Space Based Ornithology: On the Wings of Migration and Biophysics

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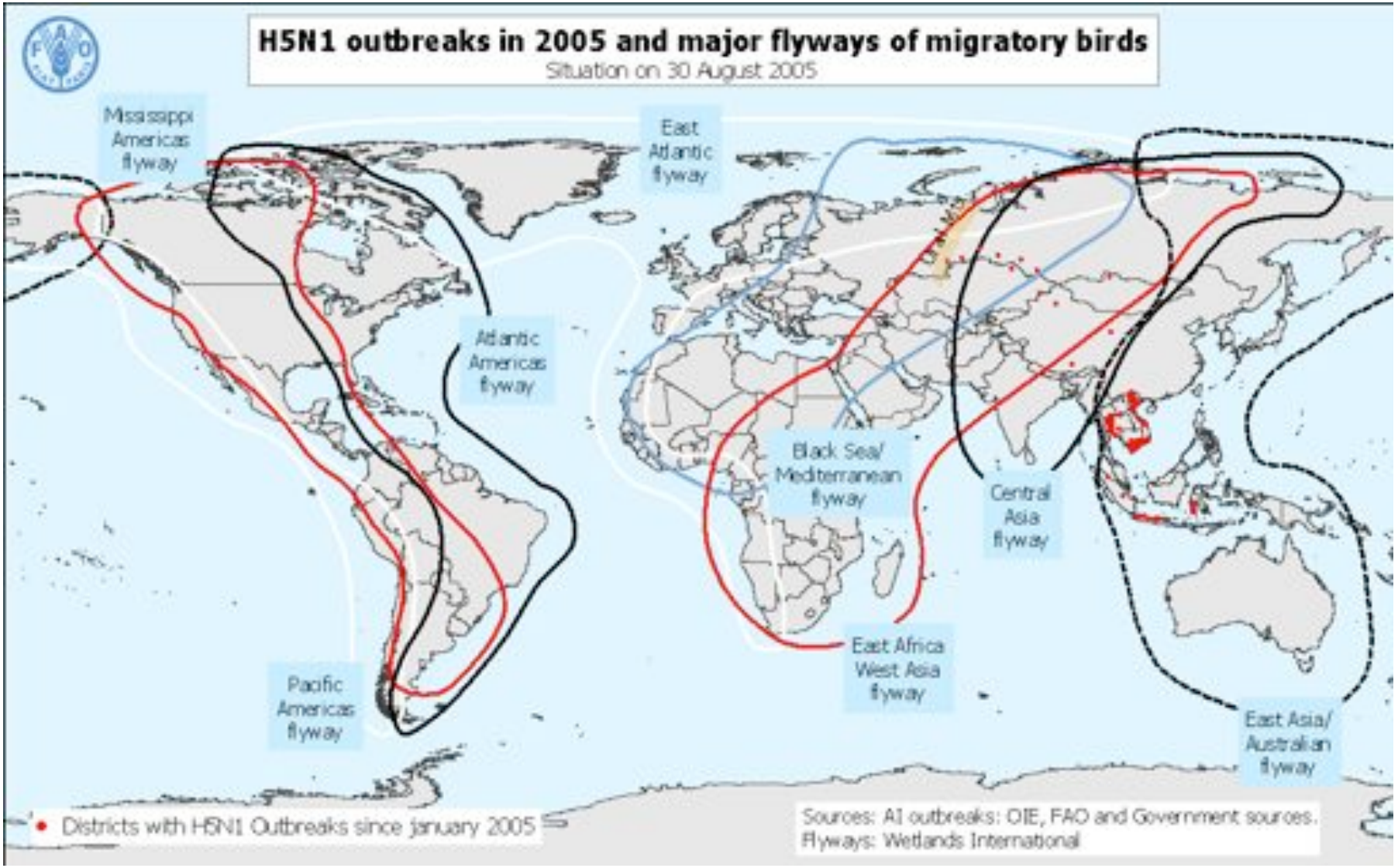

H5N1 outbreaks in 2005 and major flyways of migratory birds
Situation on 30 August 2005
Mississippi Americas flyway
East Atlantic flyway
Atlantic Americas flyway
Black Sea/ Mediterranean flyway
Central Asia flyway
East Africa West Asia flyway
Pacific Americas flyway
East Asia/ Australian flyway
Districts with H5N1 Outbreaks since january 2005
Sources: AI outbreaks: OIE, FAO and Government sources.
Flyways: Wetlands International

Outline

Background

- *–Individual bird energy models*
- *–Climate space niche*

Examples - Virtual Birds

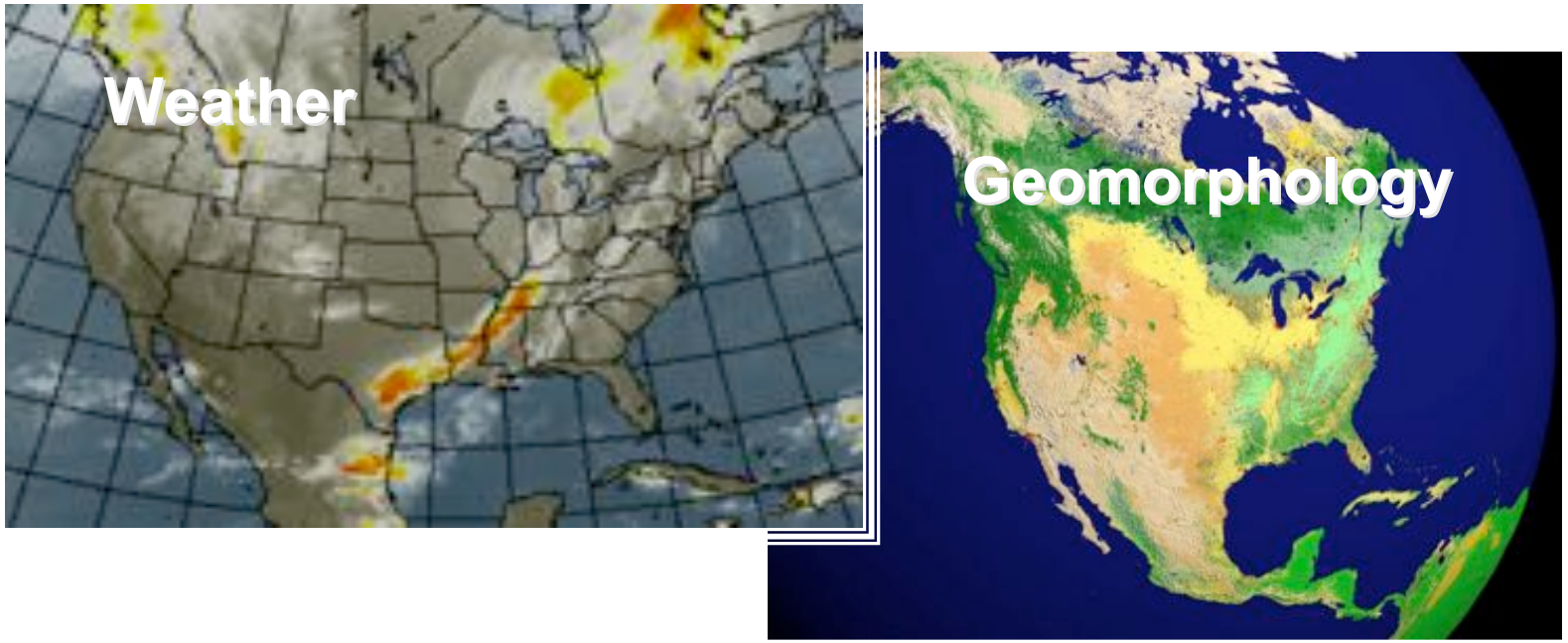
- *–Summer breeding ground*
- *–Migration patterns*

Real Birds, Observations--

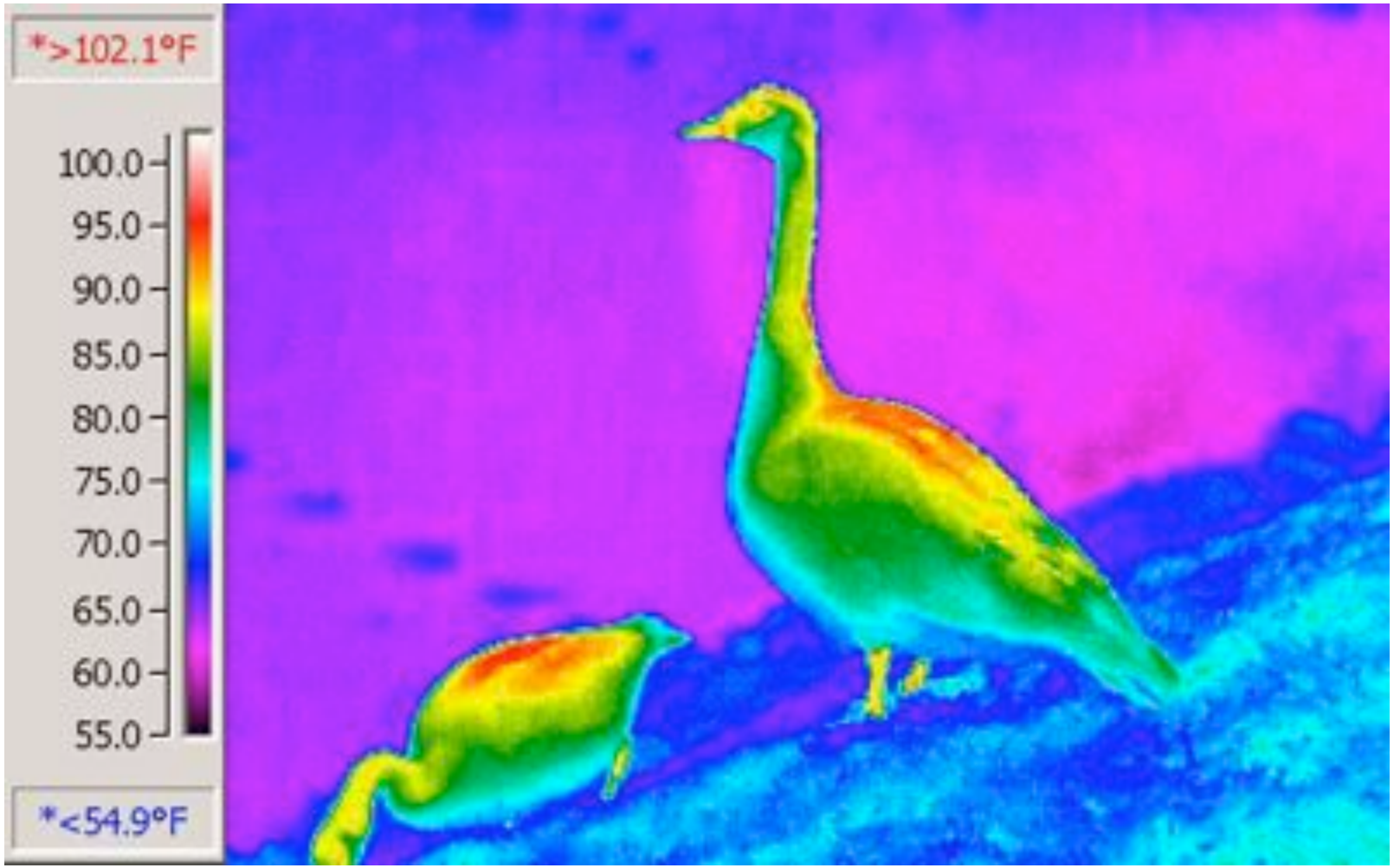
Decision Support Systems

Basic Idea

Thermal and water-relation environments of birds, as estimated from satellite data and biophysical models, can define the constraints on their occurrences and richness ("Holdridge for the Birds")

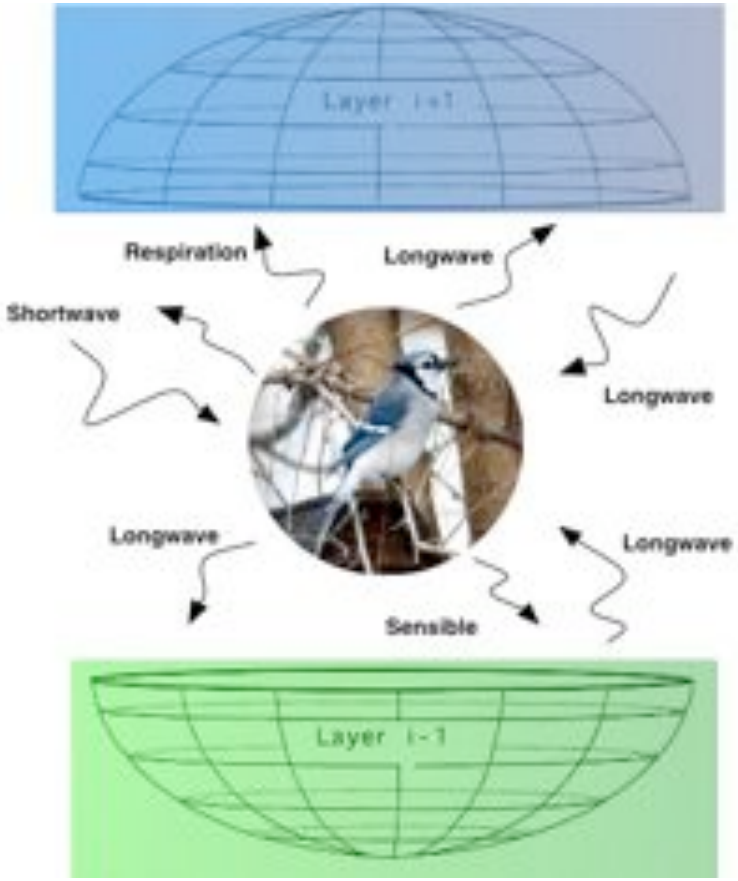


Thermal Infrared Image

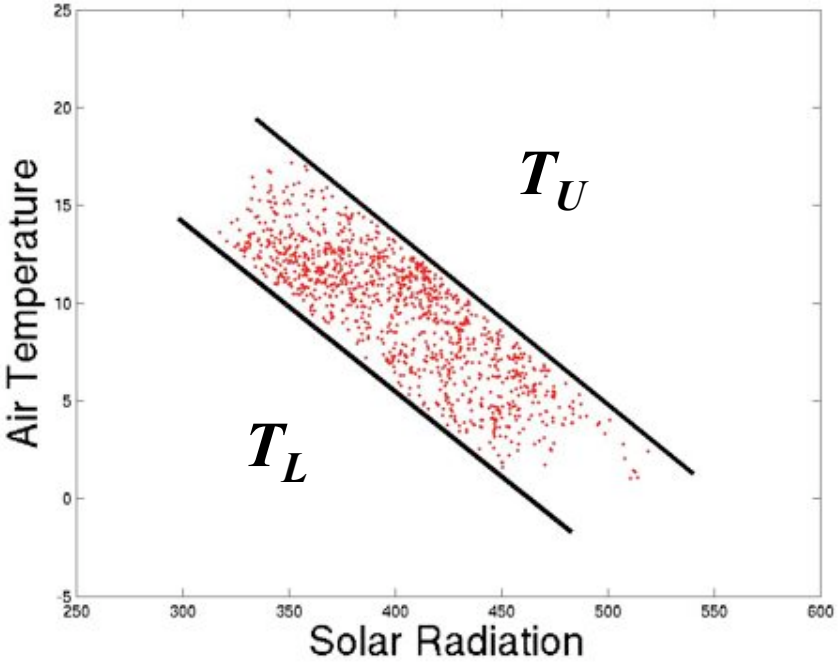


Avian Energetics

Metabolism

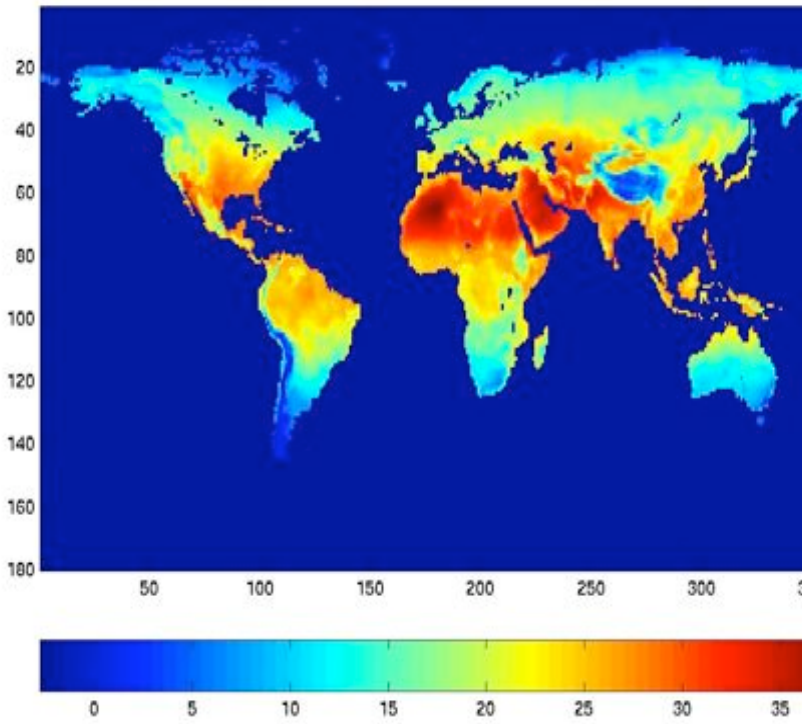


Climate space

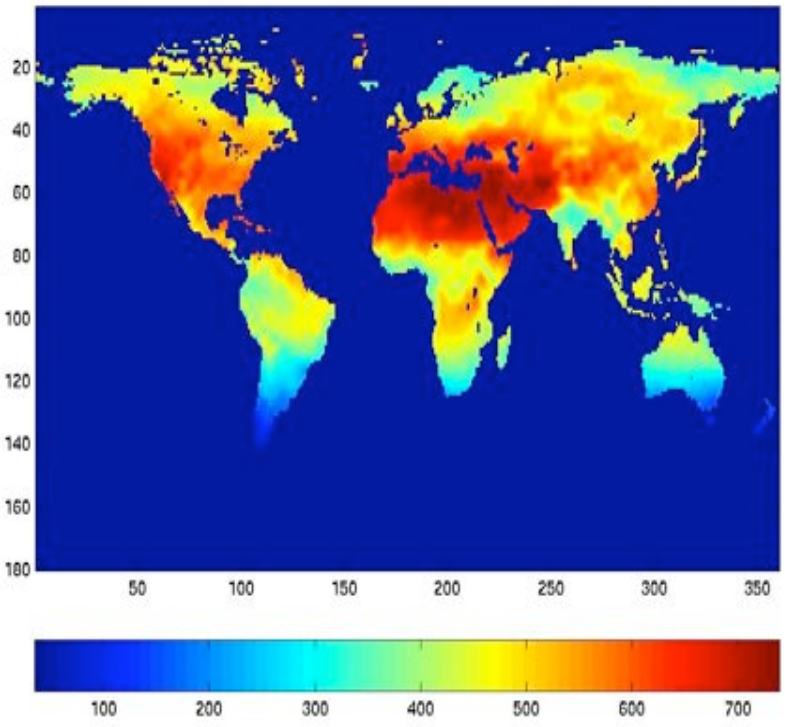


Find all {Ta,S} that satisfy
$T_L < Tb < T_U$

Example -- Summer (July)

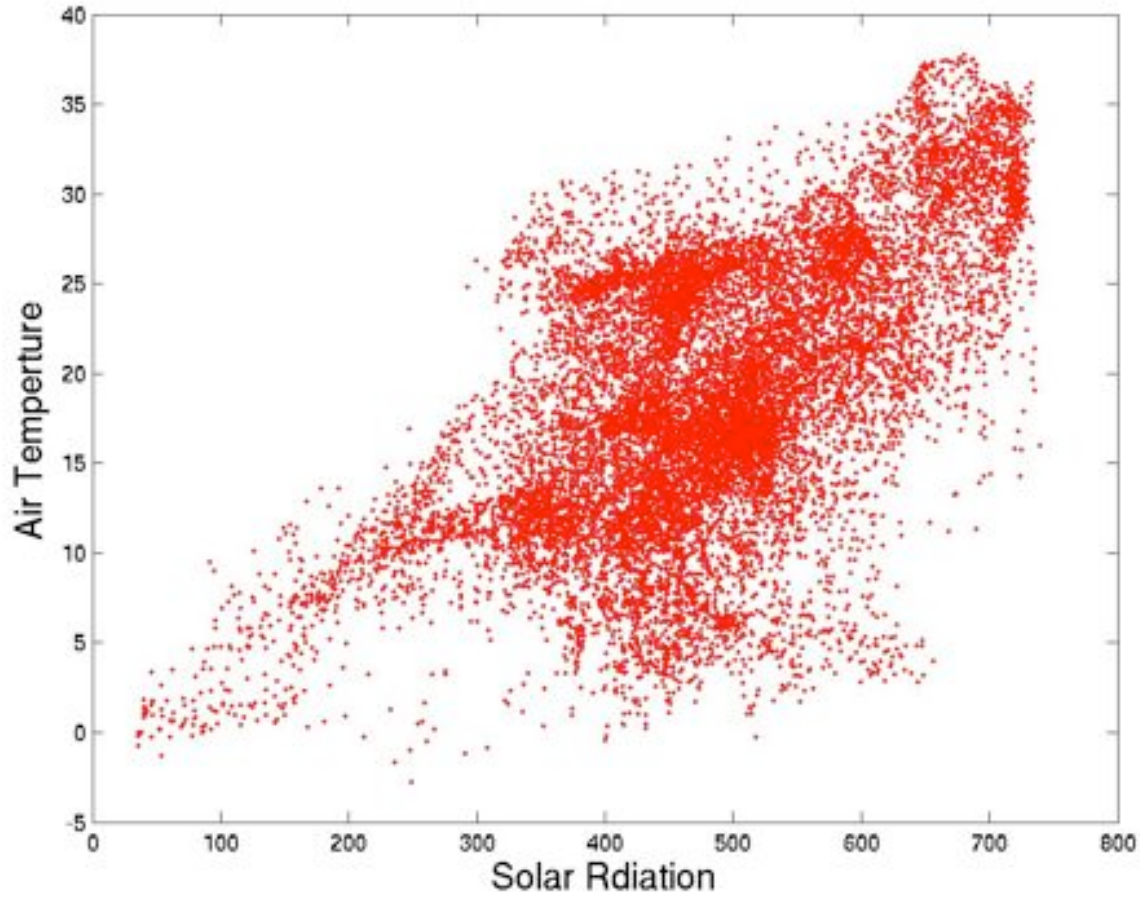


Air Temperature

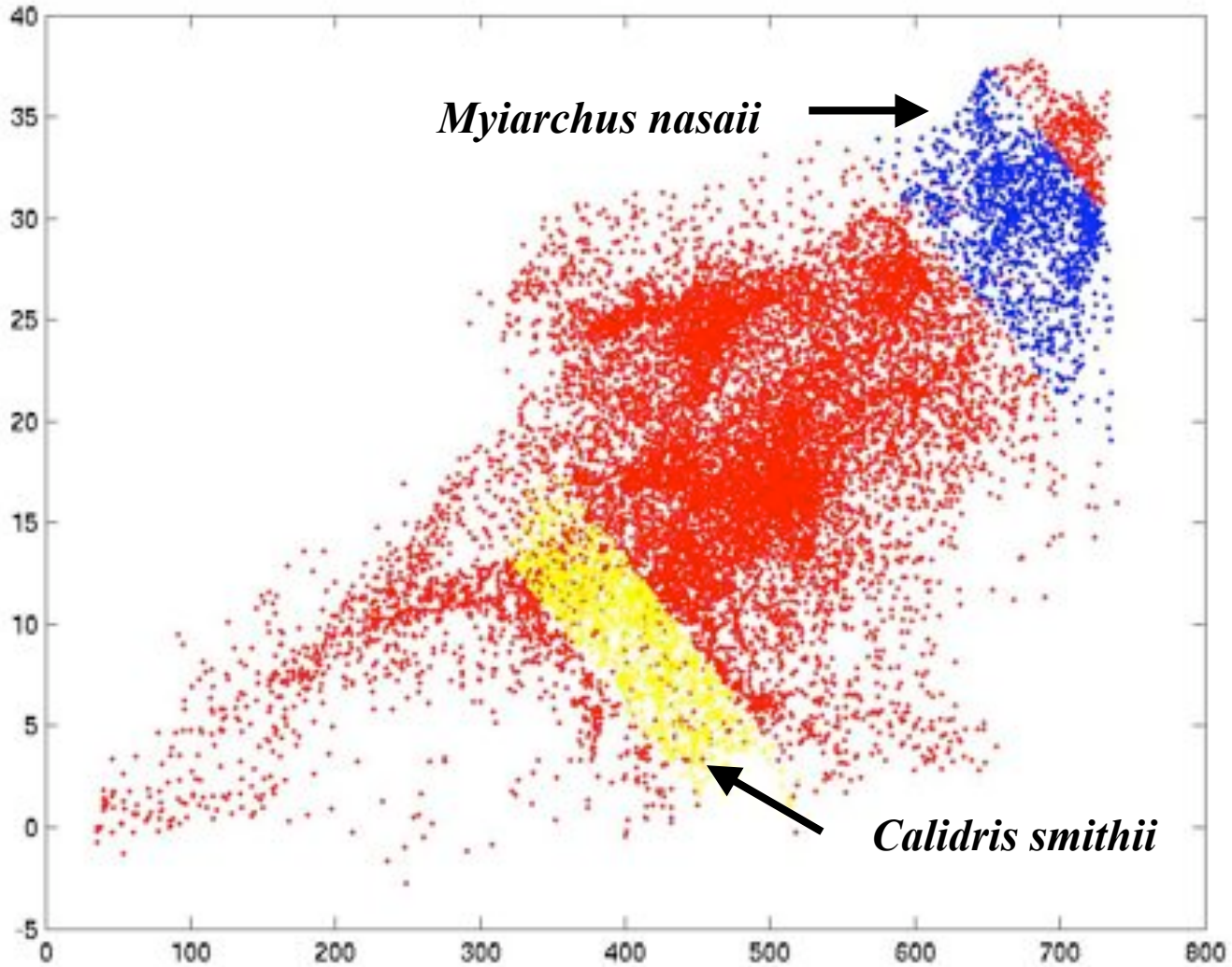


Solar Radiation

Northern Hemisphere in July

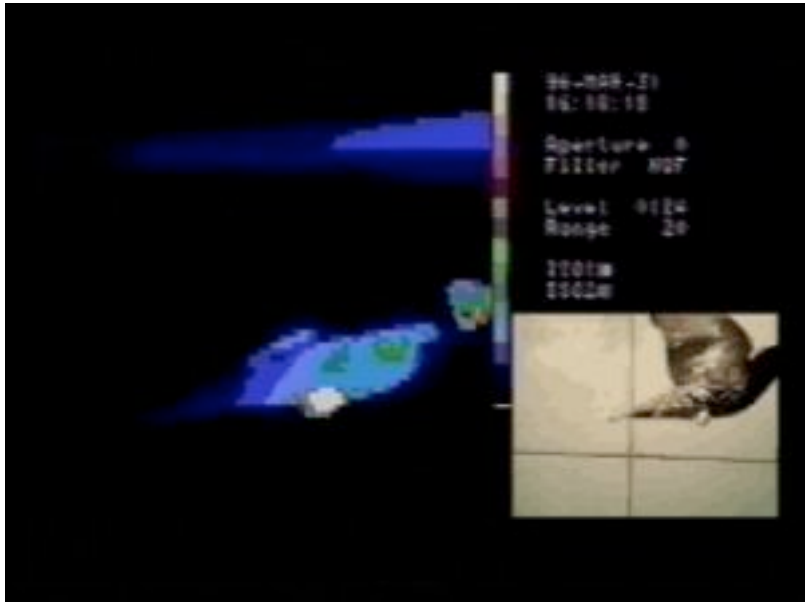


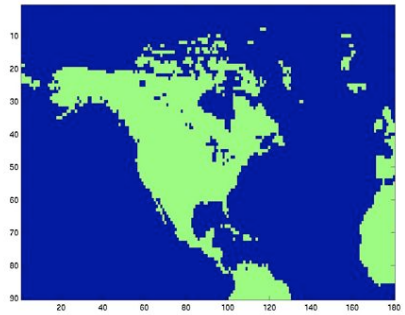
Virtual Birds

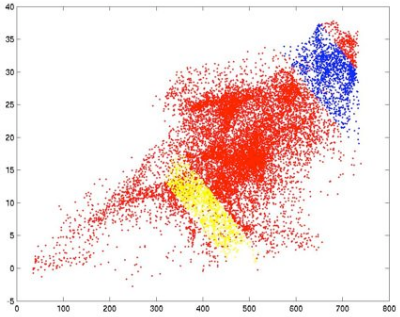


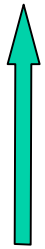
From climate to geographical space

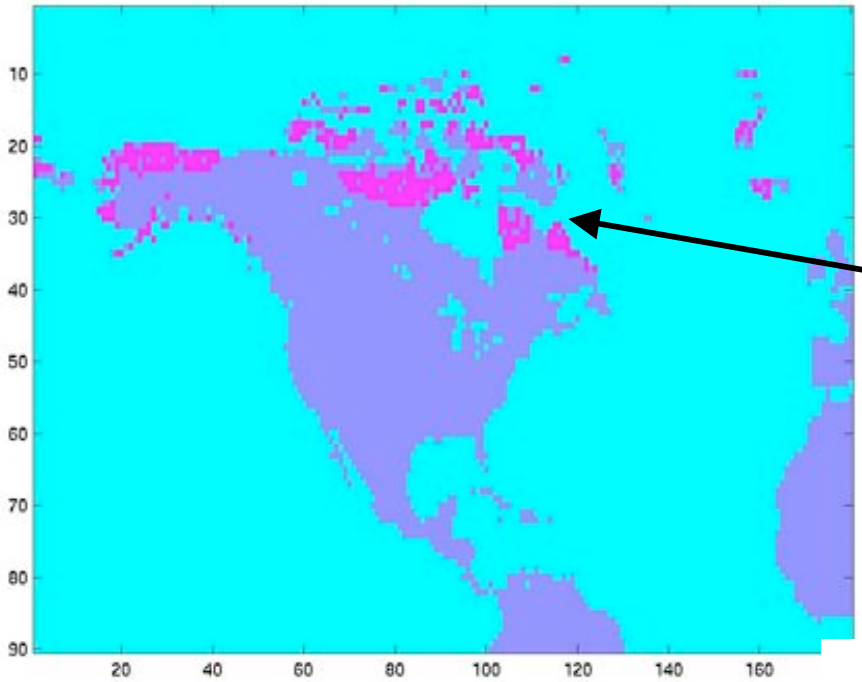
(Jeremy Rayner Leeds)







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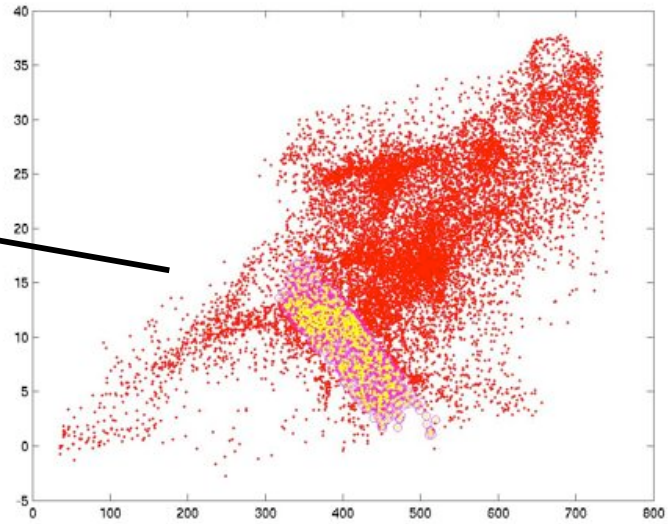
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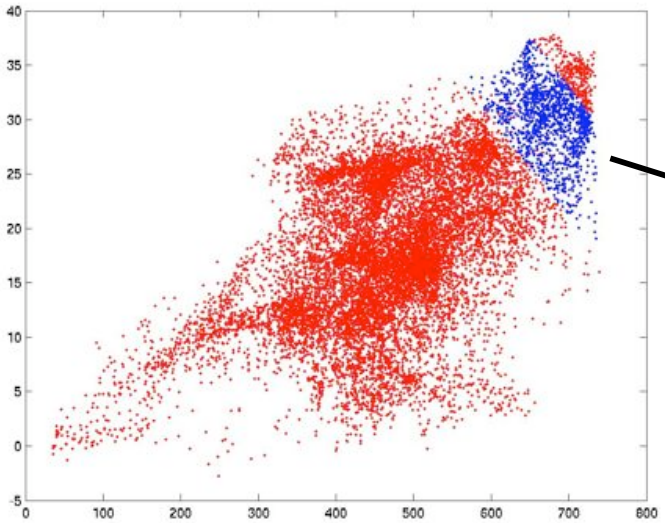
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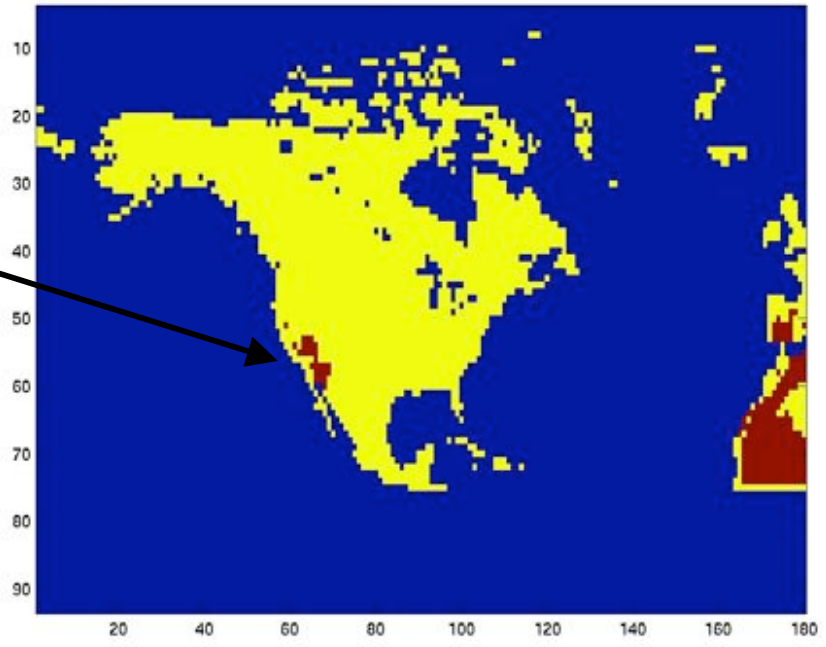
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Close Relatives

Semipalmated Sandpiper

Calidris pusilla

Habitat: Summers on tundra; winters on tidal flats.

Brown-crested Flycatcher

Myiarchus tyrannulus

Habitat: Arid or semiarid brush with saguaro cactus, streamsides, subtropical woodlands.

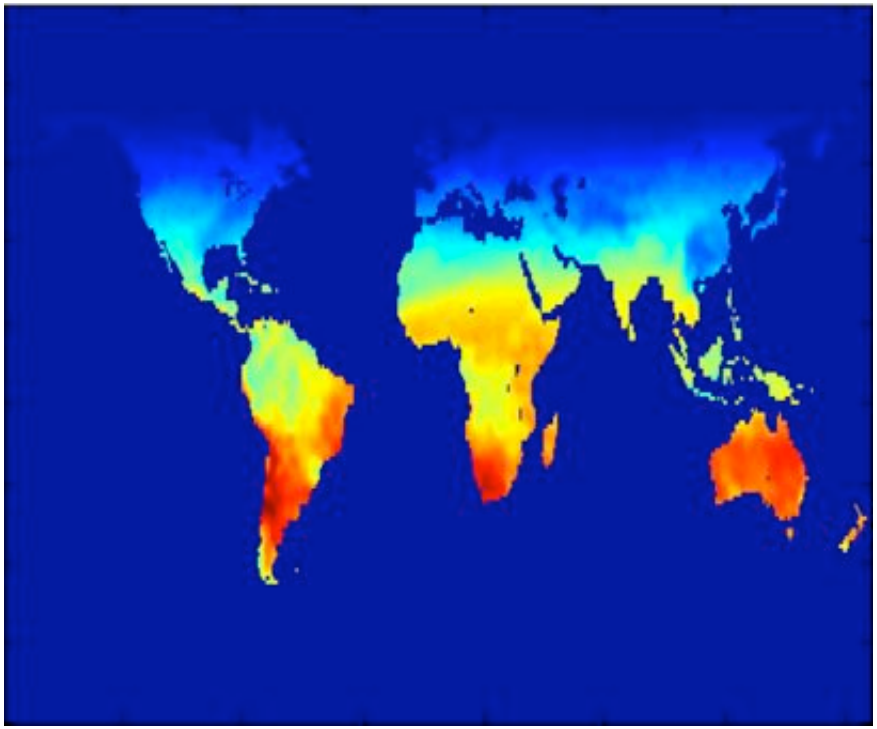
Bird Migration

"One morn the wind blowed cold and strong, And the Leaves went whirling away; The birds prepared for their journey long, that raw and gusty day."

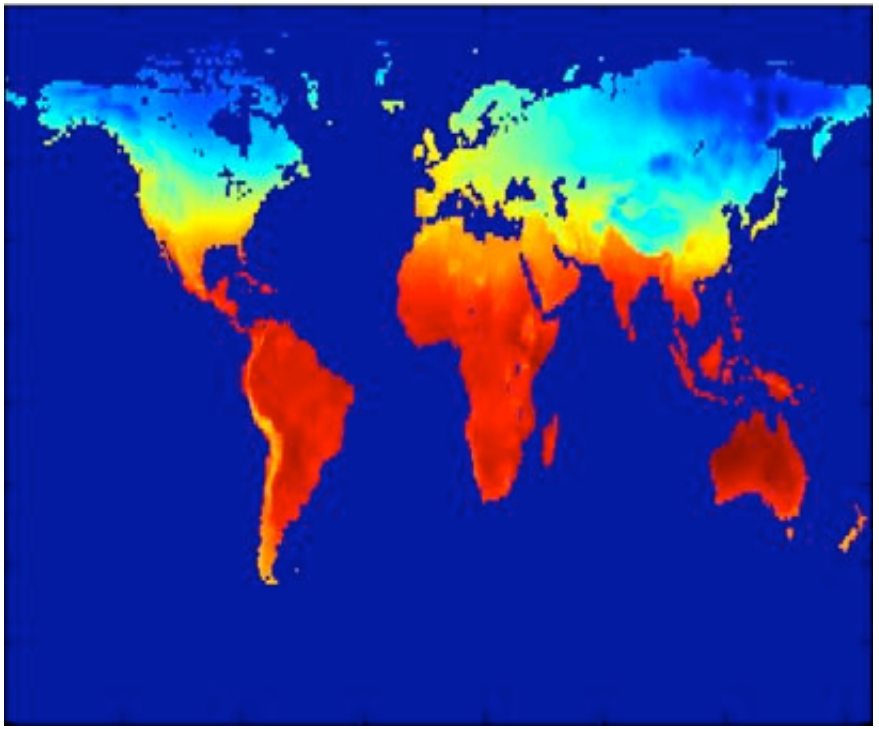
--Henry D. Thoreau

(National Geographic)

Rhythm of the Seasons

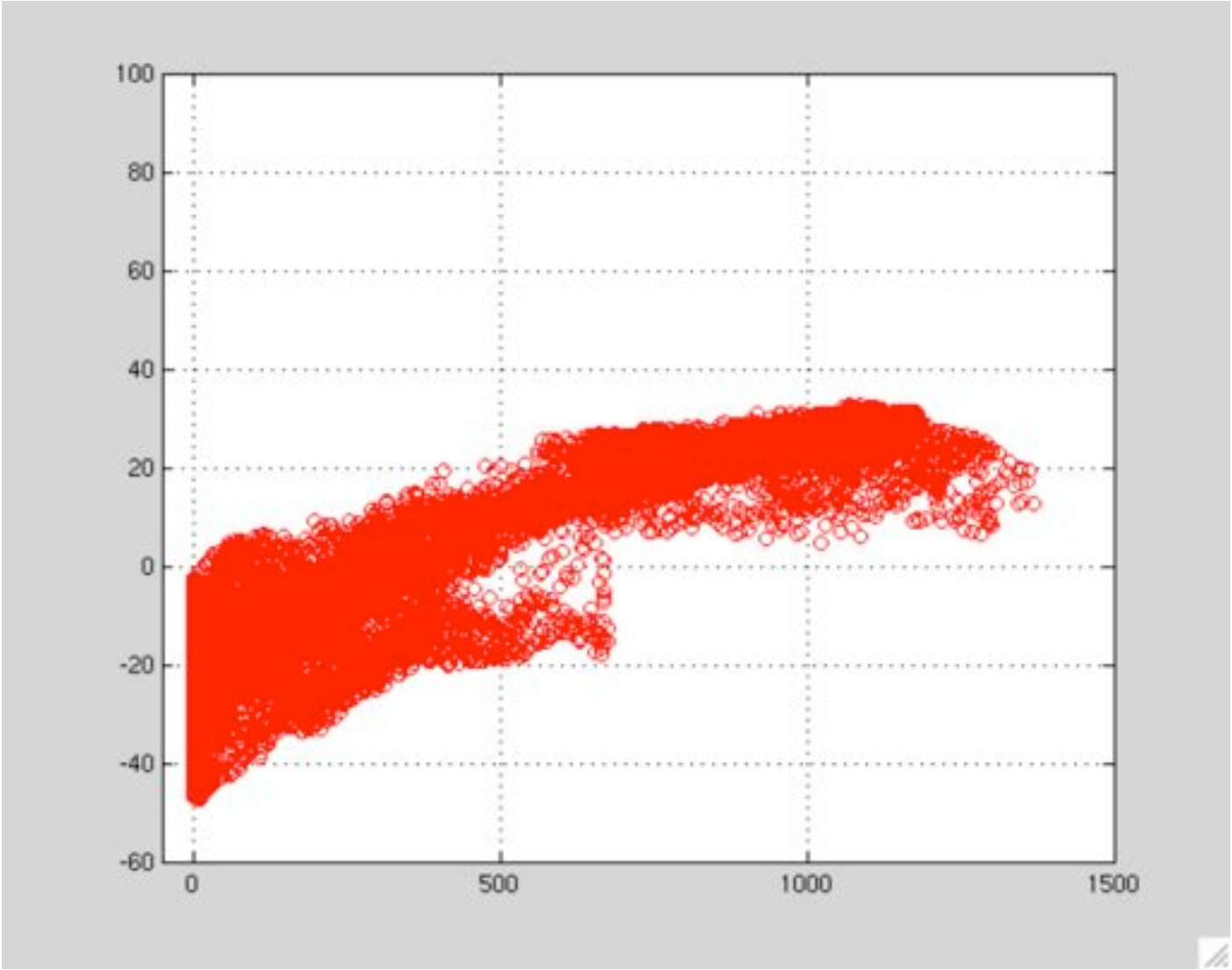


Solar Flux

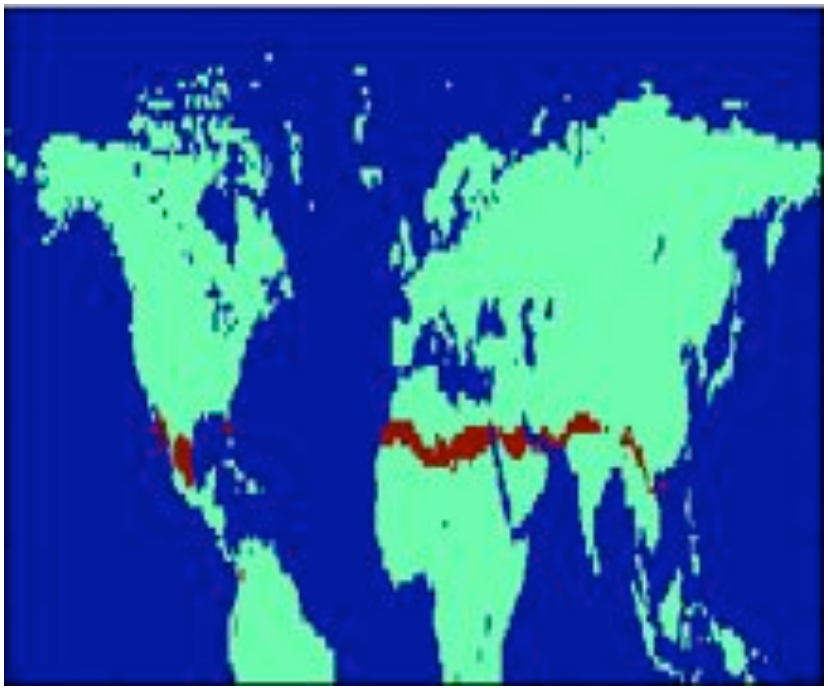


Air Temperature

Climate Space Dynamics



Bird Migration Example

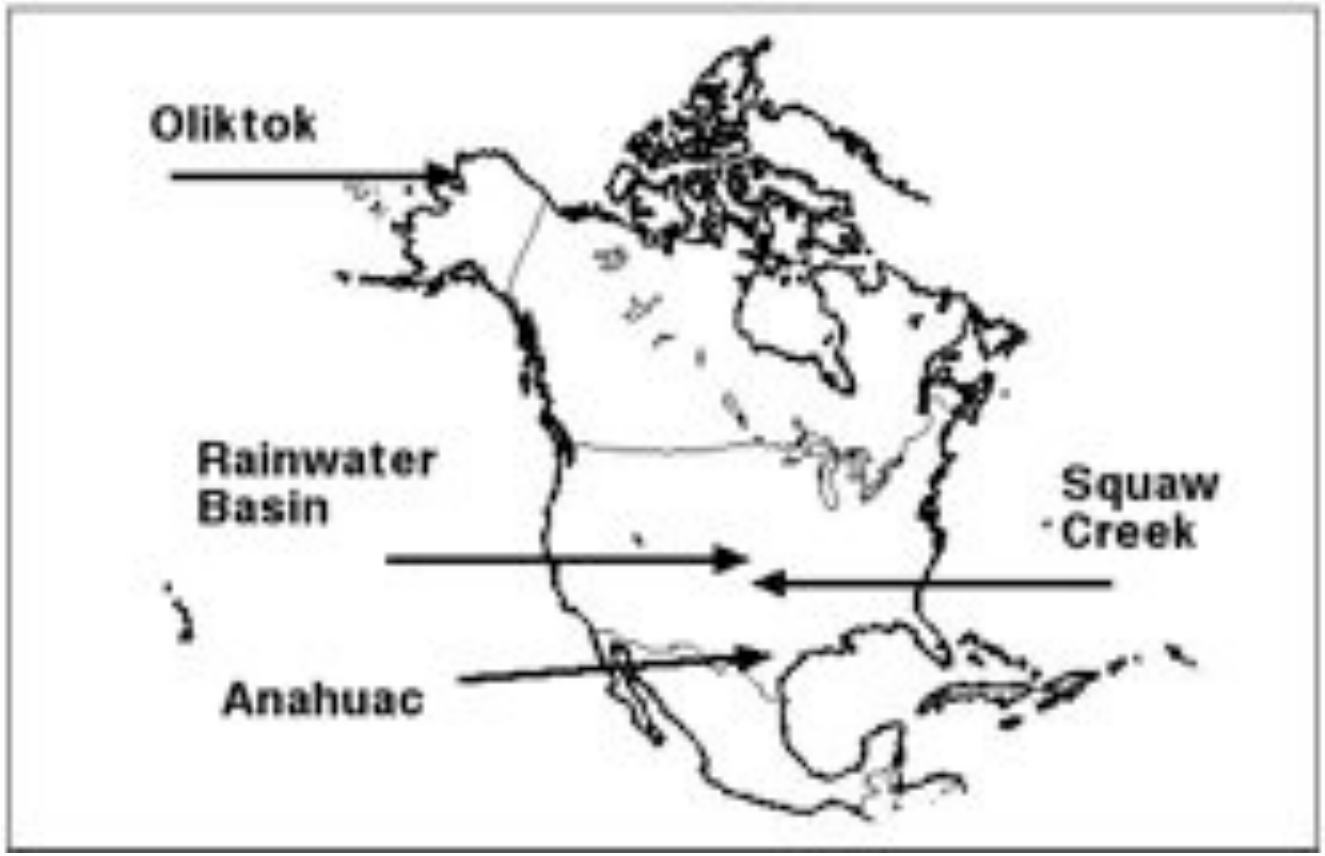


Real Birds, Observations--Decision Support

- Migratory shorebirds
  - Wetlands (Ramsar Convention)
  - Trans Gulf Express (Meso America)
  - Avian Influenza
- Observations
  - Arrival time distributions
  - Residence time distributions
  - Fat distribution levels

Dynamic State Variable Modeling with Various Optimization Landscapes

Pectoral Sandpiper



Avian Energetics - "Let Them Eat Cake"

Daily Energy Budget =
f(time budget, habitat quality, ingestion and climatic factors)

Daily Time Budget =
f(time migrating, time resting, and time feeding)

Time and Energy budgets determine bird state--latitude and energy reserves

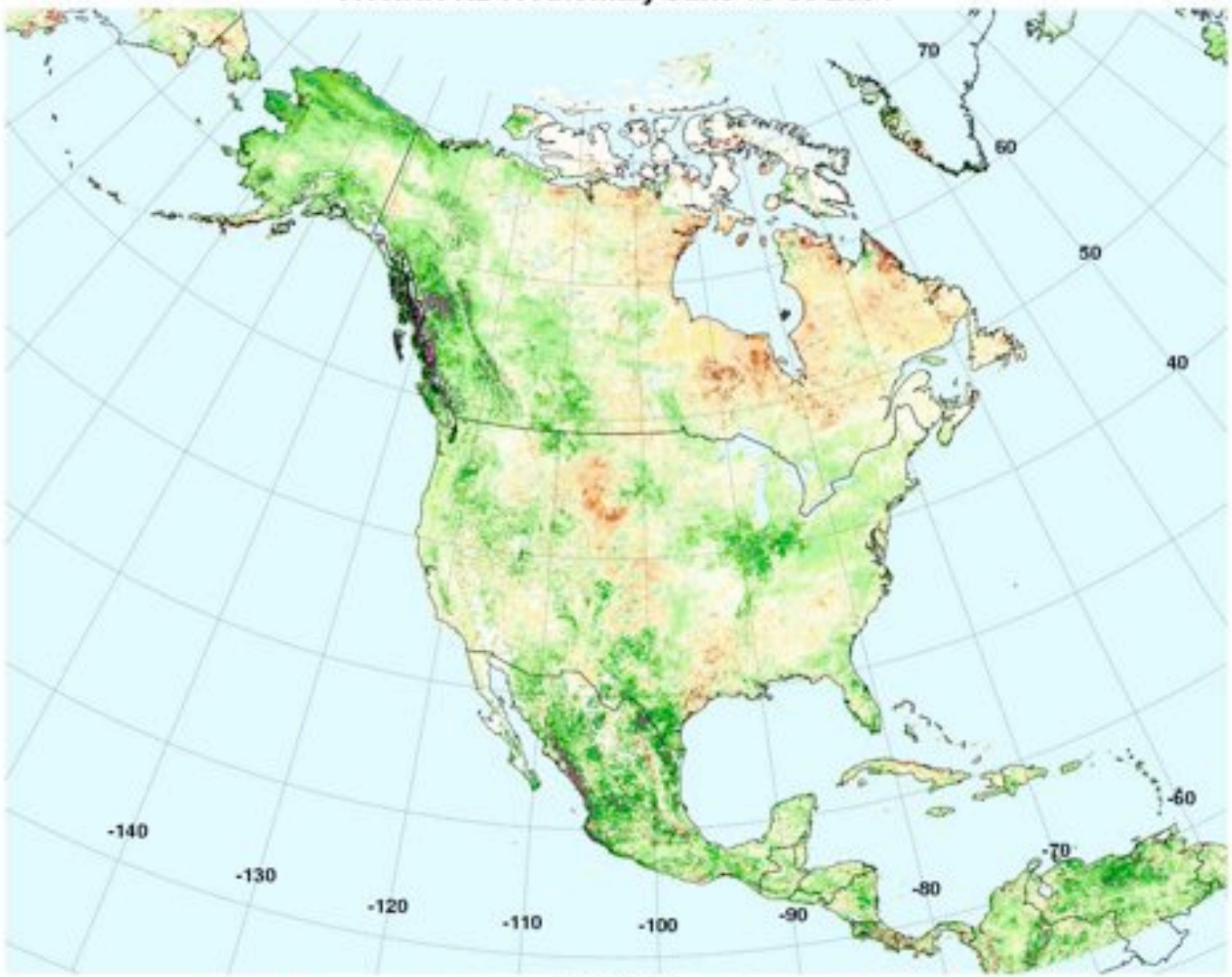
Current USGS 'DSS' Status

- Derive driving climatic/weather variables from met stations
- Have hooks for ingest "quality", but no gis/real time
- Has been run used at stop-over/refuge way-stations
- Relys on National Wetlands Inventory

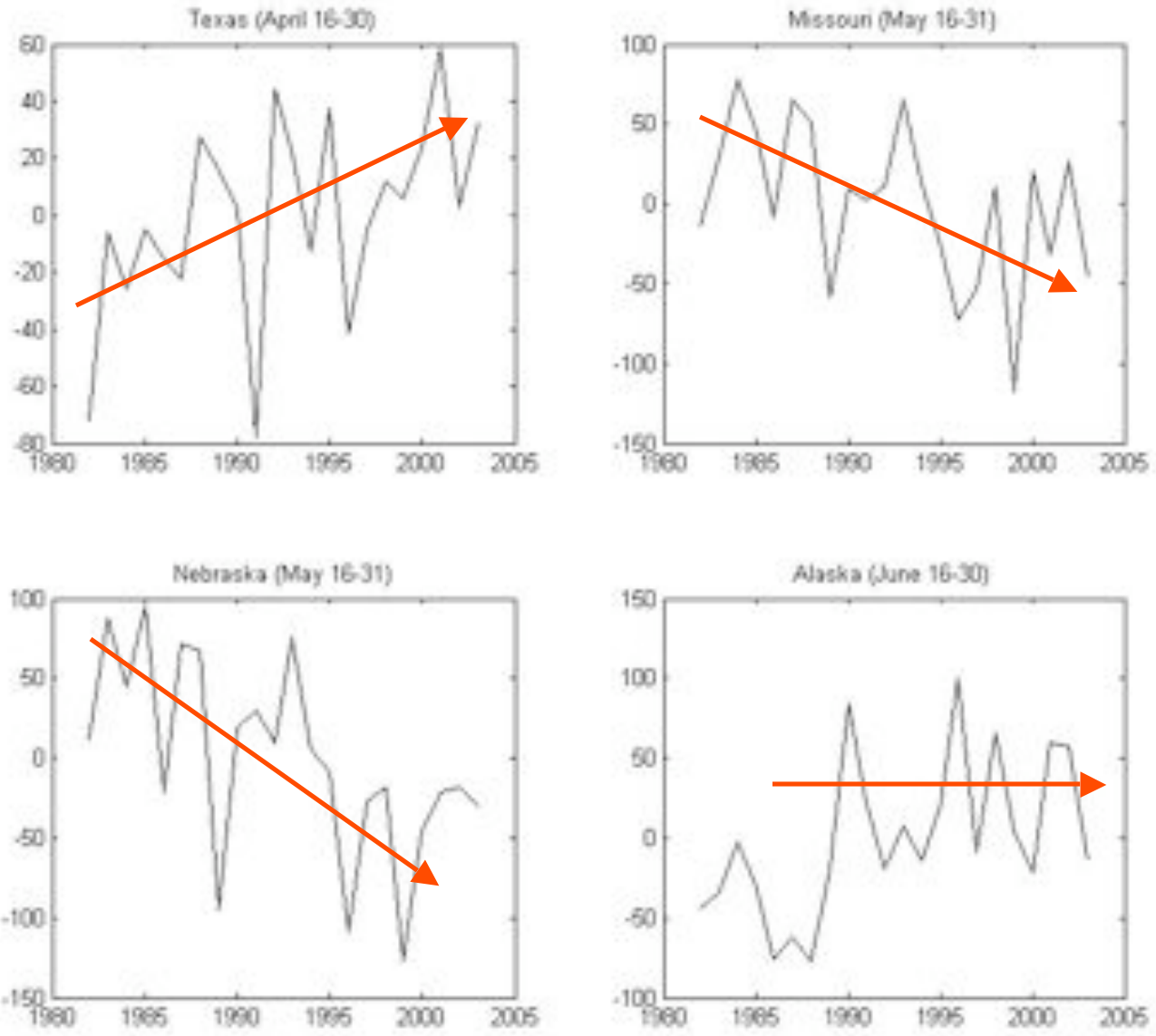
(Computational Challenges)

(Farmer and Wiens)

AVHRR NDVI Anomaly June 16-30 2004



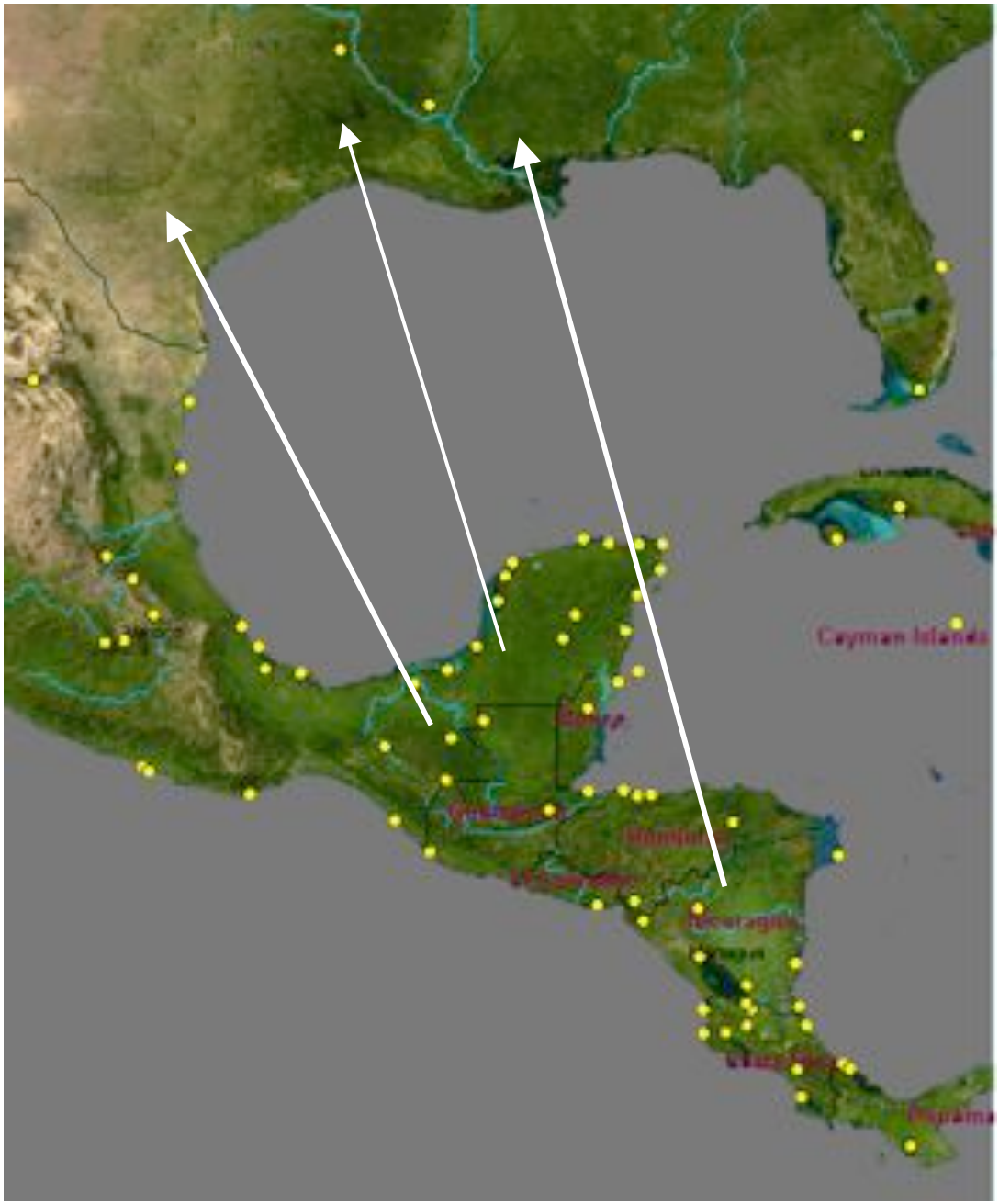
Stop-Over Sites



Site Quality

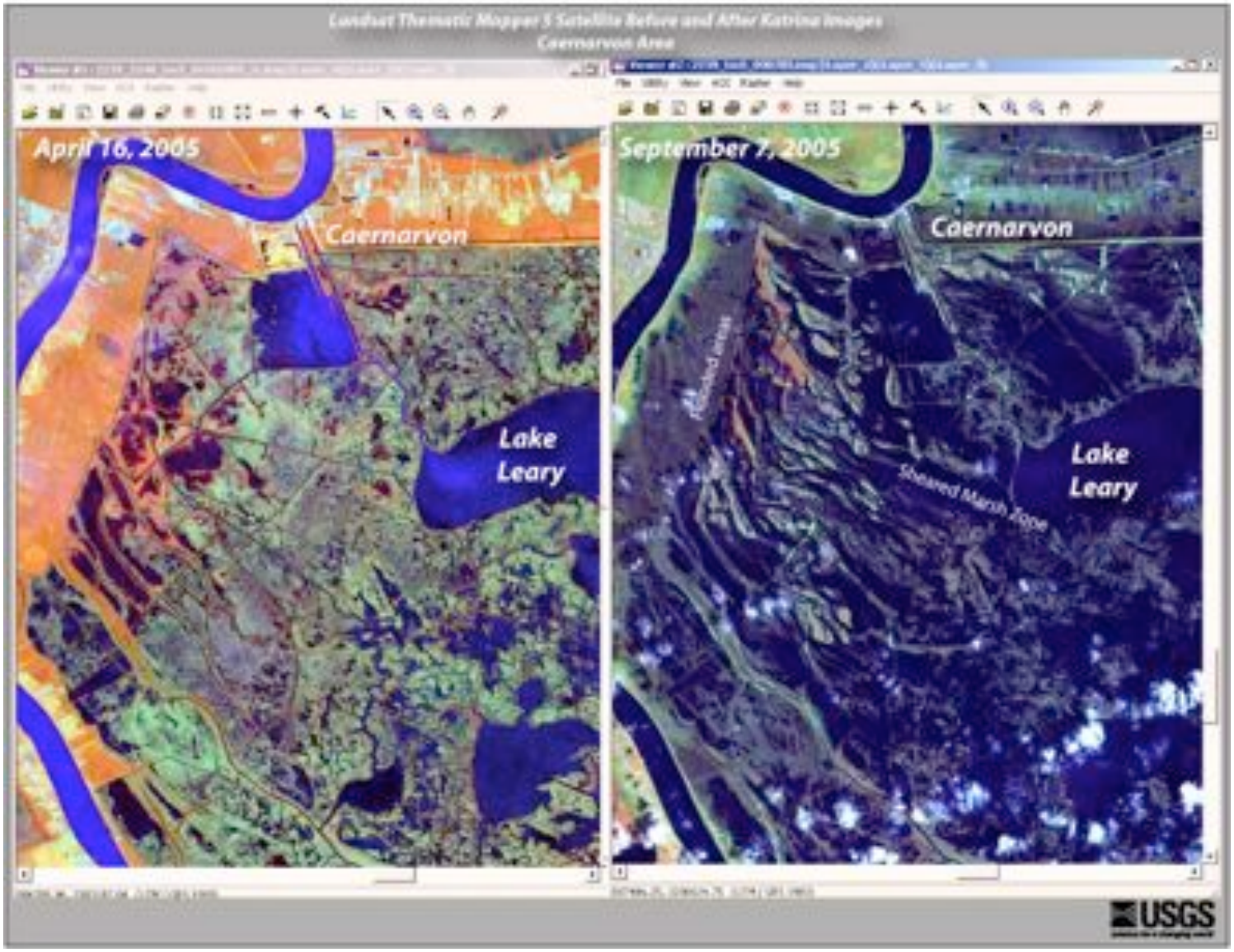
(Molly Brown)

Inter-Annual Variation

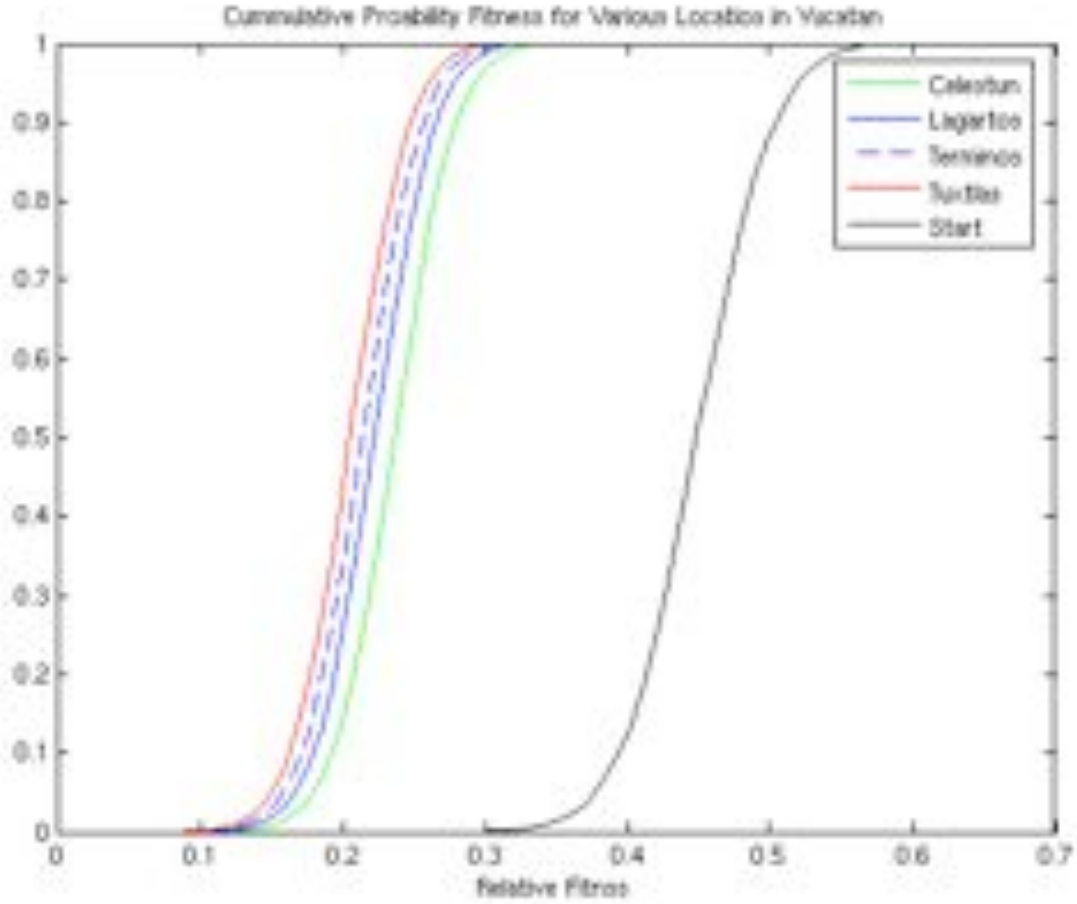


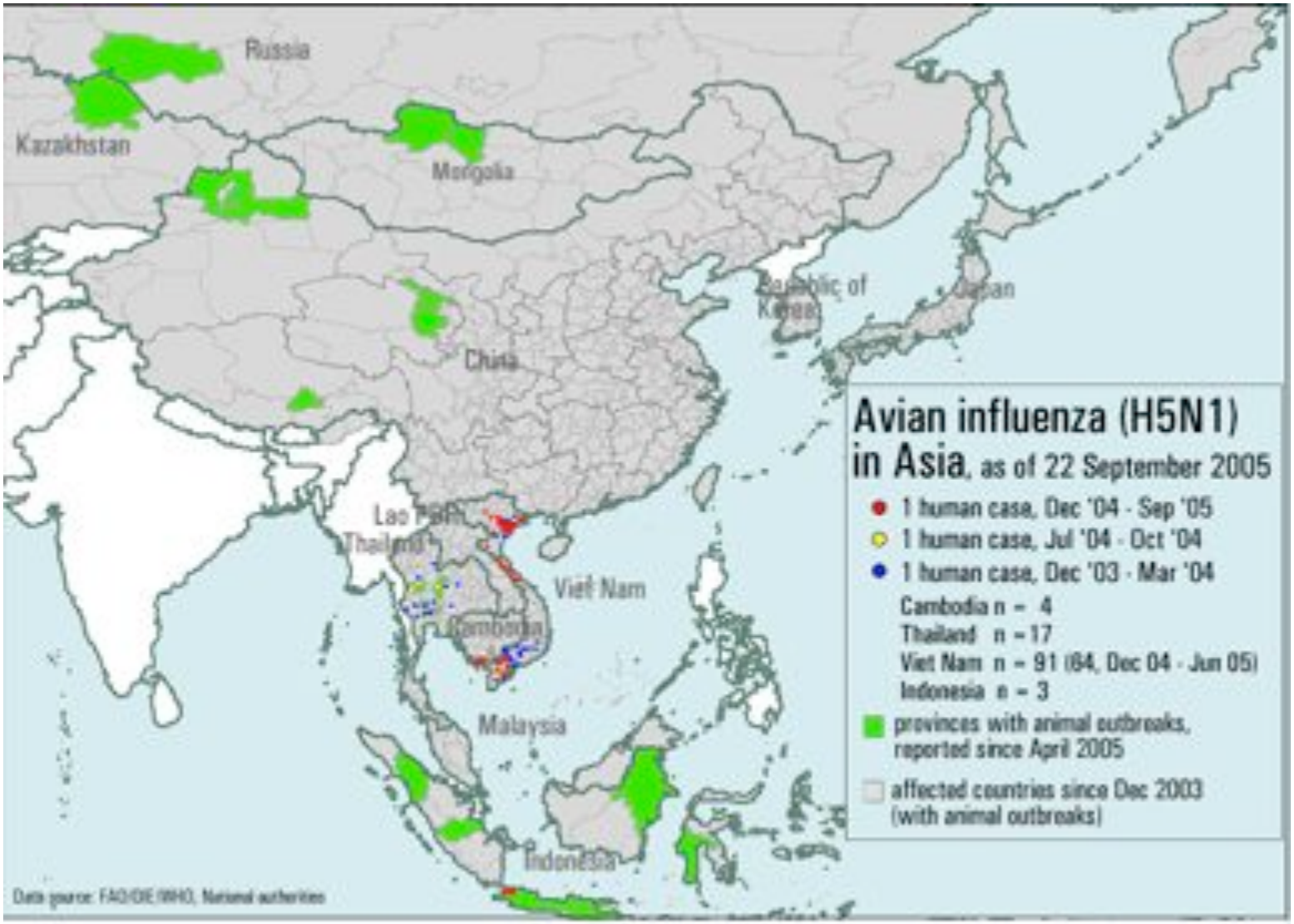
Trans Gulf Express

Fire Escape -- Manage to Variability



Identify "Full-Service -- Fire Escape"

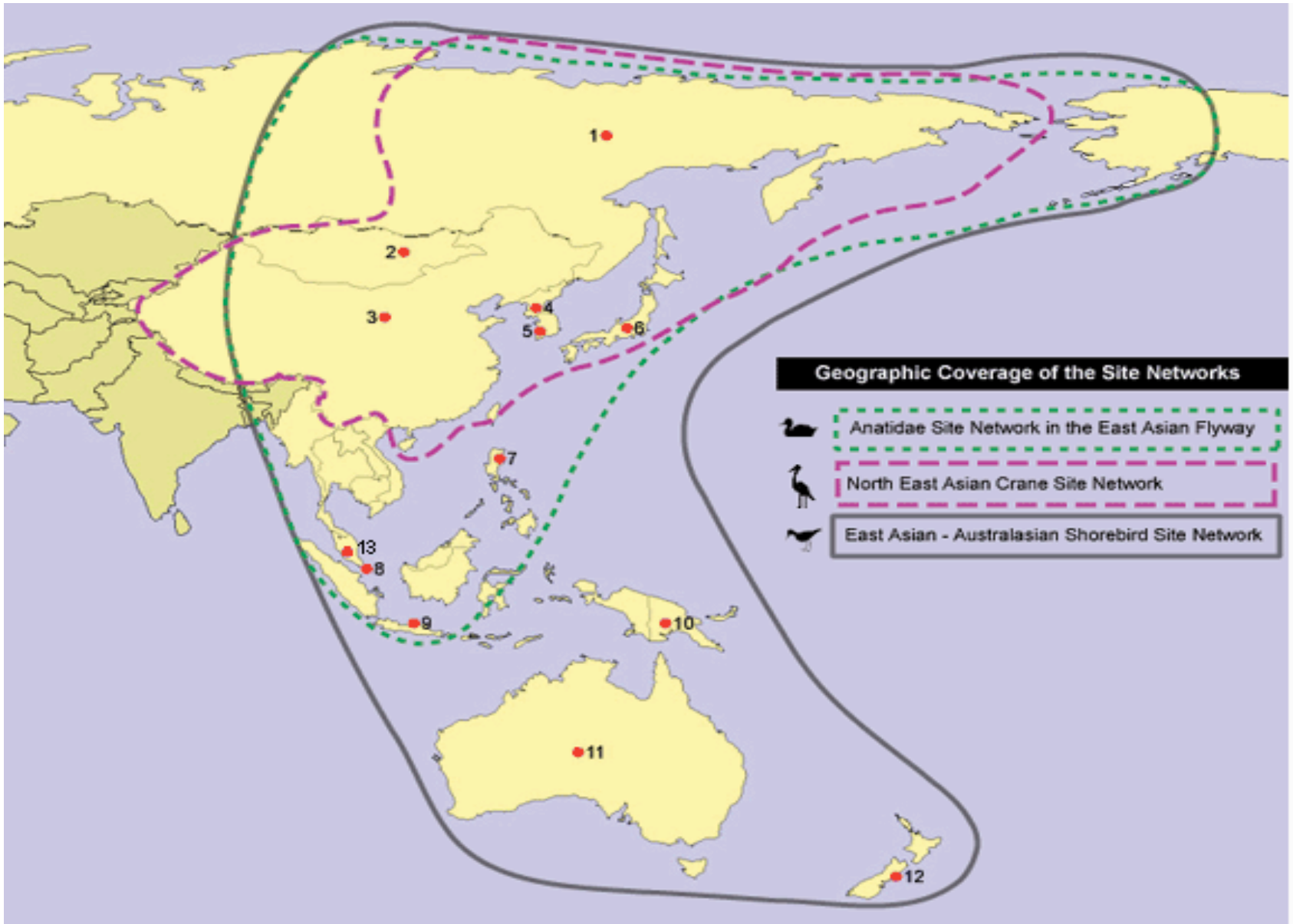




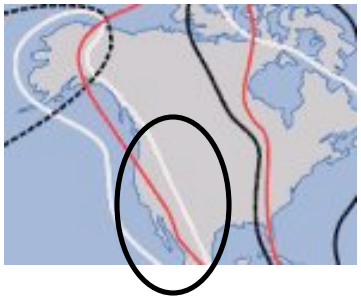
Disclaimer: The presentation of material on the maps contained herein does not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or areas or its authorities of its frontiers or boundaries.

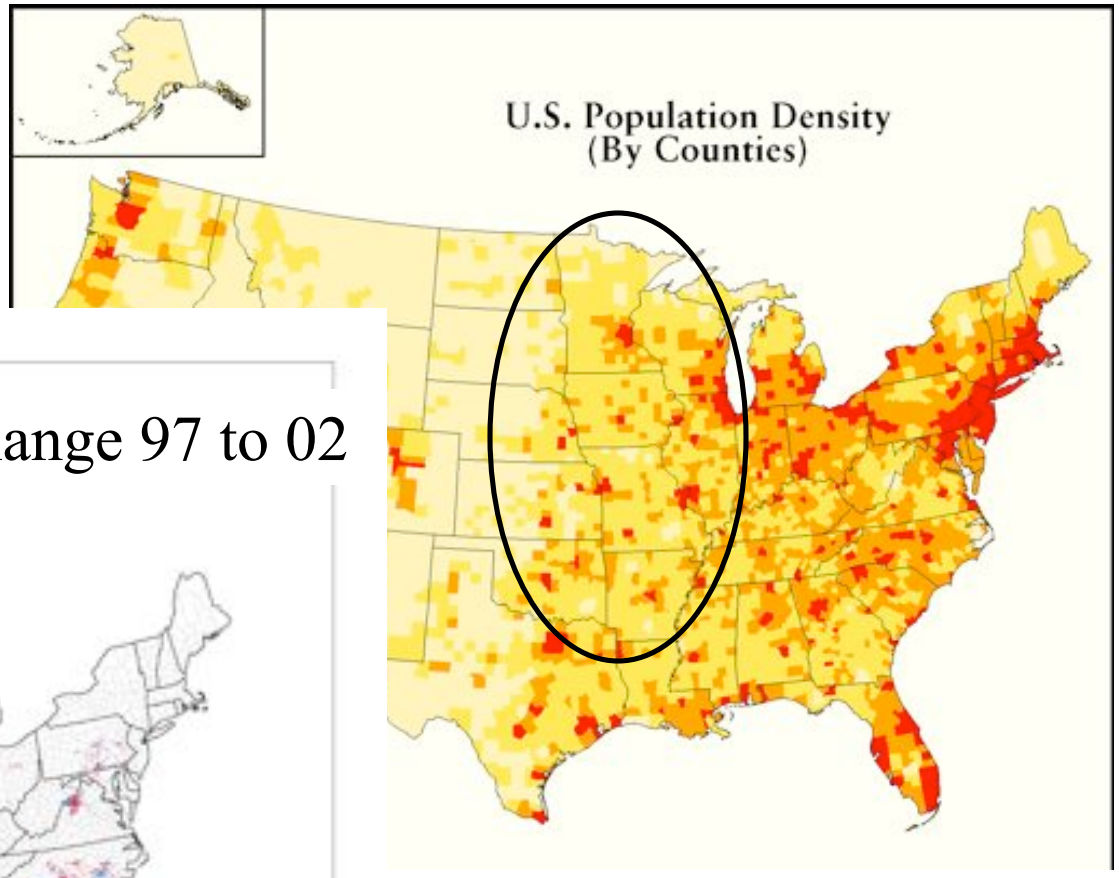
(Wetlands International)

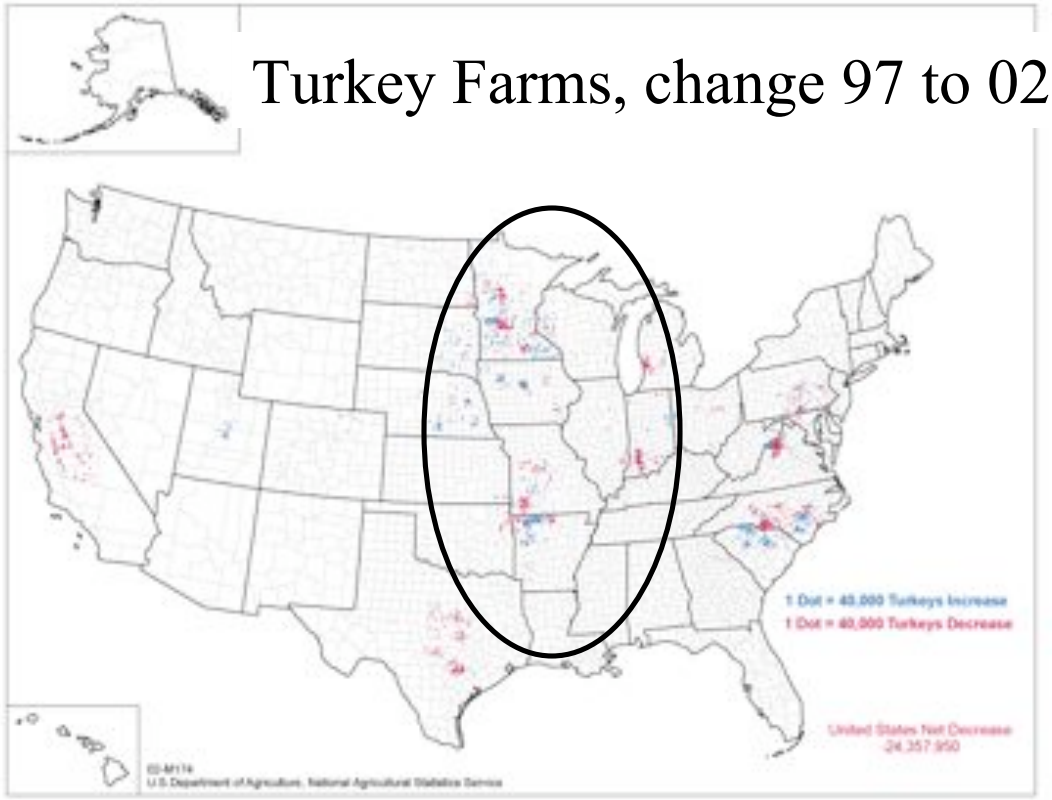
International Site Networks for migratory waterbirds in the East Asian-Australasian Region established under the Asia-Pacific Migratory Waterbird Conservation Strategy



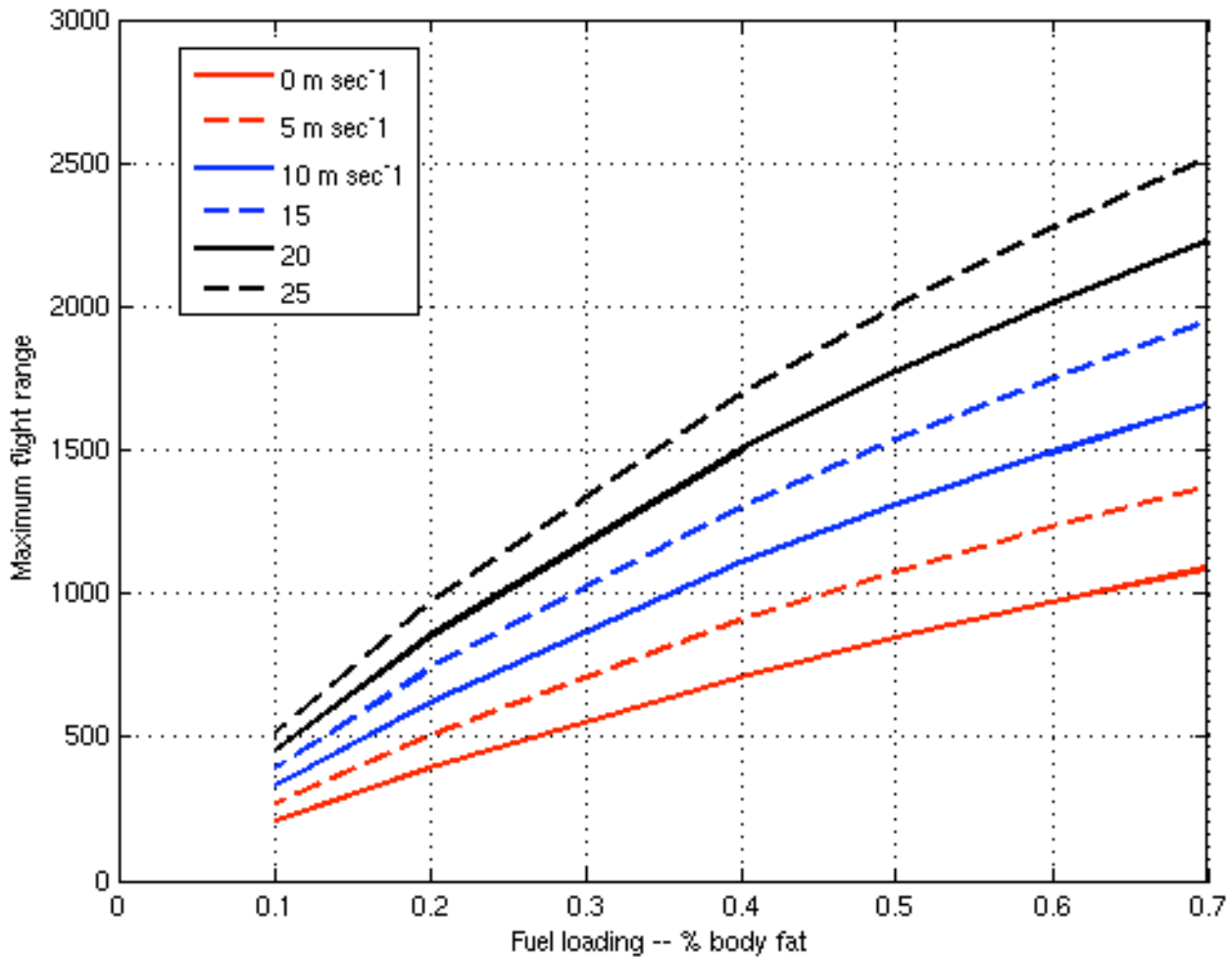
Turkey Farm Distributions







3D Wind Fields -- Trajectory Analysis



Pectoral Sandpiper

Pennycuick (1989)

Summary - "Space-Based Biophysical Ornithology"

- Start Simple -- What can we learn?
- Shorebird Migration -- Decision Support

Challenges -- Long distance tracking?

Swenson, George,W., Martin Wikelsi, and James A. Smith.
Tracking very-low-power ground transmitters from near earth orbit.
IGARSS 04