

15 August small group meeting – Biogeochemical cycles
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Needs and applications for local-to-regional scale land and land-atmosphere modeling

We first reviewed the priority topics for local to regional scale biogeochemistry modeling for the NEESPI region:

- 1) Improving changes in forest composition: dynamics, dispersal and migration
- 2) Improving representation of radiative balance in NEESPI plant communities/biomes
- 3) Improving hydrology, especially through better representation of wetlands and permafrost
- 4) Improving capabilities to simulate biogeochemistry: in particular, nutrient cycling (N, P) and emissions of non-CO₂ trace gases, and aerosols

Kevin brought up the idea of looking at these priority topics through a disturbance hindcast test case: looking for areas that were e.g., burned, and seeing how after forest recovery, changes in radiative balance, VOC emissions, precipitation, and other biophysical and biogeochemical quantities could have fed back to local to regional climate. Hank informed the group that there will be calculations of detailed forest dynamic changes done starting ca. 40 years before present, and extending into the future. The output of these calculations could easily be adjusted to provide “hooks” for adding modules to calculate e.g., radiative transfer and VOC emissions. The group agreed that this would be worthwhile pursuing, but that the next step (using these results in a more encompassing regional or global model) would require additional resources and people – neither of which is currently available.

The question was raised: Why would such an exercise be particular to the NEESPI region?

The answer has three parts, the NEESPI region has a 1) unique meteorology with important recycled precipitation, a large cryosphere, and extreme climates (cold, dry) 2) uniquely large scale of disturbances (e.g., enormous fires occur) and 3) a uniquely large scale of homogenous landscapes, (e.g., the larch forest biome).

The topic was raised that we need to involve more observational data in addressing these priority topics, e.g., using remote sensing to provide historical information on land cover change, even if only in simple land cover classes.

Making better use of observation data is largely a data mining and synthesis issue: because there exists a large data archive that is not exploited. But how much of this data is particularly relevant to biogeochemical cycles? Site-level data, e.g., eddy covariance towers, is extremely useful; remote sensing data needs to be explored further for its potential, e.g., identification of disturbance regimes (e.g., fire frequency, insect outbreaks). Soil temperature data are available, but need to be brought together with surface meteorological data (**this is a priority for data centers**).

The need to bring coherency to NEESPI projects was mentioned by group members. We are all studying a particular region, and should try to take advantage of existing

resources. NEESPI could advertise ongoing work across projects to promote interactions.

Kevin suggested creating a very simple model to quantify relative importance and sensitivity of feedbacks. The group replied that this could largely be done through literature review and synthesis because much work has already been done.

Recommendation: **compose a review paper** on potential land-surface atmosphere feedbacks with particular emphasis on processes that are specific to or dominant in the NEESPI region, which provides rationale for future work. If there are still some key feedbacks that are not at all explored in the literature, we may not need to develop new tools. We recommend simple experiments using existing global or regional climate model to explore a few biophysical feedback scenarios.

We suggest it would be useful to organize an intense field campaign in two key regions: along permafrost zone boundary, and in areas of changing forest type, because the full suite of process information (e.g., environmental controls on emissions, BGC cycling and cold region hydrology are not available in current datasets).

David mentioned the IARC Arctic System Model (ESM) as a useful future tool for investigating many of the feedbacks that we discussed.

The group concluded with the following action items:

- Prepare a synthesis paper on the importance of land-atmosphere feedbacks in the NEESPI regions.
- Leverage ongoing modeling activities like the planned forest dynamics calculations by adding radiative transfer and VOC emission components
- Encourage more data mining and the production of value-added observational datasets (of both in-situ and remotely sensed data) and synthesis of disjunct but related datasets (e.g., soil temperature and surface meteorology data)
- Emphasis should be on exploiting existing tools and expanding ongoing projects (through “hooks”) so that we don’t set unrealistic goals and/or reinvent the wheel.