EGU CR7.2

Evaluation of coupled model forecasts of sea ice during the Iceland-Greenland Seas Project (IGP)

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ENV EAST Doctoral Training Partnership

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icoland-greenland seas project

Evaluating operational and coupled forecasts during IGP

Met Office global operational forecasting system

- GA6 (transitioned to GA7 later in 2018)
- 10 km grid length
- 70 vertical levels
- Atmosphere only
- Persistent sea ice and sea surface temperature fields from OSTIA daily analysis

Experimental coupled version

- GC2 then GC3
- 10 km grid length
- 85 vertical levels
- Ocean grid resolution 1/4° and 1/12°
- Employs Forecast Ocean Assimilation Model (FOAM) with interactive ocean (NEMO) and sea ice (CICE), using OASIS coupler
- Dynamic and thermodynamic coupled sea ice and SST fields initialised from OSTIA

Sea ice and SST (GC2)

Pink contours: updated OSTIA sea ice analysis at time step

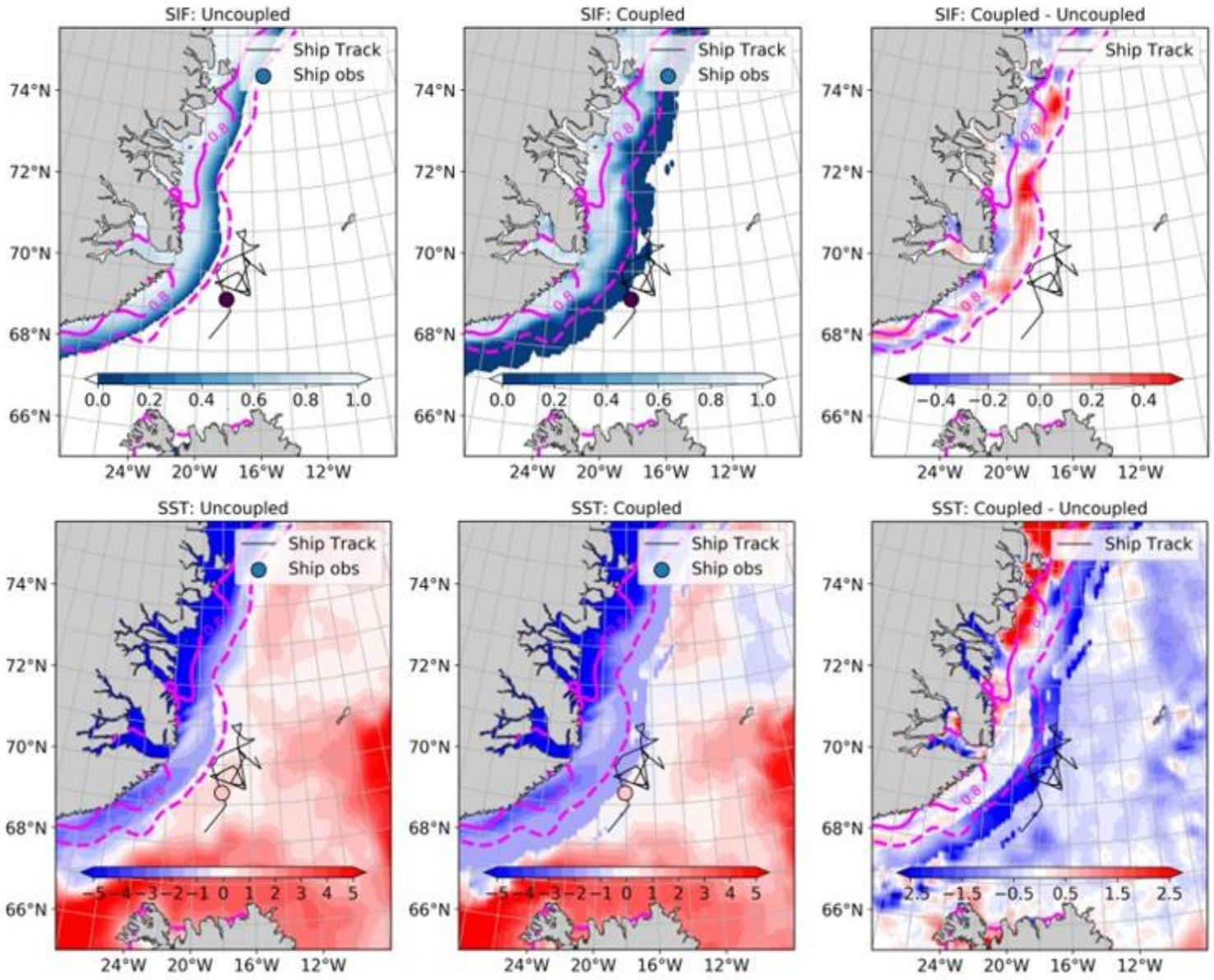
Case 1 (CAO): T+36 hours

Uncoupled model:

- Sea ice concentration minimum of 15%

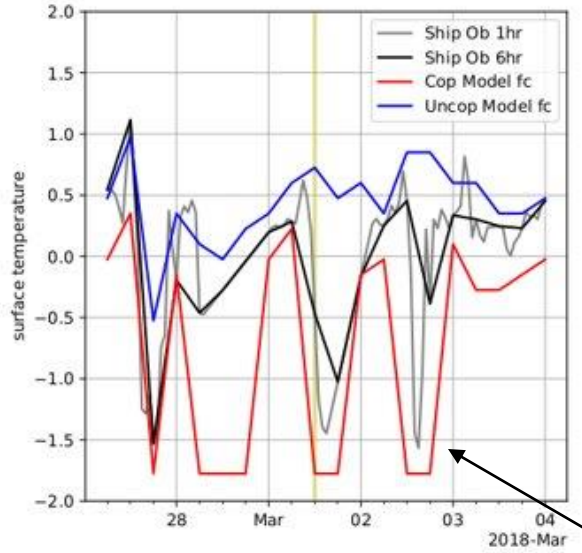
Coupled model:

- Much extended band of low concentration sea ice
- Clear band of lower SSTs associated with extended sea ice due to assumption that grid cells with SIC>0% are at –1.8°C
- Coupled model SSTs cooler over much of the domain

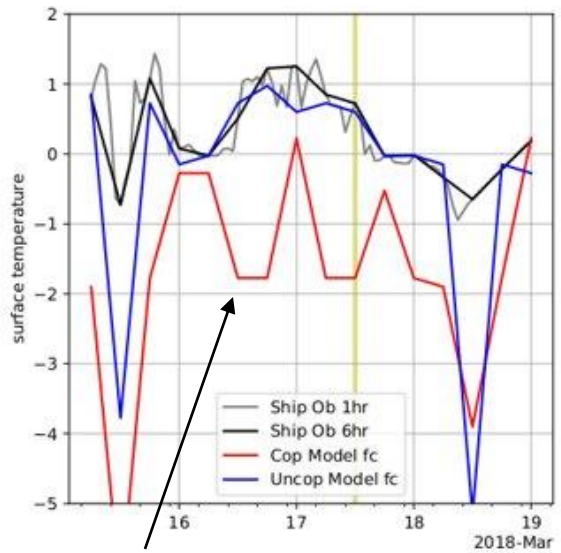


SST along ship track

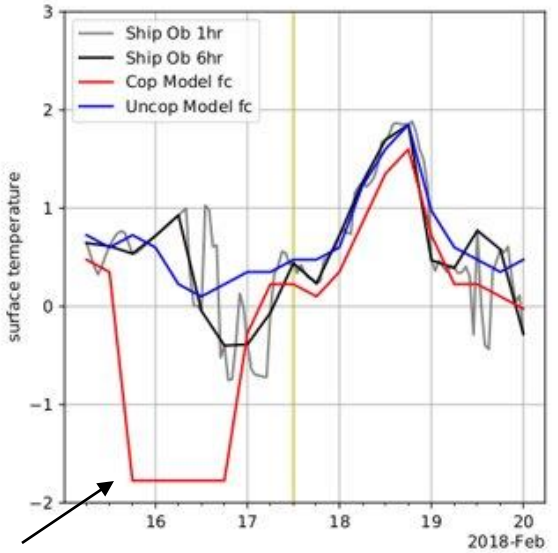
Case 1



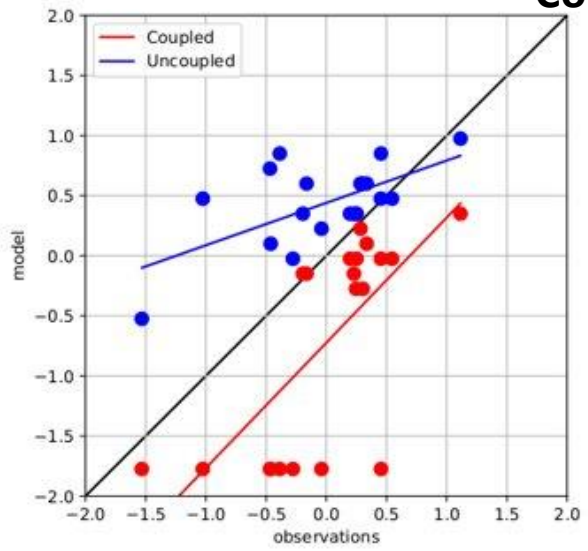
Case 2

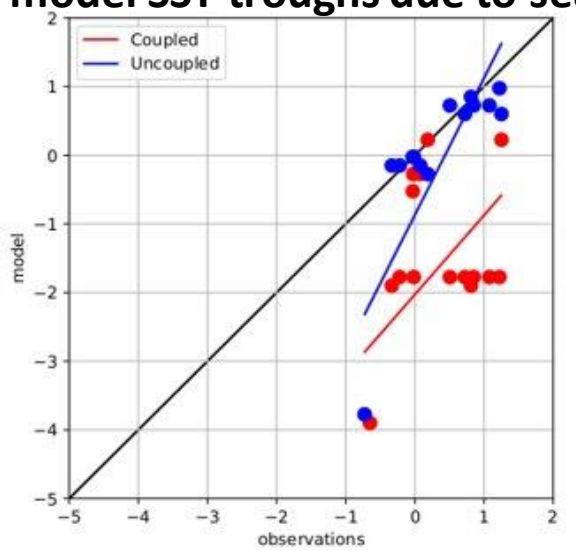


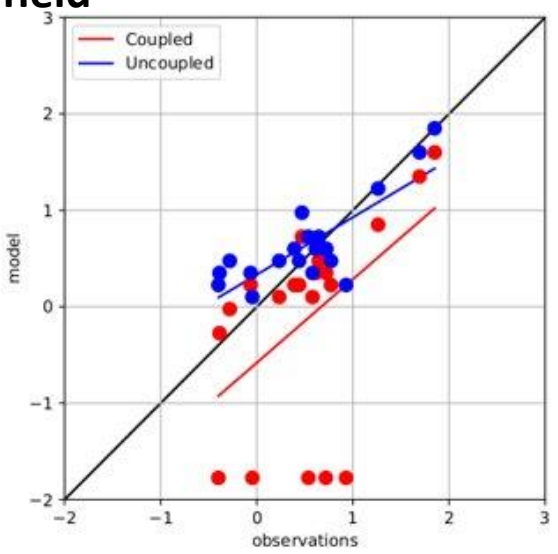
Case 3



Coupled model SST troughs due to sea ice field





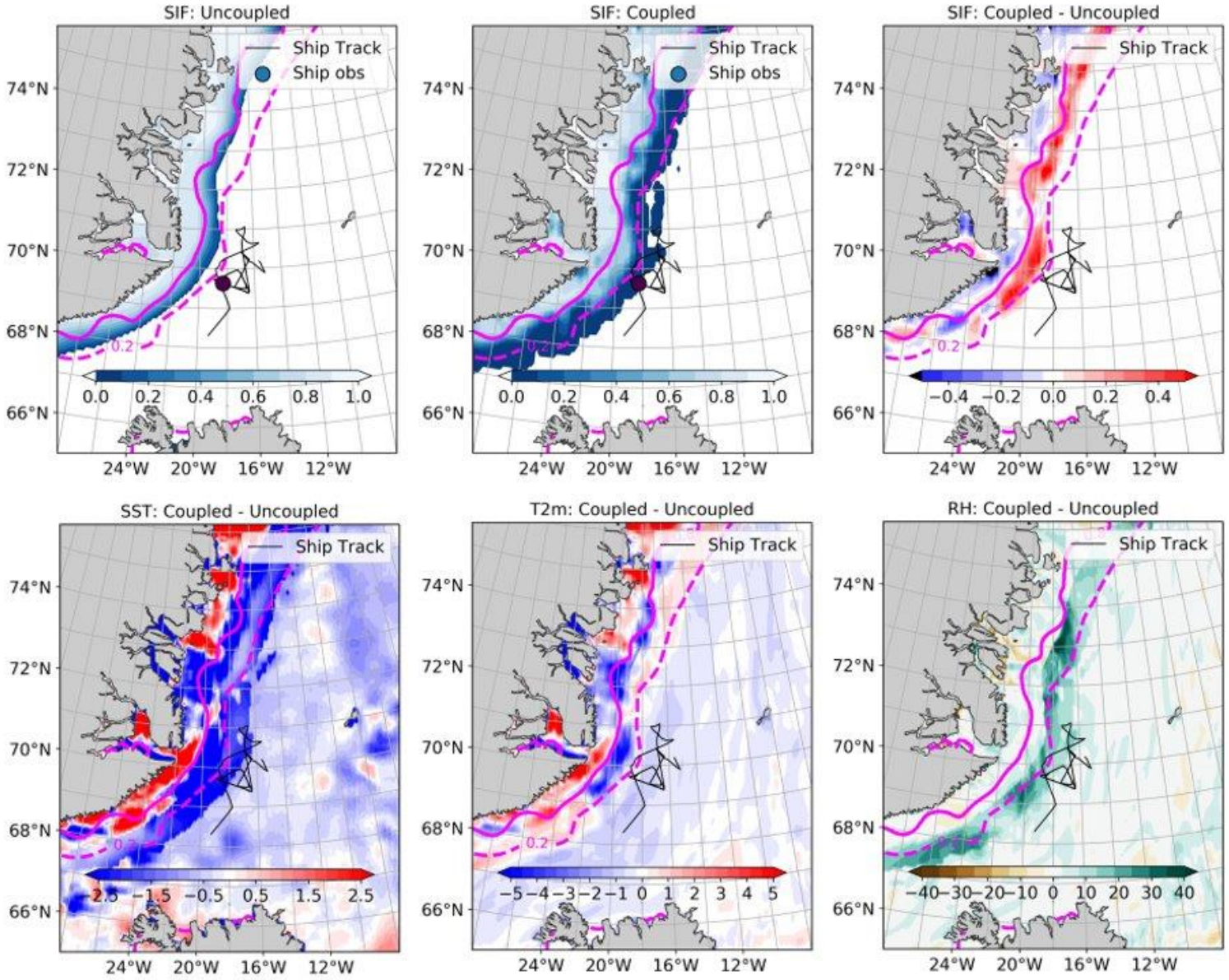


Meteorology

Case 1 (CAO): T+84 hours

Coupled model:

- Significant MIZ growth results in possibly better agreement with OSTIA analysis
- SSTs significantly cooler over entire domain but especially in MIZ
- T_{2m} cooler over open ocean – in line with SSTs – though a band of warmer temperatures occurs over coupled model only MIZ
- Substantially more upwards moisture flux over MIZ
- Surface roughness important factor



Initial conclusions

- Dynamic sea ice in the coupled model **appears** qualitatively more accurate than the uncoupled model's assumption of persistent sea ice. Yet this needs confirmation using a quantitative method.

- In the cases studied, the coupled model typically suffers from a cold bias in sea surface temperature, particularly in the MIZ. This may be partly related to ocean grid size not being able to represent the true sea ice distribution – for further investigation.

- In the region of the MIZ there are competing processes between the different SSTs and surface exchange parameterisation to consider when attempting to compare the models' performance that must be carefully considered.
  - Extra wide low concentration band of sea ice gives large region of high model surface roughness increases surface exchange
  - Cold-biased SST reduces surface exchange

- However, there are signs that in and near the MIZ the coupled model provides a more accurate forecast. (Particularly later in forecast, likely due to diverging sea ice fields).
  - With competing errors present, how much of this is luck?

IIEE analysis (GC3)

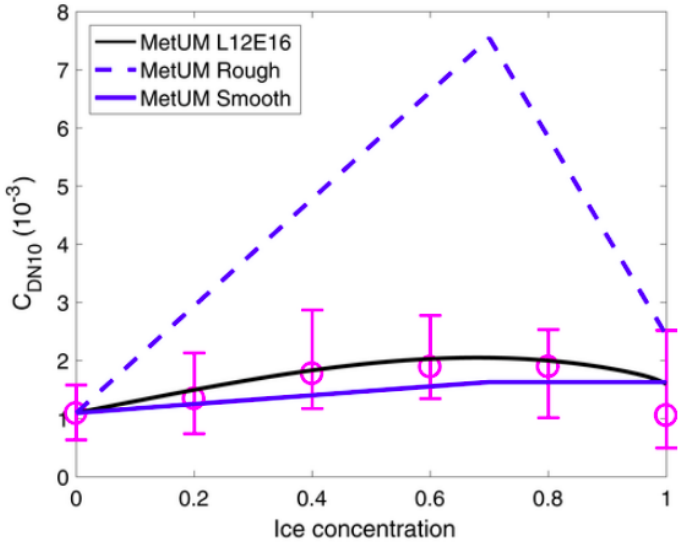
Model configuration
- GC3.1
- ORCA 1/4° and 1/12°
- *Ocean and ice initialisation?*
- MIZ wind drag too high

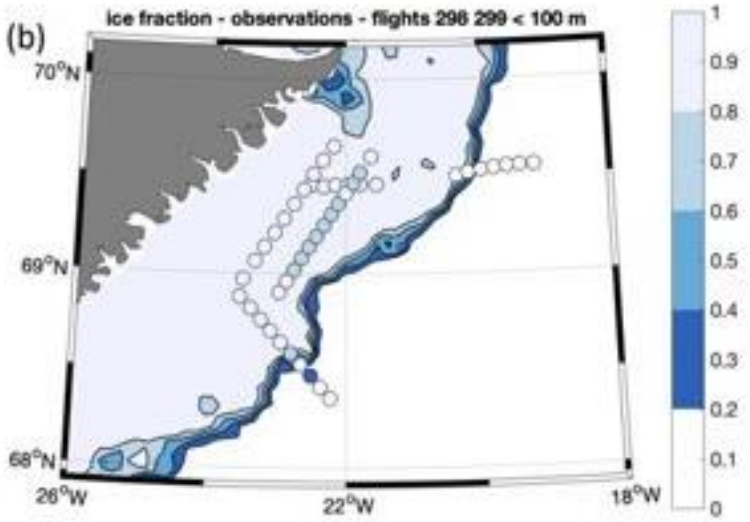
Forecasts
- 10 day length
- 17-02-2018, 01-03-2018, 01-04-2018

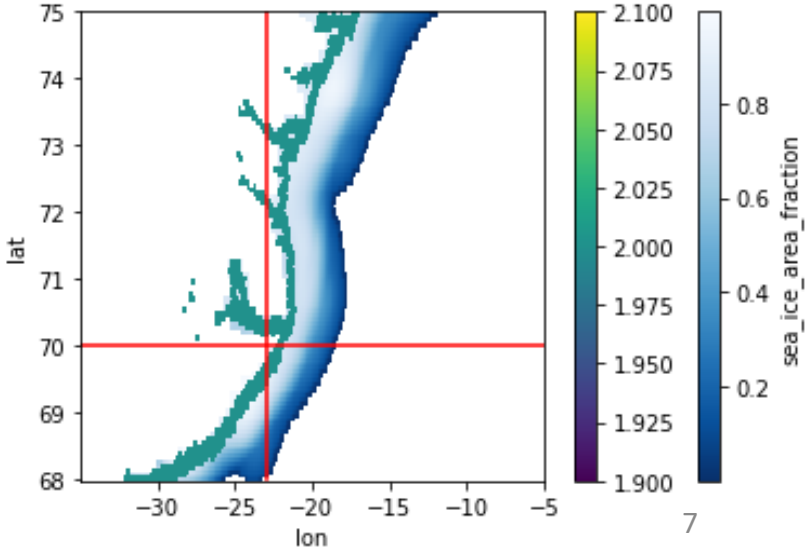
Satellite products
- OSTIA
- AMSR2
- Daily analyses at 12Z (+12 hours from forecast time)
- Both ~6 km grid

Aircraft Observations
- IGP sea ice concentration from albedo

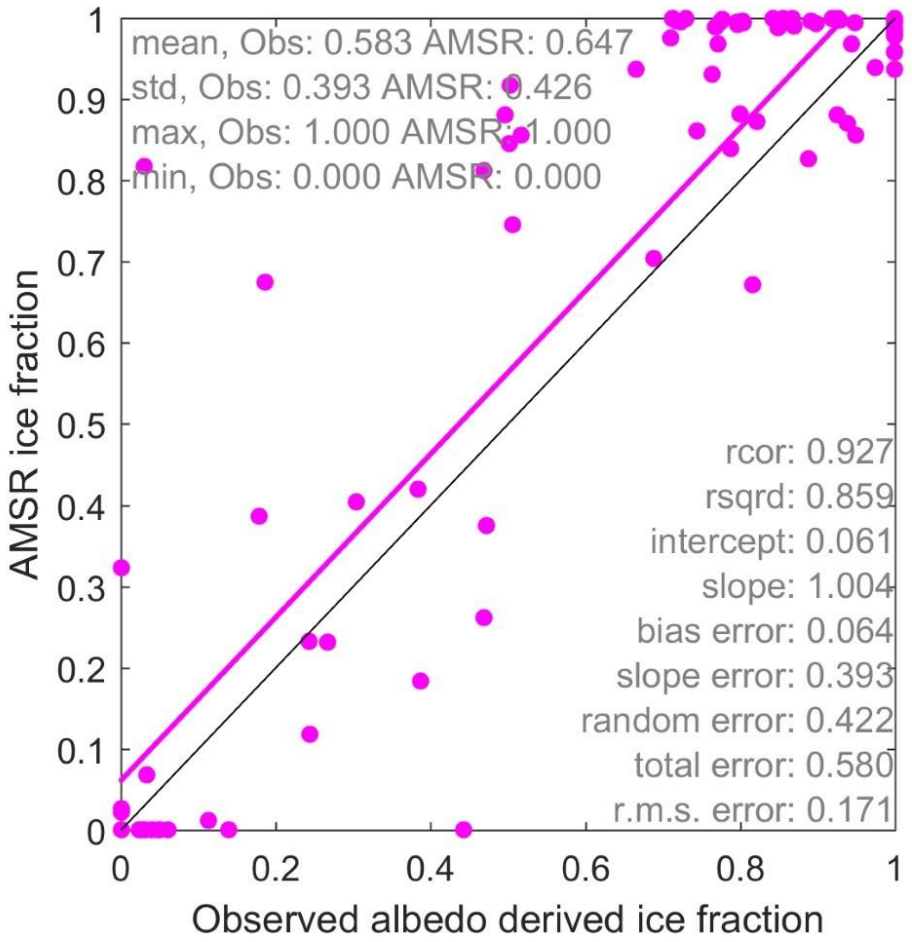
Method
- Regridding: 0.06° x 0.06°
- Land mask: grid cells converted to land at 5 cell radius of land
- Convert sea ice field to binary (0 = sea, ice = 1) based on minimum sea ice concentation threshold (>0%, >15%, >50%)
- Integrate areas enclosed by forecast and truth (overestimation, O; underestimation, U)

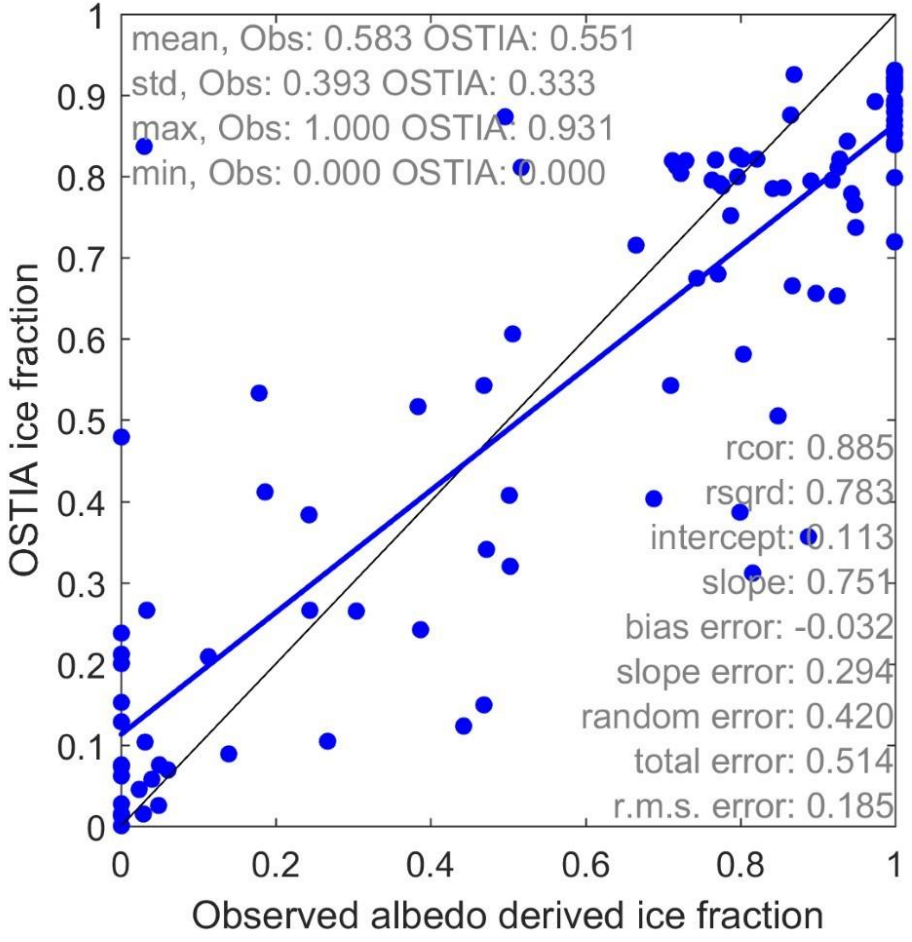




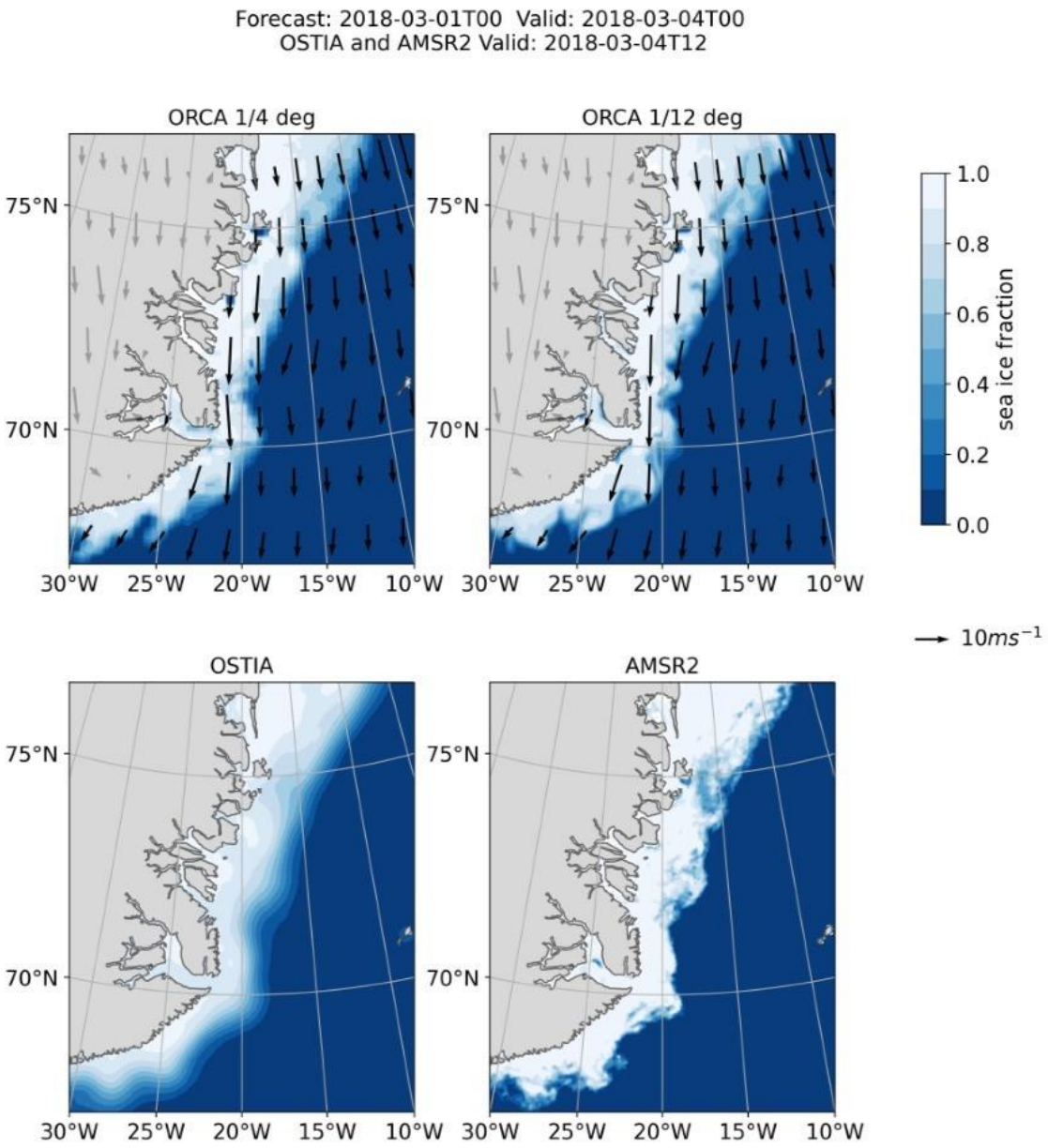


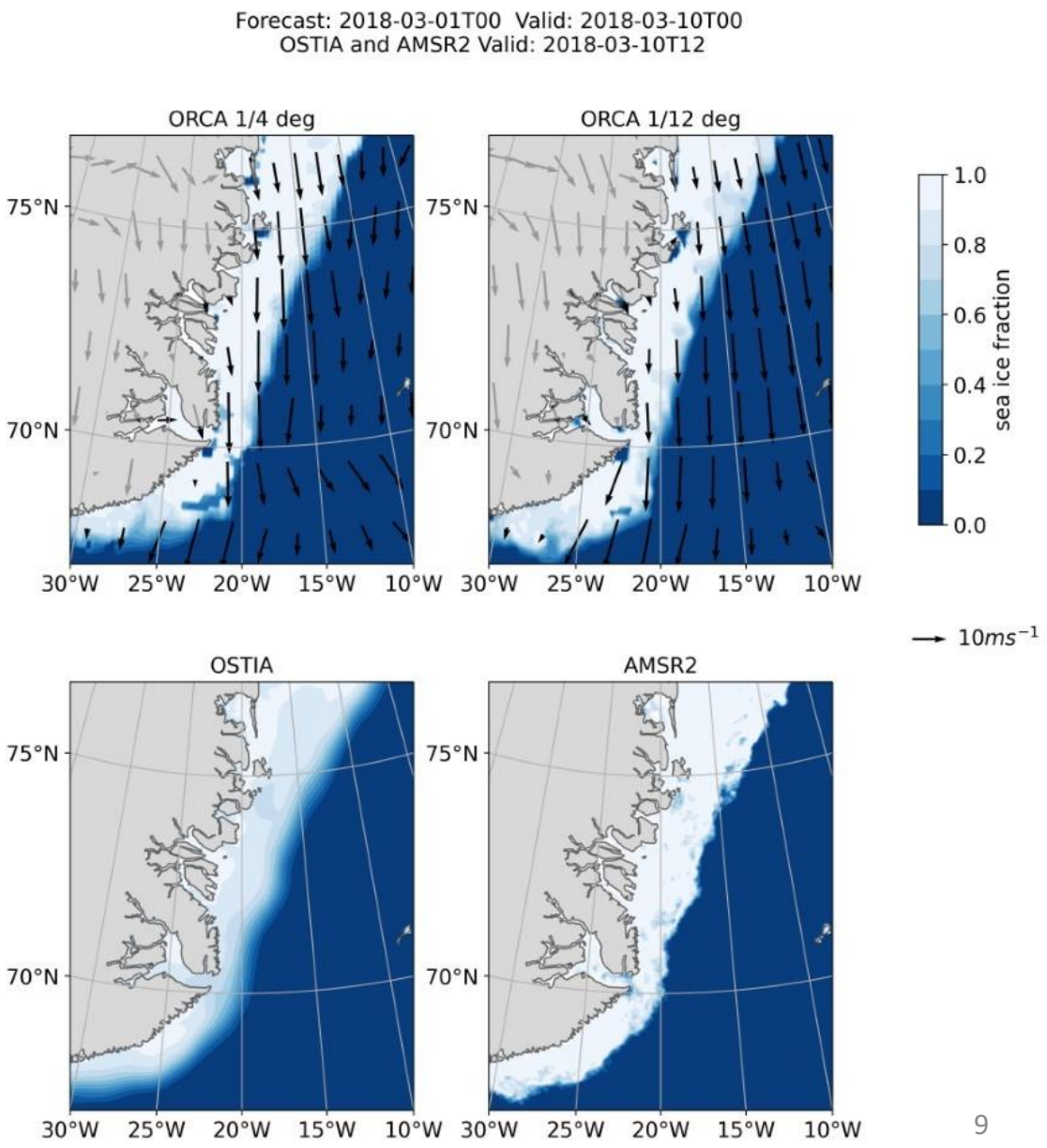
Satellite products vs in-situ observations





Sea ice and wind at T+72 hrs and T+216 hrs (fcst: 01-03-2018)

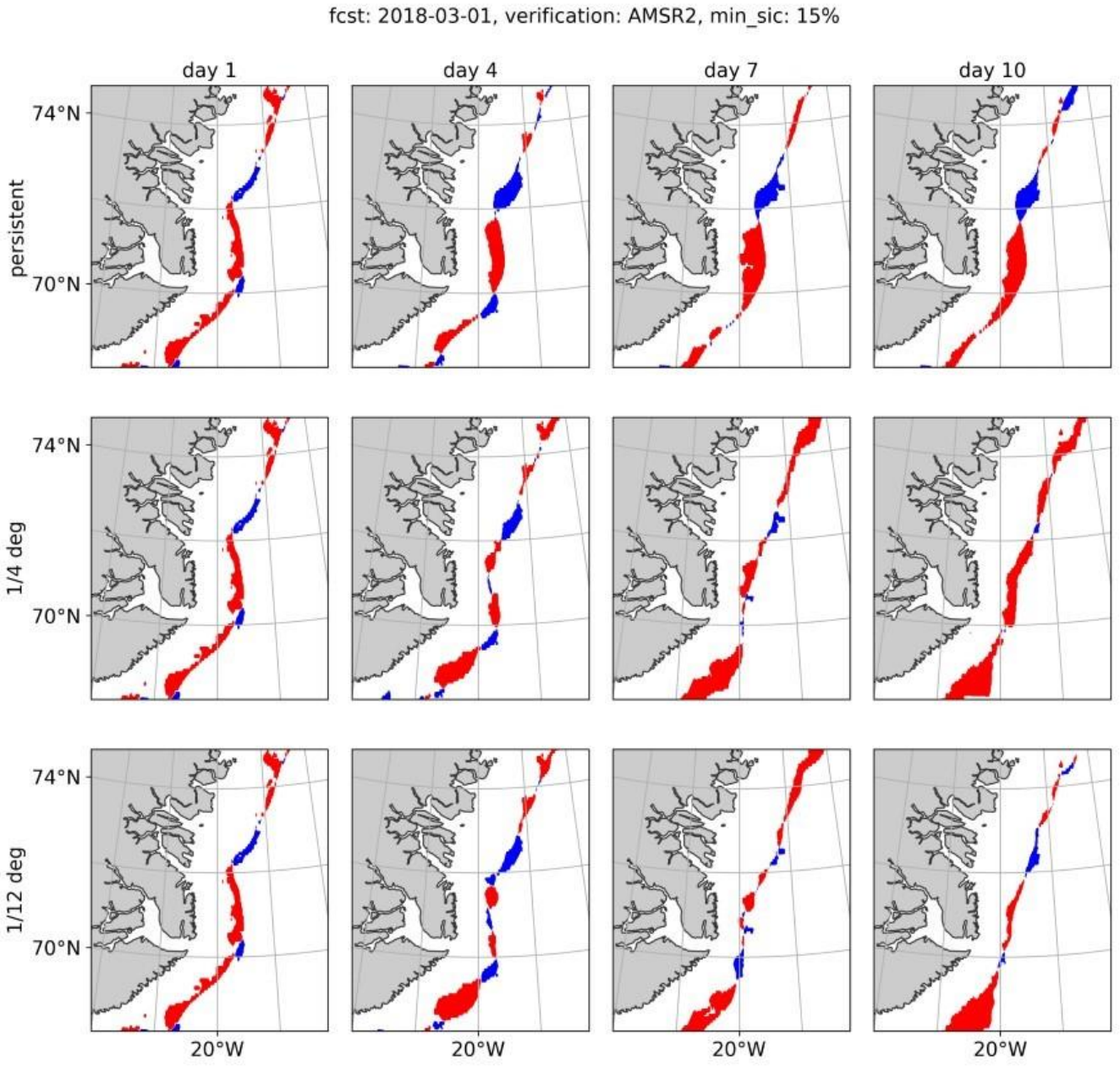




Spatial IIEE development

Using AMSR2

- Initial field (influenced by OSTIA – by how much; and time lag) judged to mostly consist of O.
- Both forecasts increasingly dominated by overestimation (O; red), particularly with large patch of overestimation developing in the south of the domain.

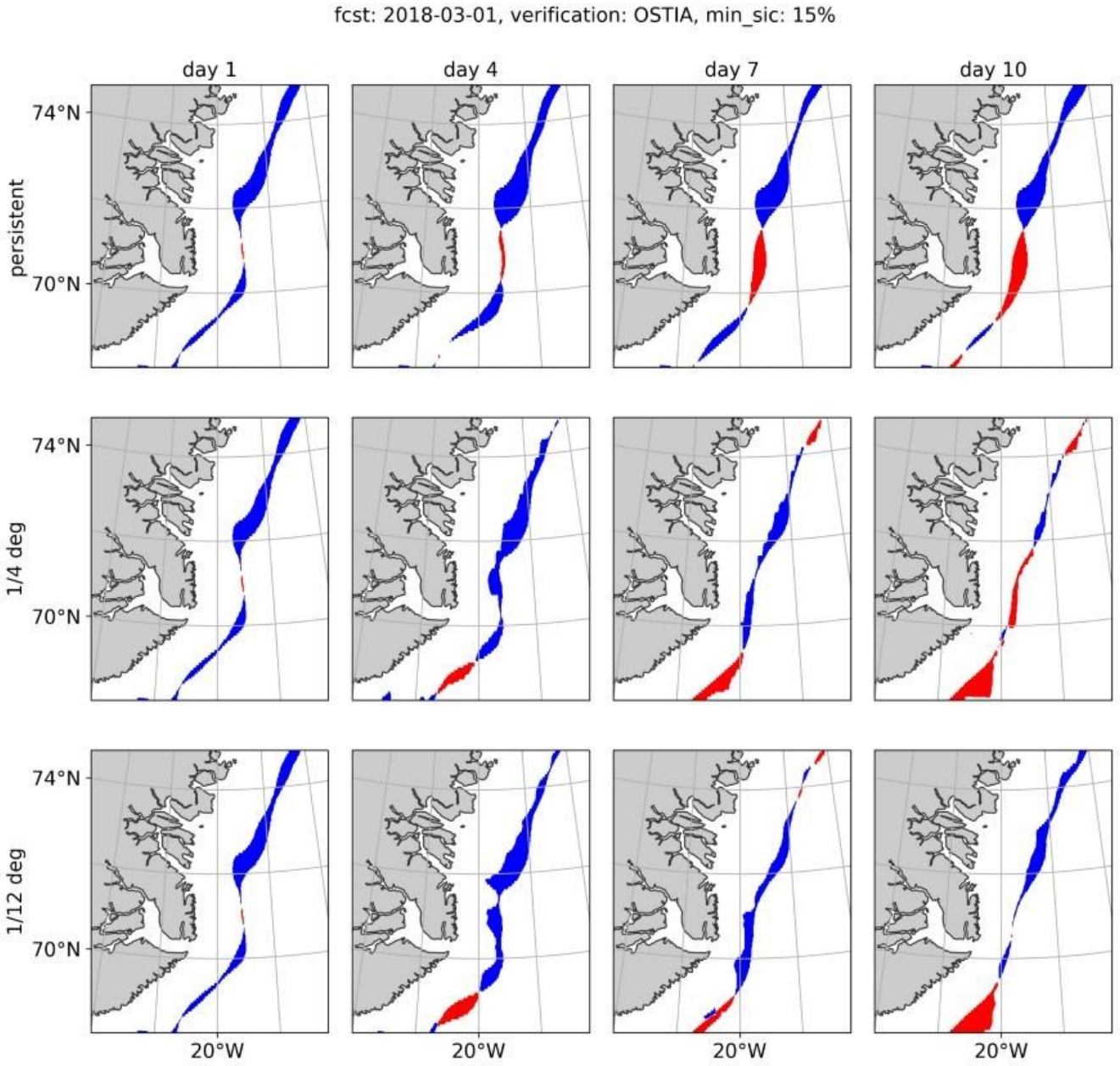


Spatial IIEE development

Using OSTIA

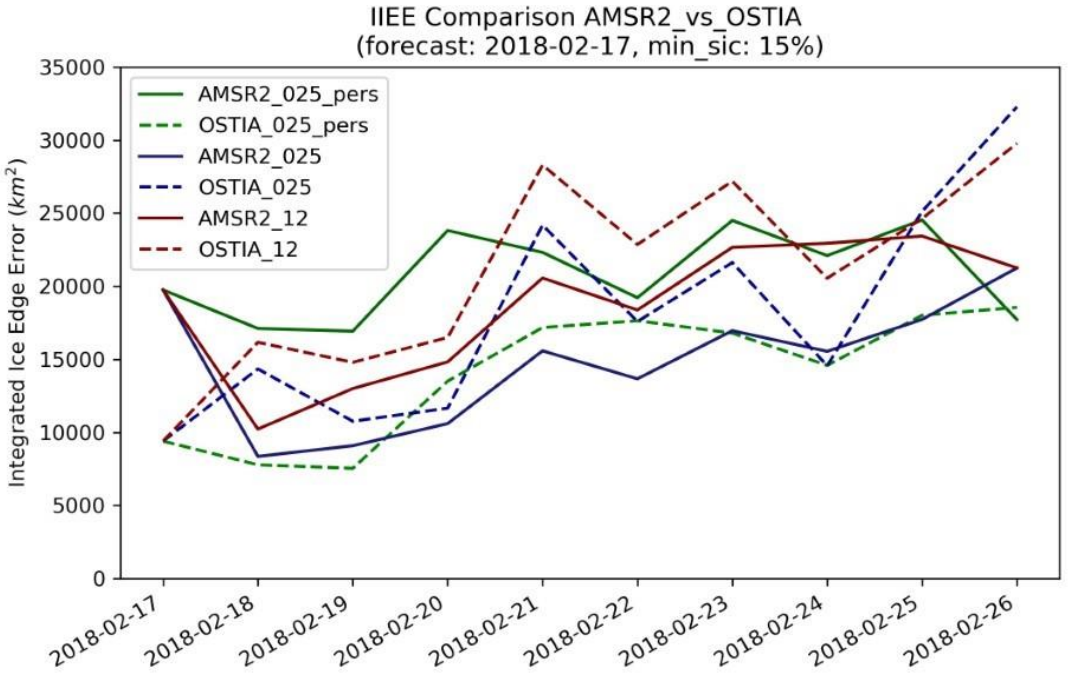
- Both forecasts increasingly tend to be dominated by underestimation (U; blue), though to a lessening degree with forecast lead time.
- However, similar patch of O also develops in the south of the domain corroborating AMSR2.
- OSTIA clearly believes 'true' sea ice field to be much wider than AMSR2 resulting in opposite initial error.

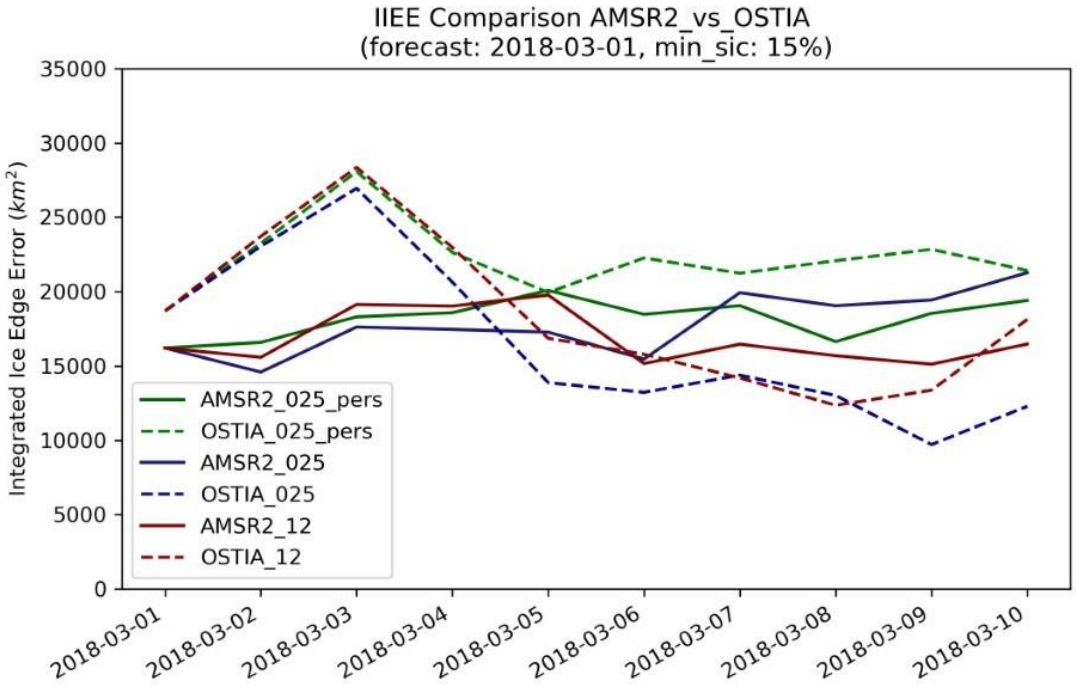
- But both products find that by end of forecast too much ice has moved south (could this be due to other factors?).

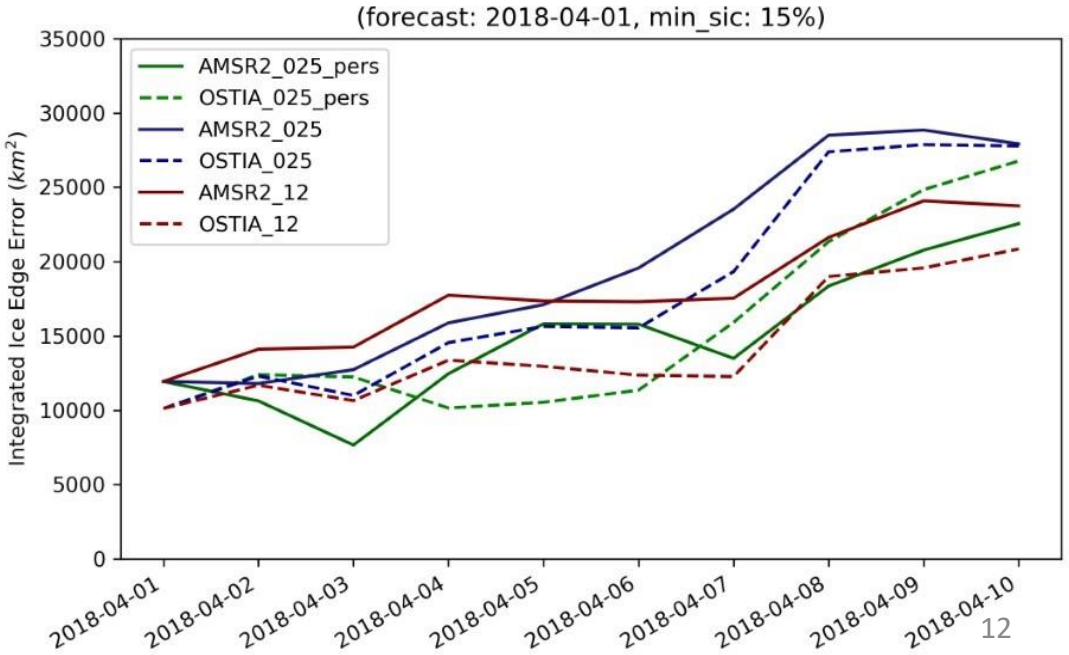


Overall IIEE results

- Evaluating three forecasts against two verification products suggests there is no significant overall advantage from increasing model resolution.
- Some possible hints of trends, e.g. during CAOs perhaps 1/12° does provide lower error at day 10, however, evaluation of more forecasts is needed to confirm.
- Little to no advantage over persistent sea ice seen here.



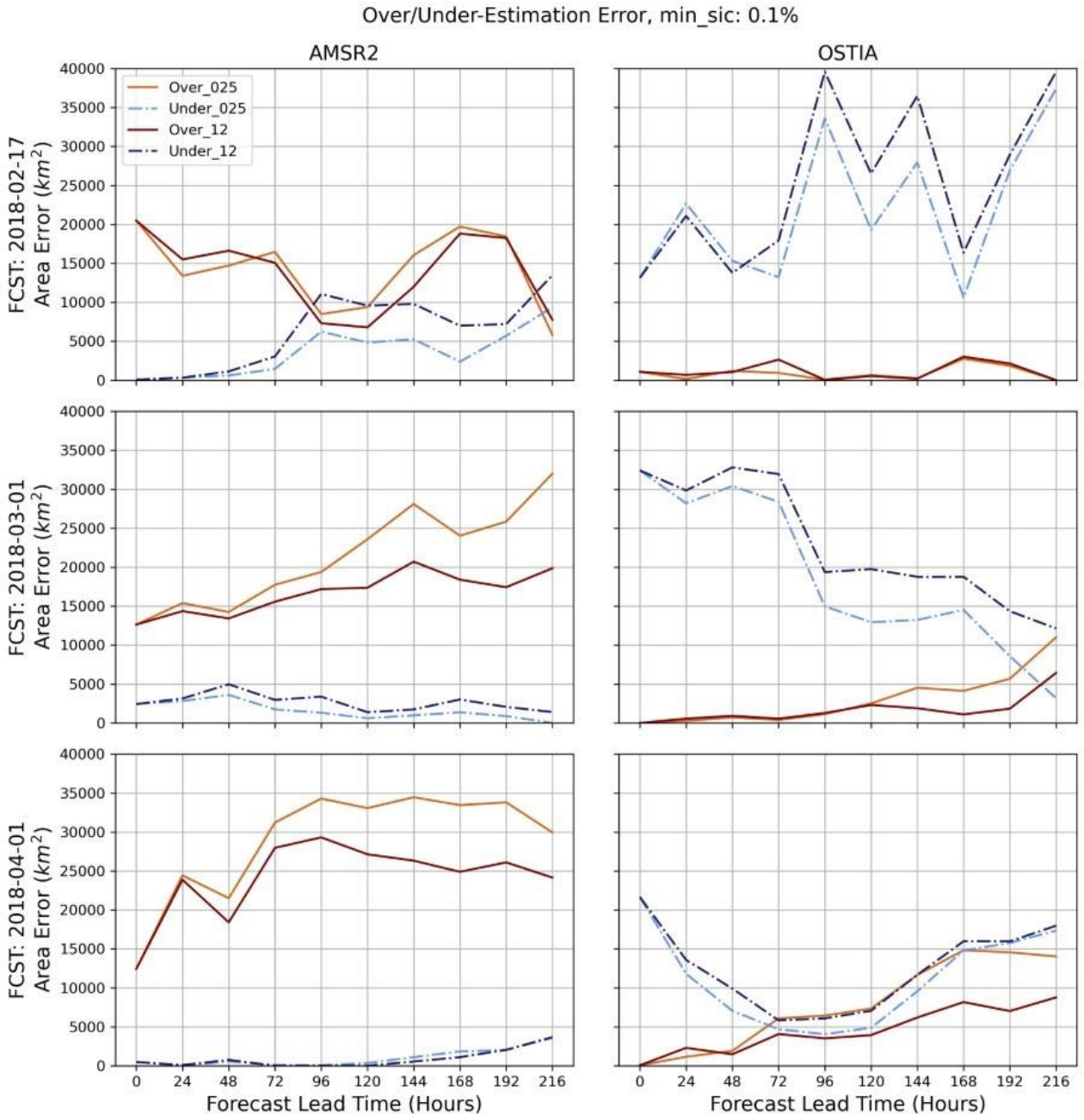




IIEE components

>0% SIC

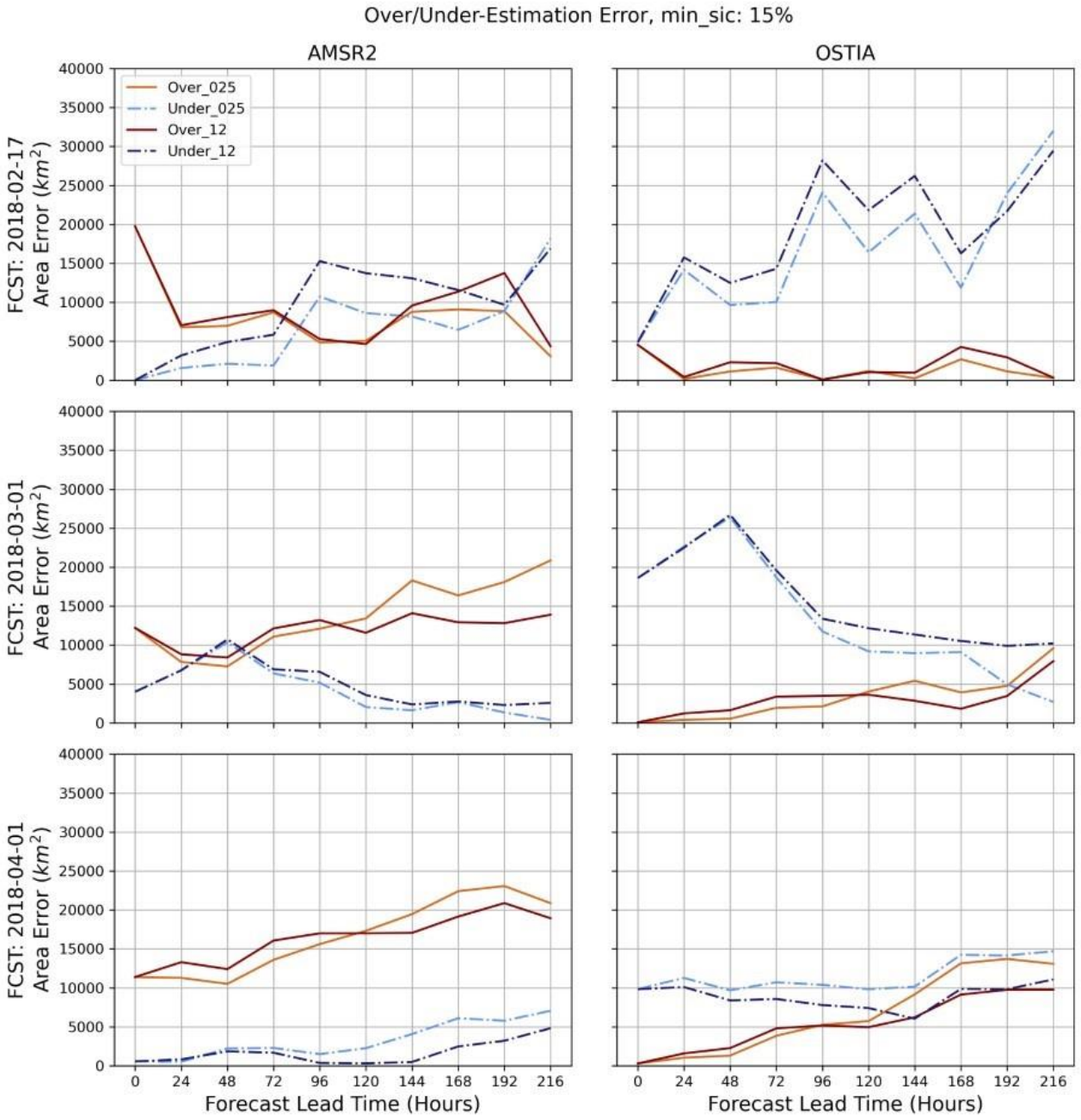
- Corroborates suggestion from spatial analysis that compared to AMSR2 the models consistently overestimate total width of MIZ, while compared to the smooth OSTIA field they consistently underestimate.
- During CAOs O grows (AMSR2), and U diminishes (OSTIA)
  suggestion dispersion of low concentration sea ice due to wind



IIEE components

>15% SIC

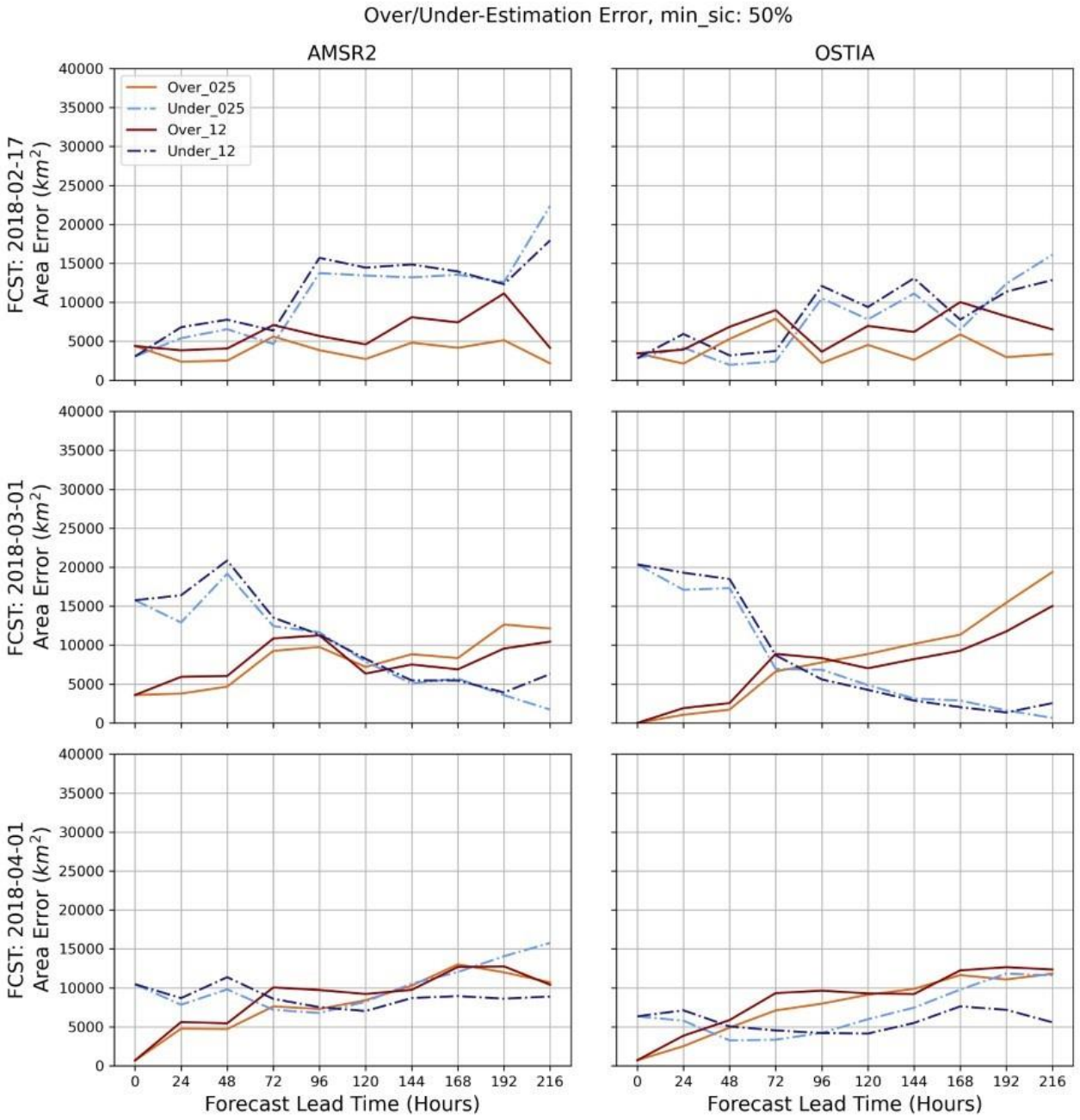
- Similar pattern of errors on initialisation
- During CAOs, error at day 10 tends to be due to absolute extent error compared to AMSR2, but misplacement error compared to OSTIA



IIEE components

>50% SIC

- During CAOs both products suggest that models underestimate sea ice (perhaps linked to AMSR2 positive sea ice concentration bias), though O does grow over course of forecast.
- 17 Feb forecast mostly suffering from misplacement error.



Conclusions

- Initialisation error
  - Timing
  - OSI-SAF SSMIS too wide

- Excessive sea ice transport due to wind
  - Leads to MIZ extent underestimation in southerly flow and overestimation in northerly wind

- Smooth OSI-SAF SSMIS / OSTIA field leads to both initialisation and verification problems
  - Can suggest false measure of accuracy

- Now performing a further experiment with reduced sea ice surface drag scheme for comparison