# Visual Data Mining of Remote Sensing Data

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# Contents

- Visual Data Mining
  - Definitions
  - Software
  - Techniques
- Examples
- Live Demos

# Data Mining

Ed Wegman:

"Data Mining is Exploratory Data Analysis with Little or No Human Interaction using Computationally Feasible Techniques, i.e., the Attempt to find Interesting Structure unknown a priori"

# Visual Data Mining (1)

- Working Definition:
  - Find structure (cluster, unusual observations) in large and not necessarily homogeneous data sets based on human perception using graphical methods and user interaction
  - Goal or expected outcome of exploration usually unknown in advance

# Visual Data Mining (2)

- First uses of the term:
  - Cox, Eick, Wills, Brachman (1997): Visual Data Mining: Recognizing Telephone Calling Fraud, *Data Mining and Knowledge Discovery*, Vol. 1, pp. 225-231.
  - Inselberg (1998): Visual Data Mining with Parallel Coordinates, *Computational Statistics*, Vol. 13(1), pp. 47-63.

# Software: XGobi/GGobi

Swayne, Cook and Buja

- Interactive environment for exploring multivariate data
  - Linked views allow “linked brushing”
  - Univariate, Bivariate and Multivariate views of the data
  - Grand tour
  - Wide variety of methods
  - Open source
  - Free

- Caveats
  - XGobi only on UNIX and Linux platforms
  - GGobi also available for PCs but not yet fully developed

# Software: ArcView

ESRI™

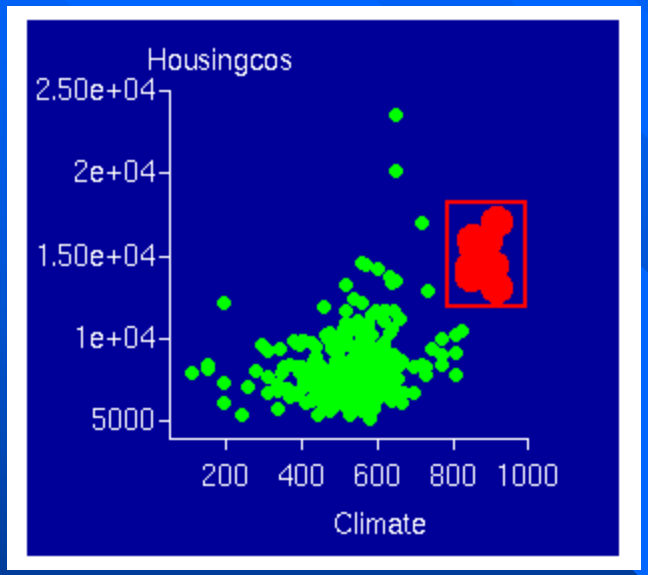
- Desktop GIS with wide Range of Viewing and Data Manipulation Functions
  - Editing Features
  - Query Operations
  - Map Display
  - Interactive Interface
  - High Level Internal Scripting Language

# Software: ExplorN/CrystalVision

Wegman, Luo, Carr

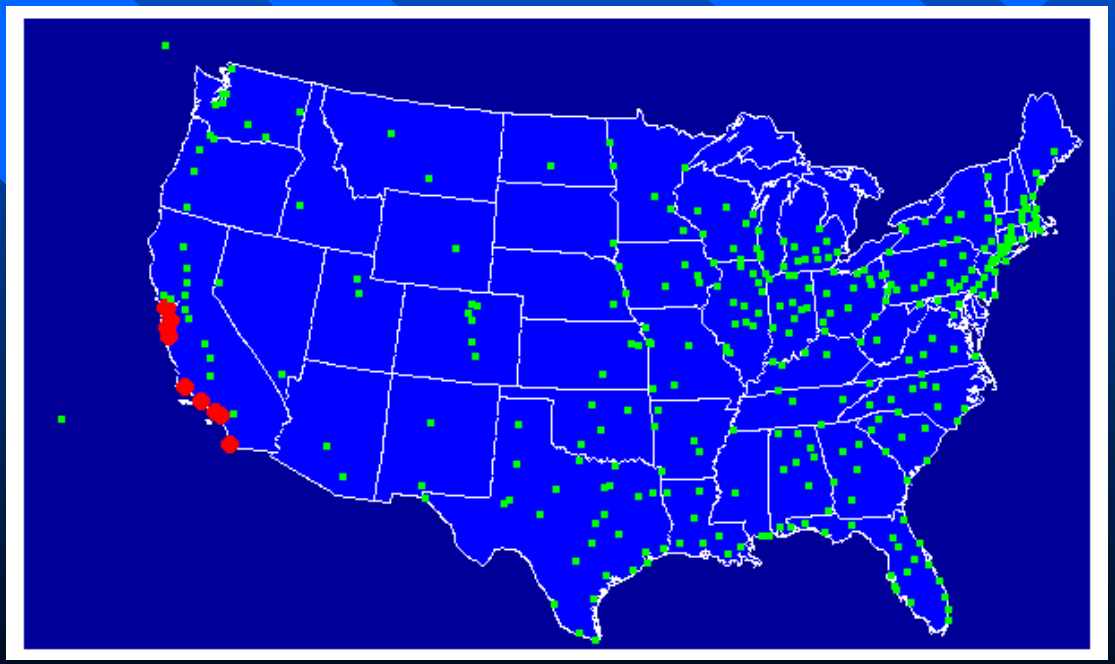
- Interactive environment for exploring multivariate data (similar to XGobi/GGobi)
  - Advanced Parallel Coordinates Displays
  - 3D Surfaces
  - Stereoscopic Displays
- Caveats
  - ExplorN only on SGI platforms
  - CrystalVision available for PCs but not yet fully developed
  - No interface to GIS software

# Tools: Linked Brushing



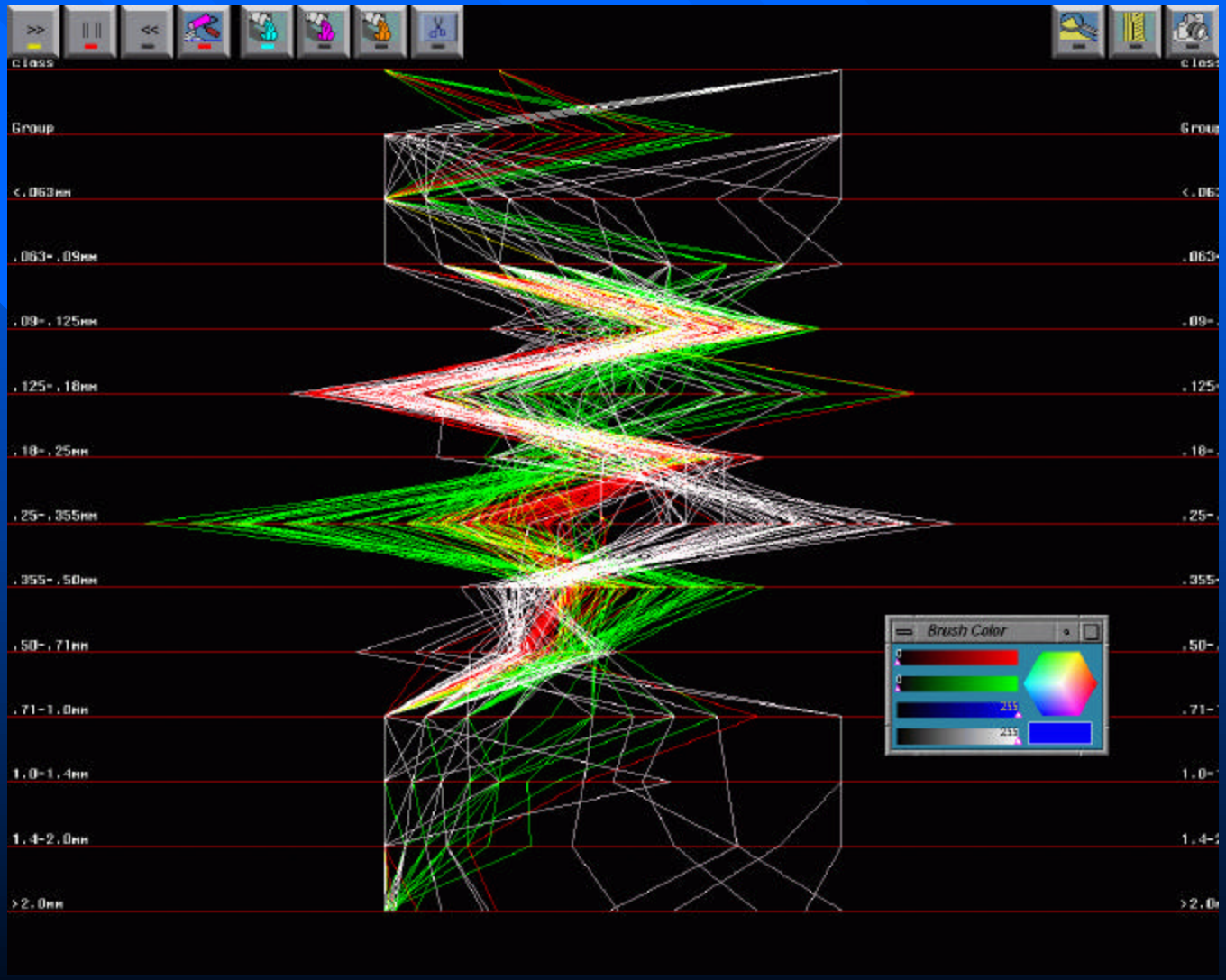

XGobi

ArcView



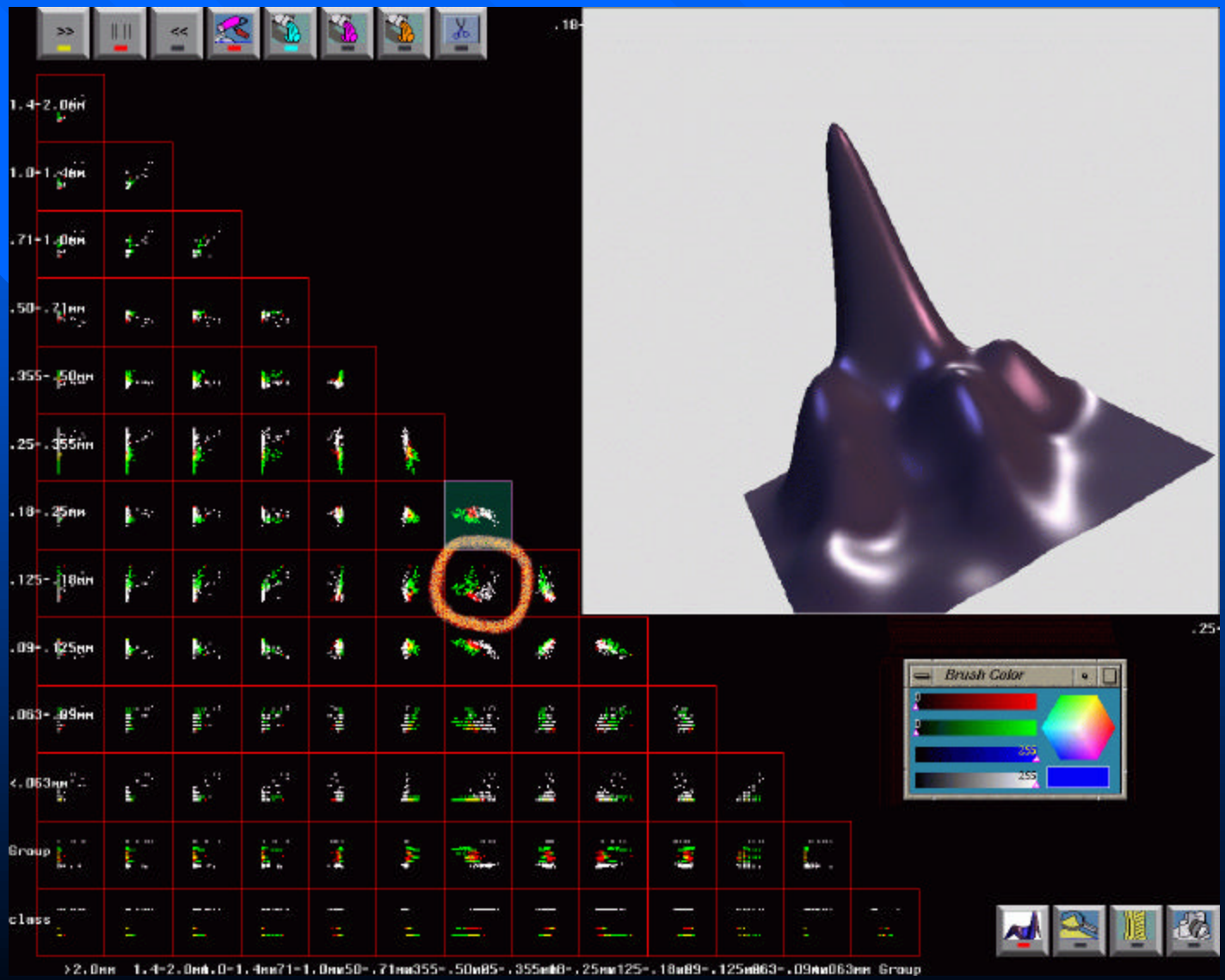
# Tools: Parallel Coordinate Plots

ExplorN



# Tools: Scatterplot Matrix & Density Plot

ExplorN



# Tools: Grand Tour

- Continuous random sequence of projections from n dimensions into 2 (or more) dimensions.

# Examples

- Historical Examples
- Vermont/New Hampshire:
  - Quarry, Water, Clouds
- Atlanta
  - City, Forest
- California (Imperial Valley)
  - Fields
- North Africa
  - Desert

# Stat Graphics & Remote Sensing

- Buja, McDonald, Michalak, Stuetzle (1991) & McDonald, Willis (1987): Confluence of 2 Rivers
- Klein, Moreira (1994): Agricultural Region in Brazil
- Scott (1986): Agricultural Scene on 5 Days
- Salch, Scott (1997): 3 Groups of Farm Crops
- Carr (1991): Nevada Test Site

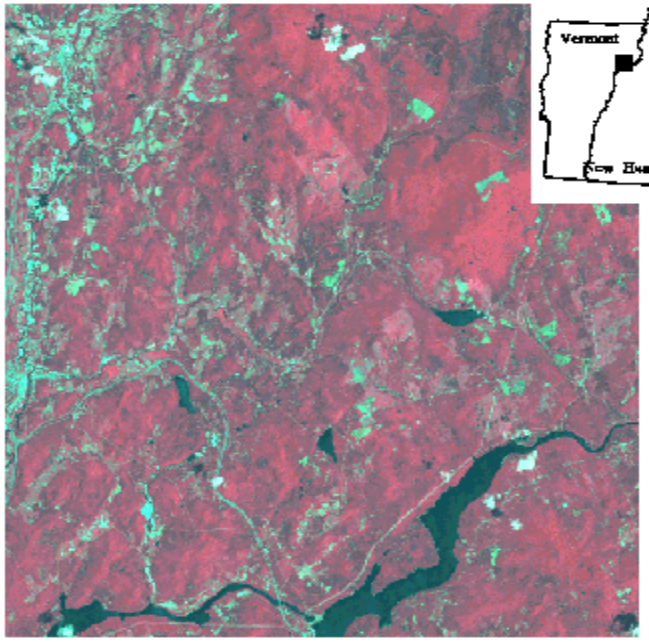
# ArcView/XGobi/XploRe & Remote Sensing

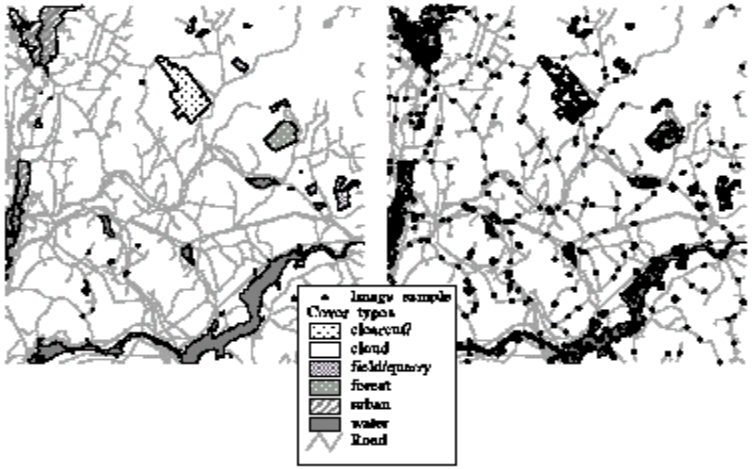
- Symanzik, Majure, Cook (1996, 1997)
- Cook, Majure, Symanzik, Cressie (1996)
- Symanzik, Cook, Klinke, Lewin (1998)
- Symanzik, Griffiths, Gillies (2000)

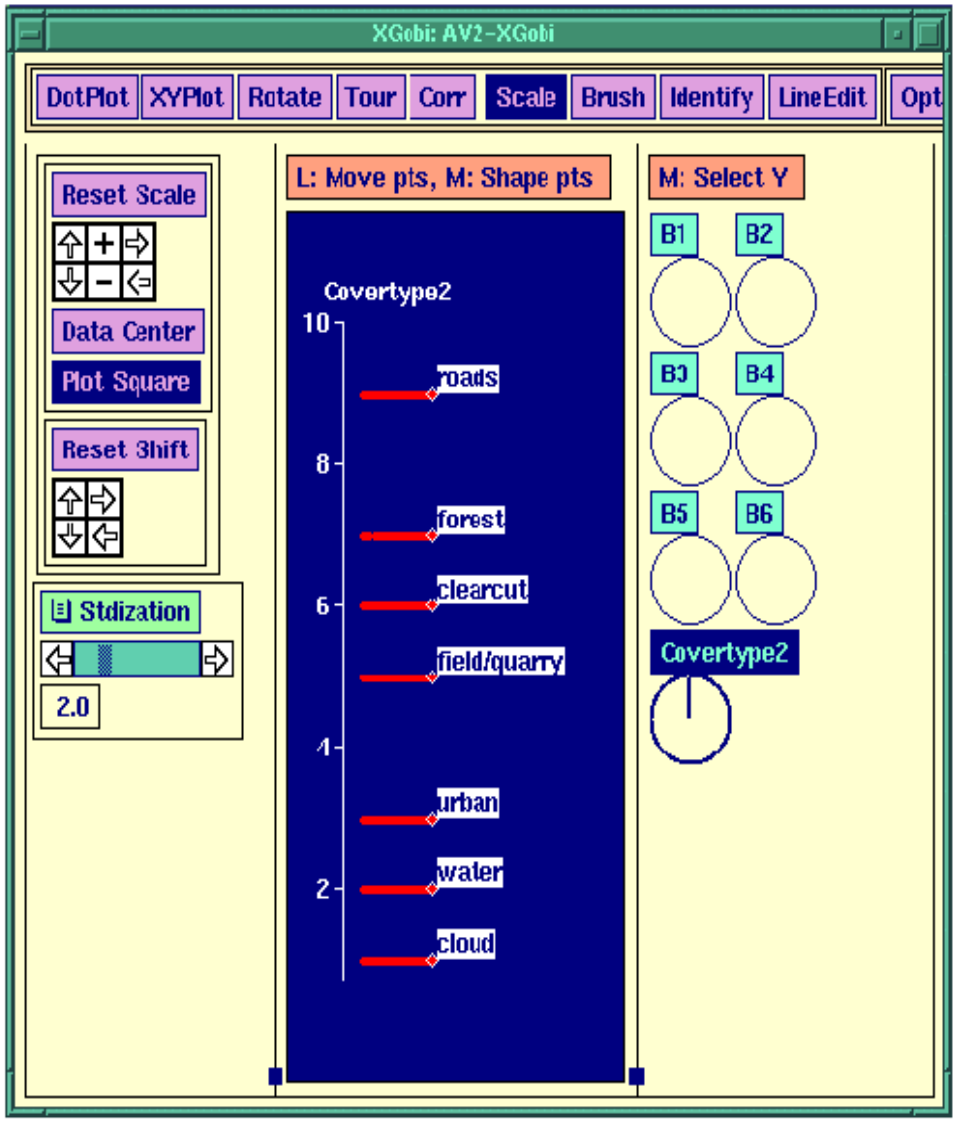
# The Vermont/New Hampshire Data

- Landsat Thematic Mapper (TM) data
- 6 Spectral Bands
- Outstanding Water Body is Connecticut River

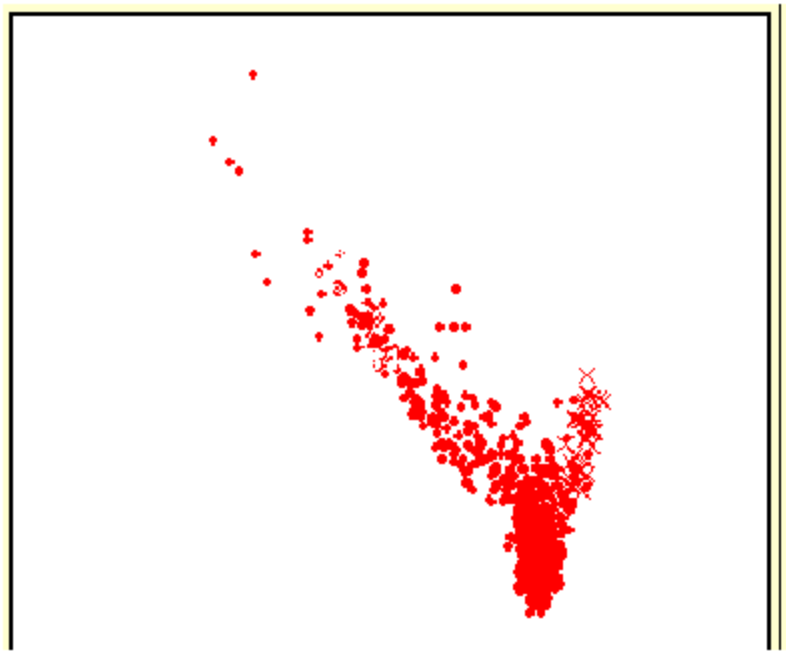
# VT/NH: Field/Quarry/Water

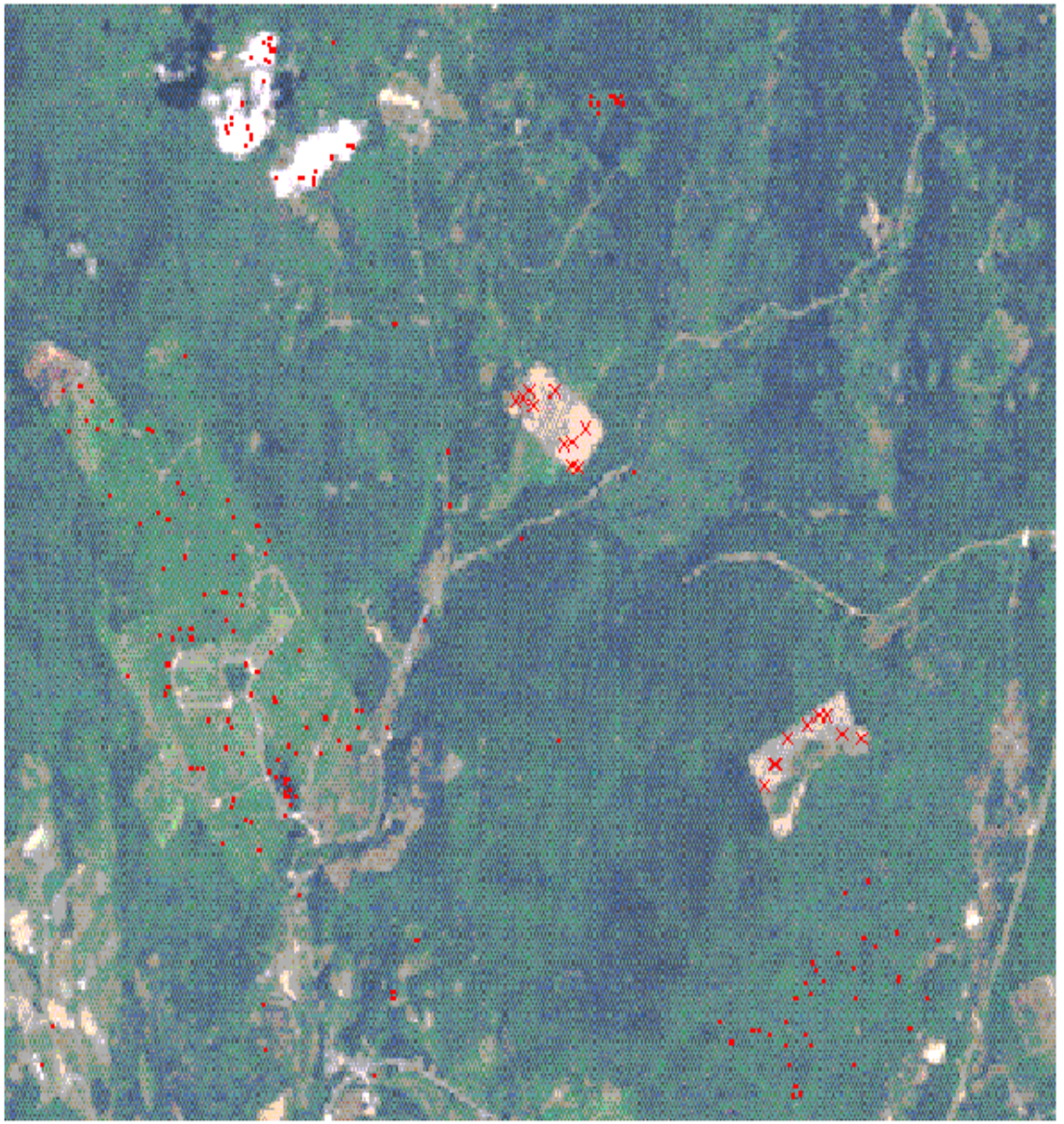


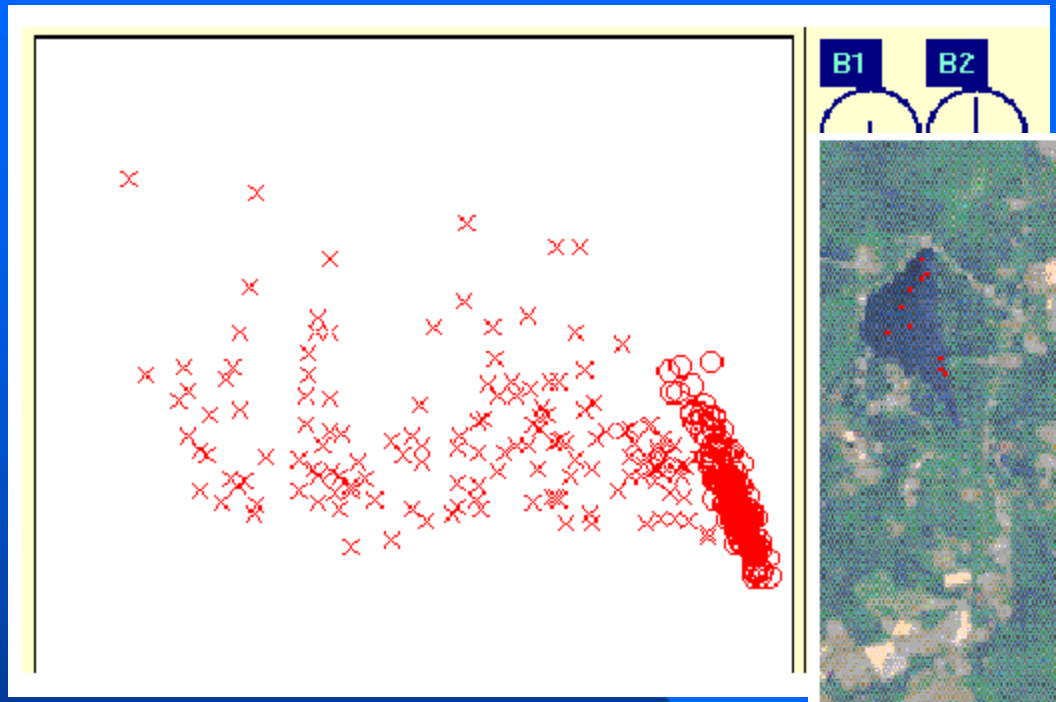



# Field/Quarry/Clouds ??

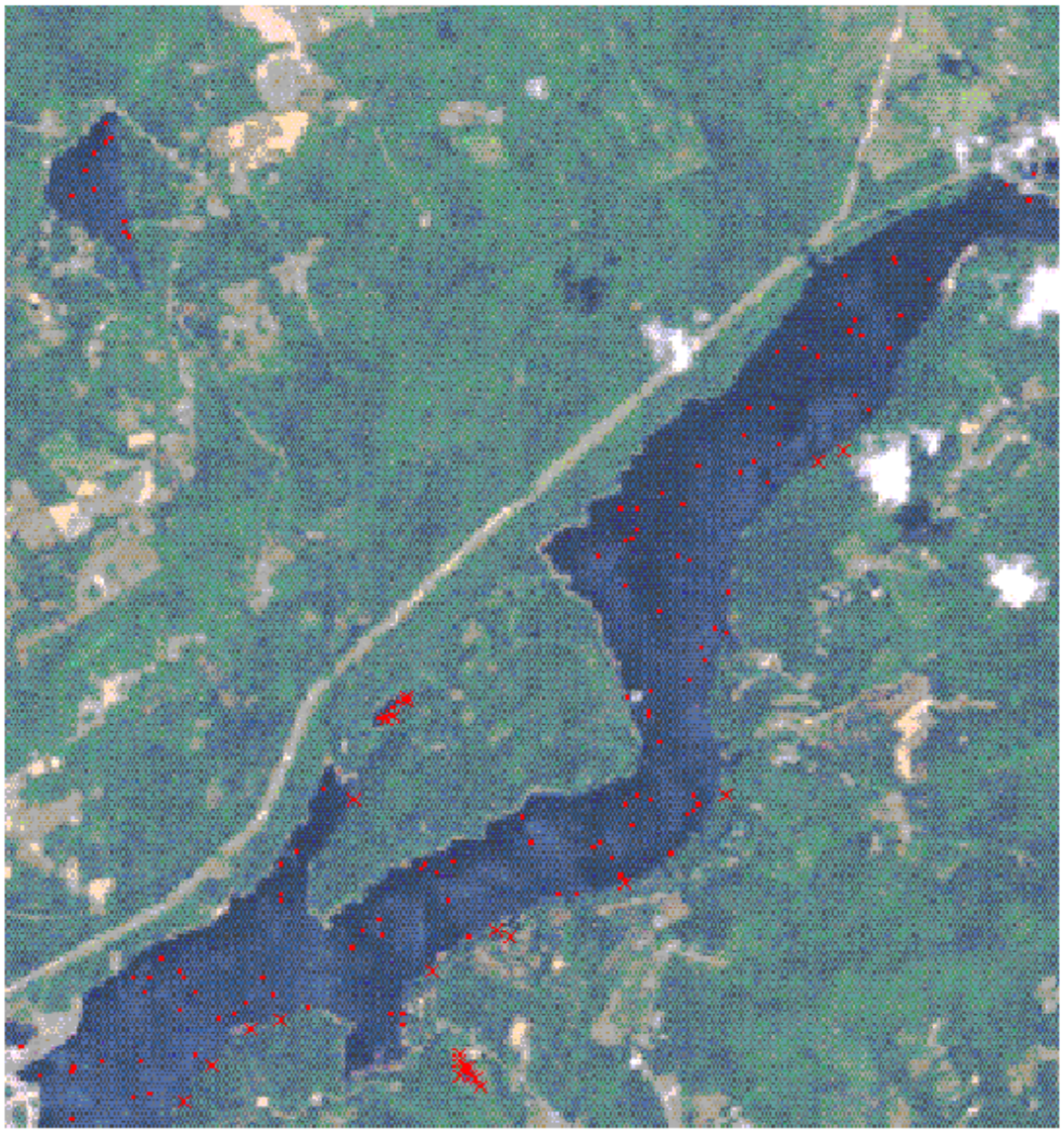


# Water = Water ??





# The Atlanta Data

- NOAA-14 Satellite (National Oceanic and Atmospheric Administration)
- AVHRR Sensor (Advanced Very High Resolution Radiometer):
  - Band 1: Red
  - Band 2: Near Infrared
  - Band 3: Mid Infrared
  - Band 4: Long Infrared
  - Band 5: (Very) Long Infrared
- Data from “NASA’s Project Atlanta”
- 18 Days from Jan 1997 to Dec 1997
- Resolution: 1 km x 1 km per Pixel
- Main Study Area: 70 km x 46 km

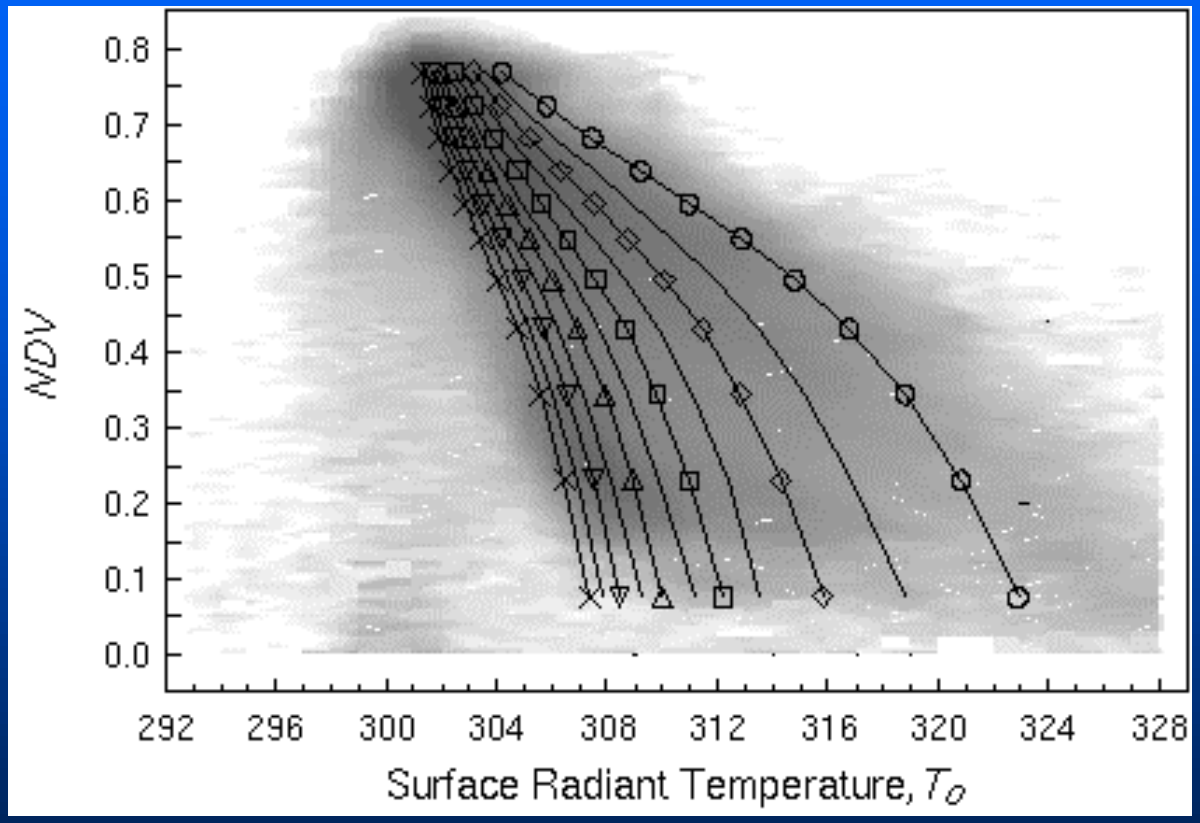
# Some Definitions

- Normalized Difference Vegetation Index:

$$NDVI = \frac{Band2 - Band1}{Band2 + Band1}$$

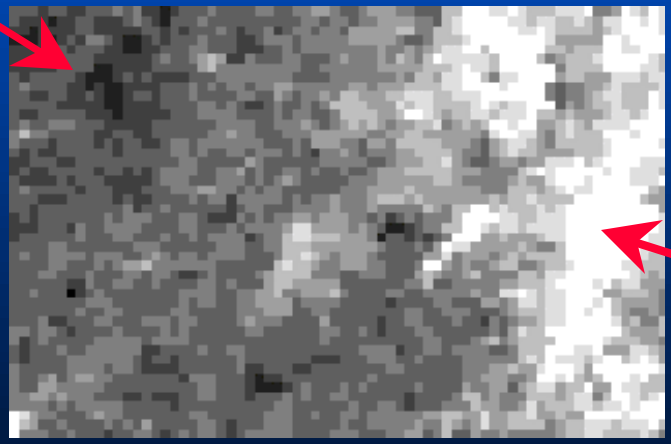
- *NDVI* ~ 0.8 for Highly Vegetated Surfaces
- *NDVI* ~ 0.1 for Bare Soil
- Surface Radiant Temperature $T_0$: Band 4
- Surface Moisture Availability $M_0$

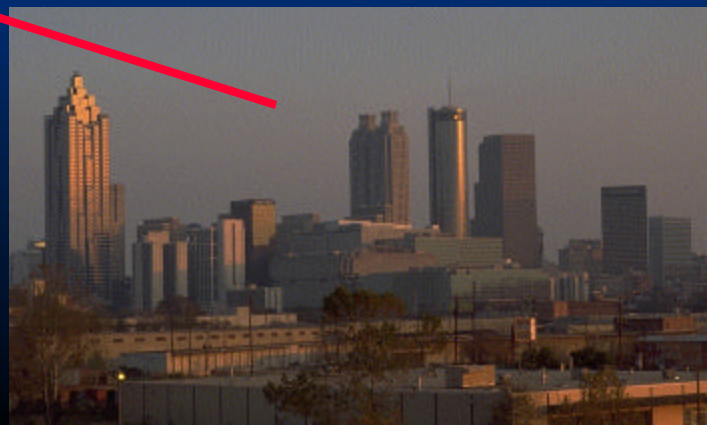
# An Example



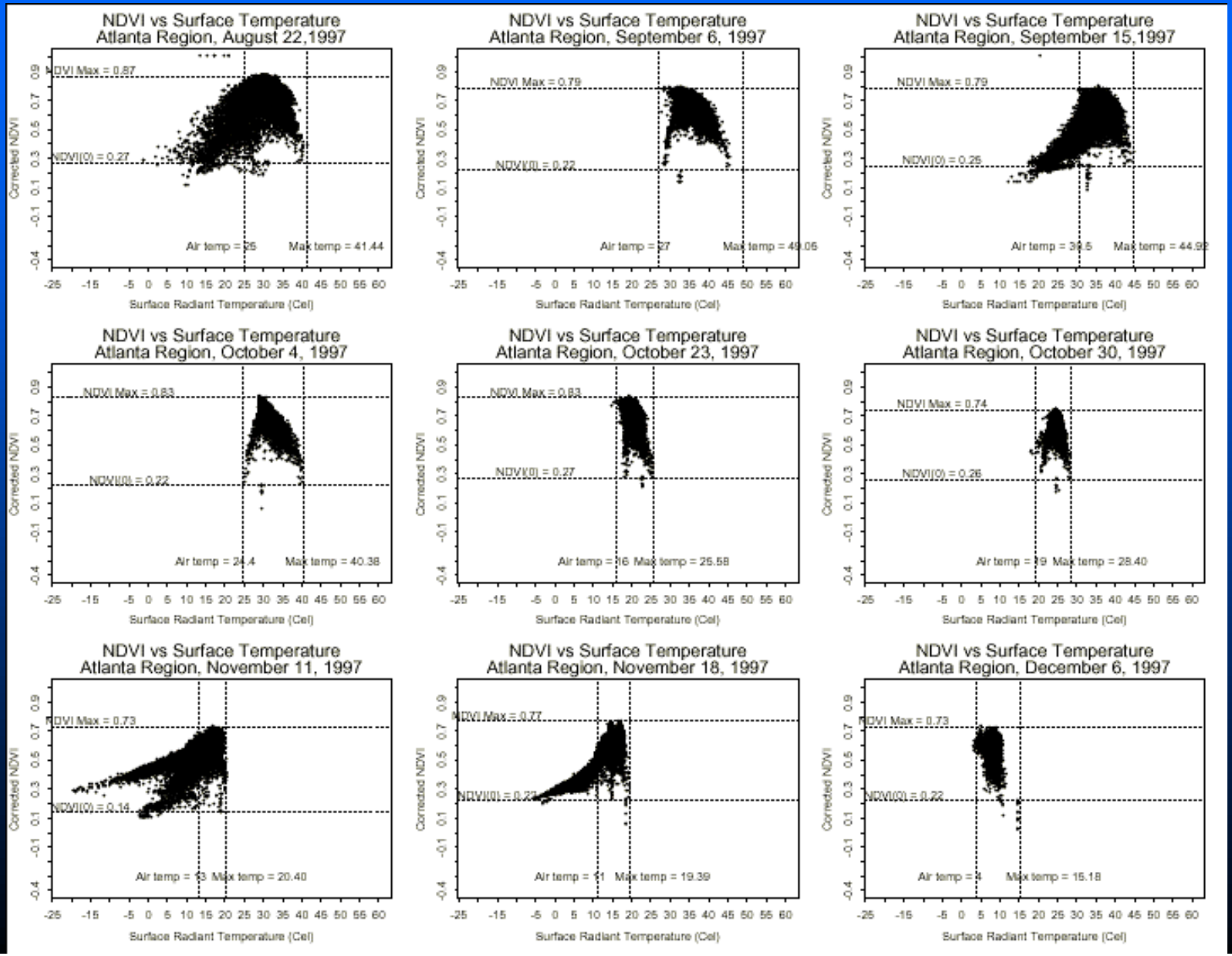

NS001-TMS derived $T_o$-*NDVI* scatterplot (gray spectral scaling) at a 5 meter spatial resolution for a 7 x 3 km area of the Mahantango Watershed, Pennsylvania. 18 July 1990, 1145 LST. Isopleths representing moisture availability index, $M_o$ are overlaid with the legend, o = 0.0 ('warm' edge), ◊ = 0.2, □ = 0.4, Δ = 0.6, ∇ = 0.8, and × = 1.0 (cold edge).

# The Main Study Area

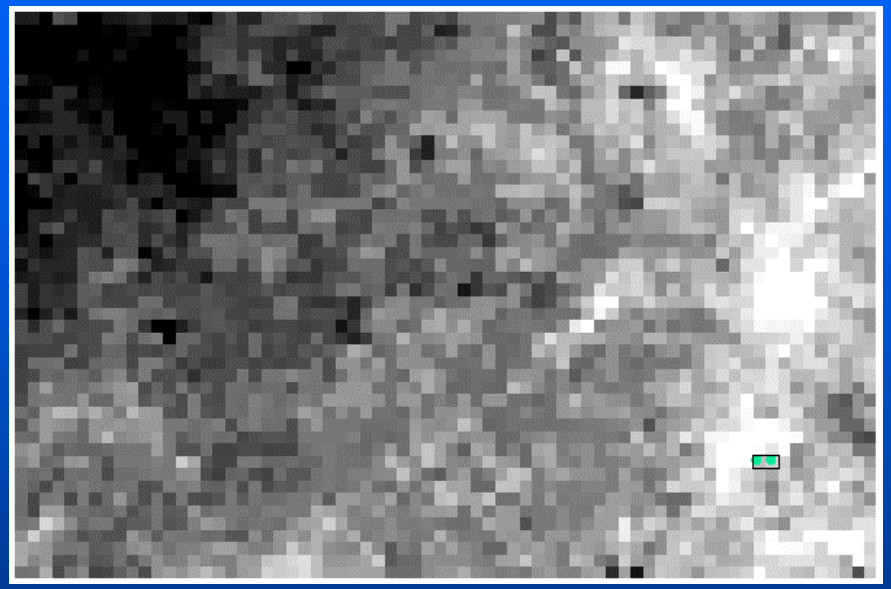





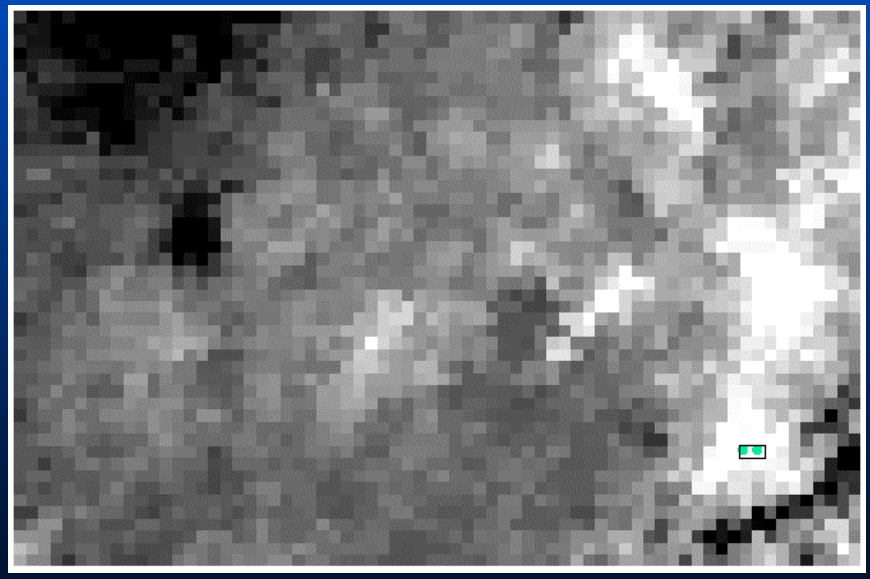
# NDVI vs Surface Temperature



# Two Months



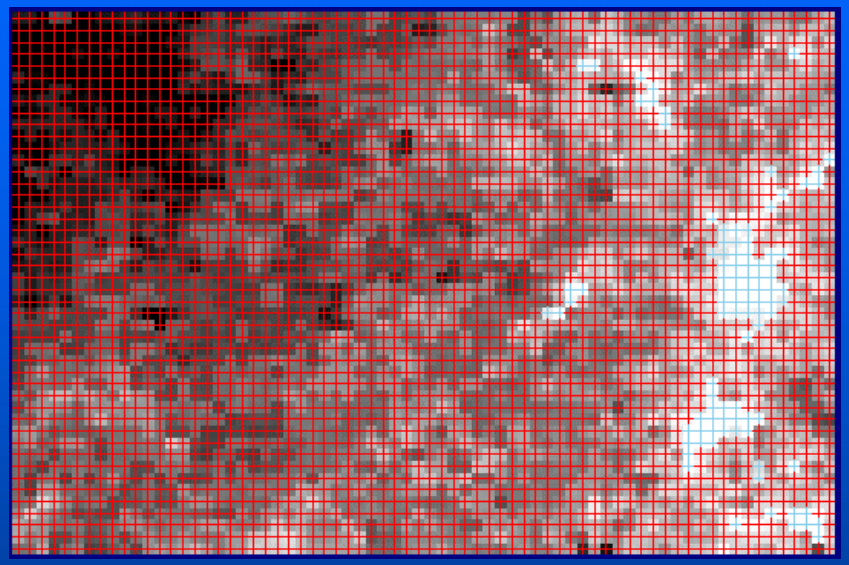
December

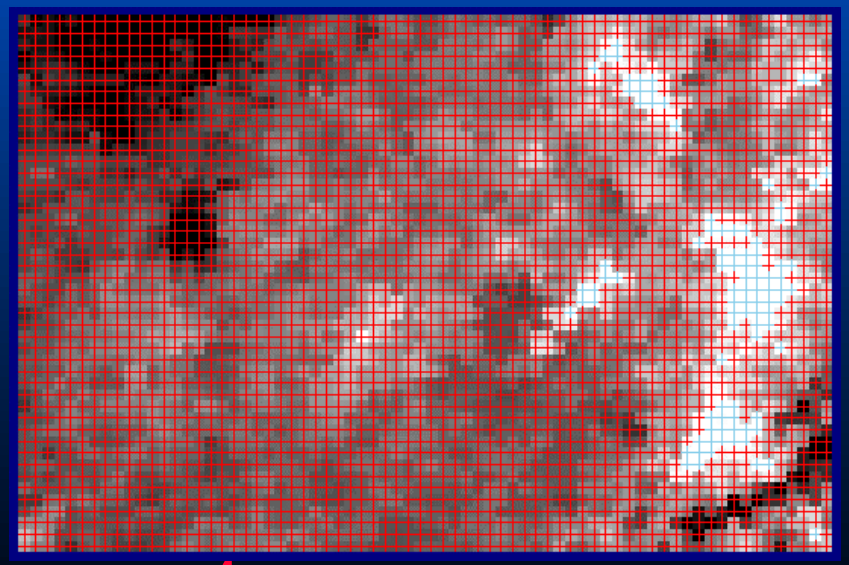


August

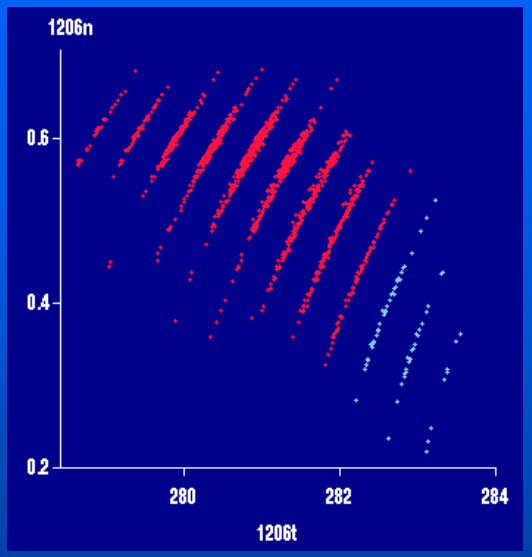
# The City

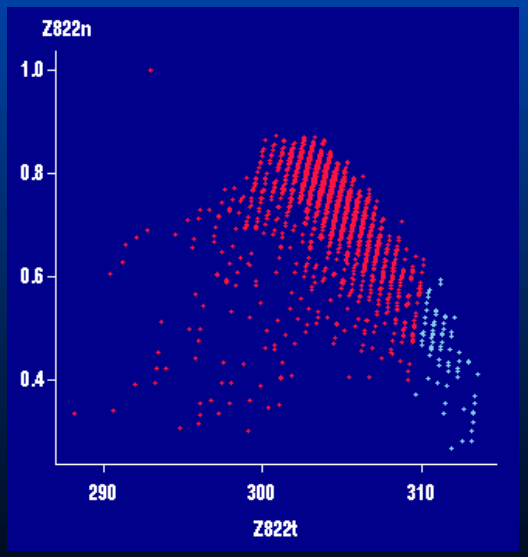
December



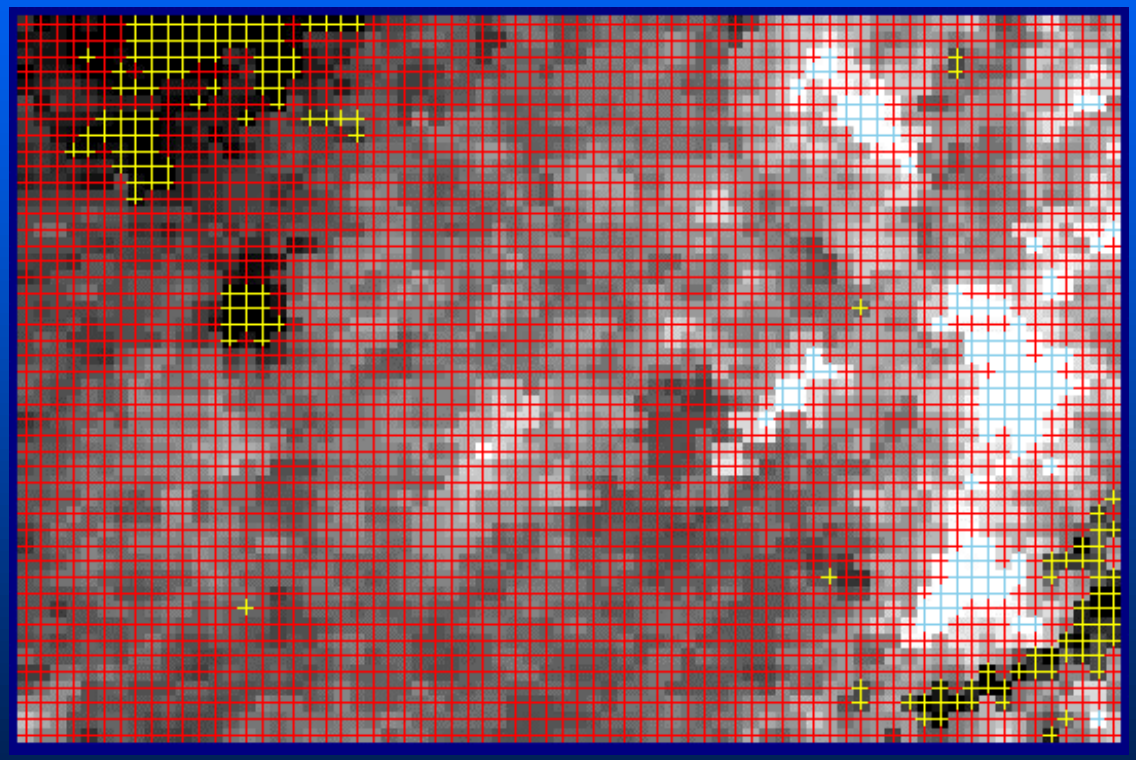


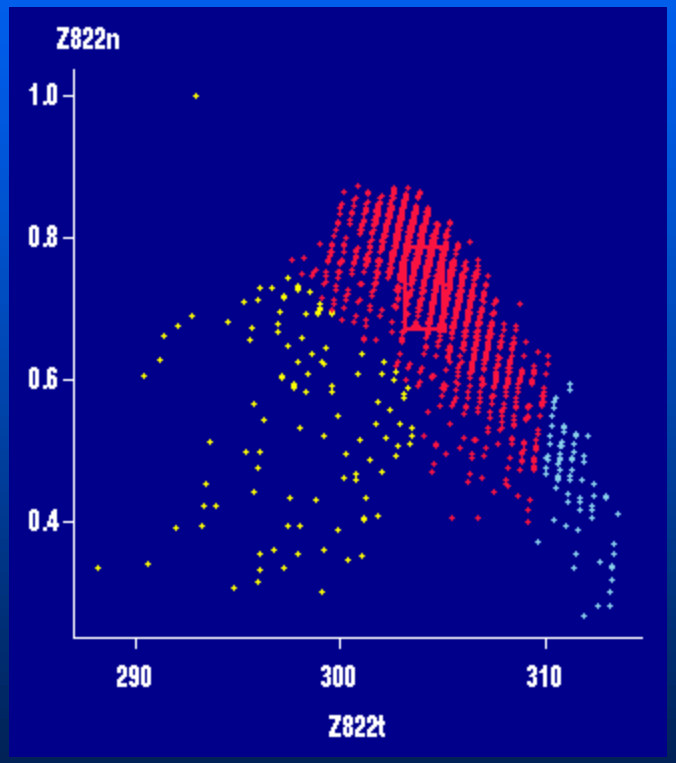
August



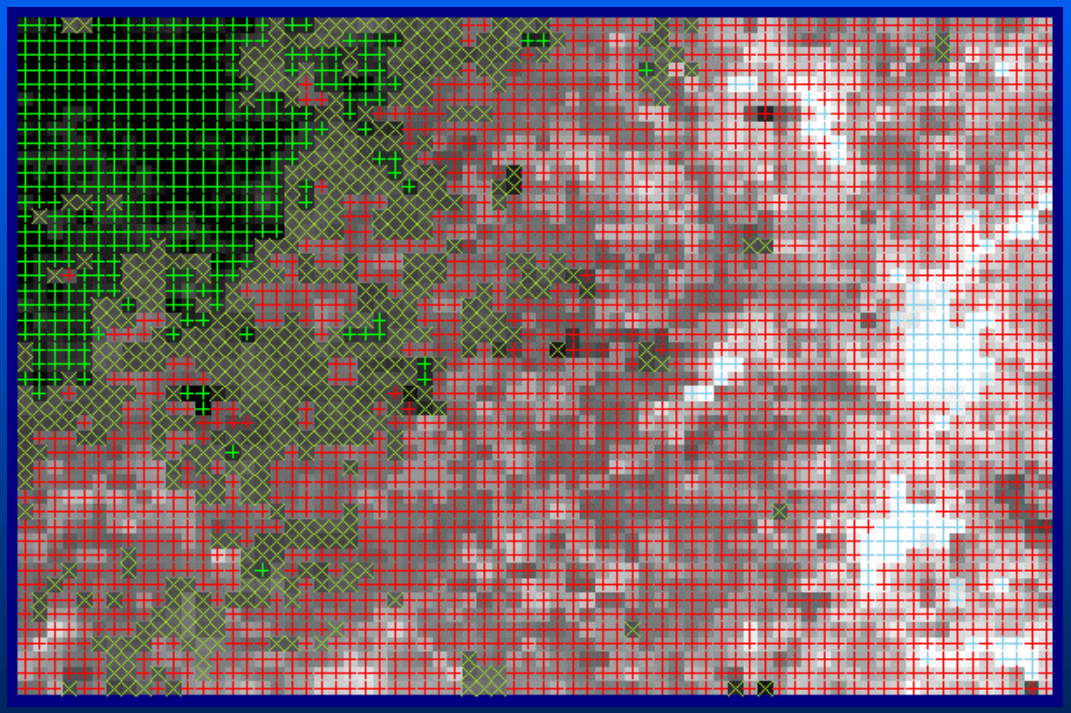
# Clouds in August



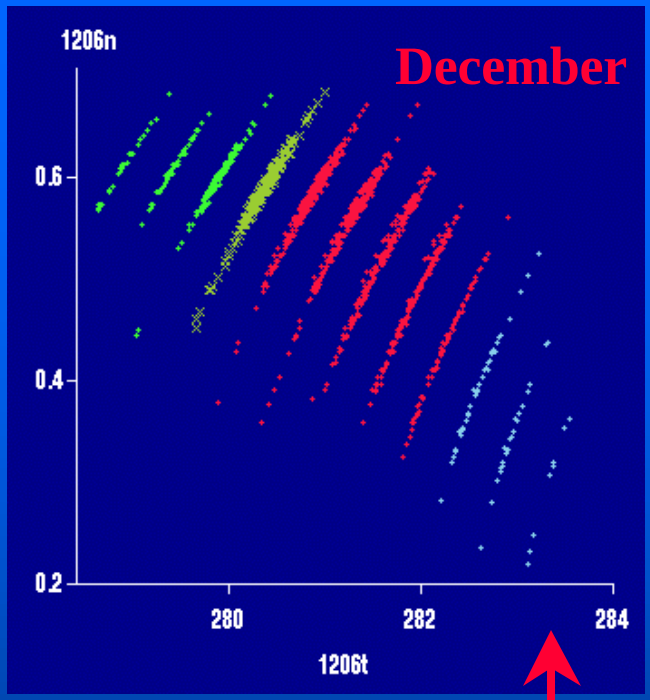



August

# Reclassification



December

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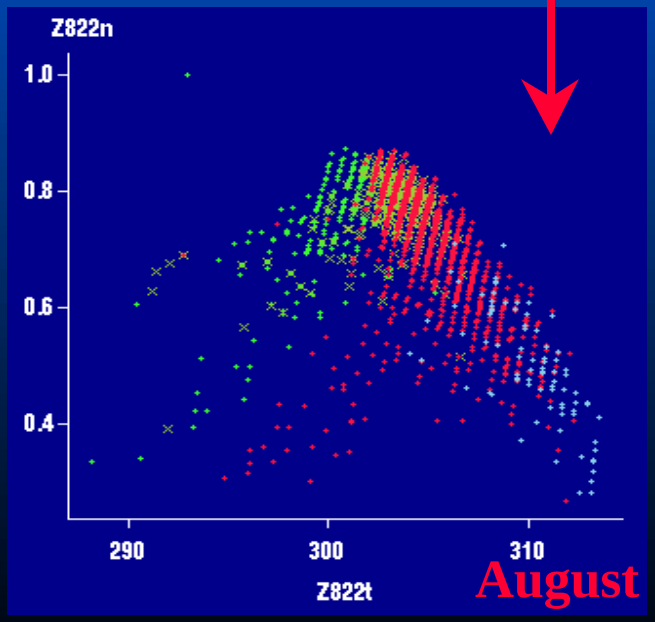
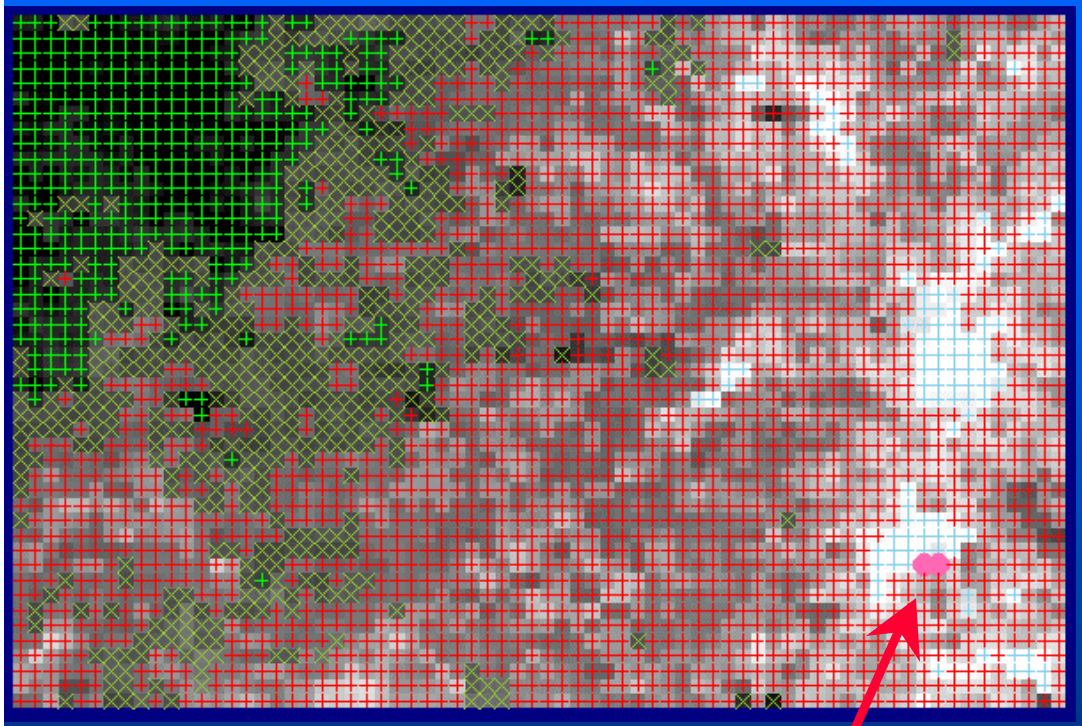
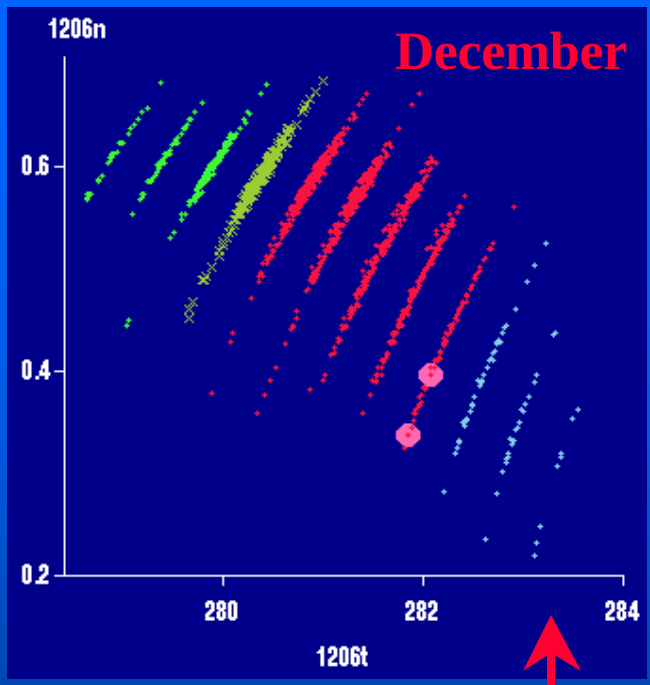


# 2 Pixels of Interest



December

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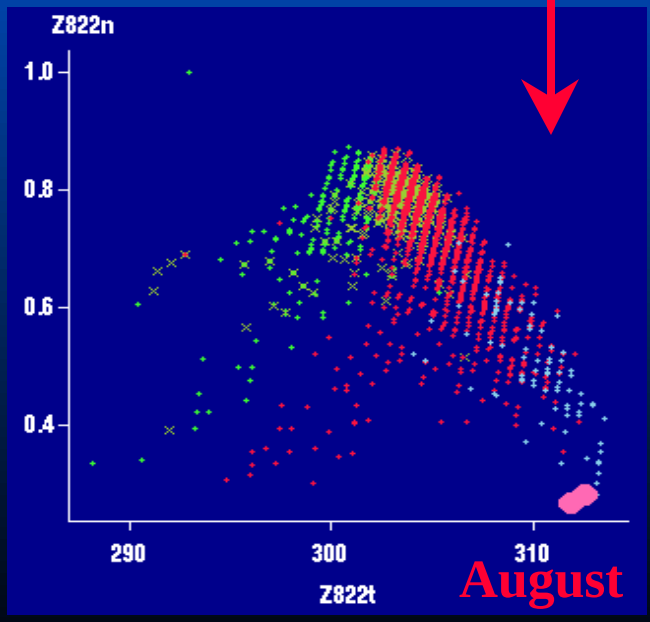
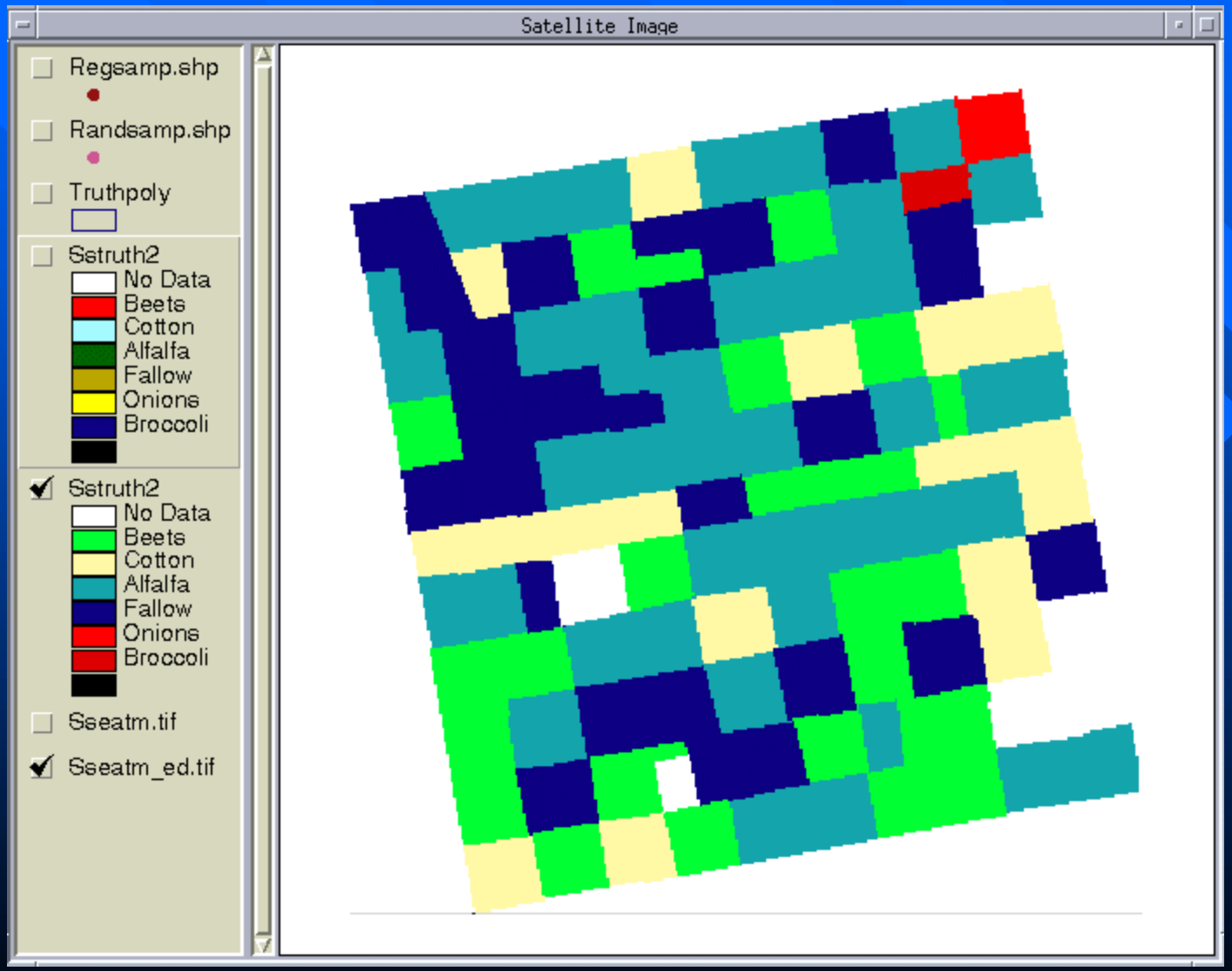


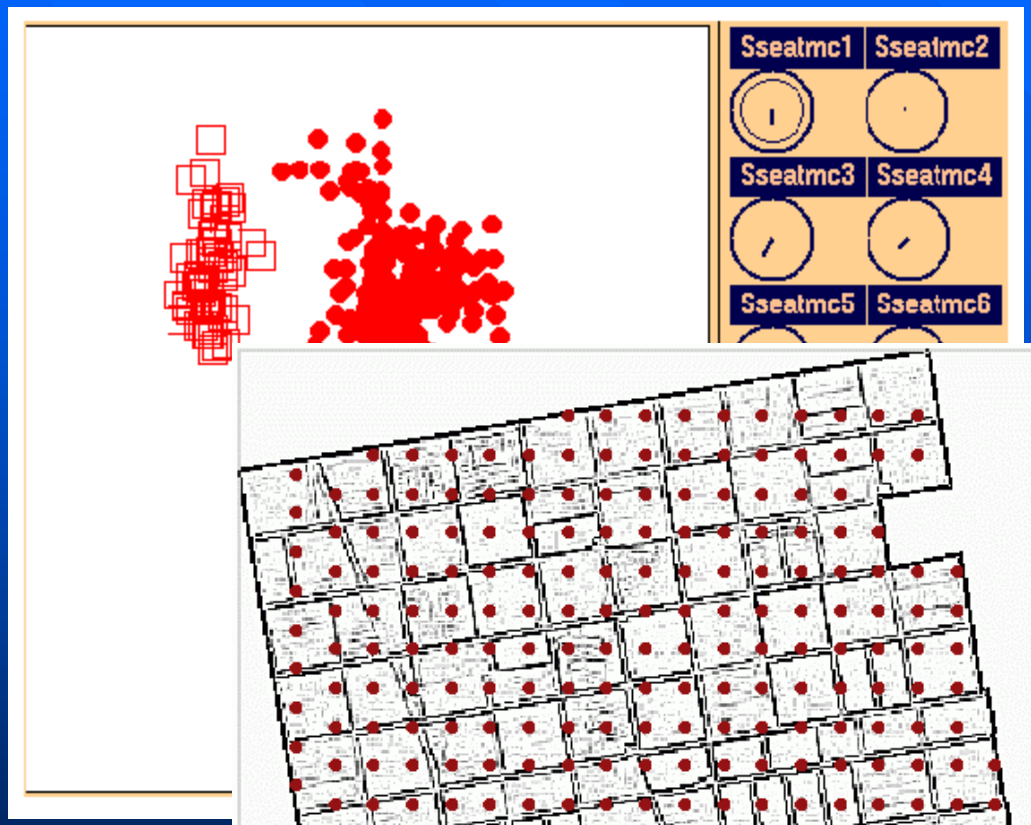
# The Imperial Valley/CA Data

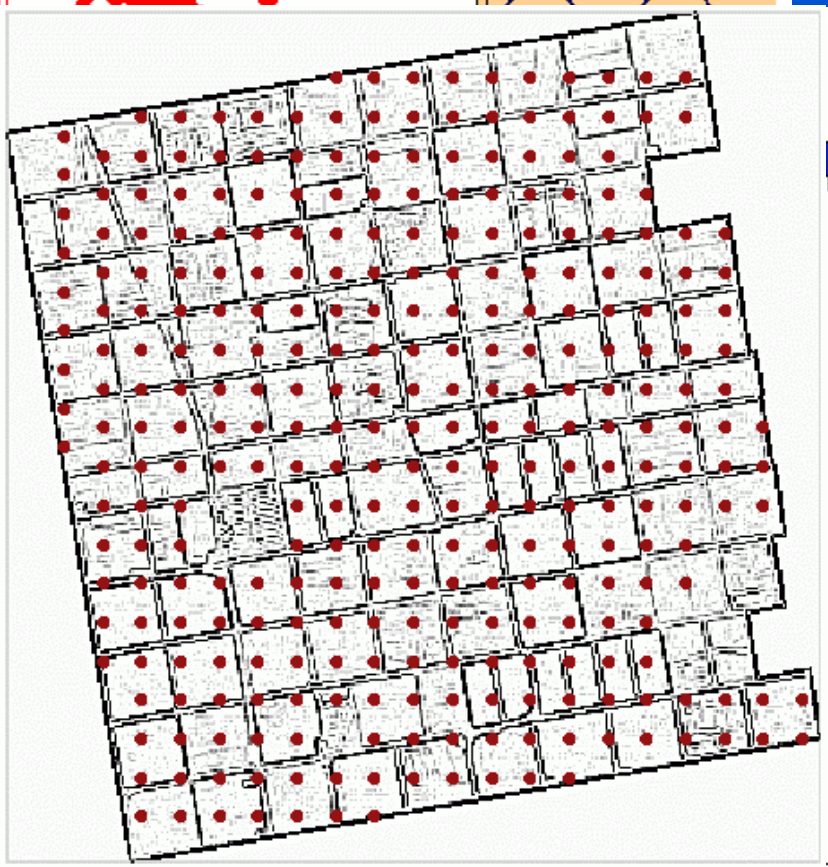
- Landsat-4 Thematic Mapper (TM) Data
- December 12, 1982
- 7 Spectral Bands
- 124 Fields with known Crop Information

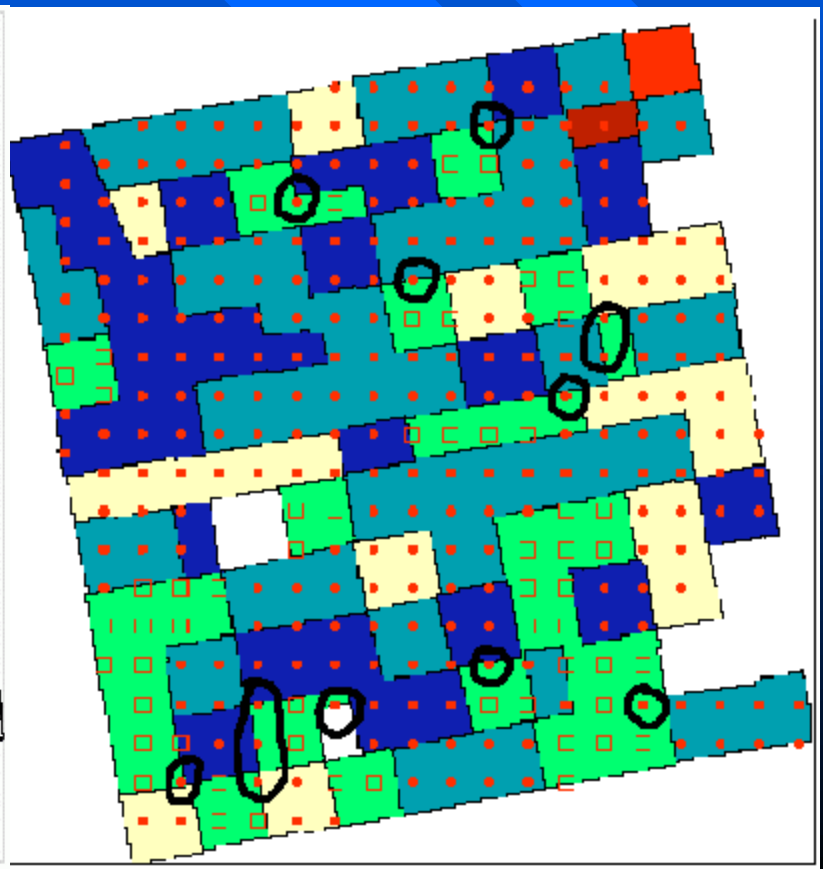
# Ground Truth



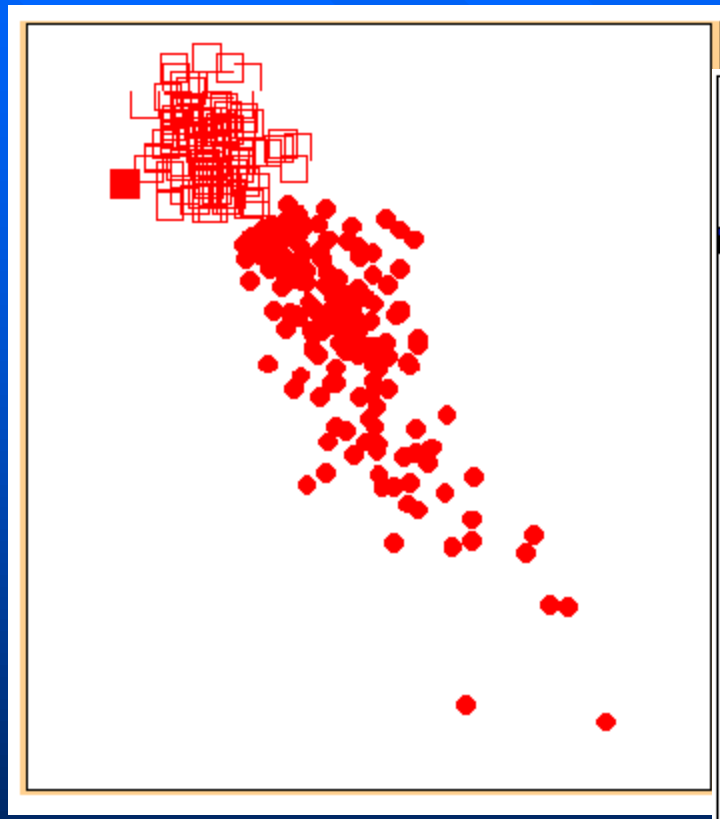
# Unclassified Pixels ?

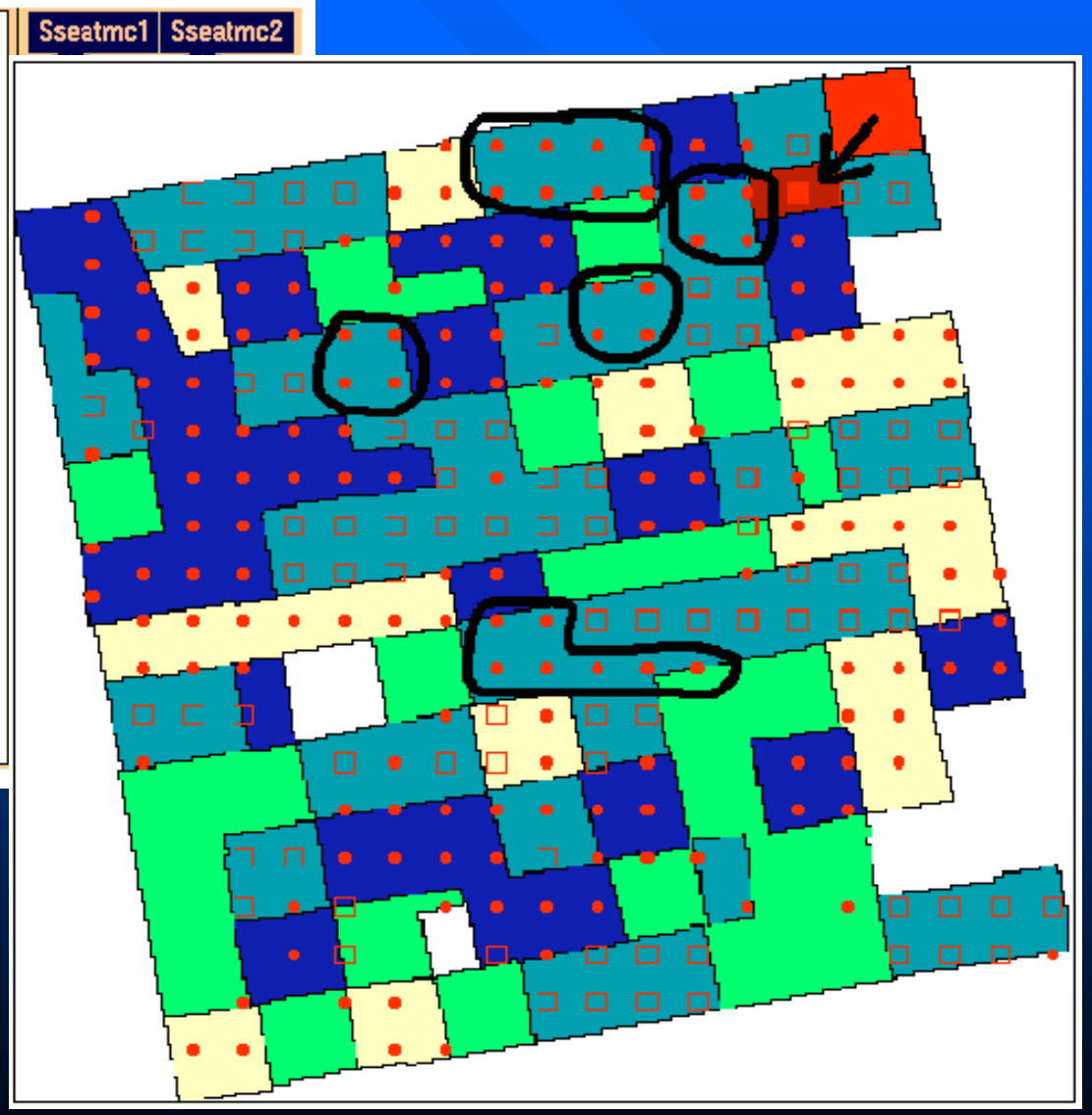




# Alfalfa x 2



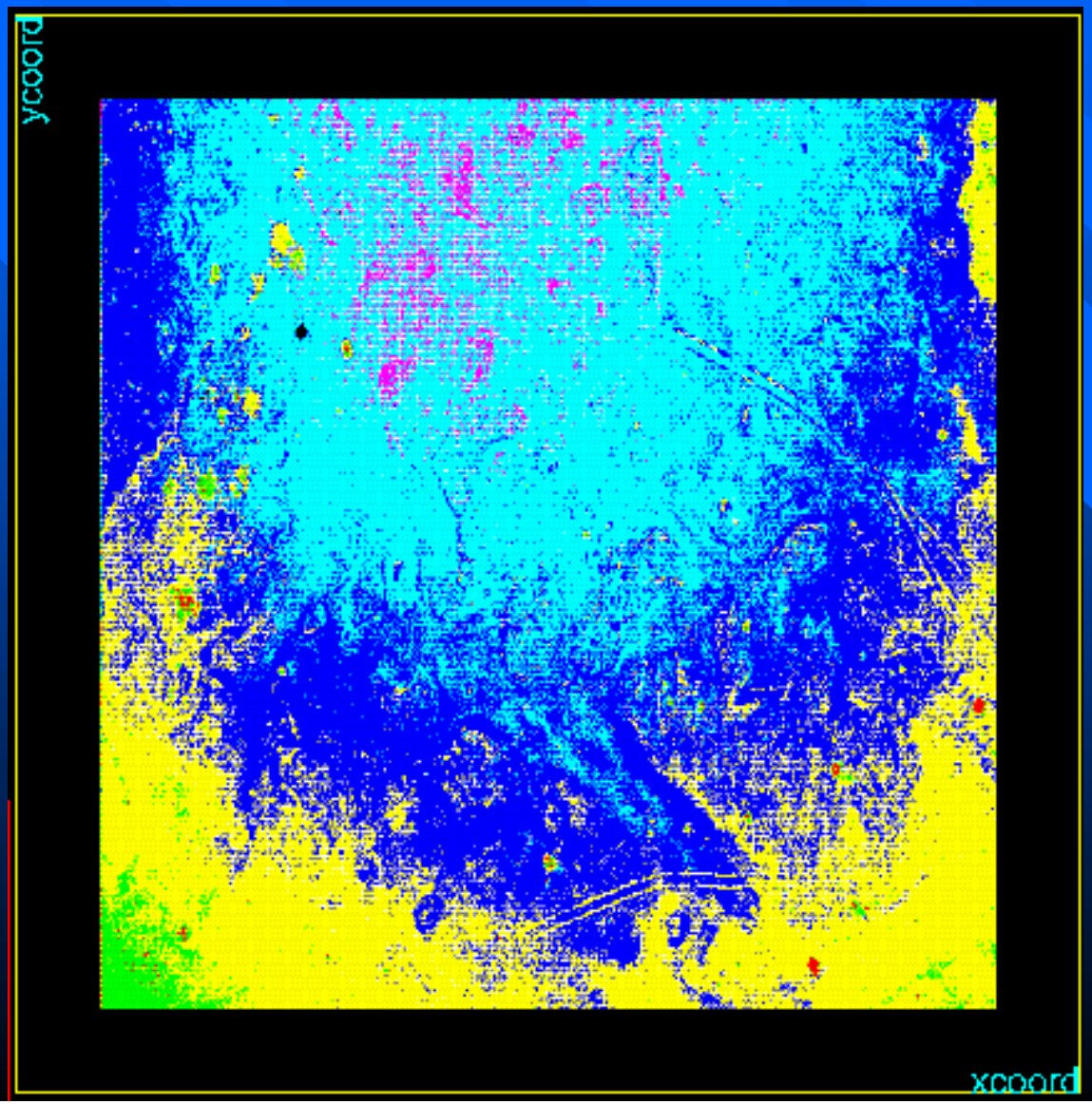


# Live Demo

GGobi

CrystalVision

# Result CrystalVision



# Overall Conclusion

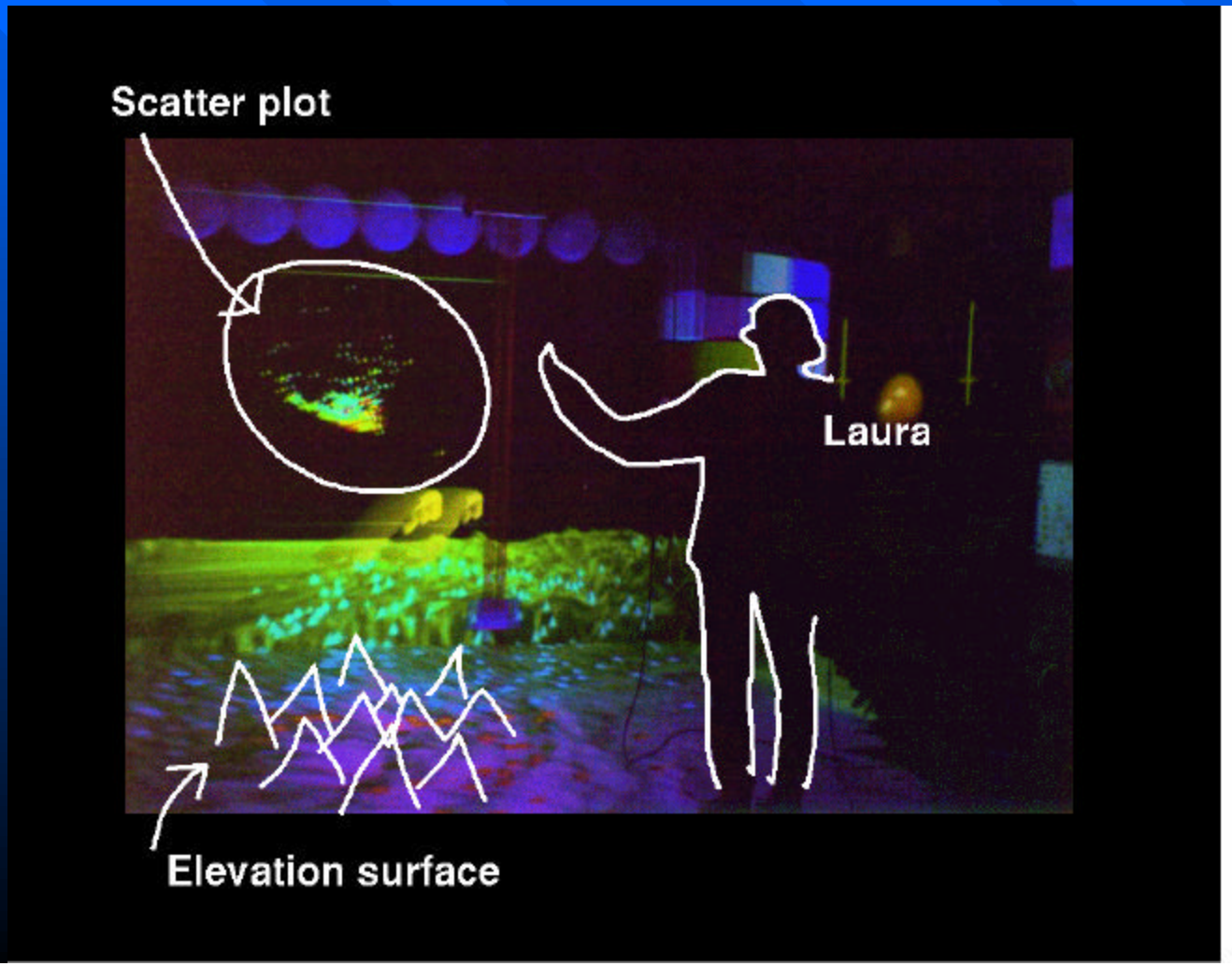
- Visual approach effective to see unexpected structure in data.
- Combination of different techniques most effective.
- Can be used for almost all types of RS data.

# Future Work (1)

- Enhance new software (GGobi, CrystalVision) to operate in a linked environment with GIS software.
- Allow access to data bases.

# Future Work (2)

- Use 3D environment (CAVE, MiniCAVE) for visualization and visual data mining.



# Contact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