

SUPPLEMENTARY INFORMATION:

Implementation of a variance-targeting sum-constrained Gaussian sampling algorithm in the MEANDIR (v1.4) river inversion model

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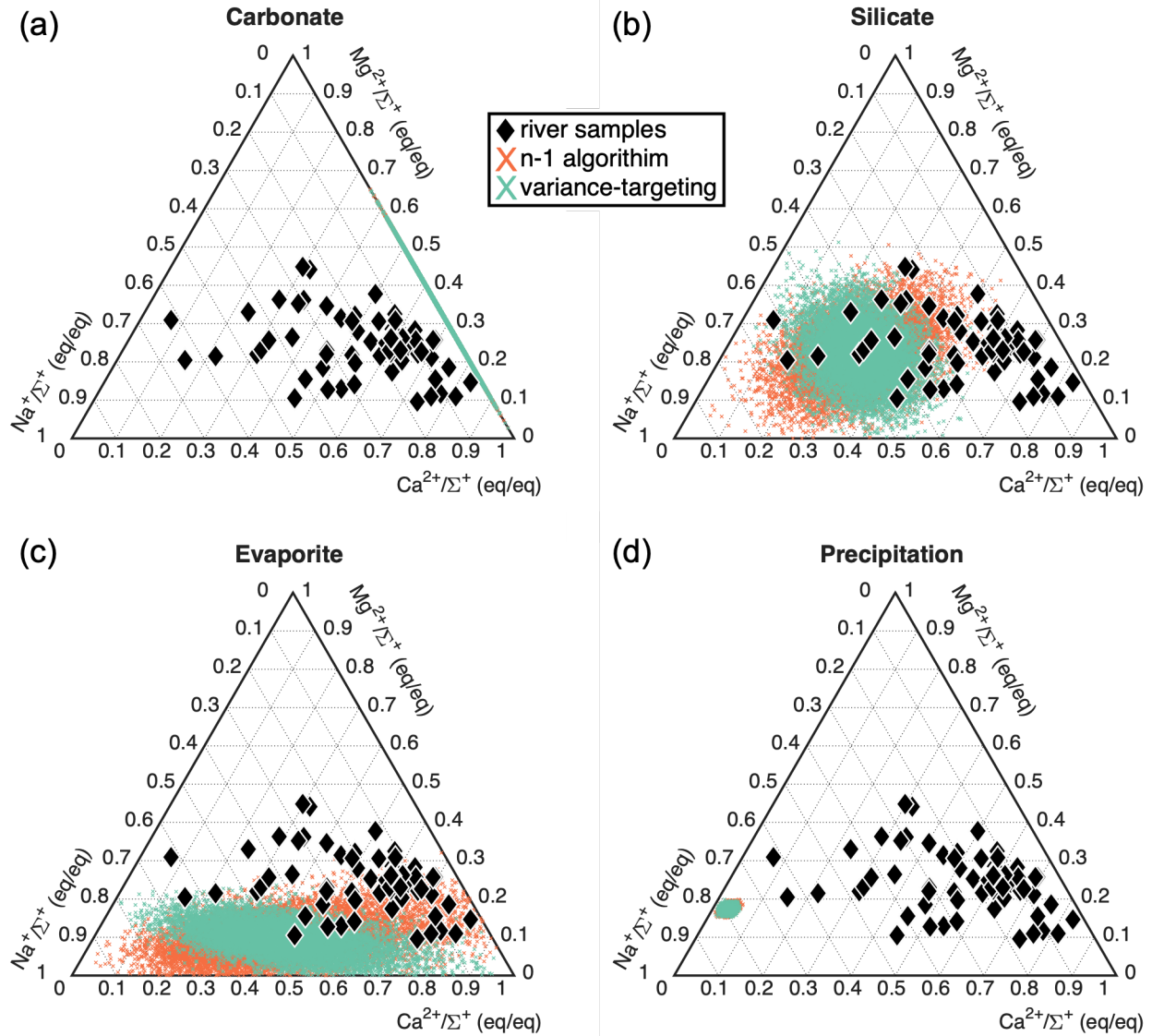


Fig. S1: Ca^{2+} - Mg^{2+} - Na^+ ternary diagrams with global river water samples (Gaillardet et al., 1999) and end-member chemical priors, for an inversion including SO_4^{2-} in the normalization variable and with a sulfide oxidation end-member (Table 1). The ranges of the (a) carbonate, (b) silicate, (c) evaporite, and (d) precipitation end-members are shown when calculated using the n-1 sampling algorithm (orange) or the variance-targeting algorithm (green). The difference between the two approaches is evident in the silicate end-member, where the reduction in Na^+/Σ^+ variance is manifest as a reduction in the density of high- Na^+/Σ^+ and low- Na^+/Σ^+ silicate end-member values. The chemistry of the evaporite end-member prior is also modified between the two algorithms, with a loss of high- Na^+/Σ^+ values and a reduction in Mg^{2+}/Σ^+ at elevated Ca^{2+}/Σ^+ ratios.

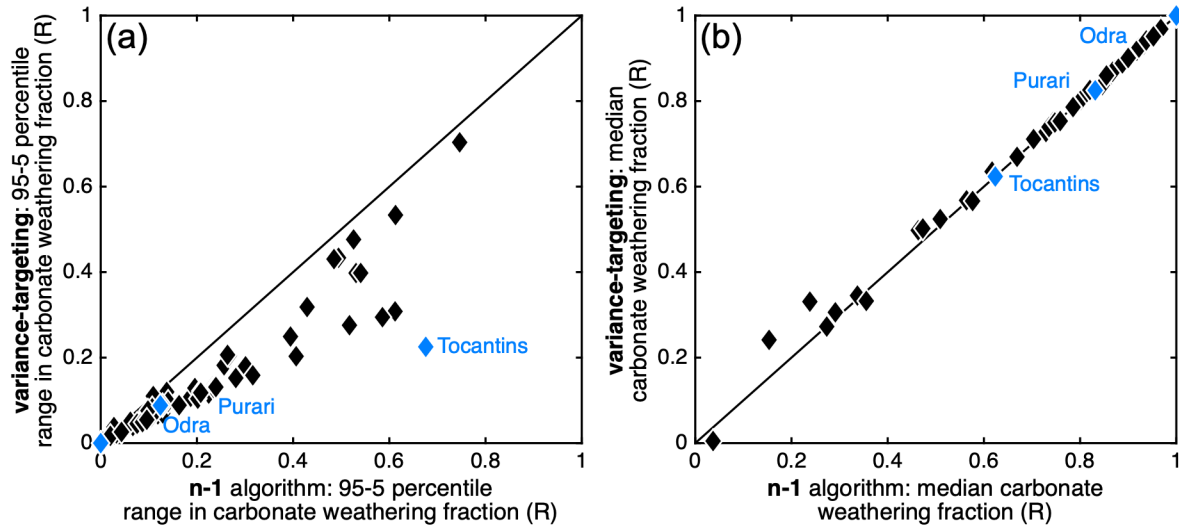


Fig. S2: Comparison of inversion results for the carbonate weathering fraction (R) when sampling end-member chemistry with either the n-1 algorithm or the variance-targeting algorithm, for an inversion including SO_4^{2-} in the normalization variable and with a sulfide oxidation end-member (Table 1). **(a)** The 95th-5th percentile range of the carbonate weathering fraction shows both modest and very large changes between the sampling algorithms, with a reduced range of results under the variance-targeting routine. **(b)** The median carbonate weathering fraction is very similar between the two sampling strategies. Taken together, these results indicate that the variance-targeting sampling algorithm removes the tails of the R distribution without major modifications to the median results. Inversion results for the Tocantins River, the Odra River, and the Purari River (blue symbols) are explored more thoroughly in Fig. S3.

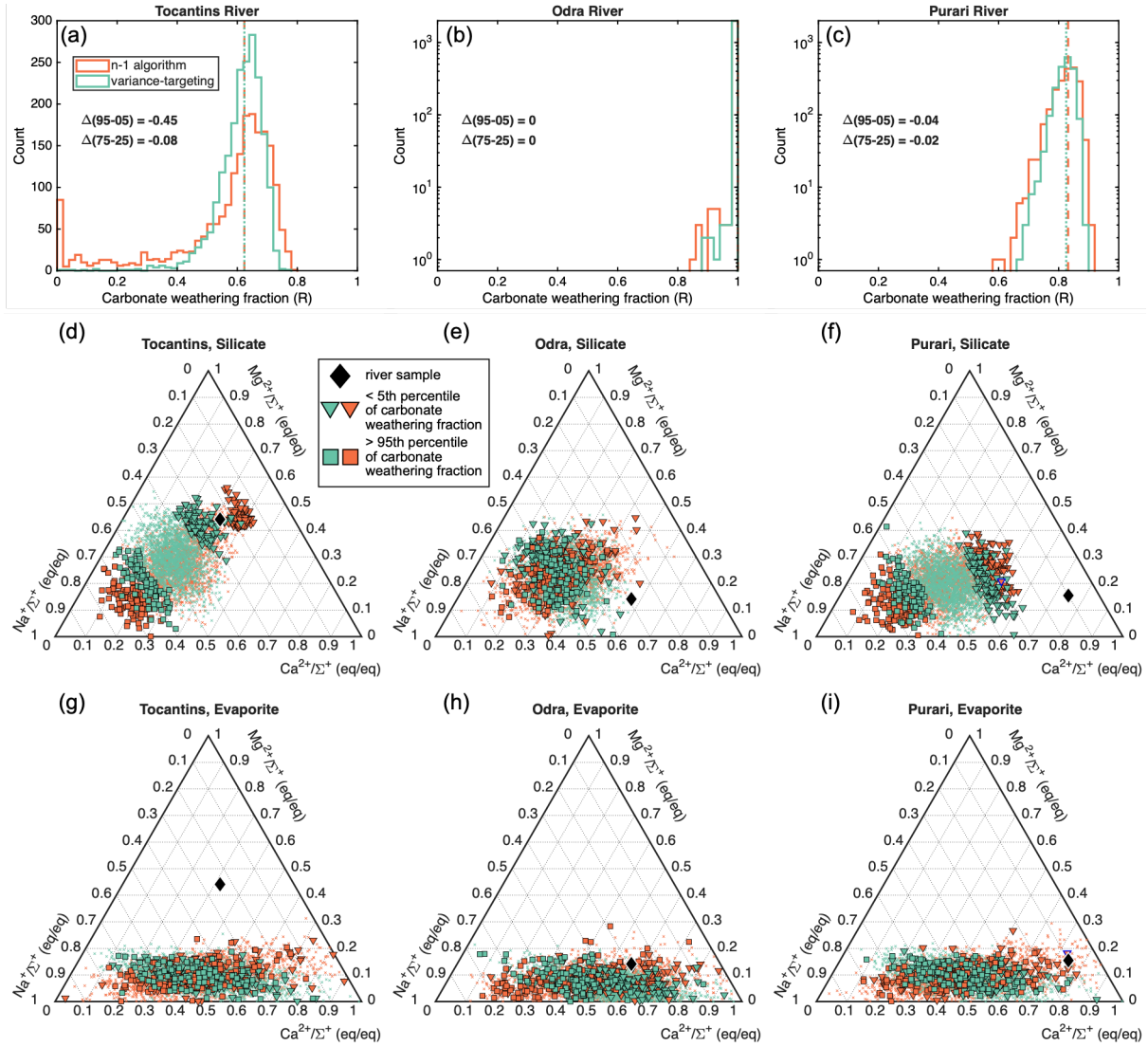


Fig. S3: Changes in the distribution of the carbonate weathering fraction (R) between the n-1 and variance-targeting sampling algorithms for water samples from the Tocantins River, Odra River, and Purari River (Gaillardet et al., 1999), for an inversion including SO_4^{2-} in the normalization variable and with a sulfide oxidation end-member (Table 1). The x, triangular, and square plotting symbols in the ternary diagrams all represent successful inversion results, where the triangles and squares highlight results below the 5th percentile and above the 95th percentile of R, respectively. Overall, narrowing the range of end-member chemistry through improved sampling reduced the range of results. (a, b, c) Changes in the distribution of R for the three rivers across the two different sampling algorithms. The dotted lines indicate the median inversion result. (a, d, g) Changes in R for the Tocantins River reflect that low-R simulations tend to occur when the silicate Na^+/Σ^+ ratio is low and high-R simulations tend to occur when the silicate Na^+/Σ^+ ratio is high. Because the variance-targeting algorithm produces fewer instances of extreme silicate Na^+/Σ^+ ratios relative to the n-1 algorithm, the change in sampling routine reduces the 95th-5th percentile range of R. (b, c, e, f, h, i) Unlike the simpler inversion results presented in the main text (Figs. 5-7), the n-1 sampling algorithm does not produce a set of low-R results reflecting low Na^+/Σ^+ ratios in the evaporite end-member. This change in behavior reflects that including SO_4^{2-} in the inversion provided additional constraints on end-member contributions to river dissolved load.