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Internal architecture of foredunes and their dynamics resolved by GPR (Regneville inlet, Normandy, France)

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Foredunes are the foremost dunes formed on the backshore of beaches by aeolian sand deposition trapped by vegetation. They are classical large scale features that develop along a large part of sandy coasts of the world. There are many papers covering various aspects of foredune (initiation, evolution, dynamics) but their internal architecture which reflects their dynamics is still not well known.
Active and relic foredunes from the Regneville inlet have been surveyed with Ground Penetrating Radar (GPR). GPR is a non-invasive geophysical method based on high frequency electromagnetic wave propagation which can provide very detailed and continuous images of the subsurface. One of the goals of GPR measurements is to determine the geometries of fine structures by imaging the structures of sedimentary deposits. The GPR profiles have been obtained by using the 100, 250, 500 and 800 MHz shielded antenna and the acquisition mode was a constant offset. Direct field observations (natural outcrops and trenches) along modern foredunes during different hydrodynamic conditions complete their sedimentary/architectural characterization and bring a strong control for the interpretation of the GPR profiles. GPR allowed here to identify buried erosional surfaces and depositional stratifications. A conceptual model developing their formation and evolution can then be proposed: it starts with a phase of wave erosion followed by a more complex phase of eolian sand accumulation (vertical aggradation, lateral accretion).
Shore-perpendicular GPR profiles reveal that the internal architecture of foredunes is marked by several sharp and seaward concave truncations which correspond to ancient marine scarps. They are the result of the erosion by waves of a foredune during storms or high-tides. Some of these scarps can be detected from the geomorphology (steps in the topographic profile, change in vegetation type), others not because they are sealed by blown sands accumulation (smoothed topographic profile). Scarp erosion is followed by the seaward rebuilding of a new foredune. Aeolian sands accumulate back of the crest of the scarp. At the foot of the scarp, an embryo-dune forms, growing in pioneer vegetation on the uppermost beach. Progressively, an incipient dune develops onto the scarp, fills it and give then birth to a new foredune.