CCAR Ocean Data System (CODS)

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CCAR
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Background

Colorado Center for Astrodynamics Research (CCAR) altimeter ocean data viewers have been online since 1996. Major updates of the processing and visualization system were performed in 2002 and 2010. The most recent update consolidated the data processing codebase into MATLAB with the goal of improving the processing and gridding methods used to produce sea surface height (SSH) data products.

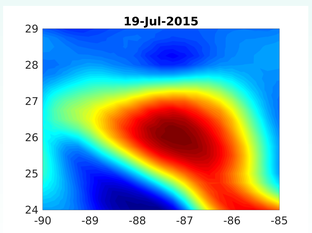
Since the last major upgrade it has become clear that the stability of the system is at risk because of software rigidity and deprecation of functionality over time. In this newest iteration of the data service we intend to fix the following problems:

- Programmatic and low bandwidth access.
- Portability and scalability.
- Snapshotting of data.
- User-side customization.
- Extensibility through modularization.
- Not mobile or IE friendly.
- Incompatibility with version 4 of the Radar Altimeter Database System (RADS).

Programmatic Access

Currently the only programmatic access to CCAR ocean data is via login only FTP. This not only precludes public access but has required users to download large files (up to 50 MB) which can take minutes to download and can cost tens to hundreds of US dollars per day of data to download while at sea. By adding programmatic access and user requested server side computation bandwidth can be reduced by over 100 times in simple cases and an extra order of magnitude in complex ones (see "User Customization"). An example of how this might work in MATLAB:

```
url = 'cods.colorado.edu/data/ssh/realtime/grid';
lon = ncread(url, 'lon');
lat = ncread(url, 'lat');
time = toDatenum(ncread(url, 'time'));
loni = -90 <= lon & lon <= -85;
lati = 24 <= lat & lat <= 29;
timei = time == datestr(floor(now));
start = [find(loni,1), find(lati,1), find(timei,1)];
count = [sum(loni), sum(lati), 1];
ssh = ncread(url, 'ssh', start, count);
pcolor(lon(loni), lat(lati), transpose(ssh));
colormap jet; title(datestr(time(timei)));
```



The addition of Web Map Servece (WMS) and GeoJSON along with the DAP2 interface shown above will combine to not only form a simple and lightweight interface but will also serve as the basis of internal data usage making all internal code usable on external systems.

Acknowledgements

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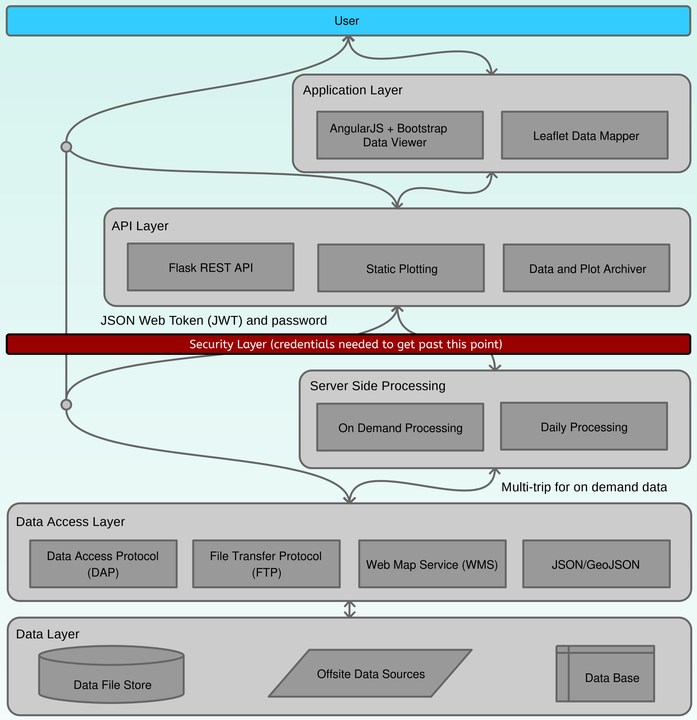
Portability and Scalability

The current generation CCAR ocean data viewer was designed with certain assumptions about future requirements. Many of these we have discovered to be false, such as exact repeat orbits. The largest future requirement is inclusion of wide swath altimetry (Fu and Ubelmann 2014). Other, more urgent requirements are on demand computation and easy addition of datasets such as the reconstructed sea level data set produced between CCAR and Old Dominion University (Hamlington et al. 2011).

To address these concerns we propose a re-architecture of the system with a data model built on DAP+WMS+JSON which will provide a standardized format for the delivery of data both between internal systems and to researchers and systems external to CCAR. The system diagram below outlines the various components that make up and use this data model.



By standardizing the communication between components we allow not only for new components to be added easily, but also for the relocation of components to offsite systems for redundancy, customization, and individual use. This allows users who wish to use part of the CODS system as a starting point for another data product to do so without requiring us to make special interfaces or processing.

The portability given by the data model will become even more important as datasets become larger and can only be processed in realtime and not copied locally before use.

References

[1] Lee-Lueng Fu and Clement Ubelmann. "On the transition from profile altimeter to swath altimeter for observing global ocean surface topography". In: *Journal of Atmospheric and Oceanic Technology* 31.2 (2014), pp. 560–568.

[2] BD Hamlington et al. "Reconstructing sea level using cyclostationary empirical orthogonal functions". In: *Journal of Geophysical Research: Oceans (1978–2012)* 116.C12 (2011).

User Customization

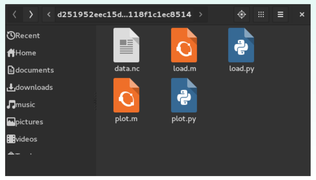
Sometimes users ask for simple additions. To accommodate this registered users will be allowed to write simple computations to in effect generate their own datasets based off of the ones we already offer. For example, the user written script below would download the same region seen earlier but would use a 9-day average of the MODIS SST data.

```
(define sstURL
    "cods.colorado.edu/data/sst/modis/aqua/l2")
(define date (dateNumber \$1 \$2 \$3))
(mean 3
    (geoSelect sstURL (-90 -85) (24 29)
        ((- date 4) (+ date 4))))
```

After posting this as `sstmean` the user could access the data via any of the supported protocals where it would be generated on demand at: `cods.colorado.edu/<user>/functions/sstmean/<year>/<month>/<day>`

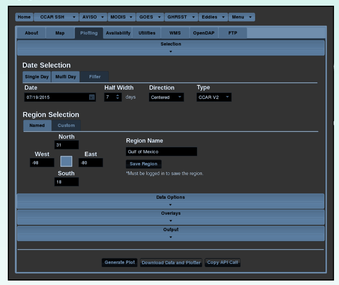
Archived Plotting

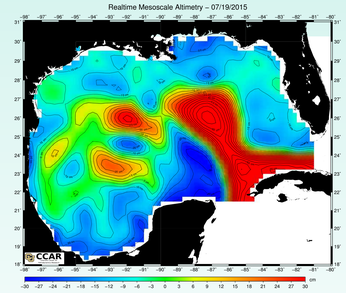
There is no guarantee from day to day that any given data will remain the same, because of the constant improvements of the datasets. Nor, is it practical to store every revision of the data. Also, many users lack the software and/or programming skills necessary to replicate the generated plots with data they download. Therefore, CODS will provide an optional download with every static plot on the website which will contain a `data.nc` NetCDF4 file containing all the data needed to generate the plot. Along with the data, functions for loading and plotting this file will be automatically generated given the user's specific website or web API inputs for both Python (based on NumPy+SciPy+Matplotlib) and MATLAB.



GUI Interface

Our current website was written in a different era of the web and because of this it has poor compatibility with mobile systems. Also, because of the in-house Javascript interface some browsers have problems with certain features of the website. To fix the incompatibility an industry standard AngularJS framework will be used instead. This will also allow for a level of interactiveness with the data via the website not available before as well a decoupling of website and data service.





The modular system mentioned in the center section also allows the web application to offer data in more complex ways than our current static image delivery system. By using the WMS and JSON data interface the website can deliver interactive maps with both heightmap and contour overlays on top of a fully zoomable world map making examination of CCAR datasets easier than ever.