How radar data were collected/used at the Neda Mine - utility, limitations

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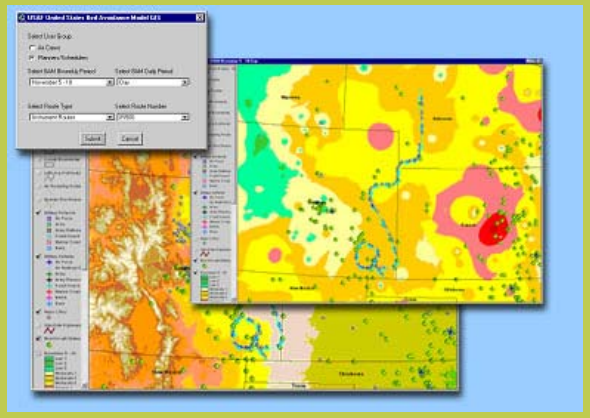
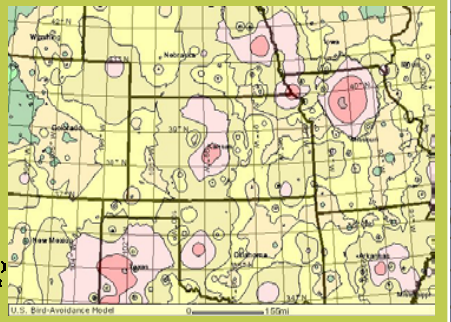
USAF Avian Hazard Advisory System AHAS

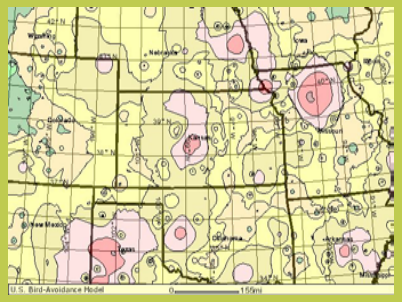
USAF
US Bird Avoidance Model (BAM)



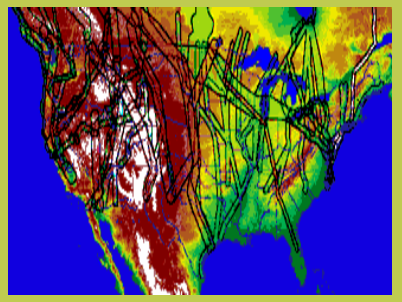


Low1 (0-140 Bird Mass)
Low2 (141-404)
Low3 (405-1748)
Moderate1(1749-8181)
Moderate2(8182-21854)
Moderate3(21854-77288)
Severe1 (77288-273201)
Severe2 (273202-965864)
Severe3 (965906-4444666)
No Data (Assume adjacent risk value)

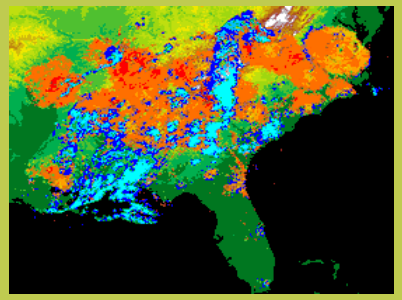
USAF BASH TEAM
Avian Hazard Advisory System (AHAS)



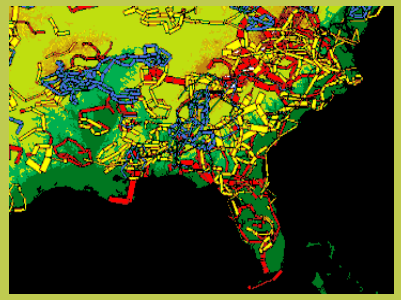
BAM



Migratory Routes



Radar Detection



Flight Routes

Risk Assessment

Segment	Hour	Risk
VR54A-B	4	Low
VR54B-C	4	Low

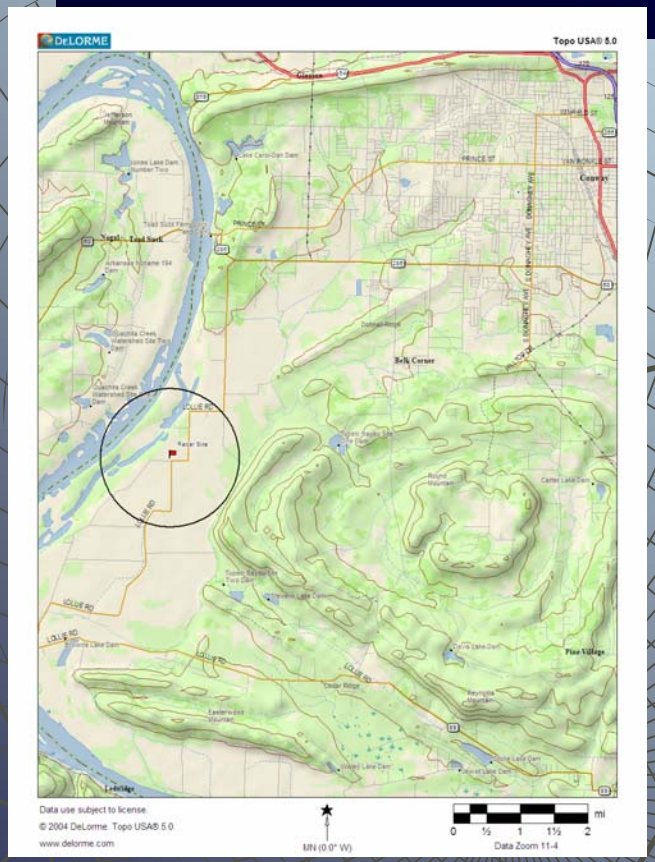
Early Methods of Data Collection

- Radar/Sensor data have been collected in a variety of ways including:
  - Visual observation of the radar screen
  - time lapse photography
  - video recording
  - bar coding
- All have limitations in the quantity and quality of data they yield and may suffer from issues with observer bias

Automated data collection

- Digital Interface allows recording of raw radar data for post-processing (if desired)
- Processing algorithms can provide clutter suppression, as well as tracking and target classification (24/7 operations are common)
- Track data are geo-referenced, time stamped and written to databases

Automated data collection



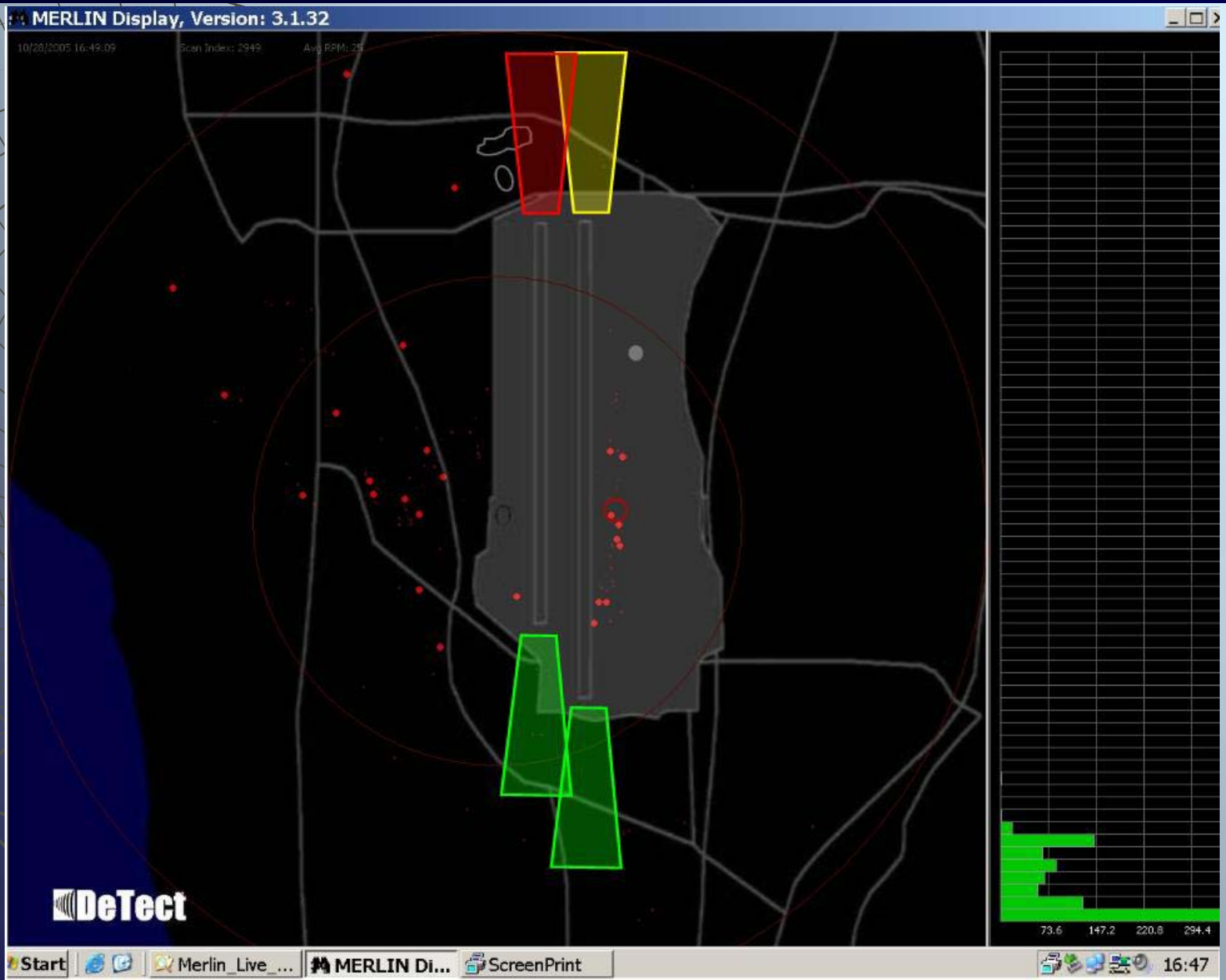
- 1 year study
- 24 “observations” per minute
- over 1 million observations per year

Automated data collection

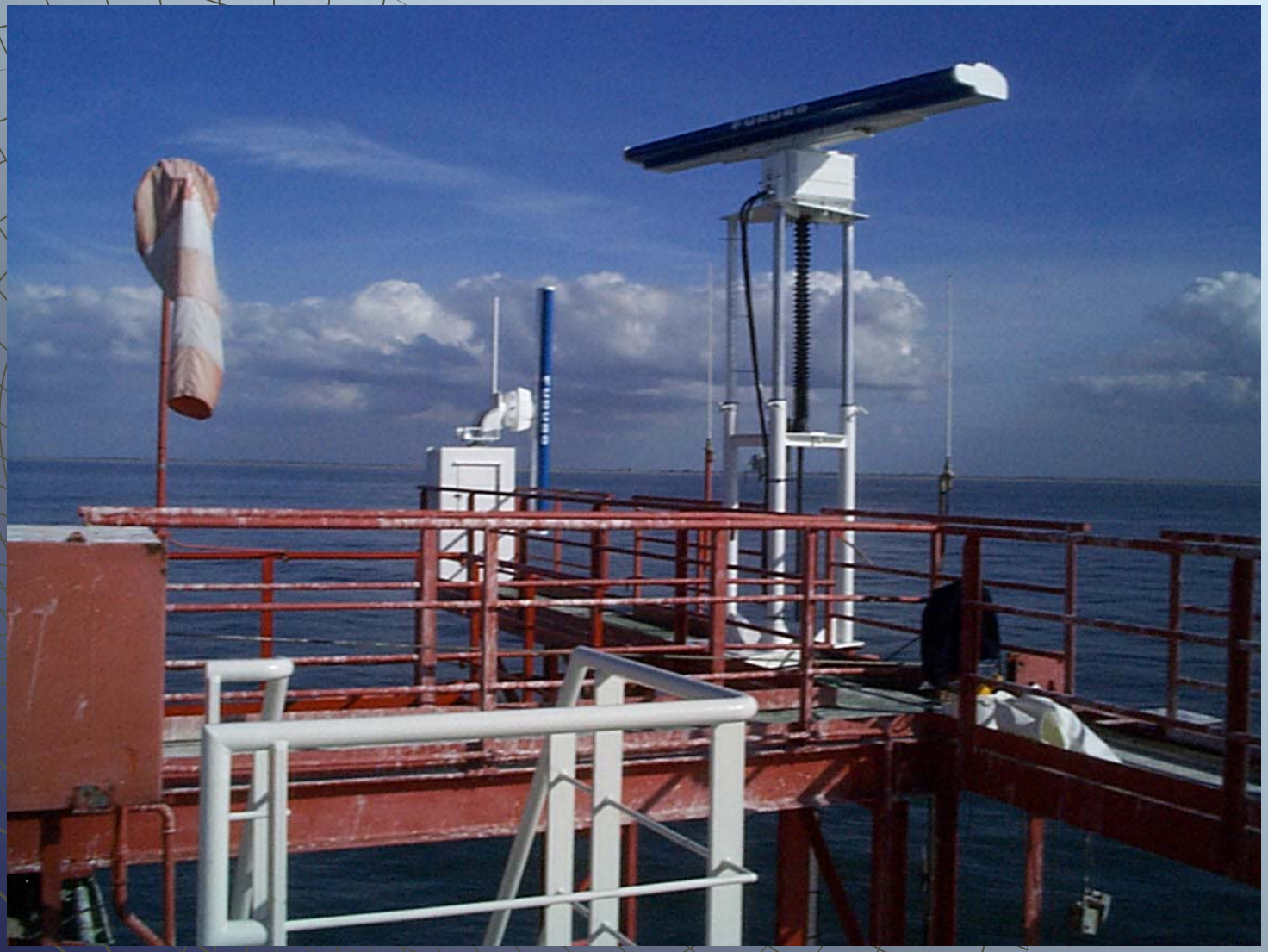
Overcoming some limitations of Marine Radar Systems

The vertical X band radar and horizontal S band radar system is gaining popularity in biological studies and are the Air Force standard for operational use because it overcomes many of the limitations of single X-band radar systems (precipitation, clutter, altitude, etc)

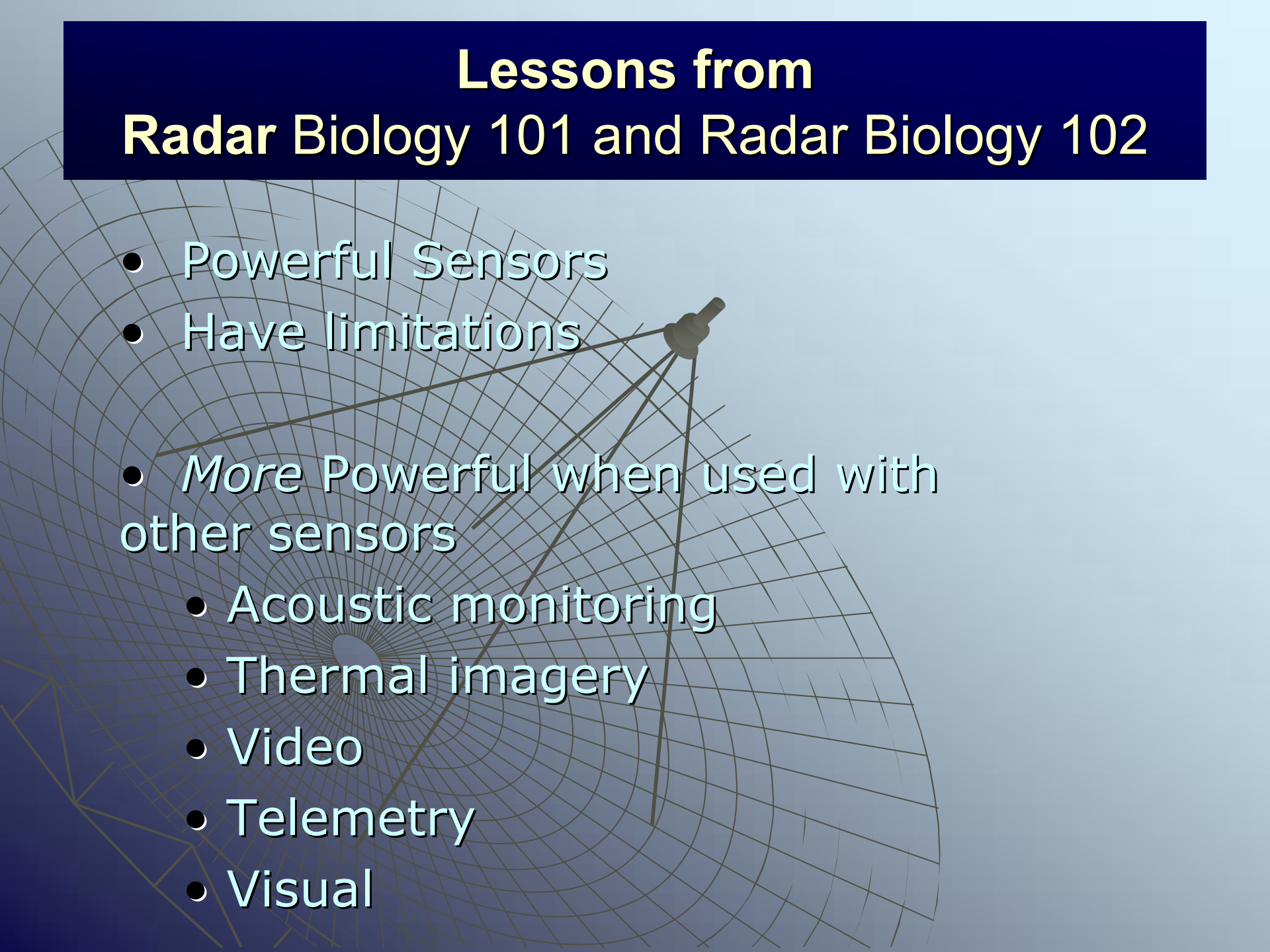
Automated data collection



Automated data collection



Lessons from
Radar Biology 101 and Radar Biology 102



- Powerful Sensors
- Have limitations

- *More* Powerful when used with other sensors
  - Acoustic monitoring
  - Thermal imagery
  - Video
  - Telemetry
  - Visual

Neda Mine, Dodge County, WI

Neda Mine Objectives

- Use multiple sensors to track bats around the Neda Mine site (radar, ultrasound bat detectors, thermal imaging camera)
- Radar detects “animals” in the air
- Bat detector can provide target species identification
- Integrating the sensor data can provide a longer range track (of a known species) to help understand how the species uses the landscape and airspace

Limitations - Sources of Error

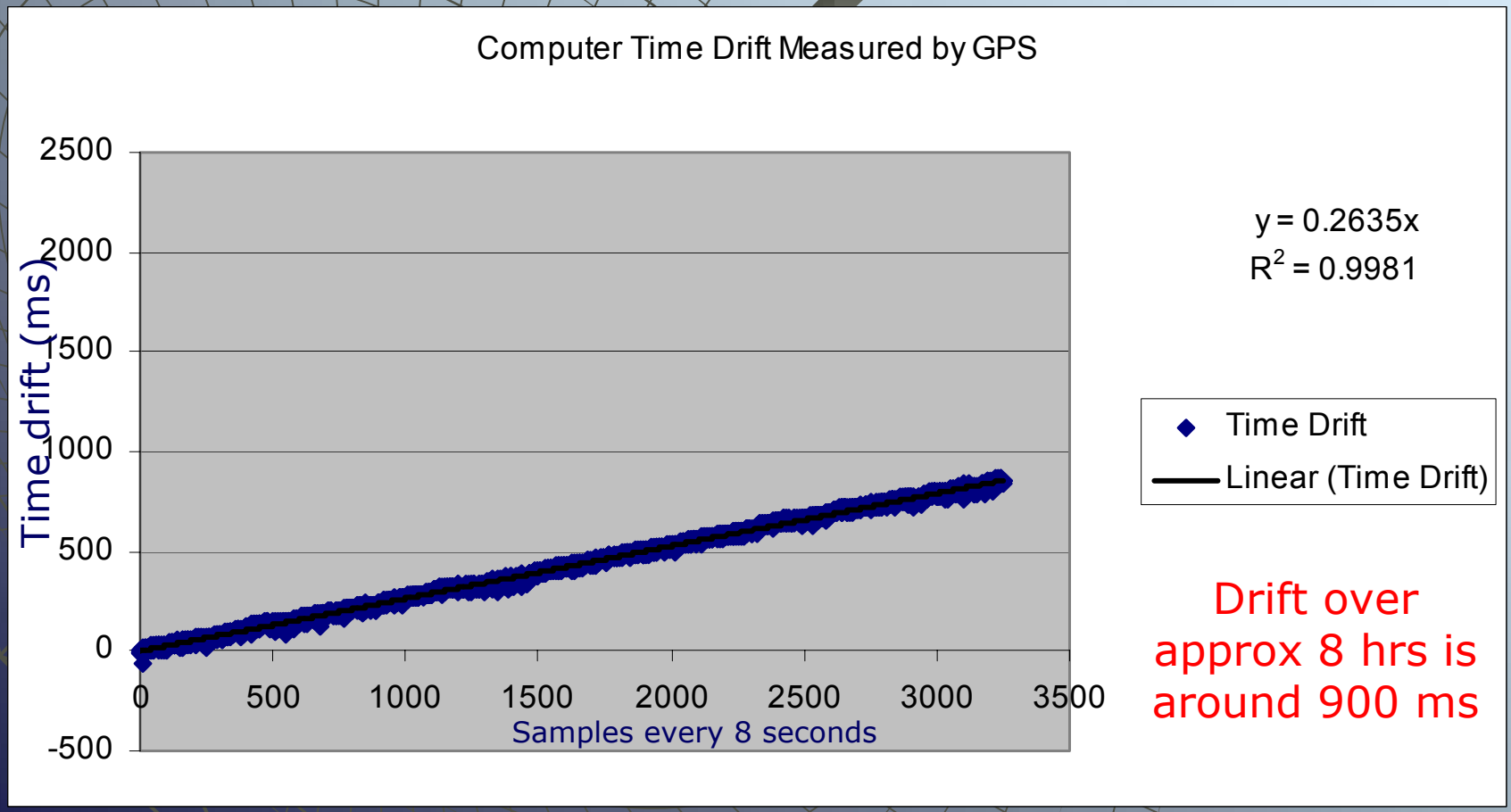
- Conducting this study allowed us to look at issues associated with integrating data from a high resolution radar with a short range acoustic sensor (approximately 50 meters)
- Assuming line of site observation of the detector and low ground clutter, the major limitations found during the study are in correlating the radar track data and bat detector data in space and time

Sources of error - Time

- Computer clocks drift in time, the time drift is both temperature and clock component dependant
- Clocks among the same models of computer can drift differently
- The same clock can drift differently from day to day
- Bat detectors do not have the same clock electronics as radars
- Radar recording data in an air conditioned shelter will drift at a different rate than a bat detector subjected to ambient temperature regime (bat detector time is likely to drift at varying rates throughout the night or over several days).

Time Drift

- Time drift for computer vs. GPS (atomic clock)

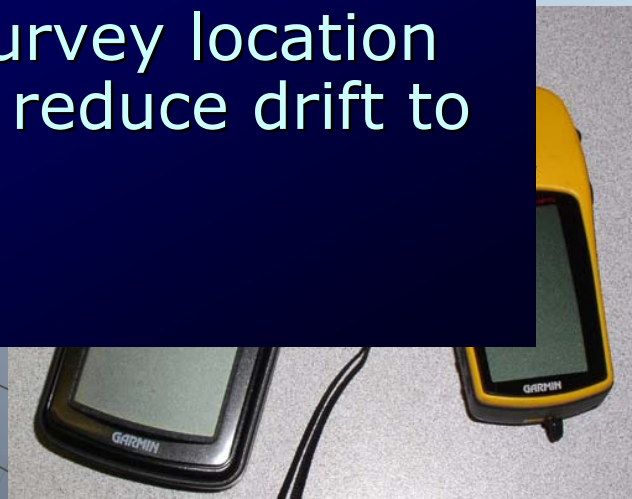


Correcting for Time

- Having a common reference time for correlating detectors is important
- We recommend using **GPS atomic clock** as a continuous reference time stamp
- Merlin radars have been updated since the Neda mine study to provide this capability
- Time correction (on the radar) is done through post-processing than by correction on the fly

Sources of Error - Position

- To integrate data from the bat detector and radar they must both be accurately located in X and Y
- GPS accuracy from one fix can be up to 25m off from the actual location
- Wide Area Augmentation System (WAAS) can improve drift to 3M, but that error combined with a position error for the bat detector can be greater than the bat detector range
- Merlin now has the capability to survey location by averaging over long periods to reduce drift to very low values



Sources of Error - Position

- Position error increases probability of placing target in the wrong pixel as distance from the radar increases

Merlin Pixel Scales for Typical Range Settings

Range Setting (nm)	Range (feet)	Pixel (feet)	Range (meters)	Pixel(meters)
0.25	1519.03	2.9669	463.00	0.9043
0.50	3038.07	5.9337	926.00	1.8086
0.75	4557.10	8.9006	1389.00	2.7129
1.00	6076.13	11.8674	1852.00	3.6172
1.50	9114.20	17.8012	2778.00	5.4258
2.00	12152.26	23.7349	3704.00	7.2344
3.00	18228.39	35.6023	5556.00	10.8516
4.00	24304.52	47.4698	7408.00	14.4688
6.00	36456.78	71.2046	11112.00	21.7031

Sources of error - Azimuth

- The sitting of a radar requires that the radar is correctly aligned to true north to match to the GPS location of the bat detector
- Any error in this azimuth alignment may result in errors greater than the effective bat detector range (an azimuth error of one degree will shift the location of the sensor 30 meters at 1 nm).
- Merlin has been upgraded in the past months to provide very accurate alignment of the radar to true north – compass module – declination is accomplished through GPS
- Merlin radars also have extremely high azimuth data resolution with sampling higher than the effective radar beam width to fully utilize the high azimuth alignment to true north

Summary

- Marine radar systems are a powerful tools in evaluating wind turbine project sites
- Additional sensors provide necessary information on species composition and altitude distributions
- Errors in time and space may result in a failure to properly synchronize sensor data
- Cumulative effects dramatically increase synchronization problems
- Integrating data from multiple sensors is dramatically improved if:
  - Both sensors have highly accurate time stamps
  - Both sensors have highly accurate latitude and longitude data
  - The radar is accurately aligned to true north

Summary

- Radar can be not only a tool for assessment, but a tool for operational management
  - Monitor operations
  - Automated shut-down

Questions

- Contact Info

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