

17 August 2015

TO: Reprocessing File  
 FROM: Al Cooper  
 SUBJECT: Vertical wind for HIPPO flights, circuits 2–5

## 1 General comments

The measurements of vertical wind from HIPPO flights appear to need different sensitivity coefficients for HIPPO-2/3 vs HIPPO-4/5, and the reason for that is not evident. Projects HIPPO-2 and HIPPO-3 are consistent and could use the same coefficients without serious error, but projects HIPPO-4 and HIPPO-5 each need significantly different coefficients and, even with those changes, the results for vertical wind appear to produce significant errors that can't be removed by AKRD calibration. Prior to January 2012, when the radome was changed, the “standard” coefficients expected to apply to the radome, determined from the PREDICT project, which was in August 2010 and so between HIPPO-3 and HIPPO-4, are listed in the following table. The suggested coefficients are also listed, and it is clear that the standard coefficients do not apply well to any of the HIPPO circuits (all flown before the 2012 radome change). There was some evident change between HIPPO-3 and HIPPO-4 (between April 2010 and June 2011), and the results from PREDICT are still different. Furthermore, the resulting vertical wind in HIPPO-2 and HIPPO-3 looks satisfactory, while there are evident problems in HIPPO-4 and HIPPO-5 that do not appear to be correctable by calibration coefficients, as discussed in the next section.

Project	Dates	$c_1$	$c_2$	$c_3$
“standard”	before 2012	5.516	19.07	2.08
HIPPO-2	Nov. 2009	5.151	15.651	7.303
HIPPO-3	Mar/Apr 2010	5.112	14.016	8.291
HIPPO-4	Jun/Jul 2011	4.876	9.882	12.275
HIPPO-5	Aug/Sept 2011	4.854	9.496	12.921

## 2 Illustration and study of the HIPPO-4/HIPPO-5 problem

Flight 3 of HIPPO-5 illustrates the problem that is present in vertical-wind measurements from HIPPO-4 and HIPPO-5. If the coefficients listed in the above table, determined from the full-project measurements combining all flights, are used the result is the vertical wind shown in Fig. 1. If fit coefficients are determine from only this flight, to avoid the possibility that other flights might have different radome characteristics and so distort the results, the coefficient are {4.76, 7.80, 15.00}. The resulting fit has only minor improvement in the residual standard deviation (0.182 vs 0.188) in comparison to using the full-project coefficients as listed in the above table. It does not appear to improve the vertical wind, however; it lowers the central portion where there appears to be too-high vertical wind, but it accomplishes this by lowering the level portions near the start and

### Flight 3 mean WIX: 0.25 m/s

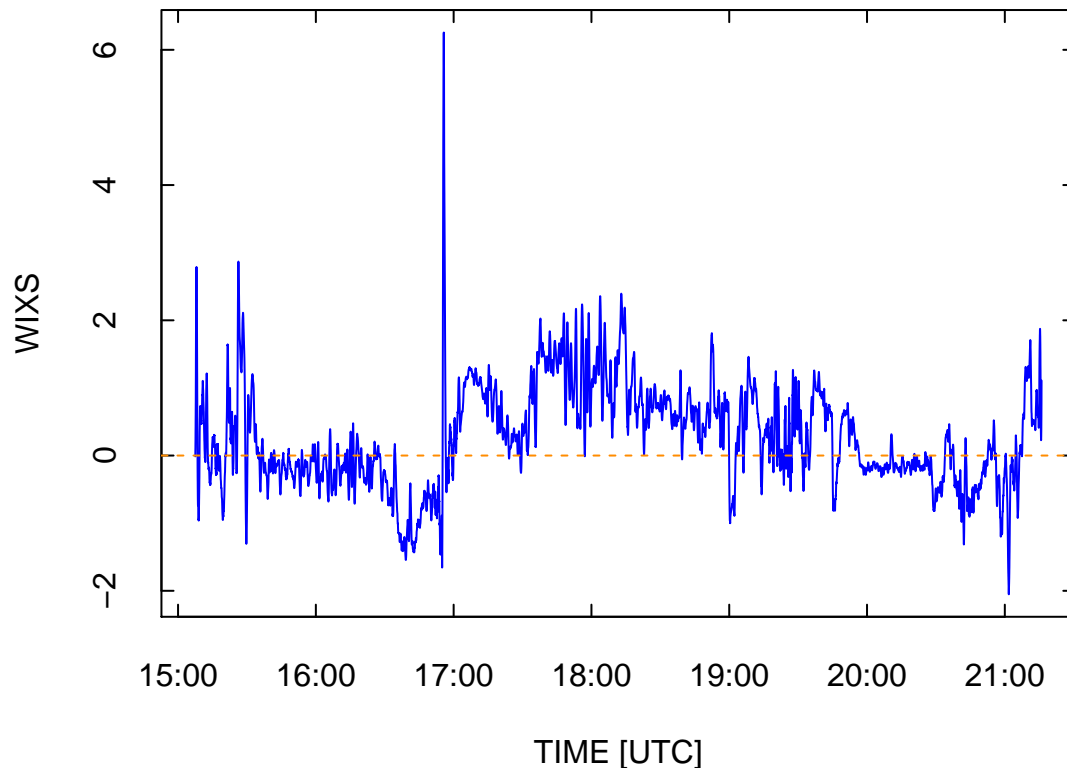


Figure 1: Vertical wind measurements WIC for HIPPO-5 flight 3.

end of the flight. Examination of the components entering the vertical wind shows that everything appears normal except ADIFR, which has enough offset in the central portion of the plot to account for the excess vertical wind.

Figure 2 shows that a similar but even more problematic deviation occurs for Flight 4. Because these features occur throughout HIPPO-5, and have both signs, it seems implausible that they are real. More likely is that the radome suffers from some problem, like some accumulation of dirt or a bug near the ports or a partial obstruction in the lines or a leak. To check for this, the measurements of ADIFR were considered as functions of altitude or Mach number to see if there is a normal pattern for level flight and if there is unusual variance in HIPPO-5. Figure 3, comparing the measurements of ADIFR from flight 4 to those from all other HIPPO-5 flights except 1, 3, and 4, shows that flight-4 measurements are clear outliers. Of course, this would be the case if the vertical wind is really low as shown in Fig. 2, but that seems unlikely over such an extended distance. It seems more likely that there was some problem affecting the radome on this flight and perhaps also others in HIPPO-4 and HIPPO-5.

**Flight 4 mean WIX: -0.55 m/s**

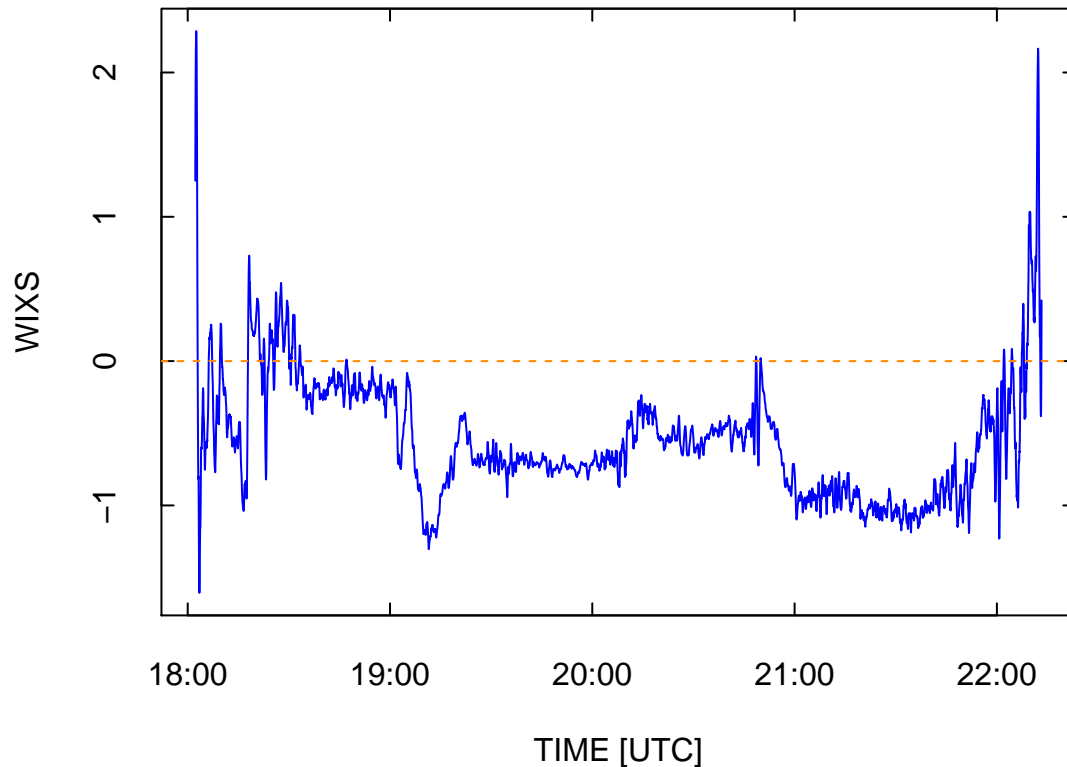


Figure 2: As in the preceding figure but for HIPPO-5 flight 4.

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Reproducibility:

PROJECT:	WICforHIPPO
ARCHIVE PACKAGE:	WICforHIPPO.zip
CONTAINS:	attachment list below
PROGRAM:	WICforHIPPO.Rnw
ORIGINAL DATA:	/scr/raf_data/HIPPO-2/rf08.nc
GIT:	git@github.com:WilliamCooper/WICforHIPPO.git

Attachments: WICforHIPPO.Rnw  
WICforHIPPO.pdf  
WI-HIPPO5.Rdata  
SessionInfo

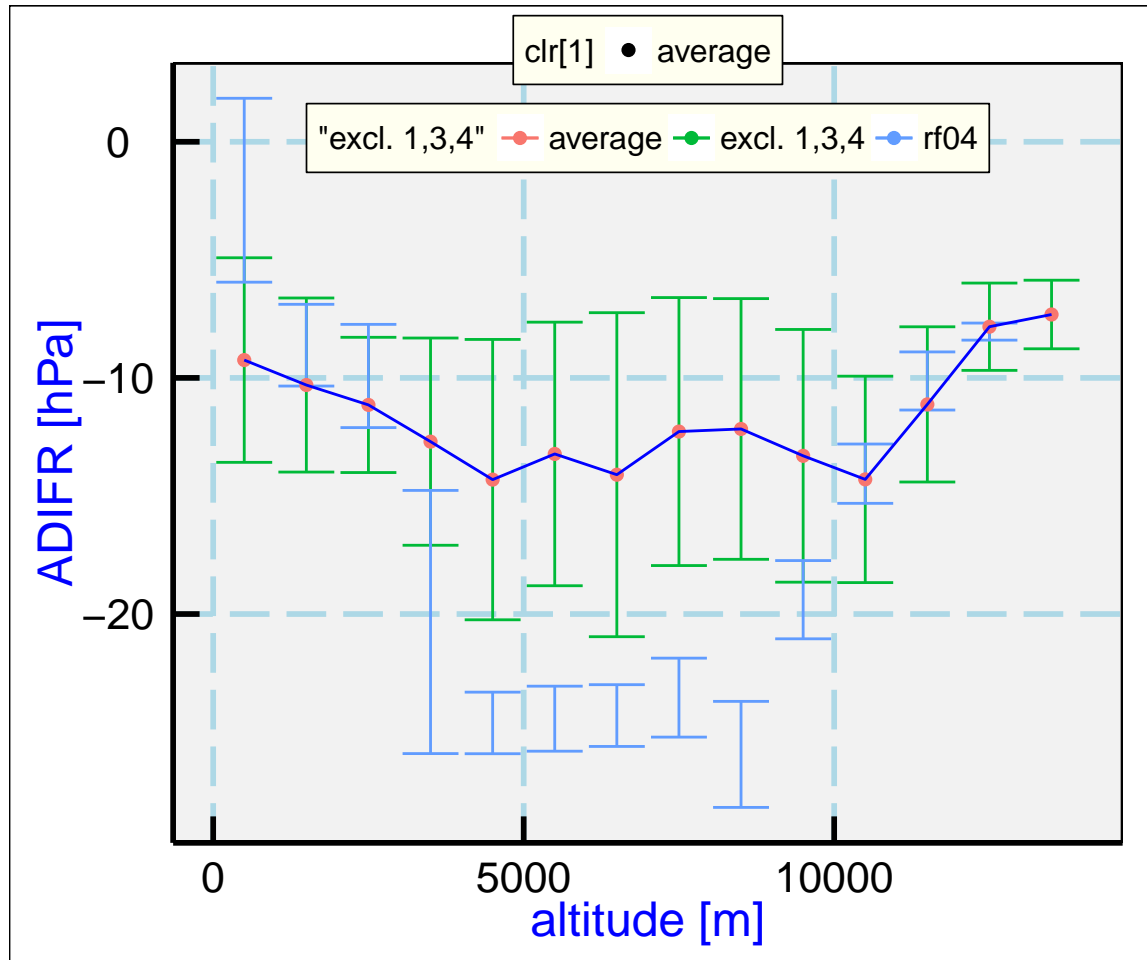


Figure 3: Distribution in ADIFR in altitude bins, for all measurements in HIPPO-5 except those in flights 1, 3, and 4 (green), and for those from flight 4 (blue).

Attachments: ProgramFile  
Document.pdf  
SaveRData