LOW RESOLUTION PLANETARY EXPERIMENTS: GRIDDING AND MAPPING ROUTINES USING IDL

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ABSTRACT:

We present a toolkit of routines for IDL. This toolkit converts a set of coordinates and data sorted by acquisition time into a map. It was developed at first for low-resolution data that require special care, such as working with equal-area pixels.

1. INTRODUCTION

1.1 Context

We are implied in several experiments of geochemistry by remote-sensing techniques. Namely, we recently participate to Lunar Prospector and Mars Odyssey, which measured respectively the composition of the Moon and Mars. Neutron and gamma-ray spectrometers are used to find the bulk composition of planetary surfaces. These techniques are relatively new in astronomy, and their data analysis is unusual. The main difference with other surface observations is the low spatial resolution that is about the spacecraft altitude. Resulting maps have details of about 40 km on the Moon, and 300 km on Mars, i.e. a few degrees typically. A second challenge with gamma-rays (not neutrons) is the low signal-to-noise ratio that translates into long accumulation times: measurements above the same nadir must be summed together for the successive orbits during the whole mission (typically 2 years).

1.2 Objectives

Assuming data have been correctly pre-processed to obtain a set of longitudes, latitudes, and values (flux or concentrations), we developed several routines to project this dataset onto a grid, and to map the result. Additional functionalities such as smoothing, changing the resolution, referencing with feature names, projecting in various coordinates were included. Another objective was to obtain an output of publication quality.

2. TOOLKIT

We wrote 18 routines in the Interactive Data Language (IDL). This toolkit is shown as a flow chart in Figure 1. These codes should be general enough to use for a variety of different planetary datasets. Keep in mind though that it was initially developed for low-resolution data (equal to or more than 0.5x0.5 degree at the equator).

2.1 Gridding

We assume that the data stream starts out with a set of time-series data (Figure 1). Time-series data is defined as a set of instantaneous values of [longitude, latitude, data]. This vector does not need to be ordered: data having the same longitude/latitude coordinates, more or less the input resolution, will be summed together to obtain a mean (or median, or total) value associated to these coordinates. The output is called gridded data.

The time-series data is converted into gridded data using the program *grid_series.pro*. This program can grid data into either equal-area sized pixels or equal degree (cylindrical) sized pixels. The size of the pixels is specified using degrees (or the equivalent degree size at the equator). The resulting array has one dimension: for each index corresponds one pixel at the planetary surface, in which all available measurement have been summed. The corresponding longitude/latitude location of the pixels for a given resolution is obtained using the program *grid_list.pro*.

2.2 Mapping

Once an array of gridded data is obtained, it can be converted into an image array using the program *grid_image.pro*. The returned image has a size of 720x360 elements. The 720x360 element image can be converted back to pixel values using the program *grid_values.pro*.

The display routine included with the toolkit is called *tvpm.pro*. (The "tv" stands for the pre-packaged IDL image display routine called tv, and the "pm" stands for Planetary Mapper). *tvpm.pro* will display global and regional images created with the other programs described in this abstract (Figure 2). *tvpm.pro* also includes an interactive feature that allows the user to make image displays using a window interface.

A few support data routines are also available: they contain support data files and feature names that can be read into IDL memory. The support data currently includes Martian topography, global relief, and albedo data. These datasets can be returned with 1/2, 1/4, or 1/8 degree resolution using the

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program *load_mars_context.pro*. A database of Martian feature names can be loaded into IDL memory using the program *load_mars_names.pro*.

2.3 Processing

Before display, image arrays can be processed further for comparison purposes or for improvement. In particular, the data within a 720x360 image can be rebinned into different pixel sizes using *grid_rebin.pro*. Finally, an image variable can be smoothed using the program *grid_smooth.pro*.

Another set of routines was also developed for statistical analysis. For examples decomposition into harmonics have been included in a format compatible with other programs. It is also possible to calculate the proportion of overlay with geological units at high resolution, and trends between two datasets. However these last programs are not fully operational today.

3. CONCLUSIONS

We used successfully our toolkit for months. These programs are still under improvements, and extensions for other planetary bodies. They are relatively simple mapping routines, but really easy to use. This is an ideal tool for a quick look at remote-sensing data. Initially dedicated to low-resolution mapping, it should be useful for a large community. We plan to make that toolkit available on the Internet.

References from websites:
http://kronos.ast.obs-mip.fr/odyssey

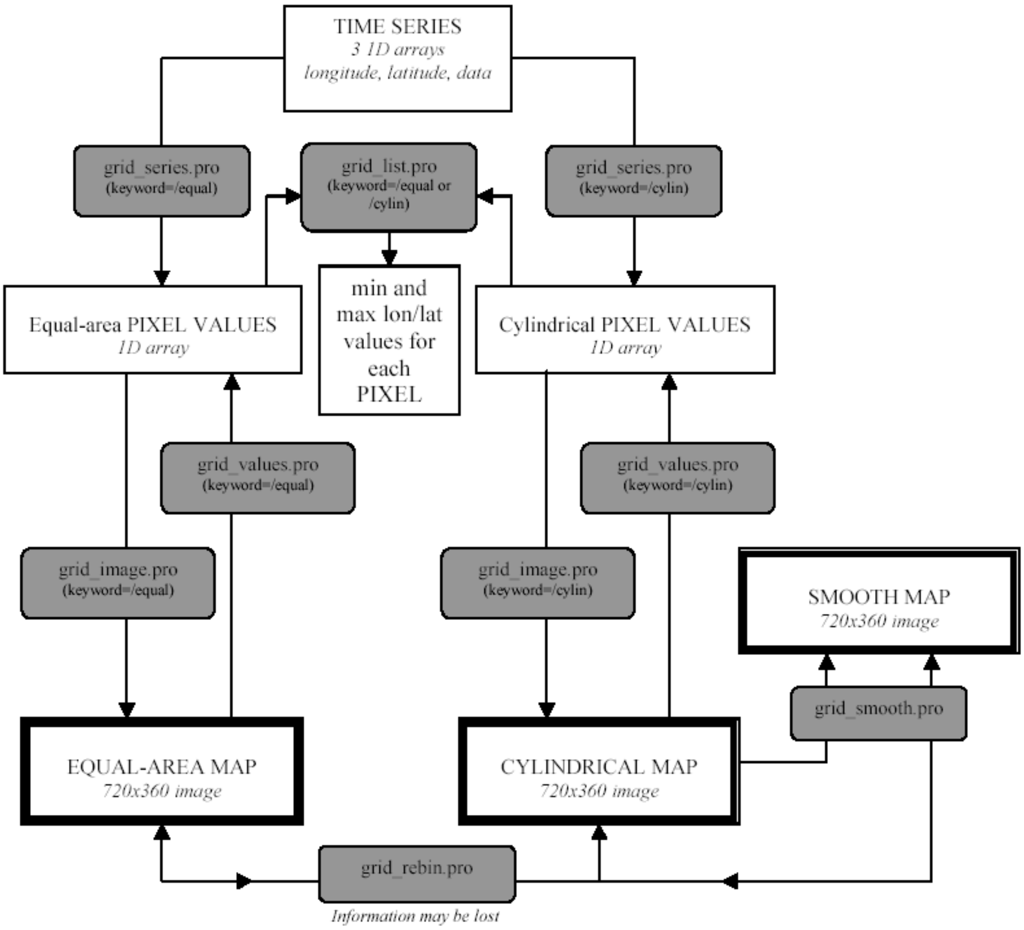

Figure 1: Flow chart of the toolkit developed for IDL. Starting from time-series, a map is produced in a few steps.

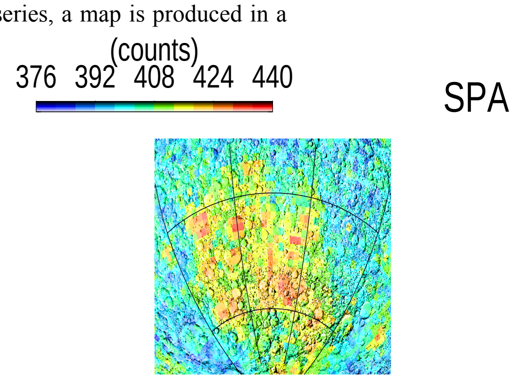

Figure 2: Fast neutron leakage flux measured above South Pole Aitken basin (Moon) by Lunar Prospector.