National Network of Regional Coastal Monitoring Programmes of England

Quality Control of Tide Data

Version 1.0 January 2022

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Quality Assurance & Quality Control of Tide Data

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Channel Coastal Observatory

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1. Introduction

The National Network of Regional Coastal Monitoring Programmes (NNRCMP) of England has developed a tide gauge network which aims to provide a valuable sea-level record in areas where coastal flooding and erosion are significant threats and where otherwise long-term tide records are unavailable. Sites are chosen to complement the National tide Gauge Network (National Tidal and Sea Level Facility). The overall purpose of the NNRCMP tide gauges is therefore to provide the evidence base needed for flood and coastal erosion risk management (FCERM).

Quality assurance (QA) and quality control (QC) practices are in place to provide high-quality marine observations and to ensure the value and credibility of the data to users. **Quality Assurance** concerns aspects such as the choice of equipment suitable for the environment; ensuring sufficient accuracy, precision, reliability and resolution of the data; and ensuring the operational maintenance required to ensure high quality observations in the long term. **Quality Control** refers to the subsequent steps taken to review the measured data using both automated and manual techniques.

The Channel Coastal Observatory (CCO) functions as the central hub for the quality control, analysis, and dissemination of sea level observations collected by NNRCMP instrumentation. This document outlines the QA practices and QC tests implemented by the CCO. The procedures are in agreement with the Intergovernmental Oceanographic Commission's guidance on quality control of in situ sea level observations (IOC 2020).

The following sea level parameters are collected and archived:

- Sea level, relative to Ordnance Datum (m)
- Sea level, relative to Chart Datum (m)
- Residual (m)

2. Quality Assurance

2.1 Wave Radars

At several sites, measurements are made using a WaveRadar REX, manufactured by Rosemount (Figure 1). The instrument is a downward-looking, frequency modulated continuous wave radar which measures distance to the sea surface. The device operates in open air and is mounted at least 3 m above the highest anticipated tide level.

Figure 1: WaveRadar REX at Deal Pier (left) and Sandown Pier (right). Photos courtesy of Fugro GB Marine Limited.

At Brighton Marina, a Valeport VRS20 Radar Level Sensor and TideMaster logger is deployed (Figure 2). The instrument is a downward-looking pulse k-band radar which measures distance to the sea surface. Like the WaveRadar REX, the Valeport VRS20 operates in open air and is mounted at least 0.80 m above the highest anticipated tide level.

Figure 2: Valeport VRS20 deployed at Brighton Marina. Photo courtesy of Fugro GB Marine Ltd.

2.2 Step Gauges

At several sites, electronic step gauges manufactured by Etrometa measure the sea level. The electrodes on the device are 5 mm in diameter and are spaced 50 mm apart (Figure 3).

Figure 3: Herne Bay (left) and Port Isaac (right). Photos courtesy of Fugro GB Marine Limited.

2.3 Pressure Transducers

At some sites, a Valeport 1 bar pressure transducer is deployed, accompanied by a TideMaster data logger.

2.4 Datum

Sea level observations are measured relative to Ordnance Datum Newlyn (OD). The difference between OD and Chart Datum (CD) is obtained from Admiralty Tide Tables Supplementary Table III. The Tide Gauge Benchmarks (TGBM) and tide gauge Contact Points (CP) are surveyed by a GPS static survey of 8 hours minimum, tied in to OS active stations. Estimated vertical accuracy of this method is ± 0.005 m.

2.5 Data Transfer

The WaveRadar REX samples continuously at 4 Hz. Tidal elevations are derived as the 1 minute average, every 10 minutes. The Valeport VRS20 samples at 8 Hz and tidal elevations are derived as the 40-seconds average of the 8 Hz readings every 10 minutes. Timestamping for both instruments is at the start of the measurement burst.

Prior to 2009, the Etrometa step gauges derived tidal elevations as the average of a 10 minute burst, sampled at 2.56Hz, with time stamping at the centre of the measurement burst. For example, a tidal elevation timestamped as 06:40 was the average 2.56Hz readings from 06:35 to 06:45. Since 2009, tidal elevations are derived as the 1 minute average, every 10 minutes and timestamping is at the start of the measurement burst. The change was made to provide more consistency with the wave radars.

Data is transferred to a shore station via cable. All shore stations are equipped with a dedicated phone line and broadband with fixed IP address. Particular care is taken to ensure correct time stamping. All timestamps are recorded in Coordinated Universal time (UTC) / Greenwich Mean Time (GMT). Anti-virus software is installed on all PCs and is kept up to date with regular software upgrades.

2.5 Equipment Maintenance

Regular maintenance is required to ensure accurate data collection, including avoidance of significant bio-fouling which can gradually degrade observational accuracy. Scheduled maintenance visits are undertaken every 9 months, except when exposure necessitate a more frequent service interval at every 6 months.

3. Quality Control

Quality control of measured data involves both automated and manual inspection. No data are removed, but poor or suspect data are flagged. As a result, users have the option of using the flags to remove data for analysis, or to undertake their own quality control. The procedures aim to apply a relatively 'light touch' in terms of QC to avoid over-flagging.

Time series are continuous and monotonic, with missing data given as "9999".

3.1 Flagging System

Each measurement is allocated a flag to indicate its quality, with a system of 9 different flags to indicate a variety of QC "failures" (Table 1). The flags match those recommended by the IOC (2020: 26).

Flag	Description
1	Good data
2	Interpolated value
3	Doubtful value, typically not used
4	Isolated spike or wrong value
5	Correct but extreme value
6	Reference change detected, typically not used
7	Constant values, i.e. flat-lining
8	Out of range
9	Missing data

Table 1: Flags indicating QC test results.

3.2 QC tests

QC tests are conducted at three different stages:

- **Real-Time** Automated checks on the plausibility of incoming data
- **Monthly** Automated data flagging, plus manual review
- **Yearly** Further manual QC of annual data file

3.2.1 Real-Time

Automated checks on the incoming data are currently undertaken by the Regions' hydrodynamics contractor(s) with a focus on identifying faults or loss of data (Figure 4). No data are removed or flagged based on these checks.

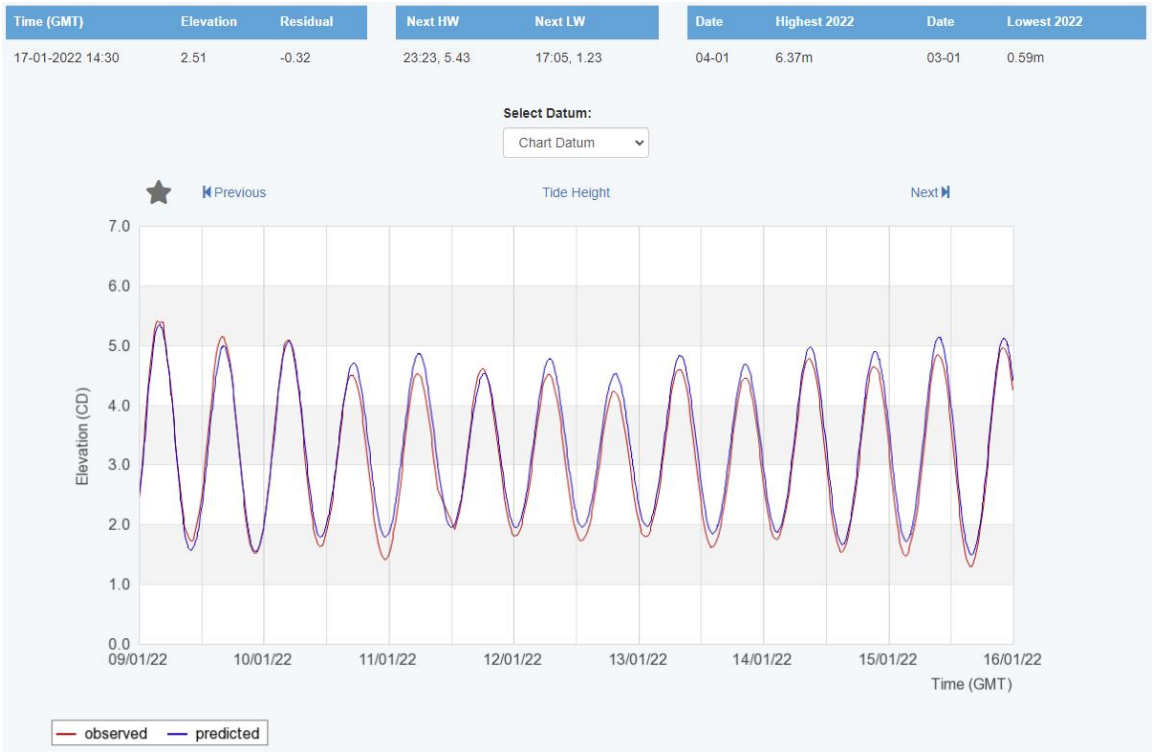

Figure 4: Real-time data display on the programme's website for Arun Platform.

3.2.2 Monthly QC

Monthly, in arrears, the data collected from all tide gauges undergoes the main quality control. Automated QC checks are performed using the tests and thresholds provide in Table 2. Thresholds are based on historical knowledge and statistics derived from data acquired over the previous decade.

Out-of-range test		**Flag 8**
Minimum	Monthly average Low Water – 3x standard deviation (3σ) of the monthly Low Water	
Maximum	Monthly average High Water + 3x standard deviation (3σ) of the monthly High Water	
Detection of spikes		**Flag 4**
Values exceeding 3x standard deviation (3σ) from a spline fitted to the data are flagged.		
Stability / flatline test		**Flag 7**
Values repeated 3x consecutively are flagged.		
Comparison with tide predictions		**Flag 4**
Residuals are visually inspected.		

Table 2: Parameters and tests for tide data with thresholds and associated flags.

Following automated QC, measurements are viewed manually to check whether data has been justifiably flagged or whether suspect data were missed.

3.2.3 Annual QC

Annually, the tide and residual undergo a final visual check (Figure 5). This annual QC regime allows for the boundaries between months to be checked.

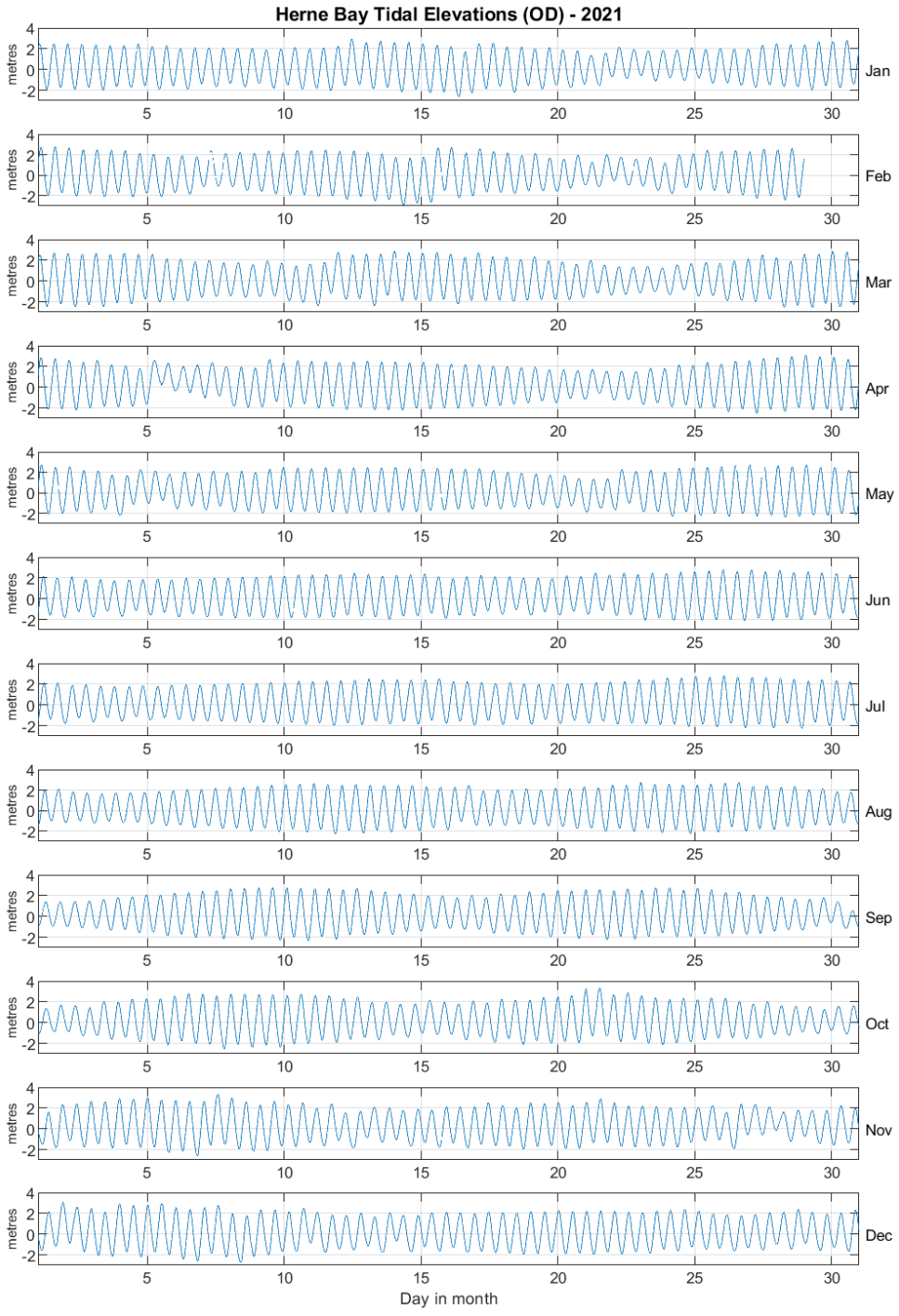

Figure 7: Quality-controlled Tidal elevations at Herne Bay during 2021

4. Data Dissemination

Tide data is made freely available via the coastal monitoring programmes' website:

- Real-time data viewer
  https://coastalmonitoring.org/realtimedata/

- Real-time data provision via API
  https://coastalmonitoring.org/ccoresources/api/

- Monthly and annual files containing quality checked tidal elevations and full metadata can be downloaded from the real-time data page of each individual tide gauge site.

- Annual reports containing statistical analysis of quality-controlled data
  http://coastalmonitoring.org/reports/

Tide data from NNRCMP gauges is also made available from the following data centres:

- High-resolution 6-second data is provided to the IOC Sea Level Station Monitoring Facility
  http://www.ioc-sealevelmonitoring.org/list.php?order=delay&dir=asc&contact=125

- Monthly and annual means are provided to the Permanent Service for Mean Sea Level
  https://www.psmsl.org/data/obtaining/

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