Improved Land Cover from Remote Sensors

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Southeast Texas Photochemical Modeling Technical Committee Meeting

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What do we mean by land cover and why do we care?

- Land cover refers to what is on the Earth's surface, but our classification is focused on vegetation.

- Biogenic Emissions Modeling
  - Improved biogenic emission inventory
  - BVOC emissions account for a large percentage of VOC in the airshed (often >50%)
- Meteorological Modeling
  - Improved input provides better distribution of surrogates for soil moisture and other parameters
- Photochemical Modeling
  - Land cover affects dry deposition rates

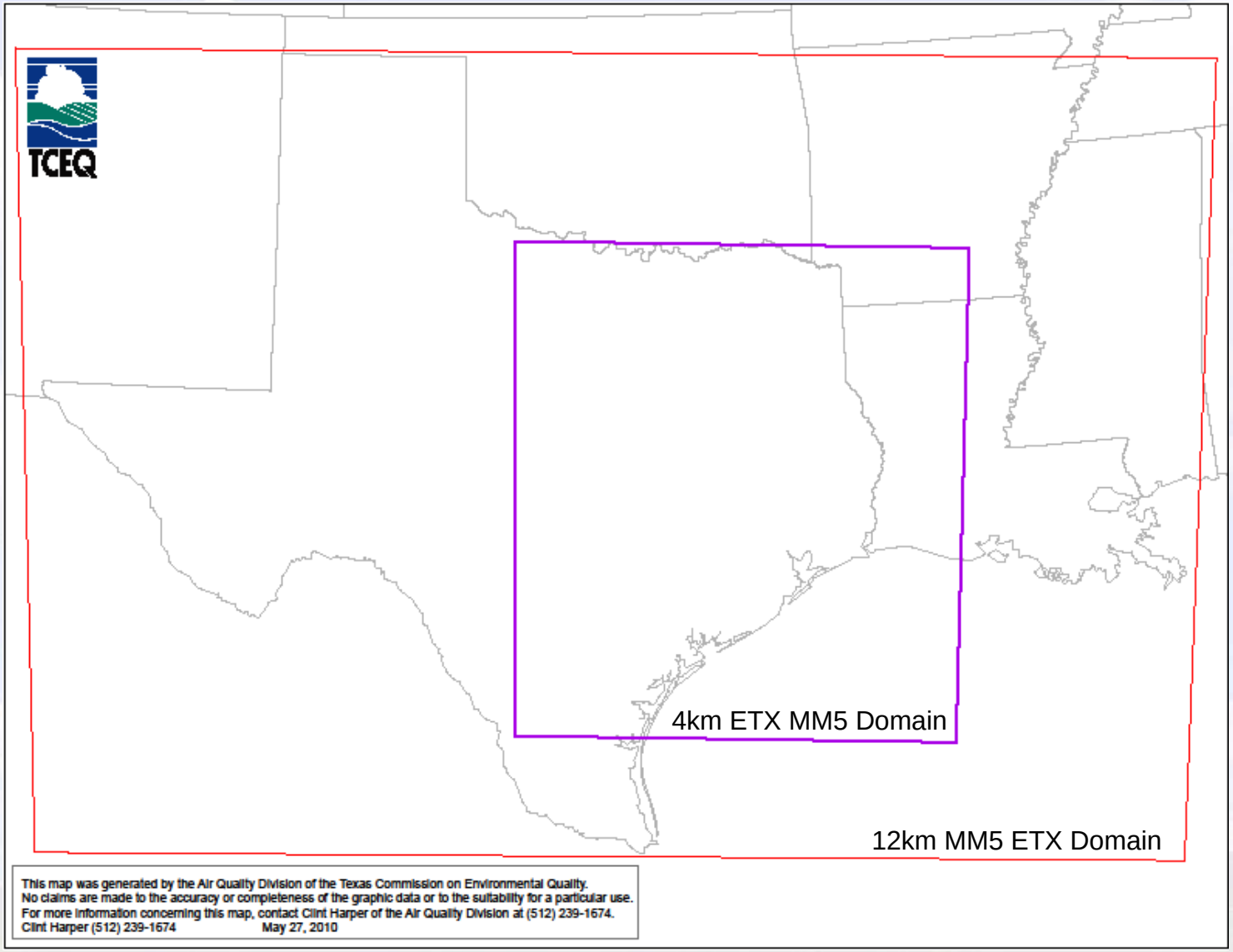
Data for Developing Biogenic Emissions

- Temperatures
- Photosynthetically active radiation (PAR)
  - Derived from Satellite Measurements
- Spatial distribution of the emitters of BVOC emissions (by genus/species)
  - Aggregated into land cover categories
  - Necessary to properly allocate BVOC emissions
- Leaf mass density (LMD) by species in g/m^2
  - LMD is associated with emission rates in the model
- Canopy structure
  - Important to estimate the interaction of photosynthetically active radiation (PAR) with leaves, which are exposed to varying amounts of sunlight depending on their position in the canopy
- BVOC Emission rates per species

Reasons for Progressive Land Cover Mapping

- Land cover constantly changing
  - Need to update regularly to reflect changes on the ground
- More and better at reasonable costs
- Leverage changes in technology
  - Improved sensors
  - Improved techniques
  - Processing power (software and hardware)
- Changes in modeling needs
  - Changes in domains
  - New regions for modeling

Meteorological Modeling Domains



EPA Biogenic Emission Land Cover Databases (BELD)

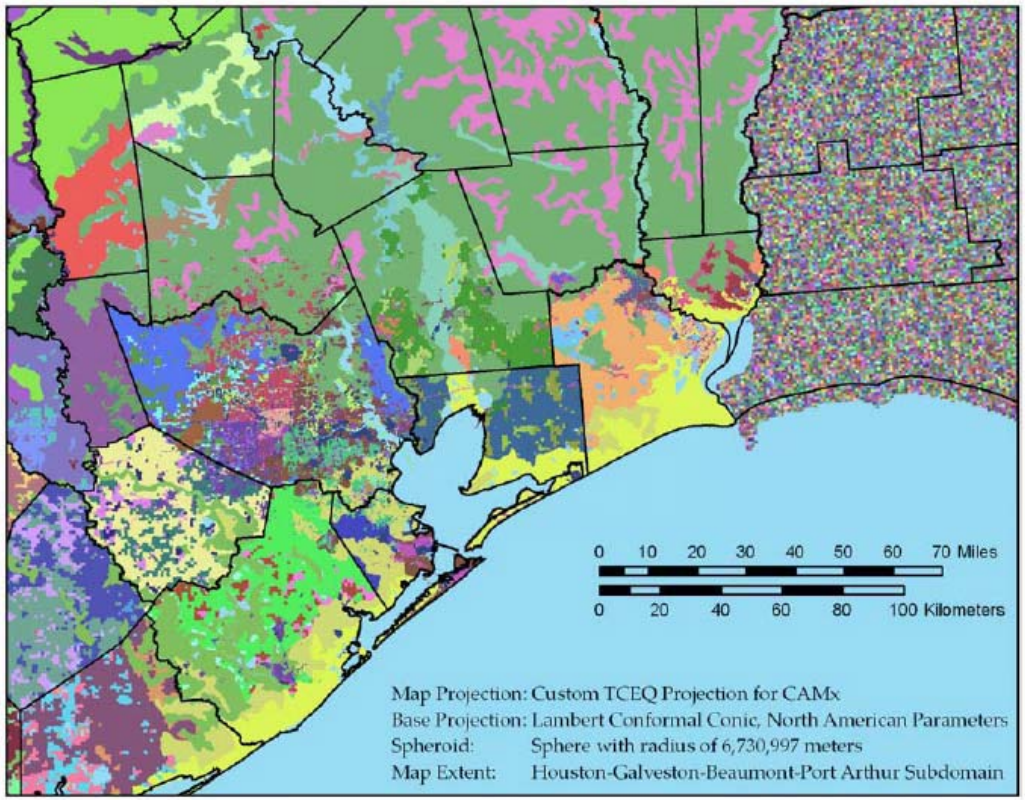
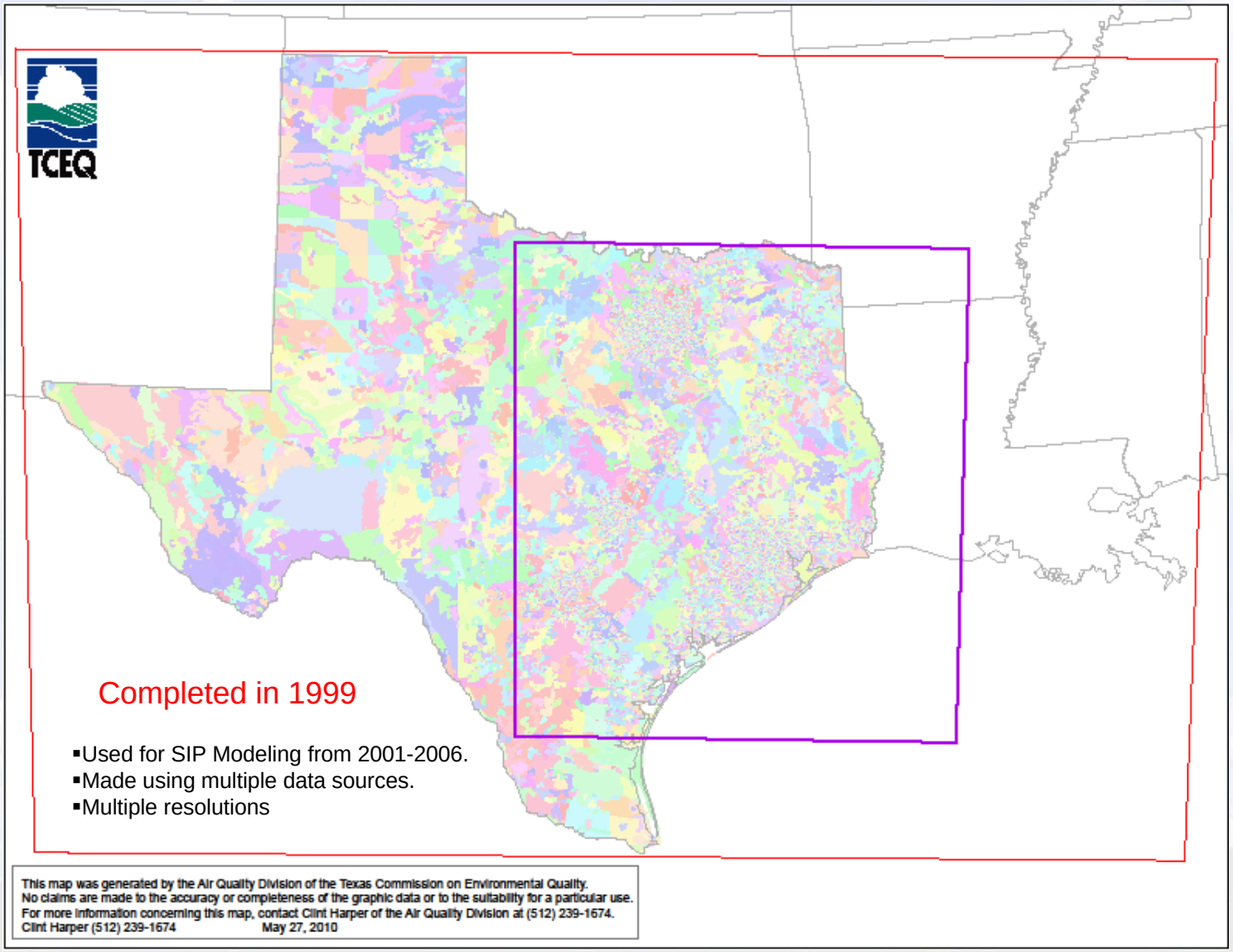


Figure 1.1. Example of Wiedenmeyer (Texas counties) and BELD 3.1 (Louisiana parishes) land cover types in the Houston metropolitan area.

Weidinmeyer Land Cover



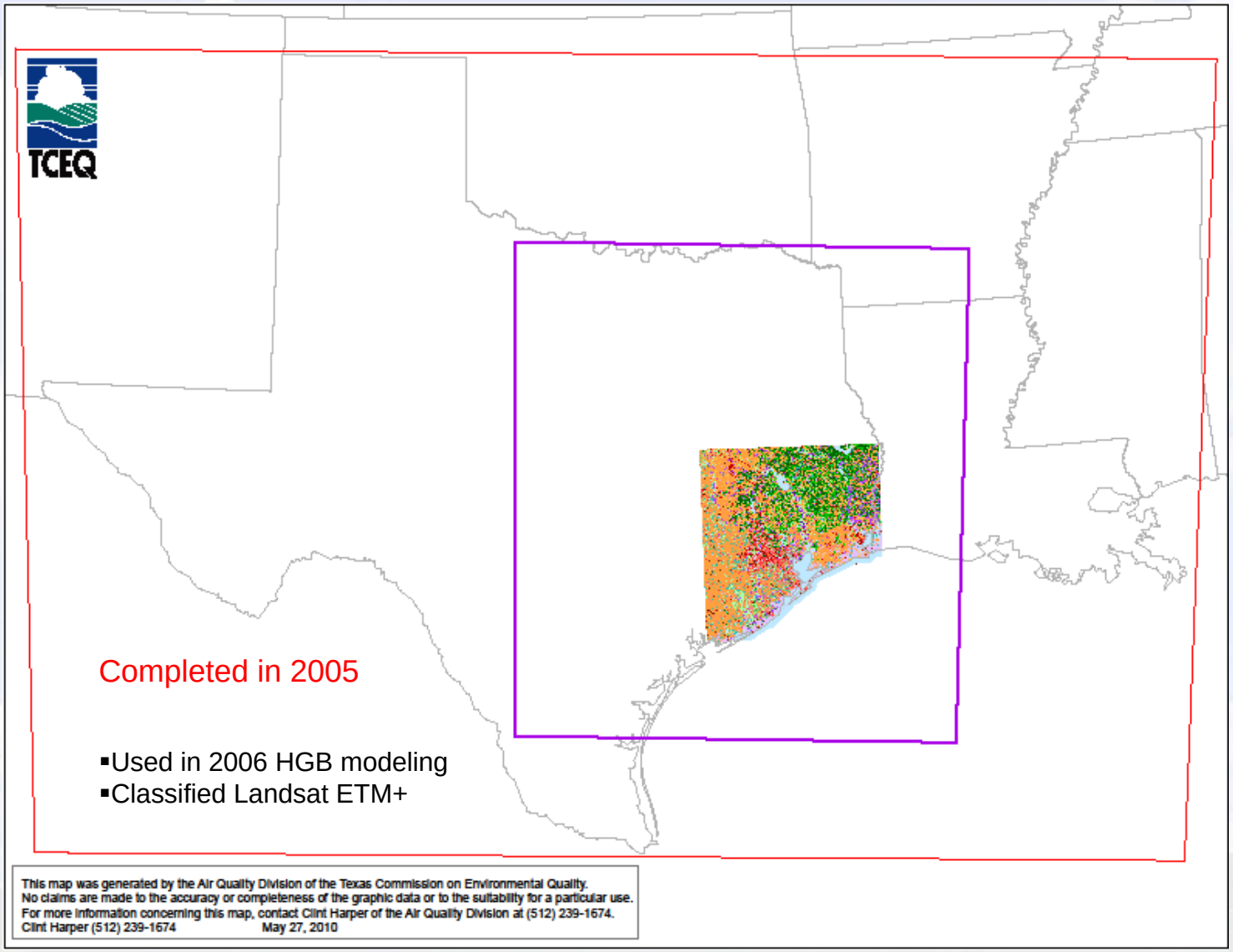
TCEQ Land Cover Requirements (2004)

- Spatially contiguous
  - reduces anomalous features
- Easily updated
  - repeatable methods and similar instrumentation
- Consistent
  - with regards to how classes are defined and assigned
- High to moderate resolution (30m cells or smaller)
  - capable of capturing heterogeneity in land cover
- Accurate
  - We should have some metric to gauge the accuracy of the data

Texas Land Classification System

- Generated from Interagency LULC Working Group, Texas Geographical Information Council (working group document retired in 2005)
- Expanded on USGS Multi-Resolution Landscape Characterization (MRLC) classification (an Anderson hierarchical classification scheme)
  - Expanded some vegetation classes
  - Possible to “crosswalk” with National Land Cover Database (NLCD)
- Currently use 26 classes
  - Woody vegetation is down to Level III or Level IV (e.g. Woody Forested Evergreen Needle-leaf), but other vegetative classes only to level II

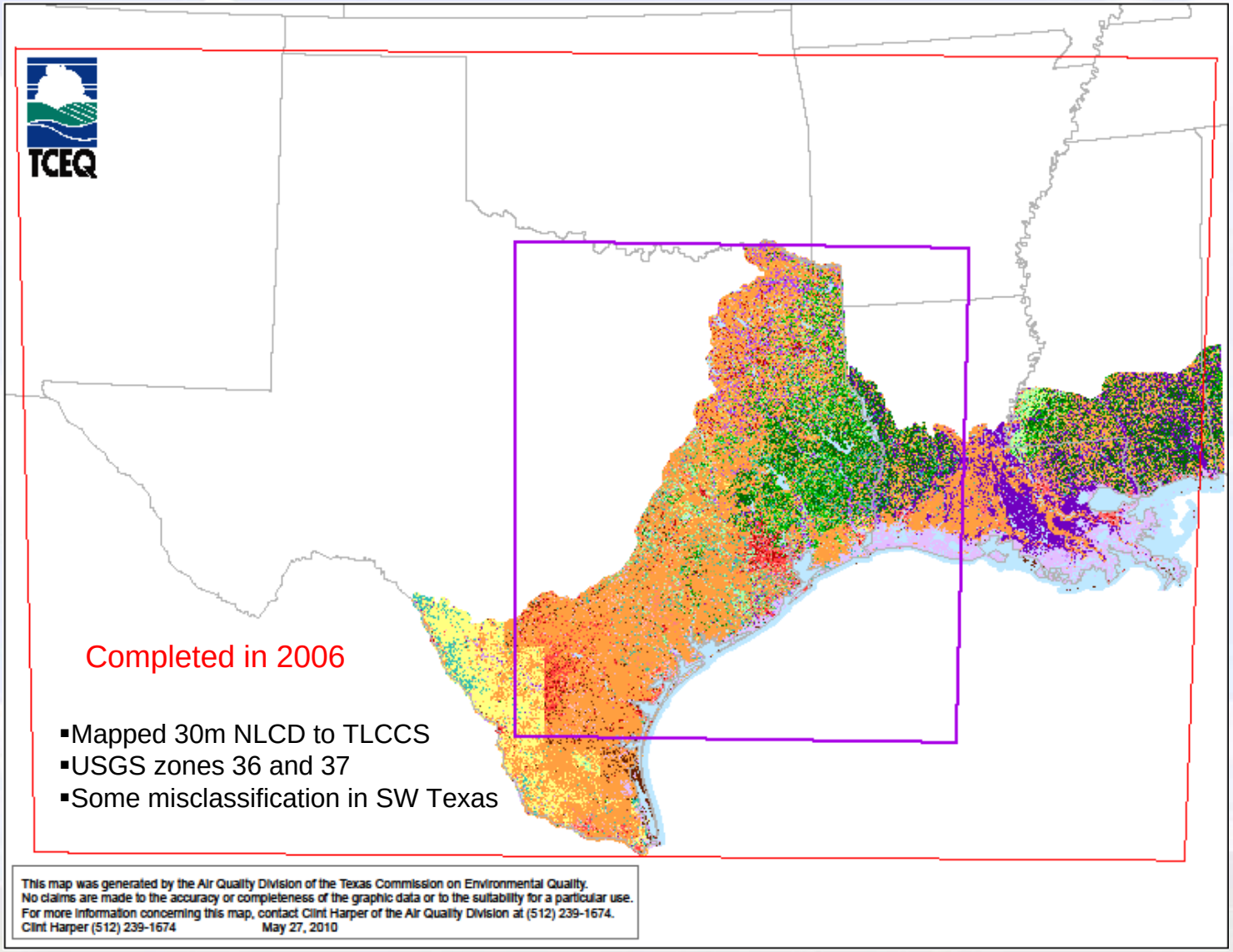
UT-Center for Space Research 4km HGB



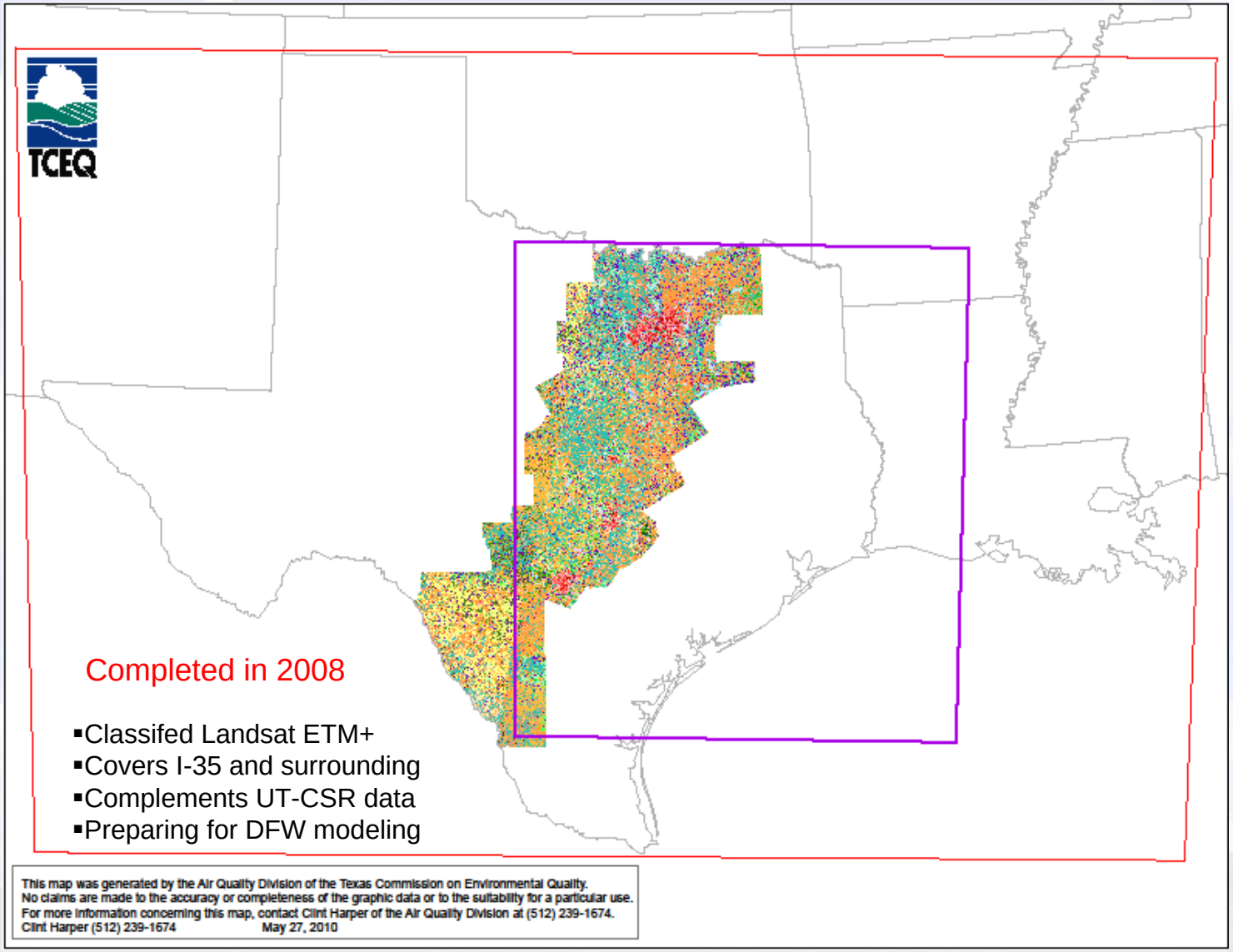
Completed in 2005

- Used in 2006 HGB modeling
- Classified Landsat ETM+

UT-CSR USGS Zones 36 & 37



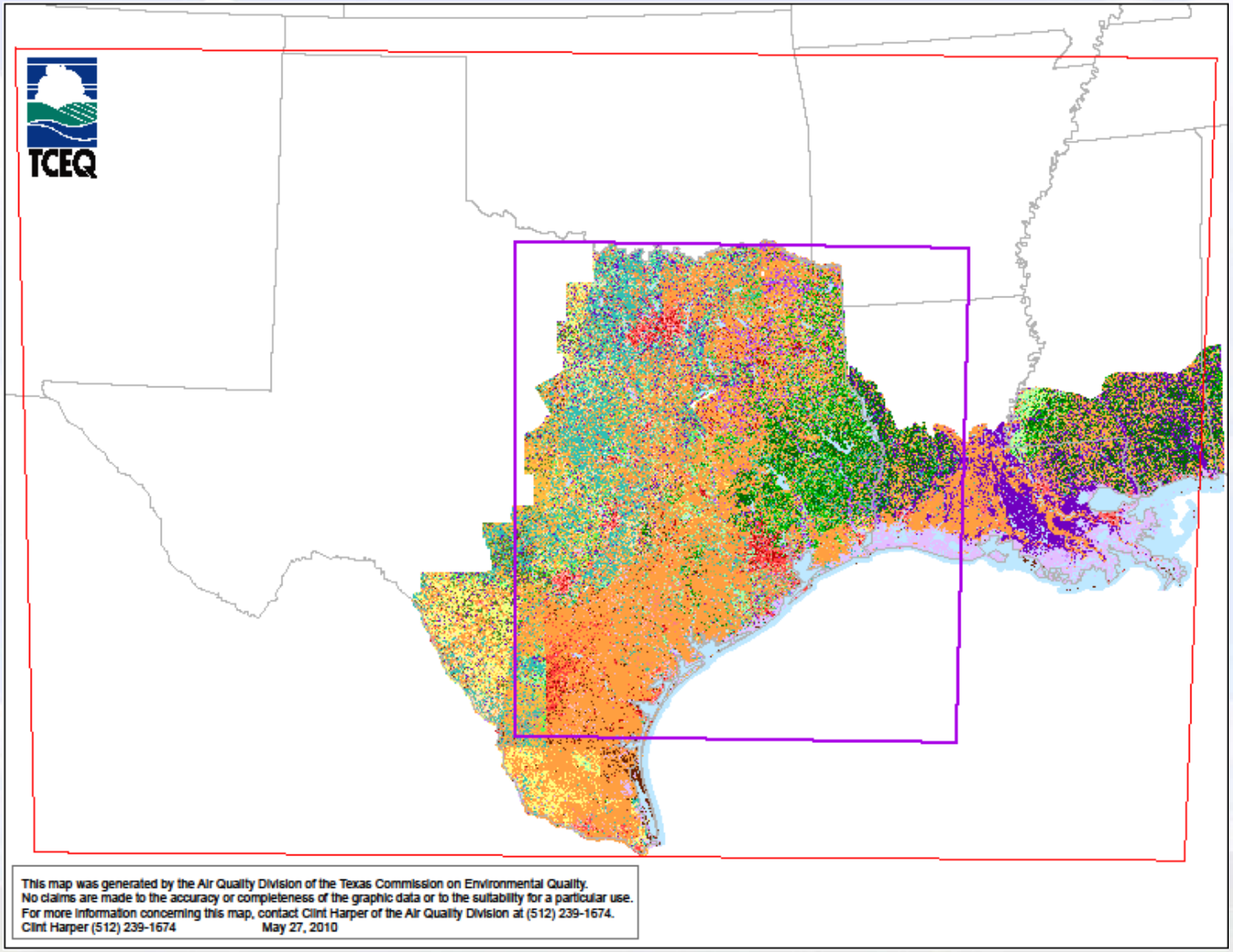
Texas A&M I-35 Corridor and Surrounding



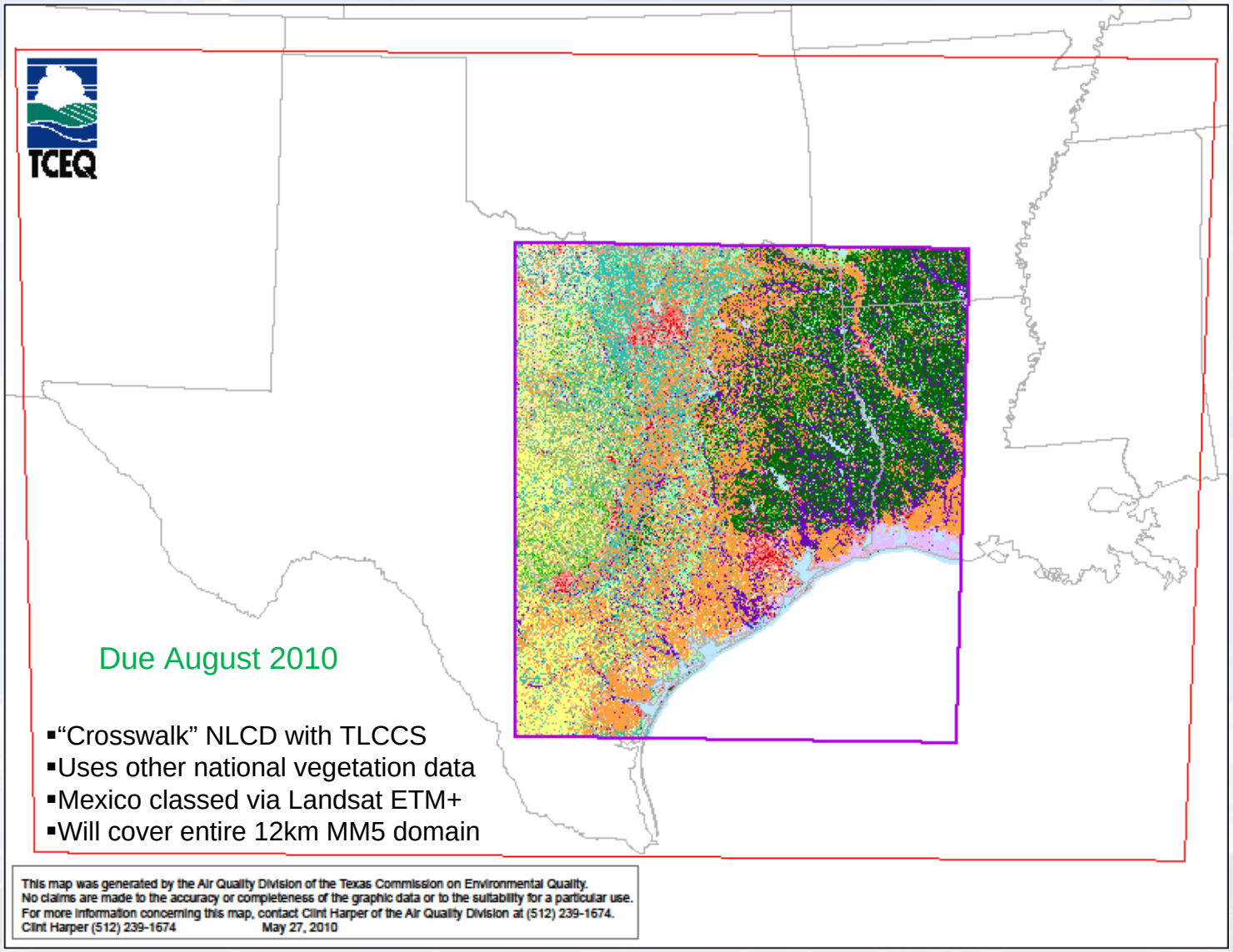
Completed in 2008

- Classifed Landsat ETM+
- Covers I-35 and surrounding
- Complements UT-CSR data
- Preparing for DFW modeling

TAMU I-35 and UT-CSR Zones 36&37

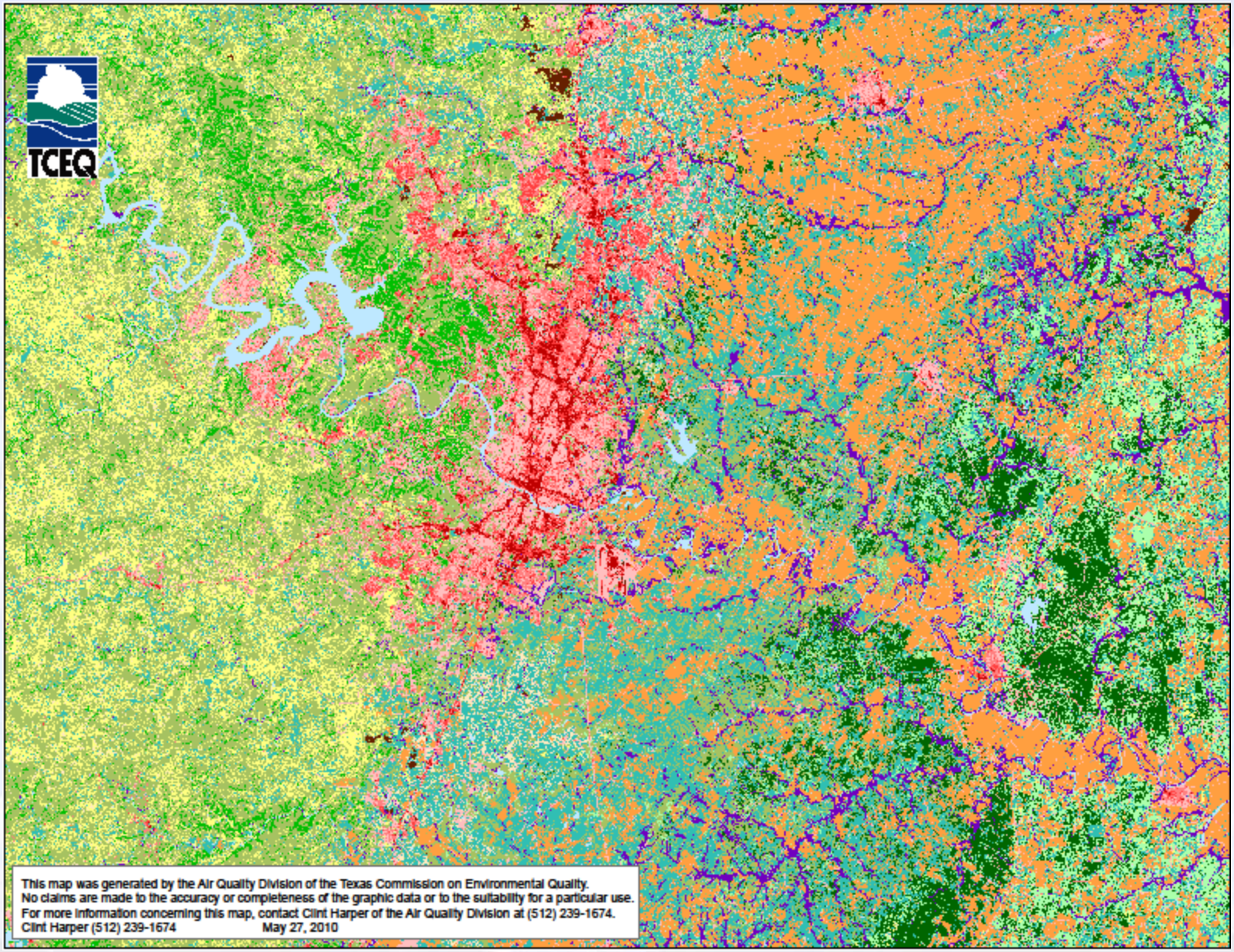


TAMU 4km ETX MM5 (Intermediate Deliverable)



Due August 2010

- "Crosswalk" NLCD with TLCCS
- Uses other national vegetation data
- Mexico classed via Landsat ETM+
- Will cover entire 12km MM5 domain


TCEQ
This map was generated by the Air Quality Division of the Texas Commission on Environmental Quality.
No claims are made to the accuracy or completeness of the graphic data or to the suitability for a particular use.
For more information concerning this map, contact Clint Harper of the Air Quality Division at (512) 239-1674.
Clint Harper (512) 239-1674 May 27, 2010

PGA 2009-25

- "Expansion of Texas Land Use/Land Cover Through Class Cross-walking and LiDAR Parameterization of Arboreal Vegetation" (TAMU – SSL, PGA# 2009-25)
  - Maps NLCD categories to TXLCS categories
  - Uses ancillary data to improve reclassification process and fill gaps
  - Landsat classification for northern Mexico
  - Ground-based and aerial LiDAR to improve allometric equations and evaluate canopy structure
  - Substantial field work
  - Complete, continuous vegetation map at 30 meter resolution for the entire 12 km MM5 domain

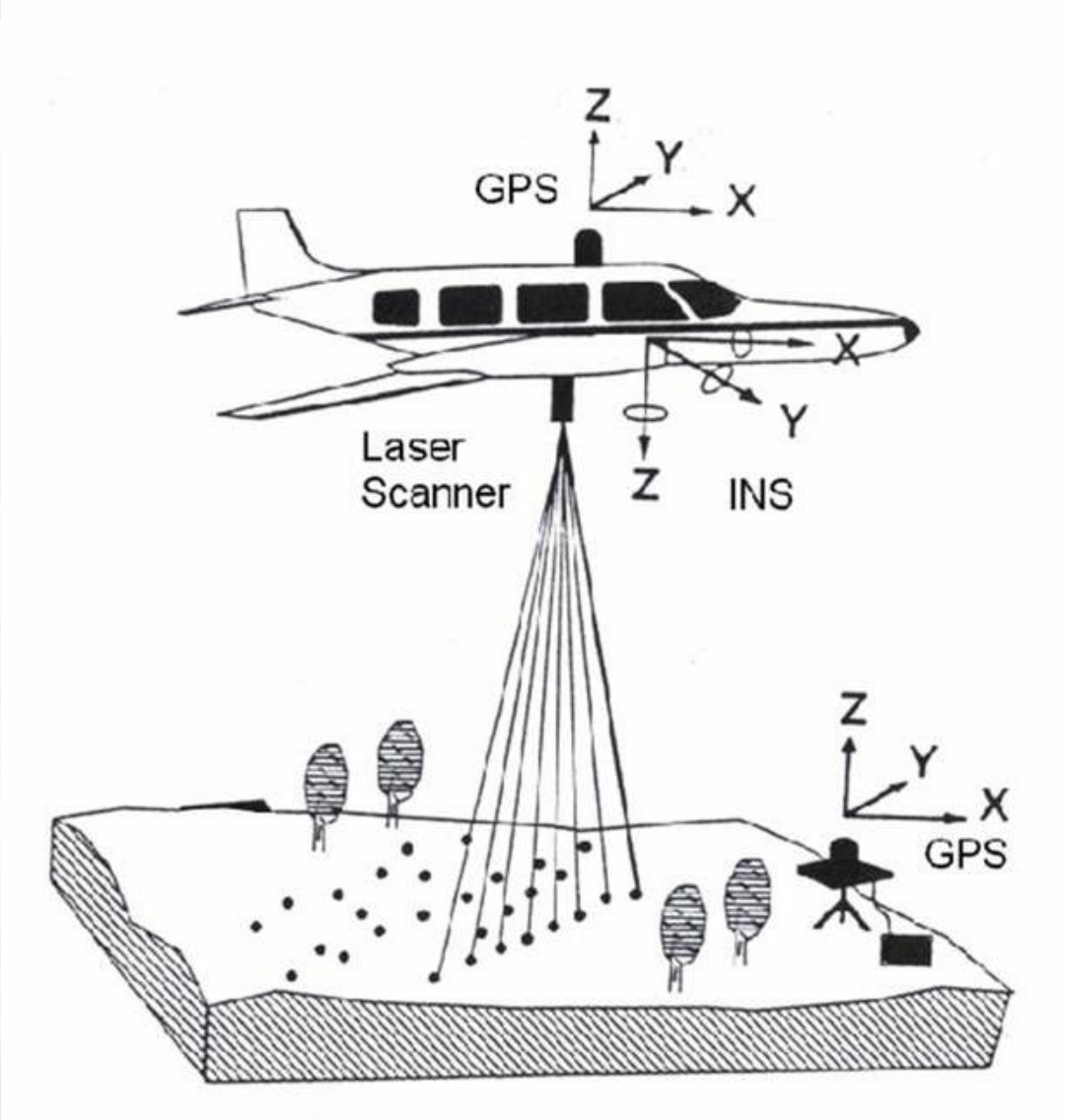
PGA 2010-28

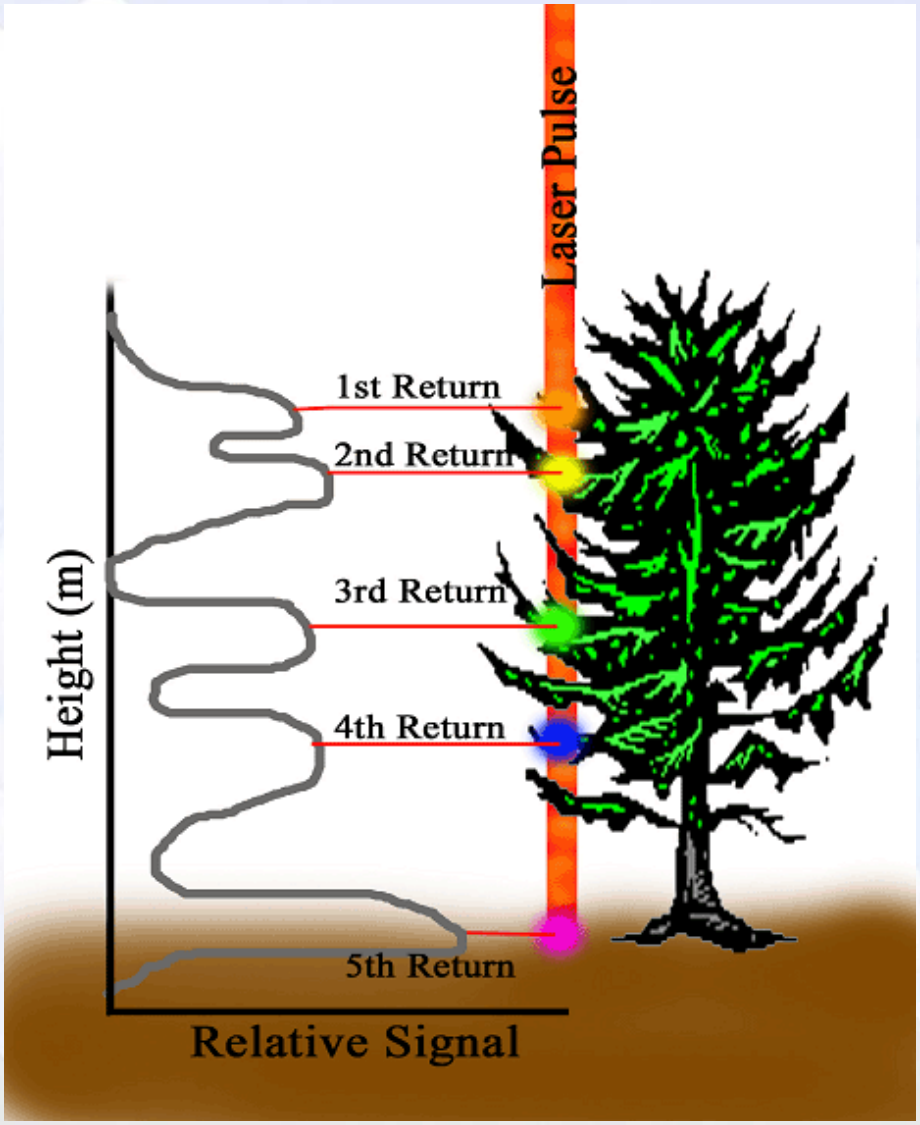
- "Speciation of Vegetation from Hyperspectral Imagery and LiDAR" – TAMU SSL, PGA# 2010-28
  - Identification of genus/species via spectral signatures
  - Improvements in spatial allocation of species
    - Direct detection of genus/species rather than assigning surrogates
  - Improved canopy measurements (with LiDAR)
    - New means to estimate crown bulk density
    - Effort to separate leaf mass from wooded mass
  - Improved allometric equations for tree species in Texas
    - Means to more accurately estimate tree parameters from imagery and LiDAR

Data for Developing Biogenic Emissions

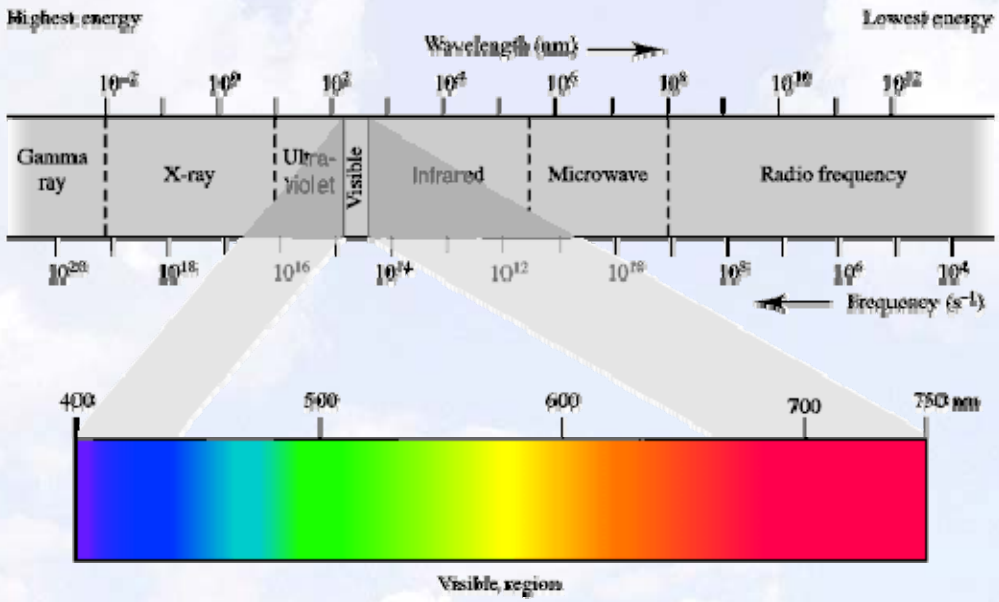
- Temperatures
- Photosynthetically active radiation (PAR)
  - Derived from Satellite Measurements
- Spatial distribution of the emitters of BVOC emissions (by genus/species)
  - Vegetation aggregated into land cover categories
    - Requires vegetation data
  - Necessary to properly allocate BVOC emissions
- Leaf mass density (LMD) by species in g/m^2
  - LMD is associated with emission rates in the model
- Canopy structure
  - Important to estimate the interaction of photosynthetically active radiation (PAR) with leaves, which are exposed to varying amounts of sunlight depending on their position in the canopy
  - Affects the emissions from leaves
  - Crown volume (for crown bulk density)
- BVOC Emission rates per species
  - Important for emission estimates in model

Airborne LiDAR

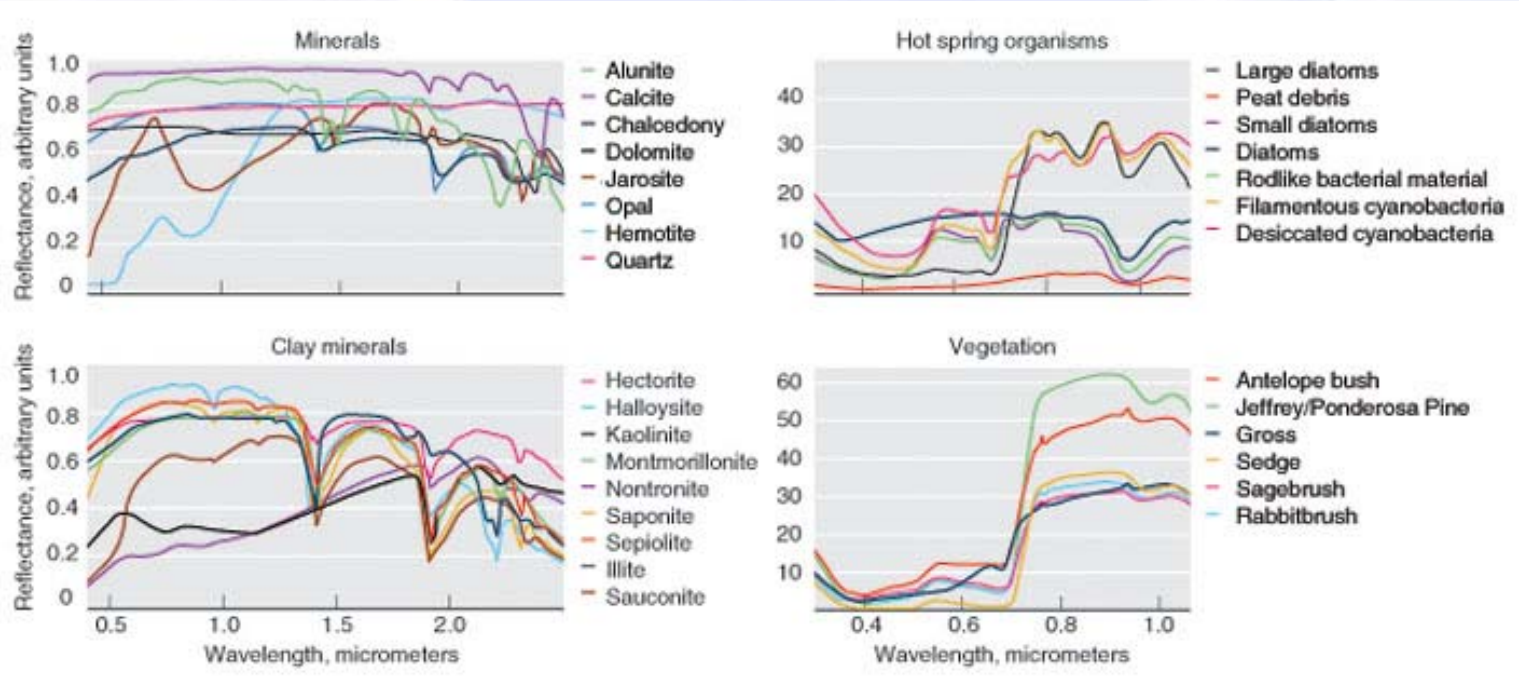



Laser Pulse
1st Return
2nd Return
3rd Return
4th Return
5th Return
Height (m)
Relative Signal

Electromagnetic Spectrum



Hyperspectral?



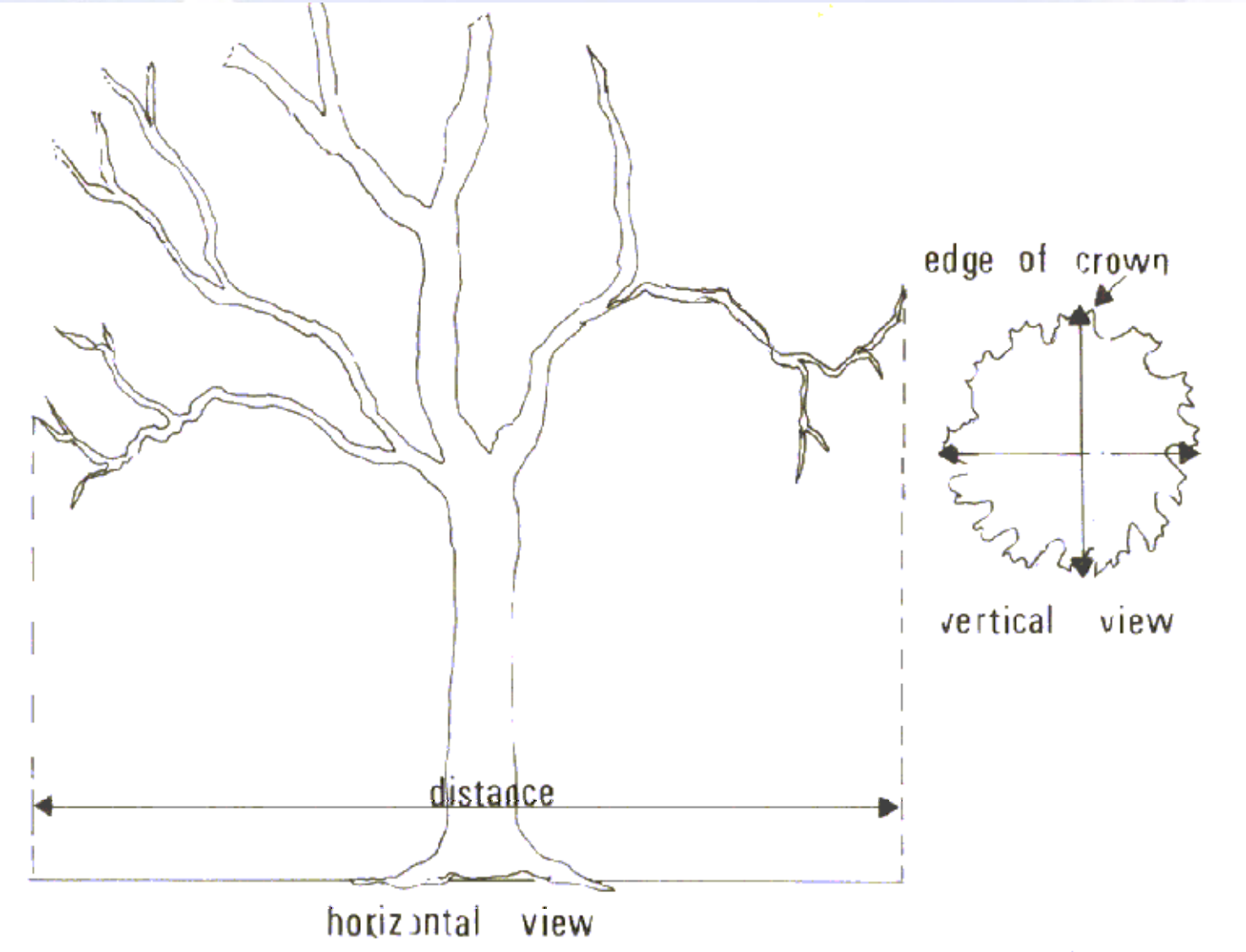
https://www.llnl.gov/str/May03/Pickles.html

Future Projects

- Conduct flux tower measurements to measure BVOCs near the source and refine emission rates
- Do change detection for land cover for temporally different datasets to reveal areas of interest/focus for future land cover work
  - Changes will likely occur in areas subject to hazards (hurricanes & fires) and urban expansion
- Refine urban land cover classes that more accurately capture vegetation distribution
  - Map urban canopy
    - Locate BVOC emissions near urban NOx sources
- Compare GloBEIS and MEGAN
- LiDAR measurements from Geoscience Laser Altimeter System (GLAS) – onboard ICESat

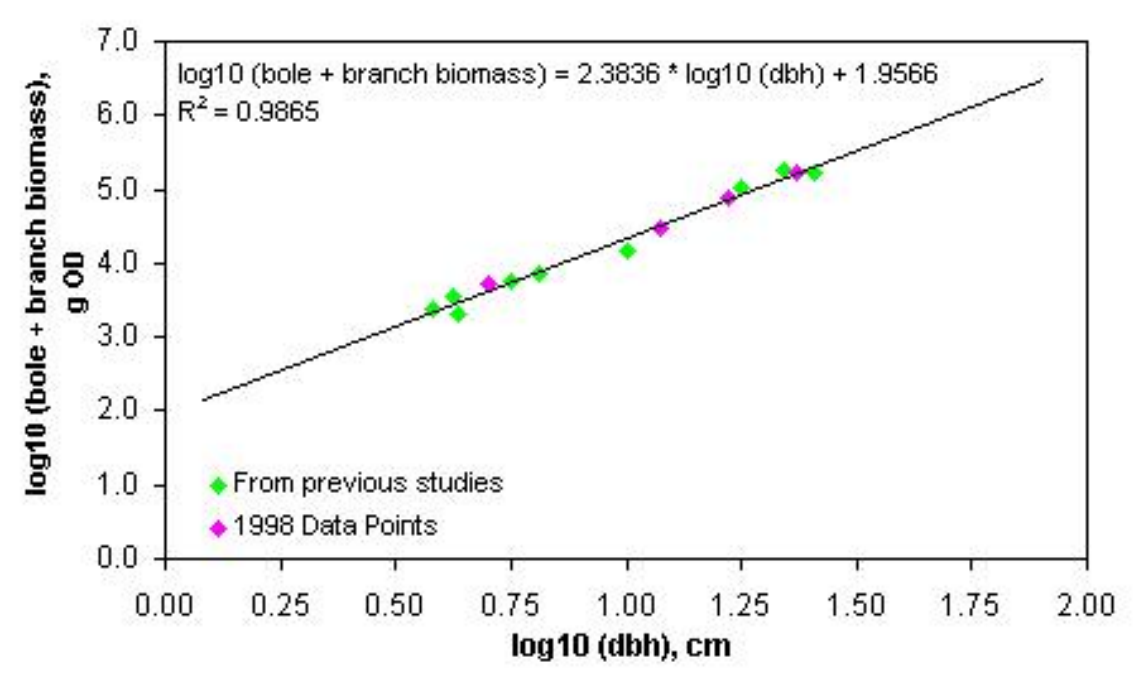
Summary

- Land cover is improved from 1 km resolution (BEIS) to 30m (New TCEQ Land Cover Map)
- Land cover is consistent and contiguous across entire 12km MM5 domain
- Improved vegetation data – spatial distribution, allometric relationships, structure, canopy data (crown bulk density, crown diameter), etc.
  - From LiDAR
  - From Hyperspectral data
    - Directly locate genus' location via spectral signatures
- Land cover now includes the northern portion of Mexico in the 12km MM5 domain
- Improved land cover available for meteorological, photochemical, and biogenic models
- Base map to track changes in land cover through time


edge of crown
vertical view
distance
horizontal view

3108
1 2 3 4 5 6 7 8 9 10
22

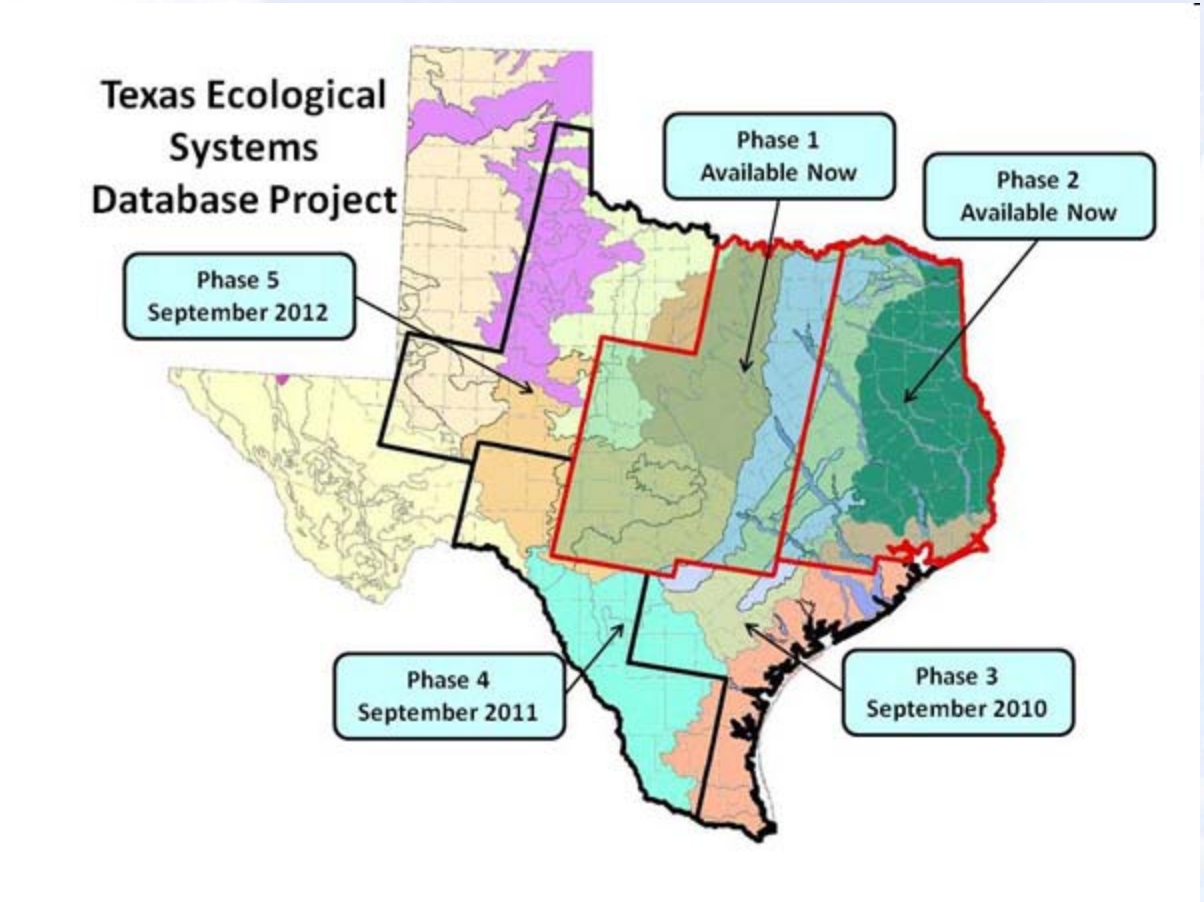
HILLCREST
FARMS

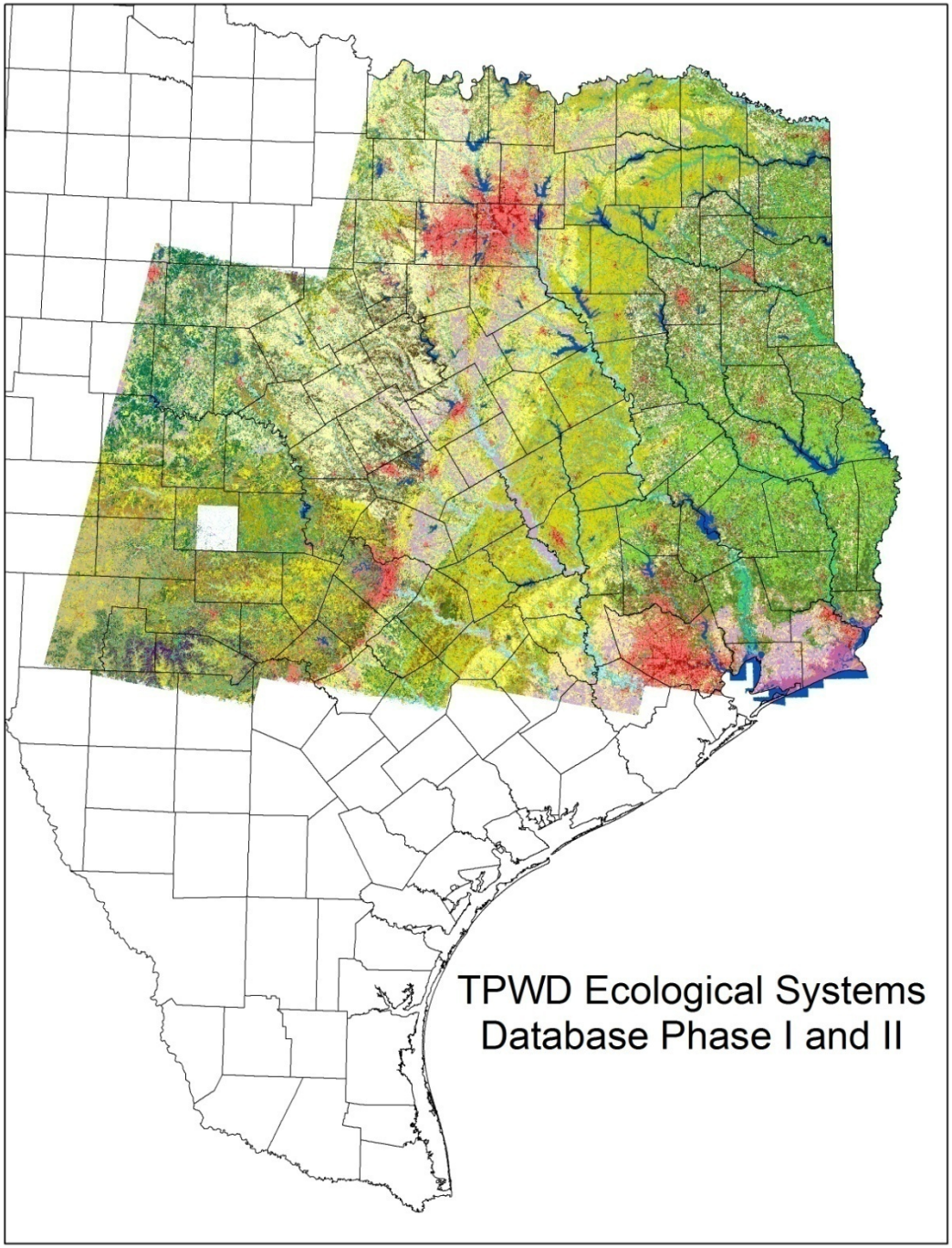


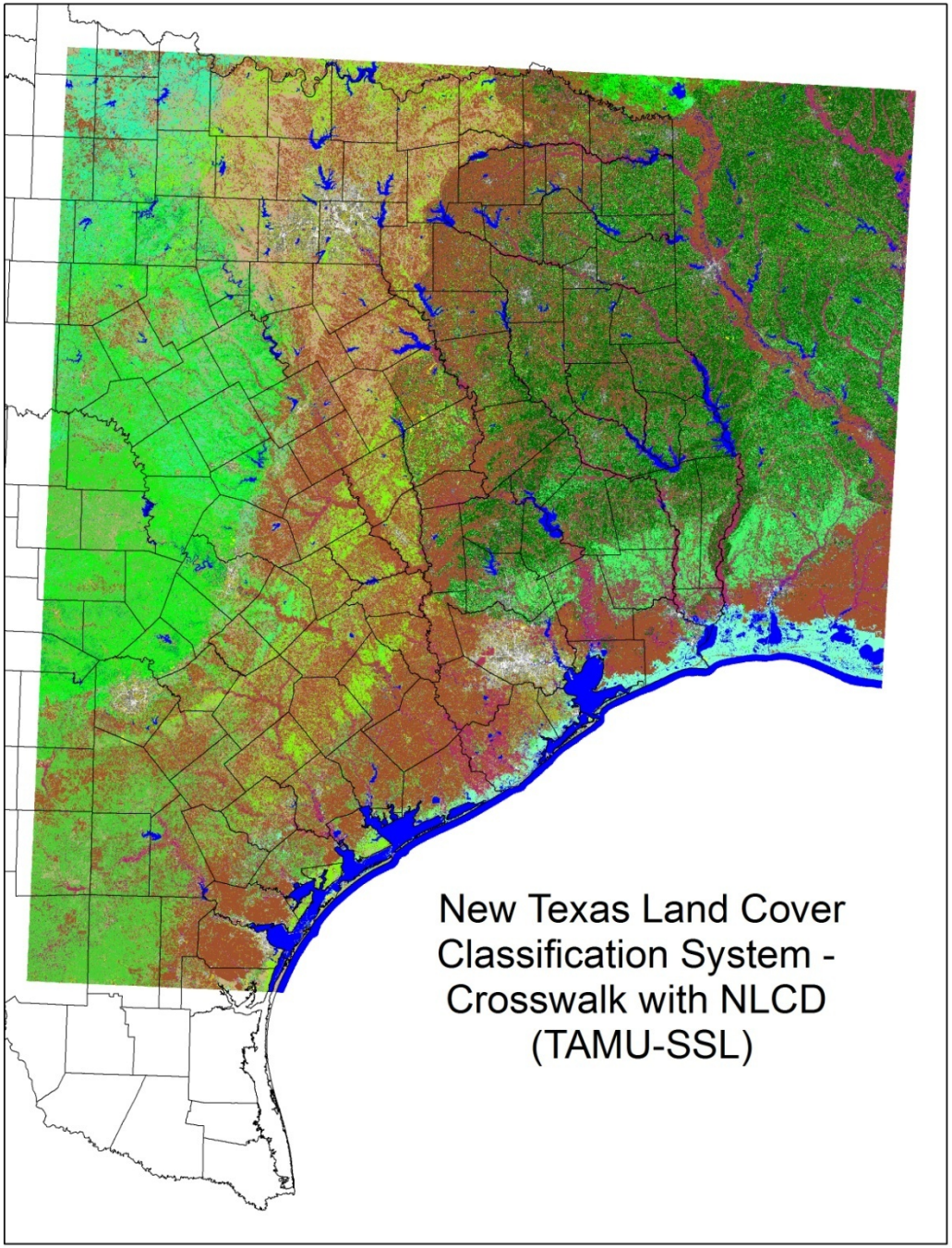
*From a 1999 Yale study using Sassafras trees

Texas Parks and Wildlife Department – Texas Ecosystem Data

- Multi-million dollar project (~ $12 million)
- Very fine, granular data from extensive field work, aerial photographs, Landsat, other ancillary data
- Much of the project conducted by the Missouri Resource Assessment Partnership
- Land cover, vegetation suites, soil data – entire ecosystem description
- Due to be completed in 2014.
- Useful to corroborate our land cover data


Texas Ecological Systems Database Project
Phase 1 Available Now
Phase 2 Available Now
Phase 5 September 2012
Phase 4 September 2011
Phase 3 September 2010


TPWD Ecological Systems
Database Phase I and II


New Texas Land Cover
Classification System -
Crosswalk with NLCD
(TAMU-SSL)

Spatial Resolution

a. Landsat ETM+ b. ATLAS c. QuickBird