COVARIANCE TESTING

DESC

ABSTRACT

There are a number of codes that compute covariance matrices analytically; the plan is to use these to build TJPCov. In this project, we start along the path of comparing these different codes, building up a suite of tools that can be used to compare covariance matrices. We expect these tools to be useful not only for converging on a single accurate code for computing covariance matrices but also more generally for understanding which parts of the covariance matrix carry the most information (and therefore need the most attention to get right) and which are not relevant (so for example matrices that are not positive definite may still be usable if the negative eigenmodes are not relevant).

1. INTRODUCTION

2. METHODS

There are several ways to tests covariance matrices. We will illustrate each of these on cosmic shear statistics $\xi_\pm(\theta)$, focusing for the most part of the Year 1 results of the Dark Energy Survey Abbott et al. (2017). One of the codes will be `Cosmolike` Krause & Eifler (2017); another will be the one used to analyze the KiDS-450 survey Khlinger et al. (2017).

2.1. *One-to-one Comparison*

This is a simple matter of comparing elements of a covariance matrix, usually starting with diagonal elements. Figure 1 shows an example.

2.2. *Eigenvalues and eigenvectors*

This is slightly more sophisticated: diagonalize the covariance matrix and examine the eigenvalues and also the associated eigenvectors. Figure 2 shows an example of the eigenvalues from two different covariance codes.

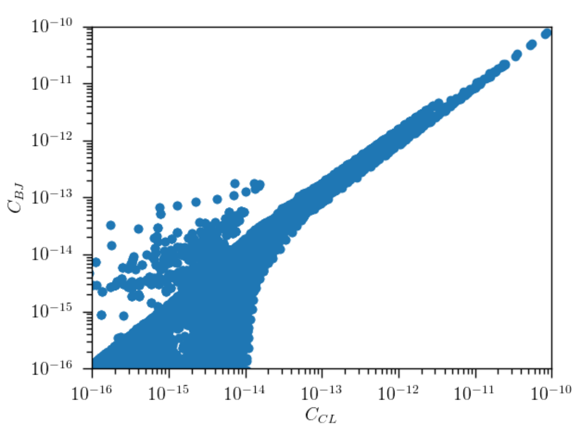

Figure 1. A simple scatter plot of elements of covariance matrices produced by two separate halo model codes.

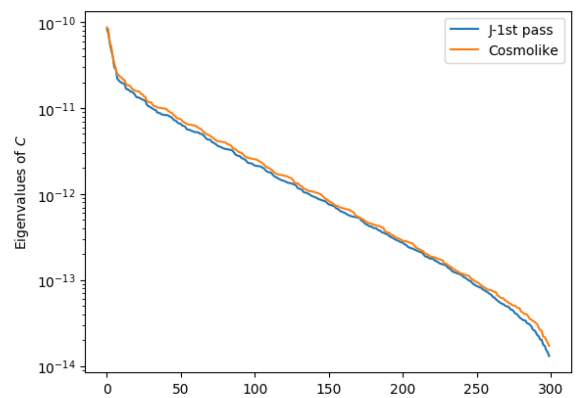

Figure 2. A simple scatter plot of elements of covariance matrices produced by two separate halo model codes.

Figure 3 shows an example of one of the eigenvectors, the one associated with the smallest eigenvalue. This low-eigenvalue mode picks up the differences between the correlation function at different angular scales (each vertical line delineates between two-point functions of shears in different tomographic bin pairs).

2.3. *Parameter Estimation*

Ultimately, what matters is well the likelihood does at extracting parameter constraints. Since most analyses assume a Gaussian likelihood, this boils down to how well the contours in parameter space agree when using two different covariance matrices.

2.4. *Shrinkage*

There have been several methods proposed in the literature to compress the data vectors, extracting as much information as possible. Here we consider two: first

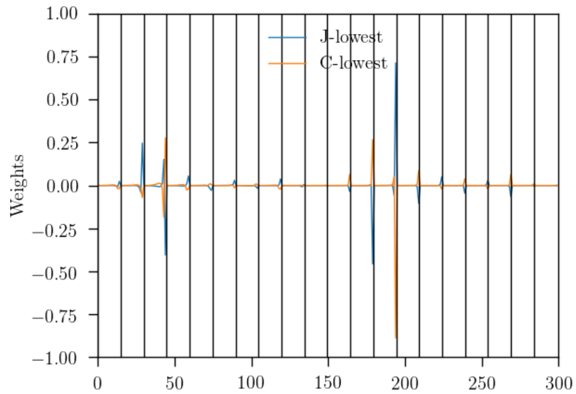

Figure 3. A simple scatter plot of elements of covariance matrices produced by two separate halo model codes.

compression at the map levelAlonso (2018), where linear combination of the tomographic maps are used. If there are 4 tomographic bins, an uncompressed analysis would require ten separate 2-point functions (or 20 for cosmic shear), whereas a compression scheme leads to just a few uncorrelated maps. If there were 3 such maps, then only three 2-point functions would need to be used for the likelihood analysis.

The second compression takes place at the 2-point levelZablocki & Dodelson (2016), with the compressed data vector containing linear combinations of the many 2-point functions. In principle, this might work with only N_p 2-point functions where N_p is the number of parameters varied, and each mode, or linear combination, contains all the information necessary about the parameter of interest.

3. RESULTS

4. DISCUSSION

5. CONCLUSION

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