Response

Anonymous Referee #2:

This manuscript develops a novel Set Operations of Coefficients of Determination (SOCD) method to explicitly quantify the overlapping and differing information for GCM forecasts and ENSO teleconnection. The proposed method and its case study are interesting and well presented.

We are grateful to you for the positive comments.

I have some comments, especially concerning the conclusions derived from the case study.

Thank you very much for the constructive comments. We have improved the paper accordingly and provide point-by-point responses.

This study derives the patterns from CFSv2 forecasts and observations. However, we should note that the forecast skills of GCMs are of high uncertainty in different models. The ability of GCMs in capturing ENSO-related climate dynamics are different. Therefore, the results and conclusions may be different when other GCMs are used. The authors should have a more detailed discussion on this issue.

Thank you for the insightful comment. We have devised an additional experiment to demonstrate the different ability of GCMs in capturing ENSO teleconnections and synthesize the results in the Discussion section:

"The SOCD method is also extended to evaluate the overlapping and differing information under other GCM forecasts and hydroclimatic teleconnections. In the supplementary material, Figures S19 and S20 show the results for the CanCM4 forecasts generated at the Canadian Meteorological Center (CMC) (Merryfield et al., 2013). It can be observed that the percentage of the pattern 000 is higher than that for CFSv2 forecasts. The CanCM4 forecasts seem to be less skilful in Europe but more skilful in the western part of Australia. These results suggest that different GCM forecasts can be complementary to each other in different regions and that they can be combined to generate more skilful forecasts (Kirtman et al., 2014; Slater et al., 2019; Schepen et al., 2020)." (Page 23, Lines 369 to 375)

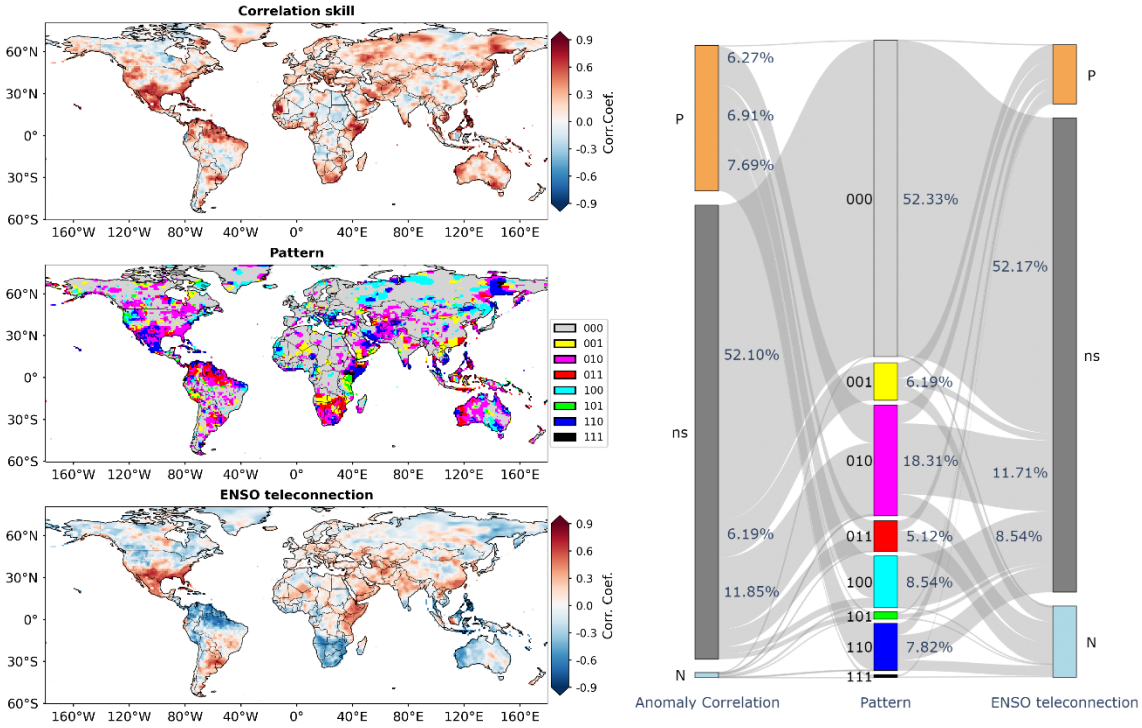

Figure S19. As for Figure 12, but for CMC2-CanCM4 forecasts in DJF

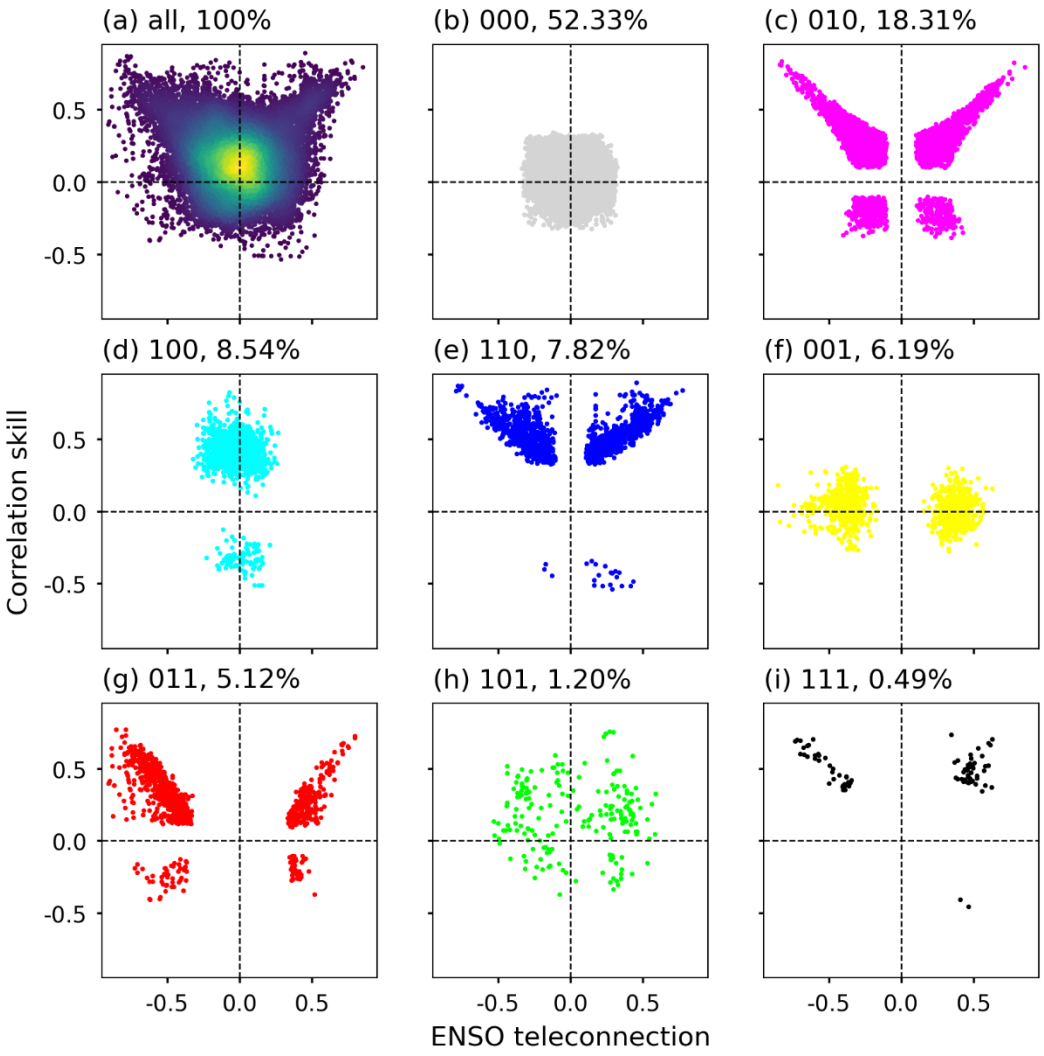

Figure S20. As for Figure 13, but for CMC2-CanCM4 forecasts in DJF

Another issue is that the lagged relationship between ENSO and seasonal precipitation that always matters. The lagged climate indices have been widely used as predictors in previous studies. In this study, the concurrent relationship between ENSO and seasonal precipitation is analyzed. We suggest that the lagged relationship should also be discussed.

Thank you for the constructive comment. An additional experiment is conducted to investigate the effects of lag time:

"The SOCD method is furthermore applied to investigate the eight patterns considering the effects of seasonality, lead time, lag time and significance level. The additional results are presented in the supplementary material. … 3) The effect of the lag time of Niño3.4 index is illustrated in Figures S11 to S14. Compared to the concurrent

teleconnection, the spatial distribution of the eight patterns tends to be similar for monthly Niño3.4 index at the lag times of 1 and 2 months, with a slight increase in the percentage of the pattern 000. The result confirm the temporal persistency in the Niño3.4 index (Yang et al., 2018). …" (Pages 22 to 23, Lines 358 to 370)

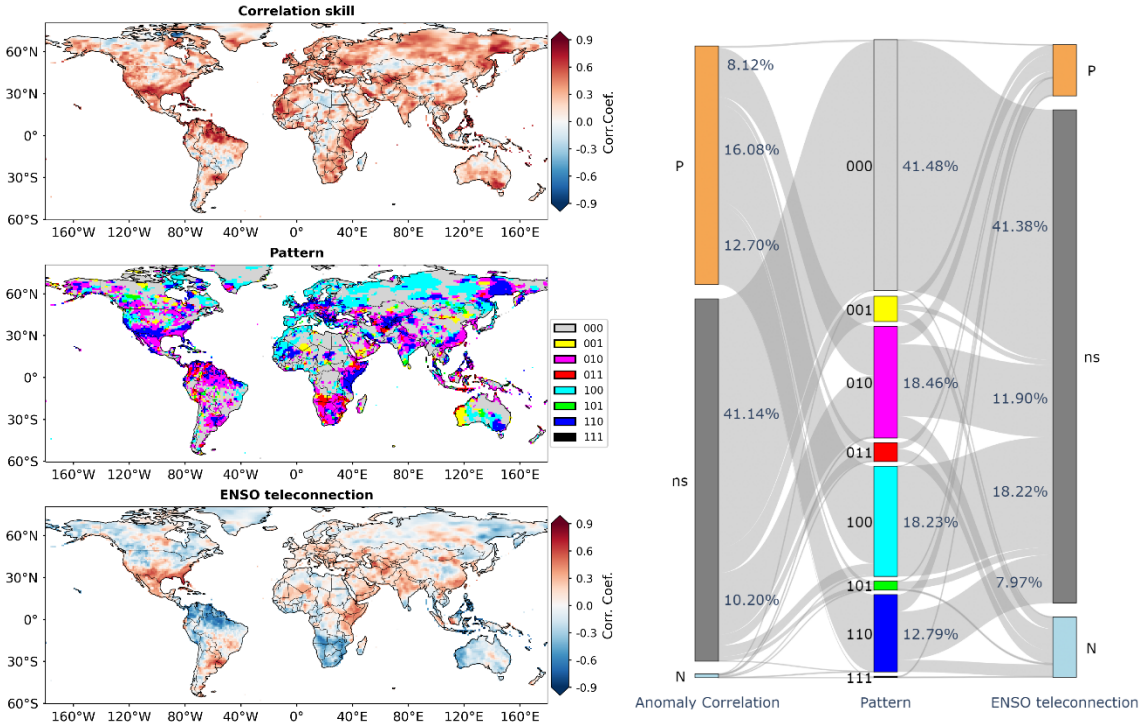

Figure S11. As for Figure 12, but for monthly Niño3.4 index at the lag time of 1 month

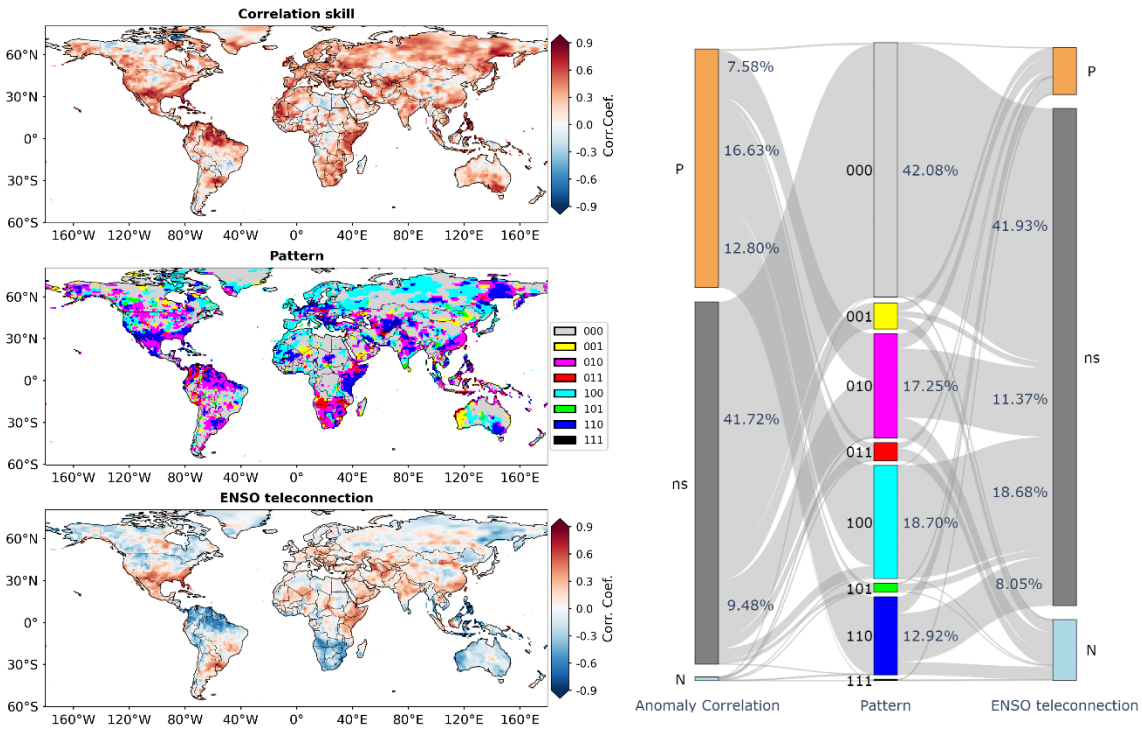

Figure S12. As for Figure 12, but for monthly Niño3.4 index at the lag time of 2 months

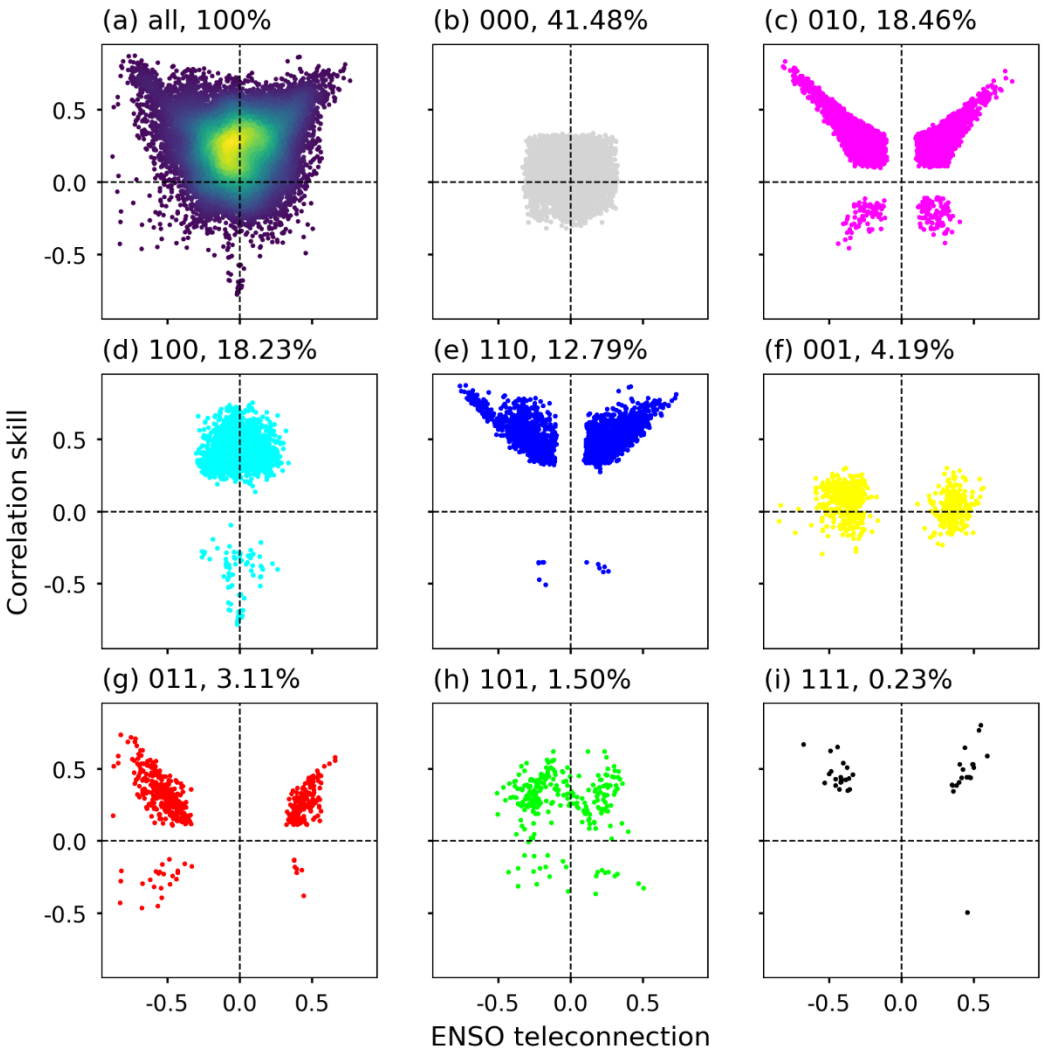

Figure S13. As for Figure 13, but for monthly Niño3.4 index at the lag time of 1 month

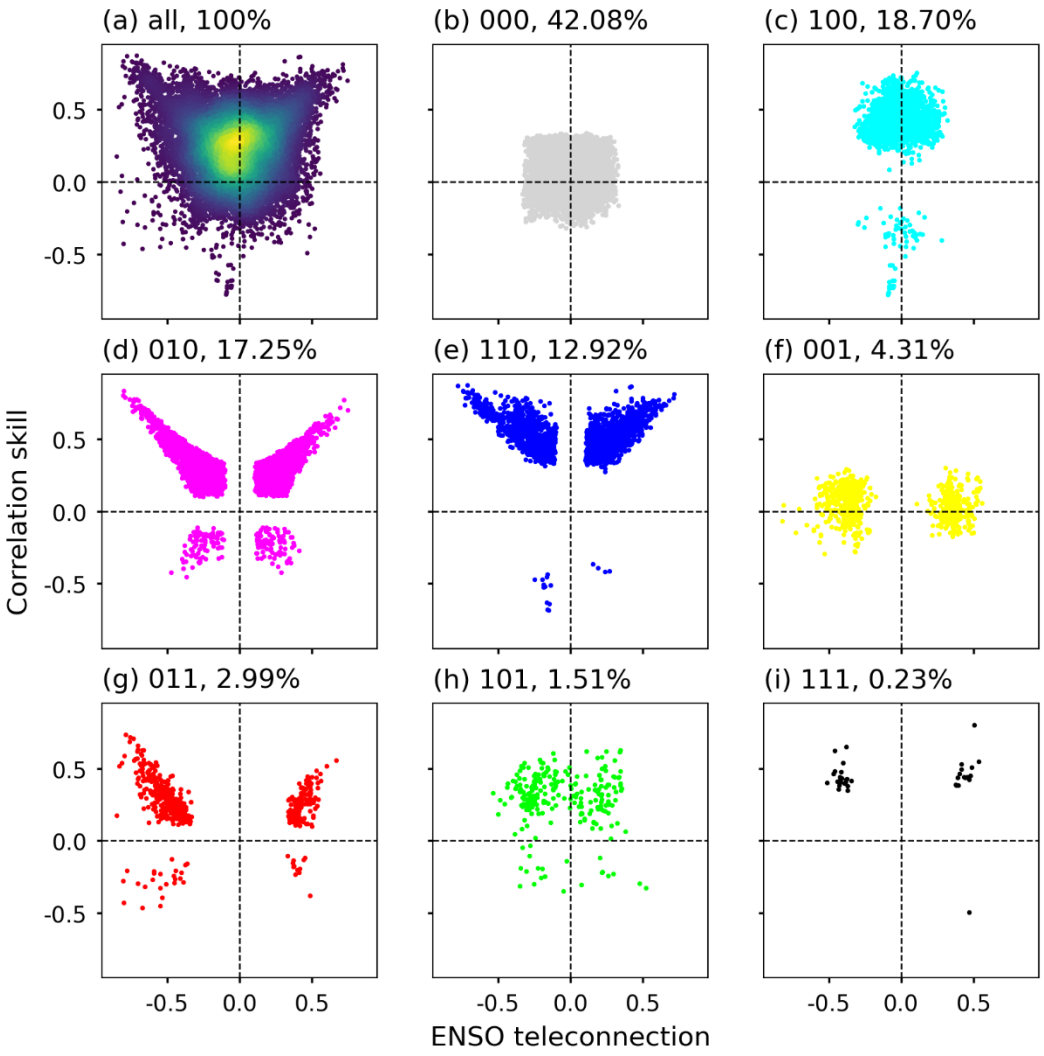

Figure S14. As for Figure 13, but for monthly Niño3.4 index at the lag time of 2 months

The SOCD method uses three classic simple linear regression models to account for the information of observations in forecasts and nino3.4 index. However, this assumption may not be sufficient. The linear regression may lose some important information, especially for extreme seasonal precipitation events. This should be discussed in the discussion section as well.

Thank you for the insightful comment. The correlation skill that assumes a linear relationship and the existence of possible nonlinear relationships are illustrated in the discussion section:

"The correlation skill is one of the most popular measures of forecast skill owing to its simplicity in calculation and robustness to zero and missing values (Barnston et al., 2012; Yuan et al., 2014; Ma et al., 2016; Slater et al., 2019; Huang and Zhao, 2022).

From spatial plots of correlation skill at regional or global scales, it can be observed where GCM forecasts are skilful and where GCM forecasts are not satisfactory (Ma et al., 2016; Slater et al., 2019; Delworth et al., 2020). Previously, it was observed that GCM forecasts tend to be skilful in regions subject to prominent influences of ENSO; accordingly, forecast skill is attributed to the effectiveness of GCMs in capturing ENSO-related climate dynamics (Kirtman et al., 2014; Slater et al., 2019; Lin et al., 2020). In this paper, the developed SOCD method not only confirms the significant overlapping information but also highlights that there exists significant differing information in GCM forecasts from ENSO teleconnection for 31.18% of global land grid cells and that there is significant differing information in ENSO teleconnection from GCM forecasts for 11.37% of grid cells. It is noted that the simple linear regression only accounts for linear relationships. Possible nonlinear relationships between forecasts and observations suggest the usage of nonlinear models in future analysis of the overlapping and differing information (Strazzo et al., 2019; Schepen et al., 2020; Li et al., 2021)." (Page 23, Lines 381 to 392)