Validating CERES Flux using Airborne Radiative Flux Measurements from the ARISE Campaign (and the effect of sea ice datasets…)

Joseph Corbett[1], Anthony Bucholtz[2], Seiji Kato[3], Bill Smith[3], and Wenying Su[3]

Special thanks to Sunny Sun-Mack and Victor Sothcott

[1] SSAI, [2] NRL, [3] NASA Langley

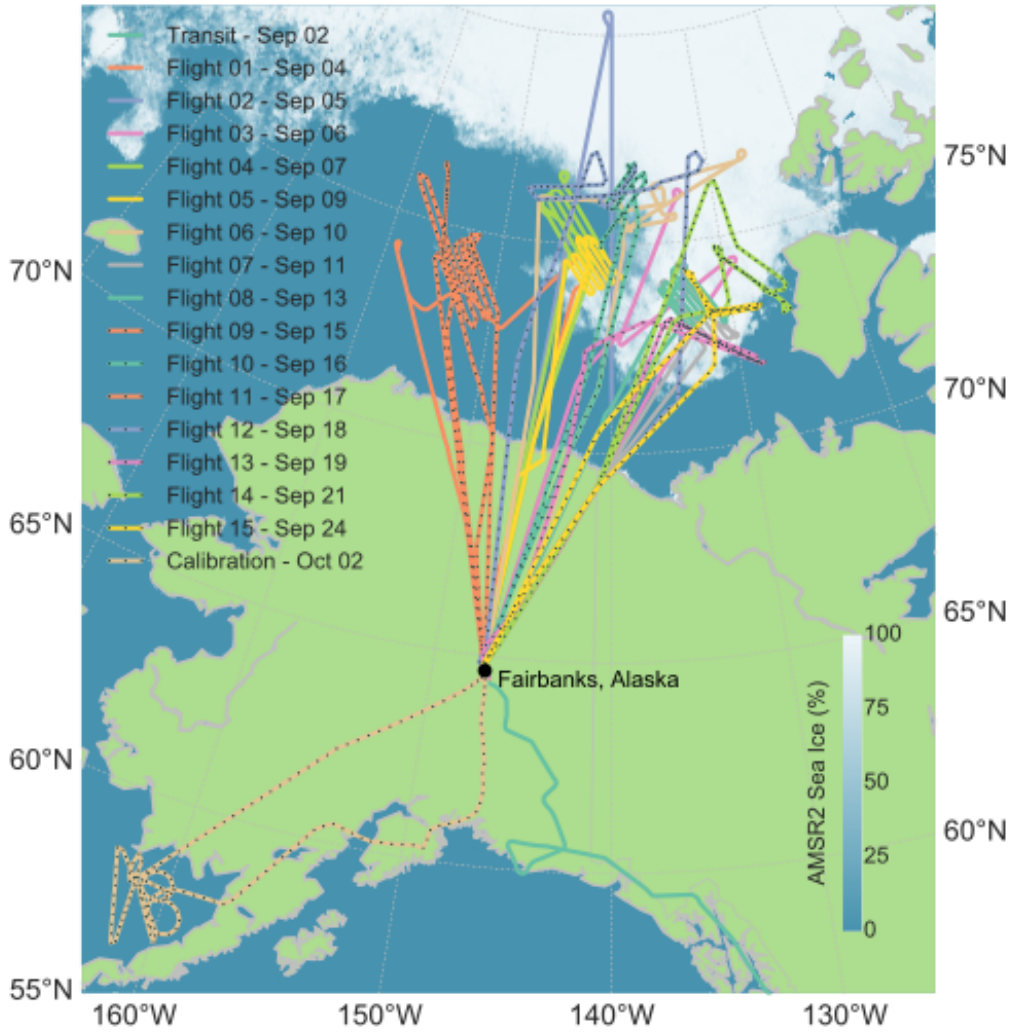
Earth Radiation Budget Workshop, ECWMF, Reading UK

Arctic Radiation-IceBridge Sea & Ice Experiment

Based in Fairbanks, Alaska during September 2014

From the NASA C-130:

- Measure spectral and broadband radiative flux
- Quantify surface characteristics, cloud properties, and other atmospheric state parameters under a variety of Arctic atmospheric and surface conditions
- Coincide with satellite overpasses as much as possible



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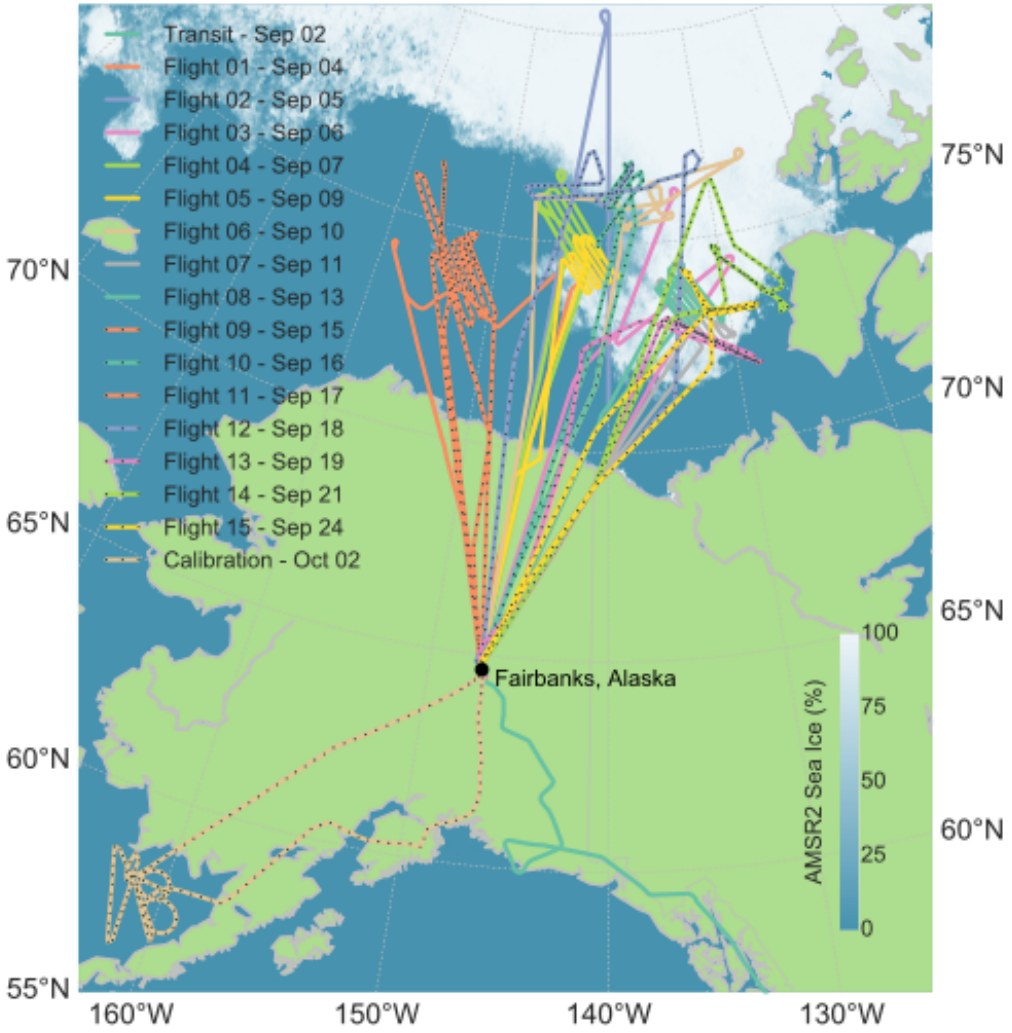
Naval Research Lab Broadband Radiometers (BBR):

[Not the instrument on EarthCare!!!!]

- SW up and down – modified Kipp and Zonen CM-22 pyranometer
- LW up and down – modified Kipp and Zonen CG-4 pyrogeometer
- 1-sigma uncertainty ~ 2.5%

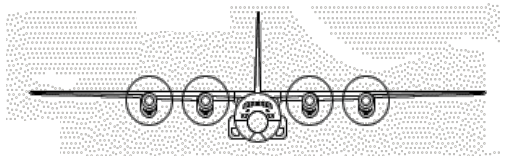


ARISE Grid-box Sampling

Top-of-Atmosphere

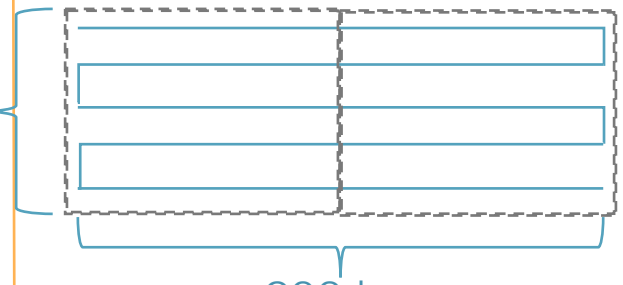
FM1 (Terra)
FM3 (Aqua)

BBR



~ 6 km

Flight Pattern (top down)

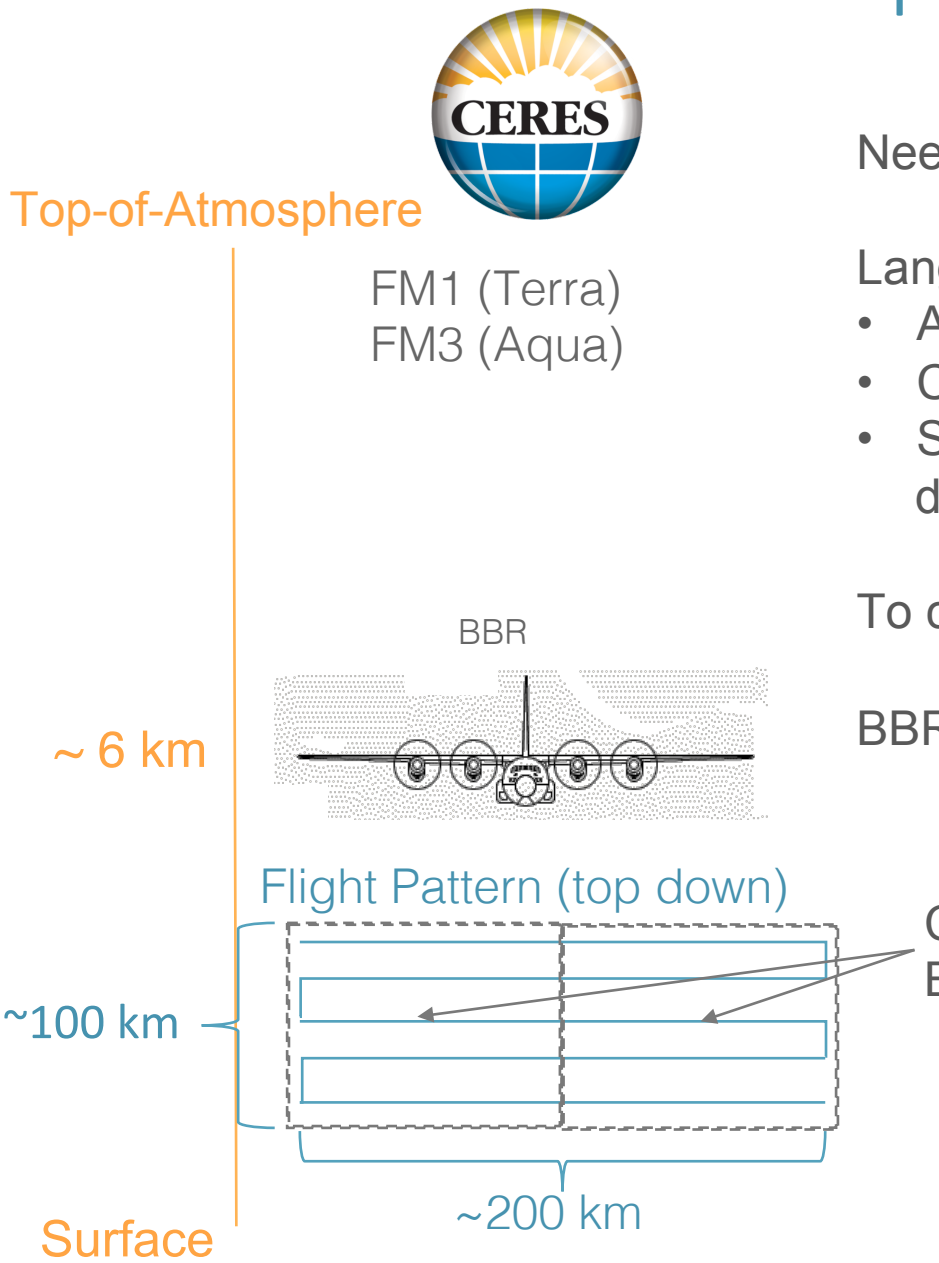


~100 km

~200 km

Surface

ARISE Grid-box Sampling



Need to account for absorption and scattering above the aircraft

Langley Fu-Liou Radiative transfer model:

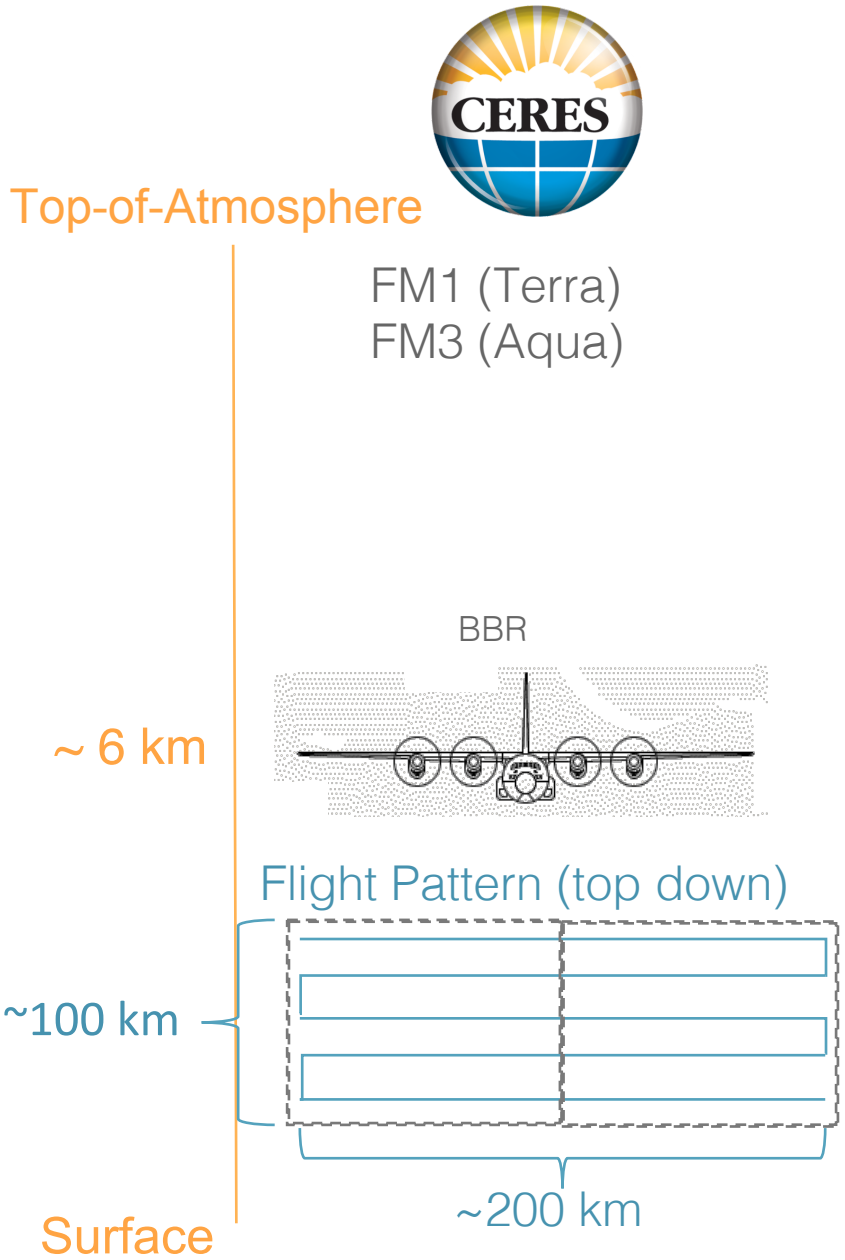
- Atmospheric state information from GEOS 5.4.1
- Cloud property information from MODIS (CERES cloud working group)
- Surface information from the AMSR2 ASI 3.5km sea ice concentration dataset (Uni. Hamburg)

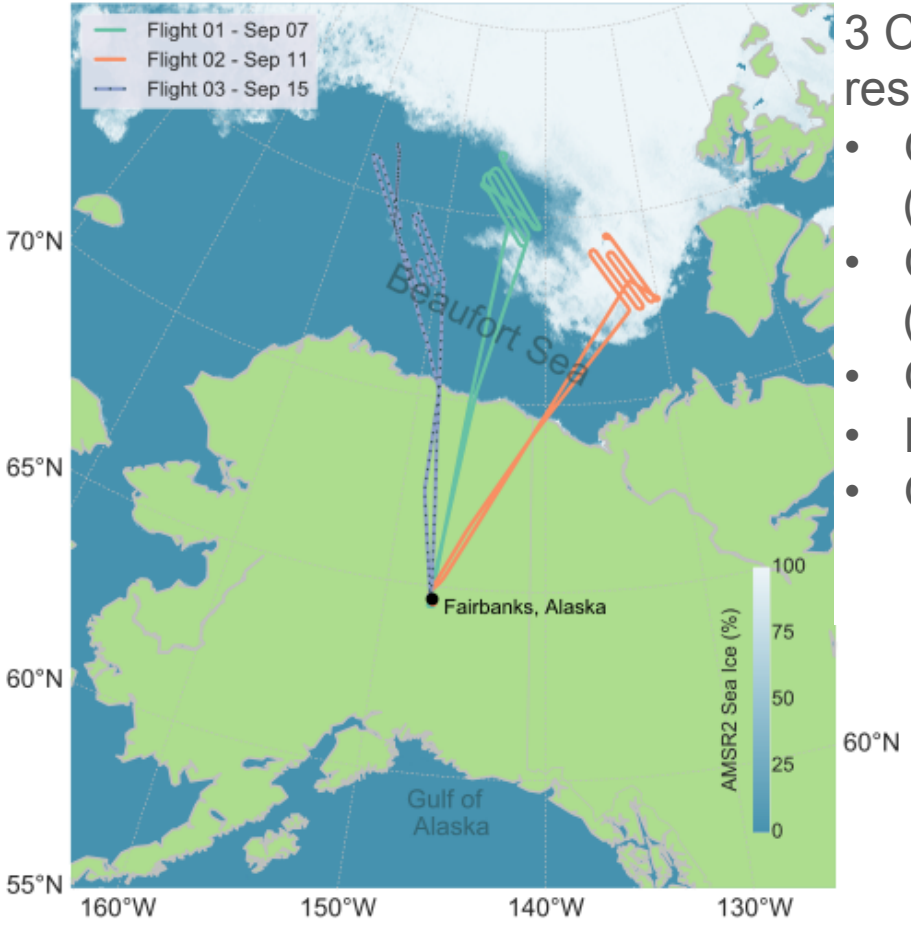
To convert BBR flux from aircraft altitude to TOA:

BBR TOA = (F(TOA) /F(C-130 Alt)) x BBR

Compare the means from CERES and BBR for each grid box

ARISE Grid-box Sampling

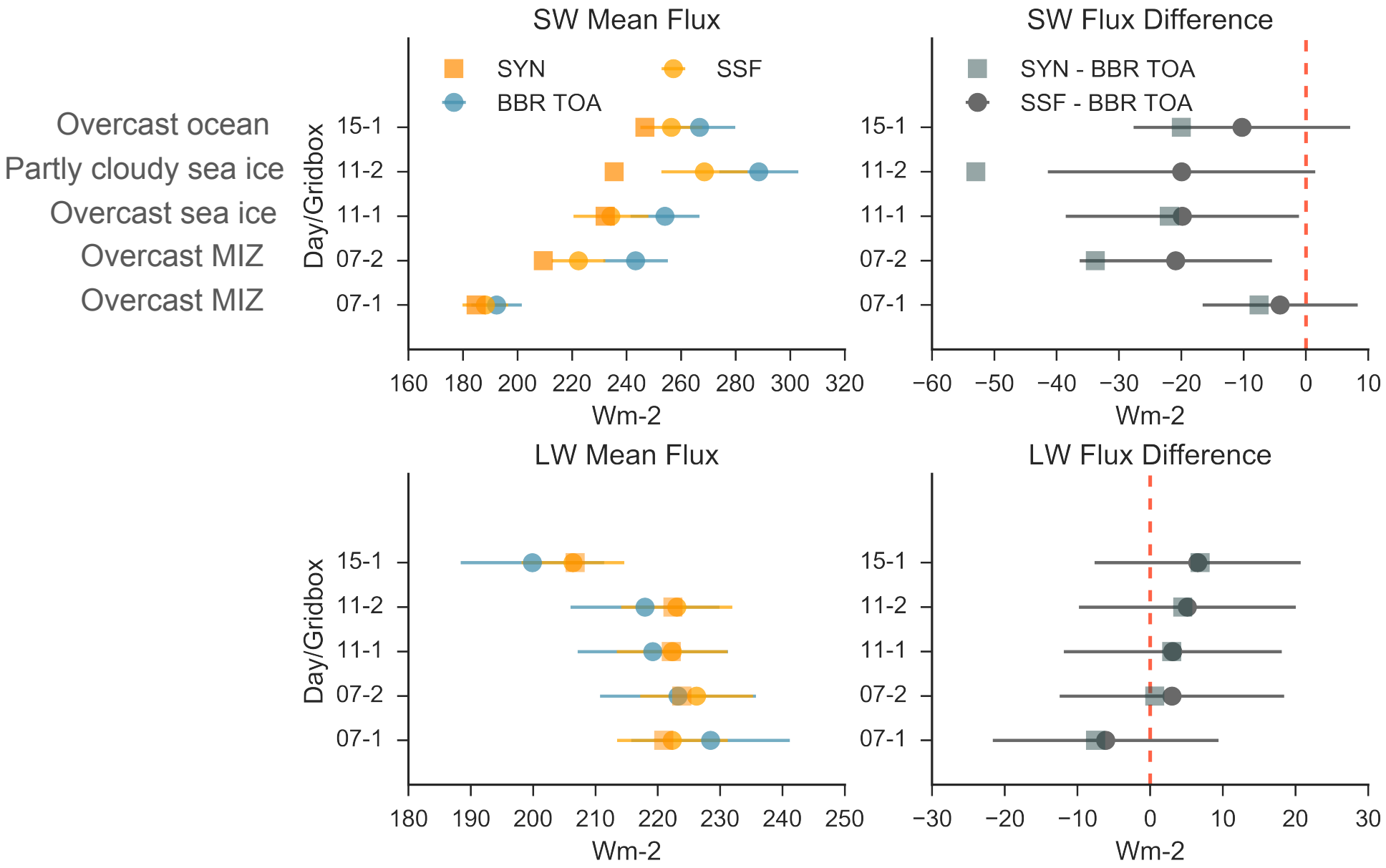




3 CERES grid-box flights performed – resulted in 5 useable grid-boxes:

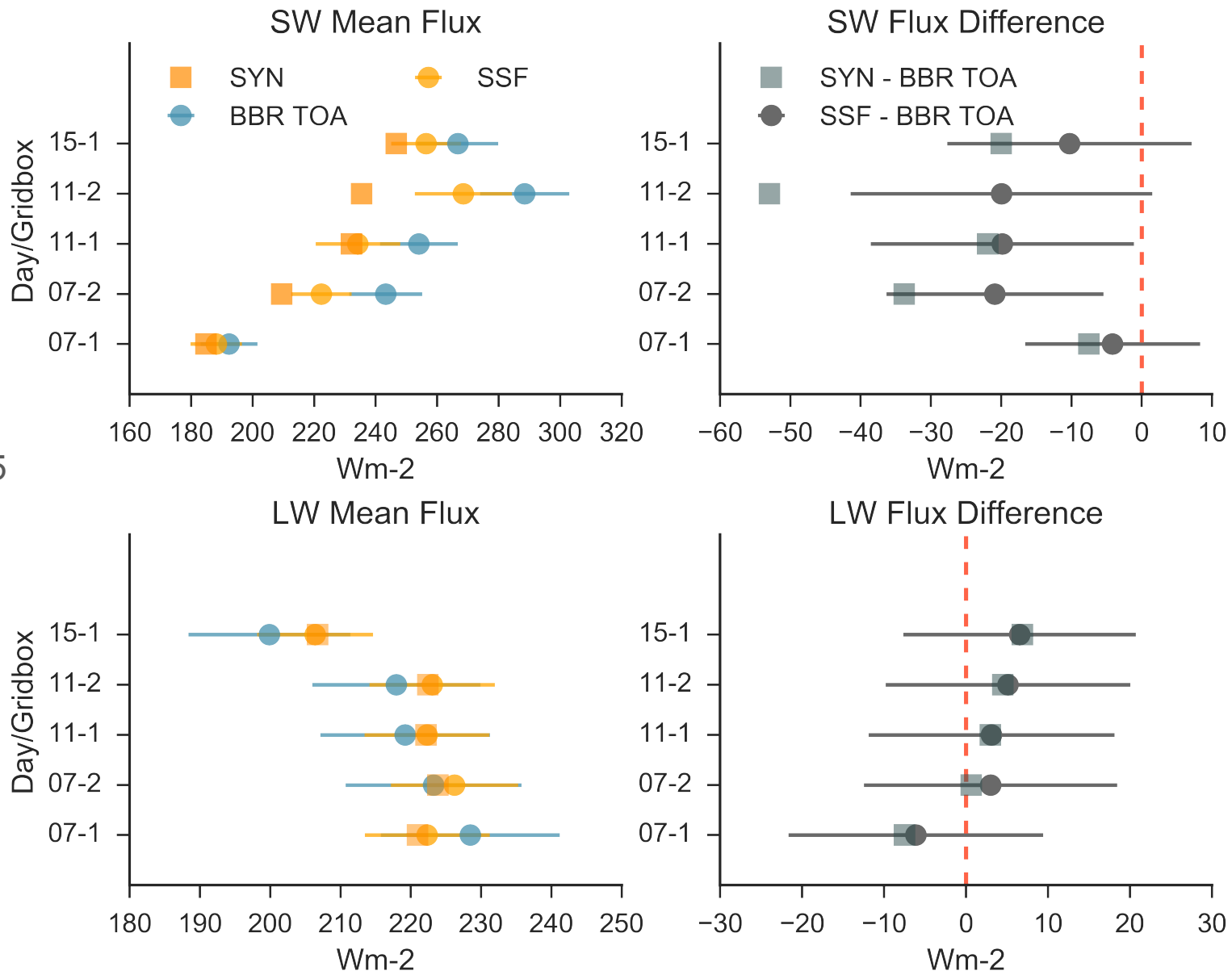
- Overcast ocean/marginal ice zone (MIZ)
- Overcast ocean/marginal ice zone (MIZ)
- Overcast sea ice
- Partly cloudy sea ice
- Overcast Ocean

ARISE Grid-box Results



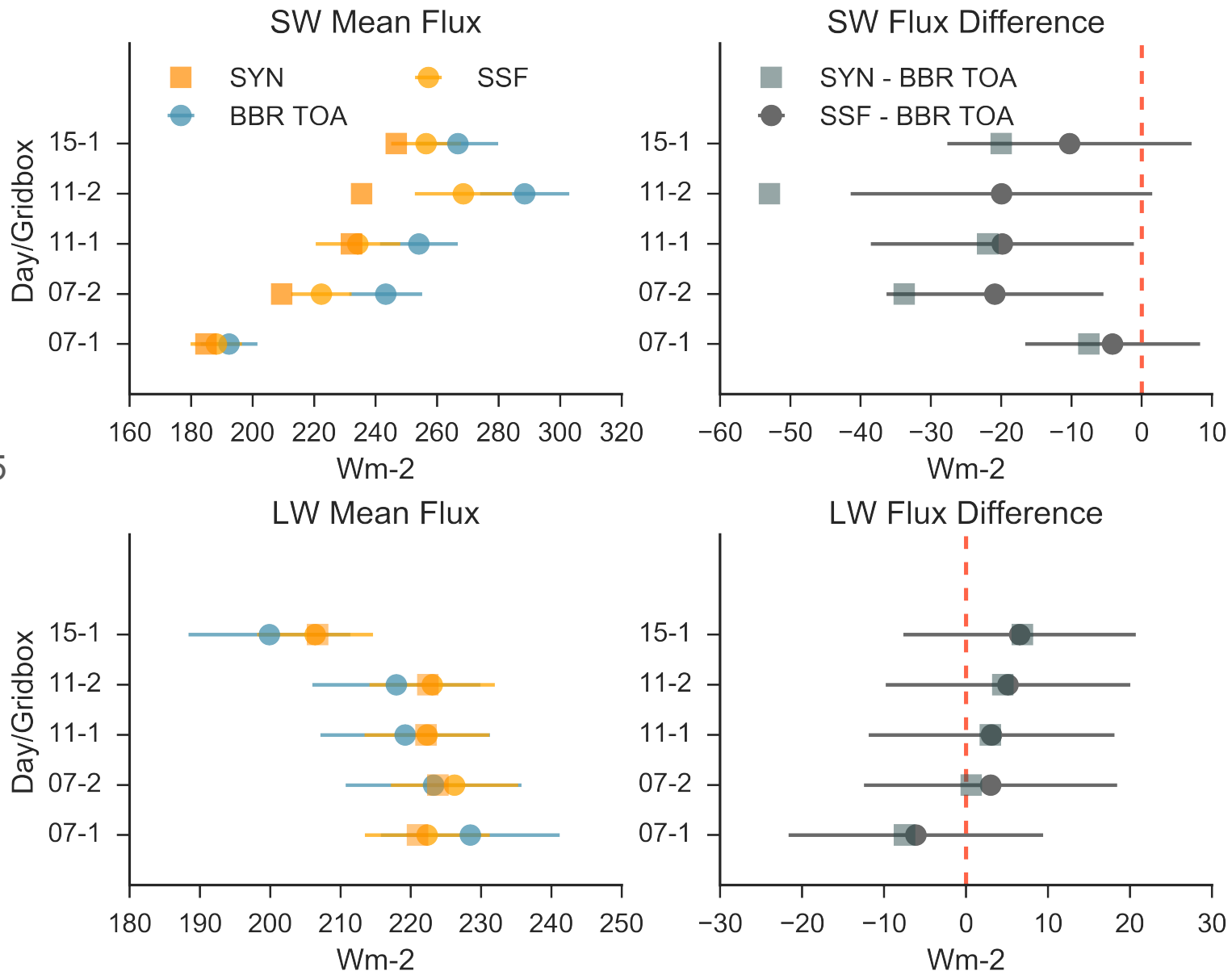
ARISE Grid-box Results

Overcast ocean
Partly cloudy sea ice
Overcast sea ice
Overcast MIZ
Overcast MIZ

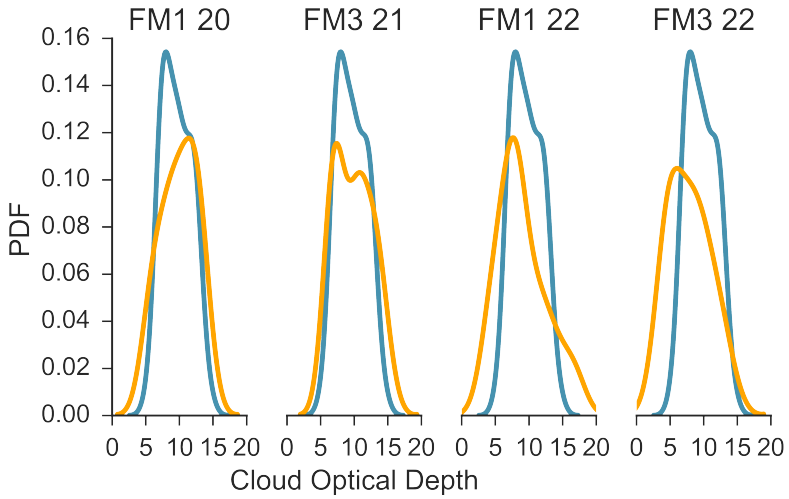


- LW shows good agreement for all grid-boxes
- SW shows agreement within uncertainty for 3/5 grid-boxes

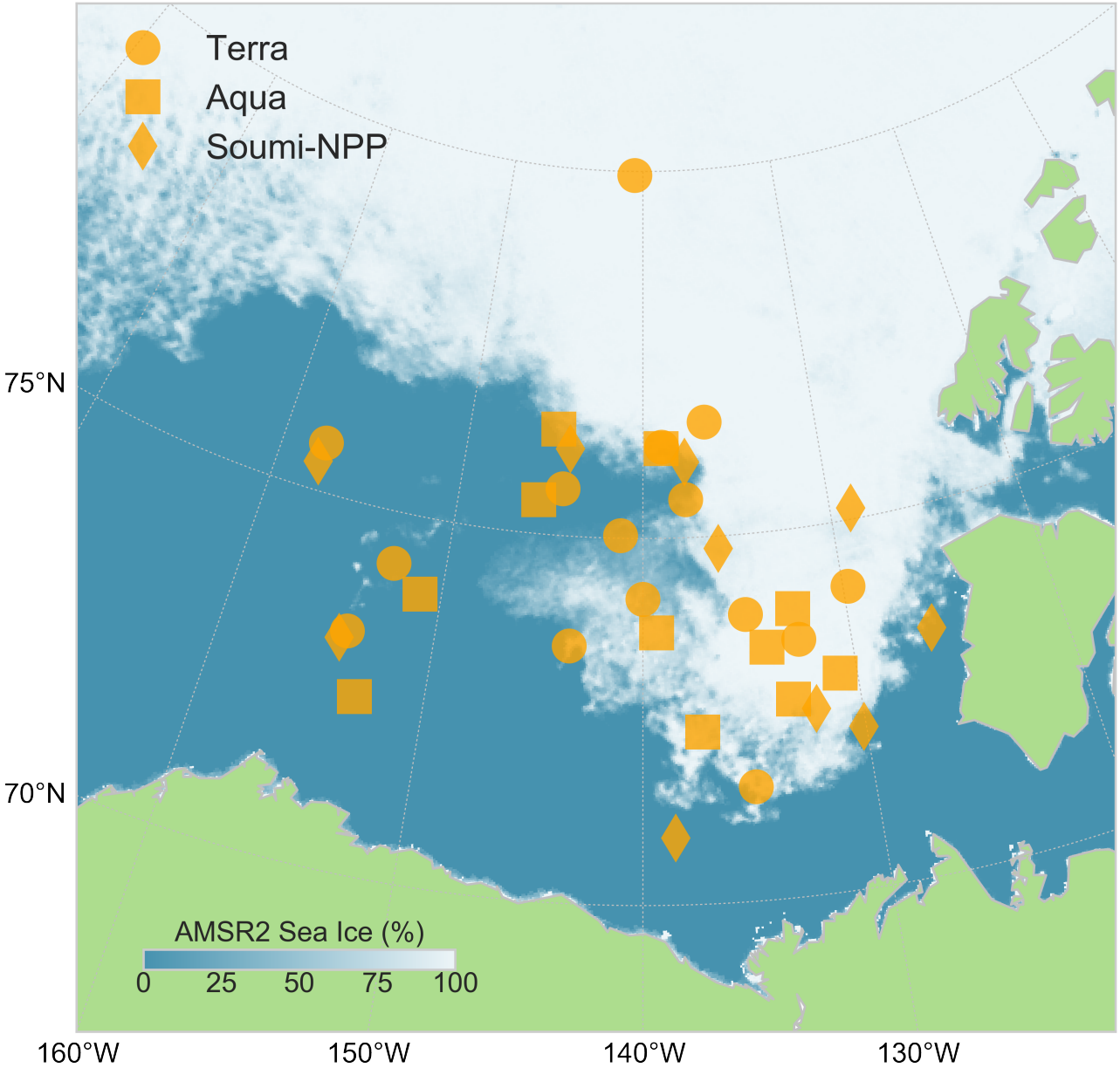
ARISE Grid-box Results



- LW shows good agreement for all grid-boxes
- SW shows agreement within uncertainty for 4/5 grid-boxes
- Cause of the negative biases?
  - Scene changes during experiment



ARISE Instantaneous Flux Comparison



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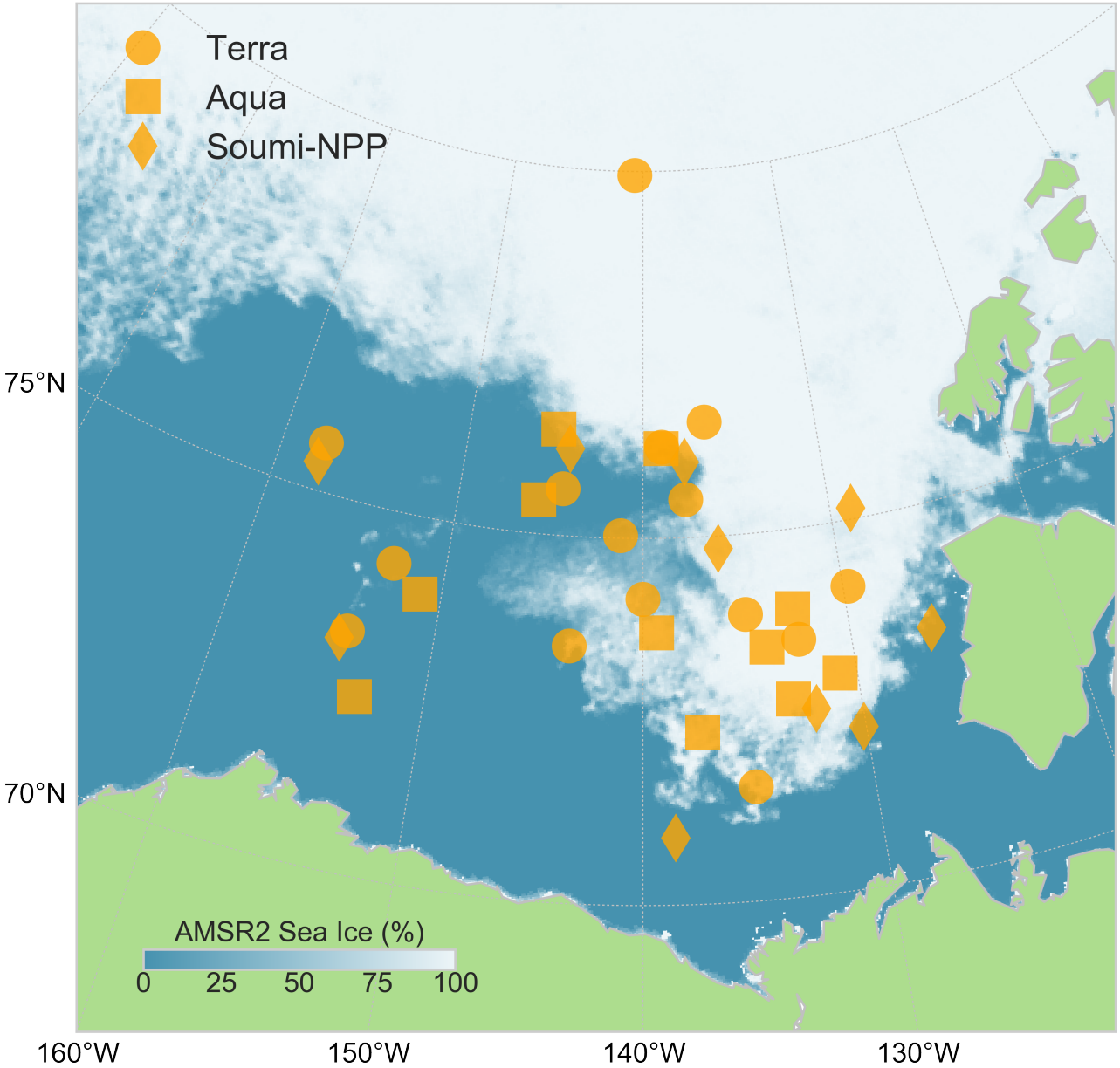
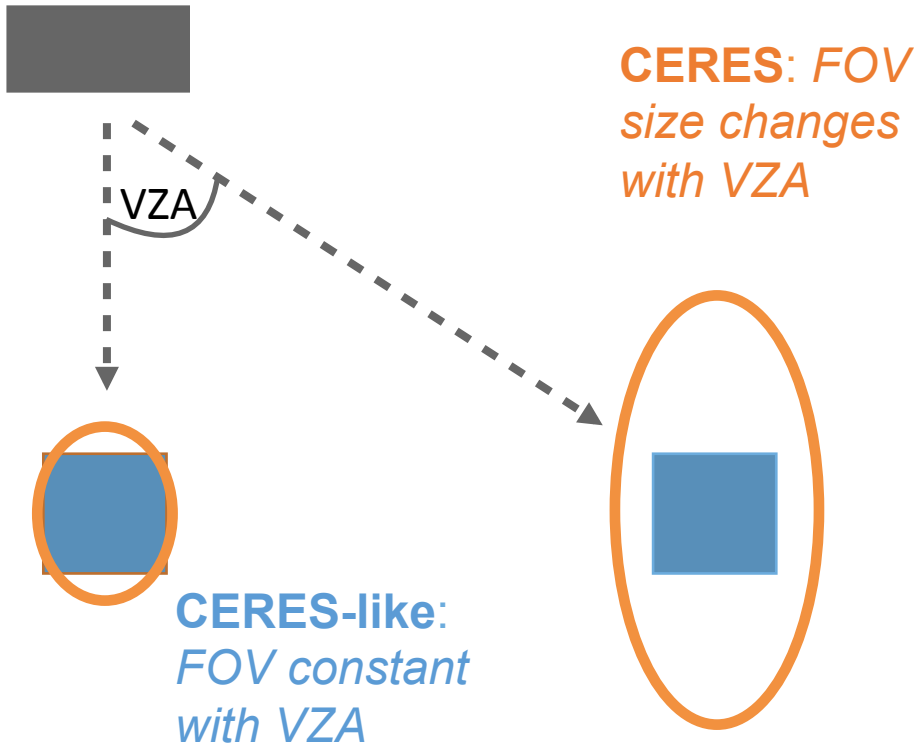


Two comparisons:

- **CERES** at footprint level
- **CERES-like**:
  1. Apply narrowband-to-broadband to MODIS pixel level radiance
  2. average over set number of pixels
  3. convert to flux



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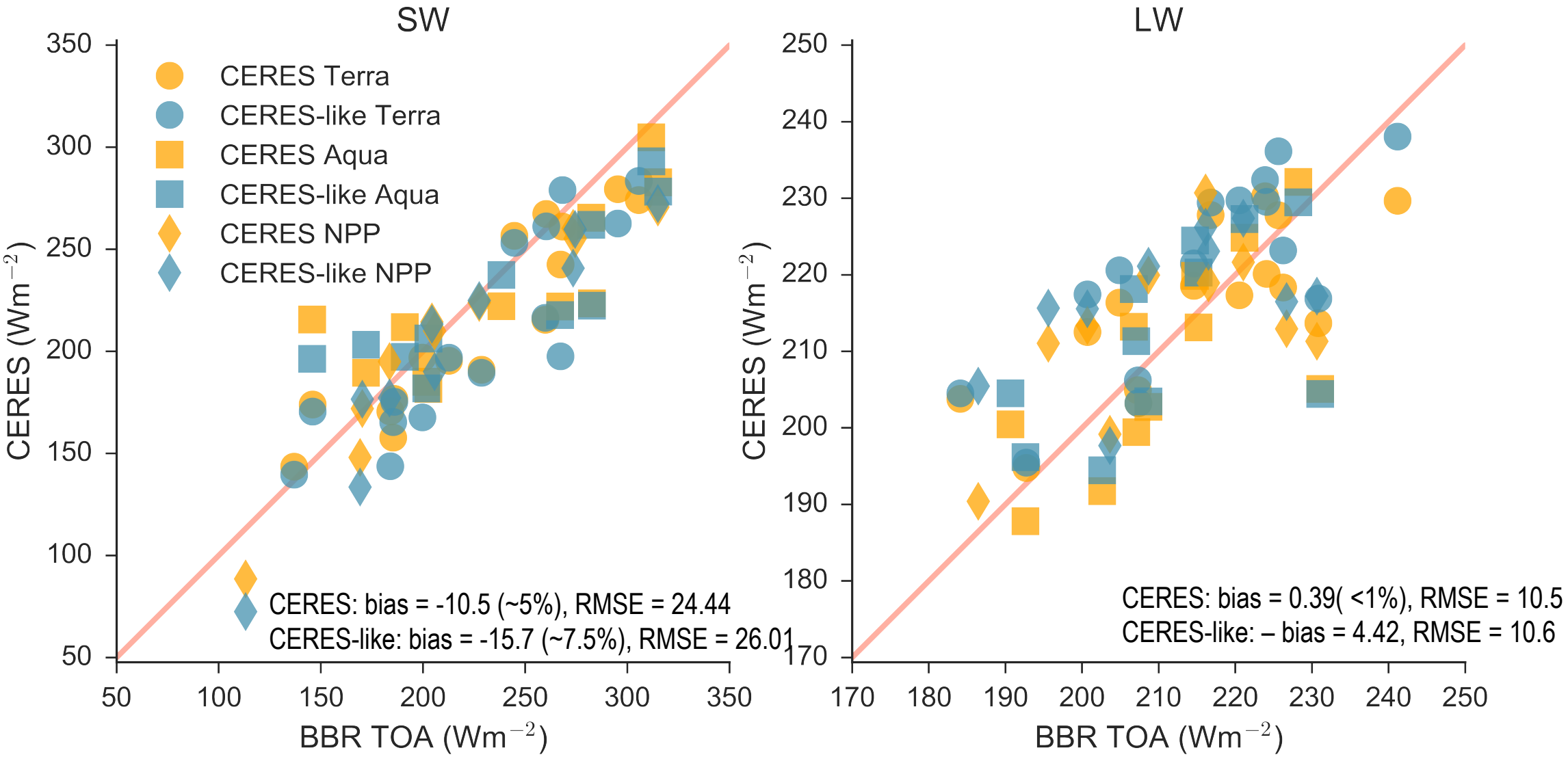
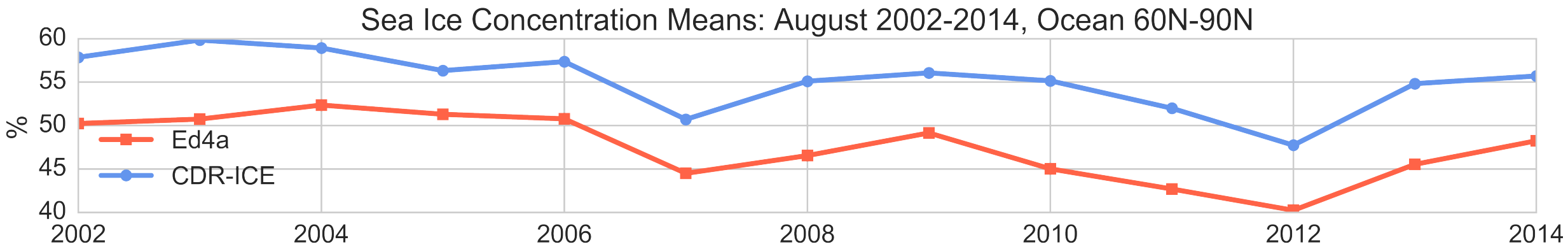
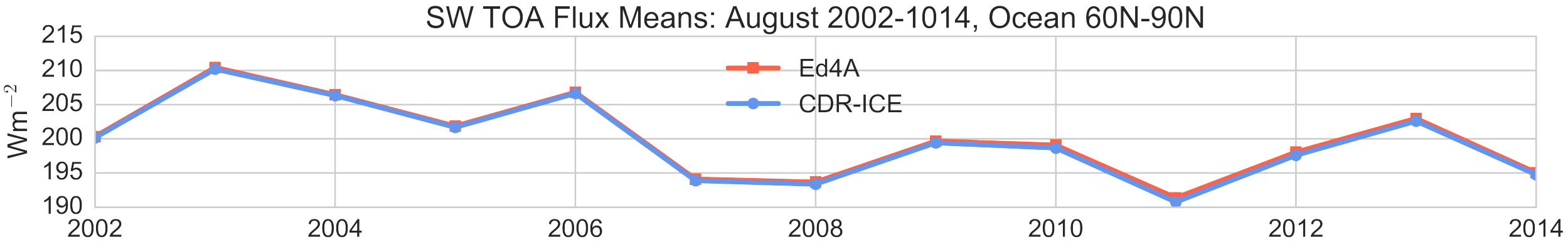


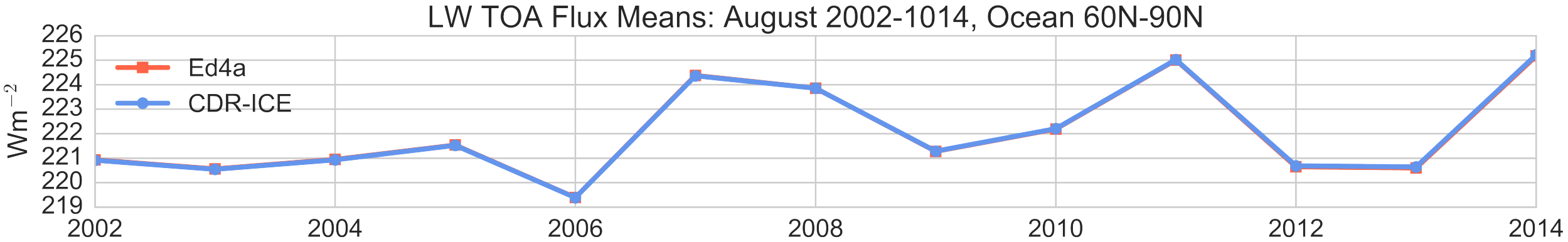
Sea Ice Datasets

	NSIDC Near-Real time Snow and Ice Extent (Ed4a)	NSIDC/NOAA Climate Data Record of Passive Microwave Sea Ice Concentration (CDR-ICE)
Instrument/ Radiances	SSMI, SSMIS on DMSP F13 and F17 19.4, 37.0 GHz Tb - NESDIS	SSMI, SSMIS on DMSP F13 and F17 19.4, 37.0 GHz Tb - RSS
Algorithm	GSFC NASA Team	Combination of GSFC NASA Team and GSFC Bootstrap
Resolution	25 Km	25 Km
Temporal Coverage	05/1994 – 10/2016	07/1987 - 12/2014
Quality Control	Low Forward processing only	High Consistent algorithm over time series Grid cell uncertainty estimates and quality flags

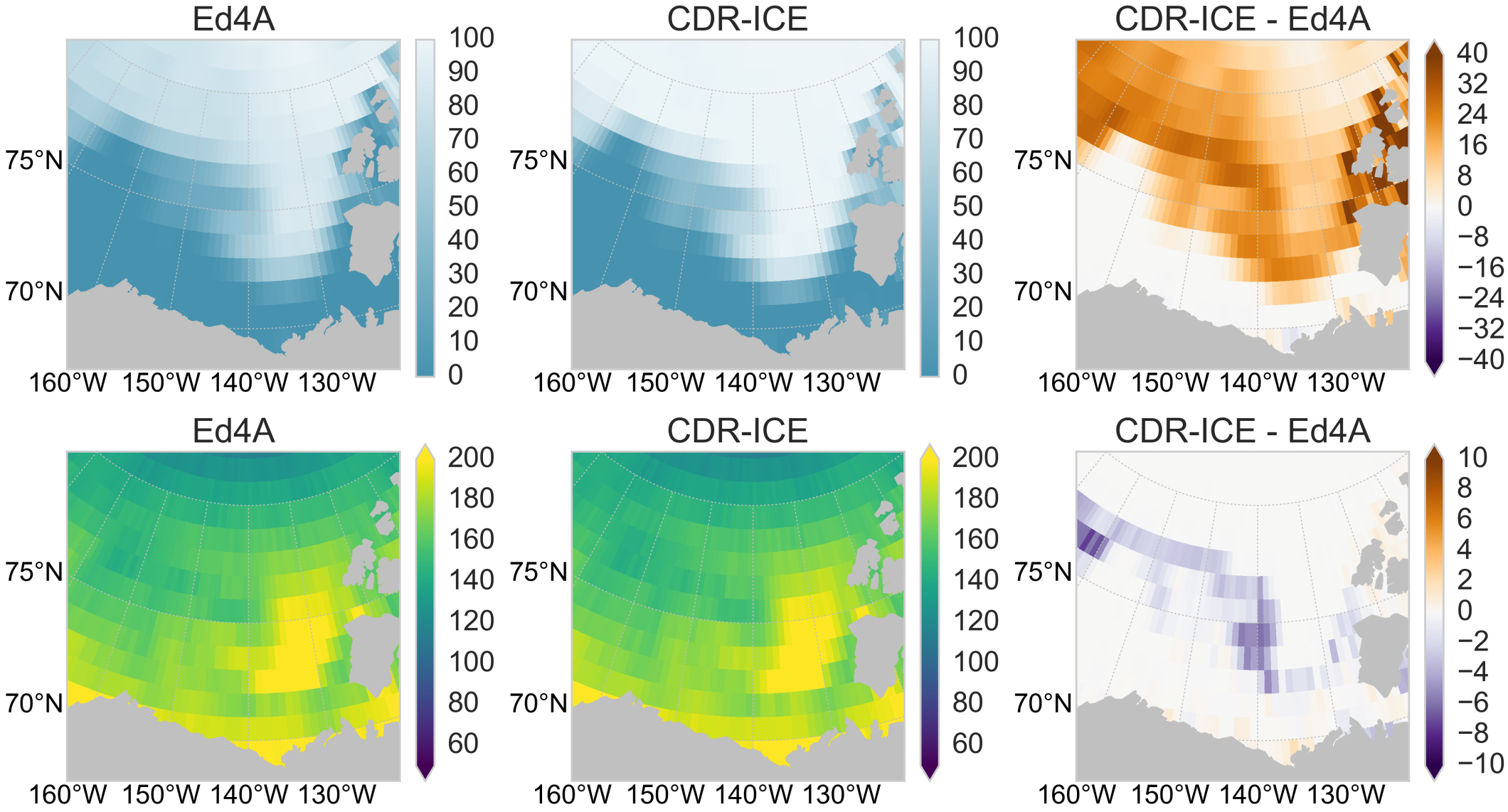
Sea Ice Datasets – Arctic Means







Sea Ice and SW Flux changes – ARISE Sep 2014



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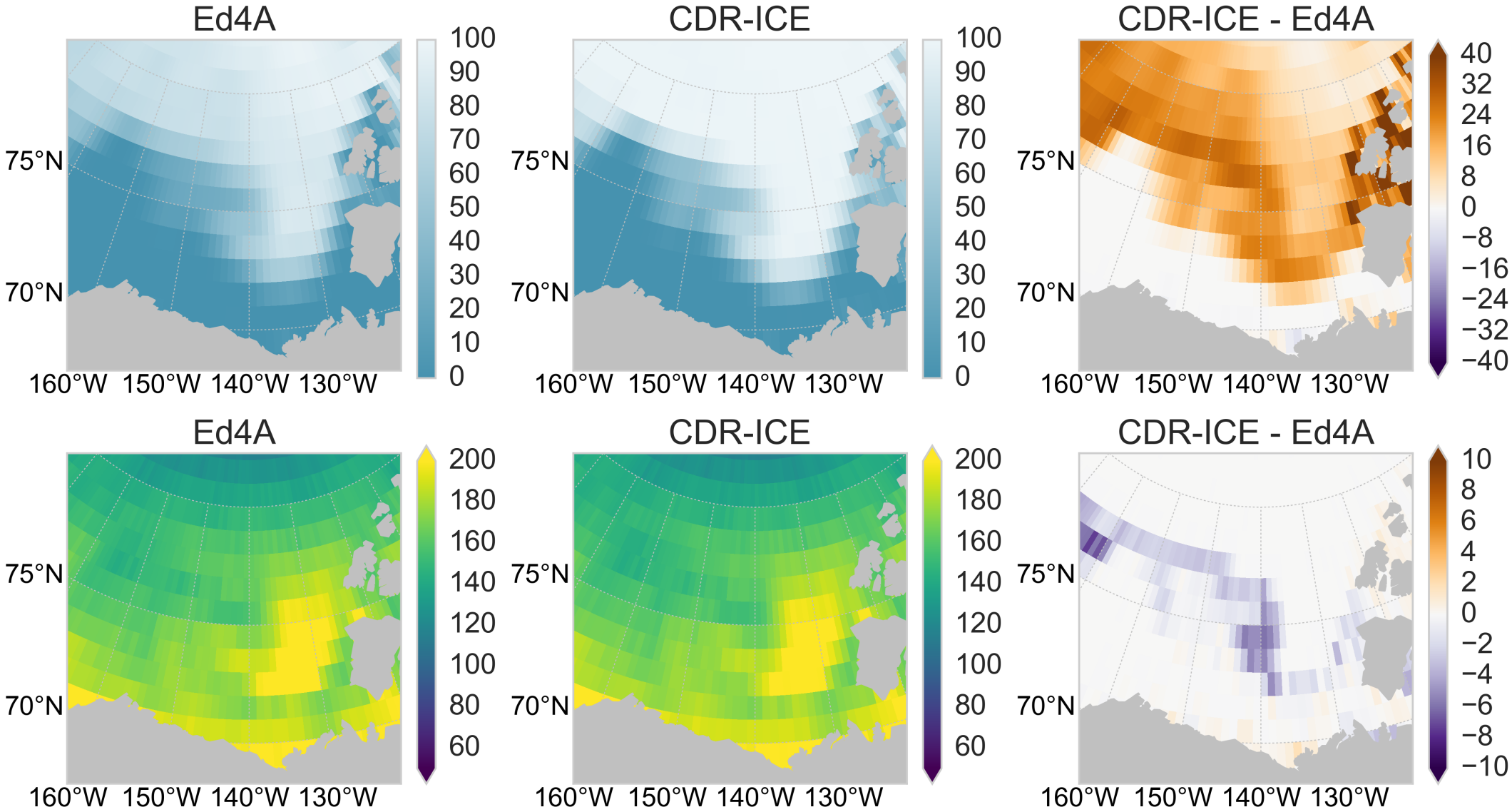
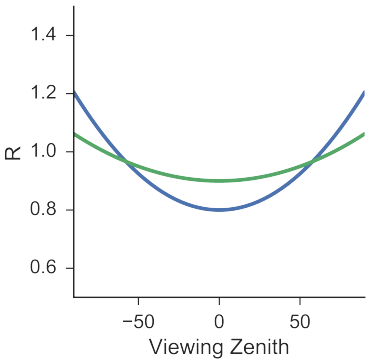
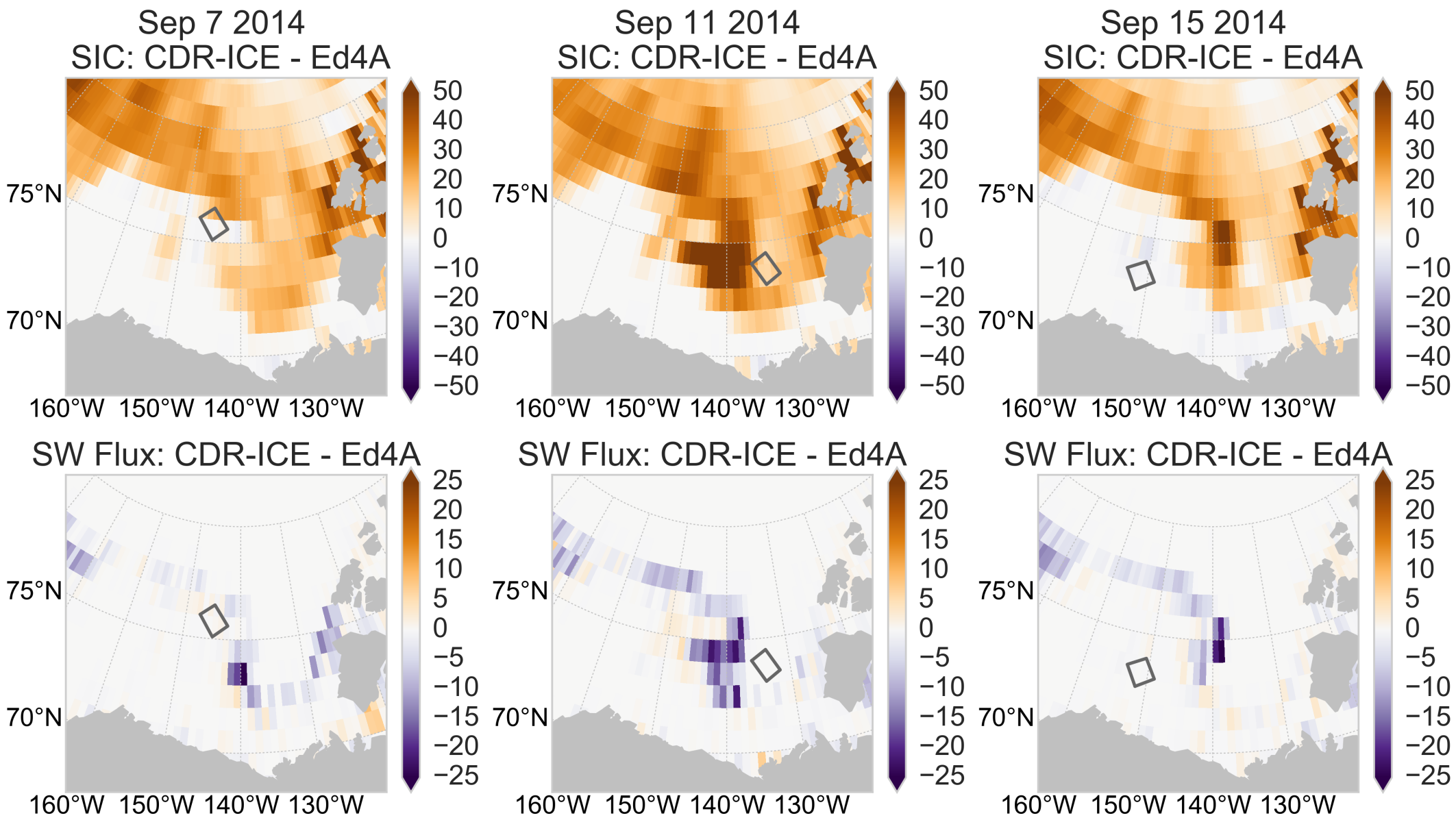


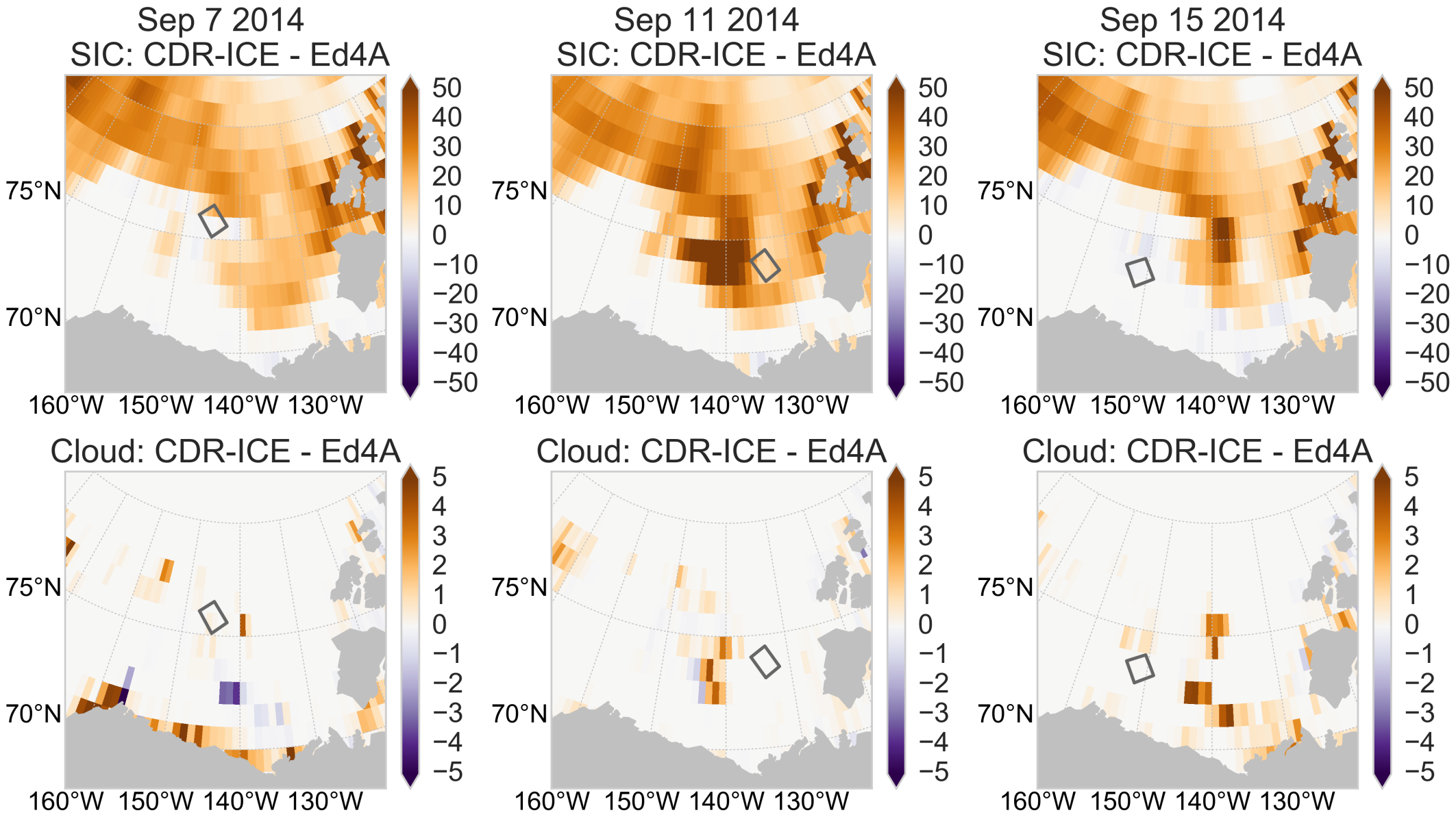
$$F = \frac{\pi I}{R(sceneID)}$$



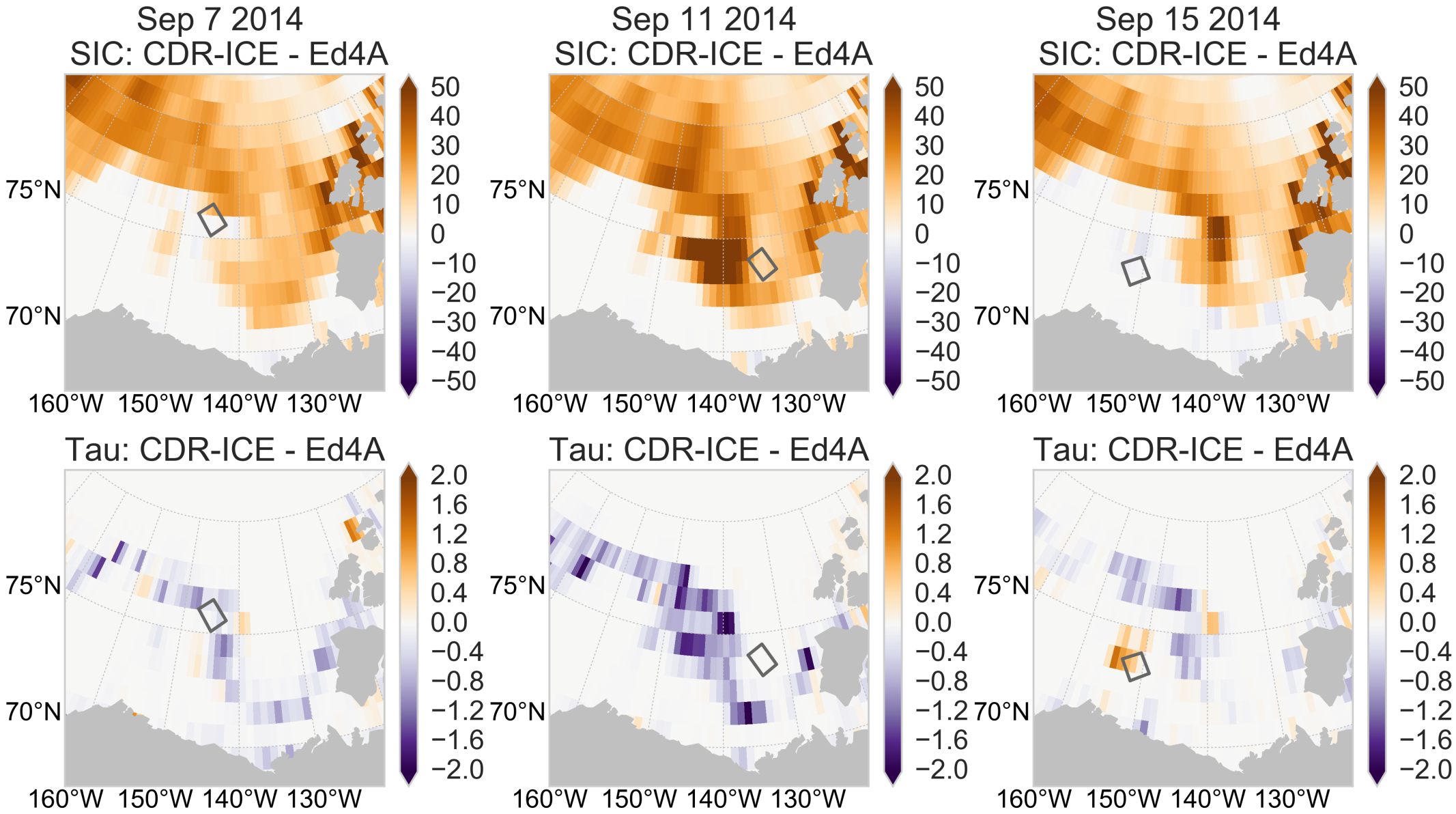
ARISE Days: Sea Ice and SW flux differences



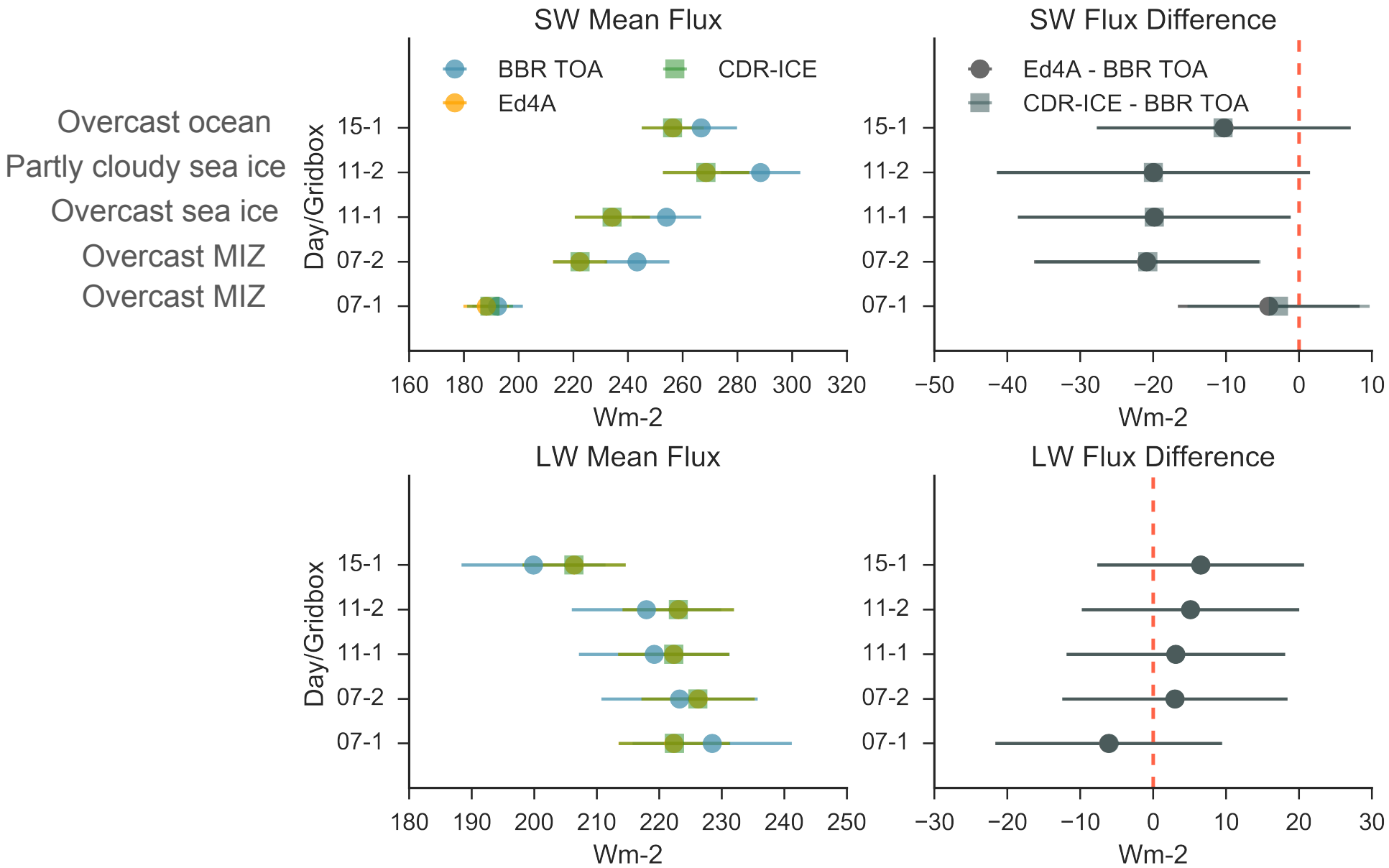
ARISE Days: Cloud Coverage Differences



ARISE Days: Cloud Optical Depth Differences



Sea Ice Datasets and ARISE - Grid box



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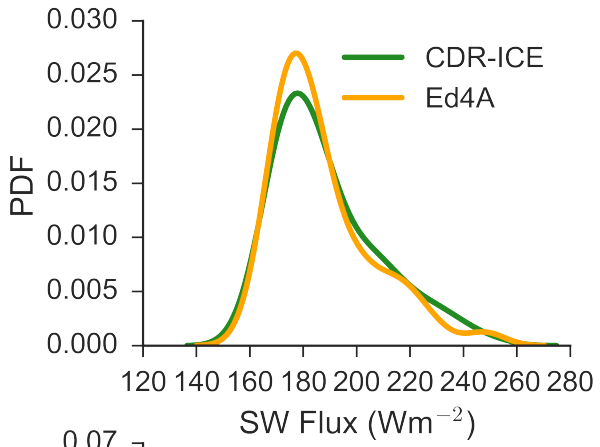

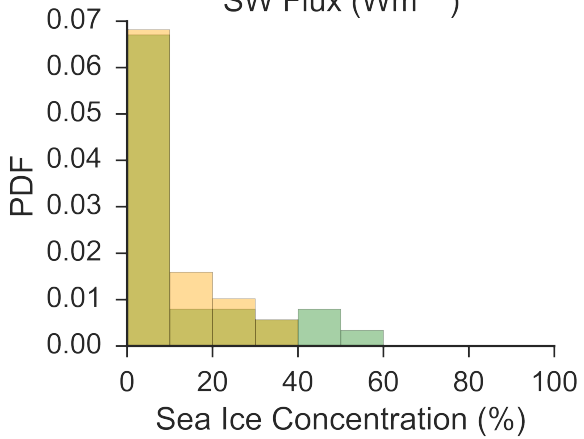

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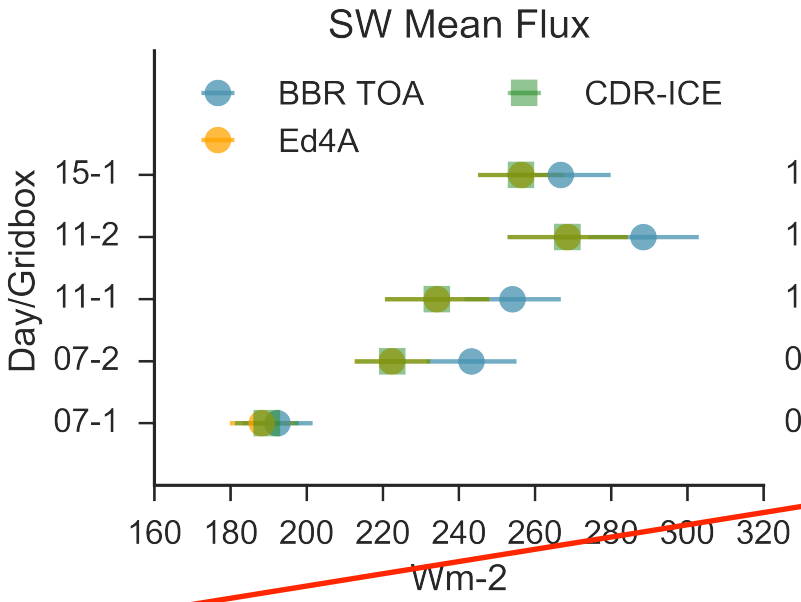
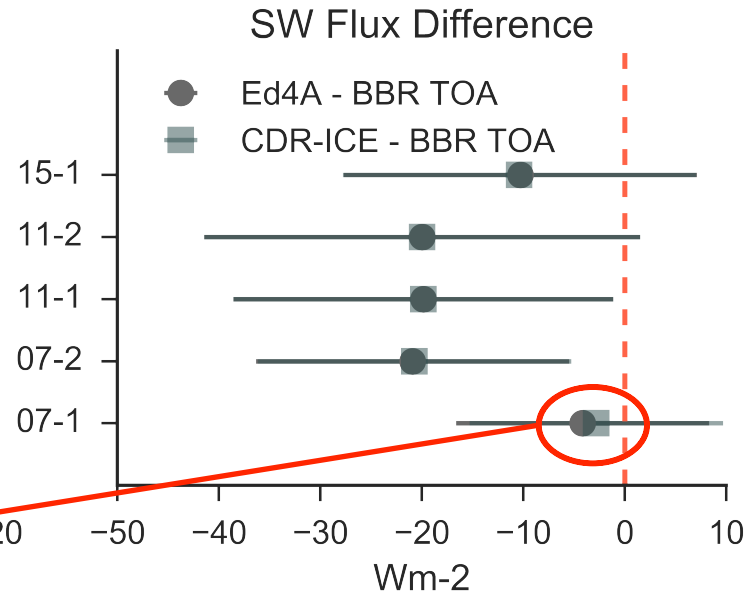
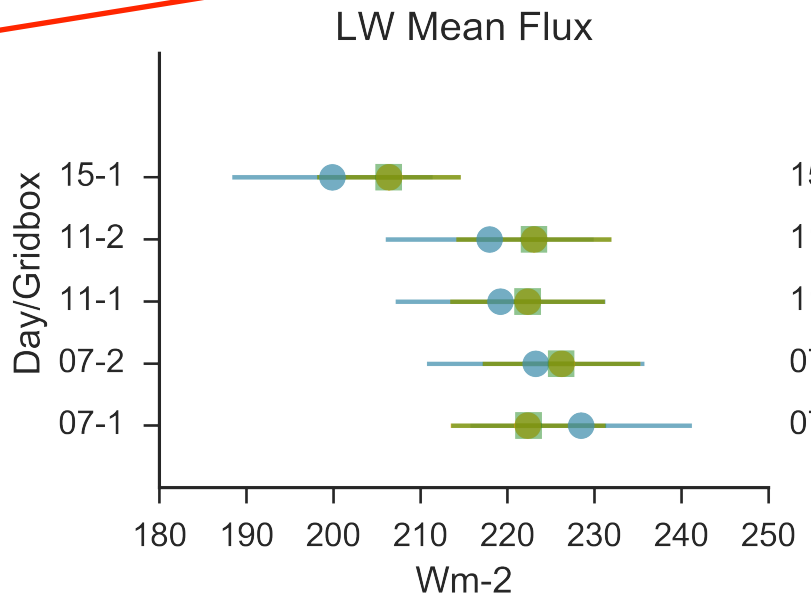
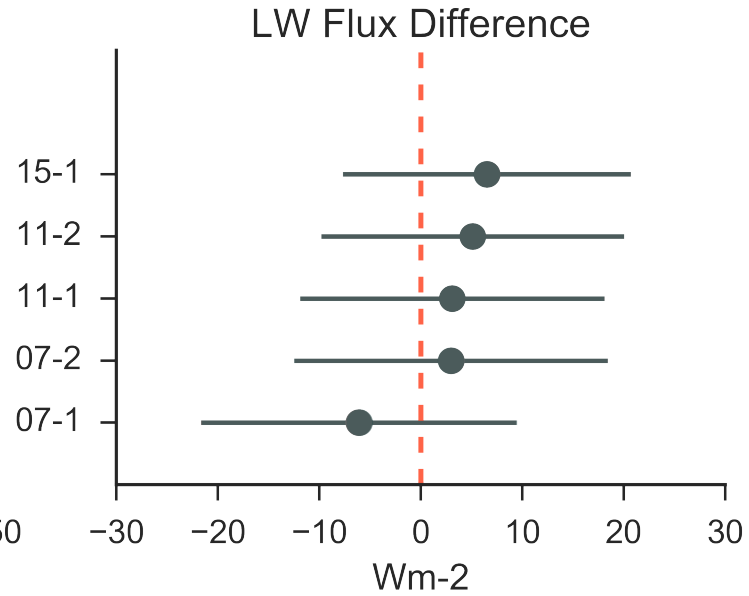
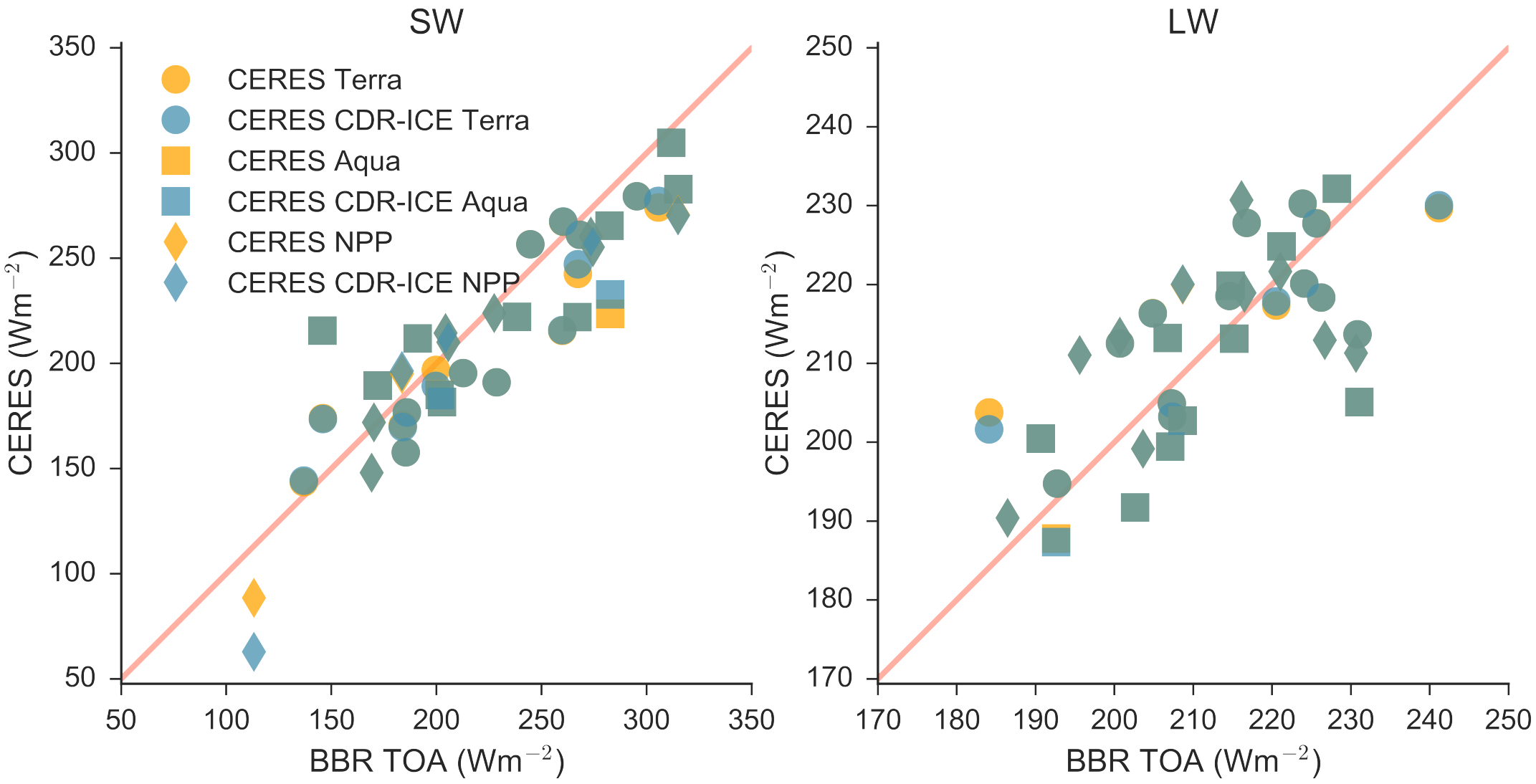








Sea Ice Datasets and ARISE - Instantaneous



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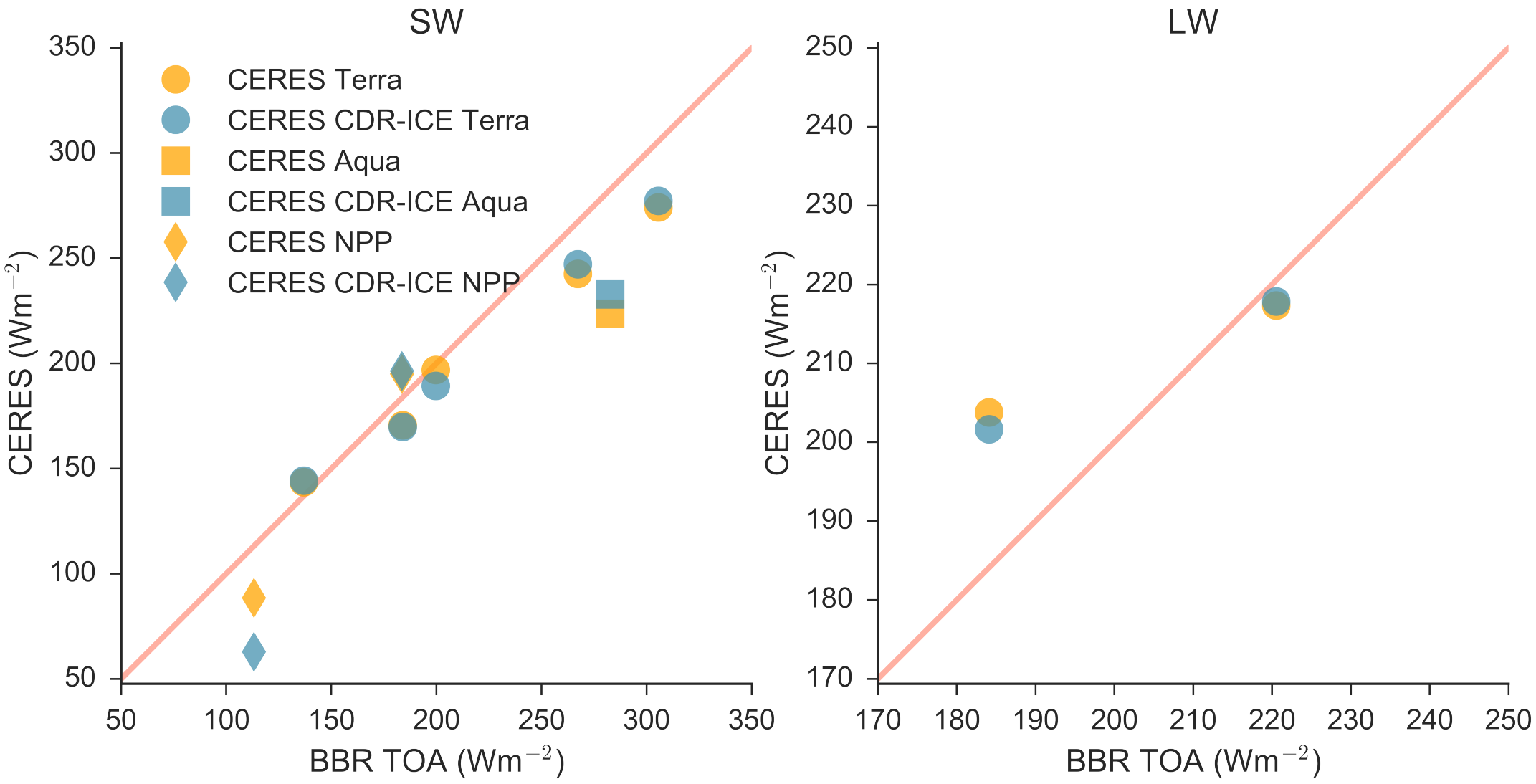

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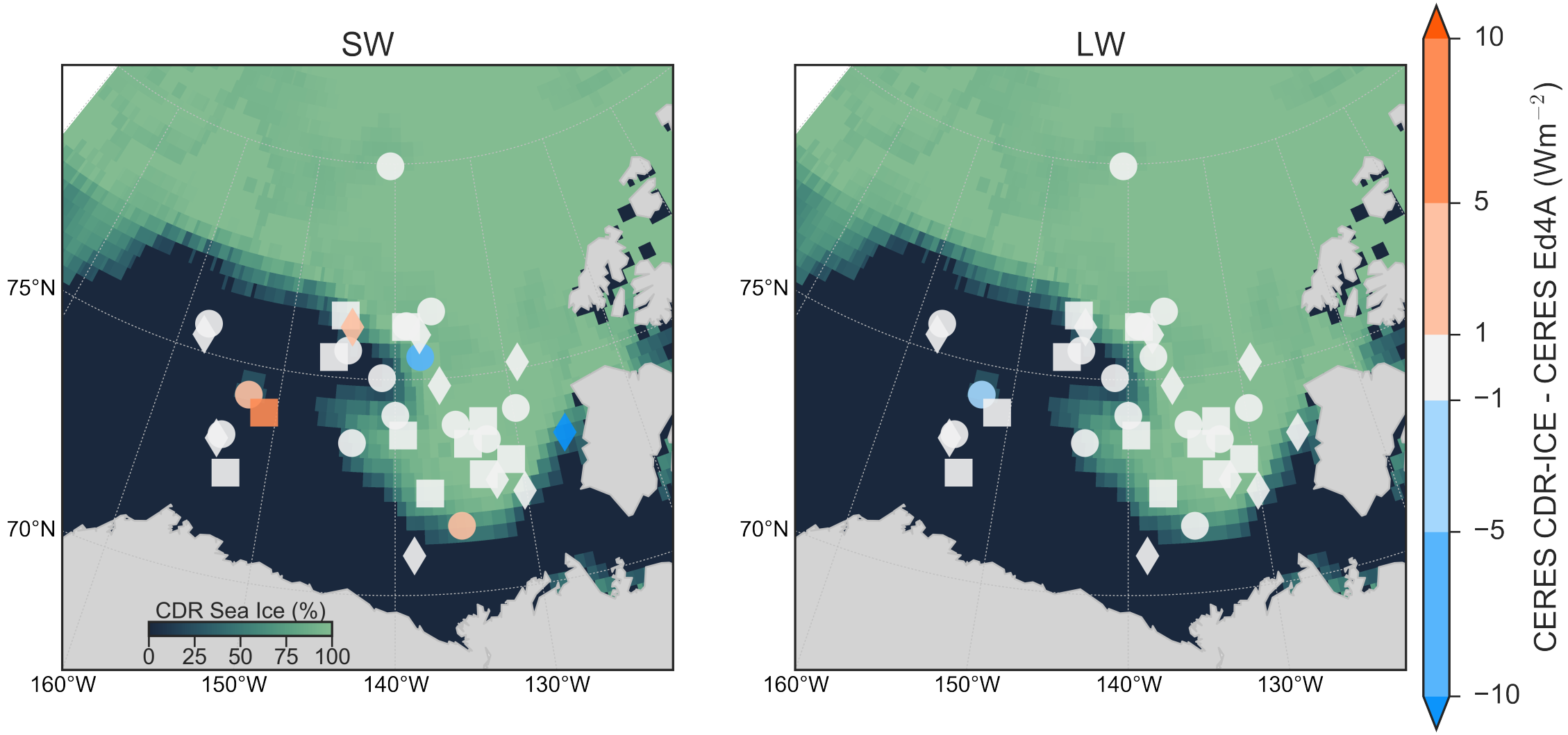
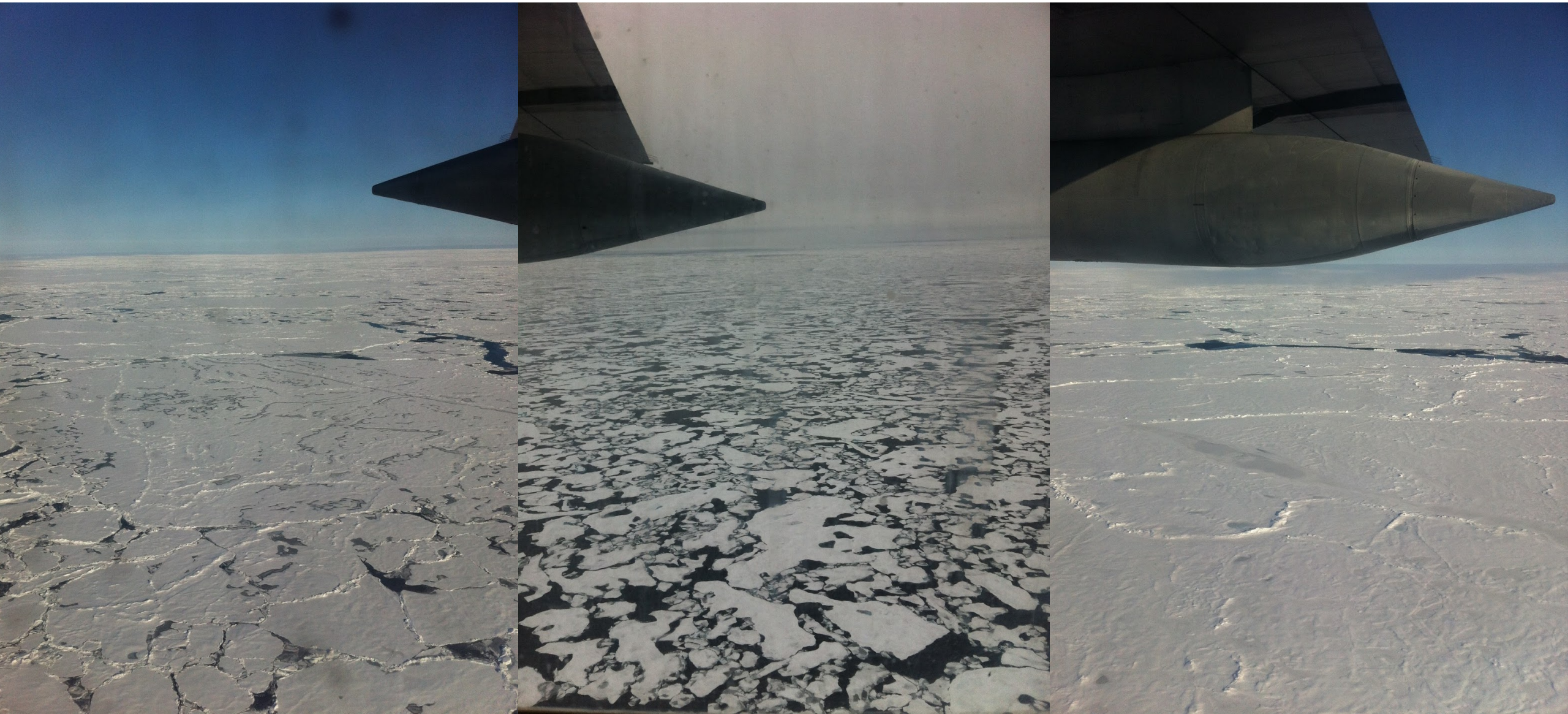
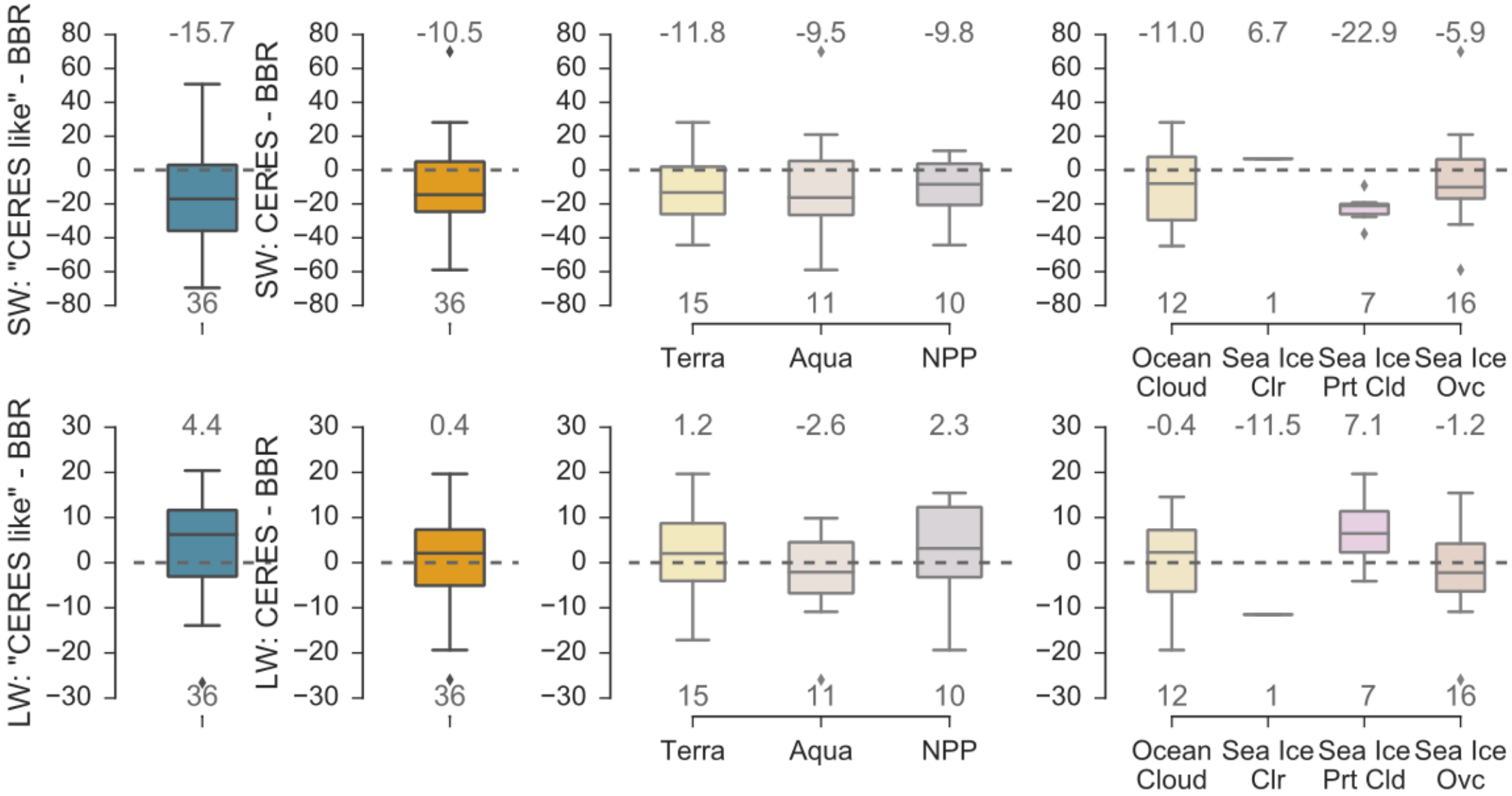


Summary

- Comparing CERES to NRL BBR shows a negative difference in the shortwave, and good agreement in the long wave during the ARISE campaign.
- True for both grid box averaged and instantaneous comparisons (but limited sampling).
- It does not seem that the difference is caused by sea ice related scene identification errors.
- Changing the sea ice dataset only affects a small number of data points in the ARISE comparison, however the points affected generally show a (small) decrease in difference.

Thank you!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