CLASI: Coordinating Innovative Observations and Modeling to Improve Coastal Environmental Prediction Systems

Brian Haus and a cast of many..

Office of Naval Research Science & Technology

Cantabria Waves Workshop, Santander 2025

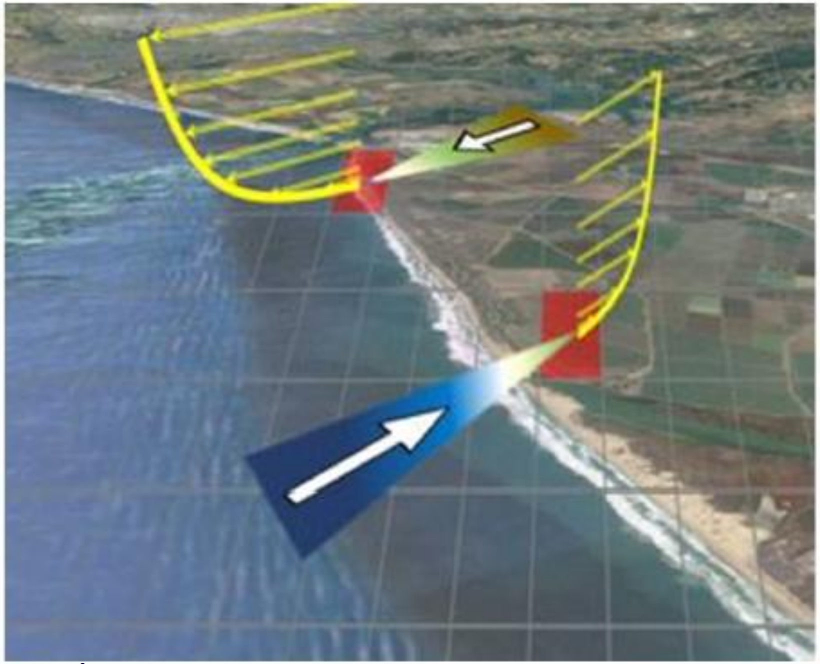
UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL of MARINE & ATMOSPHERIC SCIENCE

What am I going to talk about?

1. CLASI (coastal land air-sea interaction) overview
2. Air-sea interaction buoys deployed during CLASI
3. Northern Gulf of Mexico ASIS data in offshore winds
4. Supporting measurements in SUSTAIN

1. CLASI introduction

Moving toward a Coast-Aware parameterization of the atmospheric and oceanic surface layers.



University of Miami: Brian K. Haus, Hans Graber, Neil Williams, Milan Curcic, Samantha Ballard, Will Drennan, Sanchit Mehta, Samantha Medina, Samantha Furtney, Jacob Brooks, Ryland Lewis, Cedric Guigand, Bjoern Lund, Rolando Gonzalez

Naval Postgraduate School: Jamie Macmahan, Qing Wang, Dave Ortiz-Suslow, Charlotte Benbow, Ed Thornton, Chris Miller, Ryan Yamaguchi, Jesús Ruiz-Plancarte, John Kalogiros (Natl. Obs. Athens),

Naval Research Laboratory: James D. Doyle, David Flagg, Xiaodong Hong, James Hylwiak, Jacob Yung

University of Minnesota: **Lian Shen**, Jagmohan Singh, Xuanting Hao

Ohio State University: **Caglar Yardim**

Woods Hole Mooring Operations and Engineering

USACE: Tripp Collins

Hasanuddin University, Indonesia: Agustinus Ribal

UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL of MARINE & ATMOSPHERIC SCIENCE

CLASI Introduction

- Rationale
  - Operational environmental forecasts deficient in coastal zone
    - Drive nearshore hydrodynamic models
    - Electromagnetic-propagation
- Goals
  - To develop coast-aware parameterizations for atmosphere and ocean boundary layers in coastal zone
- Approach
  - Collect comprehensive field data set
  - LES model study to inform COAMPS parameterizations
  - Validations
- Monterey Bay experiments
  - Central Monterey Bay: June-Aug. 2021
  - Asilomar Peninsula: Aug.-Oct. 2021
  - Santa-Cruz experiment,

Haus et al. BAMS 2022

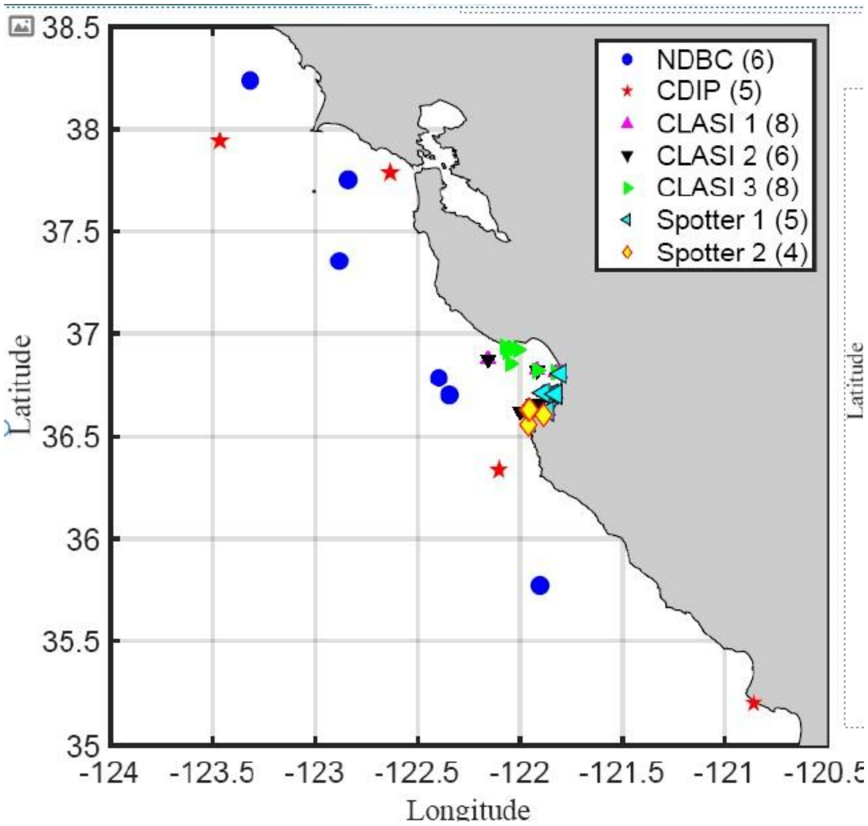
2. Air-sea buoys used during CLASI

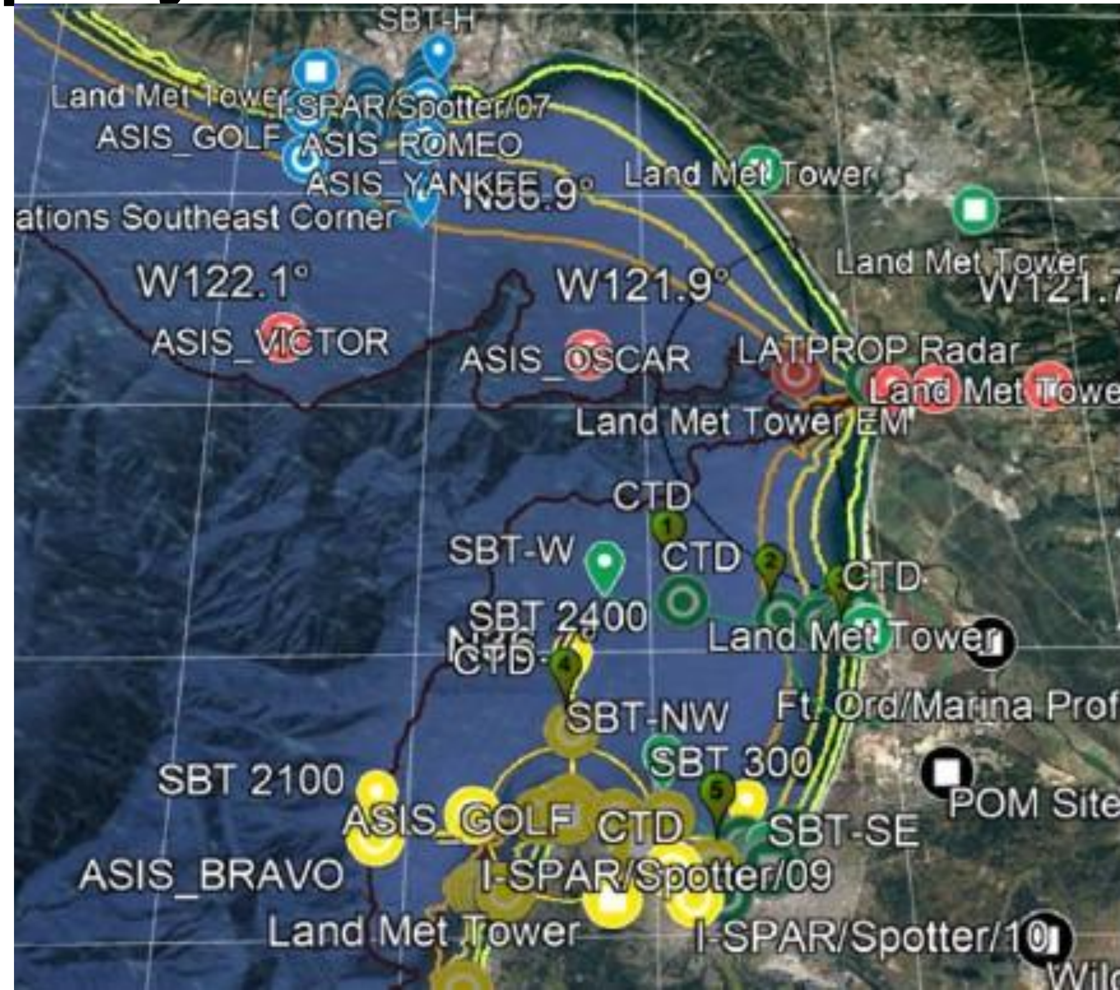
Charlotte Benbow, Jamie MacMahan, Paul Jessen, & Ed Thornton

CLASI Naval Postgraduate School Oceanography Inner-Shelf Spar (ISPAR) Buoy

- Robust (carbon fiber), lightweight (~110 lbs), inner-shelf spar buoy
- Deployable from 10-m RHIB for shallow water observations
- Operating depth - 7 m and deeper
- Measurement 4 m above the waterline,
- Wave damping assembly at bottom 4m below waterline → wave following
- IMU and GPS – buoy attitude and velocity corrections → eddy covariance
- Solar power (long duration) and iridium comms (real-time flux estimates)
- 10 functional ISPAR systems to resolve spatial variability

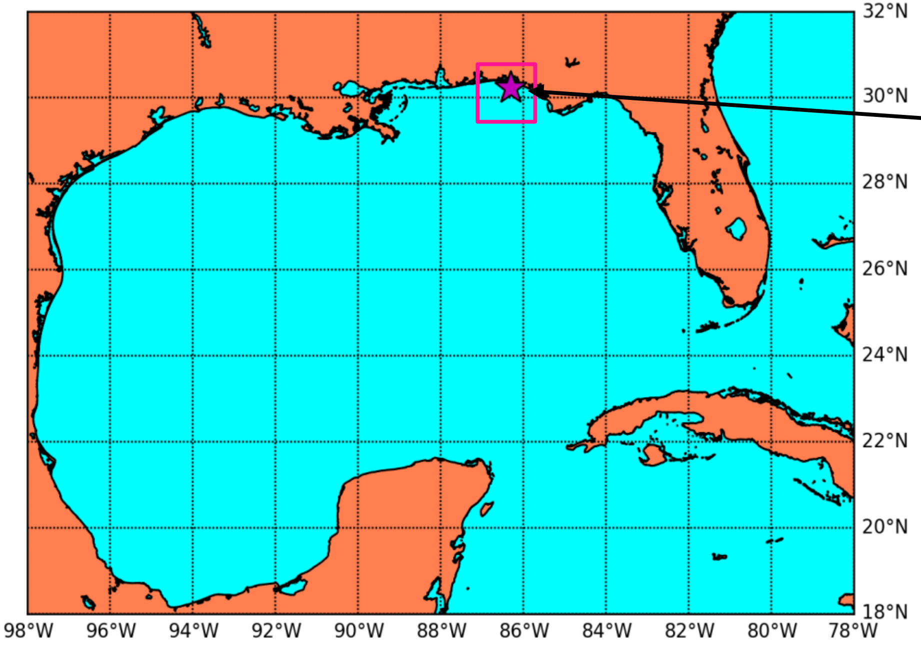
Monterey Bay deployments

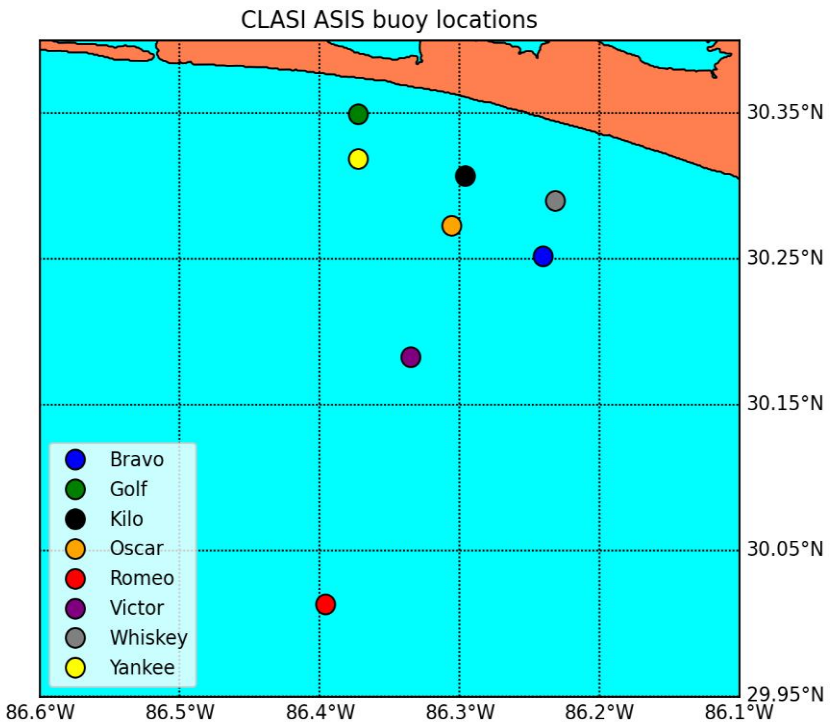


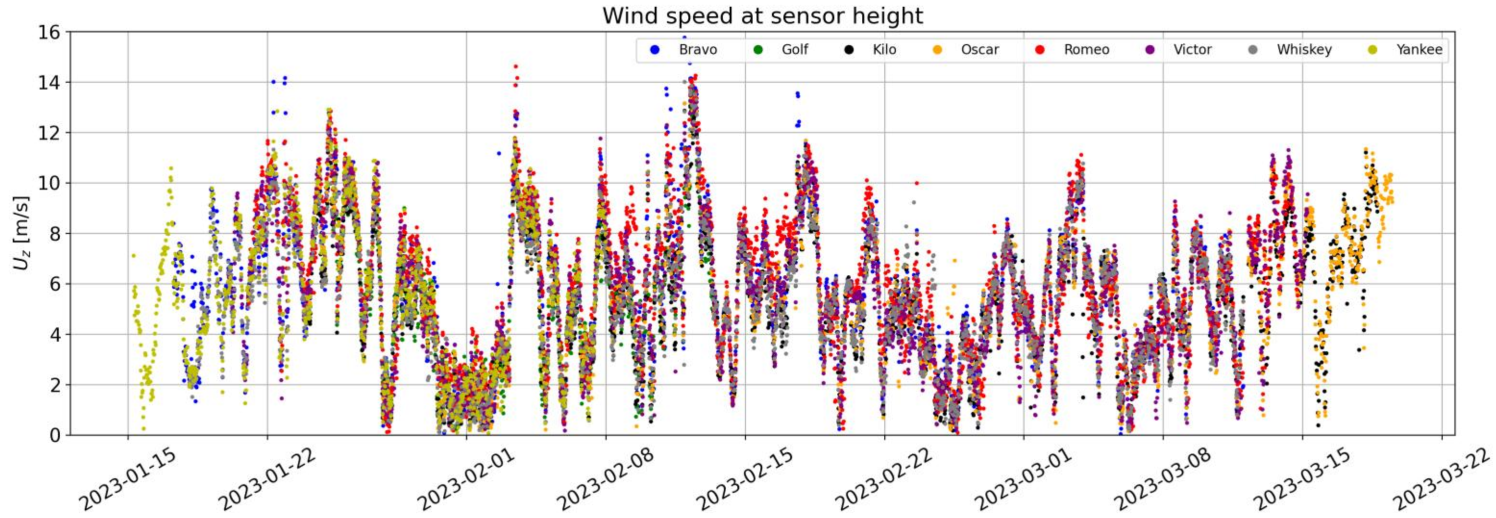


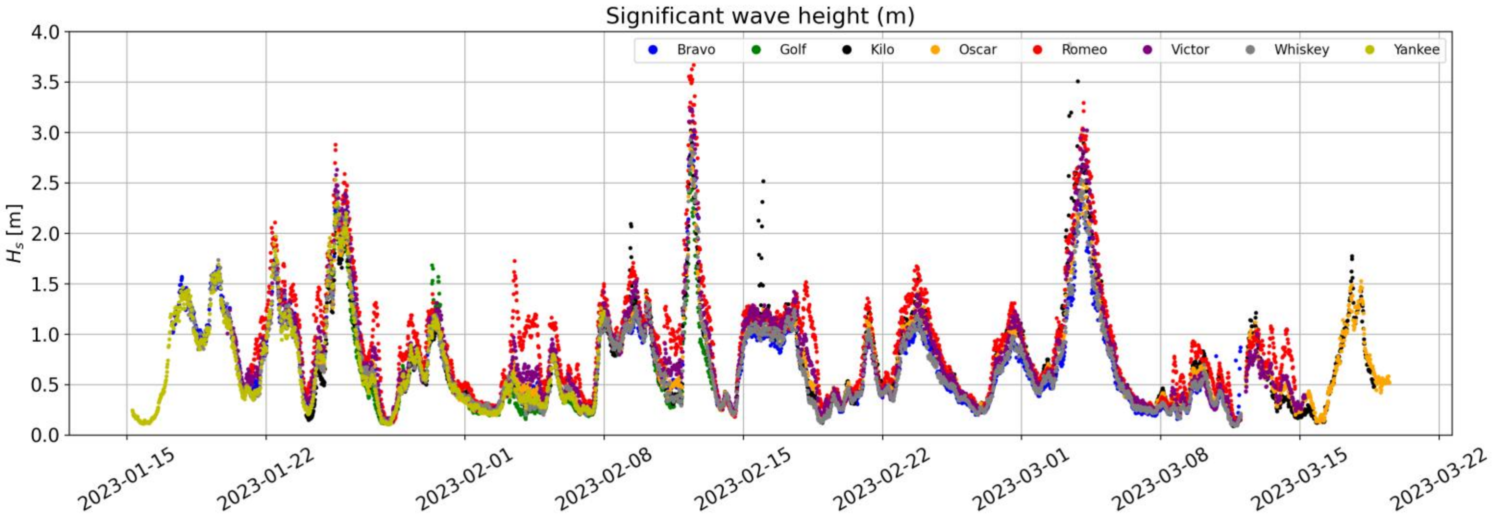
4. Wave growth and dissipation along CLASI cross-shore array in Northern Gulf of Mexico

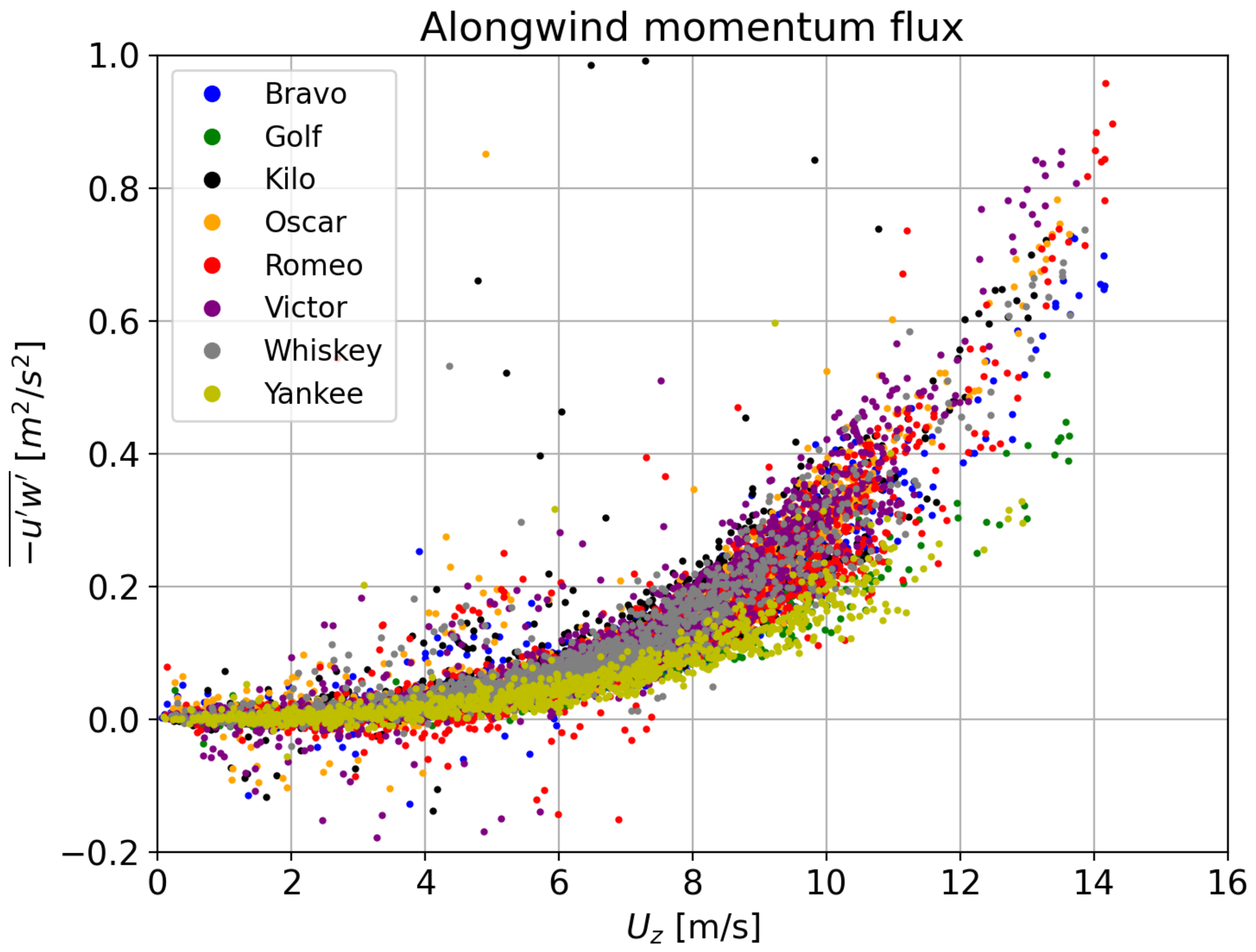
ASIS buoy locations – Northern Gulf of Mexico deployment

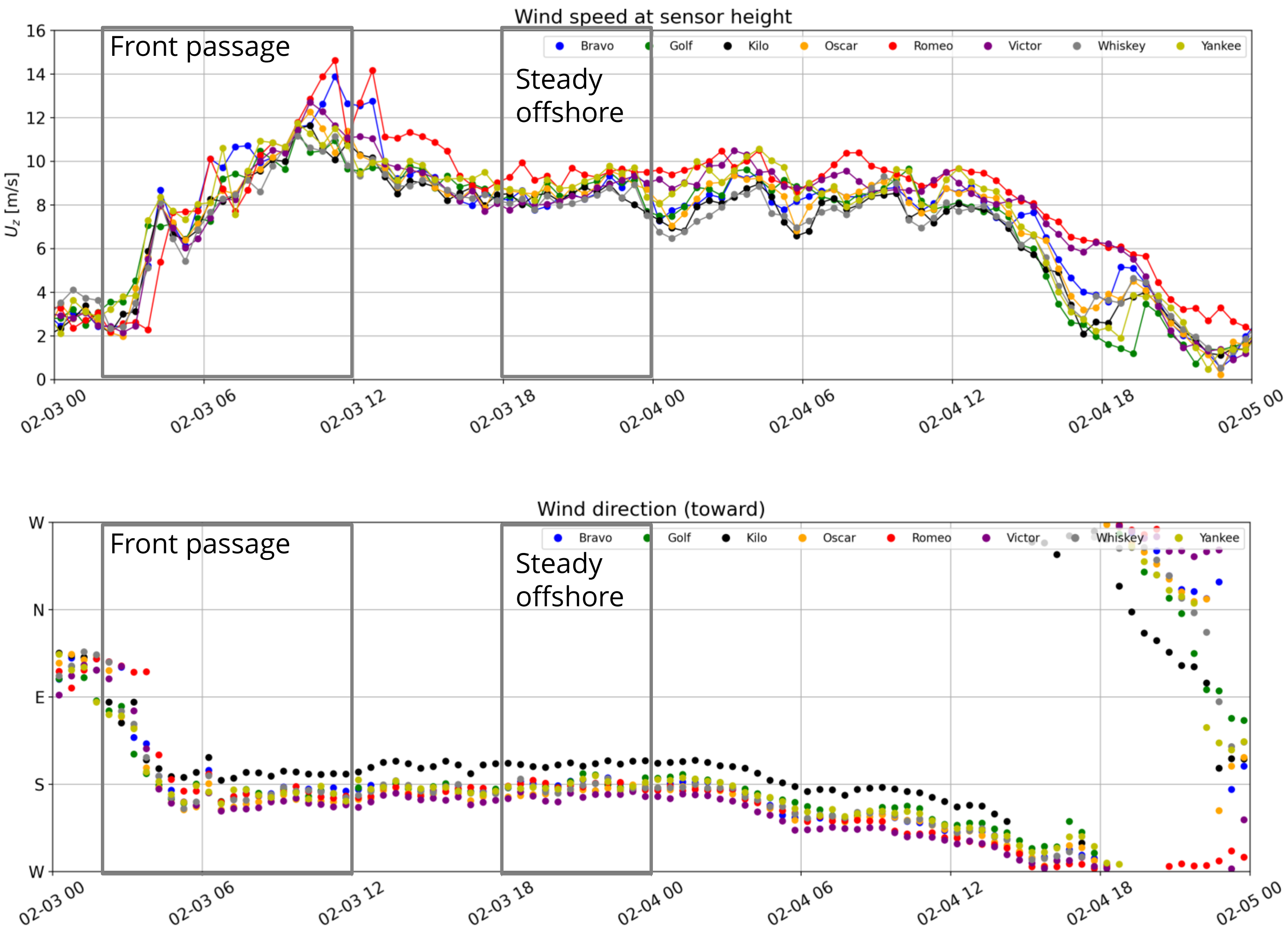




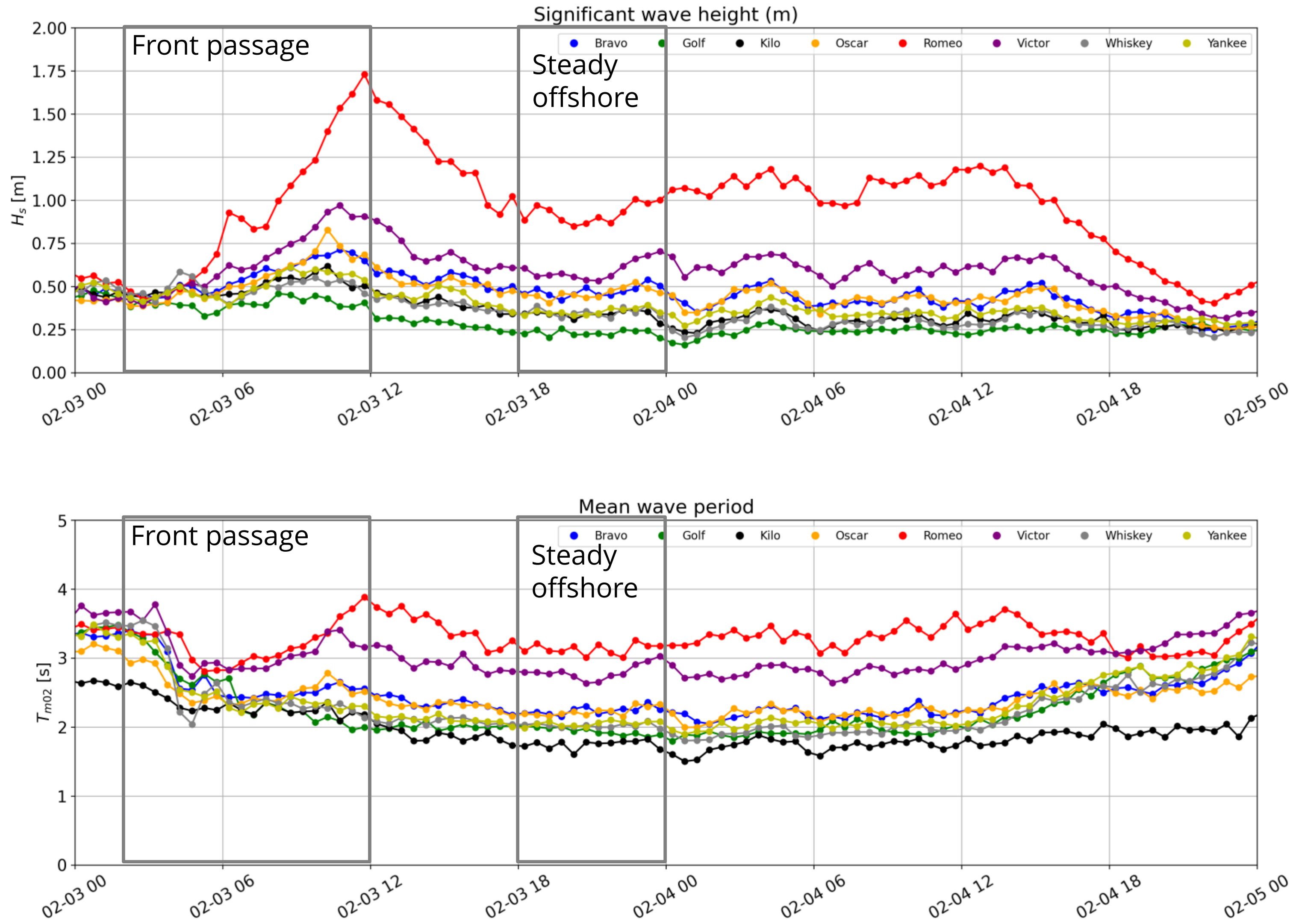

Wind speed at sensor height
U_z [m/s]
Bravo
Golf
Kilo
Oscar
Romeo
Victor
Whiskey
Yankee
0
2
4
6
8
10
12
14
16
2023-01-15
2023-01-22
2023-02-01
2023-02-08
2023-02-15
2023-02-22
2023-03-01
2023-03-08
2023-03-15
2023-03-22


Significant wave height (m)
H_s [m]
Bravo
Golf
Kilo
Oscar
Romeo
Victor
Whiskey
Yankee
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
2023-01-15
2023-01-22
2023-02-01
2023-02-08
2023-02-15
2023-02-22
2023-03-01
2023-03-08
2023-03-15
2023-03-22


Alongwind momentum flux
Bravo
Golf
Kilo
Oscar
Romeo
Victor
Whiskey
Yankee
$-\overline{u'w'}$ [m^2/s^2]
U_z [m/s]
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
2
4
6
8
10
12
14
16

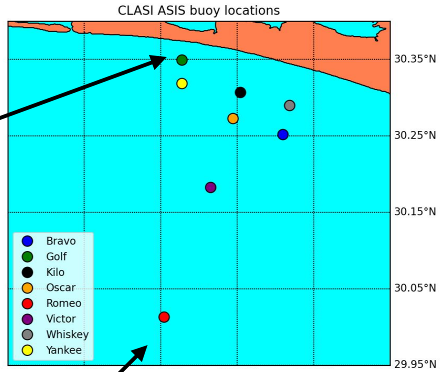


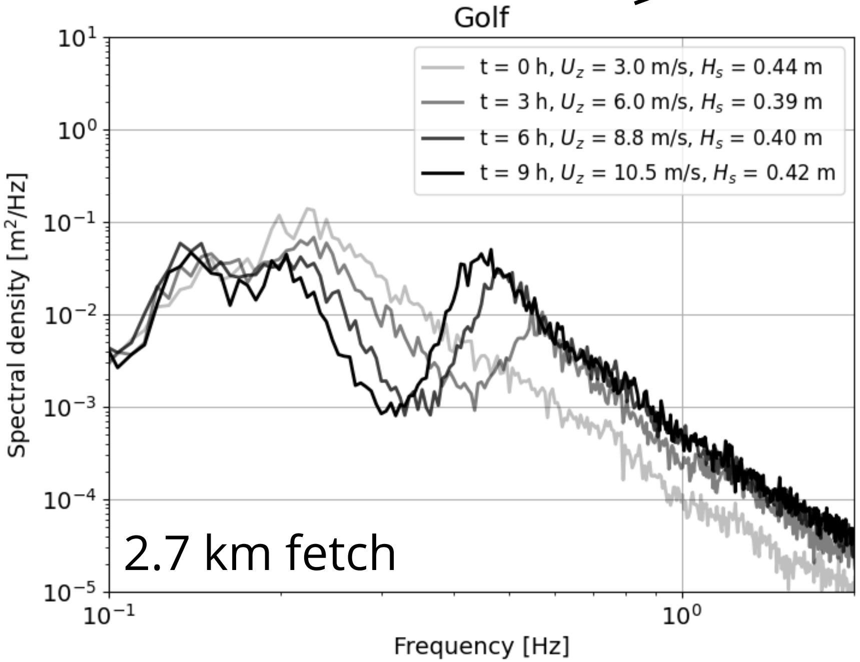
Wind speed at sensor height
Front passage
Steady offshore
Bravo
Golf
Kilo
Oscar
Romeo
Victor
Whiskey
Yankee
U_z [m/s]
0
2
4
6
8
10
12
14
16
02-03 00
02-03 06
02-03 12
02-03 18
02-04 00
02-04 06
02-04 12
02-04 18
02-05 00
Wind direction (toward)
Front passage
Steady offshore
Bravo
Golf
Kilo
Oscar
Romeo
Victor
Whiskey
Yankee
W
N
E
S
W
02-03 00
02-03 06
02-03 12
02-03 18
02-04 00
02-04 06
02-04 12
02-04 18
02-05 00

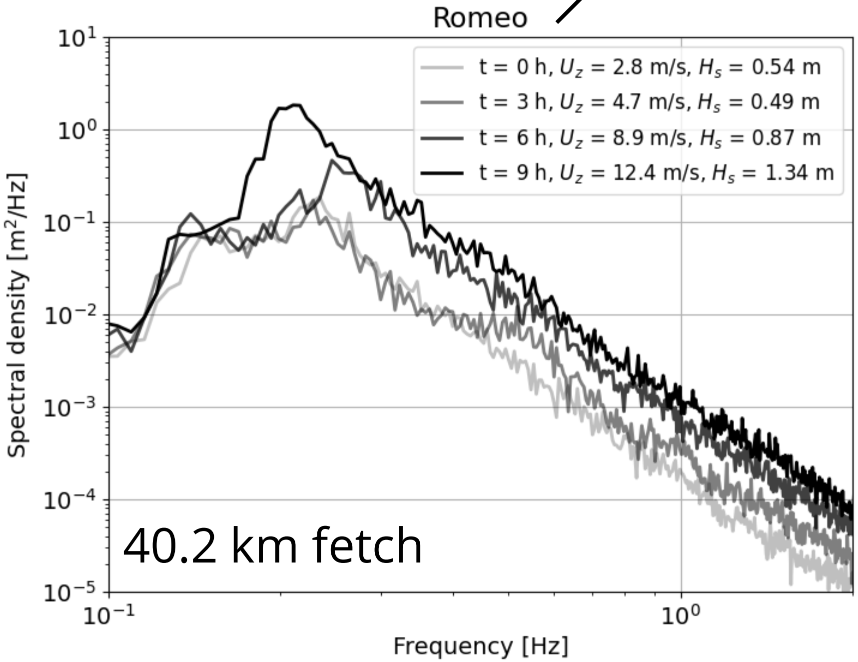


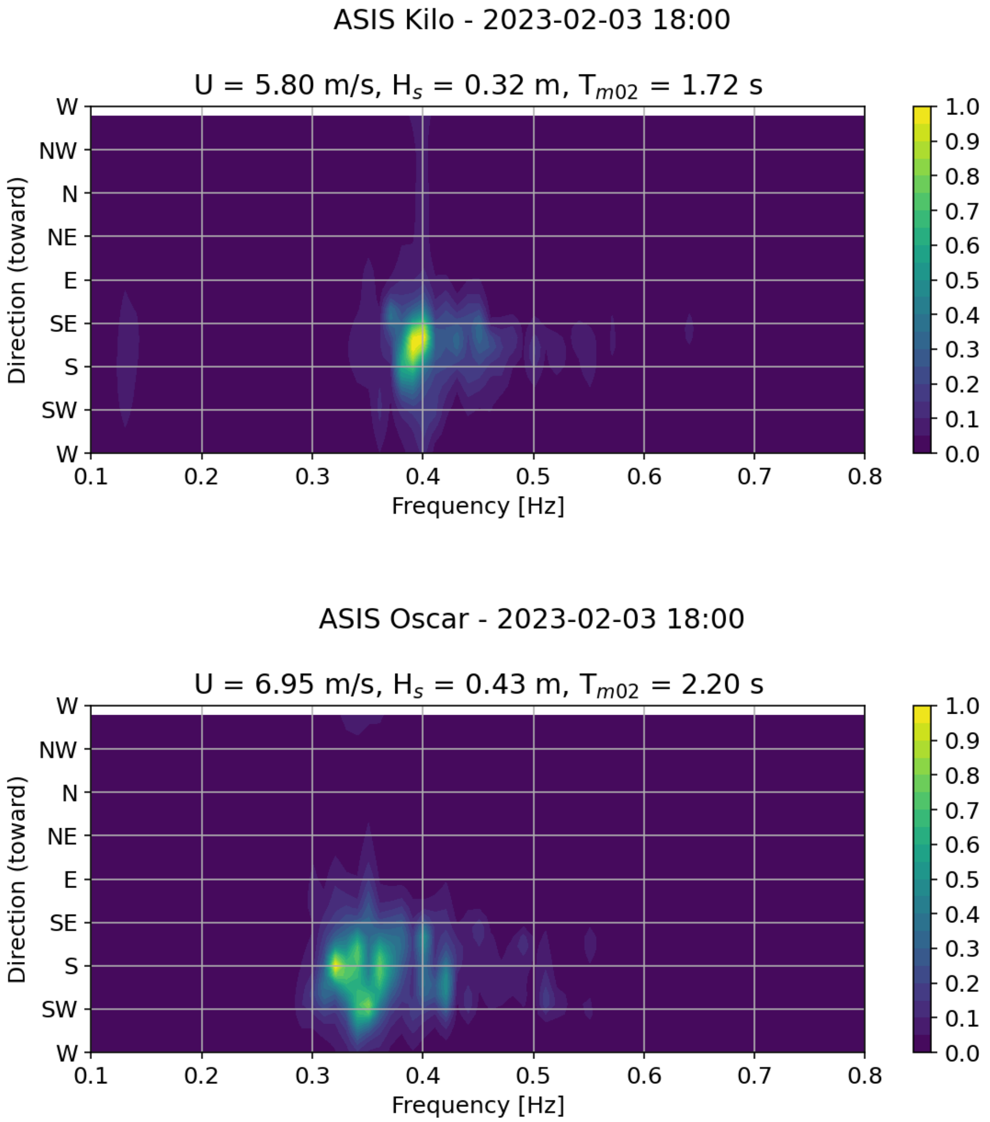
Significant wave height (m)
Front passage
Steady offshore
Bravo
Golf
Kilo
Oscar
Romeo
Victor
Whiskey
Yankee
H_s [m]
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
02-03 00
02-03 06
02-03 12
02-03 18
02-04 00
02-04 06
02-04 12
02-04 18
02-05 00
Mean wave period
Front passage
Steady offshore
Bravo
Golf
Kilo
Oscar
Romeo
Victor
Whiskey
Yankee
T_{m02} [s]
5
4
3
2
1
0
02-03 00
02-03 06
02-03 12
02-03 18
02-04 00
02-04 06
02-04 12
02-04 18
02-05 00

Spectral development during the front passage



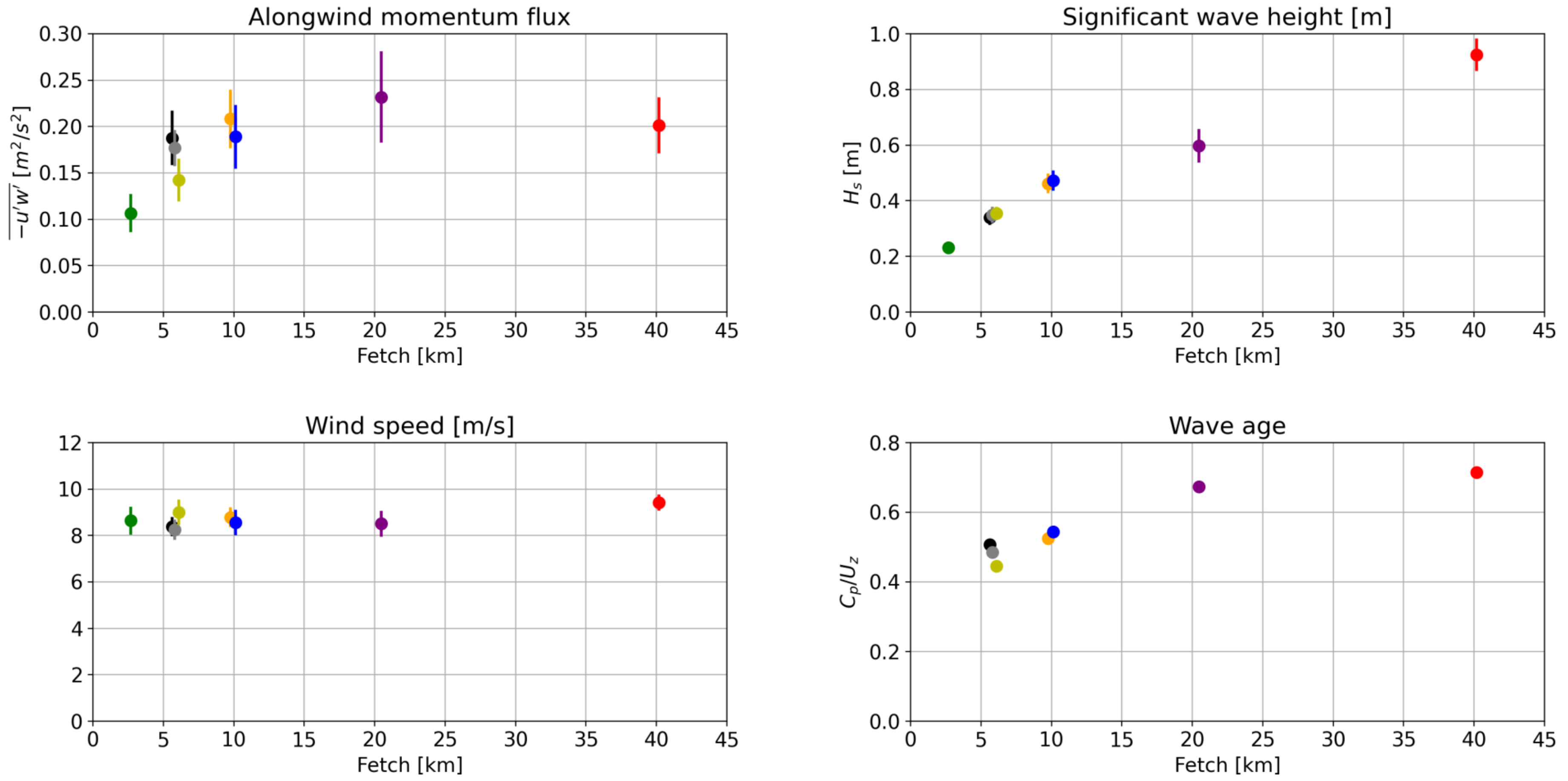




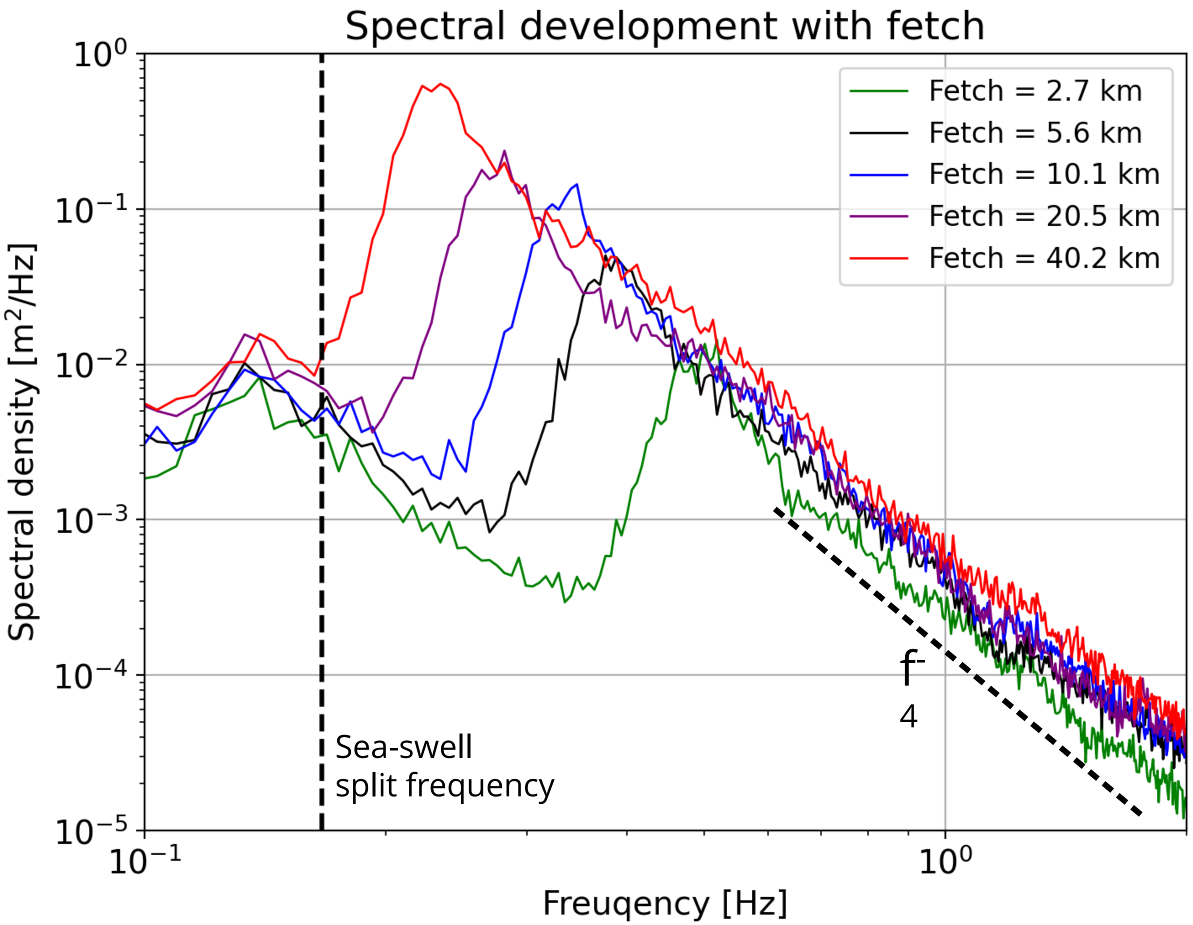


Wave directional spectra from ASIS buoy observations using multiple wave wires during offshore winds

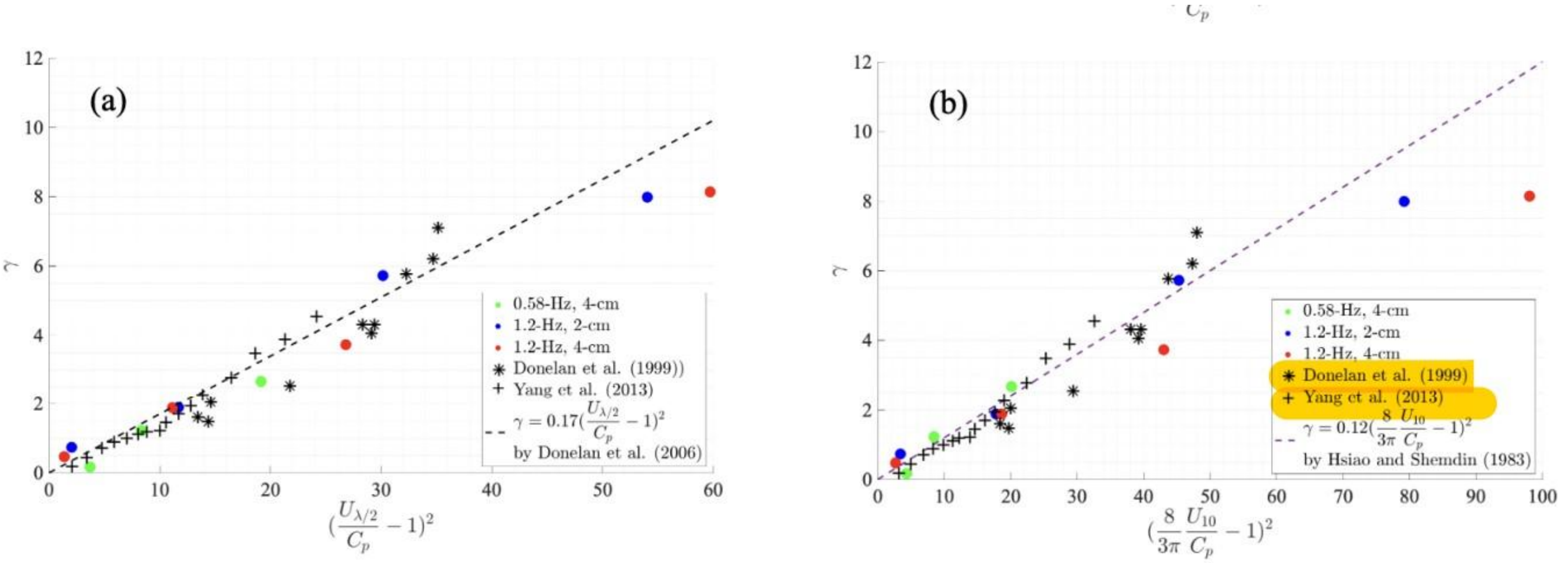
Flux and waves as function of fetch



Spectral development with fetch
Uz ~ 9 m/s steady

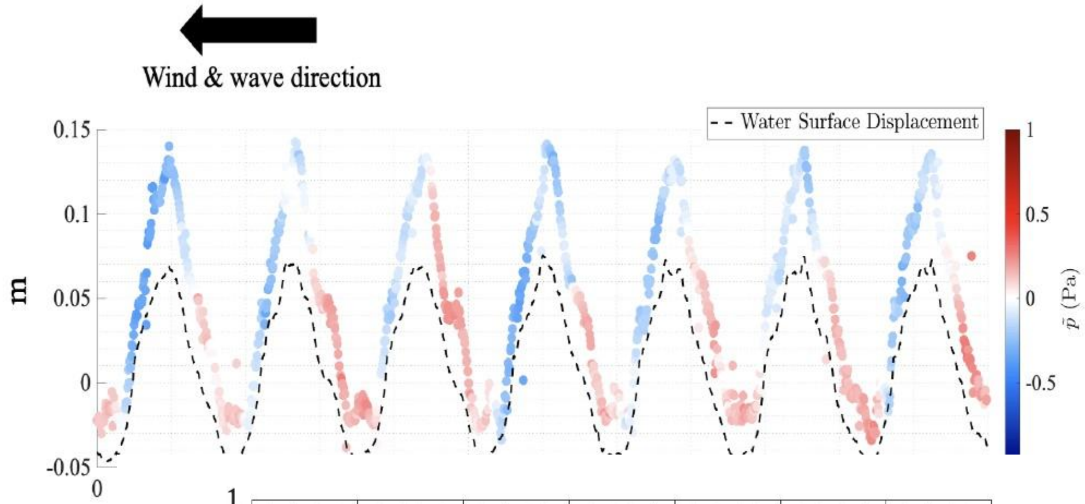


Spectral wave growth rate from array



Tan et al. (JGR, 2025)

Pressure measurements from wave follower



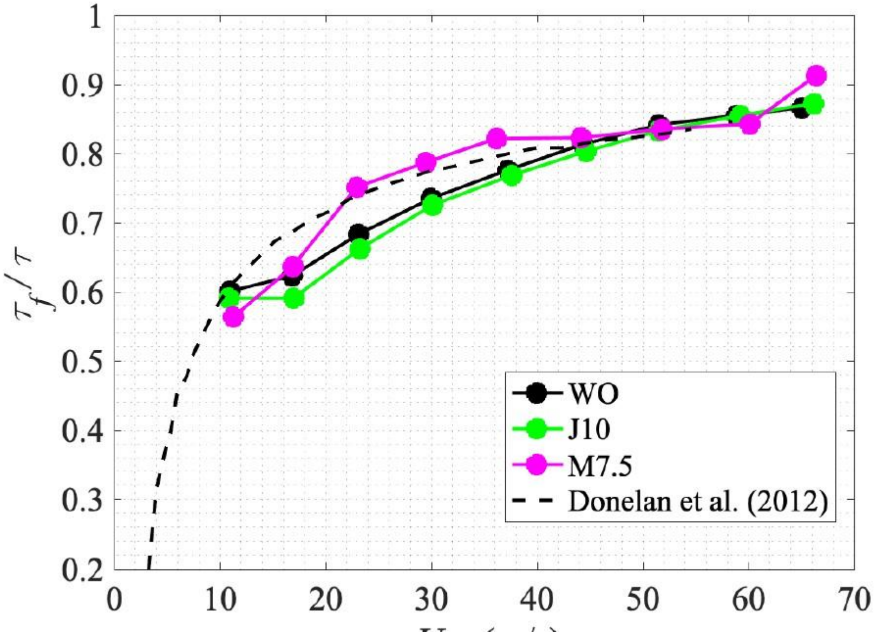


Table 2.2: Wind and wave conditions measured using wave-follower

	$f(Hz)$	$a(cm)$	$k(m^{-1})$	C_p	$U_{0.75}(ms^{-1})$	$U_{10}(ms^{-1})$	$u_{*0}(ms^{-1})$	$a_p k_p$	C_p/u_*
Run 1	0.58	2	1.79	2.21	6.28	7.49	0.3116	0.034	7.0926
Run 2	0.58	4	1.79	2.21	6.31	8.00	0.3326	0.0632	6.6446
Run 3	0.58	6	1.79	2.21	6.32	8.02	0.3463	0.09	6.3817
Run 4	0.58	8	1.79	2.21	6.36	8.06	0.3589	0.1176	6.1577
Run 5	0.58	10	1.79	2.21	6.21	7.88	0.3568	0.1472	6.1939
Run 6	0.58	2	1.79	2.21	8.42	10.63	0.4496	0.0335	4.9155
Run 7	0.58	4	1.79	2.21	8.49	10.72	0.4824	0.0616	4.5813
Run 8	0.58	6	1.79	2.21	8.50	10.74	0.5004	0.0848	4.4165
Run 9	0.58	8	1.79	2.21	8.47	10.70	0.5137	0.1111	4.3021
Run 10	0.58	10	1.79	2.21	8.52	10.76	0.5304	0.1375	4.17
Run 11	0.58	2	1.79	2.21	10.50	13.44	0.6085	0.0324	3.63
Run 12	0.58	4	1.79	2.21	10.44	13.35	0.6387	0.0588	3.46
Run 13	0.58	6	1.79	2.21	10.52	13.47	0.6641	0.075	3.32
Run 14	0.58	8	1.79	2.21	10.45	13.37	0.6831	0.1038	3.23
Run 15	0.58	10	1.79	2.21	10.64	13.63	0.7210	0.1294	3.06
Run 16	0.58	6	1.79	2.21	14.53	19.05	1.04	0.0792	2.1250
Run 17	0.58	6	1.79	2.21	18.23	24.40	1.4958	0.0777	1.4775
Run 18	0.58	6	1.79	2.21	21.84	29.75	1.9558	0.0679	1.1300

Takeaway points

CLASI provides new measurement tools and tremendous data set for coupling in coastal zones
SUSTAIN direct observations of form drag over range of wind/wave conditions including both separated and non-separated waves
Wave growth rate in SUSTAIN generally agrees with previous lab, field and LES

Thanks to the team

R. Lewis, H. Graber

B. Haus, L. Haus, S. Mehta, W. Drennan, M. Curcic, Z. Shane, P. Tan, N. Williams

S. Ballard, S. Furtney, S. Medina, J. Zwierz

J. Ryder, C. Basque, D. Ortiz-Suslow, J. Hargrove, M. Curcic, J. Rice, N. Williams, R. Lewis, B. Haus, S. Ballard,