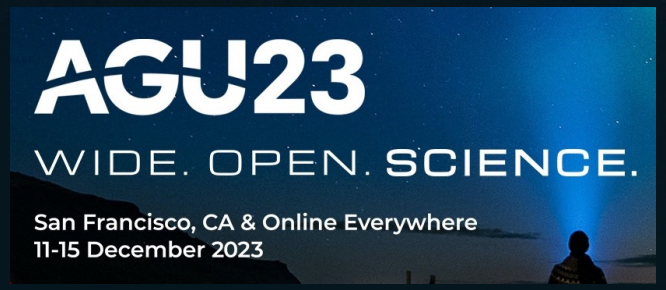


Geomorphic signatures of coastal change from multiple satellite-derived change indicators

Freya Muir

PhD: "The Construction of a Real-time Coastal Erosion Monitoring and Forecasting System"

Dr Martin Hurst, University of Glasgow
Luke Richardson-Foulger, University College London
Prof Larissa Naylor, University of Glasgow
Dr Alistair Rennie, NatureScot
Dr Douglas Pender, JBA Consulting

@fme_muir
linkedin.com/in/freya-muir/

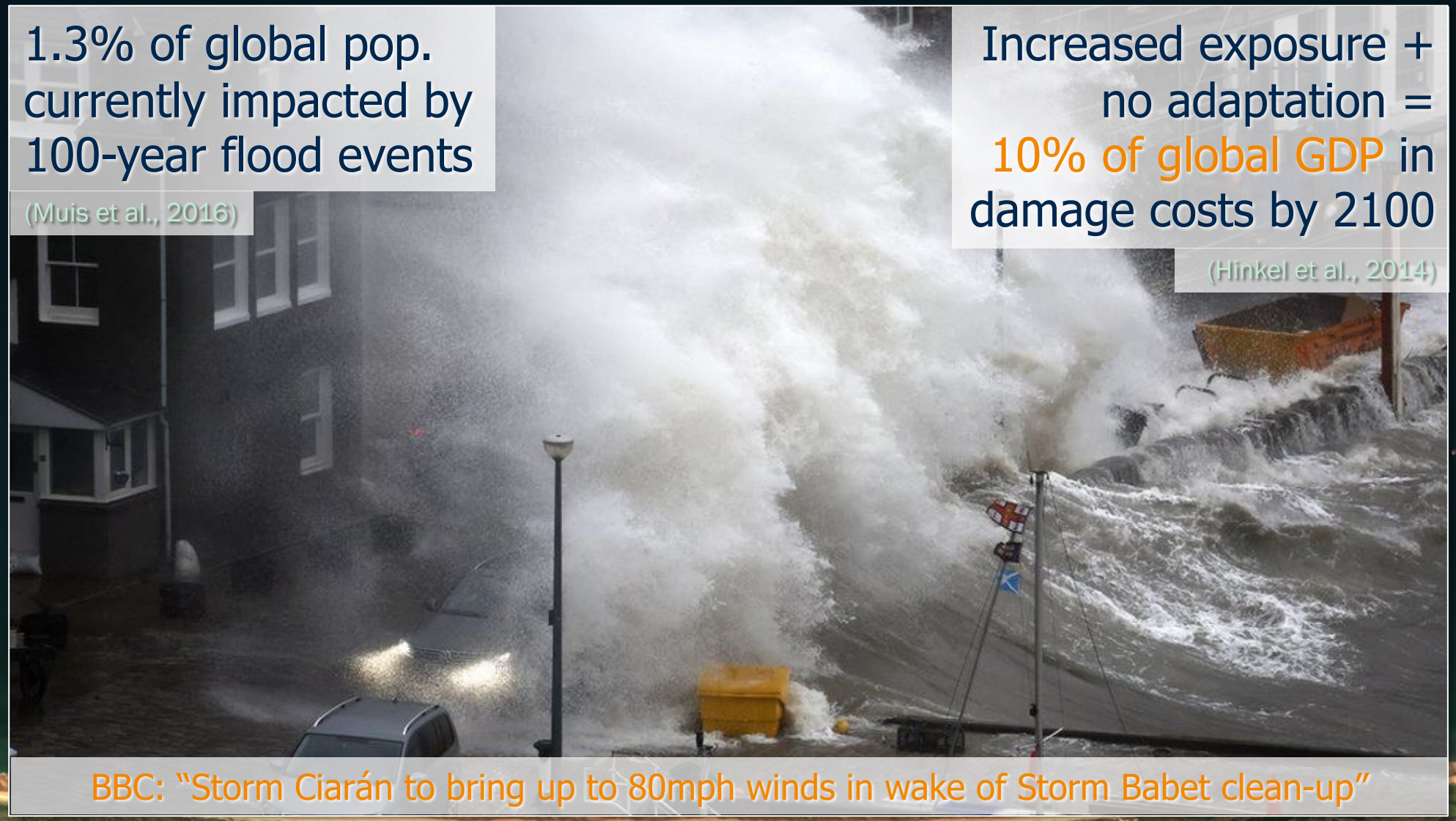
Why is coastal change important to measure?

1.3% of global pop. currently impacted by 100-year flood events

(Muis et al., 2016)

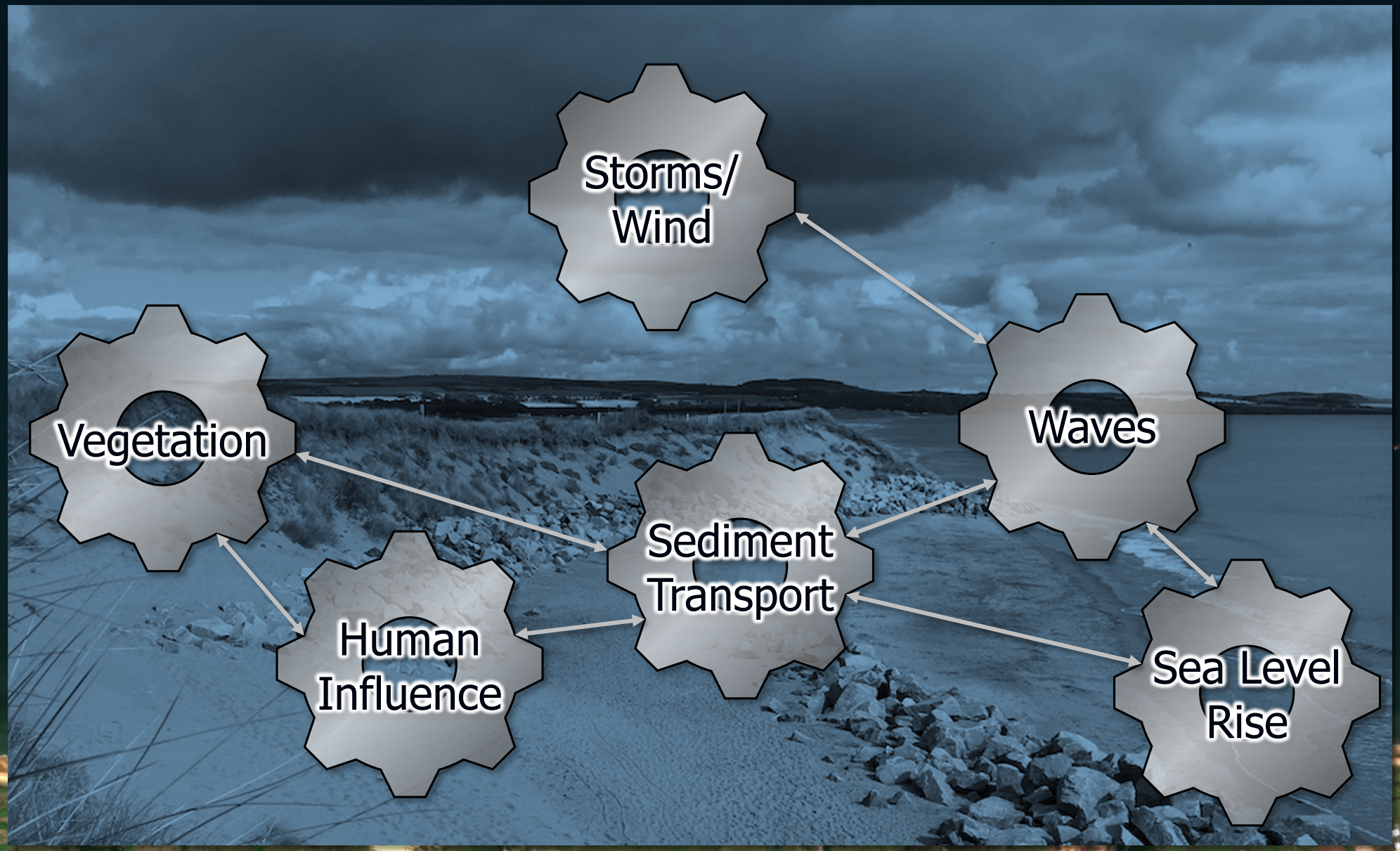
Increased exposure + no adaptation = 10% of global GDP in damage costs by 2100

(Hinkel et al., 2014)

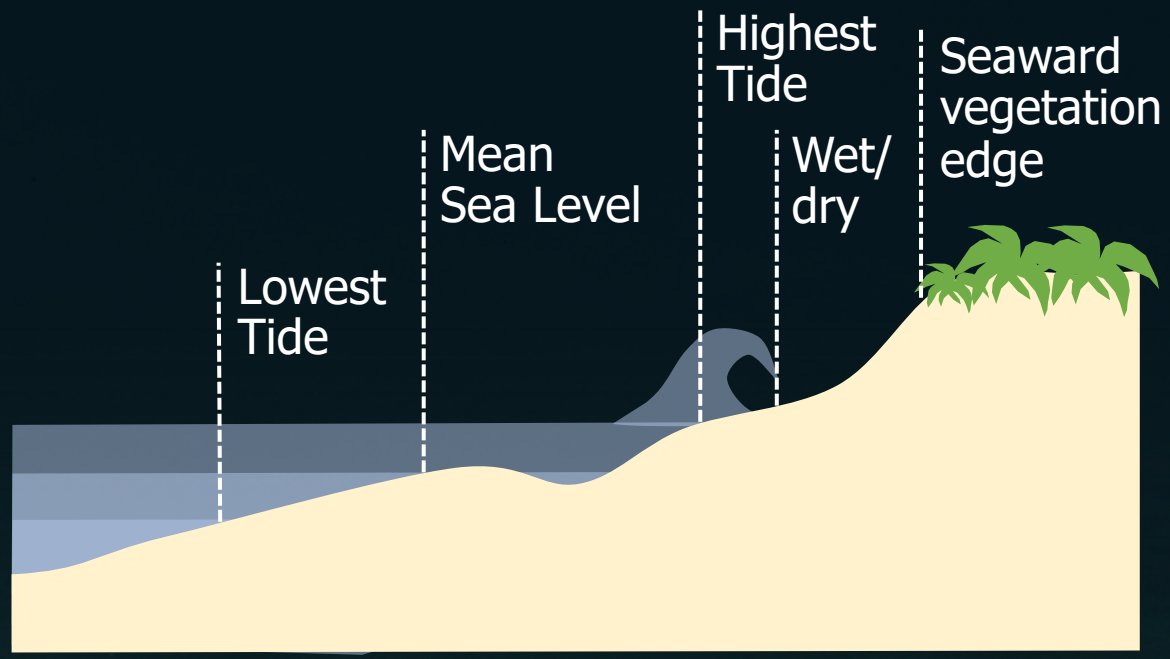


BBC: "Storm Ciarán to bring up to 80mph winds in wake of Storm Babet clean-up"

Why is coastal change important to measure?

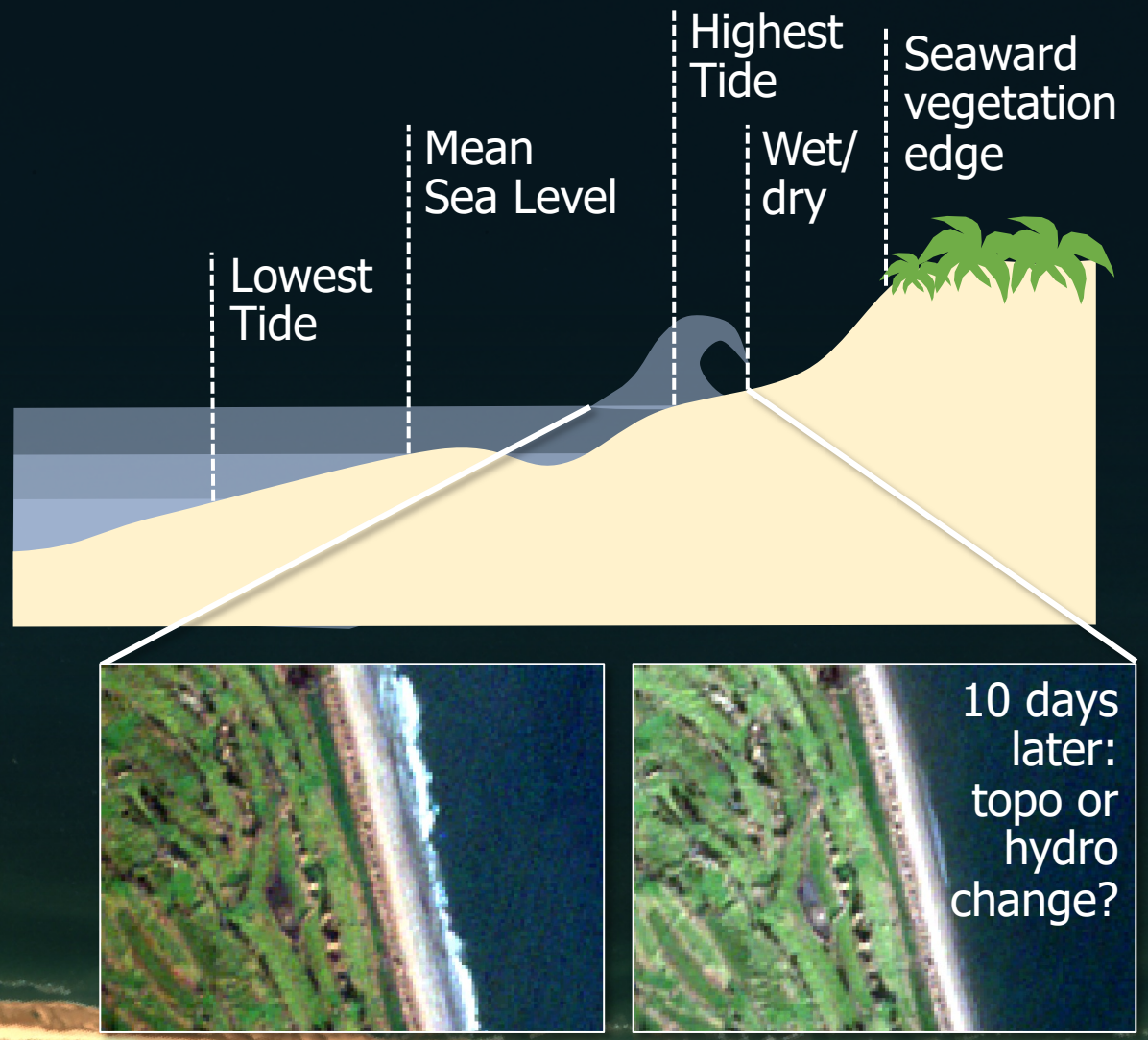


Coastal change indicators: only part of the story?



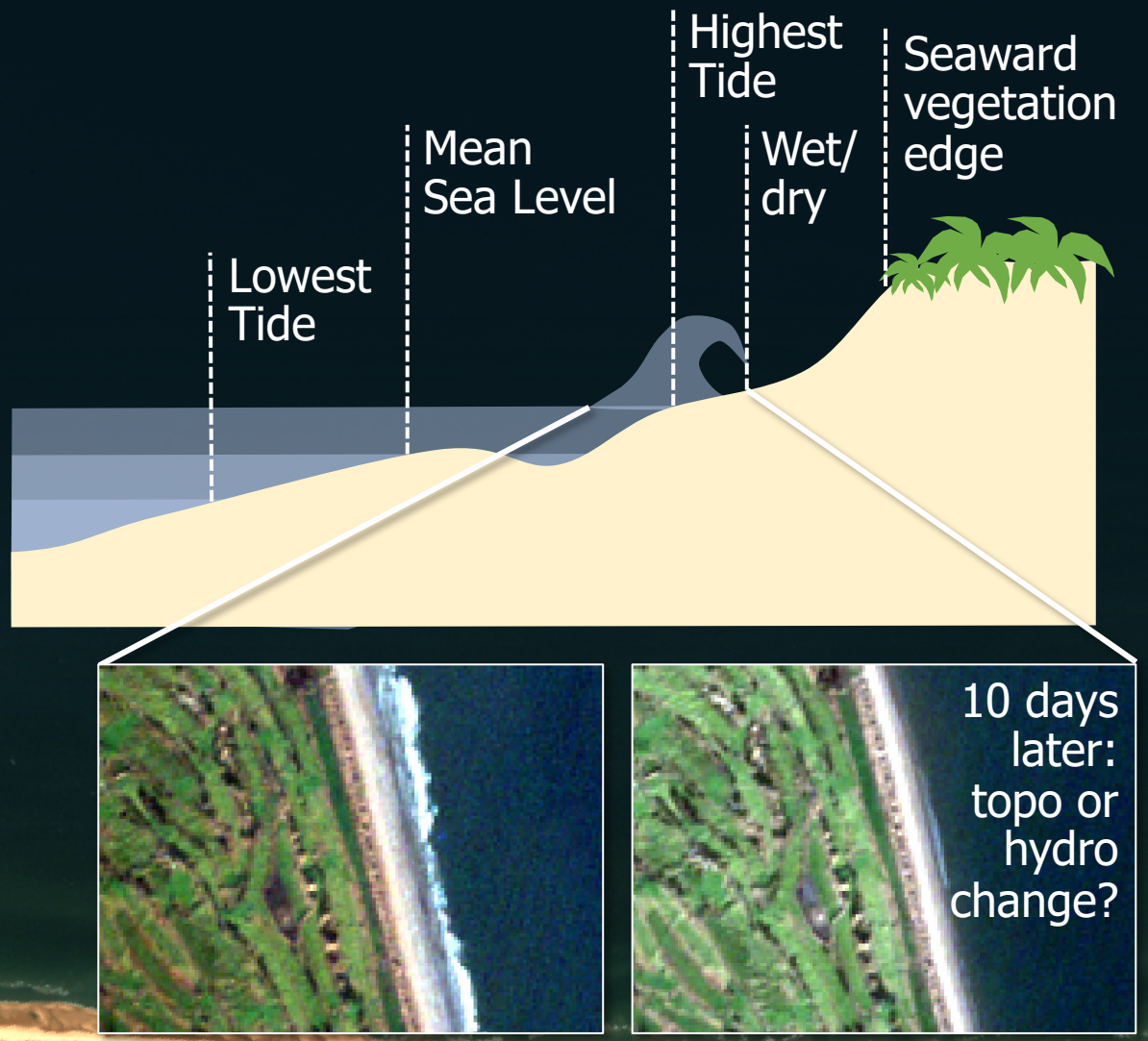
- Instantaneous shorelines (CoastSat, SHOREX, CASSIE)
- Yearly composite shorelines (ShorelineMonitor, HighTide-SDS)

Coastal change indicators: only part of the story?

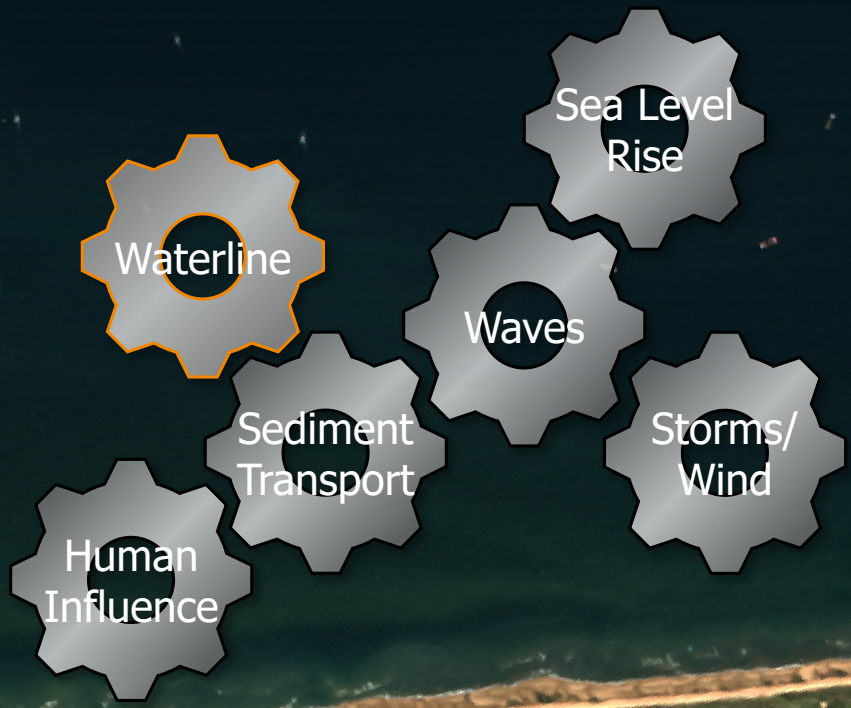


- Instantaneous shorelines (CoastSat, SHOREX, CASSIE)
- Yearly composite shorelines (ShorelineMonitor, HighTide-SDS)

Coastal change indicators: only part of the story?

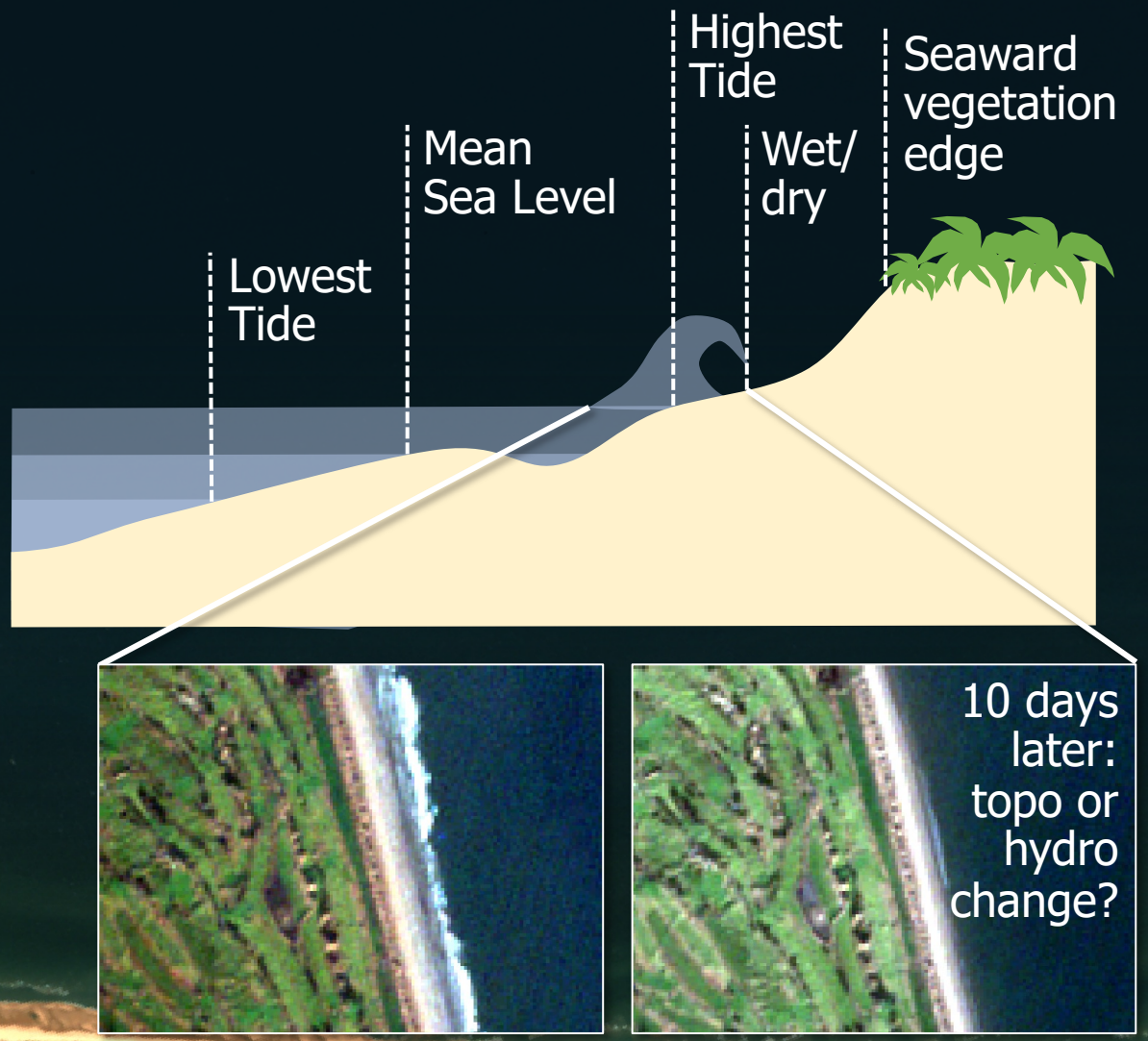


- Instantaneous shorelines (CoastSat, SHOREX, CASSIE)
- Yearly composite shorelines (ShorelineMonitor, HighTide-SDS)

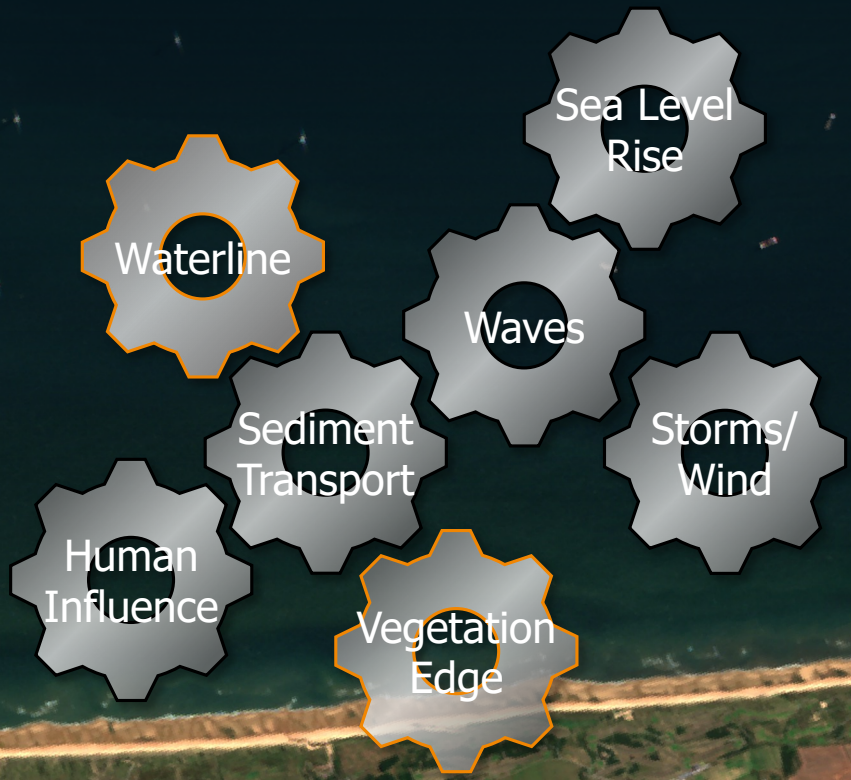


@fme_muir

Coastal change indicators: only part of the story?

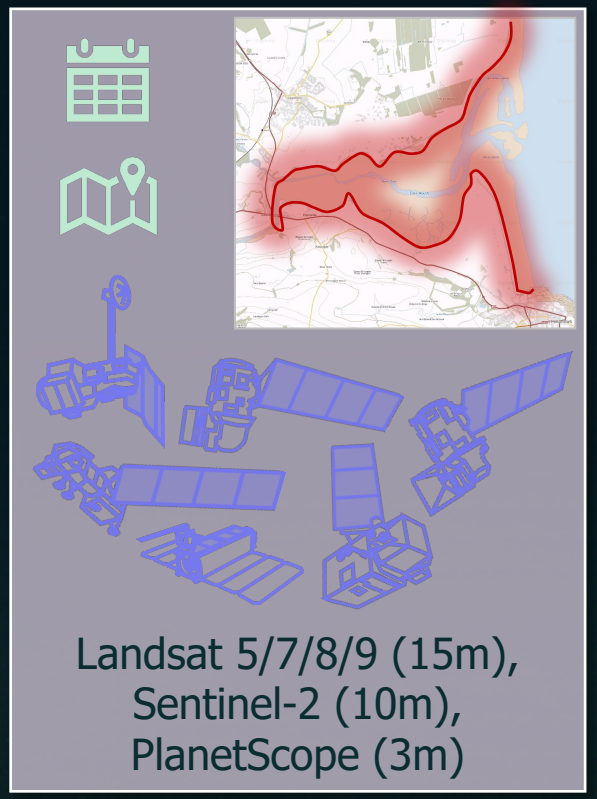


- Instantaneous shorelines (CoastSat, SHOREX, CASSIE)
- Yearly composite shorelines (ShorelineMonitor, HighTide-SDS)



@fme_muir

Watching the grass grow: Framework of VedgeSat



Landsat 5/7/8/9 (15m),
Sentinel-2 (10m),
PlanetScope (3m)

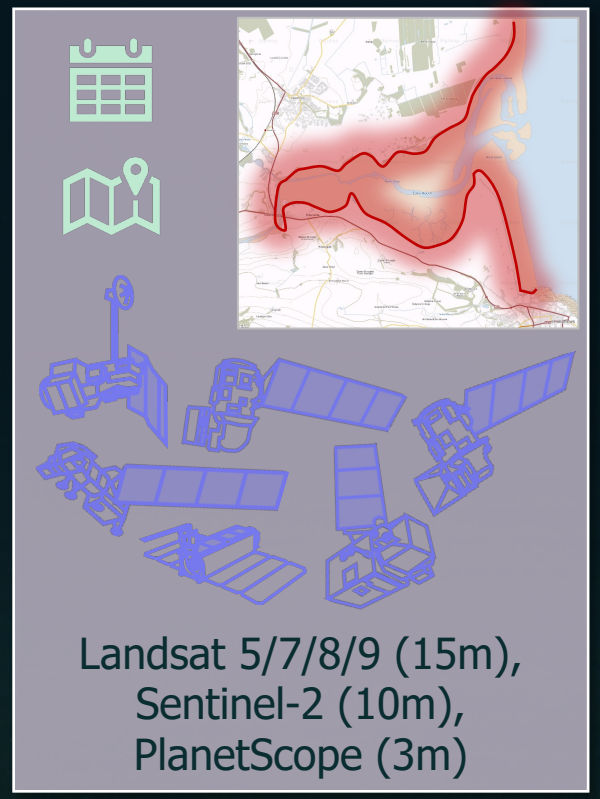
User Requirements &
Satellite Data Collation

Based on CoastSat
(Vos et al., 2019)

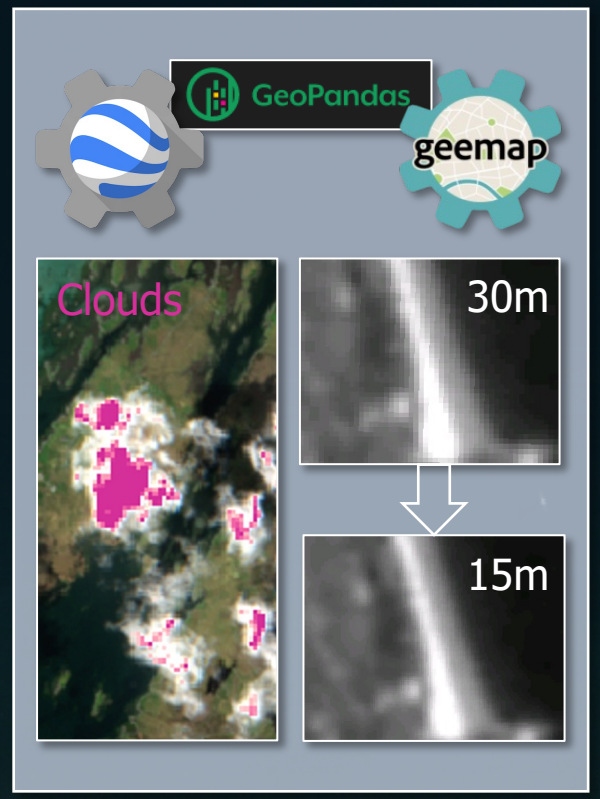
More details on the poster!
Board EP43C-2429, Poster Hall A-C, Thurs 14th 2:10PM–6:30PM

@fme_muir

Watching the grass grow: Framework of VedgeSat



Landsat 5/7/8/9 (15m),
Sentinel-2 (10m),
PlanetScope (3m)



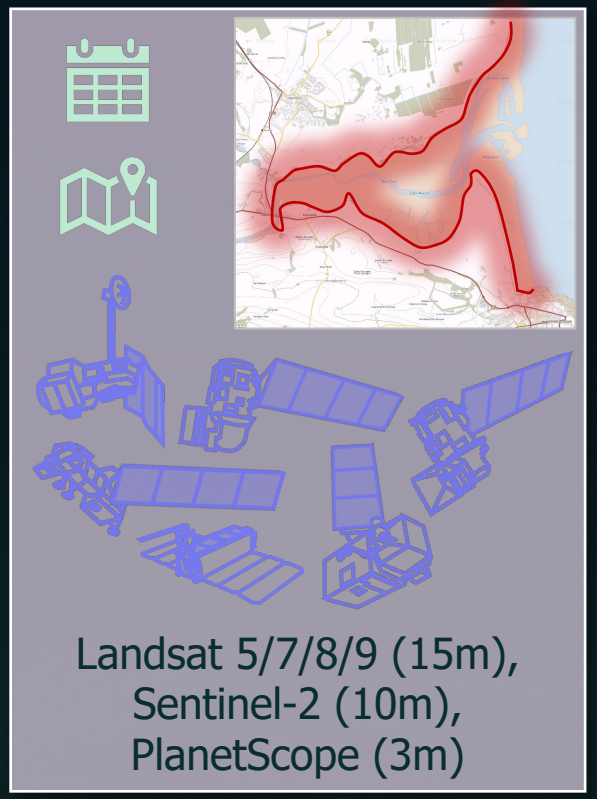
User Requirements & Satellite Data Collation → Image Pre-processing

Based on CoastSat (Vos et al., 2019)

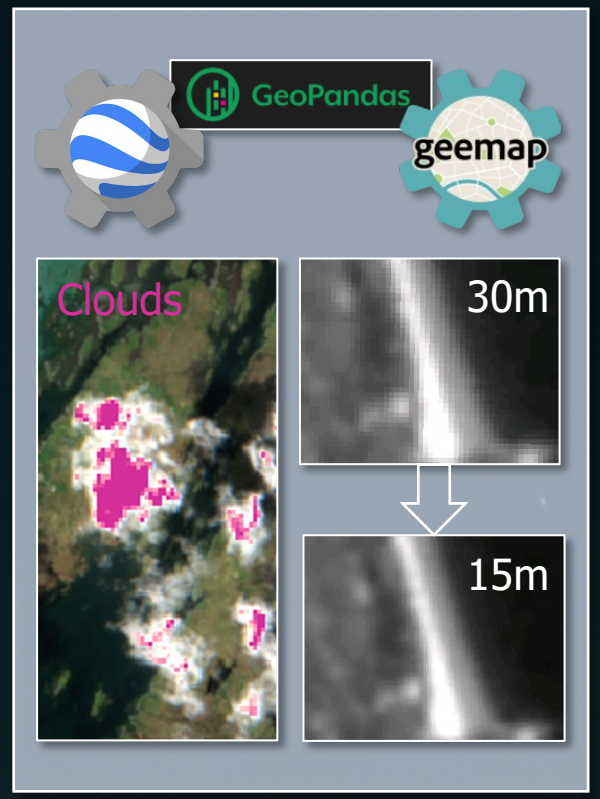
More details on the poster!
Board EP43C-2429, Poster Hall A-C, Thurs 14th 2:10PM–6:30PM

@fme_muir

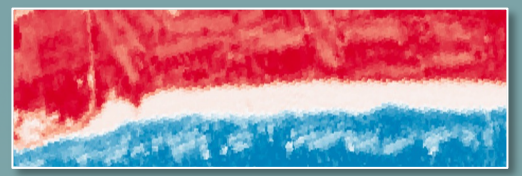
Watching the grass grow: Framework of VedgeSat



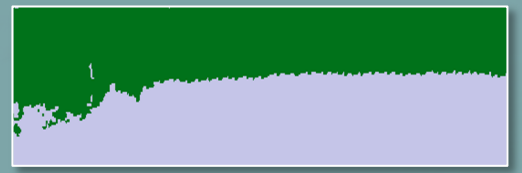
Landsat 5/7/8/9 (15m), Sentinel-2 (10m), PlanetScope (3m)



Multispectral band indices (NDVI, NDWI, RB-NDVI, NGRI, SAVI)



Pre-trained neural network classifies 'veg' and 'non-veg'



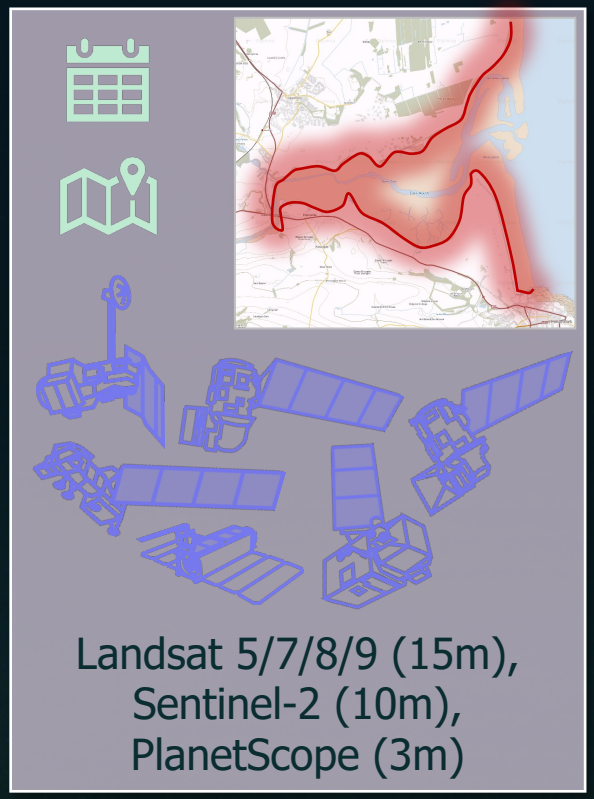
User Requirements & Satellite Data Collation → Image Pre-processing → Neural Network Classification

Based on CoastSat (Vos et al., 2019)

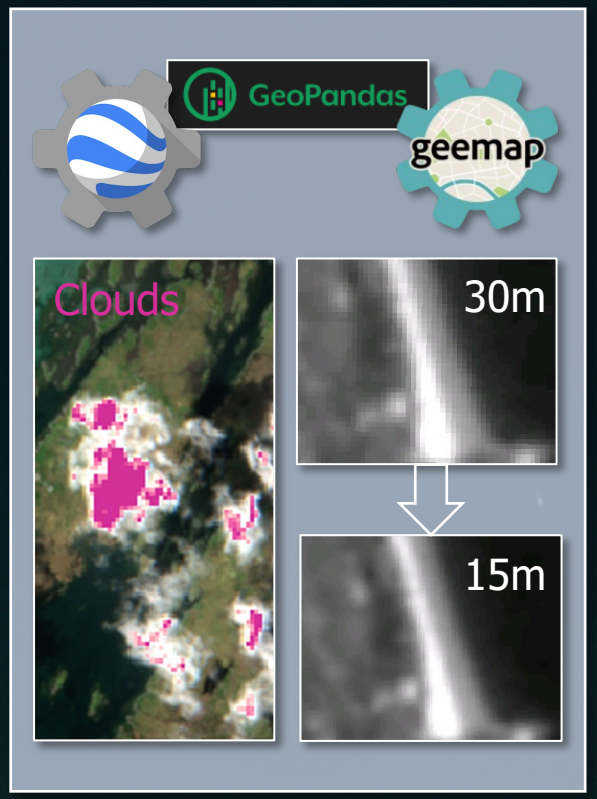
More details on the poster!
Board EP43C-2429, Poster Hall A-C, Thurs 14th 2:10PM–6:30PM

@fme_muir

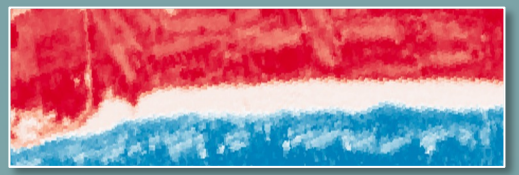
Watching the grass grow: Framework of VedgeSat



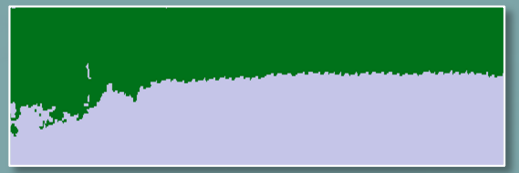
Landsat 5/7/8/9 (15m), Sentinel-2 (10m), PlanetScope (3m)



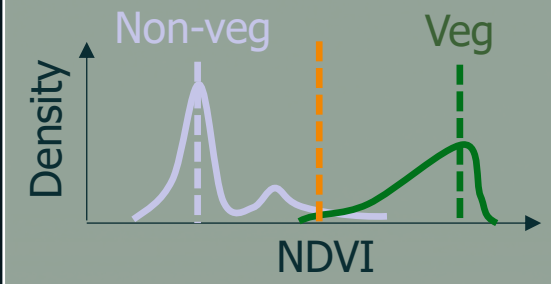
Multispectral band indices (NDVI, NDWI, RB-NDVI, NGRI, SAVI)



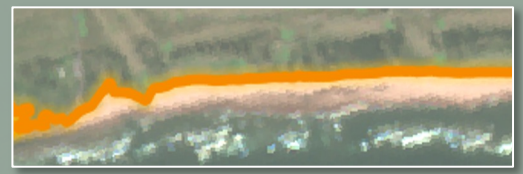
Pre-trained neural network classifies 'veg' and 'non-veg'



Weighted Peaks thresholding



Marching Squares extracts sub-pixel veg edge contour



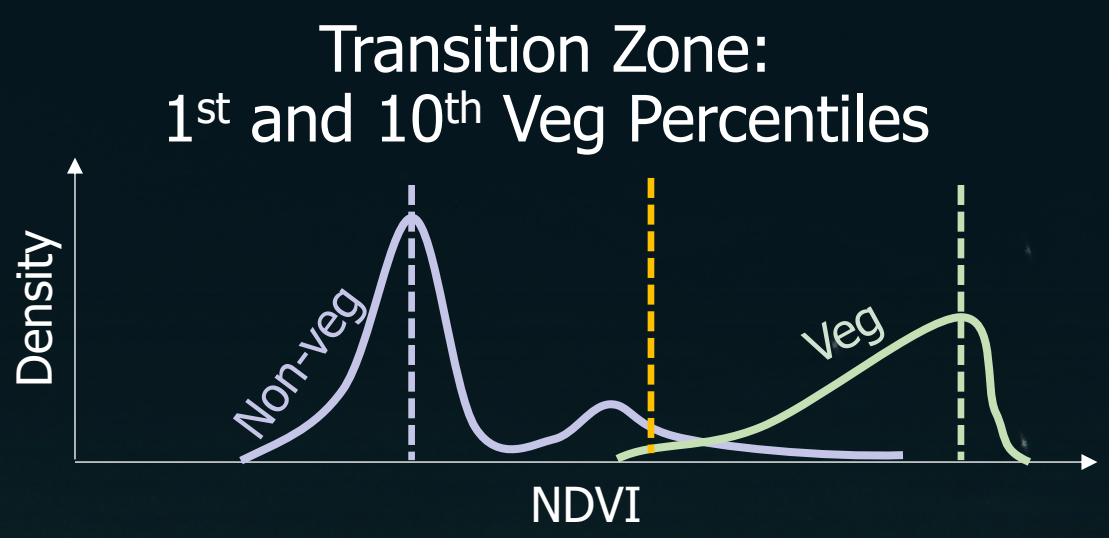
User Requirements & Satellite Data Collation → Image Pre-processing → Neural Network Classification → Sub-pixel Contouring

Based on CoastSat (Vos et al., 2019)

More details on the poster!
Board EP43C-2429, Poster Hall A-C, Thurs 14th 2:10PM–6:30PM

@fme_muir

Watching the grass grow: Framework of VedgeSat

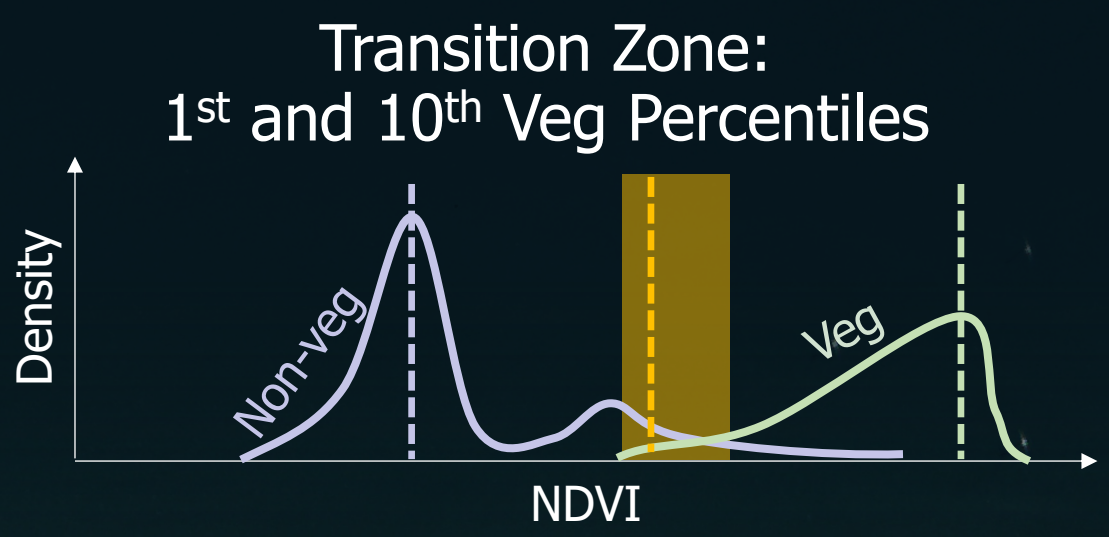


Wider transition zone = diffuse vegetation signal = greater physical resilience?

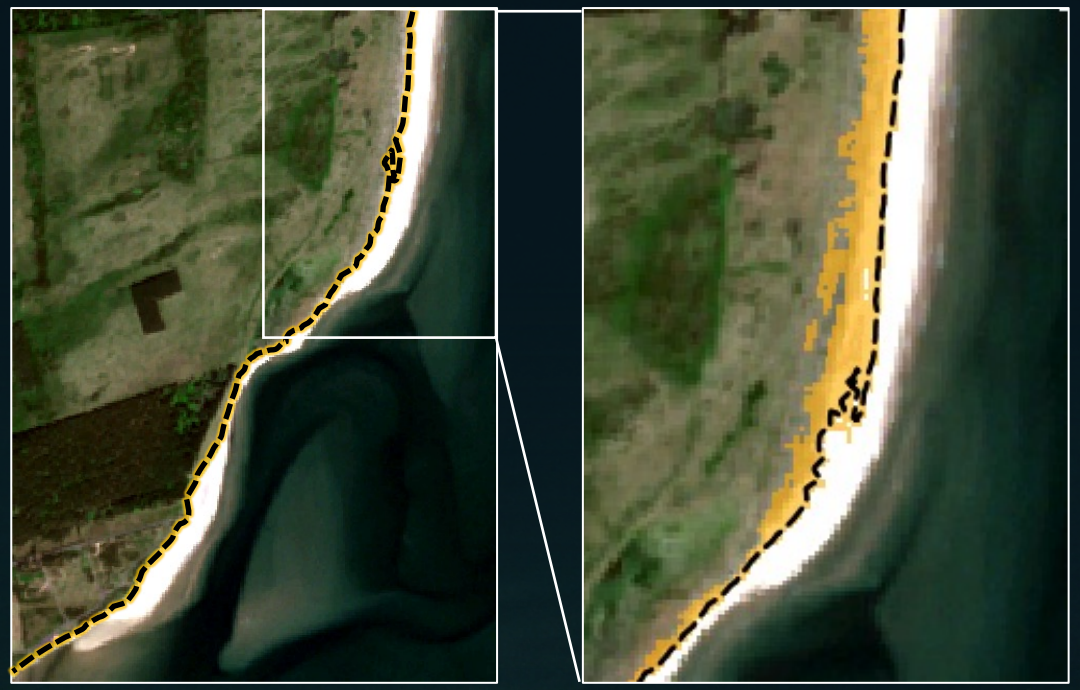
User Requirements & Satellite Data Collation → Image Pre-processing → Neural Network Classification → Sub-pixel Contouring

@fme_muir

Watching the grass grow: Framework of VedgeSat



Wider transition zone = diffuse vegetation signal = greater physical resilience?



User Requirements & Satellite Data Collation → Image Pre-processing → Neural Network Classification → Sub-pixel Contouring

Satellite-derived change indicators

Validation site:

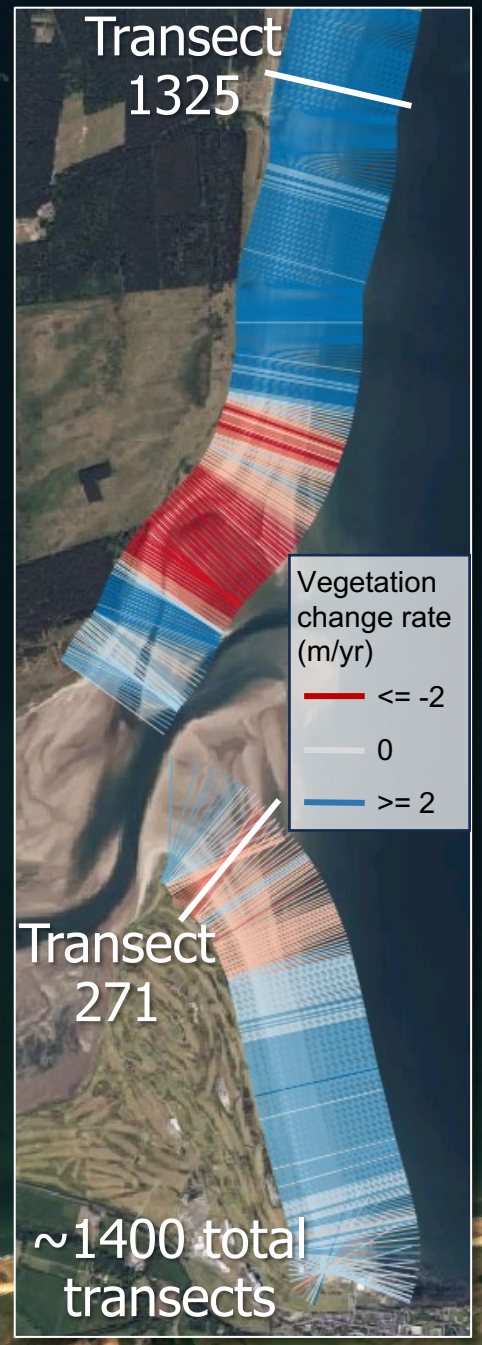
Muir et al., 2023
(in review)

@fme_muir

Satellite-derived change indicators

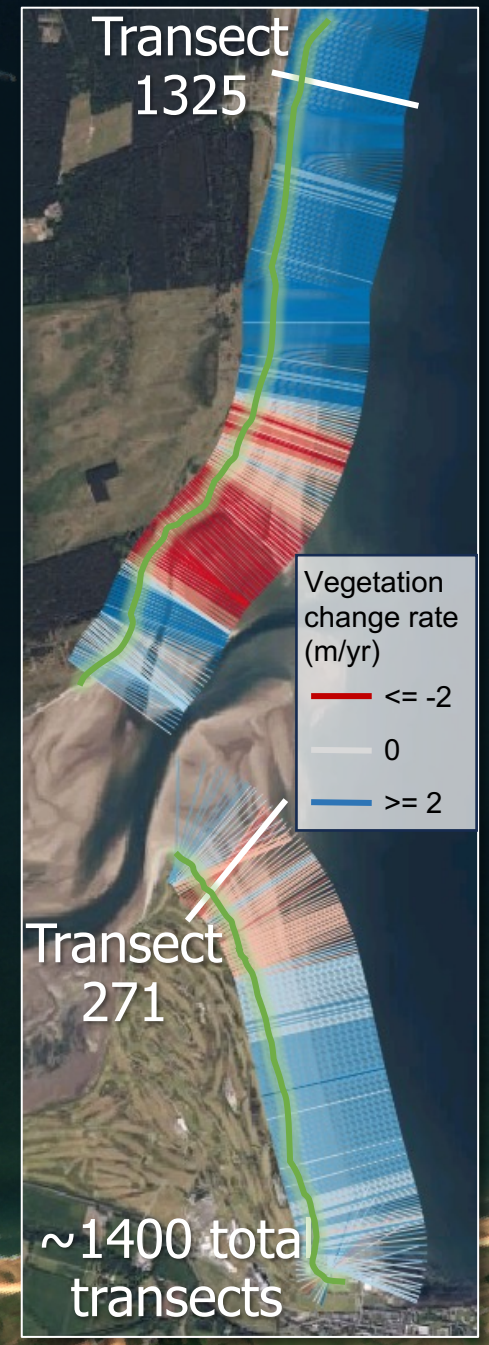
Validation site:

Muir et al., 2023
(in review)



@fme_muir

Satellite-derived change indicators



Validation site:

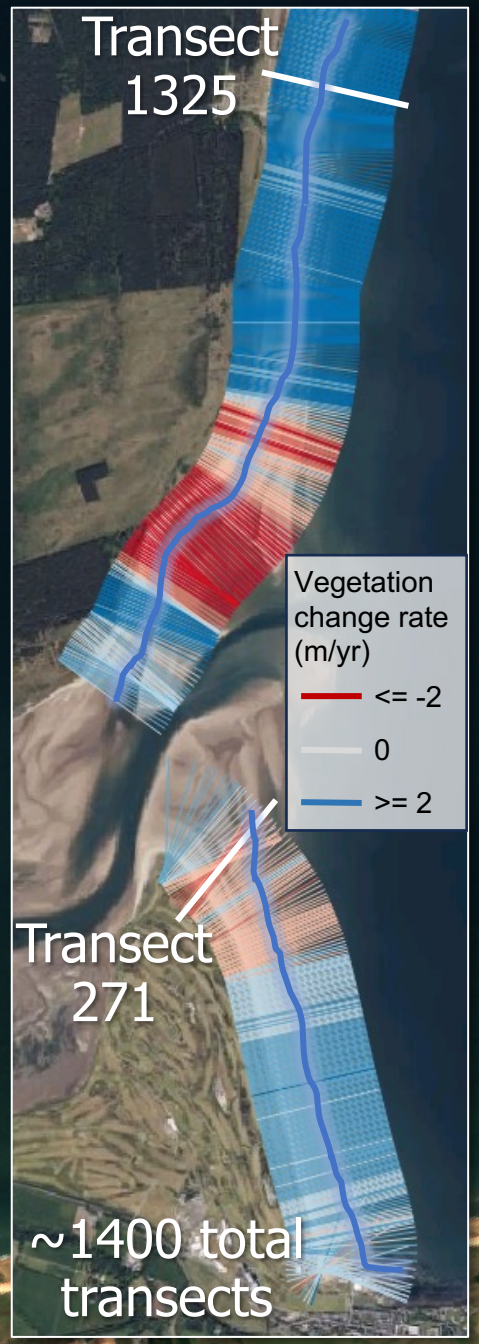
Muir et al., 2023
(in review)

@fme_muir

Satellite-derived change indicators

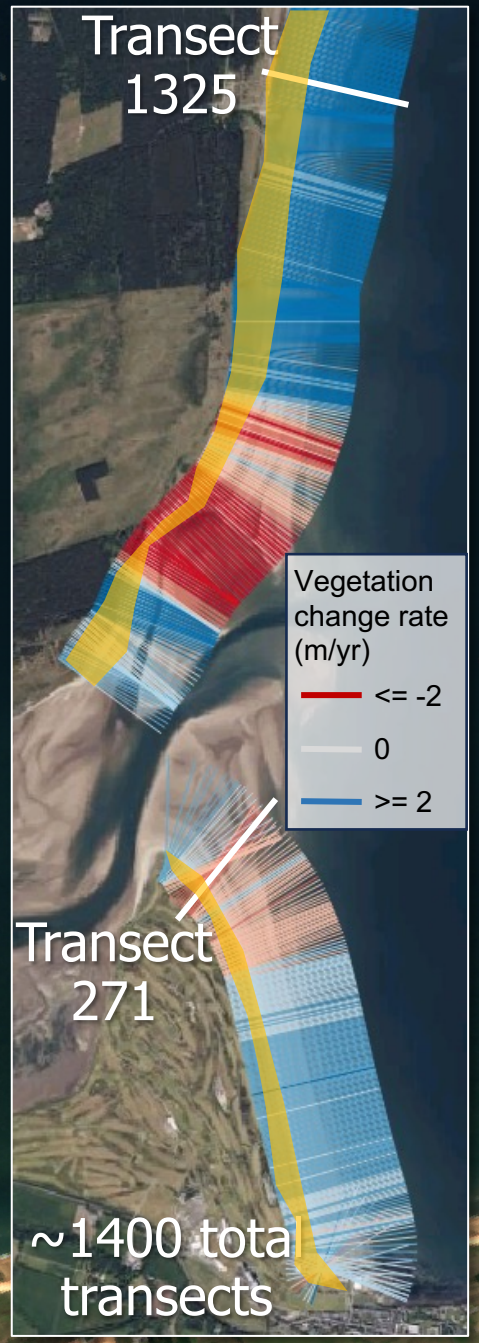
Validation site:

Muir et al., 2023
(in review)



@fme_muir

Satellite-derived change indicators



Validation site:

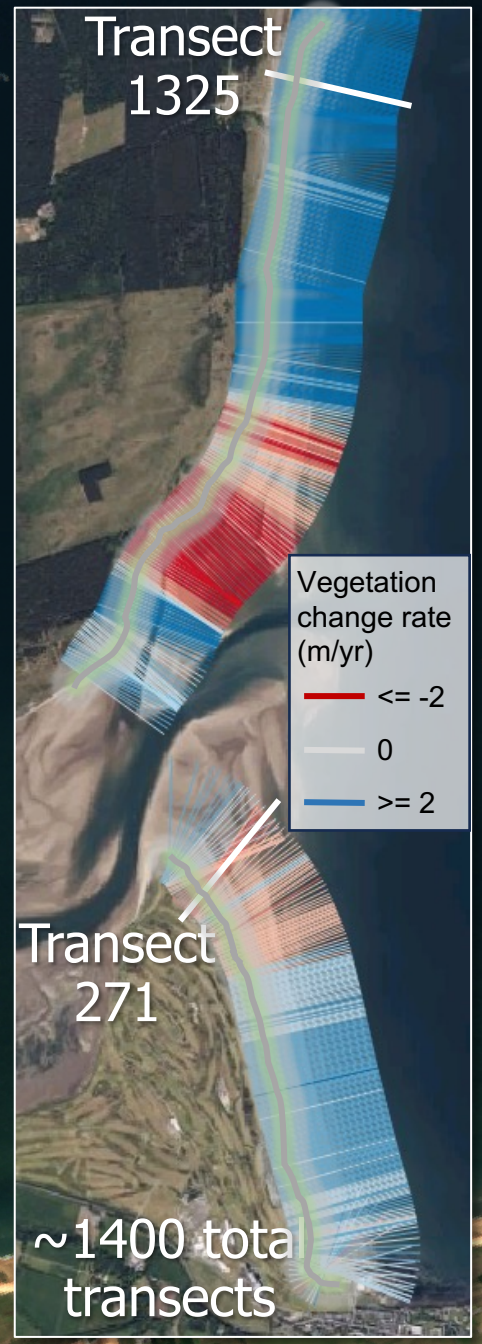
Muir et al., 2023
(in review)

@fme_muir

Satellite-derived change indicators

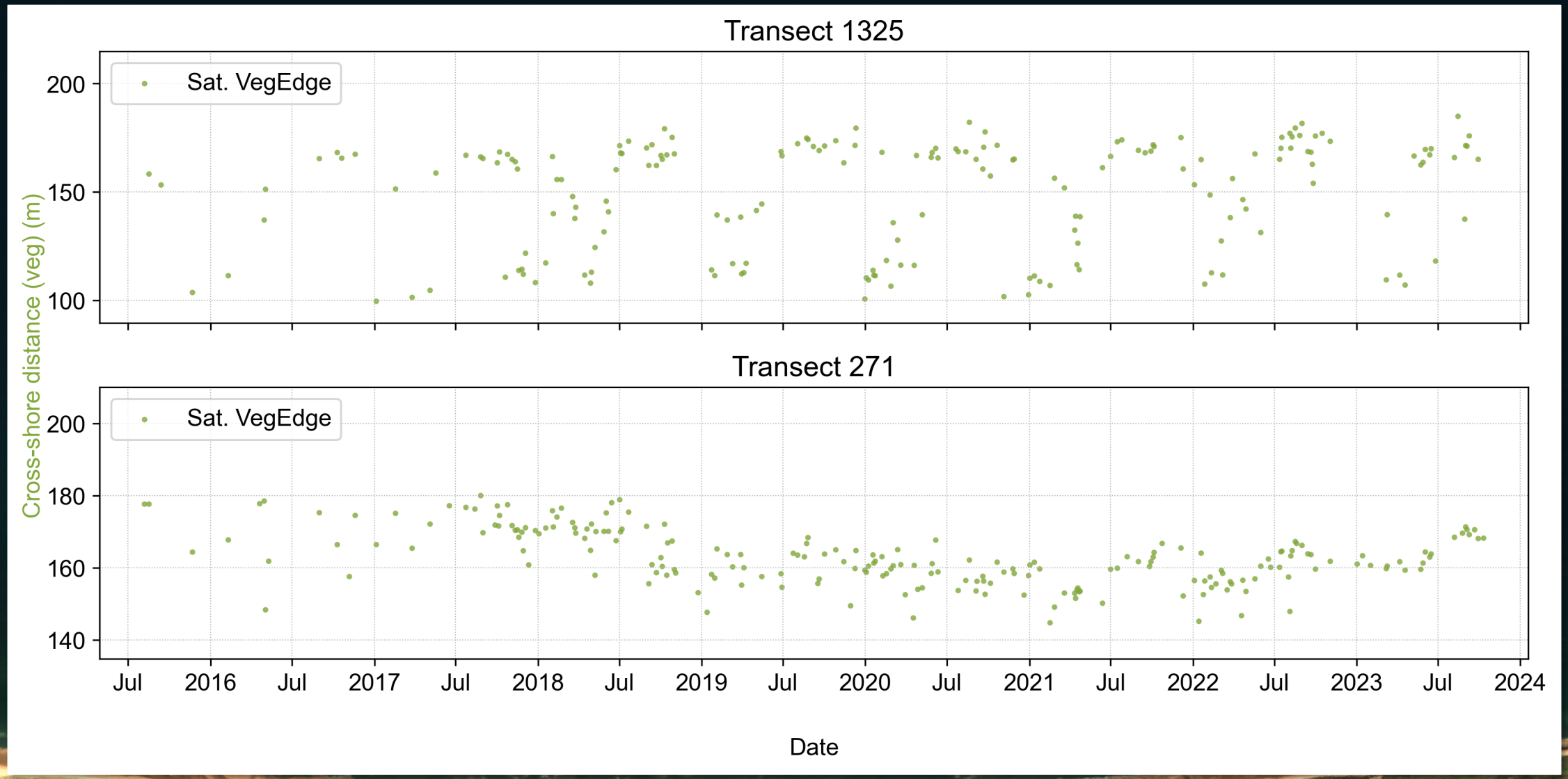
Validation site:

Muir et al., 2023
(in review)



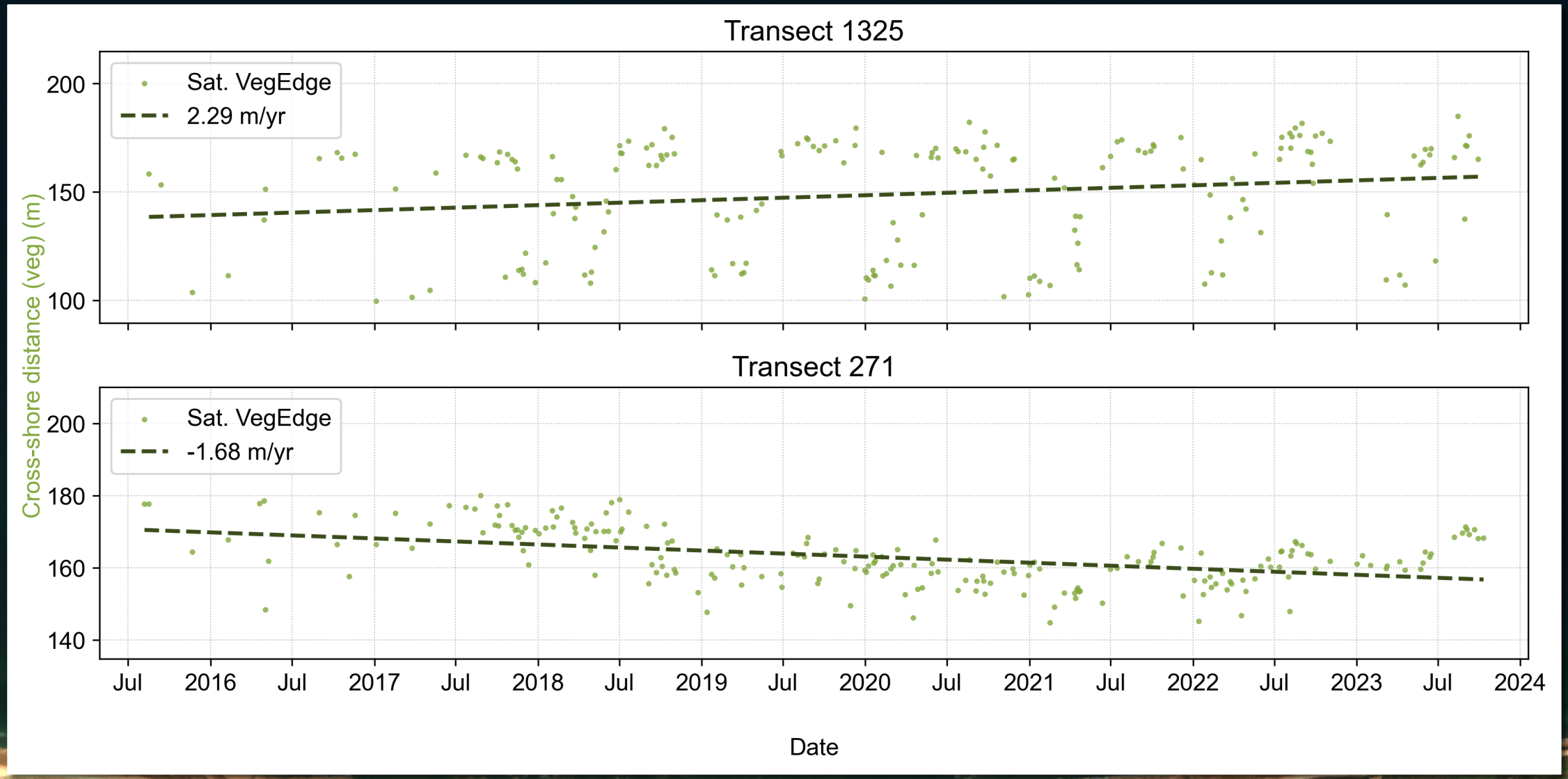
@fme_muir

Cross-shore timeseries as a measure of beach health



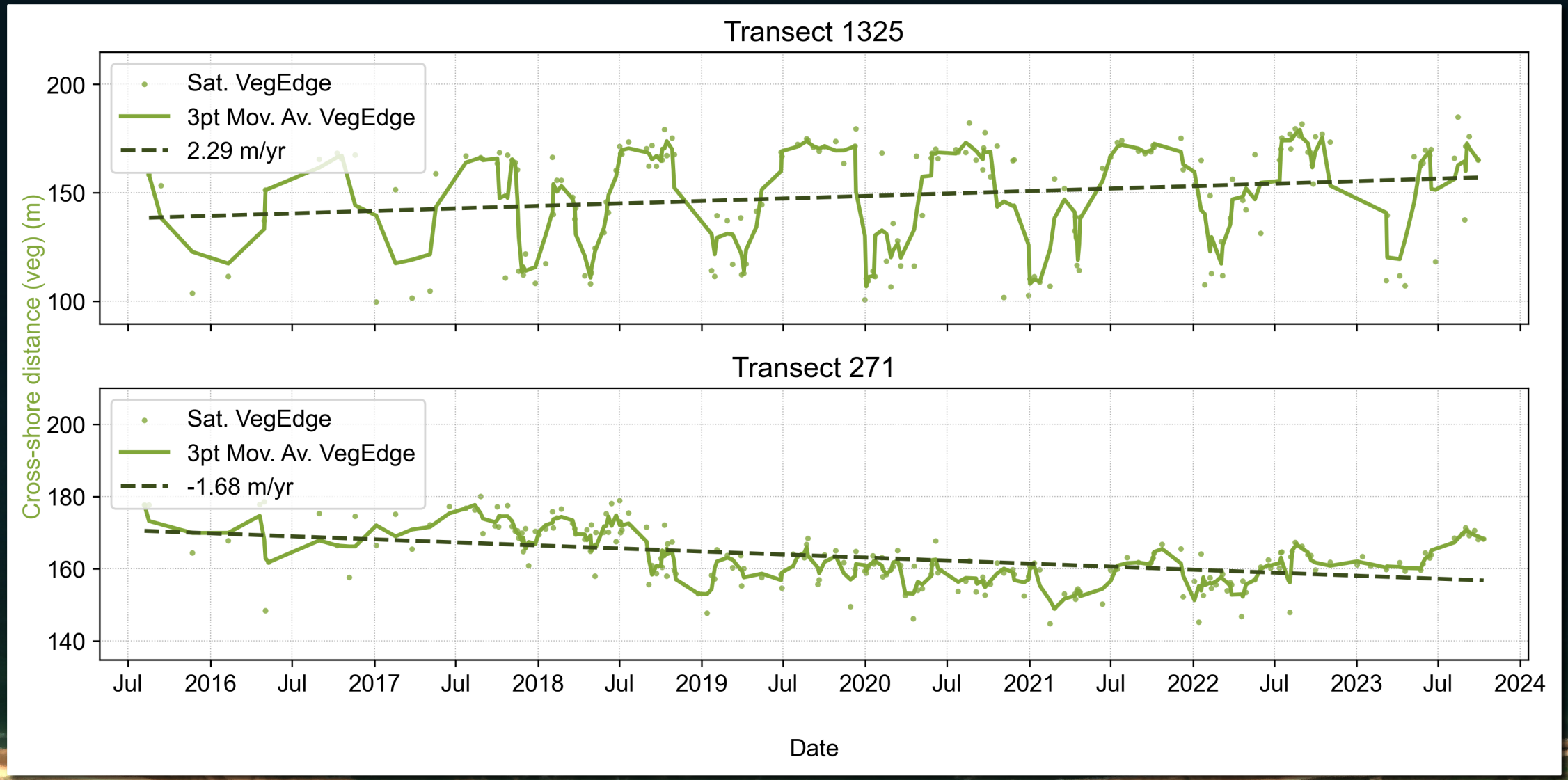
@fme_muir

Cross-shore timeseries as a measure of beach health



@fme_muir

Cross-shore timeseries as a measure of beach health

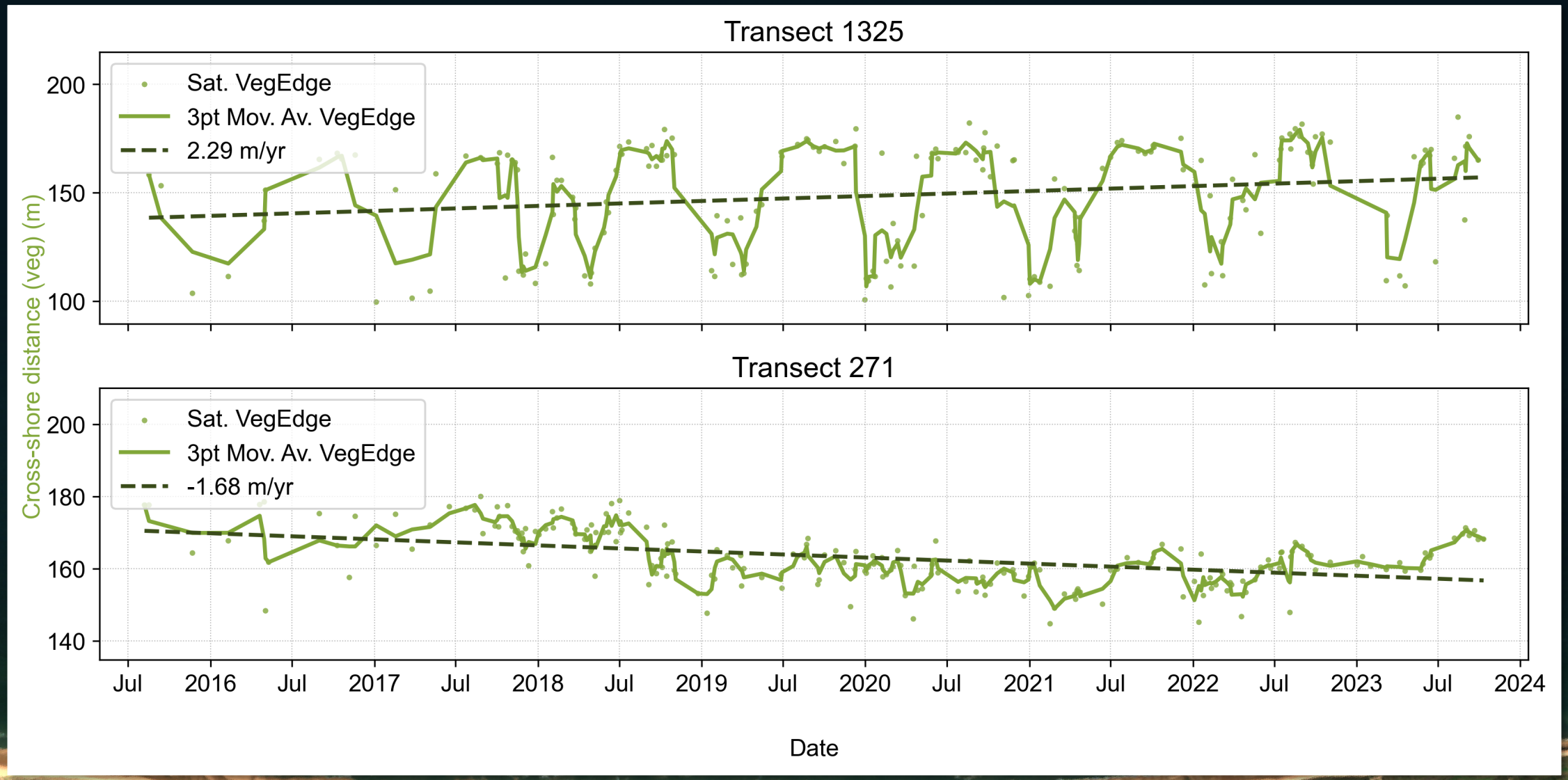


@fme_muir

Cross-shore timeseries as a measure of beach health

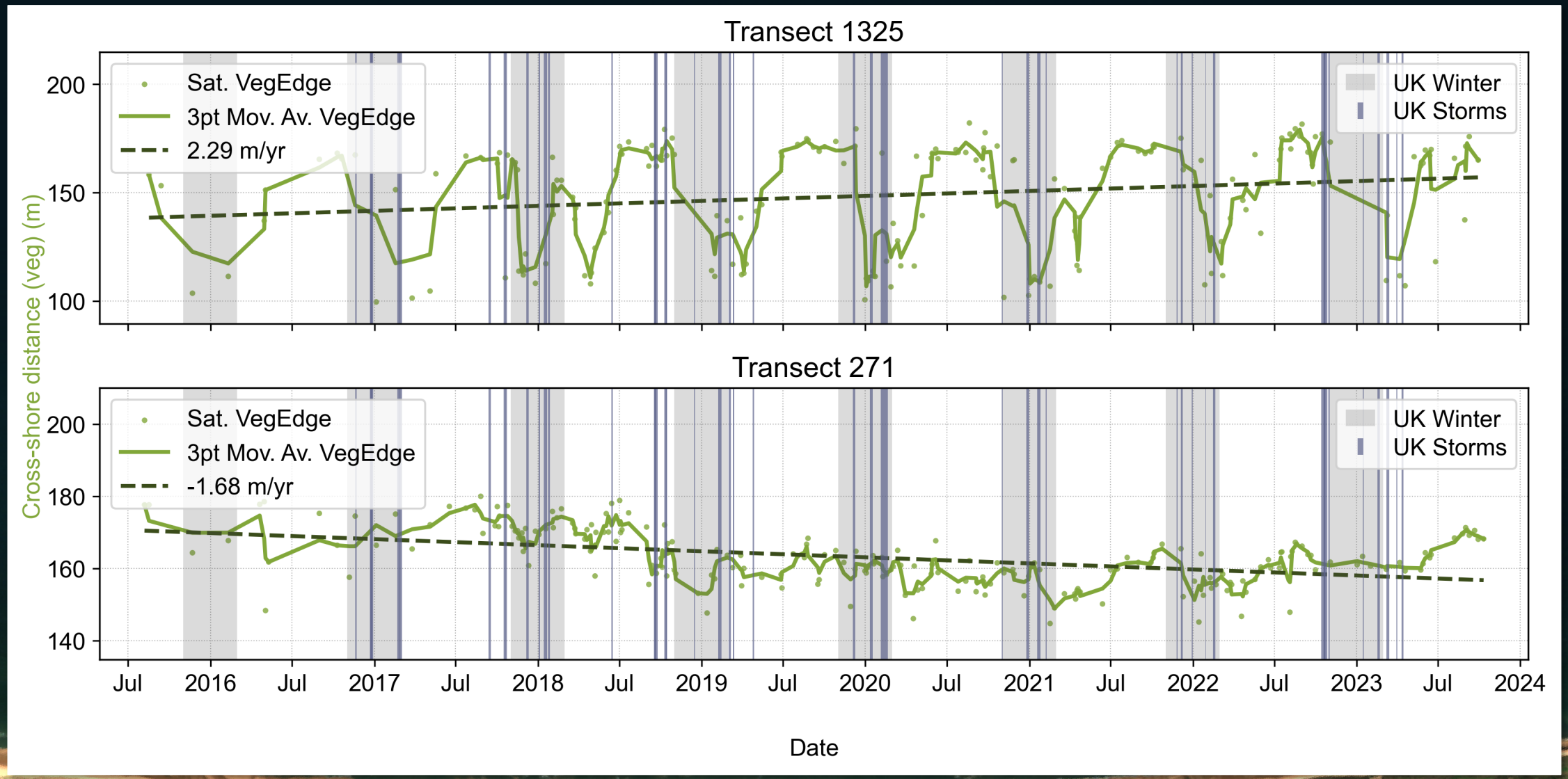
@fme_muir

Cross-shore timeseries as a measure of beach health



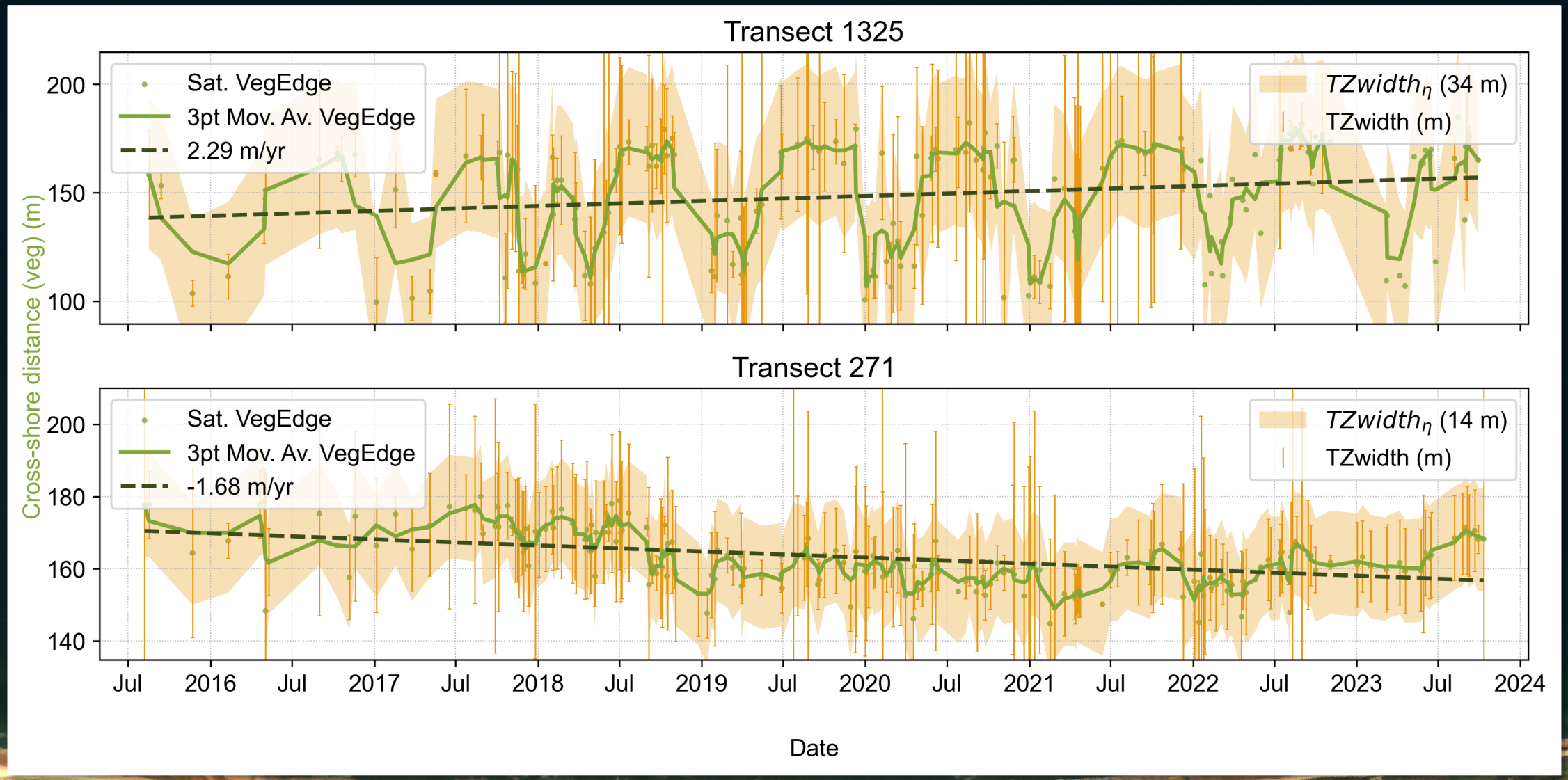
@fme_muir

Cross-shore timeseries as a measure of beach health



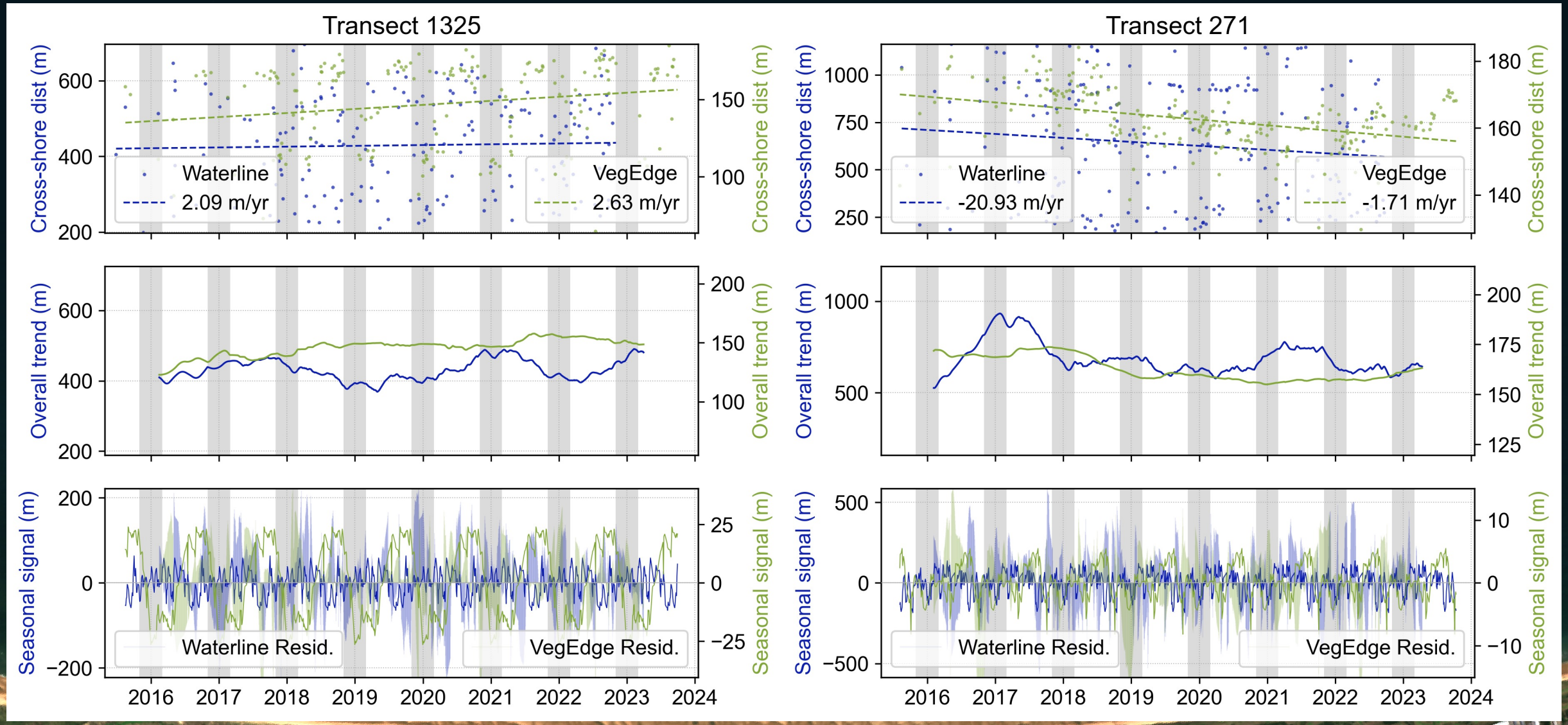
@fme_muir

Cross-shore timeseries as a measure of beach health



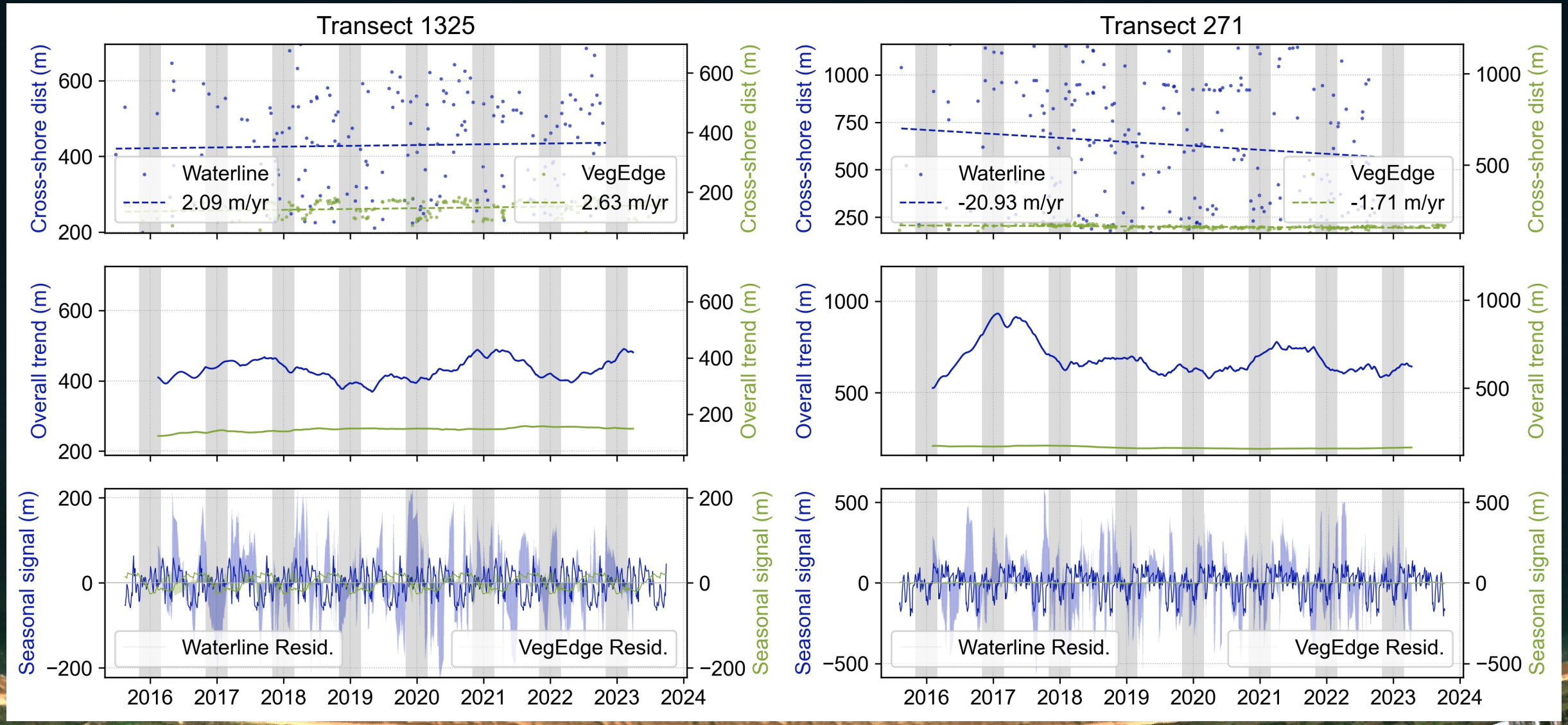
@fme_muir

Trend-informed analysis

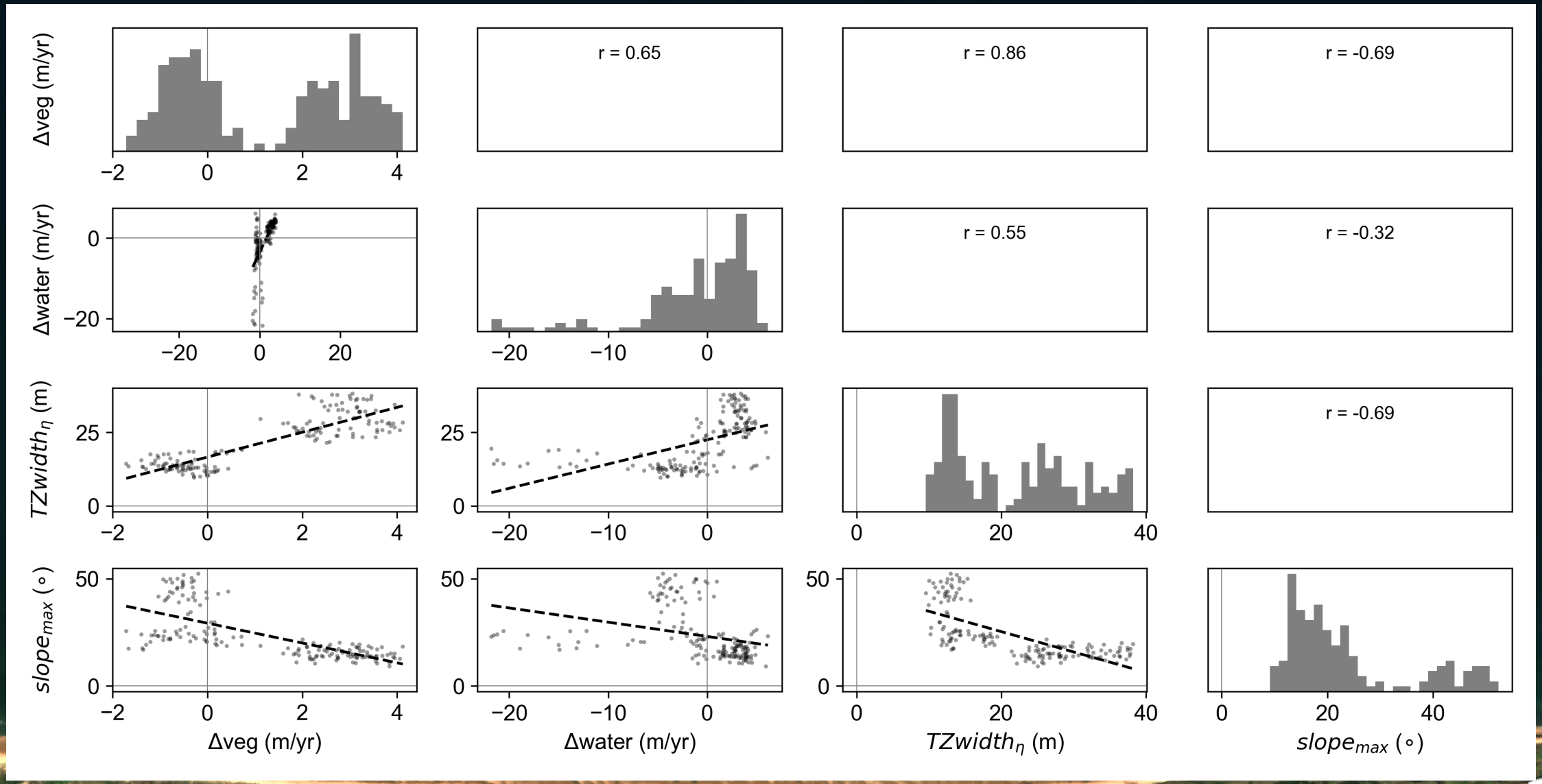


@fme_muir

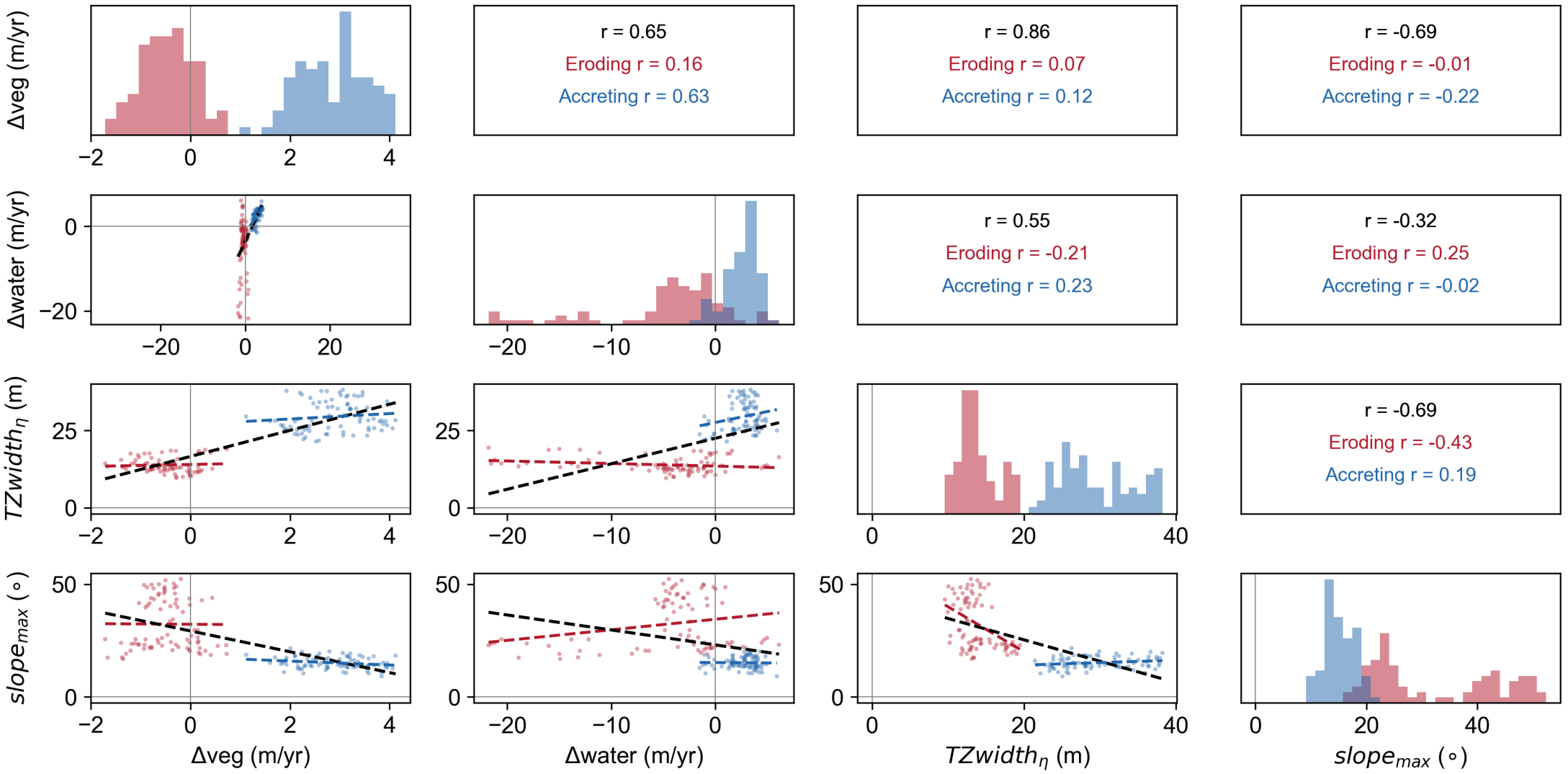
Trend-informed analysis



Multivariate Analysis: Fitting the cogs together

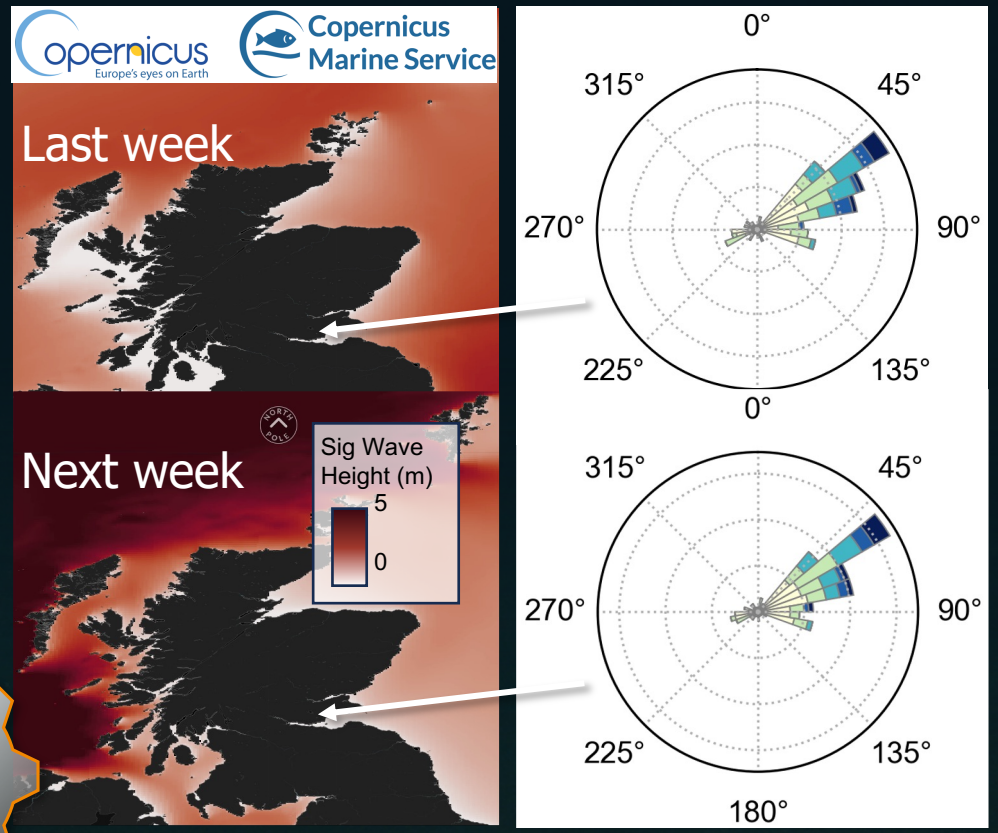


Multivariate Analysis: Fitting the cogs together



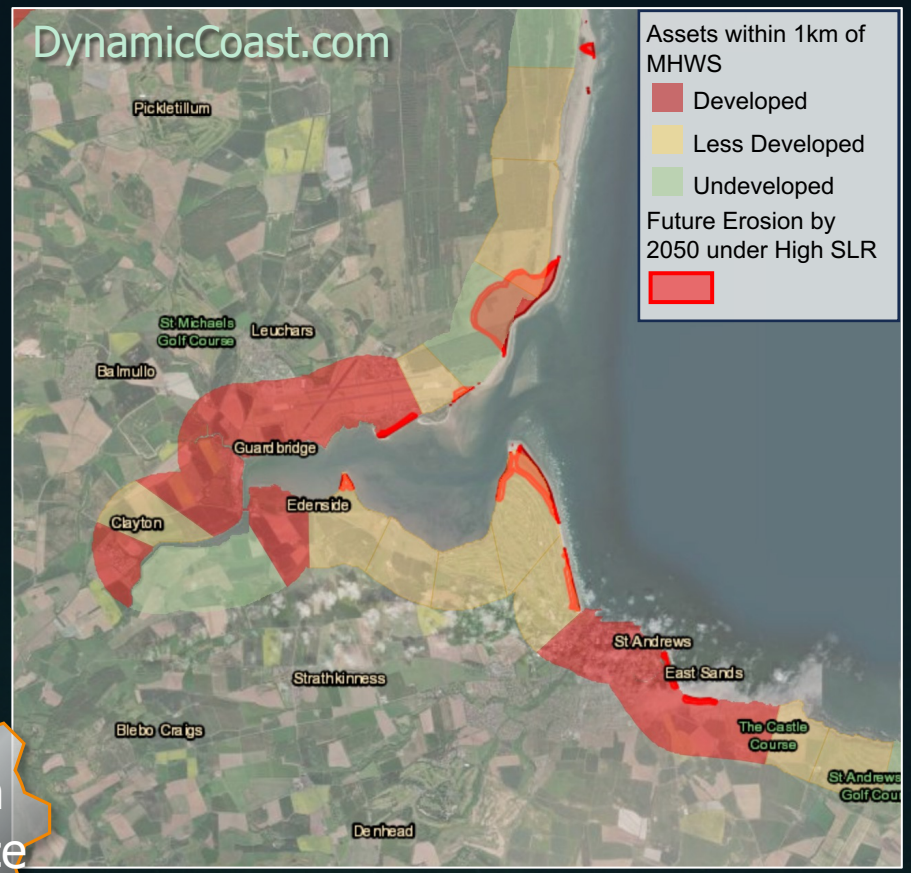
@fme_muir

Future directions



Waves

- Bring in wave data
  - Hindcast analysis of veg vs. wave climate
  - Forecasting of vegetation response using data-driven modelling



Human Influence

- Bring in anthropogenic data
  - Intersecting observed past and modelled future vegetation with coastal assets
  - Natural System Resilience supports Community Resilience

@fme_muir

Big coastal datasets offer novel geomorphic insights

Variability of veg edge much less than instantaneous waterline across macrotidal regions → better indicator of long-term coastal change

Nuanced metrics like the transition zone width offer a measure of coastal geomorphic resilience → helps inform adaptation decisions to improve coastal community resilience

Value of monitoring both veg- and water-based edges; important for practical applications with limits on scope

Thank you!

@fme_muir

linkedin.com/in/freya-muir/

VedgeSat tool (COASTGUARD Github)

References

- Muir, F. M. E., Hurst, M. D., Richardson-Foulger, L., Rennie, A. F. & Naylor, L. A. (2023). Using satellite-derived vegetation edges to quantify coastal change across varied coastal environments. Earth Surface Processes & Landforms [in review].
- Vos, K., Splinter, K. D., Harley, M. D., Simmons, J. A., & Turner, I. L. (2019). CoastSat: A Google Earth Engine-enabled Python toolkit to extract shorelines from publicly available satellite imagery. Environmental Modelling and Software, 122, 104528. https://doi.org/10.1016/j.envsoft.2019.104528