BioEarth

Biosphere-relevant earth system model

ATMOSPHERIC GROUP WORKGROUP I.A PROGRESS REPORT

All-Hand Meeting
June 26, 2012
Pullman, WA

TEAM MEMBERS

Atmospheric Team
Jennifer Adam, WSU
Serena Chung, WSU
Alex Guenther, NCAR
Xiaoyan Jiang, NCAR (new member)
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Jinho Yoon, PNNL (new member)

ATMOSPHERIC MODELING COMPONENTS
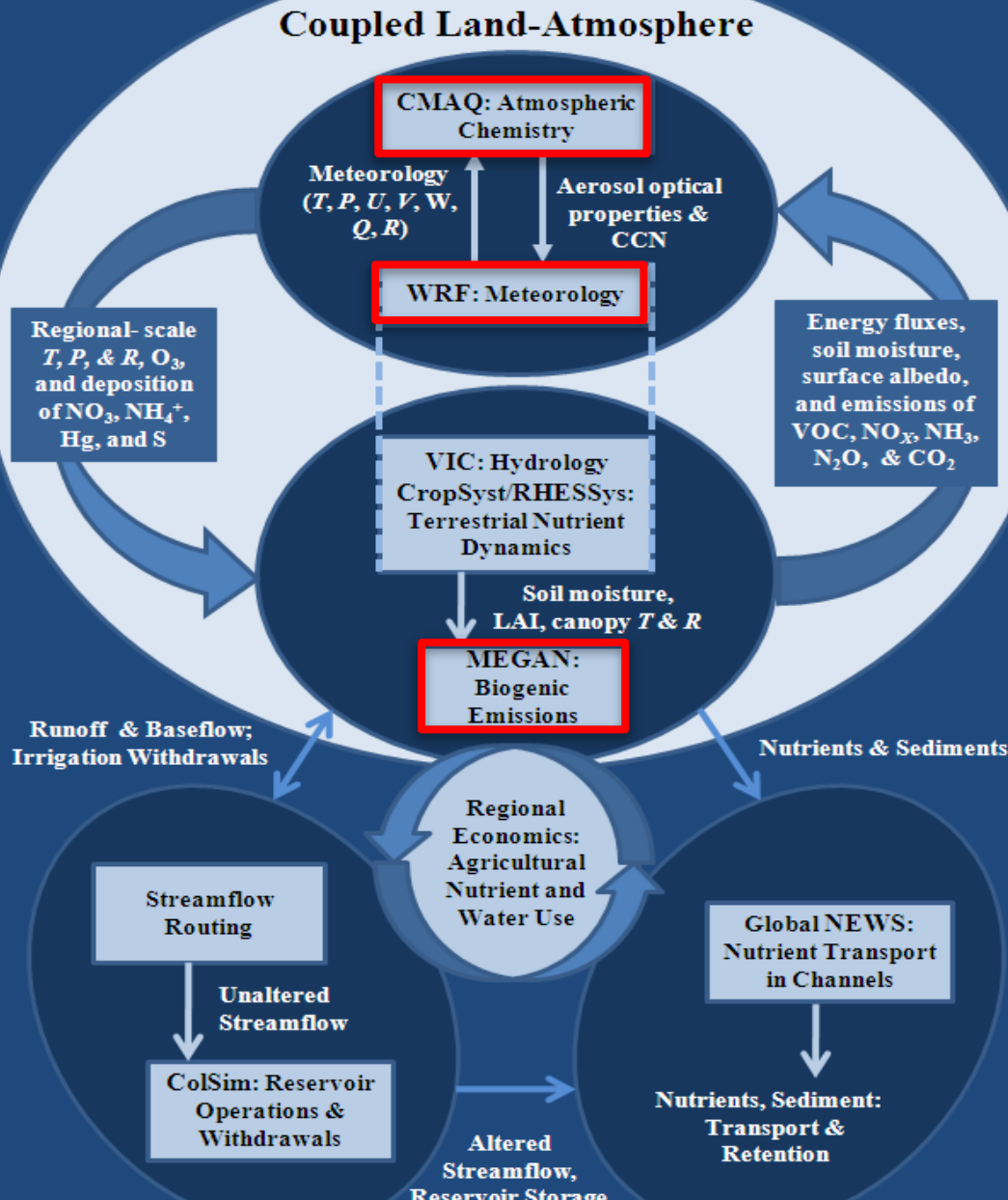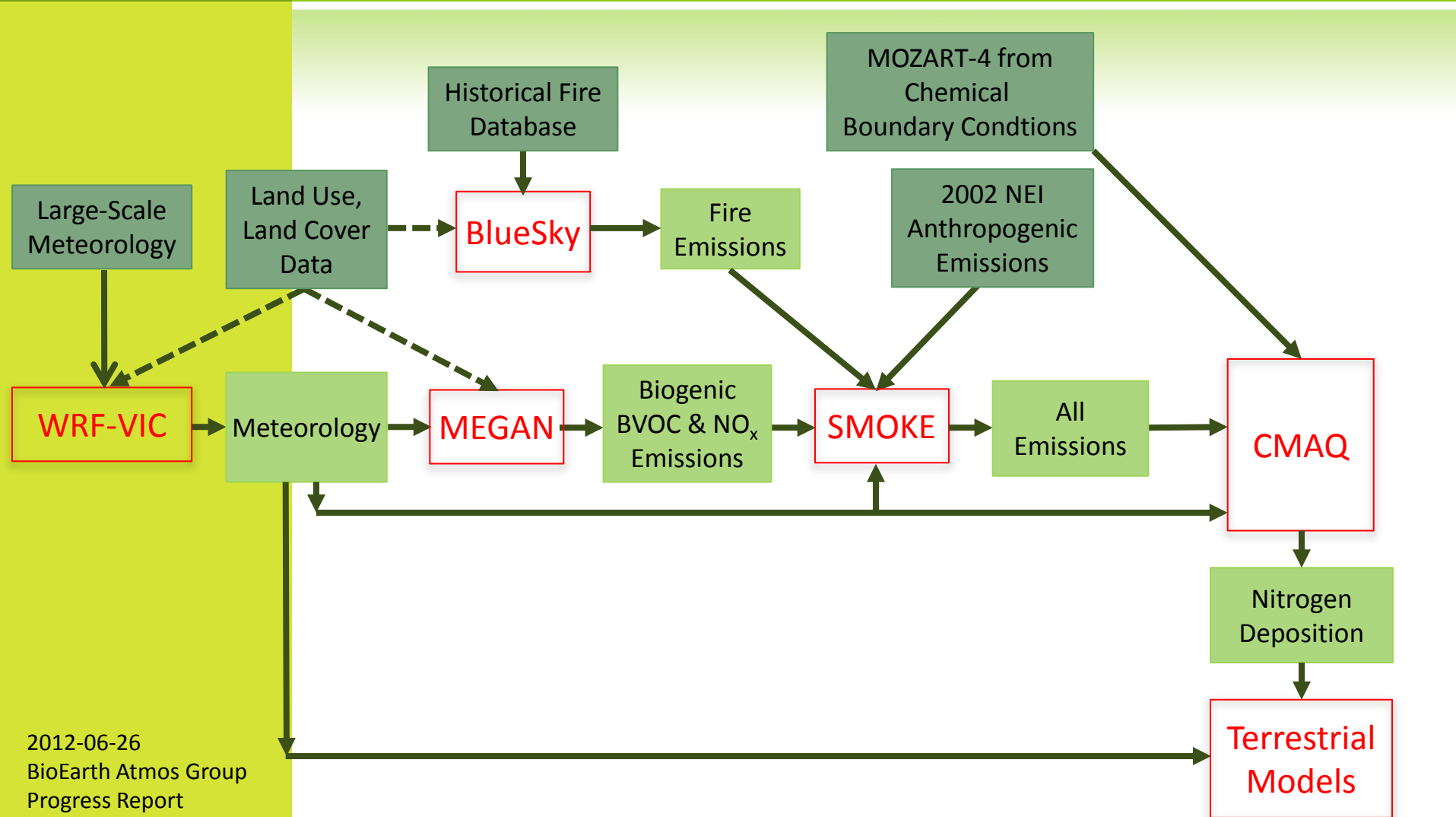
Sequential Simulations: Original Timeline

Jan – Jul 2012

Jan – Mar 2012

Jul – Dec 2012

Large-Scale Meteorology

Land Use, Land Cover Data

Historical Fire Database

BlueSky

Fire Emissions

MOZART-4 from Chemical Boundary Condtions

2002 NEI Anthropogenic Emissions

WRF-VIC

Meteorology

MEGAN

Biogenic BVOC & NO_x Emissions

SMOKE

All Emissions

CMAQ

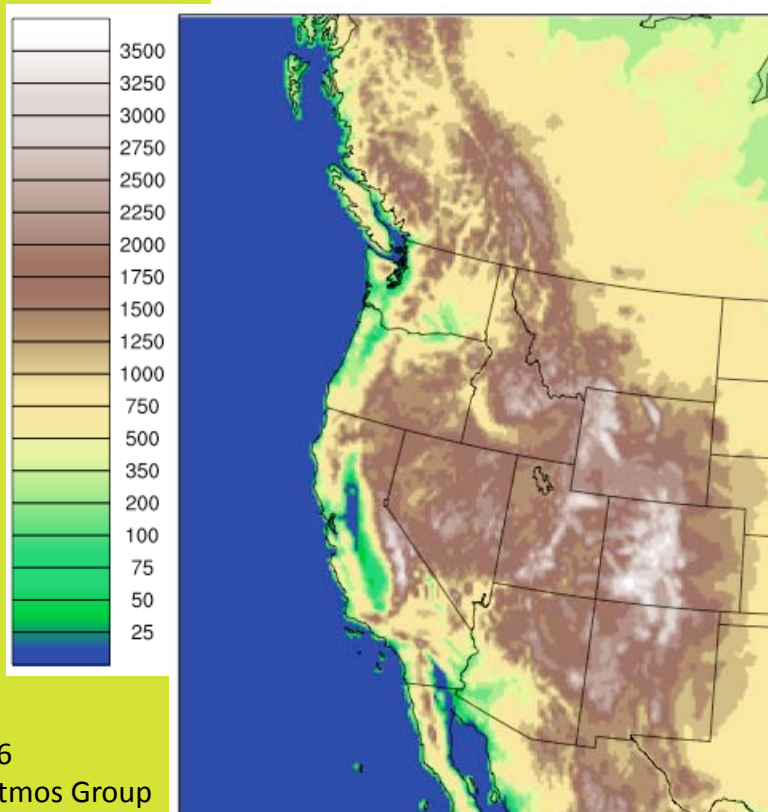Nitrogen Deposition

2012-06-26
BioEarth Atmos Group
Progress Report
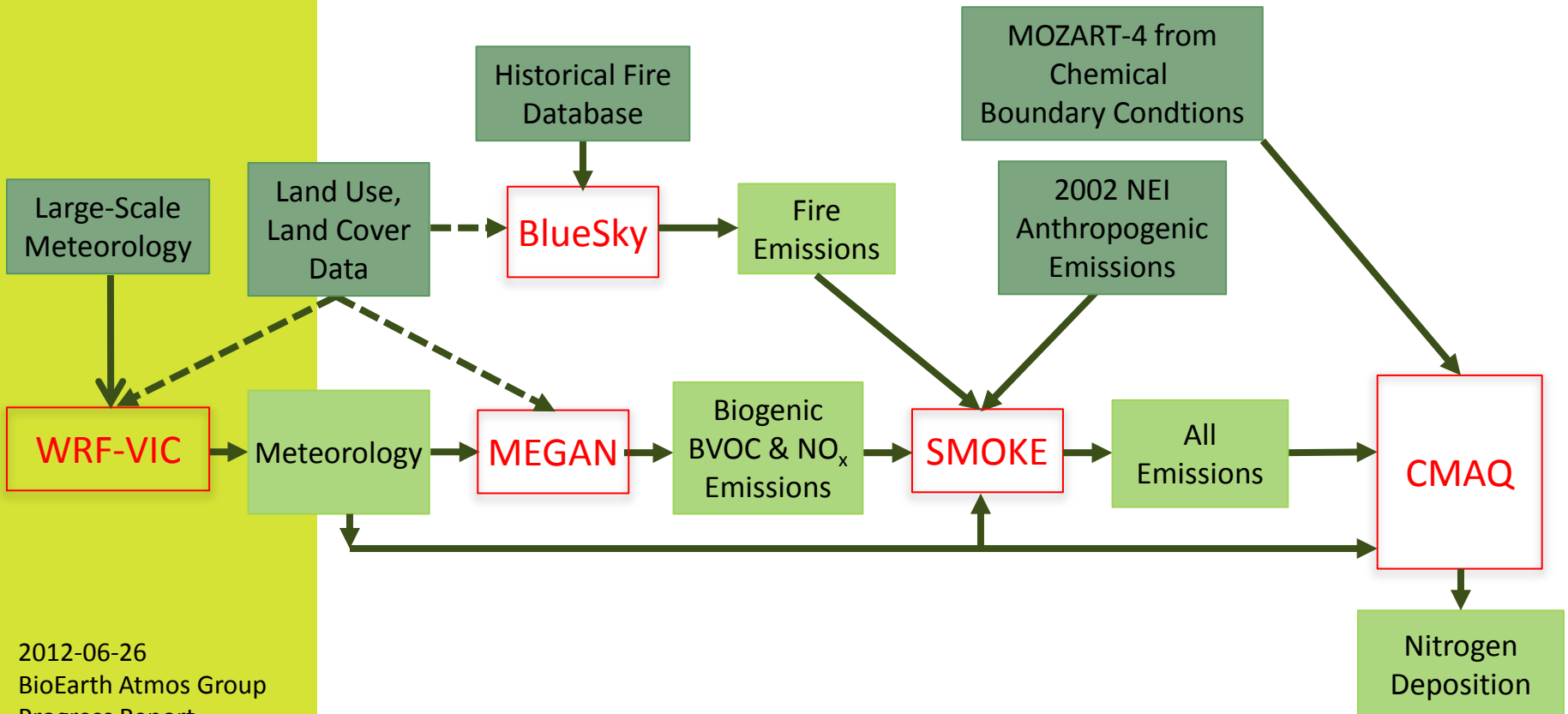
Coupled WRF-VIC Simulation for Sequential Runs

New Simulation Domain

Terrain Height (m)

- ◎ Nes Simulation Domain
  - ⊙ Previous domain is incompatible with CMAQ
  - ⊙ Still western US, but a bit smaller
  - ⊙ Still 12-km x 12-km grid cells
- ◎ WRF-VIC Simulation (old domain)
  - ⊙ Using Mauer's vegetation map and VIC parameters for runoff parameterizations
  - ⊙ Offline VIC simulation for western US has been done for spin-up/initialization of coupled WRF-VIC run
  - ⊙ Original version of WRF-VIC did not have VIC parallelized and thus has memory issues for large or high resolution domains
  - ⊙ Currently testing the updated version
- ◎ WRF-VIC Simulation for new domain
  - ⊙ Will be performed after verification of simulations on the old domain

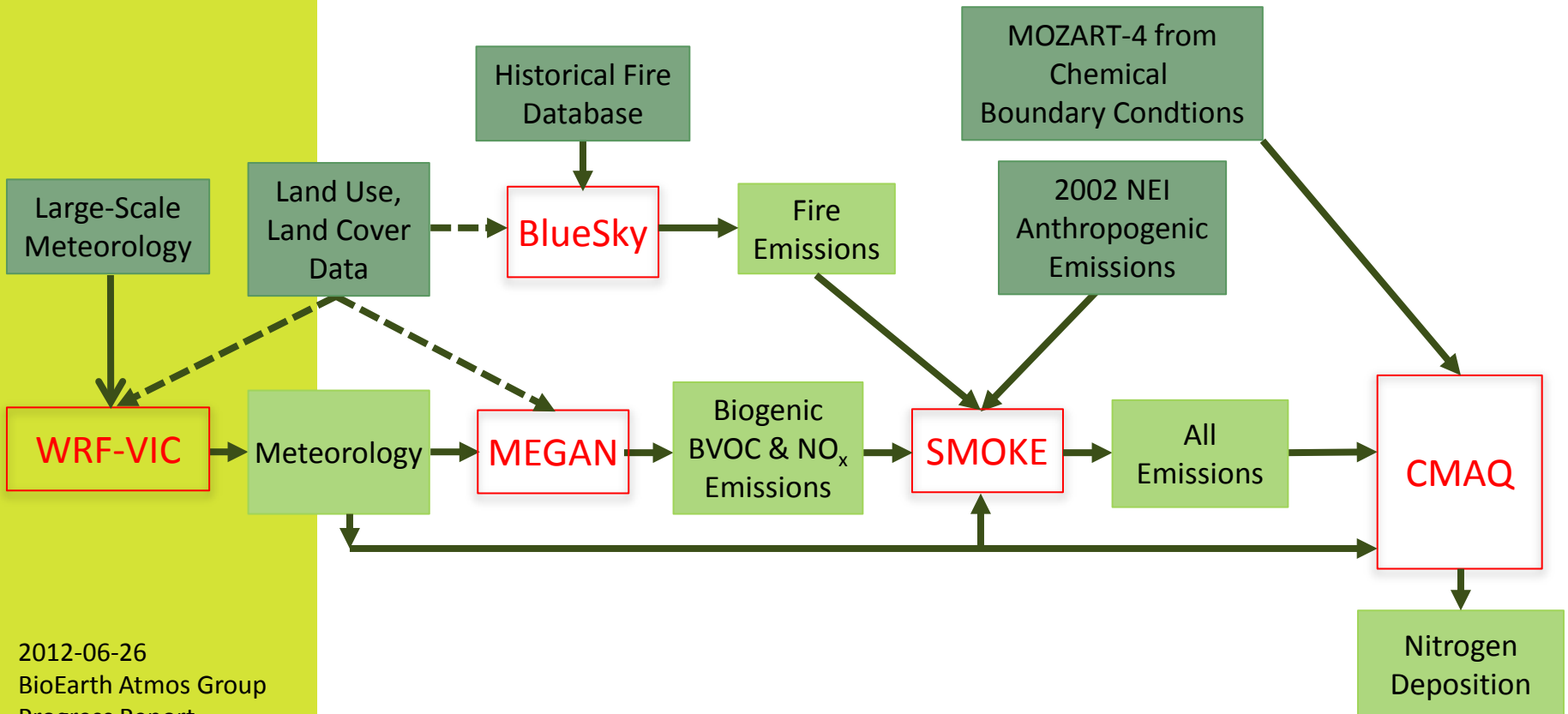# OFFLINE CMAQ SIMULATION FOR SEQUENTIAL RUNS

◎ Purpose:
- ◉ Model nitrogen deposition and evaluate how it's modulated by ENSO or other climate cycles
- ◉ Provide results to offline RHESSys and CropSyst simulations

◎ Set-up:
- ◉ A PNW subdomain within the WRF-VIC domain
- ◉ A subset of 1979-2008 to evaluate ENSO impact

◎ Chemical Boundary Conditions:
- ◉ 2007 from global chemical transport model MOZART-4 from Louisa Emmons of NCAR (already have)
- ◉ Will eventually have 2008-2009 MOZART-4 results as well

◎ Currently setting up a short WRF-Noah run to help setup emissions processing using SMOKE
- ◉ Anthropogenic Emission Inventory: 2002 National Emissions Inventory
- ◉ Historical fires: Already have BlueSky runs for 1995-2004
- ◉ Bioegenic Emissions: MEGANv2.1

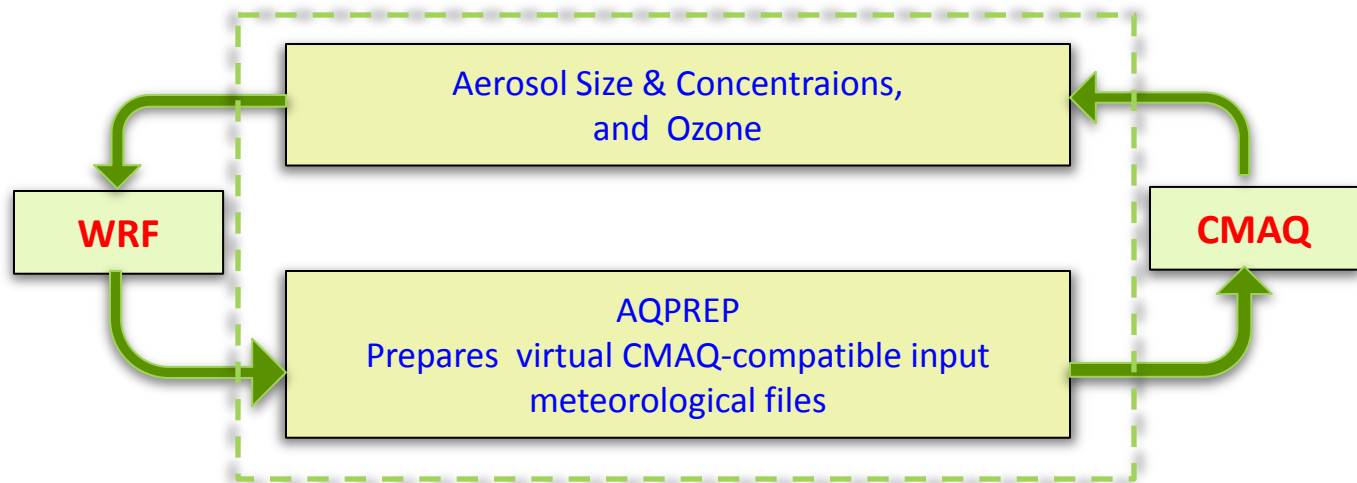# SEQUENTIAL SIMULATIONS: PROPOSED NEW TIMELINE

Now – Feb 2013

Now - Nov 2012

Dec 2012 – Jul 2013

Historical Fire Database

MOZART-4 from Chemical Boundary Condtions

Large-Scale Meteorology

Land Use, Land Cover Data

BlueSky

Fire Emissions

2002 NEI Anthropogenic Emissions

WRF-VIC

Meteorology

MEGAN

Biogenic BVOC & NO$_x$ Emissions

SMOKE

All Emissions

CMAQ

Nitrogen Deposition
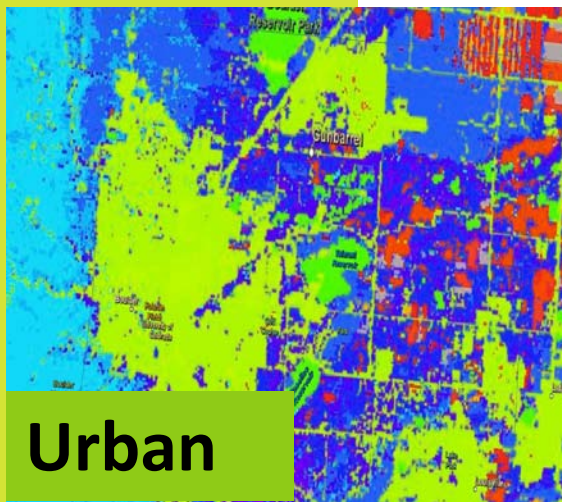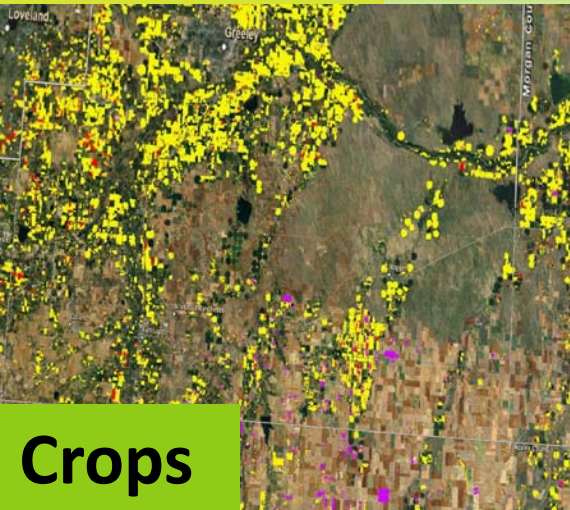
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Coupled WRF-CMAQ

◎ Currently working with CMAQv4.7.1, which is not coupled to WRF

◎ CMAQv5.0 was released to the general public in February 2012.

  ⦿ Two-way coupling built into WRF v3.3

  ⦿ Has bi-directional ammonia flux

  ⦿ Because of science updates, requires different emissions speciation profiles

  ⦿ We have tested CMAQv5.0 in offline mode on aeolus cluster
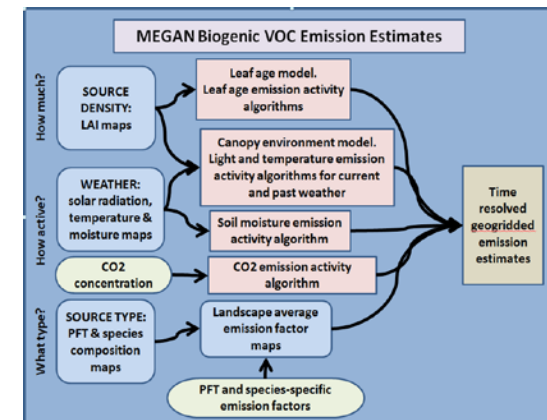
  ⦿ Will be testing CMAQv5.0 coupled to WRFv3.3 soon

WRF → Aerosol Size & Concentraions, and Ozone ← **CMAQ**

AQPREP
Prepares virtual CMAQ-compatible input meteorological files

Crops

Urban

◎ Biogenic Volatile Organic Compounds (VOCs)

⊙ Updated emission factors, emission activity parameters

⊙ New landcover data:

➢ High resolution (30-m) PFT (CLM scheme) and species composition for crops, trees, shrubs, grass. Integrates CDL, NLCD, FIA, NRCS data with adjusted NLCD in urban areas.

➢ LAI data: MODIS 8-day for individual years

⊙ Response to increasing CO_2

⊙ Additional compounds

(There are 19 classes and 147 compounds)

MEGAN Biogenic VOC Emission Estimates

http://acd.ucar.edu/~guenther/MEGAN/MEGAN.htm

MEGAN 2.1 Estimates*

Compound Class	Compounds	Emissions (Tg yr⁻¹)
Isoprene	Isoprene	535
α-Pinene	α-Pinene	66.1
t-β-Ocimene	t-β-Ocimene	19.4
β-Pinene	β-Pinene	18.9
Limonene	Limonene	11.4
Sabinene	Sabinene	9.0
Myrcene	Myrcene	8.7
3-Carene	3-Carene	7.1
Other Monoterpenes	Camphene	4.0
	β-phellandrene	1.5
	Terpinolene	1.3
Sum of the 31 other monoterpenes		14.9
α-Farnesene	αFarnesene	7.1
β-Caryophyllene	βcaryophyllene	7.4
Other Sesquiterpenes	βFarnesene	4.0
	αHumulene	2.1
	αBergamotene	1.3
Sum of the 27 other sesquiterpenes		7.1
232-MBO	232-MBO	0.6
Methanol	Methanol	996
Acetone	Acetone	43.7
Bidirectional VOC	Ethanol	20.7
	Acetaldehyde	20.7
	Formaldehyde	5.0
	Acetic acid	3.7
	Formic acid	3.7
Stress VOC	Ethene	284
	C3-hexenal	4.9
	DMNT	4.9
	C3-hexenol	2.9
Sum of the 11 other stress VOC		7.8
Other VOC	Propene	15.8
	Butene	8.0
	Homosalate	2.0
	Geranyl acetone	0.8
Sum of the 45 other VOC		5.5
Total VOC	Sum of 146 VOC	1005
CO	CO	81.6
Total	VOC and CO	1087

Global estimates of different MEGAN 2.1 compounds
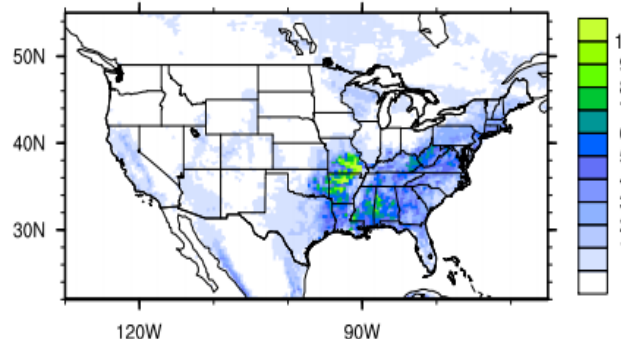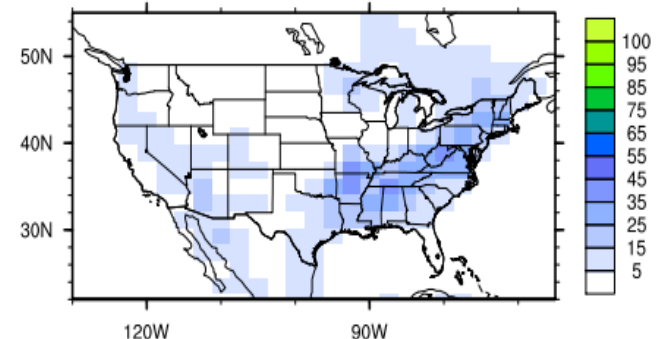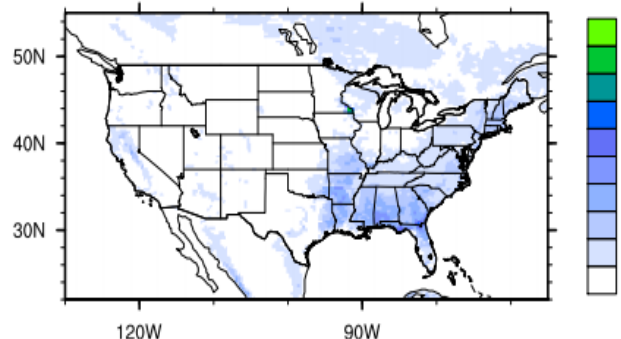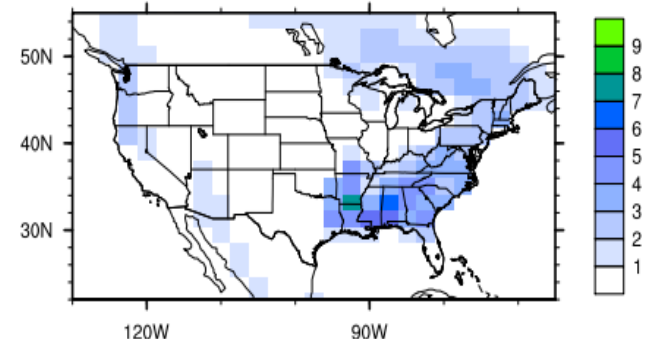
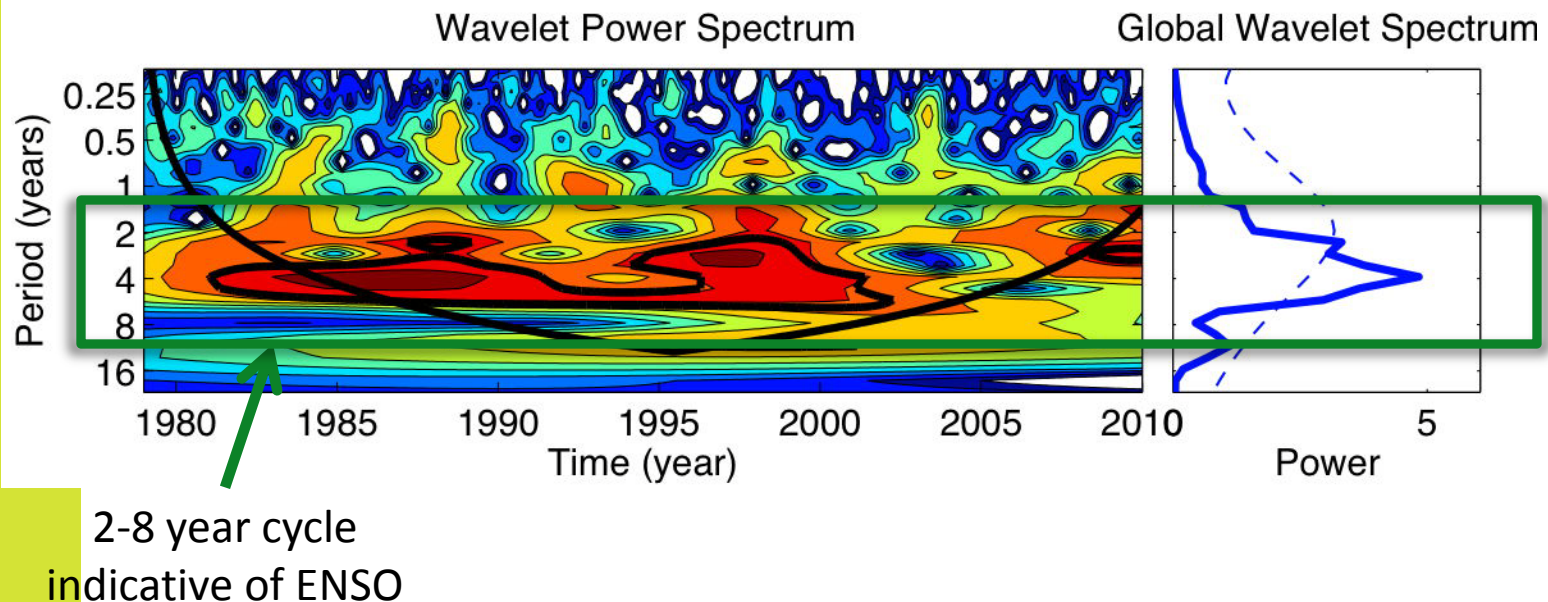Offline MEGAN 2.1 with WRF forcing   Online MEGAN 2.1 within CESM/CLM

MEGAN
Ongoing/Planned Activities

- ◎ Integrating MEGAN into Bioearth

  - ◉ Coupling with VIC-RHESSys-CropSyst

  - ◉ <u>Coupling with CESM/CLM (boundary conditions)</u> (done)

- ◎ Improve soil nitrogen emissions (NO, NH_3, N_2O)

- ◎ Add particles: pollen, fungal spores, bacteria, dust

- ◎ Use MEGAN in BioEarth to identify scientific questions that can be addressed with a PNW regional field study

  - ◉ Landcover change (e.g. poplar plantations)

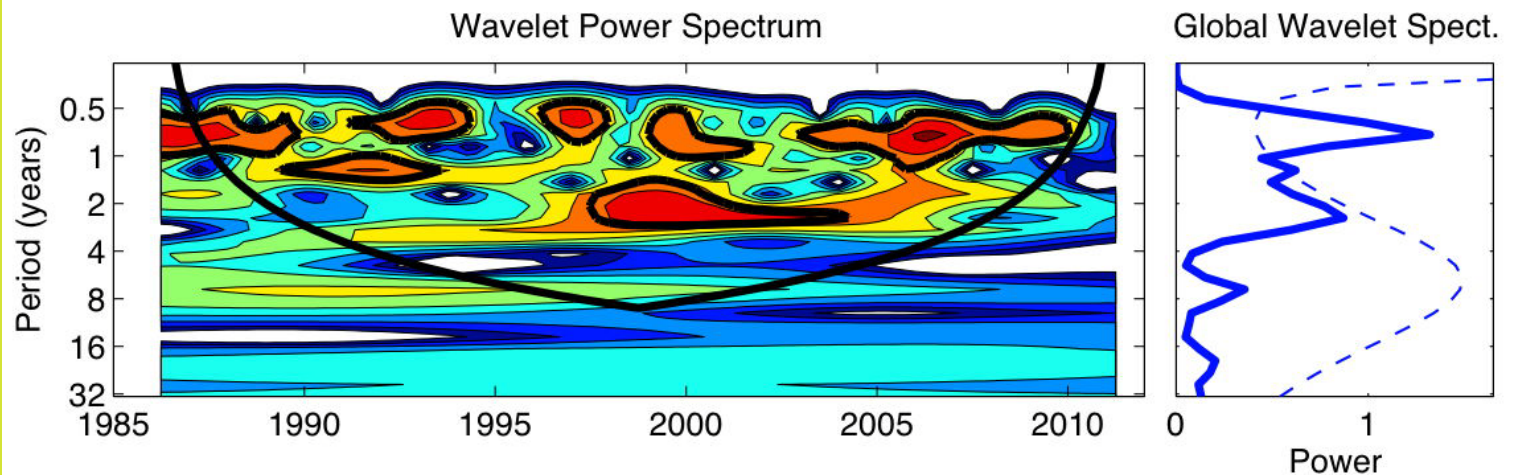 - ◉ Interactions of biogenic emissions and anthropogenic pollution

Wavelet Analysis[1] of NINO3.4 SST

2-8 year cycle indicative of ENSO

[1]Matlab code from Torrence and Compo (1998);
http://paos.colorado.edu/research/wavelets/software.html

IS NITROGEN DEPOSITION IN THE WESTERN US MODULATED BY ENSO?

Wavelet Analysis[1] of Wet NO_3 Deposition

See Poster #4.3 by Tsengel

[1]Matlab code from Torrence and Compo (1998);
http://paos.colorado.edu/research/wavelets/software.html