Height-Keeping Performance Monitoring

MET Data Issues Time-of-Day Variation

NAT HMS PT

Presented to:

Date: March 2020

Federal Aviation Administration

Overview

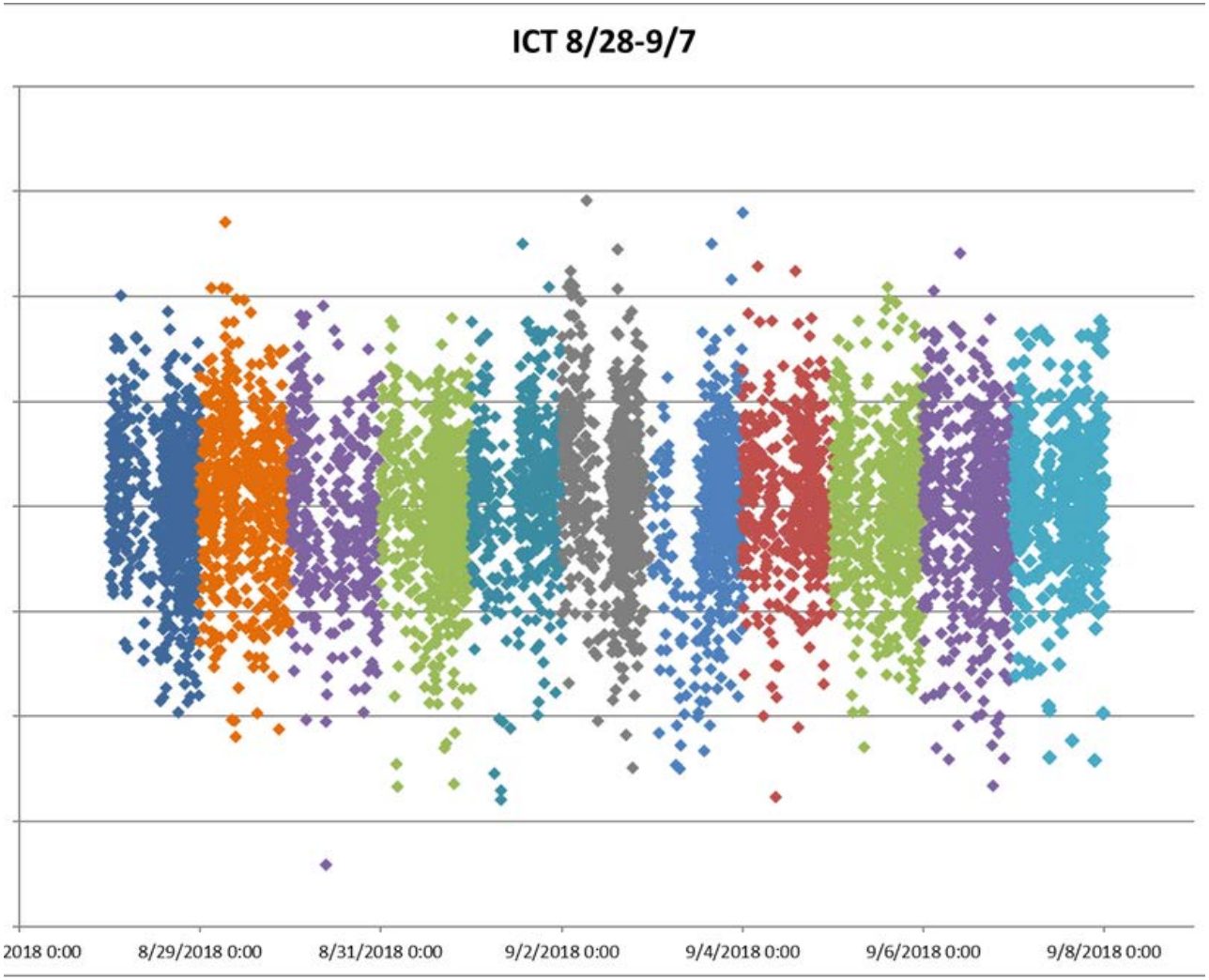
- RMACG Action Item (Review)
- Background
- ASE Ensemble, Single Aircraft
- ASE Components
- December 2019 Trend Data
- Discussion/Actions

RMACG Action and Related Questions:

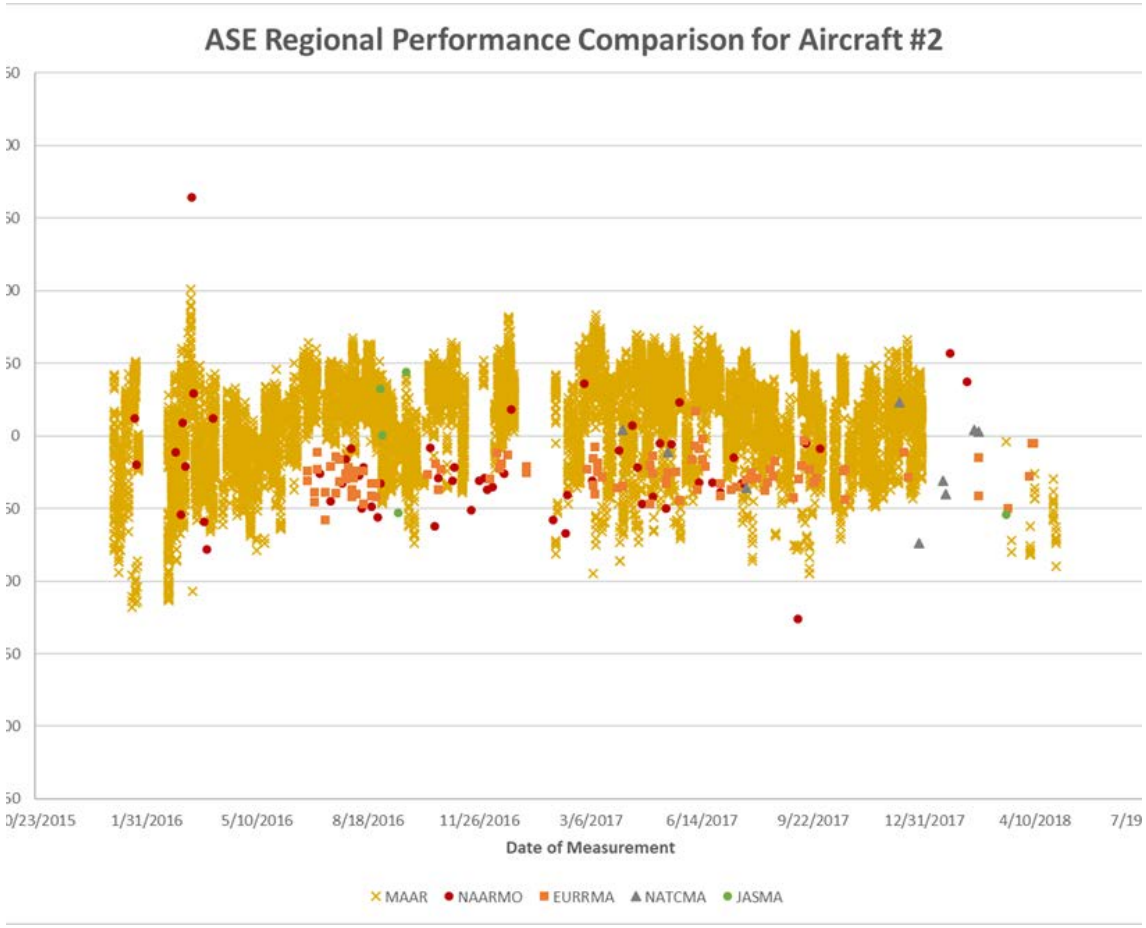
Paragraph 1.2

- **The meeting agreed to create a sub-group to assess the quality of monitoring data currently used to assess aircraft height-keeping performance, assess the effects on system performance monitoring results when using multi-source monitoring data, and determining an initial set of requirements applied to the quality of monitoring data used for performance assessments.**
- **The following questions should also be assessed:**
  - Do the measurement systems have different characteristics?
  - Are the measurements fundamentally different when calculated from different systems?
  - Determine whether use of multi-source monitoring data has an impact on collision risk estimates
  - Should we use the same form of statistical analysis based on sampling?

AGHME Ensemble Performance



ASE from Multiple Monitoring Systems (2)



An evaluation of ASE ensemble mean should be undertaken to resolve any apparent overall bias that can not be attributed to the altimetry system

In this example there appears to be a bias between ADS-B derived ASE and HMU derived ASE

Estimating the Components of TVE

Paragraph 2.28

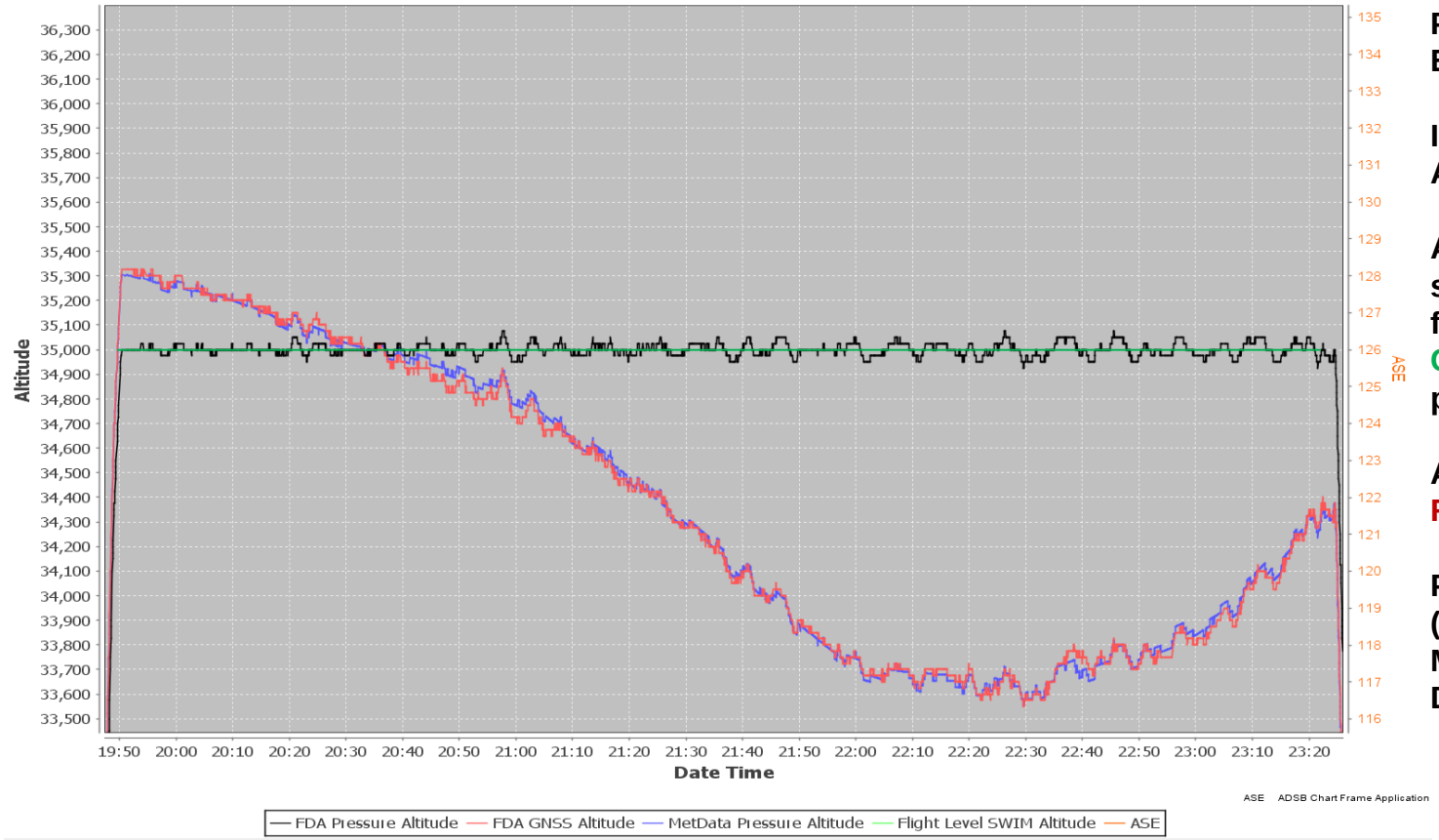
- **The ASE component of TVE is intended to characterize the difference between**
  - The true ambient static pressure in which an aircraft is operating
  - The static pressure estimated by the aircraft altimetry system and made available for control of the aircraft at the pressure altitude commanded by the flight crew.

ASE Components

Paragraph 2.33

- **The errors in estimating ASE arise from two sources:**
  - Estimation of an aircraft's geometric height, and
  - Estimation of the height of the flight level to which the aircraft is assigned

Sample ADS-B Data Set



Flight From US West Coast
PM departure
Early AM Arrival

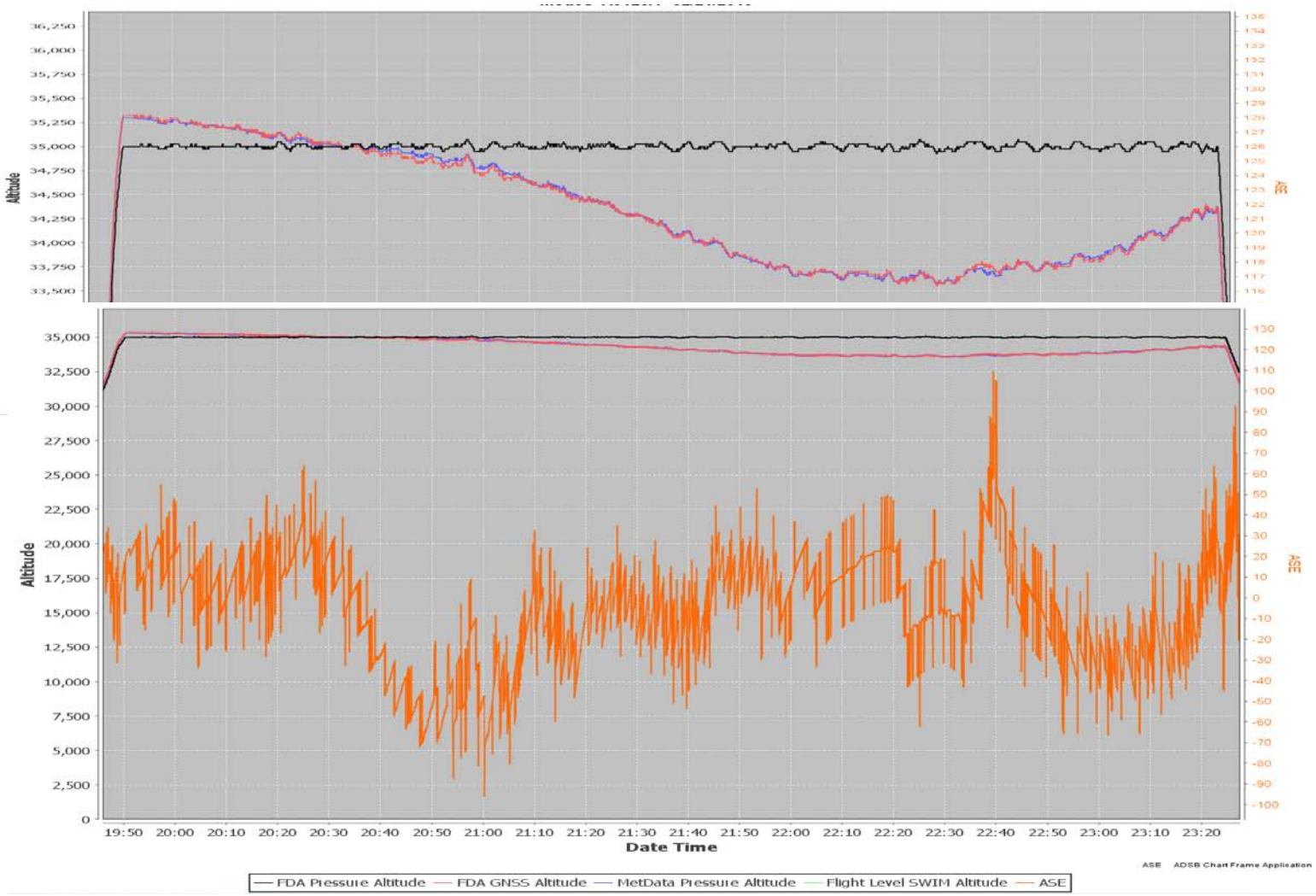
Indicated Pressure Altitude - Black

AAD is characterized by subtracting the inferred flight level (Drawn in Green) from the indicated pressure altitude

ADS-B GPS Altitude Red

Pressure Surface Height (Derived via Meteorological Model Data) Blue

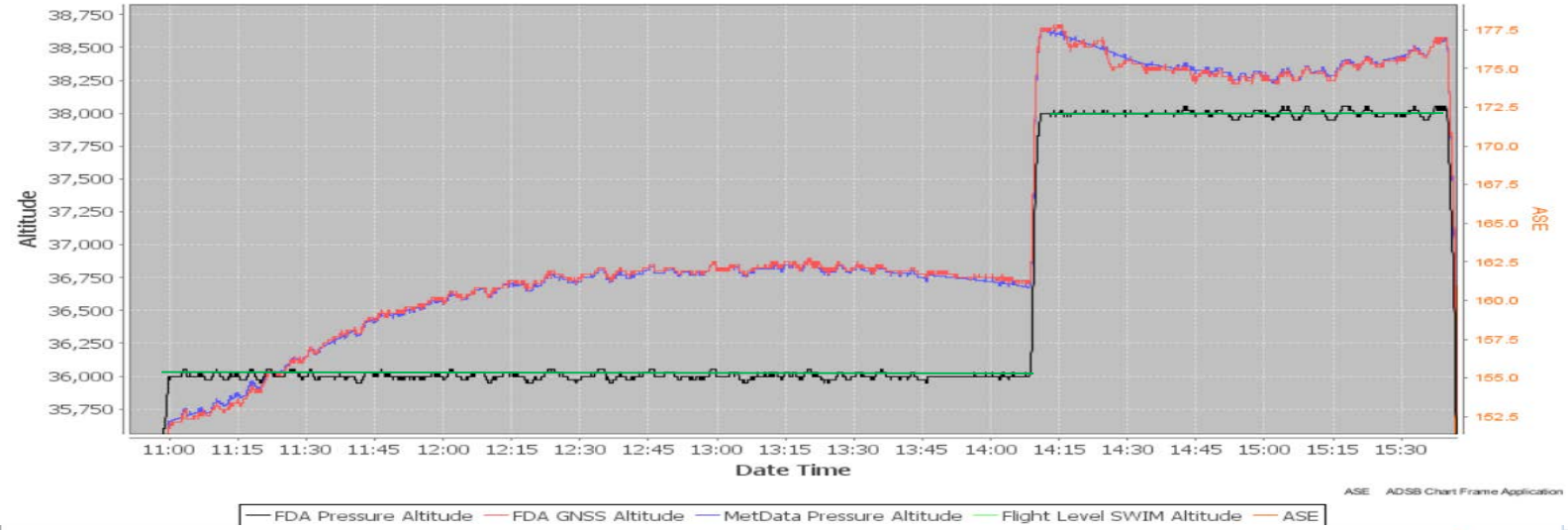
ASE Estimate

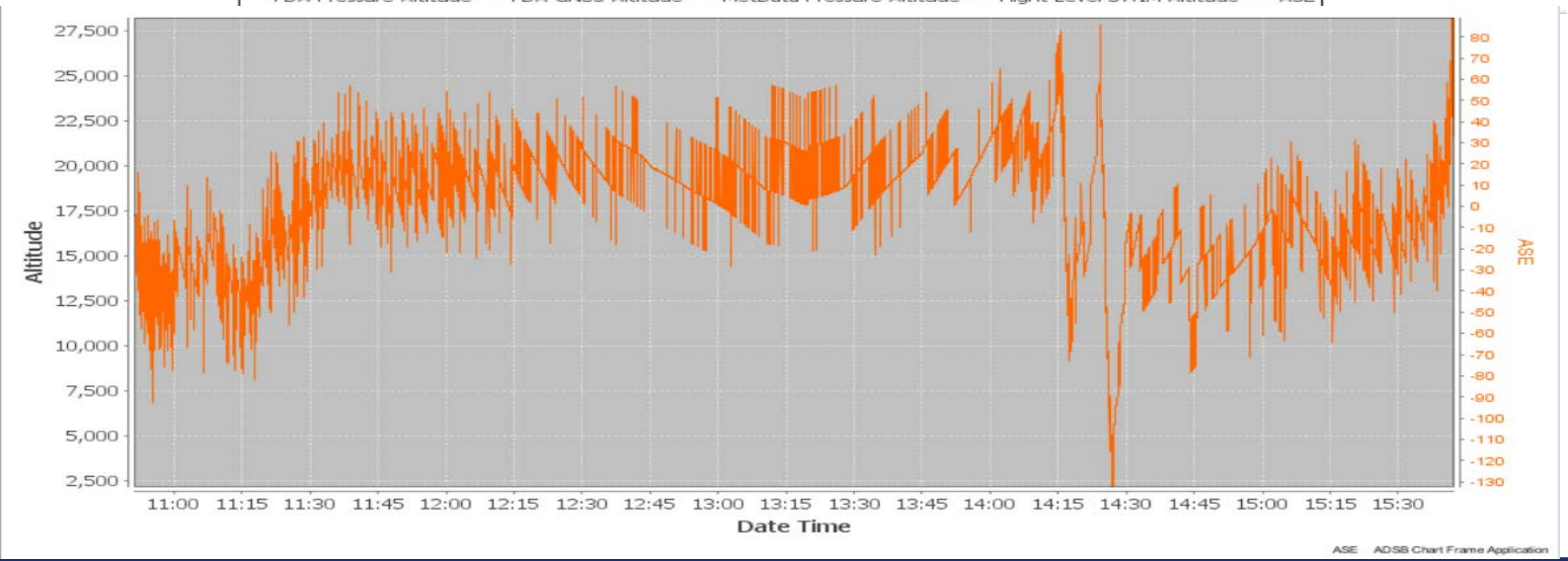


ASE estimates can be calculated directly by subtracting the indicated pressure altitude at each point by the height of that indicated pressure altitude

Averaging ASE estimates over time can be used to reduce the resolution noise

ASE Estimate





These examples demonstrate a temperature bias in the ASE estimate.

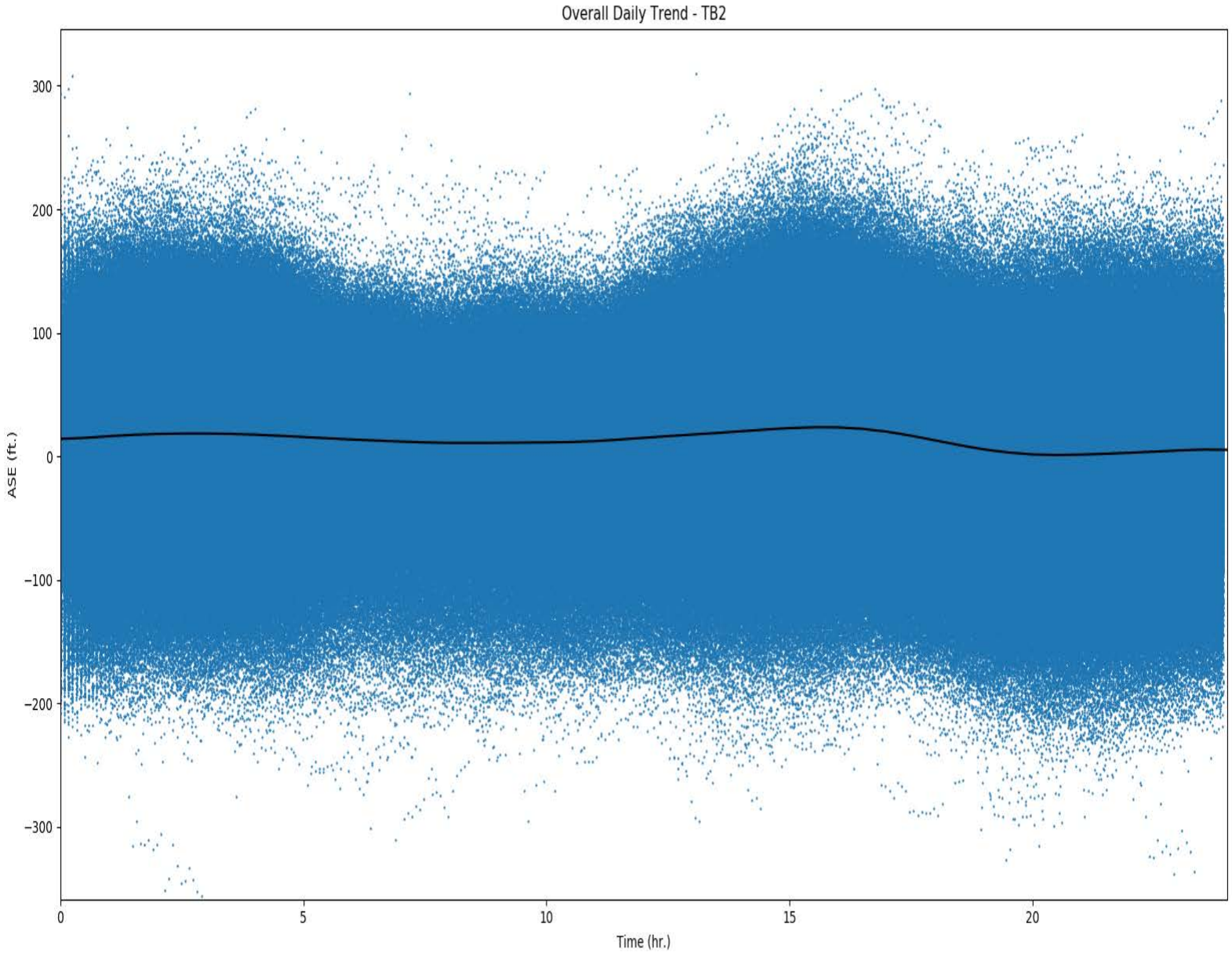
A transition is observed as the temperature increases, and seems to be most pronounced when the geometric height crosses the pressure altitude.

These transitions also appear independent of the geographic location.

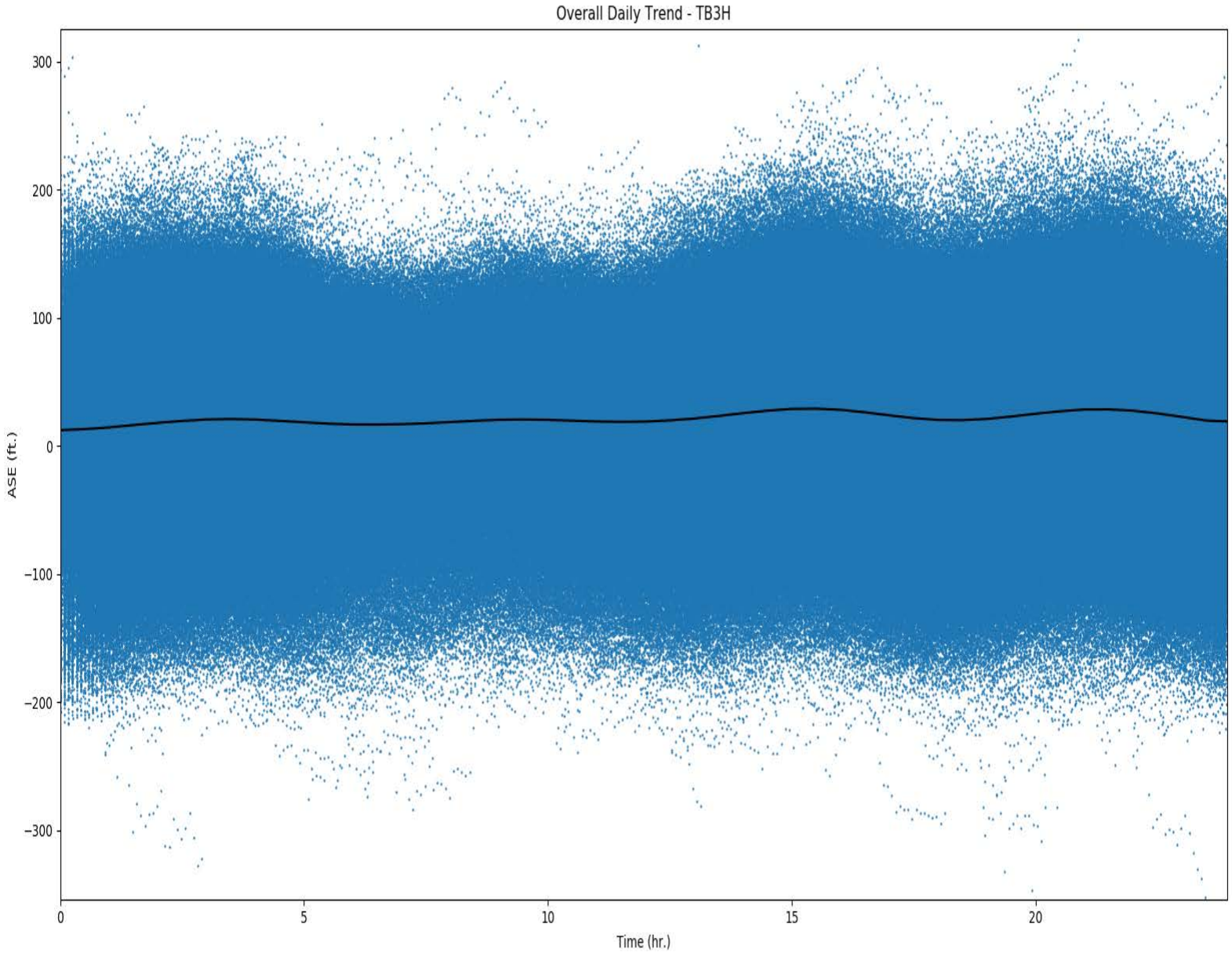
ADS-B Processed ASE Data

- **The following slides present ADS-B ASE data processed using the current baseline of our new ADS-B code**
  - ASE is calculated for all ADS-B V2 aircraft that operate with FAA ADS-B rule airspace
  - The code automatically detects all RVSM level segments, identifying an “inferred flight level, divides each segment into 5-minute level samples, and calculates average ASE and AAD for each segment
- **Recent analysis has focused on improving the determination of the geometric height of the flight level**
  - Testing has included both increased geometric resolution as well as increased temporal sampling
- **Data in the slides within this presentation will be based on either 6 hour MET data updates or 1 hour MET update**
  - More details will be presented during the next accuracy subgroup meeting

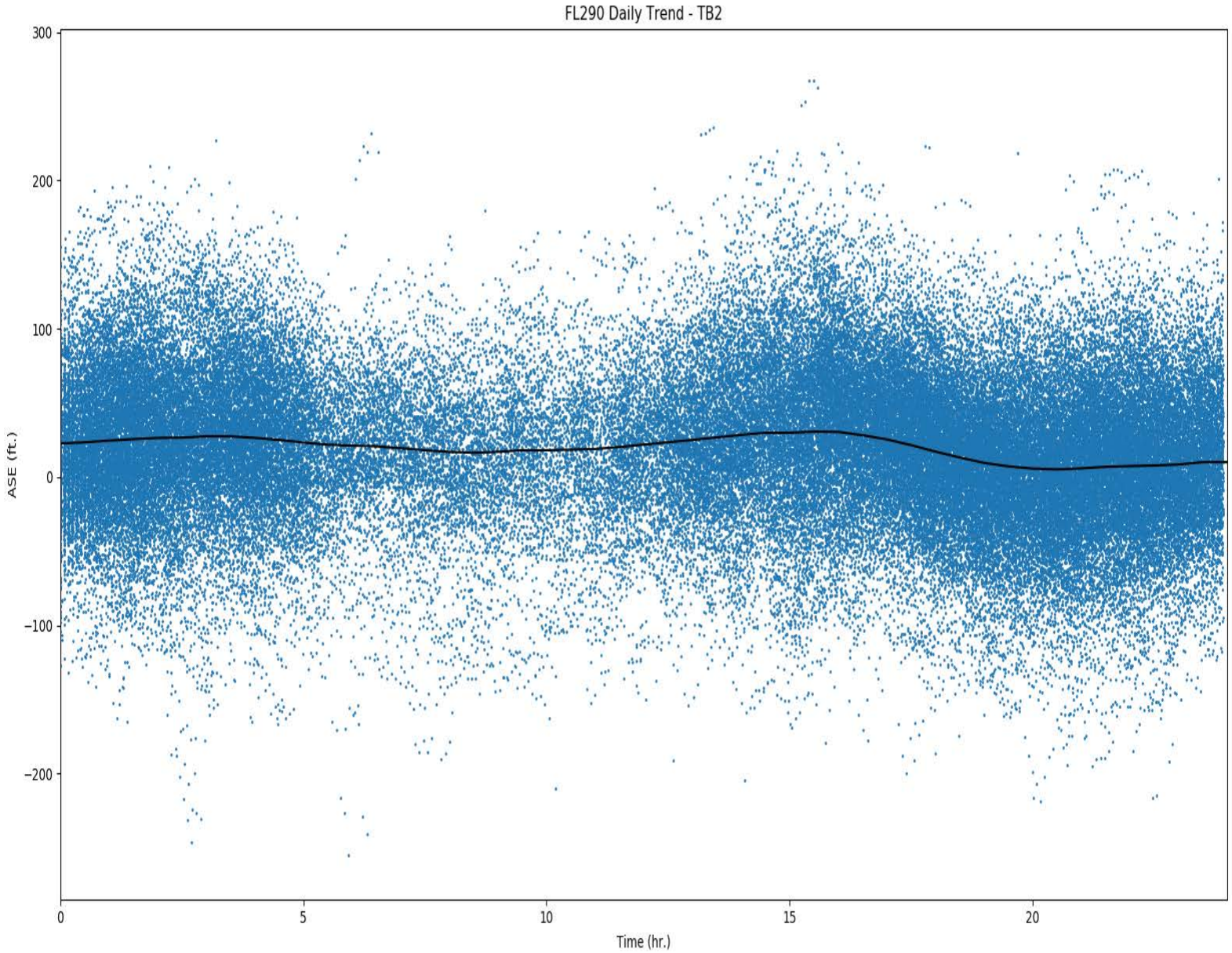
6-hour MET Files, Full US



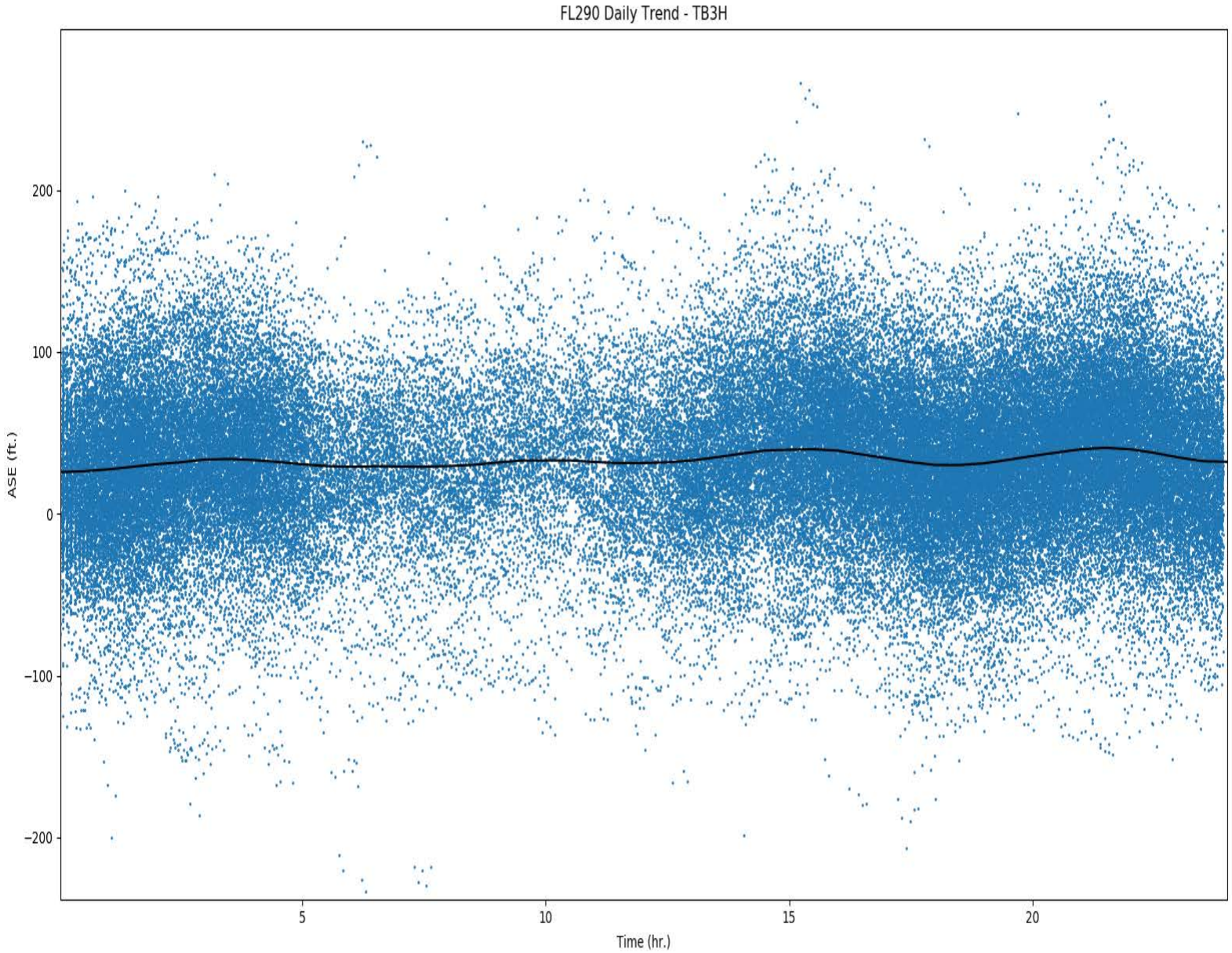
1-hour MET Files, Full US



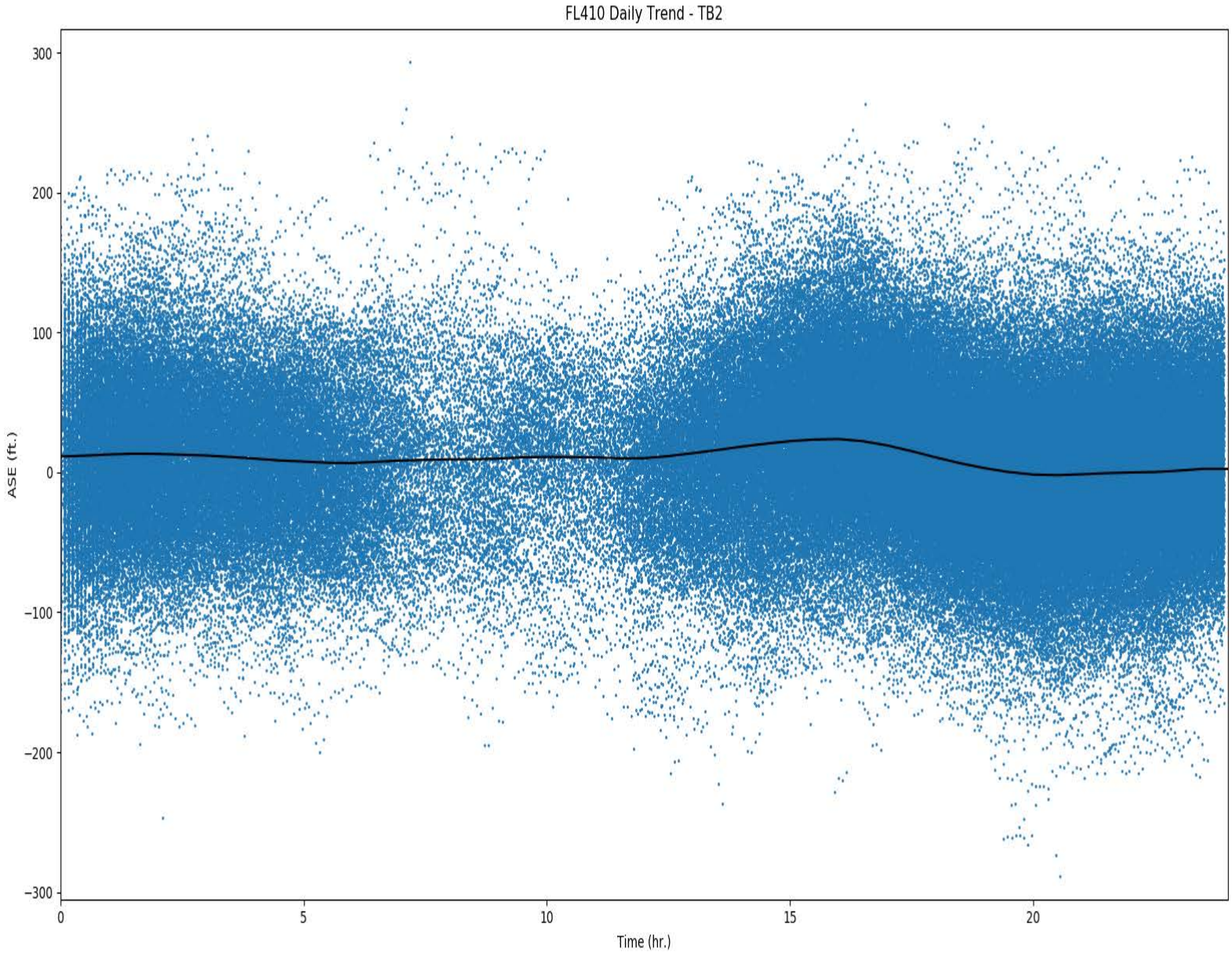
6-hour MET Files, Full US, FL290



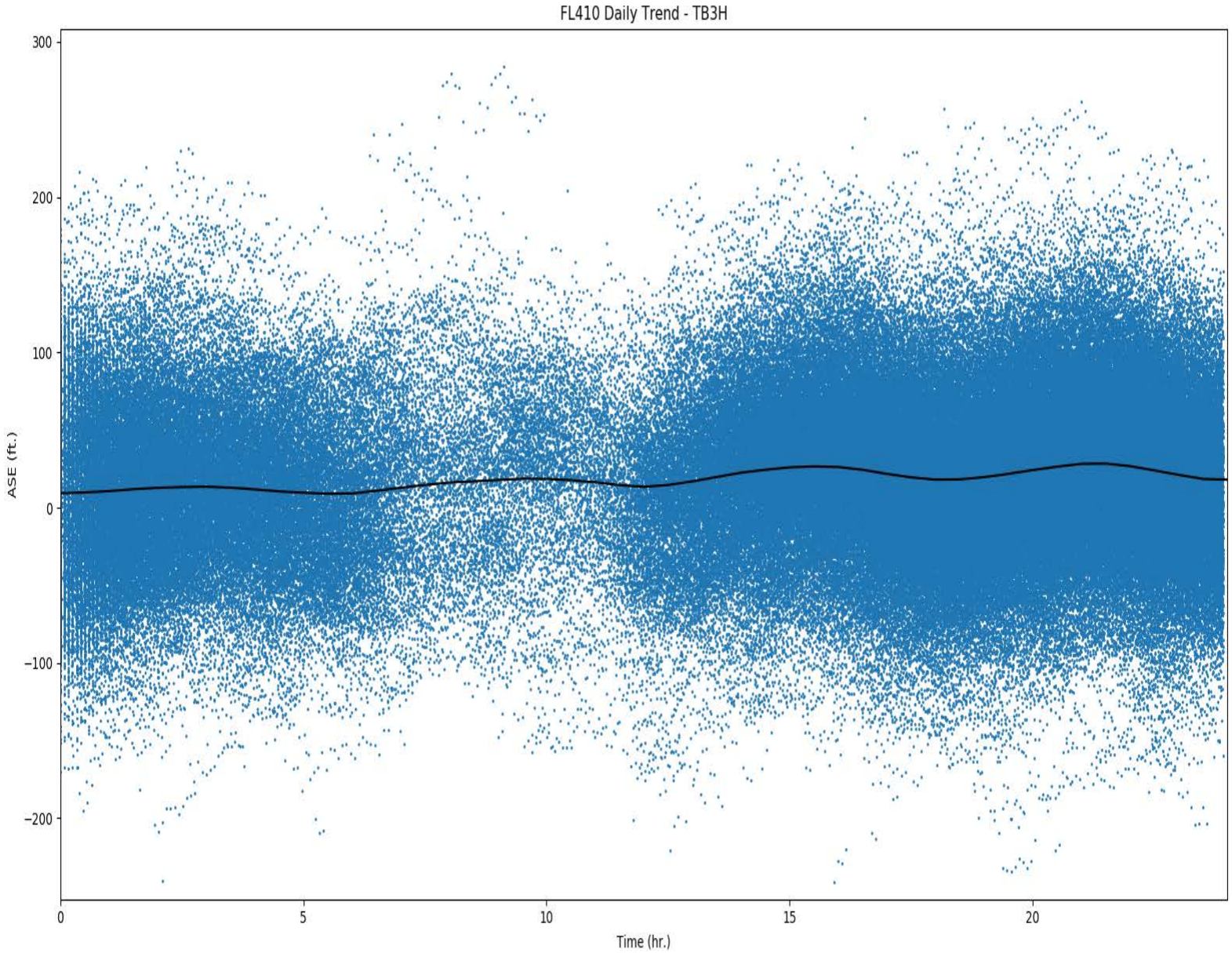
1-hour MET Files, Full US, FL290



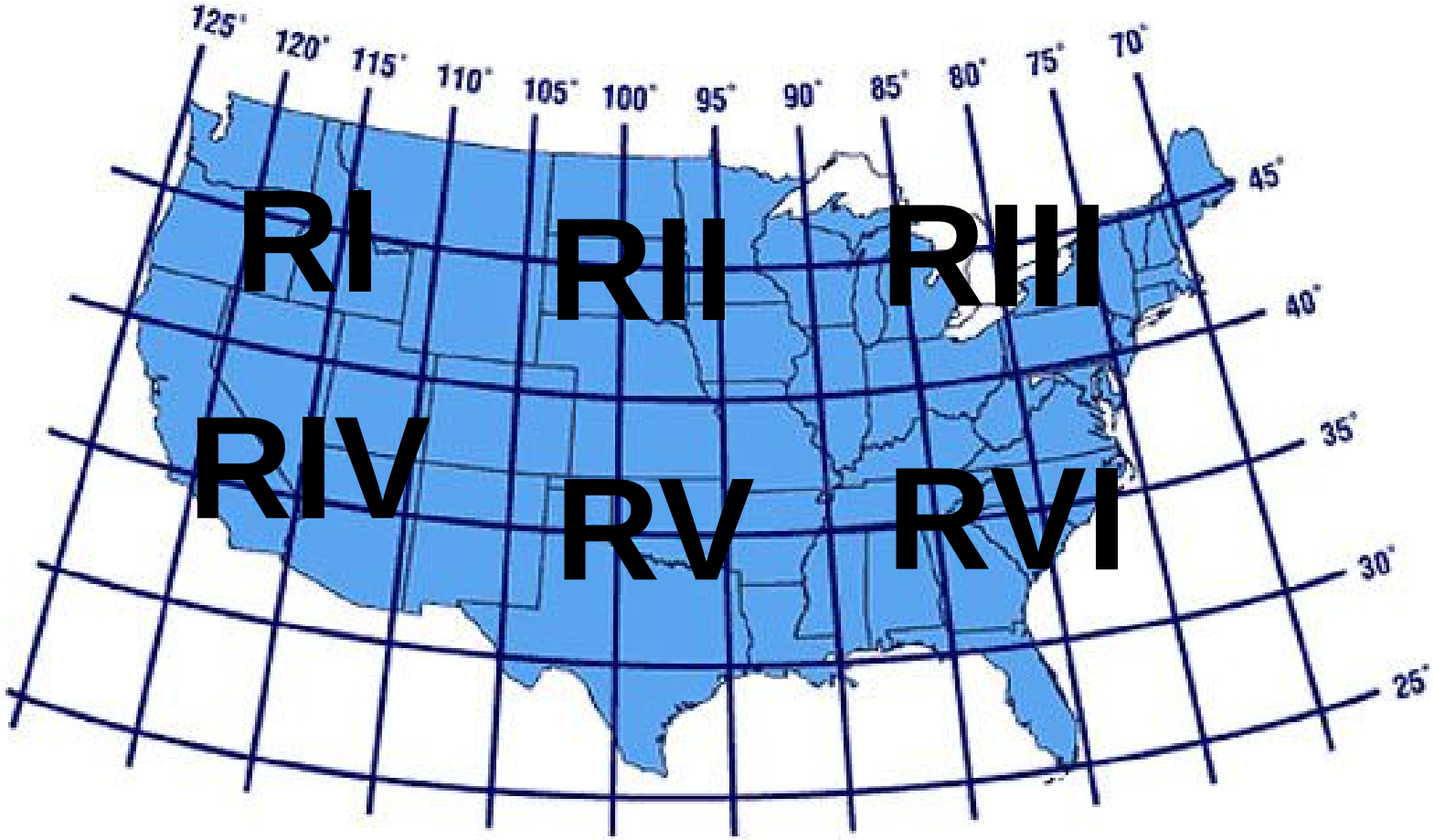
6-hour MET Files, Full US, FL410



1-hour MET Files, Full US, FL410



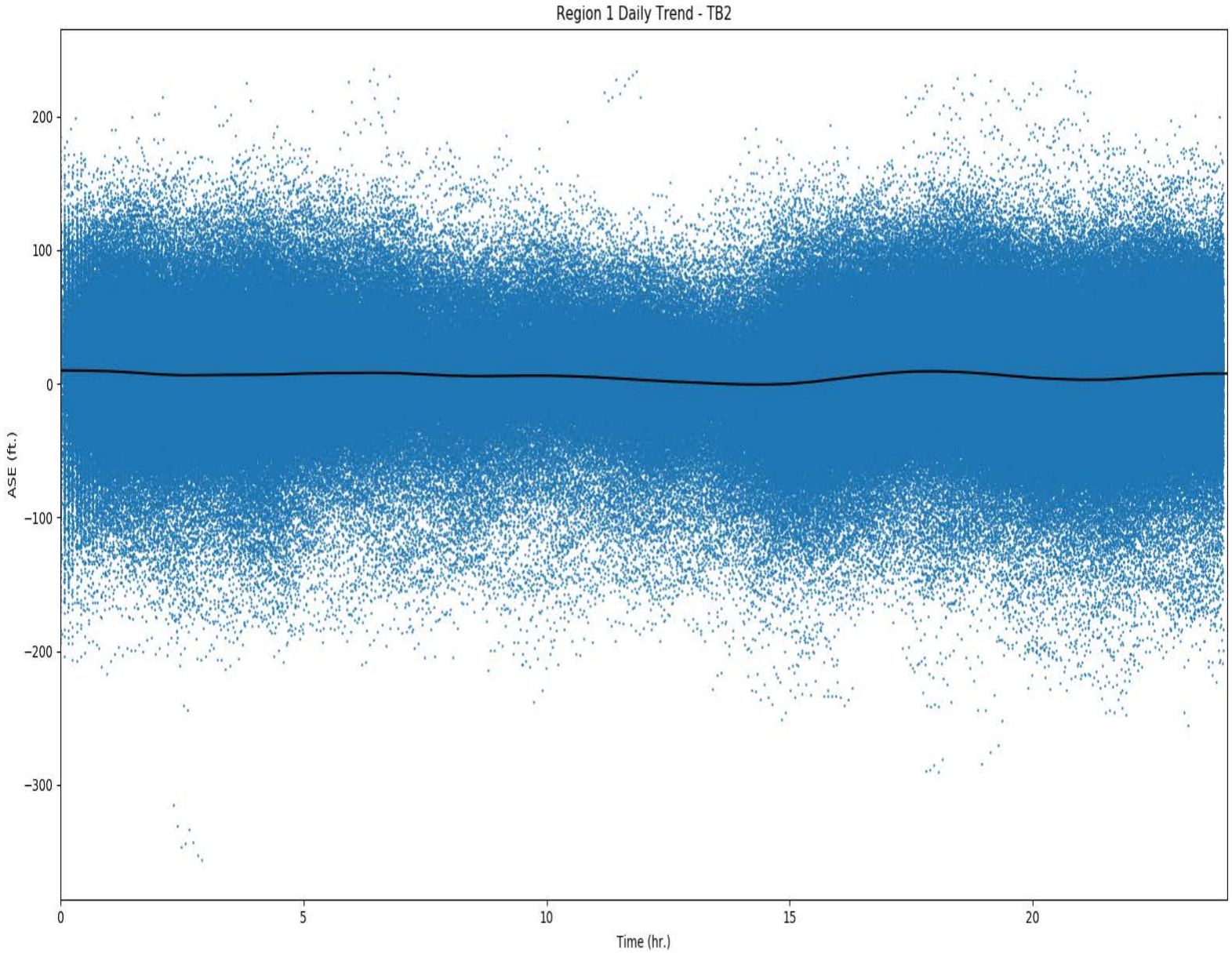
Regional Analysis



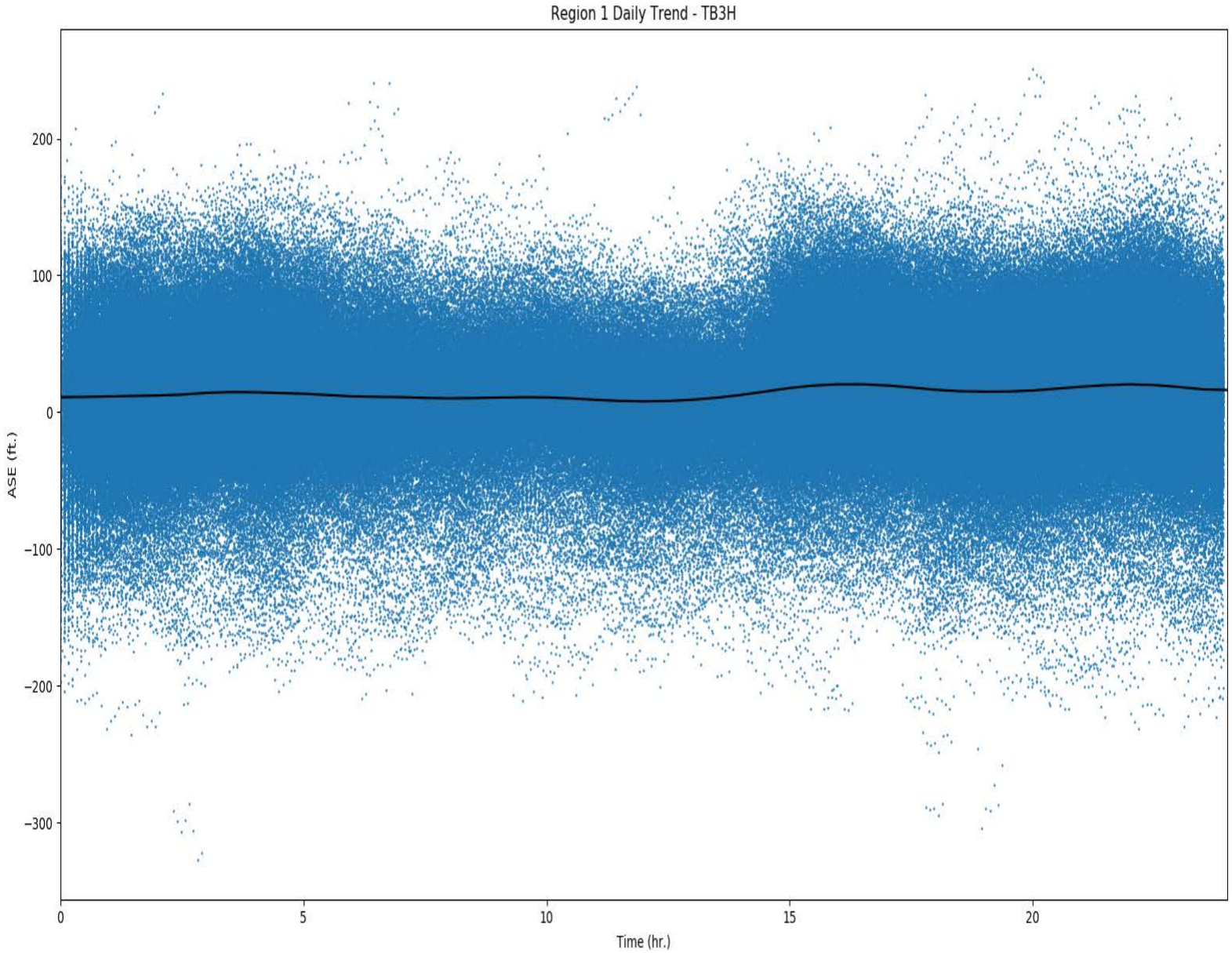
Data Comparisons

- **The next slides will compare Region I, II, III, and VI**
- **Both 1-hour and 6-hour MET based ASE are provided**
  - Regions I, II, and III will provide an east-west comparisons
  - Regions III and VI will provide a north-south comparison
  - Regions IV and V are provided in the backup slides

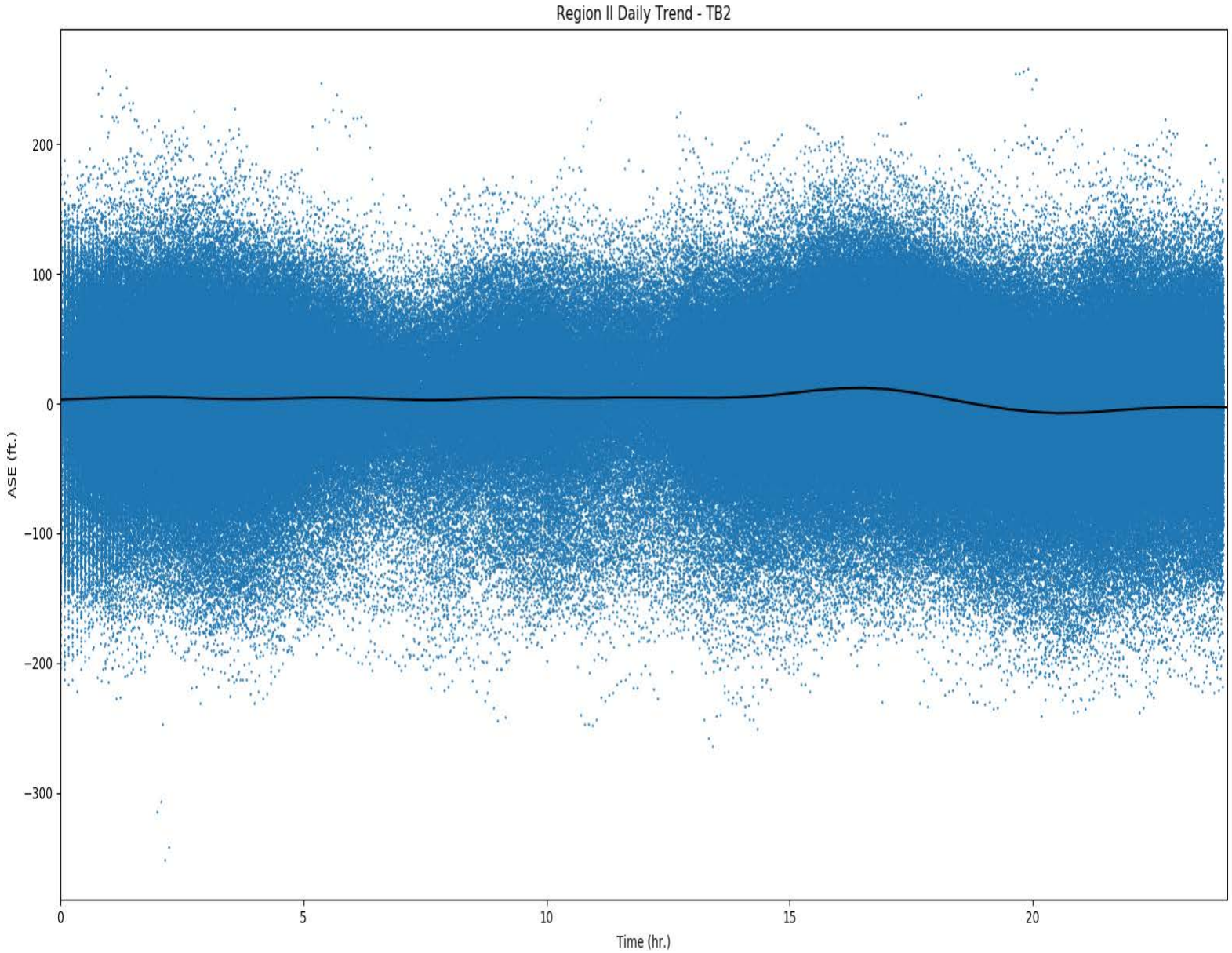
6-hour MET Files, Region I



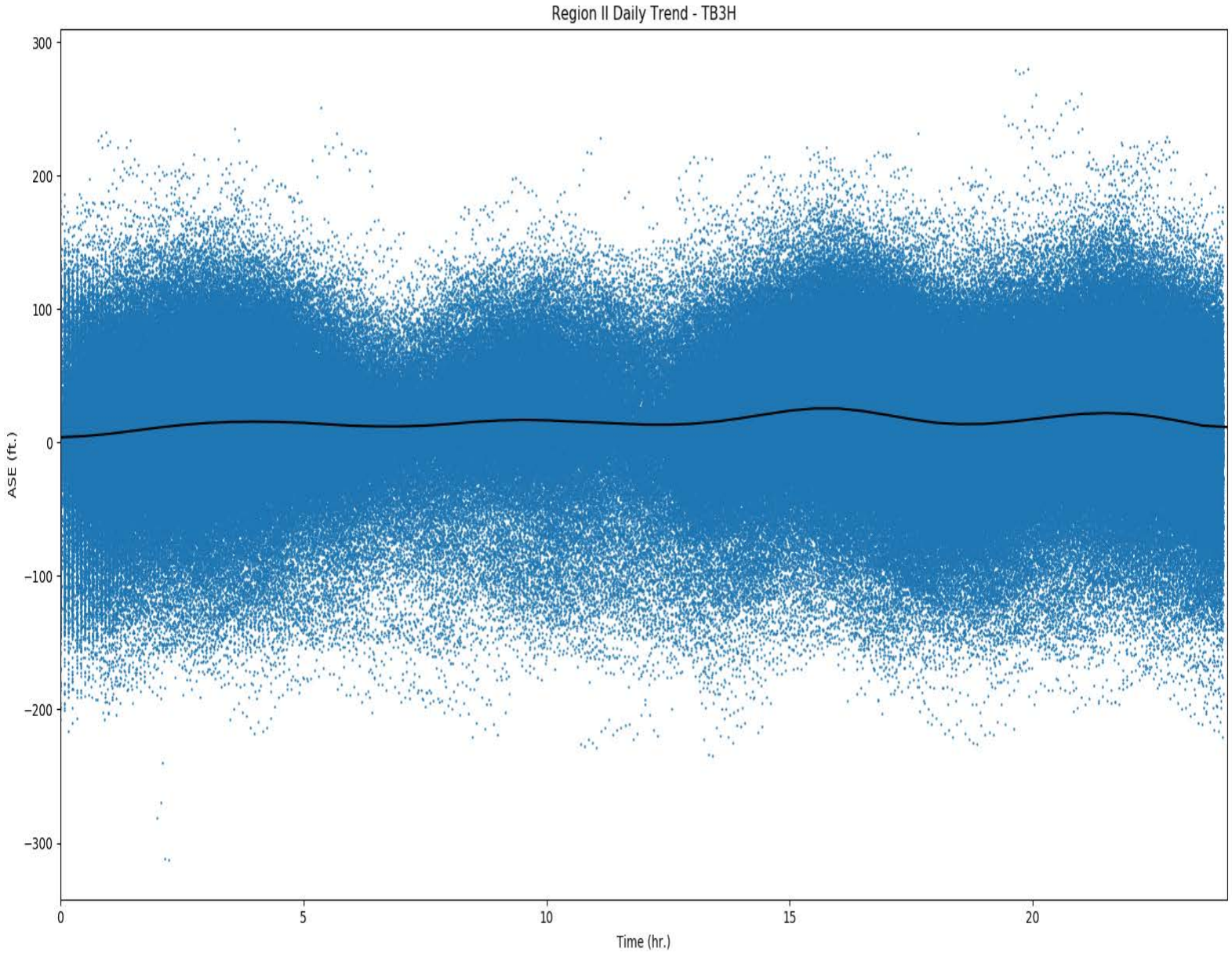
1-hour MET Files, Region I



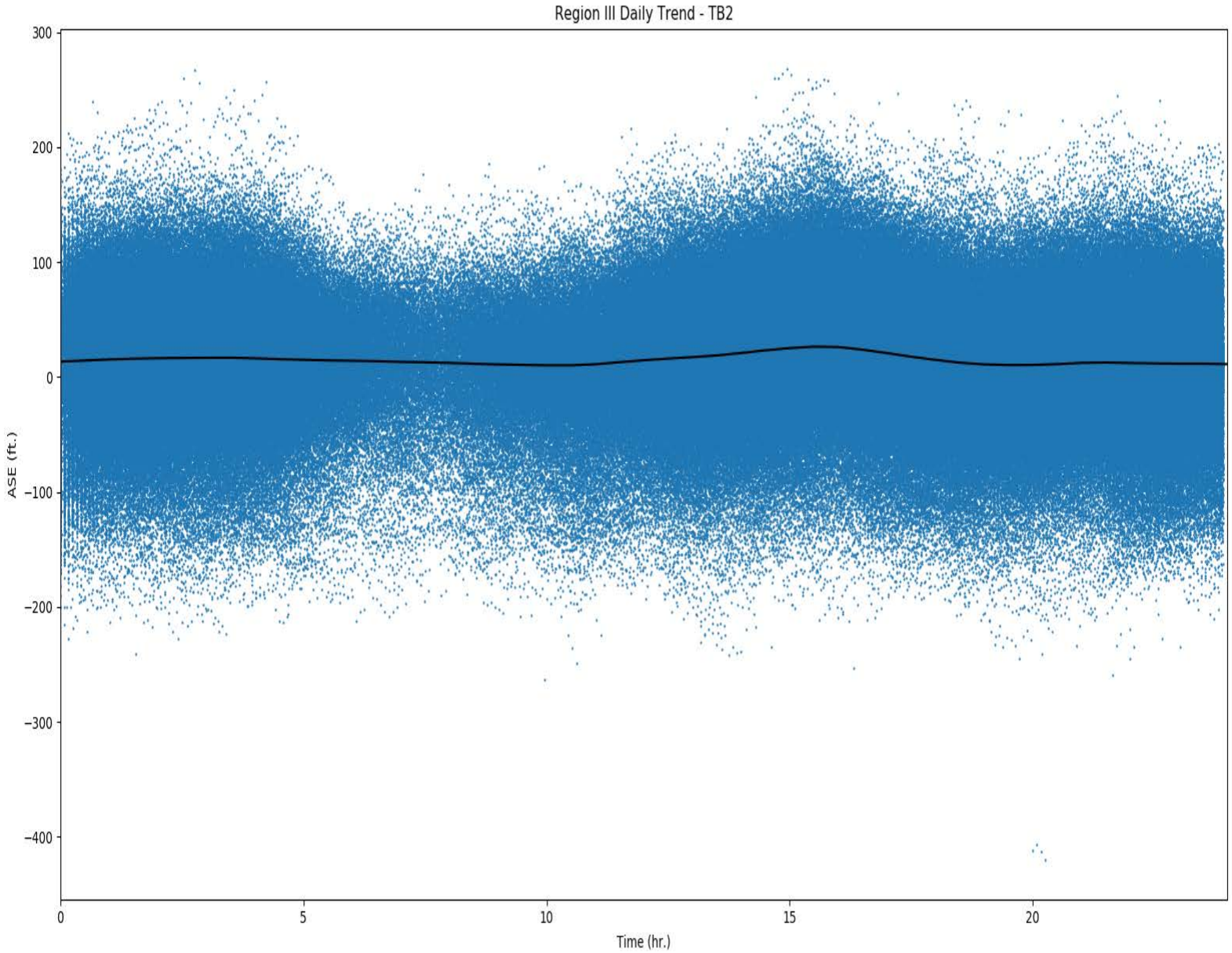
6-hour MET Files, Region II



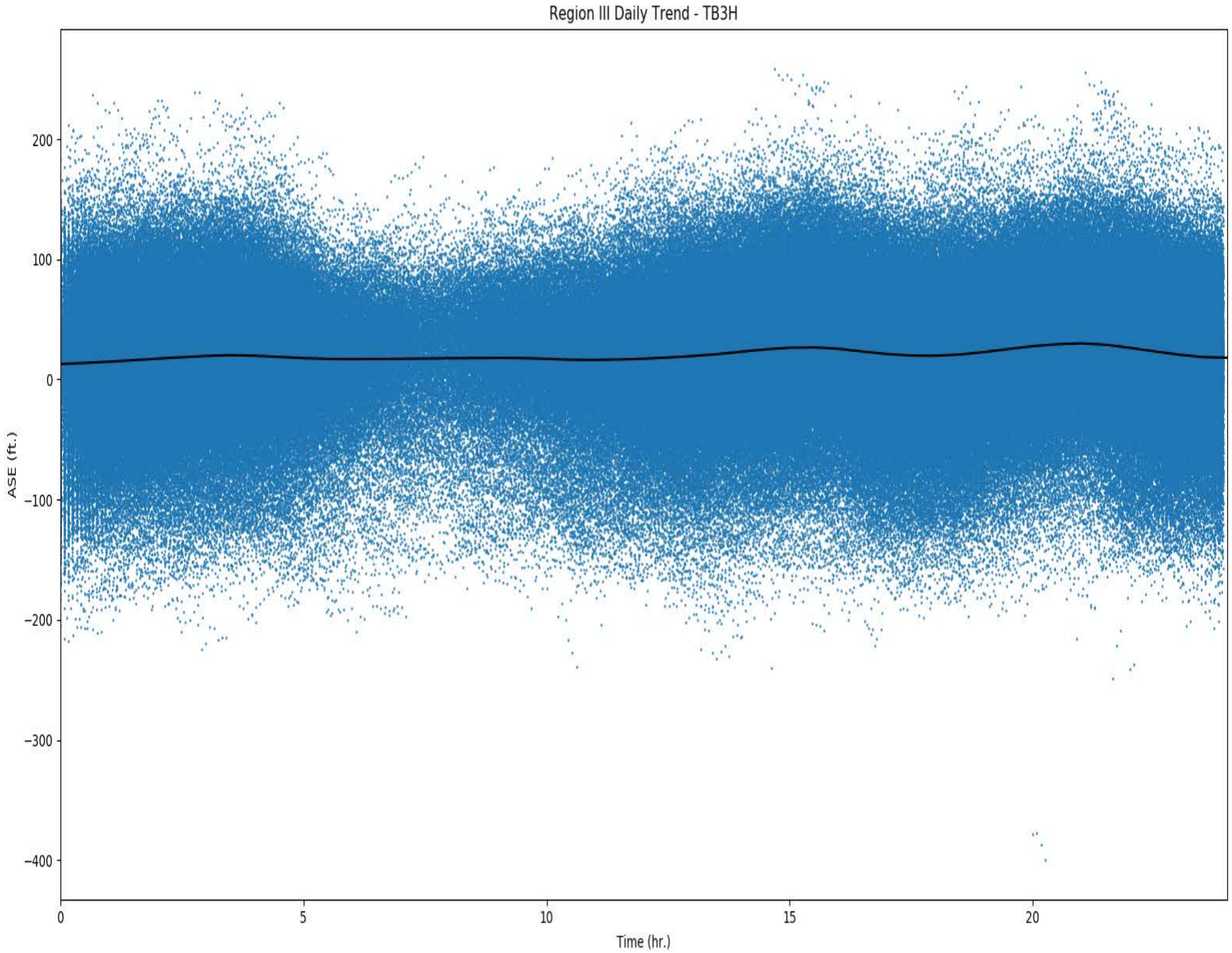
1-hour MET Files, Region II



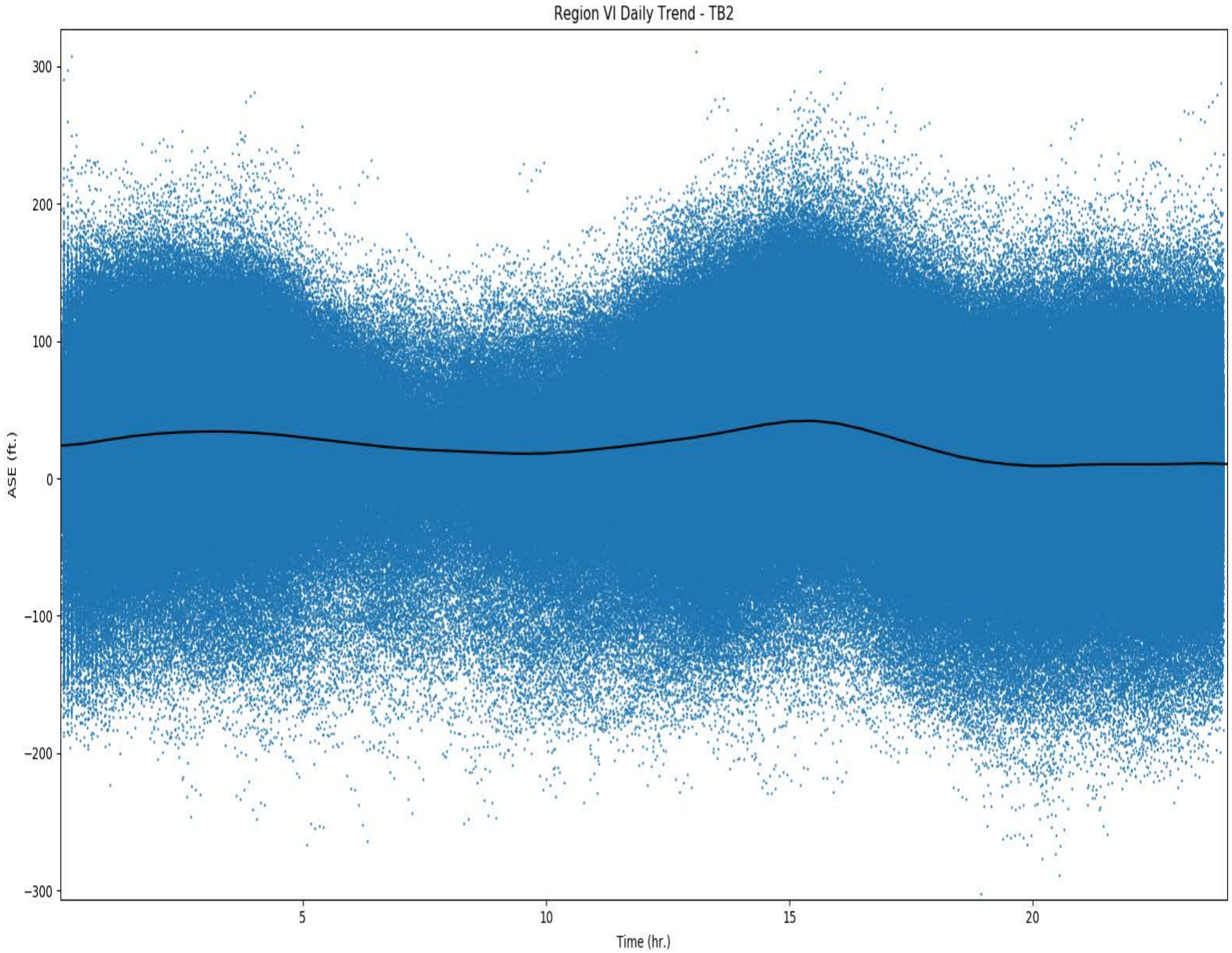
6-hour MET Files, Region III



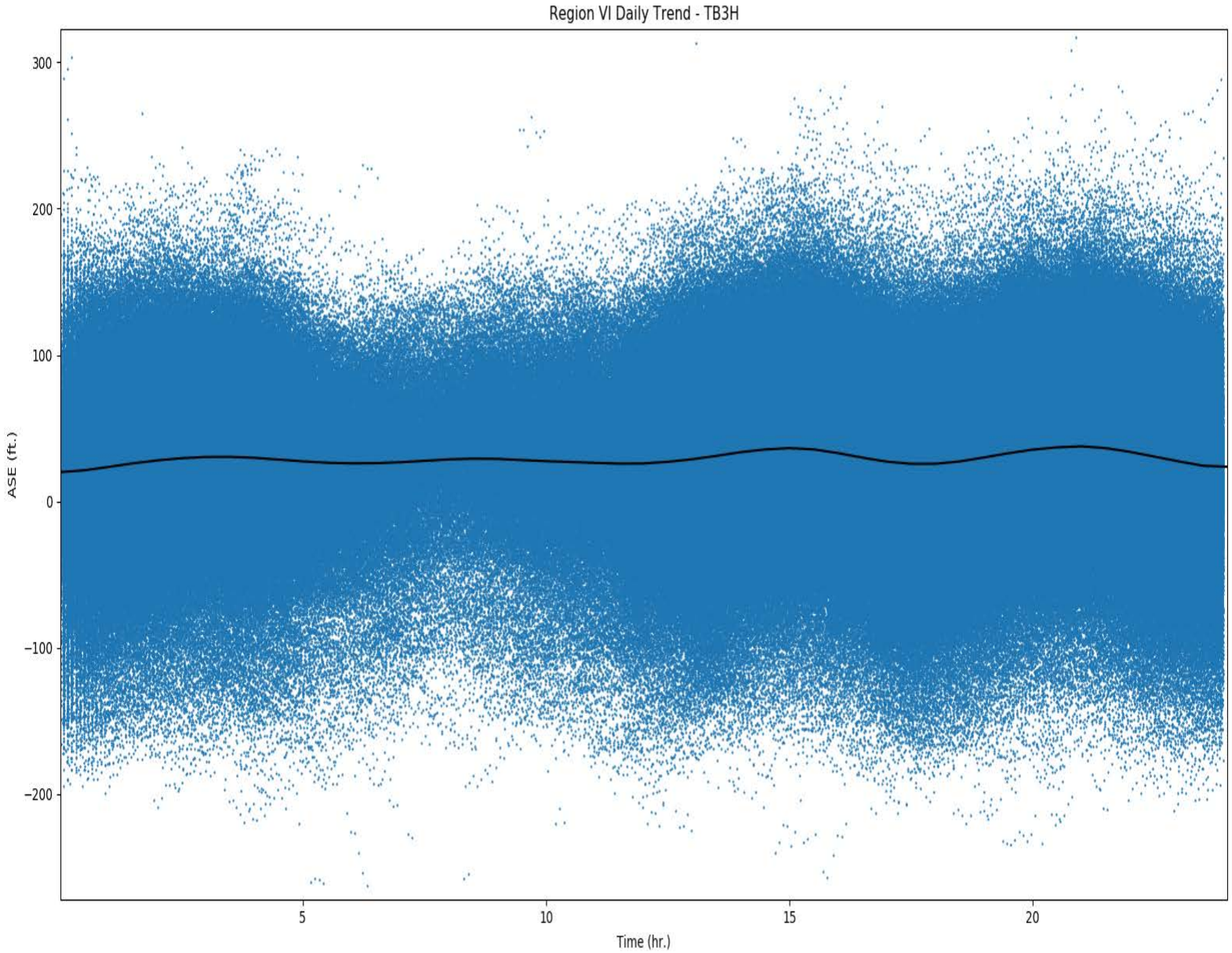
1-hour MET Files, Region III



6-hour MET Files, Region VI



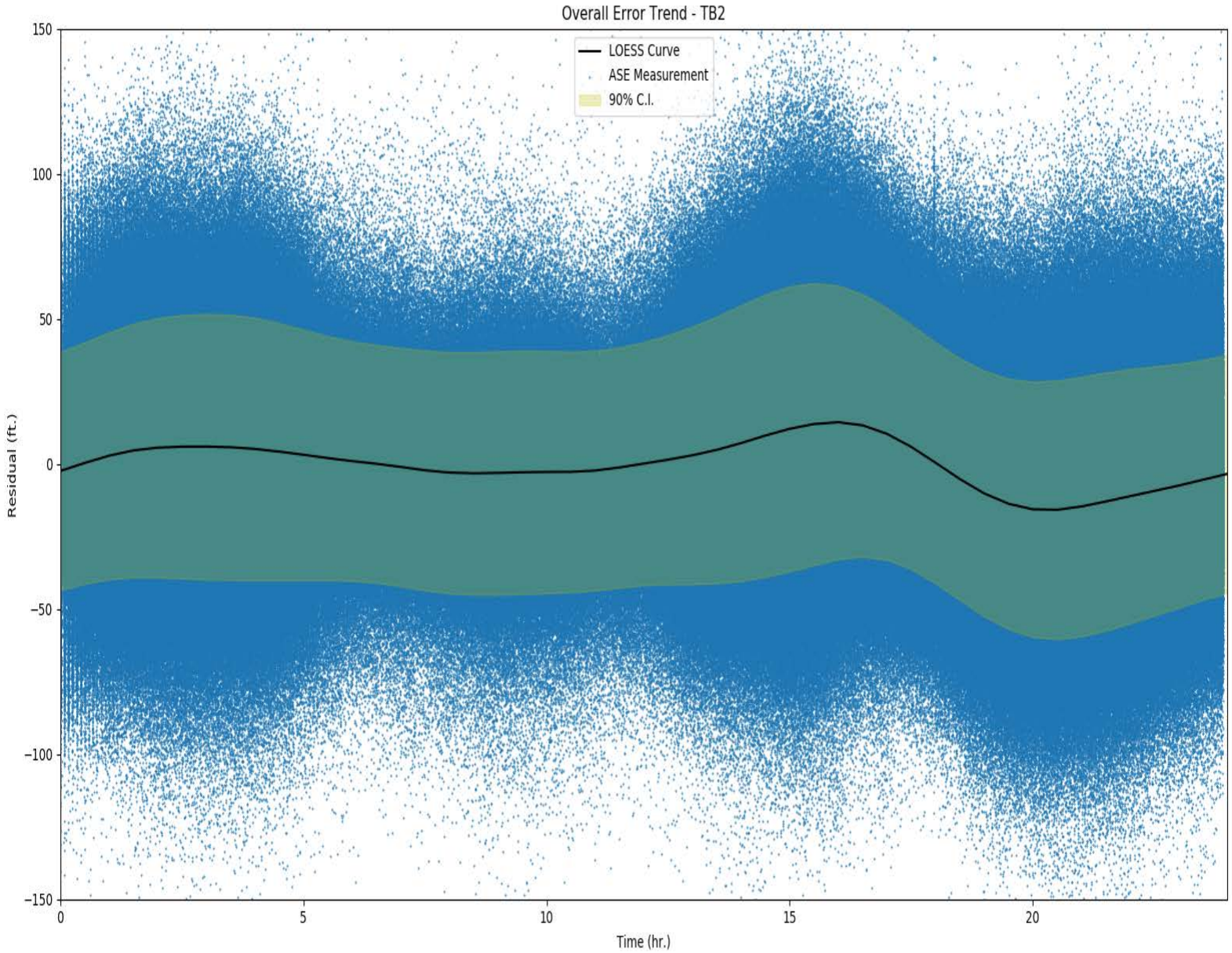
1-hour MET Files, Region VI



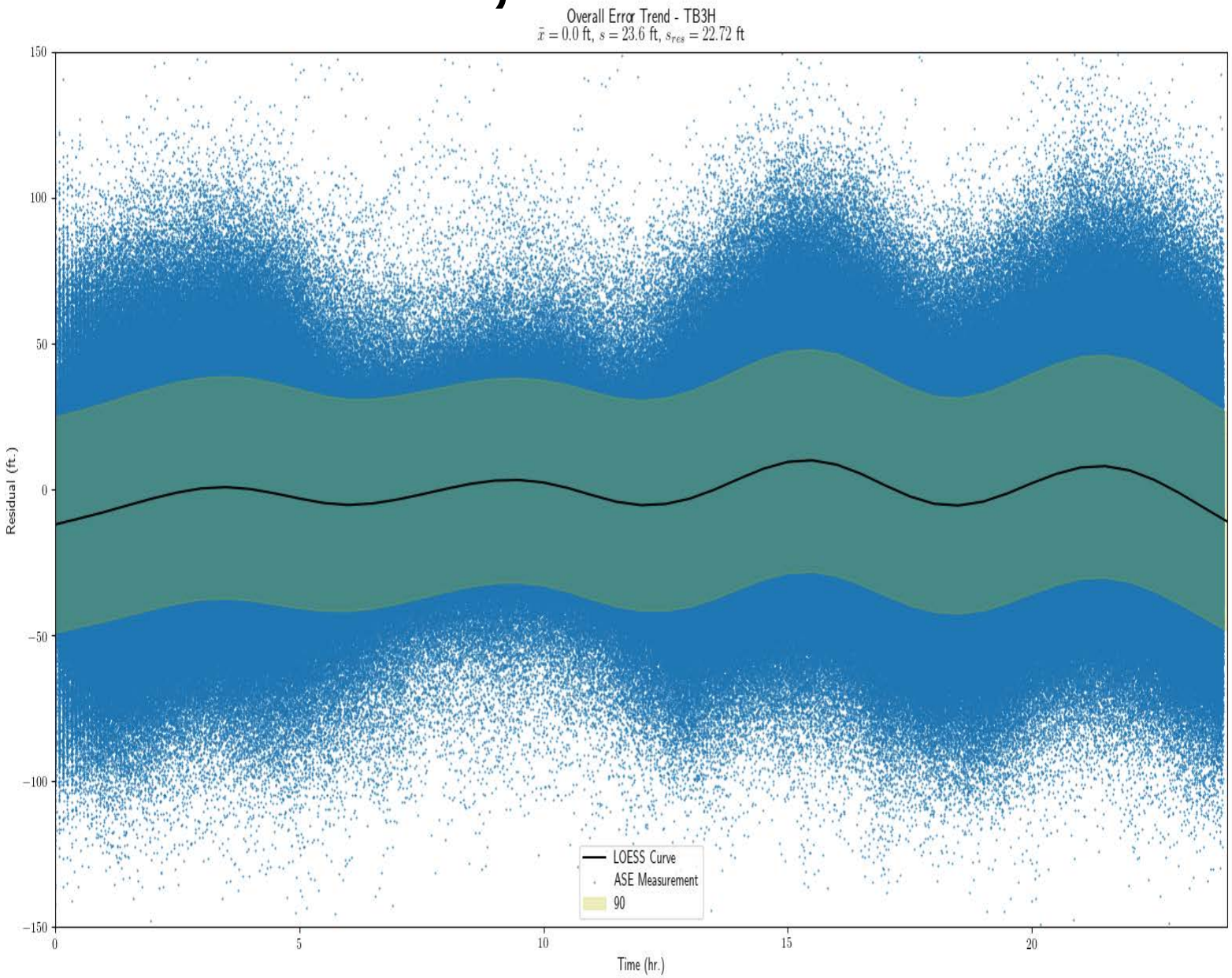
Observations:

- **1-hour MET files provide a somewhat improved statistical performance**
  - Not very visible within the plotted data
- **No significant variation is observed is seen within the East to West sample**
- **North to South comparison shows slightly more variation**
  - Southern data has a small trend that is similar to the trend presented within the MAAR data

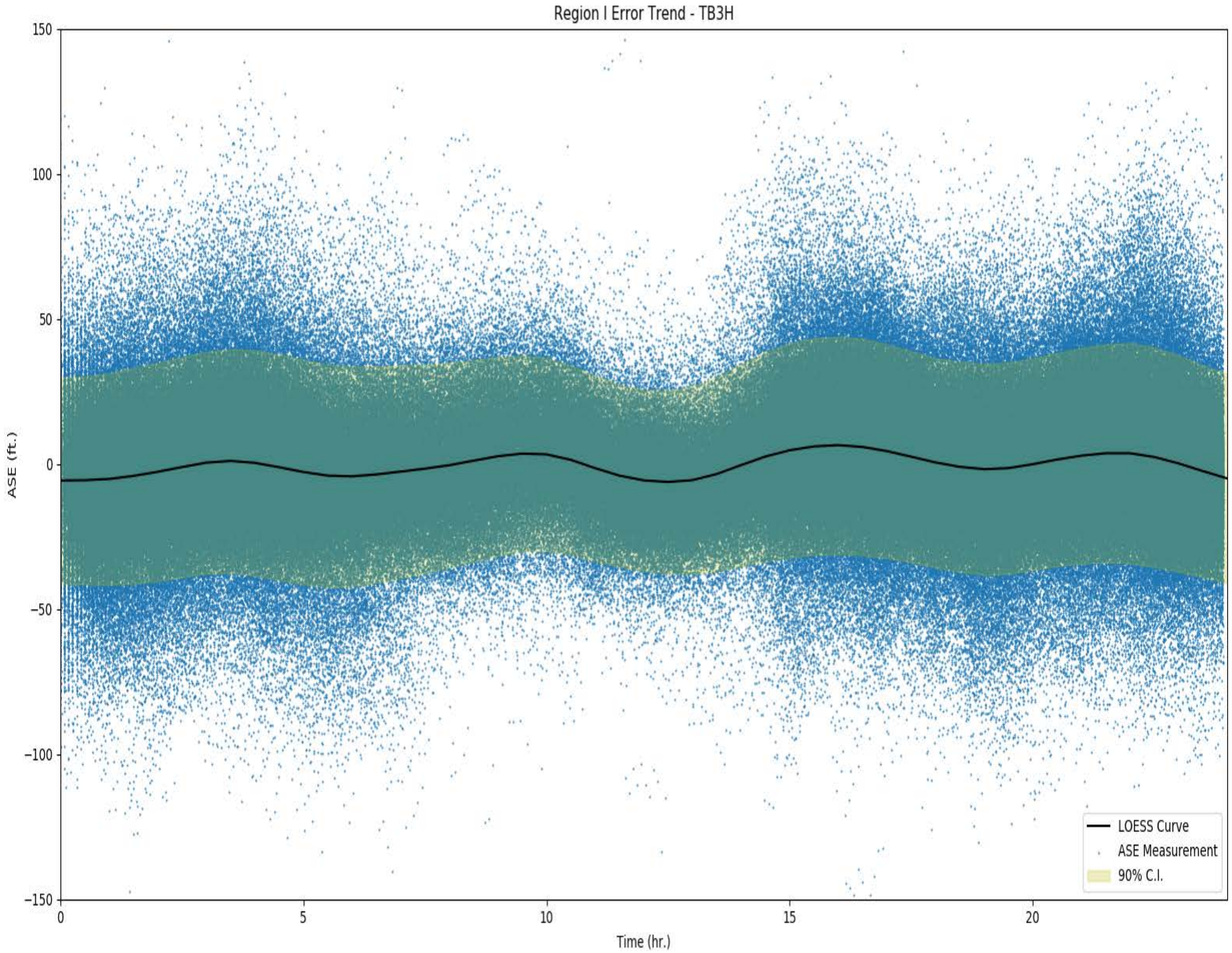
6-hour MET Files, Normalized Trend



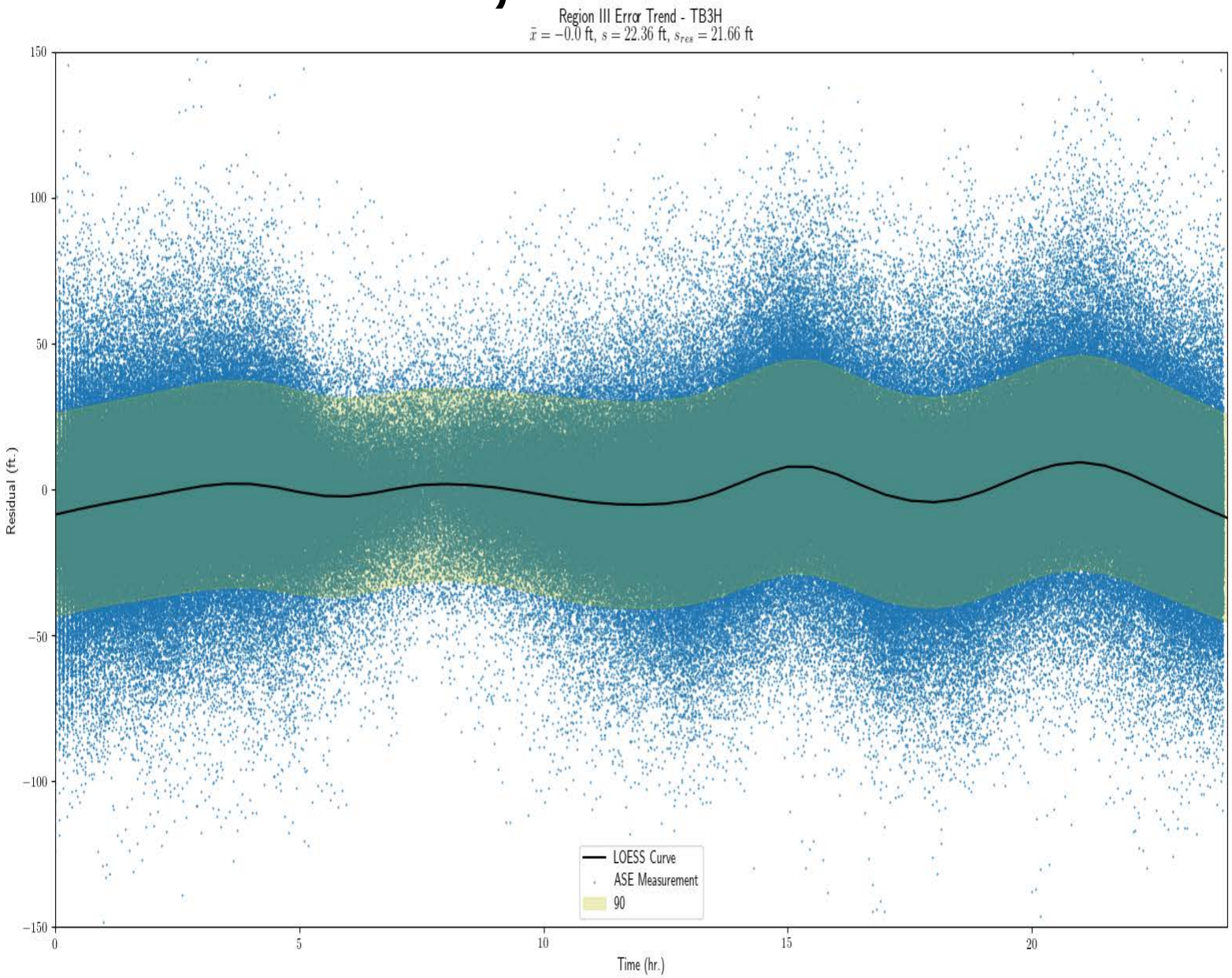
1-hour MET Files, Normalized Trend



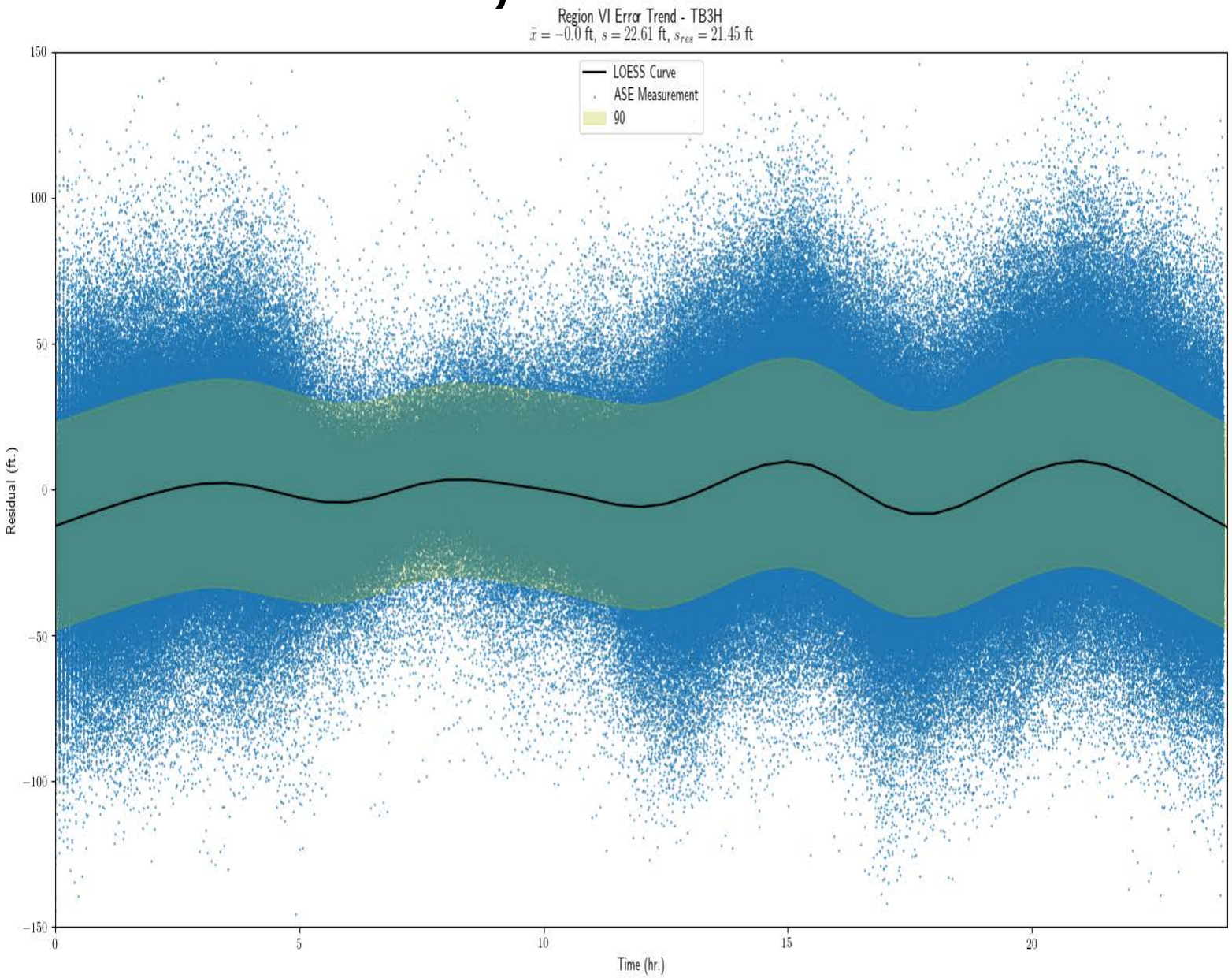
1-hour MET Files, Normalized Trend RI



1-hour MET Files, Normalized Trend RIII



1-hour MET Files, Normalized Trend RIV



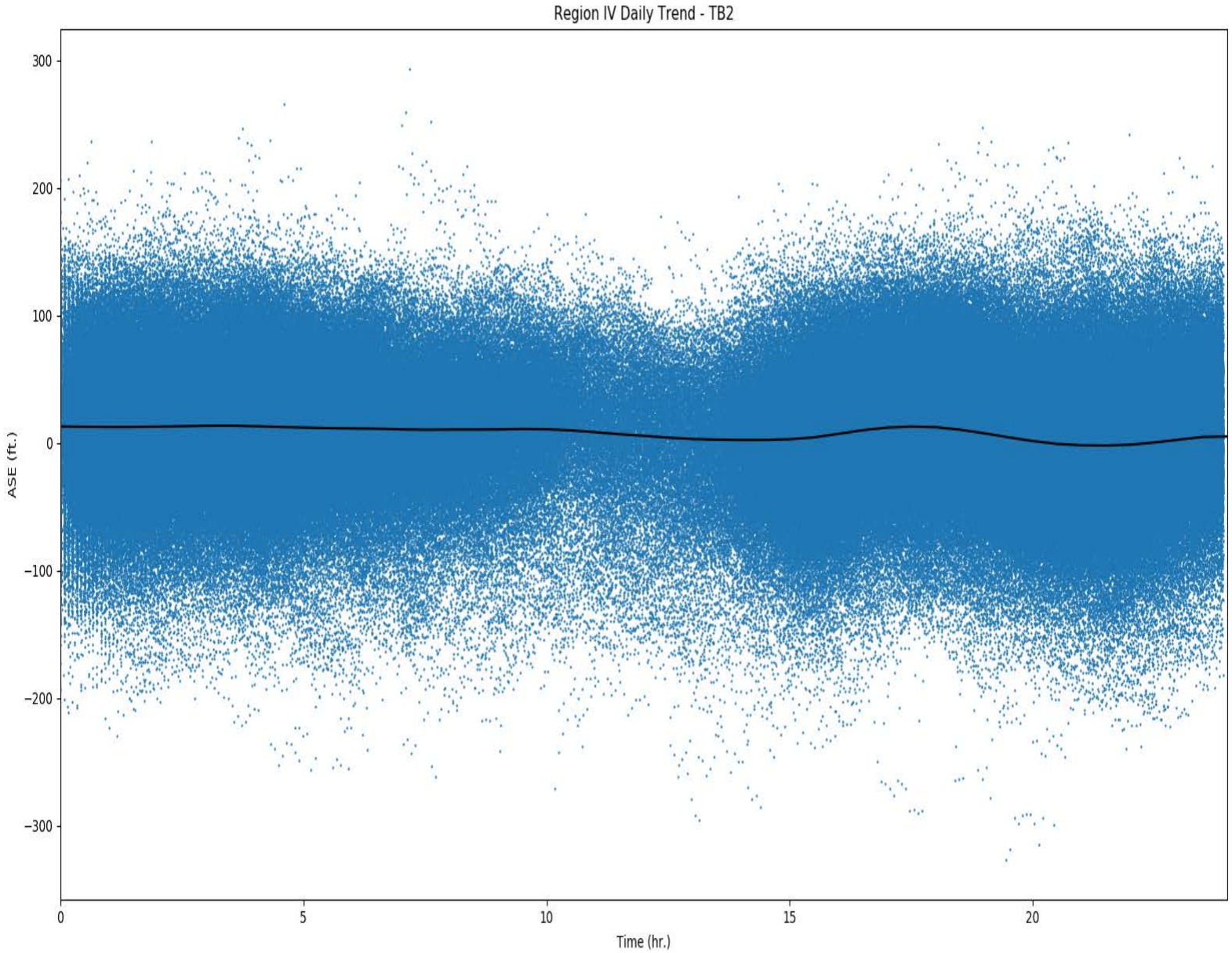
Summary/Discussion (1)

- Work on the RMACG action is progressing, focusing on the potential errors in the components of the underlying parameters used to calculate ASE
  - Primary components include the accuracy of the geometric height of the aircraft and the accuracy of the geometric height of the pressure surface
- Ensemble ASE statistics have shown a relatively consistent envelope of accuracy.
  - Variation in the width of the envelop can be used for comparison of the relative performance of the monitoring systems in use worldwide.

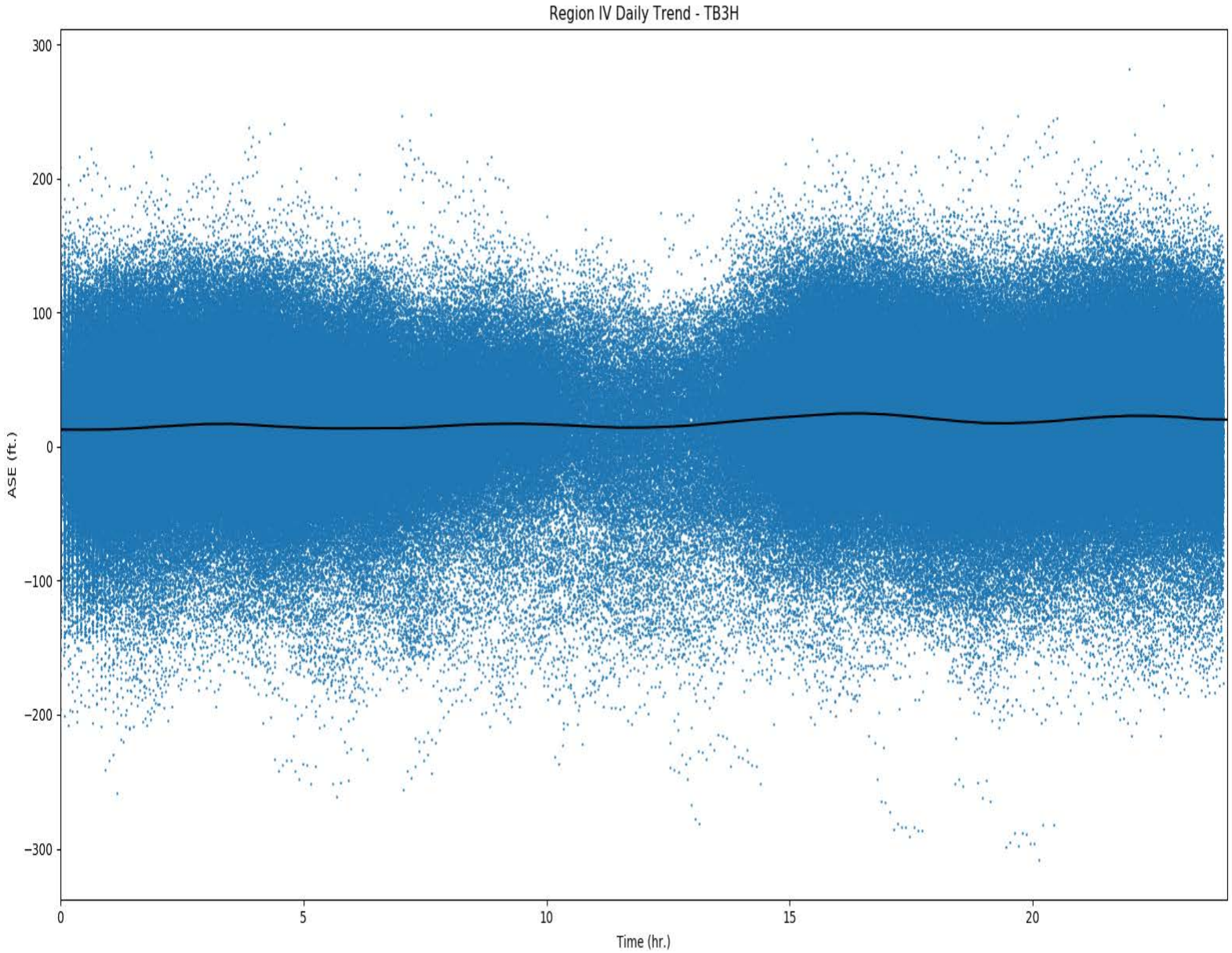
Summary/Discussion (2)

- ASE trends that seem to have functions of some dependent parameter are being examined for potential calibration or improvement.
  - Temperature and time of day are at least two parameters
- Investigation of FAA ADS-B data from December 2019 plotted as a function of time of day demonstrates a small bias with time of day
  - This is more pronounced when smaller subsets of data are examined
  - This presentation included data sorted by geographic location and altitude
- Work will continued via the RMACG ASE accuracy subgroup

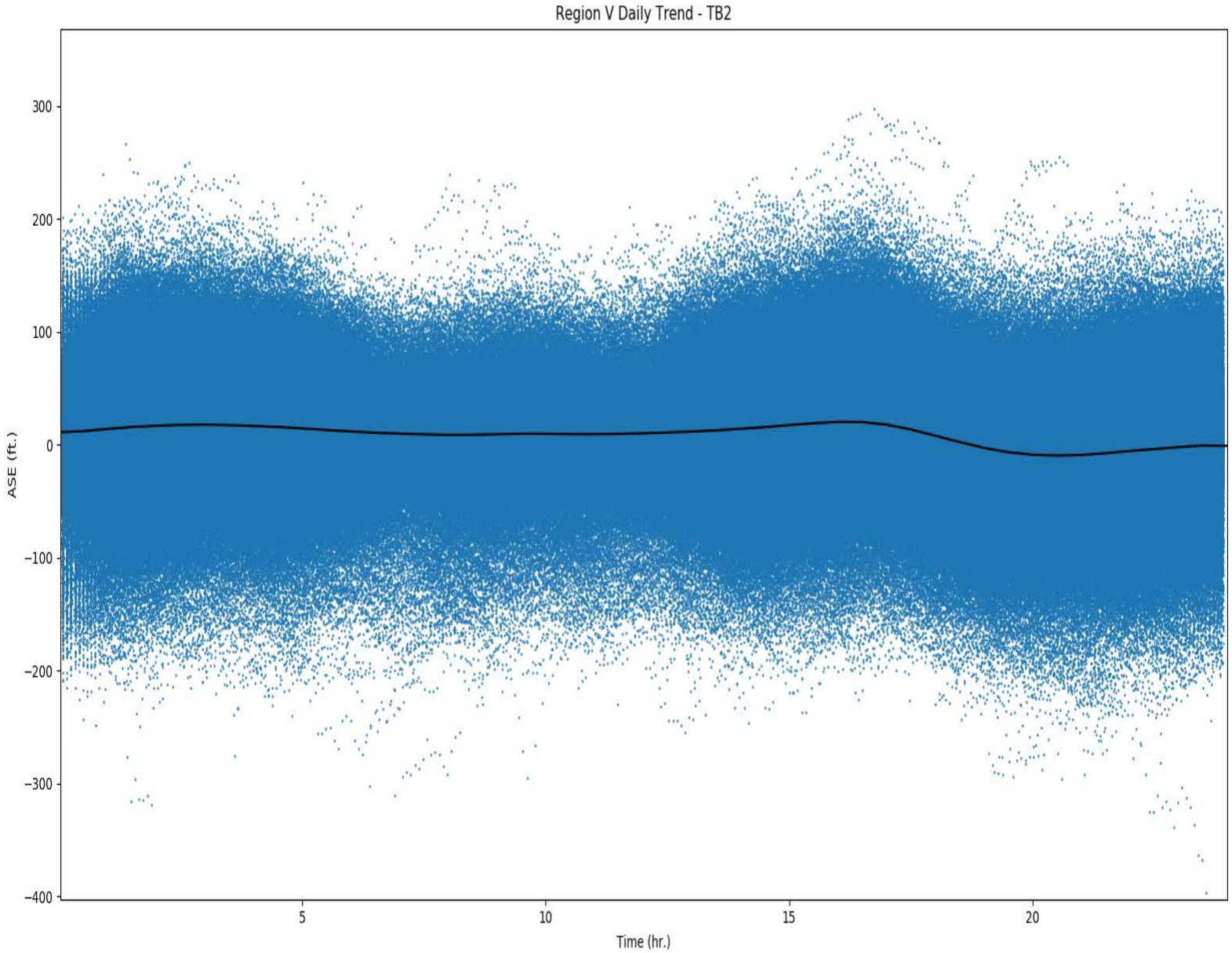
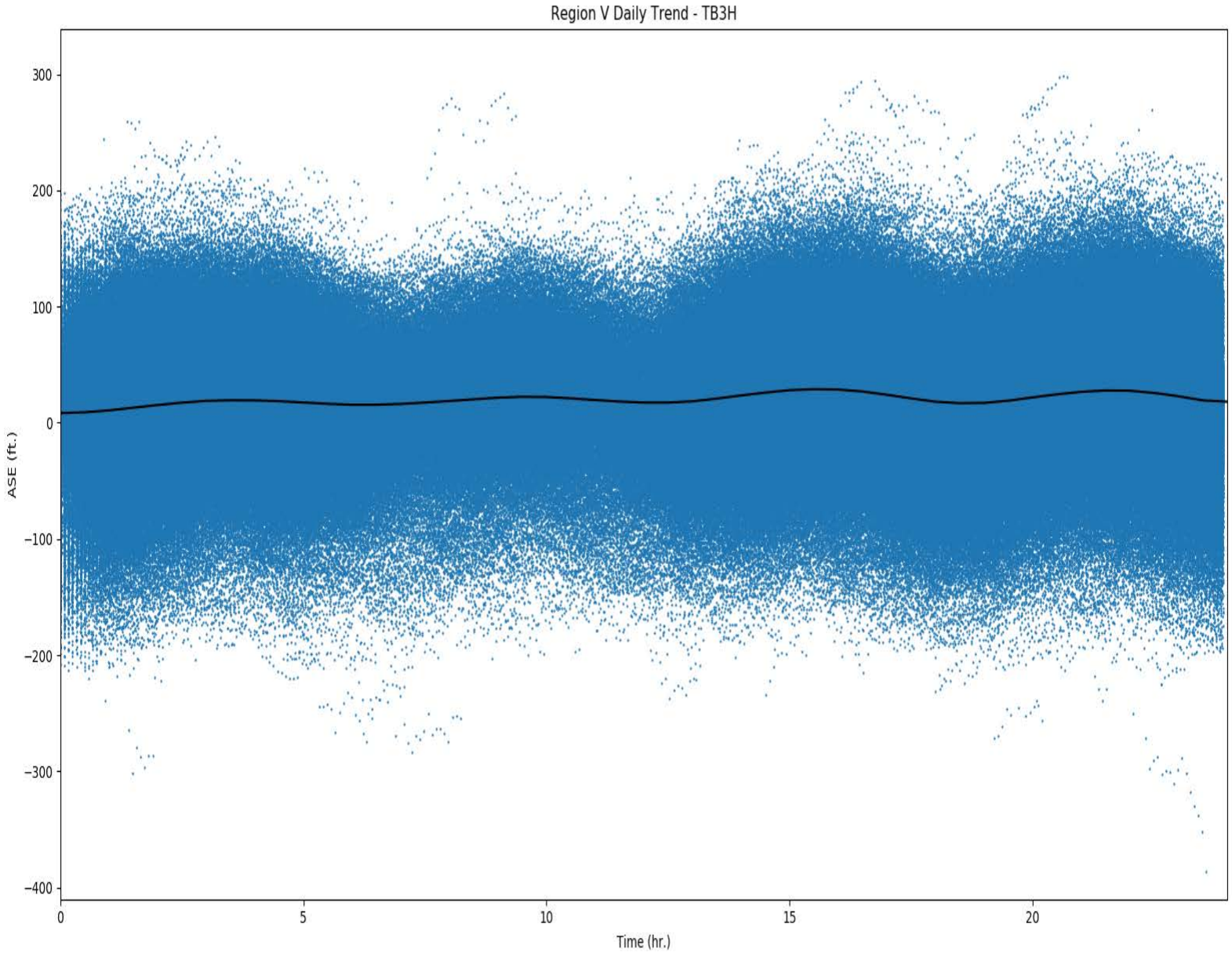
6-hour MET Files, Region IV



1-hour MET Files, Region IV



6-hour MET Files, Region V



1-hour MET Files, Region V