

A statistical approach applied to trace gas gradients with low signal to noise ratio

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Theory

The atmosphere in the subcanopy sample volume can be mixed by turbulence or non mixed.

Assumption:

- Regarding the **mixed** case, the distribution function of concentration differences of any two sample points has a **mode of zero** even though their mean can be different.

- Regarding the **non mixed** case, the distribution function of concentration differences of any two sample points has a mode possibly different from zero even though their mean can be different.

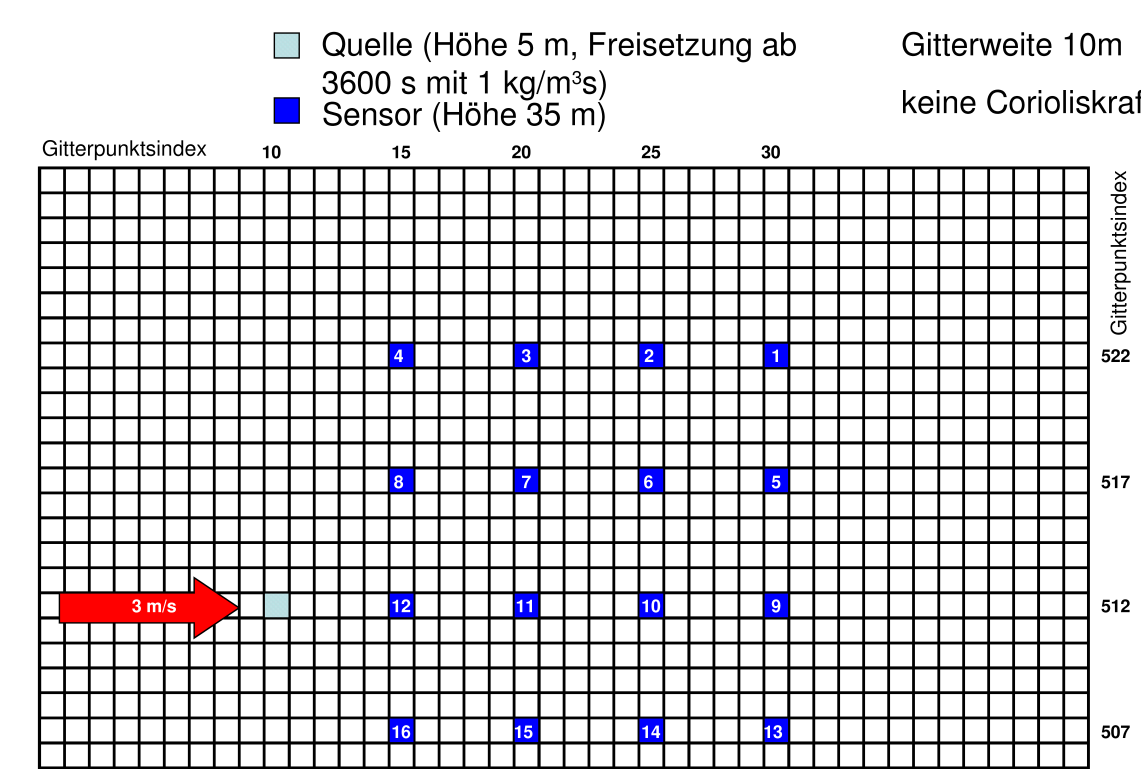
Test 1: Logic

If the air is well mixed, most often any two sample points sample the same concentration, less often they sample different concentrations.

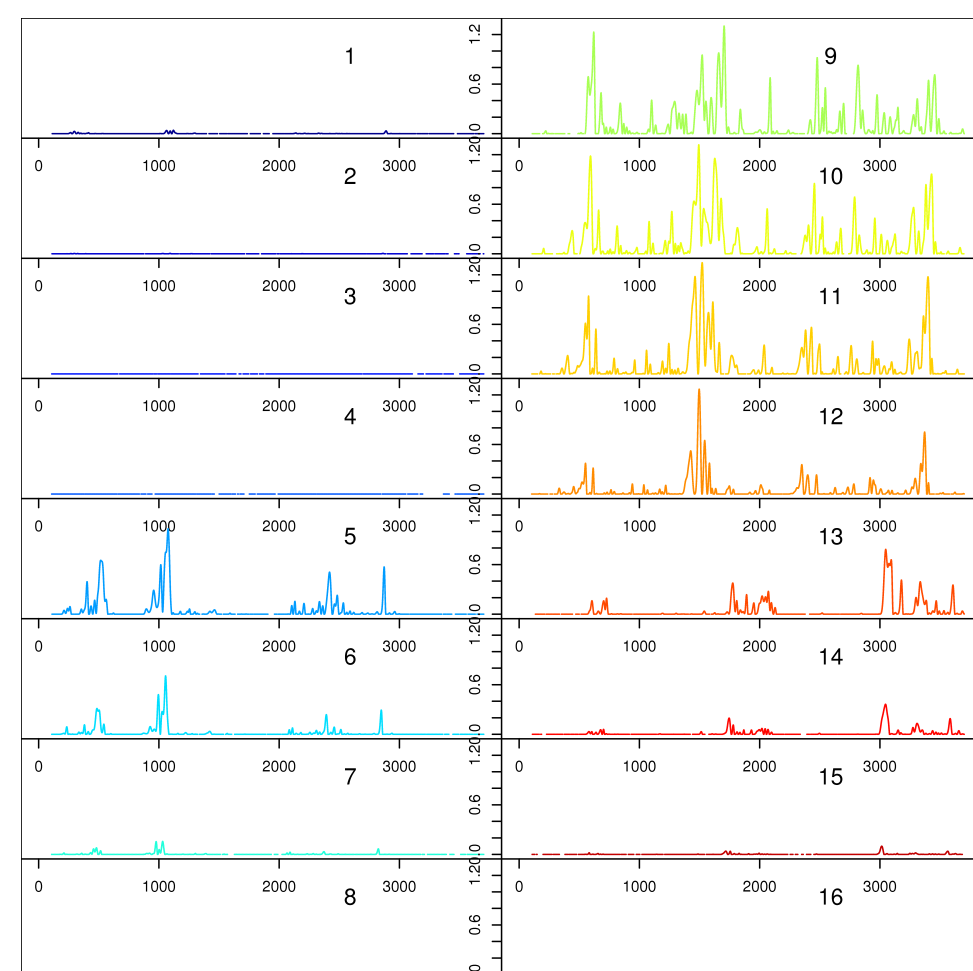
Test 2: LES

The LES simulation was run by Gerald Steinfeld.

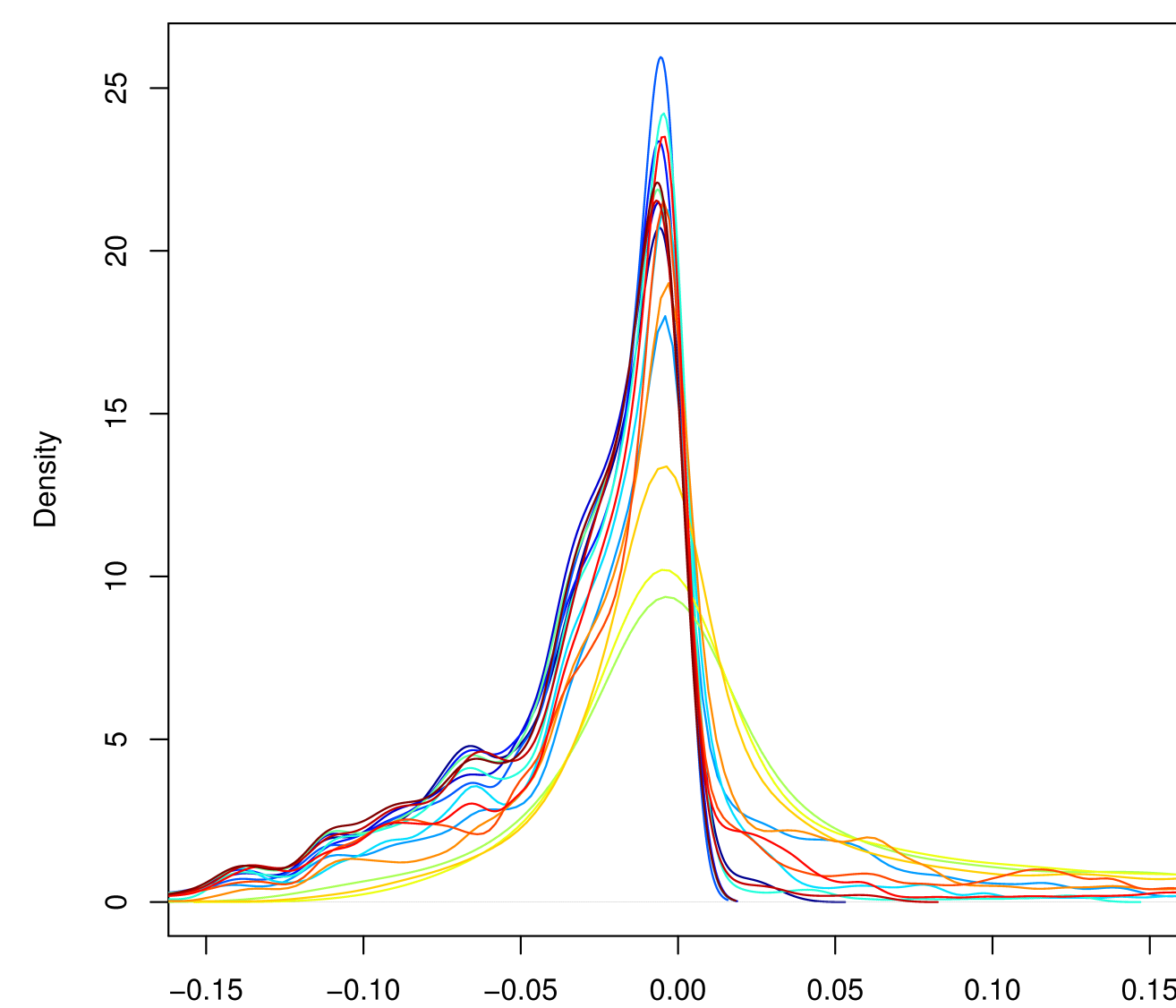
Setup



Concentration time series

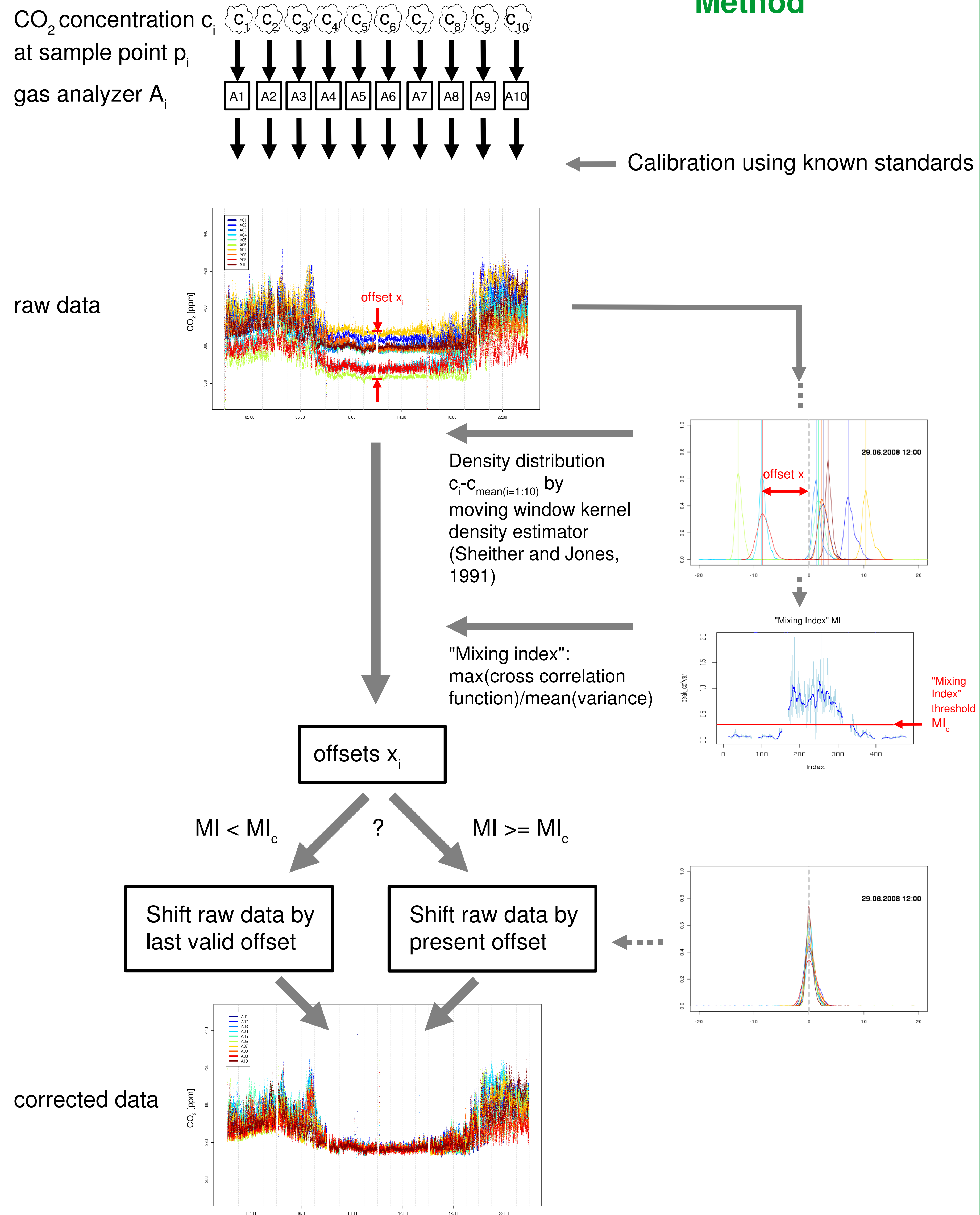


Density distribution(c_i-c_{mean})



Test result:
for turbulent conditions represented by LES the distributions of concentration differences have their mode around zero.

Method



Conclusions

Question:

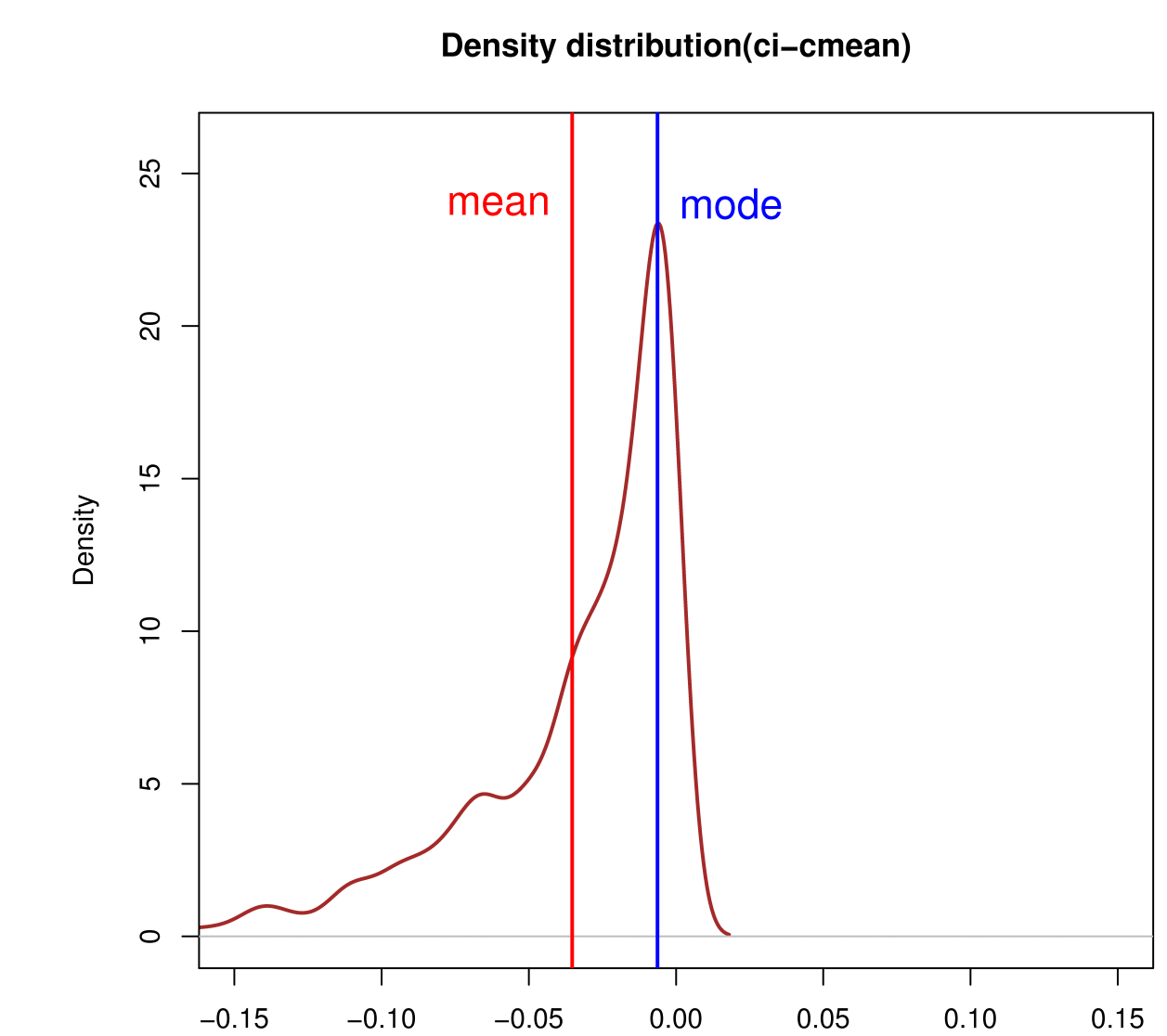
Does the presented method remove true signal, i.e. the concentration difference which is used to calculate horizontal advection?

Answer:

- Yes, a small part, since shifting the time series by an offset acts as a high pass filter. Filter window length is given by distribution window length. This effect is assumed to be a small fraction of the signal given an appropriate window length.

- No, most of the true signal is retained. The skewness of the distributions allows a mode equal to zero and a mean not equal to zero. This allows gradients to survive during signal shifting.

Comparison mean and mode



The corrected signal should be taken as a "trustable minimum estimate". It might be slightly smaller than the true signal but is never larger.

References:

Sheather, S. J. and Jones, M. C. (1991). A reliable data-based bandwidth selection method for kernel density estimation. Journal of the Royal Statistical Society series B, 53, 683–690.