Improving Biogenic Emission Estimates with Satellite Imagery

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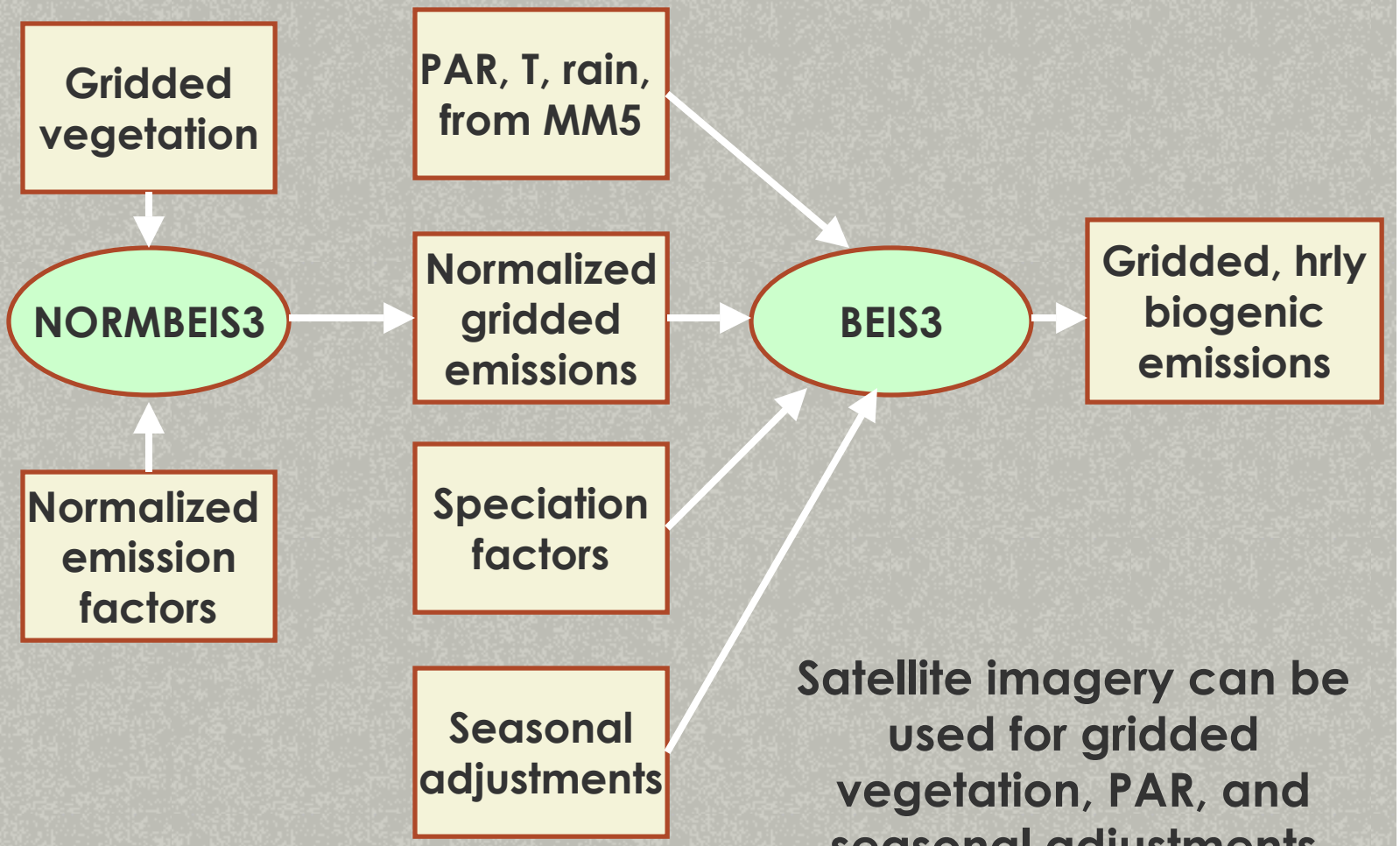
Why consider using satellite imagery to improve biogenic emission estimates?

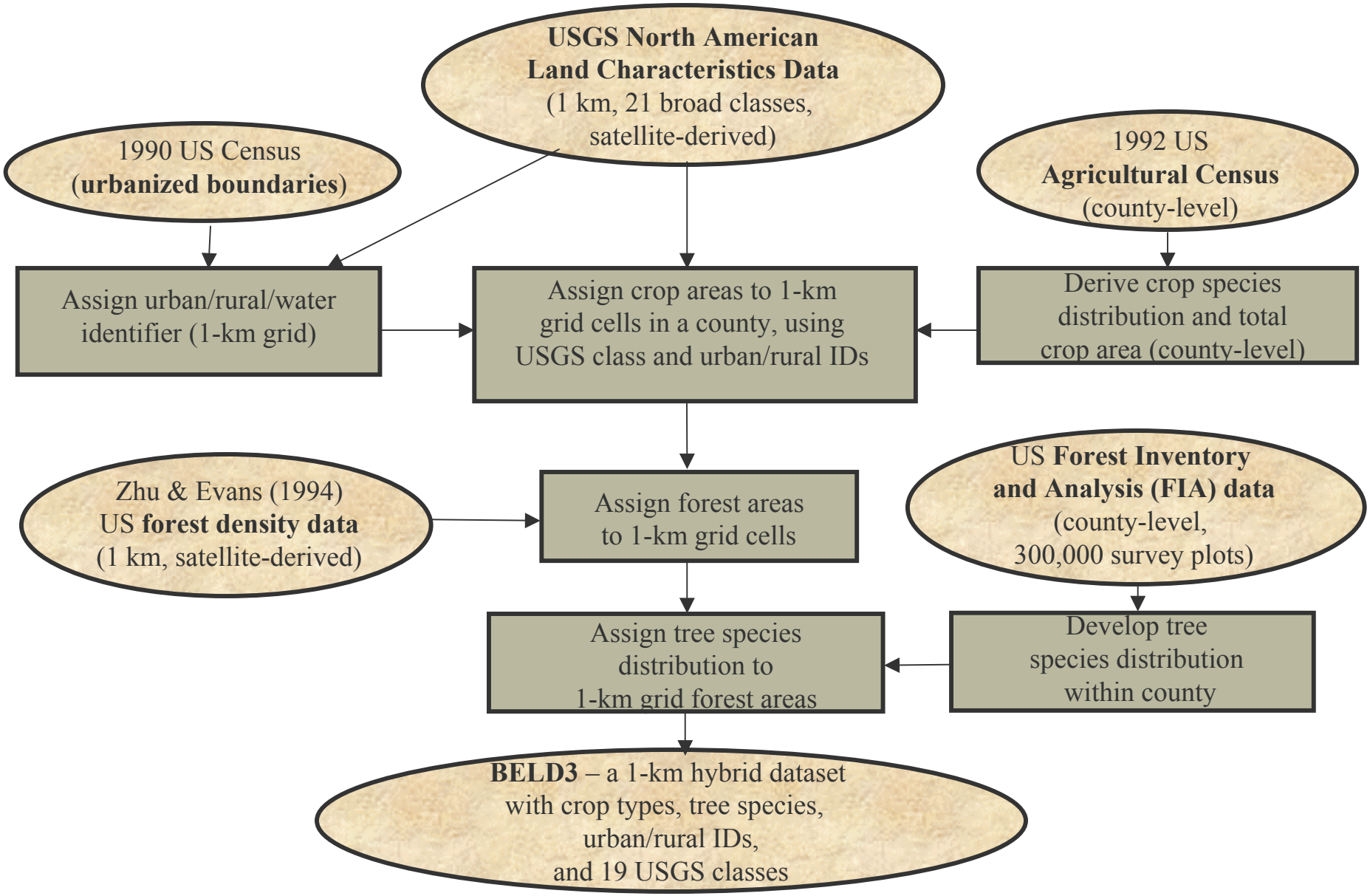
- Across North America, biogenic VOCs are estimated to be larger than anthropogenic VOCs
- Biogenic VOCs have been shown to influence the efficacy of ozone attainment strategies. They appear to be important contributors to the formation of secondary organic aerosols.
- Biogenic emission models require information on emission factors, spatial and temporal distributions of vegetation data, and spatial and temporal distributions of meteorological data.
- Satellite imagery is widely used to classify land use and to characterize meteorology.

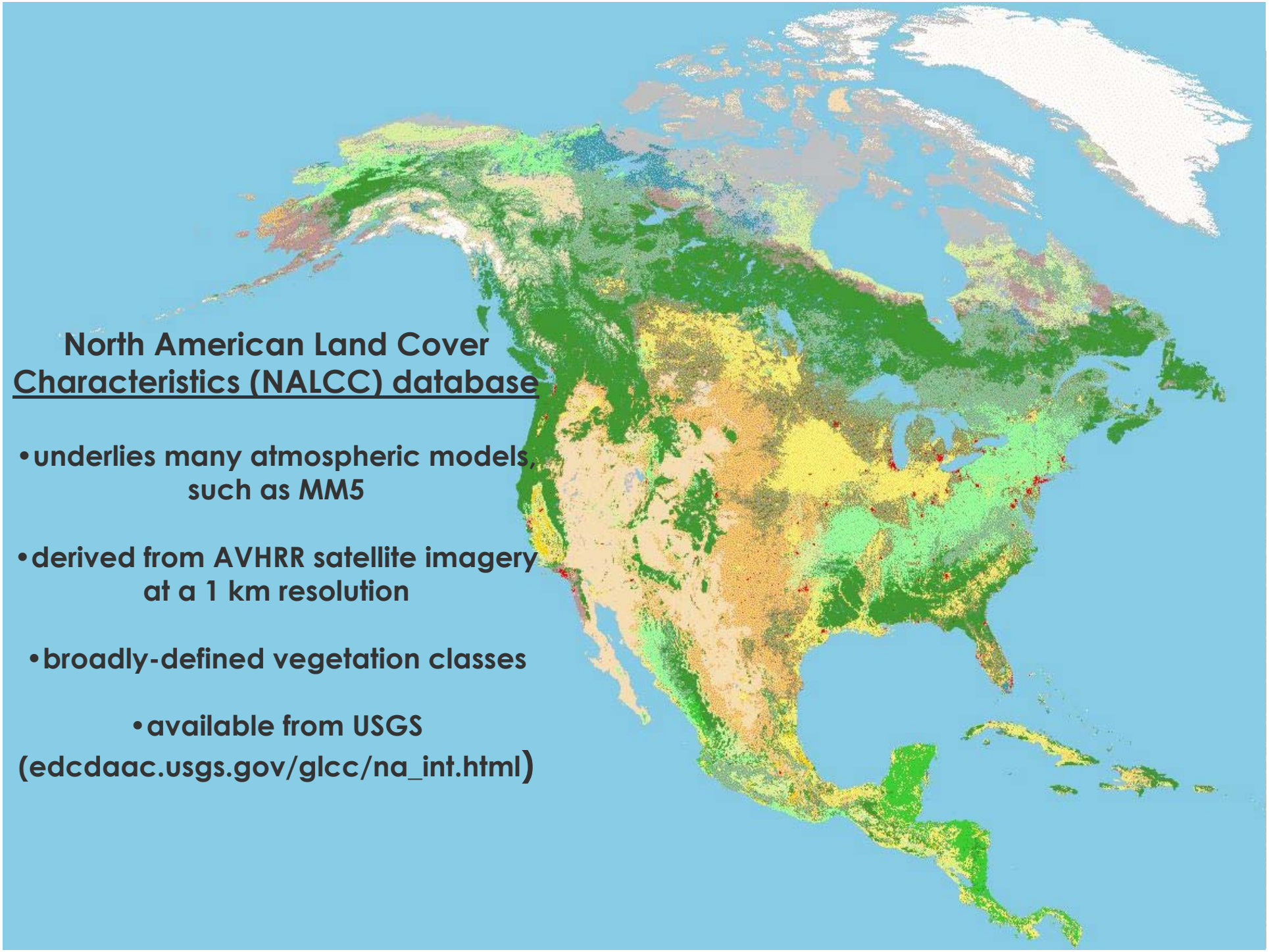
Flowchart of the Biogenic Emissions Inventory System (BEIS3)



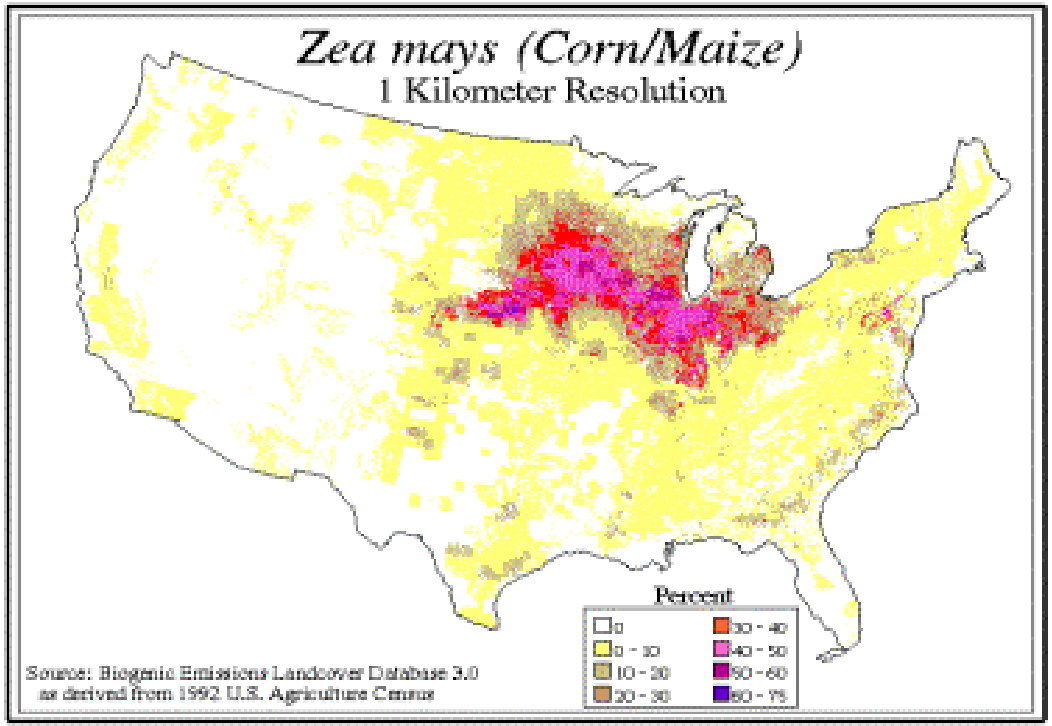
Satellite imagery can be used for gridded vegetation, PAR, and seasonal adjustments

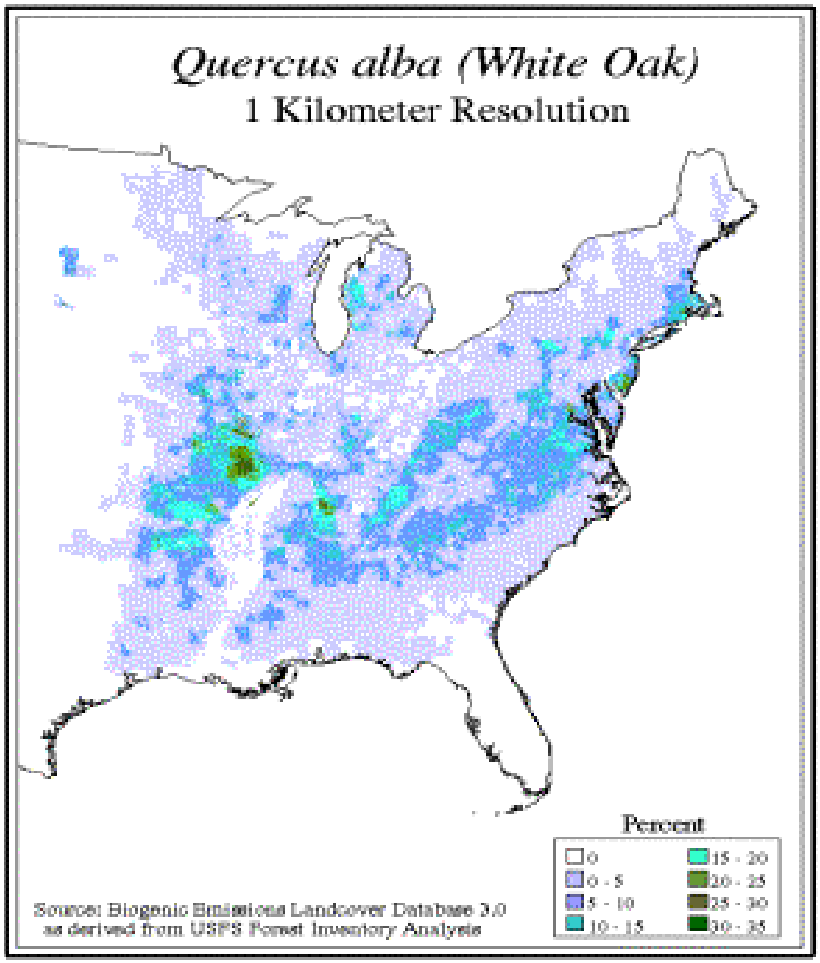
Creating gridded vegetation data for the Biogenic Emissions Landuse Database (BELD3)




North American Land Cover
Characteristics (NALCC) database
•underlies many atmospheric models, such as MM5
•derived from AVHRR satellite imagery at a 1 km resolution
•broadly-defined vegetation classes
•available from USGS (edcdaac.usgs.gov/glcc/na_int.html)

Examples of vegetation data from the Biogenic Emissions Landuse Database





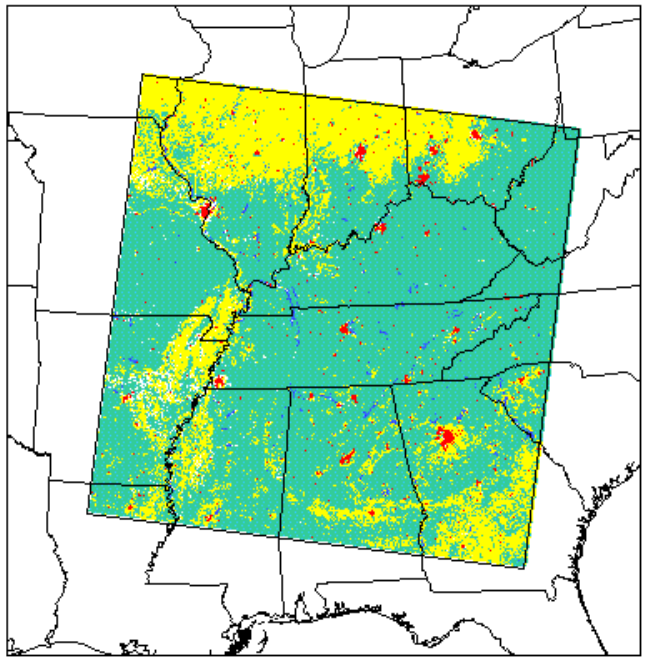
Biogenic Emissions Landuse Database, version 3 (BELD3):

- **Adapted from a variety of sources – USGS LULC (AVHRR), county agriculture census, county forest inventory, and USDA forest density (AVHRR/Landsat)**
- **Resolved to 1 km**
- **Classified into 230 vegetation types**

Comparison of alternative vegetation databases

NALCC – North American Land Cover Characteristics (derived from AVHRR 1-km, broad classes)

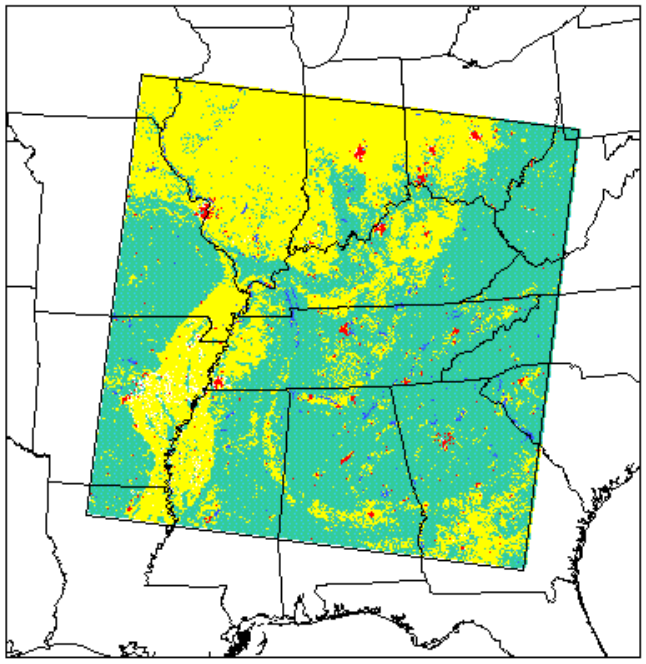
BELD3 – Biogenic Emissions Landuse Database, version 3 (forest inventory, crop census, and satellite imagery)



NALCC

Landcover
- Urban
- Barren
- Wetland
- Water
- Grass/shrubland
- Agriculture
- Forest

Source: North America Landcover Characteristics Database



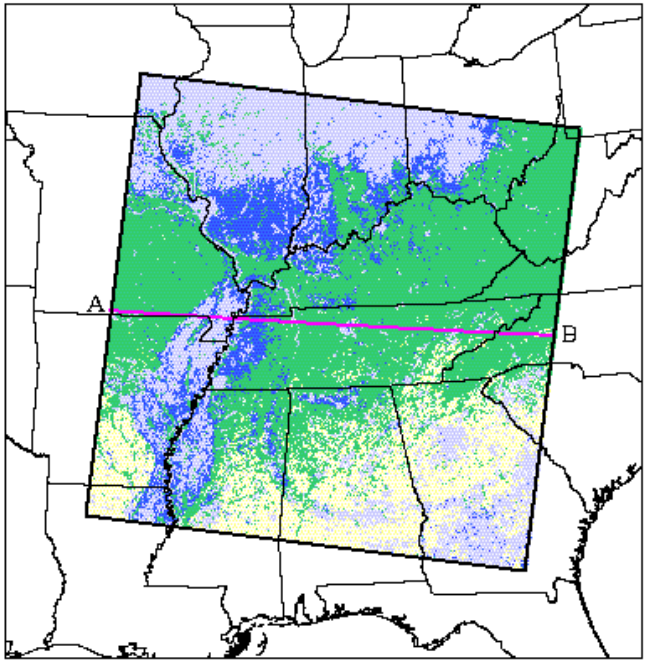
BELD3

Landcover
- Urban
- Barren
- Wetland
- Water
- Grass/shrubland
- Agriculture
- Forest

Source: Biogenic Emissions Landcover Database 3.0

Comparison of isoprene fluxes derived from alternative vegetation databases

NALCC produces smooth patterns, but does not capture high isoprene emissions in the dense oak forests of southeastern Missouri

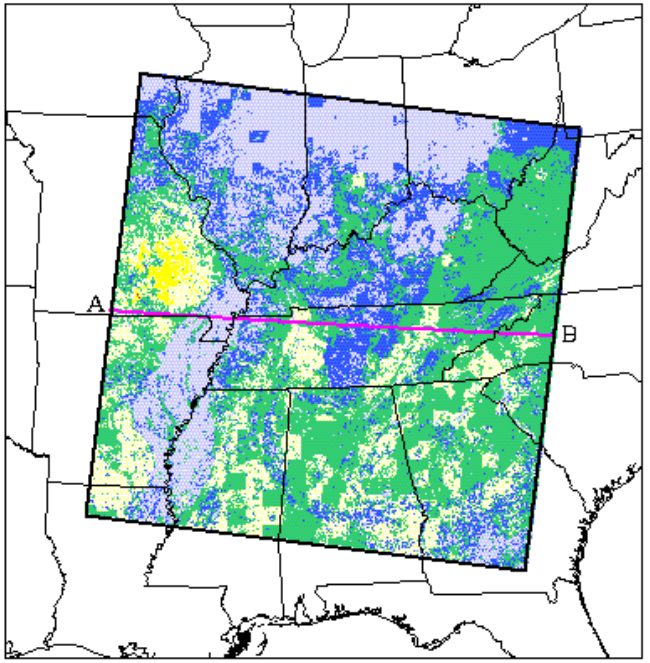


NALCC

Isoprene ($\mu g\ m^{-2}\ h^{-1}$)

- 0
- 0 - 2500
- 2500 - 5000
- 5000 - 10000
- 10000 - 15000
- 15000 - 20000
- 20000 - 25000

Source: North America Landcover Characteristics Database



BELD3

Isoprene ($\mu g\ m^{-2}\ h^{-1}$)

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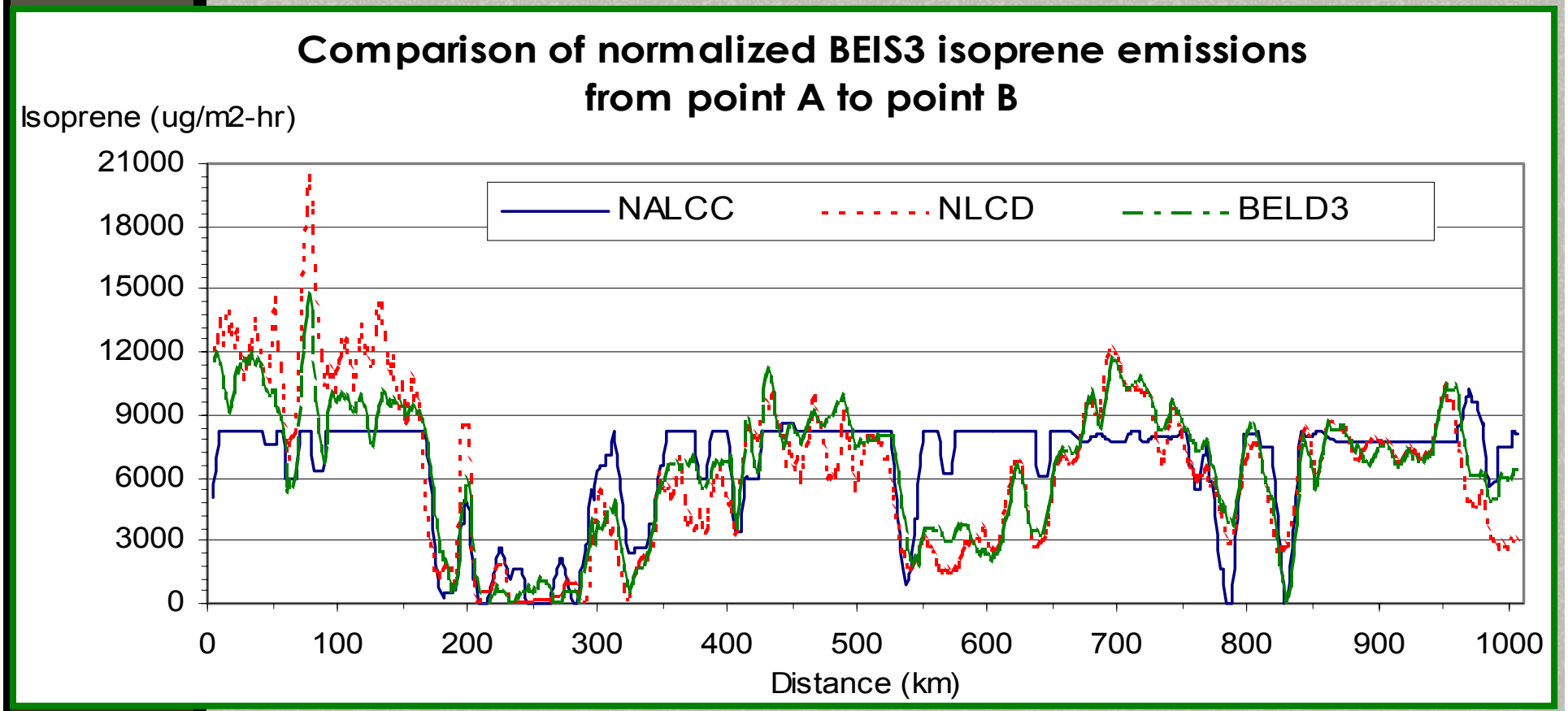
- 20000 - 25000

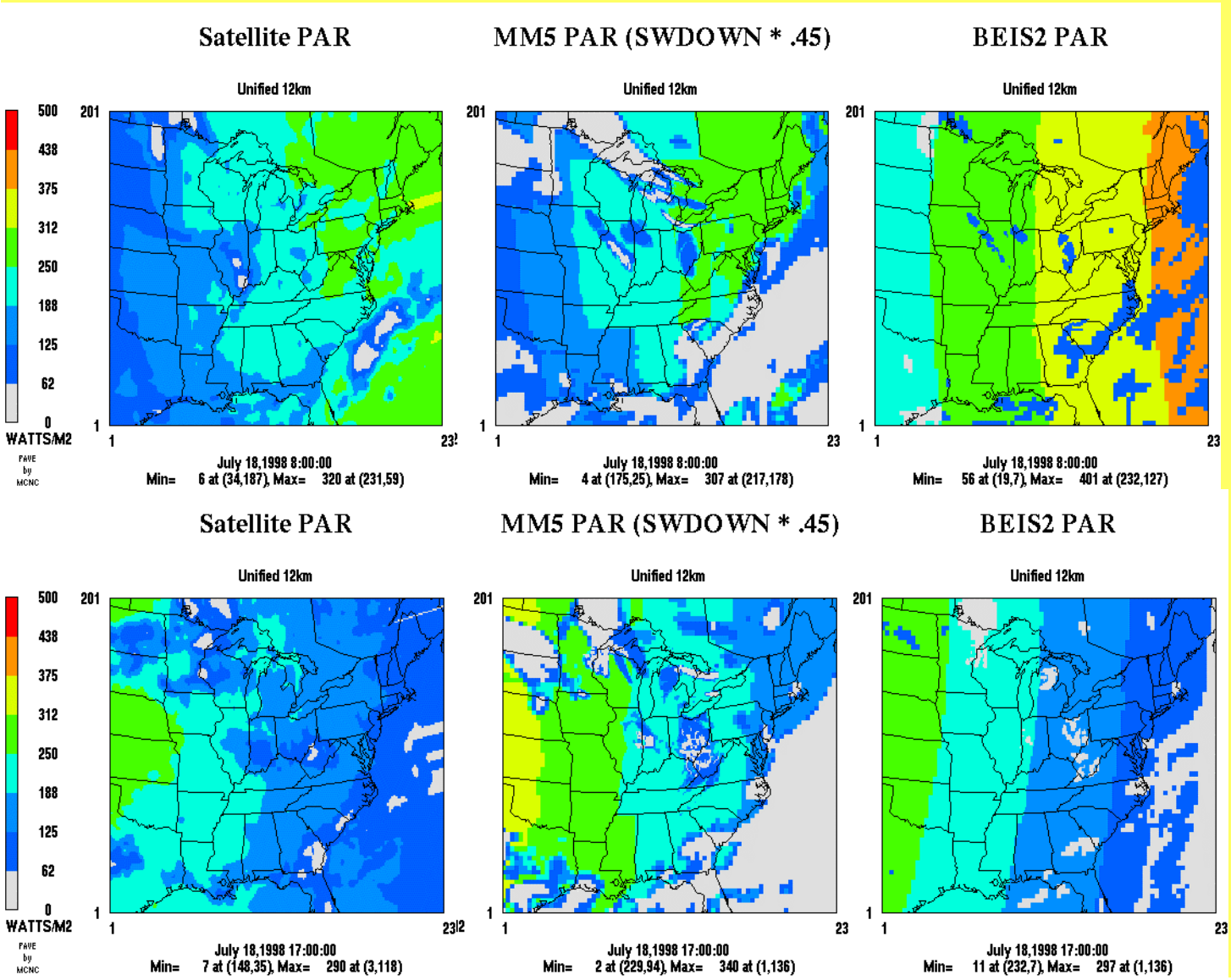
Source: Biogenic Emissions Landcover Database 3.0

Comparison of isoprene fluxes derived from alternative vegetation databases

BELD3 captures spatial variability; lack of species resolution in NALCC produces smooth patterns



Satellite imagery may improve estimates of PAR (photosynthetically active radiation)



0800 EST

1700 EST

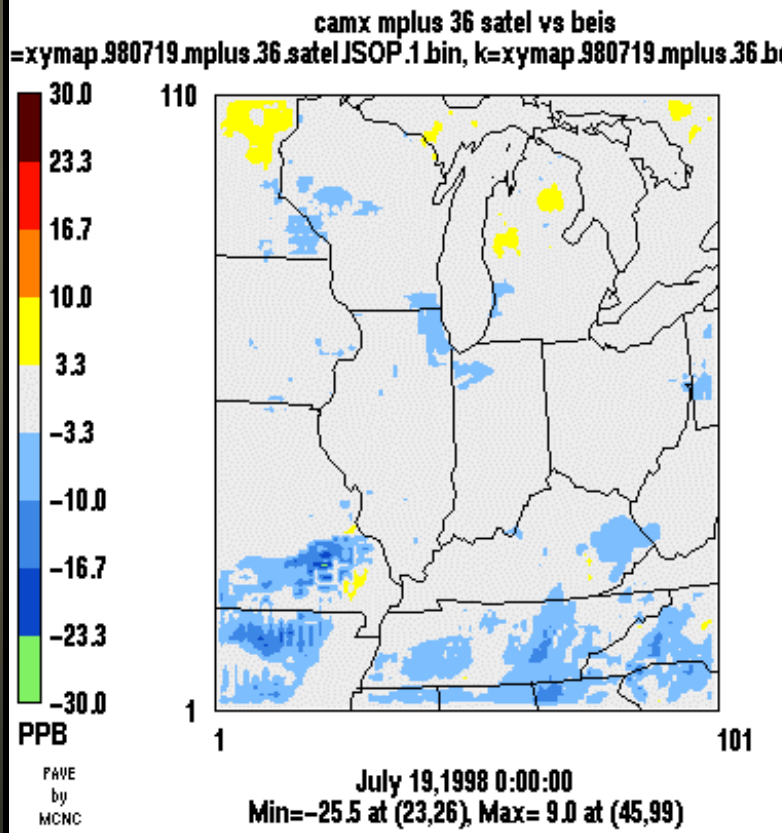
Courtesy of Kirk Baker, LADCO

Alternative estimates of PAR yield different concentrations of isoprene and ozone

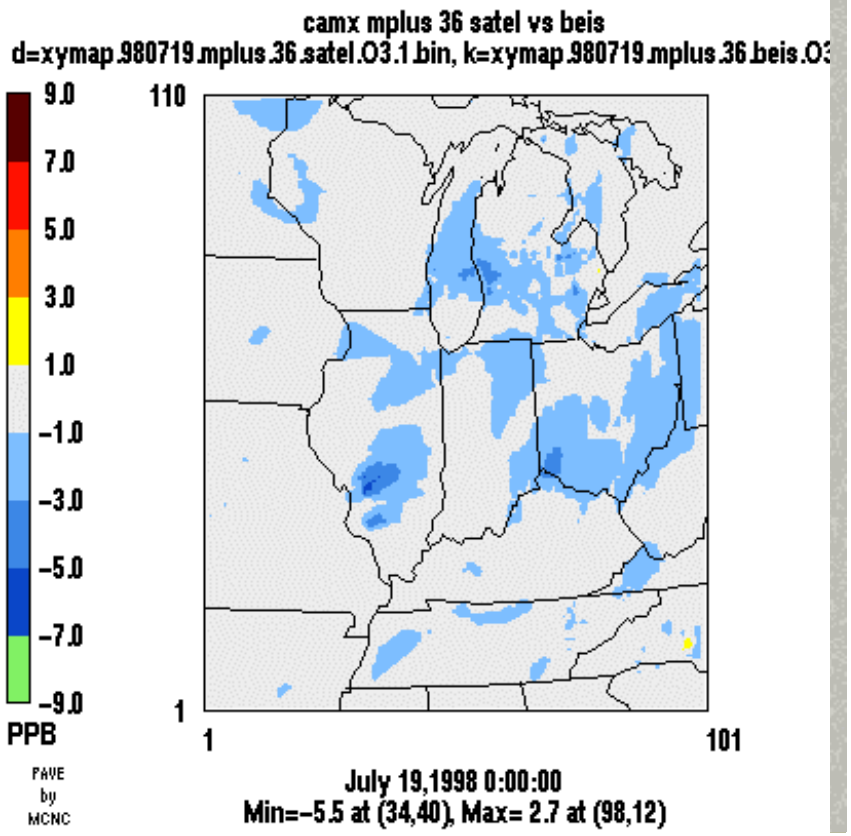
(CAMx, GOES satellite vs MM5 derived PAR)

Courtesy of K. Baker, LADCO

Peak Isoprene

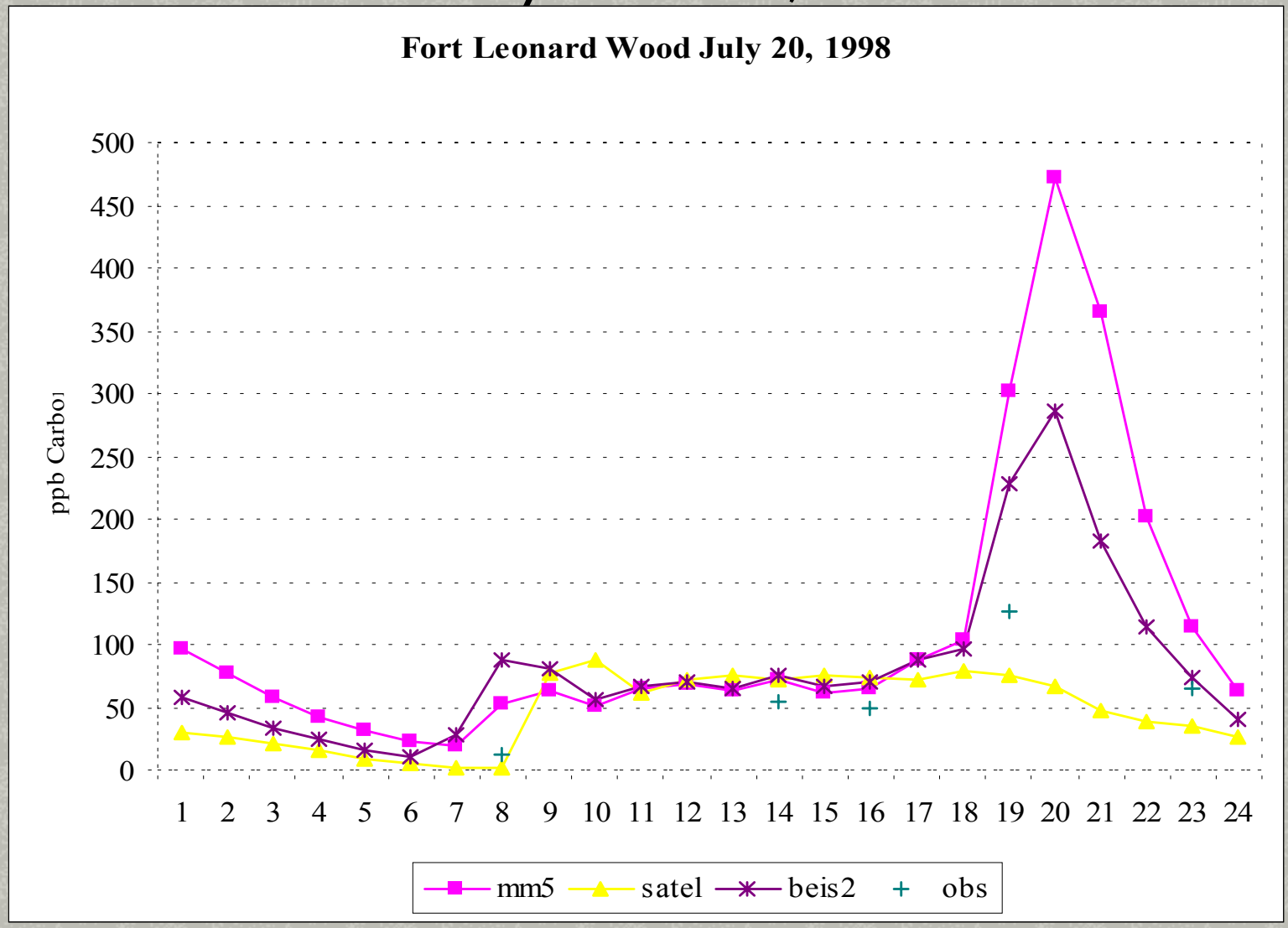


Peak Ozone



Comparison of observed and modeled isoprene using alternative estimates of PAR (CAMx, Missouri)

Courtesy of K. Baker, LADCO



Improving biogenic emissions with satellite imagery from MODIS

- The Moderate Resolution Imaging Spectro-radiometer (MODIS) is part of NASA's Earth Observing System (EOS) satellite suite that begin collecting data in 2000.
- It improves upon AVHRR with better calibrations, better spatial resolution (<1 km), and more spectral bands.
- For more information, see <terra.nasa.gov>.

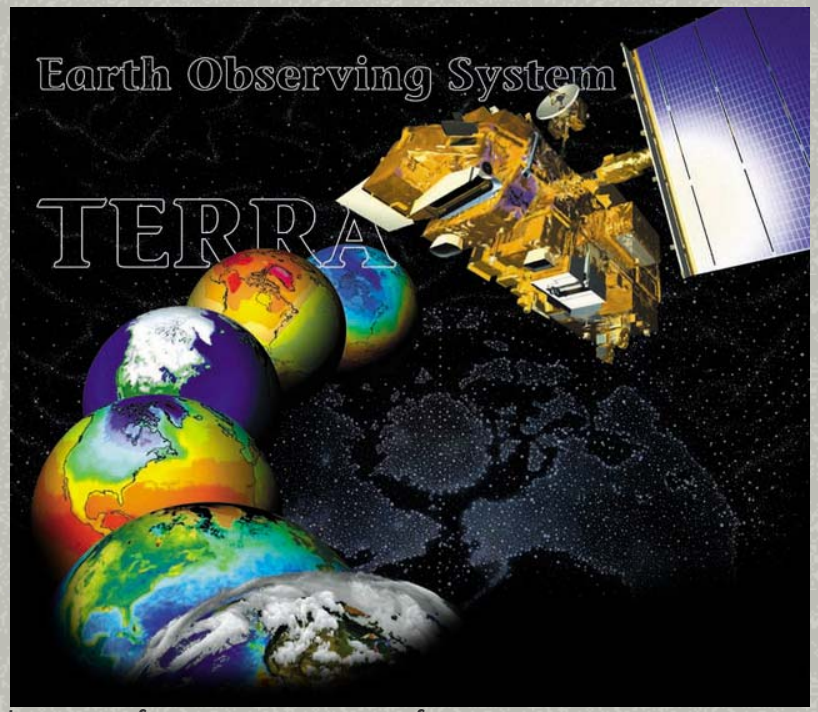
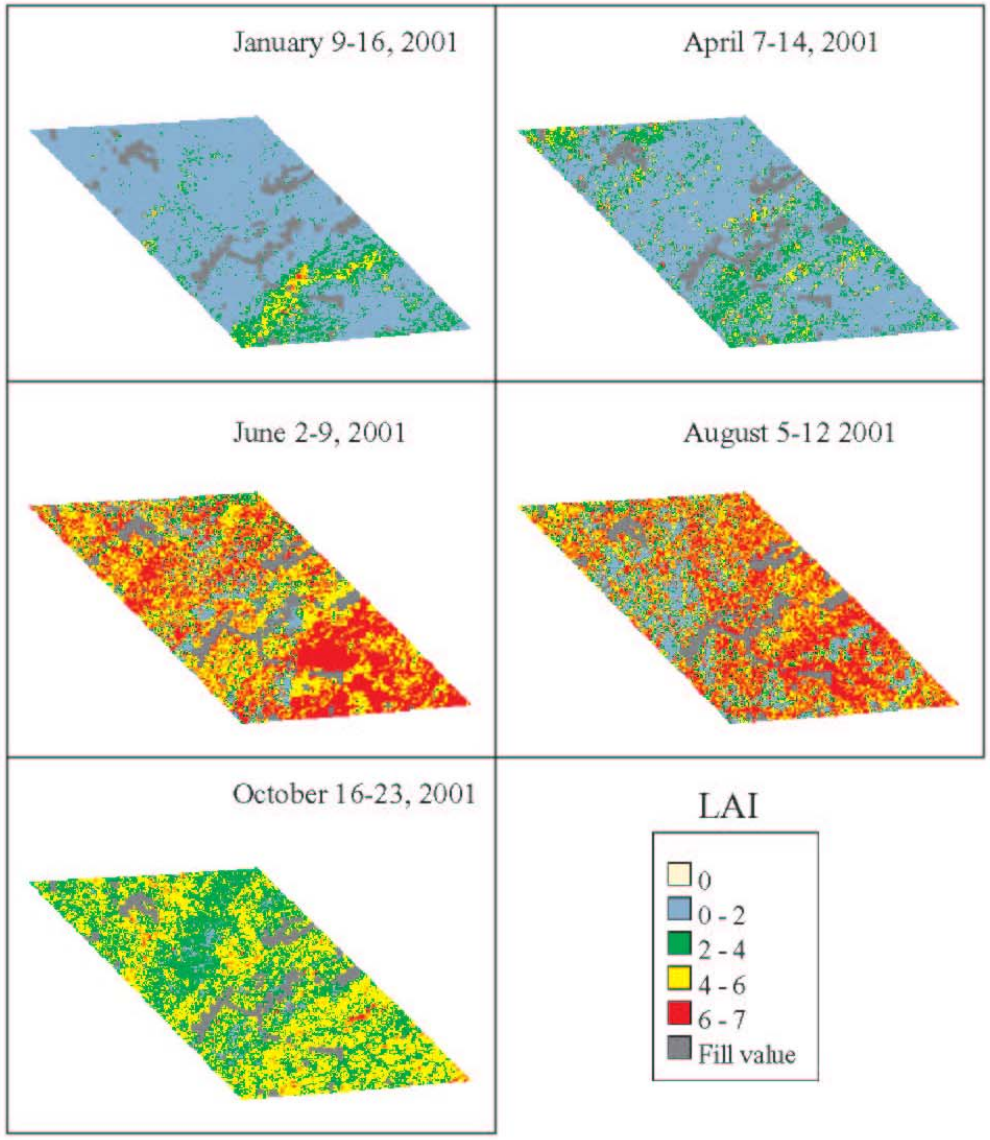


Image from eos-am.gsfc.nasa.gov

MODIS-derived Leaf Area Indices (LAI) near Oak Ridge, Tennessee



Monthly variation of LAI as derived from MODIS

Improving biogenic emissions with satellite imagery: past, present, and future

- AVHRR-derived landscape characterization and forest cover datasets have been used successfully to enhance the Biogenic Emissions Landuse Database (BELD).
- GOES imagery can be used to "improve" spatial and temporal estimates of photosynthetically active radiation (PAR), an important factor in isoprene emission.
- MODIS-derived products offer the potential to provide biweekly LAI and more-finely resolved vegetation classes.