Data-intensive multispectral remote sensing of the nighttime Earth for environmental monitoring and emergency response

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Most of the remote sensing applications rely on the daytime visible and infrared images of the Earth surface. Increase in the number of satellites, their spatial resolution as well as the number of the simultaneously observed spectral bands ensure a steady growth of the data volumes and computational complexity in the remote sensing sciences.

Recent advance in the nighttime remote sensing is related to the enhanced sensitivity of the onboard instruments and to the unique opportunity to observe “pure” emitters in visible infrared spectra without contamination from solar heat and reflected light. A candidate set of the night-time emitters observable from the low-orbiting and geostationary satellites include steady state and temporal changes in the city and traffic electric lights, fishing boats, high-temperature industrial objects such as steel mills, oil cracking refineries and power plants, forest and agricultural fires, gas flares, volcanic eruptions and similar catastrophic events. Current satellite instruments can detect at night 10 times more of such objects compared to daytime.

We will present a new data-intensive workflow of the nighttime remote sensing algorithms for map-reduce processing of visible and infrared images from the multispectral radiometers flown by the modern NOAA/NASA Suomi NPP and the USGS Landsat 8 satellites. Similar radiometers are installed on the new generation of the US geostationary GOES-R satellite to be launched in 2016.

The new set of algorithms allows us to detect with confidence and track the abrupt changes and long-term trends in the energy of city lights, number of fishing boats, as well as the size, geometry, temperature of gas flares and to estimate monthly and early flared gas volumes by site or by country.

For real-time analysis of the nighttime multispectral satellite images with global coverage we need gigabit network, petabyte data storage and parallel compute cluster with more than 20 nodes. To meet the processing requirements, we have used the supercomputer at the Kurchatov Institute in Moscow.