Modeling Emissions: FINN Approach

CHRISTINE WIEDINMYER

CIRES, UNIVERSITY OF COLORADO BOULDER

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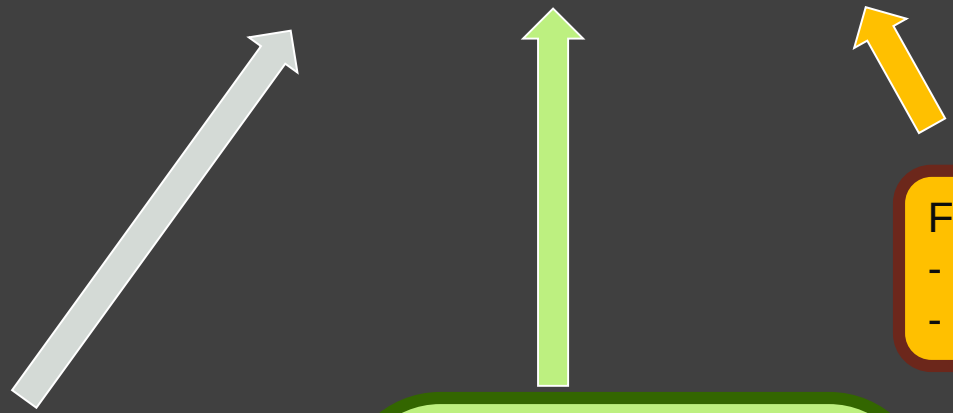
Estimating emissions from open burning

$$\text{Emission}_i = f(ef_i, \text{Biomass Burned})$$



Fire Radiative Power
- Intensity of the fire
- Temperature

Emission Factor

- Vegetation
  - Type
  - Condition
- Fire
  - Intensity
  - Stage

Biomass Burned

- Vegetation
  - Type
  - Condition
  - Density
  - Loading
- Fire
  - Intensity
  - Duration

FINN Development

1) Model for North American Fire Emissions

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

2) Fire INventory from NCAR (Version 1, FINNv1)

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

3) FINN version 2 (Updates in Progress)

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

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, …

Fire INventory from NCAR (FINN)

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

Use of Satellite Data for model inputs

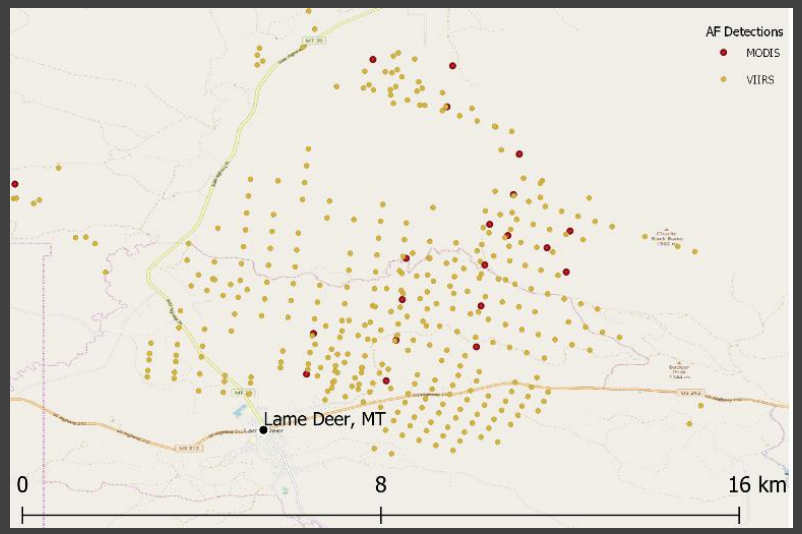
- Fire location, timing, detection
  - Rapid Fire Detections
    - https://firms.modaps.eosdis.nasa.gov/download/
    - MODIS Collection 6 and NRT data (MCD14DL and MCD14ML)
    - VIIRS Data (NEW!!)
- Fuel Loading
  - Vegetation Continuous Fields (MOD44B v5.1)
- Ecosystem burned
  - Land Cover Type (MCD12Q1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

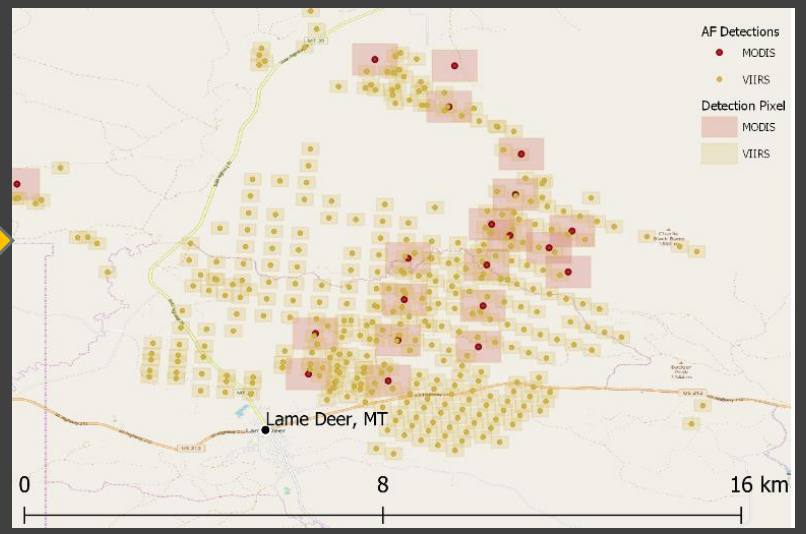
Fuel consumed is calculated as a function of tree and herbaceous cover

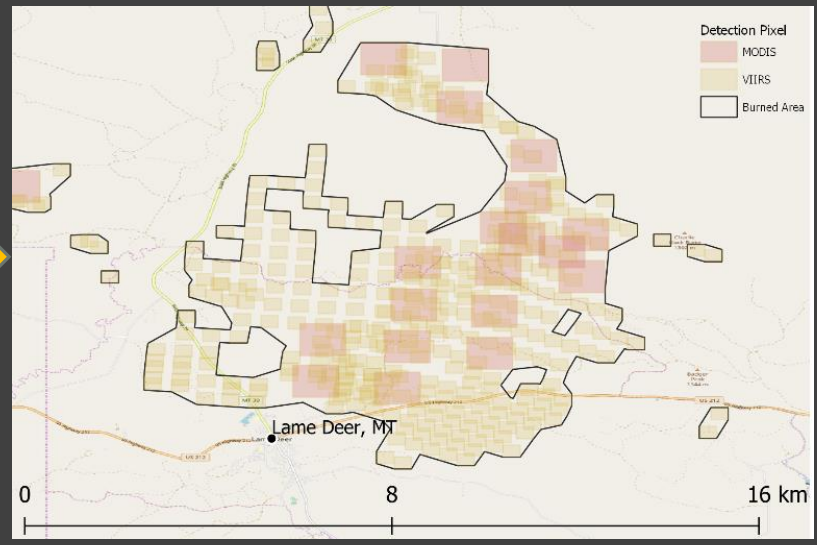
Fire INventory from NCAR (FINN)

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

Burned area determined with spatial processing of satellite fire detections







Estimating Emissions

Emission Factor
(g/kg)

- Based on laboratory and field measurements
- Dependent on measurement techniques
- Function of type of burning
- Using current results and updated frequently

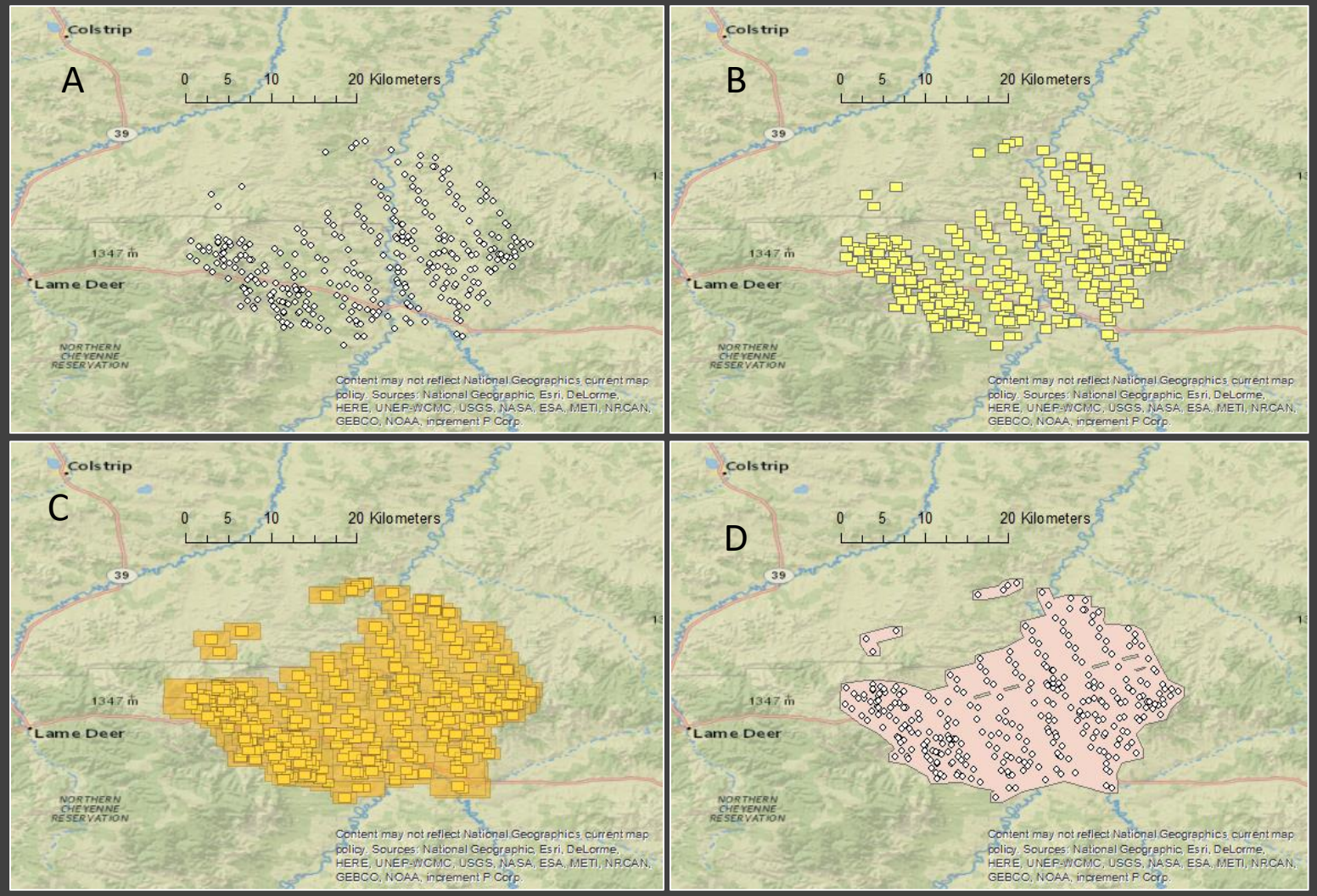
Montana Fire Sciences Laboratory (B. Yokelson)

Thomas Karl, TROFFEE Study, Brazil

FINNv2: *Updates in Progress*

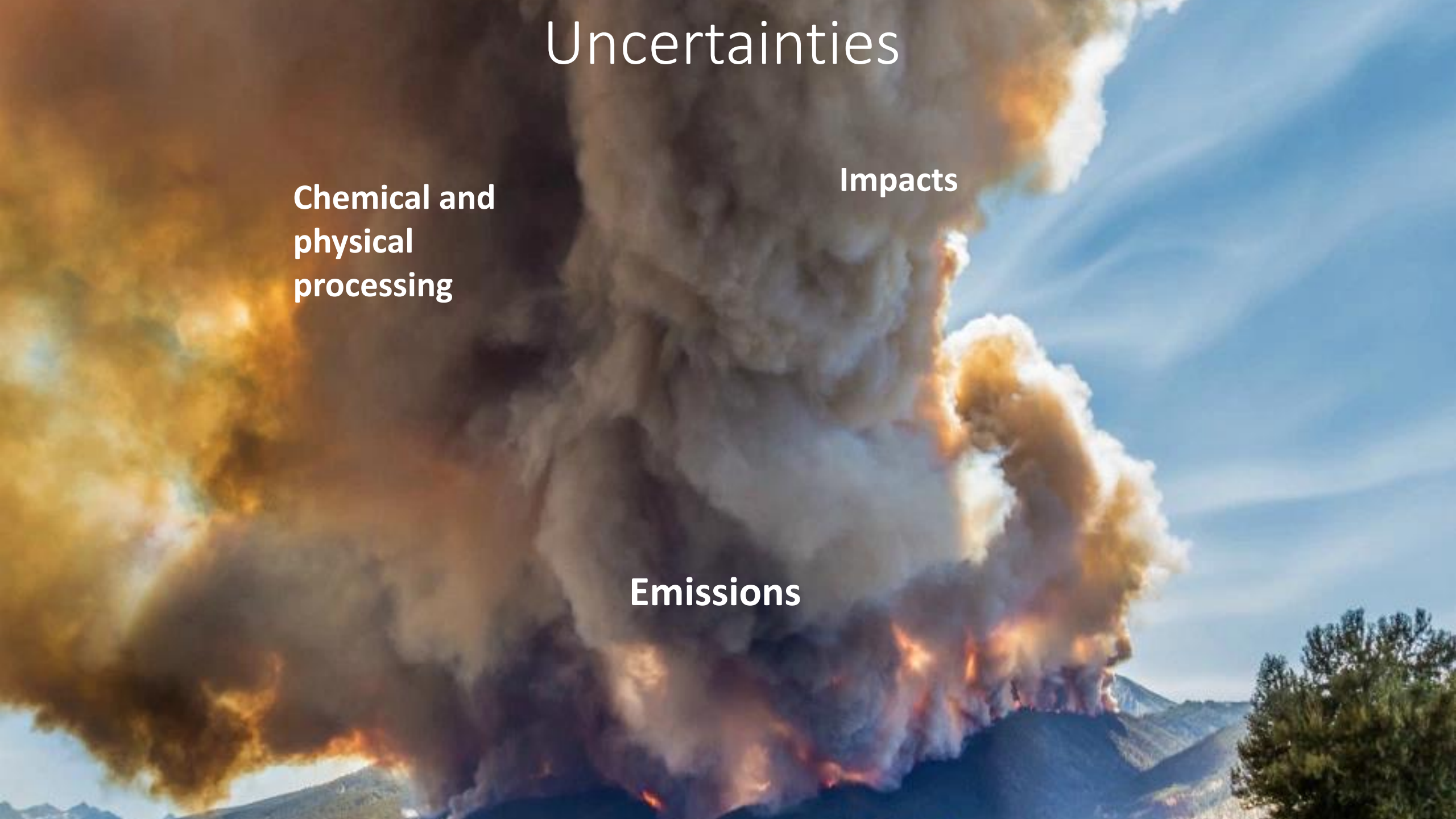
- Updated burned area estimation method
- Inclusion of VIIRS fire detections
- Temporally-varying vegetation
- Updated EFs and Fuel Loadings
- Open Source
- Flexible

- Others:
  - Inclusion of Peat burning
  - Agricultural burning



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

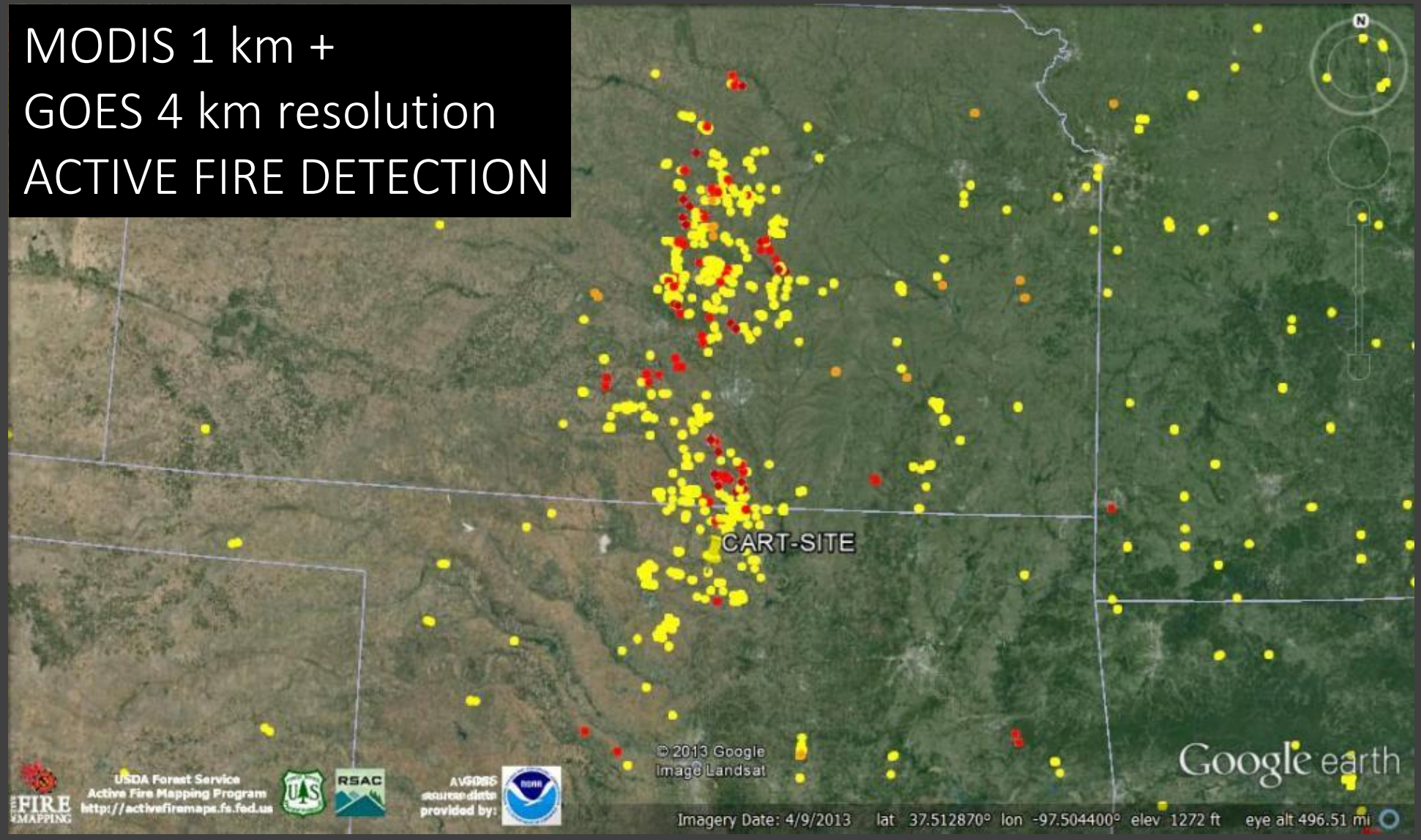
Uncertainties



Fire Identification

From B. Yokelson

MODIS 1 km +
GOES 4 km resolution
ACTIVE FIRE DETECTION

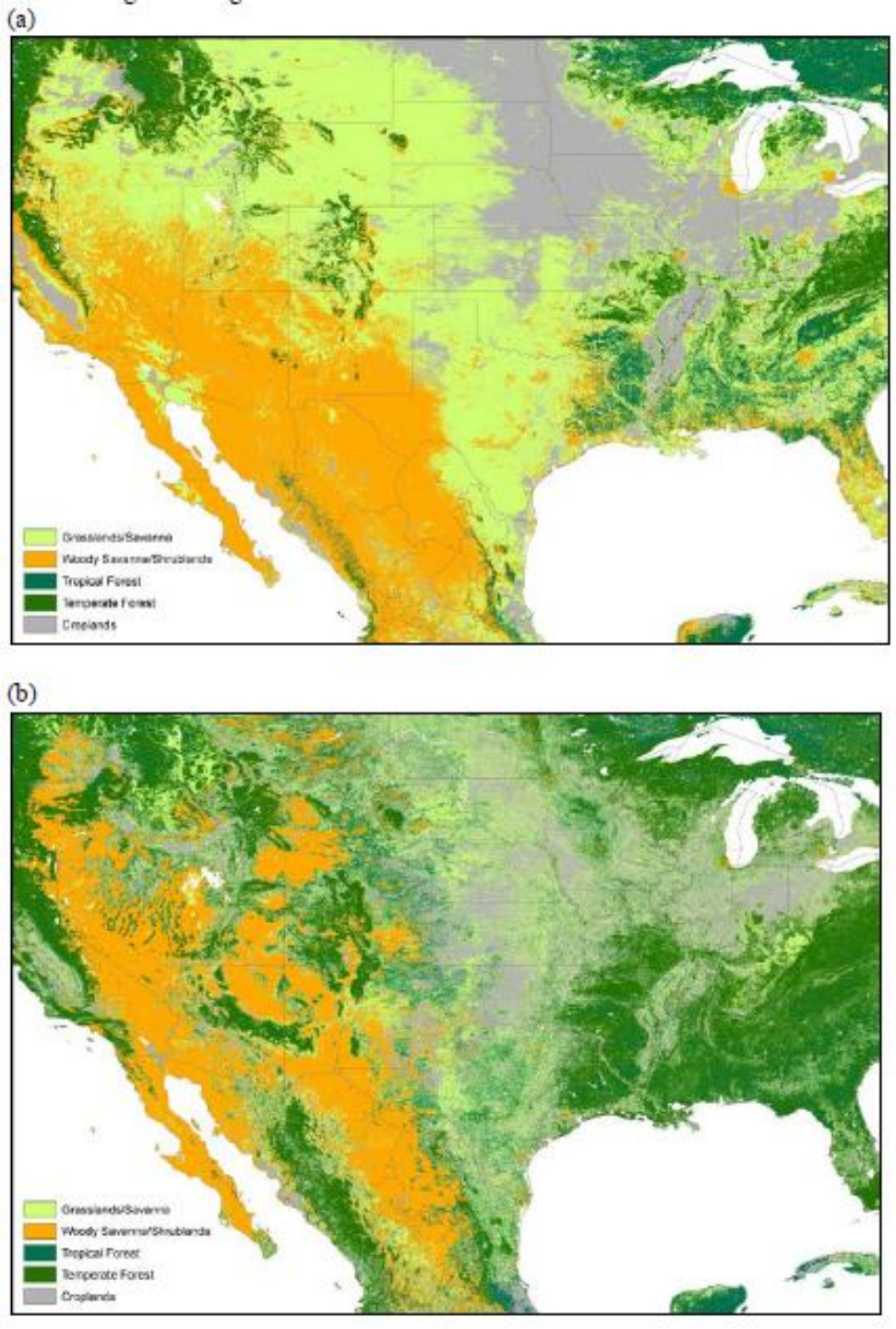


Uncertainties in Land Cover Inputs

MODIS LCT

Generic Land Cover classifications assigned to different satellite-derived datasets

GLOBCOVER



** Impacts assigned fuel loading*