GLOBALLY DISTRIBUTED TIME SERIES OF THE ENHANCED MISR CLOUD MOTION VECTOR PRODUCT

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Abstract

At the 10th IWW, Davies and Herber reported on the change in wind speed over the previous decade, using the first edition of the MISR cloud motion vector product. Since then, we not only have several more years of data, but the wind retrieval algorithm has been substantially enhanced to provide better coverage, higher resolution and to remove cross-track biases. This paper presents results from the latest analysis of the global distribution of MISR winds, and their changes over time, especially as a function of latitude. We look especially at regions of the Southern Oceans, where reanalysis data currently are of limited accuracy.

INTRODUCTION

Previously, Davies and Herber (2010) used the first generation of MISR's cloud motion vector product to show that low level wind speeds over the had decreased during the first 10 years of measurements from the Terra satellite over much of the global oceans, with the exception of parts of the Southern Ocean where they had increased. This paper uses the enhanced second-generation cloud motion vector product from MISR to update these results, and to extend the time series by a further 4 years, from March 2000 to February 2014.

MISR CLOUD MOTION VECTORS

The second-generation product is described in detail by Mueller at al. (2013). The main differences are increased spatial resolution (now at 17.6 km horizontally), resulting in better coverage, as well as improved quality assurance by using both fore and aft triplets of views. The entire time series of MISR cloud motion vectors has been reprocessed with
the second-generation algorithm to provide consistent time series that can be analysed to produce a wind climatology. In this paper we ignore land areas for which there is a well established slow bias in cloud motion vectors compared with actual winds, and focus on the major oceanic basins of the Pacific, Atlantic and Indian Oceans, as well as the Southern Ocean, which we define to be poleward of 45°S. We consider both low-level winds (altitudes less than 1.5 km) and high-level winds (between 9 and 11 km).

**LOW-LEVEL WINDS**

Figure 1 shows the mean low-level winds for each ocean basin, including the zonal, meridional and scalar mean winds. These show the expected transition between easterlies and westerlies, and the increase in wind speed with latitude in the Southern Ocean.

By taking the monthly zonal anomalies in the different wind components as a function of time, the overall trend can be calculated. For many latitudes these are not statistically significant, but there are a few points of interest.

In the Pacific, there is a strengthening of the south-easterly component just north of the equator, resulting in an increase in the scalar wind, likely associated with a change in the position of the ITCZ, but this requires further analysis. The corresponding time series of annual scalar wind speed anomalies at 4°N is shown in Fig. 3. The increase in scalar wind speed is about 1 m/s/decade.

In the Atlantic, the main feature is a reduction in the easterly component around 10°N and an associated reduction in the scalar wind speed.

The Southern Indian Ocean shows a change south of 40°S, where the scalar wind decreases due to a reduction in the strength of the westerlies.

By contrast, the Southern Ocean shows a freshening of the westerlies around 55°S, which may be associated with the expansion of the wintertime sea-ice. In Figure 4 the time series of scalar wind speed anomalies shows an increase in scalar wind speed of about 0.5 m/s/decade.

**UPPER-LEVEL WINDS**

Figure 5 shows corresponding results for the mean upper-level wind components at an altitude of 10 km, averaged over each ocean. These show an expected increase in scalar speed and westerly component going poleward in each hemisphere. The meridional component is an increasing southerly with northern latitude, and increasing northerly with southern latitude.

In terms of trends in scalar wind speed at 10 km, most latitudes showed statistically insignificant changes. The exceptions were 10-15°N in the Pacific Ocean, and 30°S in the Indian Ocean, where the speed has increased by up to 3 m/s/decade, due mainly to increasing zonal components. The corresponding time series for these regions is shown in Figure 6 and Figure 7.
Figure 1: Mean low-level winds for the Pacific, Atlantic and Indian oceans. South of 45°S, the Southern Ocean is common to each panel.
Figure 2: Decadal trend rates in the low-level winds as a function of latitude for the same ocean regions as Fig. 1. Trends between ±0.2 m/s/decade are not statistically significant.
Figure 3: Anomalies in the annual mean scalar low-level wind at 4°N averaged across the Pacific, showing an increase at the rate of ≈1 m/s/decade.

Figure 4: Anomalies in the annual mean scalar low-level wind at 56°S averaged across the Southern Ocean, showing an increase at the rate of ≈0.5 m/s/decade.
Figure 5: Mean upper-level (≈10 km) winds for the Pacific, Atlantic and Indian oceans. South of 45°S, the Southern Ocean is common to each panel.
Figure 6: Anomalies in the annual mean scalar high-level wind at 11°N averaged across the Pacific Ocean, showing an increase at the rate of ≈3 m/s/decade.

Figure 7: Anomalies in the annual mean scalar high-level wind at 29°S averaged across the Indian Ocean, showing an increase at the rate of ≈3.6 m/s/decade.
SUMMARY

These results are still preliminary, but serve to show some of the utility of a homogeneous data set of satellite-observed cloud-motion vectors. There appear to be significant changes in wind speeds and components in some oceanic regions that warrant further investigation. Whether these will turn out to be ephemeral or of sustained response to global warming remains to be seen. But without such a detailed observational base from space-borne sensors, such questions would likely remain moot for much longer.

REFERENCES
