# Understanding Arctic Processes through Delivery of Sea Ice Forecasts using the RASM-ESRL Model & Validation using SeaState 2015 Observations


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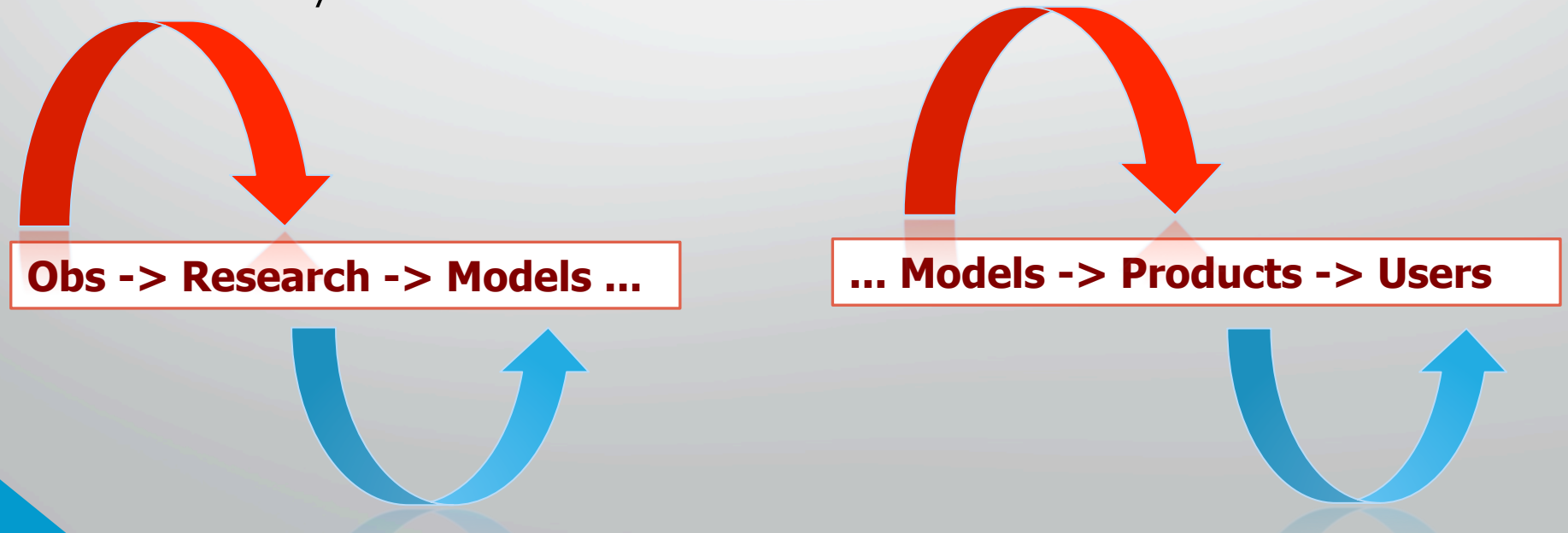
# PROJECT STORY LINE

- **Describe overall project, the model, the approach**
  - Adapted RASM to produce weather-scale coupled forecast model
  - Leveraged past experience with new opportunities (SeaState, NOAA Arctic Testbed)
- **Illustrate how we're integrating Arctic observations to understand key freeze-up processes**
  - Atmospheric fluxes, cloud structure,  ocean temps, ice observations, etc.
  - Preliminary comparisons using buoys, radiosondes, radars, surface stations, etc.
- **Next Steps**
  - Analysis of atmospheric and ice processes and forecast metrics
  - Developing forecast skill metrics  & model inter-comparisons

# PRIMARY PROJECT GOAL

Improve predictions of Arctic sea ice at 0-2+ weeks by:

- Identifying critical (large-scale & local) physical processes
- Characterizing process-level model deficiencies
- Improving model representation of key processes
  - clouds
  - surface fluxes
  - boundary layer
  - ocean mixed-layer



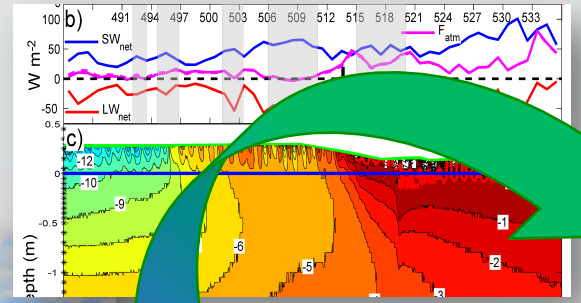
# Obs -> Research -> Models … Models -> Products -> Users

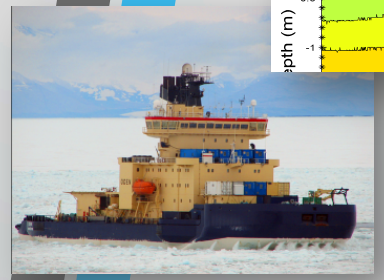
*Requires a more complete, "end-to-end" approach to the problem*

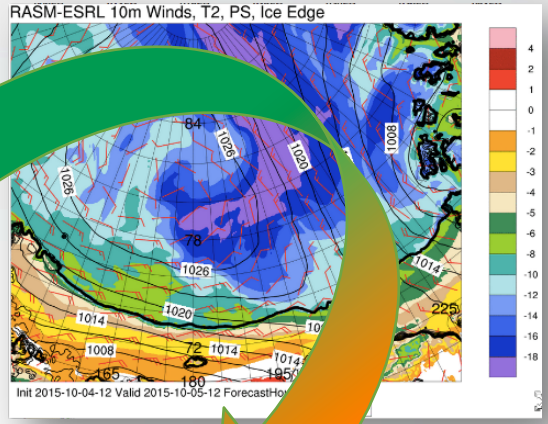
# PROJECT STRATEGY

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

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

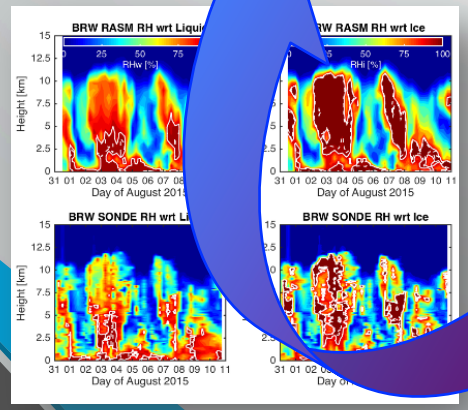





Produce experimental coupled model forecasts for delivery to ship for operations & to the Arctic Testbed for operational needs & usage information

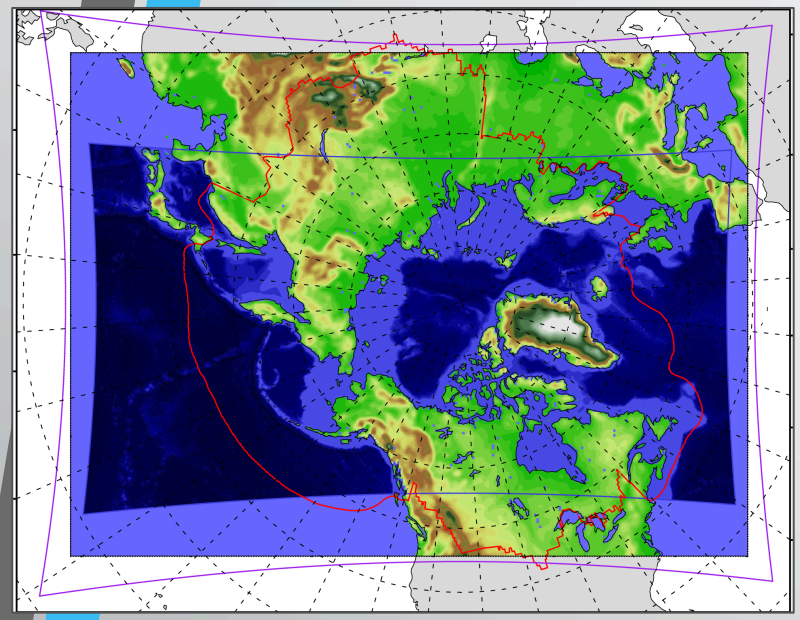
Obtain in situ observations from the 2015 freeze-up for model initialization, real time verification, & validation of sea ice evolution




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

# 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 CLM2 land surface model. All components are run at 10km horizontal grid and the WRF model is run with 40 vertical levels.

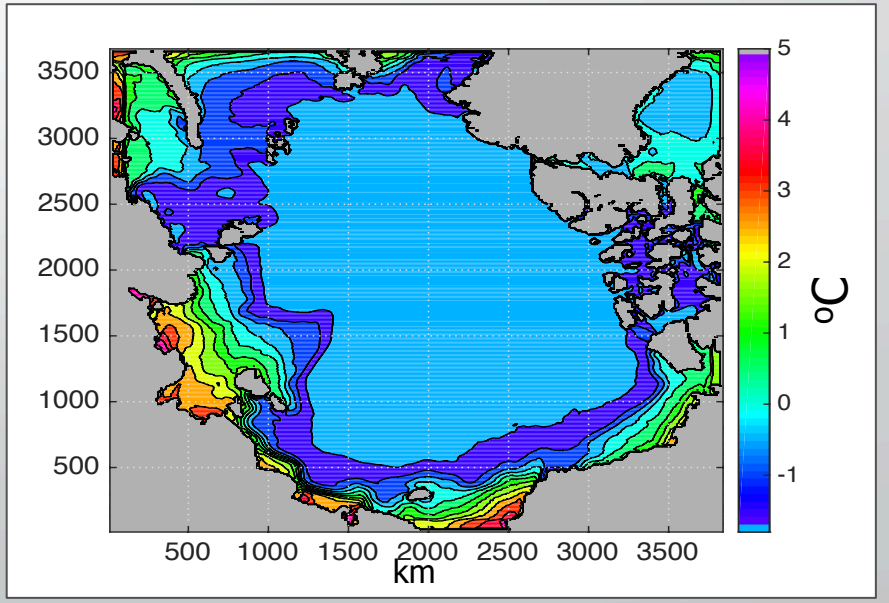


## Regional Arctic System Model (RASM)

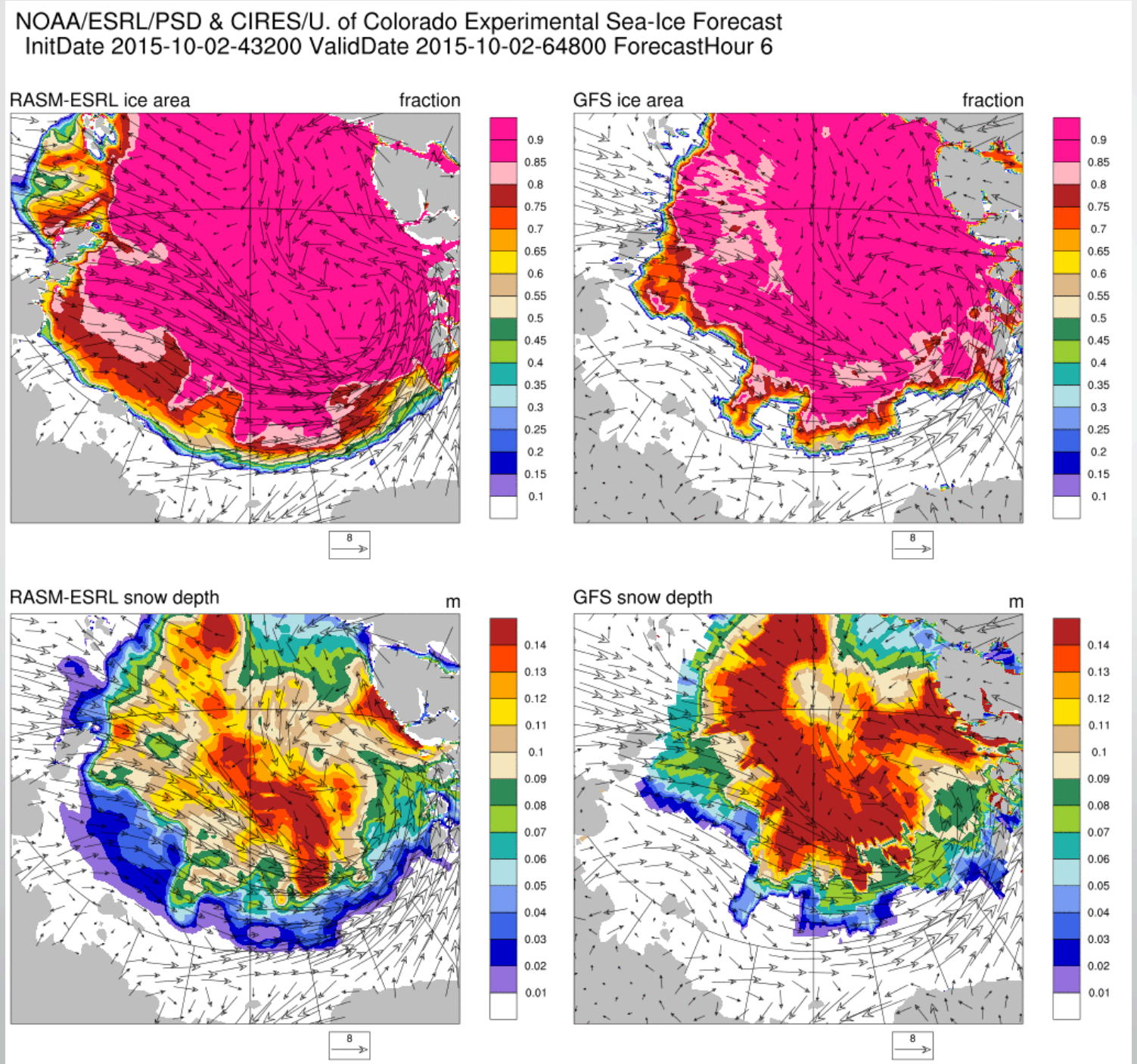
Focus on climate simulations
Includes all Arctic drainages and mid-latitude storm tracks
Medium-range atmosphere resolution (50km)
No initialization of sea ice

## 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



# Comparison of RASM-ESRL with GFS



# RASM-ESRL FORECAST PROCESS & VALIDATION

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

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lateral boundaries by GFS 3-hourl
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MRS2
ASAM2

Barrow
& radiometers

t. radar

fluxes

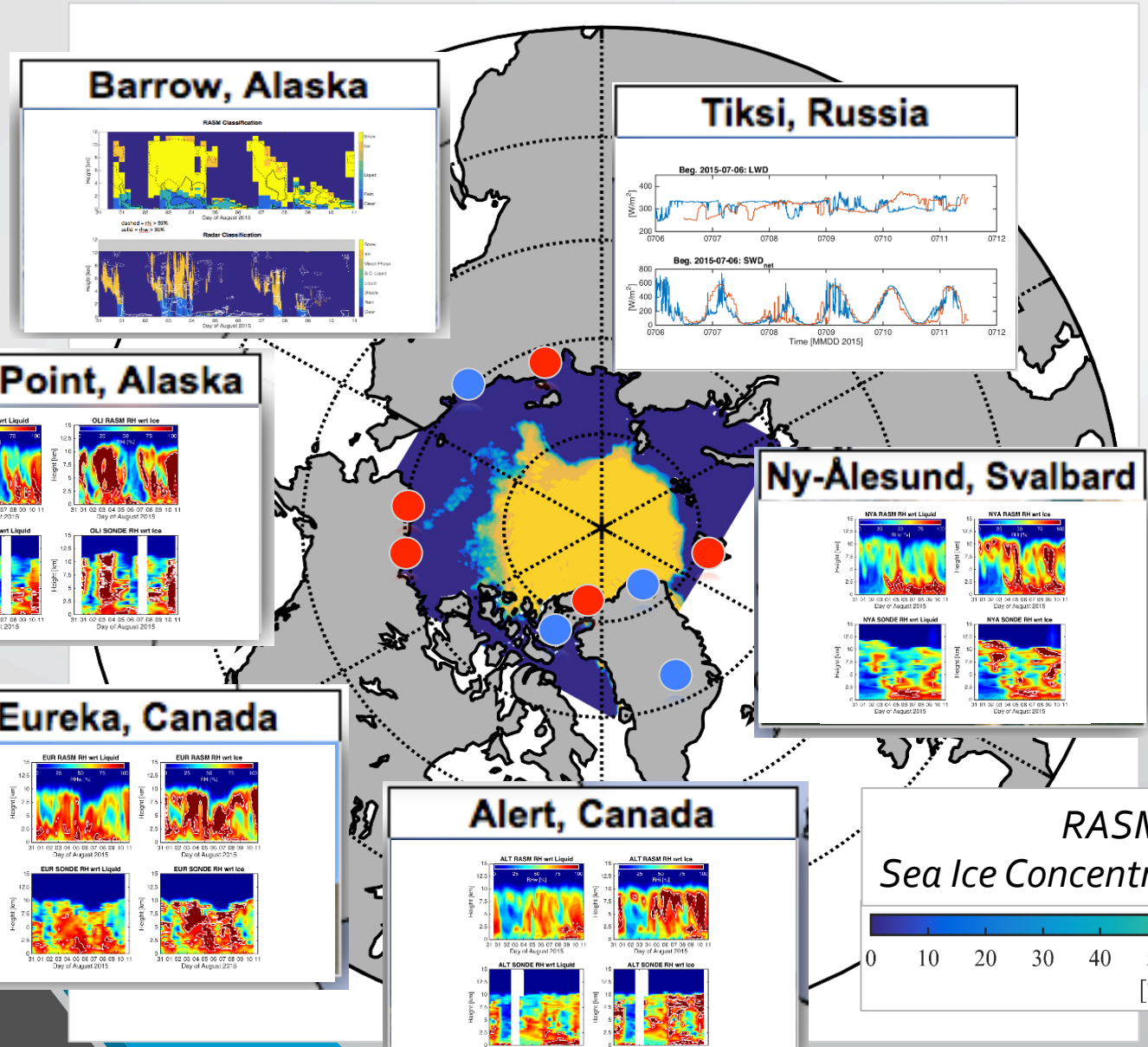
Buoy
gliders,
etc.

Satellite
SST



CLIMATE RESEARCH FACILITY

# RASM-ESRL – Validating Atmospheric Forcing




*RASM-ESRL*

*Sea Ice Concentration 11 Sep 2015*

0 10 20 30 40 50 60 70 80 90 100

[%]

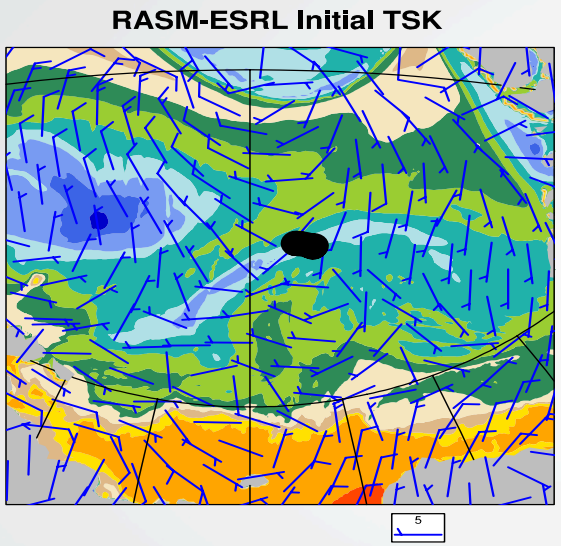
International Arctic Systems for Observing the Atmosphere

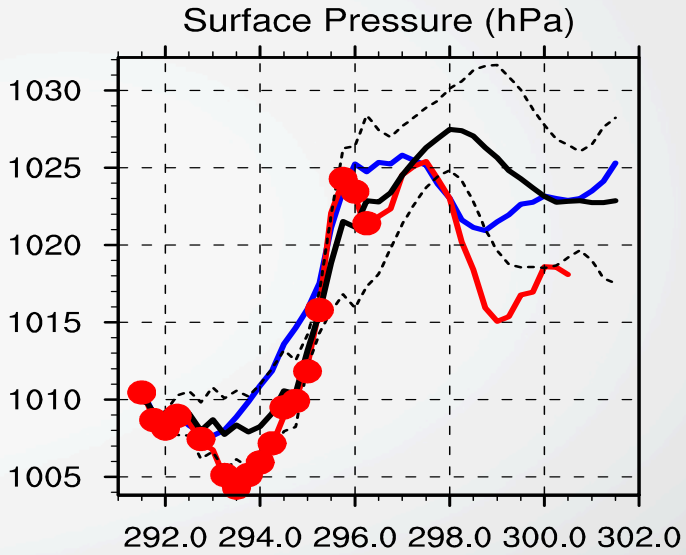
IASOA

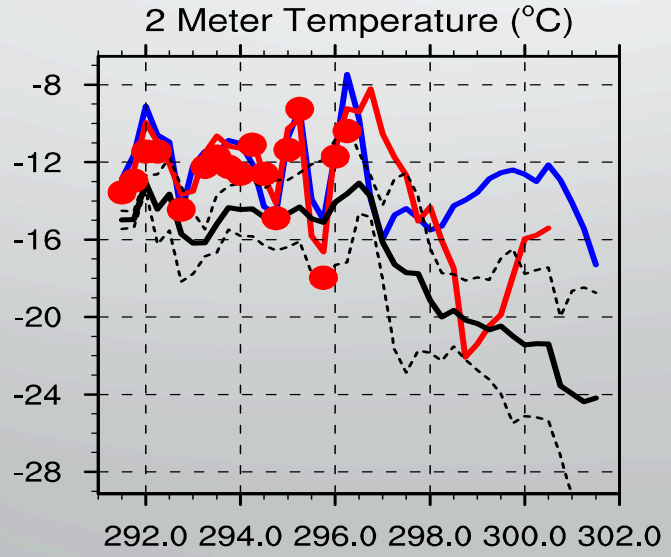
# RASM-ESRL & GFS over Central Arctic (CA): Relative to IABP Ocean/Ice Buoys

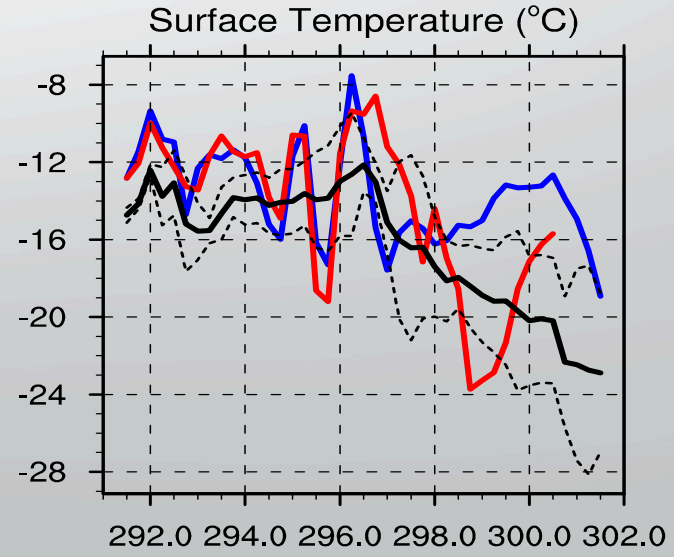
- CA Buoy
- RASM-ESRL
- GFS-Forecast
- GFS-Analysis

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



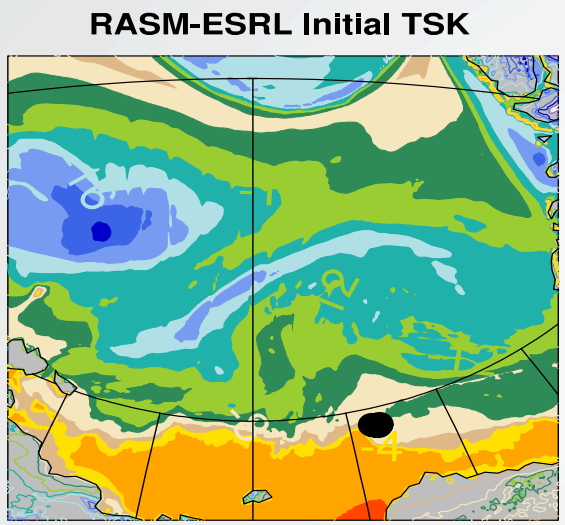



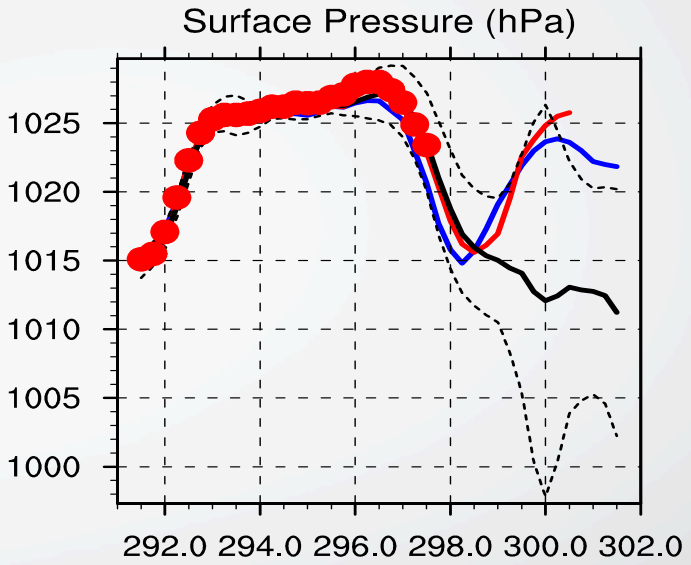



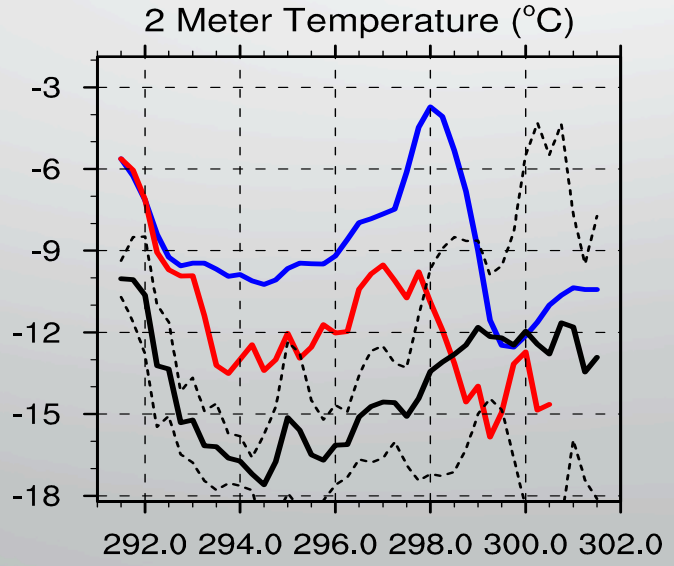
# RASM-ESRL & GFS in Marginal Ice Zone (MIZ): Relative to IABP Ocean/Ice Buoys

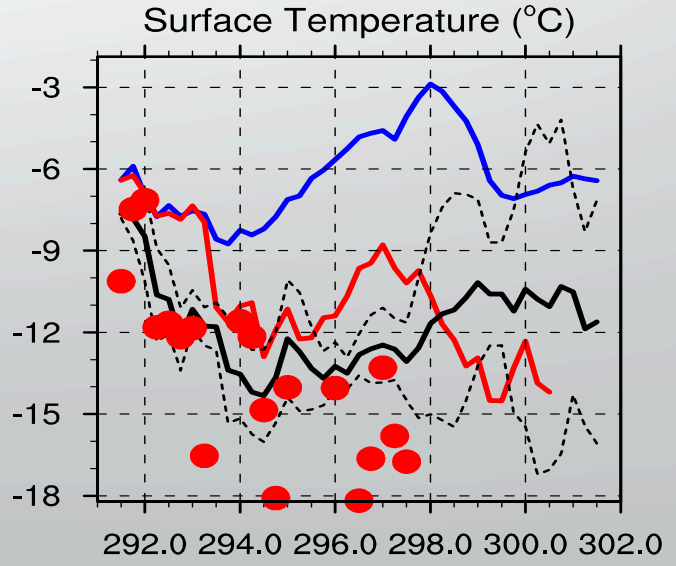
● MIZ Buoy
RASM-ESRL
GFS-Forecast
GFS-Analysis

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

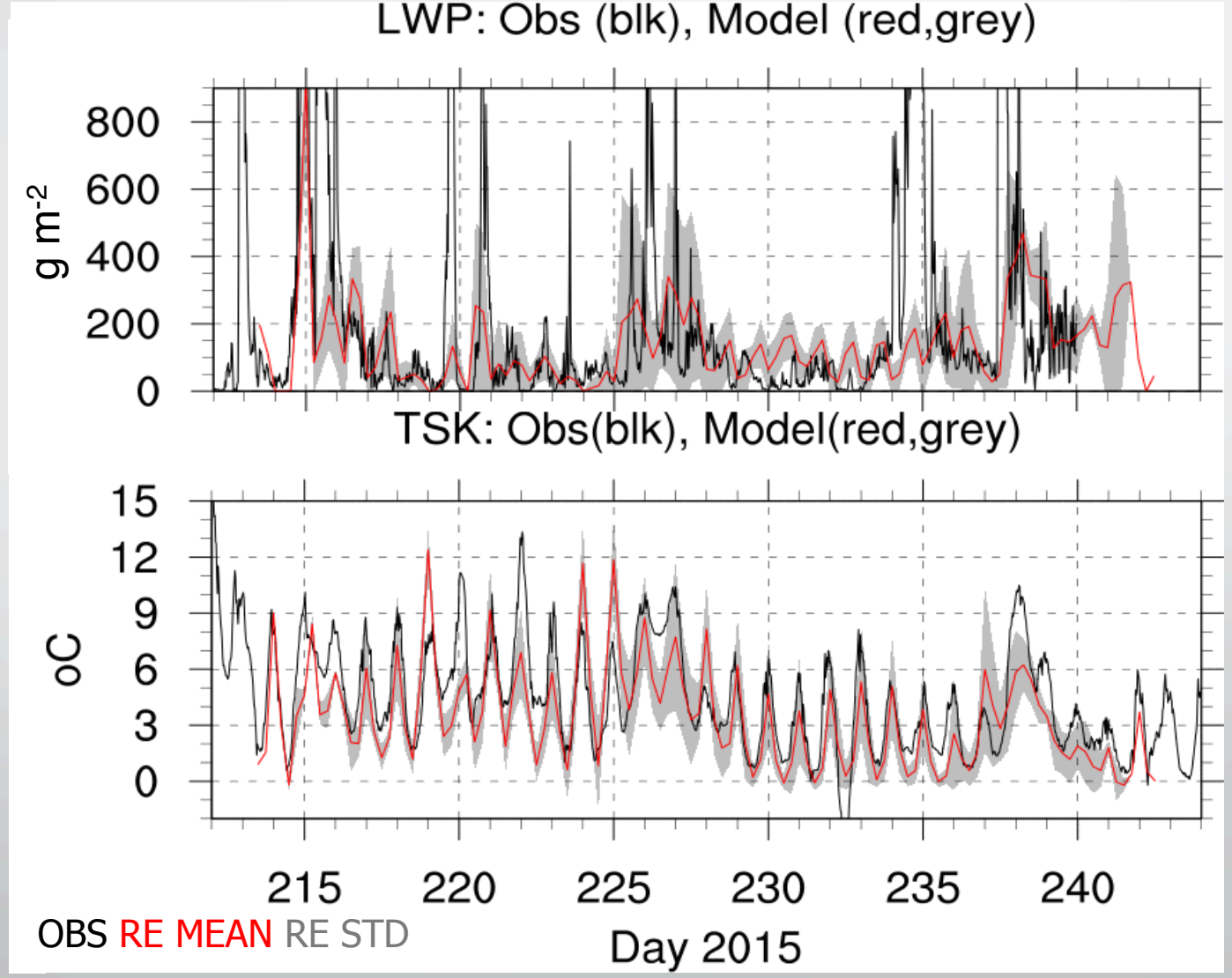


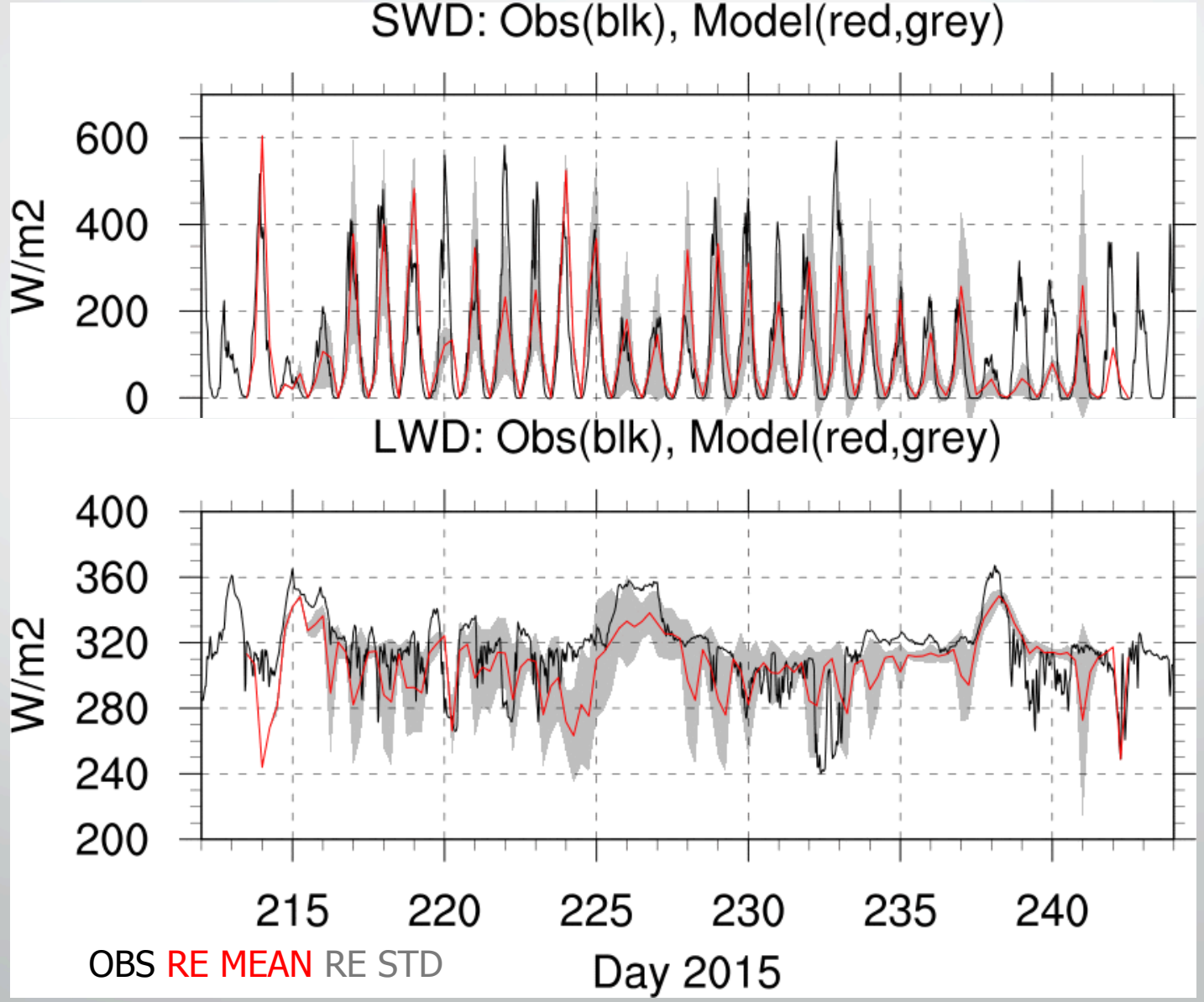



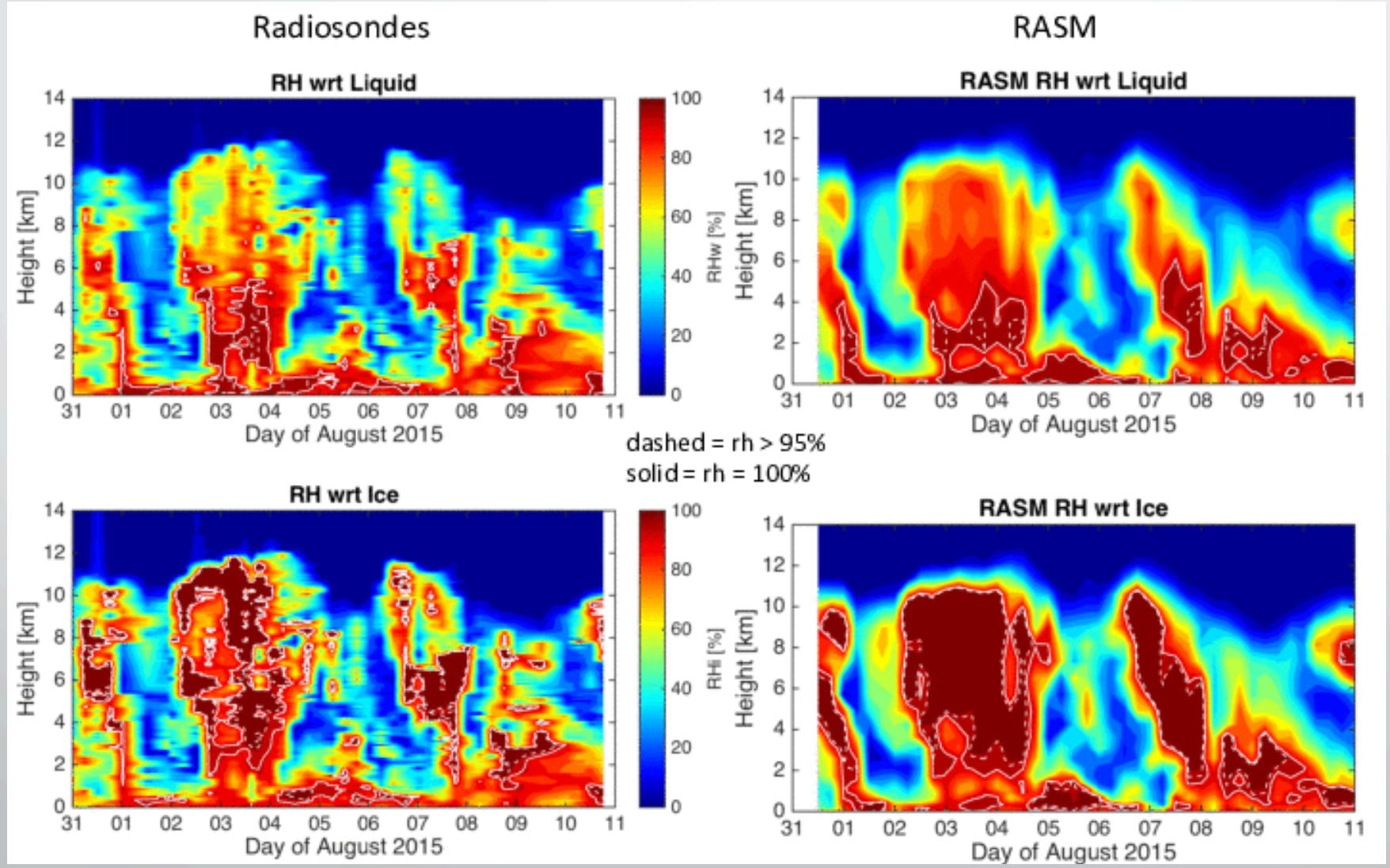
# Validation at Barrow, Alaska: Liquid Water Path & Skin Temperature from 15 13-day Hindcasts



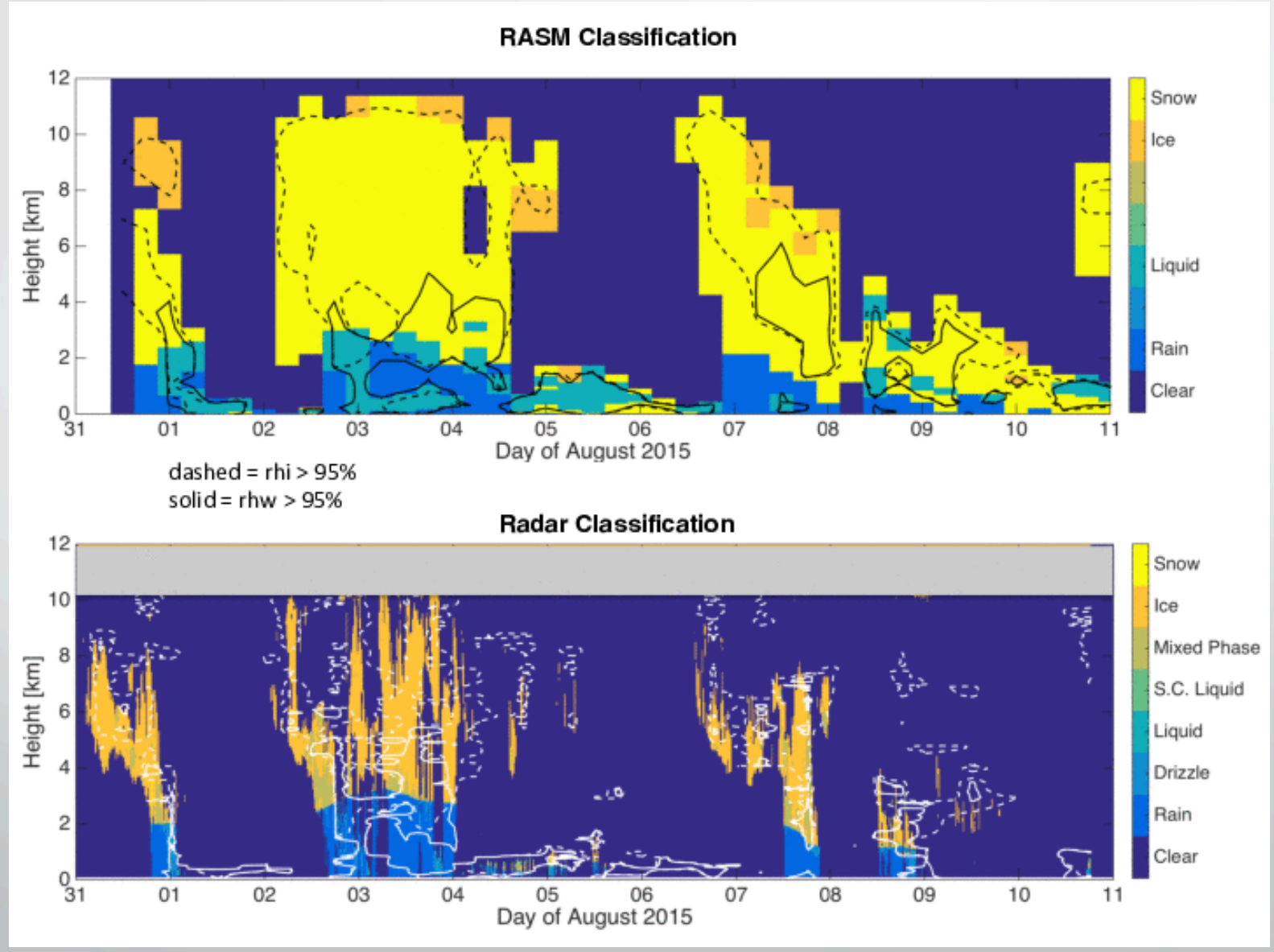
# Validation at Barrow, Alaska: Downward Radiative Surface Fluxes from 15 13-day Hindcasts



# Hindcast Validation at Barrow, Alaska: Radiosondes



# Validation at Barrow, Alaska: Cloud Radar (hindcast)



# 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
- Host workshop to review forecast model skill & validation
- 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

# Thoughts…

- Coordinated measurements / assimilation
- Wx-scale integration team approach
- Validation network-obs from ships of opportunities
- Wx-seasonal scale connections

1. What scientific or operational advances have been facilitated by network(s) of Arctic observations?

2. What opportunities exist to address new science questions, operational challenges, or questions of Arctic communities through enhanced collaboration and a robust interagency observing system?

3. How have observing activities contributed to the science needs of mission agencies or stakeholders?