Spatial Analytic Framework for Advanced Risk Information Systems

An Integrated Spatial Analytic Framework to Manage Invasive Species in Regulatory Phytosanitary Applications

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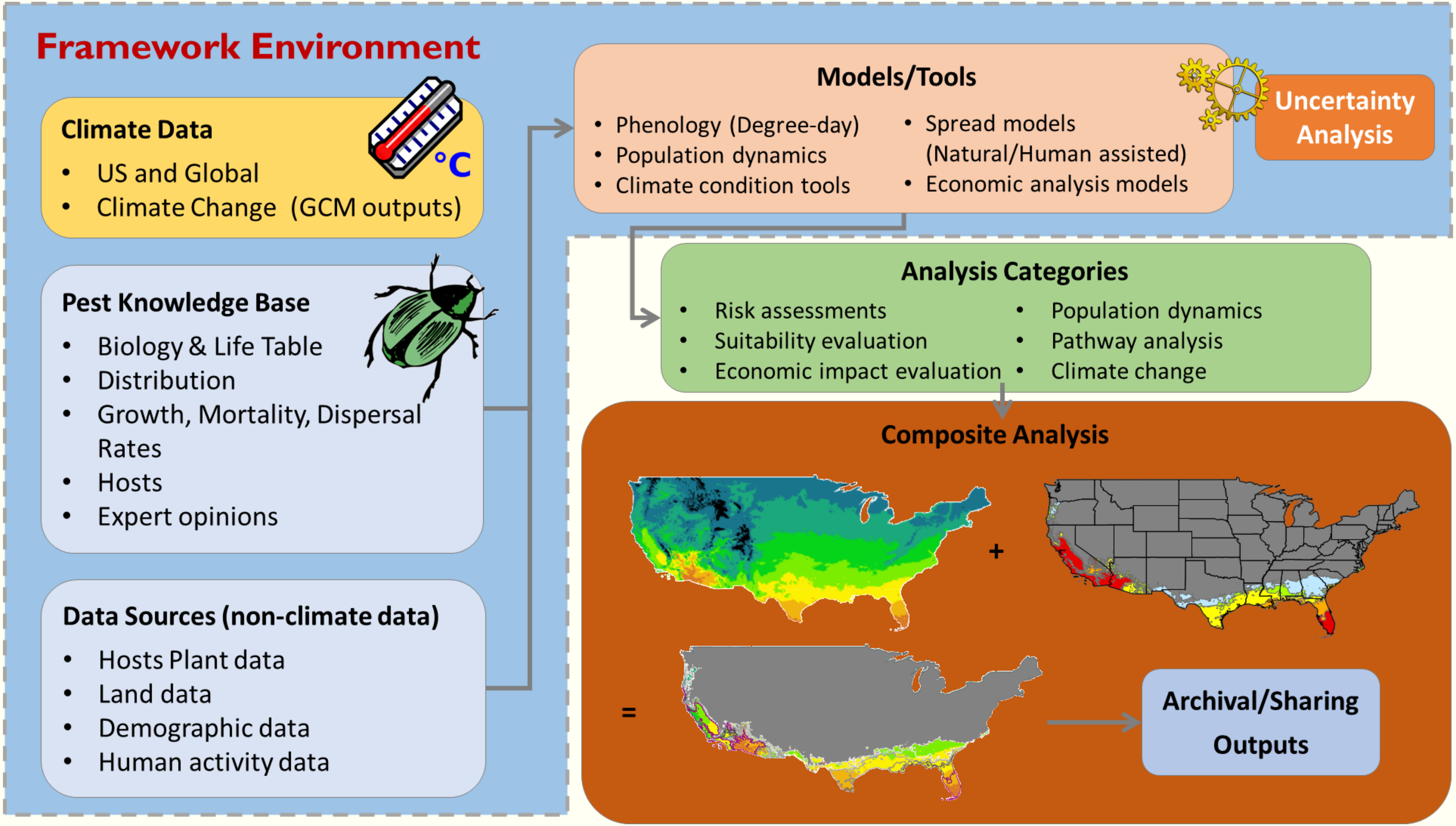
Framework for Pest Forecast

- Framework: Containers for pest models
- Each pest is unique, but all have shared features
  - Spread means
  - Infestation/infection rates
  - Climate
  - Hosts
  - Biology
- A spatial analytic framework needs to be flexible enough to accommodate a wide range of pests
- Because we can't model and predict pest natural events exactly, we must be able to address <u>uncertainty</u> associated with forecasts

Spatial Analytic Framework for Advanced Risk Information Systems

- The SAFARIS is a framework for pest forecast models that is designed for research, risk analysis, decision/policy making, rapid-response, and land management applications in need of streamlined and tractable forecasts.
- Key elements of SAFARIS
  - Minimize data processing efforts
  - Easy to share data, models, and outputs
  - Transparency
  - Uncertainty evaluation
  - Climate change effects added to pest predictions



Framework Environment
Climate Data
• US and Global
• Climate Change (GCM outputs)
°C
Pest Knowledge Base
• Biology & Life Table
• Distribution
• Growth, Mortality, Dispersal Rates
• Hosts
• Expert opinions
Data Sources (non-climate data)
• Hosts Plant data
• Land data
• Demographic data
• Human activity data
Models/Tools
• Phenology (Degree-day)
• Population dynamics
• Climate condition tools
• Spread models (Natural/Human assisted)
• Economic analysis models
Uncertainty Analysis
Analysis Categories
• Risk assessments
• Suitability evaluation
• Economic impact evaluation
• Population dynamics
• Pathway analysis
• Climate change
Composite Analysis
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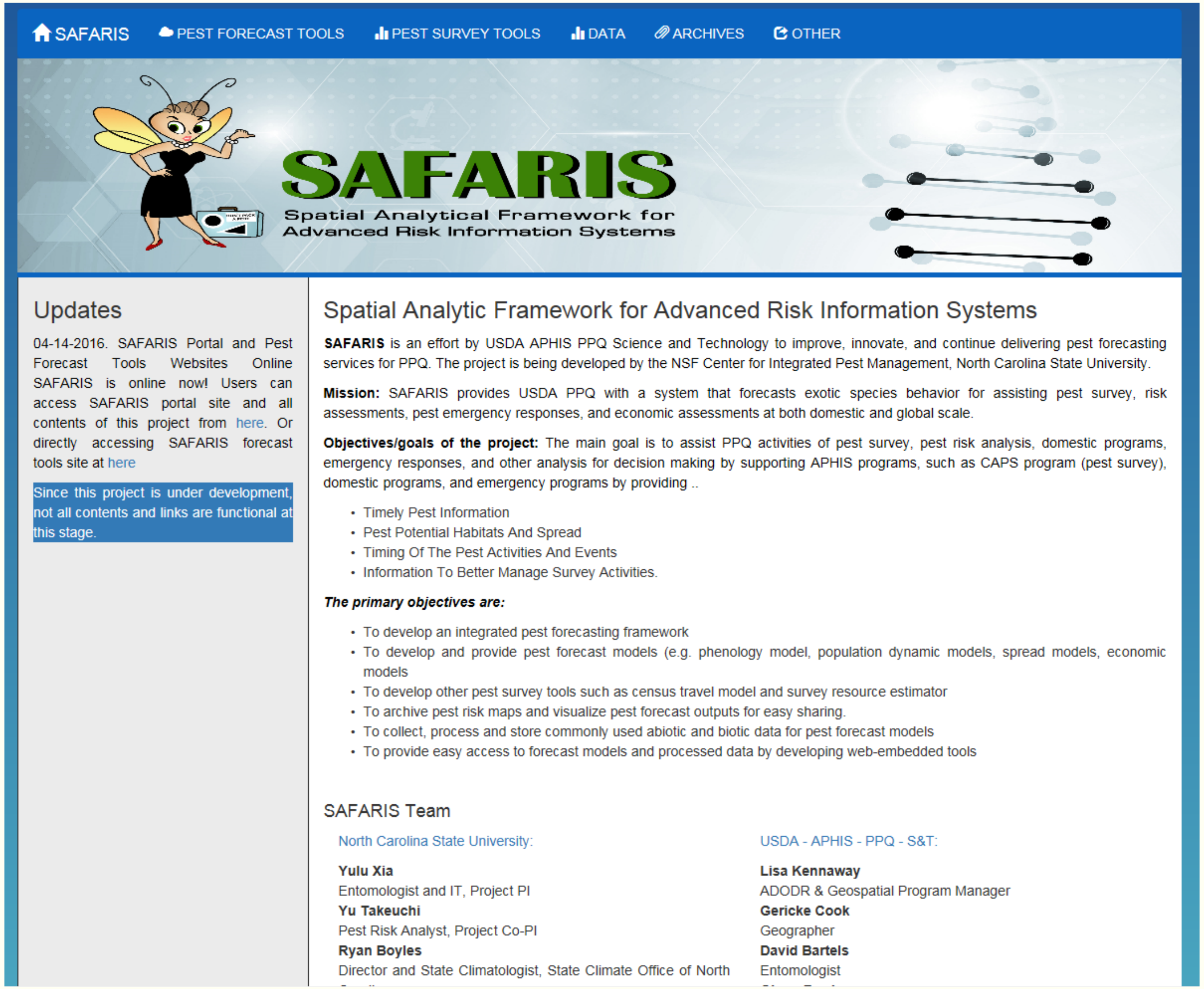
Archival/Sharing Outputs

SAFARIS: Web-based models and tools



SAFARIS | PEST FORECAST TOOLS | PEST SURVEY TOOLS | DATA | ARCHIVES | OTHER

SAFARIS
Spatial Analytical Framework for Advanced Risk Information Systems

Updates

04-14-2016. SAFARIS Portal and Pest Forecast Tools Websites Online SAFARIS is online now! Users can access SAFARIS portal site and all contents of this project from here. Or directly accessing SAFARIS forecast tools site at here

Since this project is under development, not all contents and links are functional at this stage.

Spatial Analytic Framework for Advanced Risk Information Systems

SAFARIS is an effort by USDA APHIS PPQ Science and Technology to improve, innovate, and continue delivering pest forecasting services for PPQ. The project is being developed by the NSF Center for Integrated Pest Management, North Carolina State University.

Mission: SAFARIS provides USDA PPQ with a system that forecasts exotic species behavior for assisting pest survey, risk assessments, pest emergency responses, and economic assessments at both domestic and global scale.

Objectives/goals of the project: The main goal is to assist PPQ activities of pest survey, pest risk analysis, domestic programs, emergency responses, and other analysis for decision making by supporting APHIS programs, such as CAPS program (pest survey), domestic programs, and emergency programs by providing ..

- Timely Pest Information
- Pest Potential Habitats And Spread
- Timing Of The Pest Activities And Events
- Information To Better Manage Survey Activities.

The primary objectives are:

- To develop an integrated pest forecasting framework
- To develop and provide pest forecast models (e.g. phenology model, population dynamic models, spread models, economic models
- To develop other pest survey tools such as census travel model and survey resource estimator
- To archive pest risk maps and visualize pest forecast outputs for easy sharing.
- To collect, process and store commonly used abiotic and biotic data for pest forecast models
- To provide easy access to forecast models and processed data by developing web-embedded tools

SAFARIS Team

North Carolina State University:

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Entomologist and IT, Project PI
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USDA - APHIS - PPQ - S&T:

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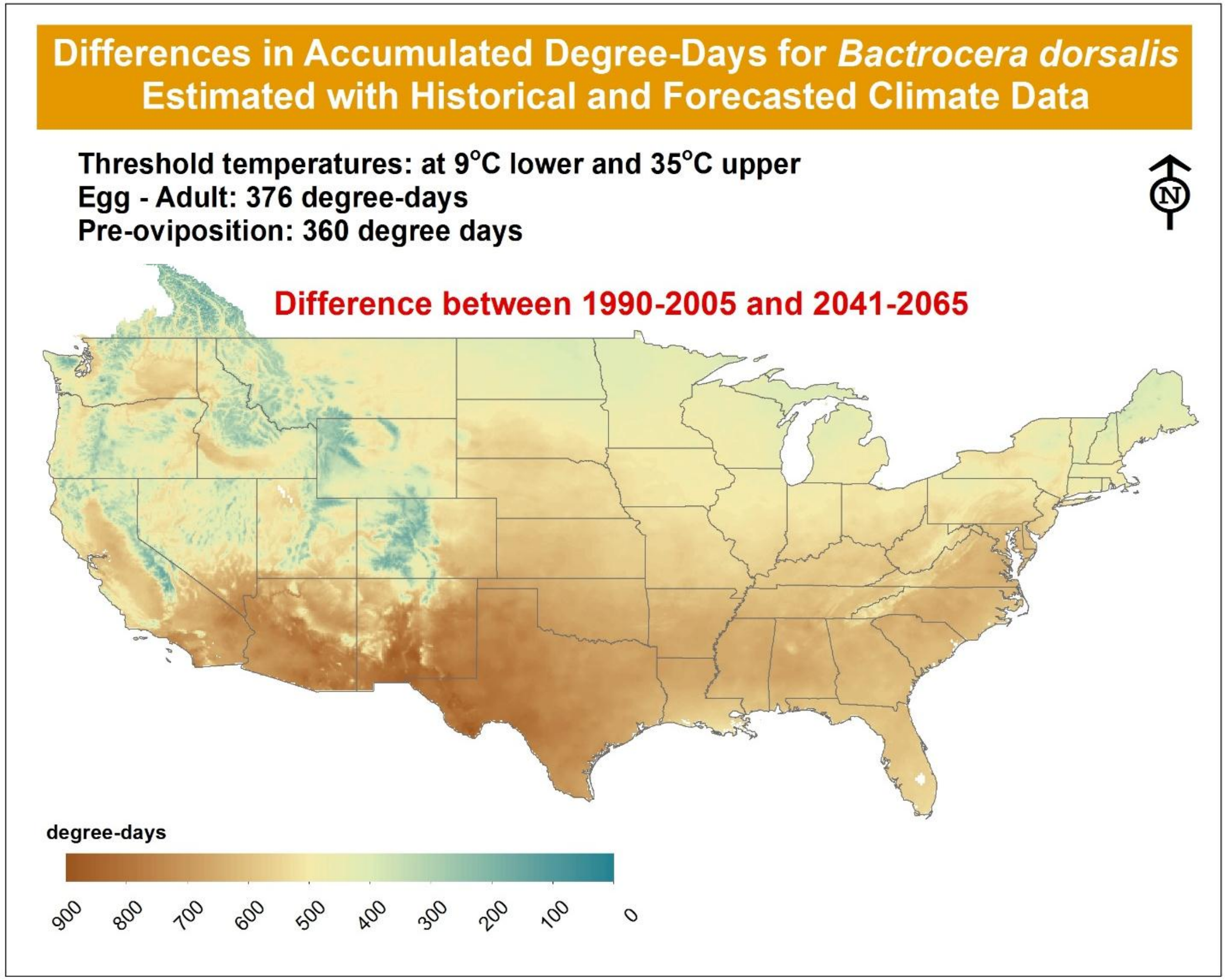
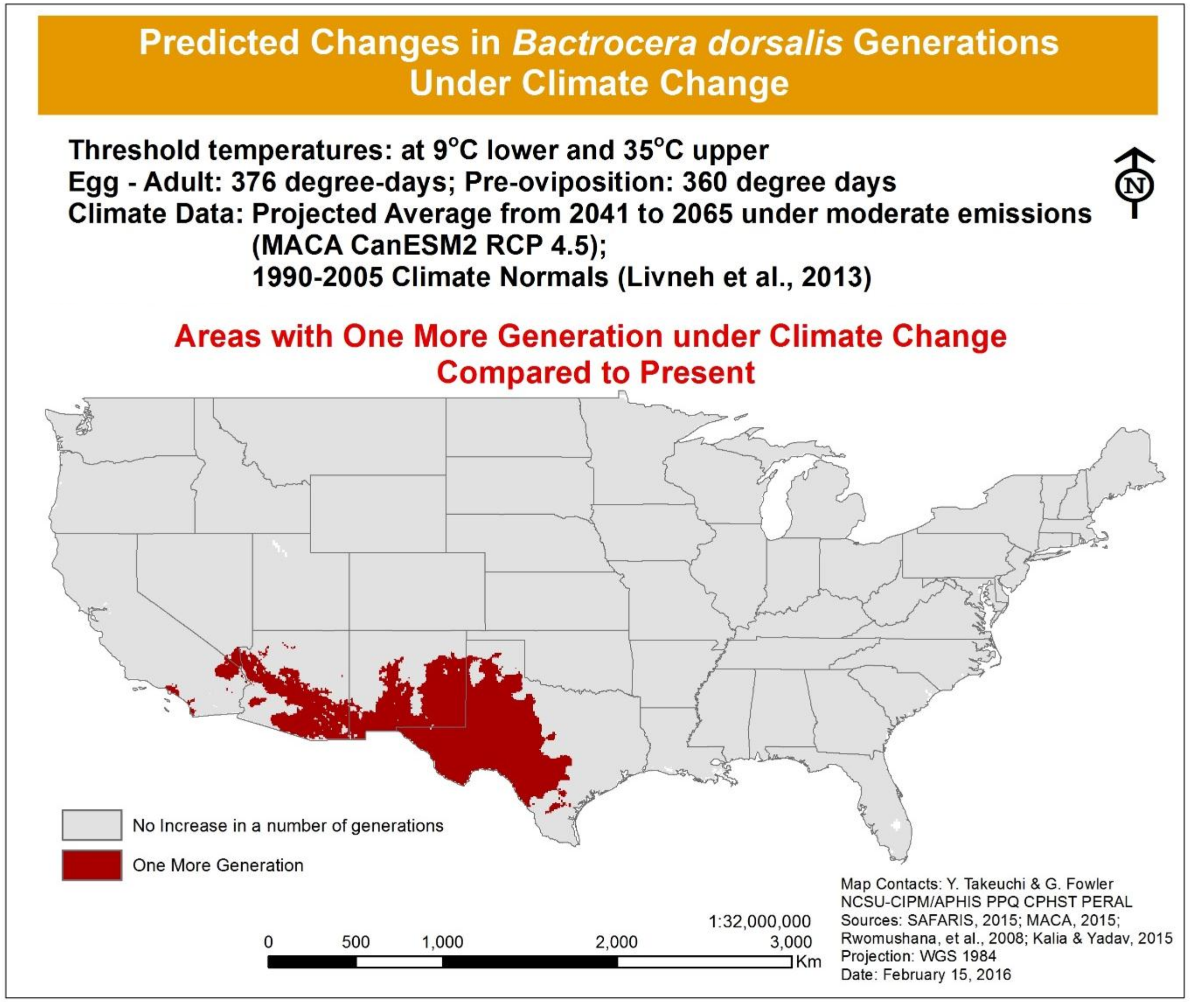
Geographer
David Bartels
Entomologist

- Phenology Models
  - Multiple sources of climate data
  - Biology database that contains degree-day requirements and threshold temperature for multiple species
  - Different methods to calculate degree-days
- Analytic Tools
  - Temperature & Precipitation suitable/unsuitable condition mapping tools
- Insect Population Dynamics Models
- Stochastic Spread Models

SAFARIS:
Adding Climate Change Effects into Pest Forecasts





Model Comparisons

- In order to compare pest models, we should use same source of climate data
- Each model uses different format of the climate data
- SAFARIS provides tools to generate CLIMEX climate data and Bioclim data

Uncertainty Evaluations within SAFARIS

- Appropriate methods to communicate uncertainty associated with pest forecasts for a regulatory agency need to be established and made available within SAFARIS.

- Methods:
  - Estimate uncertainty associated with *Lymantria dispar* L. (gypsy moth) suitability under climate change.
  - Evaluate appropriate ways to display uncertainty associated with pest forecasts.
  - Prioritize US counties based on pest suitability and uncertainty level for a improved pest management and better allocation of budget.

SAFARIS: Uncertainty

SAFARIS Environment

Pest Biology Data
- Development Requirements
- Growth Rate
- Mortality Rate

Pest Forecast Models
- Phenology model
- Population dynamics model
- Climatologically suitable/unsuitable mapping tools

Climate Data
- PRISM
- METDATA
- TopoWX
- CFSv2

Uncertainty Estimates

Pest Biology Data
- Errors in the nature of biology
- Errors in experiments

Pest Forecast Models
- Errors in mathematical algorithms

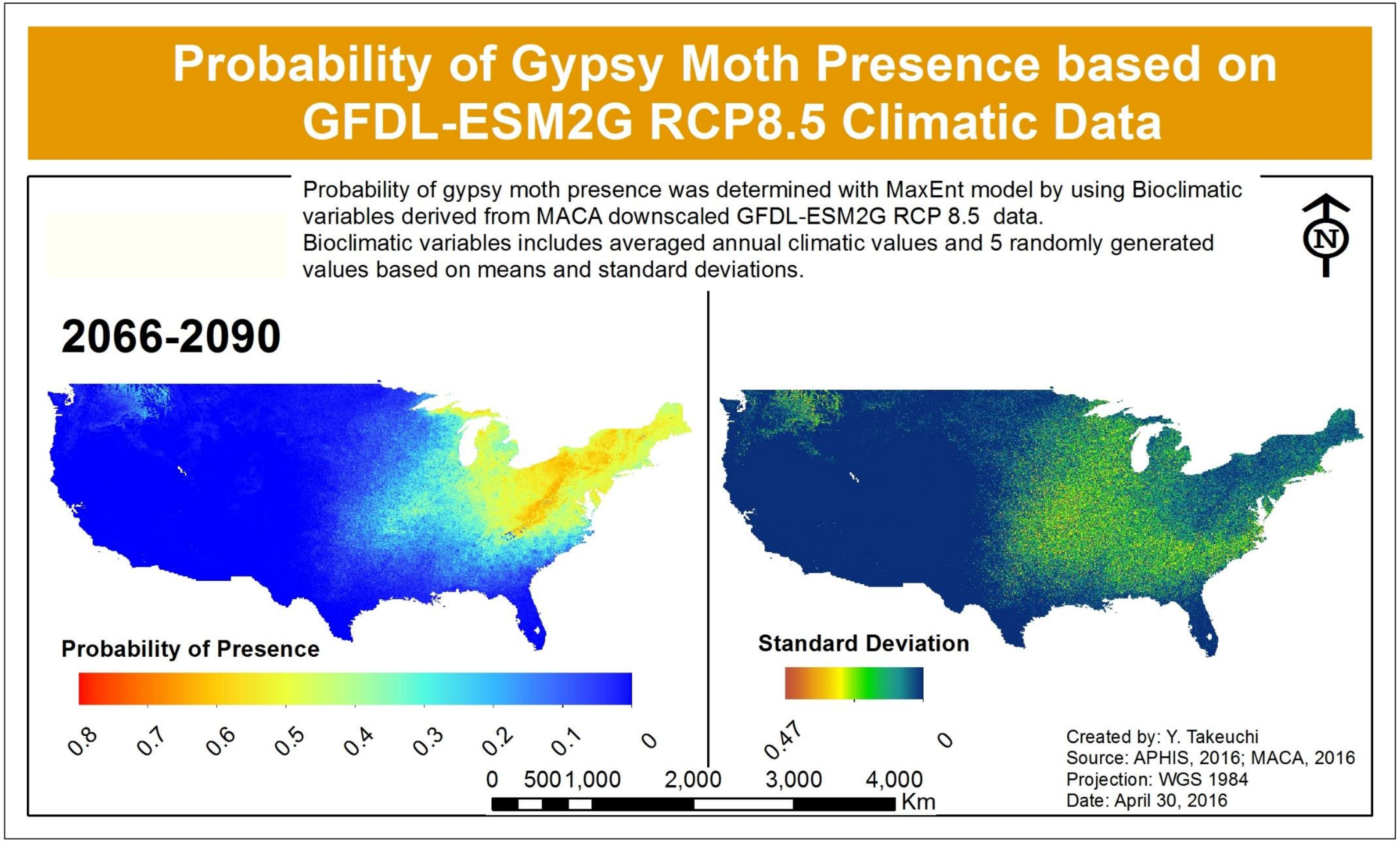
Climate Data
- Errors in interpolation methods
- Uncertainty in climate variations

Overall Uncertainties

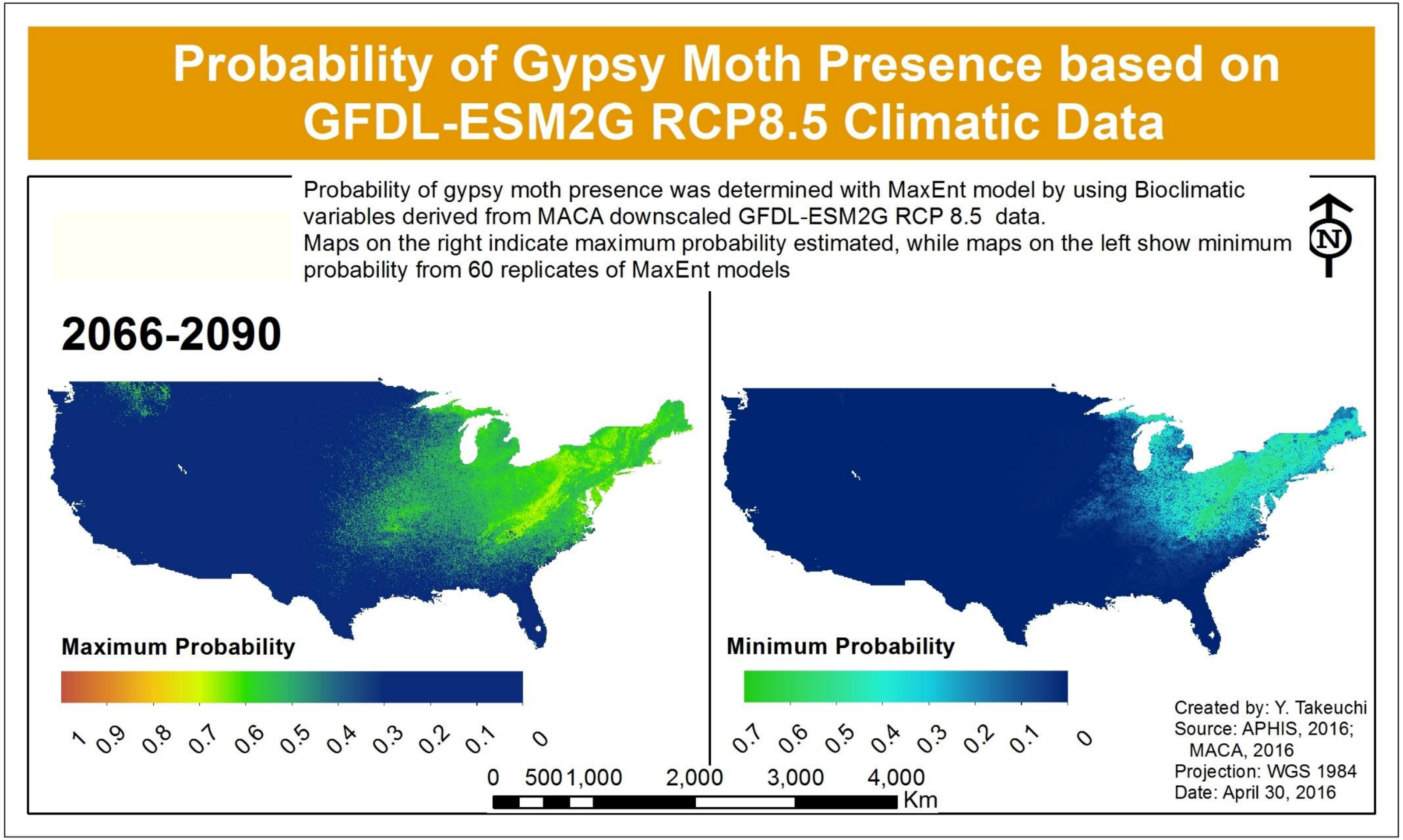
Combination of errors from pest biology, pest forecast models, and climate data

- Stakeholders
- Risk Analysts
- Decision Makers

Uncertainty from Climate Data and Models

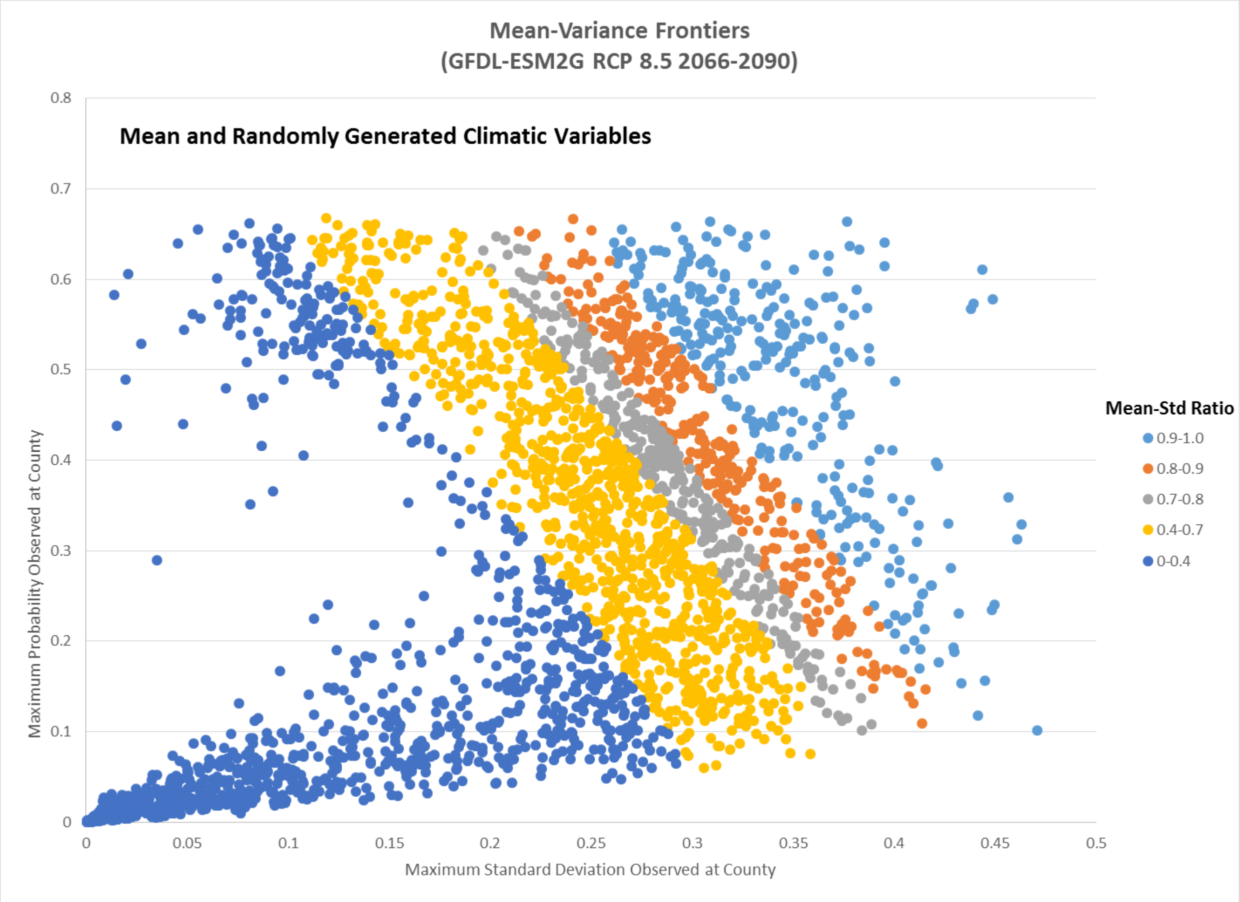


Uncertainty from Climate Data and Models

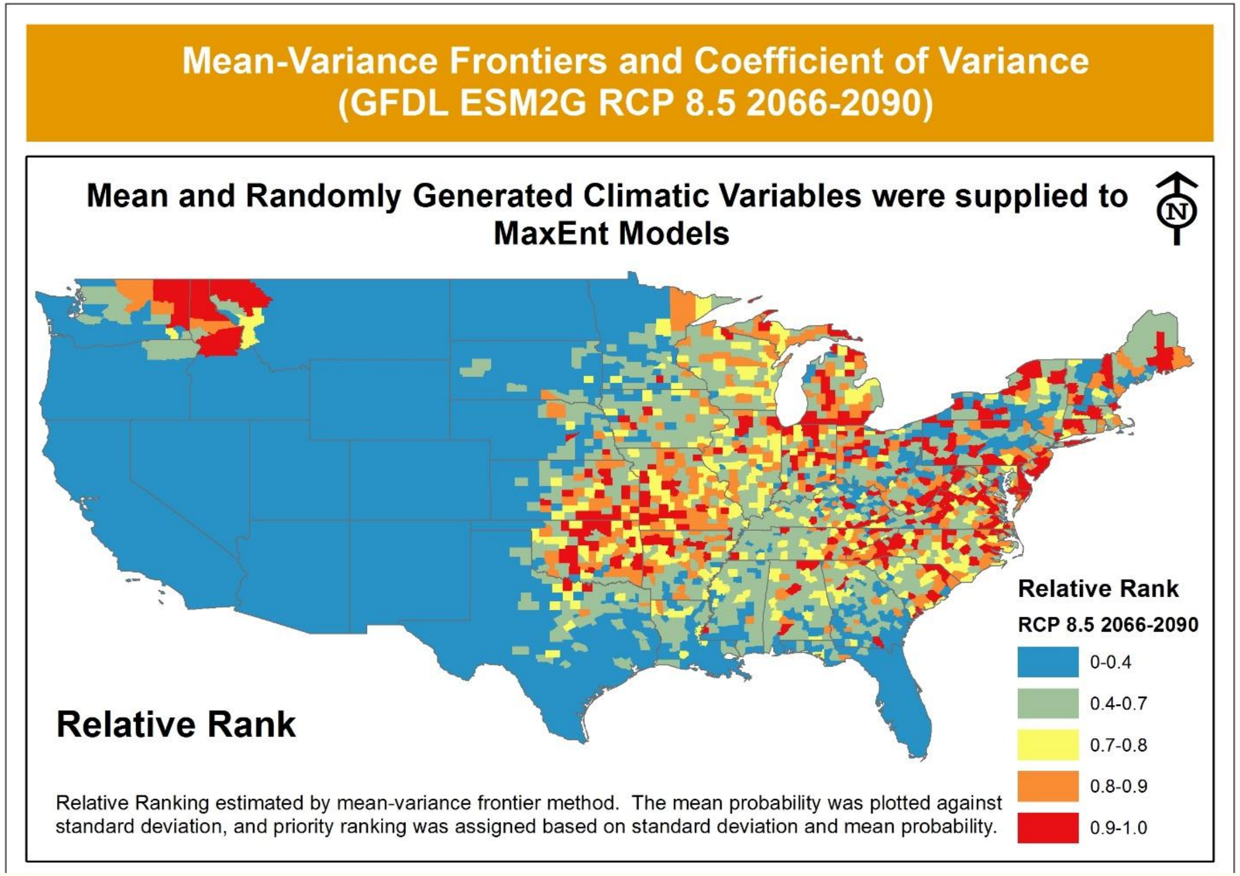


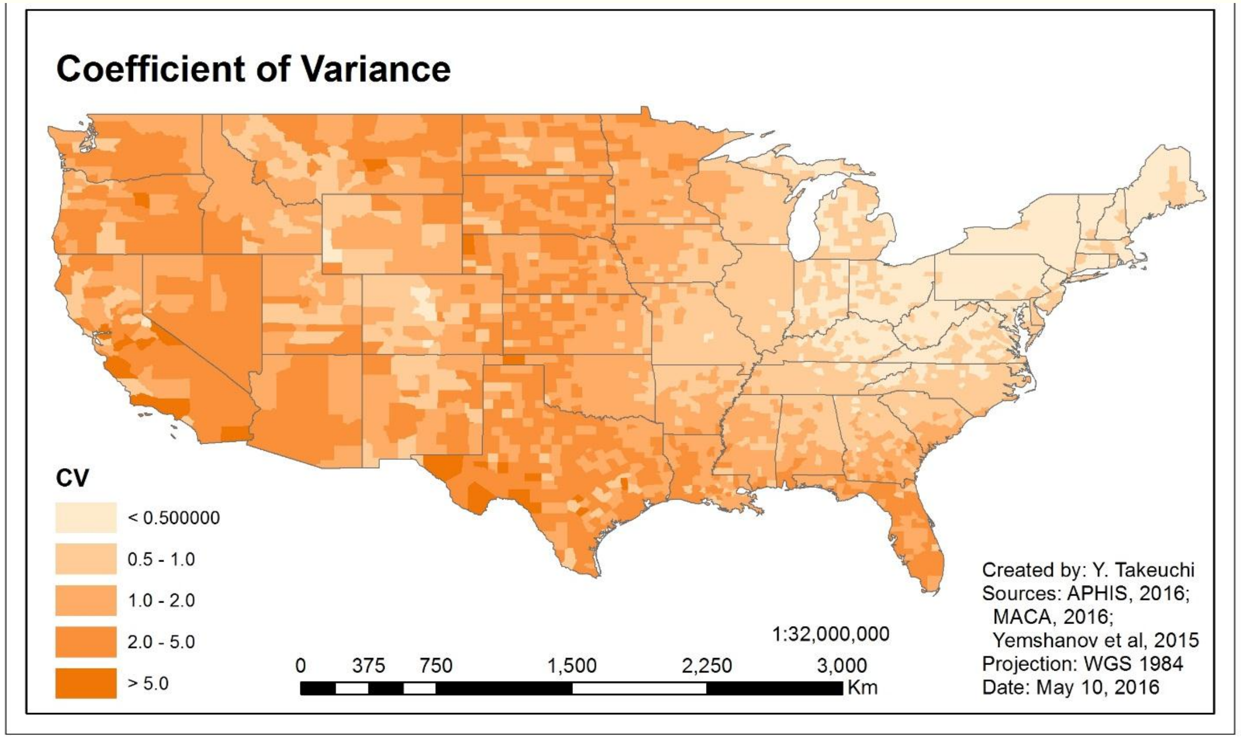
Uncertainty Evaluation within SAFARIS

- Mean-Variance Frontier Method
- Objective is to gain biological information to reduce uncertainty



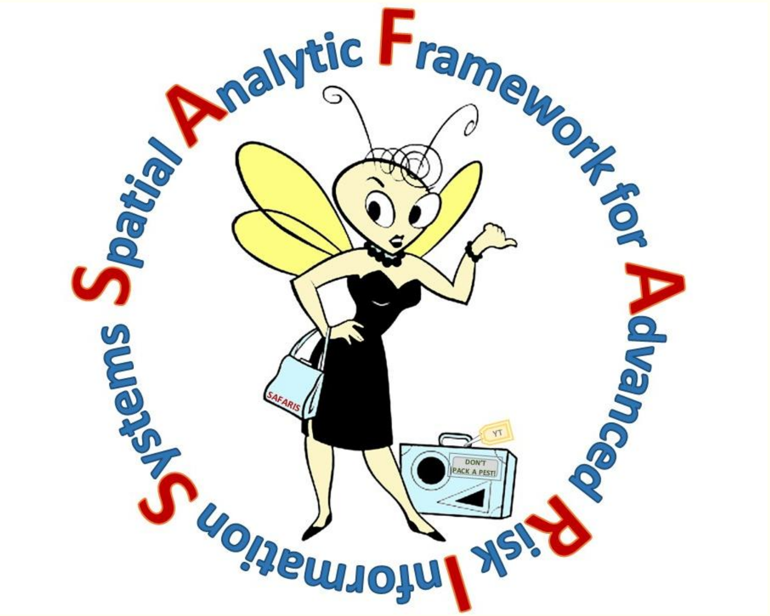
Uncertainty Evaluation within SAFARIS





Impacts of SAFARIS

- Did the idea of a spatial analytic framework really work for regulatory and management agencies, e.g. APHIS, ARS, USFS, and others?
  - Key Features
    - Flexibility among species
    - Allows to address Uncertainty
    - Assist to forecast Climate Change effects
- Assisting APHIS activities
  - Currently SAFARIS is supporting
    - New Pest Advisory Group assessments
    - Agricultural trade activities
    - Domestic program evaluations
    - Supporting CAPS (pest survey) groups
    - USDA climate hub (ARS, APHIS, USFS)



Summary

- **Main research objective is to develop a spatial analytic framework that can assist science-based regulatory agency decision making**
- The framework is able to predict pest behavior at **current and future climate conditions** and to evaluate **uncertainty** associated with pest forecasts.
- I created the Spatial Analytic Framework for Advanced Risk Information Systems to address above needs and **enable expansion** and ability to test and **replicate model advancements** (new forecasting algorithms driven by weather and pest biology).
- SAFARIS allows **multiple analyses** with minimum effort of user input due to framework flexibility.
- SAFARIS is a **transparent** system. Analysts can evaluate results and fine-tune algorithms based on newly available data and information. Model comparison is possible for the first time in an open source product.

Thank You

Core Members

- Dr. Frank Koch
- Dr. Stacy Nelson
- Dr. Ron Stinner
- Dr. Ron Sequeira

APHIS PPQ S&T

- Dr. Glenn Fowler
- Mr. Ignacio Baez
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