

Visualizing Aerosol Pollution with Google Earth

Graham Shapiro

Advisor: Bin Yu

Overview

Google Earth is a geographical data visualization application that is capable of presenting interactive 3-Dimensional photo-realistic renderings as well as animations at any location on a virtual globe. Google Earth visualization has been applied successfully to many applications such as visualizing Earthquake Data¹, Ocean Currents² and Asset Tracking³. The means to produce such impressive visualizations is made possible by a set of open data format specifications called the OpenGIS KML Encoding Standard⁴. The core of this data specification is the KML file format which is based entirely on XML. The challenge of the current research project was to produce visualizations of aerosol pollution data collected from ground as well as satellite sources which were compiled together using MatLab. Fortunately, MatLab provides all the necessary tools to format and assemble Google Earth data files.

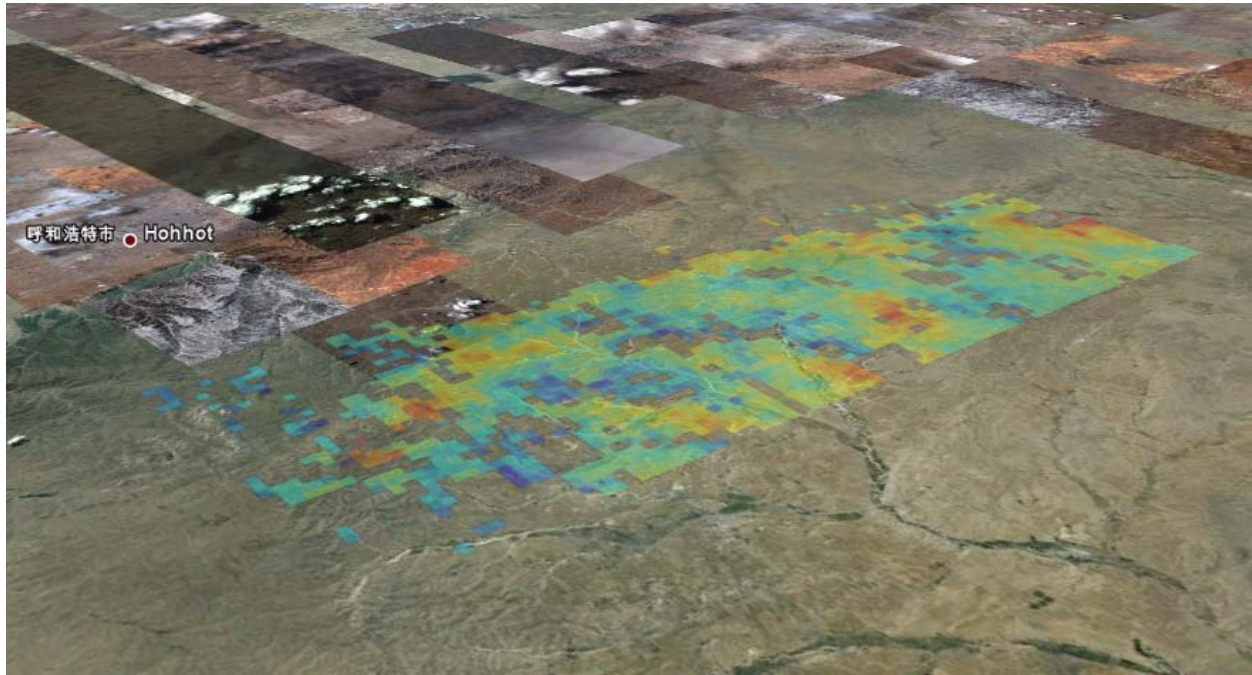
The data from which the visualization were made were matrices of varying dimensions of optical depth readings. The entries in each matrix correspond to a grid of physical locations which were specified by pairs of coordinates, one for each corner of the spatial grid. The spatial grid can be extended temporally into an animation by adding an extra dimension to the data matrix. Additionally point data was also plotted using three dimensional markers whose dimensions varied depending on the intensity of the measurements taken at each location. All these visualization were done in Google Earth produced directly from MatLab. The code as well as examples have been made available for viewing at <http://www.shapiro.gs/VIGRE/>.

Visualizing a Spatial Grid

The first task was to visualize a spatial grid of satellite optical depth measurements in the Beijing Metropolitan area. The focus of this task was to write a MatLab function which takes as input a data grid in the form of a matrix as well as Latitude and Longitude points and produces an output file that can be opened with Google Earth.

The visualization of a MatLab matrix in Google Earth was accomplished in two primary steps. The first step was to construct an XML document specifying how the data should be displayed. Next a separate image file is constructed from the matrix data. MatLab offers a variety of color scales that provide a convenient tool for mapping normalized measurement values to RGB color values. Also if partial or full transparency is desired at specific points in the visualization an Alpha channel is produced accordingly. Additionally on screen legends were also created. After all the files have been produced successfully they are zipped together into a KMZ file.

FIG. 1 – Satellite Optical Depth Grid Visualization



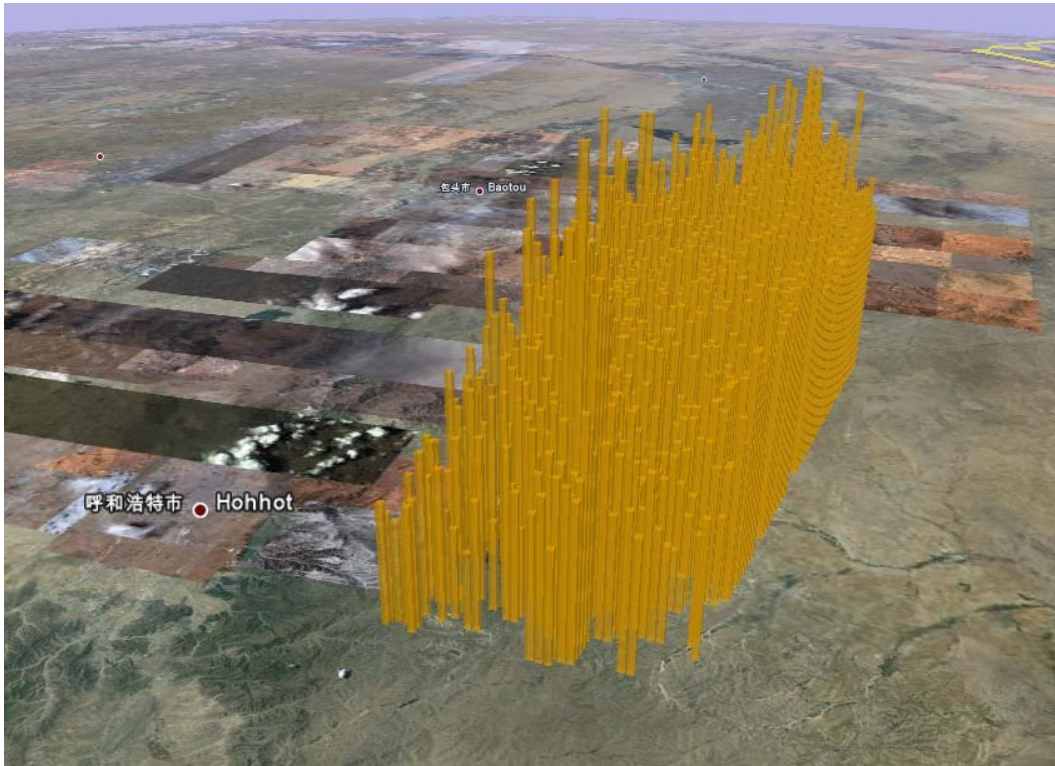
Visualizing an Animated Spatial Grid

The procedure for visualizing a single ground overlay can be extended to produce animated sequences. This is accomplished by creating many ground overlay elements each with a date and time property specifying when each frame begins and ends.

Visualizing Point Data with 3D Markers

An intuitive way of visualization point data is by using 3-Dimensional markers. This is accomplished in Google Earth by using placemarks which are rendered using a simple geometric shape such as a cone or a cylinder. Each placemark has a latitude and longitude as well and a scale property that specifies the size of the marker to be displayed. This is useful for depicting the level or degree of the measurement being visualized. For aerosol readings the marker was scaled in the vertical dimension to depict a large optical depth reading at a specified location.

FIG. 2 – Satellite Optical Depth 3D Bar Visualization



The final results of this visualization project not only produced vivid depictions of aerosol pollution that can be easily interpreted and understood, it also resulted in a set of reusable functions capable of generating similar visualizations in the future more quickly as well as from a variety of other spatio-temporal data sources.

Sources and Citations

³Google Inc. - Google Maps API Premier CASE STUDY - GTX Corp brings personal location-based services to the masses with Google Maps API Premier
http://static.googleusercontent.com/external_content/untrusted_dlcp/earth.google.com/en/us/enterprise/pdf/gtx.pdf

⁴Google Inc. - OpenGIS® KML Encoding Standard Reference
<http://code.google.com/apis/kml/documentation/kmlreference.html>

²National Oceanic and Atmospheric Administration - NOAA Dives into Ocean in Google Earth
http://www.noaanews.noaa.gov/stories2009/20090202_googleocean.html

¹Northern California Earthquake Data Center - Northern California Earthquake Catalog Search
<http://www.ncedc.org/ncedc/catalog-search.html>