Wind Fields and Aerosol Structures from the REAL at M²HATS

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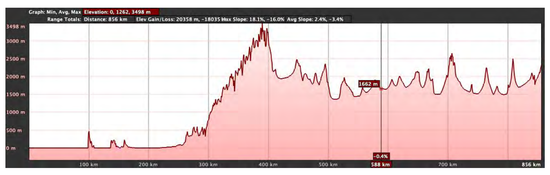
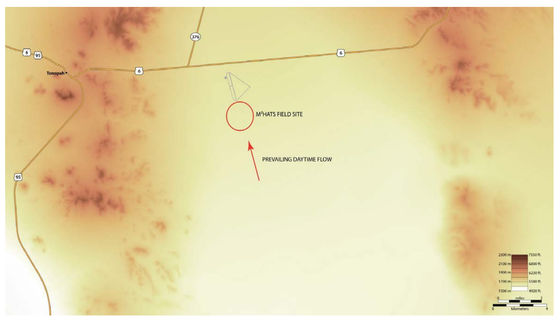
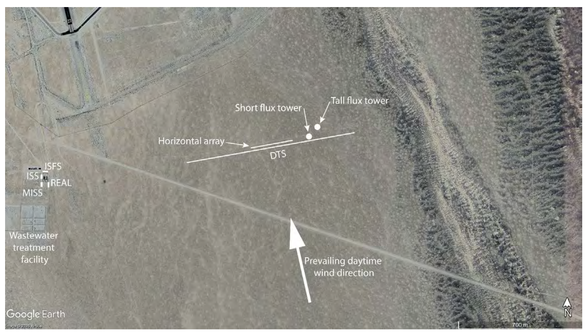
REAL aerosol movies from M²HATS:

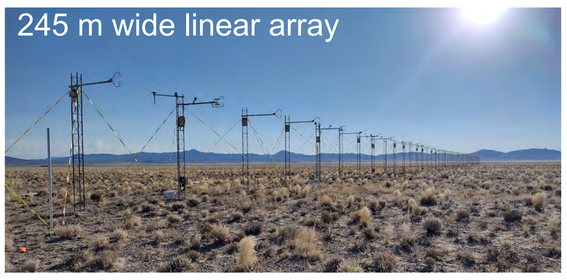
Daily summary pages from M²HATS:

LOCATION: M²HATS took place near Tonopah, Nevada, from July - September of 2023. The site is a flat, arid, high-desert environment in western central Nevada about 1600 m above sea level.

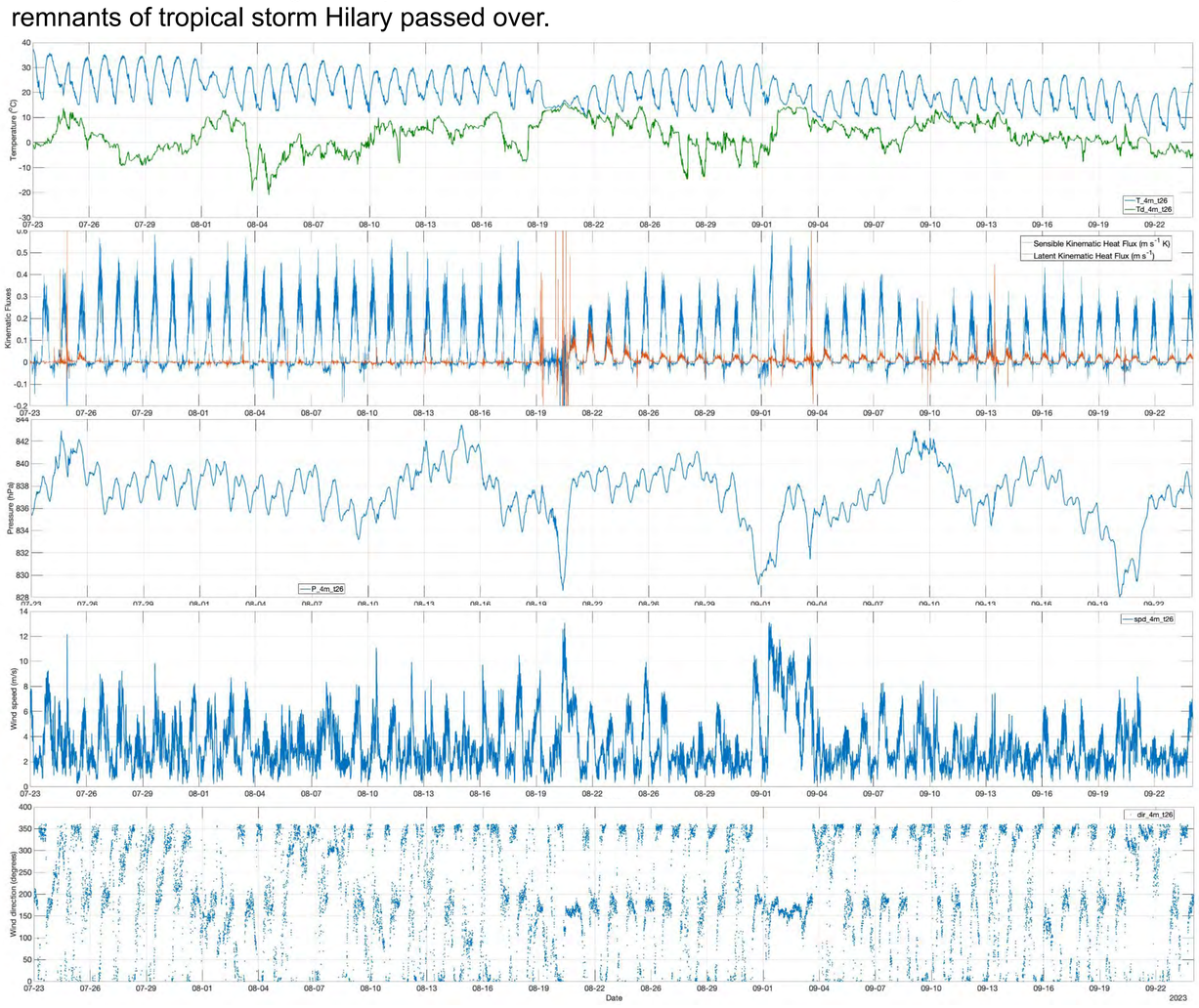








METEOROLOGICAL CONDITIONS DURING EXPERIMENT (from tower 26): Below we show graphs of 5-minute averages for the entire experiment. The diurnal cycle features warm afternoons with southerly flow and cool nights with northerly flow. Conditions were often dry but rain events occurred 19 times during the experiment. Latent heat flux was near zero until August 19 when the remnants of tropical storm Hilary passed over.



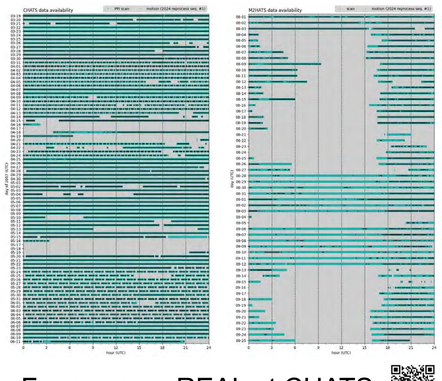
Next, we compare the availability and quality of REAL data from CHATS (92 days) and M²HATS (55 days).

1. REAL operated more continuously during CHATS. Data availability at M2HATS was less due to (1) a software bug that failed to record every other laser pulse the first 7 days of the experiment, and (2) not operating at night for large parts of the experiment.

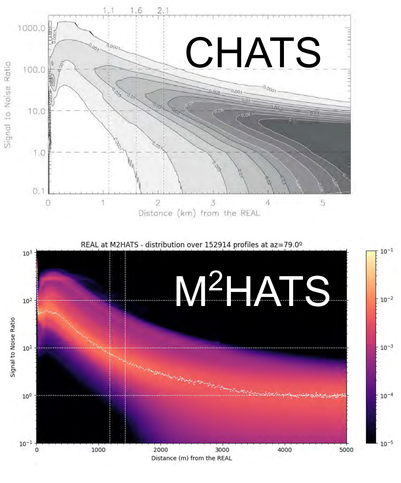
2. The raw signal to noise ratio (SNR) was significantly better in CHATS than M2HATS. Raw SNR results from both the presence of particulate matter and instrument performance. We believe that the M2HATs environment was cleaner and drier than that of CHATS.

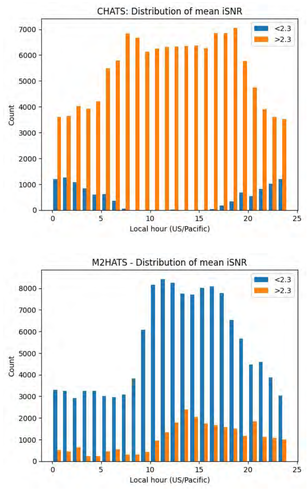
3. A significantly smaller portion of the M2HATS dataset contained adequate aerosol coherent structures to derive vector wind fields. We attribute this to the desolate environment with fewer sources of aerosol.

CHATS M²HATS

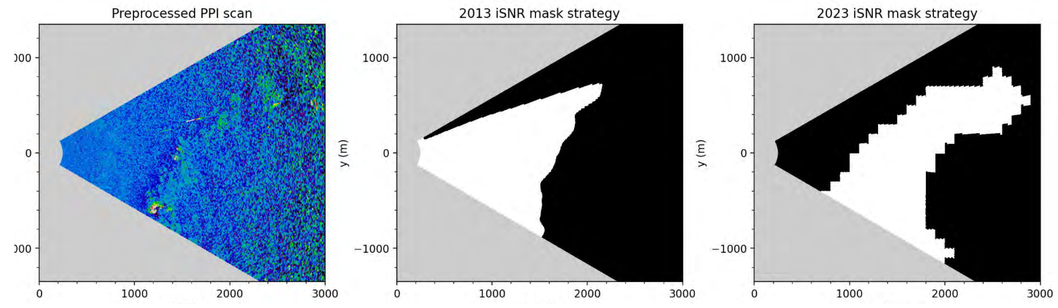


For more on REAL at CHATS:



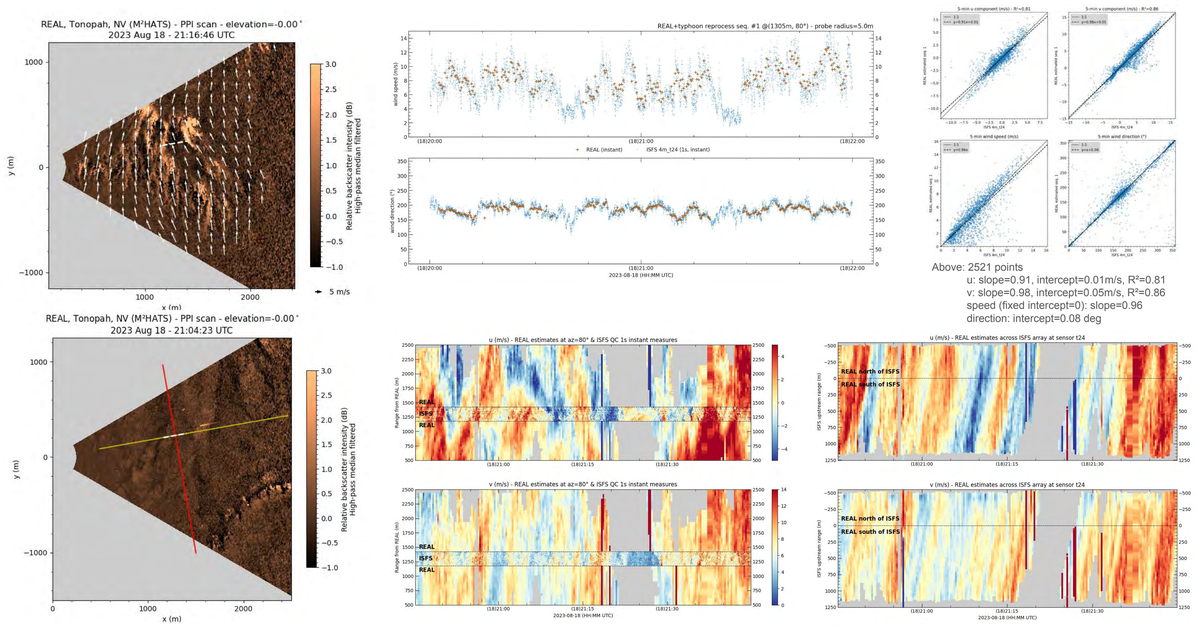


Application of Typhoon to REAL aerosol images: Aerosol backscatter images must be masked to discard low iSNR regions. In our prior work, it was a range-dependent threshold. For M²HATS it was redesigned to focus on the patchy areas of high iSNR for better flow fields near the linear array.

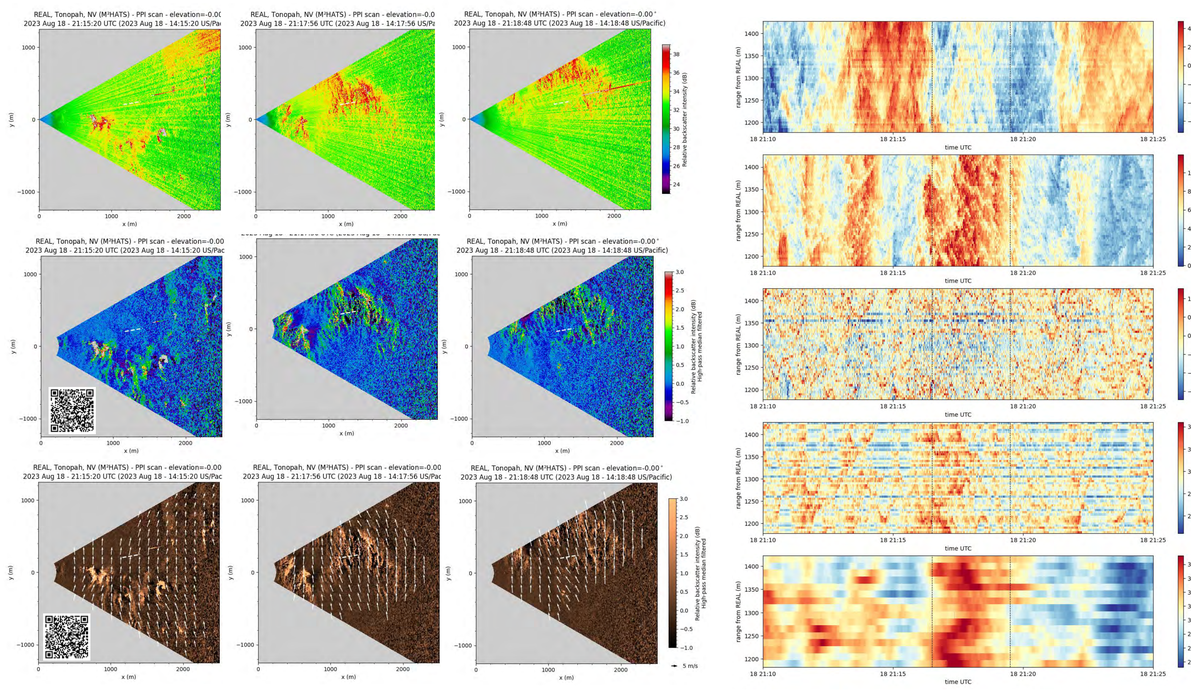


For more on Typhoon, please see our 2015 JTECH article:

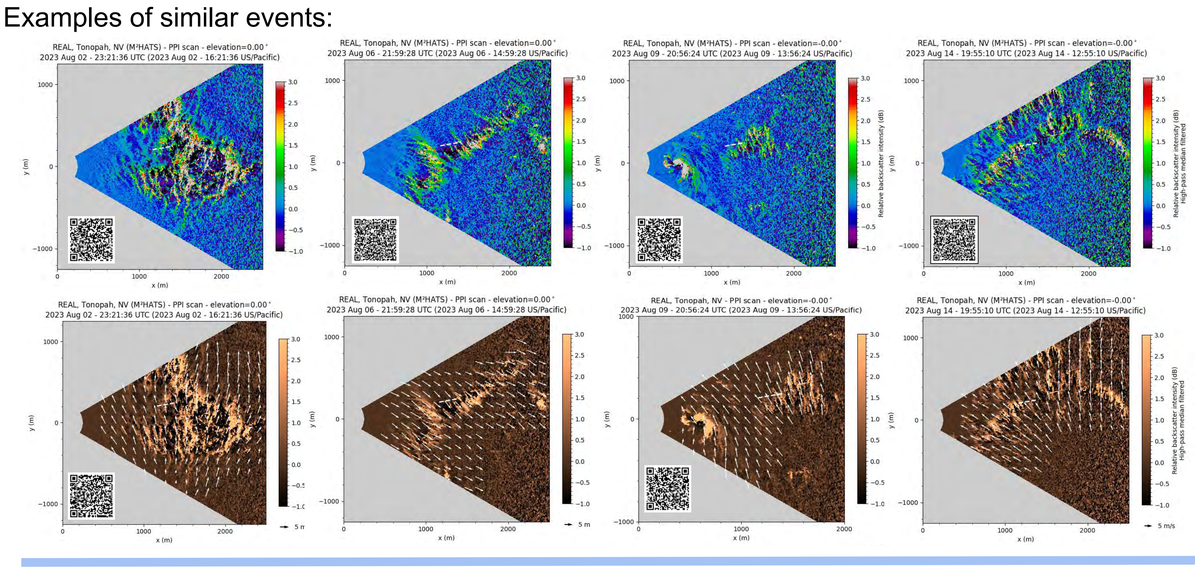
Below is an example of just one vector wind field produced by Typhoon and comparison to one of the sonic anemometers during M²HATS. Wind fields were produced every 17 s with 8 m x 8 m resolution.



We observed many interesting atmospheric aerosol features in the REAL data from M²HATS. The most impressive were large “cats-paw like” structures that occurred on unstable and windy afternoons.

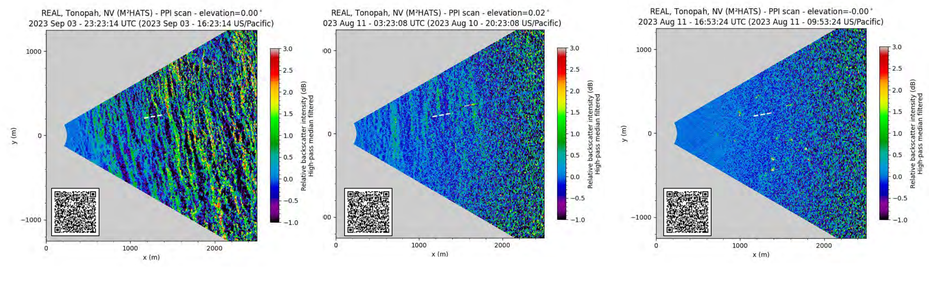


Examples of similar events:



In addition to the large cats-paws type structures shown above, we also saw a lot of fine-scale streaks during the night or highly sheared situations (below).

During weak wind, unstable conditions we observed small bright spots of aerosol backscatter that migrated across the scan sometimes exhibiting considerable rotation.



We hypothesize these to be dust devils.

In most cases, the aerosol structures were subvisual.

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