IMPROVING MODELS TO PREDICT PHENOLOGICAL RESPONSES TO GLOBAL CHANGE

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Vegetation phenology, the environmentally-mediated timing of recurrent plant lifecycle events, is both a sensitive indicator of climate change and a forceful influence on it. However, despite the robustness of phenological indicators and the central role of biosphere-atmosphere feedbacks in the global carbon cycle, existing phenology models tend to produce biased predictions, typically neglecting the possible influence of CO_2 concentrations. Manipulative global change experiments and long-term observational data are required to advance mechanistic understanding and prediction of vegetation phenology in the face of climate change.

This research will combine two independent datasets – experimental and observational – to model, validate, and predict the phenological response of boreal peatland forests to global change. The experimental dataset will be comprised of near-surface remote sensing imagery from Oak Ridge National Laboratory's Spruce and Peatland Responses Under Climatic and Environmental Change (SPRUCE) site in northern Minnesota. When construction is completed this summer, open-topped chambers at SPRUCE will be subjected to one of five warming levels (ambient to +9.0°C) and ambient or elevated (800 ppm) CO_2 concentrations. Chamber-mounted cameras will capture digital images of vegetation every 30 minutes, and we will use the image color channels to calculate a quantitative measure of phenological transitions. Observational data are from Mr. John Latimer, a rural postal deliveryman from northern Minnesota who recorded dates of flowering, budburst, and leaf-off for over 30 plant species along his mail route for the past three decades. Specifically, we are using these datasets to (1) elucidate environmental drivers of multi-species phenological transitions in a boreal peatland forest ecosystem and (2) incorporate mechanistic understanding of drivers into models predicting peatland forest phenological response to climate change.

Preliminary analysis of Mr. Latimer's data focusing on 15 of the most common N. Minnesotan woody species demonstrates species' differential temperature sensitivity and year-to-year phenological variability. On average, budburst of all 15 species advanced with increasing mean spring temperature (March-May). The median rate of advancement was 2.8 days per degree Celsius (d/°C). Trembling aspen budburst was the most temperature sensitive, advancing an average of 4.5 ± 0.57 d/°C (regression slope ± standard error), while paper birch was least sensitive and advanced only 0.50 ± 1.3 d/°C. Year-to-year variation in budburst date was 2.7 to 5.0 weeks, and leaf-off date variation was 1.9 to 5.6 weeks. Effects of increasing CO_2 concentrations on phenology are forthcoming but still unclear.