Rebuilding the NCL Visualization Gallery in Python

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Project Goals

Facilitate NCAR's transition from NCAR Command Line Language (NCL) to Python by showing how to emulate NCL features in Python.

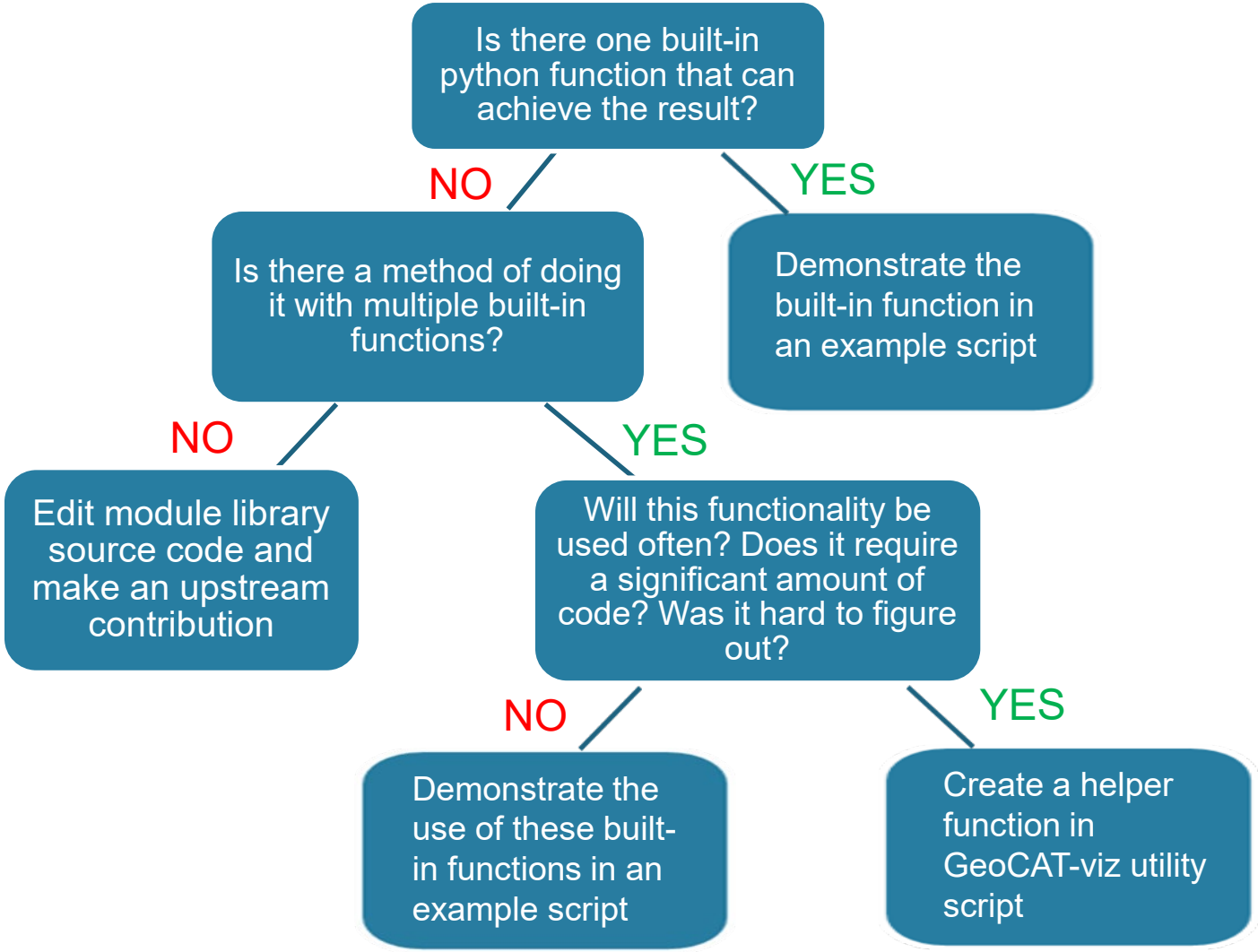
- **GeoCAT-Examples** (a gallery of example scripts for different visualizations)
  - Demonstrate all the capabilities of python
  - Document example scripts to make them easy to read
- **GeoCAT-Viz** (a collection of utility functions)
  - Reduce boilerplate code
  - Make visualization scripts easier to write

NCL vs. Python

```
vcres@vcMinDistanceF          = 0.017
```

```python
# Change the density with parameter "minDistance"
if minDistance != 0:

    lat_every = 1
    lon_every = 1

    # Get distance between points in latitude (y axis)
    lat = data['lat']
    latdifference = (float)(lat[1] - lat[0])

    # Get distance between points in longitude (x axis)
    lon = data['lon']
    londifference = (float)(lon[1] - lon[0])

    # Get distance between points that are diagonally adjacent
    diagDifference = math.sqrt(latdifference**2 + londifference**2)

    # Initialize ds
    ds = data.isel(lat=slice(None, None, None), lon=slice(None, None, None))

    if diagDifference >= minDistance and latdifference >= minDistance and londifference >= minDistance:
        warnings.warn('Plot spacing is alrady greater or equal to ' + (str)(minDistance))

    # While diagD
    while diagDifference < minDistance or latdifference < minDistance or londifference < minDistance:

        # Get distance between points in latitude (y axis)
        lat = data['lat']
        latdifference = (float)(lat[lat_every] - lat[0])

        # Get distance between points in longitude (x axis)
        lon = data['lon']
        londifference = (float)(lon[lon_every] - lon[0])

        # Get distance between points that are diagonally adjacent
        diagDifference = math.sqrt(latdifference**2 + londifference**2)

        lat_every += 1
        lon_every += 1

        ds = data.isel(lat=slice(None, None, lat_every), lon=slice(None, None, lon_every))
```

Process of expanding the GeoCAT Gallery



Types of wrapped functions

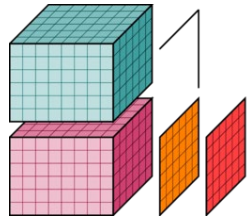
- Data Manipulation
  - Methods of altering, or extracting certain numerical features from the data
- Aesthetic
  - Features that do not add any significant meaning to a plot
  - purely for visual appeal
- Plot Manipulation
  - Features that change the way data is visualized on a plot
  - Can affect how data is perceived by viewer, or make a plot easier to understand

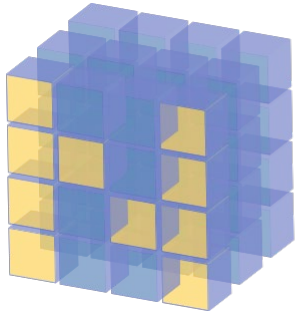
Data Manipulation

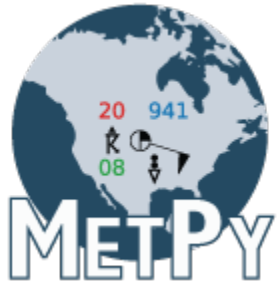
Changing, or extracting information from the raw data input of a visualization function

Examples:

- Slicing data
- Smoothing data
- Extracting features:
  - Local extrema
  - Means
  - Maximums/minimums
  - Averages



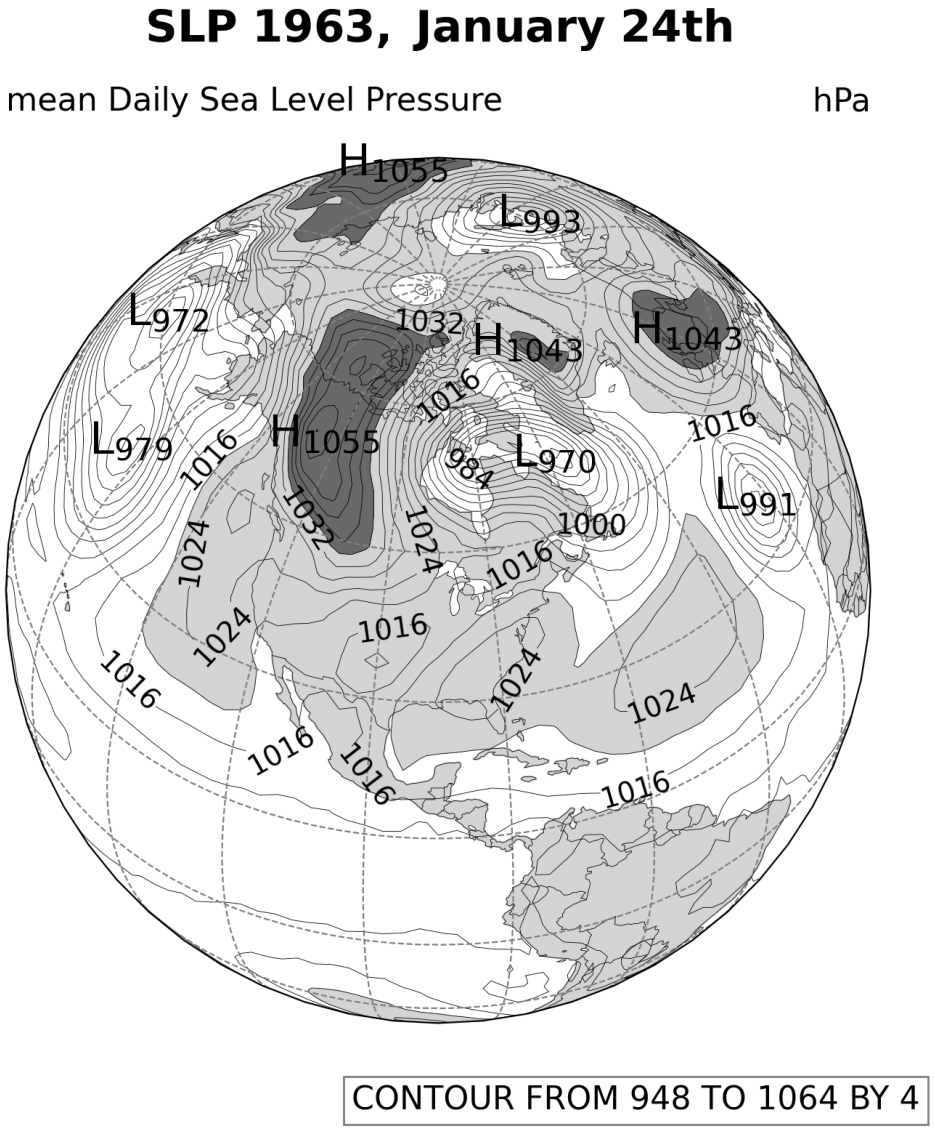




Data Manipulation: Finding local extrema

- Import data with **xarray**
- Take global gradient of data with **numpy**
- Cluster noisy data with **Sklearn** (DBSCAN)
- Find minimum/maximum of each cluster with **numpy**

Geocat-viz.util.py, find_local_extrema()



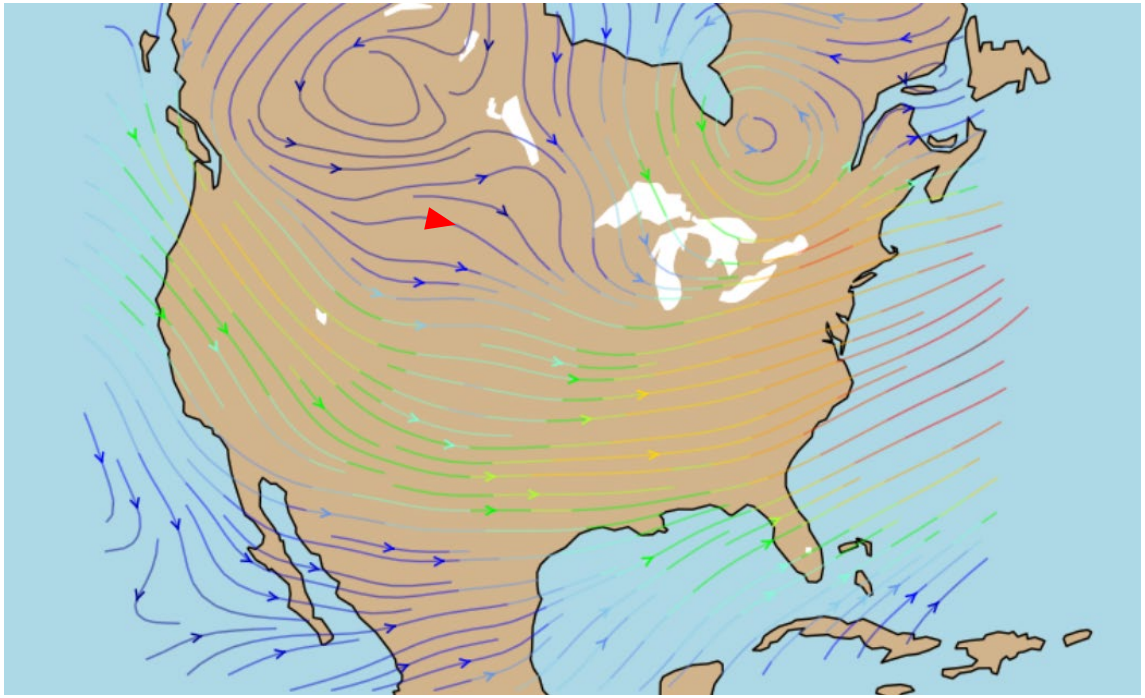
Aesthetic Features

Basic features (such as changing color, opacity, location items on the plot) are built into these libraries, but others require upstream contributions.

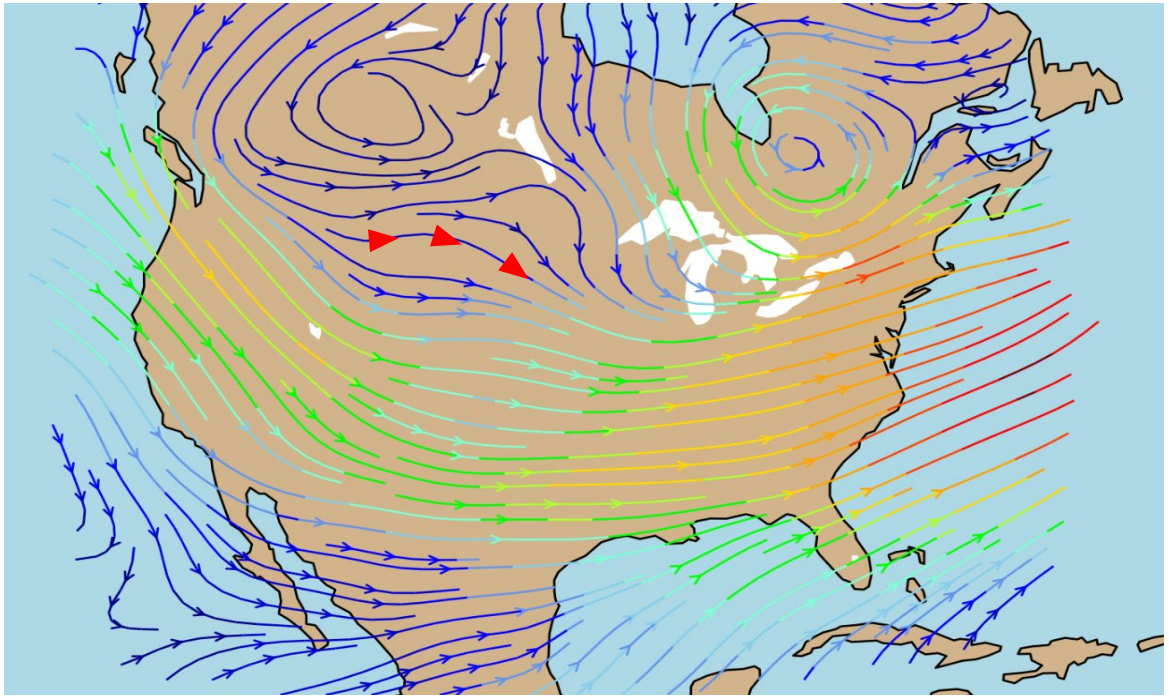
Examples:

- Allowing tick marks on non-rectangular map projections
- Adding multiple arrows to a streamplot graph

Aesthetic Features: Adding Multiple Arrows to Streamlines



One arrow per streamline



Three arrows per streamline

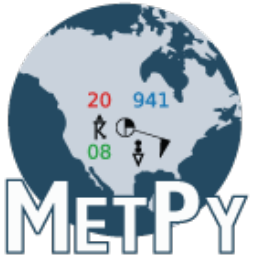
Matplotlib.Streamplot.py

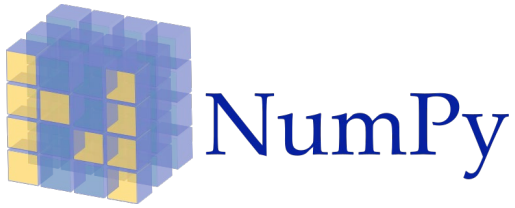
Plot Manipulation

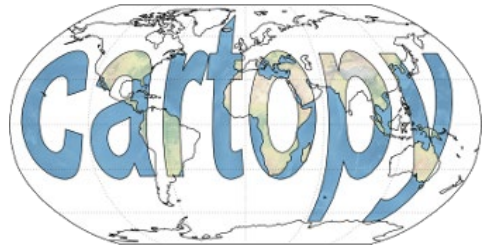
Changes that often require a combination of data manipulation and aesthetic changes.

Examples:

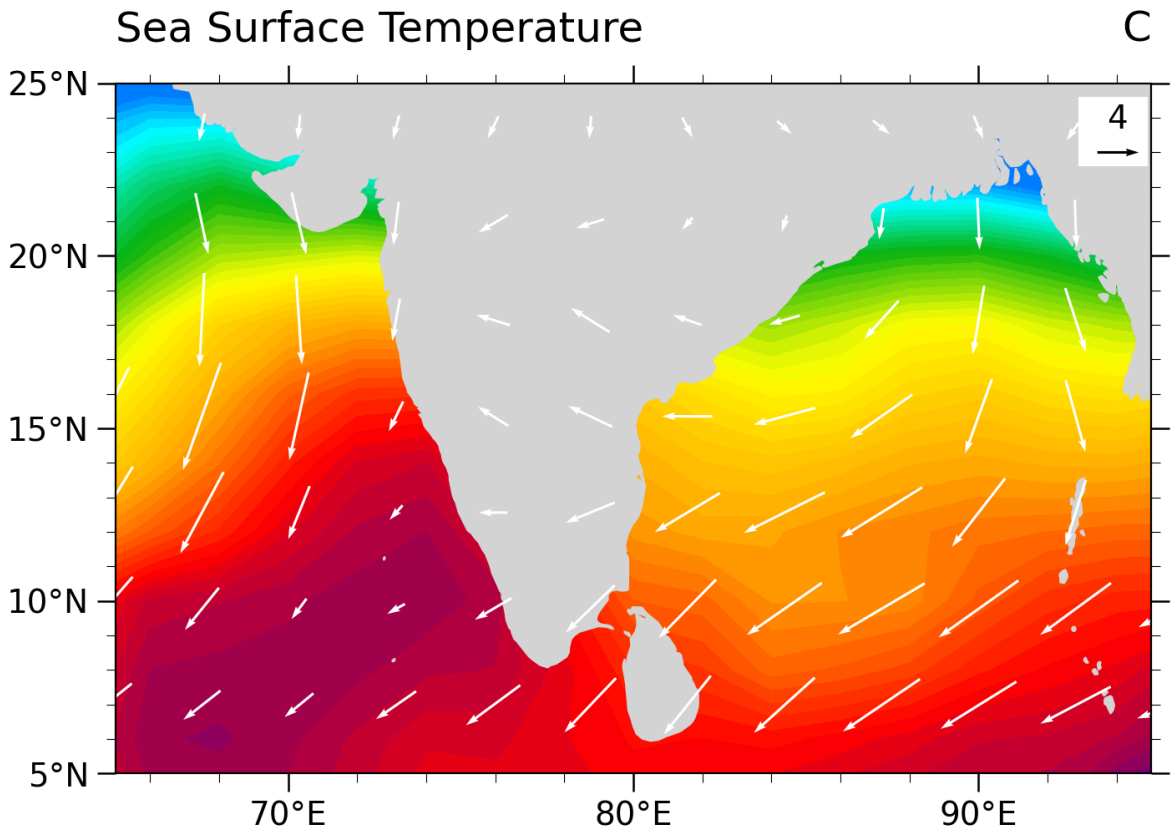
- Changing arrow density in vector plots
- Setting wedge boundaries for non-rectangular map projections



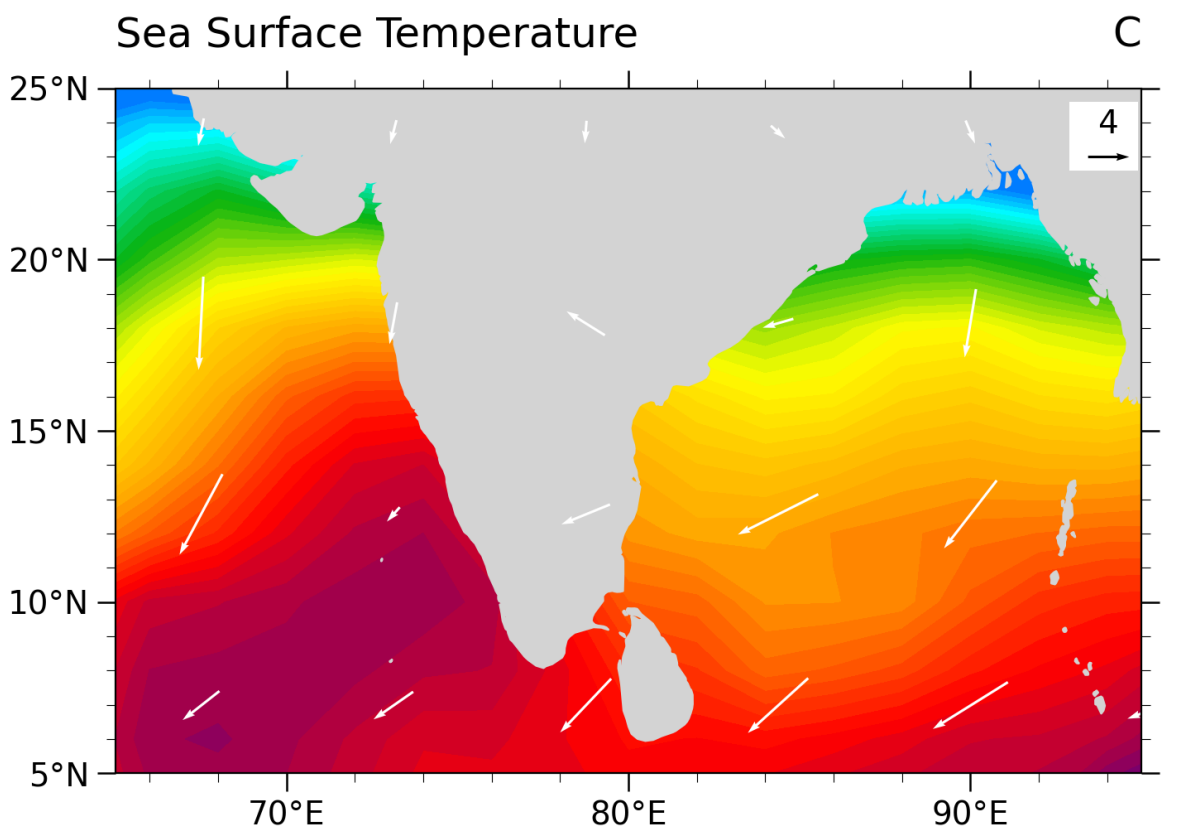




Plot manipulation: Adjusting the spacing on a vector plot



Full vector density

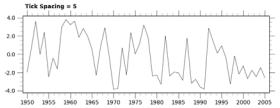


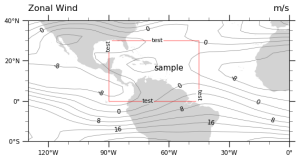
Vector density at 40%

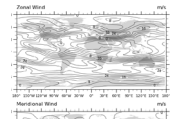
Geocat-viz.util.py, def set_vector_density()

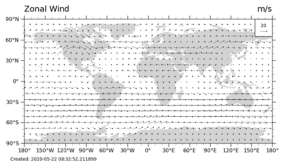
Evolution of the Python Visualization Gallery

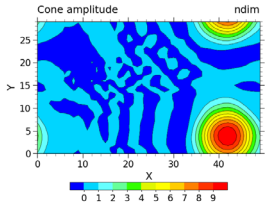
Before:

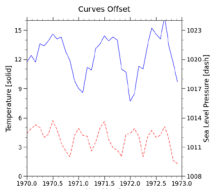


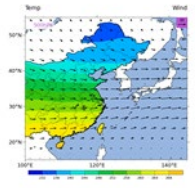


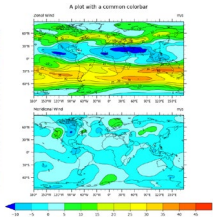


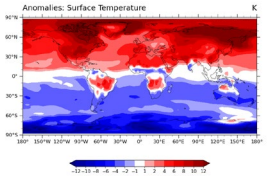


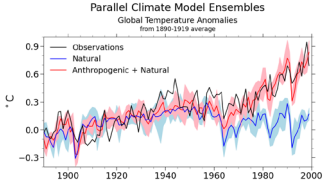


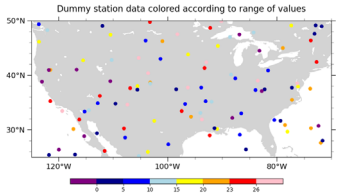


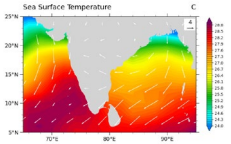


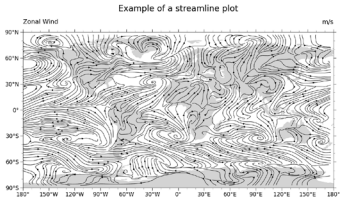


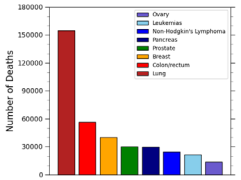


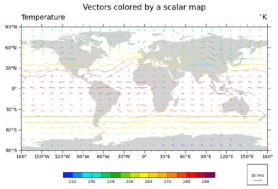












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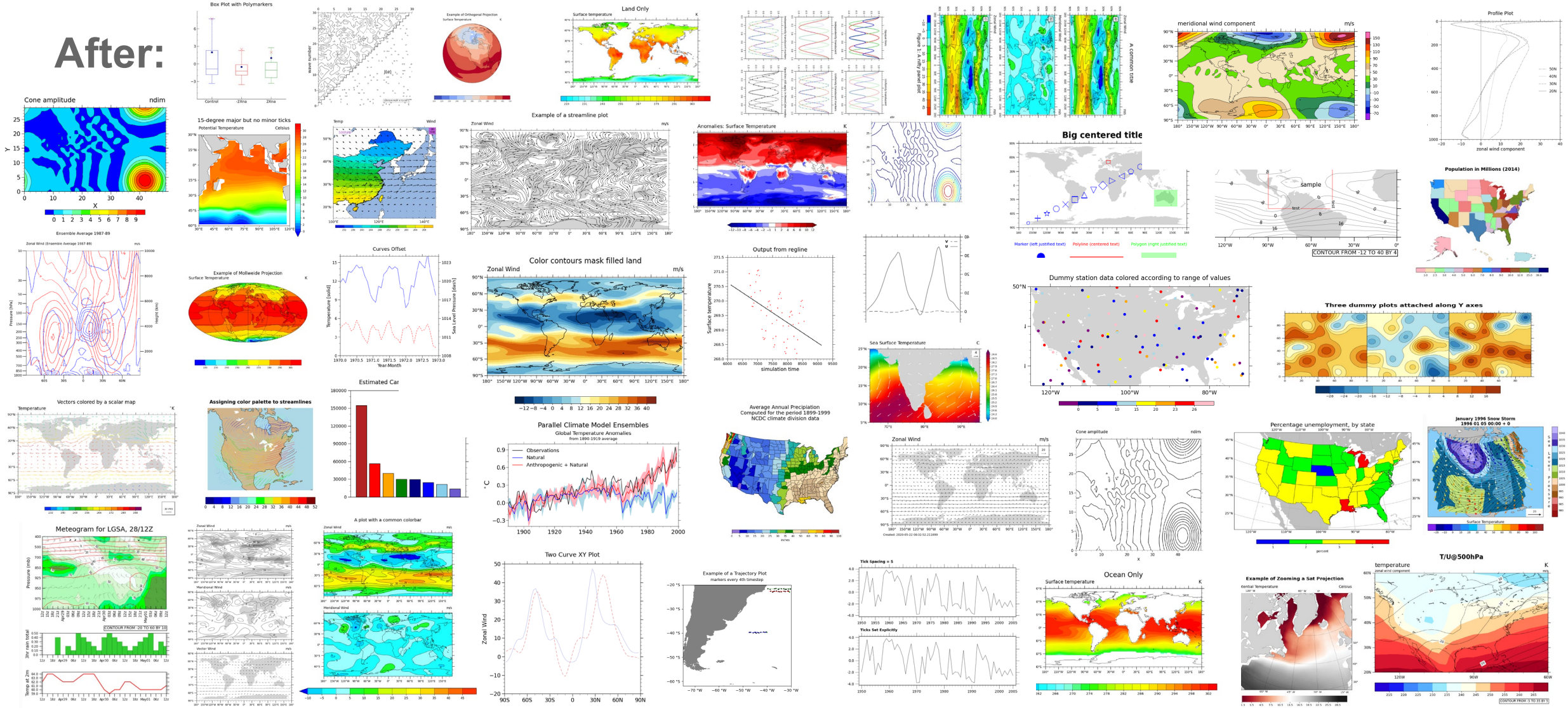
After:



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Thank you

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