Developing an automated tool for nowcasting dust and sand storms in desert environment using SEVIRI-MSG Data

Due to their low precipitation rates, arid regions are the world's major source of atmospheric dust that has an impact on local, regional and global climate. Dust and sand storms create potentially hazardous air quality to humans, and adversely affecting climate on a regional and world-wide scale. In addition to its direct effect on surrounding air quality, excessive presence of airborne dust affects both local and regional environments due to its biogeochemical impact on the ecosystem and its radiative-forcing effect on the climate system.

Remote sensing has shown to be a valuable tool in detecting, mapping and forecasting such events. Application of geostationary and polar orbiting remote sensing in dust and sand storms has been widely investigated in the past two decades. However, retrieving dust and sand storm properties over their originating location (i.e., desert, arid and semiarid regions) using conventional visible and near-infrared wavelengths becomes a difficult task because of the bright underlying surfaces over such regions. These special properties, limit the application of conventional sandstorm detection techniques to dark surfaces (i.e. water, vegetation, dark land) downwind of the source region limiting the time response in detecting these hazardous events over the originating area. To overcome this limitation, several approaches have been developed to retrieve aerosol optical properties over bright land surfaces such as desert. Most of these techniques use the sensor multi spectral properties by selecting highly contrasted areas as reference targets. This approach has shown low efficiency when applied over large and homogenous bright areas like desert with limited land cover variations. Thermal channels have also been used in detecting and mapping aerosols over desert. The thermal-based approaches use the comparison between thermal properties of mineral aerosols and the background temperature and water vapor signals. These techniques have shown some limitations due to the difficulties in separating aerosols from terrestrial environment, particularly over desert and semiarid regions. The NASA daily aerosol mapping tool, Geovanni, is also limited to aerosol retrieval over ocean and dark land surfaces.

A thermal-based technique has been developed in this study. The developed technique uses the difference in particle size between airborne dust and surface sand to detect airborne dust over desert. Previous similar studies have observed strong differences in infrared emissivity between airborne dust particles, with size less than 5 μm, and desert sand particles, with diameter greater than 70 μm. This difference in thermal behavior was used in this study to detect the presence and map the extent of airborne dust over the study area. Several well documented dust storm events that occurred between 2008 and 2009 will be used to calibrate and validate the developed tool. Due to their high temporal resolution, geostationary data from METEOSAT SEVIRI-MSG was used in this project. The preliminary results have shown a great potential of this approach in detecting airborne dust and sand over desert area.