Validating CERES Surface Irradiance in the Arctic with Airborne Radiometer Measurements from the ARISE Campaign

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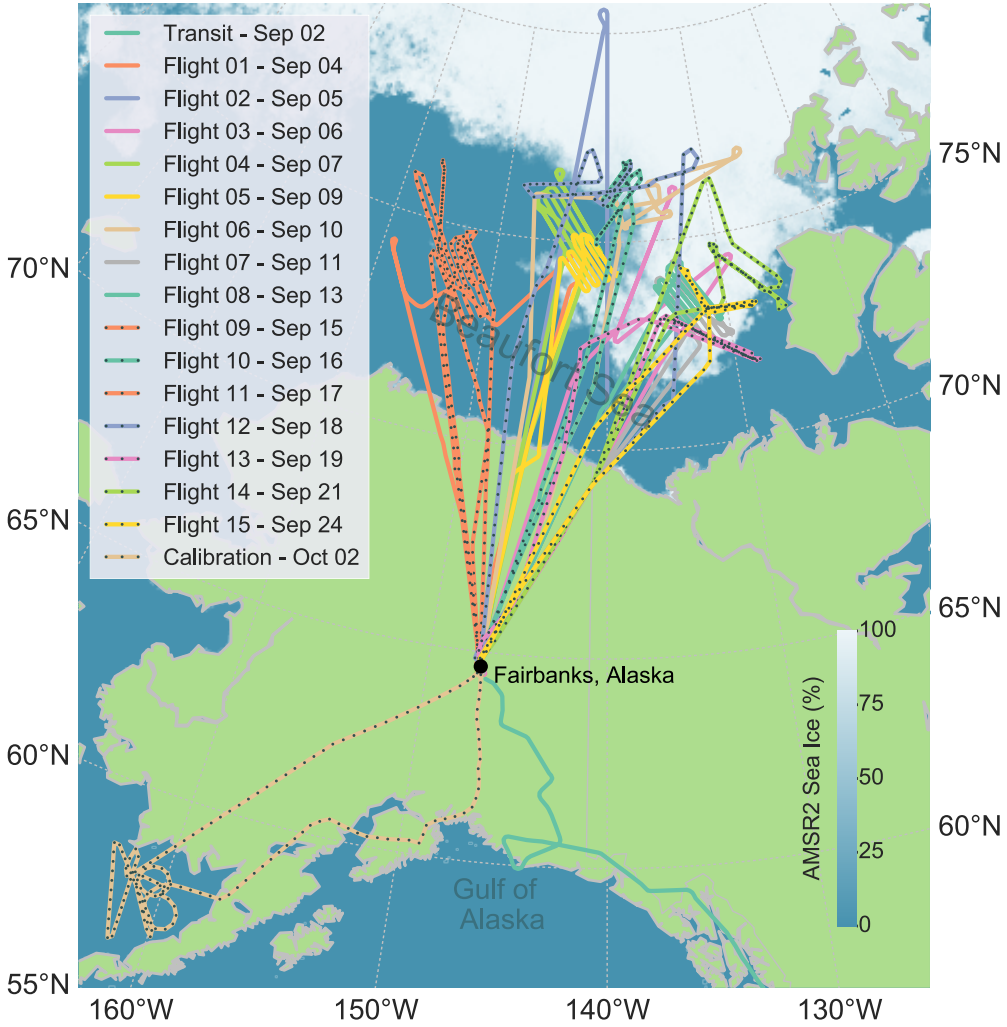
CERES Science Team Meeting Spring 2017

Arctic Radiation-IceBridge Sea & Ice Experiment

Based in Fairbanks, Alaska during September 2014

From the NASA C-130:

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



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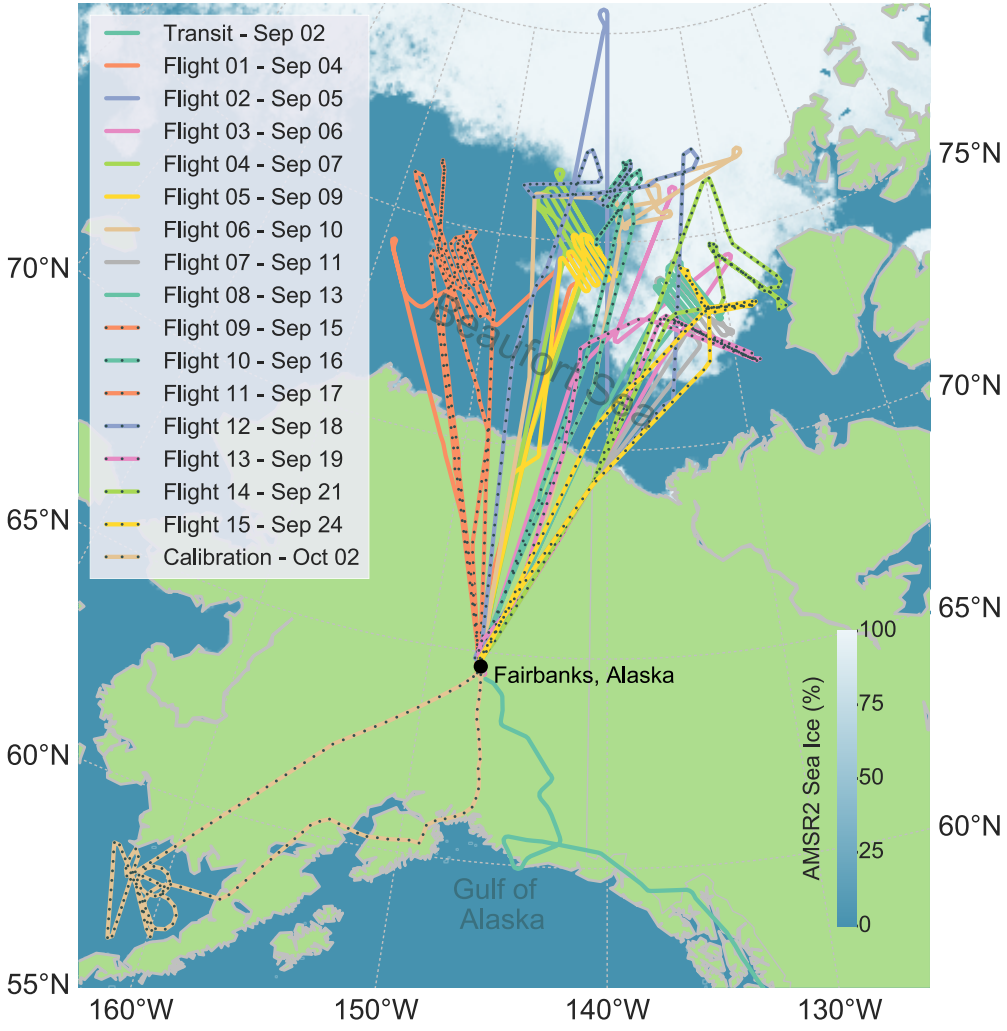
Naval Research Laboratory Broadband Radiometers (BBR):

- SW up and down – modified Kipp and Zonen CM-22 pyranometers
- LW up and down – modified Kipp and Zonen CG-4 pyrgeometers
- estimated uncertainty ~ 3-5%



CERES SYN and Existing Arctic Validation

Clouds and the Earth's Radiant Energy System Edition 4A **Synoptic** Dataset (CERES SYN):

- Hourly SW and LW up-welling and down-welling computed surface fluxes on a 1°x1° grid
- Cloud properties from MODIS
- Atmosphere from GEOS 5.4.1
- Tuned to CERES TOA measurements

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- Current estimate of uncertainty in the Arctic (monthly mean):
  - Down welling SW: 12 Wm^{-2}
  - Down welling LW: 21 Wm^{-2}

Comparing CERES SYN and BBR

3 Comparisons:

1. CERES SYN and BBR:
    - Compare the mean SYN SW and LW, upwards and downwards irradiances with corresponding mean measured BBR irradiances.

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2. Model irradiances and BBR
    - Use the Langley Fu-Liou radiative transfer model, with standard CERES inputs to calculate irradiances at aircraft level collocated with each 1-min averaged BBR measurement.
    - Gives “SYN-like” fluxes with same spatial and temporal sampling as BBR

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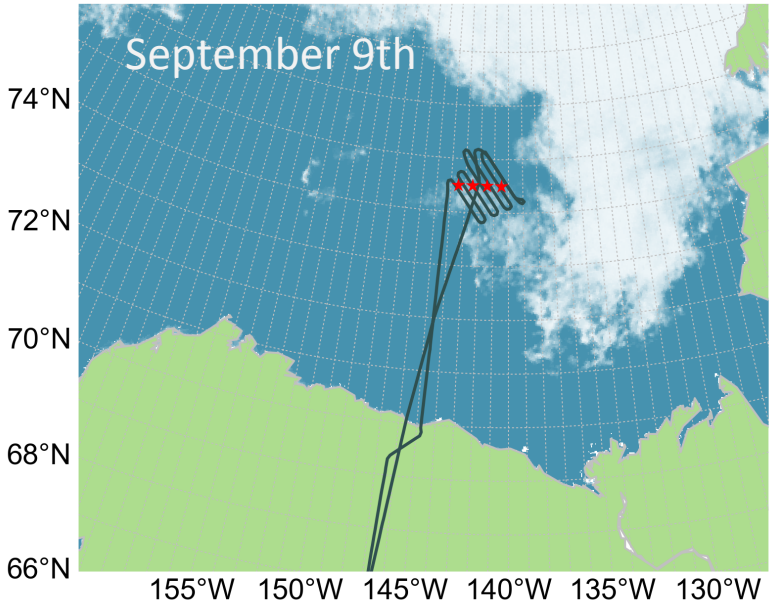
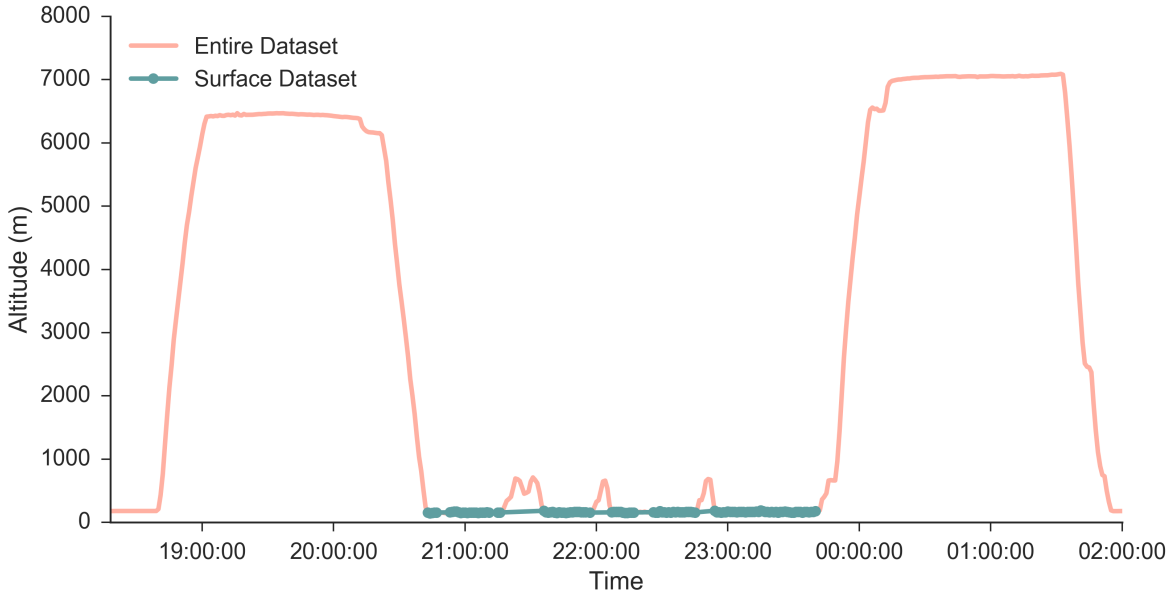
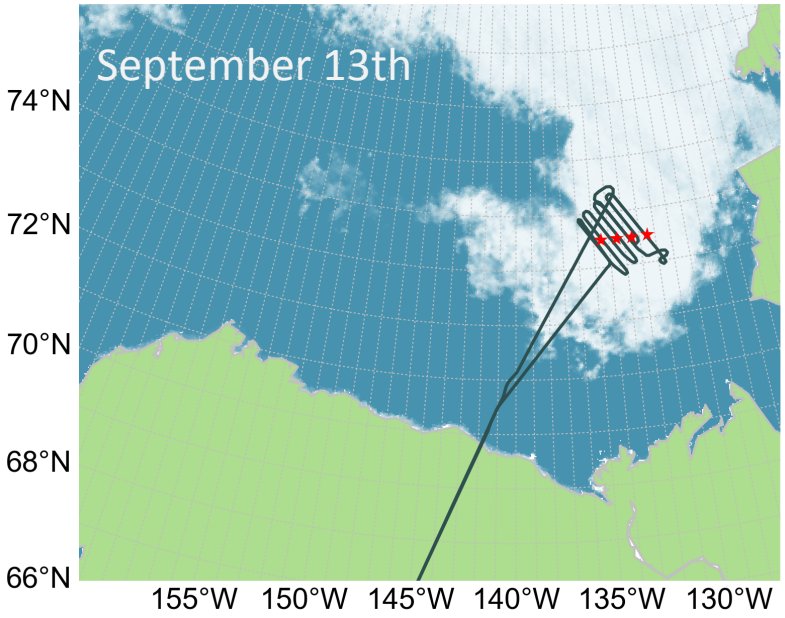
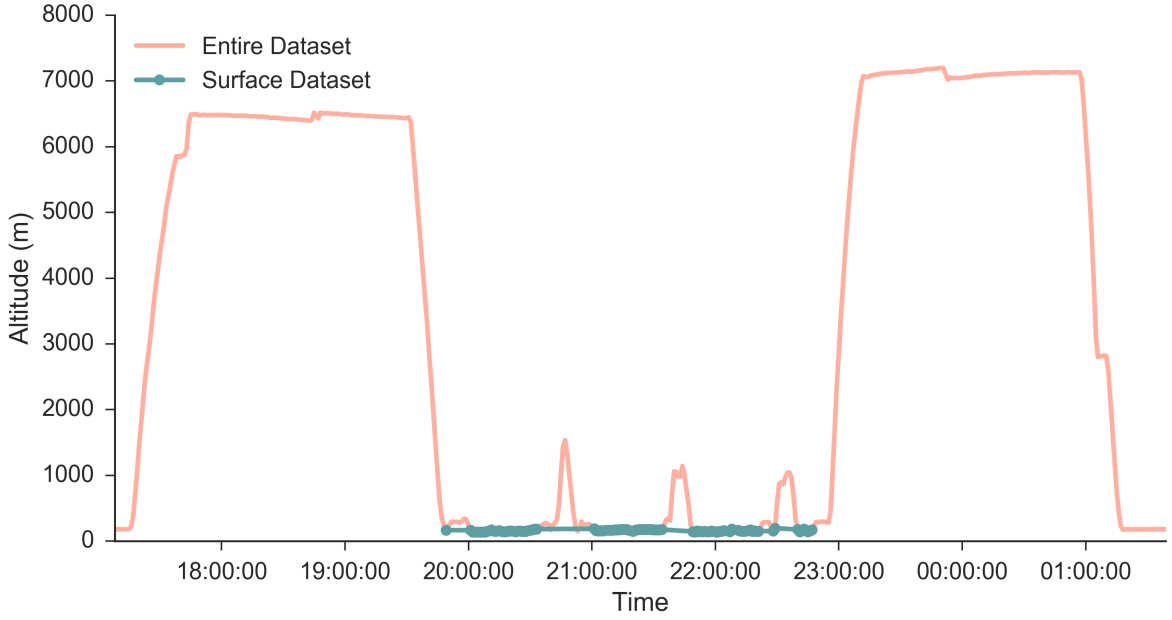
    - Gives “SYN-like” fluxes with same spatial and temporal sampling as BBR
3. Model irradiances with additional aircraft observations and BBR
    - Use the Langley Fu-Liou radiative transfer model, replacing some of the standard CERES inputs with ancillary measurements taken from the aircraft.
    - Tests the effect of changing inputs on the comparison

CERES SYN and ARISE





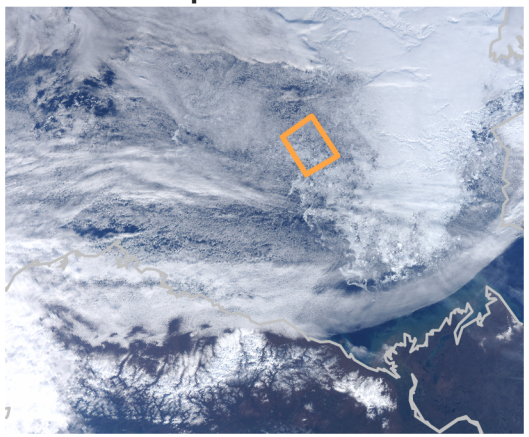




Scene Conditions

September 9th

Aqua 20:59



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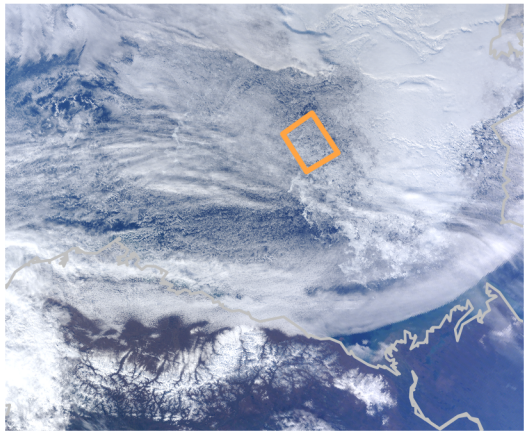

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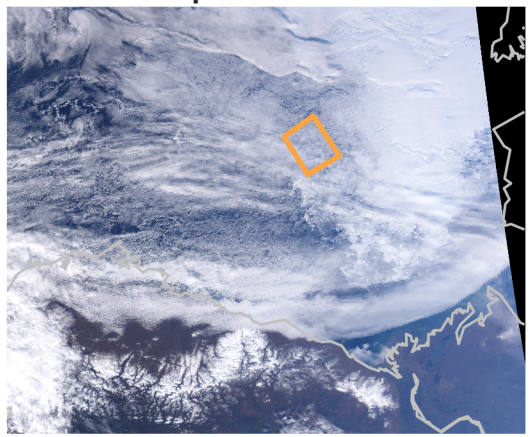

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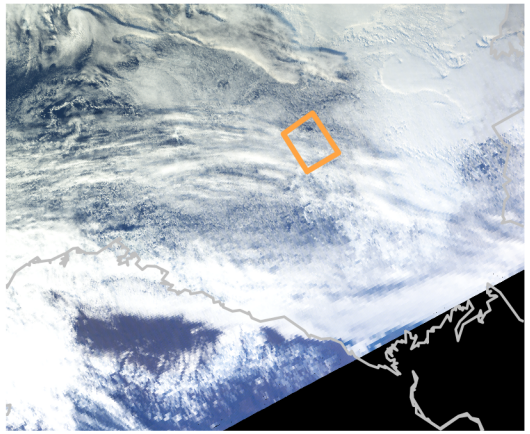

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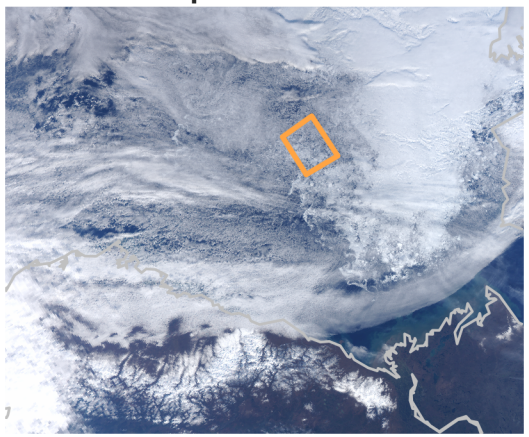

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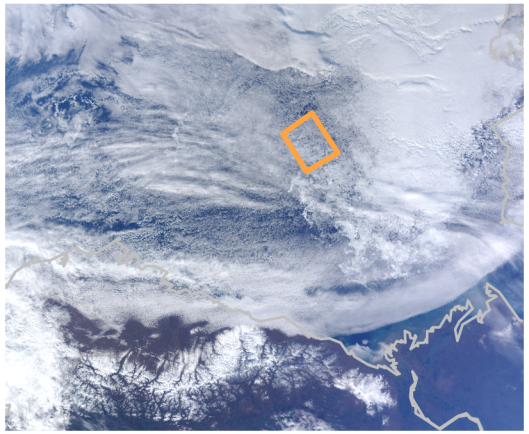

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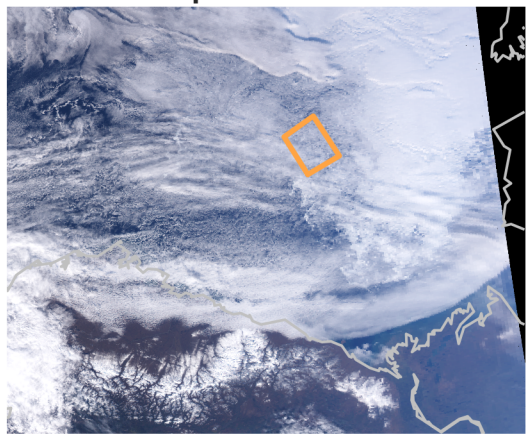

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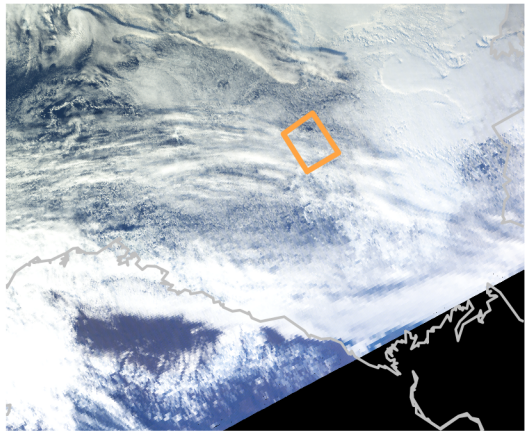

September 13th

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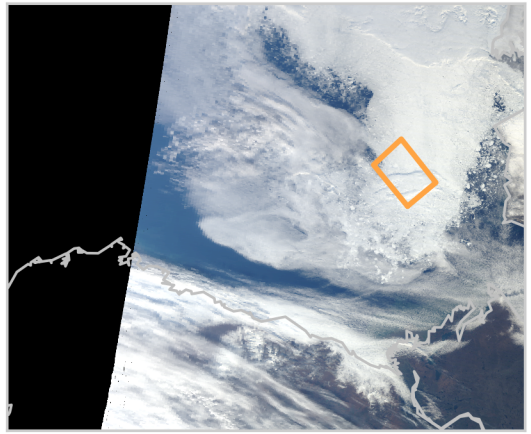

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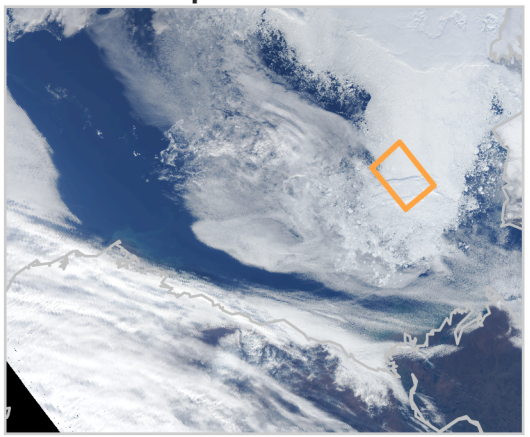

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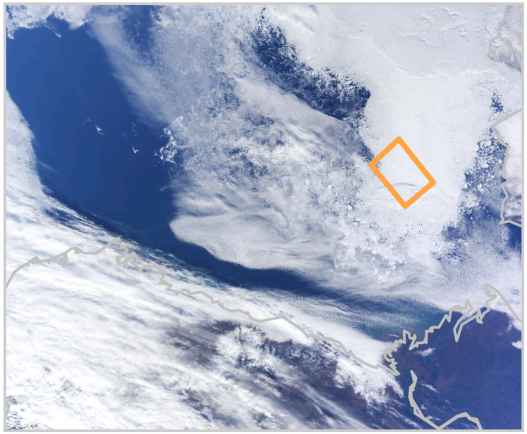

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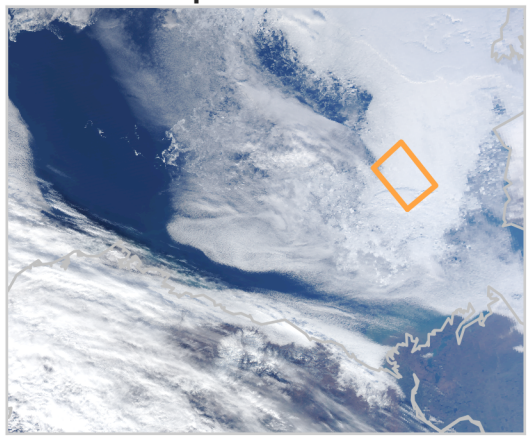
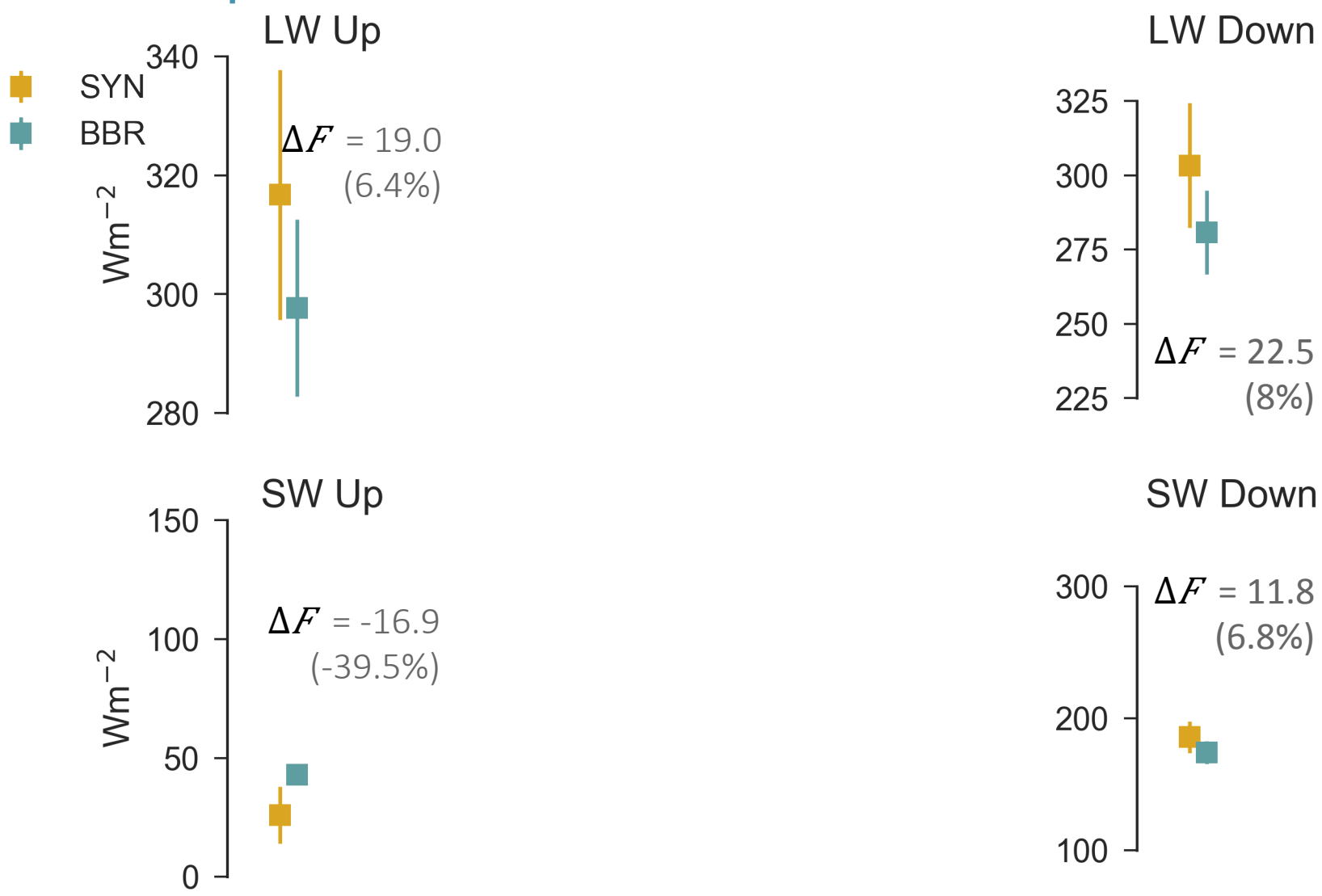


Comparison between CERES and BBR - 9th



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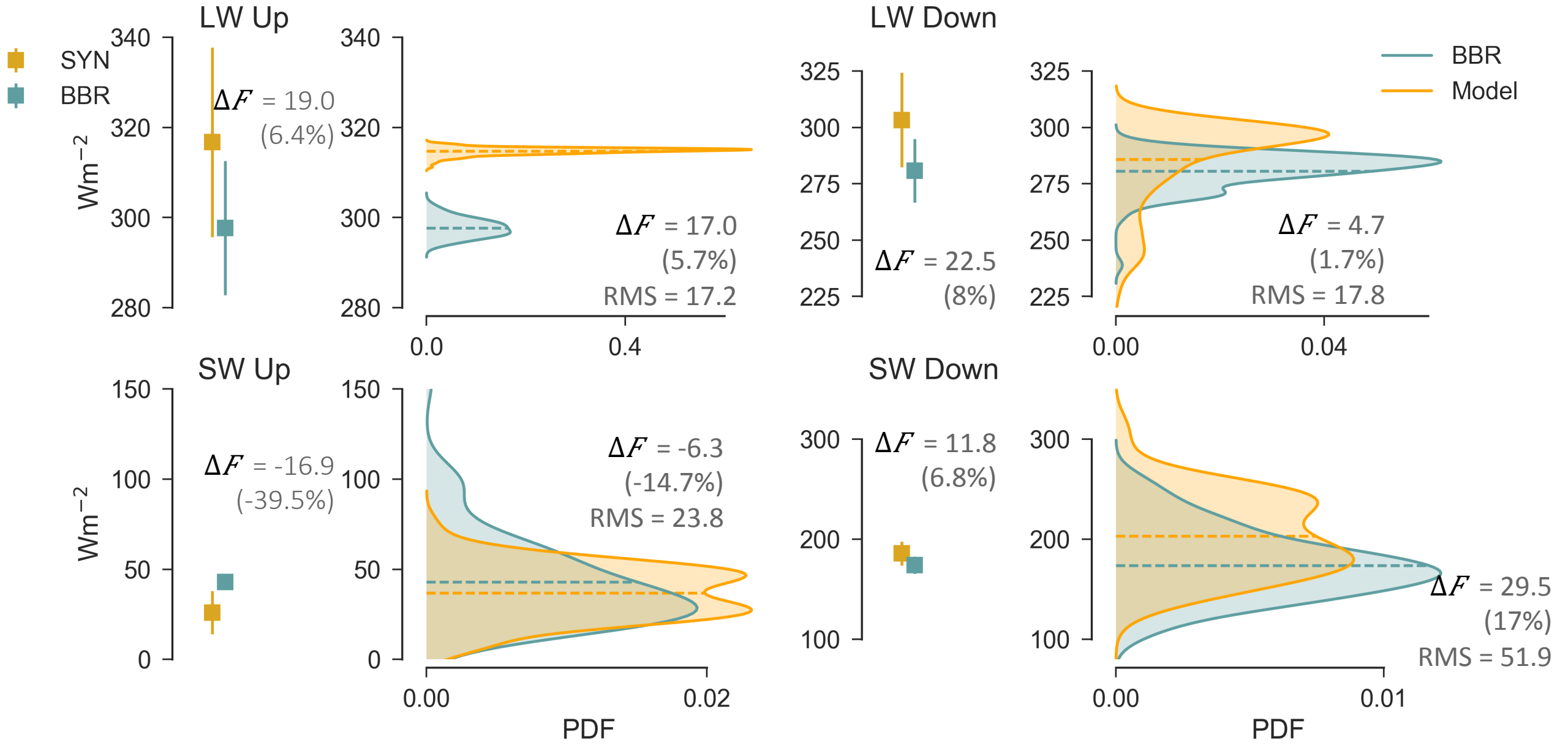
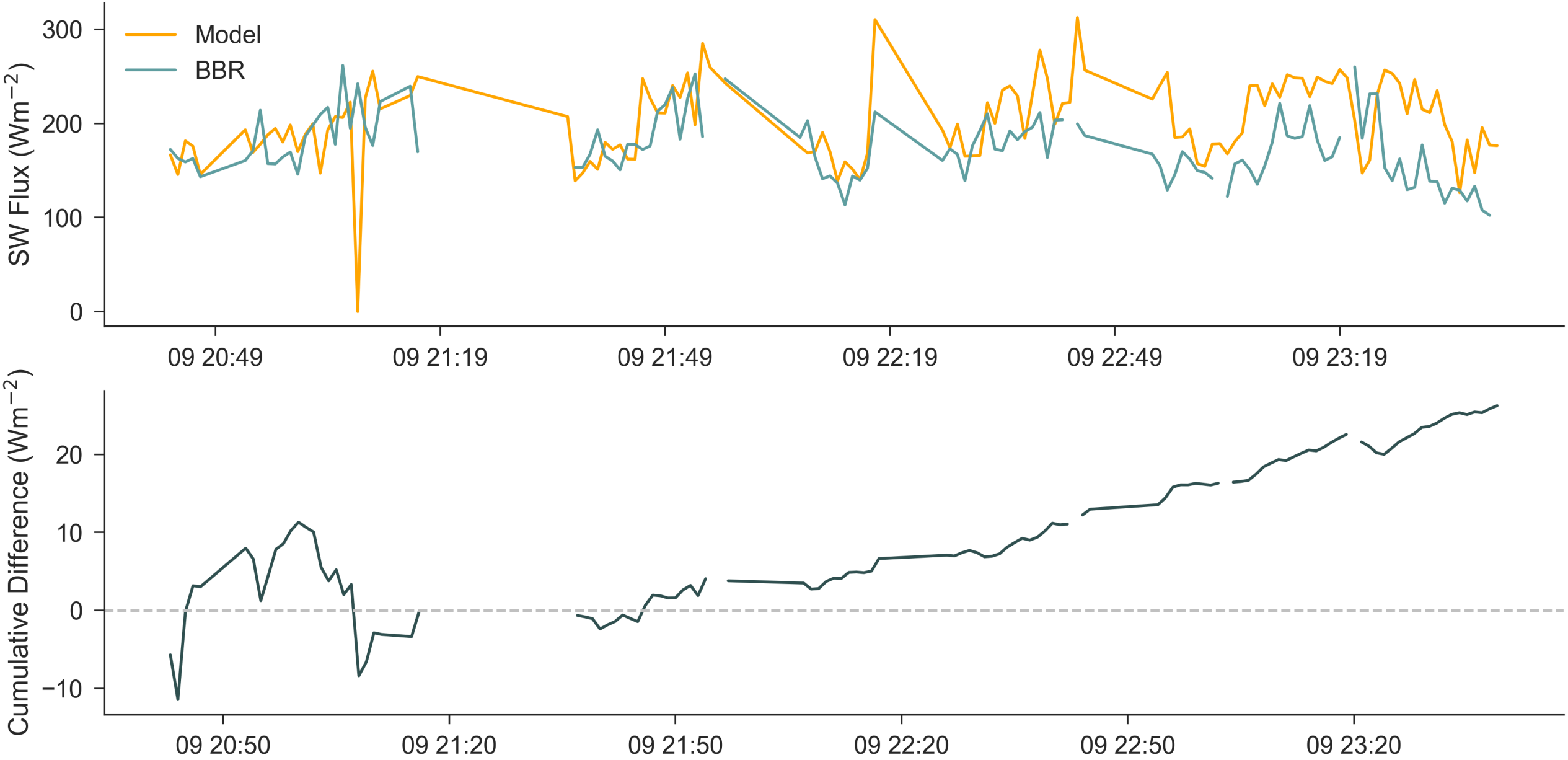


Effect of Multilayer Cloud Intrusion - 9th



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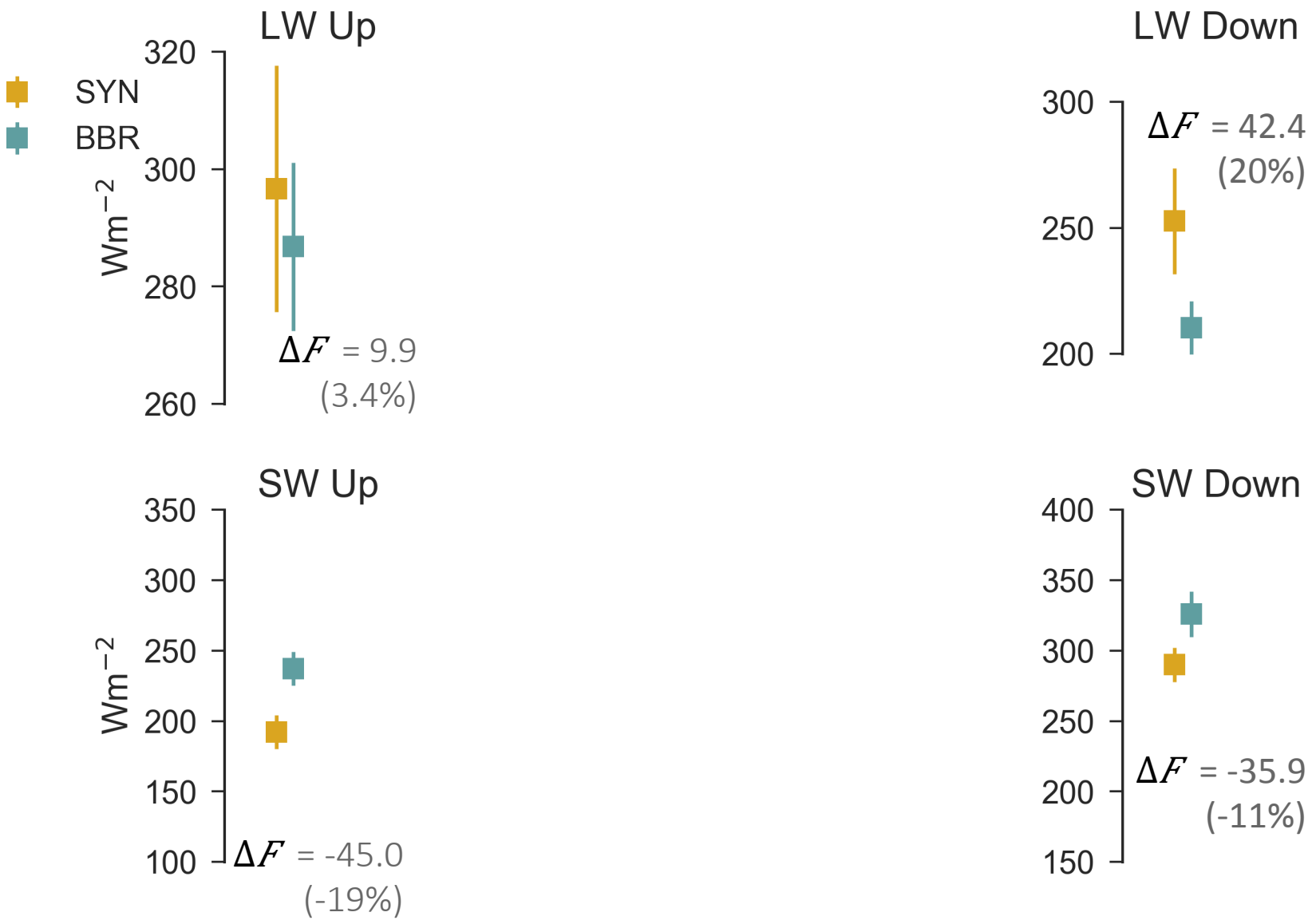

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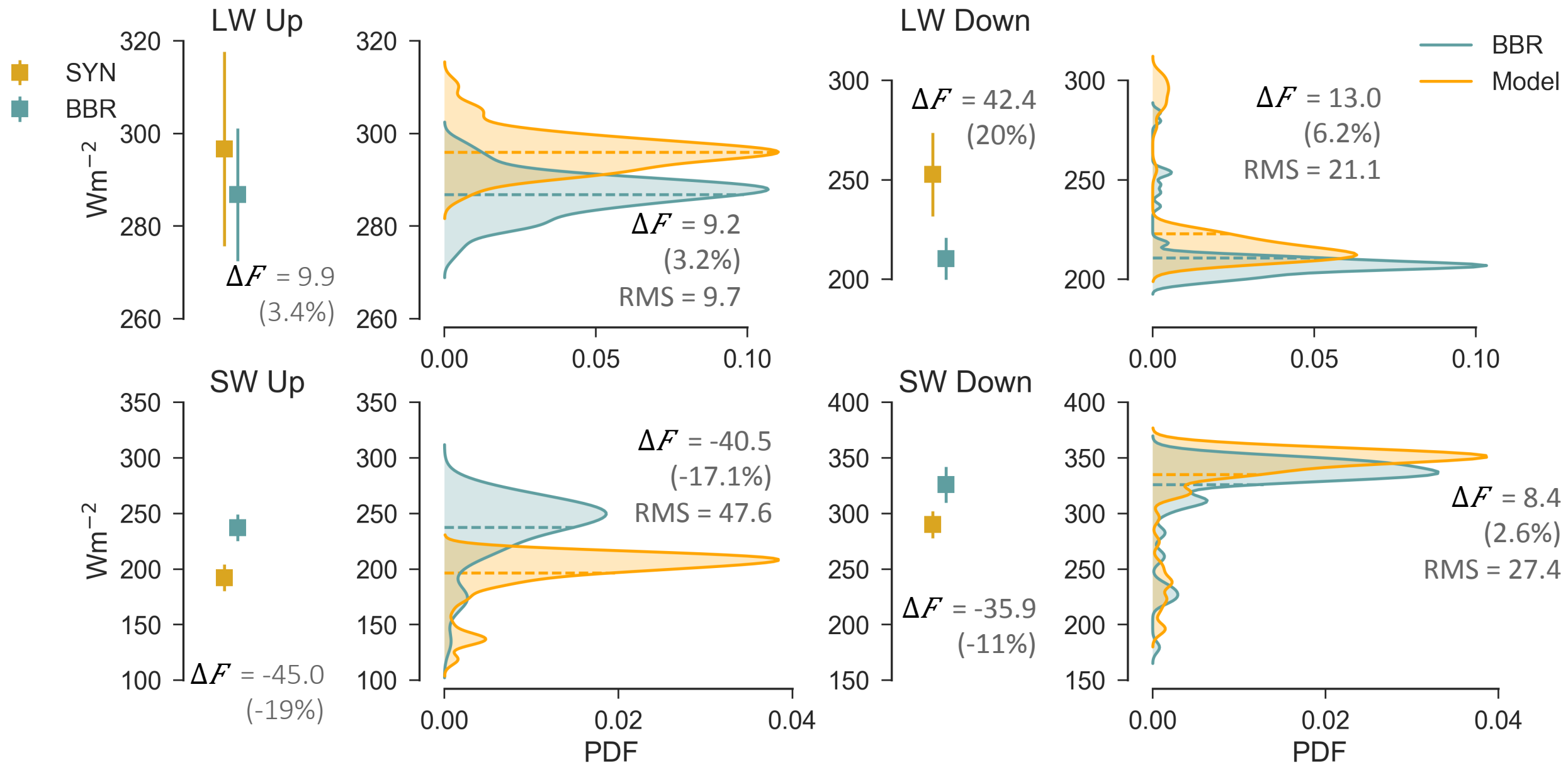
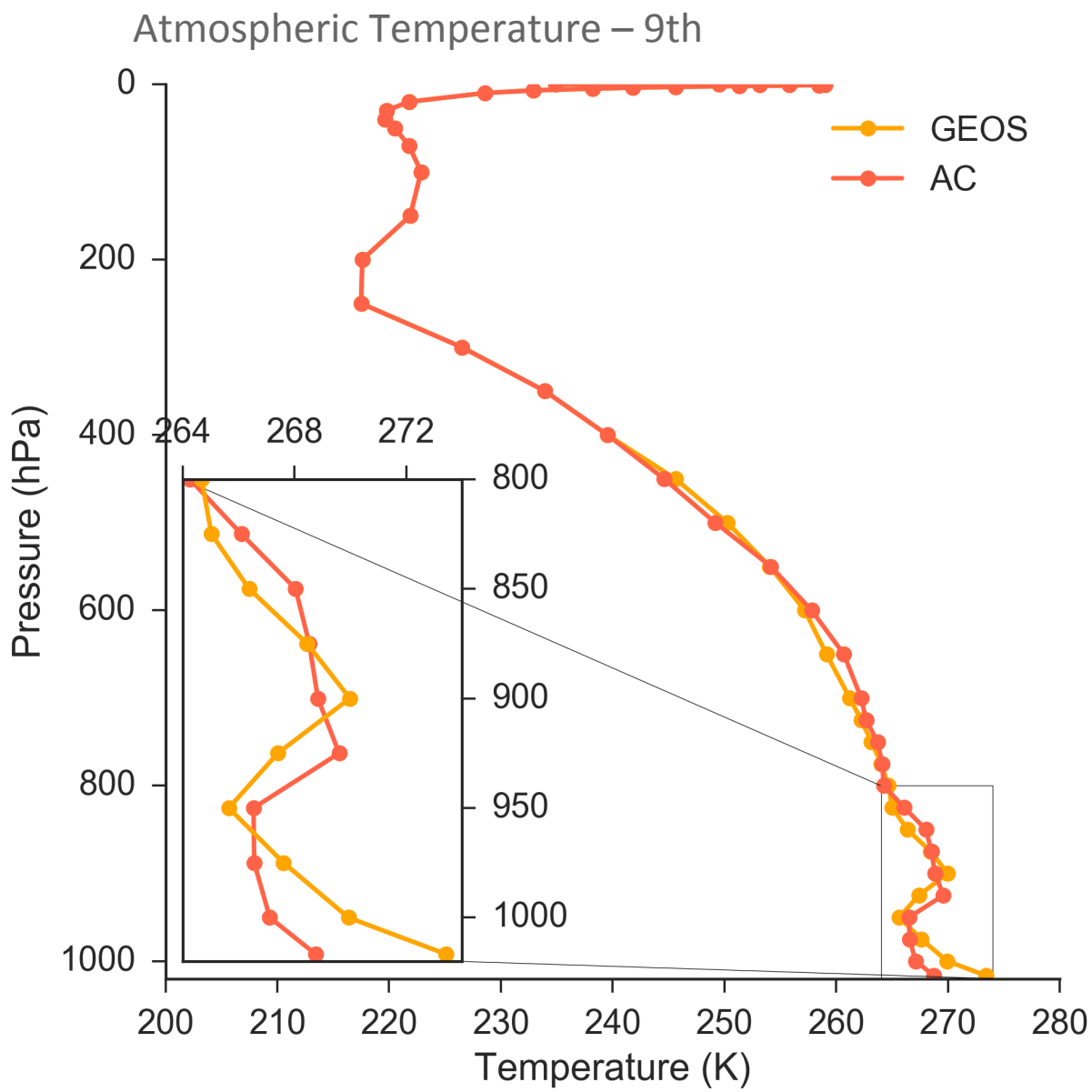
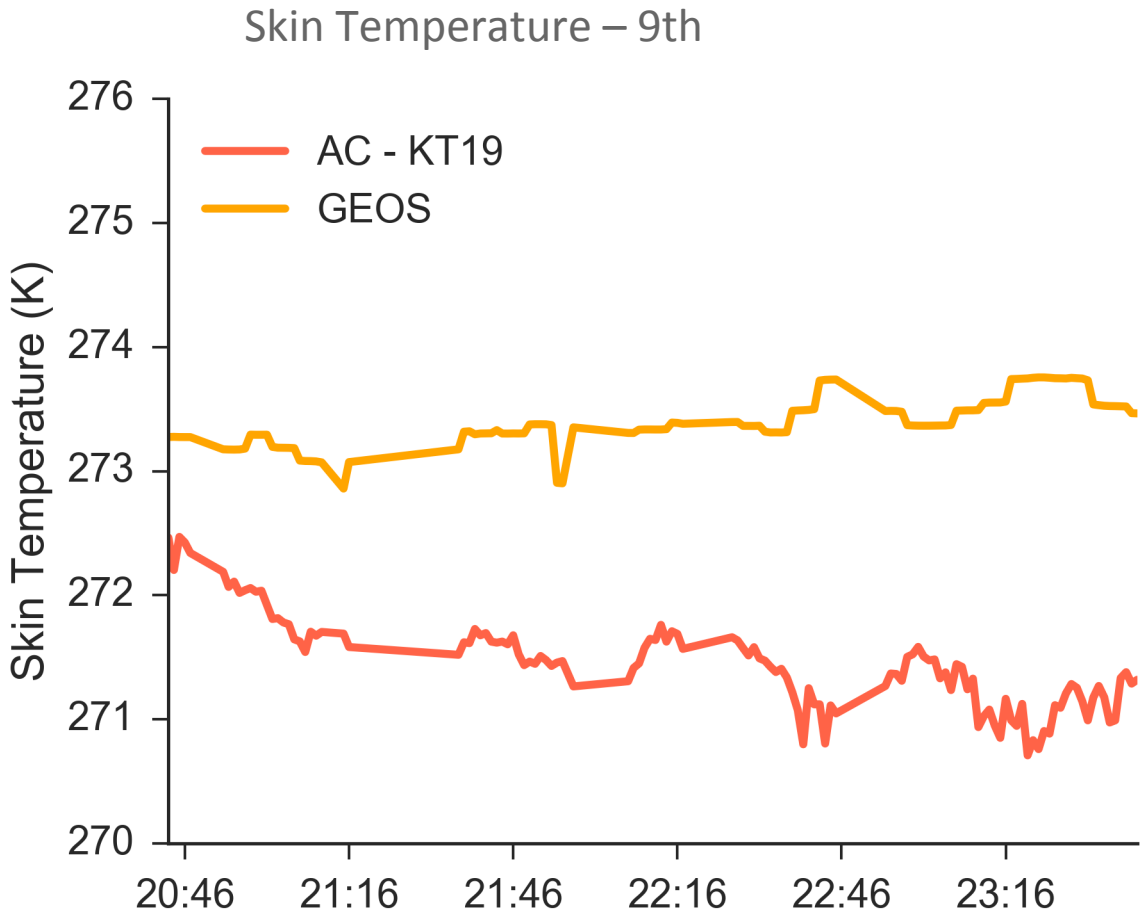


Including Ancillary Aircraft Observations

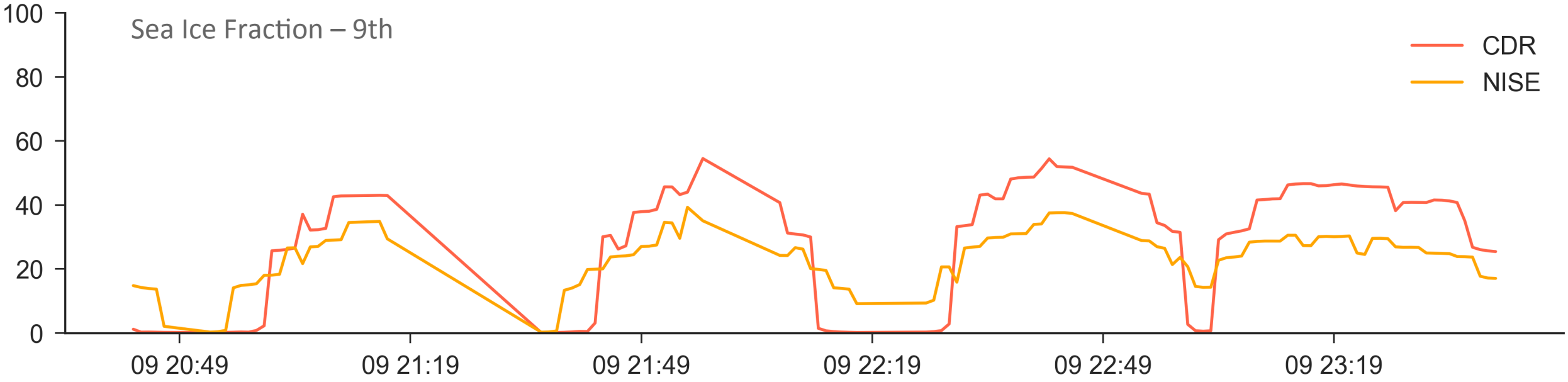


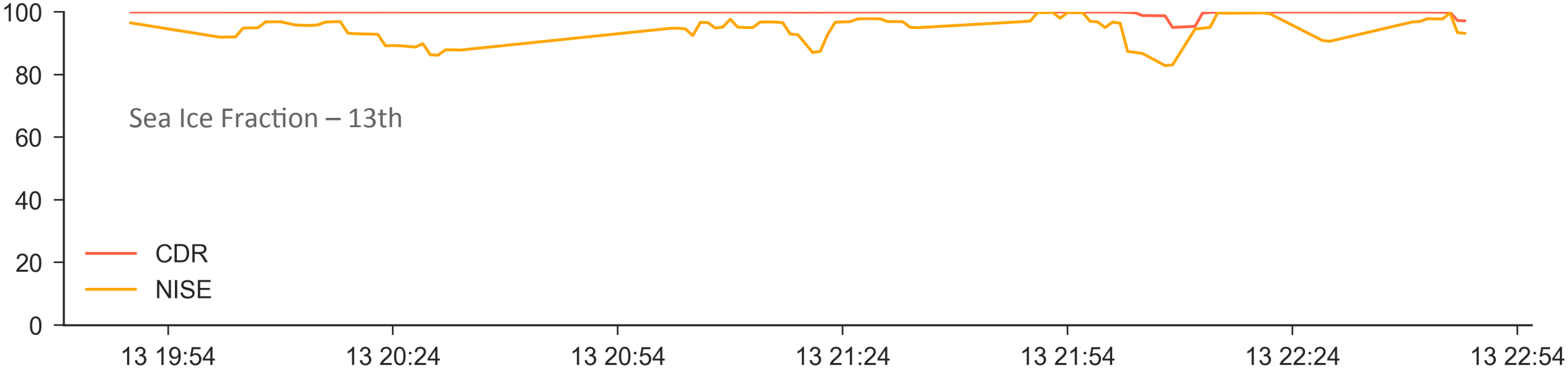


Sea Ice Datasets

	NSIDC Near-Real time Snow and Ice Extent (NISE): Ed4A	NSIDC/NOAA Climate Data Record of Passive Microwave Sea Ice Concentration (CDR): 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

Changing Sea Ice Data Source





Sea Ice Data Source Validation

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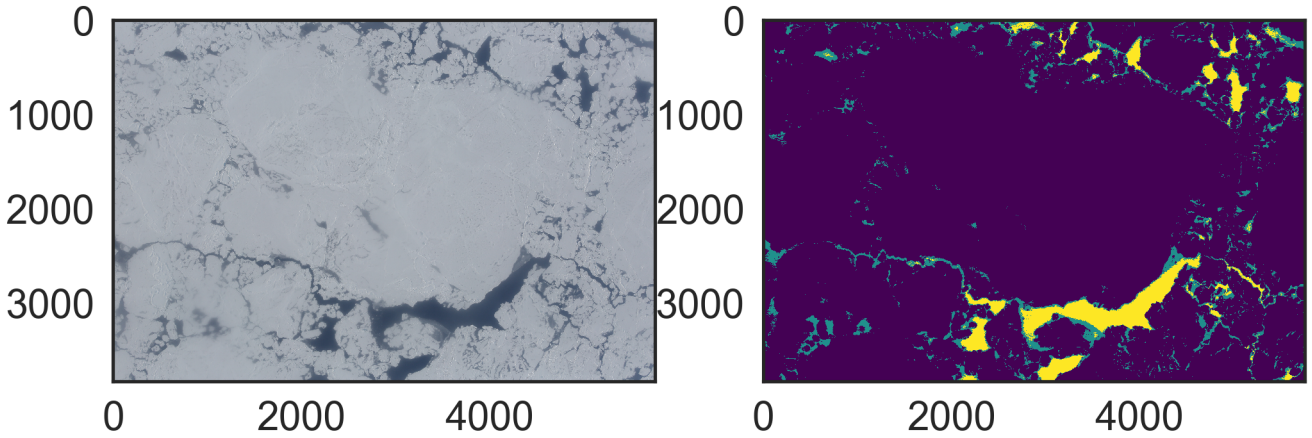

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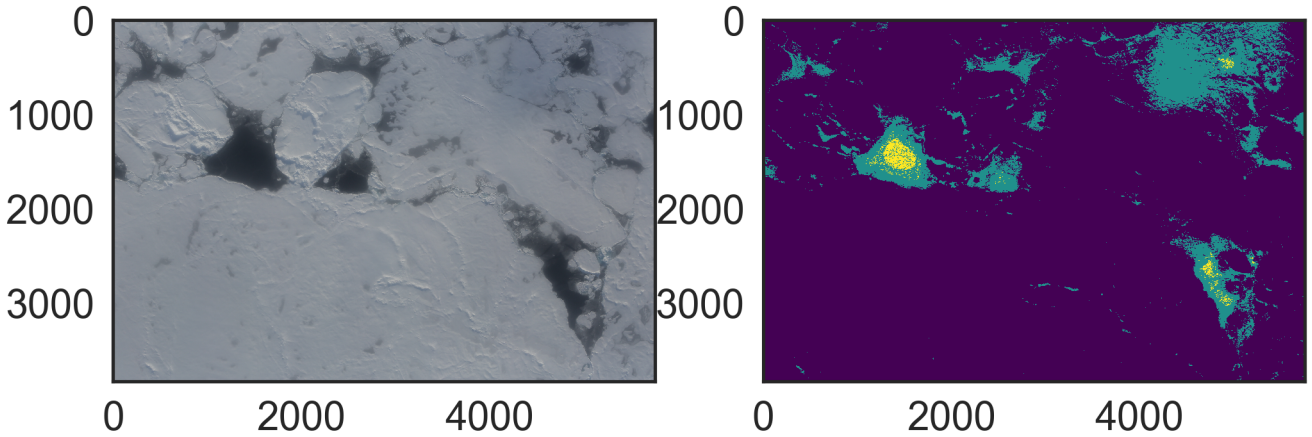


Use LVIS provided images from nadir camera.

Classify pixels into either:

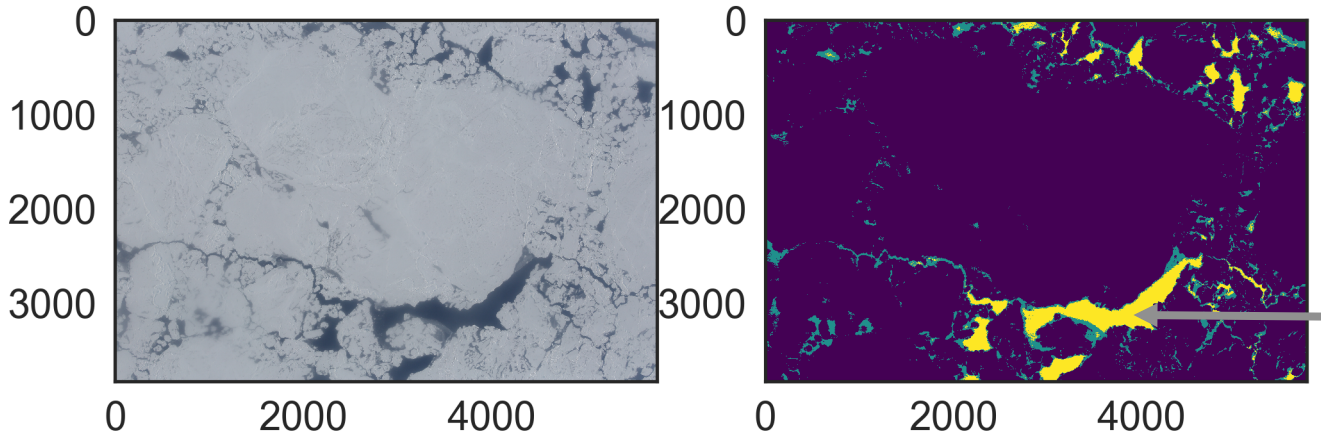
a) Ocean

b) Thin ice

c) Sea ice

Sea Ice Data Source Validation

2014/09/13 11:36:32



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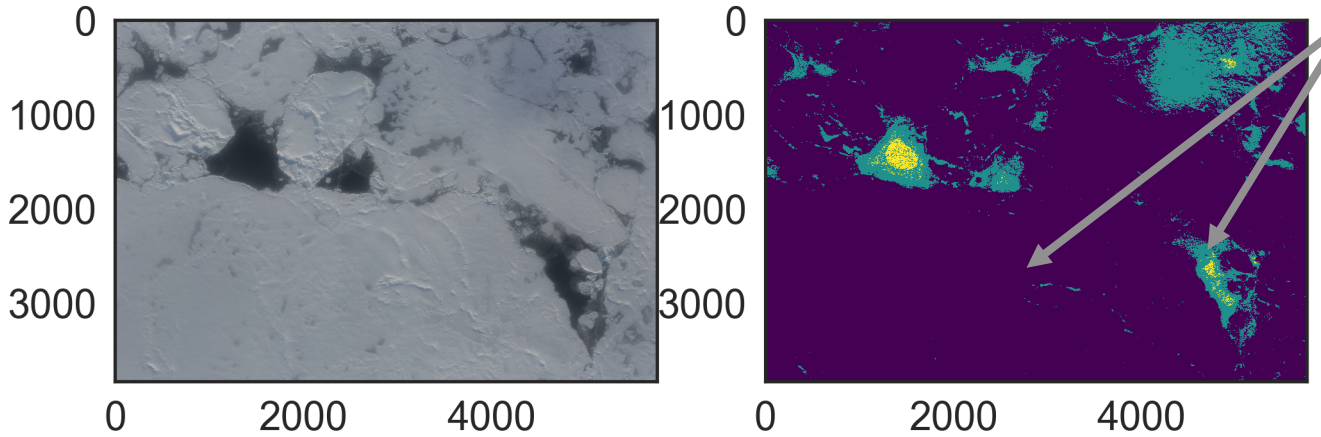

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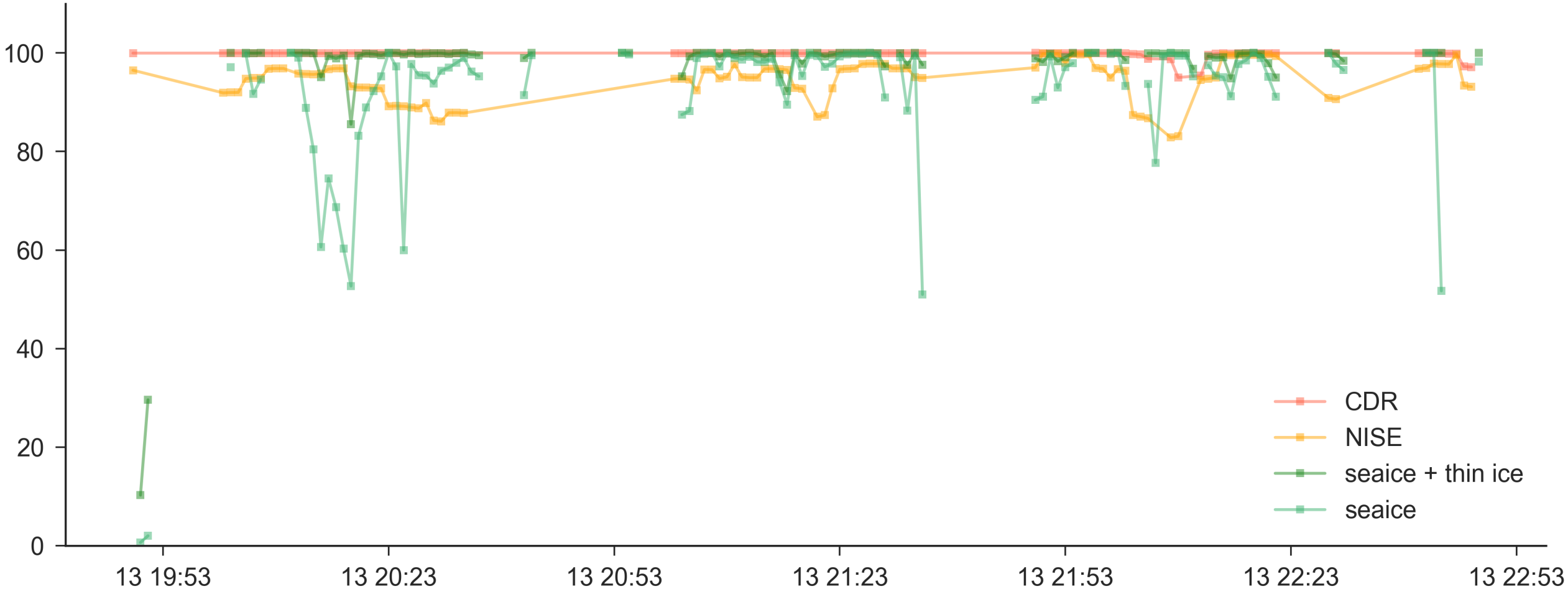

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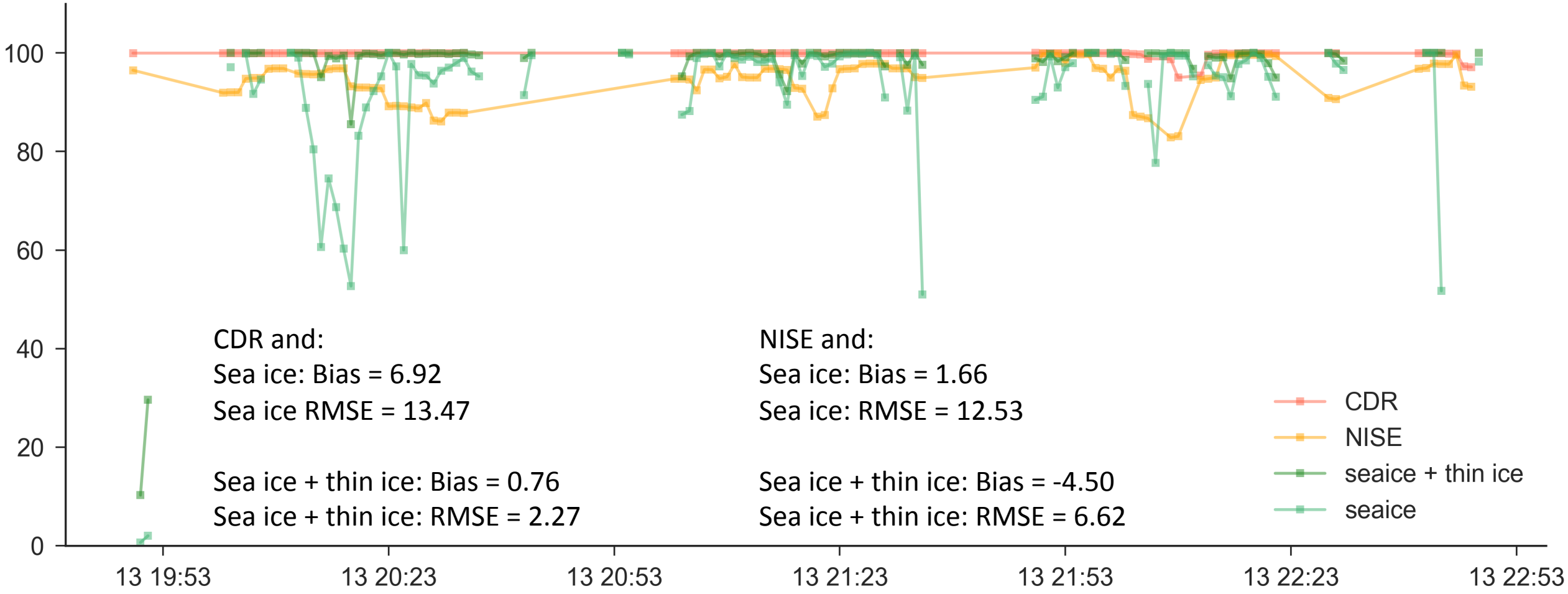

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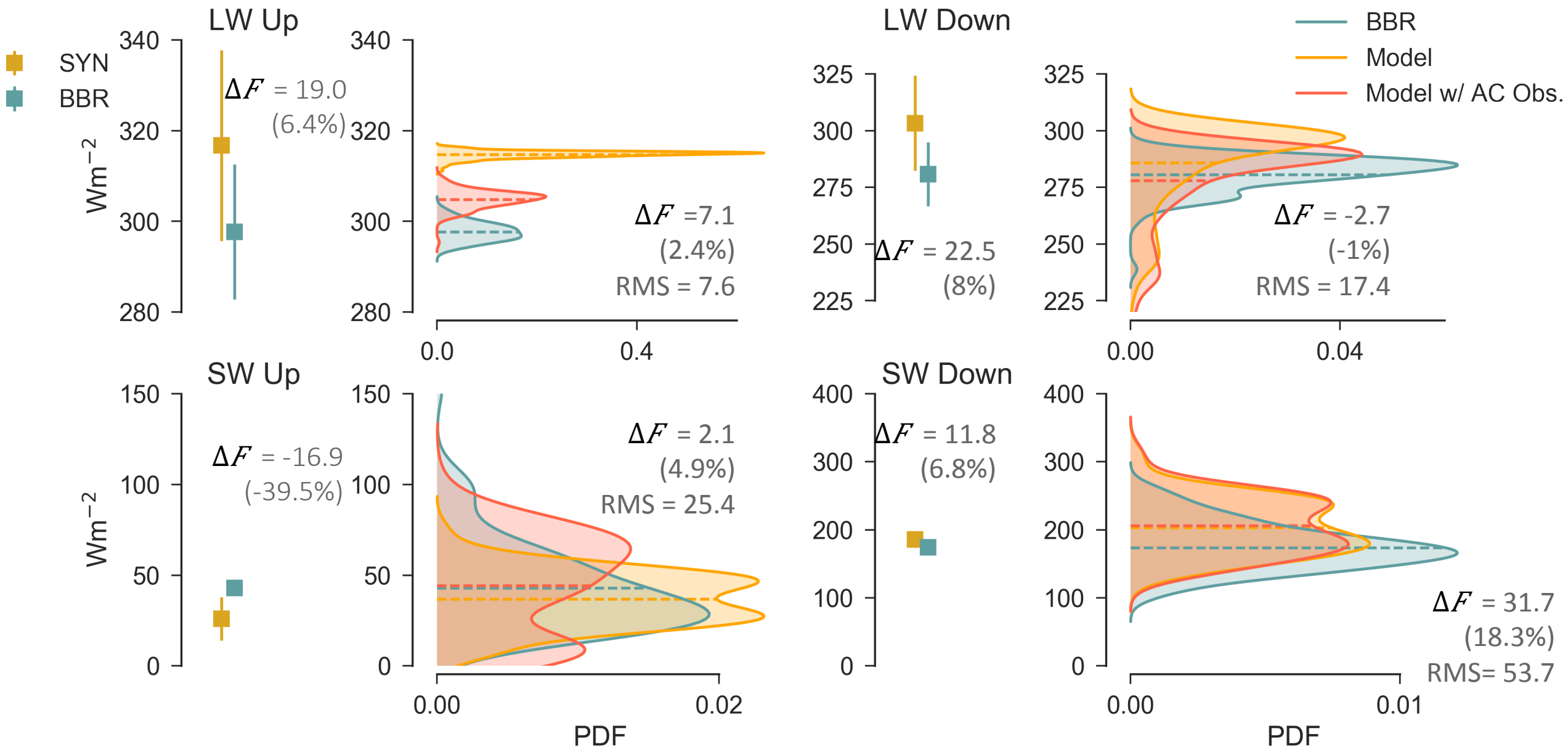

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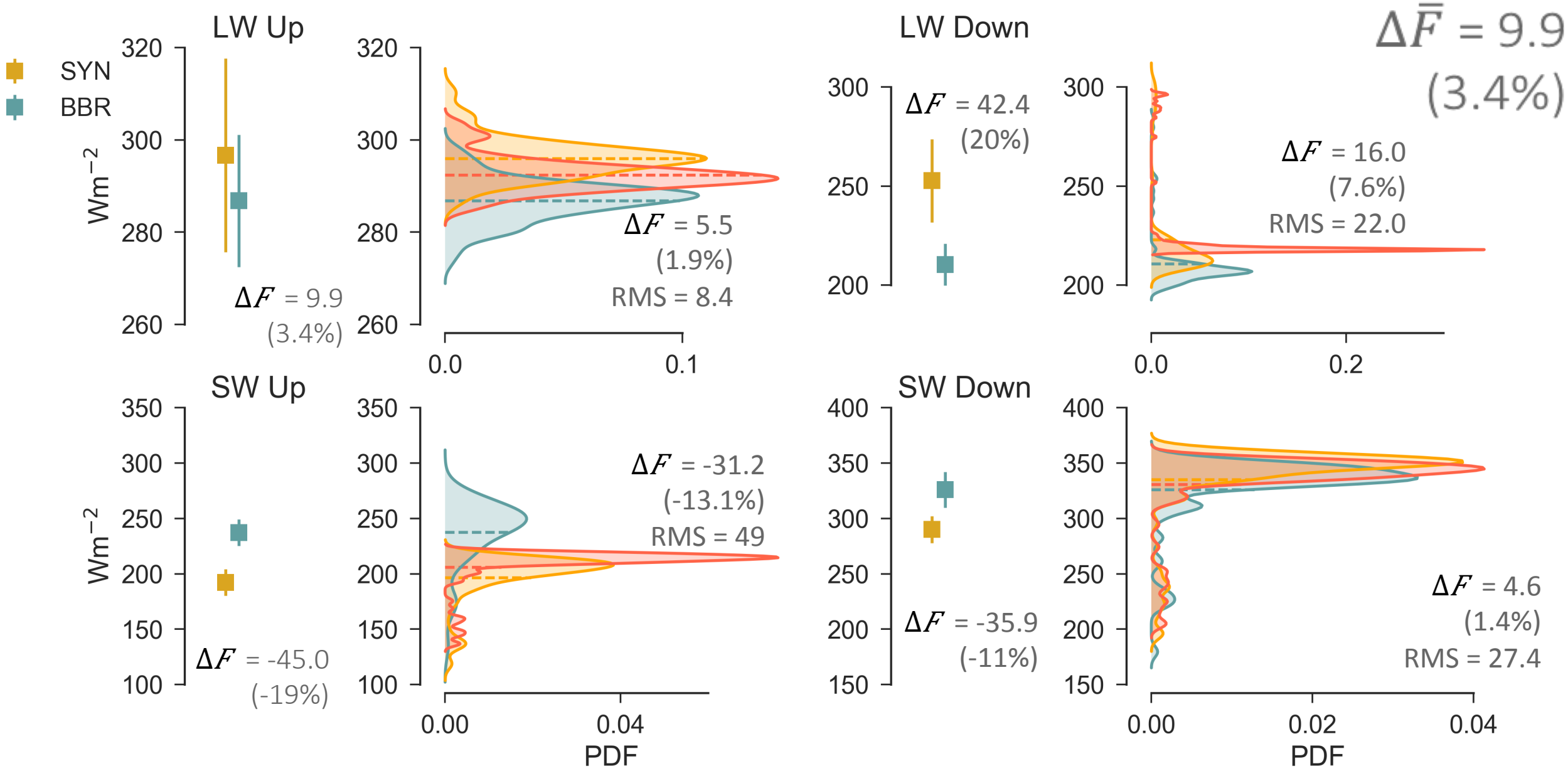
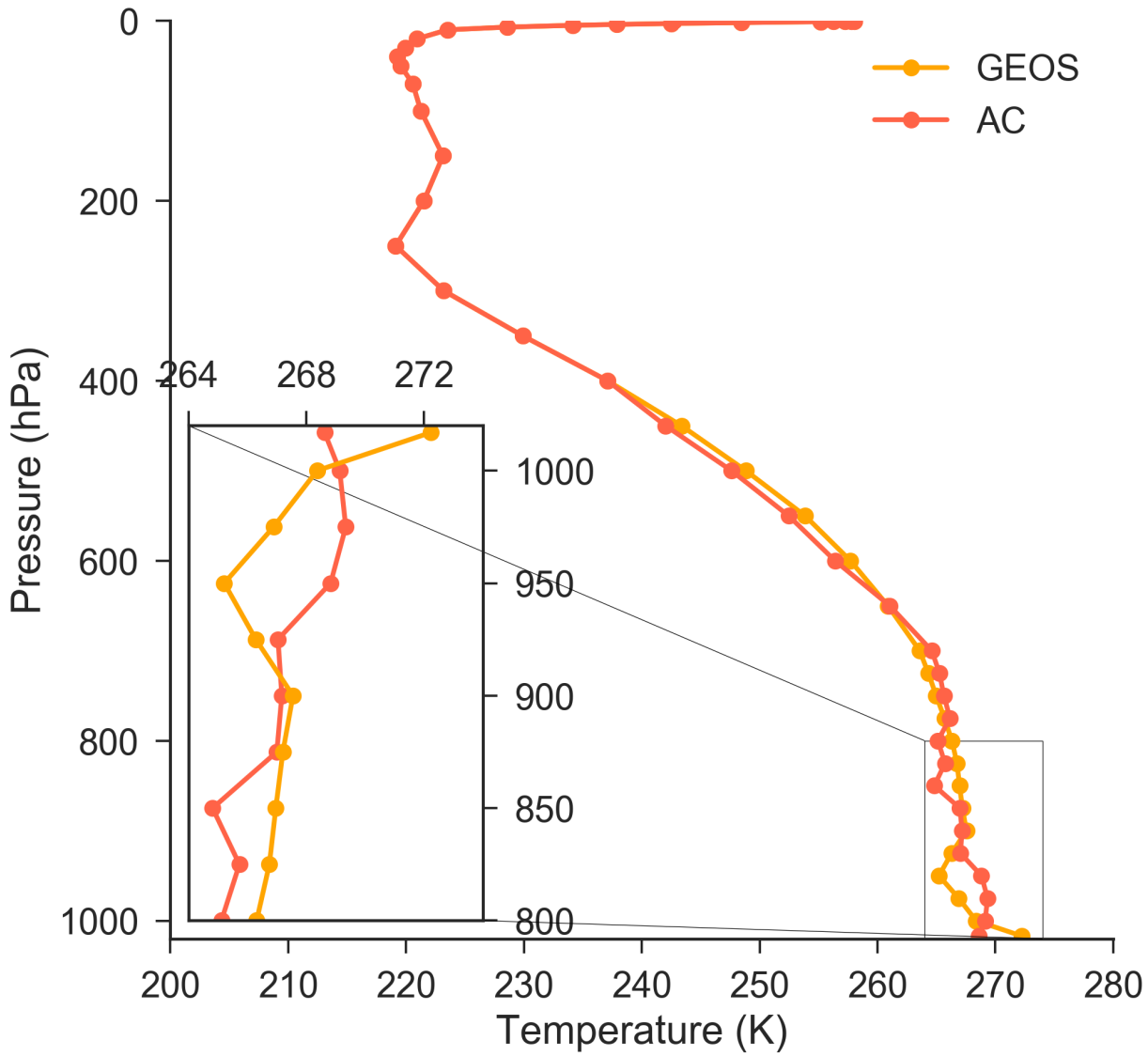


Summary

- First attempt at using aircraft observations to validate CERES surface products in the Arctic Ocean.
- We have a limited number of data points to compare with, but we can make some conclusions:
  - Differences between the SYN fluxes and BBR can be large.
  - *But* spatial and temporal sampling is important, and after accounting for that we generally get agreement to within the uncertainty for the LW.
  - The SW has worse agreement – more dependent on cloud retrievals and surface type.
- Including atmospheric and skin temperature measurements from the aircraft generally reduces the differences between observed and calculated fluxes – highlighting the importance of accurate re-analysis datasets.
- Sea ice dataset is important for the accurate modelling of upwelling SW flux. But determining which sea ice dataset is correct is difficult.

Including Ancillary Aircraft Observations

Atmospheric Temperature – 13th



Skin Temperature – 13th