

Short-term sea ice forecasts with the RASM-ESRL coupled model

A testbed for improving simulations of ocean-ice-atmosphere interactions in the marginal ice zone

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OUTLINE

- Our Forecast Strategy & Goals
- What is RASM-ESRL and How We are Using It
- Real-Time Experimental Forecasts in Support of SeaState
- Validation (DOE/ARM, IASOA, IABP)
- Next Steps

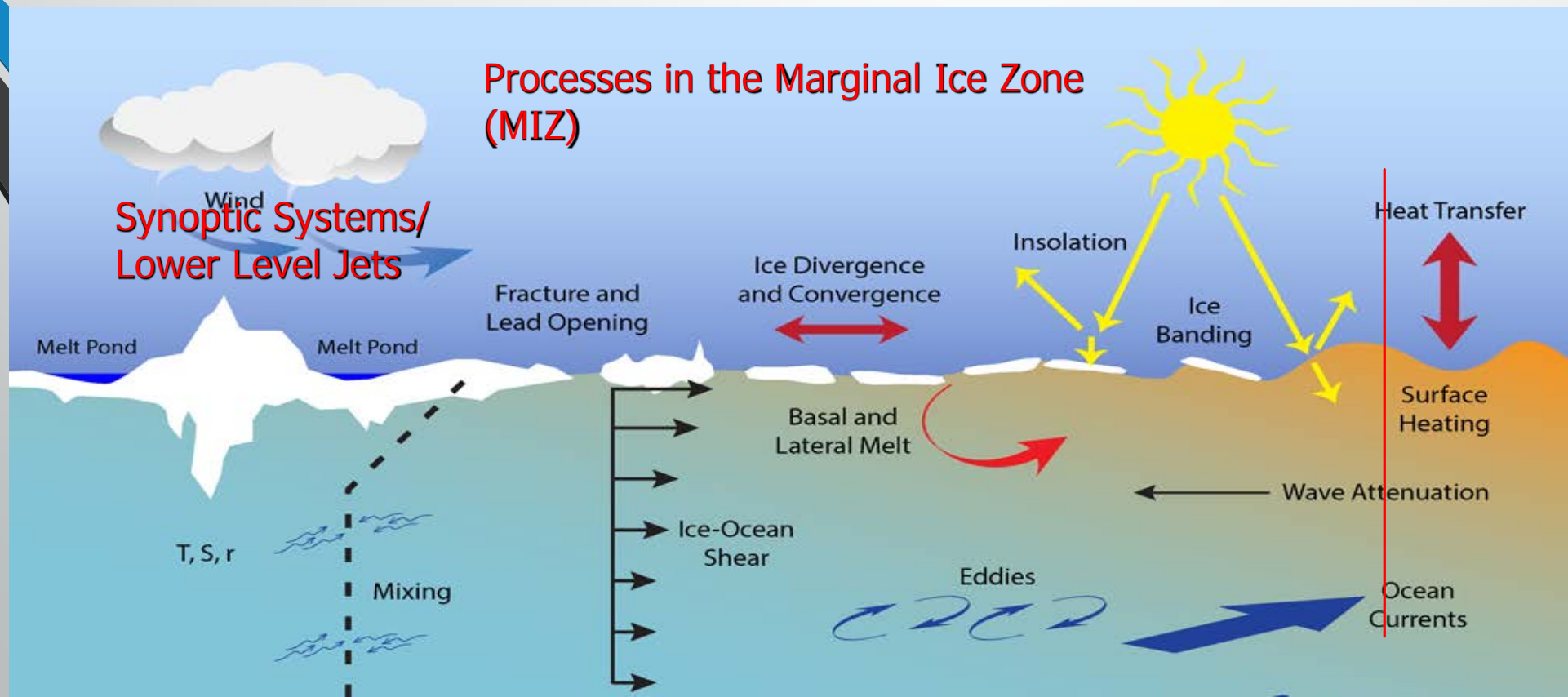
FOCUS ON HYPOTHESIS TESTING

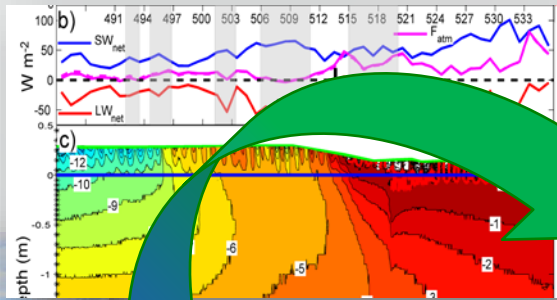
Why short-term?

ESPC greatest prediction challenge: **10-100 day gap in predictive capability**

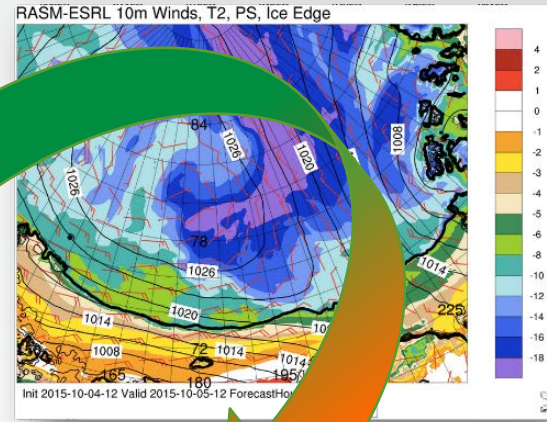
Our Working Hypothesis:

Many longer-term biases are due to "fast processes"





Utilize previously obtained obs of the Arctic atmosphere, BL, & ice-ocean interface as a basis of initial hypothesis testing

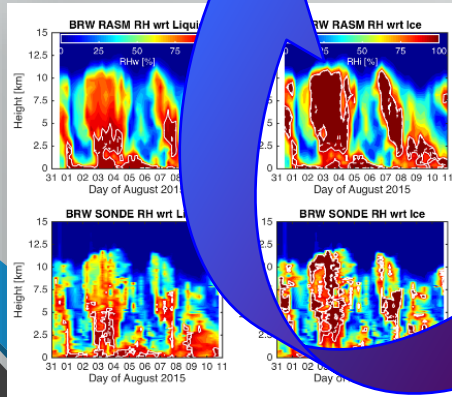


Analysis of atmospheric & oceanic influences on sea ice evolution, model skill, etc.

PROJECT STRATEGY
 [GOAL] Improve understanding of the physical processes that impact sea ice formation [APPROACH] through delivery of an experimental sea ice forecast

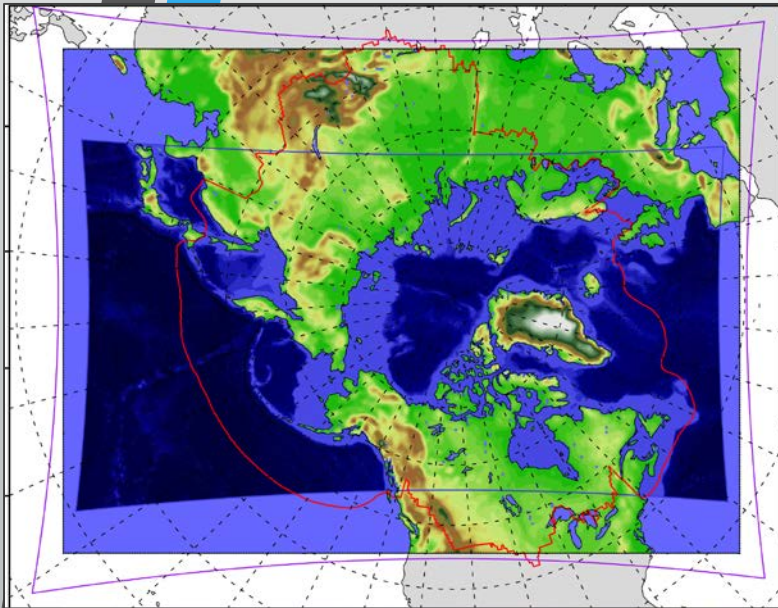
Produce experimental coupled model forecasts for delivery to ship for operations & to the Arctic Testbed for operational needs & usage information

Obtain in situ observations from the 2015 freeze-up for model initialization, real time verification, & validation of sea ice evolution



ADAPTING RASM-ESRL for SEA ICE FORECASTING

RASM-ESRL is a modified version of RASM (Maslowski et al. 2012): includes the WRF atmosphere model, LANL CICE₅ sea ice & mixed-layer ocean models, & the NCAR CLM₄ land surface model. All components are run at 10km horizontal grid and the WRF model is run with 40 vertical levels.



Regional Arctic System Model (RASM)

Focus on climate simulations

Includes all Arctic drainages and mid-latitude storm tracks

Medium-range atmosphere resolution (50km)

No initialization of sea ice

RASM-ESRL

Focus on short-term forecasting

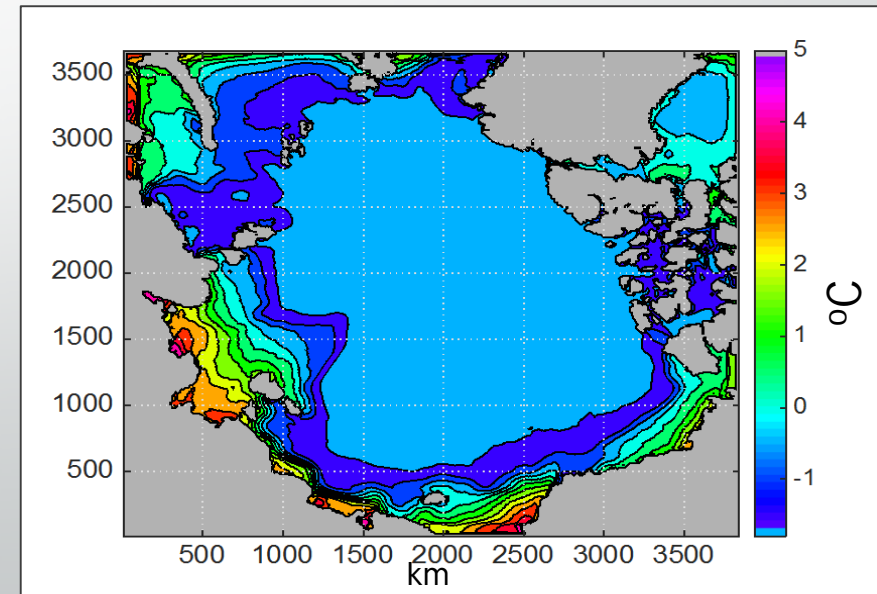
Centered on Arctic Basin

High-resolution components (10km)

Mixed-layer ocean

Initialized with GFS/AMSR₂ sea ice concentration

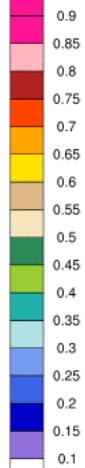
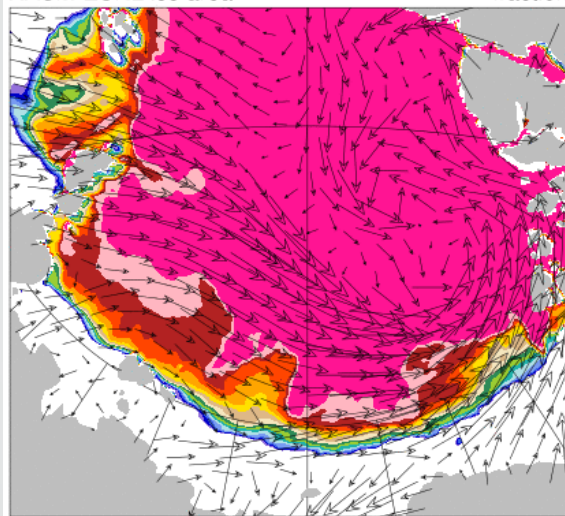
Forced by GFS 3-hourly forecasts at the lateral boundaries



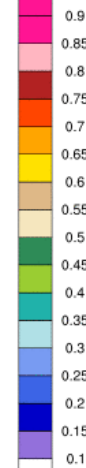
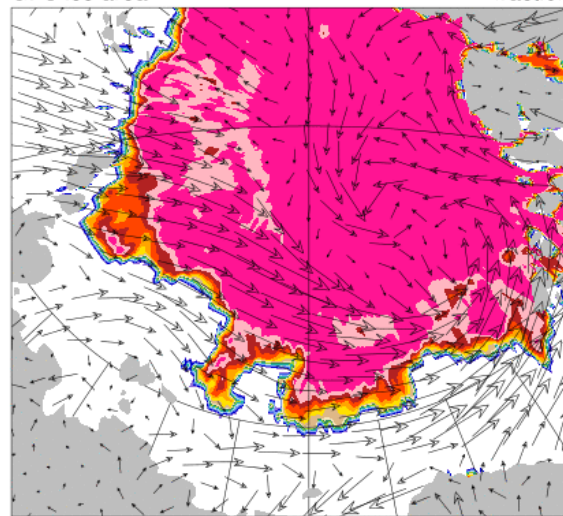
EXPERIMENTAL FORECASTS IN SUPPORT OF SEASTATE

NOAA/ESRL/PSD & CIRES/U. of Colorado Experimental Sea-Ice Forecast
InitDate 2015-10-02-43200 ValidDate 2015-10-02-64800 ForecastHour 6

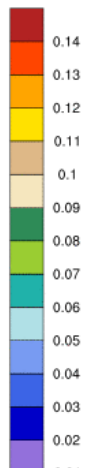
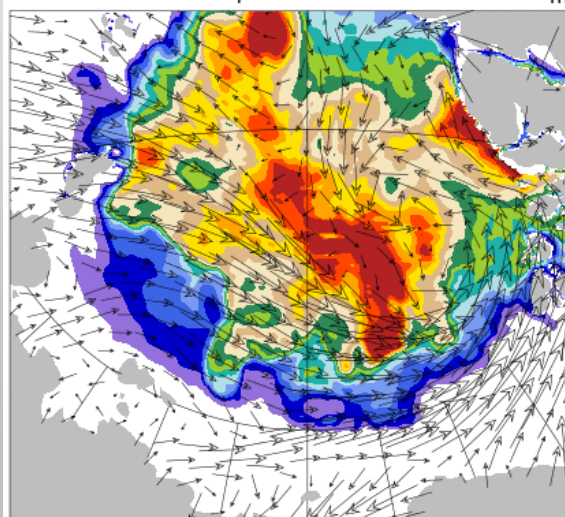
RASM-ESRL ice area fraction



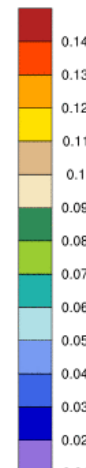
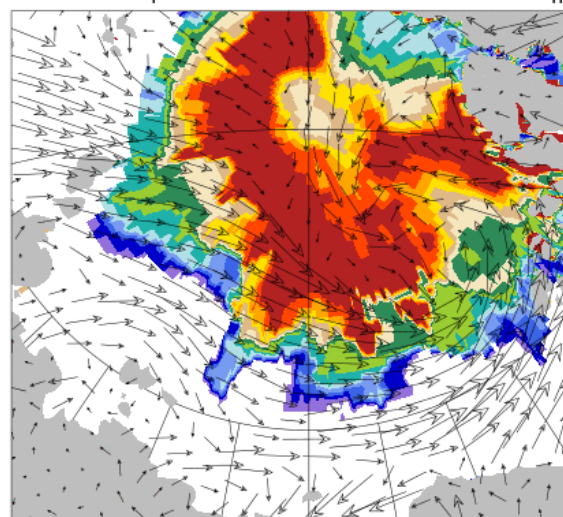
GFS ice area fraction



RASM-ESRL snow depth m



GFS snow depth m

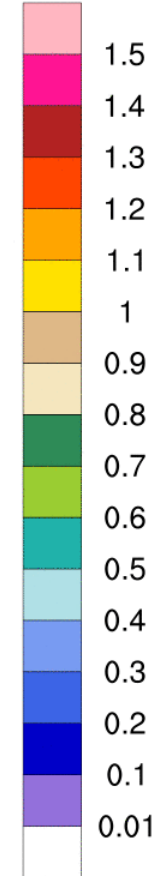
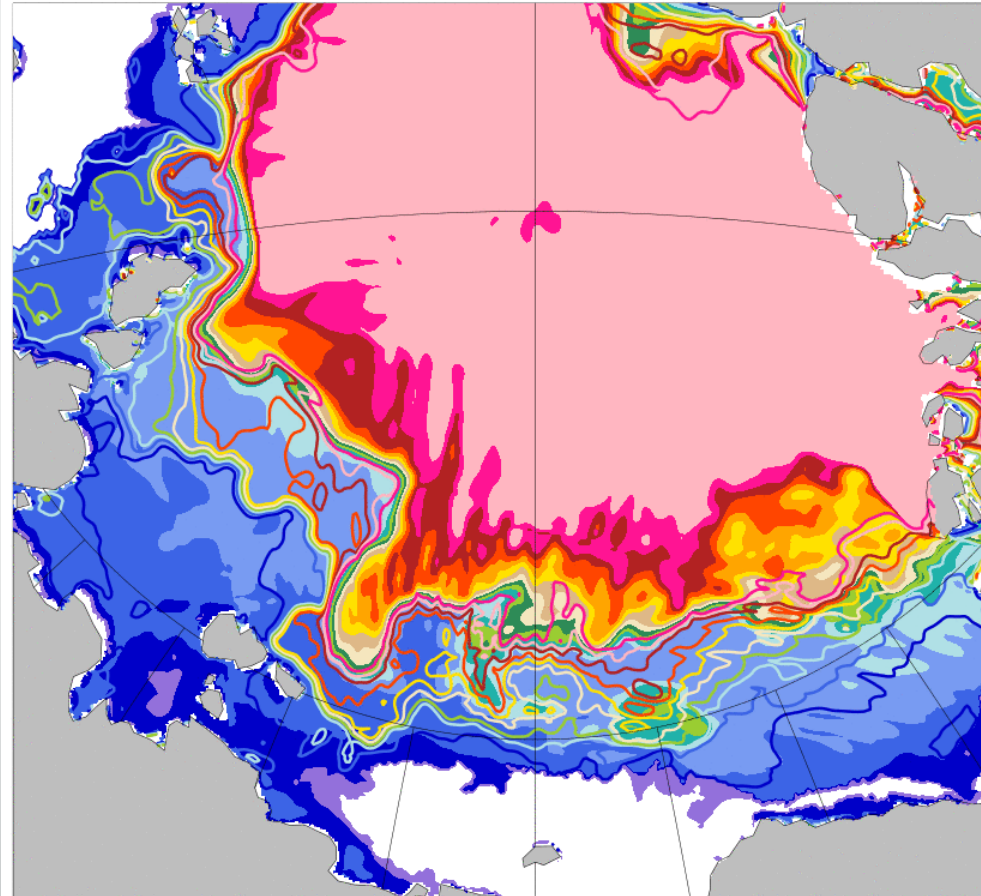


EXPERIMENTAL FORECASTS FOR NWS ICE DESK GUIDANCE

NOAA/ESRL/PSD & CIRES/U. of Colorado Experimental Sea-Ice Forecast
InitDate 2015-10-26-43200 ValidDate 2015-10-26-64800 ForecastHour 6

ice and snow thickness

m



CONTOUR FROM .01 TO .1 BY .01

RASM-ESRL FORECAST PROCESS & VALIDATION

Initialized at 12Z to produce daily 5-14 day forecasts --3 hr sea ice, 6 hr atmosphere

RASM-ESRL (WRF) is forced at the lateral boundaries by GFS 3-hourly forecasts of winds, temp, & water vapor

NOAA
NWS
soundings

IABP Psfc,
Tair, Tsfc
T2m



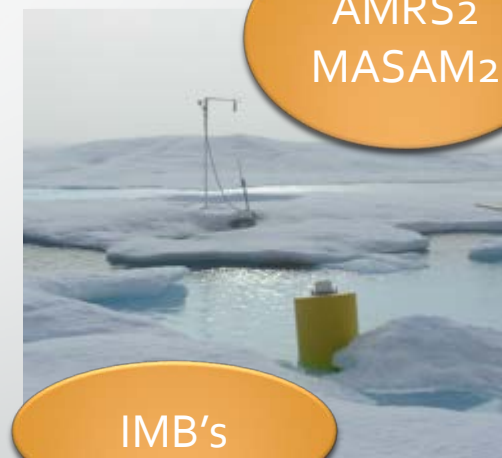
RASM-ESRL ocean mixed-layer is kept fixed at 20 m. Initialized SST (WRF Tskin) then integrated in time in ocean model

SeaState fluxes,
soundings, SST,
waves, CTD's +
previous cruises



RASM-ESRL (CICE5) ice concentration initialized by AMSR2

AMRS2
MASAM2



IMB's

Buoys,
gliders,
etc.

Satellite
SST

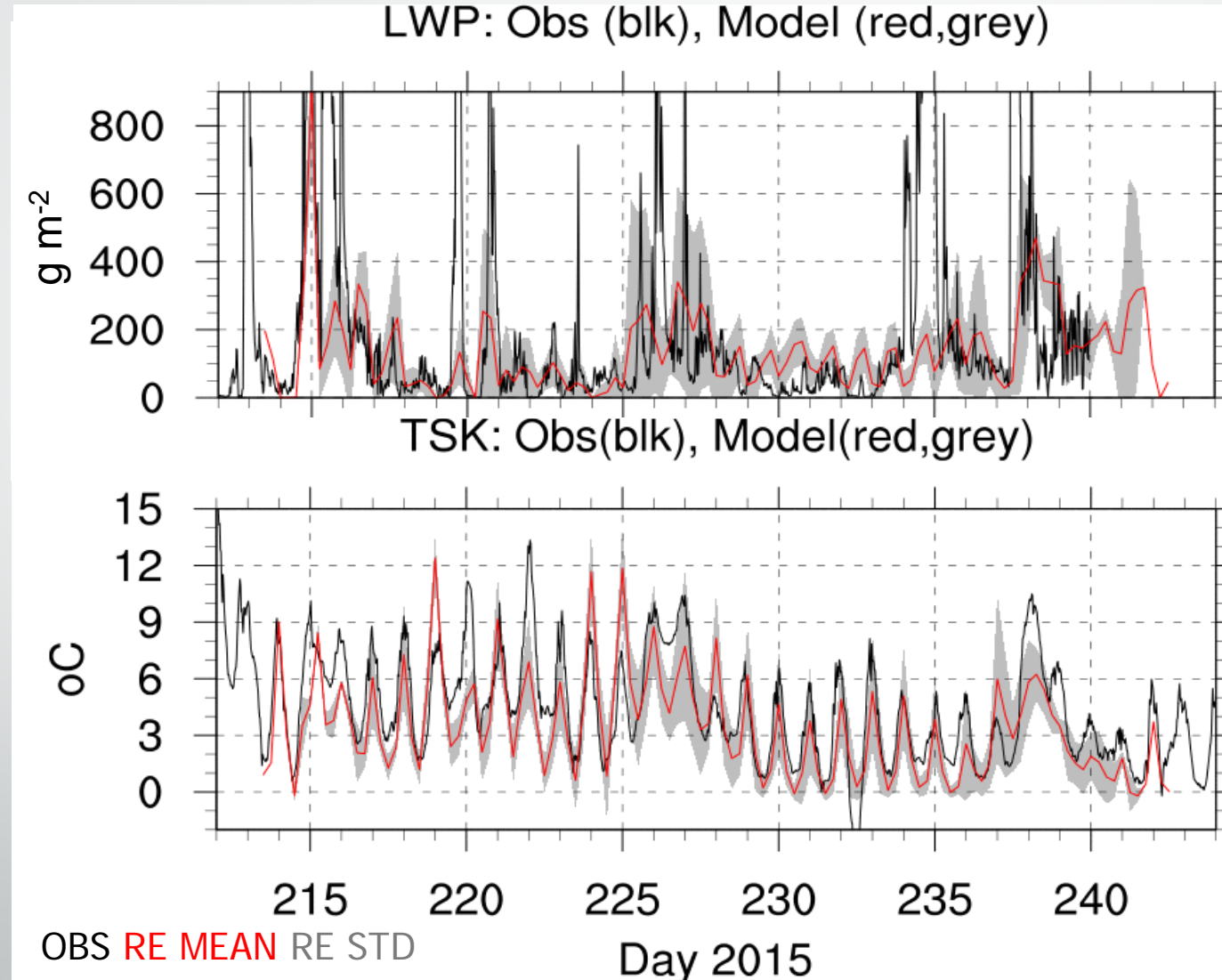


DOE ARM Barrow
& Oliktok Pt. radar
& radiometers

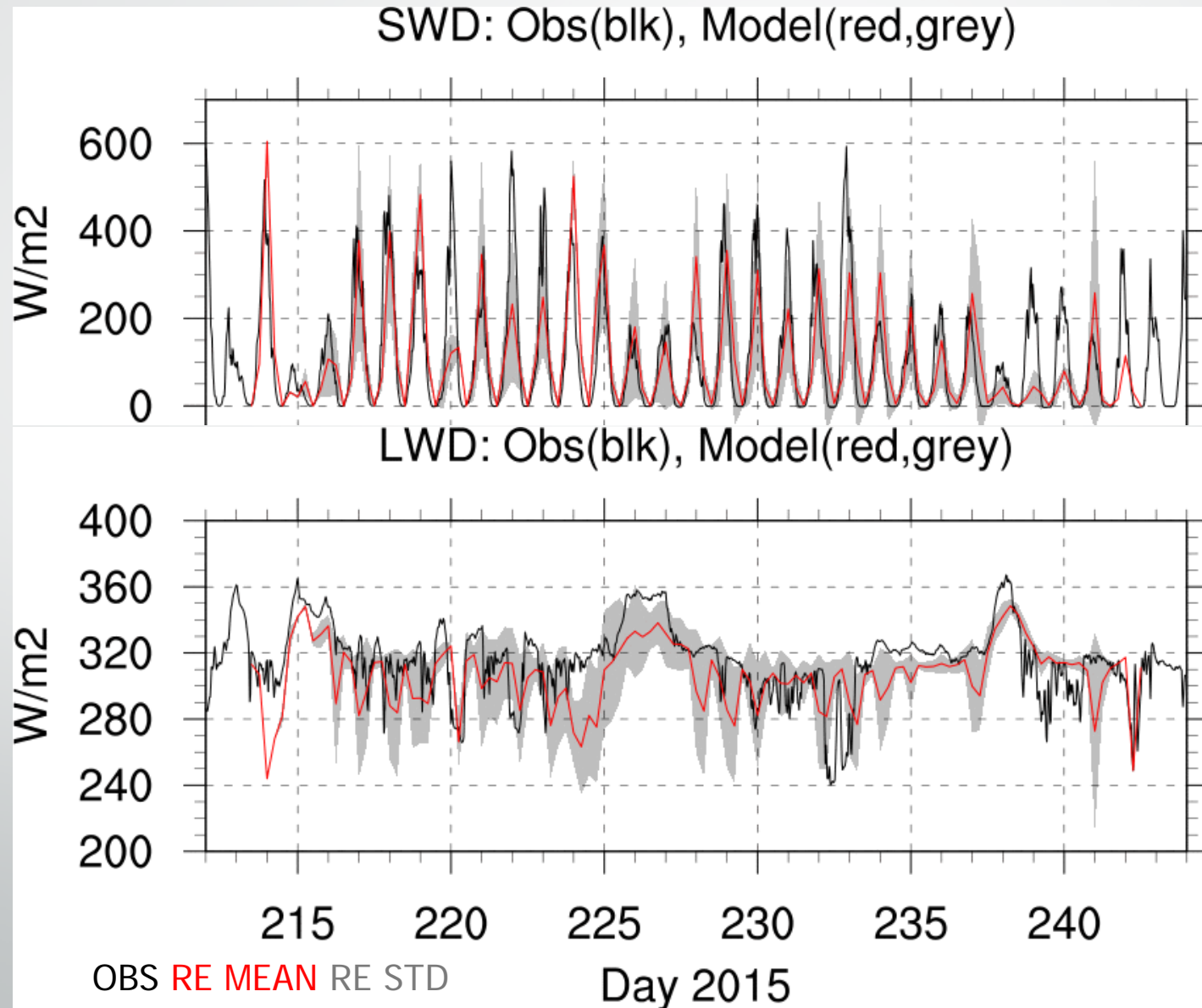
IASOA
radiative
fluxes



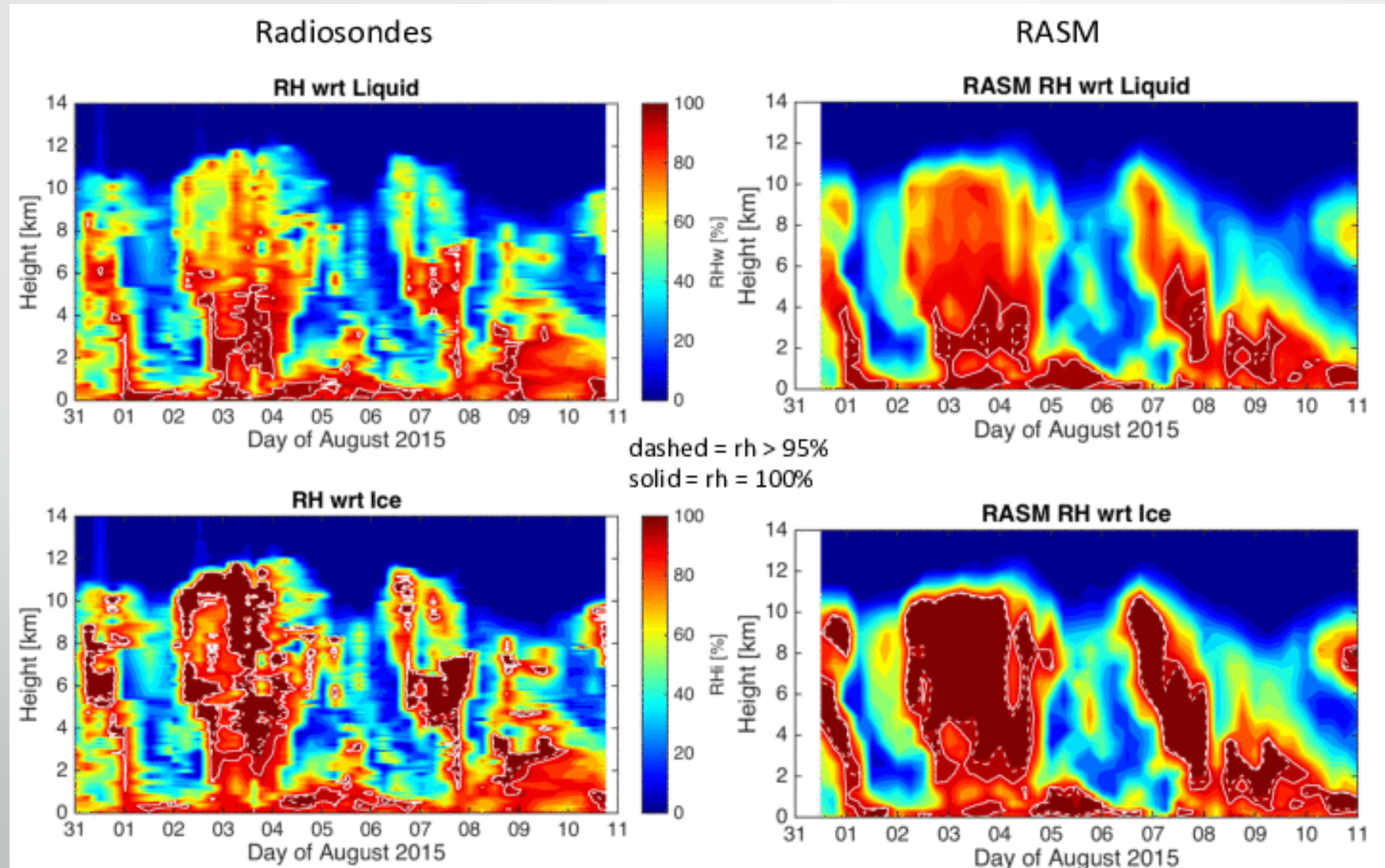
Validation at Barrow, Alaska: Liquid Water Path & Skin Temp from 15 13-day Hindcasts



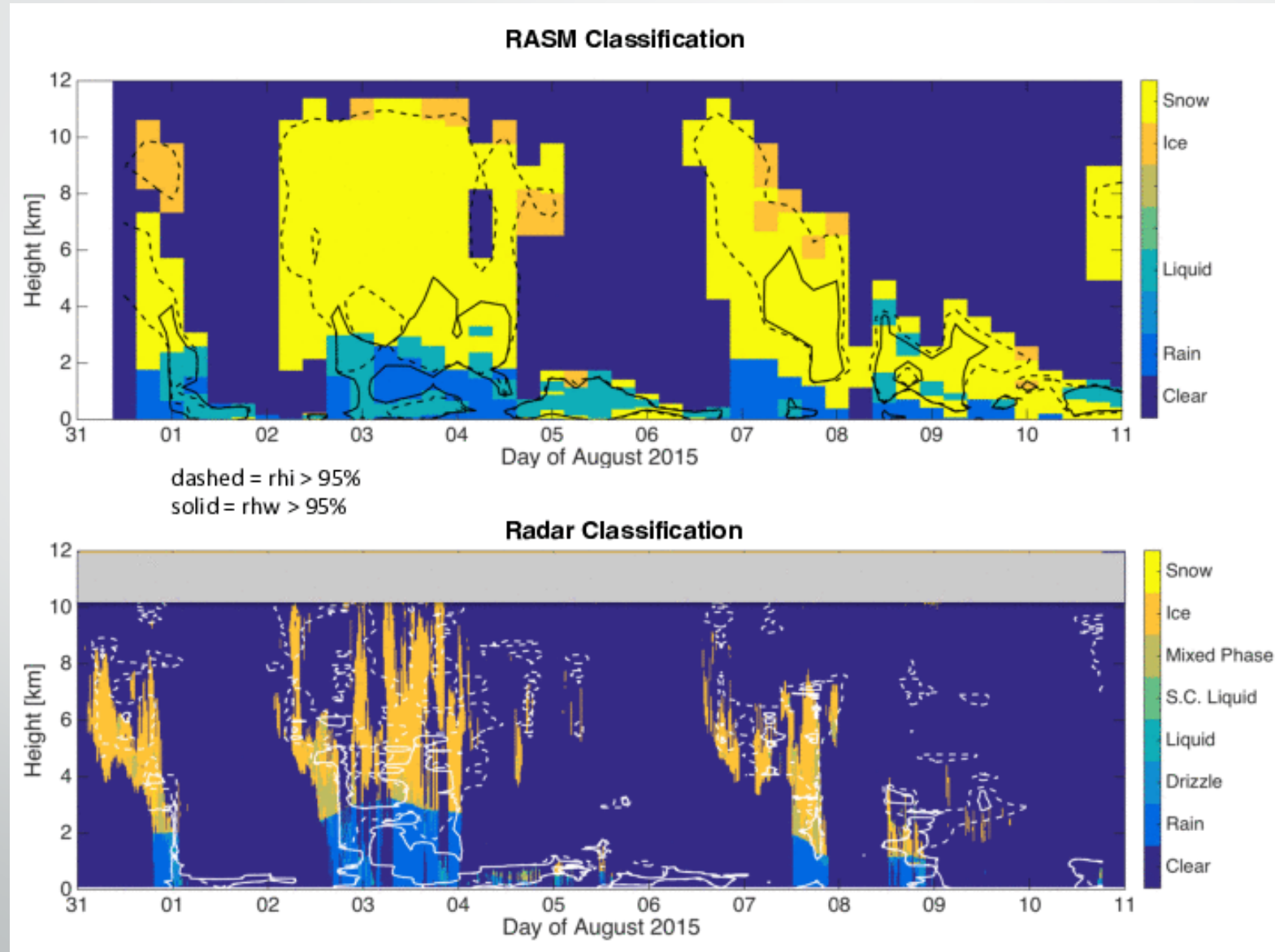
Validation at Barrow, Alaska: Downward Radiative Sfc Fluxes from 15 13-day Hindcasts



Hindcast Validation at Barrow, Alaska: Radiosondes

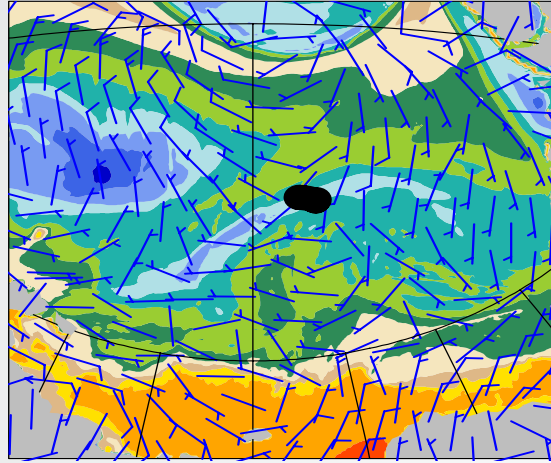


Hindcast Validation at Barrow, Alaska: Cloud Radar



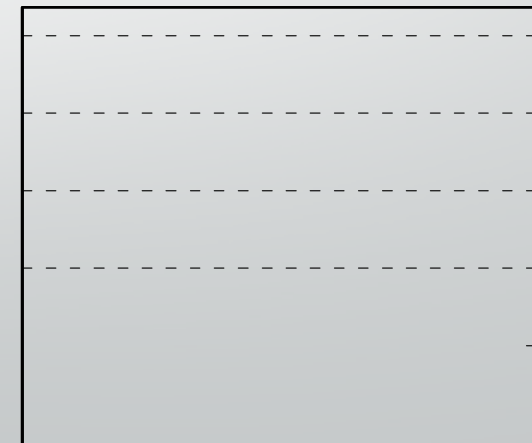
RASM-ESRL & GFS over Central Arctic (CA): Relative to IABP Ocean/Ice Buoys

● CA Buoy
RASM-ESRL
GFS-Forecast
GFS-Analysis



5 RASM-ESRL
Oct 16-20 2015
Daily Forecasts
Mean (solid)
1STD (dash)

Surface Temperature (°C)

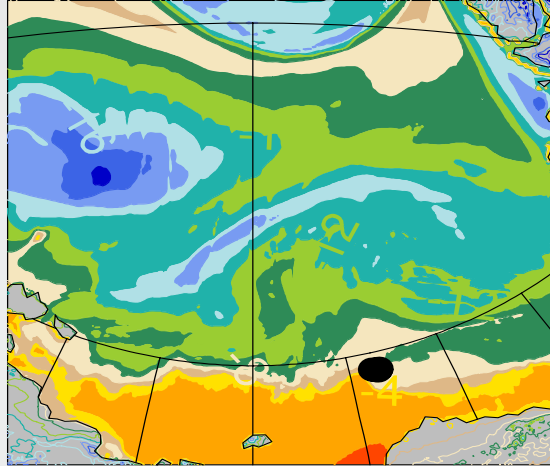


Oct 19

Oct 29

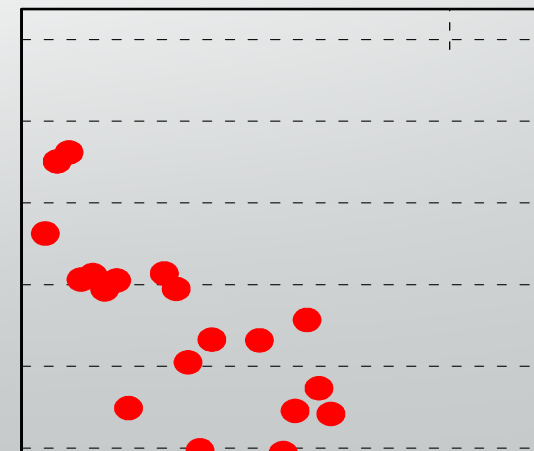
RASM-ESRL & GFS in Marginal Ice Zone (MIZ): Relative to IABP Ocean/Ice Buoys

● MIZ Buoy
RASM-ESRL
GFS-Forecast
GFS-Analysis



5 RASM-ESRL
Oct 16-20 2015
Daily Forecasts
Mean (solid)
1STD (dash)

Surface Temperature (°C)



Oct 19

Oct 29

Summary

- RASM adapted to produce wx-scale coupled model forecasts
- Delivered experimental sea ice forecasts during ONR SeaState
- Performing detailed model validation using observations of atmospheric fluxes, ocean temperatures, ice observations, etc.

Next Steps

- Analyze atmospheric, ocean, & ice processes
- Determine how to assess forecast skill & metrics
- Improve model; run experimental hind/forecasts
- Develop follow-on NWS testbed activity for fall freeze-up 2016
- Deliver experimental “Freezing Spray” model fields in 2016

Thank you to the RASM team for making the RASM model available for this study

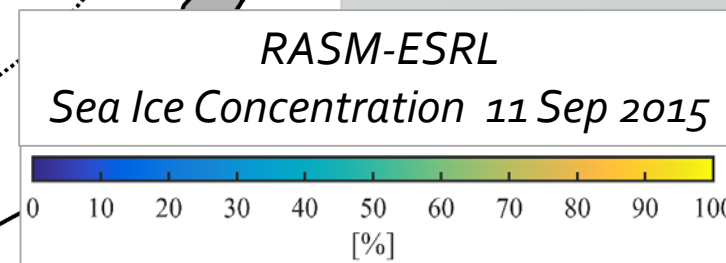
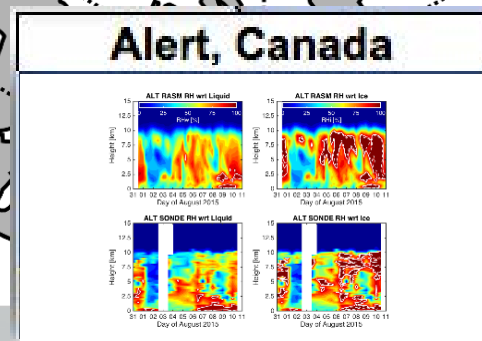
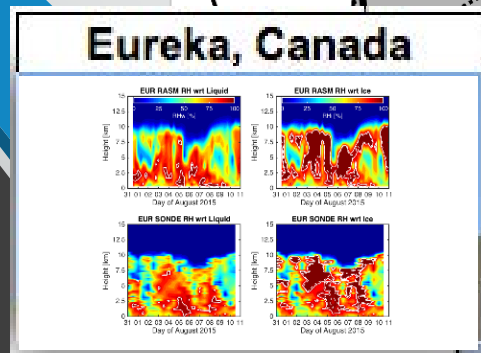
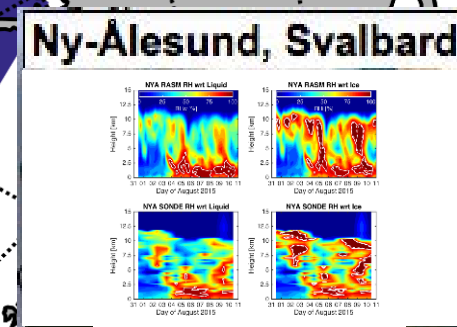
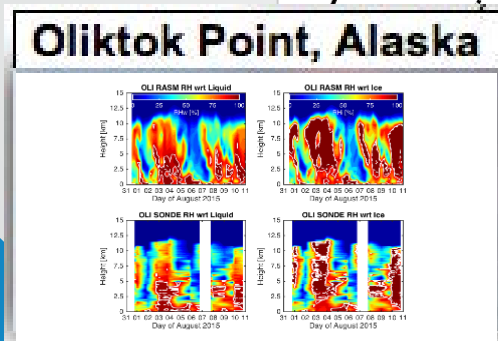
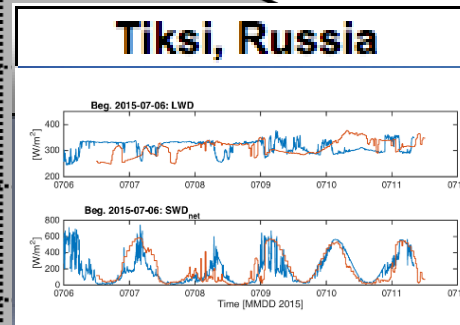
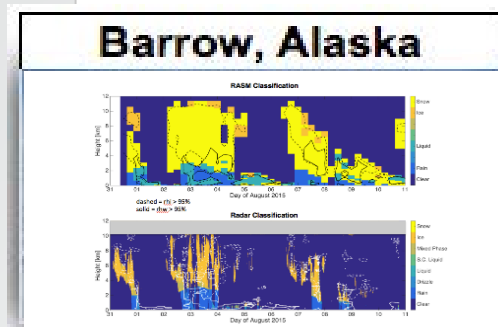
This research was funded by





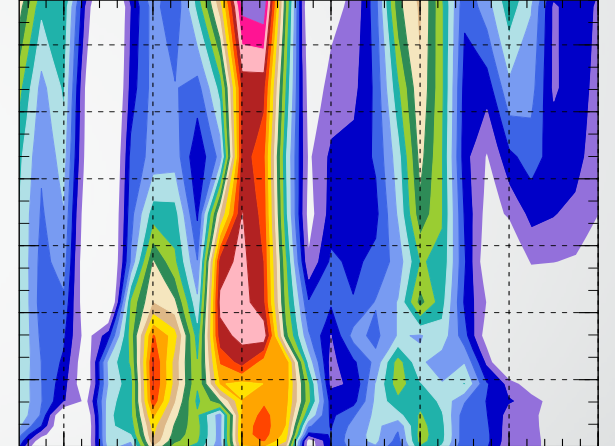
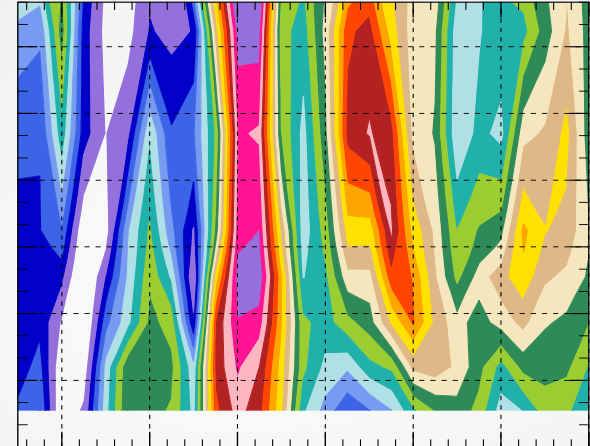
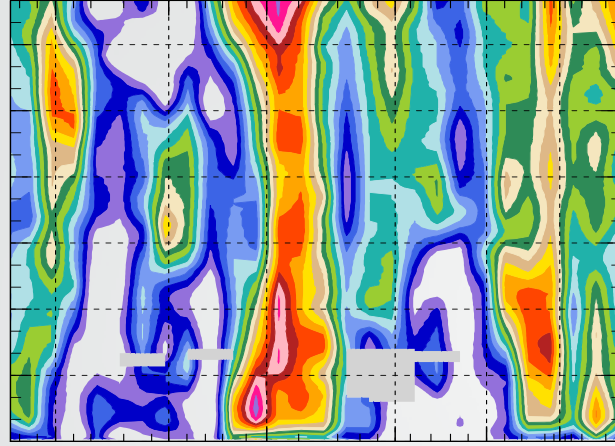
Extra Slides

RASM-ESRL – Validating Atmospheric Forcing



Measurements and Simulations of 2015 Freeze-up: SeaState Soundings 16-23 Oct 2015

WIND SPEED

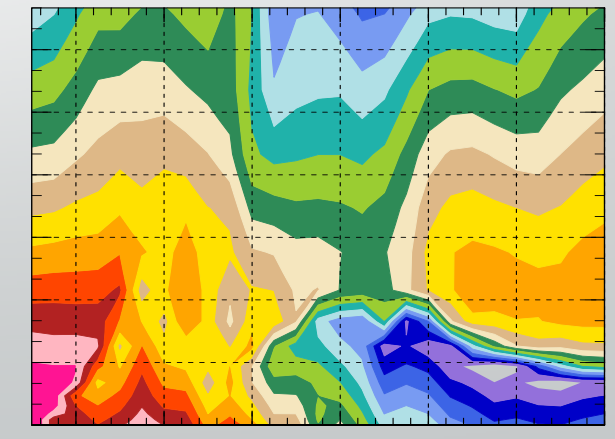
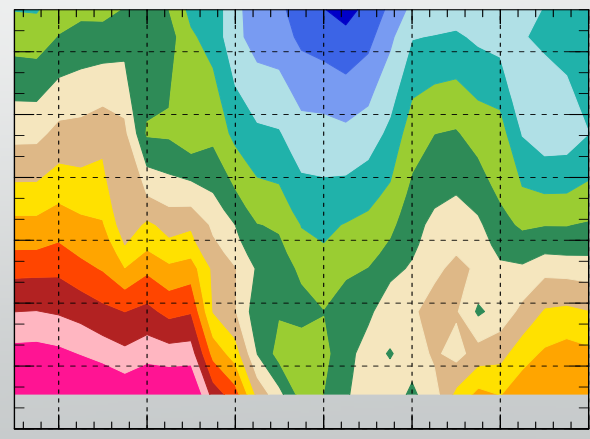
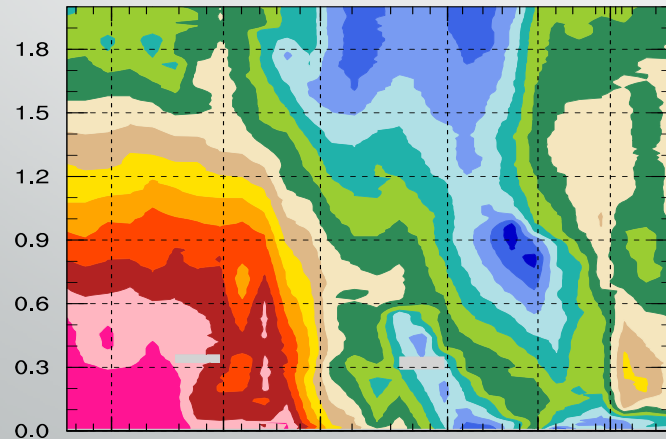


6.0

0 294.0 295.0 296.0

TEMPERATUR

E



96.0

92.0 293.0 294.0 295.0 296.0