

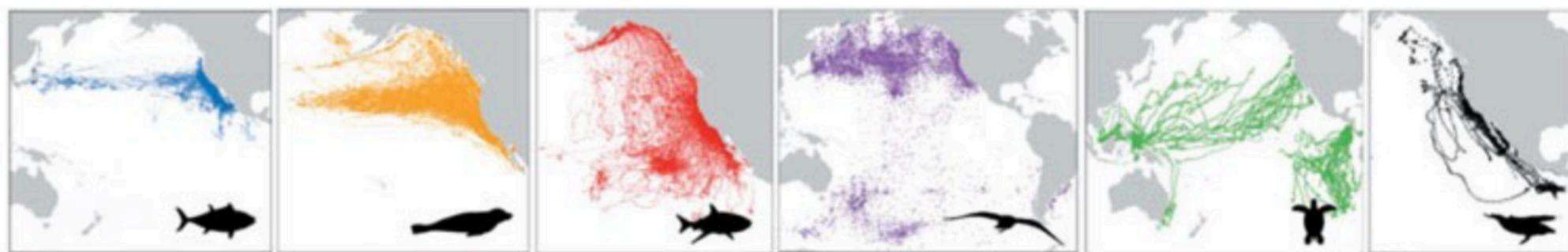
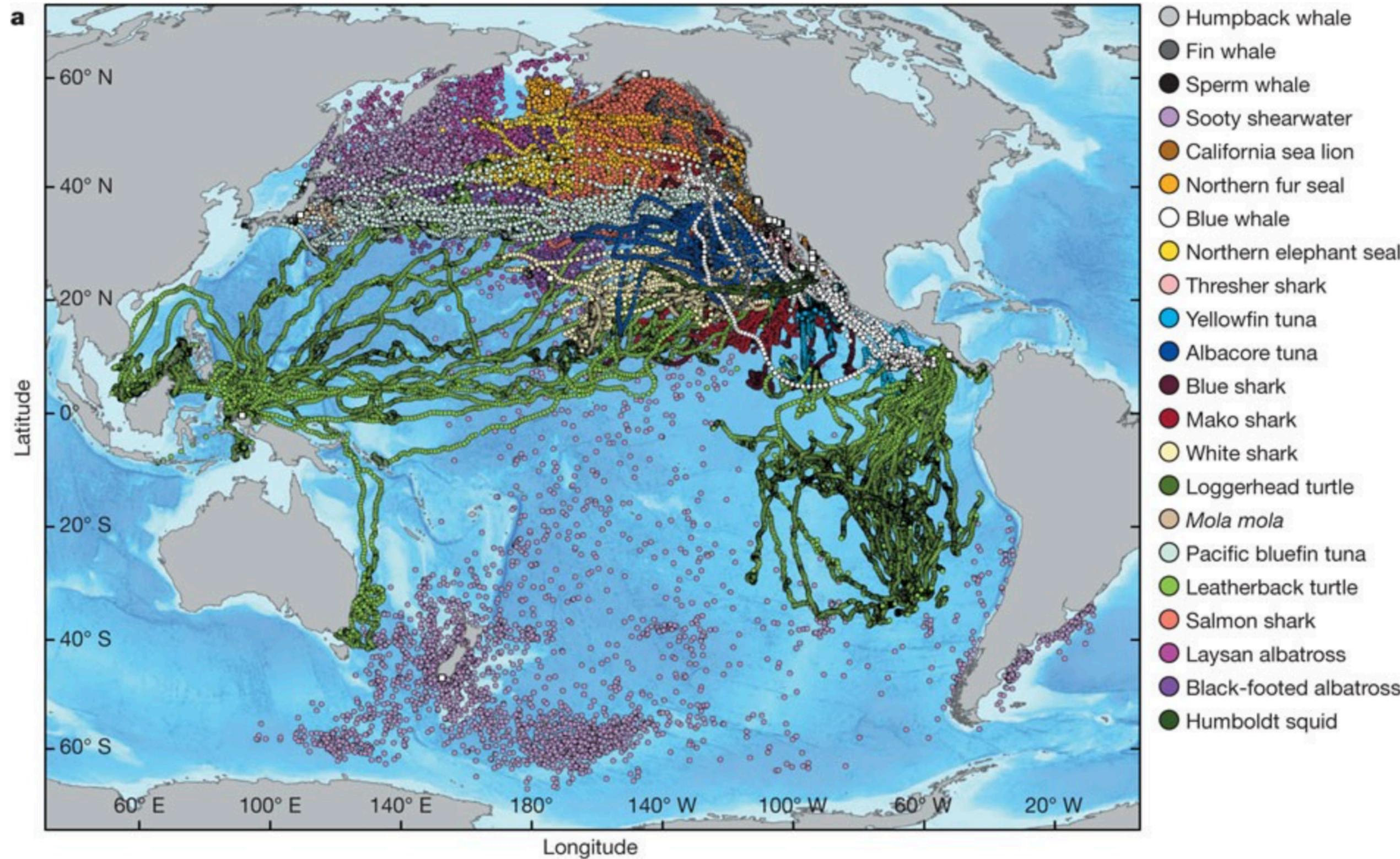
Visualization of Data in Space and Time: An Interactive Framework

Josh Cullen (*Florida State University*)

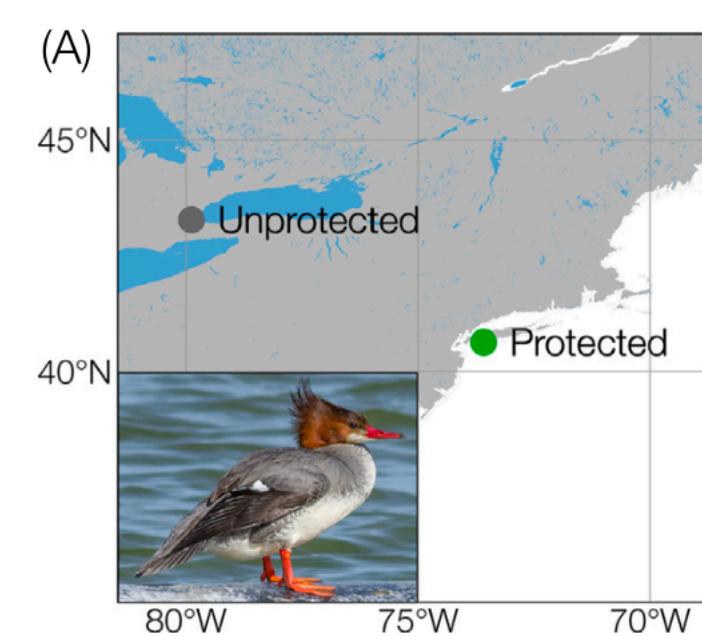
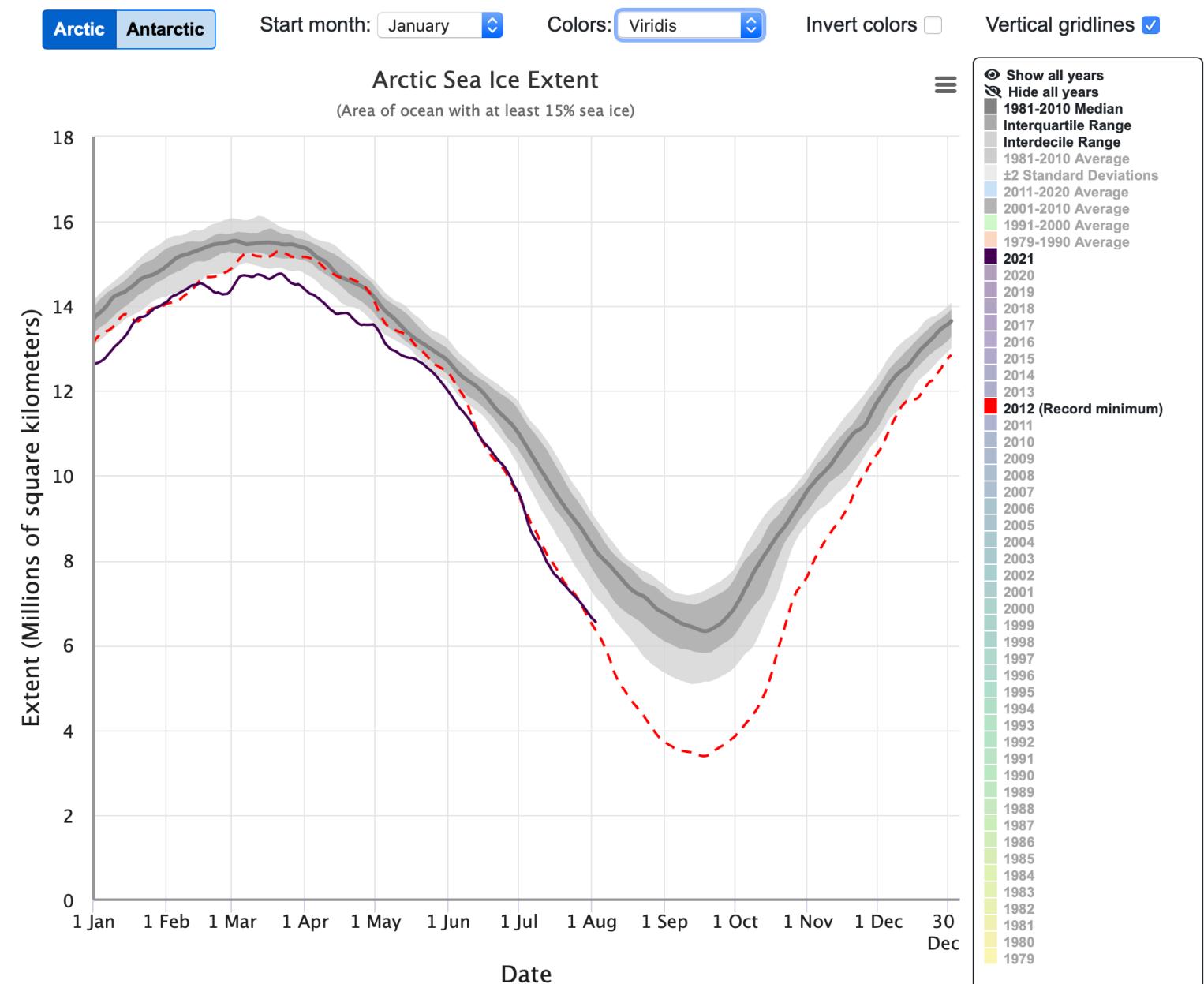
March 3, 2022

South Coast UseR March Meeting

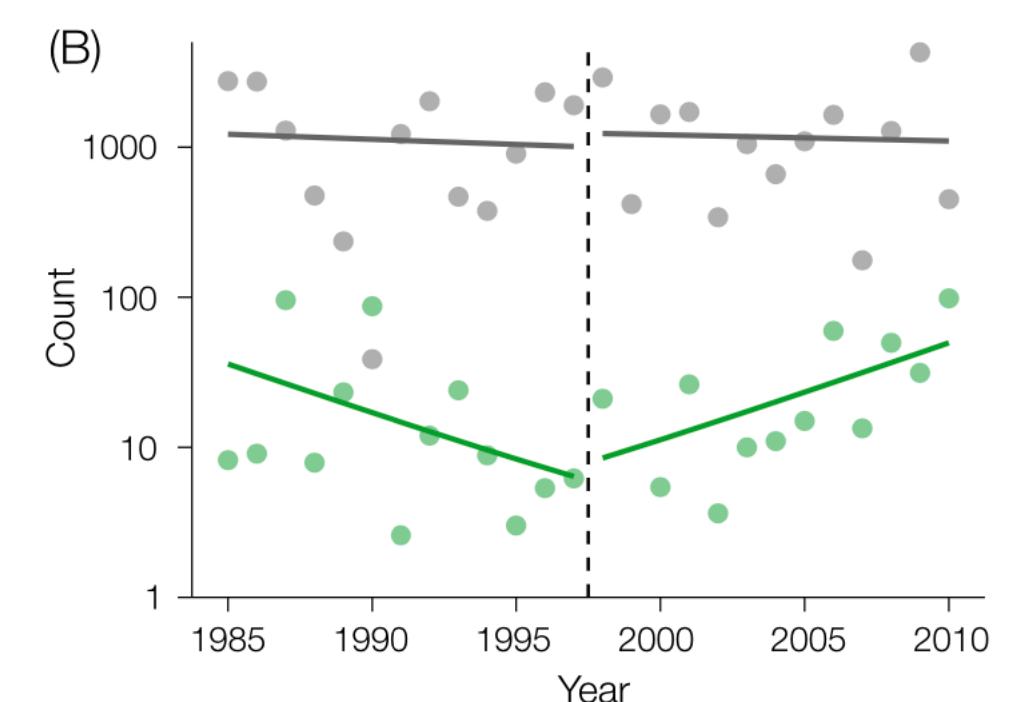
Spatiotemporal data are ubiquitous



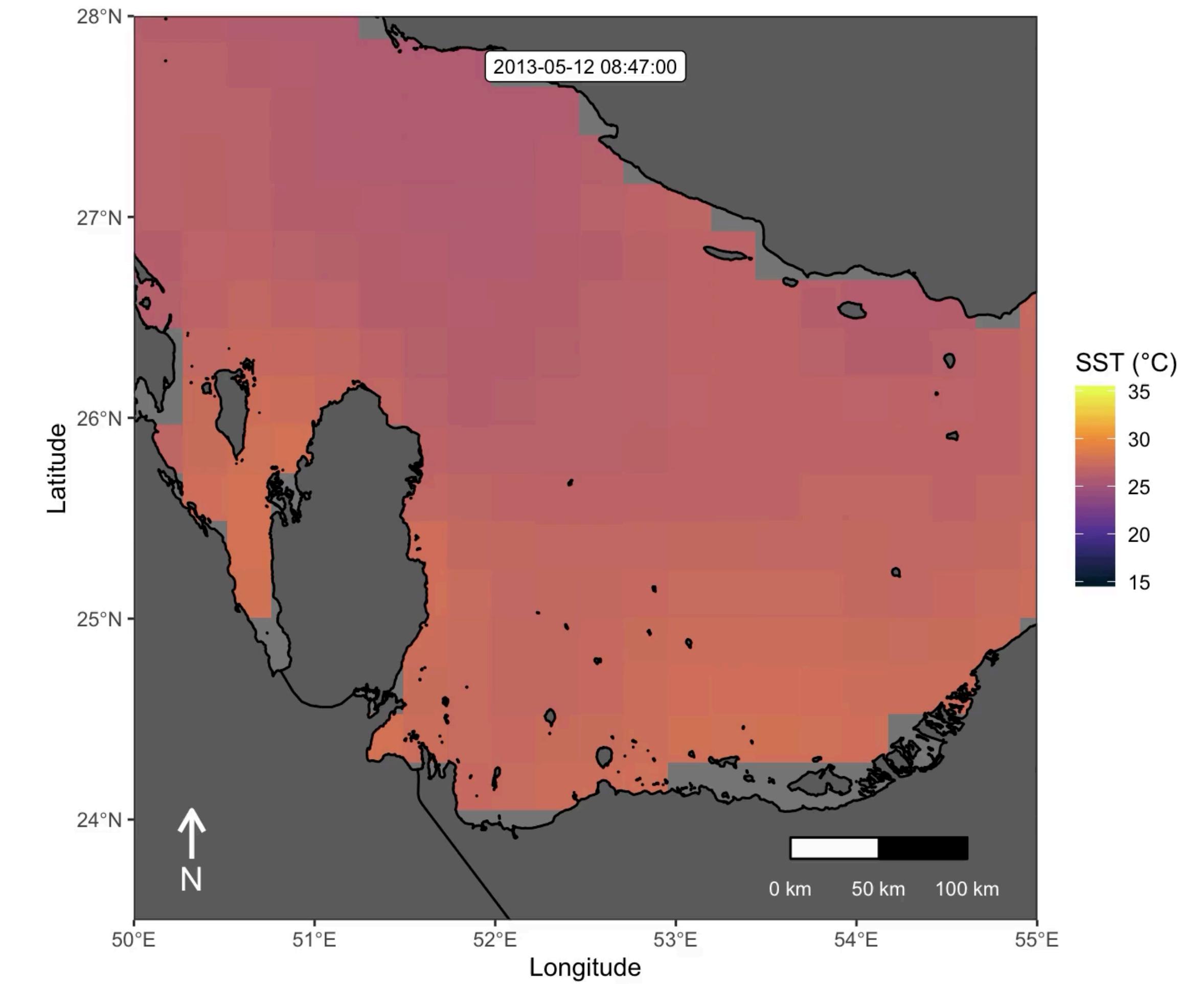
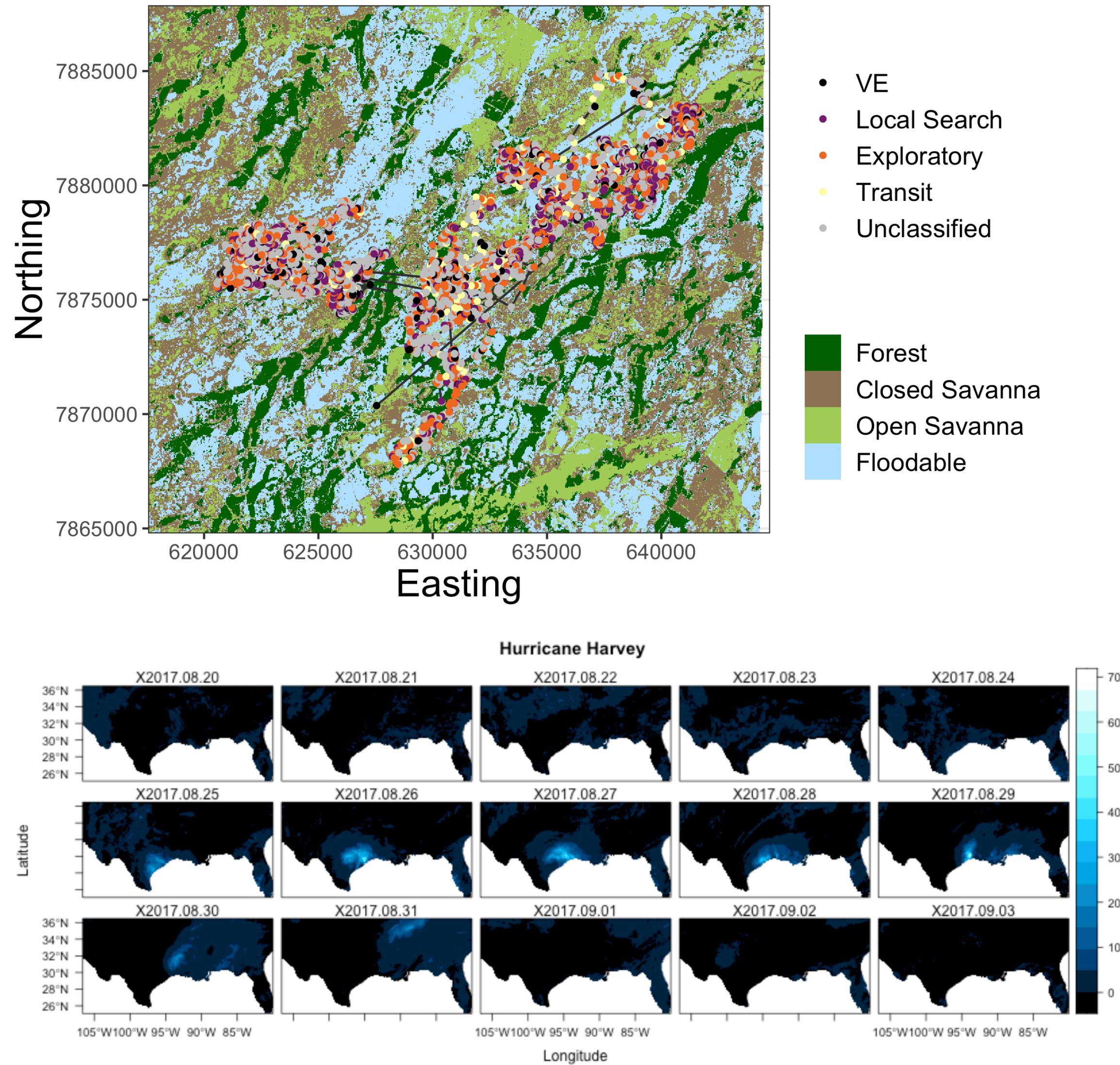
Block et al. 2011



Wauchope et al. 2021



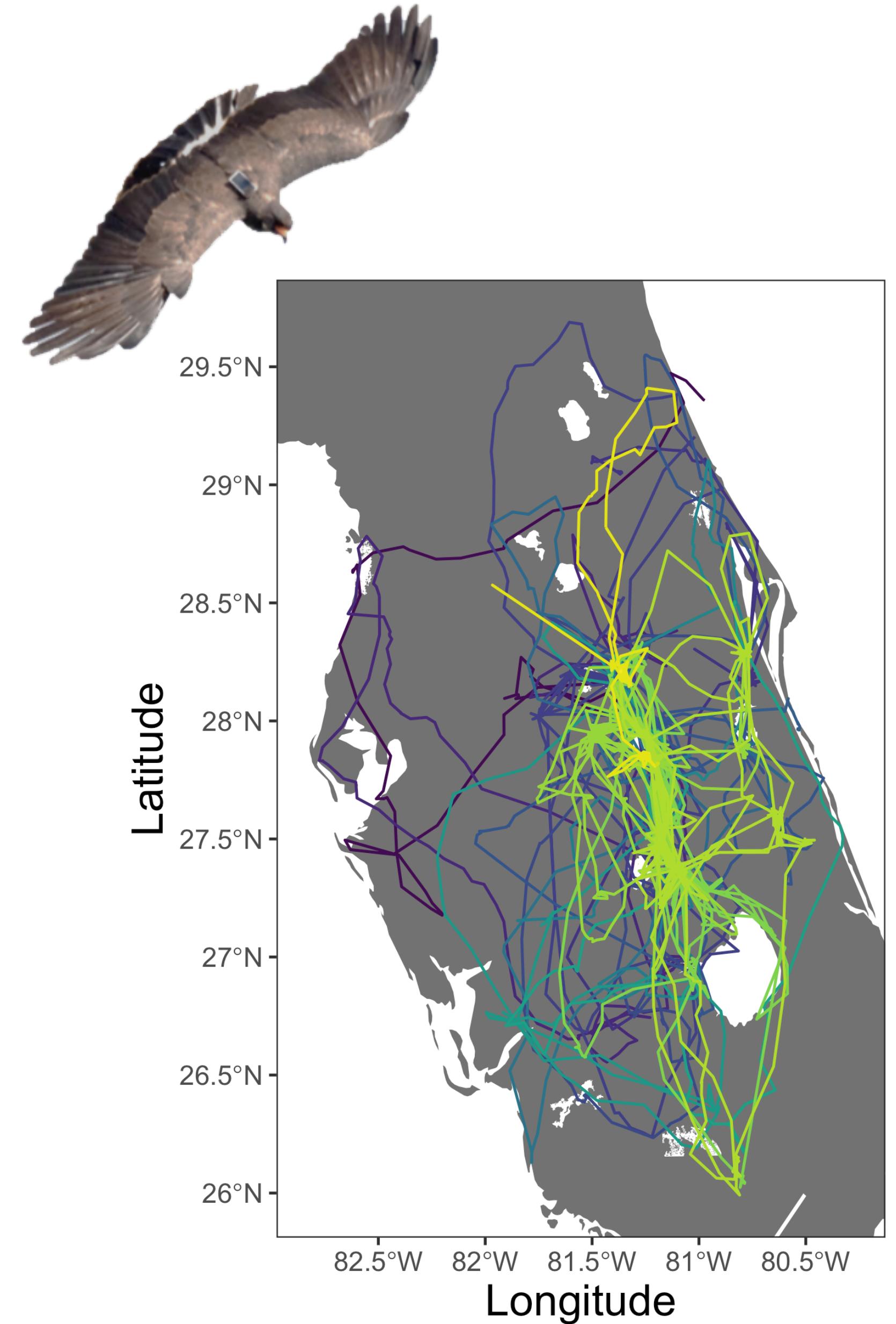
Visualizing spatiotemporal patterns can be difficult



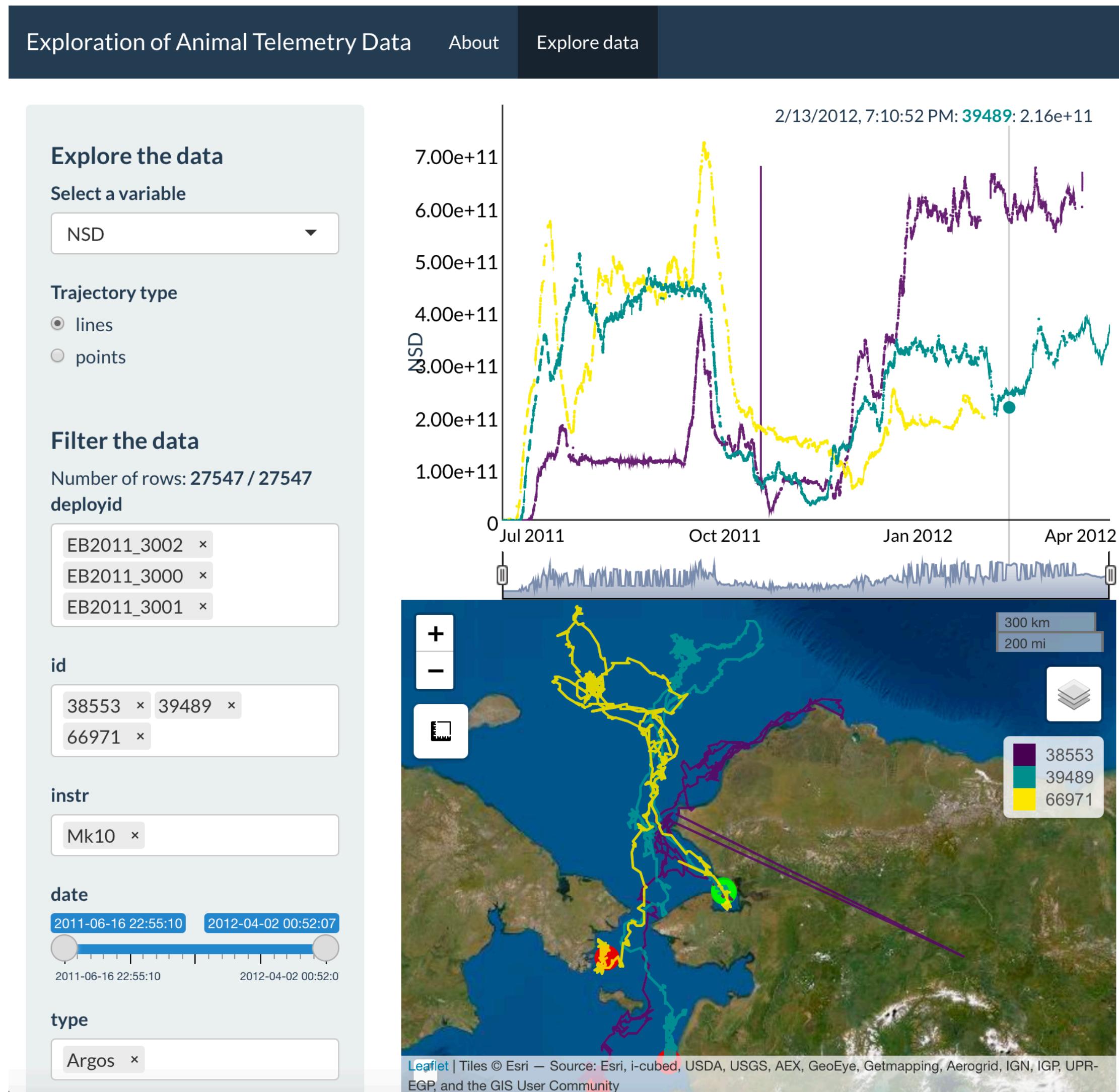
Credit: {climateR} tutorial (Mike Johnson)

The problem

- Determine patterns of behavior and space-use in endangered raptor
- How to visualize what these movement patterns look like?
 - *Create facet plot at different spatiotemporal scales*
 - *Plot time series of select variables*
 - *Create 3D plot of space and time*



Our solution



Interactively visualize animal telemetry data over space and time

Available within `bayesmove` and online:
https://joshcullen.shinyapps.io/segmentation_of_NSD



Explore time series of variables

For one or more IDs, visualize one of the variables in your dataset:

Intrinsic property of track

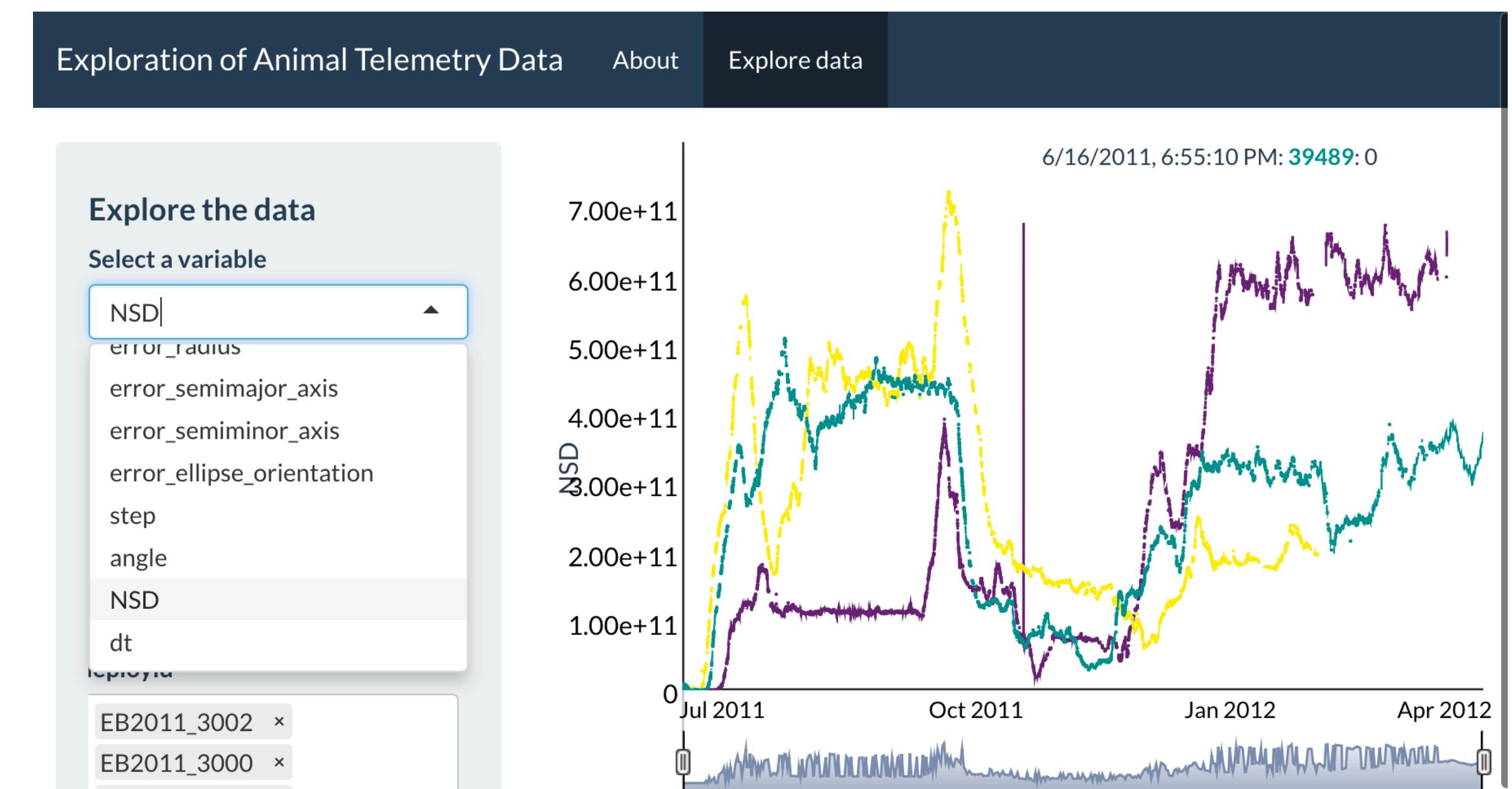
- Speed
- Net-squared displacement

Remote sensing

- Normalized difference vegetation index
- Sea surface temperature

Derived variable

- Distance to feature of interest



Explore spatial patterns of movement

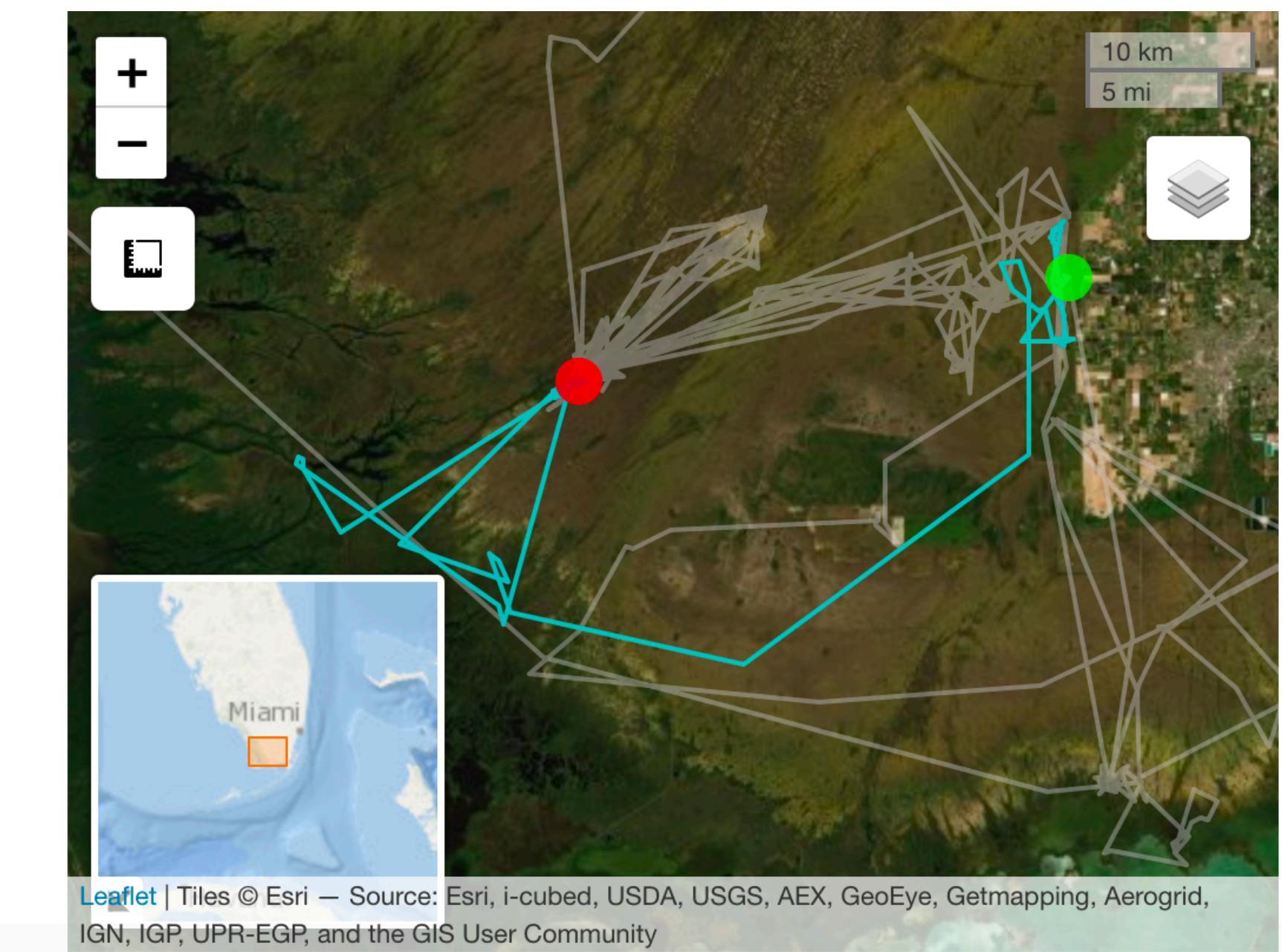
Zoom and pan around area using different basemaps to explore spatial relationships

- What type of land use/land cover?
- How frequently does animal cross roads?
- Near any bathymetric features?
- Is animal occupying unusual habitat?

POSIXct . Click and drag on the lineplot to highlight the corresponding time range on the neighboring map.

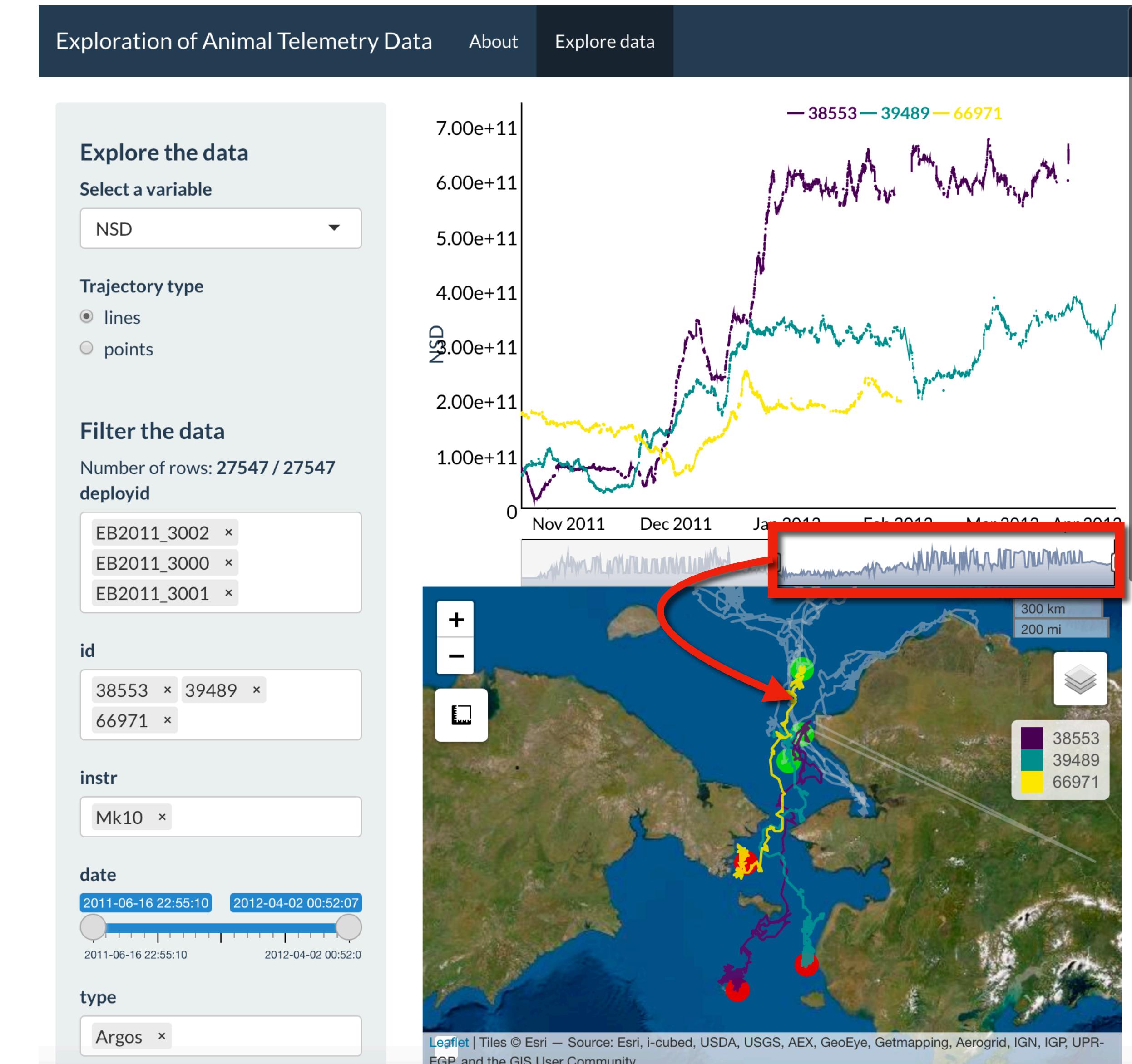
Click the **View all tracks** tab to view tracks for all individuals. This provides a quick overview of all track segments separately and allows for filtering tracks by time.

Application author: [Josh Cullen](#)
University of Florida



KEY FEATURE: Link space and time

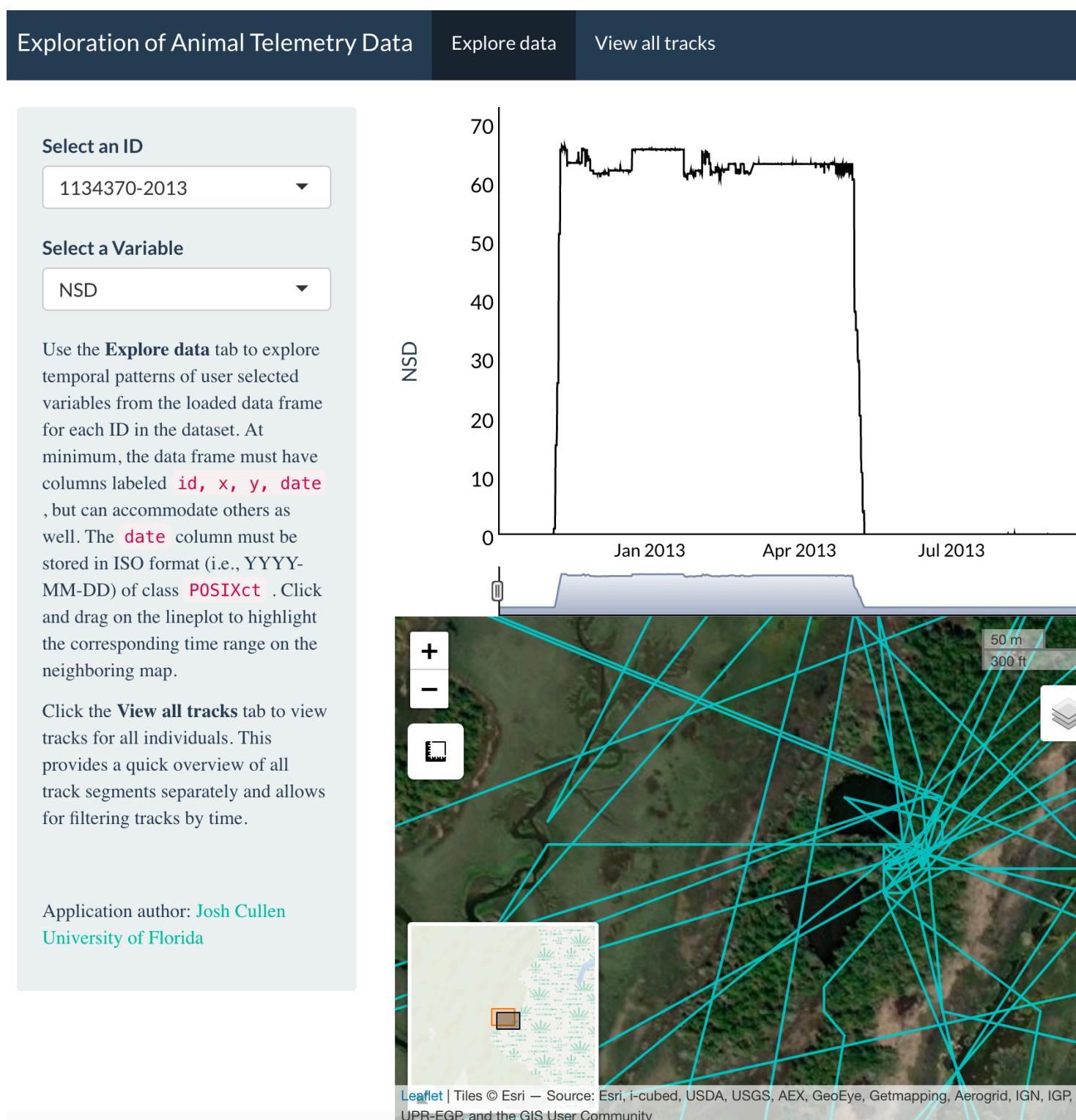
Subset time series by clicking and dragging on plot, which reactively updates the map



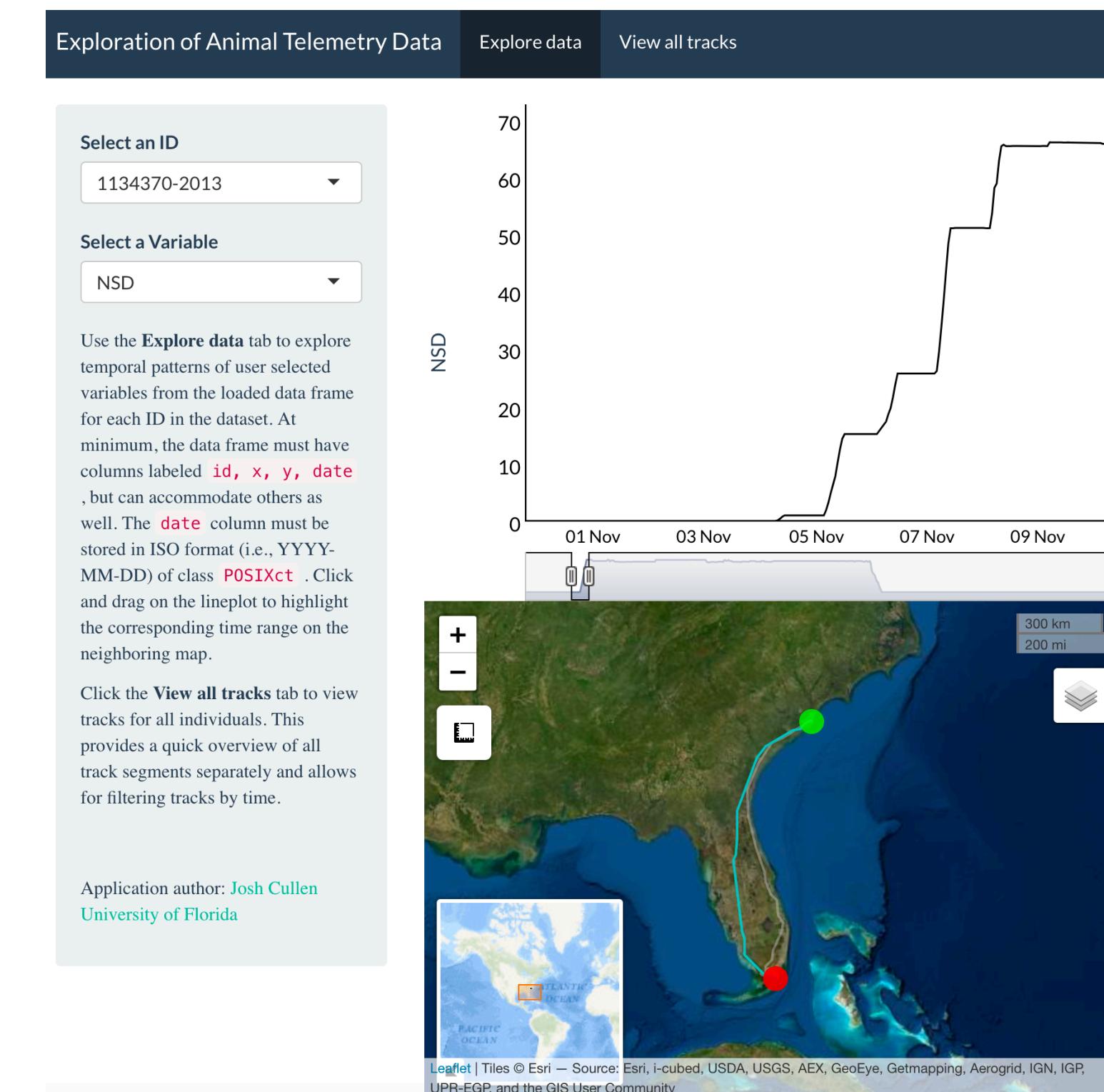
When could this feature be useful?

If user is interested in determining:

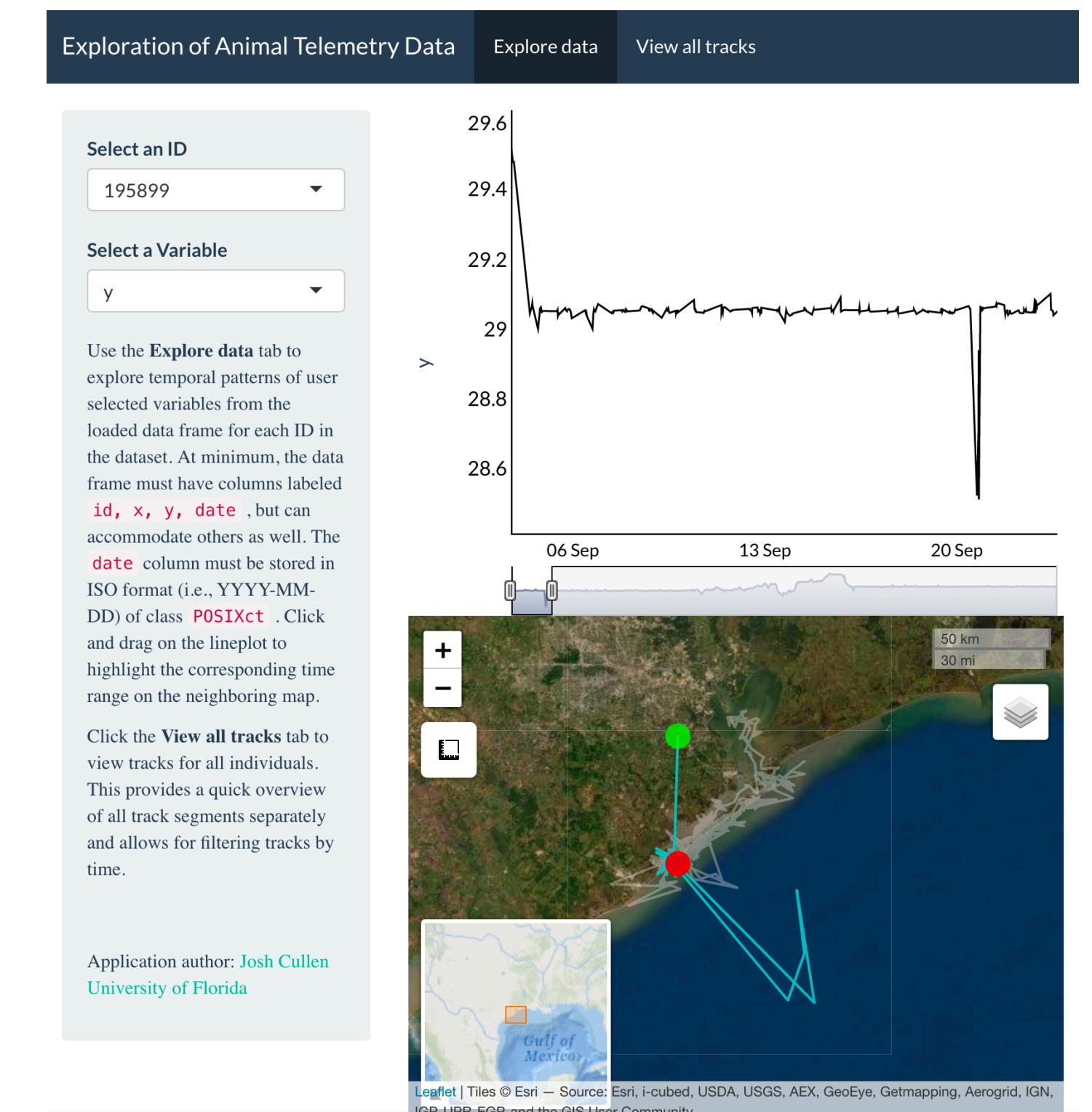
Land Cover



Time Window



Data Cleaning



Why isn't the app working? (Known issues)

- Duplicate datetimes and/or coordinates for a given ID
- At least one column has all NAs
- At least one column has one or more records that are blank (i.e., nothing present, not even NA)

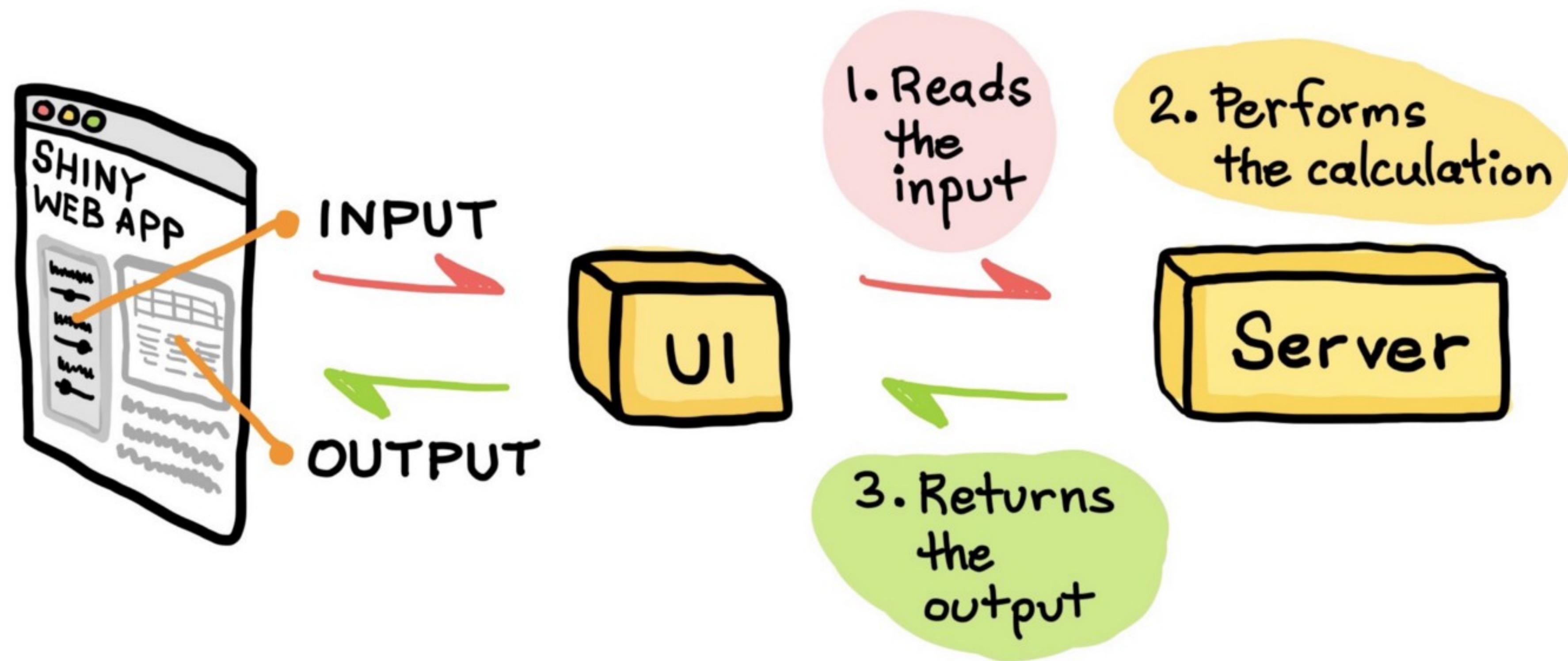
Potential extensions

- Loading of spatial layers to map (raster or vector)
- Allow users to select from multiple color palettes
- Calculation of derived variables (i.e., speed, turning angle, NSD, distance to layer, etc) or space-use (e.g., KDE)

Live demo

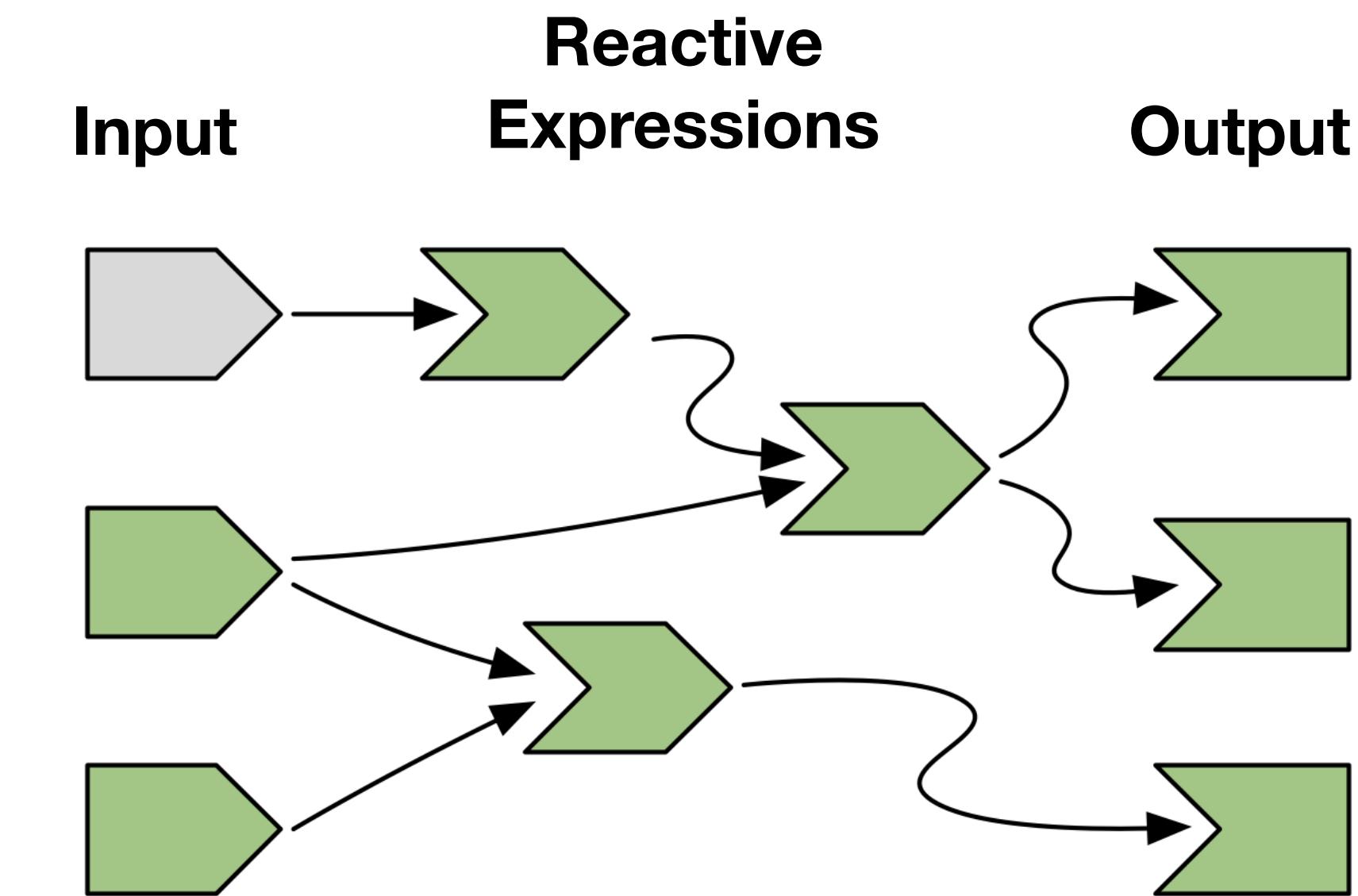
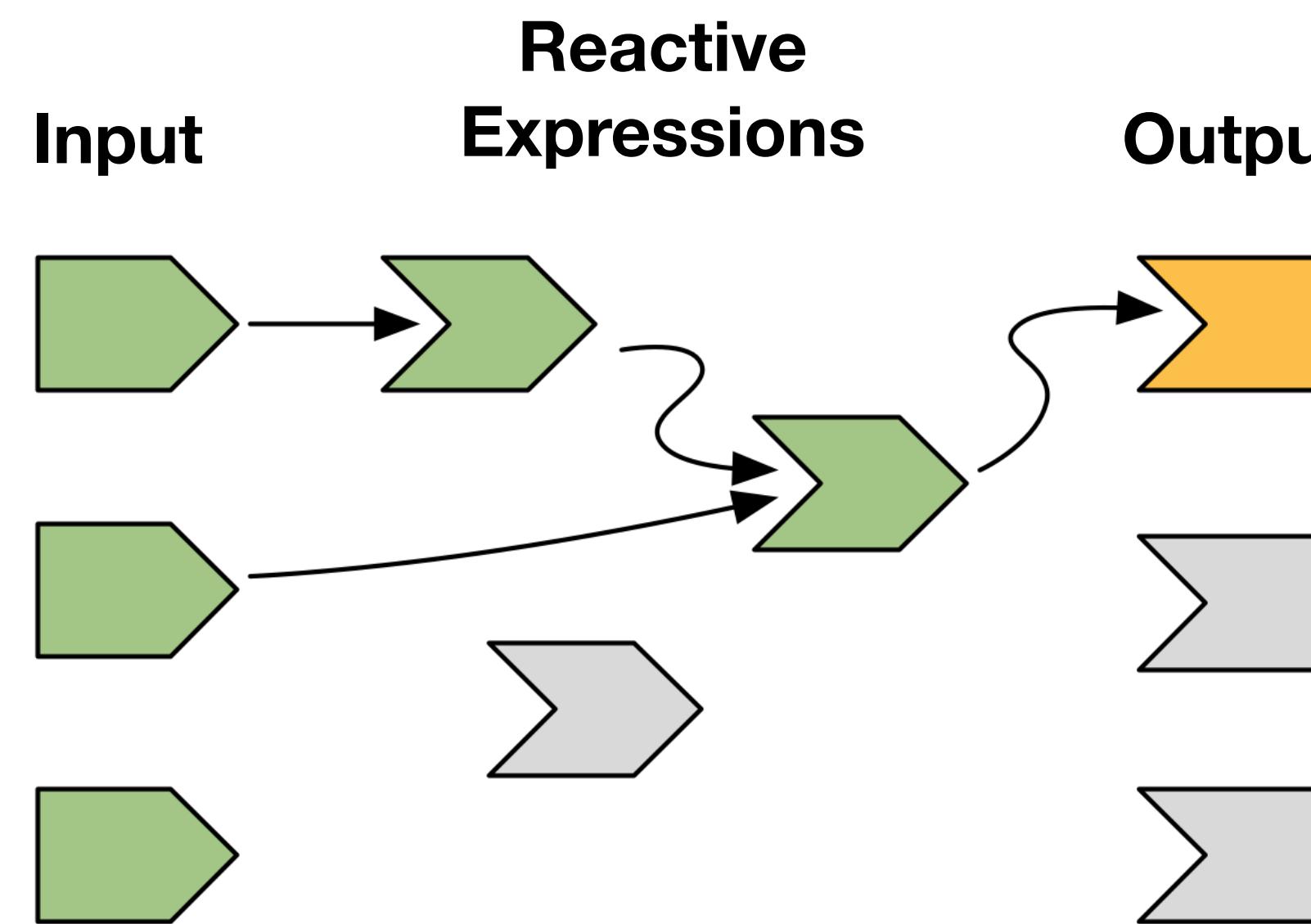


Brief R Shiny refresher



Reactivity in Shiny

Reactive expressions cache values and only change when invalidated, helping the Shiny app respond more efficiently



Let's get started

Go to my GitHub repo for R script: [https://github.com/joshcullen/bayesmove shiny demo](https://github.com/joshcullen/bayesmove_shiny_demo)

```
library(shiny)
library(dygraphs)
library(xts)
library(leaflet)
library(tidyverse)
library(lubridate)
library(sf)
```

Related R packages

Time series:

- Highcharter
- Plotly



Mapping:

- Mapview
- Highcharter
- Plotly
- Tmap



Potential uses in other Shiny apps

- Filtering a table of full dataset
- Filter data in another plot/tab conditional on time window
- Filter spatial data for export (e.g., shapefile, raster)

Thanks!



Contact info

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- 💻 <https://joshcullen.github.io>

Shiny app

- [https://joshcullen.github.io/bayesmove/
articles/Exploratory-analysis-in-Shiny](https://joshcullen.github.io/bayesmove/articles/Exploratory-analysis-in-Shiny)
- [https://joshcullen.shinyapps.io/
segmentation_of_NSD/](https://joshcullen.shinyapps.io/segmentation_of_NSD/)

