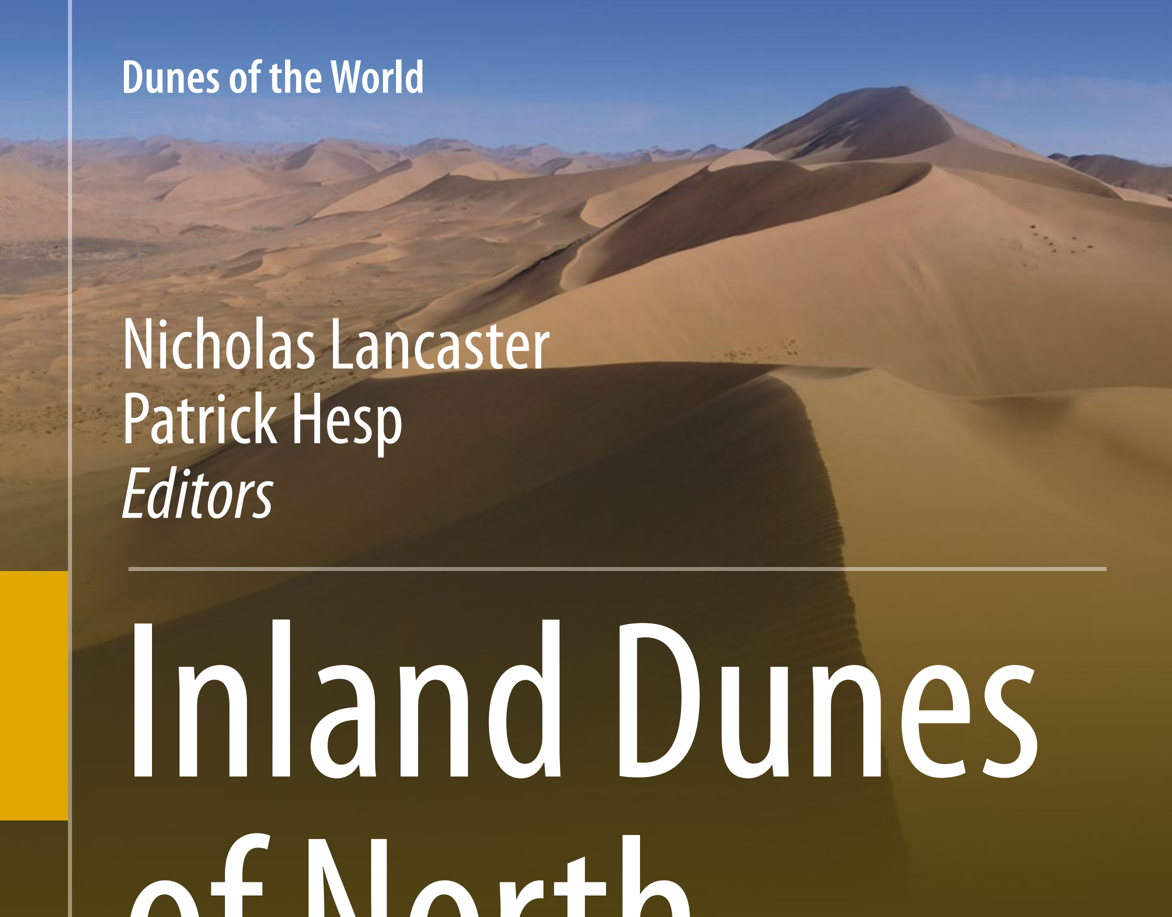

Dunes of the World

Nicholas Lancaster
Patrick Hesp
Editors

Inland Dunes of North America

Springer

Dunes of the World

Series Editors

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Sand dune systems of Quaternary age occur on all continents and at all latitudes and comprise coastal dunes and inland or continental dunes. Coastal dunes are best developed along windward coasts, where sand sized sediment is abundant. Inland dunes occur primarily in low- and mid-latitude arid and semi-arid regions, although there are many examples of cold climate dune systems. Inland dune systems are sensitive to the effects of anthropogenic disturbance (grazing, agriculture, off-road vehicles), as well as climate change and variability (drought cycles). Coastal dunes are impacted by coastal development, storms, and sea level change.

Aims & Scope

This series of volumes is intended to provide students and professionals in earth and environmental sciences with an overview of major coastal and inland dune fields. Information will facilitate decision-making and environmental management. The volumes will be regionally-based and will provide up to date information and reviews of dune field characteristics (morphology, vegetation, sediments), sediment sources, dune field history and response to climate and sea level change past, present and future. Volumes may also provide information on dune (field) processes; relations between geomorphology and ecosystem processes (e.g. dune vegetation and its effects on sediment transport and erosion and deposition patterns); dune flora and fauna; habitat restoration etc.

More information about this series at http://www.springer.com/series/15468

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Chapter 1
Introduction to Inland Dunes of North America

Nicholas Lancaster and Patrick Hesp

Abstract This chapter provides an introduction to the volume and summarizes the occurrence of inland dunes in North America, the history of dune studies, and aspects of dune chronology.

Keywords Dune fields · USA · Canada · Mexico · Luminescence chronology · Sediment supply

1.1 Introduction

Inland sand dunes are widespread in North America and are found from the North Slope of Alaska to the Sonoran Desert in northern Mexico and from the Delmarva Peninsula in the east to Southern California in the west (Fig. 1.1). They cover an area of approximately 459,165 km^2 of the United States and 42,000 km^2 of Canada (Wolfe et al. 2009). Many of these dune fields are small and isolated, and are now stabilized by vegetation and inactive or degraded in current conditions of climate and sand supply. In combination with luminescence and radiocarbon dating of periods of aeolian accumulation or stability, these dune systems provide information on past environmental conditions, including past wind regimes and periods of drought. Active (vegetation-free or sparsely vegetated) dunes are mostly restricted to parts of the southern Great Plains and the deserts of the Southwestern USA and Northern Mexico, although small areas of active dunes do occur in boreal locations, e.g. Great Kobuk Sand Dunes, Alaska (Mann et al. 2002).

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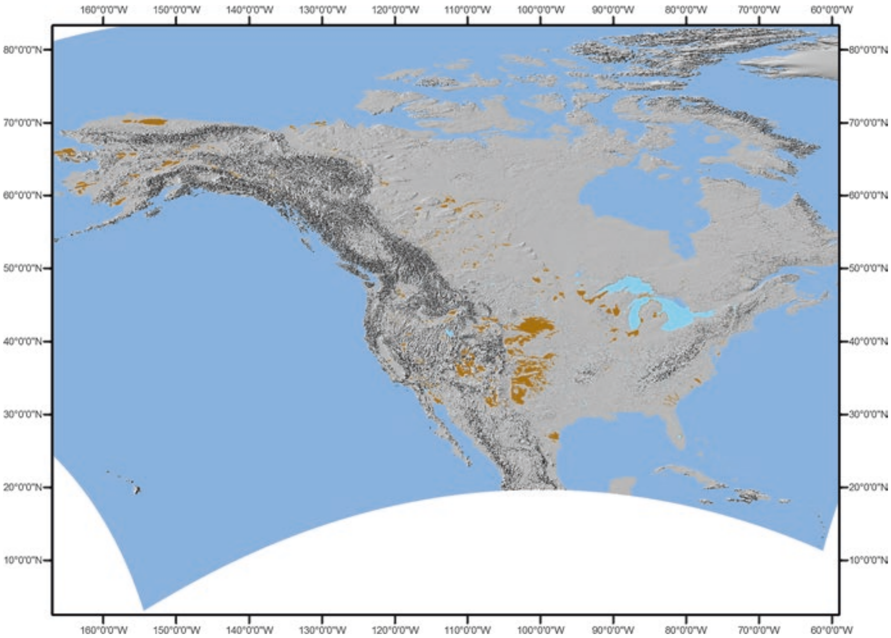

Fig. 1.1 Inland dune systems of North America. Dunefield extent from Wolfe et al. (2009) and Soller et al. (2009), supplemented by Lancaster mapping

In this volume, we provide an overview of and highlight recent research on areas of inland dunes in North America that span a range from those that are actively accumulating in current conditions of climate and sediment supply to those that were formed in past conditions and are now degraded relict systems. The contributions include detailed analyses of individual active dune systems at White Sands, New Mexico; Great Sand Dunes, Colorado; and the Laurentian Great Lakes; as well as the vegetation-stabilized dunes of the Nebraska Sand Hills and the Colorado Plateau. Additional chapters discuss the widespread partially vegetated dune systems of the central and southern Great Plains; the relict dunes of the Atlantic Coastal Plain of the eastern USA; and active and stabilized dunes of the Colorado Plateau and the southwestern deserts of the USA and northern Mexico.

1.2 Inland Dune Studies in North America

There is a long history of observations and studies of inland dunes in North America. European travelers and survey parties noted and, in some cases, mapped the occurrence of dunes (often referred to as "sand hills"). Their observations provide a valuable source of information on the state of dune fields on the Great Plains in the nineteenth and early twentieth century, as discussed by Muhs and Holliday (1995).

Many of these early observers also commented on the scenic beauty of the dunes. For example Russell (1885) in his studies of the Lake Lahontan basin noted

"The sand here is of a light creamy-yellow color, and forms beautifully curved ridges and waves that are covered with fret-work of wind-ripples, and frequently marked in the most curious manner by the foot-prints of animals thus forming strange hieroglyphics that are sometimes difficult to translate". Zebulon Pike happened on the Great Sand Dunes of Colorado in January 1807 and observed that the dunes appeared "exactly that of a sea in a storm (except as to color) and not the least sign of vegetation".

Mapping of soils and Quaternary deposits in the late nineteenth and early twentieth centuries provided important information on the nature and extent of dunes in the Midwest and Northeastern states (see references in Cooper (1935)), and in southern California (Thompson 1929). The availability of aerial photographs in the 1920s and 1930s prompted more systematic investigations. One of the first to provide a comprehensive and detailed classification of dunes and to assess geomorphic and age relations between different generations of dunes was the work of Melton (1940), in the southern High Plains. Melton also suggested that dune-forming wind regimes had changed over time from northwesterly to southerly, a change confirmed by more recent studies (see Halfen and Johnson (2013) and Sridhar et al. (2006)). Working at the same time, Hack (1941) mapped dunes in NE Arizona and provided a seminal classification of dune type in relation to vegetation cover, sand supply, and wind energy.

The first compilation of the extent of dune areas in the USA and parts of Canada was undertaken by Thorp and Smith (1952) who published a map of sand and loess deposits, based on state-by-state soil mapping. More detailed regional surveys of dune occurrence and characteristics include those by Eymann (1953) and Dean (1978) for deserts in southern California. H.T.U Smith and his son Roger (R.S.U.) Smith compiled major surveys of dunes for the central Great Plains (Smith 1965) and the North American deserts (Smith 1982). H.T.U. Smith was, in addition, one of the first to recognize the importance of past wind action in shaping the dune systems of the Mojave Desert (Smith 1967).

Despite the widespread nature of dune areas in North America, major reviews of Quaternary landforms and deposits such as Wright and Frey (1965) and Schultz and Frye (1965) focused on the extensive loess deposits of North America. It was not until the work of Busacca et al. (2003) and Muhs and Zárate (2001) that comprehensive reviews of dune areas and their context were attempted. The mapping by Thorp and Smith (1952) was updated by GIS based mapping that covers all northern areas of North America (Wolfe et al. 2009), and dune and sand sheet areas in the conterminous USA are included in the USGS digital surficial deposit map compilation of Soller et al. (2009). Additional regional studies of dune distribution and chronology are provided by Halfen and Johnson (2013) for the central and southern Great Plains; Muhs and Wolfe (1999) and Wolfe et al. (2004) for the northern Great Plains; and Markewich et al. (2015) for the eastern USA; while dune distribution and characteristics in the deserts of the southwestern USA and northern Mexico are summarized by Lancaster (this volume).

Studies of dune fields in North America have provided understanding of many fundamental aspects of dune dynamics and history. Landmark investigations include studies of the internal sedimentary structure of dunes at White Sands, New Mexico (McKee 1966); and the pioneering investigations of the Algodones, Salton Sea, and Kelso Dunes in California (Norris 1966; Norris and Norris 1961; Sharp 1966), which provided the background for many subsequent investigations of dune dynamics and sediment sources. Although North American dunes were not the primary focus of the USGS Global Sand Seas project of the 1970s, the approaches inspired by this group led to many important advances, including work on cold climate dunes (Ahlbrandt and Andrews 1978), sand sheets (Fryberger et al. 1979), and the sedimentology of Great Sand Dunes, Colorado (Andrews 1981). The recognition of dunes on Mars provided a great incentive for terrestrial analogue studies of dunes, including those in the deserts of the southwestern USA (Breed 1977; Greeley 1986) and also resulted in studies of dune fields using remote sensing data sets (e.g. Blount et al. 1990; Paisley et al. 1991; Ramsey et al. 1999). Renewed interest in planetary dunes has come as a result of the data from Mars Science Laboratory Curiosity Rover, prompting new investigations of terrestrial analogues in North America (Ewing et al. 2015; Szynkiewicz et al. 2010).

Studies of modern dune sediments as a means to better interpret the characteristics of ancient aeolian sandstones of the Colorado Plateau and elsewhere has motivated multiple studies in the Desert Southwest, (e.g. Havholm and Kocurek 1988; Hunter 1977; Kocurek and Nielson 1986; Nielson and Kocurek 1986; Simpson and Loope 1985). The application of geochemical and mineralogical methods to understand dune sand provenance, especially in the Plains and Desert Southwest, was pioneered by Muhs and colleagues, and is summarized in Muhs (2017).

The creation of better instrumentation, an increased understanding of flow dynamics, computer modeling, and realization of the importance of climate and vegetation changes to dune activity has resulted in important investigations of winds and sediment transport on dunes based on field experiments in North America, (e.g. Barchyn and Hugenholtz 2012b; Frank and Kocurek 1994; Lancaster 1989; Lancaster et al. 1996; McKenna Neuman et al. 1997; Pelletier and Jerolmack 2014; Sweet and Kocurek 1990; Walker and Nickling 2003), with applications to both inland and coastal dune systems.

1.3 Dune History and Chronology

Understanding of dune field history may provide information on past periods of aridity and dune building, as exemplified by research into the history of dune accumulation on the Great Plains of the USA and Canada, where the response of these dune systems to episodes of severe drought and the possible effects of global warming has prompted many studies (Barchyn and Hugenholtz 2012a; Barchyn and Hugenholtz 2013; Miao et al. 2007; Muhs and Maat 1993; Wolfe et al. 2006).

Dune orientations separately, or in combination with data on loess thickness and particle size trends, provide information on past wind regimes, for the last glacial maximum period (Markewich et al. 2015; Mason et al. 2011), and for Holocene drought episodes (Schmeisser et al. 2010; Sridhar et al. 2006). Such data sets are valuable in making model-data comparisons and to validate paleo-climate models (Conroy et al. 2019).

Numerical chronologies for periods of dune accumulation and stability in North America were first developed using conventional ^{14}C ages of organic matter from palaeosols and peat layers (e.g. Filion 1987). Subsequently, chronologies were developed using accelerator mass spectrometry (AMS) ^{14}C dates (Ahlbrandt et al. 1983; Mason et al. 2004). These chronologies not only bracket periods of sand accumulation, but provide useful information on periods of stability, especially when the ages are from paleosols. They are, however, limited by the availability of organic horizons in dunes, which restricts their utility to dunes in more humid areas, or dunes associated with wetlands (Mehringer and Warren 1976).

With the development and widespread application of luminescence dating techniques that provide a direct age for periods of aeolian sand accumulation, luminescence-dated numerical chronologies have been developed, beginning with the work of Forman and Maat (1990) in Colorado and Edwards (1993) at Kelso Dunes, California. These investigations used TL (Thermoluminesence) and IRSL (Infra-red stimulated luminescence), respectively. Subsequent studies have mostly employed OSL (Optically stimulated luminescence) with SAR protocols, especially on the Great Plains, where quartz-rich sands provide consistent results. In the Great Basin and Mojave deserts, however, feldspar-rich dune sands favor use of IR stimulated luminescence protocols.

The available chronologic information was summarized for dune areas in Canada and the USA north of 38°N by Wolfe et al. (2009) and then comprised 163 luminescence and 880 radiocarbon dates. This database provided the basis for a global chronologic database – the INQUA Dunes Atlas database (Lancaster et al. 2016). Currently, there are 1286 luminescence dates in the database for North America (Canada, Mexico, and the USA). Their spatial distribution is shown in Fig. 1.2. A review and interpretation of these ages is provided by Halfen et al. (2015). It is clear from Fig. 1.2 that the coverage of dated sites is uneven. In particular, there are relatively fewer published ages from dunes in the southern Great Plains, the intermountain west, Mexico, and Alaska. The temporal distribution of ages for the region is complex: multiple periods of Holocene dune accumulation and reworking have occurred and indicate the sensitivity of dunes in many areas to climate change.

Given the widespread distribution of active and vegetation-stabilized dunes in North America, it might be expected that the boundary conditions of sediment supply, availability and mobility (Kocurek and Lancaster 1999) would be similarly diverse. However, this does not appear to be the case. In areas adjacent to the Laurentide Ice Sheet, deglaciation provided an abundant source of sand from glaciofluvial deposits, leading to the formation of dune fields throughout the northern Plains and the upper Midwest (Arbogast et al. 2015; Halfen et al. 2015). Elsewhere formation of dune fields in many areas is clearly linked to enhanced sediment supply from fluvial sources, as in the Great Plains (Halfen and Johnson 2013) and the

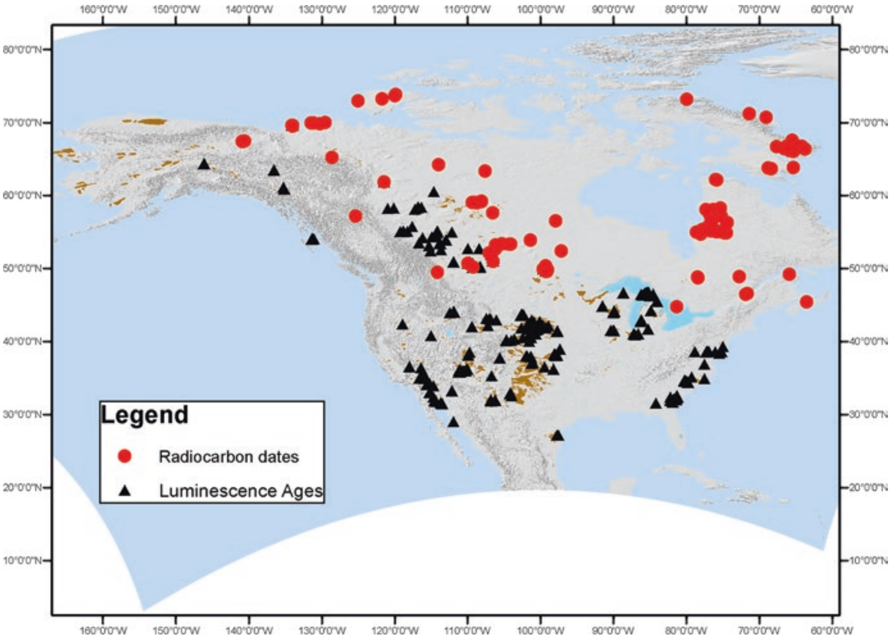

Fig. 1.2 Luminescence and radiocarbon dated dunes sites in North America. Dune extent as Fig. 1.1. Sites from INQUA Dunes Atlas Chronologic Database, http://inquadunesatlas.dri.edu

southeast coastal plain (Swezey et al. 2016). The record is more complex in areas of the southwestern deserts, in part because of the lack of luminescence ages, but fluvial sources are clearly indicated for the Algodones and Parker dunes (Muhs et al. 2003).

1.4 Conclusions

The widespread occurrence of dune fields in North America is indicative of the importance of aeolian activity in many different landscapes, from the margins of the boreal forest to hot deserts. The occurrence of the dune fields and their history reflect a variety of boundary conditions, including increased sediment supply during the late Pleistocene and Pleistocene-Holocene transition; and mid- to late-Holocene drought periods. The variety of dune field environments has promoted a range of investigations, from modern dune dynamics to Quaternary history. These different approaches are well-exemplified in this volume of studies. They also indicate the areas in which further research is needed, including application of modern luminescence dating techniques to dunes in the desert southwest.

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Chapter 2

Quaternary Eolian Dunes and Sand Sheets in Inland Locations of the Atlantic Coastal Plain Province, USA

Christopher S. Swezey

Abstract Quaternary eolian dunes and sand sheets that are stabilized by vegetation are present throughout many inland locations of the Atlantic Coastal Plain province (USA). These locations include river valleys, the Carolina Sandhills region, adjacent to Carolina Bays, and upland areas of the northern coastal plain. The eolian dunes are primarily parabolic in river valleys and in upland areas of the northern coastal plain, linear in the Carolina Sandhills region, and arcuate adjacent to Carolina Bays. Optically stimulated luminescence (OSL) ages from the eolian sands range from circa (ca.) 92–5 ka, revealing that they are relict features that are not active today. These sands have been degraded by vegetation and pedogenic processes, and are stabilized under modern environmental conditions. Most of the OSL ages are approximately coincident with the last glacial maximum (LGM), when conditions were generally colder, drier, and windier. Various features associated with these eolian dunes and sand sheets suggest that the winds that mobilized the sand blew from the northwest in the coastal plain region of Maryland and Delaware, and from the west in the coastal plain region of North Carolina, South Carolina, and Georgia. Most of the eolian dunes and sand sheets are composed of fine to medium sand, although a substantial silt component is present in the northern coastal plain, and a substantial coarse sand component is present in the Carolina Sandhills region. Eolian sand mobilization would have been facilitated by conditions of stronger wind velocity (at least 4–6 m/s), lower air temperature, lower air humidity, and (or) reduced vegetation cover. Eolian sediment mobilization appears to have occurred episodically at any given site, although sites that are farther south have preserved a greater proportion of eolian sands yielding pre-LGM ages (indicating that the southern landscapes farther from the ice sheet have experienced less reworking).

Keywords Quaternary · Aeolian · Dune · Carolina Bay · Carolina Sandhills · U.S.A.

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2.1 Introduction

In the eastern United States (U.S.), the Atlantic Coastal Plain province (Fig. 2.1) extends from New York to Florida, and contains strata and sediments of Cretaceous to Quaternary age. Until recently, much of the Quaternary record in this province has been considered to be relatively sparse, consisting primarily of a few onshore lacustrine and paludal records, some beach and barrier island complexes, and some offshore sand and mud. However, with the advent of optically stimulated luminescence (OSL) dating techniques and high-resolution topographic information from Light Detection and Ranging (LiDAR) data, new studies have revealed that the Quaternary record of Atlantic Coastal Plain province is much more extensive and complex than had previously been perceived. Some of these new studies have focused on fluvial settings (e.g., Leigh 2006, 2008; Suther et al. 2011), whereas others have focused on modern coastal settings (e.g., Mallinson et al. 2008; Scott et al. 2010; Timmons et al. 2010; Parham et al. 2013; Seminack and Buynevich 2013; Peek et al. 2014). One of the more surprising revelations from these new studies is the recognition of widespread Quaternary eolian sand dunes and sand sheets of approximately synchronous age throughout many inland locations of the U.S. Atlantic Coastal Plain province (e.g., Ivester et al. 2001; Ivester and Leigh 2003; Markewich et al. 2009; Swezey et al. 2013, 2016a, b).

Inland locations of the U.S. Atlantic Coastal Plain province are not settings in which one would typically expect widespread eolian sands because the modern climate is not conducive to eolian sediment mobilization. Indeed, most of these inland Quaternary eolian sediments are stabilized by vegetation, and the dune and sand sheet morphologies have been degraded by erosion and pedogenic processes. In other words, these eolian sediments are relict features from times when conditions were different from the modern environment. Although future work will undoubtedly reveal additional locations and features, this publication provides a summary of Quaternary eolian sand dunes and sand sheets in the following four inland settings of the U.S. Atlantic Coastal Plain province: (1) river valleys; (2) the Carolina Sandhills region; (3) Carolina Bays; and (4) upland areas of the northern Atlantic Coastal Pain.

2.2 Modern Climate

From northern Delaware to northern Florida, the modern climate of the Atlantic Coastal Plain province is humid and mesothermal with little or no water deficiency during any season (climate classification of Thornthwaite 1931, 1948). During January the mean temperature varies from ~0 °C in northern Delaware to ~12 °C in northern Florida, whereas during July the mean temperature varies from ~12 °C in northern Delaware to ~30 °C in northern Florida (Fig. 2.2). Precipitation occurs throughout the year, and mean annual precipitation ranges from ~110 cm in

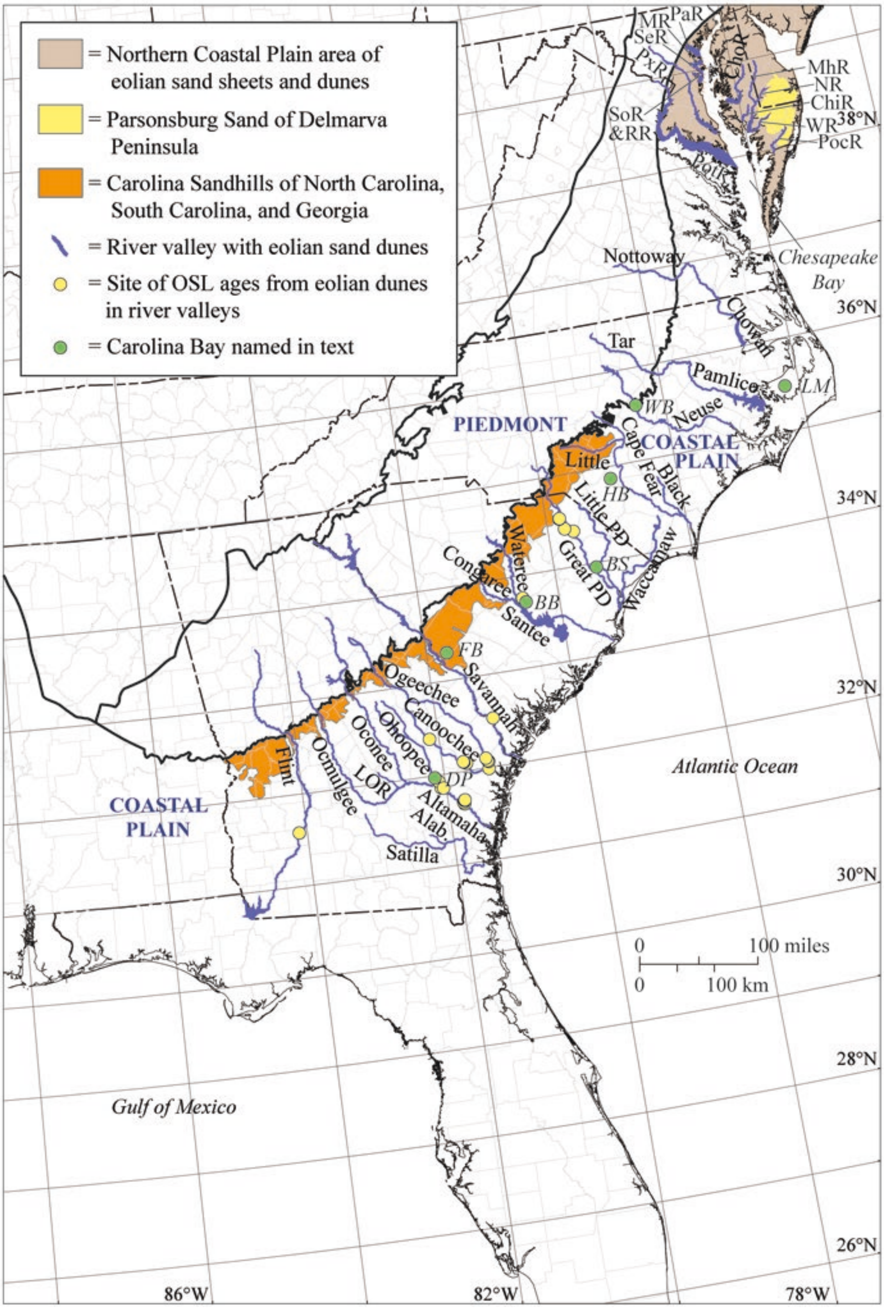
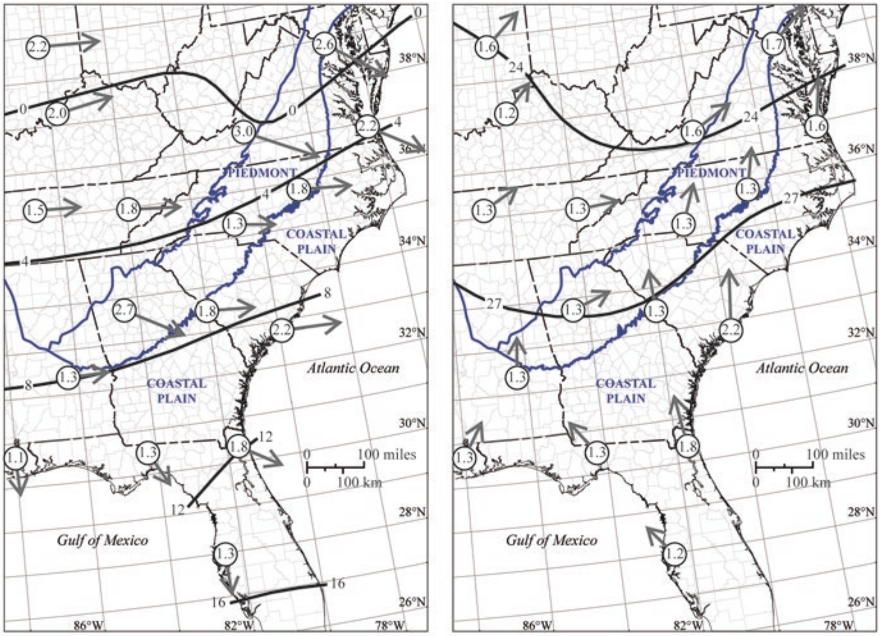


Fig. 2.1 Coastal Plain location map. The location of the Carolina Sandhills is from Griffith et al. (2001, 2002). *Alab.* Alabaha River, *BB* Big Bay, *BS* Bear Swamp, *ChiR* Chicomacomico River, *ChoR* Choptank River, *DP* Dukes Pond, *FB* Flamingo Bay, *Great PD* Great Pee Dee River, *HB* Herndon Bay, *Little PD* Little Pee Dee River, *LM* Lake Mattamuskeet, *LOR* Little Ocmulgee River, *MhR* Marsheyhope Creek, *MR* Magothy River, *NR* Nanticoke River, *PaR* Patapsco River, *PxR* Patuxent River, *PocR* Pocomoke River, *PotR* Potomac River, *RR* Rhode River, *SeR* Severn River, *SoR* South River, *WB* Wilson's Bay, *WR* Wicomico River



January MODERN JULY Modern

Fig. 2.2 Modern climate data of the southeastern United States. Mean temperature data in degrees Celsius are from Webb et al. (1993), and mean resultant wind data are from Baldwin (1975). The mean resultant wind is the vectorial average of all surface wind velocities and wind directions on the basis of hourly observations at a given place during the specified months for 1951–1960. The velocity of surface wind in meters per second (m/s) is written inside each circle, and is proportional to the length of the gray arrows

northern Delaware to ~140 cm in northern Florida (Fig. 2.2). Average annual free water surface (FWS) evaporation values range from ~92 cm in northern Delaware to ~122 cm in northern Florida (Farnsworth et al. 1982). Average annual potential evapotranspiration values range from ~74 cm in northern Delaware to ~107 cm in northern Florida (Fig. 2.2). These values yield ratios of annual precipitation to potential evapotranspiration (P:PE) that vary from 1.49 in northern Delaware to 1.31 in northern Florida. For reference, a P:PE ratio between 0.50 and 0.75 denotes a “sub-humid” climate in the UNESCO (1979) classification of arid regions.

The directions of surface winds in the southeastern United States vary seasonally (Fig. 2.2) and are governed primarily by the following three variables: (1) the westerlies; (2) the polar front jet stream; and (3) the Bermuda High. During winter, the westerlies and the polar front jet stream are stronger, the polar front jet stream moves to lower latitudes, and the Bermuda High is weaker (Sahsamanoglou 1990; Harman 1991; Davis et al. 1997). As a result, during winter the surface winds over the Atlantic Coastal Plain province blow predominantly from the west and west-northwest. Most precipitation during winter is frontal in association with the polar front jet stream where cold and dry continental air from Canada is in contact with warm and humid maritime air from the Gulf of Mexico (Court 1974; Soulé 1998; Katz et al. 2003). In contrast, during summer the westerlies and the polar front jet stream are weaker, the polar front jet stream moves to higher latitudes, and the Bermuda High is stronger (Sahsamanoglou 1990; Harman 1991; Davis et al. 1997). As a result, during summer the surface winds over the U.S. Atlantic Coastal Plain province blow from the south via the Bermuda High, bringing moisture to the Atlantic Coastal Plain from the Gulf of Mexico and (or) the Atlantic Ocean (Court 1974; Soulé 1998; Katz et al. 2003). Most precipitation during summer is associated with convection rather than fronts.

The mean resultant velocity of surface winds in the U.S. Atlantic Coastal Plain province is <3 m/s during any given month (Fig. 2.2), but there is some variability ("gustiness") around the mean. For example, wind velocities of 6 m/s or greater occurred ~8% of the time per whole year during the interval of 1981–2010 according to hourly data from the Metropolitan Airport at the city of Columbia, South Carolina (www.ncdc.noaa.gov; accessed 18 August 2016). In relatively warm low-latitude regions, however, typical threshold wind velocities for sustained eolian mobilization of 0.25–0.50 mm diameter quartz sand are 4–6 m/s (e.g., Hsu 1974), and therefore modern surface winds in inland locations of the Atlantic Coastal Plain province are really not sufficient for much sustained eolian sand transport.

2.3 Age Data

The age data presented in this paper were obtained by radiocarbon techniques and (or) luminescence techniques. Unless otherwise stated, the radiocarbon ages are reported in radiocarbon years (^{14}C yr) before present (BP), using the Libby half-life of 5568 years and with 0 ^{14}C year BP being equivalent to AD 1950. In contrast, the luminescence ages are reported in calibrated years (cal year) BP with 0 cal year BP being the year that a specific luminescence age was determined. The luminescence ages presented in this paper were compiled from different sources, and different authors used different statistical models to determine their best estimates of the ages. Where available, information on these different statistical models is given in Tables 2.1, 2.2, 2.3, and 2.4. For luminescence ages published for the first time in this paper (Table 2.2), the choice of statistical model that is thought to yield the most accurate age follows criteria discussed in Swezey et al. (2016b). In brief, if the dispersion was <25% (as determined by the R program radial plot, following Galbraith and Roberts 2012), then the preferred age was the age obtained by the weighted mean. If the dispersion was ≥25%, then the preferred age was the age obtained by the Minimum Age Model-3.

Table 2.1 OSL data from eolian dunes in river valleys of the U.S. Atlantic Coastal Plain province

Sample ID	References	State	River valley	LAT (North)	LONG (West)	ELEV (m)	DEPTH (cm)	AGE (ka)	Preferred age model
UGA-DL-3	Leigh et al. (2004)	South Carolina	Great Pee Dee River	34.53512	−79.81282	unspec.	210–180	16.6 ± 1.8	unspec.
UGA-DL-4	Leigh et al. (2004)	South Carolina	Great Pee Dee River	34.53259	−79.81730	unspec.	190–160	20.2 ± 2.4	unspec.
UGA-DL-2	Leigh et al. (2004)	South Carolina	Great Pee Dee River	34.41460	−79.76242	26	210–180	15.0 ± 1.4	unspec.
UGA-4-SC34-Br.	Leigh (2008)	South Carolina	Great Pee Dee River	34.37303	−79.64535	unspec.	210	19.5 ± 1.8	unspec.
Wateree01	Ivester et al. (2002) and Brooks et al. (2010)	South Carolina	Wateree and Congaree Rivers	33.7900	−80.4852	64	unspec.	74.3 ± 7.1	unspec.
Wateree02	Ivester et al. (2002) and Brooks et al. (2010)	South Carolina	Wateree and Congaree Rivers	33.7866	−80.4891	69	unspec.	29.6 ± 2.4	unspec.
Wateree03	Ivester et al. (2002) and Brooks et al. (2010)	South Carolina	Wateree and Congaree Rivers	33.8008	−80.4989	72	unspec.	33.2 ± 2.8	unspec.
GAW 03a	Swezey et al. (2013)	South Carolina	Savannah River	32.49416	−81.19051	11	150	22.9 ± 1.7	Weighted
GAW 03b	Swezey et al. (2013)	South Carolina	Savannah River	32.49416	−81.19051	11	150	24.0 ± 1.2	Weighted
GAW 04a	Swezey et al. (2013)	South Carolina	Savannah River	32.49416	−81.19051	11	140	18.6 ± 0.1	MAM
GAW 04b	Swezey et al. (2013)	South Carolina	Savannah River	32.49416	−81.19051	11	140	19.1 ± 0.1	MAM
GAW05	Swezey et al. (2013)	South Carolina	Savannah River	32.54332	−81.26128	12	152	32.7 ± 2.1	Weighted
GAW06	Swezey et al. (2013)	South Carolina	Savannah River	32.54423	81.26348	12	148	32.9 ± 2.5	Weighted

GAW07	Swezey et al. (2013)	South Carolina	Savannah River	32.54423	−81.26348	12	20	24.1 ± 1.5	Weighted
GAW08	Swezey et al. (2013)	South Carolina	Savannah River	32.52192	−81.23143	12	96	30.8 ± 1.6	Weighted
GAW09	Swezey et al. (2013)	South Carolina	Savannah River	32.49084	−81.19570	9	78	21.5 ± 1.3	Weighted
GAW10	Swezey et al. (2013)	South Carolina	Savannah River	32.48911	−81.18024	8	40	31.3 ± 1.8	Weighted
GAW11	Swezey et al. (2013)	South Carolina	Savannah River	32.48457	−81.20333	9	60	10.2 ± 0.7	MAM
GAW12	Swezey et al. (2013)	South Carolina	Savannah River	32.42373	−81.15730	8	80	19.2 ± 1.2	Weighted
GAW13	Swezey et al. (2013)	South Carolina	Savannah River	32.43740	−81.14857	8	90	10.3 ± 0.7	Weighted
GAW30	Swezey et al. (2013)	South Carolina	Savannah River	32.55597	−81.27906	8	549	30.5 ± 2.2	Weighted
GAW36	Swezey et al. (2013)	South Carolina	Savannah River	32.50996	−81.22414	11	82	23.3 ± 1.9	Weighted
Dalhousie-DL17	Leigh (2008)	Georgia	Ogeechee River	32.09682	−81.37651	unspec.	210–185	45.3 ± 6.7	unspec.
Dalhousie-DL15	Leigh (2008)	Georgia	Ogeechee River	32.06689	−81.35625	unspec.	195	37.5 ± 2.8	unspec.
Dalhousie-DL18	Leigh (2008)	Georgia	Ogeechee River	32.05596	−81.34448	unspec.	210–185	31.4 ± 5.9	unspec.
Dalhousie-AI-22	Ivester et al. (2001)	Georgia	Canoochee River	32.38440	−82.12426	unspec.	350	24.3 ± 3.3	unspec.
Dalhousie-AI-4	Ivester et al. (2001)	Georgia	Canoochee River	32.08542	−81.68432	21	257–233	26.6 ± 2.3	unspec.
Dalhousie-AI-5	Ivester et al. (2001)	Georgia	Canoochee River	32.08001	−81.67687	unspec.	277–253	32.8 ± 3.3	unspec.
Dalhousie-AI-3	Ivester et al. (2001)	Georgia	Canoochee River	32.06734	−81.64418	19	200	25.8 ± 1.2	unspec.

(continued)

Table 2.1 (continued)

Sample ID	References	State	River valley	LAT (North)	LONG (West)	ELEV (m)	DEPTH (cm)	AGE (ka)	Preferred age model
Dalhousie-AI-2	Ivester et al. (2001)	Georgia	Canoochee River	32.06552	−81.64565	20	201–183	29.9 ± 6.2	unspec.
Dalhousie-DL10	Leigh (2008)	Georgia	Canoochee River	31.97694	−81.35153	unspec.	200–175	34.0 ± 2.6	unspec.
Dalhousie-AI-18	Ivester et al. (2001)	Georgia	Ohoopee River	31.95195	−82.09706	52	177–153	77.4 ± 6.6	unspec.
Dalhousie-AI-15	Ivester et al. (2001)	Georgia	Ohoopee River	31.94299	−82.10378	32	127–103	23.6 ± 5.4	unspec.
UGA-BH-2	Leigh et al. (2004)	Georgia	Altamaha River	31.86451	−82.04860	25	210–180	18.6 ± 1.9	unspec.
UGA-BH5.2	Leigh et al. (2004)	Georgia	Altamaha River	31.86882	−82.08279	25	210–180	17.6 ± 2.6	unspec.
Dalhousie-AI-9	Ivester et al. (2001)	Georgia	Altamaha River	31.70031	−81.78545	16	227–203	45.0 ± 7.4	unspec.
Dalhousie-AI-11	Ivester et al. (2001)	Georgia	Altamaha River	31.69402	−81.79448	16	227–203	38.1 ± 5.0	unspec.
Dalhousie-AI-10	Ivester et al. (2001)	Georgia	Altamaha River	31.67538	−81.80657	16	235–225	4.9 ± 0.5	unspec.
Dalhousie-AI-12	Ivester et al. (2001)	Georgia	Altamaha River	31.67307	−81.80575	17	250	20.9 ± 1.2	unspec.
Dalhousie-AI-13	Ivester et al. (2001)	Georgia	Altamaha River	31.65689	−81.79436	14	250	16.2 ± 2.0	unspec.
Dalhousie-AI-6	Ivester et al. (2001)	Georgia	Flint River	31.57104	−84.13042	74	200	8.6 ± 0.9	unspec.
Dalhousie-AI-7	Ivester et al. (2001)	Georgia	Flint River	31.57104	−84.13042	74	325	15.8 ± 1.7	unspec.
Dalhousie-AI-8	Ivester et al. (2001)	Georgia	Flint River	31.56852	−84.13158	66	460	17.5 ± 1.7	unspec.

DEPTH Depth below land surface at which OSL sample was collected, *ELEV* elevation of land surface, *LAT* latitude, *LONG* longitude, *MAM* Minimum Age Model-3 (Galbraith and Laslett 1993; Galbraith et al. 1999), *Weighted* age in thousands of years (ka) ago using the weighted mean OSL value for equivalent dose (DE) determinations (similar to the Central Age Model of Galbraith et al. 1999), *unspec.* unspecified

Table 2.2 OSL data from eolian sand in the Carolina Sandhills region of the U.S. Atlantic Coastal Plain province

Sample ID	References	State	Site descript.	LAT (North)	LONG (West)	ELEV (m)	DEPTH (cm)	AGE (ka)	Preferred age model
UGA-DB-TU4-90	Leigh (2008)	North Carolina	Bogwater, Fort Bragg	35.12665	−79.22776	unspec.	90	22.7 ± 5.9	unspec.
UGA-DB-TU4-153	Leigh (2008)	North Carolina	Bogwater, Fort Bragg	35.12665	−79.22776	unspec.	153	24.1 ± 6.1	unspec.
USGS1585	Swezey et al. (2016)	South Carolina	Site 3	34.56355	−80.13365	113	47–42	10.2 ± 0.8	MAM3
USGS1586	Swezey et al. (2016)	South Carolina	Site 3	34.56355	−80.13365	113	70–65	24.1 ± 2.2	MAM3
USGS1588	Swezey et al. (2016)	South Carolina	Site 5	34.56355	−80.10430	125	42	9.4 ± 0.8	Weighted
USGS1589	Swezey et al. (2016)	South Carolina	Site 5	34.56355	−80.10430	125	85	19.3 ± 1.6	MAM3
USGS1642	Swezey et al. (2016)	South Carolina	Site 4	34.55686	−80.12839	119	200	46.3 ± 3.1	MAM3
USGS1643	Swezey et al. (2016)	South Carolina	Site 4	34.55686	−80.12839	119	60	25.5 ± 2.3	MAM3
USGS1715	Swezey et al. (2016)	South Carolina	Site 6	34.62072	−80.05958	76	210	39.8 ± 2.7	MAM3
USGS1716	Swezey et al. (2016)	South Carolina	Site 6	34.62072	−80.05958	76	250	69.6 ± 5.6	Weighted
USGS1717	Swezey et al. (2016)	South Carolina	Site 6	34.62072	−80.05958	76	250	53.7 ± 5.1	MAM3
USGS1718	Swezey et al. (2016)	South Carolina	Site 2	34.52557	−80.22427	122	40	7.0 ± 0.9	MAM3
USGS1719	Swezey et al. (2016)	South Carolina	Site 2	34.52557	−80.22427	122	145	48.9 ± 7.7	Weighted

(continued)

Table 2.2 (continued)

Sample ID	References	State	Site descript.	LAT (North)	LONG (West)	ELEV (m)	DEPTH (cm)	AGE (ka)	Preferred age model
USGS1720	Swezey et al. (2016)	South Carolina	Site 1	34.62237	−80.23235	125	90	49.8 ± 3.7	Weighted
USGS1721	Swezey et al. (2016)	South Carolina	Site 1	34.62237	−80.23235	125	160	9.2 ± 0.6	Weighted
USGS1722	Swezey et al. (2016)	South Carolina	Site 1	34.62237	−80.23235	125	210	10.9 ± 0.6	MAM3
USGS GAW-35	Previously unpublished	South Carolina	White Pond Dune	34.16364	−80.77531	91	90	92.3 ± 5.2	Weighted

DEPTH Depth below land surface at which OSL sample was collected, *ELEV* elevation of land surface, *LAT* latitude, *LONG* longitude, *MAM* Minimum Age Model-3 (Galbraith and Laslett 1993; Galbraith et al. 1999), *Weighted* age in thousands of years (ka) ago using the weighted mean OSL value for equivalent dose (DE) determinations (similar to the Central Age Model of Galbraith et al. 1999), *unspec*. unspecified

Table 2.3 OSL data from sand ridges of Carolina Bays in the U.S. Atlantic Coastal Plain province

Sample ID	References	State	Carolina Bay Name	LAT (North)	LONG (West)	ELEV (m)	DEPTH (cm)	AGE (ka)	Preferred age model
UW2786 (core 1)	Moore et al. (2016)	North Carolina	Herndon Bay	34.8603	−78.9391	50.8	180–200	27.2 ± 2.8	CAM
UW2787 (core 2)	Moore et al. (2016)	North Carolina	Herndon Bay	34.8602	−78.9377	52.3	300–330	29.6 ± 3.1	CAM
UW2788 (core 4)	Moore et al. (2016)	North Carolina	Herndon Bay	34.8599	−78.9354	52.1	160–190	36.7 ± 4.1	LC
unspec.	Ivester et al. (2003) and Brooks et al. (2010)	South Carolina	Big Bay	33.7676	−80.4590	58	60–75	2.1 ± 0.3	unspec.
unspec.	Ivester et al. (2003) and Brooks et al. (2010)	South Carolina	Big Bay	33.7661	−80.4584	58	60–75	11.2 ± 0.9	unspec.
unspec.	Ivester et al. (2003) and Brooks et al. (2010)	South Carolina	Big Bay	33.7654	−80.4647	58	60–75	25.2 ± 1.9	unspec.
unspec.	Ivester et al. (2003) and Brooks et al. (2010)	South Carolina	Big Bay	33.7709	−80.4798	59	60–75	35.7 ± 2.6	unspec.
unspec.	Ivester et al. (2003) and Brooks et al. (2010)	South Carolina	Unnamed bay near Big Bay	33.7643	−80.4683	59	60–75	20.4 ± 1.6	unspec.
unspec.	Moore et al. (2012)	South Carolina	Flamingo Bay	unspec.	unspec.	unspec.	35	5.0 ± 0.5	MAM
unspec.	Moore et al. (2012)	South Carolina	Flamingo Bay	unspec.	unspec.	unspec.	50	9.2 ± 1.0	MAM
unspec.	Moore et al. (2012)	South Carolina	Flamingo Bay	unspec.	unspec.	unspec.	65	11.5 ± 1.3	MAM
unspec.	Moore et al. (2012)	South Carolina	Flamingo Bay	unspec.	unspec.	unspec.	78	15.5 ± 1.8	MAM
unspec.	Moore et al. (2012)	South Carolina	Flamingo Bay	unspec.	unspec.	unspec.	95	13.1 ± 1.7	MAM

(continued)