

MISR 17.6 KM GRIDDED CLOUD MOTION VECTORS: OVERVIEW AND ASSESSMENT

Kevin Mueller, Michael Garay, Catherine Moroney, and Veljko Jovanovic

Jet Propulsion Laboratory, California Institute of Technology

Abstract

The MISR (Multi-angle Imaging SpectroRadiometer) instrument on the Terra satellite has been retrieving cloud motion vectors (CMVs) globally and almost continuously since early in 2000. In February 2012 the new MISR Level 2 Cloud product was publicly released, providing cloud motion vectors at 17.6 km resolution with improved accuracy and roughly threefold increased coverage relative to the 70.4 km resolution vectors of the current MISR Level 2 Stereo product (which remains available). MISR retrieves both horizontal cloud motion and height from the apparent displacement due to parallax and movement of cloud features across three visible channel (670nm) camera views over a span of 200 seconds. The retrieval has comparable accuracy to operational atmospheric motion vectors from other current sensors, but holds the additional advantage of global coverage and finer precision height retrieval that is insensitive to radiometric calibration. The MISR mission is expected to continue operation for many more years, possibly until 2019, and Level 2 Cloud has the possibility of being produced with a sensing-to-availability lag of 5 hours. This report compares MISR CMV with collocated motion vectors from arctic rawinsonde sites, and from the GOES and MODIS-Terra instruments. CMV at heights below 3 km exhibit the smallest differences, as small as 3.3 m/s for MISR and GOES. Clouds above 3 km exhibit larger differences, as large as 8.9 m/s for MISR and MODIS. Typical differences are on the order of 6 m/s.

AVAILABILITY OF MISR LEVEL 2 CLOUD PRODUCT

The new MISR Level 2 Cloud product contains height-resolved, cloud motion vectors at 17.6 km resolution; cloud top heights at 1.1 km resolution; and cross-track cloud motion components at 1.1 km resolution. Cloud masking and quality indicators are also included.

The data and further information regarding accuracy and coverage can be accessed at the MISR Level 2 Products page:

http://eosweb.larc.nasa.gov/PRODOCS/misr/products/level2_new.html

The MISR Level 2 Cloud Algorithm Theoretical Basis document is in preparation as of May 2012 and will become available at:

http://eospsso.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/viewInstrument.php?instrument=19

LEVEL 2 CLOUD CMV EXAMPLE SCENES AND COVERAGE:

The 17.6 km resolution of Level 2 Cloud CMV well captures fine scale cloud height and motion variability as demonstrated by a scene from Hurricane Franklin depicted in Figure 1. Even the rotation of the inner eye is captured. Each 17.6 km x 17.6 km grid cell constitutes an independent retrieval, as is demonstrated in Figure 1 by areas as small as 35.2 km by 35.2 km region with multiple distinct heights of retrieved CMV.

The MISR instrument has a swath width of 380 km, typically yielding daily sampling as shown in Figure 2 for representative days in boreal winter and summer. The majority of CMV are retrieved at heights below 3 km. Repeat coverage varies from multiple times per day at the sunlit pole, to every 9 days at the equator.

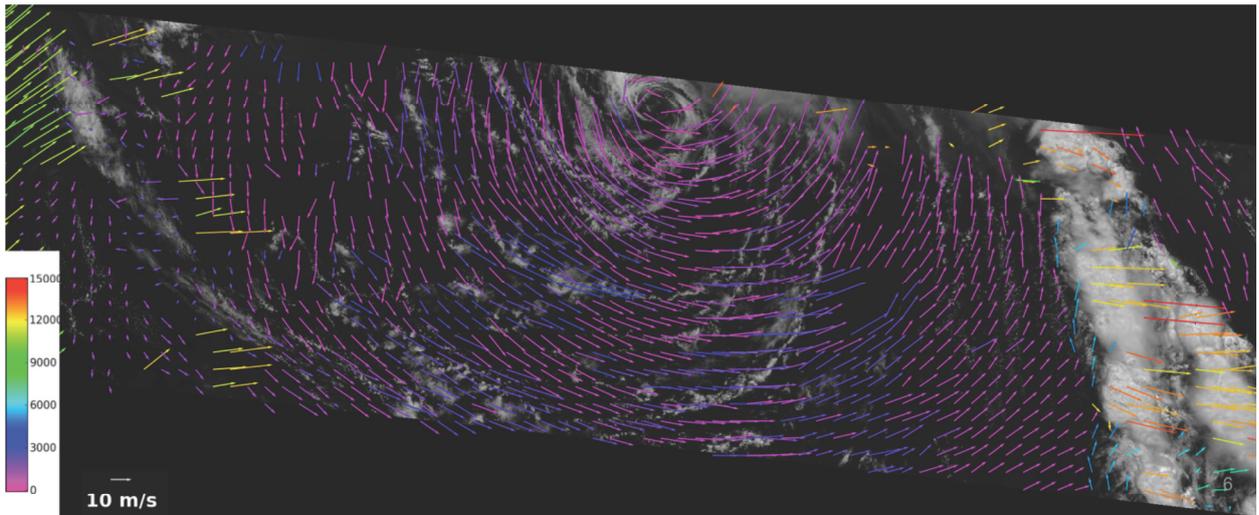


Figure 1: MISR Level 2 Cloud cloud motion vectors retrieved for Hurricane Franklin on July 25, 2010 around 1600z. Height in meters of each CMV is displayed according to the lower left colorbar. The vector scale is also shown in the lower left.

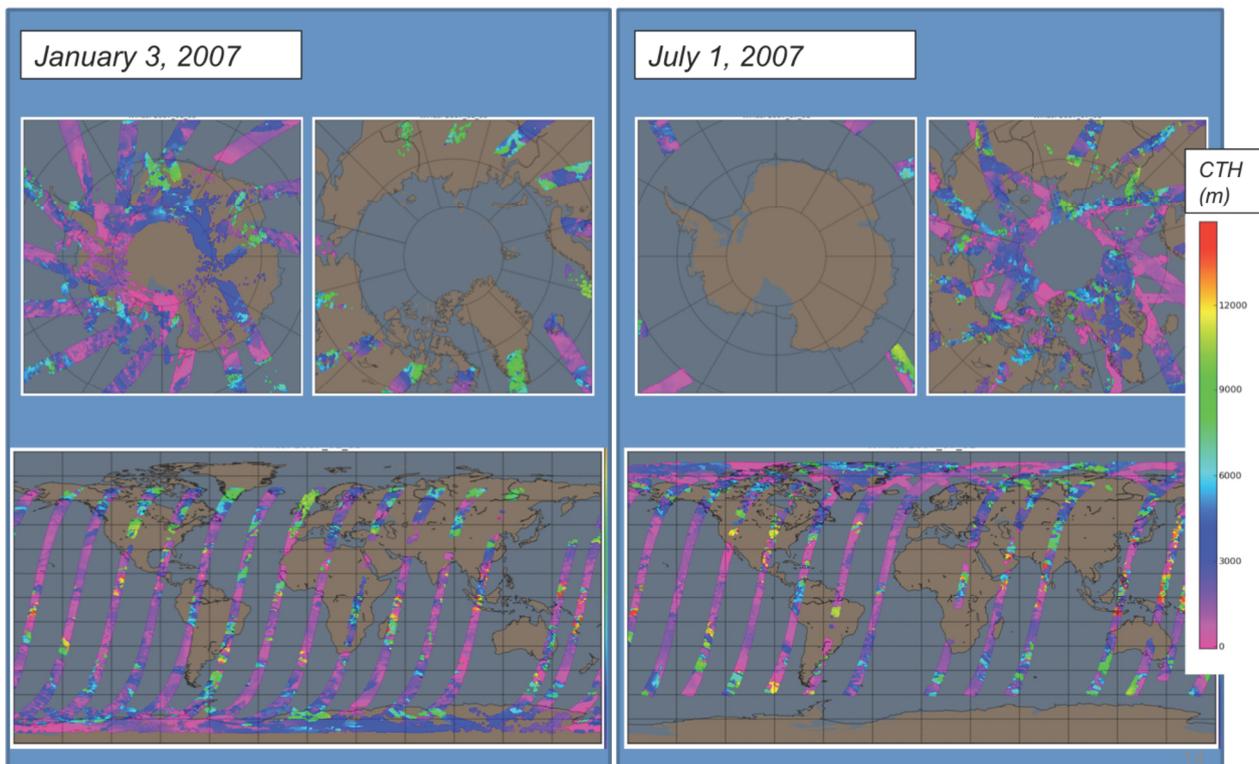


Figure 2: Representative daily MISR Level 2 Cloud coverage for boreal winter (January 3, 2007) and summer (July 1, 2007) as shown by cloud top heights (CTH) in meters of retrieved cloud motion vectors shown in three map projection for each day.

COMPARISONS WITH ATMOSPHERIC MOTION VECTORS FROM OTHER SENSORS:

MISR Level 2 Cloud CMV were compared with collocated Geostationary Operational Environmental Satellite (GOES), MODIS (aboard Terra), and radiosonde (RAOB) atmospheric motion vectors (AMV). In most comparisons, MISR cloud top heights (CTH) were used to divide the analysis into low (CTH < 3

km), middle (3 km < CTH < 7 km), and high (CTH > 7 km) clouds. In the analysis below, note that along-track refers to motion in the direction of the Terra satellite orbit (close to south except at high latitude) and cross-track refers to relatively orthogonal motion (close to east except at high latitudes). See MISR Level 2 Cloud Quality Statement for more information.

MISR relative to GOES

| | MISR height bin | | |
|--|-----------------|----------------|-----------------|
| | 0-3 km | 3-7 km | 7+ km |
| Collocations | 52600 | 3700 | 8500 |
| Component bias (along, cross-track) | (0.1, -0.3) m/s | (1.4, 0.0) m/s | (1.8, -0.2) m/s |
| Component RMS (along, cross-track) | (2.7, 1.8) m/s | (5.1, 3.5) m/s | (5.7, 3.5) m/s |
| Vector RMSE | 3.3 m/s | 6.3 m/s | 6.8 m/s |

Table 1: Statistics from comparison of MISR Level 2 Cloud CMV with collocated GOES AMV throughout January and July of 2007.

MISR relative to MODIS

| | MISR height bin | | |
|--|-----------------|-----------------|----------------|
| | 0-3 km | 3-7 km | 7+ km |
| Collocations | 8740 | 13490 | 1030 |
| Component bias (along, cross-track) | (1.5, -0.4) m/s | (1.3, -0.1) m/s | (3.5, 0.2) m/s |
| Component RMS (along, cross-track) | (4.3, 3.7) m/s | (4.1, 3.2) m/s | (6.7, 4.7) m/s |
| Vector RMSE | 5.9 m/s | 5.4 m/s | 8.9 m/s |

Table 2: Statistics from comparison of MISR Level 2 Cloud CMV with collocated northern hemisphere Terra MODIS AMV throughout January and July of 2007.

MISR relative to arctic rawinsondes

| | MISR height bin | | |
|--|-----------------|----------------|----------------|
| | 0-3 km | 3-7 km | 7+ km |
| Collocations | 206 | 67 | 19 |
| Component bias (along, cross-track) | (0.6, 0.0) m/s | (1.3, 0.0) m/s | (0.3, 0.5) m/s |
| Component RMS (along, cross-track) | (4.7, 3.5) m/s | (4.1, 3.2) m/s | (3.8, 1.9) m/s |
| Vector RMSE | 5.9 m/s | 5.3 m/s | 4.3 m/s |

Table 3: Statistics from comparison of MISR Level 2 Cloud CMV with collocated arctic rawinsonde launches between 2002 and 2009.

CONCLUDING REMARKS

With 17.6 km resolution, global coverage, a historic record dating back to 2000, possible continued operation until 2019, and comparable accuracy to operationally assimilated AMVs, CMVs provided by the MISR Level 2 Cloud product have great potential value to the numerical weather prediction and reanalysis community. The MISR team is investigating the value and effort necessary to reduce the sensing-to-data-availability latency to a plausible 5 hour from the current 12 hours.

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