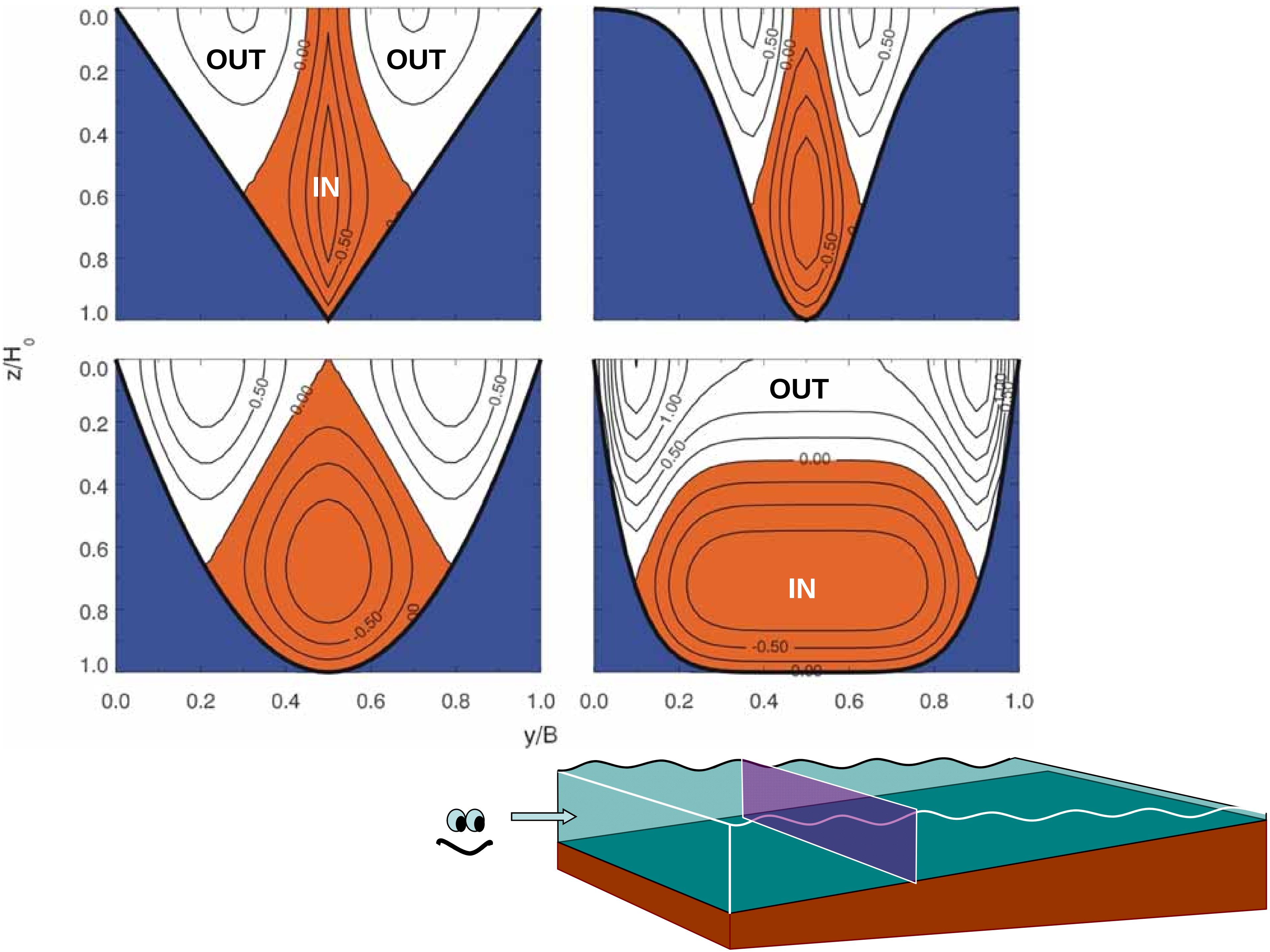


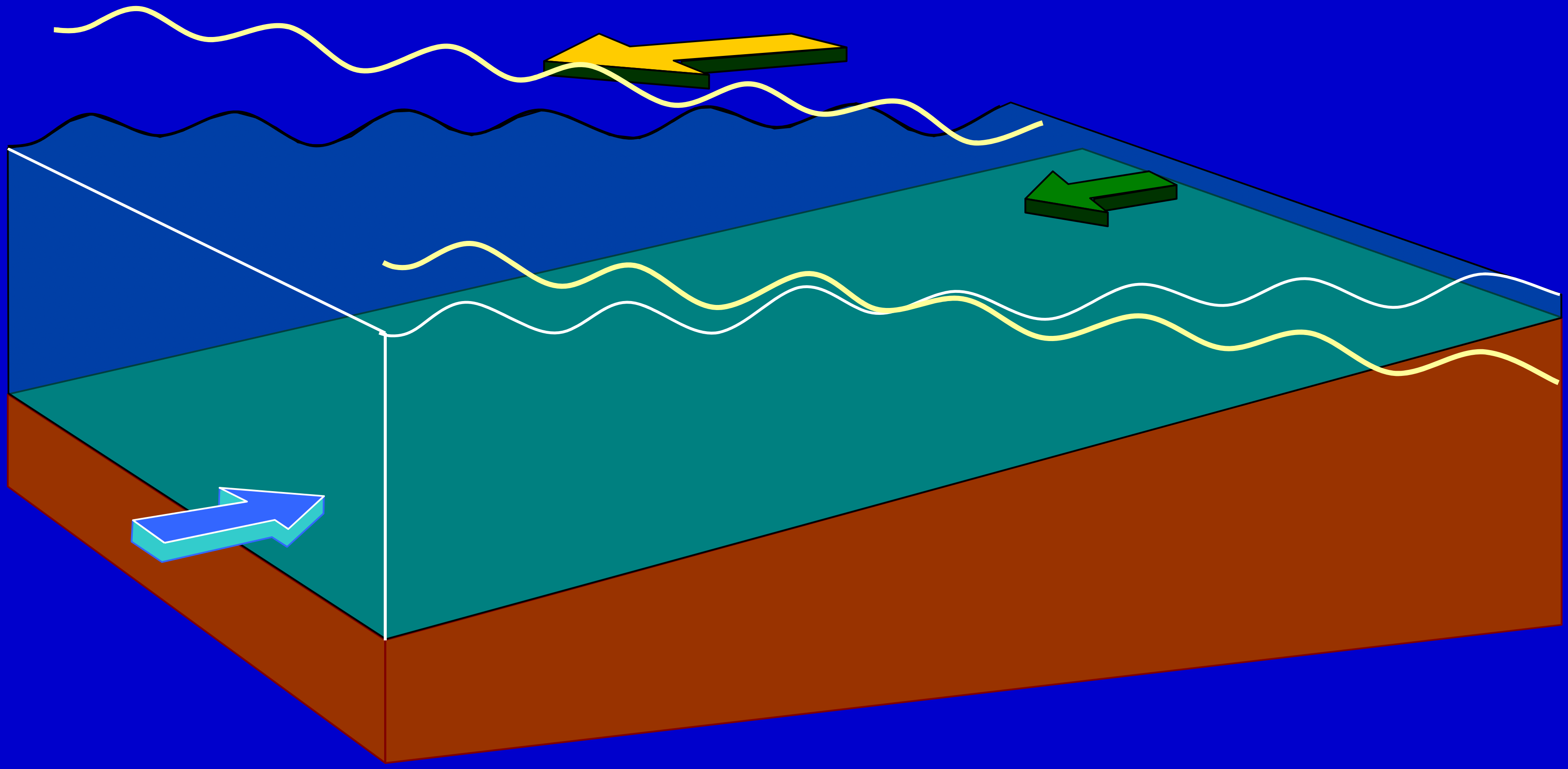
NET FLOW STRUCTURE AT TIDAL INLETS
Possible Implications for Transport of Dissolved and Suspended Matter

Arnoldo Valle-Levinson
Civil and Coastal Engineering Department

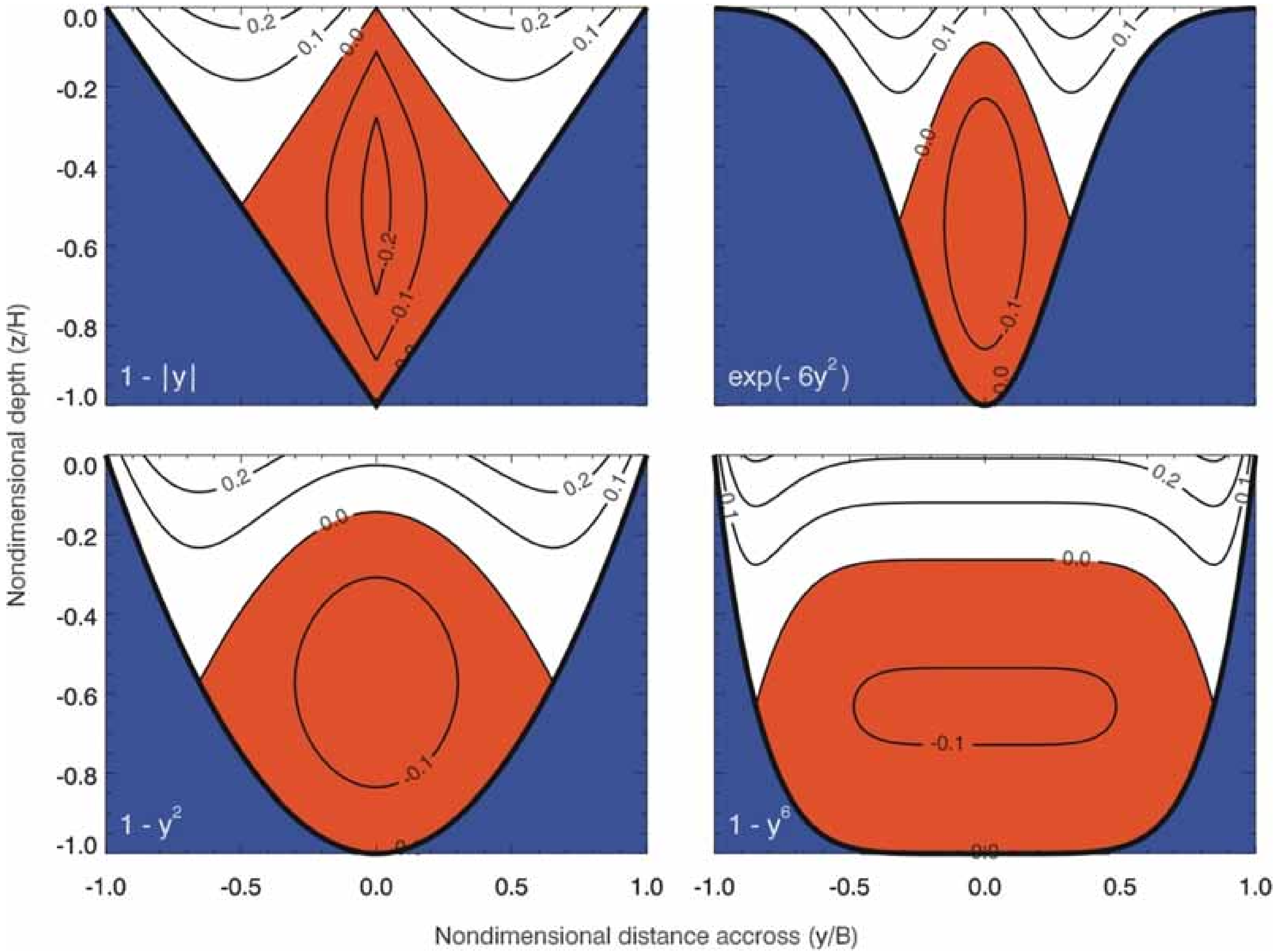
Amy Waterhouse's PhD dissertation
WI Program Initiation Fund

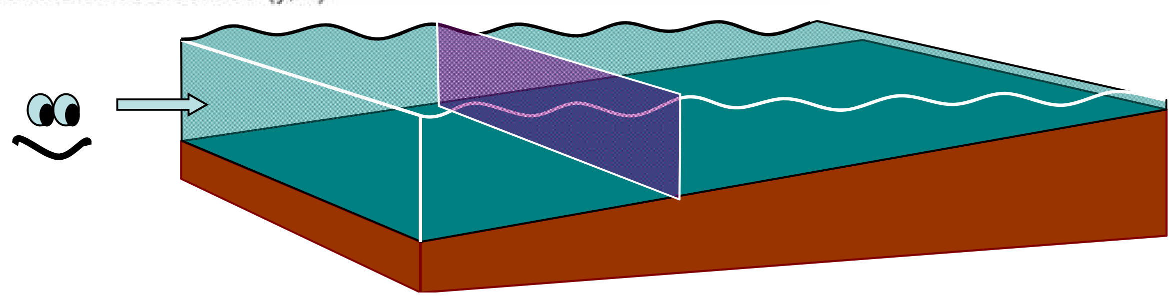

Freshwater input
Salty water inflow
(near the bottom)

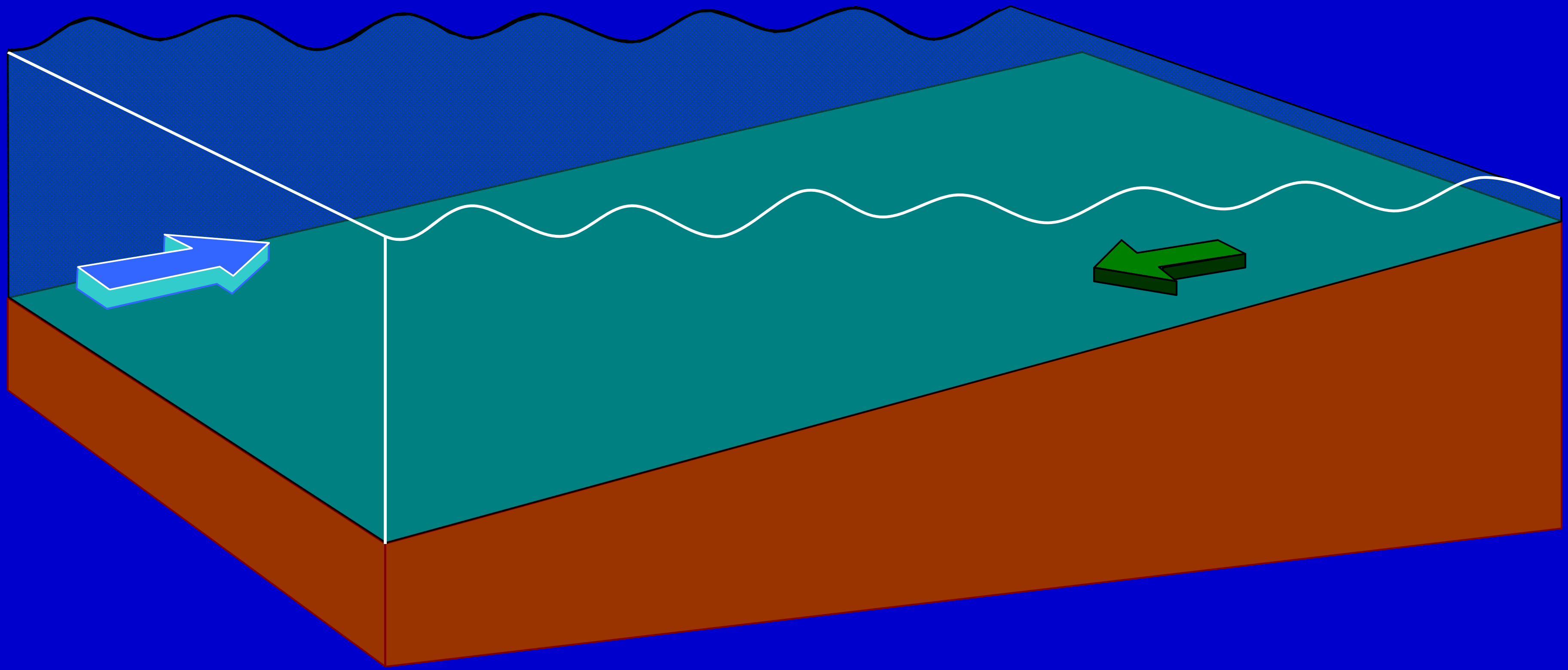

OUT
OUT
IN
OUT
IN
0.00
-0.50
0.50
1.00
z/H0
y/B
0.0
0.2
0.4
0.6
0.8
1.0



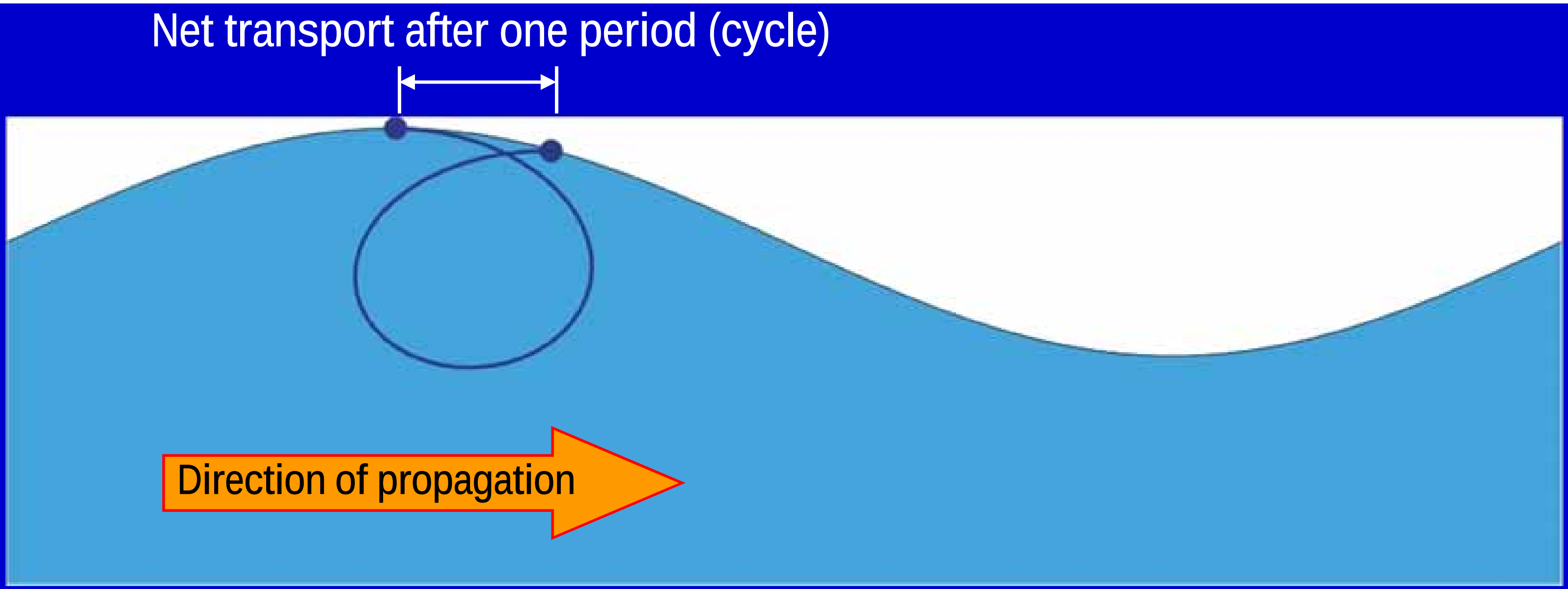
Wind-driven Flow (with no river input)


1 - |y|
exp(- 6y^2)
1 - y^2
1 - y^6
Nondimensional depth (z/H)
Nondimensional distance accross (y/B)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.0
-0.5
0.0
0.5
1.0
0.2
0.1
0.0
-0.1
-0.2

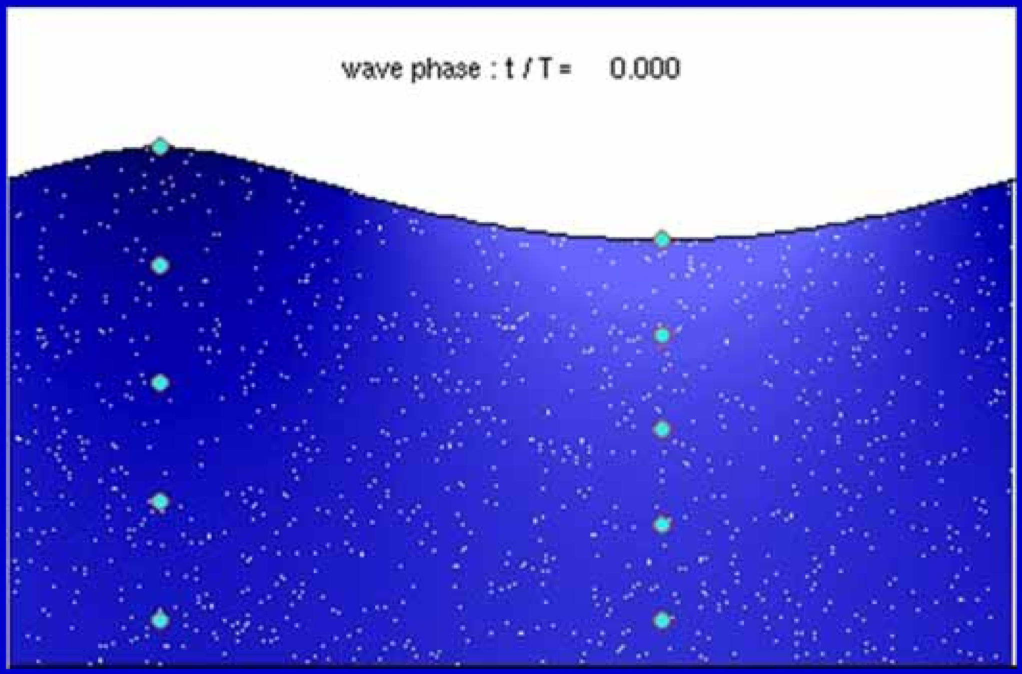




Average Tidal Flow (with no river input)

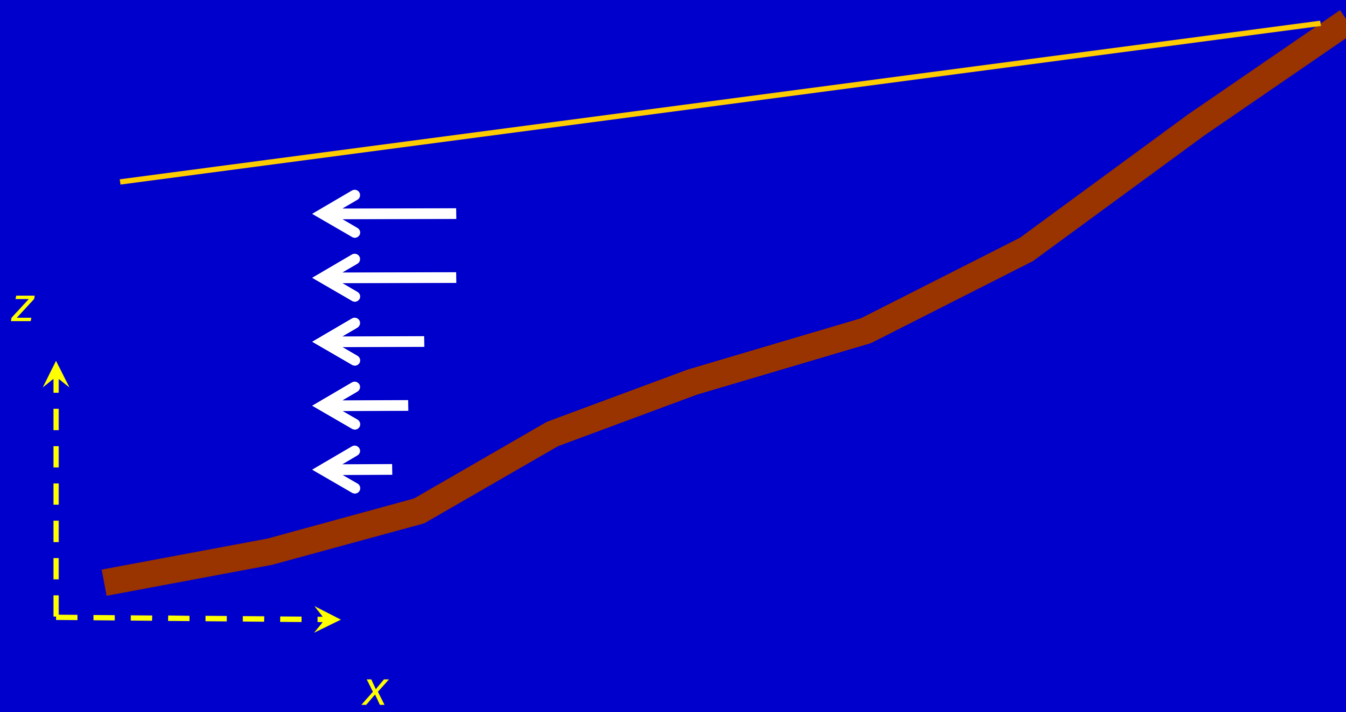


Net displacement = Stokes drift (covariance between tide and current)

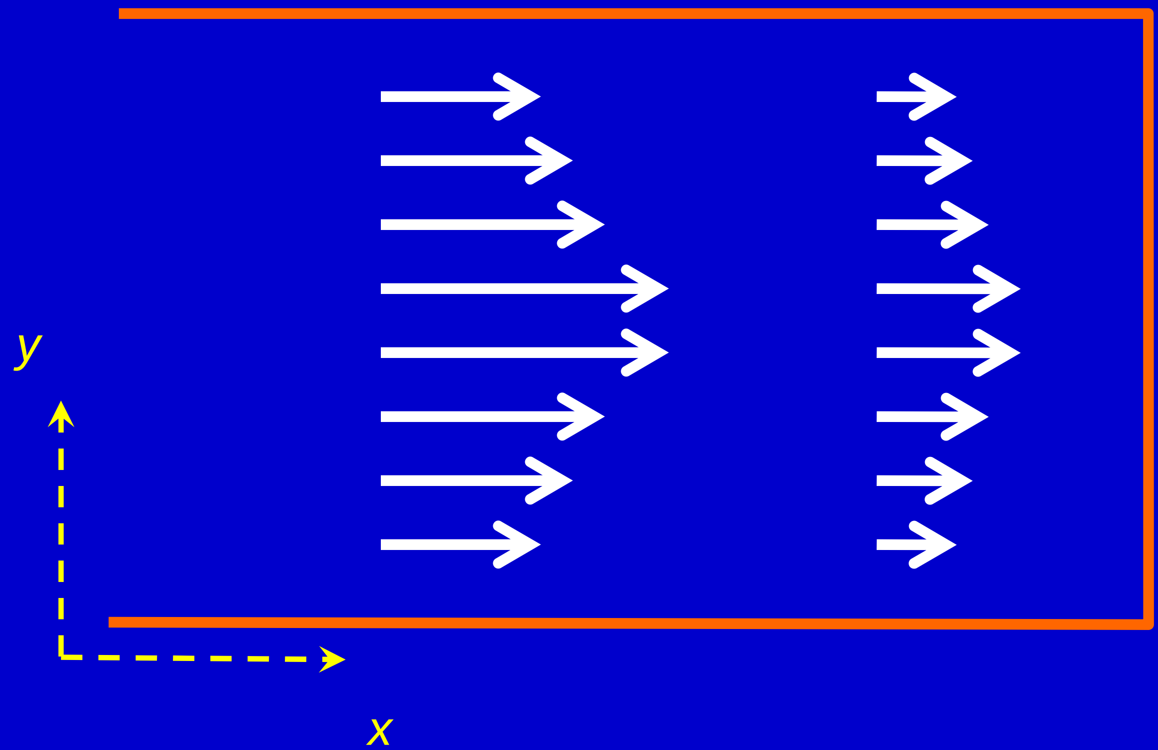


Animation taken from GREEN EARTH WORLD POWER (gewp.org)

Residual set-up

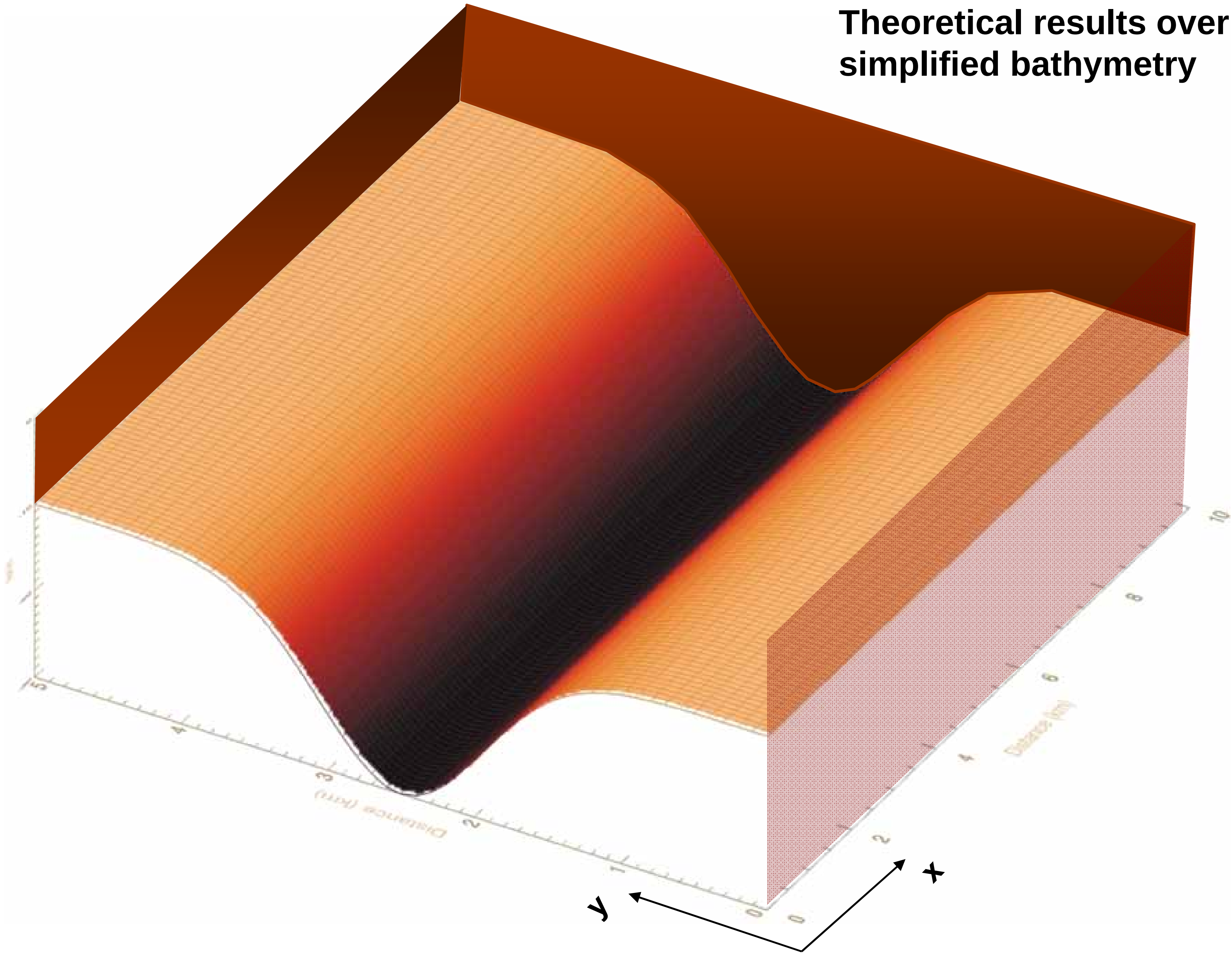


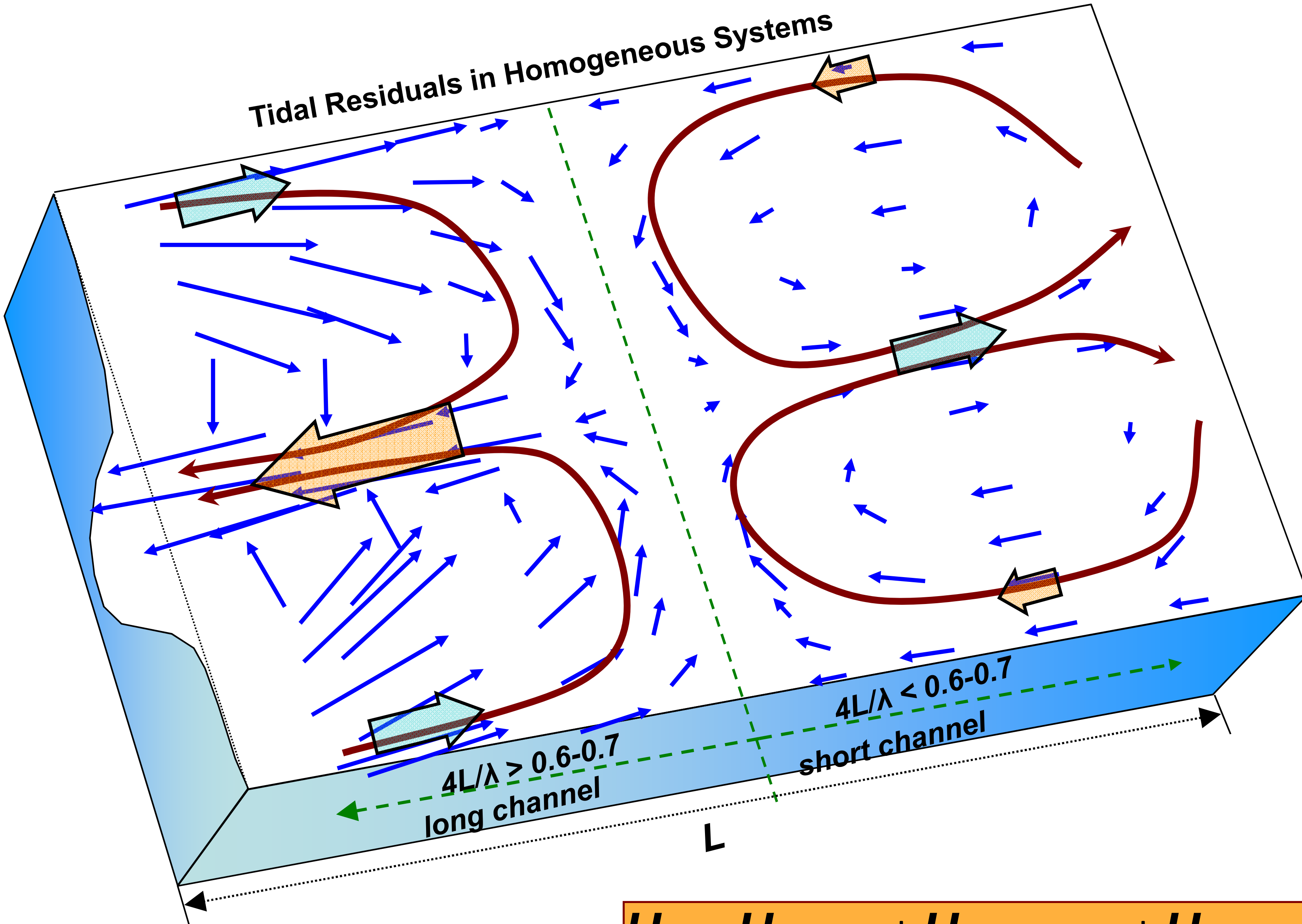
Gradients in tidal flow – tidal stress



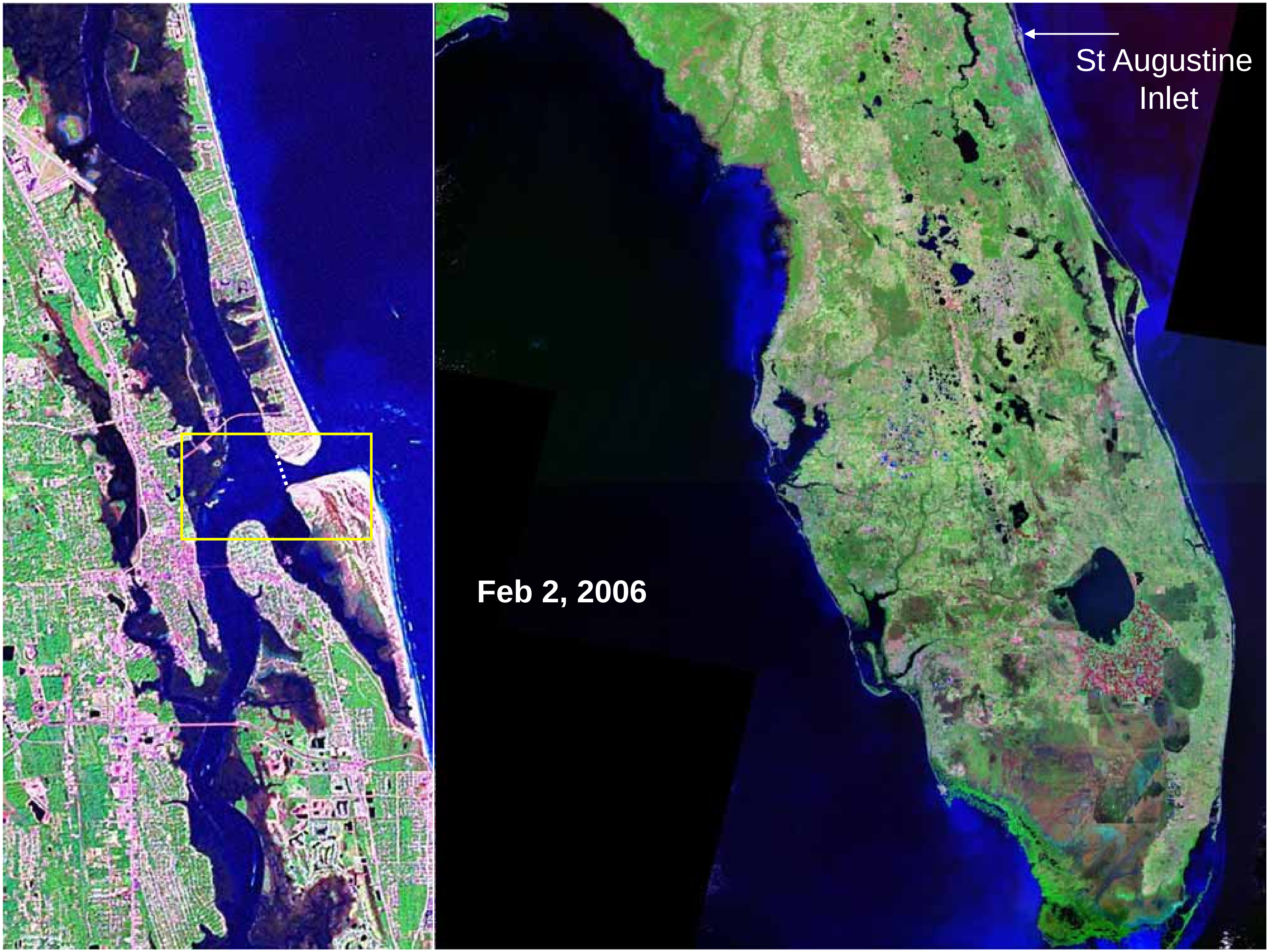
$$U_T = U_{Stokes} + U_{gradients} + U_{set-up}$$

Theoretical results over simplified bathymetry



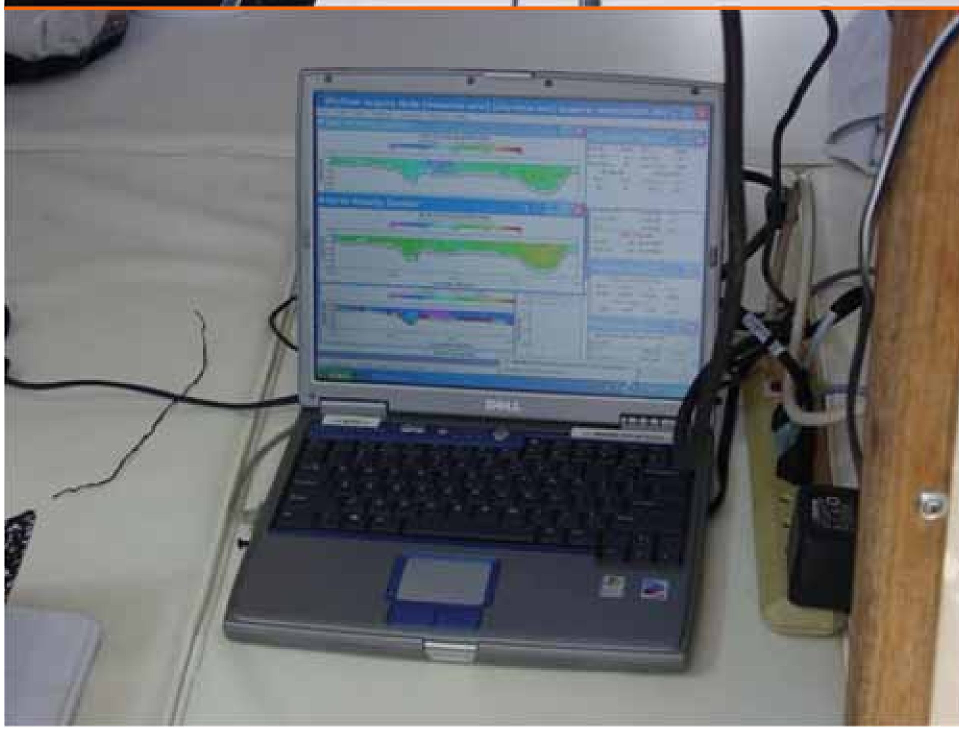


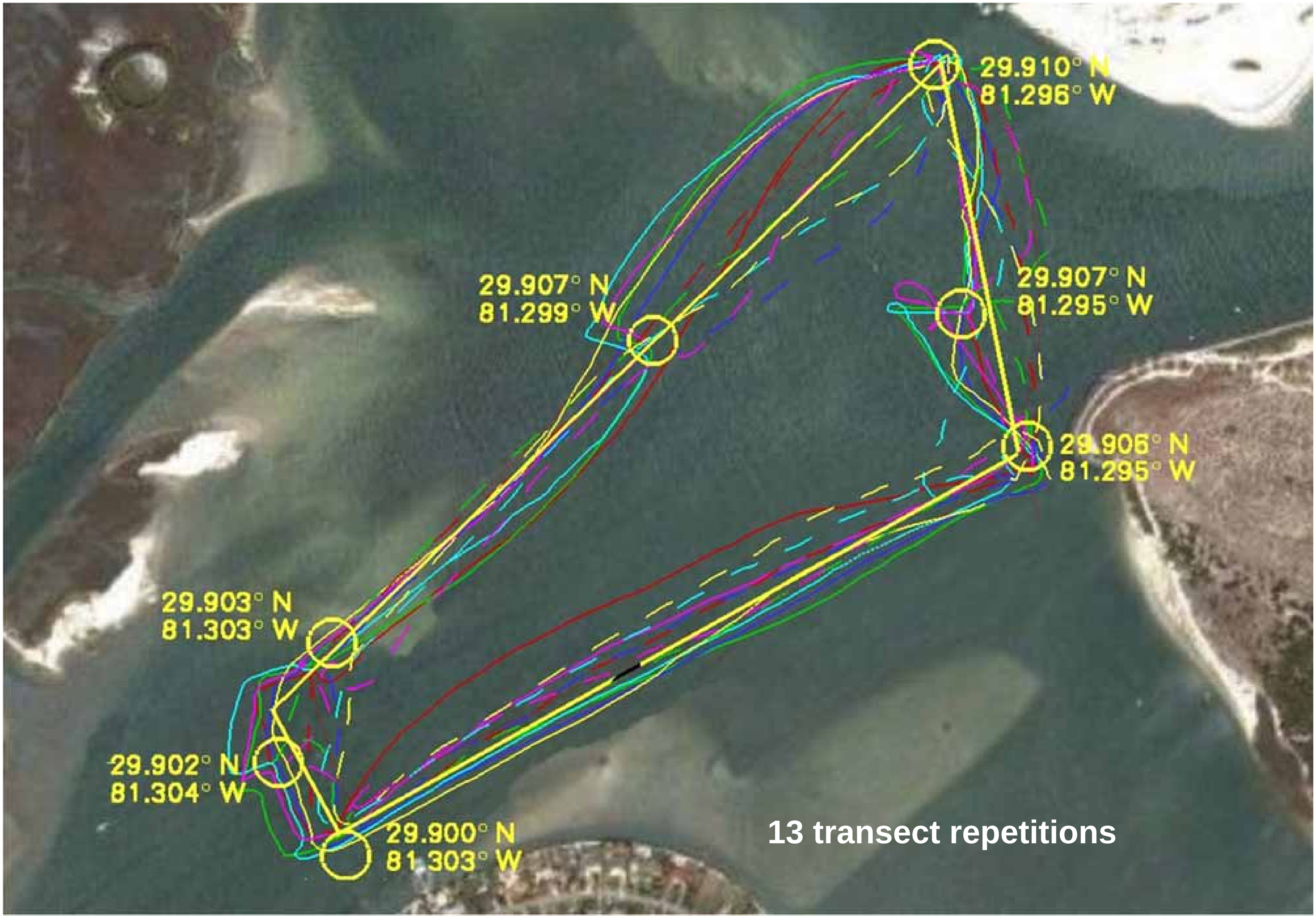
$$U_T = U_{Stokes} + U_{press\ grad} + U_{tidal\ stress}$$


St Augustine
Inlet
Feb 2, 2006

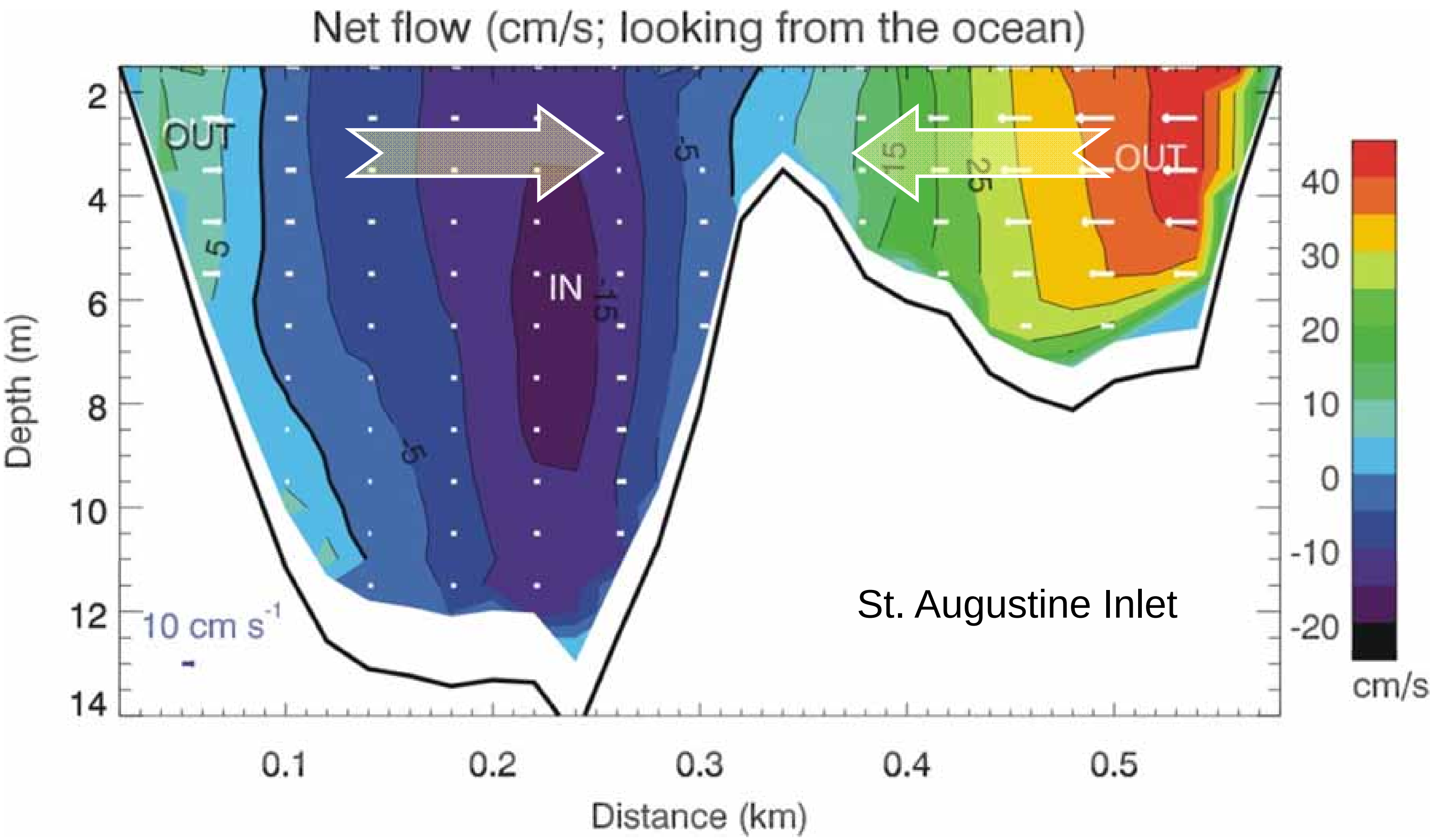
ADCP Profiles and CTD casts

Full tidal cycles

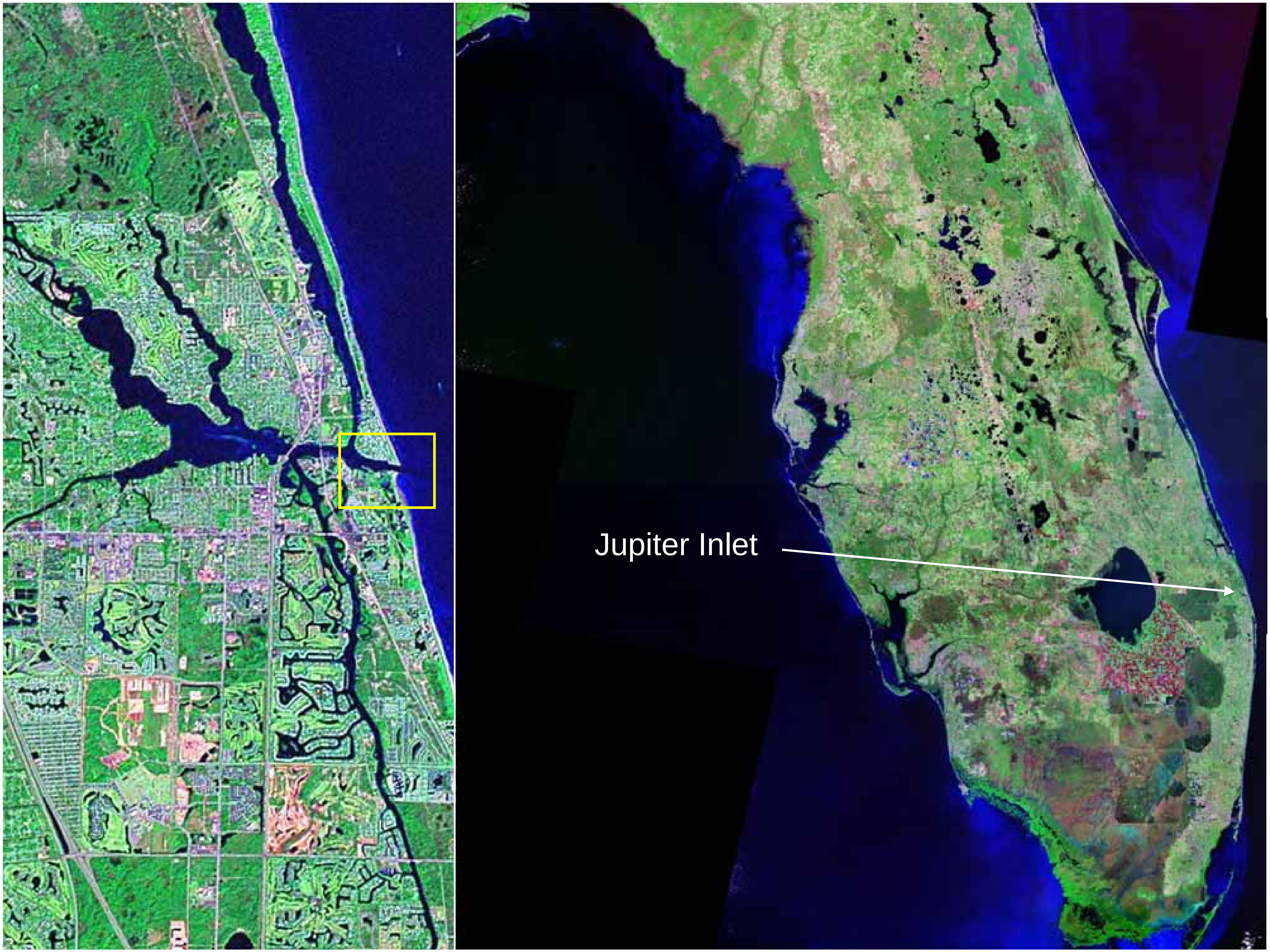


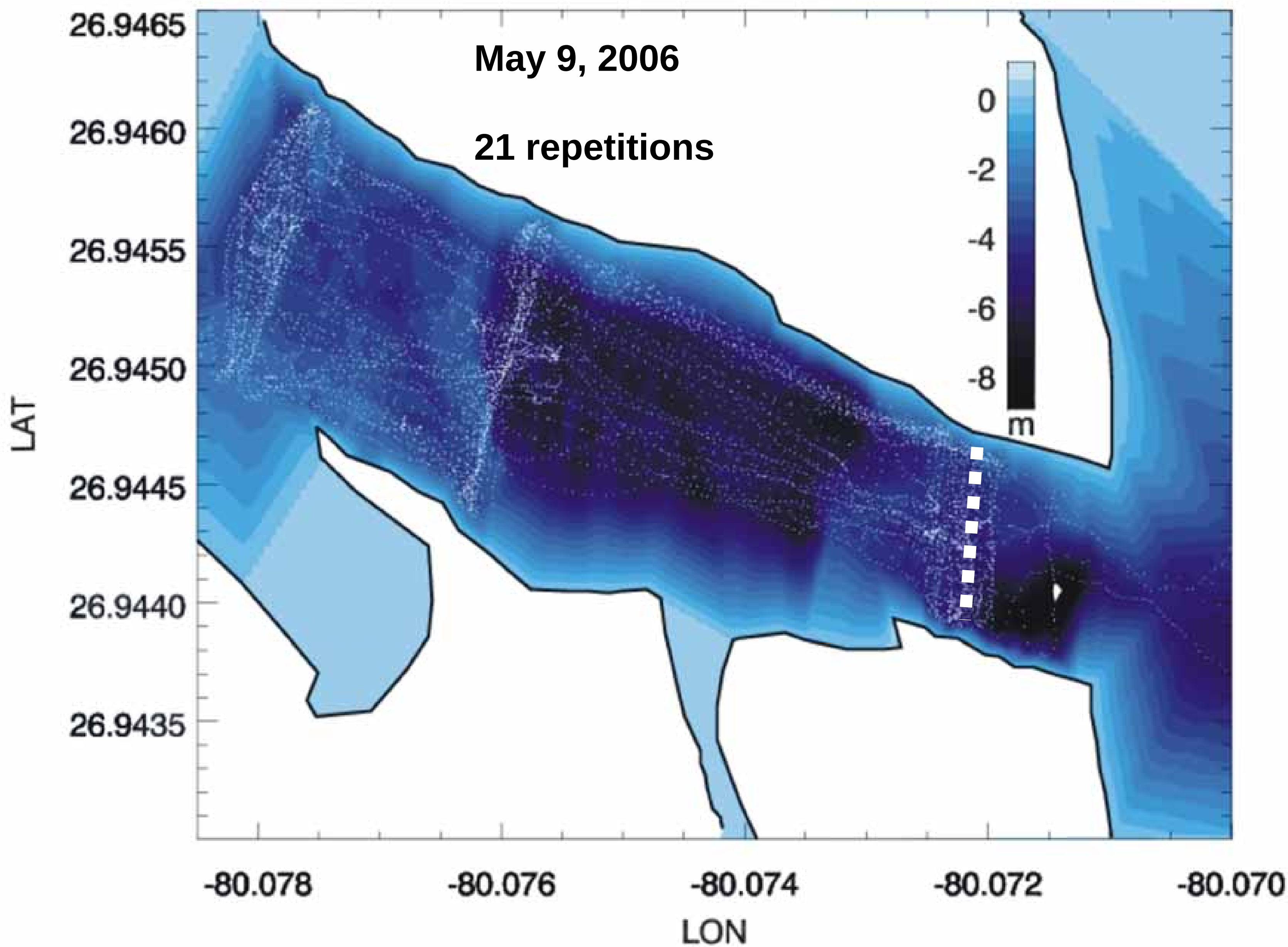


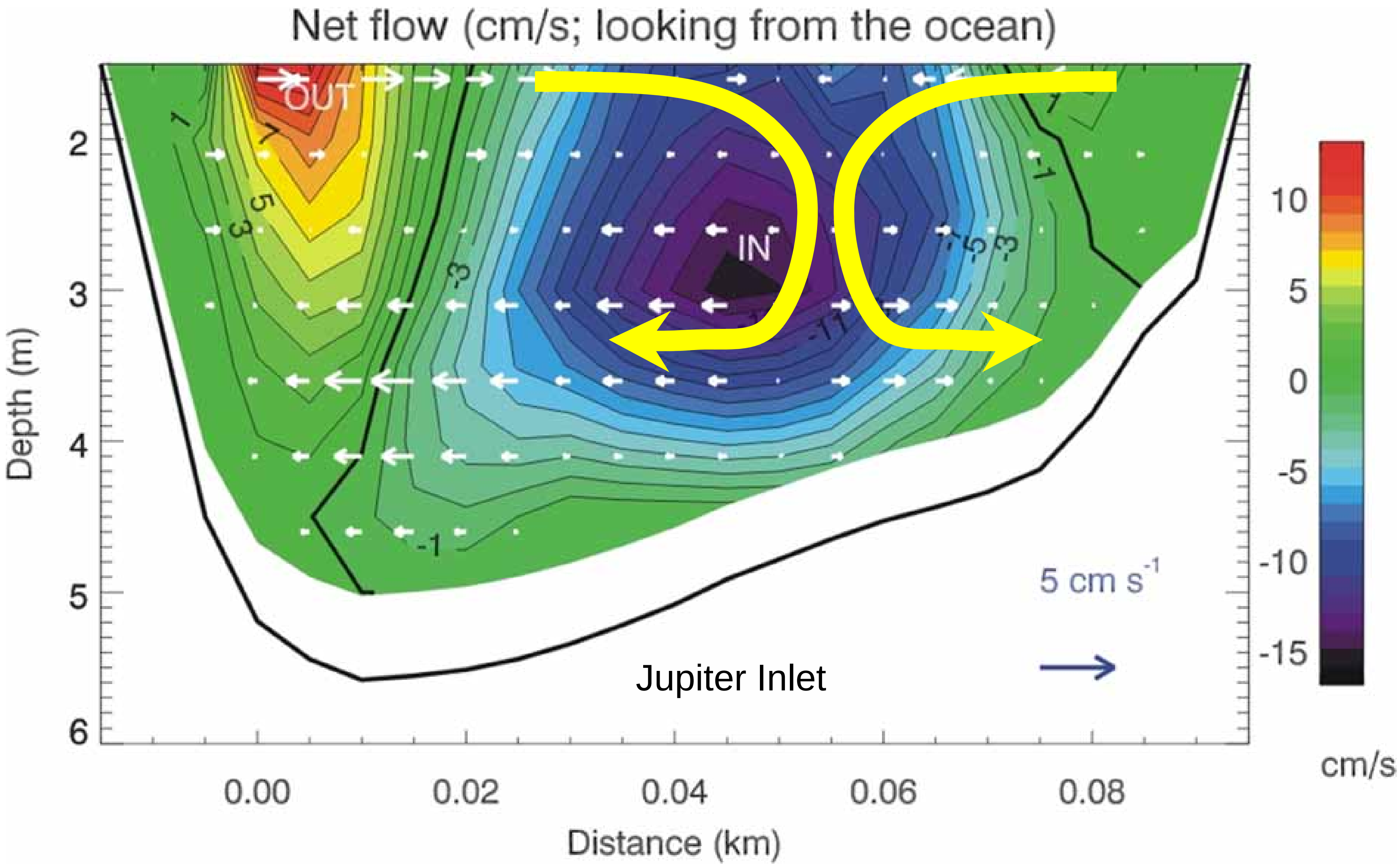
29.910° N
81.296° W
29.907° N
81.299° W
29.907° N
81.295° W
29.906° N
81.295° W
29.903° N
81.303° W
29.902° N
81.304° W
29.900° N
81.303° W
13 transect repetitions



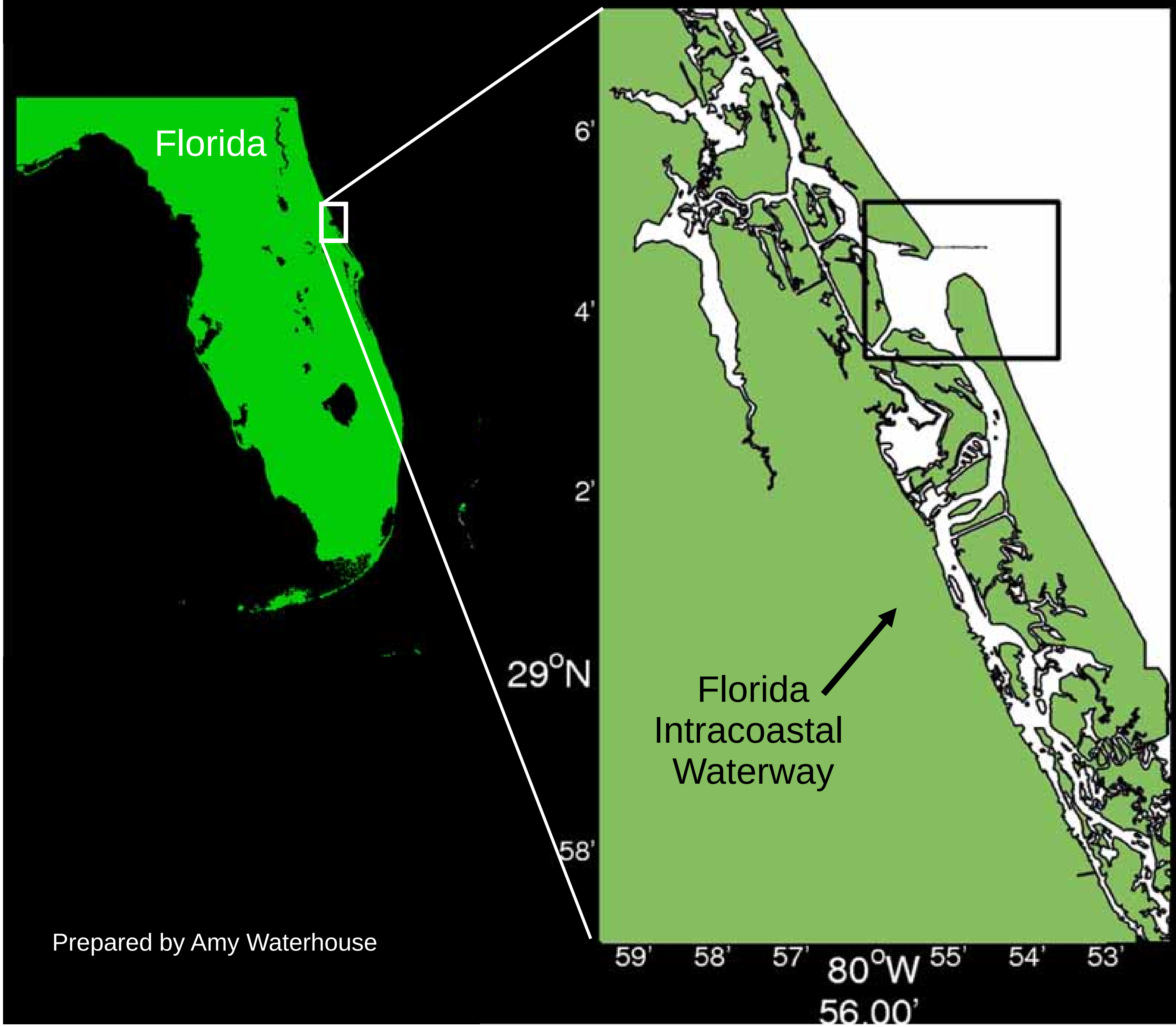
Pattern reinforced in tropical season


Jupiter Inlet


May 9, 2006
21 repetitions
0
-2
-4
-6
-8
m
26.9465
26.9460
26.9455
26.9450
26.9445
26.9440
26.9435
LAT
-80.078
-80.076
-80.074
-80.072
-80.070
LON

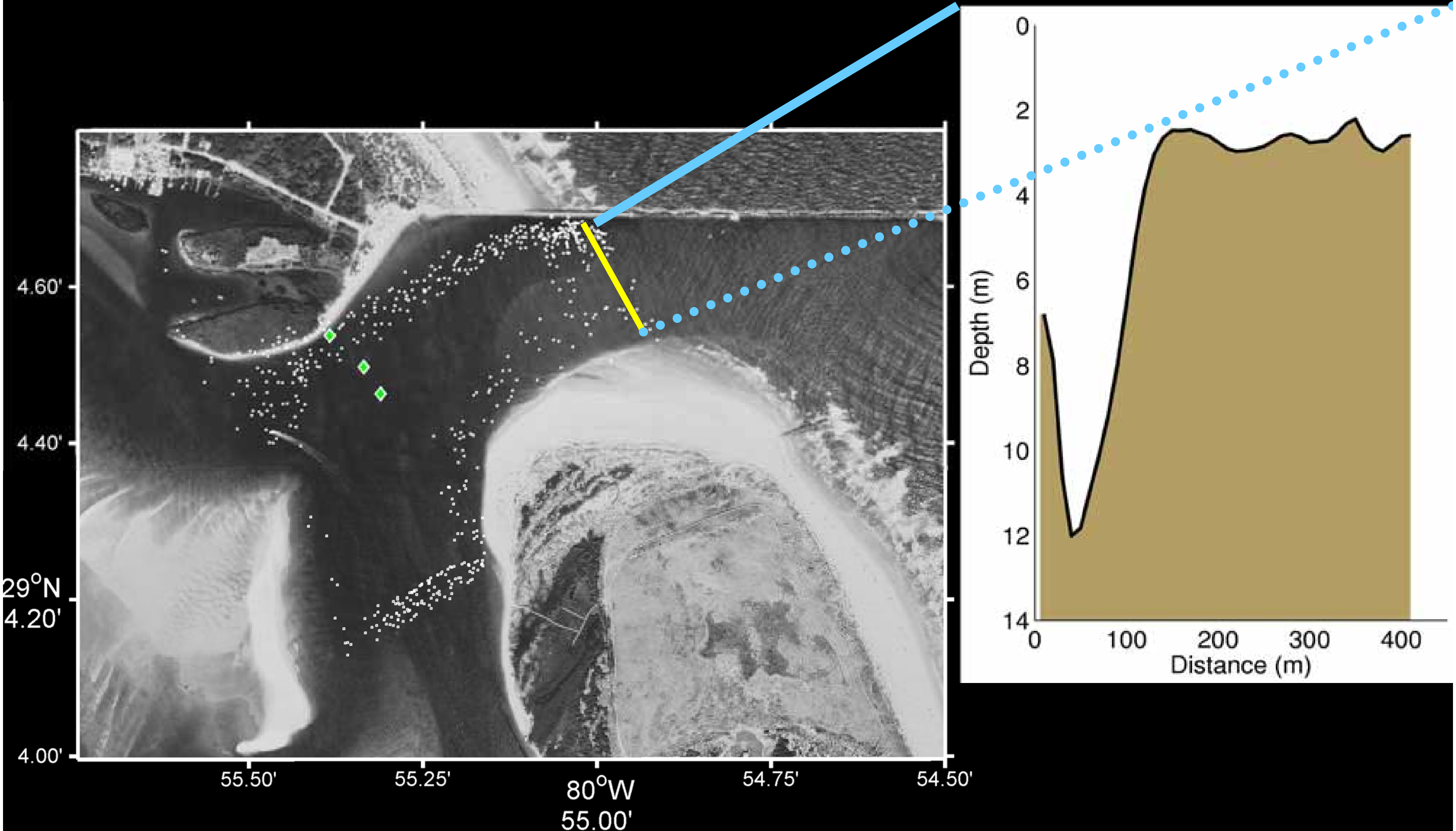

Net flow (cm/s; looking from the ocean)
OUT
IN
Depth (m)
Distance (km)
0.00
0.02
0.04
0.06
0.08
2
3
4
5
6
10
5
0
-5
-10
-15
cm/s
5 cm s-1
Jupiter Inlet

Ponce de Leon Inlet



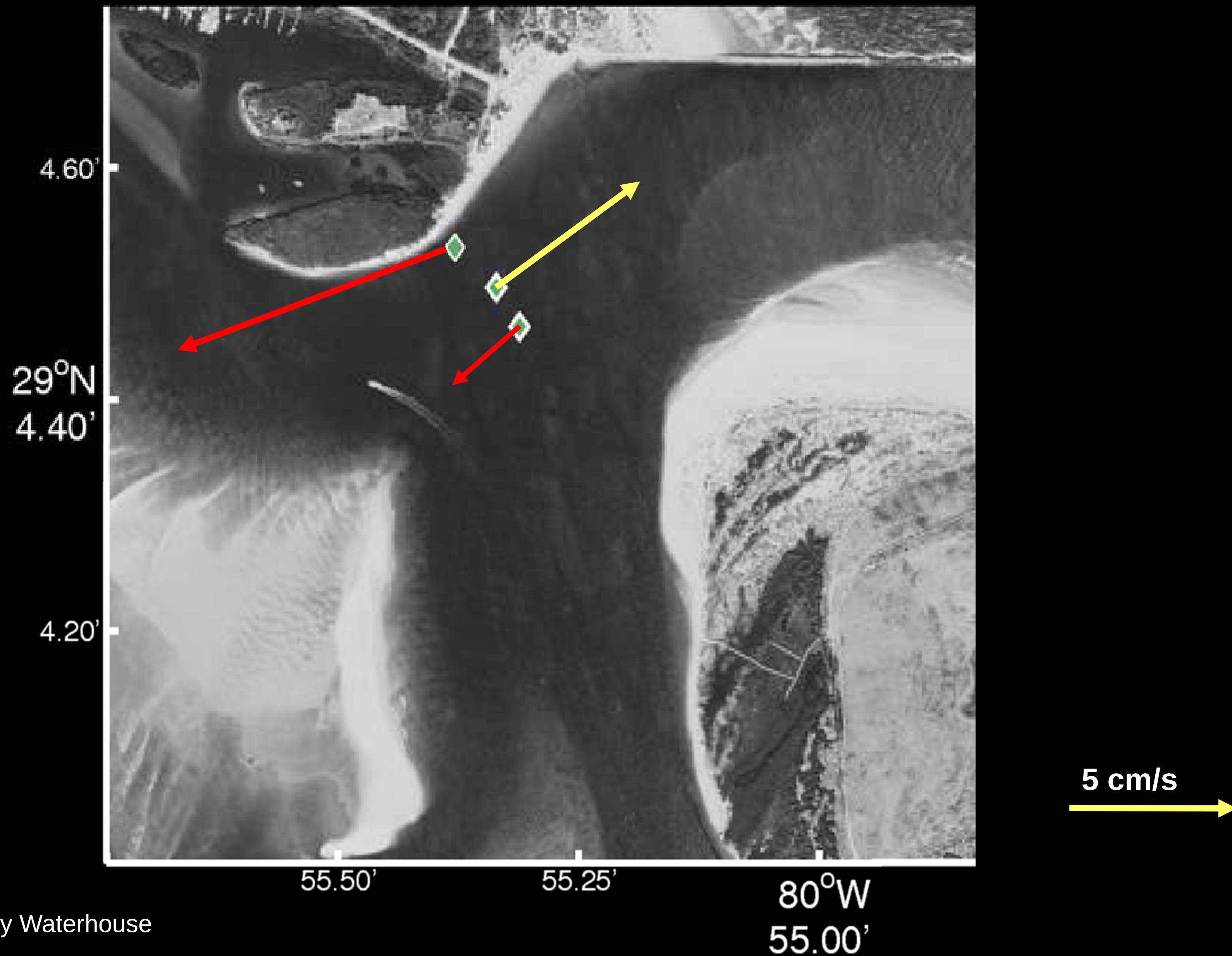
Prepared by Amy Waterhouse

Ponce de Leon Inlet



Prepared by Amy Waterhouse

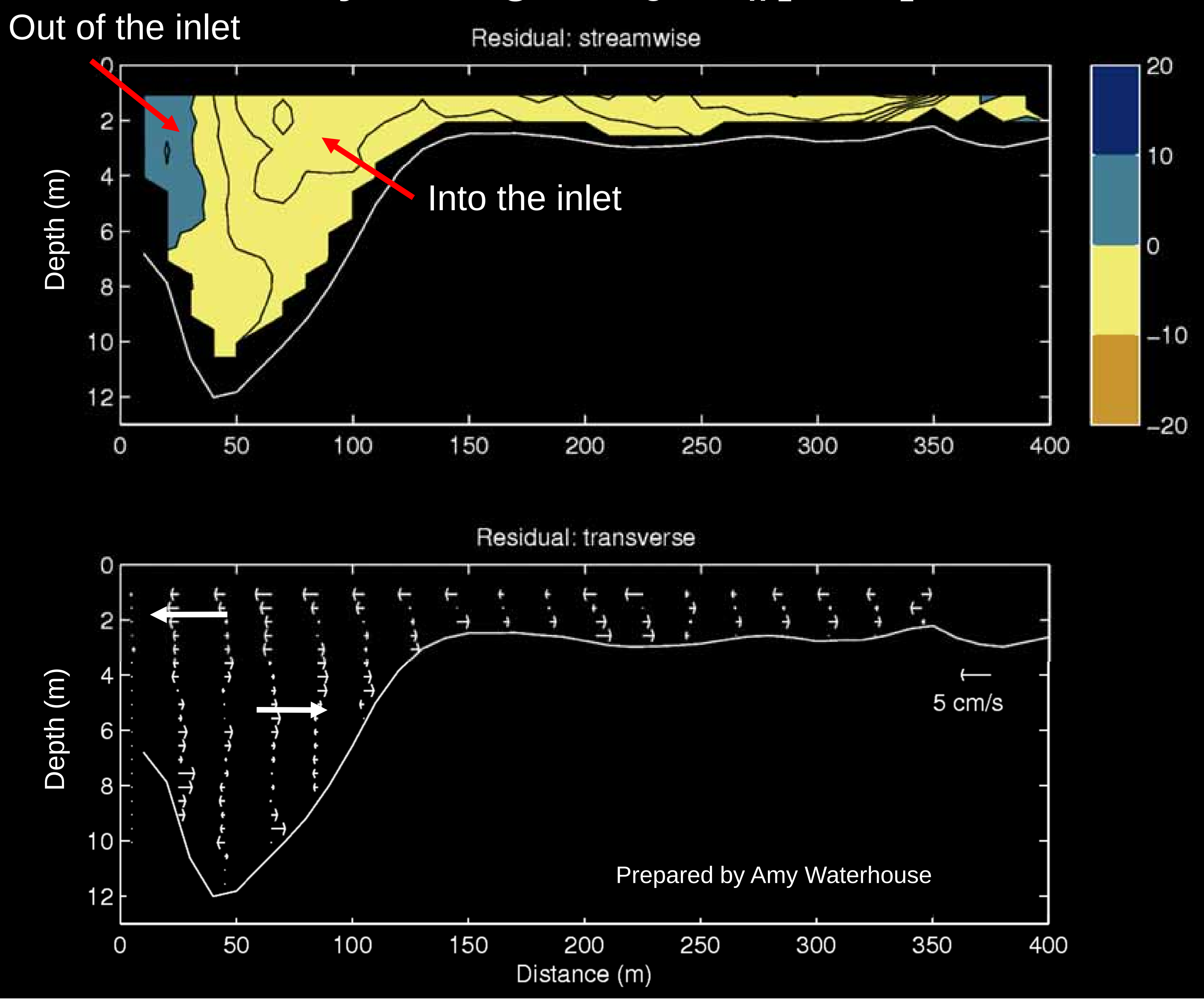
Depth averaged (~3 mo.) residual flows



Prepared by Amy Waterhouse

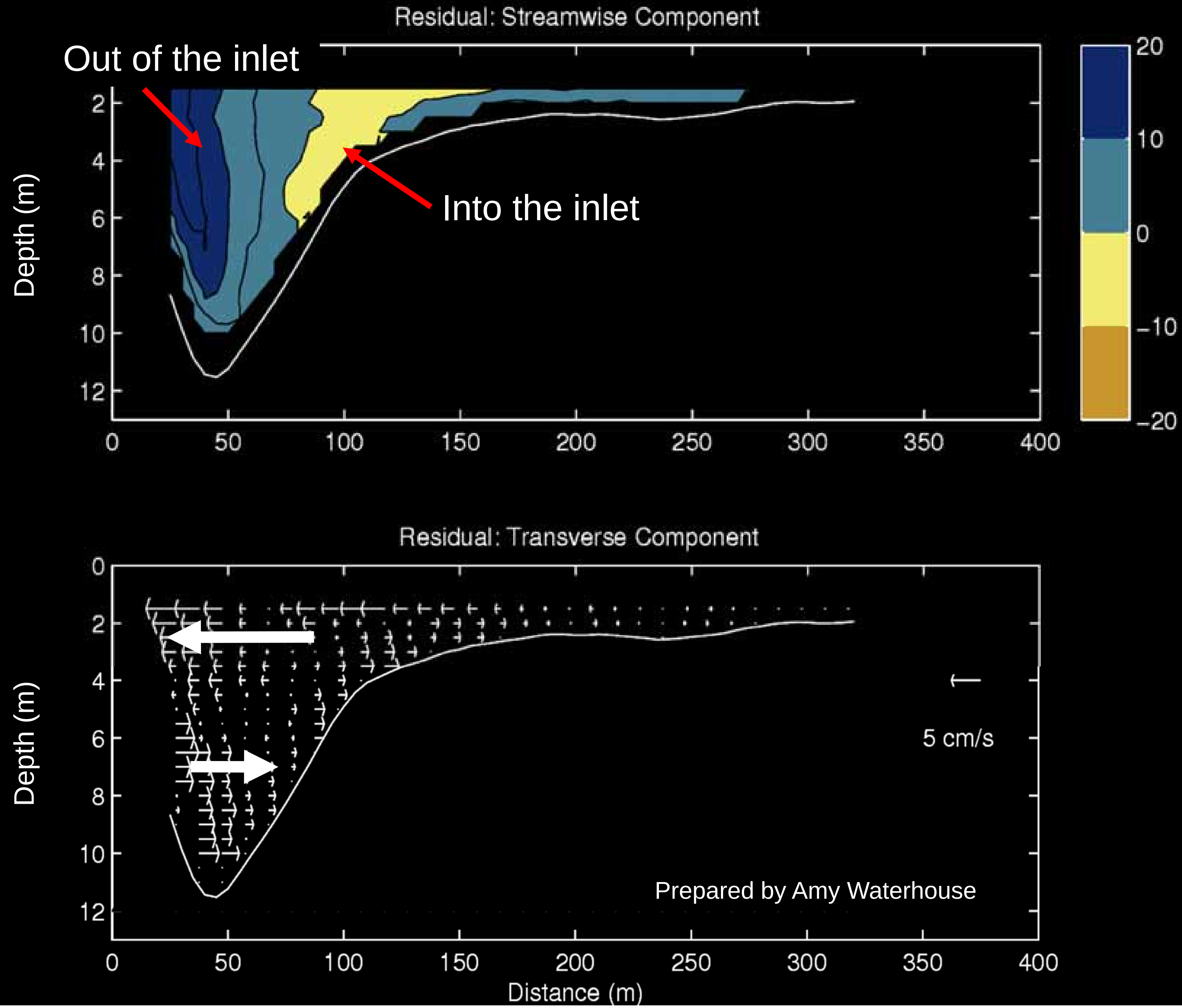
Tidally averaged: u_s & u_n [cm/s]

1st Survey

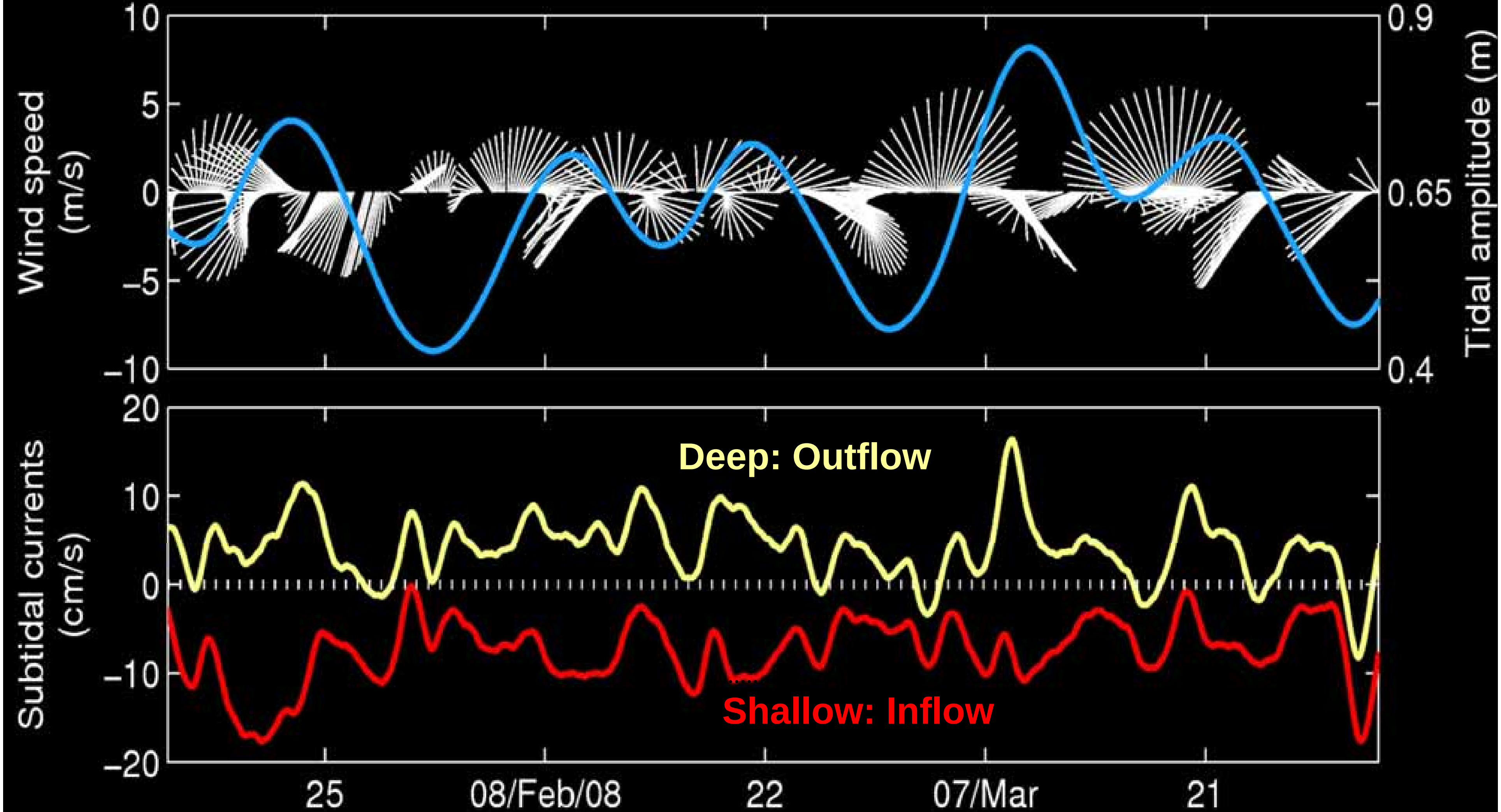


Tidally averaged: u_s & u_n [cm/s]

2nd Survey

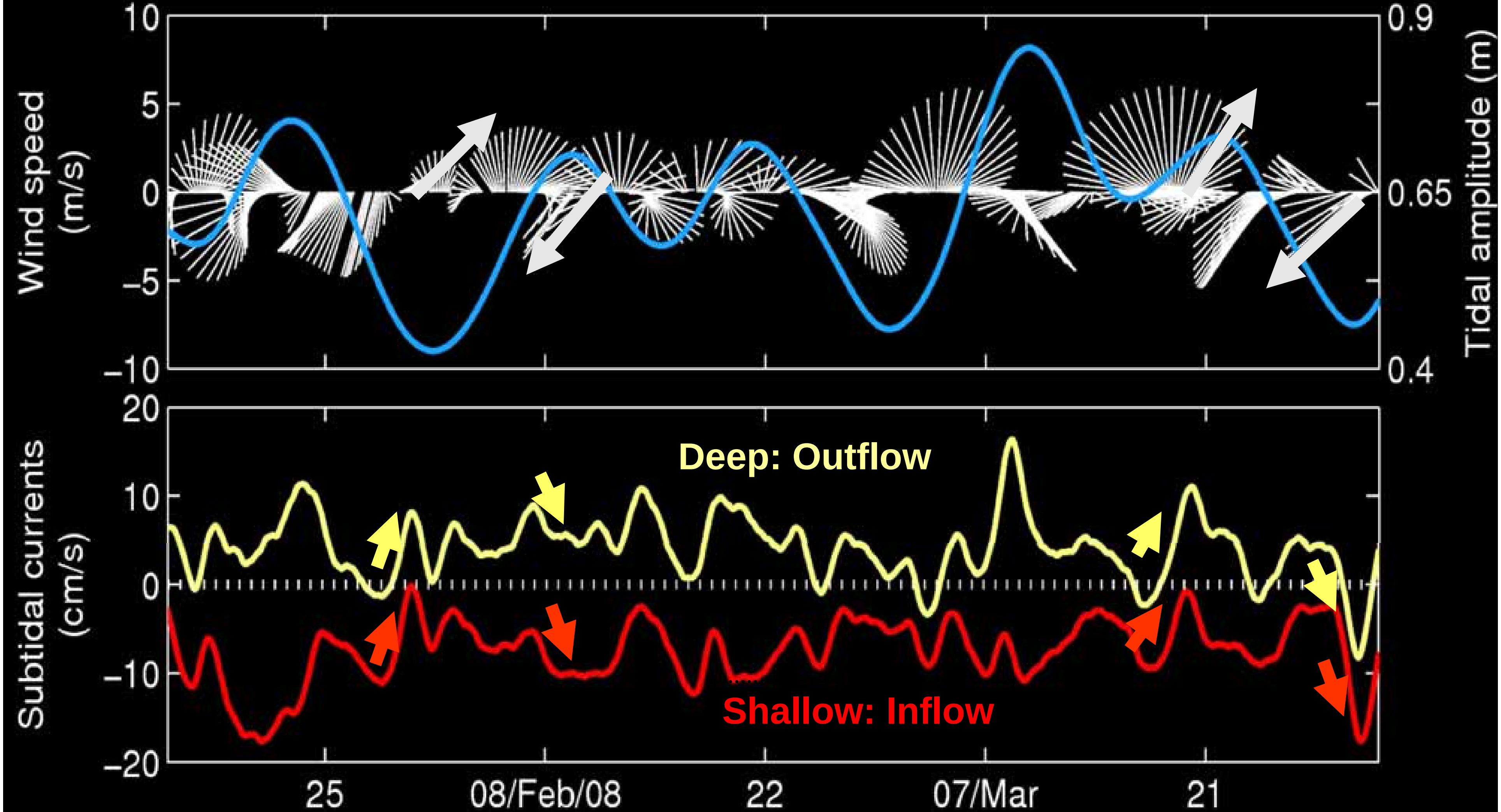


Residual flow modulated by winds and spring-neap cycle.



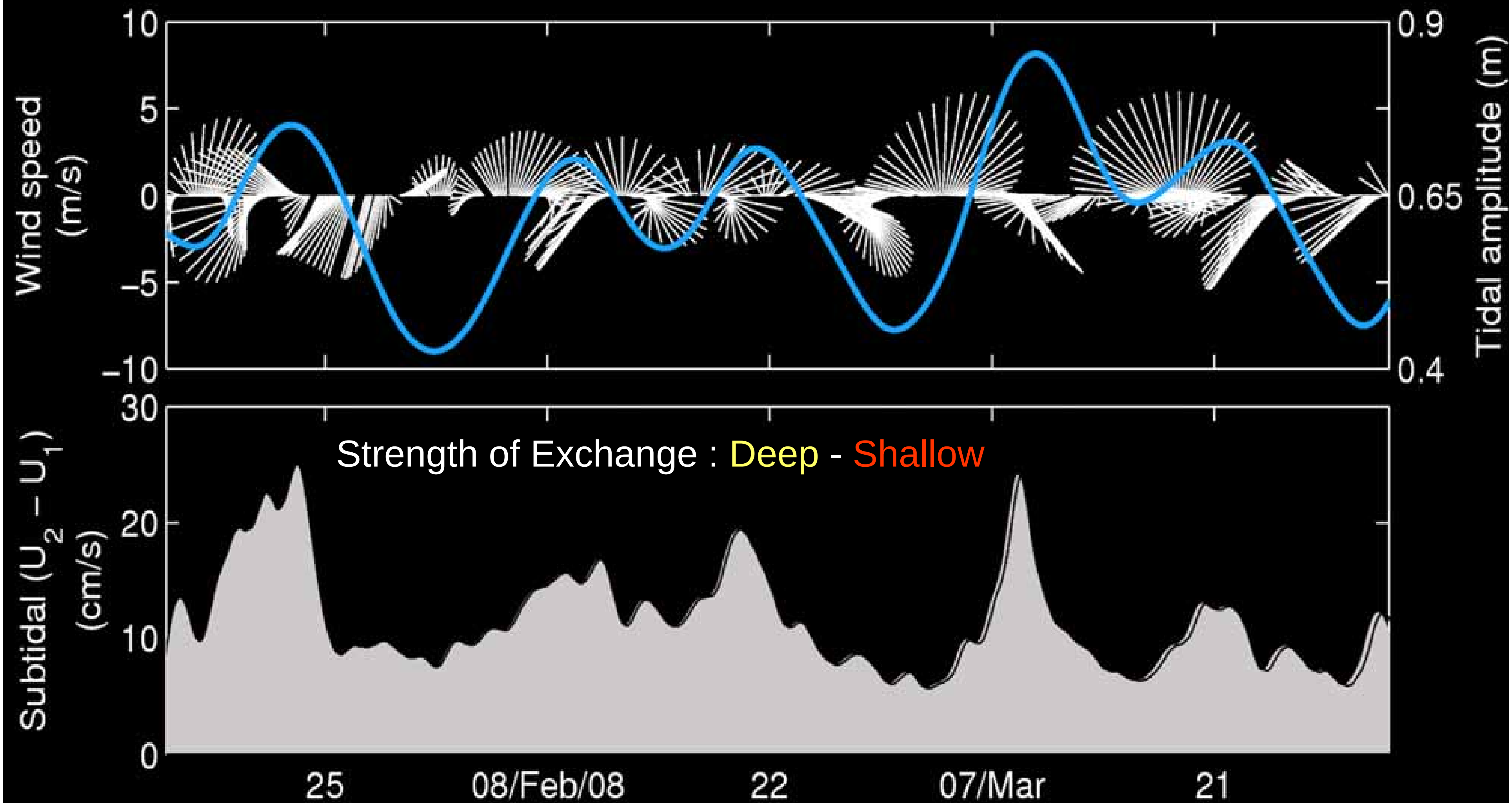
Prepared by Amy Waterhouse

Residual flow modulated by winds and spring-neap cycle.



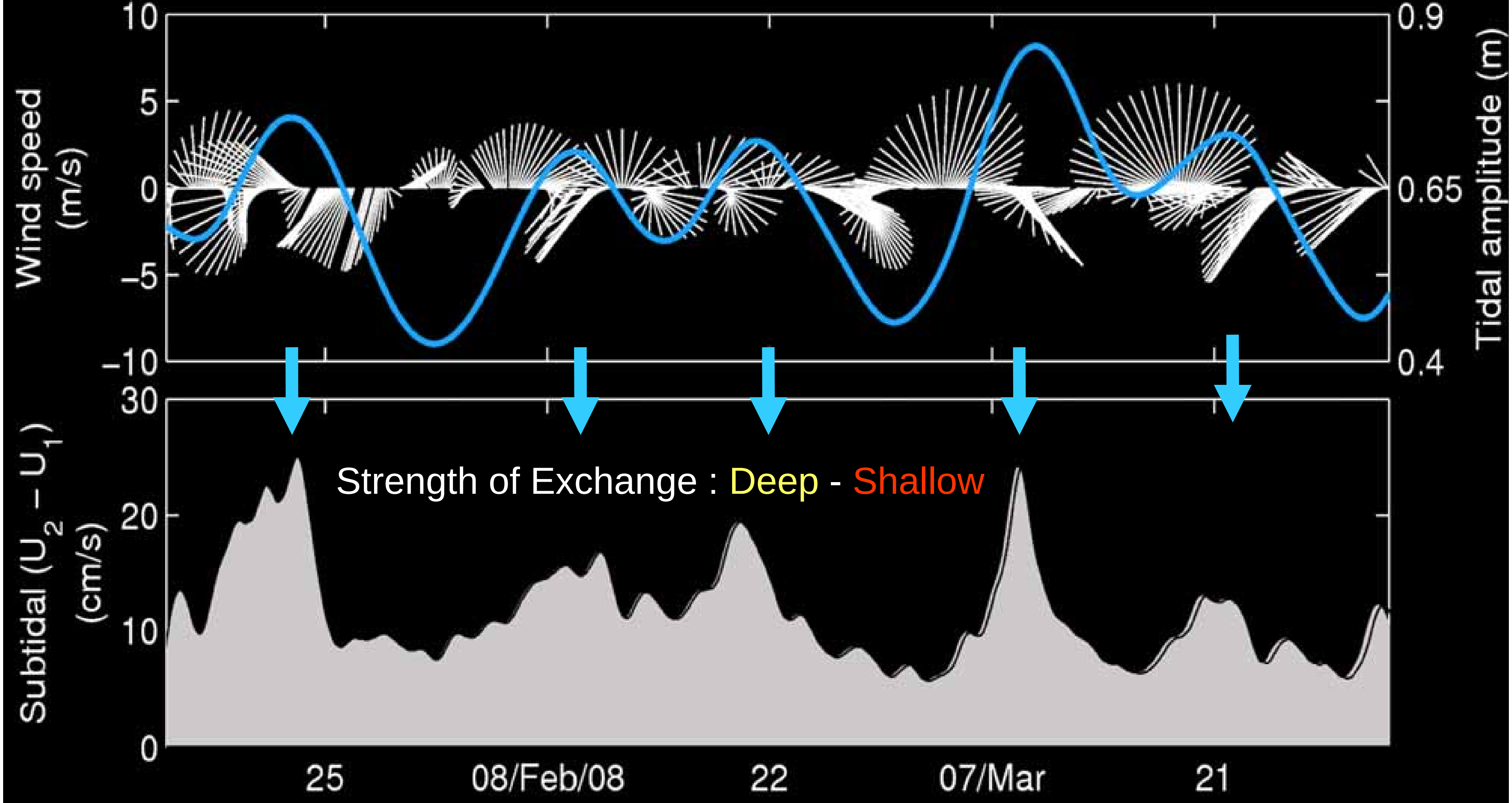
Prepared by Amy Waterhouse

Strongest magnitude of exchange occurs during spring tides

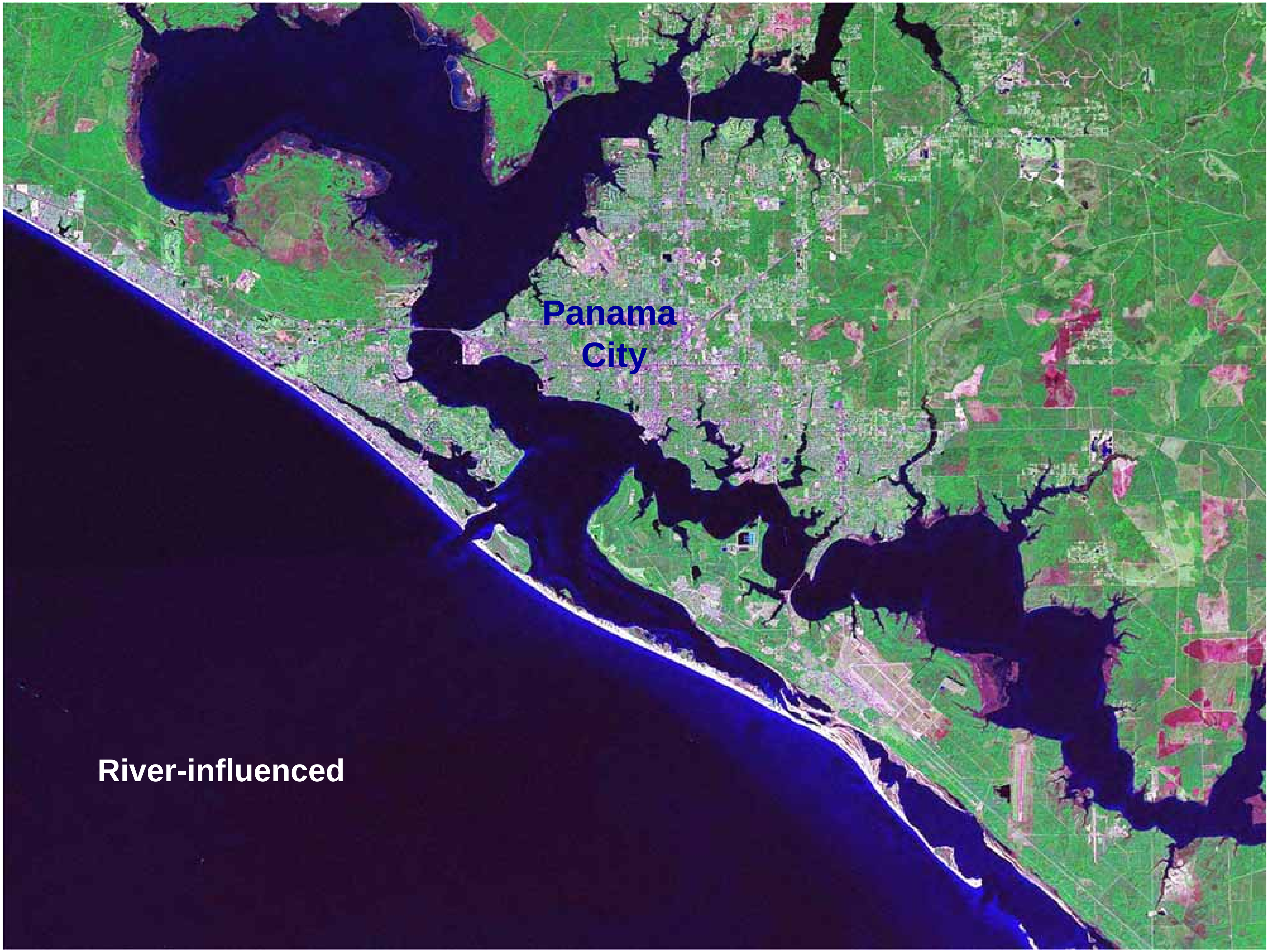


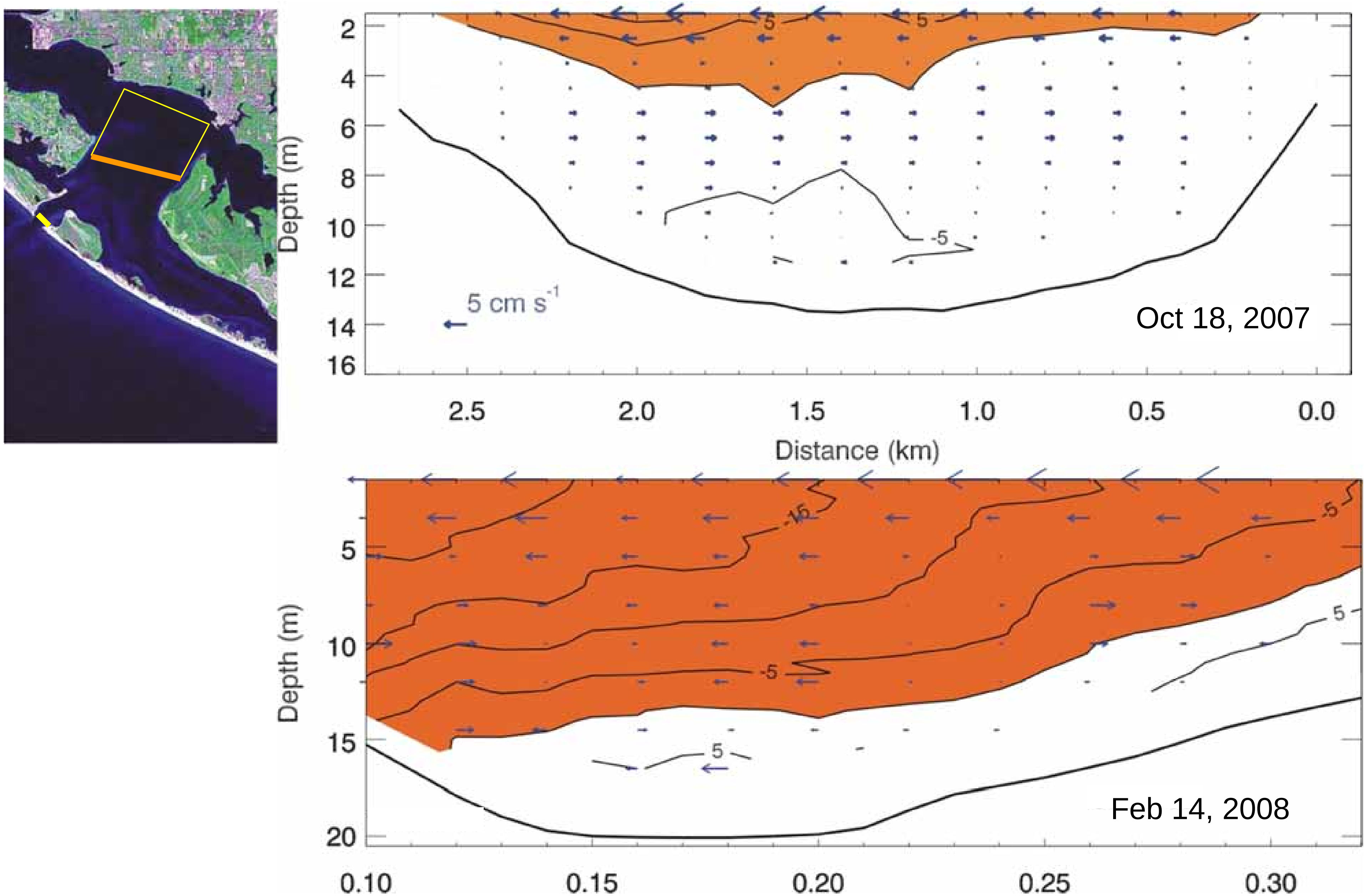
Prepared by Amy Waterhouse

Strongest magnitude of exchange occurs during spring tides

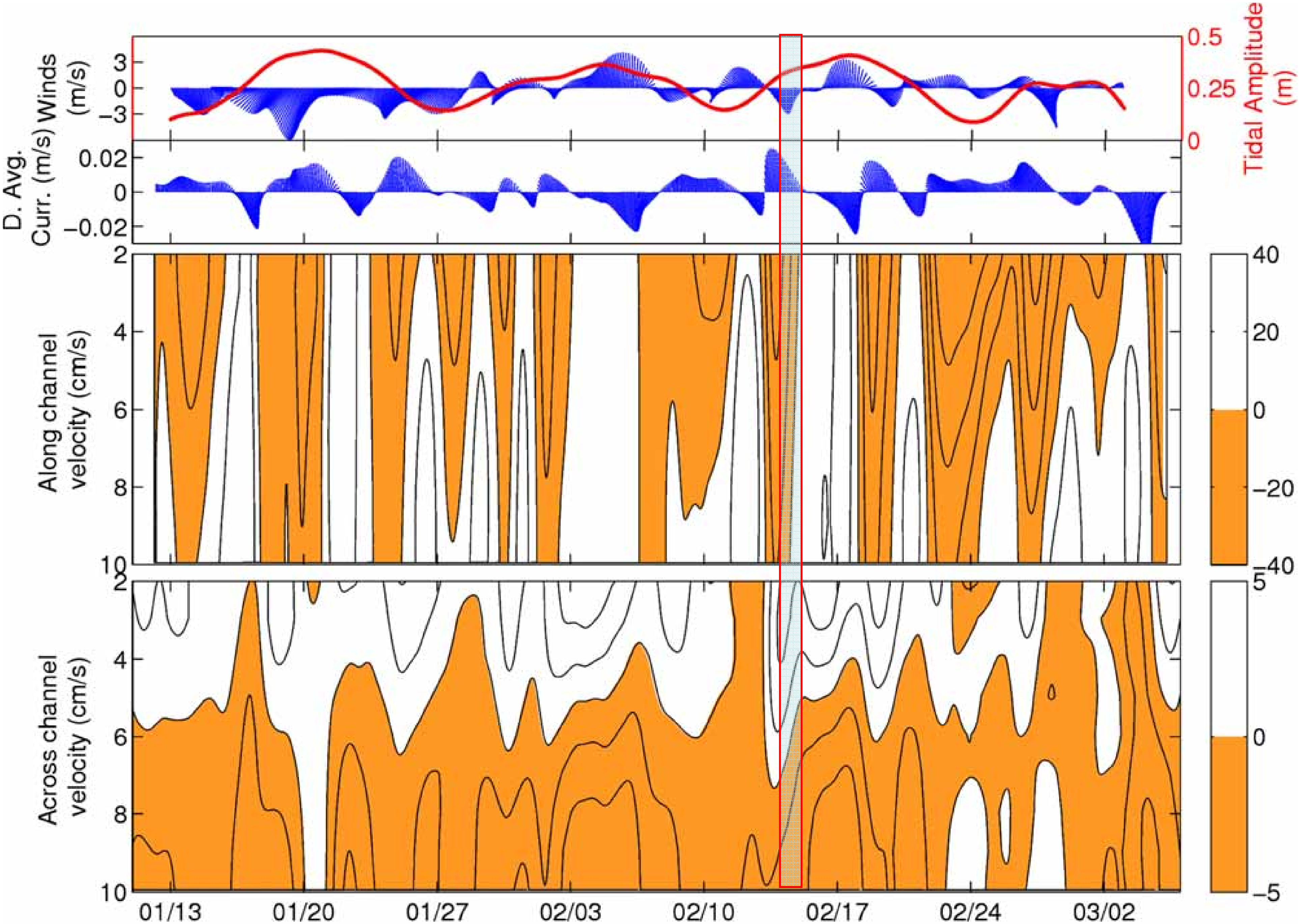


Prepared by Amy Waterhouse


Panama
City
River-influenced



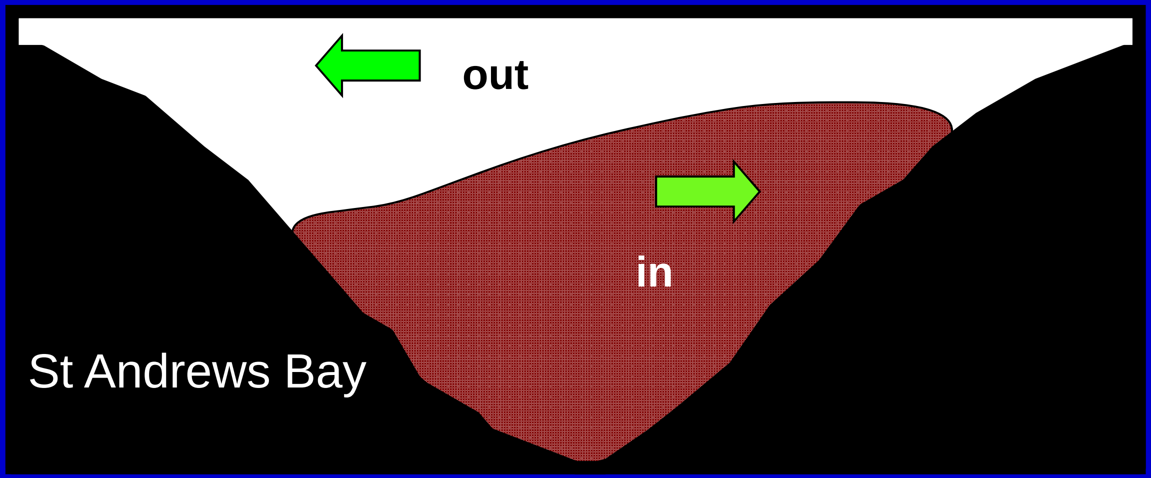
Depth (m)
5 cm s-1
Oct 18, 2007
Distance (km)
Feb 14, 2008

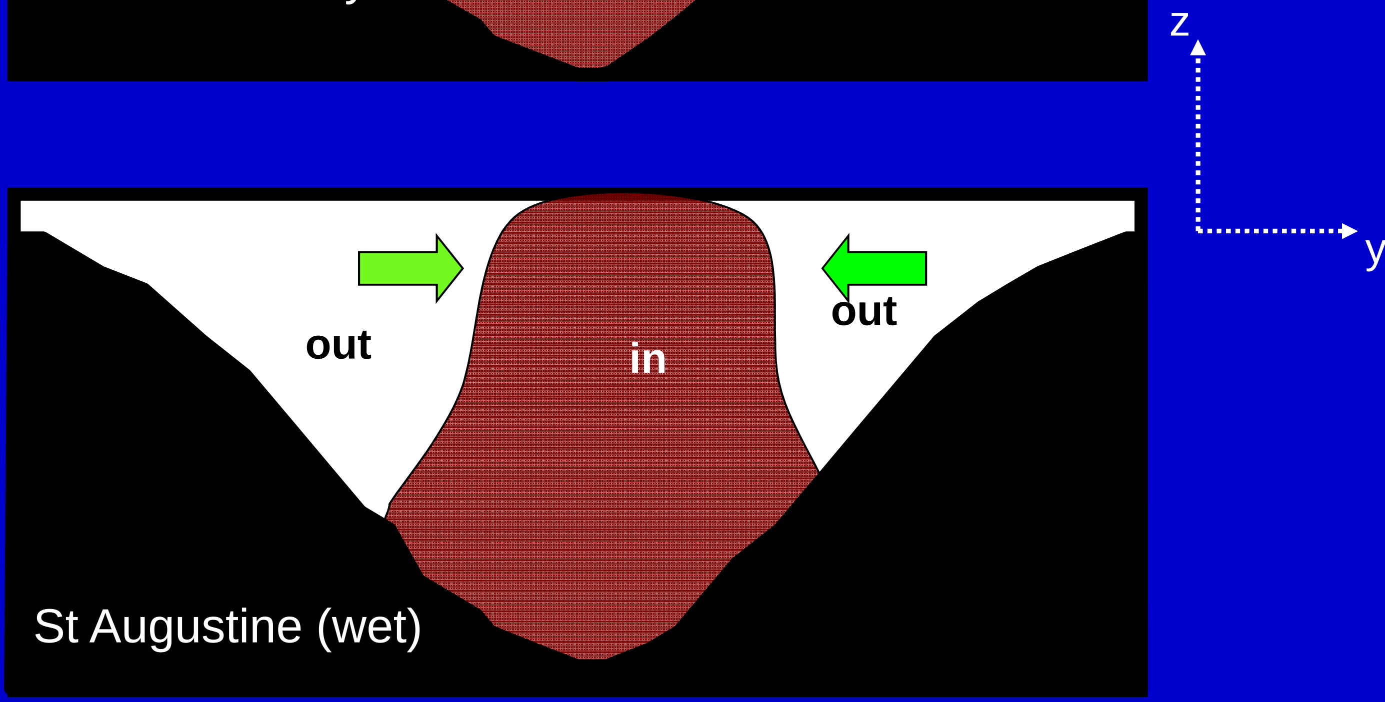


Prepared by Amy Waterhouse

SUMMARY (1)

Density-induced exchange flow



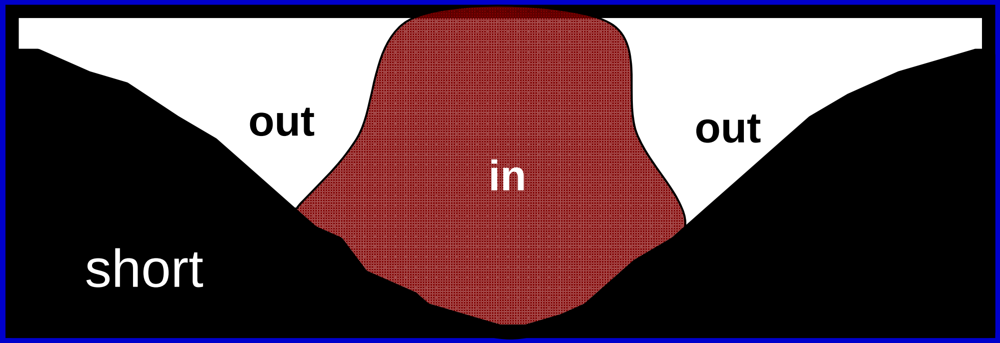


SUMMARY (2)

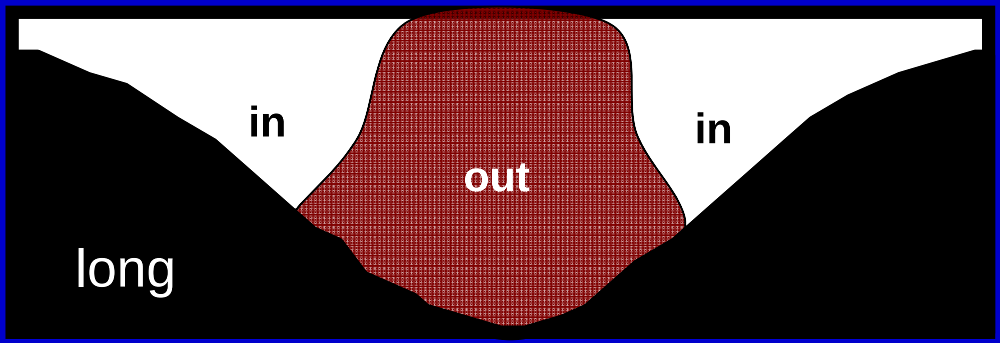
Net tidally induced exchange flow

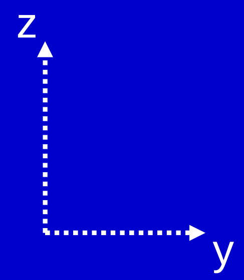
St Augustine (dry)

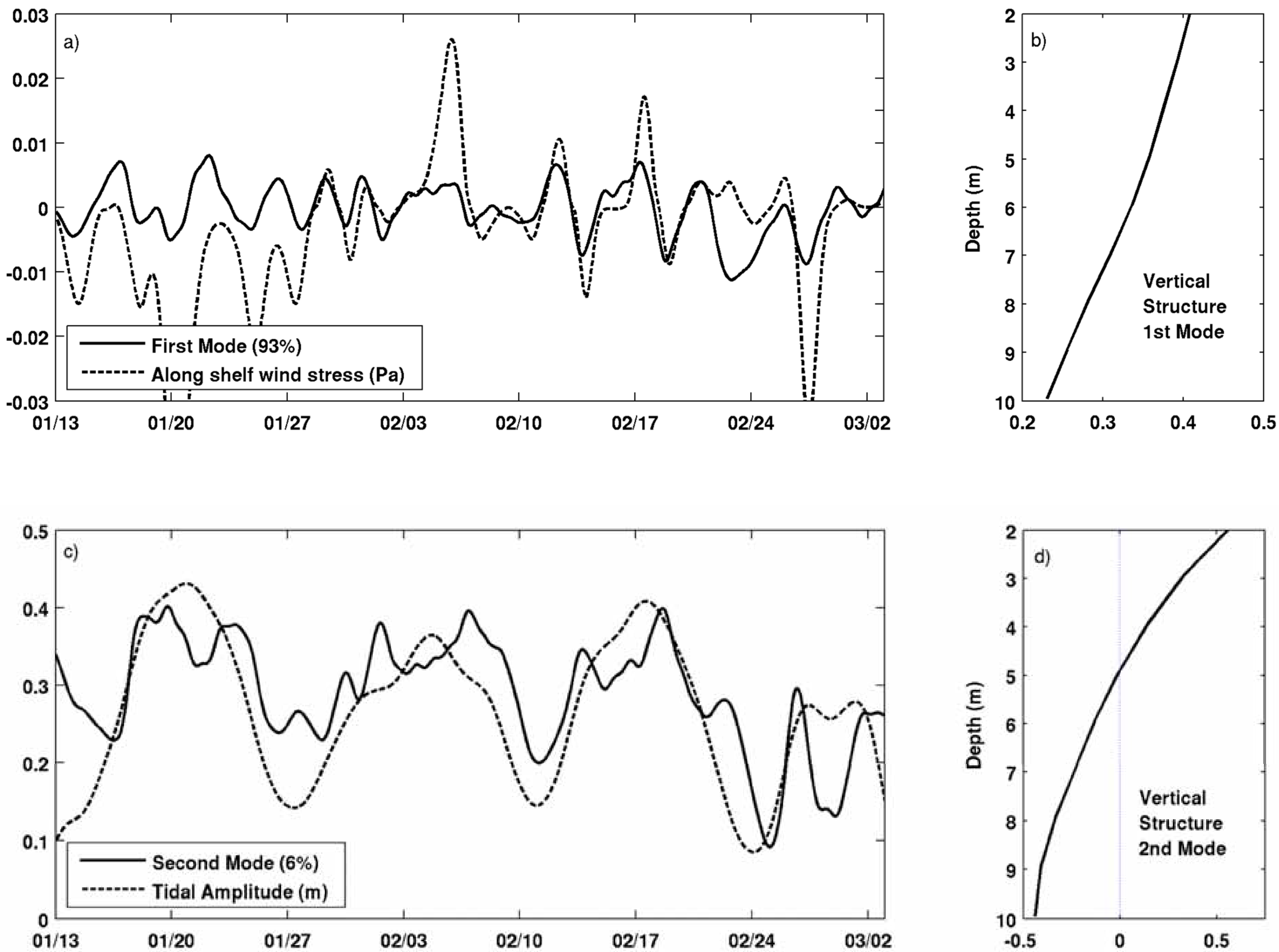
& Jupiter



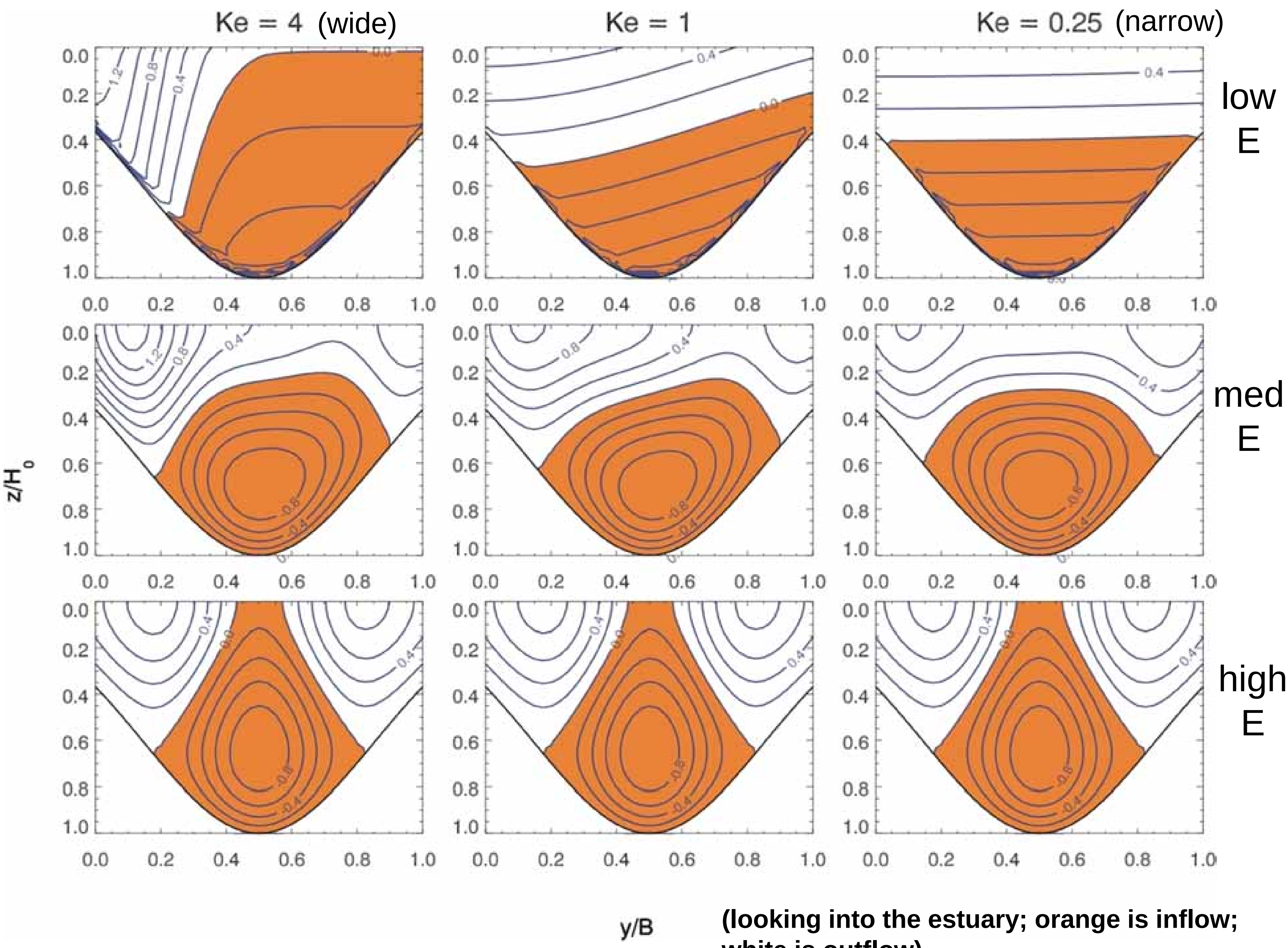
Ponce de León



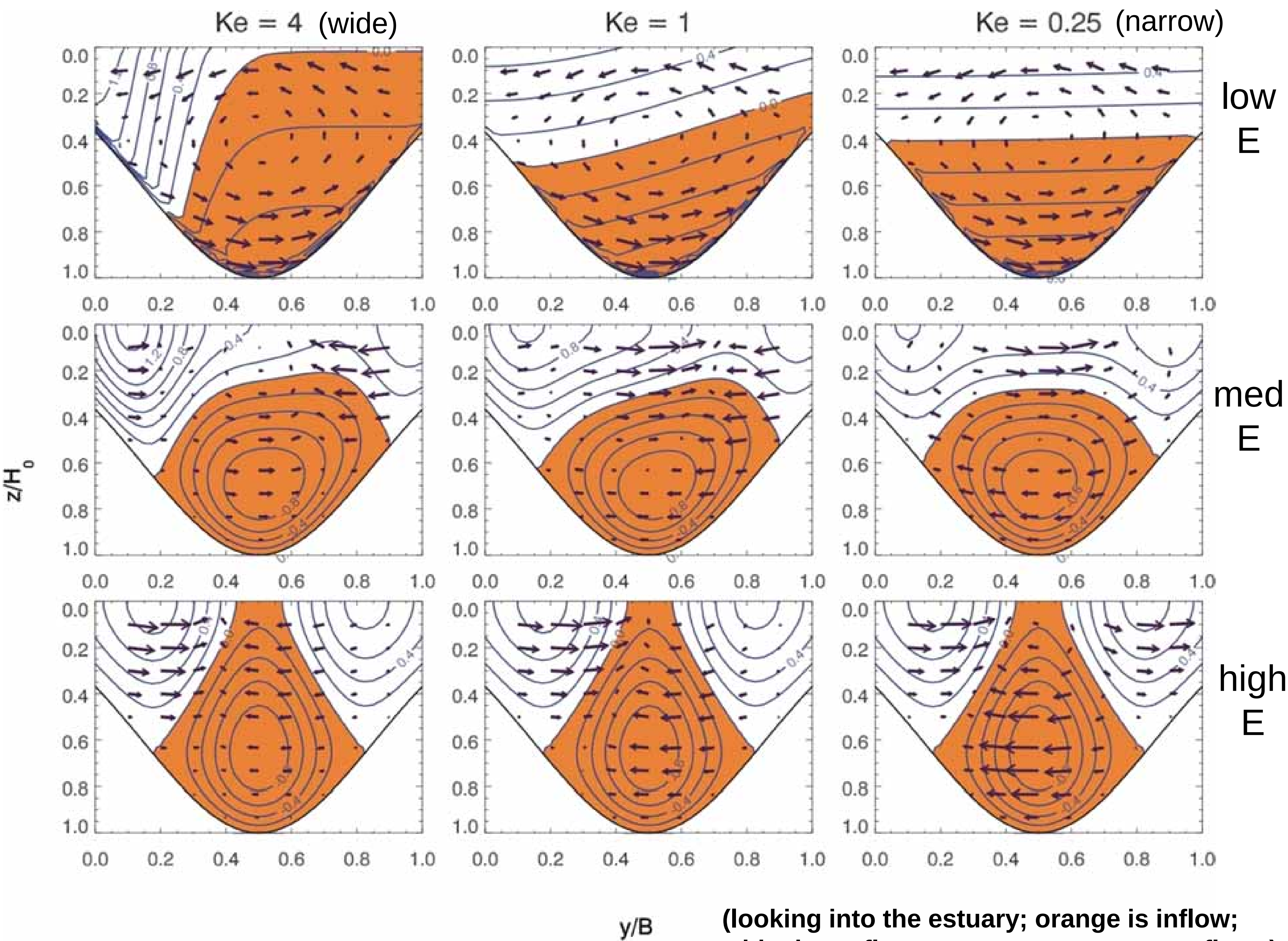




a)
First Mode (93%)
Along shelf wind stress (Pa)
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
01/13
01/20
01/27
02/03
02/10
02/17
02/24
03/02
b)
Depth (m)
Vertical
Structure
1st Mode
0.2
0.3
0.4
0.5
c)
Second Mode (6%)
Tidal Amplitude (m)
0.5
0.4
0.3
0.2
0.1
d)
Vertical
Structure
2nd Mode
-0.5
0
0.5

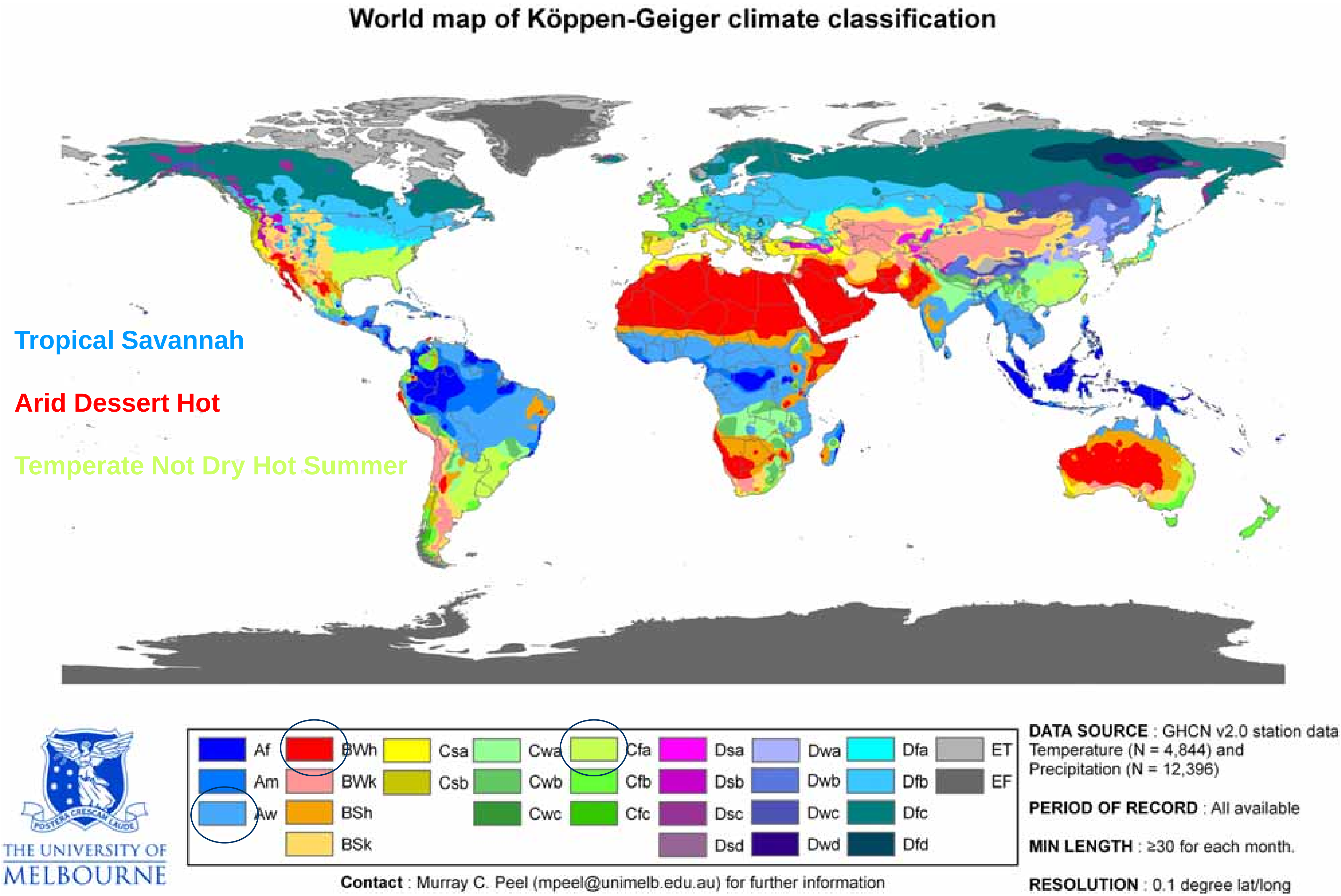


(looking into the estuary; orange is inflow; white is outflow)



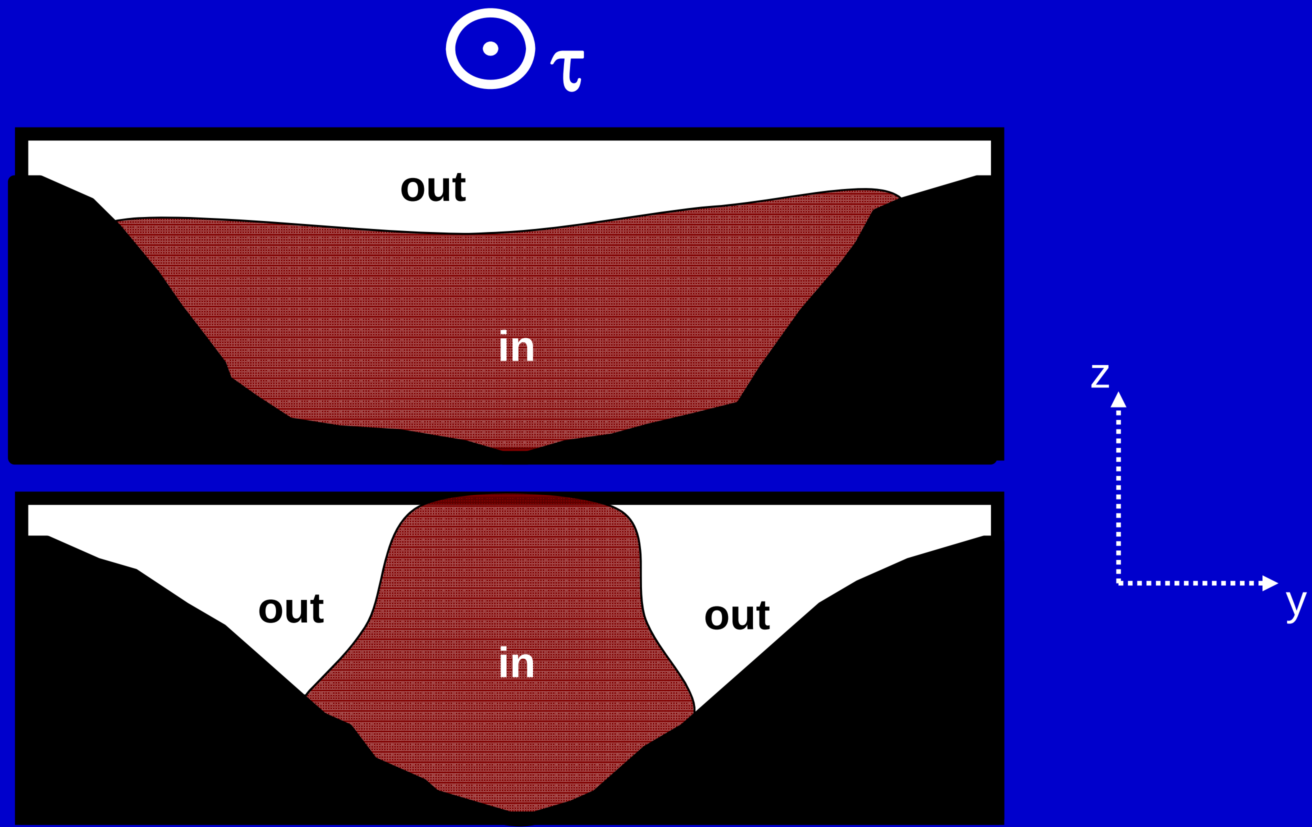
(looking into the estuary; orange is inflow; white is outflow; arrows are transverse flows)

CTD Casts - Sea Bird SBE19

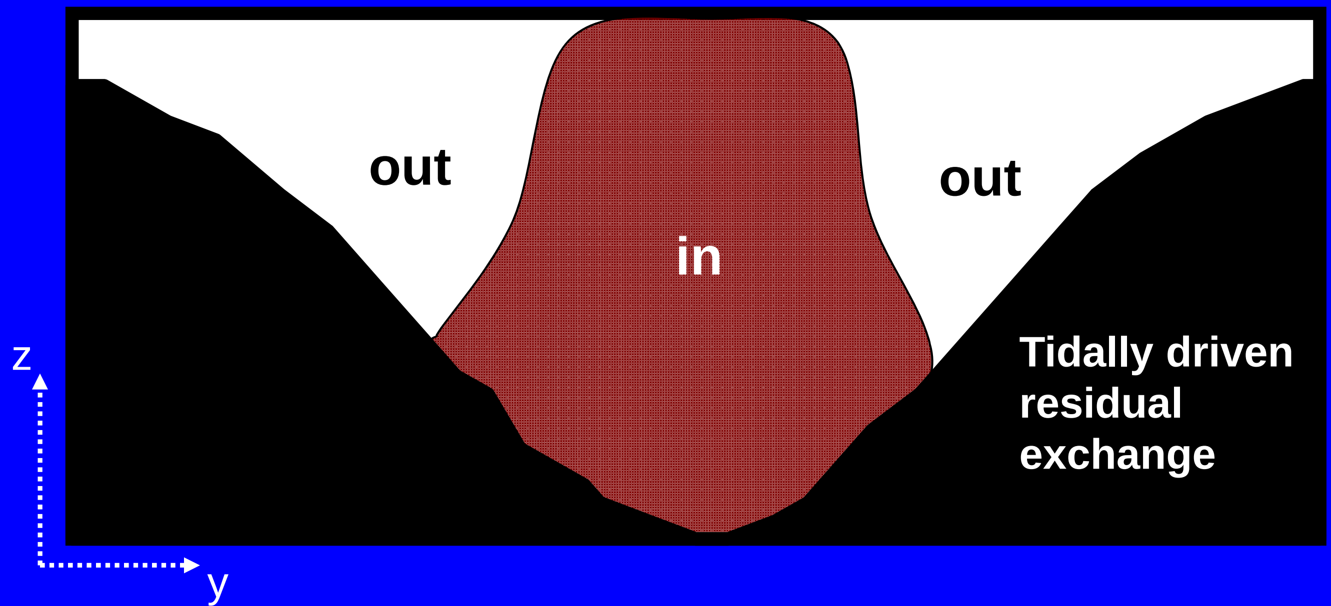


Peel, M. C. and Finlayson, B. L. and McMahon, T. A. (2007). "Updated world map of the Köppen-Geiger climate classification". *Hydrol. Earth Syst. Sci.* **11**: 1633-1644.

Wind-induced exchange flow (seaward wind)



SUMMARY



Exchange pattern (for ‘short’ basins) consistent with density-driven

Fortnightly modulation opposite to that in temperate estuaries