Recommended Quality Control for Application to UNH and UCONN Air-Sea Direct Covariance Flux System (DCFS) Measurements

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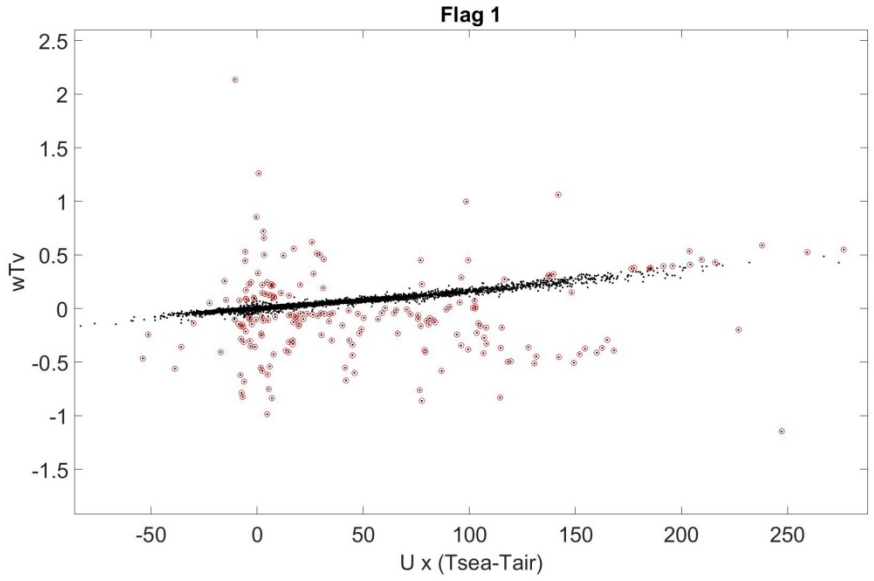
Each 20 min avg. flux measurement set of observed variables from the DCFS system on our buoys, typically measured once per hour, is provided in our net CDF files. We provide the data even for measurement periods where there may be contamination. In most cases the scalar quantities will still be valid. In all cases, the data quality flagging defined below pertains to the direct covariance flux variables (friction velocity (u*) and sensible heat flux). The user can filter data based on the setting of the data quality flag. Quality control flagging for u* is divided across 4 flags that are all contained in one binary flag word. The most conservative filtering of data would be to only use data where the flag is 0. Our examination of the DCFS data suggest that the first three flagging conditions predominately pertain to cases where moisture, likely water droplets, are impacting one or more of the Gill sonic transducers. This leads to erroneous, though sometimes subtle, data in the 20 Hz T, u,v, and or w measurements. Users will likely see that a certain percentage (20-40%) of specific storm events will not have valid flux measurements. We strongly suspect this is due to rain impacts on the sonic anemometer. Flux estimates, even using shorter time segments than 20 min, are not feasible for these cases.

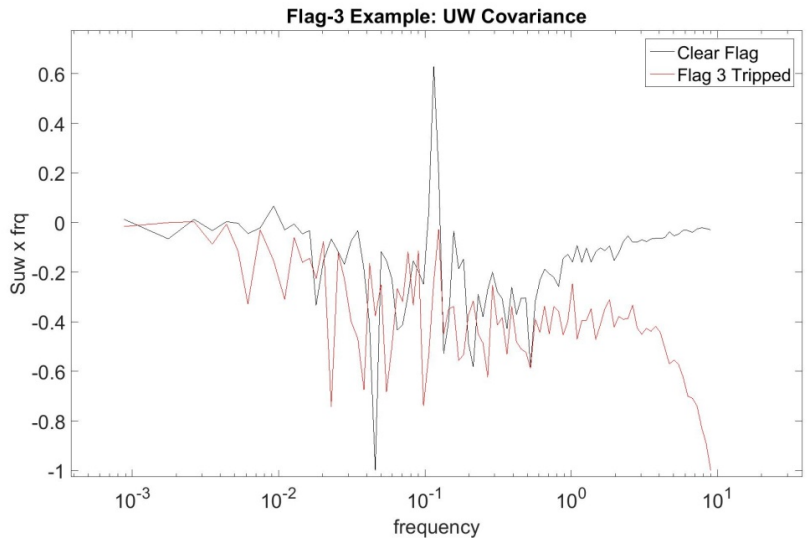
1. **Bit 1, Erroneous sensible heat flux:** This flag is designed to catch data that is likely affected by rain or spray in the sonic anemometer path. We use the relation between the vertical heat flux (<w'Tv'>) and the product of wind speed (U) and the air/sea temperature difference (Tsea-Tair) to determine the outliers. This was done by fitting a line to the above relation and flagging data outside 2 standard deviations. Outliers based on this criteria are quite evident for the JLMO data set, see plot below.

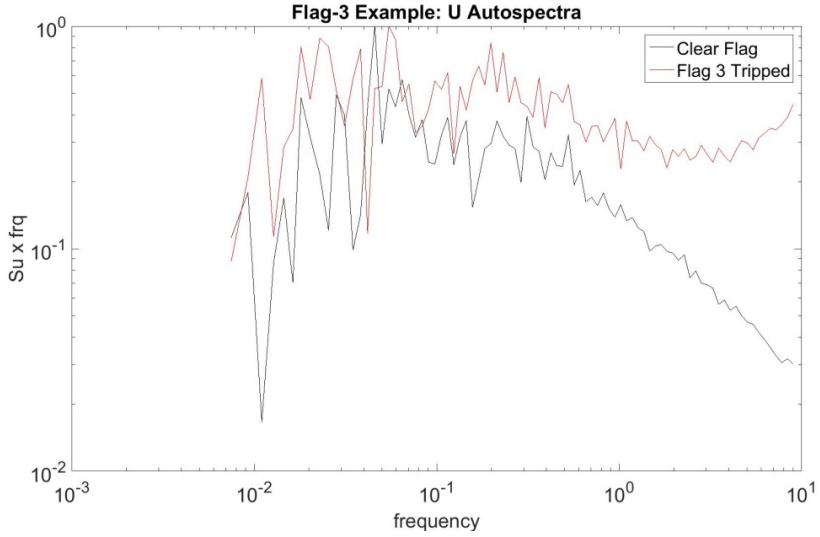


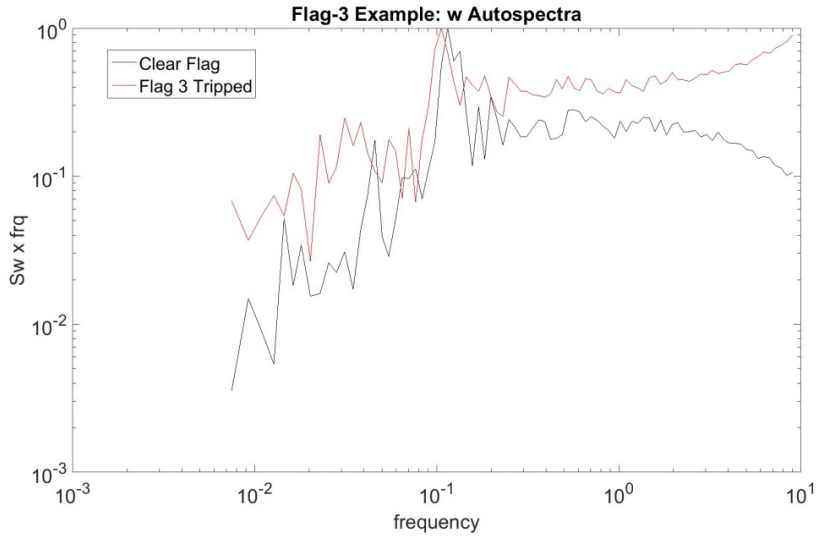
2. **Bit 2, Unrealistic tilt angle (flow distortion):** This flag is designed to catch data with an unrealistic platform tilt correction angle (beta). The beta angle is the vertical tilt angle adjustment needed to set the mean three-dimensional wind-direction for the sample period. If this angle is below zero or above the 99th percentile when the wind speed is above 3m/s this flag is tripped. The beta angle is generally used as an indication of vertical flow distortion and in the case of our buoy should always be positive as the overall structure and angled solar panels send the wind upwards from horizontal. This flag, similar to flag 1, is used more for catching issues with the sonic anemometer than for actual flow distortion. For this reason, data below 3m/s is allowed through since the beta angle is much less predictable in low winds.

3. **Bit 3, Excess u* in rain/spray due to high frequency cospectral <u'w'> content:** This flag, along with flag 4, compares an unfiltered friction velocity to a friction velocity computed from only a portion of the entire cospectra. The basic idea being if an unreasonable amount of the <u'w'> covariance (and ustar) is coming from one end of the spectra, then something is wrong. Flag 3 compares the full (0-10 Hz) u* against u* computed with a cospectrum that is low pass filtered at 2Hz. If the absolute difference is more than 5% the flag is tripped. This is believed to be caused by rain or spray in the sonic anemometer path and is evident in both the component auto spectra and the U-W co-spectra. The three-panel figure below illustrates the difference between a flagged case and an unaffected case. Instead of trailing off (-5/3 law) in high frequency, the autospectrum tends to increase in both the U and W components. This error also consistently causes the integrated cospectrum to increase unreasonably.

4. **Bit 4, a-physical excess u* in low winds due to low frequency cospectral content:** Similar to flag 3, flag 4 compares the full spectrum u* to a filtered u* computed using a 0.01 Hz high pass filter. It is designed to detect cases with a significant contribution to the cospectral flux from low frequency non-turbulent effects. This flag is triggered if the difference is over 50%, which is two standard deviations from the mean difference.


Flag-3 Example: UW Covariance
Clear Flag
Flag 3 Tripped
Suw x frq
frequency


Flag-3 Example: U Autospectra
Clear Flag
Flag 3 Tripped
Su x frq
frequency


Flag-3 Example: w Autospectra
Clear Flag
Flag 3 Tripped
Sw x frq
frequency