An Assessment of the Impact of the Assimilation of NASA TERRA MISR Atmospheric Motion Vectors on the NRL Global Environmental Model

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In this study, we examine the impact of atmospheric motion vectors (AMV) derived using imagery from the MISR (Multi-angle Imaging SpectroRadiometer) instrument flown onboard the EOS-Terra satellite. The algorithms for the MISR Level 2 Cloud product used in this study retrieve both cloud height and horizontal motion from the apparent displacement due to parallax and movement of cloud features in visible channel (670nm) camera views during a single overpass. Retrievals are redundantly derived from images from banks of four cameras each pointing forward and aft, and then synthesized into a final height-resolved AMV. AMVs derived from the MISR instrument have several unique strengths that are especially relevant for NWP applications. First, the integrated height retrievals are insensitive to radiometric calibration or atmospheric temperature profiles, giving a more accurate height assignment for the AMVs. Second, the cameras capture motion over a 200 second interval, providing an effective 17.6 km gridded resolution. Finally, MISR gives good global coverage up to 85^{o} (depending upon the season (sunlight)), much further poleward than geostationary AMVs.

The MISR winds were assimilated using the global atmospheric prediction system developed by the Naval Research Laboratory. This system is composed of NAVDAS-AR (NRL Atmospheric Variational Data Assimilation System—Accelerated Representer), and the newly-operational Navy Global Environment Model (NAVGEM). The experimental configuration was designed to closely match the FNMOC T359L50 operational configuration. The MISR assimilation runs were initialized at 00 UTC 20 October 2012, 5-day forecasts were initialized from the 00, 06, 12, 18 UTC analyses, and the entire system was run through 00 UTC 15 November 2012. For the initial assimilation test, the MISR wind super-observation generation, quality control and data selection procedures were patterned after those used for geostationary and polar-orbiter AMVs. MISR heights were converted to pressure by horizontally and vertically interpolating pressure to the observed height from the model background geopotential height field on pressure surfaces, the same process used at NRL to convert height to pressure for PIBAL and airborne lidar wind data. The MISR observation errors were identical to those used for other AMVs.

The adjoint-based observation impacts were computed for each 6-hr update cycle, using a global tropospheric moist total energy error norm. For NAVDAS-AR/NAVGEM, Atmospheric Motion Vectors from geostationary satellites dominate the reduction in the 24-hr forecast error. Even so, the MISR AMVs were ranked as seventh most important on a per-observation basis. We plan to further explore MISR wind assimilation through a series of experiments designed to enhance the extraction of information from the MISR winds, and to better understand the complementary nature of the MISR winds.