Wave Slope from Polarimetry Readme v3

These wave slope data from polarimetry described below are considered preliminary and not to be released until our review is completed. They should not be used for any purpose without consulting Christopher Zappa (zappa@ldeo.columbia.edu) and Nathan Laxague (nathan.laxague@unh.edu).

Ocean wave slope was retrieved from visible-band polarimetry. The polarimetric slope sensing (PSS) technique of Zappa et al. [2008] allows one to reconstruct the water surface slope field by measuring the polarization state of reflected light at each image pixel, allowing for surface resolutions of order 1 mm with no in-water measurement component. Due to the fact that sensitivity to polarization state depends on the sensor's incidence angle [Zappa et al., 2012], a polarimetric imager is best served by a narrow field of view (5°) in order to minimize variation of sensitivity across the image. Past applications of PSS have made use of R/P FLIP [Zappa et al., 2012; Laxague et al., 2018; Laxague and Zappa, 2020a] or research vessels [Laxague and Zappa, 2020b], providing maximal flexibility on observation location at the cost of total measurement duration.

The Polaris Pyxis Mono VIS used in this field campaign is a cutting-edge polarimetric camera. It implements the novel Sony IMX250MZR "Polarsens" 2464 x 2056 CMOS sensor array. Each 2 x 2 group of pixels (a 'superpixel') measures the intensity of light at four linear polarizations, from which we calculate the Stokes vector (S0, S1, S2) at each superpixel in a 1232 x 1028 array. From these Stokes vectors—acquired at 30 frames per second—we compute the water surface slope field in the along-look ('angle of incidence') and cross-look ('polarization orientation') directions. The spatial and temporal average of each slope field direction is subtracted from the dataset. This technique—Polarimetric Slope Sensing—was laid out by Zappa et al. [2008] as an approach for leveraging optics theory and improved camera technology for making high-resolution measurements of ocean surface wave characteristics.

The Pyxis camera was oriented at 30° incidence angle (up from nadir). Each frame was ortho-rectified via projective transform in order to ensure uniform spatial scale across the imaged patch of ocean and trimmed to 1373 x 1462 pixels.

Data were collected from the Air-Sea Interaction Tower offshore of Martha's Vineyard Coastal Observatory in October 2019 through January 2020. We collected a total of 190 quality-controlled runs of nominally 10-min each (the final run was 9 minutes). The Air-Sea Interaction Tower (ASIT; *41°20.1950'N, 70°33.3865'W*) is a rigid, low-profile structure located 3.2 km south of Martha's Vineyard in 15 m-deep water. The main thrust of the LDEO field campaign was to quantify the ocean capillary-gravity waves using visible polarimetry techniques. These measurements coincided with the NASA JPL Doppler scatterometer (DopplerScatt) system for spatially and temporally coincident measurements.

Variable List

Name	Size	Description
Sx	1373 x 1462 x 1800	Cross-look water surface slope
Sy	1373 x 1462 x 1800	Along-look water surface slope
DateVector	1800 x 6	Individual frame time stamp (YYYYMMDDhhmmss.SSS; UTC)
Scale	1	Spatial resolution in meters per pixel

Deleted: 0

The dimension of size 1462 represents the along-look direction (vertical image axis). The dimension of size 1373 represents the cross-look direction (horizontal image axis). The 190 individual runs were broken out into 1-minute files at 30 Hz, or 1800 frames. The camera's along-look direction (corresponding to the vertical image axis) was 190° true (clockwise from North).

References Cited

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