Geoscientific
Model Development
Discussions

Interactive comment on "Coupling global models for hydrology and nutrient loading to simulate nitrogen and phosphorus retention in surface water – description of IMAGE-GNM and analysis of performance" *by* A. H. W. Beusen et al.

Anonymous Referee #1

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Overall comments:

The authors introduce the IMAGE-GNM model, which builds in hydrology-based N and P loading and retention into the existing IMAGE model. The model is a great improvement over the existing Global-NEWS model, in that it resolves to $0.5° \times 0.5°$ grid cell size, rather than lumping processes together in regression equations that can only be resolved at the watershed scale. The model is also set up for future mechanistic improvements that can delineate the behaviour of different N and P species. Their modelling approach is well described and presented in a logical, transparent manner.

There are a few minor details in the model validation/discussion (see below) that can be improved upon, but overall I recommend this manuscript be accepted for publication in GMD.

Specific comments:

- While the model is developed at the $0.5° \times 0.5°$ grid cell size, it is unclear at what scale the model's output is actually valid. The discussion in section 3 comparing model results with data from the Mississippi, Meuse, and Rhine Rivers seems to rely on data from a single monitoring station (at least for the Mississippi; the number of locations used for the Meuse and Rhine is less clear). The Mississippi is a huge river, so I'm wondering how this one particular monitoring location was chosen for model comparison. It seems to me that, given the number of monitoring locations on the river, any number of sites will yield good correlation with model output (and also any number will yield poor output) just based on the variability of the river and the landscape. This discussion needs to be developed a lot more with comparison to additional stations in the river, or at least a justification for why this one particular site in St. Francisville, LA was used.

- The discussion relating the model output to European rivers seems much more valid, as many monitoring stations on each river are compared. Here the authors also briefly mention that the model has problems when modelling individual stations on small rivers. Is it possible to elaborate on this statement in a more quantitative way? How small?

Technical comments:

- in the readme file, "The python script for the N model can be started with:" is stated twice. The second time it should read P model.

- Are the ratios on page 16, line 9-10 mass ratios or molar ratios? I assume mass, but maybe clarify so the reader does not need to go to the citations to double check.

- Grammar error on page 4, line 28-29: "This global scale model focuses is on. . ."