

Ocean Wave Information Inferred from Synthetic Aperture Radar Images of the Sea Surface

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Acknowledgements: CONACYT

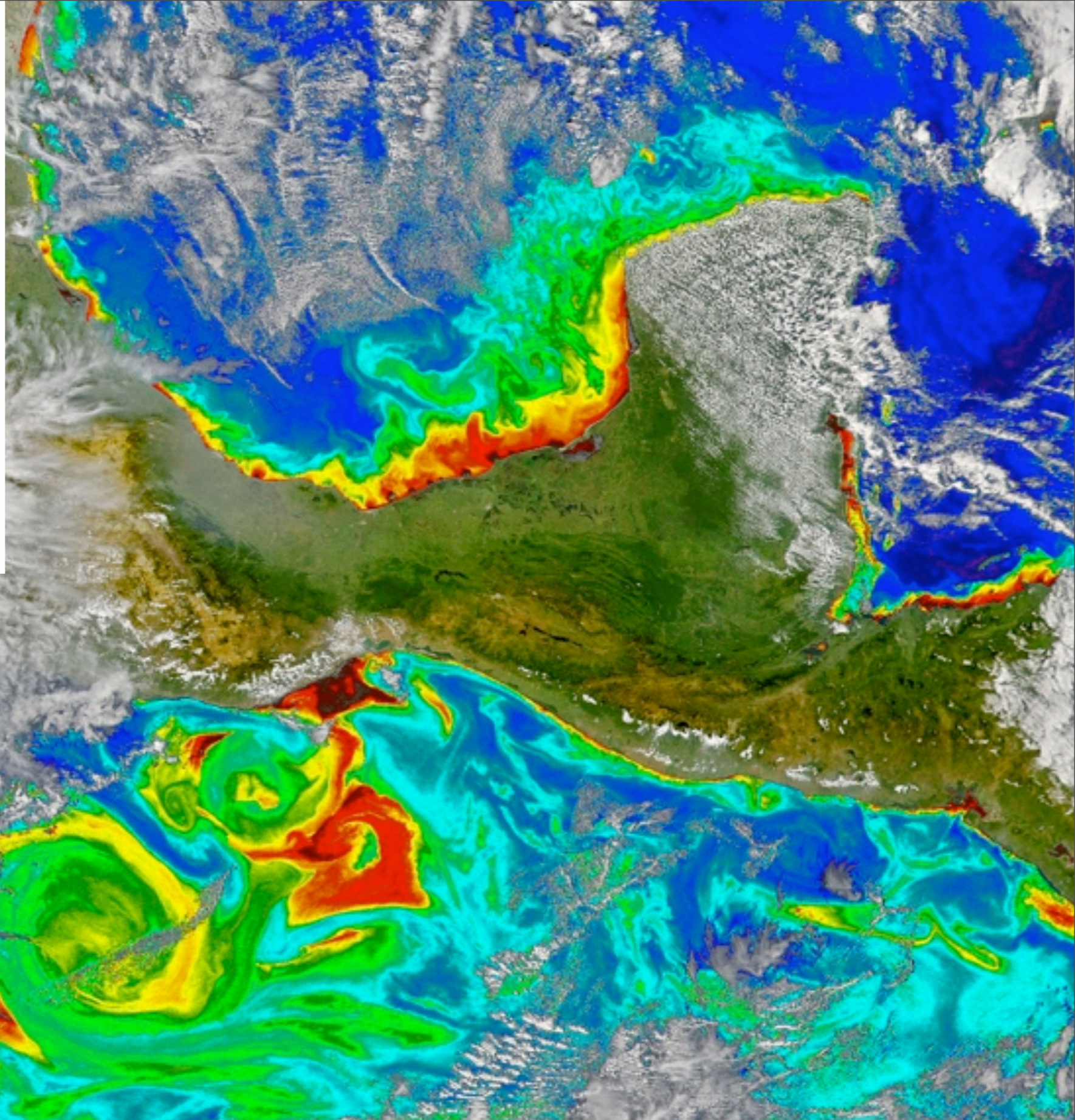
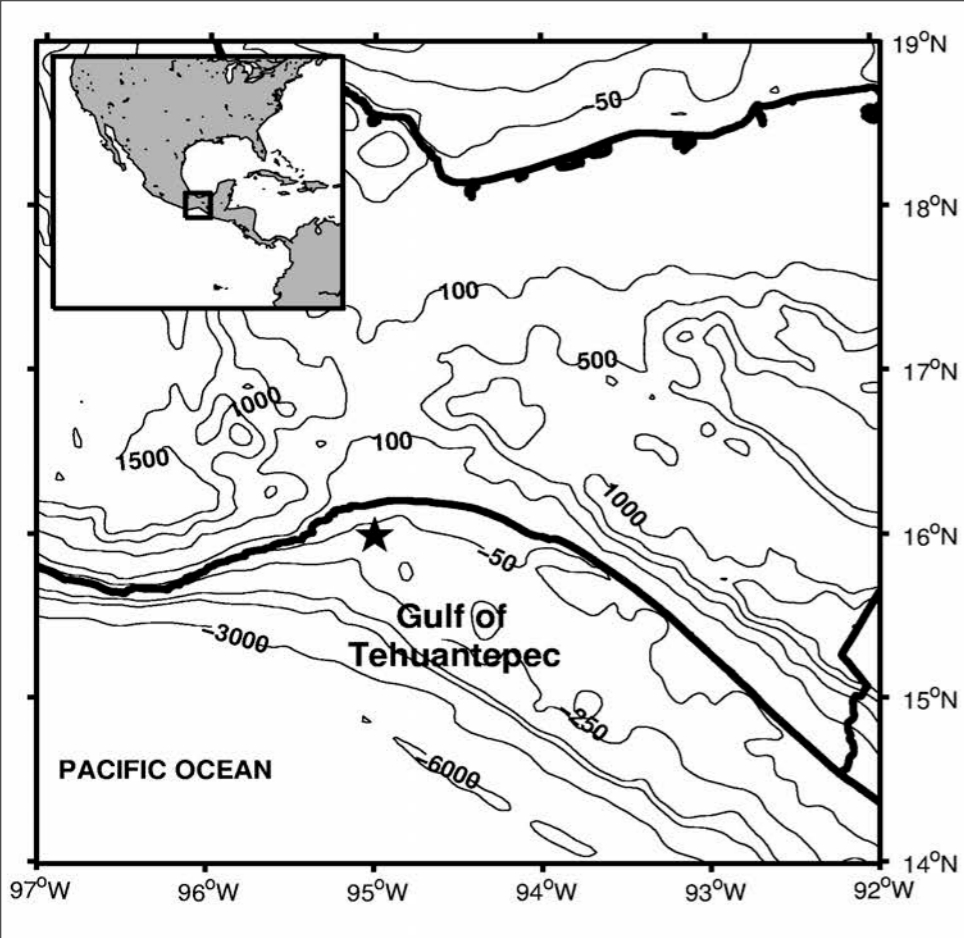
An aerial photograph of the Gulf of Tehuantepec showing a long line of yellow buoys stretching across the water. On the left end of the line is a larger yellow buoy with a white top. On the right end is a yellow metal structure with a vertical pole. The sky is overcast and grey.

Study area and motivation

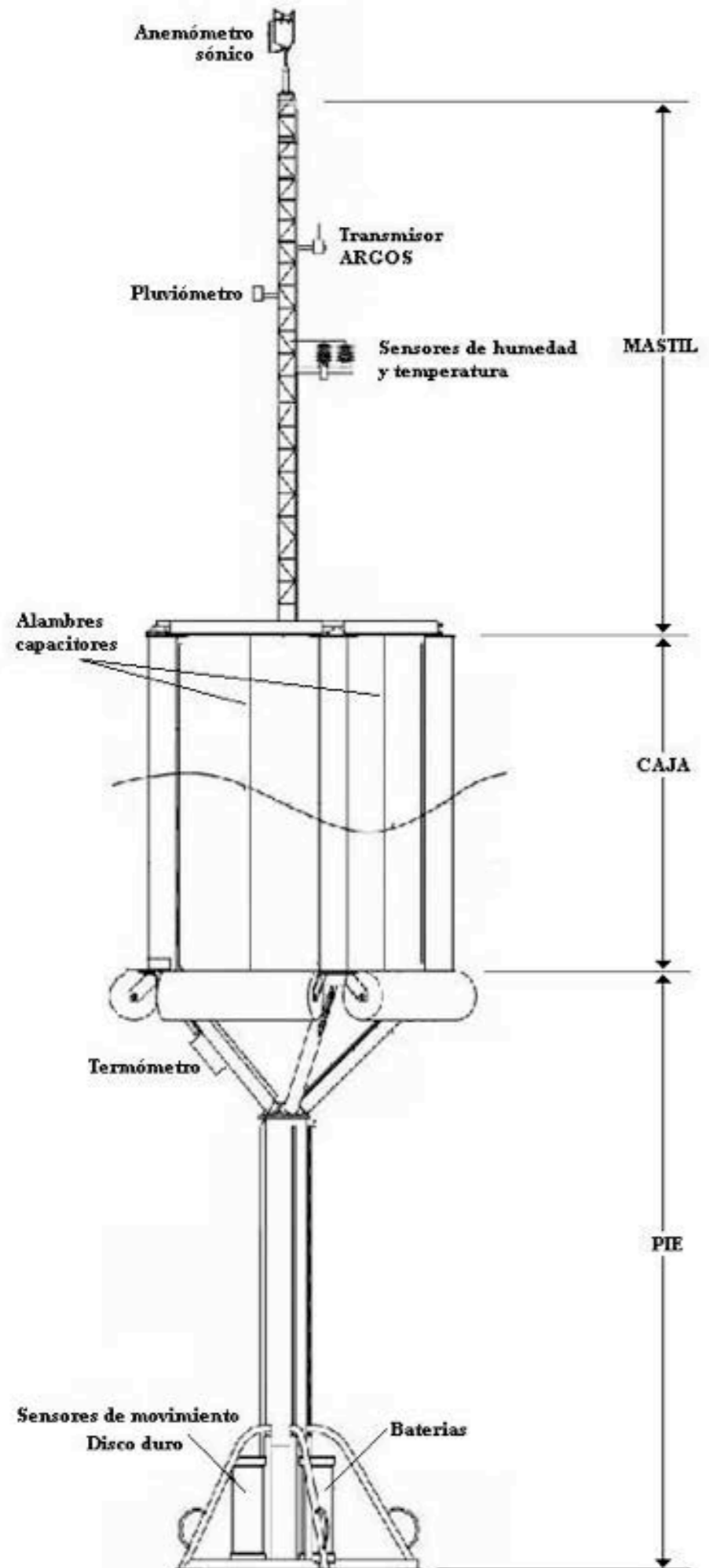
Field measurements in the Gulf of Tehuantepec

Waves from SAR images

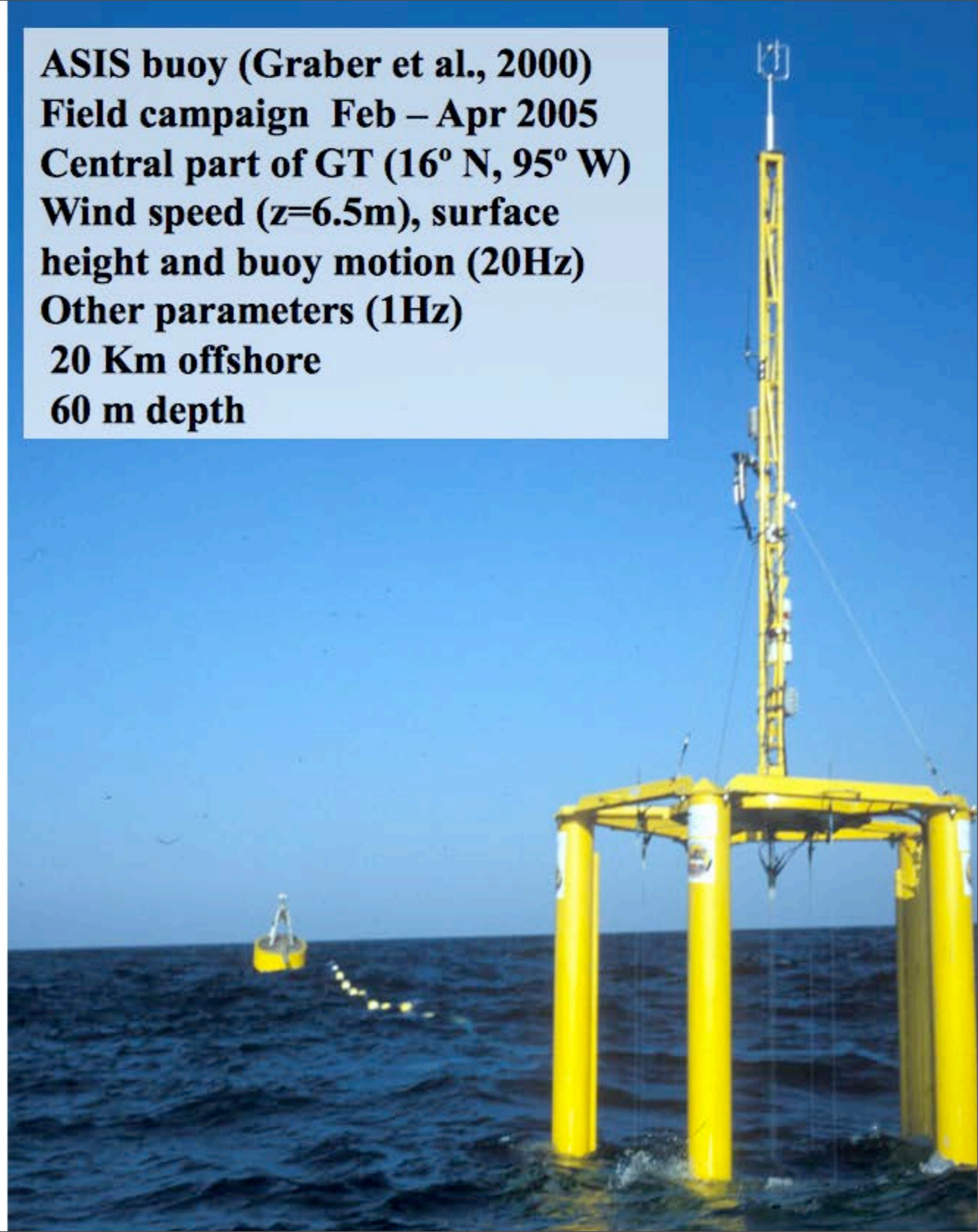
Final remarks



The Air-Sea Interaction Experiment in the Gulf of Tehuantepec
(Ocampo-Torres et al., 2011, B-LM)



ASIS buoy (Graber et al., 2000)
Field campaign Feb – Apr 2005
Central part of GT (16° N, 95° W)
Wind speed (z=6.5m), surface
height and buoy motion (20Hz)
Other parameters (1Hz)
20 Km offshore
60 m depth



Basic Data Processing

30 min runs

Motion correction

Wind velocity, surface height

Wave frequency and directional spectra

Wind stress (Eddy Correlation method)

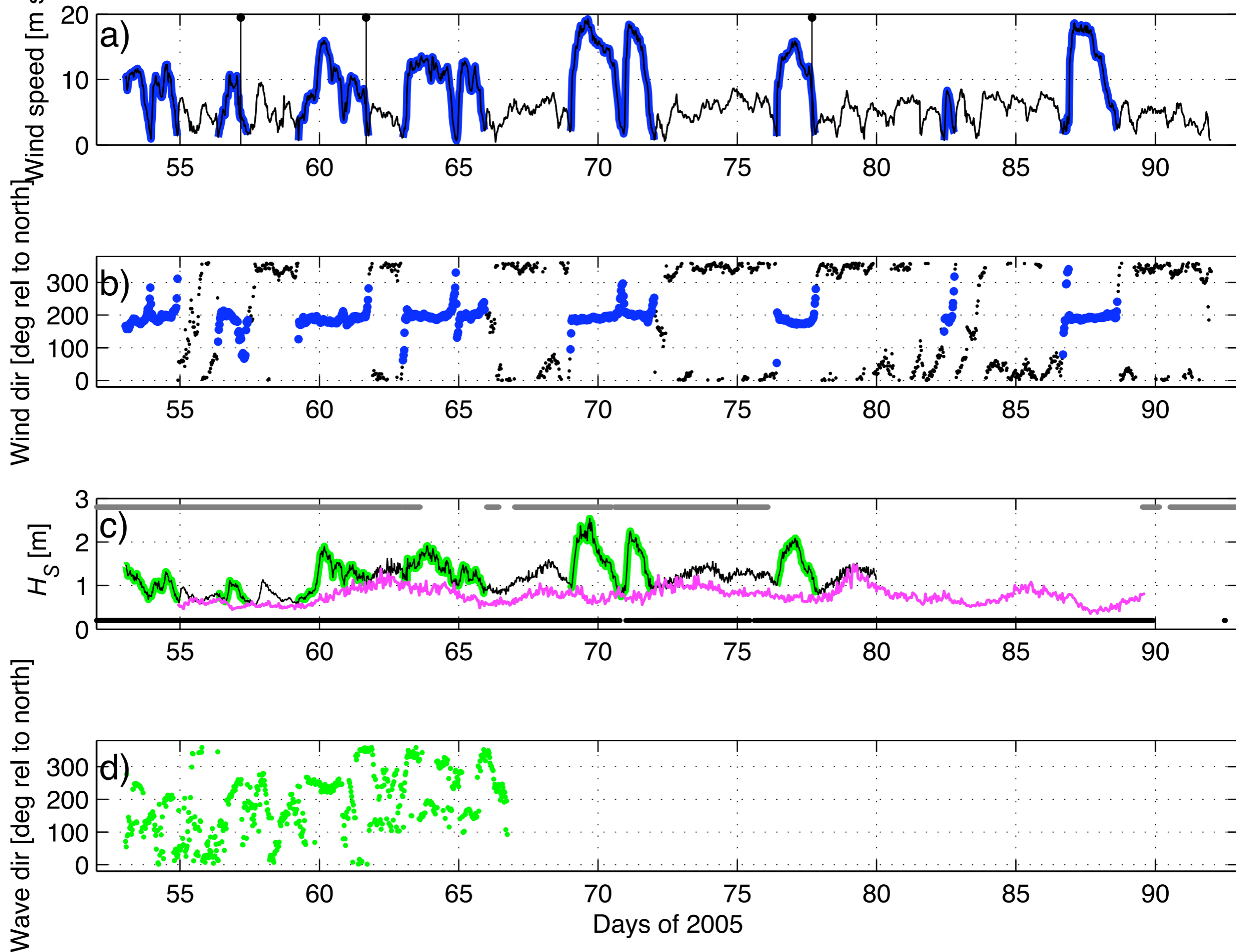
$$\boldsymbol{\tau} = -\rho(\overline{u'w'}\hat{\mathbf{i}} + \overline{v'w'}\hat{\mathbf{j}})$$

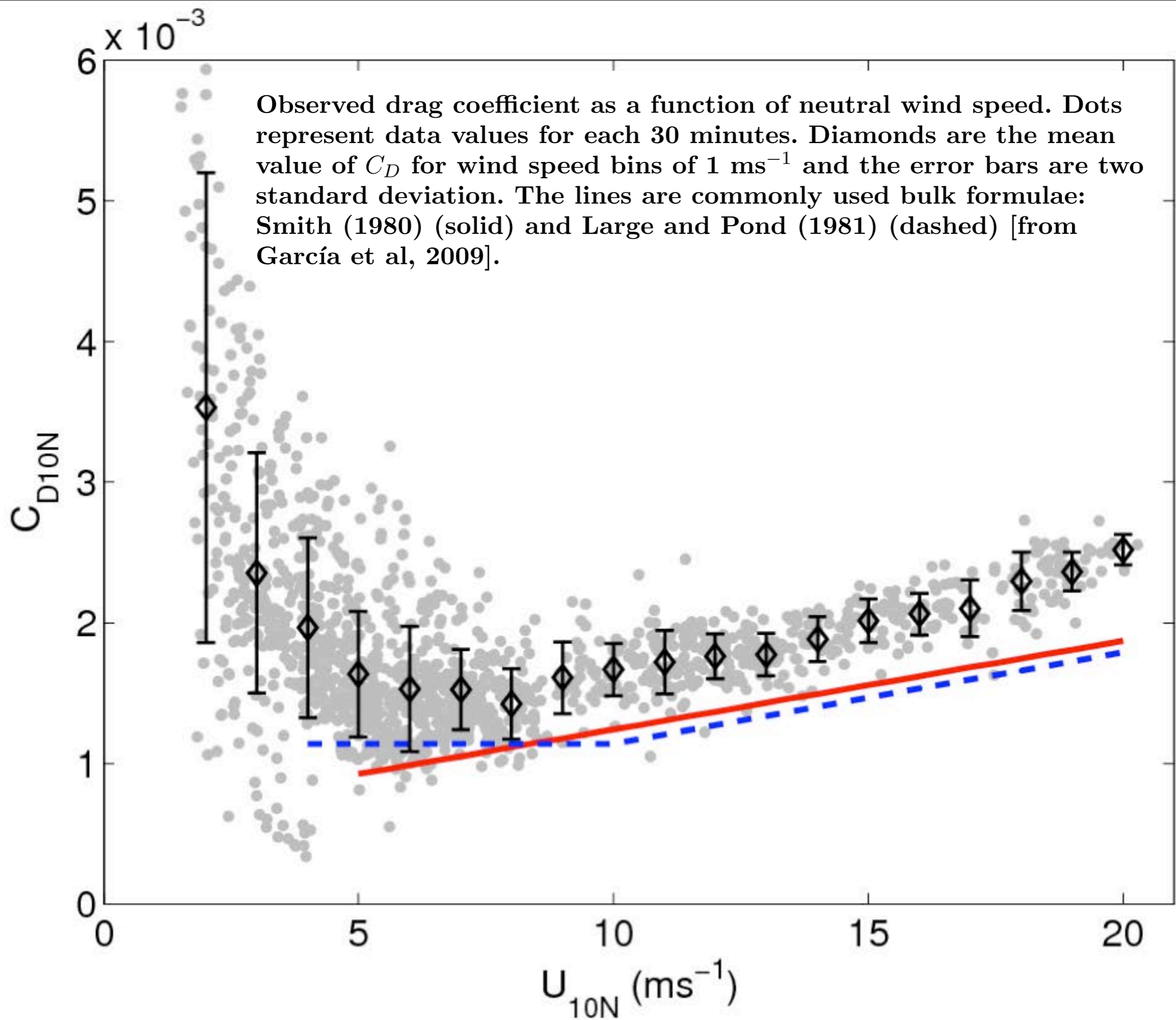
Mean atmosphere and ocean conditions

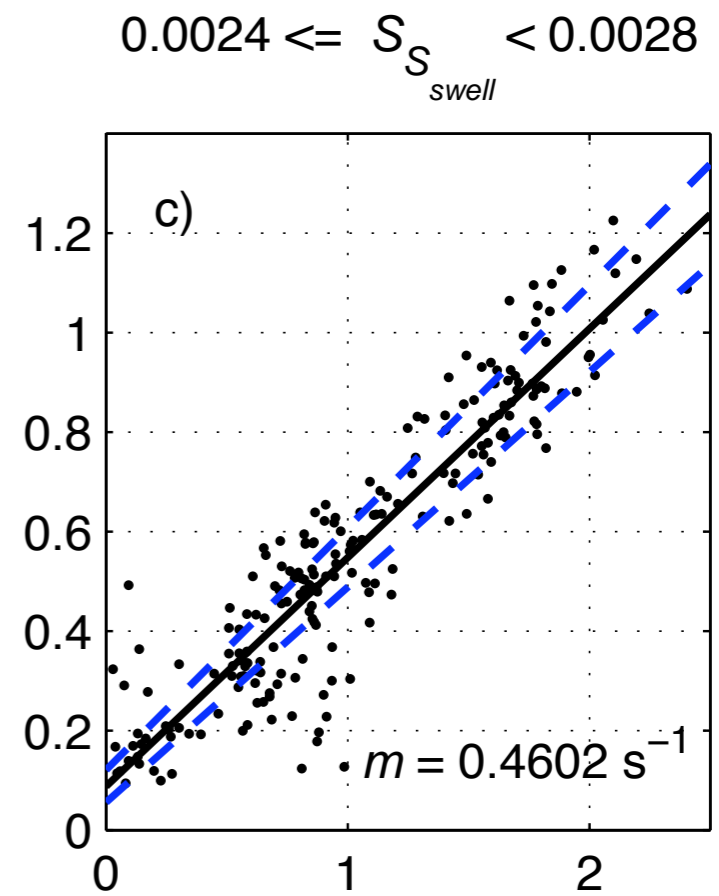
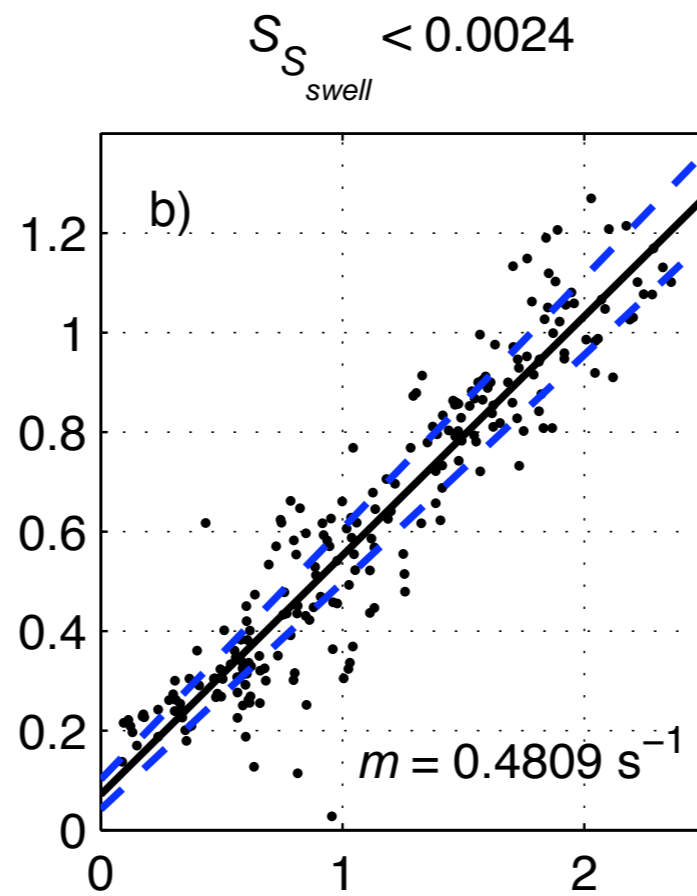
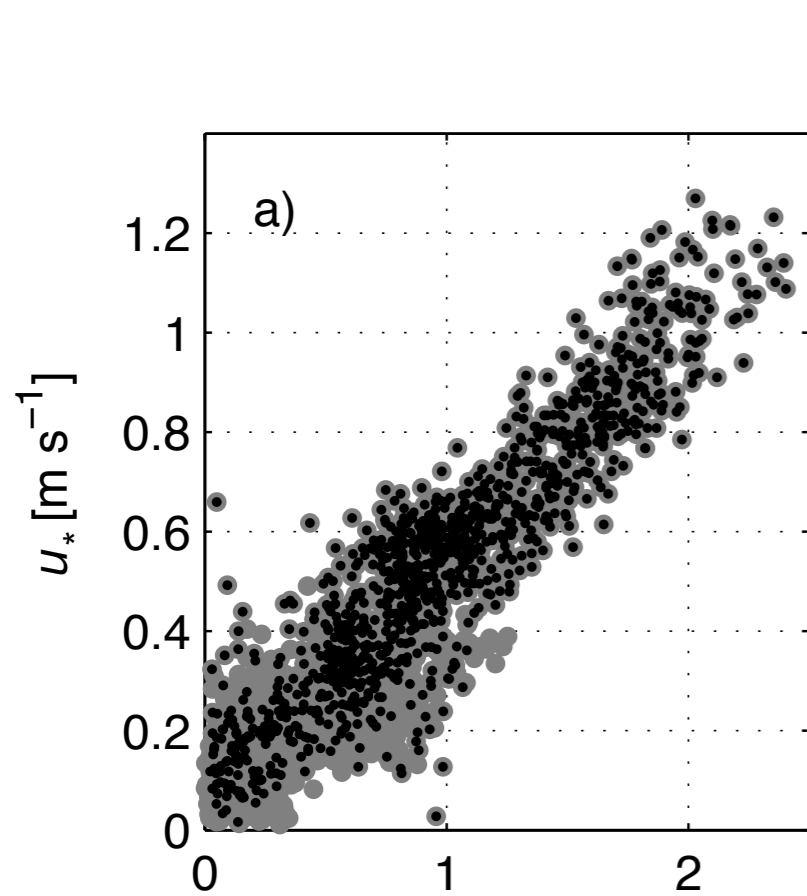
[Wind, temperature (air, water), humidity, atmospheric pressure]



Overview of measurements at Gulf of Tehuantepec 2005

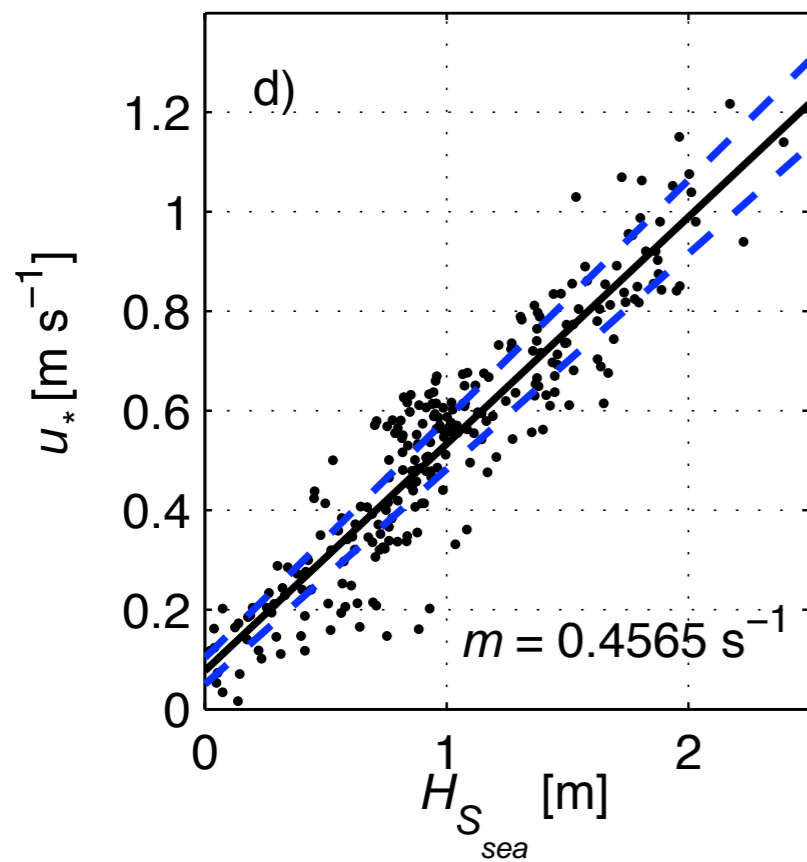




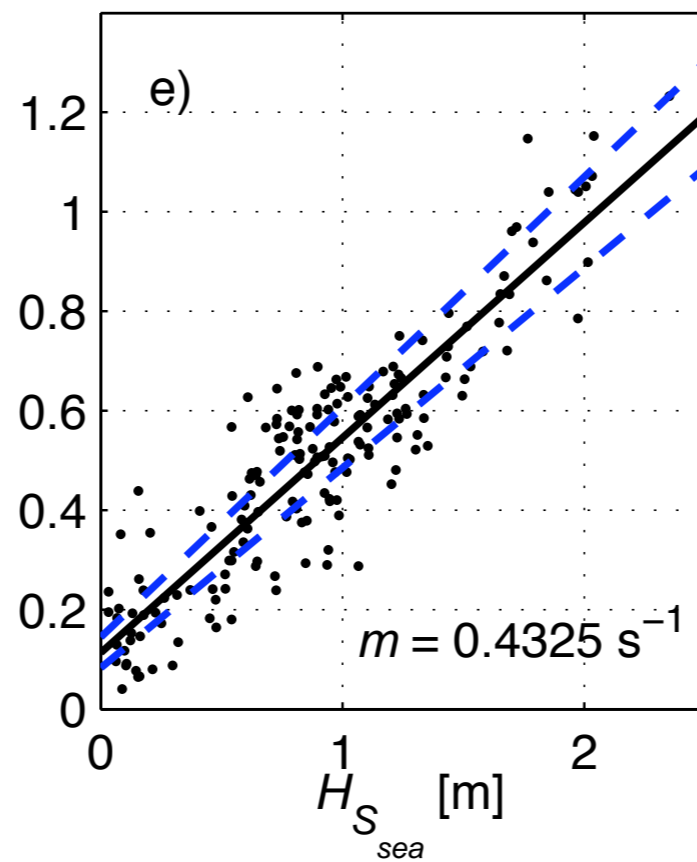


Ocampo-Torres et al. 2011, (B-LMeteor)

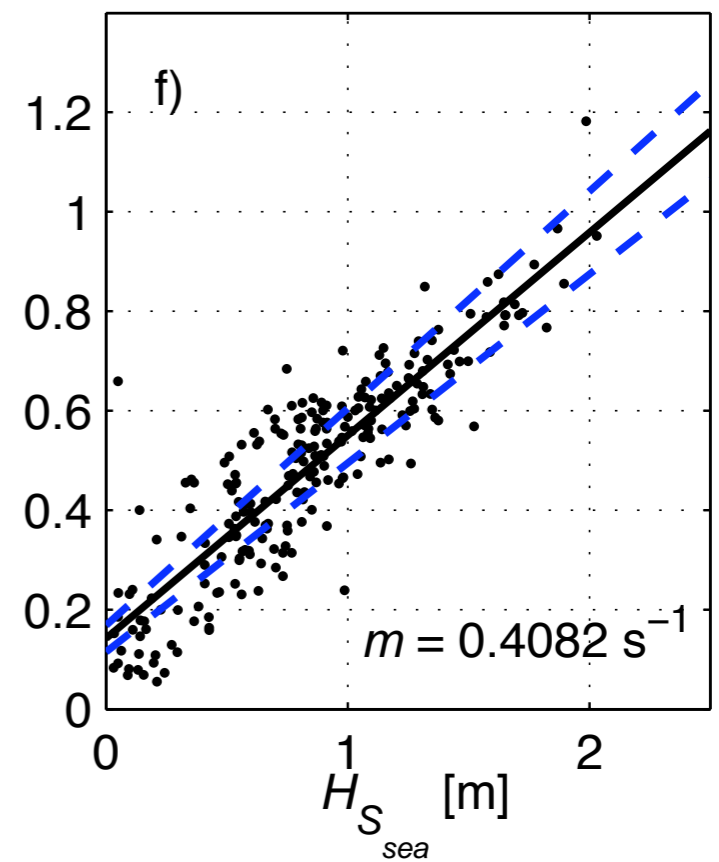
$0.0028 \leq S_{S_{swell}} < 0.0033$



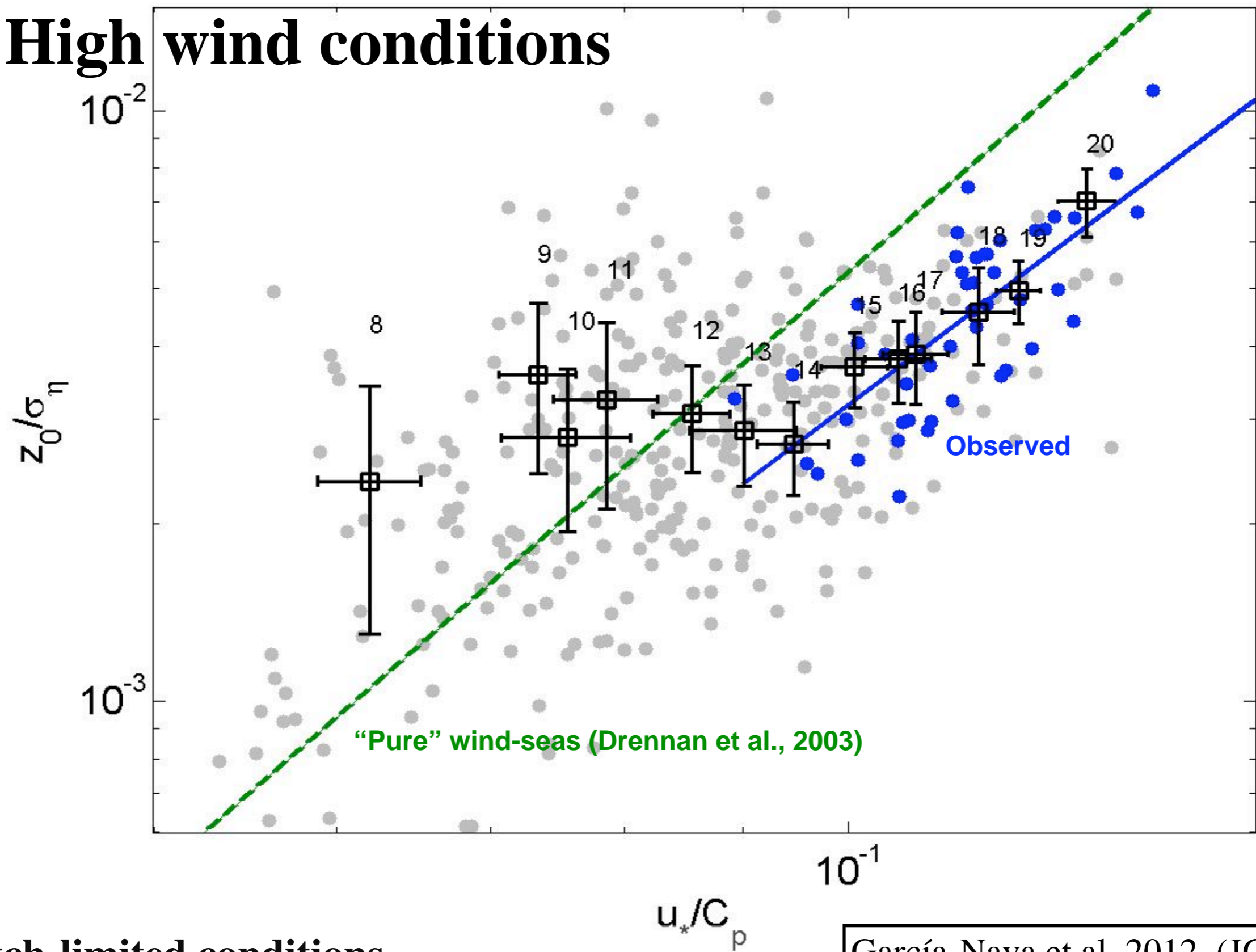
$0.0033 \leq S_{S_{swell}} < 0.0038$



$S_{S_{swell}} > 0.0038$



High wind conditions

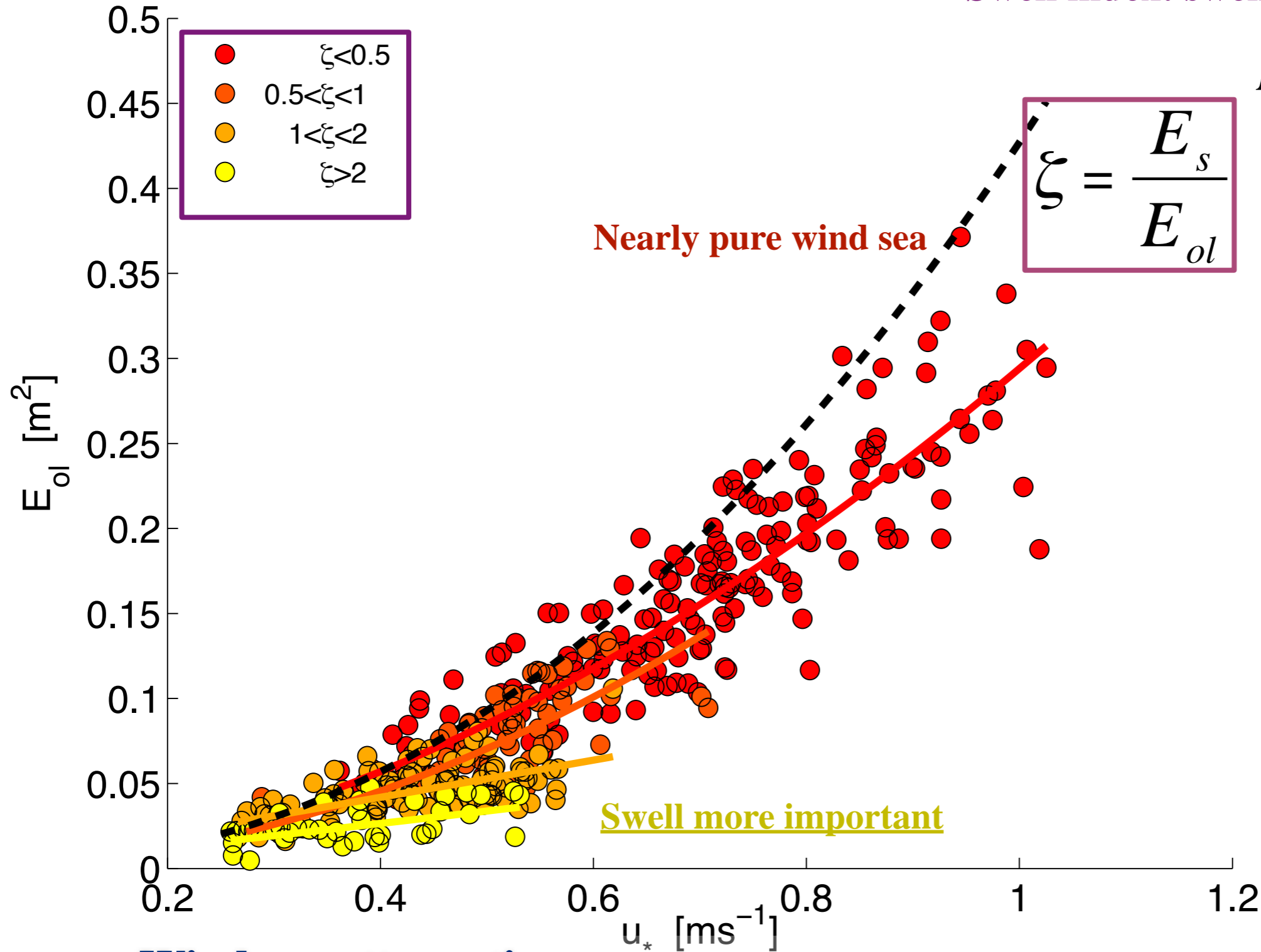


- Fetch-limited conditions
- Observed z_0 and C_D lower than expected for pure wind-seas
- Hypothesis: Swell modifies wind-sea associated roughness

García-Nava et al. 2012, (JGROceans)

Swell influence on wind sea

WIND SEA TOTAL ENERGY



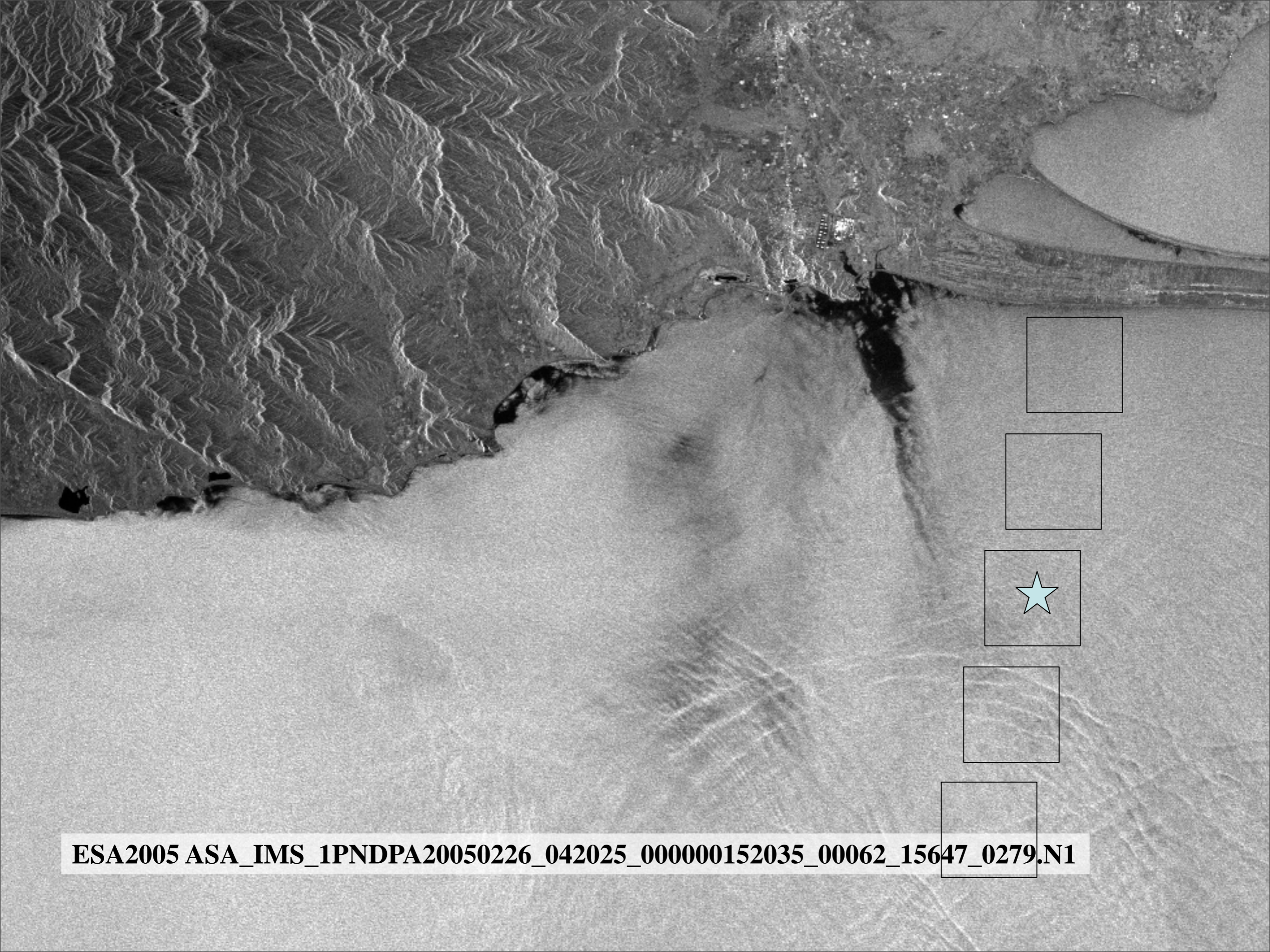
Swell index: swell relative importance

$$\zeta = \frac{E_s}{E_{ol}}$$

$$E_{ol} = \int_{f_c}^{f_{max}} E(f) df$$

$$E_s = \int_{f_{min}}^{f_c} E(f) df$$

- Wind sea attenuation
- Reduction of surface roughness

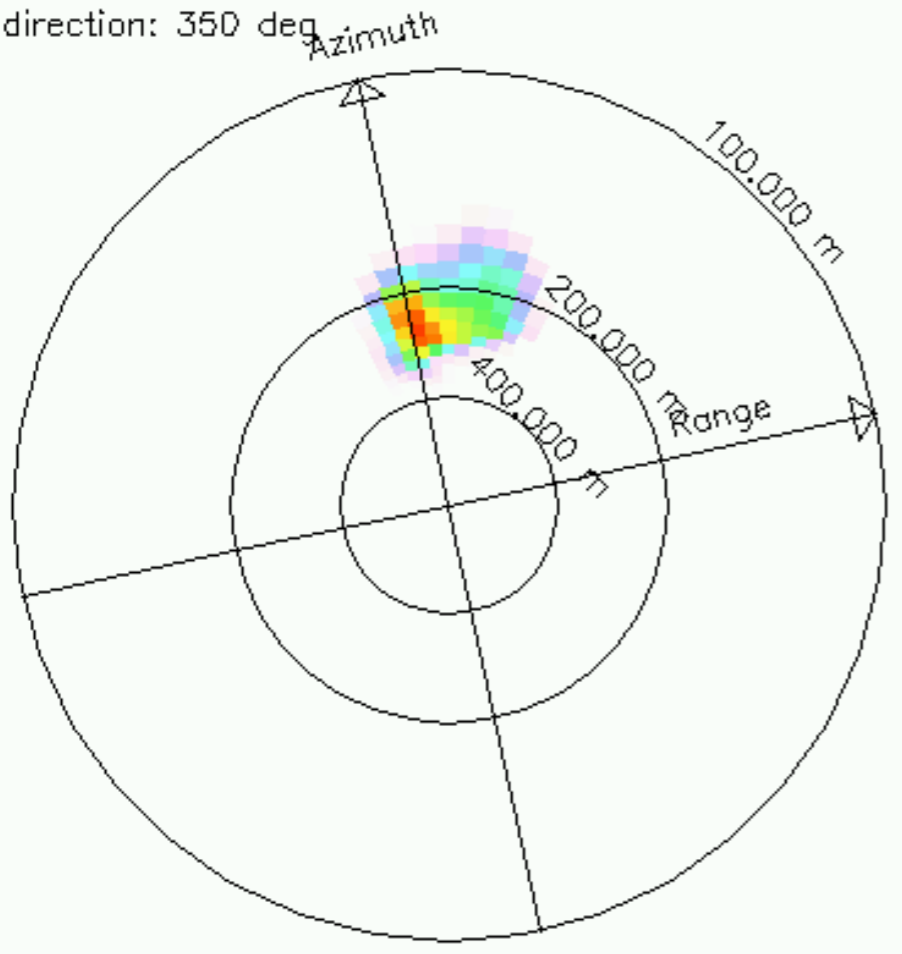
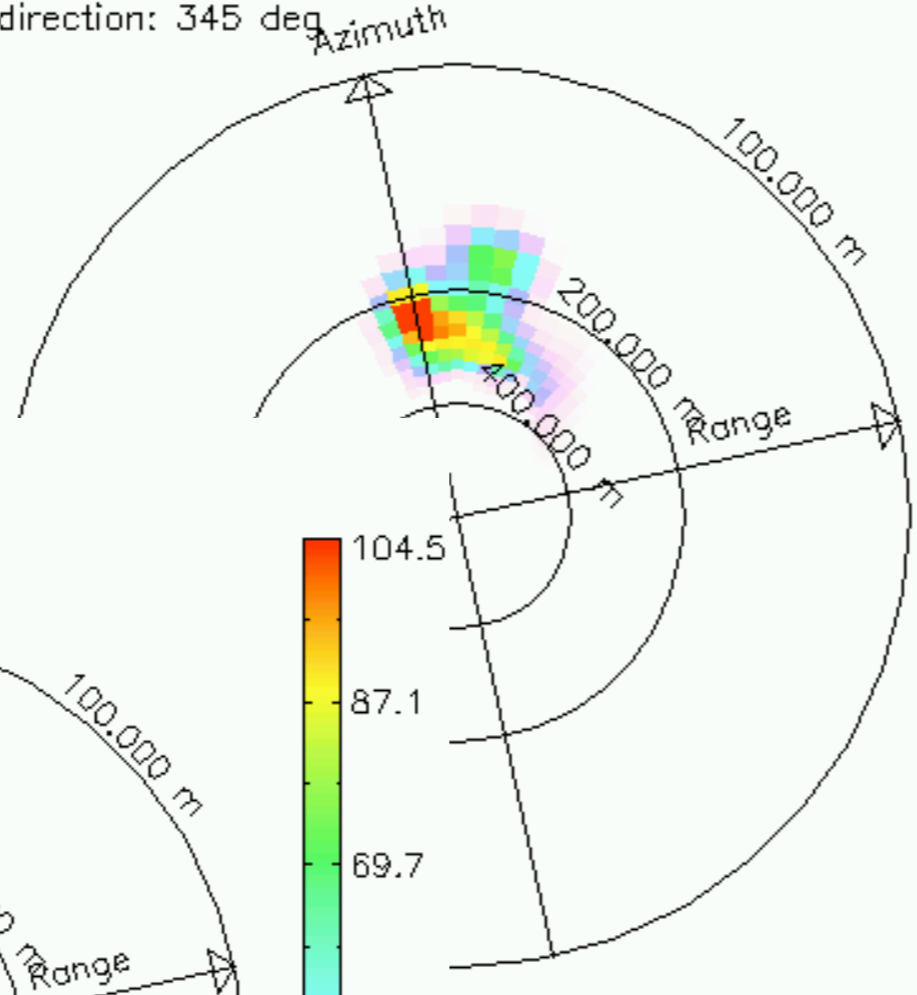
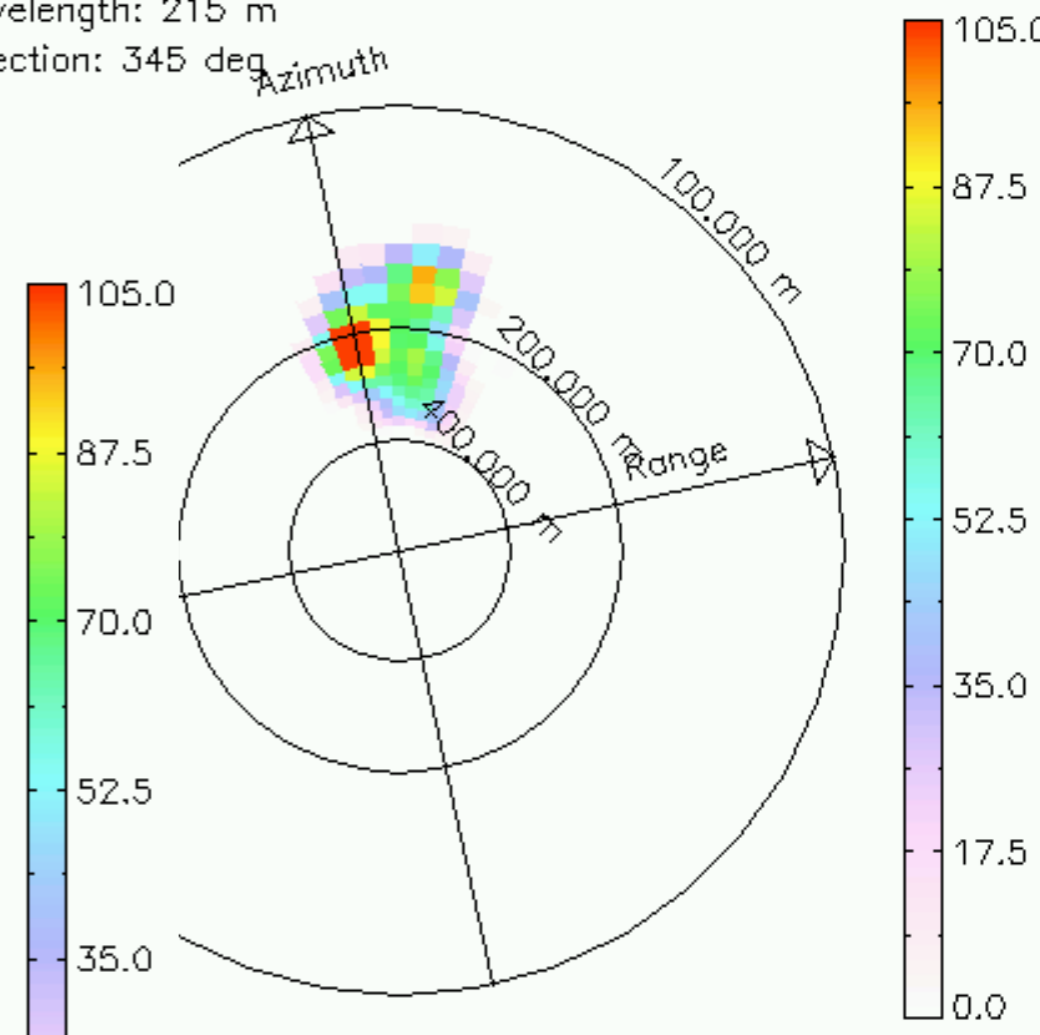


ESA2005 ASA_IMS_1PNDPA20050226_042025_000000152035_00062_15647_0279.N1

Wave spectrum
Swell wave height: 0.69 m
Peak wavelength: 215 m
Peak direction: 345 deg

Wave spectrum
Swell wave height: 0.67 m
Peak wavelength: 230 m
Peak direction: 345 deg

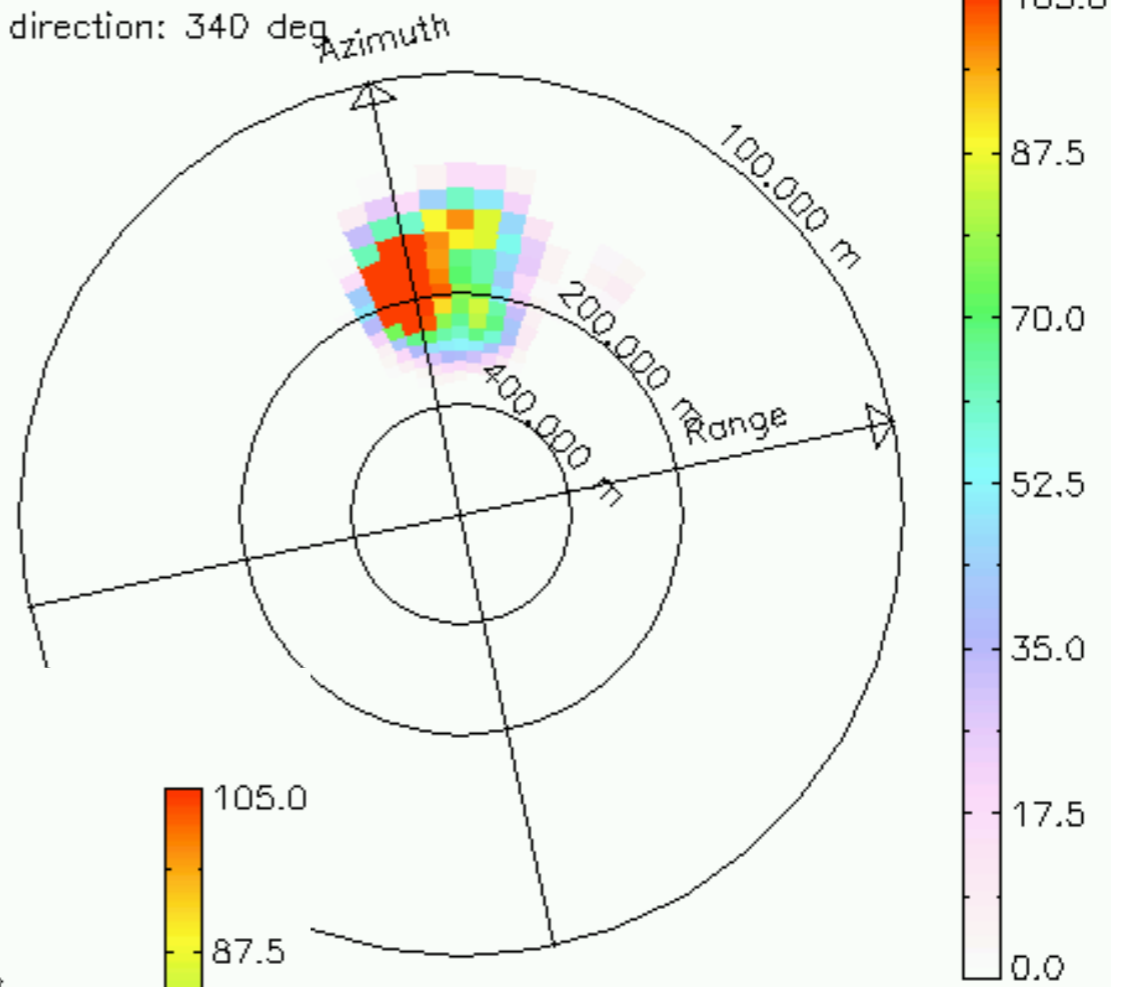
Wave spectrum
Swell wave height: 0.60 m
Peak wavelength: 235 m
Peak direction: 350 deg



lat. 16.02 lon. -94.98 depth 8:

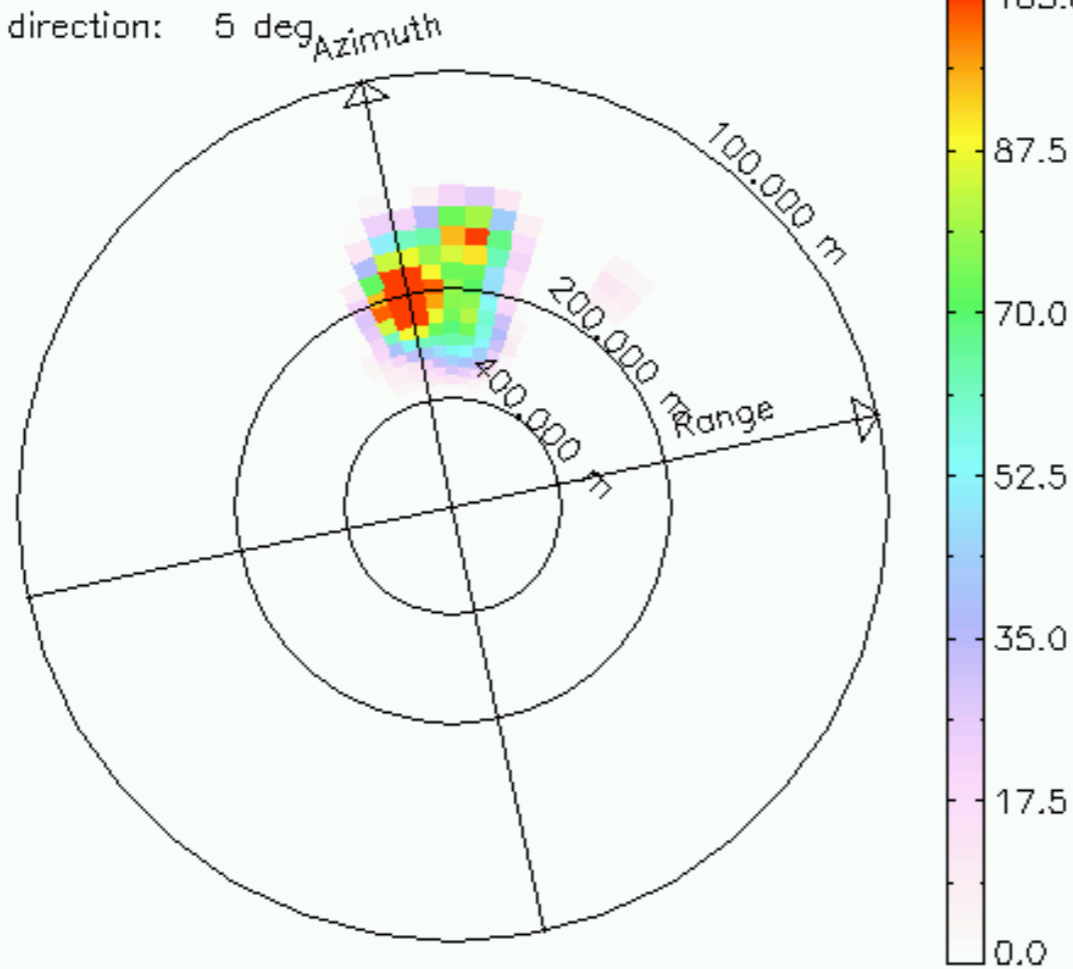
26-FEB-2005 04:20:33 lat. 15.98 lon. -94.98 depth 9:

Wave spectrum
Swell wave height: 0.80 m
Peak wavelength: 193 m
Peak direction: 340 deg



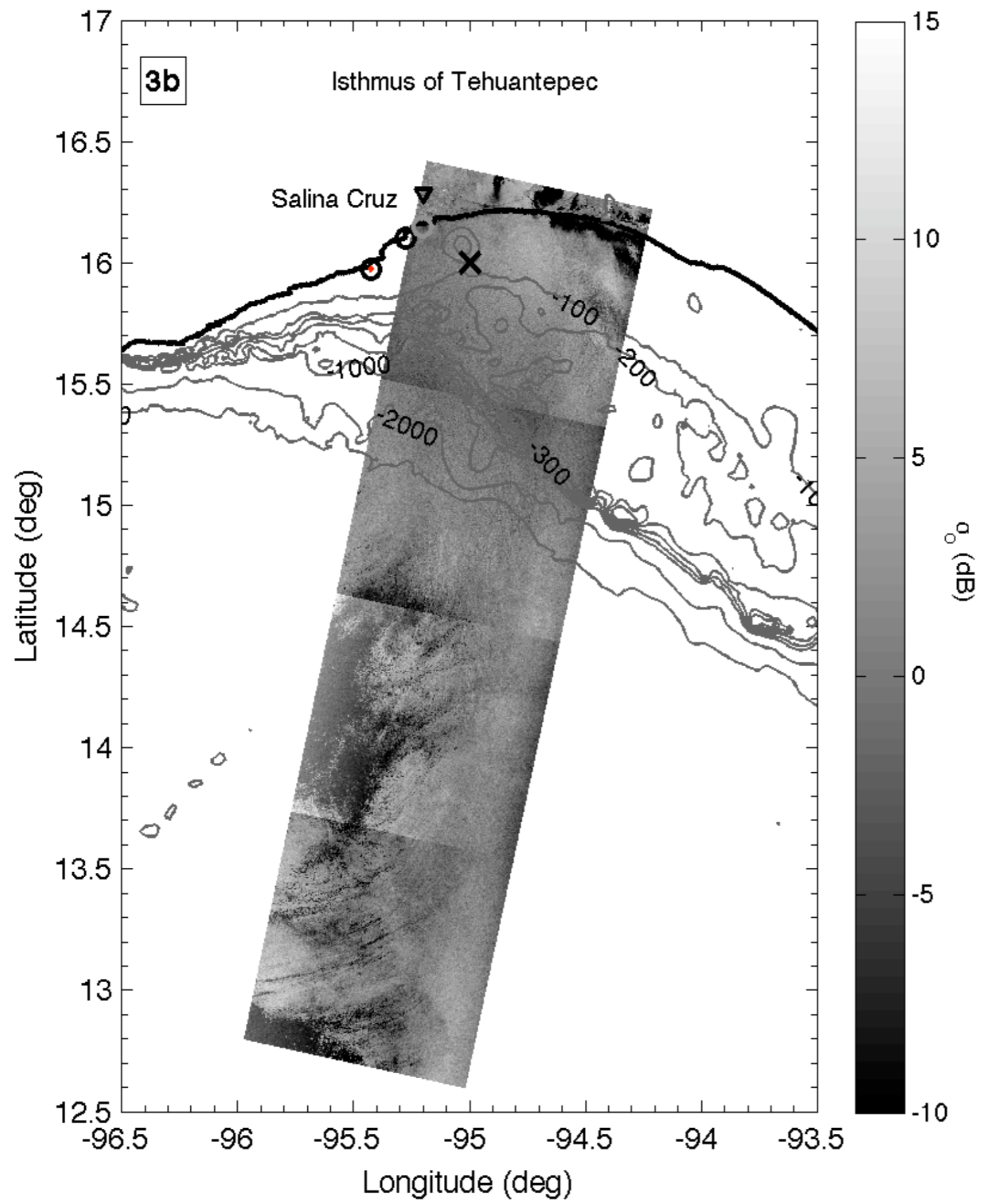
04:20:33 lat. 16.12 lon. -95.00 depth 31

Wave spectrum
Swell wave height: 0.74 m
Peak wavelength: 179 m
Peak direction: 5 deg



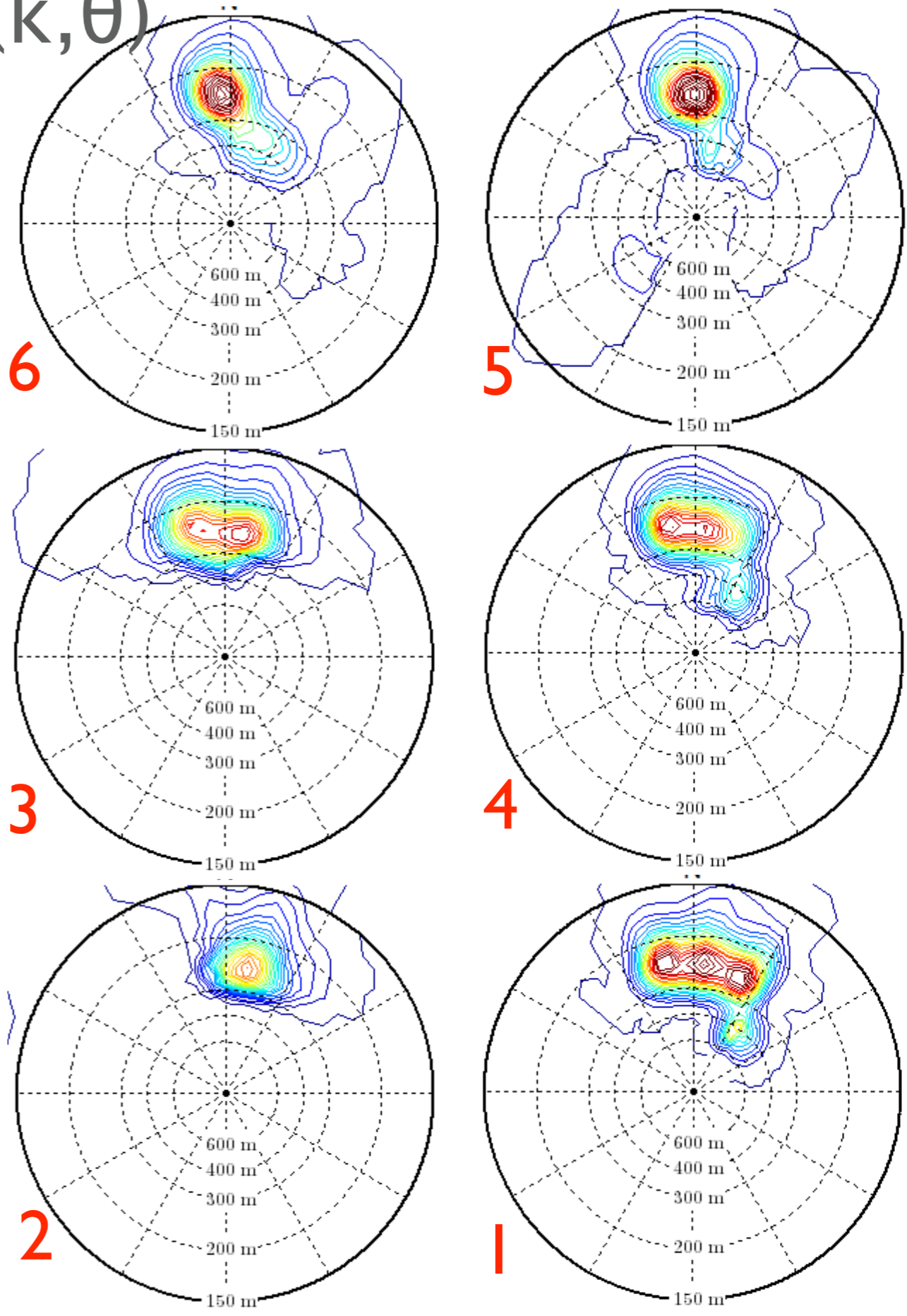
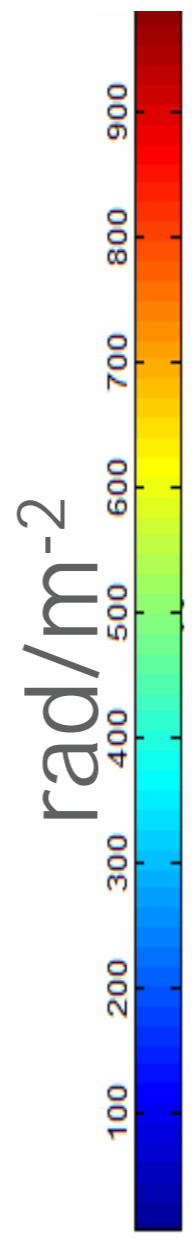
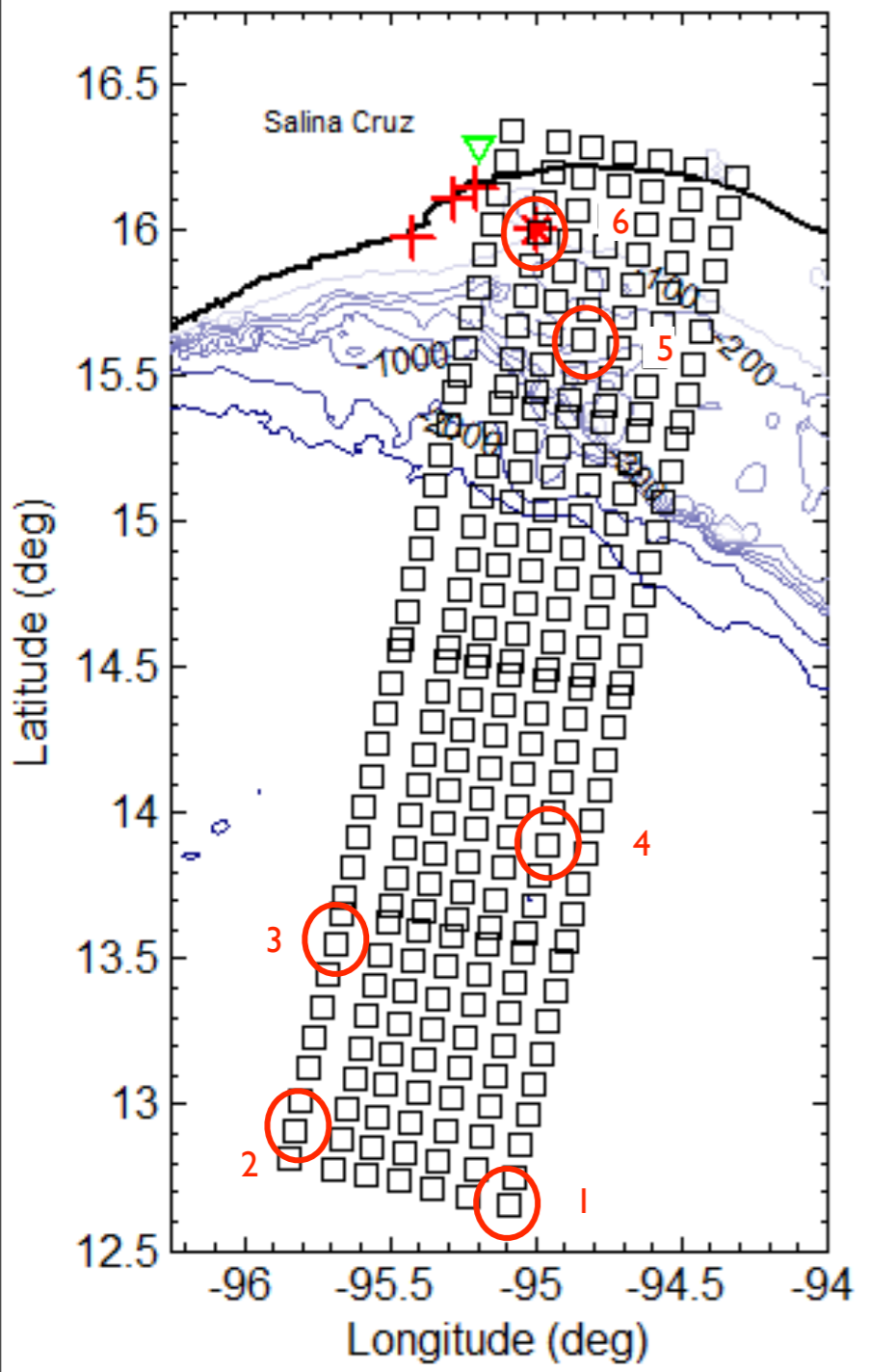
04:20:33 lat. 16.09 lon. -94.99 depth 41

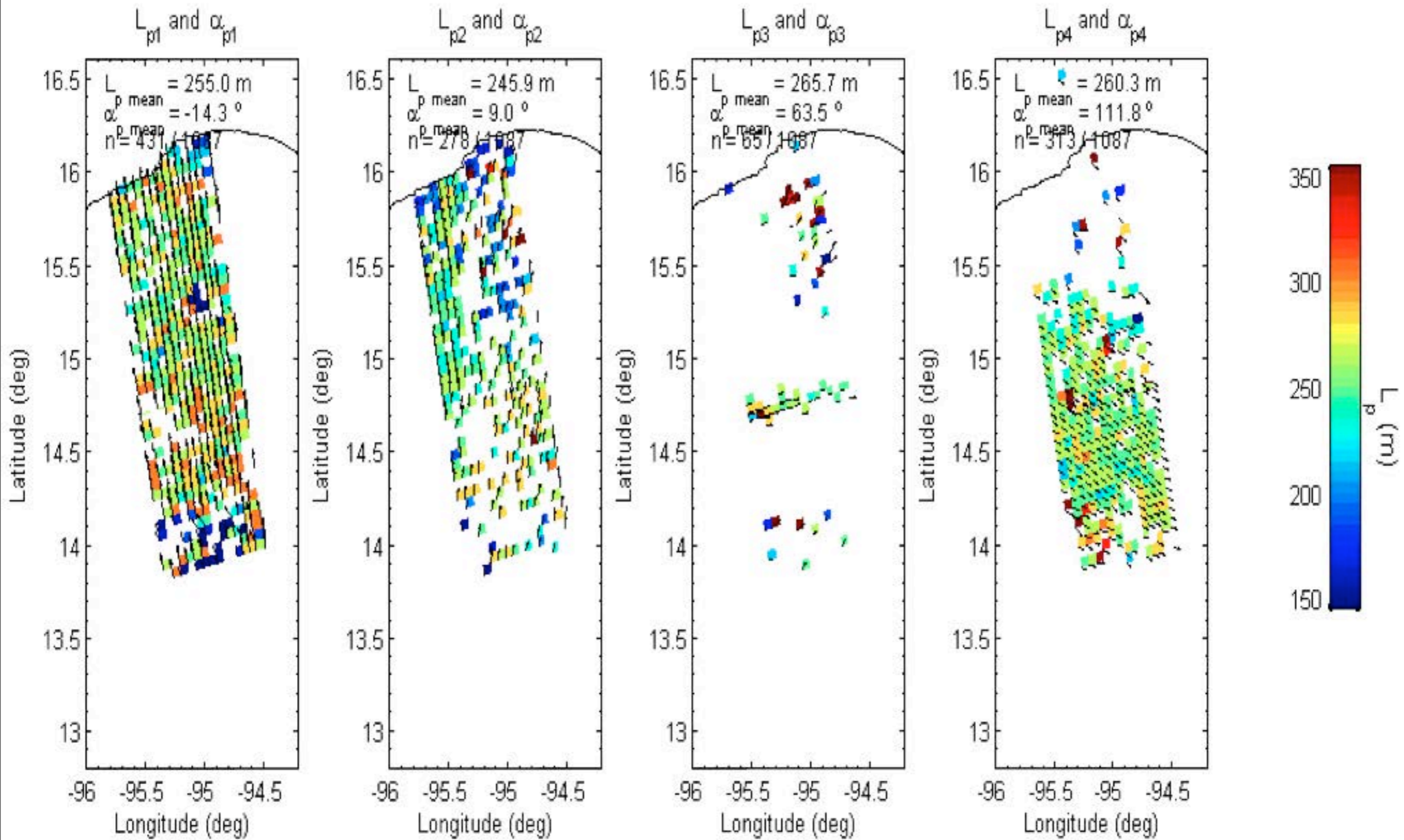


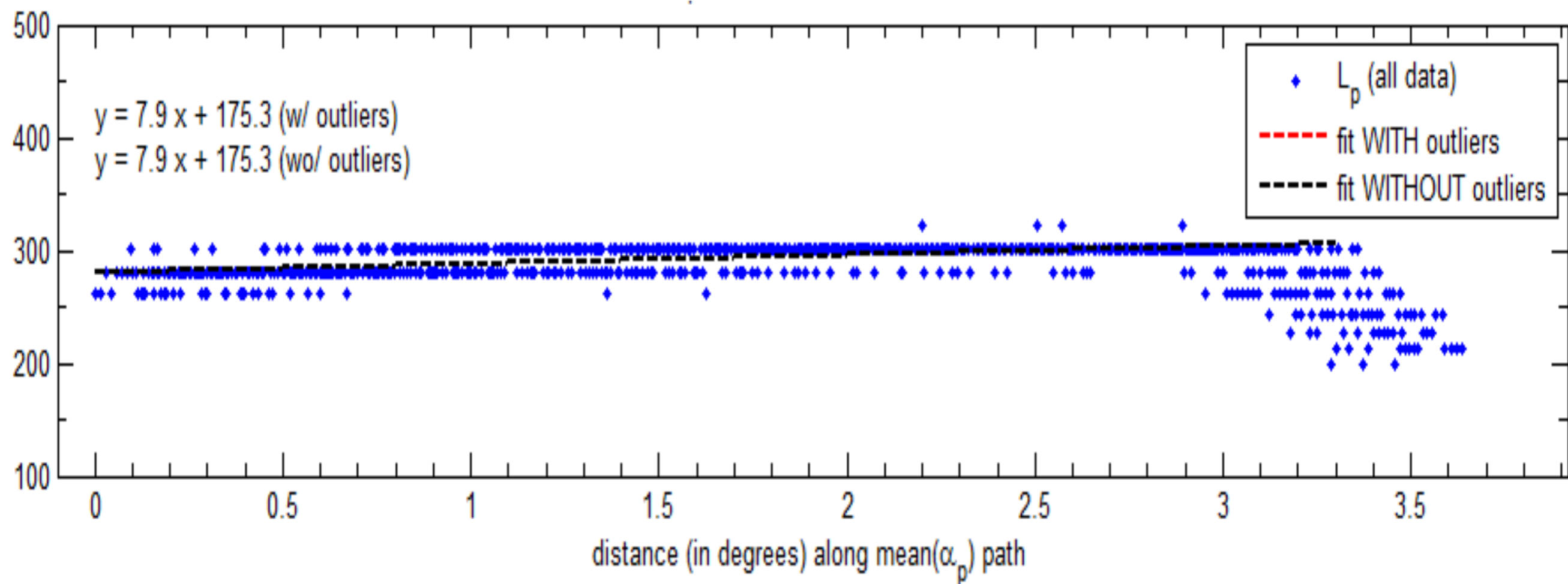


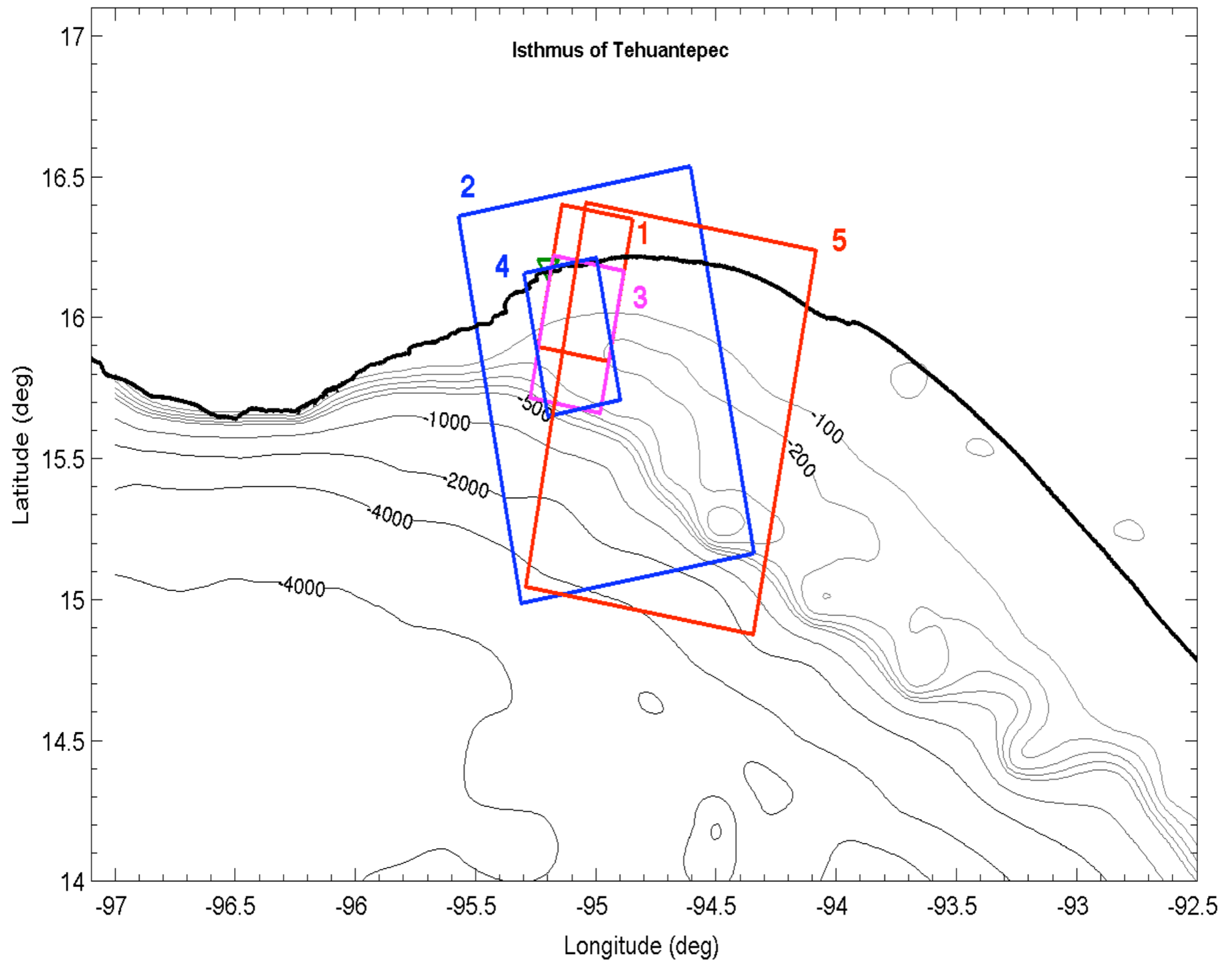
Spatial variability of $S_{swell}(k, \theta)$

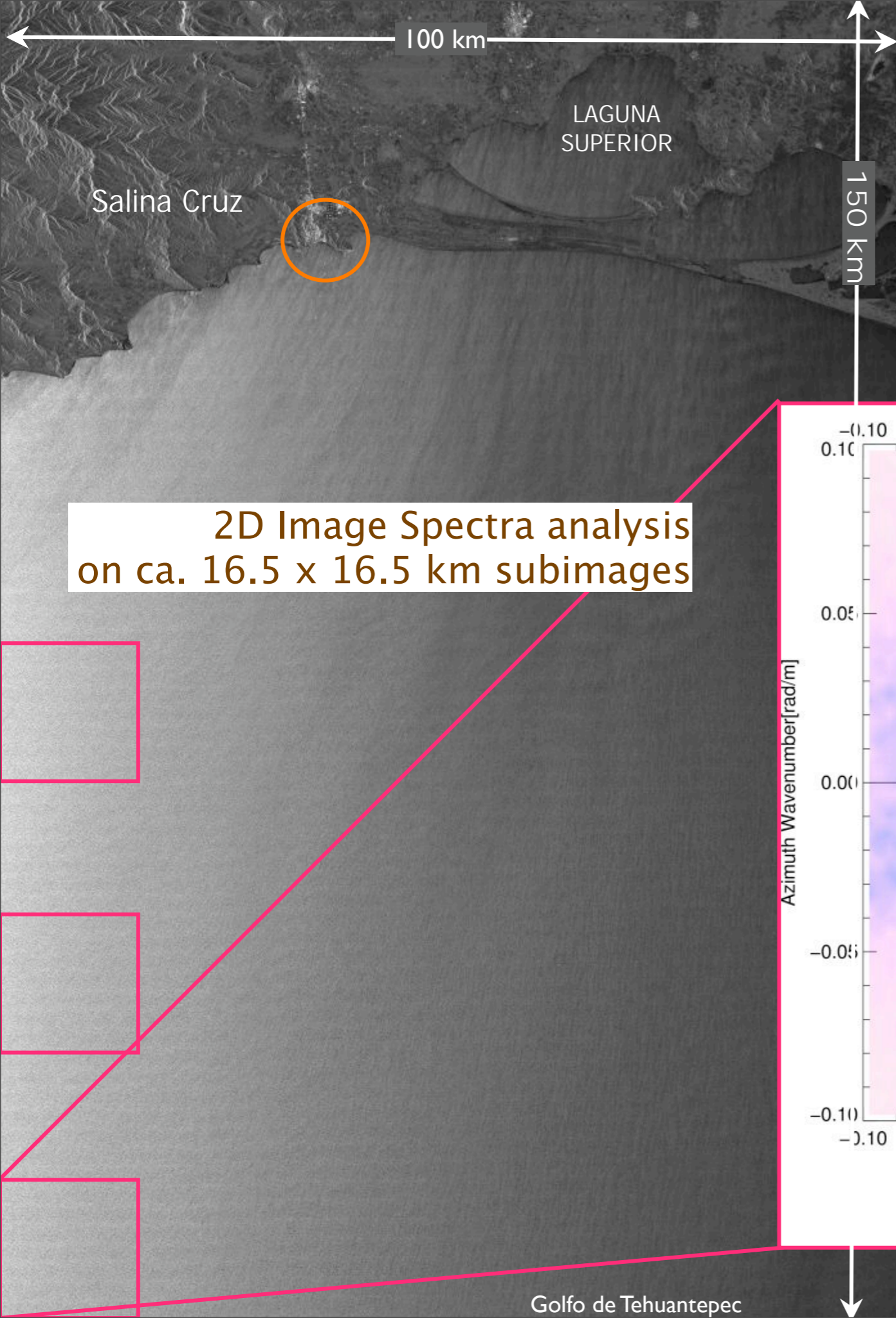
Series of 4 ASAR-SLC from
02/03/2005 @ 16:20h UTC





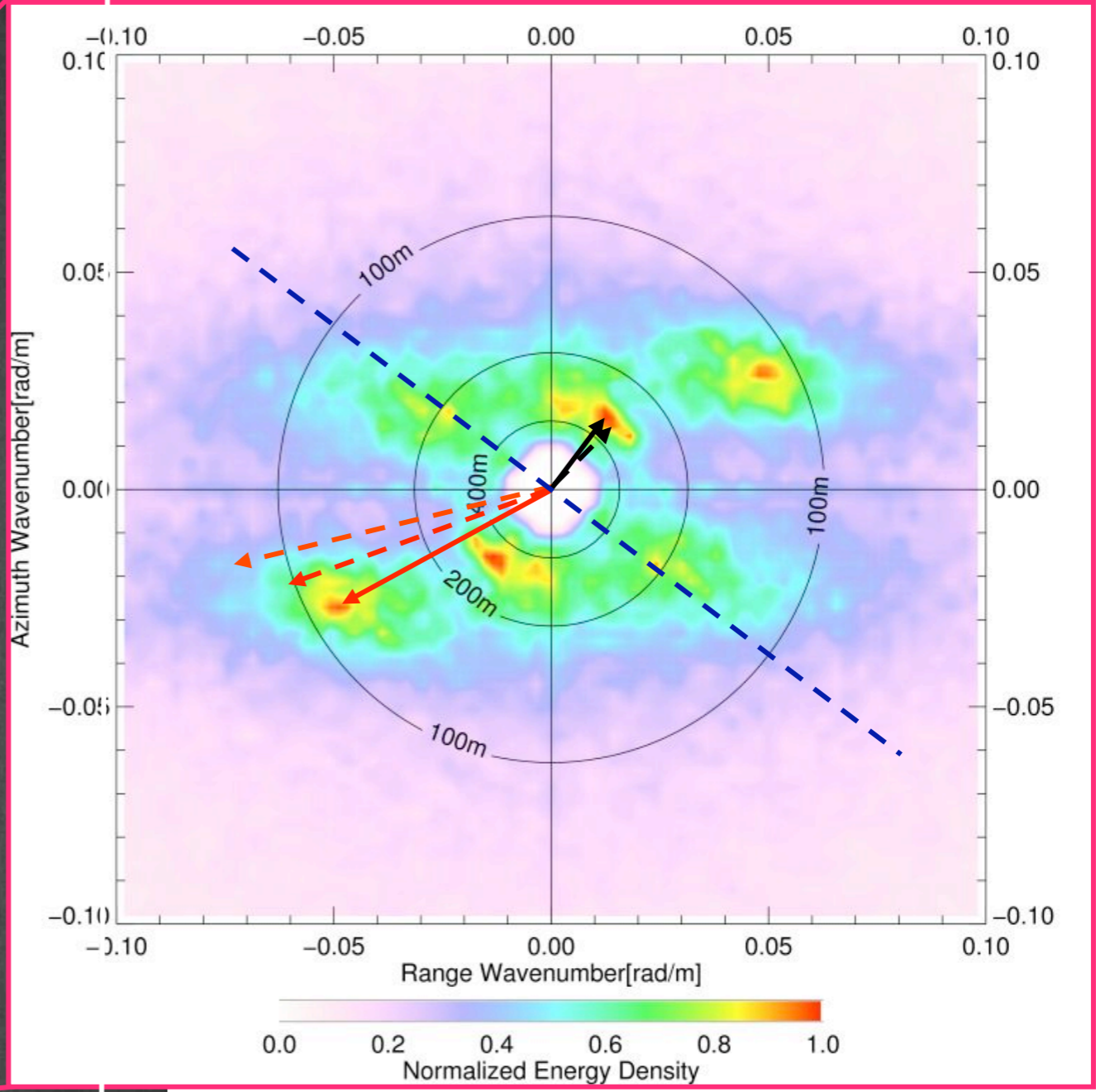






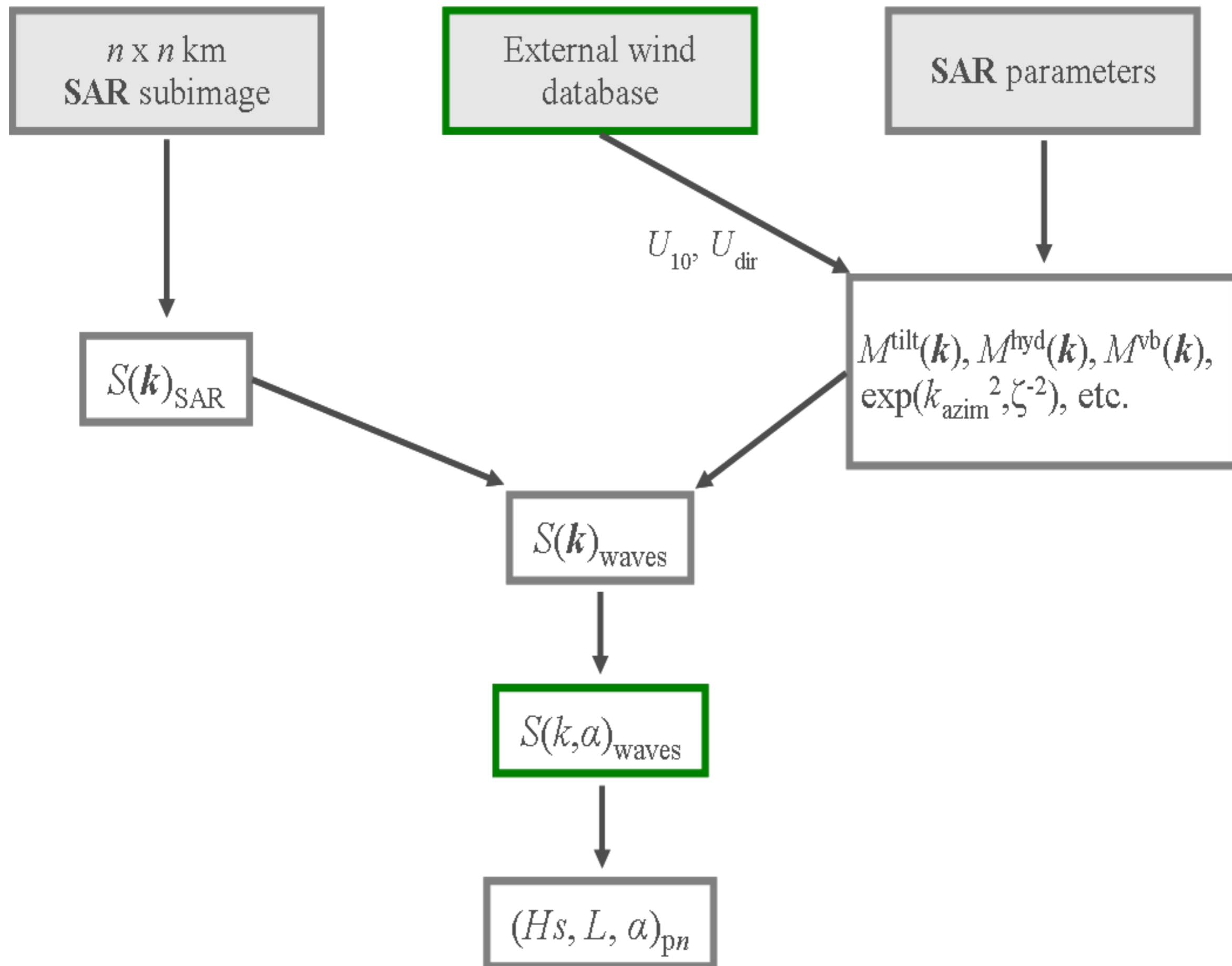
TerraSAR-X ScanSAR image
21- Mar-08 00:19h UTC
Satellite heading: 349.24°
HH polarization; Ascending path
Spatial resolution ~ 18 m

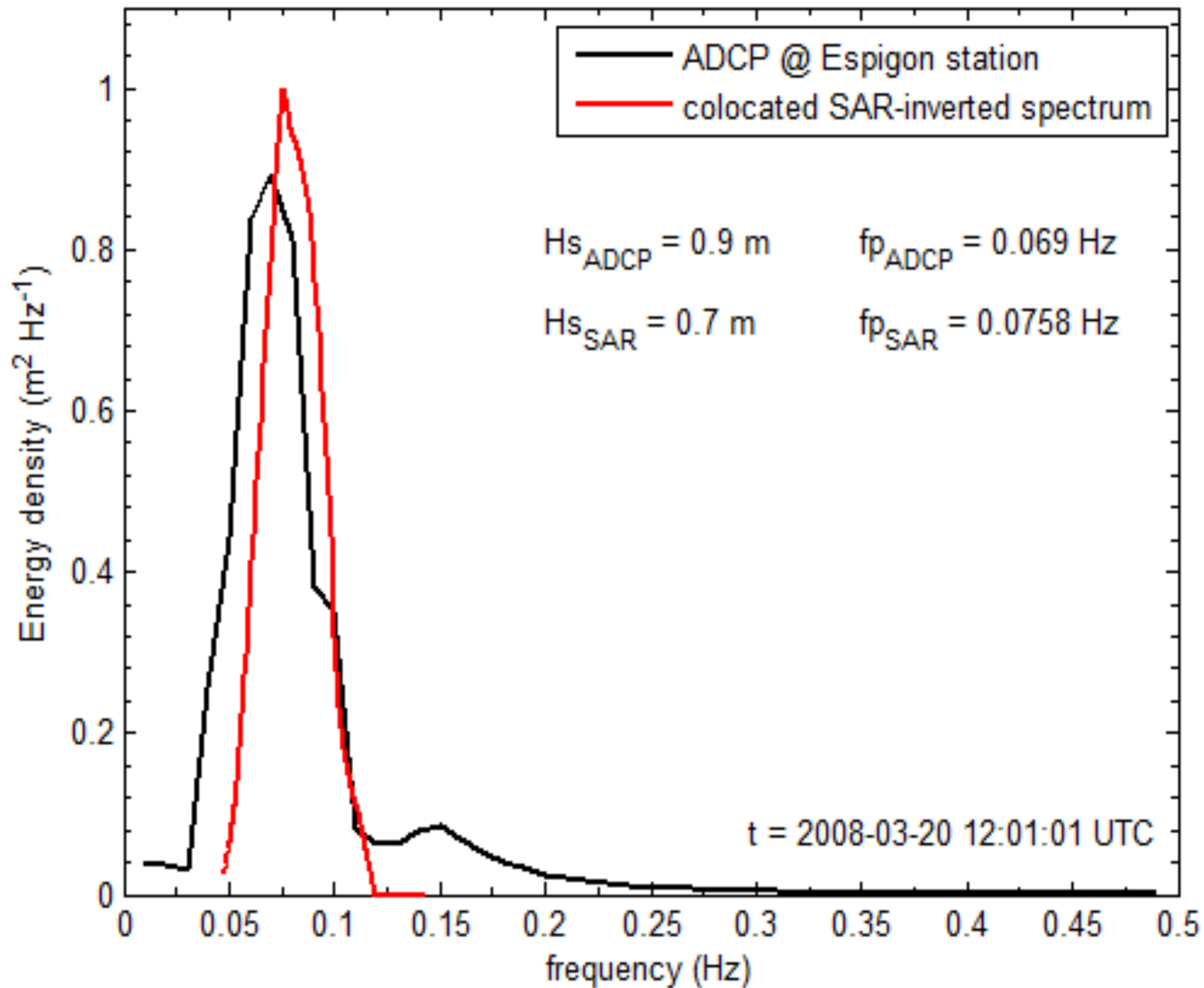
2D Image Spectra analysis
on ca. 16.5 x 16.5 km subimages



Díaz-Méndez et al. 2010, (IJRS)

Golfo de Tehuantepec





Final remarks and future work


Influence of waves on air-sea interactions

(swell reduces sea roughness at fetch-limited growth)

Spatial variability of swell spectrum

-Further analysis and retrieving wave spectra from X-band SAR

-Next field campaign in 2013



Mexican Space Agency (2011)

Open Posdoc Position 2-3 yrs (CICESE, Ensenada, México)