

An Assessment of the Navy's Sea Ice Outlook Predictions for 2014

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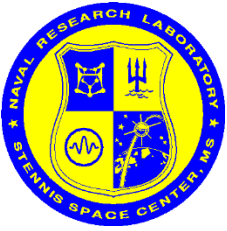
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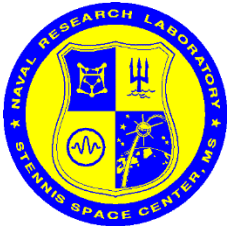
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Outline

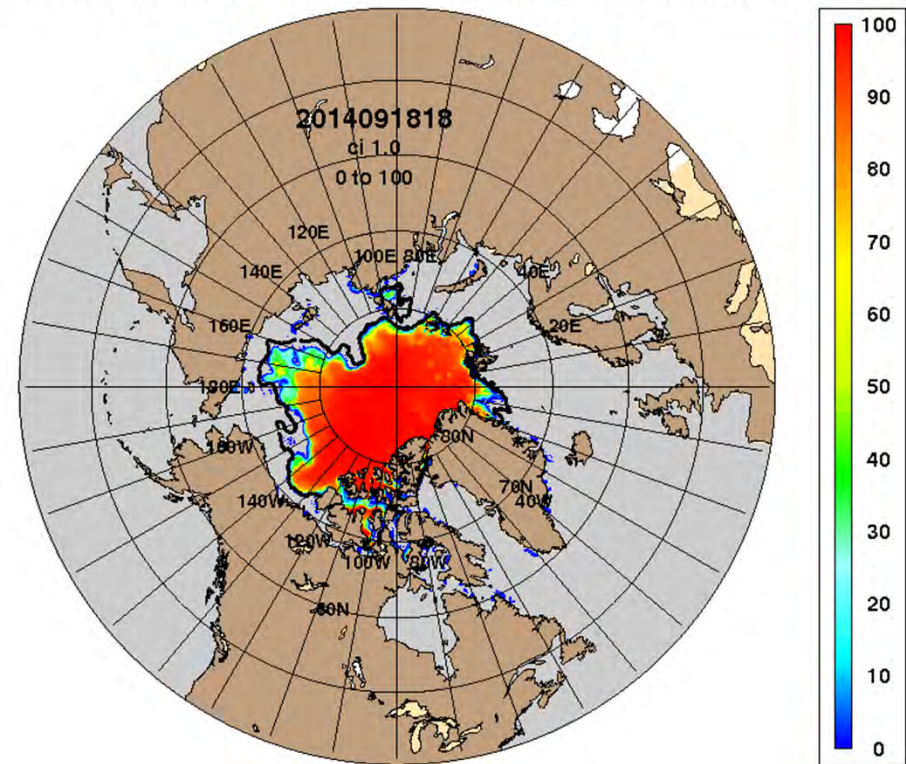
- Systems Overview
 - Arctic Cap Nowcast/Forecast System (ACNFS)
 - Global Ocean Forecast System (GOFS 3.1)
- Observed Ice Extent
- Sea Ice Outlook Estimates
- Future Plans



Arctic Cap Nowcast/Forecast System (ACNFS)

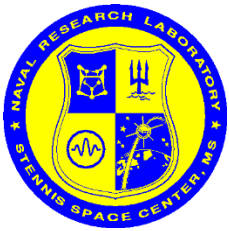
- ACNFS consists of 3 components:
 - Ice Model:** Community Ice CodE (CICE)
 - Ocean Model:** HYbrid Coordinate Ocean Model (HYCOM)
 - Data assimilation:** Navy Coupled Ocean Data Assimilation (NCODA)
- Declared operational Sept 2013
- Runs daily at the Naval Oceanographic Office (NAVOCEANO) – Stennis Space Center, MS
- ACNFS produces nowcast/7-day forecasts of ice concentration, ice thickness, ice drift, sst, sss and ocean currents
- Products pushed daily to the U.S. National Ice Center (NIC) and NOAA

ARCc0.08-03.9 Ice Concentration (%): 20140916



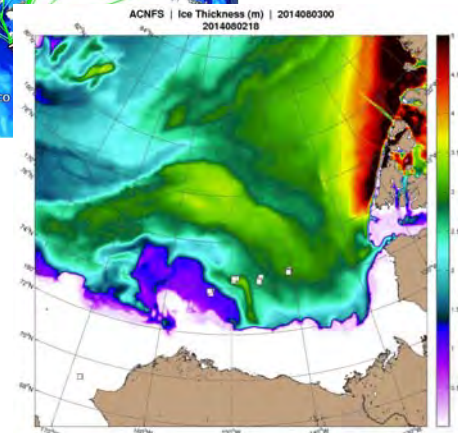
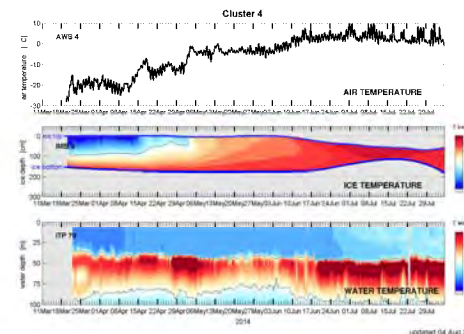
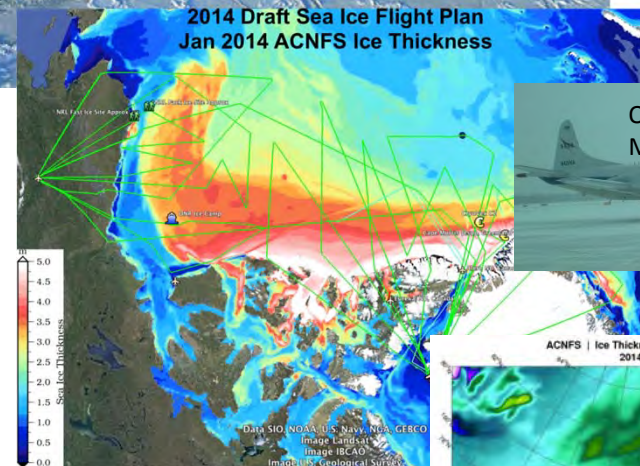
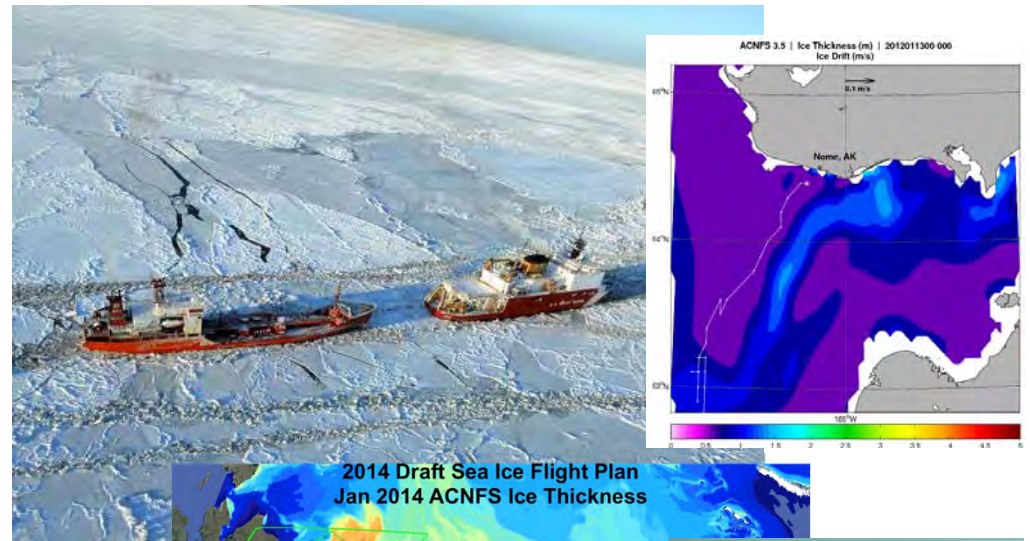
Grid Resolution ~3.5 km North Pole

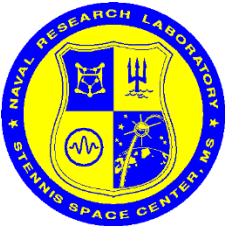
Dark line is the independent ice edge location from the National Ice Center (NIC).



ACNFS Used in Special Mission Support

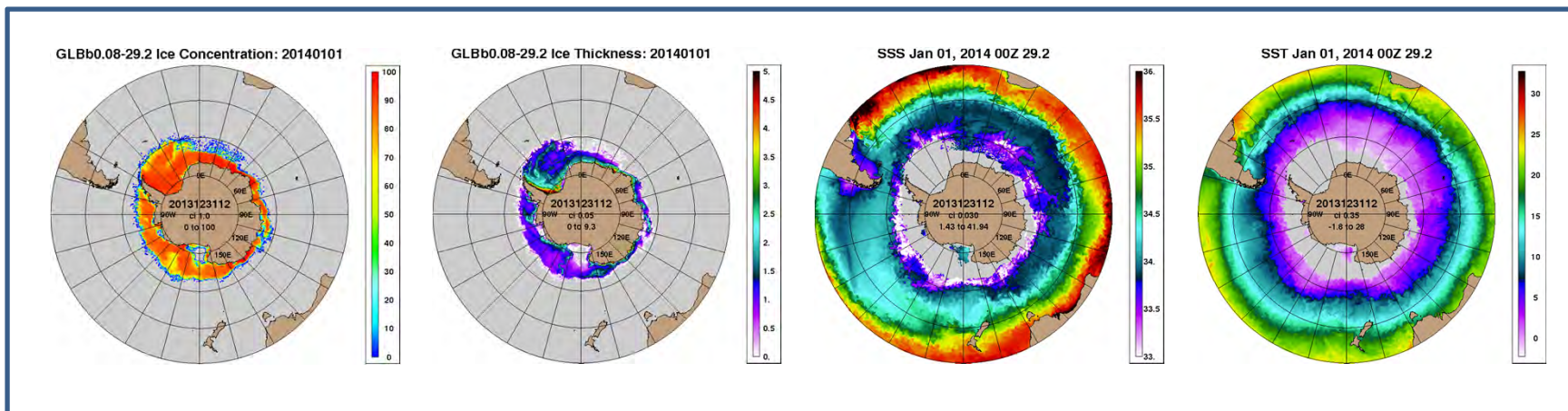
- Nov 2011-Jan 2012: ACNFS products provided guidance for convoy (CG Healy and Russian tanker) to deliver 103 M gallons of fuel to Nome, Alaska
- Provided ACNFS products to assist in 2014 NASA Operation IceBridge pre-flight planning
- Provided ice forecast products to ONR Marginal Ice Zone (MIZ) field work in Beaufort Sea region





Global Ocean Forecast System (GOFS 3.1)

- 1/12° global two-way coupled HYCOM-CICE modeling system with data assimilation
 - Transitioned to NAVOCEANO on 26 Sept 2014
 - Uses HYCOM/CICE/NCODA like ACNFS but with improved HYCOM and NCODA
 - After GOFS 3.1 becomes operational, it will replace ACNFS
 - Added capability of forecasting ice conditions in the southern hemisphere



**Ice
Concentration**

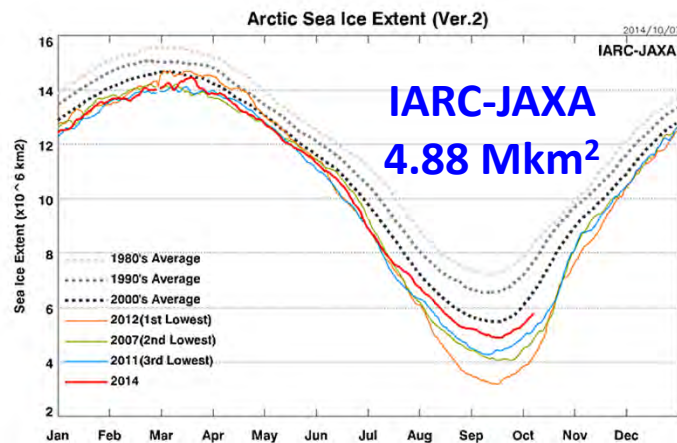
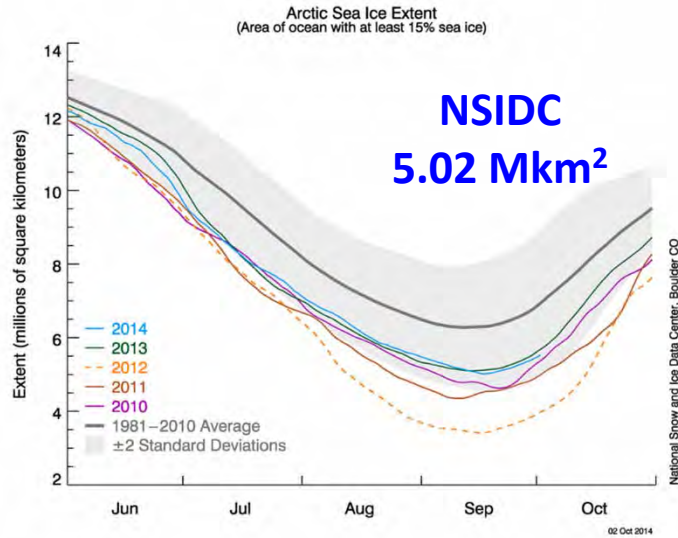
**Ice
Thickness**

**Sea Surface
Salinity**

**Sea Surface
Temperature**

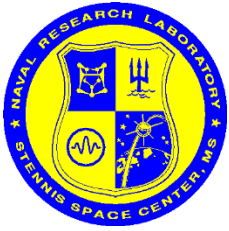


Minimum 2014 Sea Ice Extent



Minimum Sea Ice Extent for last 10 years

Year	Minimum (Mkm ²)	Date Reached
2014	5.02	Sept 17
2013	5.10	Sept. 13
2012	3.41	Sept 16
2011	4.33	Sept 9
2010	4.90	Sept 19
2009	5.10	Sept 12
2008	4.67	Sept 15
2007	4.28	Sept 19
2006	5.70	Sept 14
2005	5.32	Sept 21



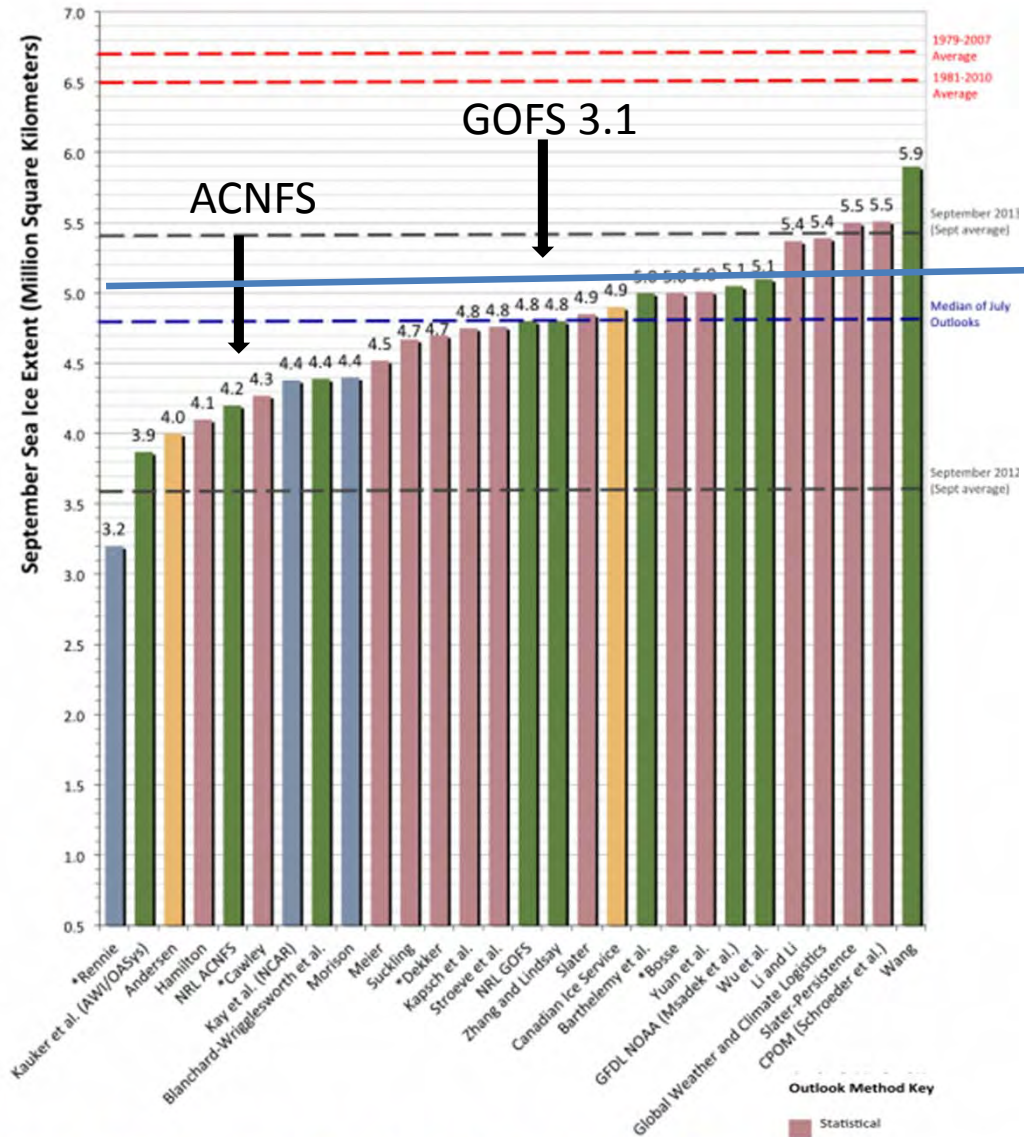
Sea Ice Prediction Network (SIPN)

Sea Ice Outlook 2014

- Community wide summary of expected September Arctic sea ice extent minimum
- NRL ACNFS and GOFS 3.1 ensemble initialized from a single sea ice analysis: May 1, June 1 and July 1, 2014
- Forced by different years of NOGAPS atmospheric forcing (2004-2013)
- To calculate the ACNFS/GOFS 3.1 minimum September sea ice estimate:
 - Used all grid cells with at least 15% ice concentration
 - Calculated the daily mean ensemble value
 - Used minimum September value as estimate



2014 Sea Ice Outlook: July Report



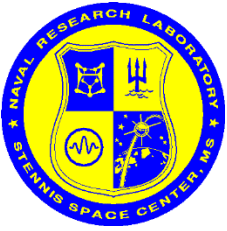
**Observed
2014 Sept
Minimum-
5.02 Mkm²**

<http://www.arcus.org/sipn/sea-ice-outlook>

October 22-24, 2014

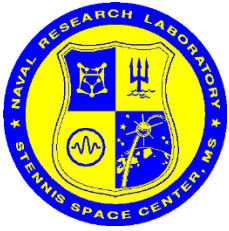
3rd FAMOS Workshop

Outlook Method Key
 Statistical
 Modeling
 Heuristic
 Mixed/Multiple Method



Bias Corrections

- ACNFS/GOFS 3.1:
 - Models have been run in data assimilative mode
ACNFS: July 2007 - present
GOFS 3.1: August 2011 - present
 - Analysis fields from these data assimilation runs were used to identify ensemble forecast model biases in Sept ice extent.
 - For 2014 Outlook, ACNFS used an averaged bias of -2.0 Mkm^2 ; GOFS 3.1 used 0.4 Mkm^2 .
 - GOFS 3.1 bias was calculated over fewer years (3 vs 7) and is less certain



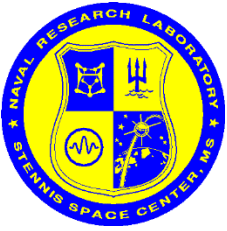
Sea Ice Prediction Network (SIPN)

Sea Ice Outlook 2014

- ACNFS/GOFS 3.1 ensemble September sea ice extent (Mkm²):

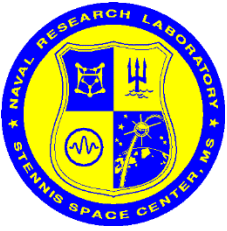
Dates	ACNFS	GOFS
	Ensemble Minimum	Ensemble Minimum
May 1, 2013	4.2 ± 0.5	----
June 1, 2013	4.2 ± 0.5	4.8 ± 0.4
July 1, 2013	4.1 ± 0.5	4.5 ± 0.3

- 2014 minimum extent of 5.02 Mkm² observed on 17 September.



Summary

- On average/after bias correction, ACNFS predicted a minimum sea ice extent of 4.2 Mkm², while GOFS 3.1 predicted 4.7 versus observed 5.02 Mkm²
- Little difference in ACNFS results regardless of which month ensemble runs were initialized (May, June and July)
- GOFS 3.1 minimum decreased slightly from June 1 and July 1 simulations



Future Plans

- Navy is interested in seasonal forecasts for ice covered regions.
 - Investigate methods to improve 3-4 month forecast skill for both ACNFS and GOFS 3.1
 - Run a data assimilative re-analysis of GOFS 3.1 from 2004 forward
 - Longer control run for GOFS 3.1 will produce a more accurate bias

Thank you!
Questions?

