



Centennial record of wind-field variations from a coastal dune (German Bight)

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We show that coastal wandering dunes bear a valuable climate record on time scales of seasons to years and can provide data on past wind-field variations for regions and/or time spans where no instrumental weather observations exist. To access this archive, we propose a combined approach, integrating sedimentological and geophysical methods. Sedimentary architecture and grain-size properties of a 32 m high parabolic dune on the barrier island Sylt (southern North Sea) were investigated using ground-penetrating radar (GPR) and laser-diffraction particle-size analyzer. A chronostratigraphic framework was established based on a series of historical aerial images covering the time period 1936 to 2009. GPR data reveal the internal sedimentary architecture of the dune with an effective resolution of about 0.3 m. Large inland-dipping foresets, being the result of the predominance of onshore winds, form the building block of the dune. The dune exhibits a complex internal architecture comprising numerous unconformities, i.e. gaps in the sedimentary record, slumps, top-lap geometries and shifting depocenters. Therefore, careful mapping of the dunes architectural elements prior to sediment sampling is essential. Grain-size statistics are based on 4900 samples taken equidistantly in a 245 m long trench parallel to the direction of dune movement. Sedimentological proxy data were calibrated using a time series of instrumental weather observations from a meteorological station, 2 km off the dune. These data reach back until the year 1950. Variations in wind speed are best reflected by the sorting of the grain-size distribution: periods of weaker winds result in better sorted sediments, whereas higher wind speeds yield a wider grain-size spectrum. This approach allows us to present a reconstruction of variations in the strength of onshore directed winds covering approximately the last 100 years. Our data show slightly increased wind speeds at the beginning of the 20th century, approx. until 1920, followed by a calmer period until the mid 1930s. Wind speeds in the time period 1935 to 1960 are elevated, comparable to the situation in the first quarter of the 20th century. The mid 1960s are characterized by a distinct increase in wind speed, which stays elevated for the decades afterwards. These results are corroborated by published data on storminess in Northern Europe.