UNIVERSITY OF TWENTE.

Continental-Scale Monitoring and Mapping of False Spring: A Cloud Computing Solution

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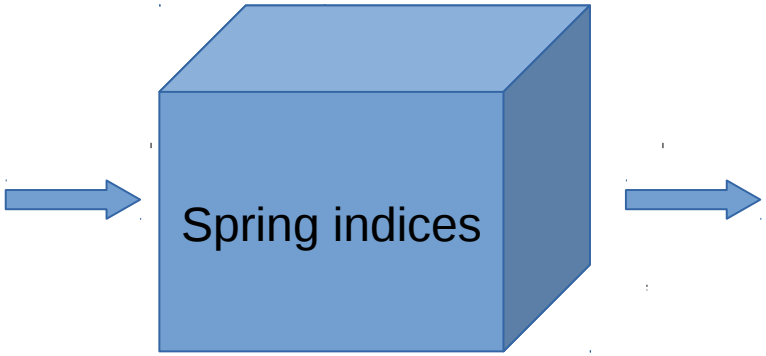
What's a false spring?

- Springs where plants get frost damage
  - Affect both natural and agricultural systems
    - Reduction in reproduction and yield
      - False spring of 2012 was estimated in 500$ millions only in the state of Michigan, USA

How to springcast?

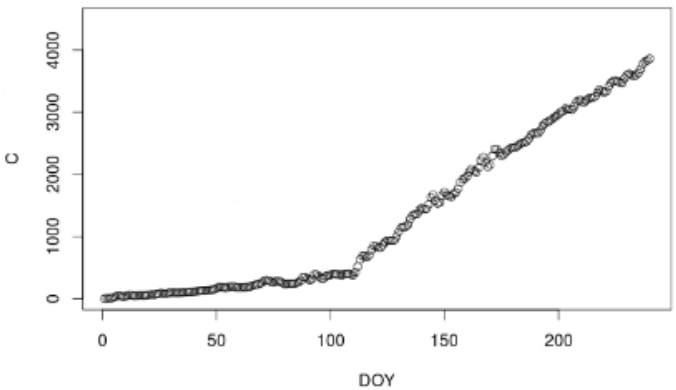
- One answer is spring index model:
  - A numerical models based on near real-time weather data
    - daily temperature
    - first leaf and bloom
      - lilacs and honeysuckle



Spring index model

- Leaf index

$$C = A_1 * MDS0 + A_2 * SYNOP + A_3 * DD57 + A_4 * DDE2$$

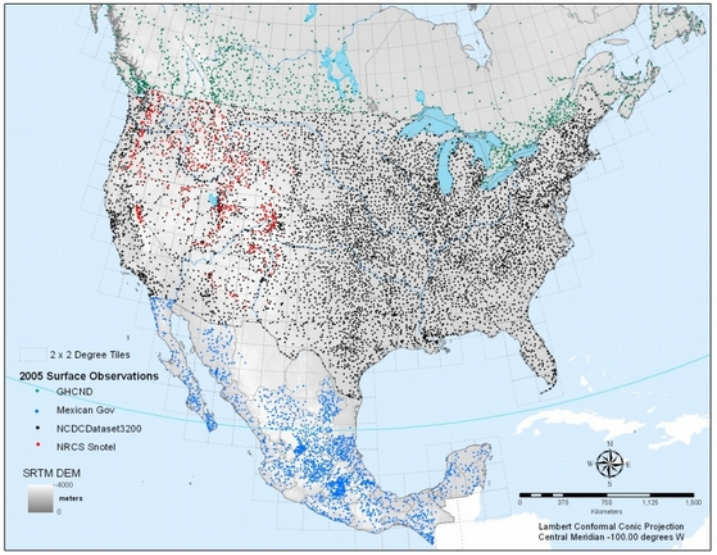


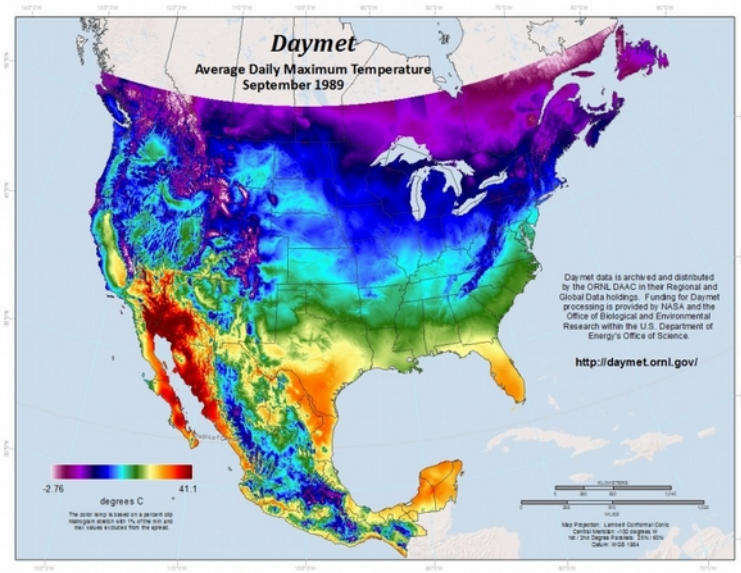
Predictor abbreviation	Description
MDS0	Days since Jan 1
SYNOP	Number of high-energy synoptic events
DD57	5-7 day degree-hour accumulations
DDE2	2-3 day degree-hour accumulations

- Last freeze index: DOY with minimum temperature less than −0.6 ◦C
- Damage index: The anomalous amount of day between first leaf and last freeze

Big Daymet data

- Weather station interpolation
- Daily temperature
- 1 x 1km resolution
- 1980-2015
- About 1 TB (only for the US)





What was the problem?

We couldn’t calculate (daily predictors of) leaf index because of lack of processing power of local machine.

~ 800 days on my laptop

Cloud computing solution

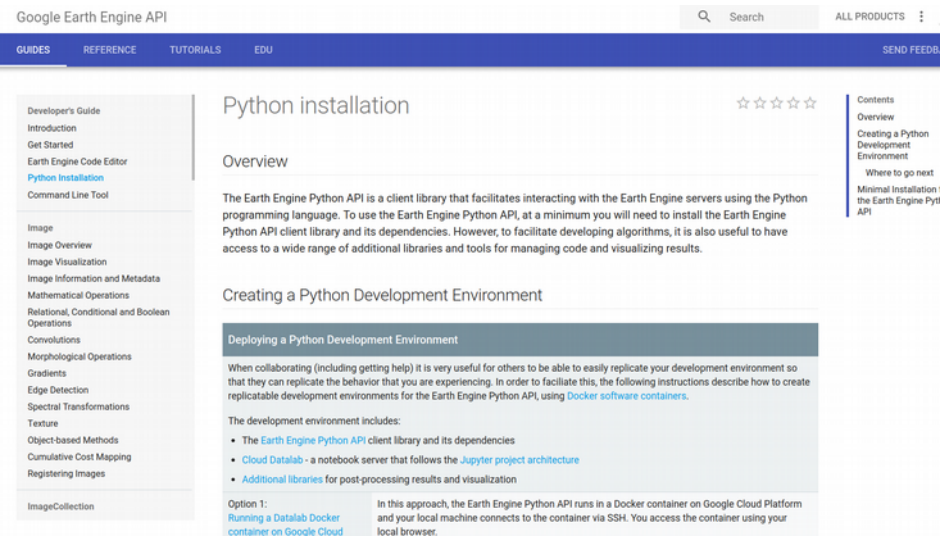
Google Earth Engine

A cloud-based geospatial processing platform for executing large-scale data analysis.

Google Earth Engine: Features

- Public data catalog: vast amounts of publicly available data (you don’t need to store data)
- Processing power (computation engine)
- Interactive development platforms
- Save and share work routines
- Google Earth community (Google Groups)

How to use it?


Google Earth Engine API
Search
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EDU
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Convolutions
Morphological Operations
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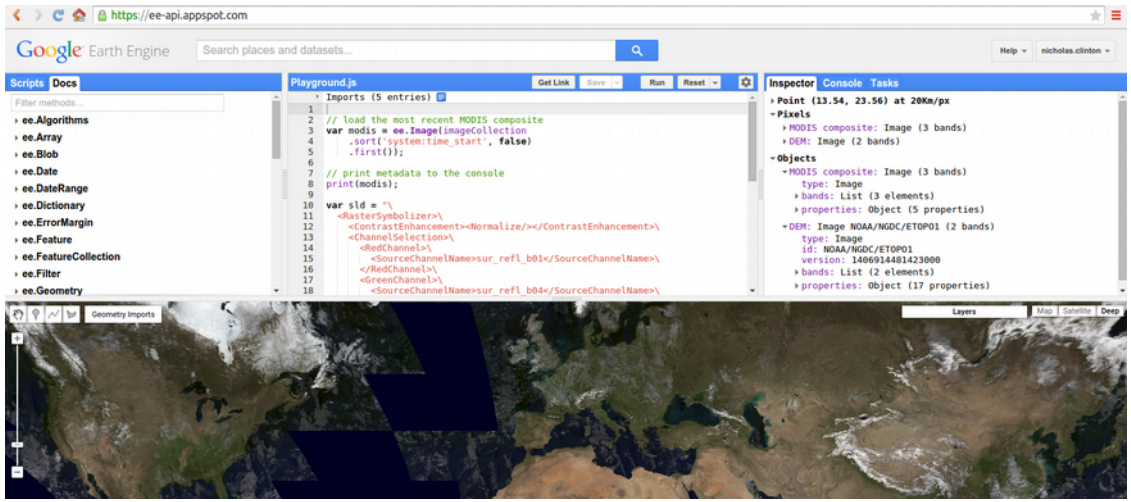
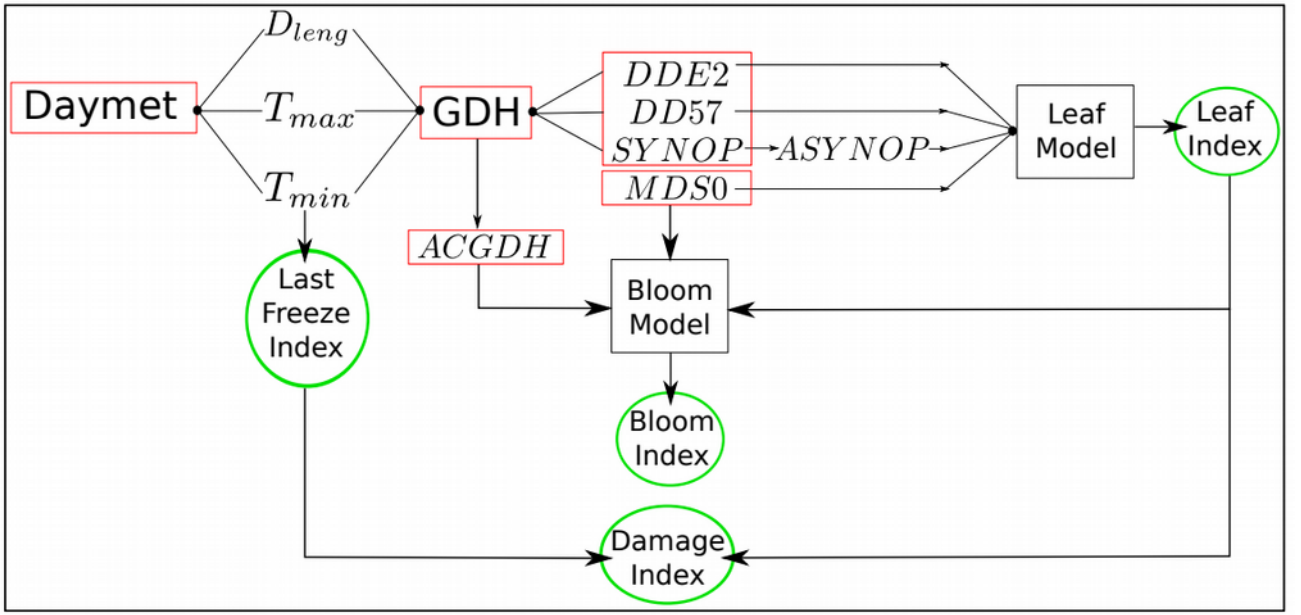
Edge Detection
Spectral Transformations
Texture
Object-based Methods
Cumulative Cost Mapping
Registering Images
ImageCollection
Python installation
Overview
The Earth Engine Python API is a client library that facilitates interacting with the Earth Engine servers using the Python programming language. To use the Earth Engine Python API, at a minimum you will need to install the Earth Engine Python API client library and its dependencies. However, to facilitate developing algorithms, it is also useful to have access to a wide range of additional libraries and tools for managing code and visualizing results.
Creating a Python Development Environment
Deploying a Python Development Environment
When collaborating (including getting help) it is very useful for others to be able to easily replicate your development environment so that they can replicate the behavior that you are experiencing. In order to faciliate this, the following instructions describe how to create replicatable development environments for the Earth Engine Python API, using Docker software containers.
The development environment includes:
The Earth Engine Python API client library and its dependencies
Cloud Datalab - a notebook server that follows the Jupyter project architecture
Additional libraries for post-processing results and visualization
Option 1:
Running a Datalab Docker container on Google Cloud
In this approach, the Earth Engine Python API runs in a Docker container on Google Cloud Platform and your local machine connects to the container via SSH. You access the container using your local browser.
Contents
Overview
Creating a Python Development Environment
Where to go next
Minimal Installation
the Earth Engine Pyt
API


https://ee-api.appspot.com
Google Earth Engine
Search places and datasets...
Help
nicholas.clinton
Scripts
Docs
Playground.js
Get Link
Save
Run
Reset
Inspector
Console
Tasks
Filter methods...
ee.Algorithms
ee.Array
ee.Blob
ee.Date
ee.DateRange
ee.Dictionary
ee.ErrorMargin
ee.Feature
ee.FeatureCollection
ee.Filter
ee.Geometry
Imports (5 entries)
// load the most recent MODIS composite
var modis = ee.Image(imageCollection
.sort('system:time_start', false)
.first());
// print metadata to the console
print(modis);
var $id = '\
<RasterSymbolizer>\
<ContrastEnhancement><Normalize/></ContrastEnhancement>\
<ChannelSelection>\
<RedChannel>\
<SourceChannelName>sur_refl_b01</SourceChannelName>\
</RedChannel>\
<GreenChannel>\
<SourceChannelName>sur_refl_b04</SourceChannelName>\
Point (13.54, 23.56) at 20Km/px
Pixels
MODIS composite: Image (3 bands)
DEM: Image (2 bands)
Objects
MODIS composite: Image (3 bands)
type: Image
bands: List (3 elements)
properties: Object (5 properties)
DEM: Image NOAA/NGDC/ETOPO1 (2 bands)
type: Image
id: NOAA/NGDC/ETOPO1
version: 1406914481423000
bands: List (2 elements)
properties: Object (17 properties)
Geometry Imports
Layers
Map
Satellite
Deep

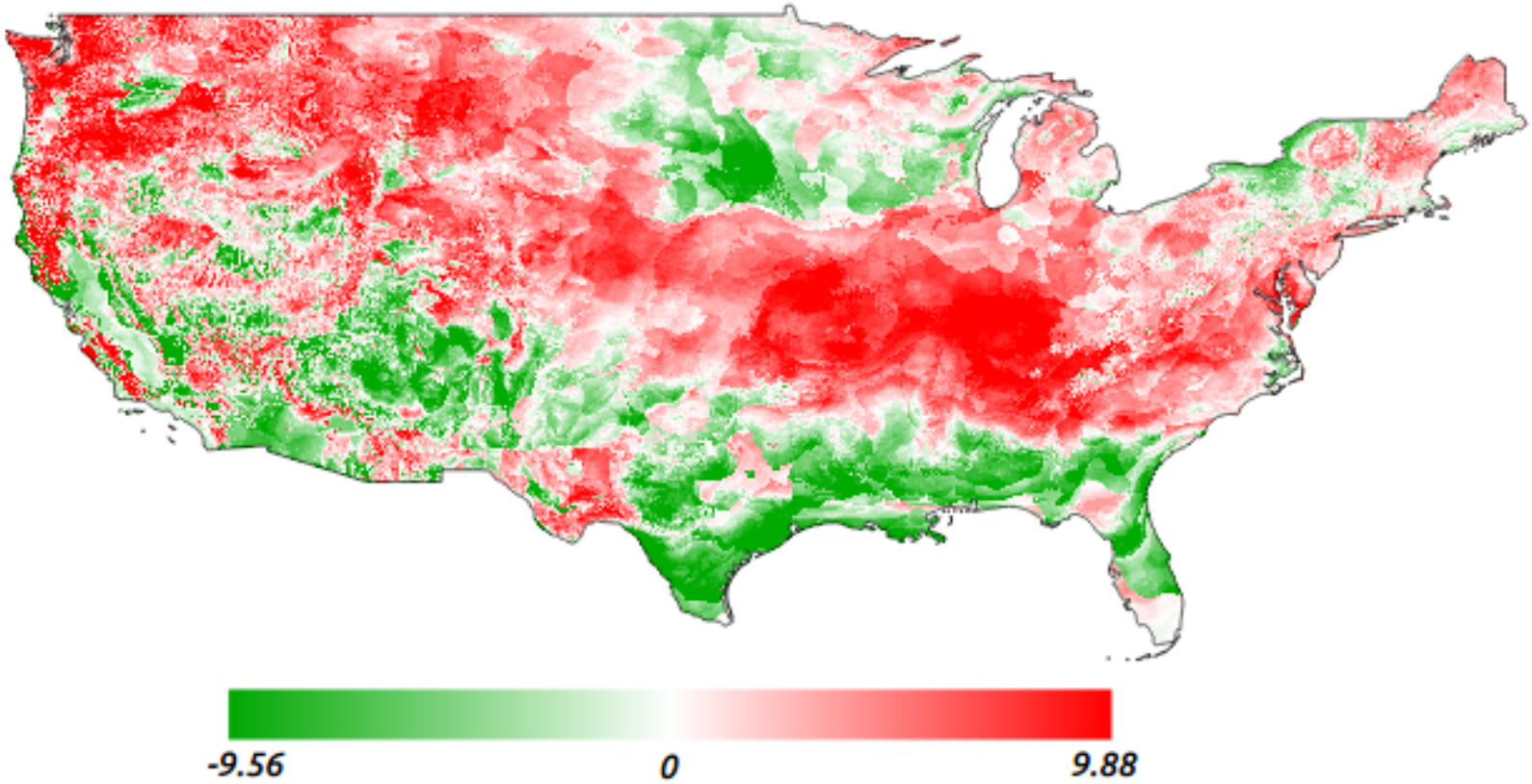

Daymet
D_{leng}
T_{max}
T_{min}
GDH
$DDE2$
$DD57$
$SYNOP$
$ASYNOP$
$MDS0$
Leaf Model
Leaf Index
$ACGDH$
Last Freeze Index
Bloom Model
Bloom Index
Damage Index

Is there anything bad about Google Earth engine?

Yes, it produce a huge amount of good results to be downloaded!

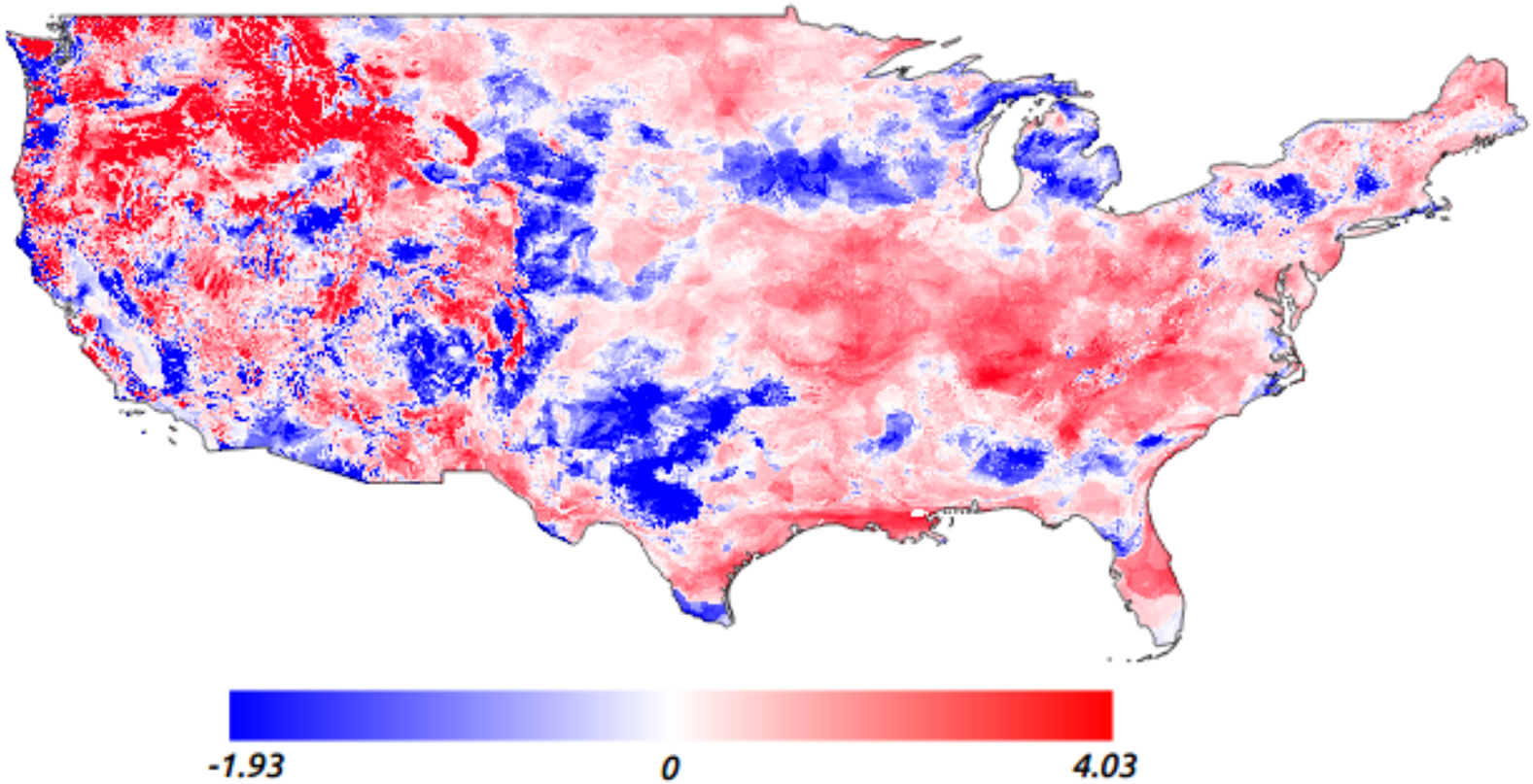
The average damage index anomalies (1980-2015)

The areas with negative values are areas where first leaf tends to occur after the last freeze



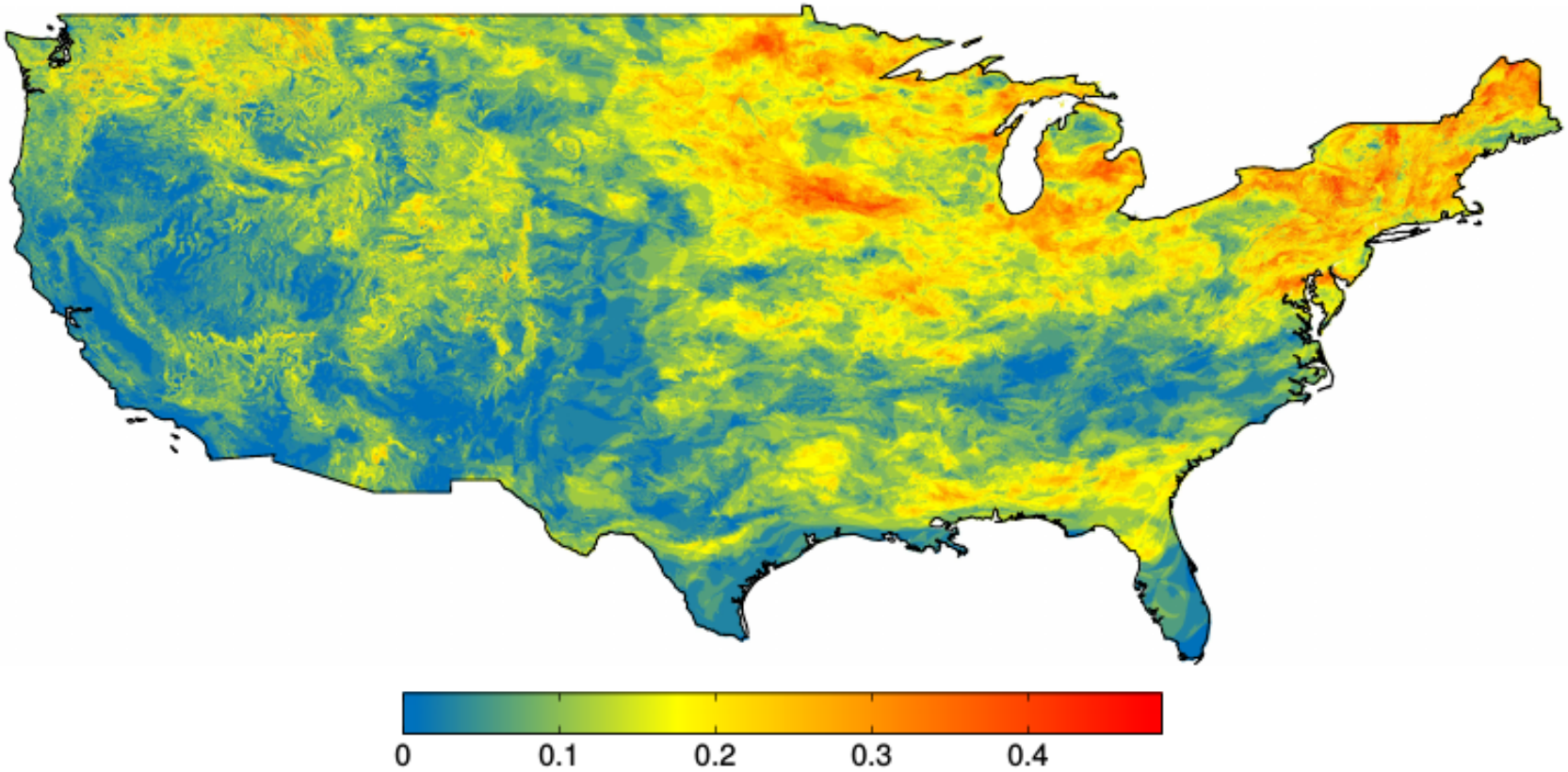
The trend of damage index from (1980-2015)

Linear regression to model the trend in damage index



The average false spring (1980-2015)

The average of binary false spring grids



Take home message

- The cloud-based approach to map false spring was computationally efficient.
- The risk of false spring exists throughout much of the US
- The need for future species-specific predictions to better understand potential effects on natural and agricultural systems

Thank you
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Your questions are welcome

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