The IQuOD initiative
International Quality-Controlled Ocean Database

Fischer et al. Oceanobs’09: “The critical importance of comprehensive, integrated long-term observations was identified repeatedly.”

Current international partners: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Japan, Mexico, Norway, Russia, Spain, South Africa, UK, USA.
Ocean’s role in Earth climate variability and change

**Societal drive:** How climate is changing (obs.) and how it will change (predictions)? Regional impacts (socio-economic-environmental)?

- Understanding climate variability and change (Earth’s energy balance, water cycle and sea level) is the most challenging application of subsurface ocean temperature and salinity observations (so-called EOV or ECV).

- It demands the highest data quality, completeness and consistency.

- To put modern changes in the context of past changes (e.g., mean and extremes), and to separate the influence of anthropogenic drivers from natural climate modes of variability (e.g., ENSO, NAO, IOD, SAM, PDO, AMO, etc).

- To evaluate/constrain, initialize, or being assimilated in numerical models to investigate physical mechanisms and causes of past/current changes, and to predict/project future changes.

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**Earth’s total heat content**

Rhein et al. (AR5 2013)
Today's big challenge: ‘Climate quality’ global database

- Significant contributions from various independent efforts in terms of assembling, rescuing and QCing historical ocean temperature profiles.

- But still... global database contains a relatively large fraction of biased, duplicated and substandard quality (e.g., lack of original and full-resolution) data and metadata that can confound climate-related research & applications.

Need for timely/effective action: a globally-coordinated approach.

Global database: Millions of temperature profiles ($$ Tens of billions dollars)

- Historical obs. system not purposely designed for climate change monitoring
- Mix of instruments/evolving technology (various accuracies & biases)
What is IQuOD about?

An internationally-coordinated approach to maximize the quality, consistency and completeness of a long-term and irreplaceable subsurface ocean temperature archive (tens of millions of temperature profiles/worth tens of billions of dollars) for a wider range of Earth system, climate & oceanographic applications of societal benefit.

Although internationally-coordinated efforts exist for the ocean surface and atmosphere-ocean observations, no similar effort has been undertaken for the historical subsurface ocean observations to this date.

How:

Development/implementation of an internationally-agreed framework

By pooling expertise and resources into a single best practice community effort:

• expect best outcome over the shortest timeframe
• avoid duplication of human and infrastructure resources (particularly welcome in times of budget cuts)
Mission statement

IQuOD aims to produce, freely distribute and curate the highest quality, most complete and consistent global subsurface ocean temperature profile database possible.

IQuOD will include *intelligent* metadata and assign an estimated uncertainty to each individual observation.
Why focus on subsurface temperature?

Measurements vs. Depth WOD13

- **Green** – Temperature
- **Red** – Salinity
- **Yellow** – Silicate
- **Pink** - Chlorophyll

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<tr>
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Courtesy of Tim Boyer, IQuOD 2nd Workshop, June 2014
Who?

International collaboration/cooperation is the key to success

- QC experts (automated/manual)
- Data management experts
- Historical/modern *in situ* instrumentation experts
- Regional oceanography experts
- Program managers
- Ocean Reanalyses experts (users)
- Climate model experts (users)

Current partners/expertise/levels of involvement
Argentina, Australia, Brazil, Canada, China, France, Germany, India, Japan, Mexico, Norway, Russia, Spain, South Africa, UK, USA.
How will IQuOD work?

**Co-Chairs:** Catia Domingues, Rebecca Cowley

**Steering committee**
Tim Boyer, Ann Thresher, Simon Good, Matt Palmer, Susan Wijffels, Gustavo Goni, Janet Sprintall, Alison Macdonald, Toru Suzuki, Steve Diggs, Viktor Gouretski

- **Task Team 1**
  - **GDAC**
    - (Tim Boyer)

- **Task Team 2**
  - **Auto QC**
    - (Bec Cowley)

- **Task Team 3**
  - **Manual QC**
    - (Ann Thresher)

- **Task Team 4**
  - **Uncertainties/Formats**
    - (Simon Good)

- **Task Team 5**
  - **Aggregation**
    - (Catia Domingues)
What makes IQuOD unique?

- Dataset
  - Automated QC
  - Manual/Visual QC (~40% of data)
  - Software, training
  - IQuOD dataset available (version control)

$\text{ci*zen science?}$
Expected outcomes: some examples

• **Development/implementation of international standard practices for automated/manual quality control of historical (and modern) temperature data.**
  This involves agreement on best practices; open-source software development/documentation/deployment; personnel training (capacity building); application of quality control procedures/audits.

• **Free and easy access to historical data (raw and interpolated products), (intelligent) metadata and uncertainties.**

• **Numerous downstream applications of the IQUOD dataset for Earth system/climate-related research and services of great societal benefit,** including future CLIVAR (e.g., *Ocean Climate Indicators; Research Foci Initiatives*) and WCRP (*Grand Challenge on Sea Level Rise and Regional Impacts*) priority-related activities.

• **Template for future efforts:** great community interest in improving the quality, consistency and completeness of the historical salinity observations and other ocean variables.
Summary

Inaugural IQuOD workshop  (30-40 people)
(Hobart, 12-14 June 2013)

• Overview talks
• Discussions
• Breakout groups

Ocean Sciences town hall meeting  (50 people)
(Honolulu, February 2014)

• Lunchtime presentation and discussion
General recommendations & developments

- Establishment of 4 task teams
  - Automated QC (Bec Cowley) => benchmarking tests; prioritize data types
  - Manual QC (Ann Thresher)
  - GDAC (Tim Boyer)
  - Aggregation (Catia Domingues)

- Establishment of extra working group: flagging/uncertainties

- Engagement with groups (ad hoc)/specify level of involvement

- Tighter engagement with end users community

- Project strategy: scientific/implementation plan (endorsements)

- Identification funding opportunities & development of applications

- Planning corporate structure/image, website, and (e/i) communication
Thank you
A major problem: missing metadata & original profiles

**Number of known & unknown XBT profiles per year**

**Proportion of unknown XBT profiles (shallow)**

**Figure 2.** Total number of shallow (dark blue) and deep (deep red) XBT profiles per year and the number of these for which the type is unknown (shallow = light blue; deep = orange).

Abraham et al. (2013)
Another major problem: manual QC reveals warm biases

Gronell and Wijffels (2008)

Pilot test: Indian Ocean/SW Pacific

World Ocean: about 1.5 million BAD temperature profiles
Instrumental (time-dependent) biases – MBTs/XBTs

Temperature Offsets between Data Types

Closer scrutiny: Gouretski and Koltermann (2007)

Implications for ocean warming variability and trend

Wijffels et al. (2008)
Domingues et al. (2008)
OHC variability and change: sensitive to small systematic errors

Impact of time-dependent XBT bias corrections

Various XBT corrections proposed

Figure 9. Comparison of correction schemes that cover the main period of XBT use for left panels) LMS T4/T6 probes and (right panels) T7/DBi probes. (top panels) The profile average multiplicative factor to be applied to the XBT depths calculated using the manufacturer FRE. (bottom panels) Temperature offset to be subtracted from the XBT temperature values. Grey lines mark the values that correspond to the manufacturer and Hansen et al. [1995] FREs.

Cowley et al. (2013)
Abraham et al. (2013)