Using tidal and vertical datum corrections when comparing tag dive depths to local bathymetric data (or how we stopped our seals from burrowing)

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Why apply corrections when comparing dive depths with bathymetric data?

Tags infer their current depth below the surface of the water by measuring pressure.

Values in many bathymetric datasets are given relative to Lowest Astronomical Tide (LAT) or Chart Datum (CD) rather than Mean Sea Level (MSL).

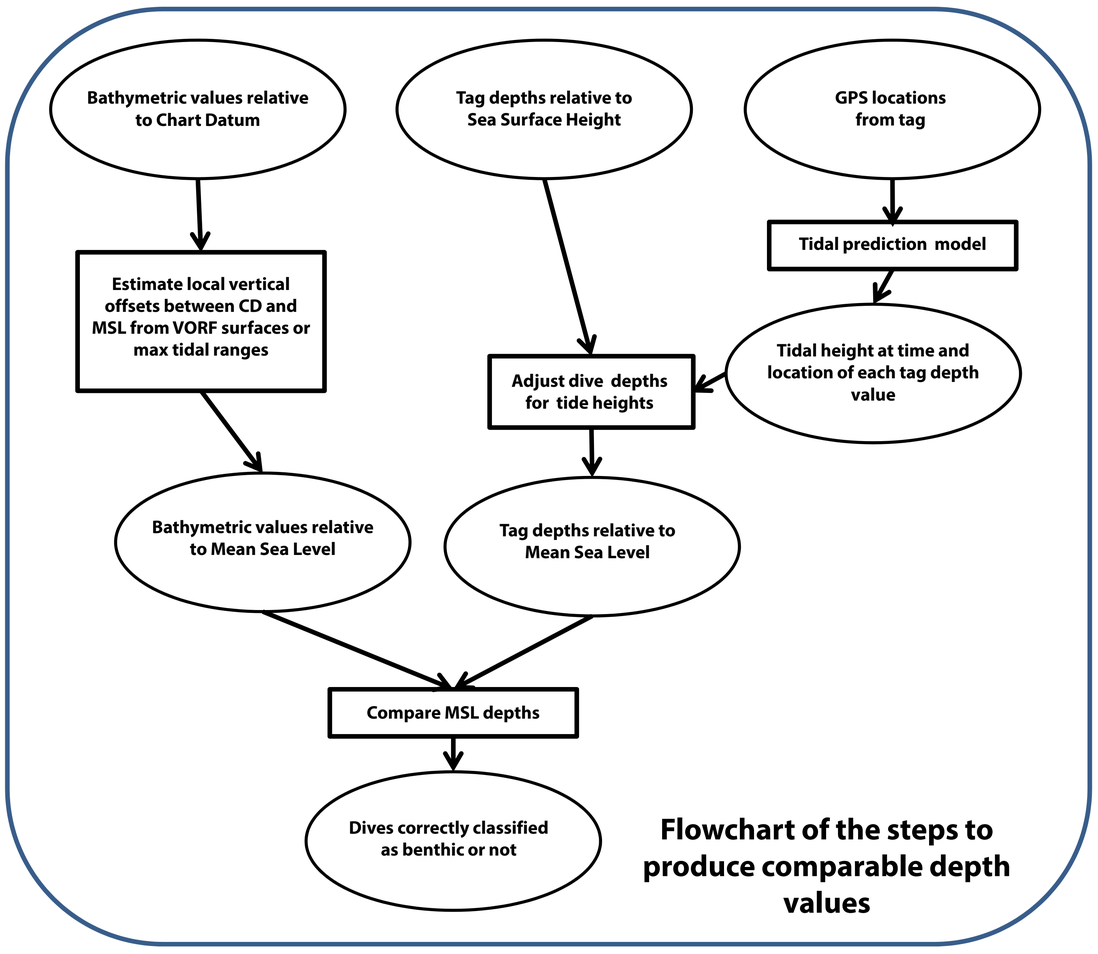
Actual water depths also change during the tidal cycle.

Around the UK many tidal ranges exceed 5m so Chart Datum depths can be > 2.5m shallower than MSL depths.

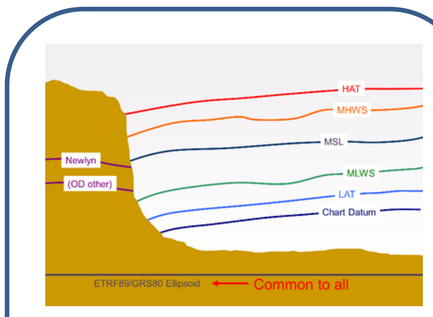
Hence at high tide benthic dives in areas shallower than 50m may appear to be >10% deeper than chart depths.

If a tidal predication model is available and the offset between the vertical datums known then a vertical correction can be potentially be estimated for each dive.

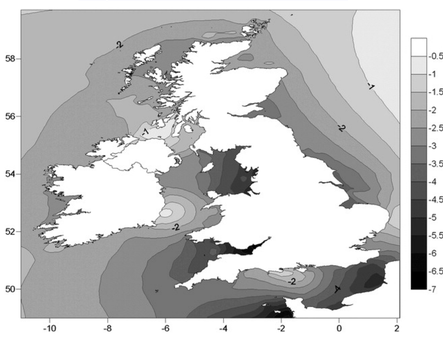
Applying such adjustments should thus allow for better comparisons between tag depths and bathymetric data.



Flowchart of the steps to produce comparable depth values



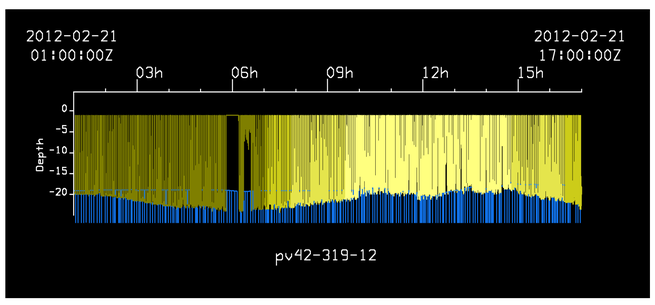
VORF Surfaces from http://www.ucl.ac.uk/vorf/surf

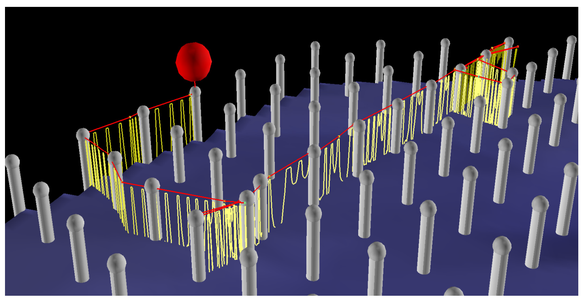


"Surface model of LAT for the U.K.–Irish waters with respect to mean sea level (m)" from Turner, et al 2010

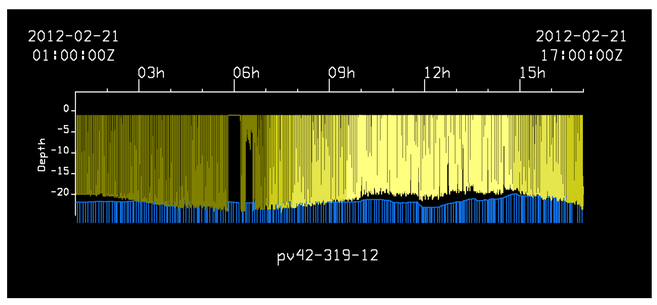
Visual representations of the offsets between the different vertical datums

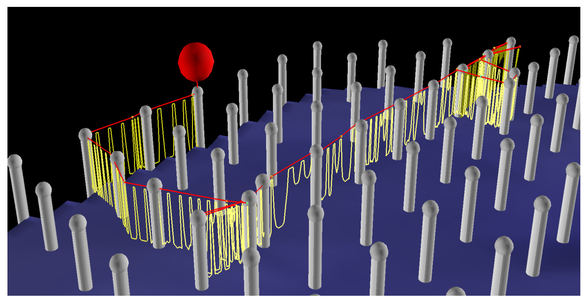
A visual example of the benefits of this approach using data from a visit to Sheringham Shoal Windfarm by harbour seal with a GPS-GSM tag



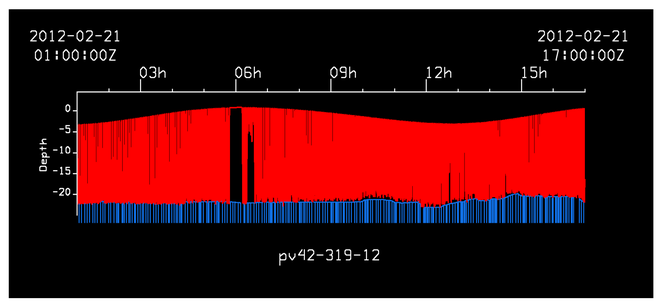


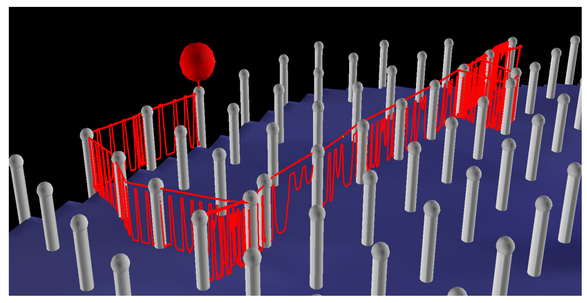
Original uncorrected dive profiles from GPS tags and bathymetric depths relative to Chart Datum. The bottoms of many of the dives appear to be several metres below the sea floor.





Uncorrected profiles from GPS tags but bathymetry corrected to Mean Sea Level using a datum adjustment of 2.75m (estimated from the VORF surface map). Dives and seafloor are a closer match but some now shallower and others still deeper





Dive profiles from GPS tags corrected to Mean Sea Level using tide heights as predicted by POLPRED and MSL bathymetry. Bottom of benthic dives now in much closer agreement with bathymetric depths.

Data & software used in the example

Tag dataset is from a SMRU study which used GPS-GSM tags to examine the potential effects of new wind farms off the east coast of England. (Russell et al 2014)

Harbour seal with SMRU GPS-GSM tag.

The gridded bathymetric data was generated from a set of Chart Datum depths for each of the installations in the Sheringham Shoal wind farm.

The tidal prediction model used was POLPRED.

Visualisations were produced using MamVisAD.

Conclusions

Bathymetric values relative to Mean Sea Level are most suitable for comparison with tag depths measured relative to the surface.

If the only available bathymetries give Chart Datum or Lowest Astronomical Tide values these can sometimes be adjusted to MSL using tidal range data or VORF surfaces.

If the location data is of GPS quality and an offshore tide prediction model is available then it can be feasible to also allow for changes in the water depth due to tides.

In such cases benthic dives may then be identified with increased confidence from such datasets.

References

Russell, D. J. F., Brasseur, S., Thompson, D., Hastie, G. D., Janik, V. M., Aarts, G., McClintock, B. T., Matthiopoulos, J., Moss, S. & McConnell, B. J. 21 Jul 2014: Marine mammals trace anthropogenic structures at sea. *Current Biology*. 24, 14, p. R638-R639. DOI: 10.1016/j.cub.2014.06.033

J. F. Turner, J. C. Iliffe, M. K. Ziebart, C. Wilson, and K. J. Horsburgh, 2010: Interpolation of Tidal Levels in the Coastal Zone for the Creation of a Hydrographic Datum. *J. Atmos. Oceanic Technol.*, 27, 605–613. DOI: 10.1175/2009jtecho645.1

MamVisAD website:
http://www.smru.st-andrews.ac.uk/MamVisAD

POLPRED tidal prediction model, NERC, UK:
http://noc.ac.uk/using-science/products/software/polpred/polpred

Scira Offshore Energy Sheringham Shoal website:
http://www.scira.co.uk/

Vertical Offshore Reference Frames (VORF) webpages at UCL:
http://www.ucl.ac.uk/vorf/

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