Cosmic Orbital and Suborbital Microwave ObservationS

STRIP-2: The atmospheric de-noise

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A brief introduction on STRIP-2:

- High frequency STRIP follow-up
- Small patch of sky
- Optical features: ~9' FWHM

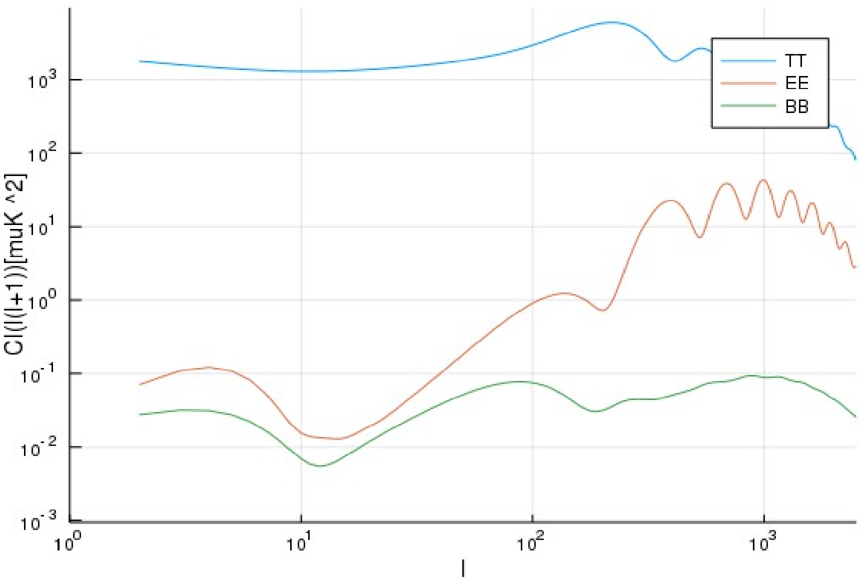
OPERATIVE FREQUENCY BAND	
Frequency (GHz)	95
Bandwidth (GHz)	31.5
# detectors	1028
OPTICAL PARAMETERS	
Resolution (arcmin)	**9.0**
Sky coverage (%)	**7.3**
Obs Time (months)	24
Duty cycle	0.35
τ_{pixel} (s)	162.3
NOISE CONTRIBUTIONS	
T_n reflectors (K)	3
T_n window (K)	5
T_n feed-OMT (K)	0.5
T_n detector (K)	10.2
T_{sky} atmosphere (K)	15
T_{sky} CMB (K)	1.1
T_{sys} (K)	34.8
ΔT per detector ($\mu K \sqrt{s}$)	200.9
ΔT total ($\mu K \sqrt{s}$)	8.9
SENSITIVITY RESULTS	
ΔQ (or ΔU) ($\mu K_{\text{thermodynamic}}$)	**0.87**

Credit by C. Franceschet - unimi

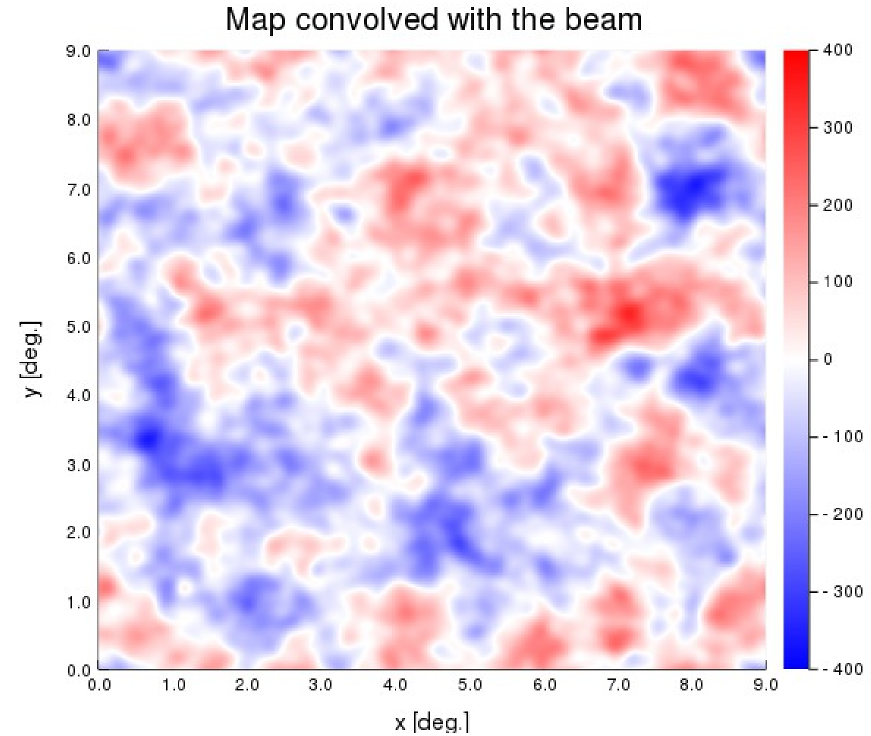
- The simulation suite take into account some main systematic effects of a typical CMB instrument like strip2:
  - Gaussian beam convolution
  - Atmospheric noise (as 1/f noise like)
  - Mapmaking algorithm

- The strip-2 simulation suite is available on GitHUB: https://github.com/algebrato/strip2.jl and has been written from scratch in Julia (v 1.1.0)

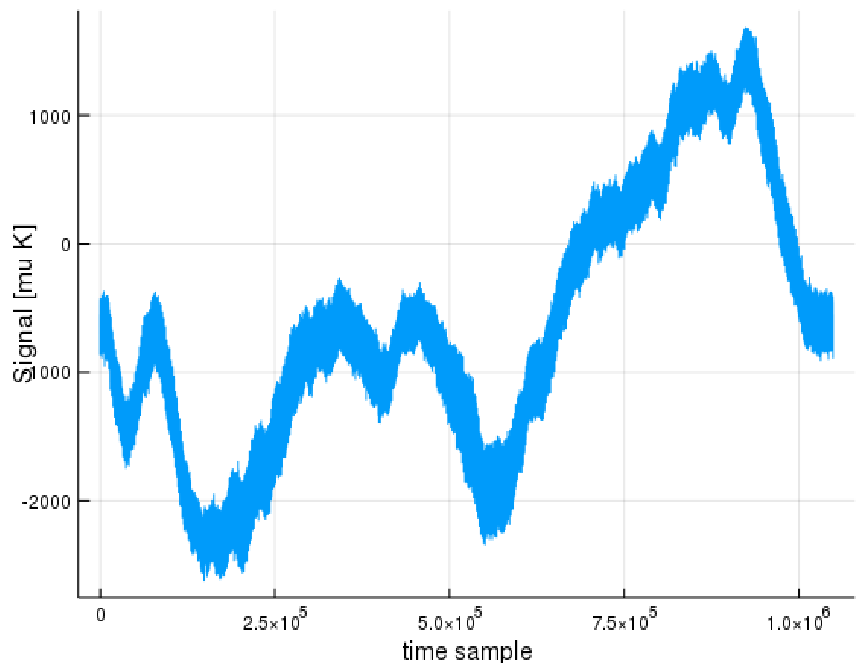
Random sky generation from CAMB power spectrum and beam convolution.



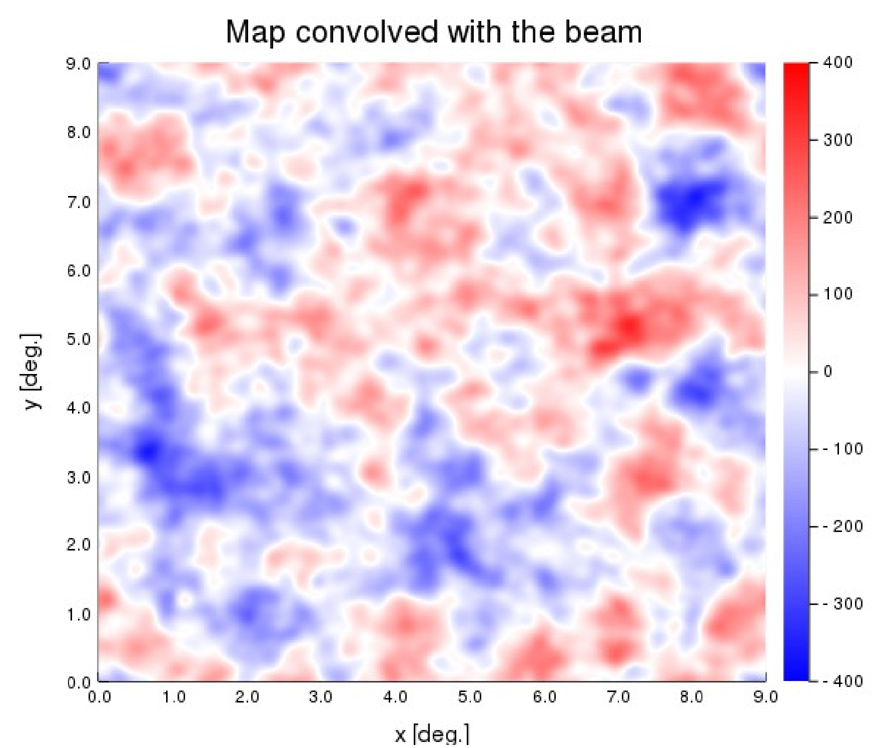
TT, BB and EE power spectrum



We have simulated the scan of the previously generated sky in order to create a comprehensive TOD with all the systematic effects: instrumental 1/f, atmospheric 1/f and white noise



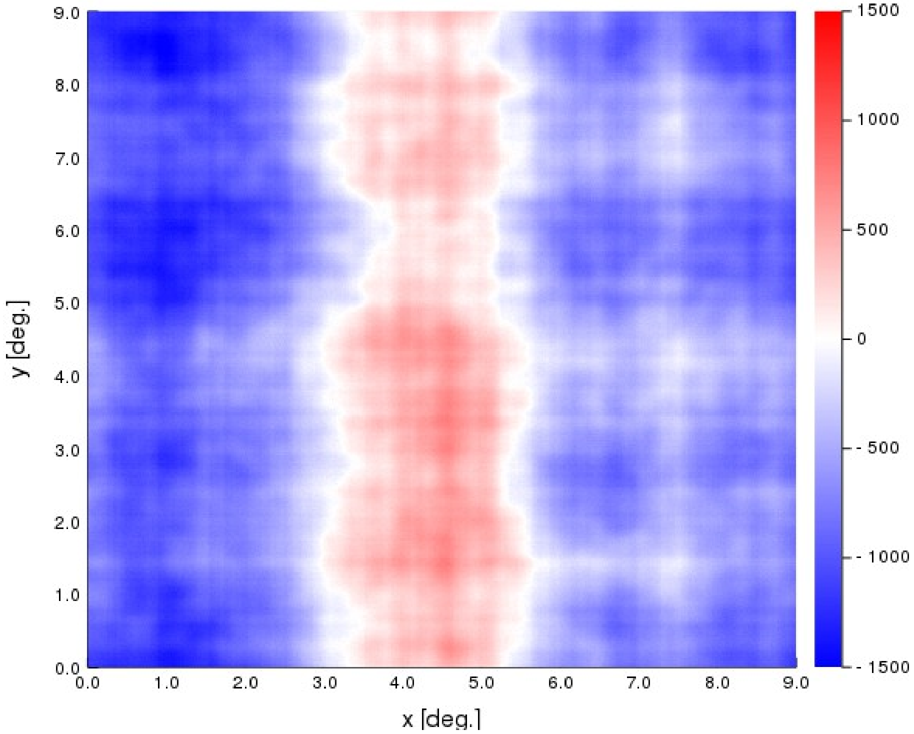
UD Scanning Strategy



Dataset of 5 UD scans and 5 LR scans

LR Scanning Strategy

The binned map:



Strong presence of correlated noise due to the atmospheric spurious signal and instrumental 1/f noise

To de-correlate the noise from CMB signal we have to resolve the mapmaking problem for noisy TOD.

The mapmaking problem for noisy TOD expressed with matrices:

$$[P^T N^{-2} P]\, m = [P^T N^{-2}]\, d$$

Where P is the pointing matrix and N is the noise matrix. The mapmaking problem is reduced to the solution of a bare linear system A x = b like, where:

$$A = [P^T N^{-2} P],$$

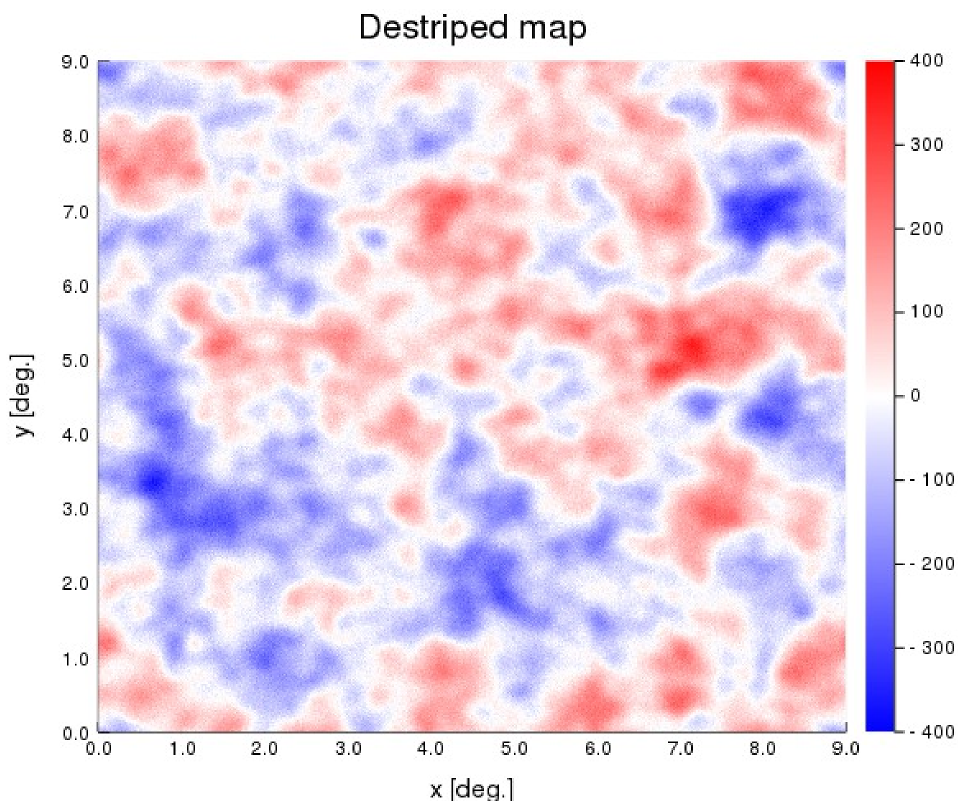
$$b = [P^T N^{-2}]\, d$$

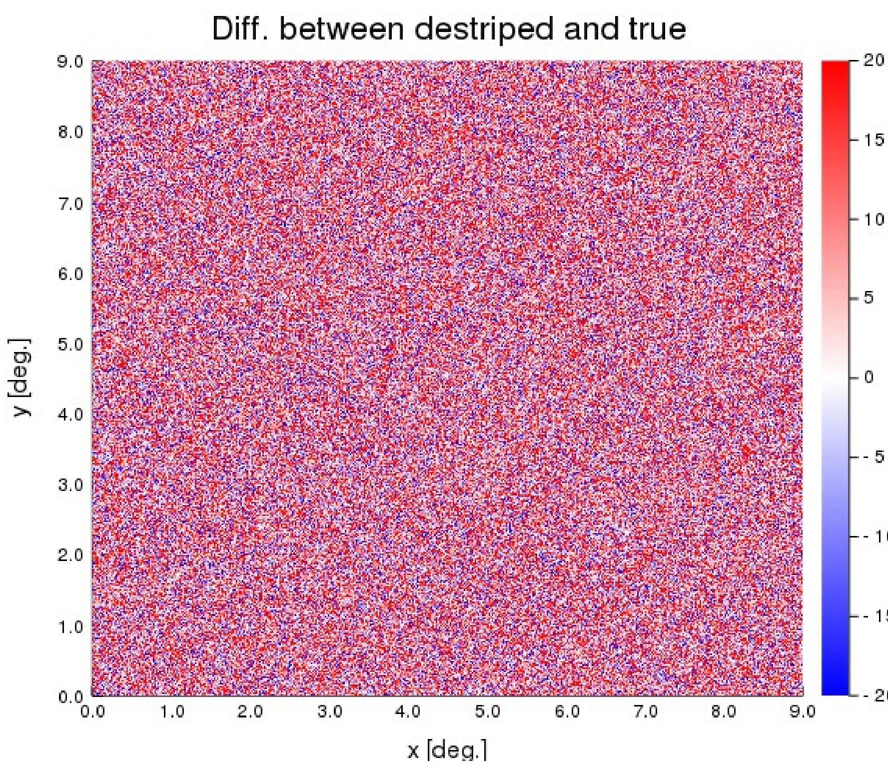
In summary:

$$m = [P^T N^{-2} P]^{-1} [P^T N^{-2}]\, d$$

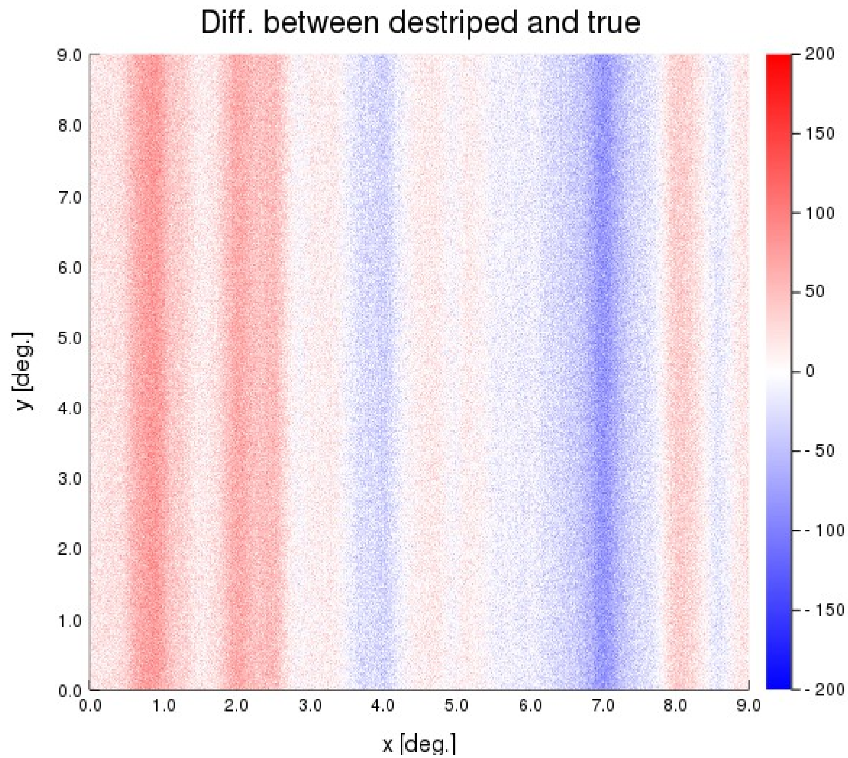
The matrix P and N are too large to be directly build. We have to resolve the mapmaking problem with an iterative method like the conjugate gradient

The result of mapmaking algorithm:





If we had used a different scanning strategy, for example with only L-R or U-D scans, we would have obtain a bad quality map



In figure is shown the difference between the de-noised map (using a dataset of 10 UD scans) and the observed sky. We can see evident correlated zones.

Future perspectives:

- I have to use an Healpix sky instead of a flat-sky approximation
- I will add new systematic effects like: ADC compression and full dynamic atmosphere simulation
- Realistic beam convolution, with side-lobes contributions