Vertical Offshore Reference Frame (VORF)

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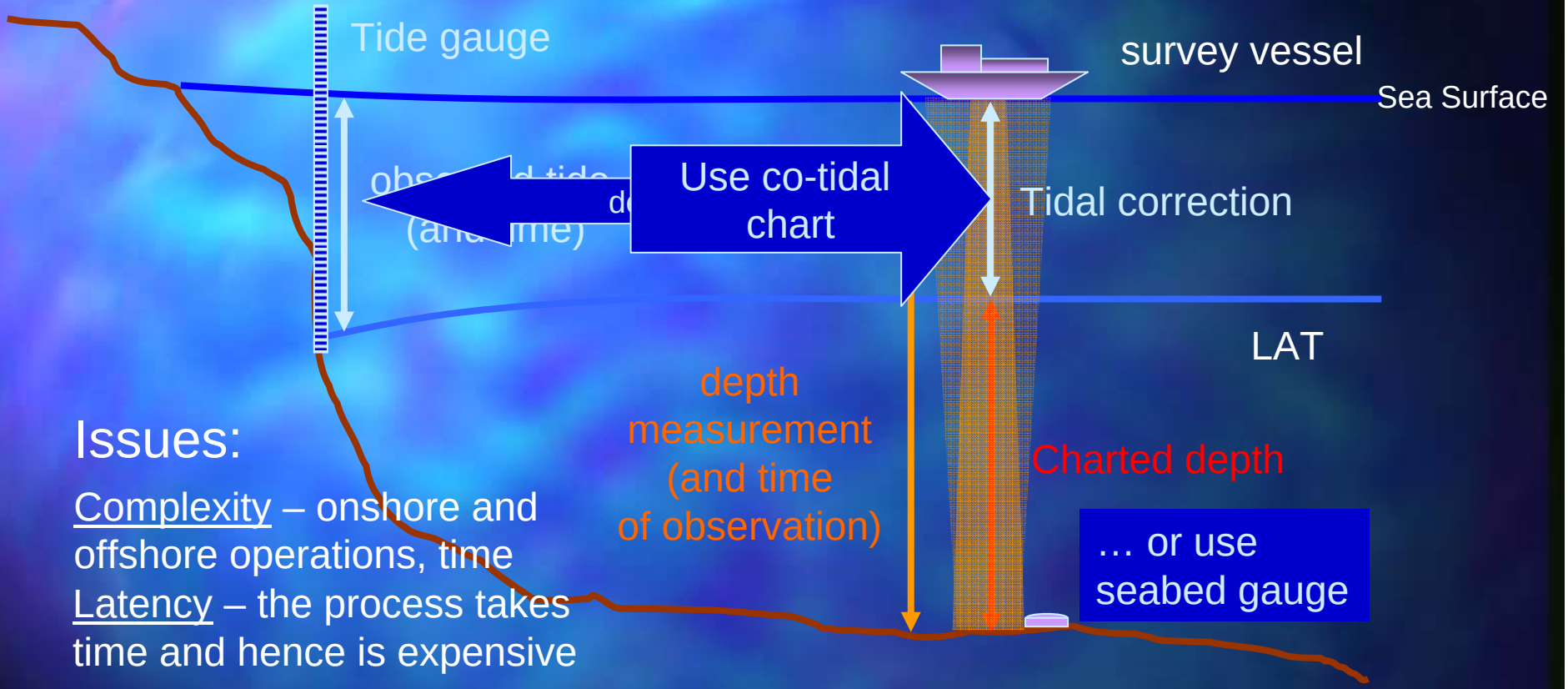
Presentation Structure

- What is VORF?
- Brief overview of the technical development
- Why is VORF needed?
- Potential uses of VORF

What is VORF?

- VORF = Vertical Offshore Reference Frame
- A set of mathematical models of the major surfaces used in the current and future charting of UK home waters
- A suite of software utilities allowing the transformation of mapping and positioning data between the VORF surfaces

Current practice for bathymetric data processing



Issues:

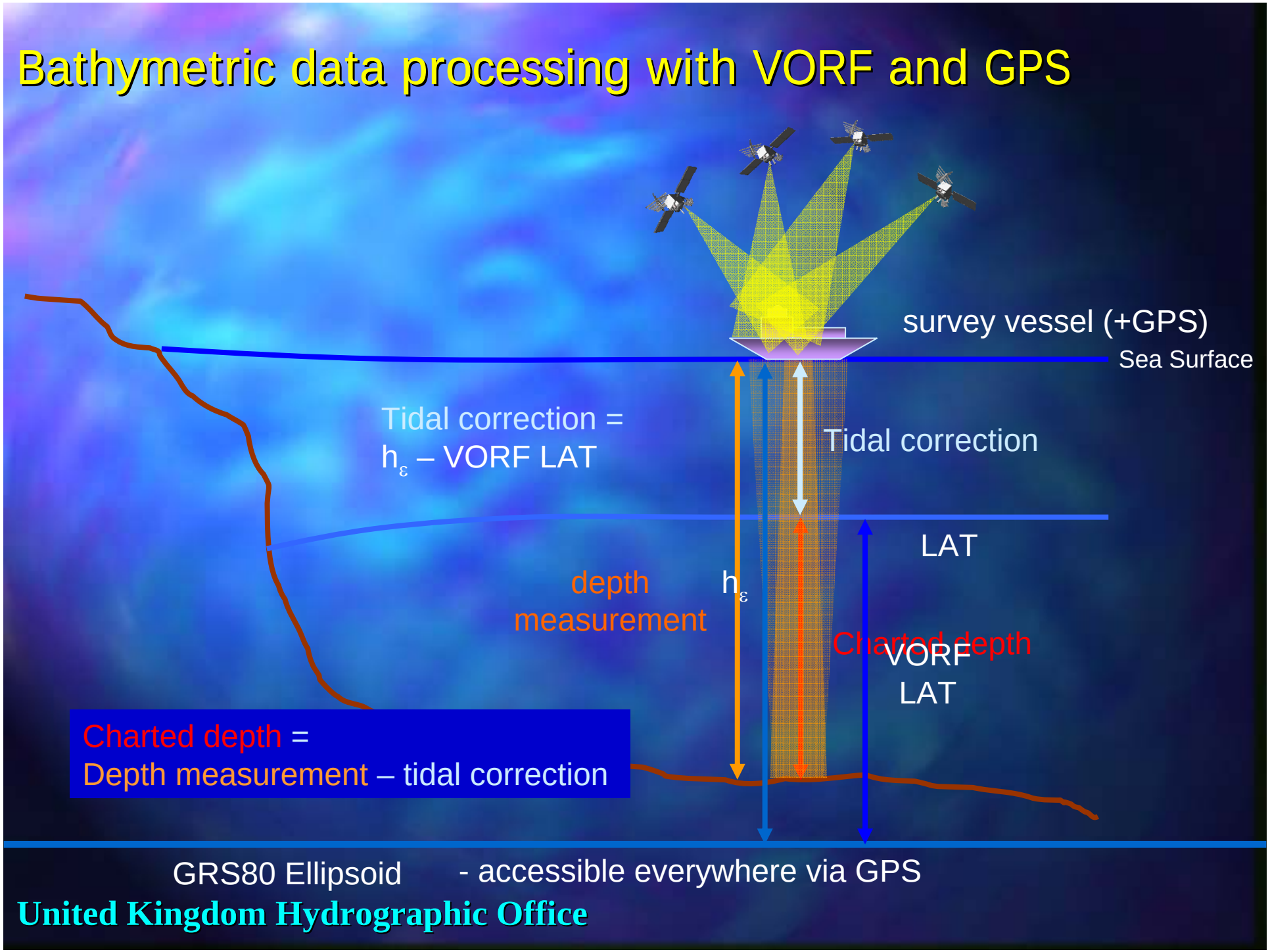
Complexity – onshore and offshore operations, time

Latency – the process takes time and hence is expensive

Accuracy issues – co-tidal charts have limited resolution and are derived from limited data; seabed gauges are expensive

Inconsistency – practices using Chart Datum are sometimes poorly defined and can lead to discrepancies

Bathymetric data processing with VORF and GPS



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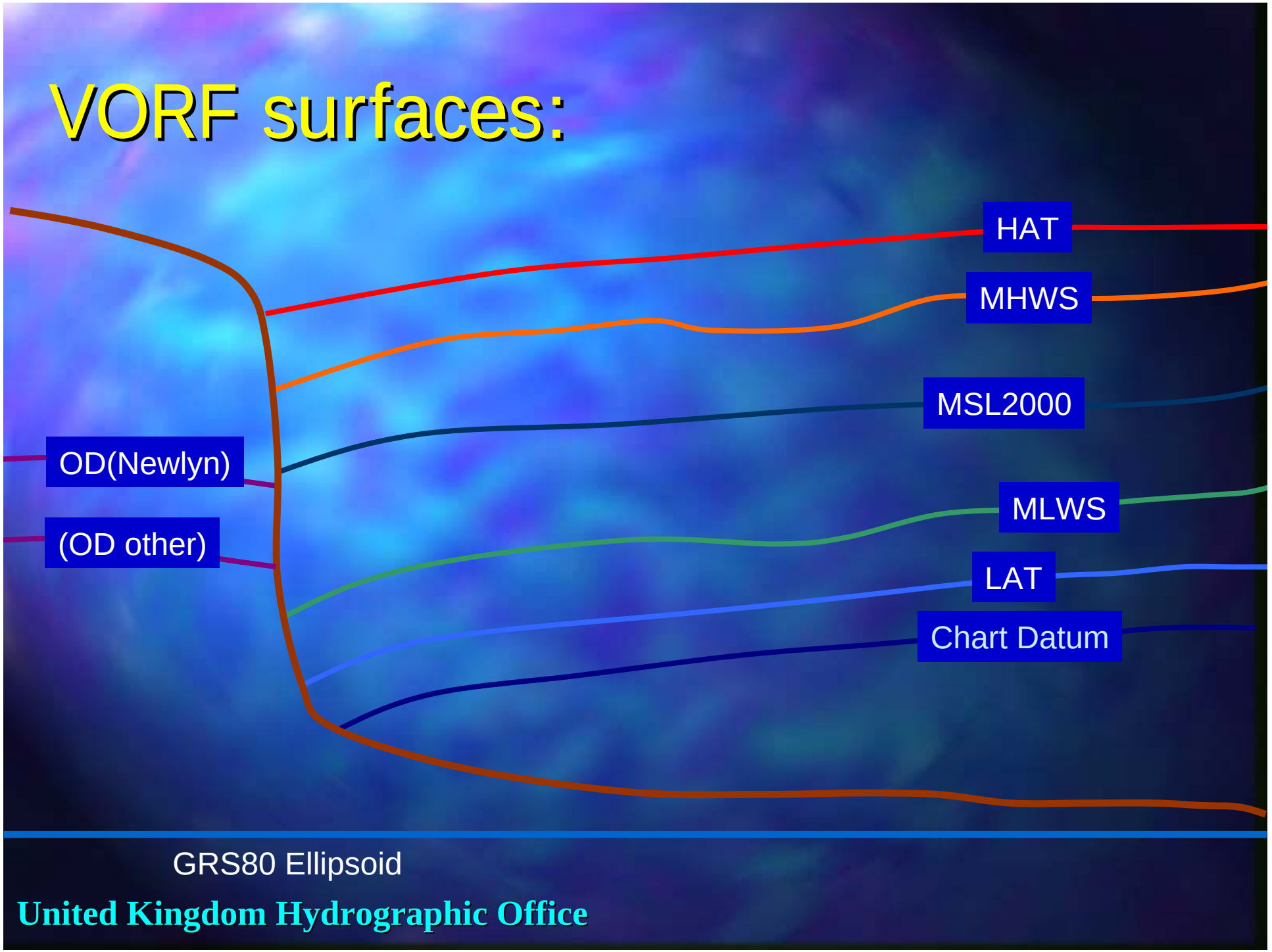
VORF surfaces:



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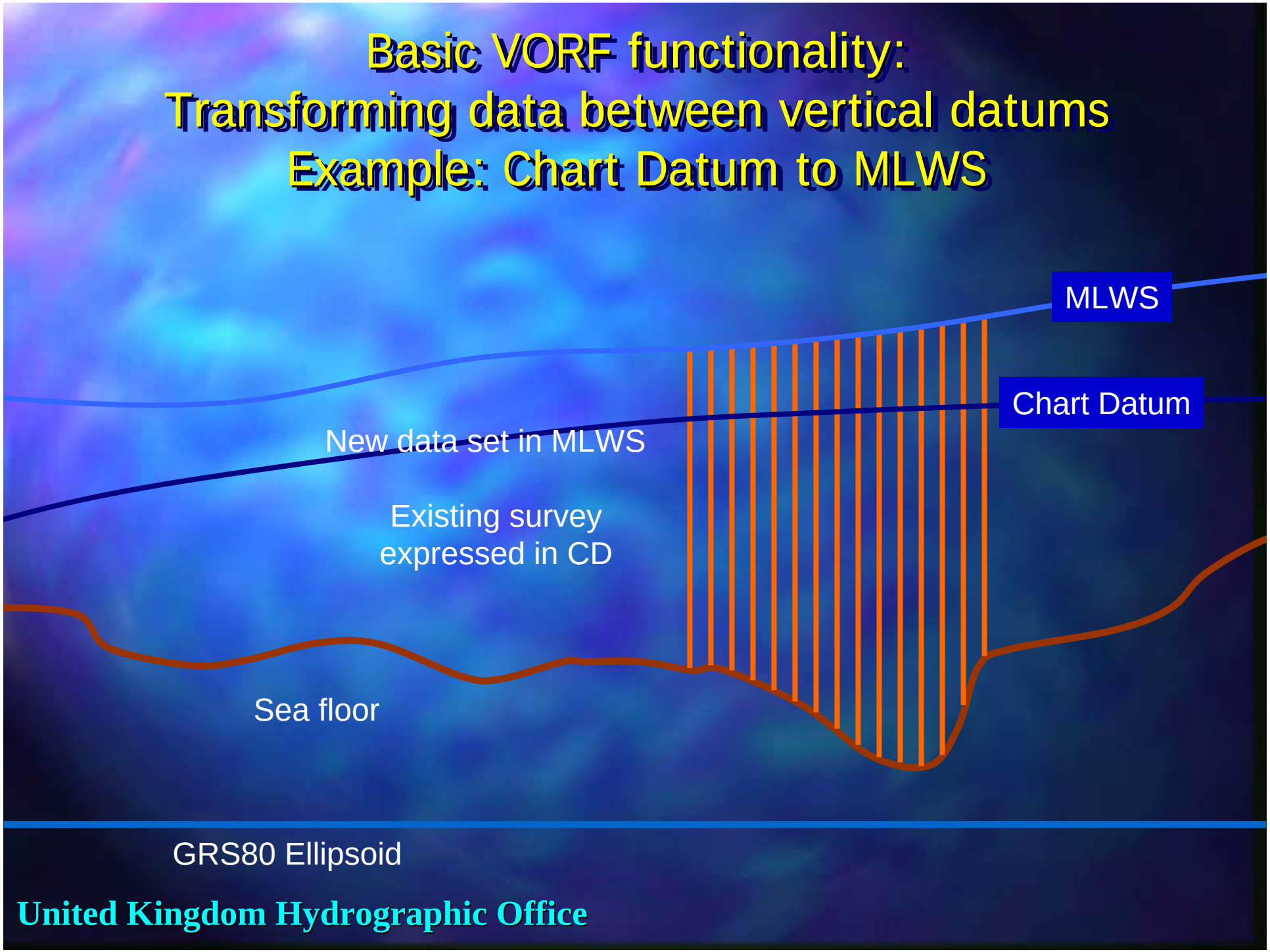
Basic VORF functionality:
Transforming data between vertical datums
Example: Chart Datum to MLWS



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Brief overview of the technical development of VORF

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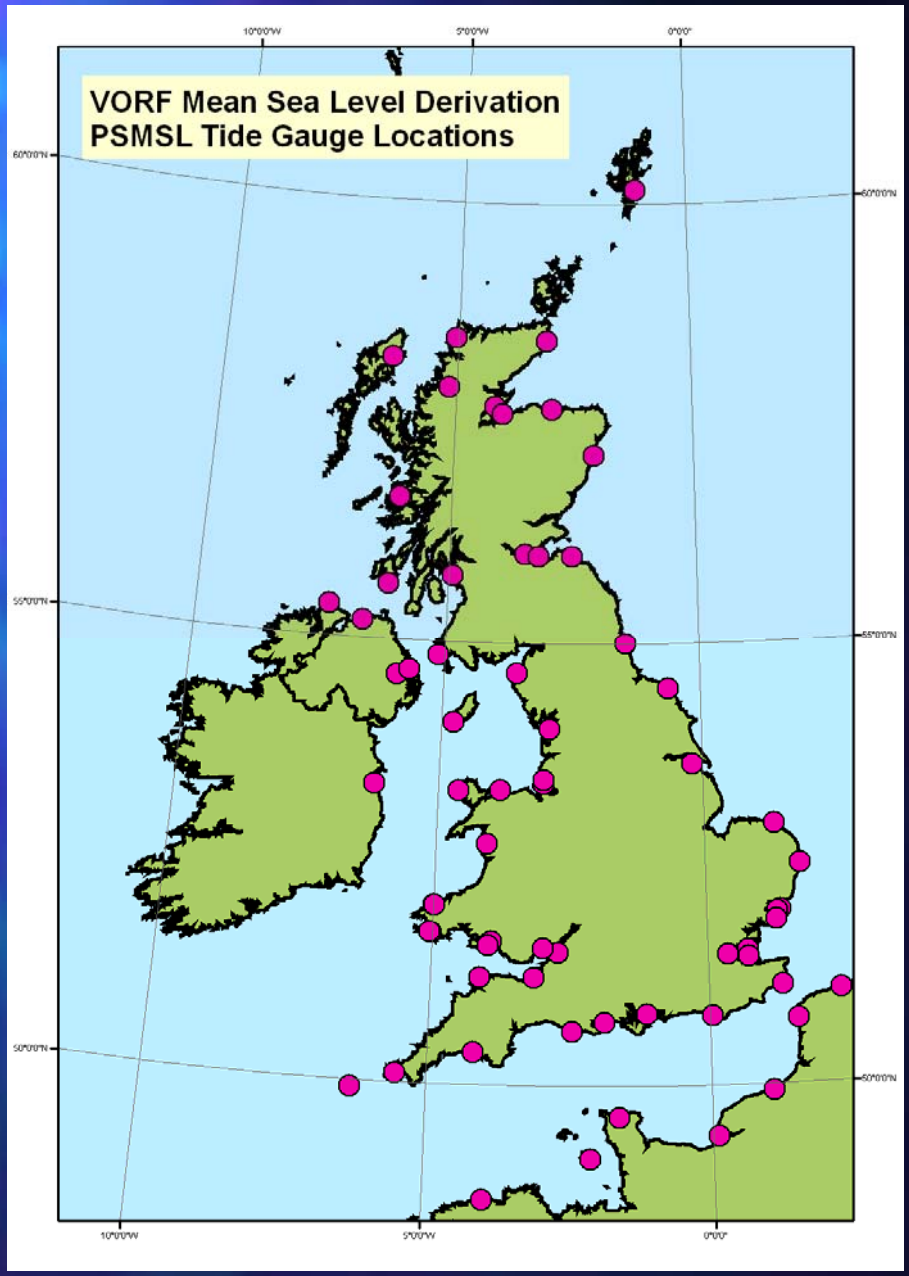
Technologies applied in development of VORF

- Tide gauge data
- GPS data
- Satellite altimetry
- Gravity field models
- Tidal modelling

Data sources:
Tide Gauge data via the Permanent Service for Mean Sea Level (PSMSL)

- National Tidal and Sea Level Facility (NTSLF) stations
- High quality continuous observations
- BUT low spatial density



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Data sources:
Tide Gauges Admiralty Tide Table (ATT)

- Around 700 Standard and Secondary Port locations
- Good spatial density
- BUT occasionally low precision due to short term data series

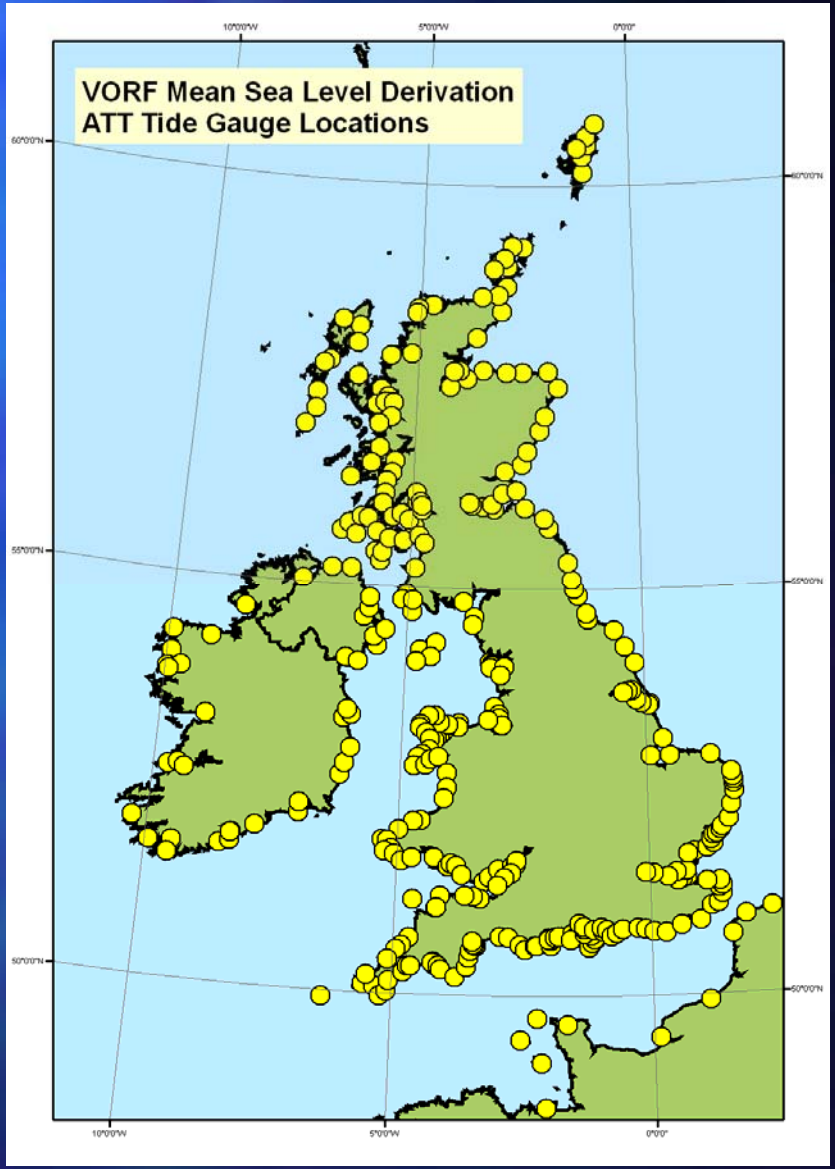
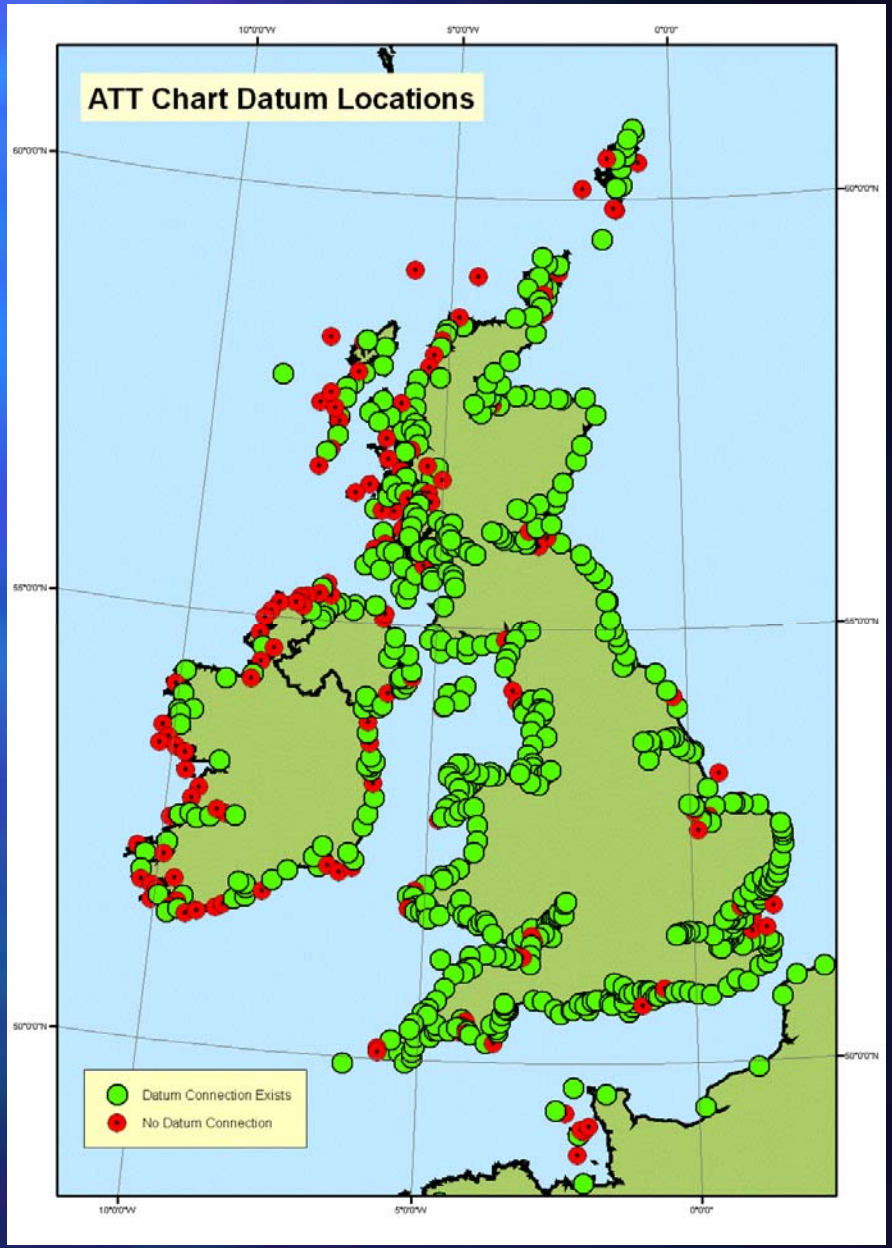


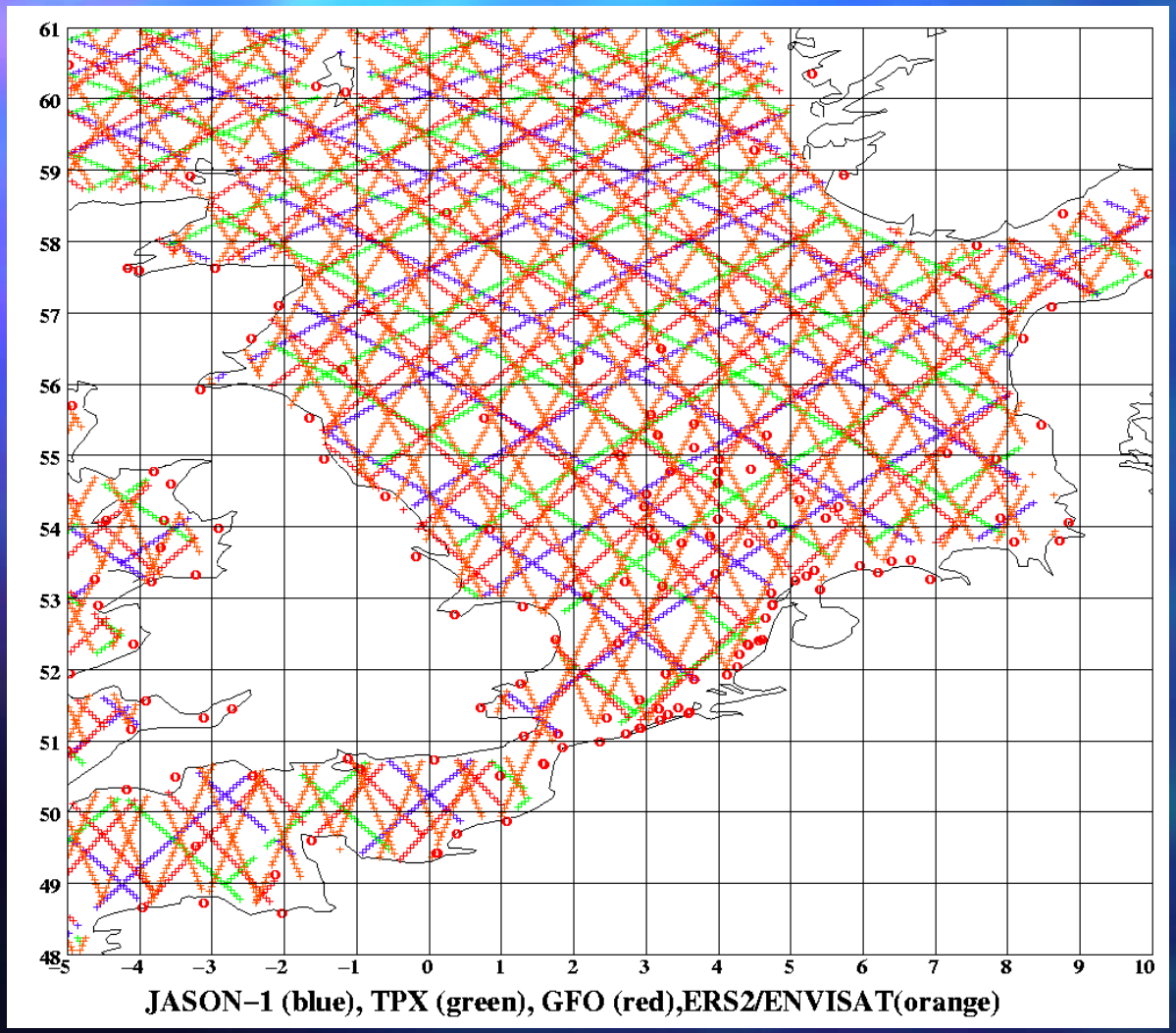
Chart Datum:

- VORF aims to unify all these separate datums into one, seamless surface
- Process involves verifying the link between CD and Ordnance Datum (the land-levelling height datum)



Technologies applied: Satellite Altimetry

Ground Tracks



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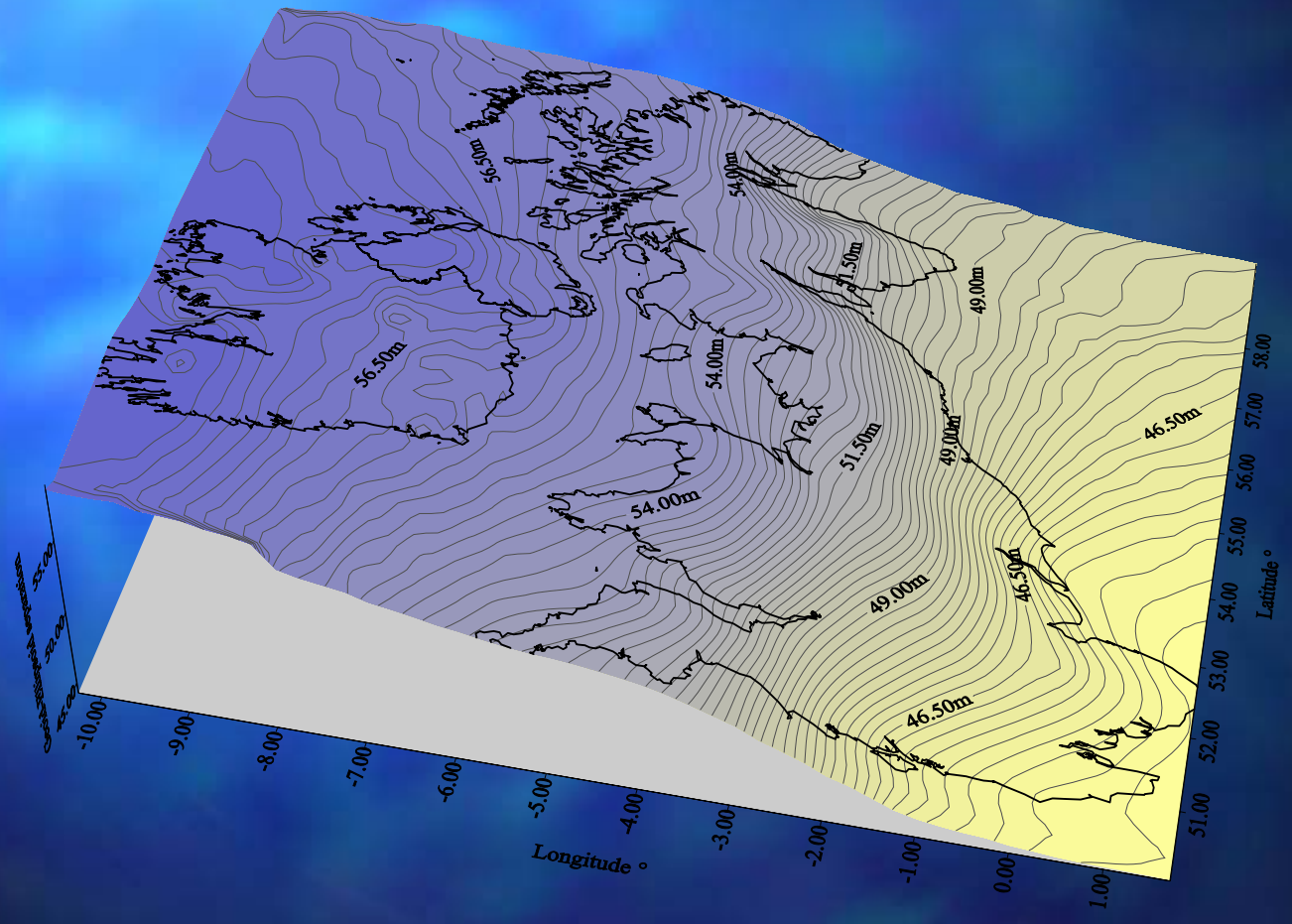
Technologies applied: OSGM05 – the latest UK gravity field model



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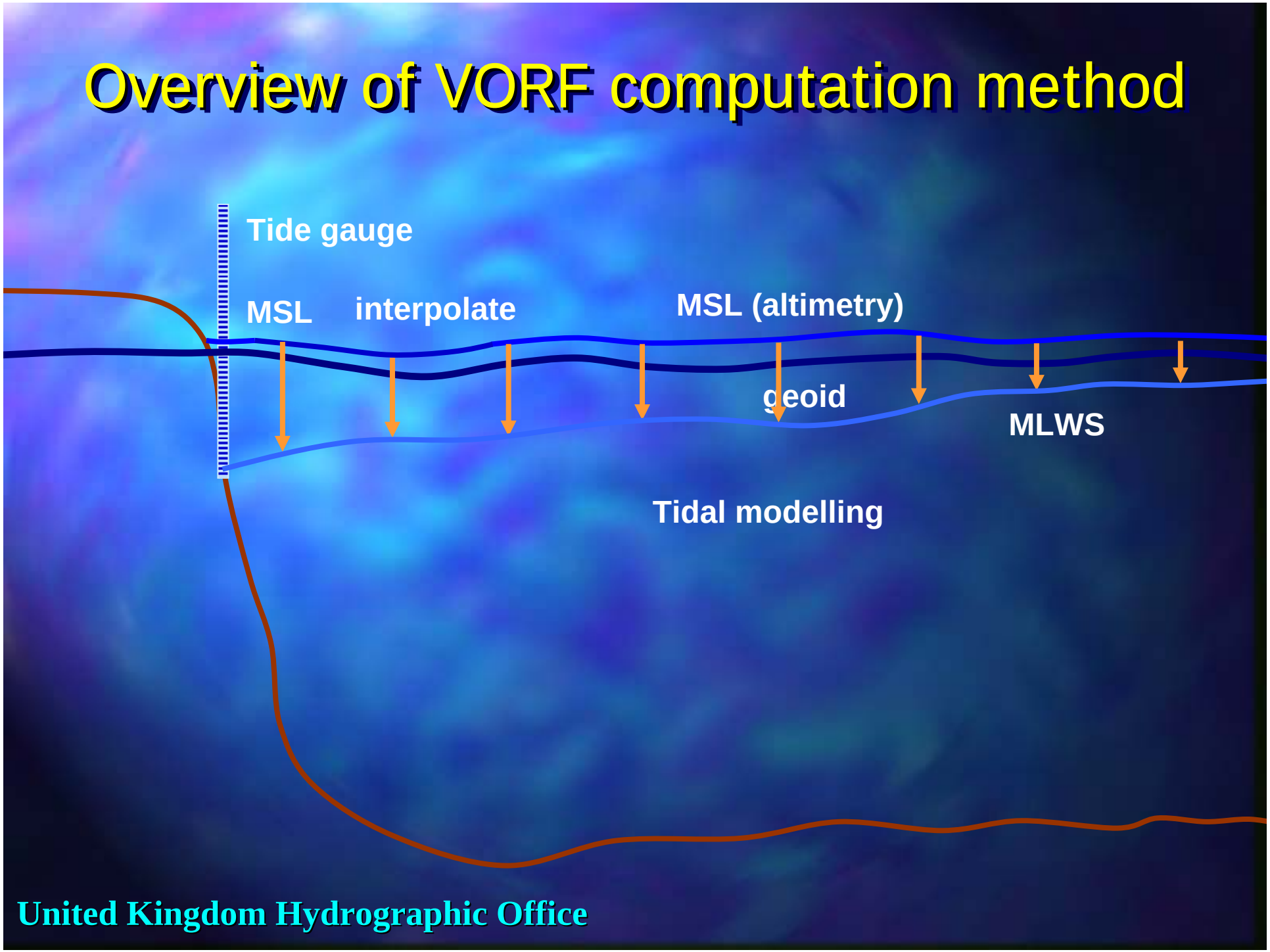
Overview of VORF computation method



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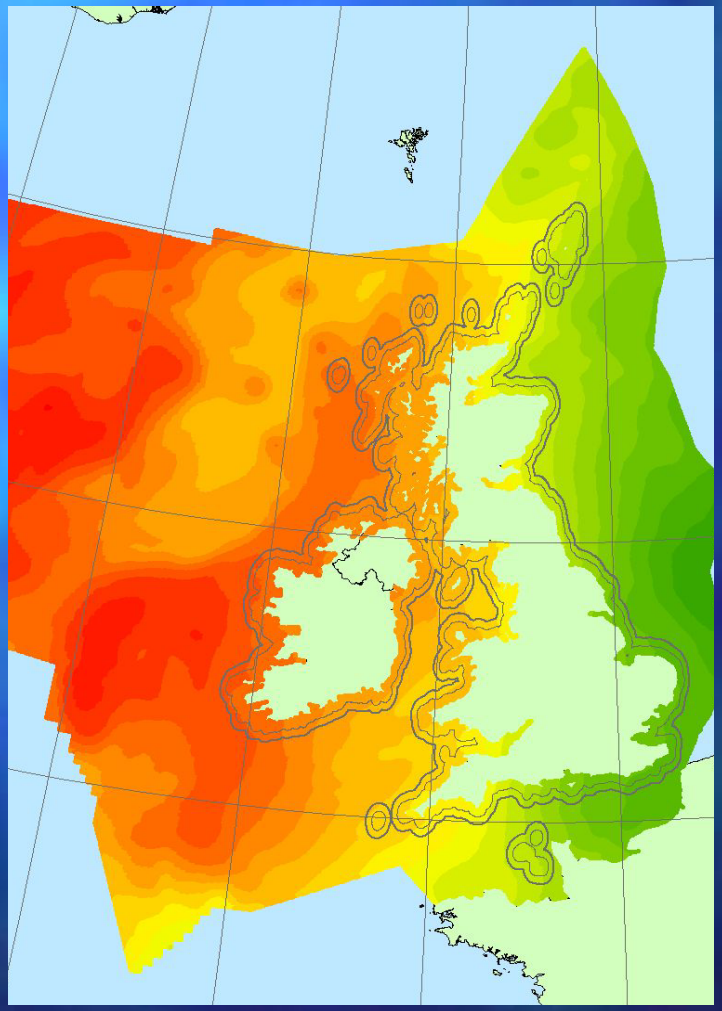
Boundaries of VORF Model
UK Continental Shelf



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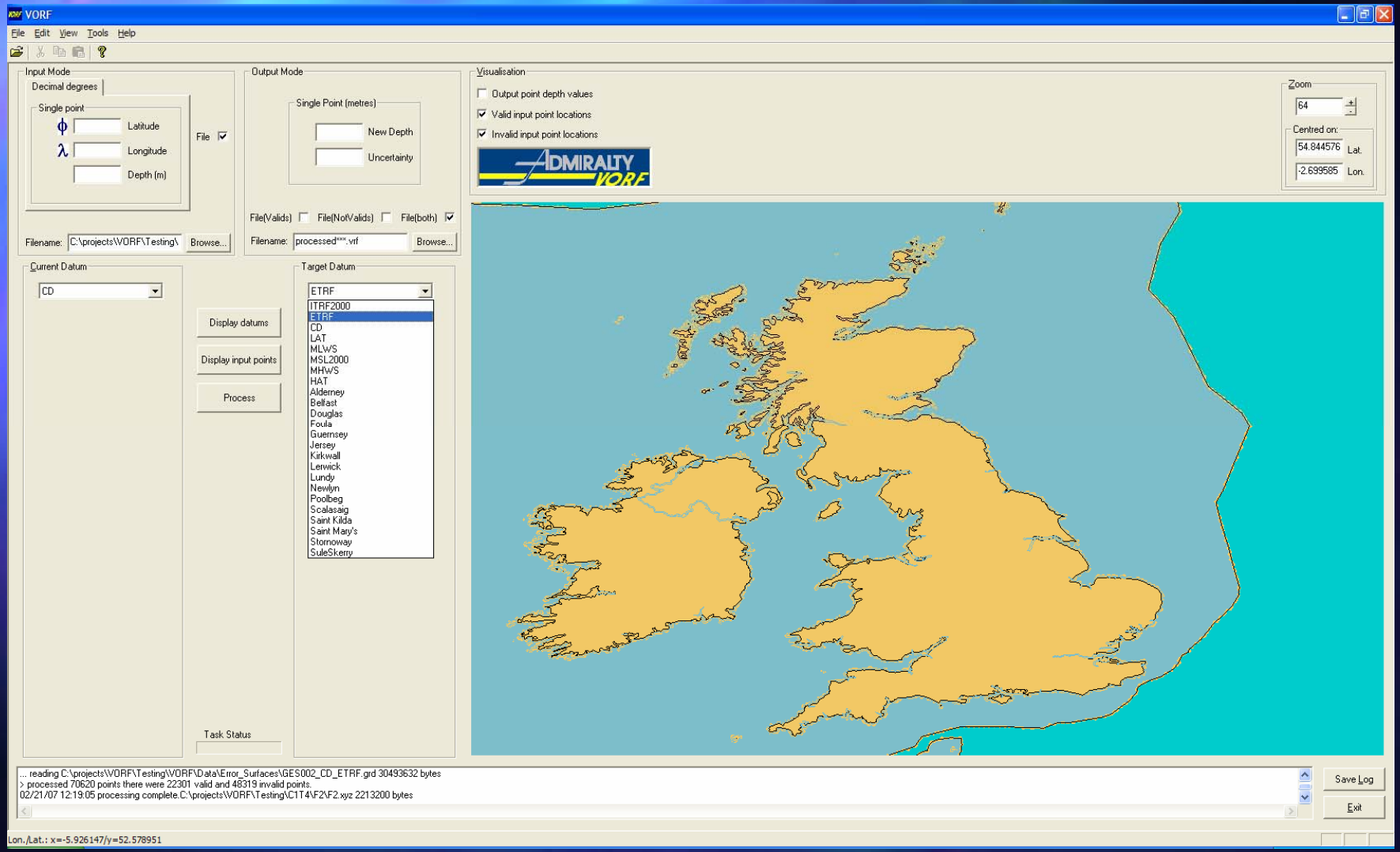
VORF software functionality

- Transformation between datums
- Estimated error in transformations
- Visualisation
- User error detection
- Point/file mode data import
- Deals with complexity of searching for special cases such as rivers and impounded datums.
- High speed data retrieval and processing.

VORF Application



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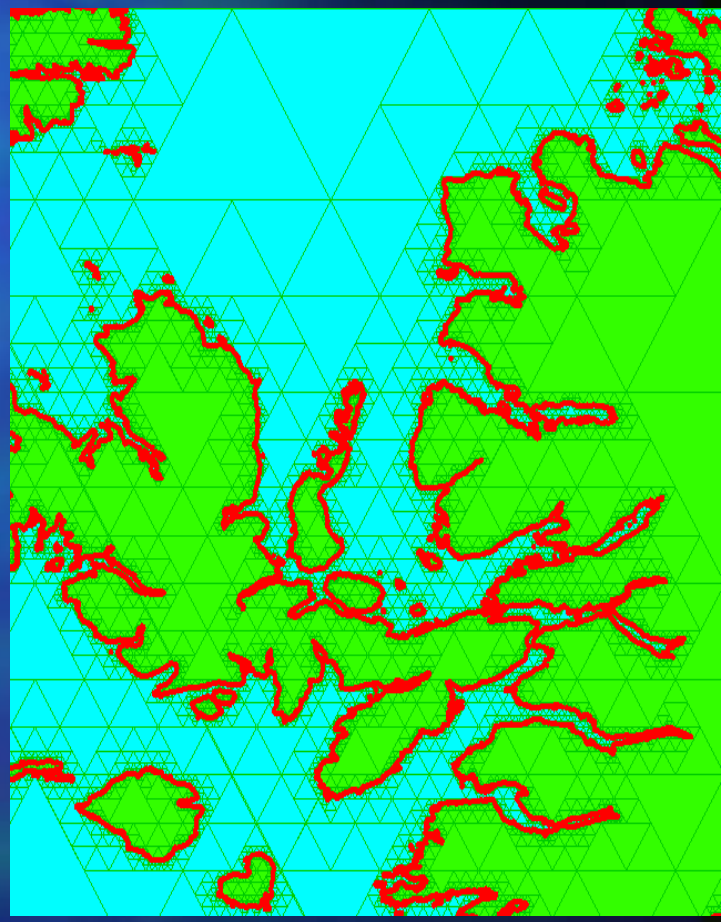
Ultra Rapid Point in Polygon (PiP) Benchmark Tests

- 400,000 line segment polygon set
- Conventional desktop PC (1 Gb RAM, 3 GHz processor)
- 8,000,000 queries carried out correctly in 16 seconds (including file reading)
- University College London (UCL) has developed new concepts in high performance PiP tests
- Technique based on quadtree subdivision of analysis space



Project status

- Demonstrator model delivered to UKHO in December 2006.
- Currently being evaluated.
- Meets the specification (10 – 15 cm 1σ) across ~80% of inshore area and ~100% of offshore areas.
- Programme of improvements to the datum surfaces proposed (due for completion end 2007).

Why is VORF needed?

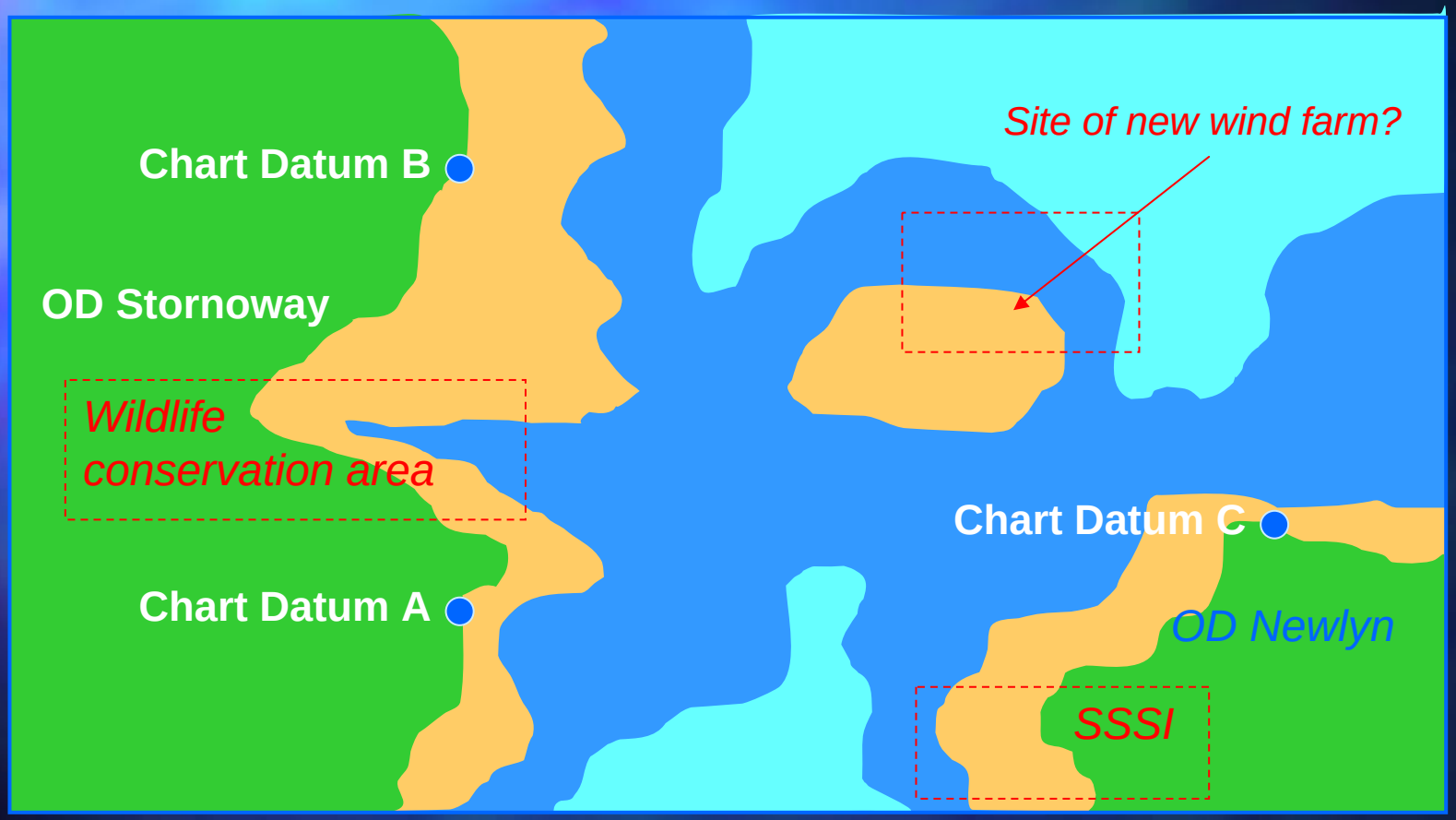
- Continuing developments in GPS
- LIDAR and multibeam technology
- Analogy with the Ordnance Survey heighting reference systems on land
- To deal with the increased use of GPS-based hydrographic surveys submitted to UKHO

How can VORF benefit the UKHO?

- Cost and efficiency of surveys
- Quality control
- Enabling new technologies
- Developing new products

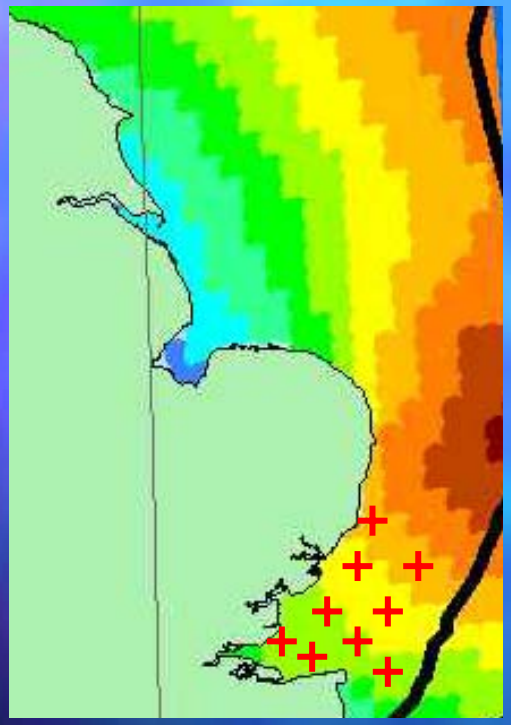
Additional uses of VORF.....

GIS applications – coastal zone projects



VORF enhances the usability of UKHO data

Specialist applications

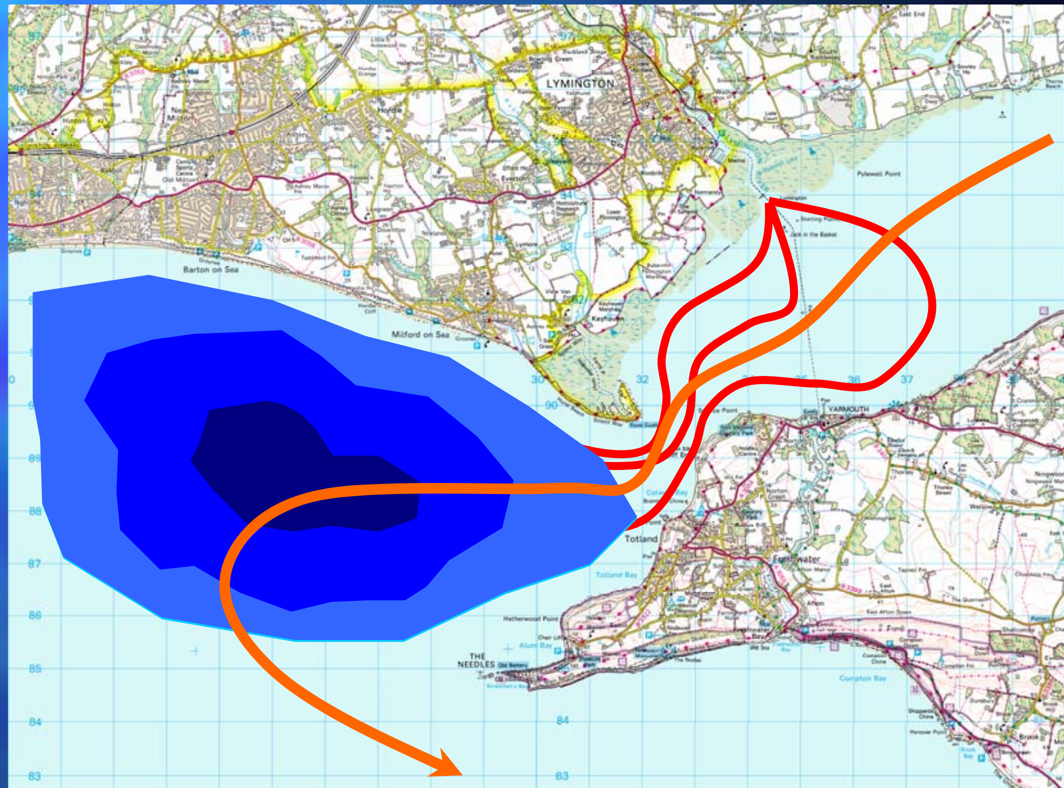


Tidal predictions at “virtual tide stations” – accessible via satellite web link.

Ship equipped with VORF and GPS is its own tide gauge – compare observed reading to prediction, plot enhanced route / timing for approach to critical areas.

Optimising the marine navigation space

- Greater accuracy in under keel clearance (extra 1dm of clearance yields £10k of cargo)
- More choices for route finding
- Rapidly produce charts in different tidal regimes



Summary of VORF advantages

- VORF derives continuous surfaces, with fixed reference to ETRF89.
- It provides a consistent interpolation between Chart Datums, and methodology for extrapolation offshore.
- It eliminates some of the reliance on remote or expensive tidal observations.
- It has the potential to be built in to real-time applications.
- It fully exploits current and future GPS technology, and is the basis for future accuracy enhancements.

Summary of VORF applications

- Simplified data acquisition – more data for the same price, or same data cheaper.
- More precise navigation – all bathymetric data plus specific hazards to navigation are brought into the same coordinate system as vessel.
- Simplification of bathymetric data sets and integration with other data sources – increased pool of users.

Conclusions

- VORF is an enabling technology
- Surveying without tide gauges – cheaper, faster, more accurate
- New navigation and space management concepts
- Fully integrated data products
- SOLAS – improved navigation in critical areas
- VORF will help UKHO in its development of marine charting and navigation products

Read More.....

- University College London (UCL) website:

http://www.ucl.ac.uk/ge/research/gps_geodesy_navigation/VORF

- Hydro-International website:

http://www.hydro-international.com/issues/articles/id696-Joining_Up_Land_and_Sea.html

- Hydrographic Journal No. 125 July 2007