Temperature

Scottish Government
Riaghaltas na h-Alba
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Key message

Temperatures have increased in all regions, with an increased rate of change over the 1981-2010 climatological period and no significant linear trend in the most recent decade. These changes are due to both the long-term global increase in temperature and the regional variations of this trend in the Atlantic Ocean. The shallow North Sea has warmed faster than regions to the north and west.

Background

Sea surface temperatures (SSTs) around Scotland are strongly influenced by the atmosphere (heat flux) and ocean circulation (advection). When looking at trends around Scotland over long periods of time (more than 50 years) SSTs show an increasing trend in line with global trends, as the entire Earth system has been absorbing more heat with climate change. On decadal and shorter time periods, these trends can differ, and can even be less obvious (and not statistically significant) due to variability on shorter time scales. The conditions in the adjacent North Atlantic Ocean influence regional temperatures in Scotland via both atmospheric and advective processes.

Temperature variability in Scottish waters is provided regularly as part of the Scottish Ocean Climate Status Report (Hughes *et al.*, 2018). For brevity, this assessment focuses on sea surface temperature (SST) in Scottish waters.

The average sea surface temperature across each Scottish Marine Region (SMR) demonstrates the influence of the adjacent North Atlantic Ocean: with winter SST on the west coast of Scotland tending to remain higher than those in the north and east of Scotland. The average winter SST in the Argyll region (in the west) is almost 1.5 °C greater than average winter temperature in the North East region (Hughes *et al.*, 2018).

SSTs around Scotland follow a seasonal cycle, similar to that in air temperature, but peak temperatures in the sea are approximately 1 month later, in August.

Results

The regional temperatures in the sub-polar North Atlantic during the 1981 - 2010 climatological period were increasing faster than 1893 - 2018 trends, due to changes in Atlantic Ocean circulation outside Scottish waters. Due to the strong influence of the North Atlantic on conditions in Scottish waters, the trends in this region during the 1981 - 2010 period are also higher than the 1893 - 2018 trend. Since 2016, the circulation of the North Atlantic sub-polar gyre has changed, which means the properties of Atlantic water have become cooler and fresher. Therefore, there has been no significant trend in the most recent decade.

For further information on this topic go to: https://marine.gov.scot/sma/assessment/temperature

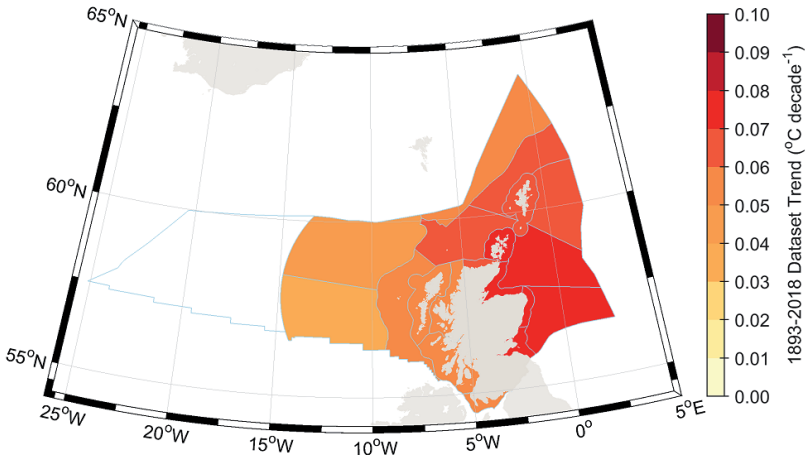


Figure 1.

SST trend from the HadISST 1.1 data product for the entire observational period (1893 - 2018) averaged by SMR and OMR.

Note the colour scale ranges from 0 to 0.1 °C per decade.

The trend in the Hatton OMR is statistically not significant, and has therefore not been included.

Scottish Marine Regions

Based on the gridded SST product, all SMRs show an increasing trend in sea surface temperature from 1893 - 2018, with trends for each region between 0.05 and 0.07 °C per decade (Figure 1). The trend in the Hatton region was not statistically significant.

When considering the 1981 – 2010 climatological period, these trends are higher for each region, ranging from between 0.2 and 0.4 °C per decade.

None of the regions have shown a significant trend for the decade between 2008 and 2017.

The SCObs datasets show no significant trend in temperature over the most recent decade, or over the 1997 - 2018 period. This dataset is still relatively short; in order to provide more information on temperature trends in Scottish coastal regions, these time series need to be continued.

The extended SCObs datasets do show a significant trend for each of the three sites at Millport, Fair Isle and Peterhead over the climatological average period: 0.50, 0.29, 0.26 °C per decade, respectively.

Offshore Marine Regions

Based on the gridded SST product, all but one of the OMRs (Hatton) show an increasing trend in sea surface temperature from 1893 - 2018, with trends for each region between 0.03 and 0.07 °C per decade (Figure 2).

When considering the 1981 – 2010 climatological period, these trends are higher for each region, ranging from between 0.22 and 0.44 °C per decade.

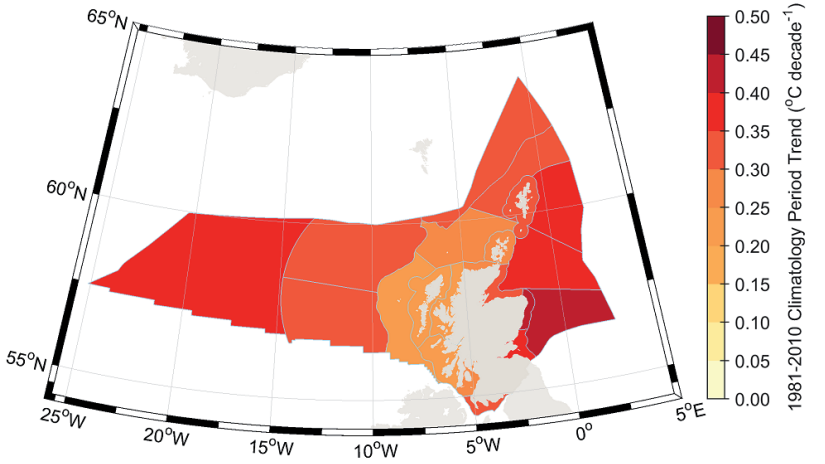


Figure 2:

SST trend from the HadISST 1.1 data product for the entire current climatological reference period (1981 - 2010) averaged by SMR and OMR.

Note the colour scale ranges from 0 to 0.5 °C per decade.

There are regional differences in the observed trends during the 1893 - 2018 and 1981 - 2010 periods. For both periods, the trends in the shallow regions of the North Sea are higher than those in regions to the north and west of Scotland. This is likely due to the dynamics of heat uptake by shallow regions. In the 1981 - 2010 climatological period, the trend in the Hatton region are also higher than those in neighbouring regions closer to the Scottish coast. This is due to changes in the circulation of the Atlantic Ocean to the south.

None of the regions have shown a significant trend for the decade between 2008 and 2017.

Conclusion

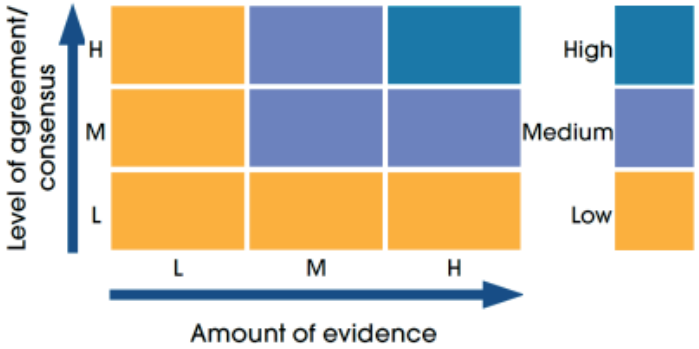
SSTs have increased globally and this is reflected by increasing trends observed in all SMRs and OMRs over the last 100 years. During the 1981 - 2010 climatological period, there has been an increased rate of change. This is the result of an increased global trend and regional variation in the sub-polar North Atlantic Ocean and its adjacent regional seas. In recent years, SST differences from the 1981 - 2010 mean have been more variable, and therefore no significant trends have been established for the most recent decade. Although global temperatures will continue to rise due to climate change, there will be regional variations which may mask the long-term trend.

Knowledge gaps

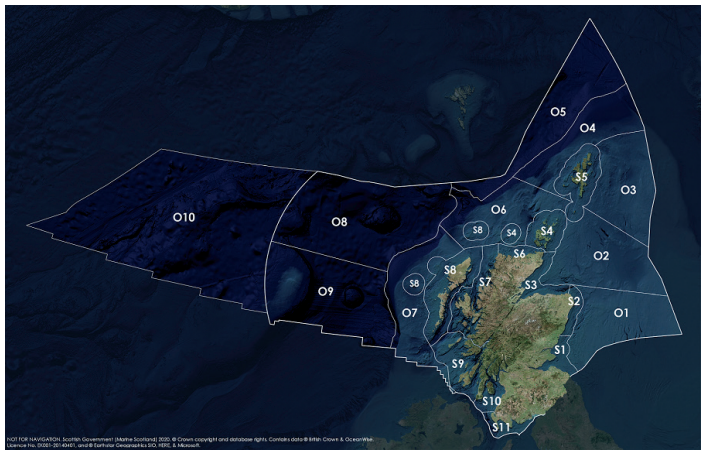
SSTs are observed well by both in situ and remote sensing observations. However, sub-surface temperature observations (near the sea bed or vertical water column profiles) remain relatively sparse. Sustaining observations at a regional level will be important to help identify how the regional temperature variability is influenced by global climate change.

Understanding of the variability at all timescales (seasonal, inter-annual, decadal and long-term) is based on observations from very long measurement records (longer than 30 years). Interruptions in these data (missing locations or broken in time) make the analyses of variability more difficult. These gaps may be improved by incorporating a combination of observations and numerical models (reanalyses).

Overal confidence

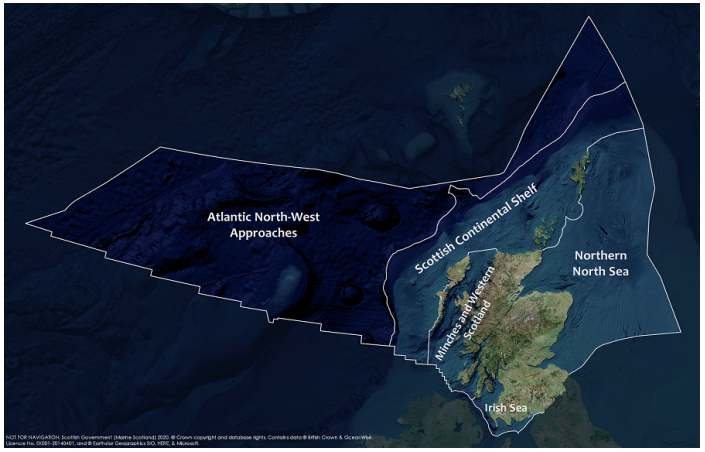


Assessment regions

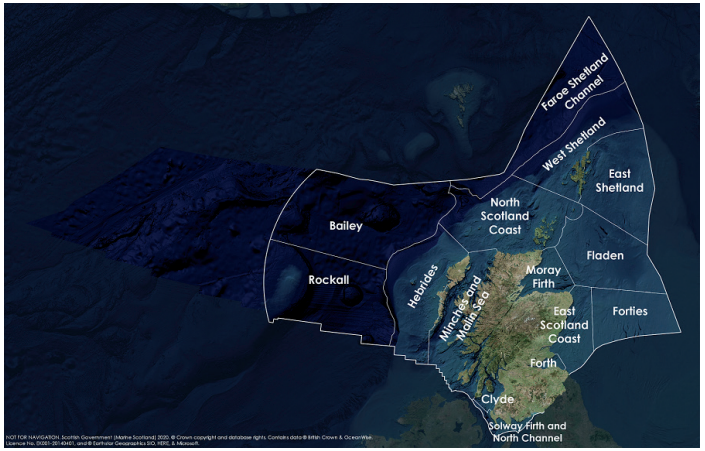


The Scottish Marine Regions (SMRs; S1 – S11) and the Scottish Offshore Marine Regions (OMRs, O1 – O10)

Key: S1, Forth and Tay; S2, North East; S3, Moray Firth; S4 Orkney Islands, S5, Shetland Isles; S6, North Coast; S7, West Highlands; S8, Outer Hebrides; S9, Argyll; S10, Clyde; S11, Solway; O1, Long Forties, O2, Fladen and Moray Firth Offshore; O3, East Shetland Shelf; O4, North and West Shetland Shelf; O5, Faroe-Shetland Channel; O6, North Scotland Shelf; O7, Hebrides Shelf; O8, Bailey; O9, Rockall; O10, Hatton.



Biogeographic, Charting Progress 2 (CP2) Regions. These have been used as the assessment areas for hazardous substances.



Scottish Sea Areas as used in Scotland's Marine Atlas 2011. These are sub divisions of the biogeographic, or Charting Progress 2 (CP2), Regions.

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NatureScot
Scotland's Nature Agency
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JNCC
Joint Nature Conservation Committee

SEPA
Scottish Environment Protection Agency

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