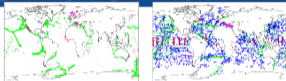


# Multidecadal oceanographic quality control and analyses

## Bruce Ingleby and Matt Huddleston



### Observations



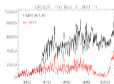
Sub-surface observations available in January 1950 (left) and December 2004 (right).  
Green – Bathy, Purple – Stations/CTD, Red – Buoy, Blue – Argo

#### Data sources:

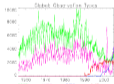
- WCOD1
- DTSP
- WOCE
- Upptran (PUEL)
- SMRD/CSIRO
- 1955-2004: 7.4 million profiles

#### Processing applied:

- Thin vertically (to 150 levels)
- Correction for XBT fall rates
- Track check
- Duplicate check
- Constant value, spike and stability checks
- Background and lumpy checks (Bayesian theory)
- Final vertical consistency check



Numbers of profiles available per month (excluding duplicates). Left – numbers of temperature and salinity reports more than 200 m deep. Right – numbers by observation type. There was a change from Mechanical to expendable Bathy-Thermographs in the mid/late 1990s. Most MBTs were slightly less than 200 m deep. The dip in numbers in the late 1990s may be partly due to research data not generally available yet. Since 2000 note the increasing reliance on Argo data for global coverage.



- 49 years of subsurface temperature and salinity data have been collated, processed and quality controlled
- The data are available at [www.hadobs.com](http://www.hadobs.com) (free of charge for research)

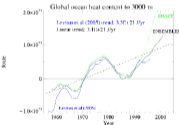
### Analyses

The observation processing was originally performed for the EU-supported ENACT project, which worked on improved methods of data assimilation (3D-Var and Ensemble Kalman Filter) and seasonal forecasting. ENSEMBLES is a broader EU program further developing earth systems models and producing estimates of uncertainty in future climate.

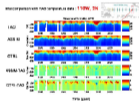
The graph on the right shows global averaged temperature anomalies over the top 200 metres of the ocean from the different ENACT analyses. Generally the analyses show good agreement for temperature, but much less consistency for salinity.

The plot below right shows cross-sections along the equator for the INGV (Italian) analysis and a comparison with in situ FAO buoys.

Some of the ENACT analyses are available on-line at [http://www.ecmwf.int/research/EU\\_projects/ENACT/index.html](http://www.ecmwf.int/research/EU_projects/ENACT/index.html). The ENACT final report (Dewey, 2005) is also available there.



Estimates of global ocean heat content (0-2000 m) from the ENACT and ENSEMBLES objective analyses, also Levitus et al (2000) for comparison. Five year running means. From about 1995 the ENACT estimates are too high because of an error in correcting XBT fall-rates. The objective analyses do not use a k-epsilon model (they relax towards climatology in data voids), they are documented in Ingleby and Huddleston (2005).



#### References

- Dewey, M. ed. 2005: ENACT final report [http://www.ecmwf.int/research/EU\\_projects/ENACT/index.html](http://www.ecmwf.int/research/EU_projects/ENACT/index.html)
- Ingleby, B. and Huddleston, M.: 2005: Quality control of ocean profiles – historical and real time data. To appear in *Journal of Marine Systems*. Available via [www.hadobs.com](http://www.hadobs.com)
- Levitus, S., Antonov, J., and Boyer, T.: 2000: Warming of the world ocean, 1955-2000. *Geophysical Research Letters*, 27