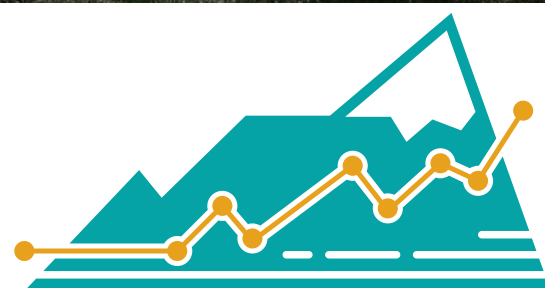


21ST CENTURY SCIENCE FOR 21ST CENTURY ENVIRONMENTAL DECISION MAKING: THE CHALLENGES AND OPPORTUNITIES OF NEAR- TERM ITERATIVE ENVIRONMENTAL FORECASTING



Sloan Foundation
NASA 80NSSC17K0711
NSF 1458021, 1638577, 1748275, 1926388

Mike Dietze
@mcdietze



Ecological Forecasting Initiative

ecoforecast.org
@eco4cast

CLIMATE CHANGE

Stationarity Is Dead: Whither ~~Water~~ Environmental Management?

P. C. D. Milly,^{1*} Julio Betancourt,² Malin Falkenmark,³ Robert M. Hirsch,⁴ Zbigniew W. Kundzewicz,⁵ Dennis P. Lettenmaier,⁶ Ronald J. Stouffer⁷

Climate change undermines a basic assumption that historically has facilitated management of water supplies, demands, and risks.

Science 2008

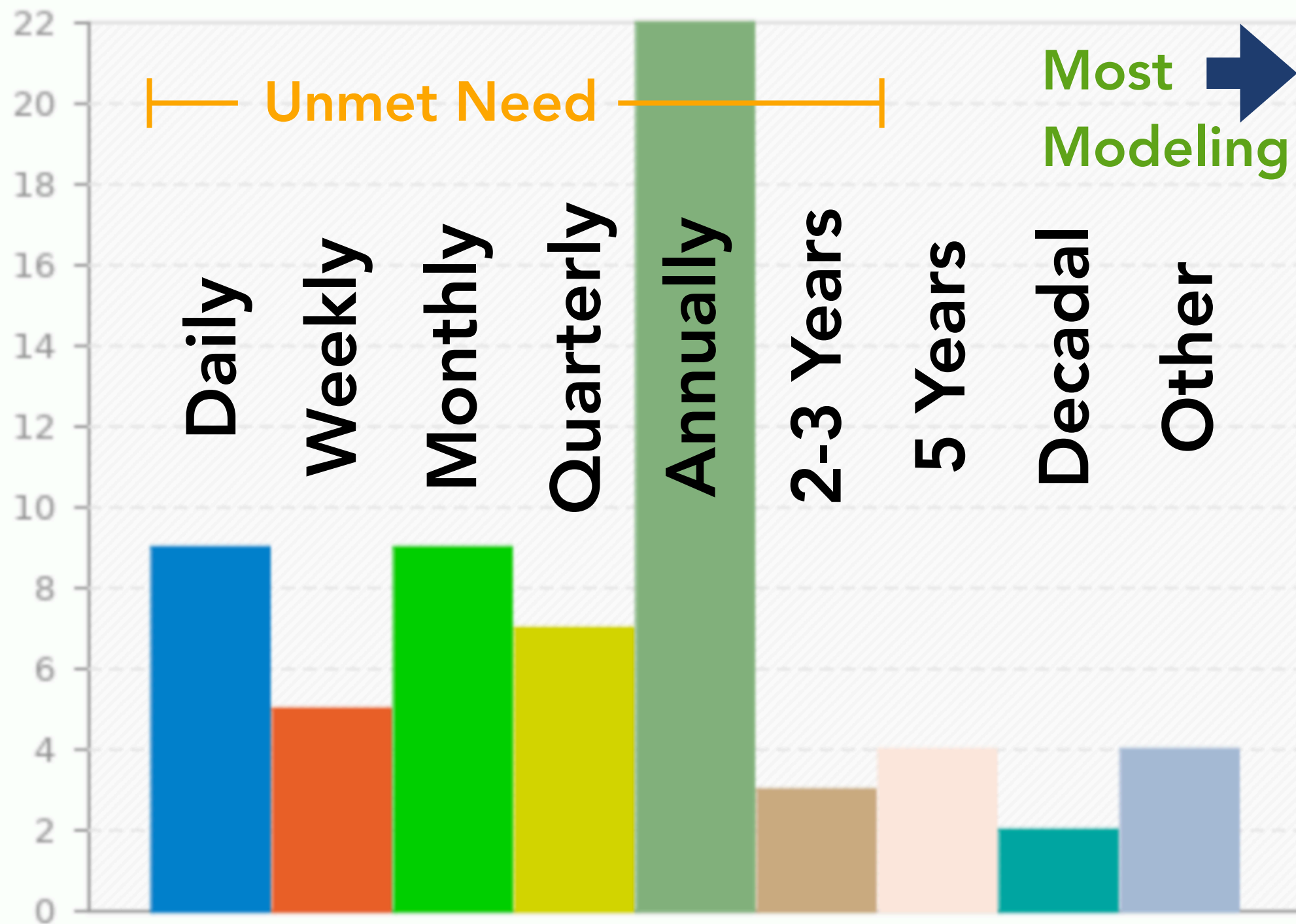
A photograph of a gravel path in a forest. On the left, a wooden signpost is partially visible. The path leads into a dense forest of evergreen trees. The ground is covered with gravel and some green vegetation.

DECISIONS ARE ABOUT
THE FUTURE

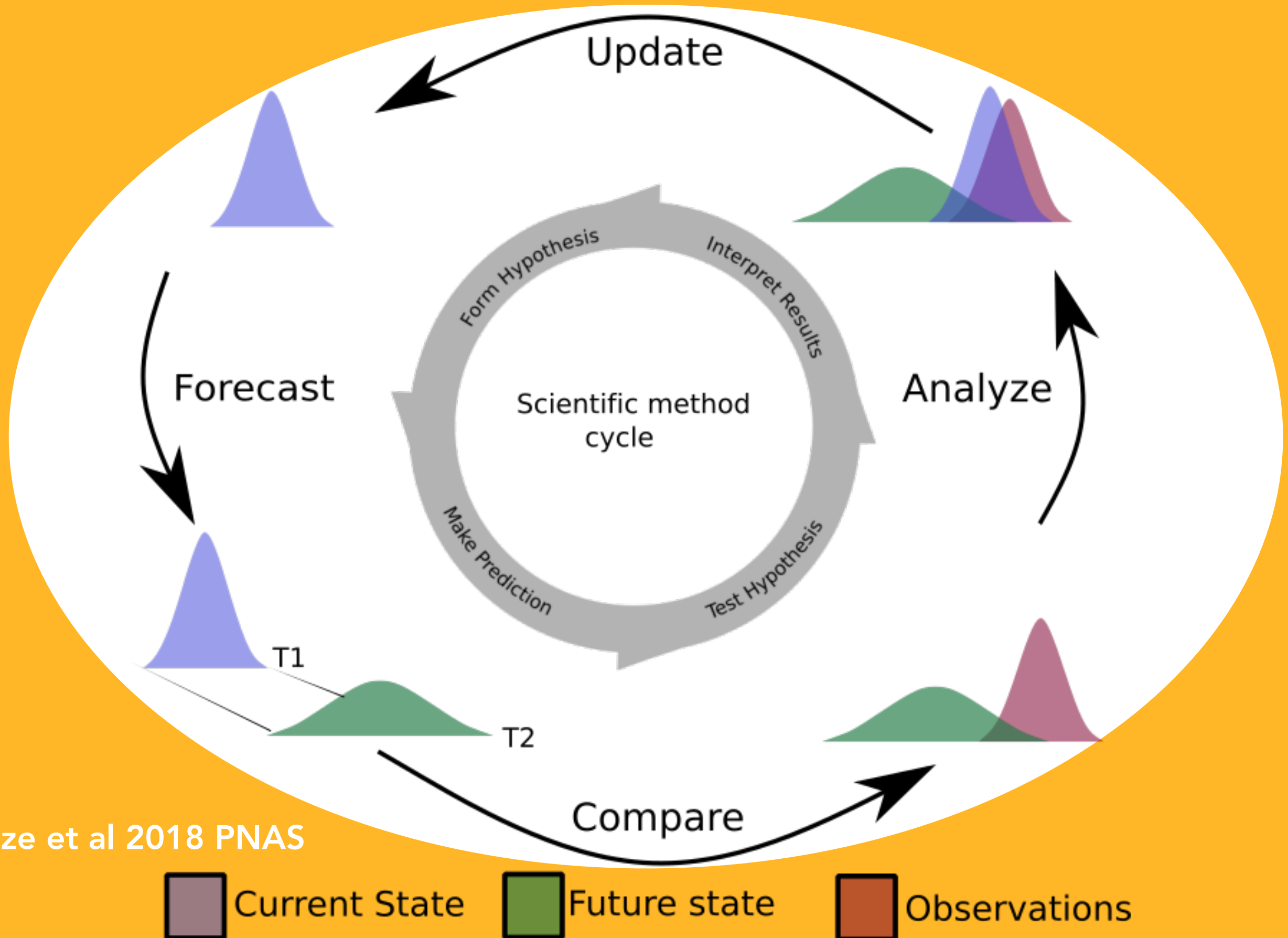
NASA Carbon Monitoring **Stakeholder** Survey

data courtesy Edil Sepulveda Carlo

IDEAL FREQUENCY



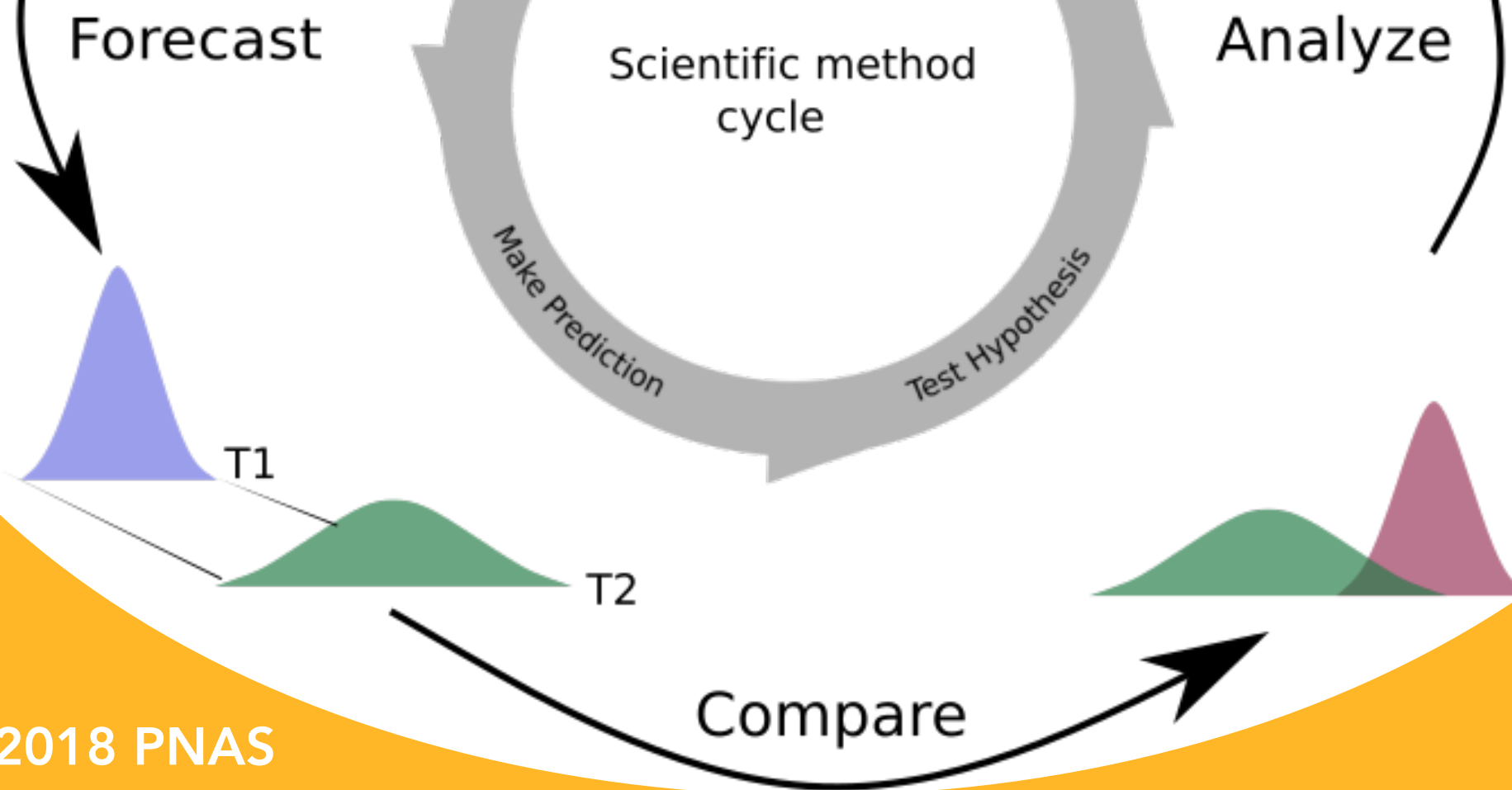
ITERATIVE FORECASTING CYCLE



Dietze et al 2018 PNAS

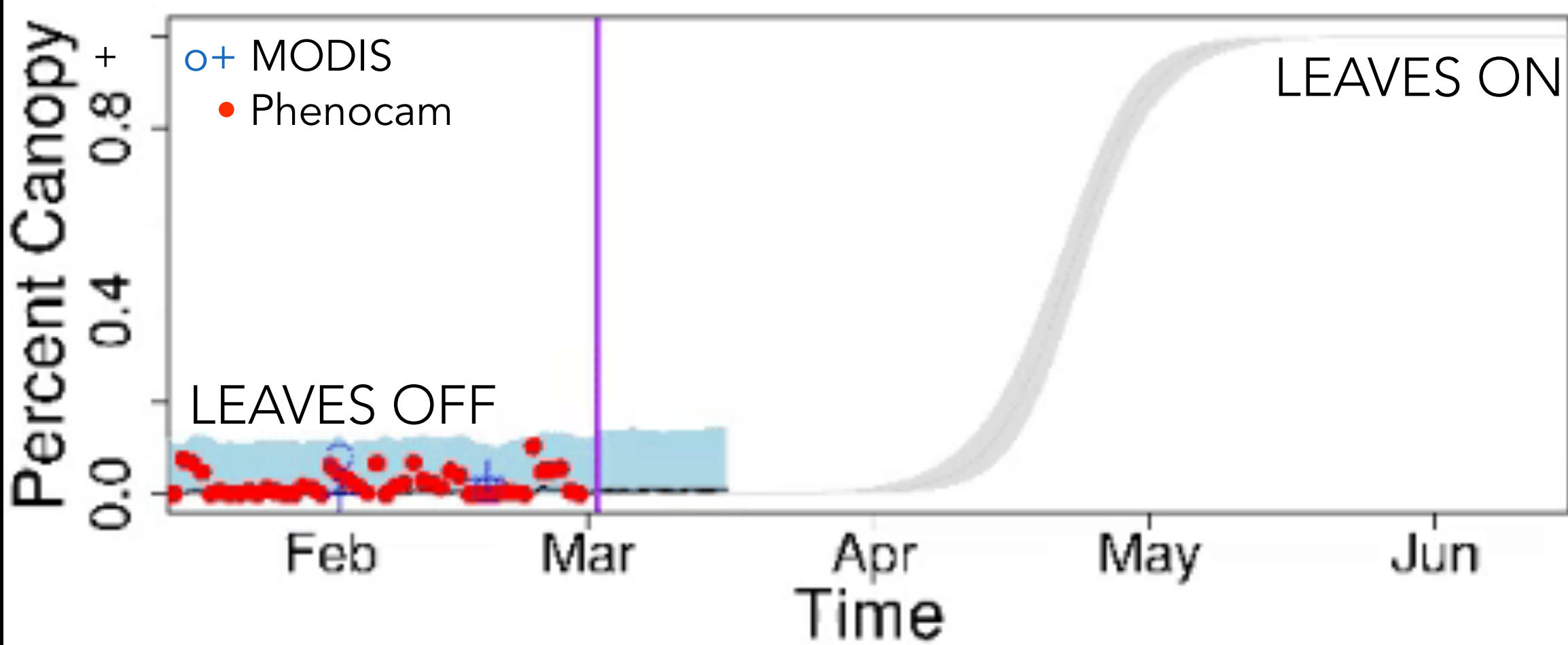
ITERATIVE FORECASTING CYCLE

FORECASTS ARE
QUANTITATIVE,
SPECIFIC, & FALSIFIABLE



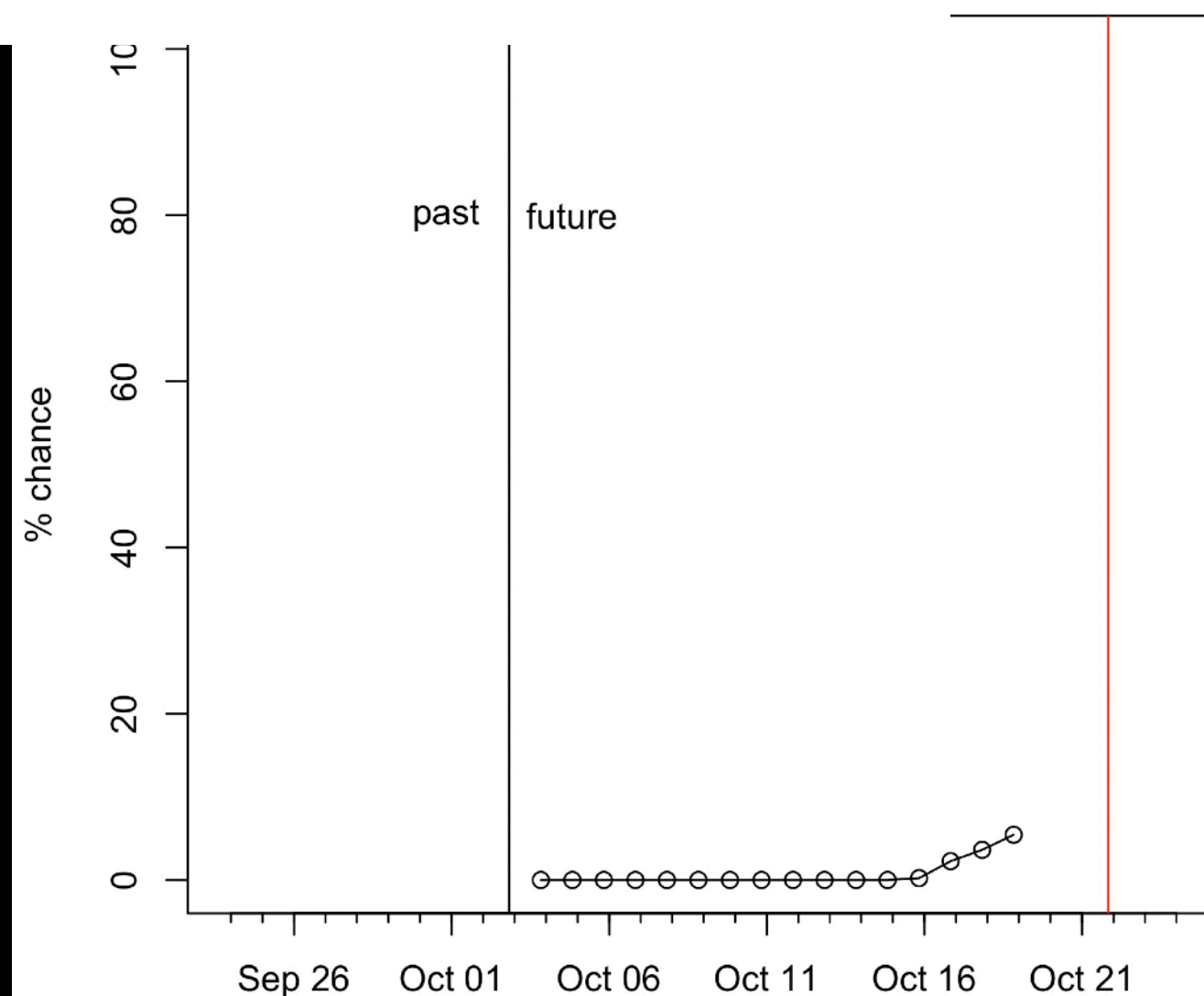
Dietze et al 2018 PNAS

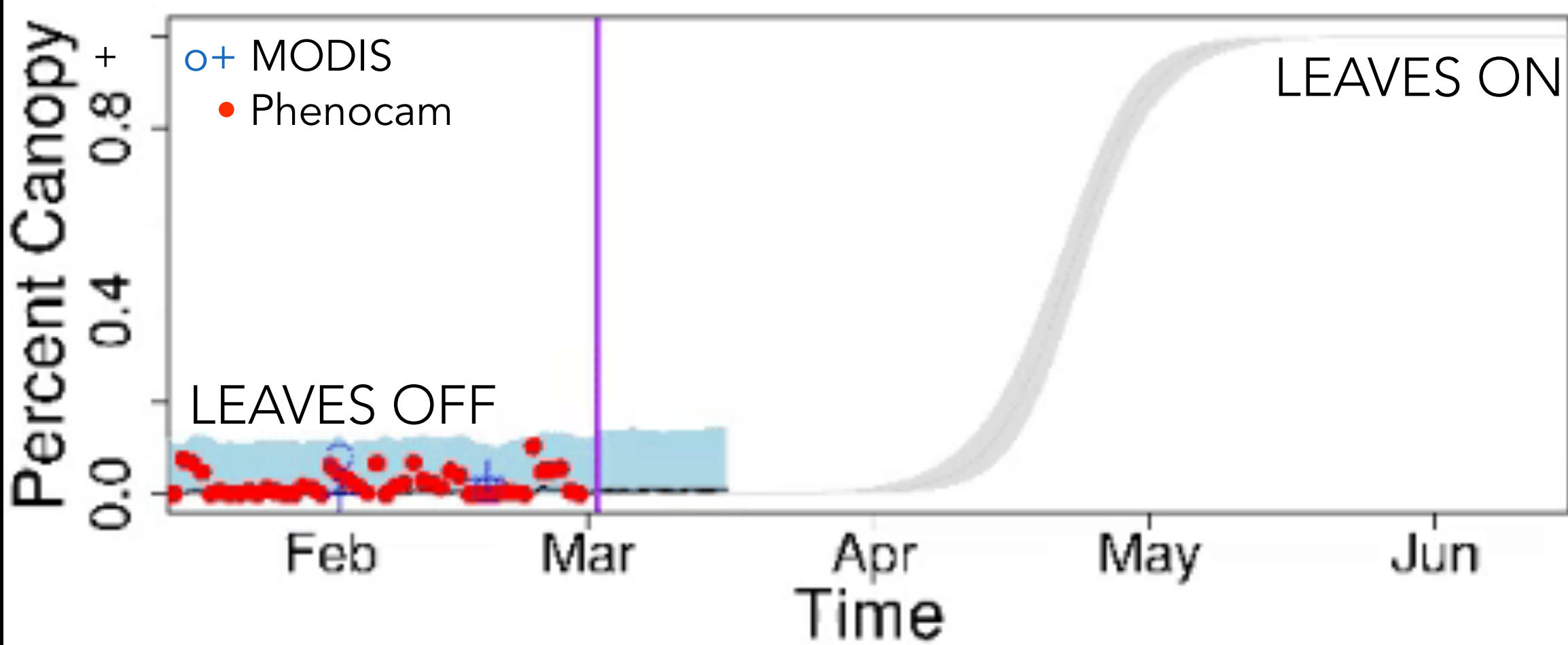




LEAF PHENOLOGY

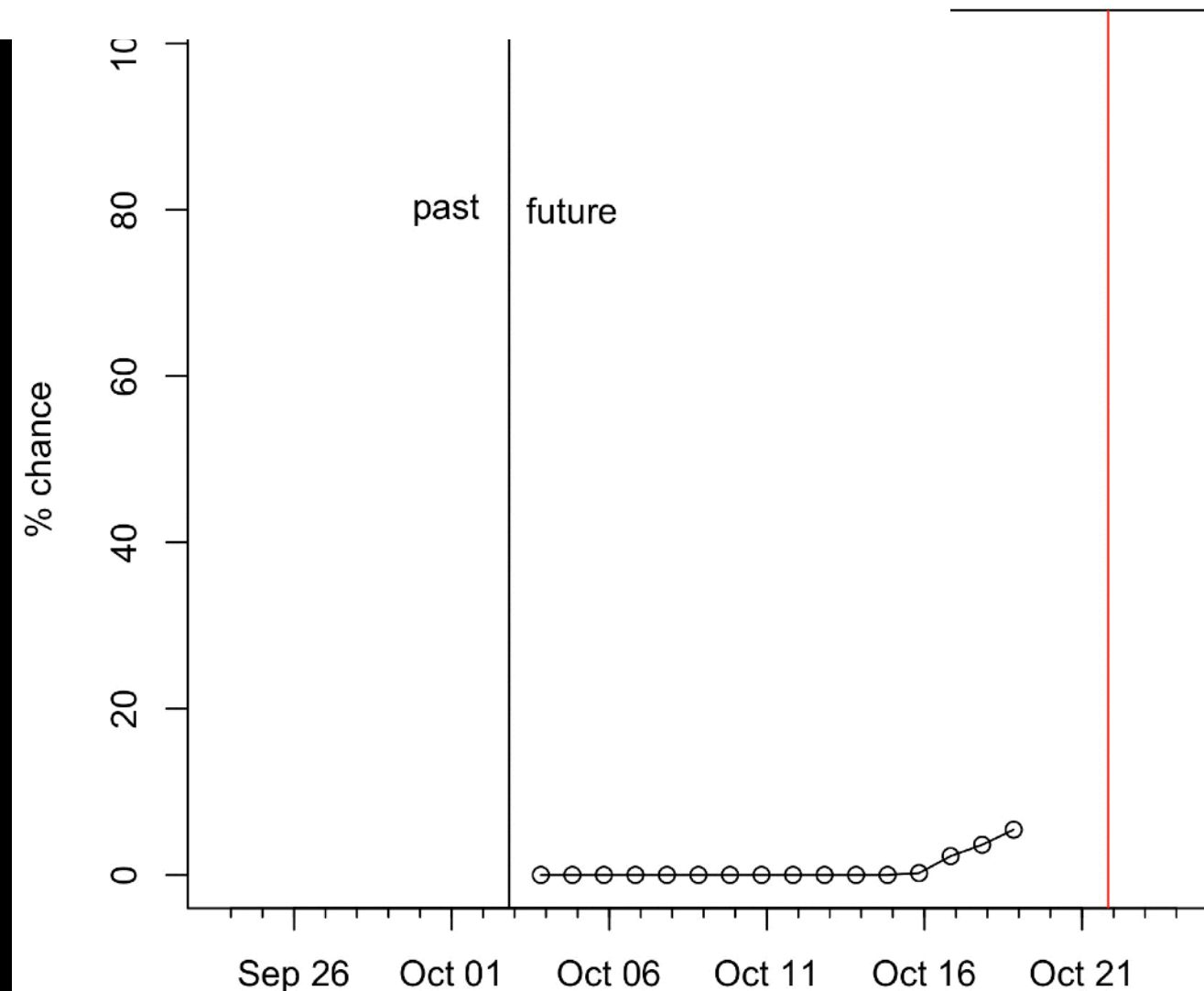
LAKE TURNOVER
SMARTRESERVOIR.ORG





LEAF PHENOLOGY

LAKE TURNOVER
SMARTRESERVOIR.ORG



REAL TIME SCIENCE



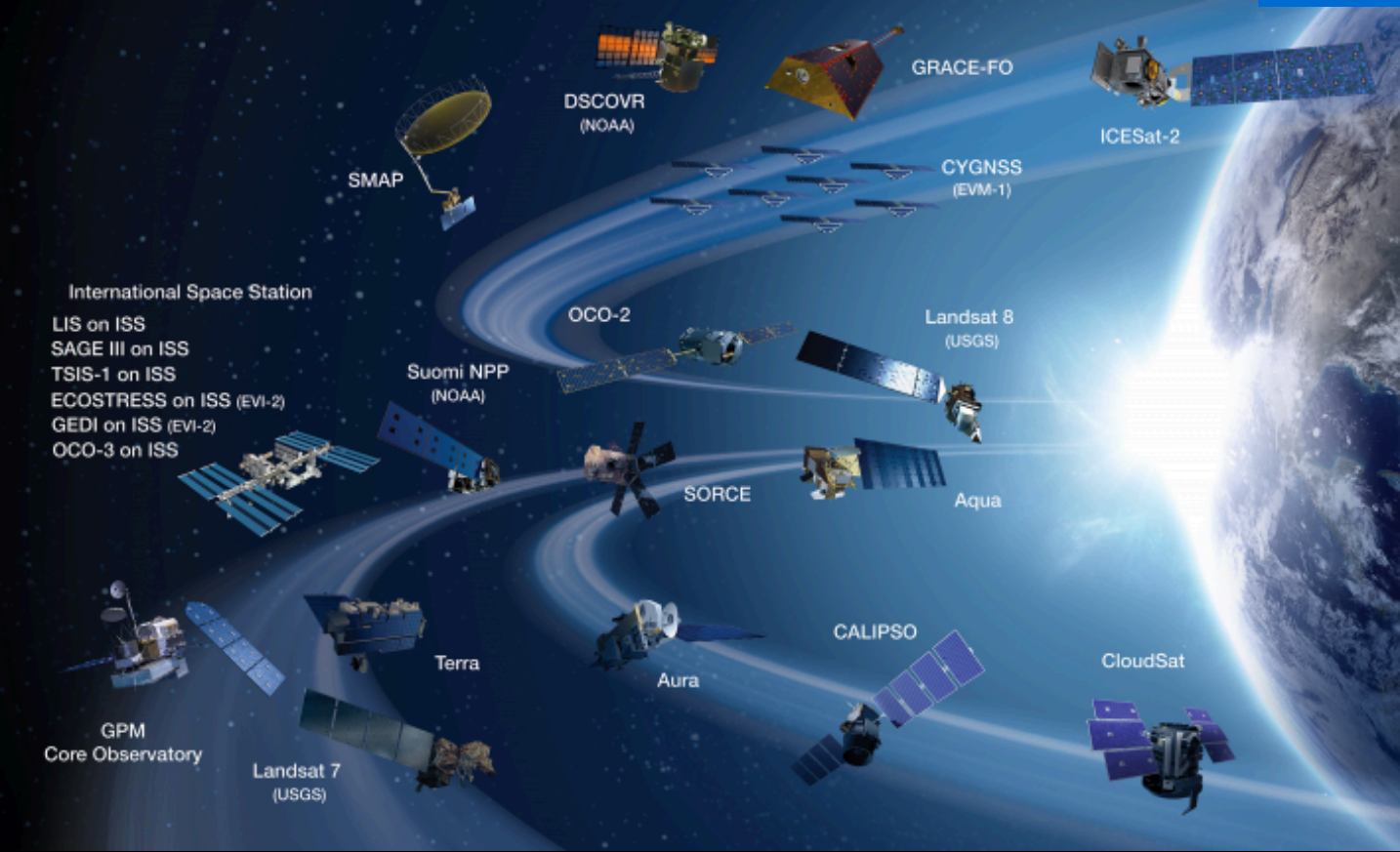
REAL TIME SCIENCE



National Ecological Observatory Network: Field Sites

NEON Aquatic NEON Core NEON Relocatable

NEON is sponsored by the National Science Foundation and operated under cooperative agreement by Battelle



USA npn

National Phenology Network

Taking the Pulse of Our Planet

eBird

iNaturalist

Explore Learn Record

GLOBAL SOUNDSCAPES

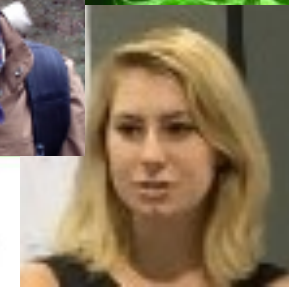
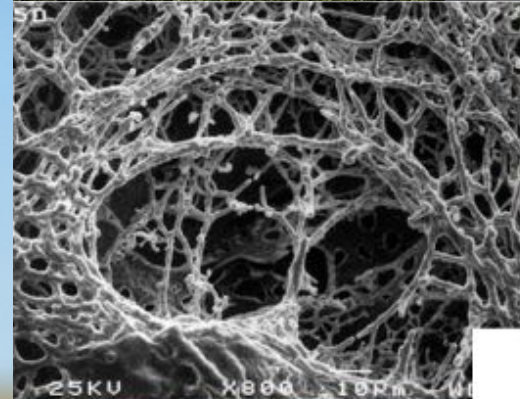


Dietze, Wheeler, Zarada: Weathers & GLEON: Aquatic Productivity
Fluxes & Phenology



Bhatnagar, Averill, & Werbin:
Microbial diversity

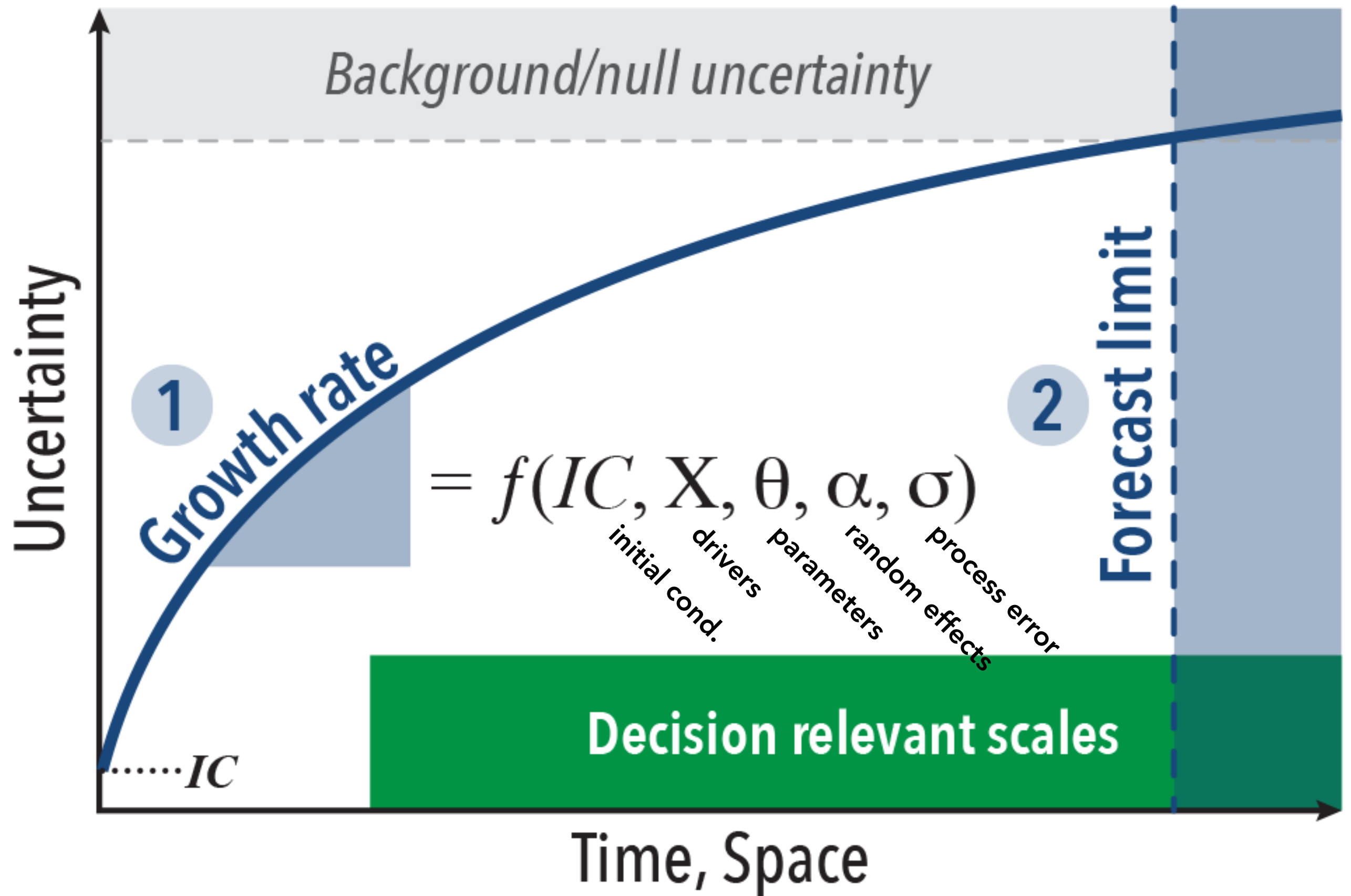
LaDeau & Foster:
Ticks & Small
Mammals



NSF Macrosystems

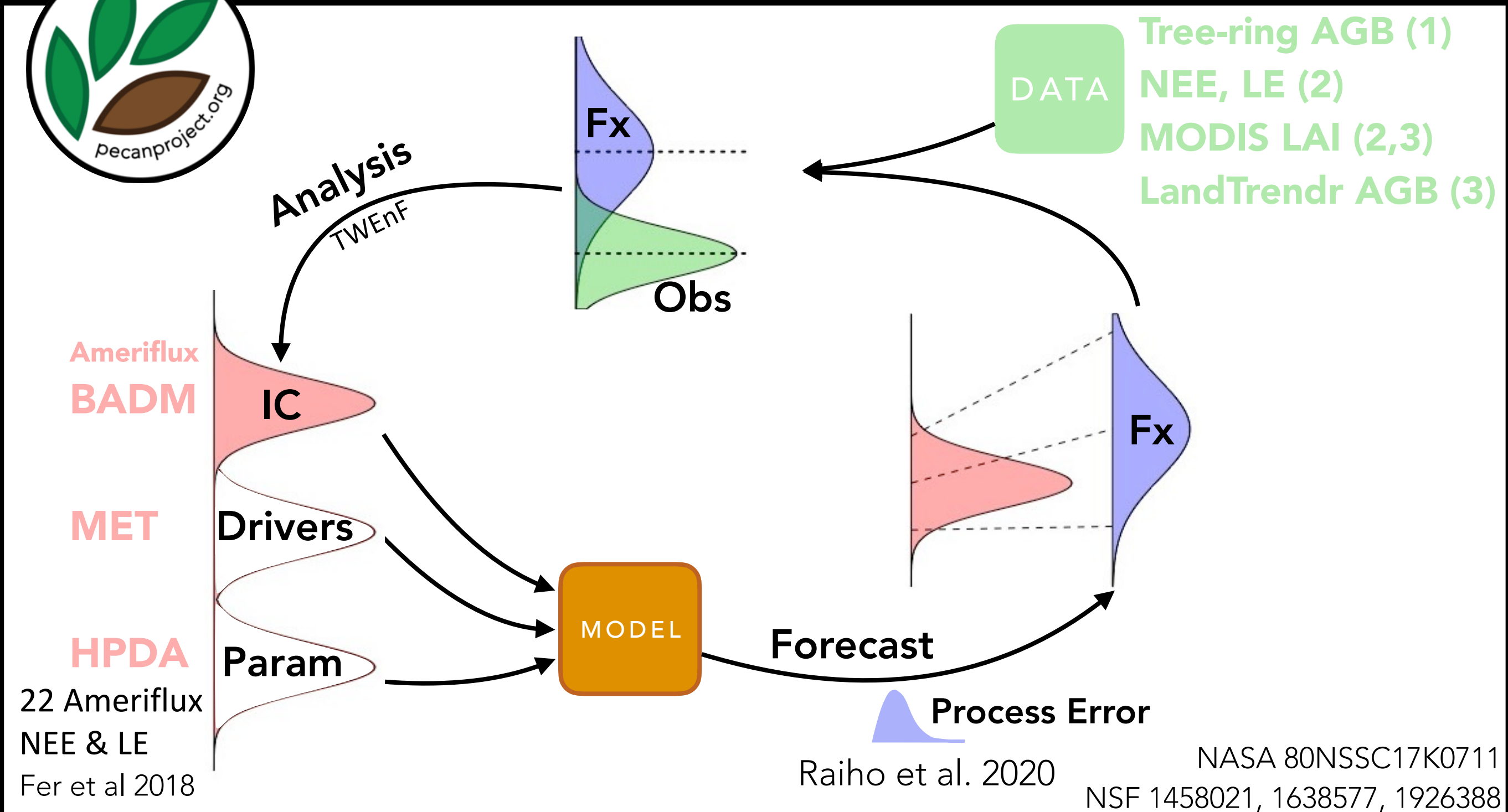


HOW DO WE MEASURE PREDICTABILITY?



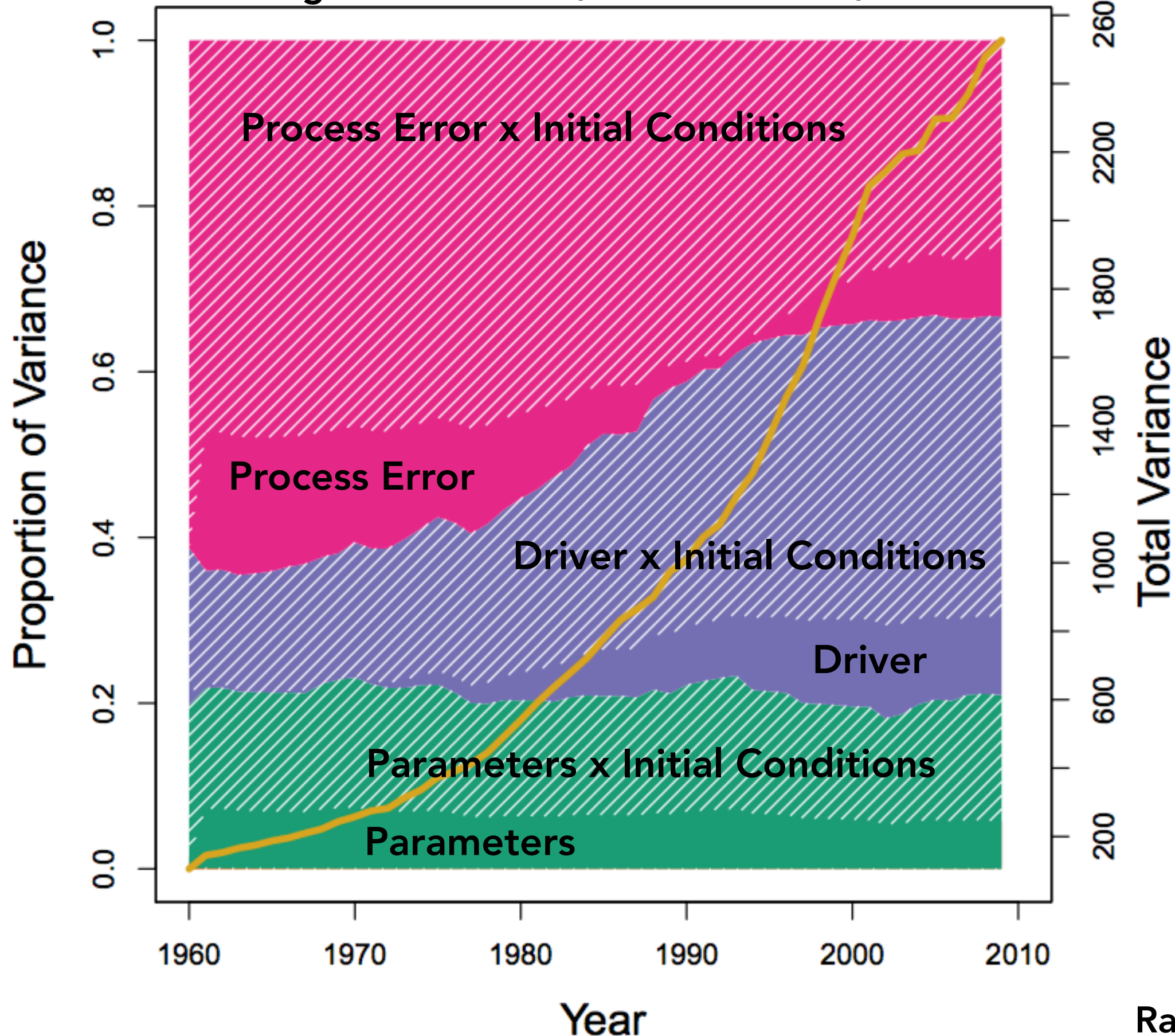
TERRESTRIAL CARBON DATA ASSIMILATION

1. UNCERTAINTY PARTITIONING & ALGORITHM DEVELOPMENT
2. 16-DAY FORECAST
3. CONUS-SCALE RE-ANALYSIS



Uncertainty Partitioning

Aboveground Biomass, Harvard Forest, MA



- IC dominates & decays slowly
- "Spin up" untenable
- Process error needs to be estimated (not tuned) and propagated



16-DAY CARBON AND WATER FORECAST

Select Site:

Willow Creek

Site Map

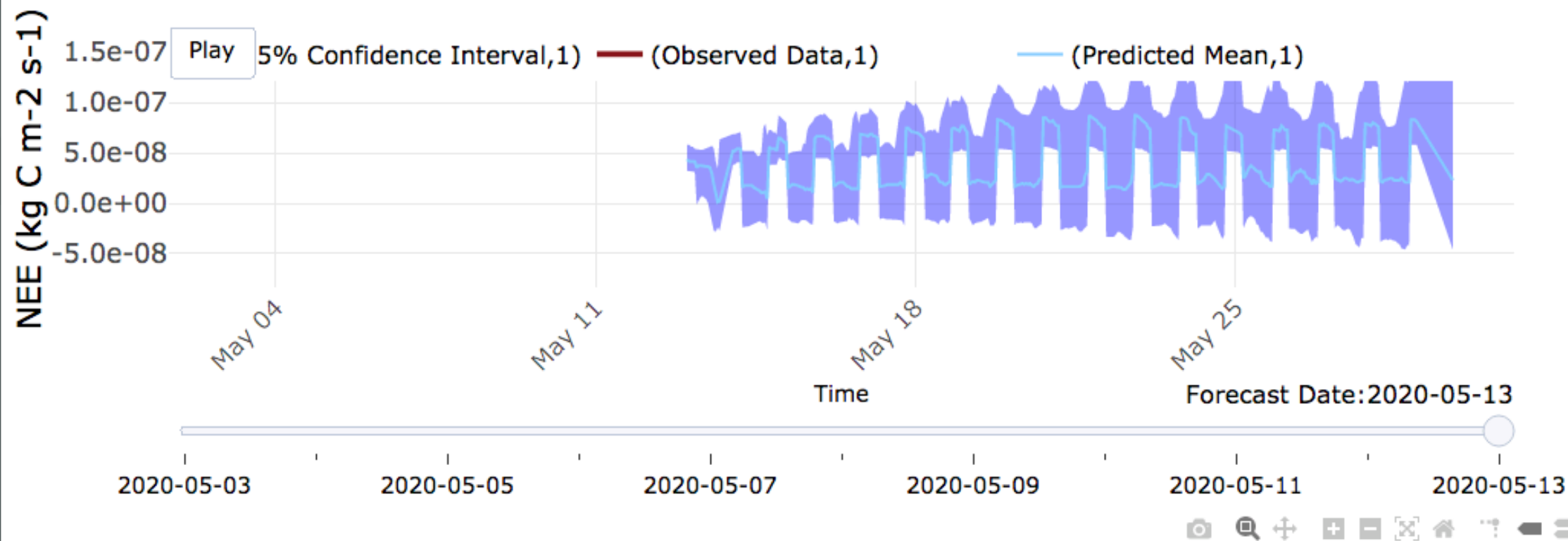
Forecast

Model Performance

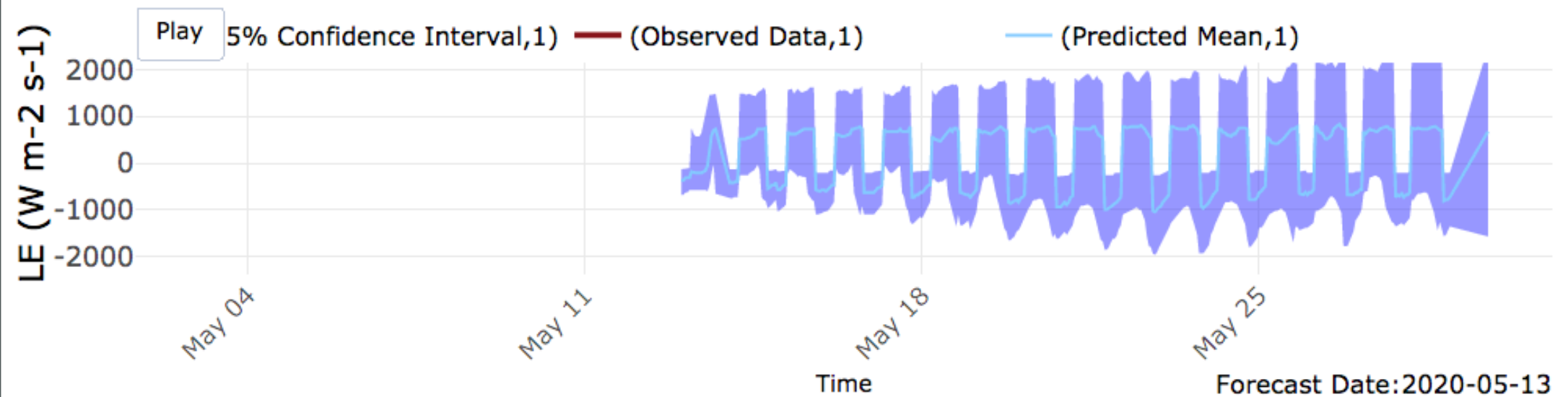
Model by Start Date

NOAA GEFS

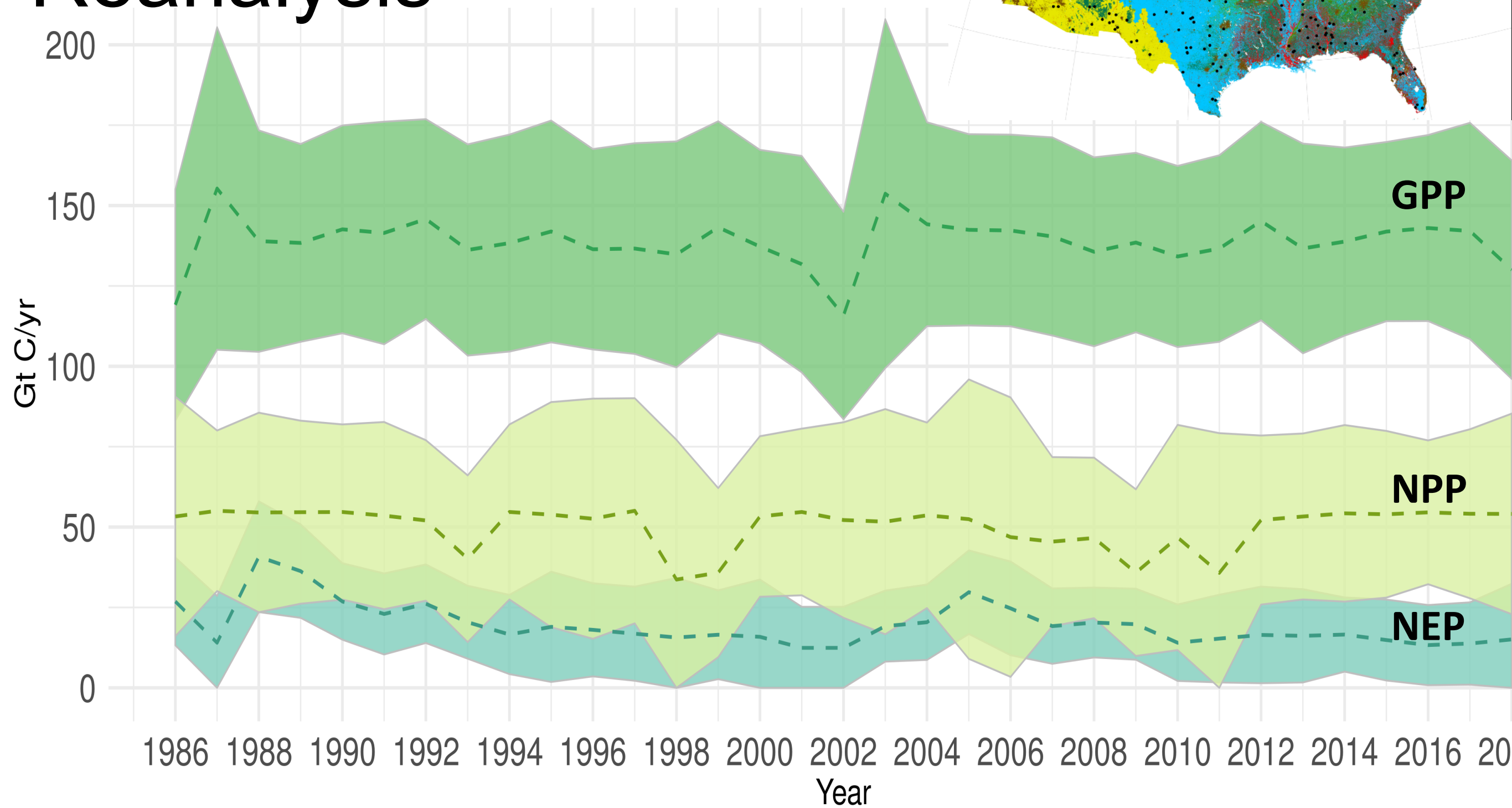
Net Ecosystem Exchange for 2020-05-03 to 2020-05-29, at WCr

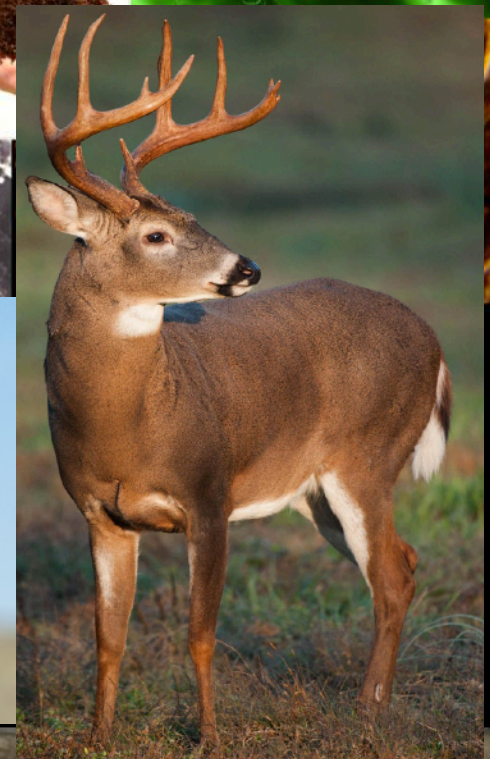
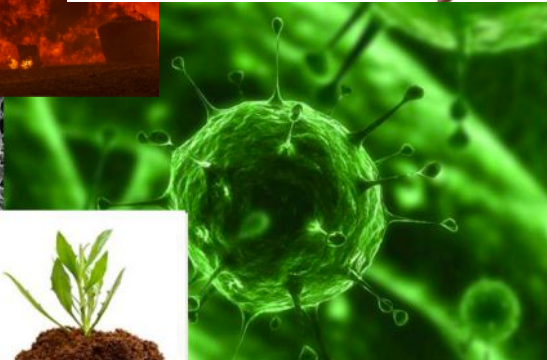
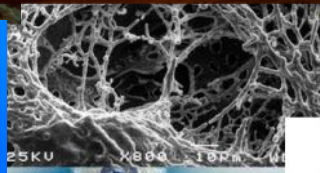
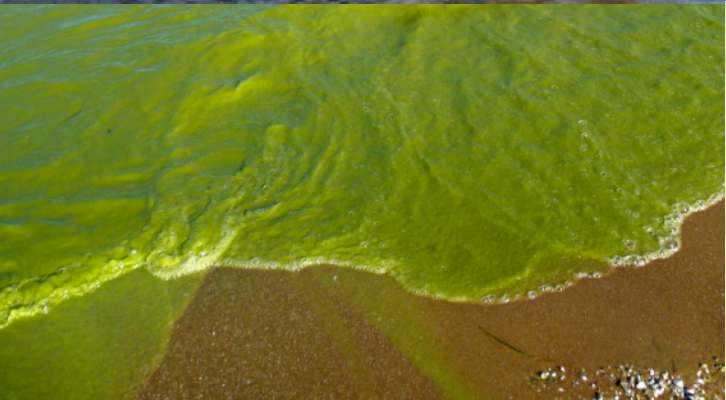
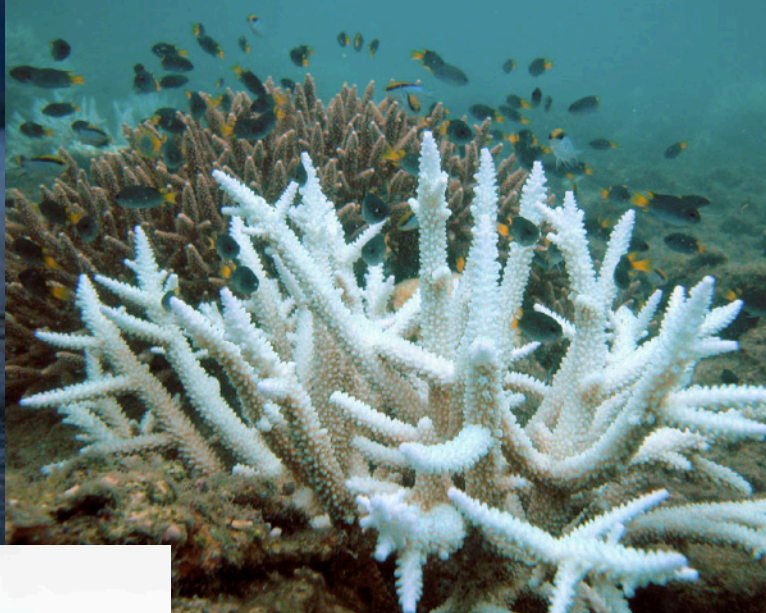


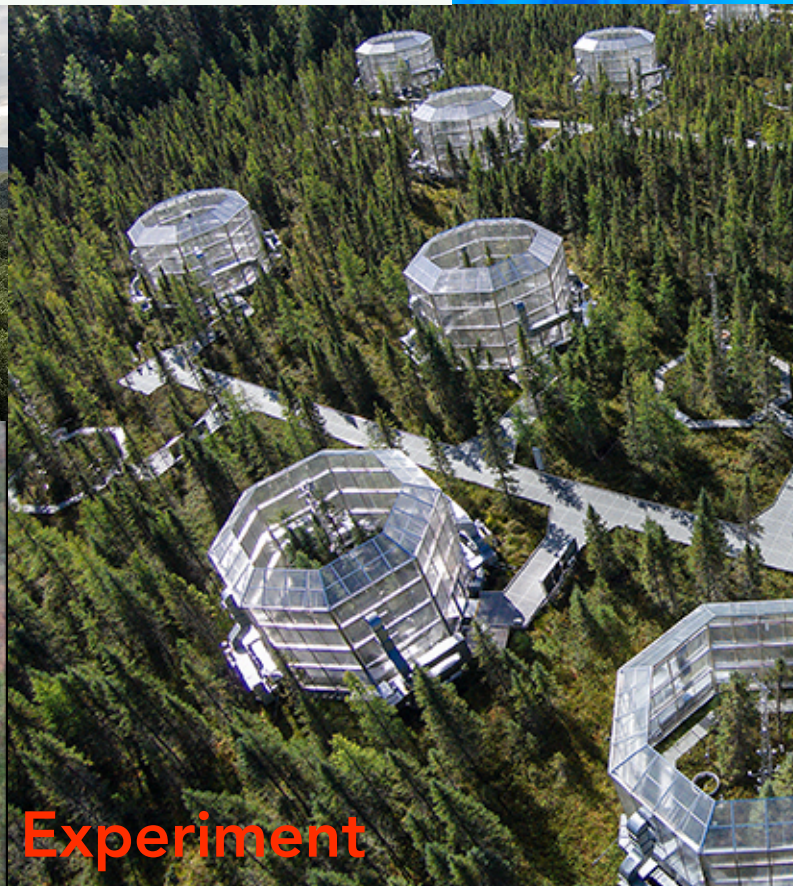
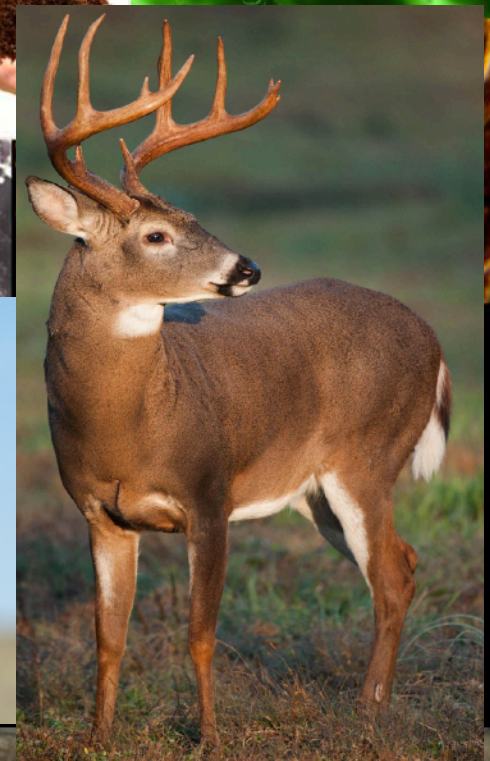
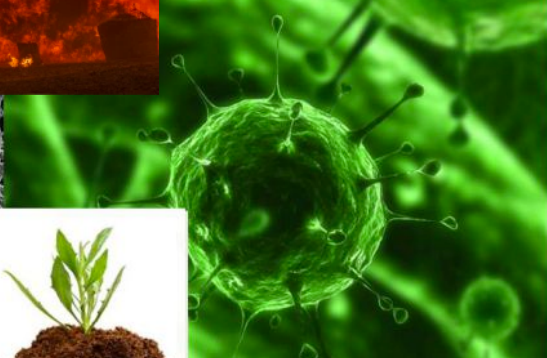
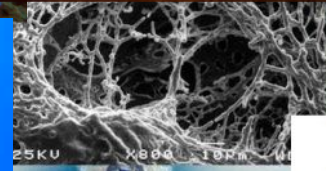
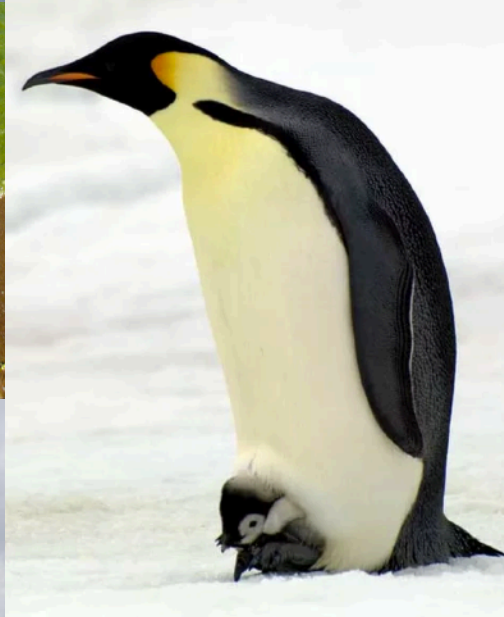
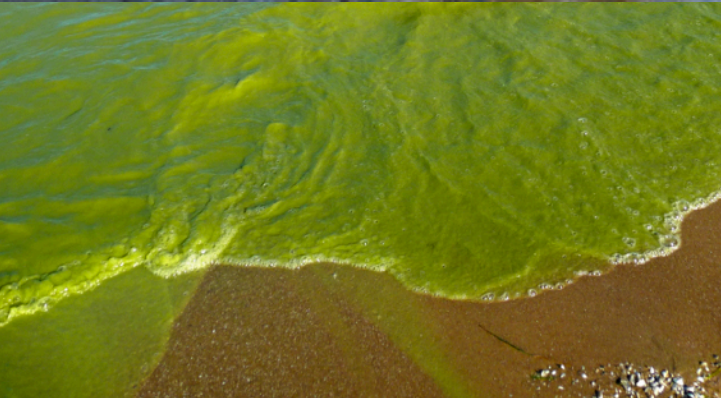
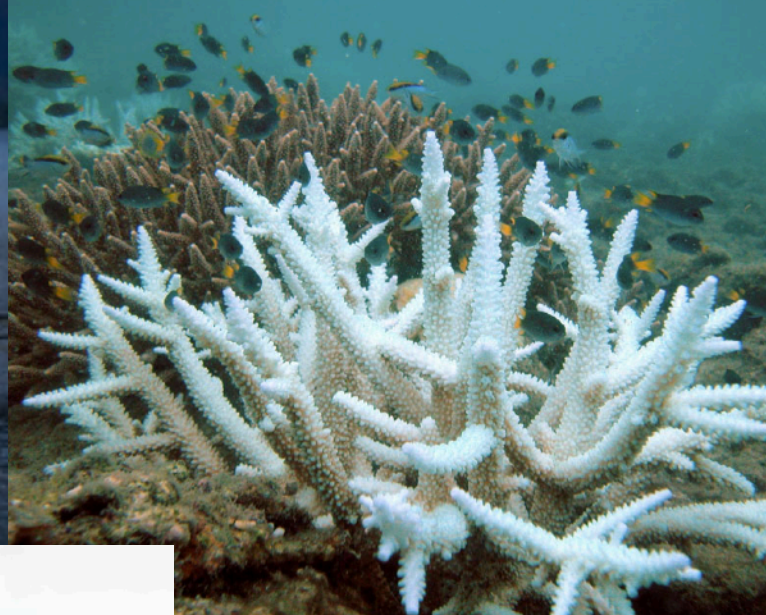
Latent Energy for 2020-05-03 to 2020-05-29, at WCr



CONUS C Flux Reanalysis







Experiment

Experiment

Experiment

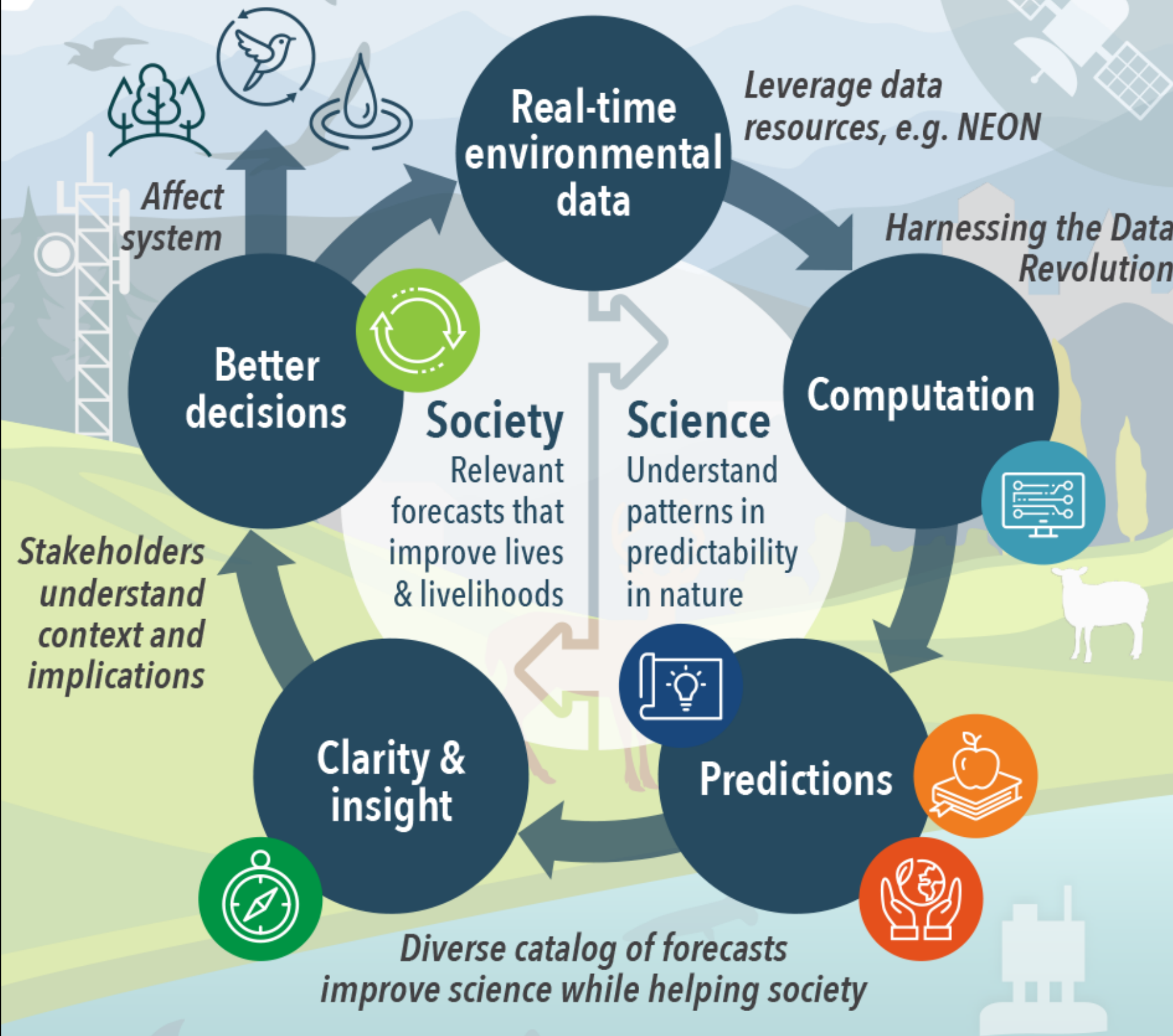
ecoforecast.org
@eco4cast



Ecological Forecasting Initiative

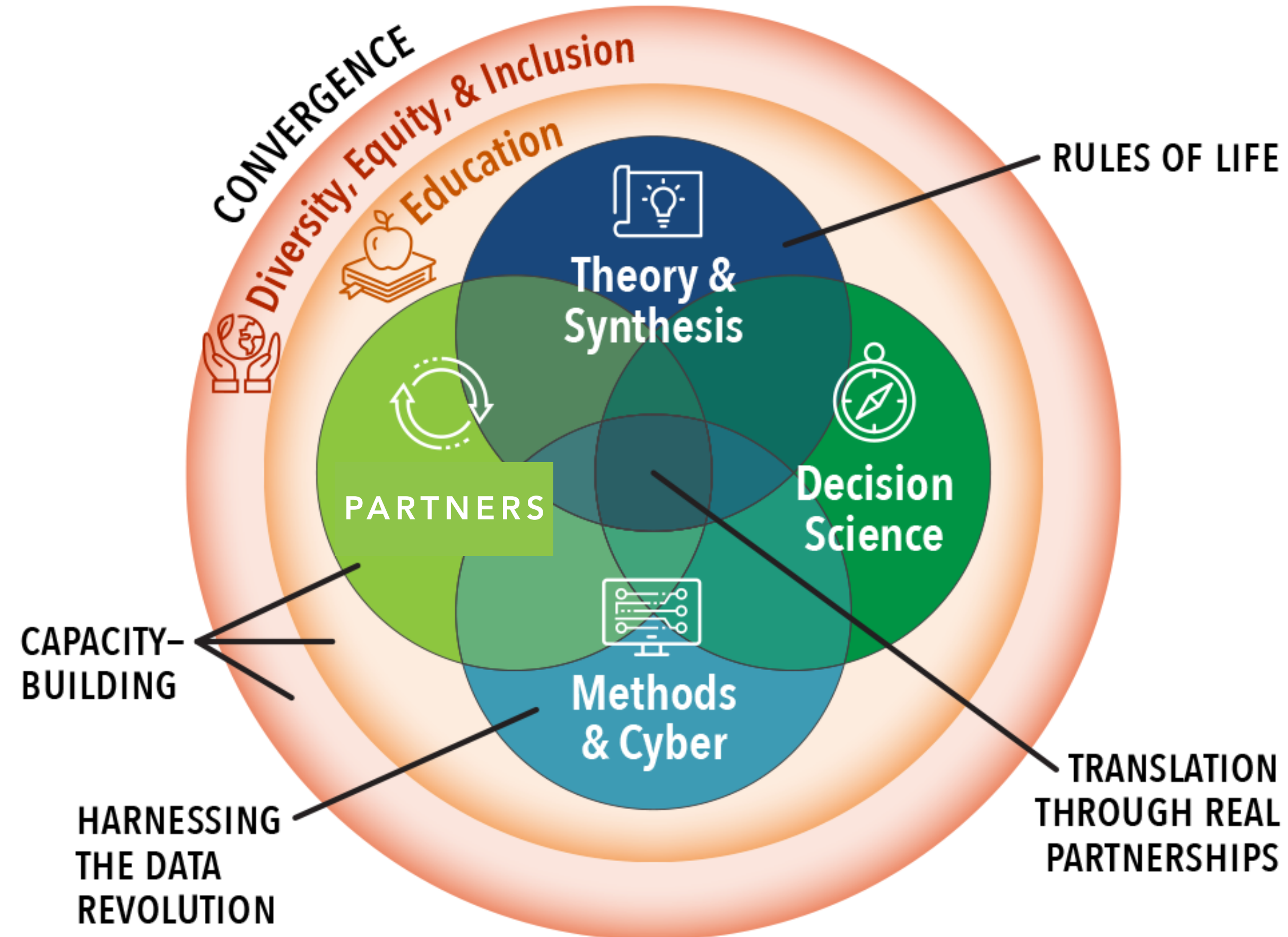
UNDERSTAND · MANAGE · CONSERVE

ECOLOGICAL FORECASTING Iterative Learning Loop



Cross-Cutting Themes

- + Student association
- + Canadian chapter



PARTNERS & SOCIAL SCI



Build bridges spanning academia, agencies, industry, community science, stakeholders.

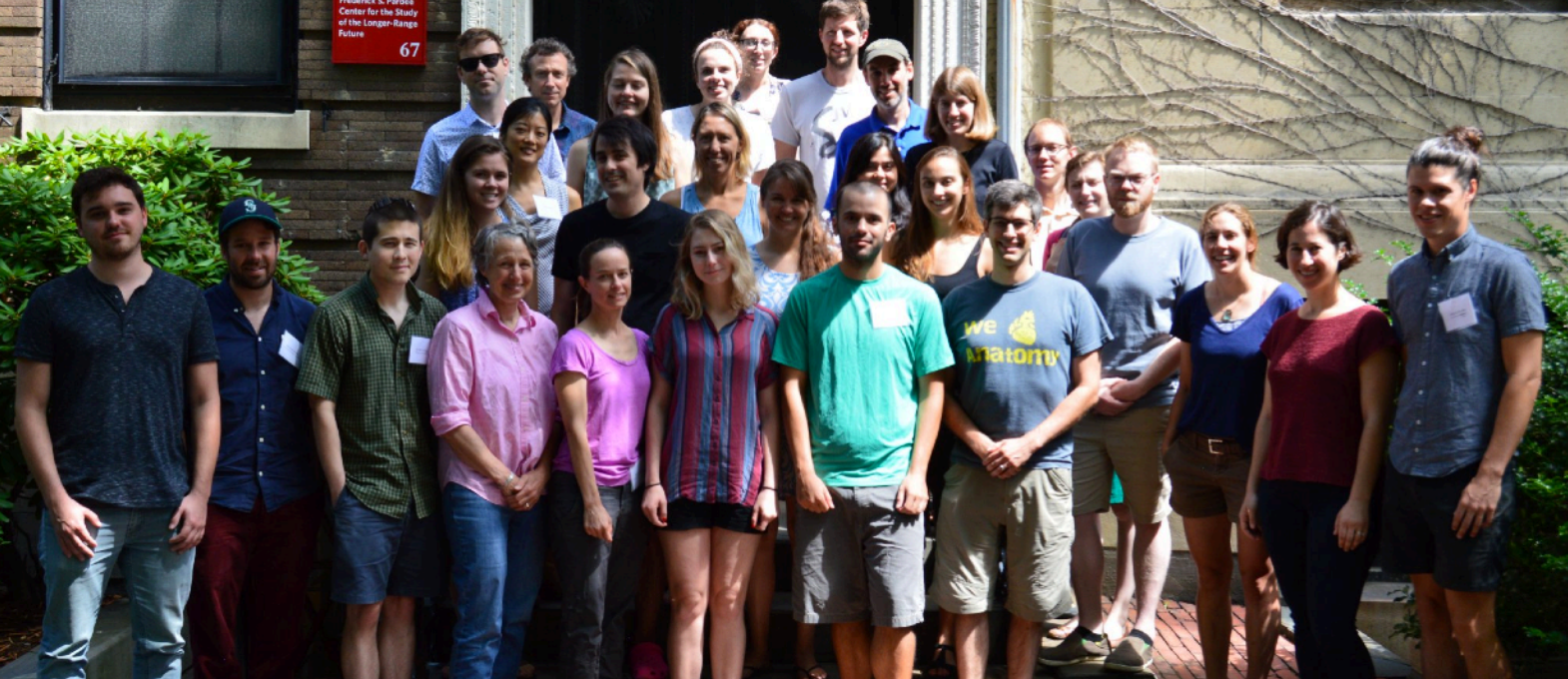
How forecasts could be used to improve decisions, and how are they used in practice?

Education & Diversity

- Building a diverse, equitable, and inclusive community
- Development and refinement of open courseware
- Support educational opportunities

<https://bit.ly/3fJsTwC>

EFI/NEON Fundamentals of Ecological Forecasting



Education & Diversity

- Building a diverse, equitable, and inclusive community
- Development and refinement of open courseware
- Support educational opportunities

<https://bit.ly/3fJsTwC>

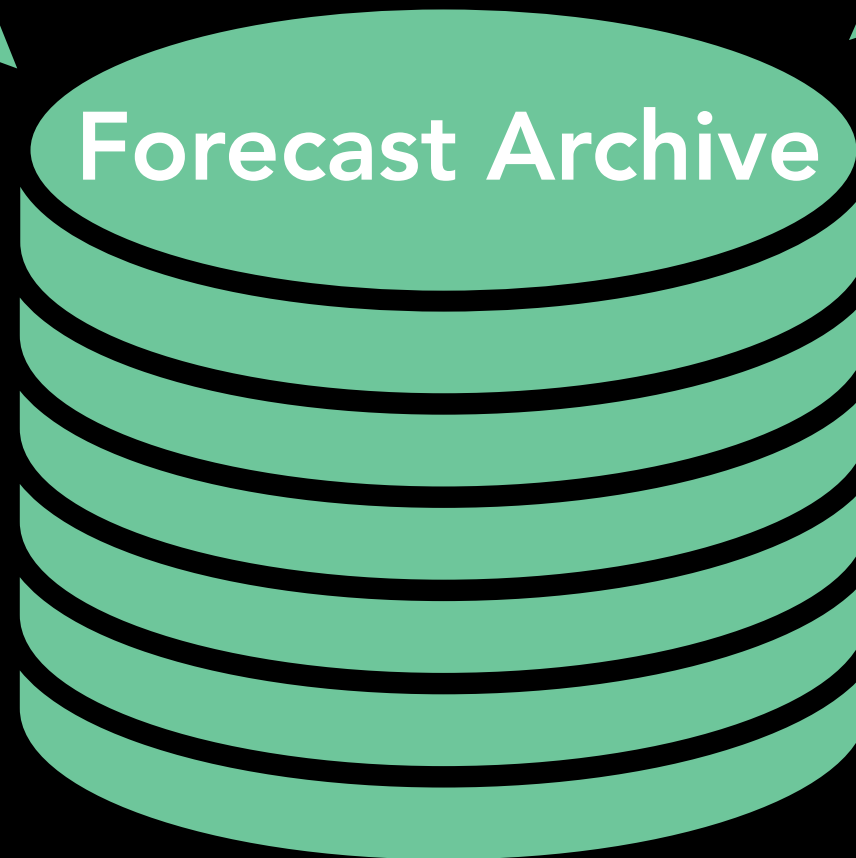
EFI/NEON Fundamentals of Ecological Forecasting

**Cyberinfrastructure
& Methods**

**Open Archive
Standards**

**Common
Analyses**

**Community
Cyberinfrastructure**



**Economies
of Scale**

**Independent
Validation**

Test Theory

**Improve
Dissemination**

THEORY

**Evolution &
Phylogeny**

Physical Environment
(Atm, Ocean, Geology, Hydrology)

```
graph TD; A[Evolution & Phylogeny] --> D[Predictability]; B[Physical Environment] --> D; C[Biological Traits] --> D; E[Ecological Interactions] --> D;
```

Predictability

Biological Traits
(Physiology, Biomechanics,
Demography)

Ecological Interactions
(competition, predation)

How to get involved

- Webpage: ecoforecast.org
- **Newsletter**, Twitter (@eco4cast), Blog
- EFI RCN: NEON forecasting challenge
- Members, Partner, & Project Listing
-  **slack**
- Working groups & student group
- Start forecasting!