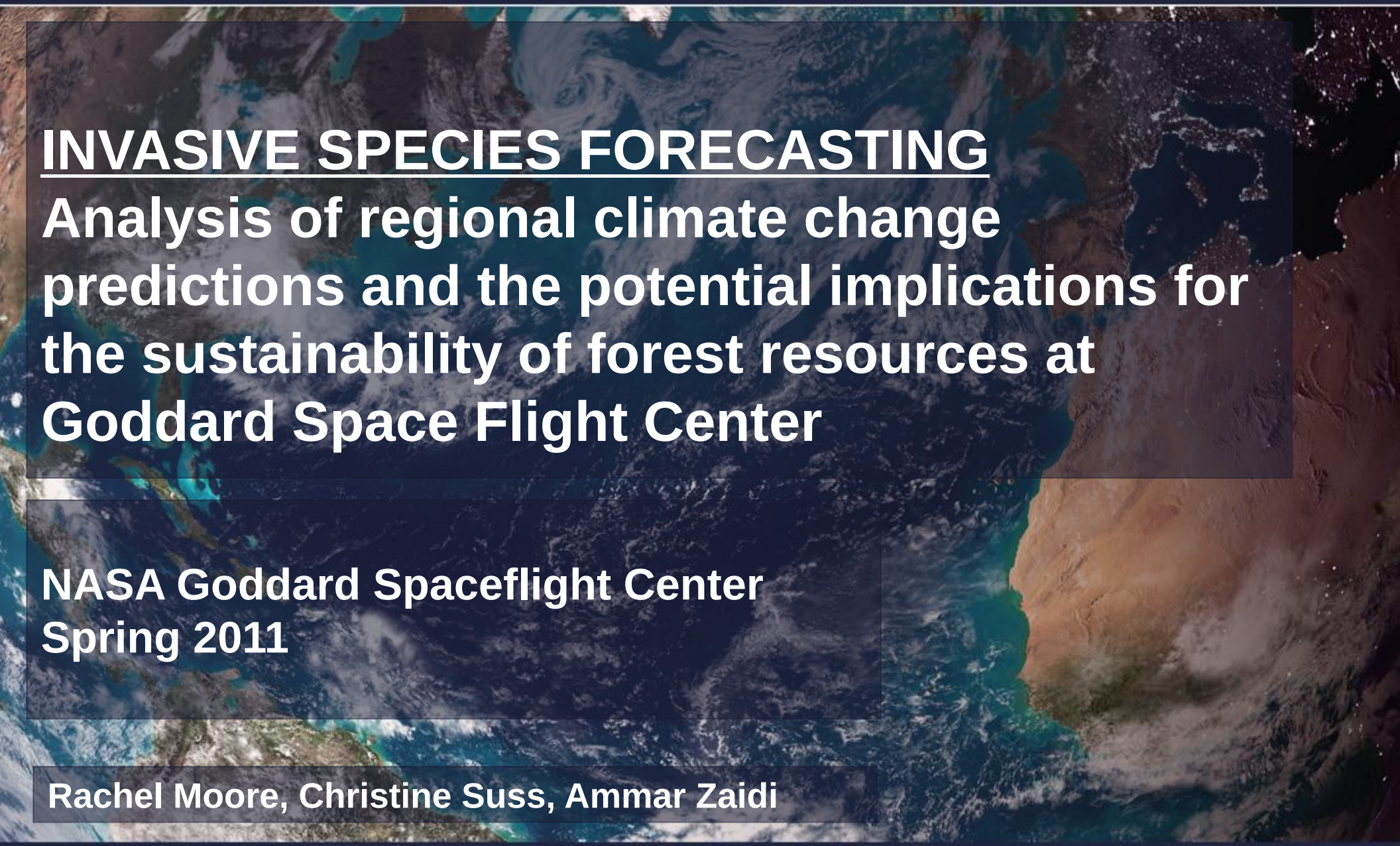


INVASIVE SPECIES FORECASTING

Analysis of regional climate change predictions and the potential implications for the sustainability of forest resources at Goddard Space Flight Center

NASA Goddard Spaceflight Center
Spring 2011

Rachel Moore, Christine Suss, Ammar Zaidi

The Climate Adaptation Science Investigator (CASI) Working Group

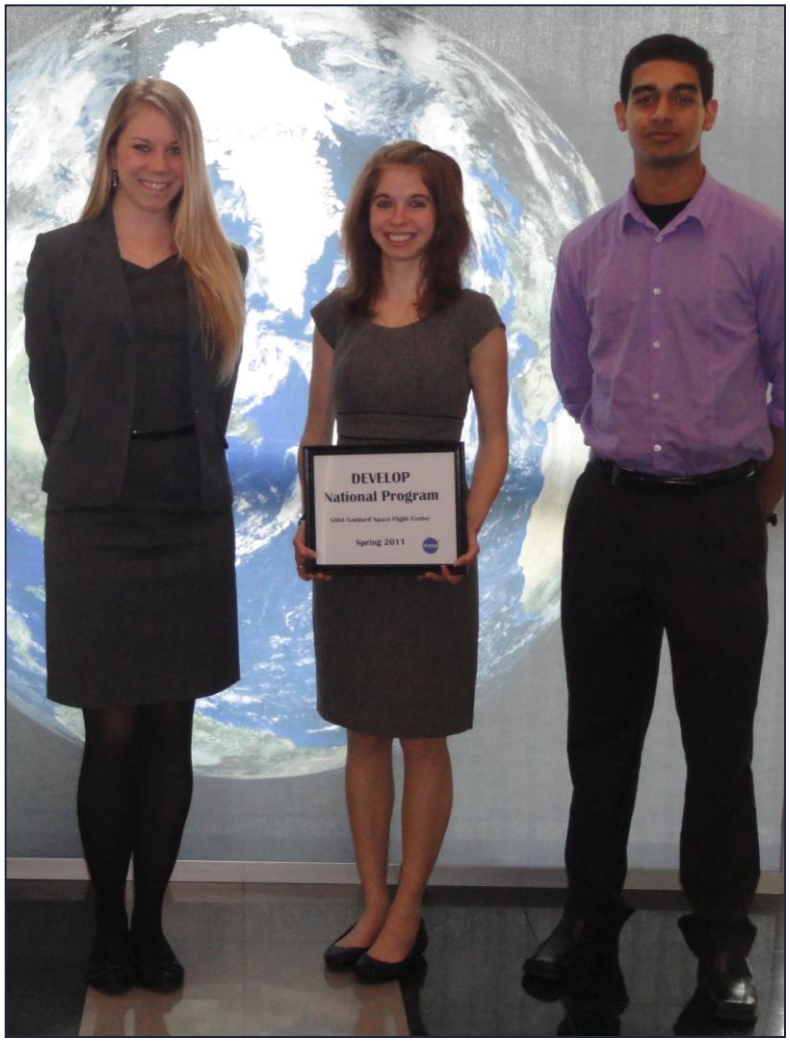
- **October 5, 2009 : President issued an executive order, "Federal Leadership in Environmental, Energy, and Economic Performance"**

  - **"…all agencies evaluate agency climate-change risks and vulnerabilities to manage the effects of climate change on the agency's operations and mission in both the short and long term."**

- **In response, NASA formed the Climate Adaptation Science Investigator (CASI) working group**

- **The Goddard DEVELOP team worked with the Goddard CASI Principle Investigator, Dr. Molly Brown, to assist in climate adaptation research.**

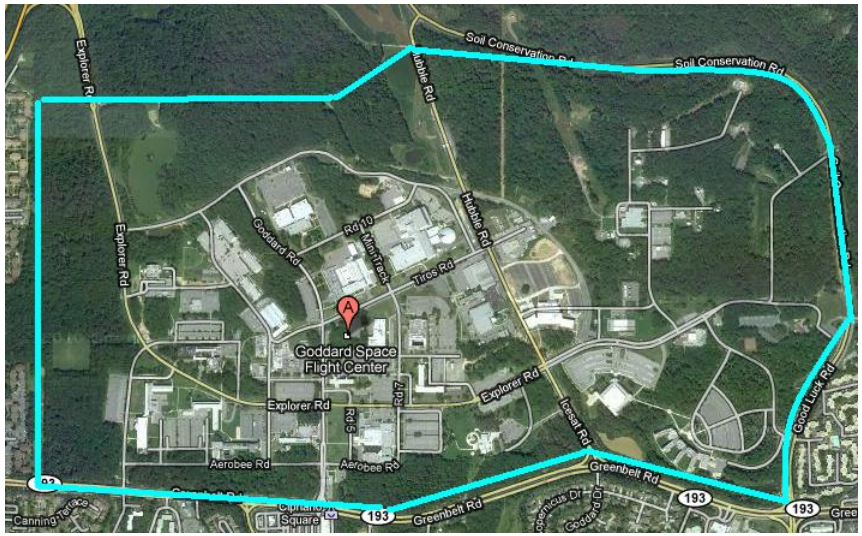
Science Advisors
Molly Brown, PhD – NASA GSFC
Lahouari Bounoua, PhD – NASA GSFC
John L. Schnase, PhD – NASA GSFC
The NASA Center for Climate Simulation



DEVELOP CASI Team Members
Rachel Moore, Christine Suss, and Ammar Zaidi

NASA Goddard Space Flight Center

- **Forests provide critical ecosystem services to Goddard Space Flight Center, as well as to the surrounding community**
- **Global and regional climate variability and change may threaten the sustainability of current forest resources**
- **In response, forest ecosystems may experience an increase in invasive plants, animals, insects, and diseases**



NASA Goddard Space Flight Center
Greenbelt, MD

Community Concern: Invasive Species

- **Invasive species are “non-native to the ecosystem under consideration, and whose introduction causes or is likely to cause economic or environmental harm.”**
- **Have an economic impact of $100 - 200 billion per year in the United States**
- **Early detection and eradication of these species by environmental managers is necessary to mitigate the effect of invasive species**

Wavyleaf basketgrass

Photo courtesy of Kerrie Kyde, MD DNR

Project Objective and Goals

OBJECTIVE

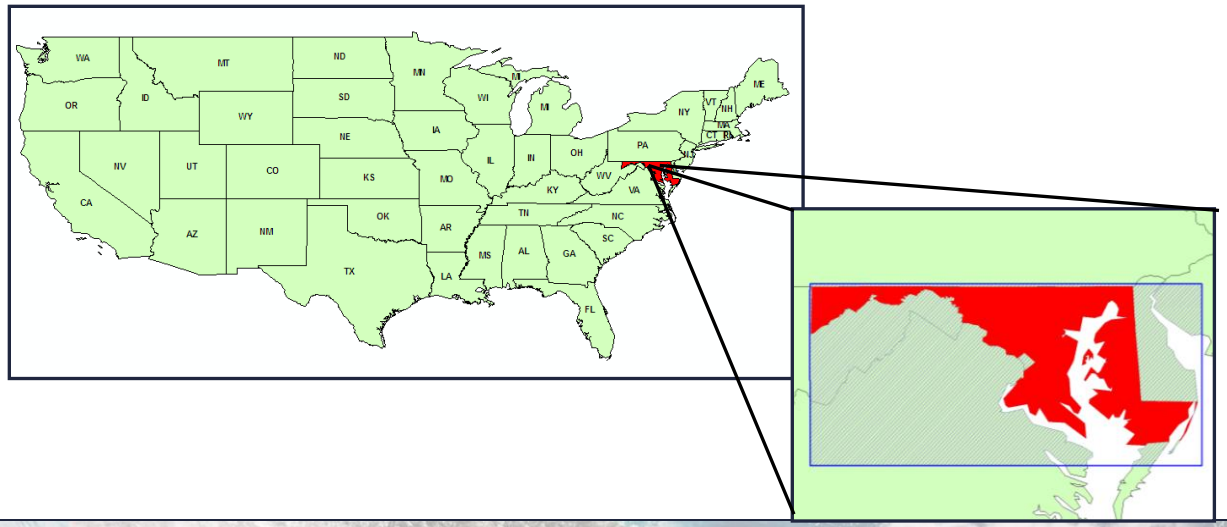
Use the Maximum Entropy (MaxEnt) habitat suitability model to map the potential shift in invasive species ranges in response to climate change

GOALS

- **Identify an invasive species of concern in the state of Maryland, and acquire in – situ presence data**
- **Identify remote sensing data layers that can provide environmental information to the model**
- **Identify temperature and precipitation data that can be used to create a map time series of climate change predictions for 2010 – 2100**
- **Determine the response of the MaxEnt model to the inclusion of time dependent climate data**

Study Area and Species

- **Study Area: Maryland**
- **Study Species: Wavyleaf basketgrass (WLBG)**
- **Study Period: 2010 - 2100**



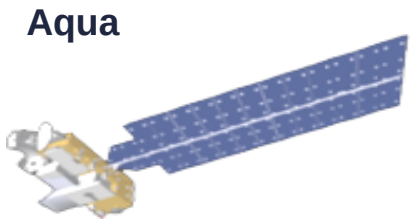
WLBG Invaded Site: 1996

WLBG Invaded Site: 2007

Photo courtesy of Kerrie Kyde, MD DNR

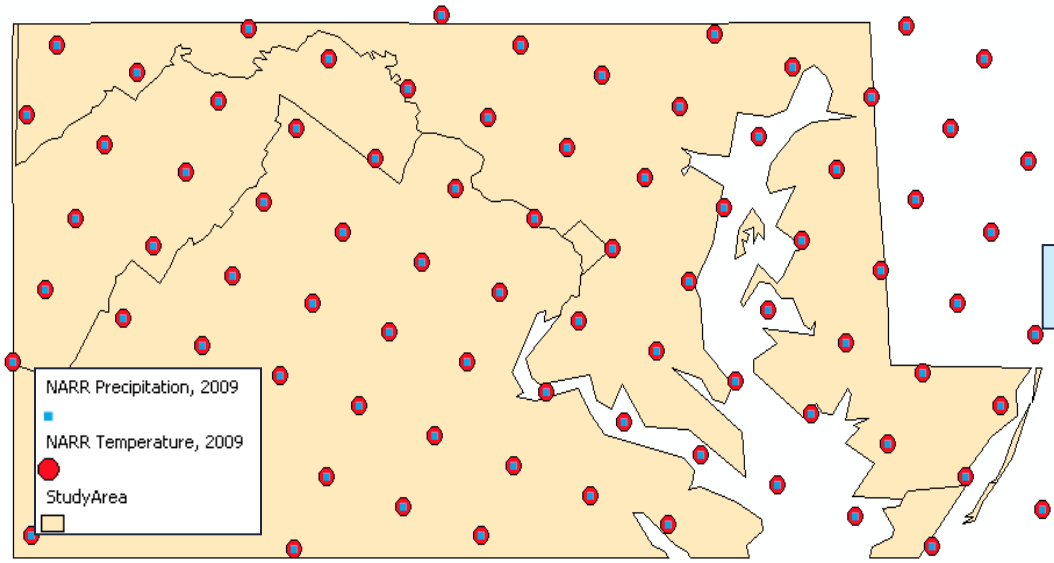
Methodology:
Data Acquisition

- **In-situ species presence data was provided by the Maryland Department of Natural Resources**
- **North American Regional Reanalysis climate data was provided by the University of Maryland Earth System Science Interdisciplinary Center**
- **Environmental data layers were acquired from several NASA sensors, including MODIS Terra and Aqua, Landsat, and SRTM**



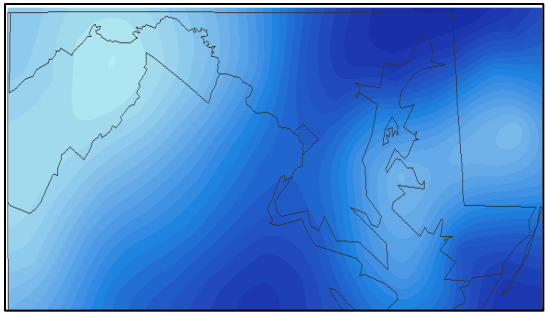
Methodology:
Creation of Climate Raster Datasets

NARR Point Data

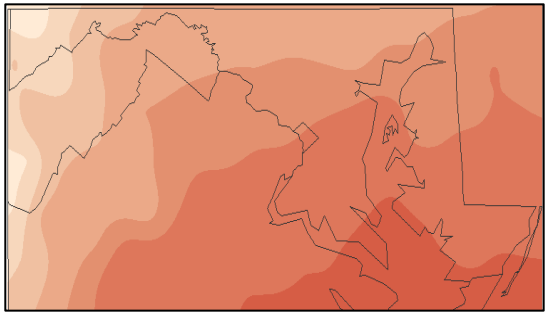


Krige Interpolation

NARR Raster Data



Precipitation 2010



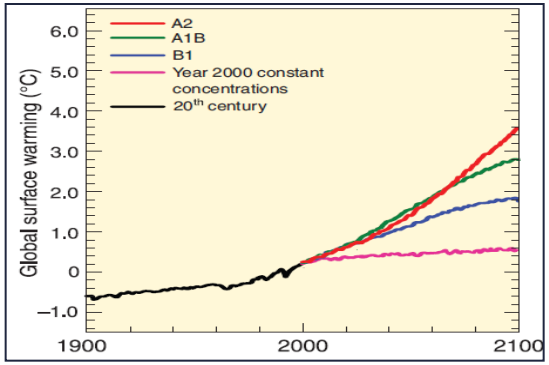
Temperature 2010

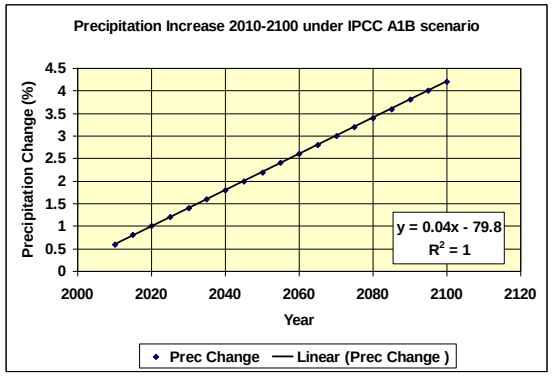
Methodology:
Creation of Climate Map Time Series

IPCC Change Curves

Linear Change Curves

Temperature





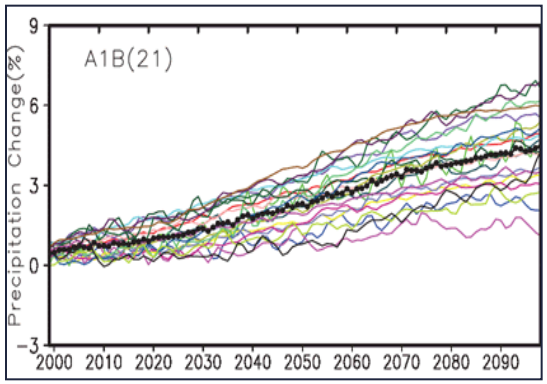
Change 2009-2100:

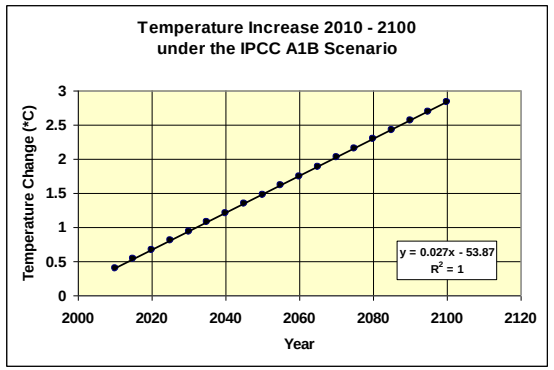
2.4 C

Change/year :

0.027 C

Precipitation





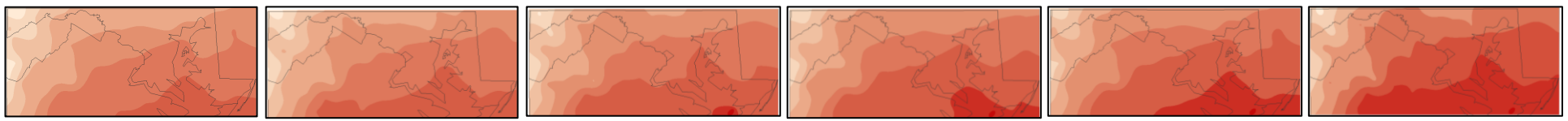
Change 2009-2100:

3.6 %

Change/year :

0.04%

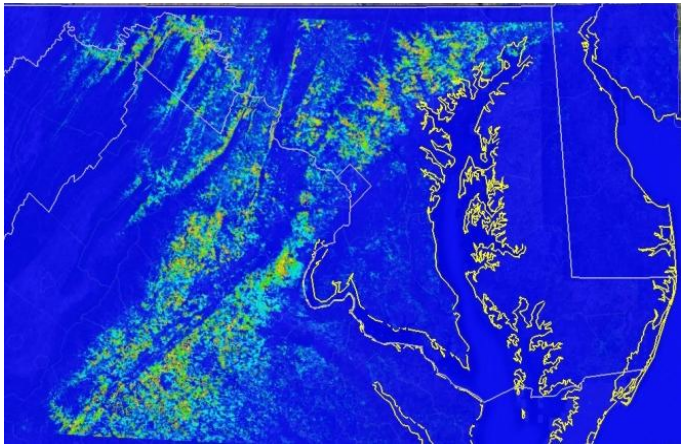
Average Yearly Temperature (Celsius)



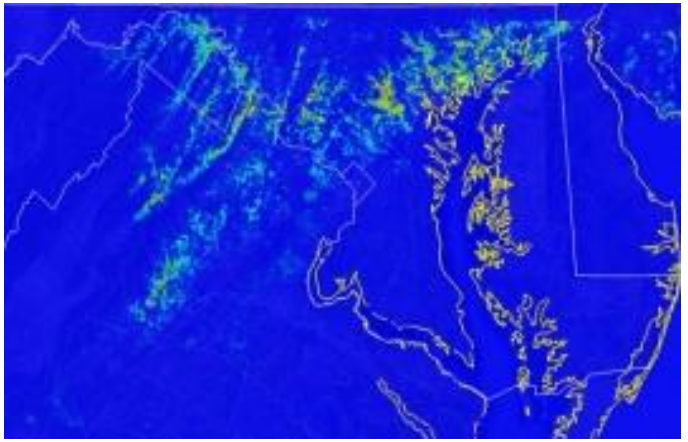
2010 2020 2030 2040 2050 2100

Methodology:
The Maximum Entropy Model

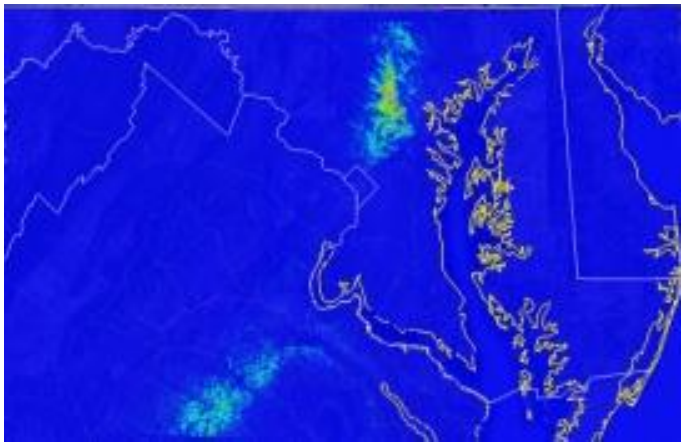
Effect of Climate Variables on Current Predicted Habitat Suitability



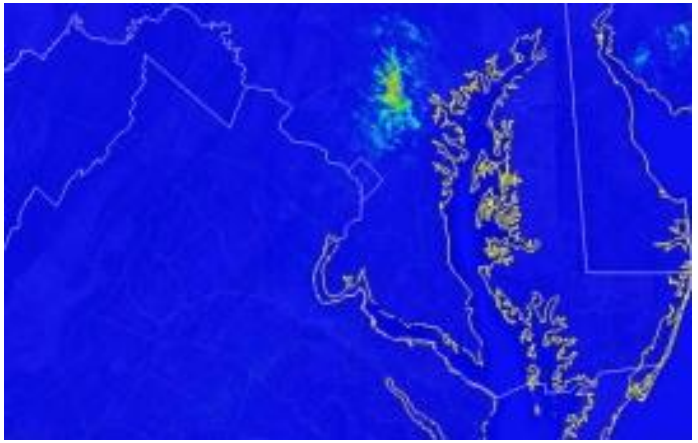
No Temperature, No Precipitation



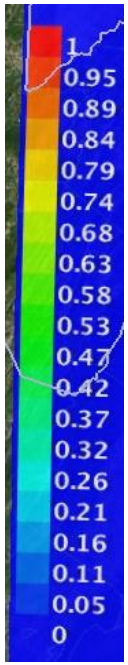
Temperature



Precipitation

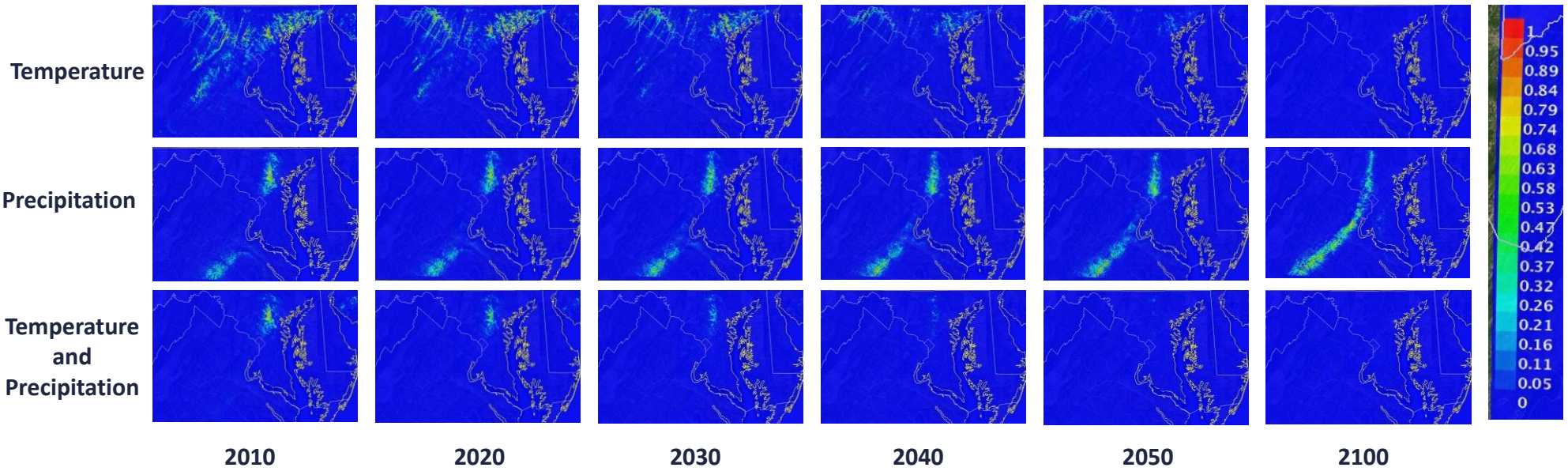


Temperature and Precipitation

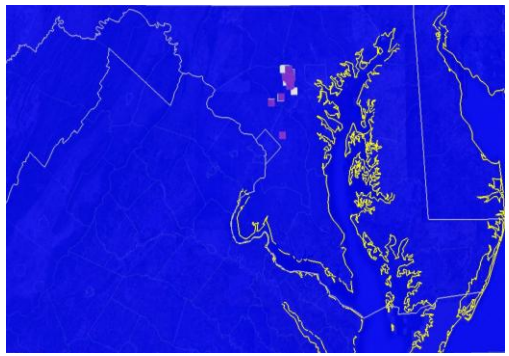


Results & Analysis

Response of WLBG predicted habitat suitability to 3 climate change scenarios, 2010-2100



WLBG Presence Points



Top Contributing Predictor Layers

Temperature	Precipitation	Temp and Prec
Elevation	Precipitation	Precipitation
Temperature	Elevation	Temperature
NDVI Max Peak Values	NDVI Max Peak Values	Elevation
Land Cover	NDVI Green Up Rates	NDVI Max Peak Values
NDVI Green Up Rates	Land Cover	Land Cover
-	Slope	Slope

Conclusions

- The application of the IPCC change curves to the NARR climate raster data successfully produced climate map time series of temperature and precipitation from 2010-2100.
- The Maximum Entropy model responded to the influence of the climate raster data sets, and has the potential for use in the mapping of invasive species range shifts in response to future climate change predictions.
- The relationship between temperature, precipitation, and species range shifts will be dependent on the species of interest. These ecological relationships must be understood prior to any habitat suitability modeling effort.
- Higher resolution data is necessary to model the habitat suitability of GSFC, but coarser resolution data can be used to determine the threat of invasive species to the areas surrounding the Center. This information can help environmental managers anticipate and mitigate possible future invasions.