

TOWARD OCEAN MODEL-DRIVEN ROBOTIC EXPLORATION

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This supplementary material provides additional analysis and figures in support of the main manuscript. In particular, it includes supplementary visualizations used to (1) clarify operational and methodological aspects of the *sample-assimilate-predict-direct* loop, and (2) enable direct, side-by-side comparisons between model solutions and in situ observations for readers who wish to examine those aspects in greater detail.

Figure S1 provides a high-resolution comparison between planned and realized autonomous underwater vehicle (AUV) trajectories for the relevant deployment days. For quantitative context, the maximum deviation between the planned and realized paths (from top-left to bottom-right panels) is 256 m, 318 m, 218 m, 155 m, and 279 m, respectively.

In our algorithmic framework, routes are not designed to target a single location of maximum pointwise uncertainty; instead, a planned route is selected to maximize the *accumulated* path-integrated uncertainty that can be sampled under the relevant operational constraints. **Figure S2** complements that perspective by summarizing how the temperature error metric accumulates over mission duration across the deployments, providing a compact diagnostic for comparing error growth behavior among scenarios.

Figures S3–S13 show qualitative comparison of SST fields across CMEMS NEMO model products and scenarios from C to C4 and from D to D4, all for October 31, 2024. Scatter plots are shown to compare the spatial models with the AUV data.

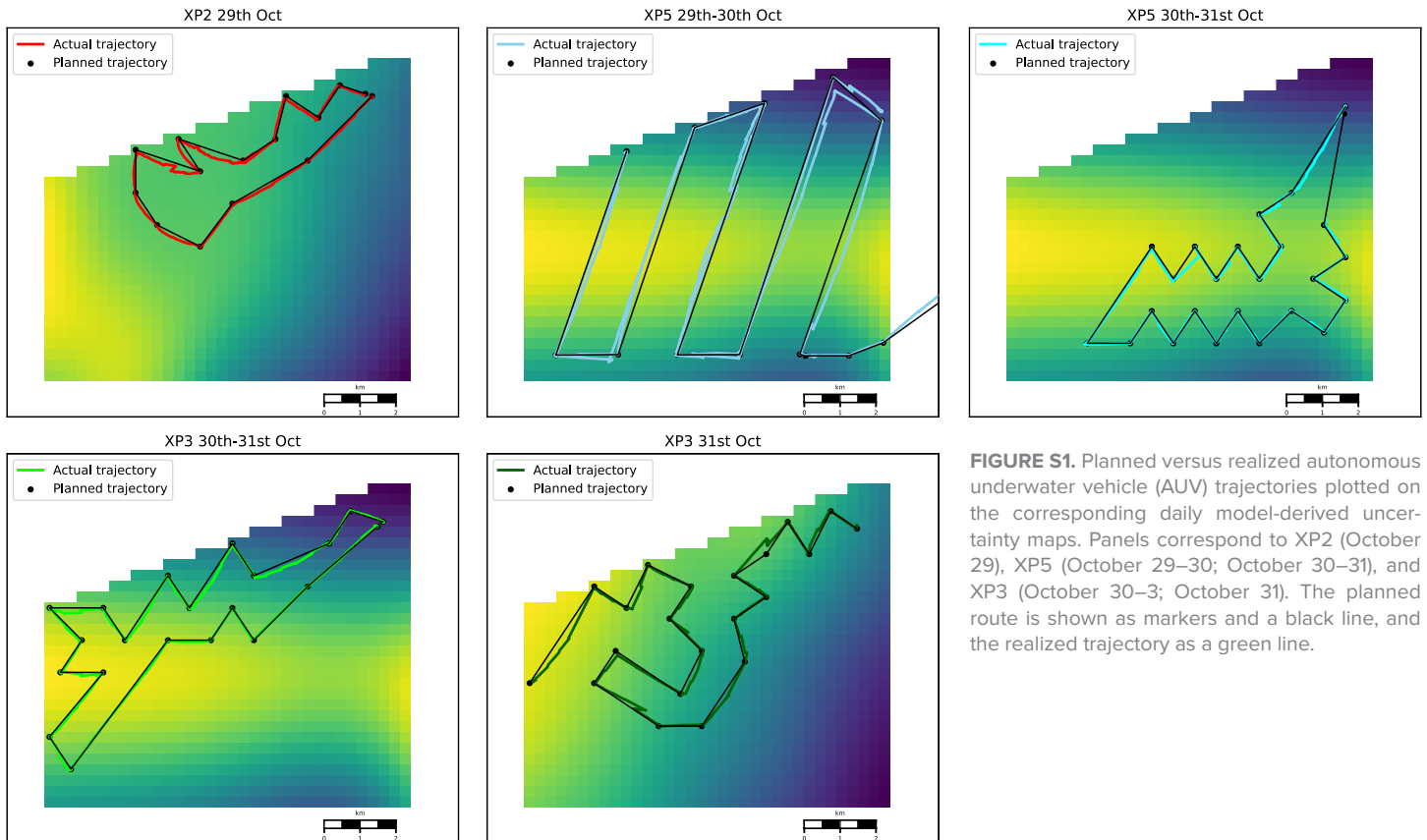


FIGURE S1. Planned versus realized autonomous underwater vehicle (AUV) trajectories plotted on the corresponding daily model-derived uncertainty maps. Panels correspond to XP2 (October 29), XP5 (October 29–30; October 30–31), and XP3 (October 30–3; October 31). The planned route is shown as markers and a black line, and the realized trajectory as a green line.

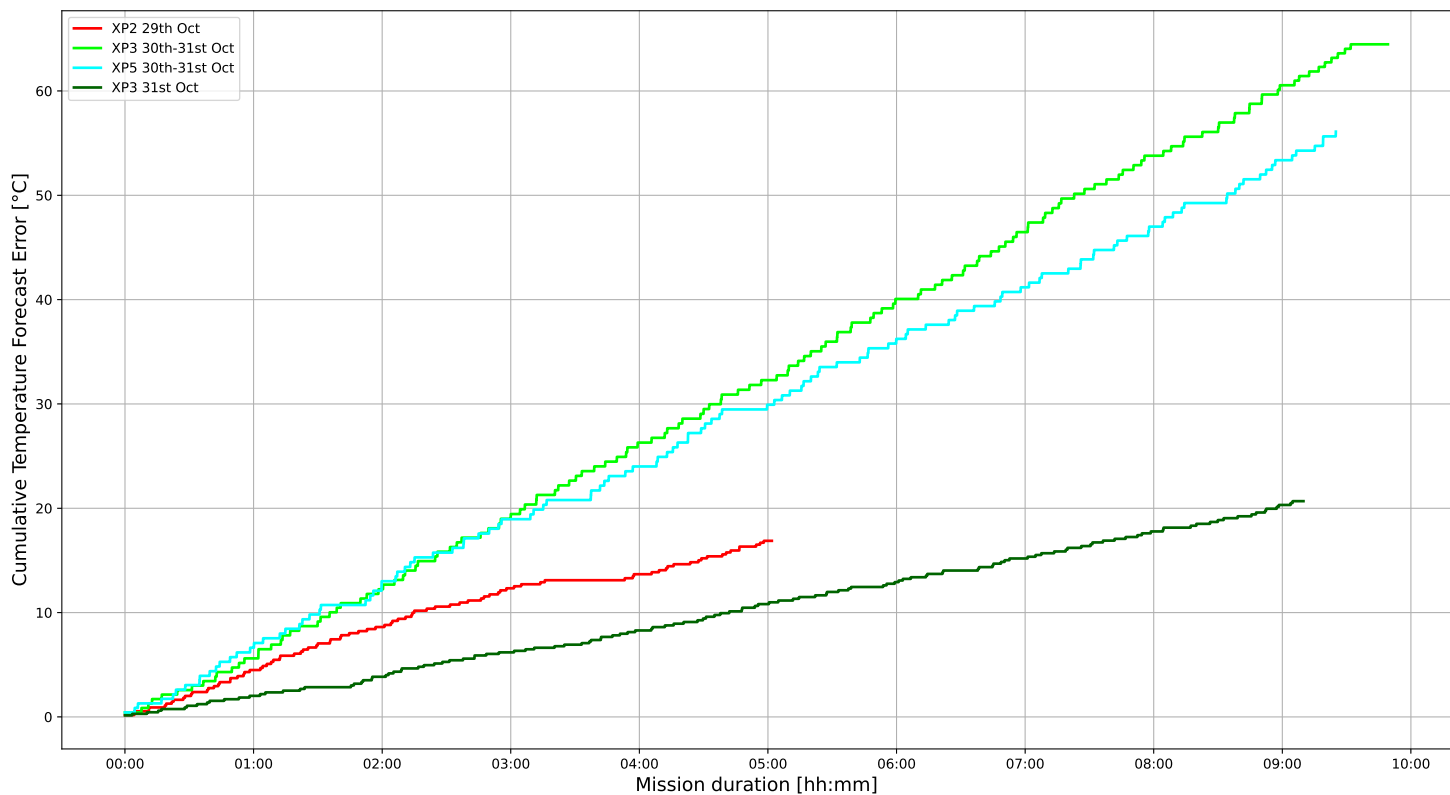


FIGURE S2. Cumulative temperature error as a function of mission duration for the different AUV missions shown in the legend. Each colored curve corresponds to a mission after generating a new plan, allowing a direct comparison of how *uncertainty* accumulates over time across missions.

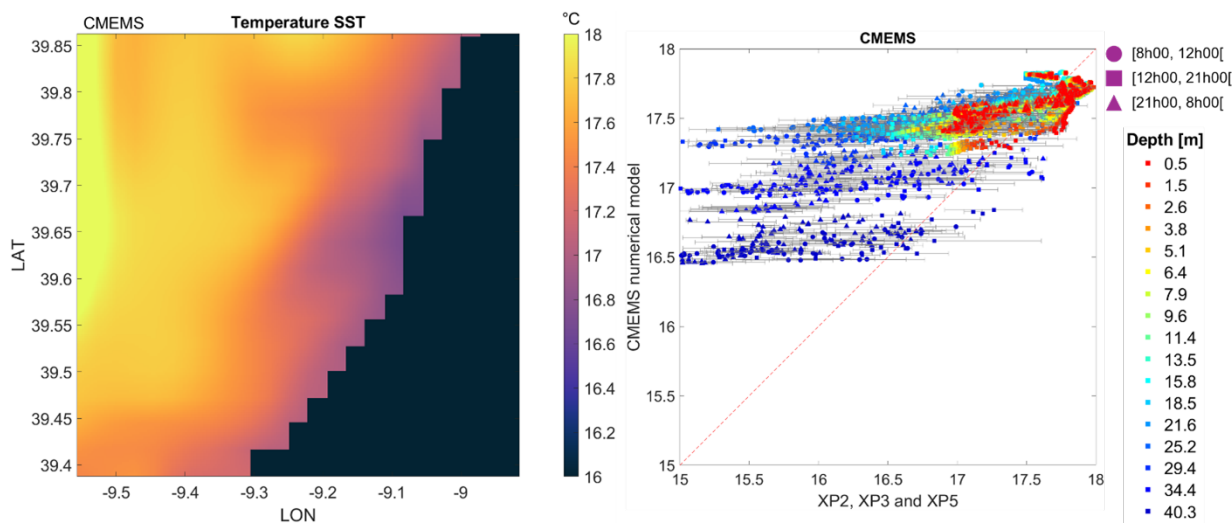


FIGURE S3. The prediction for October 31, 2024, from the CMEMS NEMO numerical model downloaded on October 30, 2024.

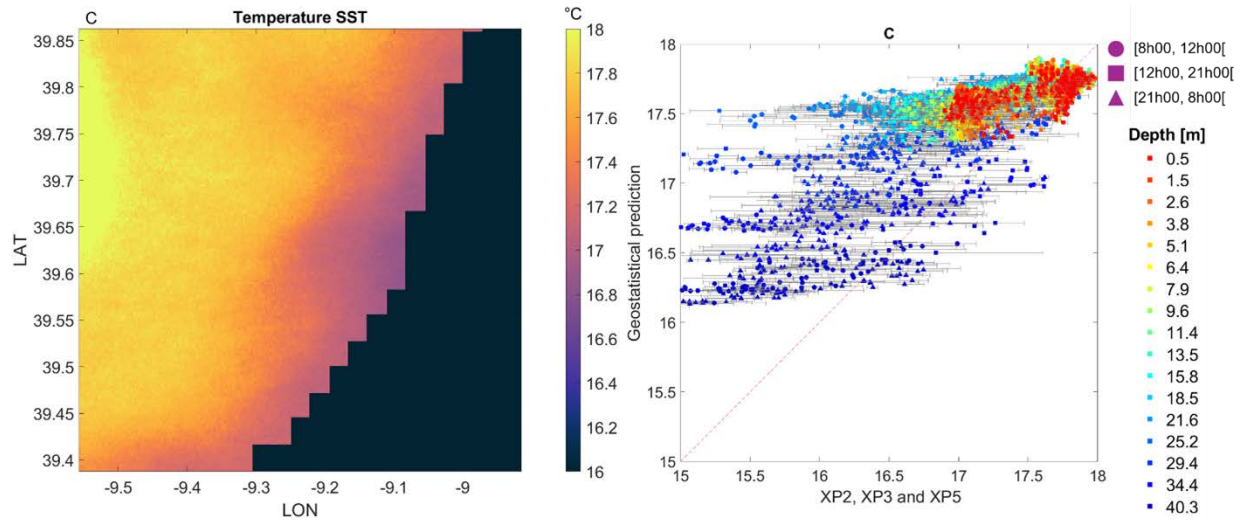


FIGURE S4. Statistical model prediction without assimilation for October, 31, 2024—Scenario C and scatterplot between prediction and values measured by XP2, XP3, and XP5.

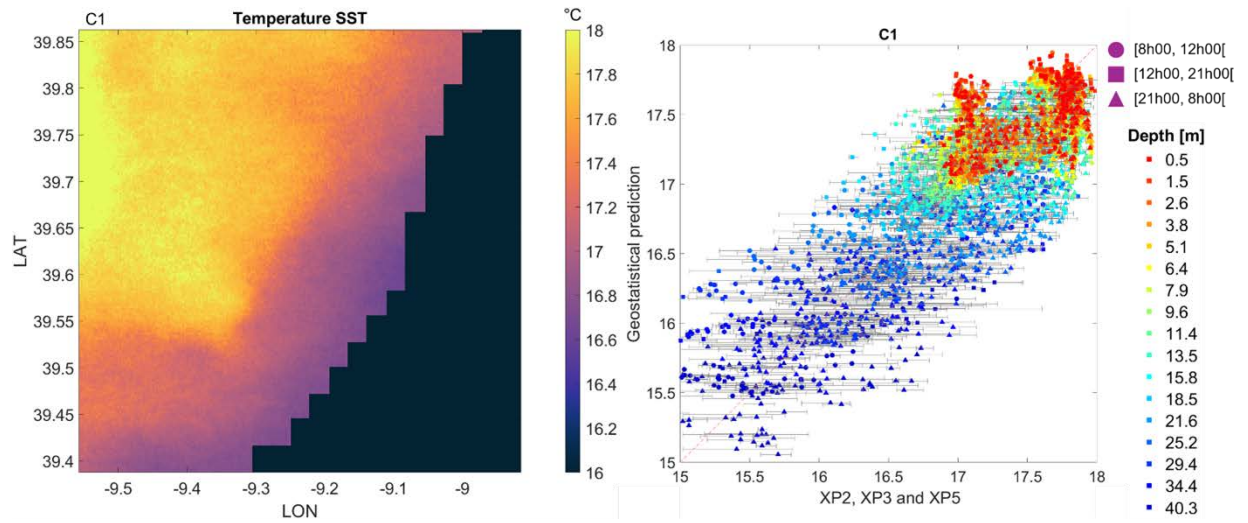


FIGURE S5. Statistical model predictions with assimilation for October, 31, 2024—Scenario C1 and scatterplot between prediction and values measured by XP2, XP3, and XP5.

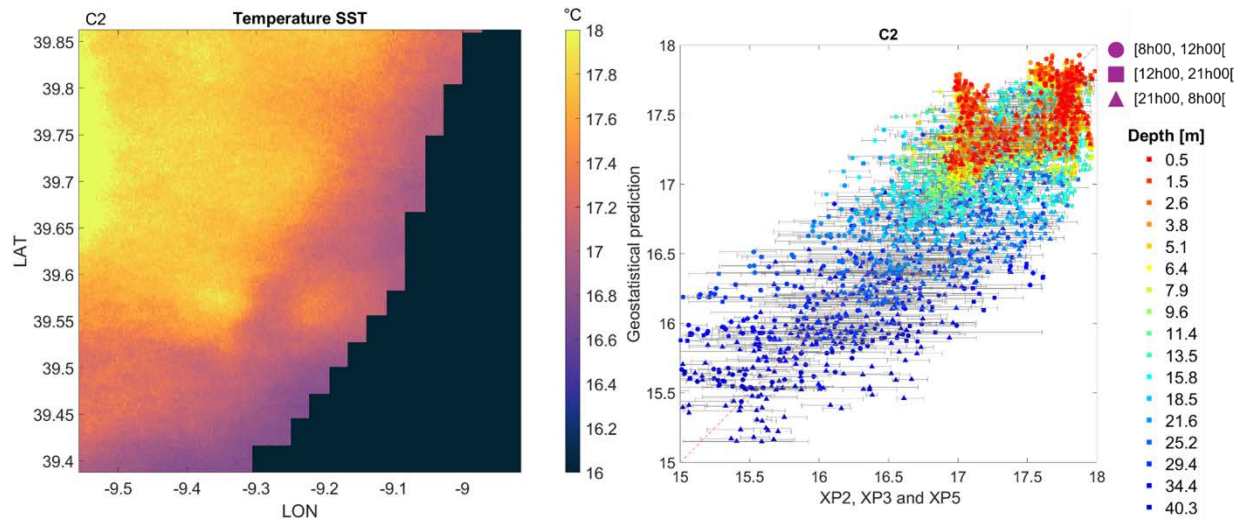


FIGURE S6. Statistical model predictions with assimilation for October, 31, 2024—Scenario C2 and scatterplot between prediction and values measured by XP2, XP3, and XP5.

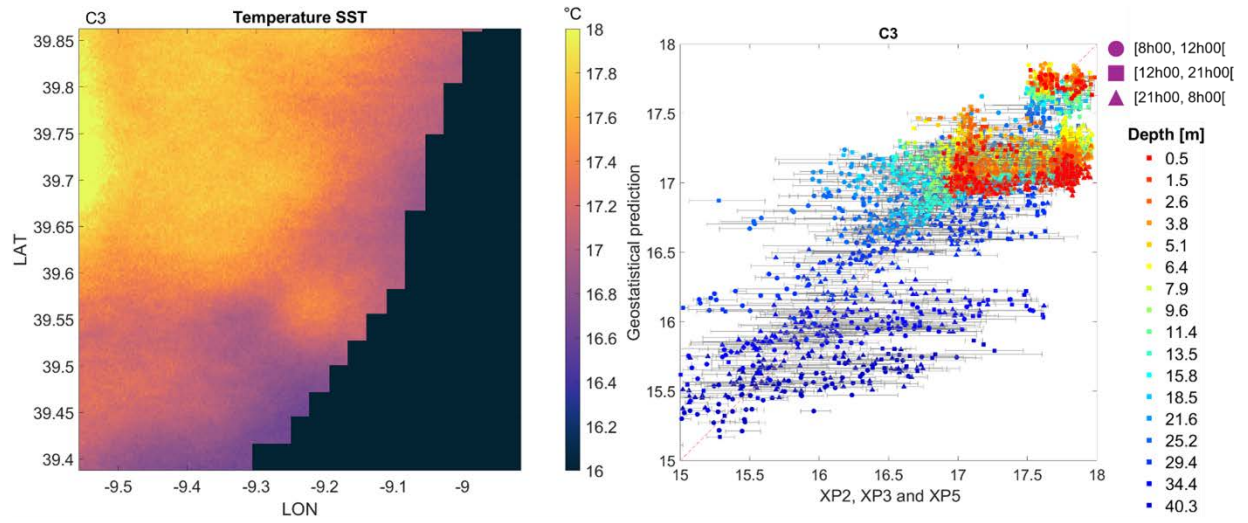


FIGURE S7. Statistical model predictions with assimilation for October 31, 2024—Scenario C3 and scatterplot between prediction and values measured by XP2, XP3, and XP5.

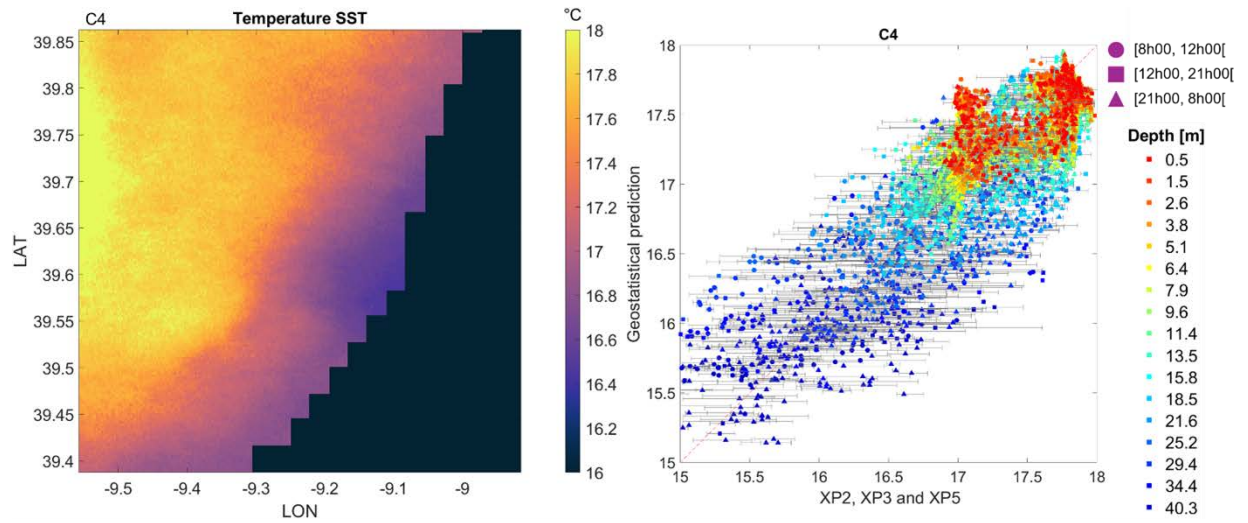


FIGURE S8. Statistical model predictions with assimilation for October 31, 2024—Scenario C4 and scatterplot between prediction and values measured by XP2, XP3, and XP5.

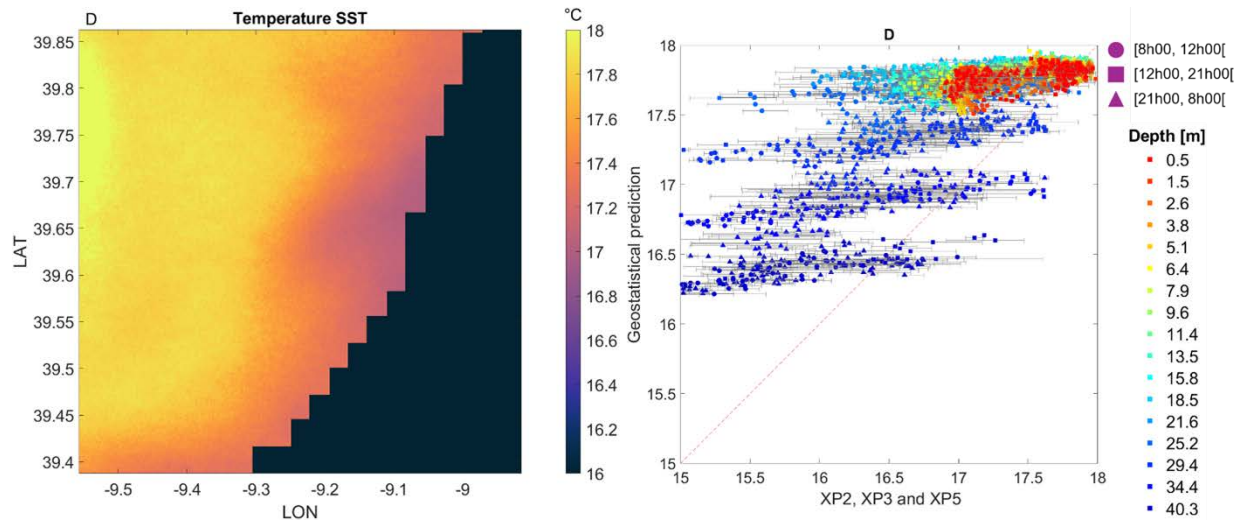


FIGURE S9. Statistical model prediction without assimilation for October 31, 2024—Scenario D and scatterplot between prediction and values measured by XP2, XP3, and XP5.

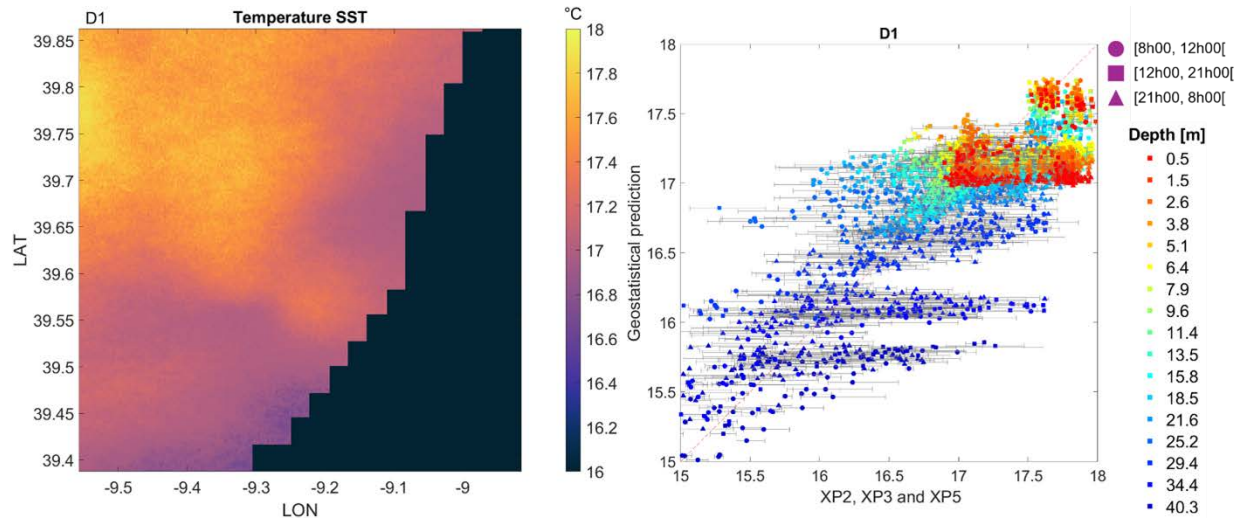


FIGURE S10. Statistical model predictions with assimilation for October 31, 2024—Scenario D1 and scatterplot between prediction and values measured by XP2, XP3, and XP5.

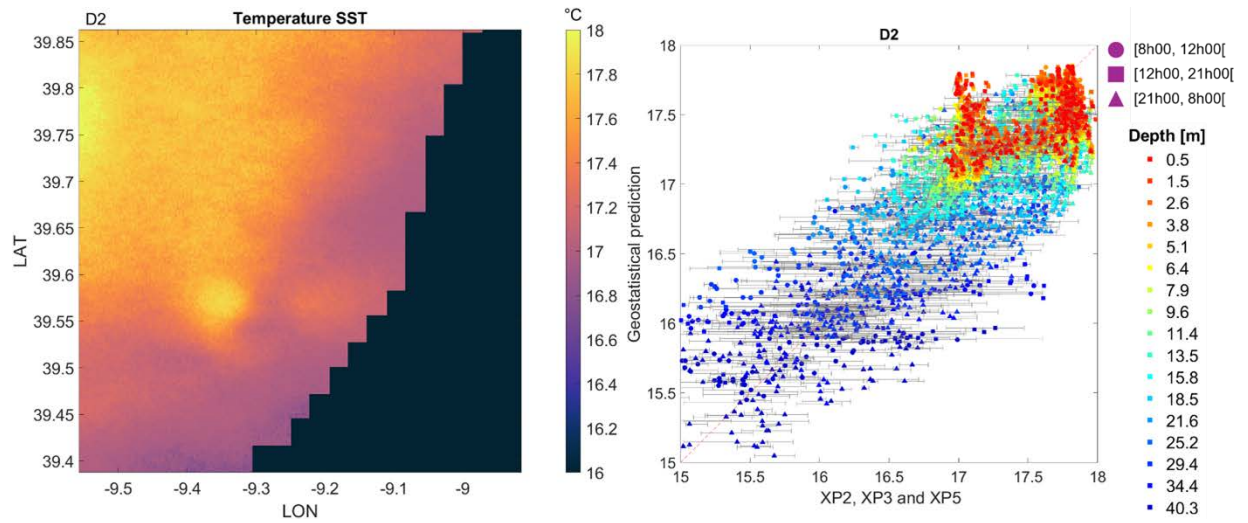


FIGURE S11. Statistical model predictions with assimilation for October 31, 2024—Scenario D2 and scatterplot between prediction and values measured by XP2, XP3, and XP5.

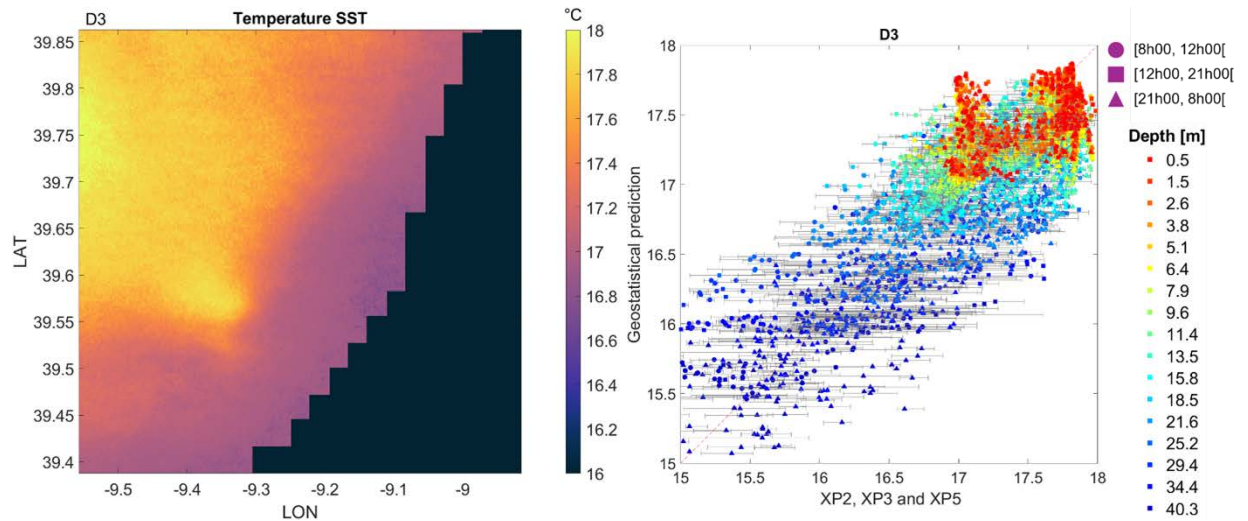


FIGURE S12. Statistical model predictions with assimilation for October 31, 2024—Scenario D3 and scatterplot between prediction and values measured by XP2, XP3, and XP5.

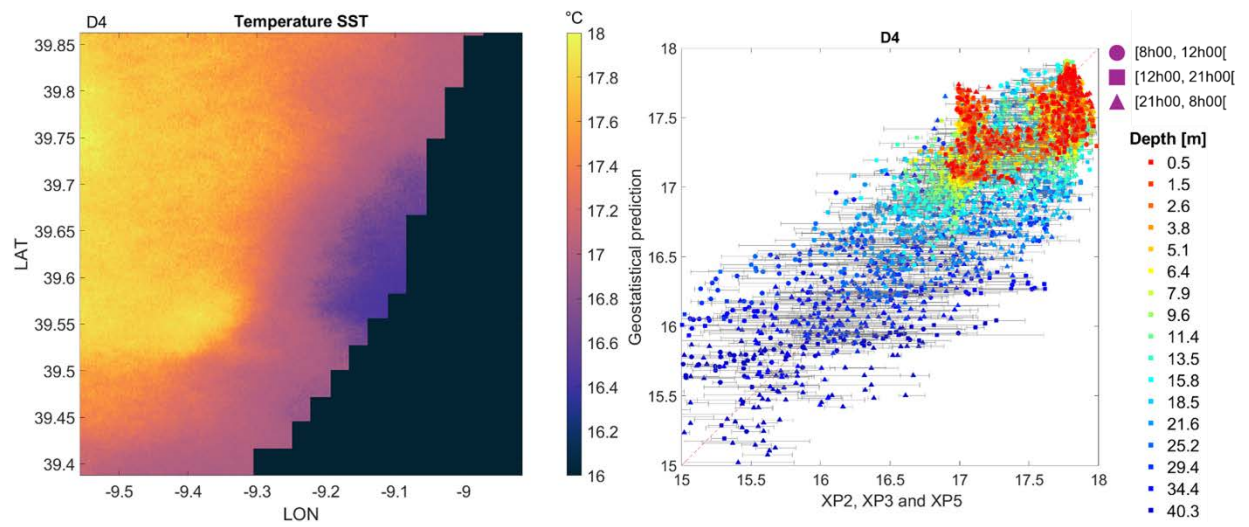


FIGURE S13. Statistical model predictions with assimilation for day October 31, 2024—Scenario D4 and scatterplot between prediction and values measured by XP2, XP3, and XP5.