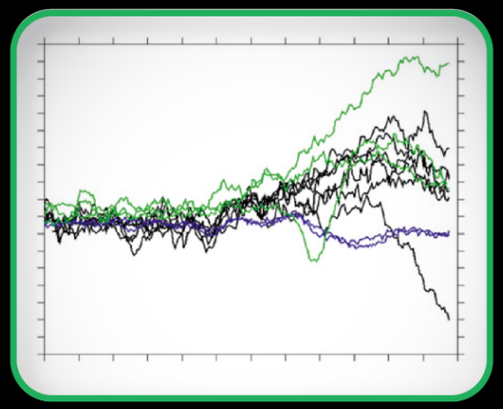
PEcAn: A community tool to enable synthesis, evaluation, & forecasting

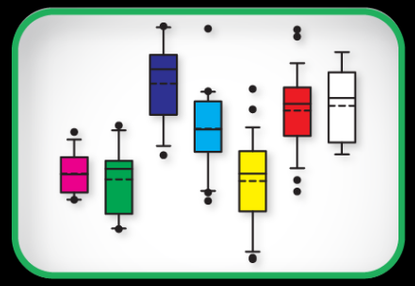
SHAWN SERBIN & PEcAn TEAM

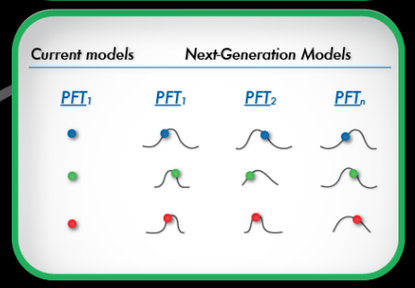
@PEcAnProject
@doctorjackpine

ESM uncertainty



New Data

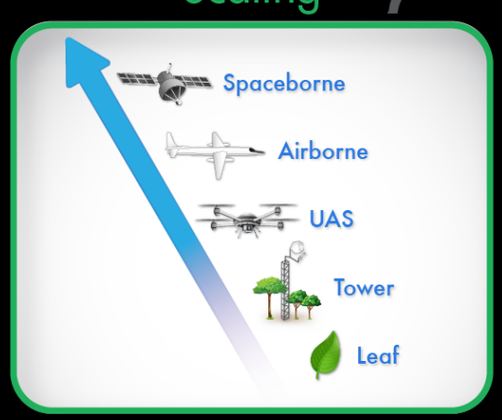




Expert Knowledge

ESM Community

Scaling

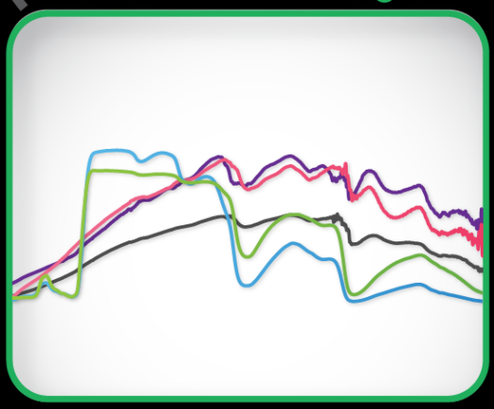


ModEx

Uncertainty Quantification

Predictive Ecosystem Analyzer

Remote Sensing

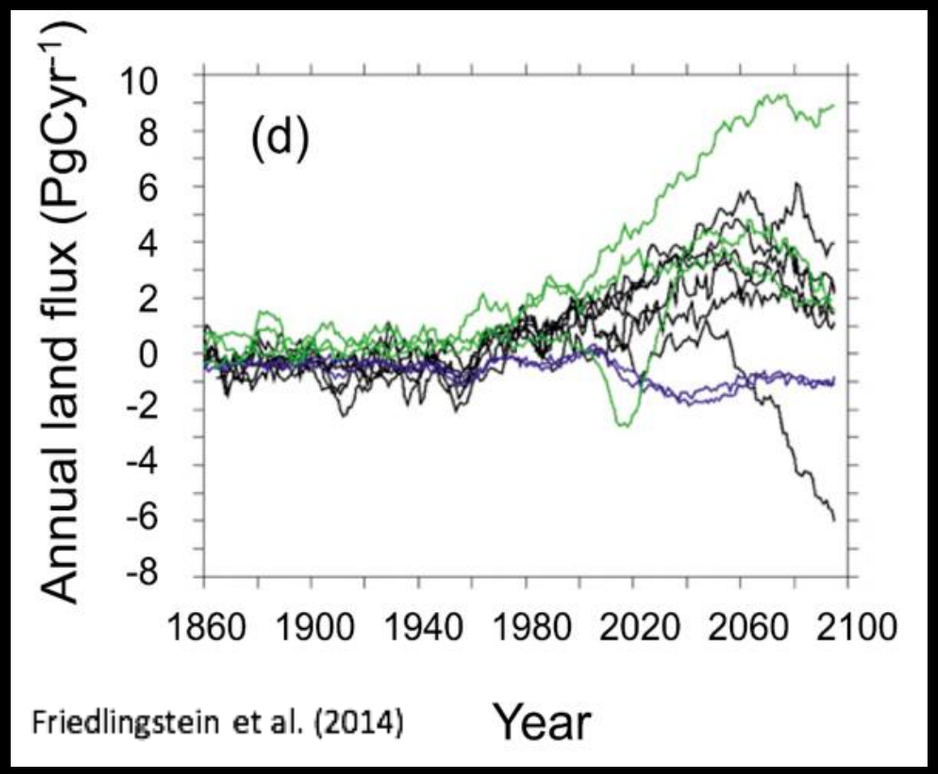


Target New Measurements

?

CHALLENGES

- Data synthesis:
  volume, diversity
- Modeling not scalable
- Models are not accessible



MULTI-MODEL VALIDATION TAKES YEARS

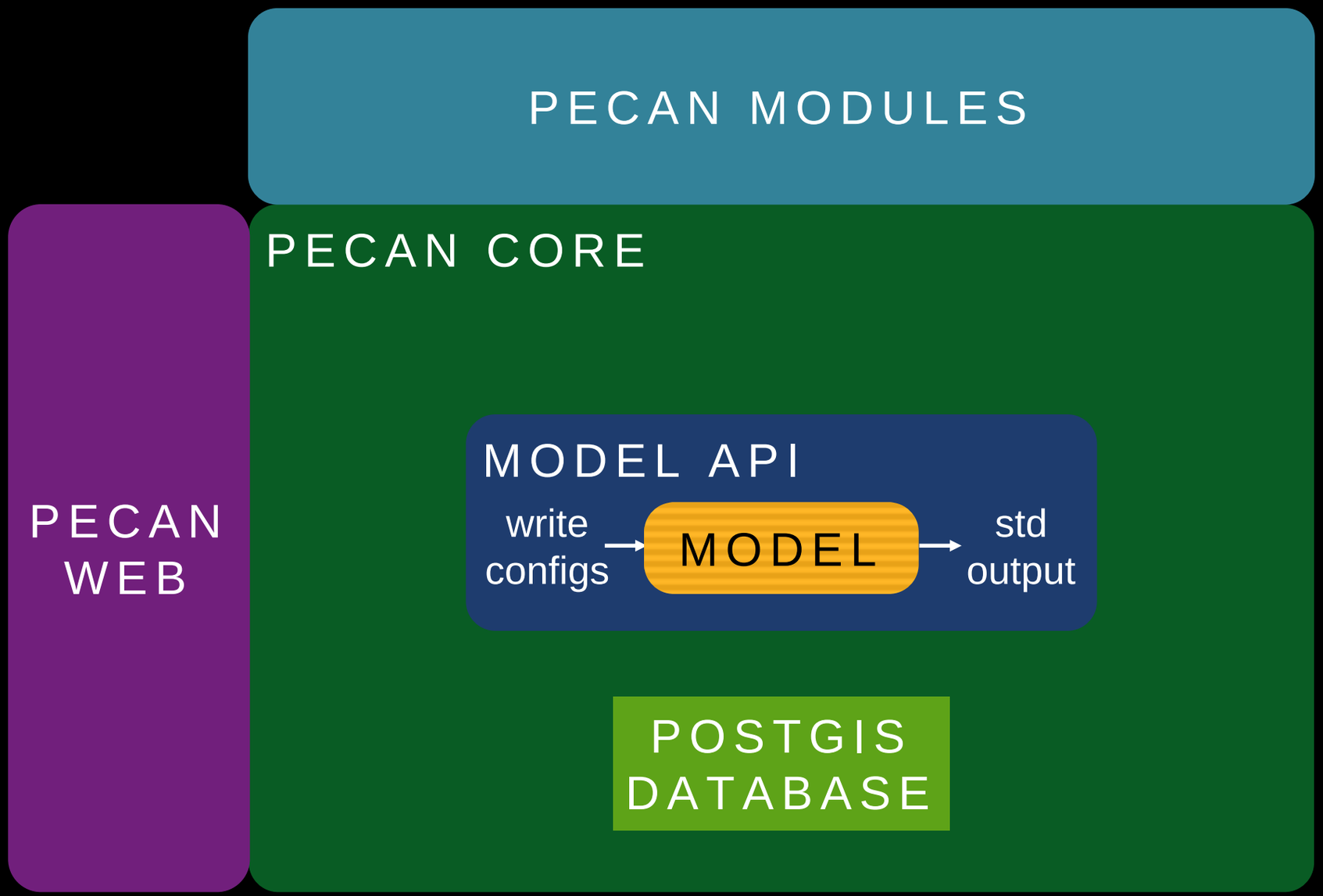
ONLY FRACTION OF DATA BEING USED

MODELING IS A COTTAGE INDUSTRY

INPUTS, OUTPUTS, AND ANALYTICAL TOOLS NOT STANDARDIZED

NOT SHARED OR REPLICABLE

NO EASY WAY FOR NON-MODELERS TO HELP



PEcAn
pecanproject.org

BETYdb.org

Standardized inputs and outputs

Provenance: Transparent & Repeatable

Accessible interface

Reusable tools for execution, analysis, visualization

Terrestrial Ecosystem Scier | PEcAn Site/Model Selectior | BETYdb: /models | pecan.book/Installing-PEc/ | Missing dependency for R L

https://modex.bnl.gov/pecan/02-modelsite.php

Select host

Based on the host selected certain sites and models will be available.

Host:

modex.bnl.gov

Model:

- ✓ All Models
- SIPNET (unk)
- MAAT_Model (dev_ngeet)
- LPJ-GUESS (v3.1)
- LINKAGES (R_version)
- LINKAGES (Revision 1.0 Ann's hack)
- ED2 (git)
- ED2 (85)
- ED2 (82)
- ED2 (81)
- ED2 (46)
- DALEC (Quaife Evergreen RSE08)
- BioCro

Workflow

Select a site to continue

Prev | Next

Logged in as Shawn P. Serbin

logout

Map | Satellite

Terrestrial Ecosystem Scier × | PEcAn Parameter Selection × | Shawn

https://modex.bnl.gov/pecan/03-inputs.php

Selected Site

Set parameters for the run.

PFT* (Show in BETY)

- luquillo.late_tropical
- populus
- temperate.coniferous
- temperate.deciduous
- temperate.needleleaf.LIpinebar

Start Date*

2004/01/01

End Date*

2004/12/31

Sipnet.climna* (Show in BETY)

- ✓ Ameriflux_SIPNET_site_0-772 2004-2004
- Use Ameriflux
- Use NARR
- Use CRUNCEP

Notes

Use BrownDog

☑

Edit pecan.xml

☑

Edit model config

☐

Advanced setup

☑

* are required fields.

Prev | Next

Map | Satellite

Niwot Ridge Forest/LTER NWT1 (US-NR1)
Niwot Ridge, CO, US

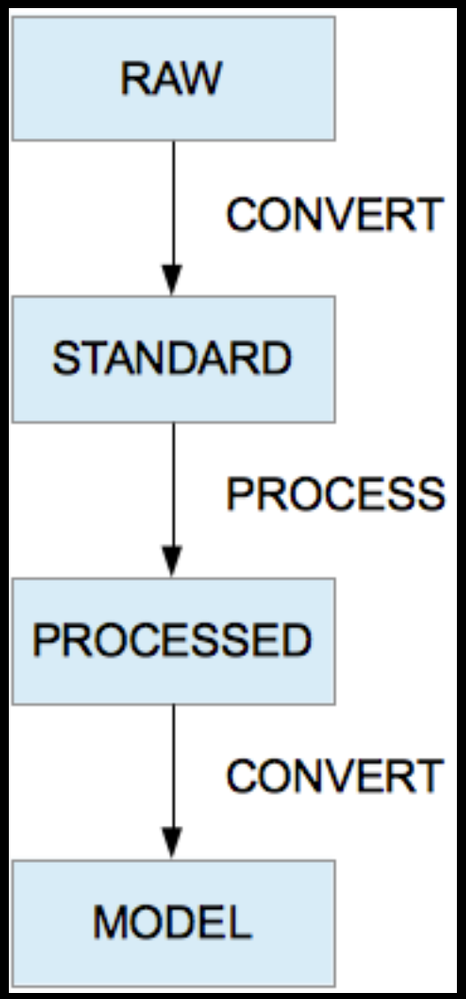
Rocky Mountain National Park
Twin Sisters Peak East
Longs Peak
Grand Lake
Allenspark
Elk Mountain
Granby
Hot Sulphur Springs
Apache Peak
Tabernash
Fraser
Winter Park
Arapaho National Forest
Byers Peak
St Mary's
Berthoud Falls
Pettingell Peak
Front Range
Nederland
Rollinsville
Coal Creek
Golden Gate Canyon State Park
Black Hawk
Gold Hill
Crescent
Eldorado Springs
Lyons
Estes Park
Campion
Berthoud
Johnstown
Mead
Hygiene
Longmont
Altona
Dacono
Erie
Boulder
Lafayette
Louisville
Superior
Henderson
Thornton
Westminster
Arvada
Golden
Denver
Lakewood
Genesee
Morrison
Evergreen

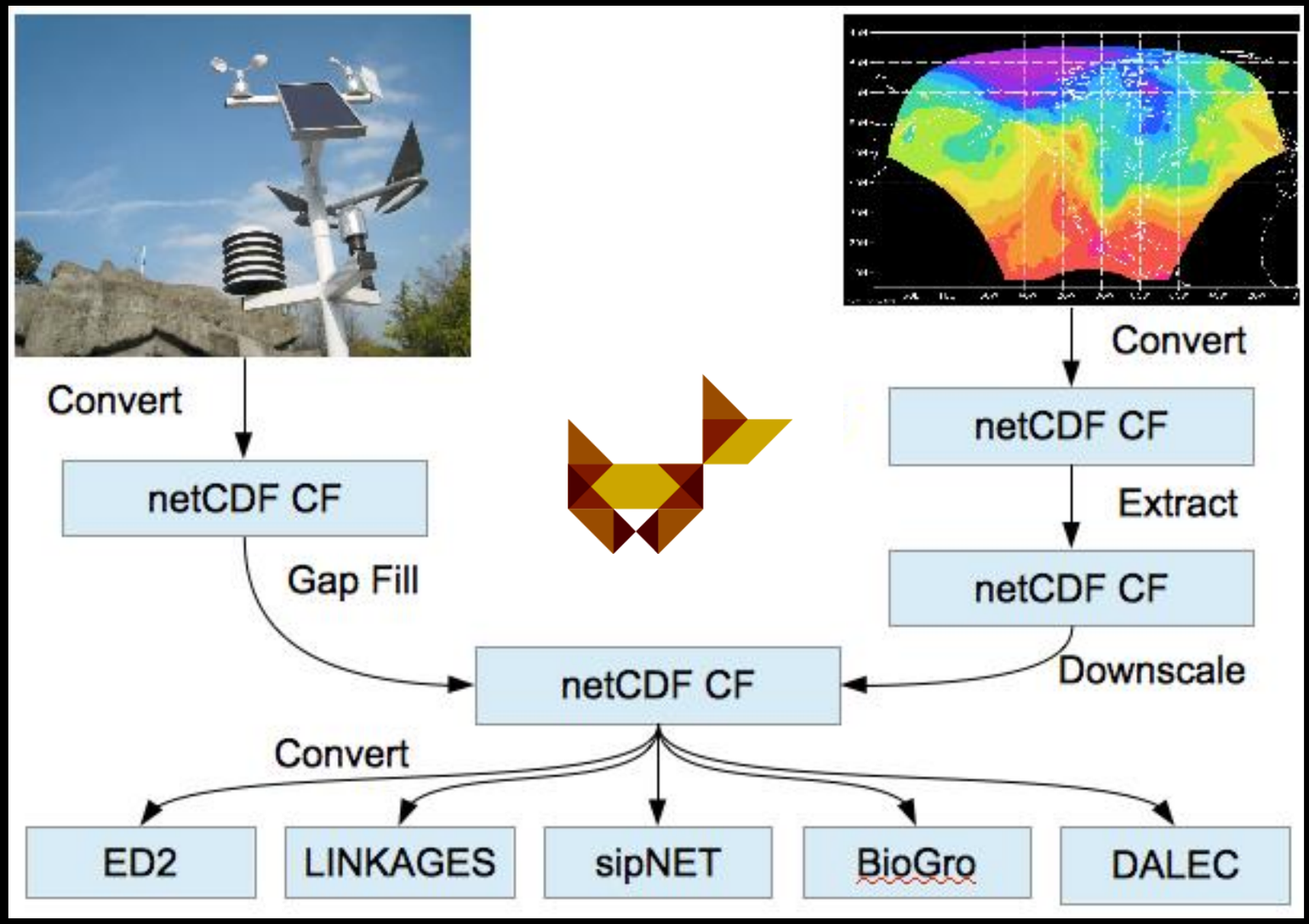
Google
Map data ©2016 Google | Terms of Use | Report a map error
powered by BROWN DOG

The PEcAn project is supported by the National Science Foundation (ABI #1062547, ARC #1023477) and the Energy Biosciences Institute.

PEcAn Version 1.4.6

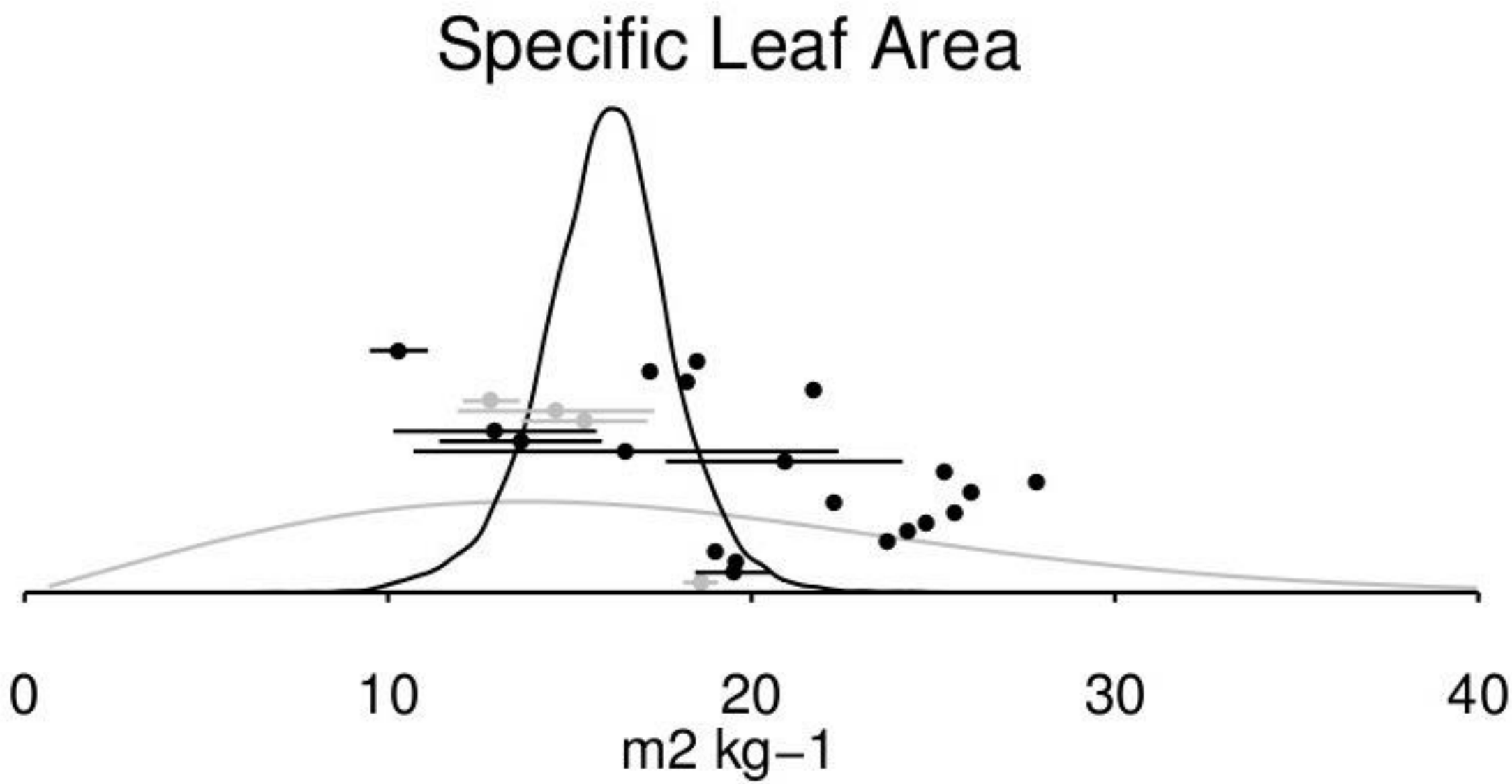
INFORMATICS MODULES



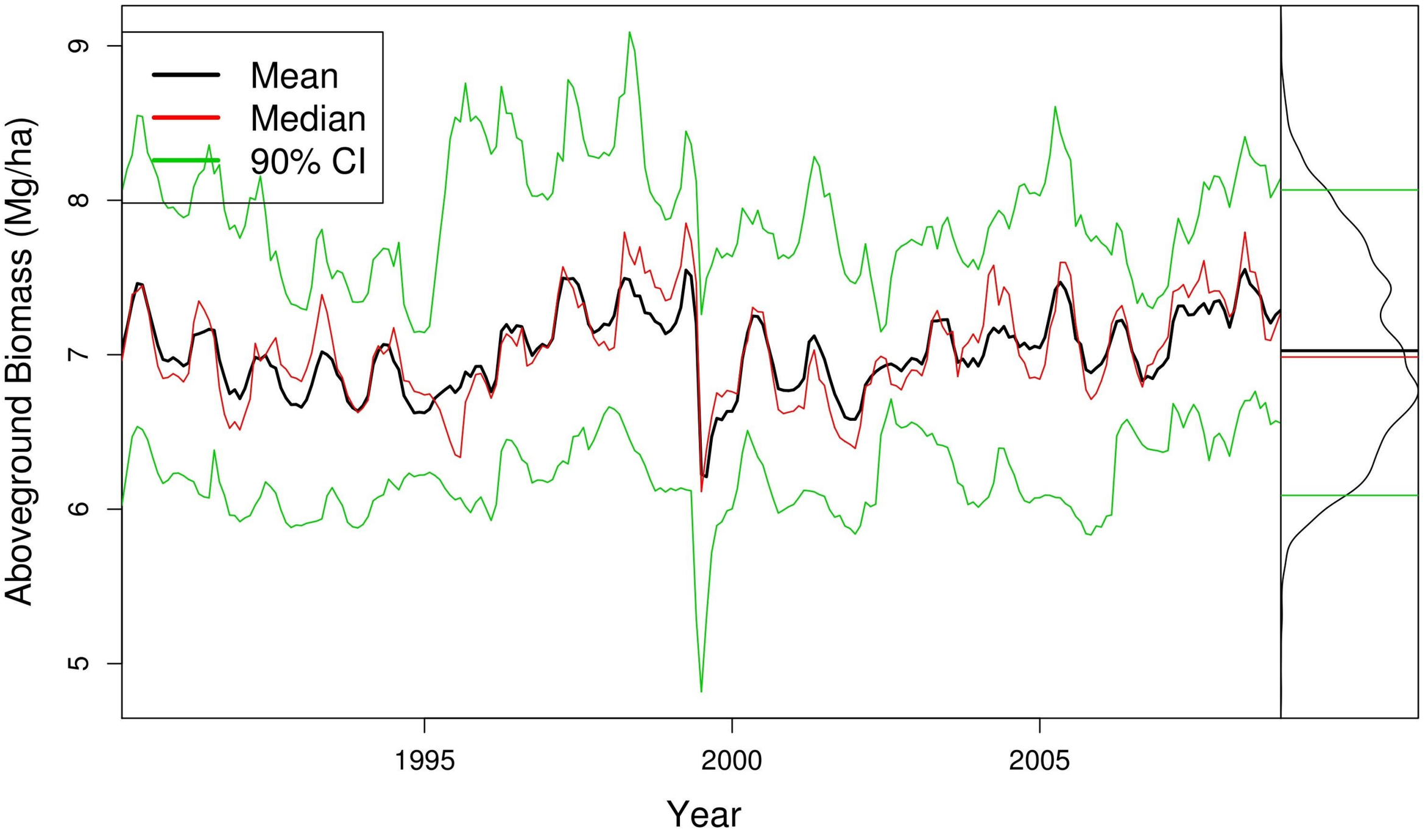


Cowdery et al in prep

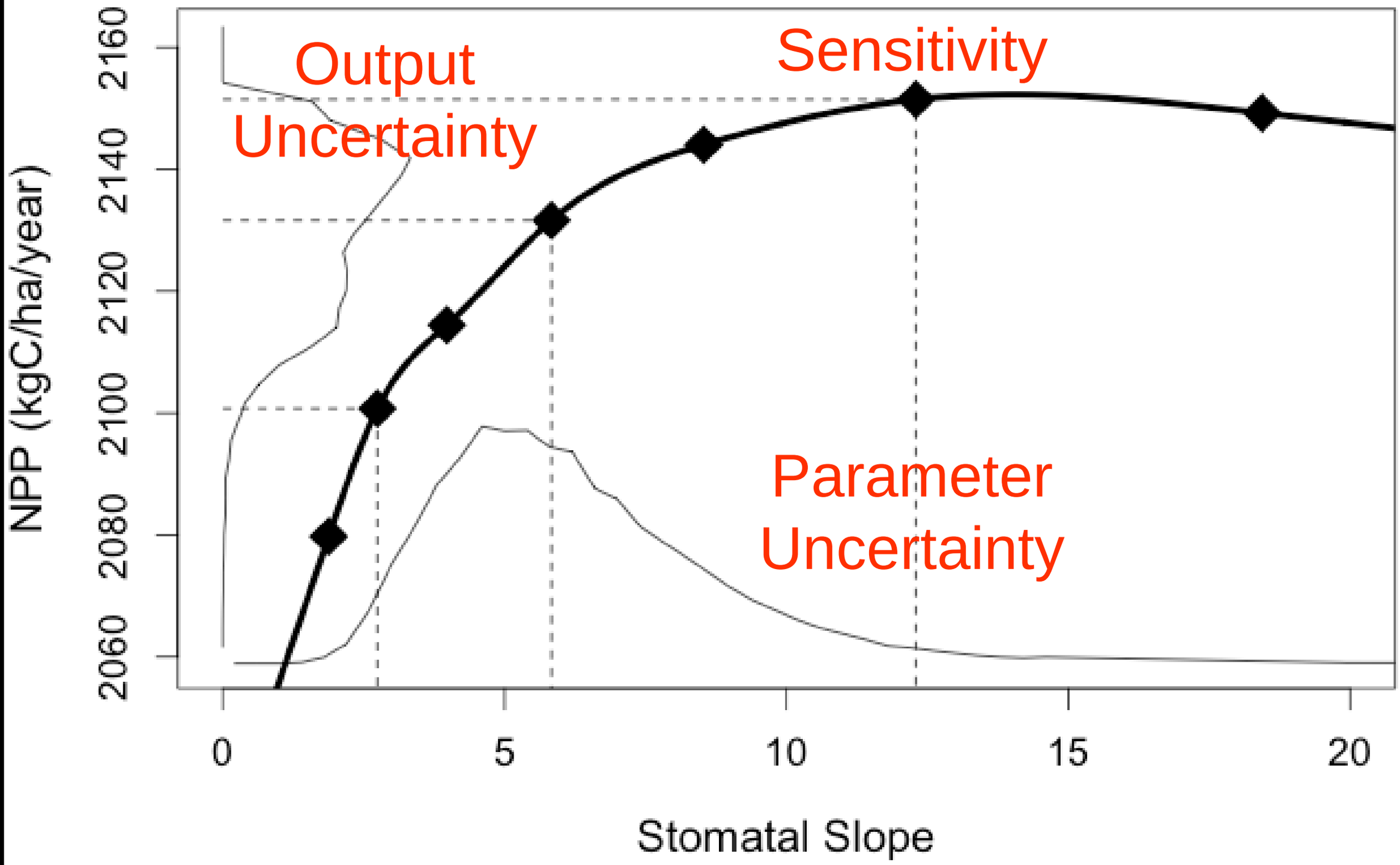
META ANALYSIS POSTERIORS



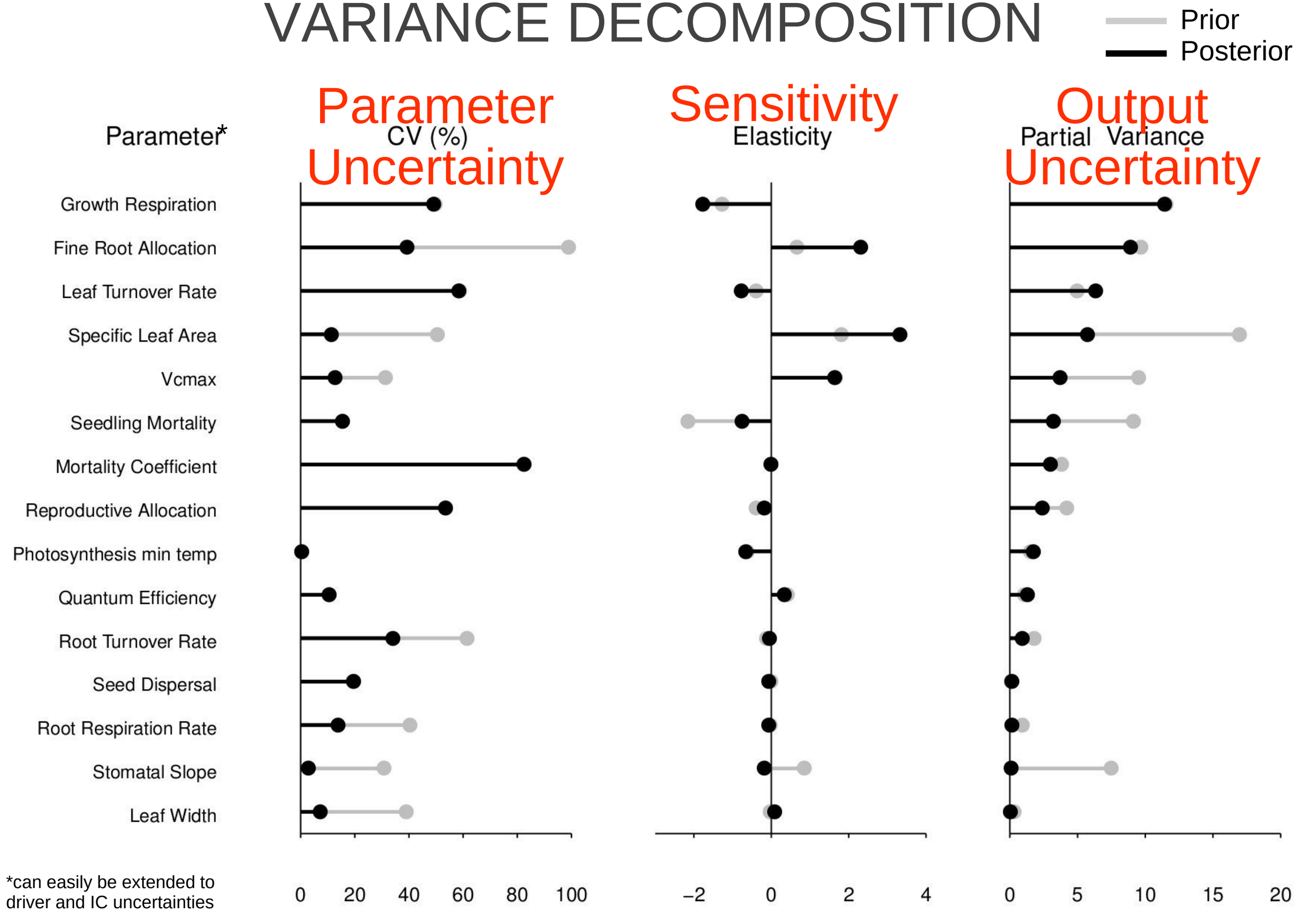
ENSEMBLE ESTIMATE



UNCERTAINTY QUANTIFICATION

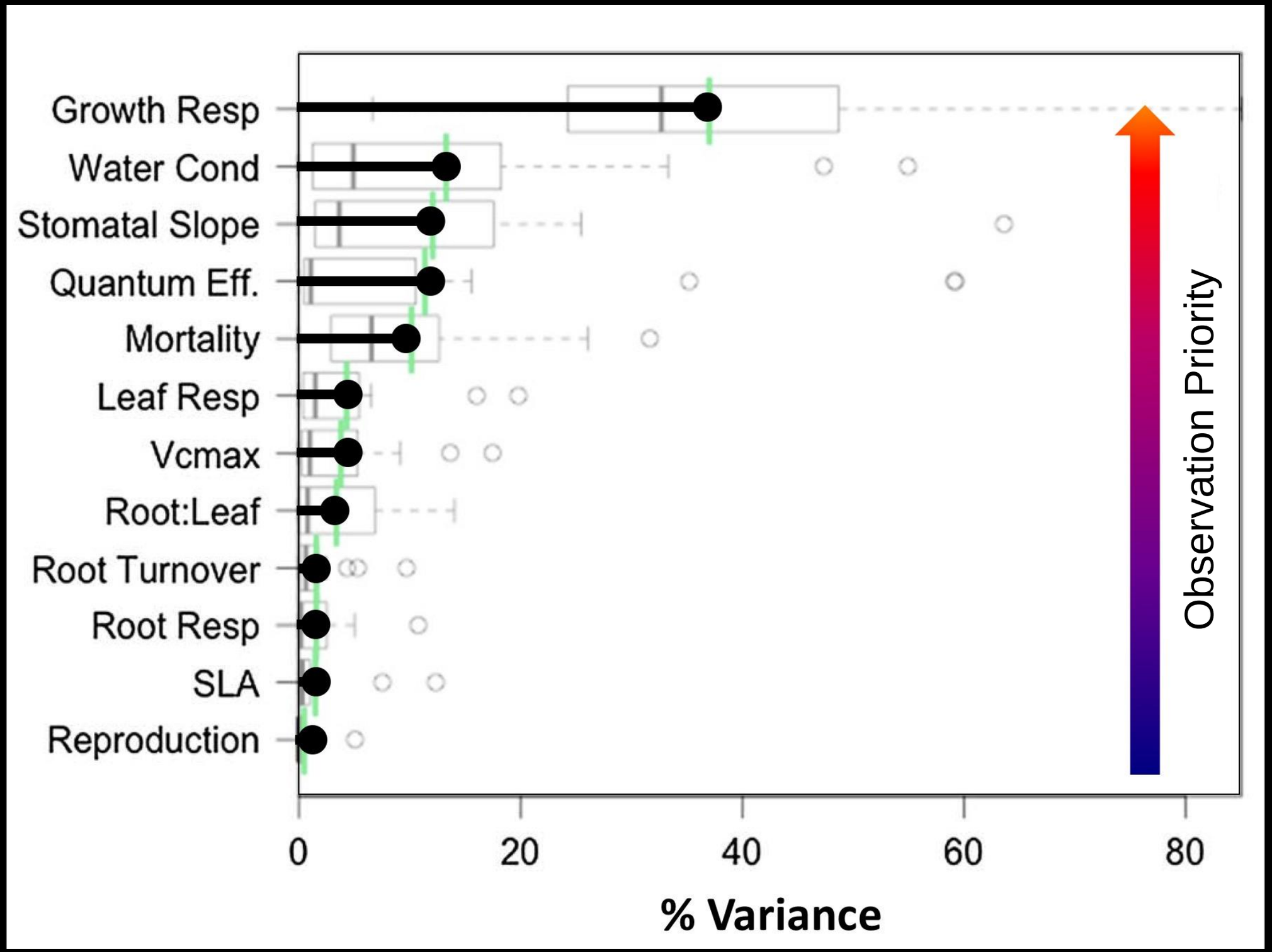


VARIANCE DECOMPOSITION



*can easily be extended to driver and IC uncertainties

NORTH AMERICA:
MULTI-SITE VARIANCE DECOMPOSITION



Dietze et al. 2014 JGR-B

INTERACTIVE VISUALIZATION

Terrestrial Ecosystem Scier | EBI Results | Shawn

https://modex.bnl.gov/pecan/08-finished.php?workflowid=2000000198

Results

Select a specific run.

Run ID

2000014596

Graphs

Year

2004

X-axis

Gross Primary Productivity

Y-axis

Net Primary Productivity

Plot run/year/variable

Inputs

File

README.txt

Show Input File

Outputs

File

2004.nc

Show Output File

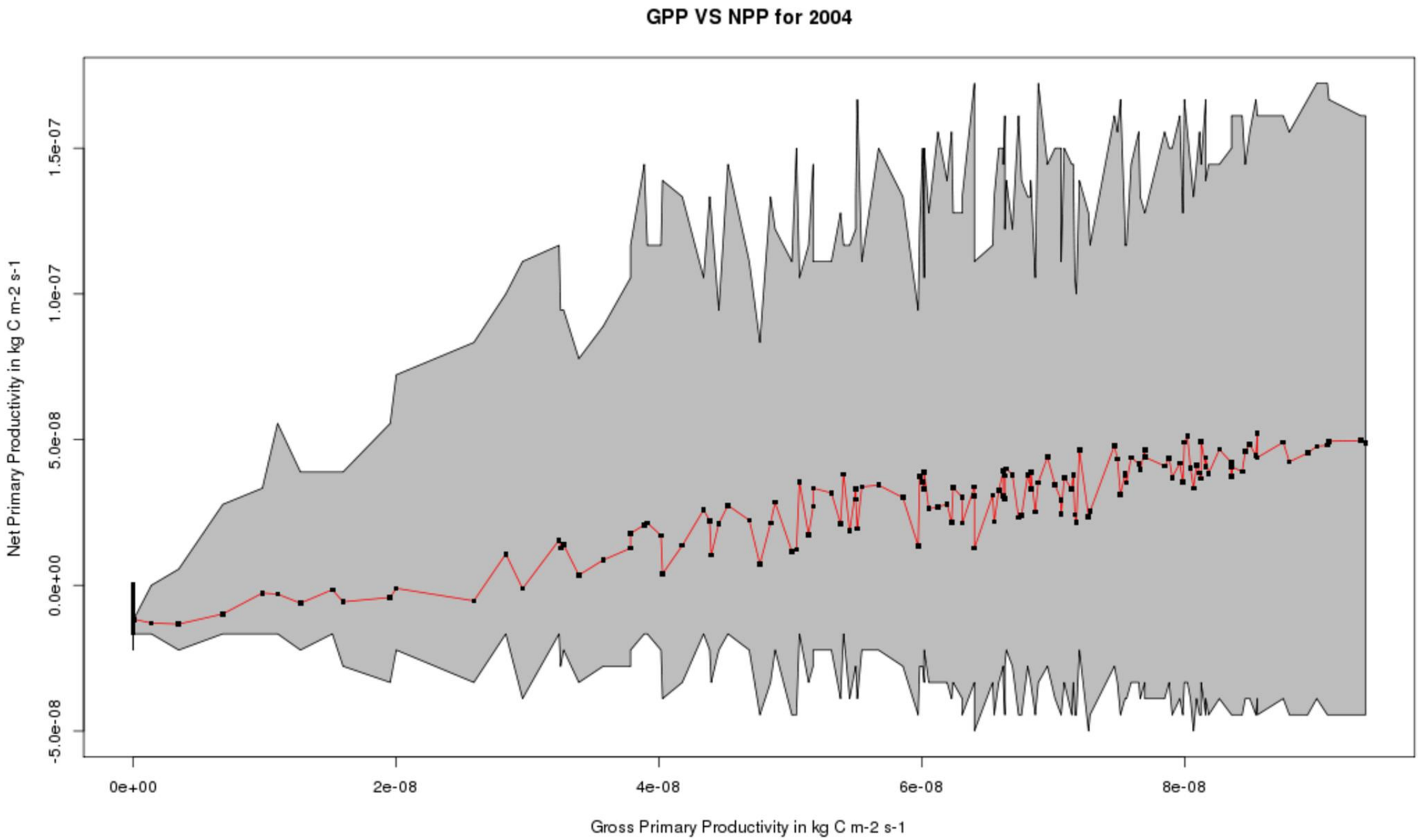
PFTs

PFT

temperate.coniferous

Output

variance.decomposition.2000



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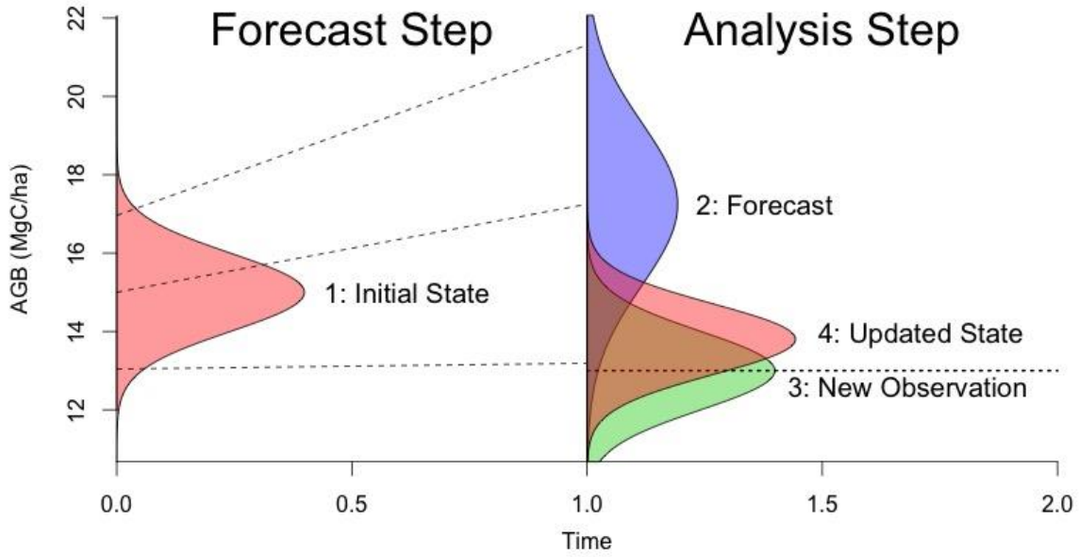
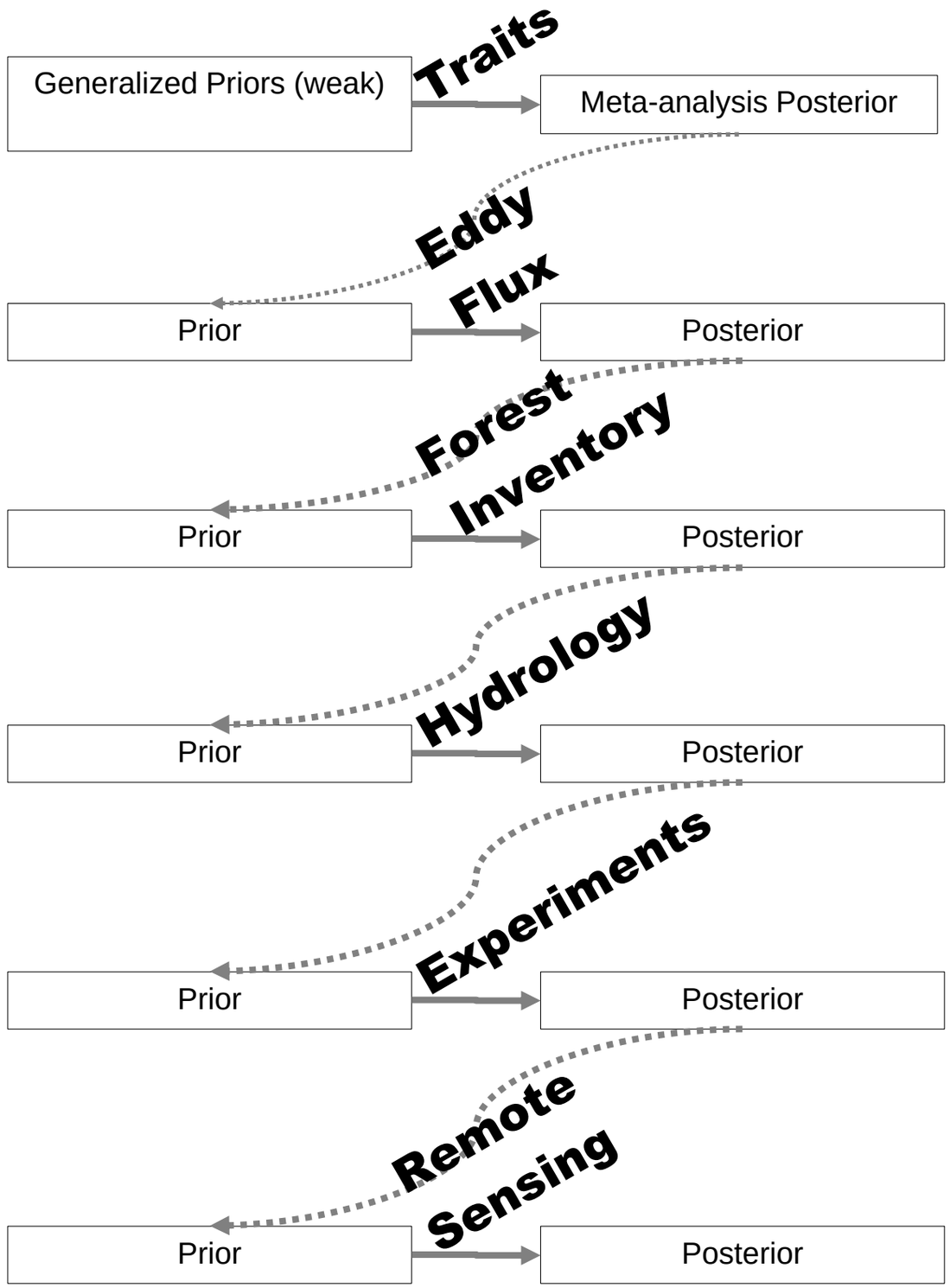
PEcAn Version 1.4.6

BAYESIAN DATA ASSIMILATION





Advanced Edit

Select a file to edit.

File Selection

pecan.xml

Start Over | Continue

Data Assimilation

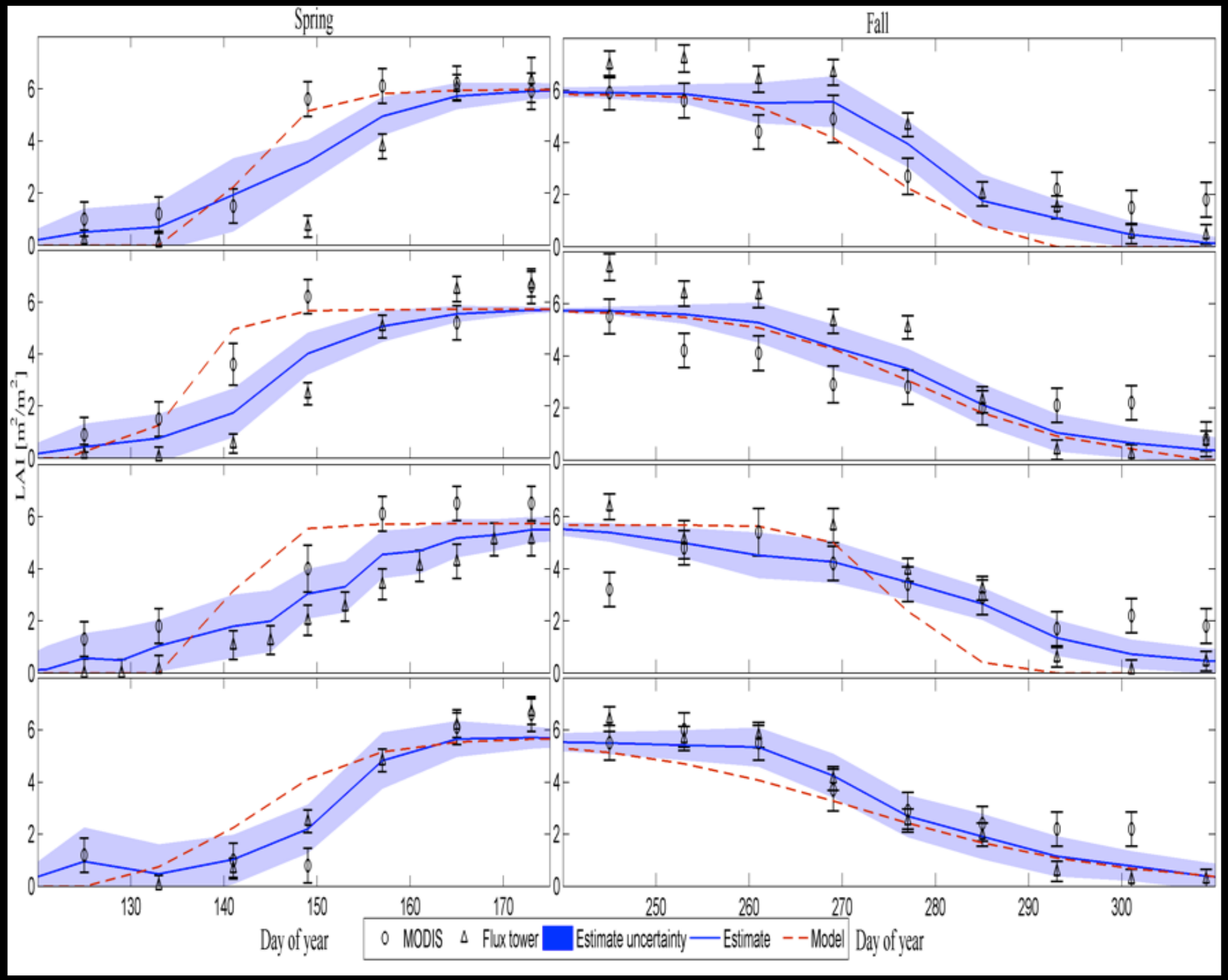
```
<?xml version="1.0"?>
<pecan>
  <assim.batch>
    <method>bruteforce</method>
    <iter>2500</iter>
    <diag.plot.iter>25</diag.plot.iter>
    <param.names>
      <param>YOUR_PARAM_1</param>
     <param>YOUR_PARAM_2</param>
      <param>YOUR_PARAM_3</param>
    </param.names>
    <jump>
      <adapt>25</adapt>
      <adj.min>0.1</adj.min>
      <ar.target>0.5</ar.target>
    </jump>
    <inputs>
      <file>
        <path>~/output/dbfiles/Ameriflux_site_0-772/US-NR1.2006.nc</path>
        <format>Ameriflux.L2</format>
        <data.model>
          <likelihood>Laplace</likelihood>
          <variable.id>297</variable.id>
        </data.model>
      </file>
    </inputs>
  </assim.batch>
  <outdir>/home/kooper/output//PEcAn_99000000006</outdir>
  <database>
    <bety>
      <user>bety</user>
      <password>bety</password>
      <host>localhost</host>
      <dbname>bety</dbname>
```

Method: MCMC, block MCMC, emulated MCMC, EnKF, SMC

Save

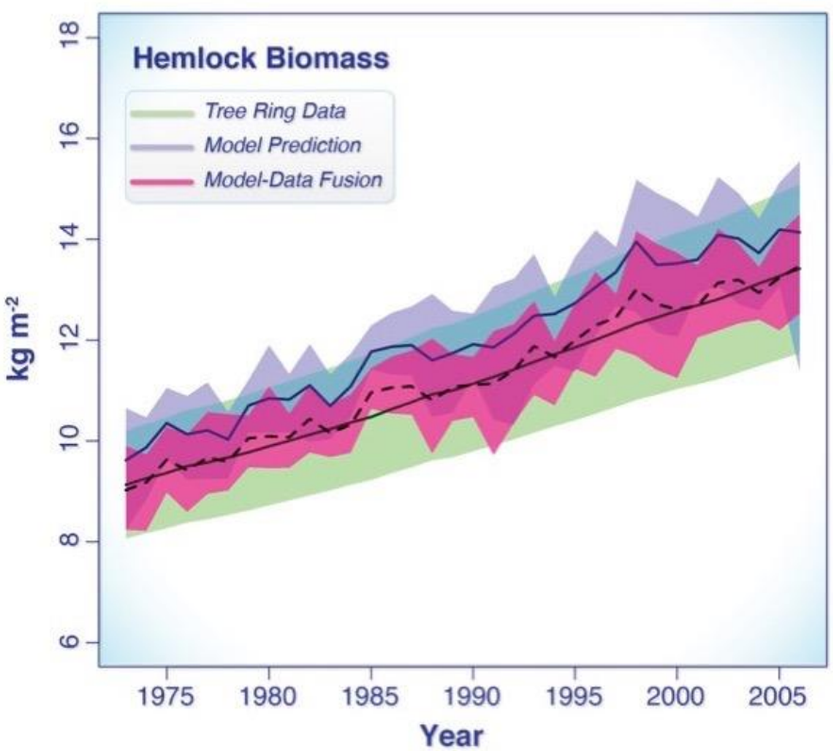
The PEcAn project is supported by the National Science Foundation (ABI #1062547, ARC

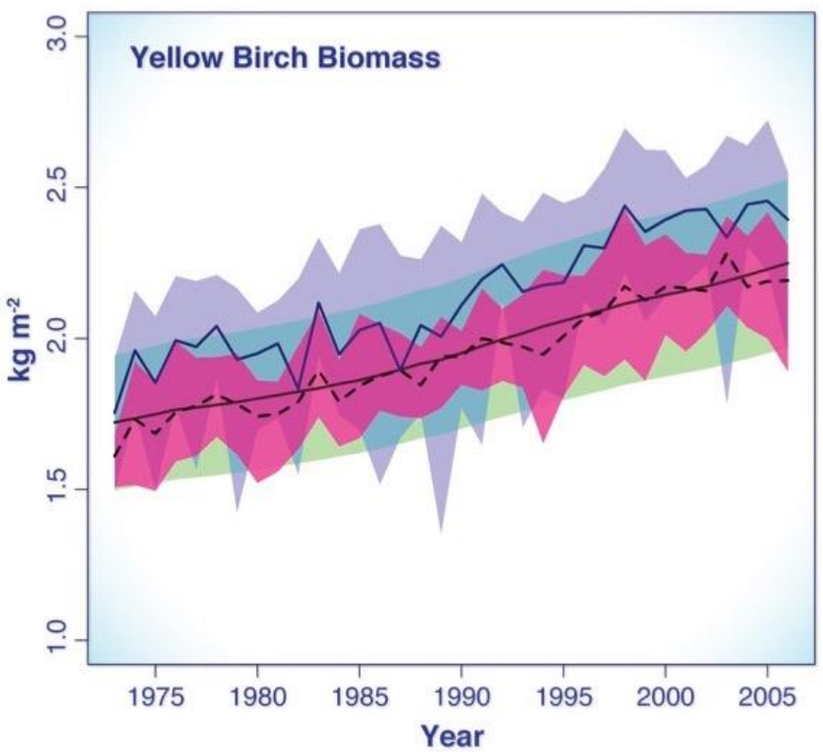
LAI ASSIMILATION: WILLOW CREEK, WI

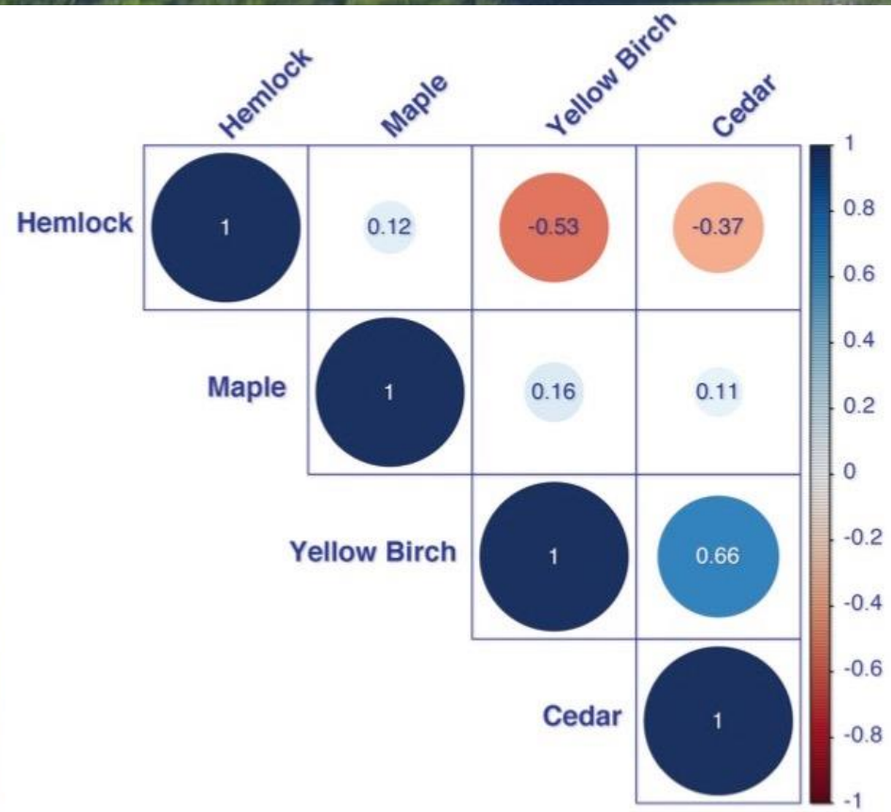


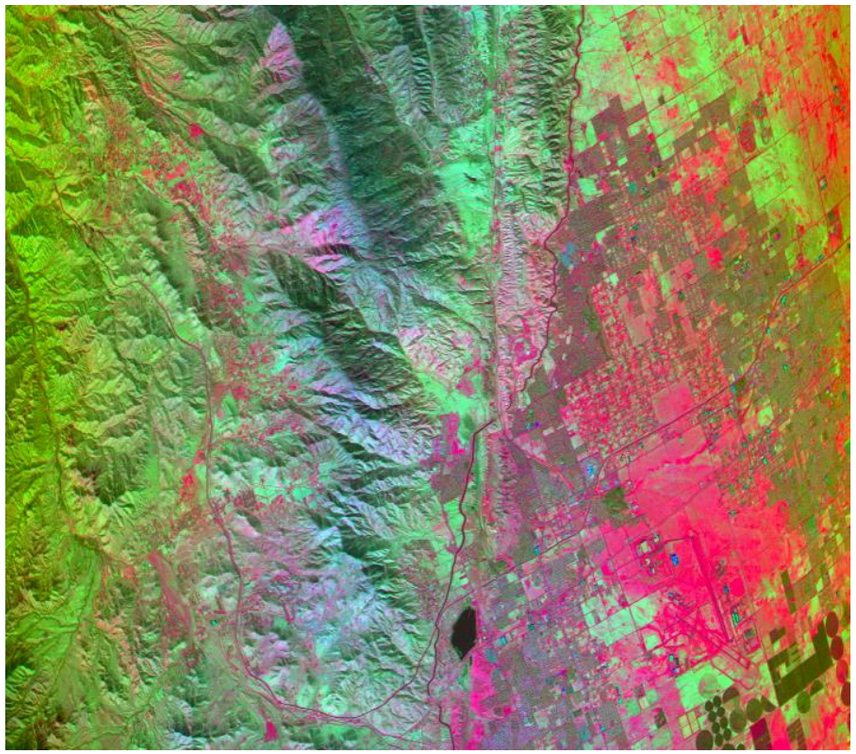
Viskari et al *2015 Ecological Applications*

Raiho & Dietze *unpublished*

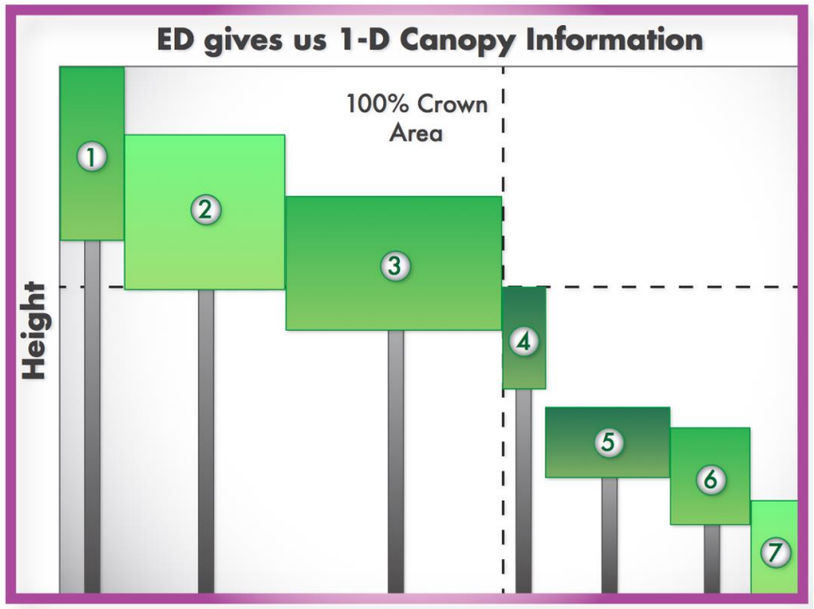


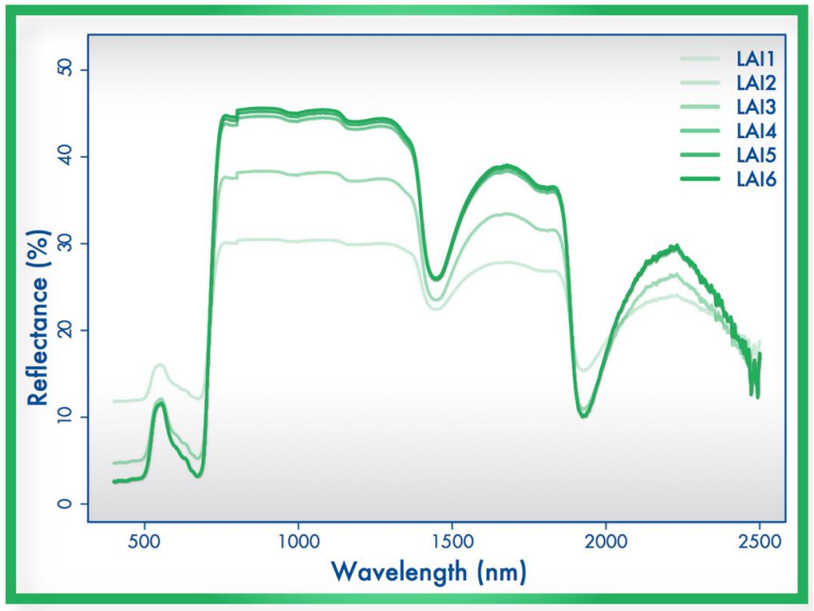


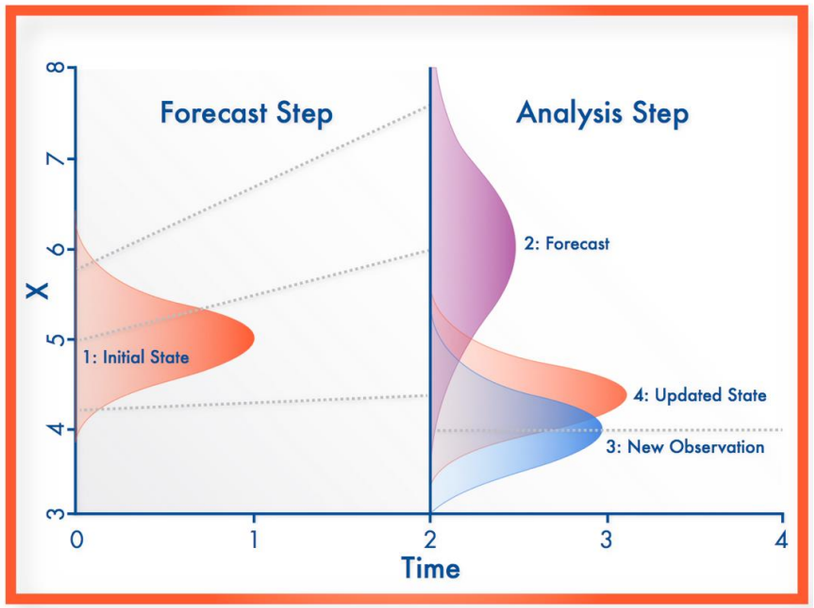




HyspIRI Airborne Campaign

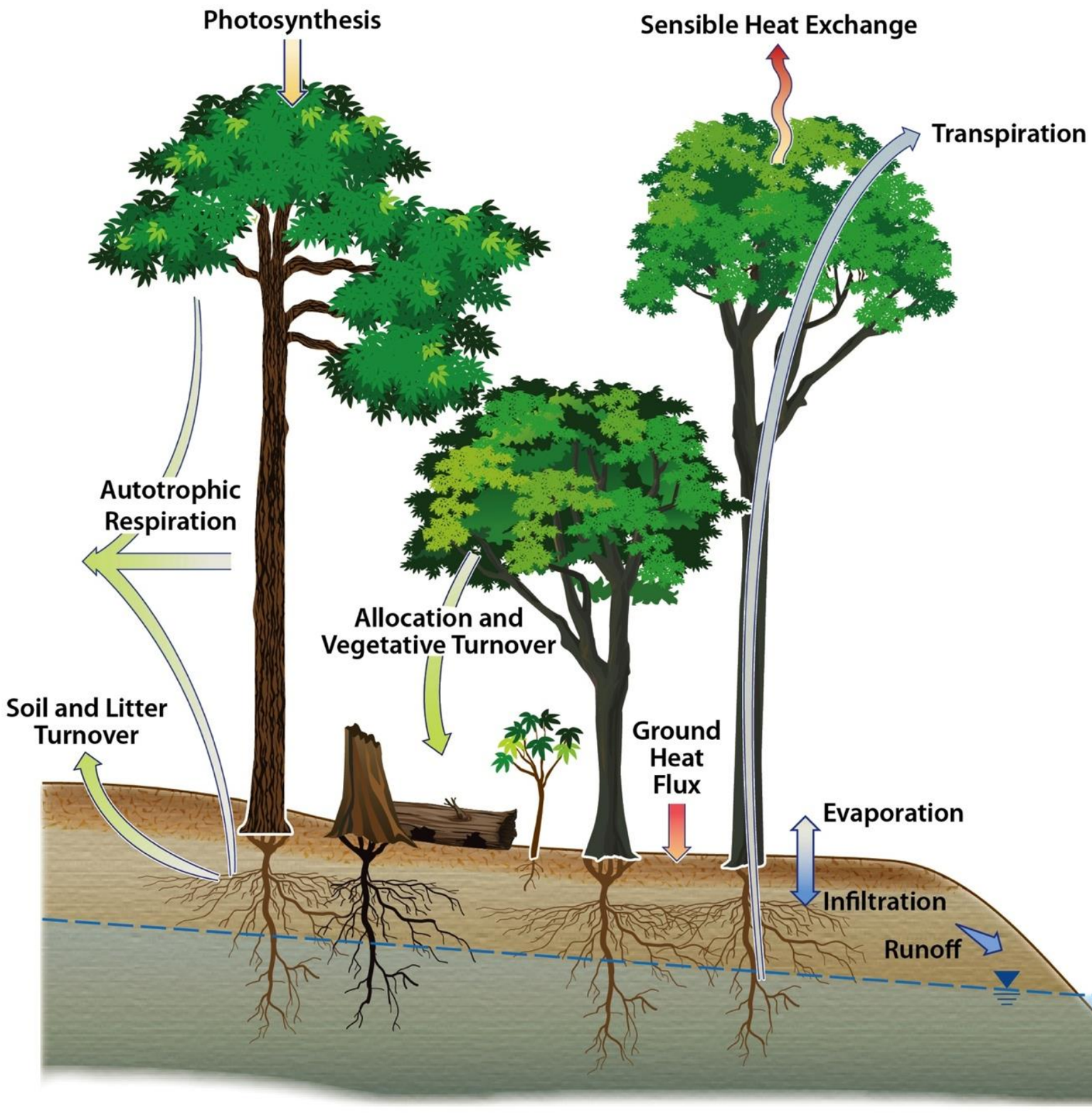






Serbin, Dietze, Townsend NASA TE

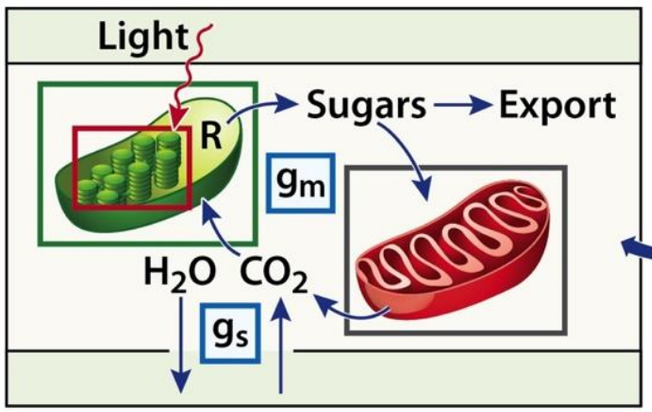
NGEE - Tropics

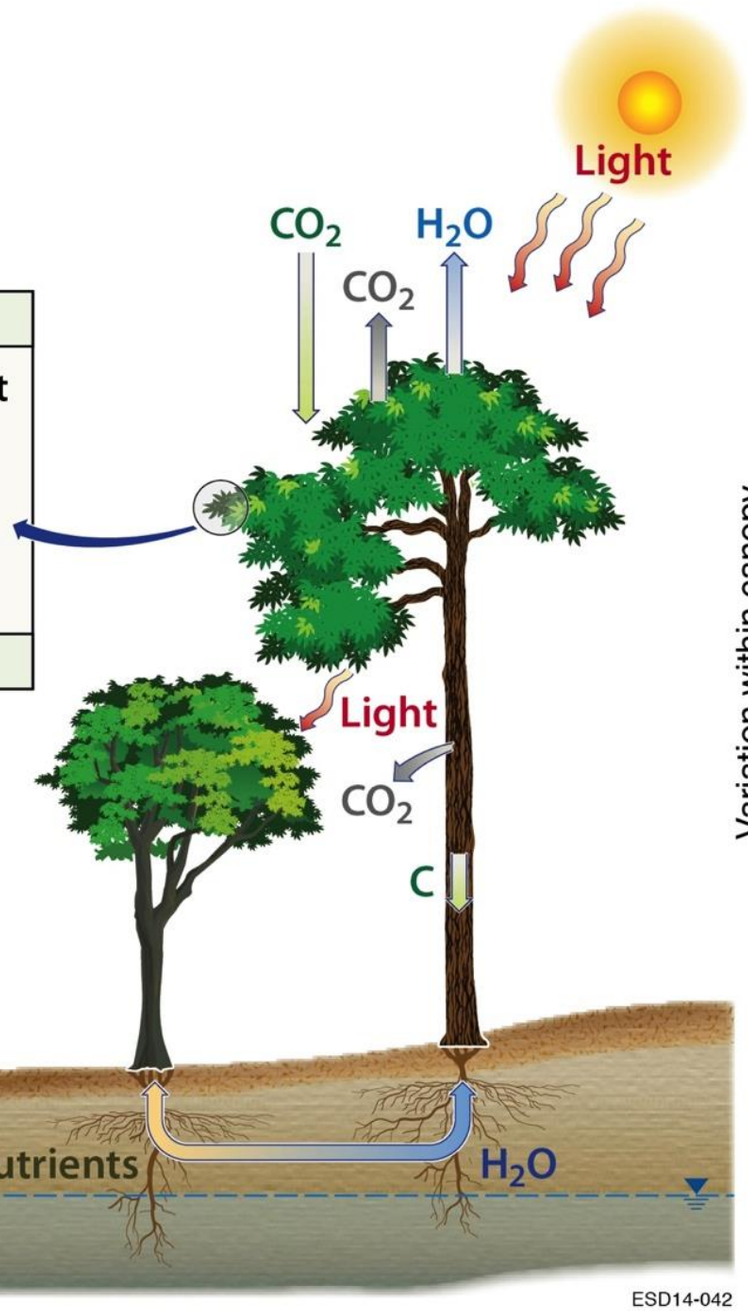


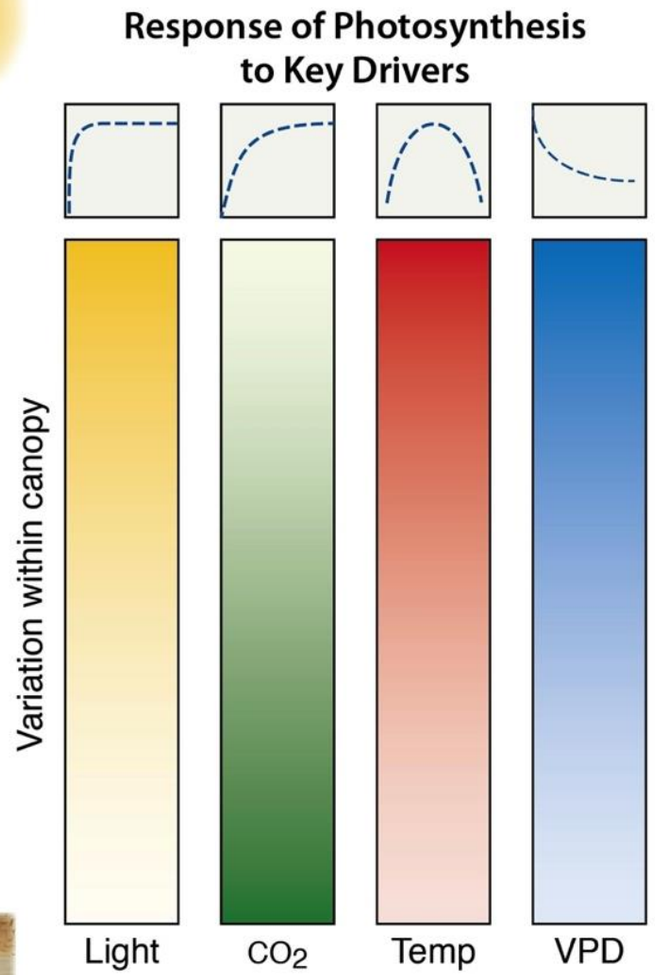
Carbon Uptake & Allocation

Key Processes

- Light Interception
- CO_2 + H_2O Transfer
- Photosynthesis
- Respiration



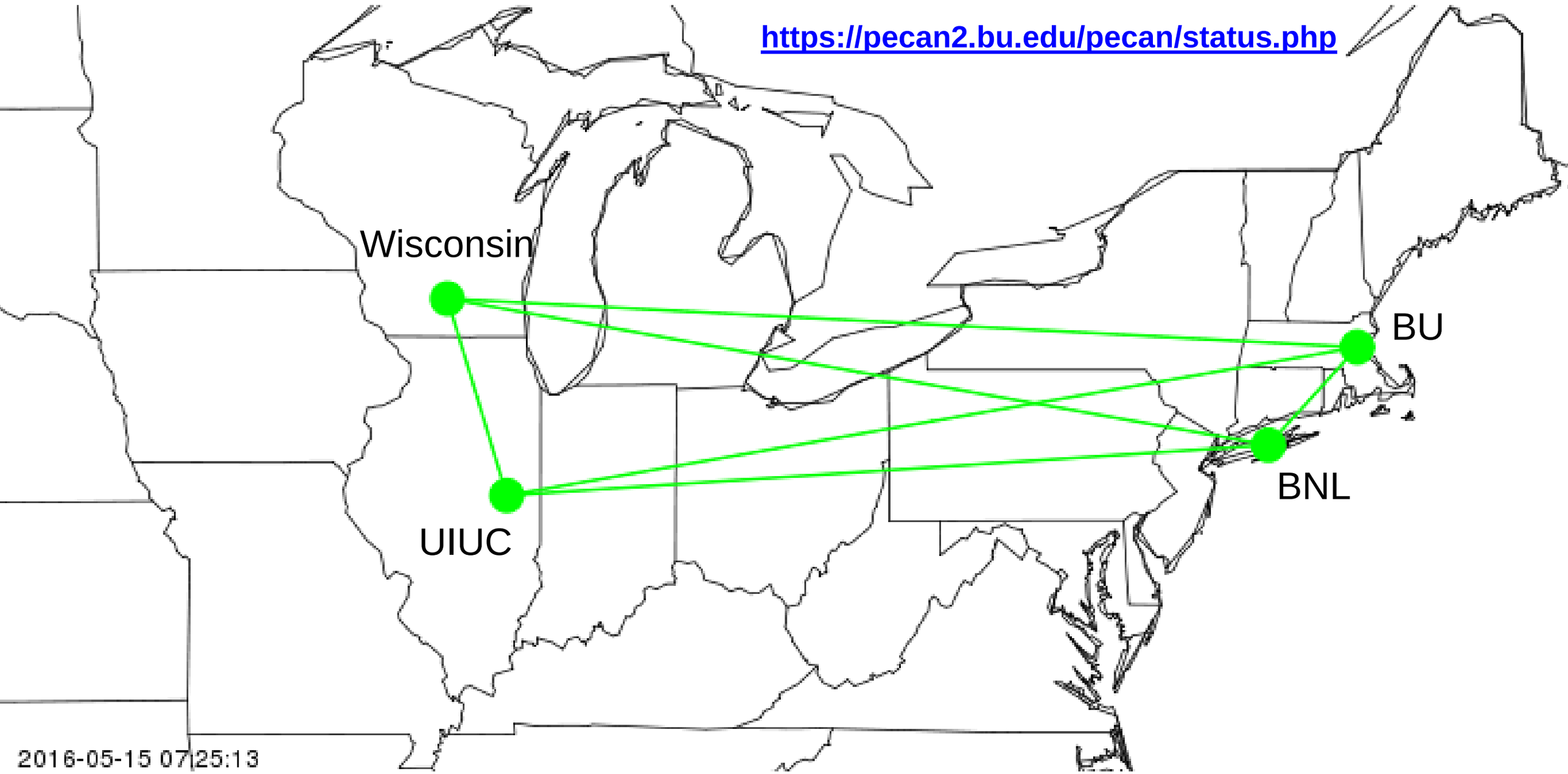




PECAN 2.0

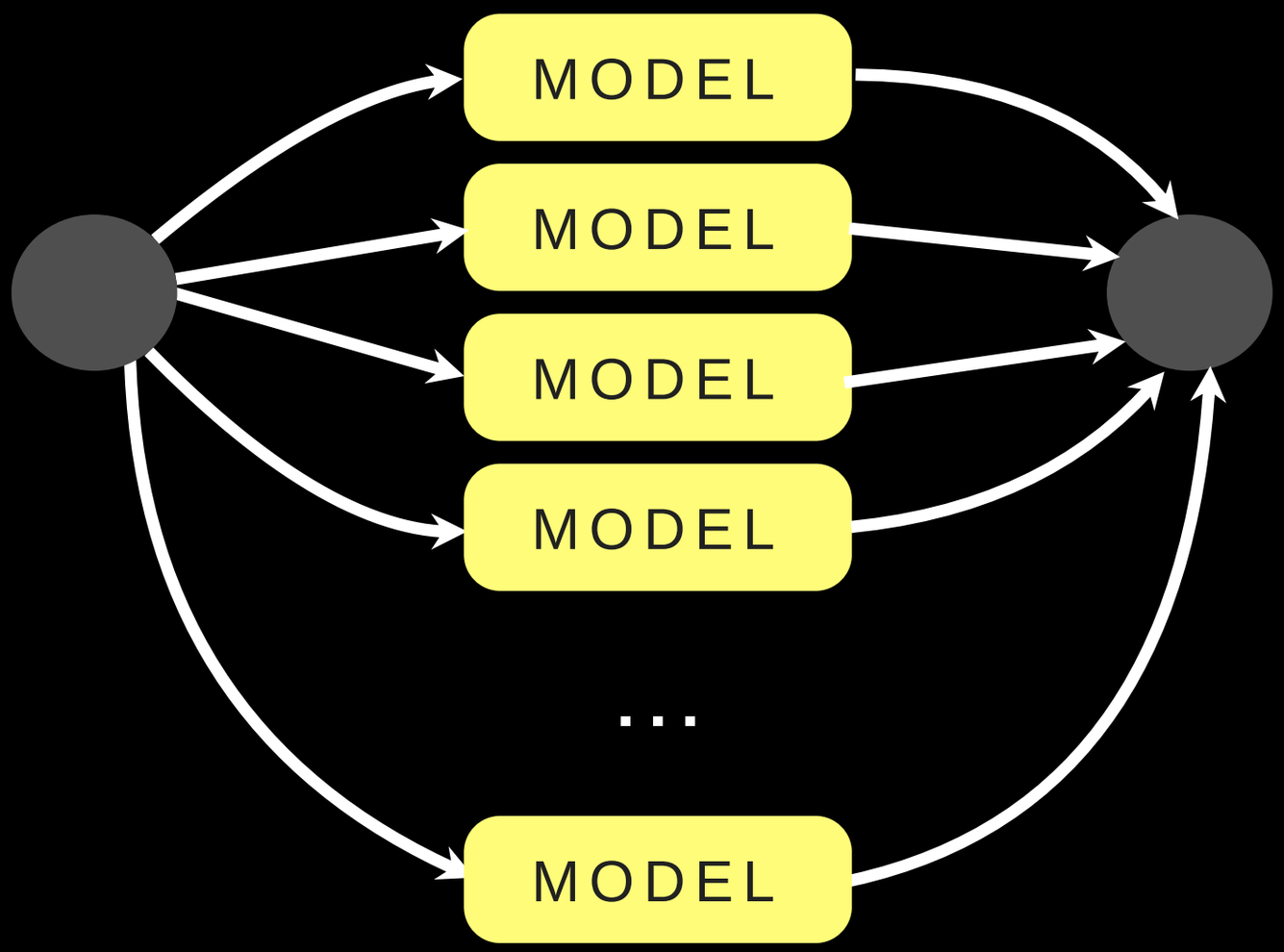
Building a collaborative network

https://pecan2.bu.edu/pecan/status.php



PECAN 2.0

Enabling multi-model synthesis & forecast



Live:
ED2, SIPNET, DALEC,
LINKAGES, BIOCRO, PRELES

In progress:
CLM, FATE, MAESPA, G'DAY,
LPJ-GUESS, MAAT

On deck:
LPJwsl, LANDIS, JULES,
ACONITE, SIB, SIBCASA,
TEM, DAYCENT, LM3, LM3-
PPA, … *many many more*

CONCLUSIONS

- Data synthesis:
  Informatics tools to tackle volume, diversity
- Common API, standards, and web 2.0 sharing to help make modeling scalable
- Web-based tools to help make models accessible
- Bayesian analysis tools for tackling challenges of data-model synthesis (*data assimilation*) & assessing uncertainties (*variance decomposition*)
- Evolving model evaluation and benchmarking tools to enable model improvements

http://pecanproject.org

https://github.com/PecanProject

PECAN TEAM: ELIZABETH COWDERY, CARL DAVIDSON, ANKUR R. DESAI, XIAOHUI FENG, BRADY HARDIMAN, TONY GARDELLA, RYAN KELLY, ROB KOOPER, DAVID LEBAUER, JOSHUA MANTOOTH, KENTON MCHENRY, AFSHIN POURMOKHTARIAN, BRETT RACZKA, SHAWN SERBIN, ALEXEY SHIKLOMANOV, TONI VISKARI, AND DAN WANG

NSF 1062547, 1062204, 1241894, 1261582, 1318164, 1346748, 1458021, NASA 13-TE13-0060, Amazon AWS Education Grant