



# Development and Methods for an Open Source Data Visualization Tool

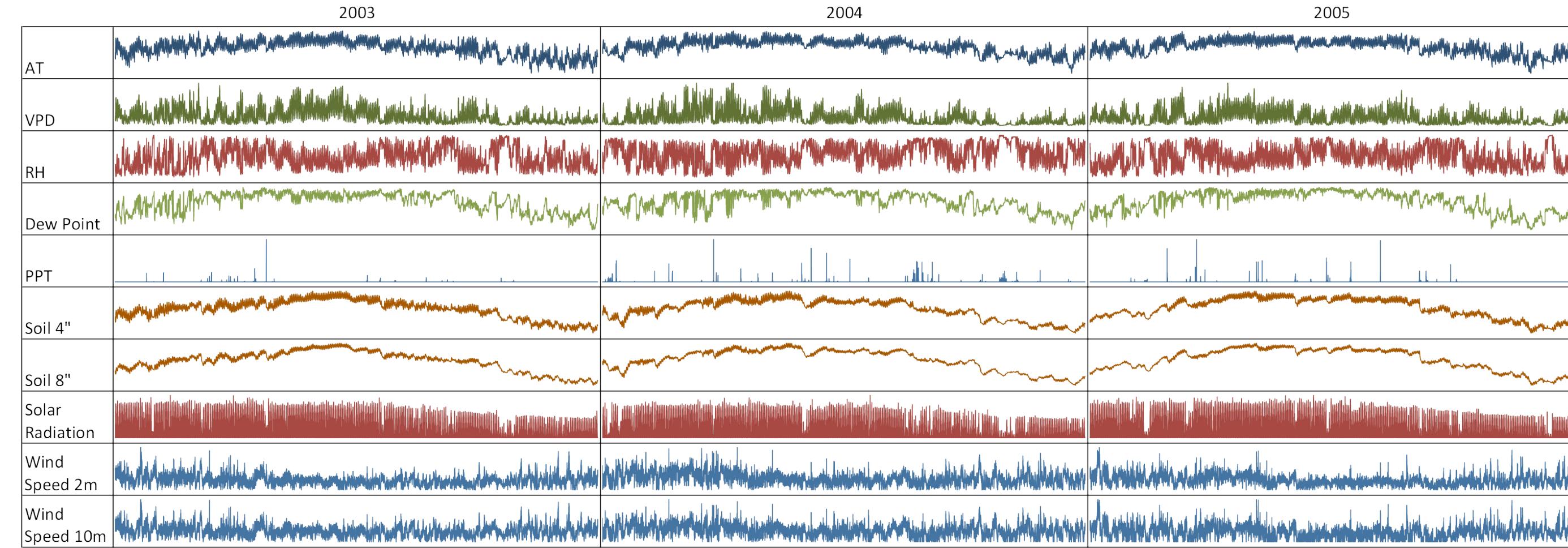
Clayton H. Dorrity and James R. Mahan, USDA-ARS Lubbock, TX

## Introduction

Understanding the spatial-temporal dynamic of varying environmental time surface images constitutes the basis for understanding the effects of the environment in a spatially explicit way. Numerous data visualization tools exist and it is possible to create time surfaces on GIS programs. In our experience, GIS programs are often limited in terms of software flexibility which limits their use in data manipulation, filtering and investigation. In response to this limiting software functionality, the design of this time surface visualization tool was to allow any potential user the ability to manipulate, filter, and investigate time surface visualizations to direct numerical and physiological analysis.

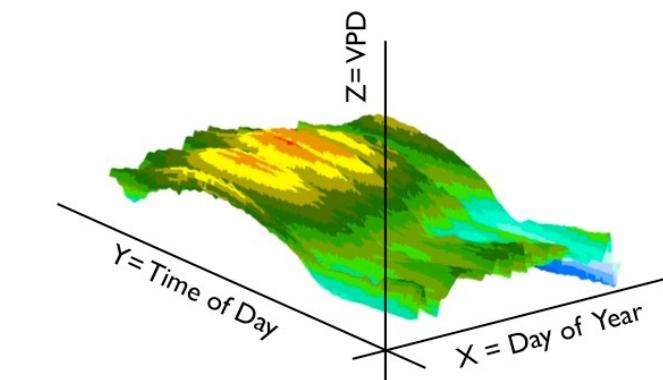
## Traditional Approach to Data Visualization

Time series of 15-min environmental data, April through December collected for 3 years.  
Can we improve visual inspection capability?



## Time surface visualization approach

We have previously used a GIS platform to present seasonal time series data in the form of 3-dimensional time surfaces that allow the visualization of thousands of data points in an interactive exploratory setting.



The time surface displays time on 2 axes; time of day vs day of year. The variable of interest is mapped on the time surface using color and elevation.

Time-surfaces - Seasonal Air Temp "time surface". This is not space...this is time...a visual representation of the growing season.

## Objective

To develop a software tool for the visualization, manipulation, comparison of environmental and plant time series measurements.

## Desired outcomes

- interactive creation and manipulation of time surfaces
- open source
- ~ 300 surface capacity
- web-hosted and local machine access
- simple graphical user interface

## Materials and Methods

- files and data import - Excel (comma/tab separated values)
- "R" scripting environment - open source
- color symbology (color palettes) - unique to data variable
- graphics - R Studio Shiny
- web-hosting and cloud implementation
- interactivity - simple and intuitive

## Conclusions

- We think that time surface visualizations are a useful tool for exploring large datasets (image to the right ~ 2.5 million observations).
- Data density in time surfaces is quite high compared to typical line graphs (10x).
- Interactive nature of the tool enables real-time data visualization/manipulation.
- Open-source framework reduces cost and increases potential for collaboration.

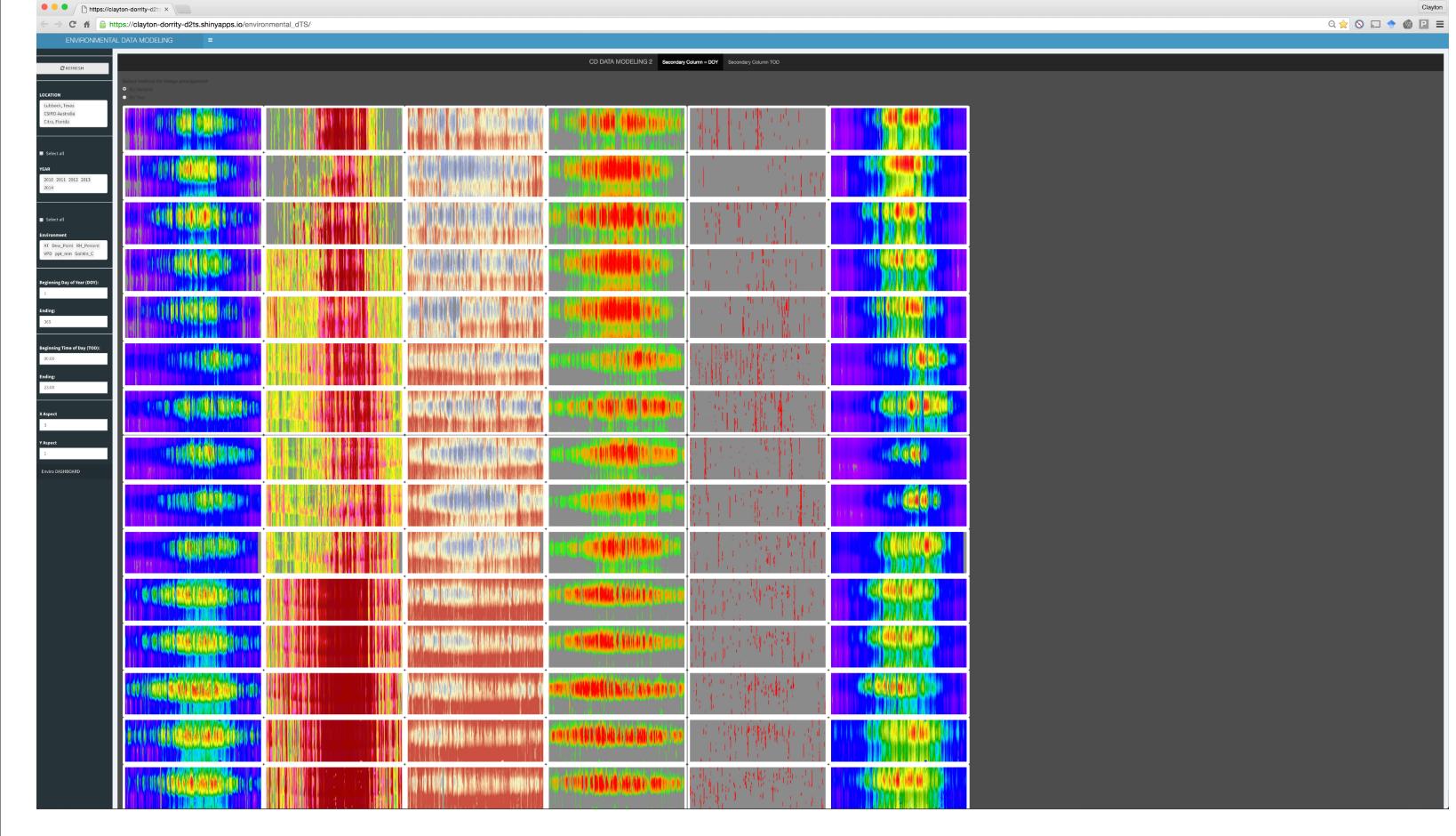
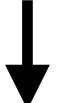
## Results

Working interface of the Open Source Data Visualization Tool (OSDVT)

- Data imported as Excel or other data formats (csv, txt, xlsx)
- Data interval 15-minutes to 1-hour
- Input boxes for data selection and manipulation
- Visualization space can manage ~300 time surfaces
- Data visualization can be filtered by: DOY, DAP, TOD, all other variables
- 2D or 3D manipulation

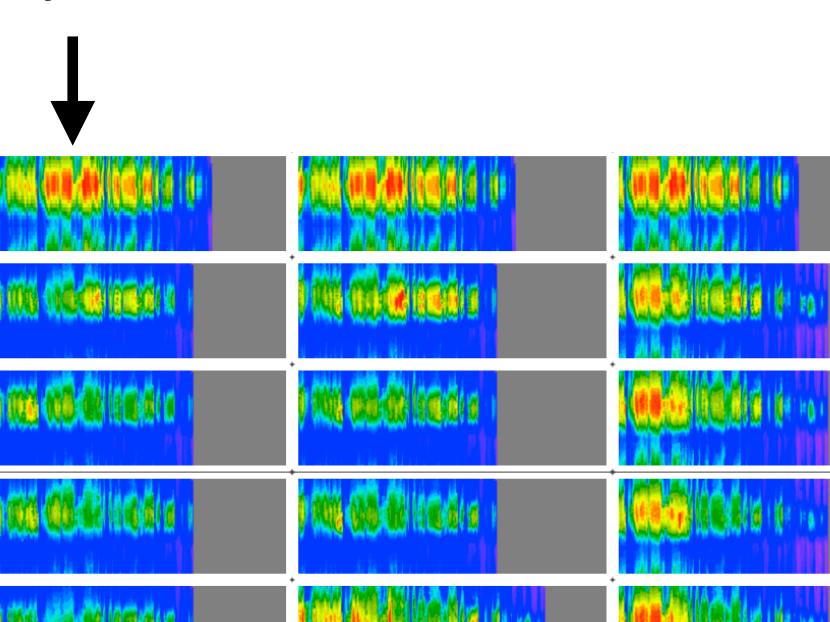
Visualization of 6 environmental variables, 5 years and 3 locations

- ~ 800,000 measurements
- Data format...rows are locations and years....columns are variables

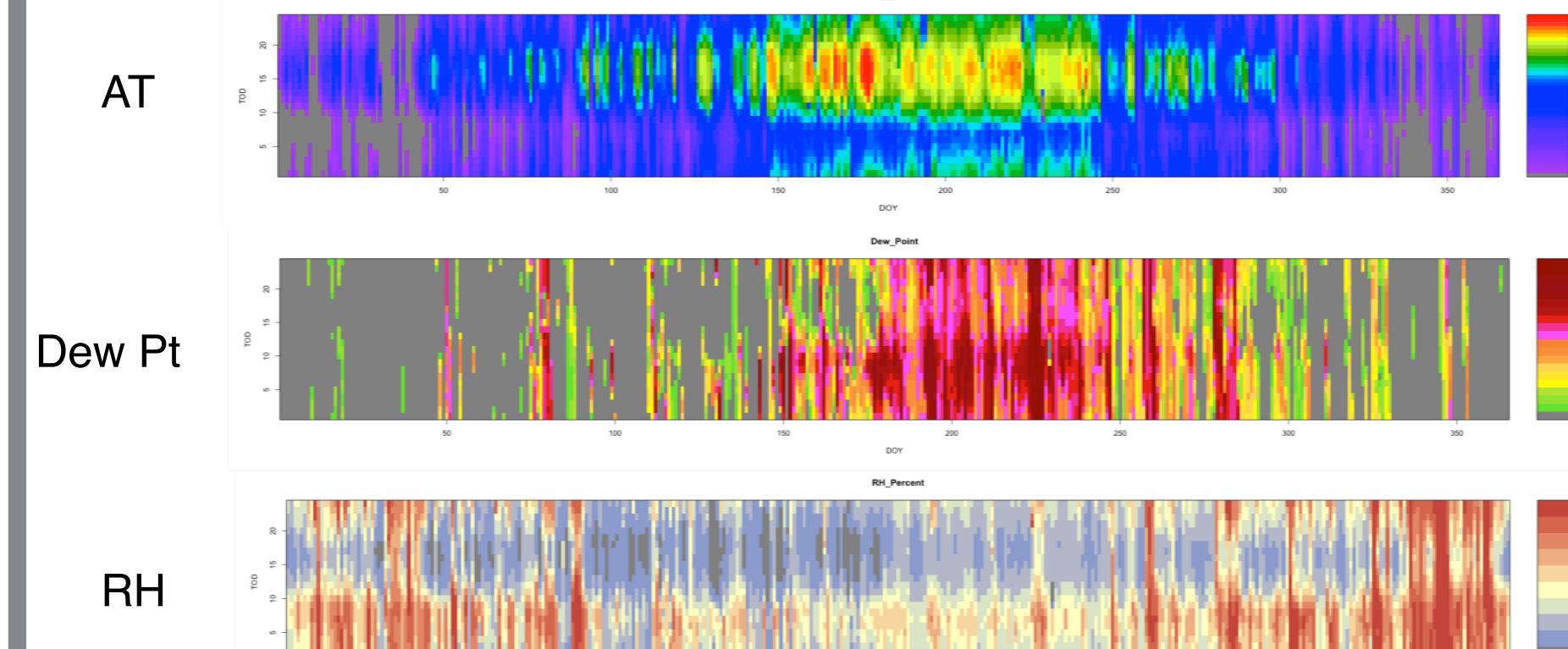


Visualization of air and cotton canopy temperatures for 4 irrigation levels and 5 planting dates. Lubbock, TX 2015.

- ~ 480,000 measurements
- Data format...rows are treatments....columns are plantings
- Irrigation effect on CT clearly visible



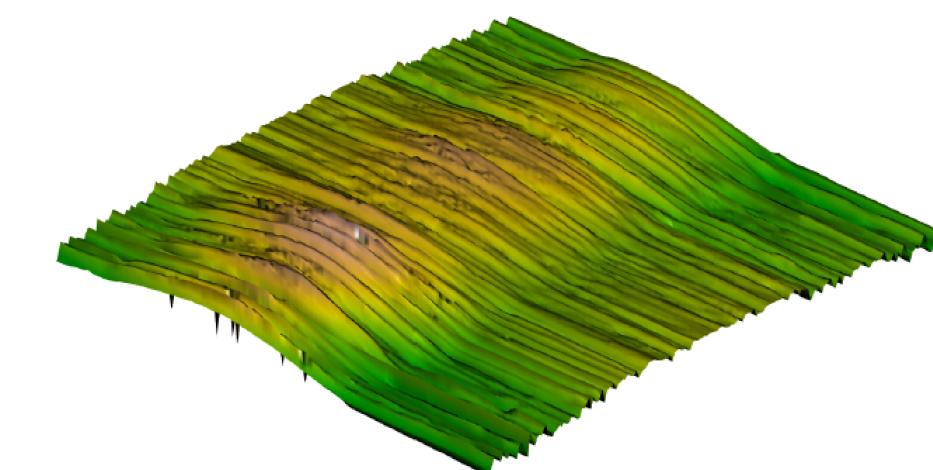
Color symbology can be customized so as to reflect contrast/variation. Color symbology is based on simple color palettes.



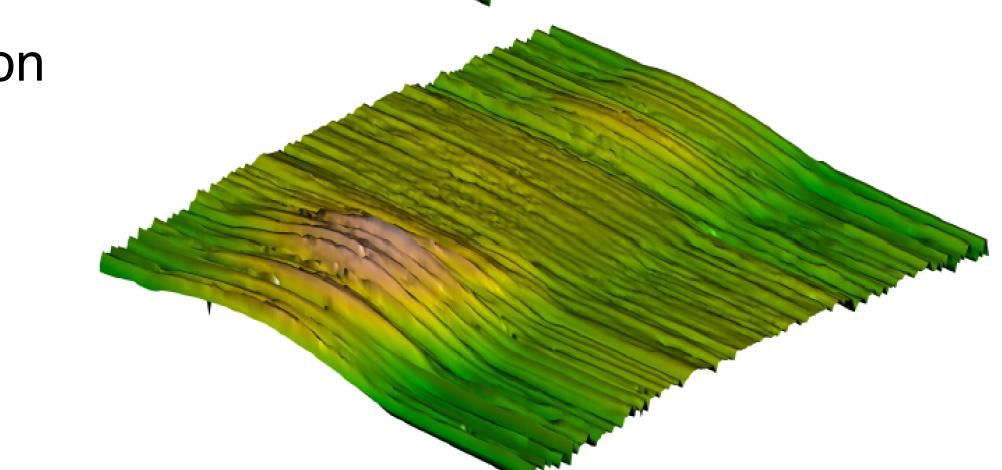
3D visualization of cotton canopy temperatures for 2 irrigation levels. • ~ 20,000 measurements

- Time surfaces below show clear evidence of the irrigation effect between cotton plants belonging to two different environments

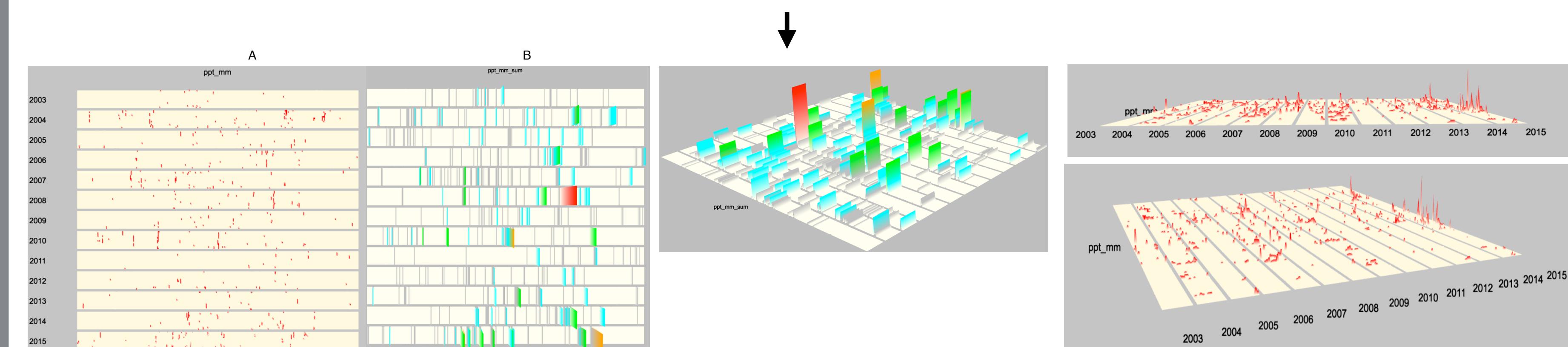
Dryland



Full Irrigation



2D and 3D visualizations rain events. Left side (A) is hourly rain events for 2003 to 2015. Right side (B) is seasonal daily rain total for 2003 to 2015. Lubbock, TX. 2D and 3D visualizations are both instructive in their own way.



Visualization of 10 weather variables for 12 years from Lubbock, TX, Narrabri NSW AU, Citra, FL. ~2.5 million observations in 360 time surfaces. Data from local weather stations. Lubbock and Narrabri have similar weather patterns and Citra is remarkably different.

Lubbock

Narrabri

Citra

