

## Introduction

The U.S. Navy's Arctic prediction systems use a coupled ice-ocean modeling system comprised of the Community Ice Code (CICE) and the Hybrid Coordinate Ocean Model (HYCOM) with atmospheric forcing from the Navy Global Environmental Model (NAVGEM). Both the Arctic Cap Nowcast/Forecast System (ACNFS) and its replacement the Global Ocean Forecast System version 3.1 (GOFS 3.1) assimilate sea surface temperature, ice concentration, ice edge, and *in situ* data via the Navy Coupled Ocean Data Assimilation System (NCODA). However, the present configuration does not assimilate *in situ* profile observations that sample too little of the water column relative to the ocean depth. These include the Polar Science Center's Upper Temperature of the polar Ocean (UpTempO) buoys, which sample to a maximum depth of 60 m or shorter in shallow shelf areas. In this study, we investigate the impact of UpTempO buoys in the ACNFS.

## Arctic Analysis/Prediction System

### Ice Model:

Community Ice Code  
(CICE) v4

### Ocean Model:

Hybrid Coordinate Ocean  
Model (HYCOM)

### Data Assimilation:

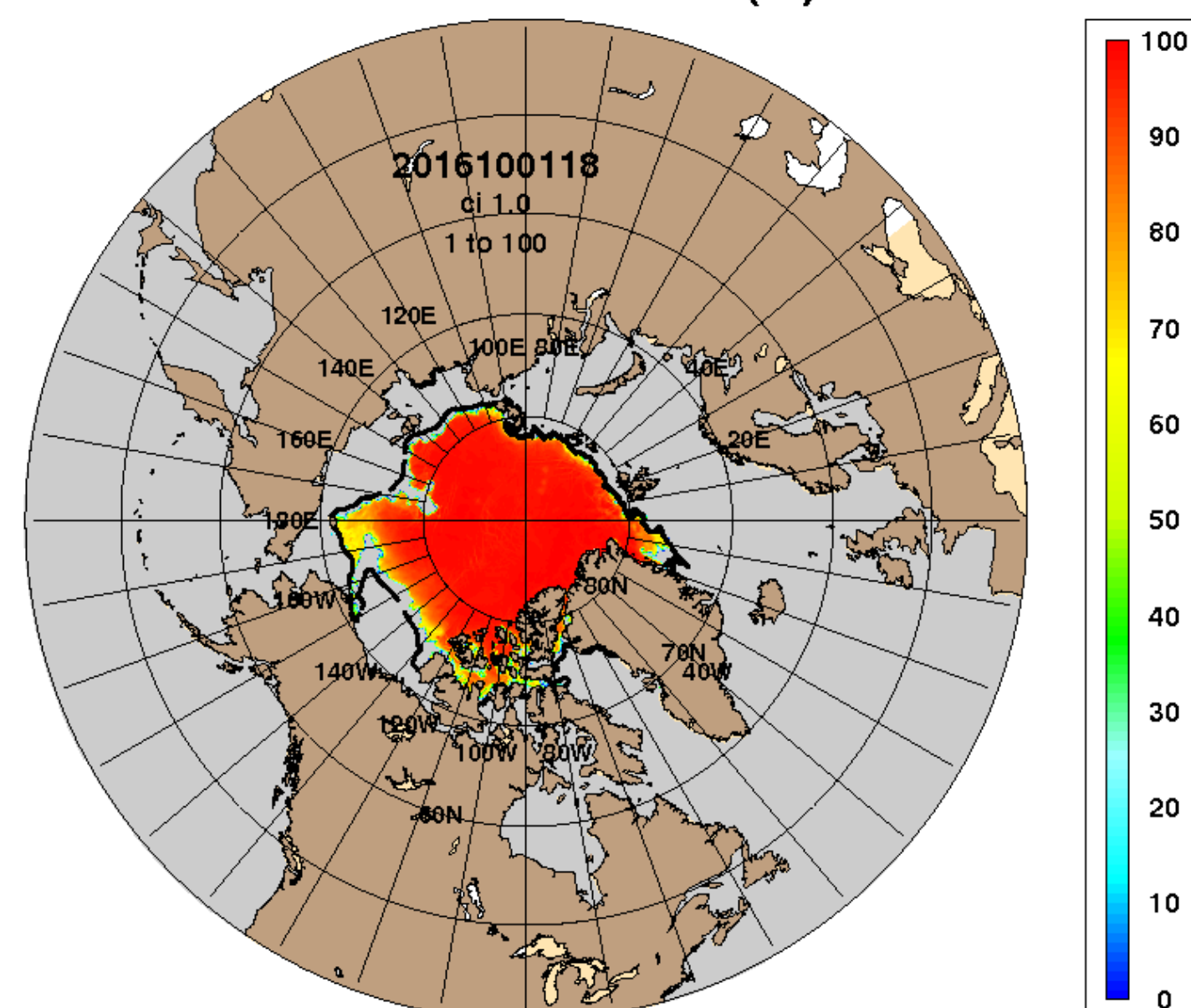
Navy Coupled Ocean Data  
Assimilation (NCODA)

### Data quality control:

NCODA\_QC

Daily graphics can be found:  
[www.7320.nrlssc.navy.mil/hycomARC](http://www.7320.nrlssc.navy.mil/hycomARC)

ARCC0.08-04.6 Ice Concentration (%): 20160929

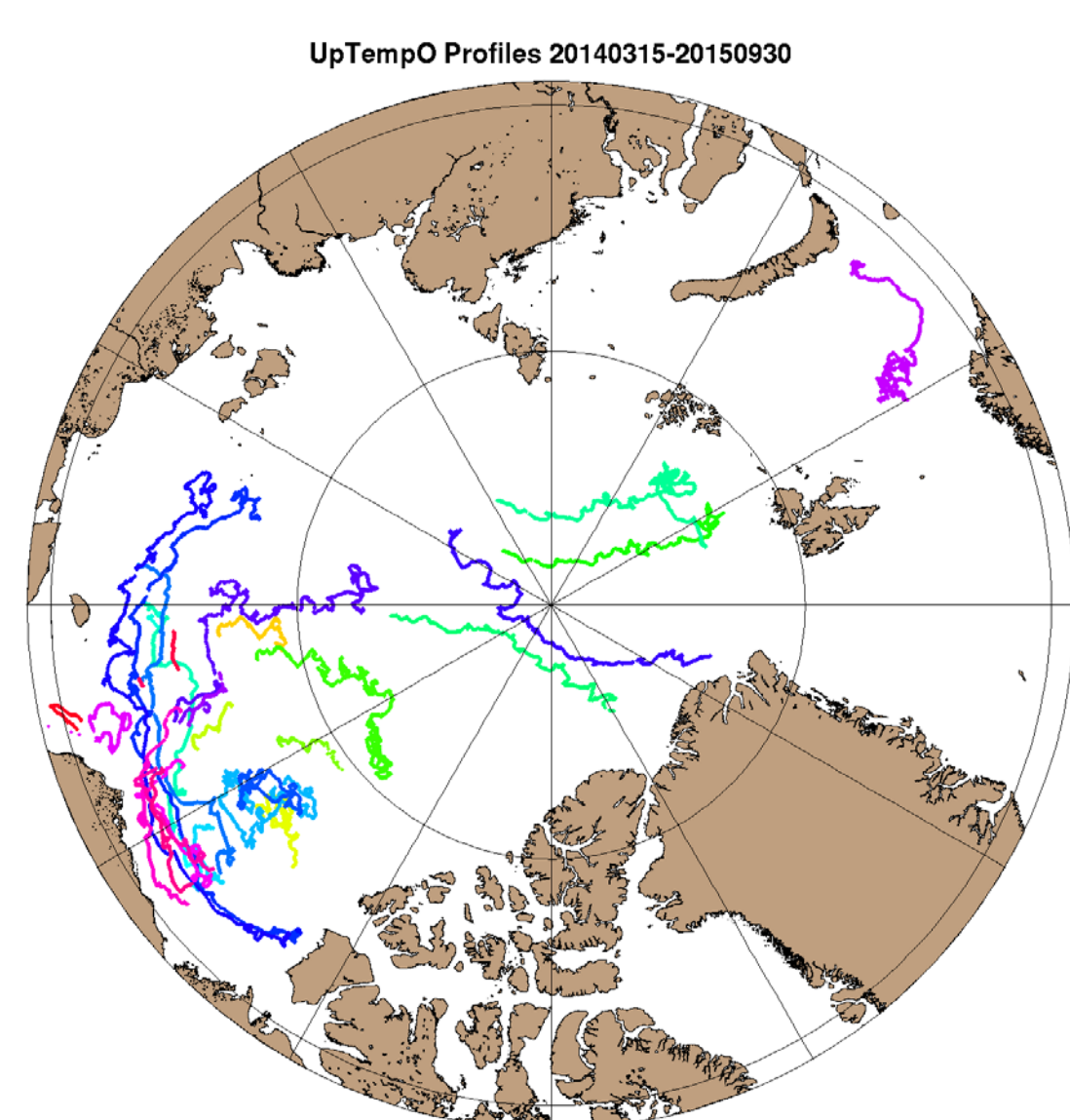
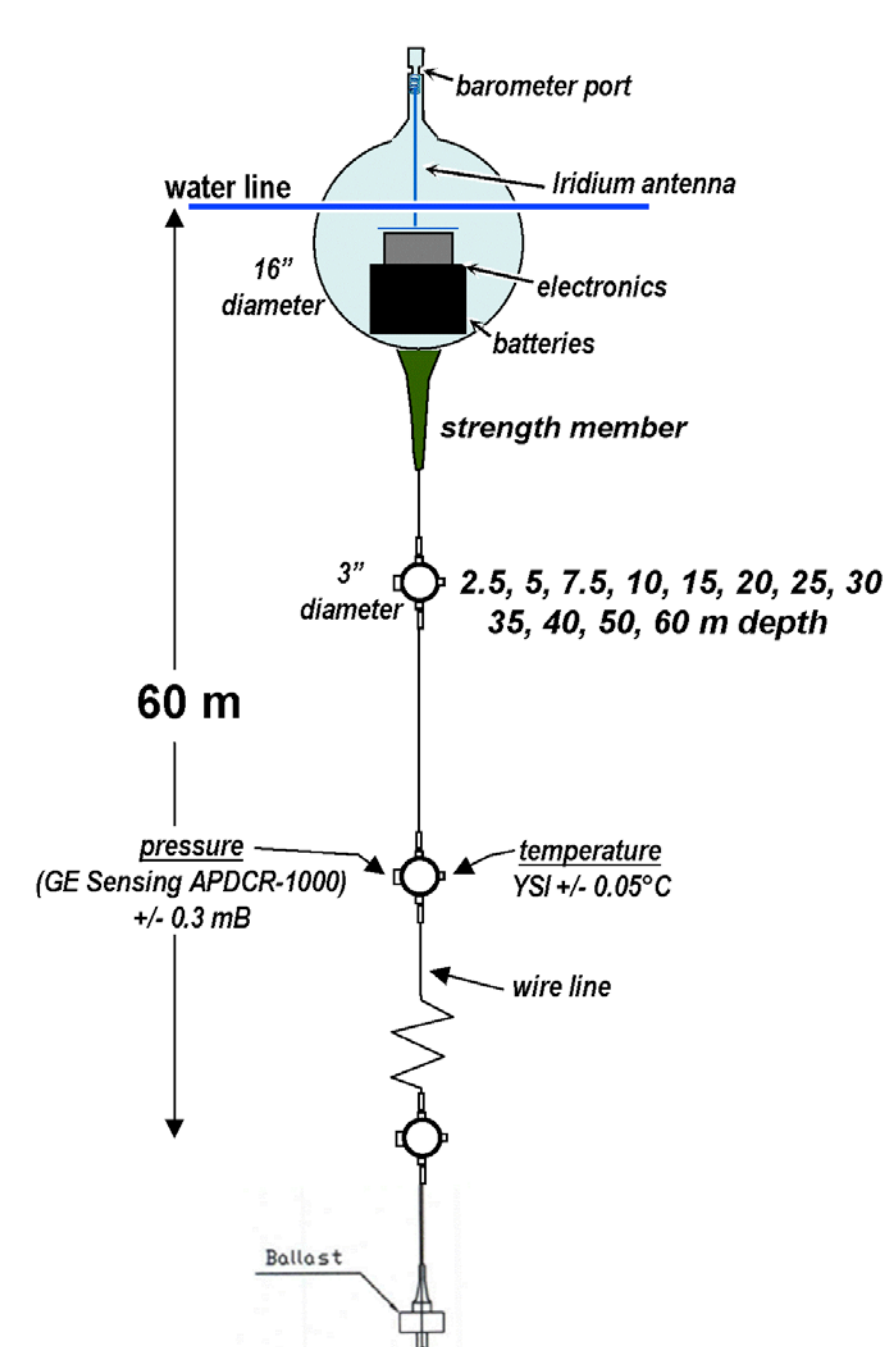


Grid Resolution: ~3.5 km North Pole  
Black line is the independent ice  
edge location (NIC).

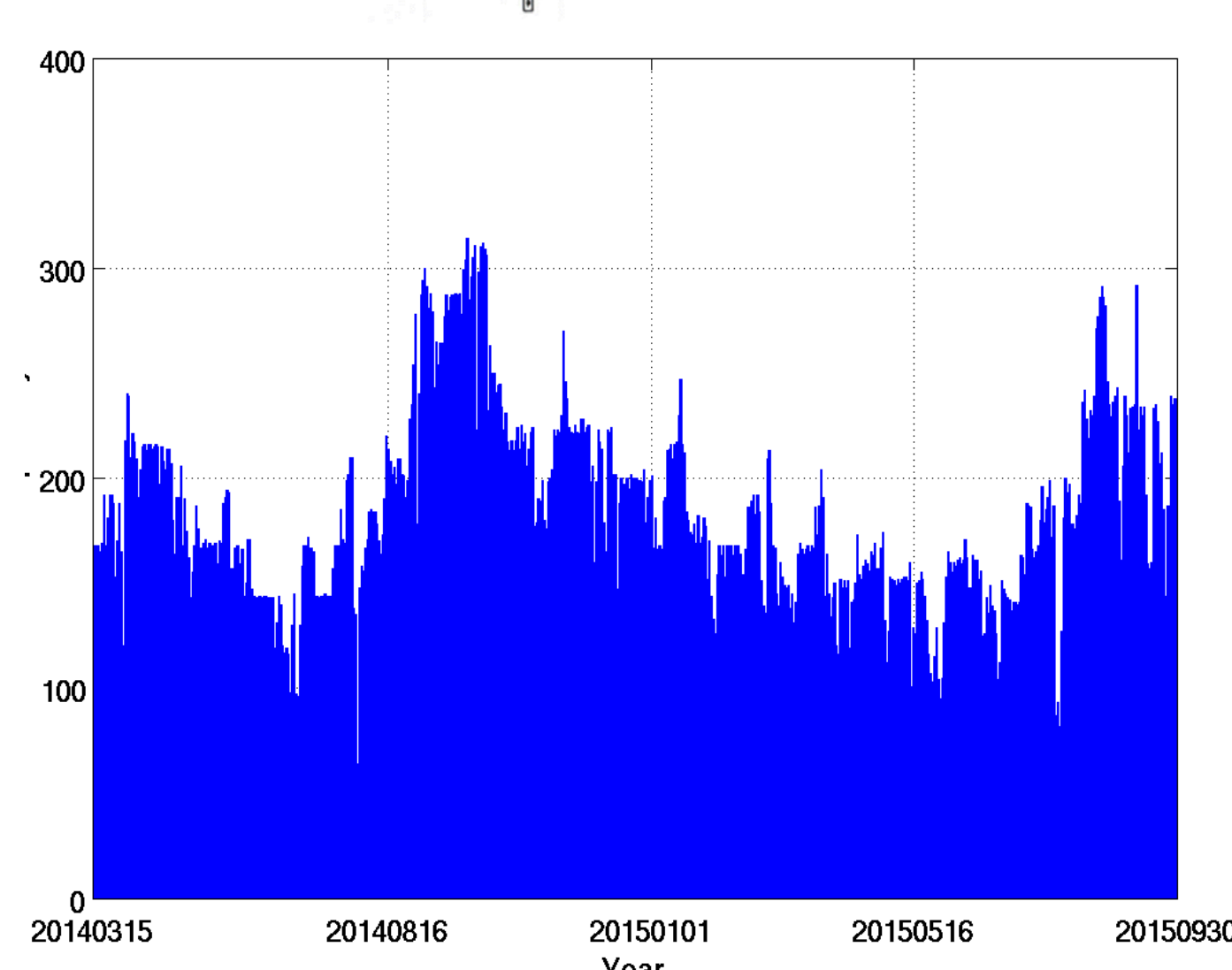
## Upper Temperature of the polar Oceans (UpTempO)

<http://psc.apl.washington.edu/UpTempO/>

### Standard UpTempO Buoy Configuration



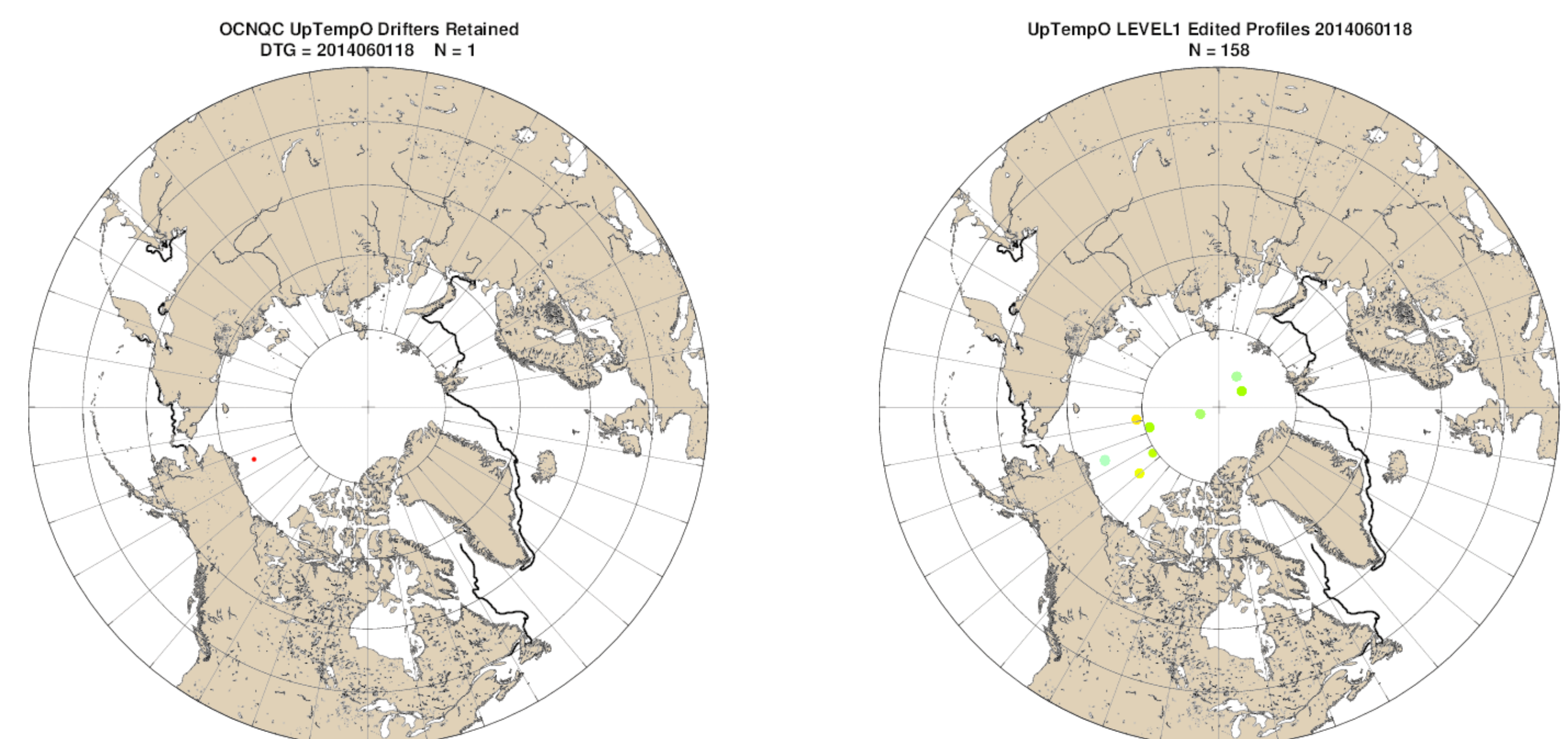
UpTempO Buoy Tracks  
2014-2015



# UpTempO profiles reported  
in GTS 03/2014-09/2015

## Real-time Handling of UpTempO Buoys

Even though UpTempO buoys report hourly, most profiles are not output from NCODA\_QC and are, therefore, not available to NCODA for inclusion in the Arctic Ocean analysis. Some of these do not even survive the real-time data handling system



UpTempO profile distribution from the real-time ocean data processing and quality control system available for assimilation (left) and all UpTempO profiles reported for the same assimilation period (right). Left panel color-coded by NCODA profile type (drifting buoys that have been confirmed to be UpTempO buoys). Right panel color-coded by PSC/API/UW-assigned UpTempO buoy number.

## Analysis/Forecast Experiments

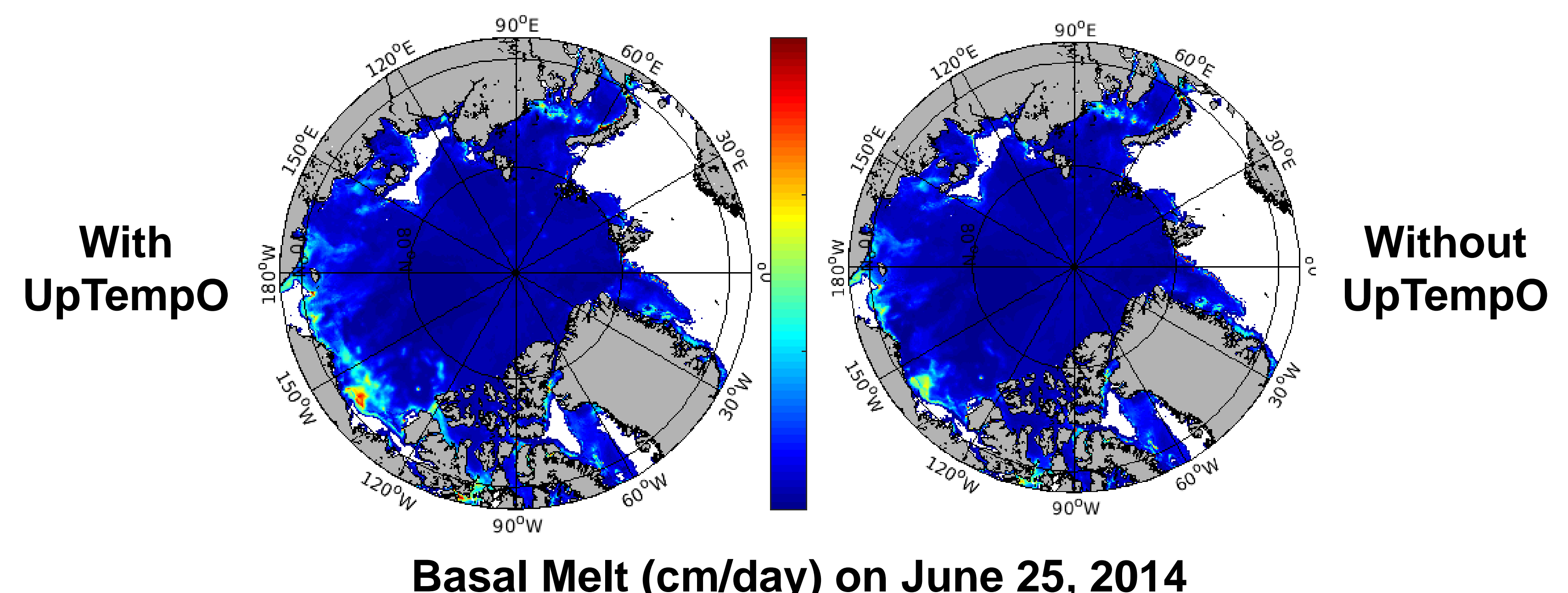
Initialized ACNFS with CryoSat2-NASA ice thickness

Performed hindcast study for a 16-month period beginning May 29, 2014 (two melt seasons). Two hindcasts:

- 1) Control run without UpTempO
- 2) Same as 1 but with inclusion of UpTempO after reprocessing all UpTempO profiles for input to NCODA\_QC and some modifications to NCODA profile selection algorithm.

## Preliminary Results

After one month of UpTempO buoy assimilation, differences in ice thickness remain small, but basal melt differences (below) indicate increased impact as the hindcast experiment integrates forward in time.



Basal Melt (cm/day) on June 25, 2014

## Continuing Efforts

Quantitative analysis of impact of *in situ* data on Arctic ice-ocean short-term forecasts

Investigate and remedy pre-NCODA\_QC procedure to ensure good Arctic Ocean *in situ* observations do not get discarded.

Optimize NCODA configuration for inclusion of shallow profiles where available and where they have impact.

## References

- Allard, R. A., S. Farrell, D. Hebert, W. Johnston, L. Li, N. Kurtz, M. W. Phelps, P. G. Posey, R. Tilling, A. Ridout, A. J. Wallcraft. Utilizing CryoSat-2 Sea Ice Thickness to Initialize a coupled Ice-Ocean Modeling System. *Adv. Space Research* (in revision).
- Castro, S.L., G.A. Wick, and M. Steele, 2016. Validation of satellite sea surface temperature analyses in the Beaufort Sea using UpTempO buoys. *Remote Sensing of Environment*, 187, 458-475.
- Hebert, D. A., Allard, R.A., Metzger, E.J., Posey, P.G., Preller, R.H., Wallcraft, A.J., Phelps, M.W., Smedstad, O.M., 2015. Short-term sea ice forecasting: An assessment of ice concentration and ice drift forecasts using the U.S. Navy's Arctic Cap Nowcast/Forecast System. *J. Geophys. Res. Oceans*, 120, 8327-8345. doi:10.1002/2015JC011283.
- Posey, P. G., Metzger, E.J., Wallcraft, A.J., Hebert, D.A., Allard, R.A., Smedstad, O.M., Phelps, M.W., Fetterer, F., Stewart, J.S., Meier, W.N., Helfrich, S.R., 2015. Assimilating high horizontal resolution sea ice concentration data into the US Navy's ice forecast systems: Arctic Cap Nowcast/Forecast System (ACNFS) and the Global Ocean Forecast System (GOFS 3.1). *The Cryosphere* 9 2339-2365. doi: 10.5194/tcd-9-2339-2015.