

GRAND FALLS DUNE FIELD, NORTHERN ARIZONA: RIPPLE FIELD IMAGING AND METEOROLOGICAL DATA RELEASE FOR 2021. A. L. Gullikson¹, T. N. Titus¹, K. E. Williams¹, and G. Cushing¹, ¹U.S. Geological Survey, Astrogeology Science Center (2255 N. Gemini Dr., Flagstaff, AZ, 86001) agullikson@usgs.gov.

Introduction: Grand Falls dune field (GFDF) is located on the Navajo Nation, ~70 km NE of Flagstaff, AZ. This active dune field displays a range of morphologies, including barchans, smaller dunes, and ripples, and is bimodal both in composition and grain size. The felsic, finer-grained component is likely derived from the Little Colorado River, and the coarse-grained mafic component (basaltic grains) is sourced from nearby cinder cones [1].

GFDF is an excellent analog site for both active dunes on Mars and other planetary bodies that have dune-like features (e.g., Venus and Titan). This work focuses on a ripple field located within the greater dune field, and allows us to study these features at a smaller scale, with little to no influence of vegetation. Through this work we will be able to record, and place better constraints on atmosphere-surface interactions.

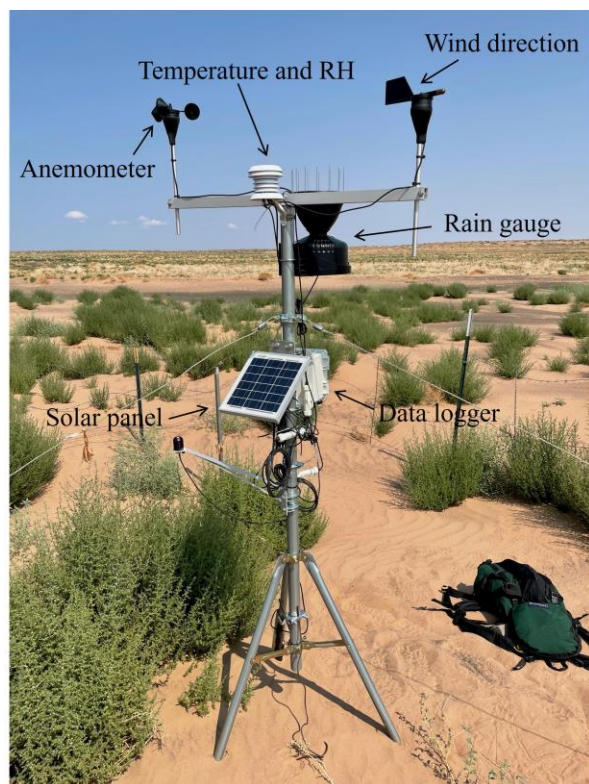


Figure 1. Meteorological station at GFDF, features are labeled. Photo credit: Kaj Williams.

Methods: We have set up a meteorological (met) station within the dune field that records temperature, barometric pressure, relative humidity (RH), wind di-



Figure 2. Ripple field site. Images from camera GF60. Cameras record air temperature (both in Fahrenheit and Celsius), the date, time, and camera name, and are included on the bottom of each image.

rection, wind speed (2 m above ground level), solar radiation, and precipitation (Fig. 1). Data are collected every 15 minutes. Next to the met station, we deployed temperature and RH sensors at five different depths: 1, 6, 12, 24, and 48 cm to capture diurnal temperature and humidity variations. These data were collected every 30 minutes. We have also set up nine cameras that surround the met station and near an active ripple field (Fig. 2), and take images every 10 minutes to monitor activity. The ripple field is ~7 m south of the met station. In addition to monitoring ripple migration, we

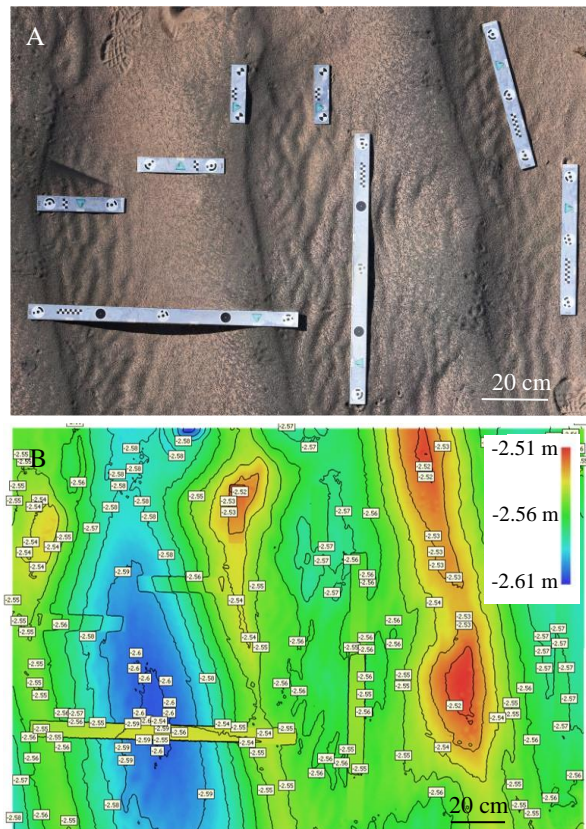


Figure 3. Photogrammetry of ripples. A) is the orthorectified image of the ripples. Scale bars are used to assist in creating the DEM. B) is the DEM final product.

also created a digital elevation model of the ripples to quantify fine-scale topography within a bi-modal grain size distribution by taking a series of images using a NIKON D250 camera and processing the data using Agisoft Metashape Professional (Fig. 3). We visited this site several times throughout the year to maintain the equipment, collect data, and survey the status of the ripple field. Imagery data, soil temperature and humidity profiles, and meteorological data have been collected for the entire year of 2021.

Data Release 2021: We have divided these data collections into two separate data releases as described below. These data collections are being published through ScienceBase, a U.S. Geological Survey trusted digital repository, which provides a reliable and easily accessible storage location for the large amount of metadata collected for this survey.

Data Release December 2020 to April 2021 (2021a): includes meteorological data, subsurface temperature and RH, imaging of the ripple field from one camera (GF60), and photogrammetry ([link to data release](#)) [2].

Data Release April 2021 to December 2021 (2021b): includes meteorological data, and imaging from all nine cameras and is currently in the process of

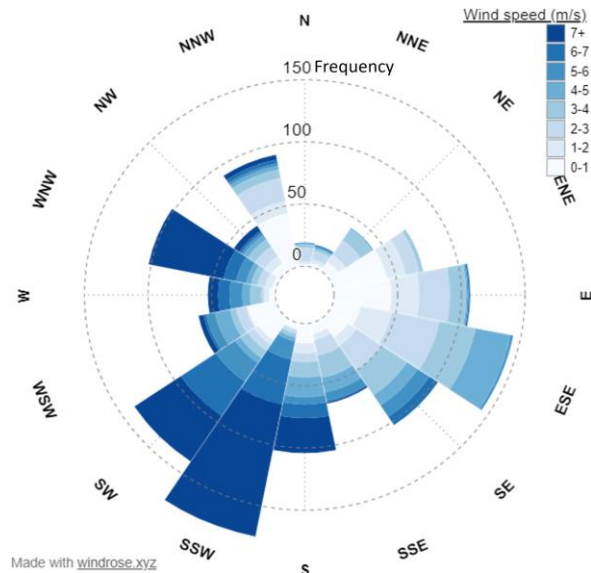


Figure 4. Rose diagram depicting wind direction and wind speed during March 1st - 14th. Frequency represents the number of data points recorded for a particular wind speed and wind direction. Color represents wind speed, binned at 1 m/s intervals. Graph was made using windrose.xyz.

being published. Issues with the subsurface temperature and RH sensor batteries occurred during the latter half of the year, therefore this dataset is not included in the 2021b data release.

Preliminary Results: Data collected here can be used to quantify ripple migration [3] and study changing morphology of a ripple field in a bimodal setting, both in composition and grain size. Dependent on the wind speed and direction, a ripple field's morphology can drastically change over a short period of time (e.g., 2 weeks; Fig. 2). March had the highest wind speeds recorded over the entire year, along with the highest number of individual wind events. Eight separate wind events reached wind speeds >9 m/s, and six of those events occurred between 3/1/2021 and 3/14/2021. Figure 2 depicts the changing morphology of the ripple field in that two-week time span, and Fig. 4 shows the different wind directions that occurred over that same period, with color representing wind speeds binned at 1 m/s intervals.

Acknowledgments: Fieldwork on the Navajo Nation was conducted under a permit from the Navajo Nation Minerals Department. Any persons wishing to conduct geologic investigations on the Navajo Nation must apply for and receive a permit from the Navajo Nation Minerals Department, P.O. Box 1910, Window Rock, Arizona 86515, telephone # (928) 871-6587.

References: [1] Hayward, R. K. et al. (2010) *2nd Int. Plan. Dunes Wrkshp.*, Abstract #200. [2] Titus, T. N., et al. (2021) USGS data release. [3] Gullikson, A. L. (2021) *Terr. Analog. Wrkshp.*, #8065.