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

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Bathymetric data processing with VORF and GPS

Tidal correction = $h_\varepsilon - \text{VORF LAT}$

Charted depth = Depth measurement – tidal correction

Charted depth accessible everywhere via GPS

GRS80 Ellipsoid
VORF surfaces:

- HAT
- MHWS
- MSL2000
- MLWS
- LAT
- Chart Datum

OD (Newlyn)

(OD other)

GRS80 Ellipsoid

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

Existing survey expressed in CD
New data set in MLWS
Sea floor

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Brief overview of the technical development of VORF
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
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).

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Technologies applied: Satellite Altimetry

Ground Tracks

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Technologies applied: OSGM05 – the latest UK gravity field model
Overview of VORF computation method

- Tide gauge
- MSL
- Interpolate
- MSL (altimetry)
- Geoid
- MLWS
- Tidal modelling

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Boundaries of VORF Model
UK Continental Shelf
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
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

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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
- LI DAR 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

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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 choice of route finding

Rapidly produce charts in different tidal regimes

Greater accuracy in under keel clearance (extra 1cm of clearance yields £10k of cargo)
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.hydrointernational.com/issues/articles/id696-Joining_Up_Land_and_Sea.html

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