RESEARCH DEPARTMENT MEMORANDUM

ECMWF

To:	RD, OD, COP	
Copy:	John Lavelle, Simon Good, Emma Fiedler	
From:	Phil Browne, Patricia de Rosnay, Sarah Keeley, Ioannis Mallas, Kristian Mogensen, Jean Bidlot	
Date:	March 29, 2017	File: RD17-095
Subject:	**OSTIA sea ice product change on 20 March 2017**	

Summary

A new version of the OSTIA Sea Surface Temperature and Sea Ice Concentration was implemented by the UK Met Office on 20 March 2017. It started to be used in our operational analysis on 21 March 2017. This product is designed to remove spurious sea ice regions that are particularly problematic around Iceland and Denmark; that had been introduced previously by OSI SAF when they switched off a filter based on T2m from the ECMWF operational analysis. Spurious sea ice connecting the Japanese Islands of Hokkaido and Honshu has also been eradicated. Spurious sea ice islands in the north Atlantic that have been seen this winter (2016/2017) in the operational OSTIA product also appear to have been removed.

In this memo we evaluate the impact of using the new product on NWP, based on a test version of the product provided by the UKMO.

The modifications to sea ice concentration (CI) has had a minor effect on the sea surface temperature (SST) fields due to OSTIA's processing. Where spurious ice had previously been introduced to the operational dataset, the SST had been reduced to make the SST and CI somewhat consistent. In the new product, where the spurious CI is not present, the SST is not artificially lowered. The effect of this is that the SST in the new OSTIA product is higher than in the old product in the regions where spurious CI has been removed.

We have not found any significant changes to skill scores as a result of this change. The change resulted in the wave model giving a better fit to buoy observations in the regions that contained spurious CI in the old OSTIA product.

This new product should be used operationally and should remove the localised problems that occurred in winter 2016/2017. The product should be monitored as the *ad hoc* masks that are used to remove spurious sea ice may be modified without our knowledge.

1 Background

The OSTIA product is a L4 data set providing Sea Surface Temperature (SST) and Sea Ice Concentration (CI) fields used as the lower boundary conditions for the IFS. OSTIA CI is derived from the L3 product OSI-401-b from OSI SAF.

OSTIA: http://ghrsst-pp.metoffice.com/pages/latest_analysis/ostia.html

OSI SAF: http://osisaf.met.no/p/ice/index.html

Spurious pixels of sea ice in the OSI SAF product (probably caused by coastal effects) have persisted in the OSTIA product. This manifests itself clearly with areas of sea ice surrounding Iceland and Denmark which are not physically accurate.

OSI SAF have produced a modified product which has been passed to the Met Office who have in turn produced a modified OSTIA product. We have received this product, along with the original OSTIA product, as of 2016-12-21 0600UTC. We believe that there are errors in the product we have received up to and including until 2017-01-24 0600UTC, thus the relevant data starts from 2017-01-25.

2 The updated OSI SAF product feeding OSTIA

The following is taken directly from John Lavelle's python notebook that processes the OSI SAF sea ice data.

> "Spurious ice can occur in the OSI SAF sea ice concentration fields, due to weather [which] effects the uncertainty of the measurement over open water.
>
> The ice concentration field is filtered to remove this spurious ice.
>
> **The Masks**
>
> The mask used to filter out spurious ice is created from a combination of four masks:
>
> - The open water mask
> - The 2m temperature mask
> - The climatology mask
> - The land mask
>
> The open water mask, effectively, removes low ice concentrations. It also removes some valid ice at the ice edge.
>
> The 2m temperature mask removes ice where the temperature at 2m is greater or equal to $8°C$."

This 2m temperature comes from the ECMWF forecast.

> "The climatology mask is based on historical records and there is one for each month.
>
> The land mask has been dilated, in order to include around the coast and thereby reduce the land spillover.
>
> The open water filter and 2m temperature masks change on a daily basis. Whereas, the climatology mask changes every month. Additional, areas (e.g. around Iceland and and Japan) are masked out. Other areas will be masked on an *ad hoc* basis, if spurious occurs there regions. "

We do not know when or where these *ad hoc* masks will be introduced. These have changed multiple times in the experimental test period and their effects seen most notably in the wave forecast, where the presence or lack of sea ice results in the absence or presence of waves.

3 Tests conducted

The experiment `gola` is used with the new OSTIA product. `fetchobs` was modified to retrieve the new OSTIA product instead of the current product.

`gola` is a CY43R1 experiment at TCo399 in *early delivery* mode. The date of the first cycle was `2017012500`. Ad hoc masks were noted until `2017022200`, so we have allowed the experiments to spin up until `2017022700` and we plot results from then onwards.

The control experiment, `gol9`, used the existing operational OSTIA product.

Initially we ran a test experiment at TCo1279 and compared directly with observations. However the OSTIA product that we used in this test was not representative of the updated product which we wish to test here. The product we used for the TCo1279 experiments were a behind real time product due to a reprocessing step that was required. The scores we found from this were significantly different to operations due to relatively large changes to the SST fields as a result of OSTIA using more observations and hence improving its SST analysis. The results from this TCo1279 experiment will be shown here only for the wave model, where verification against buoy observations shows a clear benefit from using the new OSTIA product. Global atmospheric scores are not applicable here due to the SST changes.

4 Iver scores

Full Iver scores for the TCo399 experiment are available at `file:///perm/rd/dipb/iver/plots/gol9/index.html`

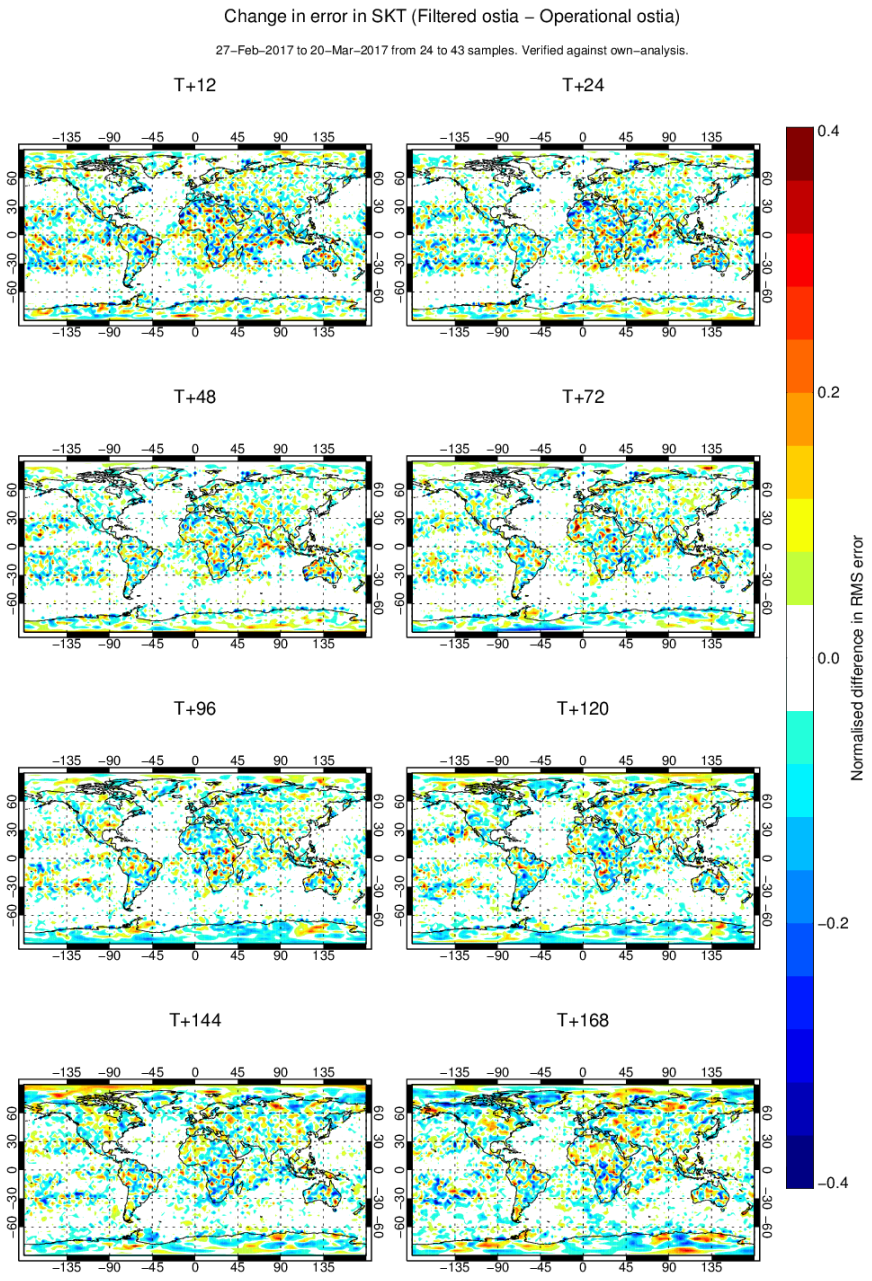

Figure 1: Normalised differences in RMS for Skin Temperature (SKT) at the surface

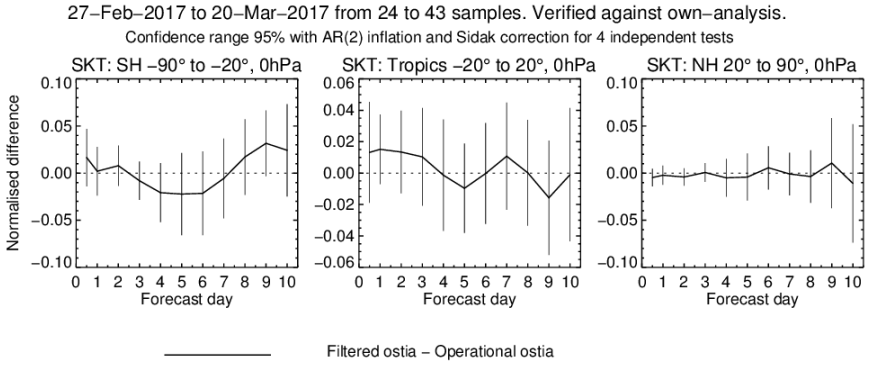

Figure 2: Normalised differences in RMS for Skin Temperature (SKT) at the surface by region

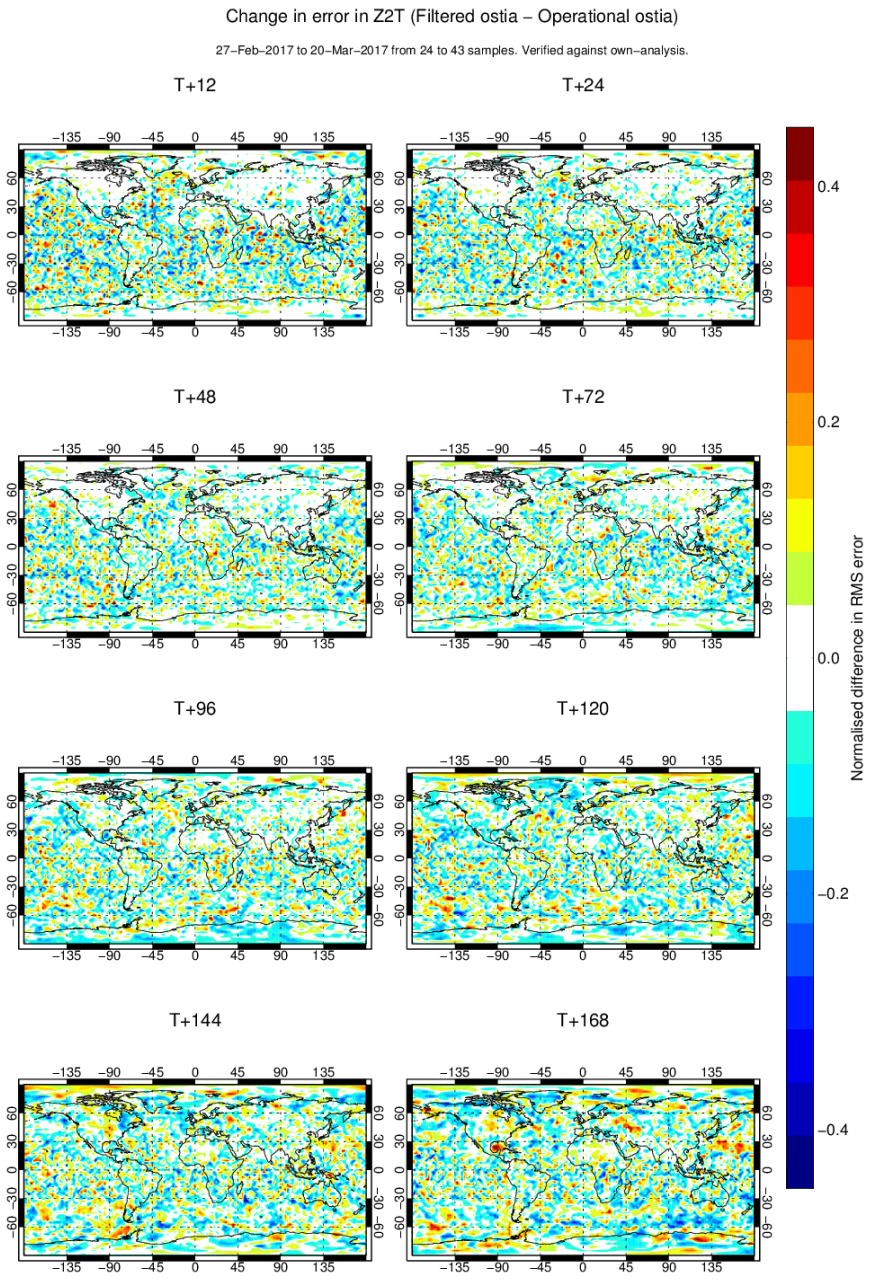

Figure 3: Normalised differences in RMS for 2m Temperature (Z2T)

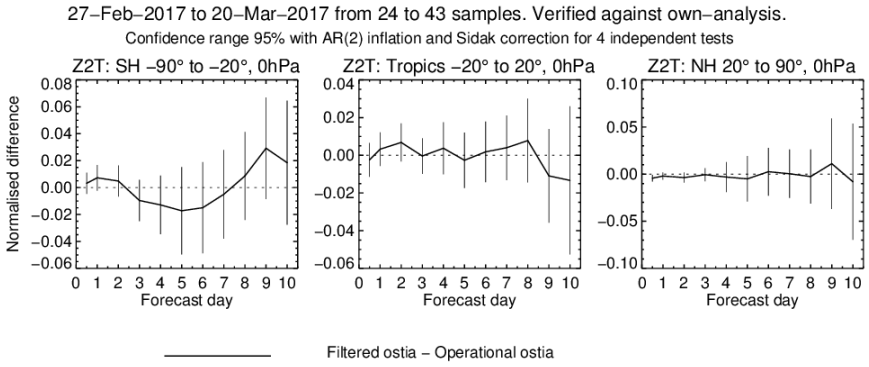

Figure 4: Normalised differences in RMS for 2m Temperature (Z2T) by region

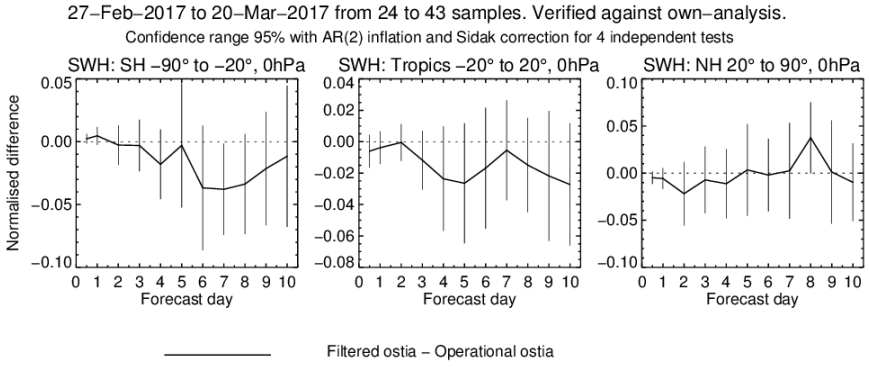

Figure 5: Normalised differences in RMS for Significant Wave Height (SWH) by region

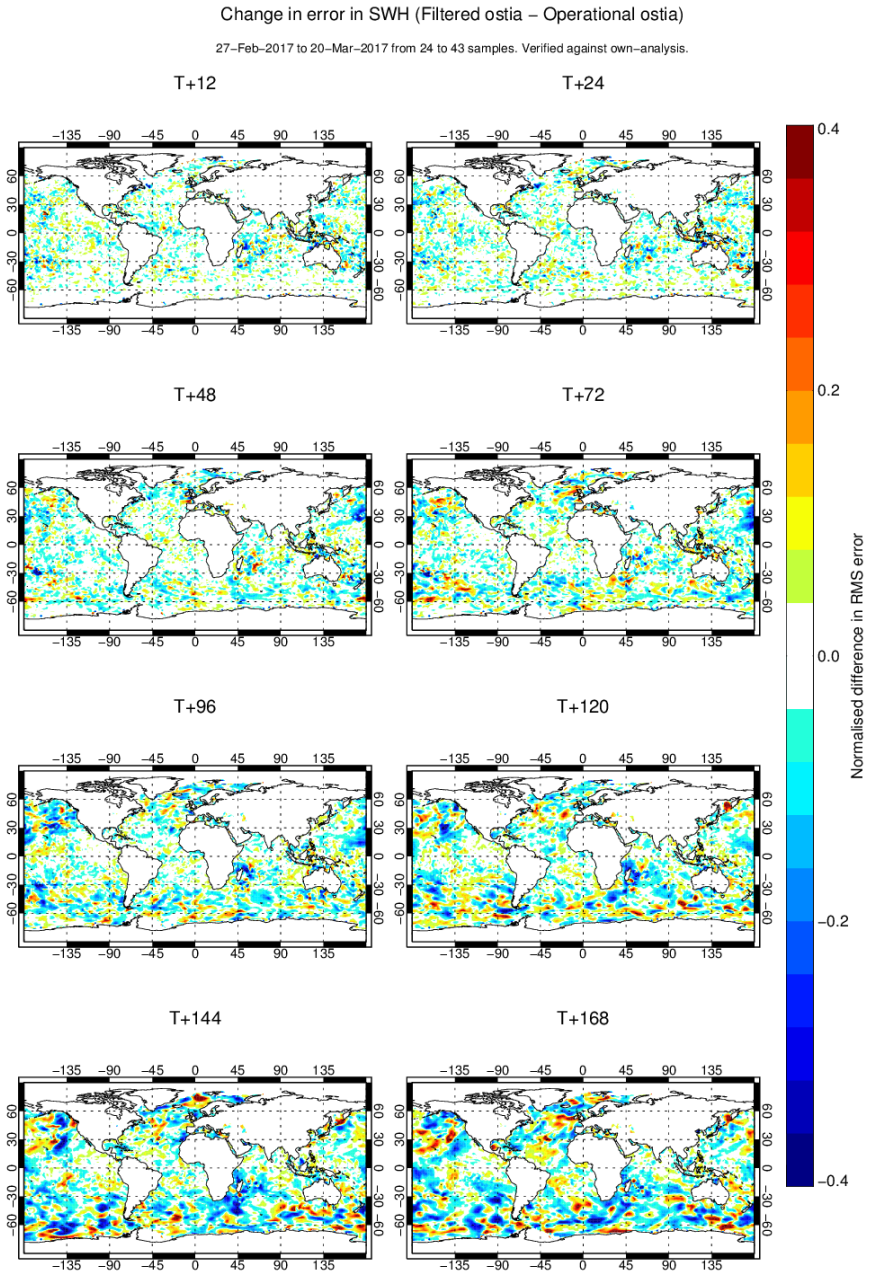

Figure 6: Normalised differences in RMS for Significant Wave Height (SWH)

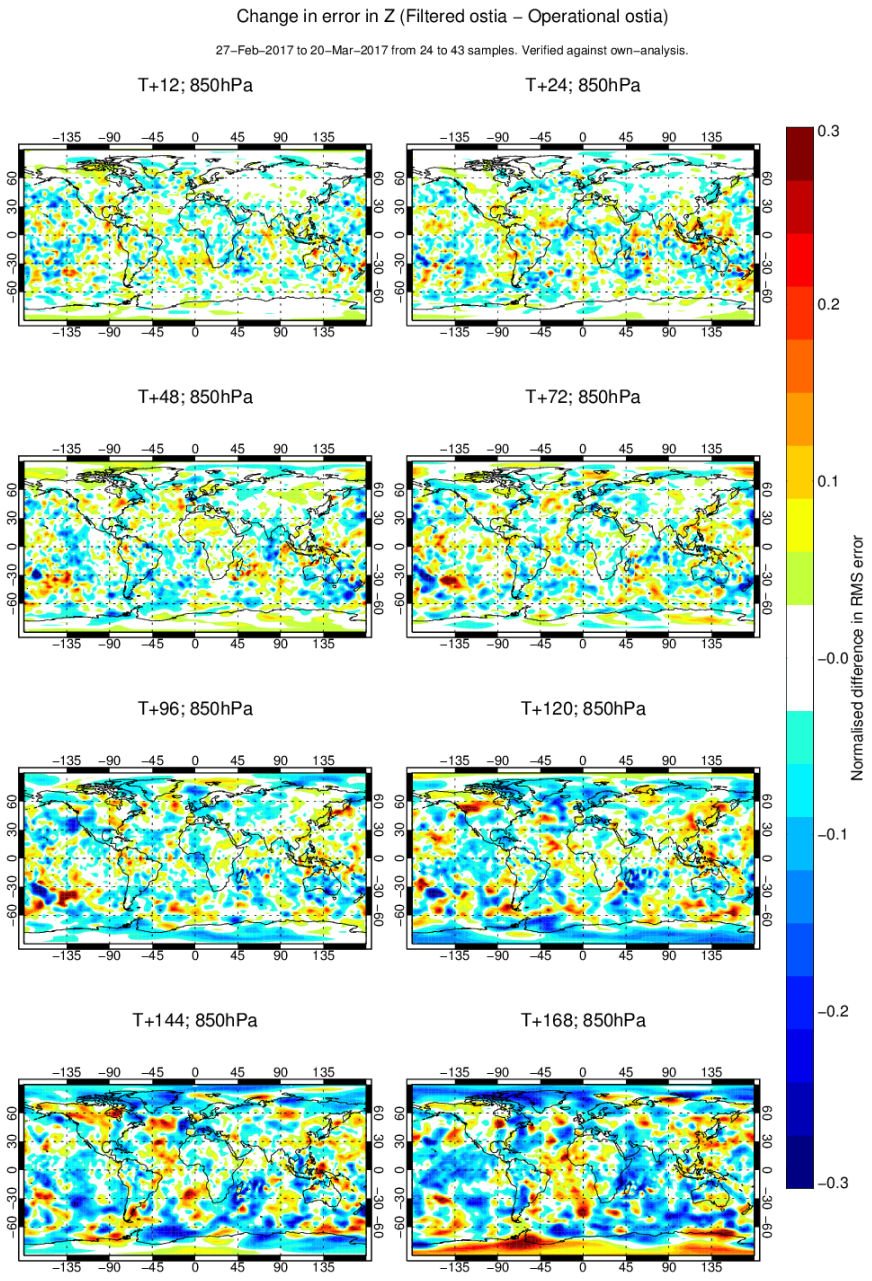

Figure 7: Normalised differences in RMS for geopotential (Z) at 850hPa

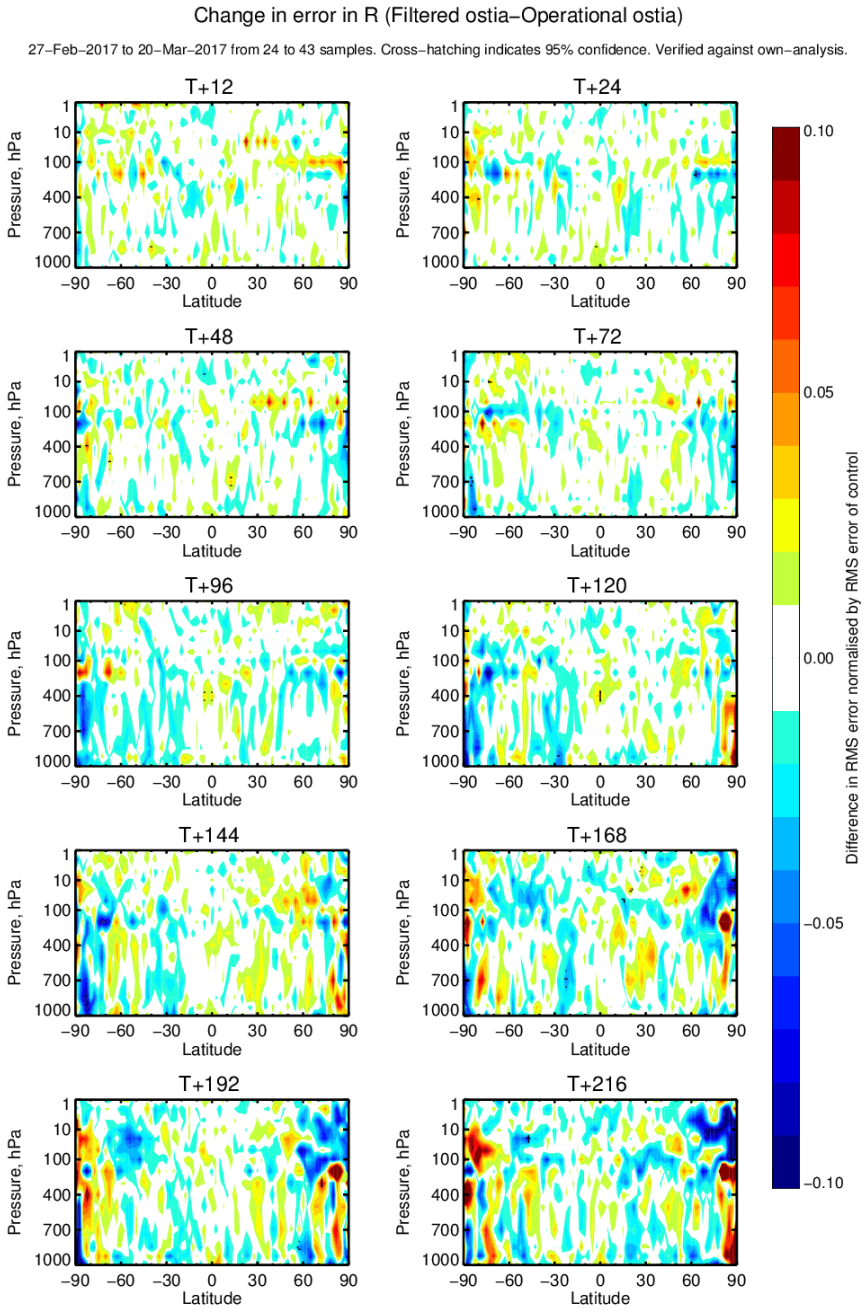

Figure 8: Normalised differences in RMS for relative humidity (R) zonally averaged

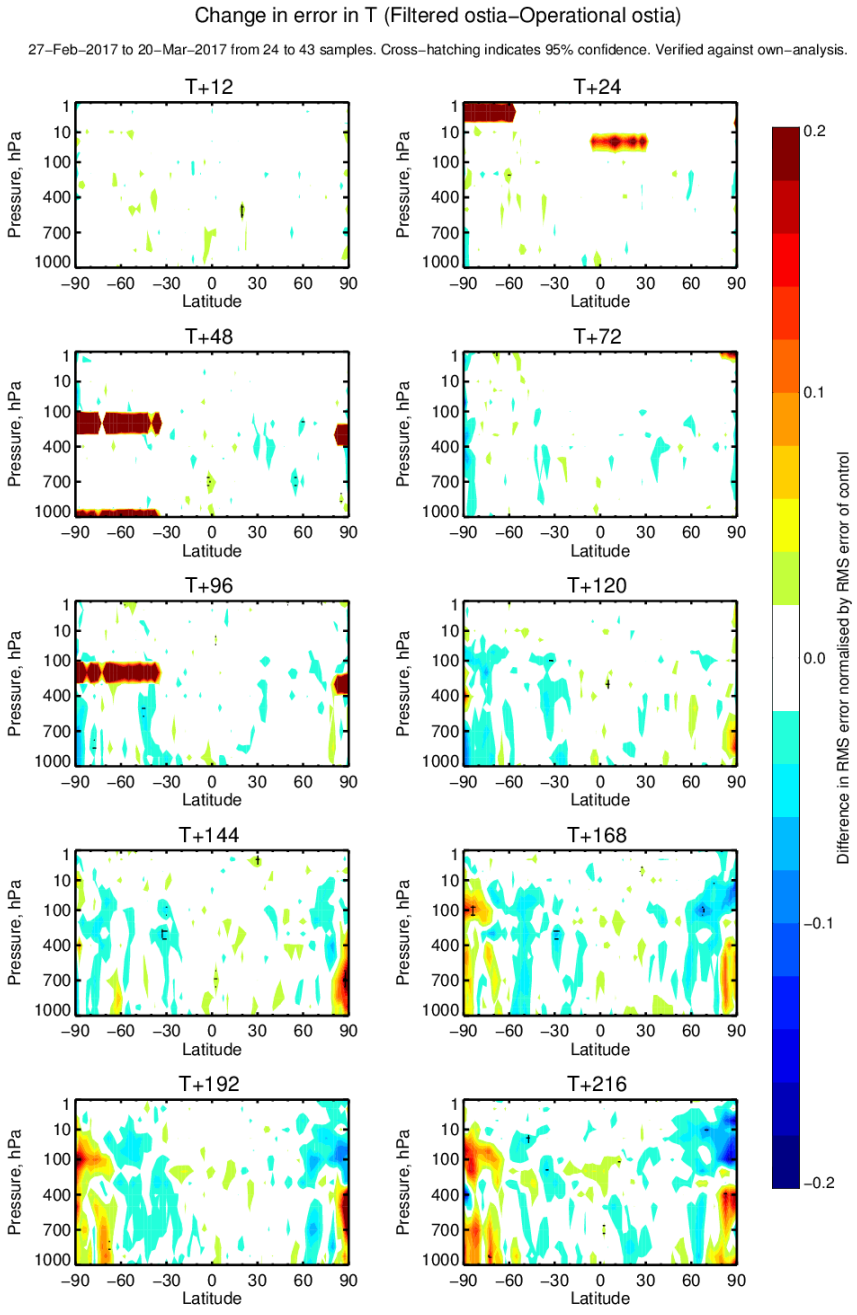

Figure 9: Normalised differences in RMS for temperature (T) zonally averaged

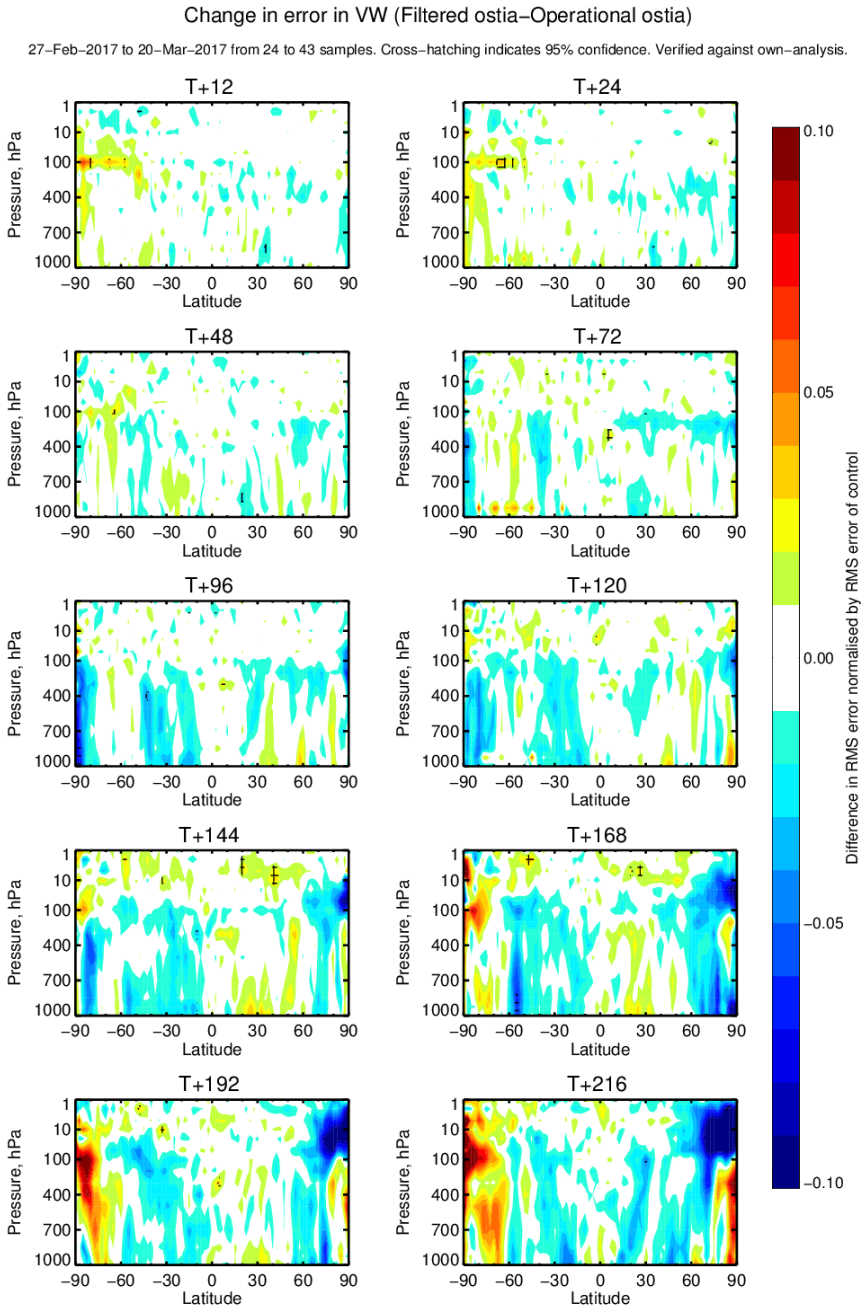

Figure 10: Normalised differences in RMS for vertical wind (VW) zonally averaged

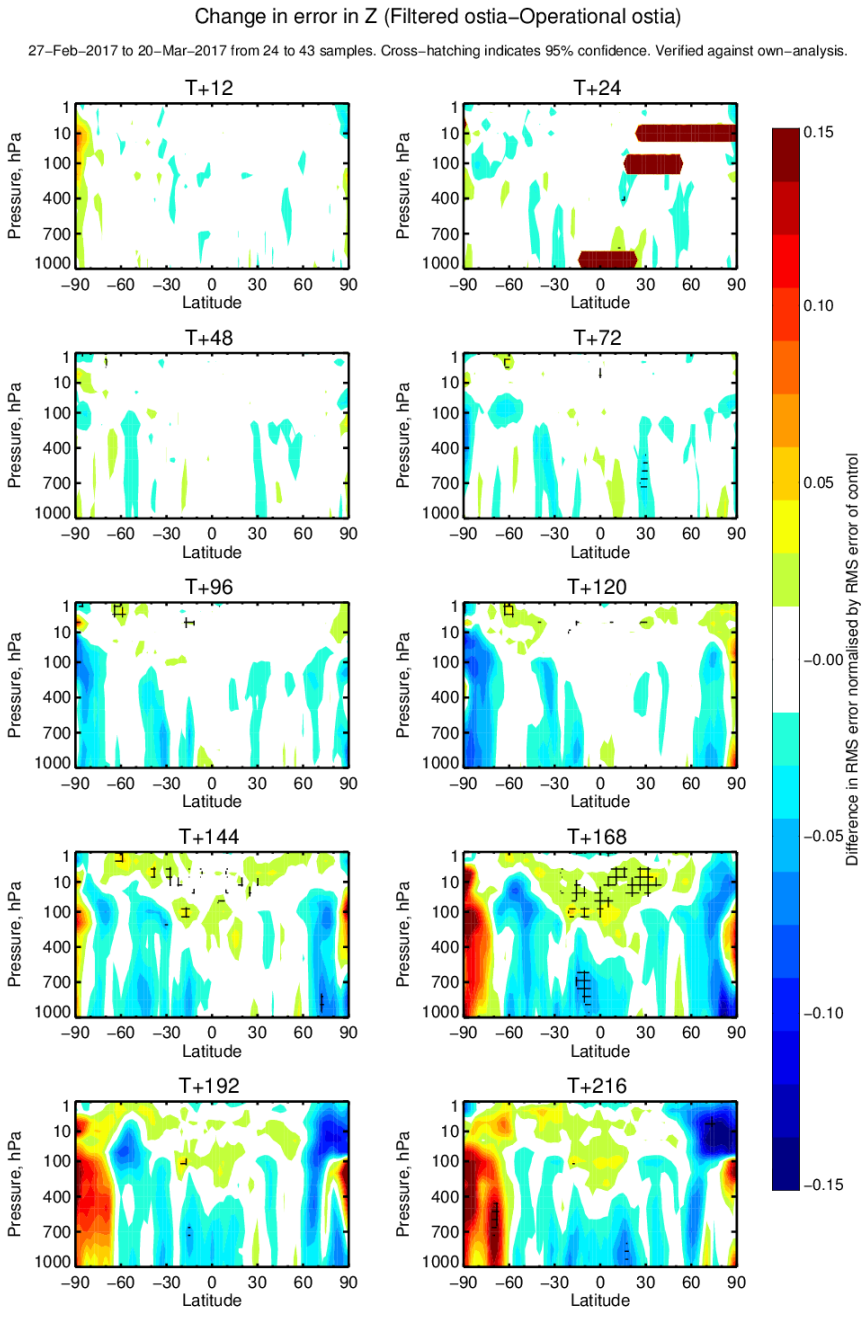

Figure 11: Normalised differences in RMS for geopotential (Z) zonally averaged. Note that here we see a region of significant degradation above 100hPa in the tropics 7 days into the forecast.

5 WAM diagnostics

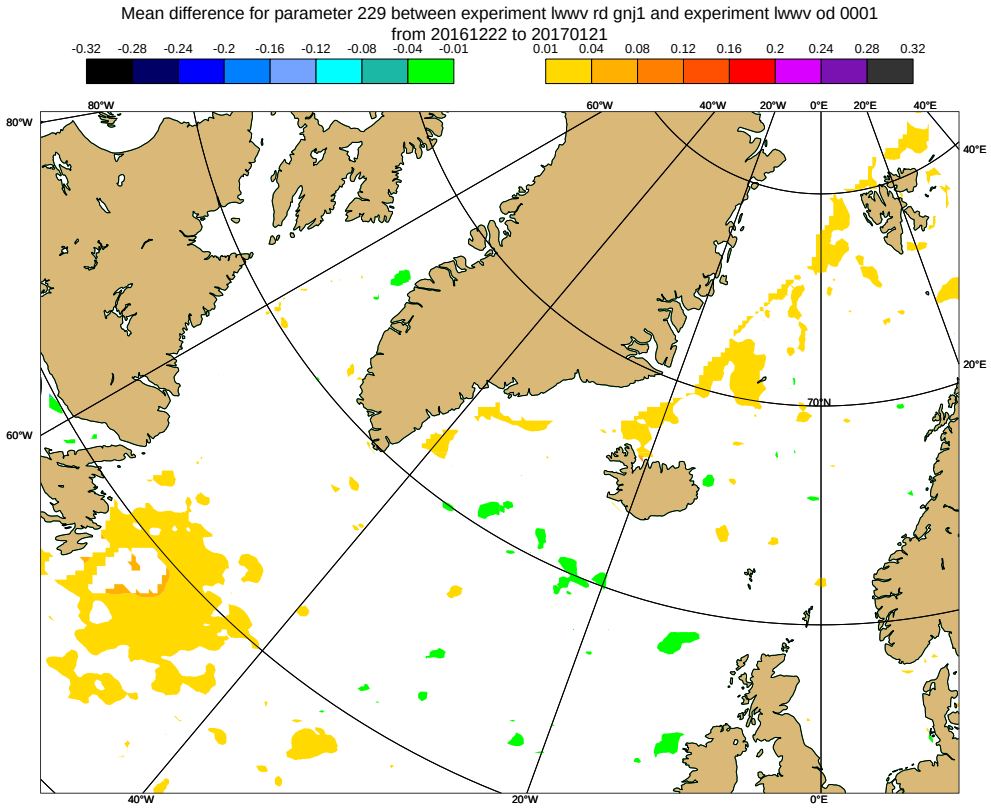

Figure 12: Mean difference in significant wave height for the North Atlantic. Note that areas that were wrongly assigned some sea ice cover over 30% would have been output with missing data. For this reason, the largest differences (something - nothing) do not appear because by default if there is any missing data, metview will return missing value for those points. Note this plot is from the TCo1279 experiment compared with operations.

(a) New OSTIA with improved sea ice

(b) Old OSTIA with spurious sea ice

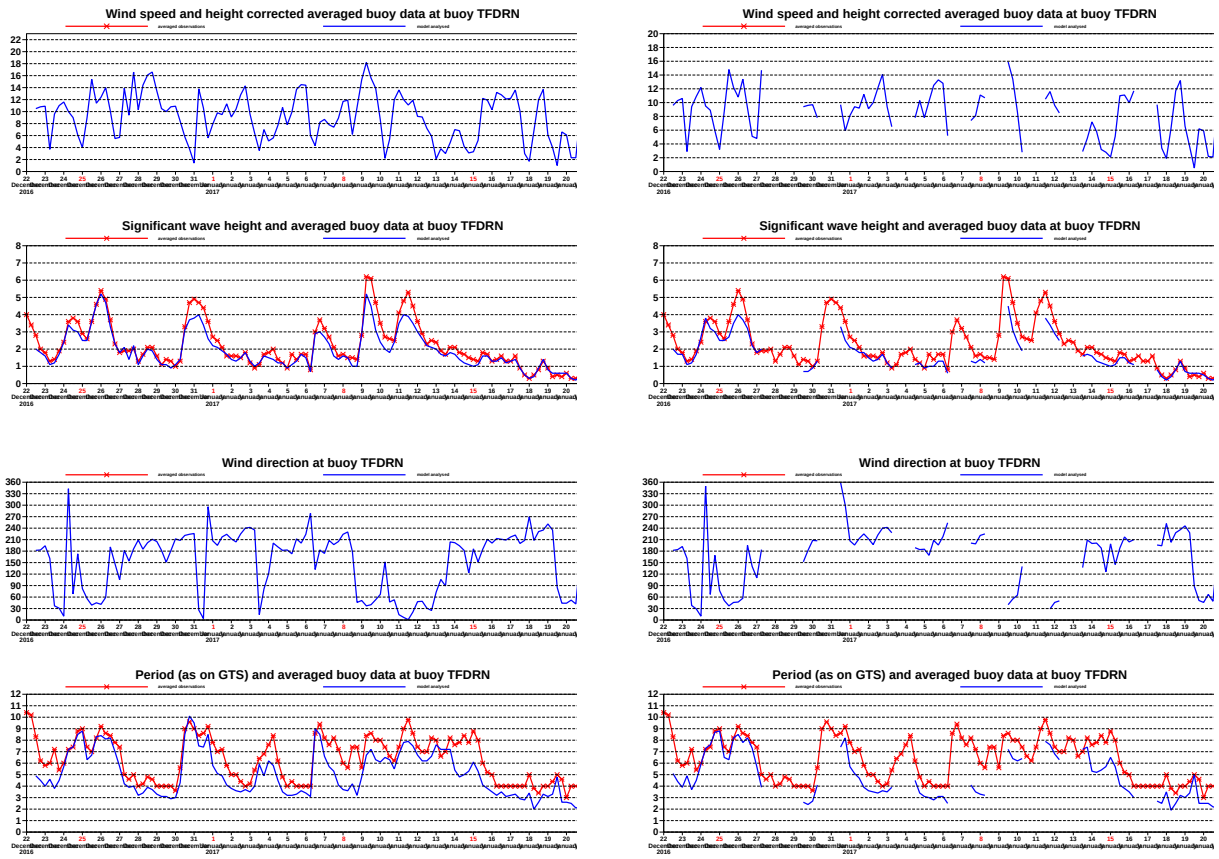

Figure 13: Impact of new OSTIA sea ice concentration on at a buoy location on the north coast of Iceland. In red are the in situ observations. In blue the model output. For this region where the buoy is showing it is in open water, the model run is capturing this with the new sea ice concentration fields from OSTIA. Note these plots are from the TCo1279 experiment compared with operations.

6 Conclusions and recommendations

A new operational OSTIA sea ice concentration product was implemented by the UK Met Office on 20 March 2017. This was included in our analysis from 21 March 2017.

This change was designed to remove spurious sea ice around, amongst other places, Iceland and Denmark.

We have evaluated the impact of this change on NWP based on a test version of the product provided by the UKMO. The test period was 22 Feb 2017– 20 March 2017. The impact of this change appears neutral.

The modifications to the OSTIA SST and CI product largely remove the spurious sea ice regions that we had noted were a problem in the HRES forecast. The changes are mostly confined to these regions, with the spurious CI removed and the SST raised accordingly. We suggest continued monitoring of the sea ice product to ensure that the *ad hoc* masks used in the OSI-SAF CI product are not being introduced erroneously.

Locally, we have found that this change resulted in the wave model giving a better fit to buoy observations in the regions that contained spurious CI in the old OSTIA product.

In the future we would like changes to the OSTIA product to be made in a more robust manner - with more time to access the impact of any changes before they are made operational.

A Selection of plots of sea ice

The following are plots of the new product minus the old product. Therefore negative values (purple) indicate regions of sea ice that have been reduced/removed. Positive values (green) indicate sea ice that has been added.

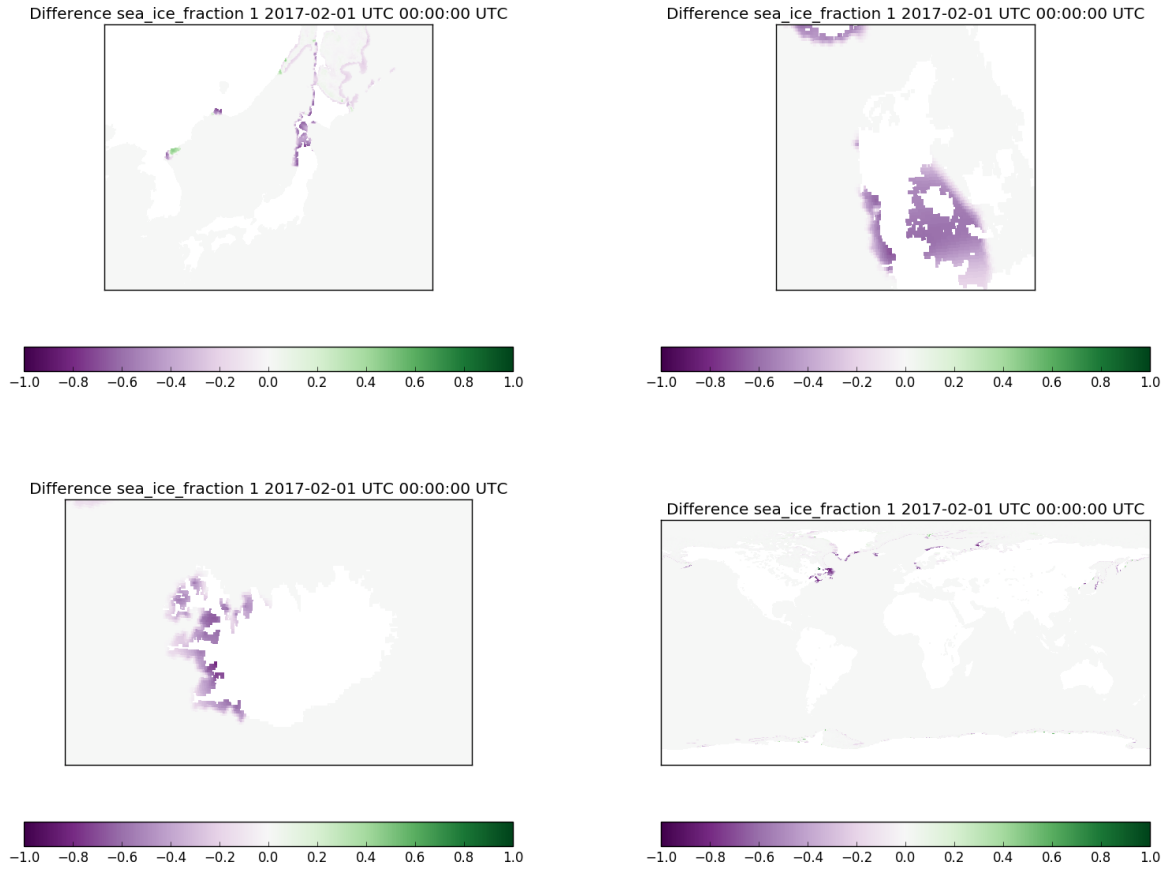

Figure 14: Difference in Sea Ice Concentration fields at various affected areas

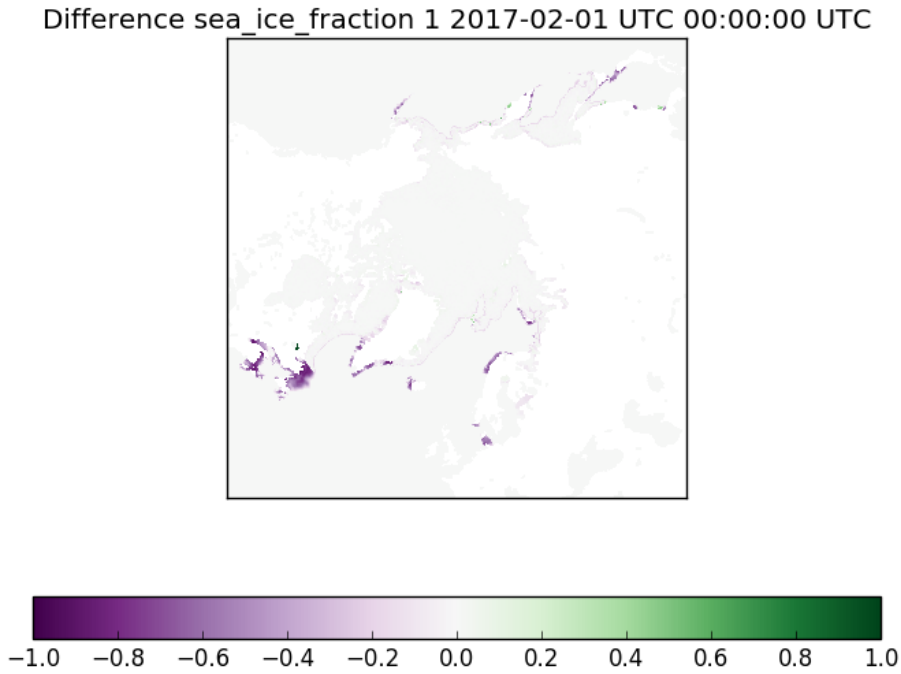

Figure 15: Difference in Sea Ice Concentration fields in the Arctic region

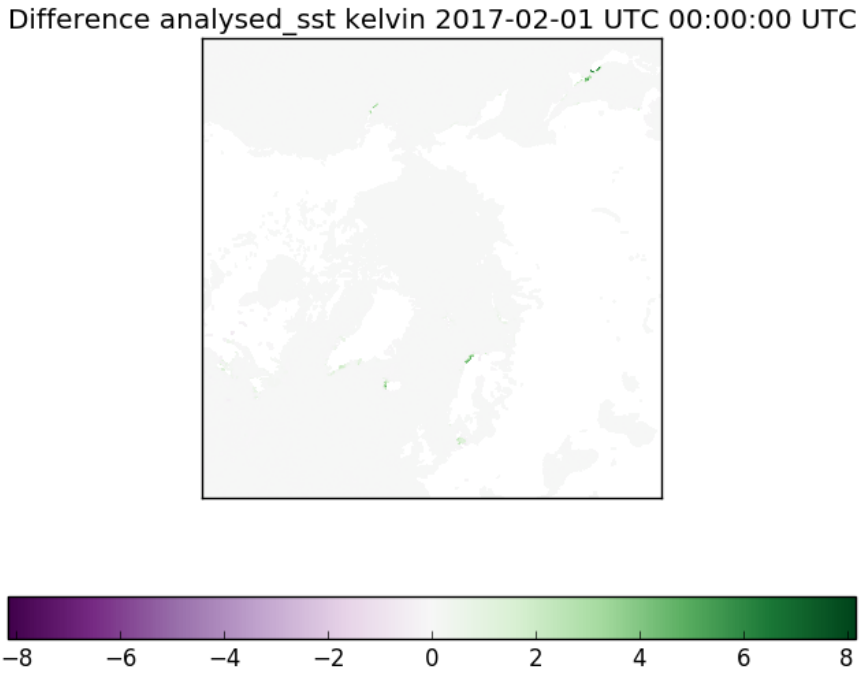

Figure 16: Difference in Sea Surface Temperature field in the Arctic region

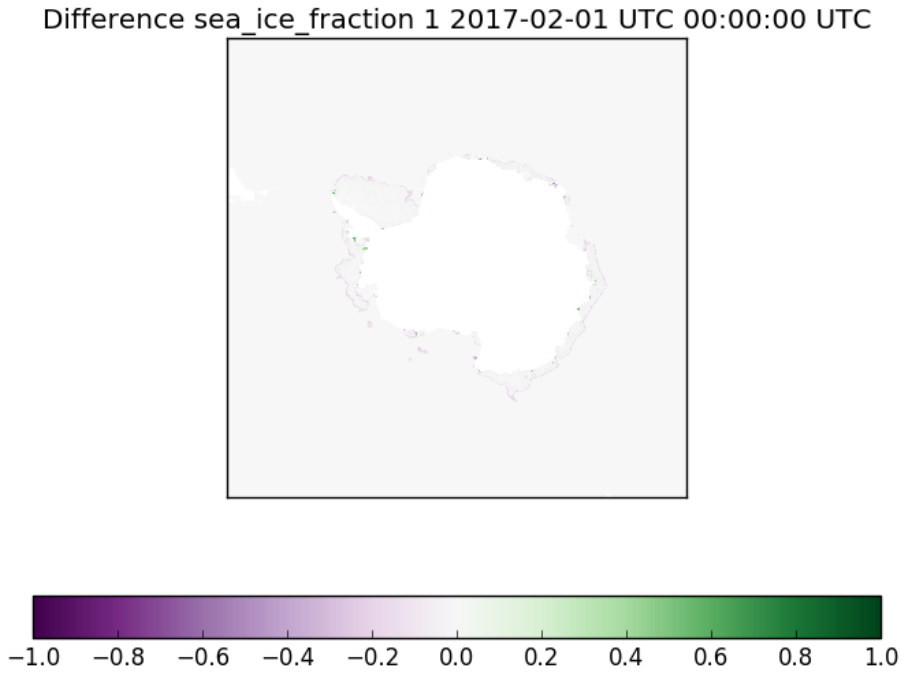

Figure 17: Difference in Sea Ice Concentration fields in the Antarctic region

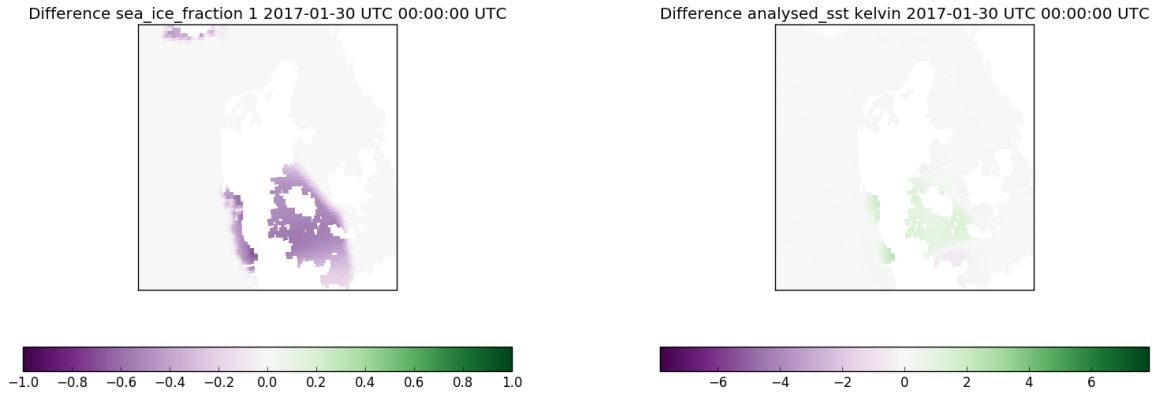

Figure 18: The change in Sea Ice Concentration also modifies the OSTIA SST fields