



University of
BRISTOL



UiT The Arctic
University of Norway



Summer sea ice freeboard processing with CryoSat-2 and Sentinel-3 A&B

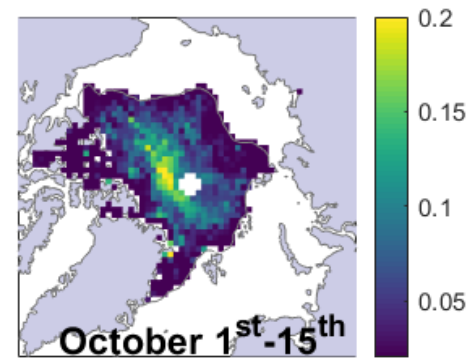
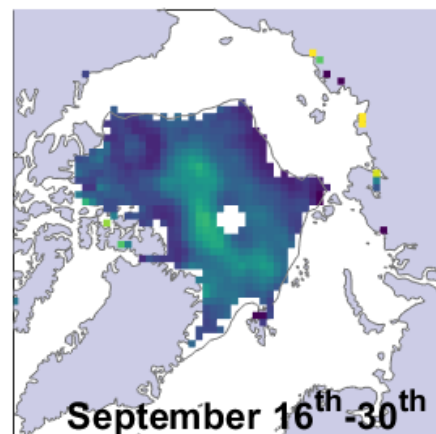
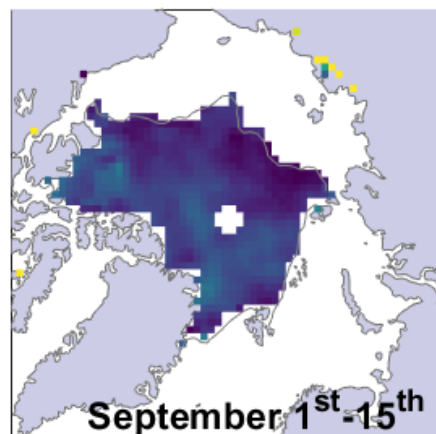
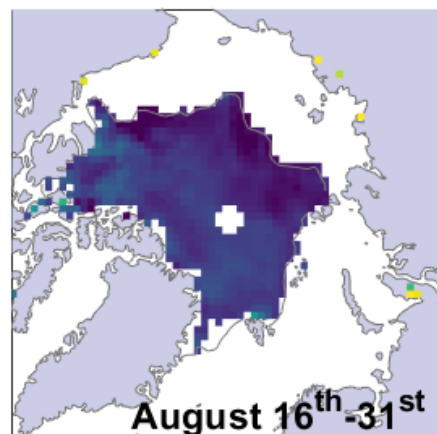
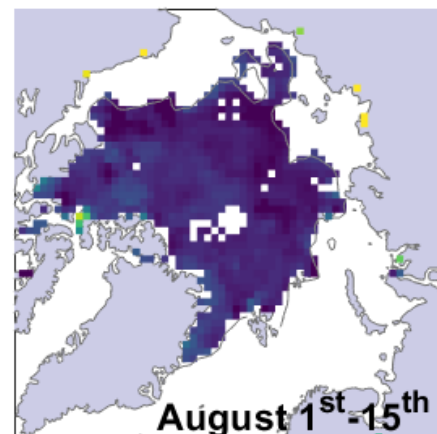
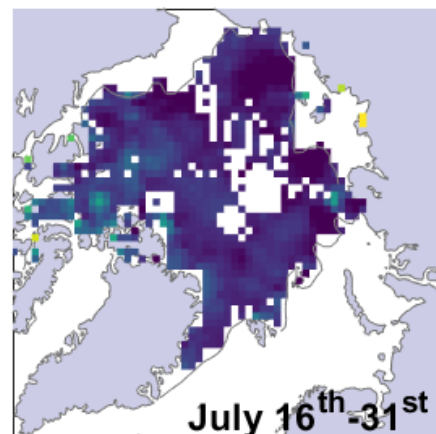
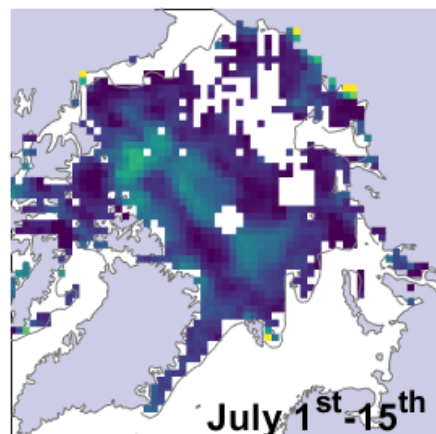
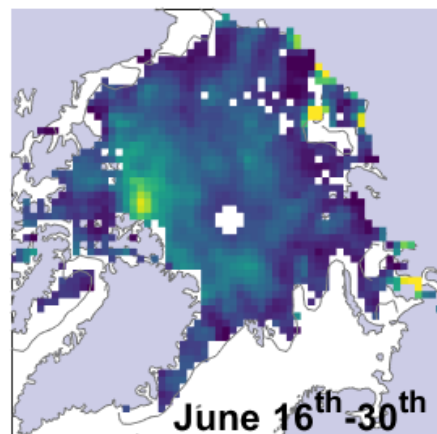
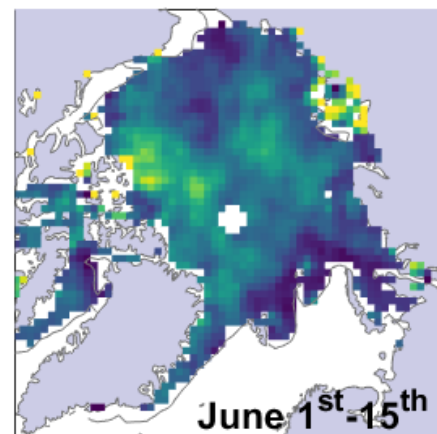
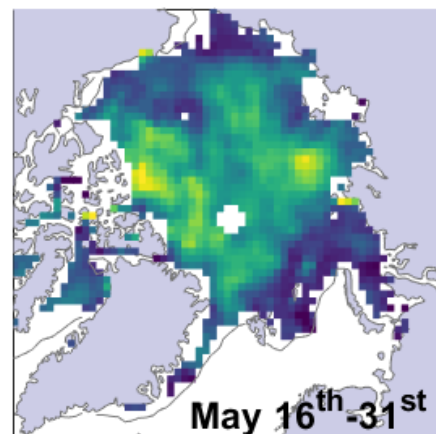
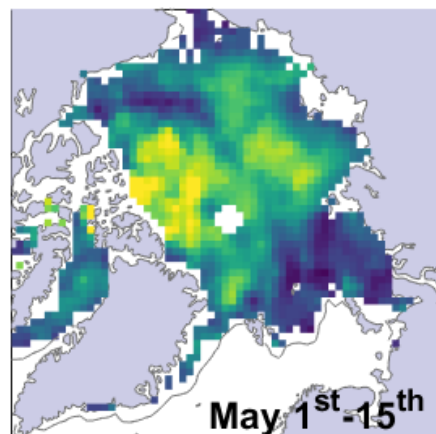
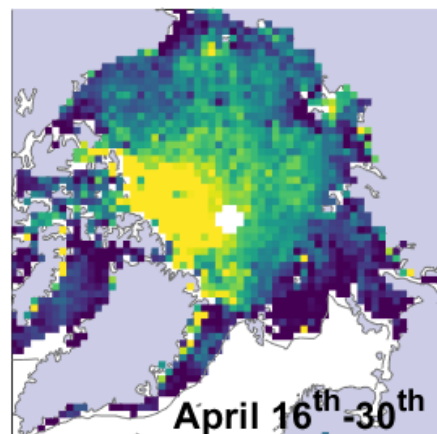
Geoffrey Dawson and Jack Landy

- Earth Console P-PRO: Sentinel-3 A and B SRAL L0 >>> L2 data processing through SARvatore
- For Arctic region May-September 2019
- Sponsorship from NoR team at ESA (through Jerome Beneviste)

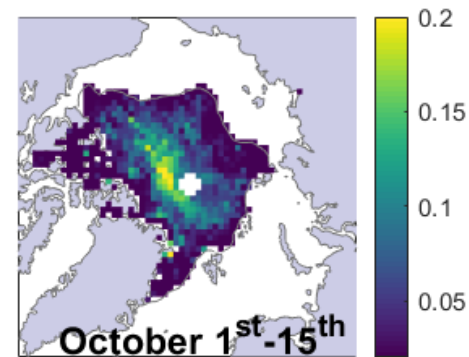
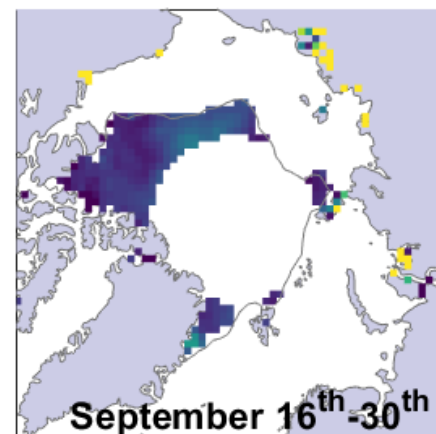
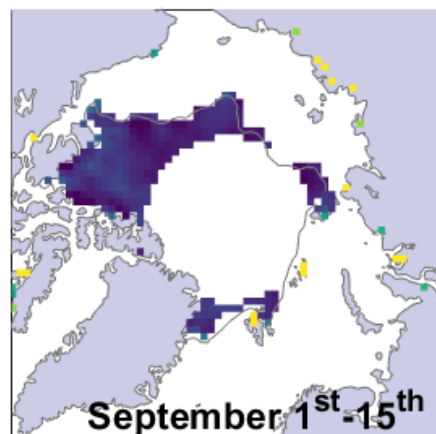
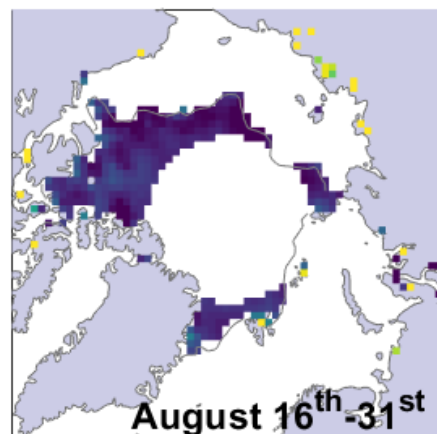
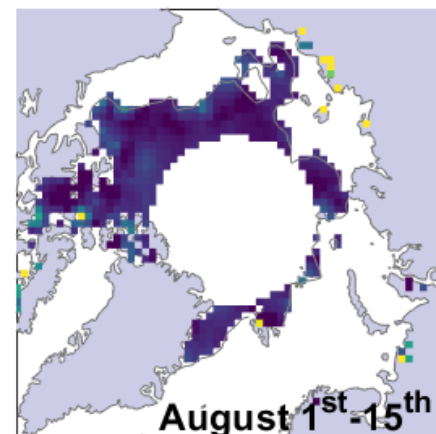
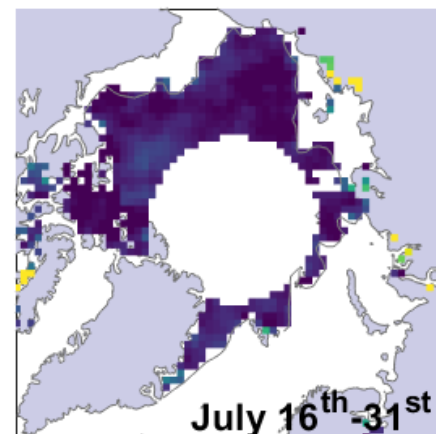
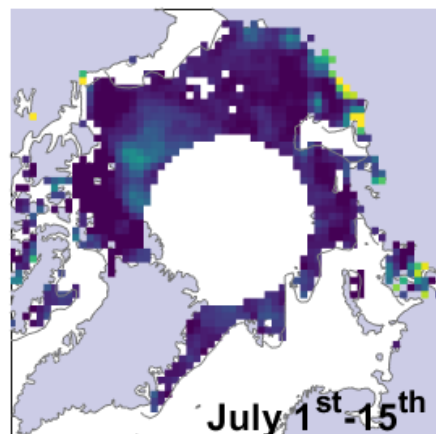
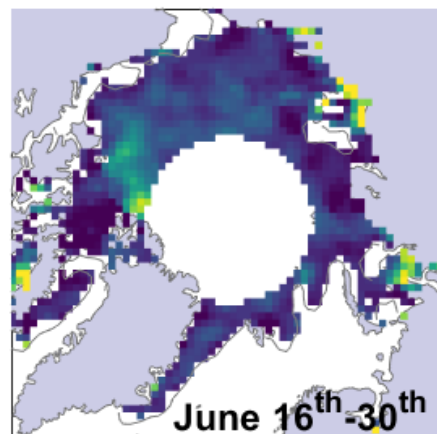
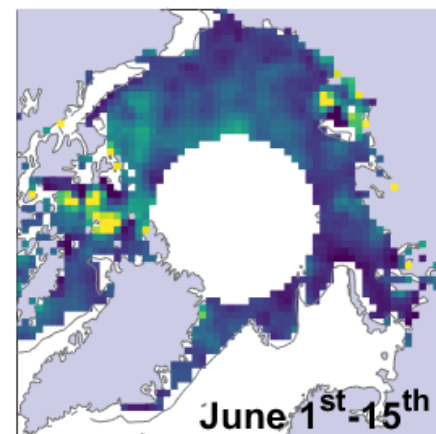
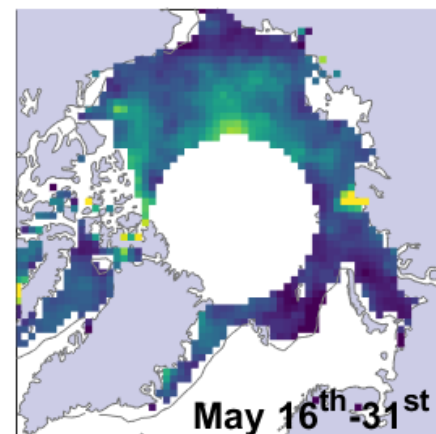
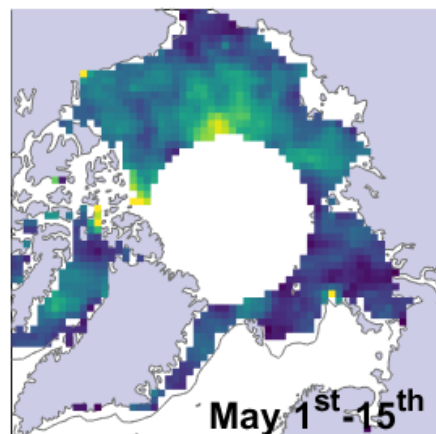
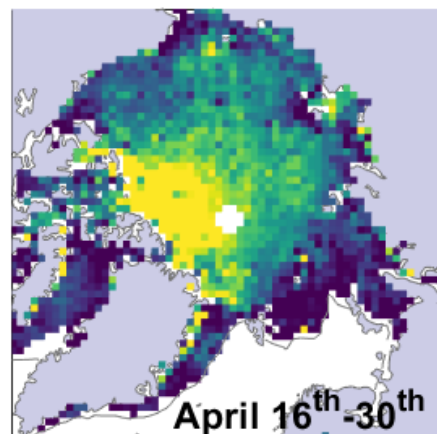
Our work with the data so far:

- Waveform classification using CNN previously applied to CryoSat-2 over sea ice in summer months [Dawson et al, RSE, 2022]
- Provides output parameters including likelihood that sample is an ice floe or lead
- Preliminary freeboards calculated around every classified lead sample
- Gridded to biweekly 80 km polarstereo
- No data filtering or cleanup yet applied
- CryoSat-2 radar freeboards for April and Oct [Landy et al, JGRO, 2020] are also shown

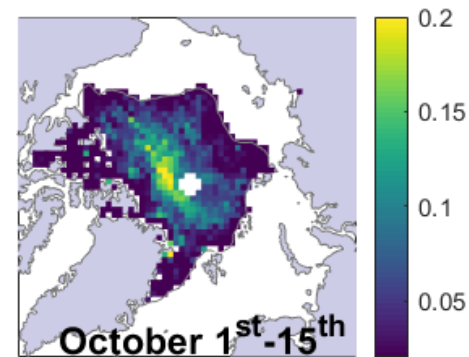
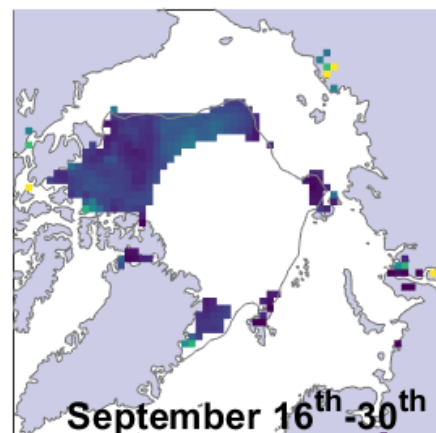
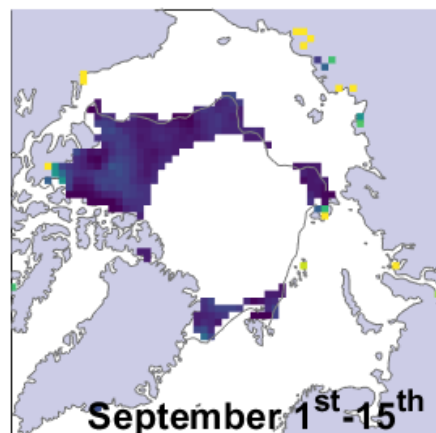
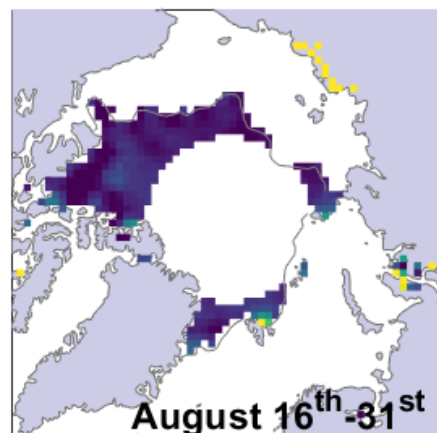
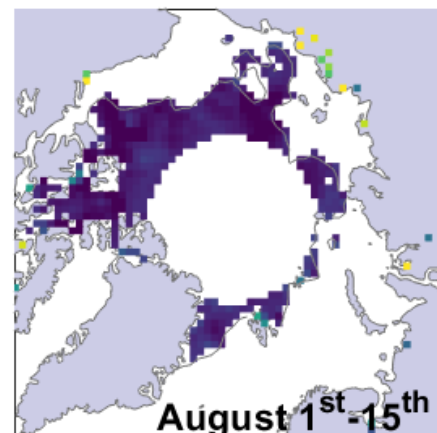
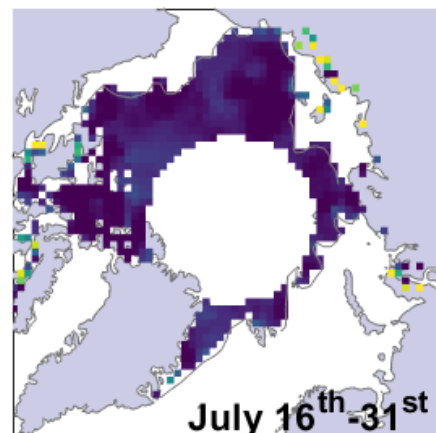
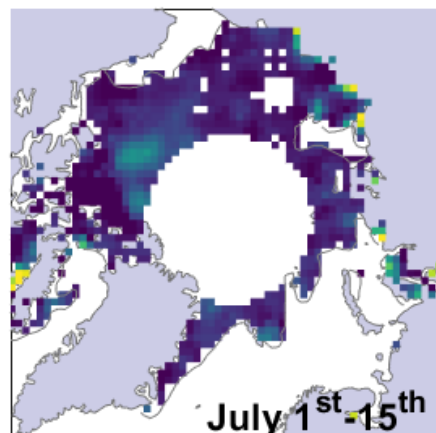
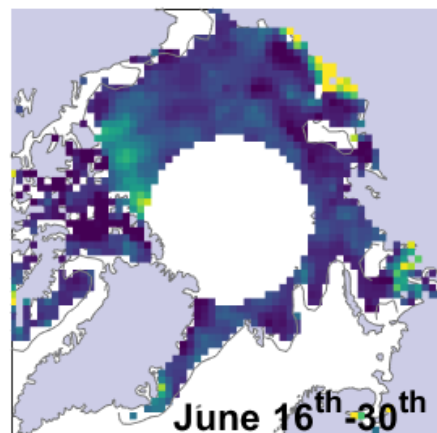
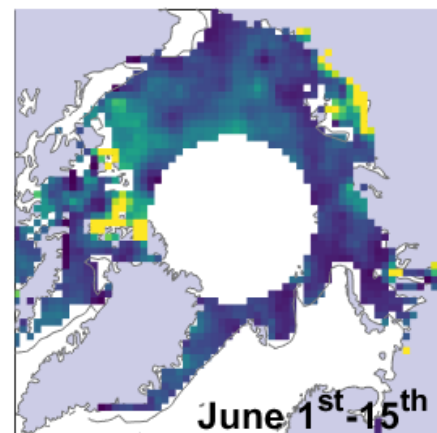
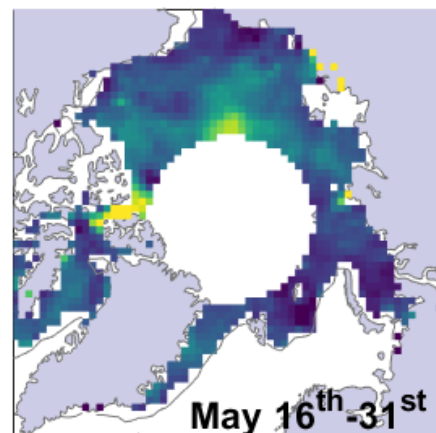
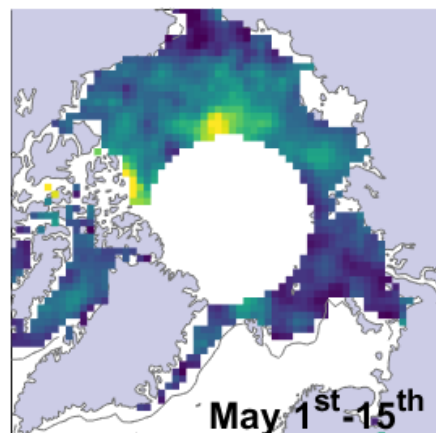
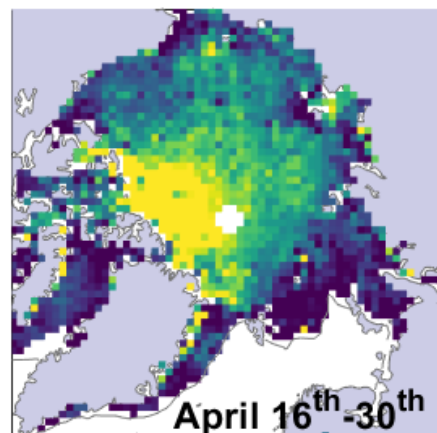
Radar freeboard
CS2
[m]



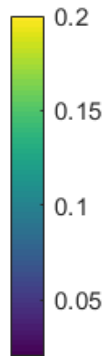
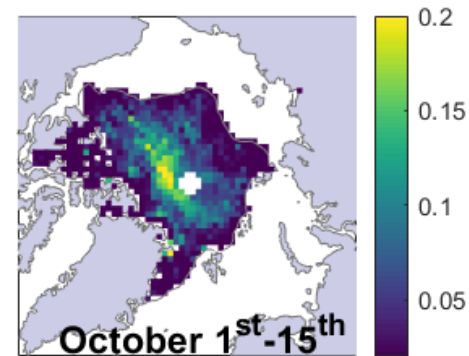
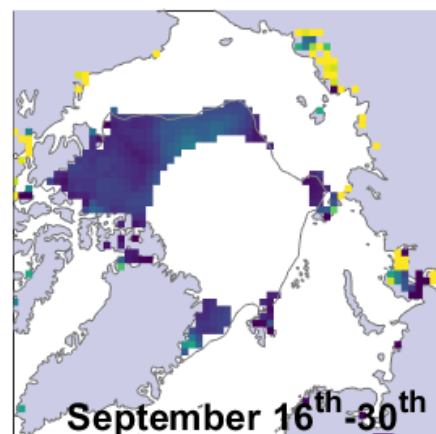
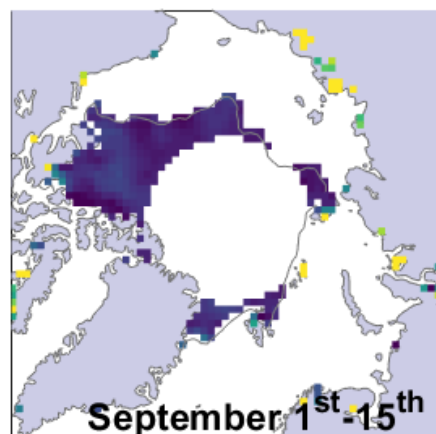
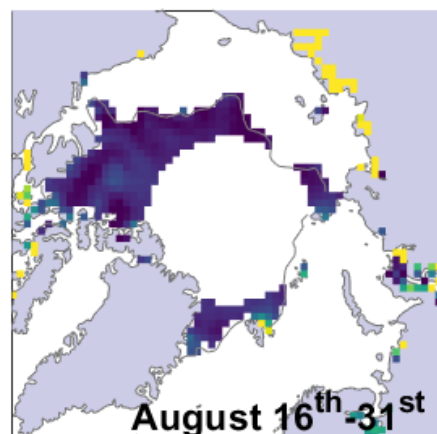
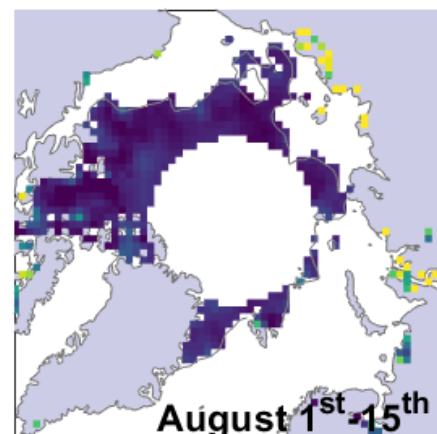
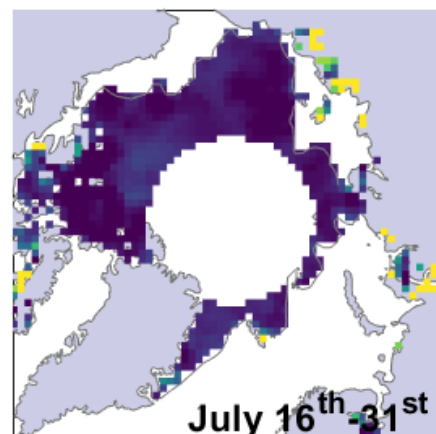
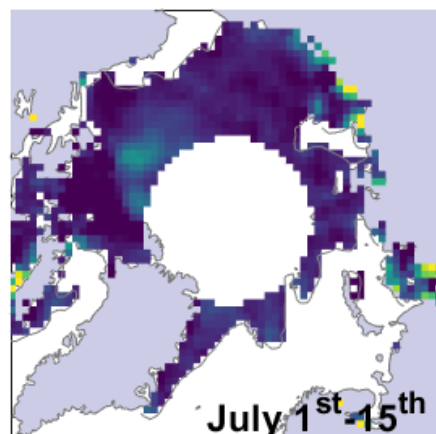
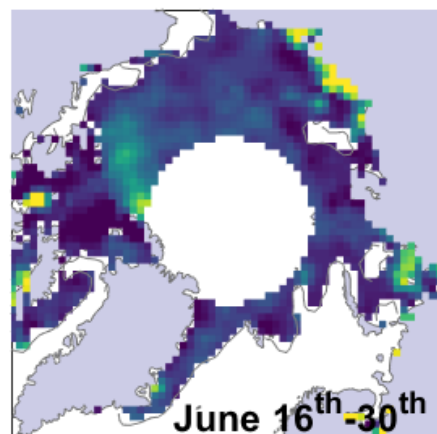
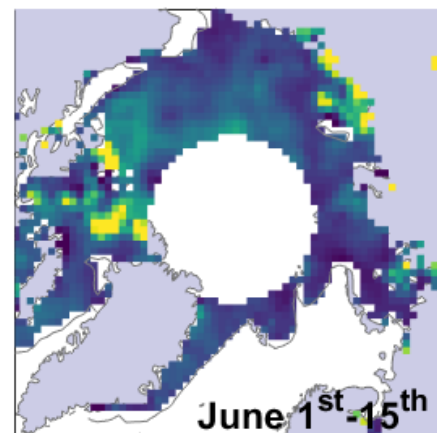
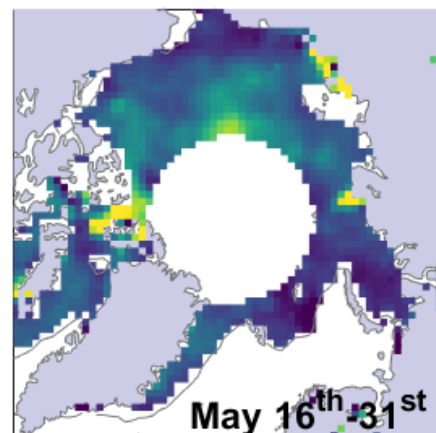
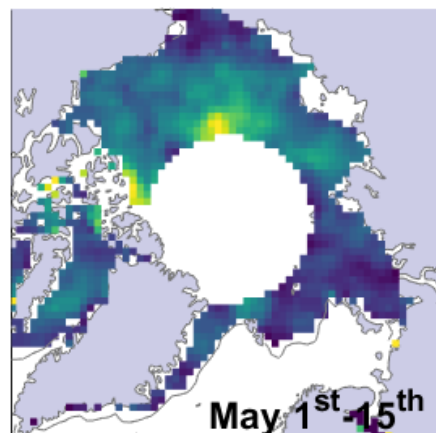
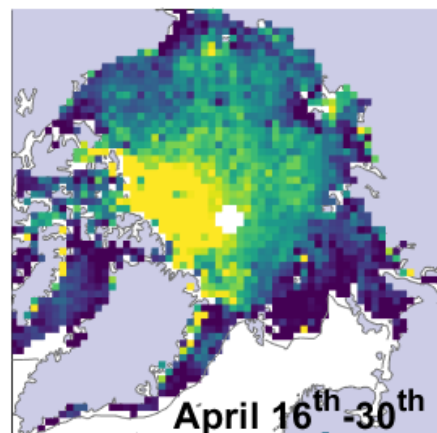
**Radar freeboard
S3A
[m]**



**Radar freeboard
S3B
[m]**



**Radar freeboard
S3A & S3B
[m]**



Radar freeboard S3A vs S3B

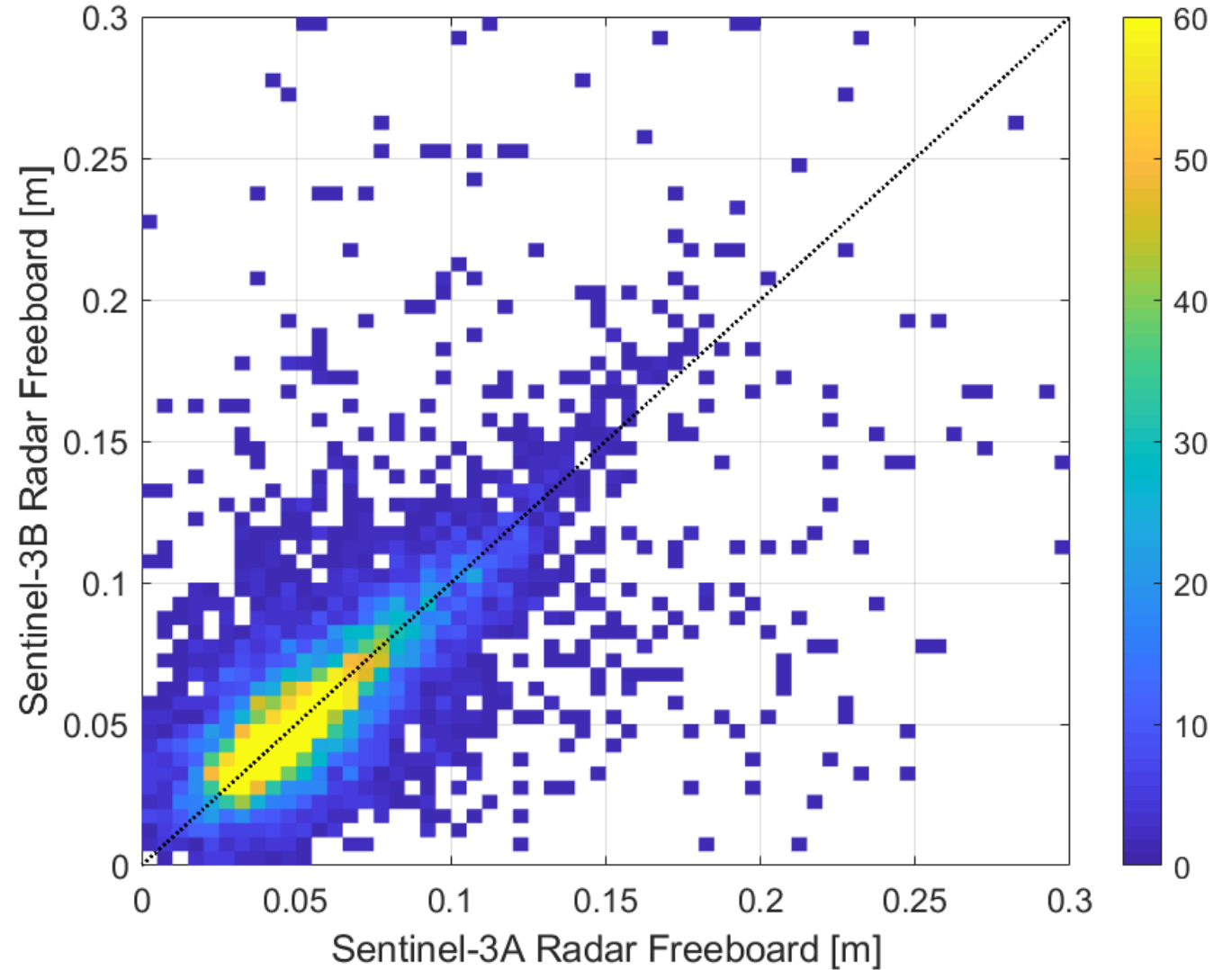
Full summer 2019

Median diff (S3A – S3B) = -0.4 mm

Std dev on the diff = 3.9 cm

R = 0.55

No bias and low std dev between S3 sensors, but still lower correlation than for winter months



Radar freeboard CS2 vs S3A&B

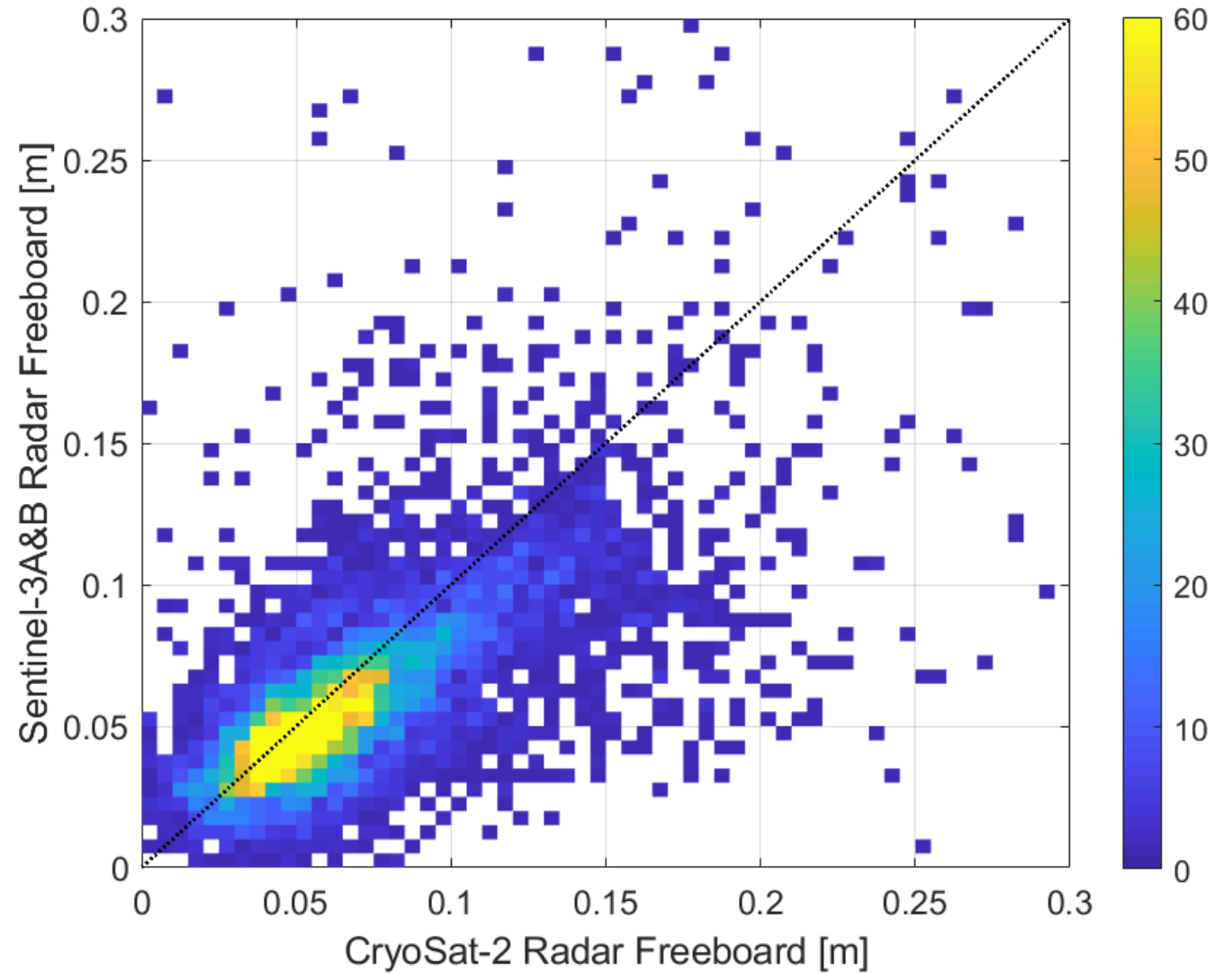
Full summer 2019

Median diff (CS2 – S3) = +7mm

Std dev on the diff = 4.5 cm

R = 0.51

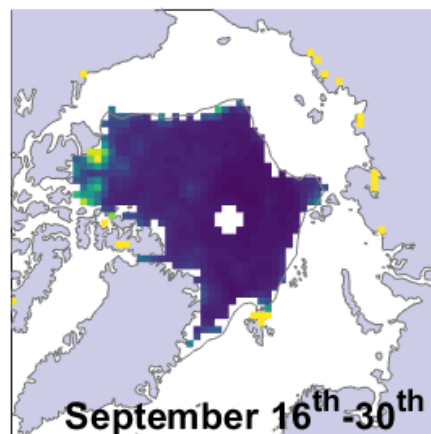
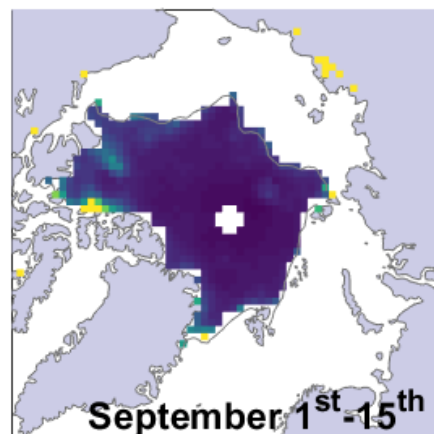
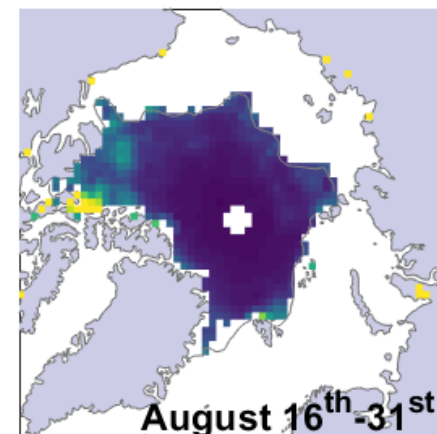
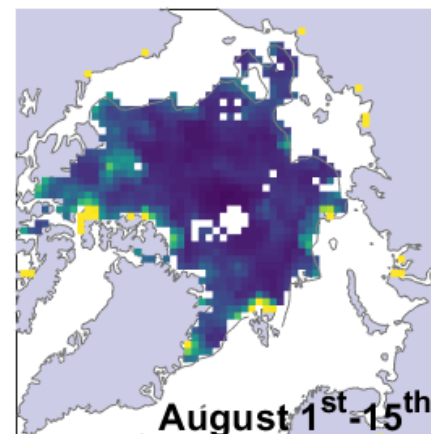
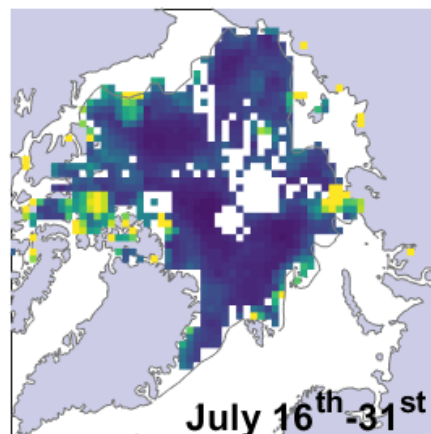
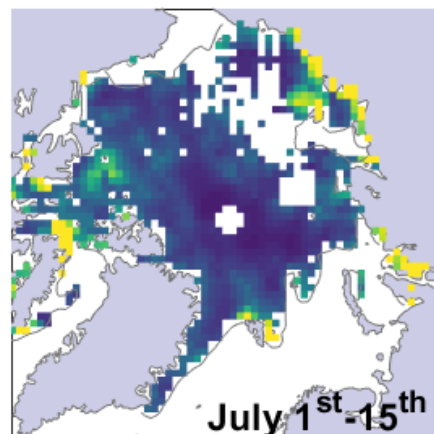
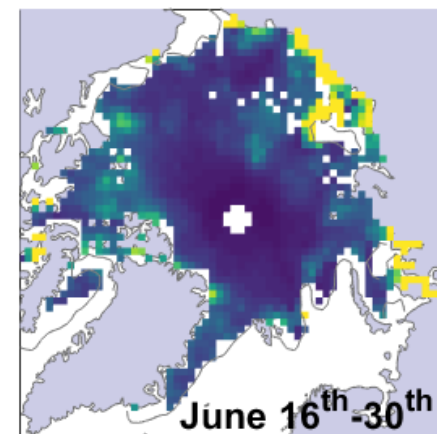
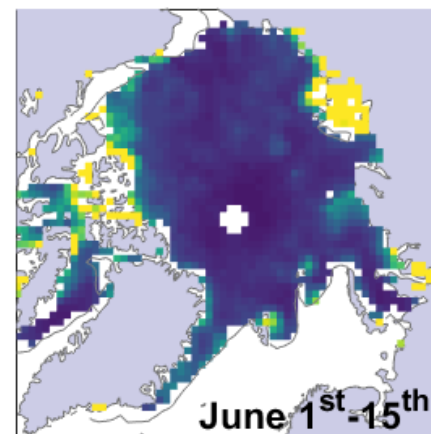
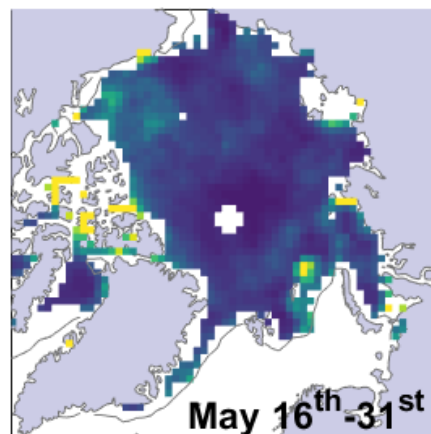
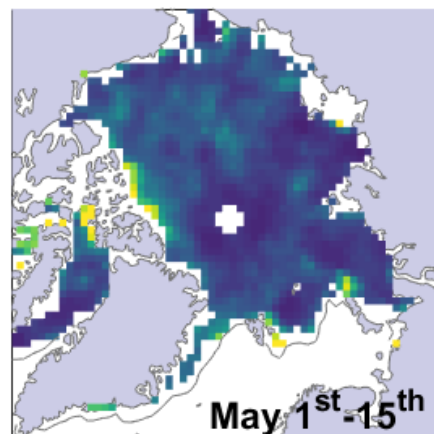
S3 underestimates CS2 slightly,
especially over thicker MYI



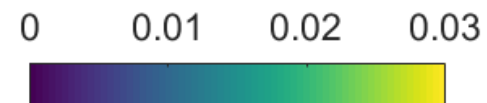
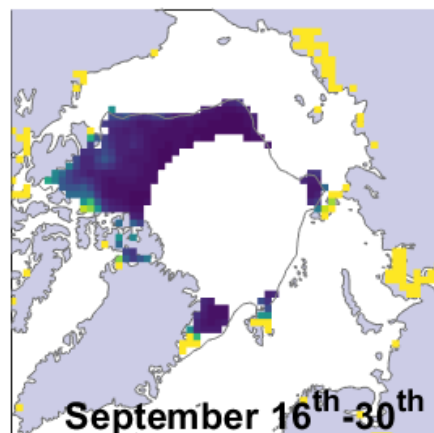
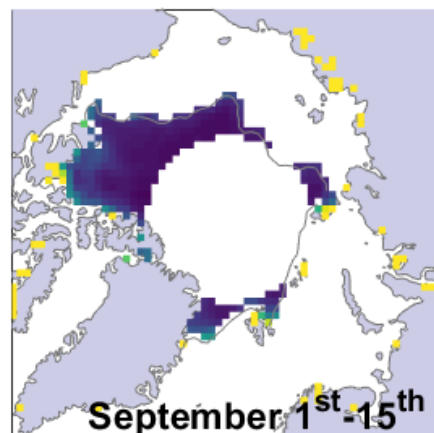
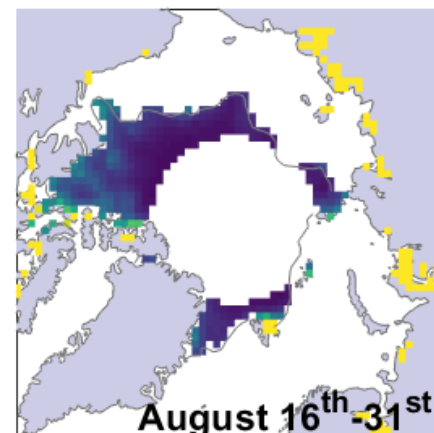
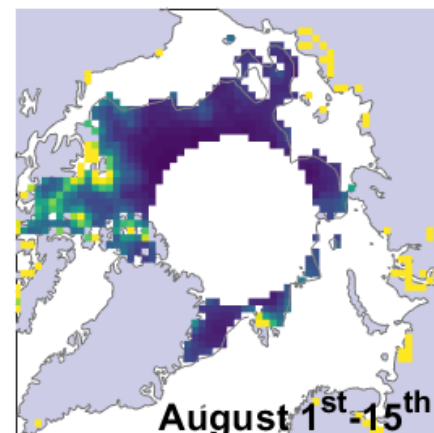
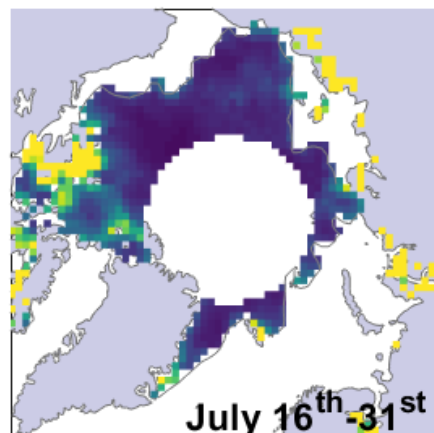
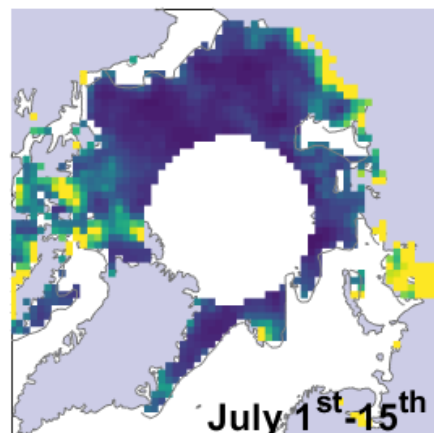
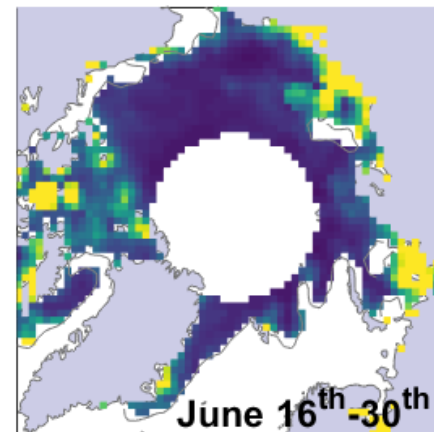
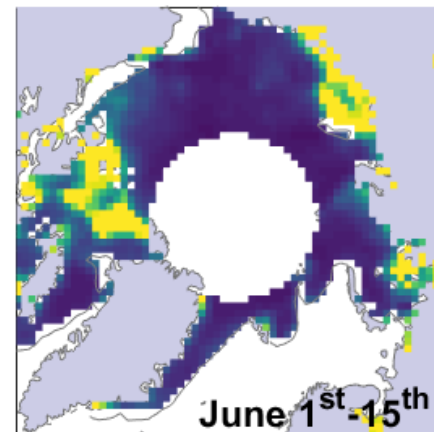
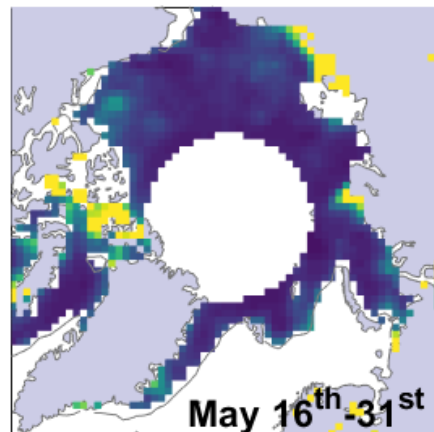
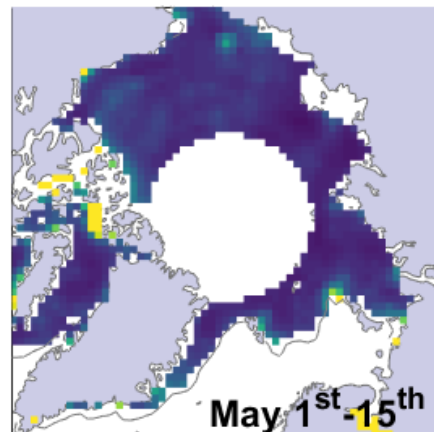
Radar freeboard standard error

CS2

[m]



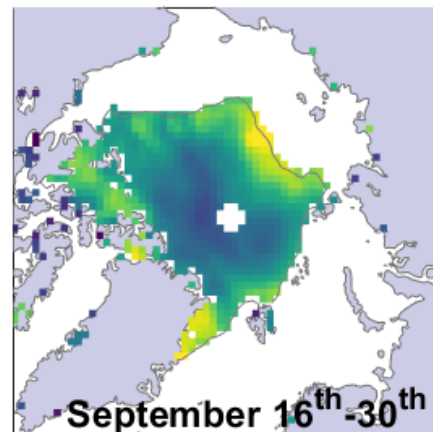
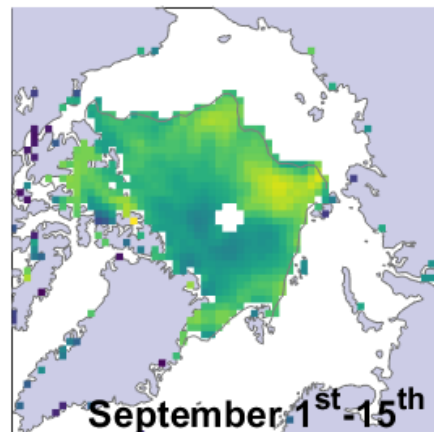
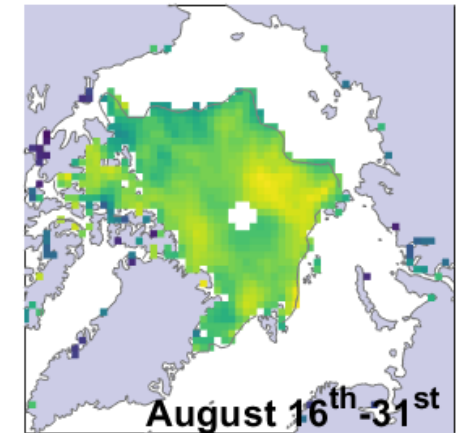
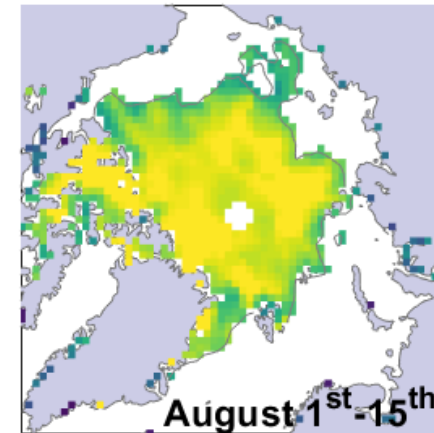
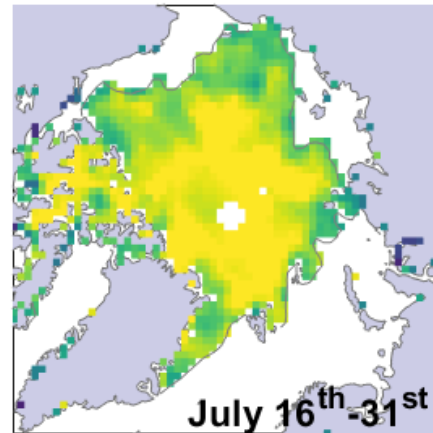
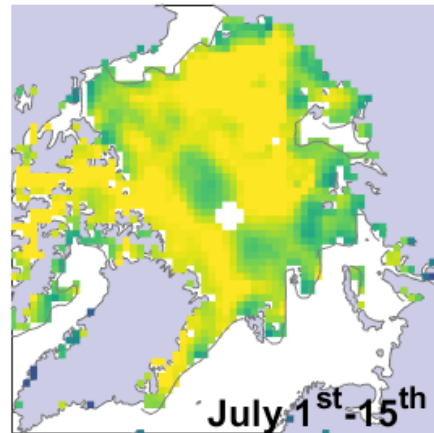
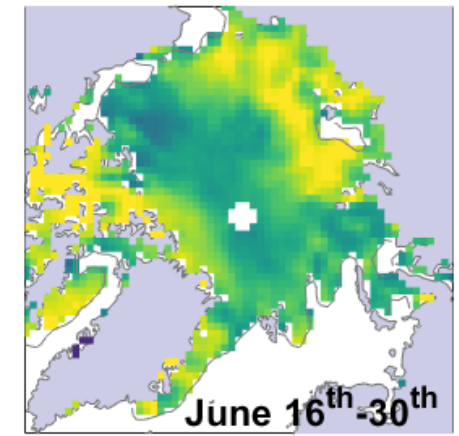
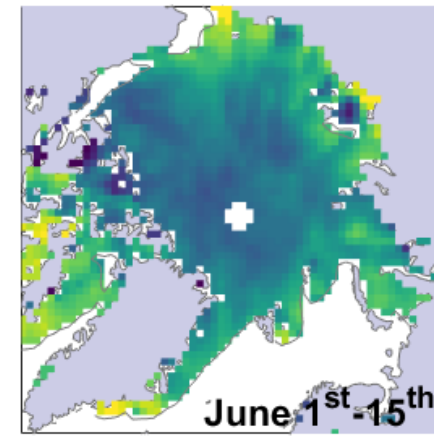
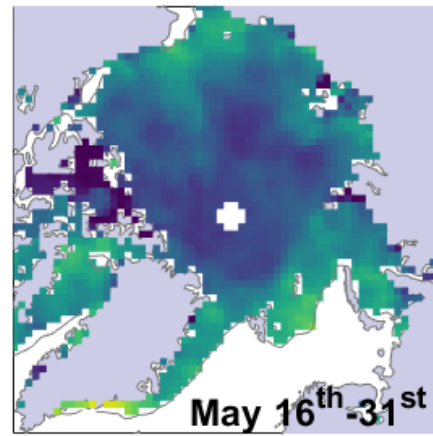
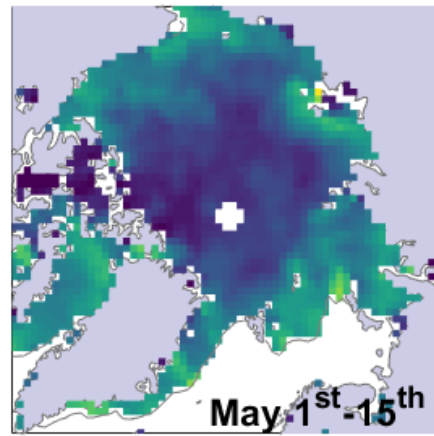
**Radar freeboard
standard error
S3A & S3B
[m]**



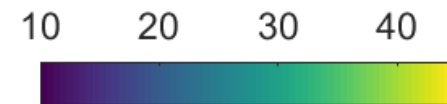
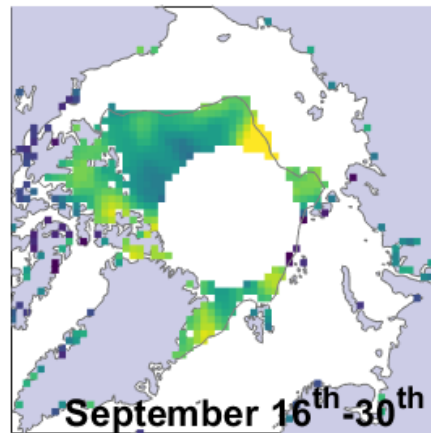
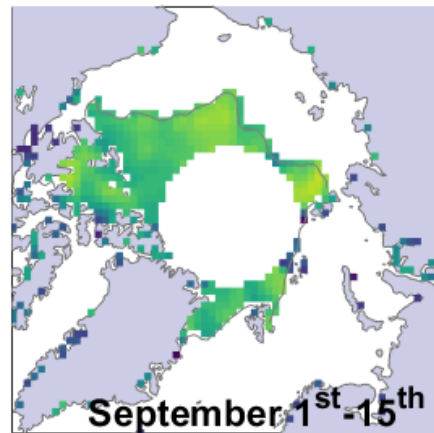
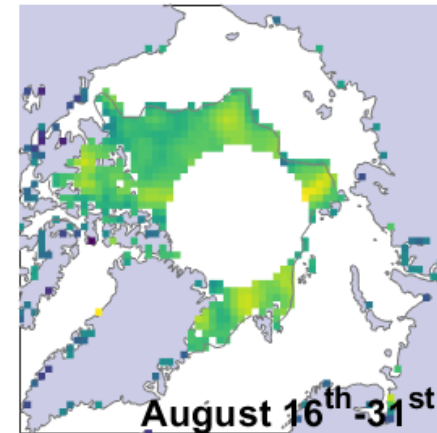
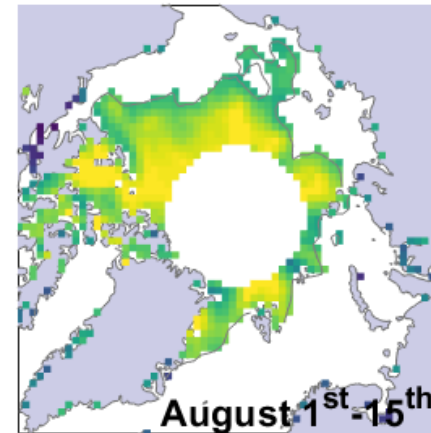
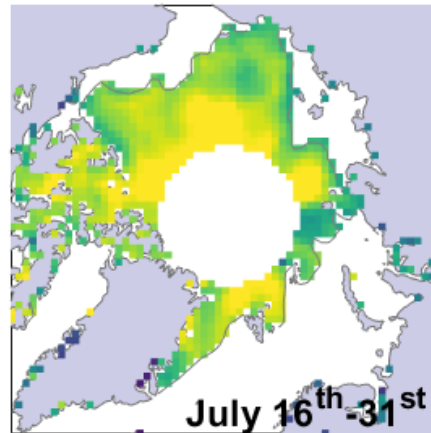
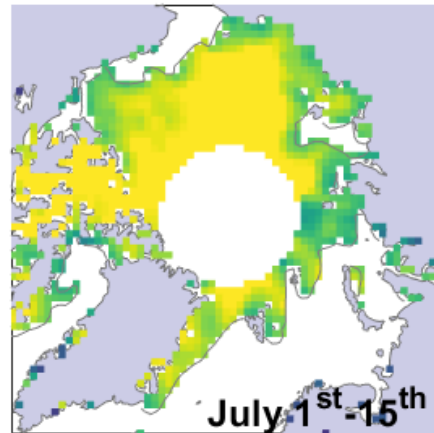
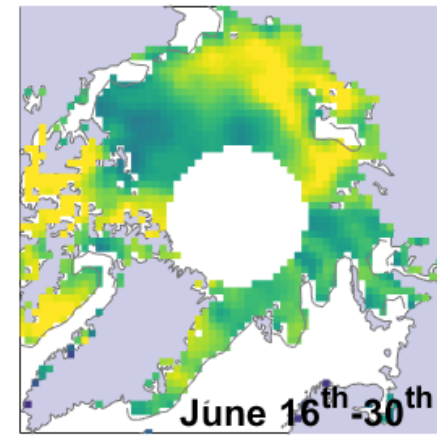
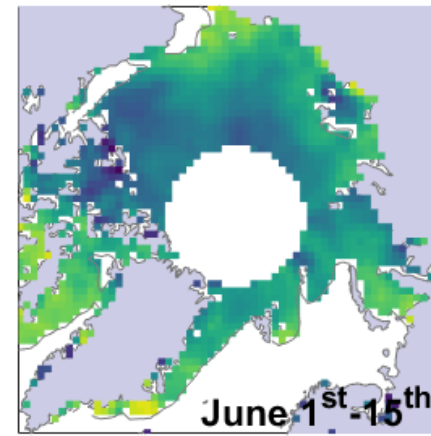
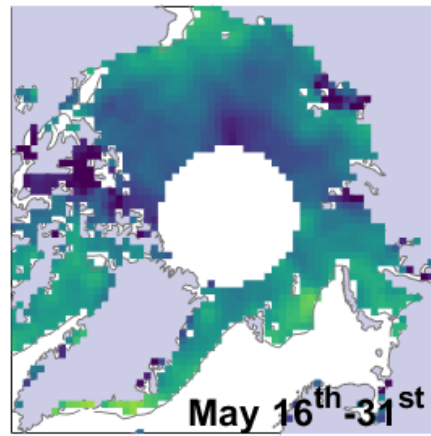
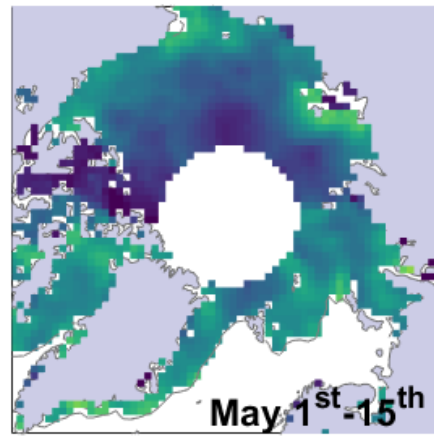
Sea ice Sigma0

CS2

[dB]

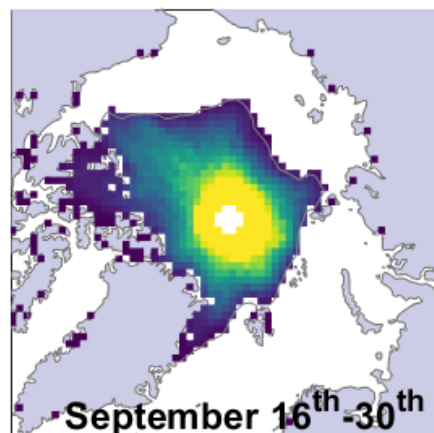
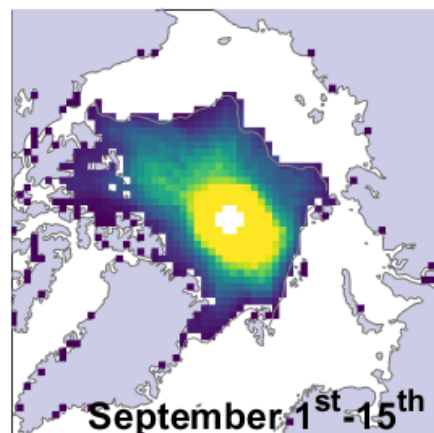
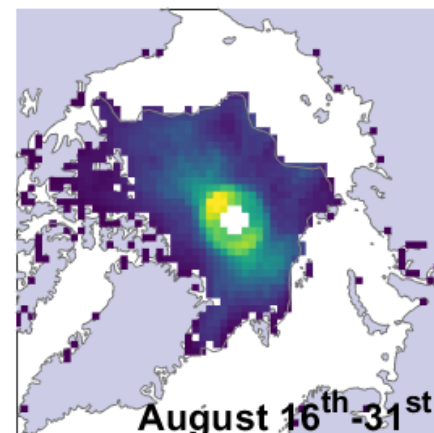
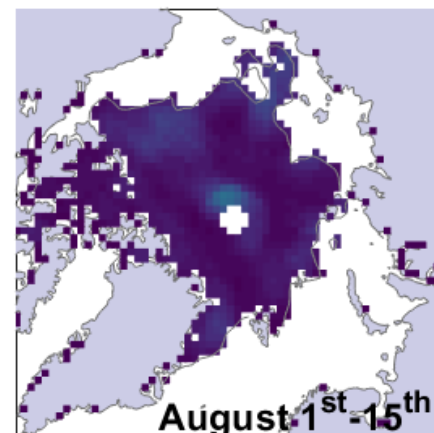
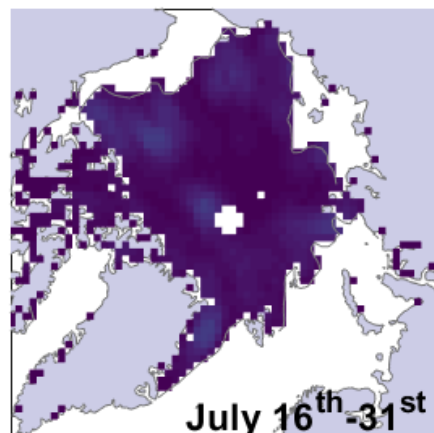
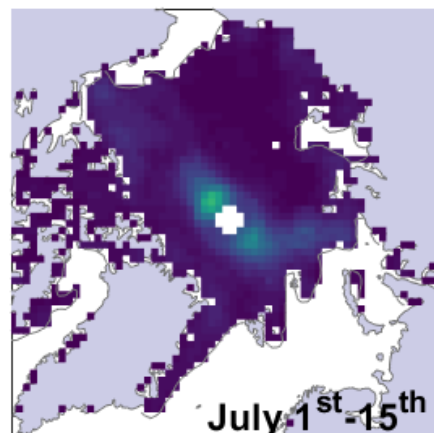
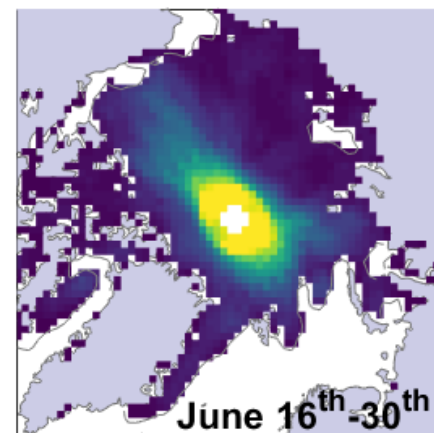
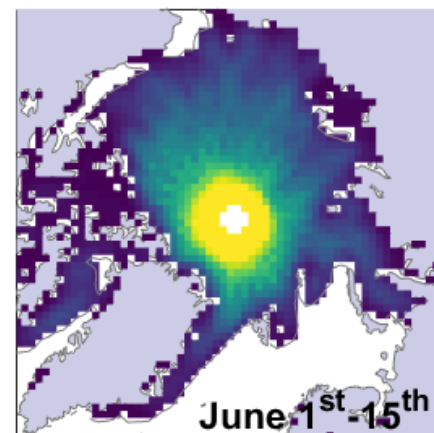
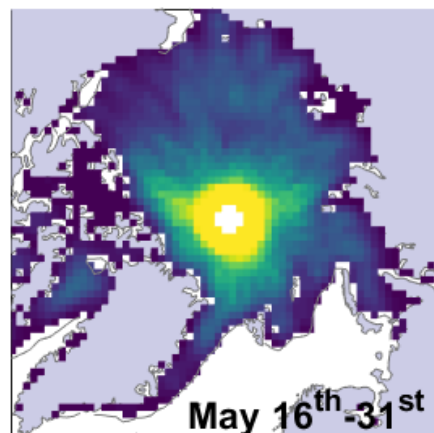
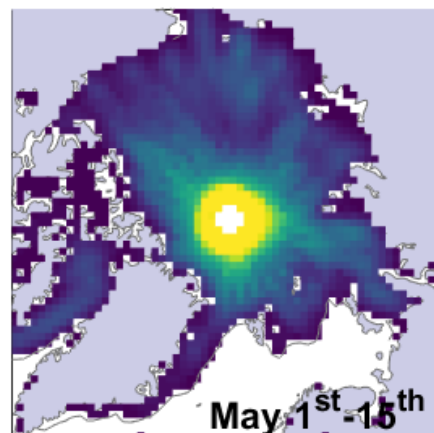


Sea ice Sigma0
S3A & S3B
[dB]



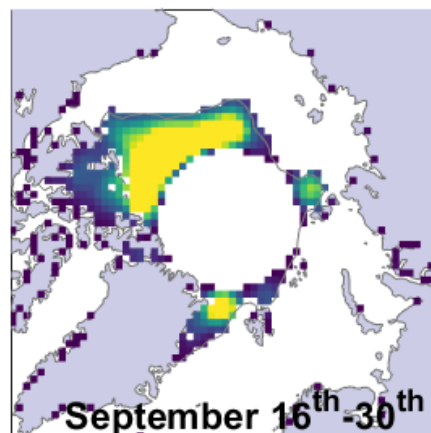
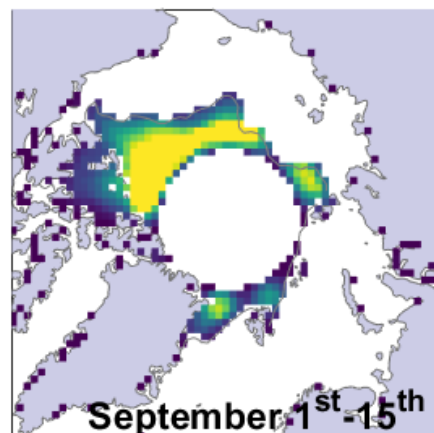
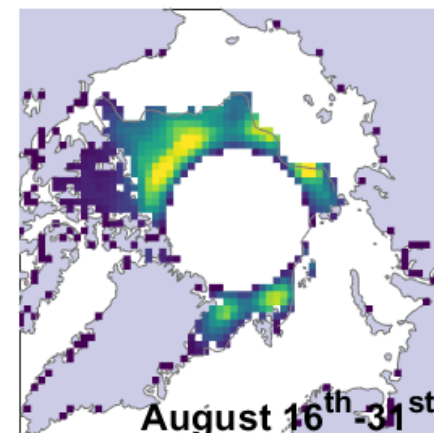
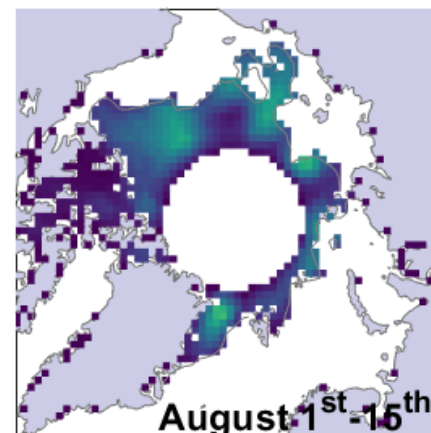
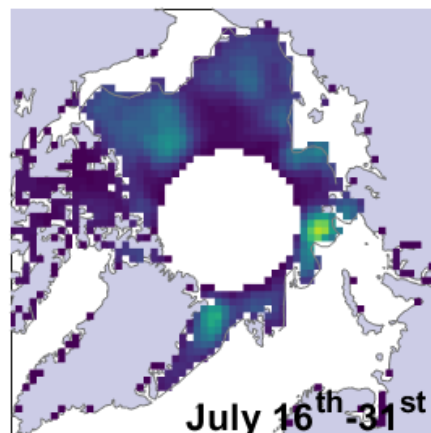
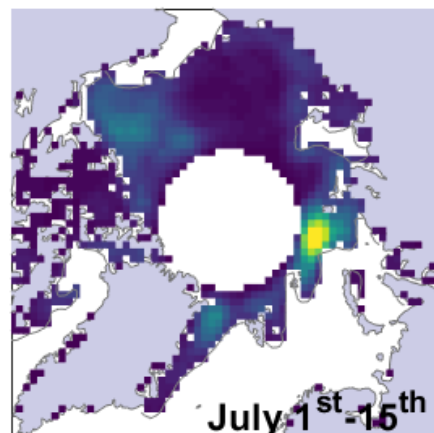
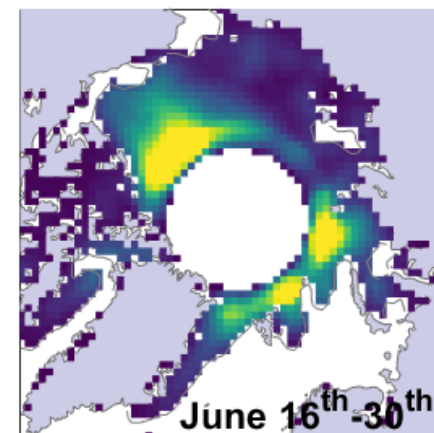
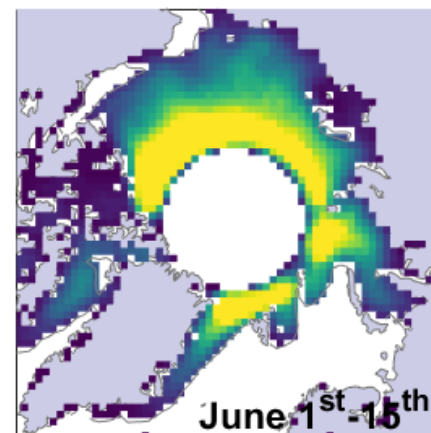
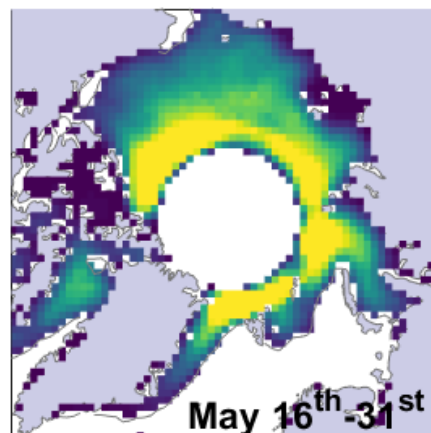
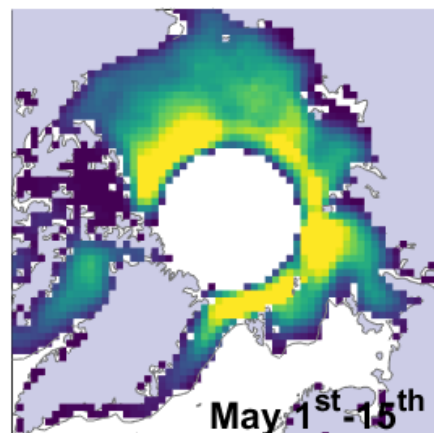
Number of valid leads (from which we can get a single rfb estimate)

CS2



Number of valid leads (from which we can get a single rfb estimate)

S3A & S3B



Summary

- Sea ice radar freeboards from S3 SRAL show similar patterns to those from CS2 SIRAL between May and Sept
- S3 systematically underestimates CS2 radar freeboard, with difference larger for thicker ice
- Patterns of the backscattering coefficient are very similar between sensors
- Future work will examine elevation and rfb differences at crossovers
- Potential for training/testing a dedicated CNN classifier for S3 in future (major job)
- Otherwise bias correction to align the sensors may be feasible
- Coverage, precision and potential resolution could all improve by combining data from all 3 sensors