Visualizing Global Satellite Images Downloading Requests

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Abstract

The USGS Earth Resources Observation and Science (EROS) Center recently made its medium resolution images taken by the Landsat 7 and Landsat 5 satellites available to the public at no charge. This caused a dramatic increase of user downloading requests both nationally and globally. Since each request takes time and significant resources to fulfill, EROS is facing great challenges of using existing resources to accommodate ever increasing requests. EROS center is looking at ways to utilize its available resources in a more efficient manner and evaluating the possibility of expanding current resources. This paper analyzes and visualizes the user download requests patterns in the last two months (October 1, 2009 - December 31, 2009). The results provided in this paper might be useful for EROS to make decisions on how to reorganize and expand its currently available resources in order to provide better services.

1. Introduction

The satellite images provided by the Earth Resources Observation and Science (EROS) center of the U.S Geological Survey (USGS) have large impact on the research areas of Geology, Geological Engineering, Hydrology and Earth Science. In October 2008, EROS made its medium resolution images taken by the Landsat 7 and Landsat 5 satellites available to the public for free. The number of download requests of EROS has significantly increased due to the new free downloading policy. For example, the number of scenes processed within the last two months is almost equal to the number of scenes processed during the last two years.

EROS records according information every time when users send requests to a log file, which includes PRODUCT_REQUEST_ID, LANDSAT_SCENE_ID, WRS_PATH, WRS_ROW and TIME_SENT_TO_PROCESS. Since these log information is recorded in the form of plain text, it is extremely difficult to analyze these data and find out the useful user download patterns hidden behind the raw data. To address this problem, we design and implement a visualization tool in this paper, which can convert the plain text information to visualized spatial information.

Using this tool, we are able to easily discover the user downloading patterns all over the world and classify user behavior habits.

We found out that there are two main types of people requesting satellite images from the EROS center from October 1, 2009 December 31, 2009. The first type is called aggressive user, who is attempting to grab all images available online. The second type is general users, who requests a small number of images related to their work and do not place much of a burden on the system. The aggressive groups have placed a major burden on the system because they sent a large number of requests within a short time. However, these aggressive users may eventually slow down once they have gathered a significant amount images.

There are two possible solutions to address the system burden currently caused by the aggressive users. The first solution is to assign higher priority to non-aggressive users. Since the general users requests are small and are the normal customers of the EROS Center, a priority queue can be used to reduce the effect of aggressive users. The second approach is to cache images at another location. A growing trend in providing services on the Internet is to cache files used frequently by users in a location closer to the end user than the central facility. It would be possible for the EROS center to cache images for aggressive users in this way by purchasing similar services from a mirror data server closer to the end user. However, this would be a costly solution for duplicating data and it requires accurate analysis on where most aggressive users locate.

The rest of the paper is organized as follows. In section 2, we present the design and implementation of the visualization tool. Visualization results are shown in section 3. Finally, section 4 provides the concluding remarks and future work.

2. Visualization Tools

The raw data, which is a log file recording the user downloading requests, was received in an ascii table. The raw data are manipulated using a series of two Perl scripts. The first script translates the data to an intermediate form and the second script processes the data. More specifically, the first script translates the raw data to a form that separates fields with commas and records with newlines. The second script takes the output from the first script and counts the number of requests from a given row and path. The script then outputs the count of each row and path to a Keyhole Markup Language (KML) file for viewing in Google Earth. Counts of zero are not included.

KML files allows us to display place marks, polygons, points, groups of polygons and points, pictures and models within Google Earth by describing them in XML. Using data obtained from EROS, every row and path output is converted to a polygon. To determine the color of the polygon, the count is multiplied by the maximum number of colors and divided by the maximum count. Colors are 32-bits long with 48-bits fields (most significant byte first): 1) Transparency, 2) blue, 3) green, 4) red. Some red and transparency are on by default; then colors are scaled first through green and then into blue.

However, when polygons are specified that cross 180 degrees longitude, Google Earth draws them going around the Earth in the opposite direction. To correct this problem, polygons that cross this line are split in two along it. Both of these halves are then placed in the same group. Google Earth then treats them as the same object when presented to the user.

3. Visualization Results

We present a group of visualization results (Figs.1 - 4) taken from Google Earth showing the amount of times a given area was requested from EROS. These images were generated from a KML file created by processing the given data set with a Perl script. They show popular locations around the globe.

4. Conclusions and Future Work

In this paper, we designed and implemented a visualization tool, which is able to convert plain text information to visualized spatial information. This visualization tool is a combination of Perl scripts and Google Earth. We illustrated how to utilize the visualization tool by generating the visualized version of global satellite images downloading requests from EROS.

Future work of this project should focus on improving the quality of generated visualization results. For example, we could remove the pins for the images with low request frequency. Further work also can be done in designing better function that decides the color based on the requests frequency. Currently, we are using a linear function but a function with standard deviation may generate better results.

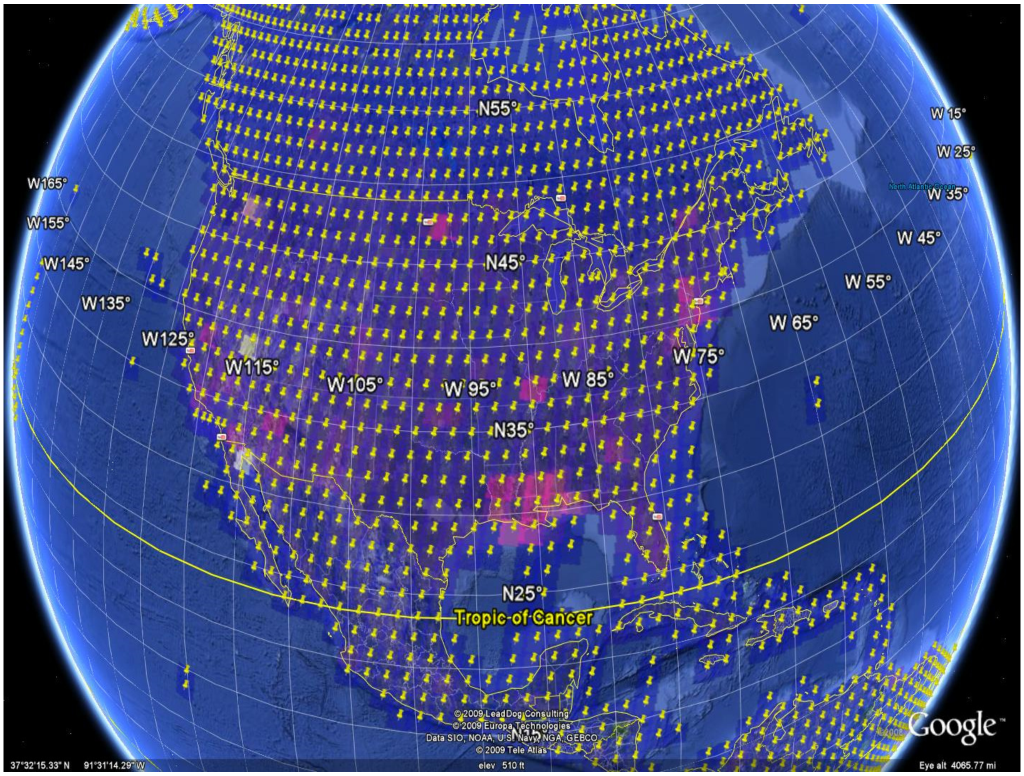

Figure 1. Sample Pattern of North America

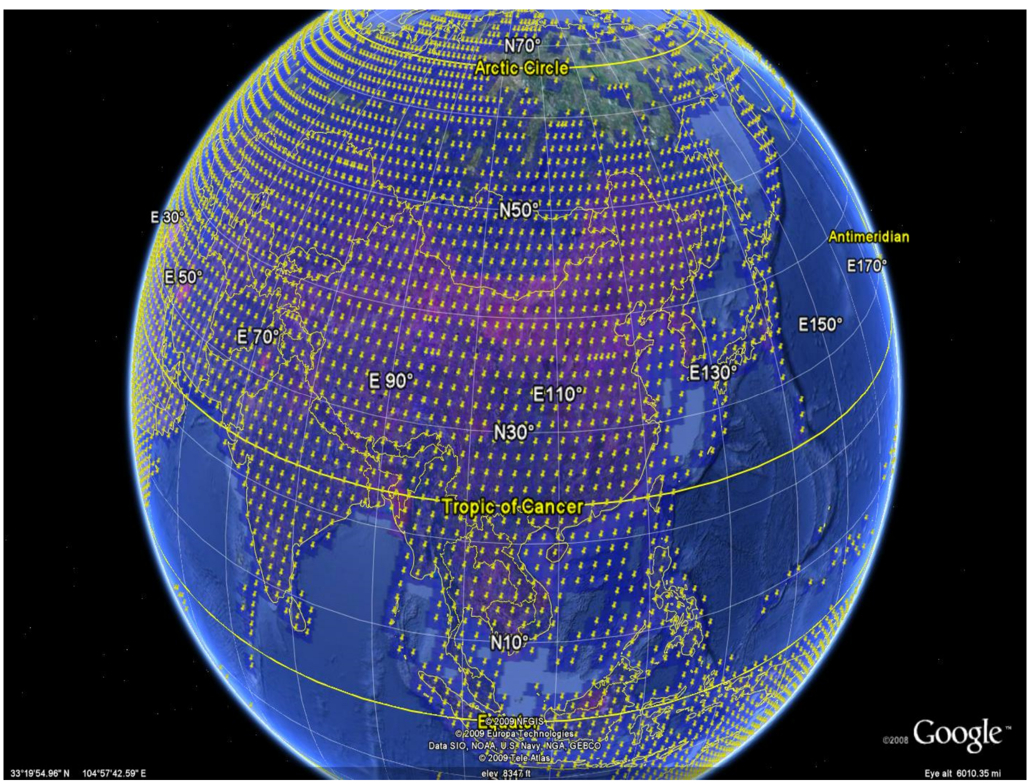

Figure 2. Sample Pattern of Asia

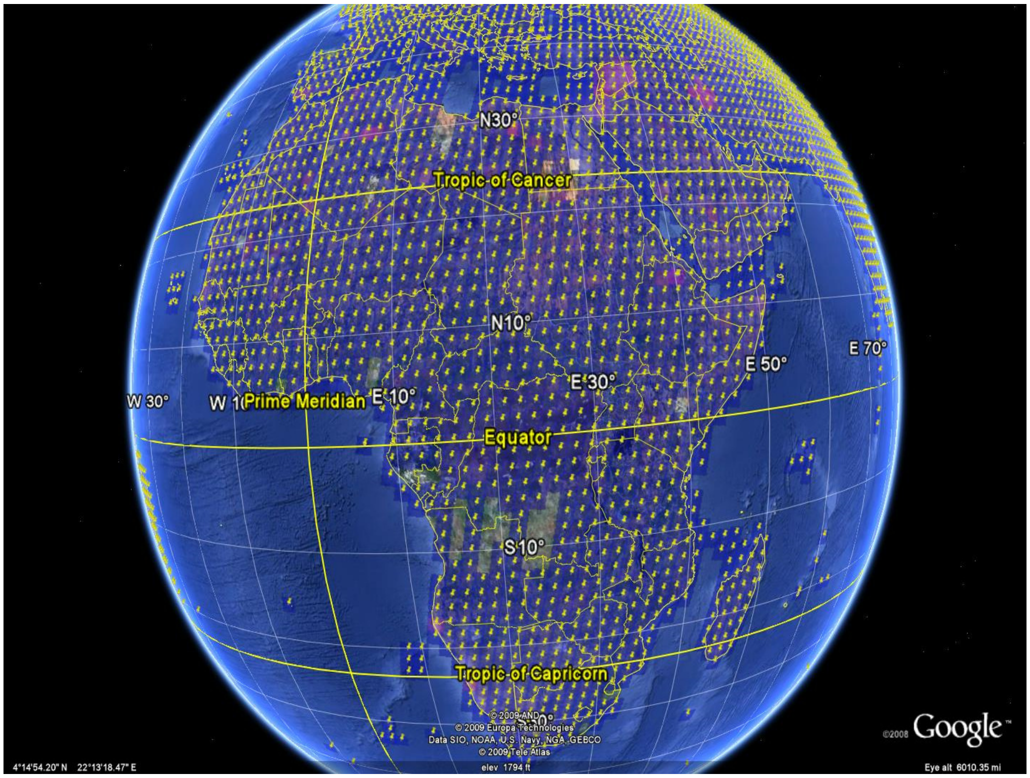

Figure 3. Sample Pattern of Africa

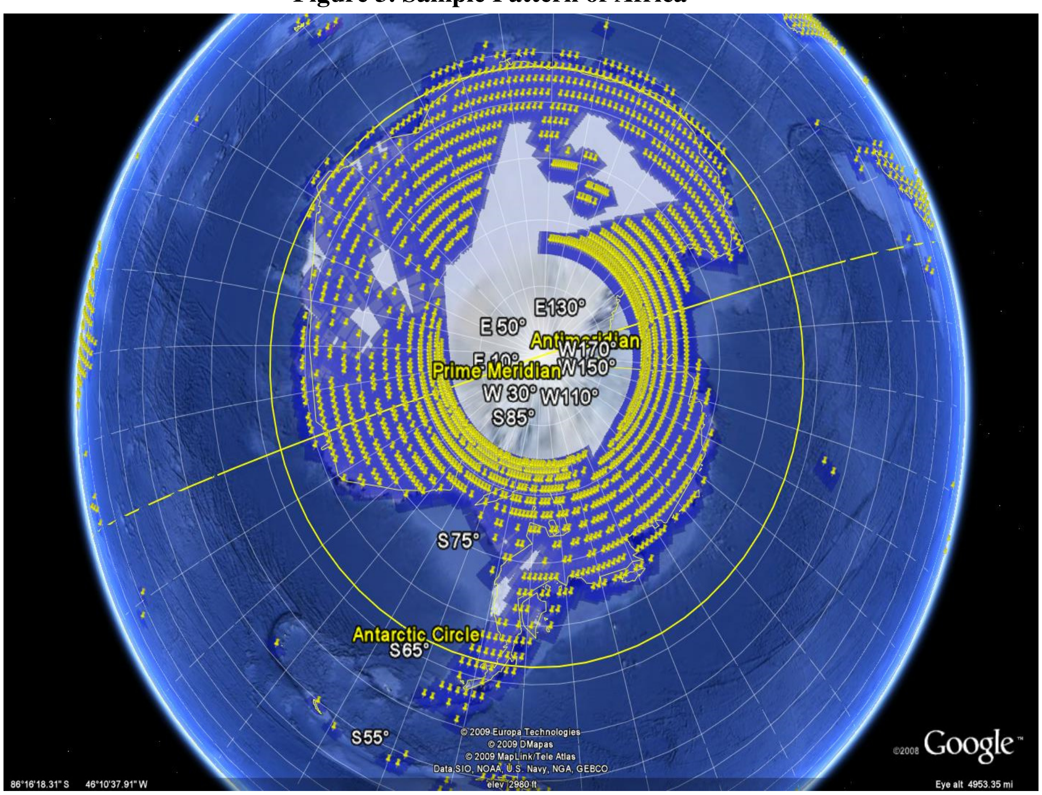

Figure 3. Sample Pattern of Antarctica