
Protect
CRYOSPHERE & SEA LEVEL
Projecting Sea-Level Rise: from Ice Sheets to Local Implications
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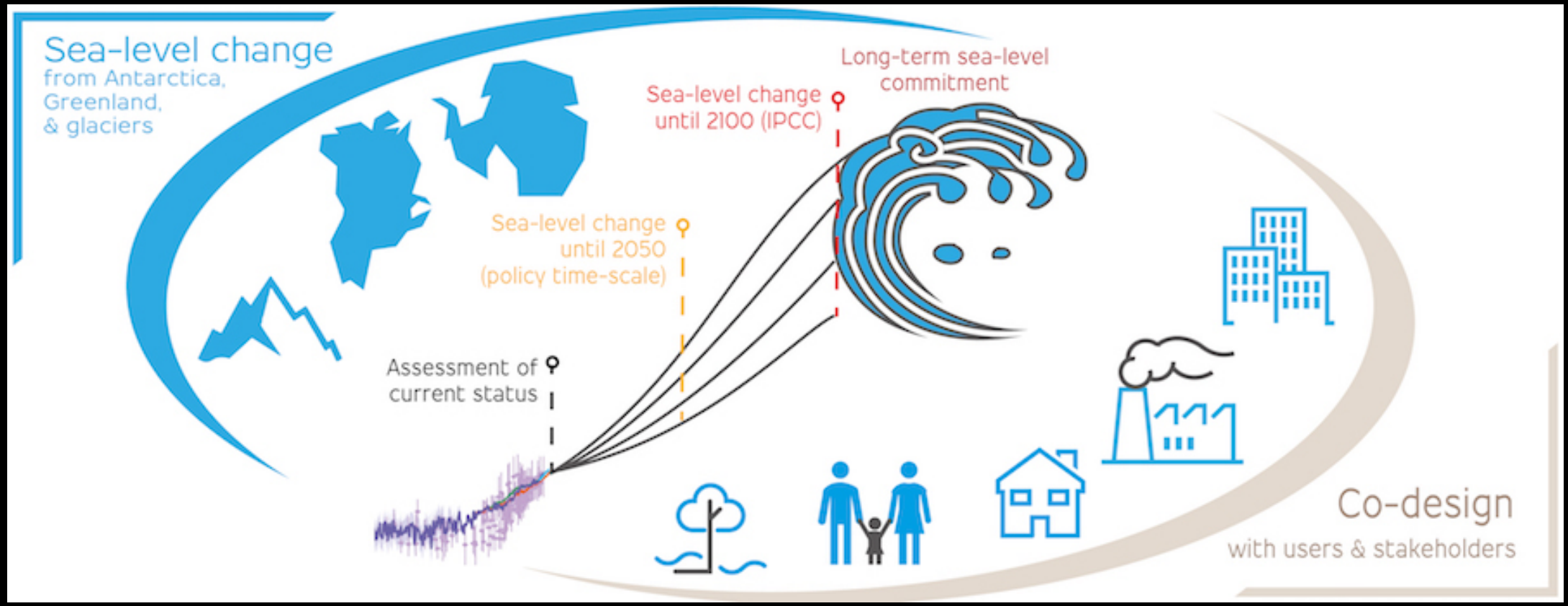
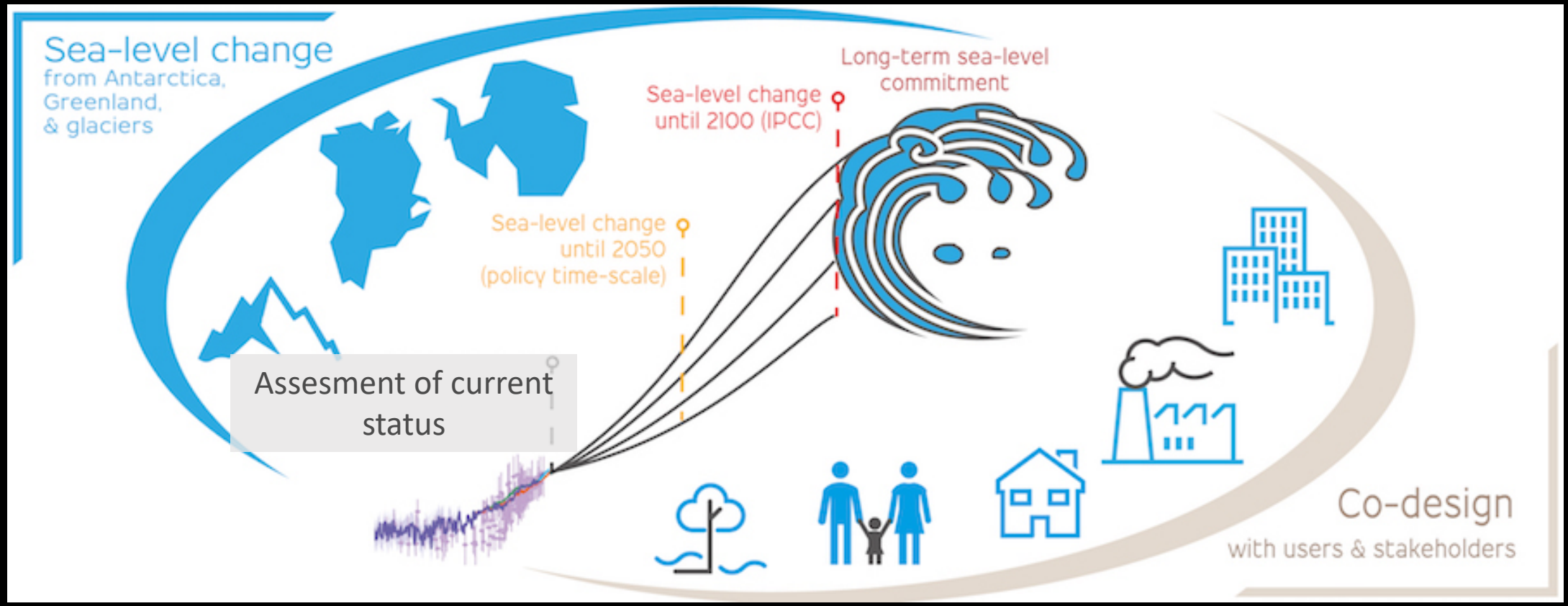
Overarching objective



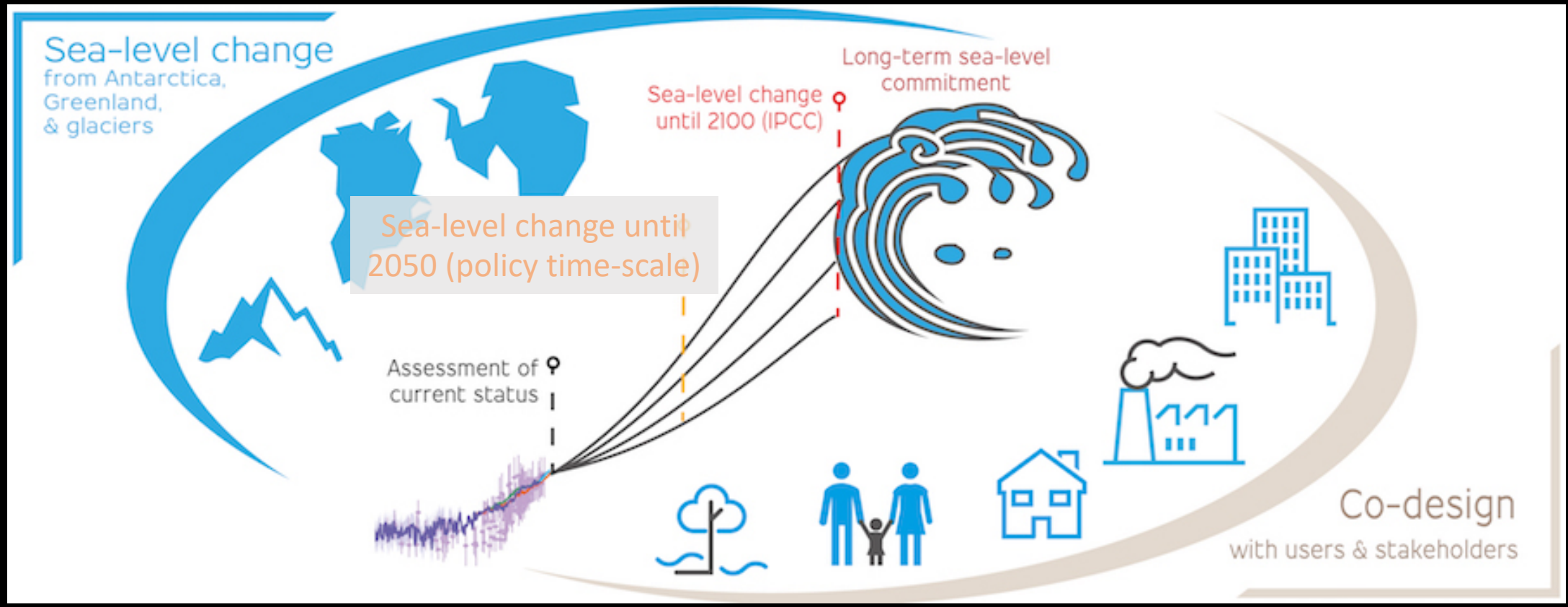
Assess and project changes in the land-based cryosphere, with fully quantified uncertainties, in order to produce robust global, regional and local projections of SLR on a range of timescales

Scientific objectives



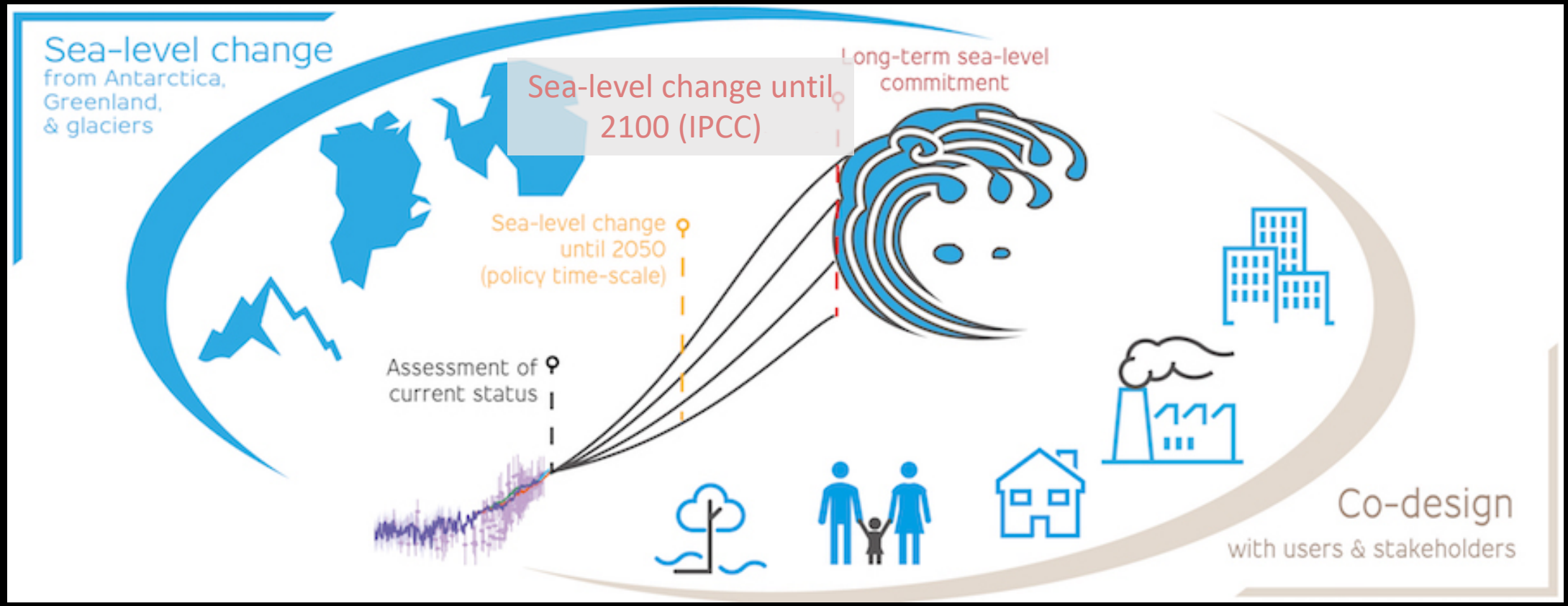
Assess the contemporary mass balance of ice sheets and glaciers, quantify the relative importance of anthropogenic forcing and internal climate variability to ice sheet and glacier changes, and use remote-sensing observations to evaluate and improve the models used for ice sheet and glacier projections.

Scientific objectives



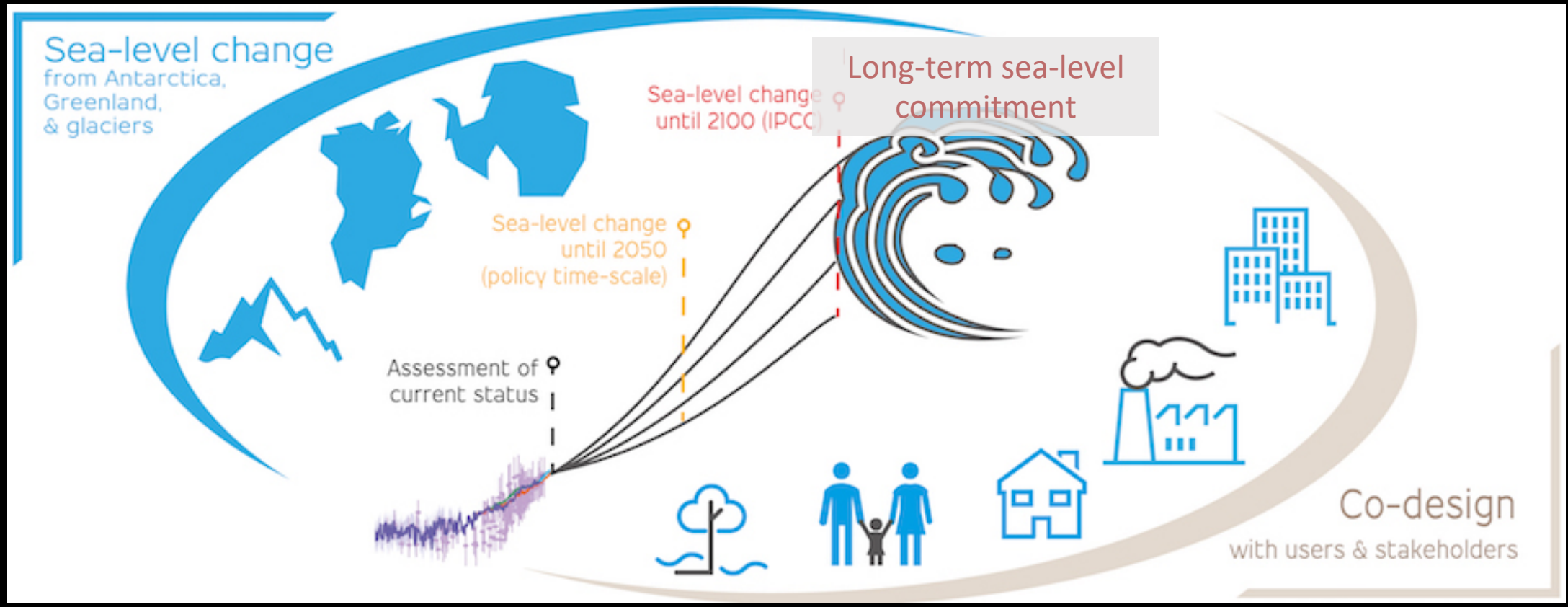
Use the improved understanding of short-term variability in glacier and ice-sheet mass balance to make projections until **2050, the time scale of relevance to many of today's coastal management decisions**.

Scientific objectives



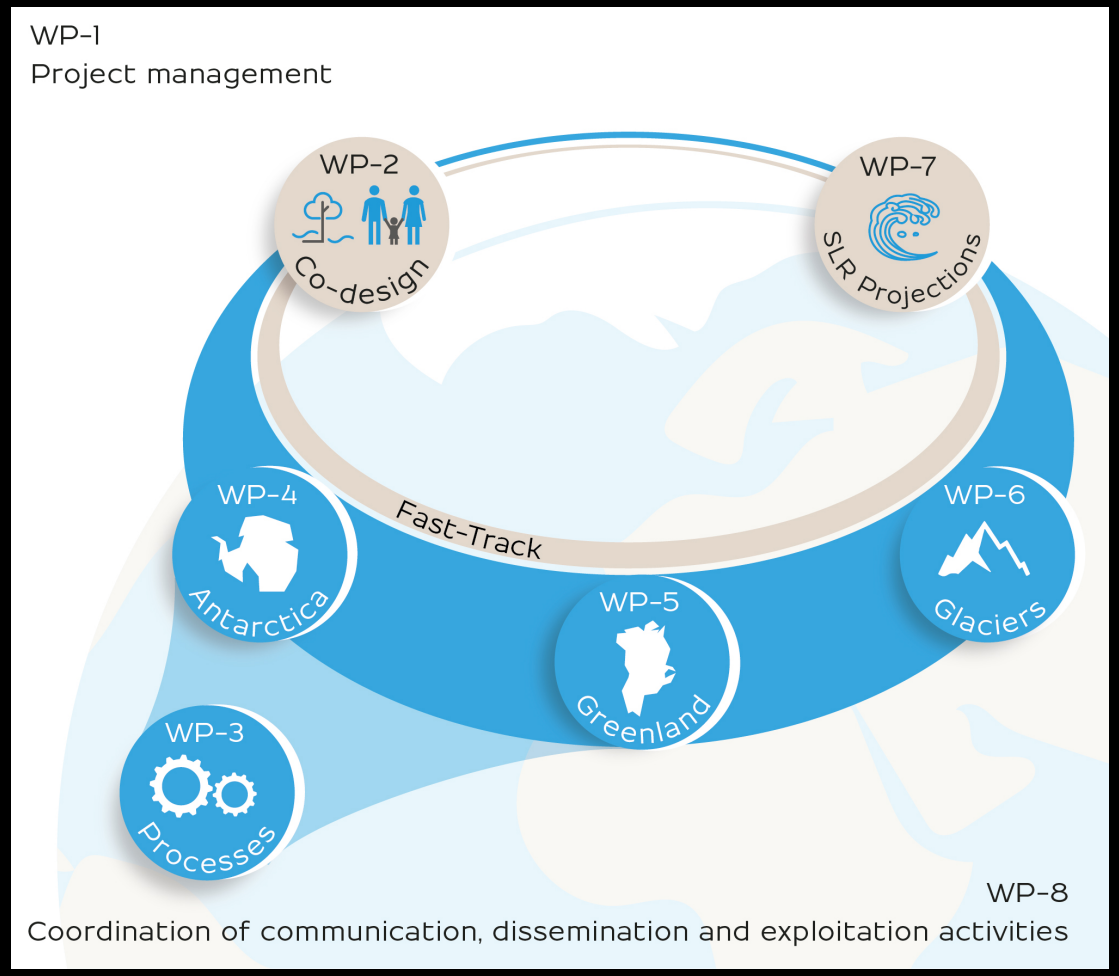
Use a range of newly-developed, coupled climate-ice sheet models to project SLR as a result of glacier and ice sheet mass change until **2100, the IPCC timescale that is relevant for long-term infrastructure planning**.

Scientific objectives



Assess the irreversibility of glacier and ice-sheet mass loss and the associated SLR commitment to **2500 and beyond, the timescale relevant to the long-term viability of coastal cities, small islands and low-lying states**.

An iterative process with users & stakeholders



Fast Track (M1-M14)

Select the most appropriate modelling and uncertainty frameworks

Full Track (M15-M48)

refine the results with the new knowledge being produced

Co-design and co-production of sea level projections and coastal climate services

- ✓ Aims to design and develop sea-level projections and innovative climate services, together with users which are tailored to their needs.
- ✓ Quantitative input for this exercise comes from the scientific results of WP-3 to 7.
- ✓ Four case studies address complementary coastal adaptation settings, including coastal communities, coastal ecosystems and critical infrastructure in different regions of the globe (France, The Netherlands, The Maldives and Greenland).
- ✓ Links stakeholders from outside the project with research activities in PROTECT.

Process understanding and model improvement

- ✓ Address physical processes and boundary conditions that control the dynamic behaviour of the Greenland and Antarctic ice sheets (calving, ice shelf damage, firn saturation and subsequent ice shelf disintegration, marine-ice cliff instability and basal sliding).
- ✓ Evaluate parameterisations for ice sheet-ocean interaction, crucial for the prediction of future sub-shelf melt rates using ocean conditions projected by coupled, coarse-resolution climate models (e.g. CMIP6).
- ✓ Address processes controlling ice sheet surface mass balance and ice shelf stability.

Contribution of the Antarctic Ice Sheet to SLR

Uses remote sensing observations and ice sheet and climate models to assess the contemporary mass balance of the AIS, with particular emphasis on its interactions and feedbacks with other components of the Earth's climate system.

- ✓ Spaceborne observations and regional climate models used to produce improved assessment of the contemporary mass balance of the AIS.
- ✓ Make projections until 2050, with special focus on the Amundsen Sea sector where contemporary mass loss is concentrated.
- ✓ Extend the ISMIP6 ensemble (2100) to include new atmosphere/ocean forcing from CMIP6 scenarios, and interactions at the ocean/ice and air/snow/ice interfaces that are missing in current CMIP projections.
- ✓ SLR commitment from mass loss of the AIS, including the possibility of ice-sheet regrowth under strong mitigation scenarios, assessed by model runs until 2500 and beyond.

Contribution of the Greenland Ice Sheet to SLR

Uses remote sensing observations and ice sheet and climate models to assess the contemporary and future mass balance of the GrIS, with particular focus on its interactions with other parts of the Earth's climate system.

- ✓ Estimate SLR contributions from GrIS mass loss until 2050 by attributing contemporary mass loss to natural (internal) variability and anthropogenic change in the atmosphere and ocean.
- ✓ The role of ice dynamics in GrIS mass loss until 2100 and structural model uncertainties are explored by taking full advantage of the new ISMIP6 model ensemble. In addition, dedicated runs with stand-alone and coupled ice sheet models will narrow down the uncertainties introduced by parameterisations of ice-ocean and ice-atmosphere interactions.
- ✓ Earth System Model with fully coupled ice sheets is used to explore SLR commitment until 2500 and the potential for a reversal in GrIS mass loss under aggressive mitigation scenarios.

Contribution of glaciers to SLR

- ✓ Uses innovative calibration of the global glacier mass balance models used in PROTECT, based on the emergence of operationally available geodetic observations of glacier's volume change.
- ✓ Time series of glacier outlines will be used to calibrate the glacier mass balance models over
- ✓ develop modular frameworks for improved model calibration and cross-validation.
- ✓ Implement parameterisations of debris cover effects on the glacier surface mass balance
- ✓ Large ensemble of model projections, we will quantify the contribution of glaciers to SLR covering the three time scales considered in the project (until 2050, 2100 and 2500), combined with comprehensive uncertainty estimates.

Regional sea-level change and implications

- ✓ Takes the results of WP-4, 5 and 6 to generate time series of contemporary and future global sea level change, and converts these to regional SLR scenarios, accounting for gravitational and rotational effects and including other SLR components.
- ✓ Quantify the implications of the projected regional SLR and extremes for coastal communities, coastal ecosystems and critical infrastructure at the global and regional scales.
- ✓ Global DIVA model will be used to assess impacts and adaptation implications on the mid-term (2050) and end-of-century (2100).
- ✓ New methods to be developed will enable a global, quantitative assessment of long-term impacts and adaptation implications from 2100 to 2500.
- ✓ Feed back into the case studies of WP-2 and support the development of coastal climate services.

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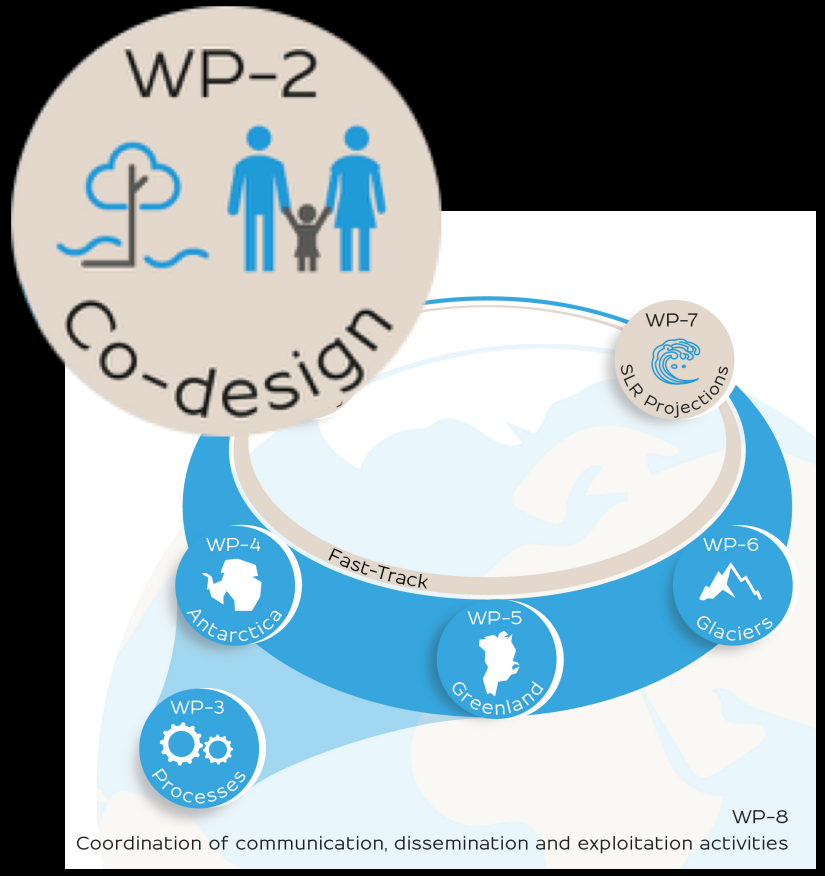
Take Home messages…



Continue and deepen the exchanges that have been initiated in INSeaPTION, join the PROTECT stakeholder group

PROTECT Kickoff and 1st User meeting
Sept 29th – Oct 1st, Orléans, France
Contact: G.LeCozannet@brgm.fr