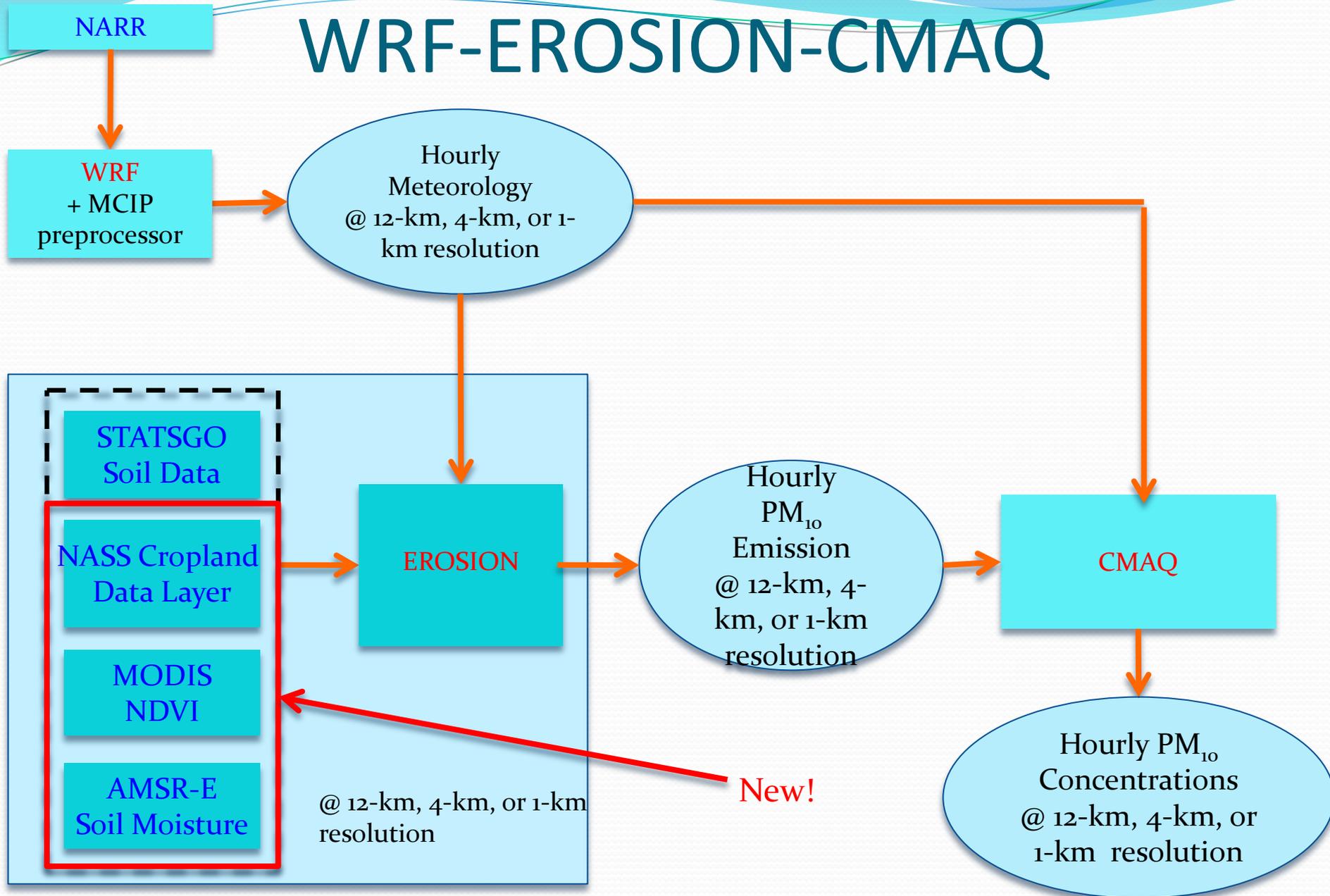# Laboratory for Atmospheric Research (LAR)
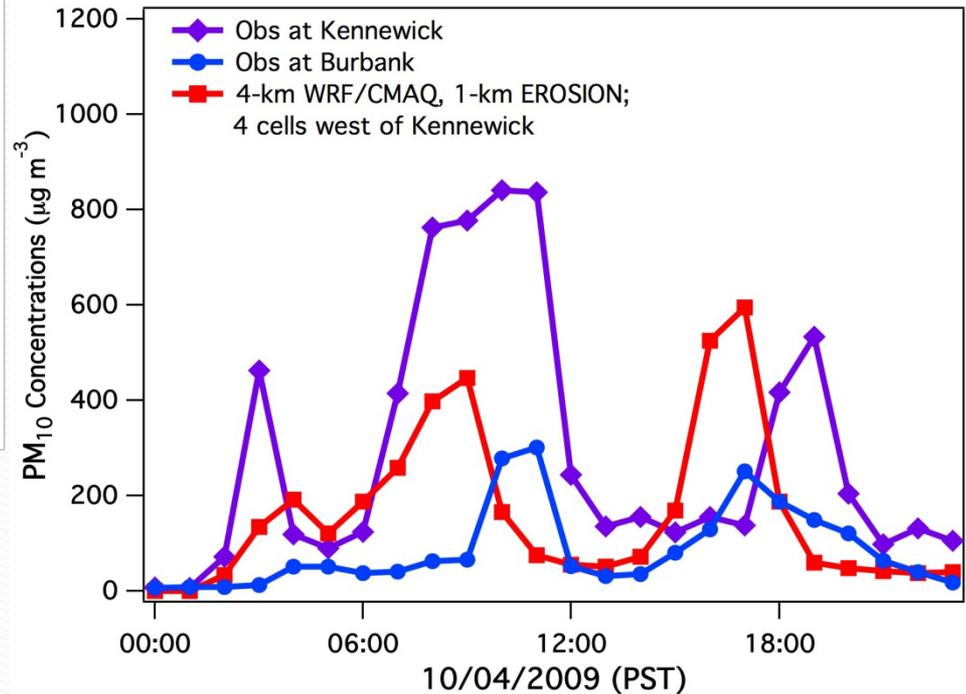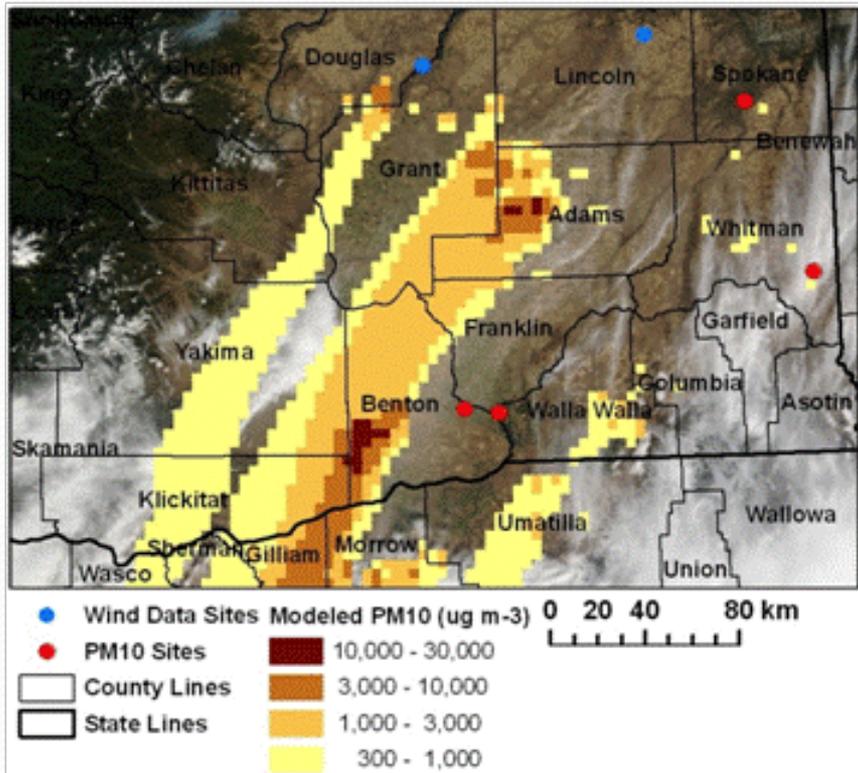# Washington State University

Ongoing and new projects

- WEPS—USDA wind erosion within AIRPACT

- Pollen and Asthma—EPA-STAR building a pollen release and transport module within CMAQ

- Black Carbon—Joint Fire Science study on the impact of fire on black carbon

- Winds in complex terrain—Joint Fire Science study—measurement of high resolution winds for specific terrain features and model evaluation

WRF-EROSION-CMAQ

NARR

WRF
+ MCIP
preprocessor

Hourly Meteorology
@ 12-km, 4-km, or 1-km resolution

STATSGO
Soil Data

NASS Cropland
Data Layer

MODIS
NDVI

AMSR-E
Soil Moisture

EROSION

@ 12-km, 4-km, or 1-km resolution

Hourly PM_{10} Emission
@ 12-km, 4-km, or 1-km resolution

CMAQ

New!

Hourly PM_{10} Concentrations
@ 12-km, 4-km, or 1-km resolution

Evaluation: October 4, 2009 Event

Contribution of Fire Emissions on BC Concentrations and Deposition Rates

- Joint Fire Science Project in collaboration with Seattle AirFire Science Group
- 1995-2003 36-km summertime CONUS simulations
  - To study inter-annual variability of fire contribution
  - Historical fire data
    - Allows for comparison with Fire Scenario Builder results
  - WRF driven by reanalysis filed –
    - Allows for comparison with ECHAM5-driven simulations done for the global change project
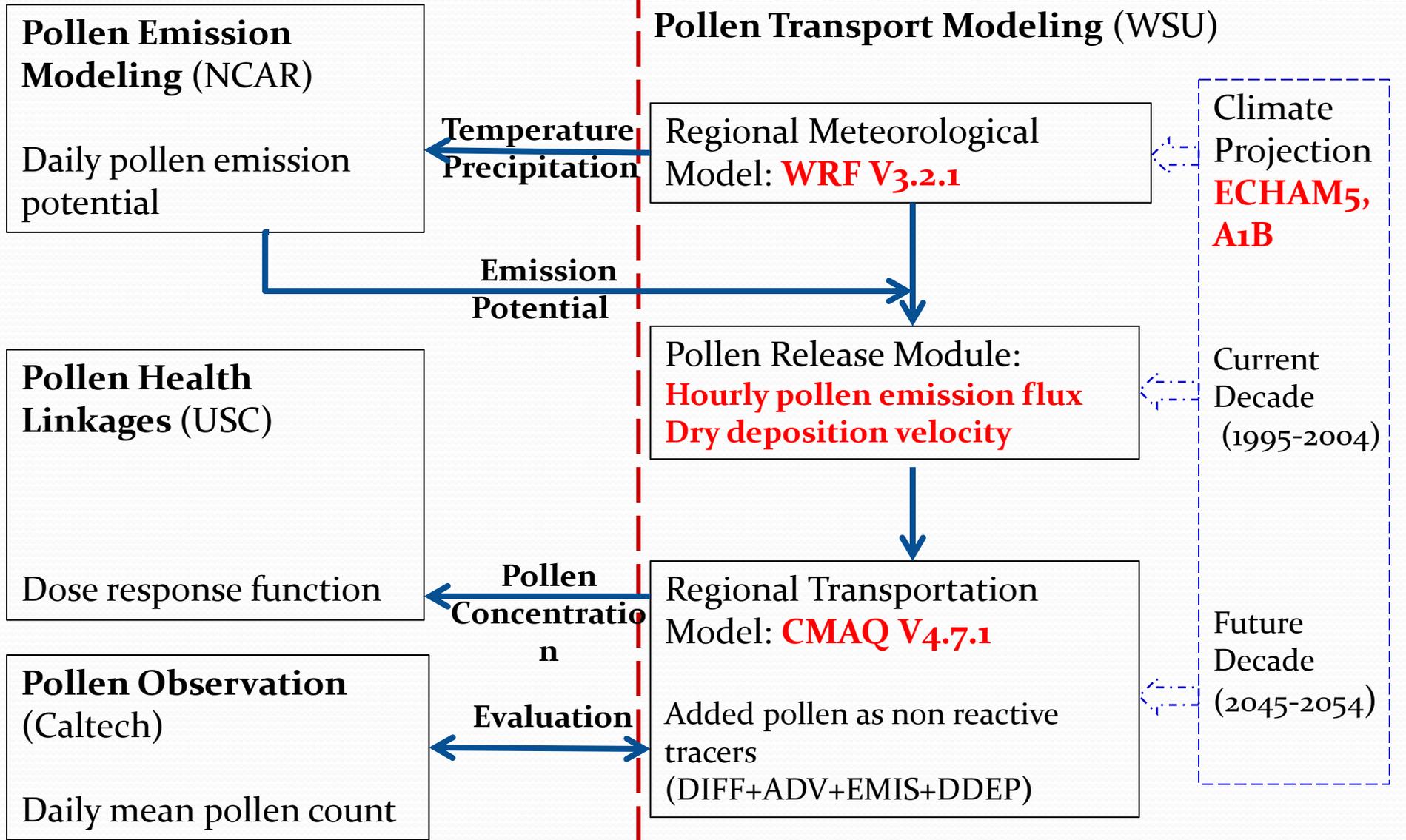
Contribution of Fire Emissions on BC Concentrations and Deposition Rates

- 36-km CONUS, 12-km western US, and 4-km PNW simulations for 2008
  - evaluate the contribution of prescribed vs wildfires
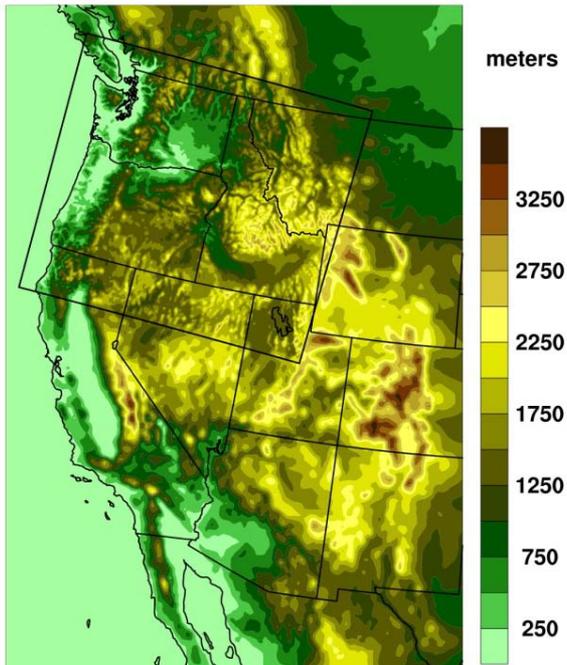
- 12-km western US and 4-km PNW simulations:
  - Focus on deposition of BC onto snowpacks, where BC decreases snow albedo

Pollen Modeling Framework

Pollen Emission Modeling (NCAR)

Daily pollen emission potential

Pollen Transport Modeling (WSU)

Regional Meteorological Model: **WRF V3.2.1**

Temperature Precipitation

Emission Potential

Pollen Release Module: **Hourly pollen emission flux Dry deposition velocity**

Pollen Health Linkages (USC)

Dose response function

Pollen Concentration

Regional Transportation Model: **CMAQ V4.7.1**

Added pollen as non reactive tracers (DIFF+ADV+EMIS+DDEP)

Pollen Observation (Caltech)

Daily mean pollen count

Evaluation

Climate Projection **ECHAM5, A1B**

Current Decade (1995-2004)

Future Decade (2045-2054)

Pollen Simulation Domain

Site Name	Full site name
AHAQMD	Anaheim, AQMD
SBBGC	Santa Barbara Boys & Girls Club
DAES	San Dimas, Allen Elementary School
SAQMD	Riverside, AQMD
GAQMD	Glendora, AQMD
SDLHMS	San Dimas, Lone Hill Middle School
LBAQMD	Long Beach, AQMD
MLAQMD	Mira Loma, Riverside, AQMD
CALTECH	Caltech Campus

Pollen count measurement data:

8 sites for USC's Children Health Study project

+

1 site at Caltech campus (Pasadena)

Terrain Height (m)
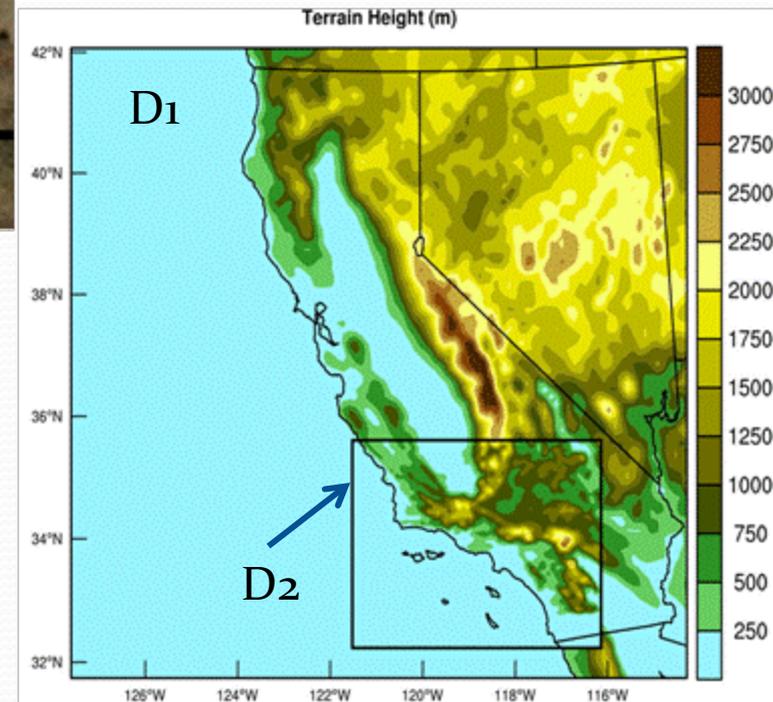
Pollen Modeling Evaluation

Birch tree @ Caltech: missing earlier peaks
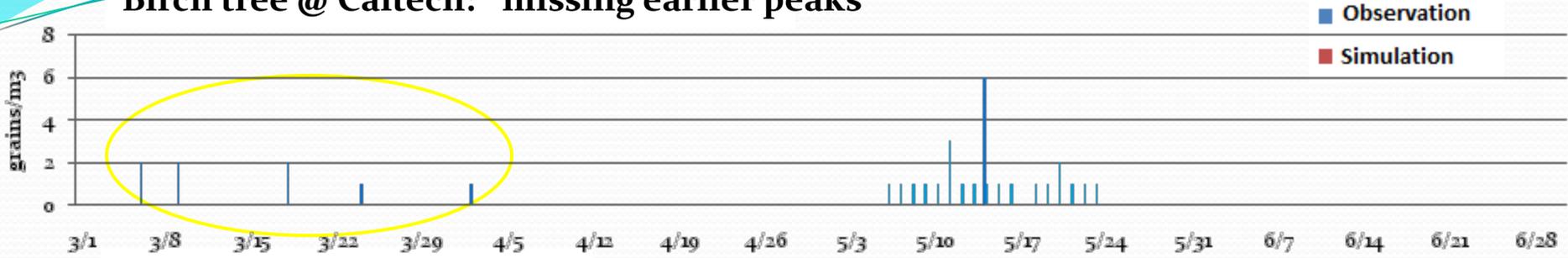
Grass @ Caltech: overestimate
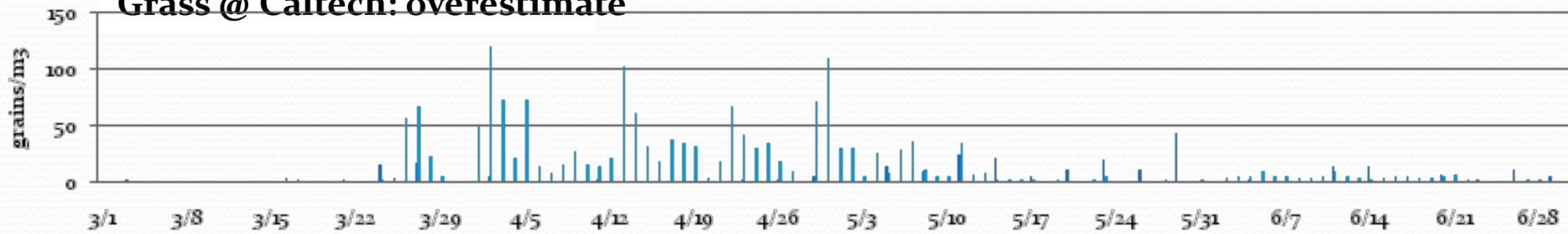
Olea tree @ Caltech: general good
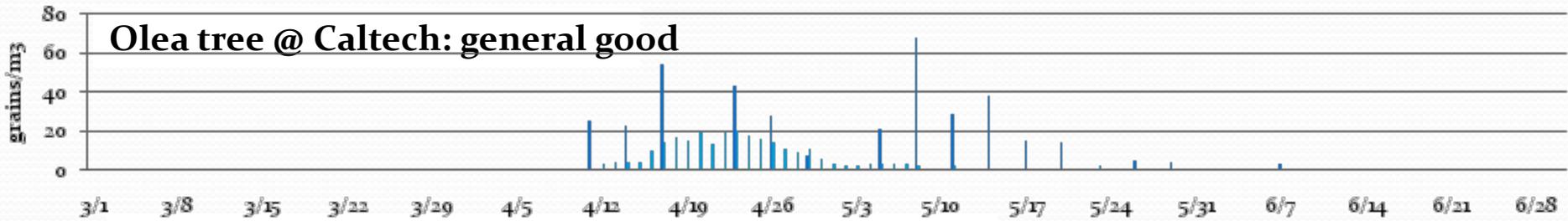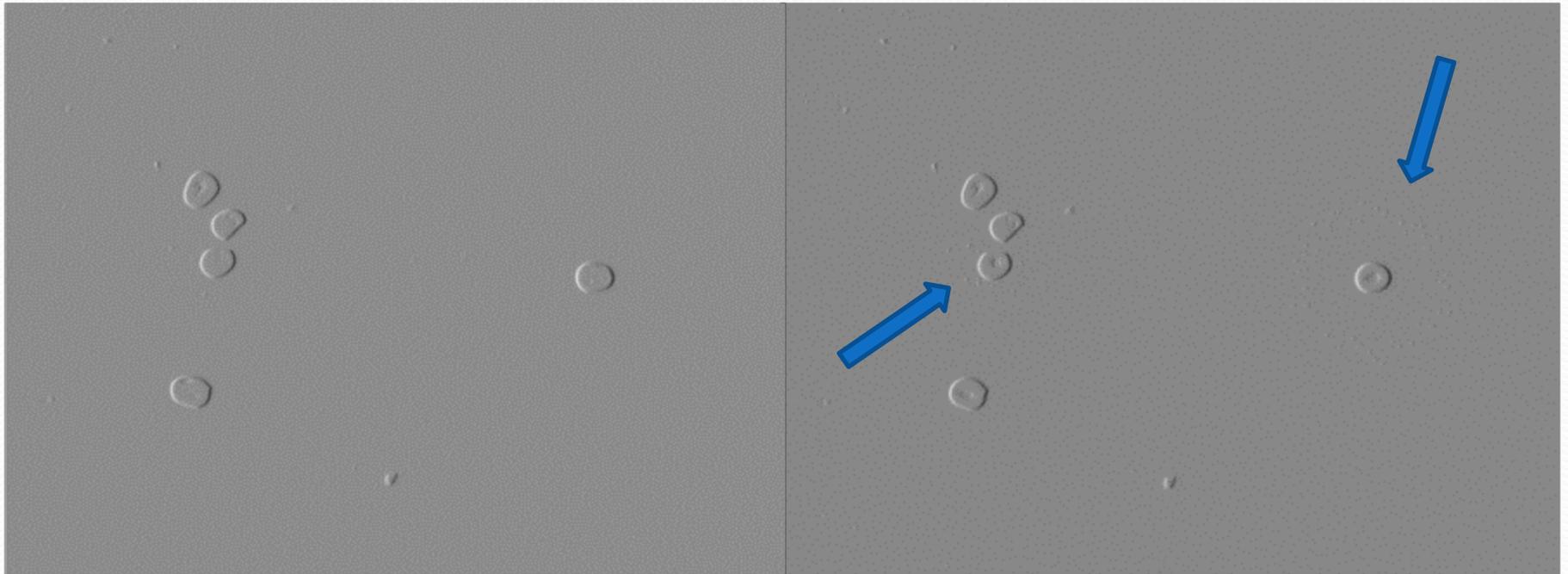
Oak tree @ Caltech: missing episode peak at late March
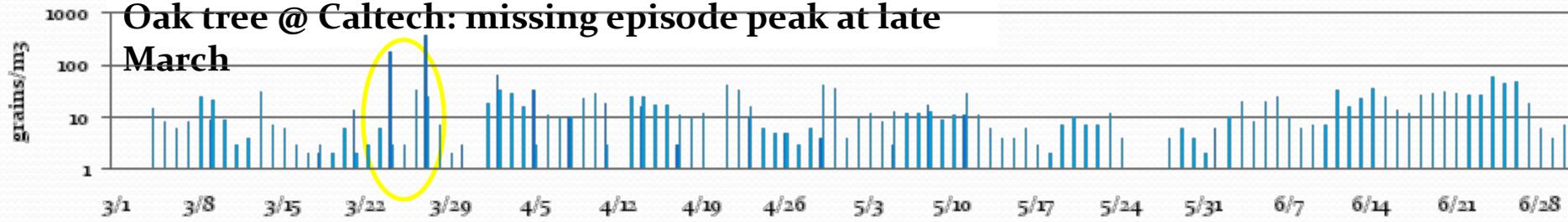
- The goal is to develop a time- and RH-dependent model for describing pollen rupture in atmospheric models.

- General approach is to observe pollen rupture under different RH conditions in a small slide chamber on a microscope stage.
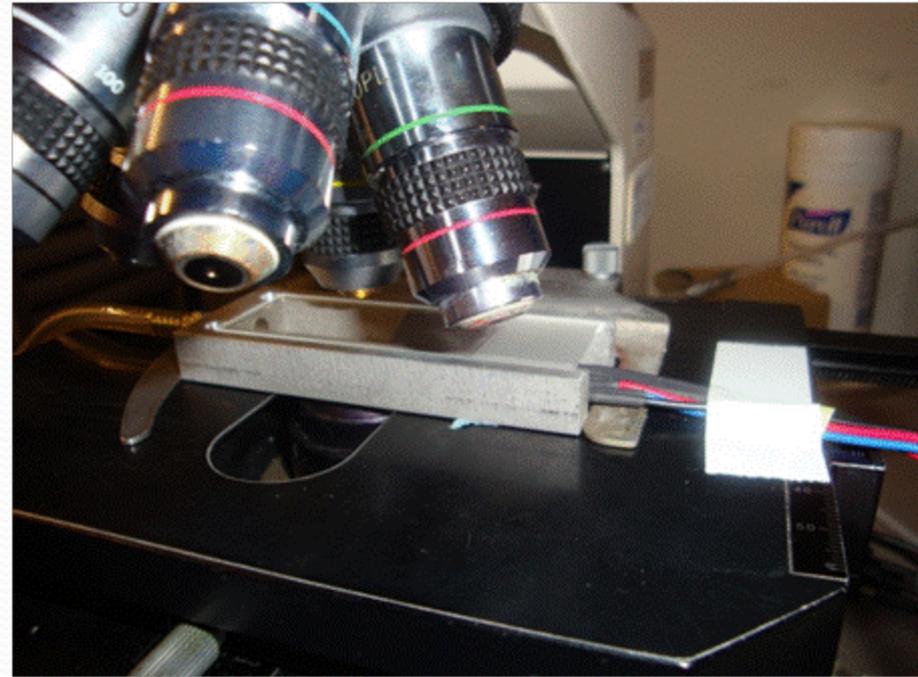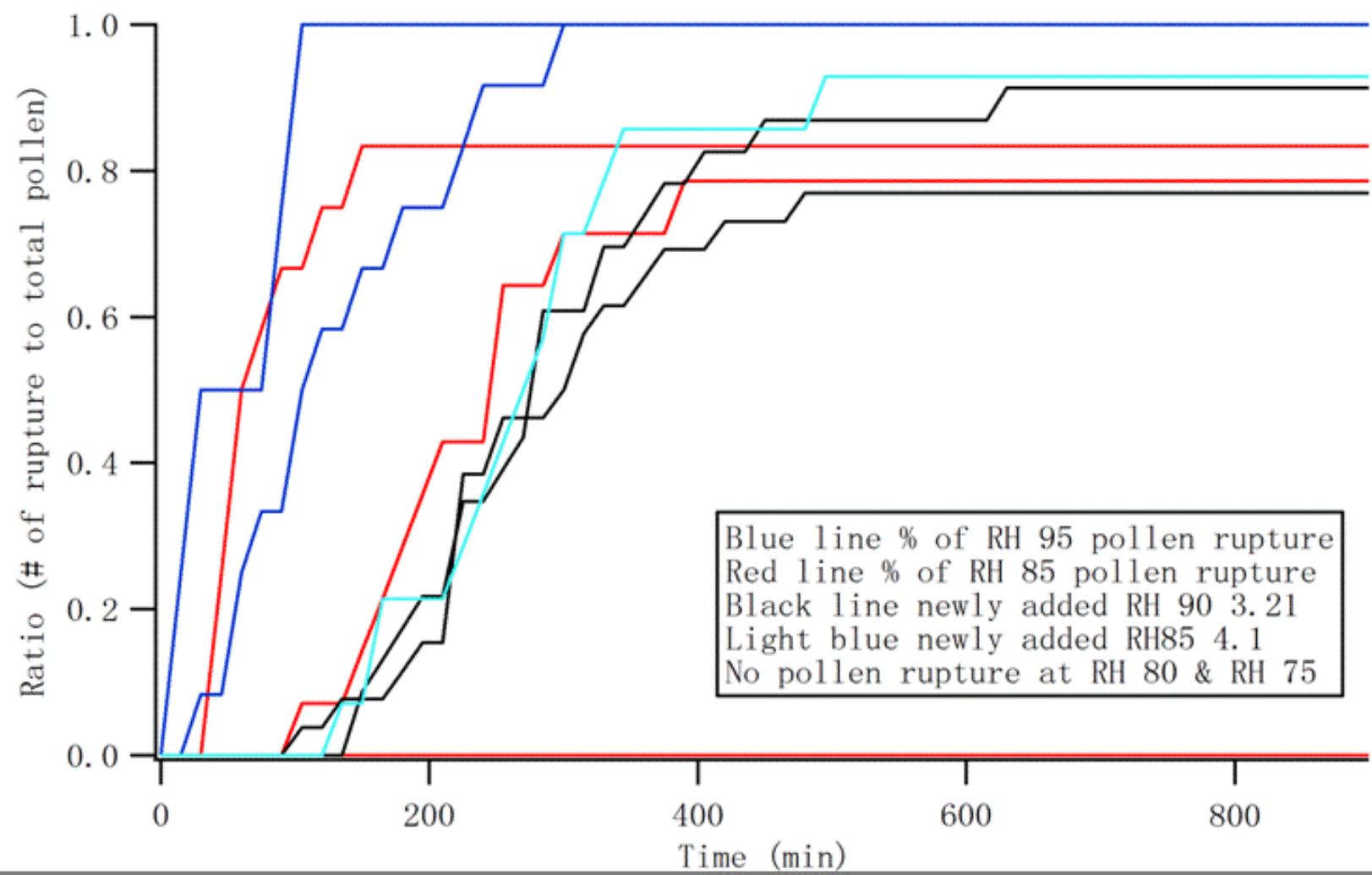
Pollen Rupture @ 90%RH

10 min vs 6 hours

Blue line % of RH 95 pollen rupture
Red line % of RH 85 pollen rupture
Black line newly added RH 90 3.21
Light blue newly added RH85 4.1
No pollen rupture at RH 80 & RH 75

Winds in complex terrain—Joint Fire Science collaboration with Missoula Fire Lab

- 50 sensors deployed for extended high-resolution wind observations
  - Big Southern Butte
  - Salmon River Canyon
  - Priest River Exp. Forest
- Model evaluation
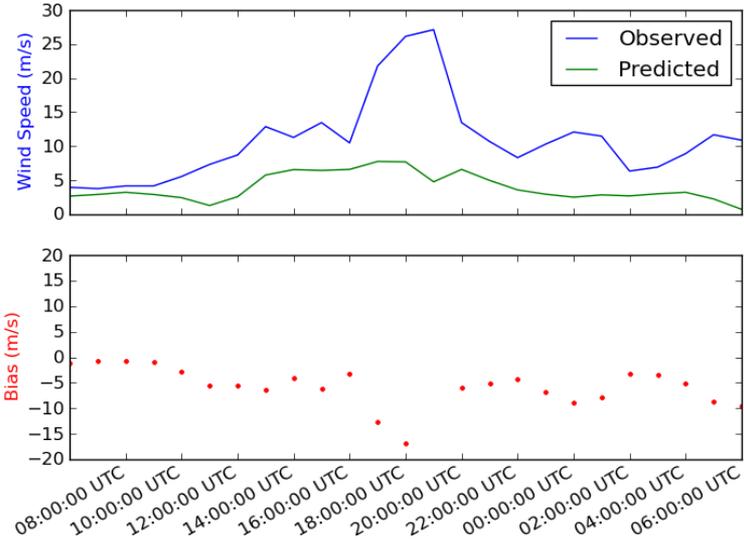 - WRF-high resolution
  - WindNinja
  - WindFOAM
  - HHHR

butte
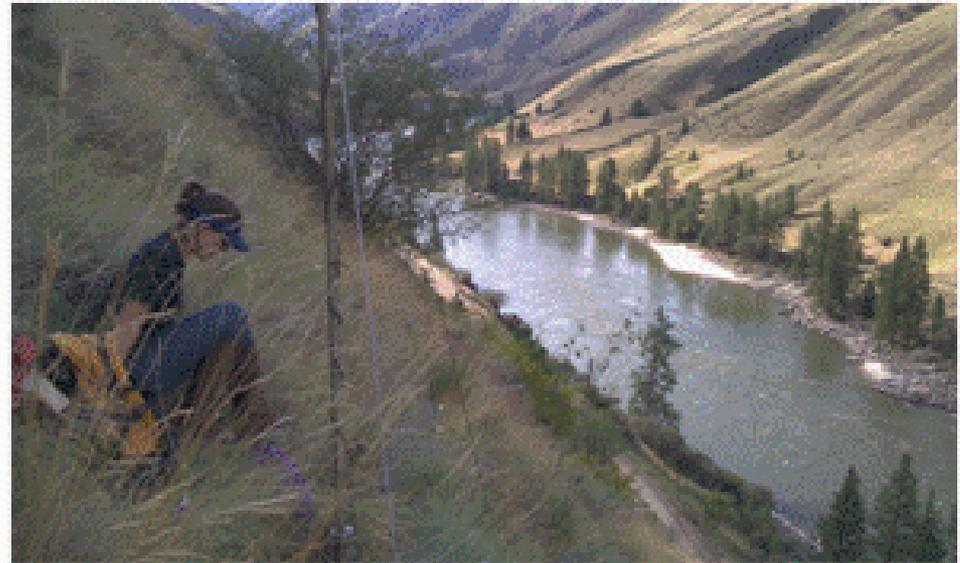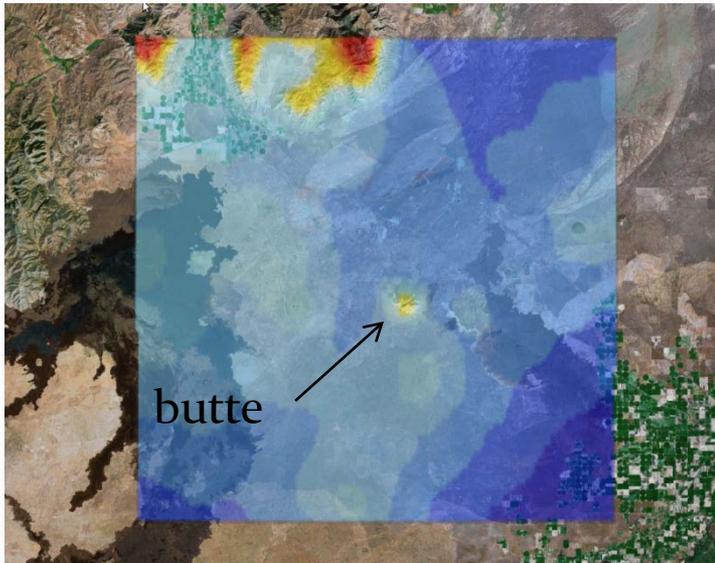
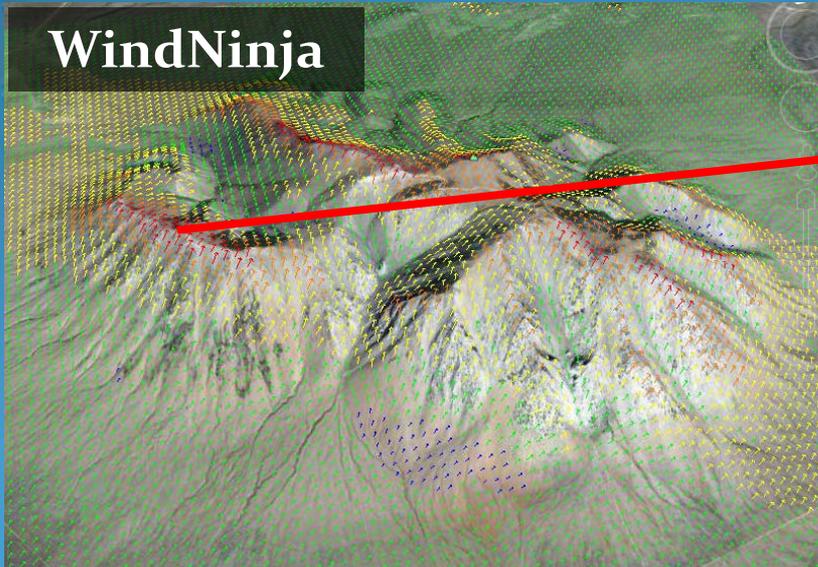WRF 4/3 km domain

WRF

Bias (m/s)
< -5
-5 to -2
-2 to 2
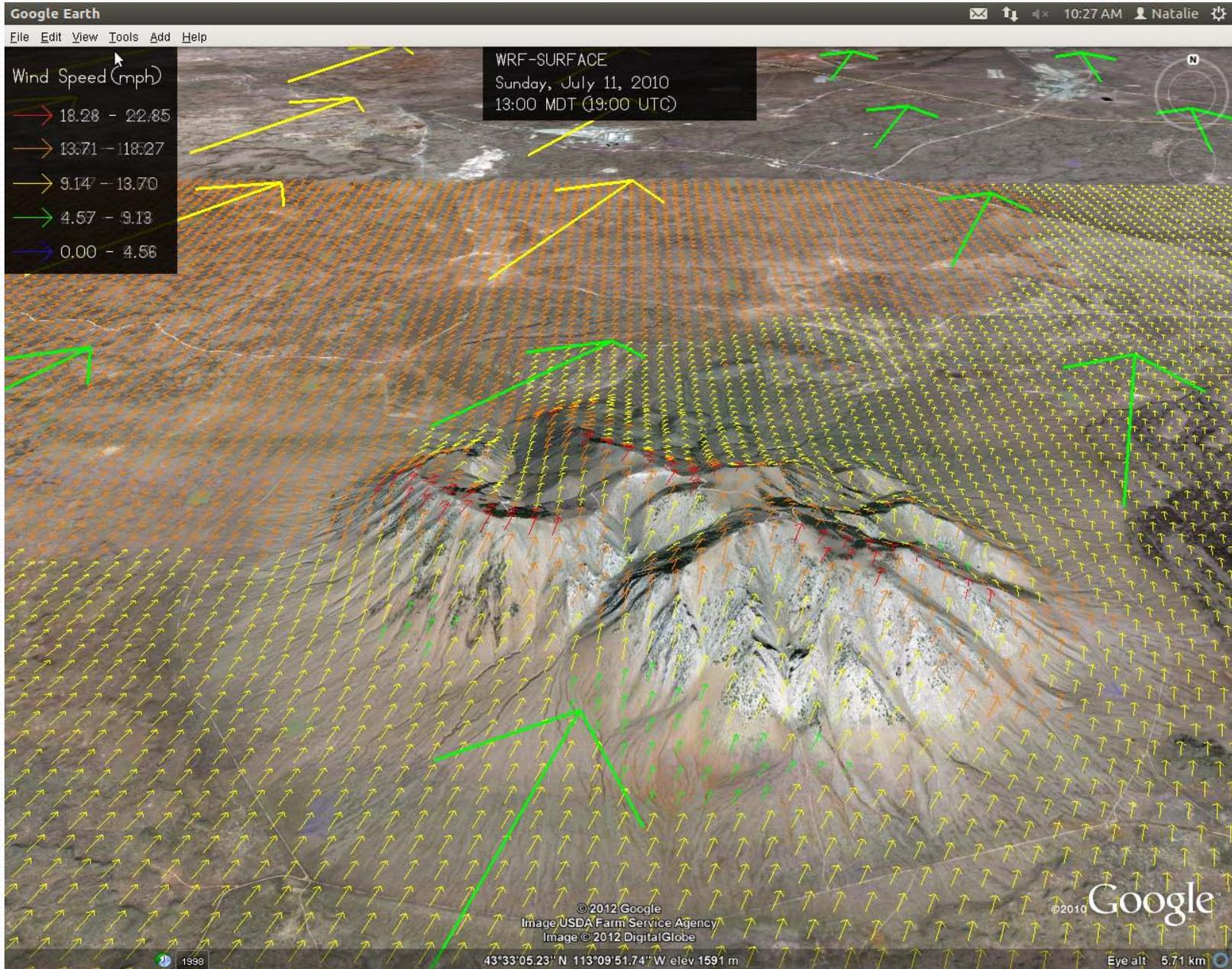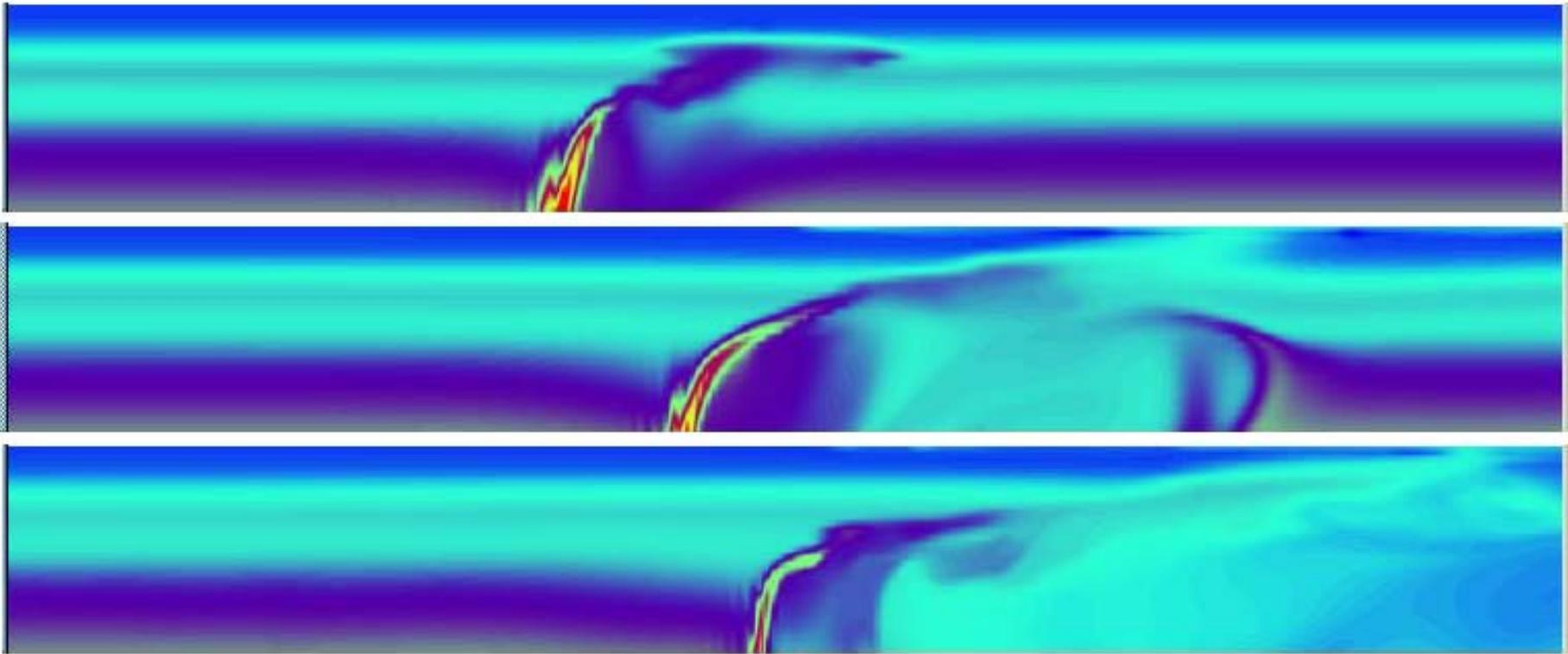2 to 5
> 5
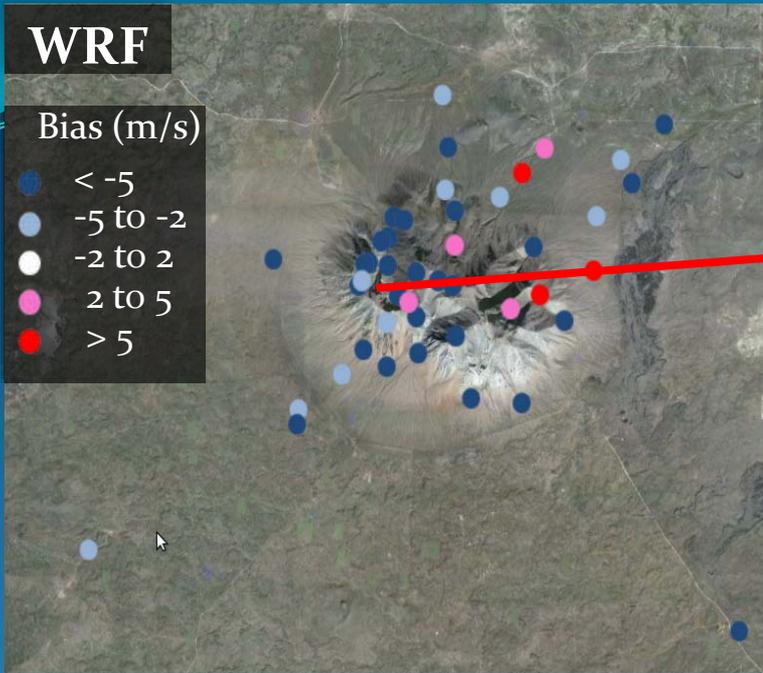
WindNinja

Plot R26 from 2010-09-04 06:00:00 to 2010-09-05 06:15:00
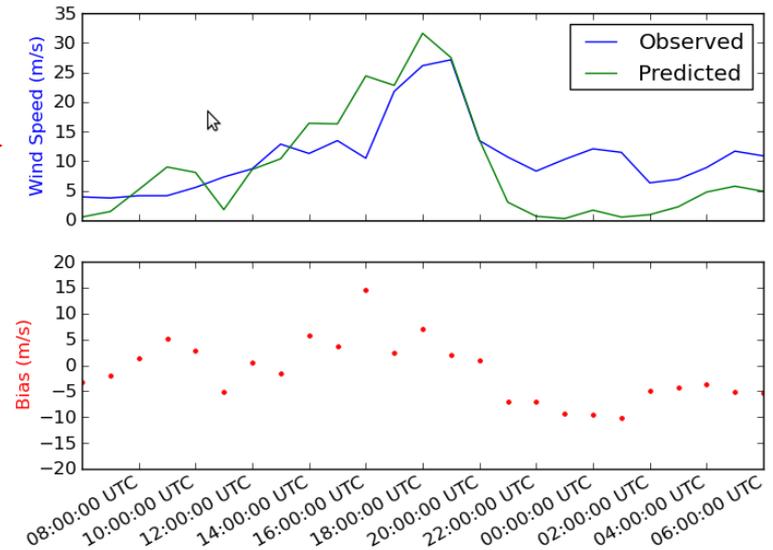
WindNinja Initialized with 4/3 km WRF

WRF-Fire sensitivity analyses

Line grass fire: water vapor mixing ratio contours (kg/kg)

# Recent new interdisciplinary research projects

- REACCH: Regional Approaches to Climate Change for cereal crops in the Pacific Northwest
  - USDA $20M, 5 yrs
  - UI, OSU, WSU
- BioEarth: A biosphere relevant earth system modeling framework
  - USDA, $2.8M, 5 yrs
  - WSU, UI, UCSB, PNNL, NCAR, Clark U.
- NARA: Northwest Advanced Renewables Alliance for development of biofuels for aviation
  - USDA, $38M, 5 yrs
  - WSU lead with multiple other institutions

Recent proposal submissions

- NASA—WRF-Fire incorporation into AIRPACT
- NSF—Earth System Modeling—Biogenic SOA impacts and control—western US
- NSF—Frontiers in Earth System Dynamics—role of fire within earth system modeling—western US
- NSF—Macrosystems—use of stable isotopes to link sources to receptors for N deposition and cycling, integration isotope results with CMAQ and HySPLIT modeling—western US
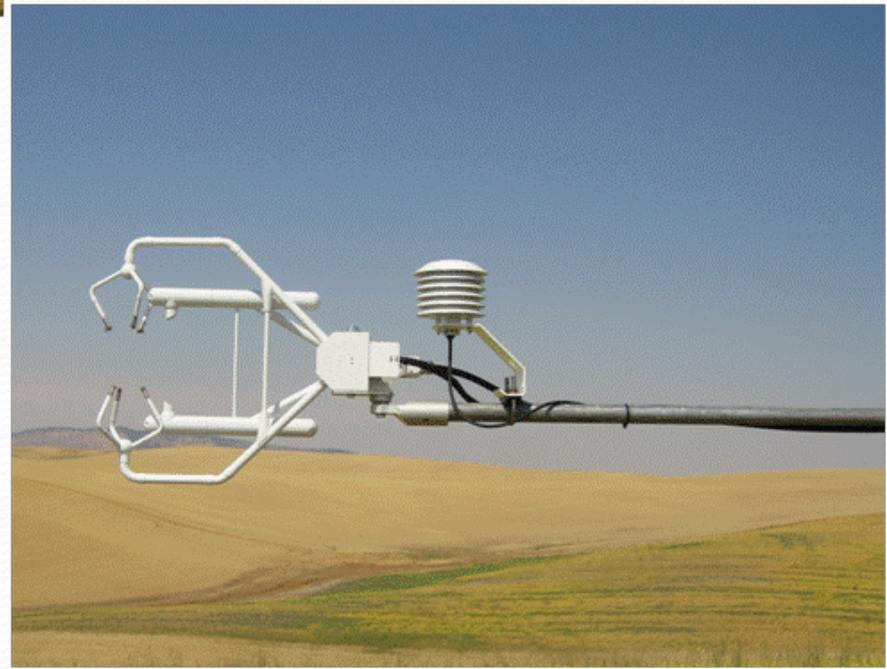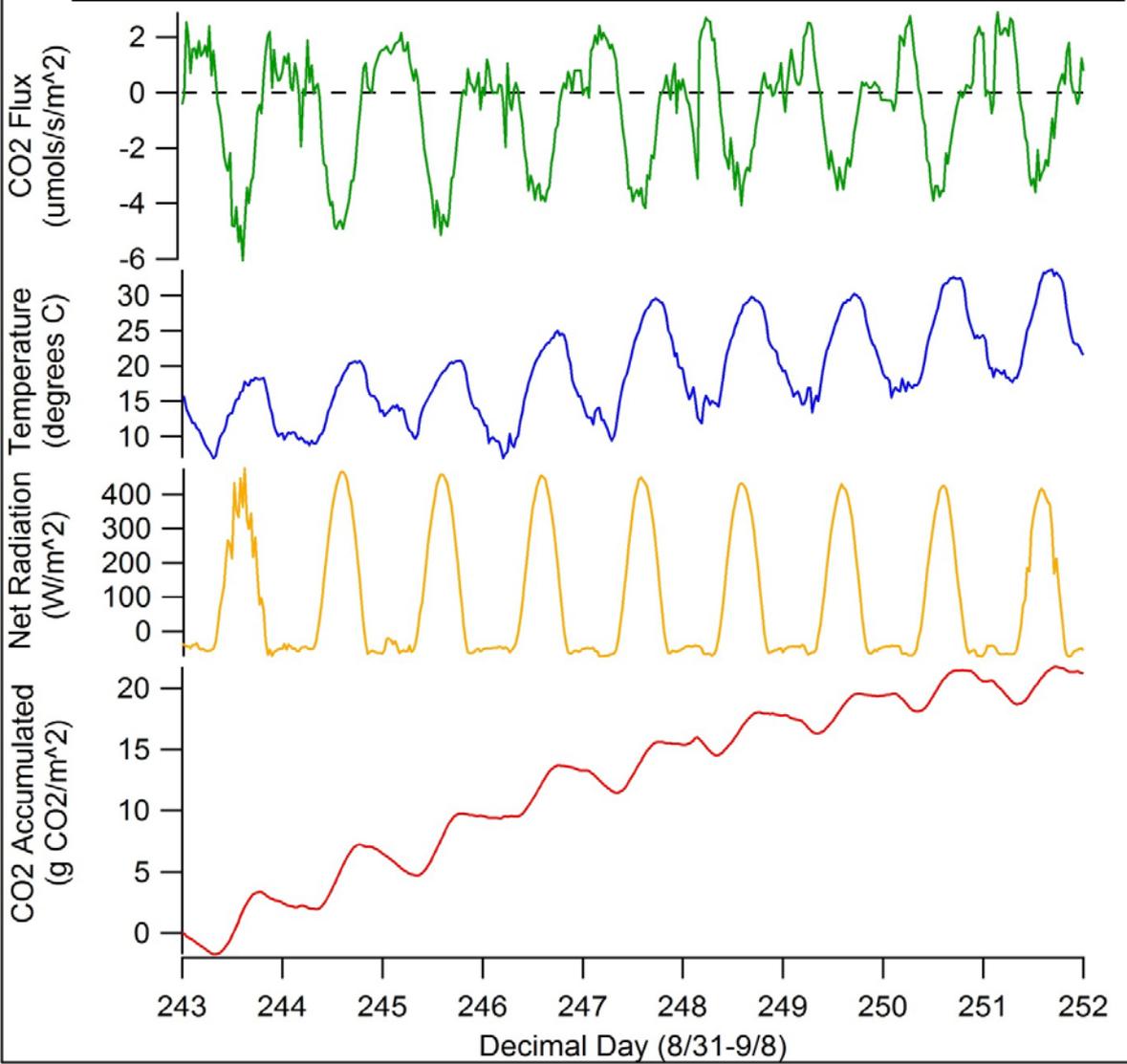
Questions?
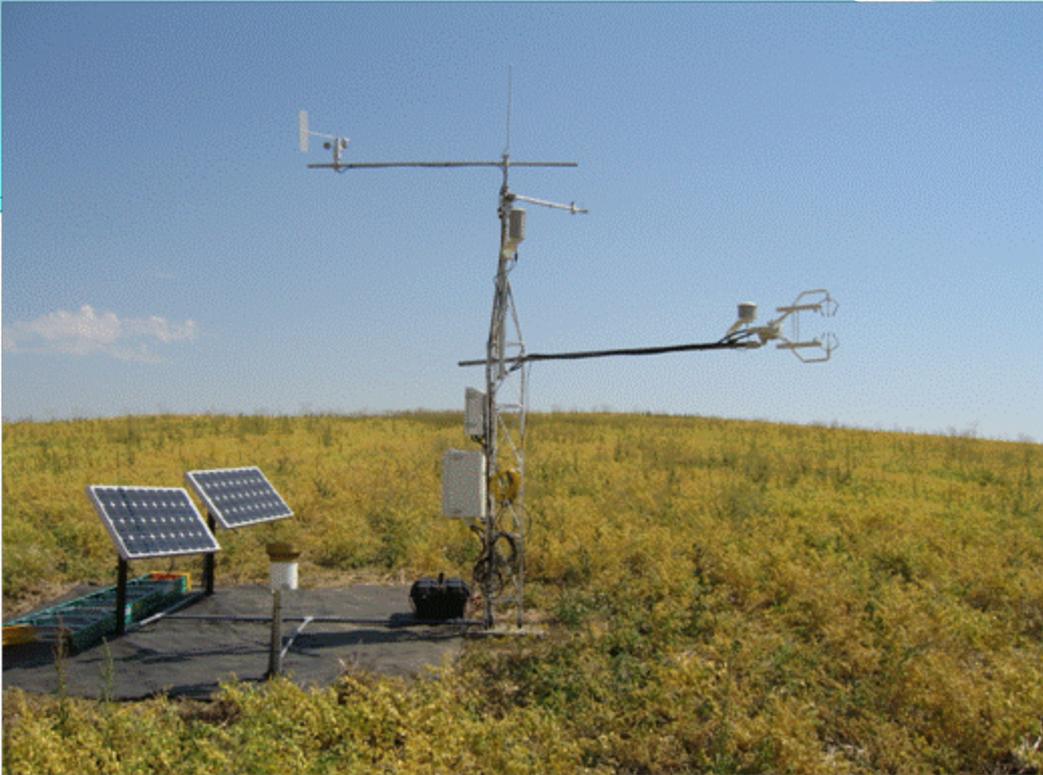
REACCH Flux Measurements
CO2, H2O, N2O, CH4 fluxes
annual C and N budgets

Six sites in eastern WA and northern ID
    Annual wheat rotation
    Dry fallow rotation
    Irrigated rotation
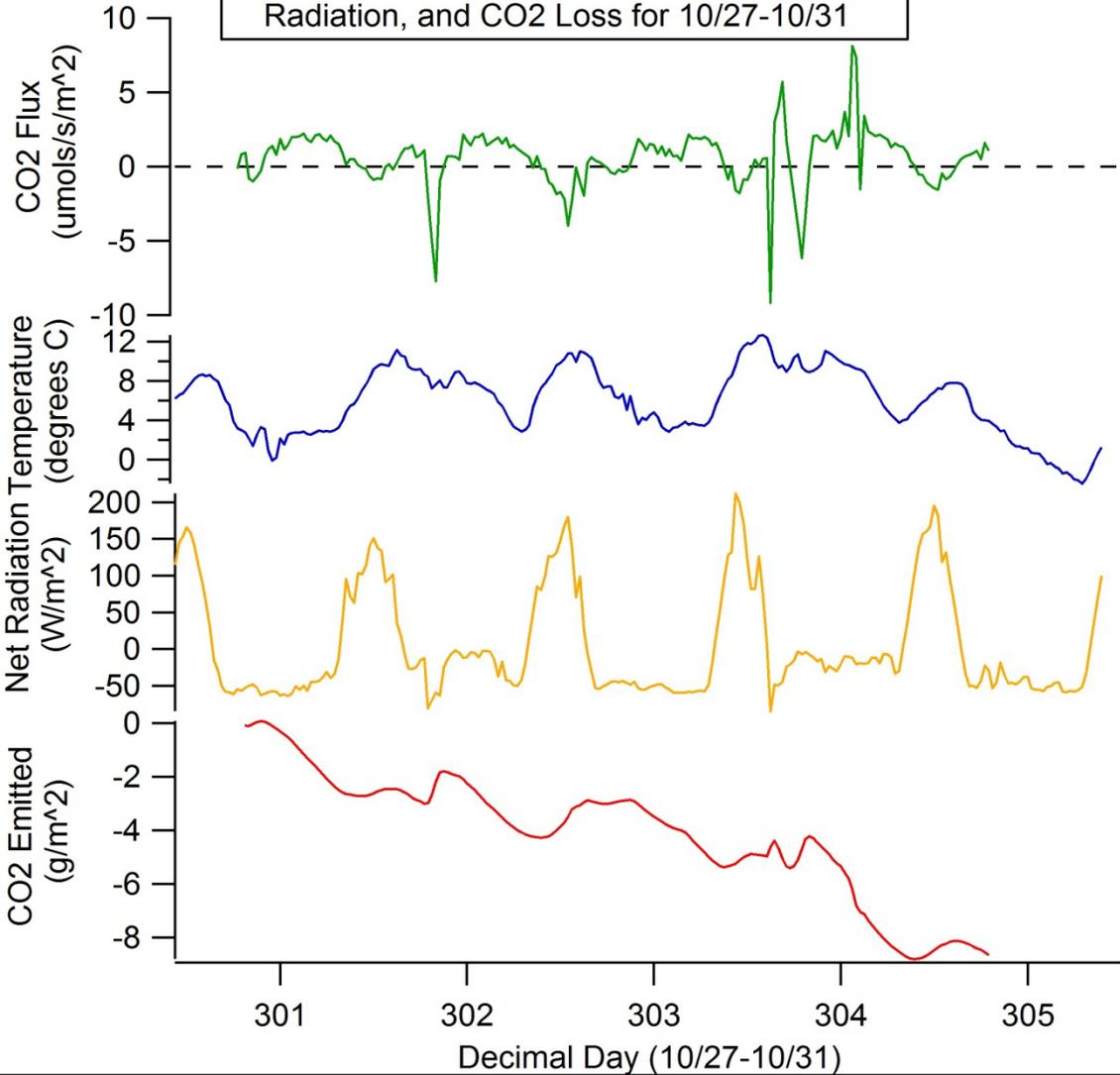Conventional and no-till practices

REACCH
Regional Approaches
to Climate Change –
PNA

Cook Farm Carbon Dioxide Flux, Temperature, and Radiation from 8/31 to 9/8

Pre-harvest fluxes

Cook Farm Carbon Dioxide Flux, Temperature, Radiation, and CO2 Loss for 10/27-10/31
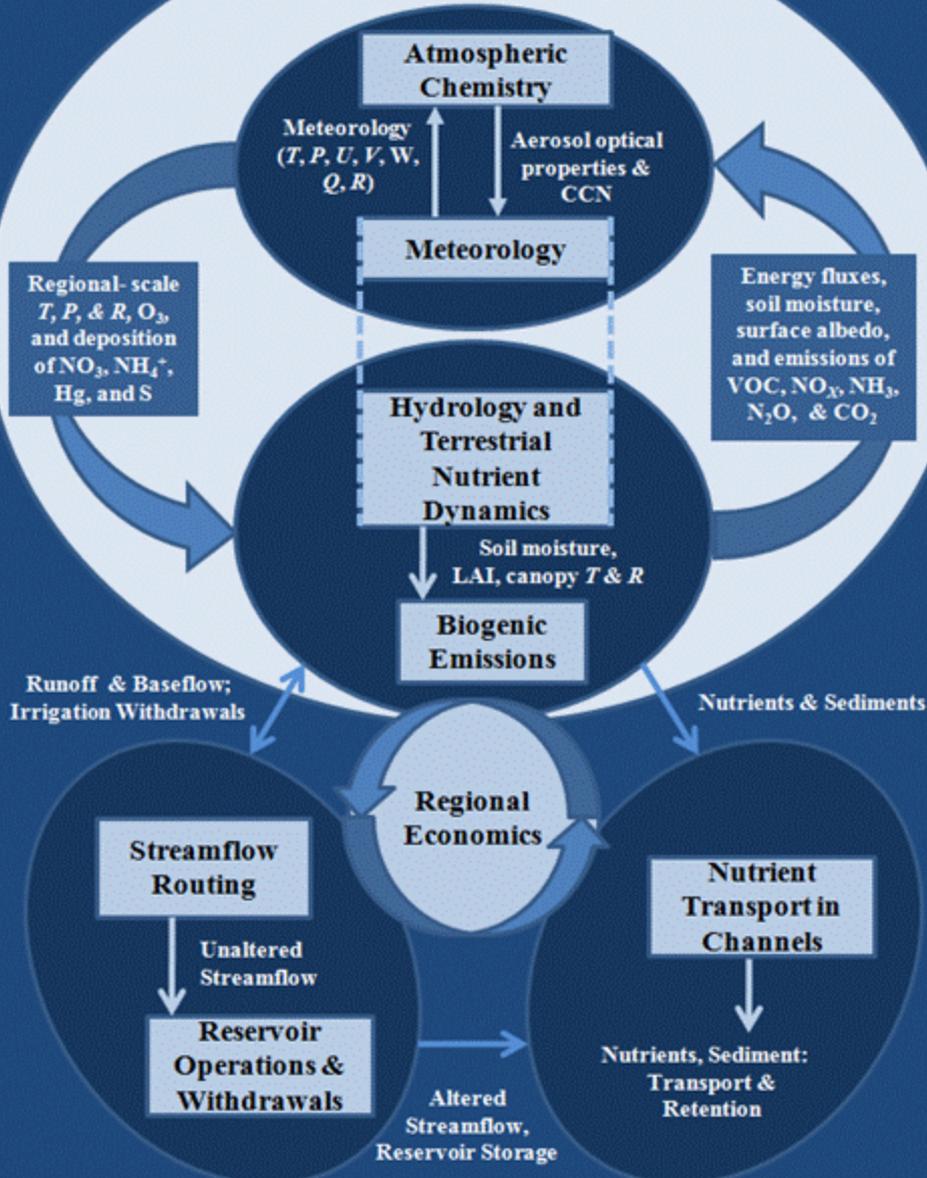
Post-harvest fluxes

BioEarth

- CCSM output for global climate
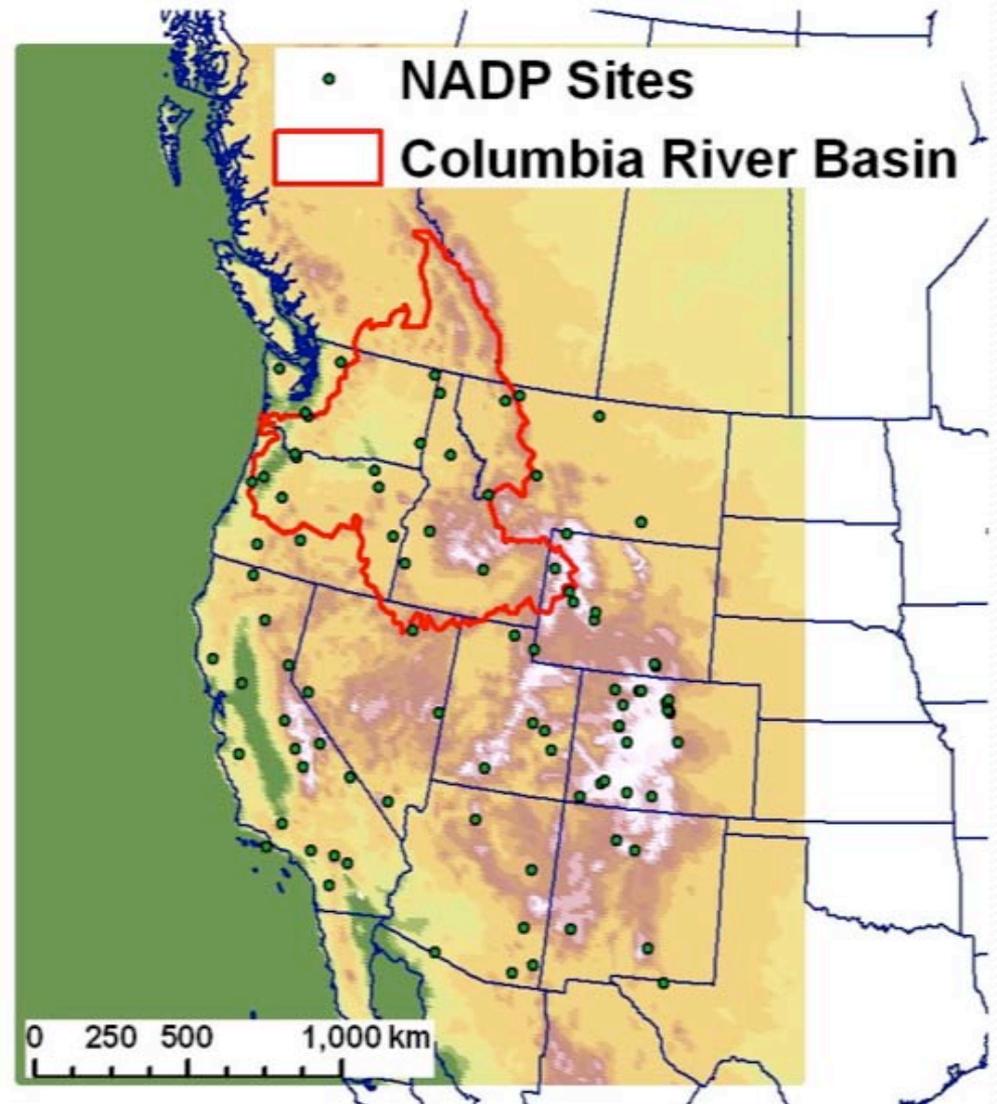
Coupled models
- WRF meteorology
- CMAQ atmospheric chemistry and deposition
- RHESSys ecosystem dynamics
- CropSyst agricultural growth
- MEGAN biogenic emissions
- VIC regional hydrology

Linked Models
- ColSim reservoir operations
- NEWS2 nutrient export
- Econ regional ag/water economics

Modeling Domain: The Columbia River Basin and the Western US

Goal and Objectives

Overarching Goal: To improve the understanding of regional and decadal-scale C:N:H_2O interactions in context of global change to better inform decision makers involved in natural and agricultural resource management.

Specific Objectives:

1. ***Air to Land Linkage***: To investigate the role that atmospheric processes play in land surface C:N:H_2O cycles.

2. ***Coupled Air/Land***: To explore how ecosystem changes in the PNW affect land/atmosphere interactions.

3. ***Coupled Air/Land/Human***: To examine how potential policy changes might affect the interactions between C:N:H_2O cycles and regional-scale climate.

4. ***Communication:*** To explore how to best communicate the model results to resource managers and policy makers.
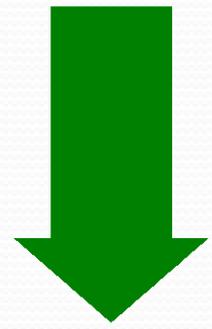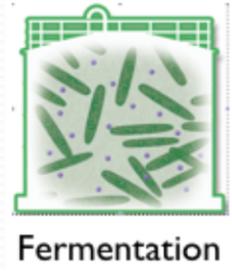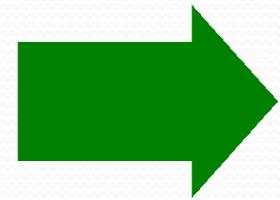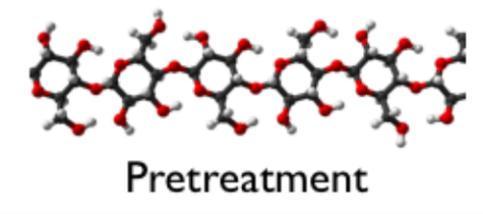
Development of BioJet Fuels
for the Pacific Northwest

Pathway for Wood to BioJet:

Conifer residues (logging and mill) and poplar plantations as feedstocks for BioJet

Pretreated Biomass Sugars: Hydrolyzate
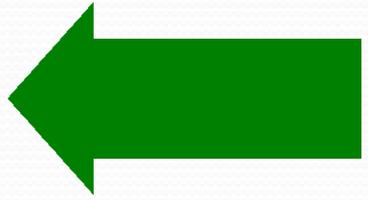
Pretreatment

Fermentation
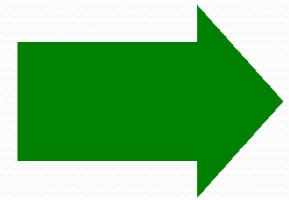
Wood to BioJet

Isobutanol

Biojet

ASTM Testing & End Users: Commercial and Military

Sustainability Analysis

Environment

LCA
Env Burdens
Energy
Carbon
Substitution

EIA
Water
Invertebrates
Air Quality

Economic

Supply
Available Harvest
Actual Harvest
Thinnings
Forest Residuals
Mill Residuals
MSW

IMPACT

STAGES
Existing Forest
Feedstock Development
Sustainable Production
Logistics
Pre-Treatment
Conversion

ATTITUDES

VALUE

Env Preferred Products
Perception of:
Feedstocks
End Users
Education

Social

What are the Regional Air Quality Impacts for BioJet Fuels?

- Biogenic Volatile Organic Compound (BVOC) emissions from forests and plantations—how will these change due to large scale feedstock production? What is the impact on ozone and PM2.5 concentrations?
- Air pollutant emissions from pre-processing and central processing facilities—are these different from existing forest products processing? How will these affect O_3, PM2.5 and air toxic levels
- Changes in transportation and other current anthropogenic air pollution sources?
- Trade-offs in greenhouse gas impacts (N_2O, CH_4, CO_2, O_3)?

LAR

http://www.lar.wsu.edu