Improving Scene Classifications with Combined Active/Passive Measurements

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The uncertainties in cloud and aerosol physical properties derived from passive instruments, such as MODIS, are not insignificant. And the uncertainty increases when the optical depths decrease. Lidar observations do much better for the thin clouds and aerosols. Unfortunately, space-based lidar measurements, such as the one onboard CALIPSO satellites, are limited to nadir view only and thus have limited spatial coverage.

To produce climatologically meaningful thin cloud and aerosol data products, it is necessary to combine the spatial coverage of MODIS with the highly sensitive CALIPSO lidar measurements.

Can we improving the quality of cloud and aerosol remote sensing data products by extending the knowledge about thin clouds and aerosols learned from CALIPSO-type of lidar measurements to a larger portion of the off-nadir MODIS-like multi-spectral pixels? To answer the question, we studied the collocated Cloud Physics Lidar (CPL) with Modis-Airborne-Simulation (MAS) observations and established an effective data fusion technique that will be applied in the combined CALIPSO/MODIS cloud/aerosol product algorithms.

This technique performs k-mean and Kohonen self-organized map cluster analysis on the entire swath of MAS data, as well as on the combined CPL/MAS data at the nadir track. Interestingly, the clusters generated from the two approaches are almost identical. It indicates that the MAS multi-spectral data may have already captured most of the cloud and aerosol scene types, such as cloud ice/water phase, multi-layer information, aerosols, aerosol/cloud mixes, ... The difficulty is that it is very difficult to label the clusters based on MAS data along, especially over high reflecting surfaces. On the other hand, we can easily label the track-only, combined CPL/MAS pixels, with the extra information from CPL. The clusters generated from MAS data (CLUSTER-MAS), are matched to the closest CPL/MAS clusters (CLUSTER-COMBINED), so that we can label (identify) the MAS clusters CLUSTER-MAS using the CLUSTER-COMBINED labels from the information-rich CPL/MAS combined measurements.

The results show that we can effectively perform good cloud and aerosol scene type classifications on the entire MAS swath with this approach.

Reconfigurable computation, a new computational concept using FPGAs, has been

investigated for real-time implementations of fast operational clustering analysis and will be introduced here as well.