Implementing an Observation Support System for the Data Assimilation Research Testbed

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Haverford College

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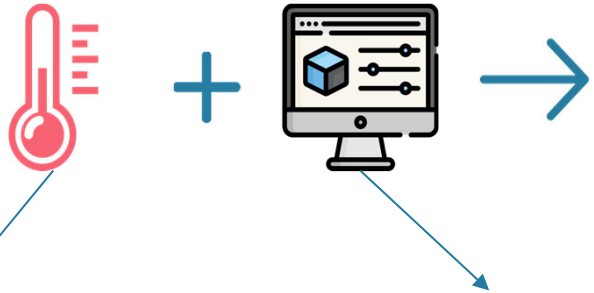
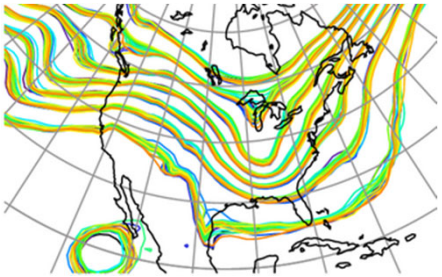
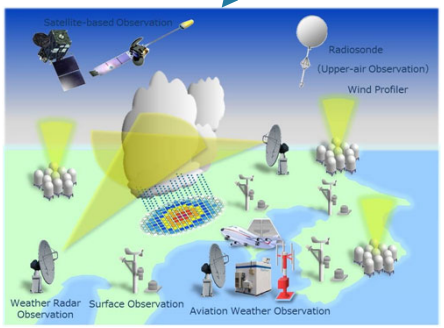
DATA ASSIMILATION

What is Data Assimilation?

- Observations statistically combined with Model Forecast to produce an analysis
- Widely used in numerical weather prediction







Model of the atmosphere, ocean, land and ice,…

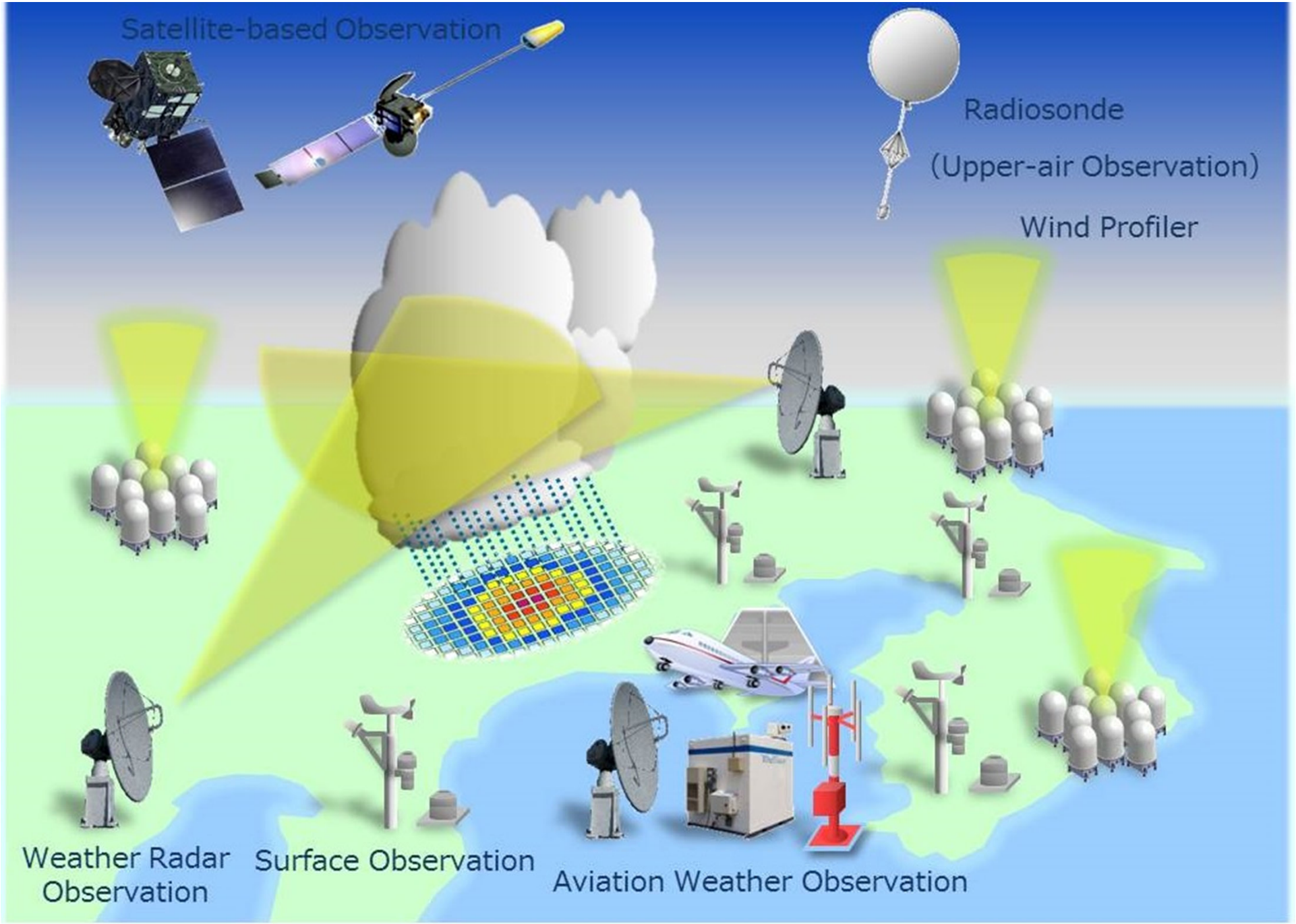


Figure 2: Weather Observations. *Japan Meteorological Agency.*

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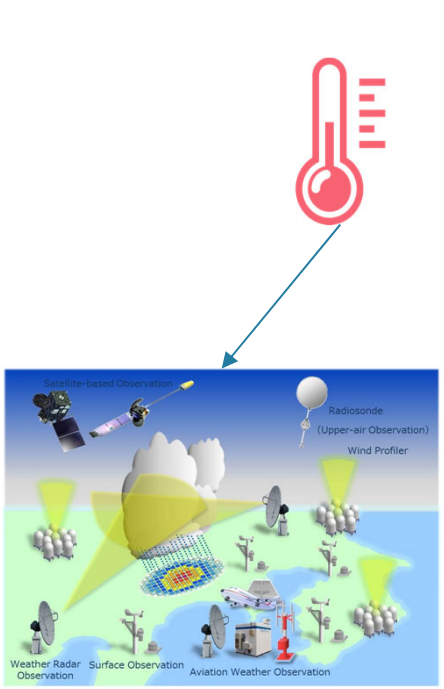

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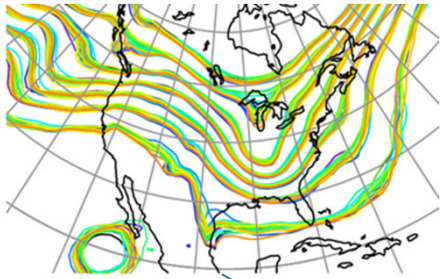


Analysis of best possible estimate

DATA ASSIMILATION RESEARCH TESTBED (DART)

- DART is a data assimilation open-source software developed by DAReS, NCAR
- DART provides modelers and observational scientists with powerful DA tools that are easy to implement and customize

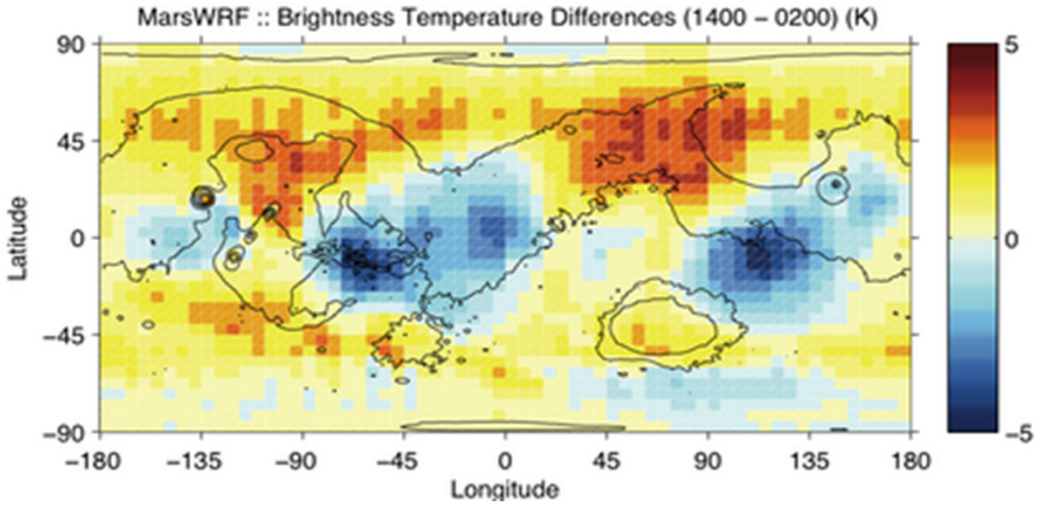


Figure 3: Brightness Temperature Difference within the Mars atmosphere. *DART, WRF, MARS*.

MOTIVATION – DATABASE PROBLEM

- DART currently stores observation information in `obs_sequence` files.
  - Pros: contains exactly needed information, supports extensible metadata
  - Cons: difficult to query, non-standard

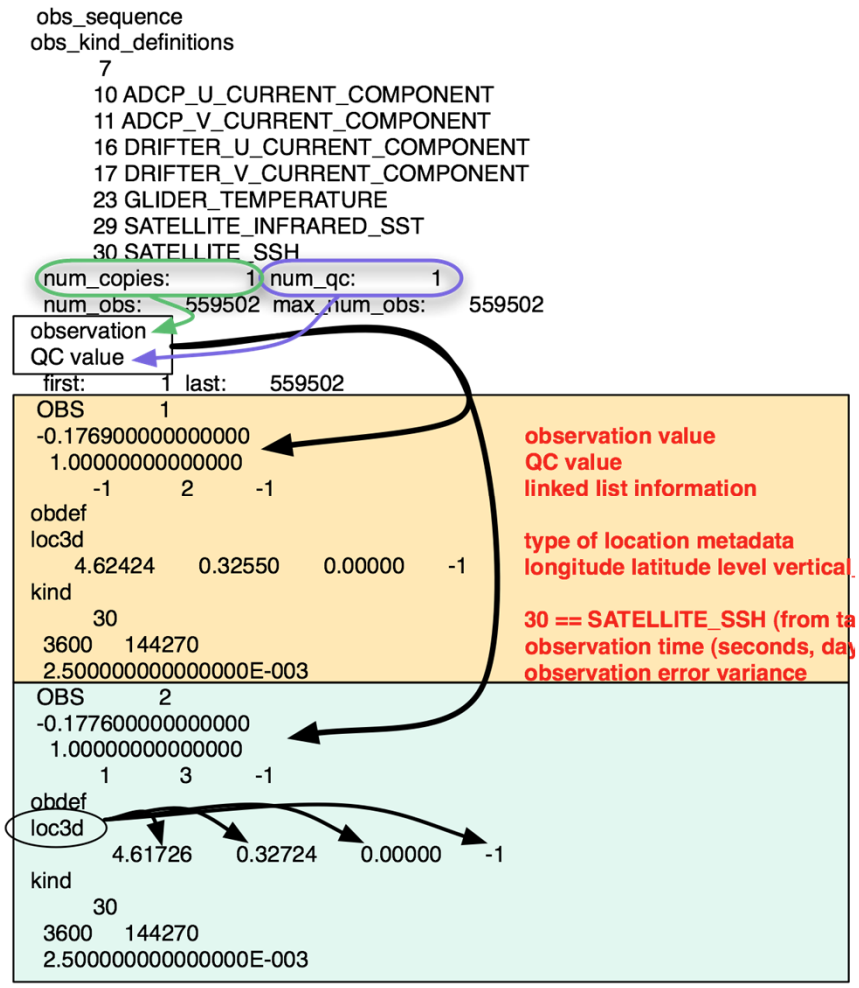


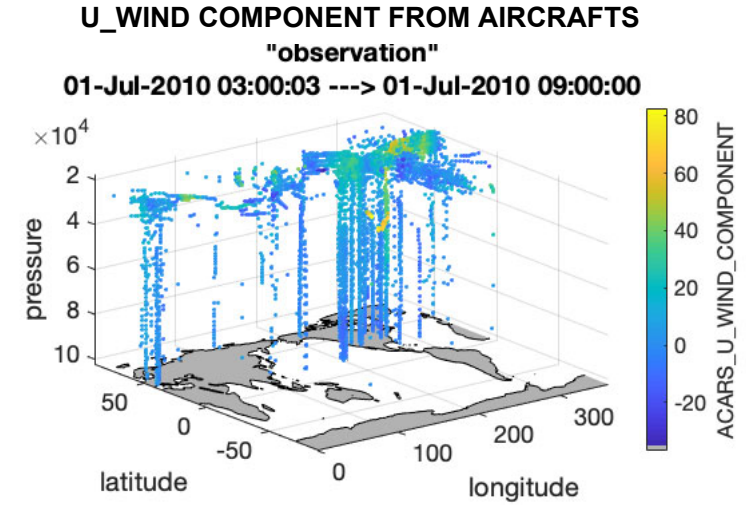
Figure 4: `obs_sequence` file structure.

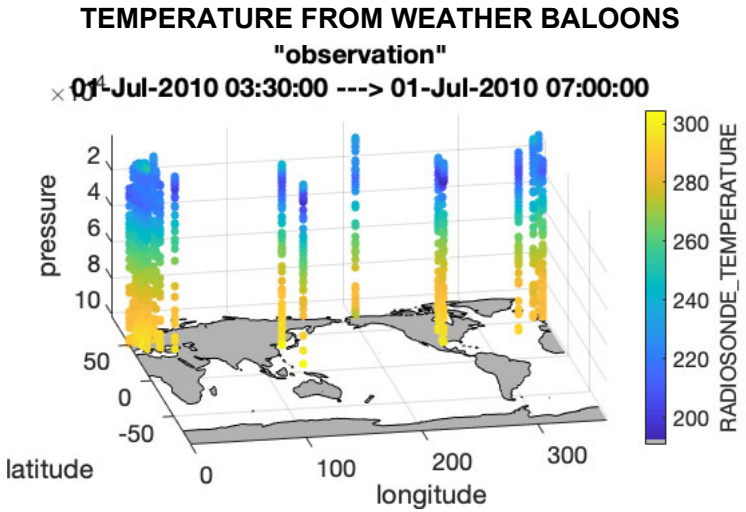
MOTIVATION – VISUALIZATION INFRASTRUCTURE

The 3D point-data obs_sequence files are not supported by current visualization software.

→ Convert to netCDF files & implement MATLAB functions to plot:

- Pros: customizable, pretty
- Cons: expensive MATLAB license, difficult to maintain, does not support extensible metadata





Plotted with MATLAB

SOLUTION – NETCDF CONVERTER

Convert to **standard** netCDF with Fortran & Python scripts

- Preserve point-data structure

```
types:
    extensible Metadata;
dimensions:
    obs;
variables:
    time(obs);
    lat(obs);
    lon(obs);
    vert (obs);
    salinity(obs);
    Metadata(obs);
// global attributes
groups: dummy {
    obs_id = 0,2,3...
    // attributes
}
```

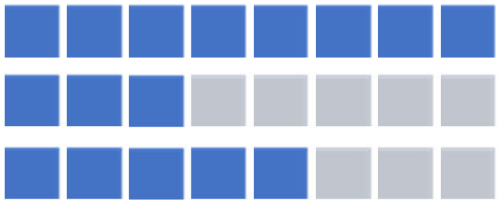
netCDF file structure

SOLUTION – NETCDF CONVERTER

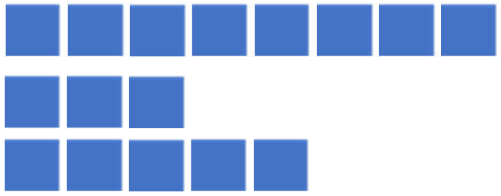
Convert to **standard** netCDF with Fortran & Python scripts

- Preserve point-data structure
- Support extensible metadata with varying-length variables

Fixed-length arrays



Varying-length arrays



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SOLUTION – NETCDF CONVERTER

Convert to **standard** netCDF with Fortran & Python scripts

- Preserve point-data structure
- Support extensible metadata with varying-length variables
- Support for data subsets with netCDF groups
- Follow netCDF metadata standards (CF Convention)

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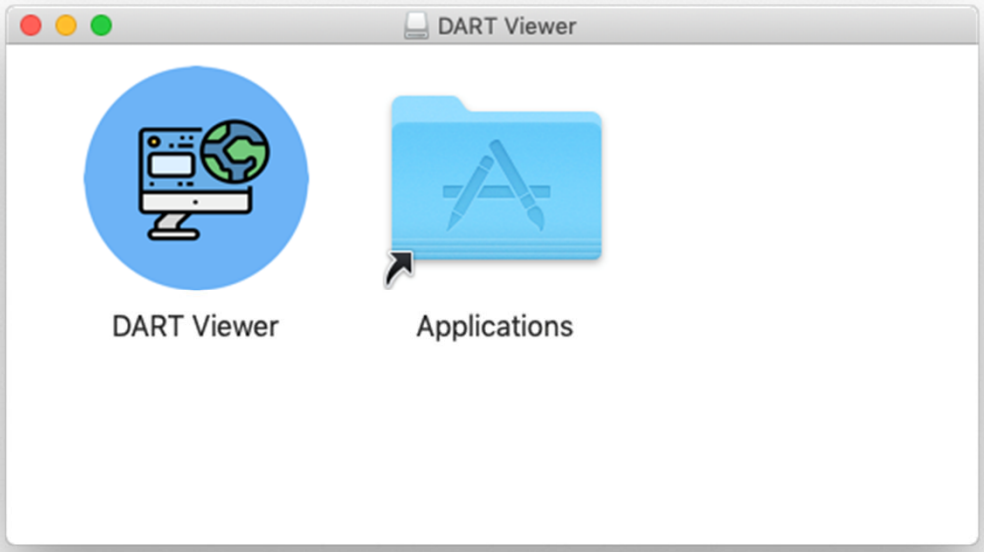
netCDF file structure

SOLUTION – GRAPHICAL USER INTERFACE (GUI)

Frontend: Built with Qt, a cross-platform software development environment

GUI pros:

- Requires no programming languages
- Free
- Mac/Linux compatible



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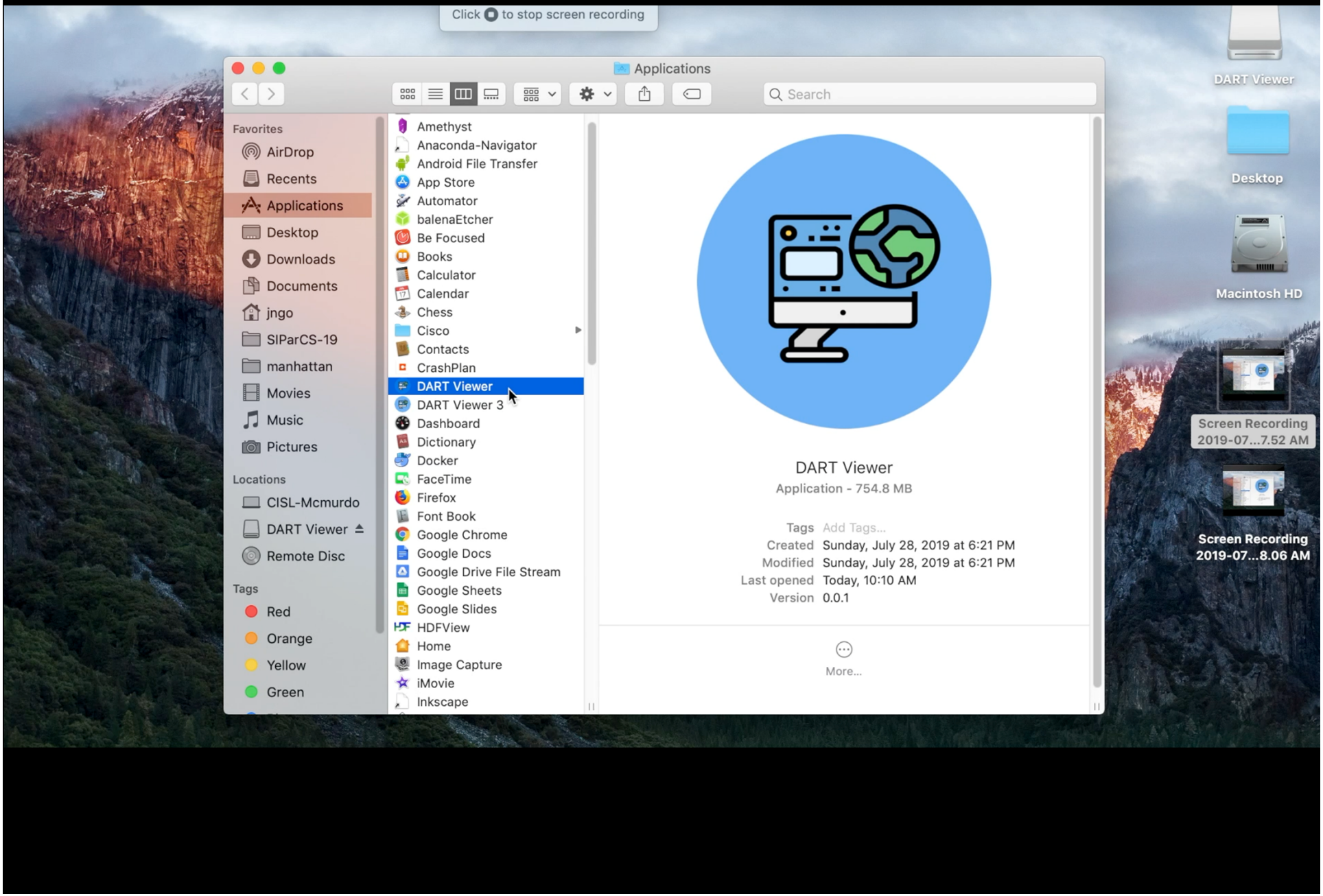

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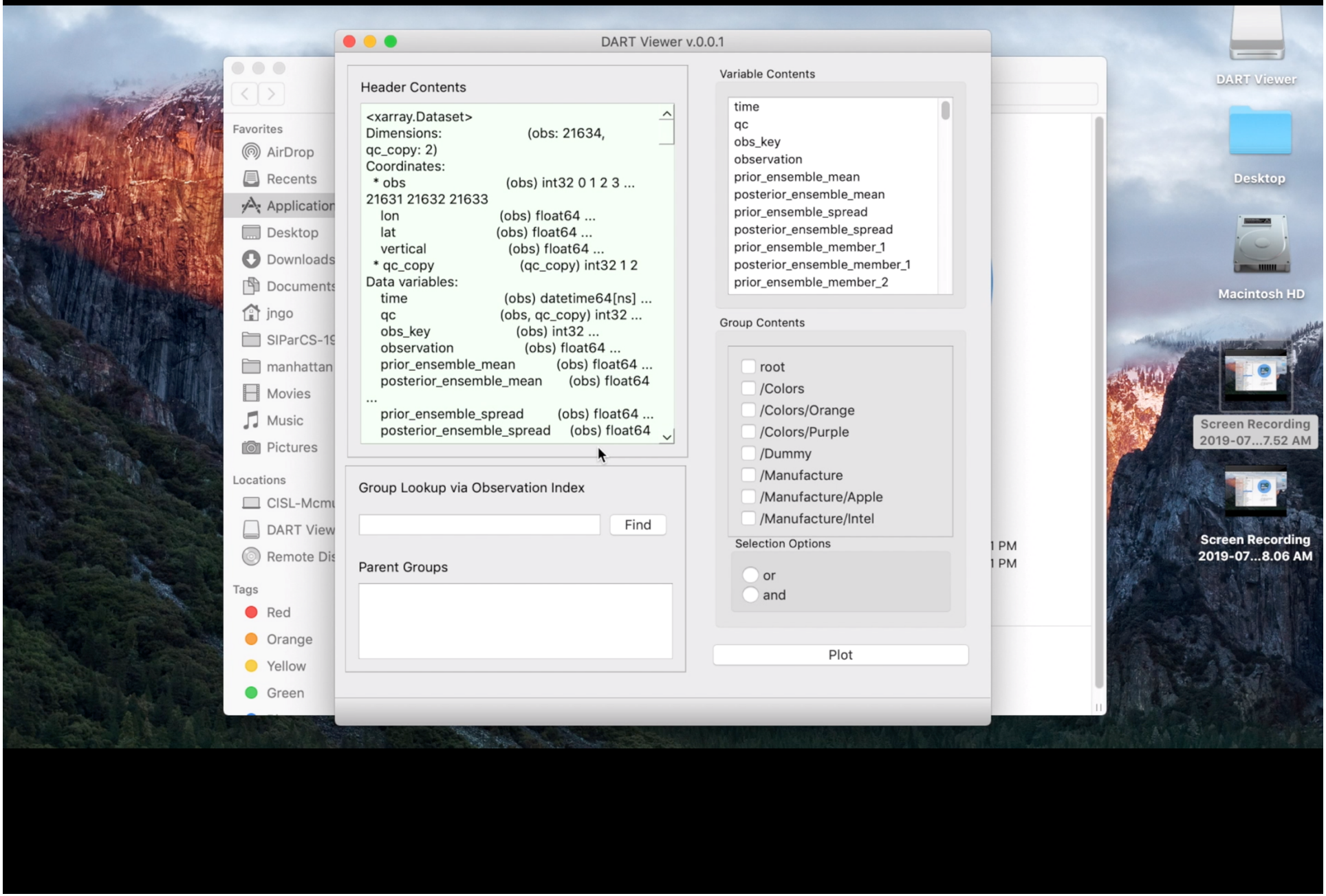

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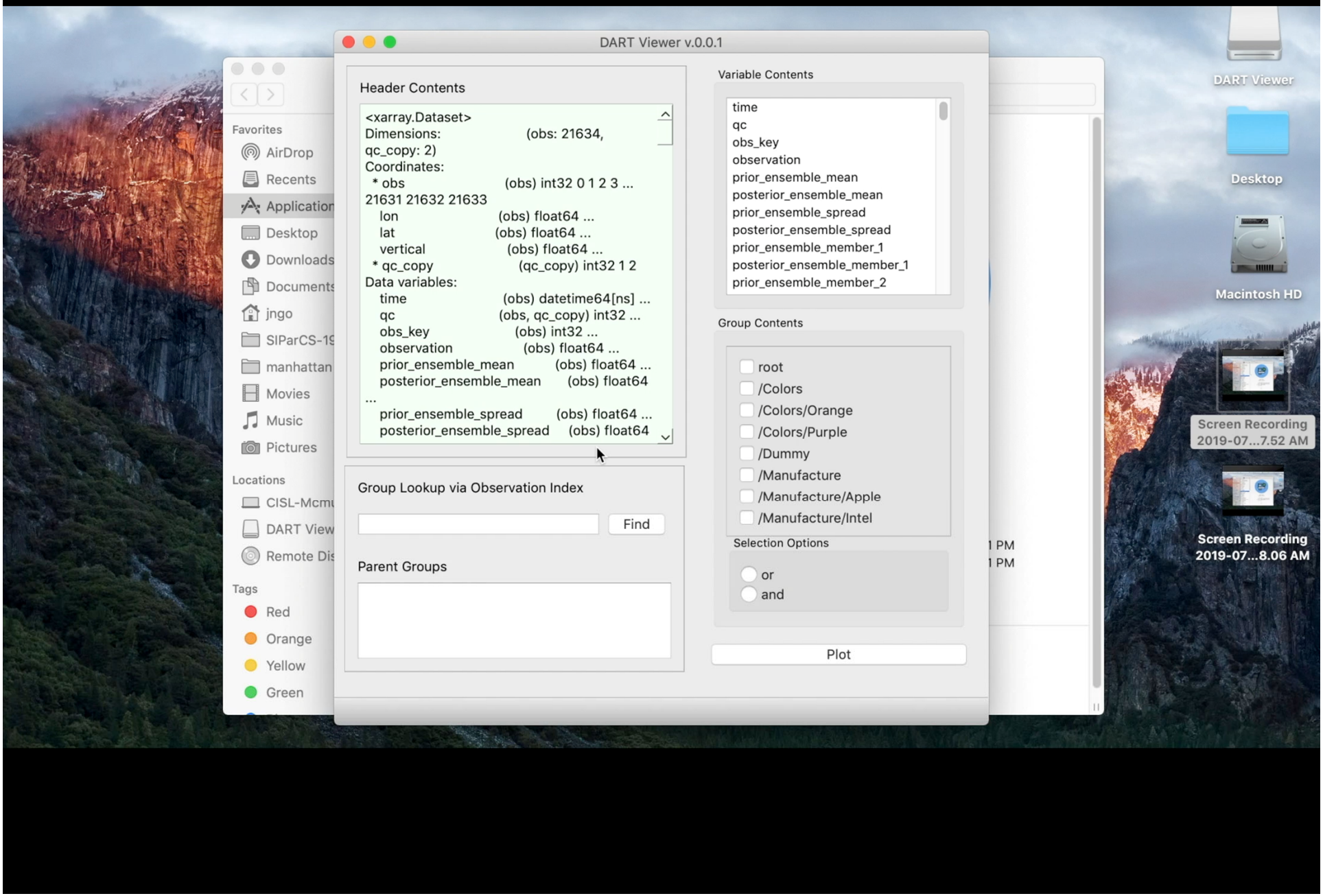

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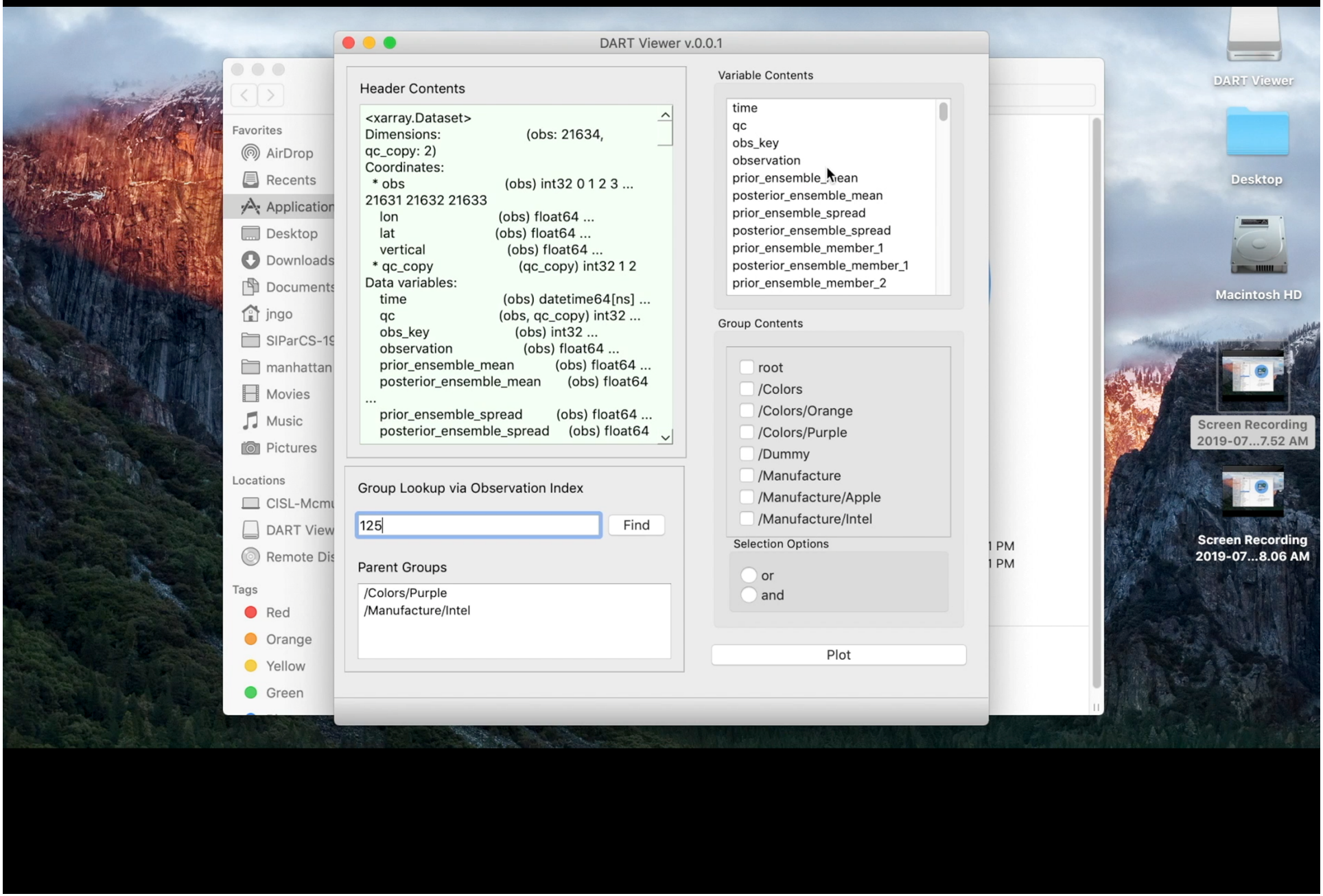

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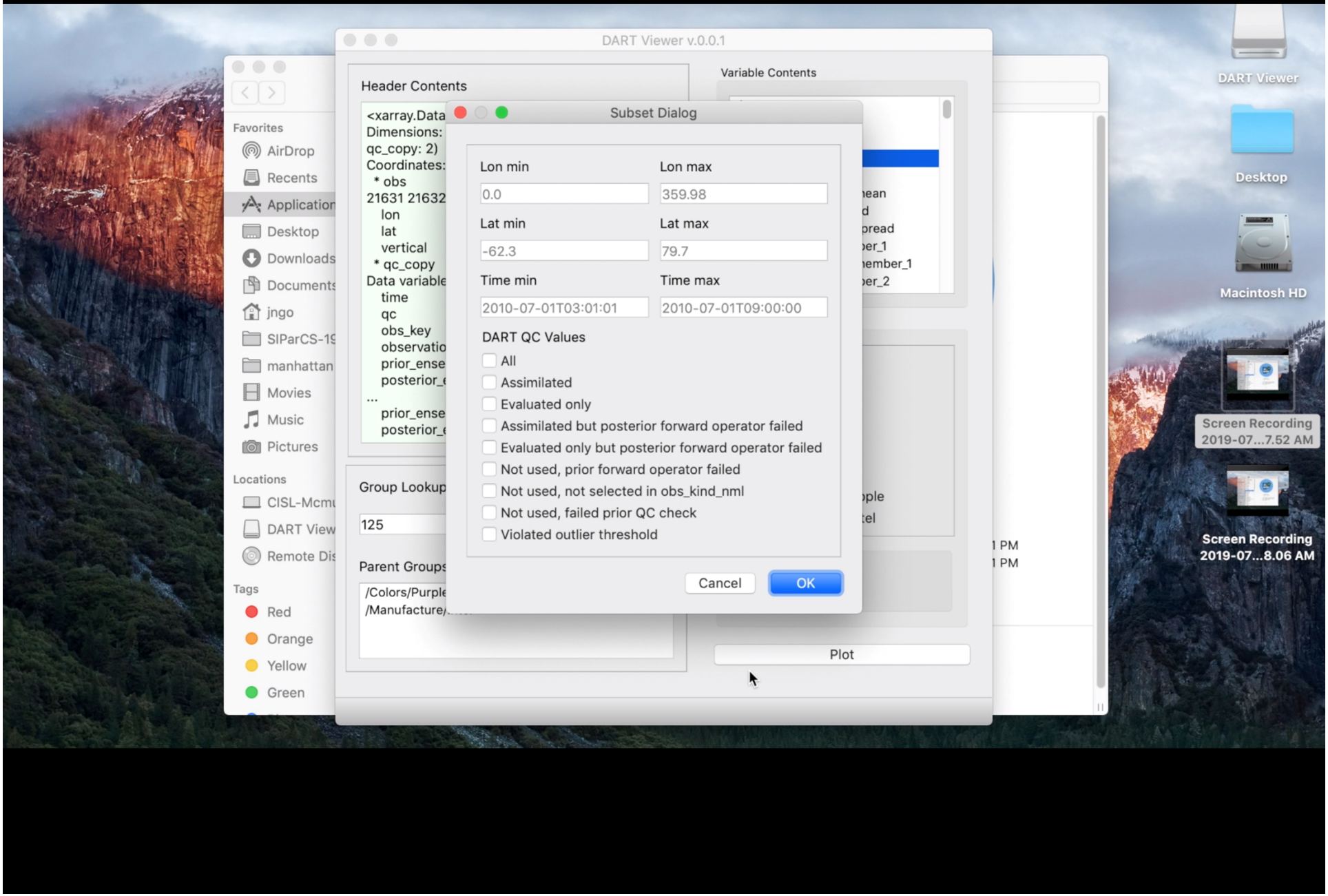

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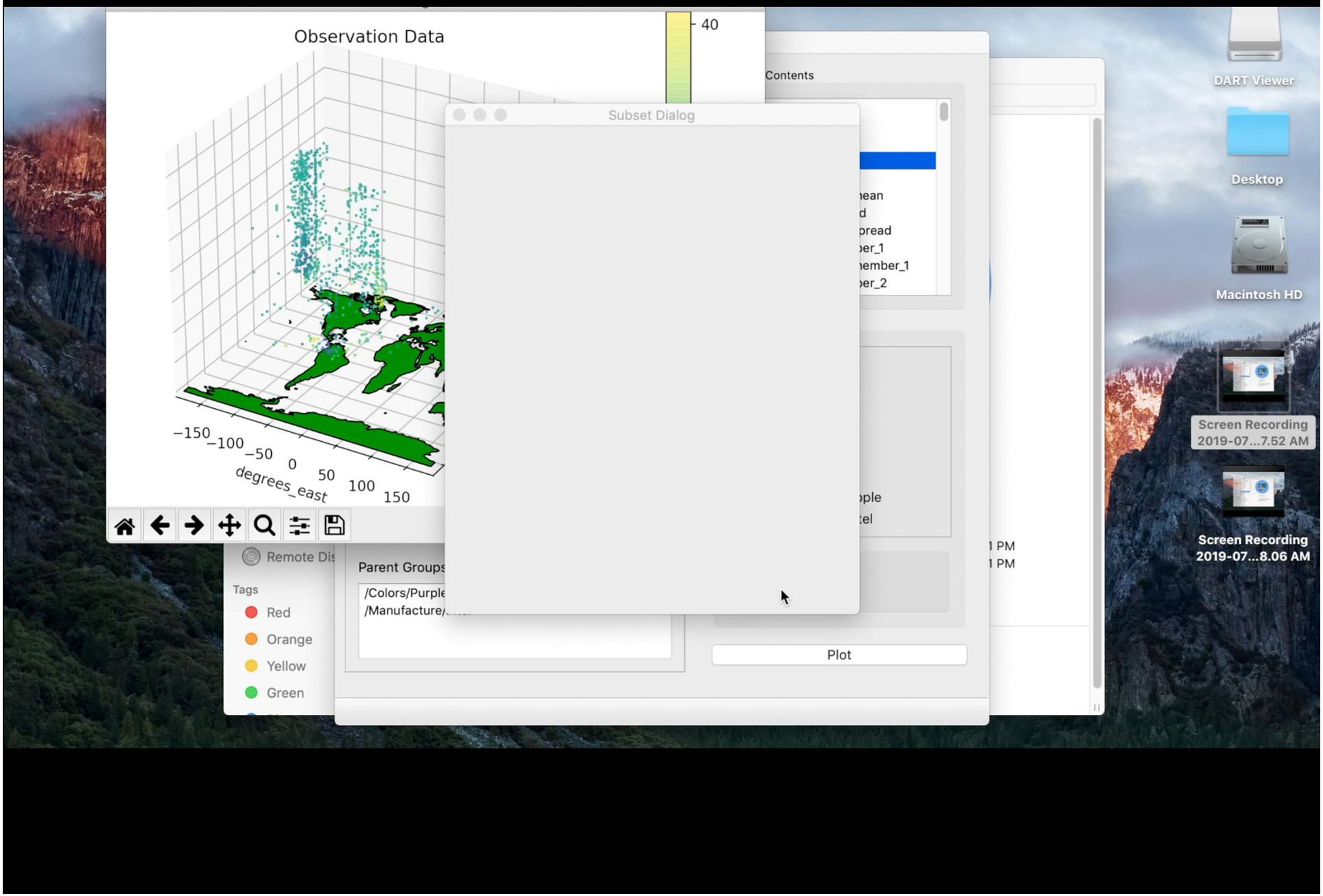

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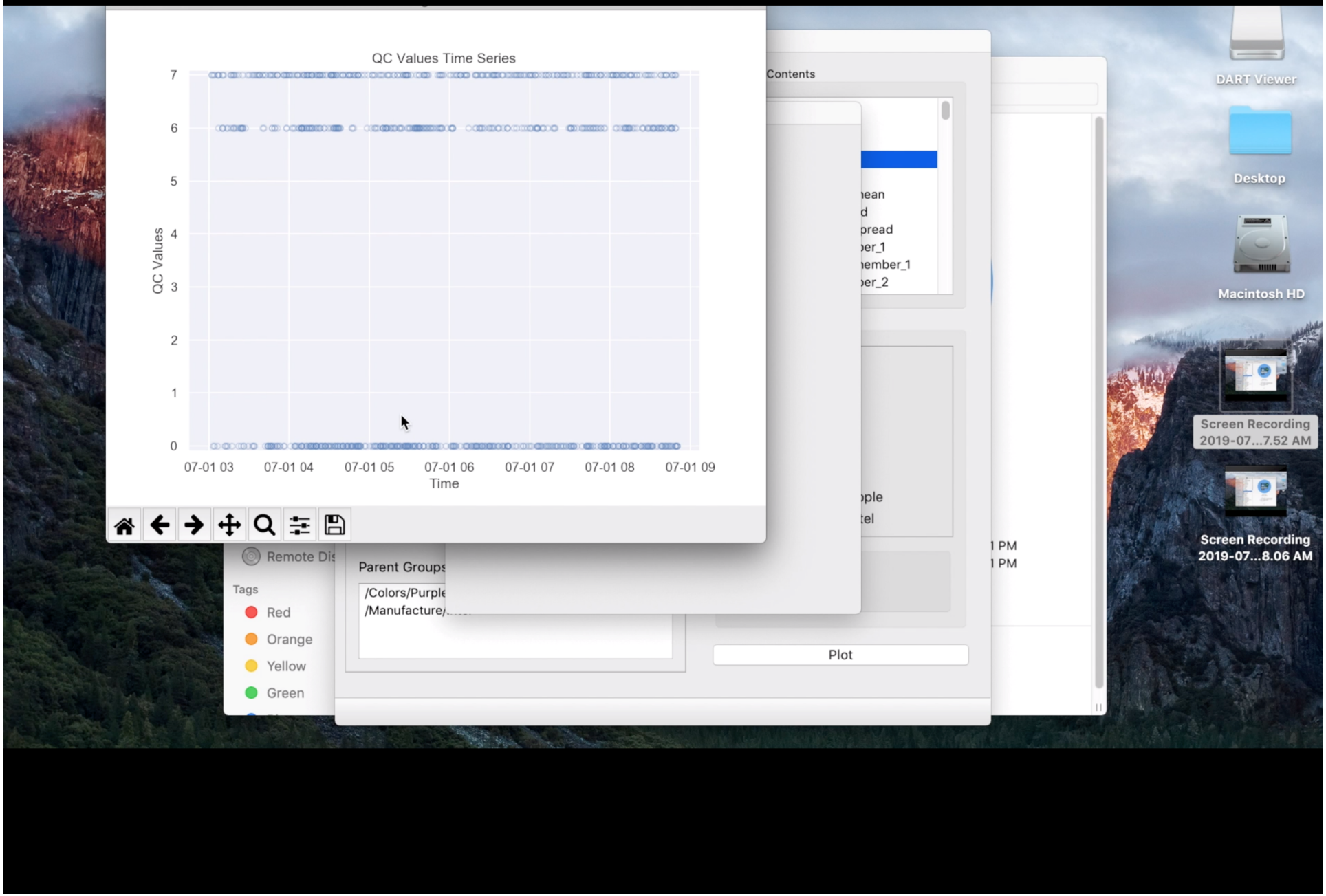

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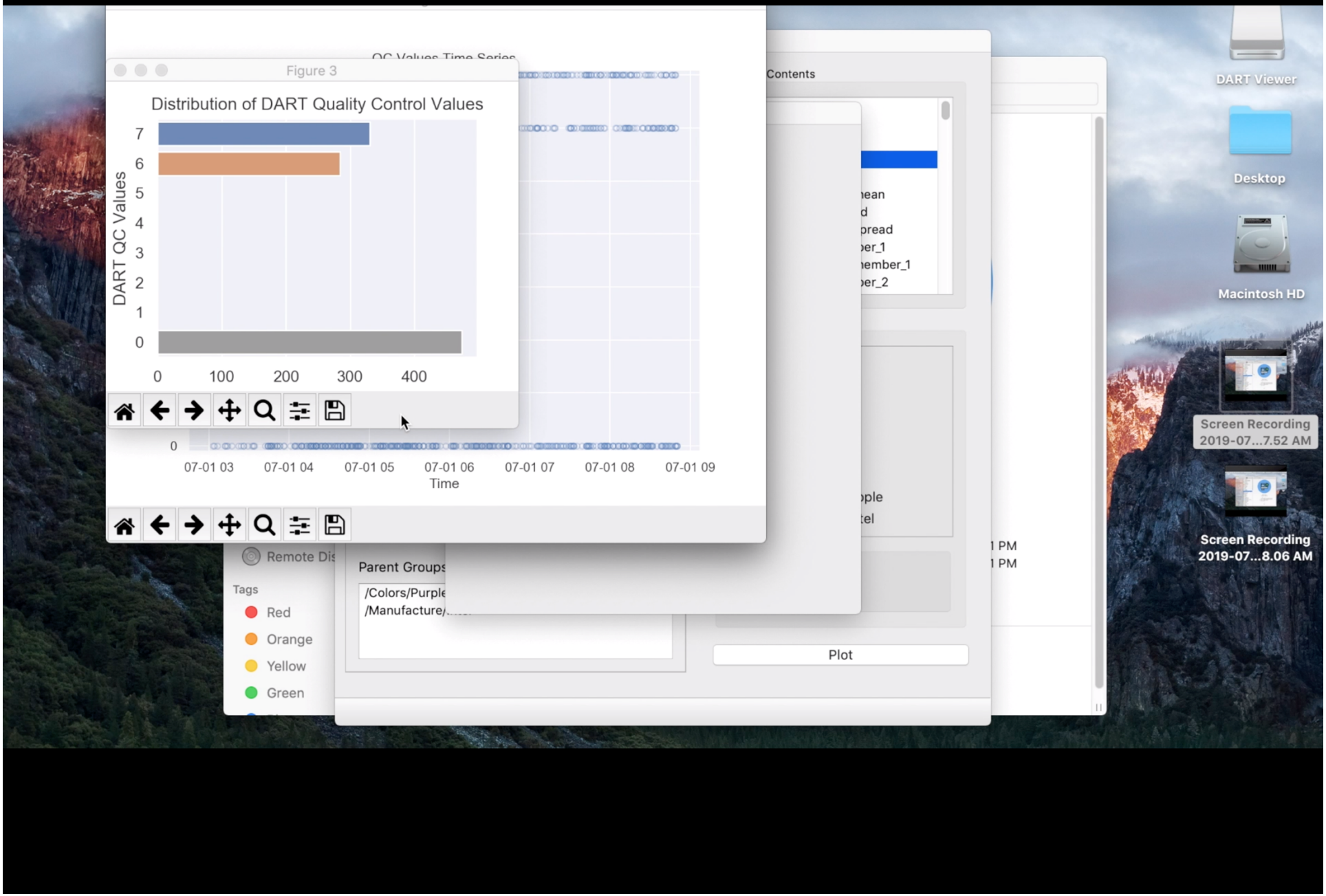
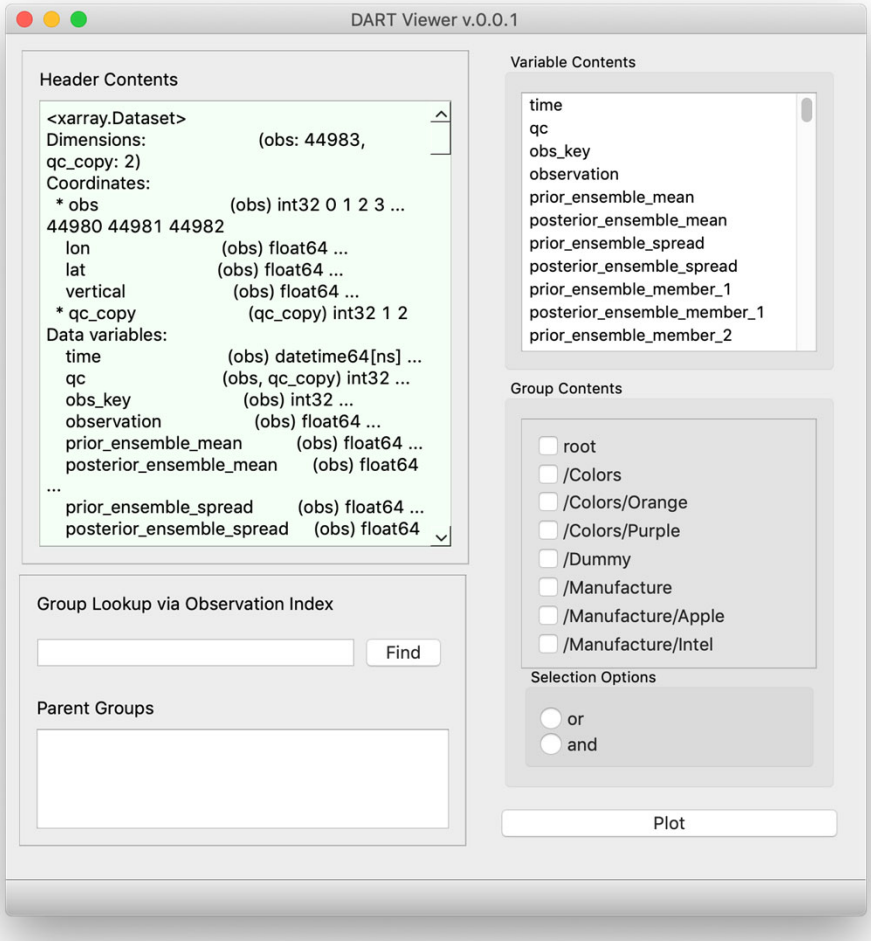


SOLUTION – GRAPHICAL USER INTERFACE (GUI)

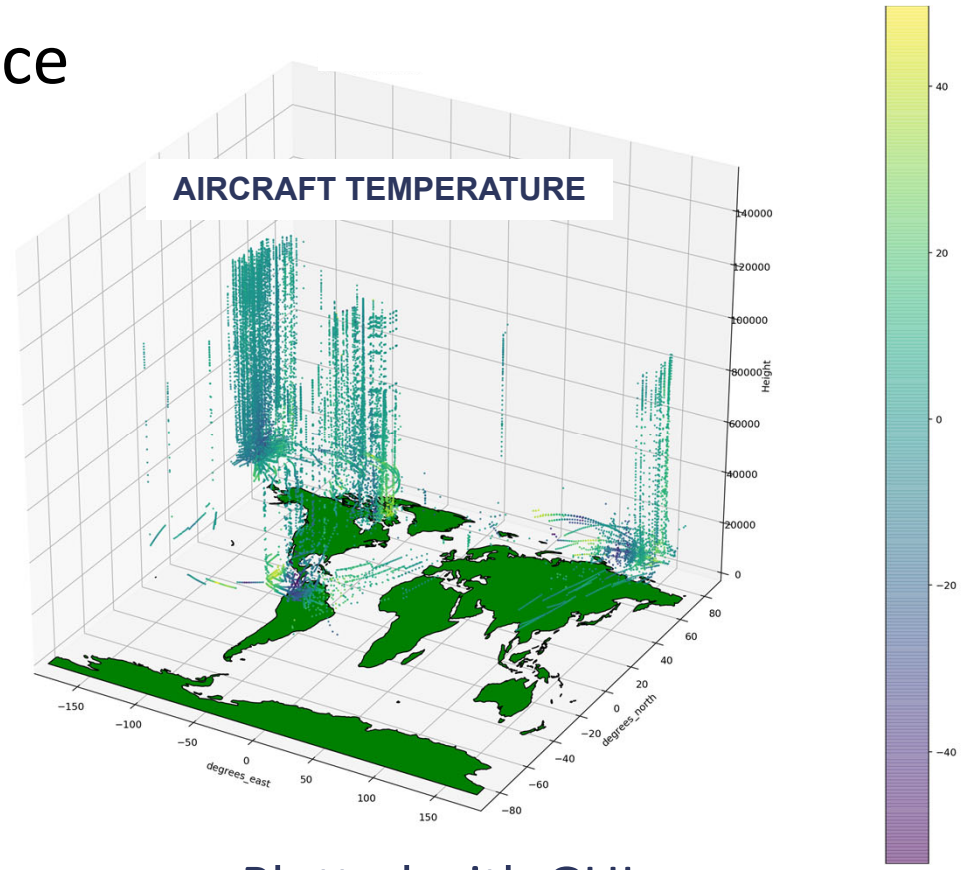
Python Backend

- Database:
  - `xarray`
  - `netcdf4`
- Plot:
  - `matplotlib`
  - `cartopy`



FUTURE WORK

- Automated testing capabilities
- Customizable plots
- More intuitive interface



Plotted with GUI

ACKNOWLEDGEMENT

- Mentors: Jeff Anderson, Nancy Collins
- Data Assimilation Research Section
- Fellow SIParCS Interns
- CODE team

Any questions ?

You can find me at

- aqngo@haverford.edu
- or at the airport on Saturday

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