

U.S. Department of Energy  
Program for Ecosystem Research  
Summary Proposal Evaluation Criteria

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**Proposal Number: 84593**  
**Effects of Warming on the Structure and Function of a Boreal Black Spruce Forest**

**Organization Name: WISCONSIN, UNIVERSITY OF**  
**Principal Investigator: Gower, Stith**

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*1. Scientific and/or technical merit of the project.*

Reviewer 1 Comments:

The authors have done a great job presenting their objectives (although there are 4 in the summary and 6 are detailed in the body of the proposal) and linking them to the hypotheses. The proposal is clear, well written and well organized. It is a pleasure to read it. The justification of the project is brief but adequate. The introduction covers the relevant most recent literature and makes the argument for this proposed work. When reviewing an excellent proposal it becomes irrelevant to write a lot of comments on the project and this is certainly the case.

Reviewer 2 Comments:

This proposal is of the high scientific and technical merit. A number of clear, testable hypothesis have been put forth, and the appropriate methods have been outlined to accomplish all objectives. However, because this work does not include changes in multiple environmental factors (the focus is entirely on warming), it does not fully match the goals of the PER.

Reviewer 3 Comments:

Gower seeks to assess the impacts of climate warming on the structure and function of the black spruce boreal forest. This forest biome is large and climate change is modeled to have the greatest impact on these systems. These systems additionally store appreciable C in soils, and this soil C budget may be significantly affected by warming, acting as a feed-forward on atmospheric CO<sub>2</sub>. The experiments/program outlined focus on a full range of structural and functional aspects of the boreal forest, including: 1) phenology of vegetation; 2) ecosystem hydrologic cycle; 3) canopy architecture; 4) nitrogen use (and soil dynamics); 5) ecosystem NPP and C allocation; 6) soil C dynamics. This suite of assessments clearly covers the major ecosystem responses and additionally the author will try to develop connections between them as many are inter-related. Although the proposed project only manipulates one factor (temperature), Gower makes a good case for the complexities of the responses of the ecosystem in that once one factor (T) changes, many other factors (H<sub>2</sub>O, N) will feed into plant response to this initial change. Strengths: 1) Planned establishment of a boreal forest warming program in North America; 2) Integrated response variables (canopy, roots, soils, biogeochemical cycles); 3) Addresses changes in ecosystem processes (NPP, C, N, H<sub>2</sub>O dynamics); 4) Strong “bang-for-the-buck”; 5) Piggy-backing with related projects; 6) Focused research director. Weaknesses: 1) Why have soil and soil+vegetation warming treatments? 2) The author seems to dismiss the elevated soil CO<sub>2</sub> flux apparent in year 3 in Figure 8. Would this change the hypotheses?; 3) No information provided on the trenching plots needed to partition respiration.

Reviewer 4 Comments:

Summary – Soil and soil plus vegetation will be warmed in a black spruce forest of northern Manitoba to examine the effects of warming on the structure and function of a boreal forest. Understanding the response of boreal forests to warming is important due to their large size, the immense amount of C stored in soils, and the sensitivity of this biome to small changes in temperature. Replicated open-top chambers will be used to increase the air temperature and buried PVC tubes containing heated water will be used to increase

the soil temperature, both 5o C above ambient temperatures. The objectives of the study are:1. Examine the effect of warming on phenology of overstory, understory and bryophyte strata.2. Quantify the effects of a hypothesized longer growing season on transpiration, and other components of the hydrologic cycle.3. Examine the effects of warming on canopy structure and species composition.4. Quantify the effects of warming on nitrogen use by overstory, understory, bryophytes, and heterotrophic microbes.5. Compare direct and indirect effects of warming on autotrophic respiration (RA), above- and belowground net primary production (NPP) budgets.6. Compare microbial dynamics and net soil surface CO2 flux of control and warmed soils to identify causes for the hypothesized small to no effects of soil warming on soil surface CO2 flux. Strengths – This was an excellent proposal in every way. It addresses very important questions within an elegantly described theoretical framework. The experimental design and proposed work plan are extremely well described and clearly will enable the main and specific objectives to be fully addressed. Over ten years of experience at this site insures that the proposed methodology has been well considered and will be successful. In summary, this is one of the finest and most complete proposals that I have reviewed. Weaknesses – There were no obvious weaknesses in this proposal. The only possible problem is the immense scale of the operation and the number of proposed measurements. However, past history has indicated that Dr. Gower is capable of such an operation and will undoubtedly produce very high quality data in all proposed measurements.

## ***2. Appropriateness of the proposed method or approach.***

### Reviewer 1 Comments:

The methodology and work plan are clearly defined. I was wondering if there was a history of high voltage cable being severed in a previous project! It definitely confirms one's opinion that the authors have a lot of experience and will be very efficient when setting up this new experiment. I have really enjoyed the intimate link between the issues raised, the hypotheses laid out, and the methodology chosen to address the issues and test the hypotheses. This is a very efficient way to present one's thoughts and this reviewer is thankful for having the chance to review this well thought out and well prepared proposal.

### Reviewer 2 Comments:

The methods proposed to simulate global warming effects on a boreal forest are appropriate. To my knowledge, this research would be the first to simulate a global warming scenario for both soil and canopy for large trees in situ. The detailed analysis of most aspects of ecosystem function, as proposed here, should provide all the puzzle-pieces required to understand how boreal forests will respond to global warming in addition to the information needed to understand the mechanisms underlying any observed shifts in structure and/or function.

### Reviewer 3 Comments:

Methods and approach are appropriate, although more information could be provided on the trenching plan to partition soil CO2 flux. It would seem that trenching might alter system hydrology, which in turn would alter respiration components. In addition, there is some concern as to the temperature profile that will be established by the pipe treatment. It would seem that heating from 20 cm depth would establish a reverse temperature profile and might additionally heat/thaw soil at depth. Although only one factor (T) is manipulated, the potential impacts of this factor on boreal forest ecosystems and potential changes in the C balance of these ecosystems warrant support by PER.

### Reviewer 4 Comments:

All methods, approaches and experimental design issues are appropriate and most likely to succeed.

## ***3. Competency of applicant's personnel and adequacy of proposed resources.***

### Reviewer 1 Comments:

Dr Gower has a lot of experinece and can no doubt lead this project to its successful end. He is however already committed to two large projects (30% of time commitment for NASA and NSF). We can only trust he will be most efficient in managing his research time between these 3 projects, 2 of which he would be PI on. Wang has been a prolific graduate student by looking at his list of publications with Dr Gower. As a graduate strudent on this project he will be an asset to the team. Myron Tanner's credential as a technician

are impeccable.

Reviewer 2 Comments:

Both Gower and Norman are accomplished in this research area and it seems as though their technician and students are excellent as well. This appears to be a strong research team.

Reviewer 3 Comments:

Personnel and physical resources are adequate for the proposal. Gower is to be commended for utilizing resources from other ongoing projects where appropriate.

Reviewer 4 Comments:

Dr. Gower is a leader in his field, highly prolific and certainly capable of conducting and leading his research team. The University of Wisconsin institutional resources are clearly adequate and many items are already in place at the field station in Manitoba.

***4. Reasonableness and appropriateness of the proposed budget.***

Reviewer 1 Comments:

The budget justification page lists in details the various reasons for each budget item. This laundry list is very compelling.

Reviewer 2 Comments:

The proposed budget to complete this work seems appropriate and justified, although 58,000 for travel seems a bit high. The authors have a good deal of experience conducting research in this area, however, and that amount may be appropriate.

Reviewer 3 Comments:

The budget request is appropriate. Indeed, the information content per investment of the project is high compared to many.

Reviewer 4 Comments:

The budgets seem reasonable.

***5. Likelihood that the research can contribute to the achievement of an extrinsic goal that is outside the research field itself and thereby serve as basis for new or improved technology or assist in the solution of other national needs.***

Reviewer 1 Comments:

The information that will be gathered in this project will be most useful for modelers, biogeographers, biogeochemists and plant physiologists alike. Results will address global carbon budget and global change issues. I look forward to seeing the data published and contribute to the overall discussion of the result. This is an exciting proposal.

Reviewer 2 Comments:

This research will, in addition to providing important information concerning global warming effects, provide a wealth of basic knowledge about the function of northern forest ecosystems. I am not aware of any particular 'national need' that this research would fulfill outside of the ecological and earth sciences, however.

Reviewer 3 Comments:

The project may help clarify potential feed-forward effects of global climate change on the boreal forest that will help ongoing modeling efforts.

Reviewer 4 Comments:

The project will further our understanding of forest tree response to changes in global climate, which in concert with other projects, may have far-reaching political and economic ramifications.