



UK Hydrographic
Office

ADMIRALTY
Maritime Data Solutions

IHO TWCWG5

March 16-18 2021

S-104 & S-III

UKHO Status Update

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S-104 Water Levels

UKHO aim

Produce S-104 compliant HDF5 files with the correct structure.

Do this for predicted, forecast and real-time water levels.

Trial (alpha) dataset, possibly just providing a snapshot in time.

Target: End of March 2021.

S-104 Water Levels : Discovery Work

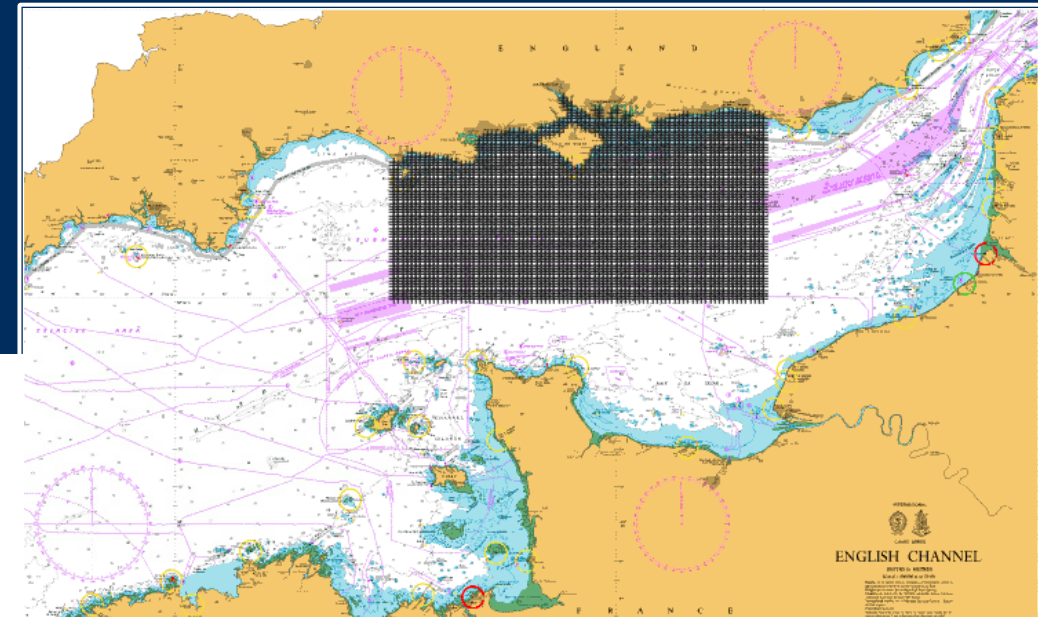
Real Time

- It is noted that the Product Specification is still in Draft and doesn't yet cover Real-Time water level height in detail.
- UKHO is experimenting with an external company with tide gauge installations in a variety of UK ports.
- Data is obtained through a **stream** via a **websocket** connection. Possibility to use an **API** (preferred).
- Each tide gauge station sends data on a different timestamp.
- Data transformation before use (e.g. change csv to columns with specific datatypes & append timestamp; download station location & create geometry).
- "Location data matching" between the tide gauge stations and the predicted locations (different sources).
- 'Water Level Trend' has been applied to the real time data.

S-104 Water Levels : Discovery Work *continued*

Forecast

- Forecast Model – Produced by the UK Met office.
- The forecast for the North-West European Shelf is produced using a forecasting ocean assimilation model, with tides, at 1.5km horizontal resolution coupled with a wave model.
- Ref: <https://www.metoffice.gov.uk/research/weather/ocean-forecasting/high-resolution-regional-ocean-model>
- NetCDF file format.
- Time-step output either 15 minutes or hourly.
- 6-day forecast.
- More challenging to apply trend analysis.

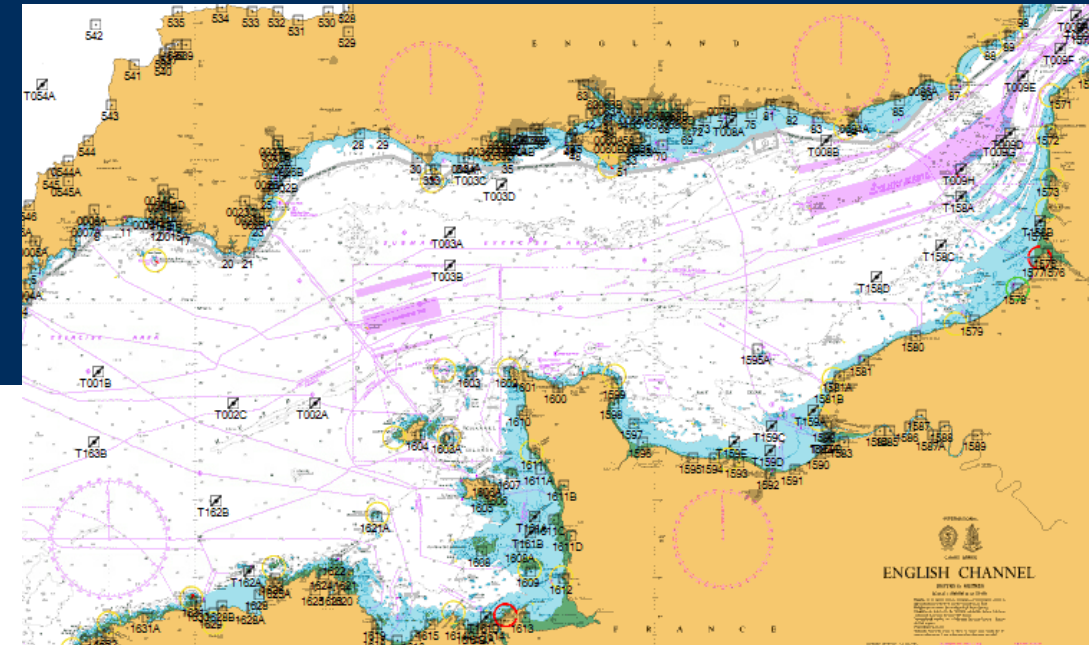




S-104 Water Levels : Discovery Work *continued*

Predicted (Astronomical Tide)

- Uses an UKHO internal API .
- Simple to loop through the different stations and return the exact information required .
- Applying trend to data during processing.

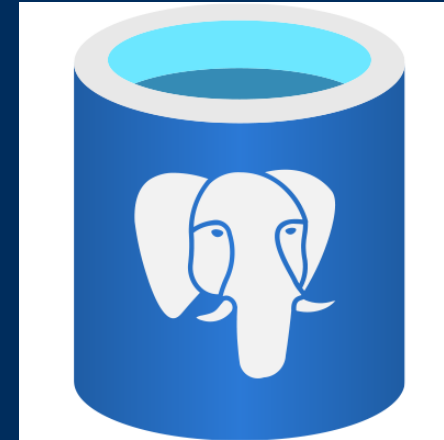




Storage

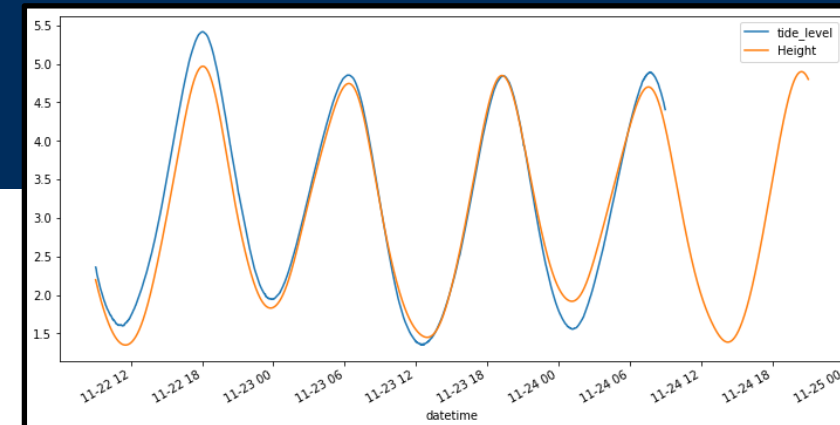
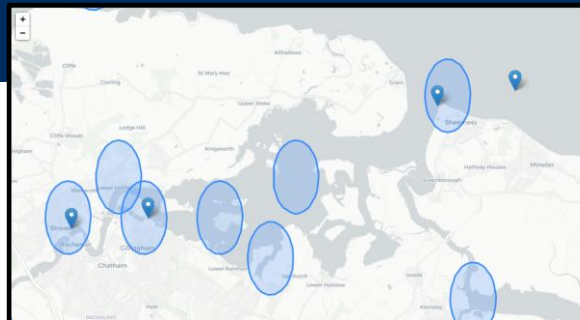
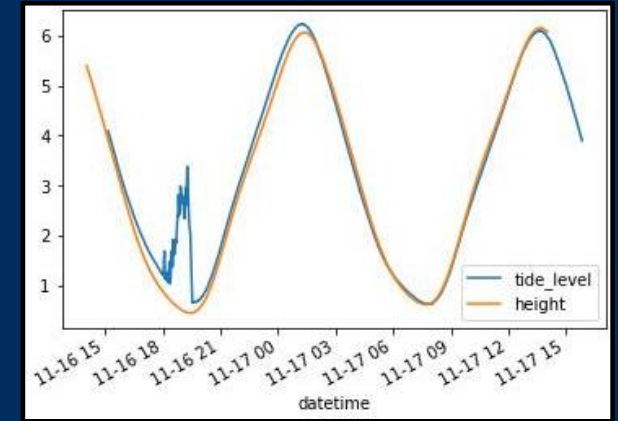
Data stored in a PostgreSQL Database on Azure:

- Data sent every 5 minutes for the past 5 minutes.
- Data stored with timestamp .
- Could be shortened or lengthened easily.
- Data from forecast storage – yet to be determined



Validation

- Data requires some internal validation – to ensure any validation done externally is ‘as expected’.
 - QA/QC checks by data provider also checked at UKHO.
- Spikes in the real-time data have been observed ‘post QA/QC’
- Data matching
 - Improvement in data matching between UKHO prediction station locations and real-time source locations.



HDF5

- Data is transformed into the HDF5 format
- Example carried out to date:
 - Predicted tidal height data retrieved from UKHO API and held in memory.
 - Trend analysis applied.
 - HDF5 structure created.
 - Data pushed into HDF5 structure as defined by Product Specification.
 - Metadata to be added (in development).
 - Real-time & Forecast data has also been transformed into HDF5 format.
- Group names are temporarily stationID's for testing purposes

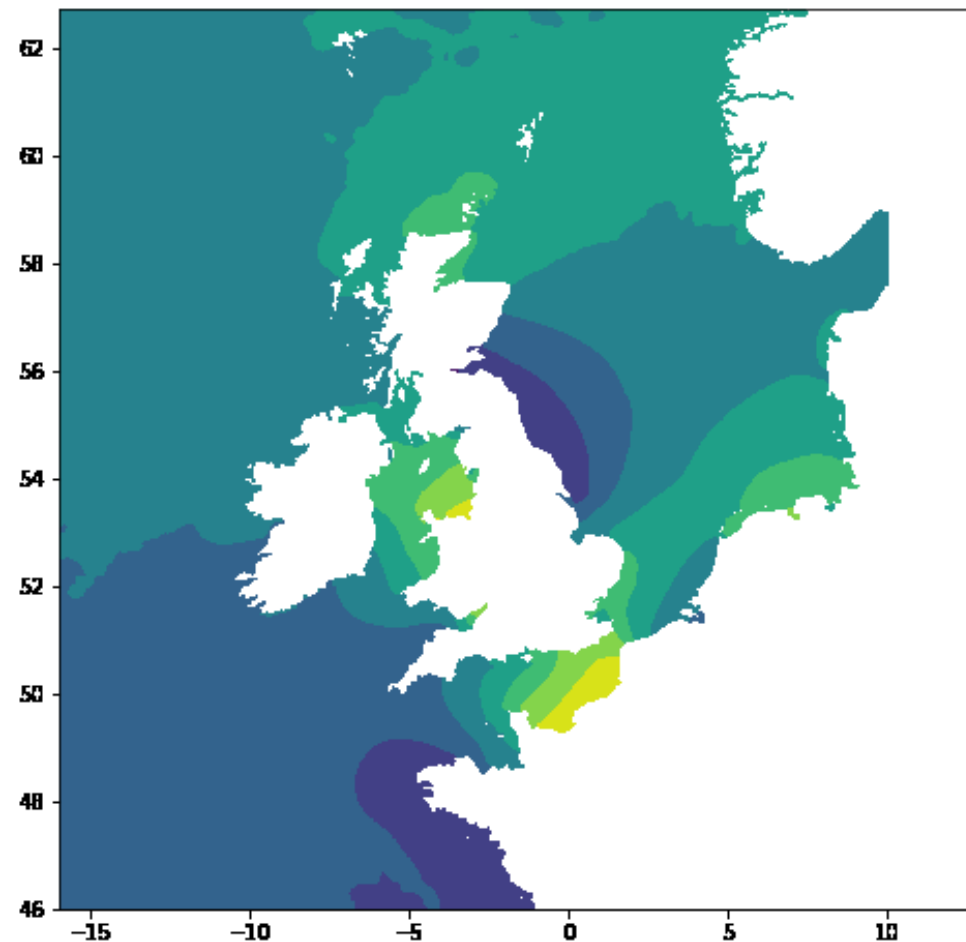
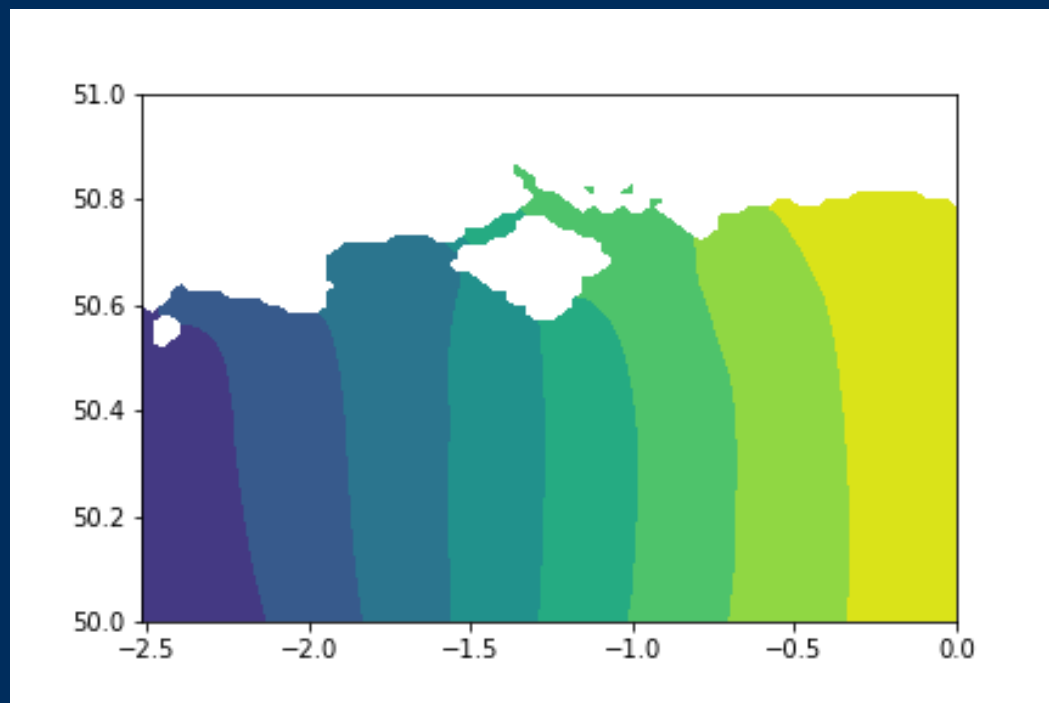
The screenshot shows an HDF5 file explorer on the left with a tree structure. The selected group is 'Group_0895' under 'WaterLevel.01'. The 'Object Attribute Info' window on the right shows the 'General Object Info' tab. It displays the 'Attribute Creation Order' as 'Creation Order NOT Tracked' and the 'Number of attributes' as 7. A table lists the attributes with their names and types. On the far right, a 'values at /WaterLevel/WaterLevel.01' window shows a table of data for 'surfaceHeight' and 'trend' over 15 rows.

Name	Type
endTime	String, length = 30, padding = H5T
numberOfTimes	64-bit integer
startTime	String, length = 30, padding = H5T
stationIdentification	String, length = 30, padding = H5T
timeIntervalIndex	64-bit integer
timePoint	String, length = 30, padding = H5T
timeRecordInterval	64-bit floating-point

	0	1
surfaceHeight	0.364432	0.352594
trend	3.0	3.0

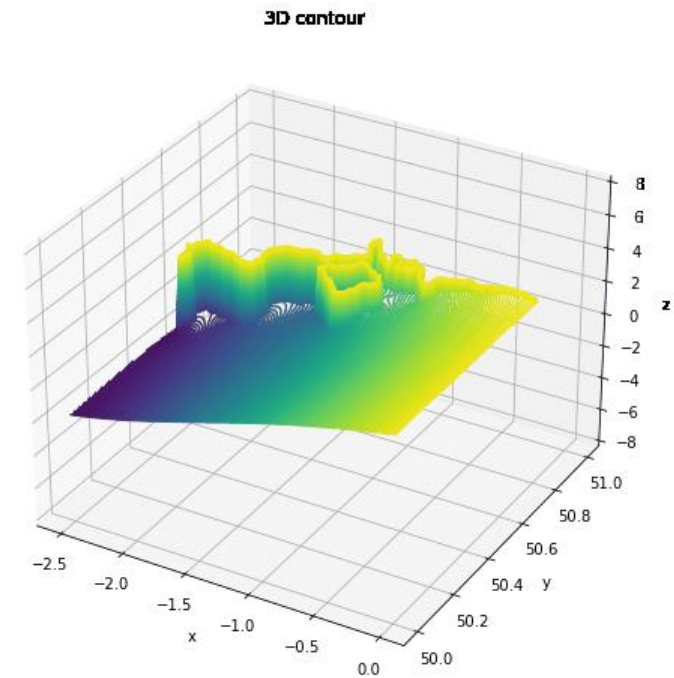
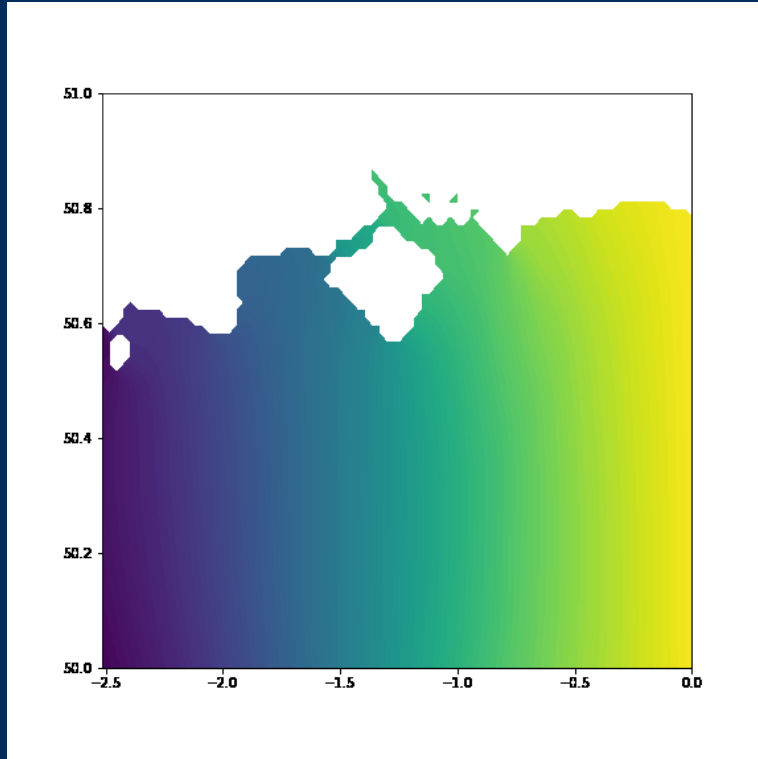


Forecast prototypes...





Forecast prototypes...



To be completed...

- Consider other real-time data (UK National TG network)
- Validation
- Metadata completion
- Delivery considerations / disseminating the data
- More development as the Product Specification matures
-

S-III Surface Currents

UKHO aim

Produce S-III compliant HDF5 files with the correct structure.

Do this for forecast surface currents.

Trial (alpha) dataset providing a snapshot in time.

Target: End of March 2021.

S-III Surface Currents: Discovery Work

- › Noting that the S-III Product Specification is more mature than S-I04 (v1 published and publicly available).
- › Looked at helpful existing sources of S-III data
- › For example NOAA NOS provided an example S-III dataset / service (nowcast and forecast systems via AWS)



	179		180		181	
	rentSpeed	surfaceCurrentDirection	surfaceCurrentSpeed	surfaceCurrentDirection	surfaceCurrentSpeed	surfaceCurrentDirection
290		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
291		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
292		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
293		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
294		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
295		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
296		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
297		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
298		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
299		-9999.0	-9999.0	-9999.0	-9999.0	-9999.0
300		114.6	-9999.0	-9999.0	-9999.0	-9999.0
301		117.5	0.05	115.5	0.08	106.5
302		118.6	0.06	126.3	0.06	115.6
303		121.2	0.05	128.9	0.04	126.3
304		141.4	0.03	146.4	0.01	129.3
305		218.7	0.01	230.6	0.02	297.5
306		286.6	0.02	290.1	0.03	306.7
307		306.6	0.04	306.9	0.05	310.2
308		318.4	0.06	314.0	0.07	312.6
309		342.2	0.06	331.0	0.07	326.2
310		355.7	0.07	345.6	0.07	339.8
311		4.2	0.08	357.1	0.08	351.9
312		8.8	0.1	4.0	0.09	1.5
313		10.4	0.11	6.4	0.09	7.8
314		9.4	0.12	8.4	0.09	12.7
315		8.5	0.12	10.2	0.1	15.8

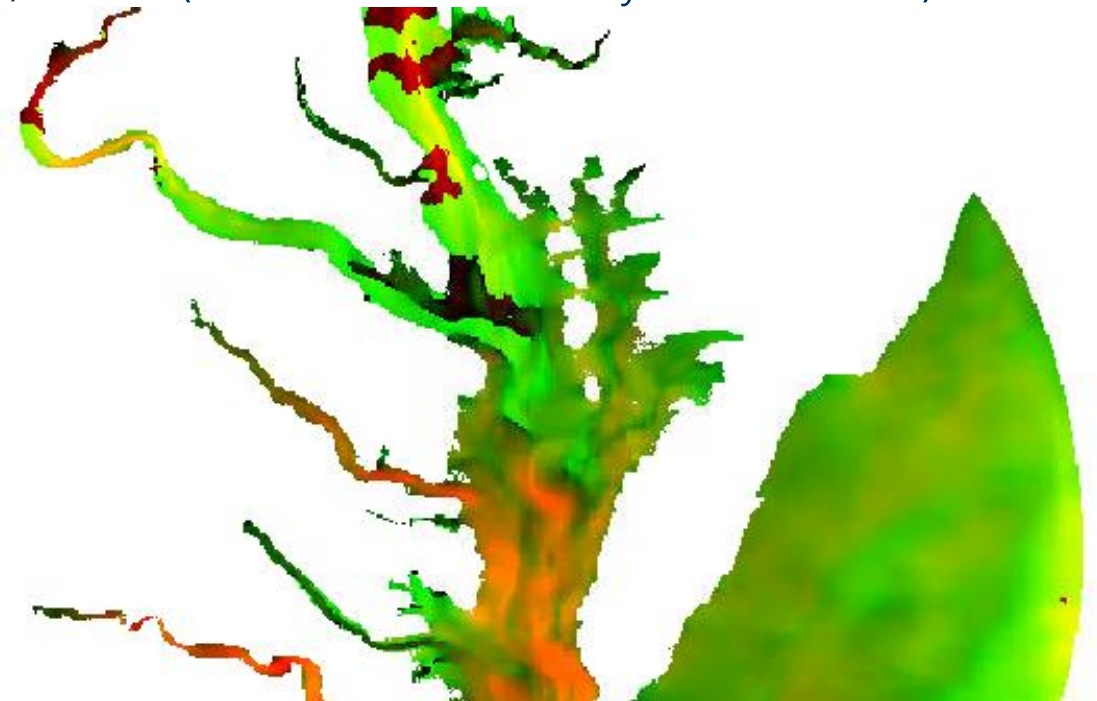


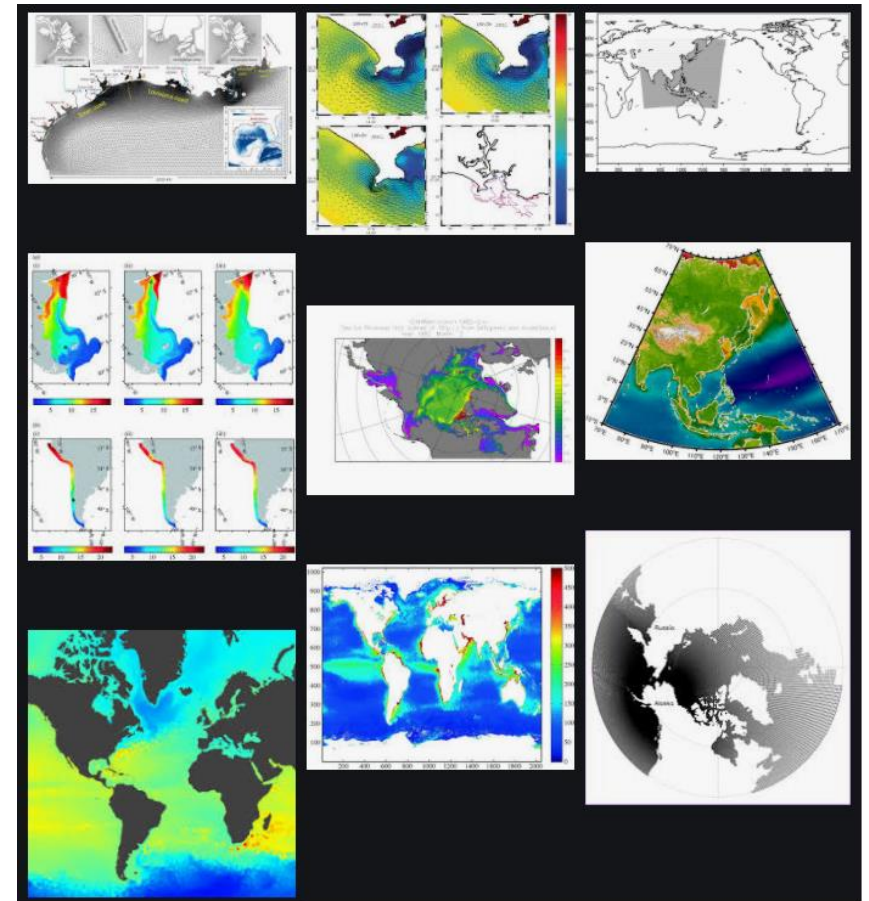
Figure 1a: Portion of a Regular Grid (DCF2) HDF5 array (Chesapeake Bay 20200910T00Z snapshots).

Figure 1b: Regular Grid (DCF2) 2-band raster

S-III Surface Currents: Discovery Work *continued*

Review of Open-Source Surface Current Models

- › Around 30 Models researched ; considering 4 candidates
- › Assessed against:
 - › Updating frequency,
 - › Temporal coverage,
 - › Temporal resolution,
 - › Spatial coverage,
 - › Spatial resolution,
 - › Potential for S-I04 water level support.



S-III Surface Currents: Discovery Work *continued*

Models Being Investigated:

FES2014



› Benefits:

- › Spatial resolution: 1/16 degree (approx. 6.5 km)
- › Spatial coverage: Global
- › S-III 'long term planning'
(i.e. surface current predictions)
- › Also 'long term planning' S-I04 water levels

› Possible drawbacks:

- › Licencing limitations

Atlantic European NW Shelf Ocean Physics Analysis and Forecast



› Benefits :

- › Temporal coverage: 2018 – present
- › Temporal resolution: 15 or 60 minutes
- › Forecast: 6 days
- › Spatial resolution: 1/0.017 degree (approx. 1.5 km)
- › Updating: Daily
- › Produced by: UK Met Office
- › Licence: Free
- › Also S-I04 forecast water levels

› Possible drawbacks :

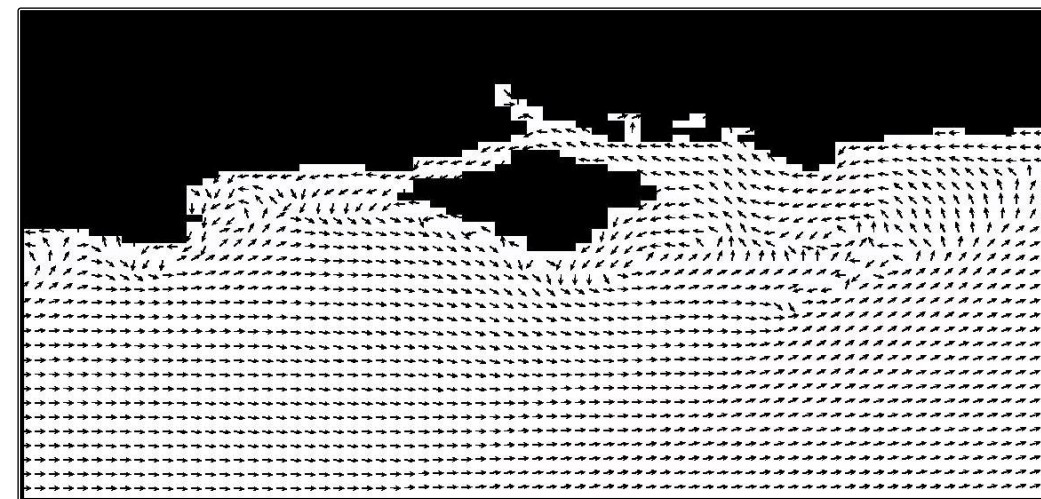
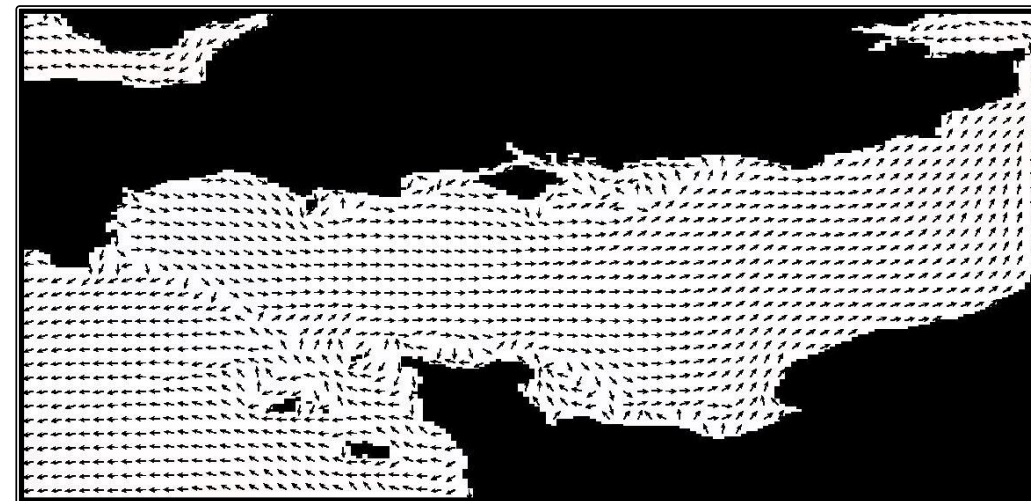
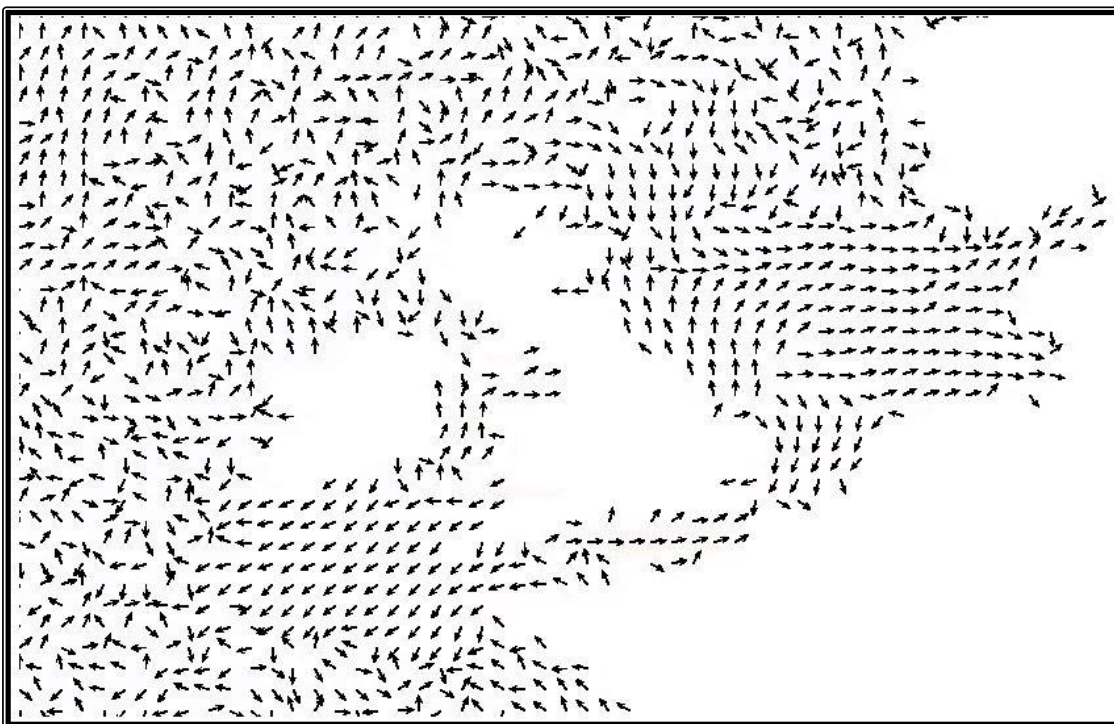
- › Spatial coverage: European NW Shelf.



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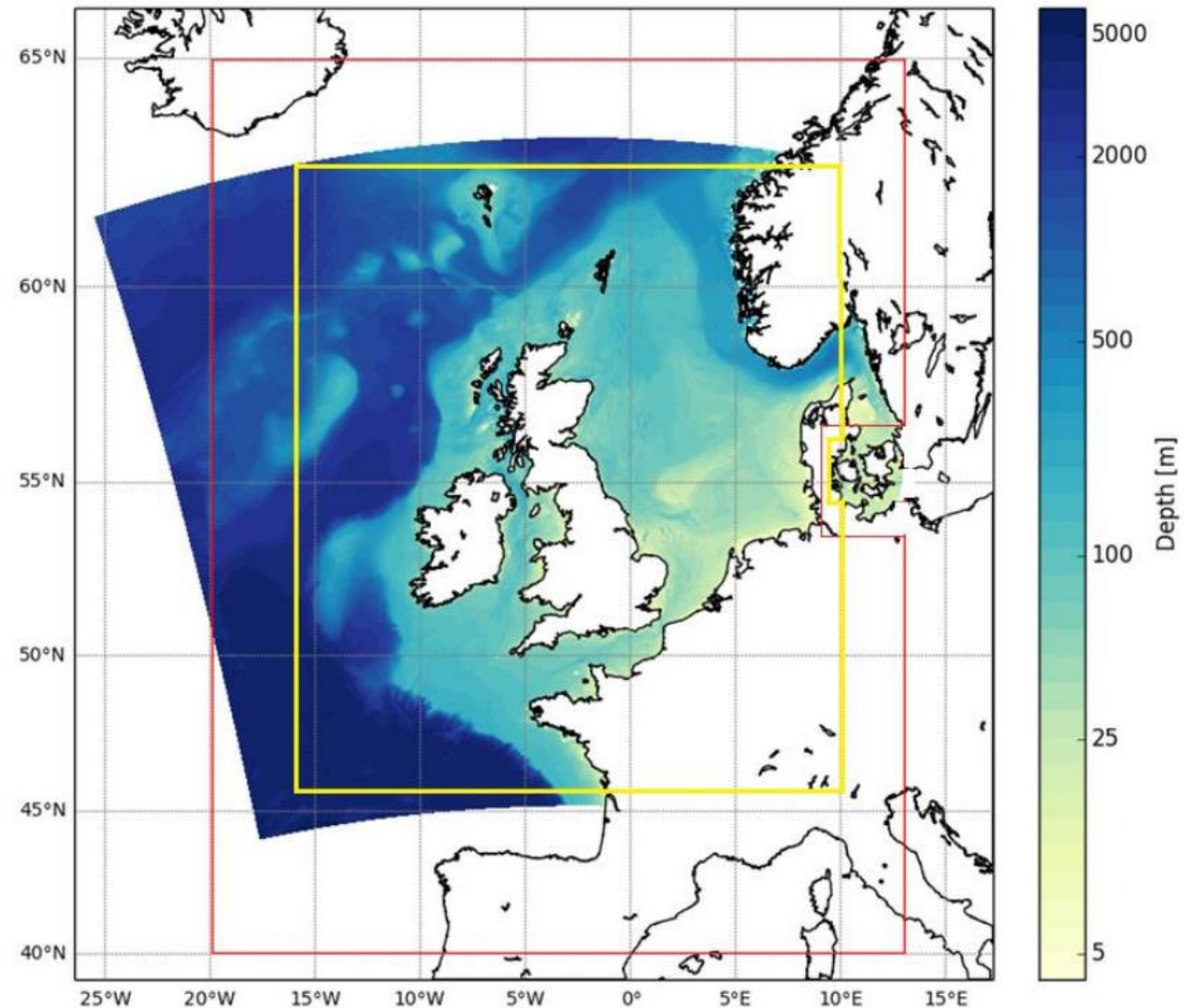
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Atlantic European NW Shelf WMS



Progress to date

- › Investigated production tooling.
- › Understanding of NOAA approach.
- › Proved ingest open-source data (MetOffice Atlantic NW Shelf model).
- › Reformat from Northward/Southward Velocities to Speed/Direction compound dataset.
- › Populated by temporal occurrence into HDF5 file,
- › Could be pushed to filestore (eg AWS S3, allowing Amazon APIs to call, facilitating dissemination).
- › Operational CMEMS account for automated downloads.



Metadata

General

Type (Feature)

Recent Files: /home/michael/Data/S-111/Output/Development_S-111_HI-CUR.h5

Object Attribute Info

Attribute Creation Order: Creation Order NOT Tracked

Number of attributes = 17

Name	Type	Array Size	Value[50](...)
dateTimeOfFirstRecord	String, length = variable, padding = H5T_STR_NULL	Scalar	20201013T130000Z
dateTimeOfLastRecord	String, length = variable, padding = H5T_STR_NULL	Scalar	20201019T000000Z
eastBoundLongitude	32-bit floating-point	Scalar	0.0
gridOriginLatitude	64-bit floating-point	Scalar	50.0
gridOriginLongitude	64-bit floating-point	Scalar	-2.5
gridSpacingLatitudinal	64-bit floating-point	Scalar	0.013333333
gridSpacingLongitudinal	64-bit floating-point	Scalar	0.029761905
instanceChunking	String, length = variable, padding = H5T_STR_NULL	0	null
northBoundLatitude	32-bit floating-point	Scalar	51.0
numGRP	32-bit integer	Scalar	132
numPointsLatitudinal	32-bit integer	Scalar	75
numPointsLongitudinal	32-bit integer	Scalar	84
numberOfTimes	32-bit integer	Scalar	132
southBoundLatitude	32-bit floating-point	Scalar	50.0
startSequence	String, length = variable, padding = H5T_STR_NULL	Scalar	0,0
timeRecordInterval	32-bit integer	Scalar	3600
westBoundLongitude	32-bit floating-point	Scalar	-2.5

Recent Files: /home/michael/Data/S-111/Output/Development_S-111_HI-CUR.h5

Object Attribute Info

Attribute Creation Order: Creation Order NOT Tracked

Number of attributes = 14

Name	Type	Array Size	Value[50](...)
depthTypeIndex	8-bit enum (1=Layer average, 2=Sea surface,	Scalar	Sea surface
eastBoundLongitude	32-bit floating-point	Scalar	0.0
epoch	String, length = variable, padding = H5T_STR	Scalar	G1762
geographicIdentifier	String, length = variable, padding = H5T_STR	Scalar	Atlantic North West Shelf
horizontalDatumReference	String, length = variable, padding = H5T_STR	Scalar	EPSG
horizontalDatumValue	32-bit integer	Scalar	4326

Recent Files: /home/michael/Data/S-111/Output/Development_S-111_HI-CUR.h5

Object Attribute Info

Attribute Creation Order: Creation Order NOT Tracked

Number of attributes = 14

Name	Type	Array Size	Value[50](...)
commonPointRule	8-bit enum (1=average, 2=low, 3=high,	Scalar	high
dataCodingFormat	8-bit enum (1=Time series at fixed statio	Scalar	Regularly-gridded arrays
dimension	32-bit integer	Scalar	2
horizontalPositionUncertainty	32-bit floating-point	Scalar	-1.0
interpolationType	8-bit enum (10=discrete)	Scalar	discrete
maxDatasetCurrentSpeed	32-bit floating-point	Scalar	0.0
methodCurrentsProduct	String, length = variable, padding = H5	Scalar	CMEMS_NORTHWESTSHELF
minDatasetCurrentSpeed	32-bit floating-point	Scalar	0.0
numInstances	32-bit integer	Scalar	0
sequencingRule.scanDirection	String, length = variable, padding = H5	Scalar	Not defined
sequencingRule.type	String, length = variable, padding = H5	Scalar	0
timeUncertainty	32-bit floating-point	Scalar	-1.0
typeOfCurrentData	8-bit enum (1=Historical observation (O	Scalar	Hydrodynamic model forecast
verticalPositionUncertainty	32-bit floating-point	Scalar	-1.0

Instance

Metadata to Resolve

› Table I 2.1

- › Epoch (how to identify this?)

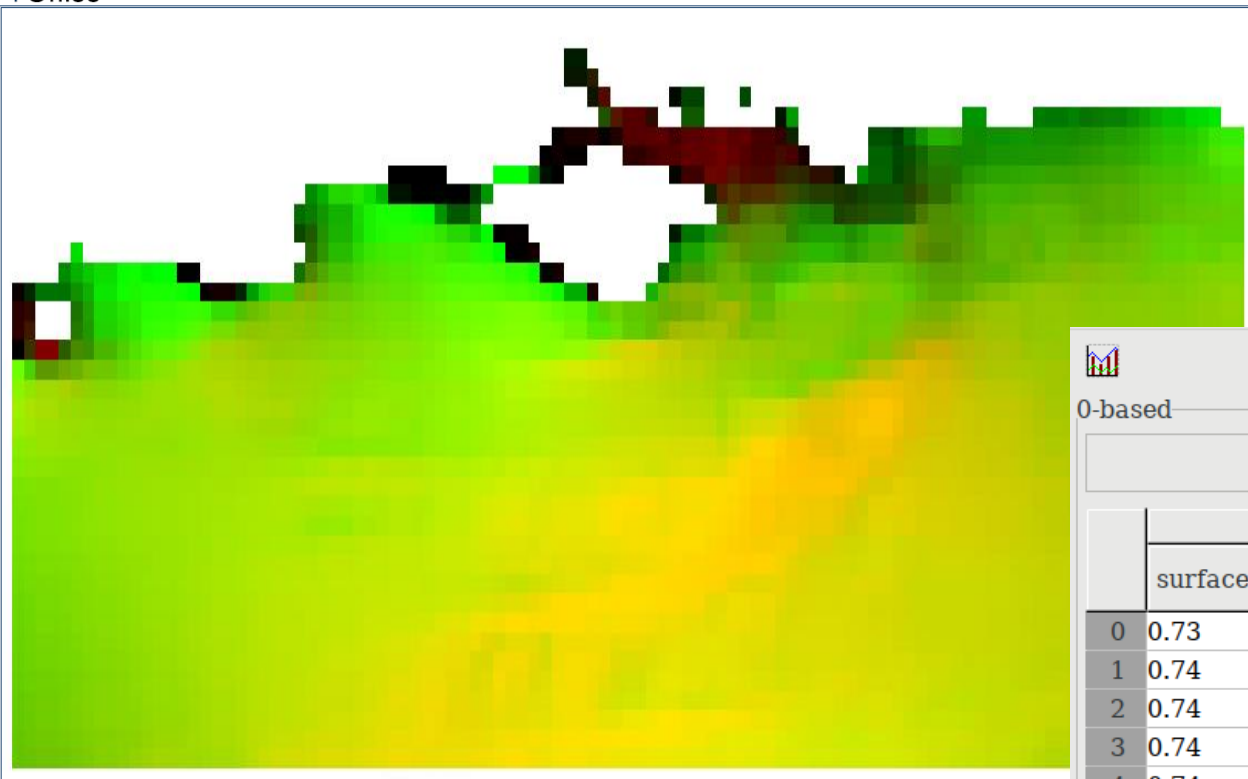
› Table I 2.2

- › commonPointRule (Recommended 4 (All) for s-I04, 3 (High) for s-III – guidance on how to determine which option would be welcome)

- › Sequencing rule (type & scan direction – further guidance welcome)

› Table I 2.3

- › instanceChunking (further guidance on when this would apply and how to implement, welcomed).



**GeoTIFF of Southampton
& Isle of Wight test area**

Gridded Speed/Direction →

0-based				
	0		1	
	surfaceCurrentSpeed	surfaceCurrentDirection	surfaceCurrentSpeed	surfaceCurrentDirection
0	0.73	247.1	0.77	247.6
1	0.74	247.9	0.78	248.7
2	0.74	248.4	0.78	249.5
3	0.74	249.3	0.77	250.1
4	0.74	250.4	0.77	251.0
5	0.75	251.7	0.78	252.3
6	0.75	253.0	0.78	253.4
7	0.76	254.3	0.78	254.8
8	0.76	255.4	0.78	255.9
9	0.77	255.6	0.79	256.4
10	0.77	255.8	0.8	256.5
11	0.77	256.5	0.8	257.0
12	0.78	257.6	0.81	258.2
13	0.78	258.6	0.81	259.2

Note: Location "0,0" represents the South-West corner.

Next Steps

- › Ensure metadata complete and S-III compliant,
- › Validation of process & output, esp. data conversion (from UO/VO to Speed/Dir),
- › Check Sea Surface Current 15min dataset (SSC QT), and SSC hourly (both added Dec 2020),
- › Load test entire NW Shelf area.



Where we are now/on-going work

NWS: Met Office support?

How will we store data?

What production tooling exists?

Maintenance and update frequency?

UKHO S-100 tiling scheme?

S-100 Working Group

Product format? Points or regular grid?

FES2014: Clarify licenced resale options

Other Models (such as FES2014):
Streams comparison/quality check

Symbology - what do we need to be thinking about?

Spatial Resolution: High-res where possible, and low-res in the open ocean?



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Thank you

