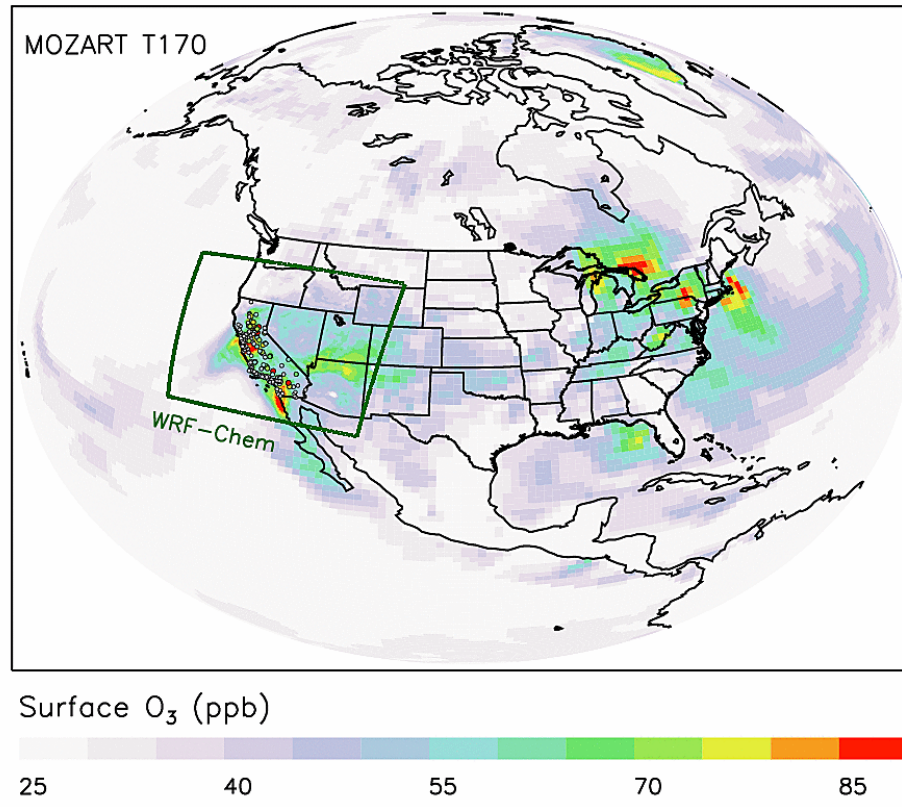


20080614 4UTC



Coupling global and regional CTMs

The WRF-Chem Modeling System (Development Lead: G. Grell) :

- **WRF with Chemistry** - Online, completely embedded within WRF
- **Consistent** - all transport done by meteorological model; same vertical and horizontal coordinates (no horizontal and vertical interpolation).
- **Chemical Schemes**: e.g. RADM2, RACM, CBMZ, MOZART
- **Aerosol schemes**: GOCART (bulk), MADE/SORGAM (modal), MOZAIC (sectional)
- **KPP option** (Kinetic Pre-Processor): reads chemical reactions and rate constants from ASCII input files and automatically generates code for chemistry integration
- Supports **Direct and Indirect Radiative Forcing** (selected physics options only)
- **Photolysis Schemes**: coupled to aerosols and hydrometeors
- **Fire Plume Calculations** (S. Freitas et al.)
- **Online biogenic emissions**

WRF-Chem/MOZCART

= WRF-Chem Updated with MOZART Chemical Mechanism linked to GOCART aerosols

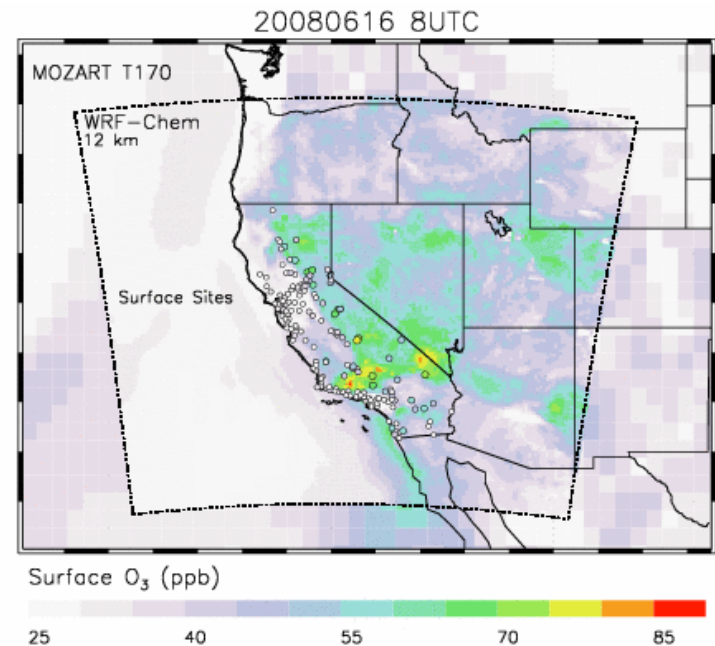
- Updates to FTUV, Dry Deposition Routines
- **Chemical initial/boundary conditions from MOZART output (time/space varying) (software package also works for CAM-Chem output)**
- CH₄ & N₂O fixed to IC
- Emissions: anthropogenic; online biogenic (MEGAN). fires (optional plumerise) aircraft (from global models); LNOx (M. Barth, in next release)

□ In works:

- Wet Deposition for Species
- Upper Boundary Conditions
- Extend to other aerosol schemes
- DART (Data Assimilation)

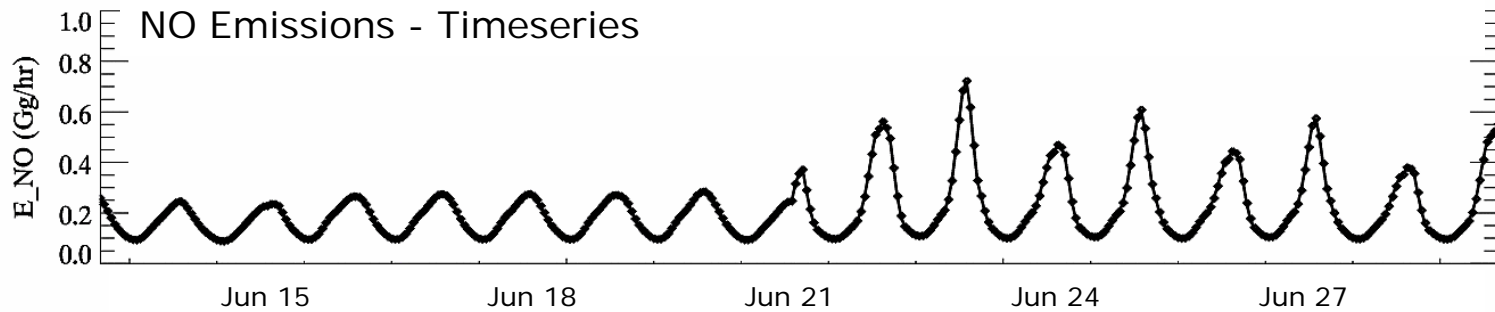
□ Model Simulations:

- California, June 2008 (ARCTAS/CARB)
- NAM winds for IC/BC/grid nudging; 28 vertical levels – Top is @ 50hPa
- Domain: 12 km x 12 km (150 x 160)



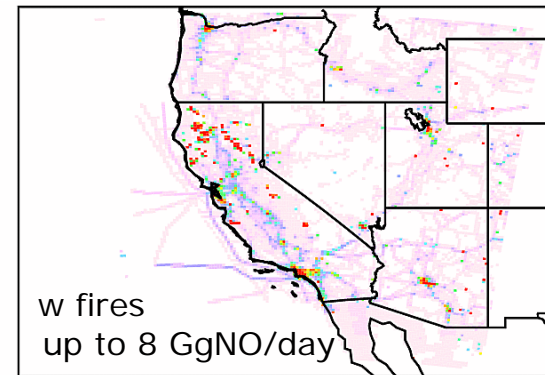
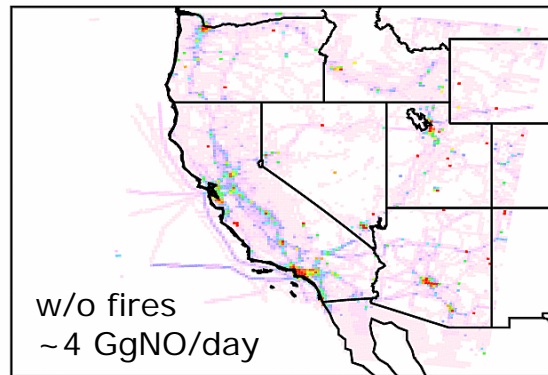
MOZART & WRF-Chem Emission Inventories

- Anthropogenic: NEI 2005 for U.S. *, CARB EI** over California
- Wildfire: C. Wiedinmyer - Fire Emissions Model V2.0



June 15-18, 2008

June 20-24, 2008



NO Emissions
(moles/km²)

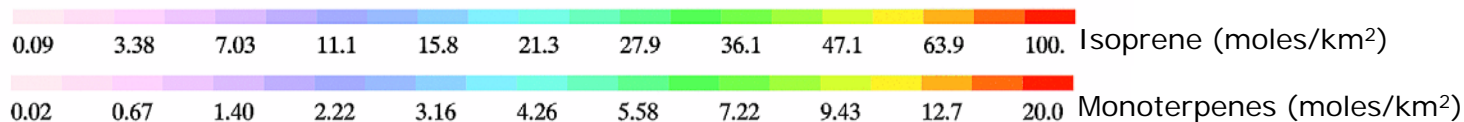
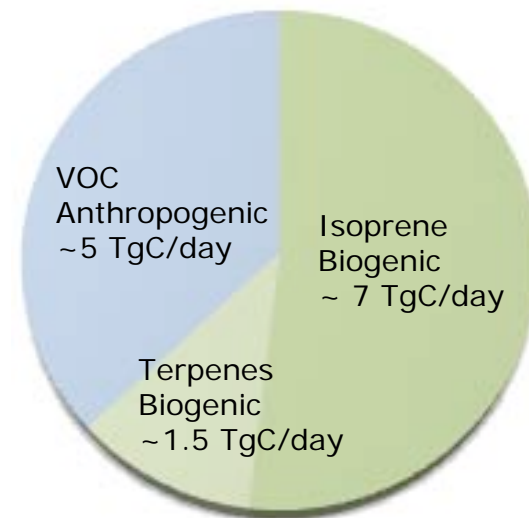
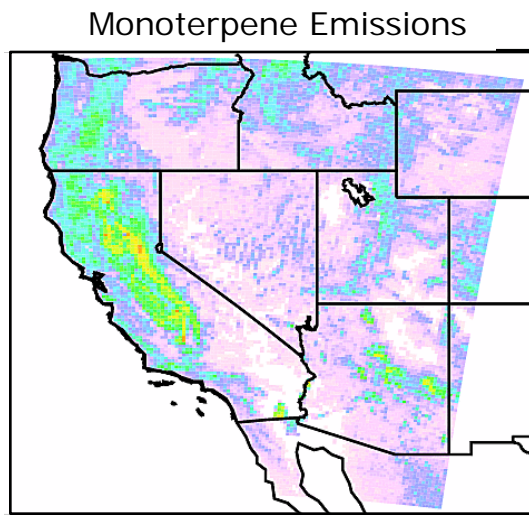
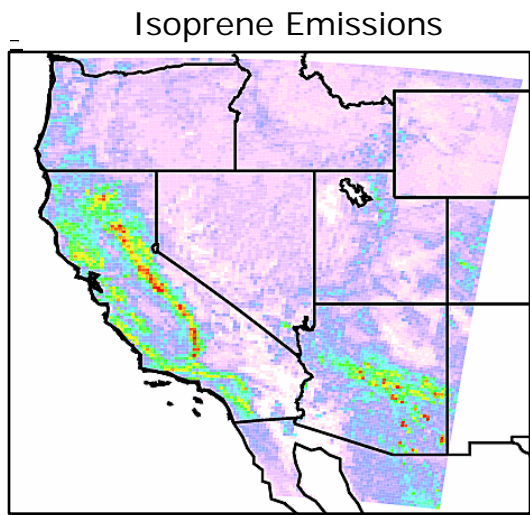
0.09 1.81 3.61 5.51 7.54 9.69 11.9 14.4 17.1 20.0 23.2 26.7 30.6 35.1 40.2 46.3 53.7 63.3 76.8 100.

* Provided by StuMcKeen (NOAA)

** Provided by Ajith Kaduwela and Jeremy Avis (ARB); EI for 2005

MOZART & WRF-Chem Emission Inventories

- Anthropogenic: NEI 2005 for U.S. *, CARB EI** over California
- Wildfire: C. Wiedinmyer - Fire Emissions Model V2.0
- Biogenic: MEGAN* (online)

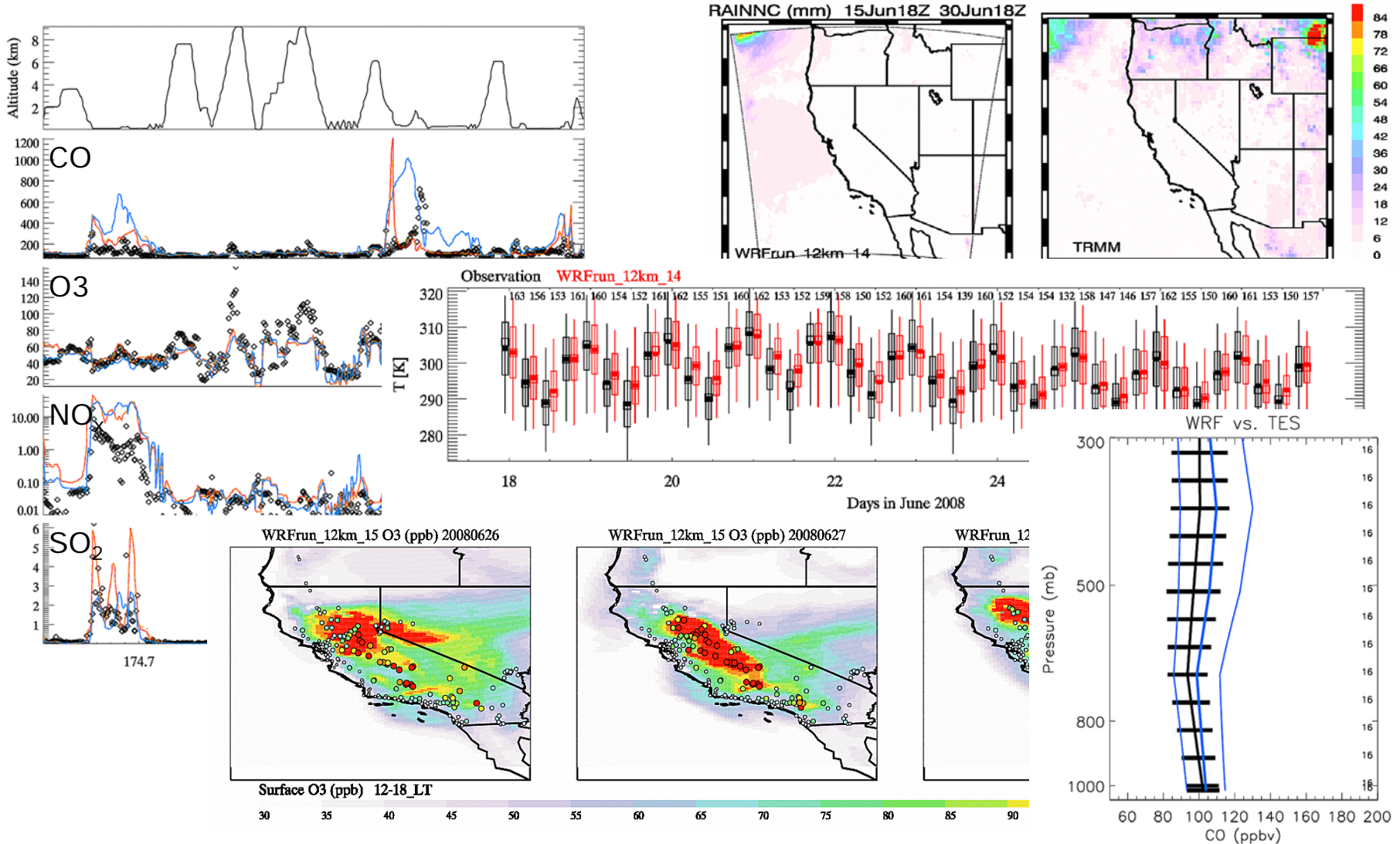


Average for June 15-30, 2008

* Model of Emissions of Gases and Aerosols from Nature (MEGAN) (Guenther et al., 2006)

Model Evaluation

- ARCTAS/CARB aircraft data; EPA surface monitoring; Satellite retrievals (MOPITT CO, TES CO&O₃, OMI NO₂, etc.); Ozone sondes; Operational meteorological data



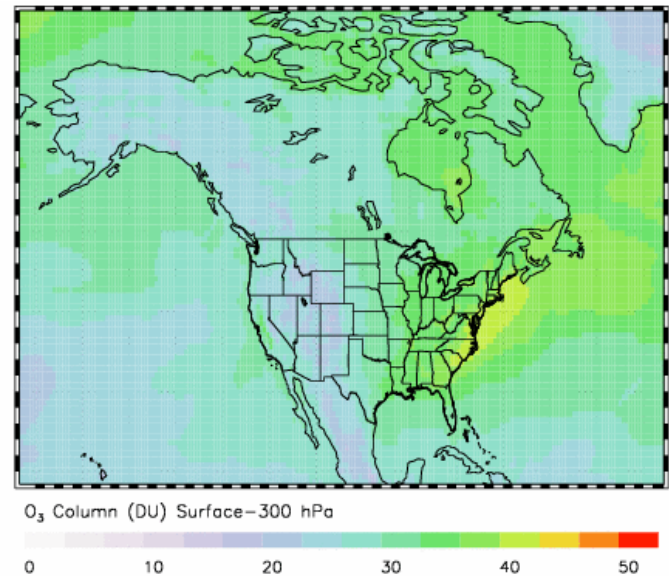
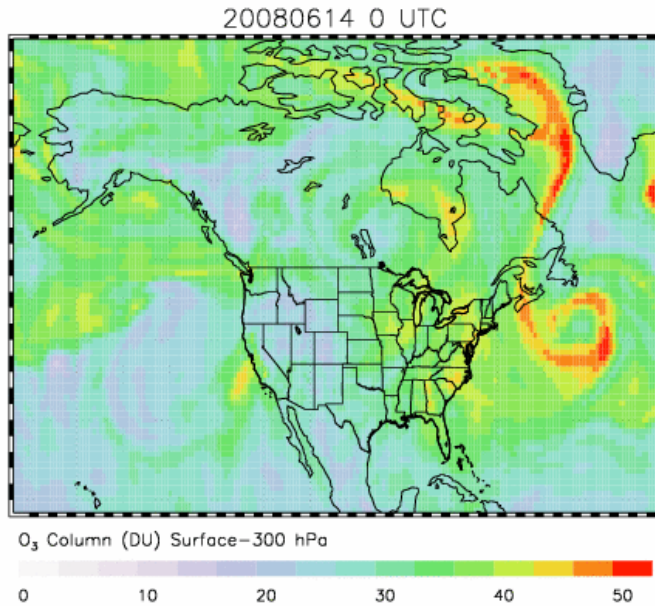
Influence of Chemical Boundary Conditions

- ✓ Time Varying \Leftrightarrow Time Averaged MOZART Initial/Boundary Conditions

Time Varying Boundary Conditions
3 hourly

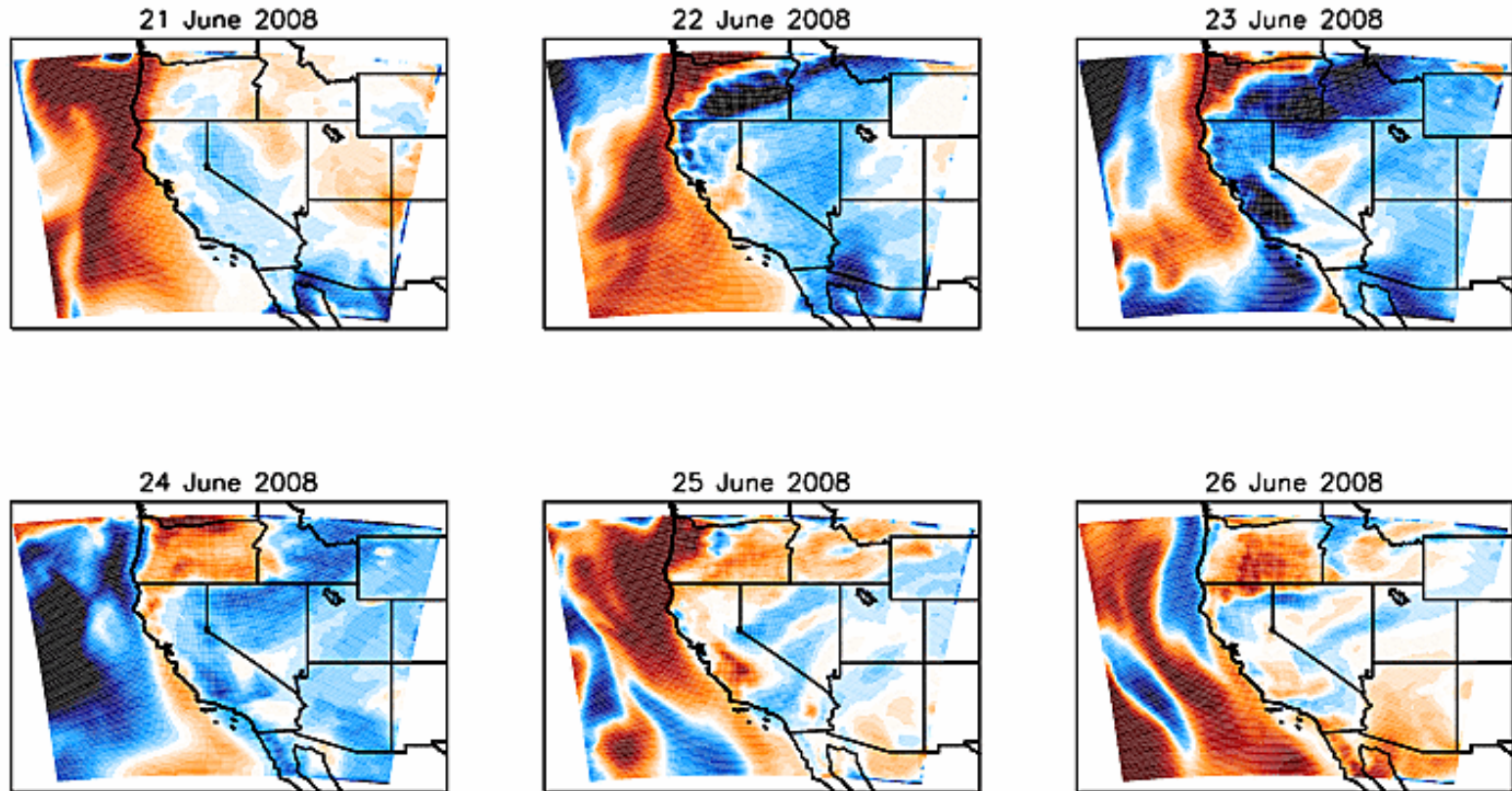


Time Average Boundary Conditions
Average for June 15-30



Influence of Chemical Boundary Conditions

✓ Time Varying ⇔ Time Averaged MOZART Initial/Boundary Conditions

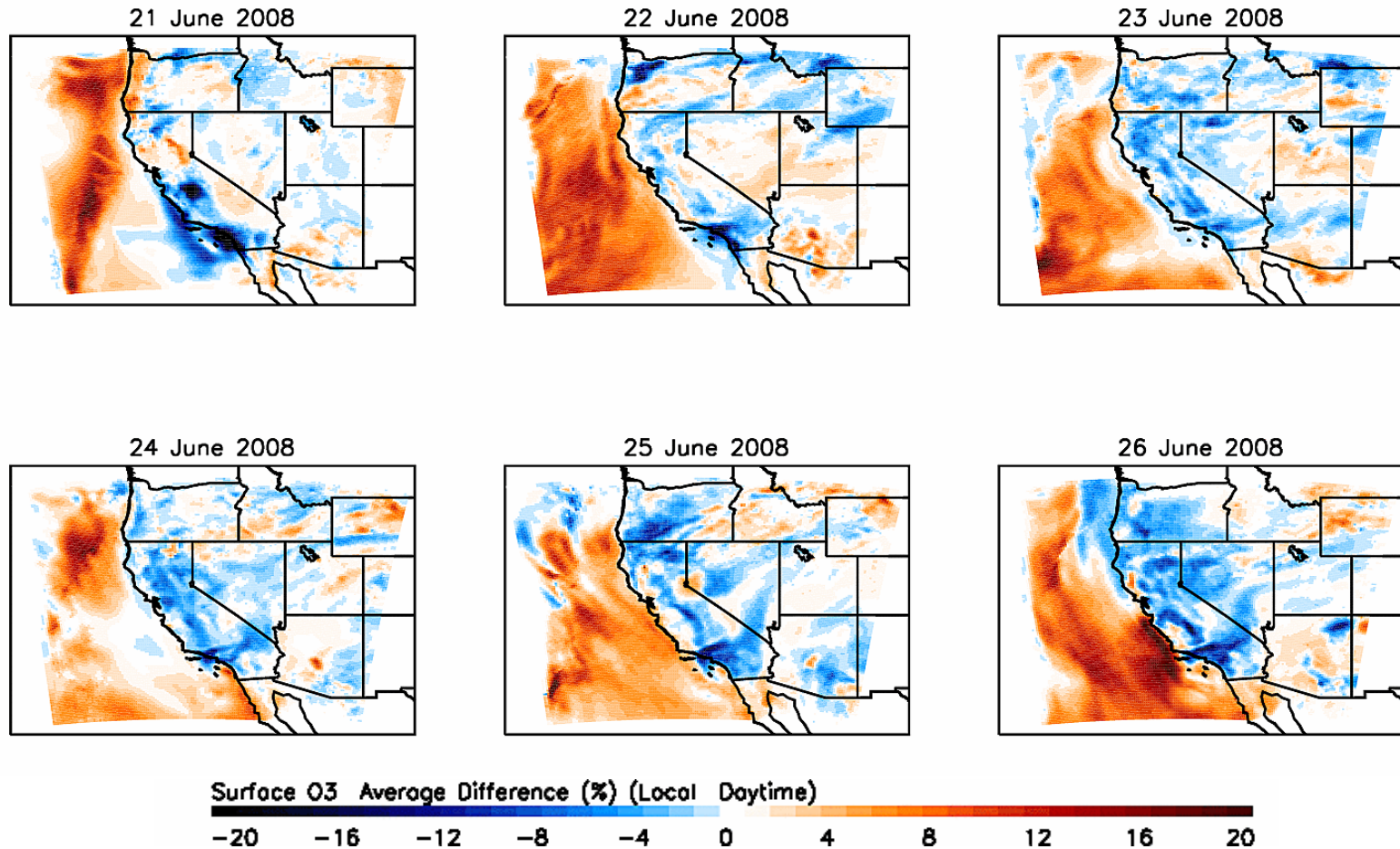


Surface O₃ Average Difference (%) (Local Daytime)

-20 -16 -12 -8 -4 0 4 8 12 16 20

Grid Nudging

✓ WRF-Chem Simulations with U,V,Q ⇔ grid nudging U,V



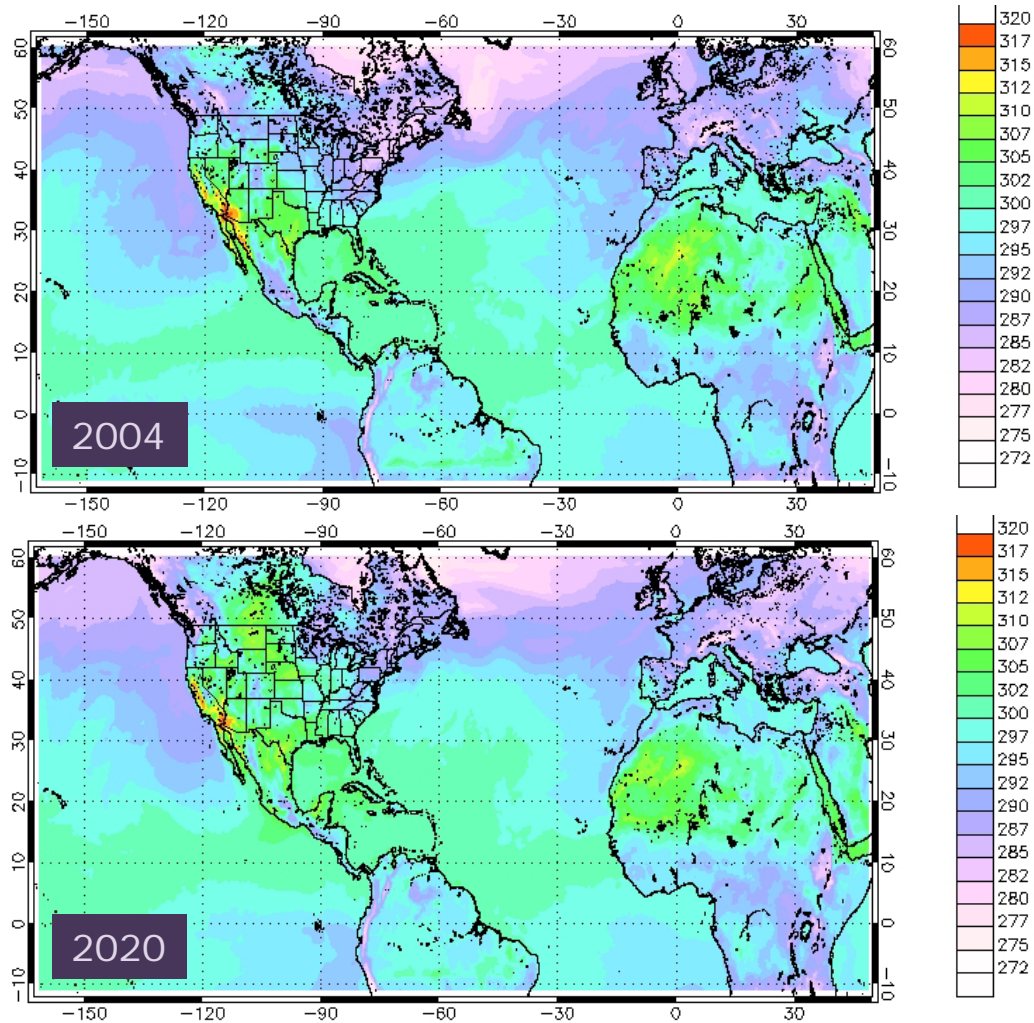
Including a chemistry component into NRCM

→ Towards a coupled system of CCSM/CAM-Chem and WRF/WRF-Chem

Initial tests:
WRF-Chem driven by output
from NRCM and MOZART

NRCM – 36km² Run

T @ 2m [K]



15 August 00 UTC

Including a chemistry component into NRCM

NRCM
Met. BC/IC

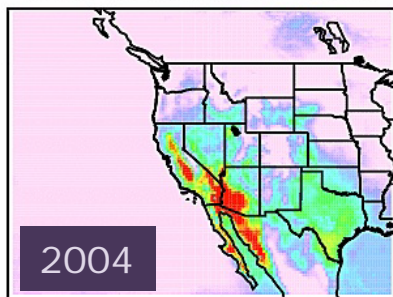


WRF-Chem Simulation
(MOZART Chemistry/GOCART Aerosols)

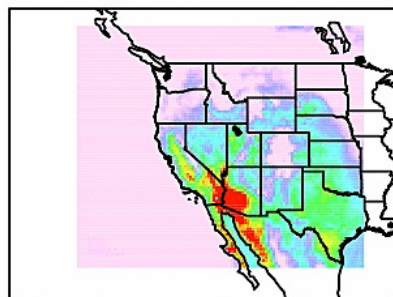


MOZART
Chem. IC/BC

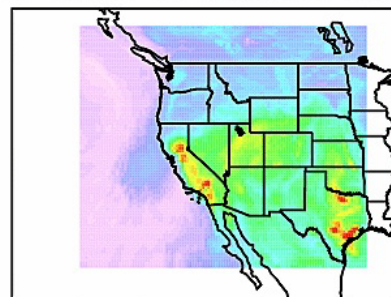
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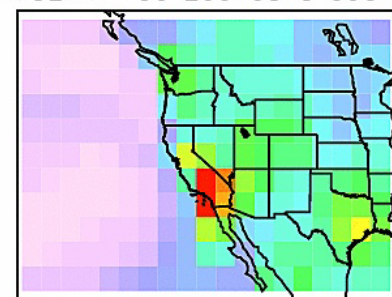
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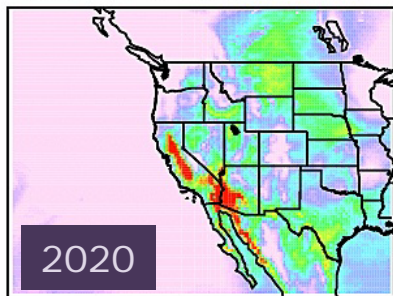
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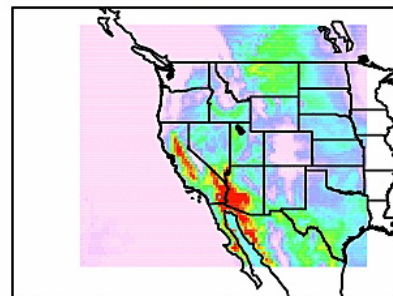
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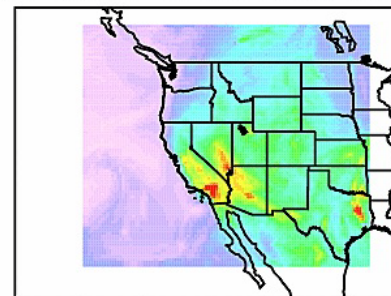
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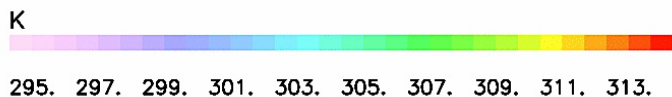
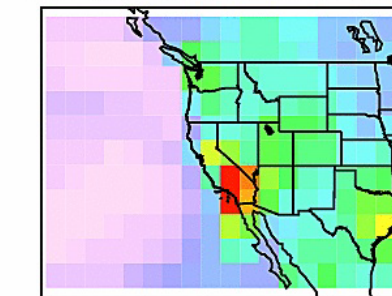
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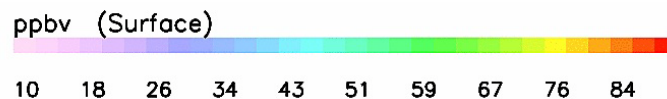
WRF-Chem o3 20200815 00UTC



MOZART O3 20200815 00UTC



T @ 2m



Surface Ozone

To be continued....