Supporting Information:

Pages: 4
Figures: 2
Movies: 6

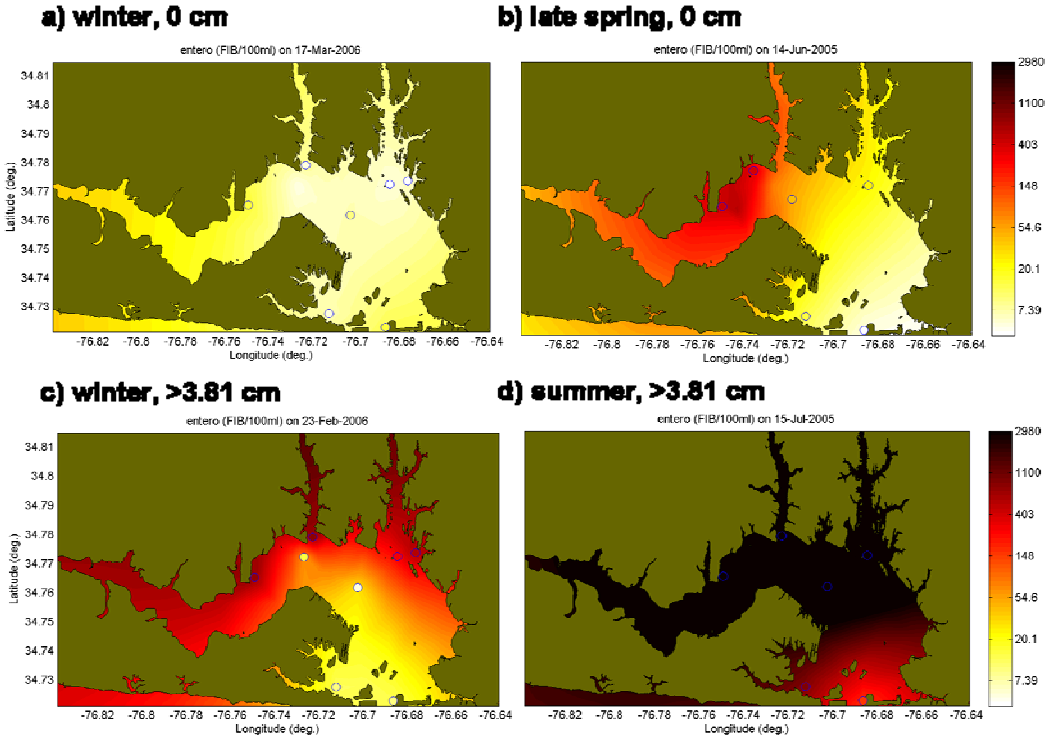
This supporting information provides (A) a description of the covariance nugget effect, (B) maps of the BME estimate of ENT (Figure S1), (C) a discussion of model fit and corresponding graphs (Figure S2), and (D) movies of BME estimates of EC and ENT. Any references referred to in the supporting information can be found in the reference section of the paper.

A. Supplemental description of the covariance nugget effect

The nugget effect of a covariance function is the component of that function which rapidly decreases for small spatial or temporal lags (p 151 of Journel and Huijbregts, 1978). An interpretation of the nugget effect is that it corresponds to measurement error variance (p 59 of Cressie, 1993). Consequently we remove the nugget effect from the experimental covariance before fitting a theoretical covariance model for the S/TRF $X(\boldsymbol{p})$ representing logFIB residual concentrations.

B. Supplemental Figure of the BME estimates of ENT

Figure S1. Maps of the BME estimate of *Enterococcus* (ENT) across the NPRE for selected events. The color bar on the right of the maps represents ENT Most Probable Number (MPN) per 100 ml. The x-axis and y-axis show the longitude and latitude coordinates, respectively.



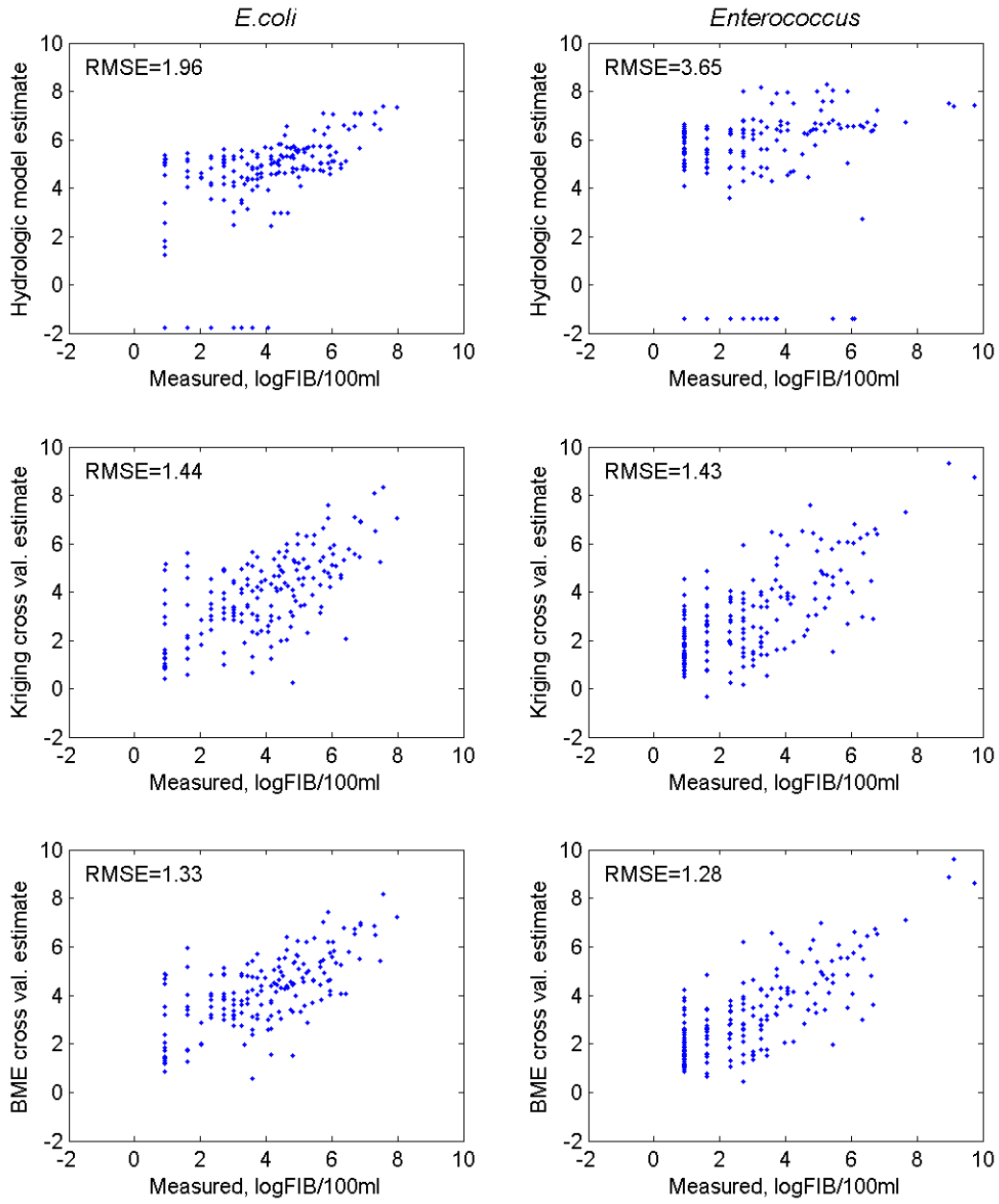
C. Supplemental description and figure about the fit of the model:

As described in Eq. (4), the fit of the model predicting logFIB can be assessed by comparing model estimates $\hat{Y}_i^{(k)}$ with the corresponding measured logFIB concentrations Y_i. The subscript (k) in $\hat{Y}_i^{(k)}$ denotes various estimation methods of interest. At the first stage of the analysis $\hat{Y}_i^{(k)}$ is simply obtained from the hydrologic model (Eq. 2). At the second stage of the analysis, $\hat{Y}_i^{(k)}$ corresponds to a cross validation estimate obtained from the FIB data in the neighborhood of Y_i, but not Y_i itself. In this supporting information section we consider two cross validation estimates. The first corresponds to the kriging cross validation estimate obtained by treating logFIB measurements as hard data, i.e. assuming (erroneously) that the measurement error is equal to zero. The second corresponds to the BME cross validation estimate obtained as described in this work, i.e. using soft data that rigorously account for measurement errors. Plots of model estimates $\hat{Y}_i^{(k)}$ versus observed values Y_i are shown in Figure S2. The RMSE (Eq. 4) for each plot is displayed on the top-left area of the plot. As can be seen from this figure, the RMSE for logEC is 1.96, 1.44 and 1.33 (logFIB/100ml) for the hydrologic model, kriging cross validation estimate, and BME cross validation estimates, respectively. The corresponding RMSEs for logENT are 3.65, 1.43 and 1.28 (logFIB/100ml), respectively.

The results for logEC indicate that the hydrologic model performs reasonably well given the difficulty of predicting microbial concentrations based solely on hydrologic variables. Indeed, the RMSE is equal to 1.96 (logFIB/100ml), which means that there is a factor of about exp(1.96)≈7 in EC estimation errors. This RMSE decreases to 1.44 (logFIB/100ml) for the kriging cross validation estimates. This decrease in RMSE is due to the gain of information provided by the fact that measurements are autocorrelated within the study area. Interestingly, we find that the RMSE for the BME cross validation estimates is even smaller, with a value of 1.33. This is remarkable, as BME uses the same information as kriging, with the only difference that it rigorously accounts for measurement errors. This improvement is due to the fact that BME accounts for soft information in a rigorous and unified manner rather than in an ad hoc and arbitrary manner as do linear statistical regression techniques such as kriging.

In the case of logENT, the RMSE for the hydrologic model is equal to 3.65 (logFIB/100ml), which is unacceptably high. This means that the hydrologic model for logENT should not be used for prediction, as was expected since the hydrologic model for ENT has a low R^2 of only 4%. However, the RMSE decreases to 1.43 and 1.28 (logFIB/100ml) for the kriging and BME cross validation estimates, respectively. This remarkable decrease in RMSE demonstrates that the BME maps obtained for ENT are just as accurate that those obtained for EC because BME takes advantage of the autocorrelation amongst logFIB concentrations and rigorously accounts for FIB measurement errors.

Figure S2: Plots showing the fit of model predictions versus observed values for logEC (first column) and logENT (second column). The predictions of the hydrologic model (Eq. 2), kriging cross validation and BME cross validation are shown in the first, second, and third rows, respectively.



D. Supplemental Movies

The following six movies showing BME estimates of EC and ENT for the entire study period have been downloaded but are also available from http://www.unc.edu/depts/case/BMElab/studies/FIB_NPRE/ :

Movie file	Description
ecoliMovie_scale10_day0920-1009.gif	EC, 23-May to 20-Aug 2005
ecoliMovie_scale10_day1010-1100.gif	EC, 21-Aug to 19-Nov 2005
ecoliMovie_scale10_ME0684-1357.gif	EC, All sampling events
enteroMovie_scale10_day0920-1009.gif	ENT, 23-May to 20-Aug 2005
enteroMovie_scale10_day1010-1100.gif	ENT, 21-Aug to 19-Nov 2005
enteroMovie_scale10_ME0684-1357.gif	ENT, all sampling events