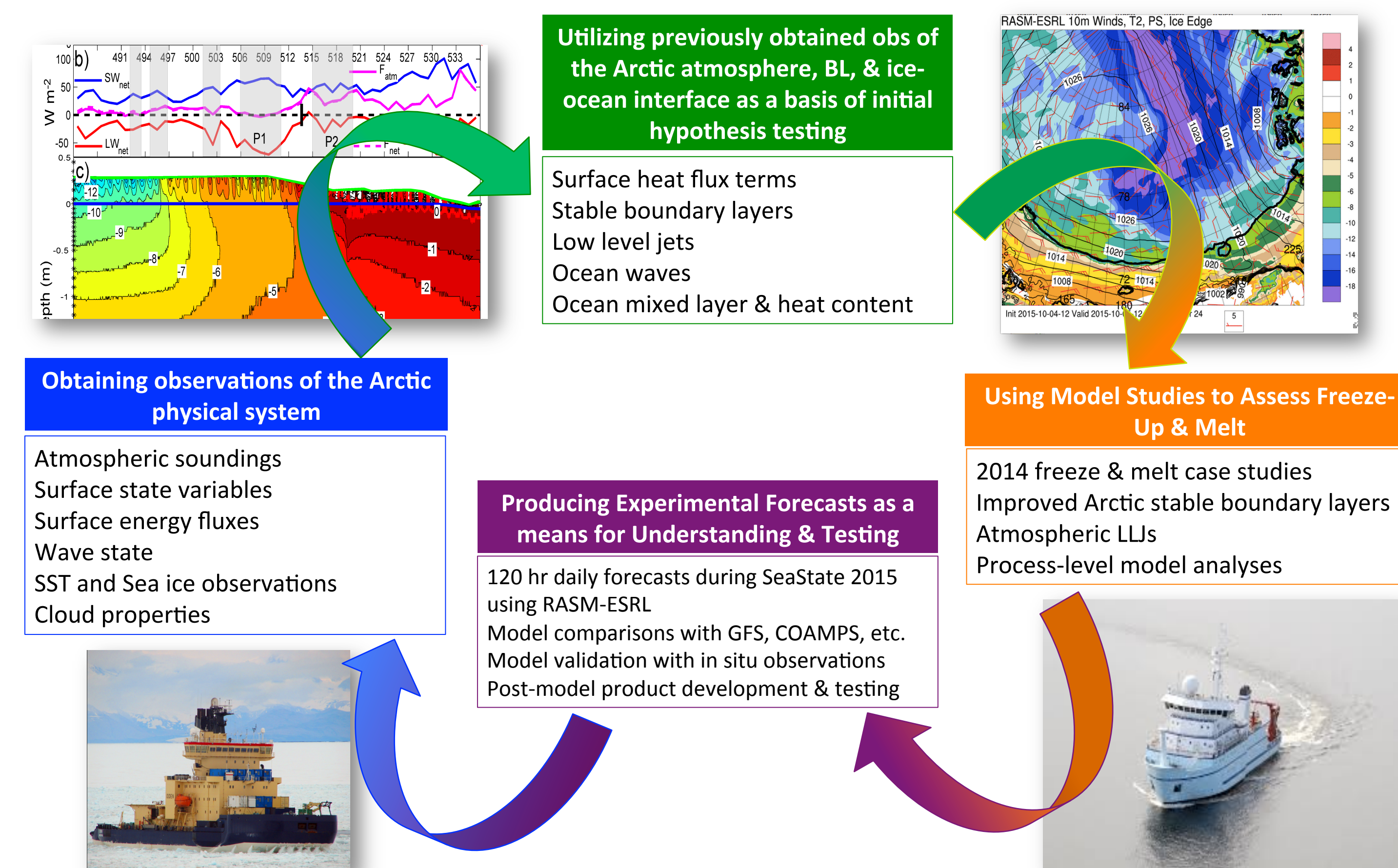# Short-term sea ice forecasts with the RASM-ESRL coupled model:
A testbed for improving simulations of ocean-ice-atmosphere interactions in the marginal ice zone

Amy Solomon[1,2], Mimi Hughes[1,2], Janet Intrieri[2], Ola Persson[1,2]
(1) CIRES/University of Colorado, (2) PSD/ESRL/NOAA

Project Strategy

Our Goal: Improve understanding of the physical processes that impact sea ice formation
Our Approach: Improved understanding through delivery of an experimental sea ice forecast

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

- Surface heat flux terms
- Stable boundary layers
- Low level jets
- Ocean waves
- Ocean mixed layer & heat content

Obtaining observations of the Arctic physical system

- Atmospheric soundings
- Surface state variables
- Surface energy fluxes
- Wave state
- SST and Sea ice observations
- Cloud properties

Using Model Studies to Assess Freeze-Up & Melt

- 2014 freeze & melt case studies
- Improved Arctic stable boundary layers
- Atmospheric LLJs
- Process-level model analyses

Producing Experimental Forecasts as a means for Understanding & Testing

- 120 hr daily forecasts during SeaState 2015 using RASM-ESRL
- Model comparisons with GFS, COAMPS, etc.
- Model validation with in situ observations
- Post-model product development & testing

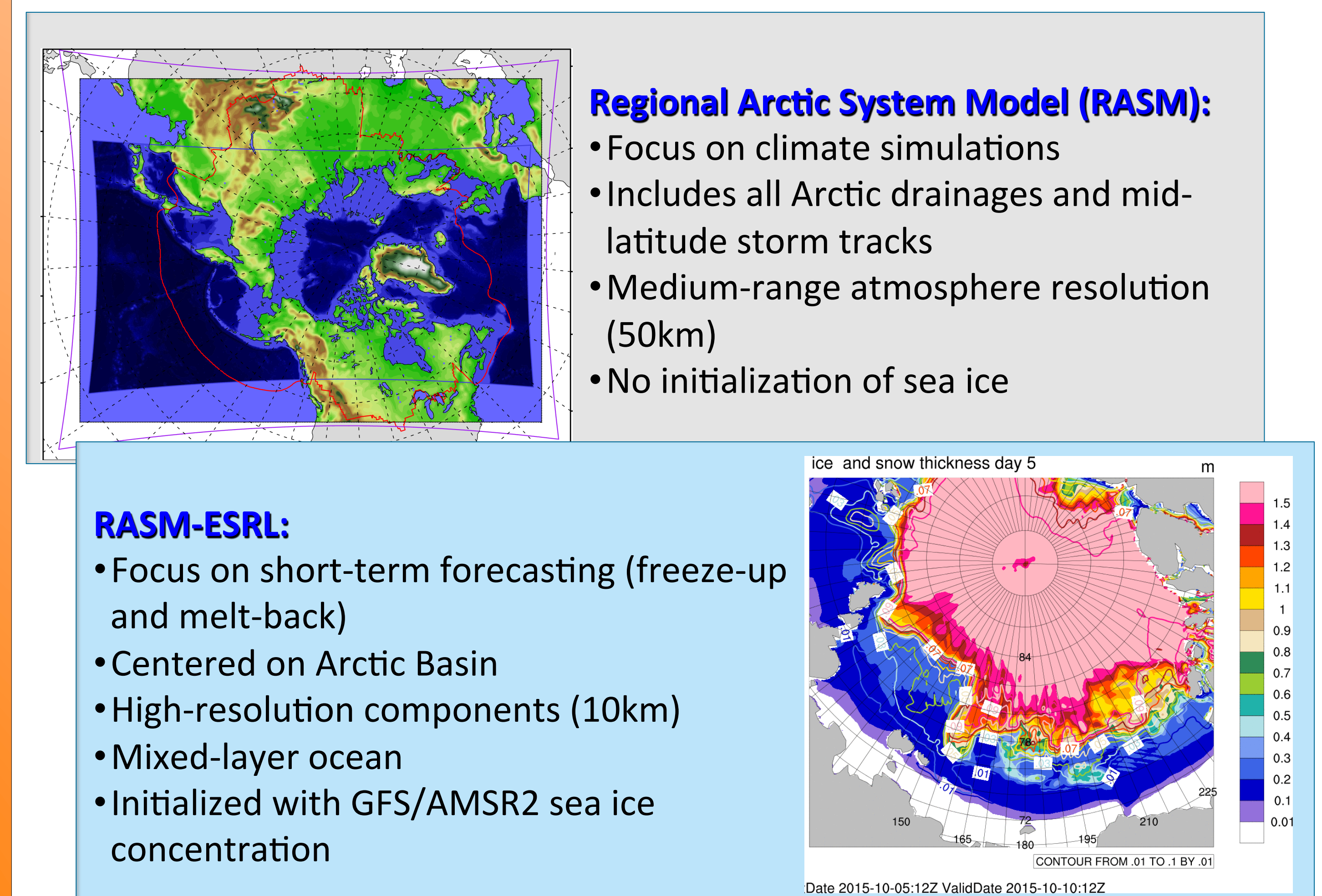## Why focus on short-term forecasts?

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

Our Working Hypothesis:
Many longer-term biases are due to "fast processes"

Synoptic Systems/Lower Level Jets
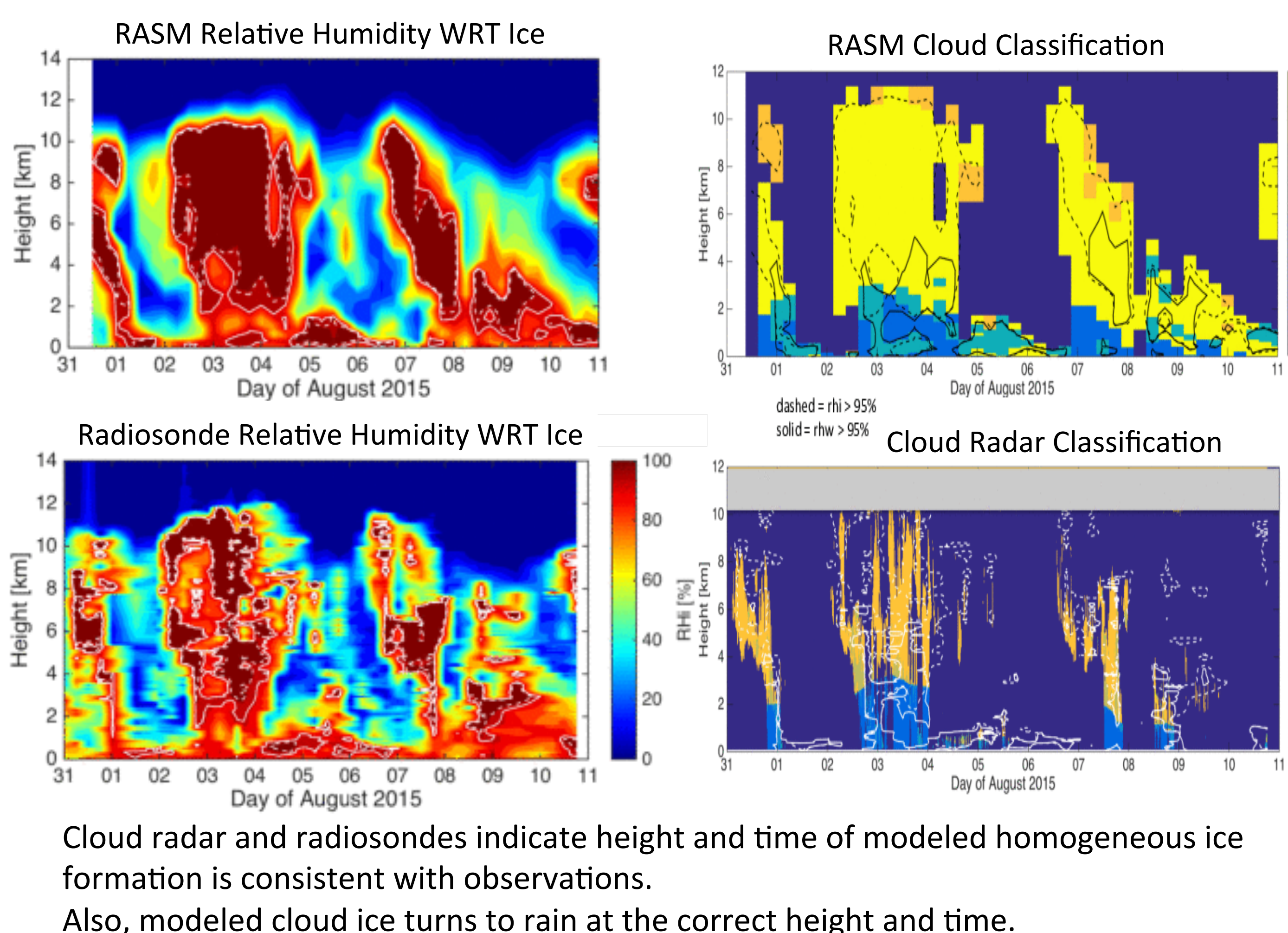
Processes in the Marginal Ice Zone (MIZ)
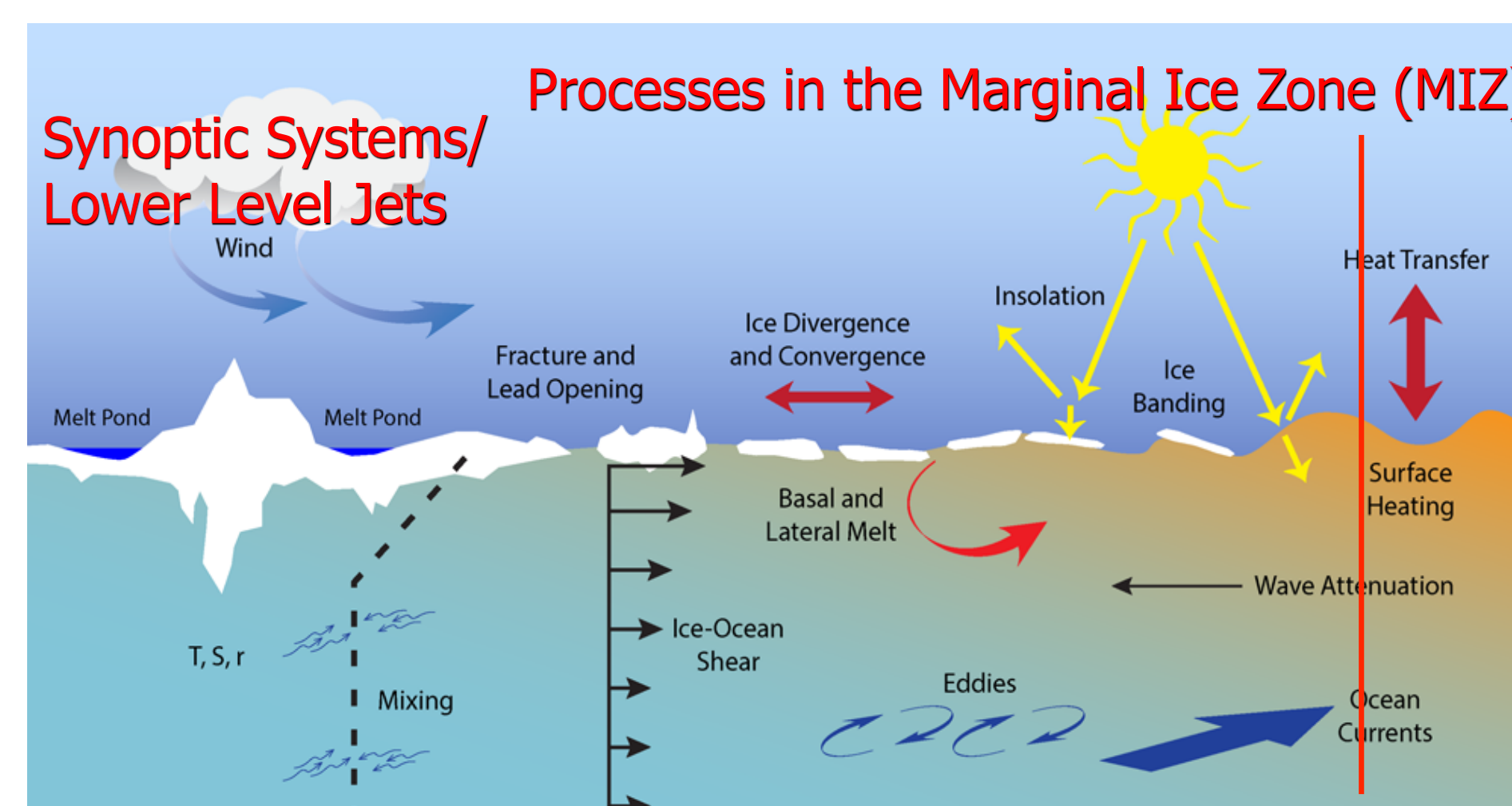
Can we improve the skill of short-term sea-ice forecasts by allowing for prognostic surface energy fluxes and atmospheric dynamics at the ice edge?
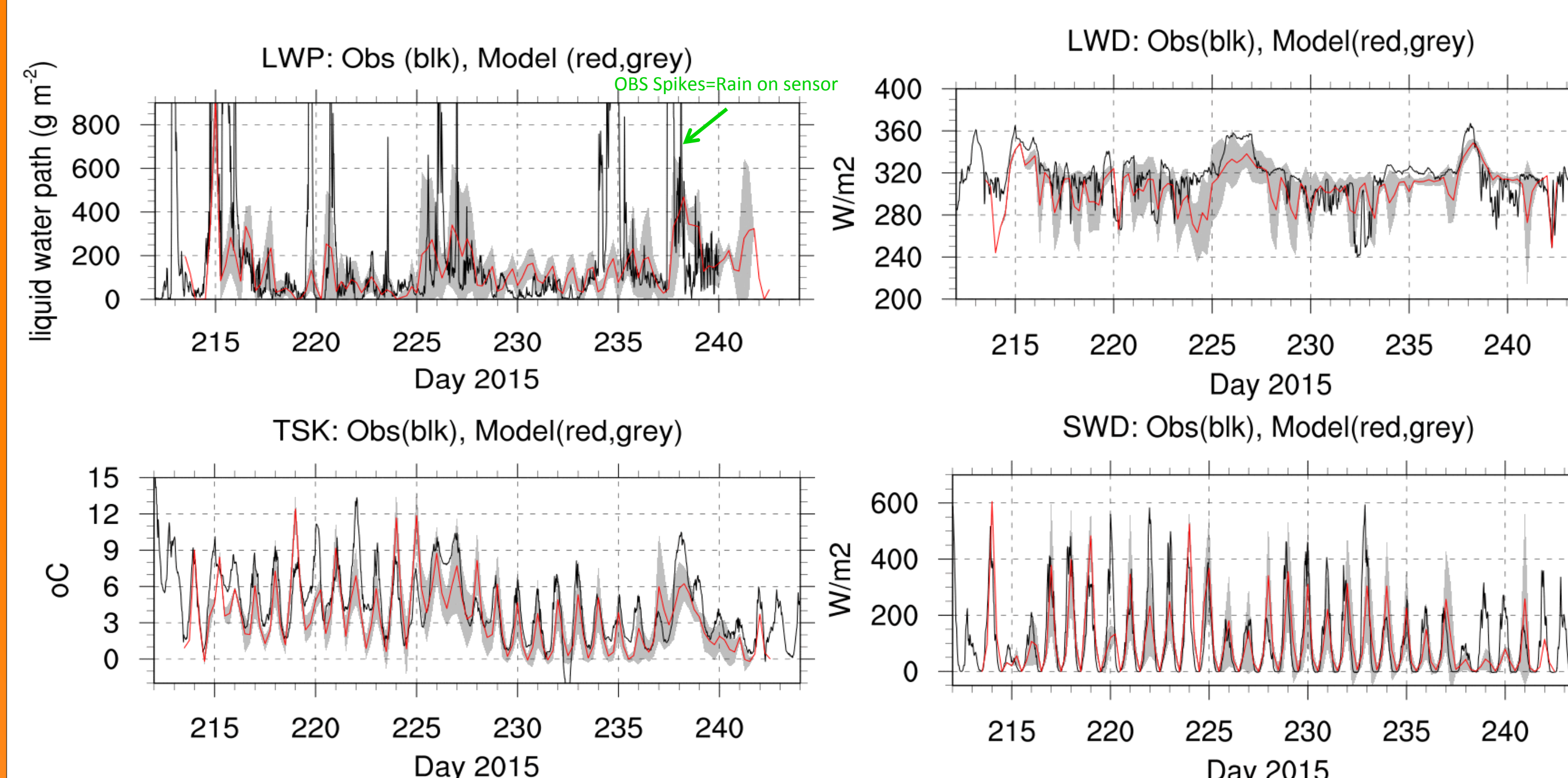
Adapting RASM for sea-ice forecasting

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 (freeze-up and melt-back)
- Centered on Arctic Basin
- High-resolution components (10km)
- Mixed-layer ocean
- Initialized with GFS/AMSR2 sea ice concentration

Validation At Barrow, Alaska: Cloud Structure

RASM Relative Humidity WRT Ice

RASM Cloud Classification

Radiosonde Relative Humidity WRT Ice

Cloud Radar Classification

Cloud radar and radiosondes indicate height and time of modeled homogeneous ice formation is consistent with observations.
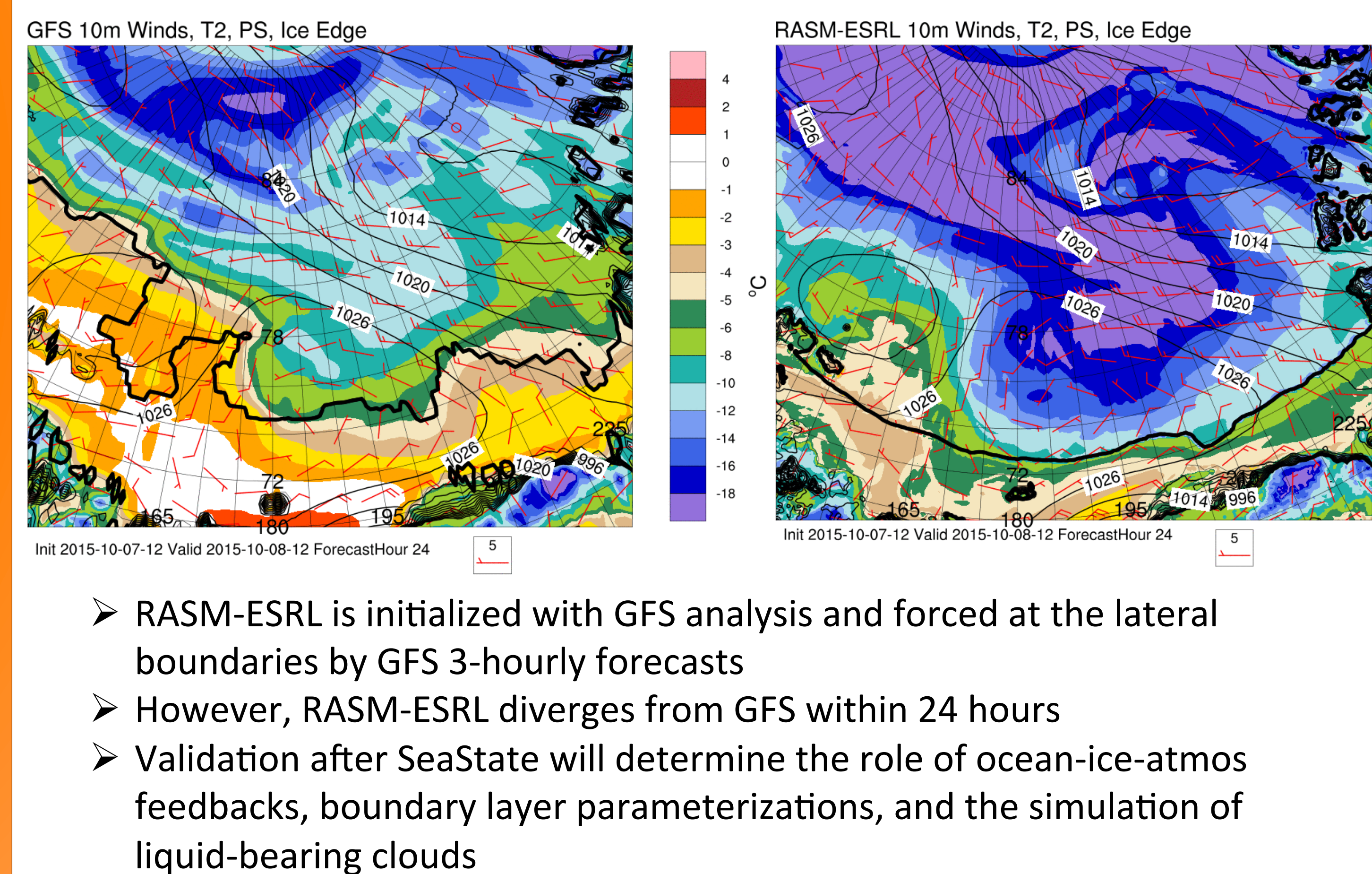Also, modeled cloud ice turns to rain at the correct height and time.

Validation At Barrow, Alaska: Surface Fluxes

Validation of liquid water path and surface radiative fluxes using DOE ground-based measurements at Barrow, Alaska

Using 15 13-day hindcast simulations forced by 3-hourly GFS Analyses

Comparison with GFS: 24-hour Forecast

➤ RASM-ESRL is initialized with GFS analysis and forced at the lateral boundaries by GFS 3-hourly forecasts
➤ However, RASM-ESRL diverges from GFS within 24 hours
➤ Validation after SeaState will determine the role of ocean-ice-atmos feedbacks, boundary layer parameterizations, and the simulation of liquid-bearing clouds

Impact of Thermodynamics on 5-day Forecasts

Full-Run minus Dynamics-Only at Day 5

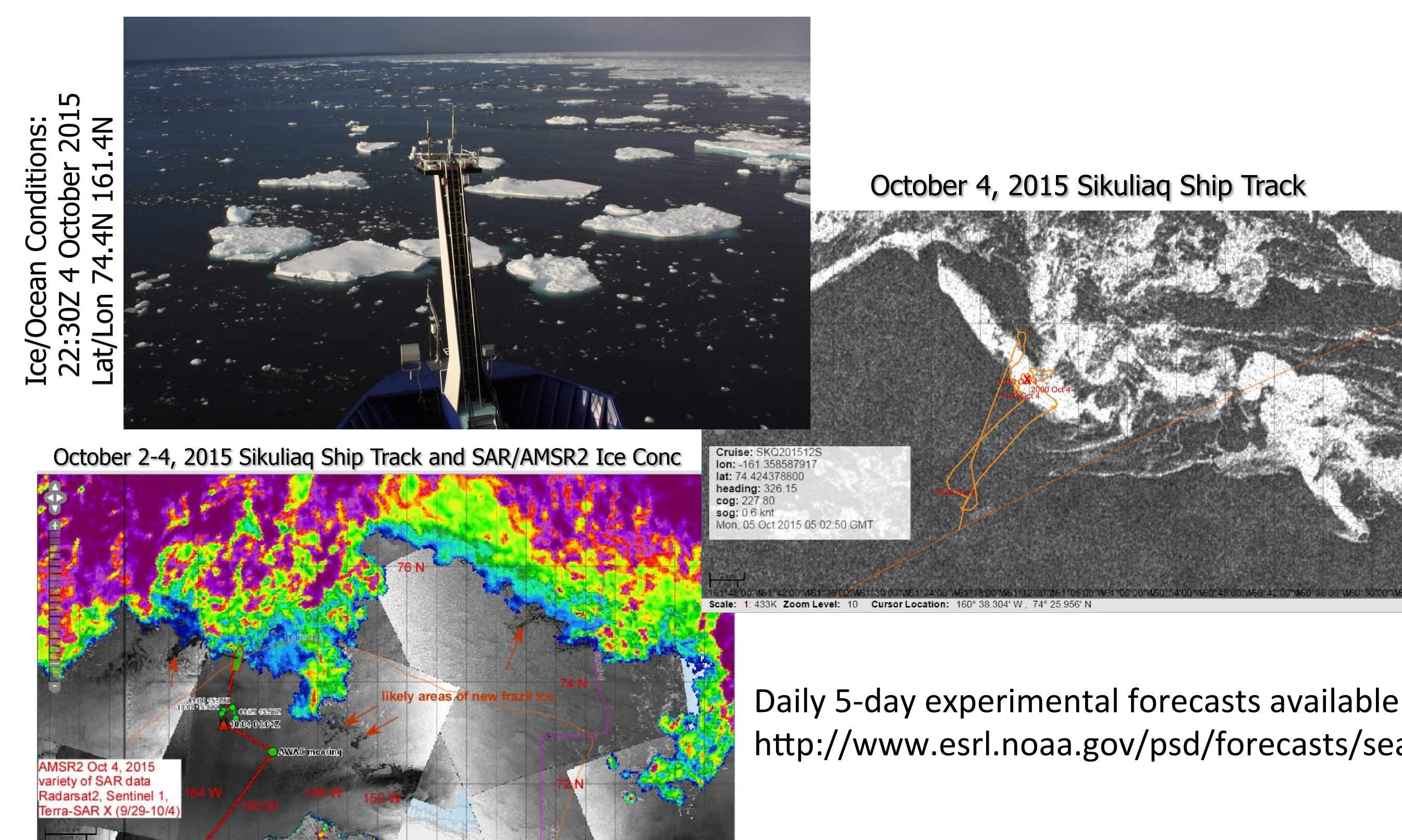Thermodynamic Ice Thickness Change

Thermodynamic Ice Area Tendency
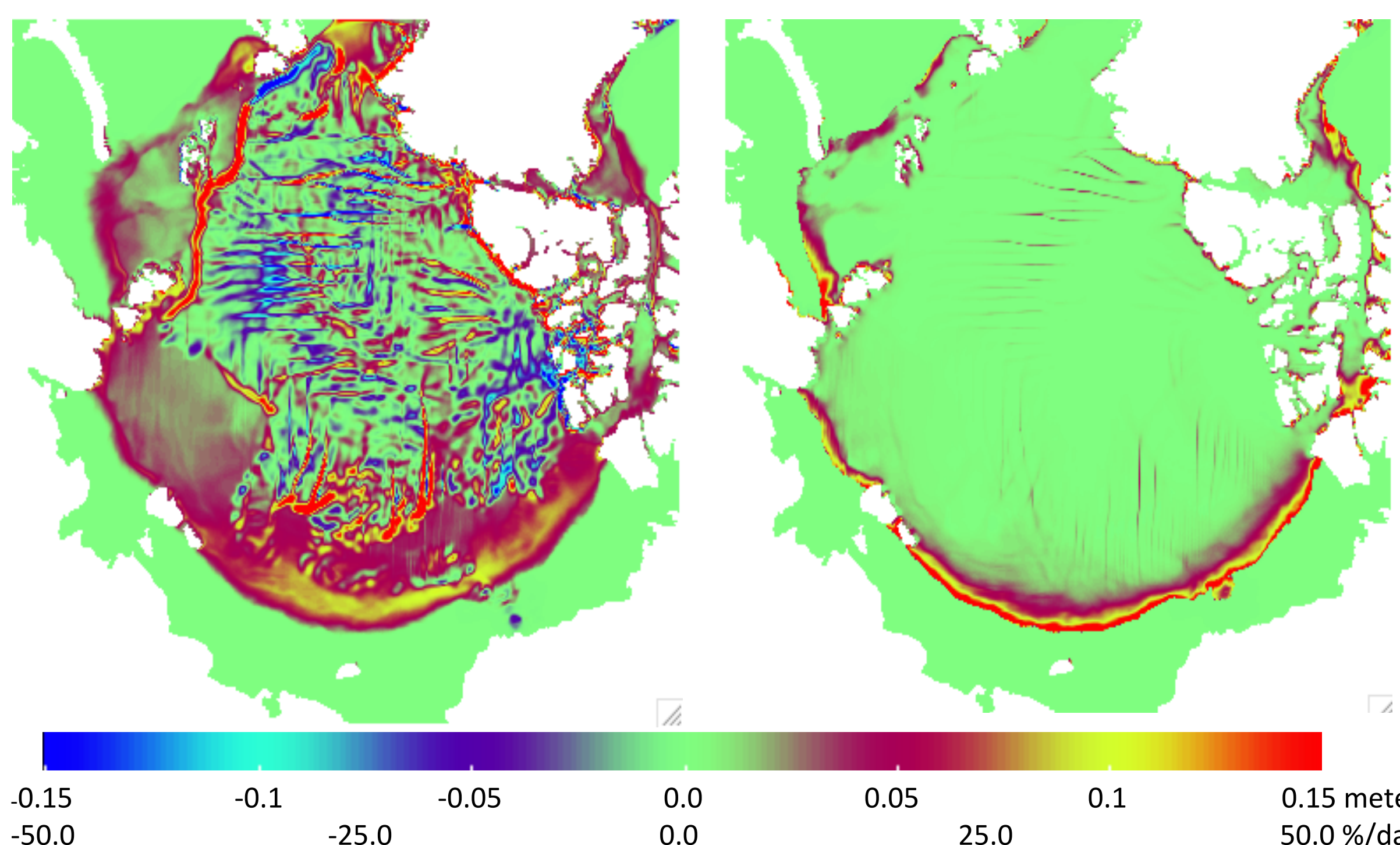
Significant new ice growth within 5 days (ice thickness change>10cm)

Putting the rubber to the road...

Using **RASM-ESRL** to make real-time forecasts during the **SeaState** Campaign

Using intensive measurements taken during **SeaState** to validate **RASM-ESRL**

Ice/Ocean Conditions: 22:30Z 4 October 2015 Lat/Lon 74.4N 161.4N

October 4, 2015 Sikuliaq Ship Track

October 2-4, 2015 Sikuliaq Ship Track and SAR/AMSR2 Ice Conc

Daily 5-day experimental forecasts available at:
http://www.esrl.noaa.gov/psd/forecasts/seaice

Next Steps

❖ Delivery of experimental products like freezing spray
❖ Detailed model validation using observations of atmospheric fluxes, ocean temperatures, ice observations, from SeaState, etc
❖ Analysis of atmospheric and ice processes and forecast skill metrics.
❖ Post-SeaState workshop to review forecast model skill and validation, etc.
❖ Work with CFSv2 to understand if better fluxes improve forecasts
❖ Contributing to NWS study on determining NGGPS sea ice model and assessment studies
❖ Prepare for follow-on testbed activity for summer melt-out

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