2016 National Conference on Beach Preservation Technology

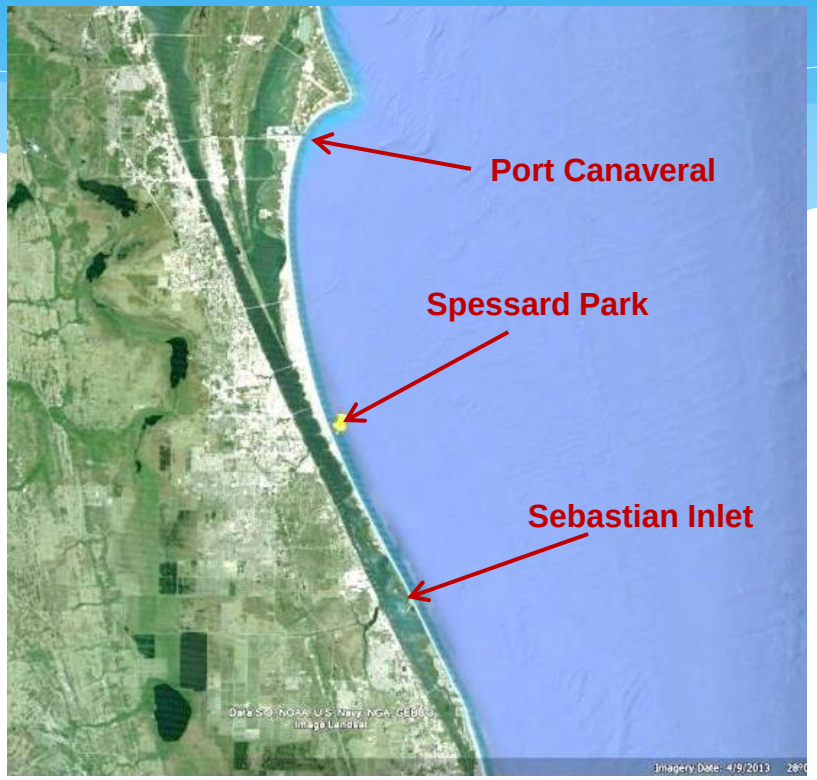
The Role of Wind in Longshore Currents

Carolina Burnette and William Dally

University of North Florida, Jacksonville, FL

UNF
UNIVERSITY of NORTH FLORIDA

Surfbreak Engineering Sciences, Inc.



10 years of data


Port Canaveral
Image © 2014 DigitalGlobe


Sebastian Inlet

Field data collection

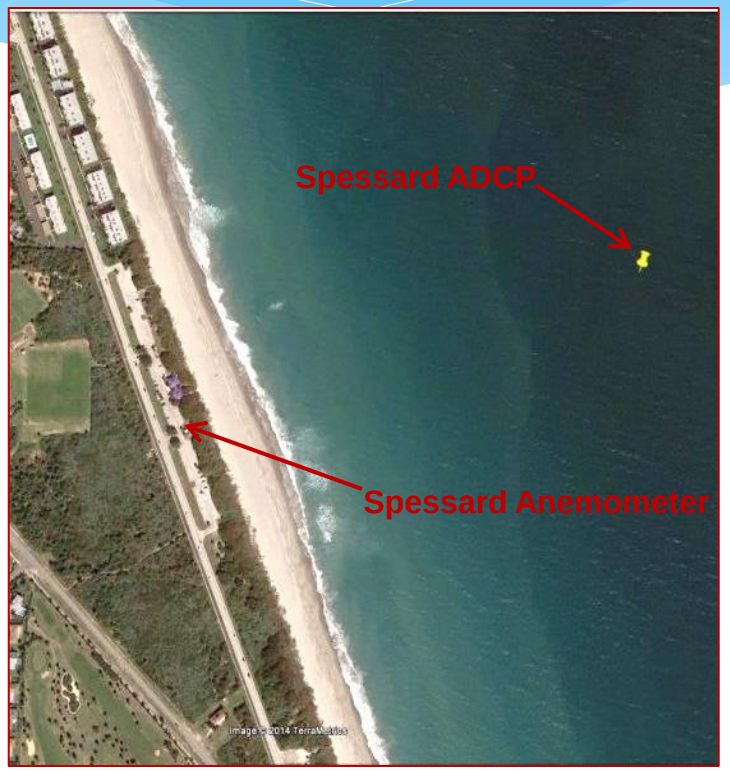
* Spessard Holland North Beach Park - Melbourne Beach

Acoustic Doppler Current Profiler (ADCP)

- Installed offshore ≈ 610 m at a mean depth 8.5 m depth (9/2001 – 10/2011)
- Current speed and direction measured over the water column ($\Delta z = 0.3$m).

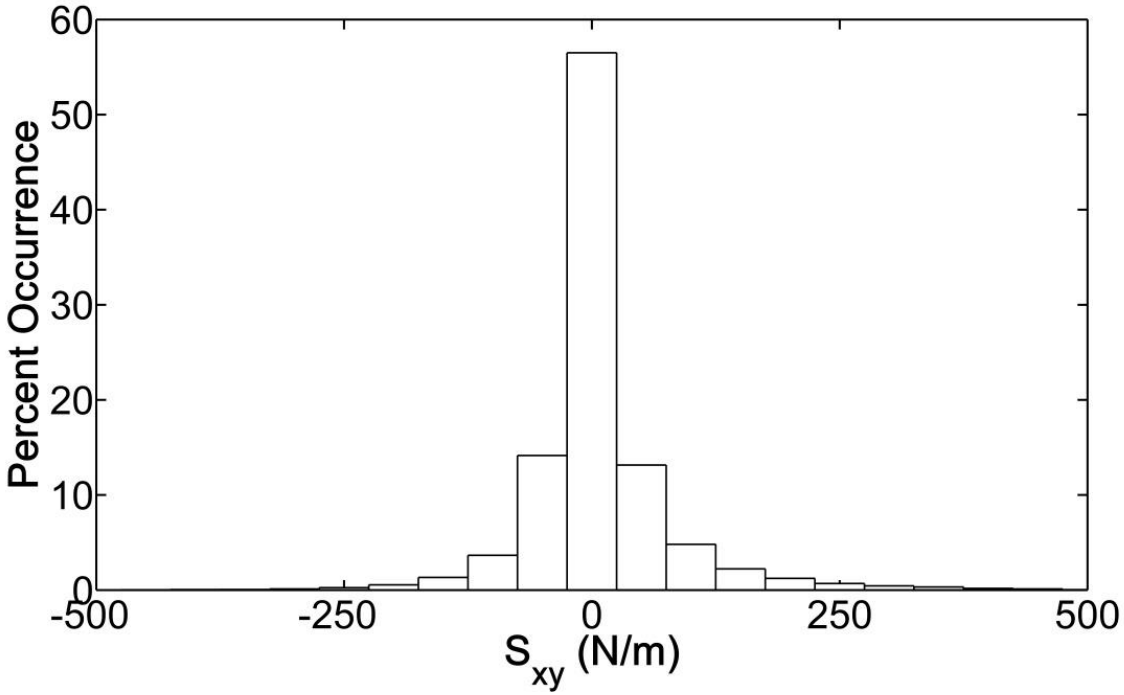
Anemometer

- Mounted to a 10 m tall tower on the dune (9/2002 – 10/2008)
- Wind speed and direction



Motivation

FSBPA – 2015
Montoya and Dally (JCR in press)

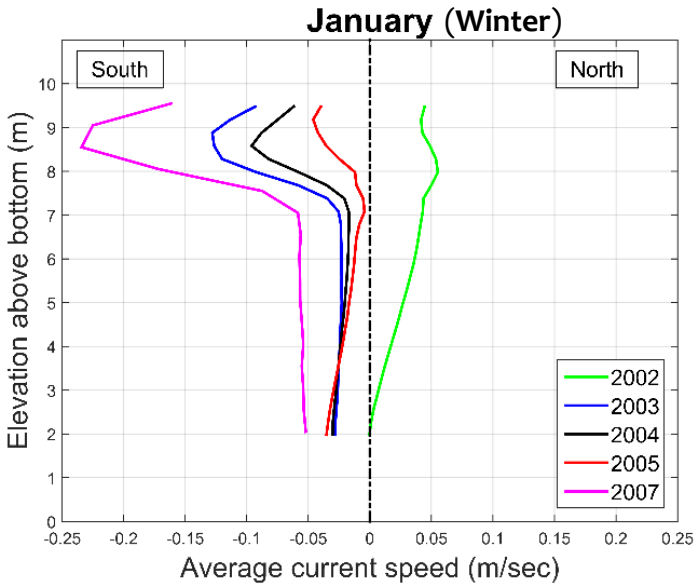


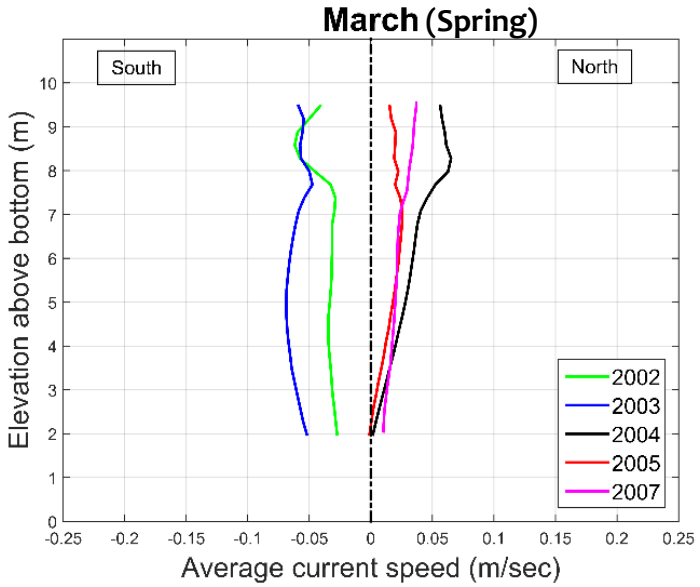
Histogram of radiation stress (Sxy) integrated from fully directional 2D (f, θ) spectra

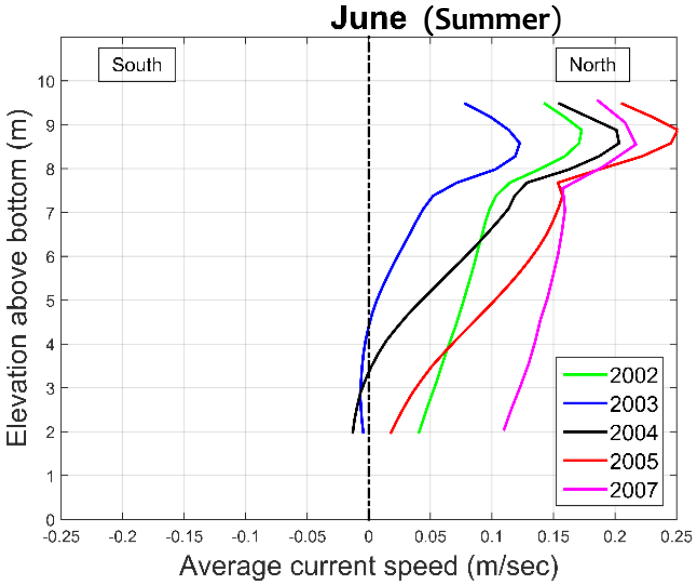
Year	Average Sxy (N/m)
2001	-11.4
2002	-10.3
2003	-4.22
2004	-13.4
2005	0.09
2006	8.79
2007	-5.5
2008	-31
2009	11
2010	-16.2
Average	**-7.22**

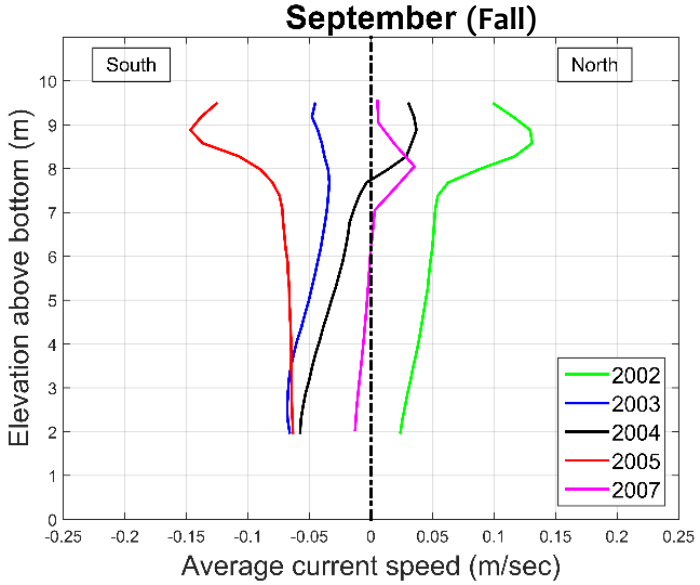
radiation stress (Sxy)

Mean Vertical Profile of Longshore Current

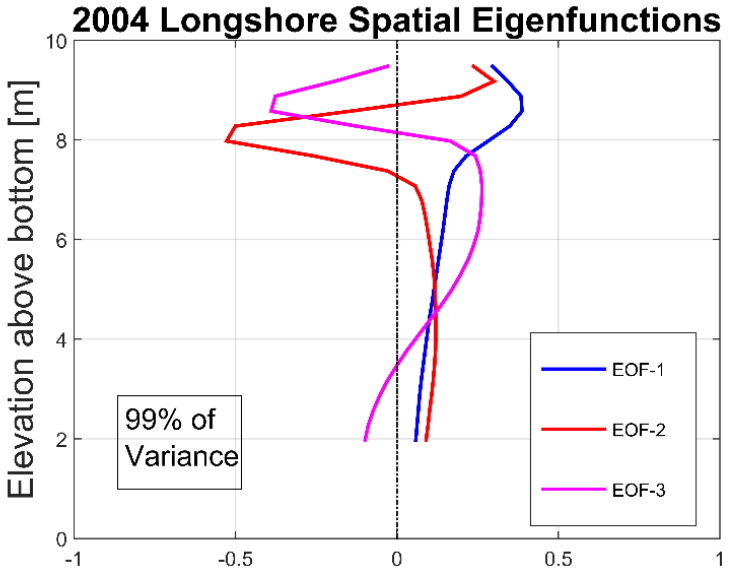






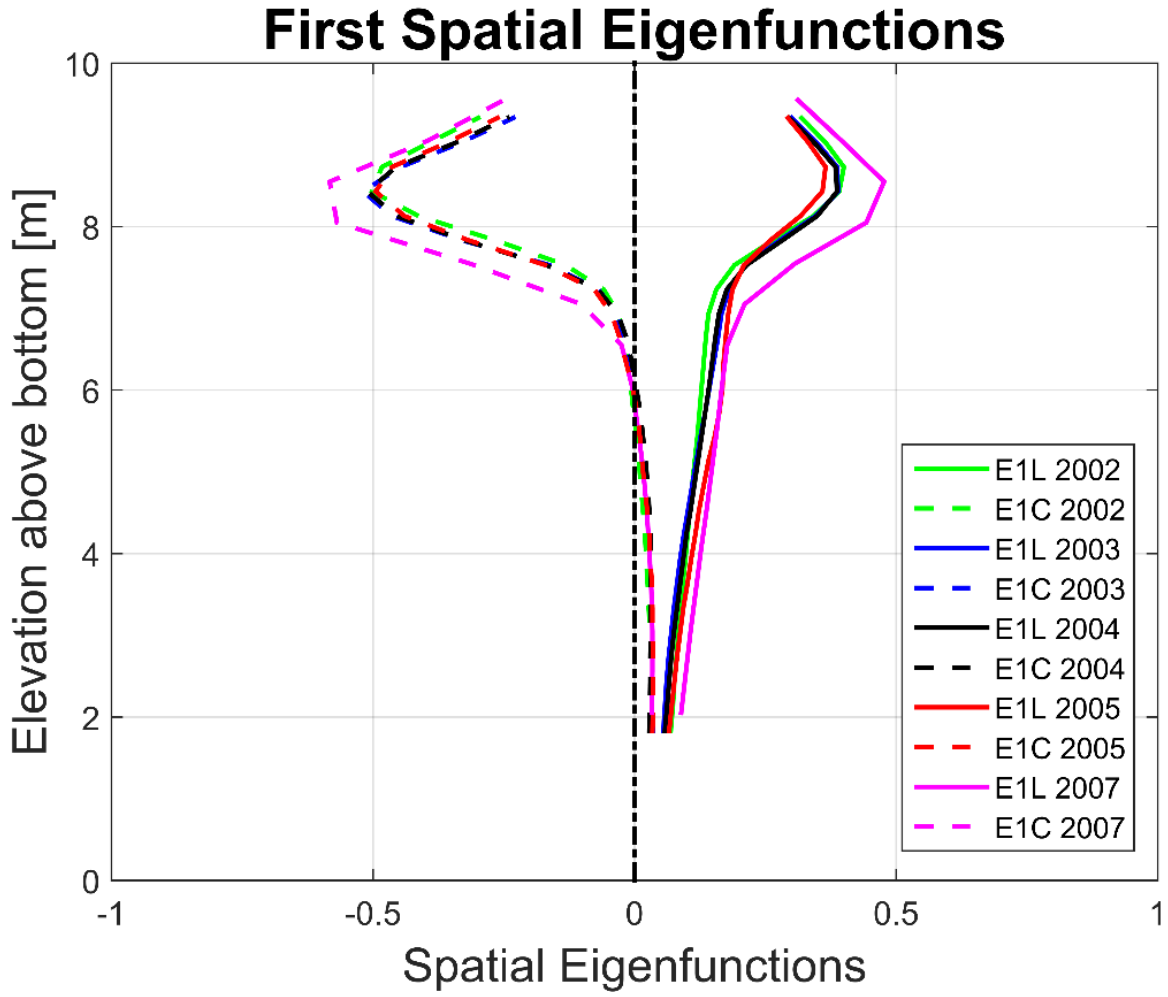


Empirical Orthogonal Function Analysis (EOF)



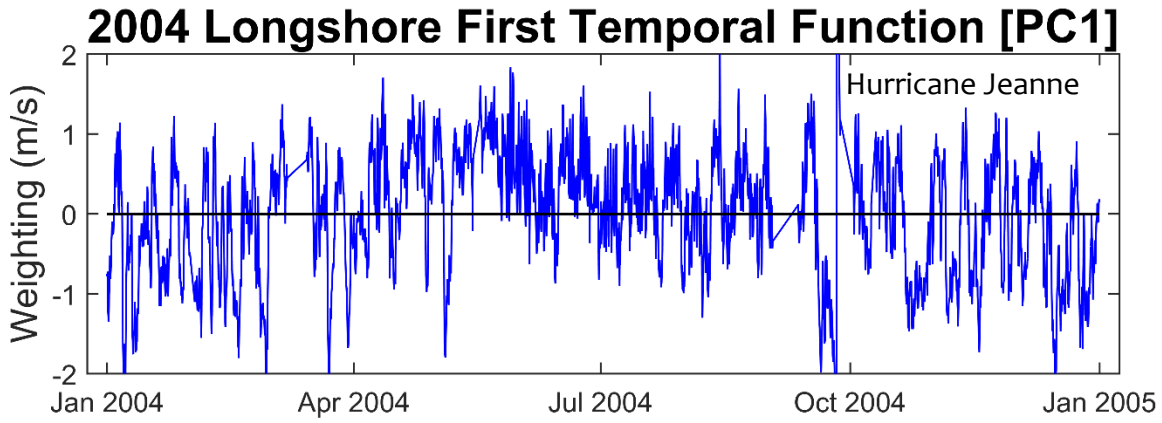
Year	Cross-shore Eigenfunctions		Longshore Eigenfunctions	
	Eigenvalues variance	Eigenvalues cumulative variance	Eigenvalues variance	Eigenvalues cumulative variance
2002	94.80	94.80	98.80	98.80
	4.40	99.20	0.90	99.70
	0.50	99.70	0.20	99.90
2003	94	94.00	98.8	98.80
	5.2	99.20	0.7	99.50
	0.6	99.80	0.4	99.90
2004	**95.3**	**95.30**	**98.9**	**98.90**
	4.1	**99.40**	**0.7**	**99.60**
	0.4	**99.80**	**0.3**	**99.90**
2005	90	90.00	98.4	98.40
	5.7	95.70	1	99.40
	3.2	98.90	0.4	99.80
2007	94.6	94.60	98.6	98.60
	4.7	99.30	1.1	99.70
	0.6	99.90	0.2	99.90

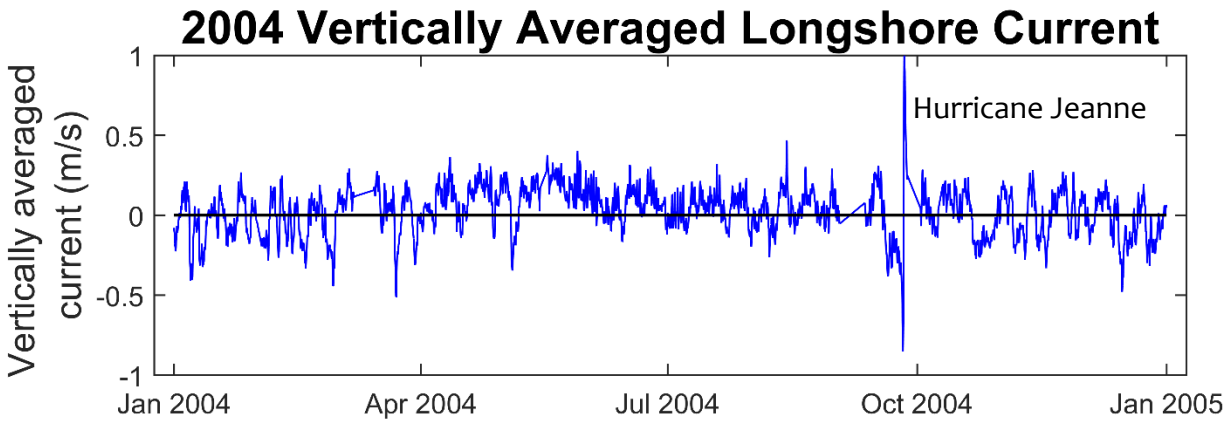
Spatial Eigenfunctions

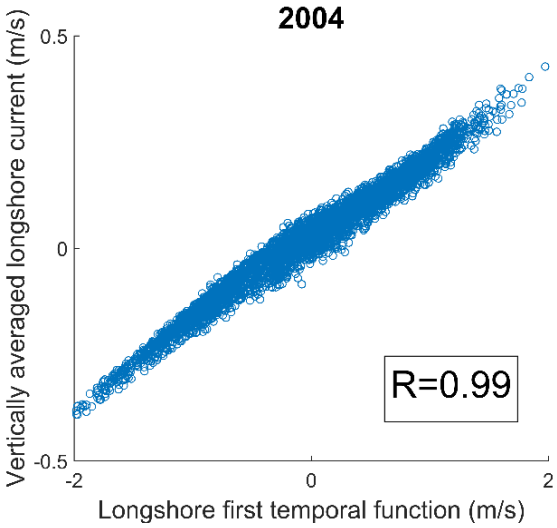


The first spatial Eigenfunctions of the cross-shore and the longshore components represent the vast majority of the variability each year.

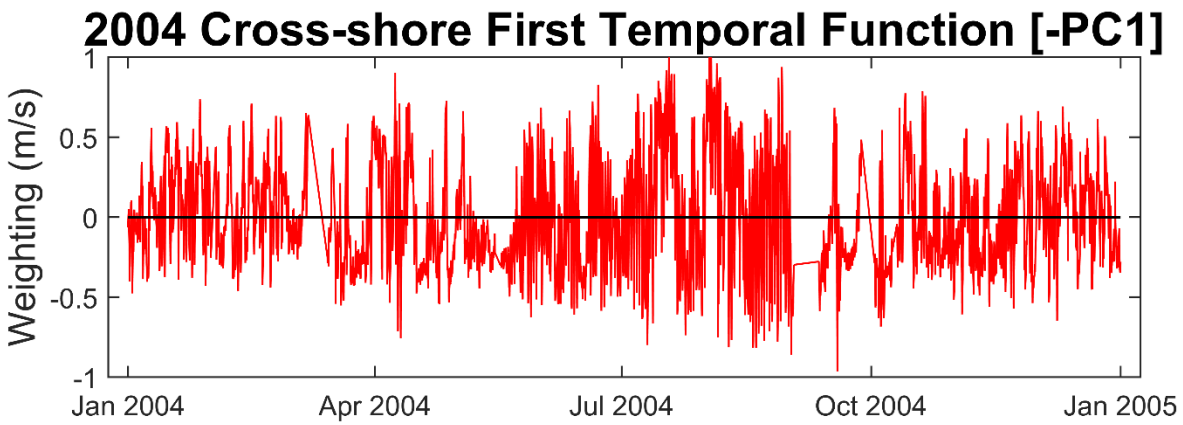
First Longshore Temporal Functions

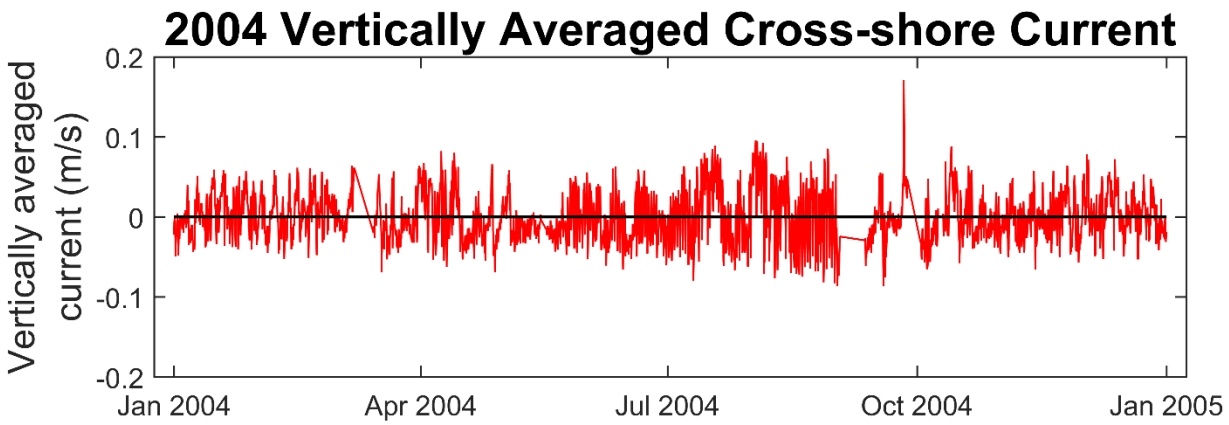


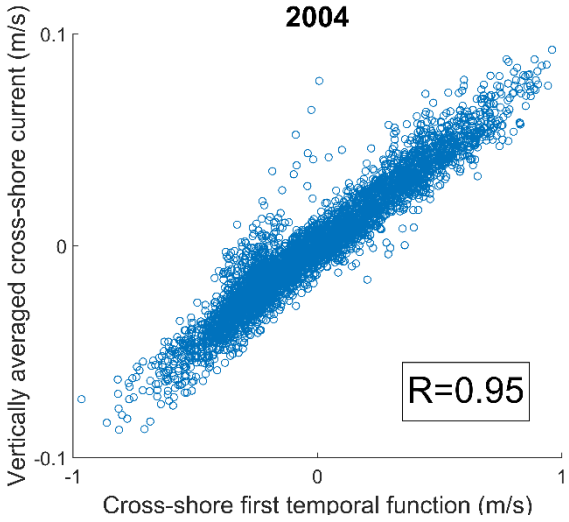




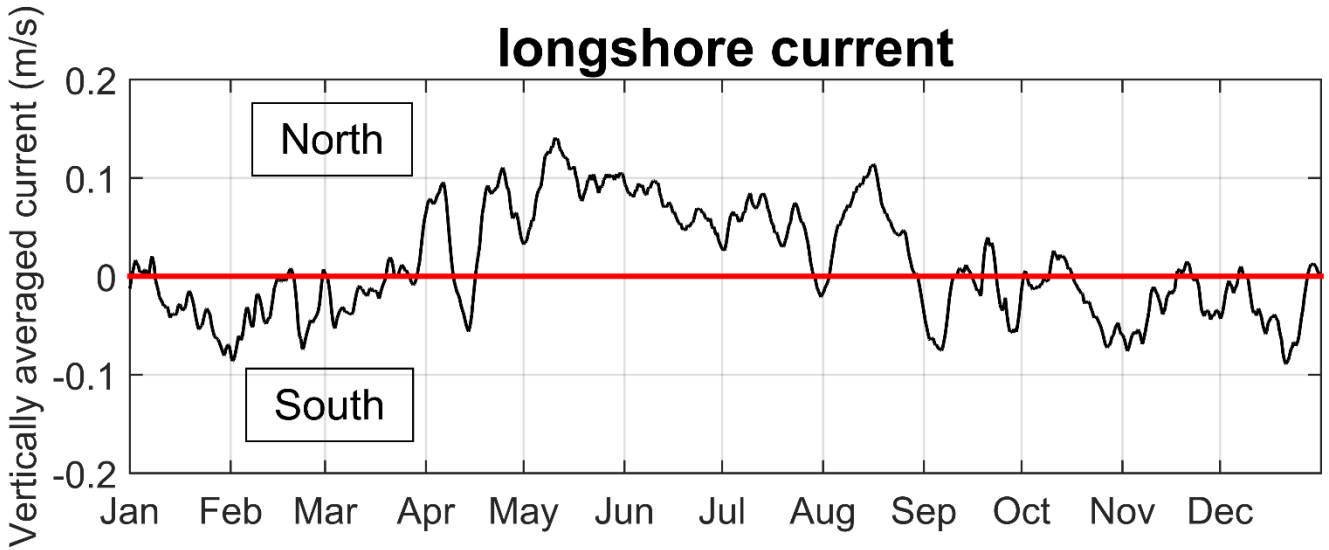
First Cross-Shore Temporal Functions



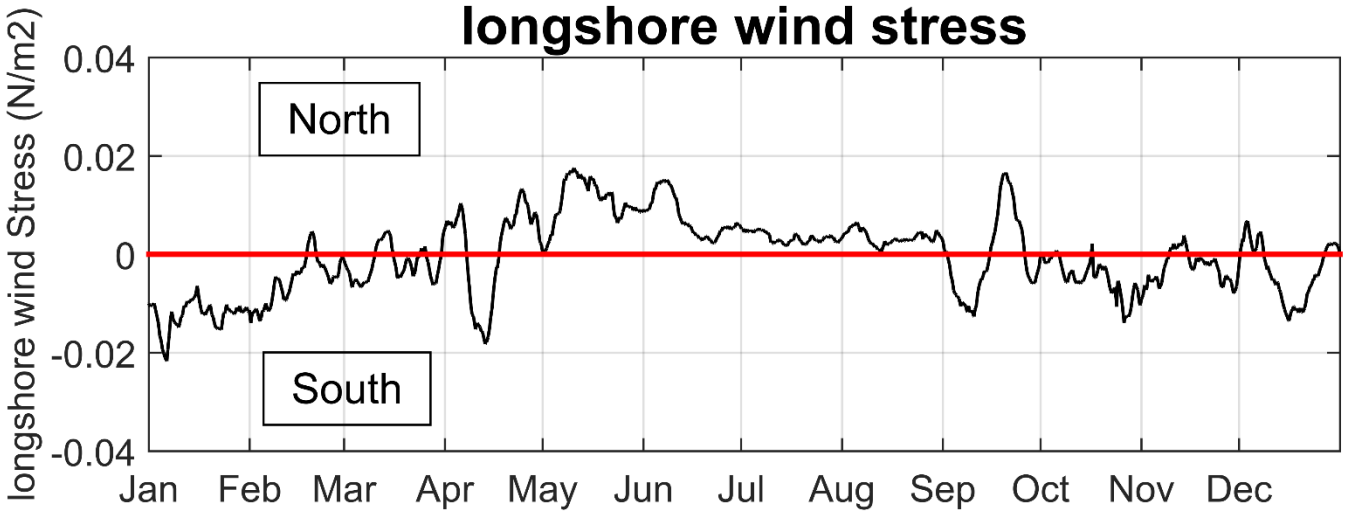




Weekly running average of longshore current and longshore wind stress

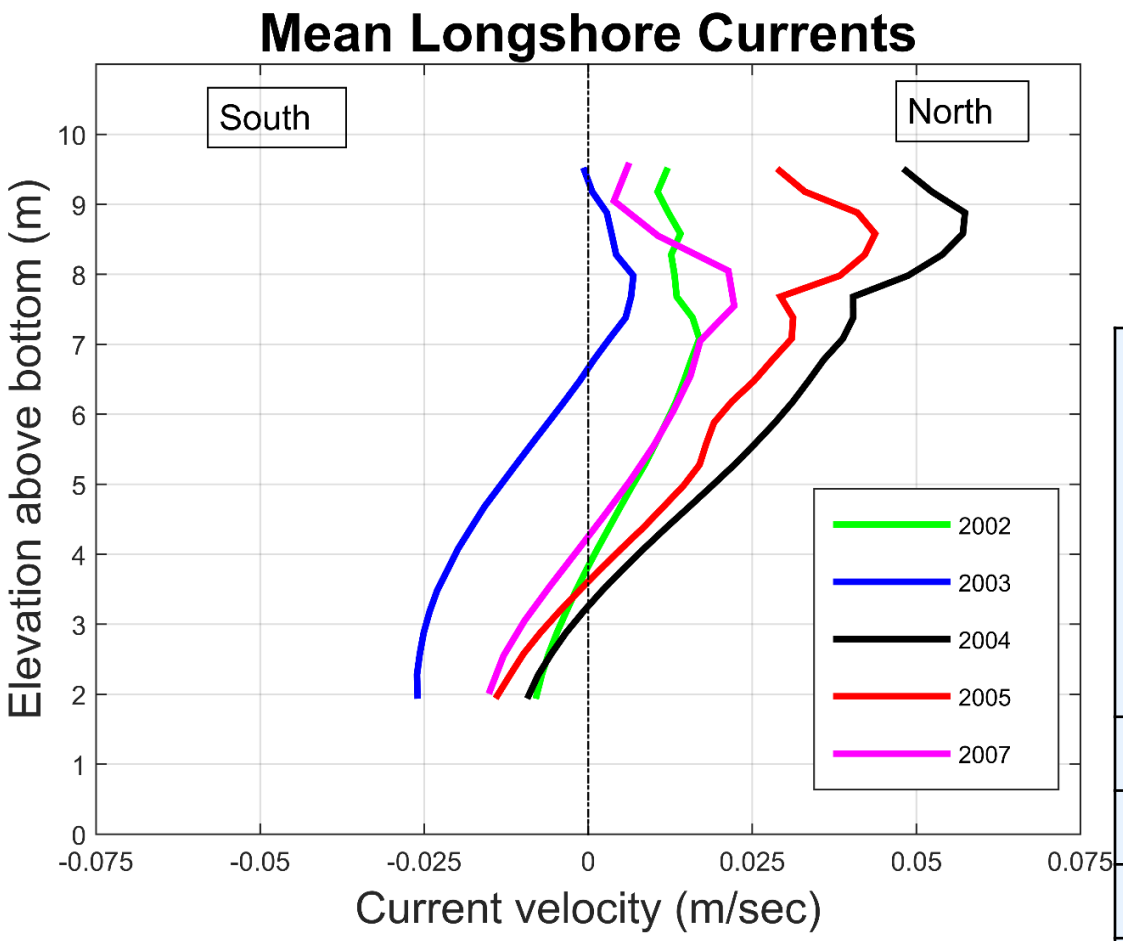


Correlation= 0.78



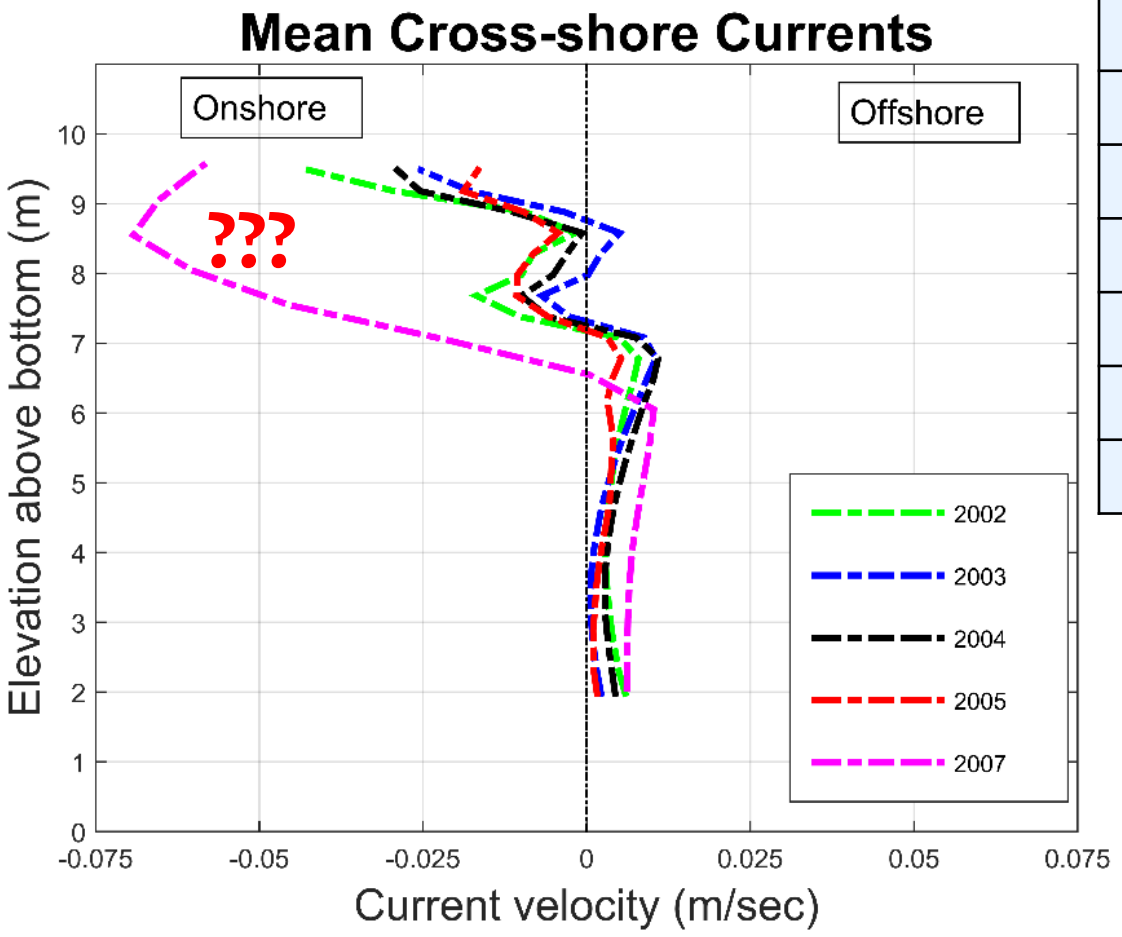
Wind Stress $[N/m^2]$		
Year	**Longshore Wind stress**	**Cross-shore Wind stress**
2002	-21.1	-179.8
2003	-92.8	-505.8
2004	13.5	-473.5
2005	-33.2	-516.4
2007	59.7	-207.2
Net	**-73.8**	**-1882.6**

Longshore Volume Flux



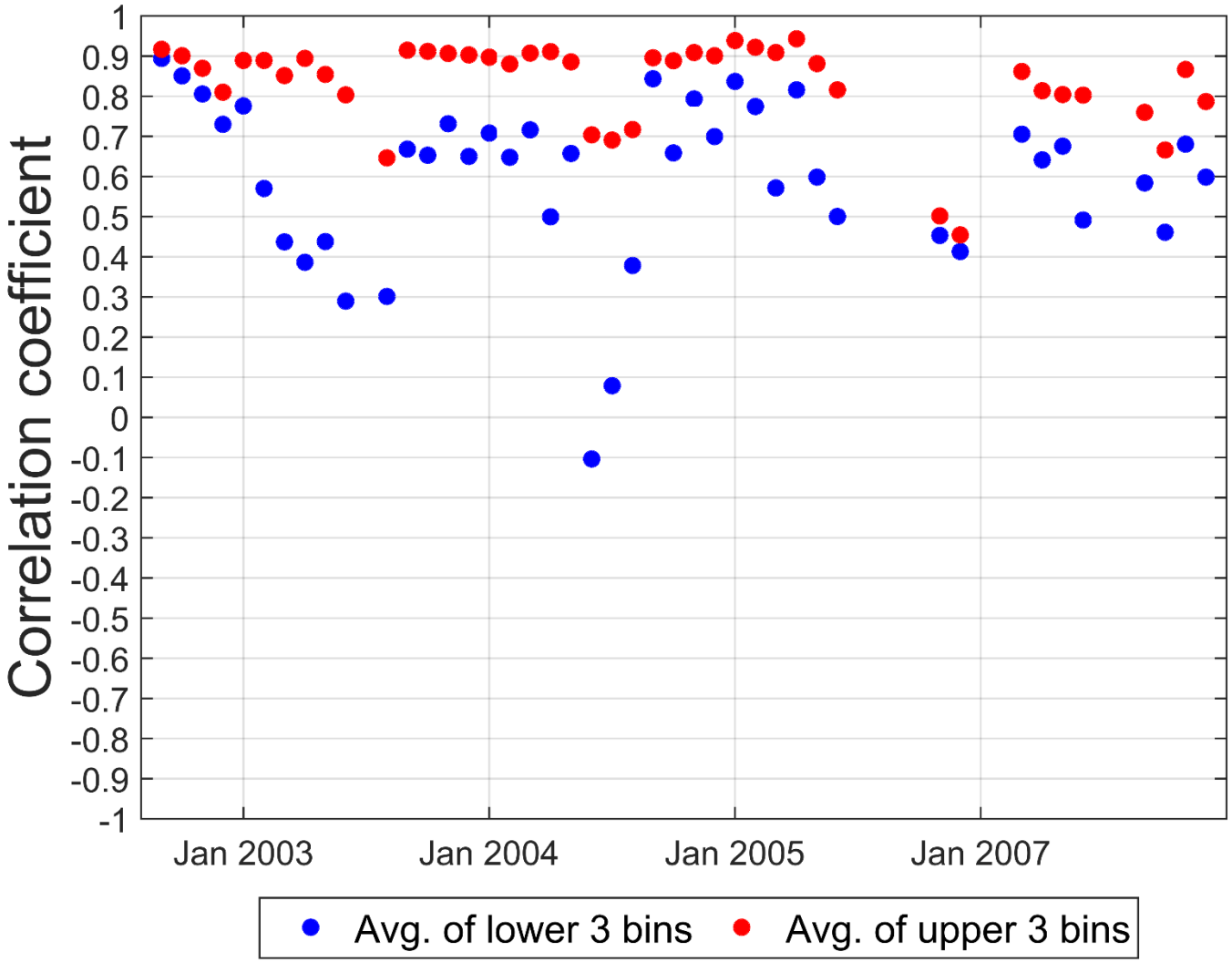
Year	Longshore Volume Flux $[m^2/sec]$		
	Volume Flux from bin 2 to 26	Volume Flux from bottom to bin 1	Total Volume Flux $[m^2/sec]$
2002	1791.20	-494.68	1296.52
2003	-2782.44	-2284.82	-5067.25
2004	9535.14	-867.33	8667.82
2005	5158.76	-1037.18	4121.59
2007	1323.50	-795.95	527.55
Net	**15026.17**	**-5479.95**	**9546.22**

Cross-shore Volume Flux

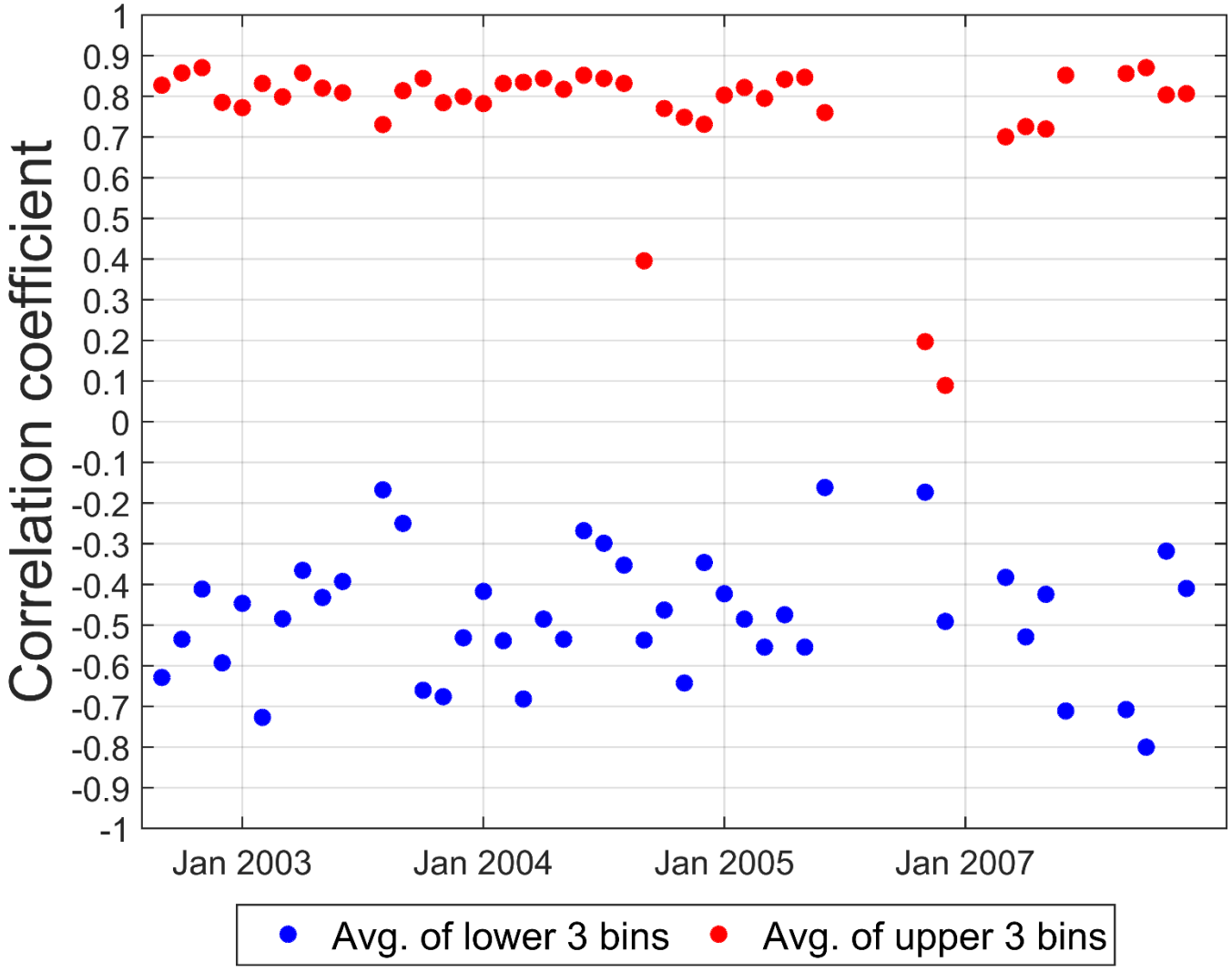


Year	Cross-shore Volume Flux $[m^2/sec]$		
	Volume Flux from bin 2 to 26	Volume Flux from bottom to bin 1	Total Volume Flux $[m^2/sec]$
2002	-493.83	369.84	-123.98
2003	235.75	191.56	427.31
2004	39.63	414.53	454.16
2005	-426.97	118.53	-308.44
2007	-3463.11?	325.11	-3138.01
Net	**-4108.53**	**1419.57**	**-2688.95**

Longshore Current Vs. Longshore Wind Speed



Cross-shore Current Vs. Cross-shore Wind Speed



Conclusions

* Longshore currents measured outside the surf zone are highly correlated with the measured longshore component of the wind.
* Most of the longshore wind influence is in the upper 20% of the water column.
* Strong seasonality in both direction and intensity of the longshore current.
* The first spatial and temporal eigenfunctions account for 98% of the variation in the longshore current and 95% of the variation of the cross-shore current.
* Although the net longshore surface currents for the five years are directed towards the north, at the bottom of the water column it appears that the mean longshore currents are to the south.

Future Work

* Examine correlation of storm waves (i.e. Hs ≥ 1.75 m) with the longshore current.
* Look more closely for a mass flux balance in the cross-shore direction.
* Add additional years using wind data from Port Canaveral.


Thanks