NOAA's National Geodetic Survey

Sky View Analysis

Who is NOAA/NGS?

The National Oceanic and Atmospheric Administration (NOAA) is the nation's oldest scientific agency dating back to 1807 when Thomas Jefferson created the Survey of the Coast. This agency was created to assist the United States of America to help increase commerce by providing maps of the land, shore and waterways to assist shipping, the main form of commerce, and avoid ship wrecks. NOAA's mission is Science, Service and Stewardship, to understand and predict changes in climate, weather, oceans, and coasts; to share that knowledge and information with others; to conserve and manage coastal and marine ecosystems and resources.

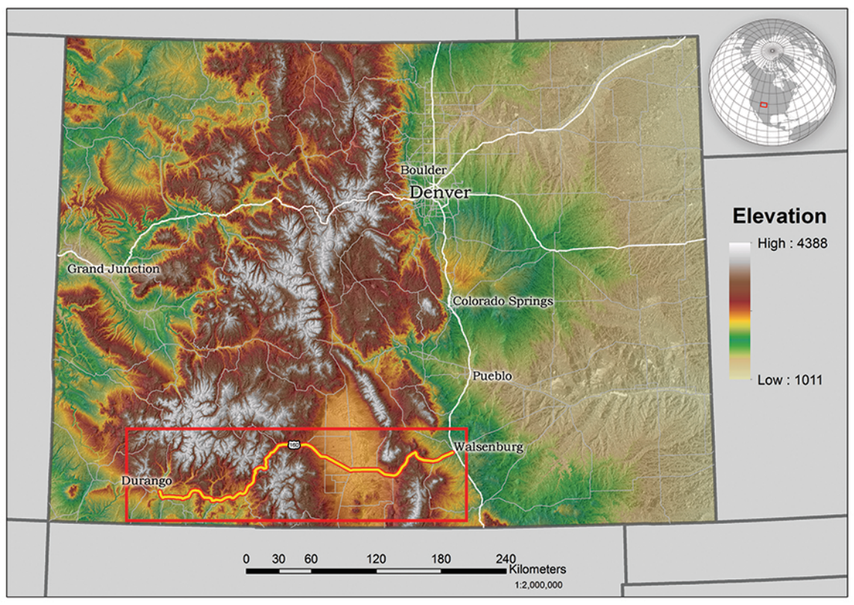
The National Geodetic Survey (NGS) is a program office within NOAA's National Ocean Service. NGS defines the position and height framework for the US and all its territories by developing the official US datums, and geoid models used for positioning. NGS' mission is to define, maintain and provide access to the National Spatial Reference System (NSRS) to meet our nation's economic, social, and environmental needs. One critical component of the NSRS is the determination of "height" --specifically ellipsoid height, orthometric height and dynamic height -- of any point in the United States or its territories. These surveys will greatly assist NGS in providing more accurate geoid models for determining or computing heights.

http://geodesy.noaa.gov

Sky View Scripts

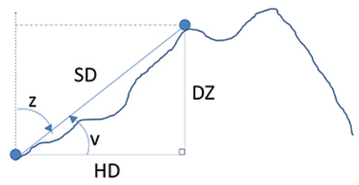
This year NGS has begun planning for a GPS survey that will be located in moountainous terrain. The quality of geodetic positions determined by GPS improves with increased sky visibility and is defined by Dilution of Precision (DOP). Mountains block GPS satellite visibility, limiting signal reception. The Sky View python script tool was created to help evaluate potential routes and to help locate ideal sites for setting new marks once a route is selected. This tool provides valuable GPS solution quality measures by using an input set of points with latitude and longitude and a DEM to estimate the "Sky View" for all submitted points. This tool outputs text files for each point with the maximum vertical angle for every azimuth. These files are then used as input into another script that calculated the average DOP over 24 hours for all points to estimate how the steep mountains and canyons will impact the sky view and GPS data collection.

The script tool was created for this particular project but it can easily be used to help perform preliminary analysis for the planning of any GPS survey. Two sites were selected along Highway 160 in Colorado and GPS data was collected to help evaluate the accuracy of the tool. The plots below show that the tool performed very well excluding areas where trees were close to the road, steep canyon walls or both.



Calculating the Angle

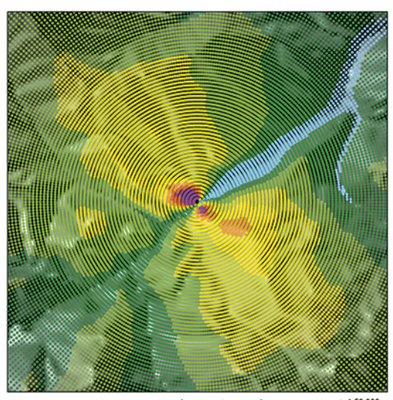
To calculate the maximum vertical angle for each azimuth it was necessary to calculate several variables including; horizontal distance (HD); slope distance (SD); elevation difference (DZ); zenith angle (z); and vertical angle (v). Determining the maximum vertical angle along an azimuth provides the maximum angle of an obstruction using a DEM. This does not account for trees and vegetation since these caclulations only used the DEM to determine elevations.

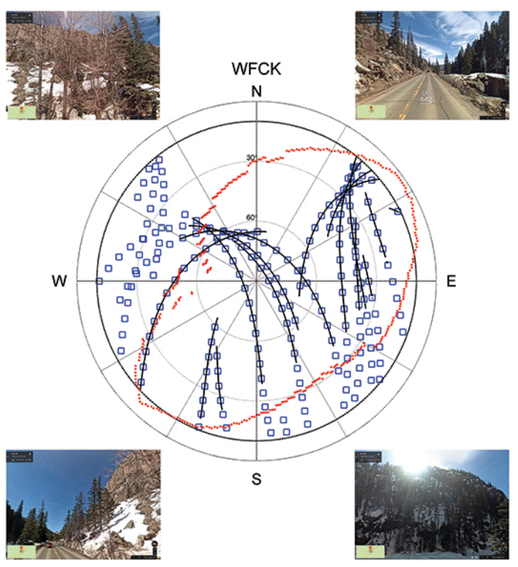


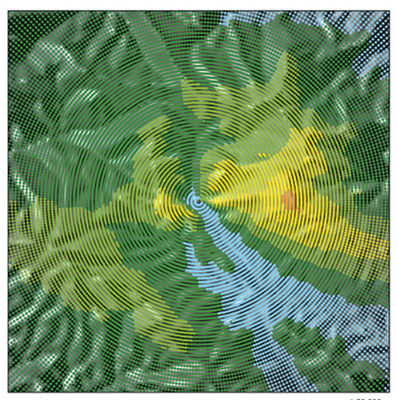
Calculations: Knowns: Point coordinates (x,y,z)
Horizontal Distance (HD) – calculated from distance between points
Height Difference (DZ) – calculated from difference in elevations
Slope Distance (SD) = sqrt(HD**2 + DZ**2) – Pythagorean theorum
Zenith Angle (z) = z = arccos(dz/sd) or arcsin(hd/sd) or z = arctan(hd/dz)
Vertical Angle (v) = 90 - z

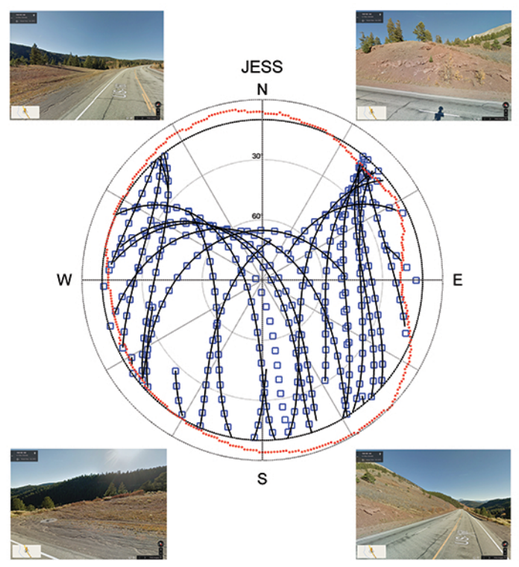
Test Sites Map and Plots

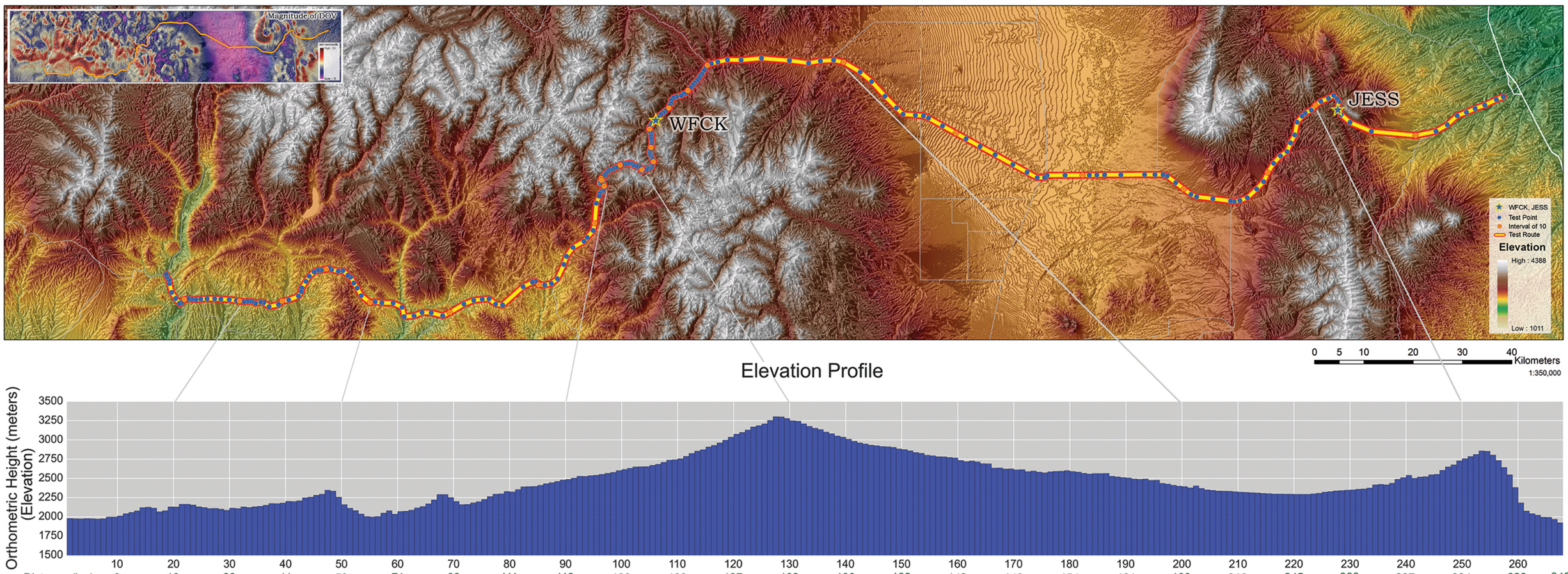
The maps and polar graphs to the right were created using data output from the Sky View python script tool. The two points were selected to evaluate different conditions along the route. For every point input into this tool the script creates points radiating out at every azimuth [0-360] to determine what the maximum vertical angle for each azimuth is. You can see that the colors of the vertical angle generally follow the topography in the area. From looking at the Street View pictures you can see the features that partially obstruct the sky view, particularly the mountains and canyons next to point WFCK. While point JESS does have mountains in the shots, they are in the distance and do not obstruct the sky view.

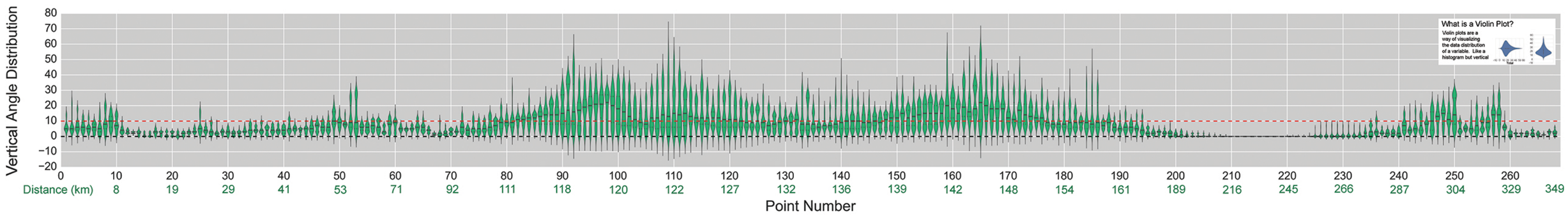












National Geodetic Survey
National Ocean Service
National Oceanic and Atmospheric Administration
United States Department of Commerce

By: Brian Shaw, Andria Bilich
Created for: Esri International User Conference 2015
Data Sources: NOAA, USGS, U.S. Census, Esri, Google
Datum: North American Datum of 1983 (2011)
Projection: USA Contiguous Lambert Conformal Conic