2.9 MULTI-ANGLE IMAGING SPECTRORADIOMETER DATA AVAILABLE FOR ATMOSPHERE, OCEAN AND LAND SURFACE CHARACTERIZATION

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1. INTRODUCTION

The Multi-angle Imaging SpectroRadiometer (MISR) provides a unique view of Earth, viewing the sunlit portion simultaneously with nine cameras pointed at different angles along the flight track. MISR provides global coverage with high spatial detail. Its imagery is carefully calibrated to provide accurate measures of the brightness, contrast, and color of reflected sunlight. These measurements are vital for increasing our understanding of the Earth's climate, its variation and for understanding the synergy of the atmosphere, ocean and land surface.

MISR provides new information for scientists studying Earth's climate, such as the partitioning of energy and carbon between the land surface and the atmosphere, and the regional and global impacts of different types of atmospheric particles and clouds on climate. The change in reflection at MISR's view angles affords the means to distinguish various types of atmospheric aerosols, cloud forms and land surface covers. Combined with stereoscopic techniques, MISR enables estimation of the total amount of sunlight reflected by Earth's diverse environments.

The MISR data are processed, archived and distributed by the Atmospheric Sciences Data Center (ASDC) at NASA's Langley Research Center. Data, information and tools are available at the ASDC web site,

http://eosweb.larc.nasa.gov.

2. MISR DATA

MISR's nine cameras are pointed at fixed angles, one viewing the nadir and four each viewing the forward and aftward directions along the spacecraft ground track at 26.1, 45.6, 60.0, and 70.5 degrees. Each of the nine MISR cameras obtains images in four spectral bands: blue, green, red and near-infrared. The center wavelengths of these bands are 446, 558, 672, and 886 nm, respectively.

The nadir camera radiances and the red band of the angled cameras have a 275m pixel resolution. The remaining bands of the off-nadir cameras have a resolution of 1.1km. MISR's swath width is 360km allowing global coverage in 9 days and repeat coverage every 16 days. The total number of distinct orbit paths is 233. Each orbit is divided into 180 blocks.

MISR data products can be categorized by processing level. Level 1 data products provide calibrated instrument data. Level 2 products provide derived quantities such as aerosol, cloud heights, and surface reflectance. Level 3 products are globally gridded statistical summaries of selected Level 1 and Level 2 parameters aggregated over various time scales (monthly, seasonal and annual).

The Level 1B2 Georectified Radiance product contains imagery from the nine cameras, calibrated and registered to one another and to the ground and then mapped into a Space Oblique Mercator projection.

The Level 2 data products include many parameters that are suited for local and global scale research. Some specific parameters contained in these data products are aerosol optical depth, bidirectional reflectance factor, leaf-area index (LAI), fractional photosynthetically active radiation (FPAR) and normalized difference vegetation index (NDVI).

The Level 3 data products are provided on a global, rectangular grid that has a resolution of 0.5 degree latitude by 0.5 degree longitude. Products include monthly, seasonal and annual averages of radiance, land/surface and aerosol parameters.

3. APPLICATIONS OF MISR

3.1 Atmospheric

MISR provides a new angular view of cloud and aerosol properties. Figure 1 illustrates a true-color nadir image of category 4 Hurricane Isabel obtained on September 11, 2003 and the associated stereoscopically derived cloud-top heights and local albedos. The cloud-top heights shown are retrieved using automated stereoscopic processing of data from several of MISR's cameras. Albedo values are dependent upon the observed cloud radiances as a function of view angle and upon the cloud height field. Cloud height and albedo are among the principle variables governing the influences of clouds on climate.

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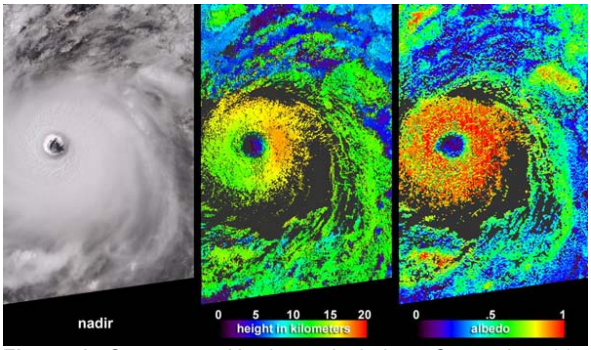

Figure 1. Category 4 Hurricane Isabel on September 11, 2003 as viewed by MISR. From left to right are a true-color nadir image, stereoscopically derived cloud heights and local cloud albedo.

MISR's stereoscopic cloud retrieval method can also distinguish clouds and cloud heights over snow and ice covered surfaces. Figure 2 shows a true-color nadir image of Russia's East Siberian Sea at left and the associated cloud heights at right.

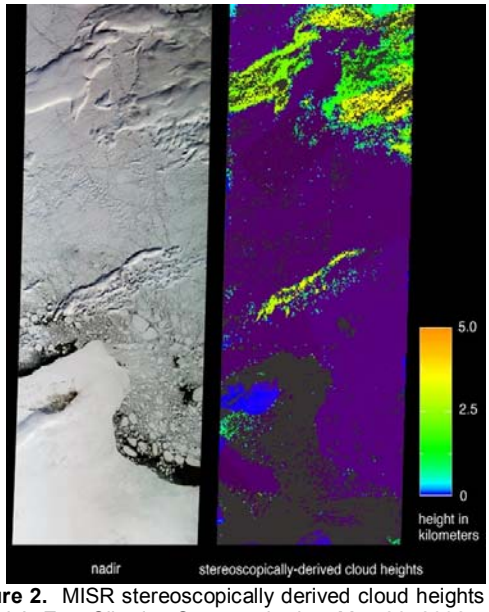

Figure 2. MISR stereoscopically derived cloud heights over Russia's East Siberian Sea acquired on May 28, 2002.

MISR characterizes aerosols from the changes in the atmosphere's ability to transmit light at different view angles and by the variation in scene brightness, as well as by the spectral characteristics of aerosols. Aerosols are retrieved in cloud-free areas only. Figure 3 illustrates the Level 3 2002 annual average global aerosol optical depth.

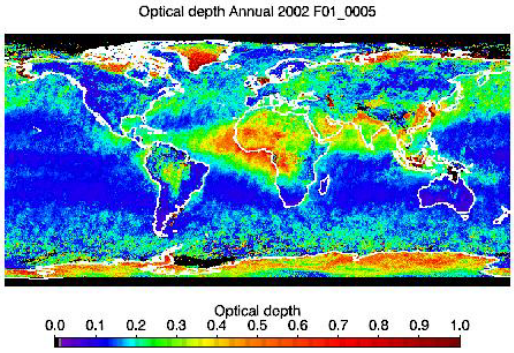

Figure 3. Globally gridded annual average aerosol optical depth for 2002 retrieved from MISR.

3.2 Oceanic

MISR's angular and spectral information can be used to make a unique contribution to sea ice mapping. Older, rougher ice predominantly exhibits backward scattering, whereas younger, smoother ice predominantly scatters in the forward direction. MISR is able to detect these characteristics. The five sea ice types shown in Figure 4 were generated using MISR's angular information in a statistical classification routine and analyzed using ice charts from the National Ice Center.

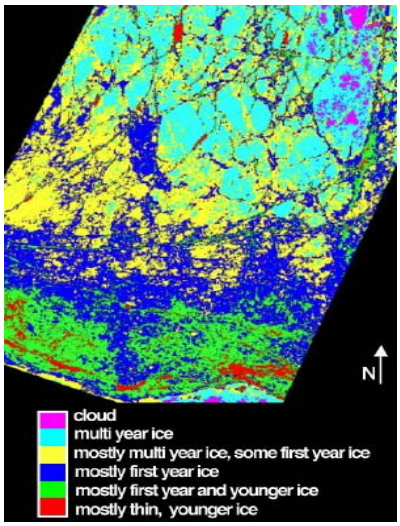

Figure 4. MISR retrieved sea ice classification of the Beaufort Sea off the north coast of Alaska on March 19, 2001.

3.3 Land/Surface

MISR's nine cameras also uniquely view the Earth's surface, providing important surface reflectance and vegetation information. Figure 5 illustrates the 2002 annual average globally gridded directional hemispherical reflectance (DHR) sometimes referred to as the "black-sky" albedo. The DHR refers to the amount of spectral radiance reflected into all upward directions. Accurate surface reflectance is very important in determining the amount of the Sun's energy that is reflected and absorbed by the surface and vegetation.

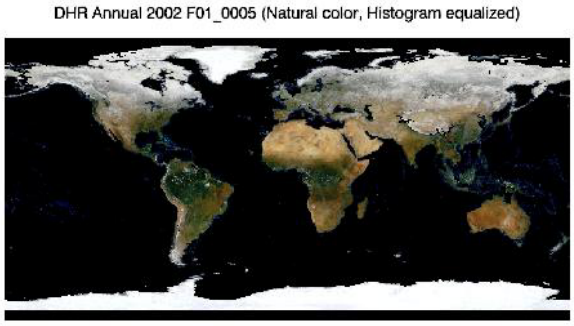

Figure 5. MISR determines the 2002 annual average Directional Hemispherical Reflectance (DHR) or "black-sky albedo".

Another important product that MISR uniquely determines is the Normalized Difference Vegetation Index (NDVI) which is based on the DHR or albedo not the difference of spectral measurements as all other NDVI are derived. Figure 6 illustrates the MISR albedo-derived 2002 annual average NDVI.

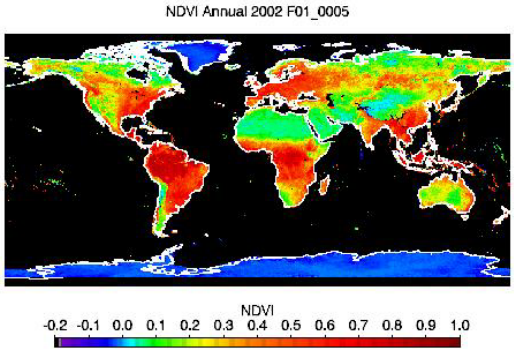

Figure 6. MISR determines the 2002 annual average Normalized Difference Vegetation Index (NDVI) from surface albedo.

4. CONCLUSIONS

MISR provides a unique view of Earth, providing spectral measurement from nine cameras angles. MISR is capable of providing new and unique data products that contribute to many aspects of atmospheric, oceanic and land/surface research.

5. ACKNOWLEDGEMENTS

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