Visualization of Time Series and 3D Spatial Data using Python

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NCAR SIParCS
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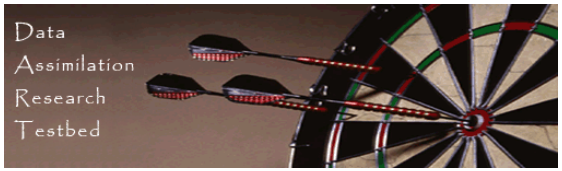
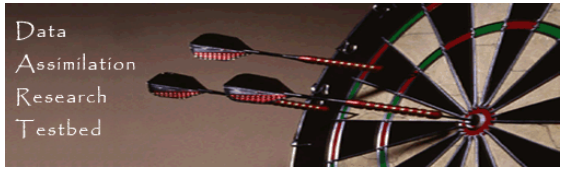


DART – The Data Assimilation Research Testbed

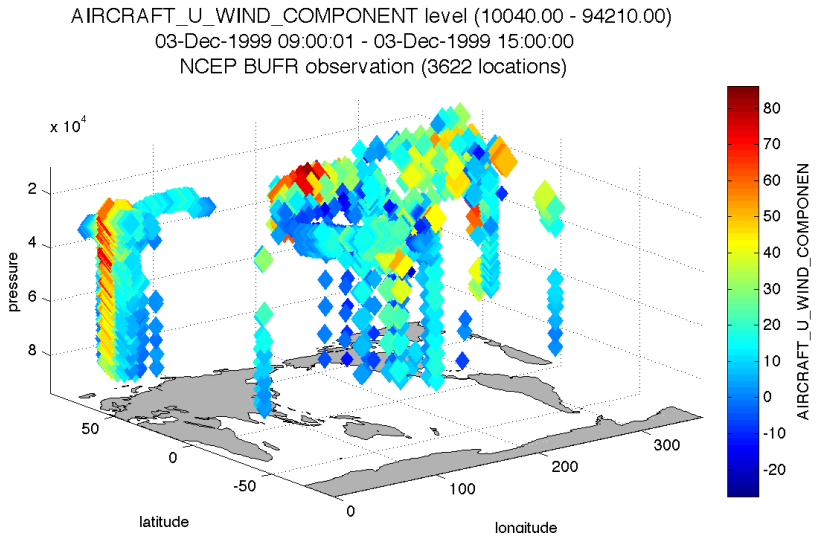


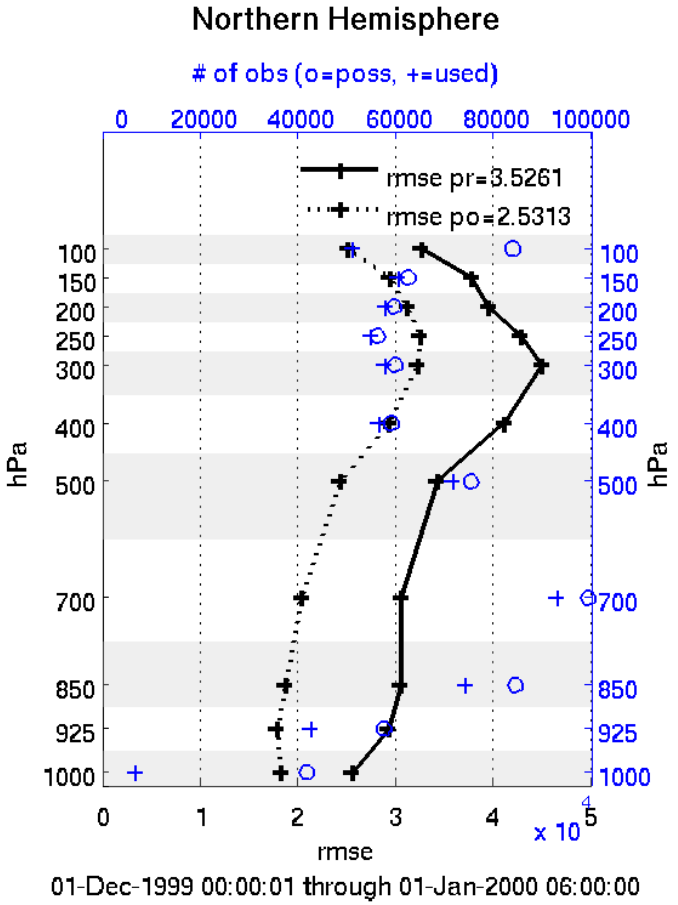
- What is Data Assimilation?
  - Observations combined with a Model forecast…

… to produce an analysis.

Existing DART diagnostic tools are:

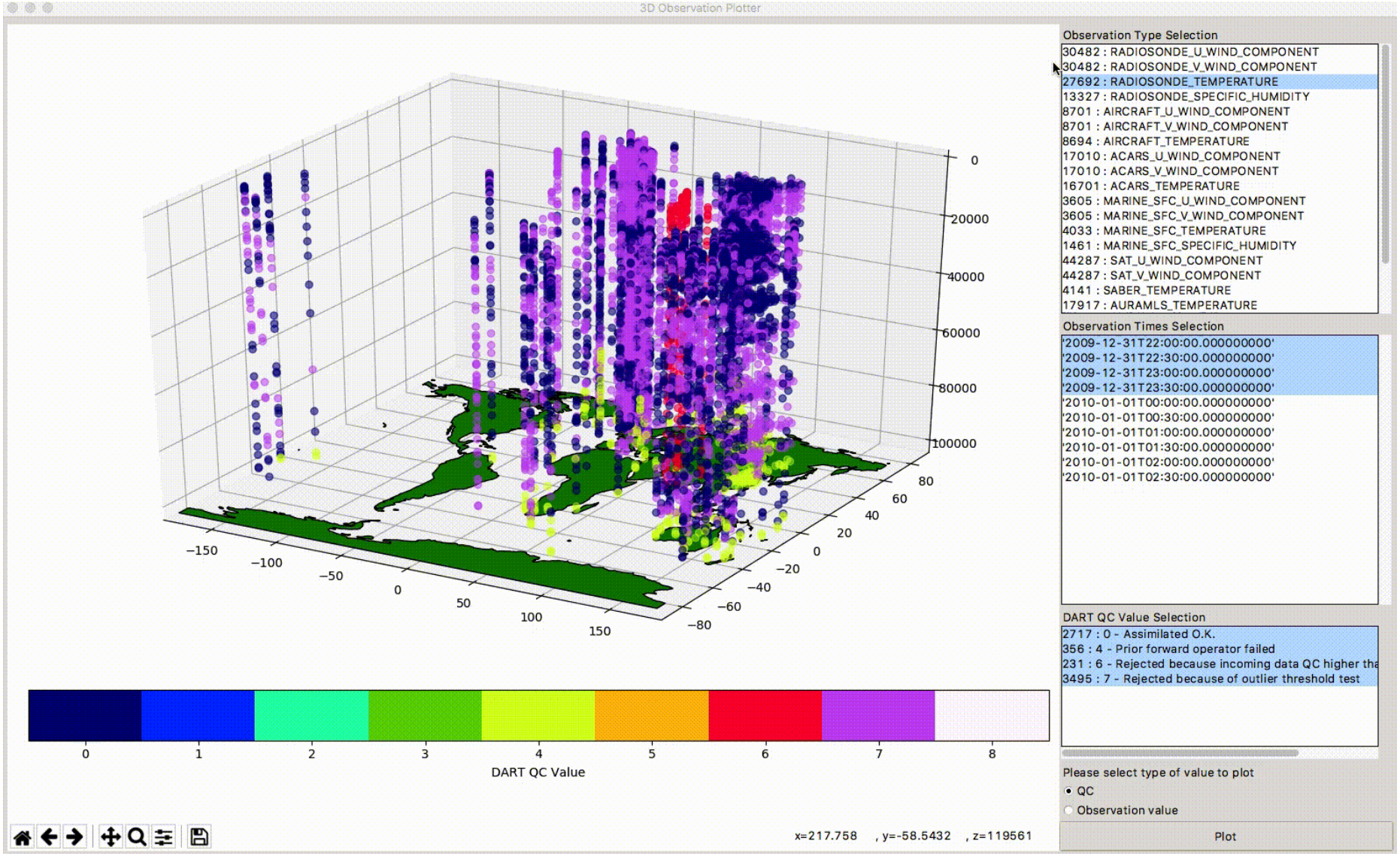
- Visually informative
- Highly configurable





Existing DART diagnostic tools are:
MATLAB functions

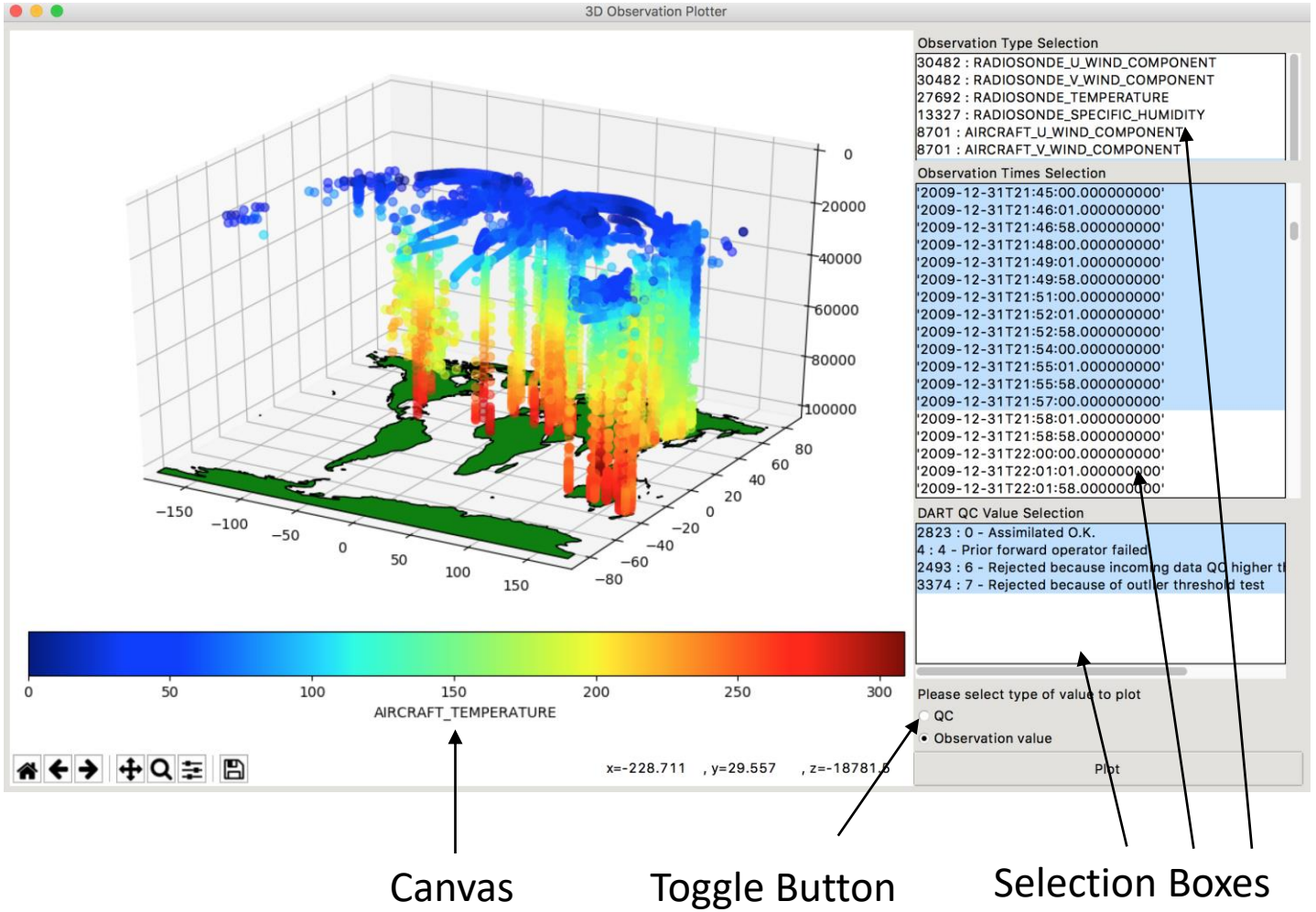
Solution: **Python GUIs**


3D Observation Plotter
Observation Type Selection
30482 : RADIOSONDE_U_WIND_COMPONENT
30482 : RADIOSONDE_V_WIND_COMPONENT
27692 : RADIOSONDE_TEMPERATURE
13327 : RADIOSONDE_SPECIFIC_HUMIDITY
8701 : AIRCRAFT_U_WIND_COMPONENT
8701 : AIRCRAFT_V_WIND_COMPONENT
8694 : AIRCRAFT_TEMPERATURE
17010 : ACARS_U_WIND_COMPONENT
17010 : ACARS_V_WIND_COMPONENT
16701 : ACARS_TEMPERATURE
3605 : MARINE_SFC_U_WIND_COMPONENT
3605 : MARINE_SFC_V_WIND_COMPONENT
4033 : MARINE_SFC_TEMPERATURE
1461 : MARINE_SFC_SPECIFIC_HUMIDITY
44287 : SAT_U_WIND_COMPONENT
44287 : SAT_V_WIND_COMPONENT
4141 : SABER_TEMPERATURE
17917 : AURAMLS_TEMPERATURE
Observation Times Selection
'2009-12-31T22:00:00.000000000'
'2009-12-31T22:30:00.000000000'
'2009-12-31T23:00:00.000000000'
'2009-12-31T23:30:00.000000000'
'2010-01-01T00:00:00.000000000'
'2010-01-01T00:30:00.000000000'
'2010-01-01T01:00:00.000000000'
'2010-01-01T01:30:00.000000000'
'2010-01-01T02:00:00.000000000'
'2010-01-01T02:30:00.000000000'
DART QC Value Selection
2717 : 0 - Assimilated O.K.
356 : 4 - Prior forward operator failed
231 : 6 - Rejected because incoming data QC higher tha
3495 : 7 - Rejected because of outlier threshold test
Please select type of value to plot
QC
Observation value
Plot
DART QC Value
x=217.758 , y=-58.5432 , z=119561

Making the GUIs: Visuals

Tkinter

- Standard GUI toolkit for Python
- Uses **widgets**

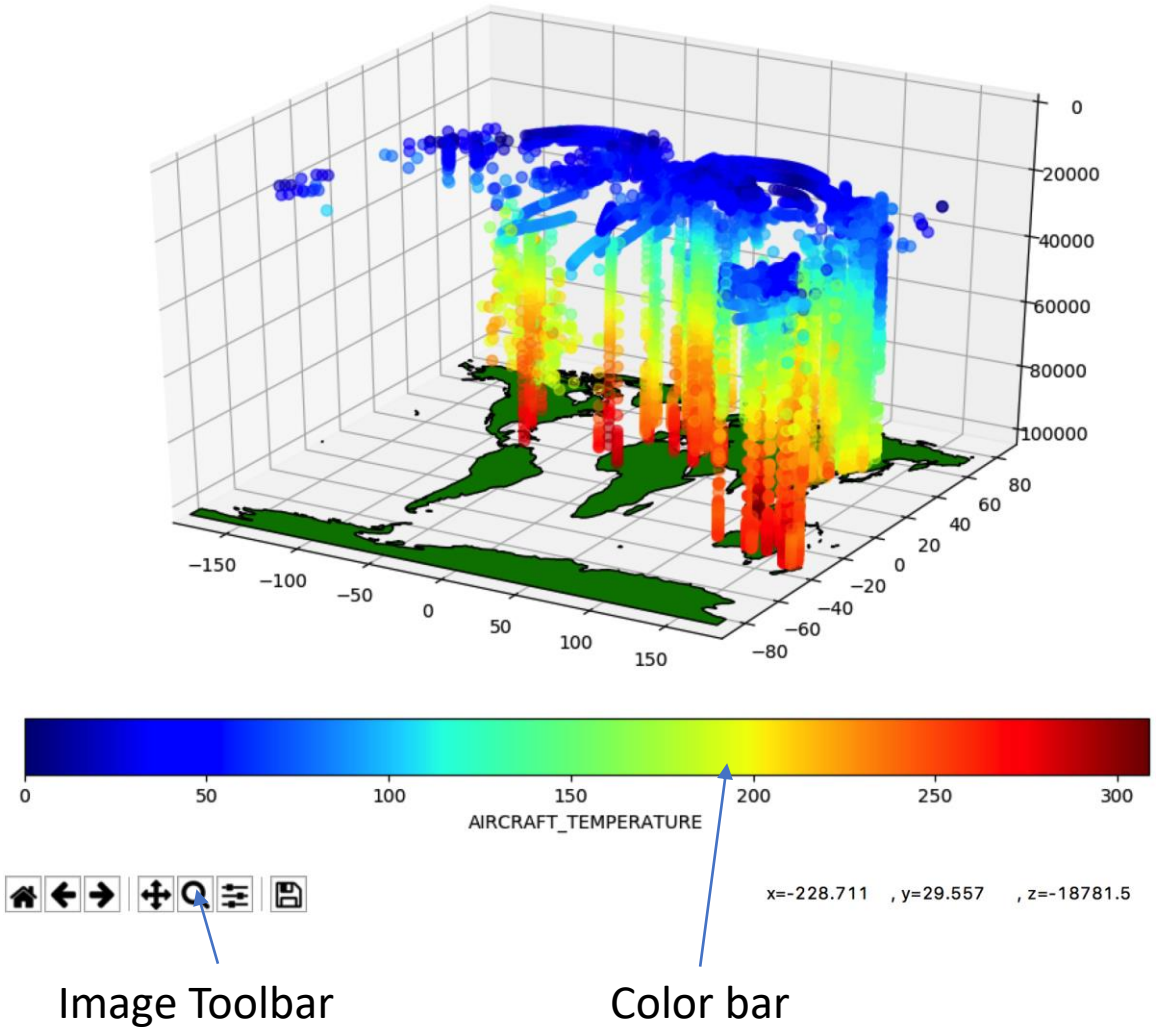


Making the GUIs: Visuals

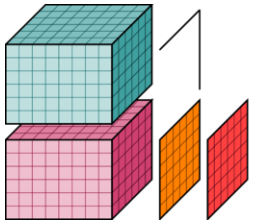
matplotlib

- Python's standard plotting library
- 2D and 3D functionality

- Plot geospatial data
- Map creation

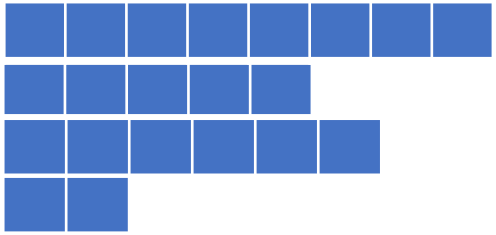


Making the GUIs: Data Processing



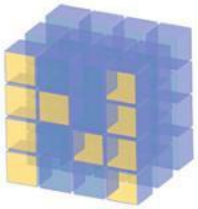
xarray has native netCDF, Matplotlib, and cartopy support, **BUT** it is best-suited for uniformly gridded datasets (most model output)

This is the shape of an observation dataset:



And this is the shape of my data structure:

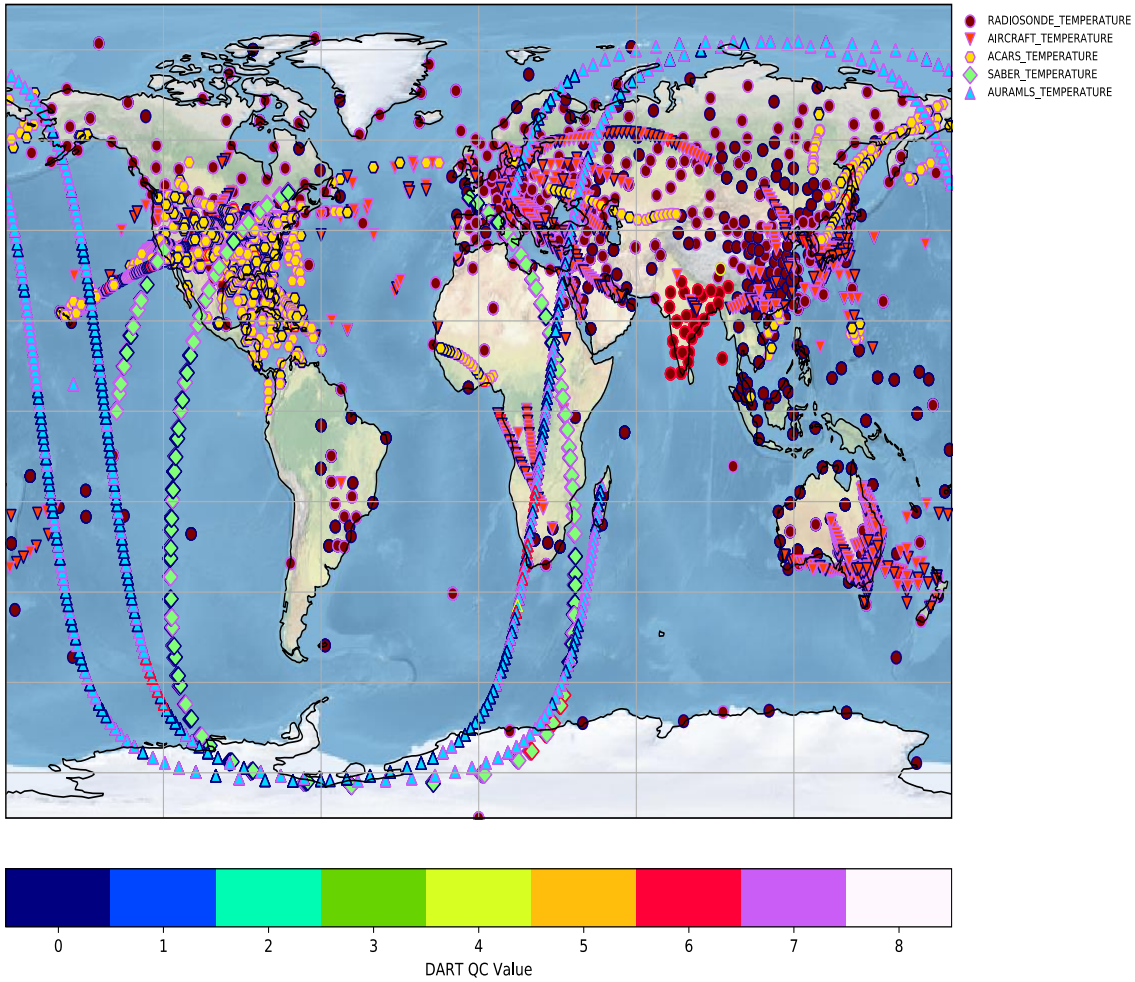
Luckily, we have



NumPy

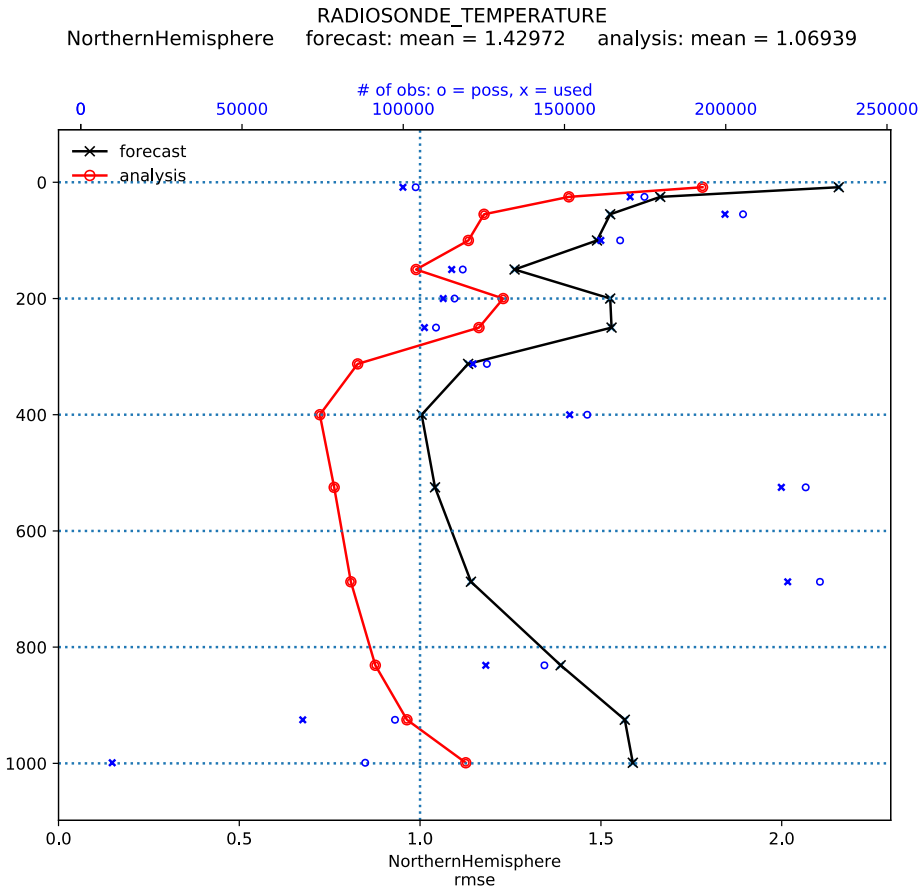
Observation Space Diagnostics

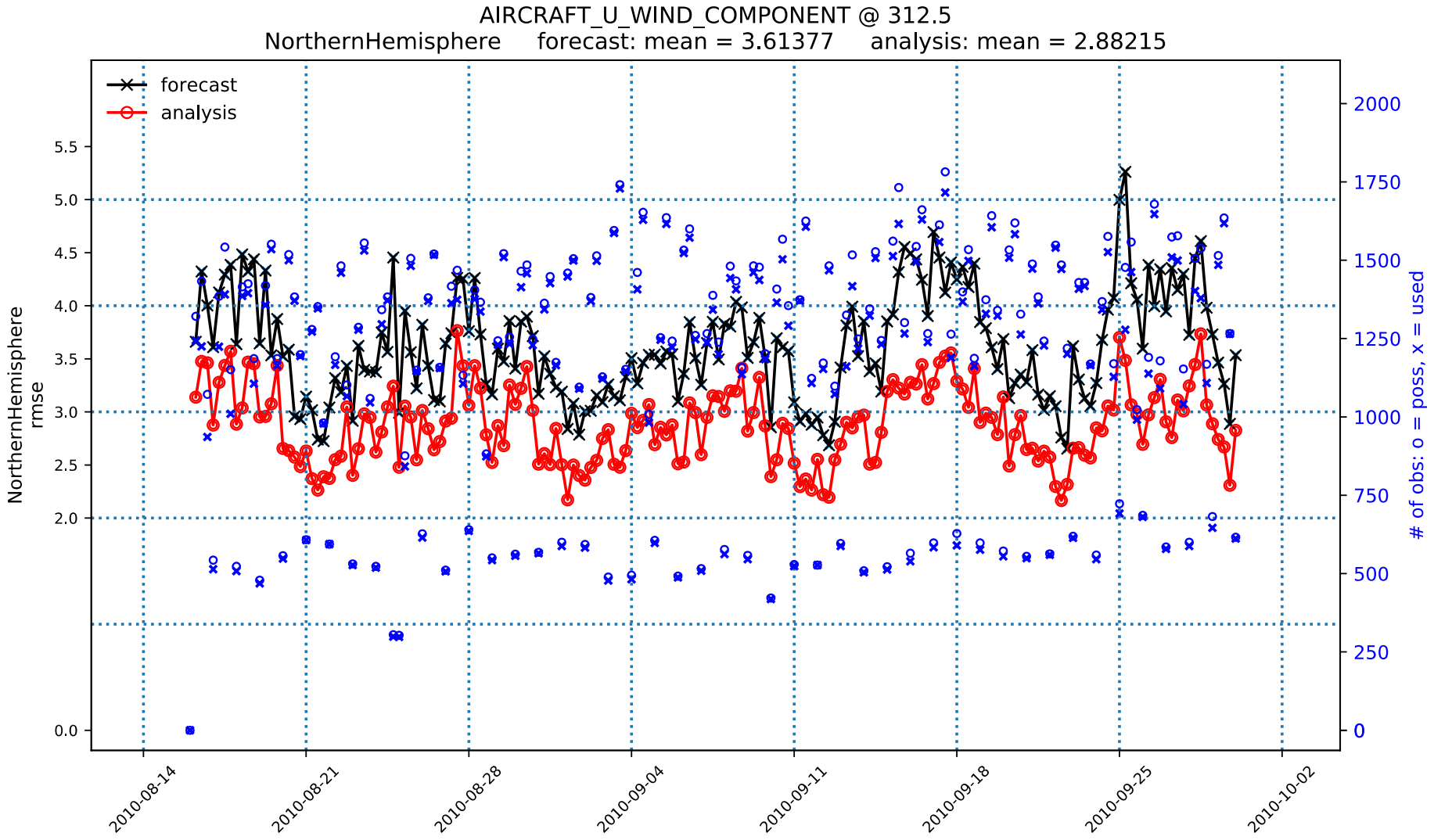
- Observation values and quality control information come from DART observation sequence files
- Two map GUIs: 2D and 3D
  - Each have extra useful traits



Observation Space Diagnostics

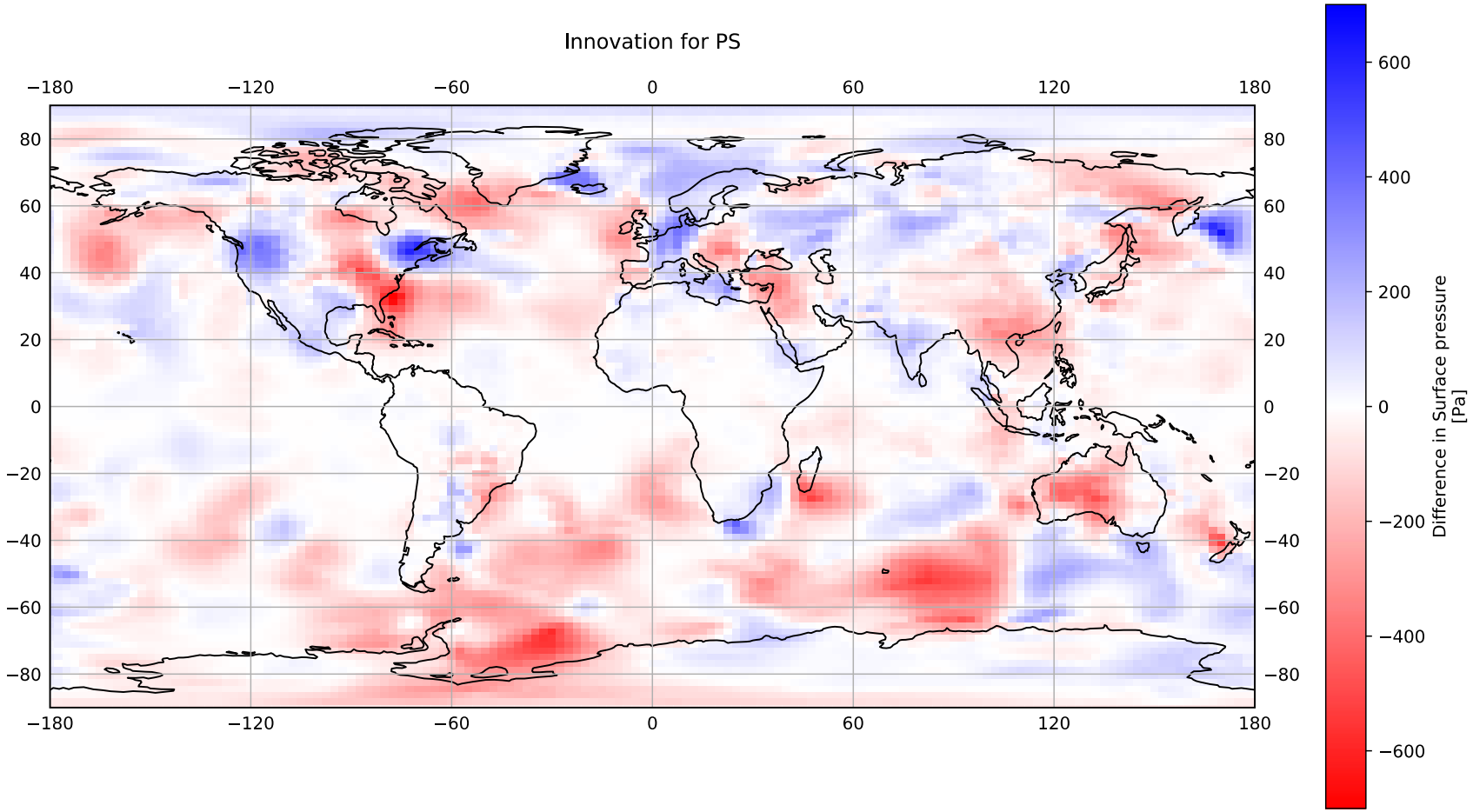
- Dart's obs_diag function produces metrics of DART's effectiveness
- Two GUIs for charting success metrics: Vertical Profile and Time Series




AIRCRAFT_U_WIND_COMPONENT @ 312.5
NorthernHemisphere forecast: mean = 3.61377 analysis: mean = 2.88215
forecast
analysis
NorthernHemisphere
rmse
# of obs: o = poss, x = used
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0.0
2000
1750
1500
1250
1000
750
500
250
0
2010-08-14
2010-08-21
2010-08-28
2010-09-04
2010-09-11
2010-09-18
2010-09-25
2010-10-02

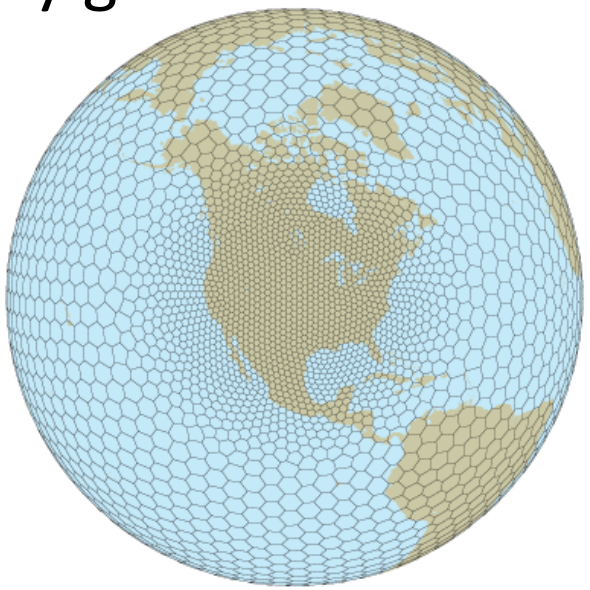
State Space Diagnostics

- Want to compare model state before and after DART



Future Work

- More selection options: more success metrics, view different ensemble members
- Make data filtration more flexible
- Add support for plotting irregularly gridded state-space geometries (MPAS)
- Add resizing capabilities
- Add more metadata to plots



Acknowledgments

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- AJ Lauer and Jenna Preston
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