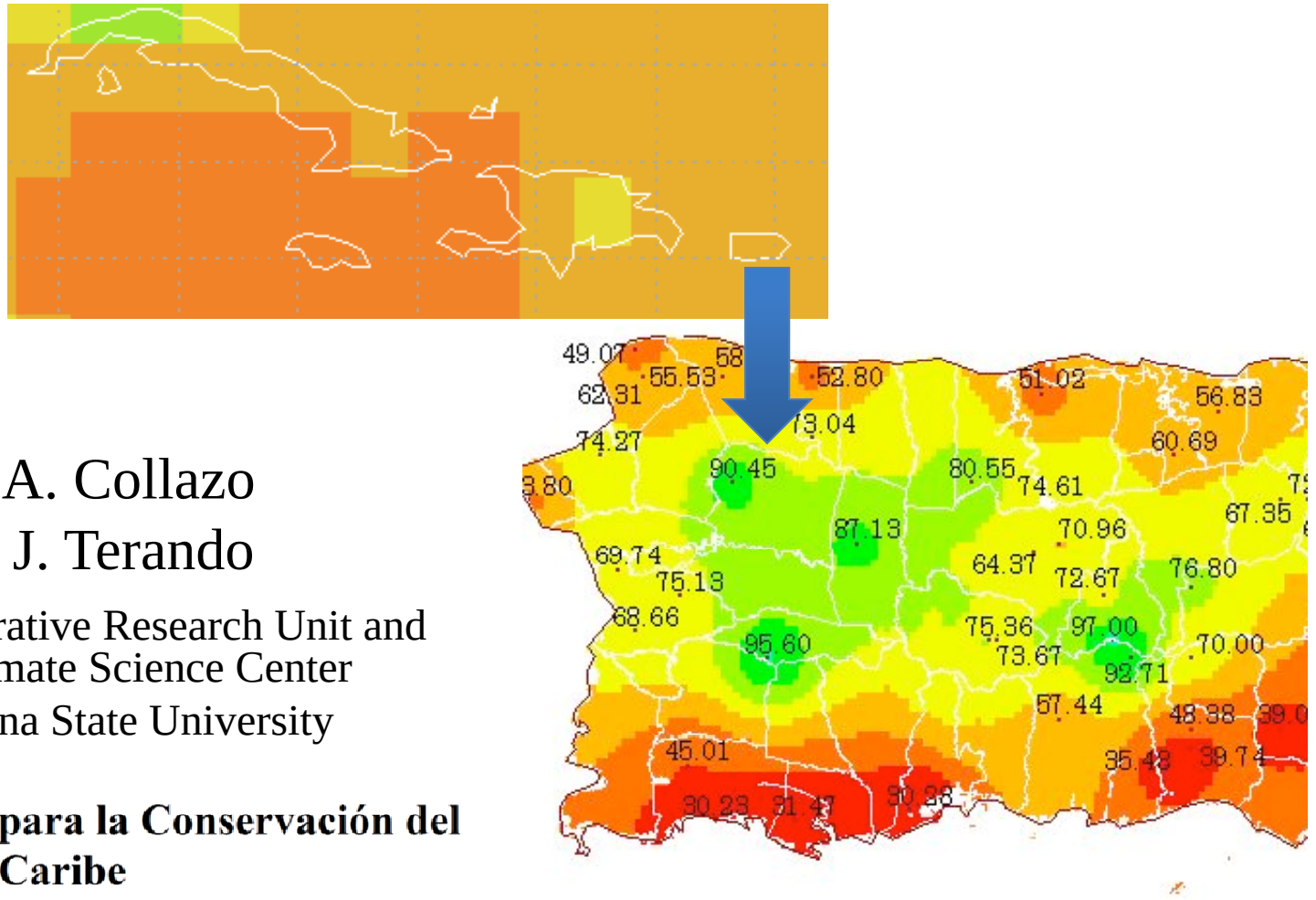
Developing high-resolution, island-centric projections of ecologically relevant climate variables for Puerto Rico: a foundation for adaptation strategies.



Jaime A. Collazo

Adam J. Terando

USGS NC Cooperative Research Unit and
Southeast Climate Science Center
North Carolina State University

Cooperativa para la Conservación del Paisaje en el Caribe

In the context of climate change planning…

adaptation generally refers to human activities intended to minimize the adverse effects of climate change on human infrastructure and *sensitive aspects of the natural environment*.

ADAPTATION STRATEGIES DEFINED

MAWDSLEY ET AL. 2009, CONBIO

Interest and Motivation

- Shifting ranges
  - Animal/Plant distribution & abundance

- Vital rates
  - Persistence?

EFFECTS ON WILDLIFE AND HABITATS

LAWLER, J. 2009, ANNALS NY ACAD. SCI.

Insularity presents unique challenges

For many tropical, insular species, “positive niche” tracking may be an extremely limited or impossible option.

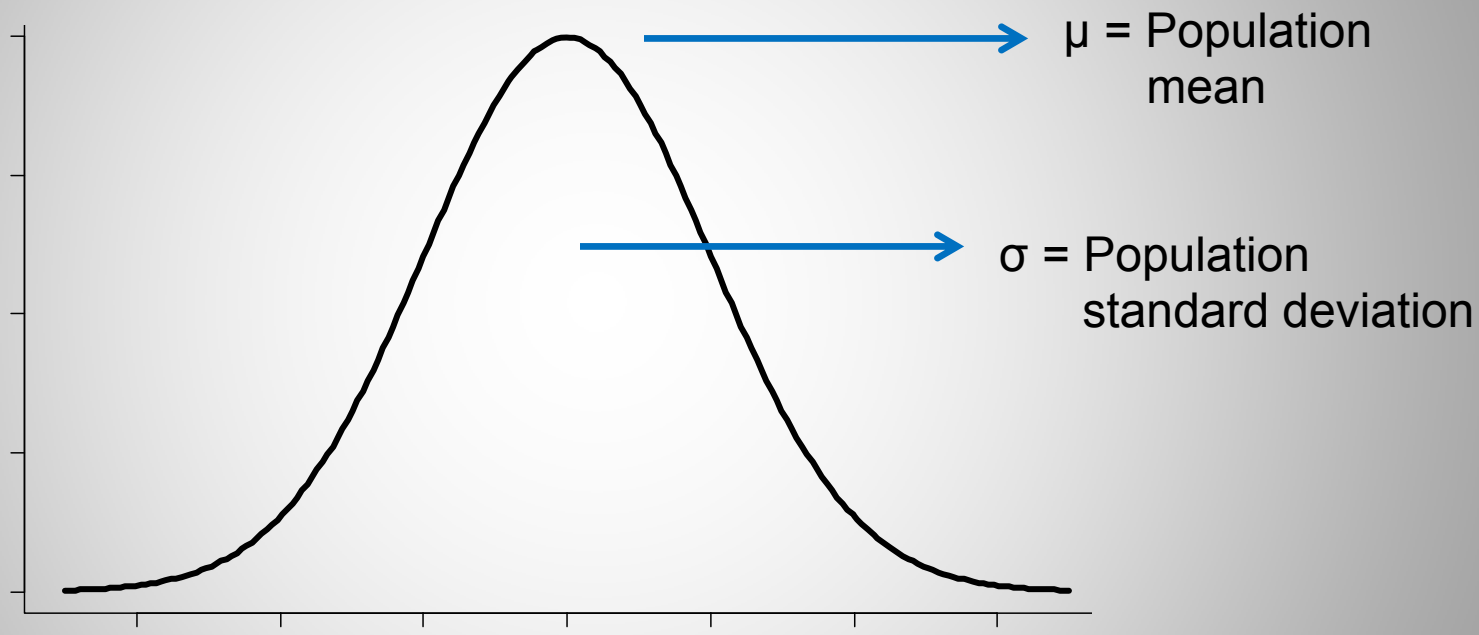
Two competing processes:

a) *in-situ* adaptation (long-lived species disadvantaged)

b) Extinction

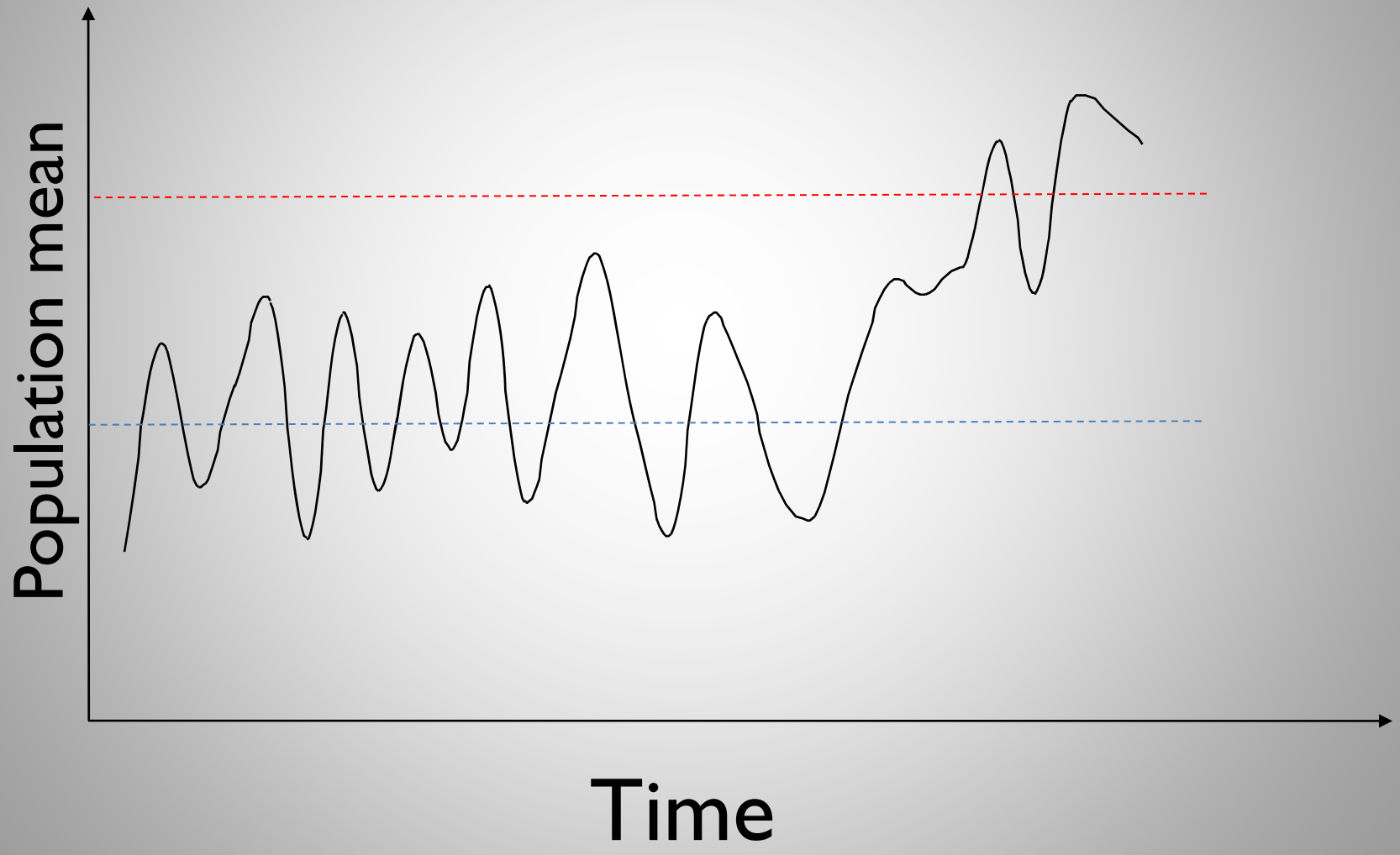
Acknowledge that projections based on historical information and experiences may not be appropriate in a changed or changing system—non-stationarity.

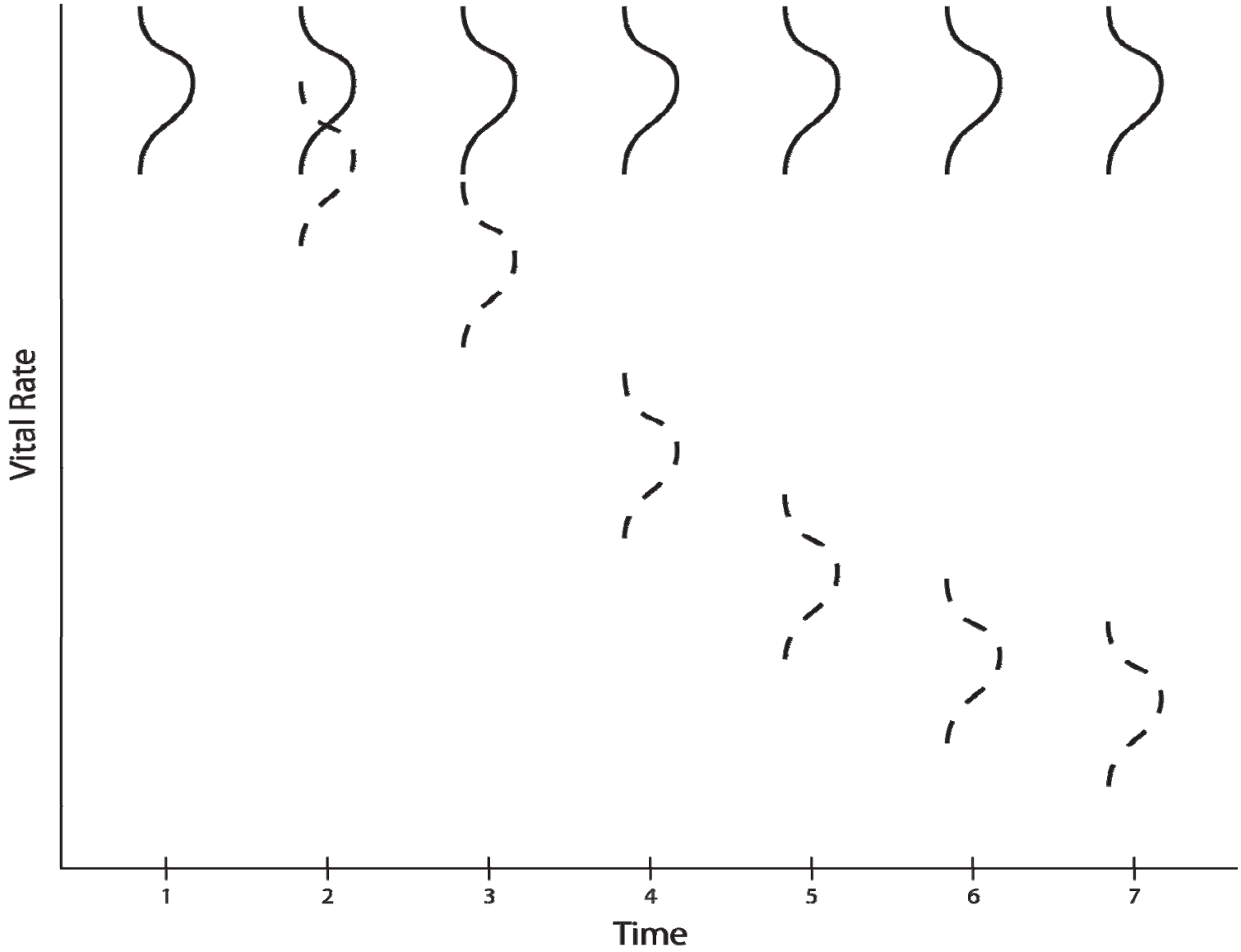
Stationarity?



Uncertain about parameters that describe the process, but assume the process is stable

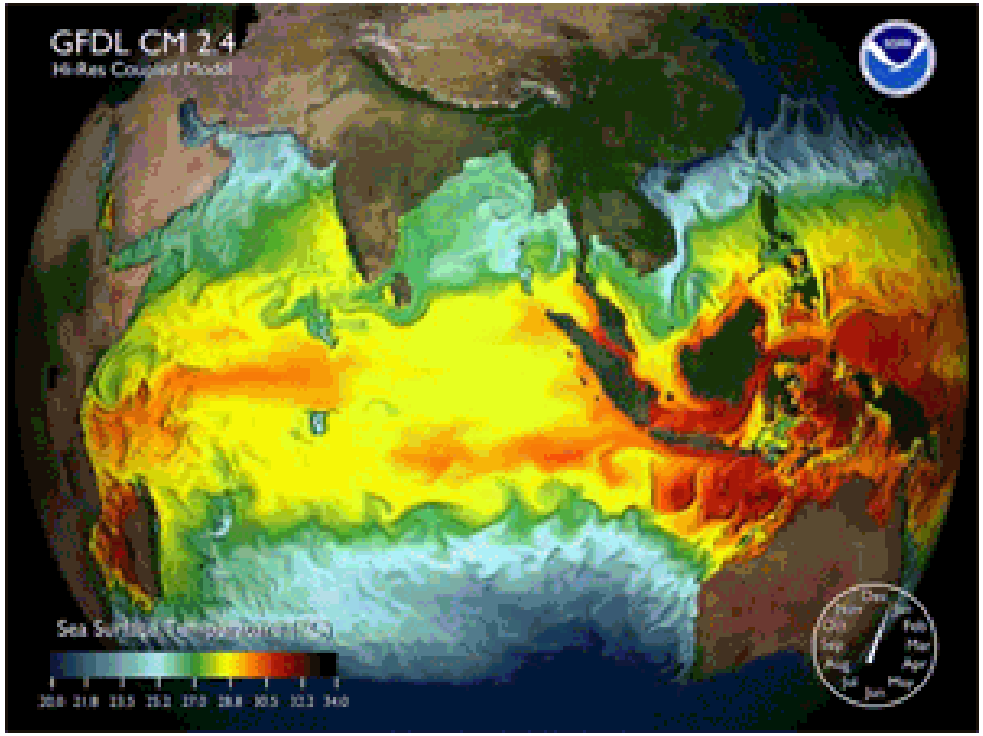
Non-Stationarity?



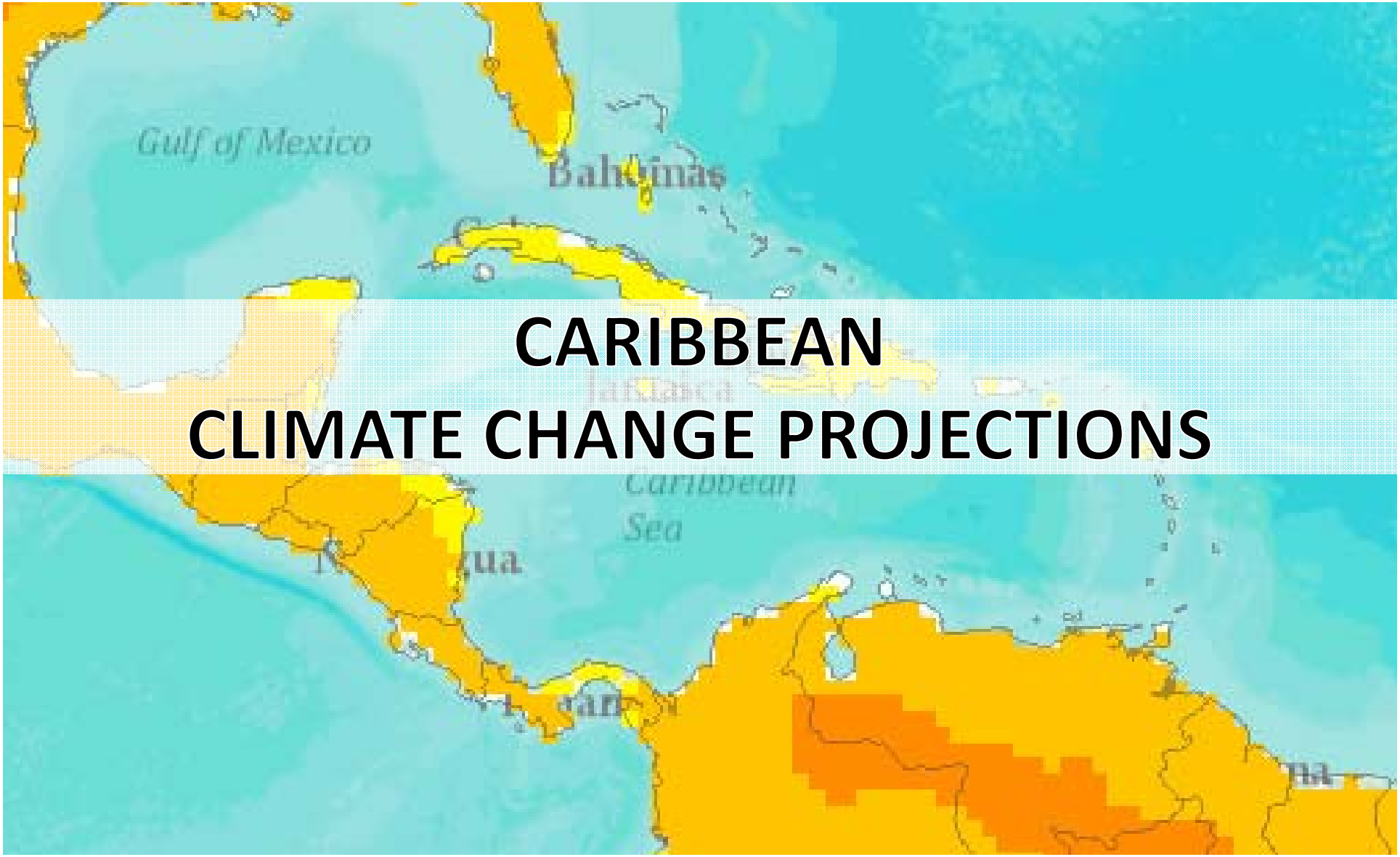


DYNAMIC RATHER THAN STATIC CONTEXT

GLOBAL CLIMATE MODELS
"Virtual Planets"



Simulate the climate system based on laws of thermodynamics and physical laws that govern the motion of a fluid.



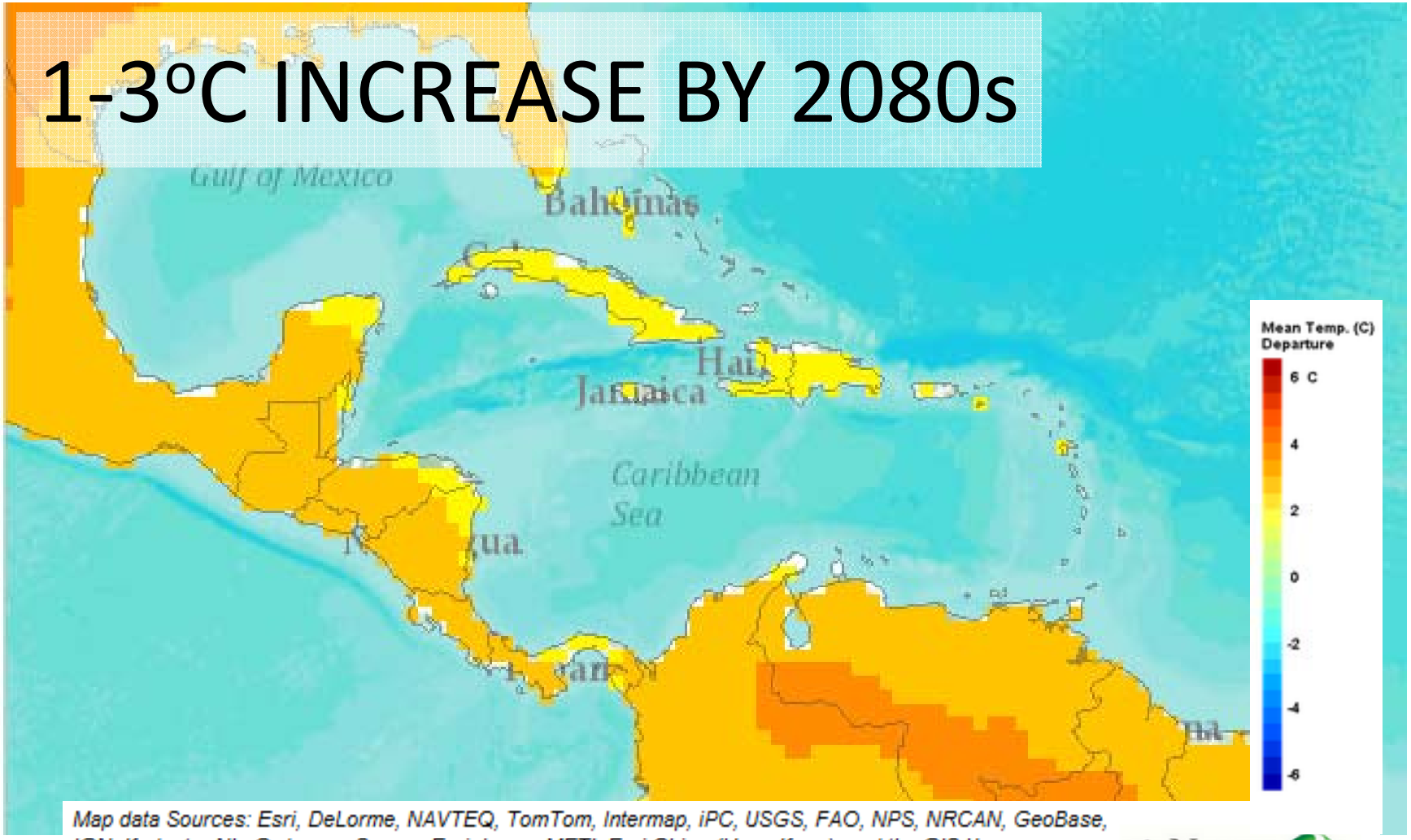
CARIBBEAN
CLIMATE CHANGE PROJECTIONS

Map data Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Data Source: Historical Global 50km: Climatic Research Unit and the Tyndall Centre. Mitchell et. al.
http://cru.csi.cgiar.org/PDF/mitchelljones.pdf

The Nature Conservancy
Protecting nature. Pres

1-3°C INCREASE BY 2080s



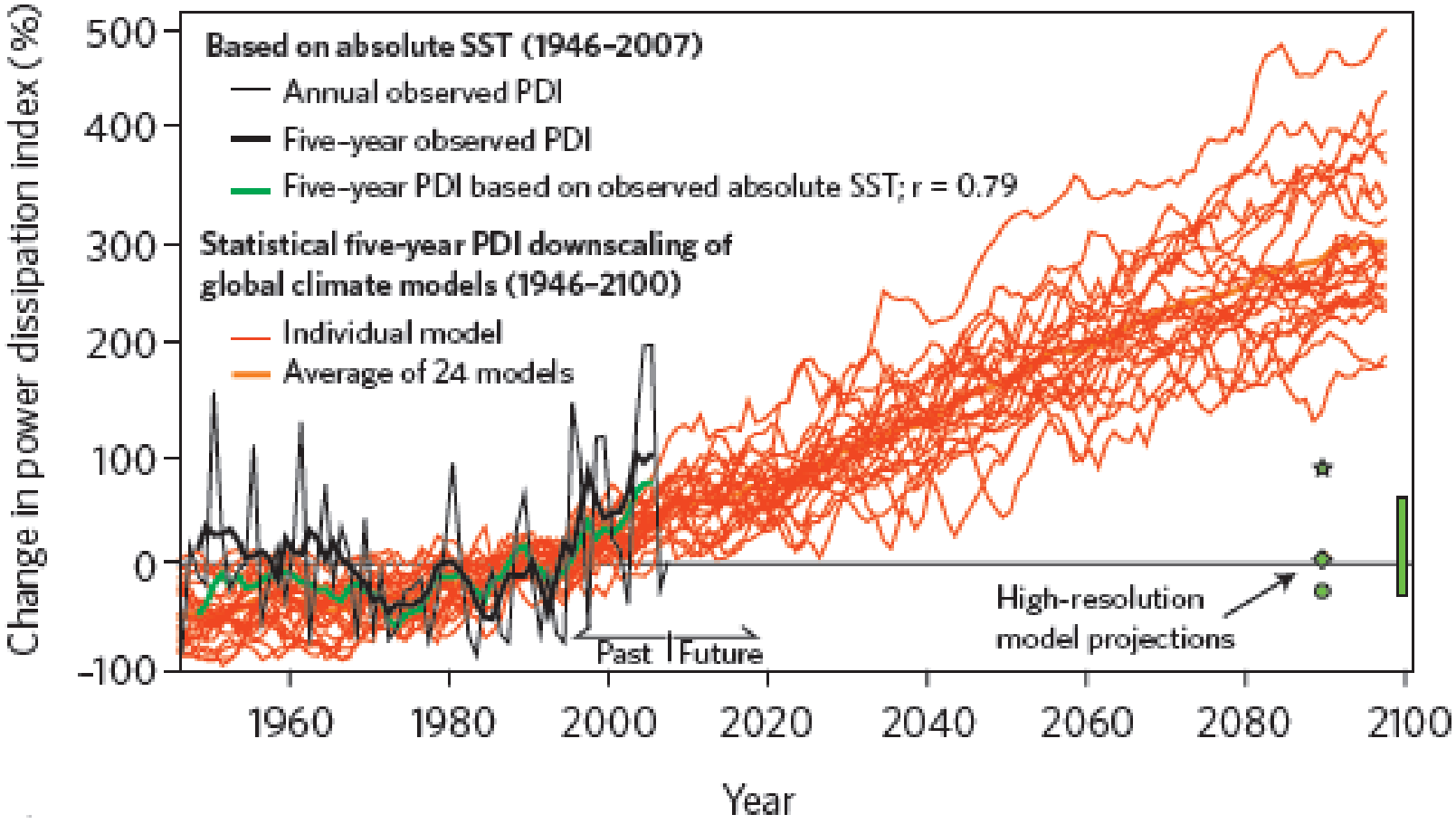
Map data Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Data Source: Historical Global 50km: Climatic Research Unit and the Tyndall Centre. Mitchell et. al.
http://cru.csi.cgiar.org/PDF/mitchelljones.pdf

The Nature Conservancy
Protecting nature. Preserving life.™

CARIBBEAN CLIMATE WARMER AND (possibly) DRIER AS GLOBAL TEMPS RISE

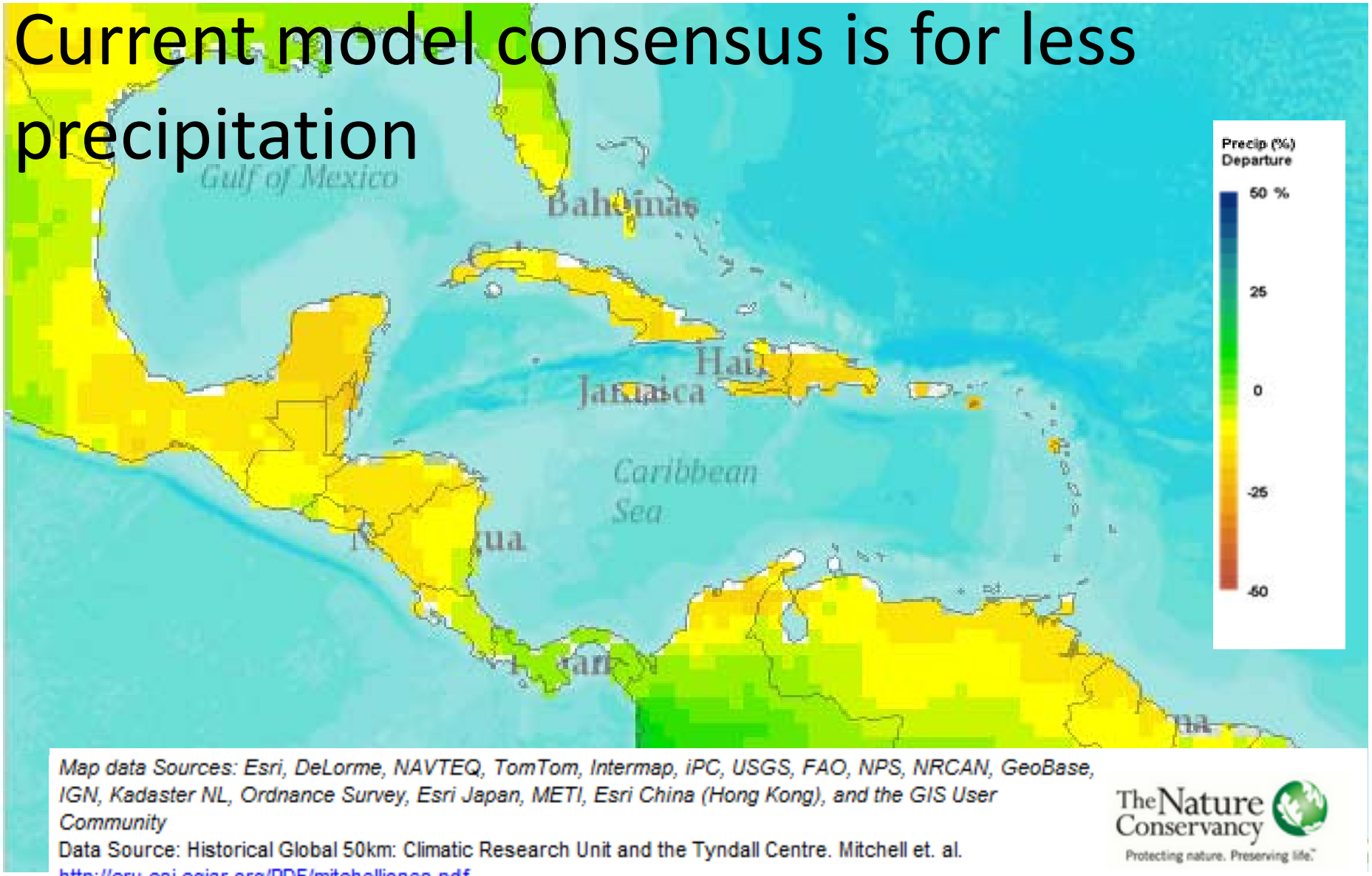
Hurricanes



More wind shear + high SST = less frequent but stronger hurricanes

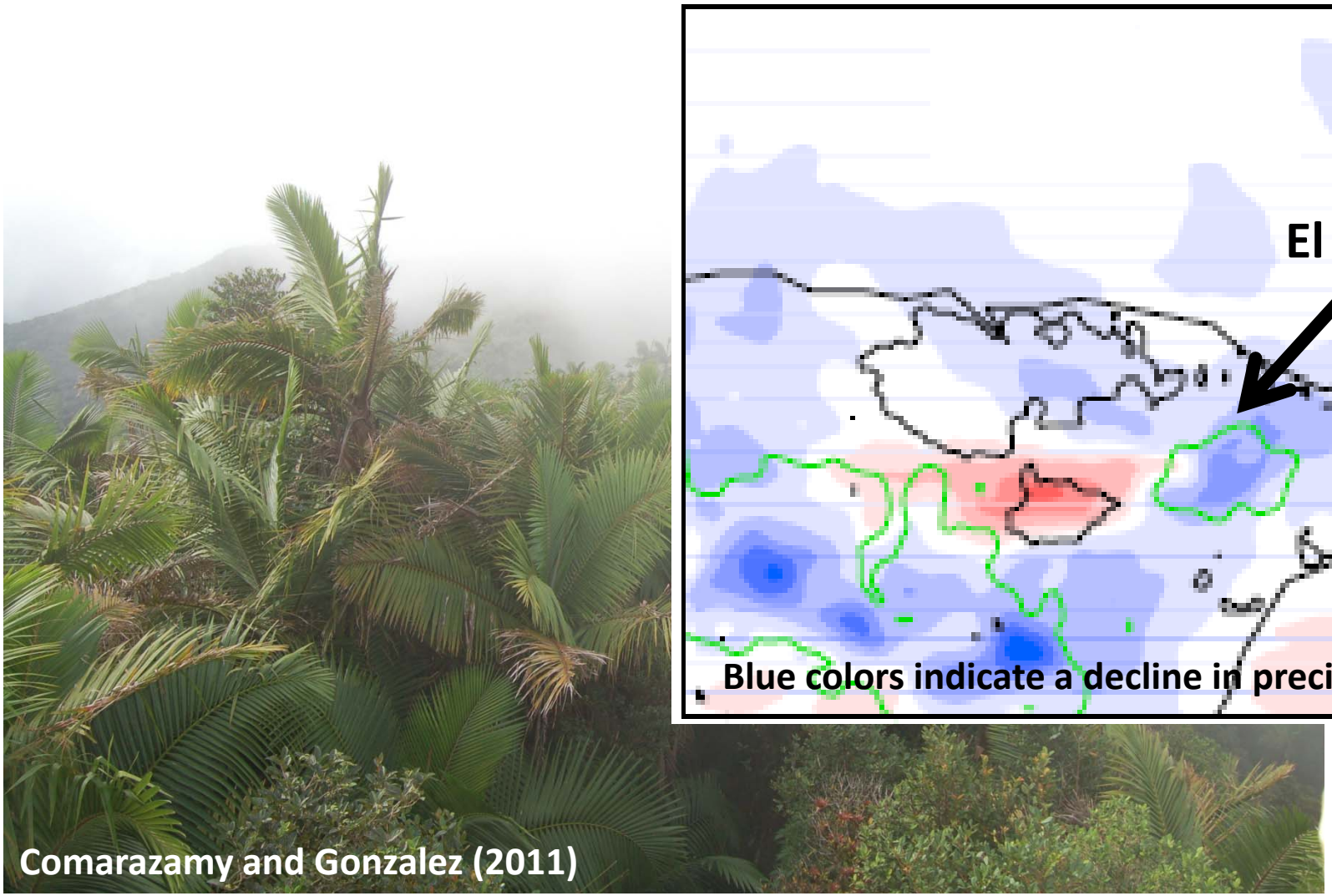
Knutson et al., Nature GeoSci 2010

Current model consensus is for less precipitation



…AND (possibly) DRIER AS GLOBAL TEMPS RISE

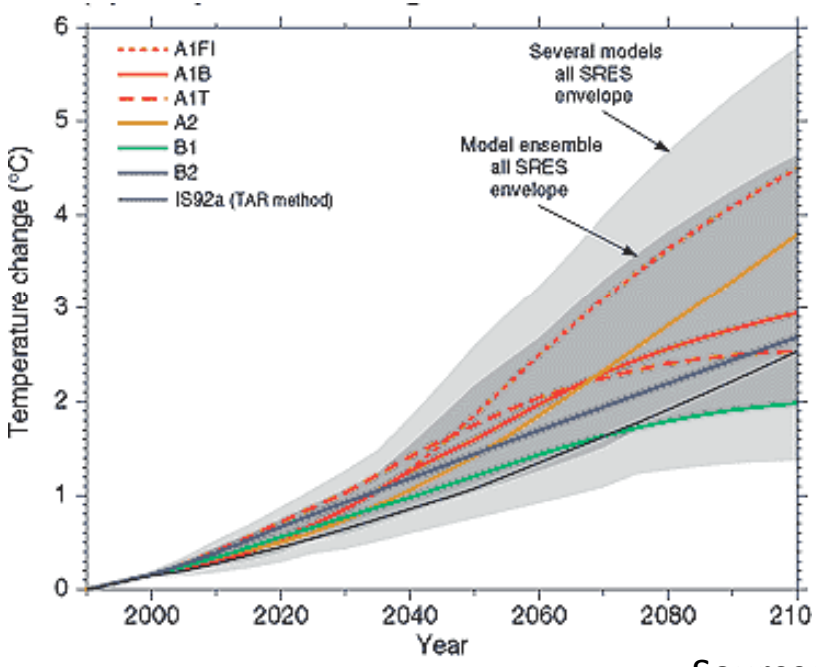
High Resolution RCM -> Cloud base higher now, lowering precipitation.



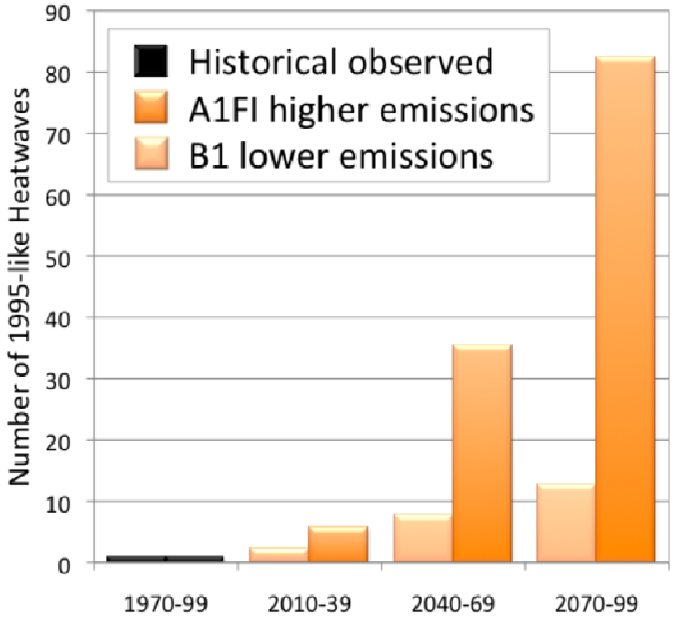
Why are high resolution projections needed?

Climate change is a global issue; but local information is needed to determine how it will affect human and natural systems around the world.

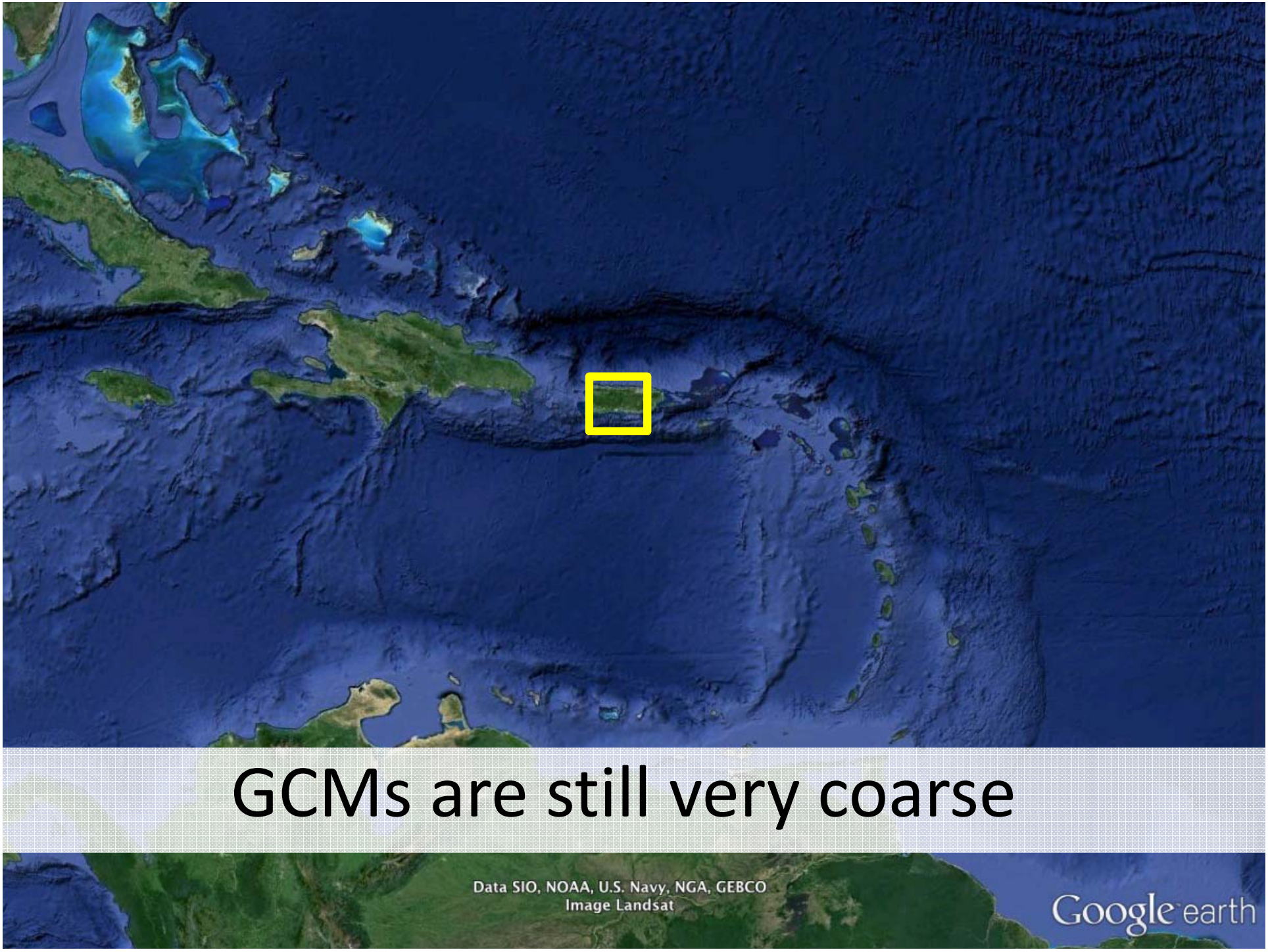
Global temperature change: 2-6°C by 2100



Implications for Chicago: 1995-like heat waves up to 3x/year by 2100

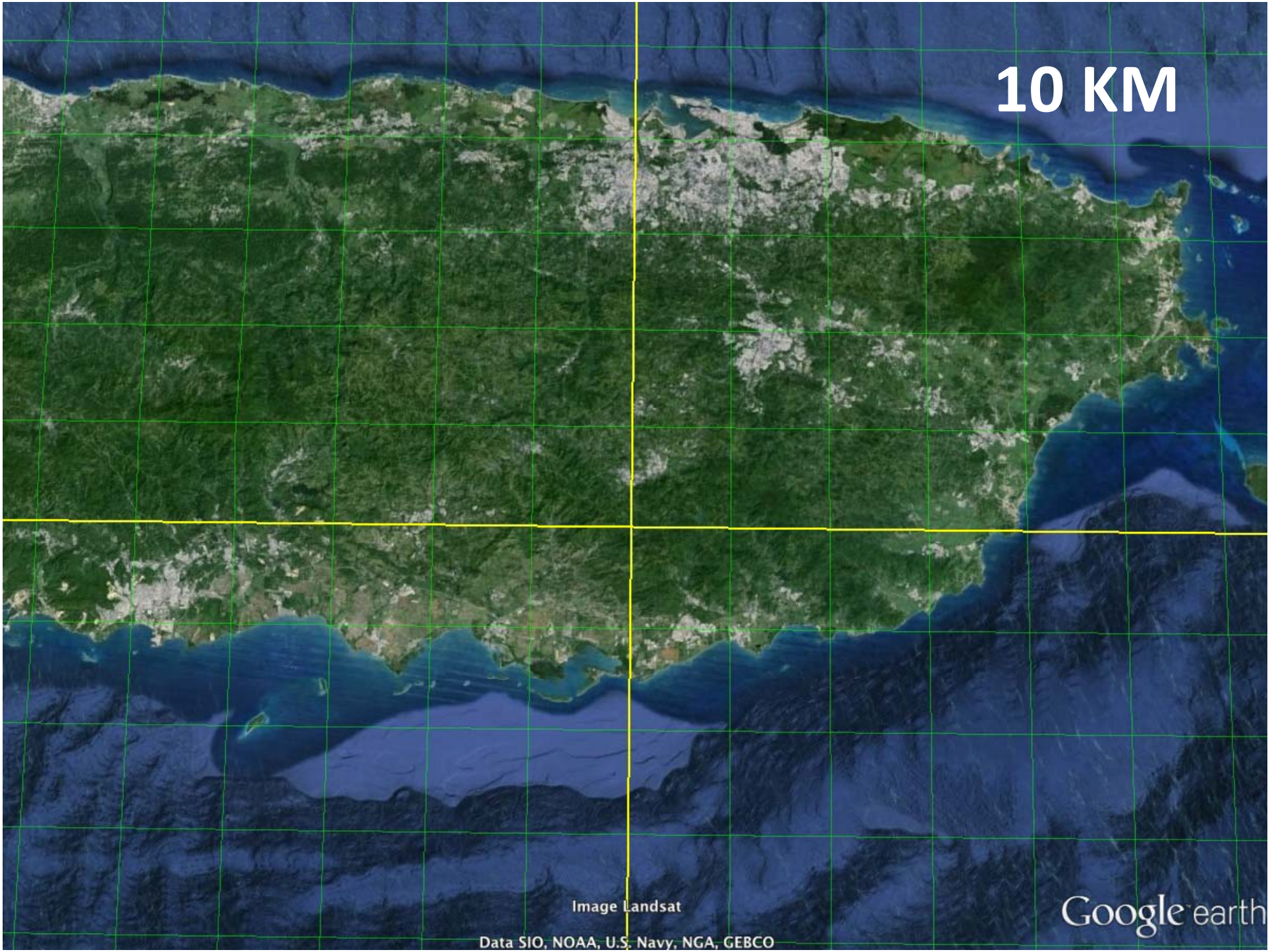


Source: IPCC Third Assessment Report; Hayhoe et al. 2009. JGLR



GCMs are still very coarse


100 KM
2100
700
800
900
2000
Data LDEO-Columbia, NSF, NOAA
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth

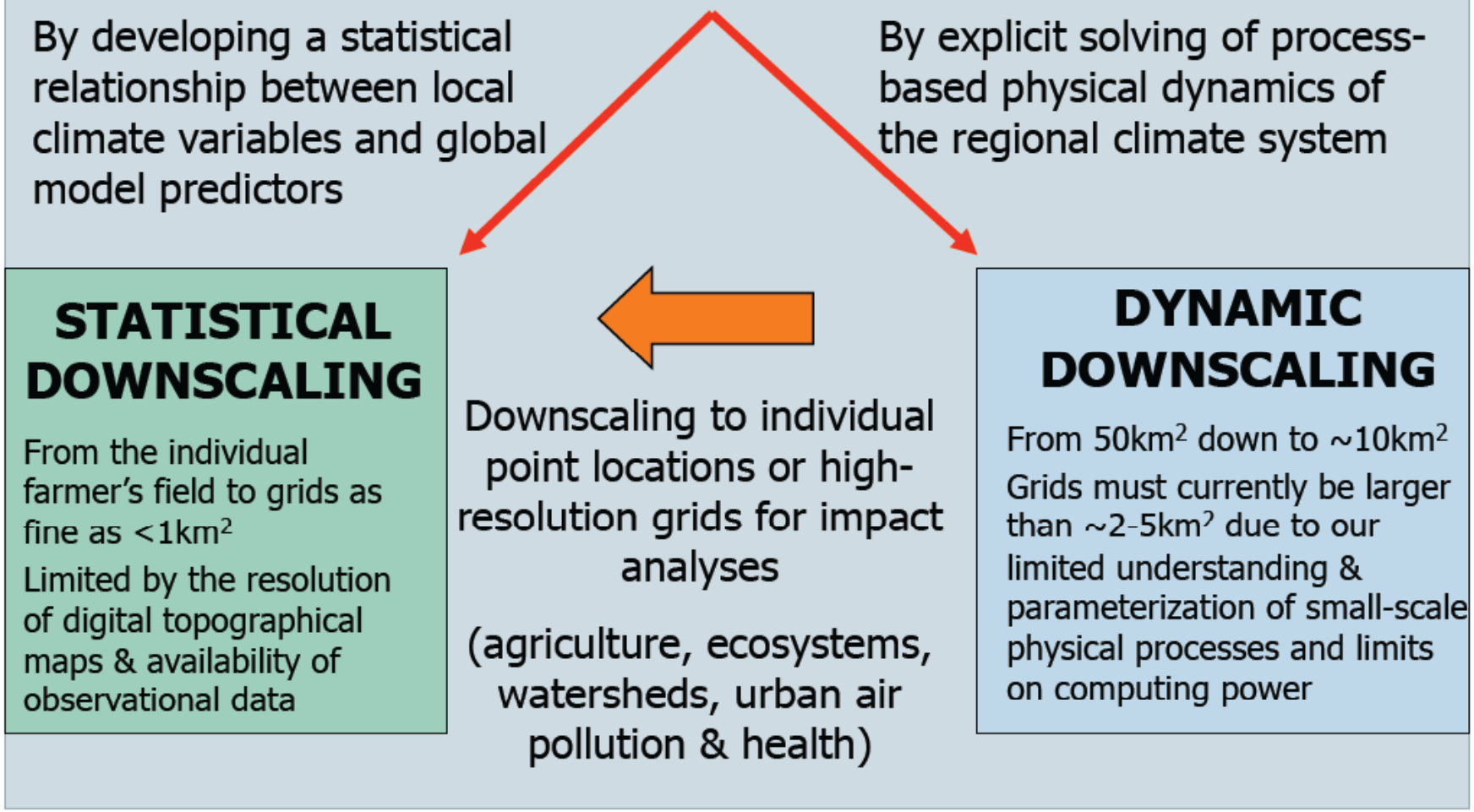

10 KM
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth

Southeast Climate Science Center

"provide scientific information, ***tools*** and ***techniques*** that …
resource managers…can apply to ***anticipate***, ***monitor*** and ***adapt*** to ***climate*** and ecologically-driven ***responses*** at ***regional-to-local scales***."

Downscaling Climate Projections

Simulating sub-grid-scale climate based on output from global models

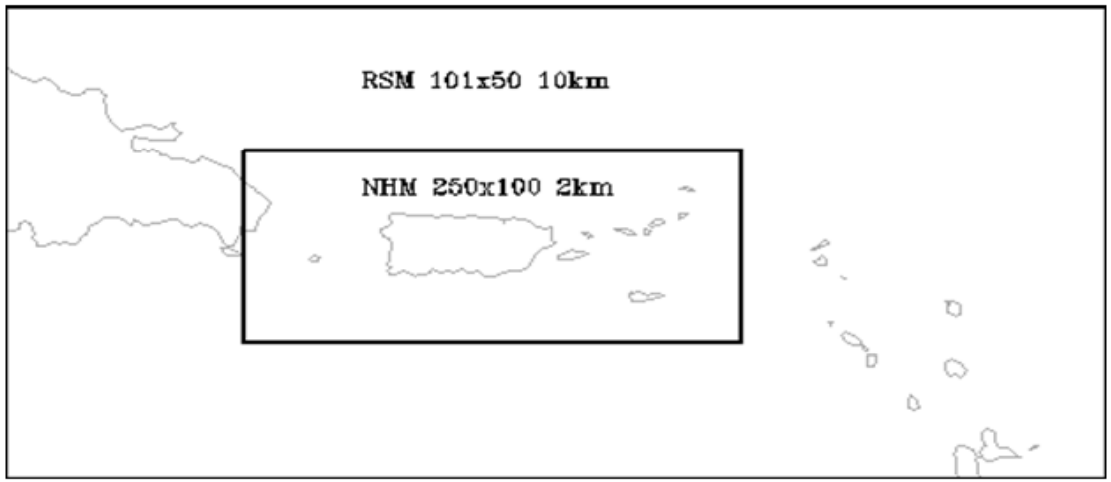


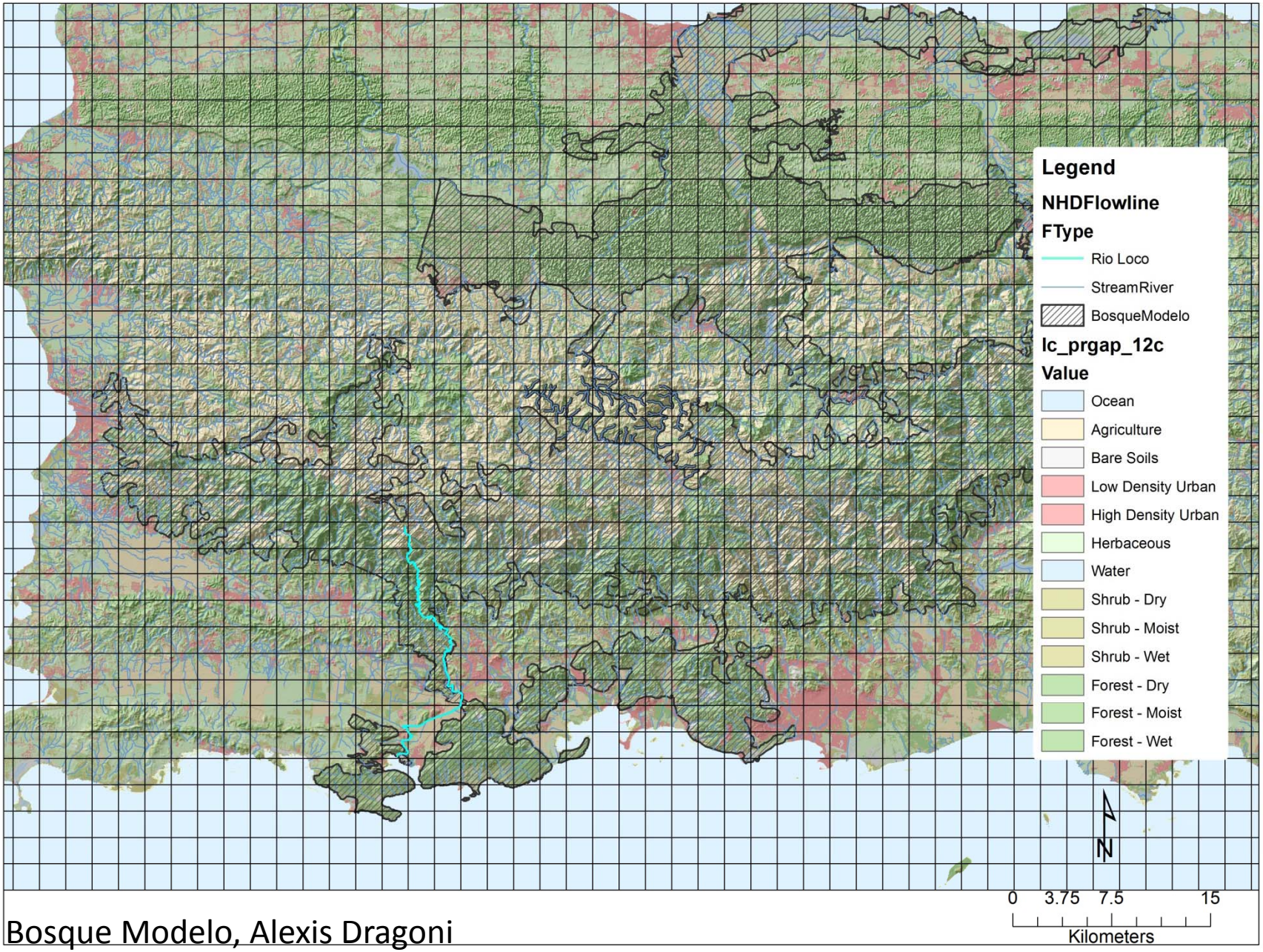
Source: K. Hayhoe

Developing high-resolution, island-centric projections of ecologically relevant climate variables for Puerto Rico and U.S. Virgin Islands.

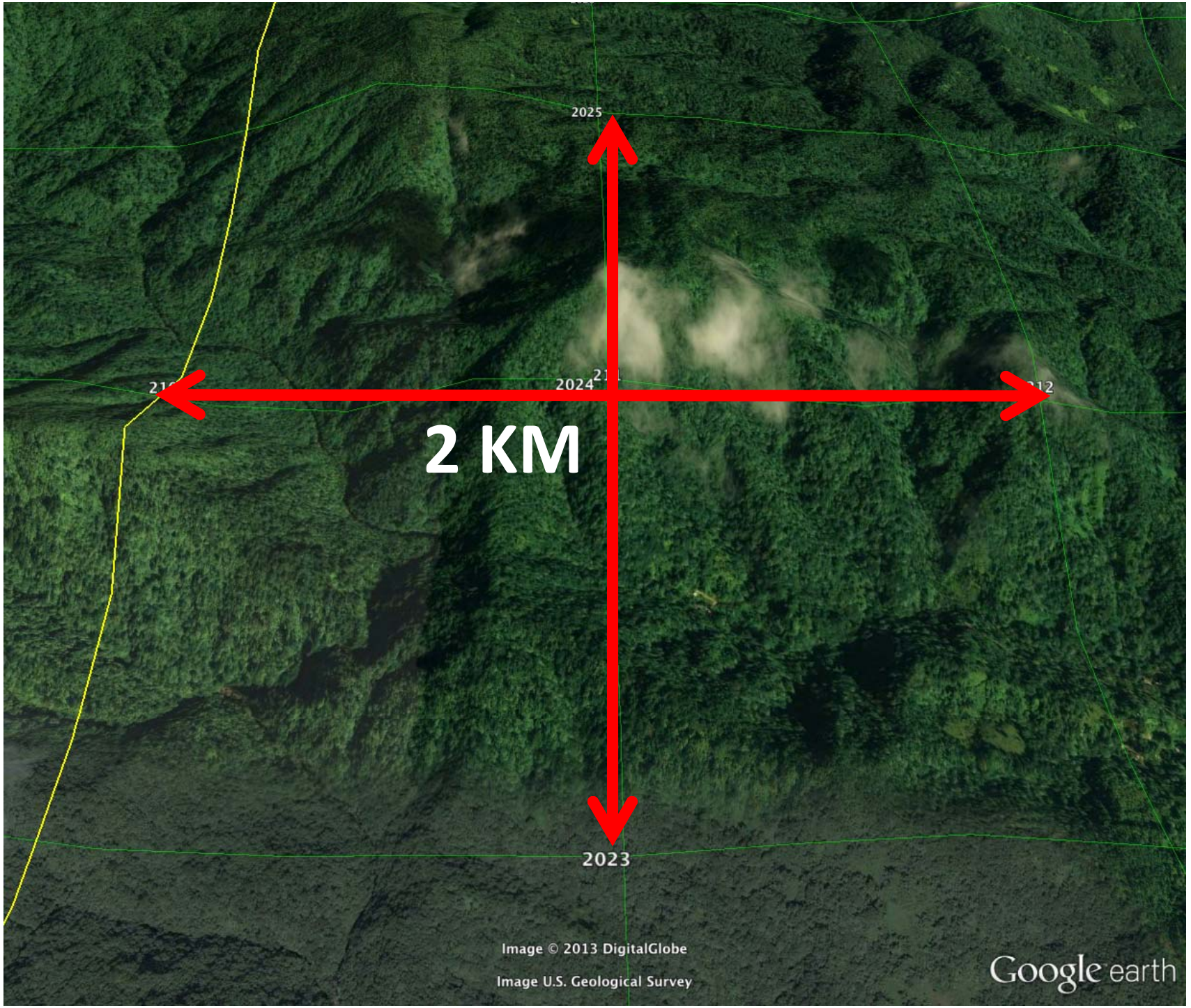
1) Simulate precipitation response to the anthropogenic “forcings” across Puerto Rico.

2) Characterize the uncertainty in the projections--‘business-as-usual’ emission scenario (known as RCP8.5).





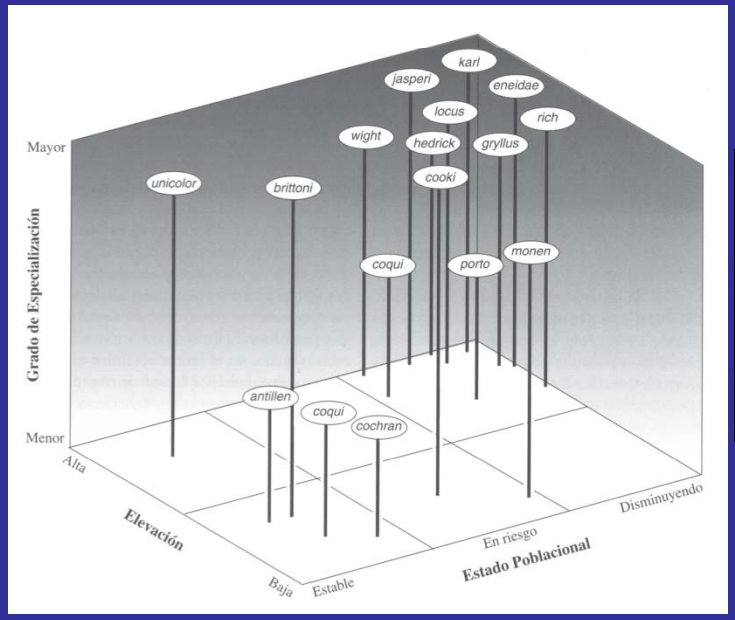
Bosque Modelo, Alexis Dragoni


2025
2024
2023
2 KM
Image © 2013 DigitalGlobe
Image U.S. Geological Survey
Google earth

What are relevant climate covariates?

Ecological (landscape) basis for sensitivity

- Species' Range
- Life History Traits



Graphic: R. Joglar

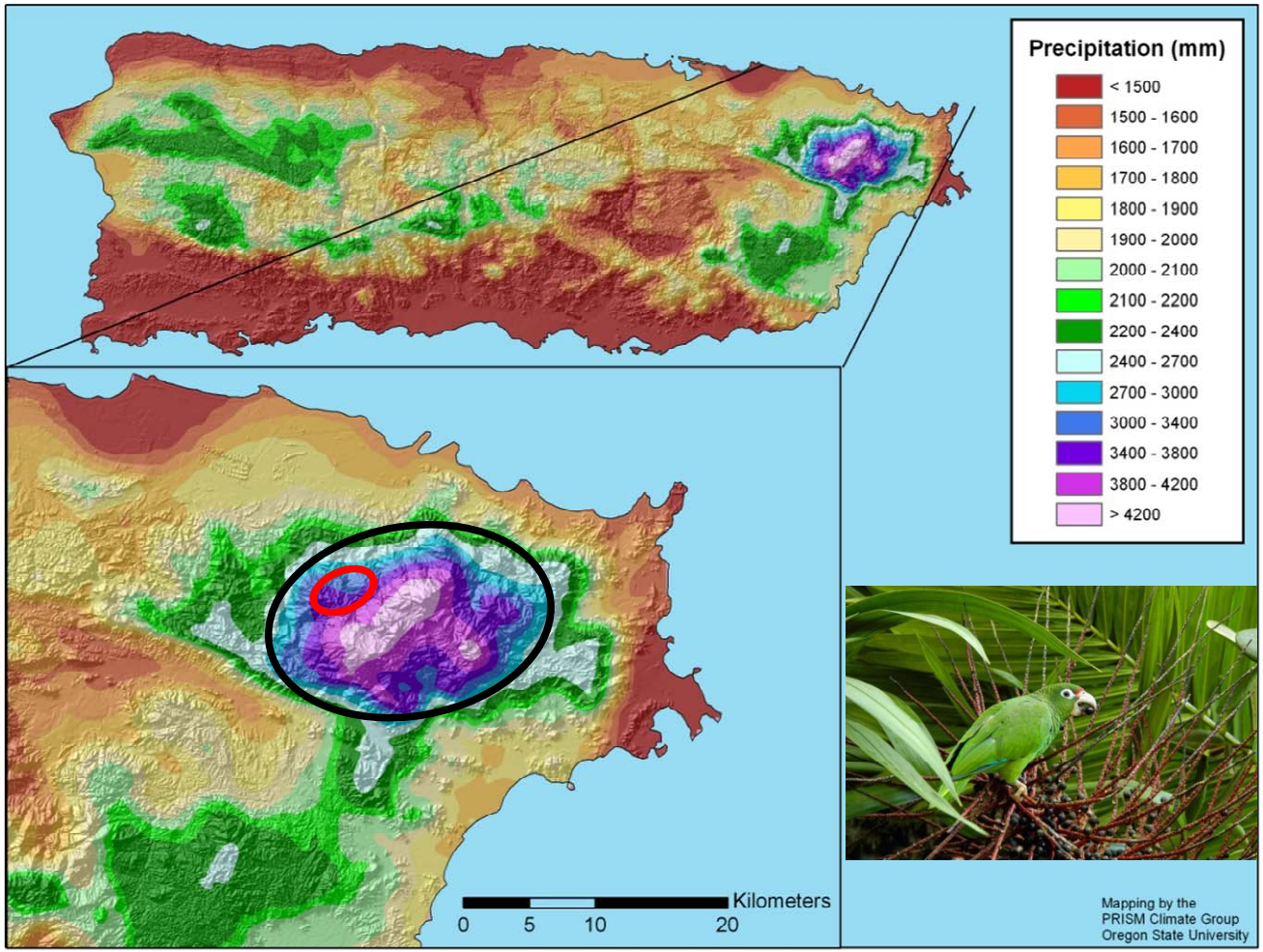
Climate Covariates

↓

Biological Processes

↓

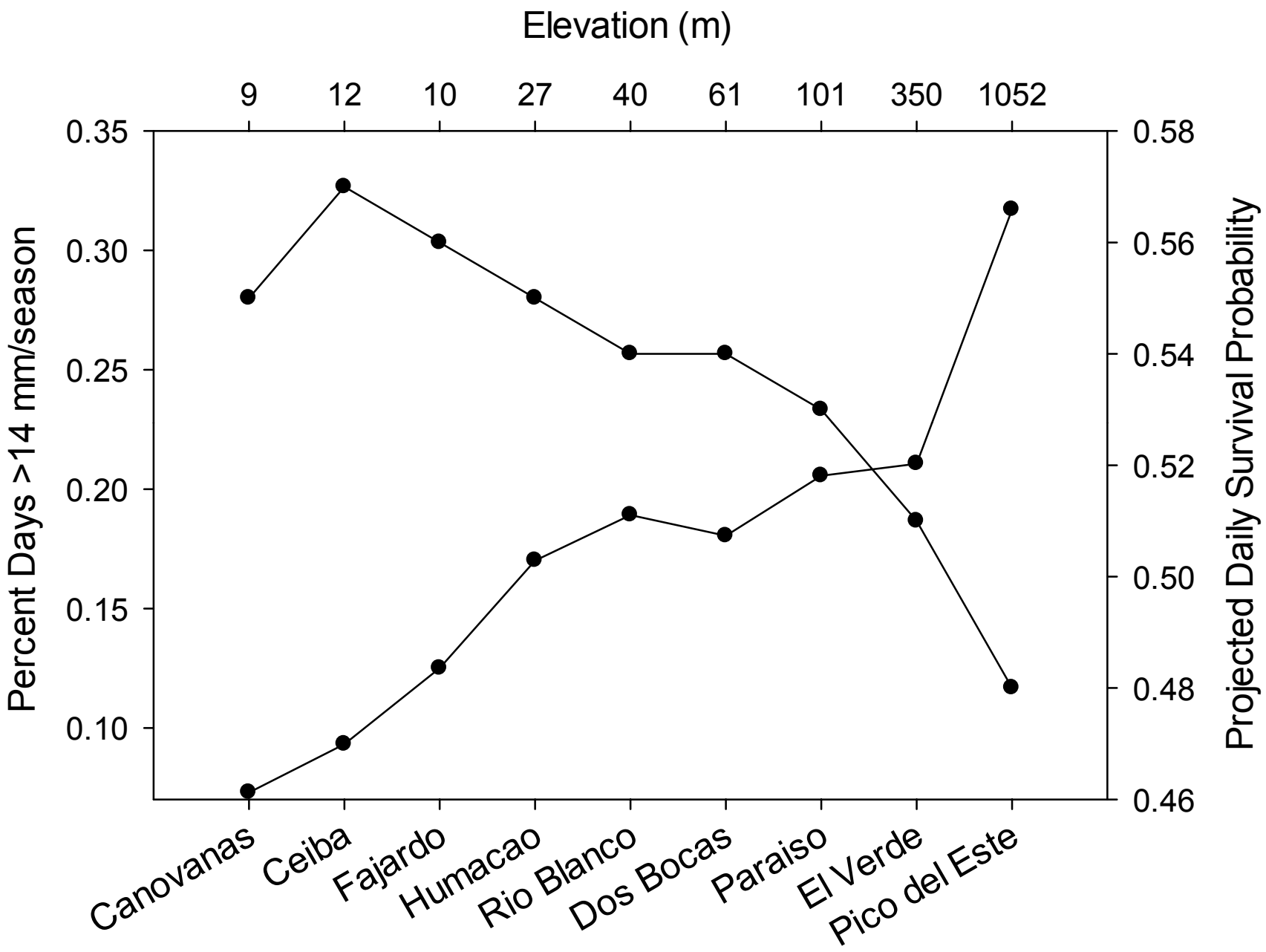
Habitat Dynamics



"Confined" to unique weather conditions

(respiratory, ectoparasites, thermoregulatory problems)

T. H. White, Jr. et al. (in prep.)


Elevation (m)
9
12
10
27
40
61
101
350
1052
0.35
0.30
0.25
0.20
0.15
0.10
Percent Days >14 mm/season
0.58
0.56
0.54
0.52
0.50
0.48
0.46
Projected Daily Survival Probability
Canovanas
Ceiba
Fajardo
Humacao
Rio Blanco
Dos Bocas
Paraiso
El Verde
Pico del Este

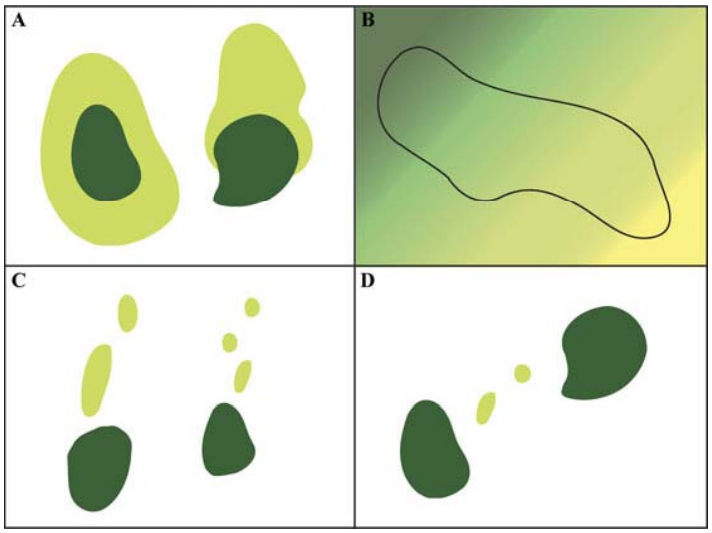
From a practical point of view, a focus on the science of climate change divorced of the decision context is only an exercise in academic curiosity...

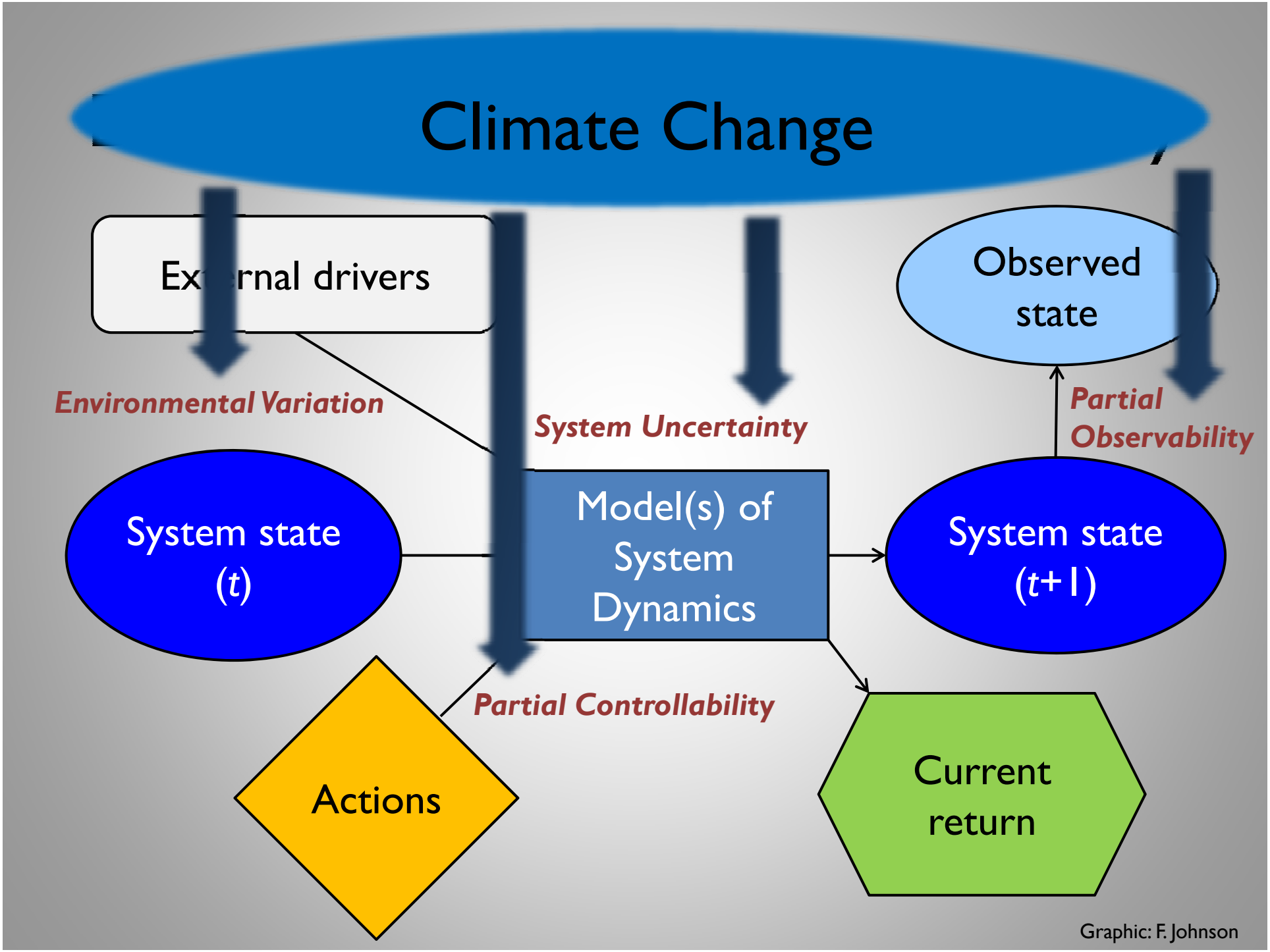
...what is needed is an understanding of how climate change will affect our decisions.

ADAPTATION STRATEGIES AND DECISION MAKING
(CONROY ET AL. 2011, BIOLCONS)

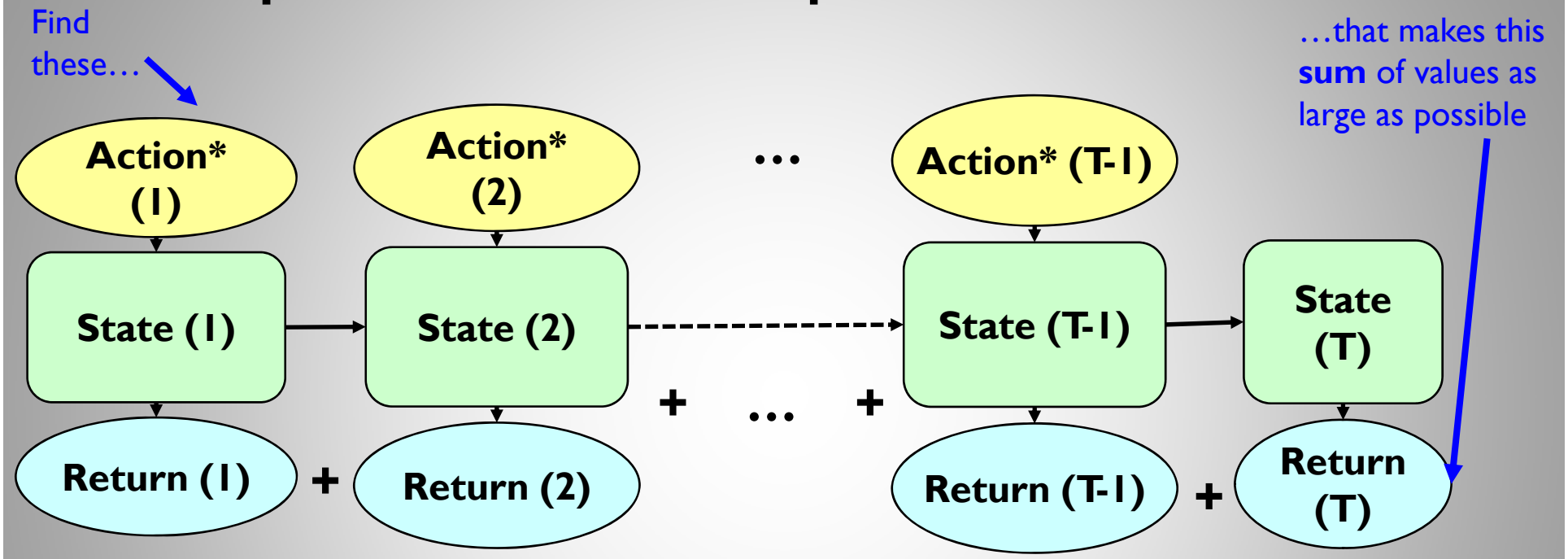
Applying downscaled climate projections to inform decisions on strategic habitat conservation.

Elicit expert knowledge to select relevant climate variables - to inform decisions on strategic habitat conservation for amphibians and other taxa…



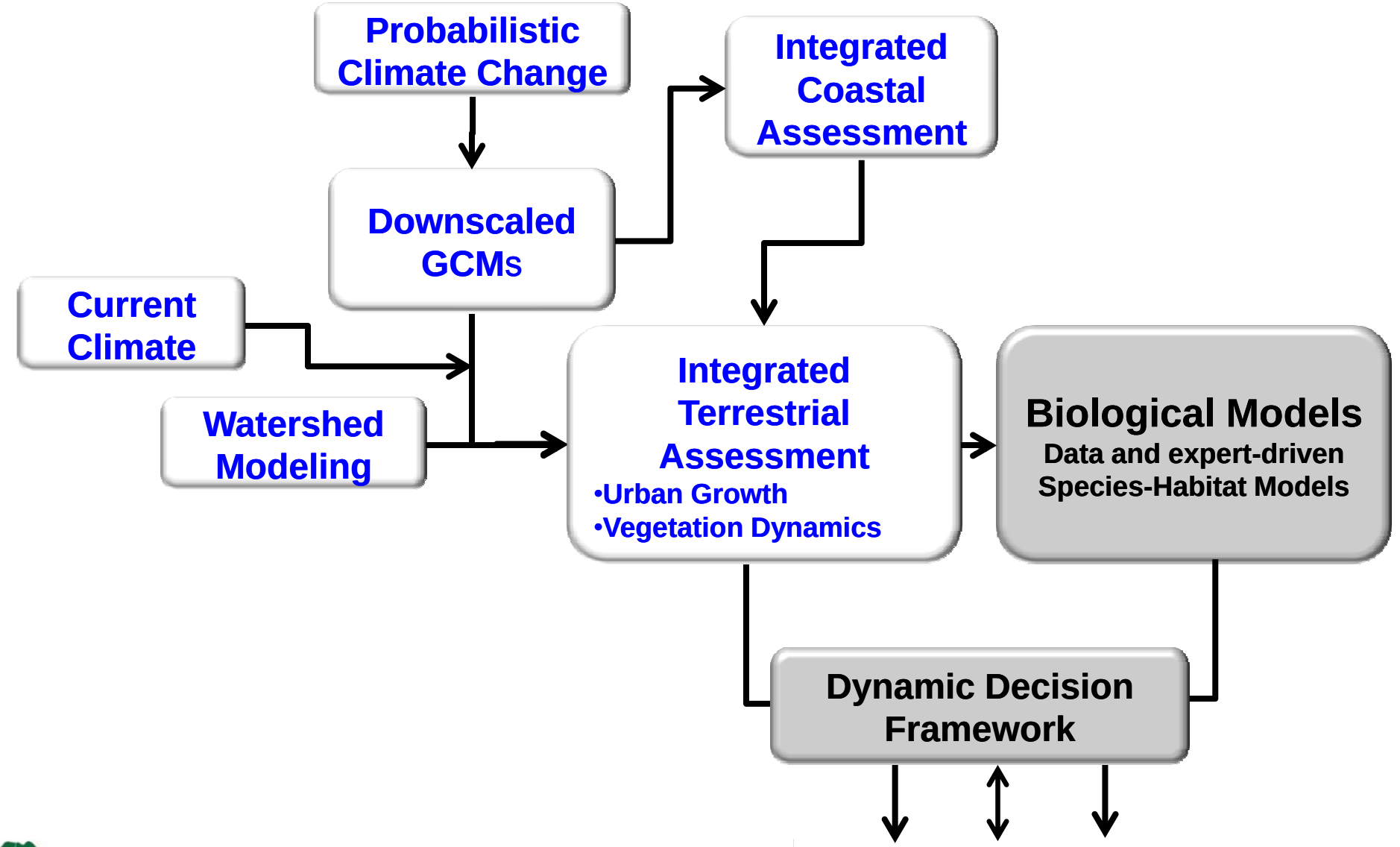

Climate Change
External drivers
Observed state
Environmental Variation
System Uncertainty
Partial Observability
System state (t)
Model(s) of System Dynamics
System state (t+1)
Partial Controllability
Actions
Current return
Graphic: F. Johnson

Implications of sequential decisions



- Account not only for immediate return
- But *all future returns* according to where the system is driven and all decisions that follow

Graphic: F. Johnson

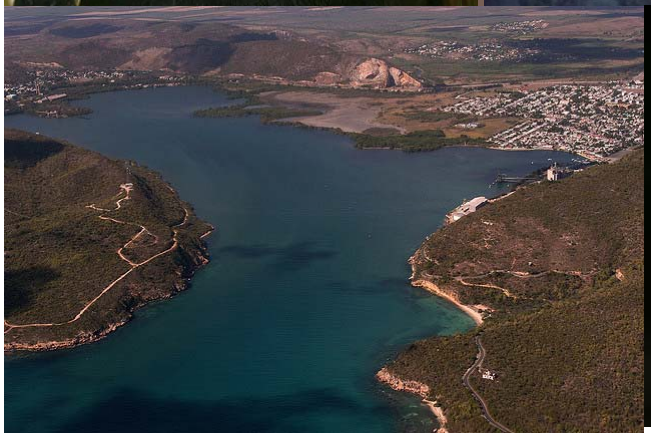


Cooperativa para la Conservación del Paisaje en el Caribe

CLCC

Developing high-resolution, island-centric projections of ecologically relevant climate variables for Puerto Rico and U.S. Virgin Islands.



PREGUNTAS?