Back to the lab again: How well do proximal aeolian storm records agree?

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Projections of future *storminess* (a term that encompasses both storm intensity and frequency) in the Euro-Atlantic region are conflicting. This uncertainty stems in large part from a lack of data, particularly on pre-instrumental timescales, limiting our understanding of the mechanisms driving natural storm activity. To fill this temporal gap, we turn to aeolian archives like coastal dunes and ombrotrophic peat bogs. Periods with sustained, strong and persistent winds that drive the movement of coastal dunes can be dated using Optically Stimulated Luminescence (OSL). The identified time intervals are however, only snapshots of activity and, due to analytical limitations, often quite broad. A more continuous picture is revealed by looking at changes in the inorganic fraction of peat bogs, where more material and larger grain sizes are deposited during stormier periods.

The nature of storms presents significant methodological challenges – being rare, short-lived and local – and site-specific factors may impact the storm signals at proximal sites and across different archives, even at small spatial scales. The island of Islay in southwestern Scotland provides a natural laboratory to test the reproducibility of storm signals between peat-based reconstructions as well as against dune chronologies. The RSPB1 peat record (~8 ka) has been analyzed for basic peat properties, geochemistry (elemental concentrations and infrared spectral-inferred mineralogy of the inorganic fraction) and grain size. Principal Component Analysis (PCA) of the elemental data suggests that the second principal component (PC2) is representative of elements hosted in coarser size fractions (Si, Ti and Zr). PC2 also shows a high correlation with the inferred quartz content (r=0.7). This coarser endmember is more important 8.0-7.1, 6.2, 3.4-2.7, 2.3, 2.0-1.8, 1.5, 1.2, 0.9-0.8 and 0.7-0.5 ka. These periods all show some increase in grain size which suggests stormier conditions. Interestingly, the opposite is not true: there are periods of increased grain size (e.g., 5.8-4.8 ka) not captured by PC2. There are potential mineral (sand) sources located at nearly all cardinal directions to RSPB1. Given the glacial transport pathways in the area, we expect a quasi NW-SE divide in source signatures. Early characterization of our "NW site" Machir Bay shows coastal dunes there have greater Si and Ti concentrations and grain sizes than our "SW site" the Big Strand (average medians of 275 vs 206 μm, respectively). Thus, the changing relationship between PC2 and grain size may actually reveal changes in wind direction.

We then compare RSPB1 with the Laphroaig storm record located 16 km away just north of the Big Strand (Kylander et al., 2020). The grain size records from these two sites shows remarkably good agreement in terms of the timing, but not the magnitude, of coarser input. This likely stems from sea level and its influence on source supply (i.e., distance to shoreline, accommodation space) early in the records. RSPB1 has more muted signals in more recent times which may be a result of its relatively higher position in the landscape (25 vs 13 m a.s.l.). In comparing these results with our OSL data from Machir Bay and the Big Strand, which date significant dune events to 2.1, 1.5–0.9 and 0.76 – 0.31 ka, we find patchy agreement. We hypothesize that the dune records may show a bias towards more recent and cooler storm periods.

References (format style Heading)

Kylander, M.E., Söderlindh, J., Schenk, F., Gyllencreutz, R., Rydberg, J., Bindler, R., Martínez Cortizas, A., Skelton, A (2020). It's in your glass: a history of sea level and storminess from the Laphroaig bog, Islay (southwestern Scotland). *Boreas 49*, 152-167.