

**PALEo-constraints on SEA-level rise (PALSEA) -
a PAGES/IMAGES working group**

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Duration: 2009 to 2012

Background

We lack a clear understanding of the dynamical response of ice-sheets to anthropogenic climate change. Therefore projections for the reduction in ice sheets and subsequent rise in sea level over the next century are highly uncertain. The paleo record of sea-level change is a potential resource to better constrain estimates of future sea-level rise. Interglacial sea levels constrain the global sensitivity of sea-level to radiative forcing. Well-dated records of relative sea level change during the glacial terminations can help to constrain the time lag between temperature change and the ice-sheet response during periods of ice sheet collapse. The information contained in records of relative sea level can help 'fingerprint' which ice sheets contributed to individual episodes of sea-level rise. This working group will bring together observational scientists and modellers of past ice-sheet change in order to define observational constraints on future sea-level rise and improve our understanding of ice-sheet dynamics during periods of rapid climate change.

Goals/Objectives

What ice-sheet dynamics were responsible for the rapid rises in sea level during the glacial terminations and how might these dynamics change in the future?

- 1) With close reference to paleo relative sea level (RSL) data, modern observations and reconstructions of ice sheets during the termination, we will aim to understand the key dynamical processes which drove the collapse of the major continental ice sheets and how these processes evolve during the glacial termination.
- 2) Using RSL data we will investigate which ice sheets were responsible for specific episodes of eustatic sea-level (ESL) rise and the phasing of these rises in sea level with respect to climate change.
- 3) Using models which incorporate these insights, closely informed by the paleo and modern data we will aim to make projections of ice sheet contributions to sea level rise over the coming century.

Why did sea level vary between interglacial periods in the past?

- 1) We will compile a consistent data set of RSL, with associated uncertainties up to MIS 15
- 2) In collaboration with other IMAGES/PAGES working groups (i.e. PMIP2 and PIGs), we will assess the relationship between RSL, radiative forcing and other climate evidence for past interglacial periods.

3) We will address the question – ‘What factors contributed to the reduction of major ice sheets in the past and what are the analogies for the future?’

Links to PAGES Cross-cutting themes and foci

Focus 1: Climate Forcings– a focus of this working group will be the modelling of ESL as well as SL fingerprinting using RSL data. A further focus is the modelling of ice volume and spatial extent during terminations and during Previous Interglacial Periods and the phasing of sea-level rise with respect to climate forcing.

CCT 1: Chronology – a focus of the working group will be compilation of U/Th dates on corals as well as the development and comparisons of correction techniques for open-system ages. A further area of interest is extending U/Th dating techniques to MIS 15. This will be a significant contribution towards a ‘sea-level master curve’ for this period.

CCT 2: Proxy development, validation and calibration – we will work to develop RSL data as a proxy for determining ESL data and fingerprinting the ice sheets responsible for specific SL rise events. Proxy records of past ice sheet coverage will be developed.

CCT 3: The compiled datasets of RSL and ice-sheet extent will be used to constrain models of isostasy to fingerprint regions of ice-sheet collapse and calculate ESL. The insights from isostatic models (ESL and individual ice-sheet changes) will be used to constrain ice sheet models during periods of rapid change. These models will in turn be used to estimate future SL change.

CCT 4: Data management – new sea-level compilations and ice-sheet reconstructions will be made available on line.

Members (attended the 1st workshop or had expressed interest)

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Scientific output

1) New RSL data compilation for terminations I and II and high stands back to MIS 15 including the Holocene. A compilation of a U-series coral sea level database with all ages calculated using consistent, agreed standards. The database would include both conventional and open-system ages. The ages would be screened or ranked in terms of reliability. Focuses would be the terminations and interglacial periods back to MIS 15 and include the organisation of inter-lab calibration efforts for U-series measurements as well as analytical issues and recent innovation. This would include establishing an agreed 234U/238U history of the ocean as a consistent standard for screening and correcting of ages.

2) Synthesis of RSL constraints. This will include

- calculations of Eustatic Sea Level from the RSL compilation
- SL fingerprinting using isostatic models, RSL data and data for past ice sheet extents.
- identifying key additional data locations to better constrain the isostatic models.

3) Constraining ice sheet models using ESL estimates, RSL data and evidence for past ice-sheet extents – working to understand the evolving processes through the terminations.

4) Empirical constraints on future sea level rise. These constraints will include

- upper limits for ESL rise in the next century
- defining fundamental processes behind ice-sheet dynamics and their evolution during periods of ESL rise
- investigating typical modes of time response (i.e. does the ice sheet response to a temperature perturbation accelerate, decelerate or remain constant over time).

Products

- Each stage of this work will be published in the peer-reviewed literature, including news articles in EOS and PAGES newsletter.
- We will present scientific output at international conferences.
- We will publish data and model output online.
- A bibliography and series of links to all data and publications will appear on our website.

- Our ambition is that this science, communicated and reviewed in this way will be of beneficial impact in assessing the potential SL rise over the next century and in particular be useful for the fifth assessment report of the IPCC in 2013.

Plan of activities

Academic visits:

2009/2010 visits for U/Th networking/interaction
2010/2011 - ice-sheet modelling/isostatic modelling visits with RSL and ice-sheet extent workers

Workshop activities (2 x Europe, 2 x North America):

September 2009 WHOI Workshop on U/Th – Compiling a user-friendly sea level data set from U-series coral ages: with a consistent set of standards for analysis and data reporting
Host – Bill Thompson

September 2010 Oxford Workshop considering RSL, ice-sheet area data and ESL modelling, allowing for glaci-isostatic, hydro-isostatic, rotational and tectonic effects
Host – Gideon Henderson

September 2011 Harvard Joint workshop with PMIP* and PIGs** working groups- sheet constraining ice models of past change using ESL estimates, RSL data and evidence for past ice-sheet extents. We will work to to understand the evolving processes through the terminations and interglacials.
Host – Peter Huybers

September 2012 Bern Projections and limits on SL rise for the next century based on RSL, ESL, ice-sheet extent data and ice-sheet models and comparison with modern observations.
Host – Thomas Stocker

*Paleo-Modelling Intercomparison Project

** Past Interglacial Changes

Mark Siddall,
January 2009