<u>Synoptic Meteorology I: Maps and Coordinates Example</u>

Surface observations valid at 1900 UTC 24 August 2022 are depicted in Figs. 1 and 2. The primary difference between these figures is the map projection used: Fig. 1 uses a Mercator map projection whereas Fig. 2 uses a Lambert conic conformal map projection with a standard longitude over the central United States.

Note the slight skewness in Fig. 2 as compared to Fig. 1. Whereas true north is directed straight to the top of Fig. 1, true north is skewed slightly on Fig. 2. In Fig. 2, we can use the knowledge that Pennsylvania's western border is aligned from north to south to help identify true north's direction, as indicated by the black vector labeled y (for the y-axis). While this may not seem important quite yet, it becomes vitally important when we begin to use these data to compute how meteorological quantities such as temperature and wind change over a given direction.

For convenience, the natural coordinates corresponding to the Pittsburgh, PA (KPIT) observation are annotated in partially opaque blue vectors on Fig. 2. The surface observation indicates a north-northwest wind direction, such that the wind is blowing *toward* the south-southeast. As the positive streamwise axis points in the direction in which the wind is blowing, the s-axis is indicated toward the south-southeast, with the normal (or n-) axis 90° to its left pointing toward the east-northeast.

Both Figs. 1 and 2 depict fixed *Eulerian* reference frames. They allow us to, for example, compute how the temperature, dewpoint temperature, or sea-level pressure are changing over time or space at any given location. This contrasts with a *Lagrangian* reference frame, which follows along with the wind. An example can be derived from the streamwise coordinate indicated at Pittsburgh, PA in Fig. 2; a Lagrangian reference frame would follow along with this wind as it initially travels to the south-southeast. A *quasi-Lagrangian* reference frame is similarly constructed, except it tracks a fixed feature such as a box instead of tracking an ever-evolving air parcel.

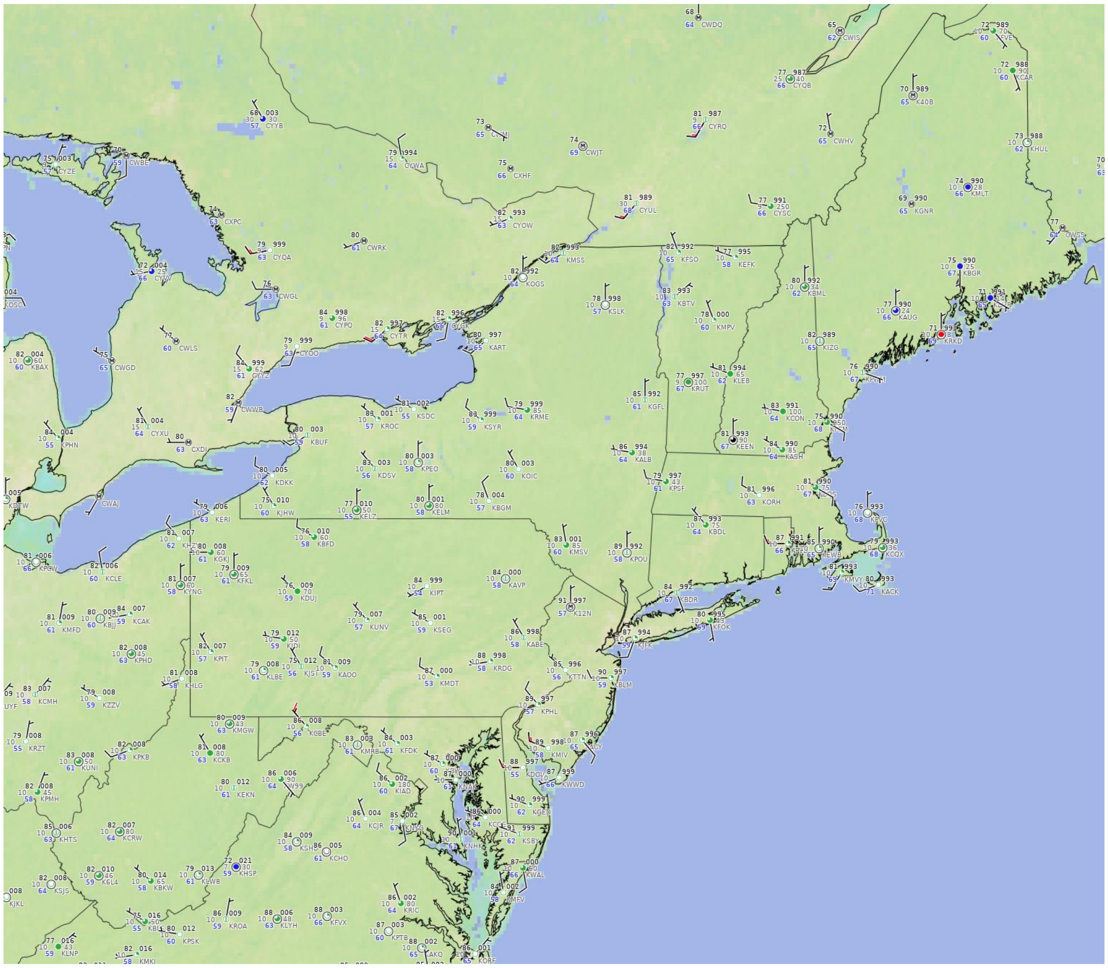

Figure 1. Surface observations encoded using the surface station model introduced earlier in the semester valid at 1900 UTC 24 August 2022 over the northeastern United States. Figure obtained from https://aviationweather.gov/metar/.

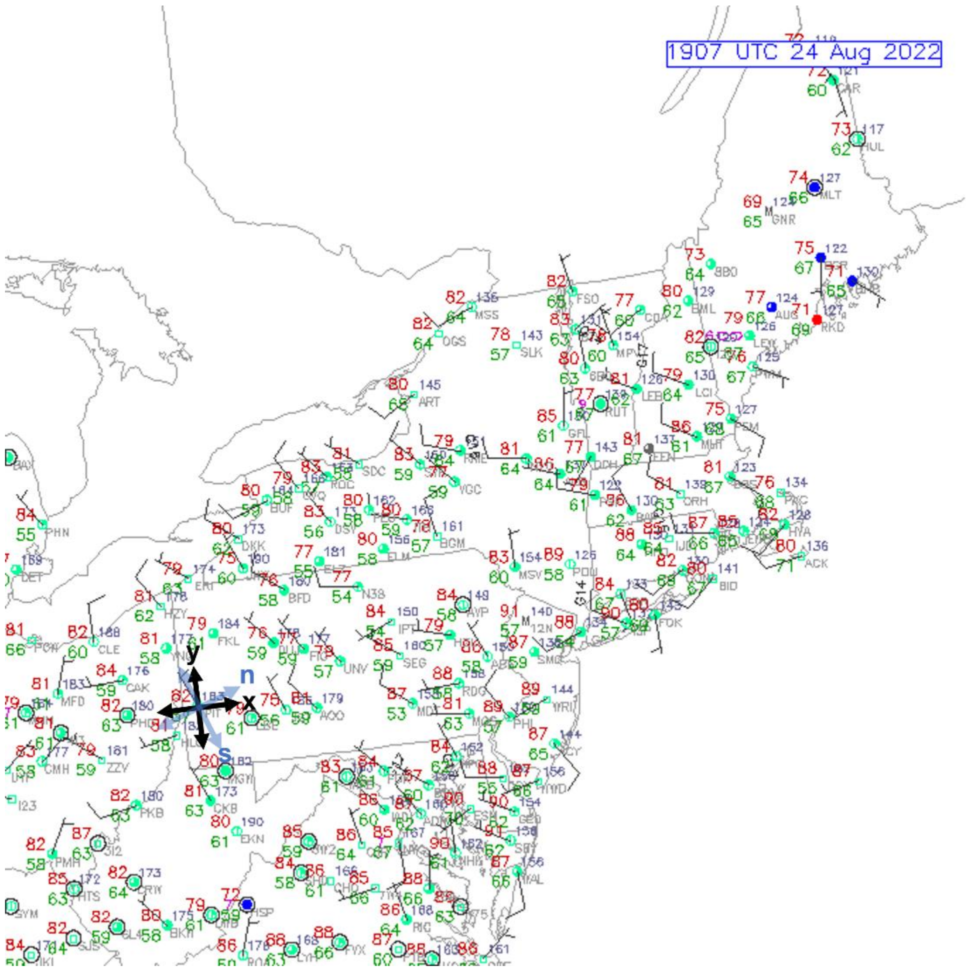

Figure 2. Surface observations encoded using the surface station model introduced earlier in the semester valid at 1900 UTC 24 August 2022 over the northeastern United States. Cartesian (black vectors) and natural (partially opaque blue vectors) coordinates valid at Pittsburgh, PA (KPIT) are annotated on the image. Figure obtained from http://weather.ral.ucar.edu/surface/.