Assessing the Impact of Erroneous Winds from the South Pole, Antarctica Rawinsonde Soundings on Reanalyses for 2005-2007

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1. Introduction

It was first reported at the 2nd Antarctic Meteorological Observation, Modeling, and Forecasting Workshop in Rome in 2007 that with the introduction of the new RS-92 sonde at the South Pole, erroneous winds were being reported due to an algorithm error (Carmody, http://www.mmm.ucar.edu/events/antarctic07/presentations/26_June_Giugno/). An initial fix was implemented sometime in 2007 but was not adequate when the sonde was distant from the Station; subsequently the winds were recomputed for the entire period 14 February 2005 to 5 December 2007 (Lazzara, email communication 12/27/2007) and are now available from the archive at the AMRC at the University of Wisconsin (ftp://amrc.ssec.wisc.edu/pub/southpole/radiosonde/). Because these erroneous winds were reported to the GTS and presumably used in subsequent reanalyses, it seemed prudent to assess their influence on various reanalyses, given the limited number of rawinsonde sounding sites over Antarctica and the potential compensating effect of satellite observations in more recent reanalysis. We used three reanalyses in our assessment: 1) the original NCEP/NCAR (NCEP-I) Reanalysis (http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html), 2) the NCEP/DOE II Reanalysis (NCEP-II) (www.cpc.ncep.noaa.gov/products/wesley/reanalysis2/) which fixed a number of bugs and improved the parameterizations in the original NCEP/NCAR Reanalysis and 3) the ERA Interim Reanalysis (ERA-I) from 1989 to the present which is expected to replace the older ERA-40 reanalysis (ECMWF Newsletter No 110). Unlike NCEP-II, ERA Interim introduced both

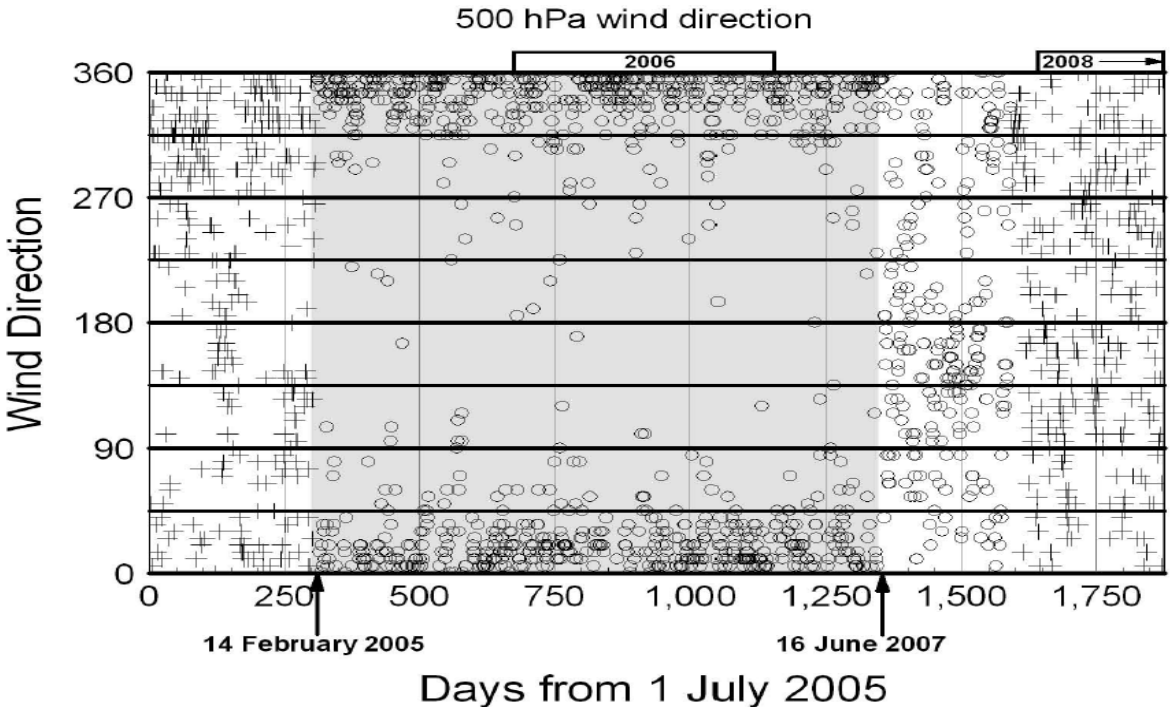

Figure 1. Wind directions at 500 hPa for the period from 1 July 2005 through 1 July 2008. Highlighted area shows period of erroneous wind directions.

satellite winds and radio occultation measurements of the atmospheric mass field in its data assimilation system. With the recent release of the Twentieth Century Reanalysis which uses only surface and sea-level pressure observations (Compo et al., 2011), we also took the opportunity to compare the South Pole observations with this new product (20CR). Figure 1 shows the distribution of wind directions archived at the British Antarctic Survey using data received in near-real time from GTS (http://www.antarctica.ac.uk/met/metlog/cui.html#upper). For comparison we used the full years 2006 (erroneous data) and 2008 (correct data) for winds at 500 hPa. It appears that the initial fix described by Lazzara took place about 16 June 2007 although the entire data set was later reprocessed through 5 December 2007. Figure 2 shows scatter plots with least-squares regression lines for 2006 using NCEP I, NCEP II, and ERA-I wind data at 500 hPa.

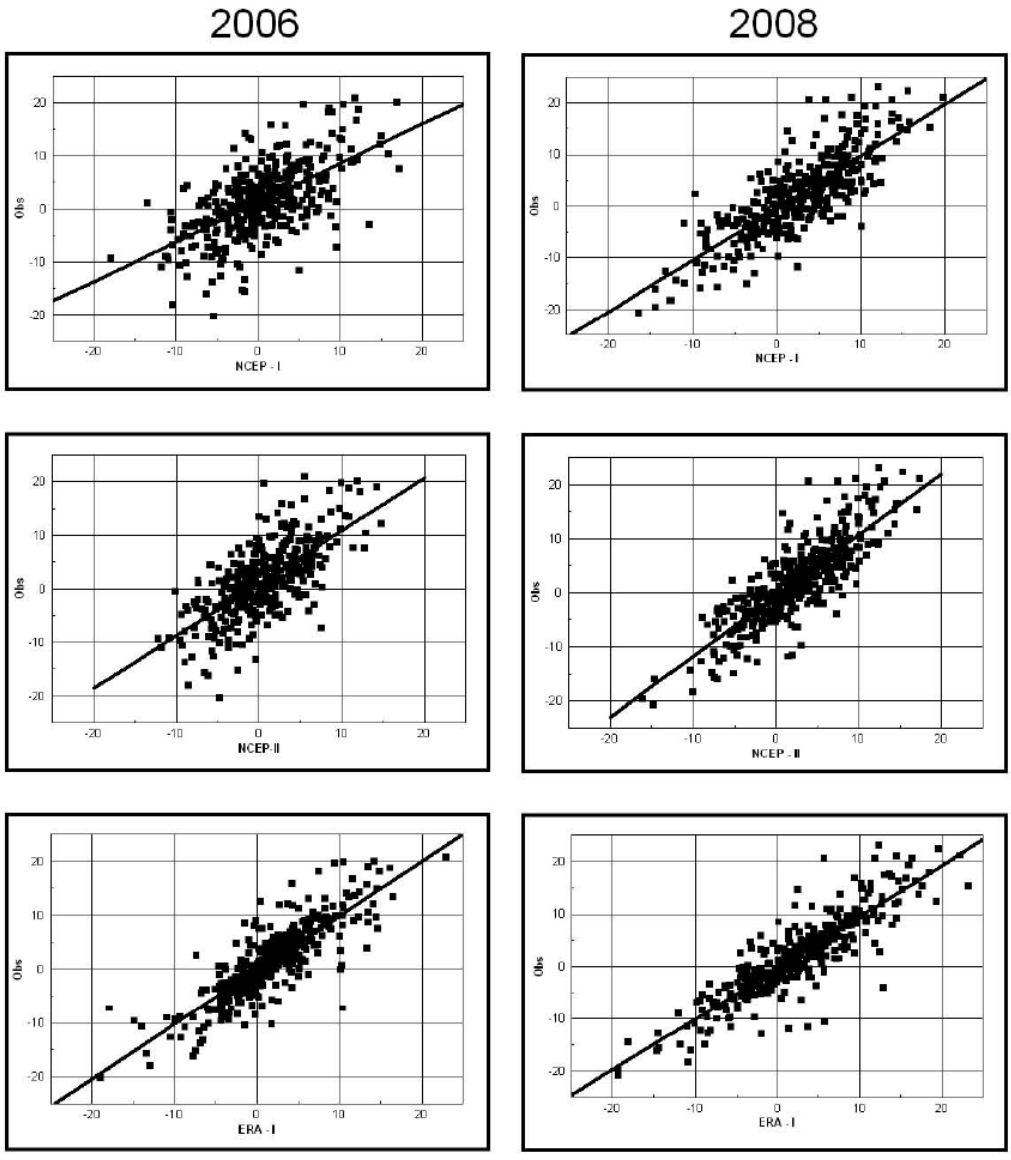

Figure 2. Least-squares linear regression fits for the u-component of the wind at 500 hPa at the South Pole using NCEP-I (top), NCEP-II (middle), ERA-I (bottom) reanalyses for 2006 (left) and 2008 (right).

Because the observational data is presumed to have larger random errors than the reanalyses, we regressed the observations on the reanalyses values. The Table shows the regression values for both u- and v-components of the wind at 500 hPa.

Table: Regression parameters (r^2/Slope) for 2006 and 2008

	2008 (correct data in GTS)		
	NCEP - I	**NCEP - II**	**ERA - Interim**
U	**0.64/1.00**	**0.68/1.12**	**0.77/0.97**
V	**0.68/0.98**	**0.67/1.11**	**0.77/0.96**
	2006 (Erroneous data in GTS)		
U	**0.37/0.74**	**0.46/0.98**	**0.69/1.00**
V	**0.36/0.71**	**0.48/0.99**	**0.70/0.97**

Summary results for NCEP and ERA-Interim comparisons:

- The ERA Interim Reanalysis provides the best correlation in both years although 2006 is slightly degraded.
- During 2006, the original NCEP reanalysis provides the least correlation (with NCEP II only slightly better) with actual observations overestimated by the reanalysis (from the least-squares-fit line)
- In 2008, NCEP-I and NCEP-II provide comparable results while the ERA-Interim provides a somewhat superior result.

We also examined results from the Twentieth Century Reanalysis Project (Compo et al., 2011) which has reconstructed the atmospheric circulation using only surface pressure observations from 1871 through 2008. Figure 3 presents a comparison of 500 hPa geopotential heights for 2006 and 2008 while Figure 4 shows the corresponding assessment of the u-component of the wind for the two years.

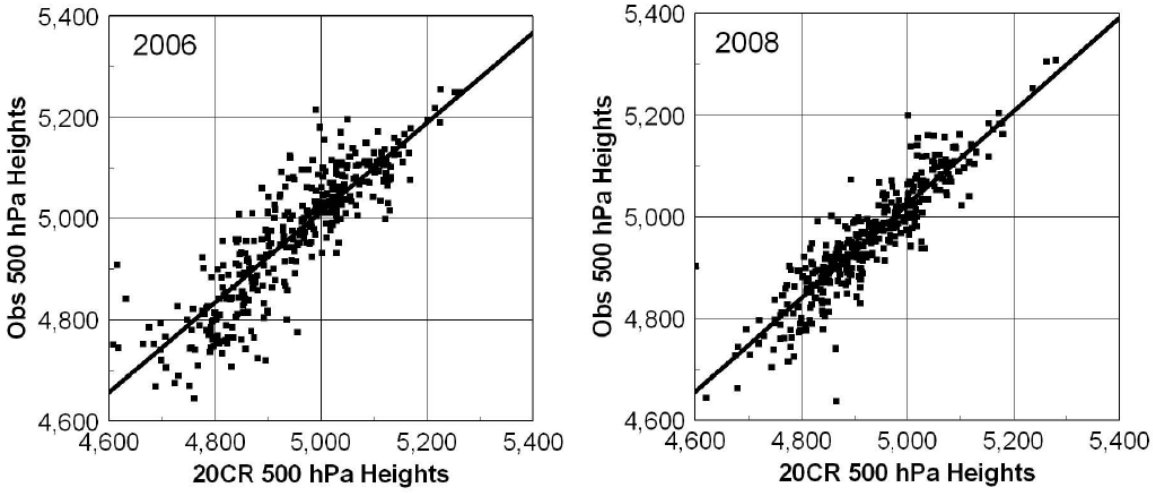

Figure 3. Geopotential height comparison with the regression of the observed heights on the modeled heights for 2006 and 2008. 2006: r^2=0.75/slope=0.89), 2008: r^2=0.82/slope=0.92)

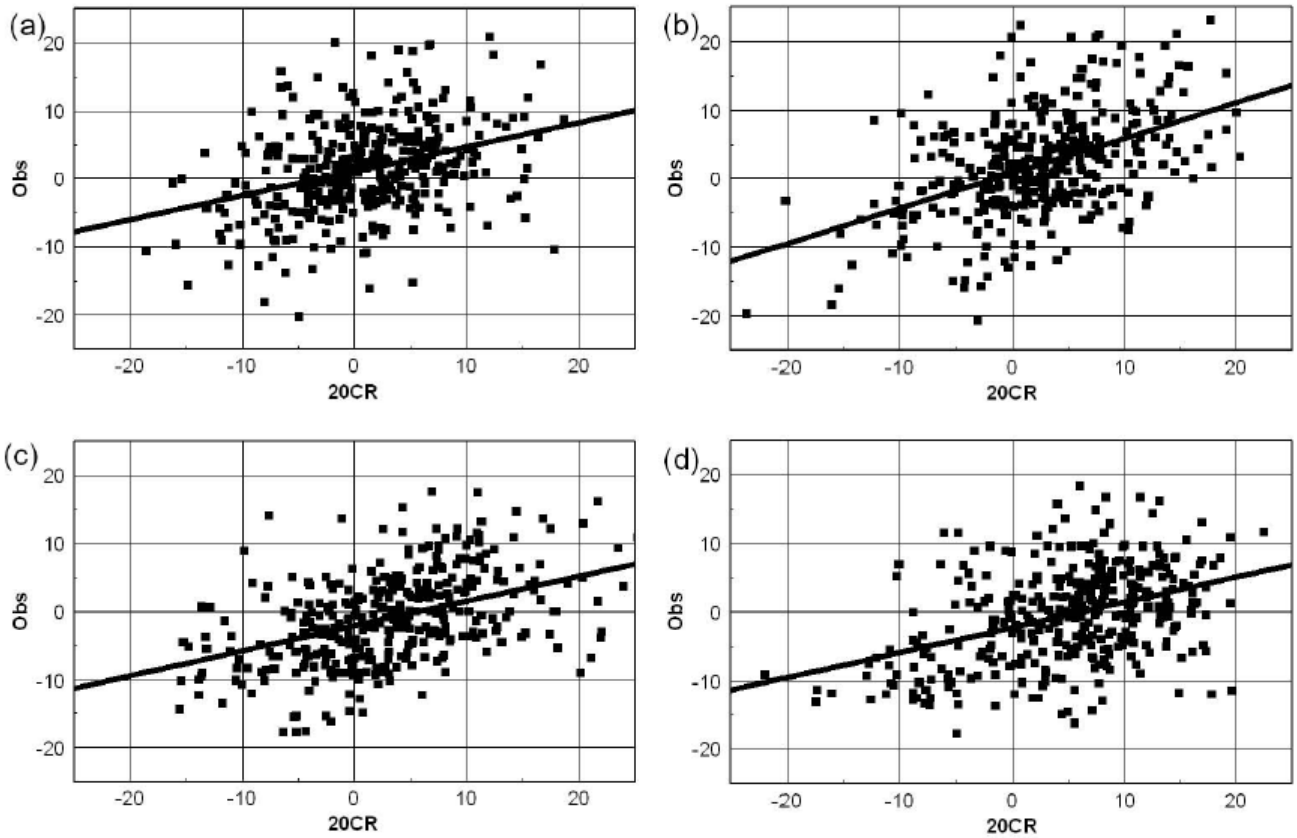

Figure 4. Observed u- and v-component of winds from 500 hPa at the South Pole regressed on the 18Z 20CR u- and v- components (top and bottom, respectively) for 2006 (left) and 2008 (right): a) r^2=0.11/slope=0.36), b) r^2=0.22/slope=0.51), c) r^2=0.21/slope=0.36), d) r^2=0.16/slope=0.36).

Summary results for the 20CR comparisons:

- Comparison of observations of 500-hPa geopotential heights reflects very credibly on the 20th Century Reanalysis (Figure 3) which suggests that the geopotential heights at the South Pole from the 20CR may provide a useful index of long-term circulation changes over the interior of Antarctica.
- Comparison of wind components show much lower correlations as might be expected in comparing a derivative field with an instantaneous sample from a rawinsonde.

Reference:

Compo, G. P., et. al., 2011: The Twentieth Century Reanalysis Project, Q. J. R. Meteorol. Soc., 137, 1-28, doi: 10.1002/qj.776.