

Use of archived radar products for investigating
influence of meteorological cues on animal
behaviors in the aerosphere (1)

- **AND** -

Quantifying Animal Phenology in the Aerosphere
Using Weather Radars (2)

(1) Winifred F. Frick, Phillip M. Stepanian, Jeffrey F. Kelly, Daniel E. Scipión,
Sarah M. Stough, Charles M. Kuster, Thomas H. Kunz, Kenneth W. Howard,
and Phillip B. Chilson

(2) Jeffrey F. Kelly, J. Ryan Shipley, Kenneth W. Howard, Phillip B. Chilson,
Winifred F. Frick, Phillip M. Stepanian, and Thomas H. Kunz

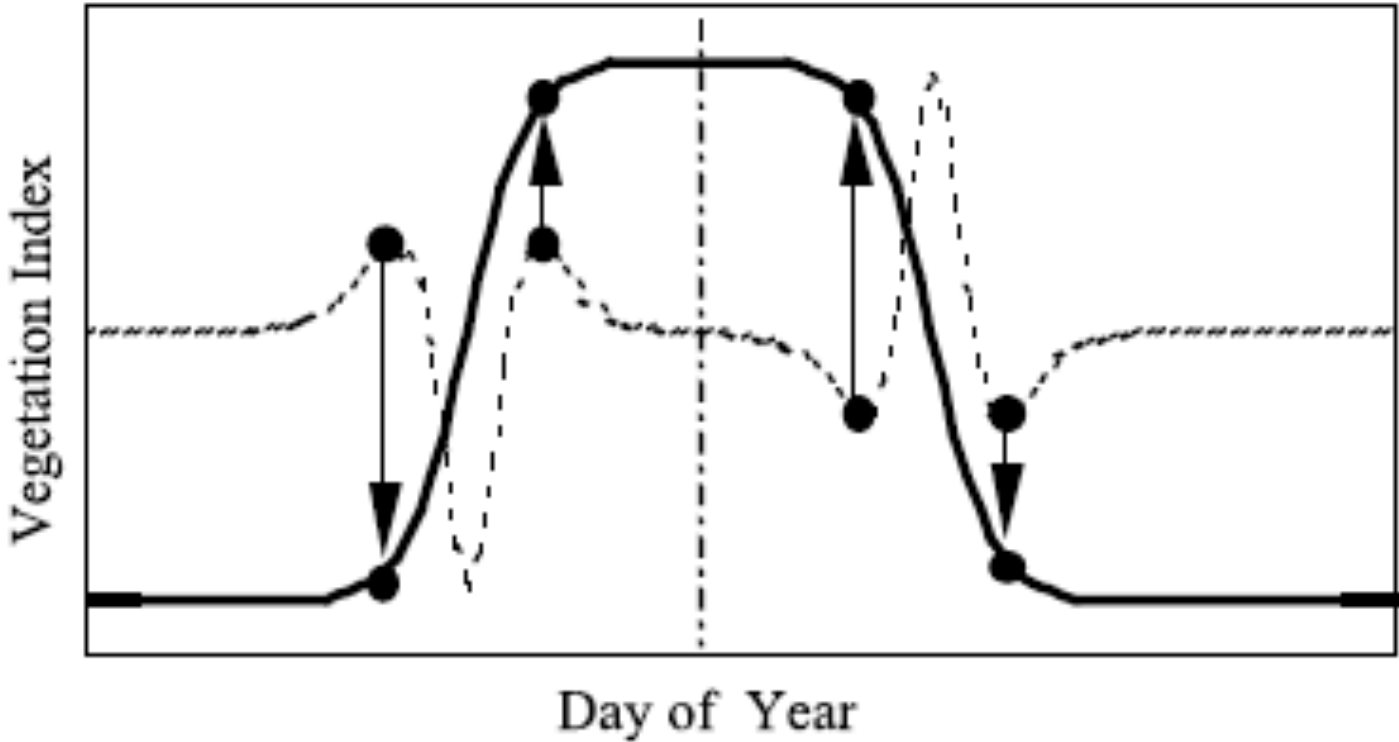
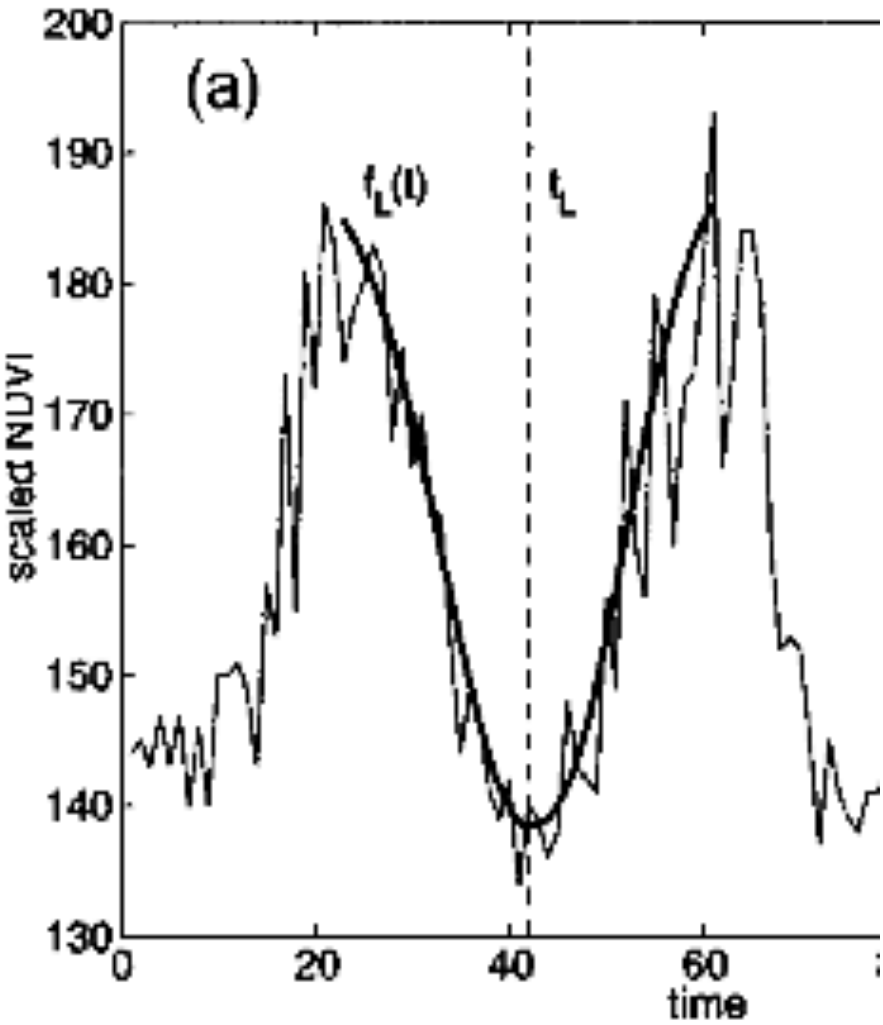
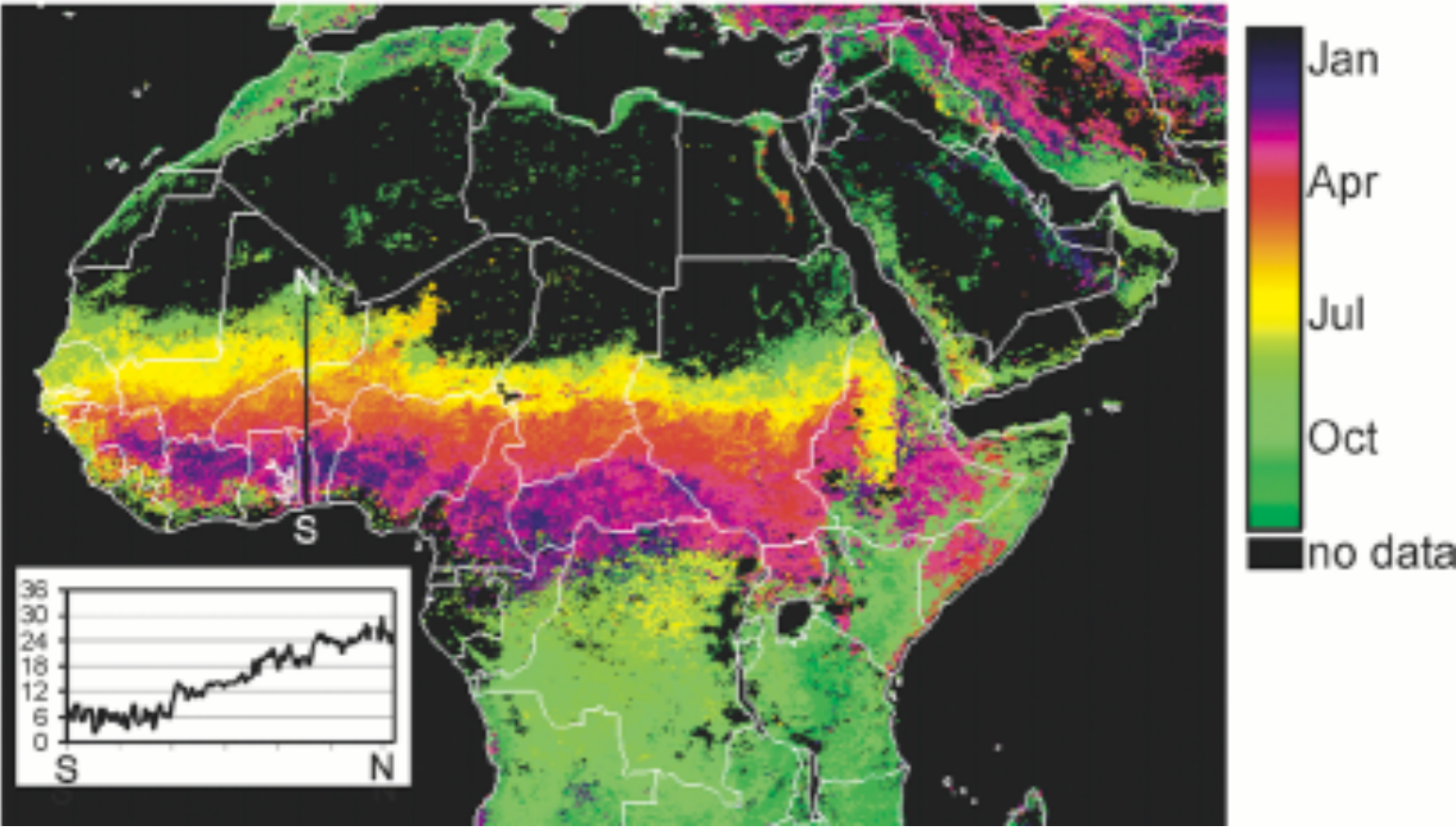
Climate & Animal Behavior

- Changes in climate predicted to affect animal and plant populations
- How animals respond to shifts in climate conditions important for understanding long-term impacts of global climate change on ecosystems
- Studying effects of climate on animal behavior requires long-term datasets

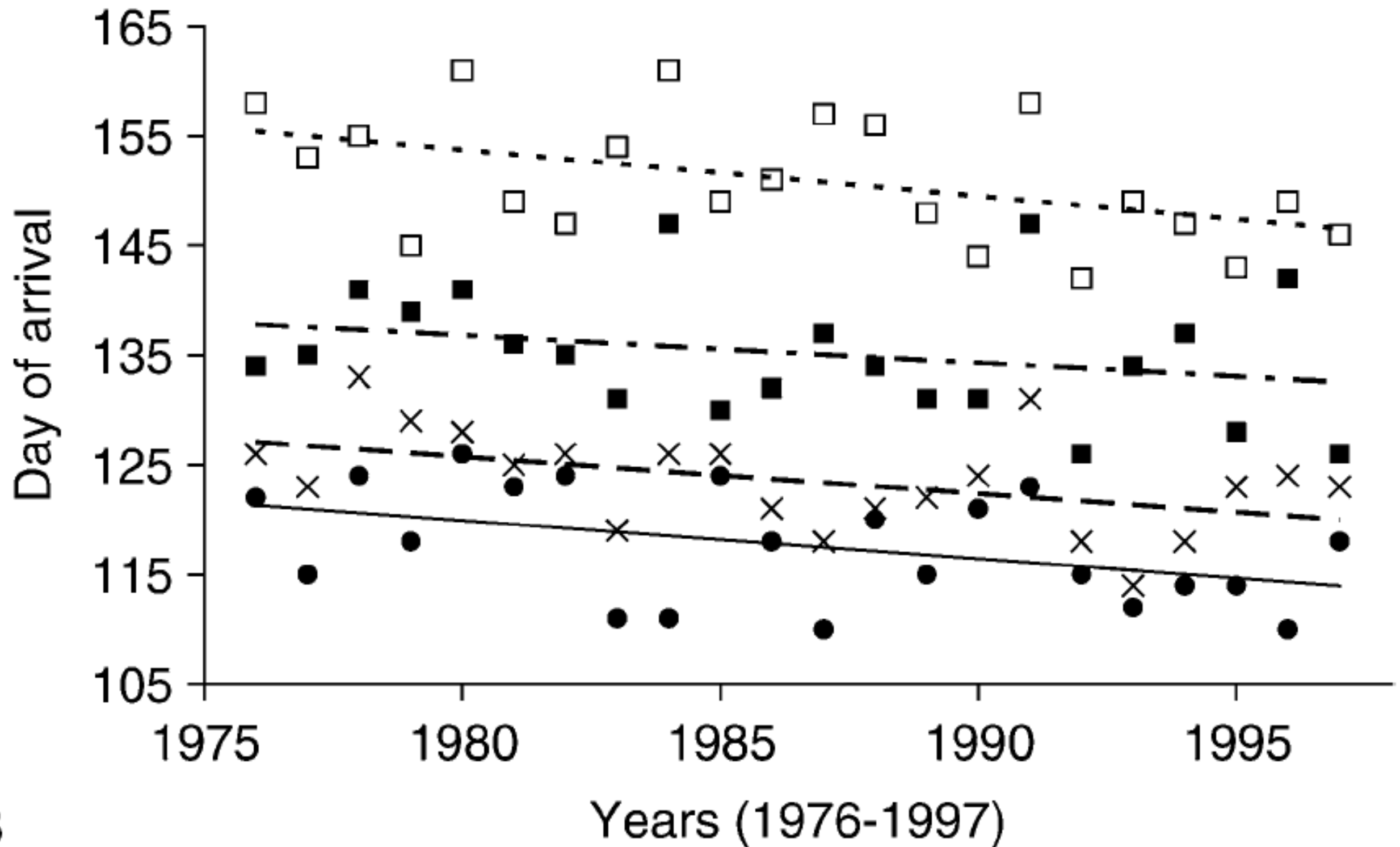
Seasonality Extraction by Function Fitting to Time-Series of Satellite Sensor Data

Per Josson and Lars Eklundh

IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, 40:8, 2002



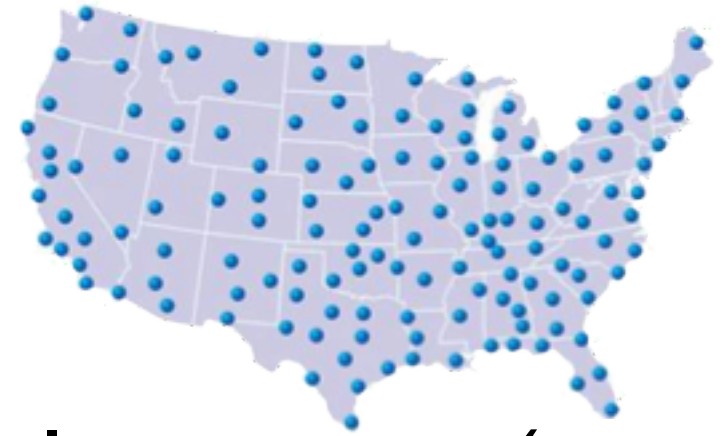
Animal Phenology is Changing



Tøttrup, A. P., Thorup, K. and Rahbek, C. 2006. Patterns of change in timing of spring migration in North European songbird populations. – J. Avian Biol. 37: 84–92.

Radar Archive for Biological Research

- The US National Climatic Data Center (NCDC) maintains data archive from the network of weather radars in the USA (NEXRAD)
- 20 year archive; 5 minute updates
- Contains information on daily behavioral patterns (e.g. when animals take flight)
 - Useful for studies of phenology
 - Animal response to daily/seasonal weather



Timing of emergence in bats

- When bats emerge to forage is adaptive behavior:
- Trade-offs early/late emergence:
 - Early emergence = increased risk predation
 - Late emergence = lower foraging success



Brazilian free-tailed bats emerging en masse from cave roost in Texas



Red-tailed hawk predating on Brazilian free-tailed bats

Brazilian free-tailed bat

(*Tadarida brasiliensis*)

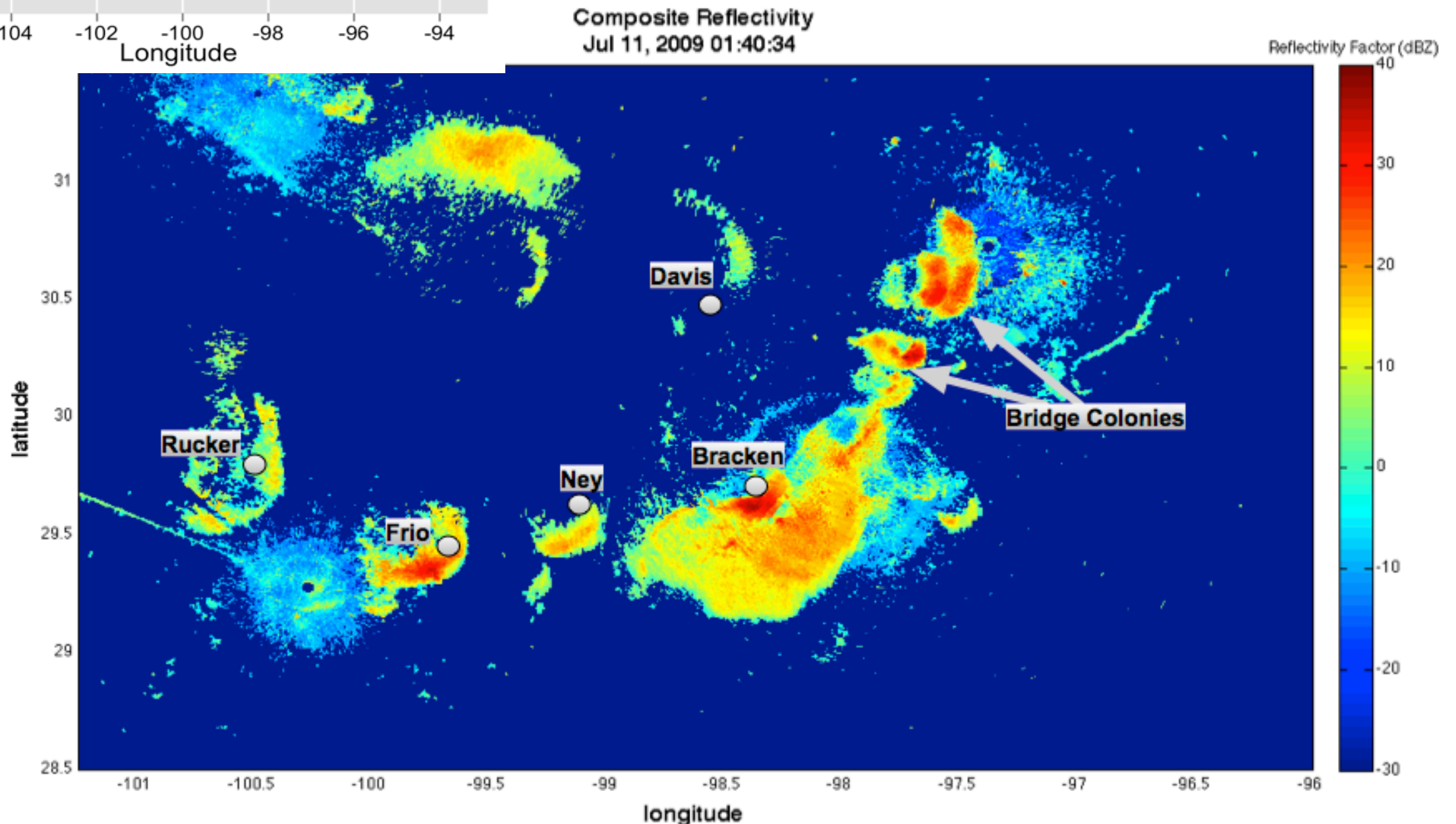
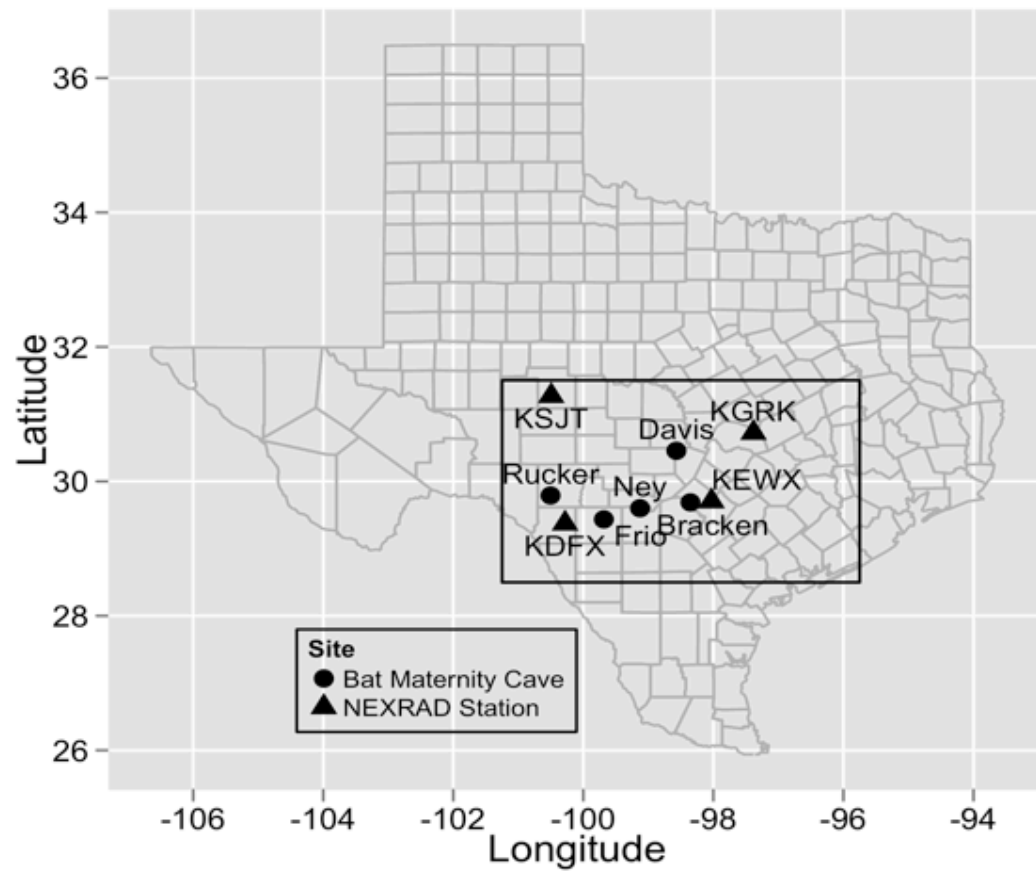


- Forms huge colonies in summer months in Texas
- Detectable on NEXRAD
- Aerial insectivores
- Consume agricultural pests

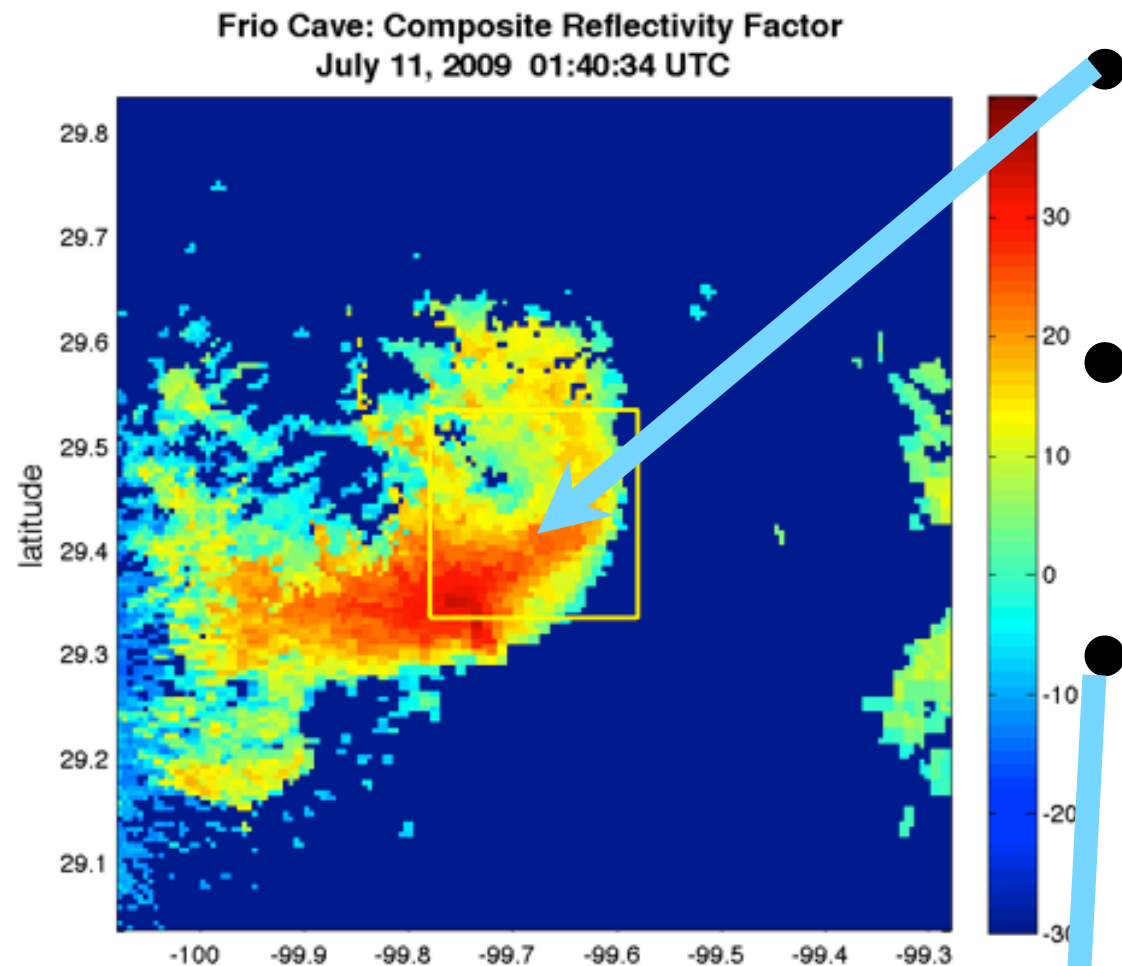


Methods

- Spatial domain = central Texas
- Temporal domain:
 - 15 June-15 July (maternity season)
 - 2001 - 2011
 - 5 large bat colonies in caves



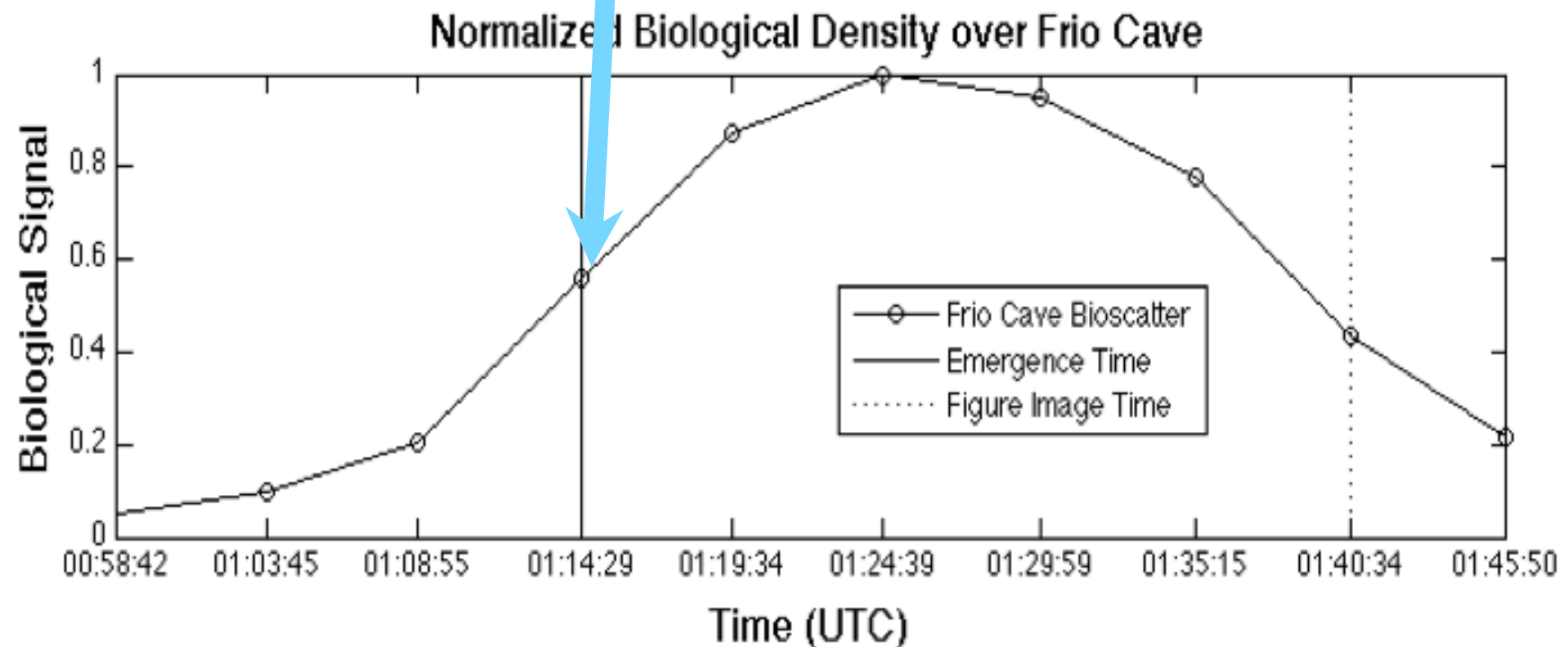
Methods



- 40 X 40 pixel domain around each cave location

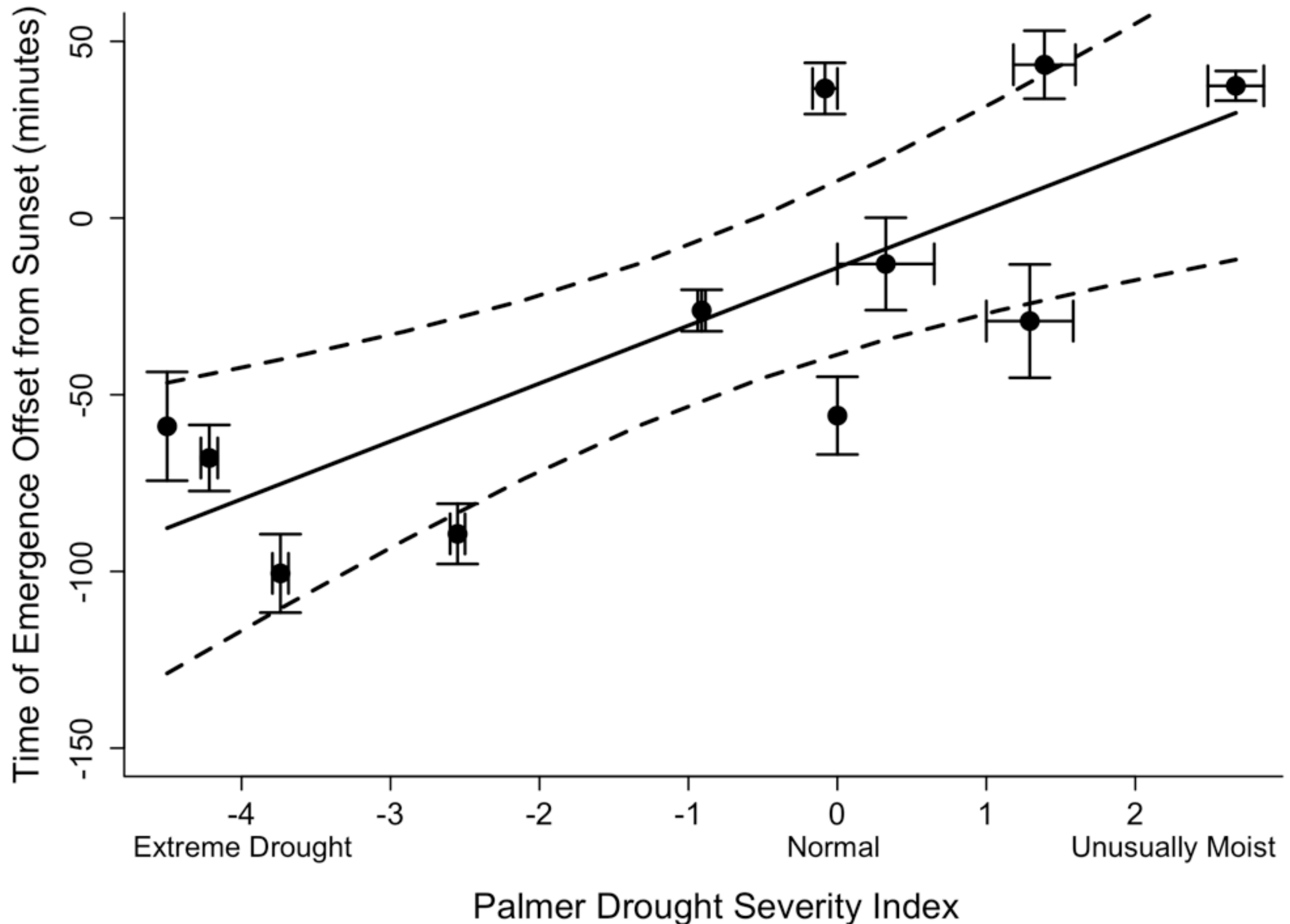
- Summed linear values of radar reflectivity factor at each 5 min

- Emergence time = maximum increase in index of biological density (dZ/dt)

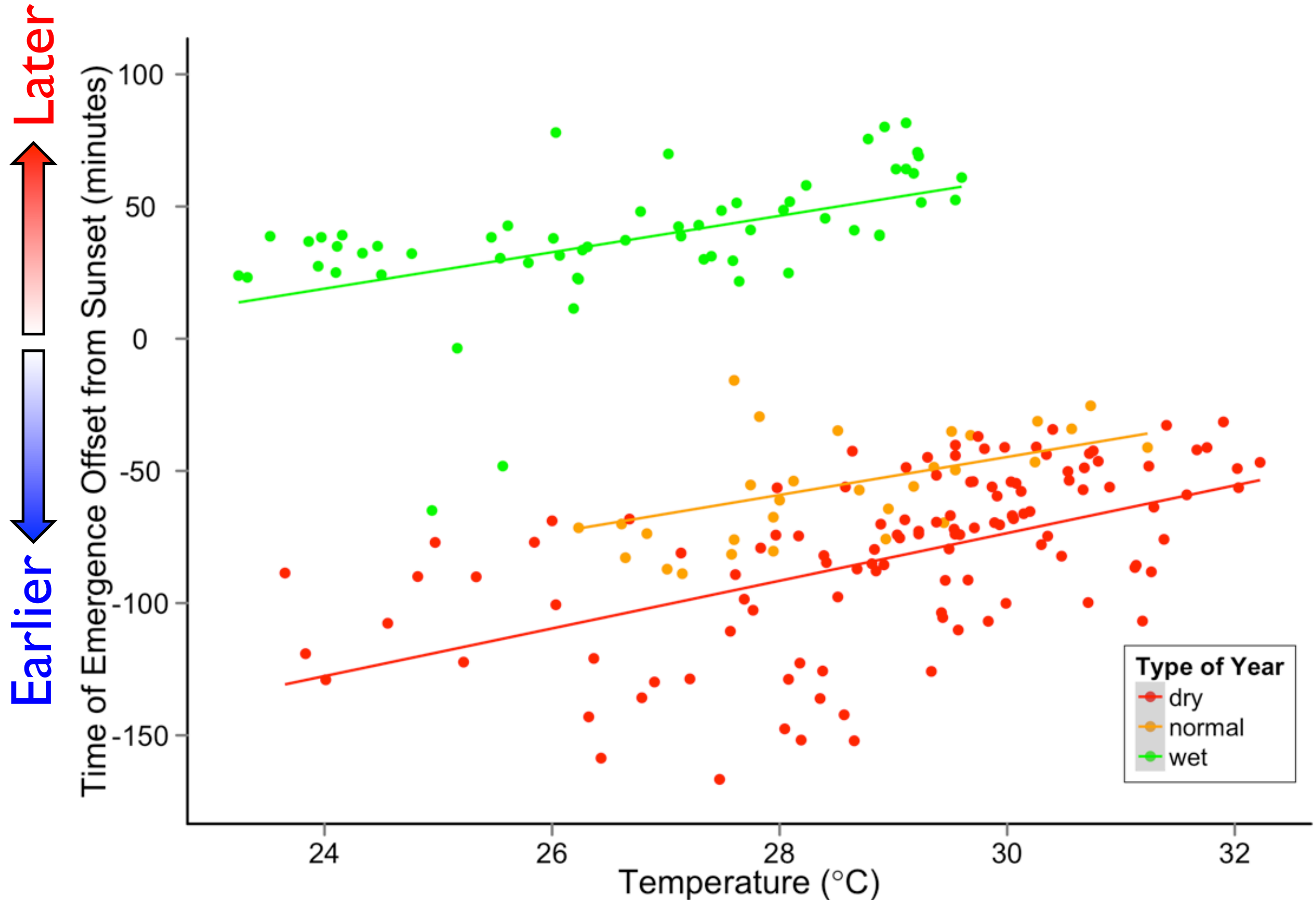


Later
Earlier

Bats emerged earlier in dry years



Bats emerged later on hotter days





Discussion: Part I



- Strong association between emergence behavior of Brazilian free-tailed bats and both annual climate and daily weather
- Archived radar products provide a novel and important way of monitoring animal behavior to determine response to annual and daily variation in weather conditions

LARGE-SCALE MAPPING OF PURPLE MARTIN PRE-MIGRATORY ROOSTS USING WSR-88D WEATHER SURVEILLANCE RADAR

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Radar Mapping of Roosts

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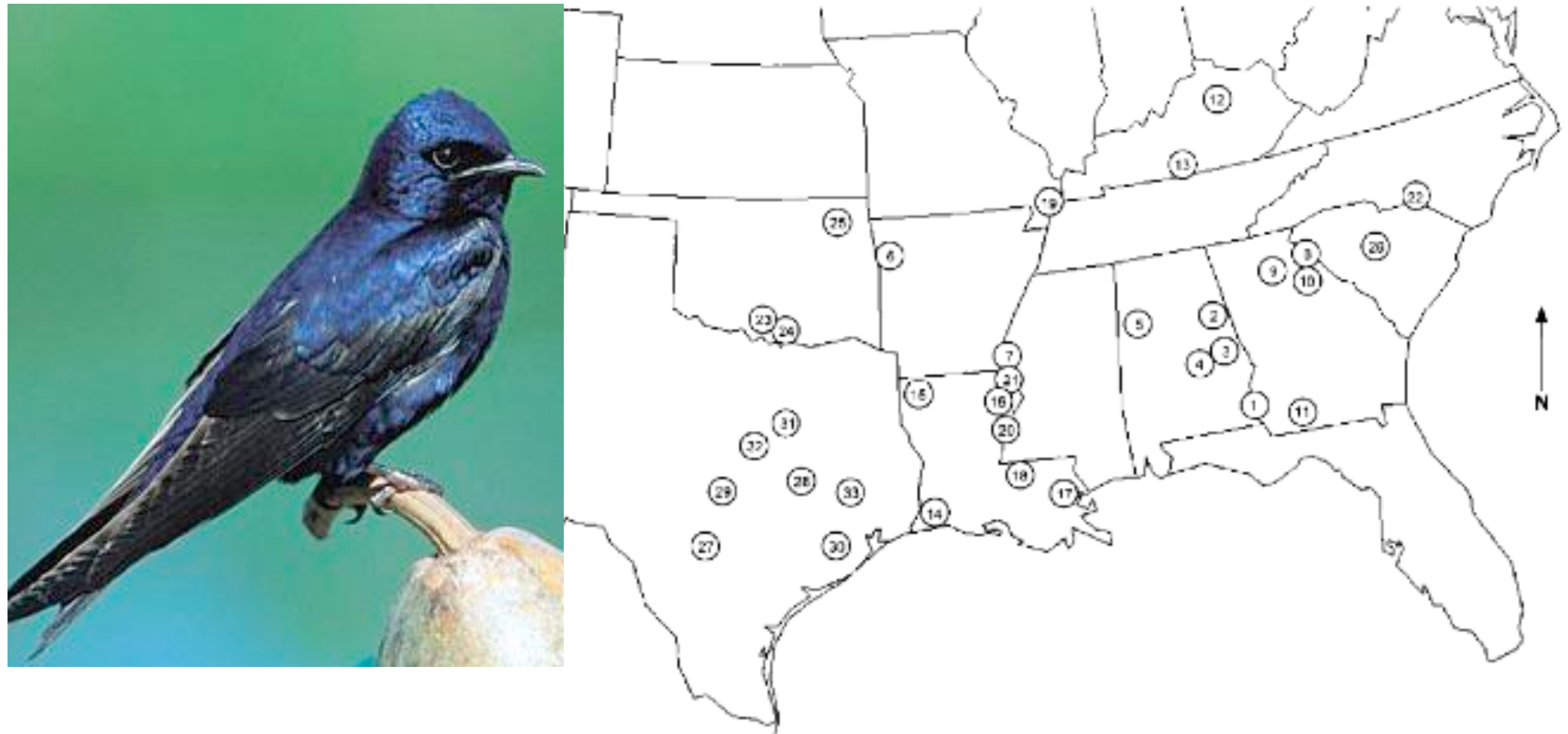
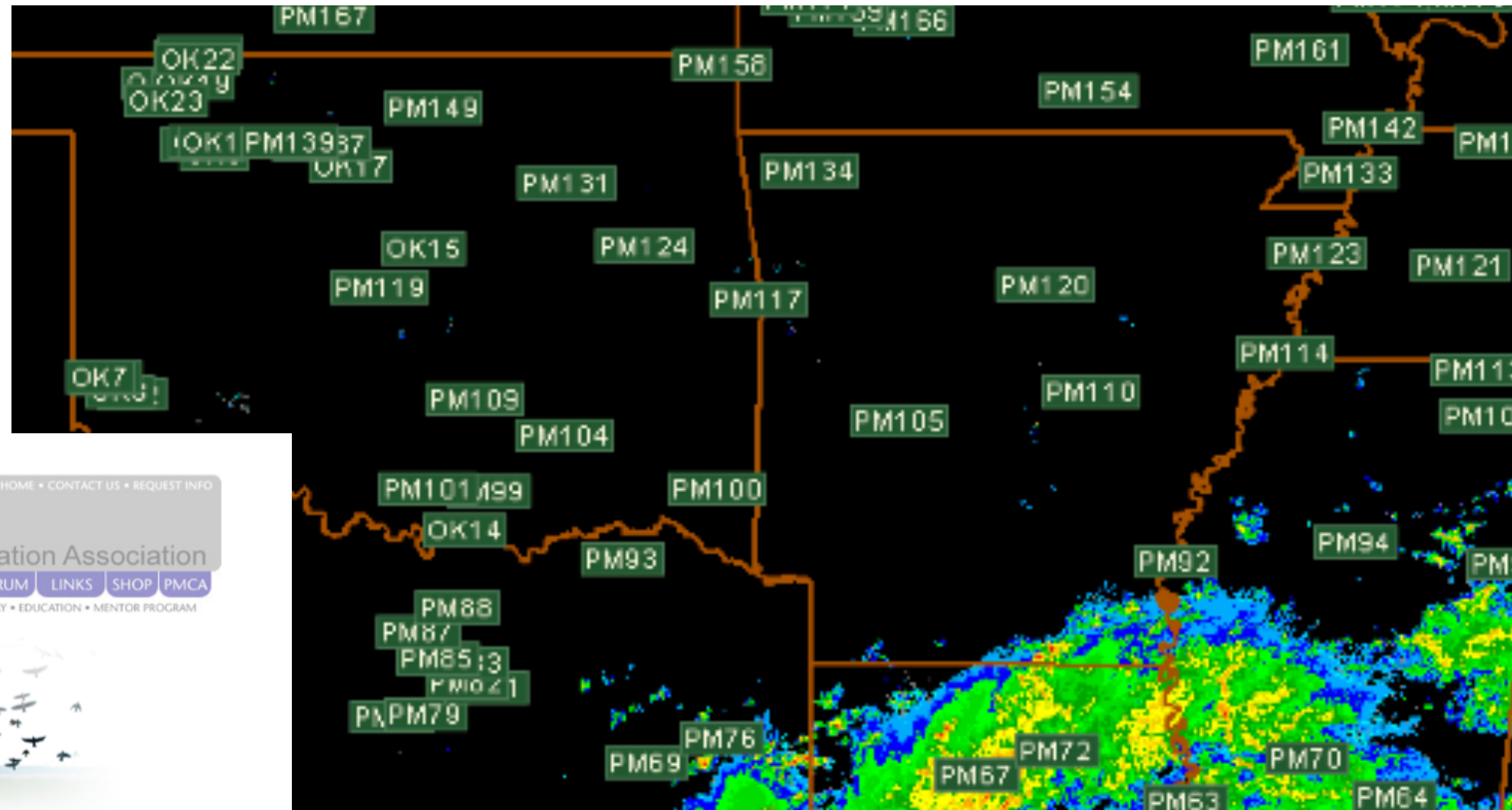


FIGURE 2. Map of roost sites (designated by circles) detected with Internet-acquired WSR-88D radar images, July and August 1996. Numbers within the circles refer to roost site descriptions in Table 1. Roost sites are not drawn to scale.

Martin Roost Phenology



**OKLAHOMA
U.S.A.**

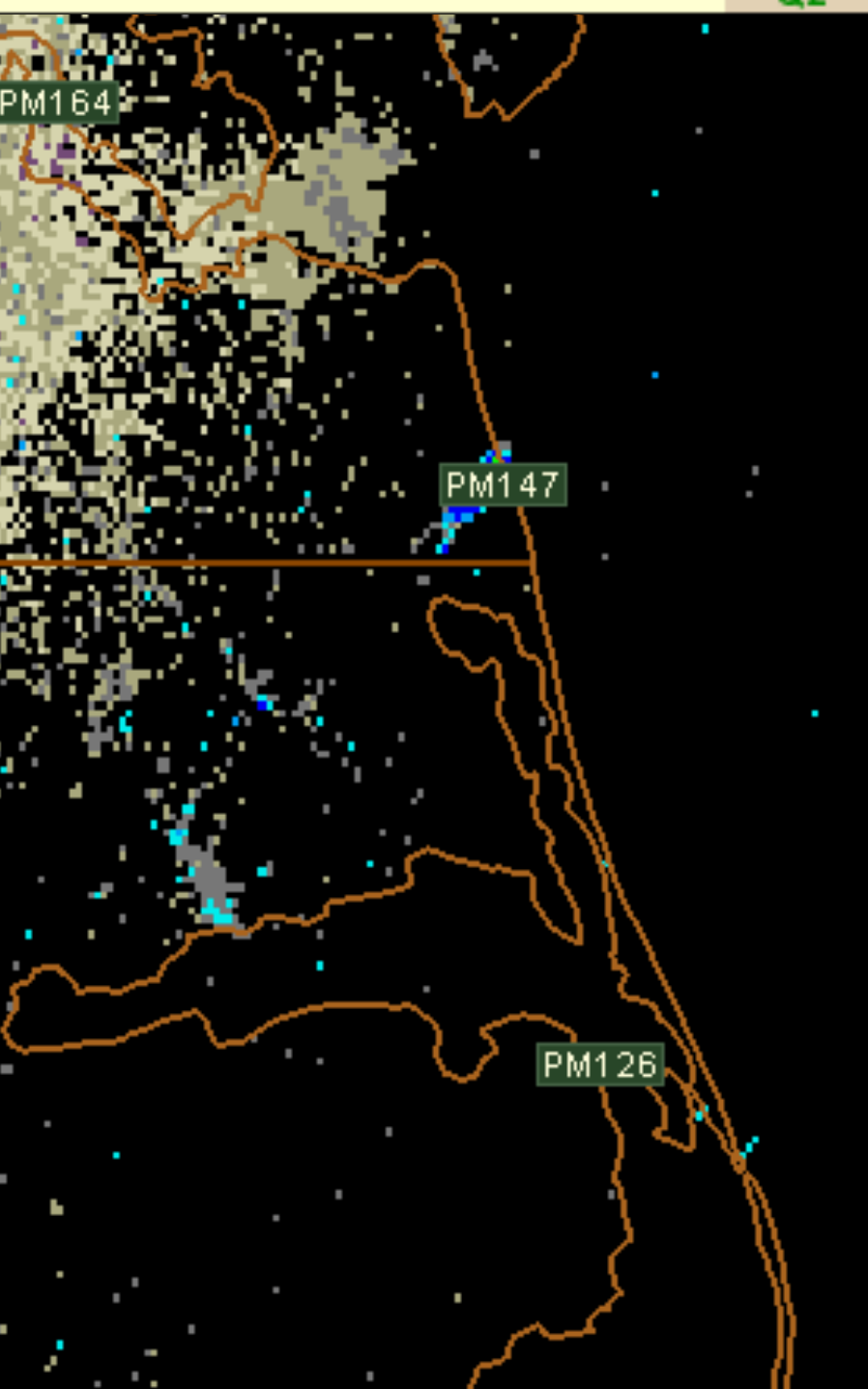
358 locations from purplemartin.org

[Home](#) > [MartinRoost](#) > [United States](#) > [Oklahoma](#)

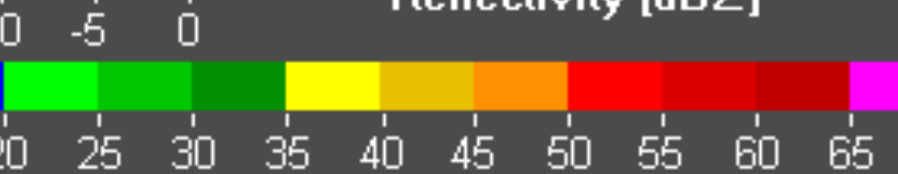
Please select a roost below to view more information.

Roost Title	City	County	Coordinates	Maps
Unconfirmed Roost *		Atoka	34.50390, -96.02256	Google MapQuest *
Unconfirmed Roost *		Carter	34.15980, -97.11567	Google MapQuest *
Unconfirmed Roost *		Garfield	36.40668, -97.97996	Google MapQuest *
Unconfirmed Roost *		Kay	36.65568, -97.06604	Google MapQuest *
Unconfirmed Roost *		Le Flore	35.36266, -94.46493	Google MapQuest *
Unconfirmed Roost *		Major	36.42932, -98.23854	Google MapQuest *
Unconfirmed Roost *		Marshall	34.14670, -96.62740	Google MapQuest *
Unconfirmed Roost *		McCurtain	34.15297, -94.77841	Google MapQuest *
Muskogee, OK	Muskogee	Muskogee	35.75262, -95.36693	Google MapQuest
OU Medical Center Roost	Oklahoma City	Oklahoma	35.47995, -97.50183	Google MapQuest

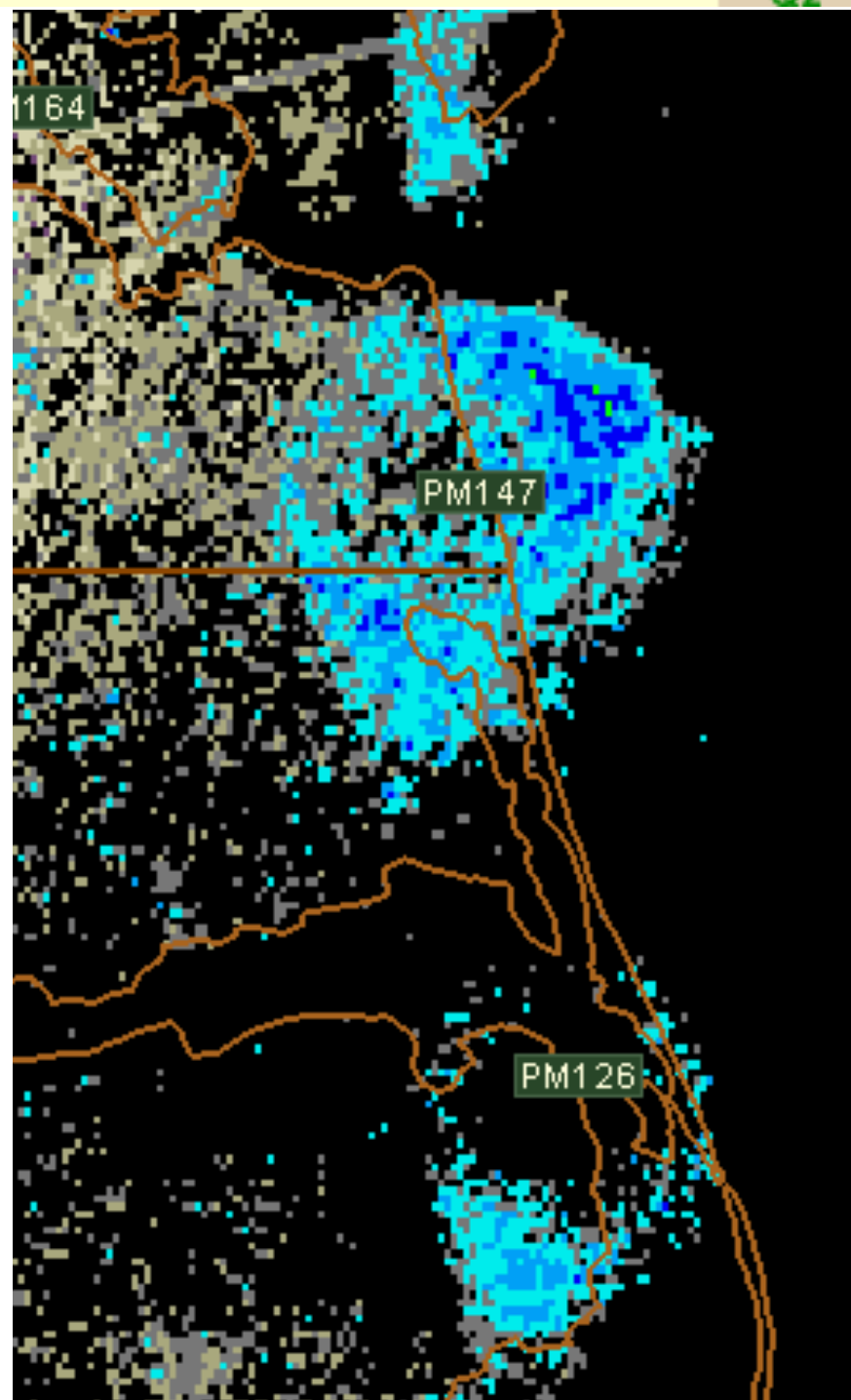
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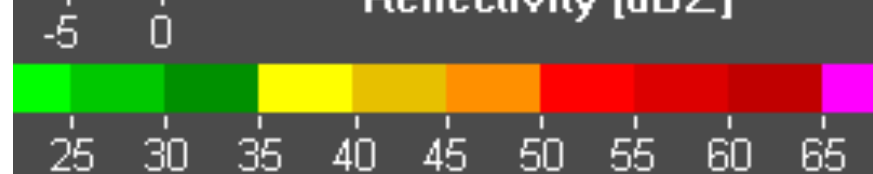
Reflectivity [dBZ]



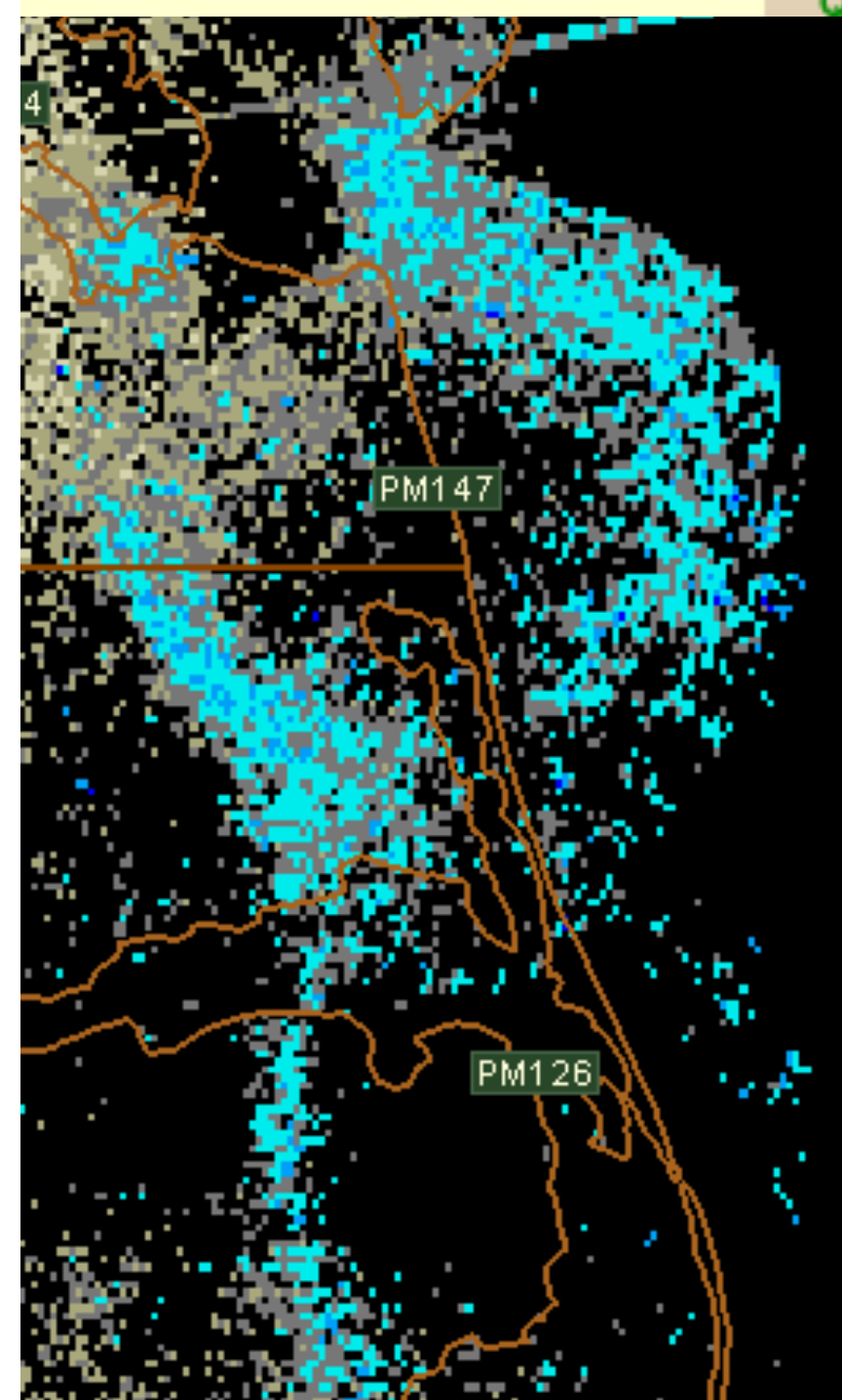
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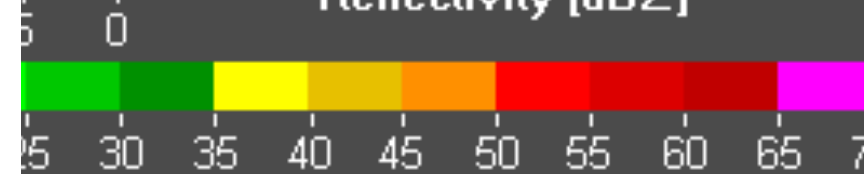
Reflectivity [dBZ]



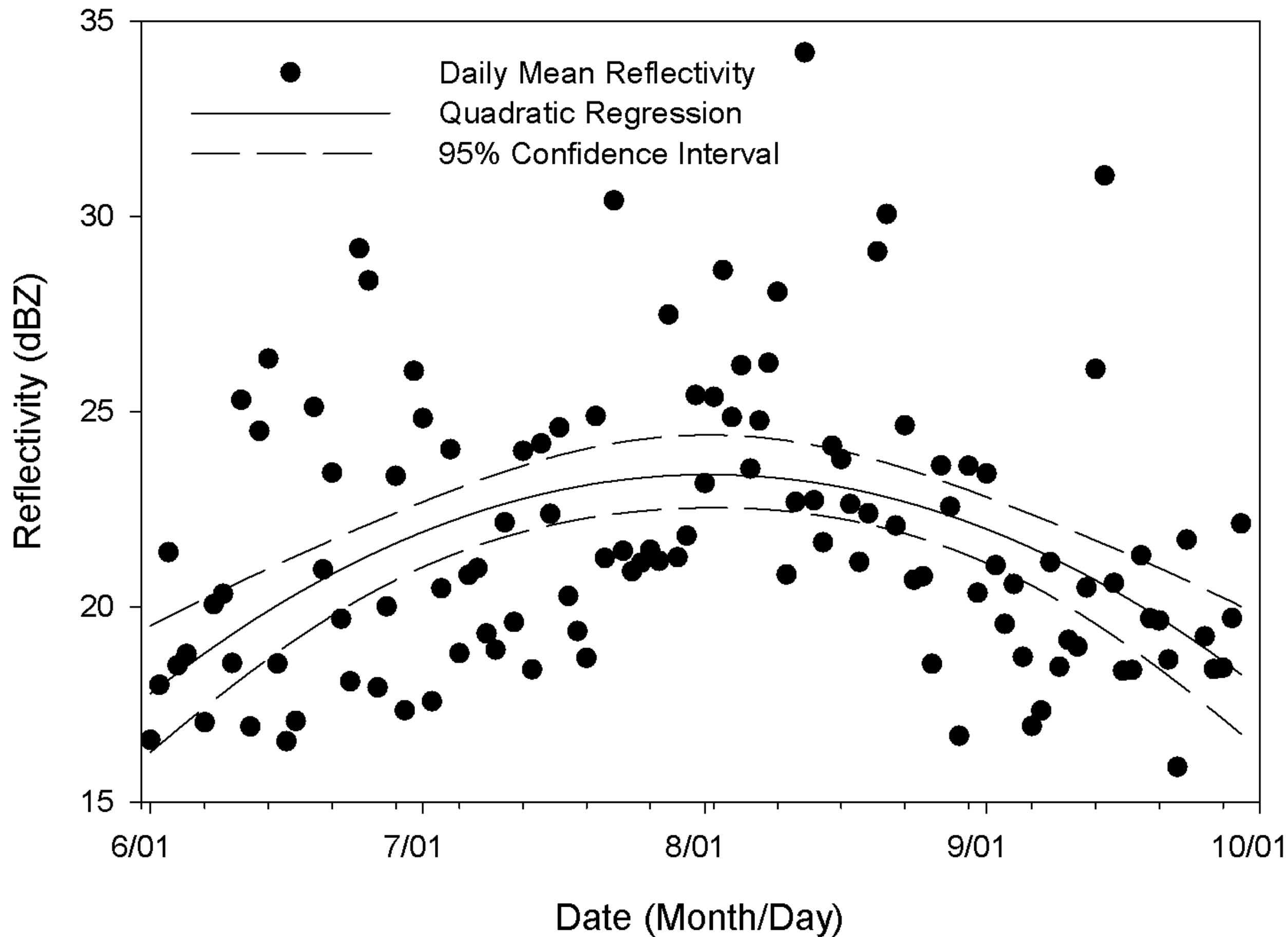
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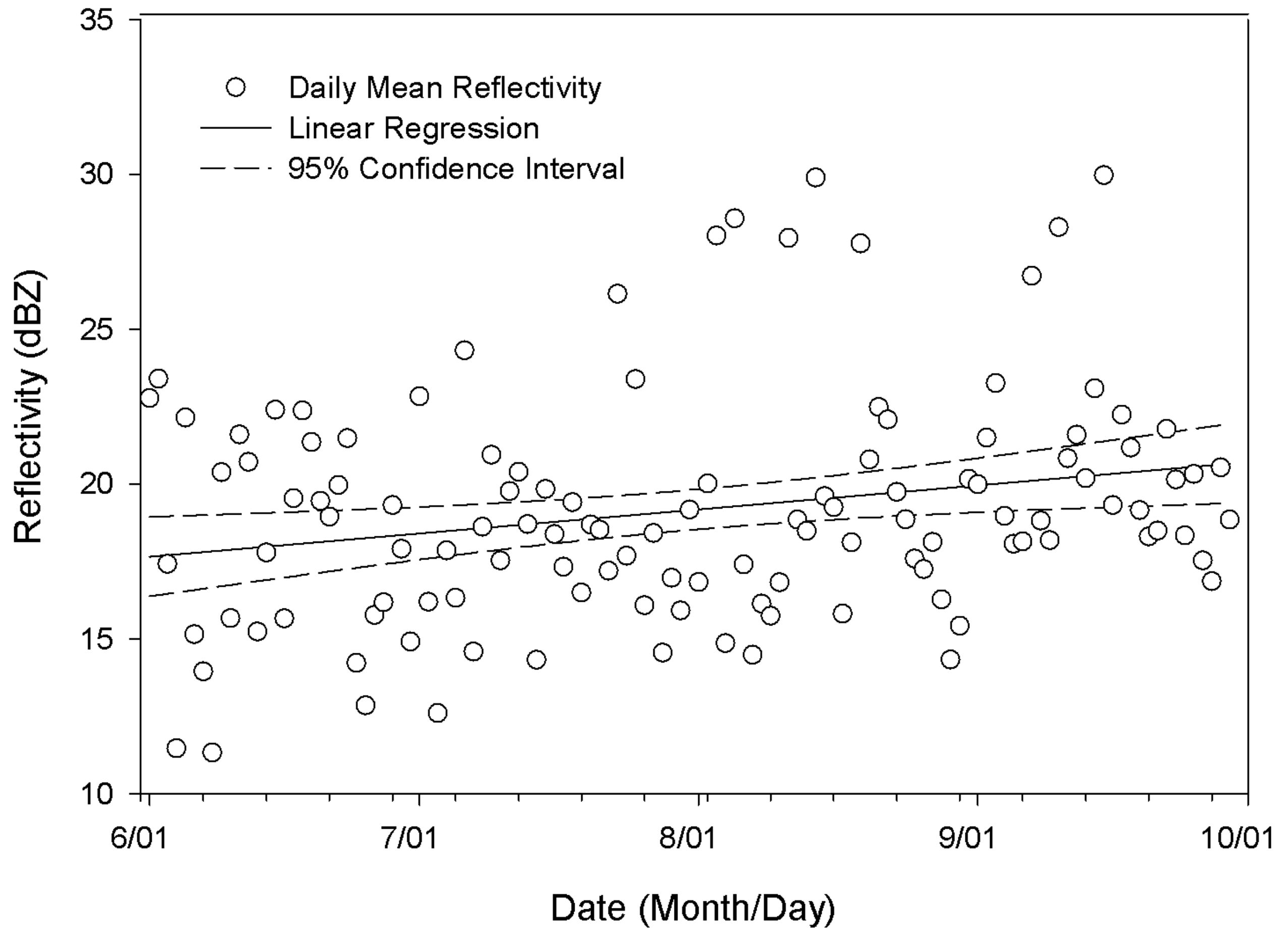
Reflectivity [dBZ]



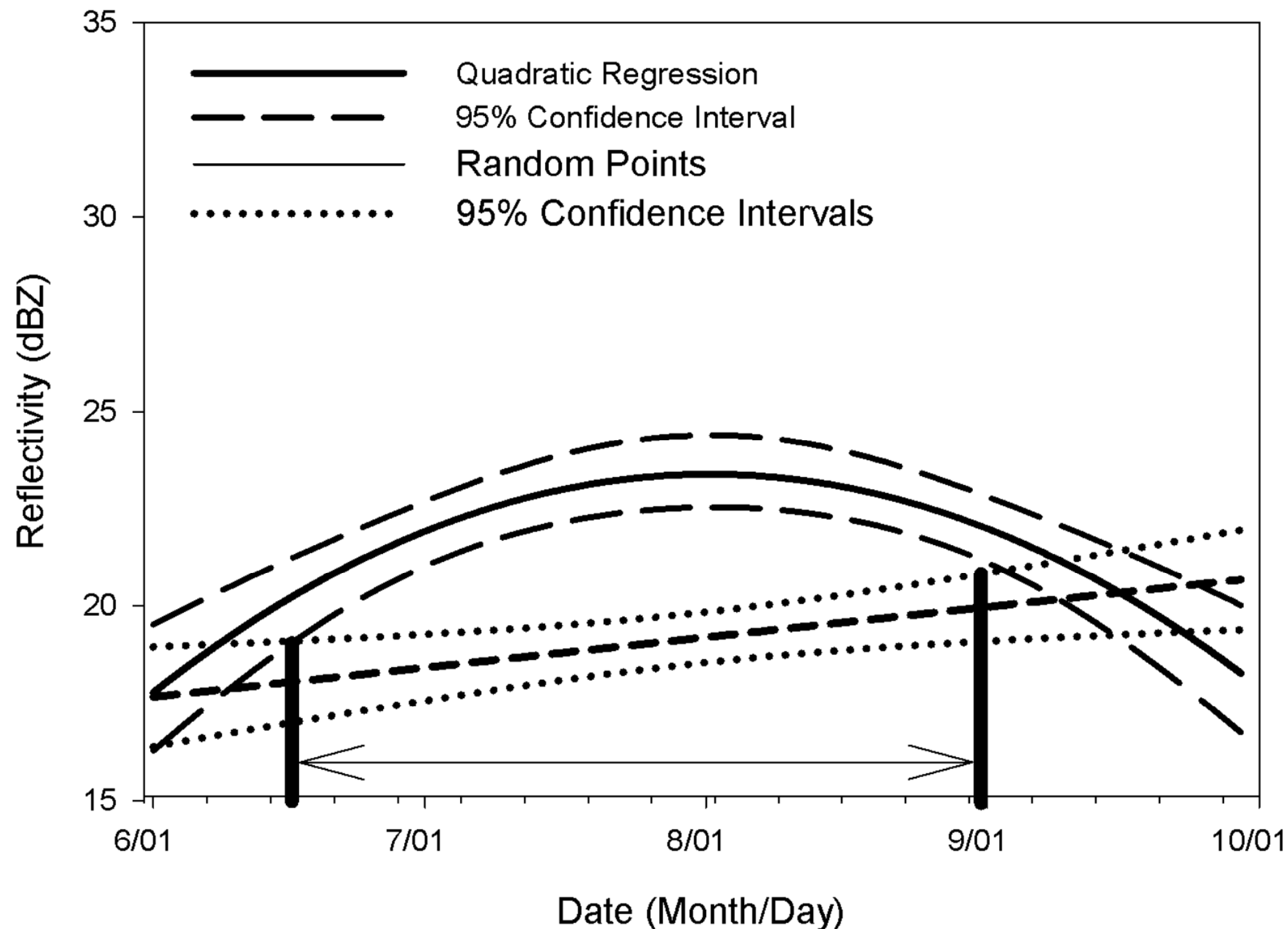
Purple Martin Roost Phenology Summer 2010



Random Sites



Purple Martin Roost Phenology Summer 2010



“Peak migration in U.S. is late Jul, Aug, and Sep, although fall migration begins as early as late May along Gulf Coast” (Brown 1997)

Radar as Observing System for Animal Phenology

Discussion: Part II

1. Potential for national radar-based measurement of animal phenology
2. A major objective is automated analysis of radar phenologies across the radar archive - 1993 to present
3. Integration with land cover and climate data in a cybercommons for ecological forecasting
4. Upgrading the NEXRAD to dual-polarization capacity - ongoing
5. <http://soar.ou.edu/>

