A Streaming Tensor Decomposition Analysis of of a Multi-Ceilometer Based Lidar Aerosol Network.

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Abstract

Aerosols are collections of suspended solid or liquid particles in the gaseous atmosphere, such as dust, sulfates and nitrate molecules, black and organic carbon, sea salt ocean droplets that can absorb and scatter solar radiation, act as nuclei in forming liquid rain and ice droplets in clouds, influence local convective storms, tropical cyclones and can destabilize the planetary boundary layer height (PBLH). Aerosol observations are required on an hourly basis to follow the changes in the PBLH. Multiple satellite-based instruments are becoming available to observe aerosol distributions. However, they still mostly measure total-column quantities or vertical profiles with low-resolution near the ground, limited frequent coverage leading to a difficult task of untangling the Planetary Boundary Layer information from the column measurement. We have built a multi-sensor ground-based observatory network of ceilometer instruments distributed over the US which provide near real-time, streaming of high-resolution aerosol profiles up to 15km from the ground. We propose to use a novel tensor decomposition method to analyze the stream of aerosol profiles. The streaming tensor decomposition method enables one to analyze Mixed Boundary Layer Height (MBLH) acquired from our observation network in near real time and over long time data archive records. The tensor has been formed using 3 dimensions, a station site location, time of day and day with a value of the MBLH derived from a machine learning holistic edge detection algorithm. The normalized output results from the tensor decomposition method consist of high order tensors components with coefficients analogous to eigenvalues. We will show the time dependence of the dominant components of MBLH. These dominant components will show the correlations of MBLH over 24 hours over multiple regions. We can also use tensor decomposition to analyze climate data records of MBLH (monthly, seasonal or annual).

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ABSTRACT

Aerosols are collections of suspended solid or liquid particles in the gaseous atmosphere, such as dust, sulfates and nitrate molecules, black and organic carbon, sea salt ocean droplets that can absorb and scatter solar radiation, act as nuclei in forming liquid

BACKGROUND WORK

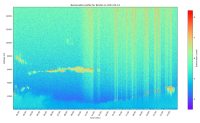
Evaluated implementation of SPLATT (Surprisingly ParalleL spArse Tensor Toolkit) on a set of 10 tensors from the FROSTT (The Formidable Repository of Open Sparse Tensors and Tools) collection, a set of tensors taken from scientific and data analytic

DATASET

- Three ceilometer stations (Bristol,Crownpoint, Blacksburg) based aerosol backscatter profiles for 1 month
- • Data: continue monitoring/streaming/archiving 3 ceilometers' data

Site name	Total size of the dataset
Crownpoint	3.42 GB
Blacksburg	3.04 GB
Bristol	1.21 GB

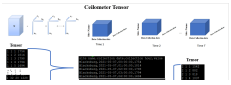
- Bristol aerosol backscatter profile



- Crownpoint aerosol backscatter profile

METHODS

- Tensor parser package is used to convert three ceilometer sites .csv file data in to sparse tensor to get .tns and .map files



RESULTS

3 ceilometer network to 31 days, 24 hours and 3 stations :---

Rank 3 decomposition for night time with Lambda values

3.487796e+04

8.348548e+03

8.666932e+03

CONCLUSION

- We have conducted and tested a scalable, secure, streaming prototype network for in-line processing and analysis of ground and space LIDAR aerosol backscatter profile concentrations.
- We performed a streaming application of planetary boundary layer heights from a distributed system of ceilometers along the East coast from PA, MD to VA and