Parameterization of Intermittent Turbulence

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As stability increases turbulence becomes more intermittent.

Intermittent turbulence is not described well in current theories.

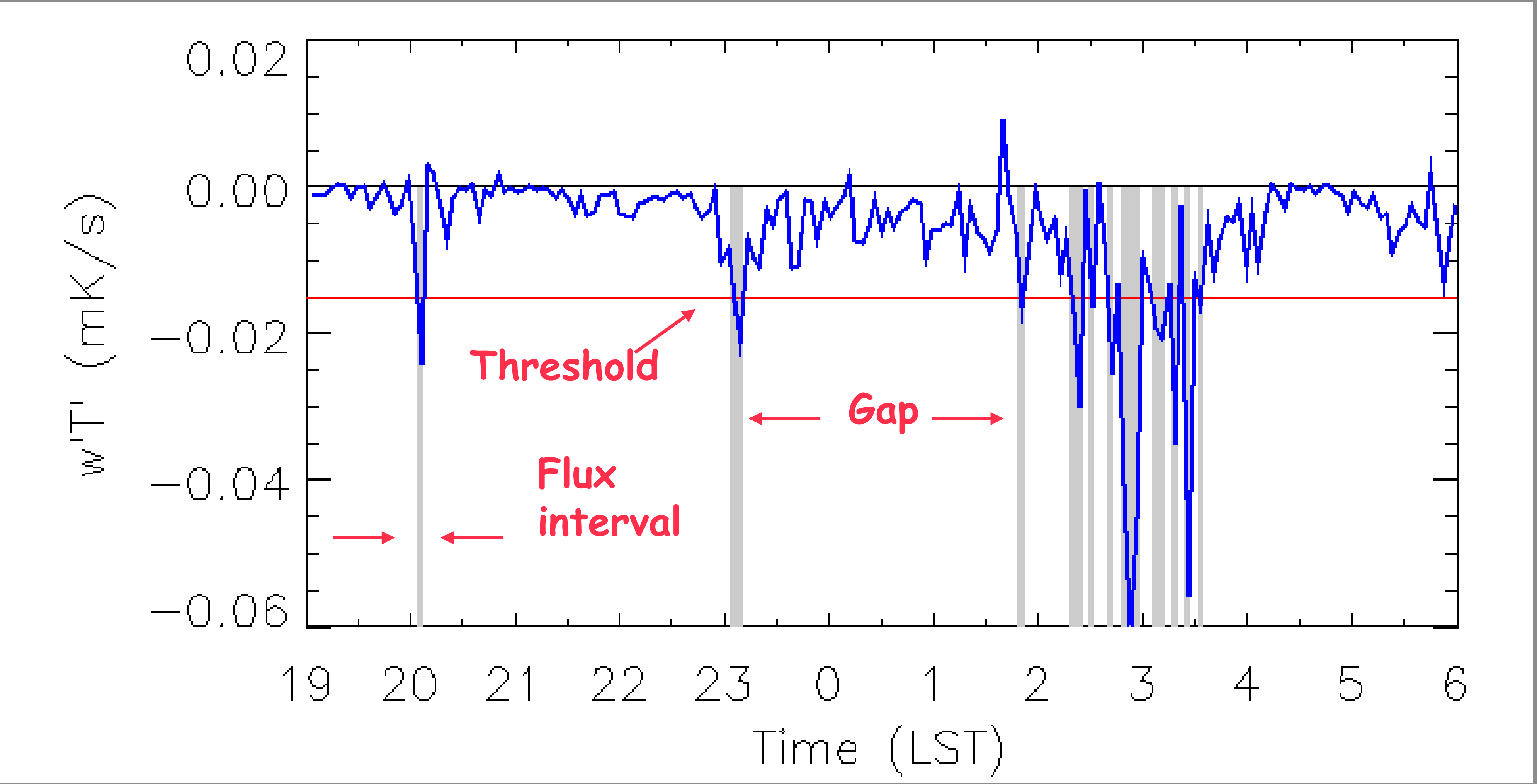
Parameterizations in mesoscale models are problematic.

Goals:

Characterize features of intermittent turbulence.

Develop a semi-empirical approach to parameterization of intermittent turbulent sensible heat fluxes.

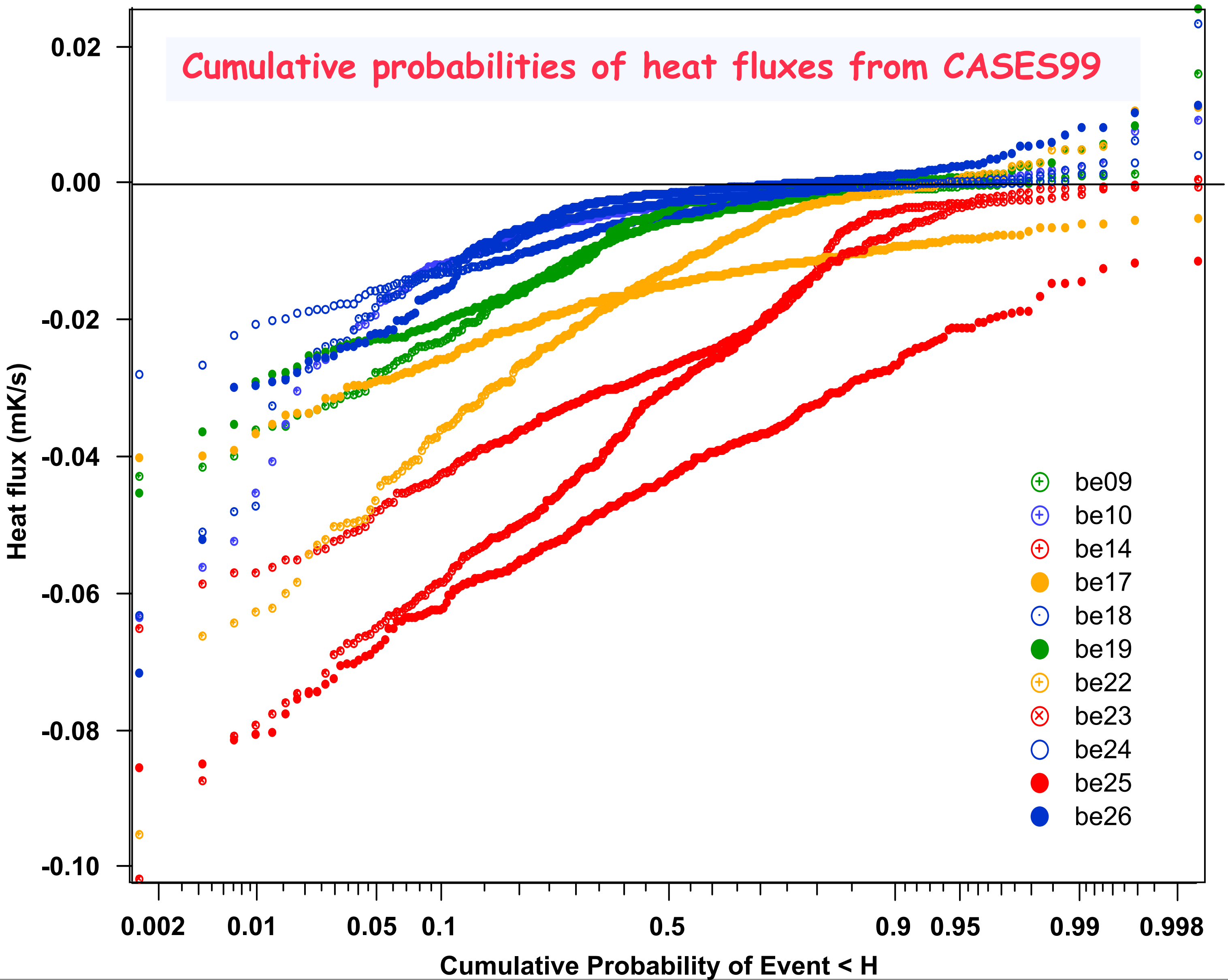
Definitions



turbulent fraction = time exceeding threshold /total time

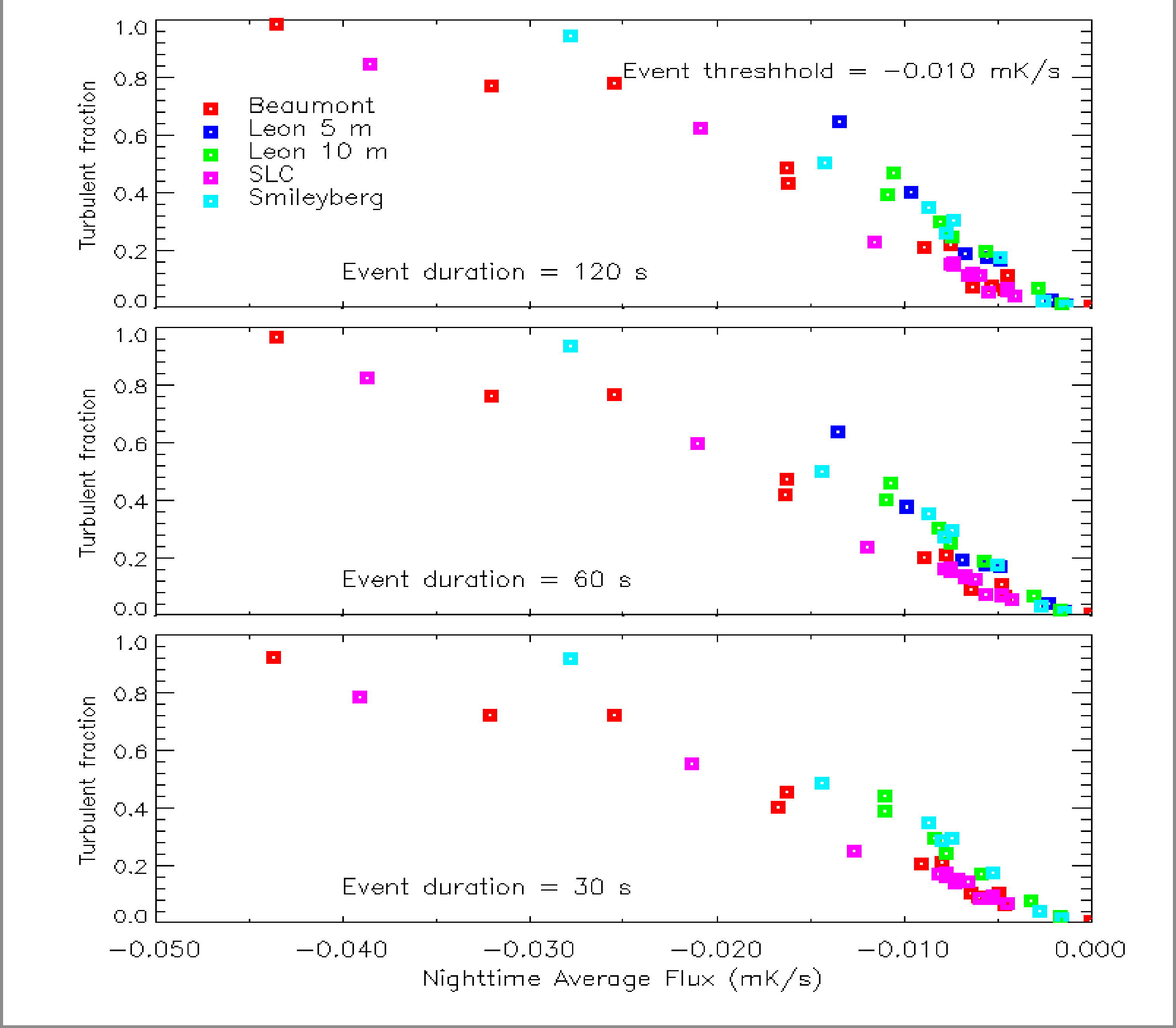
data sources:

location	height(s)	sampling frequency (Hz)
Beaumont	7 m	10
Smileyberg	2 m	20
Leon	5, 10 m	20
SLC	8.5 m	10
Hanford	4.1, 7.6, 11.2, 15.0, 21.3 m	10

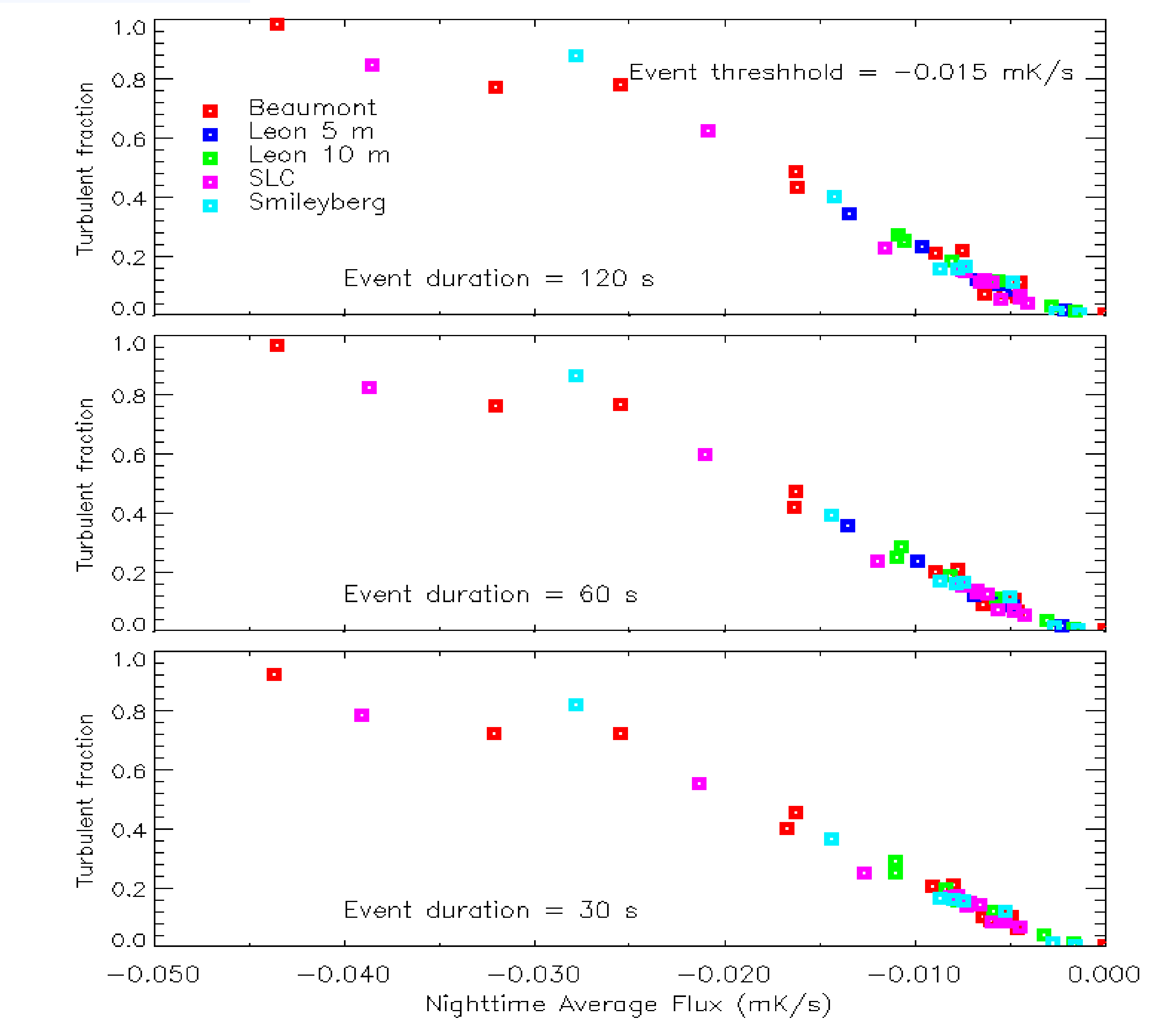


Cumulative probabilities of heat fluxes from CASES99
Heat flux (mK/s)
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
0.002
0.01
0.05
0.1
0.5
0.9
0.95
0.99
0.998
Cumulative Probability of Event < H
be09
be10
be14
be17
be18
be19
be22
be23
be24
be25
be26

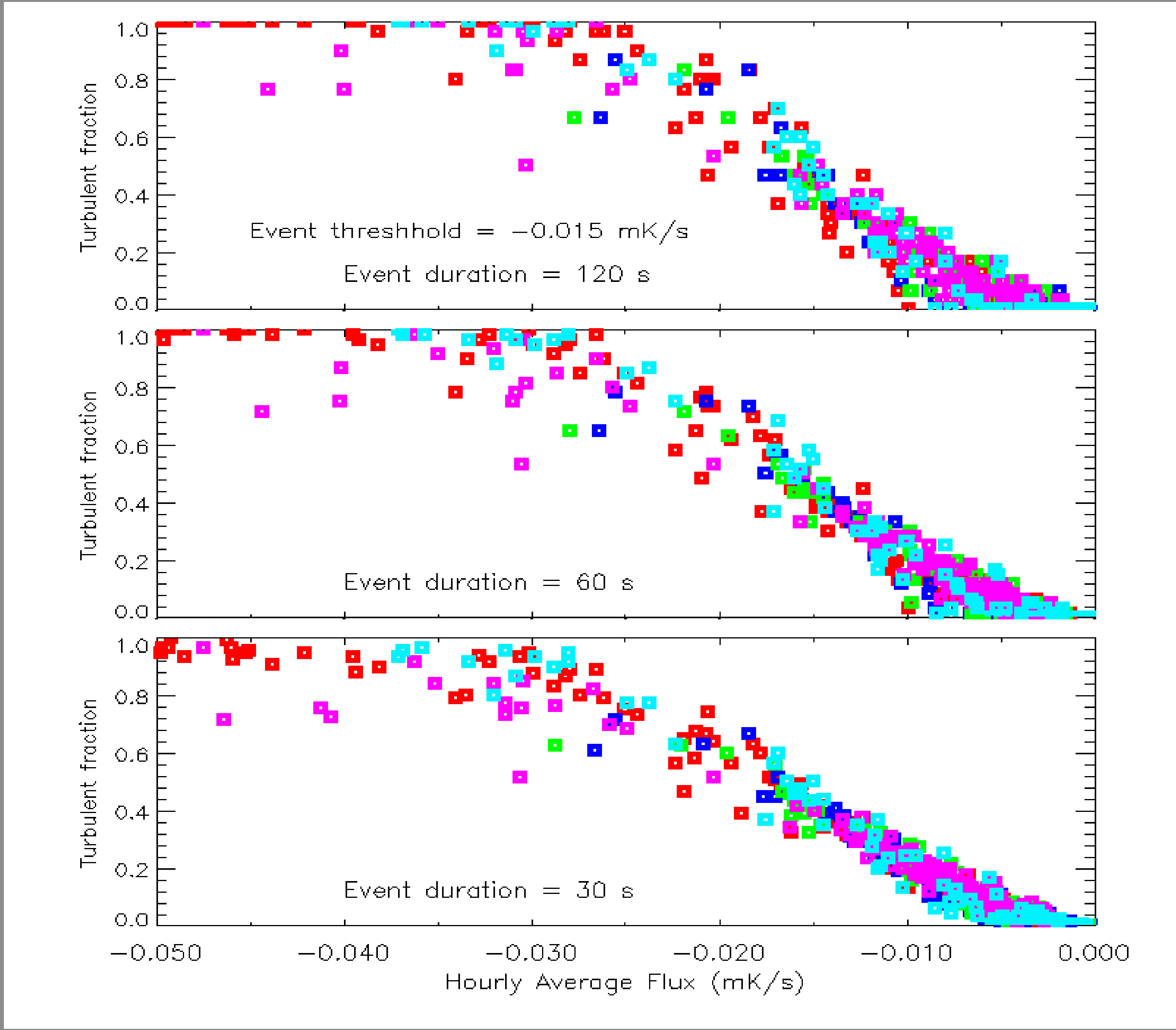
CASES99 and SLC data



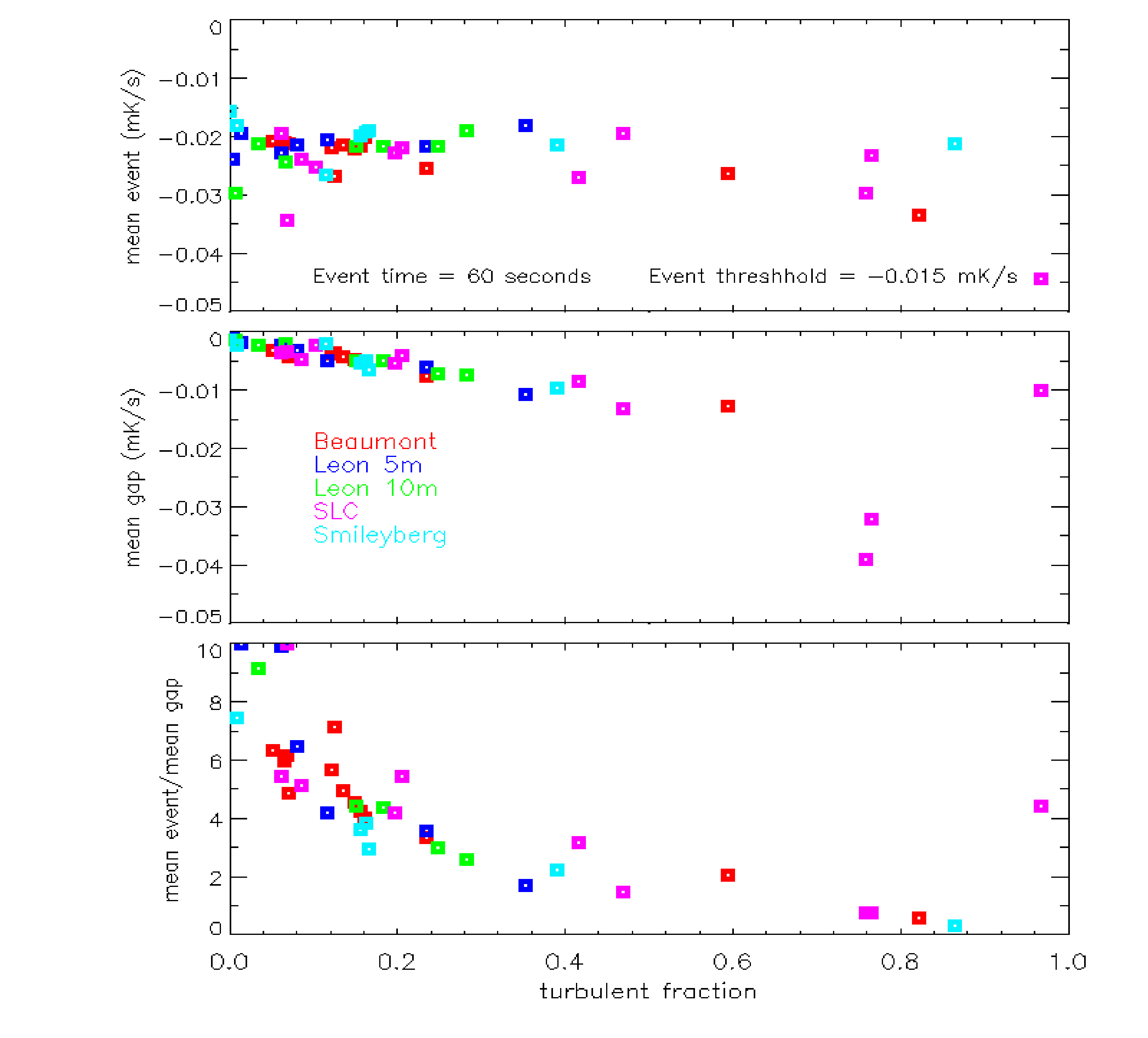
CASES99 and SLC data



CASES99 and SLC data



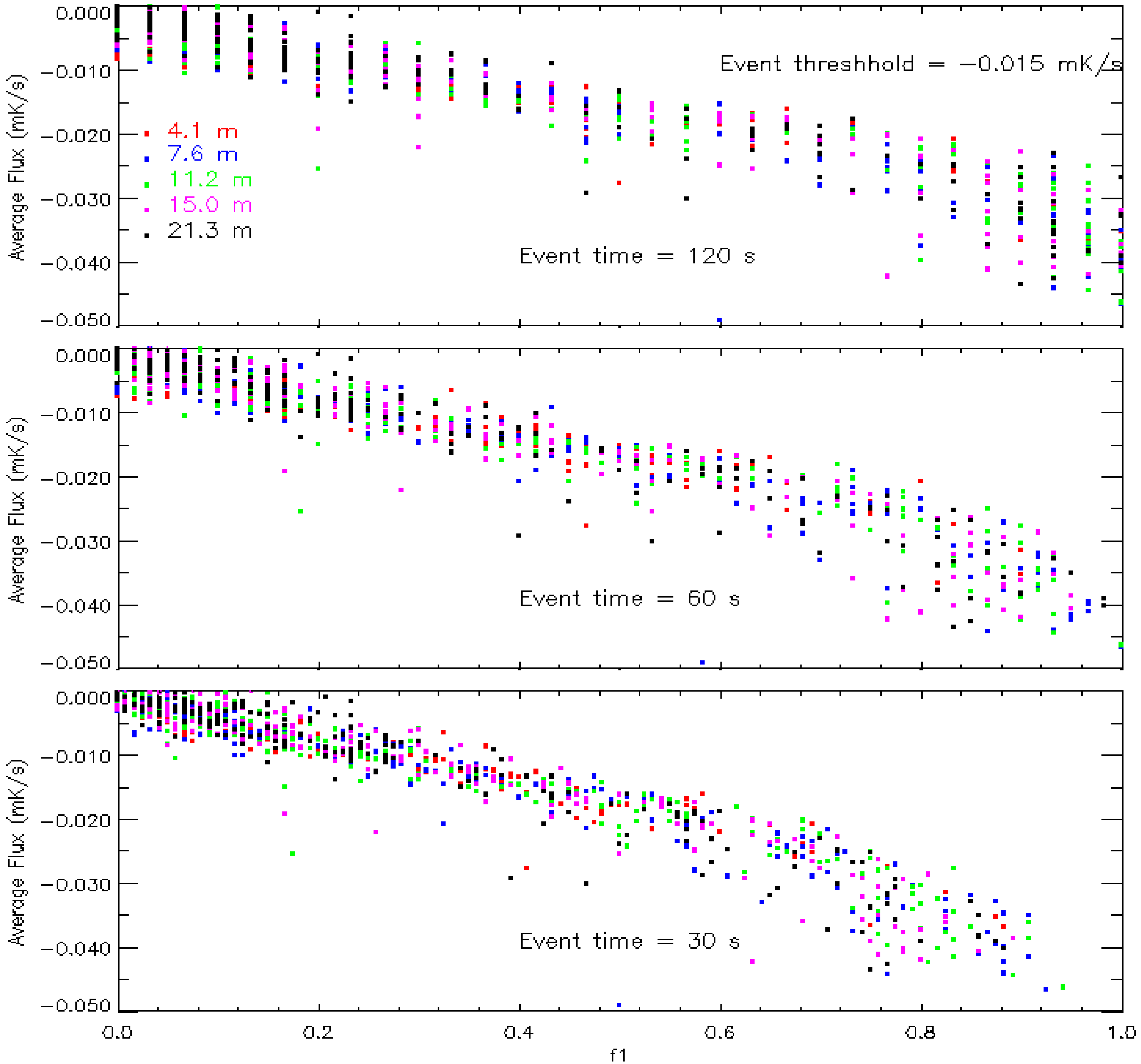
CASES99 and SLC data



Hanford tower

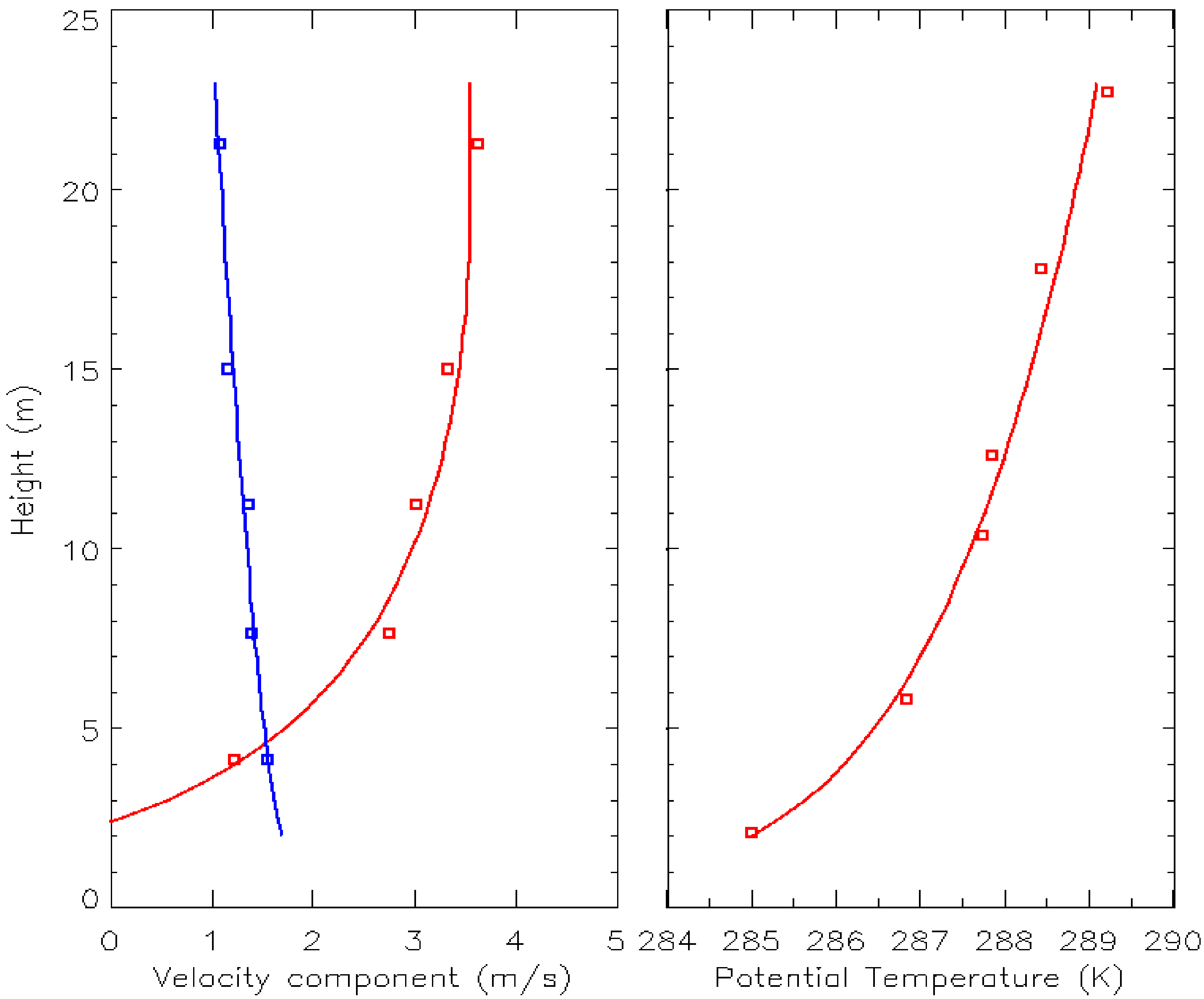
Hanford terrain

Hanford data

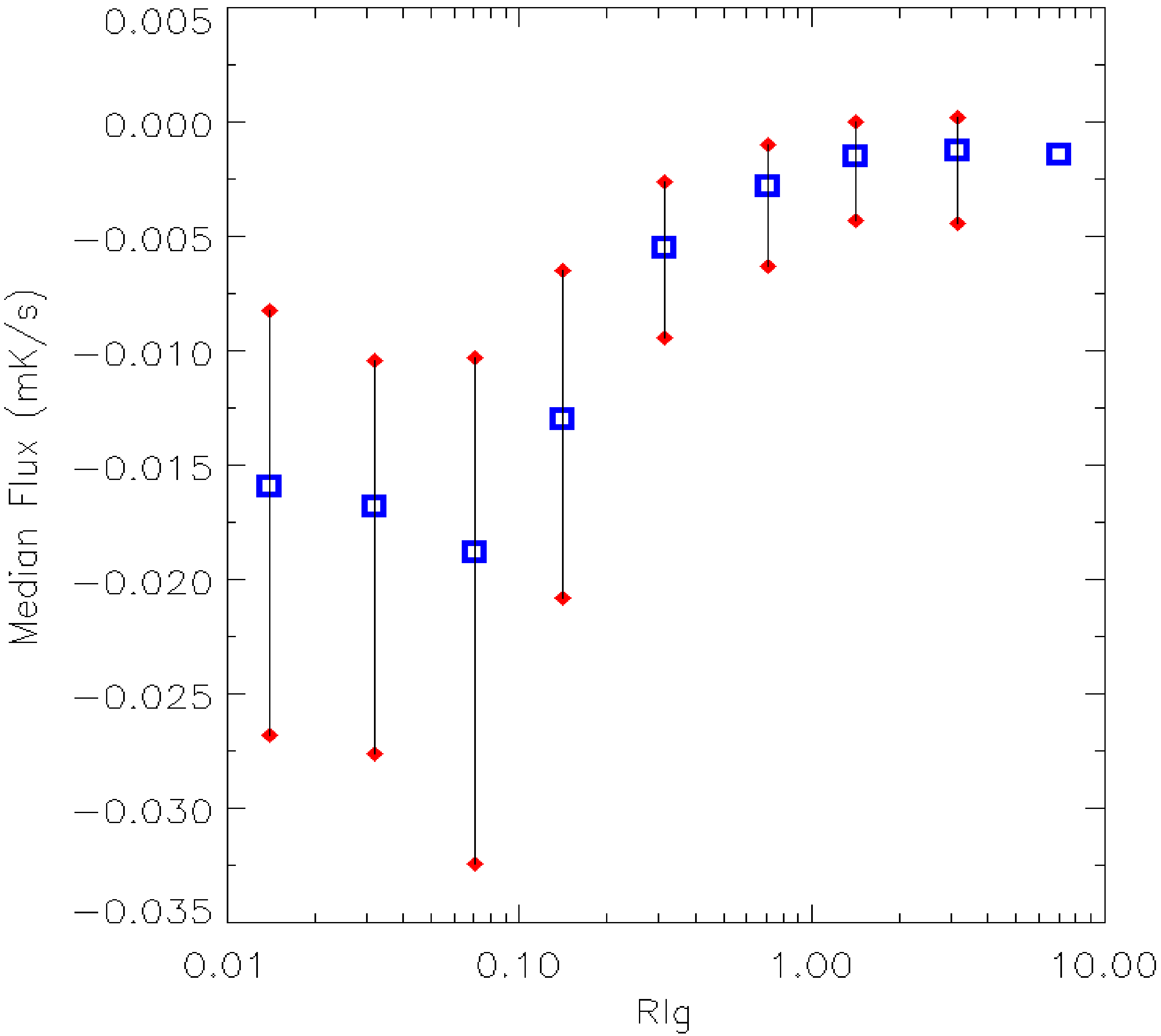


Sample least squares fits to u, v, and theta

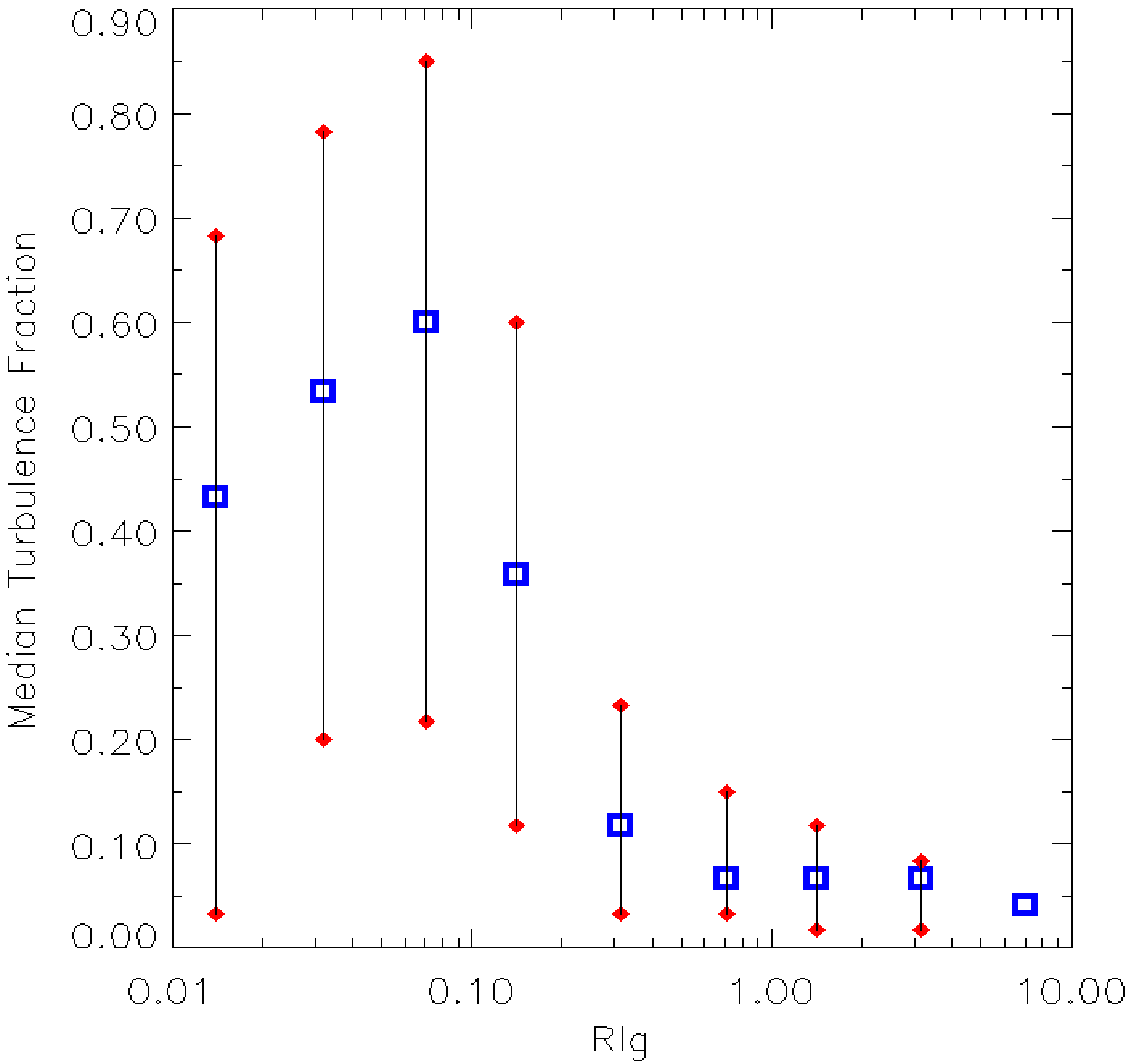
$$F(z) = A + B\ln(z) + Cz$$



Median, 25th and 75th percentile fluxes as fn of gradient Ri (Hanford data)



Median, 25th and 75th percentile turbulent fraction as fn of gradient Ri (Hanford data)



Conclusions

Turbulent fraction and average flux are linearly related for fluxes ≤ -0.020 mK/s for a range of thresholds and event durations.

Turbulent fraction and average flux are (roughly) predictable from gradient Ri.

Scatter is large and a good normalization is being sought.

The average flux in an event and the average flux in a gap vary smoothly with turbulent fraction.

Semi-empirical heat flux parameterization may be possible.