Louisiana

Center for GeoInformatics

Status Update & Ongoing Research

Joshua D. Kent, Ph.D.
Louisiana State University
College of Engineering

Presentation Overview

- Overview of C4G & Program Background
- Current Height Modernization Efforts
- Operational Activities & Funding
- Recent Accomplishments
- Addressing Challenges in the Short & Long Term

What is the C4G?

A Science & Technology Research Unit and Data Provider Focused on High-Precision 3-D and 4-D Earth Positioning in Louisiana

- Maintain a state-wide CORS network of GPS and GNSS Antennas and Receivers
- Supports scientific, commercial, and legal applications that are recognized by Louisiana statute (R.S. 50: 173.1)

Who Are the C4G?

Personnel for the Center for GeoInformatics:

George Z. Voyiadjis
Acting Director: Civil & Environmental Engineering

Clifford Mugnier
Instructor & Chief of Geodesy: Civil & Environmental Engineering and the Center for GeoInformatics

Randy Osborne
Network Administrator: Center for GeoInformatics

Joshua D. Kent
GIS Manager & Researcher: Center for GeoInformatics and Adjunct Faculty School of the Coast & Environment

Larry Dunaway
Field Operations Manager: Center for GeoInformatics

Program Background

Center for GeoInformatics (C4G) & the LA Spatial Reference Center (LSRC)

- C4G established in 2001 in College of Engineering at LSU
- LSRC established in 2002 to promote the utilization of the National Spatial Reference System (NSRS)
- Established the CORS Network in 2004
  - 18 GPS Reference Stations
- Legal Source for elevations in LA (R.S. 50:173.1)
- Established Real-Time Network (RTN) in 2007
  - 50 GPS Reference Stations
- Integrate GNSS Technologies into the RTN in 2009

Mission Statement

"It is the Mission of the Center for GeoInformatics to become a national force in expanding and strengthening the university, commercial and public-sector geospatial communities within the State of Louisiana and the US.

To this end, the Center for GeoInformatics will provide the advanced geospatial information applications, products, training, and commercialization expertise that are required to support economic development and environmental stewardship."

Current Height-Mod Efforts

The C4G is Finalizing Project Tasks for a NOAA Grant Awarded in 2010

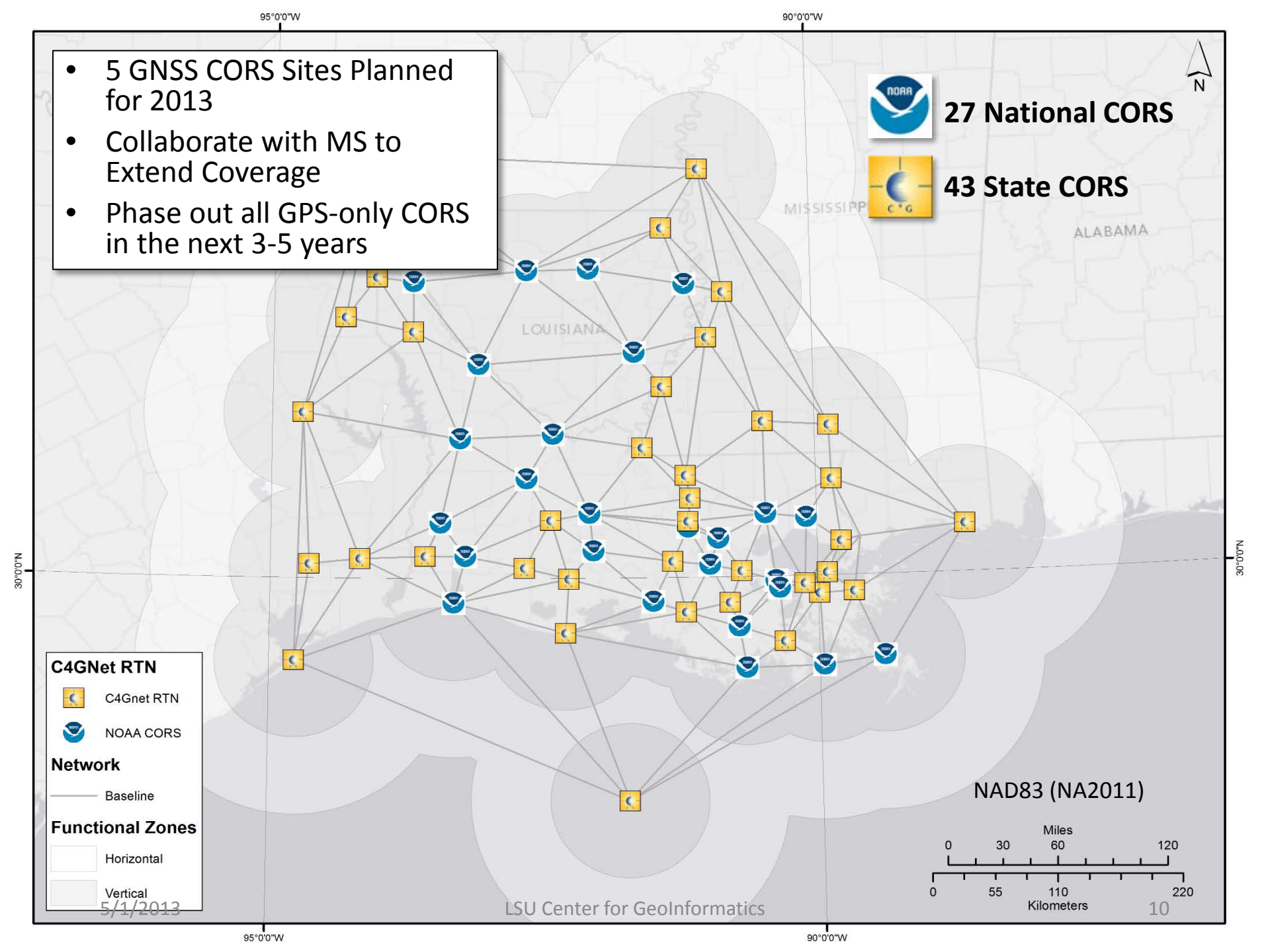
- *TASK 1: Continue daily operations of the Louisiana Spatial Reference Center, including the operations of the LSU GULFNet GNSS network of National CORS.*
- *TASK 2: Create CORS 911 – a transportable CORS positioning system that can be deployed to support NOAA activities during hurricanes along the Gulf Coast.*
- *TASK 3: Continue to provide CORS data to NOAA/NWS/ESRL GPS-MET group.*
- *TASK 4: Continue program of monitoring subsidence data at CO-OPs/NOAA Tide gauges in coastal Louisiana for absolute sea-level change monitoring.*
- *TASK 5: Conduct Height Modernization Forums for users in Louisiana and the Gulf Coast.*

TASK 1: Continue Daily Operations of the Louisiana Spatial Reference Center

C4GNet Consists of 70 CORS sites maintained by the University and through collaboration with regional stakeholders & operators:

List of Continuously Operating Reference Stations

Hardware Count	Owner	GPS Receivers	GNSS Receivers
53	LSU	36	17
9	USM Gulf Coast Geospatial Center	4	5
6	Texas Dept. of Transportation	3	3
2	NOAA Earth Research Laboratory	2	0
70	**TOTAL**	**45**	**25**



- 5 GNSS CORS Sites Planned for 2013
- Collaborate with MS to Extend Coverage
- Phase out all GPS-only CORS in the next 3-5 years

TASK 2: Create CORS911

Develop Autonomous, Rapid-Response CORS Sites that can be Deployed and Networked During Disasters…

TASK 3: Provide CORS Data to ESRL GPS-MET Group

Automated Data Delivery from CORS Sites, Includes Stations Located on Off-Shore Platforms in the Gulf of Mexico

- These stations are co-located with equipment used by the NOAA/NWS/ESRL GPS-MET group.
- The CORS station, DEV2 (near west Cameron Parish), was indefinitely deactivated by the platform's owner, Apache, in July 2012.
- The C4G is working with the GPS-Met group to recover the equipment installed at the DEV2 site and will identify a new hosting facility in the vicinity.

TASK 4: Co-Locate CORS on CO-OPS Tide Gauges

Install CORS on Sentinel Tide Gauge Stations in the Coastal Margin Supporting Absolute Sea-Level Change Monitoring

SBCH: Shell Beach
Shore of Lake Borgne in St. Bernard Parish, LA.

Amarada Pass
Atchafalaya Basin Outlet in St. Mary Parish, LA.

Calcasieu Lake Outlet
River outlet in Cameron Parish, LA.

TASK 4: Co-Locate CORS on CO-OPS Tide Gauges

Install CORS on Stations in the Coastal Margin Sea-Level Change Monito

SBCH: Shell Beach
Shore of Lake Borgne in S
Parish, LA.

Amarada Pass
Atchafalaya Basin Outlet
Parish, LA.

Calcasieu Lake Outlet
River outlet in Cameron Parish, LA.

TASK 4: Co-Locate CORS on CO-OPS Tide Gauges

Install CORS on

Coastal Margin

Change Monito

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TASK 5: Conduct Height Modernization Forums

Host Height-Modernization and GPS Best Practices Workshops

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Host Height-Modernization and GPS Best Practices Workshops

Activity Areas

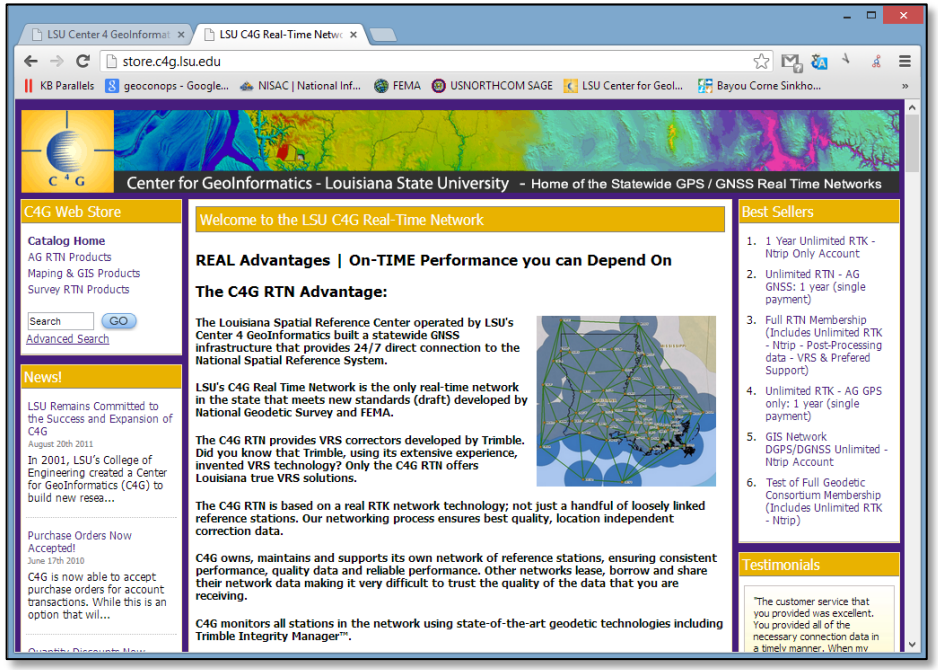
Maintain a Program of Research & Service that Addresses Critical and Timely Geodetic Issues Associated with Subsidence and Establishing a Consistent, Accurate, and Reliable Source for Vertical Control in Louisiana

- Accurate, Precise, and Consistent Geographic Reference Framework – Access to NSRS
- Outreach & Training in Support of all Stakeholders in Louisiana.
- Research & Service to the State

Positional Services

C4GNet RTN is a Service Used to Correct GPS Positions in Real-Time

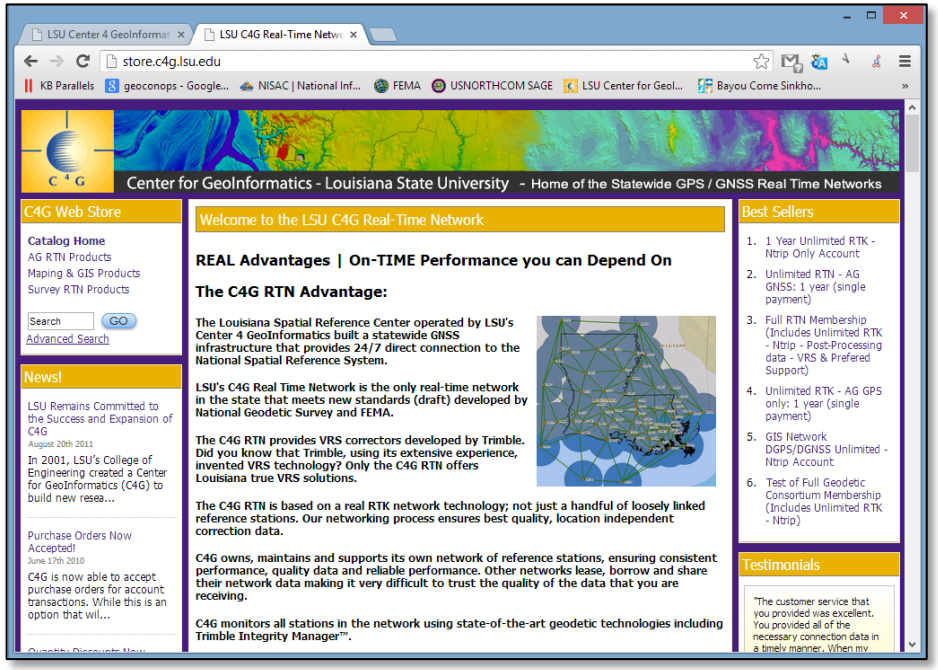
- No State Funding
- Revenue Generated from Subscription Services
  - Include Real-Time & Post-Processing
  - Surveyors, Engineering Firms, Farmers, municipalities, levee districts, State & Federal agencies.



Positional Services

C4GNet RTN is a Service Used to Correct GPS Positions in Real-Time

- Tiered Subscription Approach
  - Based on Industry Type:
    - Ag, Mapping, Surveying
  - Multiple Price-Points
  - Trial rates
  - VAR Contracts
- Current support >150 clients



Outreach & Education

- **Universities and Colleges**
  - Louisiana State University, Baton Rouge
  - Louisiana State University, Shreveport
  - Louisiana State University, Alexandria
  - Louisiana State University, Eunice
  - Loyola University, NOLA
  - University of Louisiana, Lafayette
  - University of Louisiana, Monroe
  - Northwestern State University
  - McNeese State University
  - Nicholls State University, Louisiana Tech
  - Southeastern University
  - LUMCON, Cocodrie
  - T. H. Harris Technical College
  - Folks Technical College, Jackson
- **K-12 Schools**
  - Oakdale High School
  - Franklin High School
  - Boothville-Venice School
  - Tallulah High School
  - Sicily Island High School
  - Lake Arthur Elementary
  - Lakeside Elementary
  - South Plaquemines
  - Leesville
  - Houma School District
  - Destrehan High School
  - Slidell Junior High School
  - De Quincy High School
  - Vinton High School
  - Morgan City High School
  - Ascension Parish Schools, Donaldsonville
  - Southside Elementary, Bogalusa
  - South Lafourche High School
  - Lutcher High School
  - Belle Chase High School
  - Kaplan High School
  - Sabastian Roy School, St. Bernard Parish
  - Galvez Middle School, Ascension Parish
  - Daisetta High School, Daisetta, TX
- **Federal, State and Local Governments**
  - Department of Transportation and Development
  - City of Zachary
  - City of Alexandria
  - USACE, Simmsport
  - USACE, Freshwater Bayou Lock
  - USACE, Bayou Sorrel
  - United States Coast Guard, Grand Isle
  - Cameron Parish
  - St. Tammany Parish, Covington
  - Nation Weather Service, Offshore Louisiana

Outreach & Education

- American Geophysical Union Fall Meeting
- Annual Roy J. Shlemon Specialty Conference
- Association of American Geographers Annual Conference
- Crime Mapping Research Conference
- Deepwater Horizon Oil Spill Conference
- Disaster Resistant University Workshop
- ESRI International User Conference
- Forum of European Highway Research Laboratories
- Geological Society of America Annual Meeting & Exposition
- IEEE Geoscience and Remote Sensing Society Workshop
- International GNSS Service Workshop & Vertical Rates Symposium
- The National Map Users Conference and USGS Geographic Information Science (GIS) Workshop
- National Height Modernization Workshop
- Louisiana Remote Sensing & GIS Workshop
- Louisiana Surveyor's Association Conference
- Louisiana Transportation Conference
- Real-Time Network Best Practices Seminar
- State of the Coast Conference
- Trimble Dimensions Conference
- GPS Best Practices Workshops

Research: Recent Scholarly Productivity

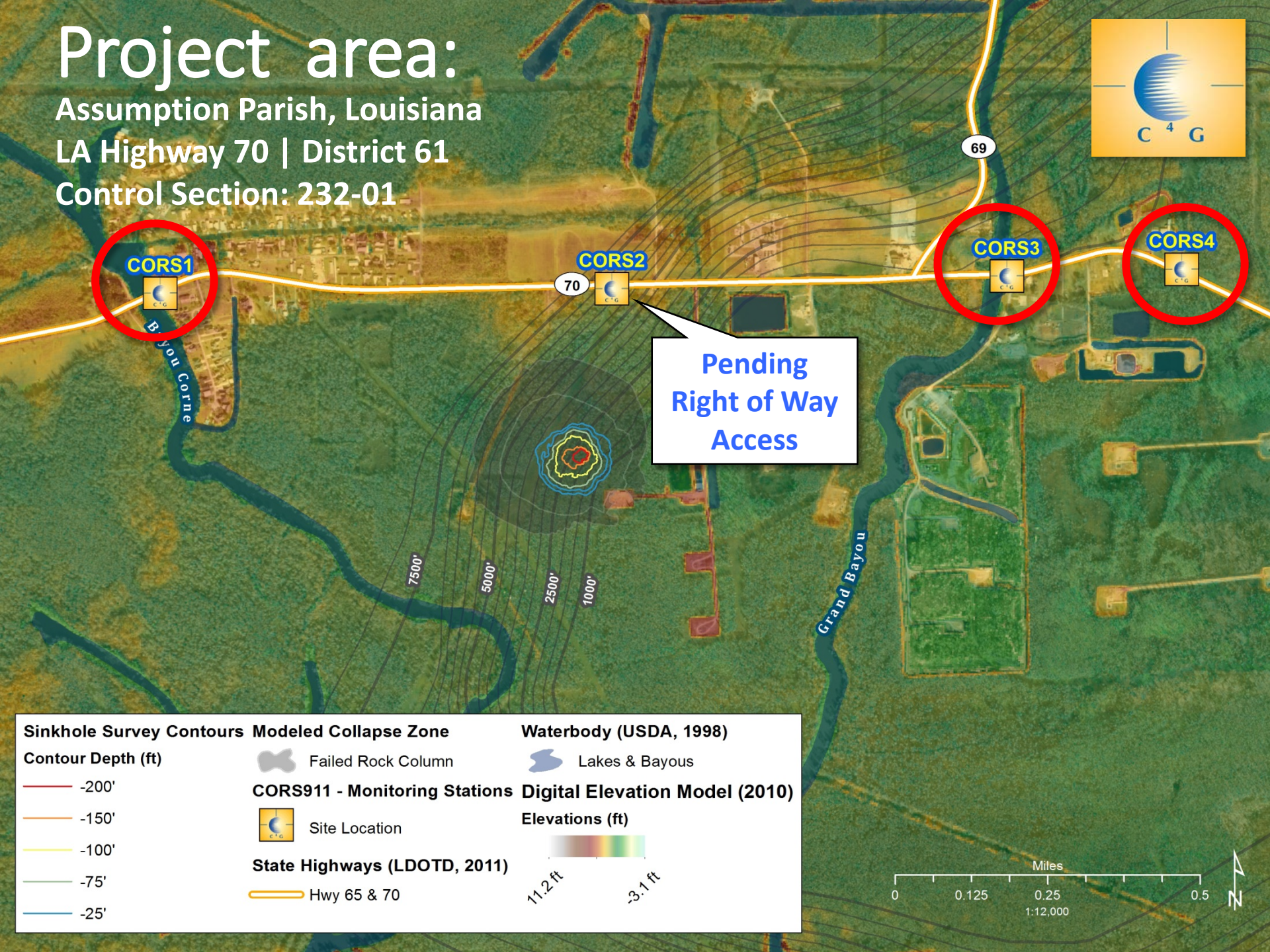
- (in Press) Mugnier, C.J. The Manual of Photogrammetry. 6th Edition, American Society for Photogrammetry & Remote Sensing, 2012. Chapters 3 and 14.
- **2013**: Kent, J. and Capello, H. Spatial Patterns and Demographic Indicators of Social Media Content During the Horsethief Canyon Fire of 2012. Cartography and Geographic Information Science (CaGIS). DOI:10.1080/15230406.2013.776727
- **2012**: Kent, J. and Leitner, M., Incorporating Land Cover within Bayesian Journey-to-Crime Estimation Models. International Journal of Psychological Studies. DOI:10.5539/ijps.v4n2p120
- **2012**: Kent, J. and Dokka, R. (posthumous). Potential impacts of long-term subsidence on the wetlands and evacuation routes in coastal Louisiana. GeoJournal. DOI: 10.1007/s10708-012-9457-7
- **2011**: Dokka, R. The role of deep processes in late 20th century subsidence of New Orleans and coastal areas of southern Louisiana and Mississippi. Journal of Geophysical Research. DOI:10.1029/2010JB008008
- **2011**: Kent, J. and Dokka, R., Realizing a Spatially Accurate Incident Reporting System during the 2010 Gulf of Mexico Oil Spill Disaster. Journal of Emergency Management. DOI:10.5055/jem.2011.0068
- **2011**: Leitner, M., Barnett, M., Kent, J., Barnett, T. The Impact of Hurricane Katrina on Reported Crimes in Louisiana - A Spatial and Temporal Analysis. Professional Geographer. DOI: 10.1080/00330124.2010.547156
- **2009**: Blom, R., Chapman, B., Dokka, R., Fielding, E., Ivins, E., and Lohman, R. Gulf Coast subsidence, crustal loading, geodesy, and InSAR: Gulf Coast Association of Geological Societies Transactions, v. 59, p. 101-114.
- **2009**: Kent, J. and Leitner, M., Utilizing Land Cover Characteristics to Enhance Journey-to-Crime Estimation Models. Crime Mapping: A Journal of Research and Practice. Vol. 1, No. 1. , pp. 33-54.
- **2009**: Leitner, M. and Kent, J. Bayesian journey-to-crime modeling of single and multiple crime-type series in Baltimore County, MD, Journal of Investigative Psychology and Offender Profiling. Vol. 6, pp. 213-236.
- **2009**: Dokka, R. K. Comparison of methods used to measure modern subsidence in southeastern Louisiana: Gulf Coast Association of Geological Societies Transactions, v. 59, p. 225-242.
- **2008**: Dixon, T.H., and Dokka, R.K. Earth scientists and public policy: Have we failed New Orleans?: EOS, v. 89, no. 10, 4 March, American Geophysical Union.
- **2008**: Dixon, T.H., and Dokka, R.K. Earth scientists and public policy: Have we failed New Orleans?: EOS, v. 89, no. 10, 4 March, American Geophysical Union.

Research: Recent Grant Funding

- **2013**: (LPN 39567-2) CORS 911: Continuously Operating Reference Stations for State Highway 70 in Assumption Parish, Louisiana, During the Bayou Corne Sinkhole. LA Transportation Research Center (LTRC). $350,785; PI: Joshua D. Kent, Ph.D.
- **2013**: (LPN 40122-1) Classifying Accident Avoidance on Heterogeneous Road Networks using Exploratory Spatial Data Analysis. U.S. Dept. of Transportation. $25,000; PI: Joshua D. Kent, Ph.D.
- **2012**: (LPN 39540-1) Bayou Corne Sinkhole: Control Measurements of State Highway 70 in Assumption Parish, Louisiana. LA Transportation Research Center (LTRC). $84,356; PI: Joshua D. Kent, Ph.D.
- **2010**: (LPN 38036-1) Quantifying the Key Factors that Create Road Flooding. LA Transportation Research Center (LTRC). $50,000. PI: Joshua D. Kent, Ph.D.
- **2010**: (LPN 37154-1) Assessing the Long Term Impact of Subsidence and Global Climate Change on Emergency Evacuation Routes in Coastal Louisiana. U.S. Dept. of Transportation. $40,000; PI: Joshua D. Kent, Ph.D.
- **2009**: (LPN 34720-1) Real-Time Kinematic Global Positioning Service for Louisiana. LA Transportation Research Center (LTRC). $79,961; PI: Roy K. Dokka, Ph.D.
- **2009**: (LPN 33740-1) Reference Measurements of Pavement Management System Roadway Elevations. LA Transportation Research Center (LTRC). $33,550; PI: Roy K. Dokka, Ph.D.
- **2009**: (LPN 33796-2) Height Modernization in Louisiana. National Oceanic and Atmospheric Administration (NOAA). $699,300; PI: Roy K. Dokka, Ph.D.
- **2008**: (LPN 33145-2) Height Modernization in Louisiana. National Oceanic and Atmospheric Administration (NOAA). $190,000; PI: Roy K. Dokka, Ph.D.

Recent Accomplishments

- 60% Growth of Subscription Services Since 2009
  - # of Clients
- Adoption of RTN by Local and Regional Entities
  - South Lafourche Levee District
  - Southeast Louisiana Flood Protection Authority – East
- Napoleonville Salt Dome Sinkhole
- Subsidence Studies


Project area:
Assumption Parish, Louisiana
LA Highway 70 | District 61
Control Section: 232-01
CORS1
CORS2
CORS3
CORS4
70
69
Bayou Corne
Grand Bayou
7500'
5000'
2500'
1000'
Pending Right of Way Access
Sinkhole Survey Contours
Contour Depth (ft)
-200'
-150'
-100'
-75'
-25'
Modeled Collapse Zone
Failed Rock Column
CORS911 - Monitoring Stations
Site Location
State Highways (LDOTD, 2011)
Hwy 65 & 70
Waterbody (USDA, 1998)
Lakes & Bayous
Digital Elevation Model (2010)
Elevations (ft)
11.2 ft
-3.1 ft
Miles
0
0.125
0.25
0.5
1:12,000
N

CORS1 – Bayou Corne

CORS1 – Bayou Corne

CORS3 – Grand Bayou

CORS3 – Grand Bayou

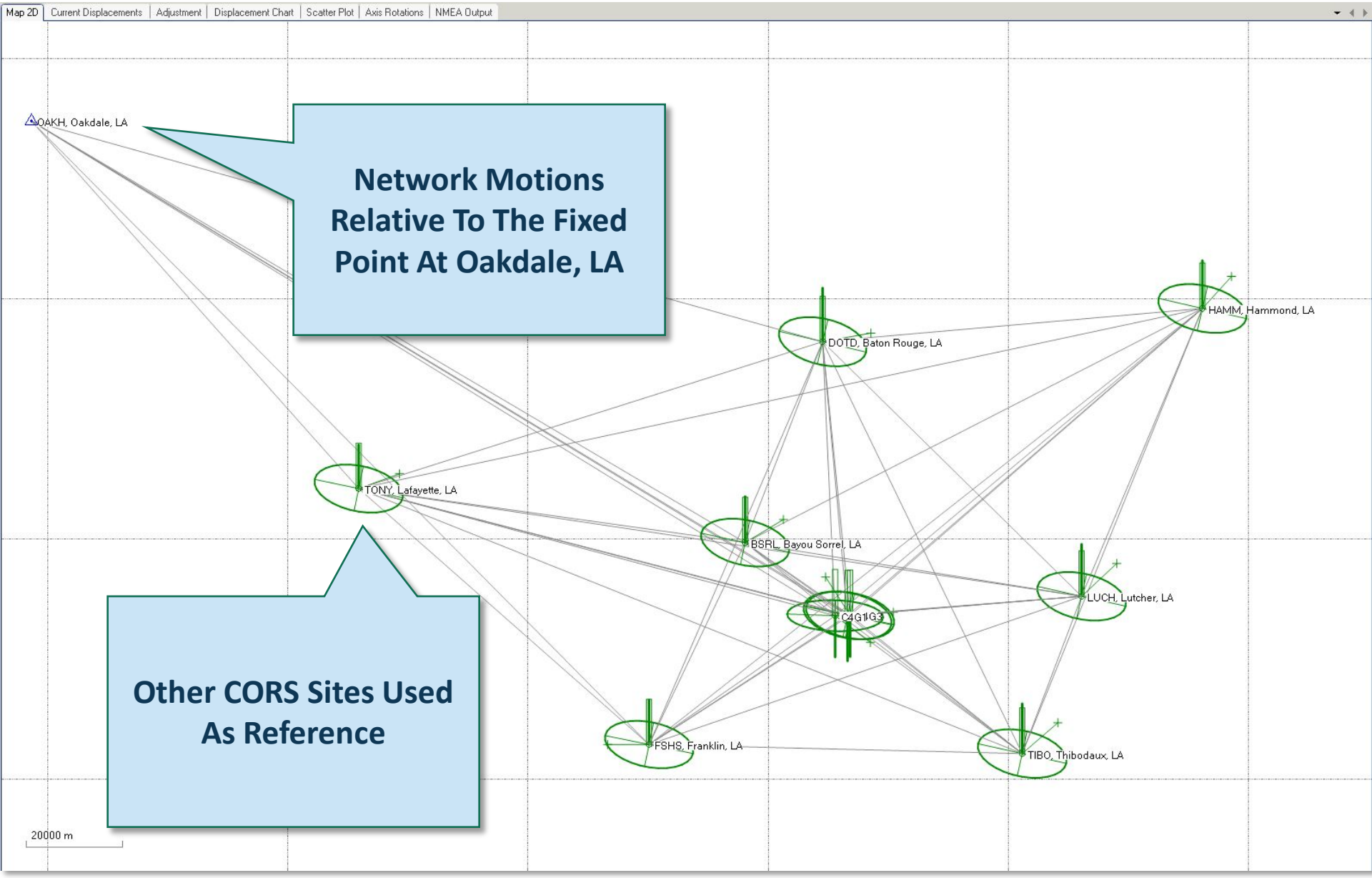
CORS4 – Bayou Choupique

CORS4 – Bayou Choupique

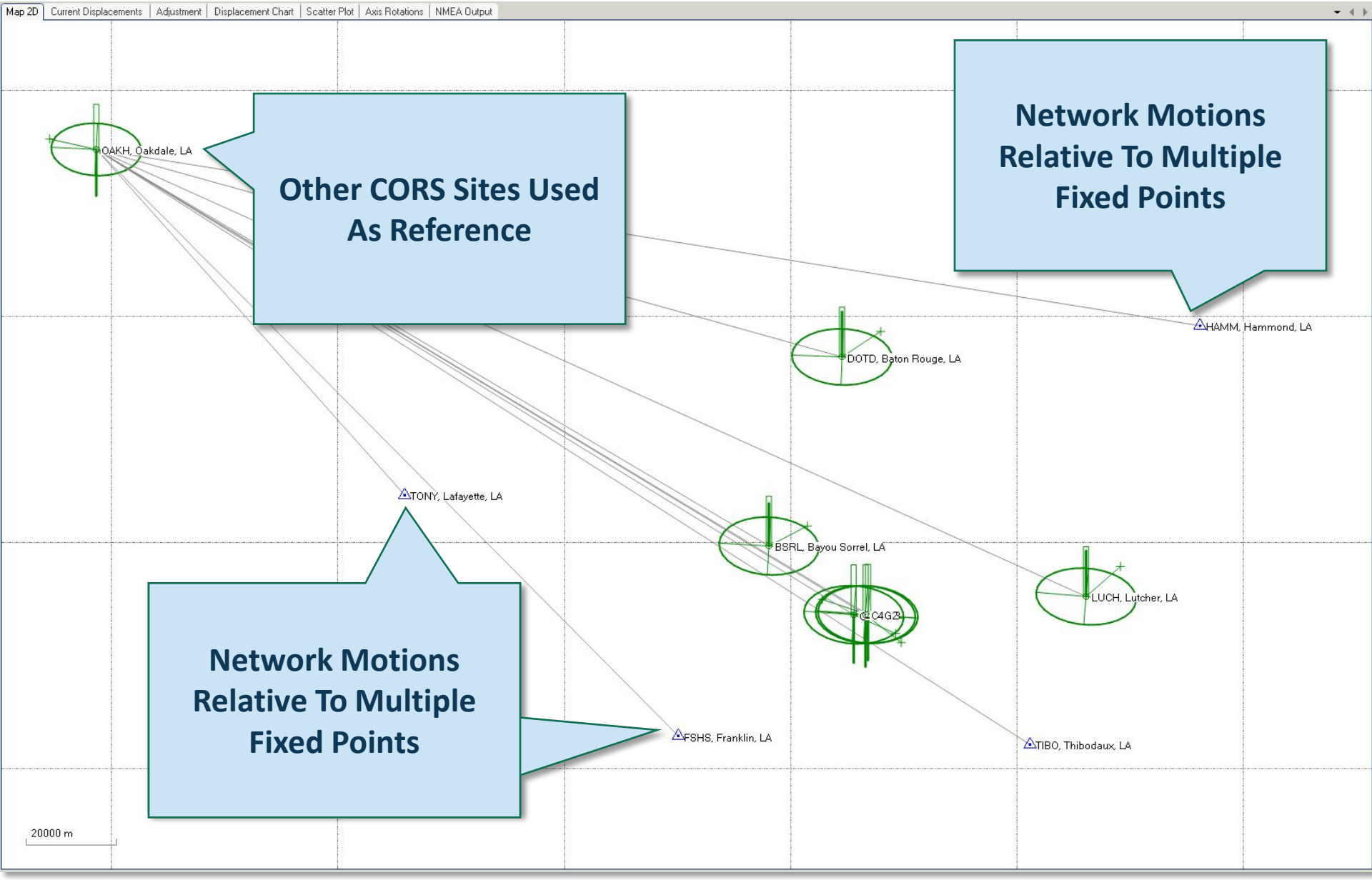
CORS911 - Monitoring Stations

Site Location

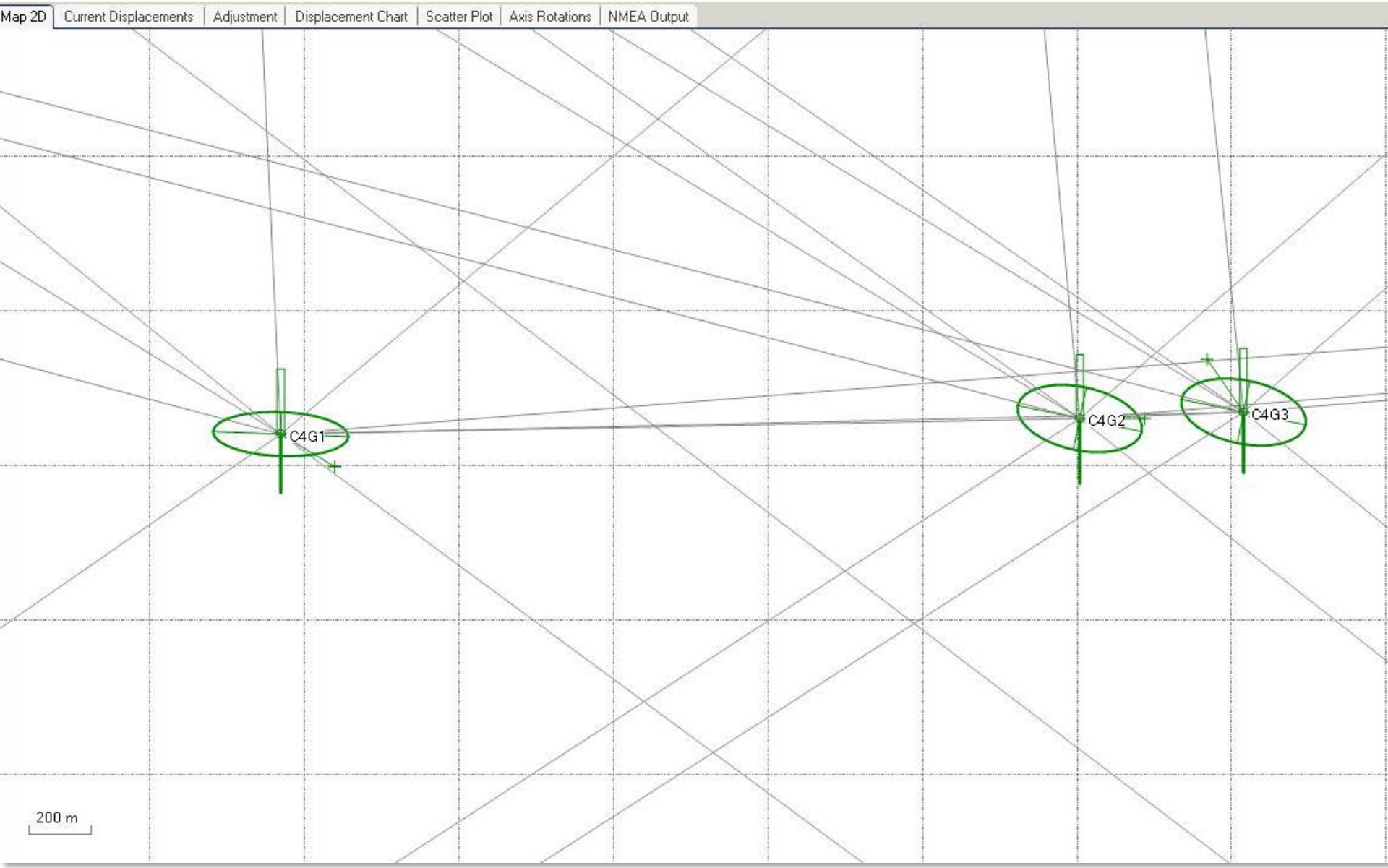
Synchronizing CORS911 Relative to the C4GNet RTN



Synchronizing CORS911 Relative to the C4GNet RTN



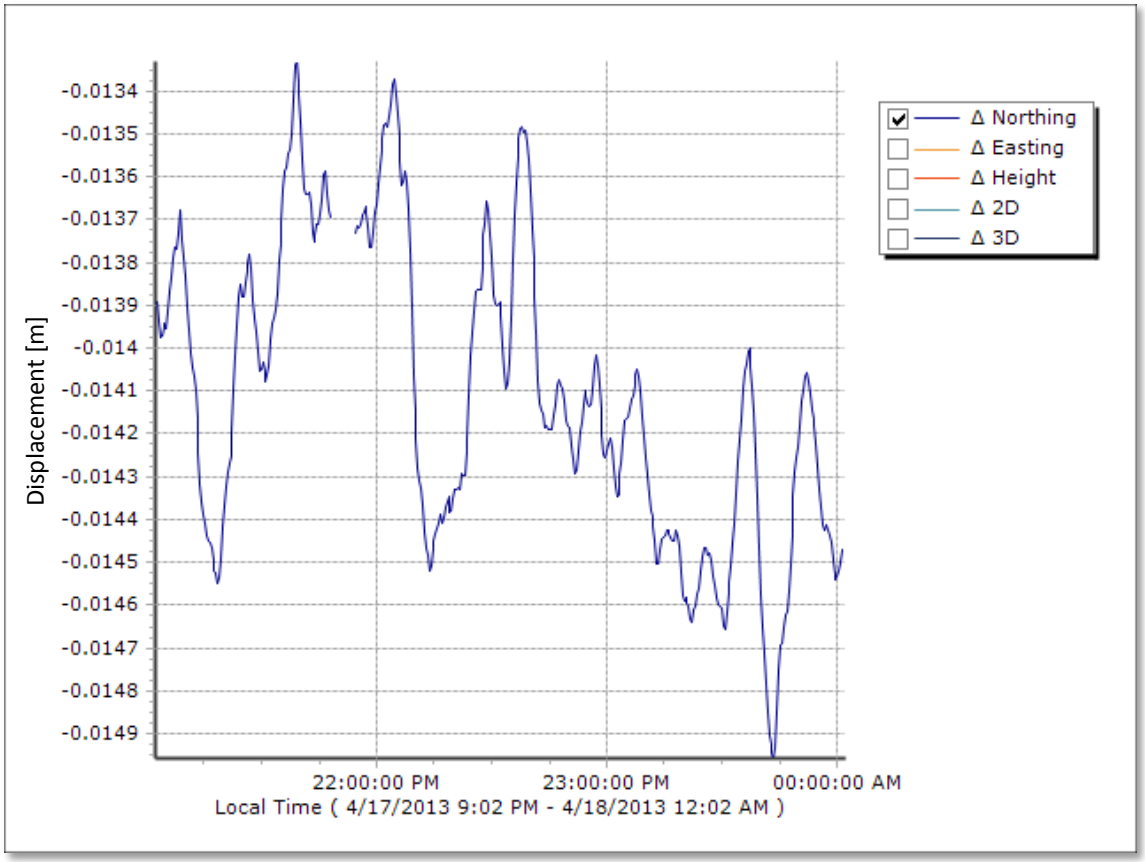
Synchronizing CORS911 Relative to the C4GNet RTN



Example

Displacement in Northing:

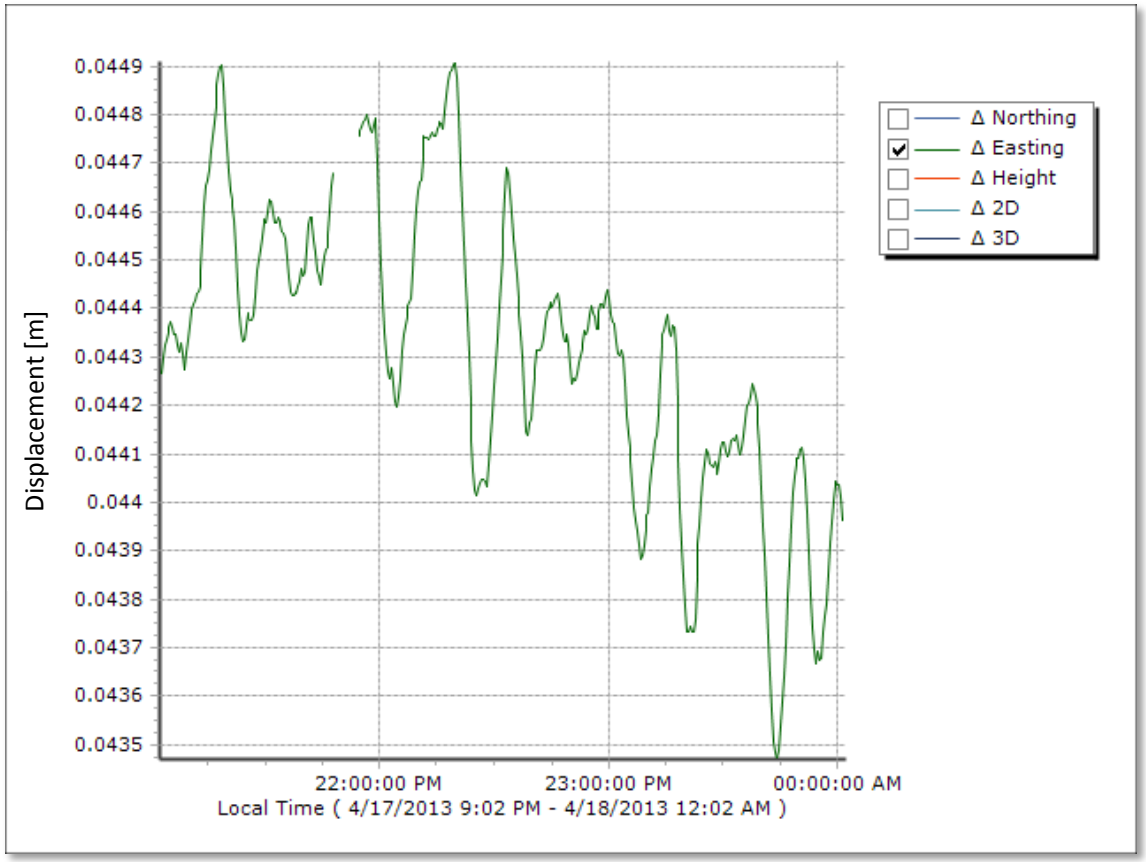
1.5 mm
(0.059”)



Example

Displacement in Easting:

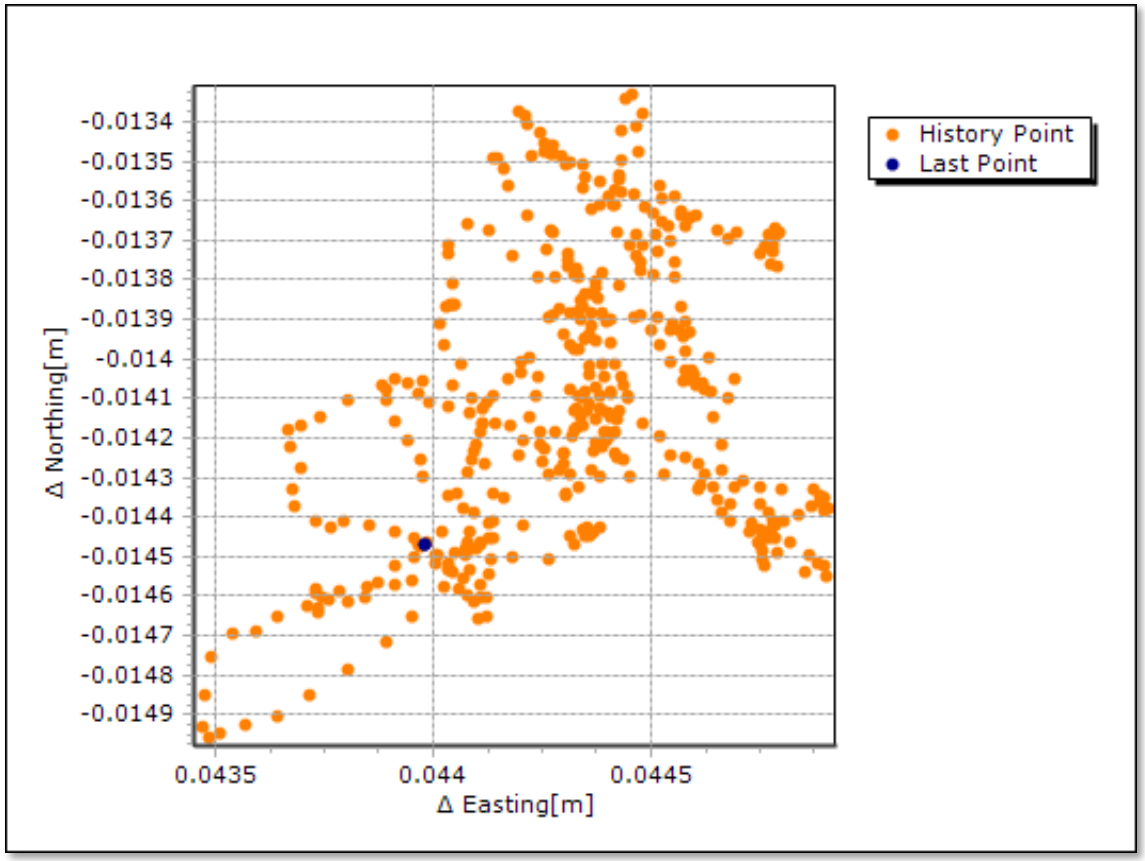
1.4 mm
(0.055”)



Example

Scatter Plots:

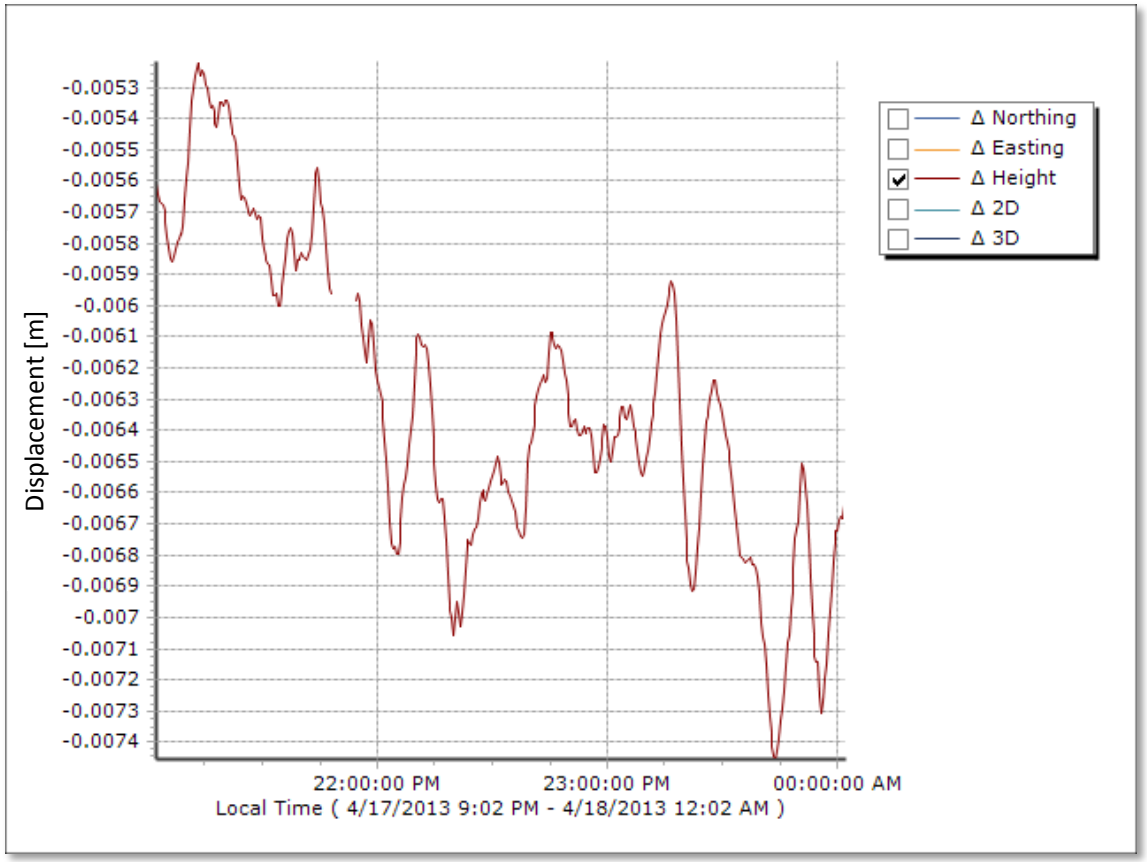
1.5 mm
(0.059”)



Example

Displacement in Vertical:

2.1 mm
(0.083”)



Example 2: Subsidence Research

Measuring the Differential Motions of Two CORS Sites

Differential Motions Between Two CORS Sites

Continuously Operating GPS Reference Stations (CORS) located on the grounds of the NASA Michoud Assembly Facility, located in New Orleans East, LA.

- **MOON**: Located on a shallow concrete slab.
- **MARY**: Attached to a deep waste-water well.

A Tale of Two CORS Sites…


Hon. Moon Landrieu
Sen. Mary Landrieu
MOON
MARY
TXTE
1LN
FOLK
BOGA
ZACH
THHR
LSUE
DOTD
HAMM
COVG
MSIN
MSGA
GVMS
TONY
BSRL
LUCH
KPLN
INRI
SBCH
FSHS
TIBO
HOUM
FWTR
PAUL
BVHS
LMCN
GRIS
DEV1
Texarkana
Paris
Denton
McKinney
Greenville
Sulphur Springs
Plano
Dallas
Arlington
Longview
Waco
Cleveland
Greenwood
Starkville
Meridian
Biloxi
Gulfport
Slidell
Lafayette
Baton Rouge
New Orleans
Houma
Bay City
Lake Jackson
Victoria
LOUISIANA


Paris
Texarkana
TX
Denton
McKinney
Greenville
Sulphur Springs
Plano
Dallas
Arlington
Longview
Waco
Cleveland
MOON
MARY
KPLN
FSHS
MCHS
TIBO
HOUM
FWTR
PAUL
INRI
SBCH
LMCN
GRIS
BVHS
LOUISIANA
Bay City
Lake Jackson
Victoria
DEV1

C4GNET INTEGRETY MONITOR REPORT:

POSITION DISTURBANCE & THRESHOLD VIOLATION

TIME:

1415Z (8:15AM Local Time)

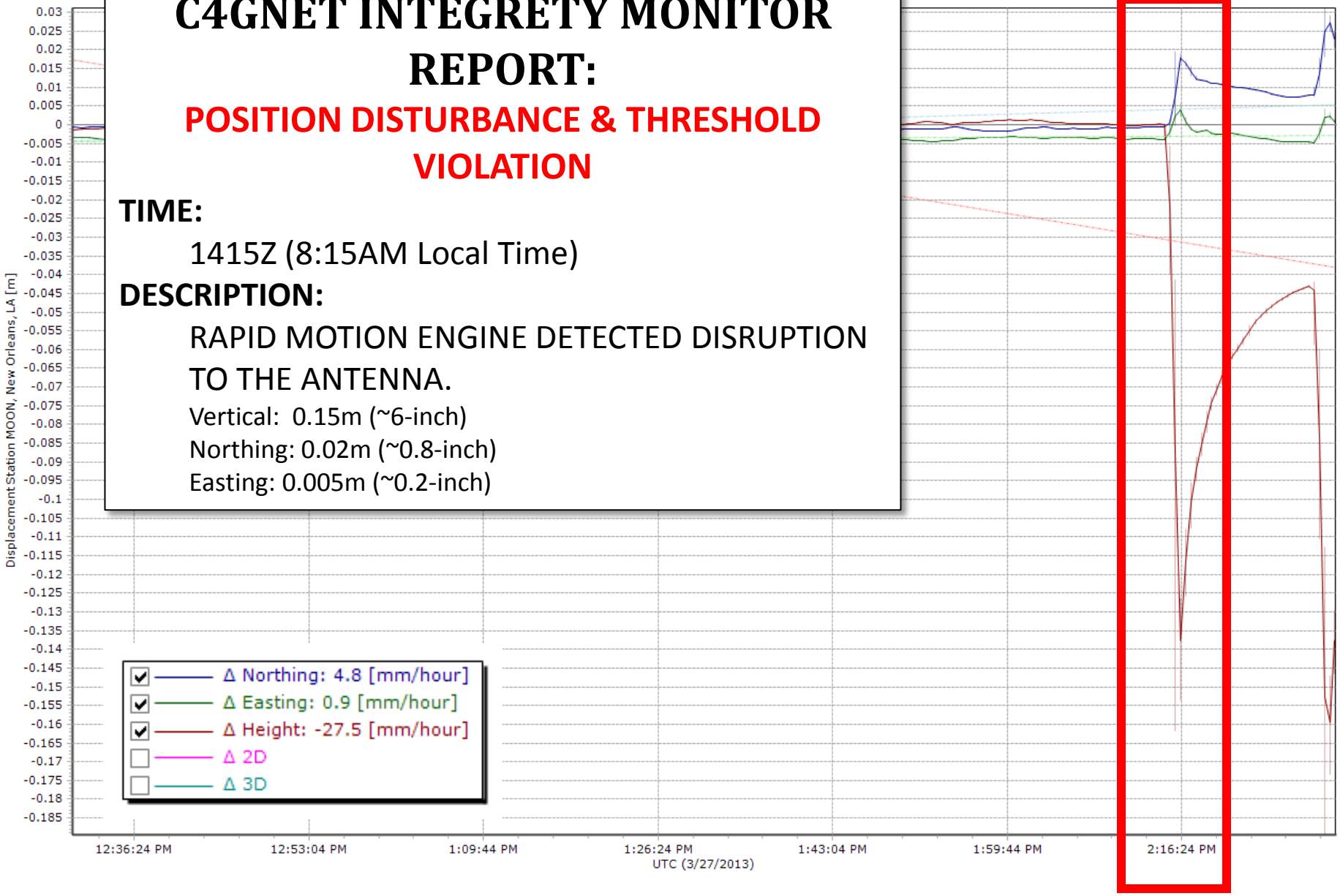
DESCRIPTION:

RAPID MOTION ENGINE DETECTED DISRUPTION TO THE ANTENNA.

Vertical: 0.15m (~6-inch)

Northing: 0.02m (~0.8-inch)

Easting: 0.005m (~0.2-inch)



C4GNET INTEGRETY MONITOR REPORT:

POSITION DISTURBANCE & THRESHOLD VIOLATION

TIME:

1422Z (8:22AM Local Time)

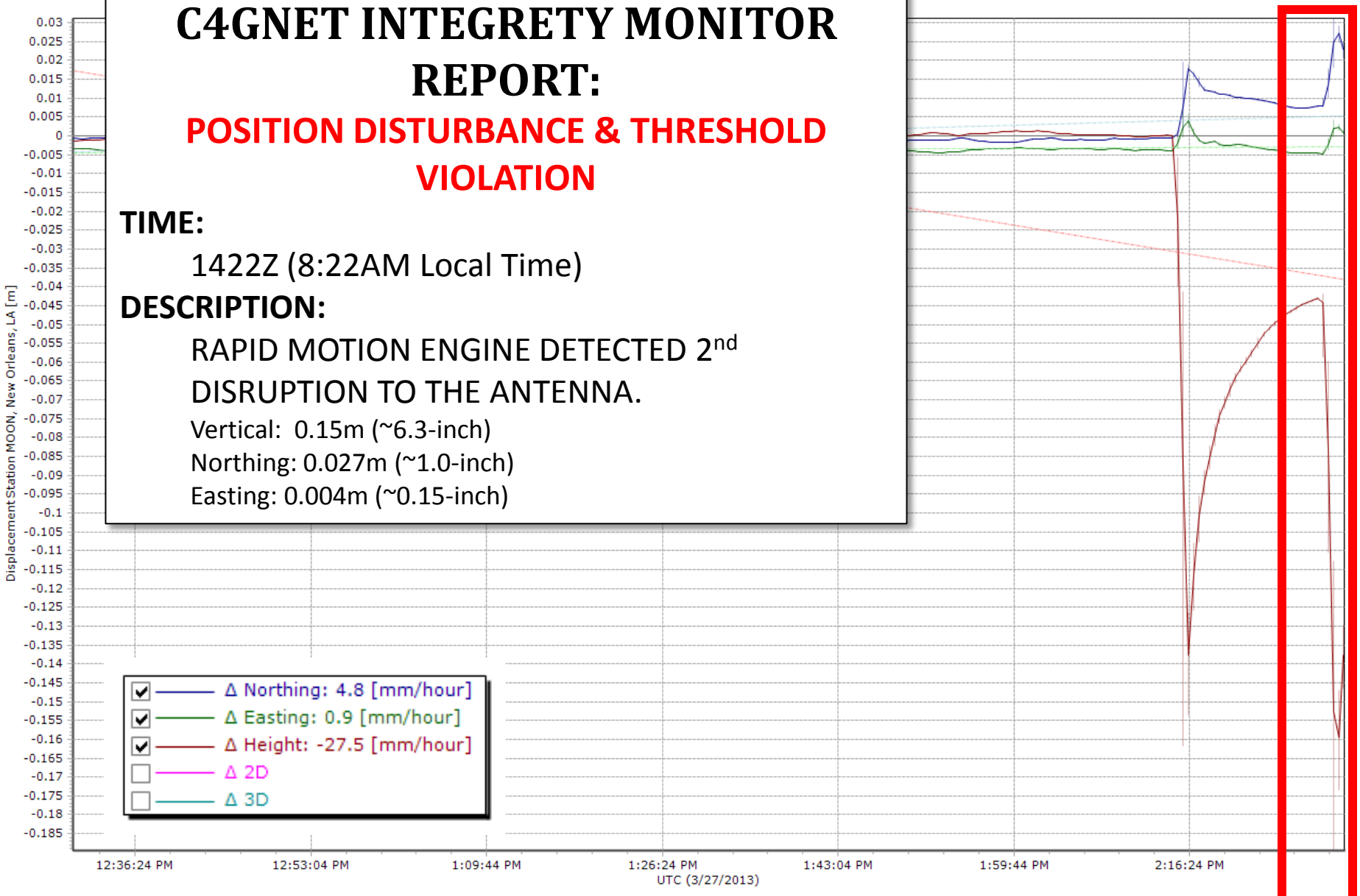
DESCRIPTION:

RAPID MOTION ENGINE DETECTED 2nd DISRUPTION TO THE ANTENNA.

Vertical: 0.15m (~6.3-inch)

Northing: 0.027m (~1.0-inch)

Easting: 0.004m (~0.15-inch)



C4GNET INTEGRETY MONITOR REPORT:

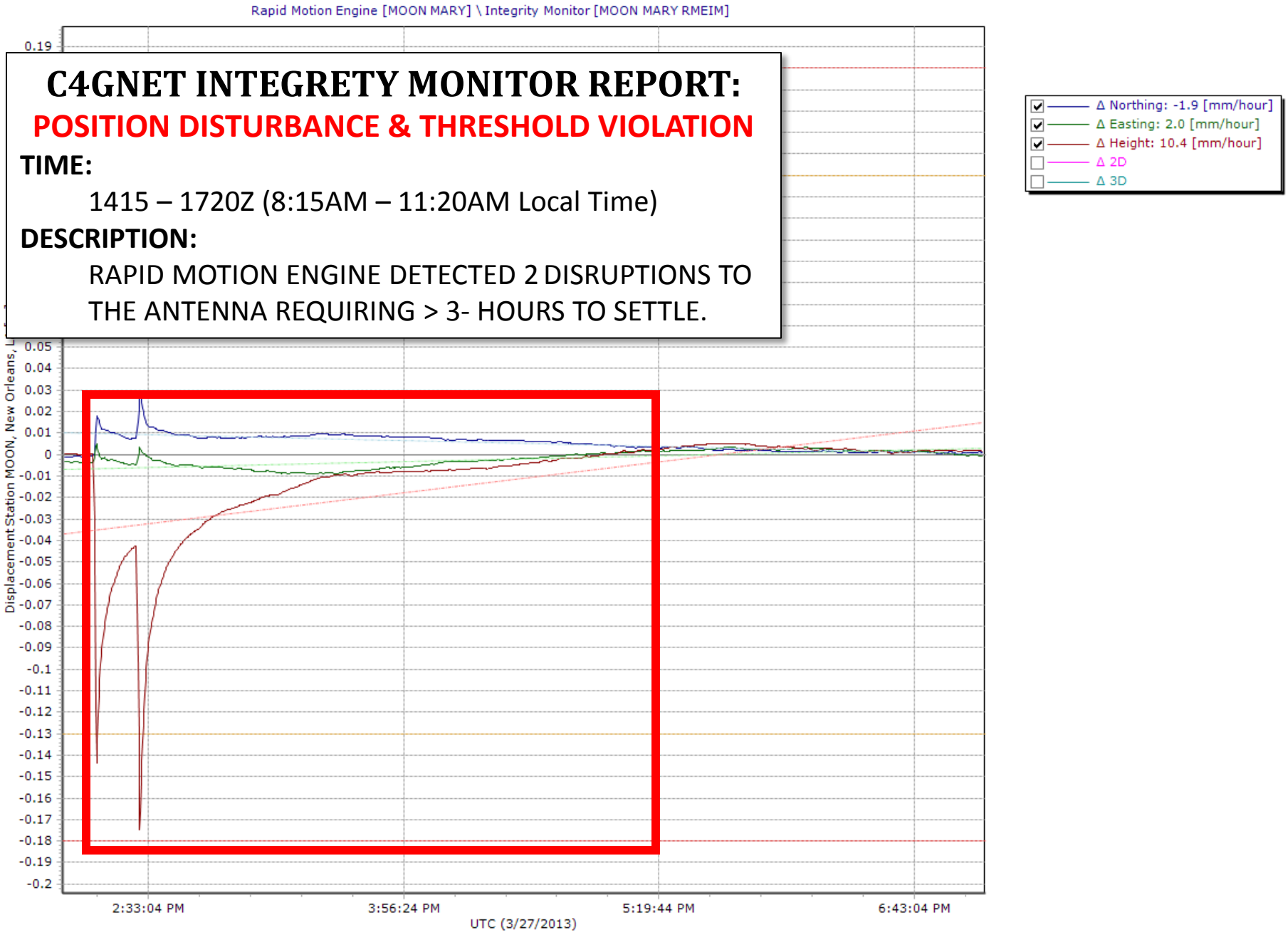
POSITION DISTURBANCE & THRESHOLD VIOLATION

TIME:

1415 – 1720Z (8:15AM – 11:20AM Local Time)

DESCRIPTION:

RAPID MOTION ENGINE DETECTED 2 DISRUPTIONS TO THE ANTENNA REQUIRING > 3- HOURS TO SETTLE.



Interpretations

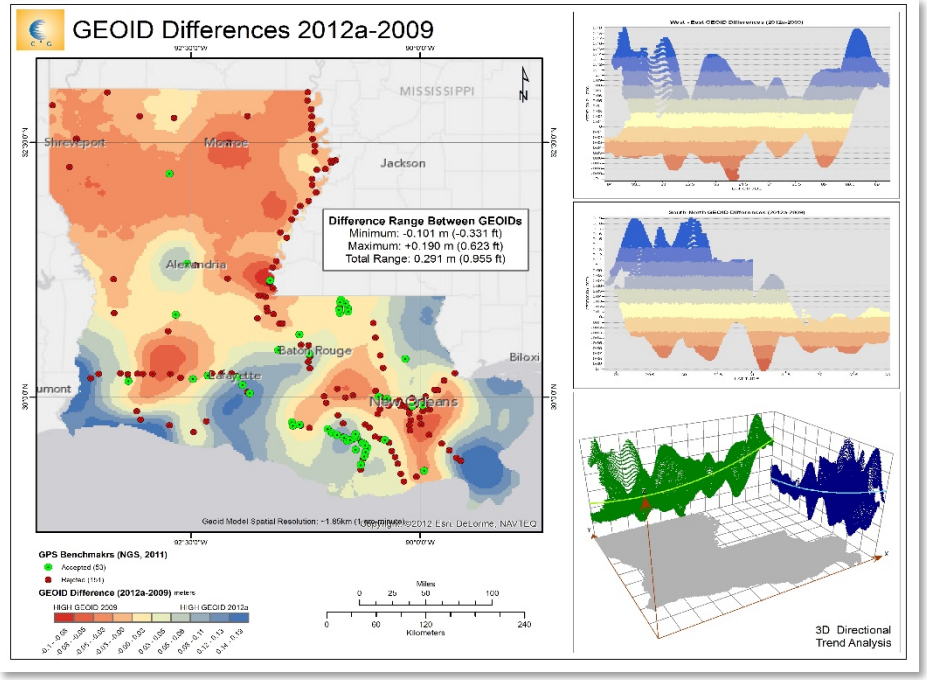
The Charts Depict Rapid Motion Relative to Two CORS Sites Located in New Orleans East

- Before 8:15am, the CORS positions were nominal (e.g., flat line), until something disturbed MOON.
- A Load likely placed near MOON caused rapid motion (spike down)
  - Warning emailed
- By 8:25am, the load shuffled and was removed (illustrated by a rebound)
  - Load adjusted (second spike down),
  - Load removed (rebound)
- By 11:20am, the position returned to steady readings (e.g., constant line).

Short-Term Plans

Expand C4G Personnel

- Hire a Director
- Licensed Land Surveyors
- Visiting Researchers
- Adjunct Research & Faculty
- Post-Doctorate Fellows



Broad Adoption of Active Reference Network

- Establish CORS RTN as a Requirements-Driven Standard of Practice
  - Increase utilization with Local, State, and Regional Governments
  - Flood Certification & Hazard Mitigation
  - Coastal Sustainability & Restoration

Short to Mid Range Plans

Computational Expansion

- Data Storage (currently @ 80TB)
- Improve *Big Data* Processing Capacity

Infrastructure Expansion

- 5 GNSS CORS Sites Planned for 2013
- Gap Analysis of Network Coverage
- Collaborate with MS to Extend Coverage
- Phase out all GPS-only CORS in the next 3-5 years
- Adopt new GNSS platforms (Galileo and Compass)

Mid to Long Term Plans

Geodetic Support

- Measure Absolute Gravity at Site
- Coordinate with GRAV-D Program & New Geoid Model
- Support for New Reference Frameworks (NAD-2016/NAVD-2018??)

Innovative Utilization

- Identify non-traditional applications
- Expand services into additional industries & grow subscriptions

Questions?

LSU Center for GeoInformatics
http://c4g.lsu.edu