Fire Emissions Modeling with EO at NCAR

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Fire Emissions Modeling at NCAR

1) Model for North American Fire Emissions

(Wiedinmyer et al., *Atmospheric Environment,* 2006)

2) Fire INventory from NCAR (FINNv1)

(Wiedinmyer et al., *Geoscientific Model Development,* 2011)

Fire emissions model output:

- 1 km^2 spatial resolution
- Daily temporal resolution
- Available for forecasting and hindsight applications
- Predicts emissions of:

  CO, PM, NO_x, NH_3, SO_2, *speciated* VOC, CH_4, CO_2, Hg, HCN, …

https://www2.acom.ucar.edu/modeling/finn-fire-inventory-ncar

Fire INventory from NCAR (FINN)

$$\text{Emission}_i = f(\text{Area burned, Fuel Burned, Emission Factor}_i)$$

- Use of EO data for model inputs
  - Fire location, timing, detection
    - Rapid Fire Detections
      - https://firms.modaps.eosdis.nasa.gov/download/
      - MODIS Collection 6 and NRT data (MCD14DL and MCD14ML)
  - Fuel Loading
    - Vegetation Continuous Fields (MOD44B v5.1)
  - Ecosystem burned
    - Land Cover Type (MCD12Q1 v5.1)

Estimating Emissions

Emission Factor
(g/kg)

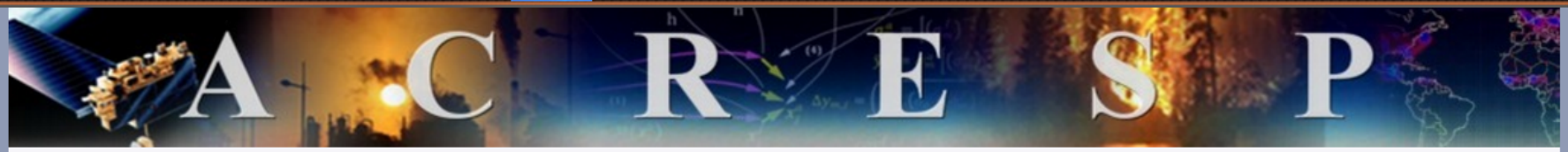
- Based on laboratory and field measurements
- Dependent on measurement techniques
- Function of type of burning

Montana Fire Sciences Laboratory, (B. Yokelson)

Thomas Kerl, TROFFEE Study, (Brazil)

Fire Emission Forecasts (FINNv1)

ACOM | ACRESP | Forecasts | MOZART | FINN | MOPITT | IASI | DC3 | SEAC4RS | KORUS-AQ



MOZART-4 / MOPITT CHEMICAL FORECASTS: FIRE EMISSIONS

Near-real-time fire emissions from the Fire INventory of NCAR (FINN), based on MODIS Rapid Response fire counts (FIRMS).

FINN PLOTS

Valid Dates:

May 1, 2012 to now.

Region: Globe

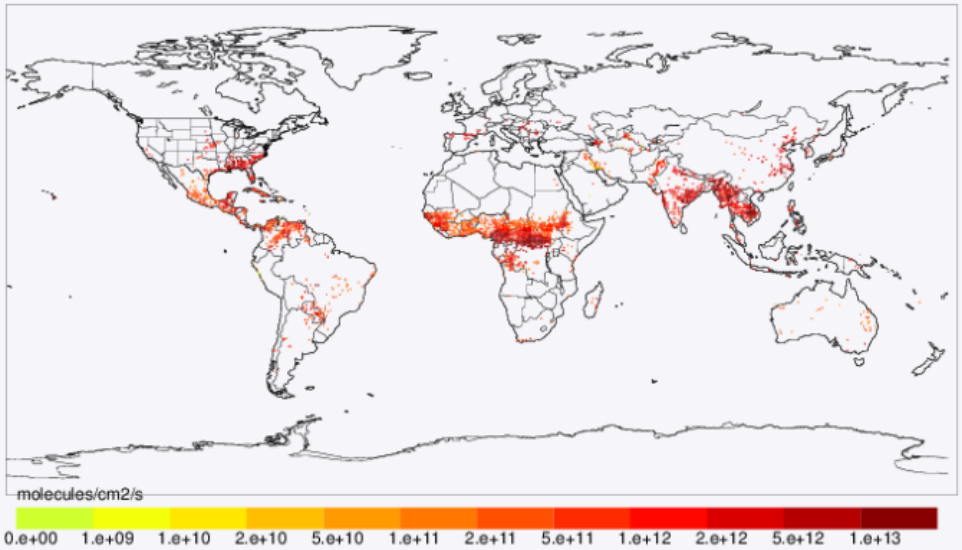
<<	<	February 2017			>	>>
	<		Today		>	
Sun	Mon	Tue	Wed	Thu	Fri	Sat
29	30	31	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	1	2	3	4
5	6	7	8	9	10	11

< Hr: 00 03 06 09 12 15 18 21 >

00:00 February 26, 2017

Play Stop

FINN CO fire emissions 0.5deg 2017-02-26



http://www.acom.ucar.edu/acresp/forecast/

Emissions data files available at: http://www.acom.ucar.edu/acresp/MODELING/finn_emis_txt/.

FINN fire emissions for previous years are available from: http://bai.acom.ucar.edu/Data/fire/.

FINN Products

- 2002-2016 Global Emissions (FINNv1.5)

Default Inputs:

- Rapid Fire Detections
- MODIS LCT
- Vegetation Continuous Fields

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NCAR UCAR | National Center for Atmospheric Research
Atmospheric Chemistry Observations & Modeling

Regional & Process Modeling
FINN
FINN Data

FIRE EMISSION FACTORS AND EMISSION INVENTORIES

For any questions or comments about the downloads on this page, please contact Christine Wiedinmyer.

Please submit your name and contact information:

- Name:
- Institution or Company:
- E-mail:
- How do you intend to use these files?

1) Fire INventory from NCAR (FINN), Version 1.5

Wiedinmyer et al., *Geoscientific Model Development*, 2011

Please choose the time period and speciation desired:

2002 MOZART4	2002 SAPRC99	2002 GEOS-chem
2003 MOZART4	2003 SAPRC99	2003 GEOS-chem
2004 MOZART4	2004 SAPRC99	2004 GEOS-chem
2005 MOZART4	2005 SAPRC99	2005 GEOS-chem
2006 MOZART4	2006 SAPRC99	2006 GEOS-chem
2007 MOZART4	2007 SAPRC99	2007 GEOS-chem
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2009 MOZART4	2009 SAPRC99	2009 GEOS-chem
2010 MOZART4	2010 SAPRC99	2010 GEOS-chem
2011 MOZART4	2011 SAPRC99	2011 GEOS-chem
2012 MOZART4	2012 SAPRC99	2012 GEOS-chem
2013 MOZART4	2013 SAPRC99	2013 GEOS-chem
2014 MOZART4	2014 SAPRC99	2014 GEOS-chem
2015 MOZART4	2015 SAPRC99	2015 GEOS-chem
2016 MOZART4	2016 SAPRC99	2016 GEOS-chem

Notes:

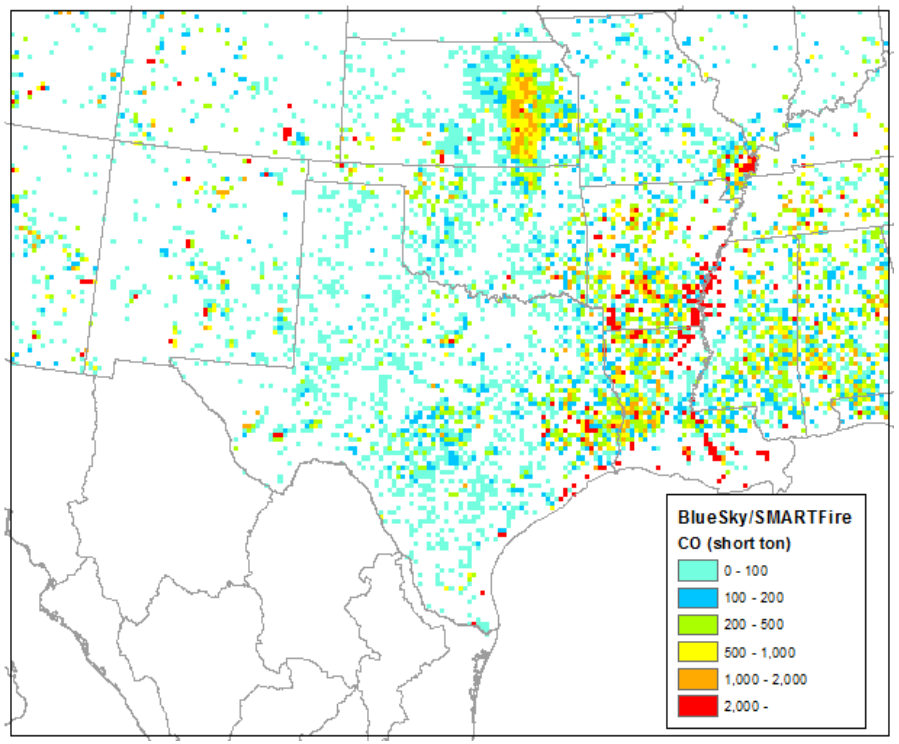
- Files are comma-delimited ASCII files. The format for the files are the same as the format of the version 1 files.
- For more information on MOZART4 and SAPRC99, please download this README file: link.
- For more information on GEOS-chem, please download this README file: link.
- The FINNv1.5 emission estimates for 2002-2013 were updated on **August 10, 2014**. The FINNv1.5 emission updates for 2014 were created on **December 02, 2015**. The FINNv1.5 emission estimates for 2015 were created in **November 2016**.
- The 2016 FINNv1.5 emission estimates are for *01 January through 31 July 2016*. These files were created in November 2016 and were driven by MODIS Collection 6 fire detections (note: 01 January - 31 April used the **archive** C6 product; 01 May through 31 July is created with the **NRT** product). These files will be updated in the future.

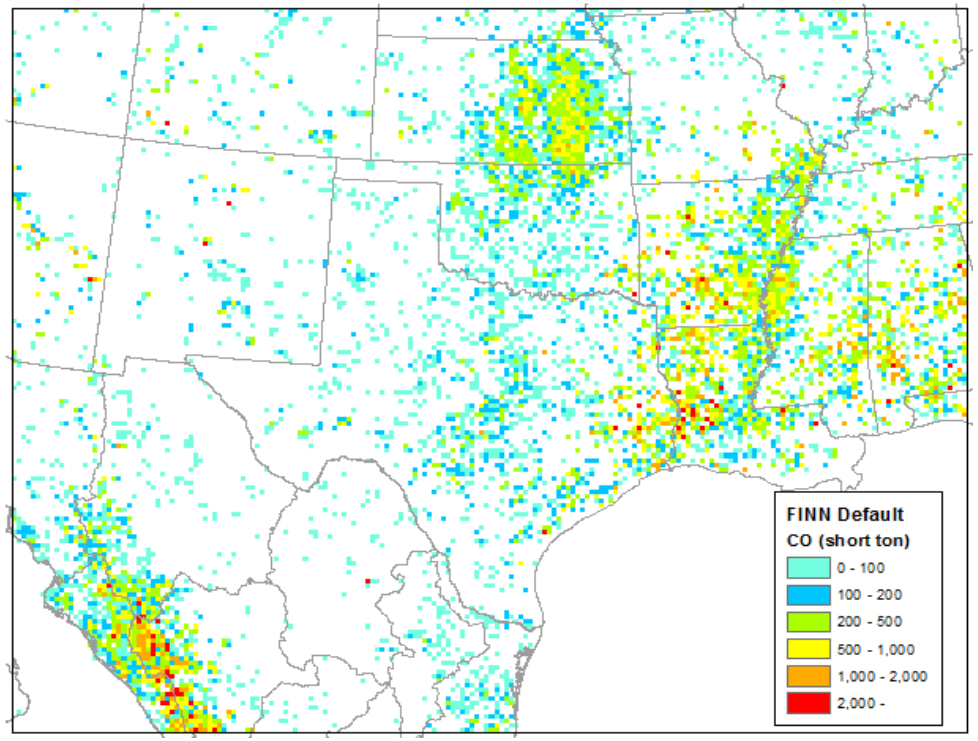
https://www2.acom.ucar.edu/modeling/finn-fire-inventory-ncar

Uncertainties in the emissions

E. McDonald-Buller, C. Emery, C. Wiedinmyer, Y. Kimura

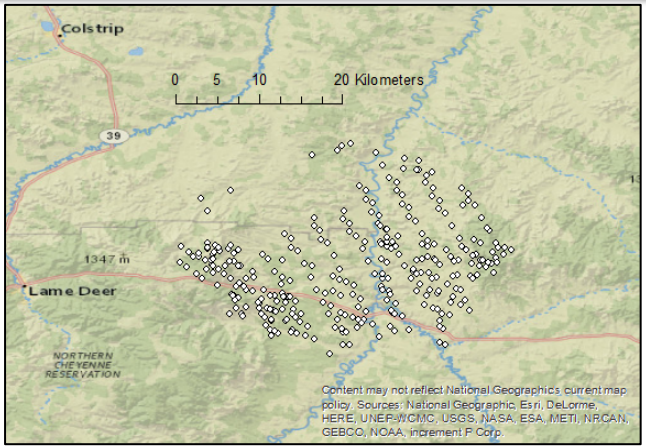
- Emission Factors
- Fire location/timing
- Fuel loadings
- Fuel Consumption



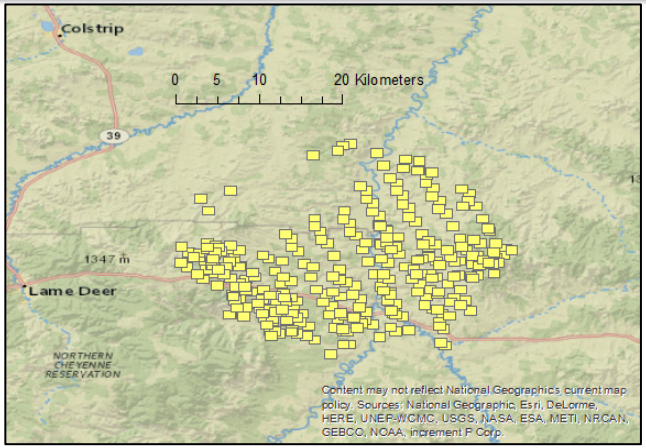


FINNv2: *Updates in Progress*

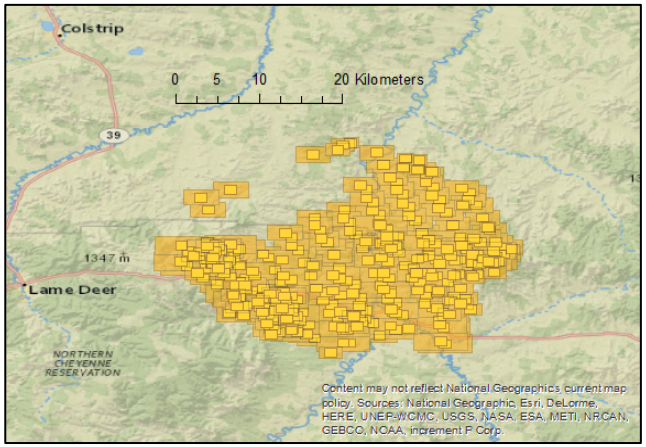
E. McDonald-Buller, C. Emery, C. Wiedinmyer, Y. Kimura



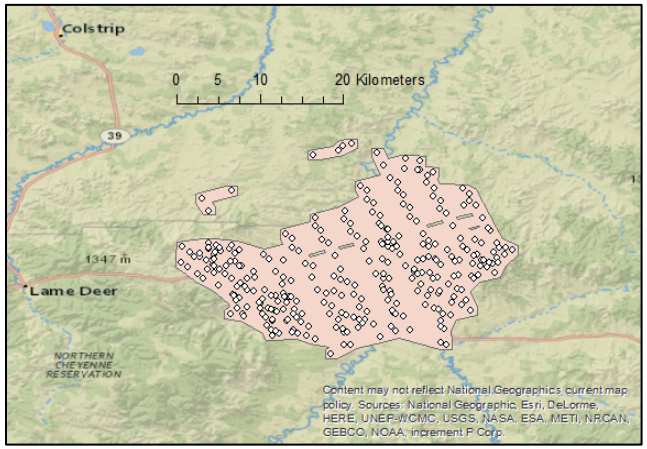
MODIS fire detections



1-km^2 area per detection



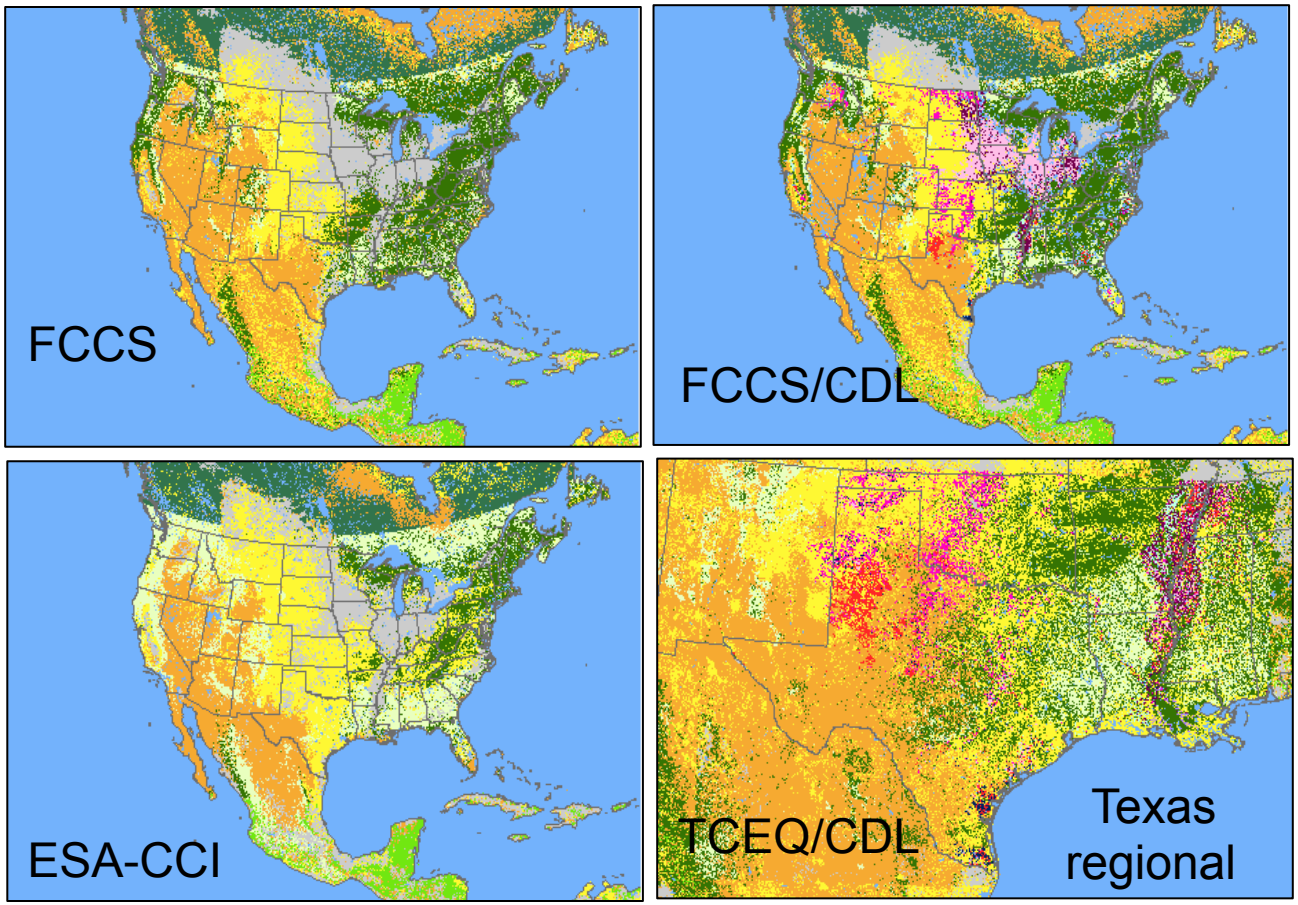
110% of easterly and northerly dimensions of satellite scan and track sizes identifies detection cluster.



Polygon formed from convex hulls of clusters of detections for burned area.

FINNv2: *Updates in Progress*

- Comparing impacts from land cover inputs



E. McDonald-Buller, C. Emery, C. Wiedinmyer, Y. Kimura

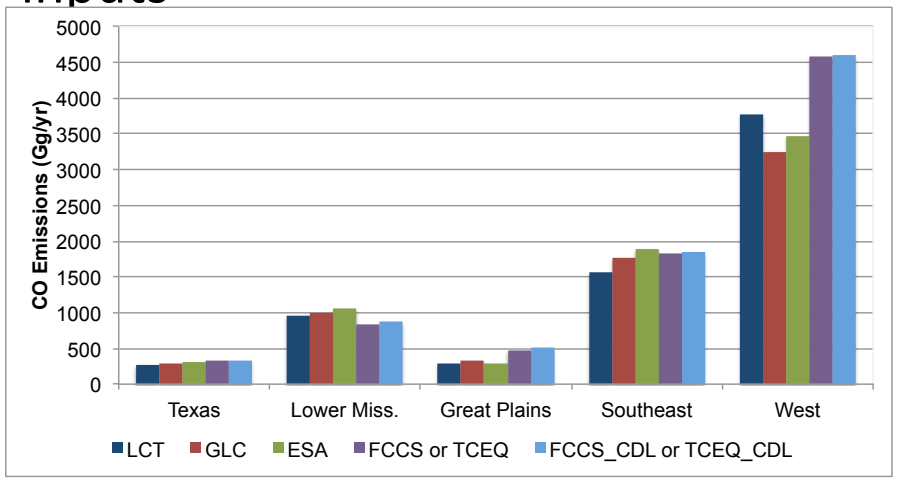
FINNv2: *Updates in Progress*

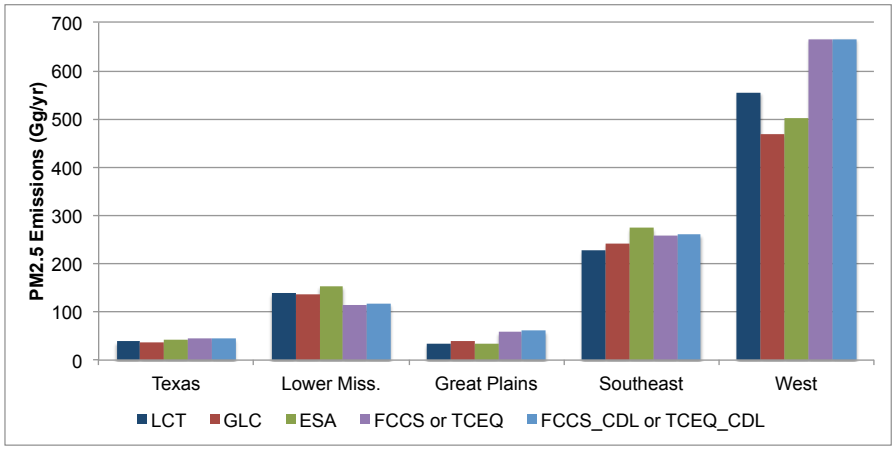
- Comparing impacts from land cover inputs

Annual regional total CO and $PM_{2.5}$ emissions during 2012 from FINN v.2.1.

Land cover influences assignments of emission factors and fuel loadings.

Specification of crops captures seasonal activity but with little effect on total emissions





*TCEQ regional land cover includes only Texas and the Lower Mississippi Valley (Louisiana, Mississippi, Arkansas). FCCS for CONUS and MODIS LCT applied elsewhere.

E. McDonald-Buller, C. Emery, C. Wiedinmyer, Y. Kimura

Applications for FINN

- Chemical Forecasting
- Air Quality Modeling
- Climate Modeling
- Emissions Inventory Development

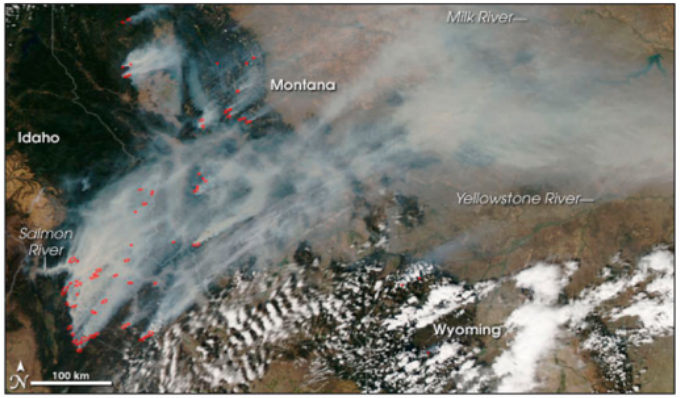
Feedbacks to regional meteorology and chemistry

Aerosols from Fires: An Examination of the Effects on Ozone Photochemistry in the Western United States

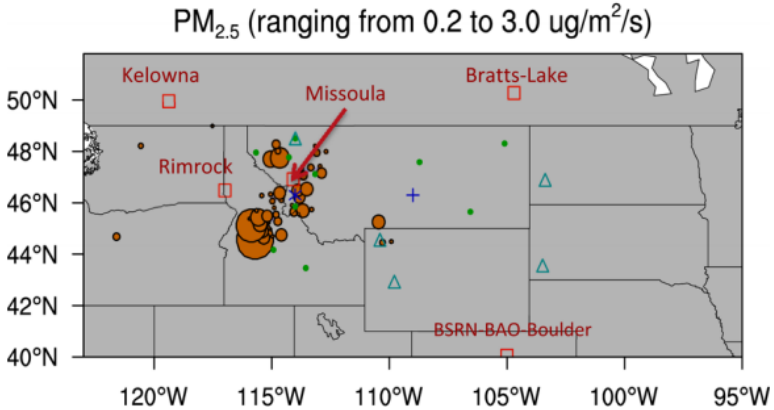
Xiaoyan Jiang,*,† Christine Wiedinmyer,† and Annmarie G. Carlton‡

dx.doi.org/10.1021/es301541k | *Environ. Sci. Technol.* 2012, 46, 11878–11886

- WRF-Chem with fire emissions
- Simulate impact of fire emissions on boundary layer and chemistry



(a)



(b)

Feedbacks to regional meteorology and chemistry

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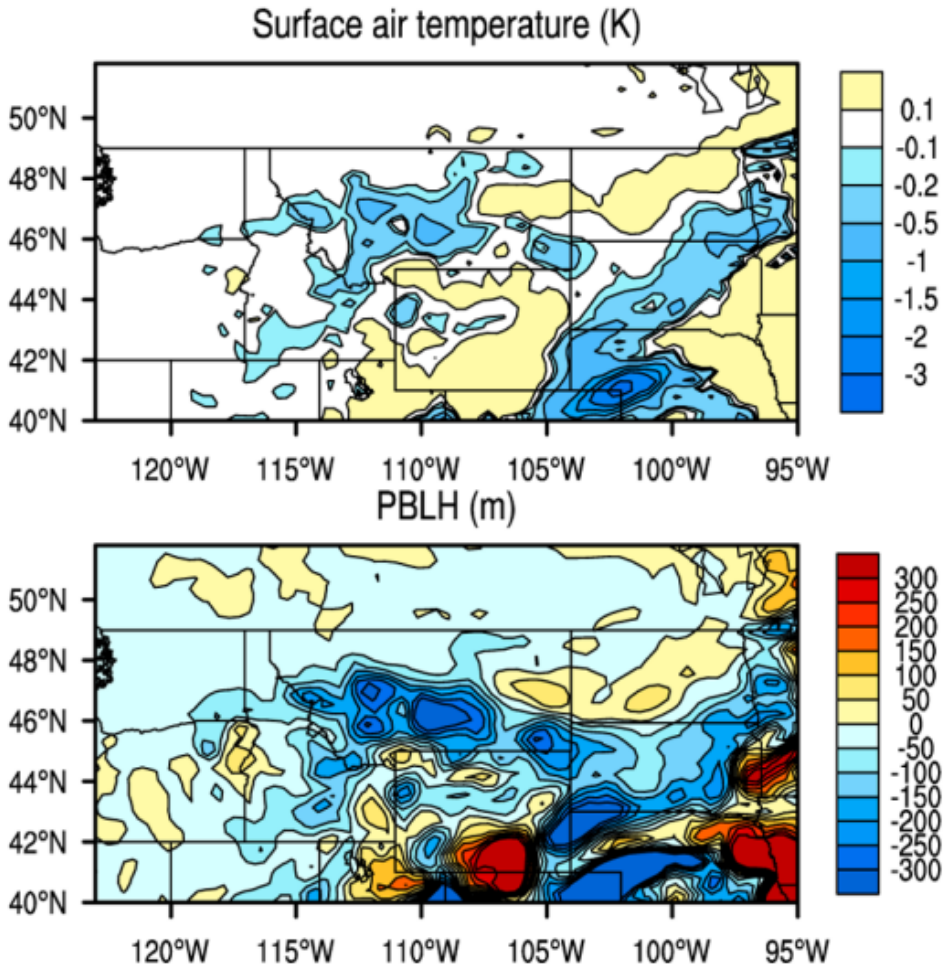
- Changes in PBL, Surface air temperature, solar radiation

Changes in -15% to +60% in ozone concentrations



Continued Work

- Update emissions outputs to FINNv2
  - Hindsight and forecast products
- Evaluate uncertainty associated with model inputs
  - Atmospheric satellite products used (i.e., AOD)
- Test chemistry of emissions (VOCs) in chemical models
- FIREX/WE-CAN/FIRE-CHEM

Other Products:

- Annual, 30-second rasters of VCF and LCT product processed and available