CLIVAR: CLIMATE & OCEAN
variability, predictability and change

WCRP Core Project on the
Ocean-Atmosphere System

WCRP
World Climate Research Programme

New CLIVAR Science

Long term objectives:

- Identify ocean and coupled **climate processes** that are critical for global and regional climate variability and change
- Identify temporal and spatial scales of **climate predictability**
- Quantify constrains on **climate sensitivity**, air-sea exchange and Earth's energy budget / ocean heat content
- Quantify **regional impacts** of climate change in **sea level, cryosphere and water cycle**
- Quantify past/present/future **ocean role in CO_2 uptake** and links between **climate and ocean ecosystems**

New CLIVAR Science Plan will be released in 2017

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Science Plan

Structure

1.1 The WCRP mission

1.2 CLIVAR's role within WCRP

2. SCIENCE GOALS

3. Organizational Structure and Implementation

4. International Coordination as Enabling Capabilities

5. Coordination and Cooperation

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Science Goals

- Determine mechanisms and regional expressions of climate variability and change.
- Understand fundamental physical processes and improve climate models.
- Identify and monitor the ocean's role in climate variability, predictability and change.
- Integrate climate research across disciplinary borders

Ocean Reanalysis Intercomparison Project (ORA-IP)

coordinated effort between CLIVAR/GSOP & GODAE OceanView with interaction with OMDP

Goal:

- To evaluate the consistency among and strength/weakness of different ocean synthesis products
- To explore merit of ensemble ocean synthesis products
- To assess observational impacts

Examples of recent progress/applications:

- Initializations of S-I & decadal forecasts.
- Near realtime monitoring of ocean state (e.g., NOAA's monthly Ocean Briefings).
- Improvement of data assimilation methods & practices.
- Utility of related tools for OSE & OSSE (e.g., TPOS2020)
- Ocean heat content & sea level changes (related to WCRP Grand Challenges)

Overview articles: **Balmaseda et al. 2015, J. Oper. Oceanogr.** + several articles in the same issue; **Fujii et al. 2015, QJRM.**

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COST/CLIVAR Workshop on ocean reanalyses and inter-comparisons

29-30 June 2017
Toulouse, France

Registration on CLIVAR web

Objectives

- Review the main outcomes of ORA-IP;
- Understand the advances in the ocean reanalysis community in terms of upgrades of individual reanalysis systems;
- Identify recommendations and good practices for the reanalysis production (e.g. spin-up, forcing, observations);
- Establish a protocol for the next inter-comparison exercise, and identify metrics;
- Envisage a strategy for linking ORA-IP with other inter-comparisons;
- Discuss strategies for the near real-time extension of the current reanalyses;
- Prepare input for the International Conference on Reanalysis (ICR5)

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CLIVAR research focus

Consistency between planetary energy balance and ocean heat storage (CONCEPT-HEAT)

Co-chairs:

K. von Schuckmann, K. Trenberth

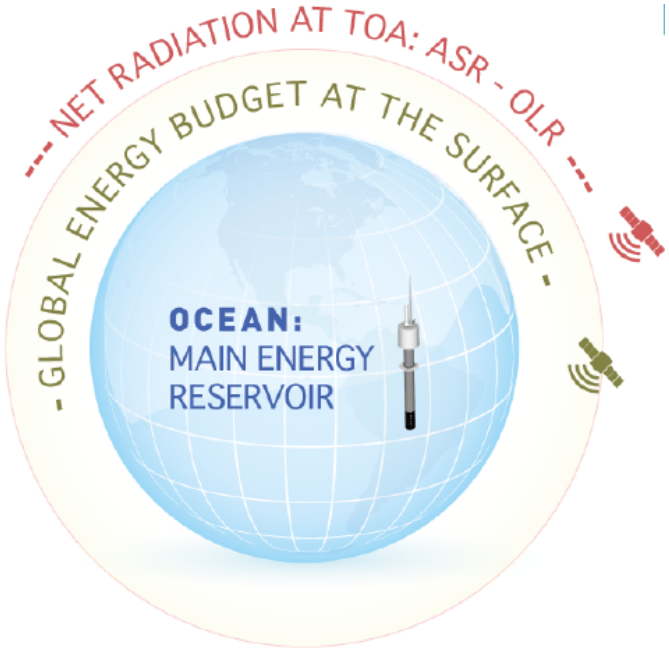
Scientific steering team members:

C.-A. Clayson; C. Domingues; S. Gulev; K. Haines; N. Loeb; M. Palmer; P.-P. Mathieu; R. Weller; M. Wild; Y. Xue

CLIVAR research focus CONCEPT-HEAT:

Consistency between planetary energy balance and ocean heat storage

An overall goal is to **bring together different climate research communities** all concerned with the energy flows in the Earth's System to advance on the **understanding of the uncertainties through budget constraints**:



- **Atmospheric radiation**
- **Ocean Heat Content**
- **Earth's surface fluxes**
- **Climate variability and change**
- **Data assimilation & operational services (R&D)**
- **Climate projection**
- **Global sea level**

Remote sensing	In situ	Reanalysis systems	Models

CLIVAR CONCEPT-HEAT: Development

First CONCEPT-HEAT workshop, Met Office, Exeter (29.09.-01.10.2015)

EEI

most fundamental measure for climate change

FINDINGS

Estimate EEI locally and as a function of time

The estimation of OHC plays a key role for climate science

Studies of energy flows in climate modes

Concept of Cages:
- TOA flux and atmos. energy transport divergence;
- ocean transport divergence & changes in OHC;
- directly computing air-sea fluxes.

- Improved ocean observation system
- Improve OHC estimate capability

- Vertical disposition of heat in the oceans
- Horizontal redistribution of heat in the oceans

- Development of recommendation letters from CONCEPT-HEAT to different research and operational instituions and structurations
- Webpage, summer school, conference session, …

Proposed development of a new group project for CONCEPT-HEAT

- Estimating the net surface flux as a residual of the top-of-atmosphere (TOA) radiative fluxes (from CERES) combined with comprehensive estimates of the vertically integrated atmospheric divergence of energy (from ERA-interim reanalyses).

- The goal is to focus first on the Atlantic (e.g. North Atlantic) in the form of a Cage experiment, i.e. an analysis of regional heat and mass budget closure.

- Another priority which has been mentioned is the analysis of ocean meridional heat transport (MHT) and its variability. For this analysis alternative estimates of MHT revealed by ocean reanalyses will be critically important.

- The key point for C-H is that this approach can be used for all the surface flux datasets combined with any or all OHC datasets, and it provides a metric of comparison and evaluation. Surface fluxes are prominent issues for both C-H and GSOP, and the framework proposed here is the basis for an intercomparison project.

International Quality-Controlled Ocean Database

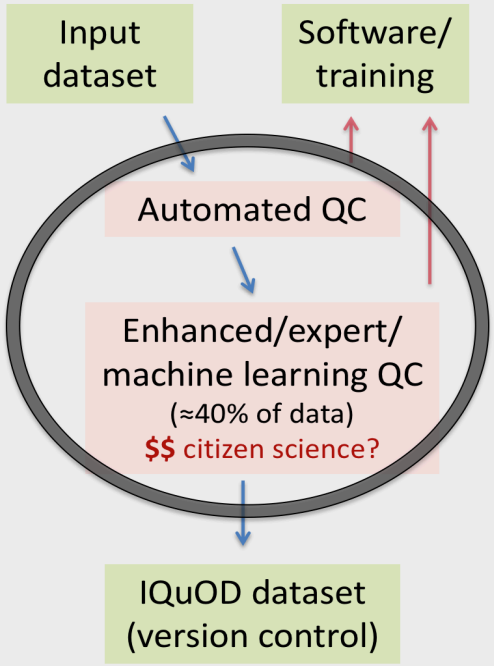
IQuOD

To **maximize the quality, consistency and completeness** of the long-term global subsurface ocean temperature database (EOV/ECV).

subsurface profiles| (intelligent) metadata | uncertainty

Task Team 1 **GDAC** (Tim Boyer)	Task Team 3 **Uncertainty** (Bec Cowley, John Gould)	Task Team 5 **Auto QC** (Simon Good, Bill Mills, Gui Castelao)
Task Team 2 **Formats** (Marty Hidas, Christine Coatanoan)	Task Team 4 **Intelligent Metadata** (Matt Palmer, Shoichi Kizu, Toru Suzuki)	Task Team 6 **Duplicates/ Machine Learning/ Expert QC** (Ann Thresher, Ed King, Gui Castelao)

Workflow



CLIVAR GSOP

International Council for Science SCOR Scientific Committee on Oceanic Research WG 148

IODE International Oceanographic Data and Information Exchange SG-IQuOD

www.iquod.org

2016/2017: IQuOD v0.1 (first interim product)

- ✓ **Duplicates**: exact duplicates flagged
- ✓ **I-metadata**: "first cut" algorithms for unknown XBTs, building on from Cowley et al. (2013) and recoded into open-source Python (Palmer et al. draft in preparation)
- ✓ **Uncertainty**: "first cut" random error attached to each discrete observation (Cowley et al. draft in preparation)
- ✓ **Format**: ASCII and netCDF ragged array (CF compliant)
- • **GDAC**: distribution via US NCEI and potentially UK MetOffice, French Coriolis, and Australian IMOS (currently under under verification phase at NCEI for format and data presentation)

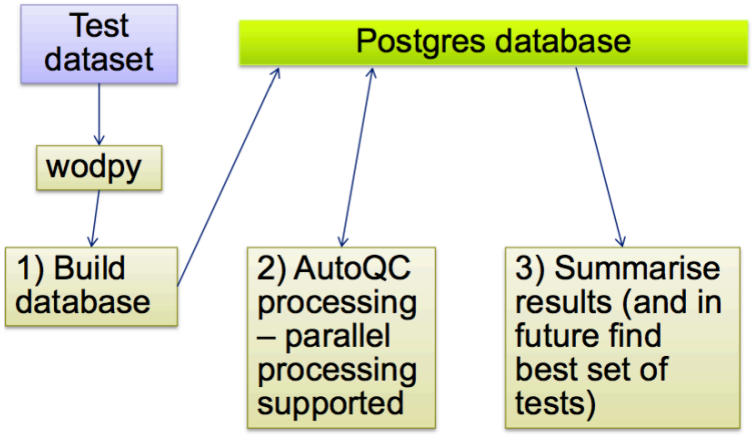
Expected IQuOD v0.1 release: 2017 (SCOR/IAPSO meeting? AGU Fall meeting?)

2016/2017: Auto QC progress

50 QC tests implemented

Argo_global_range_check	CoTeDe_location_at_sea_test
Argo_gradient_test	CoTeDe_rate_of_change
Argo_impossible_date_test	CoTeDe_spike
Argo_impossible_location_test	CoTeDe_tukey53H_norm
Argo_pressure_increasing_test	EN_background_available_check
Argo_regional_range_test	EN_background_check
Argo_spike_test	EN_constant_value_check
CSIRO_constant_bottom	EN_increasing_depth_check
CSIRO_depth	EN_range_check
CSIRO_long_gradient	EN_spike_and_step_check
CSIRO_short_gradient	EN_spike_and_step_suspect
CSIRO_surface_spikes	EN_stability_check
CSIRO_wire_break	EN_std_lev_bkg_and_buddy_check
CoTeDe_Argo_density_inversion	EN_track_check
CoTeDe_GTSPP_WOA_normbias	ICDC_aqc_01_level_order
CoTeDe_GTSPP_global_range	ICDC_aqc_02_crude_range
CoTeDe_GTSPP_gradient	ICDC_aqc_04_max_obs_depth
CoTeDe_GTSPP_profile_envelop	ICDC_aqc_05_stuck_value
CoTeDe_GTSPP_spike_check	ICDC_aqc_06_n_temperature_extrema
CoTeDe_Morello2014	ICDC_aqc_07_spike_check
CoTeDe_WOA_normbias	ICDC_aqc_08_gradient_check
CoTeDe_anomaly_detection	ICDC_aqc_09_local_climatology_check
CoTeDe_digit_roll_over	WOD_gradient_check
CoTeDe_fuzzy_logic	WOD_range_check
CoTeDe_gradient	loose_location_at_sea

The AutoQC processor



Performance metrics

Very unrepresentative sample of bad data!

NAME OF TEST	FAILS	TPR	FPR	TNR	FNR
Argo_global_range_check	1624	63.6%	0.0%	100.0%	36.4%
Argo_gradient_test	2240	87.7%	0.0%	100.0%	12.3%
Argo_impossible_date_test	0	0.0%	0.0%	100.0%	100.0%
Argo_impossible_location_test	0	0.0%	0.0%	100.0%	100.0%
Argo_pressure_increasing_test	0	0.0%	0.0%	100.0%	100.0%
Argo_regional_range_test	12	0.0%	1.1%	98.9%	100.0%
Argo_spike_test	679	26.6%	0.0%	100.0%	73.4%
CSIRO_constant_bottom	25	0.2%	1.7%	98.3%	99.8%
CSIRO_depth	3680	99.8%	100.0%	0.0%	0.2%
CSIRO_long_gradient	2917	97.4%	37.9%	62.1%	2.6%
CSIRO_short_gradient	2405	92.7%	3.2%	96.8%	7.3%
CSIRO_surface_spikes	2923	96.8%	39.8%	60.2%	3.2%
CSIRO_wire_break	2243	87.8%	0.0%	100.0%	12.2%
CoTeDe_Argo_density_inversion	0	0.0%	0.0%	100.0%	100.0%
CoTeDe_GTSPP_WOA_normbias	2447	92.4%	7.7%	92.3%	7.6%
CoTeDe_GTSPP_global_range	1632	63.7%	0.4%	99.6%	36.3%
CoTeDe_GTSPP_gradient	2049	80.2%	0.0%	100.0%	19.8%
CoTeDe_GTSPP_profile_envelop	2300	89.7%	0.6%	99.4%	10.3%
CoTeDe_GTSPP_spike_check	713	27.8%	0.2%	99.8%	72.2%
CoTeDe_Morello2014	2987	97.1%	44.9%	55.1%	2.9%
CoTeDe_WOA_normbias	2224	87.0%	0.2%	99.8%	13.0%
CoTeDe_anomaly_detection	3376	97.8%	77.7%	22.3%	2.2%
CoTeDe_digit_roll_over	2234	87.4%	0.1%	99.9%	12.6%
CoTeDe_fuzzy_logic	2503	95.2%	6.3%	93.7%	4.8%
CoTeDe_gradient	2111	82.6%	0.0%	100.0%	17.4%

- So far, 50 QC tests coded into the AutoQC framework
- AutoQC benchmarking code ready to run
- Initial software development on peformance metrics to find optimum AutoQC set

https://github.com/IQuOD

WodPy	AutoQC
General purpose Python reader for WOD ASCII format data	*Our QC code and benchmarking software*
To install: pip install wodpy	Also available as a docker image: iquod/autoqc

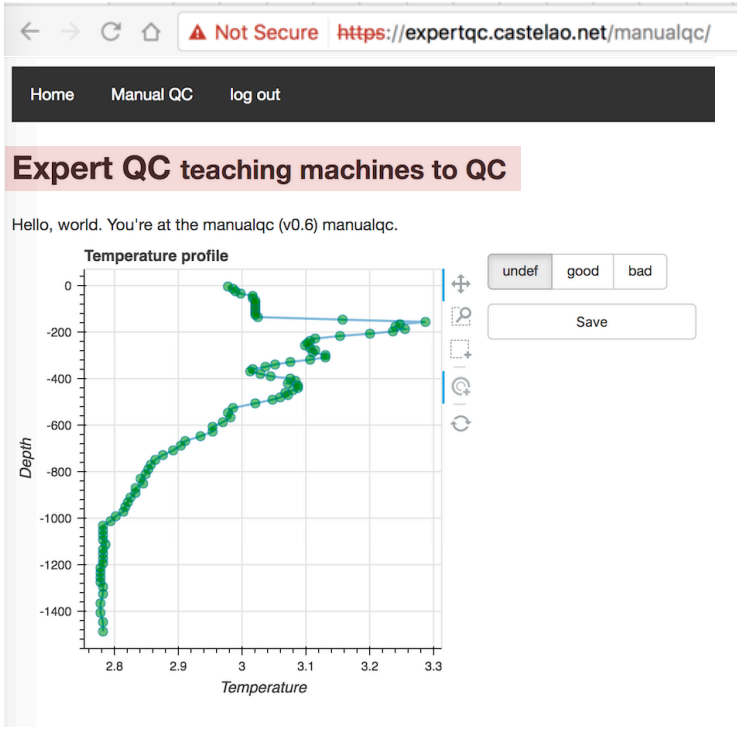
https://github.com/IQuOD

www.iquod.org

2017/18: next IQuOD advances

Incremental steps

- Improvements to first cut **i-metadata** algorithms and **uncertainty** assignments and flagging of exact and near-**duplicates**.



Major steps

- Benchmarking various **AutoQC** procedures using a number of high quality regional reference datasets and identifying the most effective combination of AutoQC checks.

- Exploring and implementing machine learning for **Expert QC**

See 3-year plan for major activities:
http://www.scor-int.org/SCOR_WGs_WG148.htm

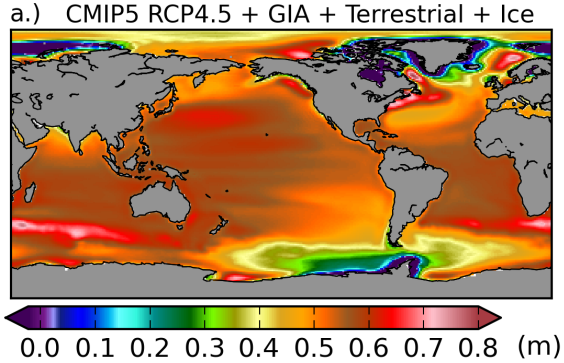
In what IQuOD v0.1 differ from WOD?

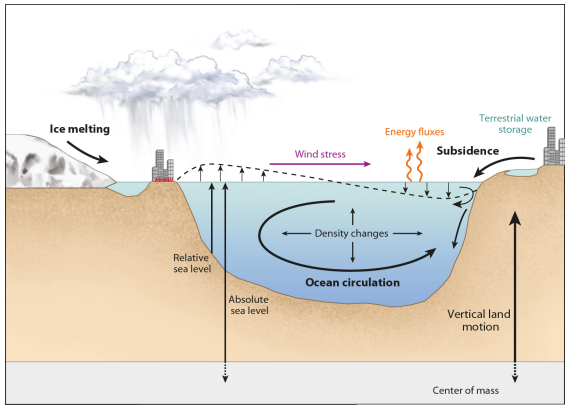
- File identification as IQuOD rather than WOD by global attributes (netCDF files) or by a “Q” (first byte of each cast for ASCII files).
- WOD has a choice for XBT bias corrections, IQuOD v0.1 will only have Cheng et al. (2014) corrections.
- Intelligent metadata for XBT probe type identified based on country, year, depth, etc.
- Replacement of WOD subjective flags by Coriolis objective analysis bullseye flags, or where available expert QC flags.
- Uncertainties set for depth, pressure, position, temperature and occasionally salinity.

REGIONAL IMPACTS
GC Regional Sea Level Change and Coastal Impacts

Five parallel, but interconnected, working groups:

1. **An integrated approach to paleo time scale sea level estimates**
2. **Quantifying the contribution of land ice to near-future sea level rise**
3. **Causes for contemporary regional sea level variability and change**
4. **Predictability of regional sea level**
5. **Sea level science for coastal zone management**





WCRP/IOC International Conference
on Sea Level Change:
Columbia University
New York, City
July. 10 – 15, 2017

http://www.sealevel2017.org

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