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Contextualization of Holocene beach ridge systems for relative sea-level reconstruction using the SRTM elevation model

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Beach ridge plains are a common feature of prograding coastlines and they have in the past been widely used as geomorphological archives for the reconstruction of past coastal dynamics, event chronologies or late quaternary sea-level change. The most critical parameters for sea-level related research are the consistent definition and confidence of information on surface elevation of the beach ridge deposits.

In most parts of the world, the availability of high-resolution geodata is very limited. The measurement of e.g. high-precision GPS (Global Positioning System) data is costly, time-consuming and essentially of limited spatial coverage. The SRTM (Shuttle Radar Topography Mission) dataset is a freely-available digital surface model covering landmasses between approximately 60° N and 56° S at a 90 m (3 arc seconds) resolution. The model elevations are indicated without decimals (integer) and are projected for the WGS84 ellipsoid.

On a beach ridge plain at Caleta de los Loros, Río Negro, Argentina, we observed a good correlation of GPS-RTK (GPS-Real Time Kinematic) measurements (estimated vertical accuracy: <0,1 m) with the SRTM elevation model along a cross-ridge transect. An average vertical deviation of 0,96 m (SD: 0,48m) between the SRTM and the GPS-RTK-based elevations was determined for mostof the beach ridge transect (79% of length). Larger errors (maximum average error: 2,78 m, SD: 1,88 m) can be explained by eolian deposition and dune migration during the approx. 13 years between the date of SRTM data acquisition and our GPS measurement. This interpretation is supported by a multi-decadal sequence of Landsat false-color composites. Vegetation cover and rounding errors are further possible factors in explaining vertical deviation. The consistency of data quality was confirmed by a comparison study using a LiDAR (Light detection and ranging)-based digital elevation model (vertical accuracy: <0,1 m) to extract surface elevations on an extensive beach ridge plain on the island of Anholt, Denmark. The relatively high accuracy of the SRTM data in near-coastal environments is probably owed to the correction of the original dataset for a fixed value of 0 m along the coastlines of the world (SRTM Water Body Data).

Our findings indicate that, at certain scales, a spatial integration of linear GPS data can be attempted using the SRTM dataset. However, the process must be aided by adequate surface information (e.g. Landsat images from close to the date of SRTM acquisition). The fixed reference datum allows a contextualization of distant field sites and thus can help to reduce bias measurement and interpretation. In our case, the SRTM data set has proven to be a valuable tool for the preparation of field work and facilitated a more accurate appraisal of the Holocene marine sedimentary record.