An Investigation into Weather's Effect on Aerosol Particles Using WRF and MAPSS

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Abstract

Aerosols are solid or liquid particles suspended in air or gas. Many processes contribute to increased aerosol particles in the atmosphere, such as winds, ocean waves, and industrial exhaust. Once suspended, particles can be carried thousands of miles before being returned to the ground by gravity or rain. Some particles can be suspended for several years and travel all around the world, these particles have the greatest impact on climate and weather.

In this research, we examine the effects of weather phenomenon on the distribution of aerosol particles. Our work method involves using NASA's MAPSS database alongside NOAA's WRF software. Our work-environment for this research is on OU's Schooner system. We plan to conduct a historic study of the Tsunami that struck Fukushima in 2011, as well as a local study of the Stillwater area. We expect our results to show that weather events play a substantial part in the distribution of aerosol particles.

In summary, we expect to not only show that weather events impact aerosols distribution, but to also use simulations to make predictions. This has potential applications in predicting fallout zones and ensuring air quality of populated areas. This material is based upon work supported by the National Aeronautics and Space Administration under Grant No. NNX15AK02H NASA Oklahoma Space Grant Consortium.

Work Plan

After an initial research period, the project will begin by setting up a work environment on OU's Schooner system. We are working in conjunction with Gerry Creager of NOAA's National Severe Storm Laboratory to create our work environment. Schooner will allow us to run WRF simulations both historical and live. We will then be able to use MAPSS to graph data to validate the simulations. We will then use a historical case to validate our methods before moving on to live events.
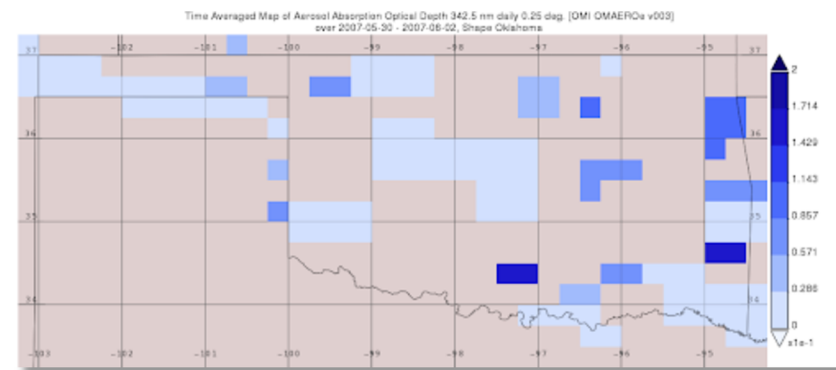
What is MAPSS?

- Multi-sensor Aerosol Products Sampling System (MAPSS)
- MAPSS uses satellite sensors to collect aerosol data.
- The sensors include AERONET, MODIS, MISR, OMI, POLDER, CALIOP, and SeaWiFS.
- MAPSS is used to confirm and compare data across the different sensors by checking satellite data against ground stations.
- MAPSS is open to the public and thus allows scientist and researchers across the world to use the collected data.

What is WRF?

- The Weather Research and Forecasting model (WRF) was created by the National Center for Atmospheric Research (NCAR).
- The software works to model a large range of meteorological events.
- It functions as a forecasting application and supports atmospheric research.
- The software has several extensions to allow for the study and modeling of the water cycle, wildfire, airborne chemicals, and more.

Aerosol Absorption Depth 342.5 mm

Time Averaged Map of Aerosol Absorption Optical Depth 342.5 nm daily 0.25 deg. [OMI OMAEROa v003] over 2007-05-30 - 2007-06-02, Shape Oklahoma
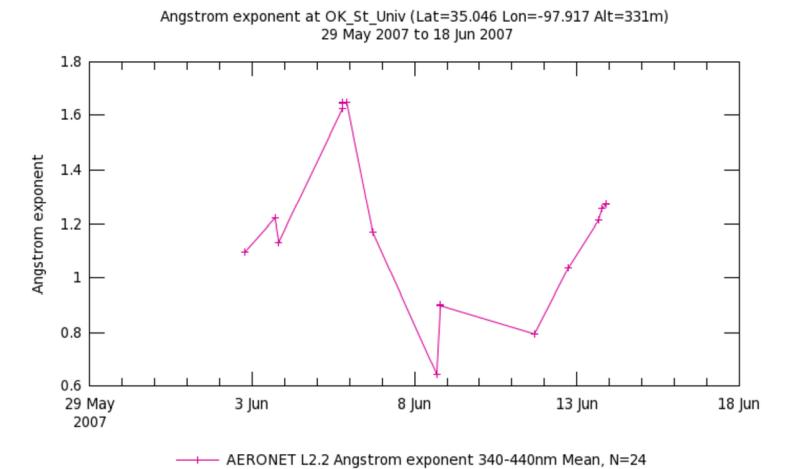
Project Outline

- Establish a work environment in OU's Schooner system for running WRF.
- Compare MAPSS aerosol data with WRF simulation predictions in a defined area, time, and particle size.
- Investigate the 2011 Fukushima weather and nuclear reactor event as a historical case study.
- Use the National Weather Service's Monthly Storm Data Reports to select local weather events for running in WRF.
- Examine an area in the Stillwater Oklahoma as a local data source.
- Continue research into various local regions and move toward using live data.
- Explore the possible applications of this technique for fallout prediction and environmental protection.
- Potentially expand the project to include Mesonet stations and other sensors from NASA's Giovanni database.

MAPSS Angstrom Exponent Graph

Angstrom exponent at OK_St_Univ (Lat=35.046 Lon=-97.917 Alt=331m) 29 May 2007 to 18 Jun 2007
AERONET L2.2 Angstrom exponent 340-440nm Mean, N=24

Moving Forward

As we are nearing the end of our initial research, we expect to have WRF running on Schooner soon. We are examining Fukushima first as it has been heavily studied and document. This will allow us to easily validate our work and serve as a base for our research.

Next, we have already selected the days leading up to and following June 1st, 2007 as the target our study of Stillwater. This time period had a severe weather event containing high winds, hail, and lightning. Stillwater was selected because it is within range of a Mesonet station that has an industrial area nearby. By studying these two events we hope to find correlation between Aerosol distribution and extreme weather events. This could prove helpful in many ways to farming, city planning, and more.

Works Cited

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