Assimilating SIF and SWE observations into CLM using DART to improve GPP over the high mountains in the Western US

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NASA Carbon Monitoring System

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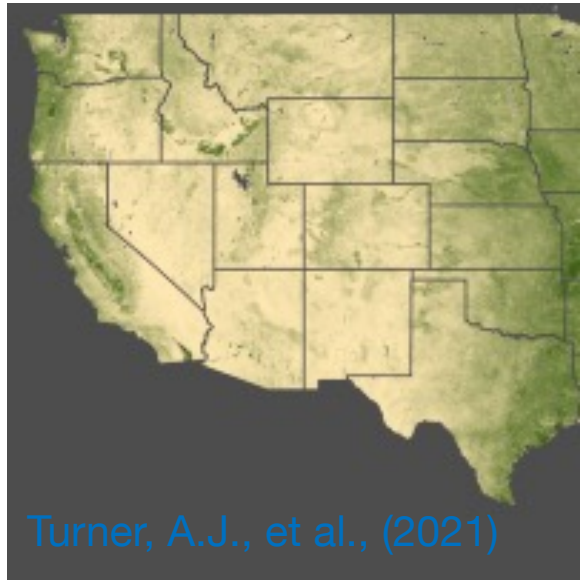
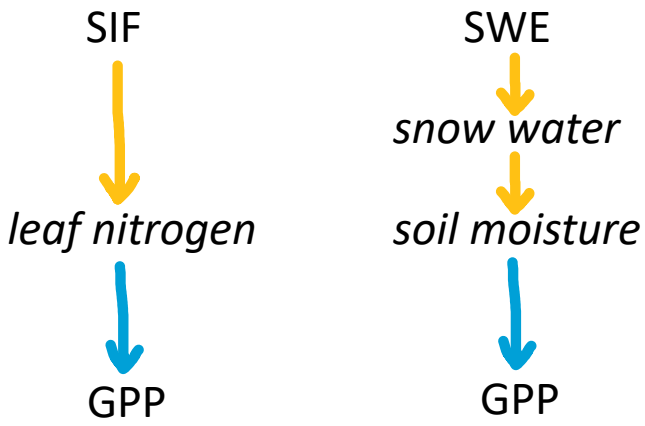
Background

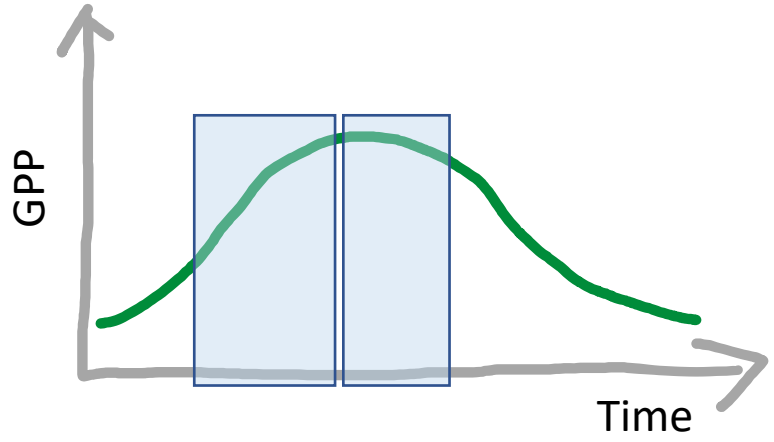
High mountains over the Western US has high biomass and the potential for terrestrial carbon storage



Hypothesis: GPP can be improved if we put constrains on leaf nitrogen and soil moisture



Questions: Which observation constraint leads to the greatest improvement in GPP, where, at what time, and Why?

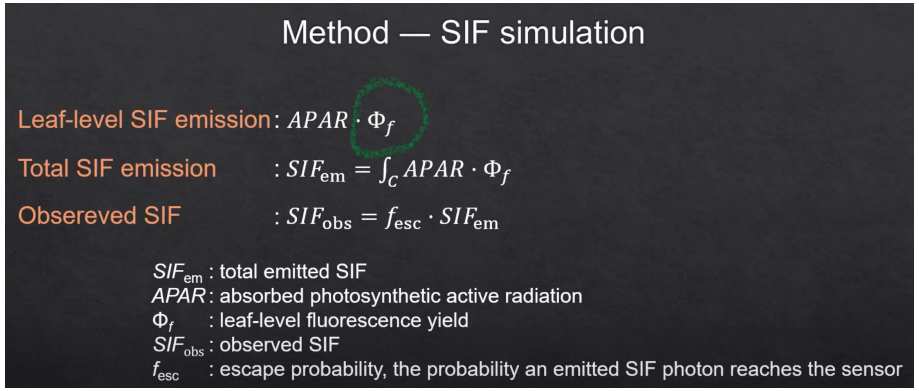


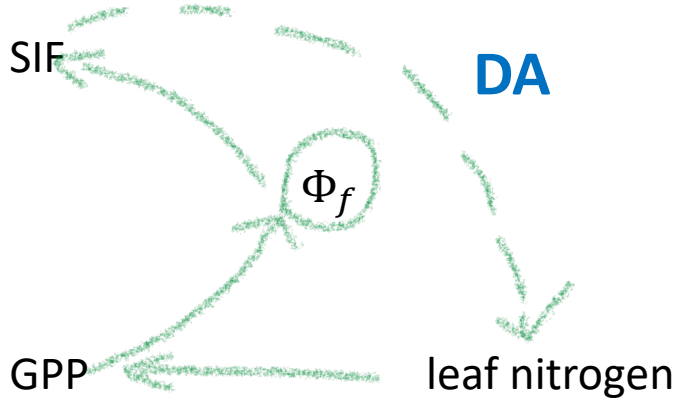
Material and Setting

- **Community Land Model**

  release-cesm2.2.01, 1 deg by 1 deg, 2003-01-01 to 2010-12-31, CAM4 reanalysis, 80 ensemble

SIF module in CLM [Li et al (2022)]





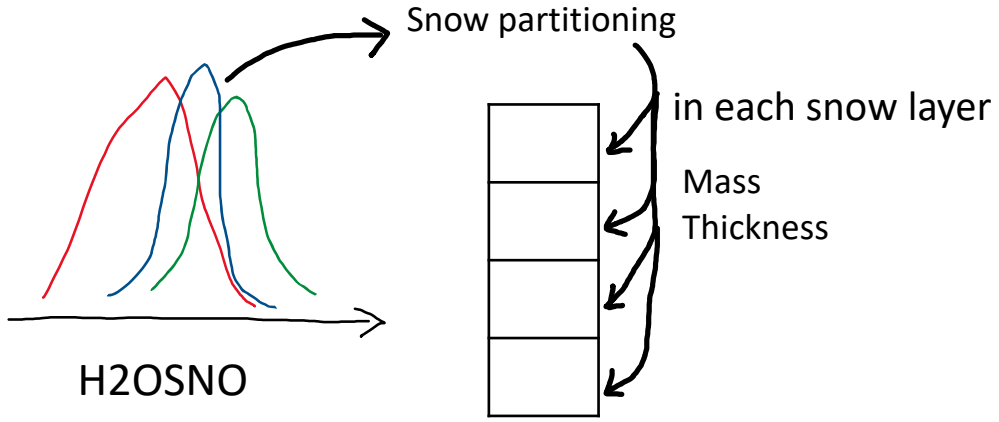
- **DART (Data Assimilation Research Testbed)**

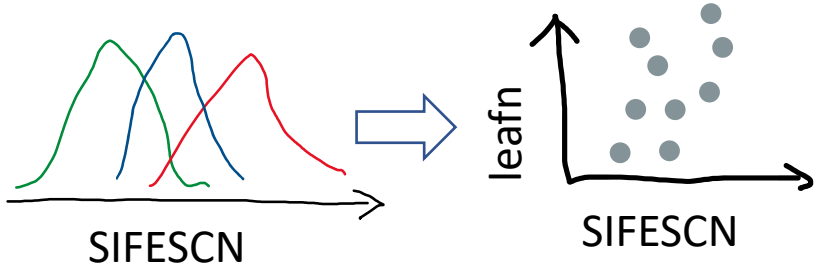
Observation :

SNODAS daily SWE
Harmonized monthly SIF

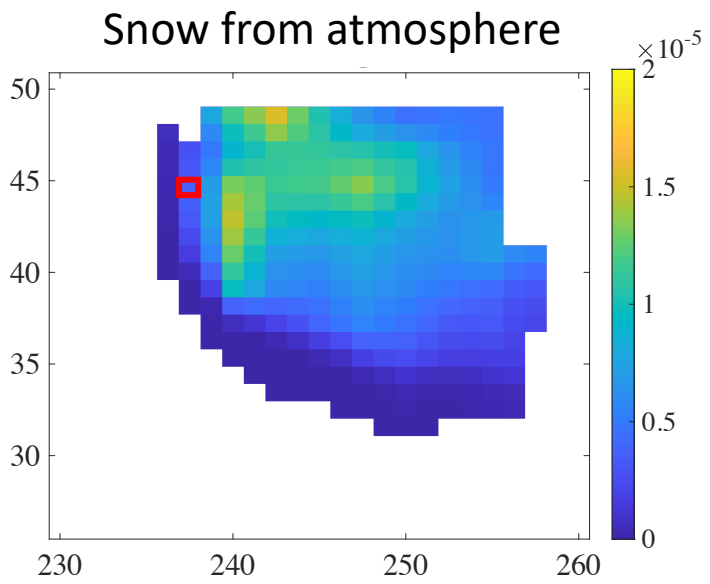
Assimilation frequency:

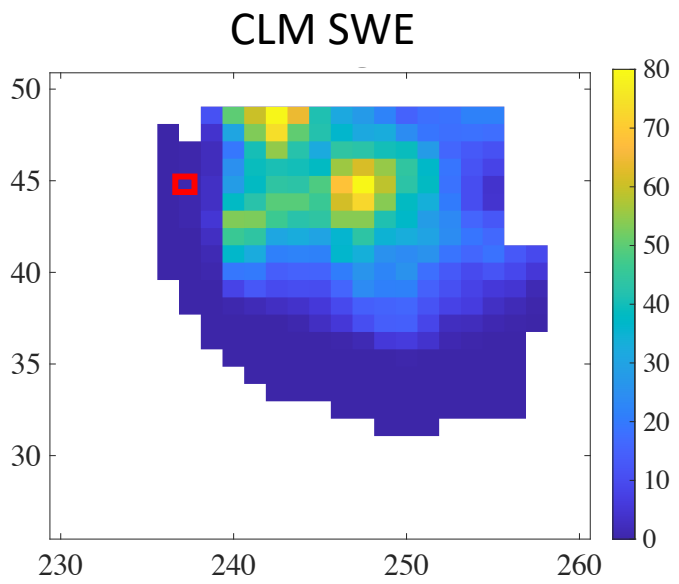
daily for SWE DA
monthly for SIF DA

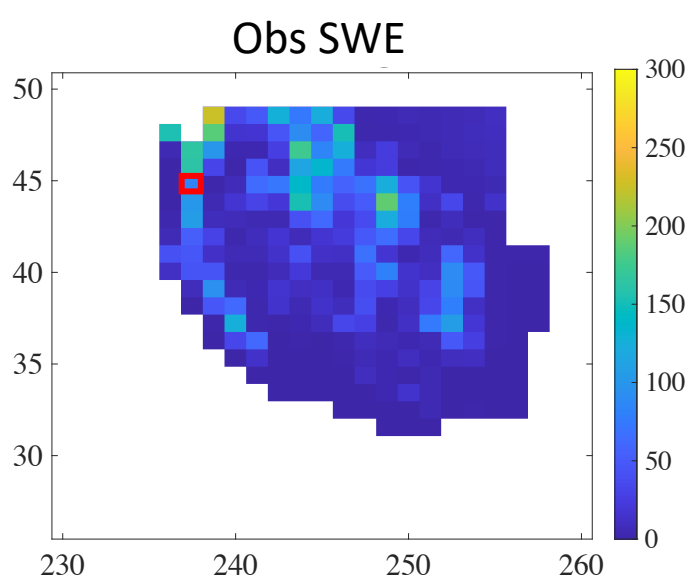


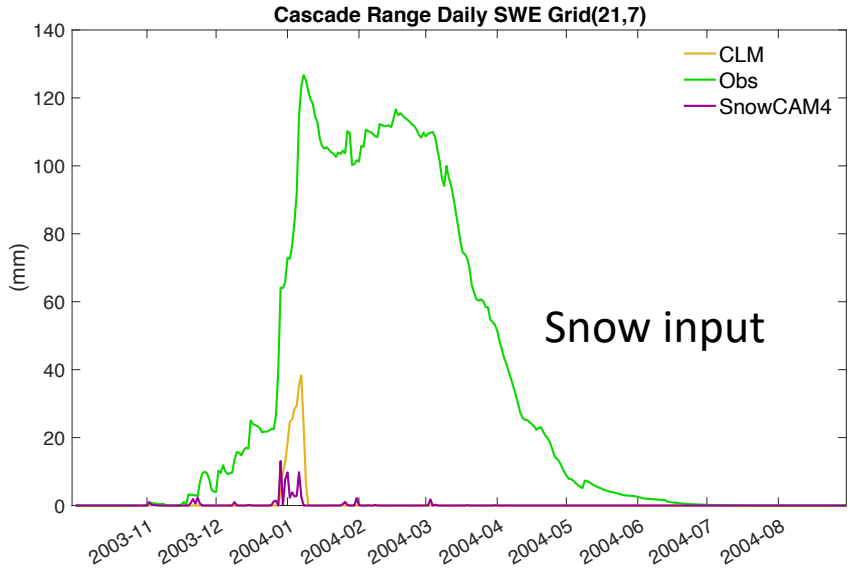


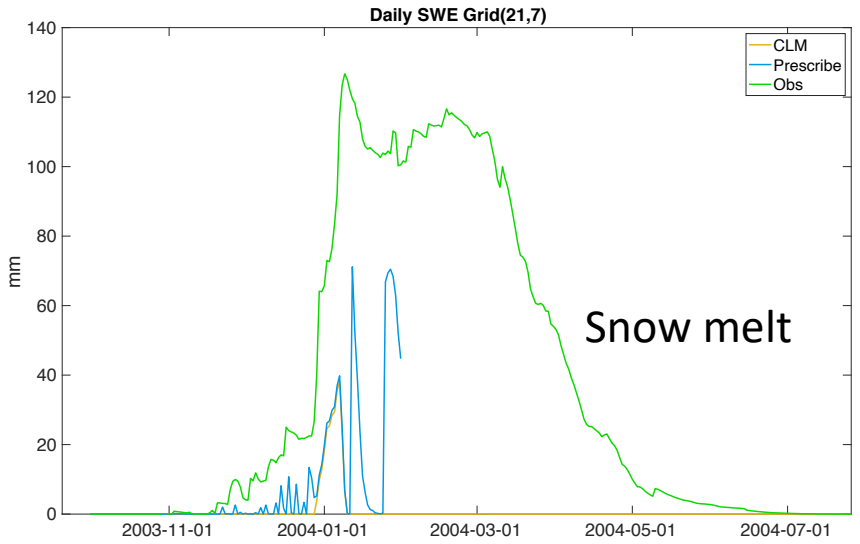
SWE DA Challenge: There are some issues with snow input and snow melting



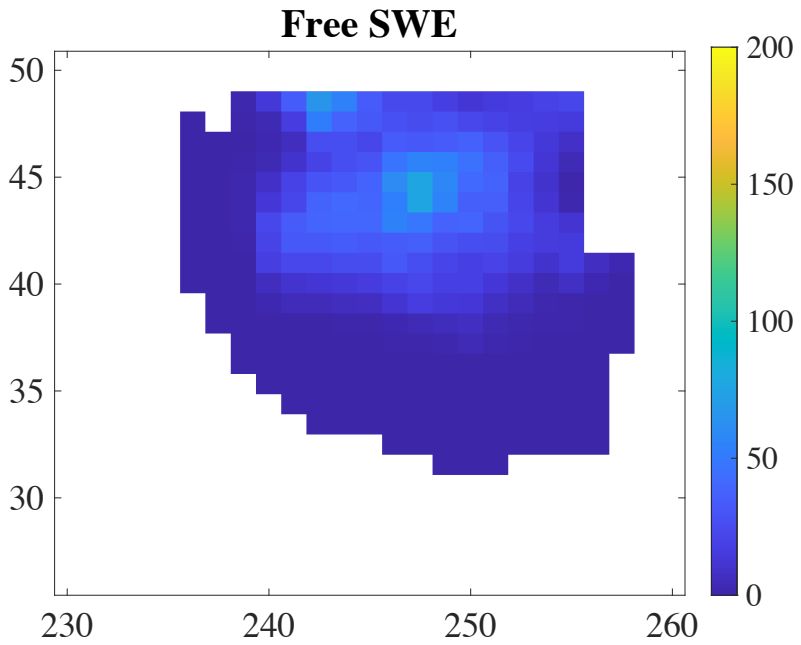


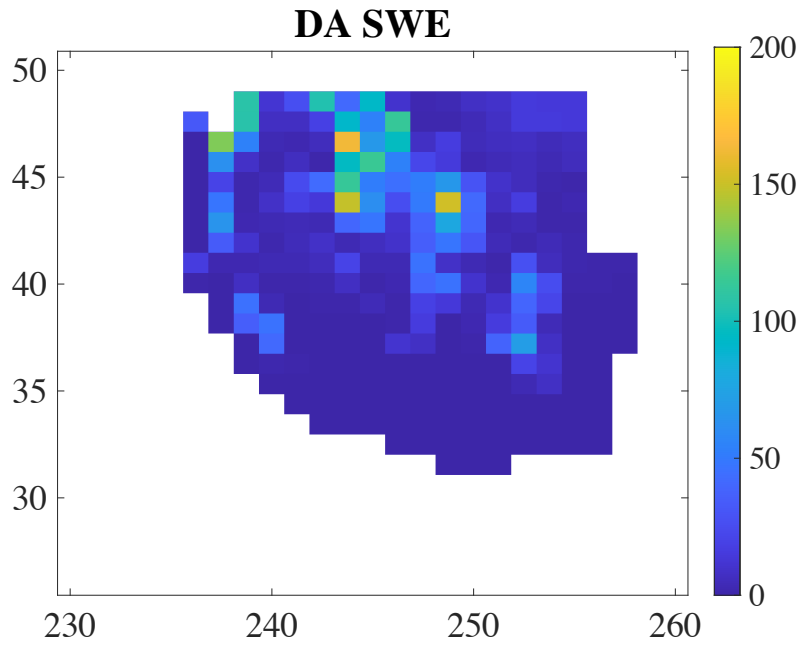


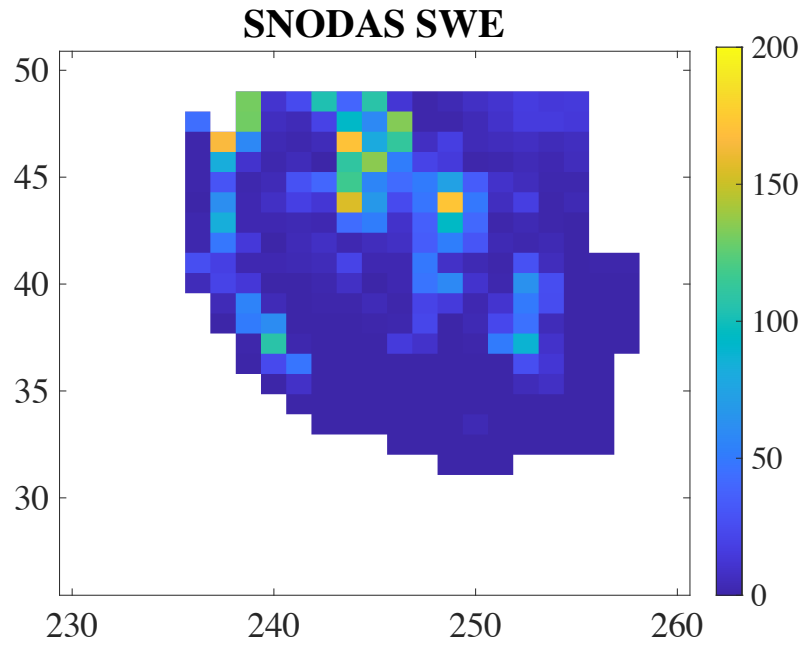




Despite challenges with snow input and melting, DA successfully corrects Snow Water Equivalent over the Western US







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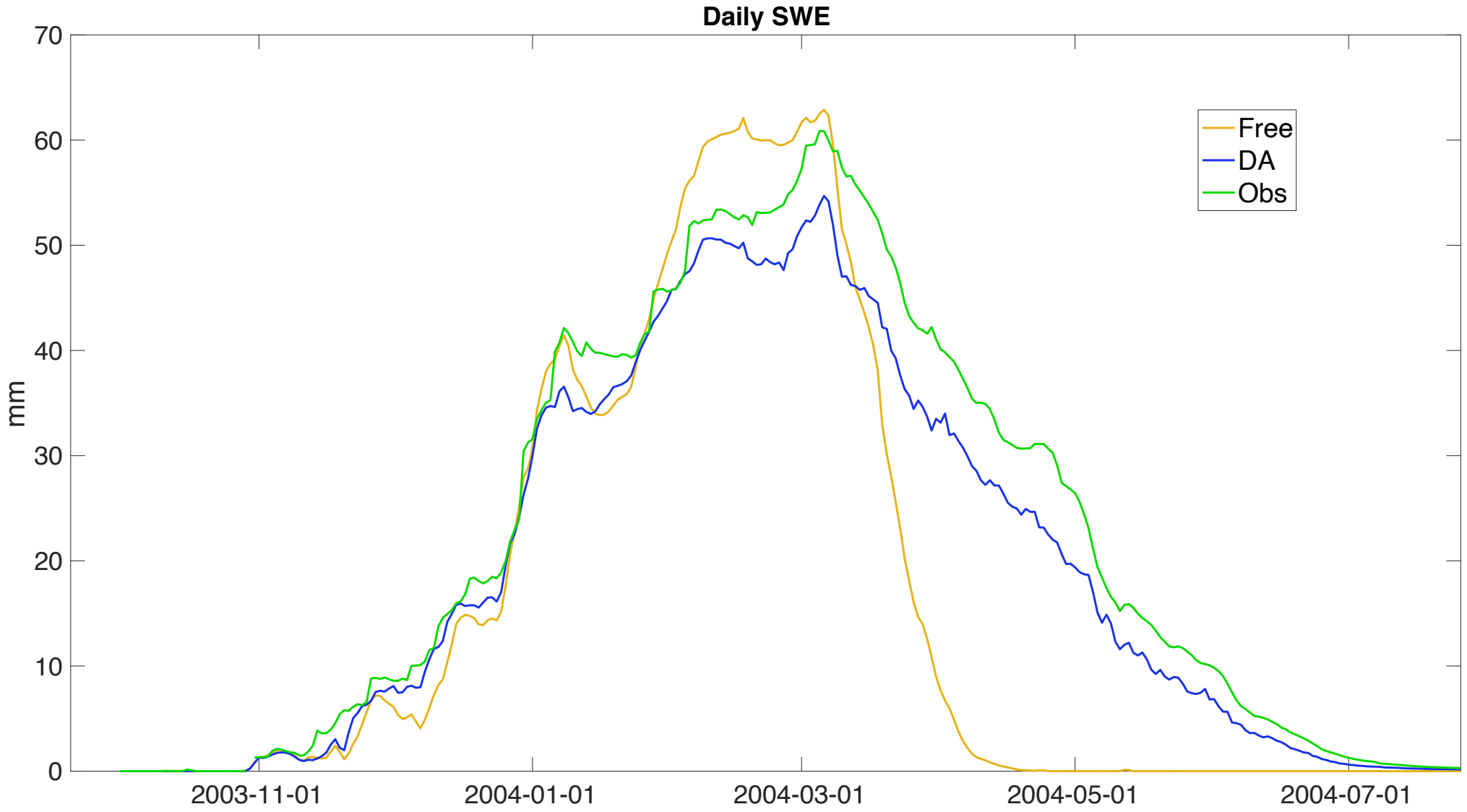
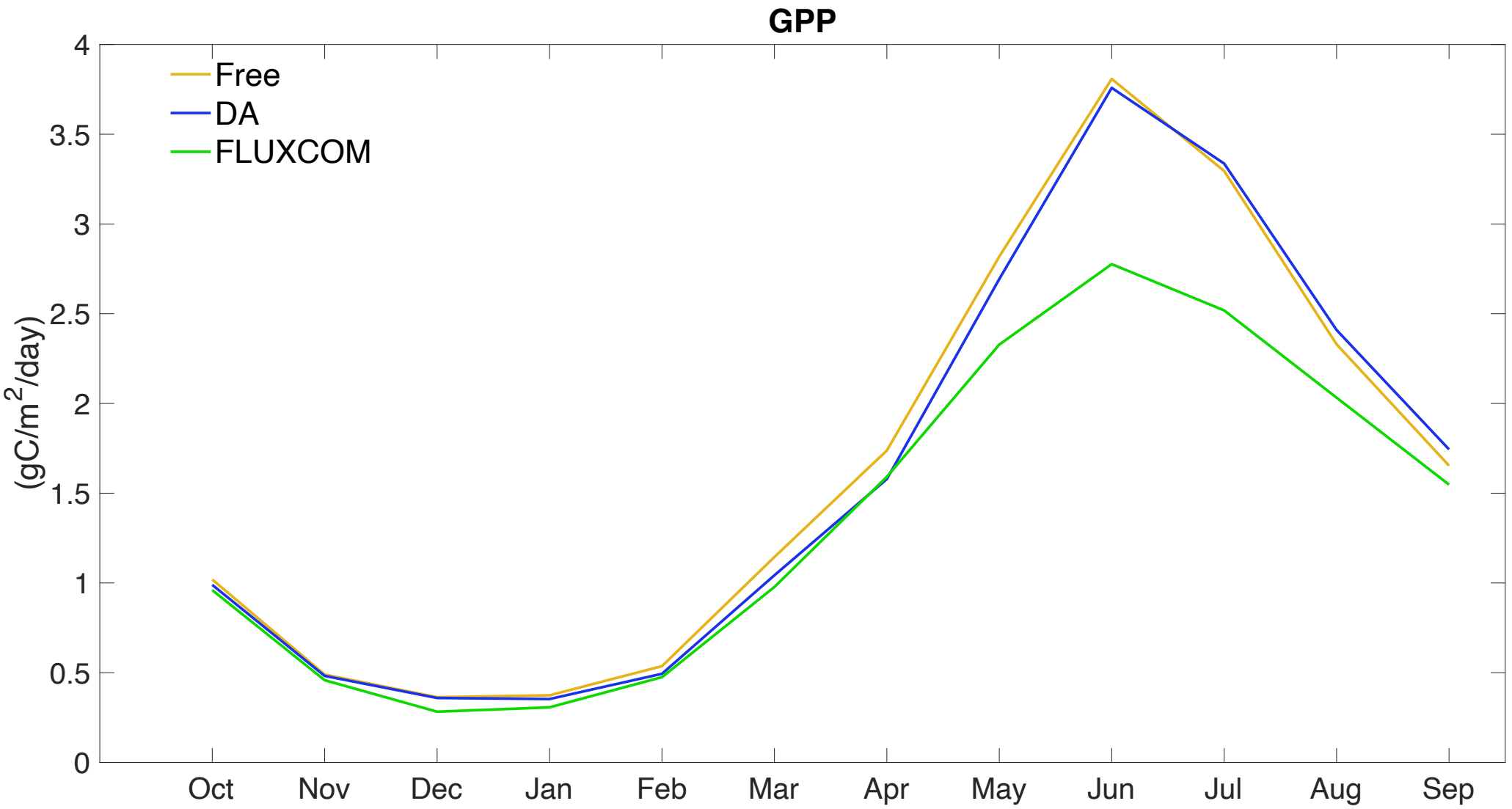
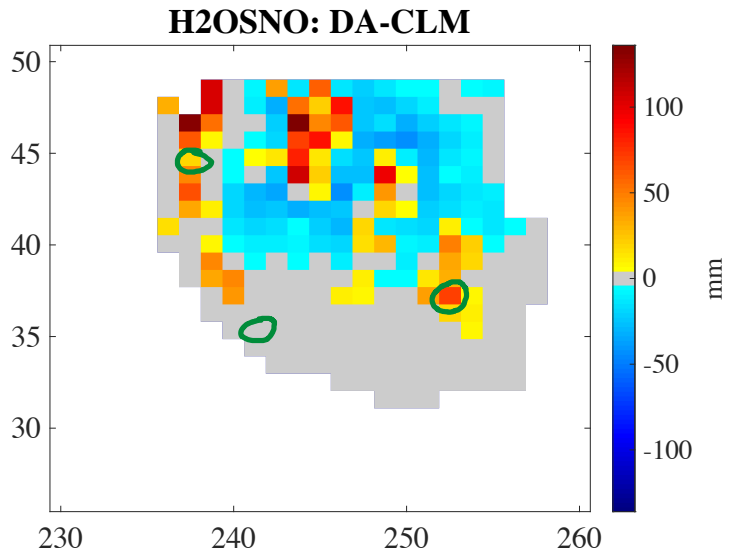
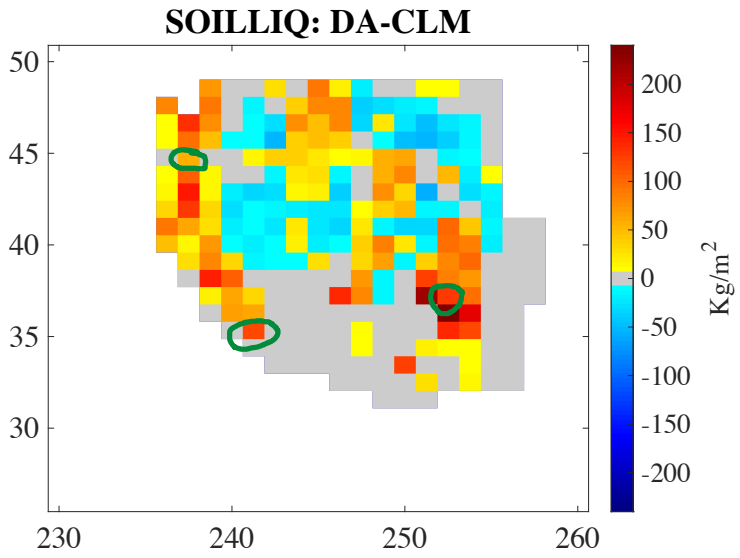


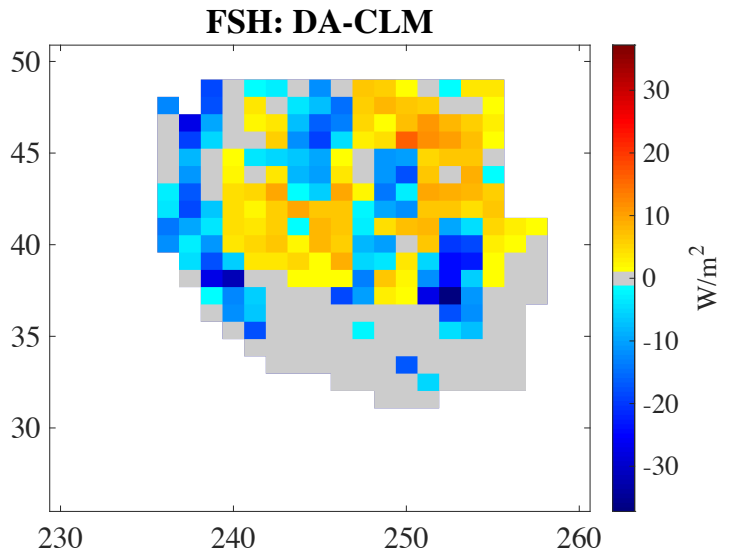
In contrast to the significant change in SWE, the regional average of GPP in the Western US changes very little

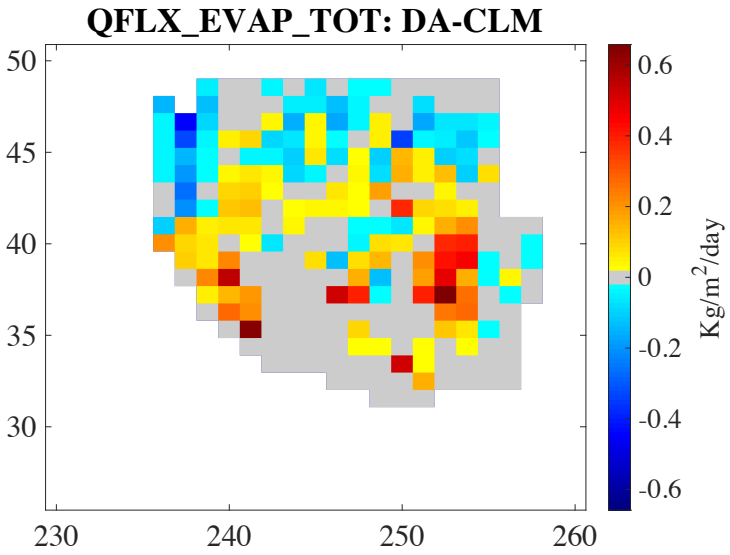


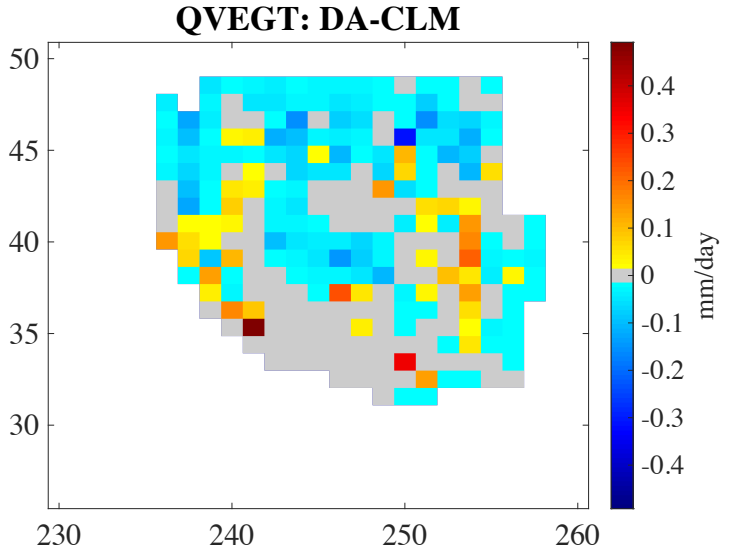
In regions where SWE increases, soil moisture increases but GPP responds differently

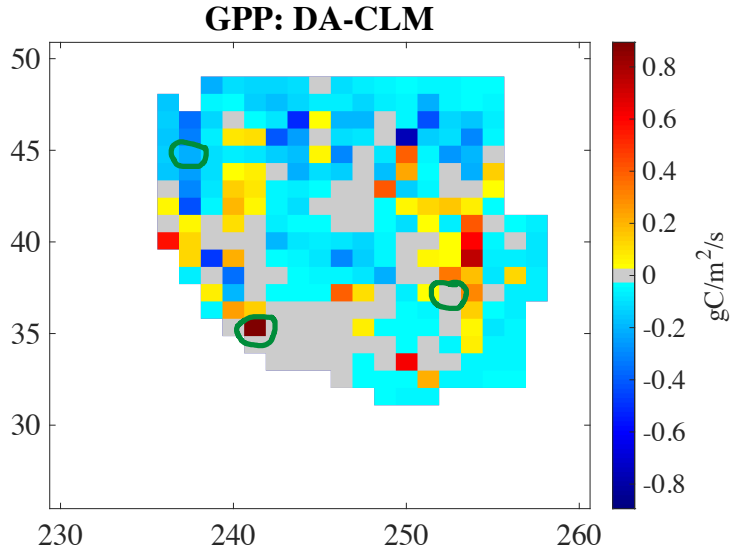






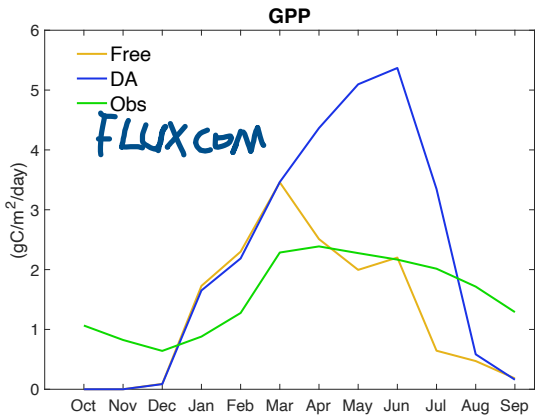


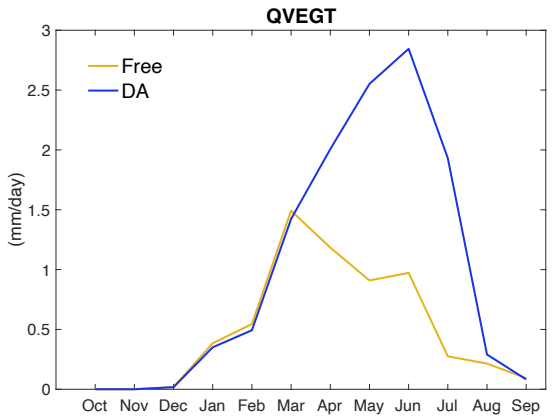


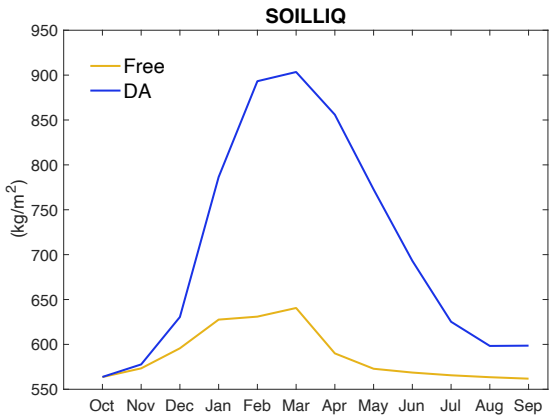


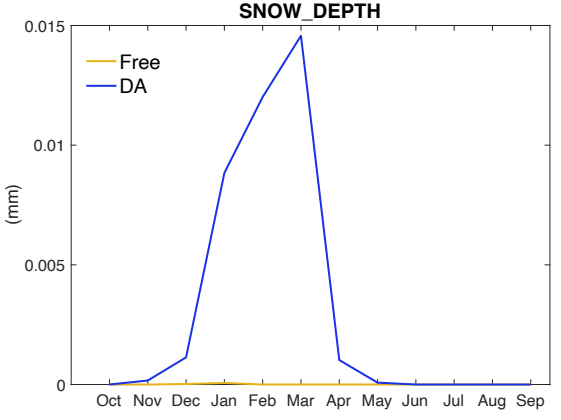
GPP responds differently depending on whether it is water-limited or limited by other environmental factors

Sierra Nevada

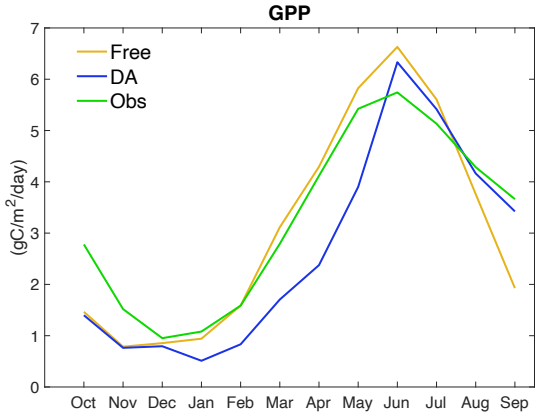


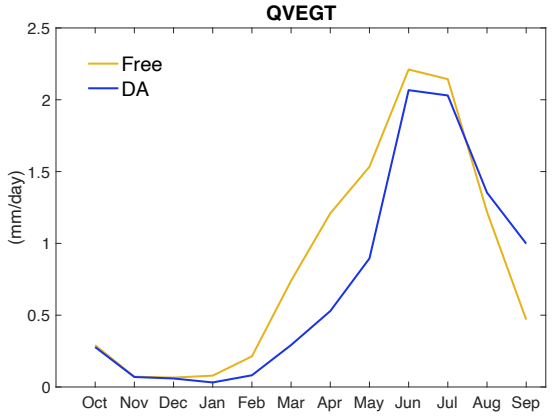


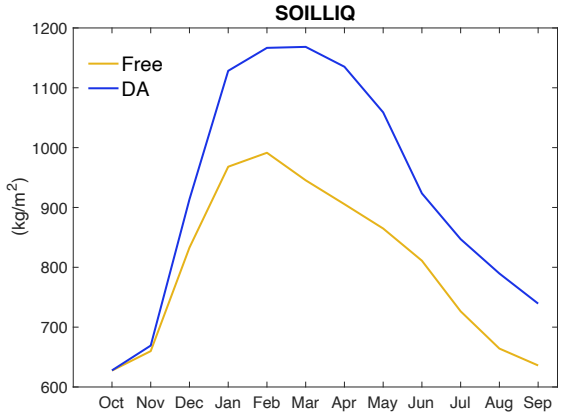


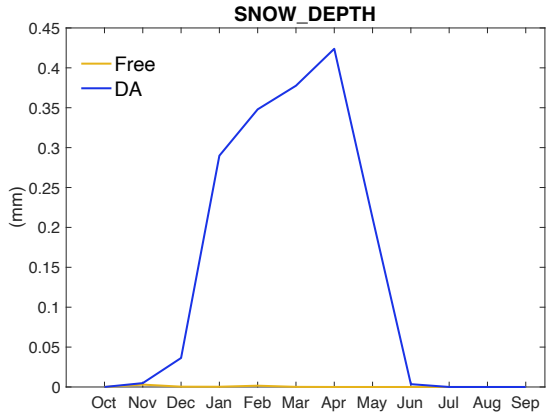


Cascade Range

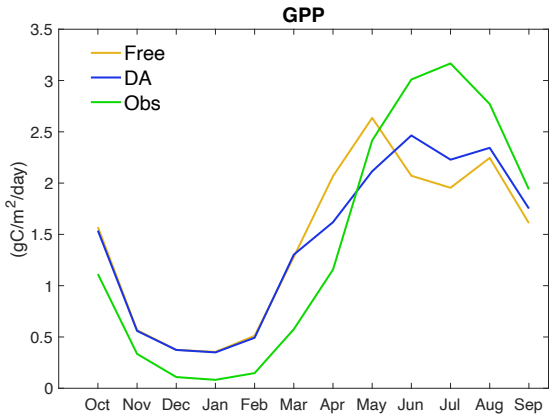


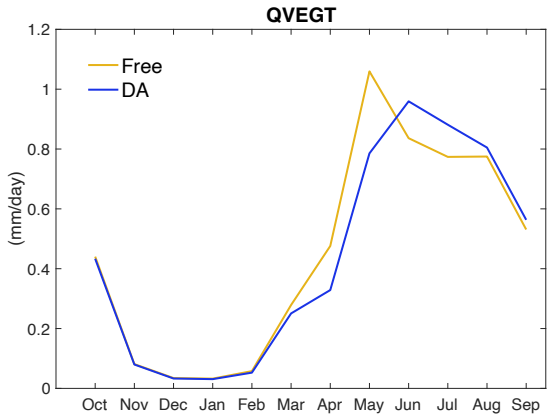


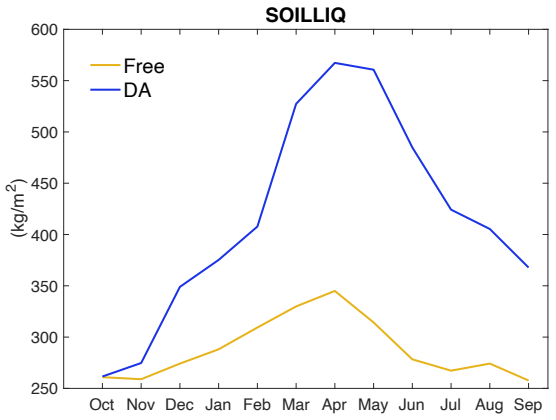


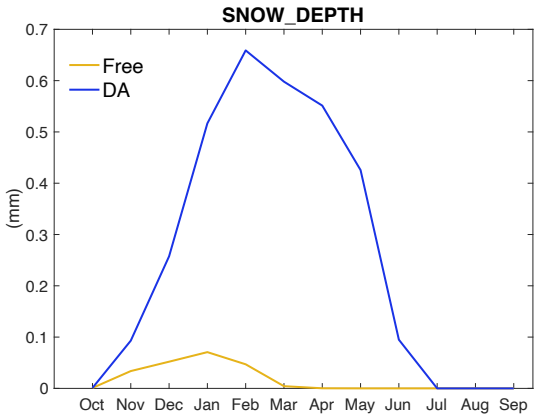


Southern Rocky

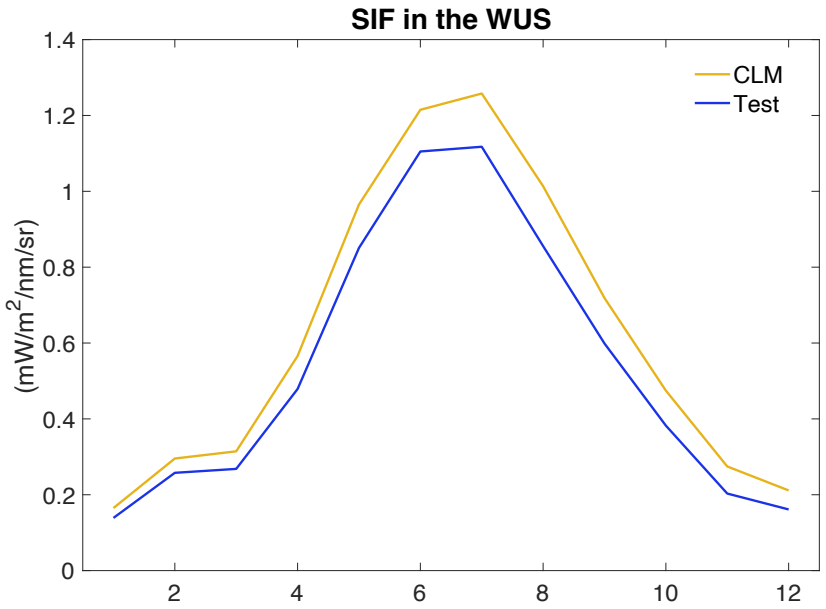


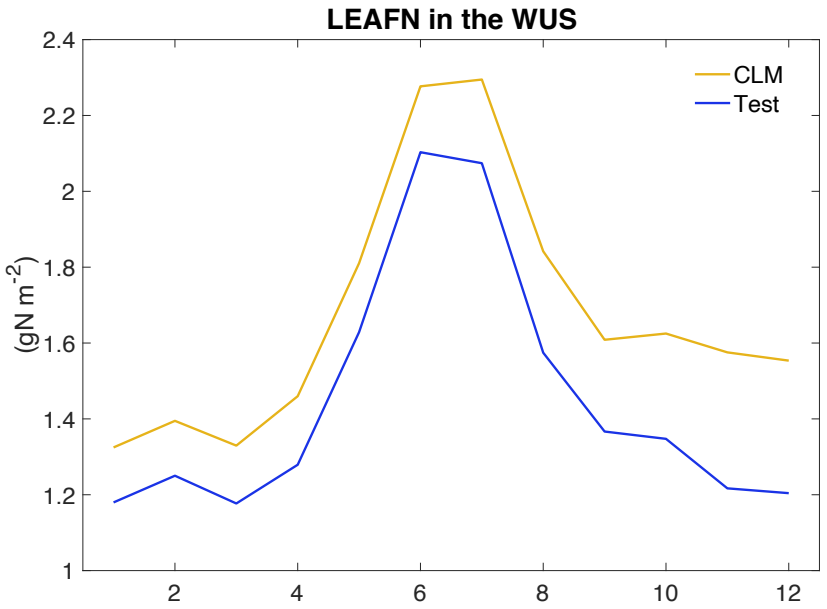


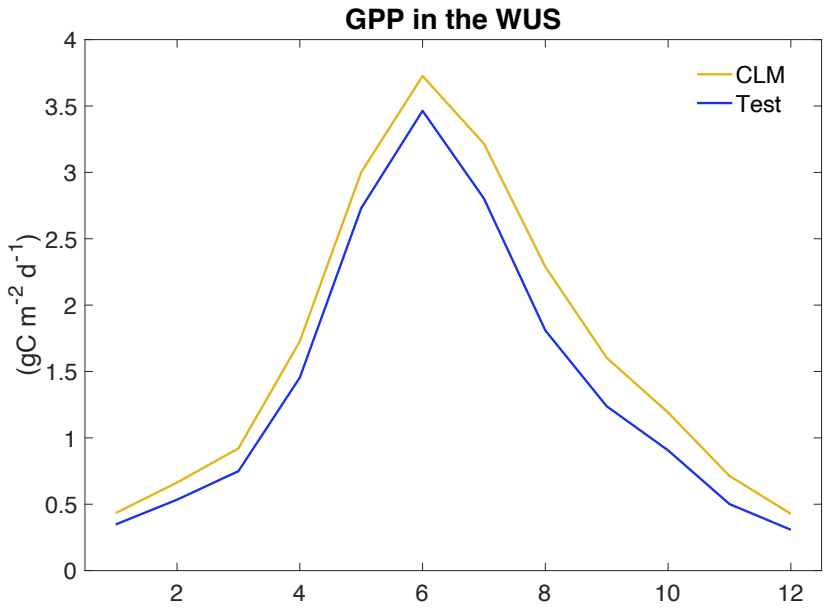




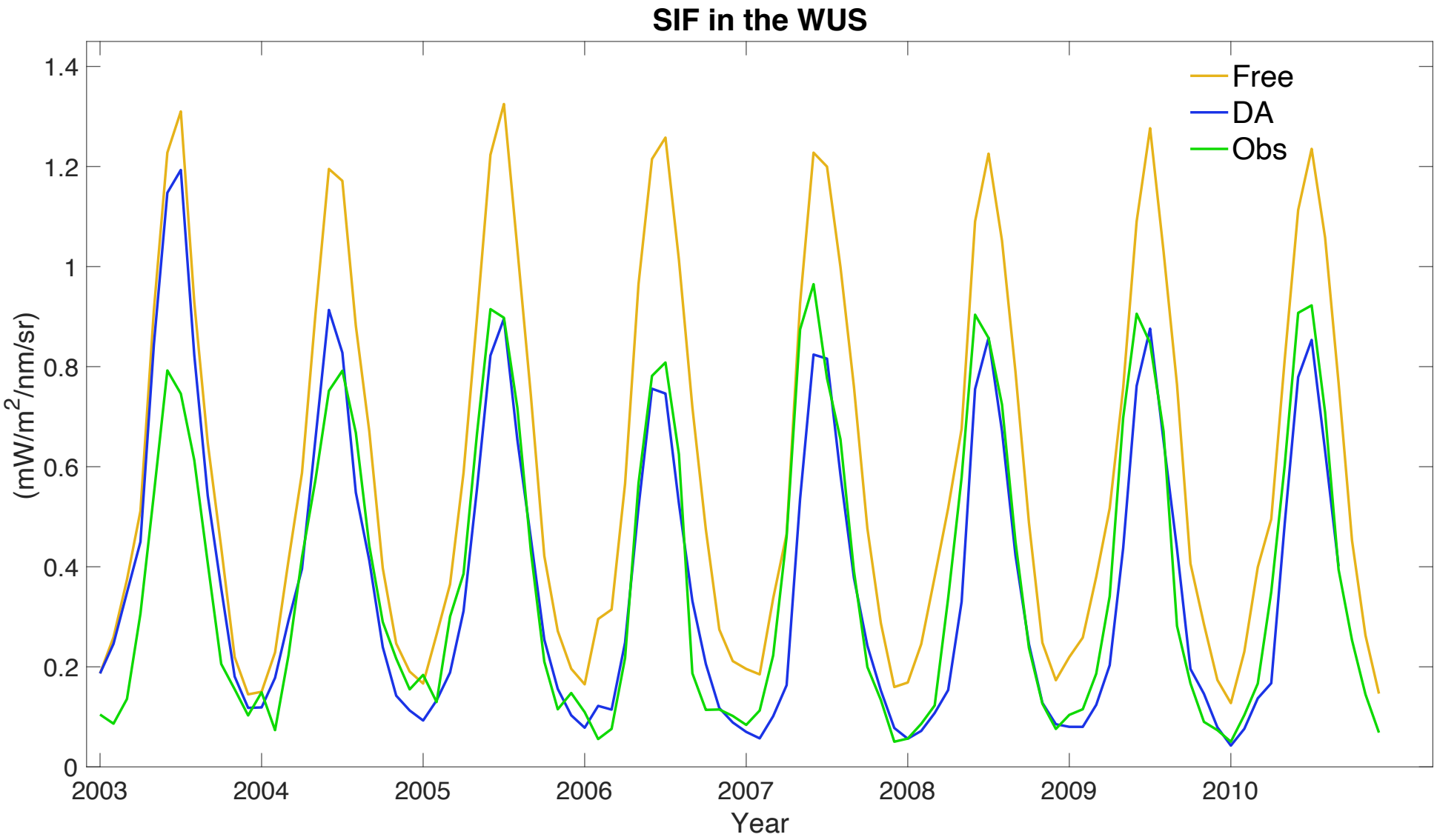
GPP is sensitive to the change of leaf nitrogen



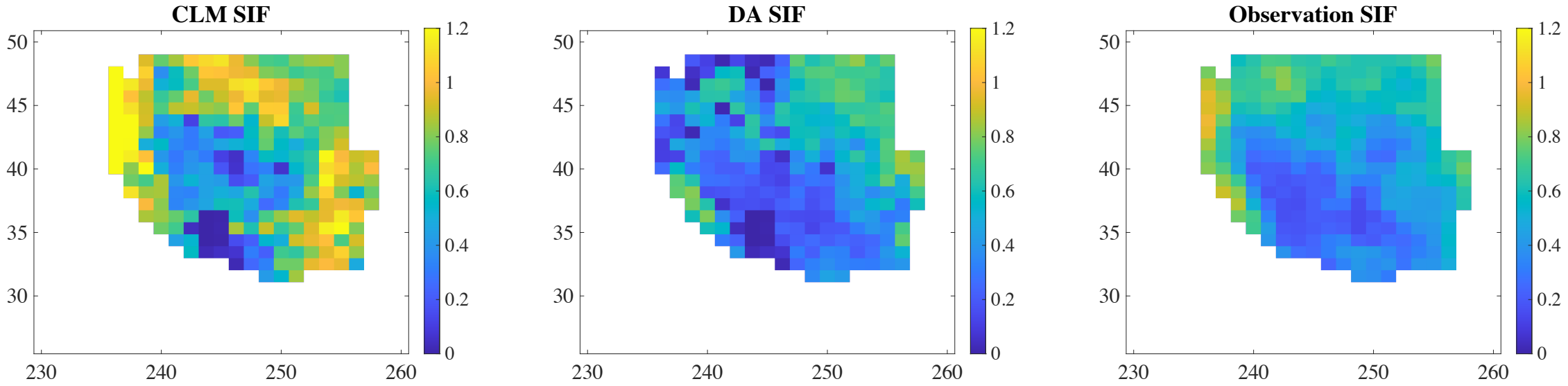




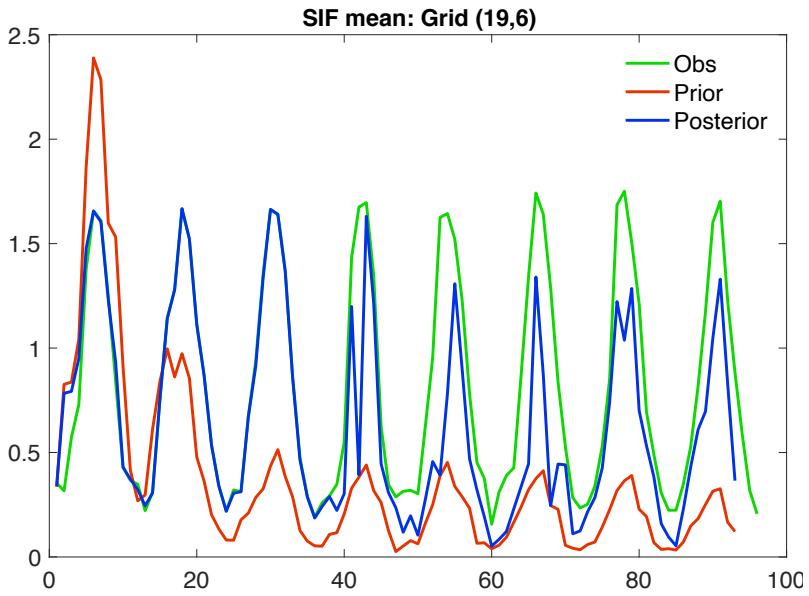
Though the regional average of SIF aligns well with the observation,

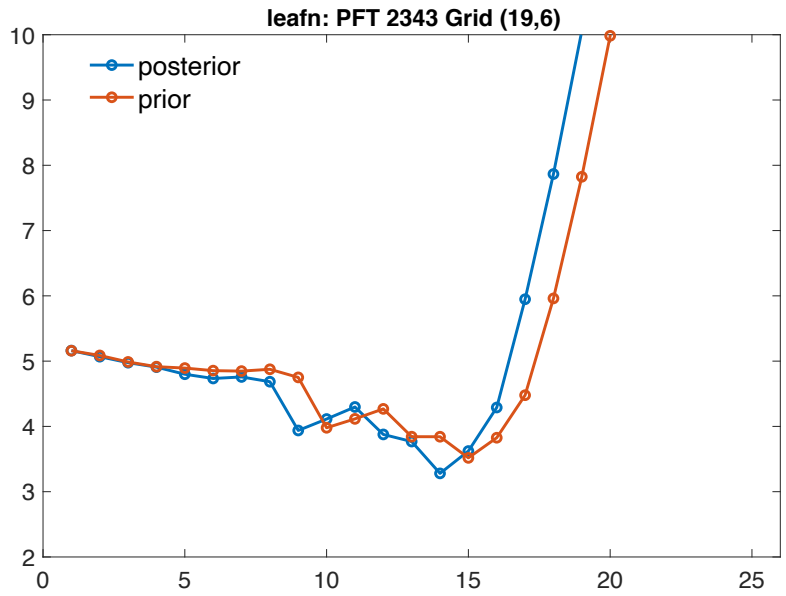


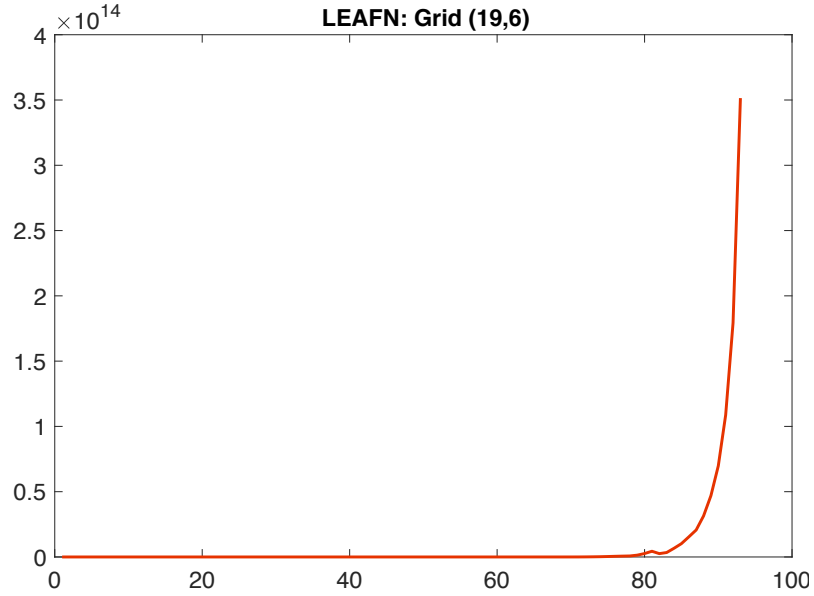
Though the regional average of SIF aligns well with the observation, SIF is overcorrected along the Cascade Range and in Montana

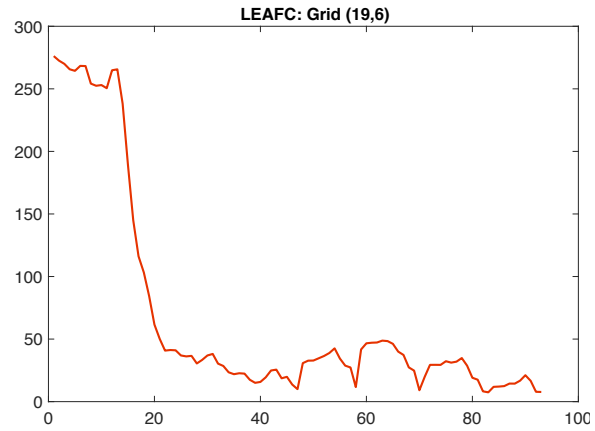


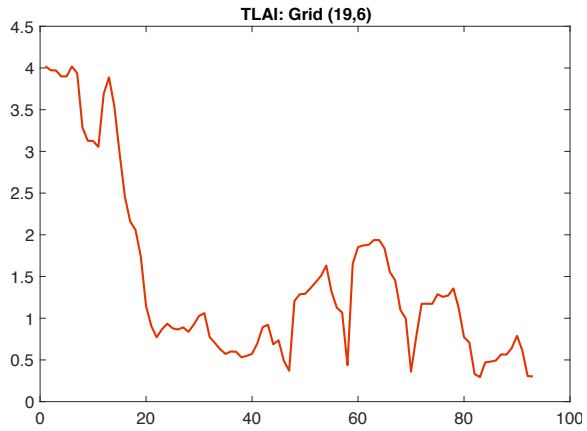
When DA keeps pulling up SIF, leaf nitrogen is raised to an excessively high level

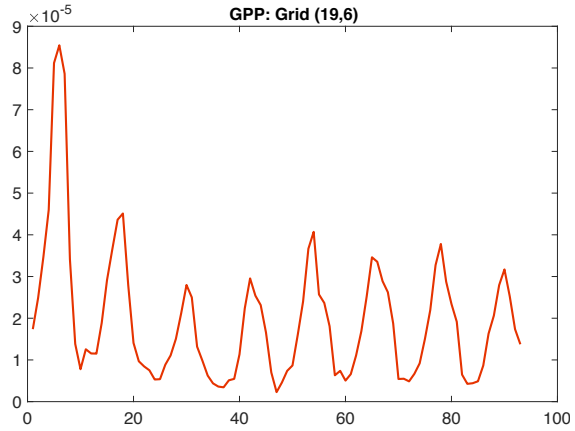


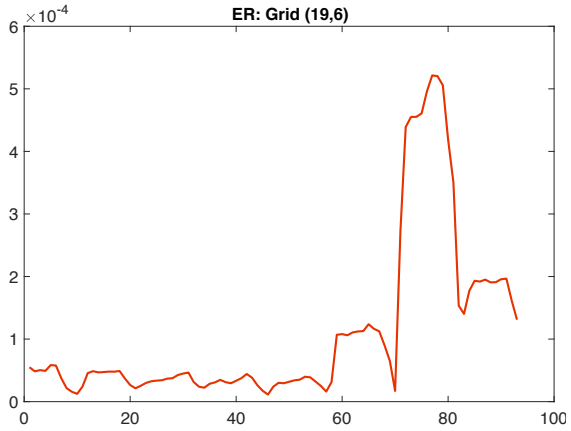






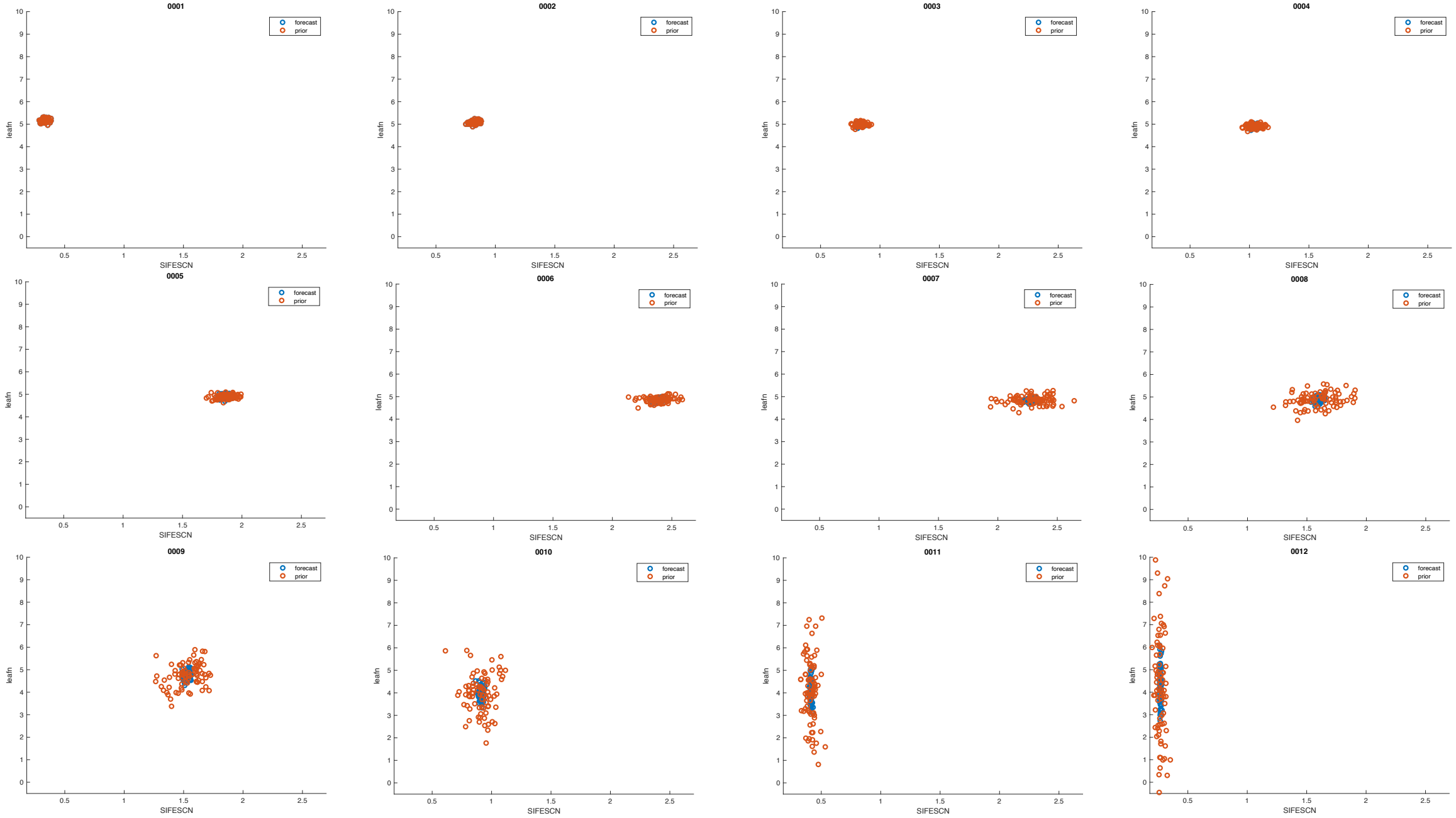




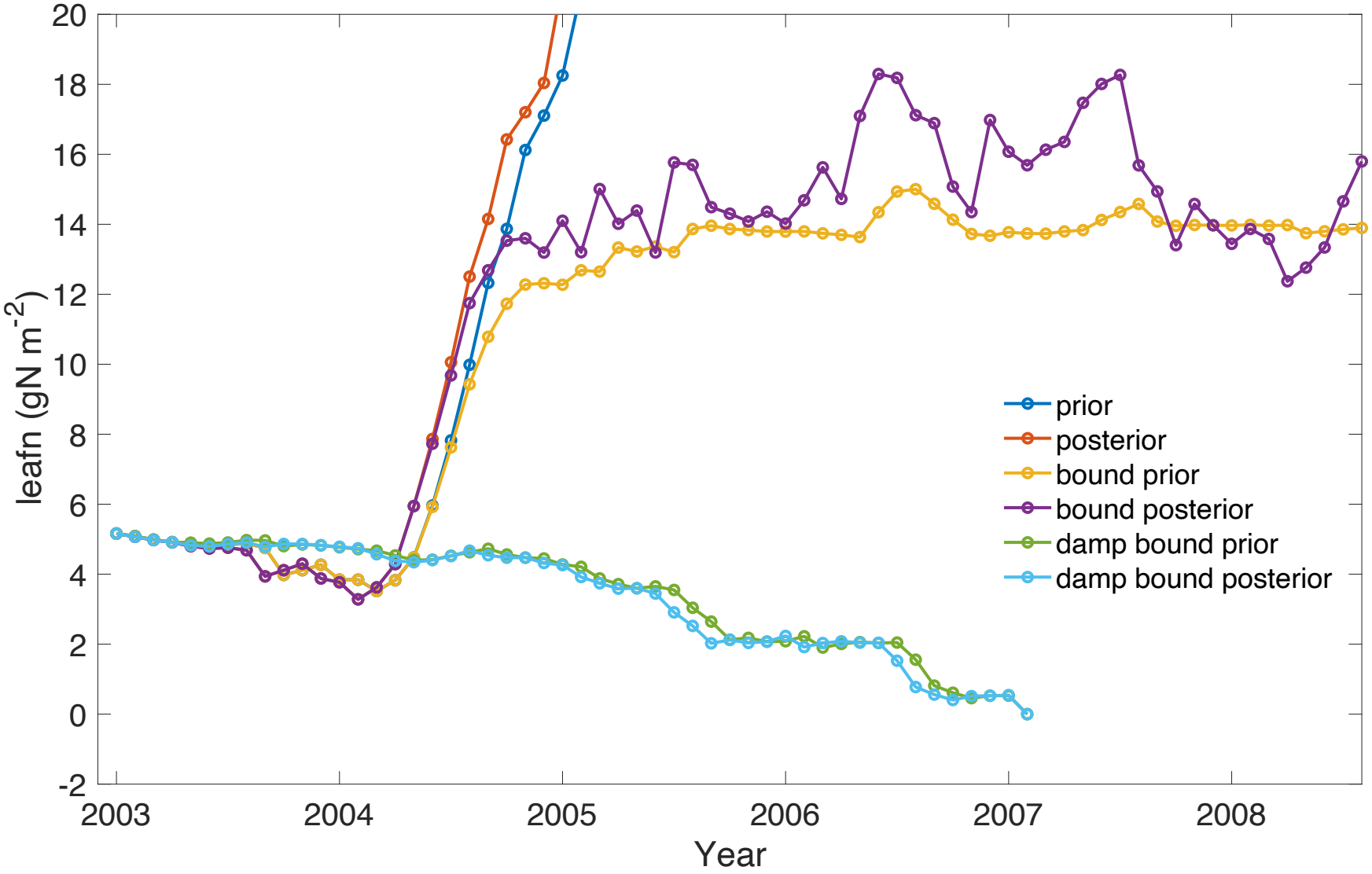


Some DA options can be tuned to keep leaf nitrogen within the reasonable range

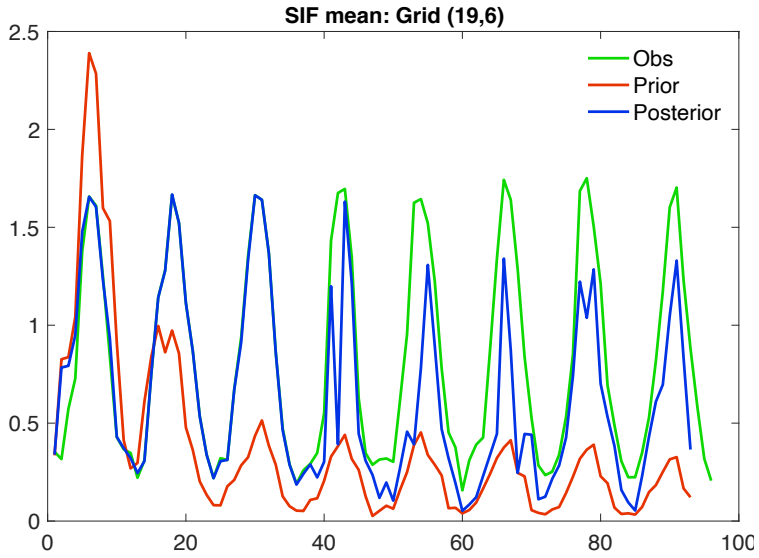
Leaf nitrogen

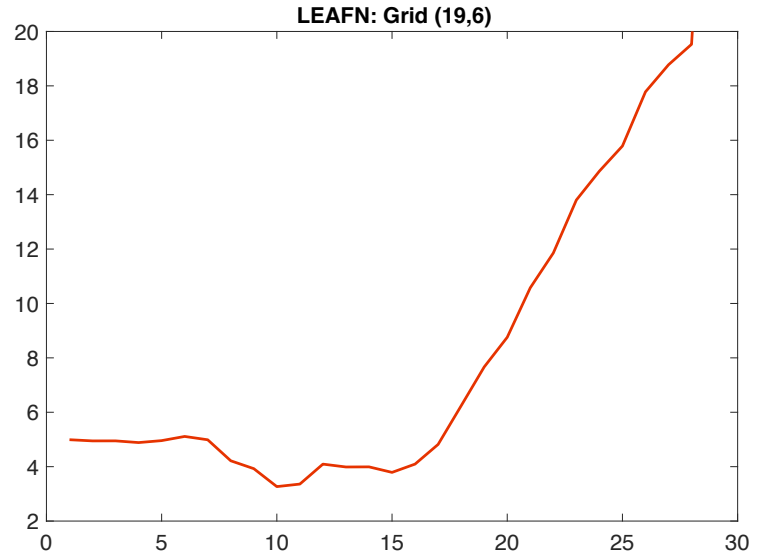


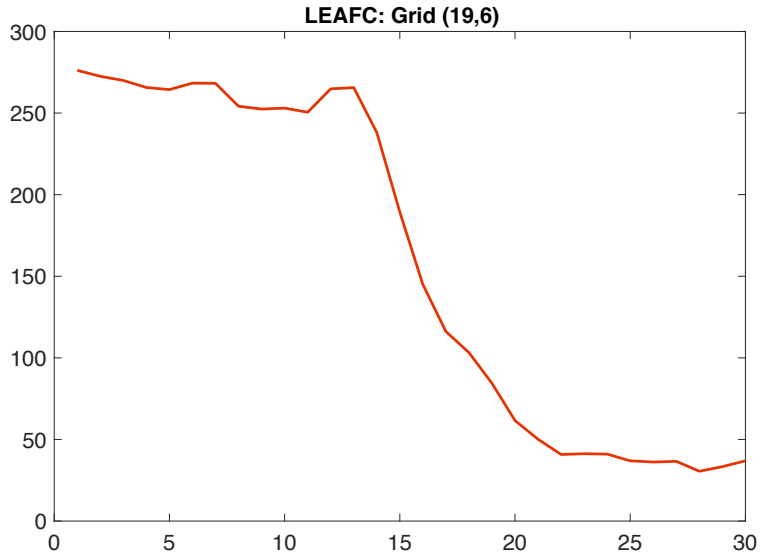
Tune DA options to keep leaf nitrogen within the reasonable range

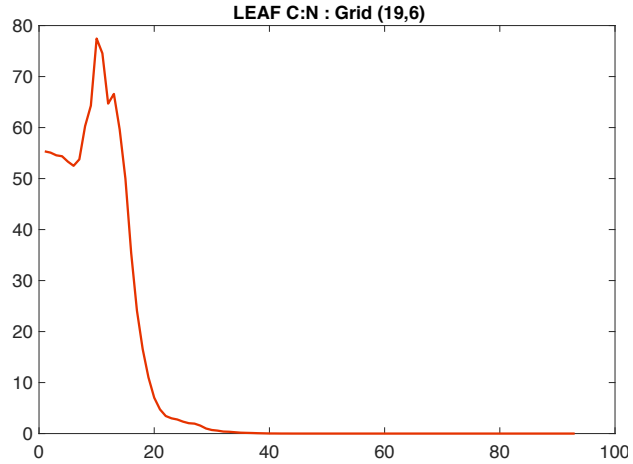


Trying to understand why the increase in leaf nitrogen causes leaf carbon to decrease with the FUN turned on









Summary

SWE DA changes the seasonality of GPP due to the impact of swe change on soil moisture and snow depth

Need to refine the way of leaf nitrogen altered by DA to effectively impact GPP