Atmospheric Intraseasonal Oscillations Leading to Sea Level Extremes in Coastal Indonesia during Recent Decades

William Kamp[1], Weiqing Han[1], Lei Zhang[1], Shochiro Kido[2], Julian McCreary[3], ***J. Clim., revised***

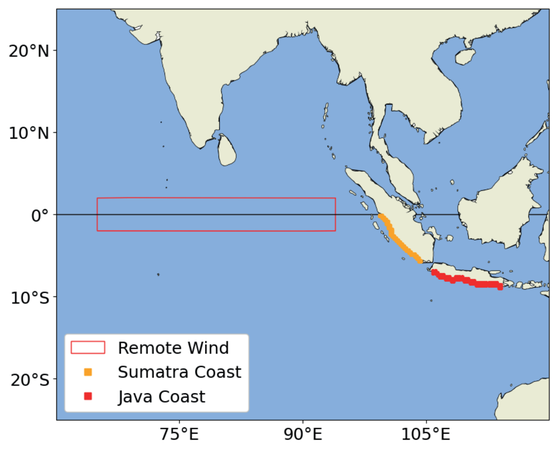
[1]Department of Atmospheric and Oceanic Science, University of Colorado Boulder, Boulder, Colorado, [2]Application Laboratory (APL), Research Institute for Value-Added-Information Generation (VAiG), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokohama, Japan, [3]University of Hawaii at Manoa, Honolulu, Hawaii

Motivation & Background

High Extreme sea level events (HEX) are destructive to human populations and infrastructure around the world, which will continue to worsen under anthropogenic driven sea level rise and population growth in coastal areas.

Extensive research into the role of synoptic and seasonal-to-decadal drivers of HEX has been performed; however, the role of intraseasonal variability (10-90 days) on HEX has been neglected.

The coasts of Indonesia are vulnerable to wind forced sea level extremes due to their location on the edge of the eastern equatorial Indian Ocean. Therefore, impacts from atmospheric InstraSeaonal Oscillations (ISOs) are expected.

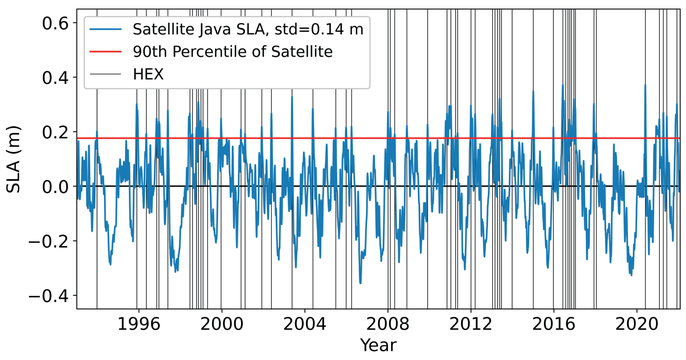


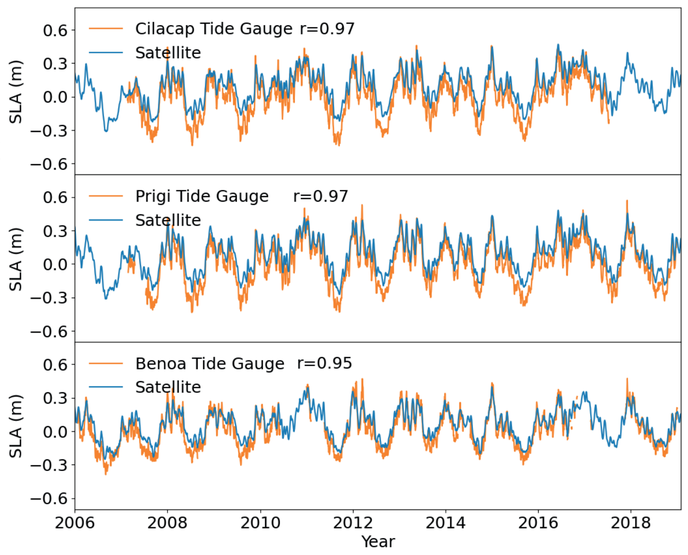
Data and Methods

The DUACS satellite dataset[1] was used to track the mean SLA along the southern coast of Java from 1993-2021.

The satellite data was validated against tide gauge data[2] at 3 locations along the southern coast of Indonesia (right).

HEX events defined as Java SLA that exceeds the 90th percentile for 5 consecutive days (below).





A Butterworth filter was used to separate ISO and Low-Pass (LP) variability for SLA, NOAA interpolated OLR[3], and ERA5 wind stress[4].

A Bayesian dynamic linear model was used to quantify forcing on Java SLA using predictors for the zonal wind over the equatorial Indian Ocean, the longshore wind along Java and the longshore wind along Sumatra for intraseasonal time scales.

Results

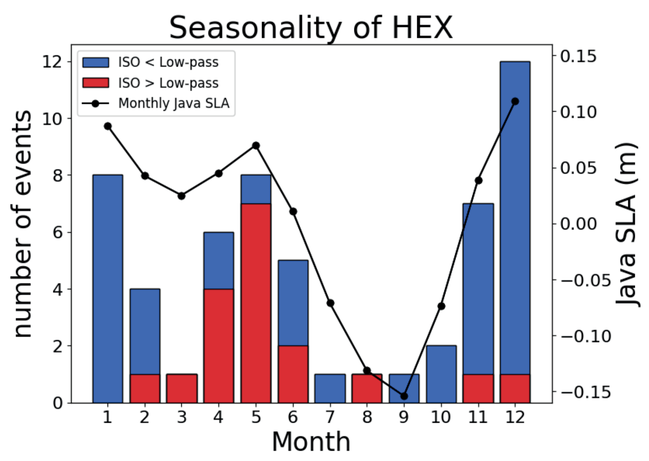
ISOs are important contributors to HEX

56 HEX events are detected

The HEX follow a strong seasonal pattern that appears to follow the seasonal cycle.

ISO dominate HEX during spring (March-May) while LP dominate HEX during winter (December-February).

ISOs are important contributors to HEX and exceed LP forcing in 32% of HEX.

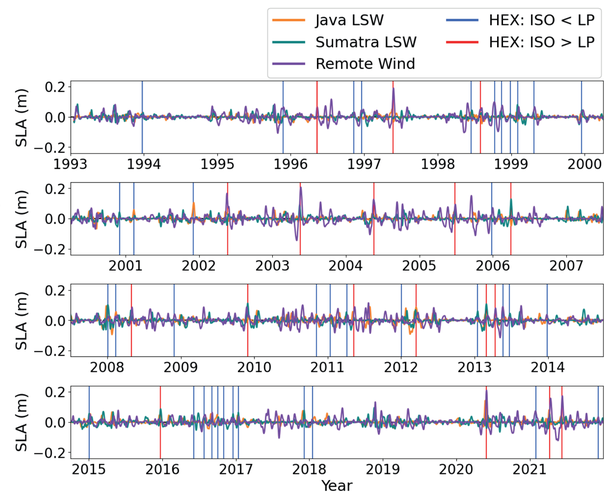


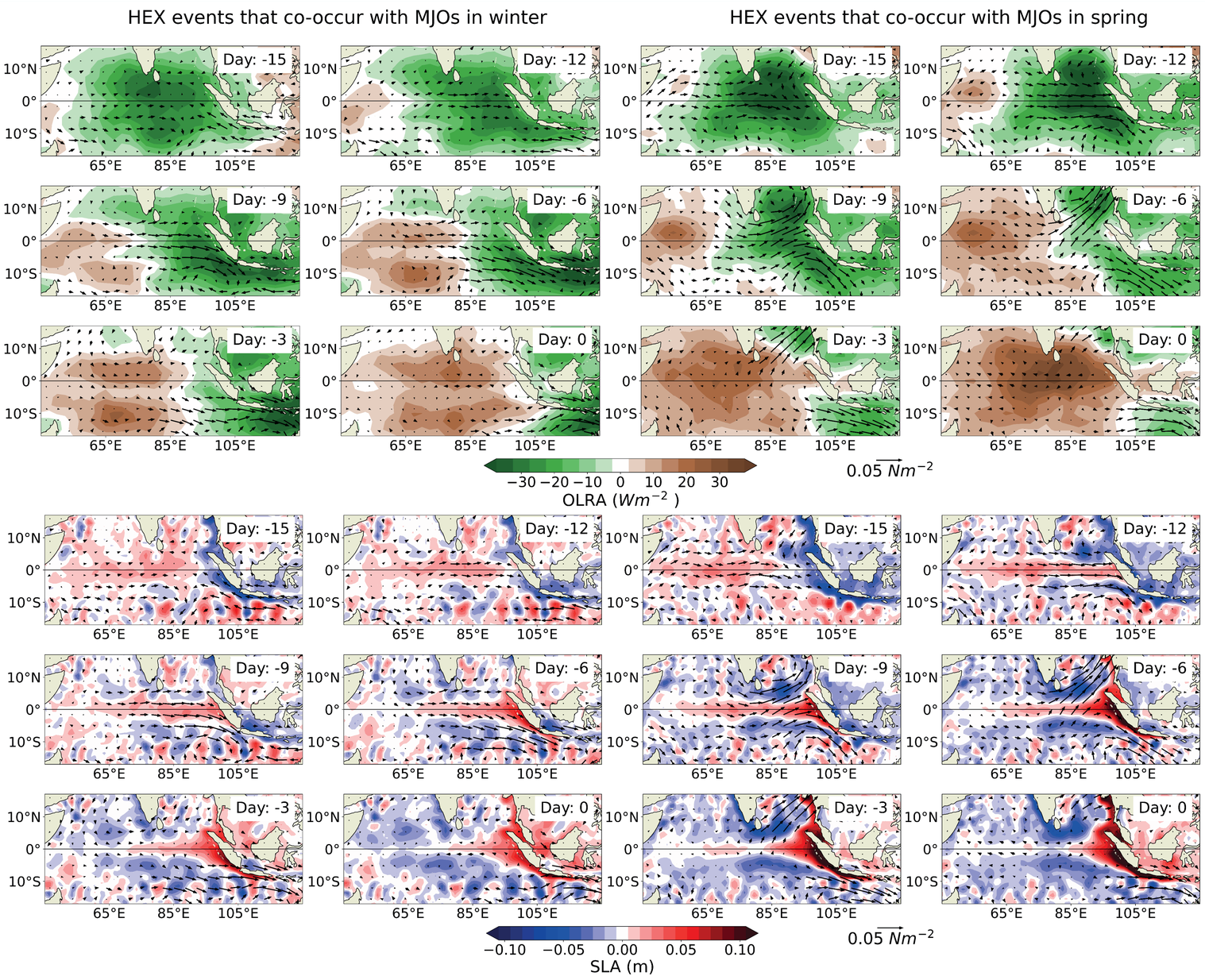
Remote equatorial wind forcing accounts for the seasonal difference in ISO forced Java SLA

The Bayesian dynamic linear model finds all three predictors are important to accurately reproduce Java SLA .

Remote wind is the dominant source of Java SLA, particularly in during spring.

During HEX that co-occur with MJOs, the remote wind forcing is 70% larger during spring compared to winter.





Composites of HEX that co-occur with active MJO events during winter (left two columns) and spring (right two columns) show the intraseasonal OLRA (top three rows), SLA (bottom three rows), and wind stress anomalies (all panels) leading to HEX events.

Spring MJOs have greater OLRA (convection) over the eastern equatorial Indian Ocean

The convection during spring is more symmetric about the equator relative to winter when the convection is shifted southwards. The greater convection over the equator is why…

Spring MJOs produce greater westerly wind stress over the eastern equatorial Indian Ocean

The greater westerly wind stress in the remote forcing region during spring compared to winter is why…

Spring MJOs have greater SLAs along the southern coast of Java

Contact: William Kamp, William.Kamp@colorado.edu

Acknowledgements: This work was made possible by the NASA Ocean Surface Topography Science Team award ONSSC21K1190.

References:

1 Taburet, G., A., et al., 2019: DUACS DT2018: 25 years of reprocessed sea level altimetry products. *Ocean Sci.*

2 Holgate, S. J., et al., 2013: 13: New data systems and products at the permanent service for mean sea level. *J. Coastal Res.*

3 Liebmann, B., and C. A. Smith, 1996: Description of a complete (interpolated) outgoing longwave radiation dataset. *Bull. Amer. Meteor. Soc.*

4 Hersbach, H., et al., 2020: The ERA5 global reanalysis. *Quart. J. Roy. Meteor. S*