Supplements of

Reconstruction of Arctic sea ice thickness (1999-2010) based on a hybrid machine learning and data assimilation approach

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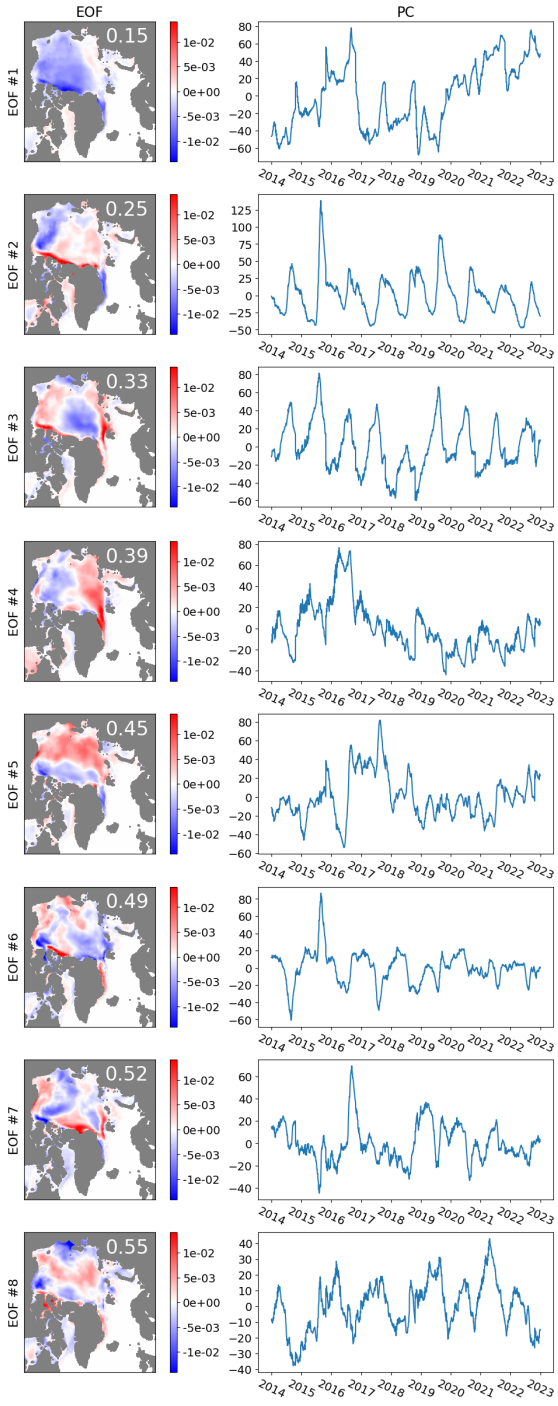

Figure S1. EOF decomposition obtained for SIT bias (TOPAZ4-RA - TOPAZ4-FR) for 8 components over the years 2014-2022. Each row shows a different component, with the left column presenting the spatial pattern of error and the right column the temporal coefficients. The cumulative explained variance is noted in the upper right corner of each EOF.

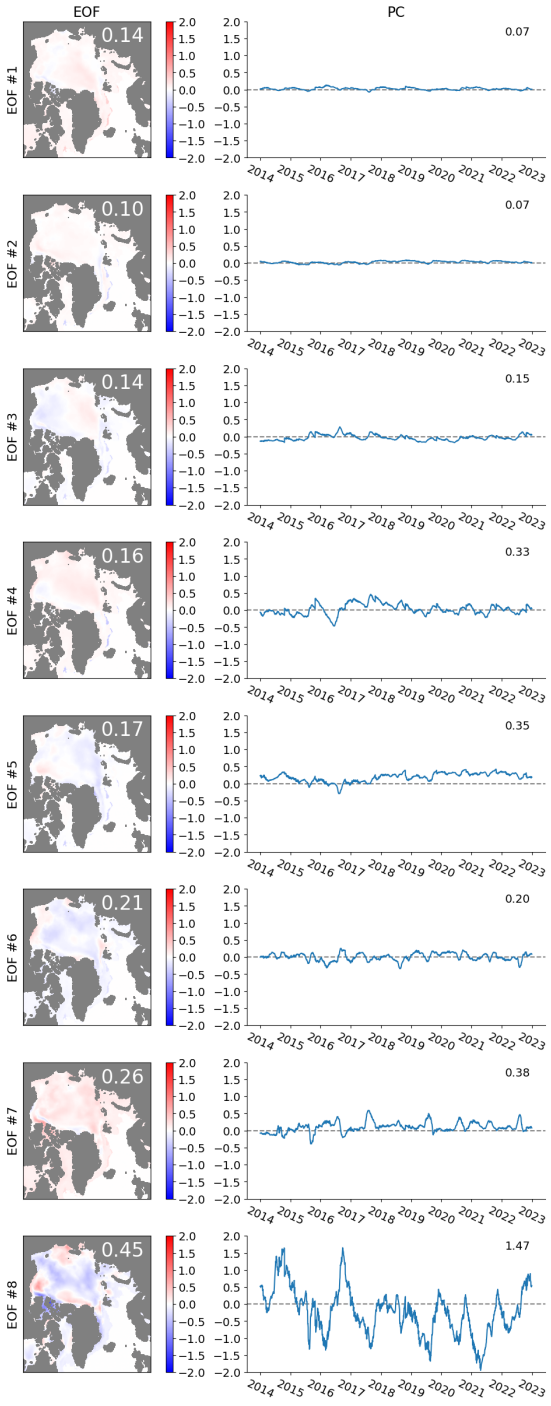

Figure S2. Differences of EOF decomposition between the 2011-2022 period and the 2014-2022. Both have been scaled between -1 and 1 before computing differences. The colour bar and y axis span from -2 to 2 to emphasize the total range of potential differences. The 95^{th} percentile of the absolute values is noted on the upper right corner of each subplot. Significant differences in EOF are observed from EOF #6 to #8. The highest differences are observed for the eighth component as it contains the residual part of the signal which is not further decomposed.

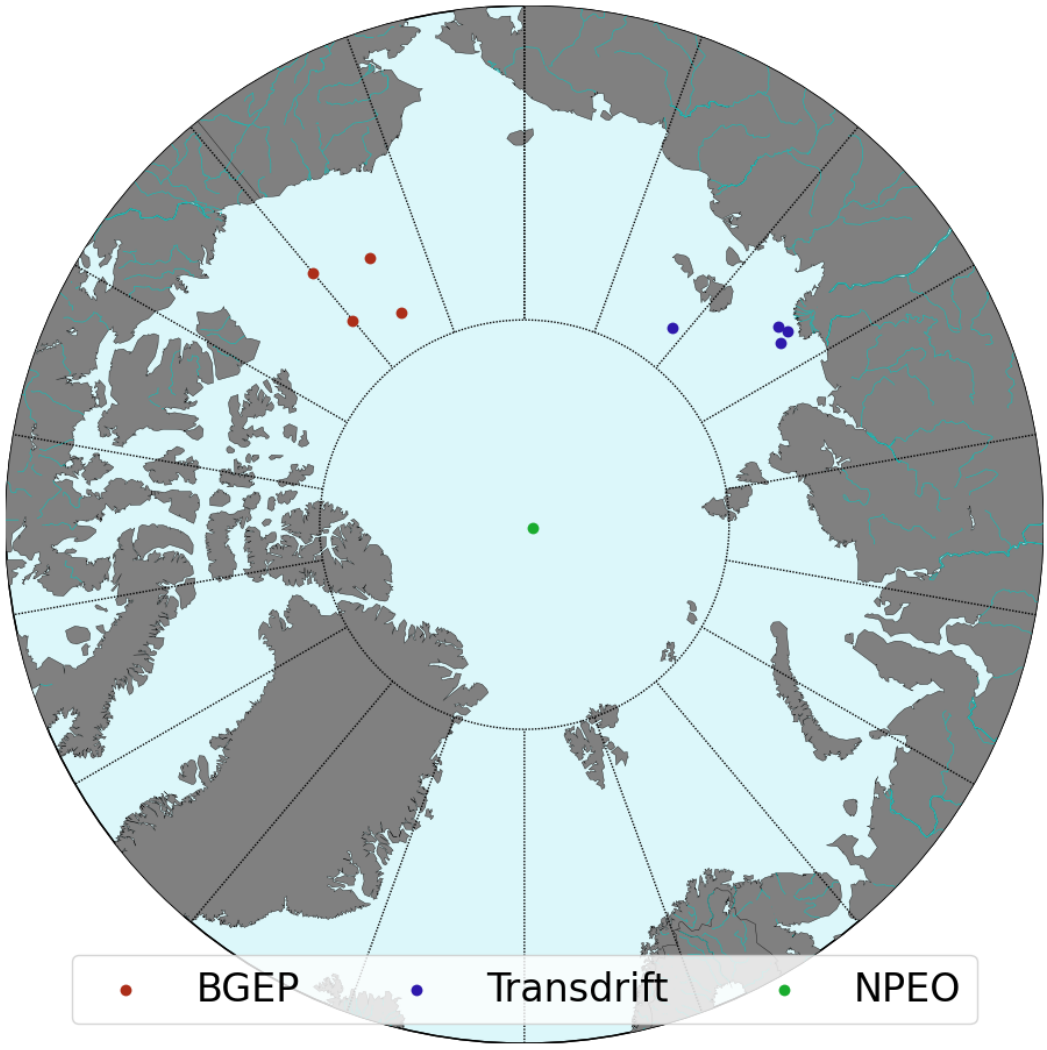

Figure S3. Locations of buoys for various datasets used in this study.

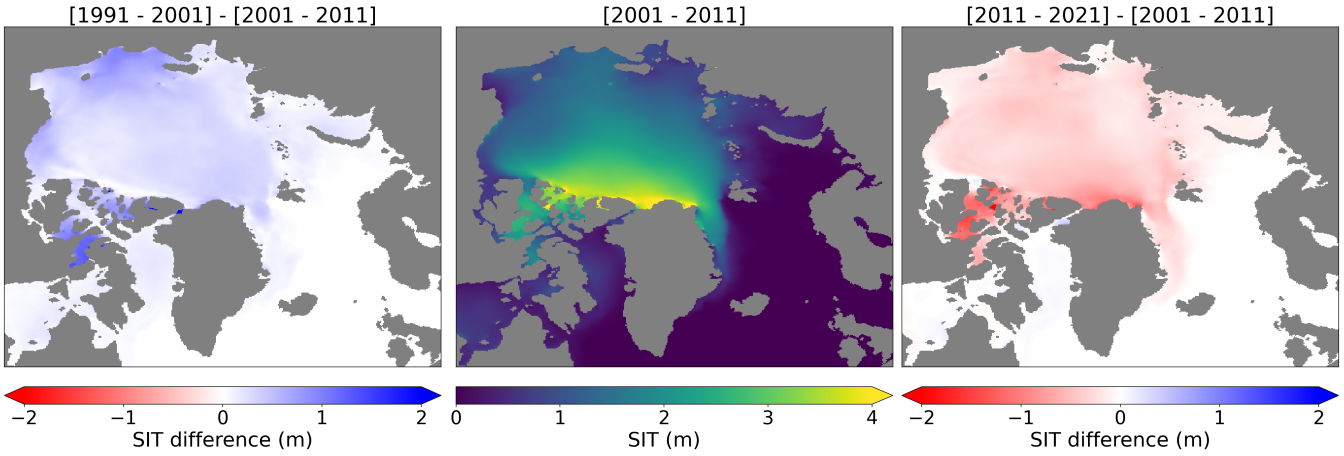

Figure S4. Mean sea ice thickness (meters) and anomalies for each decade. Anomalies are computed compared to 2001-2011.

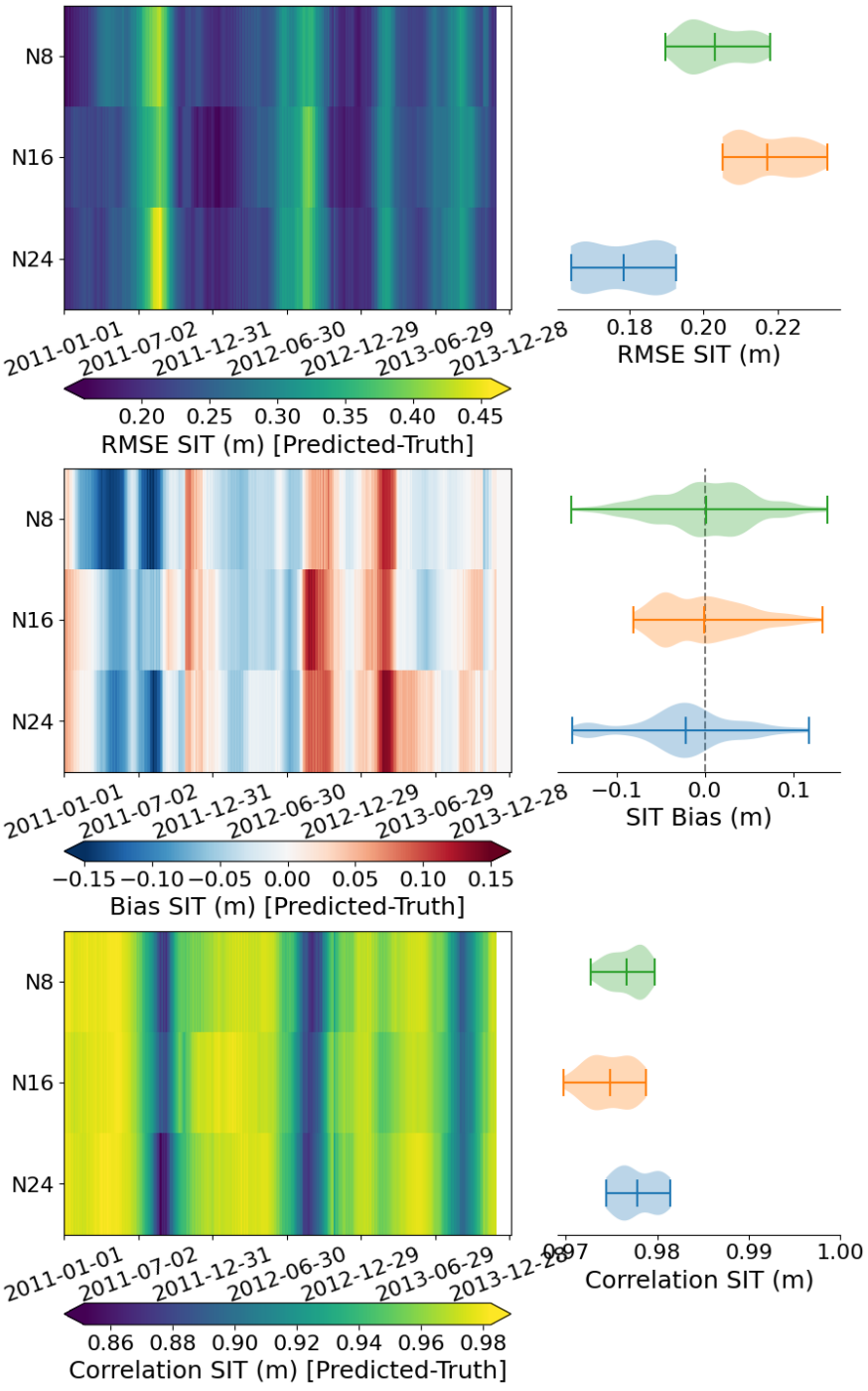

Figure S5. Comparison of the SIT predicted with 8, 16, and 24 principal components. The evaluation is conducted over the test period 2011-2013 against SIT from TOPAZ.

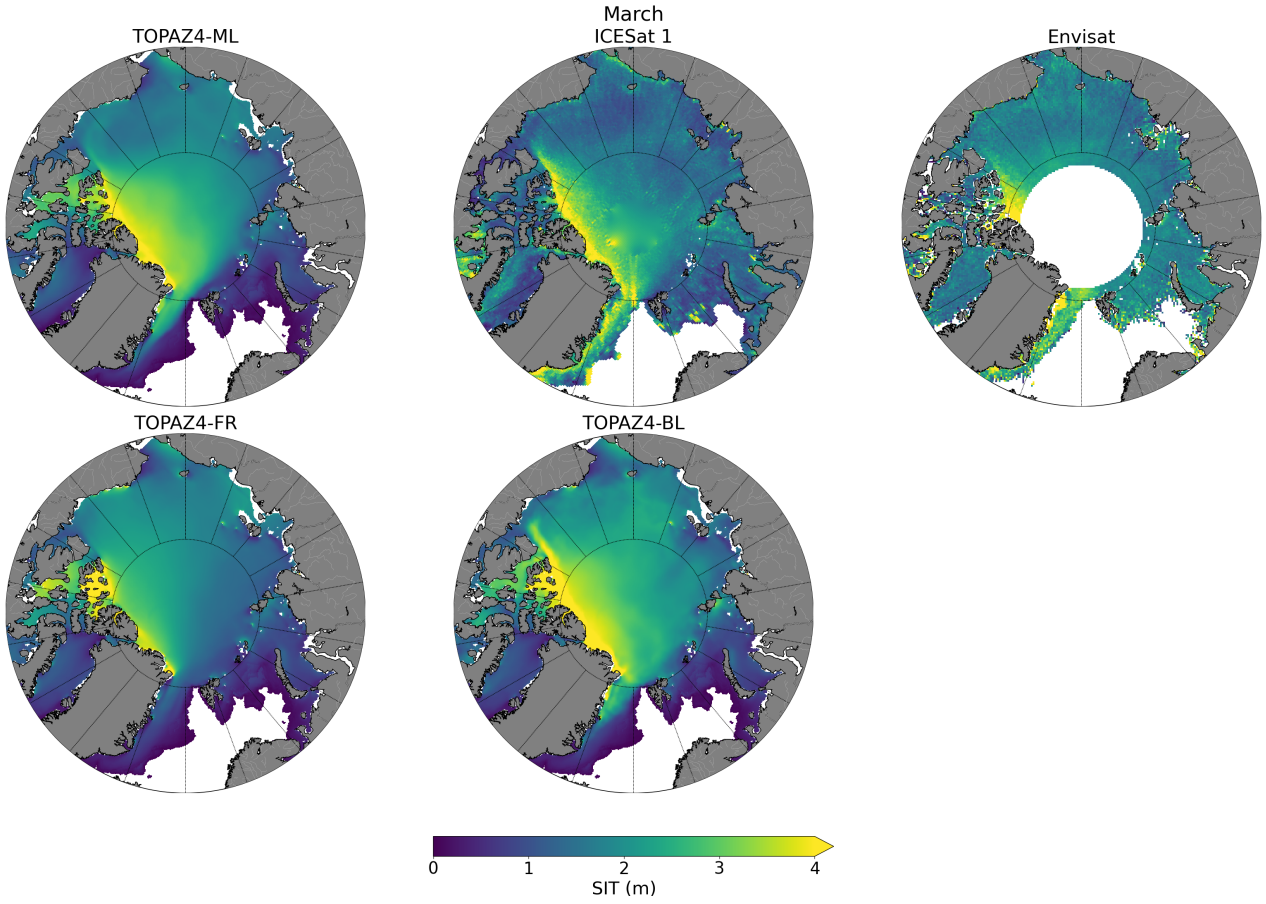

Figure S6. Sea ice thickness (meters) for TOPAZ4-ML, ICESat-1, Envisat, TOPAZ4-FR, and TOPAZ4-BL averaged over March 2003-2007. ICESat-1 observation period varies, including days in February or in April depending on the year.

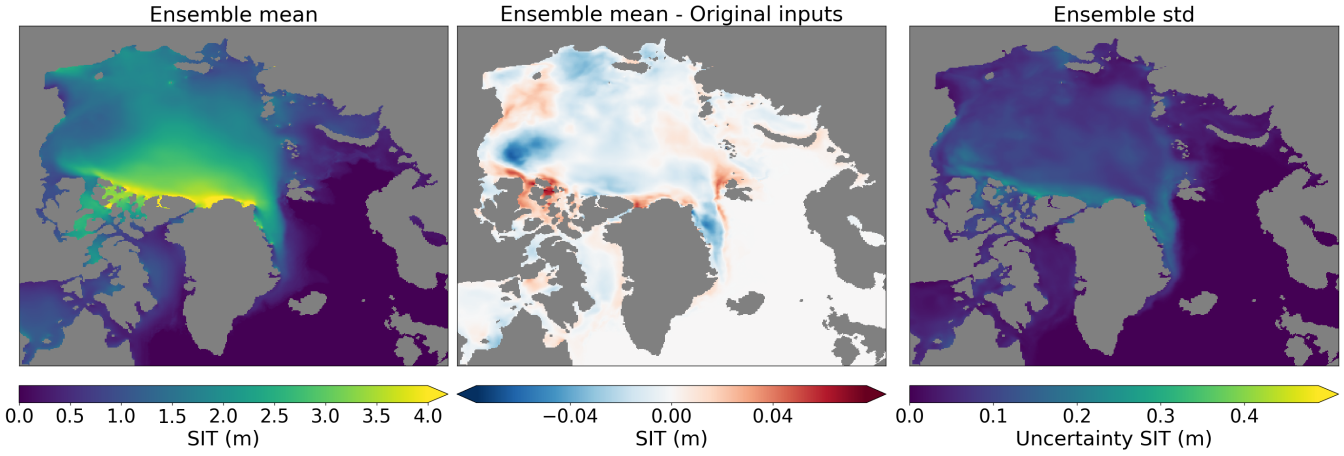

Figure S7. (left) Mean SIT (m) over 50 members. **(center)** SIT difference (m) between mean SIT over all members and input features without any perturbation. **(right)** One deviation standard of all members, which corresponds to the uncertainty of our machine learning model.

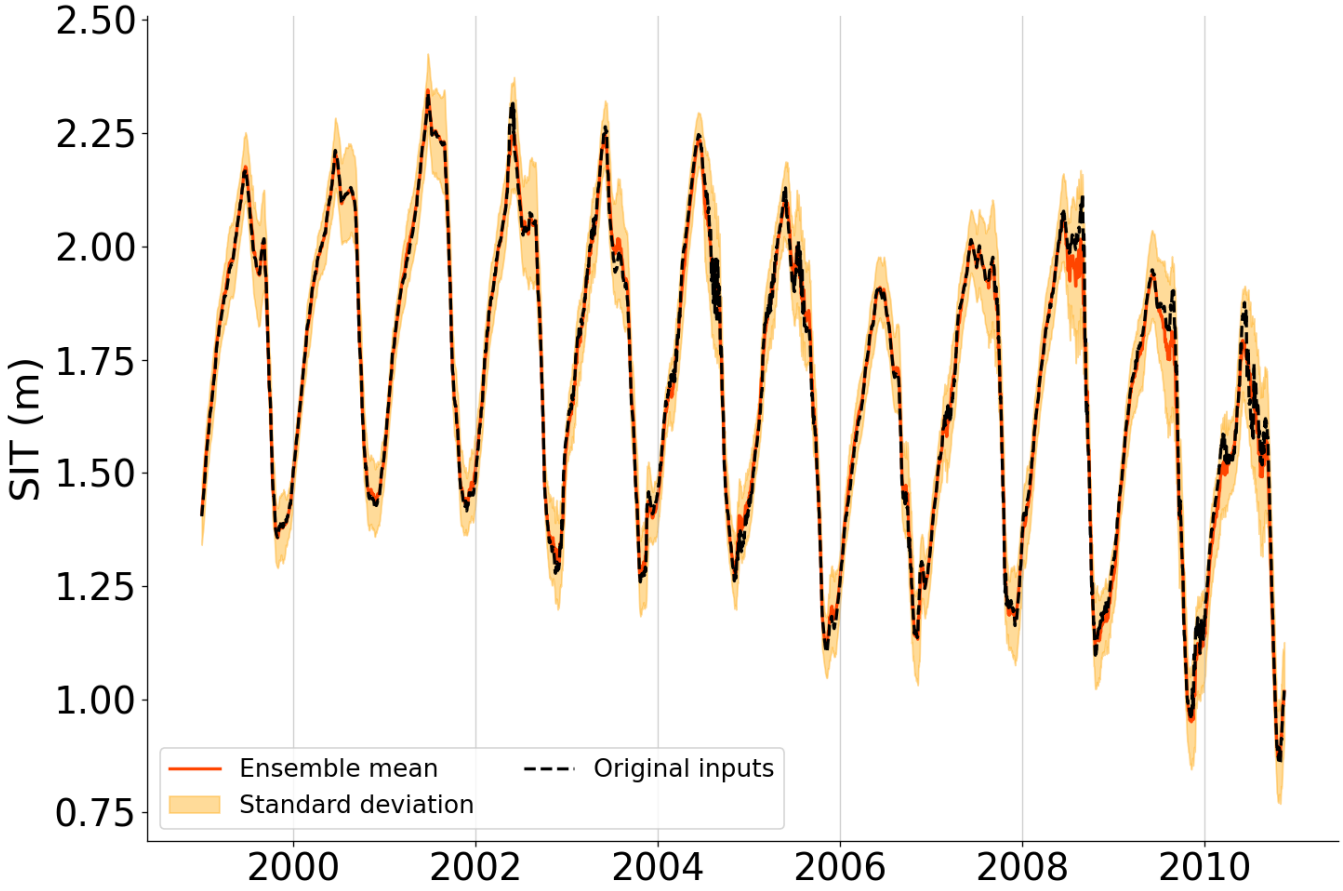

Figure S8. Daily sea ice thickness (m) averaged over the Arctic without input features perturbation, SIT averaged over 50 members with input features perturbation, and the standard deviation of these 50 members.