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A Closer, Even Closer Look at Near-Surface and Surface-Layer Temperature Changes During the August 2017 Total Solar Eclipse

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Abstract

As part of an two-day and overnight science event at Linn-Benton Community College (LBCC) in Albany, Oregon in August 2017, participants from Lane Community College (LCC) also attended the Great American Total Solar Eclipse Festival. LBCC was in the zone of totality for nearly two minutes, while LCC (in Eugene, about 40 miles south) was only near totality (99%) at best. Two days of science activities were conducted at LBCC for the general public, and several individuals and groups conducted real-time science experiments, including participants from as far away as South America and Australia. This site was the westernmost observational location for totality in the United States, as Oregon's reputation for fine weather in summer helped convince many eclipse-watchers to congregate here. The festival included many citizen science activities and discussions of new elements of the GLOBE program.

Most participants camped out overnight on the grounds, and our team had established an observation site the previous afternoon to measure below surface, skin, and near-surface temperature observations as well as shelter-height air temperature. We compare our Albany observations with our campus weather station in Eugene, where we also measured insolation. Our station normally reports every 10-15 min as part of the Citizen Weather Observer Program (CWOP), but we increased our measurement interval to 1 min for this experiment.

The observations we report here are, to our knowledge, are illustrative of the steepest near-surface temperature lapse rates and temperature changes over short periods of time thus far reported at any of the American sites, owing in large part to the long period of (typical) summer seasonal drought in the Willamette Valley and very dry atmosphere (and temporarily aerosol-free) characterizing August 2017. Other observations of atmospheric phenomena were collected as well, many following protocols established by GLOBE.

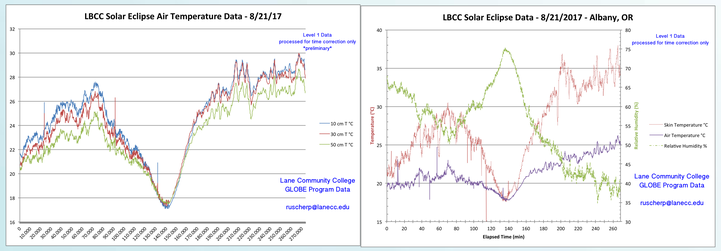
Panoramic view of main instrument site for telescopes, instrumentation, etc., at Linn-Benton Community College (LBCC, Albany, Oregon) as setup begins for the eclipse festival, attended by well over 500 people over a two-day period.

GLOBE Protocols Used

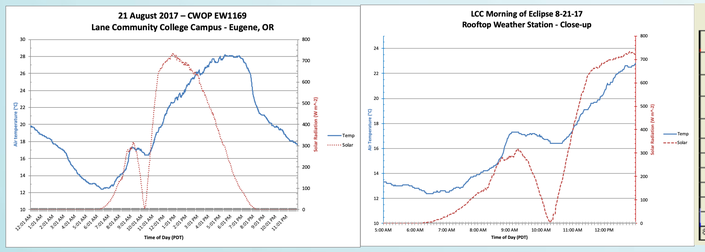
- Cloud/contrail observations
- Aerosol observations (sun photometer)
- Temperature and Relative Humidity observations
- Automated weather and soil station observations

We had intended to conduct an on-site teacher-training workshop, but an injury to the GLOBE lead three weeks prior to the eclipse event prevented it from taking place. Nevertheless, we provided weather briefings the night before, and demonstrations of how rather inexpensive technology, well-sited and sheltered, can provide useful information in environmental monitoring; instead of a teacher workshop, we demonstrated observations for participants in an informal science education setting. Many educators (formal and informal) and students participated. My family provided tremendous assistance and collaboration during the event. My appreciation also to Todd Stuhr and Rosie Kirwin at LCC for their assistance, and the entire staff at LBCC for their collaboration and assistance (in particular, Eric Styles, Greg Mulder, and Brian Reed).

Measurements



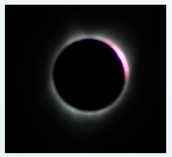
Albany, Oregon data (LBCC), August 21, 2017. Left: air temperature (°C) at 10-, 30-, and 50 cm above ground during eclipse event. Right: Air and soil temperature (°C) and relative humidity (%) during eclipse.



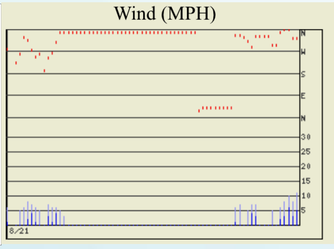
Eugene, Oregon data (LCC Roof, CWOP EW1169), August 21, 2017; diurnal change in air temperature (°C) and relative humidity (left) and close-up during eclipse (right); taken from Davis Vantage Pro Plus weather station.

Experimental Setup

(Top) The near-surface instrument set-up at LBCC on eclipse day. Inexpensive thermistor radiation shields were used for all temperature and humidity recordings, along with Vernier probes and data loggers. Data were collected at 0.1 Hz during the event. (Bottom) – overall setup including "air" temperature and humidity station.



Larger photos of diamond ring and eclipse waves are posted during poster session



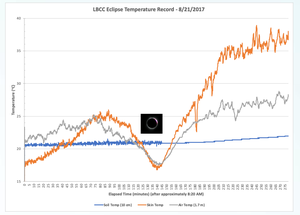
1-minute wind data during near-totality in Eugene; note the loss of wind/turbulent eddies; data captured from CWOP, http://www.findu.com/ (wind direction indicator, red; wind speed, blue (ms^{-1}); gusts, cyan).

Findings

Pre-eclipse cooling rates:

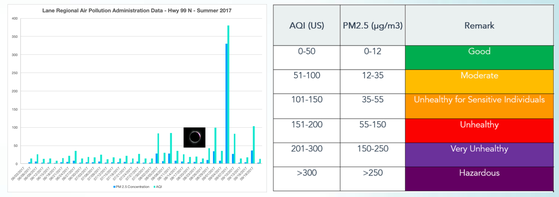
- Skin: 21.8 K h^{-1}
- 10 cm: 9.4 K h^{-1}
- 30 cm: 8.3 K h^{-1}
- 50 cm: 6.7 K h^{-1}
- Air (1.5 m): 4.8 K h^{-1}
- LCC Roof: 1.6 K h^{-1}

Net lapse rates near surface
Are > 5 K $\underline{m}^{-1}$ compared to autoconvective lapse rate of 34.2 K $\underline{km}^{-1}$
and adiabatic lapse rate of 9.8 K km^{-1}



Simultaneous 10 cm soil temperature, skin temperature (grass), and air temperature (~1.5 m)

Skin temperature impacted by shadow as someone walked by



AQI (US)	PM2.5 (µg/m3)	Remark
0-50	0-12	Good
51-100	12-35	Moderate
101-150	35-55	Unhealthy for Sensitive Individuals
151-200	55-150	Unhealthy
201-300	150-250	Very Unhealthy
>300	>250	Hazardous

Eclipse watchers were fortunate that the smoke from nearby forest fires did not impact visibility during the time of the eclipse. Data from EPA Airnow archive.

Dust devils on the drive back south, a common Willamette Valley phenomenon in summer; eclipse-driven wave patterns were evident due to small amounts of aerosol from nearby forest fires, as the sky darkened near totality

Scan to see a copy of this poster!

Useful References

AirNow Data Archive (US EPA) - https://www.epa.gov/outdoor-air-quality-data

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GLOBE – http://www.globe.gov/ (Teacher's Guide, Learning Activities, Elementary GLOBE, NGSS, …)

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