NSSL Mobile Lidar Data – TORUS 2019 Deployment

Data Authors:

Elizabeth Smith
OU-CIMMS/NOAA-NSSL
elizabeth.n.smith@ou.edu
elizabeth.smith@noaa.gov

Mike Coniglio
NOAA-NSSL
michael.coniglio@noaa.gov

General Information:

The NSSL mobile lidar is a Halo Photonics Streamline XR mounted in the bed of a truck which also supports mobile mesonet observations and radiosonde releases. Data are generated in files associated with UTC date-stamps. As such, any deployment crossing 00Z will have associated data in two files, one for each day. During each deployment, care was taken to minimize any un-levelness of the lidar. The heading of the lidar was also recorded such that winds should already be rotated to their physical wind direction. Except in cases when we chose to conduct Range Height Indicator (RHI) scans or to conduct continuous vertical stares, our **regular scan strategy consisted of a Plan Position Indicator (PPI) scan every 2 minutes with vertical stares in between.** All of our scans were completed in step-stare mode. The PPI scans are conducted at 70 deg elevation with 12 points in azimuth. We apply the Velocity Azimuthal Display (VAD) technique to the PPI scans to retrieve a profile of the horizontal wind. We have 18-m range gate spacing (first useable range gate ~40m AGL), and a Doppler bandwith of ± 19 m/s. Summary details about each deployment are available in the tables below with more information in the TORUS_2019 Field Catalog (http://catalog.eol.ucar.edu/torus_2019) under Reports>Mobile Lidar/Sounding Summary.

File Types:

All observations are provided in the netcdf format. There are three possible files for each deployment: *.*stare*.nc, *.*VAD*.nc, and *.*RHI*.nc. Most deployments will include stare and VAD files as per the typical scan strategy described above, some will include RHI files, and some may contain only stare files (continuous stare missions). Variables included in each file are discussed below. Italicized variables are two-dimensional (time, height or time, range).

All files will include the following variables:

1. Time – epoch time, seconds since 00:00:00UTC 1 Jan 1970
2. Hours – time, hours since 00 UTC on this day
3. Lat – degrees latitude, latitude position of the mobile lidar *may change during day*
4. Lon – degrees longitude, longitude position of the mobile lidar *may change during day*
5. Alt – meters, ground elevation position of the mobile lidar *may change during day*
6. *Intensity – unitless, measurement signal-to-noise ratio+1 (1.01 is a good threshold to use for filtering out noisy data)*

Stare files will additionally include:

1. Height – meters, height AGL (above lidar)
2. *w – m/s, vertical velocity directly measured as radial velocity from vertical stare*

VAD files will additionally include:

1. Height – meters, height AGL (above lidar)
2. *u – m/s, u-component velocity*

3. *v – m/s, v-component velocity*
4. *w – m/s, vertical velocity as retrieved from VAD method*
5. *Wind speed – m/s, horizontal wind speed*
6. *Wind direction – deg, horizontal wind direction*
7. *RMS – m/s, root mean square error of the derived radial velocity compared to the observed radial velocity*
8. *R_sq – Coefficent of determination comparing the derived radial velocity to the observed radial velocity. Can be thought of as a measure of homogeneity in the wind field (VAD method assumes homogeneity, which is often not true). See E. Paschke et. al. 2015 section 2.2.4.*

RHI files will additionally include:

1. Range – meters, distance from lidar
2. Elevation – degrees, elevation angle of scan
3. Azimuth – degrees, azimuth angle of scan
4. *Vr – m/s, radial velocity*
5. *Vh – m/s, horizontal component of the radial velocity*

Special Considerations:

1. Doppler lidar observations are instantaneous (or near instantaneous) observations of the wind field. Depending on the user's application, instantaneous measures may not be appropriate (e.g., comparison to model output, comparison to more coarse wind observations, etc.). In such cases, we recommend applying some type of smoothing to the data in time and/or height. Often, a simple gaussian smoothing is sufficient. Take care to consider what the lidar observation actually is and if it is representative of the focus of the application at hand. If you have questions or concerns about how to use these data for your application, we are happy to discuss it with you and provide any guidance we can.

2. Doppler lidar observations are highly dependent on the aerosol load, cloud base height, and the presence of precipitation. The lidar beam cannot penetrate cloud or precipitation, and the strength of the signal depends on having enough scatterers present. As such, the maximum height range of the observation varies day-to-day, and even within each deployment.

3. During post-processing, we identified an error in the onboard signal processing that Halo completes when producing output files. The original signal processing method was mislabeling each ray with the azimuth of the ray immediately before it. In stare or RHI mode, this was not an issue since azimuth was not changing. For PPI scans, this error resulted in wind directions that were 30 degrees too positive. After discussion with the manufacturer, we have rotated all wind observations 30 degrees counter clockwise. This has resulted in new wind direction and *u*- and *v*-component decomposition. This also means the TORUS quicklook plots (on EOL's field catalog) of wind direction are 30 degrees too positive.

Deployment Information:

More detailed deployment summaries and non-QAed quicklook plots of all observations are provided on the field catalog. Basic summary information is included in Tables 1 and 2 below.

Table 1. Deployment information during May 2019. Dates are relative to deployment start.

Date	517	518	520	522	523	524	525	526	527	528
1 Lat (deg)	40.5409	36.8983	34.3205	34.7975	36.1012	33.935	33.9722	38.2376	40.1704	39.665
1 Lon (deg)	-100.2883	-98.3651	-99.509	-97.6	-100.7638	-100.847	-101.6964	-102.7421	-103.5846	-98.1164
1 Alt (m)	786	366	421	322	909	790	1012	1201	1310	454
1 Start (Z-hr)	22.4833	22.4333	20.45	21.383	22.383	20.233	19.35	21.433	19.817	22.883
1 End (Z-hr)	23.45	23.35	21.633	21.65	23.117	20.767	20.383	22.015	20.083	23.483
2 Lat	N/A	36.6201	34.6302	34.9847	36.02	N/A	34.067	N/A	40.2995	N/A
2 Lon	N/A	-98.1616	-99.5615	-97.3716	-100.483	N/A	-101.3227	N/A	-103.5933	N/A
2 Alt	N/A	383	440	334	780	N/A	972	N/A	1280	N/A
2 Start	N/A	23.9	21.85	22.667	23.433	N/A	23.1	N/A	20.35	N/A
2 End	N/A	0.35	22.217	22.95	1.933	N/A	23.9	N/A	21.167	N/A
3 Lat	N/A	N/A	34.7101	N/A	N/A	N/A	N/A	N/A	40.2488	N/A
3 Lon	/A	N/A	-99.56	N/A	N/A	N/A	N/A	N/A	-102.6997	N/A
3 Alt	N/A	N/A	458	N/A	N/A	N/A	N/A	N/A	1239	N/A
3 Start	N/A	N/A	23.1	N/A	N/A	N/A	N/A	N/A	22.867	N/A
3 End	N/A	N/A	23.65	N/A	N/A	N/A	N/A	N/A	23.483	N/A
4 Lat	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40.5372	N/A
4 Lon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-101.7797	N/A
4 Alt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1029	N/A
4 Start	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.733	N/A
4 End	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.133	N/A
5 Lat	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40.5521	N/A
5 Lon	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-101.6288	N/A
5 Alt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1001	N/A
5 Start	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.333	N/A
5 End	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.867	N/A

Table 2. Deployment information during June 2019. Dates are relative to deployment start.

Date	602	607	608	611	613	614	615	602	607	608
1 Lat (deg)	38.1012	37.0923	39.3348	37.112	36.4571	36.4098	34.9832	38.1012	37.0923	39.3348
1 Lon (deg)	-102.6179	-102.5798	-101.8743	-100.9404	-103.1707	-100.8023	-102.4034	-102.6179	-102.5798	-101.8743
1 Alt (m)	1101	1327	1150	875	1532	893	1195	1101	1327	1150
1 Start (Z-hr)	19.3	22.933	20.833	19.667	20	19.667	22.067	19.3	22.933	20.833
1 End (Z-hr)	21.517	23.817	22.017	19.95	21.883	22.633	22.8	21.517	23.817	22.017
2 Lat	37.0923	N/A	39.3376	36.8595	36.4479	N/A	35.1017	37.0923	N/A	39.3376
2 Lon	-102.5798	N/A	-101.3712	-101.0002	-102.7926	N/A	-102.5651	-102.5798	N/A	-101.3712
2 Alt	1327	N/A	1032	860	1330	N/A	1254	1327	N/A	1032
2 Start	23.05	N/A	0.017	20.7	0.55	N/A	23.1	23.05	N/A	0.017
2 End	23.8	N/A	0.617	21.5	1.717	N/A	23.767	23.8	N/A	0.617
3 Lat	36.7708	N/A	39.2945	37.6163	N/A	N/A	35.2652	36.7708	N/A	39.2945
3 Lon	-102.5175	N/A	-101.3545	-99.3218	N/A	N/A	-102.7436	-102.5175	N/A	-101.3545
3 Alt	1272	N/A	1044	684	N/A	N/A	1272	1272	N/A	1044
3 Start	0.233	N/A	0.717	23.867	N/A	N/A	0.083	0.233	N/A	0.717
3 End	1.267	N/A	1.217	1.483	N/A	N/A	0.333	1.267	N/A	1.217
4 Lat	N/A	N/A	39.0709	N/A	N/A	N/A	N/A	N/A	N/A	39.0709
4 Lon	N/A	N/A	-101.2398	N/A	N/A	N/A	N/A	N/A	N/A	-101.2398
4 Alt	N/A	N/A	1007	N/A	N/A	N/A	N/A	N/A	N/A	1007
4 Start	N/A	N/A	1.667	N/A	N/A	N/A	N/A	N/A	N/A	1.667
4 End	N/A	N/A	2.1	N/A	N/A	N/A	N/A	N/A	N/A	2.1