Imaging Spectroscopy Applications using the DESIS Hyperspectral Instrument on MUSES

William Ray Perkins¹, Rupert Mueller², Emiliano Carmona², Robert E Griffin³, Randy Miller¹

¹Commercial Space, Teledyne Brown Engineering, ²Deutsches Zentrum für Luft- und Raumfahrt (DLR), ³Atmospheric Science, University of Alabama in Huntsville

The DLR Earth Sensing Imaging Spectrometer (DESIS), operated from the Teledyne Multi-User System for Earth Sensing (MUSES), will provide space-based Visible to Near InfraRed hyperspectral data to support scientific, humanitarian, and commercial objectives. The DESIS instrument will be the first commercially available, production-class, space-based imaging spectrometer capable of delivering near-global coverage with long-term, high quality, high spectral resolution data. This will enable significant new research, expand the dimensions of humanitarian crisis response, and provide improved large-scale commercial spectral analytic applications.

Research will include such subjects as non-linear spectral unmixing, sparse signal reconstruction, de-noising and inpainting. Investigations will be conducted for long-term monitoring of ecosystems, habitat restoration and remediation, vegetation development trends, water quality of coastal zones and oceans, as well as raw materials and minerals inventories and snow and ice cover assessment.

DESIS has experimental modes to support additional research, including as an off-nadir along track pointing mirror for BRDF investigations, forward motion compensation studies, and stereo imaging in the hyperspectral domain. These modes allow development of new scientific methods and research applications. Future instruments integrated on the MUSES platform will generate multi-modal data sets to derive new algorithms for data fusion.

Humanitarian applications will include environmental impact assessment in the surroundings of refugee camps to measure land degradation or wood fuel, wetland monitoring for water shortages, change detection under near-real time conditions, vegetation mapping for habitat categorization in the context of health mapping, or mapping of flooded areas. DESIS satellite data with high spectral information and high global revisit time will increase the value of the derived information for humanitarian aid.

The high spectral, medium spatial, and medium temporal resolution of the DESIS instrument will support commercial applications where fine VNIR spectral measurements performed at intervals of weeks to months over moderate to large geographic areas will provide enhanced value. Potential commercial markets include assessments of medium to large-scale crops, forests, and terrestrial environments, as well as marine, ocean, and inland fresh-water monitoring.

Research conducted over the last two decades has established that hyperspectral data can improve the quality and accuracy of vegetation classification, health assessments, and stress indications. Recent research has validated the use of space-based hyperspectral imagery for estuary and inland water monitoring. Fusing the DESIS spectral content with panchromatic, multi-spectral, and radar imagery will enable enhanced analyses across multiple domains within agriculture, forestry, aquaculture, and environmental management.

Teledyne commercial products will initially include calibrated and orthorectified DESIS data registered to Landsat imagery, either as on-demand taskings or from the growing DESIS archive to value added providers, service providers, and end-users. We will expand these offerings using our partnerships with research and development organizations, such as DLR and the University Remote Sensing Consortium of Alabama, to move validated research applications into commercial production for vertical markets.