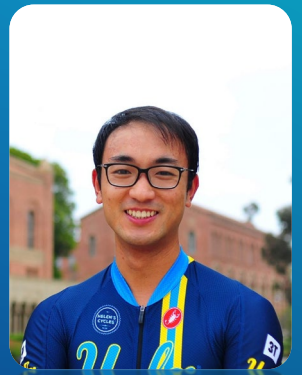
Prediction and Trend Analysis of Raster Data

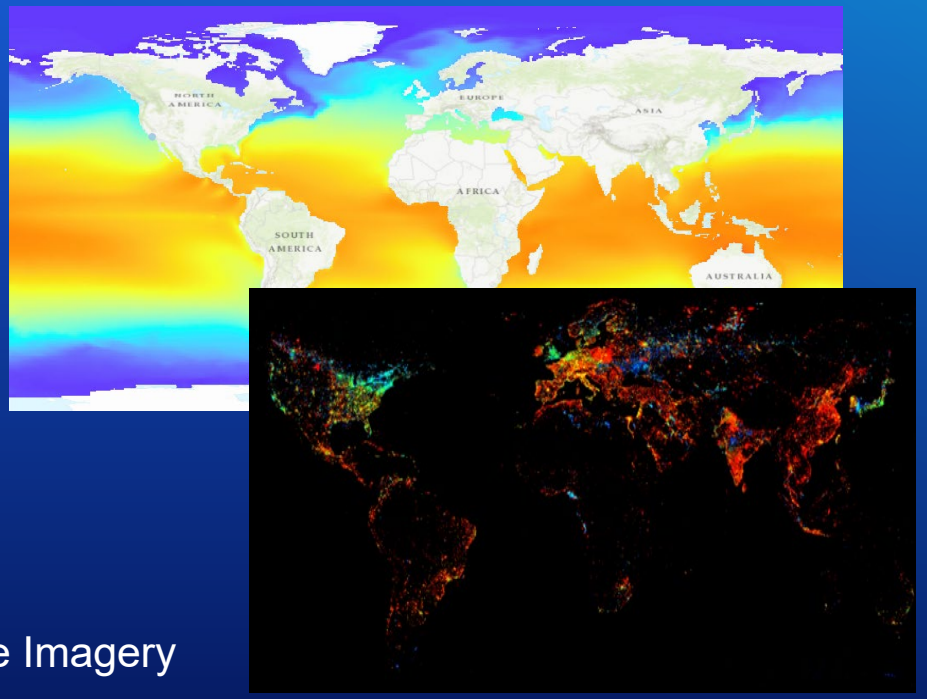
Shengan Zhan



2021 ESRI
DEVELOPER SUMMIT

Agenda

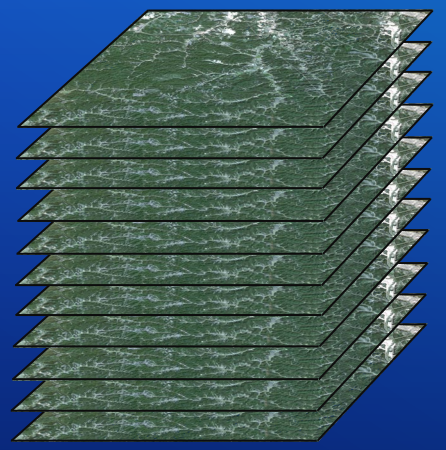
- **Key concepts**
- **ArcGIS Pro prediction and trend analysis capabilities**
  - Geoprocessing tools
  - Raster functions
  - Arcpy APIs
  - Analysis and Visualization
- **Use case demos**
  - Modeling and Predicting Sea Surface Temperature Variability
  - Modeling and Predicting Urban Growth using Night-time Light Satellite Imagery



Getting Familiar with the Concepts

Multidimensional raster

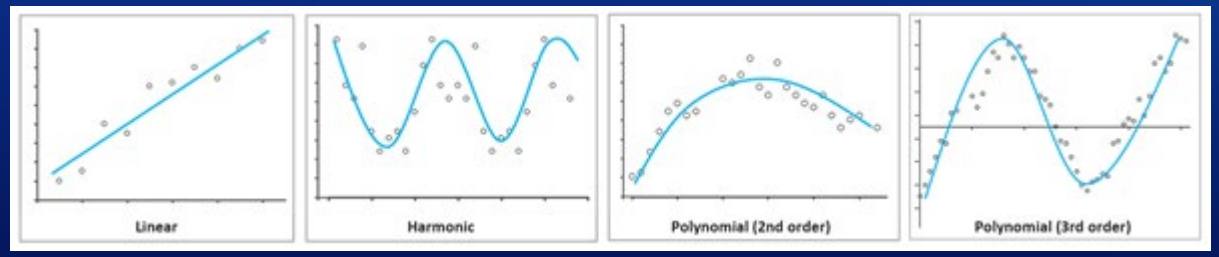
- **Multidimensional raster**
  - Well-structured raster dataset for 3 or 4 dimensional data (time, depth)
  - Manages variables and dimensional arrays
  - Examples: time series imagery, ocean temperature, etc
  - Cloud Raster Format (CRF)
    - Default output format in ArcGIS Pro
    - Supports multiple variables, dimensions and processing templates
    - Divided into small bundles of tiles and is optimized for distributed processing
  - NetCDF
    - Community standard for sharing scientific data
    - Portable and machine-independent
  - HDF
  - Grib



Getting Familiar with the Concepts

Trend analysis

- **Trend analysis**
  - To understand what's happened in the past and predict what will happen in the future
  - To fit models to describe the data along a dimension such as time or depth
  - To predict values in dimensions such as time or depth to understand what happens outside the scope of the original data



ArcGIS Pro prediction and trend analysis capabilities

Geoprocessing tools and Raster functions

Geoprocessing tools

- Generate Trend Raster
- Predict Using Trend Raster

Raster functions (on-the-fly)

- Generate Trend
- Predict Using Trend

Arcpy APIs

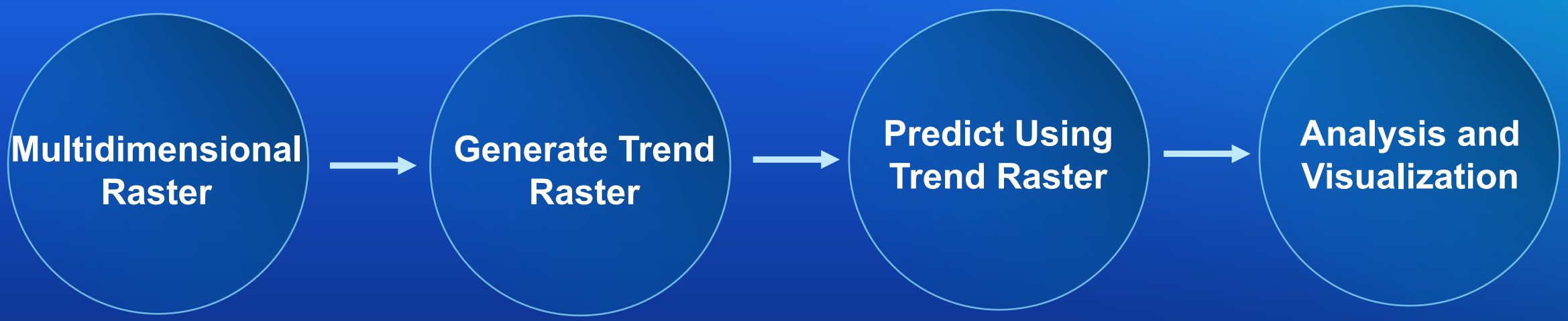
- arcpy.ia.GenerateTrendRaster (GP tool)
- arcpy.ia.PredictUsingTrendRaster (GP tool)

- arcpy.ia.GenerateTrend (raster function)
- arcpy.ia.PredictUsingTrend (raster function)

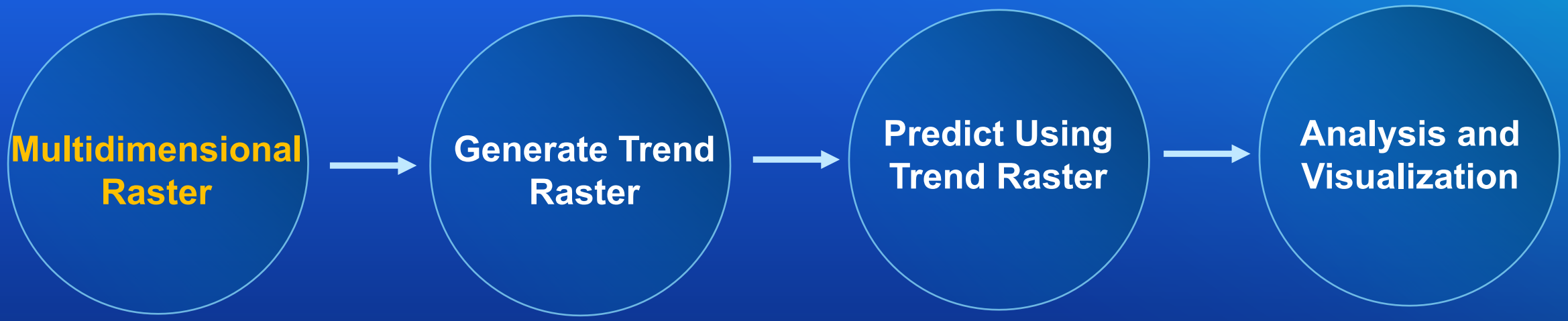
Analysis and Visualization

- Trend to RGB
- Temporal Profile

Typical workflow



Typical workflow



- Supported formats:
  - Cloud Raster Format
  - NetCDF
  - HDF
  - GRIB

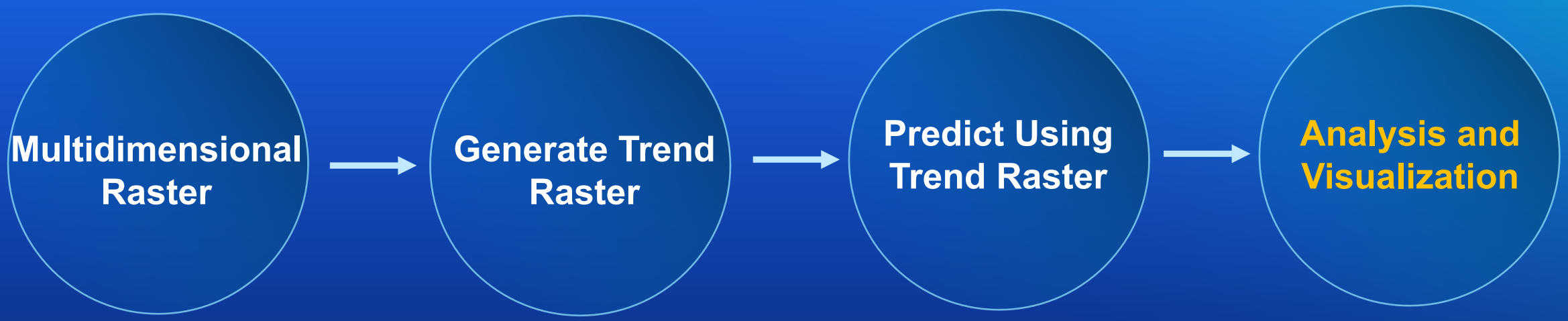
Typical workflow

- Trend type:
  - Linear
  - Harmonic
  - Polynomial
  - Mann-Kendall
  - Seasonal-Kendall

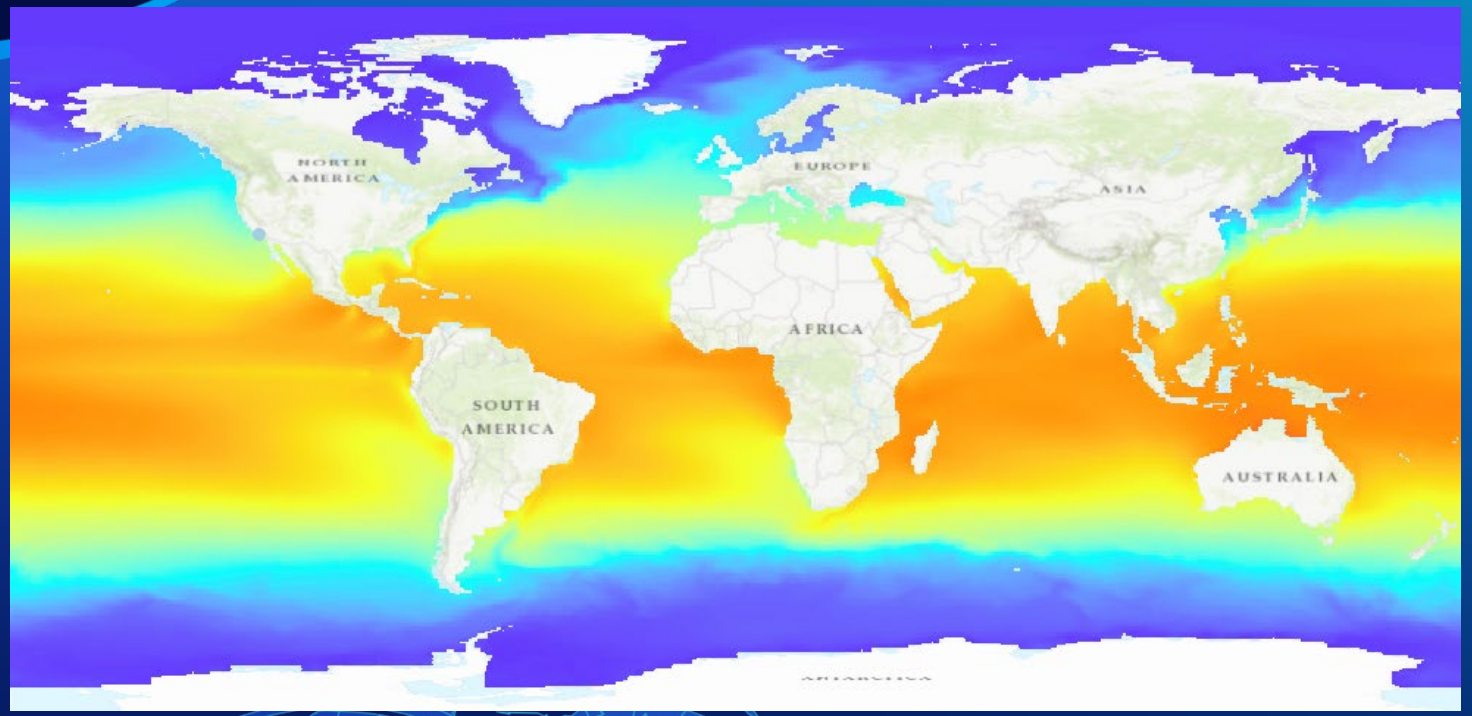
Typical workflow

- Predict methods:
  - By value
  - By interval

Typical workflow



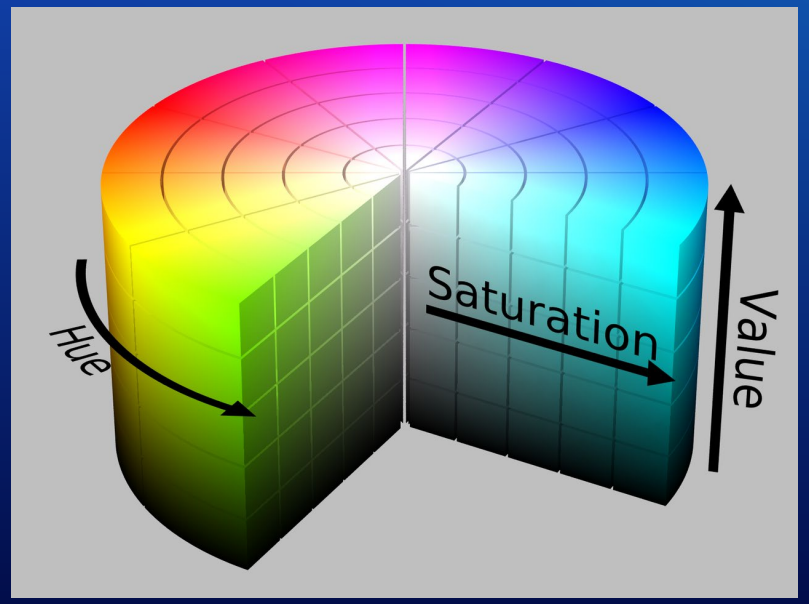
- Plot options:
  - One location with multiple variables
  - Multiple locations with one variable
  - One location with multiple bands
  - Multiple locations with one band
  - Multiple locations with multiple dimensions

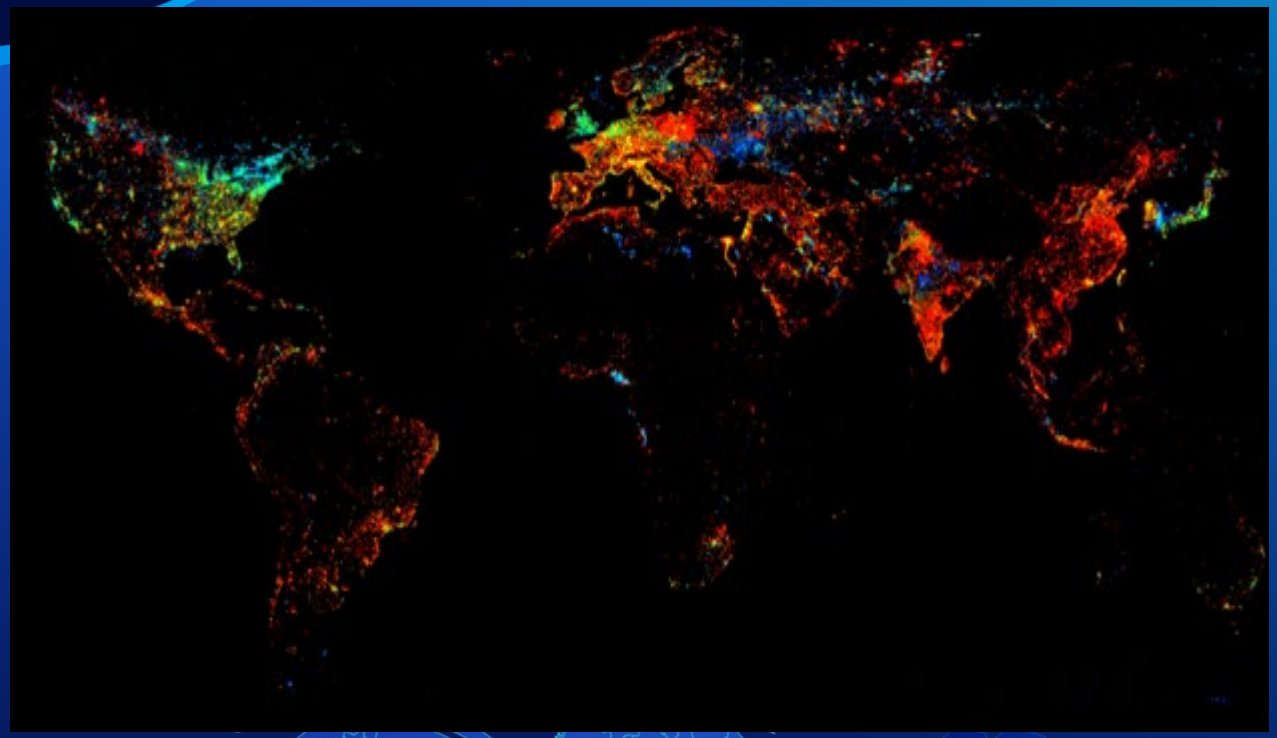


Modeling and Predicting Sea Surface Temperature Variability

Visualizing harmonic coefficients

- **Harmonic regression equation:**
  - $\boldsymbol{Variable} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} * \boldsymbol{t} + \boldsymbol{\beta_2} * \cos(\frac{2\pi}{365}\omega t) + \boldsymbol{\beta_3} * \sin(\frac{2\pi}{365}\omega t)$
  - $\boldsymbol{Amplitude} = \sqrt{\boldsymbol{\beta_2^2} + \boldsymbol{\beta_3^2}}$
  - $\boldsymbol{Phase} = \tan^{-1}\frac{\boldsymbol{\beta_2}}{\boldsymbol{\beta_3}}$
  - **Amplitude -> Saturation**
    - **Larger amplitude means brighter color**
  - **Phase -> Hue**
    - **Decides the color**
  - **1 -> Value**
    - **Constant**





Modeling and Predicting Urban Growth using Night-time Light Satellite Imagery

Additional Resources

Sessions in Dev Summit

Advanced Analysis of Satellite Imagery Using Python

Working with Multidimensional Data in ArcGIS

Advanced Custom Raster Processing Using Python

Detect Change of Raster Data

Help references

ArcGIS Pro Image Analyst toolbox

- https://pro.arcgis.com/en/pro-app/latest/tool-reference/image-analyst/an-overview-of-the-image-analyst-toolbox.htm

ArcPy APIs and examples

- https://pro.arcgis.com/en/pro-app/arcpy/image-analyst

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