9 August 2015

TO:	Algorithm Documentation File
FROM:	Al Cooper
SUBJECT:	Argument against using VSPD for vertical wind

1 Summary

This memo documents the reasons why VSPD should not be used for vertical wind and why the variable WI, conventionally based on VSPD, should be retired.

2 Weaknesses of VSPD

VSPD is the vertical aircraft speed, or rate of climb, provided by the IRU. The IRUs in use on both aircraft use updating to the pressure altitude to control the known instability that arises from integrating vertical acceleration to get rate-of-climb. As a result, the rate-of-climb represented by VSPD is with reference to a standard atmosphere, and if the atmospheric stratification differs from the standard atmosphere the resulting rate-of-climb will not be the geometric-altitude rate of climb, as needed for the calculation of vertical wind.

3 Illustration of the problem

Figure 1 shows the two measurements VSPD and VSPD_G and also the difference between them. The difference is negatively correlated with VSPD and has a magnitude of around 1 m/s. This is then reflected in WI, and shown in Fig. 2, where the red trace is VSPD/10 to provide a reference for changes in rate-of-climb. With this atmospheric stratification, there is an obvious error in WI that is correlated with VSPD. Other HIPPO flights show similar errors, sometimes with positive correlation and sometimes with negative correlation between WI and VSPD depending on the atmospheric stratification. WIC, based on VSPD_G, does not show this error. The reason for this error is evident from Fig. 3, which shows the atmospheric sounding for the period of climbs and descents in this flight. This was a far-north leg in a cold atmosphere, as shown by the blue trace in that plot. The temperatures are far below the standard-atmosphere temperatures, shown as the red line, so that is the reason that VSPD is significantly different from VSPD_G and so introduces the errors seen in Fig. 2.
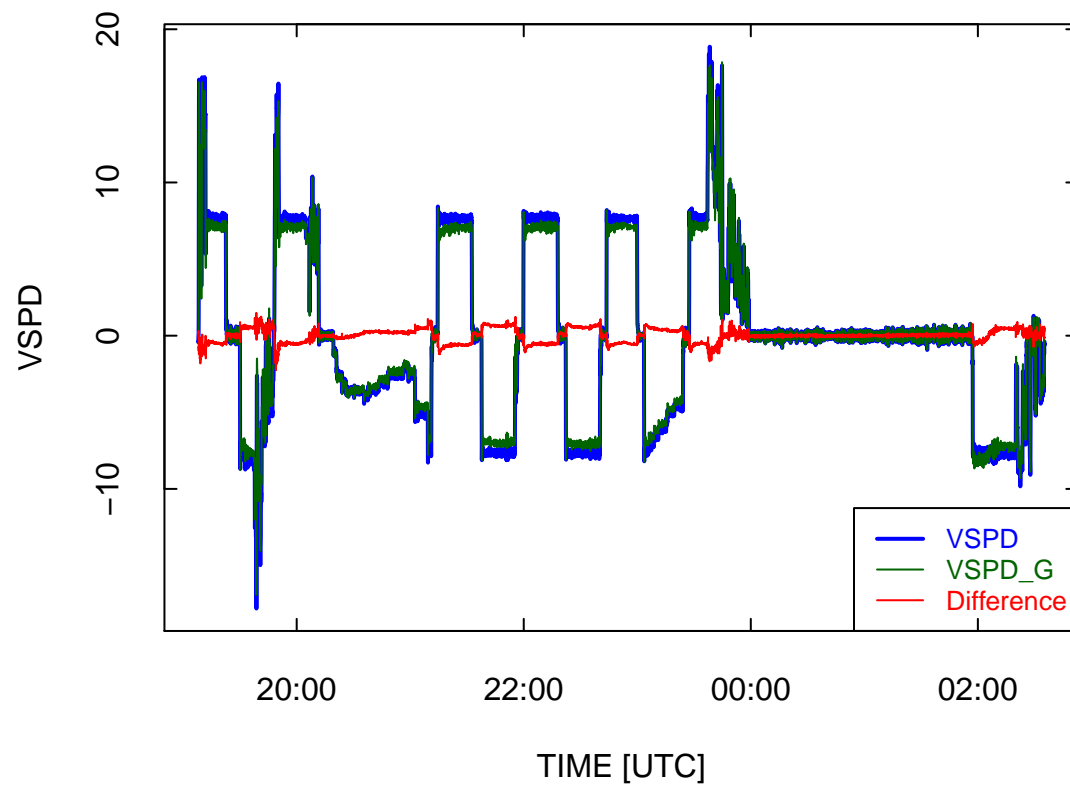
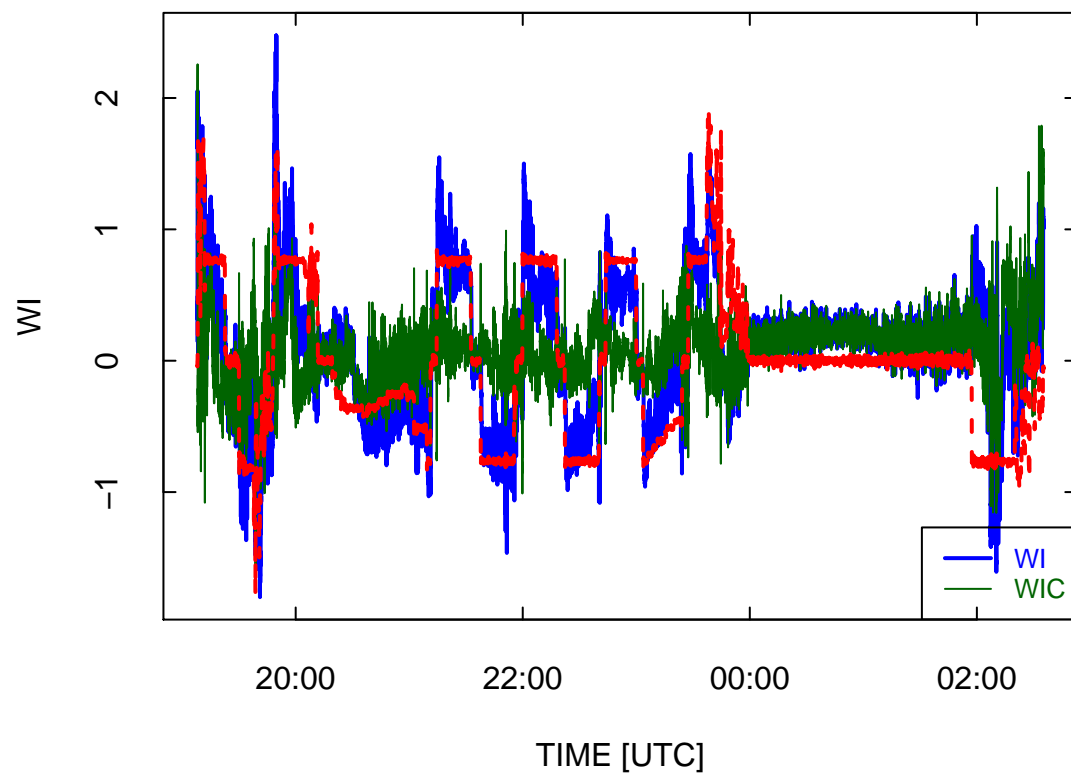Figure 1: Comparison of VSPD and VSPD_G for HIPPO-2 flight 10.
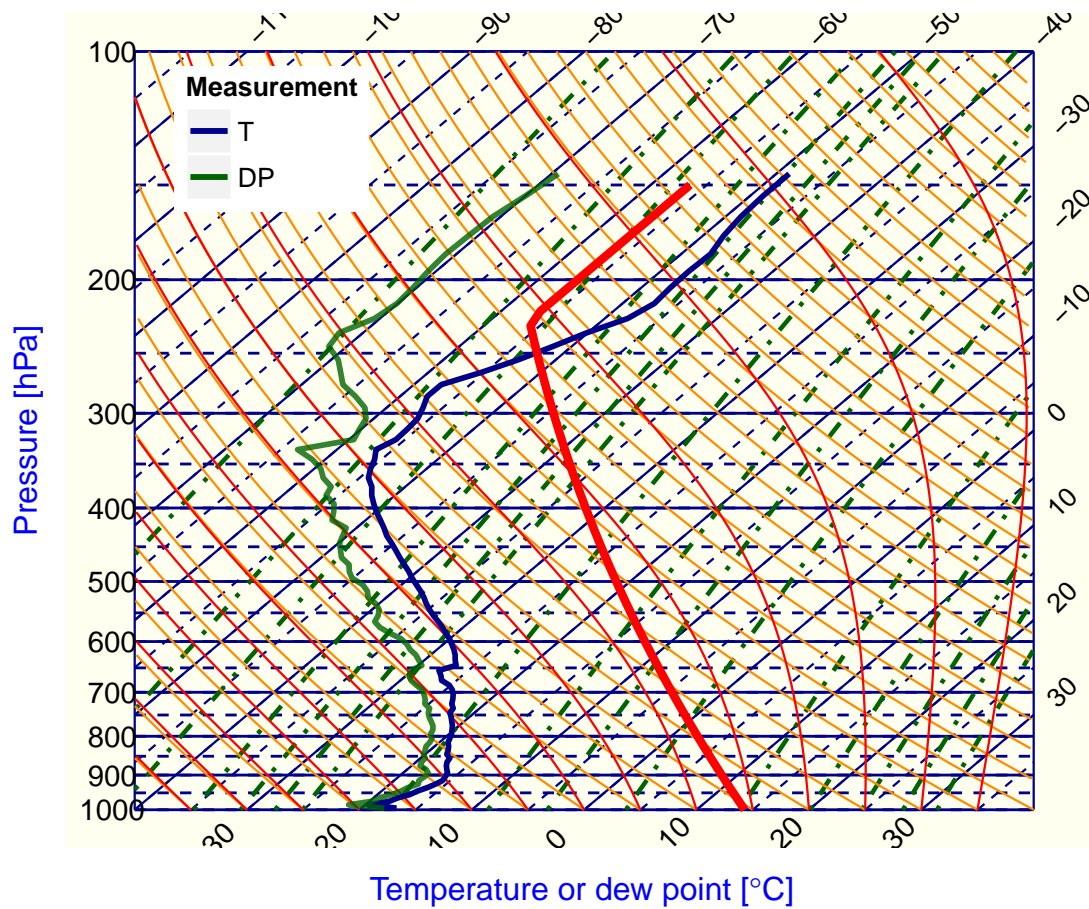
Figure 2: WI for HIPPO-2 flight 10.

Figure 3: Sounding for the period from 21:00:00 to 24:00:00 on HIPPO-2 flight 10. The red line is the temperature of a standard atmosphere.

– End of Memo –

Reproducibility:

PROJECT:	UsingVSPDforWI
ARCHIVE PACKAGE:	UsingVSPDforWI.zip
CONTAINS:	attachment list below
PROGRAM:	UsingVSPDforWI.Rnw
ORIGINAL DATA:	/scr/raf_data/HIPPO/HIPPO-2rf10.nc
GIT:	git@github.com:WilliamCooper/UsingVSPDforWI.git

Attachments: UsingVSPDforWI.Rnw
UsingVSPDforWI.pdf
UsingVSPDforWI.Rdata
SessionInfo