North America health and air quality

Utilizing Remotely Sensed Atmospheric Infrared Sounding Data for Near-Real-Time Air Quality Applications in Health Assessments and Pollutant Regulation

Amanda Schochet (University of California, San Diego), Julie Sanchez (California State Polytechnic University, Pomona), Mark Barker (California State University, Northridge)

Jet Propulsion Laboratory

Abstract

Large cities and urbanized areas tend to have significant air pollution problems due to human activities which produce aerosols and toxic chemicals. While it is known to the average citizen that most cars and factories are a source of these pollutants, very few know about the hidden atmospheric phenomena that concentrate this pollution. Two of the most significant pollution focusing processes are Temperature Inversions and Ozone Intrusions. Temperature inversions prevent vertical atmospheric mixing, which leads to higher concentrations of aerosol pollution at a given locale. Higher concentrations of atmospheric pollutants that accompany temperature inversions lead to acute respiratory problems for sensitive individuals Stratospheric ozone intrusions result in high ozone levels in the troposphere, which can damage lung tissue and causes other respiratory problems, as well as vegetation damage. Our study focused on areas within North America with known high levels of pollution, such as Los Angeles, California and Hamilton, Ontario. We used Level 2 and Level 3 products from the Atmospheric InfraRed Sounder (AIRS) Version 6, to investigate temperature inversions and ozone intrusions in North America. By processing Aqua/ Atmospheric InfraRed Sounder data in ArcMap, and increasing spatial resolution with local radiosondes and data from Aqua/ Moderate Resolution Imaging Spectroradiometer (MODIS), we developed maps highlighting areas that can potentially be hazardous to human health. Our analysis incorporates previously studied temperature inversion factors such as the weekend effect and seasonal variations. The resulting maps are designed to be simple and easily accessible to the general public while maintaining information that is relevant to health and policy decision-makers.

Objectives

- Create temperature inversion and ozone intrusion maps that allow individuals and professionals to better assess air quality health risks
- Develop methods and tutorials for using AIRS Level 2 and Level 3 data in ArcMap
- Use North American weather forecasting models and radiosonde information to confirm the maps
- Create a validated methodology for mapping temperature inversions that can be extended to parts of the world without forecasting models

Methodology

Obtain AIRS Standard Retrieval data from Mirador

Focus was on Version 6 (V6) Level 2 (L2) and Level 3 (L3) data products. Daily, eight-day, and monthly temperature data used from 2013 and 2014

Ozone Intrusions (in progress)

Downloaded AIRS L2 ozone and standard pressure data

Displayed ozone data in ArcScene, using standard pressure as the height.

Temperature Inversions

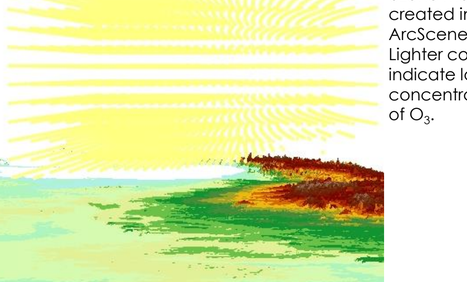
Temperature was found at a given pressure level by extracting specific bands from a principal raster layer of AIRS L3 temperature data in ArcMap

For each calculation Surface temperature was a single raster layer that was repeatedly used

The following algorithm was used in raster calculator to identify inversions:

$$Air\ Temperature\ at\ Surface - Air\ Temperature\ at\ 850\ hPa$$

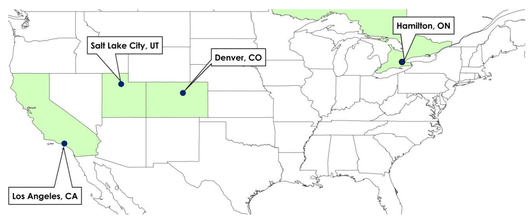
$$6000\,\frac{log(Surface\ Pressure)}{850}$$



Maps are mainly based on inversions found at 850 hPa. With higher land elevations, temperature data cannot be collected at that pressure

Surveyed the topography and elevation to decide whether to add temperature data at a higher level to fill the gaps

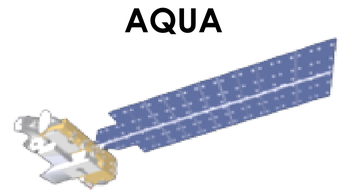
Study Area



The study area consists of the mainland U.S. and major populated cities within it; Los Angeles, Denver, Salt Lake City

Earth Observations

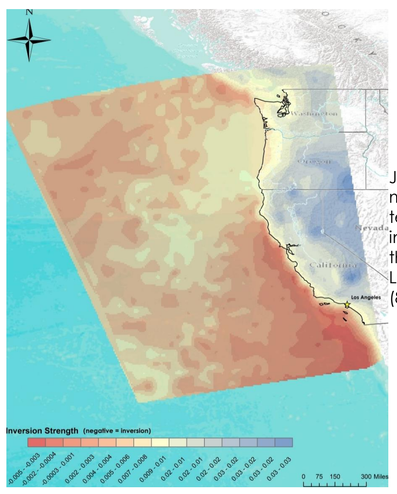
AQUA



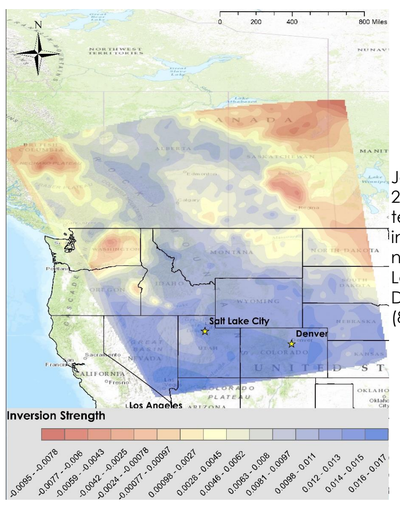
AIRS (Atmospheric Infrared Sounder), MODIS (Moderate Resolution Imaging Spectroradiometer)

Results

Temperature Inversions



June, 8 2014 map of temperature inversions of the coast of Los Angeles. (850hPa)



January 25, 2014 map of temperature inversions north of Salt Lake City and Denver. (850hPa)

Ozone Intrusions

Image from 3d ozone model created in ArcScene. Lighter colors indicate lower concentrations of O_3.

Conclusions

- AIRS data can be used to identify temperature inversions on national or regional levels.
- The resulting inversion maps will give medical researchers and professionals an additional tool for identifying risks to people with respiratory problems.
- AIRS smooths temperature data across changes in altitude, so inversions that occur very close to the Earth's surface, or within a small change in altitude, may not be observed.
- Future steps can incorporate MODIS and topography data to increase the sensitivity and accuracy of the maps.

Team Members

(Left to Right)Julie Sanchez, Mark Barker and Amanda Schochet

Project Partners

Dr. Julie Wallace at the Firestone Institute for Respiratory Health

Kevin Durkee at the South Coast Air Quality Management District

Dr. Anthony Reale at the NOAA Center for Satellite and Applications Research

Dr. Daniel Jacob at the NASA Air Quality Applied Sciences Team

Acknowledgements

- Tom Pagano, Sharon Ray, Dr. Bjorn Lambrigtsen, Dr. Eric Fetzer, Dr. Evan Fishbein, Dr. Brian Kahn, Dr. Sun Wong of the AIRS team
- Kevin Durkee at SQAMD, Dr. Daniel Jacob at NASA AQAST, and Dr. Anthony Reale at NOAA, and Julie Wallace at the Firestone Institute for Respiratory Health,
- Christine Rains and Scott Barron at NASA DEVELOP