EGU General Assembly 2022

ATTO
AMAZON TALL TOWER OBSERVATORY

BG1.4

The ATTO Micrometeorological Intercomparison Experiment (ATMIX)

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Embrapa

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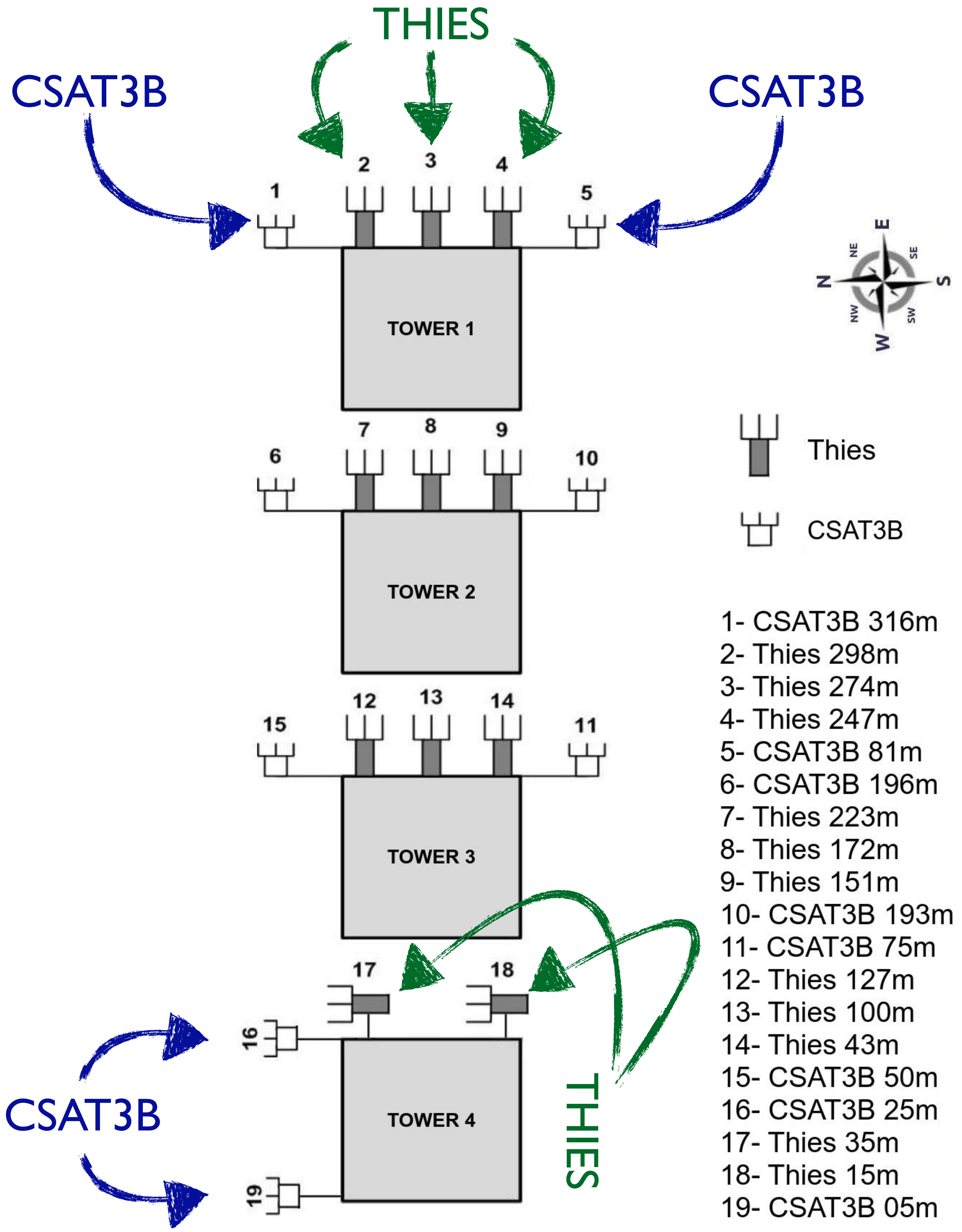
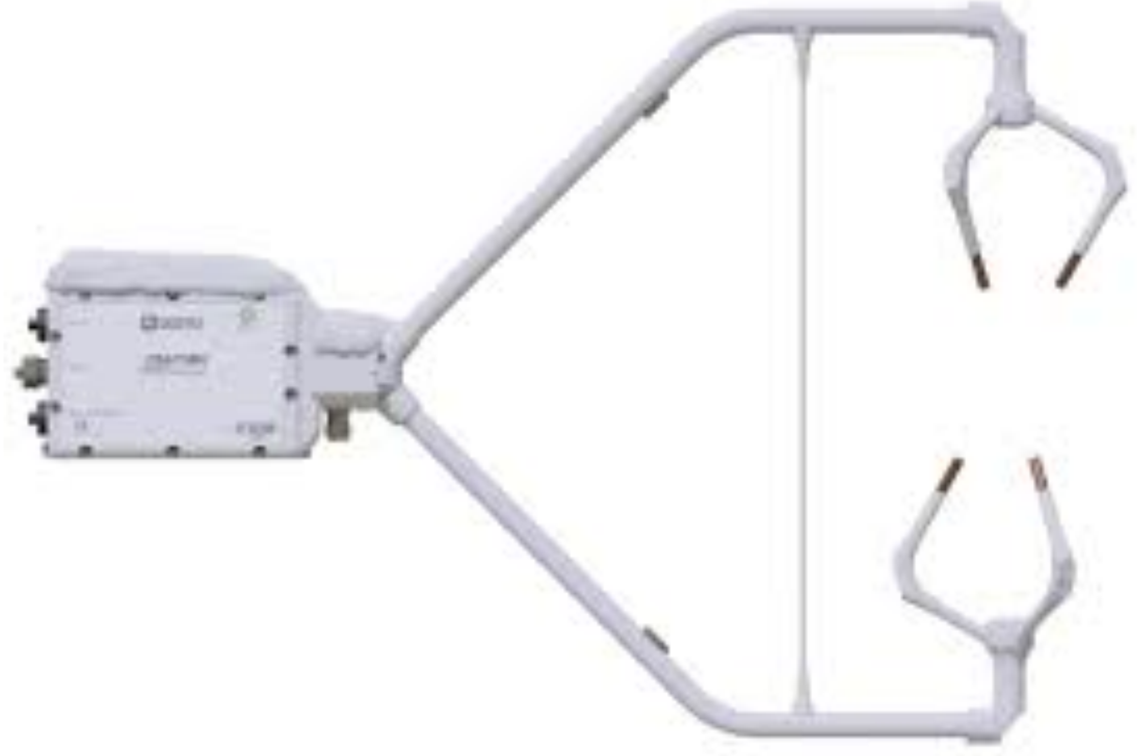
The ATMIX Experiment

28th November 2020 - 6th January 2021



CSAT3B



THIES

The ATMIX AIMS

The main objective of the experiment was to check how close the sonic anemometers designated to be installed permanently respond to the same atmospheric conditions, and to develop confidence in interpreting profile data measured at the two towers.

ATMIX is similar in philosophy to the experiment described by Mauder and Zeeman (2018):

> Several anemometers placed side-by-side are supposed to be measuring the same wind velocities and turbulence statistics, but an *absolute* reference is missing (one cannot assume one of the instruments to be the standard against which to compare the others); moreover, site limitations and possibly flow distortion among the sonics add further uncertainty.

Quality Analysis

A very simple quality control procedure was applied, based (but not equal to) on Zahn et al. (2016). A data block is generally referred to as x_i, i = 0,...,n − 1 with n = 18000. Quality control divides a block with n data points into n/m sub-blocks with m points each. We used m = 600 which corresponds to 1 minute of data measured at 10 Hz (For the THIES temperature data, however, m = 6000). For each sub-block we calculate the median $\tilde{x}_s$ and the mean absolute deviation around it MAD$_s$, defined as:

$$MAD_S = \frac{1}{m}\sum_{i=0}^{m-1}\left|x_{sm+i} - \tilde{x}_s\right| \qquad (1)$$

where (the sub-block index) runs from 0 to n_s − 1, and where n_s = 30 is the number of sub-blocks. Before quality control, missing or erroneous data are flagged with NANs. A spike is defined as

$$\left|x_{sm+i} - \tilde{x}_s\right| > n_\delta\, MAD_S \qquad (2)$$

A **locking condition** (x_i varies too little over a sub-block) is defined as

$$max_s MAD_s > Q_{MAD} \qquad (3)$$

Finally, a **non-stationary condition** is defined as

$$max_r\tilde{x}_r - min_s\tilde{x}_s > Q_{\tilde{x}} \qquad (4)$$

Then the following criteria are applied sequentially:

If the number of values in the block equal to NAN is more then 1% of the block size, i.e. #(x_i = NAN) > 0.01n, then set all x_i to NAN and return code 1 (**rc_x = 1**).

Flag all spikes with NANs and add to the previous number of NANs. Then, if #(x_i = NAN) > 0.01n, set all x_i to NAN and return code 2 (**rc_x = 2**).

If max$_s$ MAD$_s$ < Q_{MAD}, set all x_i to NAN and return code 3 (**rc_x = 3**).

If $max_r\tilde{x}_r - min_s\tilde{x}_s > Q_{\tilde{x}}$, set all x_i to NAN and return code 4 (**rc_x = 4**).

If none of the above occurs, fill all runs of NANs in x with linear interpolation from the valid extremities and return code 0.

(kfastcontrol, Dias et al. 2022)

Quality Analysis

Tower I

Sonic	Total Blocks	QC Passed for u, v, w	QC Passed for u, v, w, T	
CSAT3B 82m	285	246	246	
CSAT3B 316m	285	242	242	
THIES 247m	285	273	84	$\sim 31\,\%$
THIES 274m	309	296	120	$\sim 44\,\%$
THIES 298m	309	299	110	$\sim 40\,\%$

Coordinate Rotation

Double Rotation (Mc Millen, 1985)

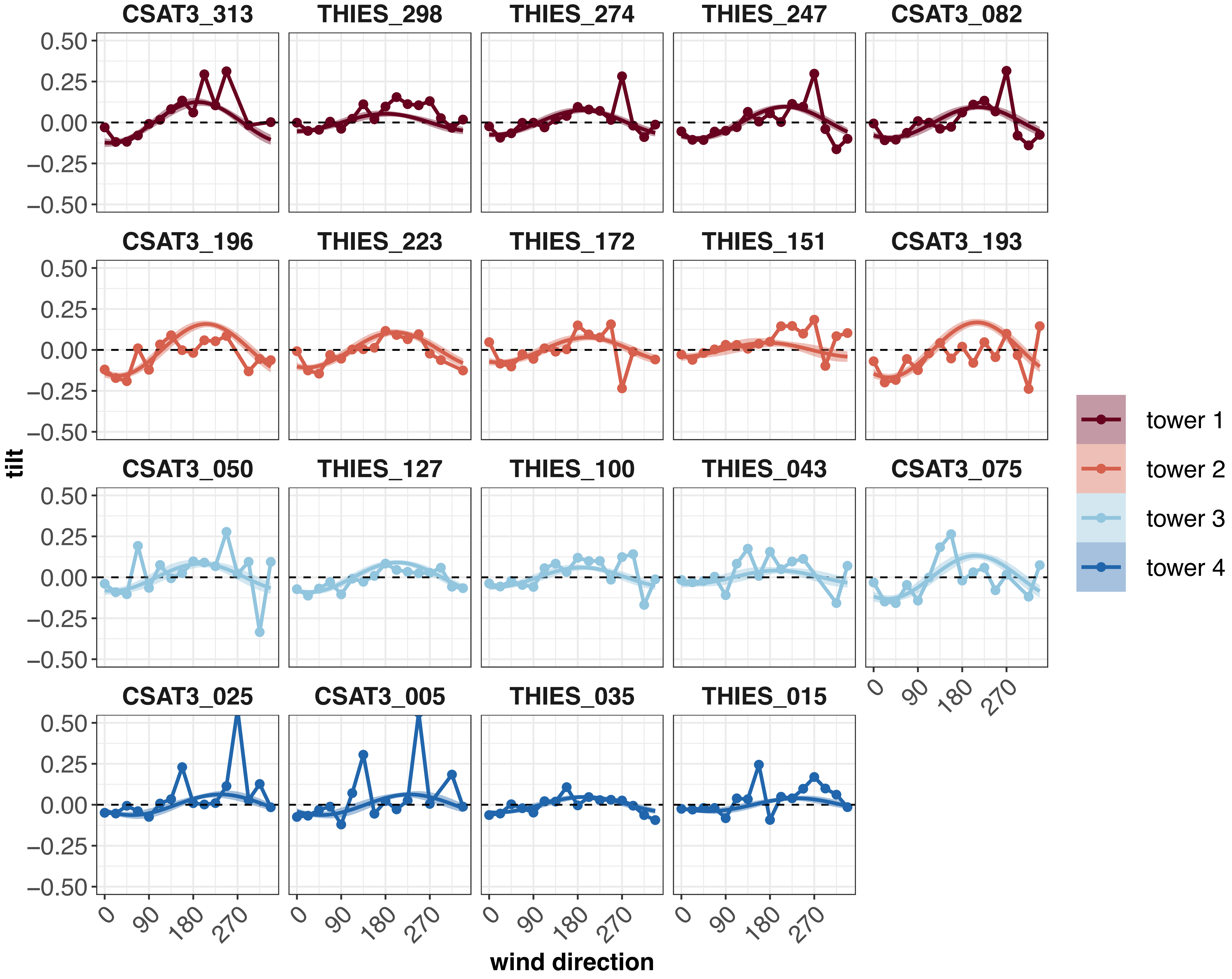
Planar Fit (Wilczak et al., 2001)

While the Double Rotation rotates the wind vector imposing a null vertical velocity for each individual block, the Planar Fit considers the whole dataset and rotates the data imposing that the mean vertical velocity of all measurements is zero; in other words, the planar fit technique evaluates the plane of the flow streamlines and rotates it into a coordinate system where the average vertical velocity of the flow is zero. In sloped terrain or in the presence of complex orography, when the w axis is not parallel to the acceleration of gravity vector, the two techniques lead to different estimates of turbulent momentum and heat fluxes. The tilt correction is crucial in a multi level experimental site where spectra and cospectra are compared at different heights or two-point statistics are evaluated.

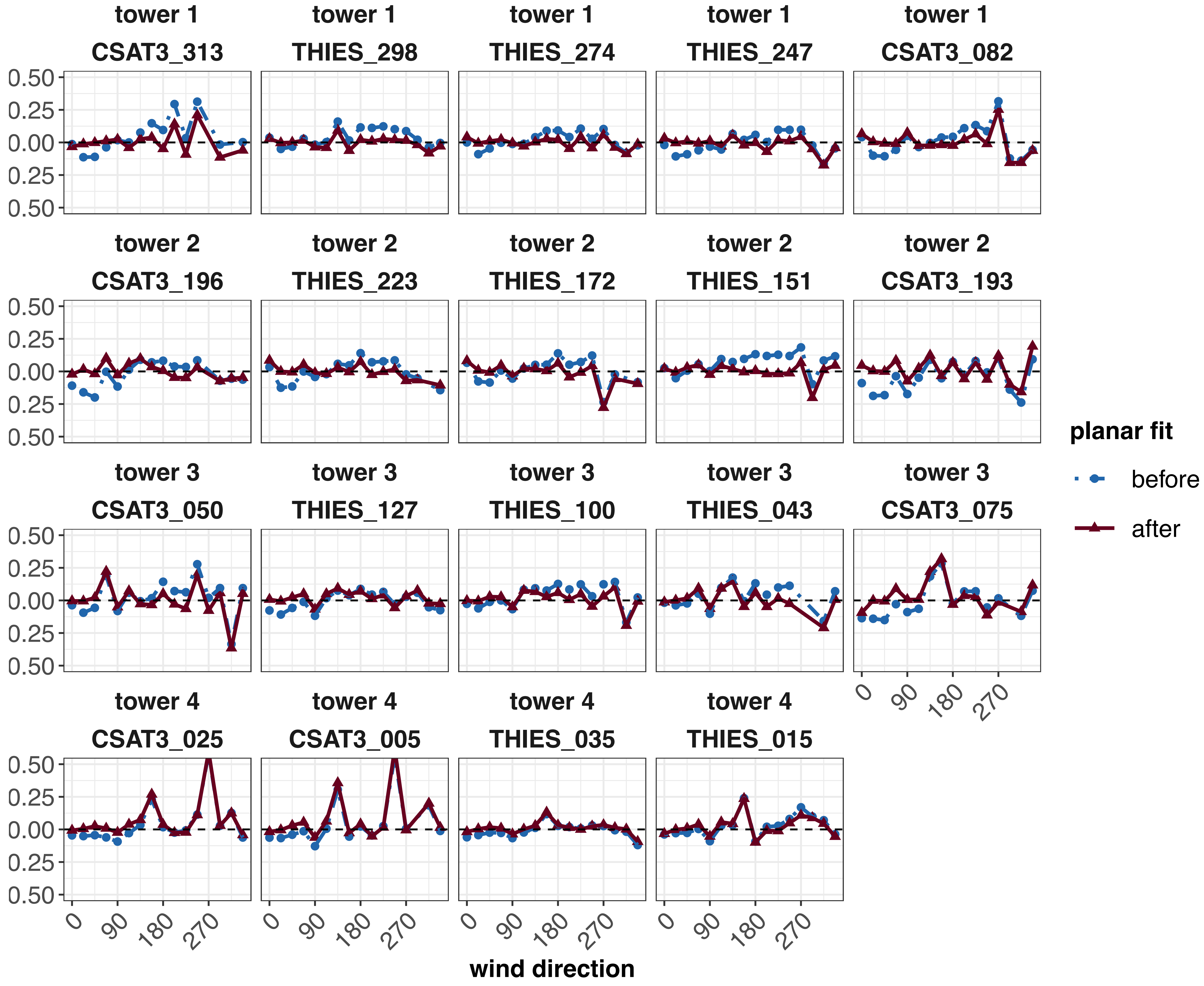
Coordinate Rotation

Planar Fit (Wilczak et al., 2001)

Raw Data



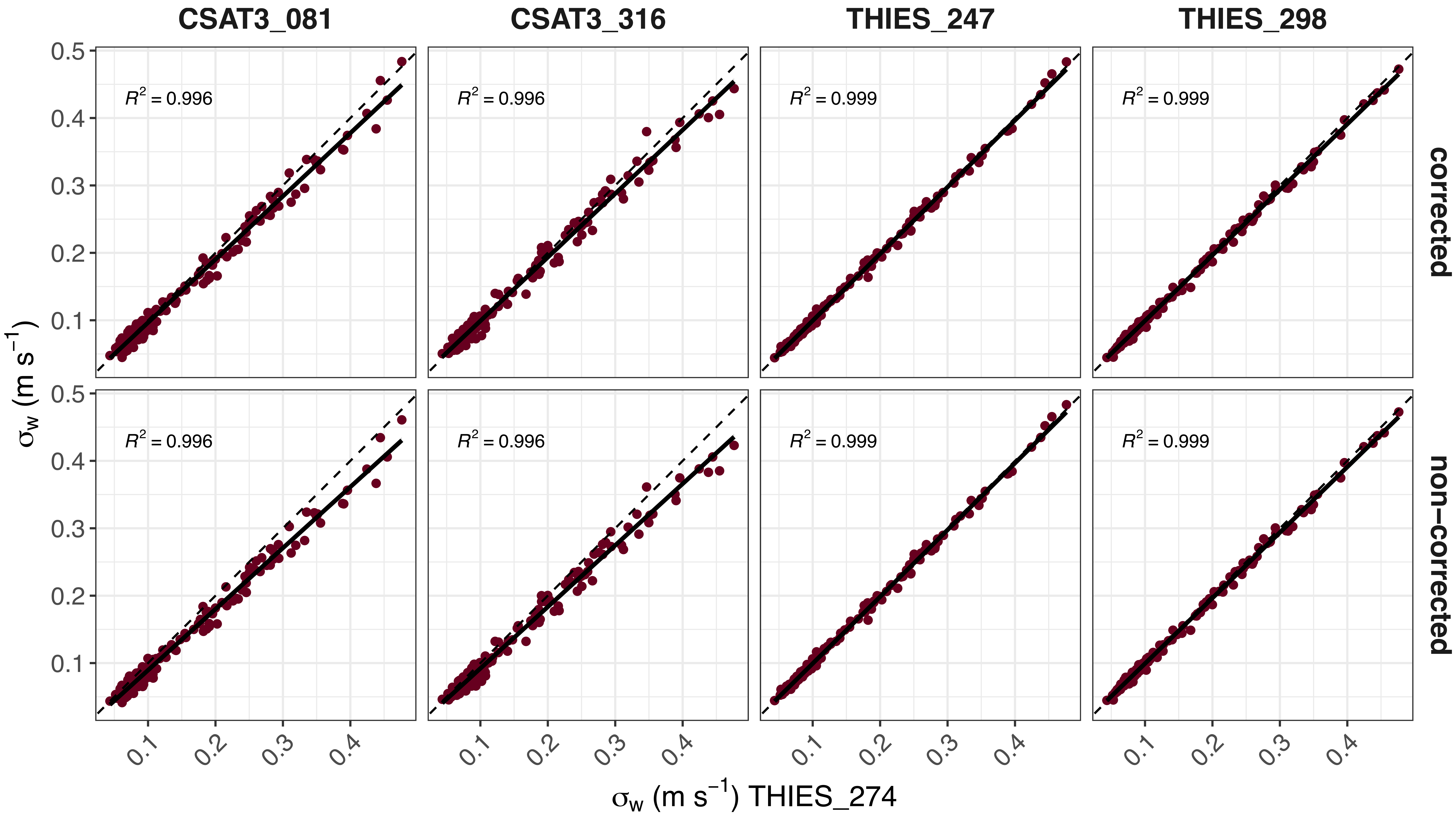
Rotated Data



Shadowing correction
(Horst et al. 2015)

The shadowing correction improve the comparison, especially for the CSAT3B.

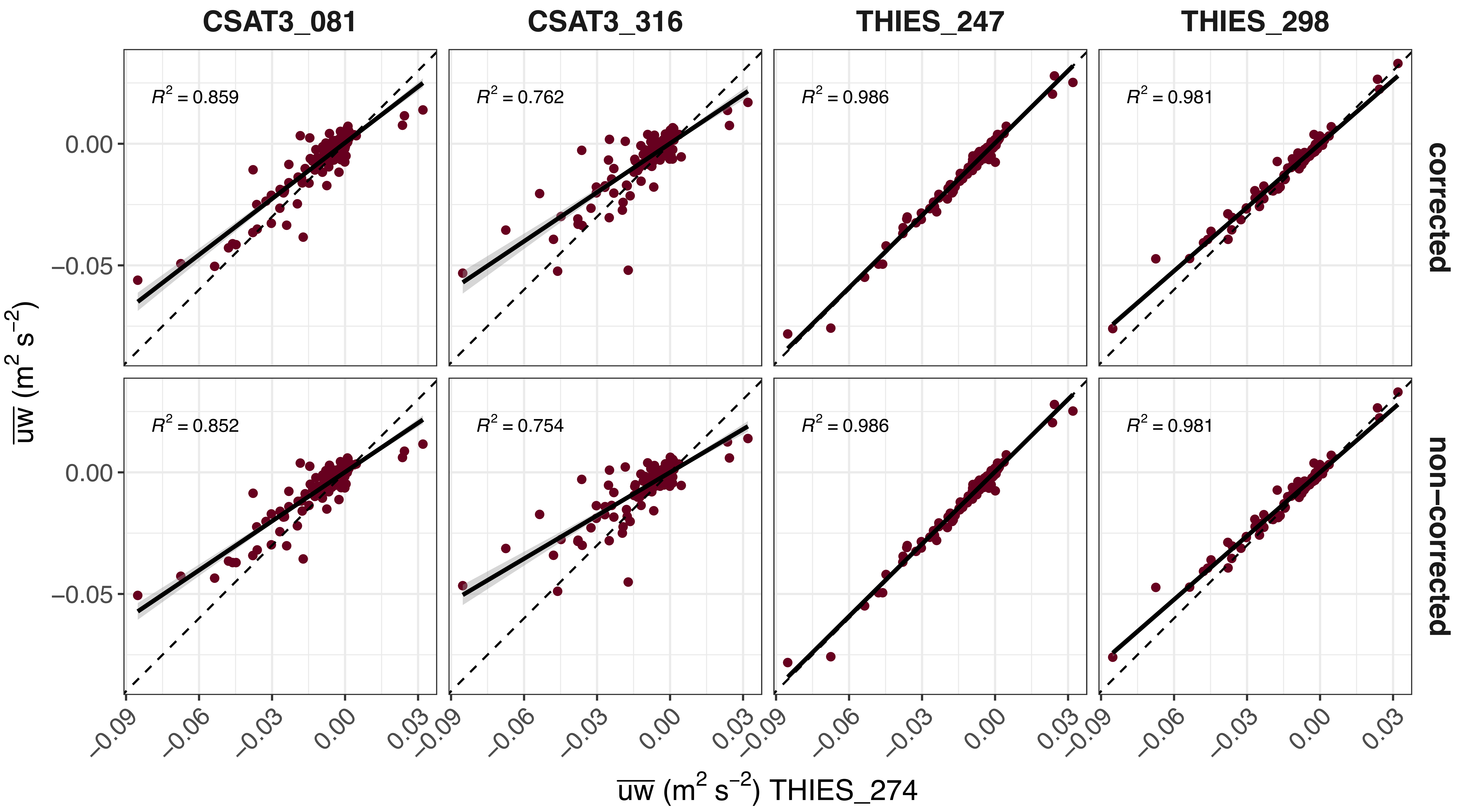
The comparison among THIESs is always better than the comparison among CSAT3B (not shown).



Shadowing correction

(Horst et al. 2015)

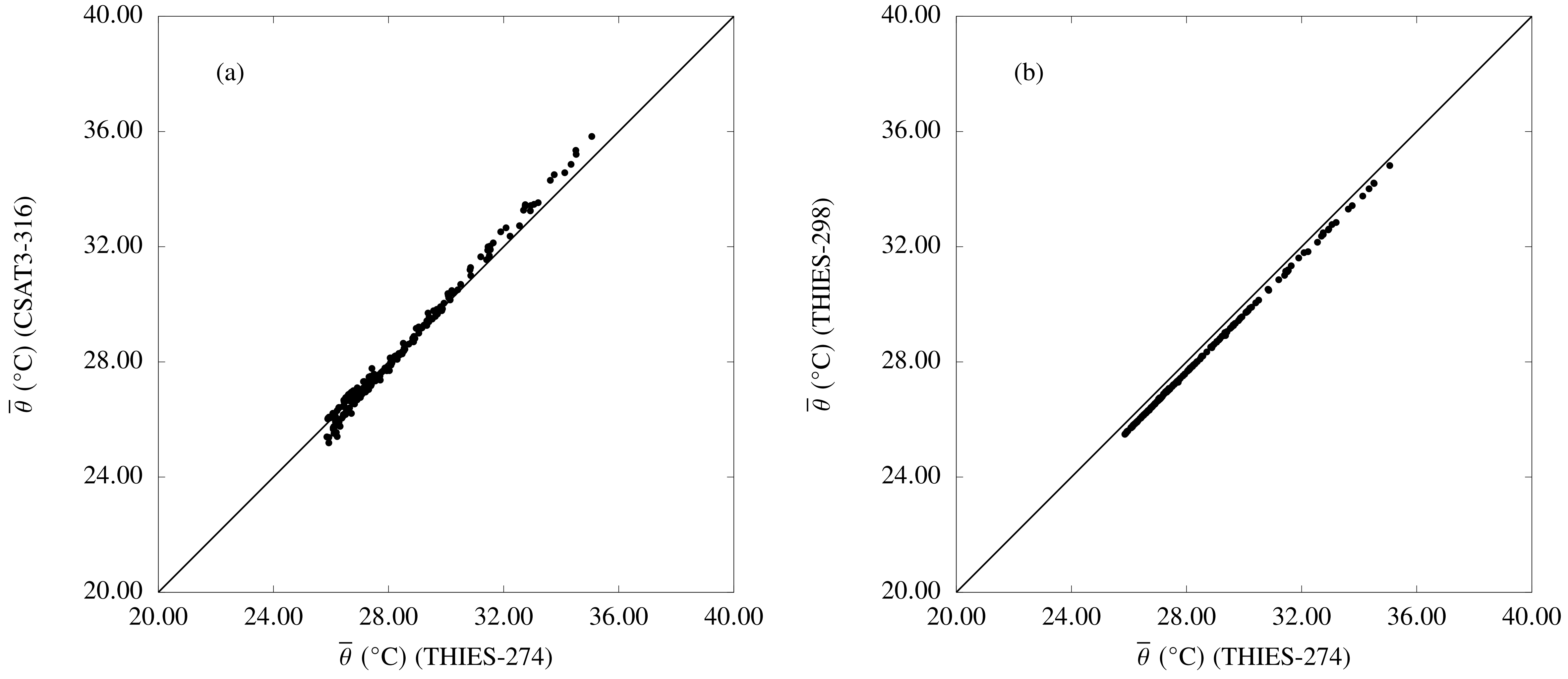
The momentum flux comparison between THIESs and CSAT3B is not ideal.



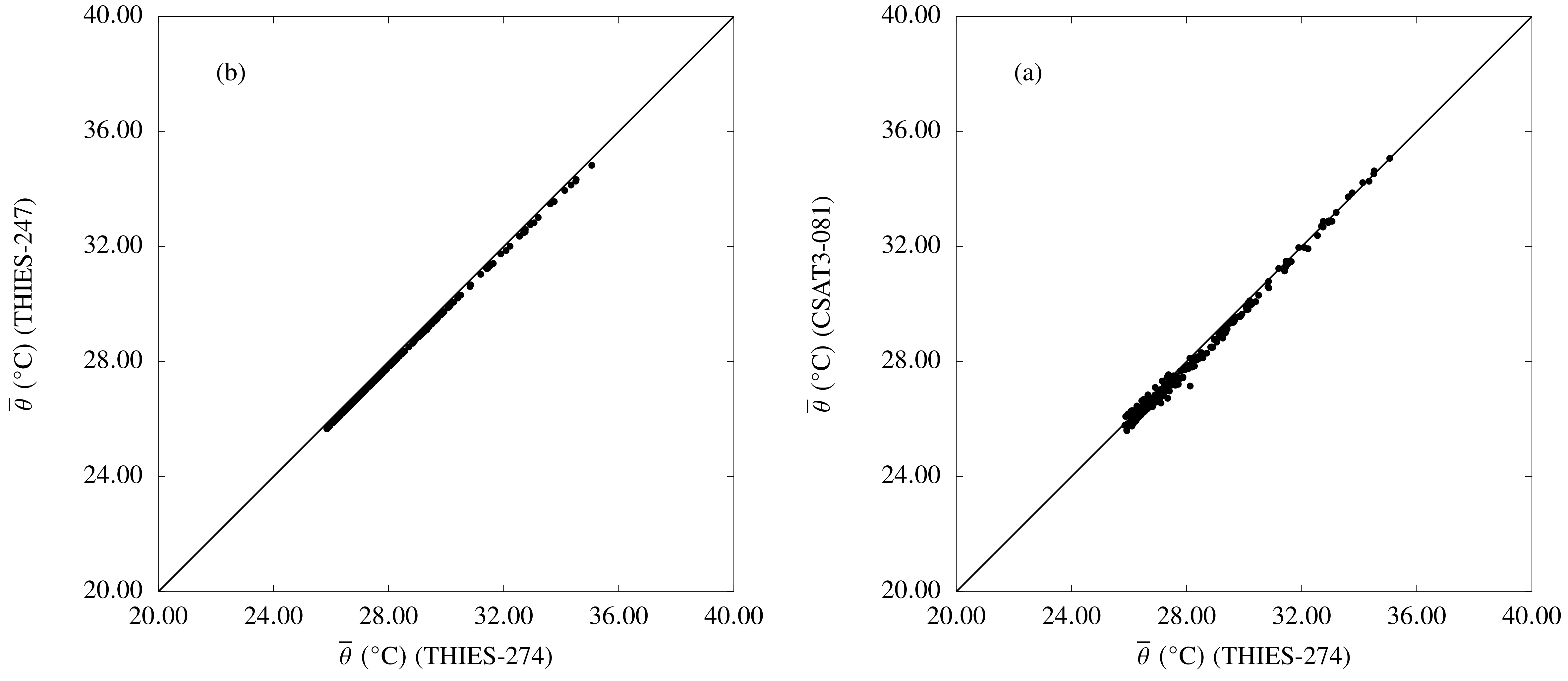
Mean Values

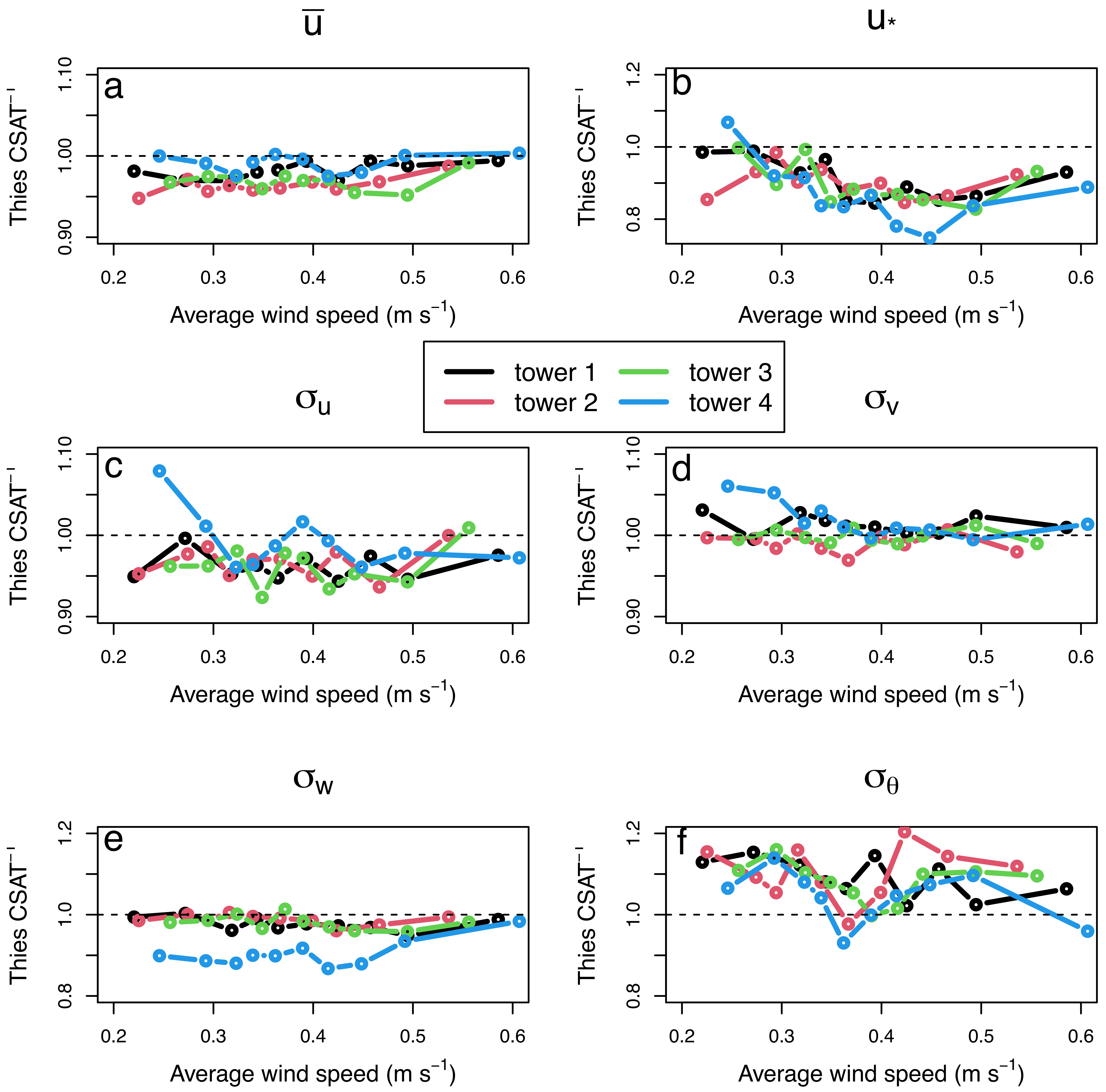
Dependence on wind speed

$\bar{\theta}$



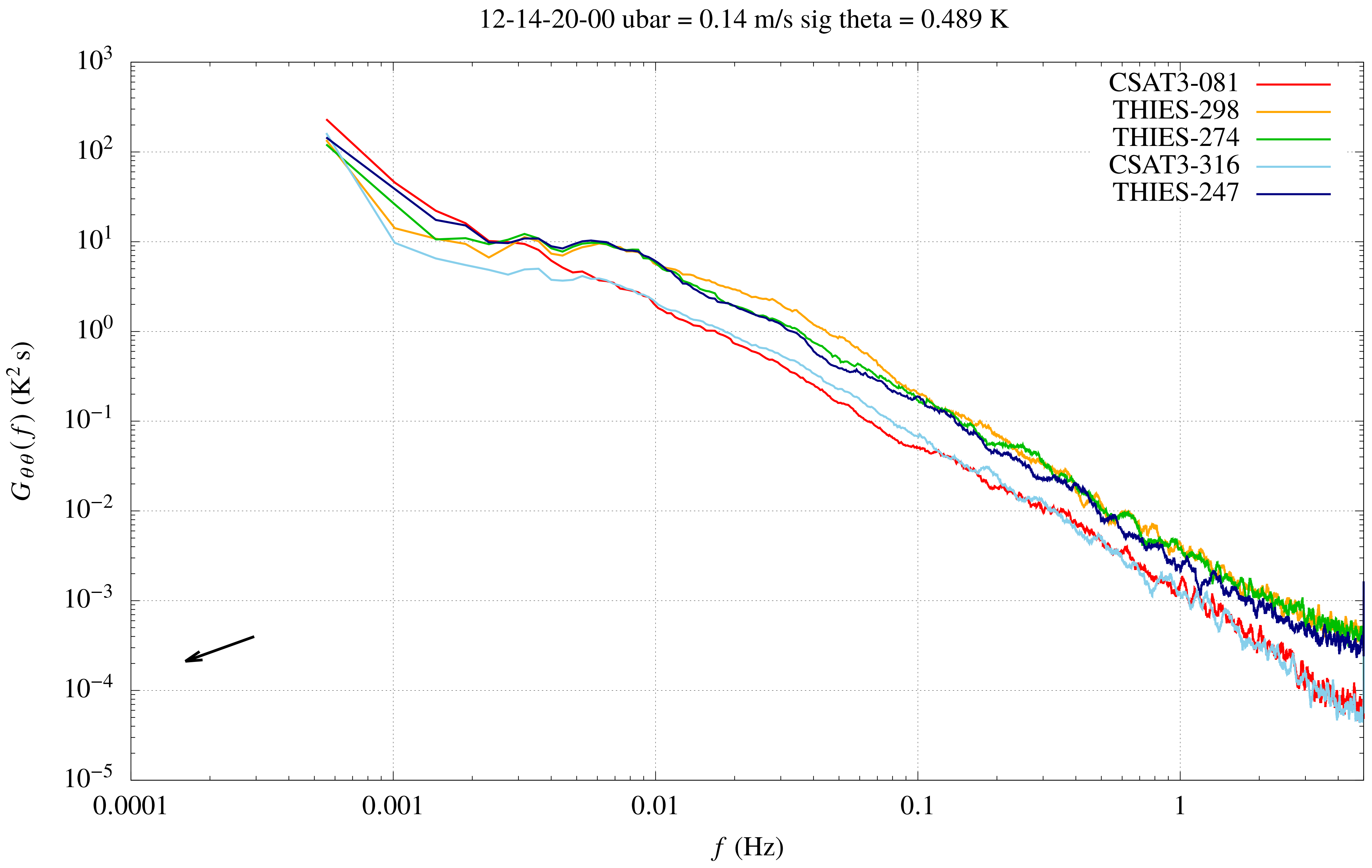
Surprisingly, $\bar{\theta}$ shows a very good agreement!



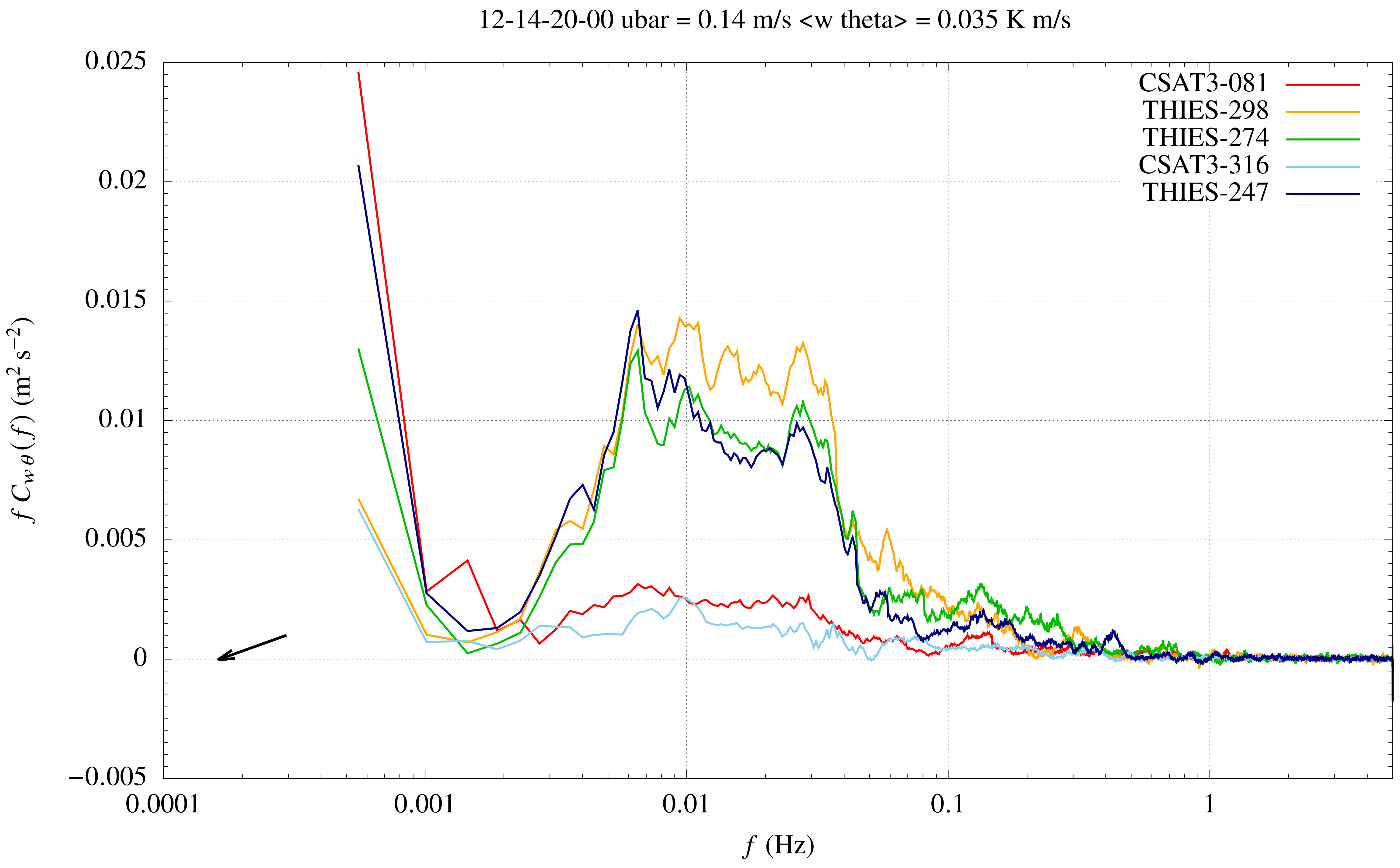


Spectra

Temperature Spectra



$w\theta$ Cospectra



The agreement between temperature spectra and the $w\theta$ cospectra is not satisfying. This represents a fairly general tendency: the CSAT3s temperature spectra are usually below those of the THIESs , as all as the corresponding cospectra (in absolute value).

Conclusions

I) The planar fit technique identified the main equivalent slope direction of the streamlines; indeed, spectra calculated with 2D rotation showed poorer agreement and behavior (not shown).

II) the Horst et al. (2015) correction for the CSAT3B improved the agreement between THIESs and CSAT3s remarkably. Therefore, we recommend that is applied to the corresponding turbulence datasets henceforth measured at ATTO.

III) The THIESs measurements proved to be more consistent among them than the CSAT3s.

IV) The THIES are strongly limited by a 0.1 K resolution of the sonic temperature. However, the blocks that passed the temperature-related quality control are reliable.

V) The comparison of temperature-related quantities between the THIES and the CSAT3 is not conclusive.

Dias NL, Dias-Júnior CQ, Mortarini L, Acevedo O, Oliveira P, Brondani D, Araújo A, Rossato F, Sörgel M, Tsokakunku A, Nobre Quesada CA, Ramos de Oliveira L, Teixeira PR, Tanaka Portela BT, Mata JR, Xavier TL, Manzi A. ATMIX: The ATTO Micrometeorological Intercomparison Experiment. Submitted to Atmospheric Measurements Techniques.