

A large community of scientists are now working on the inclusion of vegetation demographic models (VDMs) in Earth System Models. These developments are a clear opportunity to increase the fidelity of how ecosystem are represented in ESM's. They also pose a huge challenge, owing to the increased model complexity and the new potential for model-data interaction which they provide.

Challenges collectively faced by this community include parameterization in very high-dimensional space, initialization of vegetation structure, understanding complex internal feedback processes, the representation of co-existence, and the availability and usefulness of benchmarking and validation data. Underpinning these emergent properties of VDMs are a set of additional process representations, distinct from those in traditional land surface models, which together allow ecological dynamics to be simulated, but also add an additional dimension of process uncertainty. Here we collate progress so far on the inclusion of VDMs in ESMs, assess the new model features necessitated by these development, consider alternative model formulations and opportunities for progress. Finally, we assess driver and benchmarking datasets; those that are available, and observational gaps specific to VDMs which are so far poorly constrained.