PROCEEDINGS OF SCIENCE

Map-making for the Planck 30 GHz channel with the Polar and MADAM destriping codes

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Our two map-making codes are based on the destriping approach, where the correlated noise is represented by a sequence of constant baselines in the time domain. MADAM utilizes information about the noise covariance matrix, whereas Polar does not. This allows MADAM to use shorter baselines (here 1.2 s) than Polar (here 1 min), and thus to model the noise more accurately.

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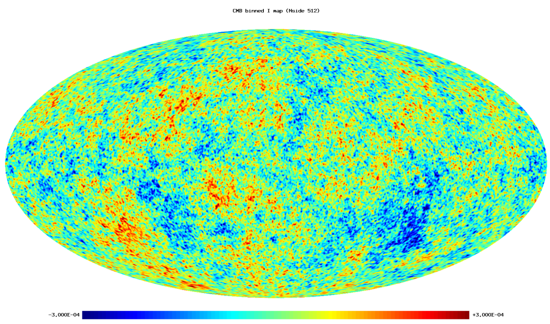
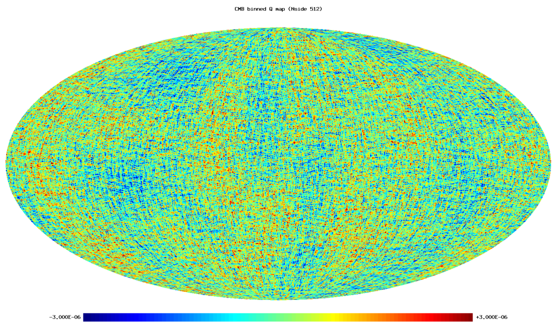
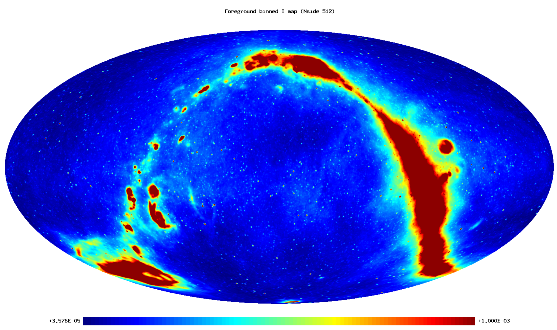
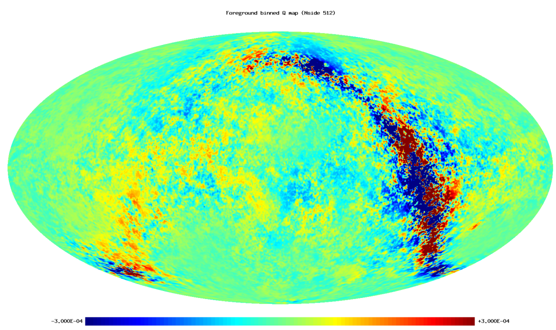
1. Introduction

We present here some maps made by two map-making codes, Polar and MADAM, which are both based on the destriping approach. These maps were produced as a part of the larger effort of Working Group 3 (also known as the CTP Working Group) of the Planck Consortia to compare different map-making methods [1,2,3]. In the destriping approach, the correlated low-frequency noise (1/f noise) is modeled as a sequence of uniform baselines in the time domain. The difference between Polar and MADAM is that MADAM utilizes information about the noise covariance matrix, whereas Polar does not. This allows MADAM to model noise more accurately by using shorter baselines (here 1.2 s) than Polar (here 1 min).

2. Input data

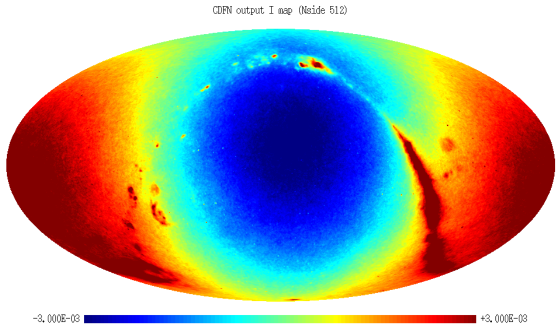
In this study we used 1 year of simulated data of the four Planck 30 GHz detectors. The simulated data contained CMB, foreground, dipole, and noise. In the next two rows of figures we show the first two of these input components. In all figures the two columns from left to right are the Stokes parameters I and Q. (To save space we do not show the Stokes parameter U, which looks qualitatively similar.) All maps are given in units of antenna Kelvin. For the 30 GHz frequency 1 antenna K corresponds to 0.977 thermodynamic K in the CMB anisotropy.

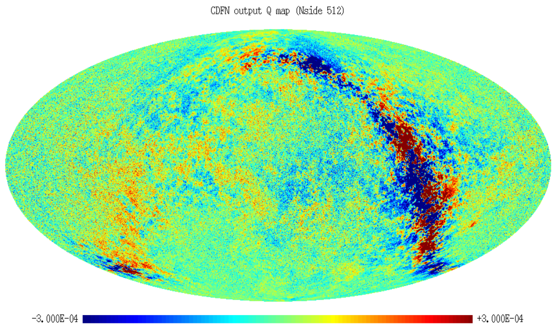



3. Output maps

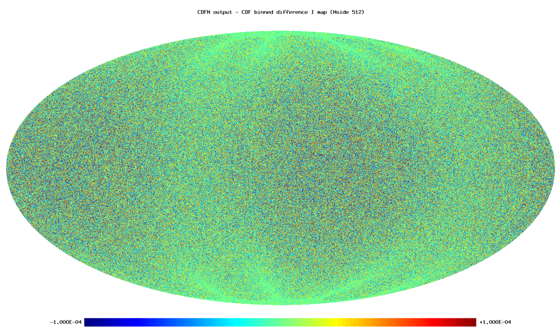
The next pair of figures shows the output maps from Polar (maps from MADAM look similar). The Stokes I (temperature) map is dominated by the dipole.

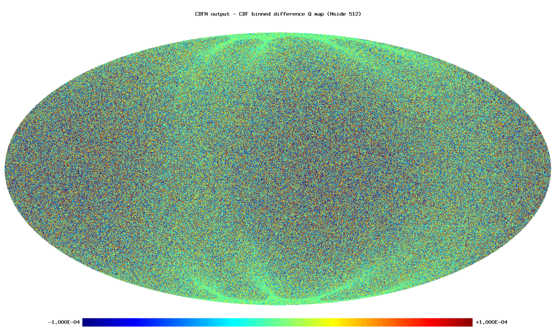




4. Residual error

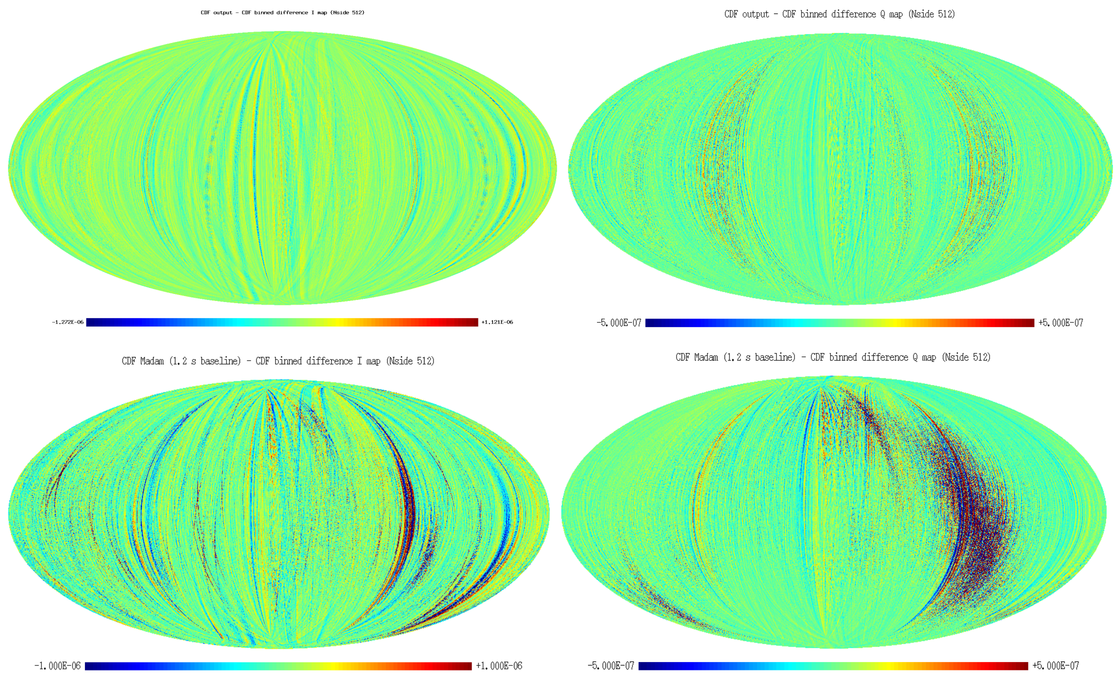
The next pair of figures shows the output–input difference maps from Polar (maps from MADAM look similar). The difference maps are dominated by white noise. The amount of noise can be characterized by the standard deviation (std) of these difference maps. (We use std instead of root-mean-square, since the monopole (average) of the map is treated differently by different map-making methods and is not of interest). The std of these Healpix [4] Nside = 512 difference maps (pixel size 7’) are 42.03 (I), 59.34 (Q), 59.85 (U) μK (antenna temperature) for Polar and 41.85 (I), 59.08 (Q), 59.59 (U) μK for MADAM. These should be compared to the level of white noise which is 41.66 (I), 58.83 (Q), 59.38 (U) μK. Thus MADAM produces maps with slightly lower noise, getting closer to the white noise limit. (These numbers are in line with the Planck mission goals. Note that they are for 7’ pixels. If they were evaluated for pixels of the size of the 30 GHz beam, about 33’, the numbers would be correspondingly smaller.)





5. Signal distortion

In addition to white noise and remaining correlated noise, the difference maps contain a contribution from signal distortion, which is due to the effect of pixelization noise on the map-making method. This distortion can be revealed by making a map from noiseless simulated data, and taking the difference with the input map. See the next two rows of figures. As a price for the more aggressive noise removal this signal distortion is larger for MADAM (bottom row) than for Polar (top row).



While this effect is small (less than a μK for most of the sky) compared to the remaining noise on the maps, it has a different nature, being correlated with the signal on the sky.

Acknowledgements

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