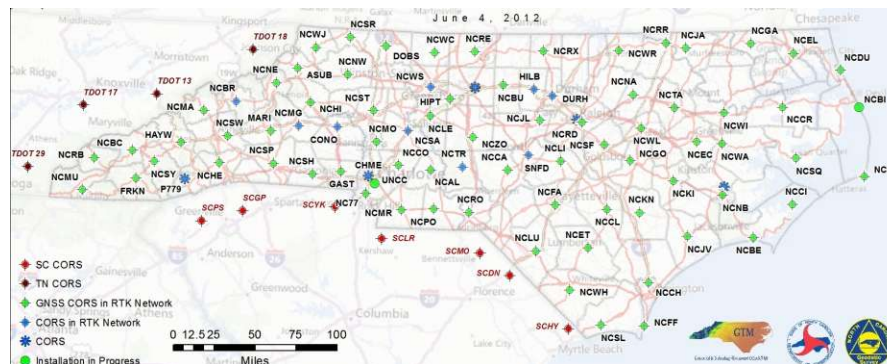


North Carolina Geodetic Survey

North Carolina Continuous Operating Reference Stations (CORS)





What is a CORS?

- Continuously Operating Reference Station (CORS)
 - A permanent Global Navigation Satellite System (GNSS) receiver, antenna (with a surveyed reference position), and support equipment







What is a CORS?

- Continuously Operating Reference Station (CORS)
 - NC CORS Network
 - Composed of 77 CORS
 - 3 new CORS have been installed
 - Salisbury (NCSA)
 - Roanoke Rapids (NCRR)
 - New Bern (NCNB)
 - 1 new CORS is being installed
 - Bodie Island (NCBI)
 - Collects data 24/7 at 1 second intervals
 - Receiver type
 - 67 GPS+GLONASS
 - 10 GPS



Former Pea Island CORS



Carolina Country magazine source of imagery



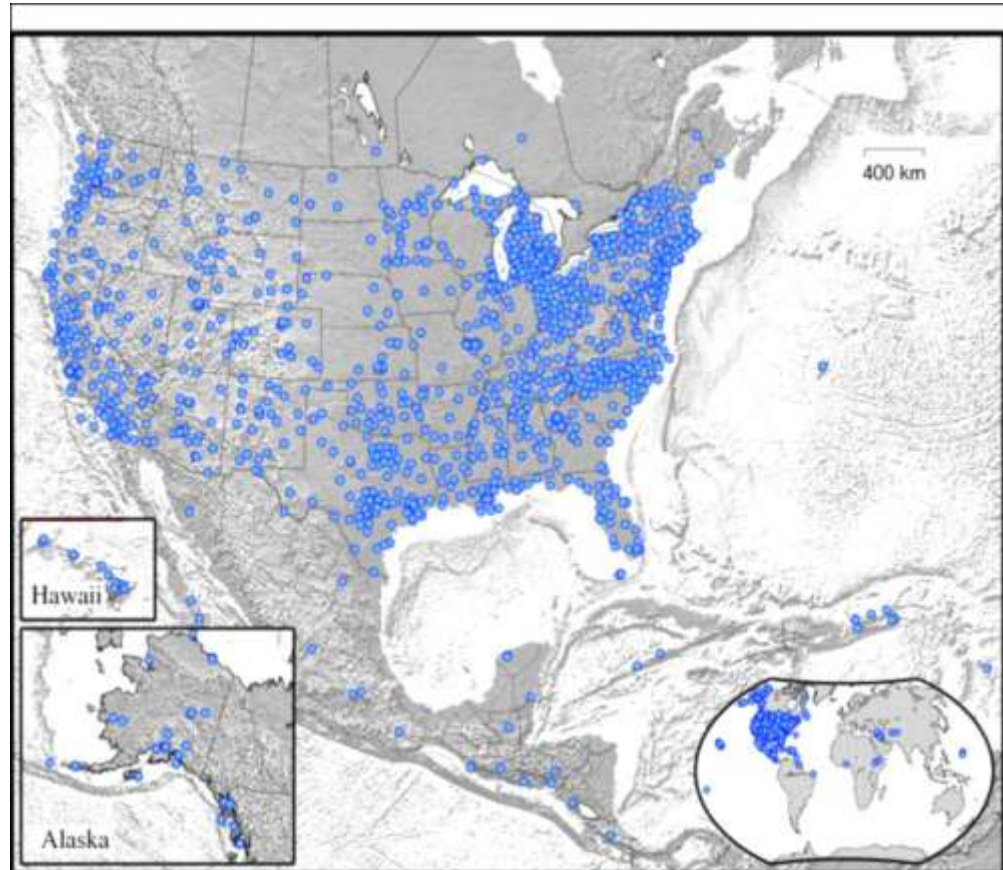
What is a CORS?

- Continuously Operating Reference Station (CORS)
 - CORS in NC that are in the National CORS network but not included in the Real Time Network (RTN)
 - New Bern NDGPS (NBR5 and NBR6)
 - Greensboro NDGPS (NGR5 and NGR6)
 - Plate Boundary Observatory CORS at Rosman (P779)
 - Charlotte (CHME)
 - Conover (CONO)
 - Hillsborough (HILB)



National CORS

- National CORS Benefits
 - Included in OPUS solutions
 - Monitored by NGS (60 day plot)
 - Will be include in any future national adjustments



NCKI
KINSTON
Kinston, NC
USA

National Geodetic Survey - CORS



Site operated by:
[NCGS](#)

[Description of photos](#) | [Additional Photos](#) | [Send Photos to Us](#)

Pictures of equipment may not reflect equipment currently installed. Please see [sitelog](#)

- [Coordinates](#)
- [Data Sheet \(ARP only\)](#)
- [Data Sheets](#)
- [SiteLog](#)
- [Photographs](#)
- [Data Availability](#)
- [Standard Files](#)
- [Custom Files \(UFCORS\)](#)

- [Time Series \(60-day\)](#)
- [Time Series \(longterm\)](#)

- [Google Map ncki only](#)
- [Google Map all CORS](#)

Enter SiteID

[CORS Home](#)



View looking north



View looking west



Overall View



View looking east



View looking south



View of roof surface



View mount attached to bldg

No Photo Submitted



NCKI
KINSTON
Kinston, NC
USA

National Geodetic Survey - CORS



Site operated by:
[NCGS](#)

- [Coordinates](#)
- [Data Sheet \(ARP only\)](#)
- [Data Sheets](#)
- [SiteLog](#)
- [Photographs](#)
- [Data Availability](#)
- [Standard Files](#)
- [Custom Files \(UFCORS\)](#)

- [Time Series \(60-day\)](#)
- [Time Series \(longterm\)](#)

- [Google Map ncki only](#)
- [Google Map all CORS](#)

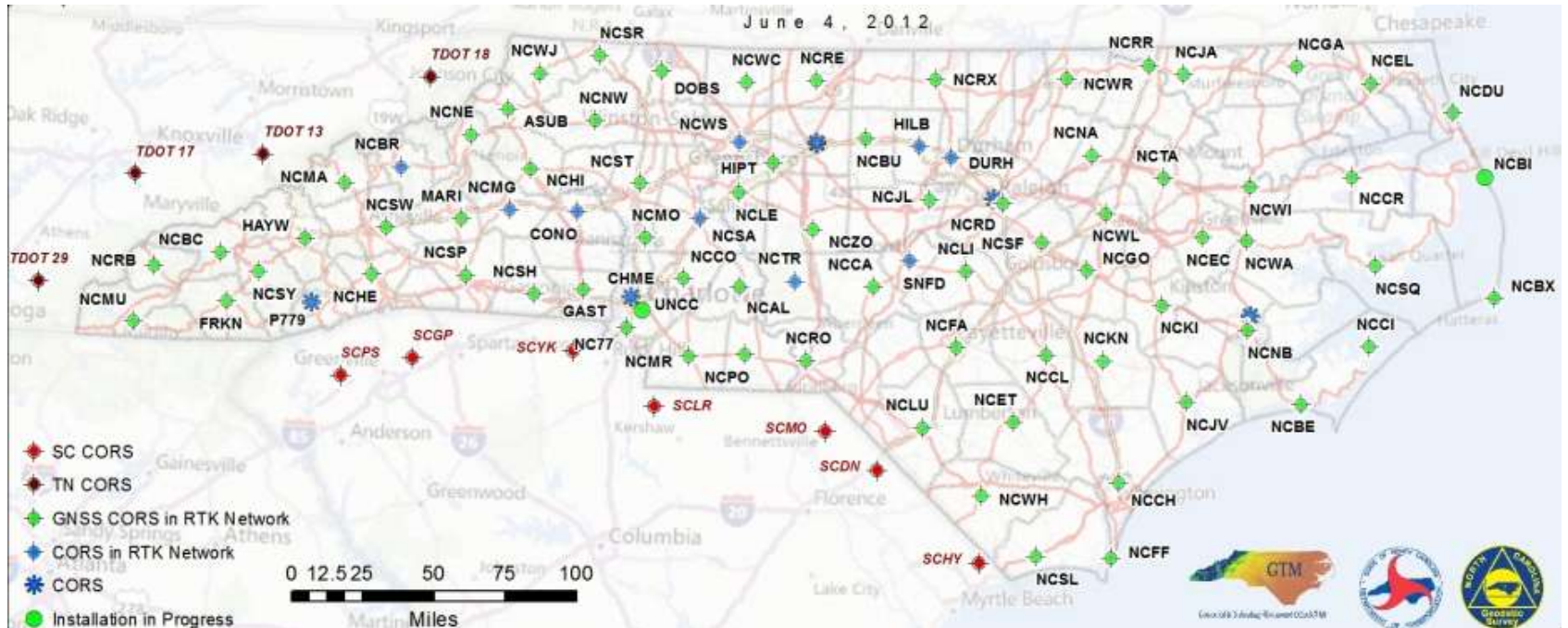
 Enter SiteID

[CORS Home](#)



NCKI
KINSTON, NC

Operational & Proposed (CORS)



CORS Installation Components

- **Planning**

- NGS Guidelines
- Hardware
- Monumentation
- Software
- Communication

- **Installation**

- Documentation
- Submittal to NGS

**Guidelines for New and Existing Continuously
Operating Reference Stations (CORS)**

National Geodetic Survey

National Ocean Survey, NOAA

Silver Spring, MD 20910

February 2006

CORS Hardware



- GNSS Receiver
 - Uninterruptible Power Supply (UPS)
 - Receiver location
 - Surge protection
 - Internet connection



CORS Hardware



- GNSS Receiver
 - Uninterruptible Power Supply (UPS)
 - Receiver location
 - Surge protection
 - Internet connection



CORS Hardware



- GNSS Antenna
 - Antenna Type
 - Type of leveling device
 - Antenna location
 - Monumentation/mounting
 - Lighting protection
 - Grounding
 - Antenna cable
 - Length/Type
 - Routing

Guidelines –Equipment Antennas

-L1 and L2

-Radomes NOT recommended

WHY: distort signal and not required in design of antenna

-Oriented to true North

WHY: apply antenna phase center values correctly

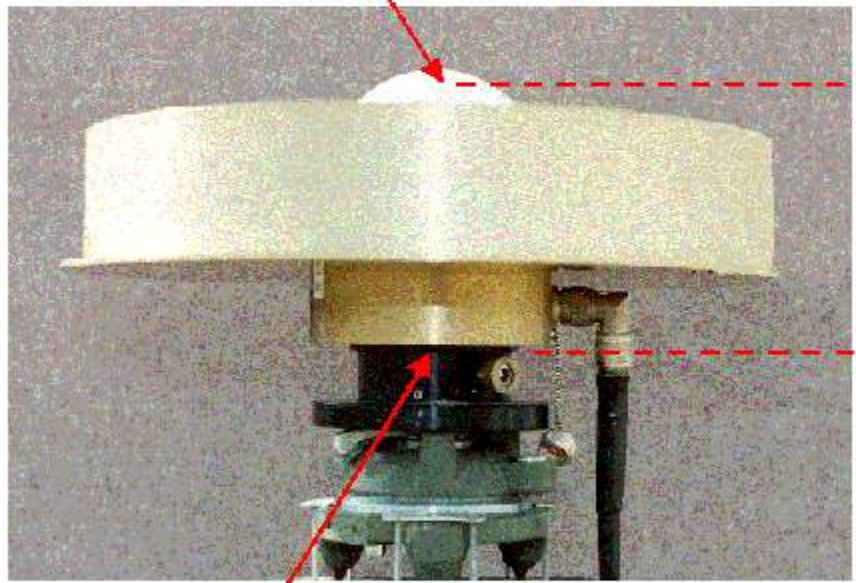
-Reference mark to antenna reference point (ARP)
constant

WHY: change antenna same coordinate

CORS Hardware (Leveling Devices)



The antenna phase centers are located somewhere around here



The user does not need to know these offsets. They are passed to the processing software through the antenna type

The antenna offsets are the distance between the phase centers and the ARP

If the user selects NONE as the antenna type, the offsets are set to 0.000 and the antenna phase center becomes the reference point

The Antenna Reference Point (ARP) is almost always located in the center of the bottom surface of the antenna.

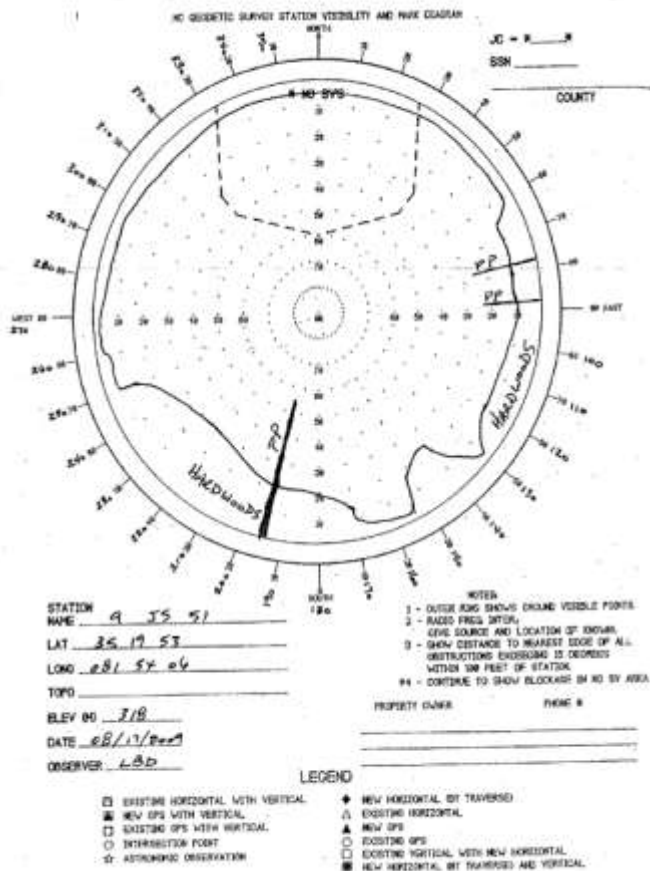
Site Selection



- Clear view of the sky
 - Unobstructed view of the horizon 360 degrees
- No nearby signal reflectors
 - 0.5 m to 1.5 m above horizontal surfaces
- No nearby signal transmitters
 - 300 meters
- Stability
 - Thermal expansion
 - Wind loading
 - Soil expansion/contraction

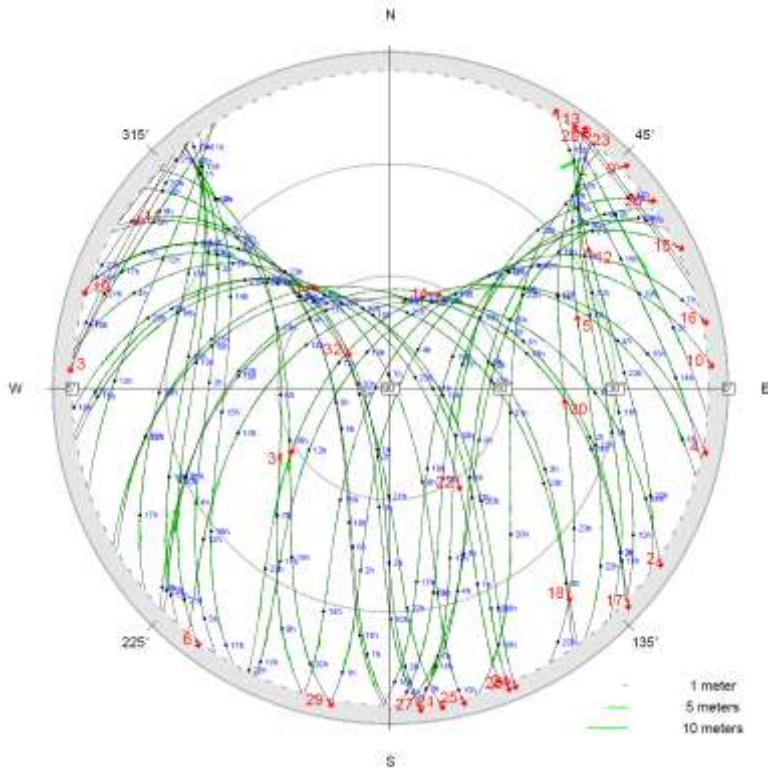
Site Selection

- Reconnaissance
 - Visibility diagram
 - Photographs of proposed location
 - Measurements for monumenatation
 - Cable routing and type
 - Are drilled holes required in walls
 - Length of cable
 - Type of cable (LMR400 or LMR600)
 - Internet connection
 - Collect 24 hours of data

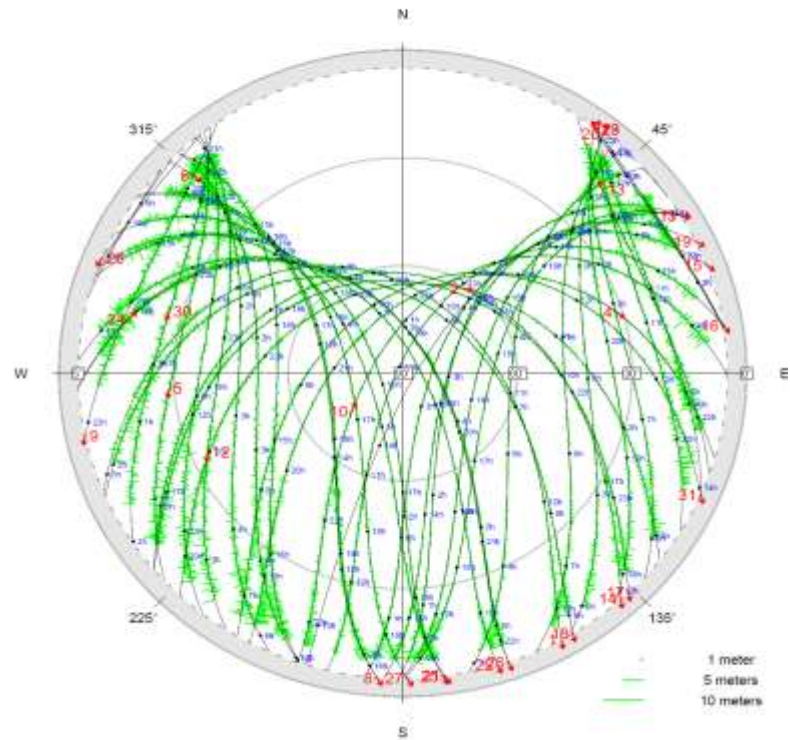


Site Selection

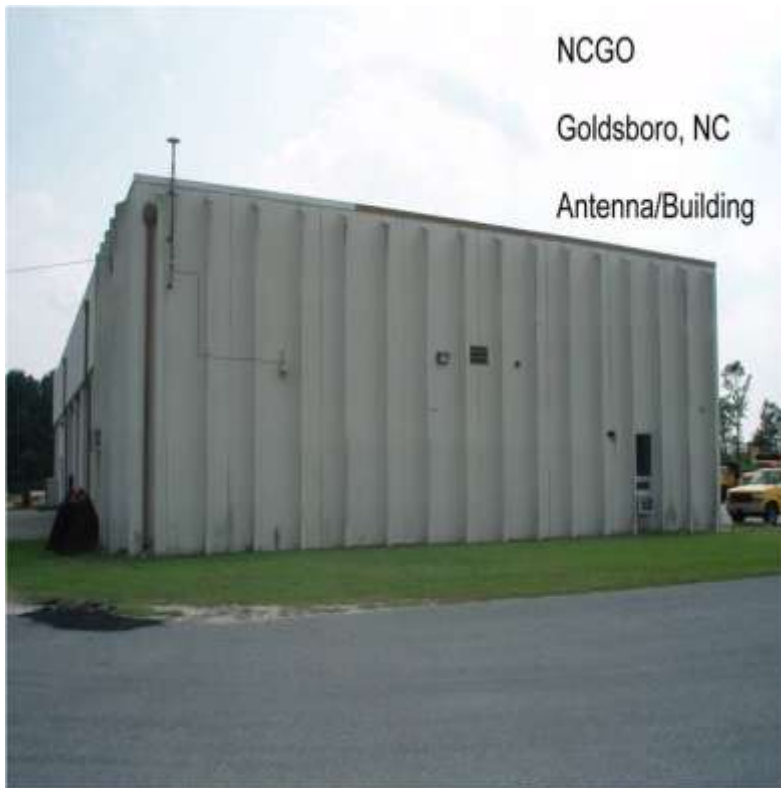
C1 Pseudorange Multipath at Sparta
Lat: 36.4977° Lon: -81.1147° Ell.Ht: 839.8 (m)
GPS Time: Start 2008/03/15 00:00:00 Stop 2008/03/15 23:59:31



C1 Pseudorange Multipath at New Bern CORS NBR6
Lat: 35.1750° Lon: -77.0498° Ell.Ht: -23.5 (m)
GPS Time: Start 2007/11/12 00:00:00 Stop 2007/11/12 23:59:31



Site Selection



- Building Mount
 - Brick/block or concrete building
 - Building must be 5 years or older
 - Chimney mount requires that chimney be filled with concrete
 - **No Metal Roofs!!!!**

Monumentation

- Ground Monumentation
 - Concrete
 - Metal



Monumentation



- Drilled-Braced
 - Most stable
 - Specialized equipment required for installation

Monumentation

- Building Mount
 - Rooftop attachment
 - Wall attachment



Monumentation (Building Mount)



- How will you mount antenna
 - Stability
 - Type of attachment
 - Fasteners
 - On site welding required?
 - Tools required
 - Lift truck
 - Ladder



Problem lightning rod obstructs satellites

Problem wooden support U-bolts height can change



Problem tribrach "feet" cannot be locked height can be changed



Antennas on towers with guy wires poor stability





Good top
surface of pillar
narrower than
antenna.
Problem no
orienting &
leveling device



Good orienting &
leveling devices



Good rooftop
with orienting &
leveling device



Installation

- Stable GNSS antenna
- Power and internet connections are successful
- Antenna mount is acceptable to the site manager
- Installation Report
 - Acquired all photos required by NGS
 - Acquire all metadata required by NGS
 - Record all serial numbers
 - Document site contact

CORS Administration

- Latency
 - Bandwidth
 - Transmission medium
 - Router and switch performance
 - Firewall
 - Wireless network voice/data traffic

CORS Administration

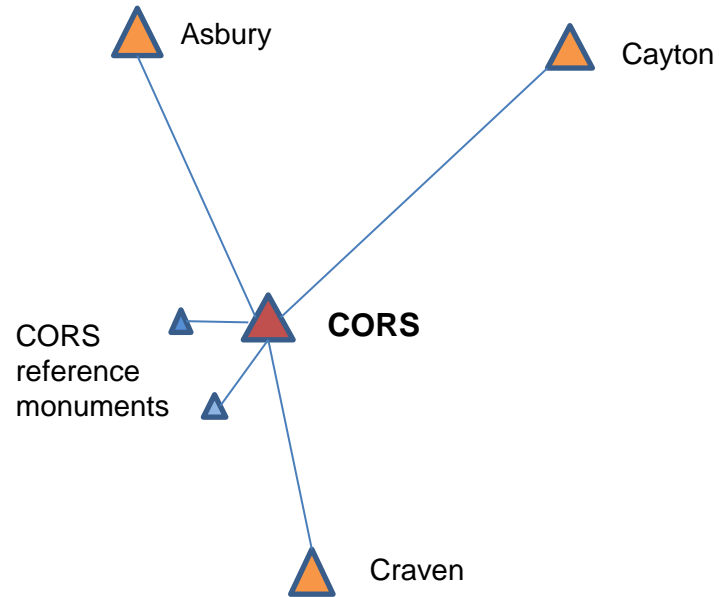
- Reference Station Datum
 - Benefits of using a reference datum that is consistent with the datum used by NGS
 - Easy to verify
 - Consistent with National CORS
 - Can use OPUS to position RTN CORS

CORS Administration

- Reference Station Datum
 - Ramifications of using a datum that differs from a datum utilized by NGS
 - OPUS and RTN solutions are based on different reference datums
 - OPUS can not be used to check RTN solutions
 - RTN can not be used to check OPUS solutions
 - Could create confusion with users

CORS Administration

- Connection to NSRS
 - Recommend local static surveys be performed to connect RTN CORS with local NSRS passive stations
 - NCGS uses NGS-58 to connect the CORS to the NSRS
 - Three (3) HARN monuments
 - Two (2) local CORS reference monuments



CORS Administration

- Connection to NAVD88
 - Connection completed before CORS antenna is installed or afterwards if offset leveling plate has been installed
- Field techniques
 - Geodetic leveling
 - Trigonometric leveling
 - NGS -58 survey



Geodetic Leveling to CORS ARP



Geodetic Leveling to CORS ARP

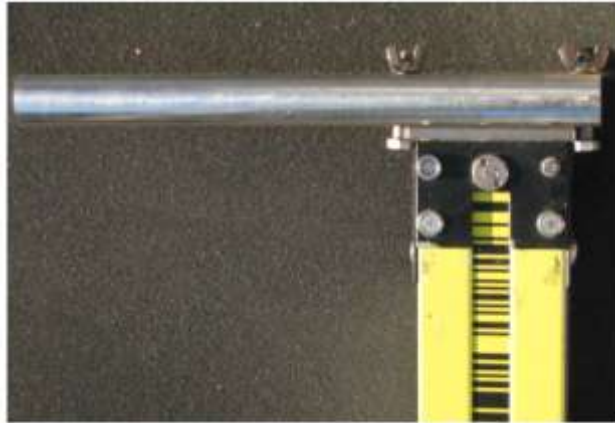


Figure 5. Leveling bar properly attached to rod. Bolt heads grip the rod's base plate.



DATASHEETS - Windows Internet Explorer

http://www.ngs.noaa.gov/cgi-bin/ds_desig.pl

File Edit View Favorites Tools Help

Google Search More >> Sign In

startnow Search with Bing Search Shopping Games Travel MSH Amazon eBay Facebook Twitter

Favorites Suggested Sites Free Hotmail Web Slice Gallery

DATASHEETS

The NGS Data Sheet

See file [dsdata.txt](#) for more information about the datasheet.

```

DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 7.88.3
1 National Geodetic Survey, Retrieval Date = JUNE 12, 2012
DK7747 *****
DK7747 CORS - This is a GPS Continuously Operating Reference Station.
DK7747 DESIGNATION - CRESWELL CORS ARP
DK7747 CORS_ID - NCCR
DK7747 PID - DK7747
DK7747 STATE/COUNTY- NC/WASHINGTON
DK7747 COUNTRY - US
DK7747 USGS QUAD - LEONARDS POINT (1974)
DK7747
DK7747 *CURRENT SURVEY CONTROL
DK7747
DK7747* NAD 83(CORS) POSITION- 35 54 56.93119(N) 076 28 25.29233(W) ADJUSTED
DK7747* NAD 83(CORS) ELLIP HT- -28.216 (meters) (12/??/08) ADJUSTED
DK7747* NAD 83(CORS) EPOCH - 2002.00
DK7747* NAVD 88 ORTHO HEIGHT - 8.918 (meters) 29.26 (feet) ADJUSTED
DK7747
DK7747 NAD 83(CORS) X - 1,209,562.351 (meters) COMP
DK7747 NAD 83(CORS) Y - -5,028,018.211 (meters) COMP
DK7747 NAD 83(CORS) Z - 3,720,613.981 (meters) COMP
DK7747 GEOID HEIGHT - -37.10 (meters) GEOID09
DK7747 HORZ ORDER - SPECIAL (CORS)
DK7747 VERT ORDER - SECOND CLASS II
DK7747 ELLP ORDER - SPECIAL (CORS)
DK7747
DK7747.The coordinates were established by GPS observations
DK7747.and adjusted by the National Geodetic Survey in December 2008.
DK7747
DK7747.The datum tag of NAD 83(CORS) is equivalent to NAD 83(CORS96).
DK7747
DK7747.The coordinates are valid at the epoch date displayed above
DK7747.which is a decimal equivalence of Year/Month/Day.
DK7747
DK7747.The orthometric height was determined by differential leveling and
DK7747.adjusted in April 2010.
DK7747
DK7747.No vertical observational check was made to the station.
DK7747

```

Done Internet 100%

NC Geodetic Survey on Twitter



- NCGS has developed a Twitter web page (<http://twitter.com/ncrtn>), which is similar to the NCDOT Twitter page (<http://twitter.com/ncdot>)
- Provides information on the status of NC CORS, RTN, and other web features.

twitter Have an account? Sign in

Get short, timely messages from NC Geodetic Survey.

Twitter is a rich source of instantly updated information. It's easy to stay updated on an incredibly wide variety of topics. [Join today](#) and follow [@ncrtn](#).

[Sign Up](#) Get updates via SMS by texting [follow ncrtn](#) to 40404 in the United States. Codes for other countries

 **ncrtn**

Name NC Geodetic Survey
Location North Carolina
Web <http://www.ncgs.s...>
Bio Twitter Page for the North Carolina GPS Real Time Network

0 following 76 followers 3 listed

Tweets 87

Favorites

Following

 [RSS feed of ncrtn's tweets](#)

The NCZO (NC Zoo) and NCFA (Fayetteville) CORS are operating again.
5:25 AM Nov 4th via web

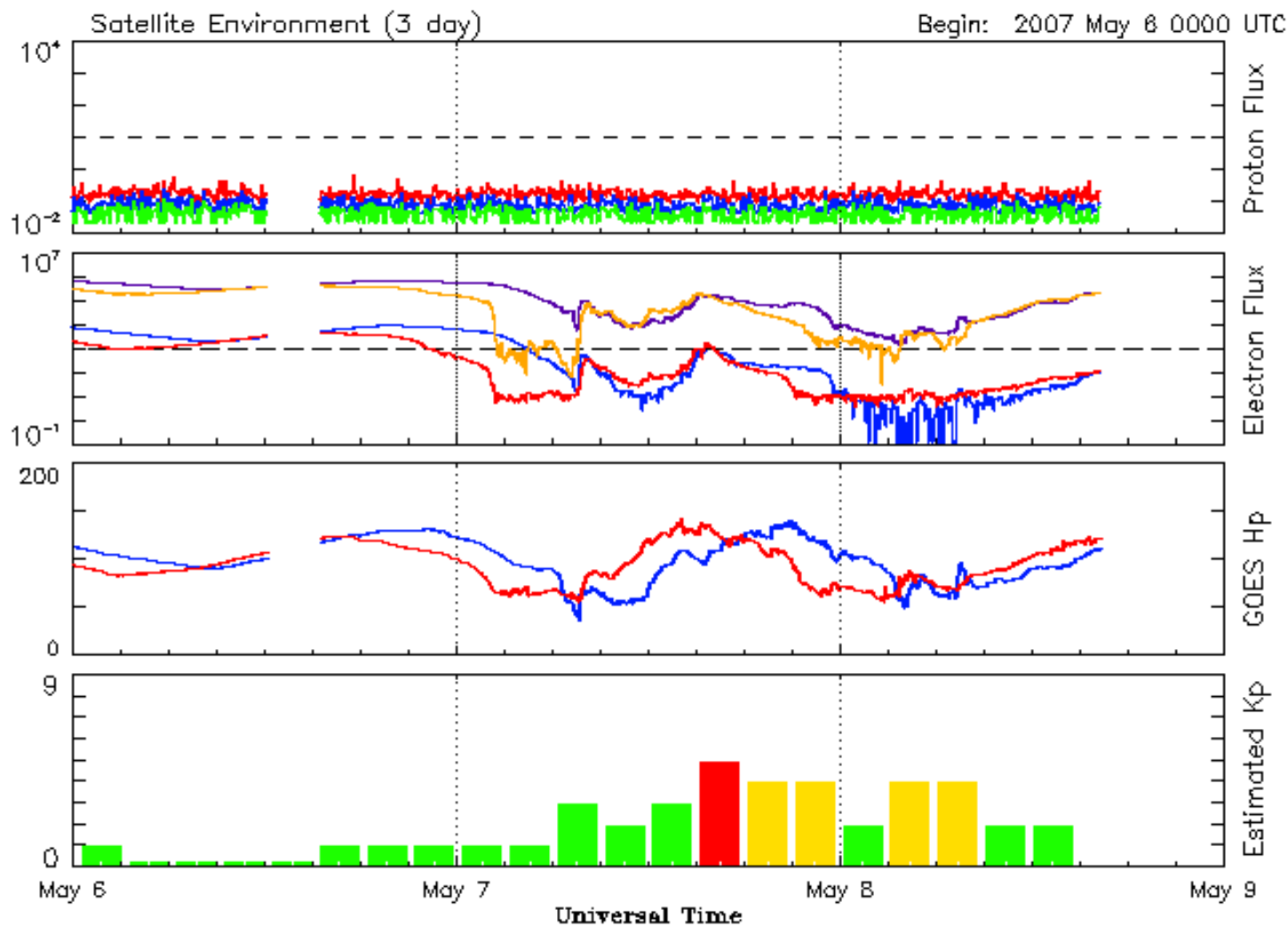
The NCZO (NC Zoo) and NCFA (Fayetteville) CORS are currently not operating.
11:34 AM Nov 2nd via web

The NCTR (Troy) CORS is working again.
10:24 AM Nov 2nd via web

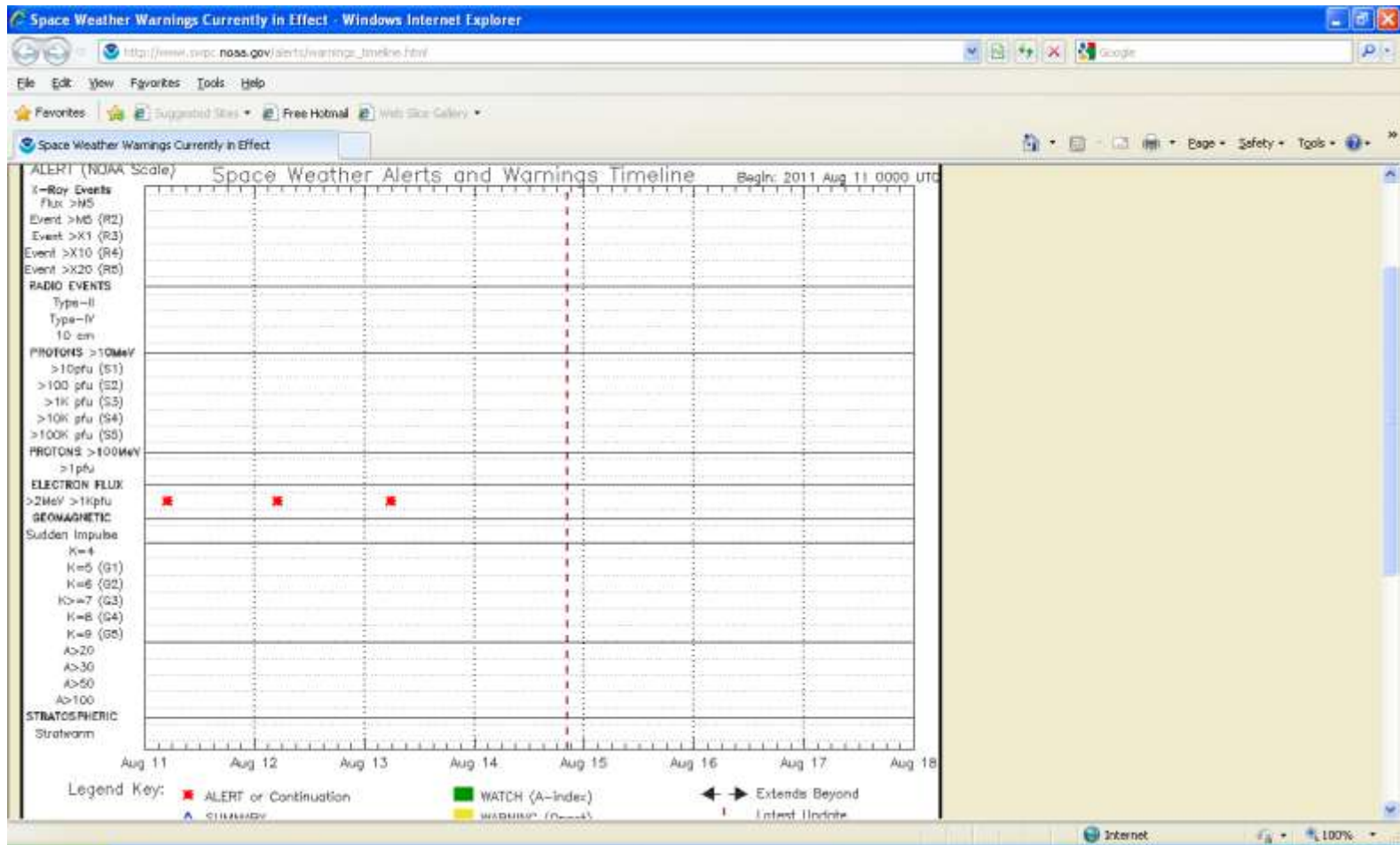
The NCCO (Concord) CORS is operating again. The NCTR (Troy) CORS is currently not operating.
5:58 AM Nov 2nd via web

The NCCO (Concord) and NCTR (Troy) CORS are currently not operating.
5:45 AM Nov 1st via web

Space Weather

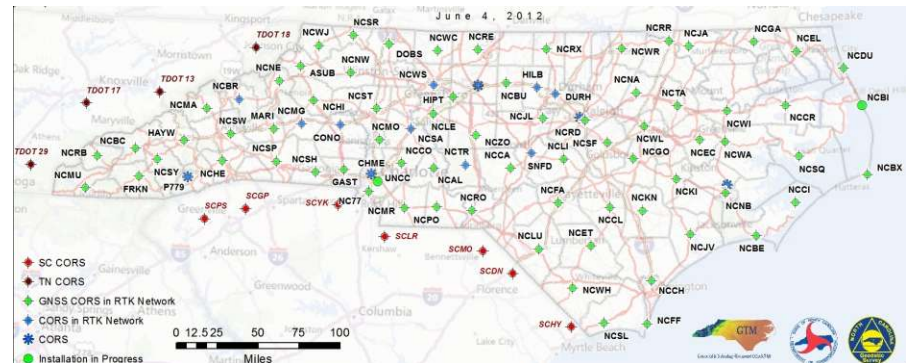


NOAA Space Weather Warnings



2012 CORS Upgrade

- GPS to GPS+GLONASS
 - Durham (DURH)
 - Sanford (SNFD)
 - Troy (NCTR)
 - Winston Salem (NCWS)



- New CORS
 - University of NC at Charlotte
- New location
 - Move HAYW at Haywood Community College to Bethel Elementary School

User Friendly CORS Version 3.6.2 - Windows Internet Explorer

http://www.ngs.noaa.gov/UFCORS/

File Edit View Favorites Tools Help

★ Favorites ☆ Suggested Sites Free Hotmail Web Slice Gallery

User Friendly CORS Version 3.6.2

User Friendly CORS

Version 3.6.2

This utility allows you to obtain a specific block of Global Positioning System (GPS) data for a continuously operating reference station (CORS) contained in the network of GPS sites managed by the National Geodetic Survey.

The GPS data will be in "receiver independent exchange" (RINEX) format, version 2.10.

[UFCORS Page Info](#) [Trimble Products Configuration](#) [UFCORS Problem/Comment Form](#)

Starting Day: Jun 10, 2012 - 162 [Get Older Data](#)

Start Time of the field observation: 00:00 [Day and Time Info](#)

Time Zone relative to observation location: UTC (GMT) [Time Zone Info](#)

Number of hours of data you wish to receive: 1 Please LIMIT requests for 1-second sampling rate data to 2 hours.

[CONTINUE](#) [CLEAR](#)

[NOS Home](#) | [Contact Info](#) | [Privacy Policy](#) | [Disclaimer](#) | [Document Viewers](#)

Web site owner: [National Geodetic Survey \(NGS\)](#), [National Oceanic & Atmospheric Administration \(NOAA\)](#)

Done Internet 100%

User Friendly CORS

Version 3.6.2

GPS data are available for the following sites for your specified time interval:

Site ID: [Site Info](#), [Site Map](#), [Data Availability](#), [Time Series](#)

How many seconds do you want between individual data points?

Sampling Rate: Data files are decimated to a 30-second sampling rate after they have become 30-days old. You may only request data with sampling rates equal to or lower than the sampling rate available in the CORS Archive.

Would you like the corresponding files?

Coordinate File: [Coordinate File Info](#)
Met File: [Met File Info](#)
NGS data sheet:
IGS Orbits in SP3 format: [Orbit File Info](#)

Please choose the compression format.

Files can be compressed using: [Compression Info](#)

Processing will take place within a minute. A window will appear after processing that allows you to select where on your hard drive to save the transmitted files. Also, a window displaying icons for several directories (folders) and files may appear. You may use this window to view the transmitted files. This feature is browser dependent and may not work on your browser.

[Report a problem or send a comment](#)



North Carolina Real Time Network (RTN) Upgrade

CORS/RTN Upgrade

- New Servers
 - Three (3) dedicated servers
 - Housed in the western data center
- Software upgrade
 - VRS3-Net
- New features for users
 - Network status
 - Improvements in iono models
 - Access flexibility
- Schedule
 - Servers purchased and installed
 - Software purchased
 - Installation of software has been completed
 - Beta testing completed



CORS/RTN Upgrade

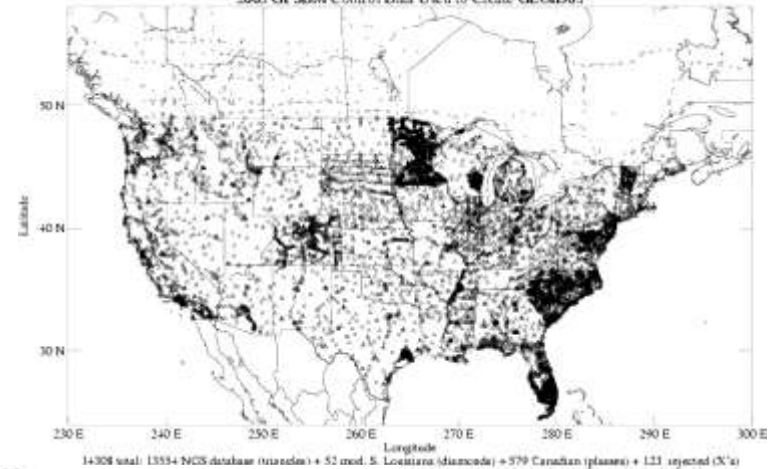
- NCGS plans to operate both systems until to Geoid12 is available
- The new CORS/RTN system will utilize coordinates from the Multi-Year CORS Solution (MYCS)
 - NAD83/2011

Geoid Model History

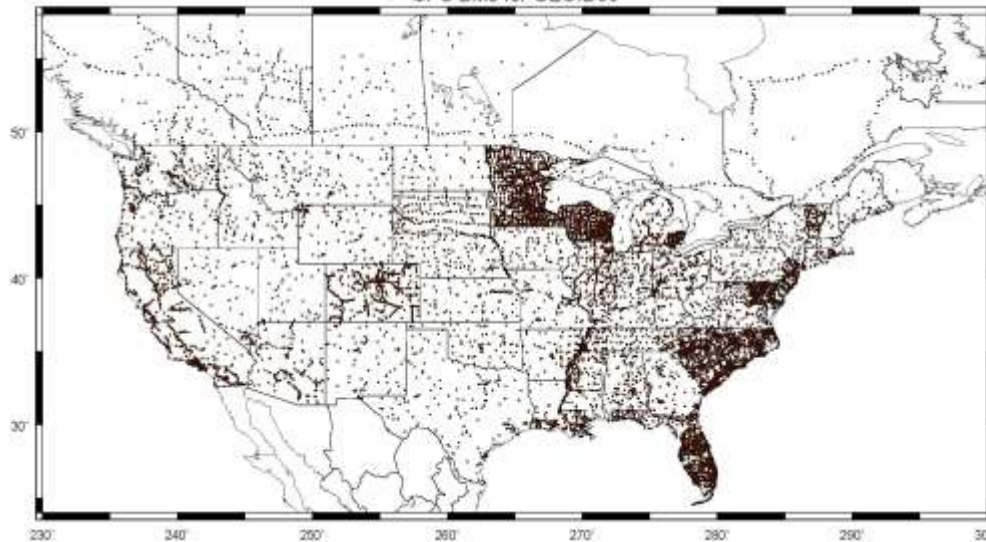
GPS/BMs for GEOID99 (6169 points)



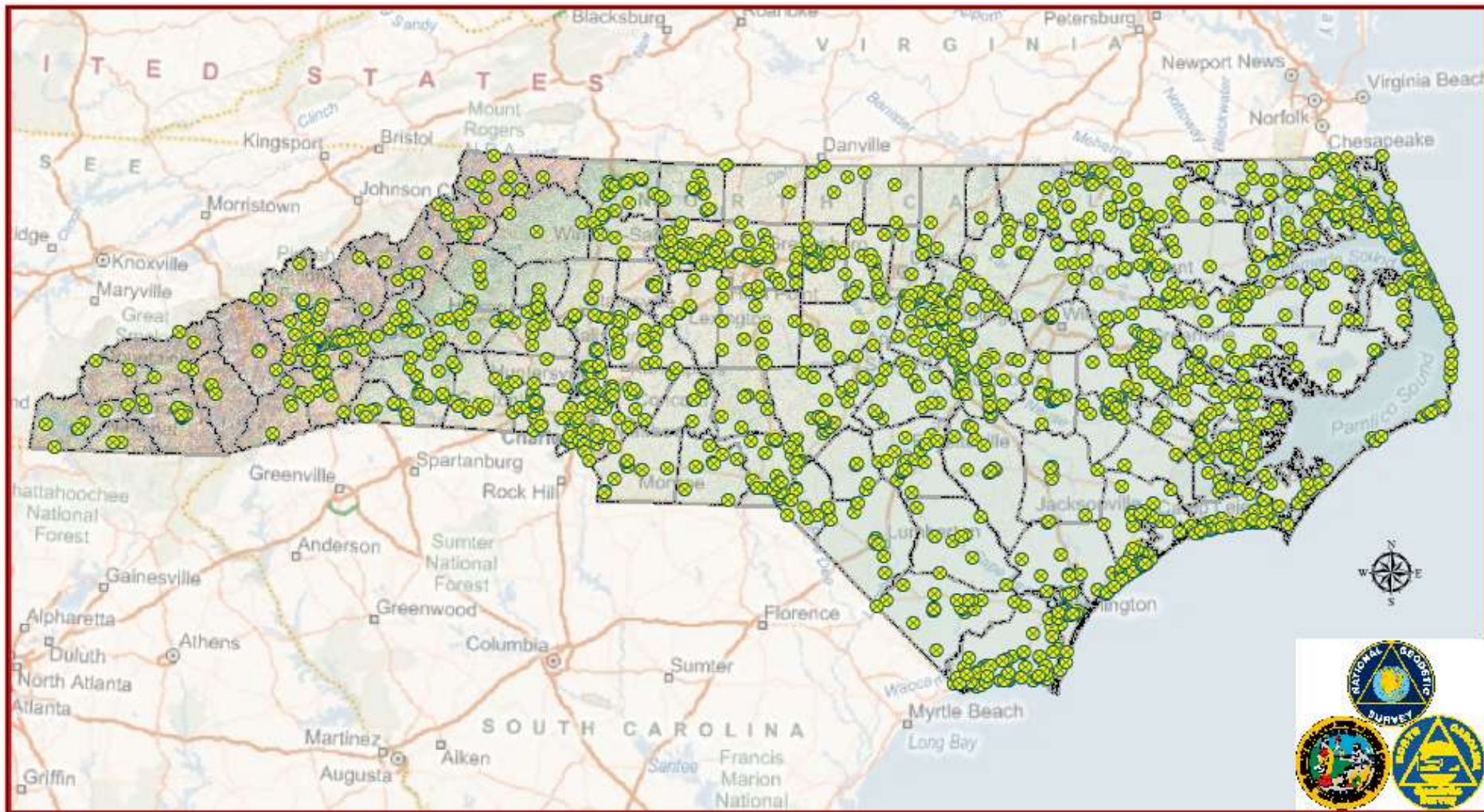
3001 GPSBM Control Data Used to Create GEOID03



GPS BMs for GEOID09



Distribution of Control used for the generation of GEOID 09 in North Carolina



RTN Upgrade Notice

The screenshot shows a Windows Internet Explorer browser window displaying the North Carolina Geodetic Survey website. The browser's address bar shows the URL <http://portal.ncdenr.org/web/ncgs/geodetic>. The website header includes the text "Division of Land Resources" and "North Carolina Geodetic Survey". A navigation menu contains links for HOME, LAND QUALITY, GEOLOGICAL SURVEY, and GEODETIC SURVEY. A search bar is present with the text "Search DENR".

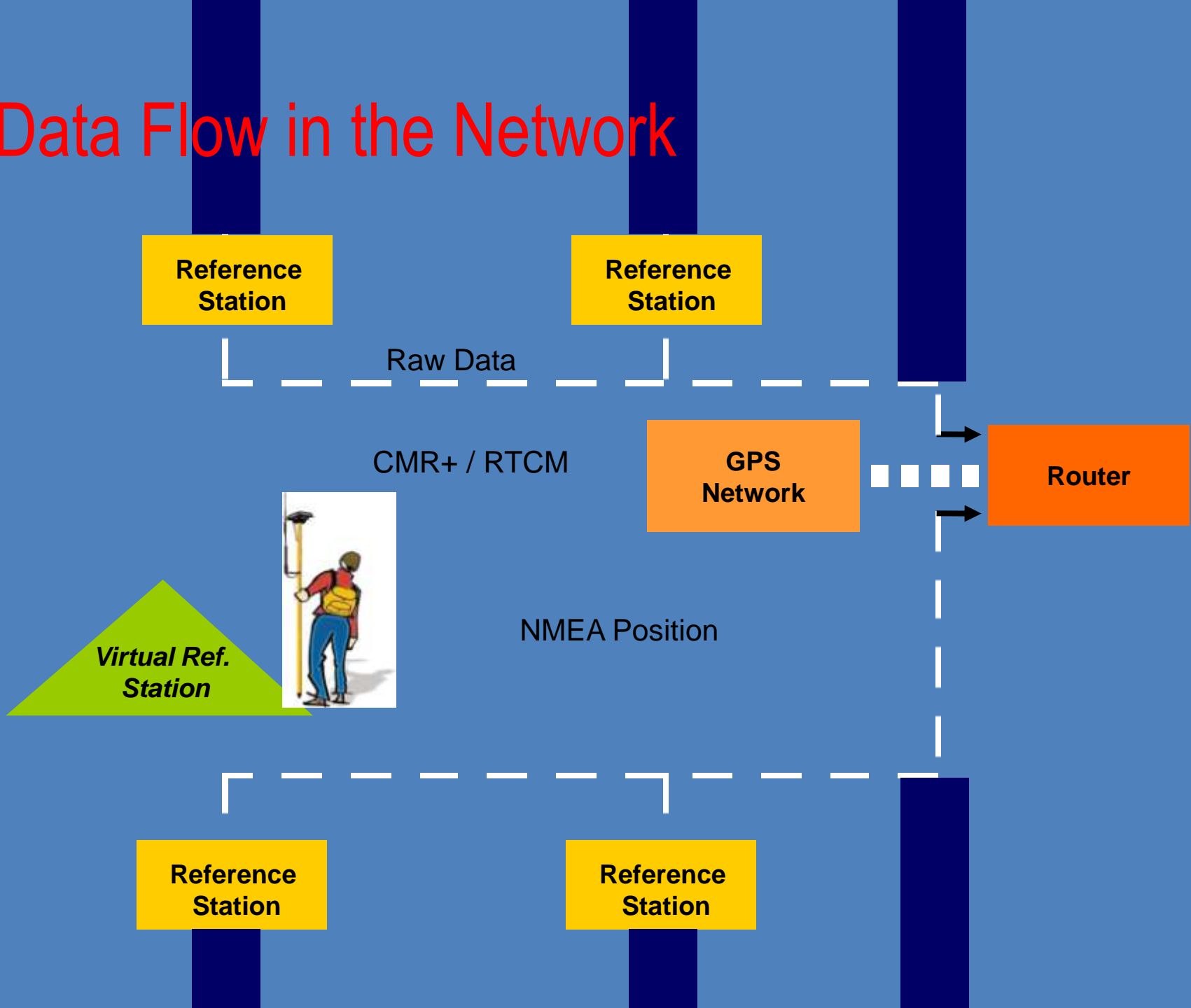
The main content area features a "General Information" sidebar with links such as "About NCGS", "Mission Statement", "Products and Services", "News", "FAQs Regarding NAD83(HRS2007)", "Contact Information", "Workshops", "Instructional Videos and Media", "Event Calendar", "Internal Forms", and "Email a Question".

The central content area displays a "RTN System Status" notice dated April 5, 2012, 9:03 AM. The notice states: "The old RTN network (NAD83(HRS2007)) will remain operational and accessible until the NAD83(2011) adjustment and GEOD12 are released. NCGS will post updates on this website. Please be aware you will still need a new login and password to access the new network. Contact bart.allgood@ncdenr.gov if you have any questions or concerns." The notice is attributed to Steven Kaufman and includes a "Search" button.

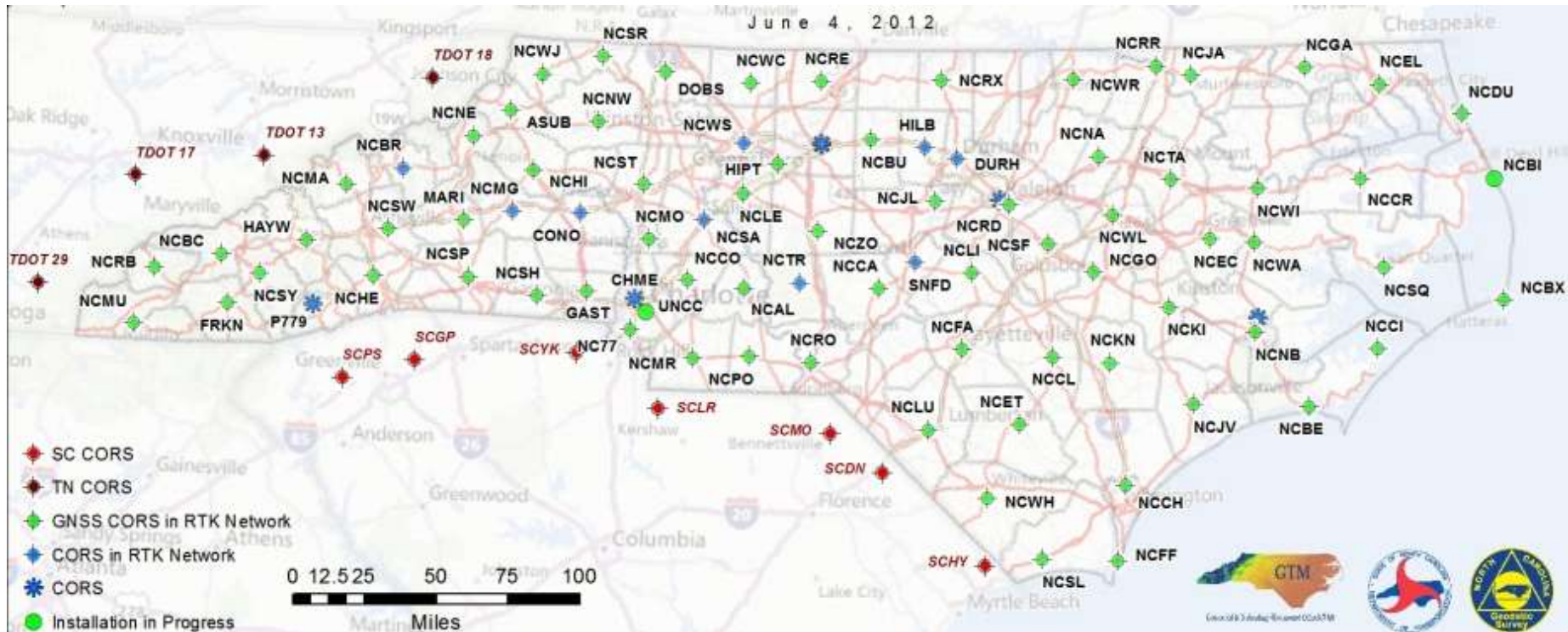
Below the RTN System Status notice is a "Message for NC RTN users!" dated March 30, 2012, 1:47 PM. This message states: "Access to the old RTN (referenced to NAD83(HRS2007)) will end on the evening of April 4, 2012. If users have not received a new RTN access information email, contact Bart Allgood at bart.allgood@ncdenr.gov for further directions." It also mentions the new RTN system will be referenced to the most recent National Geodetic Survey (NGS) adjustment of NAD 83, NAD 83(2011) (http://www.ngs.noaa.gov/web/surveys/NA2011/NA2011_Project.shtml), which is aligned with the recently published multi-year CORS solution (www.ngs.noaa.gov/CORS/coord_info/myyear_FAQ.shtml).

At the bottom of the page, a note states: "Although NGS has published the new multi-year CORS solution, they are still in the process of adjusting the passive marks to NAD 83(2011). NGS is producing a new epoch (GEOD12) to be released in early 2012 to be used with NAD 83(2011). For more info

Data Flow in the Network



RTN Coverage Area



RTN Upgrade

North Carolina GNSS Real Time Network - Welcome - Windows Internet Explorer

gnss internet radio

North Carolina Geodetic Survey

North Carolina GNSS Real Time Network

> Home

- Home
 - Sensor Map
 - Login
 - Register

Welcome

Welcome to the North Carolina GNSS Real Time Network Web Application!

[Login](#)

[NORTH CAROLINA GEODETTIC SURVEY](#) [CONTACT](#)

start Radmin Viewer North Carolin... 2 Windows ... Inbox - Micros... 2 Remote D... Trimble VR5?N... untitled - Paint 100% 12:06 PM

RTN Upgrade

The screenshot displays the Trimble VRS2Net software interface. The main window shows a map of the Southeastern United States, including parts of Kentucky, Virginia, North Carolina, and South Carolina. The map is populated with numerous icons representing RTN (Real-Time Network) upgrade stations, which are depicted as green and orange trees. Major highways and cities are labeled on the map. The software interface includes a menu bar (File, View, Help), a toolbar with various icons, and a status bar at the bottom. The status bar shows the current center of the map, status messages, and system information.

Trimble VRS2Net

File View Help

Network Map Google™ Maps View

Map All stations All rovers

Map accuracy: 10 meters

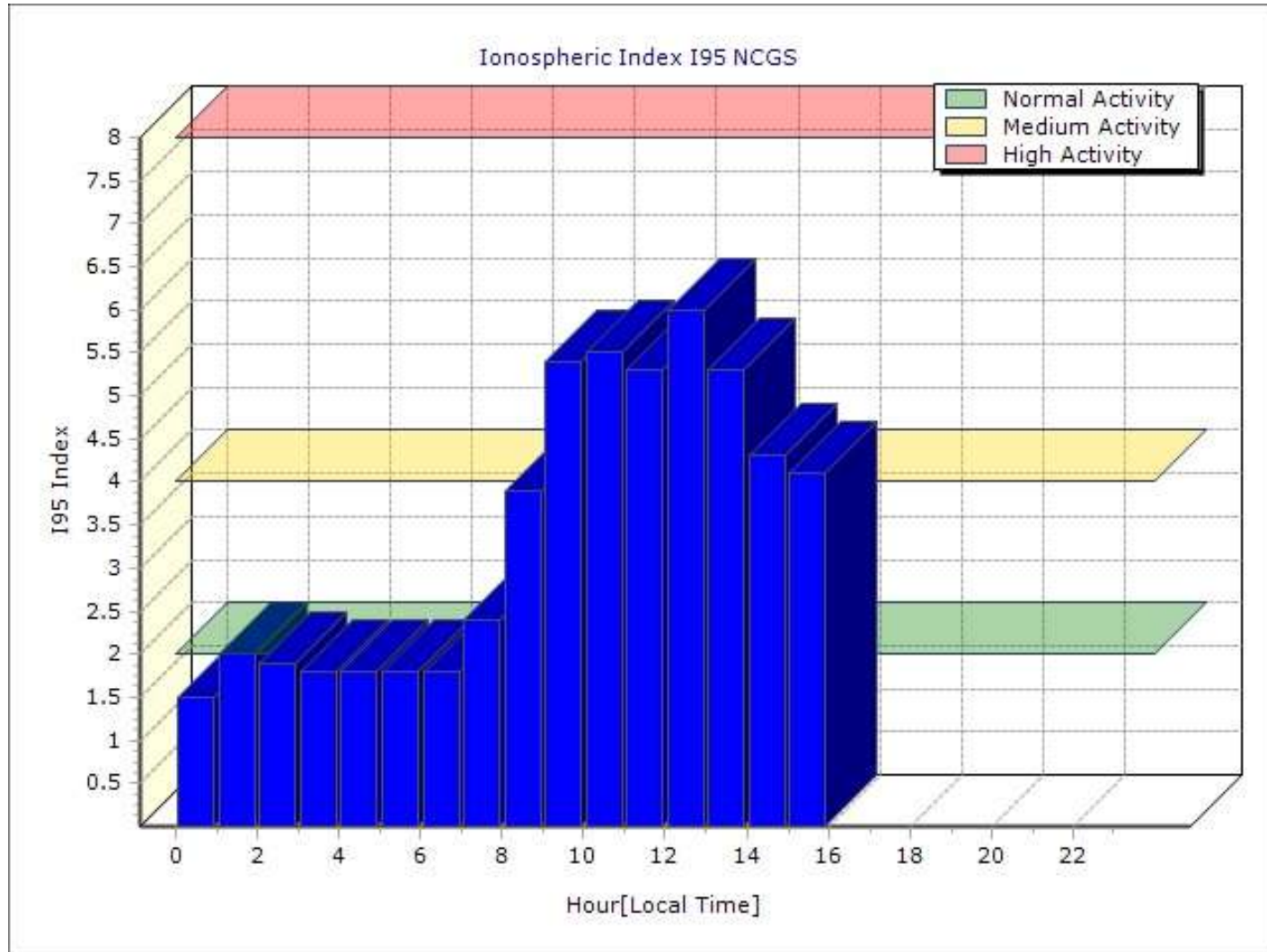
The current center of the map is: N35°13'07.82142", W79°45'33.09514"

Status Messages: Last 20 Items

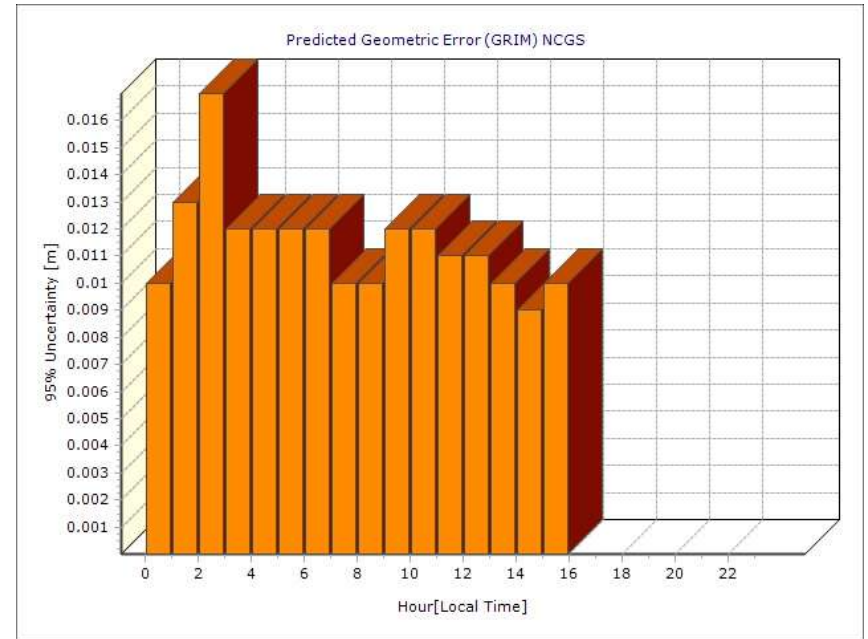
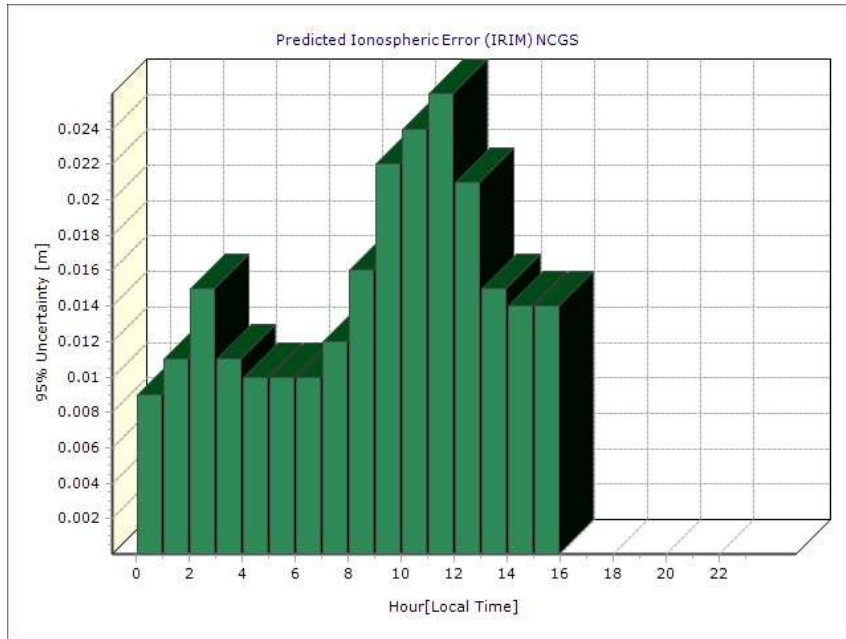
Loading of system configuration "NCGS_10-31-2011" finished.

3271 MB 11/10/2011 4:33:42 PM [UTC Time]

RTN Upgrade



RTN Upgrade



RTN Upgrade

North Carolina GNSS Real Time Network - Position Scatter Plot - Windows Internet Explorer

http://rtn2.ncdenr.org/MemberPages/PositionScatterPlot.aspx

File Edit View Favorites Tools Help

North Carolina GNSS Real Time Network - Position Sca...

North Carolina Geodetic Survey

North Carolina GNSS Real Time Network

> Home > Position Scatter Plot

- Home
 - Sensor Map
 - Position Scatter Plot
 - Status Messages
- Network Information
 - I95 Ionosphere
 - IRIM/GRIM
- Reference Data Shop
- My Account
 - Personal Data
 - Change Password
 - Logins
 - Sessions
- Active Subscriptions
- Administration
 - Status Messages
 - Add Status Messages
 - Edit Status Messages
 - Regions
 - Add Regions
 - Edit Regions
- User Management
 - User Management
 - Create User
 - Approve Users
 - Export e-mail addresses
- Extended User Info
 - Extended User Infos
 - Info Fields

Position Scatter Plot

Configuration: NCGS NME
Timespan: Last hour
Sensor: ASUB

Scatter Plot

Legend:
History Point
Last Point

- Display balance-point-centered¹
- Show level lines²
- Show σ lines³
- Display min/max⁴

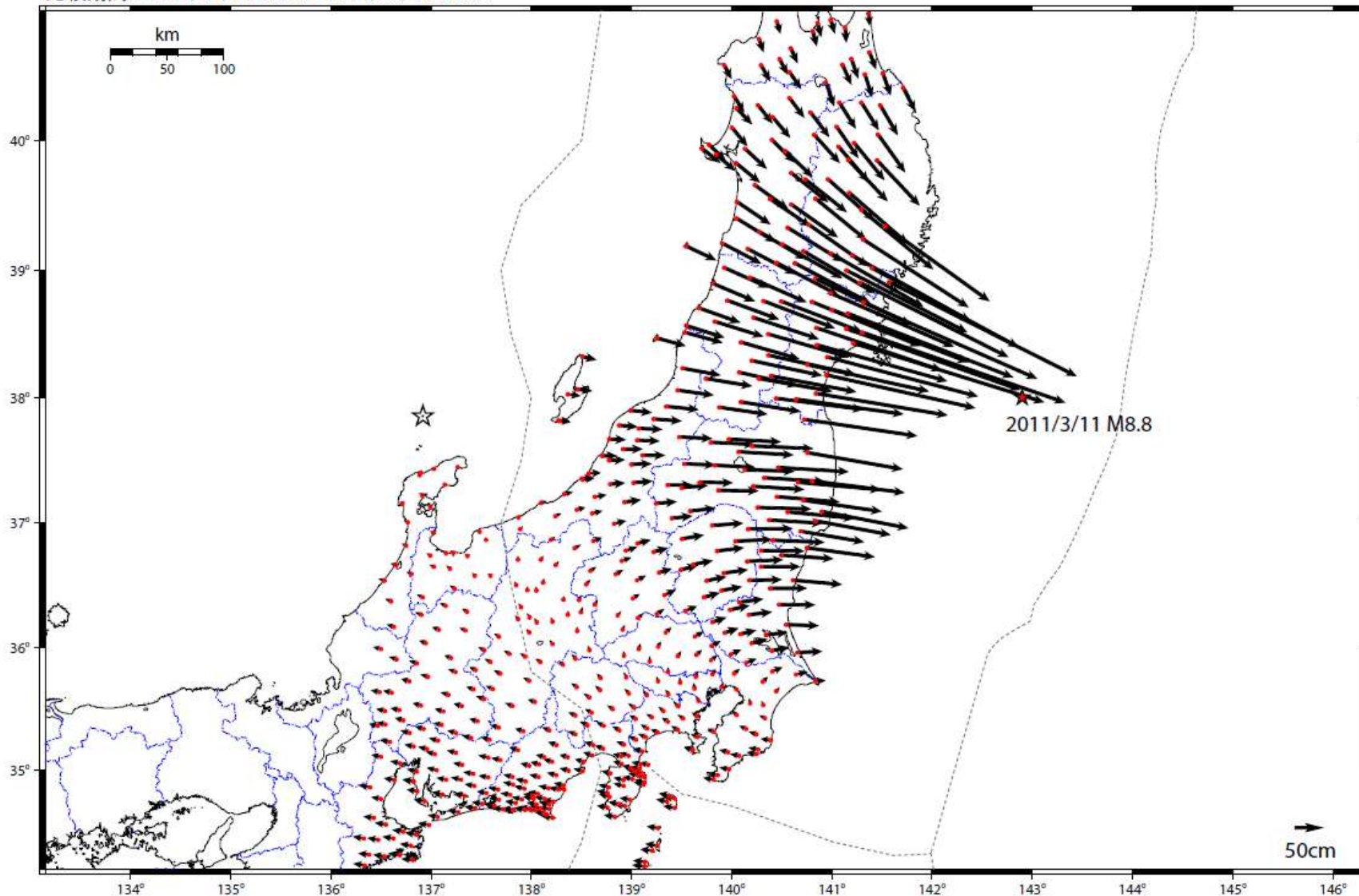
Done

Internet 100%

変動ベクトル図 (水平)

基準期間 : 2011/03/01 21:00 - 2011/03/08 21:00

比較期間 : 2011/03/11 16:30 - 2011/03/11 16:30

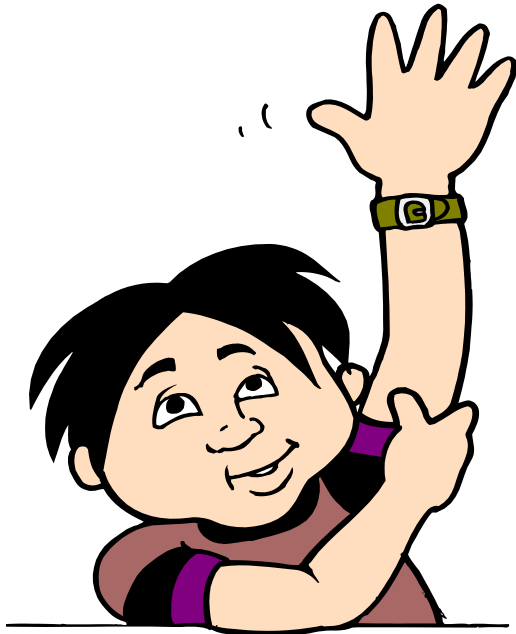


[基準 : R3速報解 比較 : S3迅速解]

☆固定局 : 船倉島 (950252)

国土地理院

Questions?



Gary Thompson, PLS
NC Geodetic Survey
512 North Salisbury Street
Raleigh, NC 27604
919-707-9230 phone
Gary.thompson@ncdenr.gov