STUDY OF THE WINTER 2005 ANTARCTICA POLAR VORTEX

F. Lascaux, E. Masciadri, S. Hagelin and J. Stoesz

Abstract. During winter and springtime, the flow above Antarctica at high altitude (upper troposphere and stratosphere) is dominated by the presence of a vortex centered above the continent. It lasts typically from August to November. This vortex is characterized by a strong cyclonic jet centered above the polar high. In a recent study of our group (Hagelin et al. 2008) of four different sites in the Antarctic internal plateau (South Pole, Dome C, Dome A and Dome F), it was made the hypothesis that the wind speed strength in the upper atmosphere should be related to the distance of the site to the center of the Antarctic polar vortex. This high altitude wind is very important from an astronomical point of view since it might trigger the onset of the optical turbulence and strongly affect other optical turbulence parameters. What we are interested in here is to localize the position of the minimum value of the wind speed at high altitude in order to confirm the hypothesis of Hagelin et al. (2008).

1 Introduction

During winter, the stratospheric circulation at both poles is characterized by a large cyclonic vortex centered in a region close to the pole (Haynes 2003). Extended climatology of the polar vortex have been already conducted, using ECMWF or NCAR-CEP data set (Karpetchko et al. 2005; Waugh et al. 1999) with methods based on potential vorticity to define the vortex. It is well known that the vortices are much more stronger in mid-winter than in summer (Waugh et al. 1999; Harvey et al. 1999). In this study we want to determine the minimum speed of the high altitude wind above the Antarctica continent. This might help us in identifying the center of the polar vortex and we could use this information to qualify the sites for astronomical applications.

Indeed, during a previous study about site characterization for optical turbulence above the internal Antarctic Plateau using ECMWF analysis, our group

1 INAF/Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125 Florence, Italy

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investigated four different sites (Hagelin et al. 2008): Dome A, C and F and South Pole. One of the conclusions was that in the free atmosphere, above around 10 km, the wind speed increased monotonically in winter proportionally to the distance to the center of the polar high. Thus Dome C was the site showing the highest wind speed above 10 km. We propose in this study to confirm this hypothesis looking at a climatology of the high altitude wind speed and the corresponding vortex above the Antarctica continent for winter 2005. Due to the weak variability of the Antarctica vortex proved in other studies, we can deduce that this one-year study can provide a quantitative estimate with a good accuracy about the position of the minimum wind speed in altitude.

2 The median high altitude wind speed

We used the ECMWF analyses from MARS catalog for every day between May 1st and September 30th, 2005, at 00 UTC. The analysis employs the 4D-VAR assimilation scheme to assimilate a wide number of observations, including in-situ conventional data and synthetic data from satellites. The averaged distance between two horizontal grid points is of the order of $\sim 40$ km. To perform our study, we focused on the wind speed at two different altitudes, 15 km and 20 km from May 1st and September 30th, every 24 hours at 00 UTC. We computed the monthly medians of the wind speed and deduced a preferential position for the minimum of wind speed in altitude for winter 2005.

Fig. 1 shows the monthly median of the wind velocity at two different heights, 15 and 20 km, computed from May 2005 to September 2005.
The minimum of the median wind is clearly identified at 20 km. The median polar vortex center (corresponding to the minimum wind speed) remains in an area between South Pole and Dome A. Between the four sites investigated by Hagelin 

et al. (2008), Dome C is the farthest away from the polar vortex center, and by consequence the one with the highest wind speed in altitude.

3 Conclusion

This study confirms the conclusion regarding the "position space" of the polar high deduced by Hagelin et al. (2008), and the link between the position of an Antarctic site with respect to this center and the wind speed in altitude. Dome C appears to have in winter a wind speed in altitude much higher than other sites like South Pole and Dome A, closer to the center of the vortex. Such a quantitative information should be considered by astronomers as a key issue in future plans for astronomical facilities to be set-up in different sites of the Internal Antarctic Plateau.

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