Ocean Vector Winds: science and data needs in coastal regions

Bourassa M, Fewings M, Grieco G, Han W *(alphabetic)*

Two parts:

- I. Recent science results
- II. Need & methods for improving coastal winds

Nov 1st, 2023, IOVWST meeting, virtual

Motivation

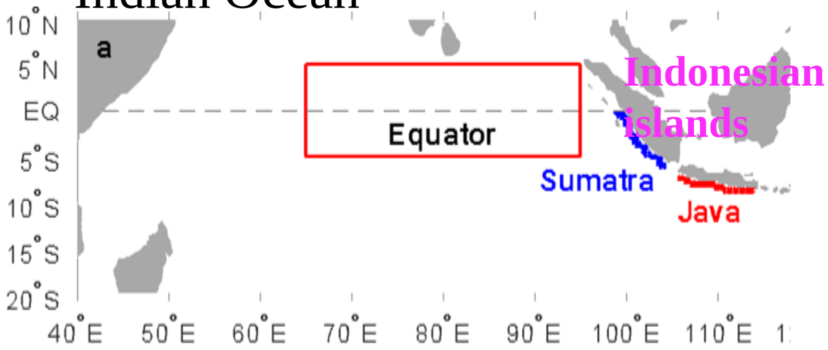
Coastal Ocean:

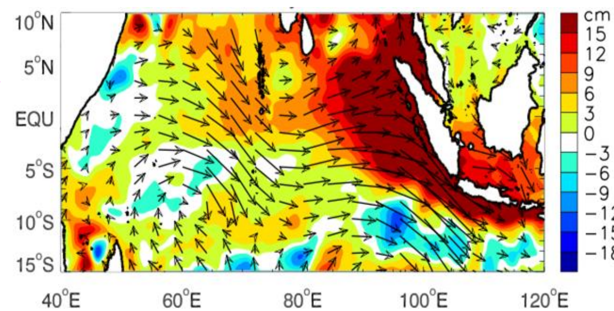
- ❖ Coastal upwelling is important for biological productivity, marine ecosystems and fishery
- ❖ Coastal sea level rise and sea surface Height EXtreme (HEX) events cause flooding & damage, disrupting human society and marine ecosystems
- ❖ Both local winds near coasts and remote winds from open ocean are crucial for determining coastal ocean processes
- ❖ Improving the accuracy of ocean vector wind product, especially in coastal ocean where land contamination occurs, is important for scientific community

I. Climate-driven extreme sea level events in coastal Indonesia during recent decades

W. Han, W. Kamp and coauthors

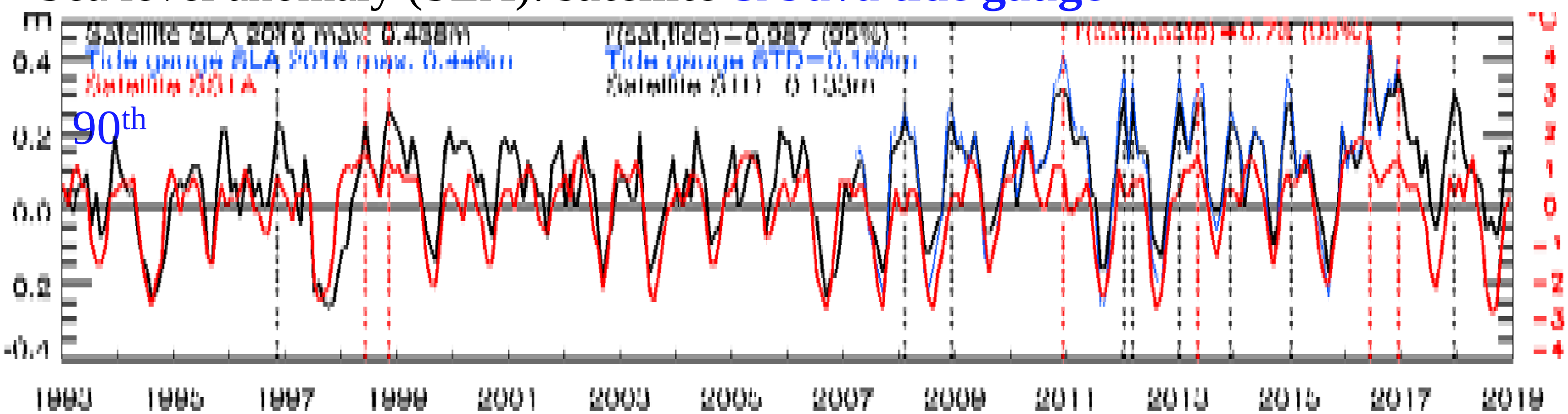
Indian Ocean



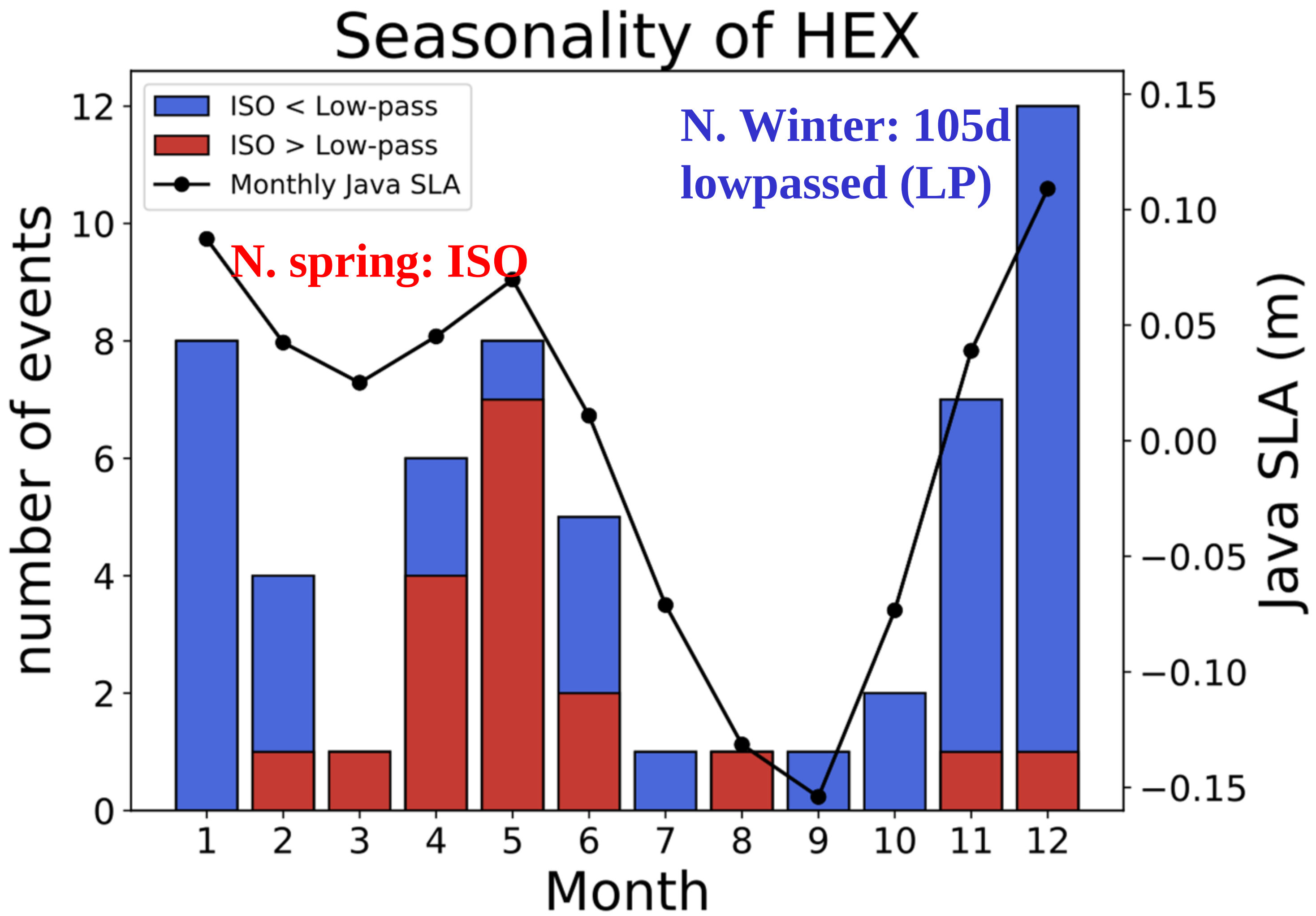


- Remote EQ wind;
- Local longshore wind

Sea level anomaly (SLA): **satellite** **& Java tide gauge**



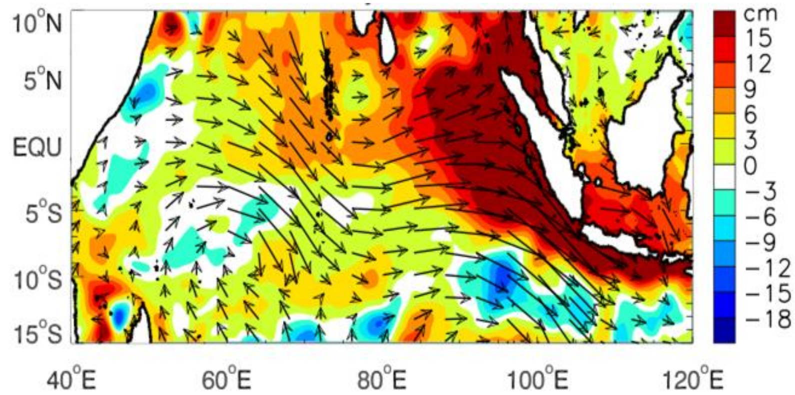
Sea surface Height EXtreme (HEX) events: daily satellite sea level anomalies (SLA) > 90th percentile



The number of HEX events for each month (bar graph), together with the monthly mean SLA climatology for the 1993-2021 period (black curve). The HEX events are divided into two categories The first with ***ISO** signals (105-day highpass filtered SLA) < 105-day low-passed **(LP)*** signals (blue) and the second with *ISO signals > LP signals (red).*

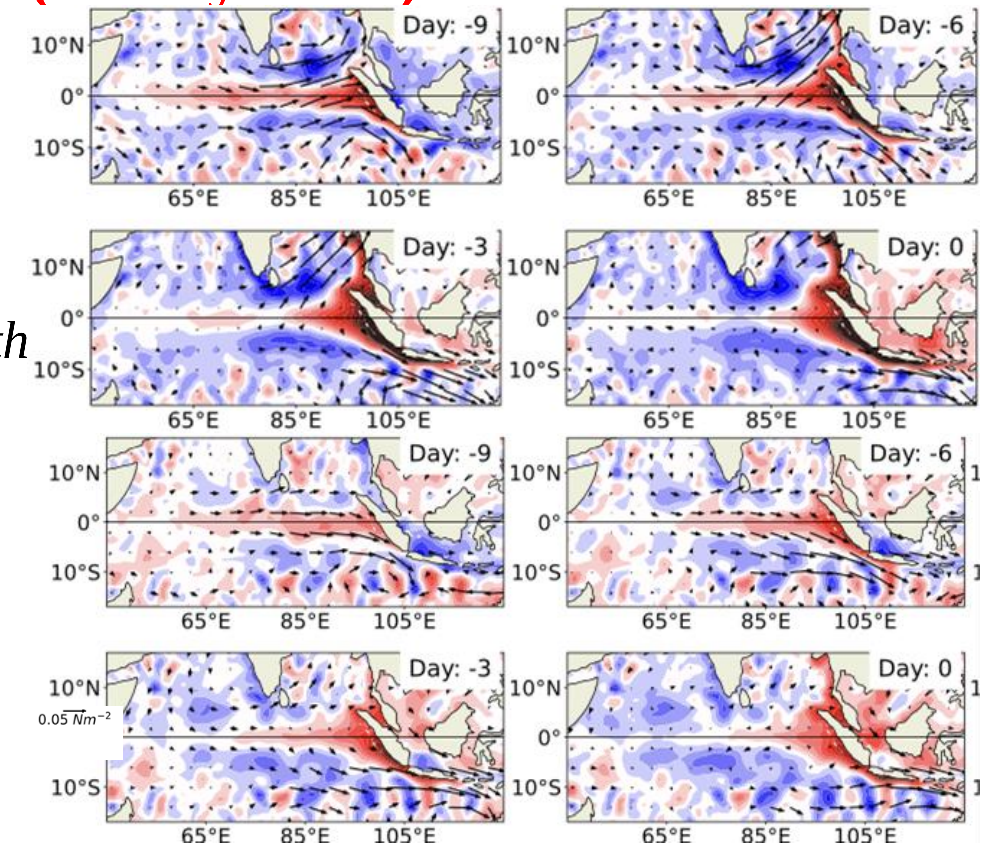
(a) Northern winter: LP (seasonal & interannual dominate) dominate

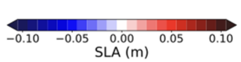
- *Westerly & northwesterly wind anomalies associated with* ***Australian-Indonesian monsoon****, exacerbated by* ***-IOD & La Nina, causing LP dominance of HEX.***



(b) Spring: Why do ISO (mainly MJO) contribute more to HEX?

- ***Spring MJO****: stronger EQ westerlies & stronger HEX*
- ***Winter MJO:*** *shift south of EQ, weaker EQ westerlies*



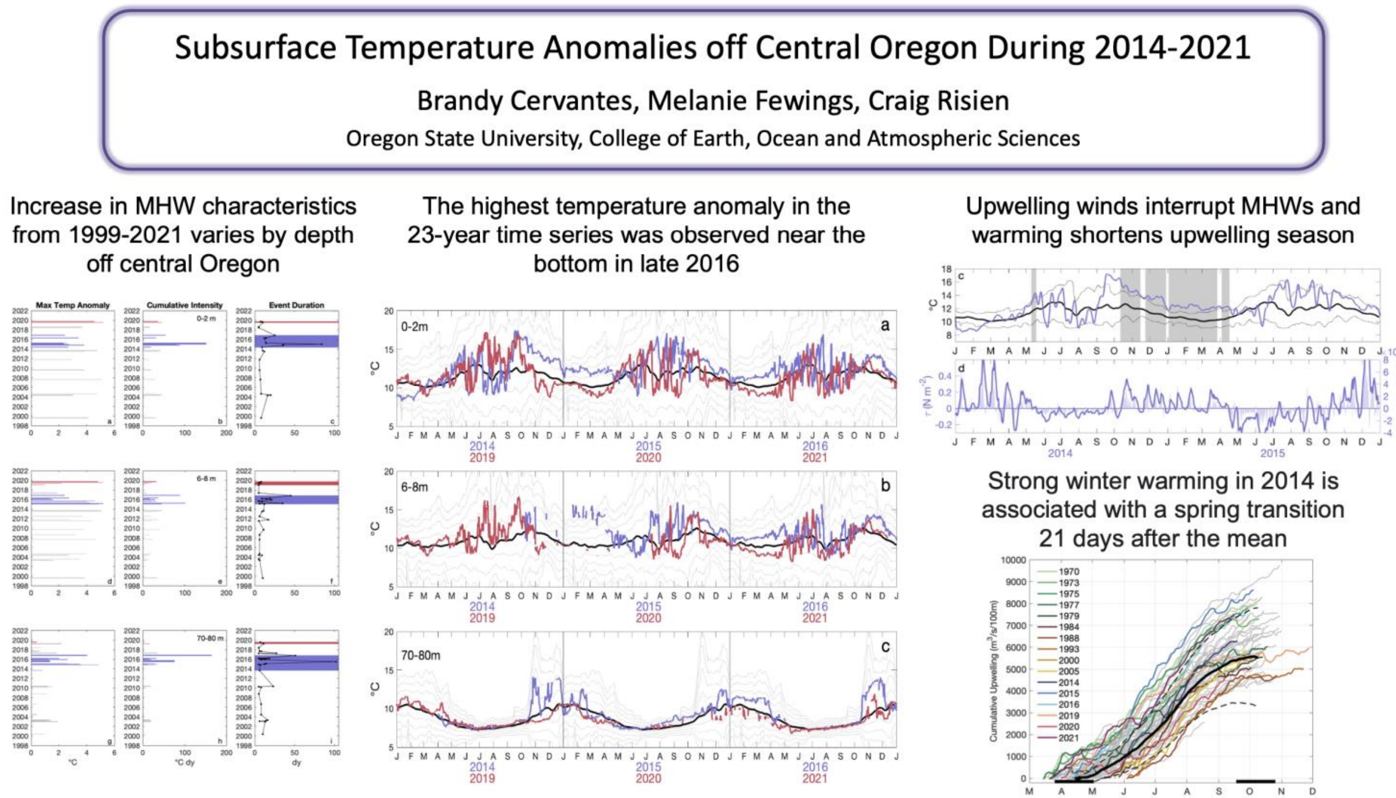


Poster: Coastal Marine heatwaves (MHW) off Central Oregon

B. Cervantes, M. Fewings, C. Risien (OSU)

- Observed increase in MHW from 1999-2021
- Highest temperature anomaly near the bottom
- Upwelling winds interrupt MHWs & warming shortens upwelling season

Please visit the poster for more details

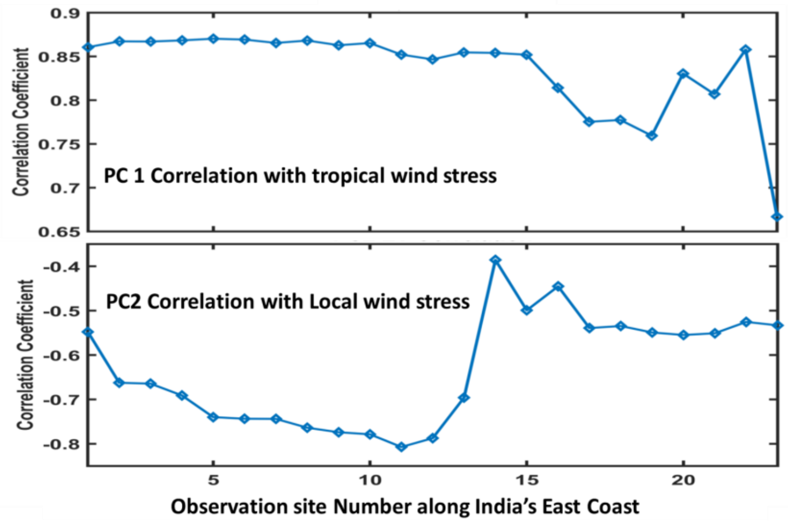


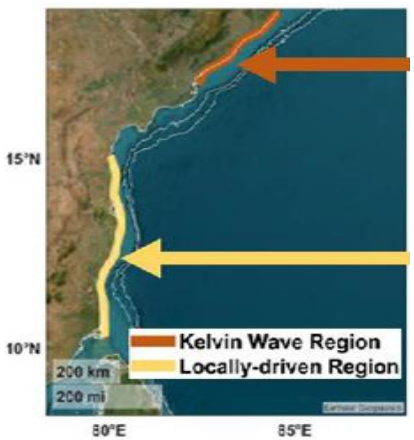
Coastal Upwelling in the Western Bay of Bengal: Role of Local and Remote Windstress

Sthitapragya Ray, Debadatta Swain, Meer M. Ali and Mark A. Bourassa

Research Gap: Relative contribution of Ekman Transport and Kelvin waves to coastal upwelling along India's eastern coast (western Bay of Bengal).

Motivation: Coastal upwelling is the most important physical process determining the biological productivity of coastal oceans.





Principal Component Analysis of a coastal sea surface height anomalies results in two main modes of variability:

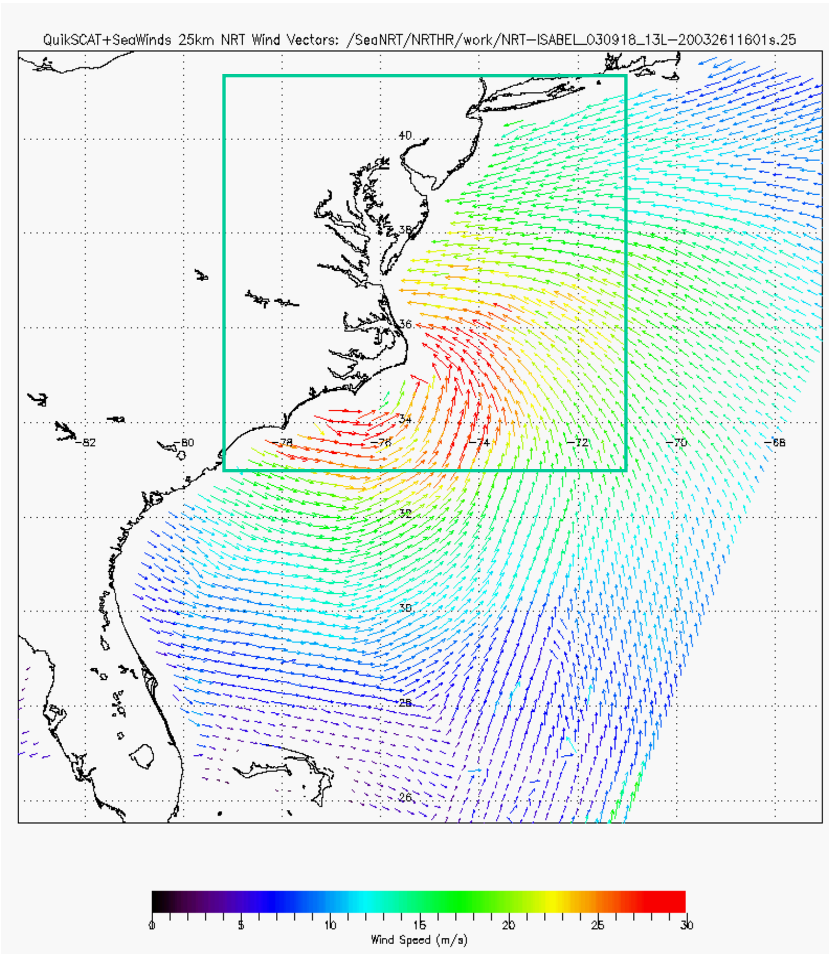
- **PC1 is associated with coastal Kelvin waves**
- **PC2 is associated with local Ekman forcing**

Conclusions:

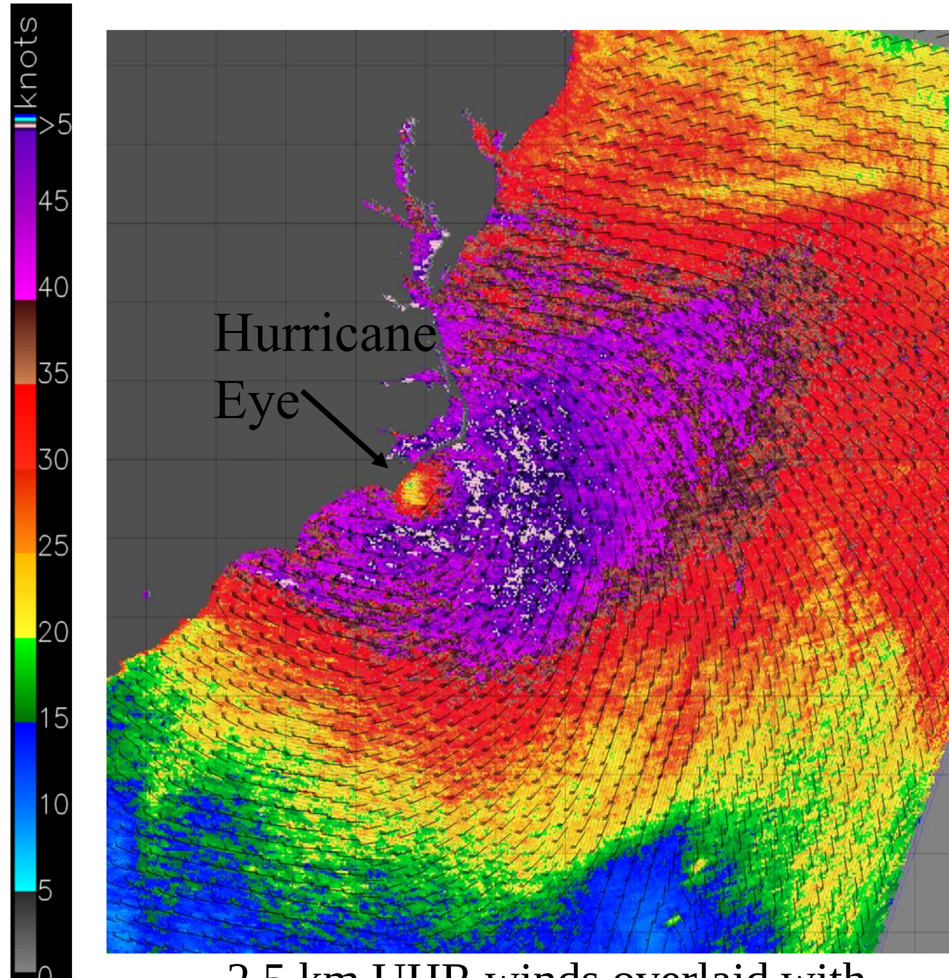
- Coastal SST cooling coincides with alongshore winds in the south, while the cooling precedes the winds in the north.
- SSHA along the northern section is influenced by Mode 1 which is correlated with equatorial zonal winds.
- SSHA along the south is driven by Mode 2 which is correlated with local winds.

II. Need & methods for improving coastal winds

Hurricane Isabel – Conventional vs UHR winds QuikSCAT



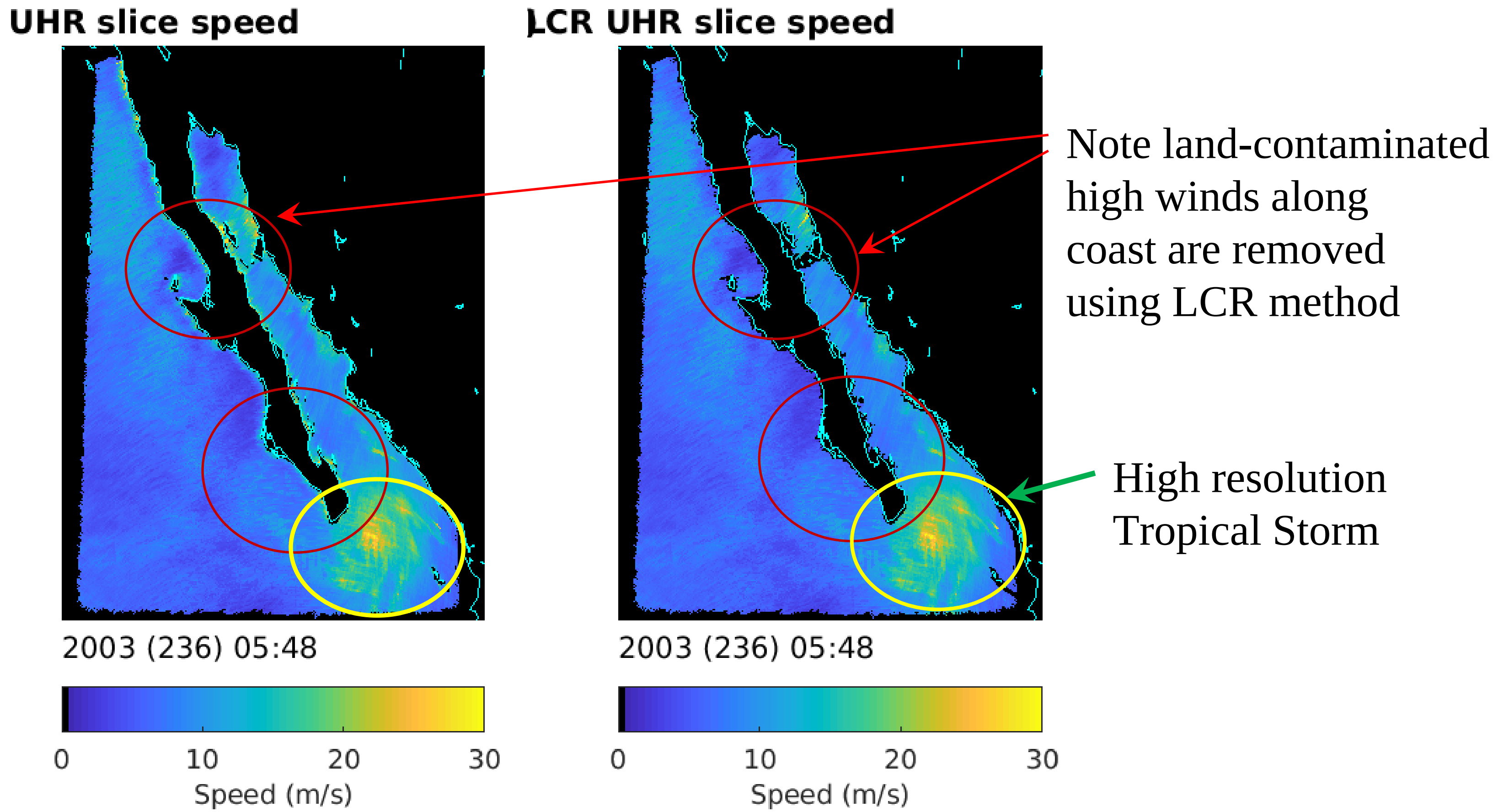
Conventional 25 km resolution wind vectors



2.5 km UHR winds overlaid with 25 km barbs

Provided by D. Long

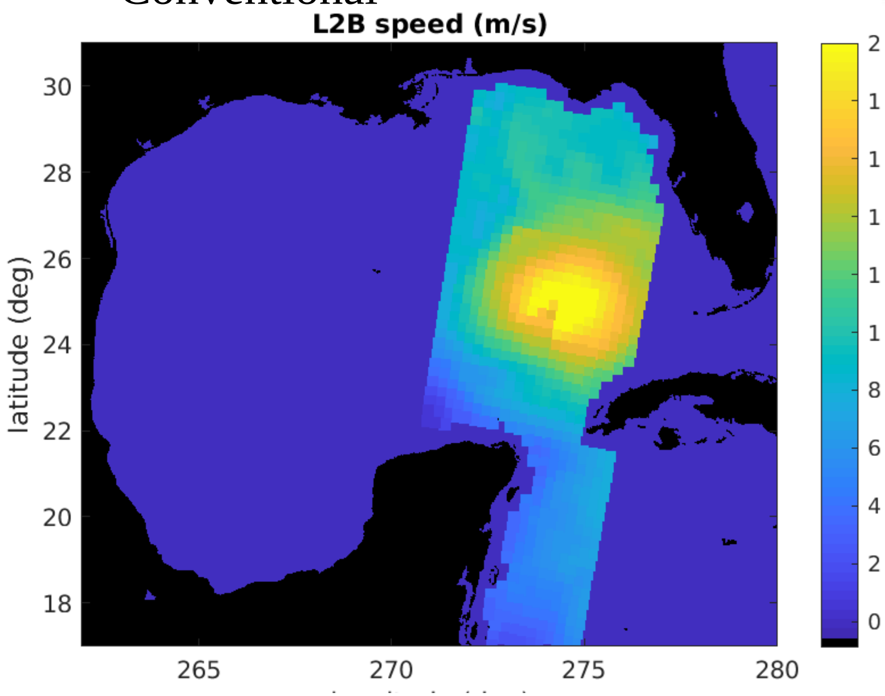
QuikSCAT Near-Coastal Wind Land Contamination Correction Example

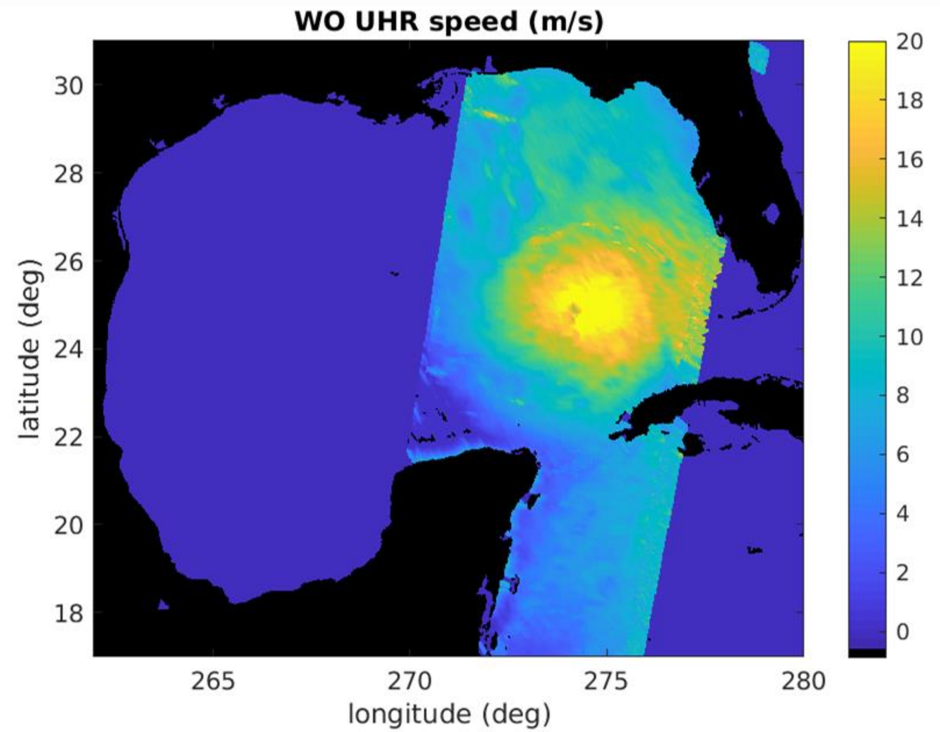


Provided by D. Long

ASCAT Enhanced Resolution Example: Hurricane Ida

Conventional





Conventional (25 km)

BYU Ultra-High Resolution Retrieval (2.5 km*)

* Posted resolution. Effective resolution ~8 km.

Provided by D. Long

Coastal wind retrievals from QuikSCAT-corrected σ_0s

- σ_0s are corrected with **noise regularization**
- It consists in projection land-contaminated σ_0s onto the pdf of non-contaminated σ_0s
- Good performance. Cannot deal with negative σ_0s (<3%) but no impact on retrievals

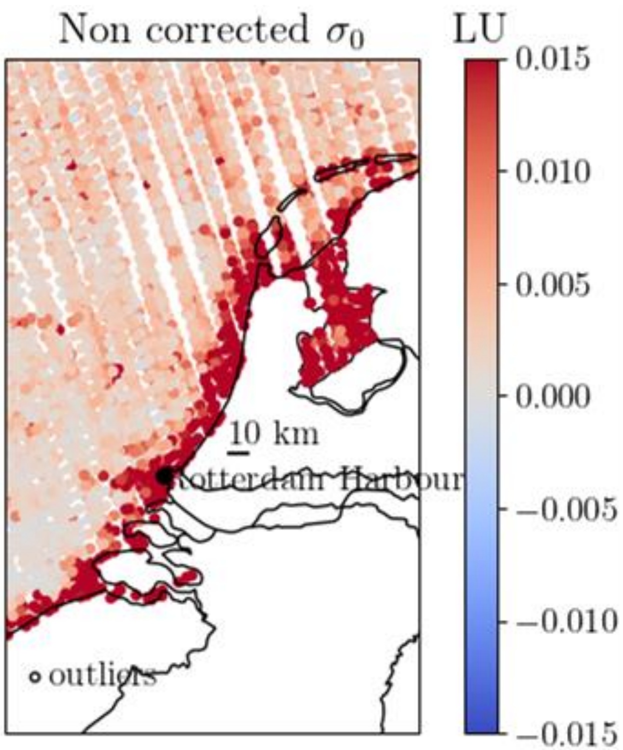


Fig. 1: σ_0 in linear units (LU) before correction

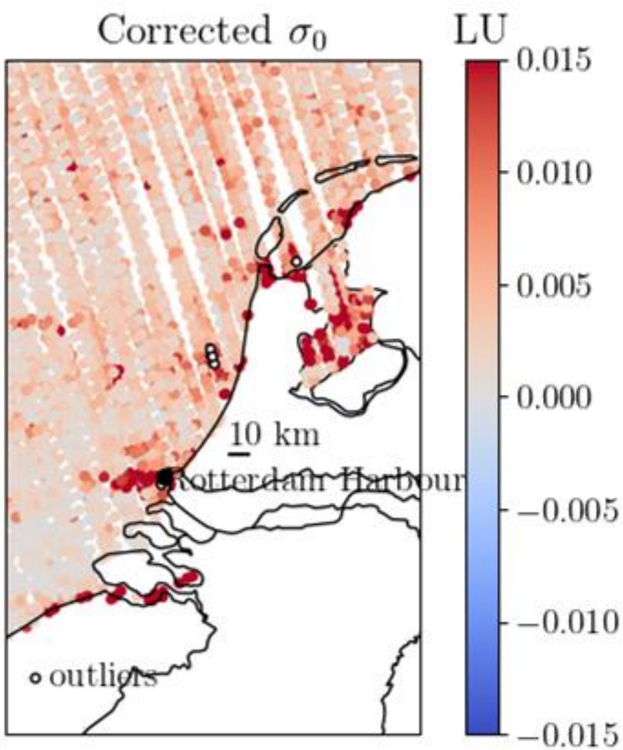


Fig. 2: σ_0 in LU after correction. outliers: fill values

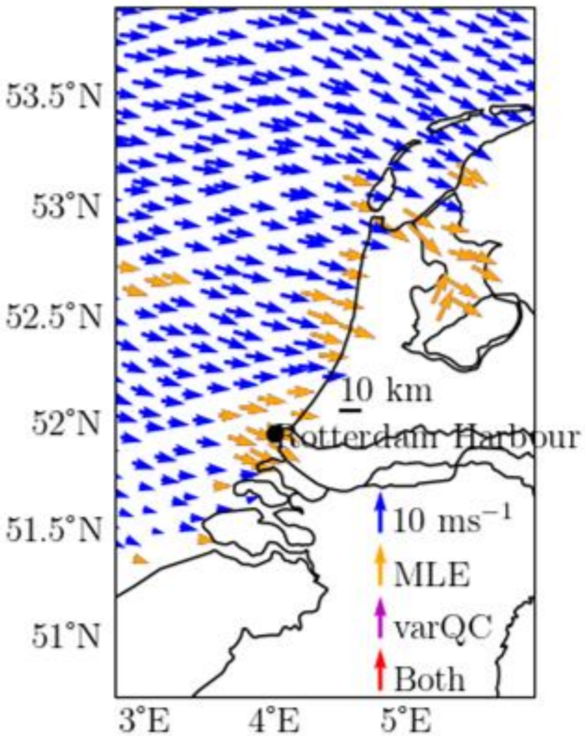
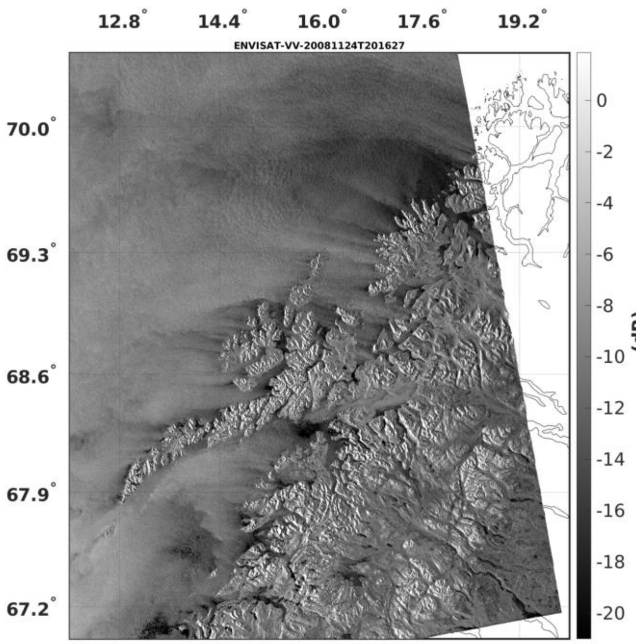


Fig. 3: Blue arrows: QC winds @ 12.5 km. Yellow arrows: MLE-flagged winds. Magenta arrows: varQC-flagged winds. Red arrows: MLE and varQC-flagged winds

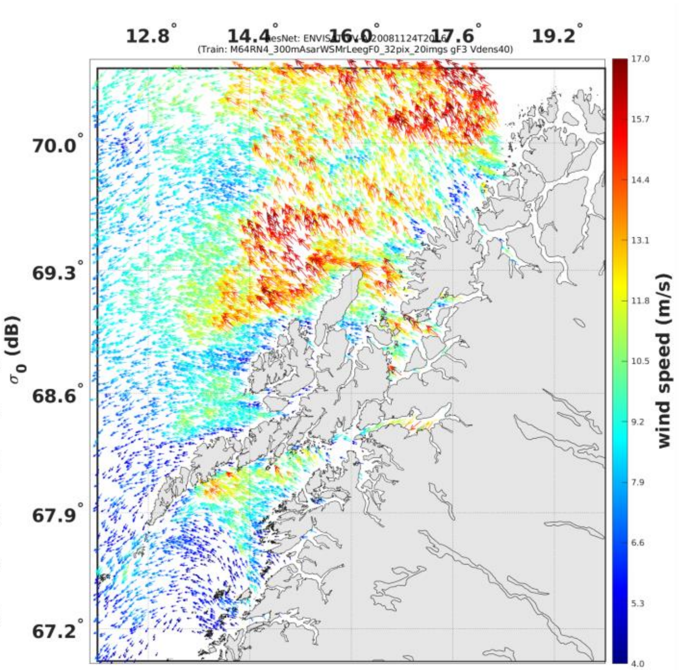
G. Grieco

Validation of scat-derived coastal winds: is SAR suitable?

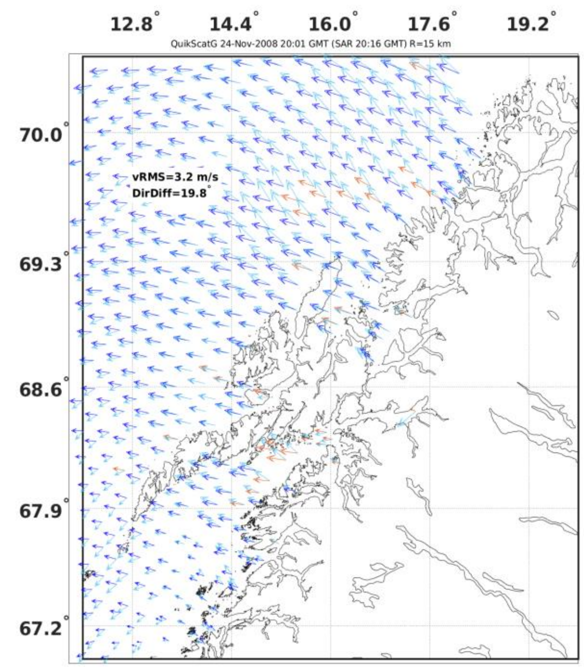
- How can we validate scat-derived coastal winds?
- Is SAR mature for this purpose? If not, how can we improve it?
- Can scat-derived winds be used to validate SAR winds? How?



ASAR σ_0^{VV} in dB



ASAR-derived winds with a 2-step procedure: ResNet (direction) + CMOD7 (speed). Grid spacing is 900 m



Light blue (dark blue) arrows: ASAR (QuikSCAT)-derived winds on the QuikSCAT WVC grid @ 12.5 km. Orange arrows: rainy WVCs

G. Grieco

Issues and discussion

- Needs: Good ways to calculate (wind curls & Ekman pumping velocity): there will be a poster on Day 3 on this topic

- Needs: Reduce averaging in coastal winds