ECOR: Improvements and VAP; NIM Aircraft Effects and Solar Diurnal Tides

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ABSTRACT

The new ECOR systems have generally operated reliably. However, some improvements have been made and others are in the process of being made to make the system more robust and to better indicate data quality. These improvements include: the addition of a wetness sensor to allow precipitation/dew/frost effects on the CO2/H2O sensor to be detected, determination of and correction to sonic alignment at one site, setting up additional serial ports for use when a port fails, the use of serial line isolators to reduce serial port failures, improvement in the procedure for calibration of the CO2/H2O sensor, determination of wind directions for valid and invalid data, and the development of a VAP that will make a series of corrections to the fluxes as well as produce a data quality flag. The effects on fluxes from nearby aircraft landings/takeoffs and the detection of the solar diurnal tide in pressure measurements at the NIM AMF installation are also presented.

IMPROVEMENTS

Recent:

1) Determination of wind directions for valid and invalid flux data; the results and guidance are included in the ECOR Handbook and in Data Quality Reports D061219.7 – D061219.15.
2) Correction for sonic directional misalignment in one ECOR system.
3) Improvement in the SGP calibration procedure for the LI-7500 CO2/H2O sensor.
4) Setting up additional serial ports for use when a port fails; only two of the 4 ports are set up initially.
5) Serial chip in LI-7500 CO2/H2O sensor. The mentor discovered the use of a replacement serial port chip that did not support required voltages for optical isolators and obtained agreement from the manufacturer to not use that chip in ARM systems.
6) Modification of the ECOR Preventative Maintenance Procedures.

Future Improvements:

1) Wetness sensor (Fig. 1) to allow detection of precipitation/dew/frost effects on the CO2/H2O sensor. This is presently being tested.
2) Development of a VAP that will make a series of corrections to the fluxes as well as produce data quality flags. See the next section for more information.
3) Serial line isolators (Fig. 2) to reduce serial port failures; these are presently being tested.

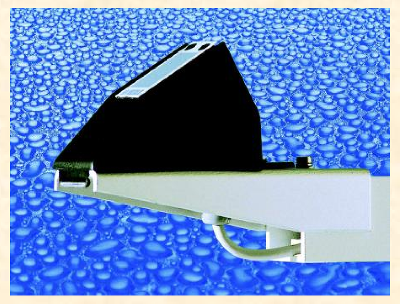


Figure 1

Figure 2

References

Butler, S. T., and K. A. Small, 1963: The excitation of atmospheric oscillations. *Proc. Roy. Soc. London,* **A274,** 91-121.
Siebert, M., 1961: Atmospheric tides. *Advances in Geophysics*, Vol. 7, Academic Press, 105-107.
Whiteman, C., D., and X. Bian, 1996: Solar semidiurnal tides in the troposphere: detection by Radar Profilers. Bull. of Amer. Meteo. Soc., **77,** 529-542.

ECOR VAP

A VAP will be developed to take the un-rotated CO_2, sensible heat, and latent heat, and momentum fluxes, and perform the following corrections:
1) Coordinate rotation to rotate to a geometrically horizontal plane (this is presently the only correction applied to the ECOR data).
2) Correct for losses due to sensor separations and time constants.
3) Adjust sensible heat flux for water vapor effects on sonic signal. 4) WPL corrections for the "biasing" of fluxes by sensible heat flux.
5) Removal of out-of-range data.
6) Provide flags for incorrect data (including contaminated wind directions).
7) Figs. 3a -3c below show the difference between uncorrected and corrected fluxes. In this example from an ANL Ameriflux site, CO_2 and sensible heat fluxes are overestimated and latent heat flux is underestimated before corrections are applied.

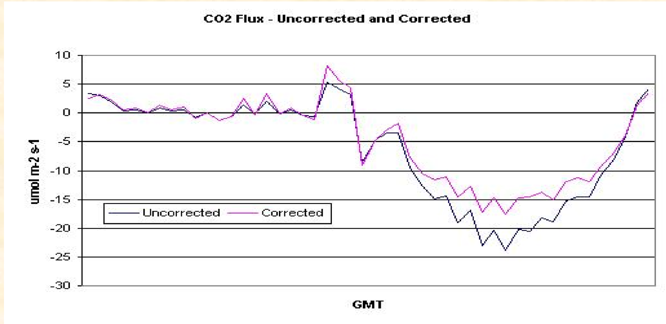


Figure 3a

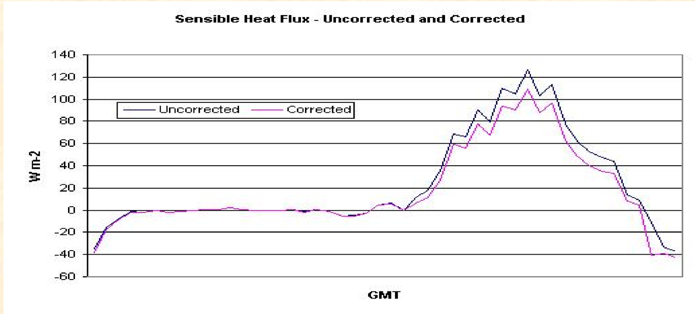
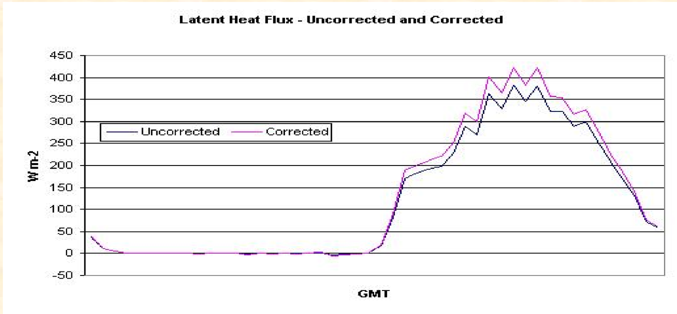


Figure 3b

Figure 3c



AIRCRAFT EFFECTS ON CO_2 DATA AT NIM

The effects on CO_2 concentrations and fluxes from the exhaust of aircraft that were landing, departing, or standing at the NIM airport runway and terminal area to the east and northeast of the ECOR are described in DQR D070215.5, and summarized below:
1) Usually small increases in half hour averaged CO_2 concentration; range 0 to 1.0 mmol m^{-3}.
2) Often large spikes in CO_2 flux; range 1 to 100 or more umol m^{-2} s^{-1}.
3) Normally occurred with easterly wind direction.
4) Occurred on 40% of days in March and April 2006, sometimes multiple times in a day.
5) The condition occurred even during the early March 2006 dust storm.
6) Figures 4 and 5 (during dust storm in Figure 5) below typical effects.

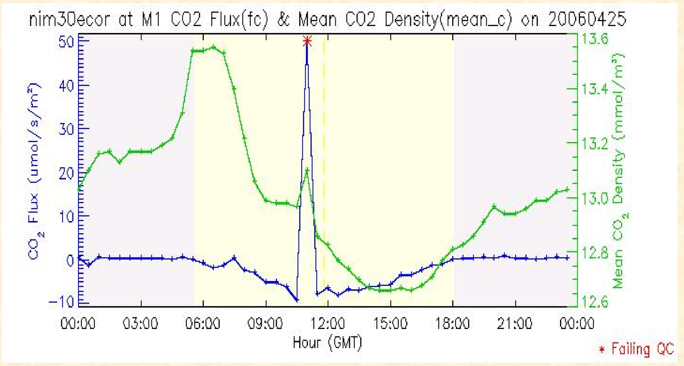


Figure 4

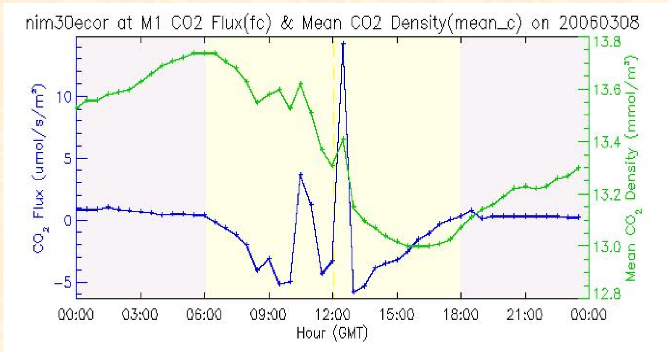


Figure 5

SOLAR SEMI-DIURNAL TIDE IN AMF NIM (NIGER) ECOR AND SMOS

The solar semi-diurnal tide is most easily seen in pressure oscillations at the Earth's surface. Solar energy absorbed by atmospheric water vapor (Siebert, 1961)) and stratospheric ozone (Butler and Small, 1963) result in warming of the atmosphere and thus air mass redistribution, thereby changing the weight of the air column and thus the surface pressure (Whiteman and Bian, 1996). Solar semi-diurnal tides are most easily detected in tropical areas where synoptic-scale storm systems are infrequent. Niamey, Niger provided the perfect place for detecting the semi-diurnal tide in barometric pressure records. Whiteman and Bian (1996) indicate that oscillations of 0.1 kPa are typical, but the NIM AMF ECOR and SMOS barometric pressure sensors indicate oscillations of 0.2 to 0.3 kPa (Figs. 6 and 7). The morning oscillation is always larger than the nighttime oscillation, as would be expected from the greater forcing of the morning solar warming. The oscillations are generally larger in magnitude during north or east winds in winter (Figure 4) than during west winds in summer (Figure 5); west winds appear to damp the magnitude of the westerly moving pressure wave. Furthermore, the winter trace is not as smooth as the summer trace. On unusual occasions, semi-diurnal pressure oscillations of similar magnitude can also be detected in SGP pressure data, such as on 29 July 2006 at the E18 EBBR with south-southwest winds (Fig. 8). The trace at SGP is never as smooth as at NIM and the difference in magnitude of the morning and night oscillations is significantly larger at SGP than at NIM.

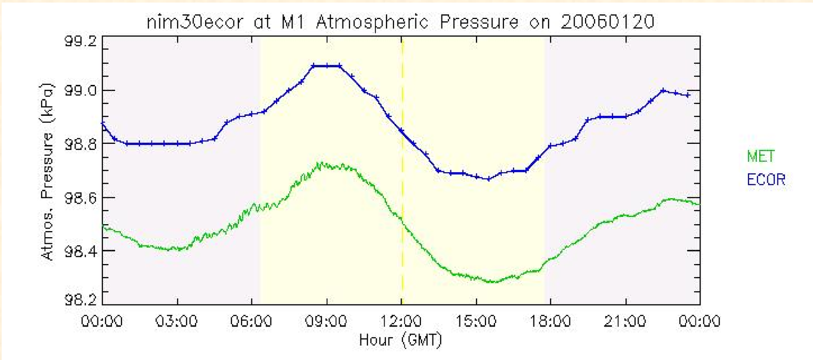


Figure 6

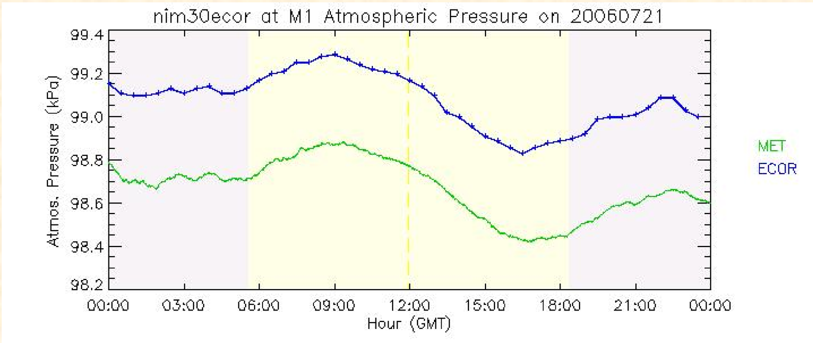


Figure 7

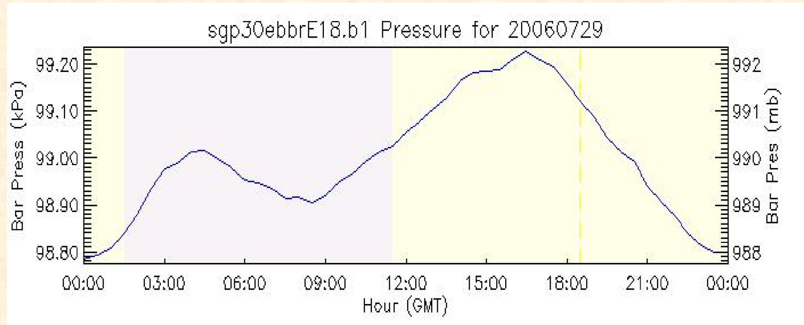


Figure 8