1. Examine the total monthly variation (Jan-Dec, not the monthly time series) of RMSE for each variable in each subregion (not over the entire study region) to better demonstrate the inherent seasonal patterns, rather than just some fluctuations during the experimental period.

Response: We have regenerated the monthly RMSE distributions of SST, SCHL, and SSW for the three subregions, and accordingly revised the related descriptions in the main text to reflect the monthly RMSE results. Due to space limitations, the monthly RMSE distributions have been included in the Supplementary Material. The revised figures and corresponding descriptions are as follows.

"Meanwhile, the monthly RMSEs of SST, SCHL, and SSW across different subregions were further evaluated (Fig. S3). The results show that, for SST, T-DINEOF achieves the highest reconstruction accuracy in most cases, with particularly notable improvements in subregion 2. Only in subregion 1 during January to March does the reconstruction accuracy of T-DINEOF appear slightly lower than that of Multi-DINEOF. For SCHL, in subregion 1, T-DINEOF achieves the best reconstruction accuracy in most months. In subregion 2, the reconstruction accuracy of T-DINEOF is slightly higher than that of Multi-DINEOF in most months, while Single-DINEOF yields the lowest accuracy. In subregion 3, T-DINEOF shows higher accuracy from October to the following February, whereas from May to September, its reconstruction accuracy is lower than that of both

Multi-DINEOF and Single-DINEOF. For SSW, in subregion 1, T-DINEOF demonstrates higher accuracy in most months except from April to June. In subregion 2, T-DINEOF outperforms both Multi-DINEOF and Single-DINEOF in most months. In subregion 3, T-DINEOF achieves higher reconstruction accuracy from October to the following February and in April, while in the remaining months, Single-DINEOF performs better than T-DINEOF. It is also noteworthy that Multi-DINEOF exhibits the lowest accuracy for SSW. As discussed in Section 4.1, the correlation between SSW and the other variables (SST and SCHL) is relatively low. Therefore, the multivariate synergy in Multi-DINEOF does not enhance the reconstruction accuracy of SSW under low-correlation conditions. This also demonstrates that the T-DINEOF method, owing to its tensor-based reconstruction framework, is more effective in improving the reconstruction accuracy of variables with weak inter-variable correlations."
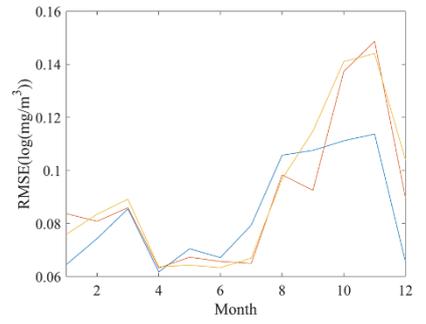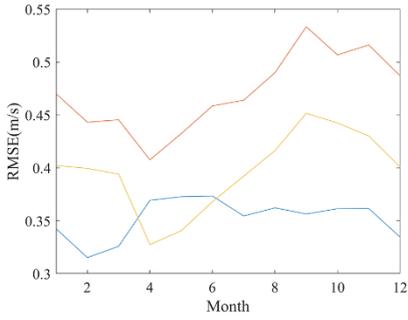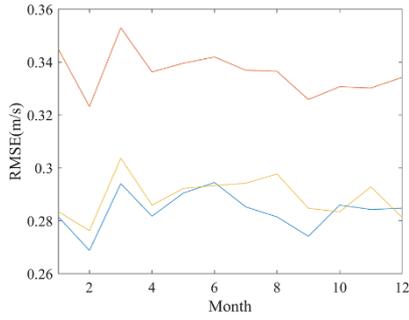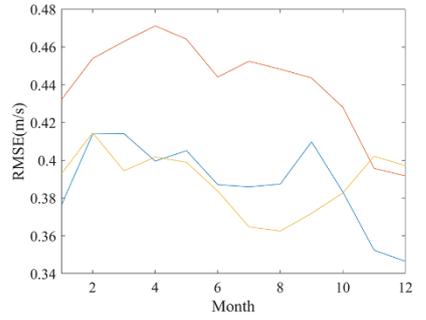

(a) (b) (c)
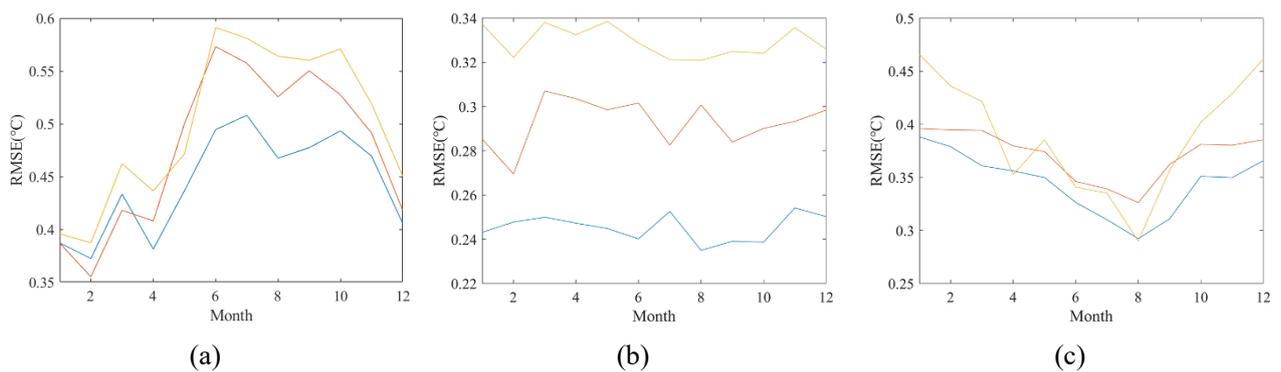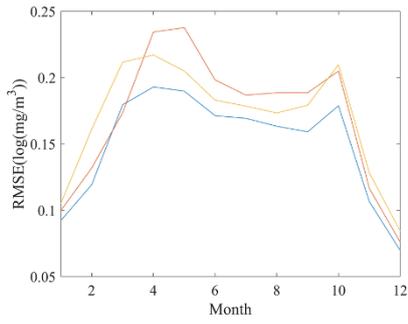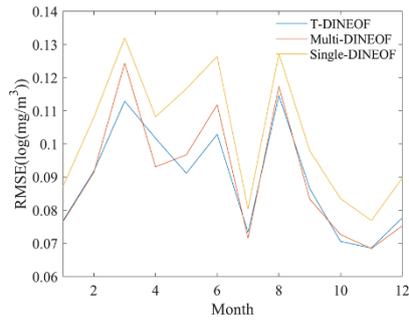
Fig.S3 Monthly RMSEs for (a-c) SST, (d-f) SCHL, and (g-i) SSW in subregions 1-3 (from left to right).