Precursors to Understanding Coexistence with CLM-FATES in California

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The CA FATES Project

Understand how past and future climatic conditions may affect wildland vulnerability to drought and fire

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Goals of the CA FATES Project

**Goal 1:** Understand 2011–2015 drought impacts on ecosystems and fire through observations

**Goal 2:** Simulate the 2011–2015 drought and its effects on fire and tree mortality

**Goal 3:** Quantify the role of anthropogenic warming in the 2011–2015 drought

**Goal 4:** Simulate future drought and fire effects on vegetation productivity, mortality, and distribution
Vegetation Modeling with FATES: the Functionally Assembled Terrestrial Ecosystem Simulator

Important differences from big-leaf CLM:

• Environment and competition determine biogeography, so...

• Biogeography can change through time
1. Define PFT parameterizations

1. Benchmark against site-level observations

1. Replicate fundamental niche resulting from climate and soils for each PFT

1. Replicate realized niche resulting from competition, i.e. observed biogeography
1. Growth characteristics
   - Vcmax
   - leaf longevity
   - evergreen/deciduous
   - needle leaf/broad leaf
   - specific leaf area

2. Drought stress tolerance
   - soil moisture that stomata close
   - stem p50 (FATES-Hydro)

2. Allometry
   - tissue allocation

3. Fire resistance
   - bark thickness
   - resprouting (to be added)
Benchmarking Fluxes at a Tower Site

*Initialized, Static Stand Structure*

**GPP**

- Legend:
  - Tower
  - FATES

**ET**

- Legend:
  - Tower
  - FATES
Iterative Process of Defining PFTs

- **Fundamental niche**
  - If fundamental niche is not correct, revisit definitions

- **Realized niche**
  - If not achieving coexistence, revisit PFT definitions and re-run fundamental niche **
  - competition (multiple PFTs)

- **PFT definitions**
  - empirical data
  - parameter sensitivity test results
  - species categorization

**May need to prescribe fire/disturbance**
Southern Sierra Study Area

- 4 tower sites
- 4km x 4km resolution
  - climate forcing from Abatzolgou & Brown 2012
- Started with 2 PFTs:
  - pine & oak
- Single-PFT Run
  (fundamental niche)
- Multiple-PFT Run
  (realized niche)

Adapted from Klos et al., 2018
Current Strategies for Improvement:
1. Soil depth
2. Rooting depth
3. Cold stress mortality
Coexistence: Realized Niches

Started from Bare Ground

- Soil depth
- Rooting depth
- Cold stress mortality
- Physiology parameters
FATES Model Development Opportunities for CA Ecosystems

Subsurface water storage and root access

Crown fire and complex terrain

Klos et al., 2018

Beetle Outbreaks

Post-disturbance recovery:
• seedling germination and survival
• resprouting
Project Decisions

Time and Resources

- Rigorous Sensitivity Testing
- Model Development
- Benchmarking

Benefits of Community Development

- Specialized expertise
- Regular communication
- Division of labor
Initial Science Questions

• What are the relative effects of physiology, allometry, and stand structure on GPP and transpiration?

• How might forest type and structure affect flux responses to drought?

• What was the contribution of anthropogenic climate change to the area/magnitude of tree mortality in the recent drought?