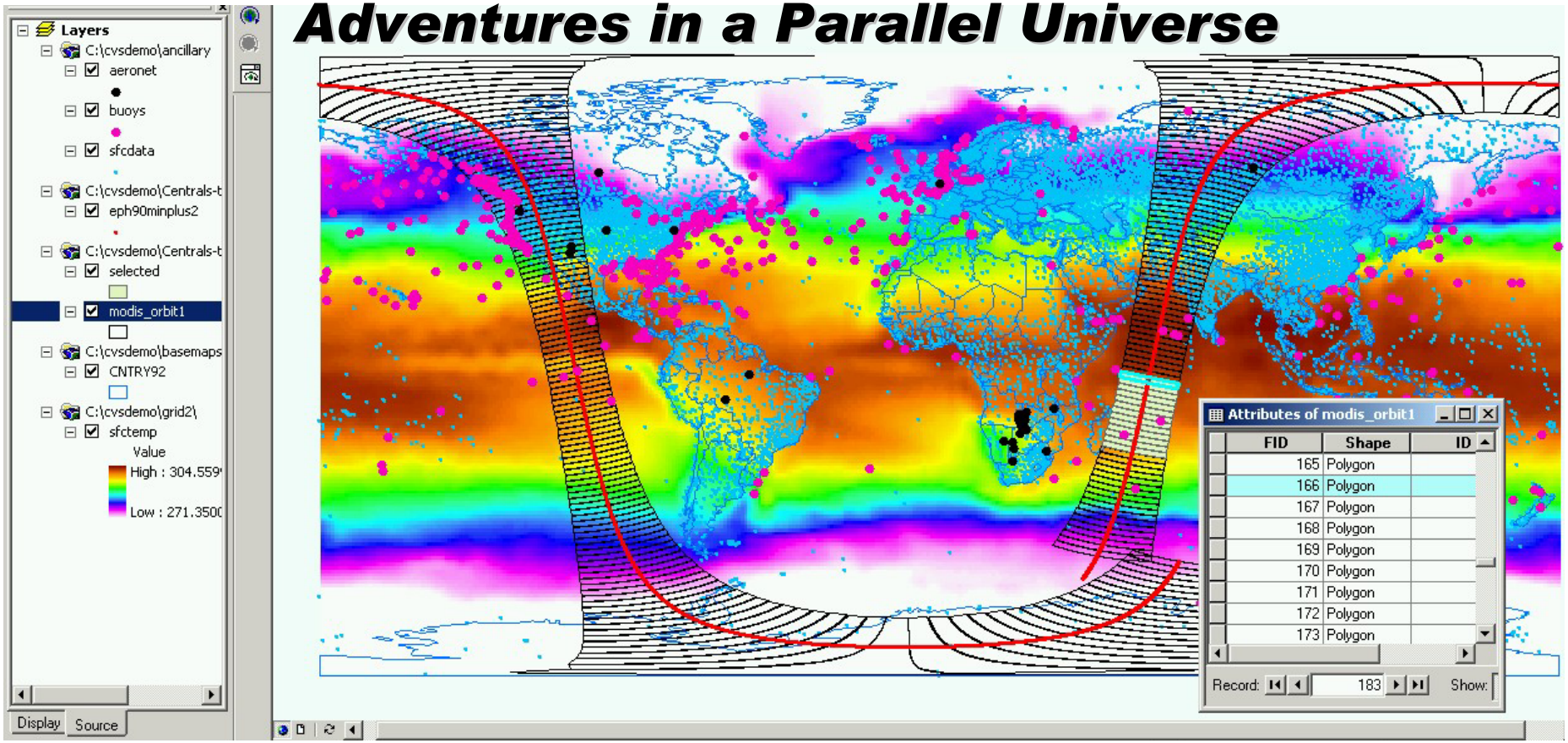
George Mason University

Raytheon

GIS Applications in Meteorology

(or)

Adventures in a Parallel Universe



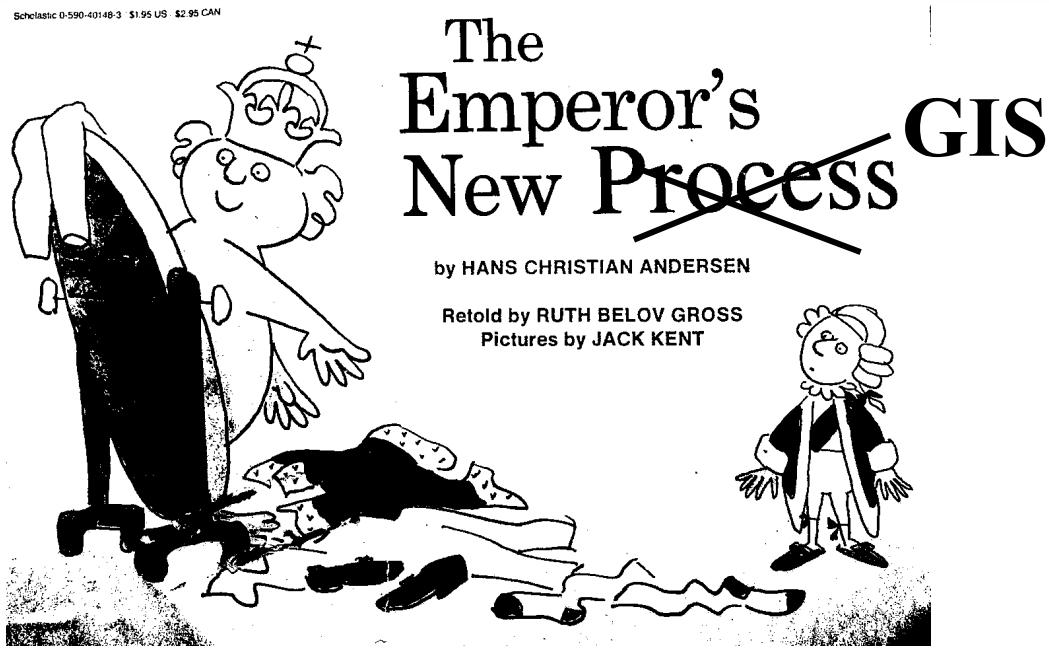
Dr. Scott T. Shipley

Dept. Geography, George Mason University

24 June 2003

Expanding Horizons

- **Ted Haberman – What is GIS?**



- **Shipley - Parallel (GIS) Universe**

- **Olga Wilhelmi – NCAR's GIS Initiative**

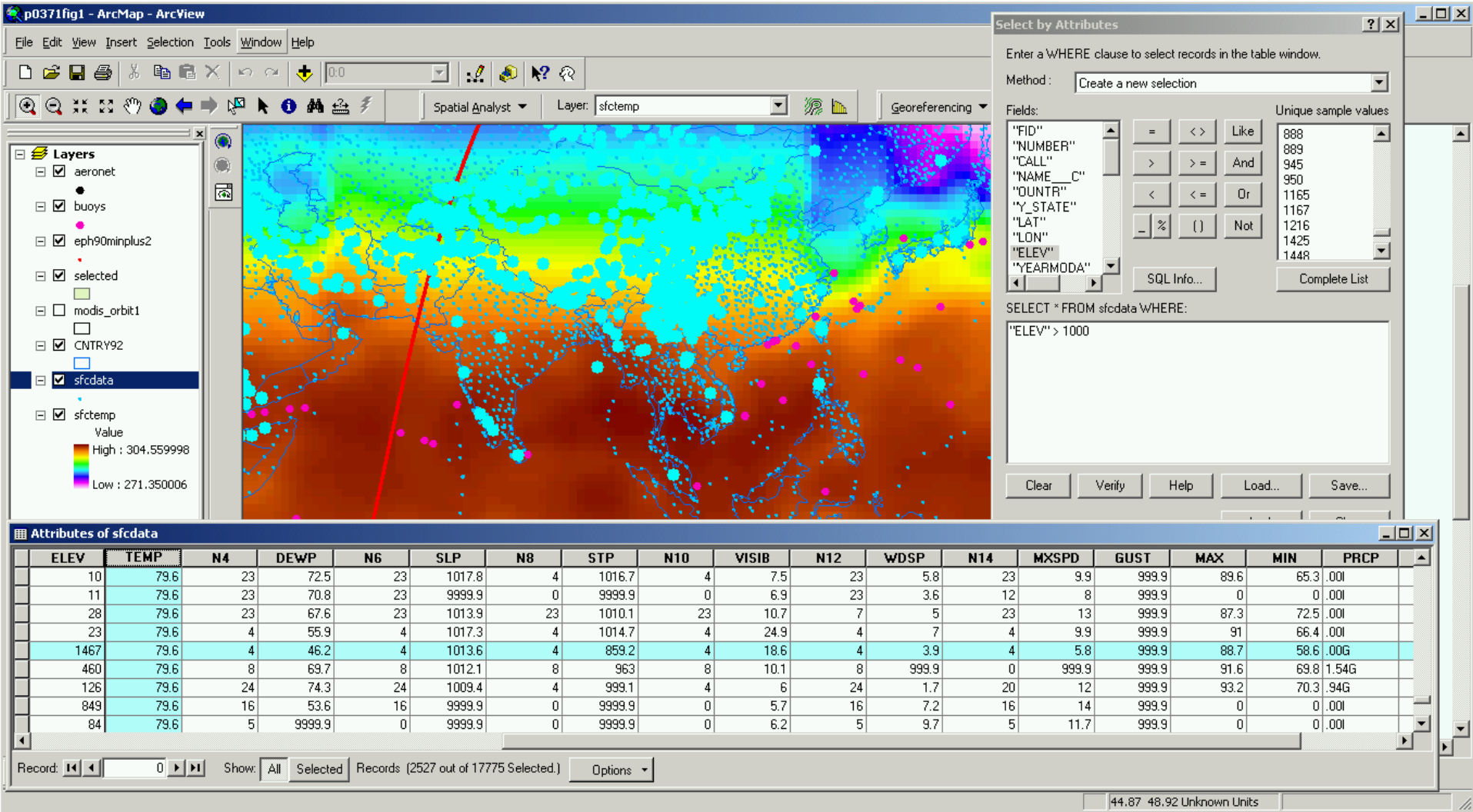
Geographic Information Systems (GIS) Initiative
National Center for Atmospheric Research
NCAR

http://www.gis.ucar.edu/

Presentation Goals

- "GIS" versus "WPS"
  - A brief history . . . since 1994
    - All Wx Data are GEOGRAPHIC Information !
    - NWS initial response to **EO 12096** (1994) claimed otherwise
      (Executive Order 12096 – Coordinating Geographic Data Acquisition and Access, created FGDC)
- Selected GIS Applications in Meteorology
  - World Agricultural Outlook Board (USDA)
  - NEXRAD Siting (NWS)
  - Satellite Calibration/Validation
- Dr. T's Fearless Forecasts
  - GIS and the Global Warming debate (1998)
  - Interoperability, web-enabled Geodatabases, JAVA & Linux

Spatial-Relational Example



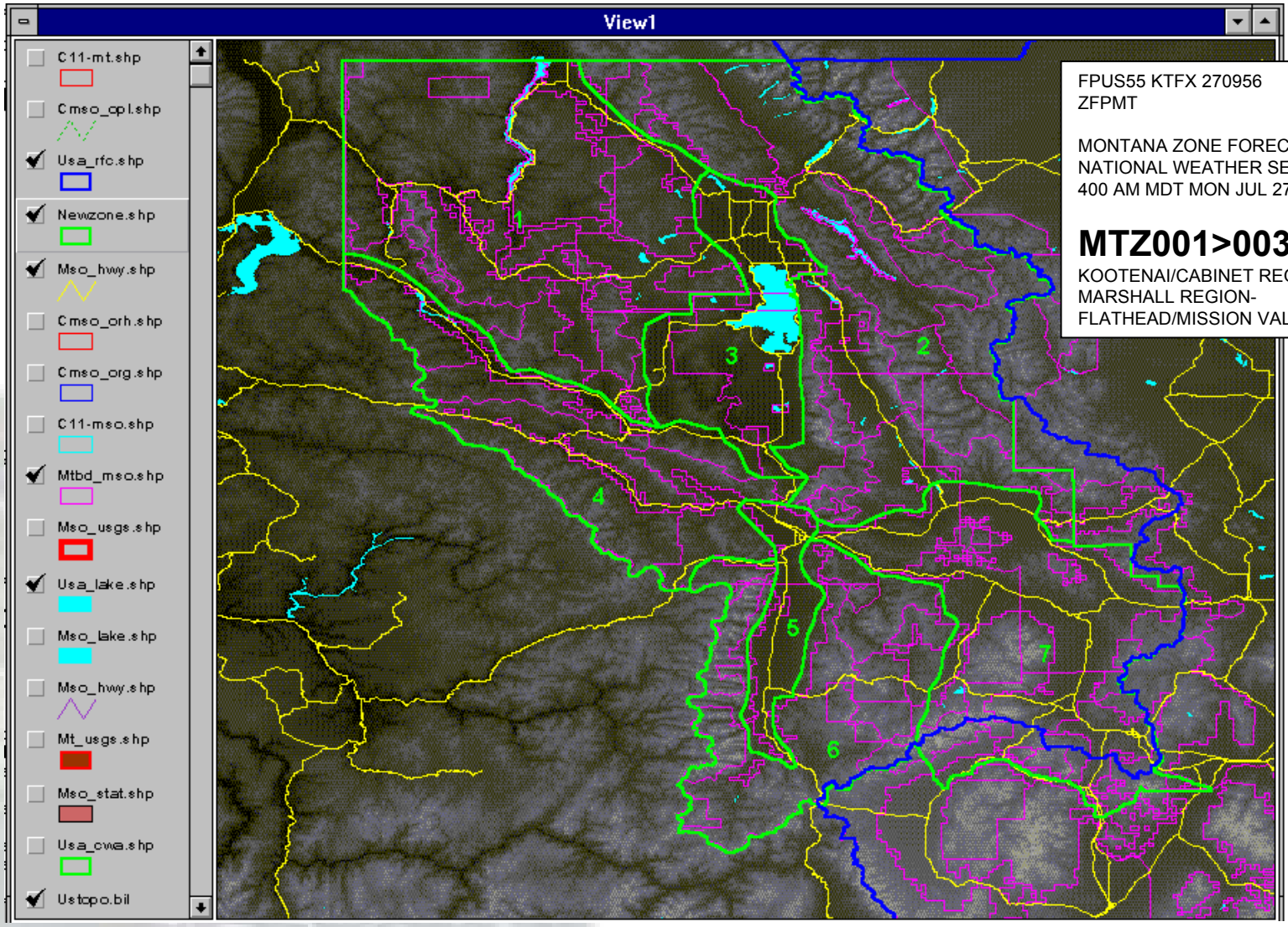
A Brief History (GIS Wx in NWS)

- "Examine GIS as an alternative for AWIPS"
  – Roger Shriver, NWS AWIPS Program

- "GIS is too slow and will never have value for meteorological data processing." – Shipley (1994)

- PRC Examines ArcView 1 (1993) – rejected
- Demonstration of Arc/Info to NWS (1995) – rejected
- ArcView 3.0 applied to NWS map databases (1997)
- AWIPS D2D-ArcView Interface (2000)
- NWS GIS Forum established (2001)
- Internet Map Server (IMS) prototype (2002)
- 1rst GIS Meteorology Session at AMS (2003)

Using GIS to define Forecast Zones



FPUS55 KTFX 270956
ZFPMT

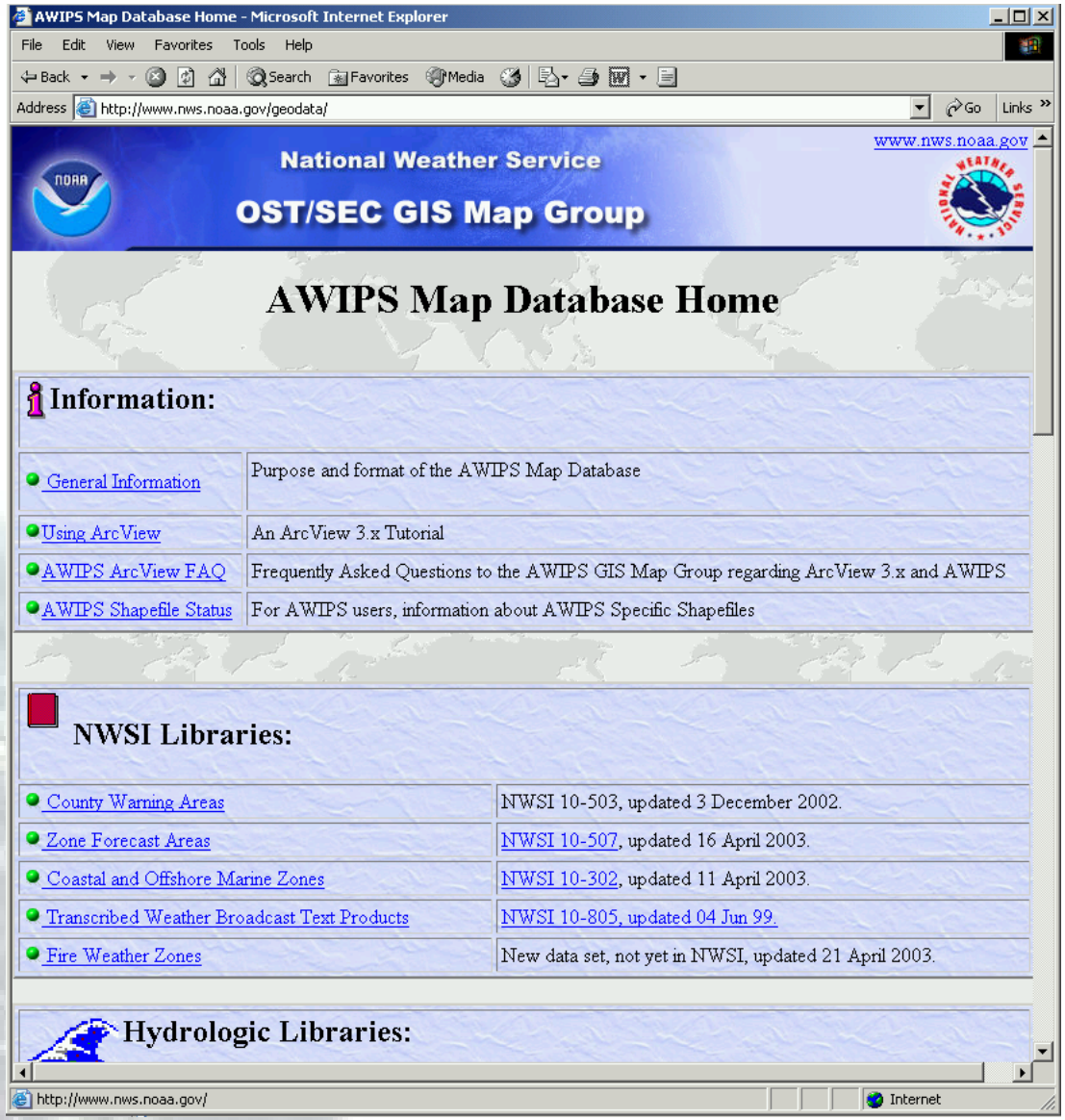
MONTANA ZONE FORECASTS
NATIONAL WEATHER SERVICE GREAT FALLS MT
400 AM MDT MON JUL 27 1998

MTZ001>003-272200-

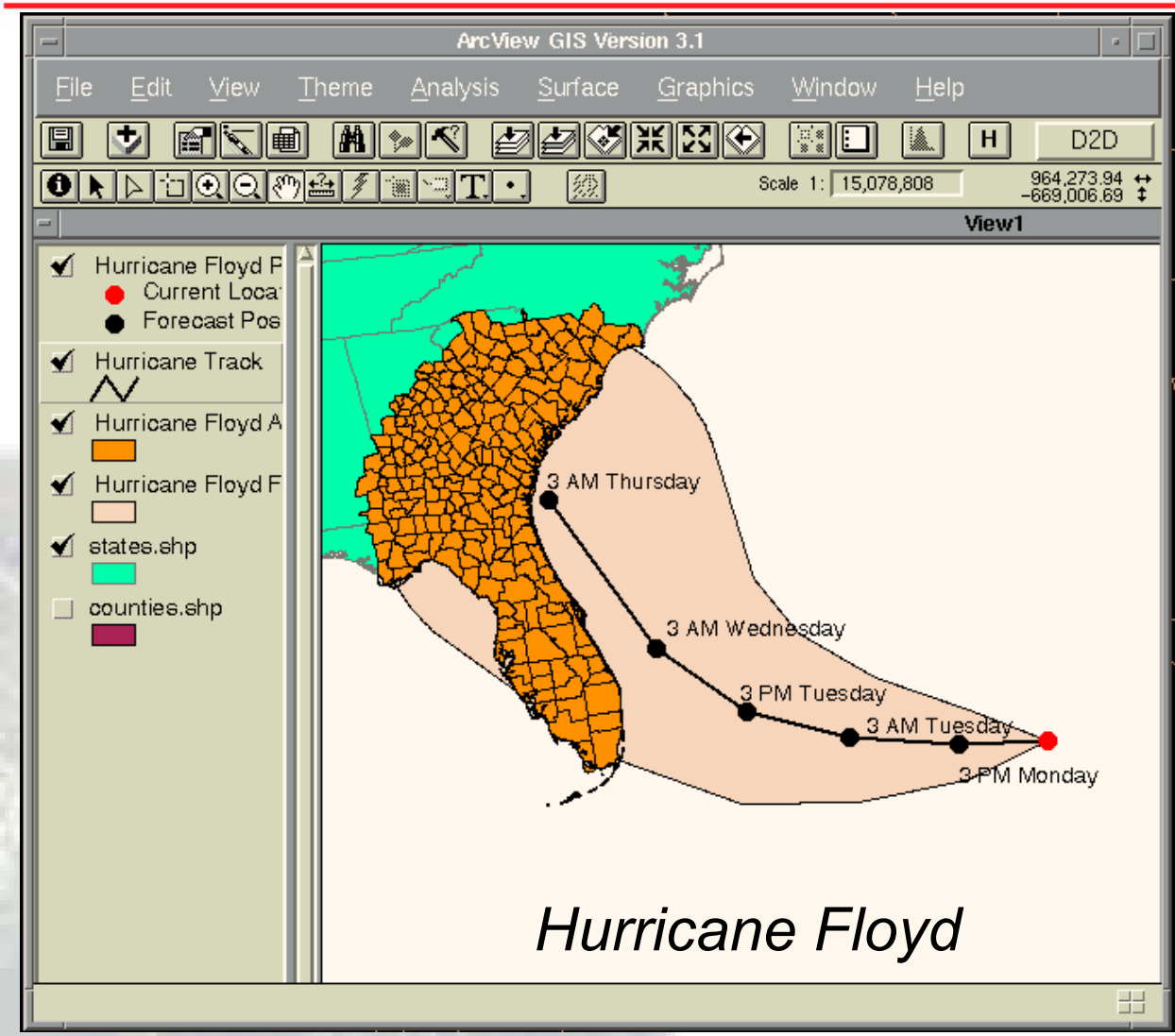
KOOTENAI/CABINET REGION-WEST GLACIER/BOB MARSHALL REGION-
FLATHEAD/MISSION VALLEYS

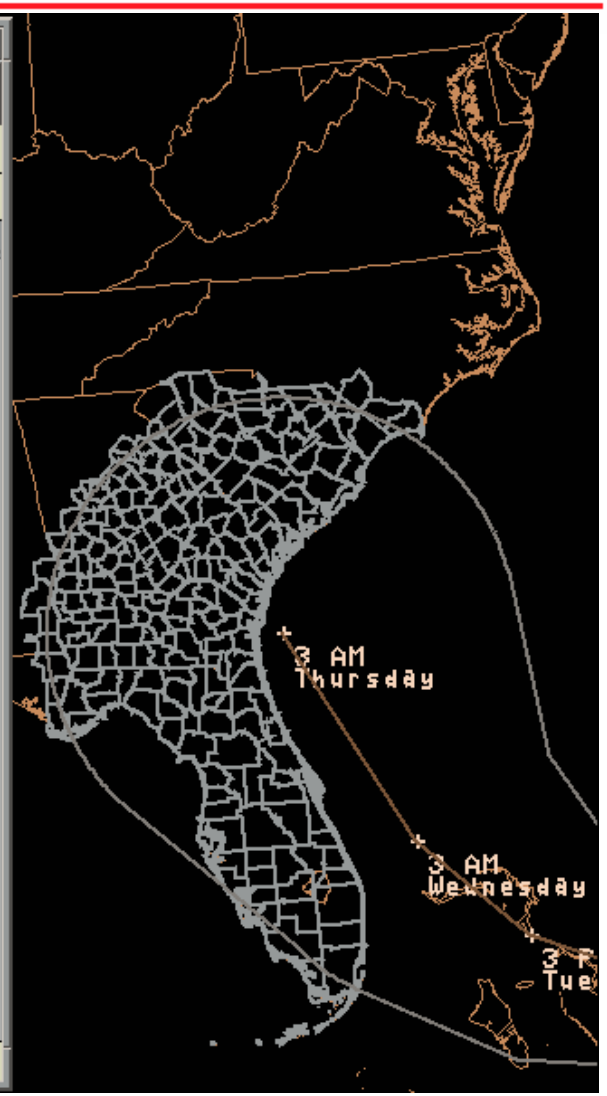
http://www.nws.noaa.gov/geodata/

http://www.nws.noaa.gov/geodata



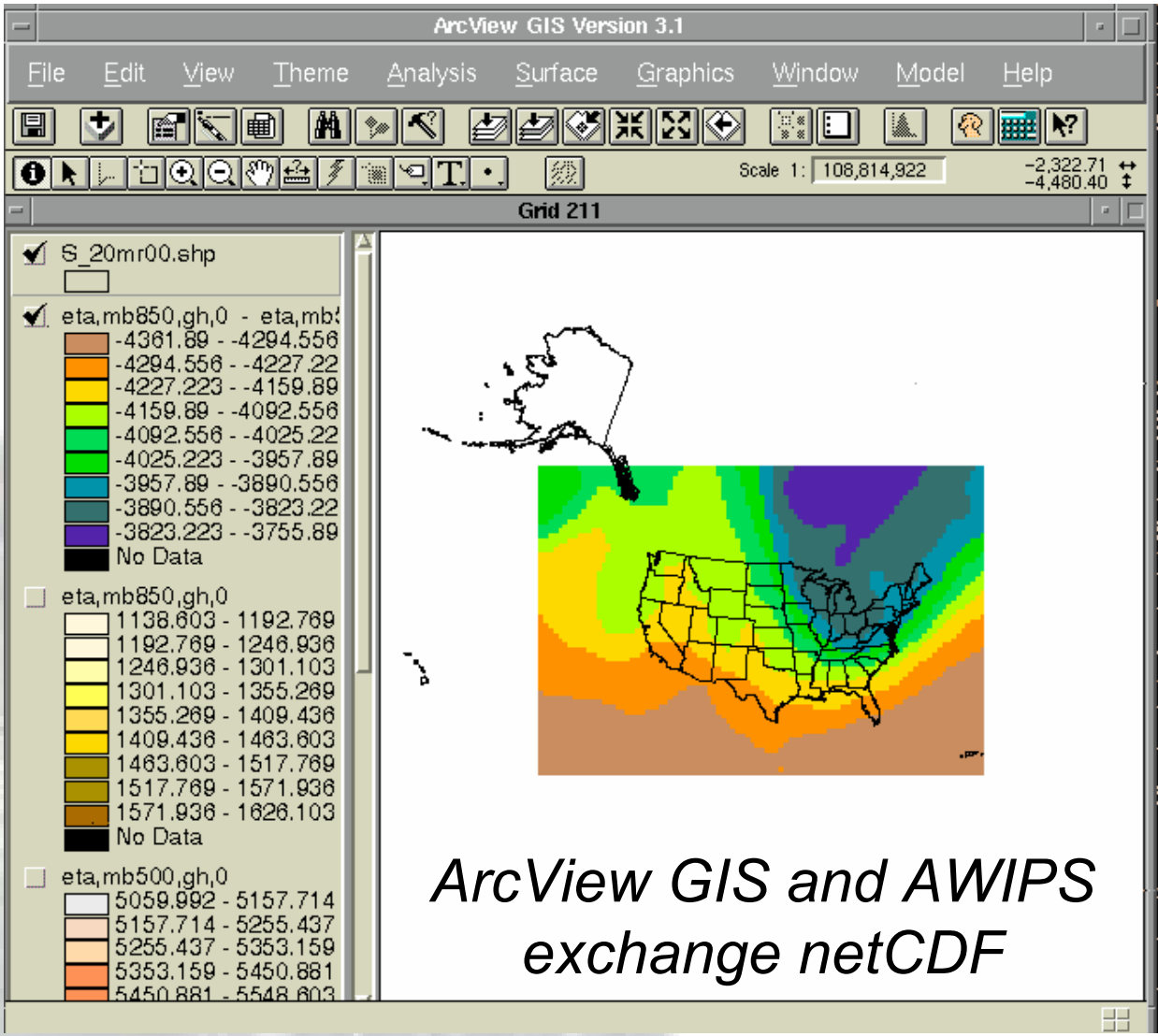
Upload any Shapefile™



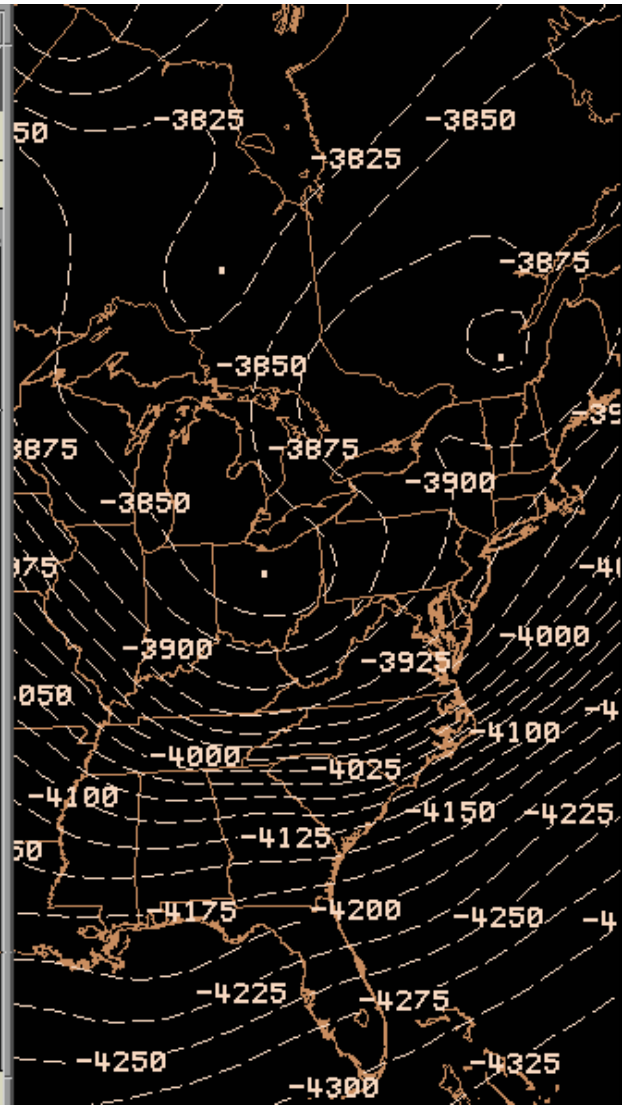


http://www.nws.noaa.gov/geodata/

GIS "MetCalc" with AWIPS D2D



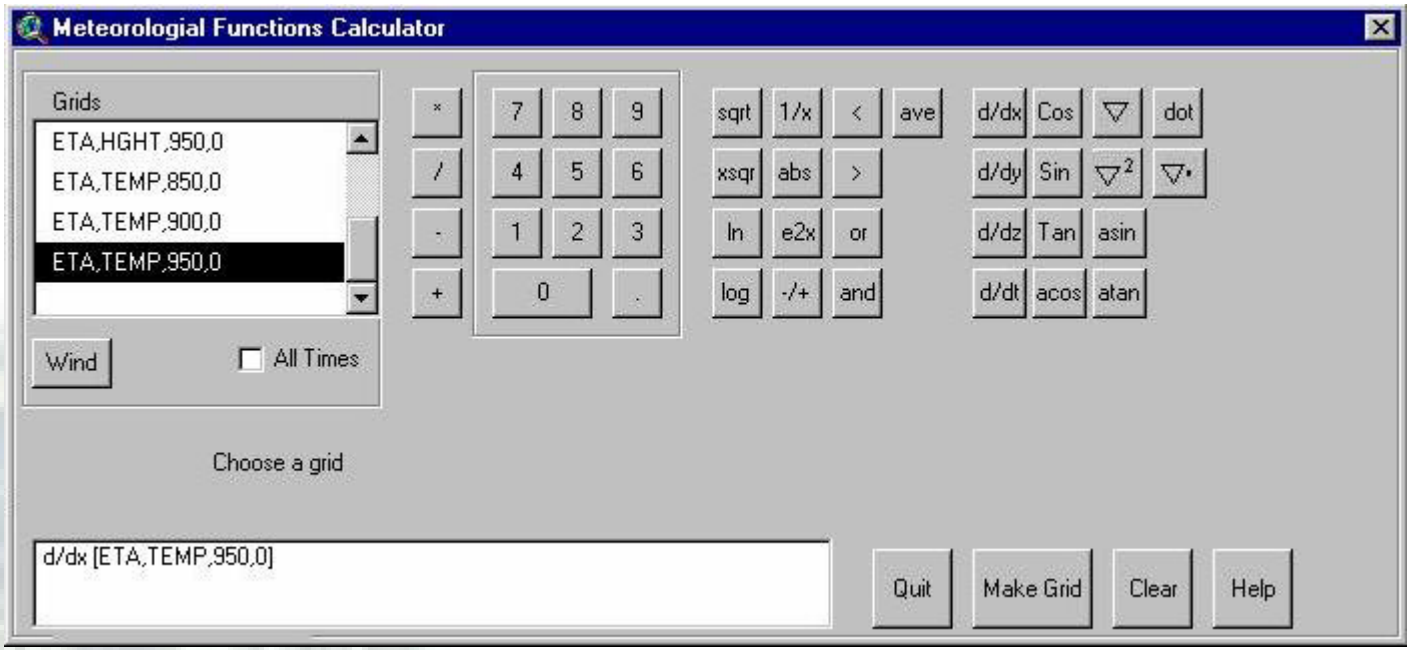
ArcView GIS and AWIPS exchange netCDF



http://www.nws.noaa.gov/geodata/

Meteorological Functions Calculator

GRID field calculator



by Ira Graffman (NWS HQ),
developed for Sterling, VA WFO (LWX)

NWS GIS Forum

AWIPS Full Court Press
Volume 4, No.22. December 29, 2000

Geographic Information System (GIS) Forum.
The Systems Engineering Center has set up a list server for the purpose of starting a dialog on the different types of projects that can benefit from GIS COTS software. The purpose of the forum is to explore the ways in which GIS can be used in NWS. Users can subscribe to the forum http://infolist.nws.noaa.gov/scripts/lyris.pl
(Roger Shriver 301-713-3409 X105)
GIS Survey (Shriver)

NWS GIS Survey

General Questions

1. What office are you answering for?

LMRFC-Slidell, LA

2. Is your office currently using GIS? Please explain.

Yes, for the following:

Daily observed precip analysis and AWIPS text product generation (NEWHYDSIL)

Web graphics including:

a) Gridded rainfall estimates (Stage III) in increments of 1,3,6,12,24 hours, 2,3,5,7 day, monthly and yearly.

b) QPF out to 72 hours

c) Gridded observed rainfall analysis in 1,2,3,5 and 7 day increments

d) Climate/Drought products derived from Stage III data and PRISM data

e) Daily basin average rainfall (MAP) from rain gages

f) Flash Flood Guidance (gridded and county) all SR RFC's with zoom to each state

In house programs:

a) Flood Outlook Product (interactive)

b) River Flood Outlook (web graphics creation)

c) Contour analysis/HYD program (interactive)

d) StageIII-Gage analysis comparision graphics (in-house)

e) DAM-CAT

MAP creation for special events

Background mapping for D2D

Currently setting up demo licence of IMS

CAPS program

3-D Radar

3. If you are not using GIS, do you see a need for GIS? Please explain.

4. What is your office's view towards GIS use? For example, is it your goal to train all interested employees in its use, or are you hiring GIS experts to work on your programs?

Everyone in our office is trained in Arcview since we use it operationally. Specialized training is available for those interested. We utilize over 25000 lines of avenue/VB code every day for products and in house projects.

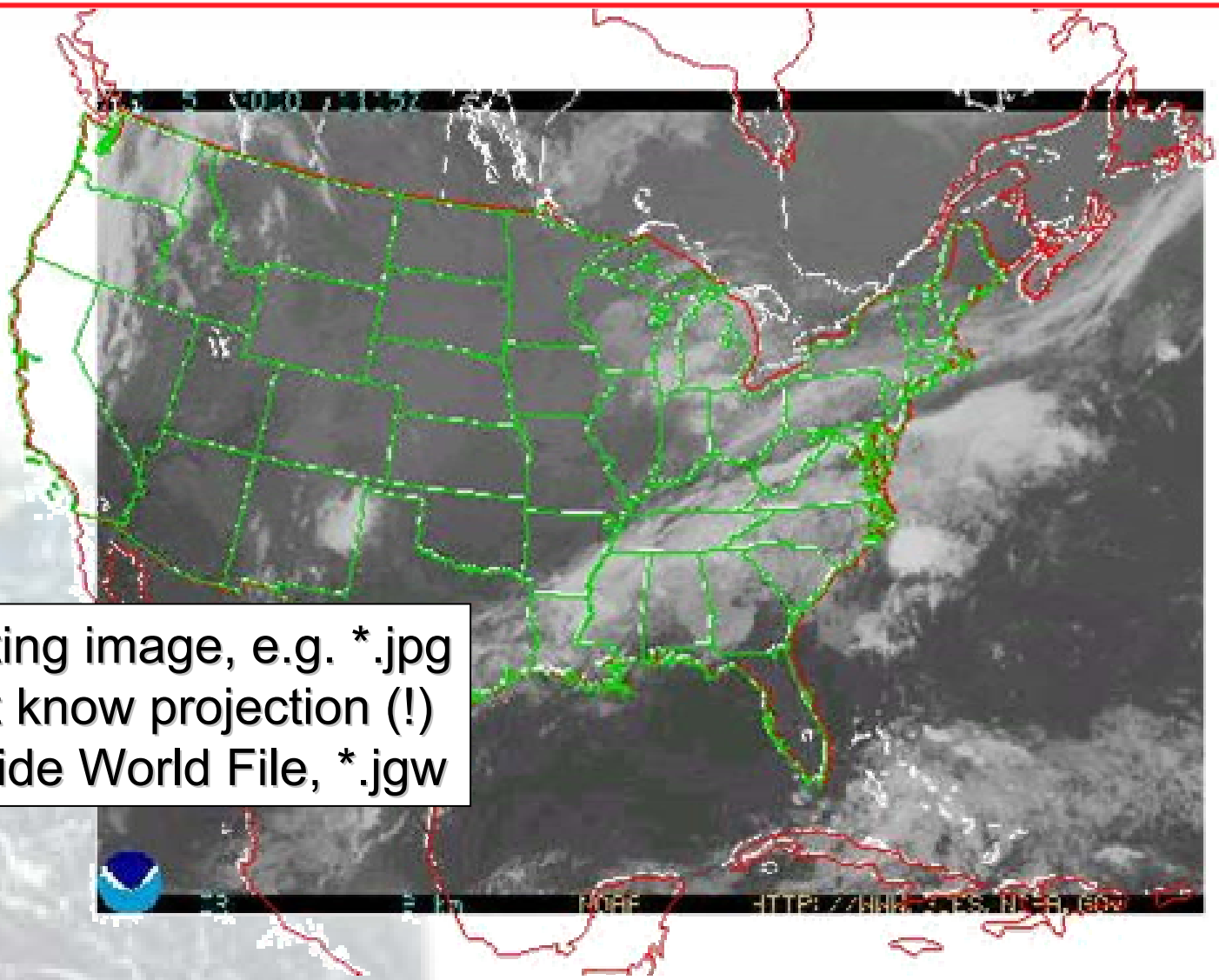
People

Who are the lead "GIS people" at your office?

Keith Stellman

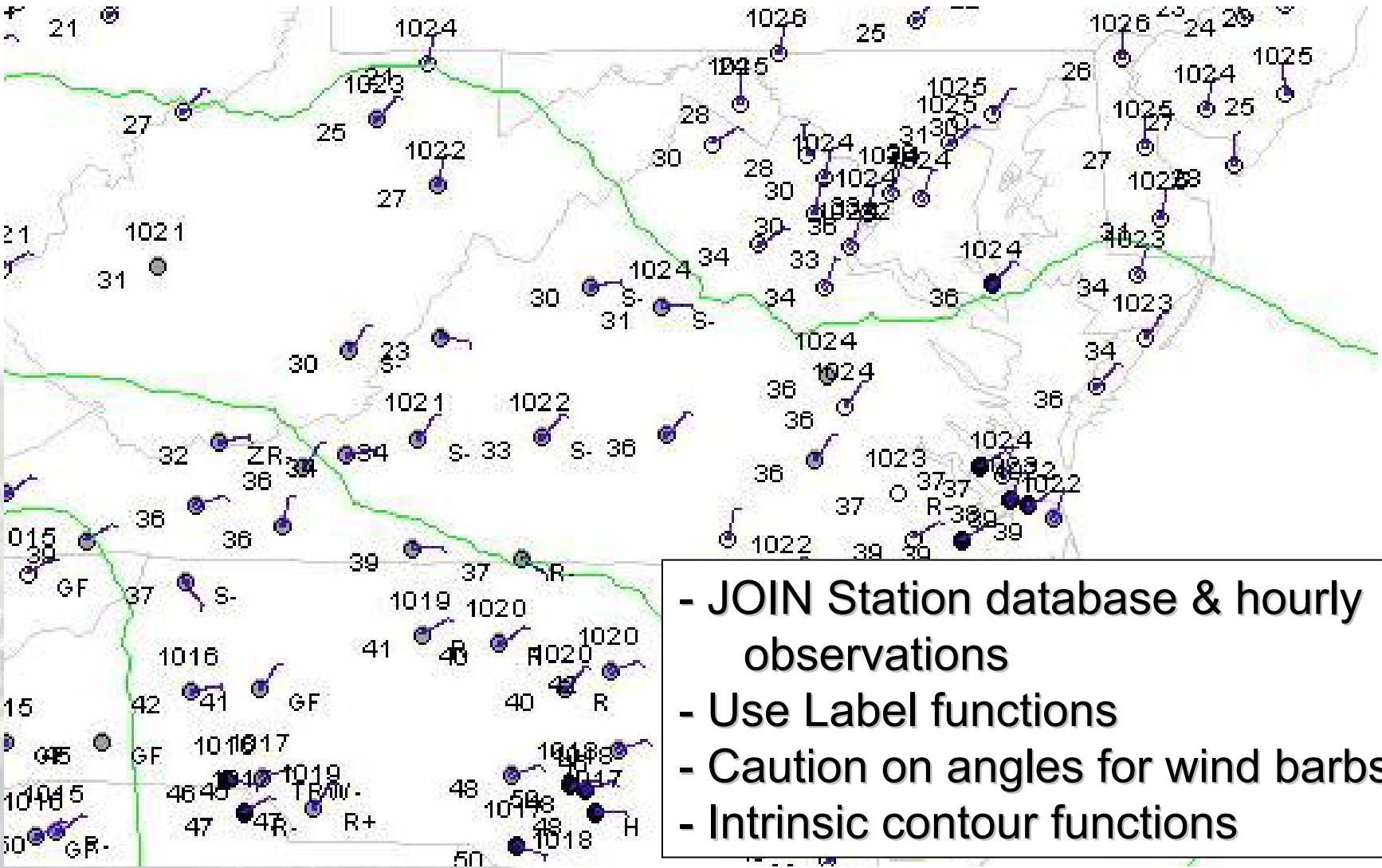
David Welch

Registering Images



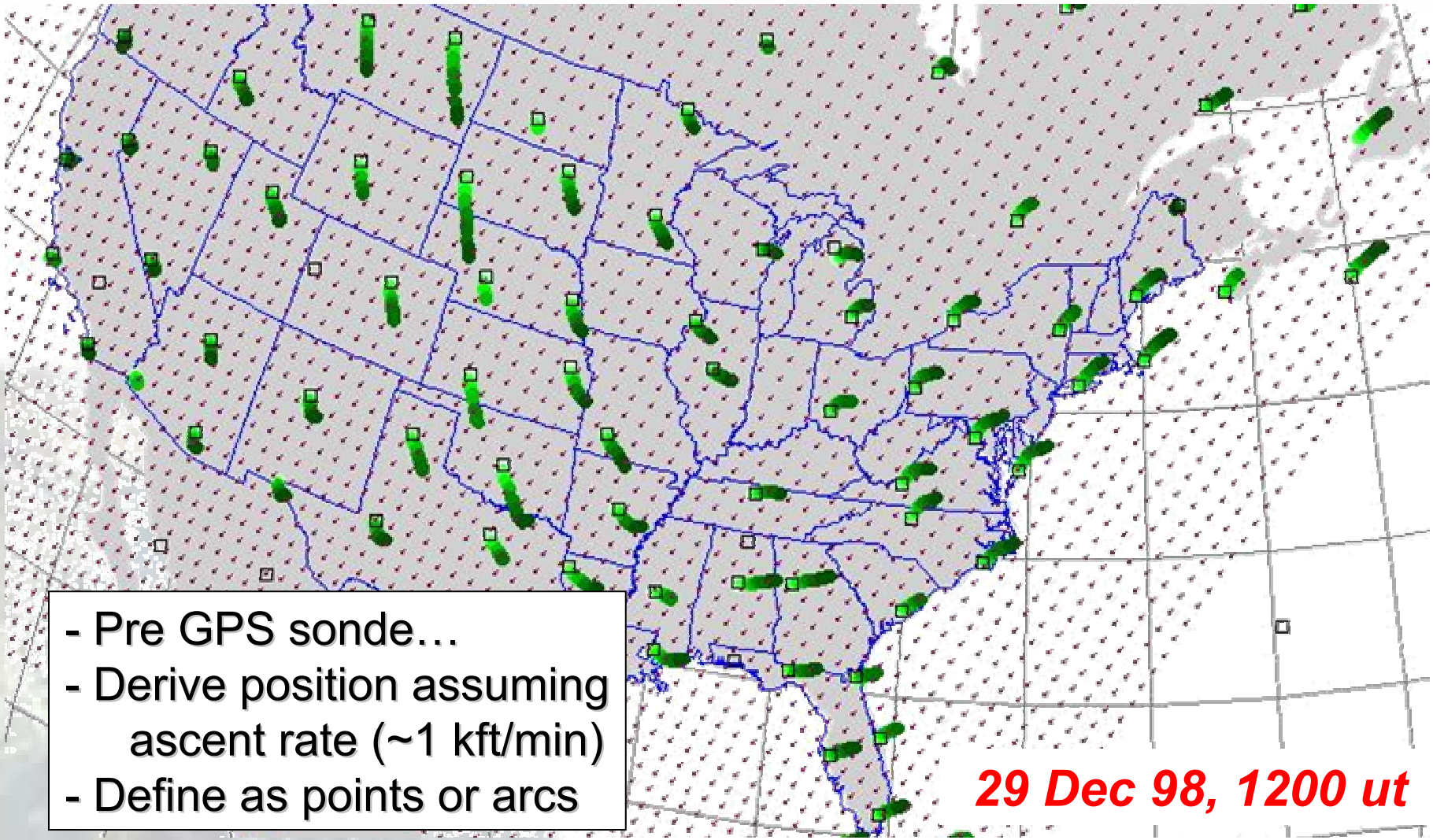
- Existing image, e.g. *.jpg
- Must know projection (!)
- Provide World File, *.jgw

GIS Station Plots



- JOIN Station database & hourly observations
- Use Label functions
- Caution on angles for wind barbs
- Intrinsic contour functions

1. Do Raobs Go Straight Up?



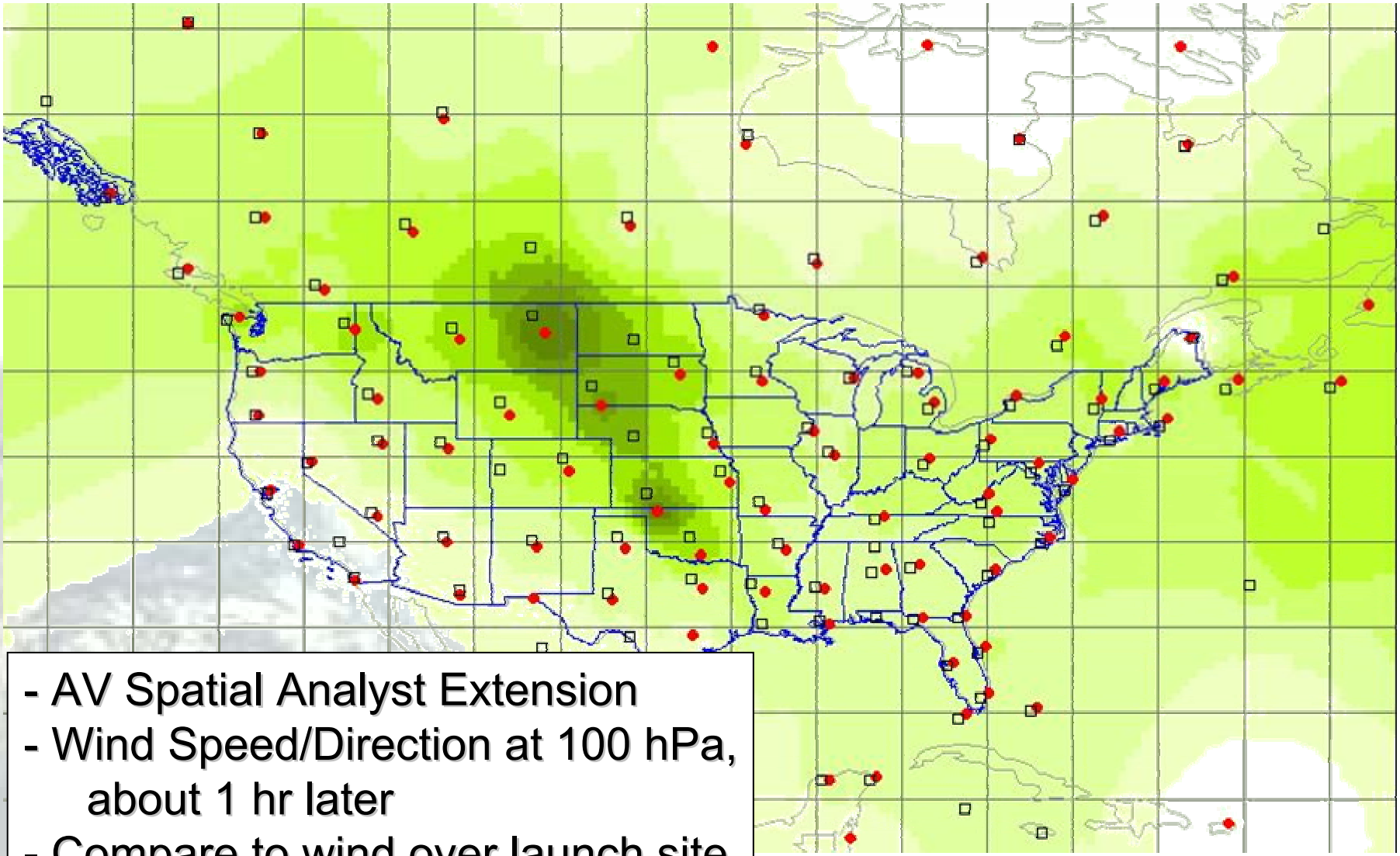
- Pre GPS sonde…
- Derive position assuming ascent rate (~1 kft/min)
- Define as points or arcs

29 Dec 98, 1200 ut

http://raob.fsl.noaa.gov

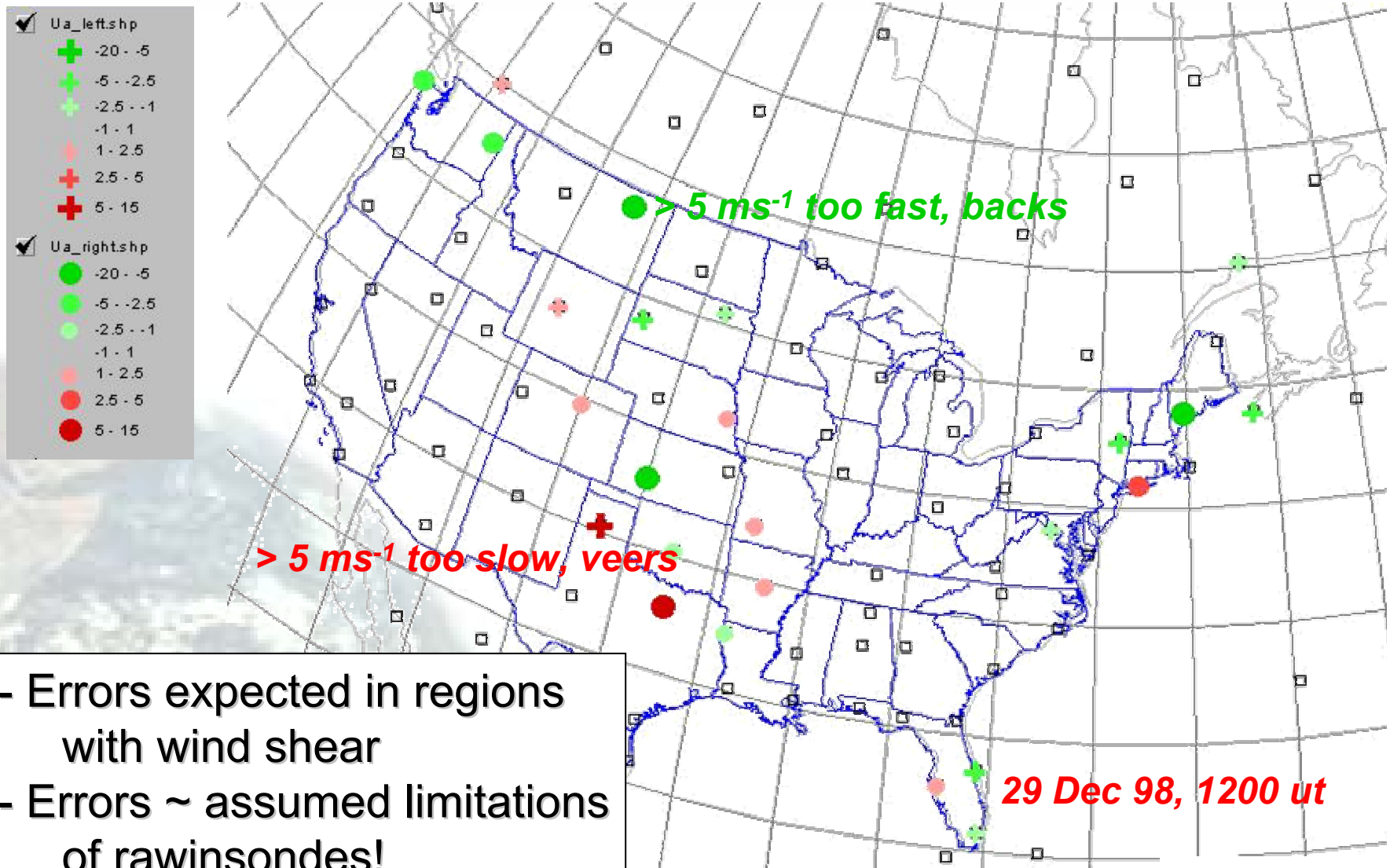
GIS Applications, Shipley
16th IIPS, 11 Jan 2000

2. Rawinsonde "Reanalysis"



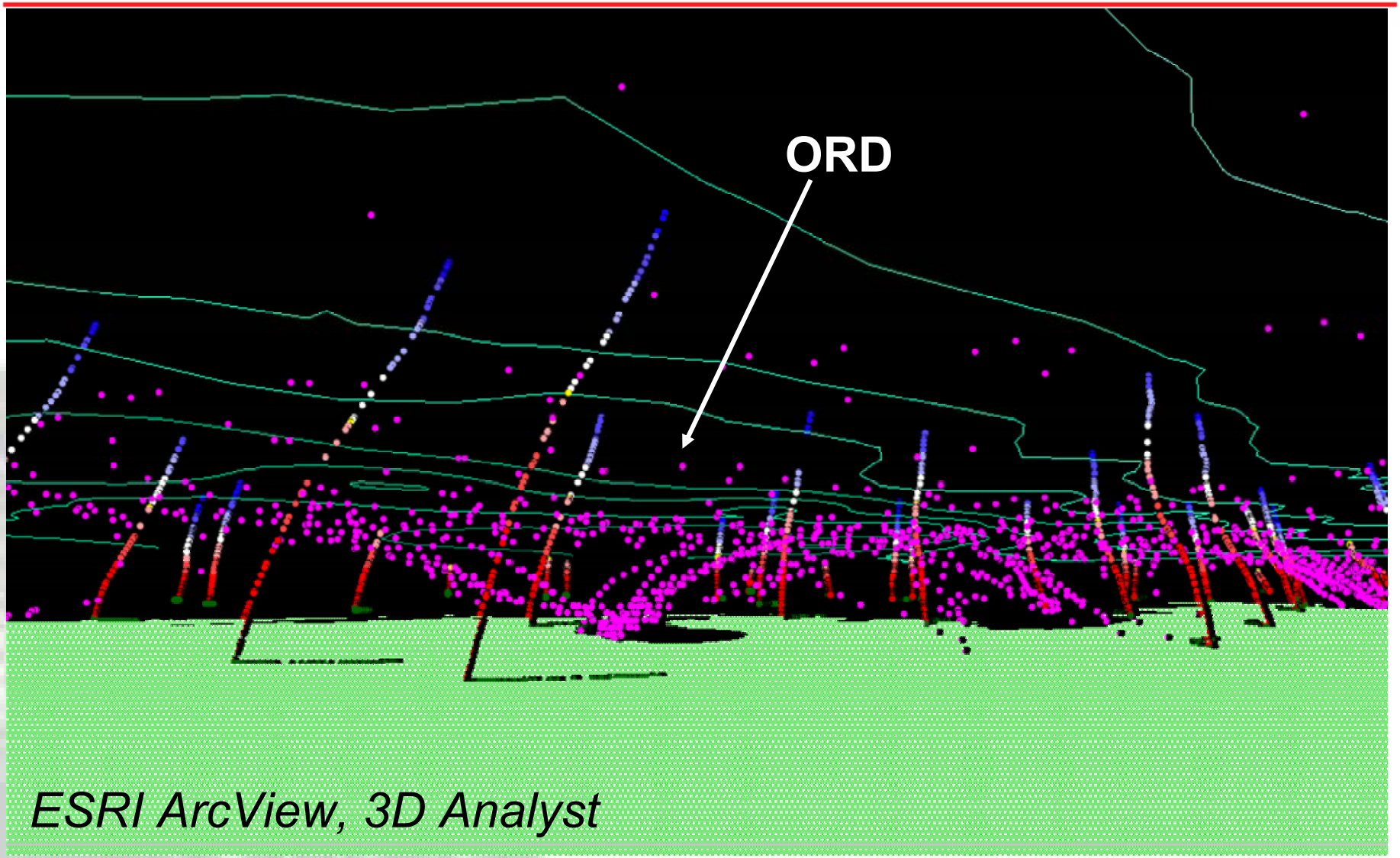
- AV Spatial Analyst Extension
- Wind Speed/Direction at 100 hPa, about 1 hr later
- Compare to wind over launch site

3. Velocity Errors at 100 hPa

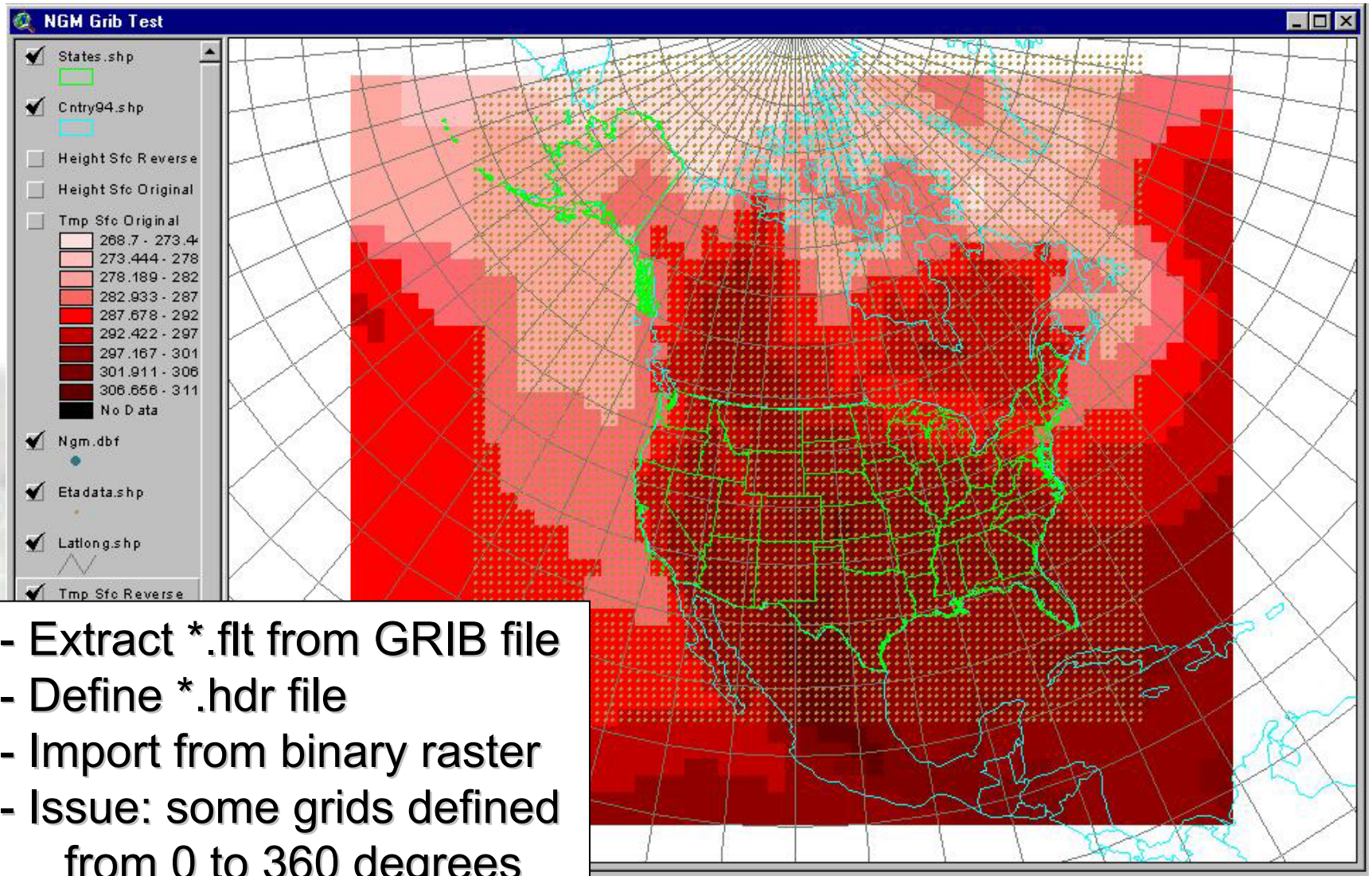


- Errors expected in regions with wind shear
- Errors ~ assumed limitations of rawinsondes!

Compare ACARS & RAOB Sample Volumes

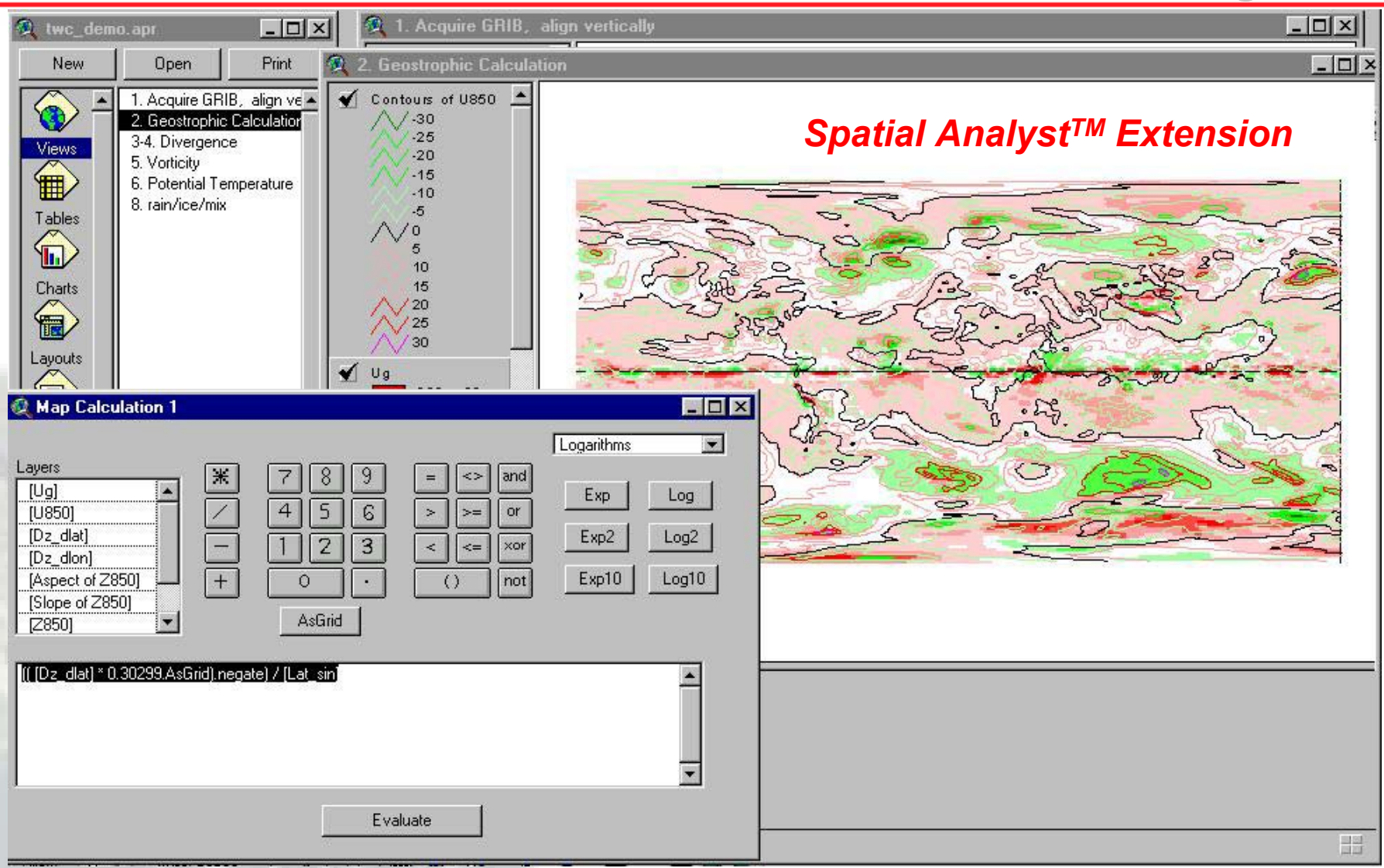


Registering GRIB

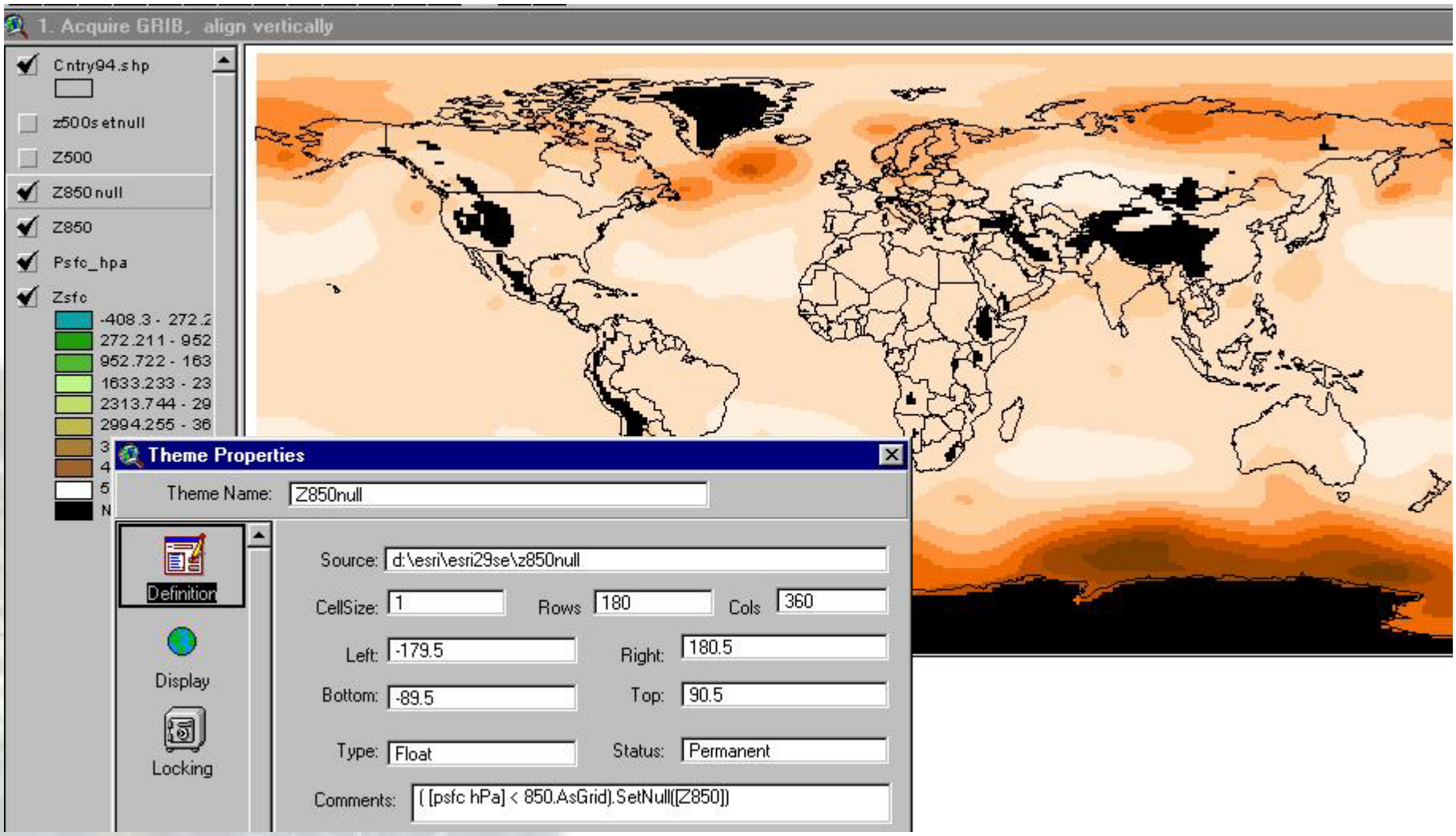


- Extract *.flt from GRIB file
- Define *.hdr file
- Import from binary raster
- Issue: some grids defined from 0 to 360 degrees

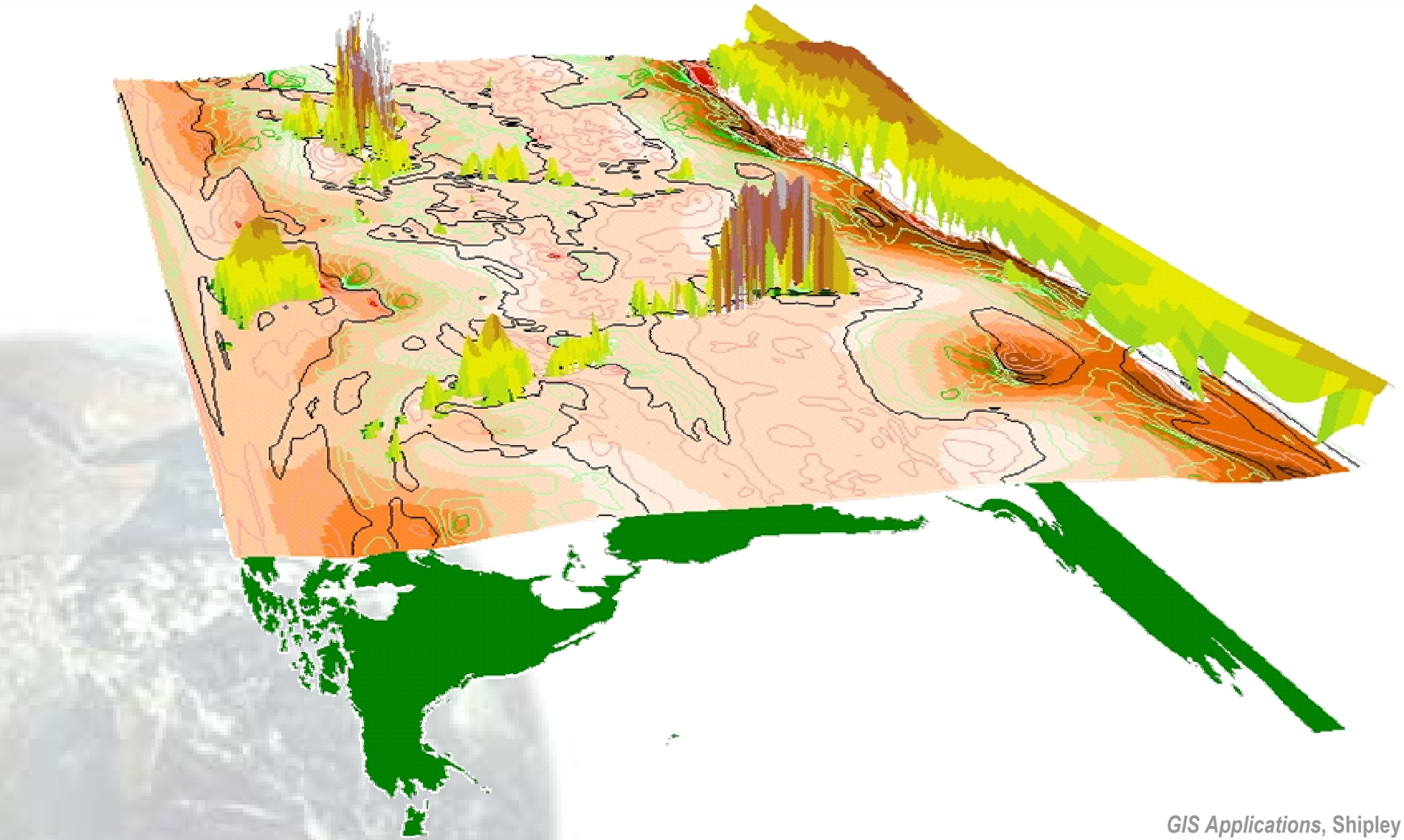
NCEP GRIB - FNL 850 hPa : z & u_g



850 hPa Height - exclude subterranian



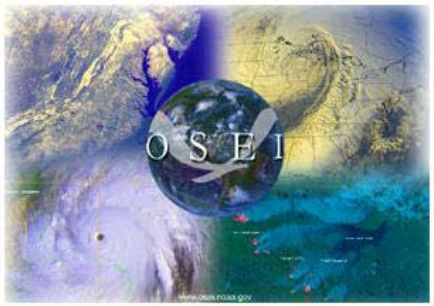
850 hPa Geostrophic Wind



Georeferenced Satellite Imagery

noaa satellite services division

Welcome to the NOAA Operational Significant

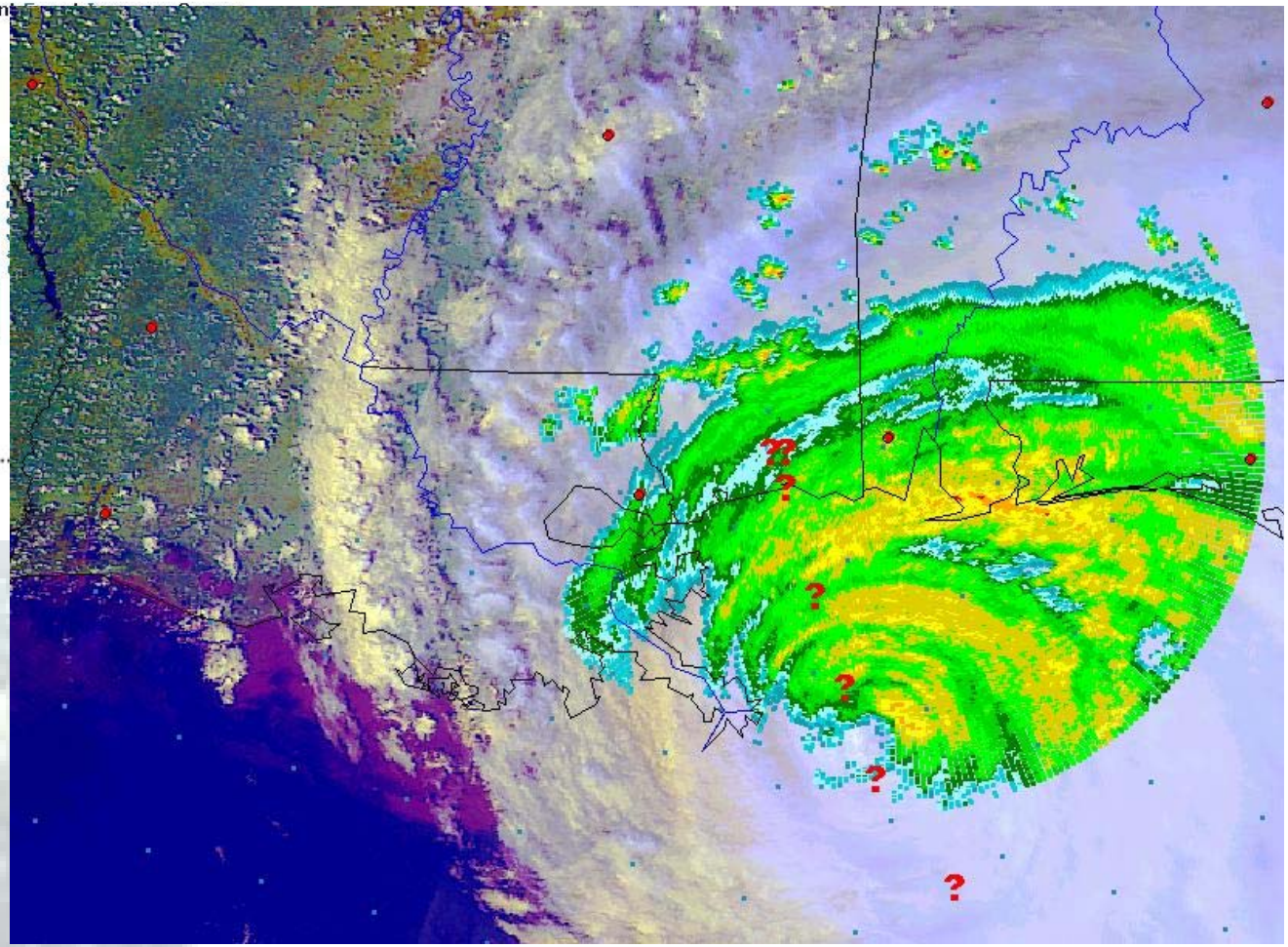


Open GIS Consortium

Spatial connectivity

for a changing world.

State plane projection!



http://www.osei.noaa.gov/

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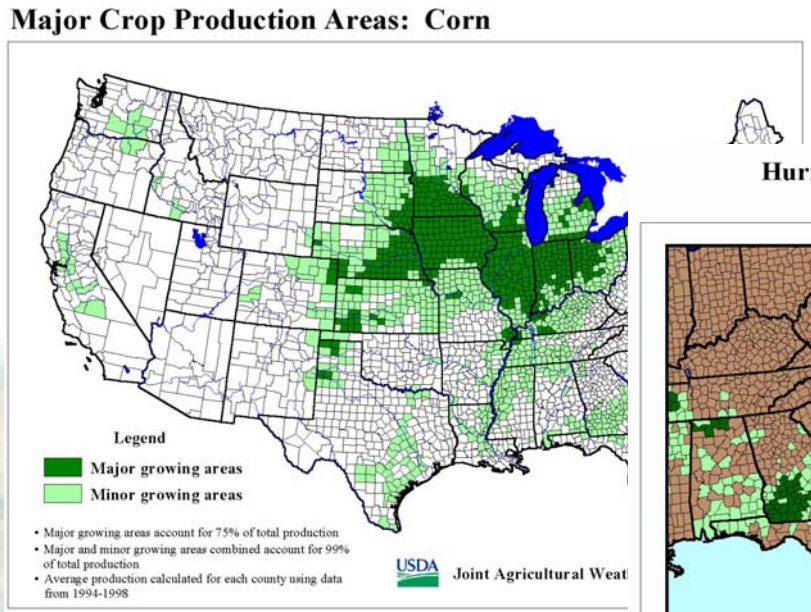
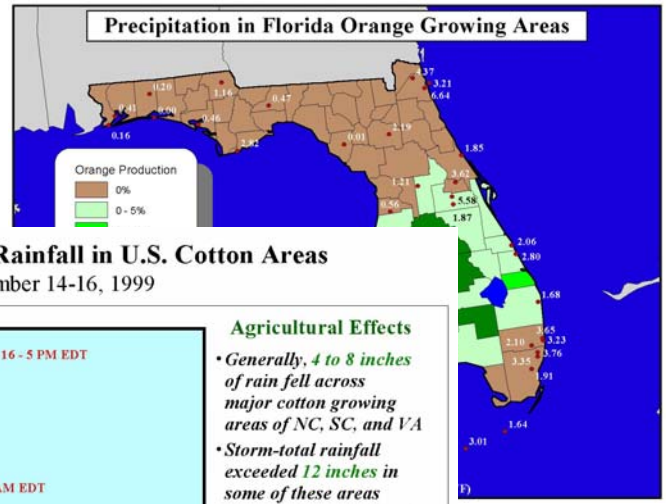
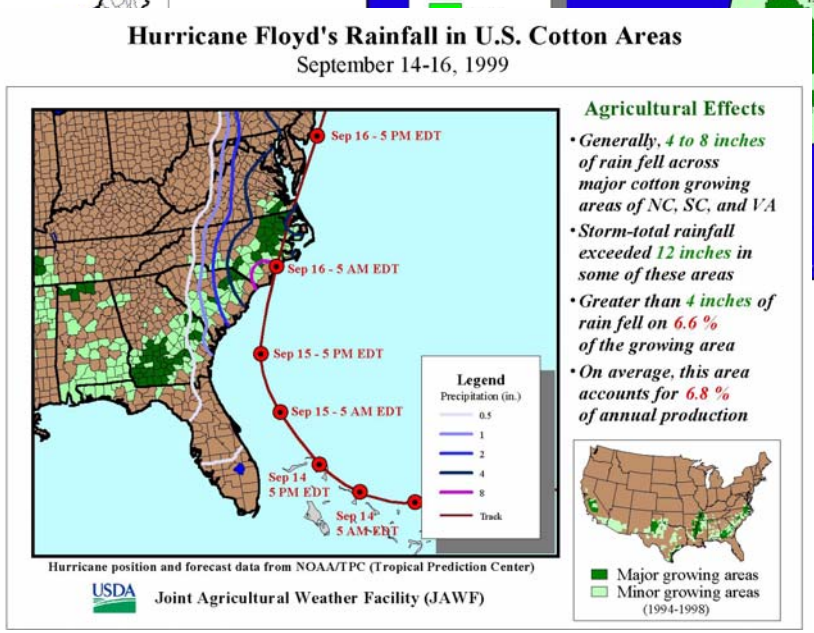
Raytheon

ARCVIEW APPLICATIONS IN USDA CROP WEATHER ANALYSIS

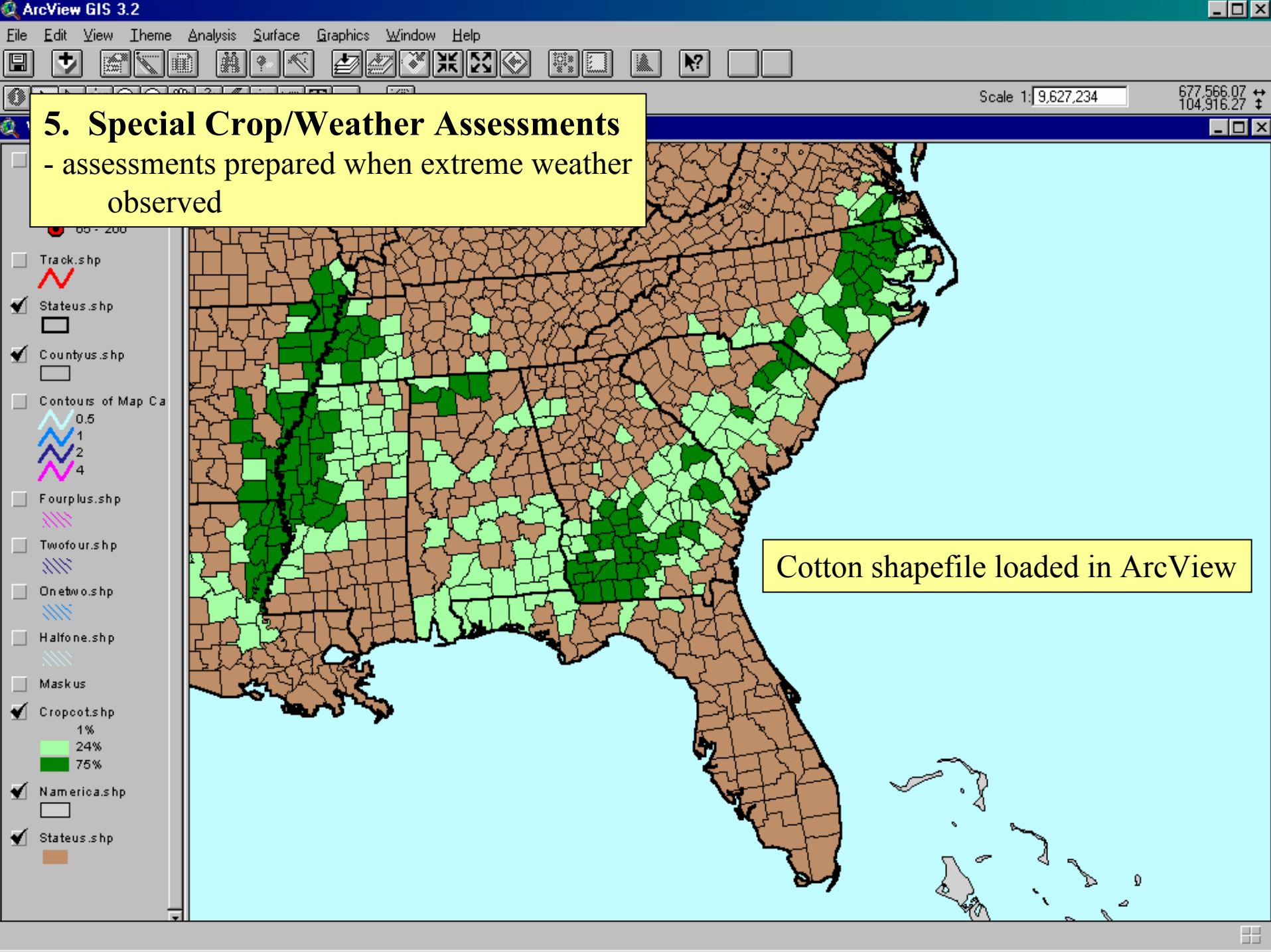






Harlan D. Shannon
Meteorologist/GIS analyst
USDA World Agricultural Outlook Board
Washington D.C.

USDA **World Agricultural Outlook Board**


ArcView GIS 3.2
File Edit View Theme Analysis Surface Graphics Window Help
Scale 1: 9,627,234
677,566.07
104,916.27
5. Special Crop/Weather Assessments
- assessments prepared when extreme weather observed
Track.shp
Stateus.shp
Countyus.shp
Contours of Map Ca
0.5
1
2
4
Fourplus.shp
Twofour.shp
Onetwo.shp
Halfone.shp
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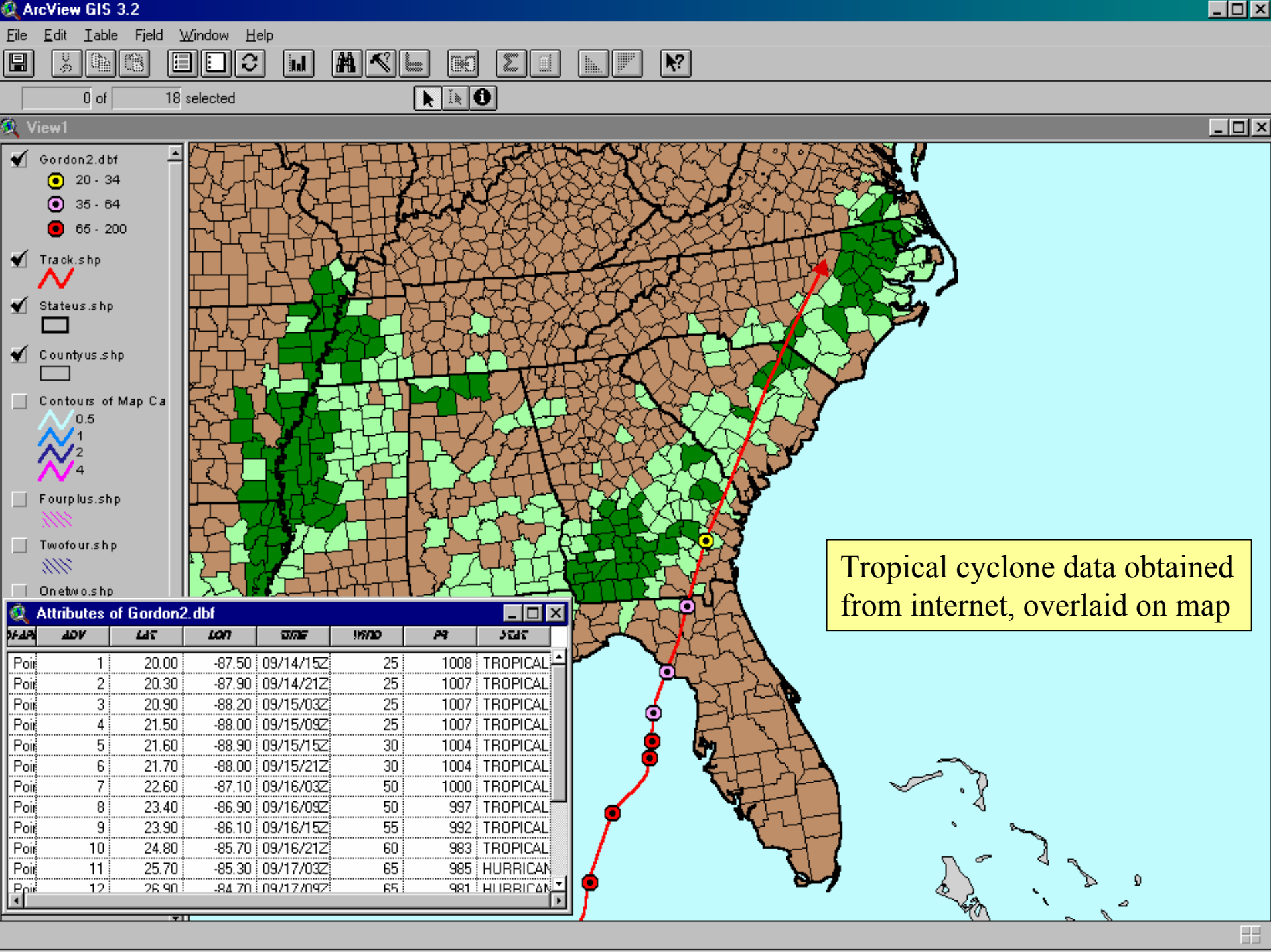
Stateus.shp
Cotton shapefile loaded in ArcView


ArcView GIS 3.2
File Edit Table Field Window Help
0 of 18 selected
View1
Gordon2.dbf
20 - 34
35 - 64
65 - 200
Track.shp
Stateus.shp
Countyus.shp
Contours of Map Ca
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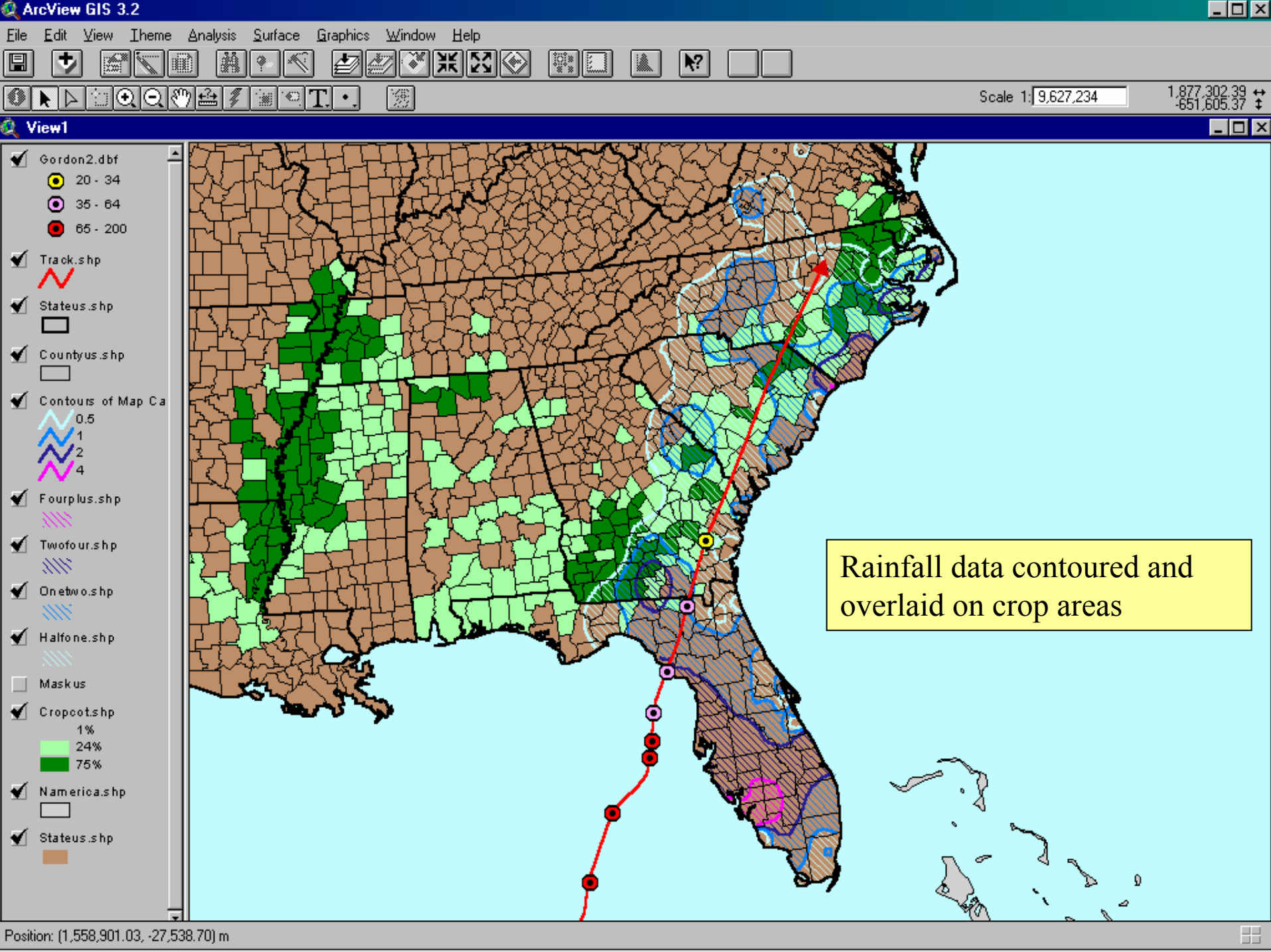
Fourplus.shp
Twofour.shp
Onetwo.shp
Attributes of Gordon2.dbf
ADV LAT LON TIME WIND PR STAT
Poi 1 20.00 -87.50 09/14/15Z 25 1008 TROPICAL
Poi 2 20.30 -87.90 09/14/21Z 25 1007 TROPICAL
Poi 3 20.90 -88.20 09/15/03Z 25 1007 TROPICAL
Poi 4 21.50 -88.00 09/15/09Z 25 1007 TROPICAL
Poi 5 21.60 -88.90 09/15/15Z 30 1004 TROPICAL
Poi 6 21.70 -88.00 09/15/21Z 30 1004 TROPICAL
Poi 7 22.60 -87.10 09/16/03Z 50 1000 TROPICAL
Poi 8 23.40 -86.90 09/16/09Z 50 997 TROPICAL
Poi 9 23.90 -86.10 09/16/15Z 55 992 TROPICAL
Poi 10 24.80 -85.70 09/16/21Z 60 983 TROPICAL
Poi 11 25.70 -85.30 09/17/03Z 65 985 HURRICAN
Tropical cyclone data obtained from internet, overlaid on map


ArcView GIS 3.2
File Edit View Theme Analysis Surface Graphics Window Help
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Twofour.shp
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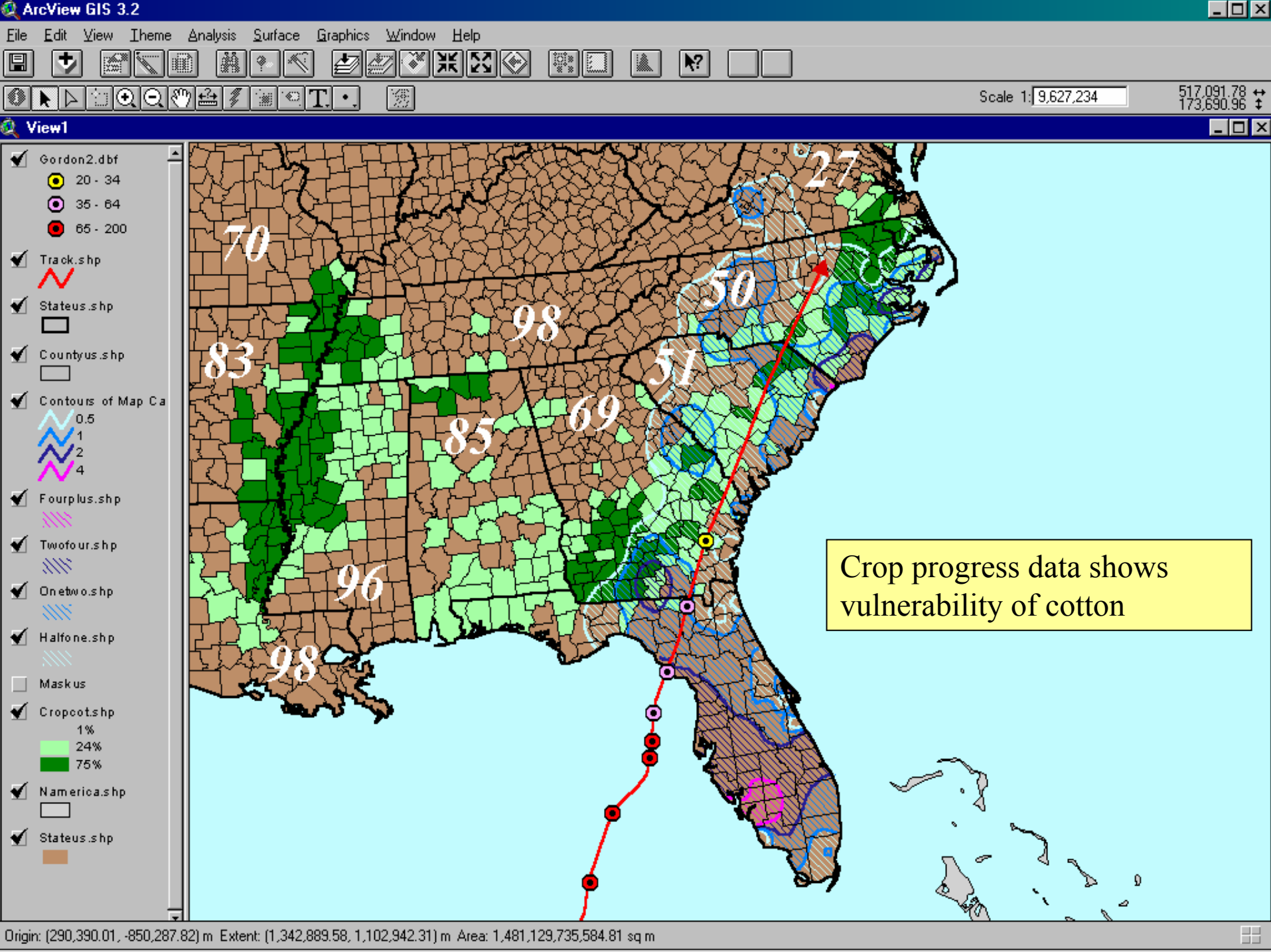
Namerica.shp
Stateus.shp
Rainfall data contoured and overlaid on crop areas
Position: (1,558,901.03, -27,538.70) m


ArcView GIS 3.2
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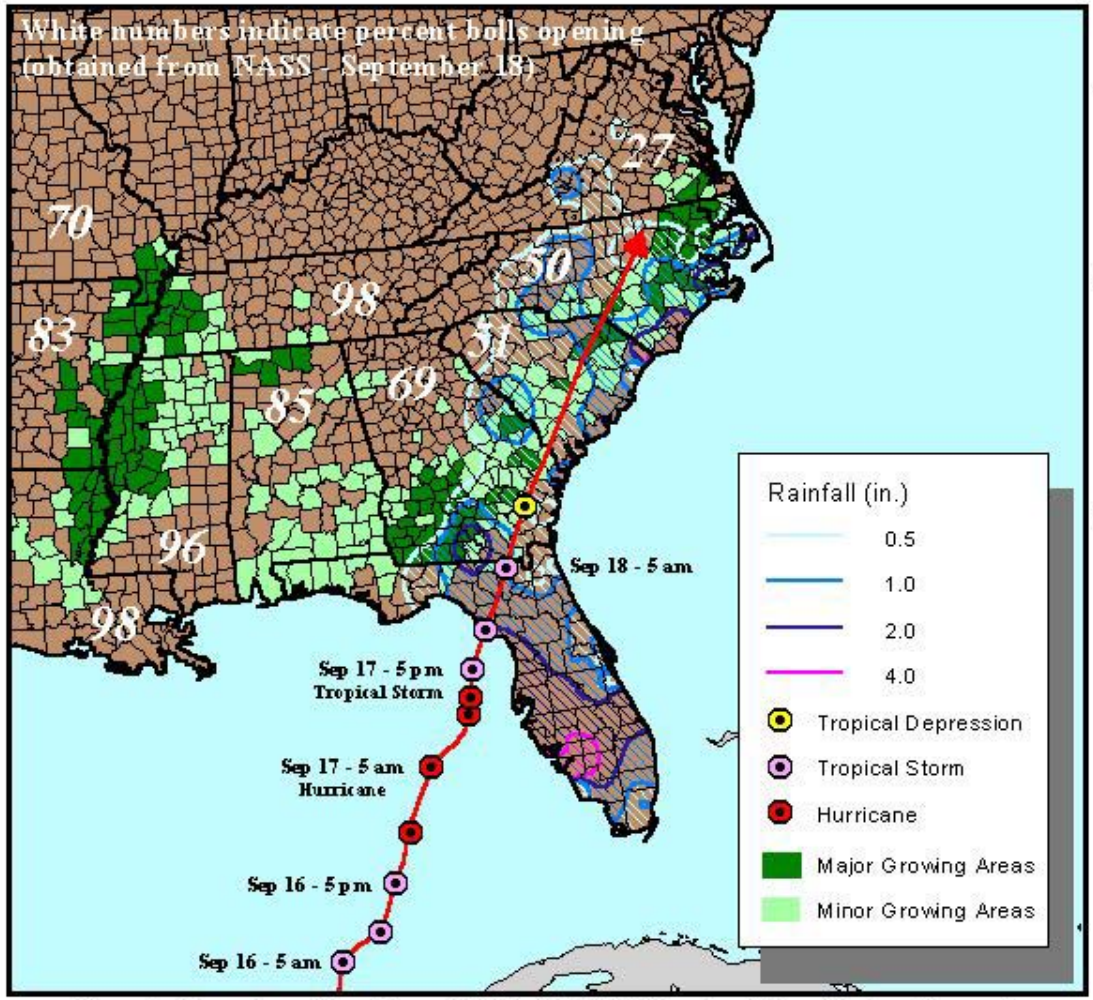
75%
Namerica.shp
Stateus.shp
70
98
83
85
69
96
98
50
51
27
Crop progress data shows vulnerability of cotton
Origin: (290,390.01, -850,287.82) m Extent: (1,342,889.58, 1,102,942.31) m Area: 1,481,129,735,584.81 sq m

Gordon's Rainfall in U.S. Cotton Areas

September 16-19, 2000

Map exported as JPEG



Tropical cyclone data from NOAA/TPC (Tropical Prediction Center)

Summary

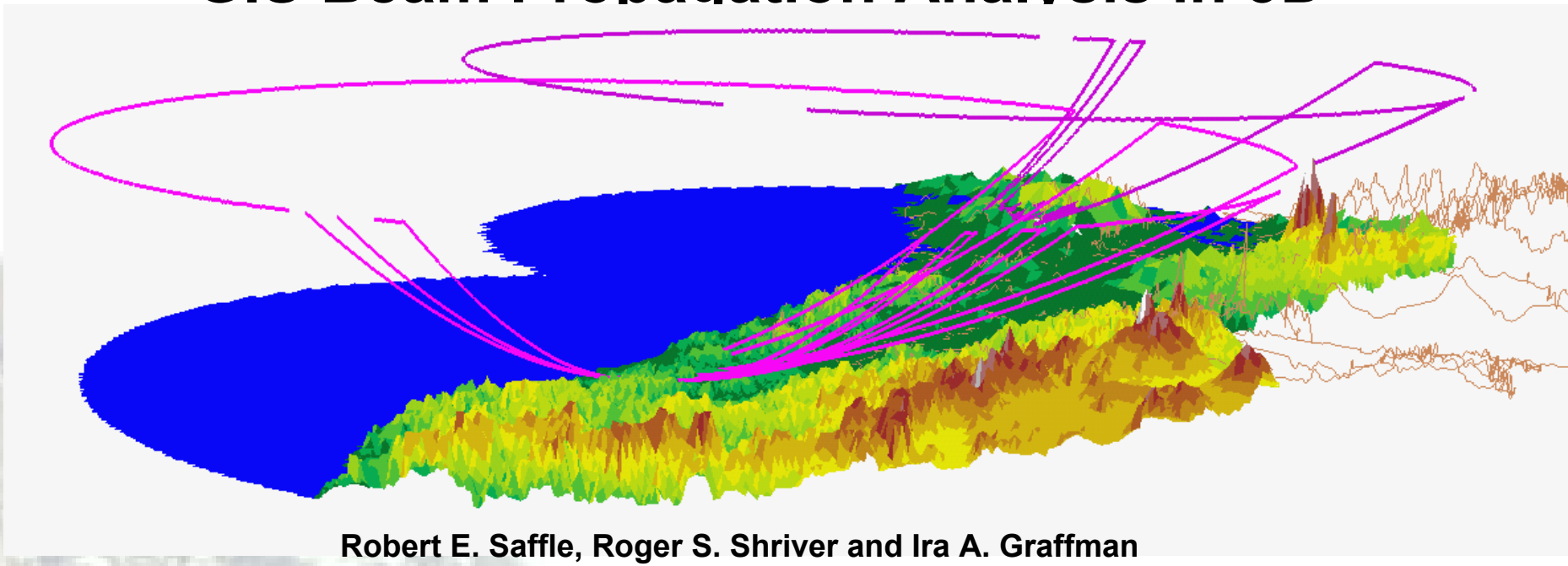
- Hurricane Gordon weakened into a tropical storm before making landfall on the evening of September 17 near Cedar Key, Florida.
- Locally more than 2 inches of rain fell from Florida to North Carolina, soaking cotton that was more than half in the open-boll stage of development.
- Rainfall from Gordon was mostly welcomed from Florida northward through the Carolinas, easing long-term dryness and benefiting citrus and soybeans. However, the moisture caused some delays in cotton, corn, and peanut harvesting and created the potential for some quality downgrades in cotton, especially in areas of greatest rainfall.

USDA Joint Agricultural Weather Facility (JAWF)

George Mason University

Raytheon

NEXRAD to Shapefile Conversion
and
GIS Beam Propagation Analysis in 3D



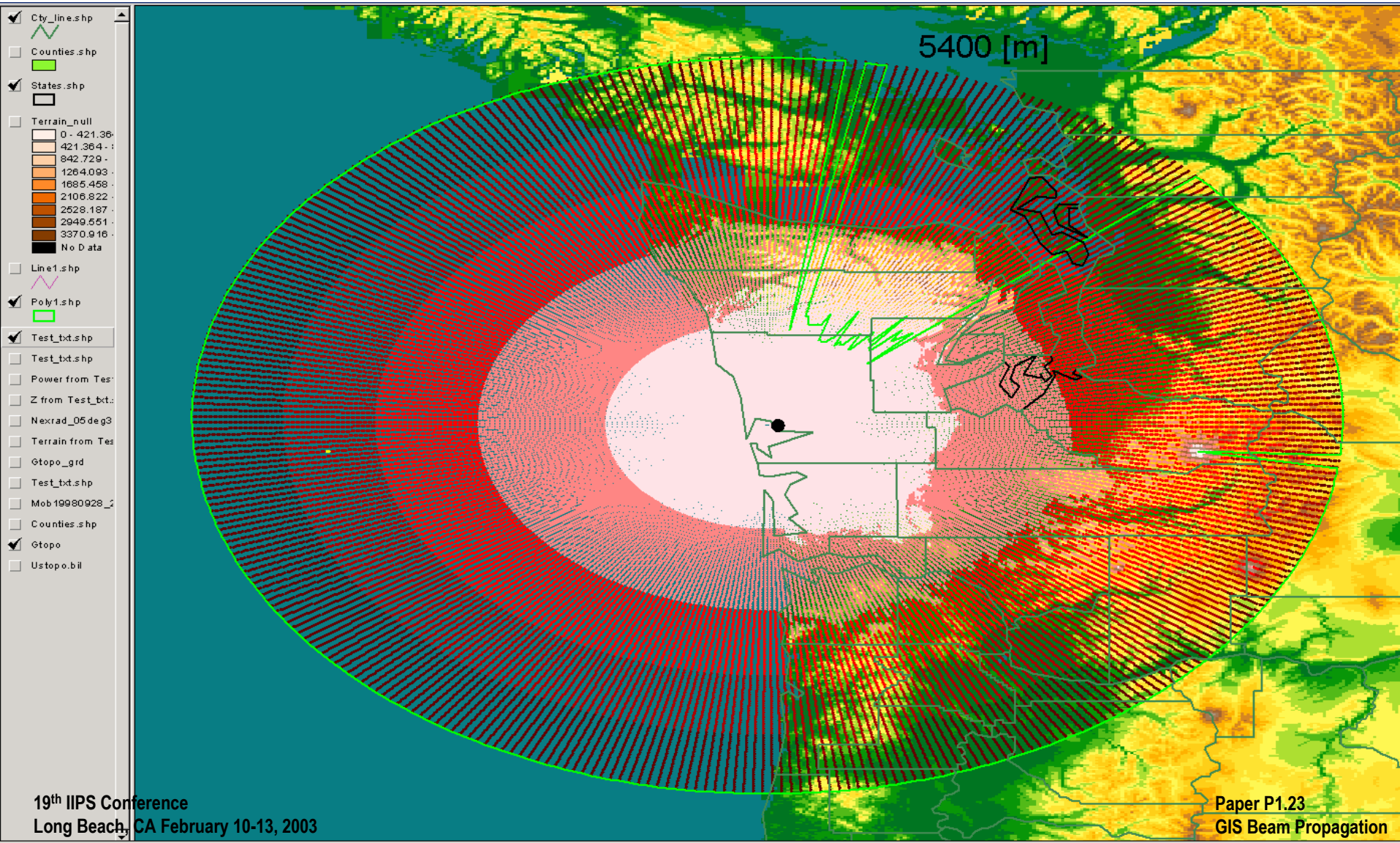
Robert E. Saffle, Roger S. Shriver and Ira A. Graffman
National Weather Service, Silver Spring, Maryland

Scott T. Shipley and Dan M. Gillespie
Raytheon ITSS, Lanham, Maryland

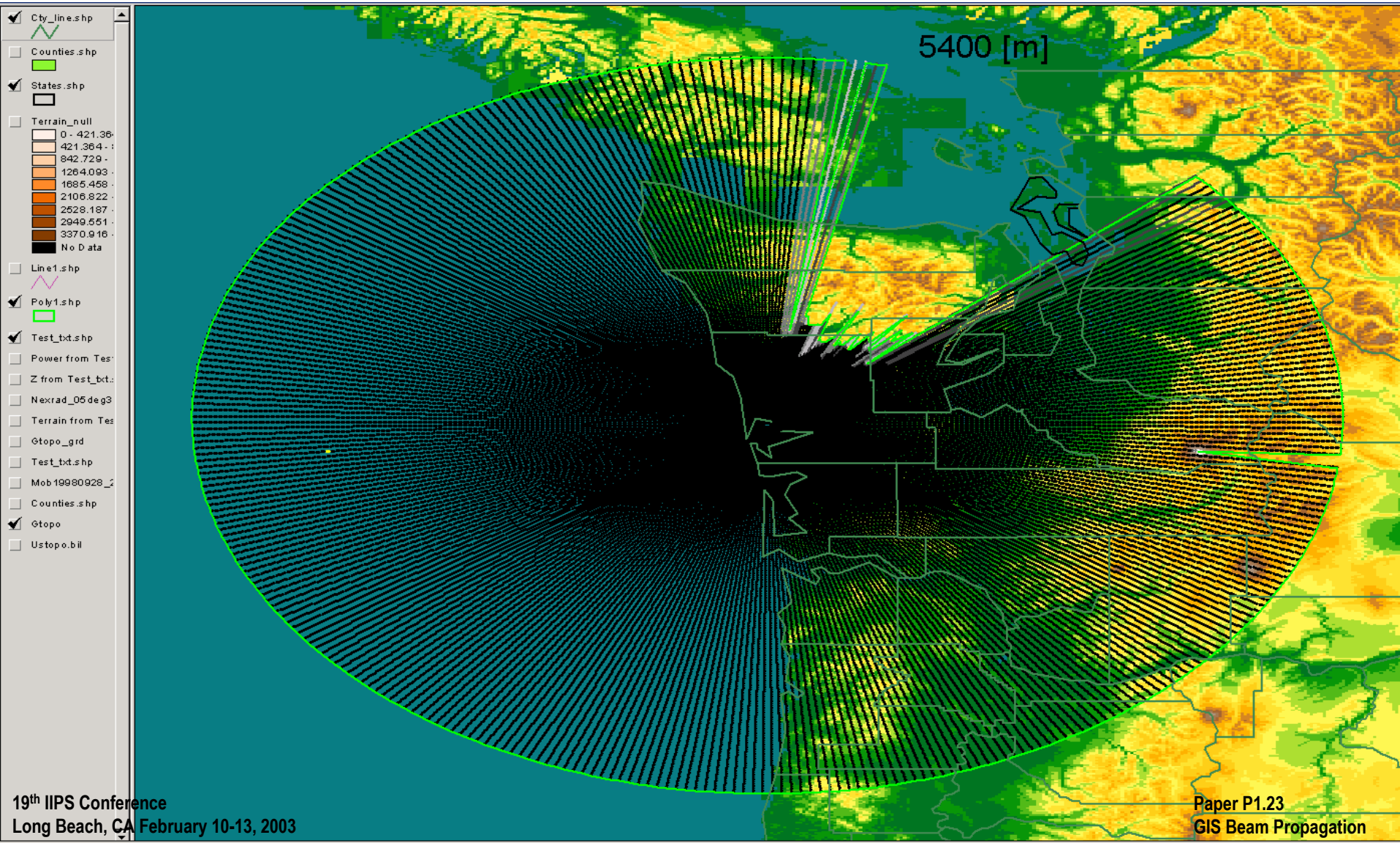
George Mason University

Raytheon

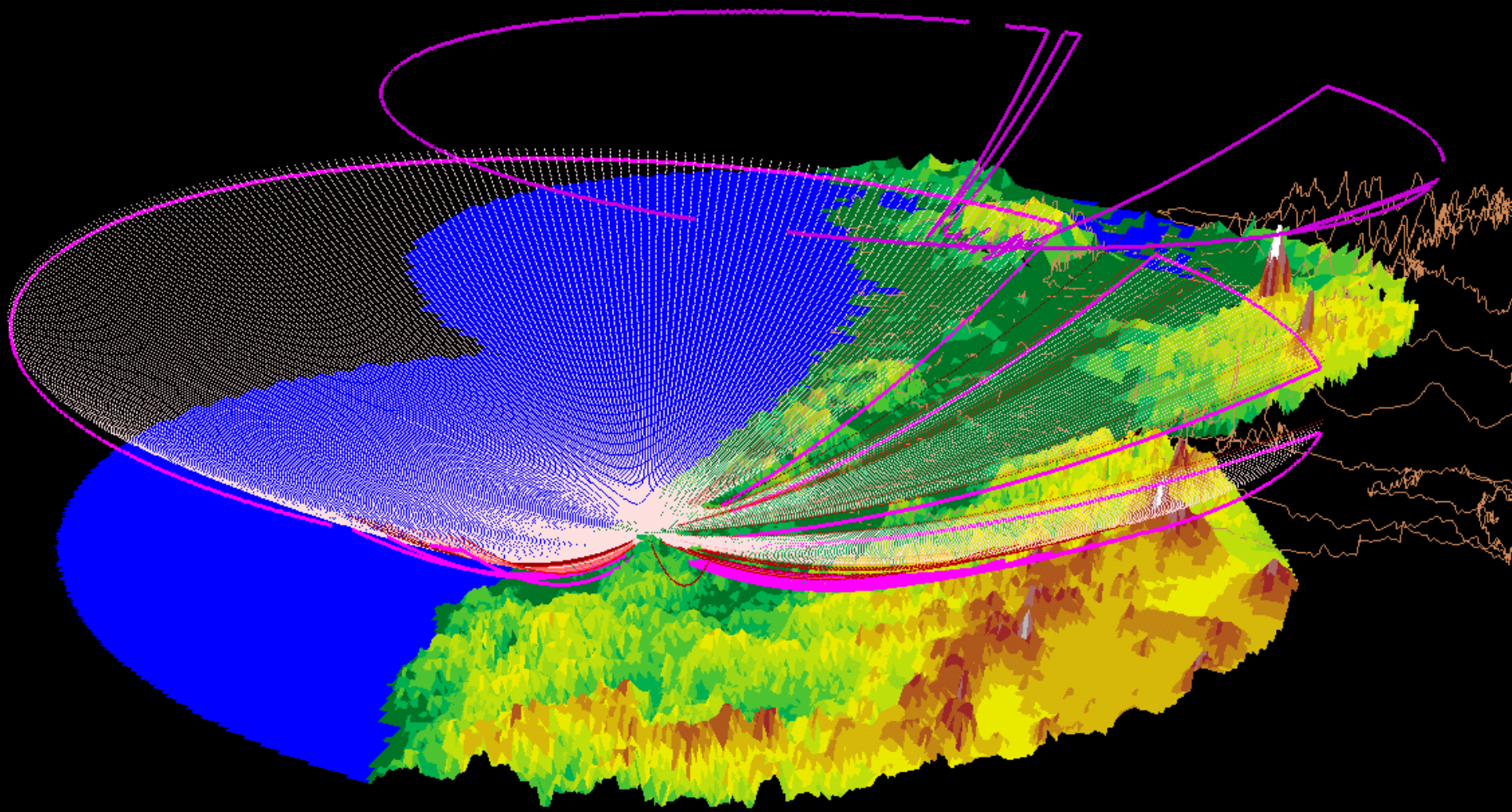
Step 1 – Generate Test Pattern



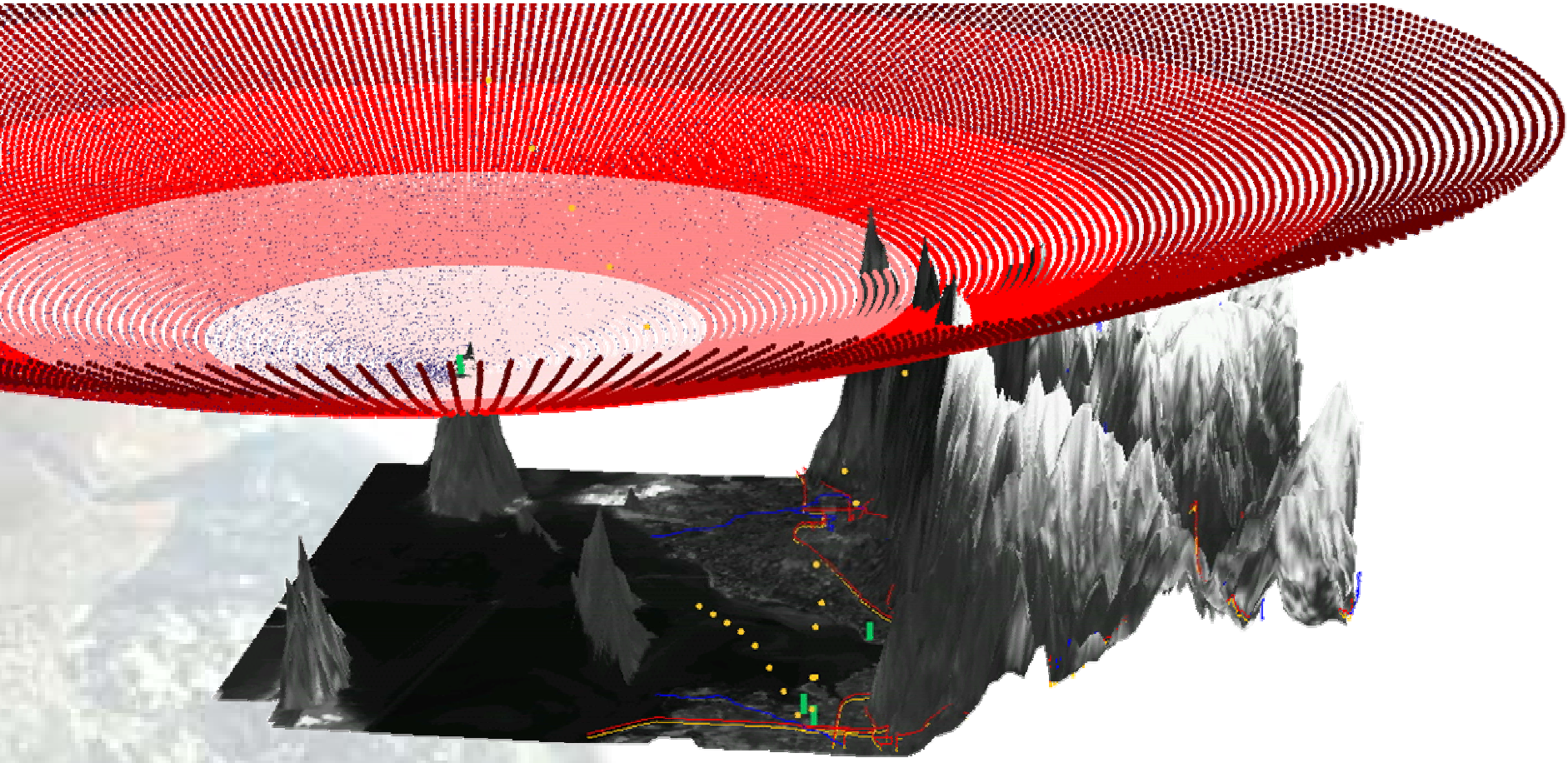
2) Estimate Terrain Blockage & 3) Create Range Rings



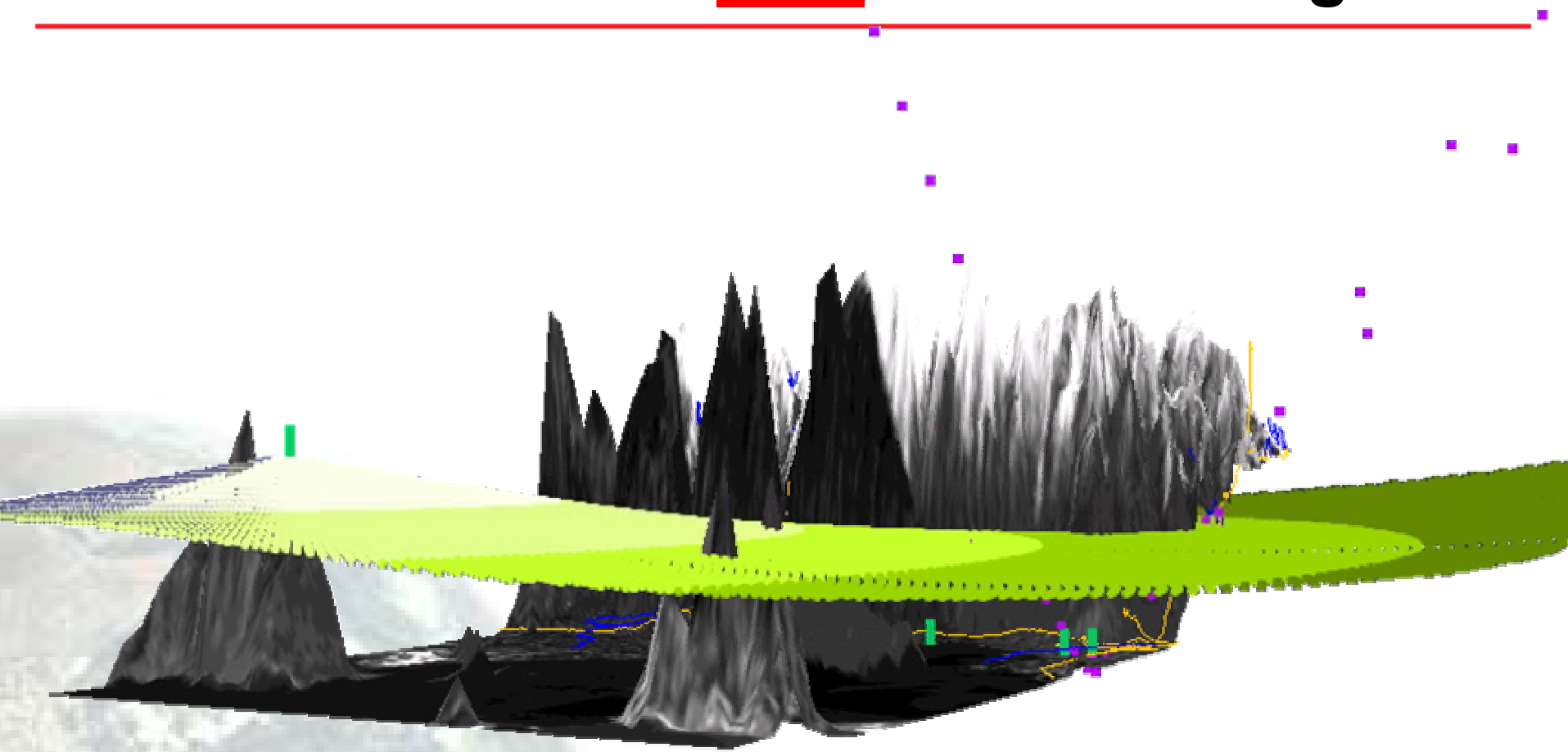
Step 4 – Cast in 3D



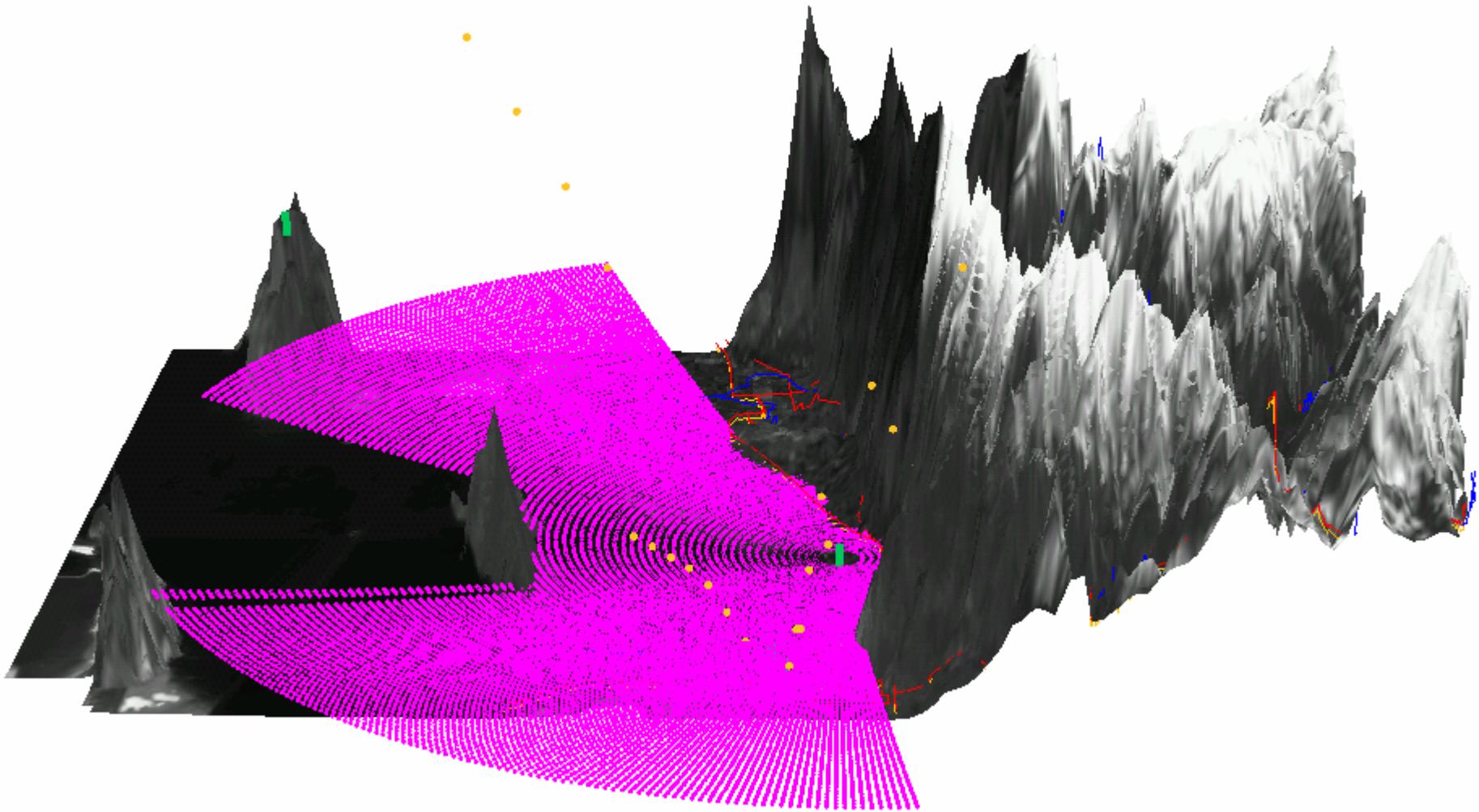
SLC NEXRAD at +0.5° Elevation Angle



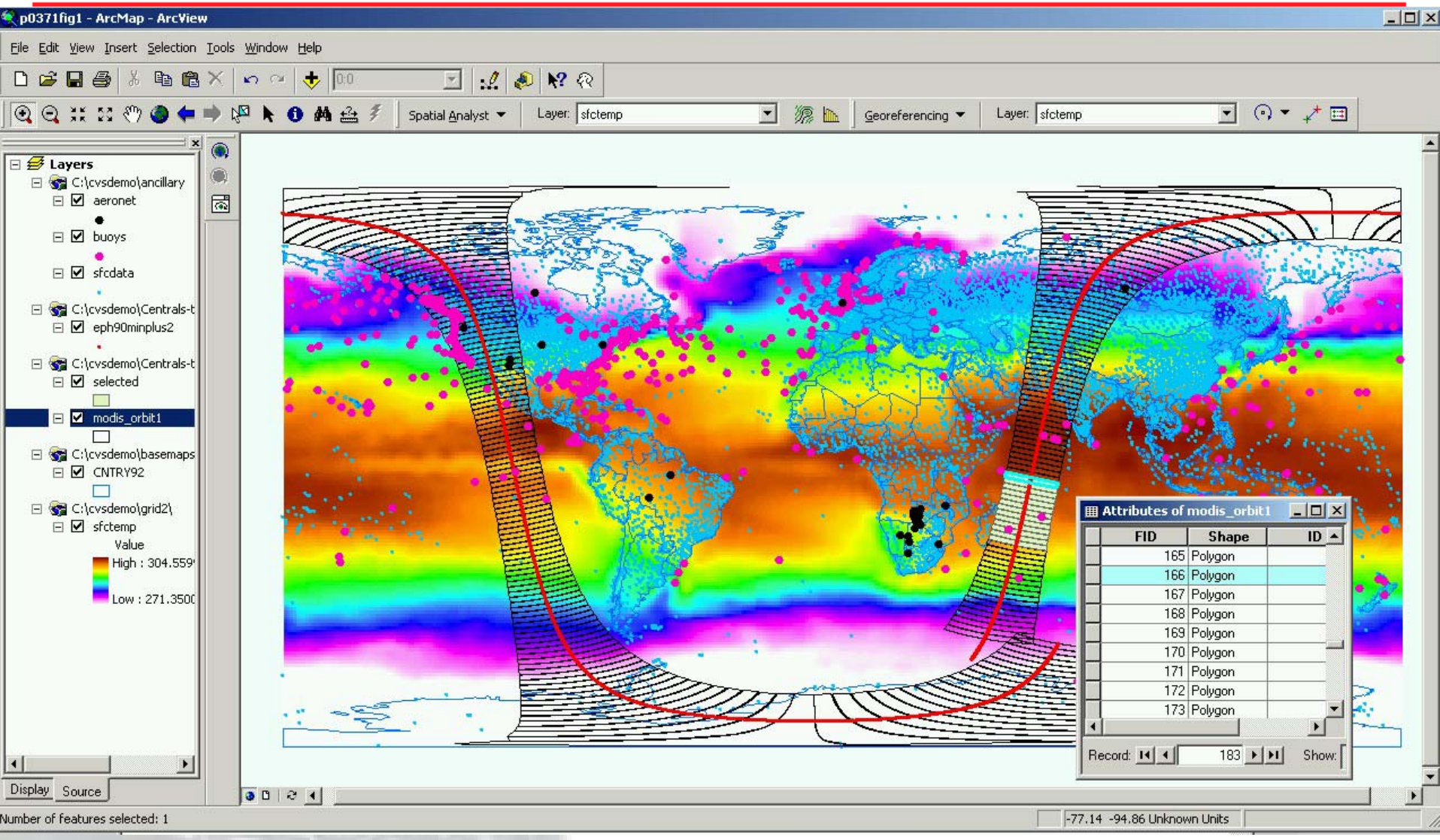
SLC NEXRAD at -0.5° Elevation Angle



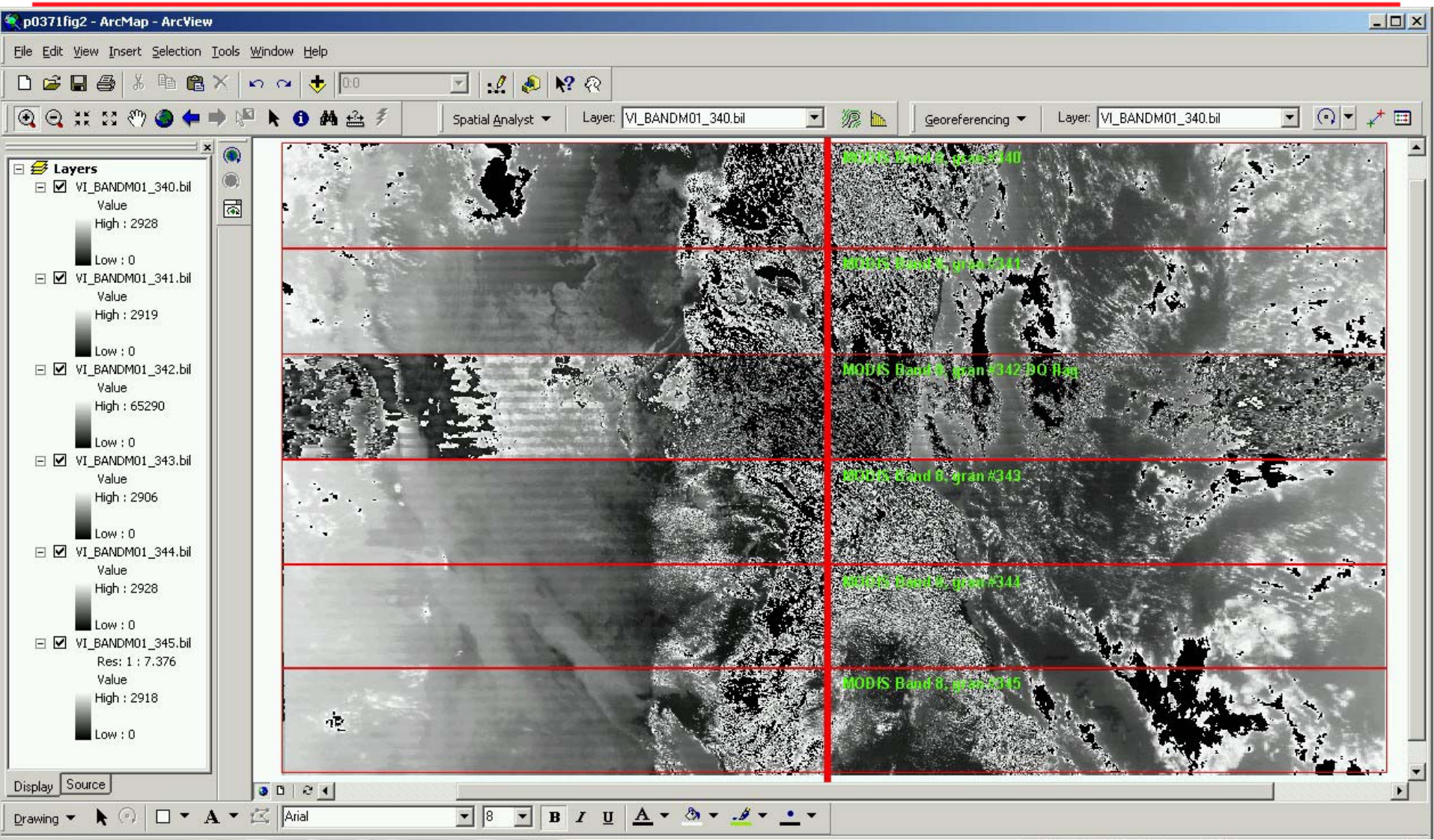
FAA TDWR at +0.2° Elevation Angle



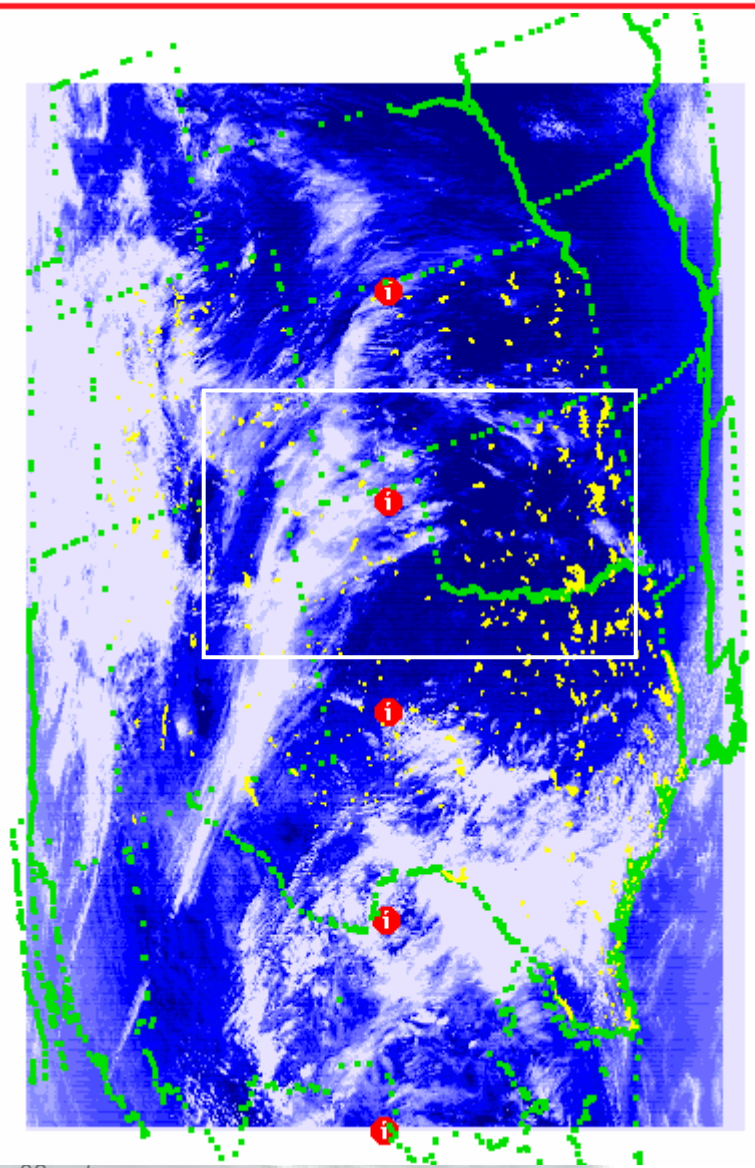
MODIS Granule Plan – Map Space



MODIS Band 8 (413 nm) – Sensor Space



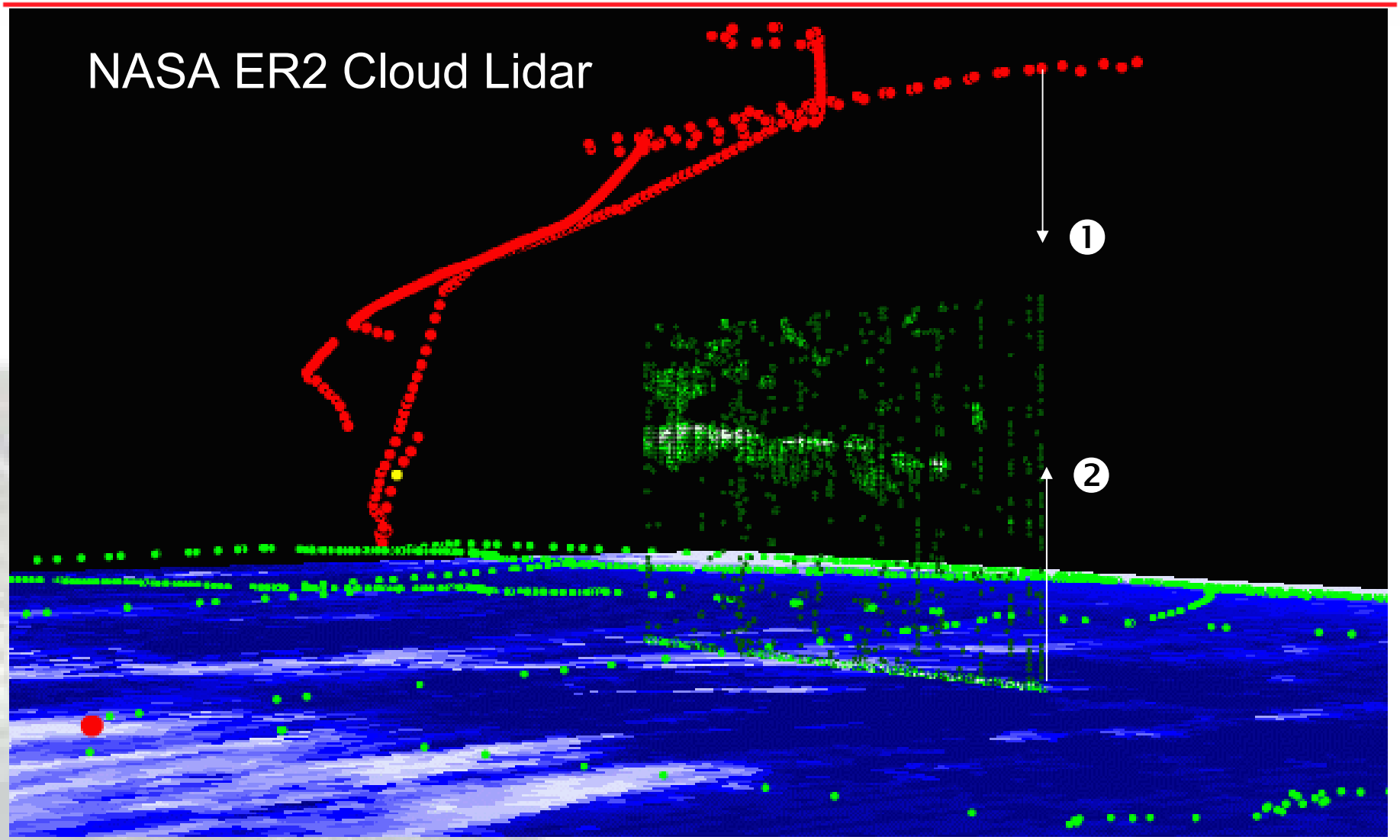
Earth Geoid Navigation – Sensor Space



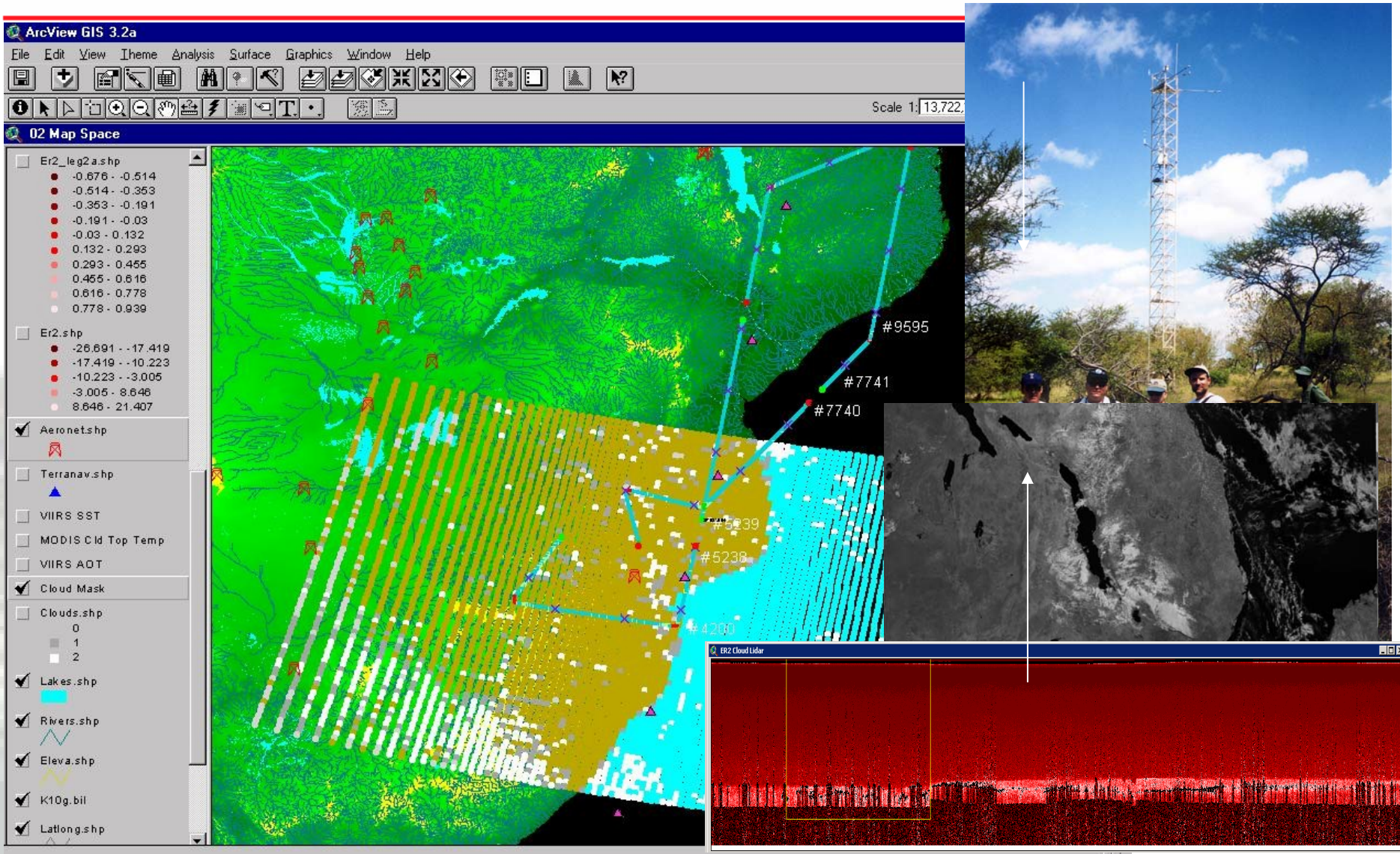
- Try working in “sensor space”
- Transform geographic data to sensor coordinates
- Spherical Earth yields ~14 km error midlatitude
- WGS 84 Ellipsoid better (NAD 83)

MODIS on Eos Terra, 14 Apr 2000

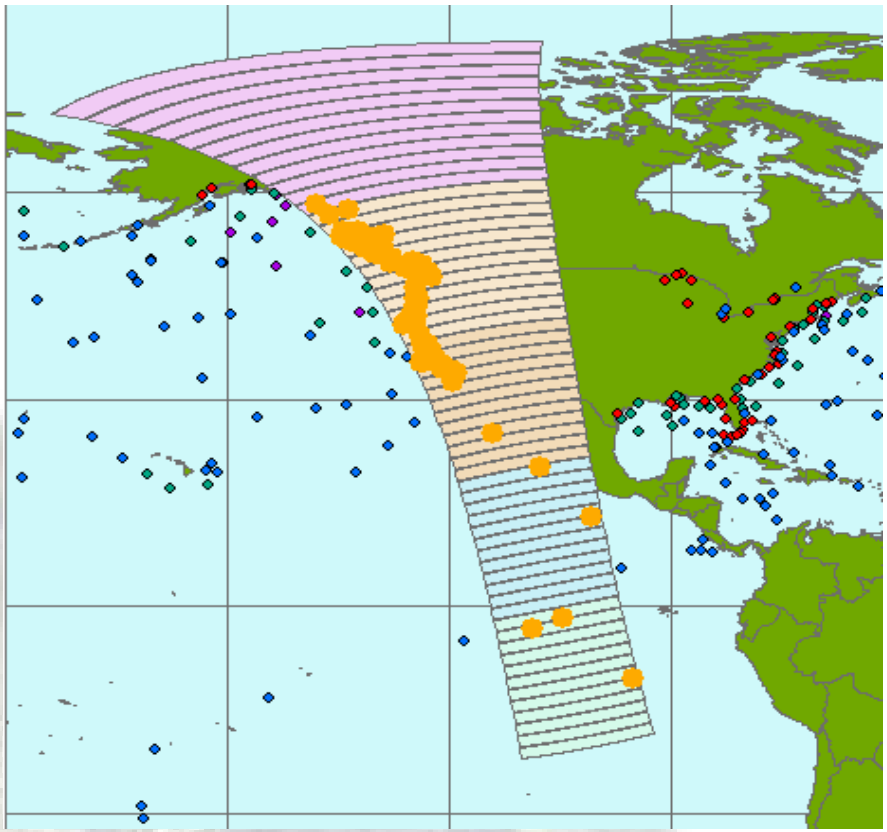
in situ collocation in x,y,z,t



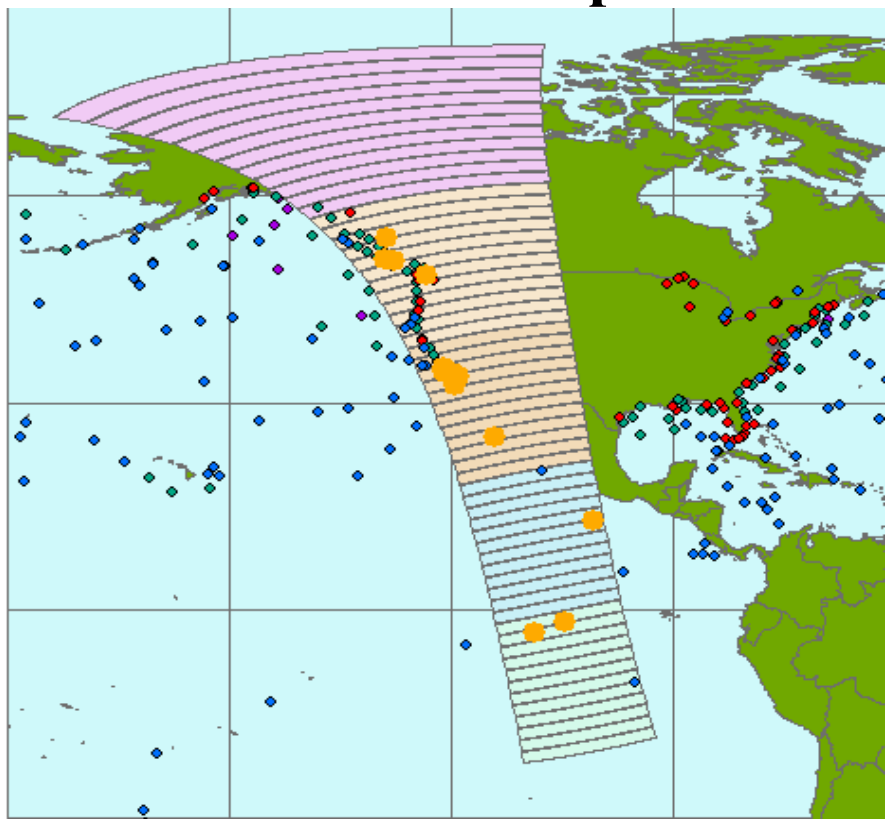
Combine Data Across Disciplines & Scales



Generate Metrics Product – SST



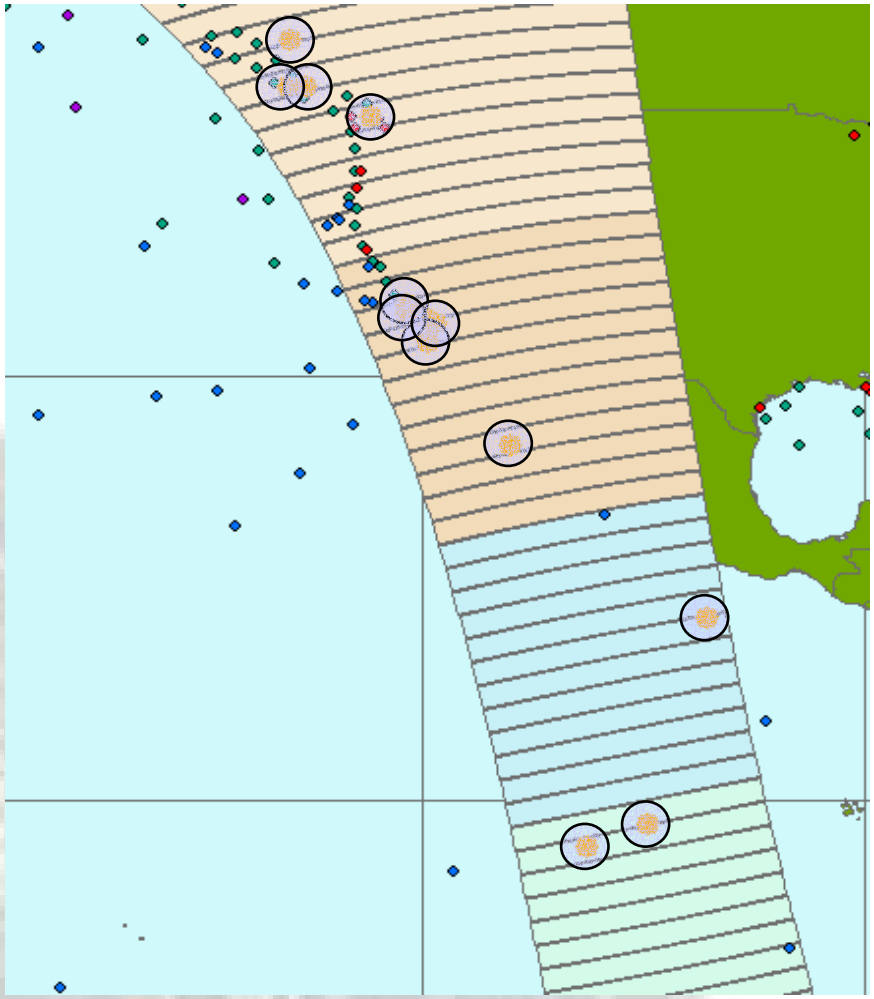
Match granules and ancillary data in time and space



Filter out ancillary data with high wind speed

- Bonnie Reed (Raytheon ITSS)

Generate Metrics Product - SST

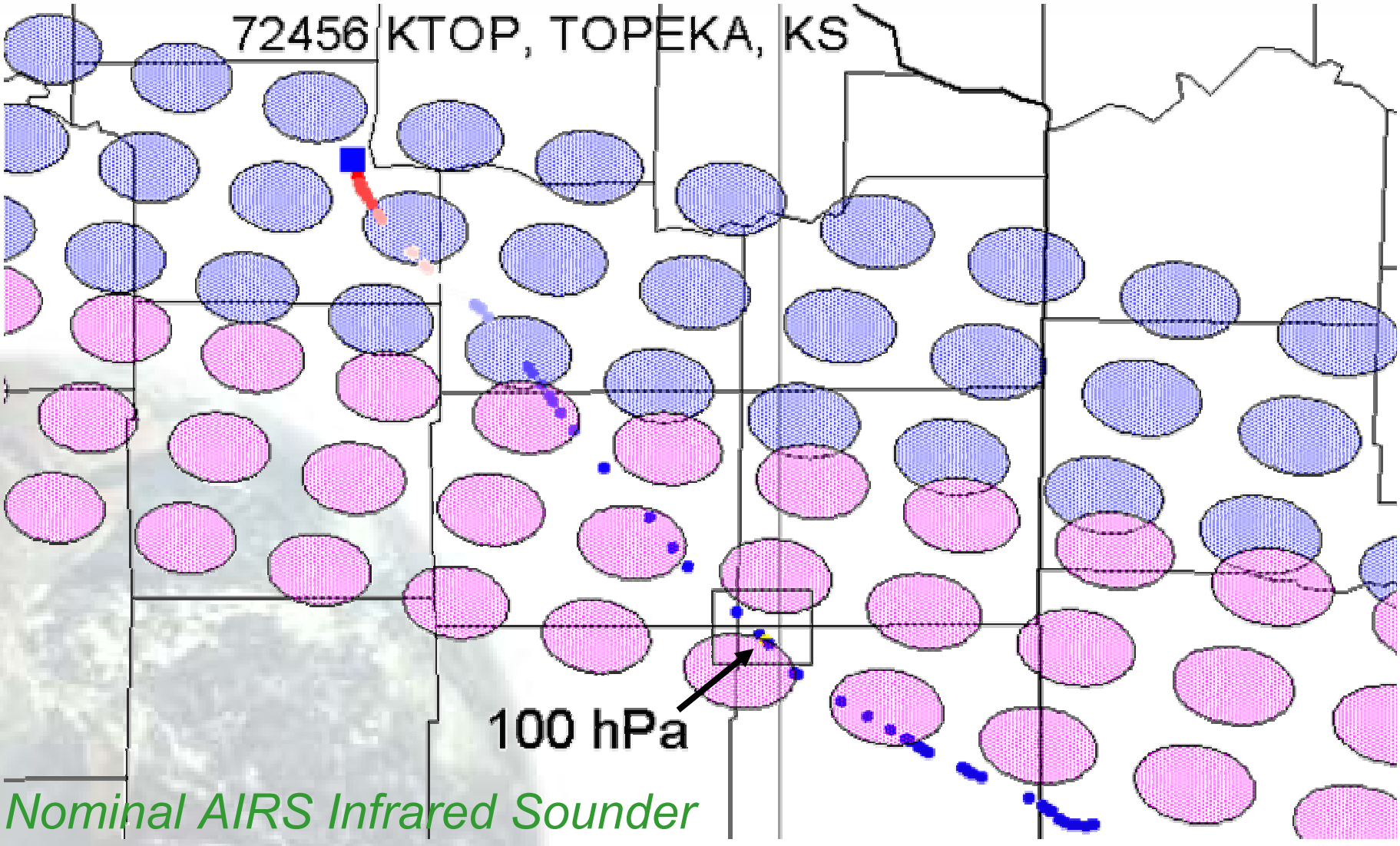


Average MODIS SST values for a defined area around each valid ancillary data point.

Note: Only average MODIS pixel values that are defined as either Confident Clear, Probably Clear, & Probably Cloudy.

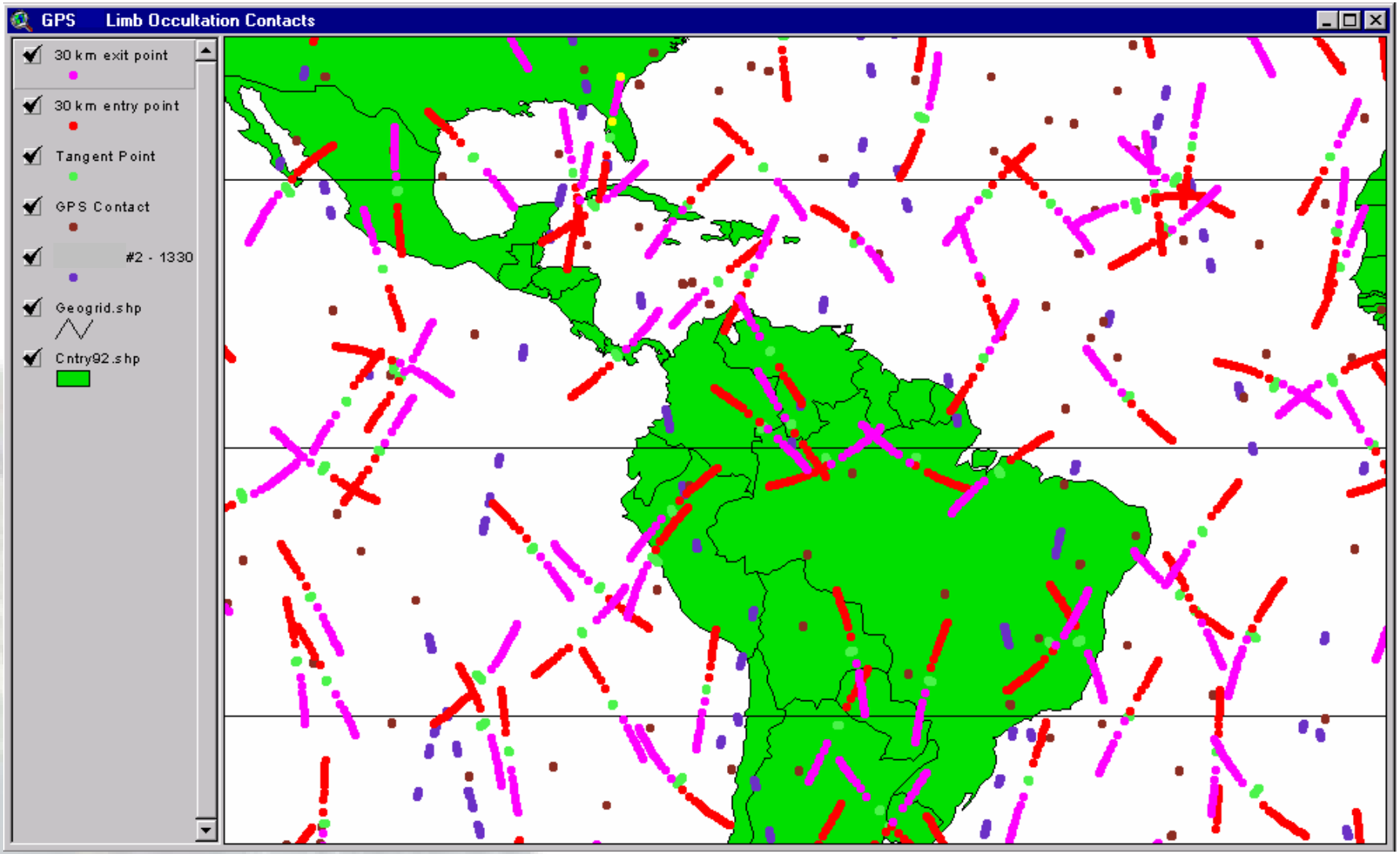
- Bonnie Reed (Raytheon ITSS)

Satellite – Raob Intercomparison

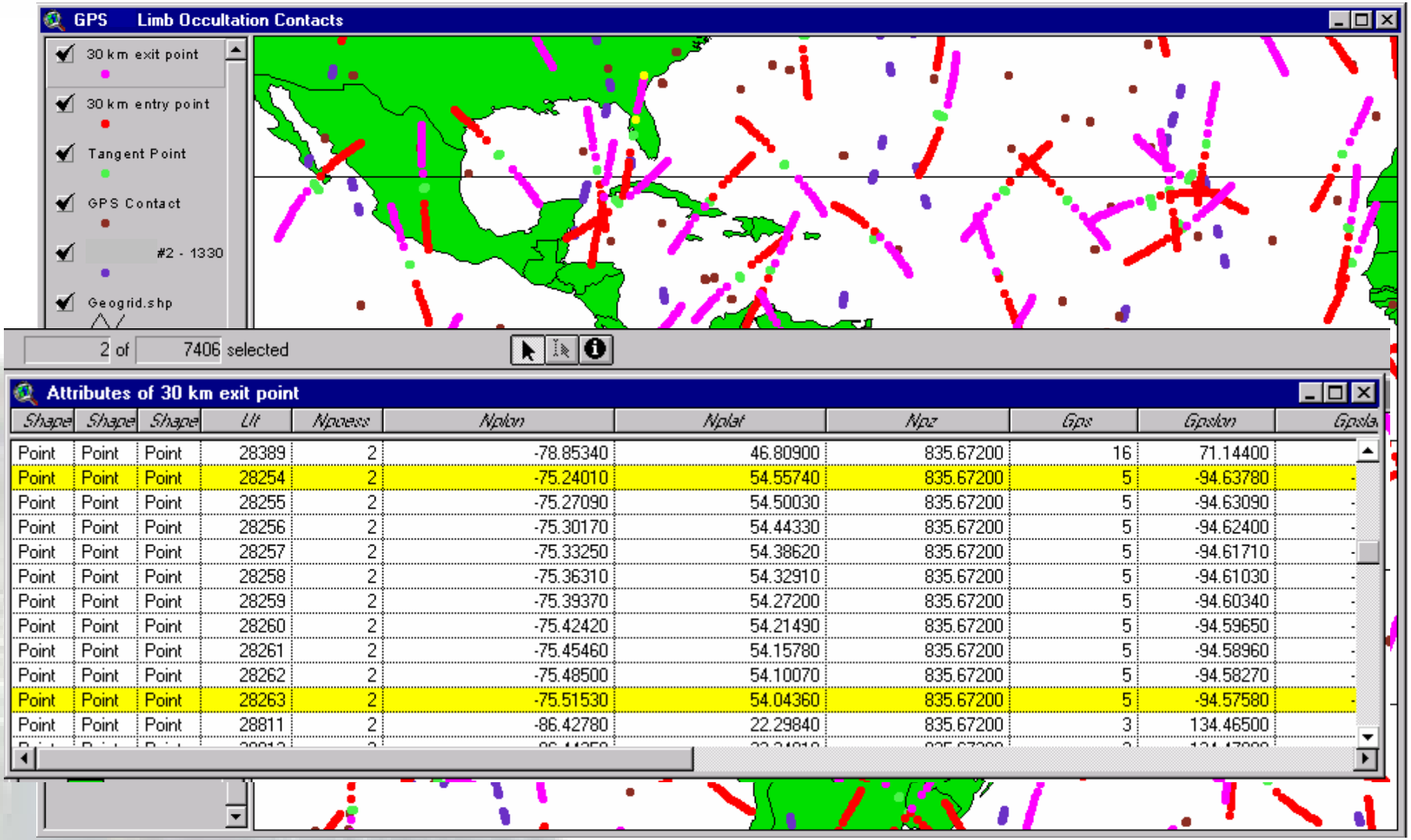


Nominal AIRS Infrared Sounder

GPS Limb Soundings



GPS Limb Soundings



Shape	Shape	Shape	Ut	Npoess	Nplon	Nplat	Npz	Gps	Gpslon	Gpsla
Point	Point	Point	28389	2	-78.85340	46.80900	835.67200	16	71.14400	
Point	Point	Point	28254	2	-75.24010	54.55740	835.67200	5	-94.63780	
Point	Point	Point	28255	2	-75.27090	54.50030	835.67200	5	-94.63090	
Point	Point	Point	28256	2	-75.30170	54.44330	835.67200	5	-94.62400	
Point	Point	Point	28257	2	-75.33250	54.38620	835.67200	5	-94.61710	
Point	Point	Point	28258	2	-75.36310	54.32910	835.67200	5	-94.61030	
Point	Point	Point	28259	2	-75.39370	54.27200	835.67200	5	-94.60340	
Point	Point	Point	28260	2	-75.42420	54.21490	835.67200	5	-94.59650	
Point	Point	Point	28261	2	-75.45460	54.15780	835.67200	5	-94.58960	
Point	Point	Point	28262	2	-75.48500	54.10070	835.67200	5	-94.58270	
Point	Point	Point	28263	2	-75.51530	54.04360	835.67200	5	-94.57580	
Point	Point	Point	28811	2	-86.42780	22.29840	835.67200	3	134.46500	

George Mason University

Raytheon

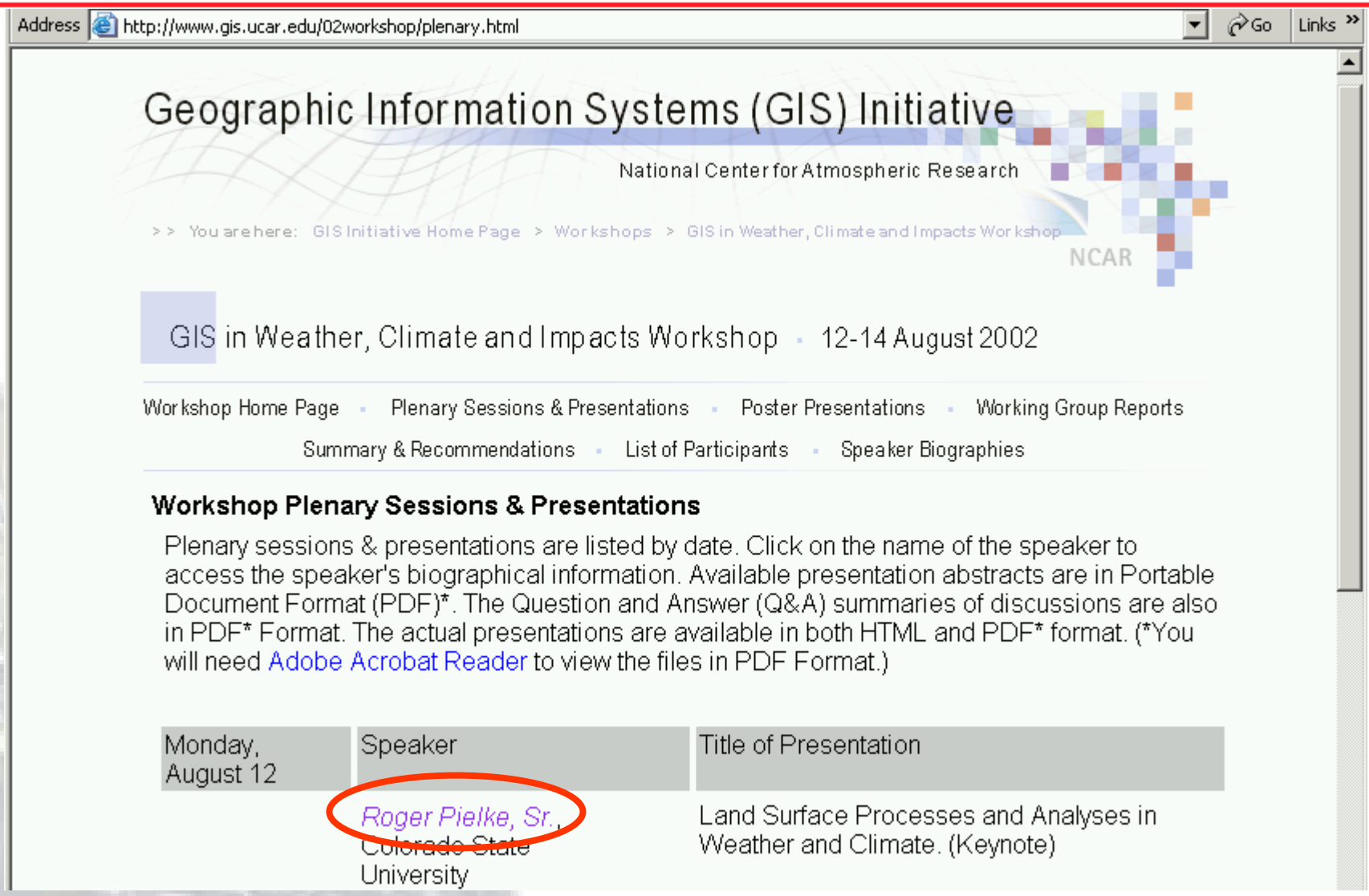
1rst GIS Session at AMS

19th IIPS - Feb 2003
Nancy Soreidi & S. Shipley (co-chairs)

Call for papers – 20th IIPS, due 1 Aug 2003

1:30 PM		**SESSION 6: GIS APPLICATIONS** Chairpersons: Nancy N Soreide, NOAA/PMEL, Seattle, WA; Scott T. Shipley, Raytheon, Lanham, MD
1:30 PM	6.1	SOLVING COMPLEX BUSINESS PROBLEMS WITH GIS AND METEOROLOGICAL DATA. Ronald J. Sznaider, Meteorlogix, Minneapolis, MN
1:45 PM	6.2	WESTERN REGION FLASH FLOOD PROJECT. Greg Smith, NOAA/NWS, Salt Lake City, UT
2:00 PM	6.3	GIS DATA/APPLICATIONS AT THE LOWER MISSISSIPPI RIVER FORECAST CENTER. Keith M. Stellman, NOAA/NWS, Slidell, LA; and D. M. Welch
2:15 PM	6.4	USING GIS FOR ENVIRONMENTAL DATA IN IOWA. Dennis P. Todey, Iowa State University, Ames, IA; and D. E. Herzmann
2:30 PM	6.5	WEATHER INTELLIGENCE: A GIS APPROACH TO ENRICH WEATHER DATABASES. May Yuan, University of Oklahoma, Norman, OK; and J. McIntosh
2:45 PM	6.6	GIS MODULE FOR THE NATIONAL WEATHER SERVICE'S MANAGEMENT INFORMATION RETRIEVAL SYSTEM. John Kozimor, NOAA/NWS, Silver Spring, MD; and P. Kingsbury
3:00 PM		COFFEE BREAK (EXHIBITS OPEN 1:30–6:00 P.M.)
3:30 PM	6.7	GIS AS A BRIEFING AND PLANNING TOOL IN THE NWS. Ira A. Graffman, NOAA/NWS, Silver Spring, MD
3:45 PM	6.8	AN HISTORICAL TROPICAL CYCLONE MAPPING AND ANALYSIS TOOL. Ethan Gibney, NOAA, Charleston, SC; and R. Jackson
4:00 PM	6.9	AN ARCIMS-BASED WEB PORTAL TO REAL-TIME OBSERVATIONS AND FORECASTS FOR ESTUARIES AND THE COASTAL OCEAN. John G. W. Kelley, NOAA/National Ocean Service, Silver Spring, MD; and M. Kennedy and M. Westington
4:15 PM	6.10	MOTION TRACKER- USING INTERNET MAP SERVERS AND JAVA TECHNOLOGY TO PROVIDE NEAR-REAL TIME MAPPING OF MOVING OBJECTS- RESEARCH VESSELS AND MARINE MAMMALS. Nazila Merati, JISAO/Univ. of Washington, Seattle, WA; and J. Fabritz, T. C. Vance, D. Shields, and R. Hobbs
4:30 PM	6.11	VRML-BASED VISUALIZATION OF GIS DATA FOR A MARINE SANCTUARY. Tiffany C. Vance, NOAA/National Marine Fisheries Service/Alaska Fisheries Science Center, Seattle, WA; and C. Alexander, N. Merati, and C. W. Moore
4:45 PM	6.12	EXPLORATION OF GIS INTEROPERABILITY TECHNOLOGIES FOR THE INTERNATIONAL H2O PROJECT. Olga Wilhelmi, NCAR, Boulder, CO; and T. Betancourt
5:00 PM	6.13	AN INTEROPERABLE WEB MAPPING APPLICATION AT THE GES DAAC. Nathan Pollack, NASA/GSFC, Greenbelt, MD; and W. Teng, J. Bonk, L. Lu, D. Nadeau, P. Hrubiak, and G. Serafino
5:15 PM	6.14	GIS CALIBRATION AND VALIDATION OF SATELLITE MEASUREMENTS. Heather S. Kilcoyne, Raytheon ITSS, Lanham, MD; and S. T. Shipley

GIS to address Global Warming



Address http://www.gis.ucar.edu/02workshop/plenary.html Go Links

Geographic Information Systems (GIS) Initiative

National Center for Atmospheric Research

>> You are here: GIS Initiative Home Page > Workshops > GIS in Weather, Climate and Impacts Workshop

NCAR

GIS in Weather, Climate and Impacts Workshop • 12-14 August 2002

Workshop Home Page • Plenary Sessions & Presentations • Poster Presentations • Working Group Reports

Summary & Recommendations • List of Participants • Speaker Biographies

Workshop Plenary Sessions & Presentations

Plenary sessions & presentations are listed by date. Click on the name of the speaker to access the speaker's biographical information. Available presentation abstracts are in Portable Document Format (PDF)*. The Question and Answer (Q&A) summaries of discussions are also in PDF* Format. The actual presentations are available in both HTML and PDF* format. (*You will need Adobe Acrobat Reader to view the files in PDF Format.)

Monday, August 12	Speaker	Title of Presentation
	Roger Pielke, Sr., Colorado State University	Land Surface Processes and Analyses in Weather and Climate. (Keynote)

Address http://www.gsfc.nasa.gov/topstory/20020926landcover.html

top story

Goddard Space Flight Center

October 01, 2002 - (date of web publication)

LANDCOVER CHANGES MAY RIVAL GREENHOUSE GASES AS CAUSE OF CLIMATE CHANGE

While many scientists and policy makers have focused only on how heat-trapping gases like carbon dioxide are altering our global climate, a new NASA-funded study points to the importance of also including human-caused land-use changes as a major factor contributing to climate change.

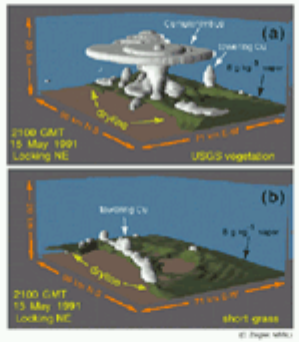


Image 1

Land surface changes, like urban sprawl, deforestation and reforestation, and agricultural and irrigation practices strongly affect regional surface temperatures, precipitation and larger-scale atmospheric circulation. The study argues that human-caused land surface changes in places like North America, Europe, and southeast Asia, redistribute heat regionally and globally within the atmosphere and may actually have a greater impact on climate than that due to anthropogenic greenhouse gases combined.

The study also proposes a new method for comparing different

Related Links

For more information contact:

Krishna Ramanujan
Goddard Space Flight Center,
Greenbelt, Md.
(Phone: 301/286-3026)

Brad Bohlander
Colorado State University
(Phone: 970/491-1545)

Viewable Images

Caption for Image 1: The Effect of Landscape Change on Central Great Plains Thunderstorms

The effect of landscape change on thunderstorms in the central Great Plains of the U.S. is illustrated in these two figures. In the top figure, the current mixed landscape of

Dr. T's Fearless Forecasts

Observations

- *Data formats impact interoperability*
- *Wx Community behind in GIS education*
  - *Wx community would rather build than buy – are we training programmers or meteorologists?*
  - *Geography Depts are also behind*

Fearless Forecasts

- *ArcGIS 9.x will support JAVA interface*
- *ArcObjects will support LINUX deployment (sometime…)*
- *Web-enabled Geodatabases will transform how we use and distribute Wx data*
- *HDF5 (JTA Standard) will supplant NetCDF*

Challenges

- **Access Wx data in "GIS Ready" formats**
  1. METAR, raobs, NEXRAD, GRIB, satellite, …
  - Wx crypt formats are barrier to wider use

- **Evolve past "data viewers" to data <u>analysis</u>**
  2. Apply intrinsic GIS functions
  3. Interface with external Wx applications

- **Challenges to GIS**
  4. Animation

Recommendations

1. Amend raob formats – add lon,lat,time
2. Adopt WGS84 ellipsoid (Govt Standard)
3. Record lon,lat to +x.xxxxx degrees (and report in decimal degrees)
4. Get ArcGIS 8.3 with Spatial & 3D Analysts
   – ArcGlobe coming with 3D Analyst in ArcGIS 9.x