Deliverable 4.1:

Prototype MADAM module

Authors	Anna-Stiina Suur-Uski Elina Keihänen
Date	September 21st, 2018
Work Package	WP4 - Map making
DocId	[xxx-xxx-xxx]

Revision History

Version	Authors	Date	Changes
1.0	Anna-Stiina Suur-Uski Elina Keihänen	September 13th, 2018	Initial Version

Contents

Overview

Map-making in a standard CMB analysis chain compresses the time-ordered data into sky maps. One map example is shown in the left panel of Figure 1. The pre-processed data, however, contains contributions from instrumental noise, which if left untreated will alter the statistical properties of the resulting maps.

For Planck LFI radiometers the noise model consists of two independent components: white (uncorrelated) and 1/f (correlated) noise (J. Delabrouille, A&A Supp. Serr. 127:555-567, 1998). The untreated 1/f noise component shows up in the resulting maps as stripy features, as illustrated in the right panel of Figure 1. Hence, in addition to visualising and compressing data, a proper map-making algorithm aims to remove the 1/f noise, while processing the CMB signal and white noise as little as possible.

Map-making step in the BeyondPlanck work is performed with the Madam map-maker code (E. Keihanen et al, A&A, 510: A57, 2010). The code is fully functional, and it has been the main map-making tool of the LFI DPC. Madam map-maker is based on a destriping principle (C. Burrigana et al., astro-ph/9906360, 1999), where the 1/f noise component is modelled by a sequence of constant offsets, called baselines. Further, the Madam map-maker is able to use a noise prior to constrain baseline amplitudes (E. Keihanen et al., A&A, 510, A57, 2010), which allows us to shorten the baseline length considerably.

Our aim is to integrate the Madam map-maker with the BeyondPlanck pipeline in such a way that it can be run repeatedly as part of the automatized pipeline. This requires, for example, modifications to the data reading routines, as the format of the input data changes when moving the analysis to a different computing site from the LFI DPC environment. The prototype Madam module will be the Madam 3.8.3 (version used for the official Planck analysis) running on the Oslo Owl cluster with a simulated dataset. Tuned Madam module to be delivered in month 12 (Madam 3.9.X) will be fully interfaced with the BeyondPlanck pipeline.

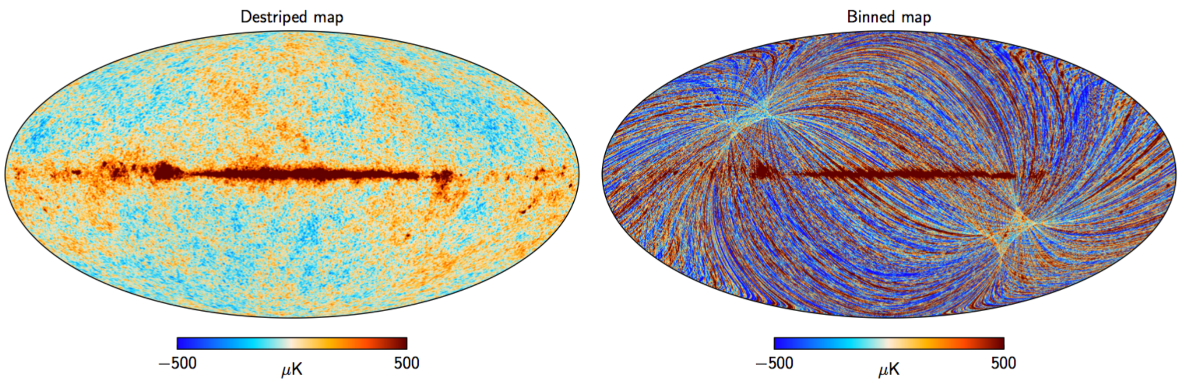

Figure 1: The effect of destriping on a simulated data set. Left: Destriped map. Right: Binned map. The binned map appears stripy due to the 1/f noise, while the destriping brings out the CMB and foreground signals. In reality the shown binned map is exaggeratedly stripy, as the pre-processing of the real data already removes correlations on time scales longer than a pointing period. Maps are shown in Galactic coordinates.

Software and compilation

Madam 3.8.3 is available on the Owl cluster in directory

- /mn/stornext/d14/bp/annastiina/Madam_HelsinkiTutorial/Madam3.8.3

with the latest Makefile.

In the GitLab repository Madam version 3.8.3 is the first commit of Madam version 3.9:

- https://gitlab.com/BeyondPlanck/repo/commits/master/madam

To compile Madam, the user must have access to the following compilers and libraries:

- Fortran MPI compiler, for instance Intel
- CFITSIO, https://heasarc.gsfc.nasa.gov/fitsio/fitsio.html
- FFTW, http://www.fftw.org/
- HDF5, https://support.hdfgroup.org/HDF5/ (for Madam 3.9 with HDF5 input files)

Options for the compilers and libraries are defined in the Makefile.

Following modules need to loaded before compiling:

- module load Intel_composer_xe/2017/1.132
- module load openmpi/Intel/2.1.1
- module load Intel_parallel_studio (for Madam 3.9 with HDF5 input files)

The Madam code can be compiled as follows:

- cd <your_path>/Madam3.8.3
- make

The resulting executable is <your_path>/Madam3.8.3/madam

Usage

To run Madam one needs a parameter and a simulation file, which contains information about the dataset and detectors.

For creating a simulation file, we have a python script make_simufile_owl.py. Run by typing:

- module load python/3.6
- python make_simufile_owl.py

Inside the make_simufile_owl.py script the user must define the location of the detector pointing files (detpt_dir), the location of the data files (tod_dir), the focalplane database file (fpdb), and name of the output simulation file (f_out). The test dataset on the Oslo Owl cluster created with Level-S simulation software for Planck LFI 30GHz full dataset is at:

- TOD and pointing: /mn/stornext/d14/bp/annastiina/Madam_tutorial/levels
- Focalplane database: /mn/stornext/d14/bp/annastiina/DX12/mission/focalplane_db_LS_13.0.fits

Example parameter file on the Owl cluster is

- /mn/stornext/d14/bp/annastiina/Madam_HelsinkiTutorial/madam.par

The user must specify at least the following parameters (other parameters are set to their standard values):

- Simulation file (parameter called simulation)
- Output map name (parameter called file_map)
- Pointing period file (parameter called file_pntperiod). For our test data set the correct file is /mn/stornext/d14/bp/annastiina/DX12/mission/pntperiods_30GHz_DX12.dat

Full Madam manual, that explains for example all the possible input parameters, is available from the BeyondPlanck wiki: https://gitlab.com/BeyondPlanck/repo/uploads/b16319d097c852b8dff8887d0533e18f/manual.pdf

Madam is run on Owl as follows:

- mpiexec -n N <your_path>/Madam3.8.3/madam madam.par > madam.out

The number of cores, N, may be set to any number, typically the same number of cores as is available on the compute nodes employed for the analysis.

Typical outputs are:

- file_map
- file_hit (optional)
- file_binmap (optional)

- file_cov (optional)
- file_4Dmap (optional)

A successful test run with preliminary Madam module with the simulated dataset (326G) on 24 dual cores took 412.5 seconds for I/O, 419.5 seconds for the actual computations, and 1053.5 seconds in total. With the final Madam module to be delivered in month 12 we hope to decrease the wall-clock time for I/O.

References

J. Delabrouille. Analysis of the accuracy of a destriping method for future cosmic microwave background mapping with the PLANCK SURVEYOR satellite. Astron. Astrophys. Supp. Ser. 127:555-567, 1998

E. Keihanen et al. Making cosmic microwave background temperature and polarization maps with MADAM, Astron. Astrophys., 510: A57, 2010

C. Burrigana et al. A preliminary study on destriping techniques of PLANCK/LFI measurements versus observational strategy, astro-ph/9906360, 1999