GEOS-5 Mobile Application

Joseph Clamp[1], Daniel Duffy[2], and Bill Putman[3], *(1) Pennsylvania State University, College of Earth and Mineral Sciences, 201 Old Main, University Park, Pennsylvania 16802*, (2) *NASA Center for Climate Simulation, NASA Goddard Space Flight Center*, *(3) Global Modeling and Assimilation Office, NASA Goddard Space Flight Center*

Introduction & Background:

The Global Modeling and Assimilation Office (GMAO) at NASA Goddard Space Flight Center (GSFC) has created the Goddard Earth Observing System, Version 5 (GEOS-5) which is a system of global models that are integrated with the Earth System Modeling Framework (ESMF)[1]. Using this application, the GMAO produces forecasts for weather, climate and environmental data. The main purpose of GEOS-5 is to support NASA's earth science research, observing system modeling and design, climate and weather prediction, and basic research[1]. GEOS-5 produces forecasts four times each day (0Z, 6Z, 12Z, 18Z). The forecasts run out 240 hours for 0Z runs, 120 hours for 12z runs and 33 hours for 6Z and 18Z runs. The data has a resolution of 1/2° x 1/3° and forecasts for over 50 total variables in each run.

The purpose of this project is to create a mobile application that will allow users to visualize key GEOS-5 forecast variables. These variables include total column ozone, sulfate AOT, total aerosol AOT, organic carbon AOT, total precipitation, relative humidity, temperature and more. Currently, there is no mobile application that delivers GEOS-5 data to the public for viewing. Further, no existing mobile weather applications provide forecasts for aerosols (such as carbon). This project fills both of those gaps by utilizing data produced by GEOS-5 to develop an interactive mobile application for visualizing forecast output. With mobile devices continuing to become an integral part of everyday life, it is important to give users the ability to view GEOS-5 data on their phone. This project aims to accomplish exactly this for scientists and the public that rely on GEOS-5 forecasts.

Development:

The front-end of the mobile application was developed using Ionic[2], which is a hybrid framework that allows for one app to be deployed on all mobile platforms. Through Ionic the app will run on iOS and Android when released. Ionic utilizes Angular JS and HTML to accomplish cross-platform development of apps. The application uses Leaflet[3], a mapping library similar to Google Maps, to overlay the data onto a global map. Leaflet takes care of animating and switching the layers based on user inputs and preferences. The back-end of the app is running GeoServer[4], which is a Java based web mapping software. The raw netCDF data output from GEOS-5 is loaded into GeoServer so that the application can call the data for rendering. Specifically, using GeoServer the app communicates with a web mapping service (WMS) to receive tiles of data for rendering within the application. This allows for efficient rending of data by only loading data that is within a users' current view. The rendered data within the app is styled using a Styled Layer Descriptor (SLD). Each layer has its' own independent SLD that is used when the app calls for the data in that layer. SLDs also allows for the data to be transformed into contours for sea level pressure and atmospheric heights. Furthermore, SLDs are also used to create wind barbs for the GEOS-5 wind data.

Graphs & Simulations:

The following plots were created using data from GEOS-5 model output:

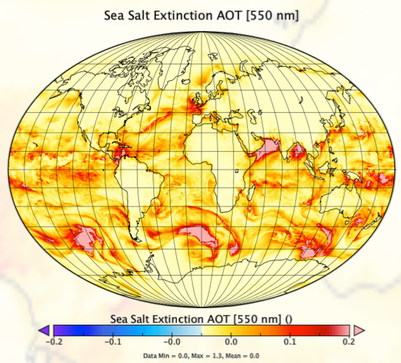

Figure 1: Plot of data Sea Salt AOT data field from GEOS-5 forecast on July 26th, 2015 at 8PM EDT. Created using Panoply[5].

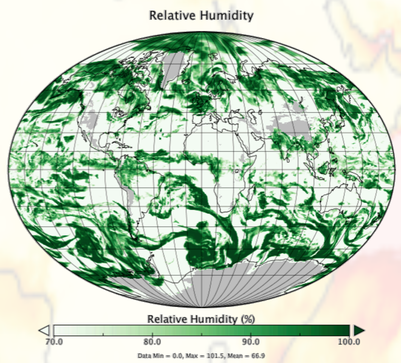

Figure 2: Plot of data Relative Humidity data field from GEOS-5 forecast on July 26th, 2015 at 8PM EDT. Created using Panoply[5].

The figures above show the raw netCDF data plotted using Panoply. The same data can be seen in figures 3 and 4 below. The data is rescaled using the previously mentioned SLD files and rendered in the app. This is an example of how the SLD files are used to rescale the data to make it easier to view and analyze the forecasts.

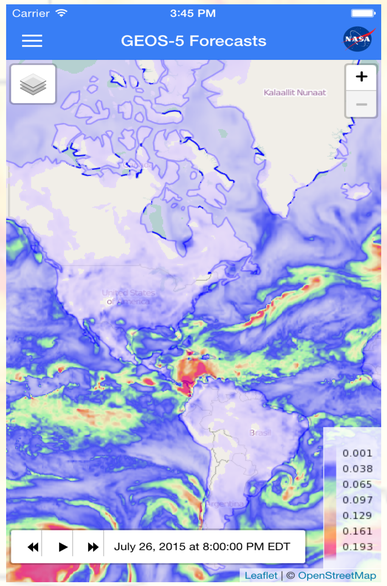

Figure 3: Screenshot of application running on an iPhone 6. The app is displaying Sea Salt AOT from July 26th, 2015 at 8PM EDT.

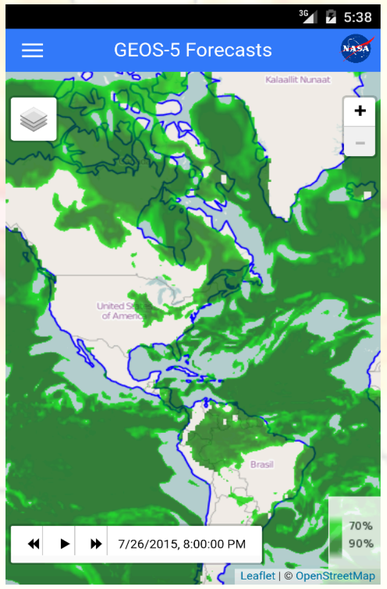

Figure 4: Screenshot of application running on a Nexus 7. The app is displaying Relative Humidity from July 26th, 2015 at 8PM EDT.

Discussion & Conclusion:

The previously shown figures illustrate the GEOS-5 mobile application running in iOS and Android environments. We can see the benefit of using Ionic that enabled development of one app for both major mobile platforms. Furthermore, the user interface (UI) is almost the exactly the same on both platforms. This helps to add consistency between devices in the event that users have multiple devices with iOS and Android. Since the app will also run on tablets, users will have the ability to load it onto their iPad or Android tablet and view the GEOS-5 forecasts with larger screened devices. Furthermore, this gives users with multiple devices a seamless experience between all of them.

The potential for expansion of this app is vast. One such way is to add atmospheric height levels as an option for the data. This would allow users to view the meteorological data on the 850, 700, 500 and 200 millibar pressure levels. Another way to expand the app could be to add more models to the available set of data. Adding other forecast like the GFS and ECMWF could be incorporated into the app for more perspectives on how weather, climate and environmental events are expected to play out. This opens up the possibility of doing model run comparisons between times, models, and heights. As an example, a user could do a comparison between the GEOS-5 and GFS precipitation forecasts to see where they differ. Then they could use this comparison to qualitative and quantitatively generate some uncertainty across the different forecasts in order to make better decisions.

Through this app, we have the ability to make GEOS-5 data more accessible to both the science community and the. The app brings the data to a new platform to give users the ability to view it on the go. As previously stated, the goal of this project was to create a mobile application to view GEOS-5 data. This is exactly what was accomplished and then some. A new back-end server was created that could be expanded to include more data for visualizing within the app. Furthermore, this application will be able to serve a forecasting tool for anyone who chooses to use it. Above all, this mobile application will allow scientists and the public to visualize GEOS-5 forecasts for aerosols, precipitation, atmospheric ozone, temperature, and many others right in the palm of their hands.

References & Acknowledgements:

1. GEOS-5 Homepage: < http://gmao.gsfc.nasa.gov/systems/geos5/ >
2. Ionic Framework: < http://ionicframework.com >
3. Leaflet Homepage: < http://leafletjs.com >
4. GeoServer Homepage: < http://geoserver.org >
5. Panoply: < http://www.giss.nasa.gov/tools/panoply/ >

I would like to thank Universities Space Research Association for sponsoring this project and NASA GSFC for the opportunity to work on this project. I would also like to thank my mentor, Dan Duffy, for his guidance and help throughout the project.