FIRST 2018 RESULTS FROM WIND PROFILES FOR MEGARIPPLES IN THE PUNA OF ARGENTINA.

J. R. Zimbelman[1], S. L. de Silva[2], M. G. Spagnuolo[3] and K. D. Runyon[4], [1]CEPS/NASM, Smithsonian Institution, Washington, DC, zimbelmanj@si.edu; [2]Coll. of Earth, Ocean, and Atm. Sci., Oregon St. Univ., Corvallis, OR; [3]IDEAB, UBA-CONICET, Buenos Aires, Argentina ;[4]Johns Hopkins Applied Physics Lab., Laurel, MD.

Introduction: In November of 2018 we collected new wind profile data at several settings within and around fields of megaripples in the Puna high desert of Argentina (see [1] for setting). Here we present initial results obtained on the first day at a location called Campo Piedra Pomez (CPP). Wind data were also collected at CPP West, Lago Purulla, Purulla, and Incahuasi; we intend to include first results from these locations in the conference presentation.

Setting for CPP measurements: On the first day in the field we set up two portable wind towers near the downwind edge of a megaripple field immediately east of the eroded ignimbrite that gives CPP its name. Each tower consisted of connected pole segments that gives a tower height of about 2.8 m, to each of which five data logging anemometers were attached at a logarithmic height spacing (Fig. 1). Tower 1 was positioned 22 m

Figure 1. Context for the tower locations at CPP site, before commencement of data logging. Tower 1 (near field) is 2.8 m tall. Anemometer controllers were mounted on a tripod behind the tower. Note logarithmic height distribution of sensor heads. Tower 2 is about 50 m in the distance (at right).

downwind of a 33-cm-high megaripple, part of a field of megaripples extending hundreds of m upwind, with the entire surface covered by dark lithic fragments in the small gravel size range (Fig. 2). Tower 2 was located about 50 m south of Tower 1 where a lithic gravel plain extended hundreds of m upwind (Fig. 3). The tower location and anemometer heights were chosen based on guidelines given by Wieringa (1993 [2], the most important of which are that the tower be located where the upwind fetch is homogeneous in surface roughness elements for >200 m, the tower is downwind >15 times

Figure 2. Vertical view of lithic fragments near crest of the megaripple upwind of Tower 1 (see Fig. 1).

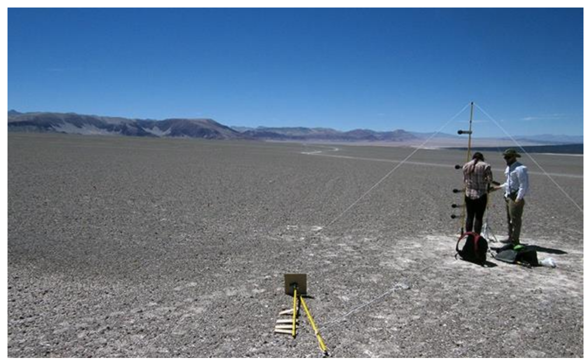

Figure 3. Tower 2 during setup, with a flat gravel surface for hundreds of m upwind of the tower.

the height of the major roughness elements, the lowest anemometer is positioned at a height above the surface at least 20 times the expected roughness length, and the entire region is not on a prominent regional slope. Each anemometer recorded wind speed at a 2 sec interval.

CPP wind data: Tower 1 started data logging slightly before Tower 2, but the distinctive recorded wind gust patterns allowed us to correlate data from both towers to within one 2-sec recording interval (Figs. 4 and 5). Here we present results for the first coincident 20 minute time period (600 data points) recorded at each tower; data records extend >40 min beyond this initial period, and these data will be addressed in subsequent analyses. Previous studies indicated a roughness length of about 1.5 cm for the CPP [3], so the bottom anemometer was mounted 40 cm above the surface. Wind data were averaged for each anemometer over the 20 min period in order to investigate wind conditions that ranged between 0 and 12 m/s (see Figs. 4 and 5 and Table 1).

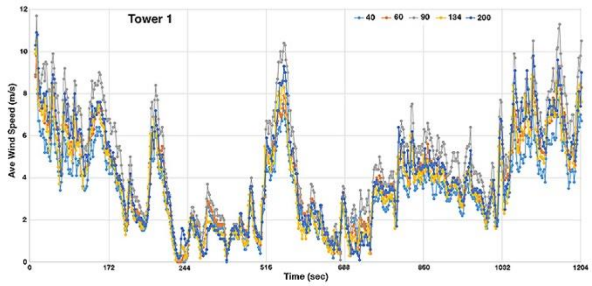

Figure 4. Tower 1 plot of wind speed coincident in time with Tower 2 data (compare with Fig. 5).

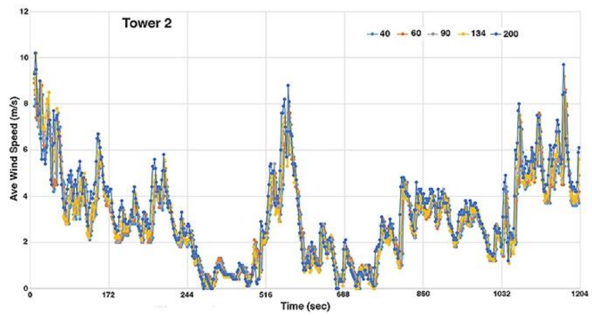

Figure 5. Tower 2 plot of wind speed coincident in time with Tower 1 data (compare with Fig. 4).

Table 1. Average and standard deviation for anemometers on the two towers at CPP, for a concurrent 20 minute time interval (see Figs. 4 and 5) on 11/19/18.

Height	40 cm	60 cm	90 cm	134 cm	200 cm
Tower 1					
Ave	3.32	3.96	4.86	3.76	4.07
Std Dev	1.79	2.15	2.64	2.25	2.39
Tower 2					
Ave	2.92	2.98	3.00	3.04	3.28
Std Dev	1.76	1.82	1.90	2.00	2.05

Tower 2 showed a nice progression of wind speed with height but anemometers 2 and 3 on Tower 1 were consistently higher than anticipated from winds documented at the other three anemometers; this trend continued through the entire record at the CPP site. We were concerned that the two anemometers may have not been operating correctly, but a controlled comparison conducted after the field work showed the anemometers reported consistent wind speeds within a 0.15 m/s standard deviation, which is less than the 0.2 m/s accuracy of the instruments. We determined a best-fit logarithmic profile for the data in Table 1, from which a projected zero wind velocity at a height of 4.3 cm for Tower 1 (with a correlation coefficient r of 0.37), interpreted to be the roughness length, and 1.37 cm height for zero velocity for Tower 2 (r = 0.89). Removing anemometer 2 from the fit for Tower 1 gives a roughness length of 7.69 cm with r = 0.72, but removing both anemometers 2 and 3 from a fit for Tower 1 gives an unrealistic roughness length of only 0.023 cm even though the fit is improved (r = 0.98). Using only the top two anemometers at Tower 1 gives a roughness length of 1.04 cm (r = 1.00), a value consistent with the roughness length of the gravel plain at Tower 1. Averaging over the entire 1.5 hr recorded period at the CPP site, the five anemometers of Tower 1 give a roughness length of 3.33 cm (r = 0.49). The megaripples therefore appear to add several cm to the roughness length represented by the gravel particles alone (Tower 2).

Discussion: Why are the recorded wind speeds high for anemometers 2 and 3 of Tower 1? Given our post-trip tests we do not think that this is the result of malfunctioning instruments, unless somehow the conditions at the Puna could have altered only those two instruments relative to their function under normal conditions back in the US. If the stated instrument accuracy is taken as the probable standard deviation, the values from anemometers 2 and 3 are three and five sigma, respectively, above what would be expected from the other three anemometers on Tower 1. Perhaps some form of wave phenomenon developed downwind of the megaripple field, somewhat analogous to atmospheric lee waves downwind of mountain ranges [4], although it is difficult to extrapolate atmospheric conditions present at multi-km scale to near-surface conditions at decameter scale. We will explore additional possible explanations as we process the rest of the wind data collected during the 2018 trip, but we point out that field notes indicate unusual values, either higher or lower than expected, for anemometers 1 to 3 for observations within other megaripple locations in the Puna. Since the anemometers do not appear to be malfunctioning, we think it is prudent to explore possible unexpected wave phenomena downwind of some long fetches of large megaripples in the Puna. As more data are evaluated, we hope that the situation will become more clear.

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References: [1] de Silva S. L. et al. (2013) *GSAB, 125, 11/12*, 1912-1929. [2] Wieringa J. (1993) *Boundary Layer Met., 63*, 323-363. [3] Zimbelman J. R. et al. (2016) *Icarus, 266*, 306-314. [4] Wurtele M. G. et al. (1993) *NASA Contractor Rpt 186024*.