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Evidence for Widespread Eolian Activity in the Coastal Plain Uplands of North and South Carolina Revealed by High-Resolution LiDAR Data

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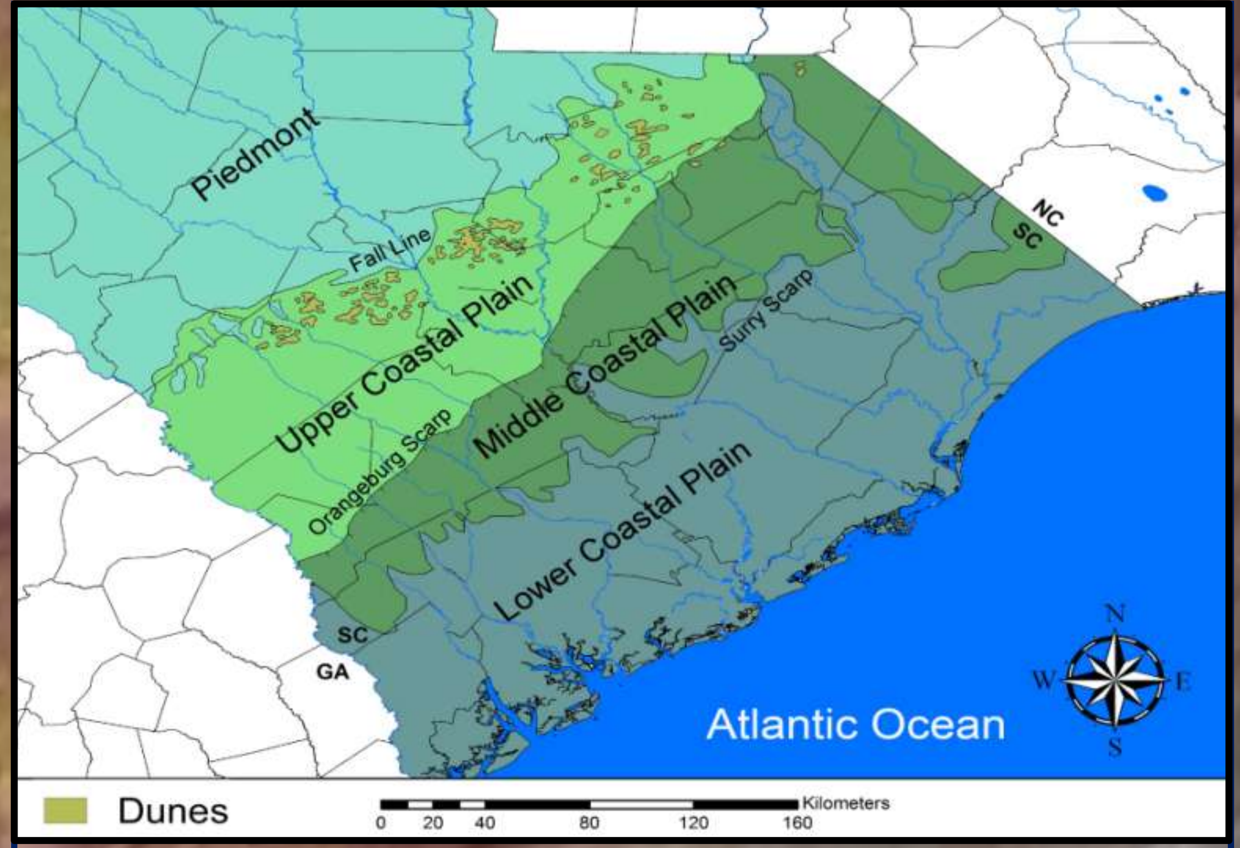
Abstract

High resolution LiDAR (Light Detection and Ranging) elevation data have been available in North Carolina for several years and were produced by the North Carolina Floodplain Mapping Program (http://www.ncfloodmaps.com/) in response to Hurricane Floyd in 1999. Since that time, South Carolina has initiated a Statewide LiDAR Consortium where individual counties working with state and federal agencies have produced LiDAR data for participating counties. These data are now becoming available to researchers and offer potential to investigate large-scale, low-relief geomorphic features not visible or easily recognizable prior to the collection of LiDAR data.

An analysis of LiDAR data for various coastal counties in North Carolina along with areas recently made available in South Carolina have revealed visual evidence for widespread and large-scale (i.e., kilometers long) eolian activity in the Coastal Plain uplands. These generally low-relief geomorphic features include large swaths or ribbons of coalescing parabolic dunes, transverse or nested parabolic dunes, flat blowout regions near the point of dune origin, and hummocky terrain typical of eolian geomorphic features. Although dune topography in the Coastal Plain has been recognized and mapped prior to the development of LiDAR, these deposits appear to represent an under-recognized or at least under-appreciated geomorphic feature within many areas of the Coastal Plain of North and South Carolina. Eolian features appear associated with dominant westerly winds within flat upland regions of the Coastal Plain and often originate from incised upland terraces and incised headwater regions of small upland feeder streams. As such, eolian deposition may be linked to periods of downcutting and fluvial incision—providing a sand source for eolian remobilization downwind of incised terraces and streams. These dunes, although likely Pleistocene in origin, have implications for archaeological sites in the Coastal Plain uplands where limited Holocene reworking of a plentiful sand source may have contributed to site burial and preservation. Future work should focus on ground truthing these features to verify an eolian origin along with the application of luminescence (OSL) dating to determine the timing of eolian events and linkages to regional paleoclimate data.

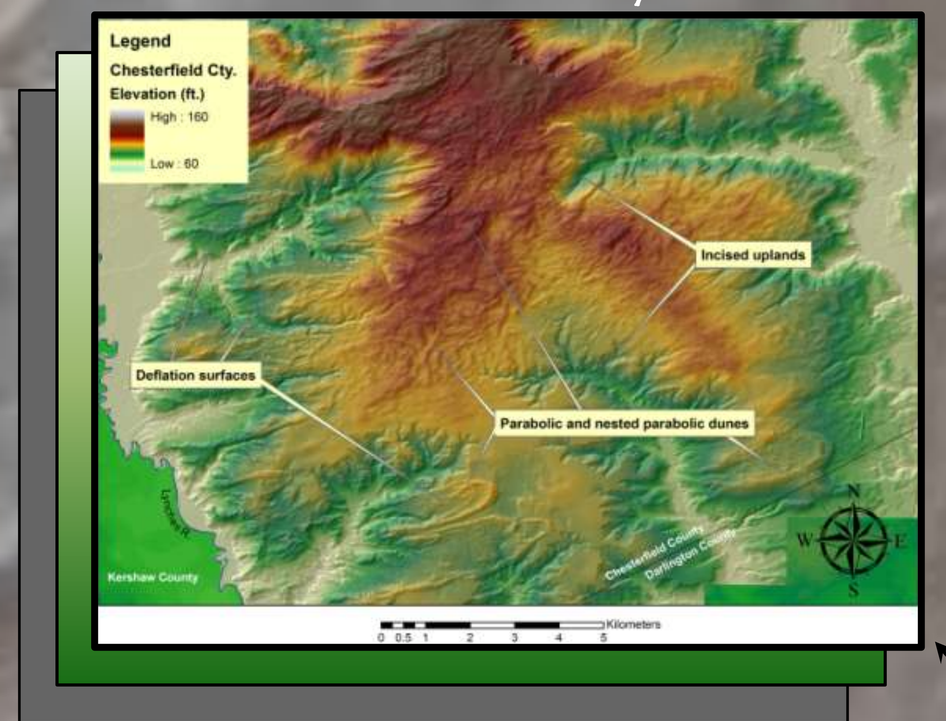
Background and Objectives

Quaternary-aged eolian cover sands and dunes have been recognized in the Coastal Plain uplands of the Carolinas for some time (Bartlett 1967; Soller 1988; Markewich and Markewich 1994; Nystrom et al. 1991; Nystrom and Kite 1988; Owens 1989; Pooser and Johnson 1961); however, the widespread nature of these geomorphic features remained somewhat elusive until the recent release of very high resolution LiDAR data for North Carolina. Now LiDAR data are becoming available for portions of the South Carolina Coastal Plain. These data are revealing an extensive patchwork of Upper *and* Middle Costal Plain upland eolian features in ways that were not possible prior to an analysis of 'bare-earth' LiDAR data. In many cases, these upland eolian deposits represent the Upper Coastal Plain Pinehurst Formation, as redefined by Bartlett (1967) in North Carolina, and extend from northern Aiken County, SC northwest into North Carolina (see below) (Nystrom et al. 1991). In South Carolina, dune deposits are often cross-bedded with steep, eastward dipping foresets (indicating prevailing westerly winds), clear dunal topography, and are usually composed of >90 percent quartz sand with trace amounts of clays and pebbles (Pooser and Johnson 1961). Pooser and Johnson (1961) also associated these sands with the Pinehurst Formation and extended the range from Lexington County, SC to Southern Pines in North Carolina—a region now uniformly referred to as the Sandhills. Age estimates for these deposits have ranged from Miocene(?) to Holocene (Bartlett 1967) to Pliocene(?) to Holocene (Smith 1980); however with the exception of OSL dating on source-bordering riverine dunes and dunes associated with Carolina bays (e.g., Brooks et al. 2010; Ivester et al. 2007), indicating a late Pleistocene to Holocene age, few absolute dates exist for these upland dunes and eolian sand sheets. The objective of this presentation is to illustrate examples of large-scale and widespread upland eolian sand bodies revealed by LiDAR imagery and to offer several observations about likely age(s), linkages with climate, and the possible connection between upland feeder stream incision (erosion) and eolian deposits in the Upper and Middle Coastal Plain of North and South Carolina. Implications for archaeological site burial are also discussed.



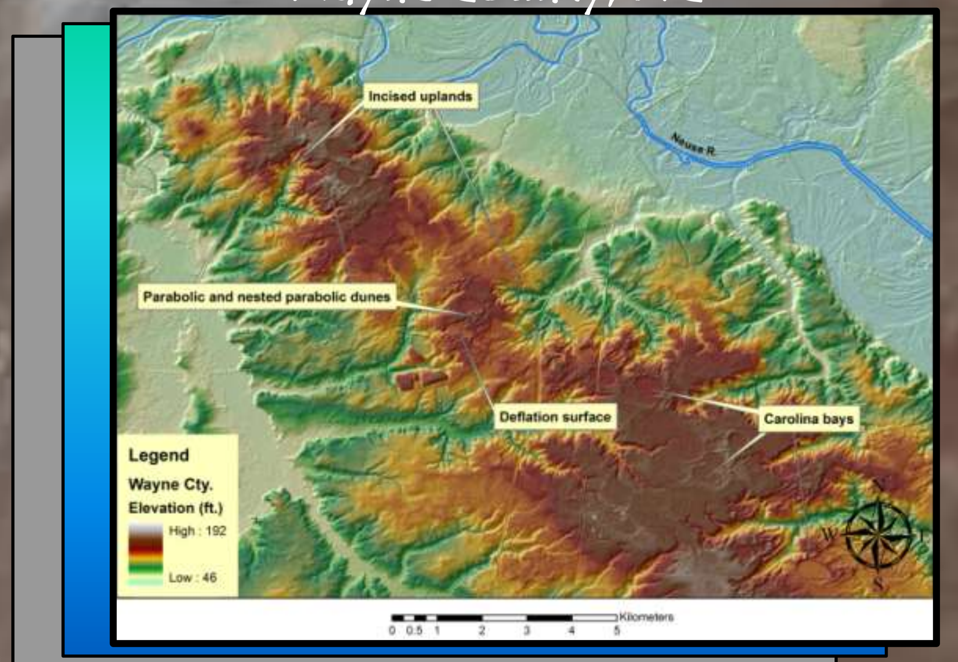
Mapped eolian deposits of the Pinehurst Formation in the Upper Coastal Plain of South Carolina (Modified from Nystrom et al. 1991). Note: LiDAR data reveal Upper & Middle CP eolian sands not mapped.

Chesterfield County, SC



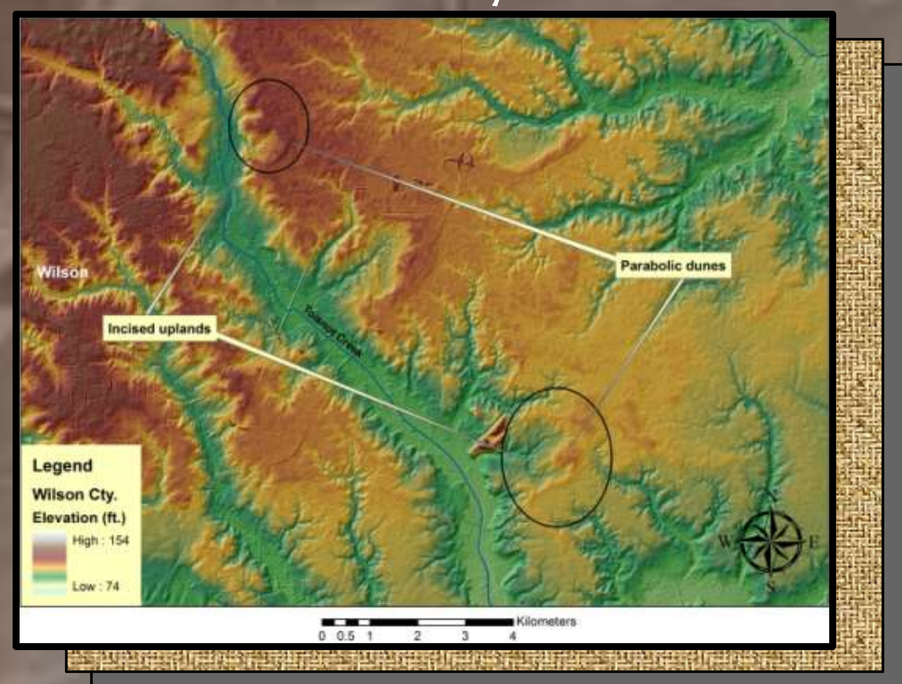
LiDAR image showing extensive and widespread relict eolian dunes covering much of the coastal uplands in southern Chesterfield County, SC.

Wayne County, NC

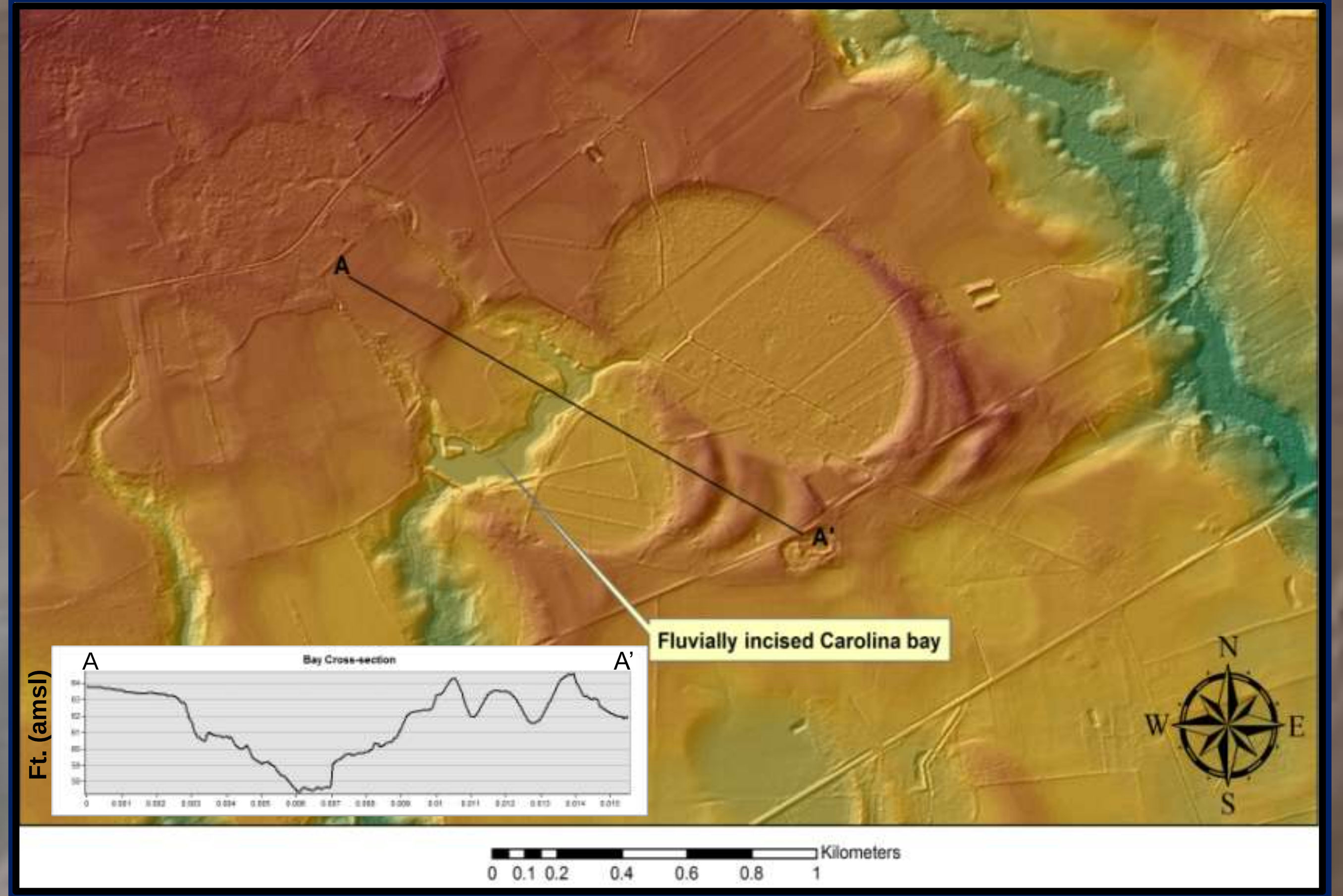


LiDAR image showing upland eolian features associated with incised upland stream heads and Carolina bays in western Wayne County, NC.

Wilson County, NC

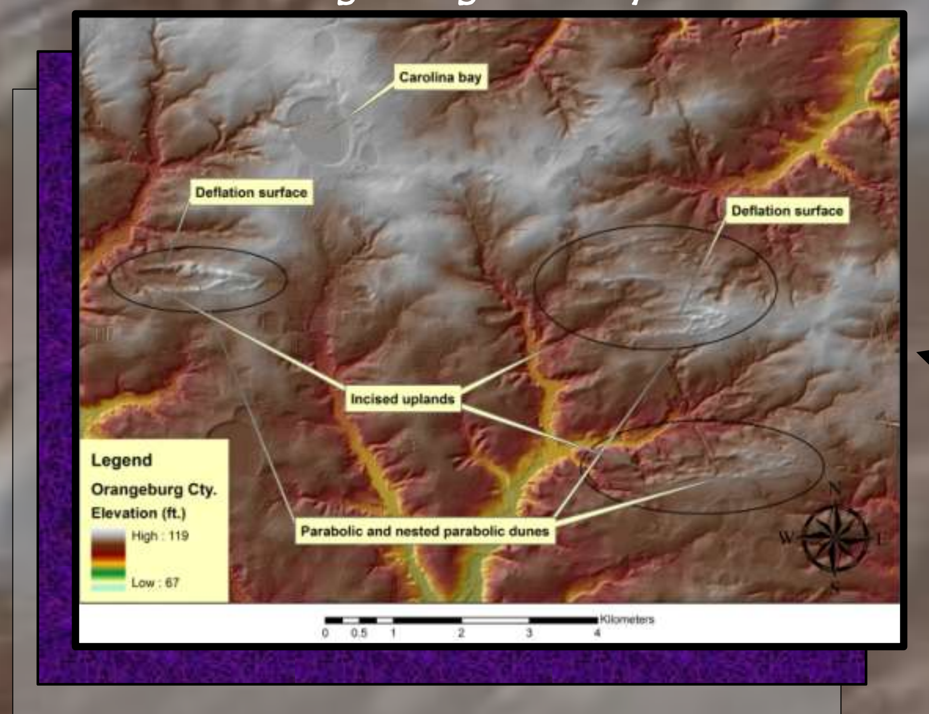


LiDAR image from along Toisnot Creek in Wilson, NC showing large parabolic dune features associated with incised upland streams. Note lack of extensive eolian topography across the uplands typical of regions further south.

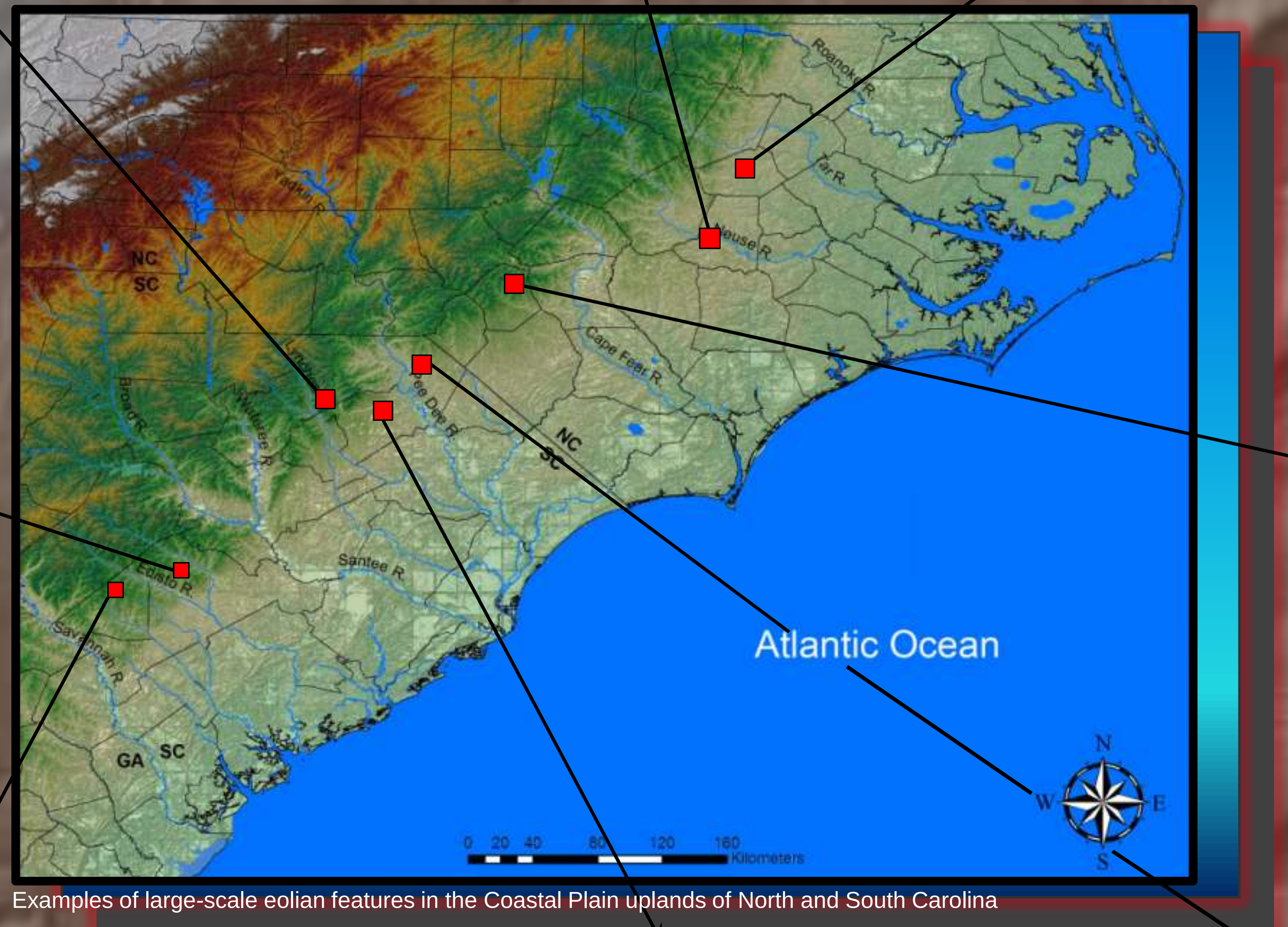


LiDAR image showing Carolina bays fluvially incised by headward erosion of 1st order streams in Darlington County, SC. Incisement of upland streams younger than some Carolina bays and may suggest upland dunes are younger than bays.

Orangeburg County, SC

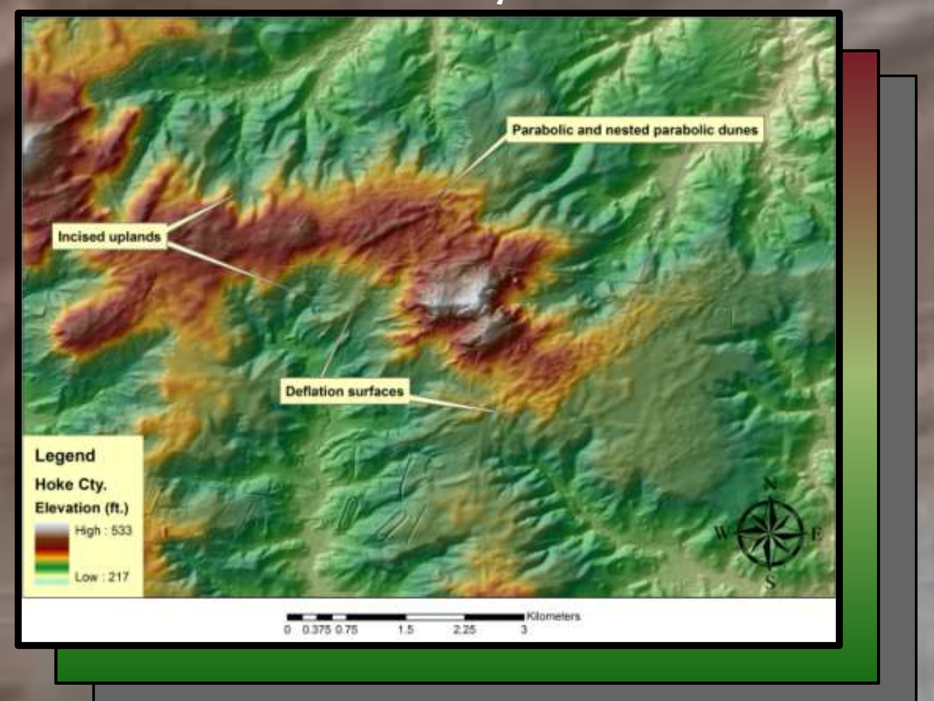


LiDAR image showing large-scale (km long) eolian deflation surfaces, Carolina bays, and extensive parabolic dunes extending west from incised upland streamheads.



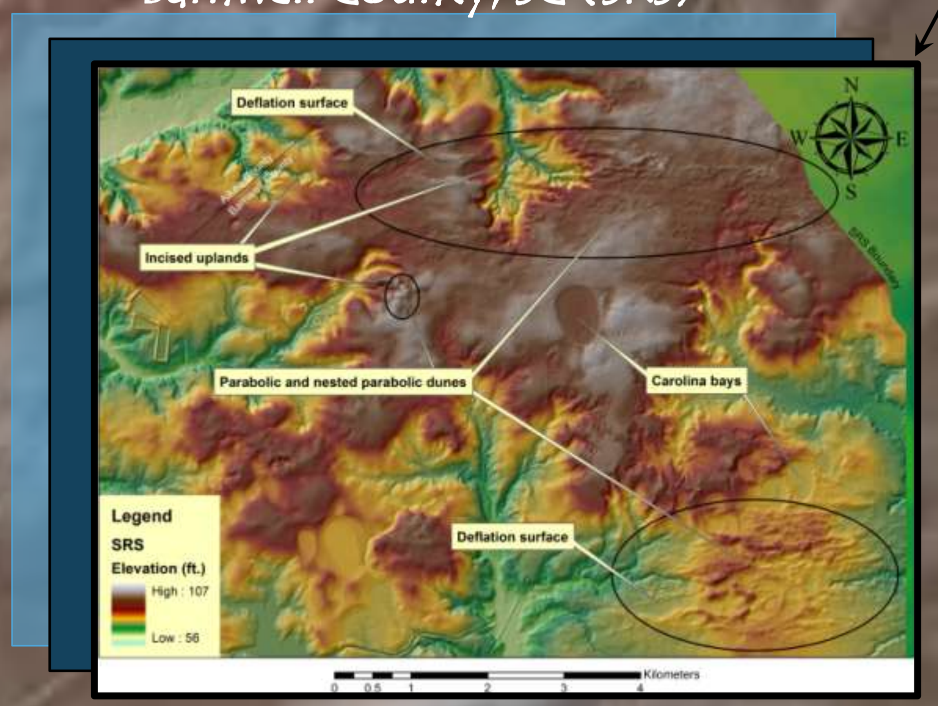
Examples of large-scale eolian features in the Coastal Plain uplands of North and South Carolina

Hoke County, NC



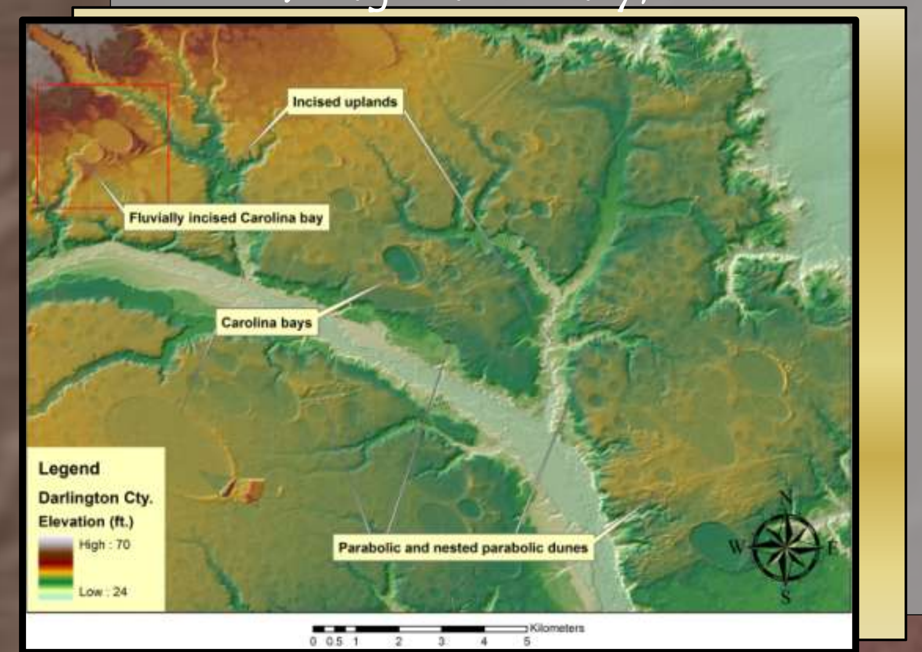
LiDAR image from Fort Bragg with evidence of large-scale eolian reworking of sand deposits along the major interfluvial divide between Lower Little River and Rockfish Creek.

Barnwell County, SC (SRS)



LiDAR image from the Savannah River Site (SRS) showing large-scale eolian activity including deflation surfaces, km long 'ribbons' or swaths of relict dunes and parabolic features originating from incised streams.

Darlington County, SC



LiDAR image showing eolian dunes originating from Carolina bays and from fluvial and upland Sand sources. Note: Close-up of fluvially incised Carolina bay in upper right of poster.

Marlboro County, SC

LiDAR image showing eolian deflation surfaces and extensive parabolic and nested parabolic dunes originating from incised upland streams and covering large areas within the broad and flat Coastal uplands of Marlboro County, SC.

Discussion

An analysis of recently released LiDAR elevation data for North and South Carolina have revealed regions of the Upper and Middle Coastal Plain uplands with large-scale (i.e., km long) and widespread eolian cover sands and dunes. Many of these surficial Quaternary cover sands have been recognized and mapped in the Upper Coastal Plain of North and South Carolina (e.g., Nystrom et al. 1991) as part of the Pinehurst Formation redefined by Bartlett (1967) in the North Carolina Sandhills. The benefit of LiDAR data is that it allows the recognition of these eolian cover sands in ways never possible before and indicates that relict dunes are more extensive and widespread than previously recognized. Although primarily an Upper Coastal Plain/Sandhills phenomena, these large-scale eolian features are also present in parts of the dissected uplands in the Middle Coastal Plain immediately east of the Orangeburg Scarp in South Carolina and in the Middle Coastal Plain portions of North Carolina. While the timing is likely related to riverine source-bordering eolian dunes, the sand source for many of these upland eolian deposits appears to be derived from upland incisement and erosion by primarily 1st order streams. In fact, many sources appear to originate from the incised borders of broad dissected coastal uplands with numerous small feeder streams and streamhead sources. In other words, the downcutting and incisement events appear correlated with dune and eolian sand-sheet formation in the uplands where extensive erosion would have provided a plentiful sand source for remobilization as eolian dunes. Although the timing of upland incisement is not clear, it likely occurred most recently during or sometime just after the last glacial maximum when large river systems in the Southeast were transitioning from braided to meandering and incised fluvial systems (Leigh 2006). Fluvial incision of numerous Carolina bays by 1st order streams also indicates incision postdates some bay formation (shown to be more ~100 ka for bays dated in South Carolina). An interesting feature of these dunes is the linear ribbons or swaths of dune topography that are long (several km) and narrow (~1/2 km or greater) that stretch across broad upland flats (e.g., Hoke County, and Barnwell County) and form parabolic, nested parabolic, and transverse dunes. Large-scale deflation or blowout surfaces are also evident from LiDAR data at or near points of origin. The presence of large-scale eolian features suggests periods of extreme climate change including periods of arid or semi-arid conditions in the Coastal Plain upland of the Carolinas possibly associated with fluvial downcutting. While most of these features probably pre-date human occupation of the New World, limited Holocene reworking of a plentiful sand source may have contributed to site burial and preservation in the coastal upland of the Carolinas.

References

Bartlett, C.S., Jr. (1967) Geology of the Southern Pines Quadrangle, North Carolina, [M.S. thesis]: Chapel Hill, University of North Carolina, 101 p.

Brooks, M. J., Taylor, B. E., Stone, P. A., and Gardner, L. R., (2001) Pleistocene encroachment of the Wateree River sand sheet into Big Bay on the Middle Coastal Plain of South Carolina. Southeastern Geology. vol. 40, pp. 241-257.

Brooks, M.J., Taylor, B.E., and A.H. Ivester (2010) Carolina bays: Time capsules of culture and climate change. *Southeastern Archaeology* 29 (2):146-163.

Ivester, A. H., Mark J. Brooks, and Barbara E. Taylor (2007) Sedimentology and ages of Carolina bay sand rims. Abstract, Southeastern Division of the Geological Society of America, Savannah, Georgia.

Leigh, D. S. (2006) Terminal Pleistocene Braided to Meandering Transition in Rivers of the Southeastern USA. *Catena* 66: 155-160.

Markewich, H. W., and W. Markewich (1993) An overview of Pleistocene and Holocene inland dunes in Georgia and the Carolinas-morphology, distribution, age, and paleoclimate, United States Geological Survey Bulletin 2069. Washington, DC.

Nystrom, P. G. Jr., Ralph H. Willoughby, and Lucille Kite Price (1991) Cretaceous and Tertiary Stratigraphy of the Upper Coastal Plain, South Carolina. In The Geology of the Carolinas, edited by J. W. Horton and V. A. Zullo, pp. 221-240. University of Tennessee Press, Knoxville.

Nystrom, P. G. Jr., and L.E. Kite (1988) The Pinehurst Formation in South Carolina: Geological Society of American Abstracts with Programs, v. 20, no. 4, p. 307-308.

Owens, J. P., A.E. Grosz, J.C. Fisher (1989) Aeroradiometric map and geologic interpretation of part of the Florence-Georgetown 1º x 2º quadrangles, South Carolina: US Geological Survey Miscellaneous Investigations Map I-1948-B, scale 1:250,000.

Pooser, W. K and HS Johnson, Jr. (1961) Geology of the Fort Jackson North Quadrangle, Richland County, South Carolina. 1:24,000 scale map. South Carolina Geological Survey, South Carolina Department of Natural Resources.

Soller, David R. (1988) Geology and Tectonic History of the Lower Cape Fear River valley, Southeastern North Carolina. *U.S. Geological Survey Professional Paper 1466-A*.

Acknowledgements

We wish to thank some of our colleagues and friends for helping us put this poster together. These include Andrew H. Ivester (Department of Geosciences, University of West Georgia), Ralph H. Willoughby (retired SC DNR Geol. Sur.), and Christopher L. Thornock (Savannah River Archaeological Research Program). We also want to acknowledge the SC LiDAR Consortium co-chaired by the SC DNR and the USGS as well as the North Carolina Floodplain Mapping Program and the North Carolina DOT for providing access to LIDAR data. These data are available at the http://www.dnr.sc.gov/GIS/lidar.html for South Carolina LiDAR and http://www.ncfloodmaps.com/ for North Carolina LiDAR.