Yes, lightning does strike twice in the same place!
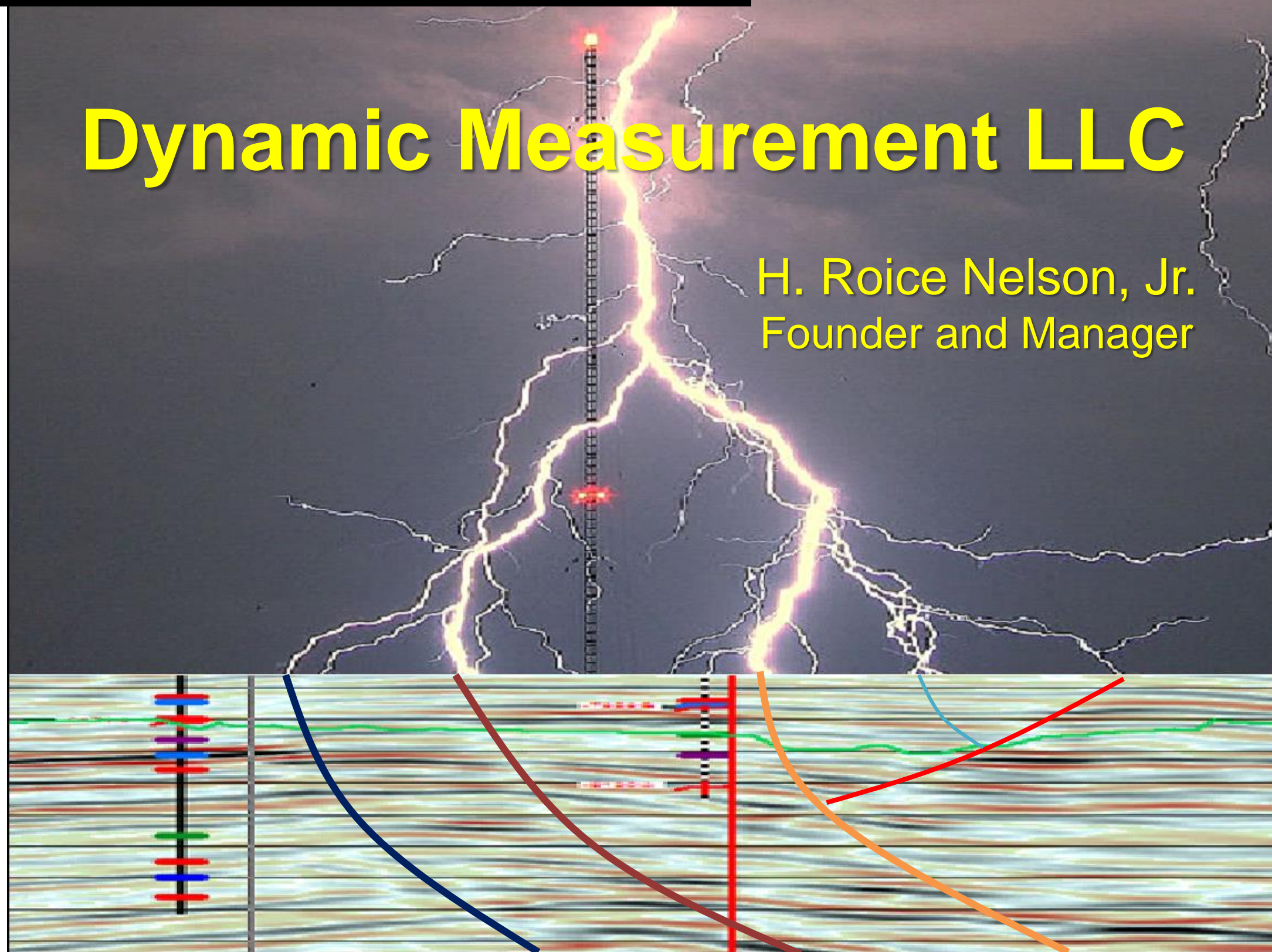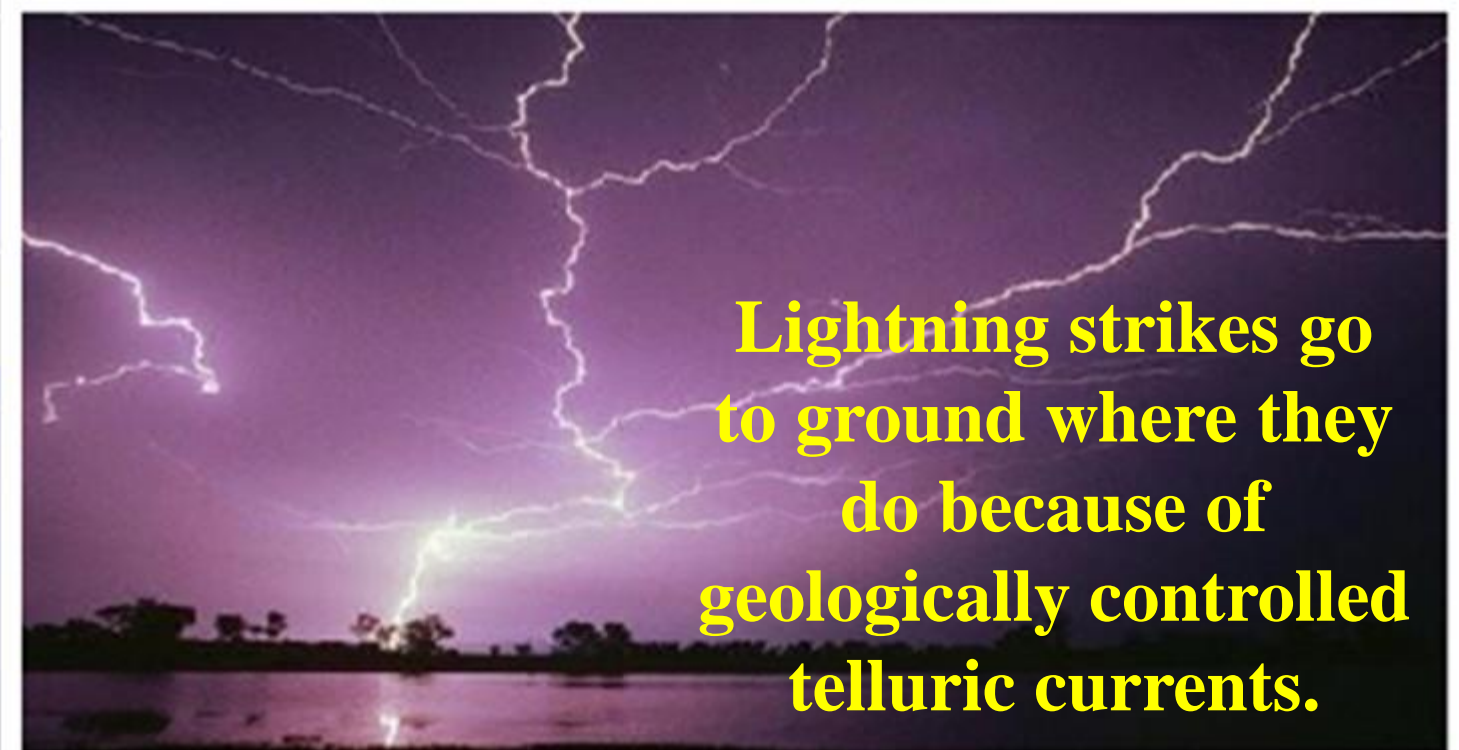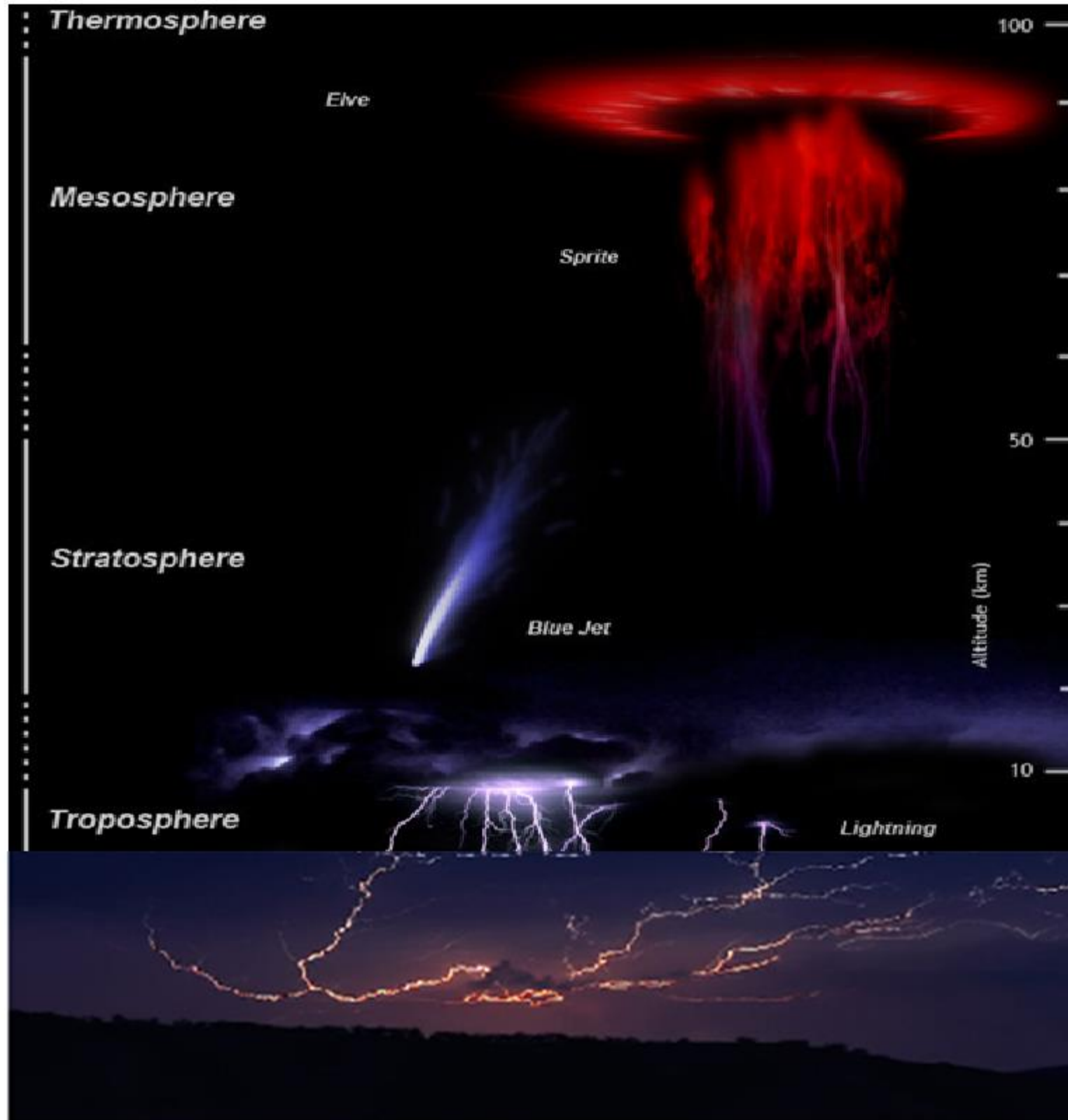
Dynamic Measurement LLC

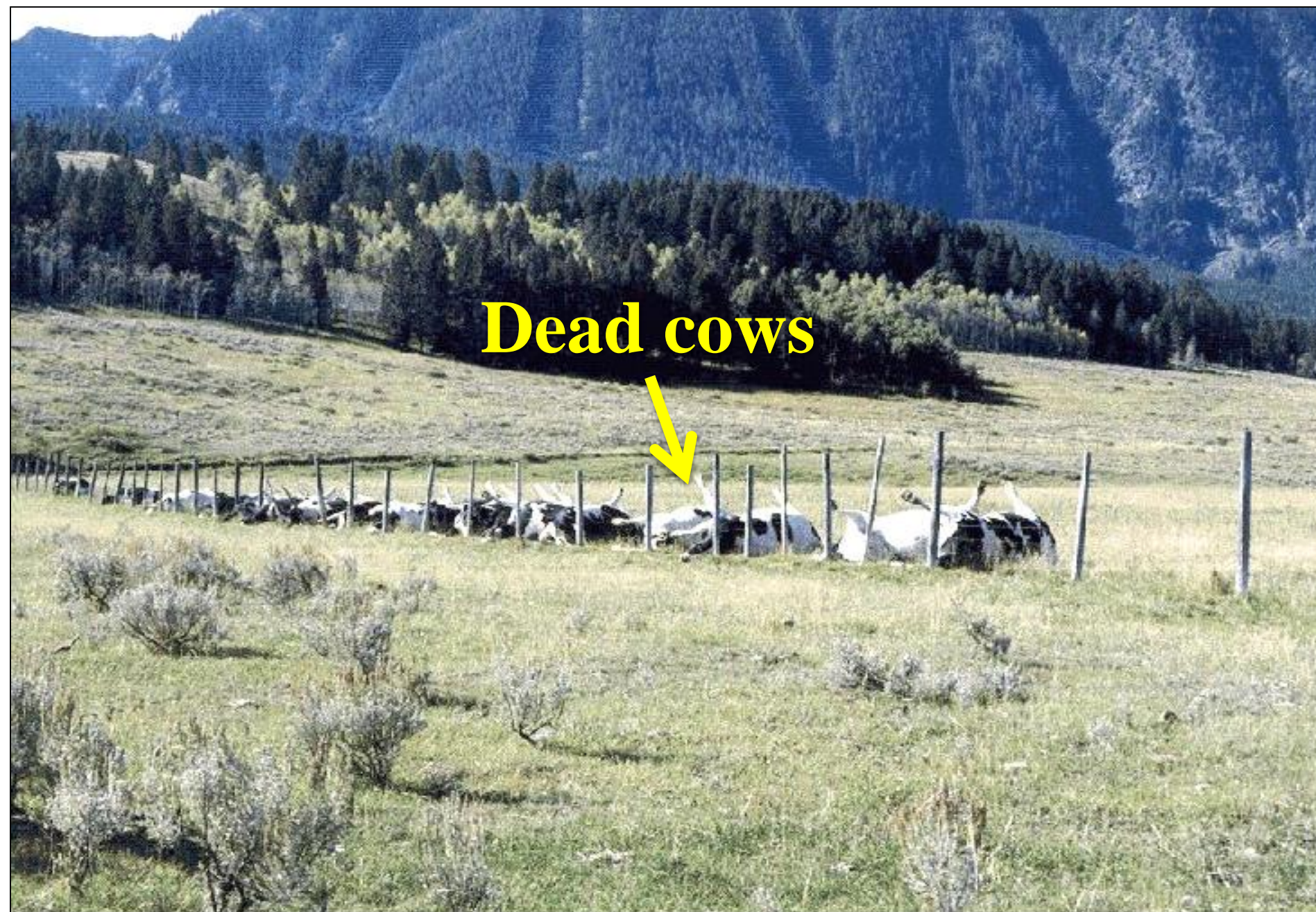H. Roice Nelson, Jr.
Founder and Manager

350 million annual cloud-to-ground strikes provide a rich evergreen database to mine

Cloud-to-Cloud lightning travels 250+ km or 2 ½ times more distance than Sprite & Elves.

Lightning strikes go to ground where they do because of geologically controlled telluric currents.

Lightning recorded for early storm warning, safety, insurance, & meteorology purposes
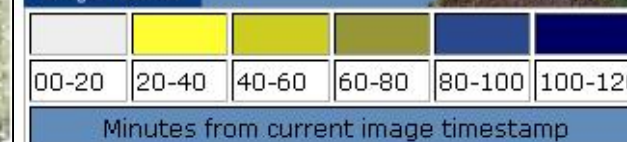

Dead cows

Lightning strike map

2011 5:15 PM PDT

08/30/2011 23:20:00 - Total events: 40198

VAISALA
Map generated using
Vaisala's NLDN
All rights reserved

| 00-20 | 20-40 | 40-60 | 60-80 | 80-100 | 100-120 |

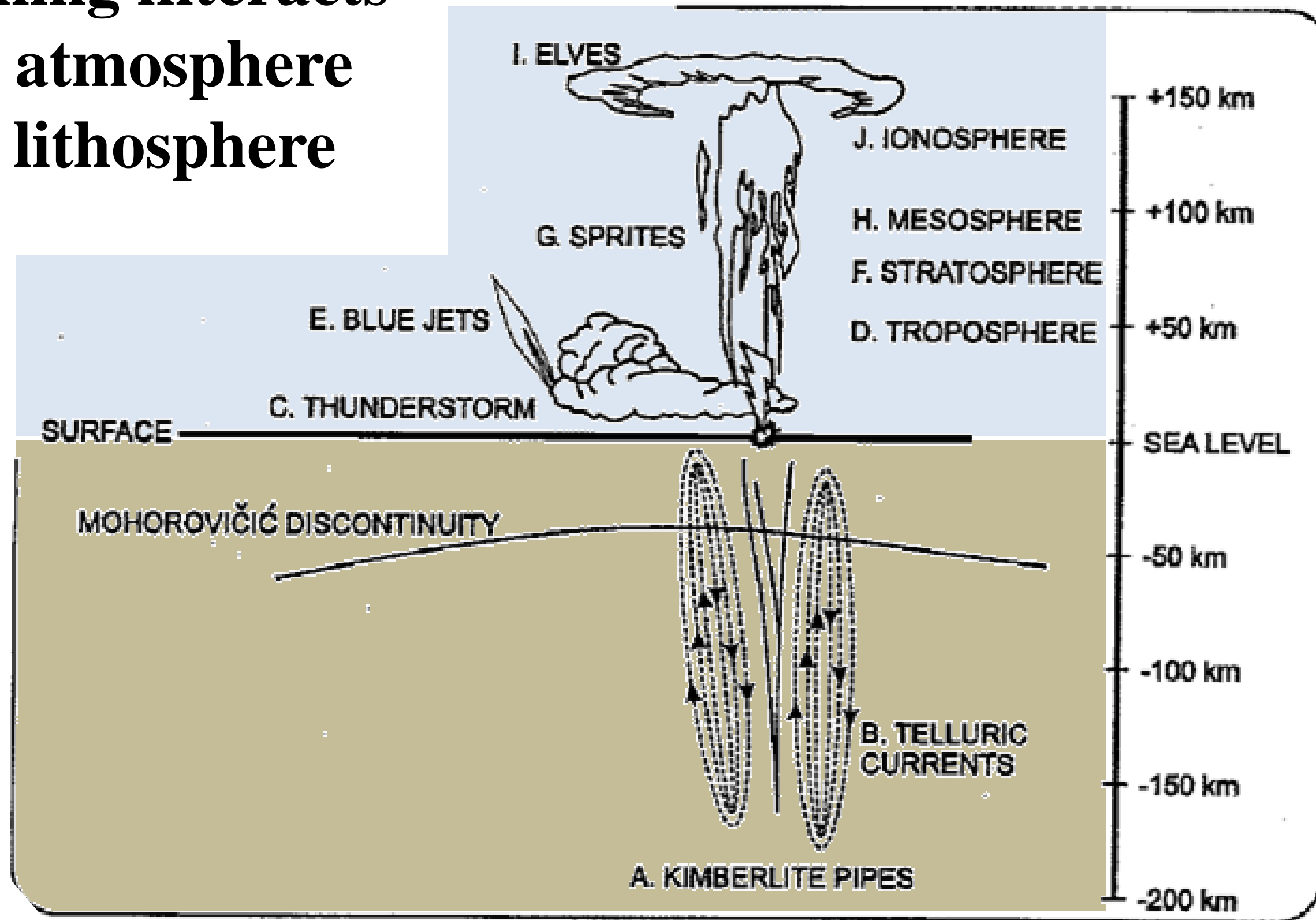Minutes from current image timestamp

Lightning Probability Forecast Map - Pacific Northwest

The U.S. NLDN (National Lightning Detection Network) owned by Vaisala

Lightning interacts with atmosphere and lithosphere

Lightning Strikes Cluster over North Dakota Fields

Yellow: Red Sky 3-D seismic outline
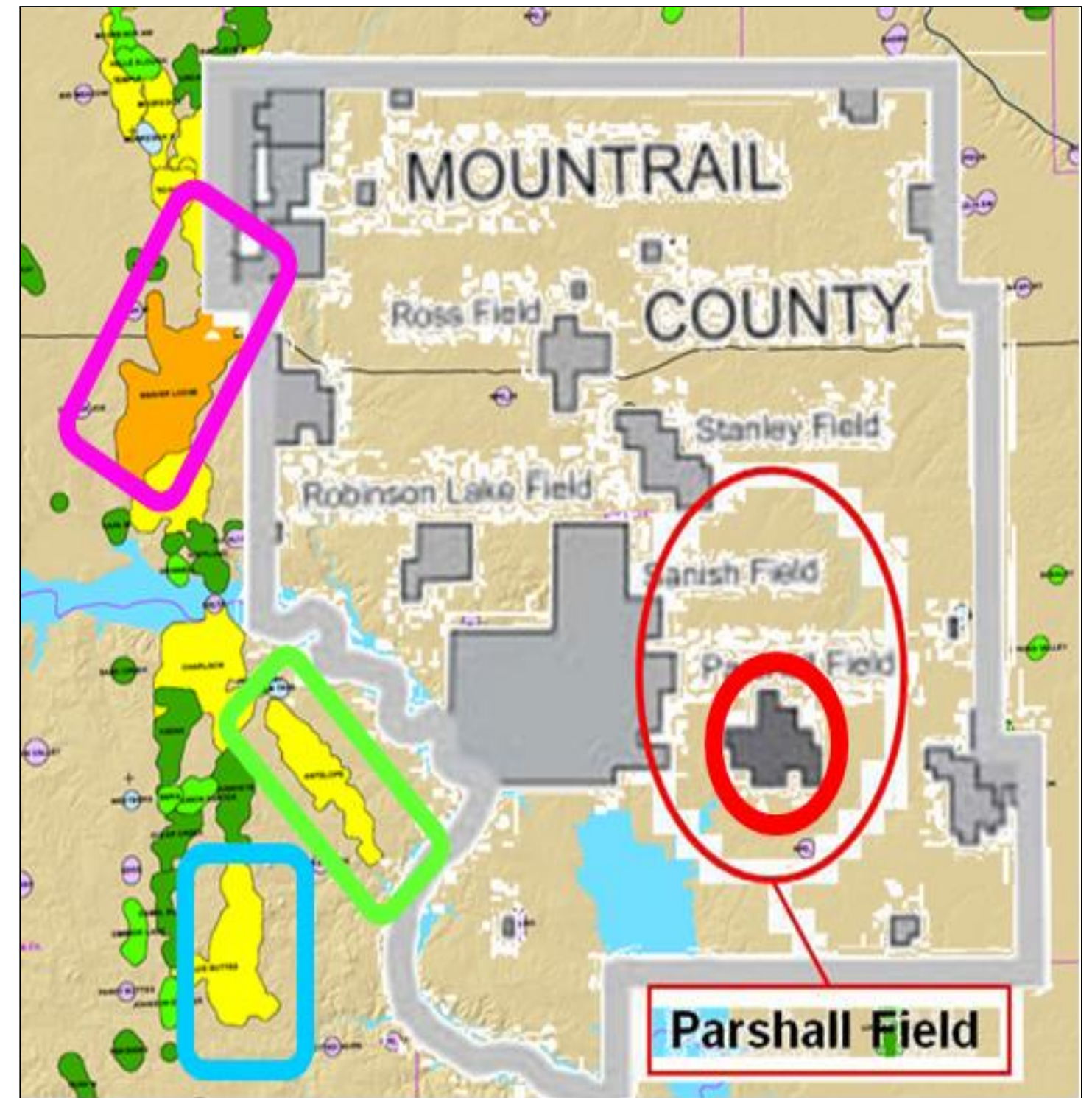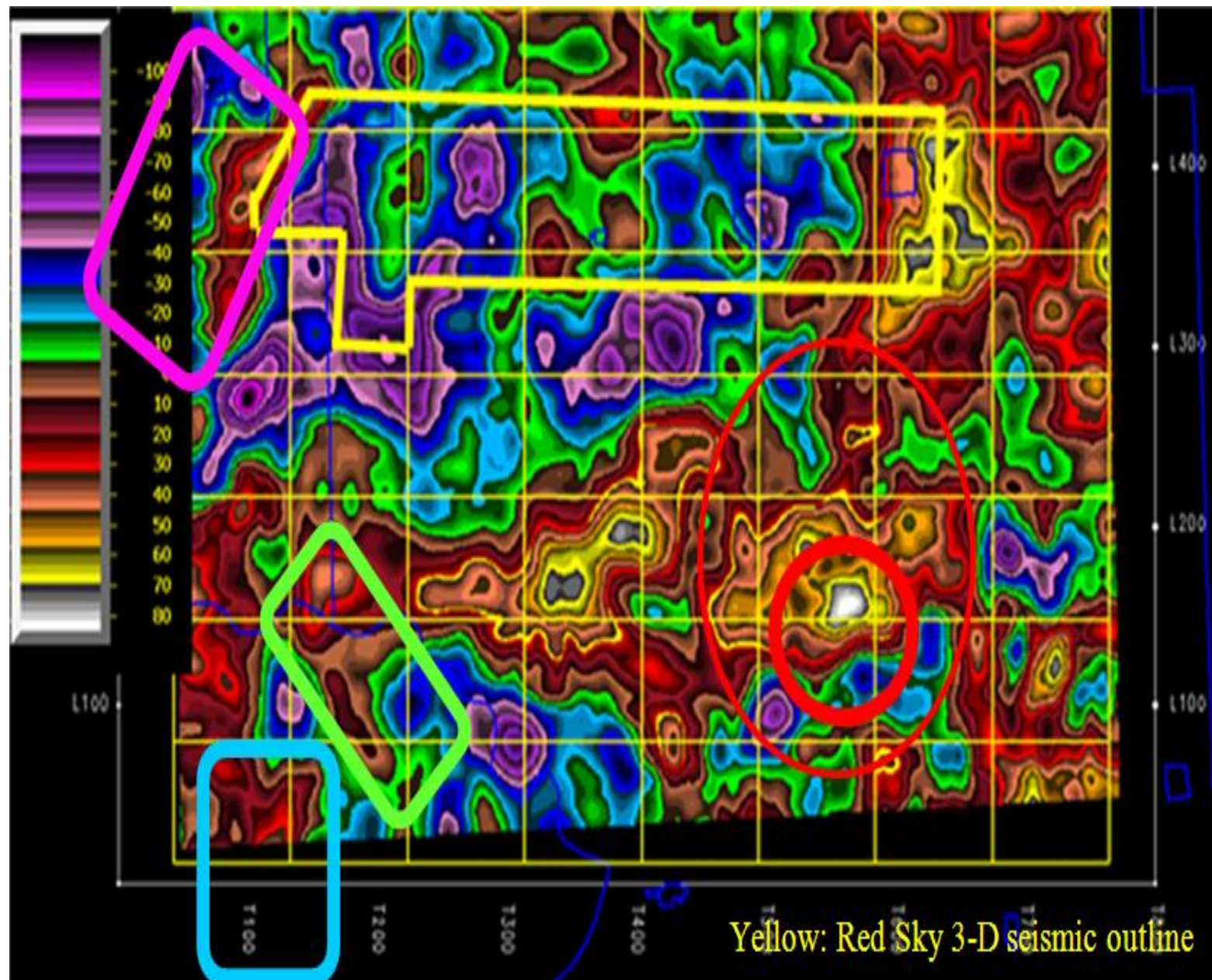
Key Fields in Mountrail County, ND correlate with high density lightning clusters at high lunar tide

Lightning maps enabling high-grading of leases, leads, & prospects.

Lightning Data is both an Old & a New Geophysical Data Type

1752 Benjamin Franklin measured electricity attaching a metal key to the bottom of a dampened kite, in what we now know as the Marcellus Shale Resource Play.

1833 First measurements of earth's magnetic field by Carl Friedrich Gauss.

1920's Seismic refraction & reflection techniques pioneered in Germany & the U.S.

1927 Doll-Schlumberger's first electrical resistivity well log recorded in France.

1936 Howard N. Potts Medal to Vening Meinesz for the first modern gravimeter.

1950's Magnetotellurics invented, measuring lightning charged earth currents.

1960's & '70's The first image processing of satellite imagery.

1974 First 3-D seismic survey collected for Gulf Oil by GSI.

1997 CSEM (Controlled Source Electromagnetics).

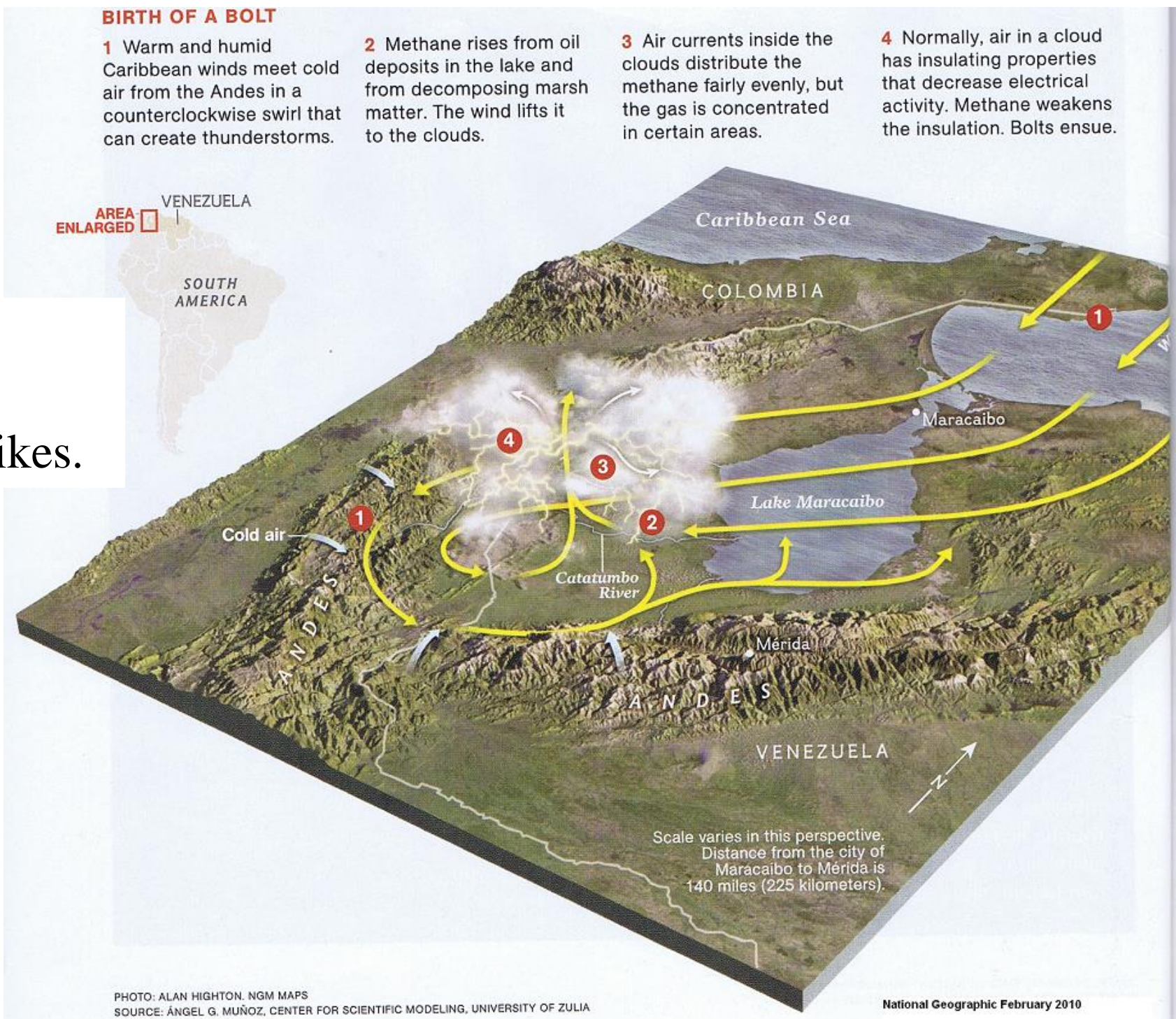**2008 Data mining lightning data as a new Geophysical Data Type.**

Each new data type sparked millions of dollars in sales of data & services.

Lightning Technology Sparking Interest

2006: Hunting Ducks
2007: Repeat
2011 Sep 27th: hundreds of strikes.
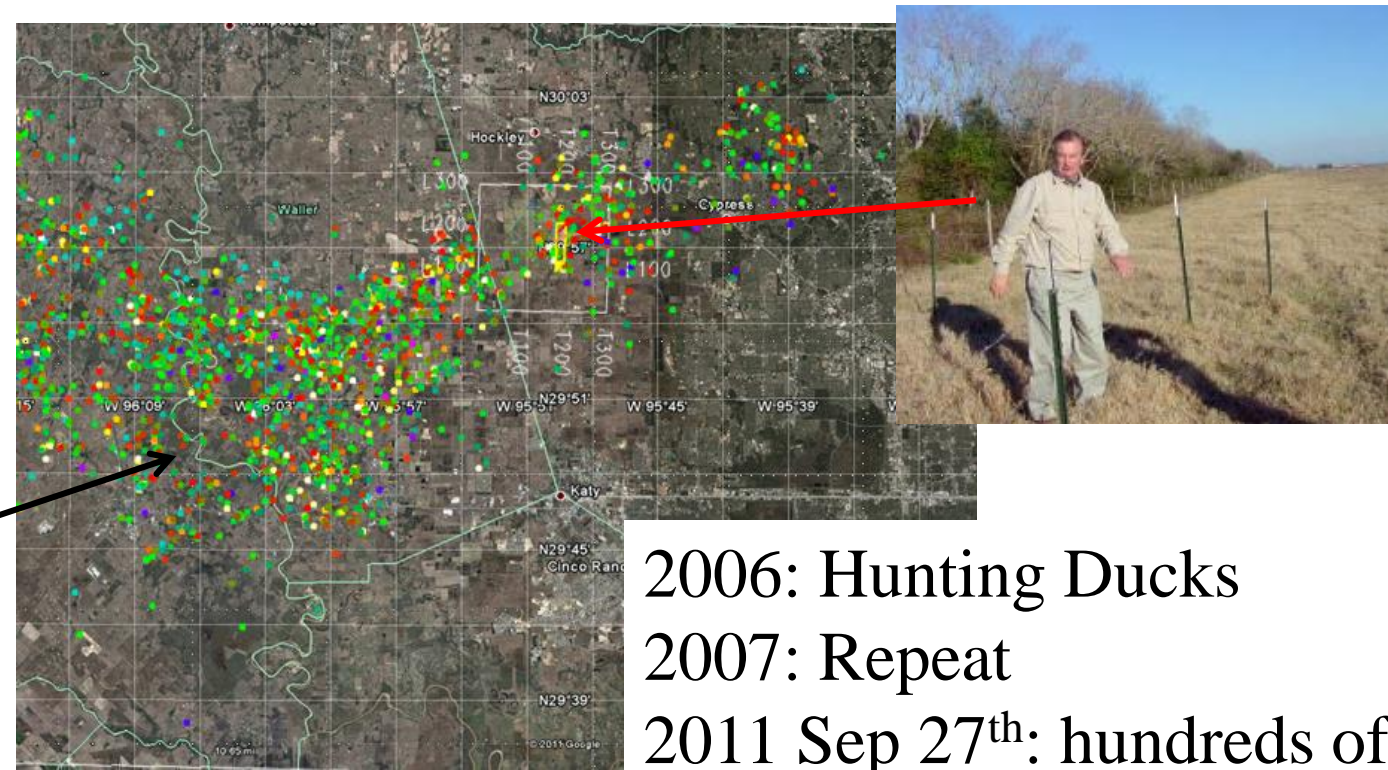
Largest Tesla Coils Ever Will Recreate Natural Lightning

Published on November 27, 2011, by Joshua Philipp - Posted in *Tech Bytes, Tech News*   💬 9

BIRTH OF A BOLT

1 Warm and humid Caribbean winds meet cold air from the Andes in a counterclockwise swirl that can create thunderstorms.

2 Methane rises from oil deposits in the lake and from decomposing marsh matter. The wind lifts it to the clouds.

3 Air currents inside the clouds distribute the methane fairly evenly, but the gas is concentrated in certain areas.

4 Normally, air in a cloud has insulating properties that decrease electrical activity. Methane weakens the insulation. Bolts ensue.

Scale varies in this perspective. Distance from the city of Maracaibo to Mérida is 140 miles (225 kilometers).

PHOTO: ALAN HIGHTON. NGM MAPS
SOURCE: ÁNGEL G. MUÑOZ, CENTER FOR SCIENTIFIC MODELING, UNIVERSITY OF ZULIA
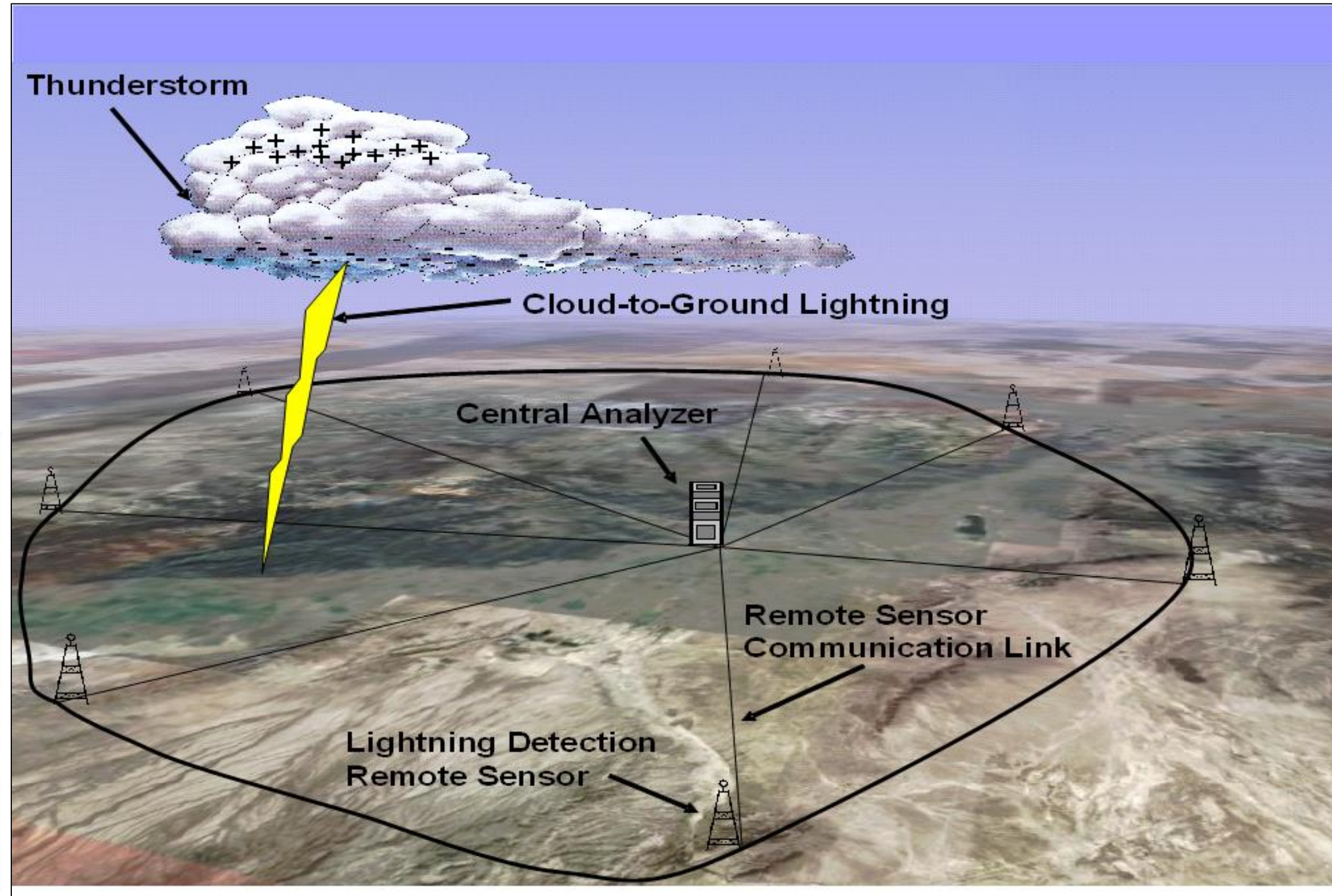
National Geographic February 2010

Lightning Measurements

- Location
- Time and Duration
- Rise Time
- Peak Current
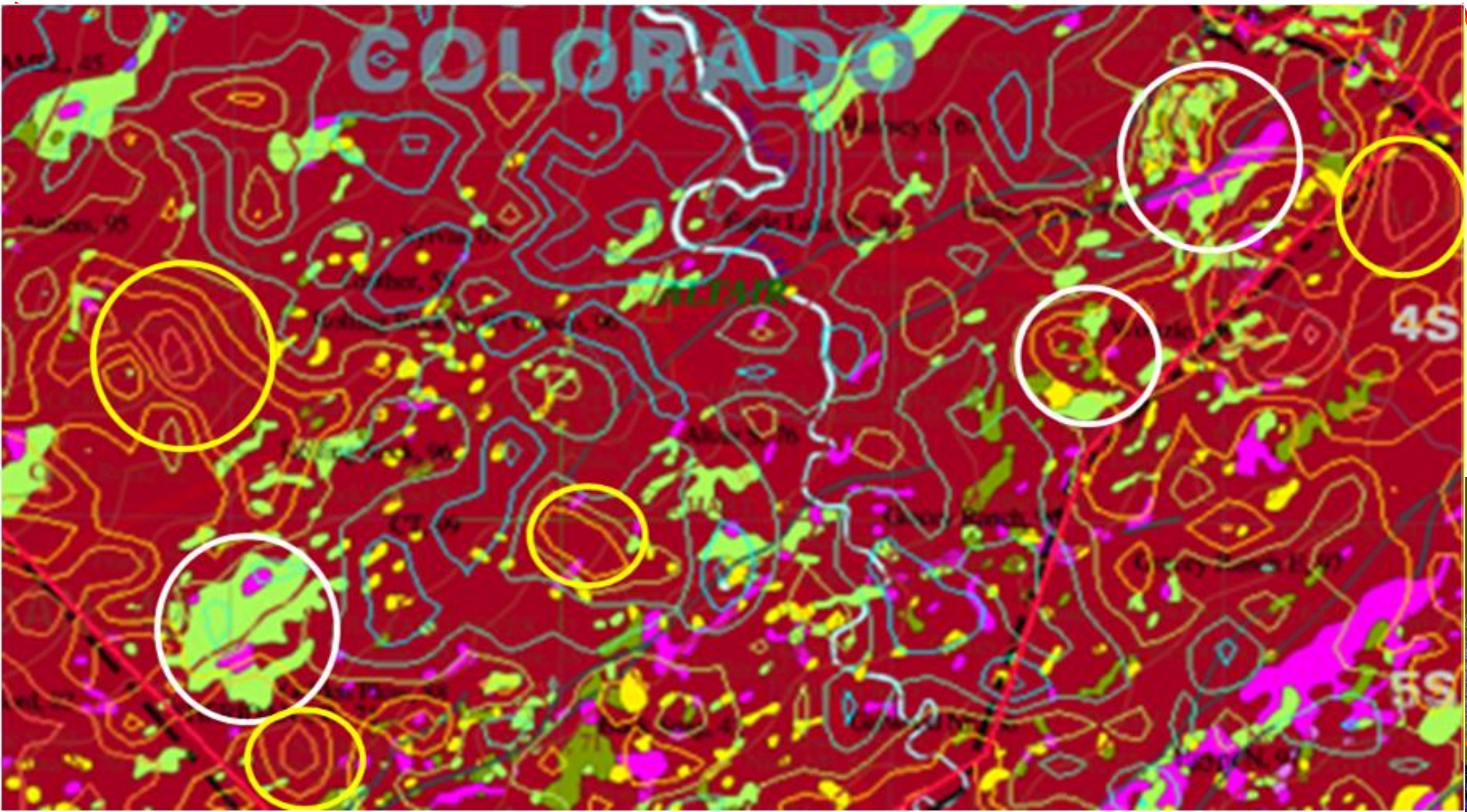- Peak-to-Zero
- Polarity
- Chi Squared
- Number of Sensors

~330 Sensors record U.S. lightning strikes with +/- 100-500 foot location resolution
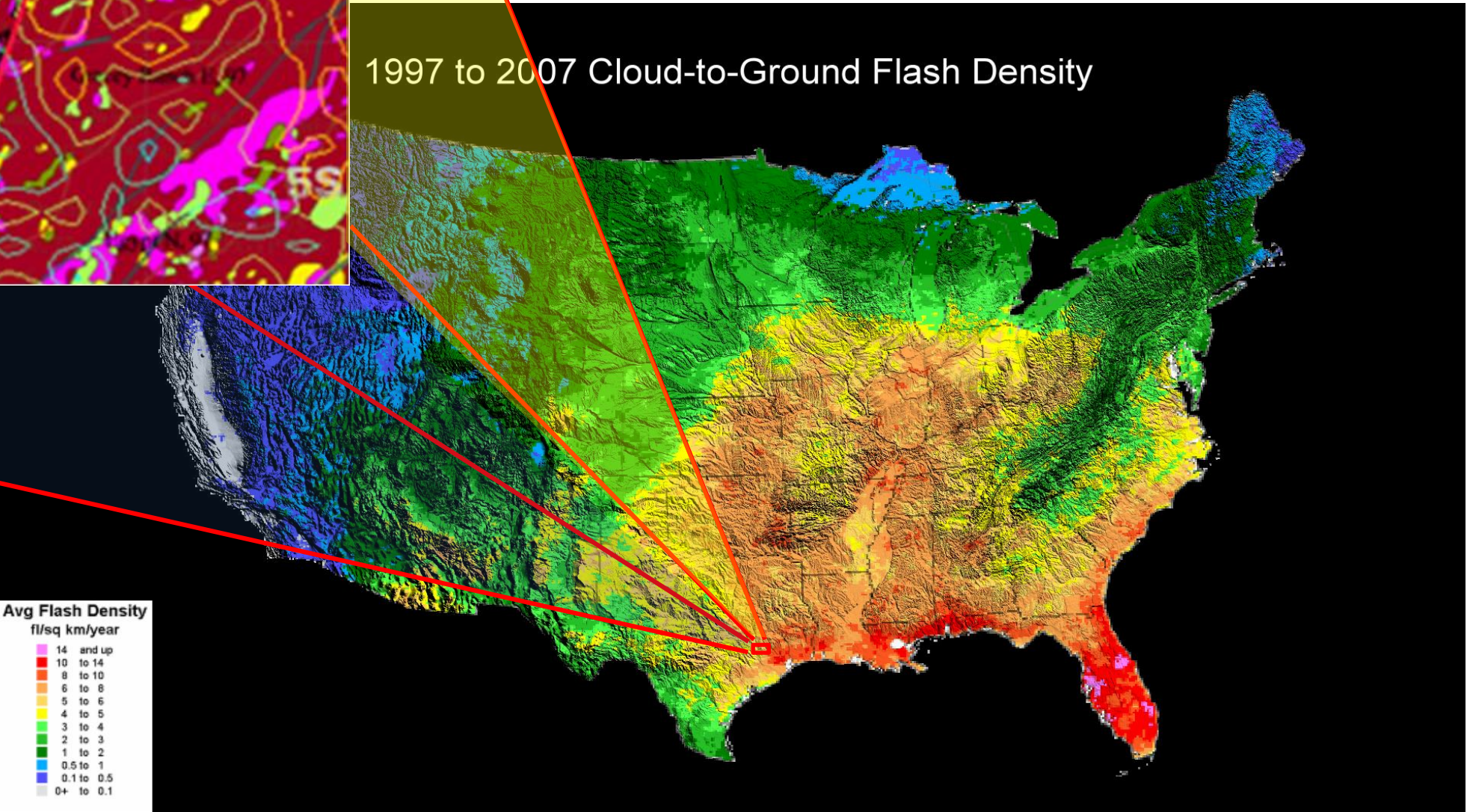

Thunderstorm

Cloud-to-Ground Lightning

Central Analyzer

Remote Sensor Communication Link

Lightning Detection Remote Sensor

Sensor Electronics

LS7000/8000

LDAR

Lightning maps & natural resources

Locally controlled by geology

1997 to 2007 Cloud-to-Ground Flash Density

Regionally controlled by meteorology

Avg Flash Density
fl/sq km/year

|	
14	and up
10 to 14	
8 to 10	
6 to 8	
5 to 6	
4 to 5	
3 to 4	
2 to 3	
1 to 2	
0.5 to 1	
0.1 to 0.5	
0+ to 0.1	

Texas Lunch Hour Storms: 08 March 2010
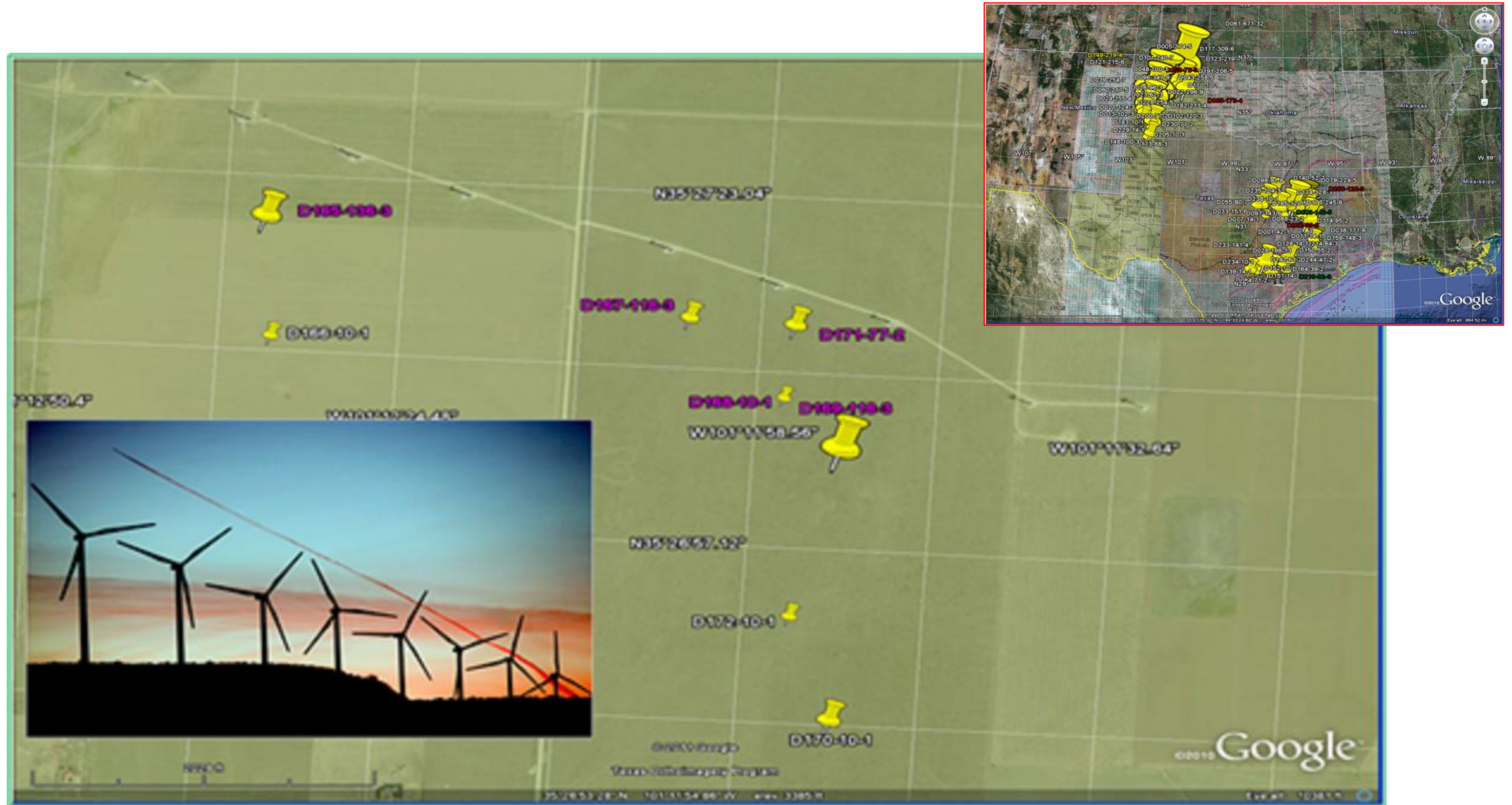
Lighting is a new Geophysical Data Type

- Lightning occurs everywhere (less dense near the poles & in deep water),
- the data is in databases & the public domain (DML has an exclusive worldwide license for natural resource exploration with Vaisala's database), &
- lighting data is less expensive than other geophysical data types.
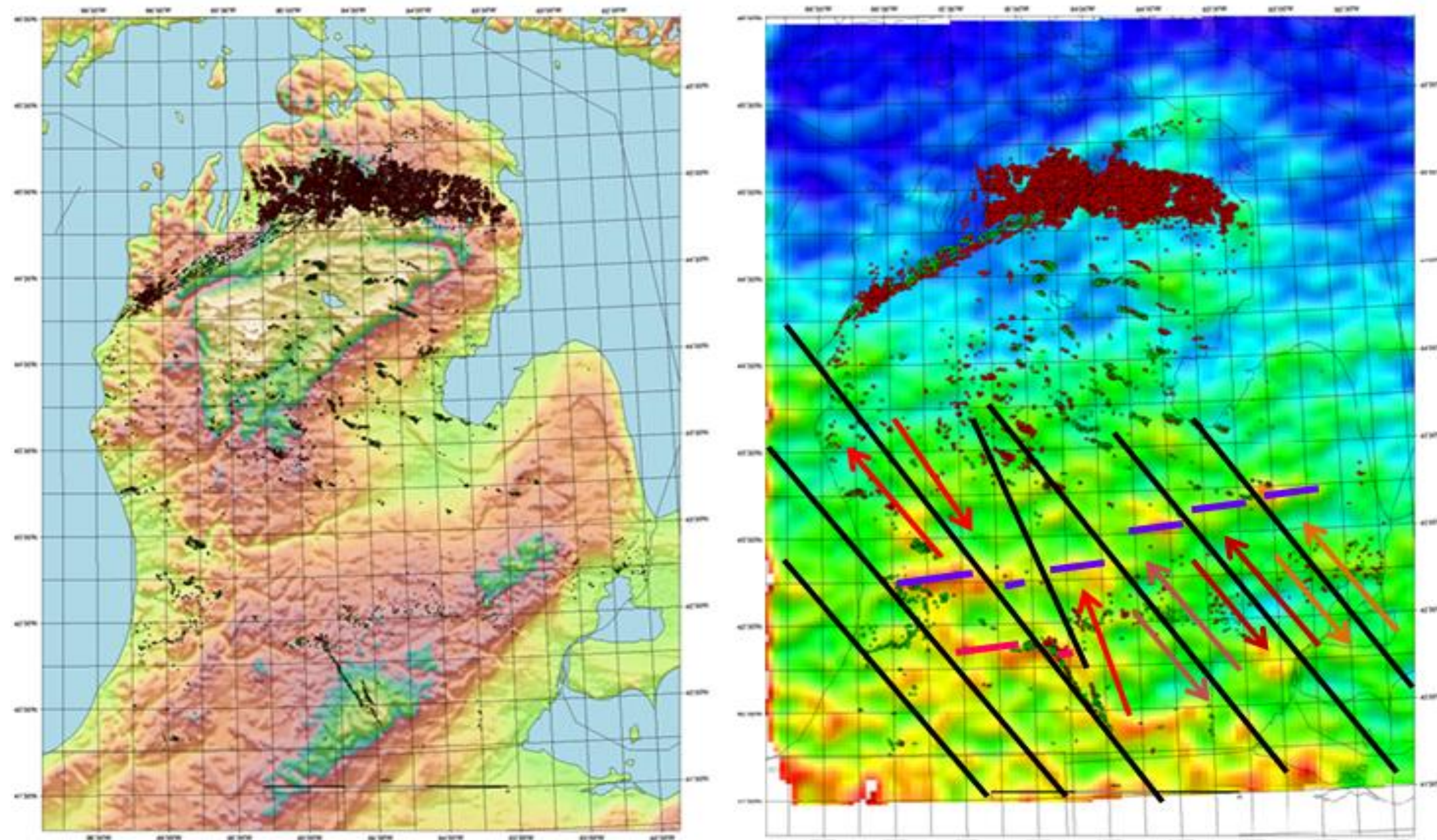
Michigan Topography (left) **and Lightning Density Map** (right)
highlighting interpreted transverse faults (red gas & green oil wells)

DML Patent: Method for locating sub-surface natural resources issued 01 January 2013

US008344721B2

(12) United States Patent
Nelson, Jr. et al.

(10) Patent No.: **US 8,344,721 B2**
(45) Date of Patent: **Jan. 1, 2013**

(54) **METHOD FOR LOCATING SUB-SURFACE NATURAL RESOURCES**

(75) Inventors: **H. Roice Nelson, Jr.**, Houston, TX (US); **Joseph H. Roberts**, Houston, TX (US); **D. James Siebert**, Katy, TX (US); **Wulf F. Massell**, Conroe, TX (US); **Samuel D. LeRoy**, Houston, TX (US); **Leslie R. Denham**, Houston, TX (US); **Robert Ehrlich**, Salt Lake City, UT (US); **Richard L. Coons**, Katy, TX (US)

(73) Assignee: **Vaisala Oyj**, Helsinki (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 391 days.

(21) Appl. No.: **12/655,810**

(22) Filed: **Jan. 7, 2010**

(65) **Prior Publication Data**

US 2011/0163733 A1 Jul. 7, 2011

(51) Int. Cl.
G01R 31/02 (2006.01)
G01N 27/00 (2006.01)
G01W 1/00 (2006.01)
(52) U.S. Cl. **324/72**; 324/71.1; 702/4
(58) Field of Classification Search 324/72, 324/71.1; 702/4
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,417,282 A * 5/1995 Nix 166/248
2010/0023267 A1 * 1/2010 Karabin et al. 702/4
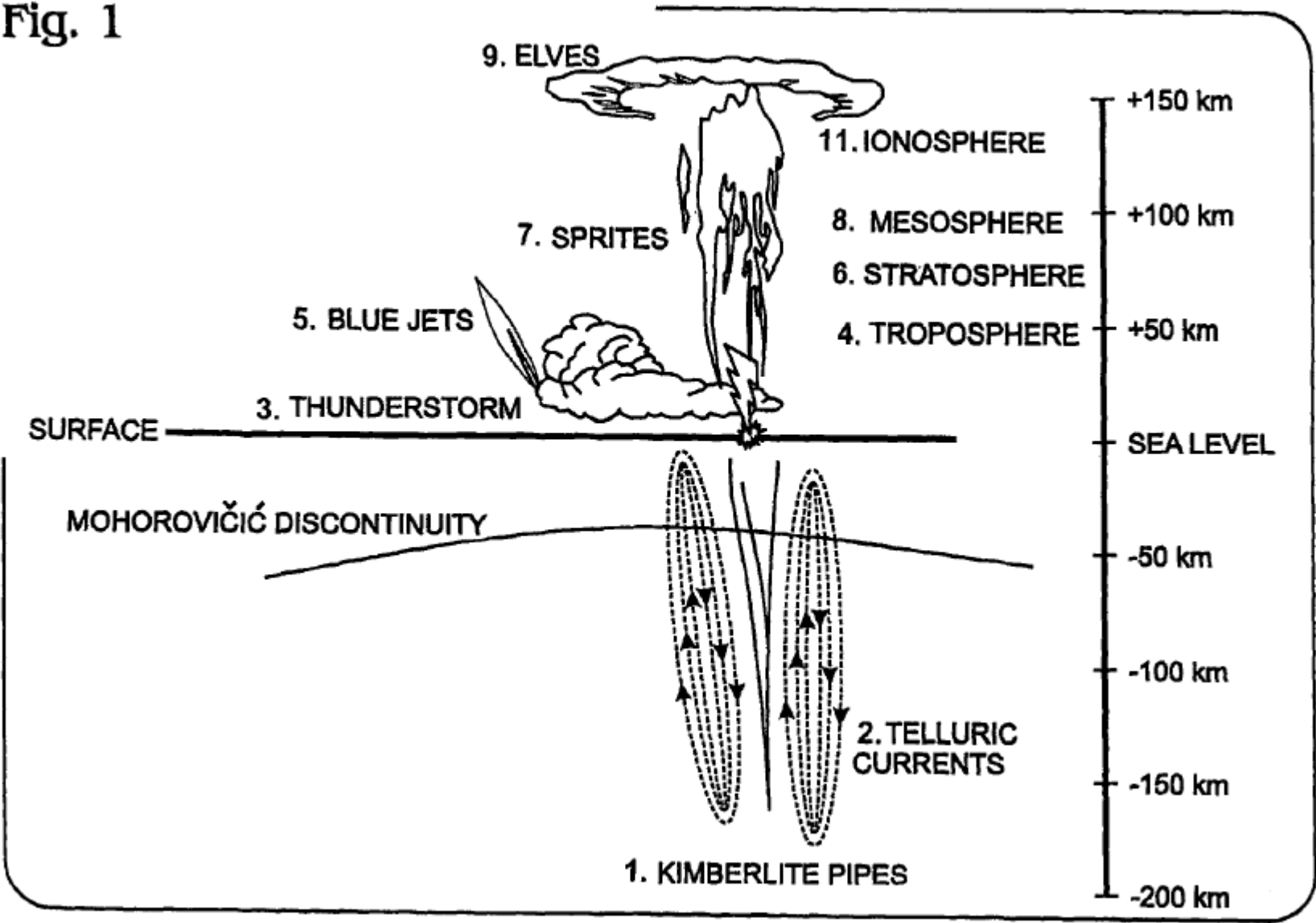
* cited by examiner

Primary Examiner — Amy He
(74) *Attorney, Agent, or Firm* — Portland Intellectual Property, LLC

(57) **ABSTRACT**

A method for locating sub-surface natural resources. The method utilizes lightning data to discern relatively likely locations for finding the sub-surface natural resources.
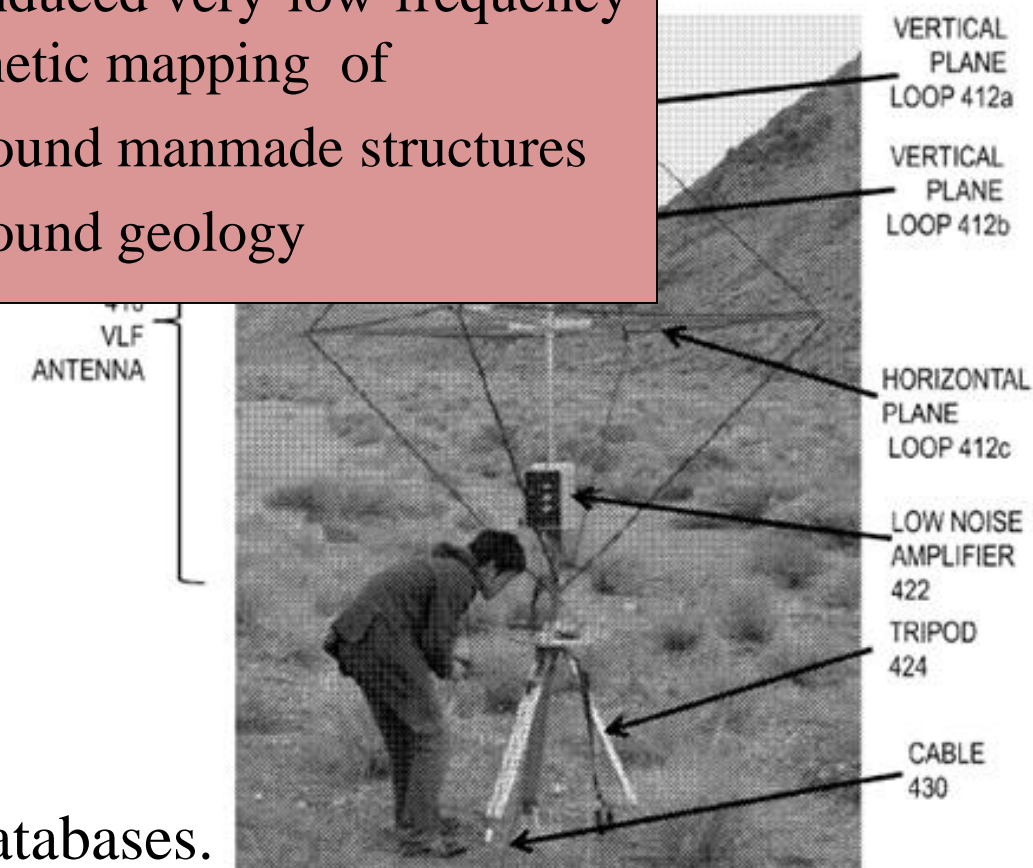
16 Claims, 8 Drawing Sheets

Fig. 1

Competition

- No Direct Competitors yet in the new market for natural resource exploration with lightning data.
- Indirect Competitors:
  - Potential Field Data and Services Companies:
    - getech
    - ARKeX
    - GravityServices.com
  - Integrated Geophysical Service Providers:
    - CGG-Fugro
    - NeosGeo
    - TGS
- Competitive Advantages:
  - First to market.
  - Trade Secrets regarding how to clean and data mine lightning databases.
  - Exclusive worldwide license agreement with Vaisala for natural resource exploration.
  - U.S. Patent 8,344,721 and planned additional patents.
- DML will maintain our competitive advantage by creating a viable new business, benefiting the bottom line of Vaisala, the lightning data provider, so our exclusive agreement is renewed every 8 years, and by licensing new technologies, like the Stanford Patent Application, if the patent is issued.

- **Stanford University US patent application** #20110095763
- Lightning induced very-low-frequency electromagnetic mapping of
  - underground manmade structures
  - underground geology

VERTICAL PLANE LOOP 412a
VERTICAL PLANE LOOP 412b
410 VLF ANTENNA
HORIZONTAL PLANE LOOP 412c
LOW NOISE AMPLIFIER 422
TRIPOD 424
CABLE 430

DML's Key advantages

1. Worldwide exclusive license with Vaisala for lightning data use in natural resource exploration

2. U.S. Patent

3. Understand Markets: energy & raw materials

Value Proposition

- Natural Resource demand exceeds new discoveries, as driven by population growth and industrialization:
  - Oil & Gas
  - Minerals (gold, etc.)
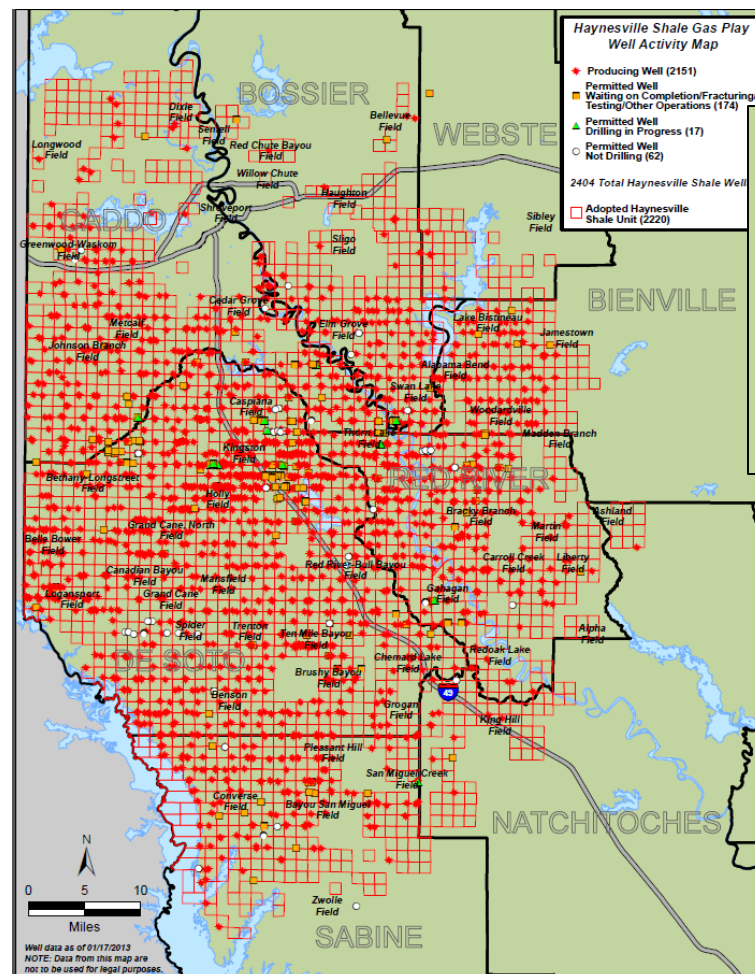 - Diamonds
  - Water
  - Geothermal Energy
- 14 Case Histories and $300,000 project completed for major oil company.

- Company "A" has a $2 million seismic budget.
  - Where is the optimal location for new seismic?
  - Which of $20 million dollars worth of spec seismic is best to purchase?
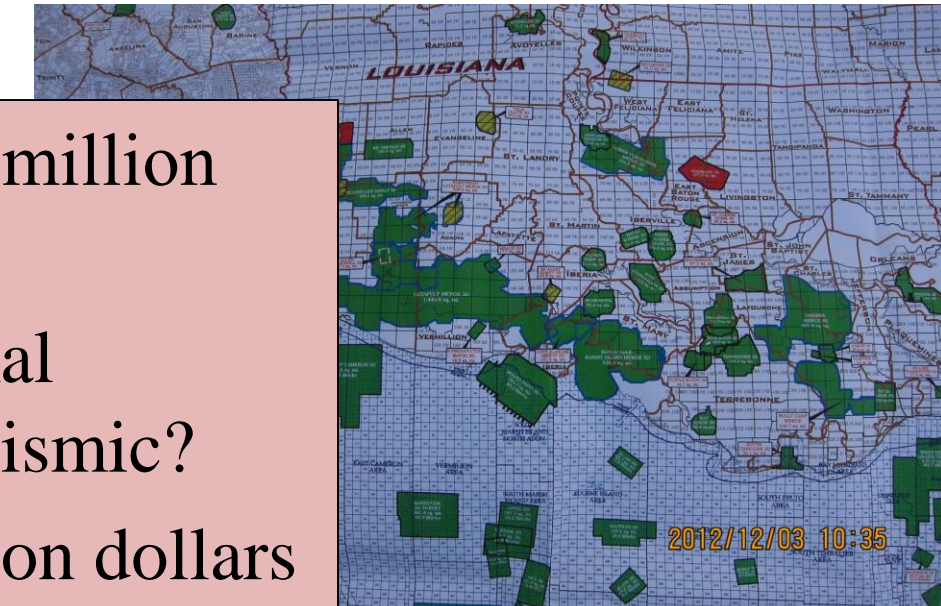
SEI 3-D Seismic Spec Map LA

Lease Map Haynesville Shale

- Company "B" has millions of acres of leases about to expire.
  - How do they rank the sweetspots?
  - What leases are kept?

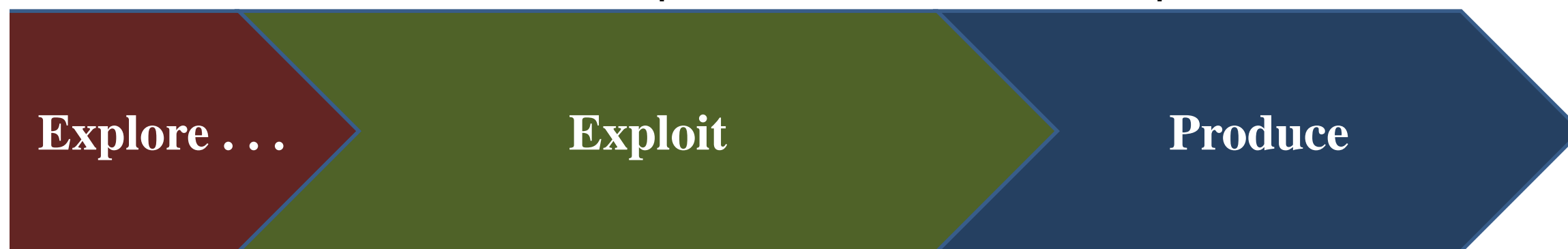- A $50,000 to $200,000 lightning analysis answers the questions.

Oil & Gas Pain & Gain

DML is opening a new market: education and case histories are key, slow adoption at first, then widespread.

MARKET TYPE
New Market

2016
2015
2014
2013
2012
2011
2010
2009

Anticipated DML Sales Curve

Explore . . .	Exploit	Produce

Rank Exploration	Play Fairway	Resource Plays	Bypass & Deeper	Re-Exploration

Customer Pain

No Data	Limited Data	Missing Sweetspots	ID Source	ID Economic opportunities

Customer Gain from doing Lightning Data Analysis

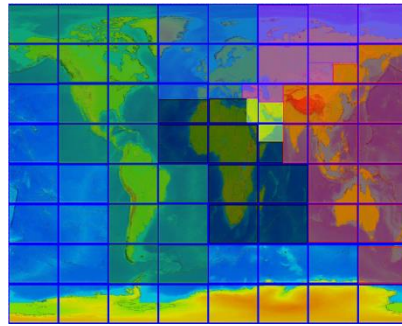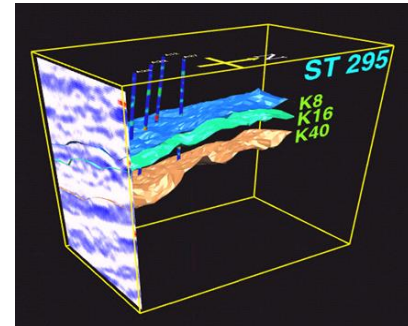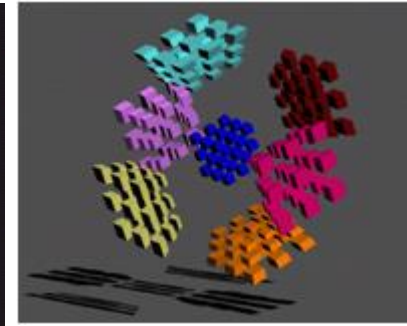| Cheaper Regional Data	Extrapolate Trends from Control	Extrapolate, Map Fractures & Rank Leases	Shallow Strat Traps & Map Seep Halo	Map Trends to Glean Areas of Focus

Integration process
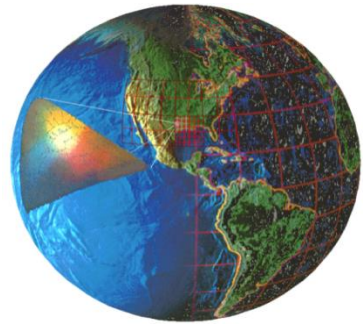
Mapping in **2-D** **3-D** **4-D** **…** **N-Dimensions**
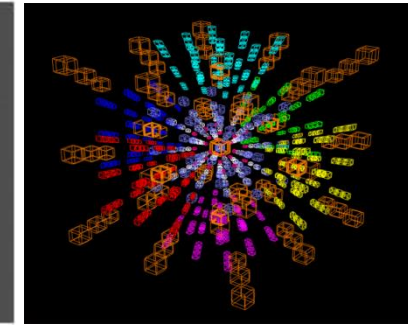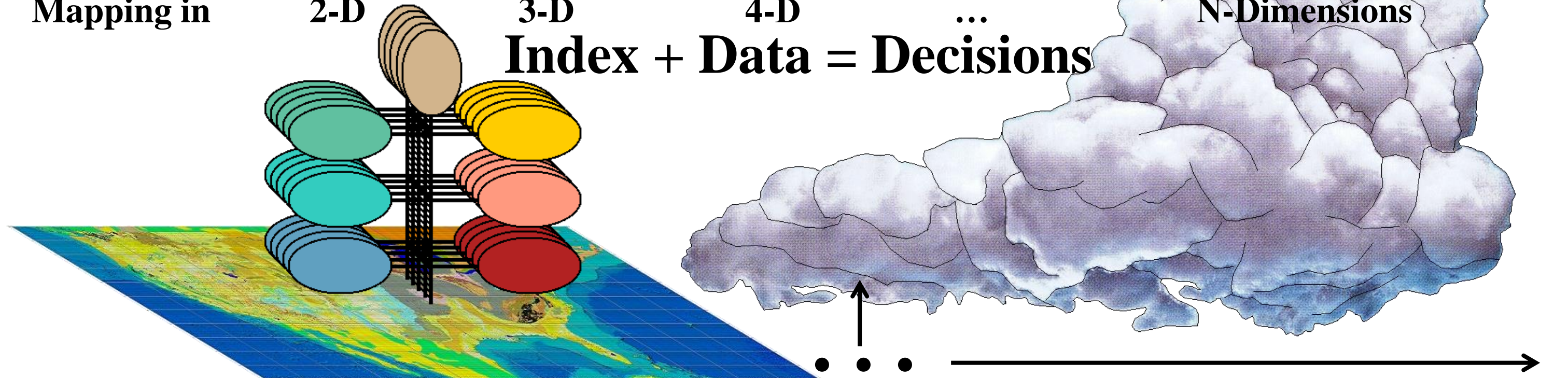
Index + Data = Decisions

Reservoir characteristics

Satellite thermal data

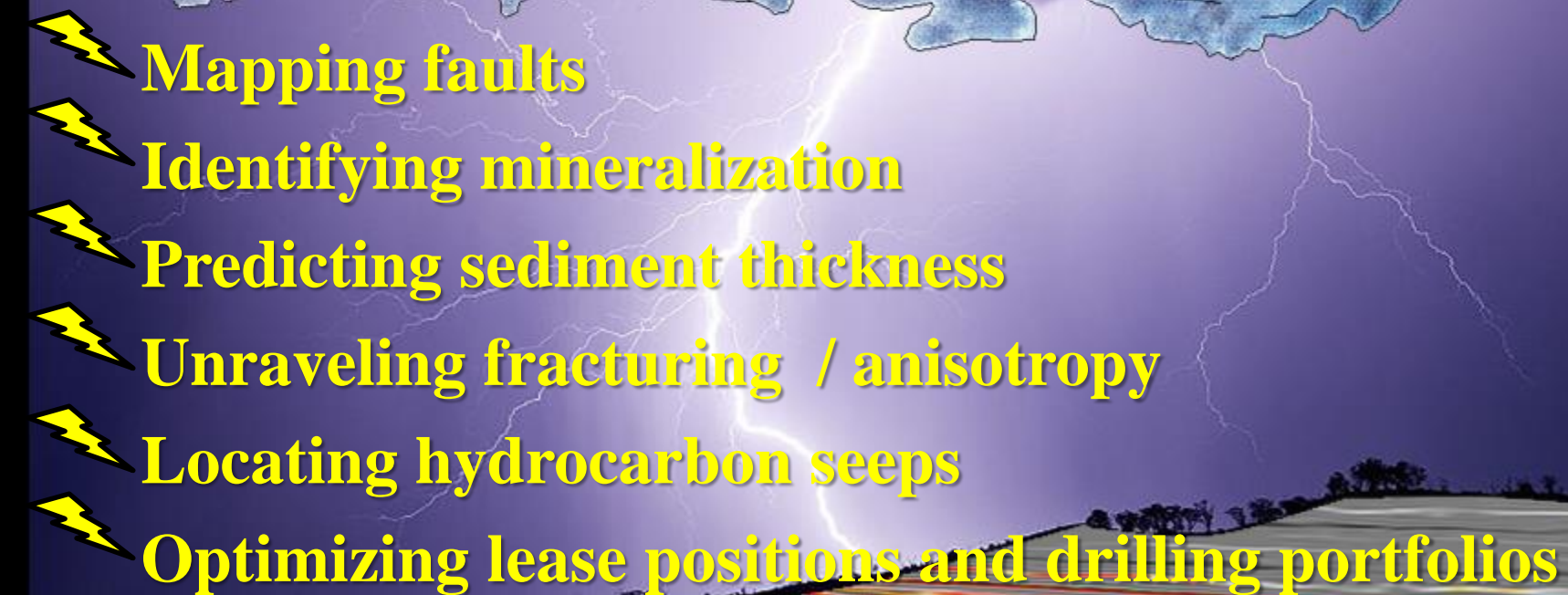**Bottom hole temperature (property of earth)**

Geopressure depth (pressure property of earth)

Topography (spatial property of earth)

Lightning data (electrical property of earth)

DML technology is KEY for new natural resource exploration

- Mapping faults
- Identifying mineralization
- Predicting sediment thickness
- Unraveling fracturing / anisotropy
- Locating hydrocarbon seeps
- Optimizing lease positions and drilling portfolios

Possible Thesis/Dissertation Topics

1. Electrical characteristics of Elm and Oak trees, including root systems and preferential soil chemistries.
2. Statistical Analysis of lightning strike clusters related to topography, vegetation, infrastructure, and geology.
3. Modeling telluric currents as a means to predict lightning clusters.
4. Modeling lightning clusters as a means to predict telluric currents.
5. Relationship between lightning clusters and high altitude lightning events like blue sprites and elves.
6. Using lightning clusters as a basis for time-lapse electromagnetic measurements.
7. Lightning analysis of Iron County, UT relating strike attributes to known iron reserves and micro-earthquakes.*
8. Lightning analysis of Prince of Wales Island, Alaska to extend maps of vein-dyke rare earth deposits.*
9. Lightning analysis of Cortez Hills, NV (116º-117ºW , 40º-41ºN) to calibrate known gold mines and trends.*
10. Lightning analysis of San Bernardino County, CA to map the extent of the Mountain Pass Rare Earth deposit.*
11. Lightning analysis of the Mississippian Limestone hydrocarbon play in OK and KS.*
12. Quantitative correlation of South Texas lightning density with known oil and gas fields.
13. Correlation of lightning density with mapped gas hydrates offshore North Carolina.*
14. Correlation of lightning density with known oil and gas fields in Southern Louisiana.*
15. Mapping top geopressure and correlating lightning clusters with shallow depth to top geopressure in TX & LA.*
16. Correlate lightning attributes and density with gravity and magnetic and electrical and seismic data.
17. Lightning analysis Yellowstone National Park to correlate with known geothermal deposits.

*Requires licensing of lightning data.

This is just the beginning!