The Chandra Source Catalog : Google Earth Interface

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Abstract

The Chandra Source Catalog (CSC) contains multi-resolution, exposure corrected, background subtracted, full-field images that are stored as individual FITS files and as three-color JPEG files. In this paper we describe how we took these data and made them available to the Google Earth (GE) application via its KML mode. We will highlight some of the challenges which include converting the data to the required Mercator projection, rectifying the 3-color data for accurate processing, and ways to reduce the data volume through re-binning, using color-maps, and special keyhole Markup Language (KML) tags to only load images on demand. The result is a collection of some 11,000 3-color images that are available for all the individual observations in the CSC Release 1. We also have made available all ~400 Field of View (FOV) files (both per-chip regions), which are trivial to produce starting with a single observation. In the first week of release, approximately 40% of the images have been accessed at least once through some 50,000 individual web hits which have served over 4GB of data to roughly 750 users in 60+ countries.

We will also highlight some future directions we are exploring, including real-time catalog access to individual source properties and eventual access to file based products such as FITS images, spectra, and light-curves.

Google Earth Basics

Google Earth (GE) is a stand alone application available for Windows, Mac, and Linux. It provides a very intuitive way to zoom into and explore the sky. Google Earth allows users to render their own data via three-color mosaic images, and renders the images.

Switching to Sky mode, users see DSS or SDSS mosaics of images as well as outlines of the Constitutions and various points of interest. GE allows users to render their own data via Keyhole Markup Language (KML). The data is drawn as different layers that can be individually turned on or off. This allows one to visually check for spatial correlations.

Three Color Images

We are using the Lupton et al (arXiv:astro-ph/9412045) technique to create the 3-color images. This involves picking intensity and scaling factors. We are using the mean of the R, G, and B intensity for the color. For the PNG conversion we found that compensating for non-linear scaling using asinh(x) gives better results. The maximum pixel value was one of the critical parameters to adjust in the technique; we eventually found that using a 99.7% quantile of the pixel values as the upper limit gave us reasonable dynamic range over the wide variety of images being processed.

Field of Views

Every Chandra observation has a field of view (FOV) file that is part of the primary data package. These were regeneratred for the Chandra Source Catalog to match the time range of the data as imbeded in Level 3. We also excluded any chips that were dropped from processing due to extended emissions. The FOVs are clickable and provide OBJ and Object information.

To convert these FITS region files to KML format we start by giving the polygon command to the now, so simple straight lines to give us the celestial coordinates for the row of the active CCDs. Simple straight lines load the images that would be invisible. Block 4 images are loaded when they would cover 128 pixels, block 2 if 256 pixels, and at 512 pixels, so users only load the largest/first detail when they have zoomed in enough.

Conclusions

We have shown the simplicity and power of publishing a large percent of the interesting Chandra data in GE. We have also shown some of the limitations of our data and things that we could do differently to provide even better data to the scientific community.

As we start to see more VO services come online we anticipate that they will be integrated into GE, much as the Microsoft World Wide Telecone application makes use of the VO registry and provides GeoSearch services. We envision future usages such as:

- Proposal planning to quickly see where Chandra has already observed or has access to the observatories parameters.
- Authors creating tours to accompany their papers which may for example be to show maps of the active telemetry data in their surveys.
- Non X-ray astronomers will be able to quickly see what data Chandra has on objects that are not their favorite objects.
- Contended interest from the public at large in the universe that Chandra sees.

Google Earth in Sky mode provides a very powerful browser for the sky. The ability to overlay multiple images from multiple wavelengths and to blend/mix images on the fly is a feature that will be attractive to any professional observatory. It has capabilities well beyond EPO; it is a powerful tool for individuals and groups to publish data to the public.

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