Supplementary Material

1 SUPPLEMENTARY TABLES AND FIGURES

Figure S1 We determine the optimal variable combination to train a generalized linear model based on the Akaike Information Criterion (AIC), the model accuracy of forecasting a bloom and no-bloom occurrence. We selected up to five variables out of a total of nineteen candidate variables to avoid overfitting, which results in a total of 16,663 variable combinations. The optimal five-variable combination is {T, S, pH, swrad, TON}.

Figures S2-S4 In the main manuscript, we show the response of (the logit of) the probability of a *P. minimum* bloom of the generalized additive model trained using variable combination {T, S, pH, swrad, TON} to salinity, temperature, and interacting solar irradiance and temperature (Fig. 5). For completeness, we show this response to all other (interacting) variables.

Figures S5-S8 In the Chesapeake Bay Program database, when measurements are below the detection limit, the value of the parameter is set to the detection limit. Detection limits for many parameters have been lowered over the life of the program. We show the relative frequency distribution of the normalized in situ observations that are directly measured. If these changes were important for our application, we would expect that these distributions would show sharp peaks at low values, and that the difference between these low values and observations surpassing these low values (i.e., the detection limit difference) would be large compared to the total measuring domain. However, we do not see this.

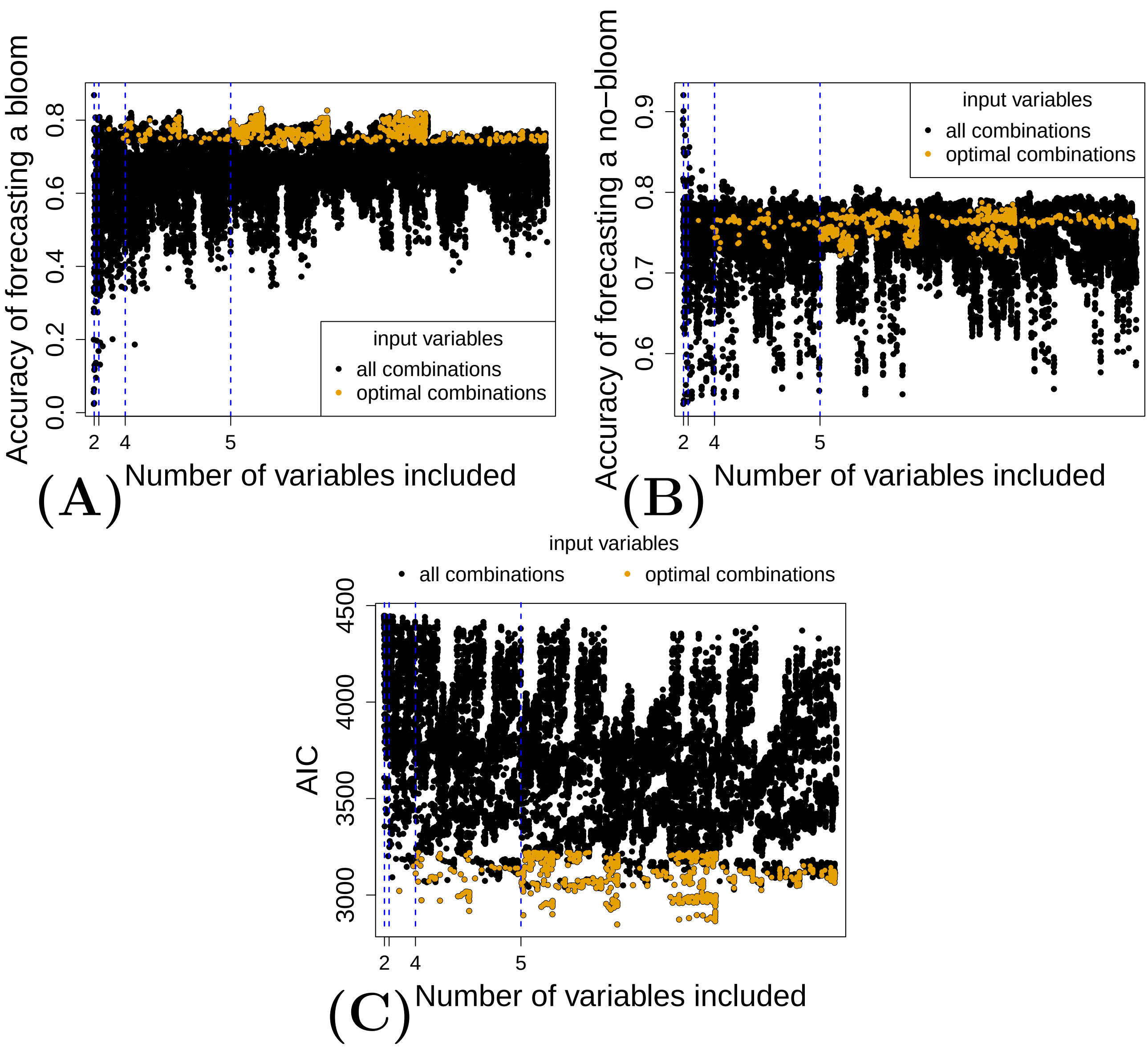

Figure S1. The goodness-of-fit of the generalized linear model (GLM) for all 16,663 variable combinations (black dots) and the 627 optimal combinations (orange dots) quantified by the model accuracy of forecasting **(A)** a bloom and **(B)** no-bloom event, and **(C)** Akaike Information Criterion (AIC).

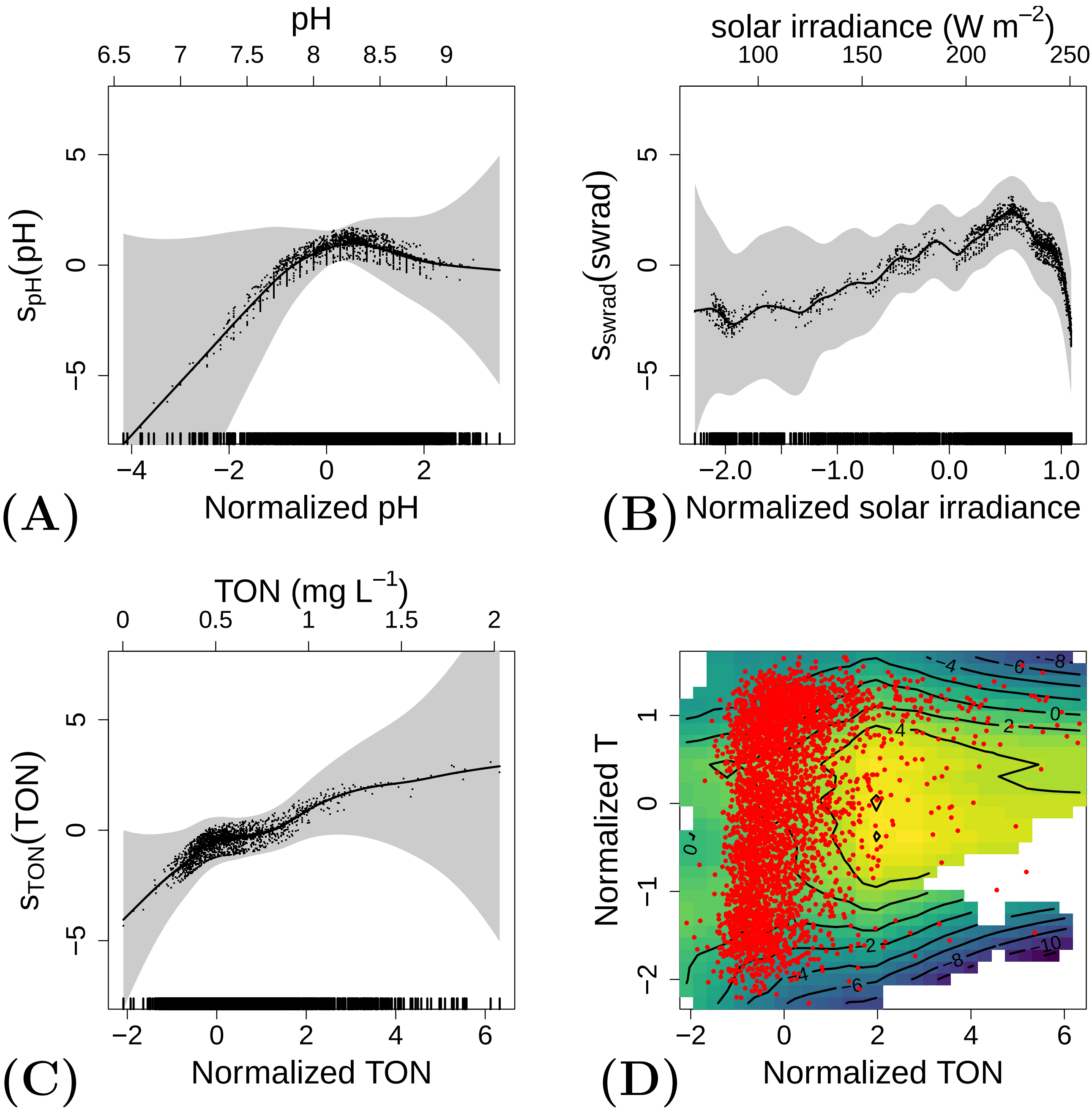

Figure S2. Nonlinear response of (the logit of) the probability of a *P. minimum* bloom to normalized **(A)** pH, **(B)** solar irradiance (swrad), **(C)** total organic nitrogen (TON), and **(D)** interacting normalized TON and water temperature (T), and the corresponding observations (red dots).

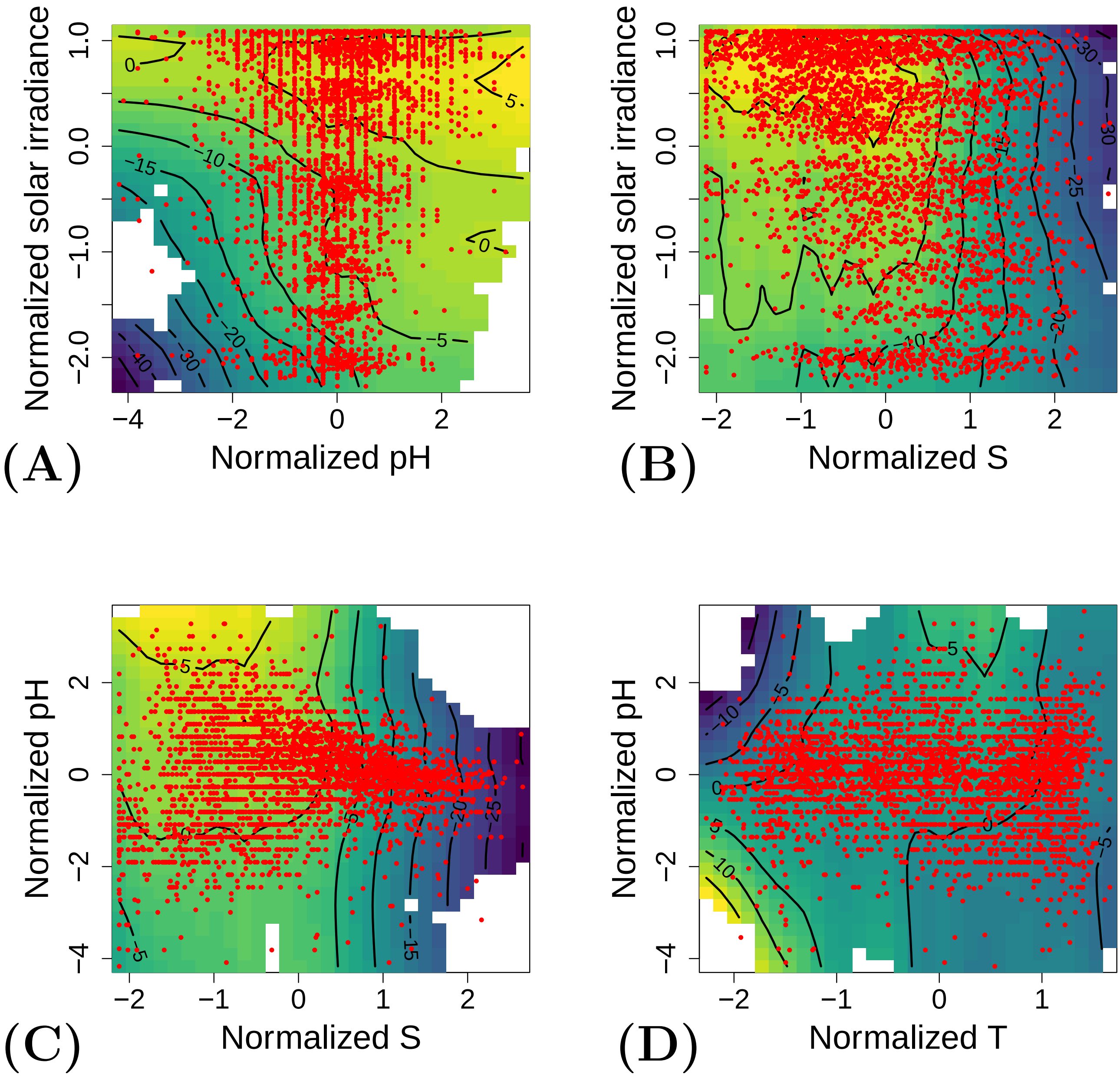

Figure S3. Nonlinear response of (the logit of) the probability of a *P. minimum* bloom to interacting normalized **(A)** pH and solar irradiance (swrad), **(B)** salinity (S) and swrad, **(C)** S and pH, and **(D)** water temperature (T) and pH, and the corresponding observations (red dots).

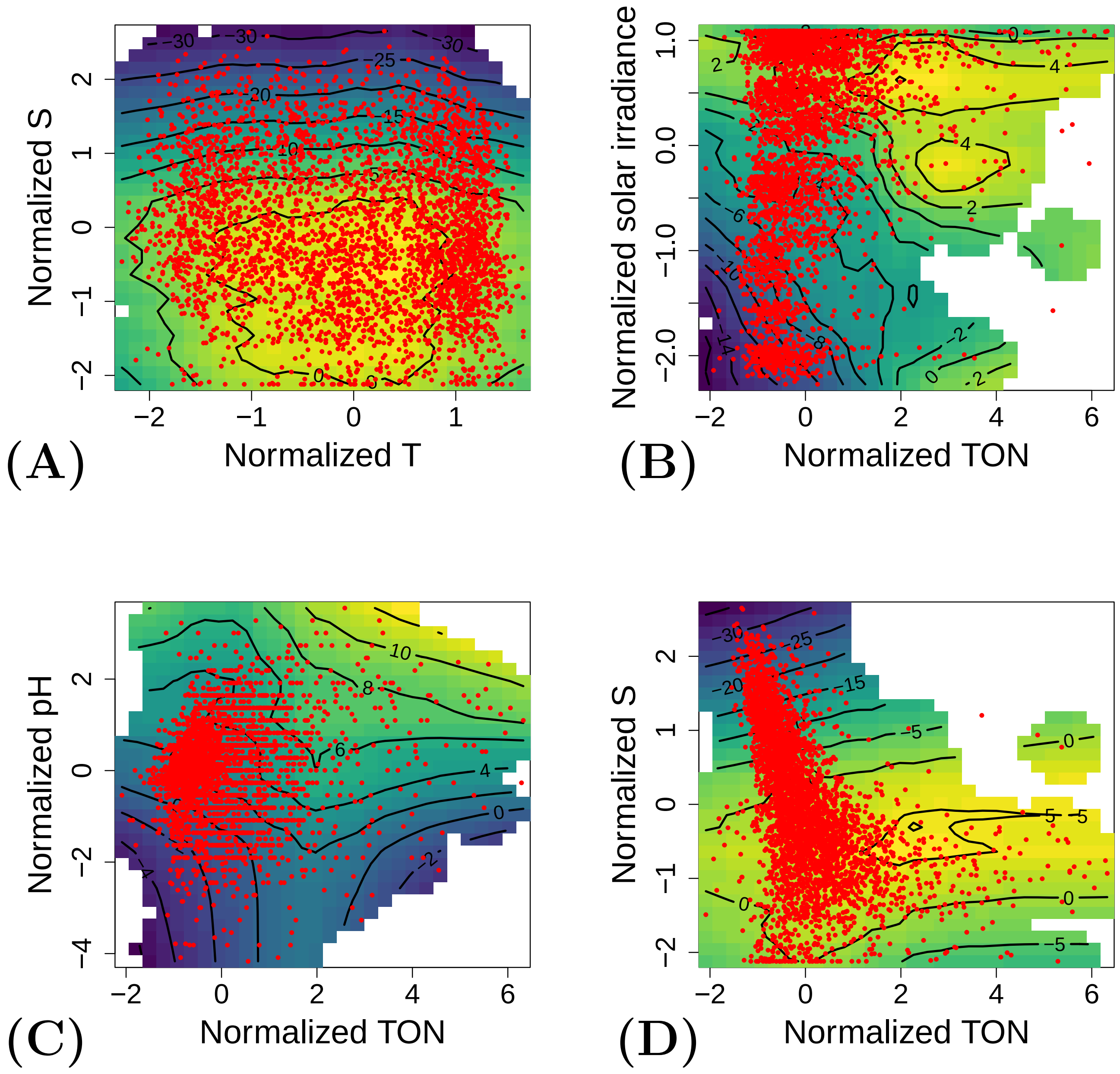

Figure S4. Nonlinear response of (the logit of) the probability of a *P. minimum* bloom to interacting normalized **(A)** water temperature (T) and salinity (S), **(B)** total organic nitrogen (TON) and solar irradiance (swrad), **(C)** TON and pH, and **(D)** TON and S, and the corresponding observations (red dots).

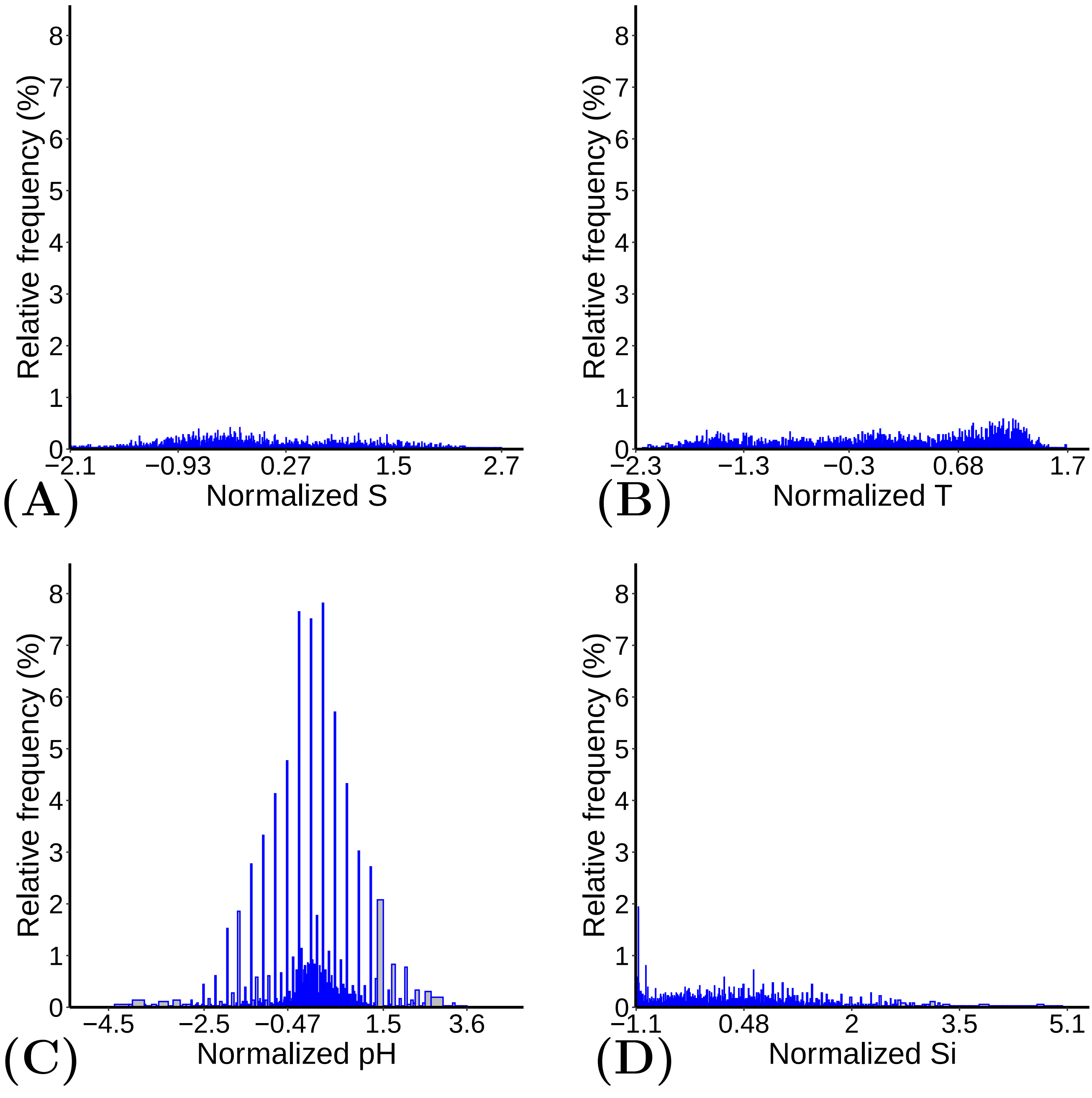

Figure S5. Relative frequency distribution of the normalized in situ observations of **(A)** salinity (S), **(B)** water temperature (T), **(C)** pH, and **(D)** silica concentration (Si).

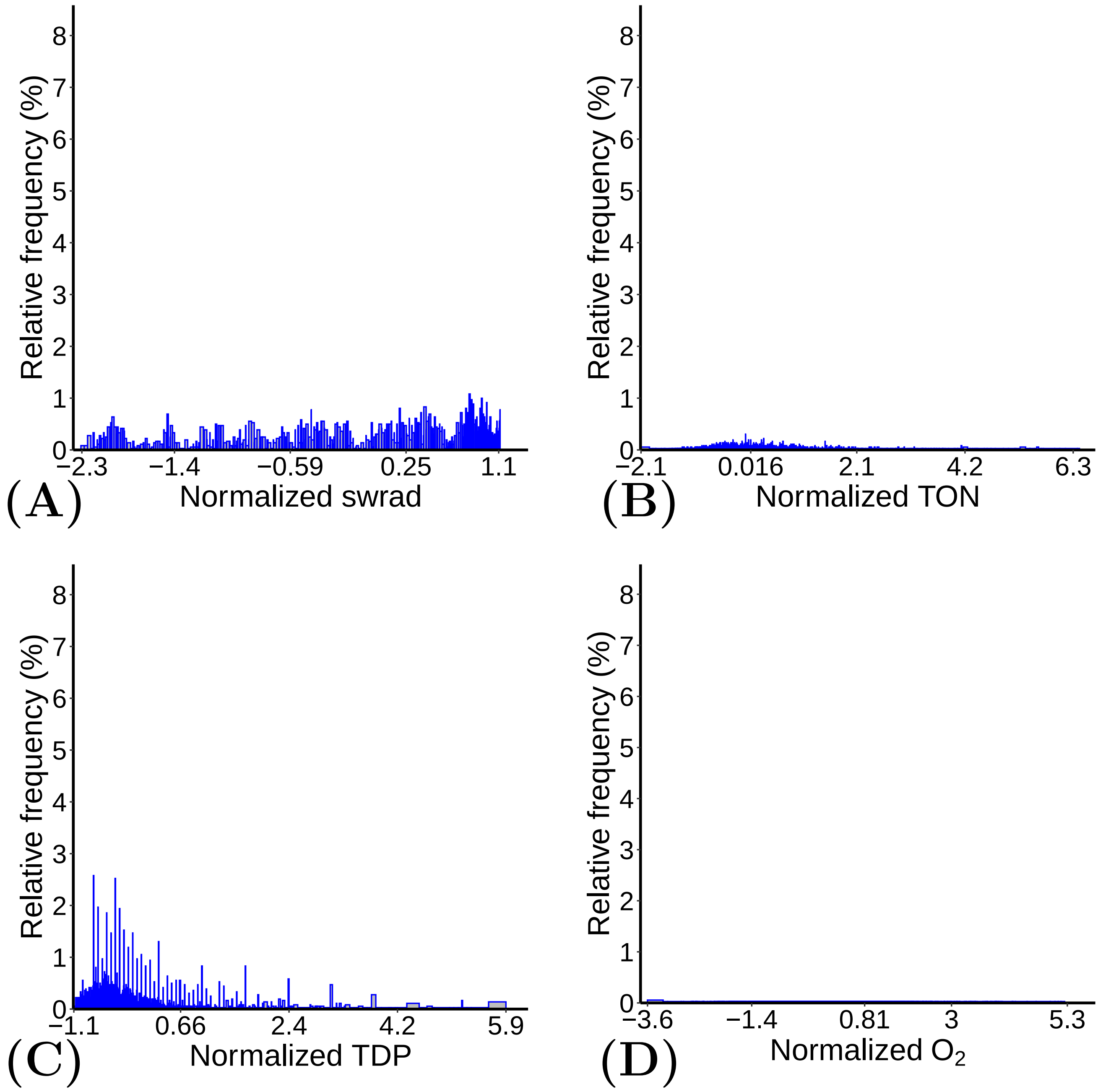

Figure S6. Relative frequency distribution of the normalized in situ observations of **(A)** solar irradiance (swrad), **(B)** total organic nitrogen concentration (TON), **(C)** total dissolved phosphorus concentration (TDP), and **(D)** dissolved oxygen saturation (O_2).

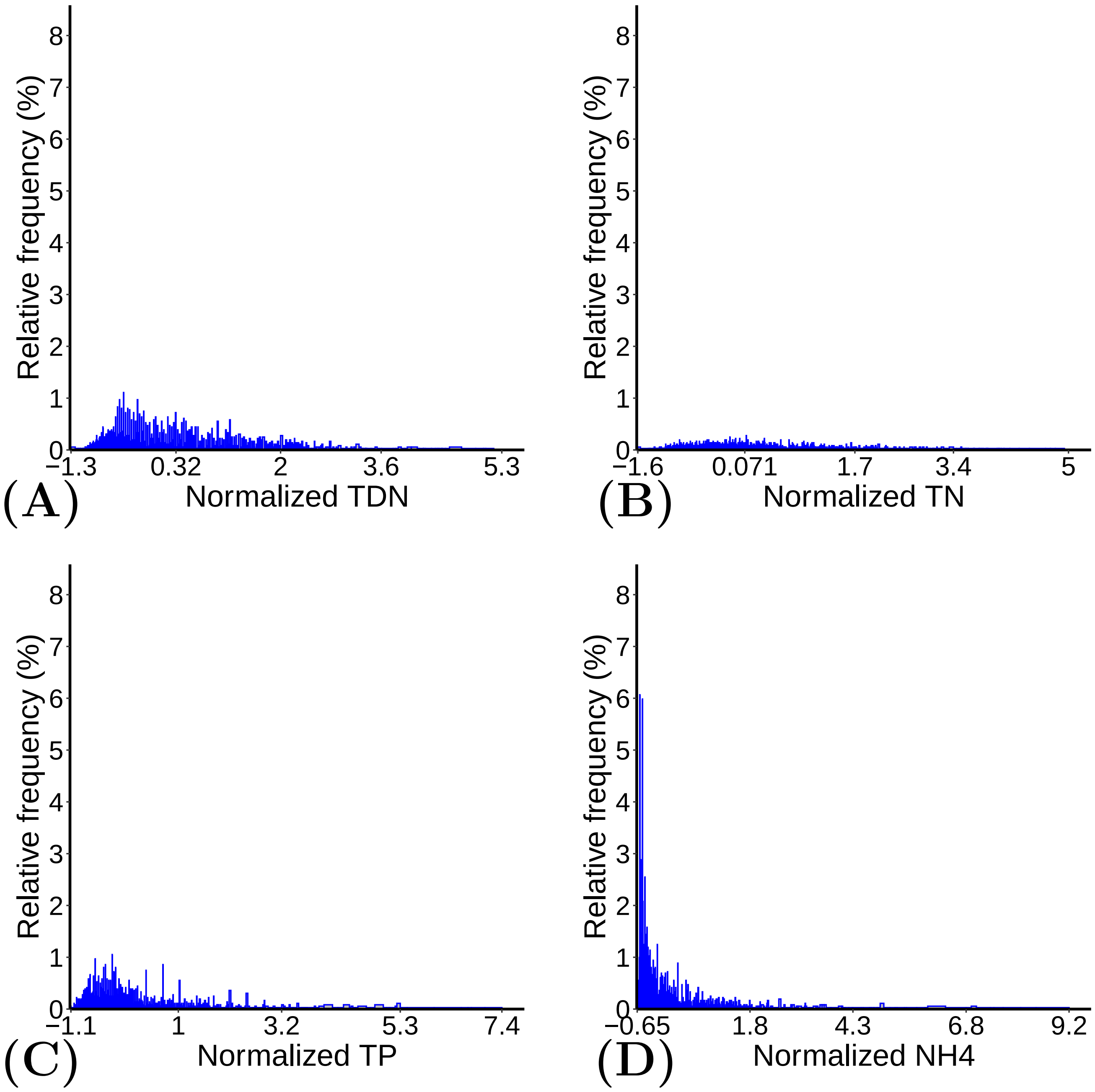

Figure S7. Relative frequency distribution of the normalized in situ observations of **(A)** total dissolved nitrogen concentration (TDN), **(B)** total nitrogen concentration (TN), **(C)** total phosphorus concentration (TP), and **(D)** ammonium concentration (NH4).

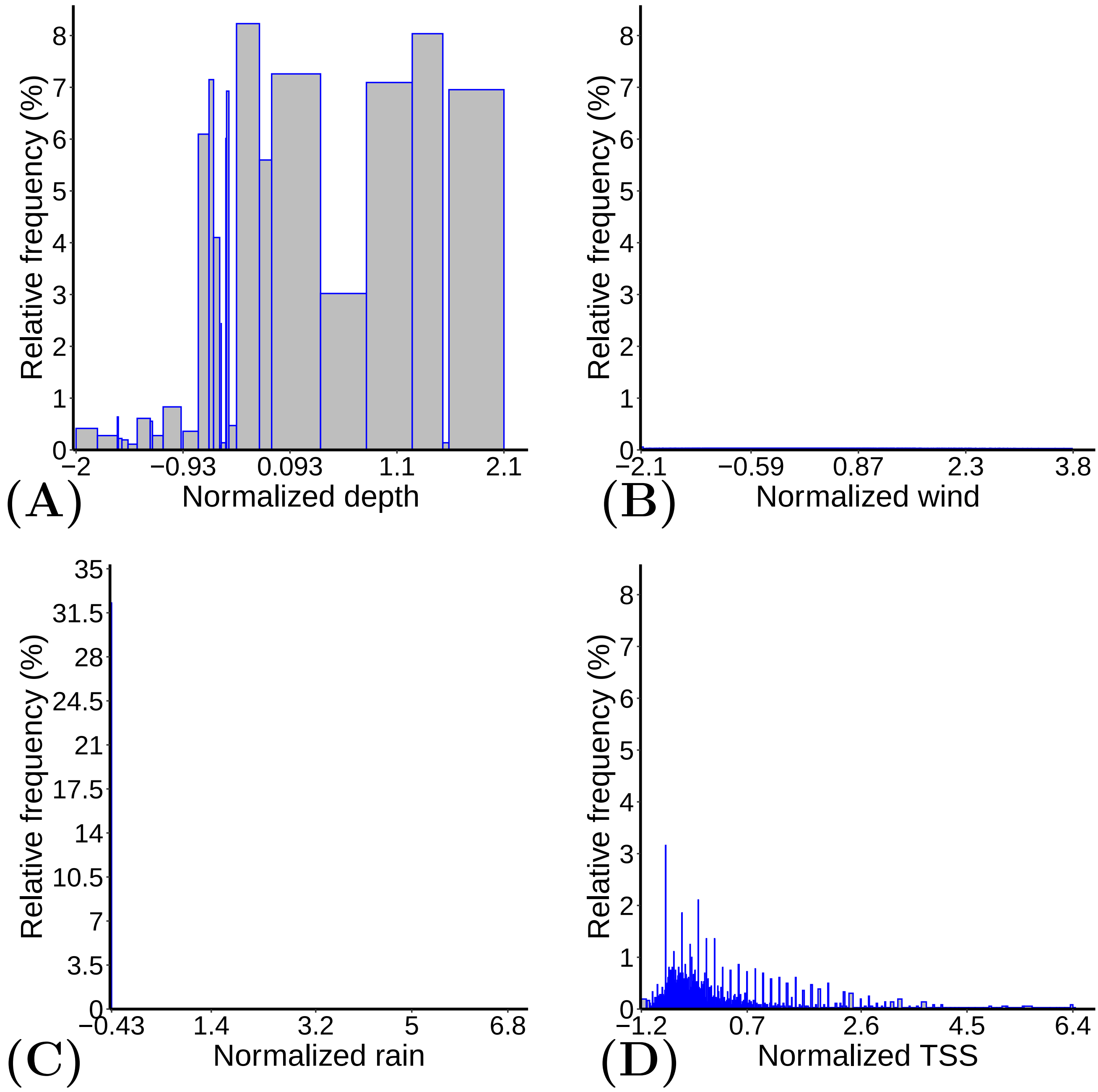

Figure S8. Relative frequency distribution of the normalized in situ observations of **(A)** long-term time-averaged water depth (depth), **(B)** magnitude of the wind velocity (wind), **(C)** precipitation (rain), and **(D)** total suspended solids concentration (TSS). Note that the y-axis corresponding to the precipitation observations was rescaled because a significant number of the observations correspond to no precipitation (i.e., 0 kg m^{-2} s^{-1} or $\sim$ -0.43 when normalized).