Clivar research focus

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

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Scientific steering team members:

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Positive Earth’s Energy Imbalance: accumulation and storage of heat

von Schuckmann at al., 2015, under review
Different approaches determining Earth’s energy imbalance

- Loeb et al., 2012
- Josey et al., 2015

Radiation at TOA

Ocean heat content

Hindcast and climate projection

Surface flux

IPCC, 2013

http://www.ias.ethz.ch
Large uncertainties in our estimates challenge our ability to infer the absolute measure of the Earth Energy Imbalance and its changes over time.

An ongoing accounting of where heat goes and its manifestations is a great need and has implications for interpreting the recent past and immediate future.

Improving the knowledge and observational capability necessary to "track" the energy flows through the climate system is critical to better understand the relationships between climate forcing, response, variability and future changes.
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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
Numerical model
More precisely, this **CLIVAR research focus CONCEPT-HEAT** has the main objective to build up a pluri-disciplinary synergy community for **climate research** aiming to work on two different issues:

1. Quantify Earth’s energy imbalance, the ocean heat budget, and atmosphere-ocean turbulent and radiative heat fluxes, their observational uncertainty, and their variability for a range of time and space scales using different observing strategies (e.g., in-situ ocean, satellite), reanalysis systems, and climate models.

2. Analyze the consistency between the satellite-based planetary heat balance and ocean heat storage estimates, using data sets and information products from global observing systems (remote sensing and in situ) and ocean reanalysis, and compare these results to outputs from climate models to obtain validation requirements (for model and observations).
“What are the expected outcome and who will use the info?”

**Outcome**
- Refinement of the global climate research community
- Enhancement on uncertainty evaluation and assessment of the different components of the climate budgets by assessing already applied methods, developing new methods and inter-comparison initiatives (link to ongoing initiatives, and development of new priorities and initiate their realization)
- Insight into climate research topics, and link to socioeconomic impacts

**Use:**
- Climate research community
- Global observing system programs, institutions, initiatives and operational centers (using recommendations and perspectives for climate research applications)
- Internationally organized scientific initiatives and programs
2012: Presentation of CONCEPT-HEAT (ideas, objectives): CLIVAR SSG meeting

2013: Joint CLIVAR-ESA scientific consultation workshop on: EO Measurement Constraints on OHC

2014-2015: ISSI international working group
Earth’s Energy Imbalance. Currently +0.5 to 1 Wm\(^{-2}\)

The absolute measure of the Earth Energy Imbalance and its changes over time are vital pieces of information related to climate change as this is the single quantity defining the status of global climate change and expectations for continued global warming.

ISSI working group: “Consistency of Integrated Observing Systems monitoring the energy flows in the Earth System”

First meeting June 2014, Bern, Switzerland

K. von Schuckmann
A. Cazenave, D. Chambers,
J. Hansen, S. Josey, Y. Kosaka,
N. Loeb, P.P. Mathieu, B. Meyssignac,
M. Palmer, K. Trenberth, M. Wild

Perspective paper NCC under review
(von Schuckmann et al., 2015)
CLIVAR CONCEPT-HEAT: Development

2012: Presentation of CONCEPT-HEAT (ideas, objectives): CLIVAR SSG meeting

2013: Joint CLIVAR-ESA scientific consultation workshop on: EO Measurement Constraints on OHC

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2014 (July) Pan-CLIVAR: Break-out session: Scientific questions and white paper

2014 (November) Finalization of the CONCEPT-HEAT white paper

2015: Start of implementation phase after CLIVAR SSG 2014 meeting

2015: Establishment of the CONCEPT-HEAT scientific steering team

2015 (Sept./Oct.): 1st joint GSOP/CONCEPT heat meeting 1st CONCEPT HEAT workshop

... future development for the next 3-5 years ...
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Key scientific questions

Question A: What is the magnitude and the uncertainties of our estimates of Earth's energy imbalance (EEI), and how does it vary over time?

Question B: Can consistency between planetary heat balance and ocean heat storage achieved and what are the major limitations?

Question C: How are TOA net radiation and ocean heating rate distributed in space and time?

Question D: How can we improve validation requirements for and from coupled climate models to improve estimates of EEI?

Question E: How can we better constrain the surface energy fluxes and their spatio-temporal variations at regional scale?
Potential main common objectives:

- develop an overview on recommendations for **global climate observing systems and climate tools**
- develop an overview on recommendations for future **coordinated research through dedicated initiatives**, well defined key questions and key challenges for climate research on the Earth’s energy budget
- **Improve accessibility and information content of products** to evaluate the different components of EEI for use by wider community.
- **Continue performance of multi-analysis reanalysis ensemble approach** to study the uncertainties
- Complement the GSOP inventory of surface flux products with “assessment”-type **information**
- Evaluate **OHC changes from the ensemble of current ocean reanalyses** and work with the OHC community to identify and understand differences, coming from different observations such as gap filling, data assimilation
Potential main common objectives:

- To achieve advancements in **commonly agreed data quality control issues and management of data and metadata archeology** (IQuOD)
- Evaluate the **relative importance of the ice-covered ocean, marginal seas and deep ocean** (> 2000m) of ocean heat content change and to understand how heat is transferred vertically, with the objective to develop recommendations for observing system design.
- To increase the exchange between in situ and remote sensing communities for the further cross-validation.
- Cross cutting reanalysis / in situ:
  * Evaluation of OHC structure during hiatus period
  * Develop diagnostics for heat transport estimates