TOWARDS A BETTER UNDERSTANDING OF LONGER-TERM AEOLIAN PROCESSES ON EARTH VIA DYNAMICAL DOWNSCALING.  T. I. Michaels\textsuperscript{1, 1}Southwest Research Institute, 1050 Walnut St Suite 300, Boulder, CO 80302, USA, tmichael@boulder.swri.edu.

Introduction: Dunes and other aeolian surface features are the net product of a complex time-series of winds and other surface/atmosphere conditions. Timescales important to the creation, maintenance, and evolution of such surface features range from less than one second to tens of years or more. In particular, larger-volume particulate bedforms such as dunes often have response/evolution timescales (i.e., the characteristic time required to significantly change their shape/orientation) that are conveniently measured in months, years, or even decades. Furthermore, conditions that support significant aeolian transport commonly occur only episodically and/or stochastically (e.g., 2 months out of 12, or 1 year out of 4; as opposed to quasi-continuously) – and thus are perhaps best described/characterized by more complex/advanced statistical methods, not simple averages and variances.

Clearly then, understanding the longer-term (months to decades) evolution of dunes and other aeolian surface features requires atmospheric time-series of comparable duration and relevant temporal/spatial resolution. Unfortunately, many locations on Earth that are particularly interesting from an aeolian surface interaction perspective lack any in situ (or even nearby) environmental measurements. Even among those sites that do have such information available, the duration, continuity, and/or self-consistency of the data is often less than satisfactory. In spite of numerous limitations, is there a practical way to procure/generate such datasets relevant to aeolian processes from whatever meteorological measurements were gathered/preserved by humankind in years past?

Infused with actual measurements: By the mid-1990s scientific computing capabilities were sufficient to enable the construction of so-called “reanalysis datasets”, spanning multiple decades. Examples of such projects include the NCEP/NCAR Reanalysis I (1948-present; [1]), the ECMWF reanalyses (1957-present; [2], [3]), and the NOAA/CIRES 20CRv2 (1871-present; [4]). These datasets are created by running a global numerical weather/climate model forward in time from a past year, folding in all appropriate worldwide historical observational data as it marches forward. In a sense, the model is performing a type of interpolation on the observational data in a manner consistent with known physical principles.

These datasets are lower-resolution, with typical grid-spacings in the 60-240 km range and information every 6 hours. Quality of the reconstruction varies with time and space, with larger uncertainties within observational data “voids” (e.g., the southern Pacific Ocean) and during the pre-meteorological-satellite era (i.e., before 1979). Inherent caveats and limitations aside, such datasets are substantially better than nothing – the focus of this discussion now pivots to “improving” their temporal and spatial resolution.

Increased resolution in time and space: Dynamical downscaling is a process in which higher-resolution limited-area (i.e., not global) numerical weather/climate models are used to better resolve/predict environmental conditions in an area of interest. For the reconstruction of historical conditions, a lower-resolution re-analysis dataset provides initial and boundary conditions for the limited-area mesoscale model – this is known as Type 2 dynamical downscaling (as defined in [5]). This allows important smaller-scale topography and processes to be taken into account, while the solution as a whole remains substantially constrained by the copious historical observational data used to generate the reanalysis dataset.

It has been demonstrated that such a process can yield meaningful information [6] that is unavailable otherwise. The results are infused with and guided by actual measurements, but not unnecessarily limited by them. However, it should be noted that significant amounts of computational time (and related data storage and processing) are required for each area of interest.

Preliminary results: The work presented will concentrate on an area that includes the Grand Falls, Arizona dunes, due to their relevance to the meeting. The historical reanalysis time-series and dynamically downscaled output show important day-to-day, seasonal, and multi-year variabilities in estimated saltation strength, direction, and duration, among other quantities.

References: