GLOSS Group of Experts XVII **November 2022**

GLOSS UK National Report

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The UK's contribution to the GLOSS Core Network comprises gauges from the UK Tide Gauge Network (UKTGN), gauges in the British Dependent Territories of the South Atlantic and Gibraltar and gauges in Antarctica. The UK Environment Agency (EA) maintains several of the UK GLOSS gauges on behalf of the UK Coastal Flood Forecasting (UKCFF), a partnership between the Environment Agency, Scottish Environment Protection Agency, Natural Resources Wales and Northern Ireland's Department for Infrastructure Rivers. The National Oceanography Centre (NOC) maintains the South Atlantic tide gauge network and has installed three new GLOSS-quality tide gauges at Liverpool, Newlyn and Sheerness as part of a pilot project.

The State of the UK Climate 2021 (2022) report stated, "The rate of sea-level rise in the UK is increasing, with selected locations recording a range from 3.0±0.9 to 5.2±0.9 mm year^{-1} over the past 30 years when corrected for vertical land movement, compared to the1.5±0.1 mm year^{-1} since 1900s." but that, "Due to ongoing issues with data quality, there was unfortunately not enough data to update the annual UK sea level index … with a value for 2020 and 2021."

The Environment Agency is developing its strategy for the UK tide gauge network. The project is currently exploring options to adapt and evolve the existing system, maintaining the valuable data series but also determining how to deliver a forward looking network. It is critically important that the project achieves the Environment Agency's primary objective, which is to continue to inform the Agency's Incident Management Flood Forecasting system. To shape this vision, the Environment Agency is consulting with UK Coastal Flood Forecasting (UKCFF) partner organisations, users of the UK system, and subject matter experts for input and experience to help develop these options.

GLOSS Core Network - UK

Figure 1: UK Tide Gauge Network sites

Lerwick (GLOSS 236)

The UKCFF installation consists of two full tide bubbler gauges and a mid-tide bubbler. The Global Navigation Satellite System (GNSS) (site code LWTG) last reported February 2015.

The gauge was last visited for annual maintenance in October 2022.

Newlyn (GLOSS 241)

The UKCFF installation consists of two full tide bubbler gauges, a mid-tide bubbler and a float gauge. GNSS (NEWL) still reporting but maintenance responsibility has been transferred to the NOC.

07/06/2022: Annual maintenance and DQ configuration repair
01/07/2022: Component repair and levelling

In September 2021 the NOC installed state of the art sea level sensors alongside the UKCFF sensors. The NOC's sensors comprise an open water radar sensor and a guided wave radar sensor, the latter of which sits inside a narrow stilling tube. These are clamped to a pre-existing Rolled Steel Joist which is suspended over the larger tidal observatory stilling well. Supporting electronics for the NOC tide gauge are mounted on a freestanding frame in the North West corner of the observatory, to the right of the entrance door and the electronic enclosure is labelled to reflect the ownership of the equipment. Note that the NOC tide gauge components are freestanding due to the listed building status of the observatory.

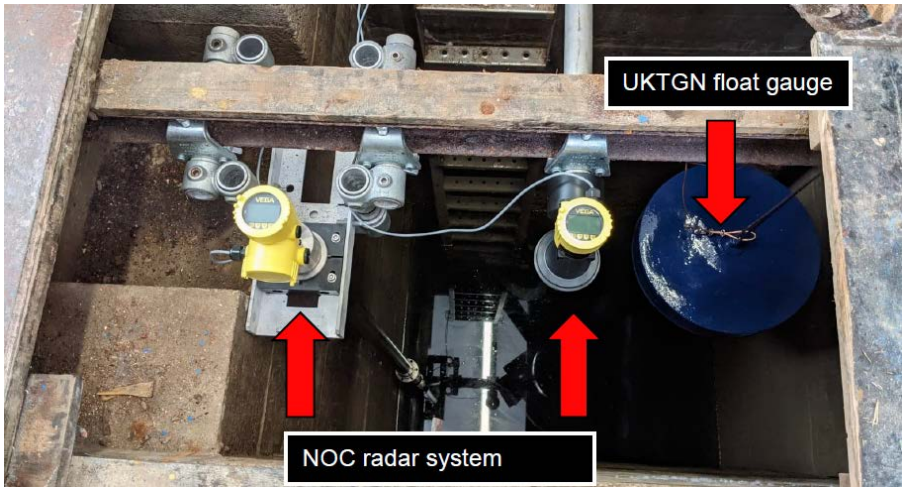

Figure 2: Observatory stilling well containing the NOC radar system and the UKCFF float gauge

Stornoway (GLOSS 238)

The UKCFF installation consists of two full tide bubbler gauges and a mid-tide bubbler. GNSS operational (SWTG).

29/09/2022: Annual maintenance, pneumatic panel replacement and levelling

GLOSS Long Term Trend Sites

Aberdeen

The UKCFF installation consists of two full tide bubbler gauges and a mid-tide bubbler. GNSS operational (ABER) but the current location is not suitable for GNSS-IR.

30/09/2022: Annual maintenance & pneumatic panel replacement

North Shields

The UKCFF installation consists of two full tide bubbler gauges and a mid-tide bubbler. The primary channel has been blocking. GNSS available (NSLG) for 2022.

14/02/2022: Annual maintenance, levelling & pneumatic panel replacement

Sheerness

The UKCFF installation consists of two full tide bubbler gauges, a mid-tide bubbler and a WL61 radar.

23/02/2022: Annual maintenance
06/06/2022: Pneumatic panel replacement

In September 2021, the NOC installed a GLOSS quality system at Sheerness. The NOC's sensors comprise a dual radar system mounted on bespoke steelwork and a GNSS system fixed to a steel monument. The radar system is located on the edge of quayside to the south of the tide gauge hut (Figure 3). The GNSS system is located adjacent to the northern outer wall of the tide gauge hut (Figure 4).

Figure 3: The NOC radar system

Figure 4. The NOC GNSS system and location relative to the NOC radar system

Liverpool

The UKCFF installation consists of two full tide bubbler gauges and a mid-tide bubbler at Liverpool (Gladstone Dock). The primary channel has data quality issues due to possible gas loss. There is no GNSS at site.

16/02/2022: Annual maintenance
21/06/2022: Annual maintenance & battery replacement

In January 2022 the NOC installed a new GLOSS-quality system at Alfred Dock, Birkenhead (latitude: 53° 24’ 20” N, longitude: 3° 0’ 52” W). The installation consists of two Waterlog Nile radars and is powered entirely from renewable energy sources (solar panels and a wind turbine). A Trimble GNSS is installed to monitor vertical land movement and sea level can be determined using GNSS-IR data processing techniques.

Figure 5: The NOC installation at Alfred Dock

South Atlantic Network

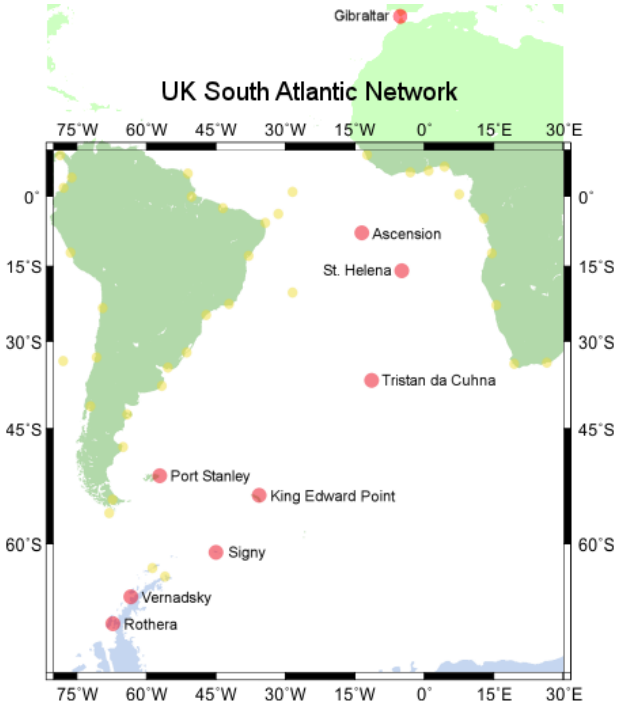

Figure 6: The NOC South Atlantic Tide Gauge Network

Ascension (GLOSS 263)

In July 2022 the Ascension Government lifted the quarantine restrictions for people visiting the island. The intention is to replace the existing gauge at English Bay with a dual radar system. Unfortunately, it is not possible to utilise the old stilling well, which has now partially collapsed after 30 years of operation. Work has started on the new gauge, the new steelwork has been fabricated and is now having an external coating applied to the steelwork, due to the harsh environment in which it will be installed. The electronics cabinet has been built and is now on test with the new calibrated sensors.

Currently, flights to Ascension are still very infrequent with access only via South Africa and St Helena. The NOC will be using an external contractor to install the gauge. The new tide gauge is due to arrive in early January or February 2023 and will be installed soon after.

Figure 7: Electronics cabinet and radar arm

St Helena (GLOSS 264)

The new stilling well was installed in May 2022, on the new wharf at Rupert's Bay, St Helena, alongside the existing open water radar.

Figure 8: St Helena new stilling well, alongside open water radar gauge

The new stilling well houses a guided wave radar, therefore providing two operational radar sensors, both transmitting 1-minute averaged sea level data. In addition, the electronics have also been upgrade to include a new logger and a Barometric pressure sensor. In the future, this station will be upgraded to a 6 minutes transmission timeslot and thereby upgrading it to tsunami enabled gauge. The data is also downloaded locally from the gauge every three months and emailed back to the NOC. This is to allow for any missing data in the transmitted near real time feed to be filled in at a later date.

As part of the agreement with the St Helena Government on the upgrade of the station at Rupert's Bay, it was requested that the original tide gauge installed on the wharf at Jamestown should be removed. Prior to this happening, a levelling campaign was carried out to tie both gauges together using the new and existing benchmarks.

The GNSS station at Rupert's Bay is still operational, but data are only accessible via local downloads. The remote access is currently being investigated by Norman Teferle from the University of Luxemburg and hopefully will be resolved in the near future.

Tristan da Cuhna (GLOSS 266)

Unfortunately, the gauge at Tristan is not operational. This is a particularly difficult site due to its remoteness and the lack of onsite engineering help. A possible solution will be to fit a GNSS-IR station which could provide a tidal signal.

Port Stanley (GLOSS 305)

The gauge at Port Stanley is still operational and is transmitting 1-minute averaged data back every 15 minutes to the IOC Sea Level Station Monitoring Facility. Unfortunately, the existing radar at Port Stanley started to fail in 2022 after about 6 years of trouble-free operation. Normally this would be swapped out for a new radar sensor, but the wharf area is due to be completely refurbished which will result in the gauge having to be completely removed and reinstalled in the new location.

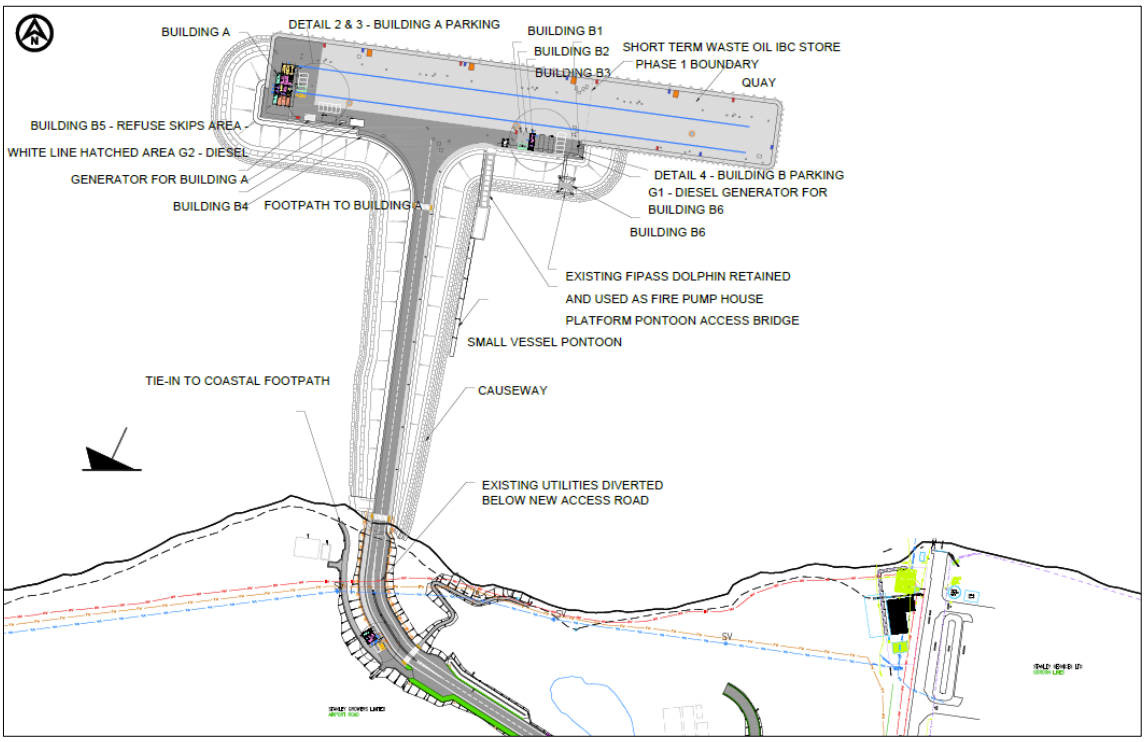

Figure 9: Port planning application drawing adapted from www.falklands.gov.fk/commercialservices/capital-projects/new-port-development/planning-application-new-port-development (downloaded November 2022 - not for construction)

The NOC has recently been informed that the new wharf has now been put on hold for the foreseeable future. For this reason we have decided to upgrade our existing tide gauge to a dual radar and pressure system, using the latest tide gauge technology early next year, 2023.

King Edward Point (GLOSS 187)

The newly installed tide gauge (March 2021) at KEP has been working well and is transmitting 1-minute averaged data from a guided wave radar and two pressure sensors, every 15 minutes. The sensors were installed in a bespoke stilling well integrated into the new Wharf at KEP, which now provides additional protection from sea ice and small bergs.

Figure 10: King Edward Point new wharf and stilling well

The data are also downloaded locally from the gauge every three months and emailed back to the NOC. This is to allow for any missing data in the transmitted near real time feed to be filled in at a later date.

Signy (GLOSS 306)

This site was decommissioned in 2016.

Vernadsky (GLOSS 188)

The station at Vernadsky is operated by the National Antarctic Scientific Centre (Ukraine). The new tide gauge has been in operation since March 2020, transmitting 1-minute averaged radar and pressure sensor data every 15 minutes. The gauge is performing well with only a few small interruptions due to antenna ice build-up.

Figure 11: Tide gauge electronics cabinet at Vernadsky

The data are also downloaded locally from the gauge every three months and emailed back to NOC. This is to allow for any missing data in the transmitted near real time feed to be filled in at a later date.

Rothera (GLOSS 342)

The new tide gauge at Rothera was upgraded in January 2022. Two new pressure sensors and a new Barometric sensor were added to the installation alongside the existing guided wave radar. At the same time the logging system was upgraded and the NOC is working with the Rothera IT department to enable remote access for maintenance and data capture via their VSAT system.

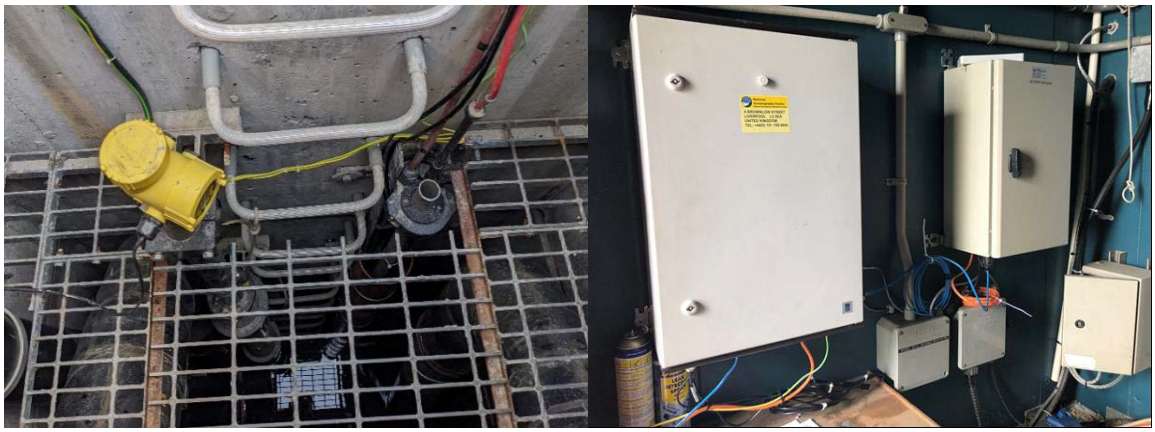

Figure 12: Rothera well and logger

The data are also downloaded locally from the gauge every three months and emailed back to the NOC. This is to allow for any missing data in the transmitted near real time feed to be filled in at a later date.

Gibraltar (GLOSS 248)

Both the tide gauge and GNSS stations at Gibraltar have been working well. The data from the tide gauge is transmitted every 6 minutes to the IOC Sea Level Station Monitoring Facility via the Meteosat satellite network. The gauge can also be accessed via the Broadband connection providing remote maintenance and data download. The GNSS station is also accessed via the broadband connection for data downloads and remote maintenance.

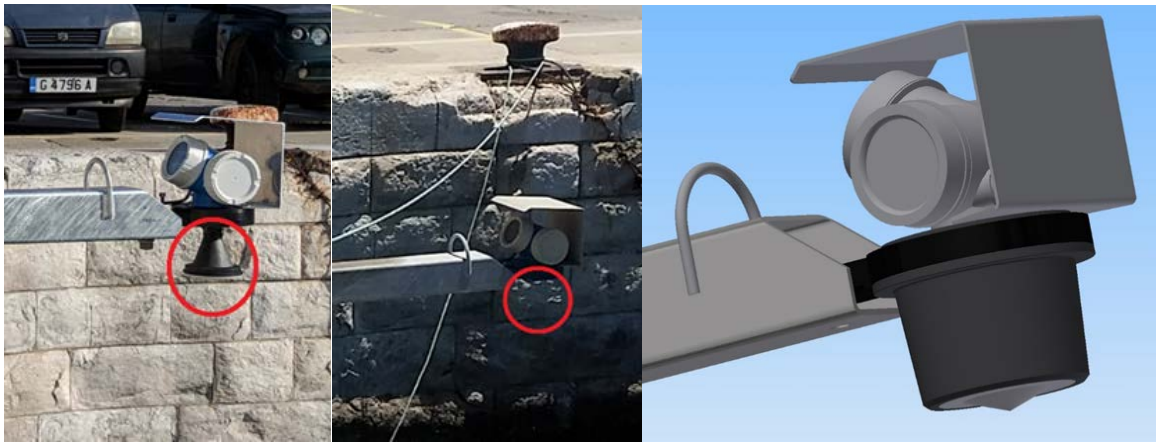

Figure 13: Gibraltar radar gauge showing loss of cone, and design for new cover

Unfortunately in May 2022, the radar was damage by a mooring line which snapped the horn off. The radar is still operational with reduced accuracy, but will eventually fail. A replacement has now been

tested & calibrated and is ready for shipping. A modification has been made to the design of the radar itself, which includes additional protection for the horn, preventing similar damage occurring in the future. The intention is to courier the replacement radar and arrange a site visit in late 2022 to carry out the installation and ongoing maintenance.

National Oceanography Centre partnerships and projects

Karachi (GLOSS 30)

The station at Karachi is currently operational and the logger was upgraded to a new Sutron Satlink3 at the request of the NOC in 2020. The NOC then provided a replacement for the OTT Kalesto radar in the form of a new OTT RLS radar and two new KPSI pressure sensors which were installed by Mr Mutahher Abbas. The NOC tide gauge engineers haves since helped diagnose issues and replace a number of items which has allowed the gauge to remain operational.

Figure 14: Karachi tidal observatory

Nouakchott, Mauritania

The station is still operational and the NOC engineers have been working with Mr Lemine Vall from the Port Autonome de Nouakchott to help diagnose and make recommendations on how to keep the gauge operational. This installation is still using the original hardware that was supplied as part of the ODINAFRICA project. The pressure sensors have since failed but the OTT Kalesto radar is operational.

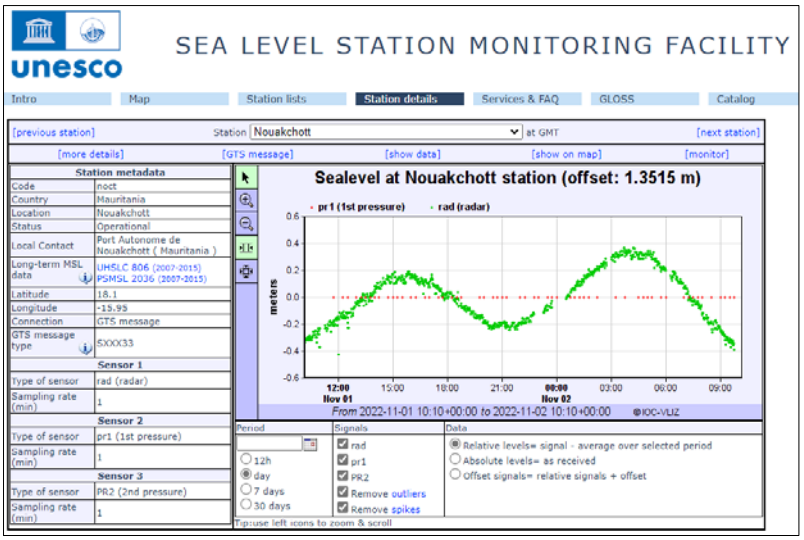

Figure 15: Nouakchott data at the IOC Sea Level Station Monitoring Facility

St Lucia

The St Lucia government contracted the NOC to install tide gauges at three locations (Soufriere, Vieux Fort and Dennery). These installations were completed in October 2021 and incorporated dual technologies (radar and pressure sensors) for resilience and harnessed solar power and a free system of satellite communications (Geostationary Operational Environmental Satellite - GOES) for real-time remote data access and for reduced running costs. The NOC designed bespoke galvanised steelwork within stilling wells that would allow underwater pressure sensors to be removed, cleaned and replaced easily for maintenance purposes.

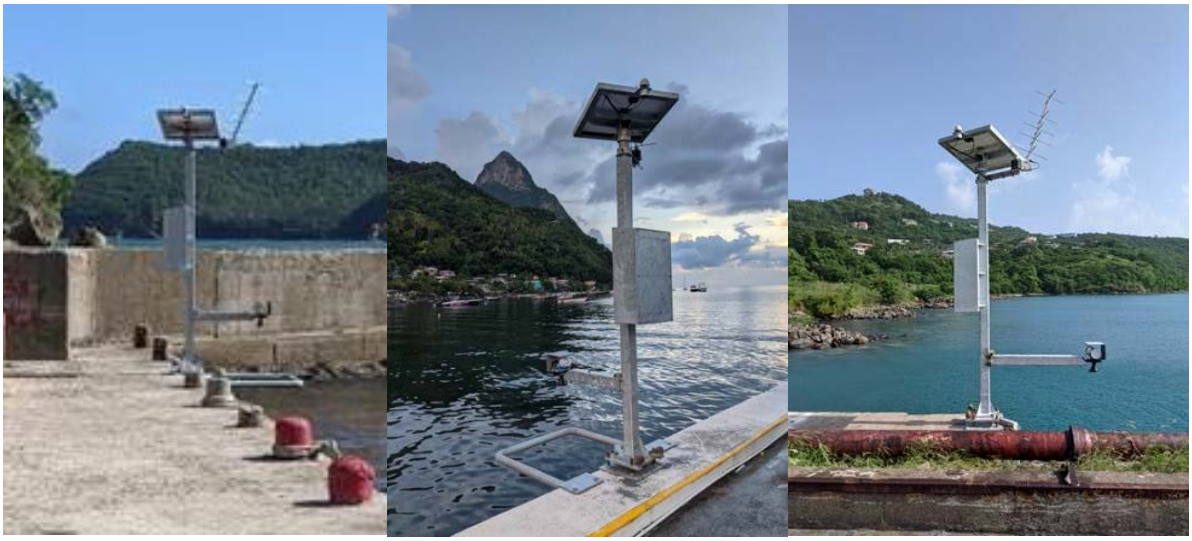

Figure 16. Solar-powered satellite communications-based tide gauges at Dennery (left), Soufriere (middle) and Vieux Fort (right) in St Lucia Solar-powered satellite communications-based tide gauge at Vieux Fort

References

Kendon, M., McCarthy, M., Jevrejeva, S., Matthews, A., Sparks, T., Garforth, J., & Kennedy, J. (2022). State of the UK Climate 2021. *International Journal of Climatology*, 42(Suppl. 1)(S1), 1– 80. https://doi.org/10.1002/joc.7787