1. **Dataset Title –** NOAA PSL radiosonde and thermodynamic profiles retrieved from a combination of active and passive remote sensors and numerical weather prediction models with the optimal estimation physical retrieval TROPoe at Platteville, CO, USA

2. **Dataset Author(s) –** Laura Bianco (laura.bianco@noaa.gov).
Others: Bianca Adler (bianca.adler@noaa.gov)

3. **Time of Interest –**09/27/2021, 09/28/2021, 10/05/2021, 12/22/2021, 01/10/2022, 01/12/2022.

4. **Area of Interest –** Platteville (CO): Lat: 40518; Lon: -104.73; Alt: 1503 m.

5. **Data Frequency –** Thermodynamic Retrievals: 5 minutes

6. **TROPoe information –**

- Algorithm code = TROPoe Retrieval Code (formerly AERIoe).
- Algorithm authors = Dave Turner, NOAA Global Systems Laboratory (dave.turner@noaa.gov), Josh Gebauer, NOAA National Severe Storms Laboratory / CIWRO (joshua.gebauer@noaa.gov), Tyler Bell, NOAA National Severe Storms Laboratory / CIWRO (tyler.bell@noaa.gov).
- Algorithm comment = TROPoe is a physical-iterative algorithm that retrieves thermodynamic profiles from a wide range of ground-based remote sensors. It was primarily designed to use either infrared spectrometers or microwave radiometers as the primary instrument, and include observations from other sources to improve the quality of the retrieved profiles. Original code was written in IDL and is described by the "AERIoe" papers listed below.
- Algorithm additional comment = Code was ported to Python, and packaged into a container with the needed radiative transfer models and other required inputs. The TROPoe code is available via DockerHub.
- Algorithm disclaimer = 'TROPoe was developed by NOAA and is provided on an as-is basis, with no warranty.
- Algorithm code version = 0.6.28
- Algorithm package version = TROPoe-0.6.ddt5

7. **General Dataset Description –**
This dataset contains daily files with thermodynamic profiles retrieved with the Tropospheric Remotely Observed Profiling via Optimal Estimation physical retrieval (TROPoe, Turner and Löhnert 2014; Turner and Blumberg 2019; Turner and Löhnert 2021). It includes retrieved temperature and humidity profiles from various combinations of input data collected at Platteville, CO, by passive and active remote sensing instruments, in-situ surface platforms, and numerical weather prediction models. Among the employed instruments are Microwave Radiometers (MWRs), Infrared Spectrometers (IRS), Radio Acoustic Sounding Systems (RASS), ceilometers, and surface sensors. TROPoe uses brightness temperatures and/or radiances from MWRs and IRSs, as well as other observational inputs (virtual temperature from the RASS, cloud base height from the ceilometer, pressure, temperature, and humidity from the surface sensors) in a physical-iterative retrieval approach. This starts from a climatologically reasonable profile of temperature and water vapor, with the radiative transfer model iteratively

adjusting the assumed temperature and humidity profiles until the derived brightness temperatures and radiances match those observed by the MWRs and/or IRSs instruments within a specified uncertainty, as well as within the uncertainties of the other observations, if used as input. TROPoe is used with different observational input combinations, some of which also include information higher than 4 km above ground level (agl) from the operational Rapid Refresh numerical weather prediction model (Benjamin et al. 2021). These temperature and humidity retrievals can be assessed against independent collocated radiosonde profiles also included in the dataset.
Additional input data in TROPoe are cloud base height from a collocated ceilometer, temperature, water vapor mixing ratio, and pressure from collocated near-surface measurements and from hourly analysis profiles from the operational Rapid Refresh (RAP,) weather prediction model at the closest grid point. The latter are used only outside the atmospheric boundary layer (ABL) above 4 km above ground level (AGL) and provide information in the middle and upper troposphere where little to no information content is available from the infrared radiances.
In addition to these temporally resolved input data, TROPoe requires an a priori dataset (prior) which provides mean climatological estimates of thermodynamic profiles and specifies how temperature and humidity covary with height as an input (for details see e.g. Djalalova et al. 2022). The prior is a key component of the retrieval and provides a constraint on the ill-posed inversion problem. For this study, we computed the prior from operational radiosondes launched near Denver, CO.

Selected basic variables are (many more provided):

Name	Dimension	Unit
base_time	Single value	Seconds (since 00 UTC 1 Jan 1970)
time_offset	Time	Second (since base_time)
hour	Time	Hours since 00UTC this day
height	Height	km AGL
temperature	Time, Height	C, temperature
waterVapor	Time, Height	g/kg, water vapor mixing ratio
theta	Time, Height	K, potential temperature
pressure	Time, Height	hPa, pressure
rh	Time, Height	%, relative humidity
dewpt	Time, Height	C, dew point temperature
thetae	Time, Height	K, equivalent potential temperature
sigma_temperature	Time, Height	C, 1-sigma uncertainty temperature
sigma_waterVapor	Time, Height	g/kg, 1-sigma uncertainty water vapor
cdfs_temperature	Time, Height	cumulative degrees of freedom for temperature
cdfs_waterVapor	Time, Height	cumulative degrees of freedom for water vapor

The time stamp of all data is in UTC.
Bold variables are the main retrieved profiles, from which the other variables are derived.
Note that the vertical resolution of the retrieved profiles decreases with height, because of the broadening of the weighting function as a function of height. Thus, there are relatively few

independent pieces of information in the profiles, this is reflected in the cumulative degree of freedom variables. The majority of the information from the IRS is in the lowest 2-3 km, above that most information comes from the RAP model.
Because of strong emission in the infrared from clouds, clouds strongly impact the ability to retrieve profiles from the IRS and care should be taken when analyzing the retrievals in the presence of clouds.
Retrievals were constructed at a 5-min temporal resolution using different data input sources to examine the impact of added information content on the retrieved thermodynamic profiles.

Retrieved Thermodynamic Profile Data Description –
An optimal estimation physical retrieval algorithm TROPoe was used to construct vertical profiles of temperature (ºC) and the water vapor mixing ratio (g kg^{-1}).
Please reference to Turner and Löhnert (2014) and Turner and Blumberg (2019) for more information on the employed optimal estimation physical retrieval algorithm.

References –
Benjamin, S. G., S. S. Weygandt, J. M. Brown, M. Hu, C. R. Alexander, T. G. Smirnova, J. B. Olson, E. P. James, D. C. Dowell, G. A. Grell, H. Lin, S. E. Peckham, T. L. Smith, W. R. Moninger, J. S. Kenyon, and G. S. Manikin, 2016: A North American hourly assimilation and model forecast cycle: the Rapid Refresh., *Mon. Wea. Rev.*, 144:1669–1694, https://doi.org/10.1175/MWR-D-15-0242.1.

Djalalova, I. V., D. D. Turner, L. Bianco, J. M. Wilczak, J. Duncan, B. Adler, and D. Gottas, 2022: Improving thermodynamic profile retrievals from microwave radiometer by including radio acoustic sounding system (RASS) observations, *Atmos. Meas. Tech.*, 15, 521–537, https://doi.org/10.5194/amt-15-521-2022.

Turner, D. D., and U. Löhnert, 2014: Information content and uncertainties in thermodynamic profiles and liquid cloud properties retrieved from the ground-based Atmospheric Emitted Radiance Interferometer (AERI). *J. Appl. Meteor. Clim.*, **53**, 752-771. https://doi.org.10.1175/JAMC-D-13-0126.1.

Turner, D. D., and W. G. Blumberg, 2019: Improvements to the AERIoe Thermodynamic Profile Retrieval Algorithm. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 12, no. 5, pp. 1339-1354. https://doi.org.10.1109/JSTARS.2018.2874968.

Turner, D. D., and U. Löhnert, 2021: Ground-based temperature and humidity profiling: Combining active and passive remote sensors. *Atmos. Meas. Tech.*, 14, 3033–3048, https://doi.org/10.5194/amt-14-3033-2021.

8. **File Names** –
Radiosonde File Information
15 radiosondes were launched for comparison. File names are:
Sounding_yyyymmdd_hhmm.txt

Where *yyyymmdd_hhmm* provides information on the year (*yy*), month (*mm*), day (*dd*), hour (*hh*) in TC, and minute (*mm*) of the radiosonde launch.

Retrieved Thermodynamic Profile File Information

Different data input groups are saved using the following format:

pvltropoe_data_input group.yyyymmdd.hhmmss.nc

The *data_input group* are defined below:

- *ASSISTX*: denotes the use of the IRS in input for TROPoe.
- *MPXXXXA*: denotes the use of the MWR in input for TROPoe.
- *RAP*: denotes the use of the MWR in input for TROPoe.
- *RASS449*: denotes the use of the RASS in input for TROPoe.

The *yyyymmdd.hhmmss* denotes the year, *mm* denotes the month, *dd* denotes the day of the month, *hh* denotes the initial hour (UTC), *mm* denotes the initial minute, and *ss* denotes the initial second.

The configuration (so called vip) files used to run TROPoe can be provided after request to the contact author.

9. **Data restrictions –** N/A.

10. **GCMD Keywords** – Earth Science - Atmosphere – Atmospheric Temperature
Earth Science - Atmosphere – Humidity

11. **Publications** – Bianco, L., B. Adler, L. Bariteau, I. V. Djalalova, T. Myers, S. Pezoa, D. D. Turner, and J. M. Wilczak, 2024: Sensitivity of thermodynamic profiles retrieved from ground-based microwave and infrared observations to additional input data from active remote sensing instruments and numerical weather prediction models, *Atmos. Meas. Tech. Discuss.* [preprint], https://doi.org/10.5194/amt-2023-263, in review.