Middle East Health and Air Quality:

Using NASA EOS in the Arabian and Sahara Deserts to Examine Dust Particle Size and Spectral Signature of Aerosols

NASA DEVELOP
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It's estimated that up to 2 million metric tons of arid soil is transported through the atmosphere each year. According to the Environmental Protection Agency, airborne particulate matter below 2.5 micrometers can cause long term damage to the human respiratory system. Community concerns of this research are focused on the respiratory health of American service members as a significant number of them are unable to meet physical fitness requirements upon returning home from deployment to Iraq. Our project partners include the U.S. Naval War College, the U.S. Army Corps of Engineers, and the U.S. Geological Survey. We hope to enhance the decision making process of our partners by utilizing NASA EOS to provide more effective measures of monitoring atmospheric conditions that may impact the health of servicemen and women.

Using NASA EOS to calculate Brightness Temperature Different

Before we can examine EO-1 Hyperion imagery for a mineral analysis, of dust storms. We first have to identify a dust storm and that can be challenge. Because what you look through imagery isn't always what's actually there on the ground. So we went through MODIS data looking at natural color composites for a sizeable dust storm. As you can see here this is obviously a very large dust storm. But we wanted to be more sure than that. So we used an index what they called brightness temperature difference. That can distinguish the dust from clouds or any other kind of aerosol so we can be absolutely sure that regions of interest we examine on EO-1 Hyperion weren't clouds or any other kind of materials. So as you can see here on this yellow swath which represents the hyperion scene its definitely over a major part of the dust storm, but the center part isn't. this helped us not only verify this is a dust storm, but to know that the polar ends of this scene were the ones we want to analyze for mineral content.

Using NASA EOS to examine mineralogy of aerosols in dust storms.

Several of the minerals endemic to soils in the Arabian Peninsula have been linked to human respiratory illness. Hyperspectral information collected by the Hyperion sensor on board NASA's EO-1 satellite can be used to identify the spectral signatures of particulate minerals within dust storms. Using the Spectral Angle Mapper utility within ENVI image processing software, observed pixel spectral from an april 17th 2008 dust storm were compared to spectra sourced from the Jet Propulsion Laboratory Spectral Library. Here we can see the spectral signatures of 10 observed minerals within the dust storm. And over here we can see the distribution of each mineral within the Hyperion image.

Using NASA EOS to analyze particle size of aerosols in dust storms.

Particle size was estimated apply the Angstrom Exponent equation using NASA's MODIS and SeaWiFS data. If the value from Angstrom Exponent is large, then the particle size is small. The values range from -1 to 5. The darker values as seen here in the Sahara desert represents large particles and the lighter greens represents here and here in the Arabian Desert represents small particles. The other equations we used was Aerosol optical depth which represents visibility. The higher the AOD value, the lower the visibility. These values can range from 0.5 to 5. An AOD value of 3 or higher indicates an area of zero visibility. As you can see here the darker blue values in the Sahara Desert represents low visibility the even darker blue values represented here in the Arabian Desert represents zero visibility

Based on our results, the Sahara and Arabian Deserts are different. Out of the nine minerals studied with the hyperspectral data were similar, the vermiculite. Particles sizes were smaller in the Sahara desert when compared to the Arabian desert. Future work would be comparing our results from this term with other deserts. For example, Sonoran Desert in the SouthWestern United States and the Gobi Desert in Mongolia and China.