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WORKING GROUP I CONTRIBUTION TO THE IPCC SIXTH ASSESSMENT REPORT (AR6)

Background information

(Submitted by the Co-Chairs of Working Group I on behalf of the Working Group I Bureau)

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1. Introduction

This document is provided by the Co-Chairs of Working Group I on behalf of the WGI Bureau to describe the broad structure and rationale of the Working Group I contribution to the IPCC Sixth Assessment Report (WGI AR6) as outlined in WG-I:13th/Doc.2, and informed by WG-I:13th/Doc.2.

Firstly, this document describes the actions taken by the WGI Bureau in preparation for the AR6 scoping meeting held in Addis Ababa, 01-05 May 2017 (Sections 2-5). This includes the development of the WGI contribution to the Chairs' AR6 Vision Document, the undertaking of a pre-scoping questionnaire, and the selection of scoping participants. The section that follows (Section 6) describes the structure of the scoping meeting itself and the process by which the WGI AR6 outline was developed during the course of the scoping meeting. The next section of the document (Section 7) describes how the WGI outline is linked to the other AR6 products and the related coordination implications needed to ensure a comprehensive and integrative assessment cycle. The AR6 WGI annotated outline is presented in the final section (Section 8). Four annexes are included with this report that summarize the analysis of the WGI contribution to AR6 pre-scoping questionnaire, the WGI selection process for participants for the AR6 Scoping Meeting, the AR6 Scoping Meeting agenda, and a mapping of the treatment of topics in the AR6 as compared to the AR5.

2. Vision Document

The WGI Bureau contribution to the Chair's Vision Document for the Scoping Meeting the AR6. The document is available here:
http://www.ipcc.ch/apps/eventmanager/public/event/46/

The WGI contribution introduces the major themes to be considered for the scoping of the AR6 WGI report. This includes a discussion of topics related to the WGI assessment as well as cross-WG topics requiring a coordinated approach, and recommendations for the development of the report outline. The document also includes an analysis of key findings and gaps from the AR5 WGI report and identified a range of emerging topics since the AR5.

3. Pre-Scoping Questionnaire

The WGI TSU undertook a community consultation through a pre-scoping questionnaire that was sent to all AR5 CLAs and to the international network organizations related to the WGI research community.

- Responses were invited from 51 organizations and 30 WGI AR5 CLAs;
- 22 responses were received from 12 different organizations;
- 40 individual responses were received, 15 from WGI AR5 CLAs and one former WGI Co-Chair.

Feedback and recommendations were sought to build on the AR5 experience, highlight emerging knowledge, provide information about other assessments and reports that are relevant to the IPCC, and elicit input on the structure and content of the WGI AR6 report. A diversity of perspectives were expressed in the suggestions and comments received and were an input for the WGI Co-Chairs and Bureau preparing for the AR6 Scoping Meeting in May 2017. A synthesis of these suggestions was

presented to Scoping Meeting participants and a summary of the analysis of the questionnaire responses is provided in Annex 1.

4. Call for nominations for the Scoping Meeting

A call for nomination for experts to participate in the Scoping Meeting was issued to governments and observer organizations on the 3rd October 2016, with nominations submitted by the 14th November 2016.

Participants were sought with a broad understanding of climate change and related issues to collectively have expertise in the following areas:

- Climate system (atmosphere, ocean, land surface, cryosphere): observations (past and present), processes, and interactions.
- Natural and anthropogenic drivers of climate change (land use, well-mixed greenhouse gases, short-lived forcers including aerosols), carbon and other biogeochemical cycles.
- Climate modelling, model evaluation, predictions, scenarios and projections, detection and attribution, on global and regional scales.
- Earth system feedbacks and dynamical responses, including abrupt change.
- Climate variability, climate phenomena and teleconnections, extremes and implications for regional climate.

In addition, the following areas of expertise cutting across WGs were identified as relevant:

- Co-benefits, risks and co-costs of mitigation and adaptation, including interactions and trade-offs, technological and financial challenges and options;
- Ethics and equity: climate change, sustainable development, gender, poverty eradication, livelihoods, and food security;
- Perception of risks and benefits of climate change, adaptation and mitigation options, and societal responses, including psychological and sociological aspects;
- Climate engineering, greenhouse gas removal, and associated feedbacks and impacts;
- Regional and sectorial climate information;
- Epistemology and different forms of climate related knowledge and data, including indigenous and practice-based.

5. Scoping Meeting Participant Selection

The WGI Bureau undertook the selection of 60 experts from a pool of 603 candidates self-identified as having expertise related to the WGI report, out of a total of 1250. The selection paid attention to the expertise, geographical and gender representation, past IPCC experience, and the need to bring in new experts at the forefront of climate science development to the IPCC process. The selection process, related statistics, and the final list of participants is provided in Annex 2.

6. WGI Scoping Meeting

The scoping meeting was structured to foster a fully involved discussion amongst all participants towards a consensus-based development of the report outline in light of ongoing research developments, considering the three AR6 Special Reports, the treatment of cross-WG topics and coordination needs, and the lessons learned from previous WGI assessments. The meeting program is provided in Annex 3.

Figure 1 shows the arc of the meeting and the iterative process followed during the course of the meeting. The meeting was initiated with scene setting presentations, then participants split into smaller break out groups, returning to plenary to take stock and refine the next stages of the meeting, developing the outline, going back to smaller groups to mature the detailed structure of the report. Finally, participants returned to plenary to jointly converge on the proposed outline and structure. The WGI Bureau met each evening to assess daily work progress and coordinate the preparation of the following day. This process was successful in achieving consensus, support and confidence across the participants in the proposed outline submitted for consideration by the IPCC Plenary.

- The meeting was initiated around themes with discussions on Monday and Tuesday to identify the core elements of the report, the inter-linkages between themes, discussions about potential chapters and identifying cross-WG issues.
- Wednesday was dedicated to cross-WG coordination and discussions, as well as a discussion on potential topics for the Synthesis Report.
- Thursday was focused on structuring the outline, consolidating the storyline and chapters, and bringing together the outcomes of the first three days.
- The proposal for the WGI outline was finalized by Friday lunchtime and subsequently presented to the full AR6 Scoping Meeting Plenary on Friday afternoon.

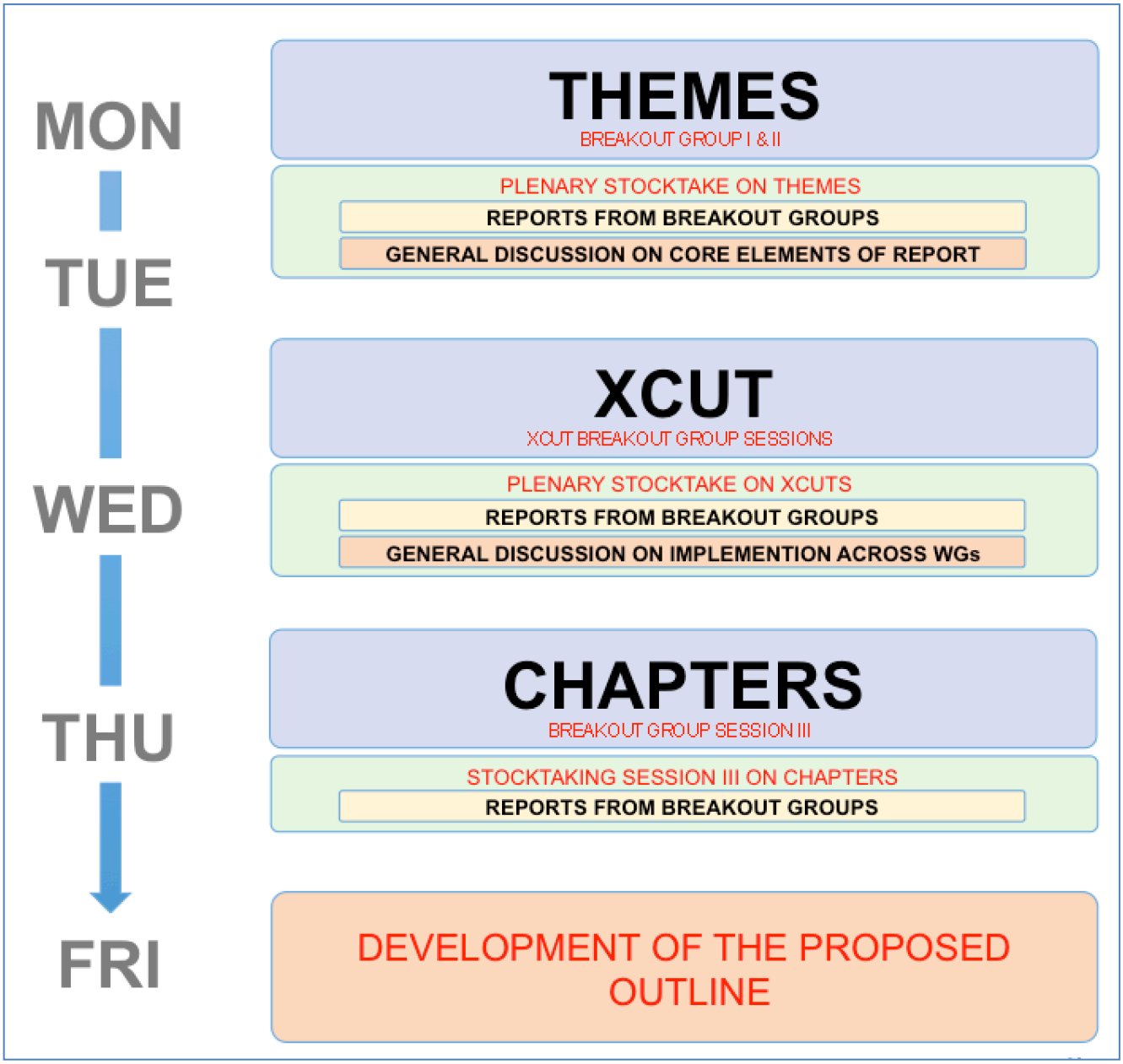

Figure 1: Arc of WGI Scoping Meeting

The WGI Bureau solicited eight 10 minute scene-setting presentations and invited these to be prepared in a collaborative way across groups formed by the participants to identify key messages and new developments since the AR5 and to initiate the meeting discussions with a diverse and comprehensive set of perspectives. Presenters could also propose options for addressing the breadth of their respective topics within the AR6 WGI report.

The following topics were selected by the WGI Bureau for the scene-setting presentations, recognizing that the selection was not exhaustive of all topics relevant for the WGI assessment:

- Historical radiative forcing and the global energy budget
- Climate sensitivity
- Carbon and biogeochemical feedbacks
- Overview of CMIP6[1] activities
- Climate variability
- Extreme events
- Near-term climate predictability and prediction
- Regional climate projections

Participants were distributed amongst break out groups of the same topics and were charged with identifying the core elements and storyline of the WGI report, potential chapters, and cross-WG topics that would need a dedicated joint discussion on Wednesday. These were reported back to the plenary by Tuesday afternoon resulting in a mapping of all the elements, including those not specifically addressed in the opening presentations with which participants, facilitated by the WGI Bureau, would base the development of the WGI report outline.

The cross-WG breakout group discussions held on Wednesday completed this picture and provided a unique opportunity for the three WGs to coordinate the development of their respective assessments, critical to have early in a cycle where more integration across WGs is expected than in previous cycles, building on the cross-WG Special Reports that are currently underway.

The WGI Bureau presented a strawman outline to the WGI plenary on Wednesday afternoon, based on progress so far on Monday and Tuesday, and the cross-WG BOGs that took place earlier on Wednesday. The WGI scoping meeting participants were then charged with building on from the core elements of the WGI assessment and the implementation of cross-cutting issues to converge on proposals for the chapters. The participants considered a range of options for the report structure that could accommodate the assessment needs of WGI. The discussion focused on achieving an outline that would build on previous WGI assessments, ensuring continuity as well as integrating new elements of the assessment made possible by progress in scientific understanding and the state of the art in climate science tools and methodologies. A key part of the discussion was on the need for the WGI assessment to focus on policy relevant questions, integrating more with the assessment of WGII and WGIII. The outline continued to evolve together with the development of the detailed chapter structure throughout Thursday in break out groups around related chapter clusters, with smaller focused groups then matured the indicative bullet points of content expected for each chapter.

On Friday, during the final WGI plenary, consensus was achieved around the proposed structure that is presented here, with each chapter title and indicative bullet point discussed and refined in real-time and re-checked by all participants before being presented to the full scoping meeting Plenary during the final afternoon session.

[1] Coupled Model Intercomparison Project Phase 6, https://www.wcrp-climate.org/wgcm-cmip

7. Working Group I AR6 Report Structure and Coordination

The following dimensions are reflected in the report structure and narrative developed by the scoping meeting participants:

- to build on the conclusions of previous IPCC assessments;
- to build on lessons learned from previous WGI report structures and on the possibilities for integration resulting from the maturation of climate science since the AR5;
- to ensure a comprehensive assessment by integrating various lines of evidence (e.g. observations, paleoclimatic evidence, models, statistical analyses) in each chapter;
- to develop a solution- and output-oriented structure that is focused on policy-relevant aspects;
- to strengthen the assessment of climate information for regions;
- to enhance information flow between WGI with WGII and WGIII;
- to provide a link to assessment results in the three Special Reports, minimizing duplication but ensuring suitable coverage and updating (where necessary, in particular considering CMIP6 simulations) of all relevant material;
- to ensure relevance to the climate information needs for the Global Stocktake, adaptation, mitigation, and understanding impacts at both global and regional levels.

The outline is presented in Box 1. The storyline of the report begins with a framing and narrative of the report, explaining how the report is organised. The report can then be considered in three segments. The first segment (Chapters 1-4) is focused on the current state of the climate system, the understanding of human influence on observed changes, and future projections. The second segment (Chapters 5-9) is focused on global climate processes shaping global and regional climate, including the global biogeochemical cycles and short-lived climate forcers, energy and water cycles, and sea level. The final segment (Chapters 10-12) draws on the global climate system response to assess climate information at regional scales and regional climate change, including extremes in a changing climate and the assessment of regional climate information required for impacts and risk assessment.

Box 1: Outline of the WGI AR6

Summary for Policy Makers
Technical Summary

Chapter 1: Framing, context, methods
Chapter 2: Changing state of the climate system
Chapter 3: Human influence on the climate system
Chapter 4: Future global climate: scenario-based projections and near-term information
Chapter 5: Carbon budgets, biogeochemical cycles and feedbacks
Chapter 6: Short-lived climate forcers and air quality
Chapter 7: The Earth's energy budget, climate feedbacks, and climate sensitivity
Chapter 8: Water cycle changes
Chapter 9: Ocean, cryosphere, and sea level change
Chapter 10: Linking global to regional climate change
Chapter 11: Weather and climate extreme events in a changing climate
Chapter 12: Climate change information for regional impact and risk assessment

Annexes
Regional Atlas
Glossary
Technical Annexes
List of Acronyms
List of Contributors
List of Reviewers

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The report will also include Frequently Asked Questions (FAQs) and Executive Summaries (ES) of each chapter. The report will include a Summary for Policy Makers (SPM) and Technical Summary (TS), as well as options for cross-Working Group integration including the development of a joint Glossary and an Atlas resource on information for the Regions. The Atlas may be envisaged as an online, interactive compendium of regional climate change observations and projections on multiple time-scales, including extreme statistics.

Each chapter is expected to build on all available lines of evidence, including:

- paleoclimatic evidence;
- observational evidence;
- modelling capabilities and limitations;
- variability, including timescales of variability and effects of large-scale modes of variability;
- detection and attribution;
- projected future changes at different time-scales and their uncertainties, including near-term predictability;
- domain-specific extreme events;
- spatial detail, where appropriate;
- potential abrupt change and other surprises;
- assessment methodologies, where appropriate.

This structure is designed to achieve a more compact assessment report, providing an update on key AR5 findings in the first chapters, and facilitating integration building on multiple lines of evidence and building on the assessments undertaken in the three Special Reports. The domain-focused chapters reflect a state of the art vision of current research approaches to understanding the physical basis of climate change.

The treatment of topics within the AR6 WGI structure compared to the AR5 report has been mapped and is provided as a supplementary table in Annex 4. The table helps identify where topics assessed in the AR5 are included in the AR6 WGI report and to highlight some of the new aspects of the proposed report outline.

The Co-Chairs propose that the report includes Technical Annexes on methodological aspects that are cross-cutting to multiple chapters to ensure consistency across chapters, for example on:

- paleoclimatic data
- observational datasets and reanalyses
- analysis of CMIP6 model outputs
- radiative forcing and climate metrics
- detection and attribution methods

The Technical Annexes will facilitate a transparent and coherent treatment of these aspects throughout the report. The writing teams for the Technical Annexes would come from the relevant chapters.

The AR6 is a highly interlinked assessment cycle, with three Special Reports overseen by multiple Working Groups, and a proposed AR6 structure with enhanced inter-linkages across the Working Groups on a range of cross-cutting topics. Meeting these assessment needs will require coordination to ensure an integrated assessment, consistency across products and this is expected to facilitate the assessment process of the Synthesis Report. The scoping meeting considered a comprehensive list of cross-WG topics in break out group discussions that are summarized in IPCC-XLVI/Doc. 6. The following sub-sections (7.1-7.4) describe the key coordination implications for the WGI report in the context of the AR6 reports (WGII, WGIII, Special Reports, and SYR).

7.1 Linkages with WGII

Two major areas that require coordination across WGI and II are regional information in the assessment of climate mechanisms and linking climate variability and change and related uncertainties to the risk assessment framework. The opportunity for cross-WG integration through the risk assessment framework was highlighted at the Integrating Science across the IPCC on Climate Risk and Sustainable Solutions meeting (Stockholm, Sweden, 29-31 August 2016)[2] and at the recent International Conference on Climate Risk Management (Nairobi, Kenya, 5-7 April 2017)[3]. Chapter 12 of the WGI report explicitly includes the assessment of changes in hazards to facilitate integration with the other dimensions needed for risk assessment in WGII. Similarly, the WGII outline identifies the integration of WGI information in its sectoral and regional chapters.

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[2] http://www.futureearth.org/events/future-earth-provia-ipcc-risks-and-solutions-workshop

[3] https://www.ipcc.ch/meeting_documentation/pdf/Climate_Risk_Management/ClimateRiskManagementPaper-Draft.pdf

The inter-linkage between the WGI and WGII reports depends on the implementation of a 'handshake' between the use of regional information in climate assessment of climate mechanisms and responses to drivers with the use of regional information for application in decision making (risk management, including adaptation options) and impacts analysis (see also (see also WGII-13th /INF.1, Section 6 'regional aspects' and 'risk and uncertainty'). The former requires an assessment of the understanding of the underlying physical mechanisms, causes, and feedbacks of regional change, as well as associated uncertainty. The latter requires an assessment of the construction of regional climate information and its delivery (e.g. probabilistic information, regional Atlas, region-specific narratives climate variability and change). The cross-WG treatment of regional issues is expected to strengthen the coherency in the attribution of human influences in climate variables and impacts.

A proposal to hold an Expert Meeting on the assessment of regional climate information in the first trimester of 2018 is being developed. The Expert Meeting would be expected to address the implementation of the 'handshake' between WGs and support the cross-WG treatment of regional issues.

The scoping meeting cross-WG break out group on regional aspects recommended the establishment of a cross-WG Task Group to foster and facilitate these interactions. This task group would consist primarily of WGI and WGII experts concerned with regional analysis and risk assessment, but may also include WGIII given the linkages in the risk assessment framework to the socio-economic pathways and mitigation options. The cross-WG Task Group would explore specific needs for the assessment of regional climate information in the WGI context, the integration of different types and scales of data (e.g., hazard, exposure and vulnerability data), and the development of socio-economic pathways and climate projections.

The development of a cross-WGI-II regional Atlas was recommended during the scoping meeting. In the context of the risk assessment framework, coordination is necessary for mapping risk and the determinants of risk and its dynamics, including the end-to-end treatment of uncertainty and underlying data and information needs (e.g. addressing different nature and scales of data). A cross-WG Atlas was also a recommendation from the IPCC Workshop on Regional Climate Projections (São José dos Campos, Brazil, 15–18 September 2015)[4] to facilitate the coherent implementation of the risk framework within the AR6 report.

7.2 Linkages to WGIII

WGI-WGIII cross-cutting topics include the assessment of carbon budgets compatible with climate targets, land surface aspects (including land management and climate feedbacks), climate and air quality effects of short lived climate forcers and their mitigation potential, and greenhouse gas removal and solar radiation management.

Climate change scenarios is a key overarching topic that will require an enhanced integrated approach across the WGs to ensure a consistent and complete assessment in the AR6 (see also WGIII-13th /INF.1 Annex V, section on 'scenario analysis'). The IPCC Expert Meeting on Scenarios (Vienna, Austria, 18-20 May 2015)[5] recommended that *"The new IPCC leadership should consider installing an "Author Scenario Group" that would coordinate throughout the writing process of the AR6 cycle the use and assessment of scenarios across the IPCC Working Groups…."* in order to

[4] https://wg1.ipcc.ch/meetings/region/RPW_WorkshopReport.pdf

[5] http://www.ipcc.ch/pdf/supporting-material/EMR_Scenarios.pdf

foster enhanced integration and consisting of authors from all three WGs. This recommendation was repeated at the IPCC Expert Meeting on Mitigation, Sustainability and Climate Stabilization Scenarios (Addis Ababa, Ethiopia, 26-28 April 2017)[6]. Options that were discussed included the establishment of authorship roles during the AR6 that cut across chapters and WGs, as well the development of a scenario chapter that is common to all three WGs. Cross-WG discussions on best practices for model intercomparison projects were recommended. Finally, it was recommended that the selection of authors should include a wide-range of expertise and authors that can enhance integration across WGs. A break out group on governance of scenarios noted that the Bureau could facilitate engagement across WGs by inviting participants from other Working Groups (e.g., CLAs/LAs or Co-Chairs) to join calls or Lead Author Meetings.

The cross-WG integration on scenarios was discussed further during the AR6 scoping meeting and reflected in the recommendations from the break out group on scenarios: *"create cross-WG scenario team"* and *"include (at a minimum) authors from key scenario-relevant chapters in each WG"*. Participants suggested that integration could be achieved by identifying and applying a common set of scenarios and the development of a consistent set of indicators to characterize scenario outcomes across WGs, ensuring cross-WG expertise in scenario-related chapter author teams and ensuring cross-WG expertise in reviewers of scenario-related chapters (e.g., commit authors from other WGs for this task). A further recommendation from the break out group was for the scenarios community to develop a guidance document on scenarios for the benefit of AR6 authors and the research community more broadly.

A cross-chapter task force for the coordination of the assessment of scenarios has been established by authors of the SR15. It includes authors from all chapters and expertise from WGI, II and III. This has so far proved to be an effective and fruitful mechanism for enhancing and improving consistency of definitions and terminology across chapters. This successfully implemented arrangement could be considered as a starting point for ensuring consistency across the three Special Reports and the WG reports. A cross WG-team on scenarios for the AR6 would have a clearly stated mandate and objectives and be active during the writing of the three Special Reports, thereby initiated ahead of the writing of the main AR6 report and the Synthesis Report. Members of the group would be selected from the WGI-II-III author teams and the composition of such a group would evolve according to the selection of author teams for the various reports.

7.3 Linkages across the AR6 Special Reports

The Special Reports are an integral part of the overall sixth Assessment cycle and their contents were fully considered as part of the AR6 scoping. A mapping of the WGI topics across the three Special Reports (SR15, SROCC and SRCCL) is summarised in Table 2. The WGI outline has strong links with all three Special Reports across multiple topics.

The WGI report will build on and update the assessments undertaken in the Special Reports. We note that the results of the sixth phase of the WCRP Coupled Model Intercomparison Project (CMIP6) simulations will not be available for use and assessment in the three Special Reports and should be comprehensively assessed in the AR6 WGI report. The SR15 includes an update since the AR5 of the analysis of CMIP5[7] simulations and an assessment of extremes, sea level change

[6] https://www.ipcc.ch/pdf/supporting-material/IPCC_2017_EMR_Scenarios.pdf
[7] https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip5

and biogeochemical feedbacks, focusing on low emissions scenarios. These findings will be revisited using CMIP6 outputs in the AR6 WGI report. The SROCC will assess new knowledge on process understanding since the AR5 on regional changes in the ocean and cryosphere system, including sea level. The WGI report will provide an update, particularly related to CMIP6 new projections and results.

Land-climate aspects are transverse to the SR15, SRCCL and multiple chapters of the WGI report. The SRCCL includes a new chapter (Chapter 2: Land-Climate Interactions), not previously included as a dedicated chapter in WGI assessments, focused on land-climate interactions. For this reason, the WGI AR6 outline does not include a specific chapter on land. The WGI report will build on and update the SRCCL assessment, in particular in terms of GHG fluxes, extremes, importance of land-climate interplays for regional climate, as well as through the assessment of CMIP6 simulations.

Table 2: High level mapping of the treatment of WGI themes across the reports of the AR6 cycle.

		WGI Themes							
		Oceans & Cryosphere	**Land**	**Atmosphere**	**Observations & Trends**	**Regional**	**Variability**	**Extremes**	**Projections, Predictions & Model Evaluation**
AR6 Reports	**WGI**	Observed global change, CMIP6 analysis & model evaluation. Ocean-Atmosphere interactions.	Obs & simulated large-scale indicators of change to land & biosphere.	GHGs. SLCFs. Air quality. Biogeochemical cycles. Water cycle. Radiative forcing. Ocean-Atmosphere interactions.	Climate indicators and metrics. Observations and Paleoclimate. Detection and attribution.	Downscaling. Risk & hazards. Internal variability at the regional scale. Methodolodies. CORDEX.	Internal variability and external forcing. Modes of variability. Monsoons	Detection & attribution. Mechanisms, drivers and feedbacks. Extreme water levels. Heat waves. Urban climate.	CMIP6. Decadal and centennial timescales. Climate sensitivity. Global cycles. GHG removal & SRM.
	SR15	Long term sea level trends	Land use change.	GHG emissions, SLCFs and other climate drivers	Detection and attribution.	Regional impacts at 1.5°C. Hotspots.	Natural variability and external forcing including volcanoes.	Changes in extremes.	CMIP5. Overshoot. Irreversibility. Emissions pathways for 1.5°C. GHG removal & SRM. Tipping points.
	SRCCL		Land-climate interactions. Degradation. LUMIP. Forests. Water-soil-energy nexus.	GHG fluxes, biophysical and non-GHG feedbacks.	GHG fluxes. Land degradation. Land-use change. Soil. Water.	Hot spots. Regional land-use change. Desertification. Climatic- and human-induced changes. Drought.	Impacts of natural variablity on food security and land-use change.	Detection & attribution. Drought. Dust storms. Desertification.	CMIP5. Land-use change, changes in degradation and desertification.
	SROCC	CMIP5. Processes. Sea level rise. Ice-sheet instability. Ocean-cryosphere-climate interactions.	Permafrost. Fresh water supply.	Influence of atmospheric & ocean circulation on polar regions.	Observations and Paleoclimate. Glaciers, permafrost, and snow. Sea level. Ocean temp, acidity.	Polar regions. High mountains. Sea level rise. Coastal, including upwelling, and deep ocean. Ocean regions.	Coupled ocean-atmosphere interactions, ENSO. Water supply variability.	Detection & attribution. Coastal flooding. Marine extremes.	CMIP5. Sea level rise. Abrupt change.

NB: Themes are indicative.

7.4 Implications for the AR6 Synthesis Report

The WGI contribution to the Synthesis Report will draw on the WGI report as well as all three Special Reports. The WGI Report outline is designed to strengthen integration within the WGI assessment, as well as across WGs. The WGI report structure is expected to facilitate the synthesis process, developing a common platform, unified terminology and a consistent and comprehensive assessment. This is expected to benefit the development of the Synthesis Report in terms of supporting an integrative and consistent assessment and in achieving policy relevance.

The WGI assessment of the current state and future evolution of climate, together with metrics of the global energy budget, radiative forcing, climate sensitivity, and carbon budgets will provide a quantitative treatment of aspects that are relevant to assessing the state and trends of the climate system, underpinning the Global Stocktake. The structure of the WGI report facilitates the contribution to the Synthesis Report in terms of discerning the differences in climate change trajectories at the global and regional scale, including the water cycle and extremes, taking into

account natural variability. The report will provide the climate science evidence to quantify regional climate change, including avoided change, relying on a synthesis of the assessment of carbon budgets and biogeochemical cycles, non-CO_2 forcers, regional climate effects, and the drivers of sea level. It will inform how regional climate change, its magnitude and timing, is affected by different emissions scenarios. This includes the detection and attribution of the climate effect of different anthropogenic drivers of climate change drivers, long-lived greenhouse gases, short-lived forcers, and land use on key global and regional, short- and long-term climate change indicators and timescales of emergence.

8. Annotated Outline of the AR6 WGI Chapters

Chapter 1:
Framing, context, methods

Executive Summary

- Synthesis of key findings from AR5 and connections to AR6 Special Reports
- Framing in the context of the Global Stocktake, mitigation, adaptation, and risk assessment
- Assessment approach
- Observational and reanalysis developments since the AR5
- Model and experimental design developments since the AR5
- Emissions and forcing scenarios
- Treatment of uncertainty

Frequently Asked Questions

The charge of this chapter is to provide the necessary framing, context, background and methodological details necessary to interpret the remainder of the report.

The first bullet briefly synthesises key findings from AR5 WGI and the three AR6 special reports that provide the basis from which the current assessment starts. To the extent necessary, this may involve a longer-term view on the history of climate science developments and WGI assessments, with a focus on the status of the most recent assessment findings.

The second bullet provides a brief framing of the context within which the assessment is being performed, including the links to WGII and WGIII and the key stakeholder requirements of the AR6 cycle as a whole. This may include aspects such as, but not limited to, the Global Stocktake, mitigation, adaptation and risk assessment. This may include a box on the risk assessment paradigm adopted across WGs in AR6 to provide the reader with necessary context.

The third bullet outlines the rationale and approaches underlying the assessment, including a rationale describing the remaining chapter structure compared to that used in AR5 (and AR4). This particularly highlights the holistic approach taken in the AR6 WGI assessment report that uses multiple lines of evidence from paleo archives, observations, and simulations of the past, present and future to assess understanding of key processes. It outlines that Chapters 5-9 undertake a process oriented approach to answer key questions of policy relevance. It stresses the focus on regional climate information and extremes to facilitate integration with WGII for risk assessment.

The fourth bullet introduces key observational and observationally constrained model products (reanalyses) to be used in the remainder of the report. In both cases new approaches, tools and capabilities can be introduced to the reader in a way that subsequent chapters can easily refer to.

For observations, the full range of tools available could be introduced (proxy information from natural archives, in-situ, ground-based, satellite and reanalysis datasets).

The fifth bullet refers to climate modelling. This chapter introduces the CMIP6 experimental design, including the CMIP6 baseline experiments (the DECK experiments: Diagnostic, Evaluation and Characterization of Klima) and relevant CMIP6-Endorsed MIPs[8] beyond the DECK. In addition, the key characteristics and advancements of the CMIP6 models is introduced, for example the increase in complexity and resolution as well as variable resolution GCMs with nested regions, or the concept of emergent constraints to inform the use of projections. The CORDEX regional modelling exercise is introduced along with key innovations such as large single-model ensembles, single forcing experiments, and the assessment of confidence in projections.

The sixth bullet presents the shared socio-economic pathway (SSP) scenarios, which are introduced, compared and contrasted to the RCP scenarios (and earlier ones) to support the subsequent chapters. This can include sufficient information upon the underlying assumptions to enable subsequent chapter usage as a reference. Clearly, here coordination with Chapter 4 and onwards is required, also in terms of coordination with WGIII, as described in Section 7.2.

The seventh bullet refers to the uncertainty guidance to be used in the assessment statements. It can recapitulate and introduce the range of uncertainty concepts referred to in the report (structural, parametric, ensemble-of-opportunity etc.) in a comprehensible manner. Coordination in this regard would be advisable with all remaining chapters in the report to ensure this guidance is fit-for-purpose and the chosen nomenclature is adopted consistently across the report.

Chapter 2:
Changing state of the climate system

Executive Summary

- Multi-millenial context, pre-industrial to present day
- Natural and anthropogenic forcings
- Radiative forcing
- Large-scale indicators of change in the atmosphere, ocean, cryosphere, land, and biosphere
- Modes of variability

Frequently Asked Questions

The charge to this chapter is to discuss the evidence basis for changes in climate drivers and the changes and variability evident in the climate system.

The first bullet considers the totality of evidence over a period that includes relevant paleoclimate perspective (spanning at least a multi-millennial context), to the pre-industrial period, and finally to the present-day observation rich period. This is related to the use of appropriate reference periods and focus time-slices. This may include the long-term, instrumental (1850-), and the modern instrumental (1979-) periods. As in Chapter 3, the period also includes the most recent past, Chapter 2 makes recourse to the totality of evidence including proxy records, in-situ records, satellite records and reanalysis products. The assessment can include an evaluation of fitness for purpose (both within chapter needs, and to the extent necessary for other chapters) and uncertainty for all observation-related products considered.

[8] https://www.wcrp-climate.org/modelling-wgcm-mip-catalogue/modelling-wgcm-cmip6-endorsed-mips

The second bullet presents and assesses the evidence for changes in climate drivers arising from both natural and anthropogenic sources. This discussion must be cognizant of, and consistent with, evidence presented in Chapters 5 through 7, through cross-chapter coordination.

The third bullet addresses the assessment of the radiative imbalance and its uncertainty relative to various benchmarks including 'pre-industrial' background forcings.

The fourth bullet considers the evidence basis for change in the climate system across all components (atmosphere, ocean, cryosphere, biosphere, land), with a focus on changes in multiple, key, large-scale indicators that provide a comprehensive indication of the overall state of the system. Large scale indicators include, for example, surface air temperature, upper air temperature, precipitation (atmosphere), ocean heat content, pH, and salinity (ocean), sea ice, snow cover, glaciers and ice sheets (cryosphere), desertification, length of the growing season and soil moisture (land), and vegetation changes (biosphere).

The assessment is focused on changes at the large scale to avoid overlap with Chapters 10 through 12 and the assessment considers aspects of both long-term change (trends) and variability across a range of timescales (seasonal to multi-decadal). The chapter coordinates with (at least) Chapters 3, 4 and 10-12 to identify the set of key indicators and this may logically constitute a cross-chapter box that supports their selection. The assessment of the key indicators can then be returned to in more detail in the process-oriented Chapters 5-9. This analysis can directly inform an overall assessment of the totality of the observed evidence basis for a changing climate. The chapter synthesises the evidence basis across domains to support an overall assessment of observational climate change.

The firth bullet provides an overview of observations of key modes of variability and their historical changes to serve as a basis for the assessment of the rest of the report. Coordination is needed with the other chapters to determine the aspects of variability that are important to consider for the report. The Chapter will be coordinated with Chapters 3 and 4 on decadal rates of global temperature change (e.g. hiatus), informing the analysis of anthoprogenically-forced vs. natural internal variability changes.

Chapter 3:
Human influence on the climate system

Executive Summary

- Overview of model performance and development since the AR5
- Simulated large-scale indicators of change in the atmosphere, ocean, cryosphere, land, and biosphere
- Simulated modes of variability
- Natural variability versus anthropogenically-forced change
- Attribution of large-scale observed changes

Frequently Asked Questions

The charge of this chapter is to assess the extent to which human influence on the climate system has affected its evolution. This may include evidence of human influence on the climate system over the past millennia and during the instrumental era, and can include consideration of observations and model simulations ending as close to the present as possible.

Elements of the climate system to be considered include as many of the elements assessed in Chapter 2 for which there is adequate data and available literature. The primary focus should be global scale changes in the mean state of the climate system, but global scale analyses of changes in extremes may also be considered. Individual forcing factors (natural forcers, greenhouse gases, aerosols, etc.) may be considered to the extent possible. Close coordination with Chapters 2, 5, 6 and 7 will be needed to ensure a coherent assessment of new knowledge related to radiative forcing. Coordination will be required with Chapters 9, 10, and 11, for example with respect to time periods and approach, as these chapters are also expected to assess specific aspects of human influence.

In the first bullet, the evaluation of human influence on the climate system requires the estimation of the expected responses to forcings and estimates of the internal and unforced variability of the climate system. These estimates are obtained with the aid of climate and Earth system models, and thus a first step is to develop an overview of model performance, including performance improvements since the AR5 in CMIP6 and remaining challenges. This includes the evaluation of a suite of standard performance metrics, including metrics of bias and variability.

The second bullet compares the ability of models to represent the large-scale evolution of the climate system, using indicators such as the evolution of the global mean (or other representative spatial average) and spatial patterns of trends for a basic collection of climate variables that are representative of the atmosphere, ocean, cryosphere, land and biosphere.

The third bullet assess the ability of models to simulate the large-scale variability of the climate system, including the ability to simulate the climate's key modes of variability. The latter is focused on the specific time scales, spatial scales, and modes that are critical for the assessment of human influence on the climate system.

This section can provide the primary assessment of global climate models for the AR6. It is completed by a fitness-for-purpose evaluation in the subsequent chapters. The overview of model performance and the fitness-for-purpose evaluation can be aided by the CMIP evaluation tools that have been developed since the AR5. This would allow provenance and visual consistency for selected figures across the chapters.

The fourth bullet considers the respective influences of anthropogenic forcing and natural variability in the indicators. This could include, for example, evaluation of the uncertainty in trends, over decadal or multi-decadal time scales, that arises from natural variability relative to the magnitude of the anthropogenically forced change. It could also include assessment of internal variability and other factors in our understanding of the recent and previous global warming "hiatus" periods, which has evolved significantly since the AR5, and which may provide insights into the role that internal variability may play in future variations in global warming rates.

Finally, the fifth bullet assess the contribution of anthropogenically-forced change to observed changes at large scales across the climate system. This may include the assessment of results obtained with a range of detection and attribution methods, but can focus on the large scale, including global overviews of changes in extremes over time. Single forcing assessments could include stratospheric ozone only, CO_2-only, solar-only, and volcanic-only forcings and improved estimation of the climate response to individual forcings in the past and future. Attribution of changes at regional scales and in regional extreme phenomena will be assessed in Chapters 10 and 11, respectively. Attribution of changes in the ocean, cryosphere and in sea level can be

assessed in Chapter 9. This implies close coordination with these chapters, for which an option is a common Technical Annex on detection and attribution methods.

As a handoff to Chapter 4, this chapter may also consider the extent to which attribution results can be used to constrain projections of future change, including the circumstances under which it may, or may not, be possible to impose observational constraints on projections or identifying emergent constraints.

Chapter 4:
Future global climate: scenario-based projections and near-term information

Executive Summary

- Projections of global mean surface temperature and other key global indicators
- Evaluation of multi-model ensemble methods
- Large scale patterns of climate change
- Commitment, climate targets, overshoot, irreversibility, abrupt change.
- Greenhouse gas removal and solar radiation management
- Interplay between internal variability and forced change
- Variability and unexpected changes of global mean surface temperature
- Near-term predictability, sources and capabilities
- Responses to short-lived forcers, including volcanoes in context of near term predictability
- Synthesis of climate information in the near-term

Frequently Asked Questions

This chapter is the natural continuation of Chapters 2 and 3, which describe recent climate change and diagnose contribution, by looking ahead to the climate in the 21st century and beyond. Chapter 4 marks the transition toward considering the future in more detail in Chapters 5–12 and hence serves as a framing aid for these. Chapter 4 provides a synthetic assessment of future climate simulations (uninitialized and initialized) considering a broad range of possible drivers and, when opportune, the information contained in recent observed and simulated trends. Chapter 4 focuses on global-mean surface temperature (hereafter global temperature) and a set of other key global indicators (e.g., Atlantic meridional overturning circulation, Arctic sea-ice area), leaving detailed process and regional aspects to later chapters. By considering both long-term and near-term changes, Chapter 4 will facilitate consistent treatment of the two.

The first bullet refers to a broad assessment of future scenarios. This includes expanding on issues introduced by Chapter 1 concerning scenario description and climate models. Long-term projections are presented for global temperature and other key global indicators, ideally the same set as addressed by Chapter 3. This chapter is expected to compare CMIP6 with CMIP5 projections, as a basis for regional or impact studies building on CMIP5 and/or CMIP6 outputs.

The second bullet takes as its starting point that the long-term projections (21st century and beyond) covered by the first bullet are be mainly based on CMIP6 multi-model ensembles; therefore a discussion of the approaches leading to the synthesis of multi-model ensembles (e.g., model weighting or culling, ranges of uncertainty recalibrated on the basis of considerations of climate sensitivity ranges) can be presented, addressing the “opportunistic” nature of the sample of models that form the CMIP6 ensembles. Furthermore, the combined use of CMIP6 and reduced-complexity climate models can be discussed.

The third bullet includes an overview of patterns of change in quantities such as average temperature, precipitation, or other large-scale quantities, complementing the time series of integrated indicators of global climate in the first bullet. This material introduces quantities or fill gaps as necessary, relative to the more detailed projections presented in the later chapters, but avoid duplication.

The fourth bullet addresses the policy-relevant topics of commitment, irreversibility, overshoots, aspects of abrupt change, and climate targets. The assessment of carbon budgets and their connection to climate targets in both the near and the long term are expected to be addressed in Chapter 5. An update of key findings from SR1.5 is expected here from the CMIP6 simulations.

A recurrent thread through bullets 1-4 is the representation of the relative benefits of mitigation at all relevant time scales, either as a function of alternative scenarios (stronger or weaker mitigation) or as a function of different levels of global temperature change. Global-scale results from this chapter pave the way for a similar synthesis of mitigation benefits at the regional level (Chapters 10-12) and corresponding analyses of avoided impacts in WGII.

The fifth bullet places greenhouse gas removal and solar radiation management into this context of mitigation benefits. Analysis of solar radiation management scenarios (e.g., from CMIP6/GEOMIP)[9] can be integrated into the assessment of possible future drivers and change.

The sixth bullet includes near-term changes, starting off with the required discussion of the interplay between internal variability and forced change. The assessment of the near-term changes would cover the same global quantities as the long term (global temperature and other key global indicators), and not an exhaustive consideration of regional changes. The chapter examines the implications of past variability for possible future climate fluctuations. The timescale of near-term changes may be the next 2–30 years, up to around 2050.

The seventh bullet uses the recent surface-warming hiatus and the possibility of a surge in the near future as an example of the variability and unexpected changes in in global temperature. This assessment could be well placed in a cross-Chapter Box linking across all chapters and synthesizing all relevant information in one place.

The eighth bullet discusses the sources of near-term predictability and the nature of the initialized simulations (also known as climate predictions). These predictions will be produced, among others, by the CMIP6 Decadal Climate Prediction Project (DCPP)[10]. The ensuing challenges (e.g., drift, ensemble generation, forced response) and forecast quality (with a particular focus on reliability) are assessed, including the implied model evaluation.

The ninth bullet is related to the assessment of chapter 6 and covers the responses to short-lived forcers, including their effects on e.g. temperature, precipitation, extremes, and those of unpredictable volcano eruptions. This latter discussion is integrated into the theme of possible future drivers and consequences, for example, by using the Model Intercomparison Project on the climatic response to Volcanic forcing (VOLMIP)[11] ensemble.

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[9] http://climate.envsci.rutgers.edu/GeoMIP/

[10] https://www.wcrp-climate.org/dcp-overview

[11] http://volmip.org/

The final bullet brings together all the available sources of information (initialized and uninitialized model experiments and observed recent trends) to produce a consolidated synthesis of near-term climate information (including multi-model weighting) of the same global quantities addressed in the long term. This synthesis would serve as a hand-off to the following chapters, including air quality in Chapter 6 and regional issues in Chapters 10 and 12.

Chapter 5:
Carbon budgets, biogeochemical cycles and feedbacks

Executive Summary

- Feedbacks between climate and biogeochemical cycles, including paleoclimate information
- Ocean acidification
- Historical trends and variability of CO_2, CH_4 and N_2O; sources and sinks
- Projections of global biogeochemical cycles from near-term to long-term
- Abrupt change, irreversibility
- Model evaluation, emergent constraints
- Transient climate response to cumulative emissions and remaining carbon budgets for climate targets
- Impacts of mitigation options including greenhouse gas removal and solar radiation management on biogeochemical cycles

Frequently Asked Questions

This chapter provides information on the contemporary global biogeochemical cycle budgets (CO_2, CH_4 and N_2O), the remaining emissions budgets compatible with climate stabilization targets, and assesses carbon-climate feedbacks, particularly those that could lead to abrupt or irreversible changes. This chapter is expected to update the assessment of ocean and land relevant aspects from SROCC and SRCCL.

The first bullet refers to the analysis of paleoclimate records of CO_2, CH_4 and N_2O to assess the drivers of changes at multiple time scales and an emphasis on carbon-climate feedbacks.

The second bullet indicates that ocean acidification should be addressed in this chapter, including the physical basis of changes, information from paleoclimate archives, recent trends and future projections.

The third bullets refers to the assessment of historical, multi-decadal trends of CO_2, CH_4 and N_2O, their sources and sinks, and attribution to drivers. This includes land vegetation greening trends and associated biogeochemical consequences, decadal and inter-annual variability and the corresponding attribution of carbon sources and sinks. It also includes the global budgets of the three greenhouse gases, including the most recent decade, and their biogeochemical interactions.

The fourth is on the assessment of future long-term dynamics of carbon sources and sinks under different climate scenarios, using both offline and fully coupled carbon-climate models of the Coupled Climate Carbon Cycle Model Intercomparison Project (C4MIP)[12]. In the context of the

[12] http://c4mip.net/index.php?id=3387

Global Stocktake, the chapter is expected to assess the predictability of the carbon cycle at multi-year to decadal scales and decadal prediction, in close relationship with the near-term outputs of Chapter 4.

The fifth bullet highlights the importance of assessing the possibility of biogeochemical-climate feedbacks leading to abrupt changes (at different time scales) and irreversibility. The chapter is expected to place an emphasis on emerging understanding not yet fully captured by models.

The sixth bullet is focused on model evaluation, including benchmarking against historical data, and identification of processes missing in models of the carbon and N_2O cycles, including carbon and nitrogen flows from land to water, multi-year and decadal ocean carbon dynamics, nitrogen and phosphorus interactions. The chapter is also expected to assess recent developments related to emergent constraints for future projections (e.g., CO_2 fertilization effect, productivity sensitivity to temperature, constraints on permafrost emissions).

The seventh bullet indicates the importance of assessing the carbon budget in relation to temperature targets and its evolving scientific understanding (e.g., feedbacks, role of non-CO_2 forcing etc.). The outputs of this chapter with respect to transient climate response to cumulative carbon emissions, and equilibrium temperatures, are closely linked to the assessment of climate sensitivity in Chapter 7.

The last bullet addresses the impact of land management mitigation options (e.g., bioenergy, greenhouse gas removal) on global biogeochemical cycles, as well as the assessment of the global biogeochemical implications of solar radiation management.

Chapter 6:
Short-lived climate forcers and air quality

Executive Summary

- Key emissions: natural, anthropogenic, historical and scenarios
- Observed and reconstructed concentrations and radiative forcing
- Direct and indirect-aerosol forcing
- Greenhouse gases lifetimes
- Future air pollution, including cities
- Implications of different shared socio-economic pathways

Frequently Asked Questions

The first bullet notes that short-lived climate forcers (SLCFs) are governed by emissions of species that will not be assessed in other chapters of the report. This includes primary emissions but also emissions of precursors (e.g. NO_x, CO and VOCs for ozone and SO_2, VOCs for aerosols). The role of technological and socio-economic developments in addition to environmental issues governed emission trends can be covered. The shared socio-economic pathway scenarios provide an opportunity to assess the emission scenarios in terms of the factors governing emission trends (including technological, socio-economic and environmental aspects).

The second bullet addresses the understanding of current and historical concentrations, including variations in space and time, and the implied radiative forcing, with a focus on gases, including ozone. For the concentrations of most short-lived climate forcers there are limited observations in time and space, as is also the case for their precursors. Thus the assessment could consider how reconstructed analysis (i.e. model based or other) could be included. The historical development of

radiative forcing forms a basis for estimation of climate sensitivity from the historical records. This is a cross-chapter issue to be coordinated with Chapter 7.

The third bullet represents a major part of the chapter. The terms direct and indirect effects are used rather for simplicity and not to suggest a deviation from terminology of the AR5 (aerosol-radiation interactions and aerosol-cloud interaction). This active field of research still constitutes the major source of uncertainty in the estimate of the net radiative forcing. An in-depth analysis of how even minor differences in model set-up could have significant influence on the aerosol-cloud interaction can, in particular, be addressed. New methods combing satellite observations and models would also be important for the assessment.

The fourth bullet focuses on how emissions leading to changes in short-lived climate forcers have an impact on the oxidation capacity of the atmosphere and thus the lifetime of key greenhouse gases (mainly methane but also hydrofluorocarbons, and hydrochlorofluorocarbons). These processes involve complex non-linear photochemistry, and models tend to give different answers as to how the oxidation capacity has changed. This assessment has implications for how parts of historical and future changes in these greenhouse gases are assigned to primary emission changes, and how parts of these changes are indirect chemical effects. This has cross-chapter linkages with Chapters 2 and 7 (on historical radiative forcing, global warming potential, global temperature change and other emissions metrics).

The fifth bullet point addresses how primary short-lived climate forcers emissions and, in most cases, their precursors are also sources of air pollution. Additionally, while local and episodic changes in short-lived climate forcers are important since they contribute to air pollution. This includes health issues at local scale (i.e. cities), but also agriculture crop losses. The report can include an assessment of the impacts of different scenarios and the role of climate feedbacks (temperature, cloudiness, precipitation rates, etc. changing the lifecycles of short-lived climate forcers) on air quality.

The final bullet covers how the shared socio-economic pathways provide emission pathways that determine the future short-lived climate forcers concentrations and radiative forcing, whilst at the same time include projections of population, incomes, urbanisation etc., which potentially have a significant impact on the risks related air pollution. The assessment may consider how different shared socio-economic pathways affects air quality, for example, in urban areas, in coordination with the WGII and III assessments of how socio-economic trends determine the susceptibility of the population to harmful impacts of short-lived climate forcers.

Chapter 7:
The Earth's energy budget, climate feedbacks, and climate sensitivity

Executive Summary

- Energy budget and its changes through time
- Radiative forcing: definitions, estimates, and its representation in models
- Climate feedbacks
- Sensitivity of the climate system: methods and uncertainty
- Empirical constraints on the sensitivity of the climate system, including paleoclimate
- Global warming potential, global temperature change potential, and other metrics

Frequently Asked Questions

The chapter is expected to provide an overview of the present-day energy balance at Earth's surface, of the atmosphere and at the top-of-the-atmosphere, as measured from the ground and from space. The first bullet is on the assessment of the evolution of Earth's energy budget since pre-industrial times can thereafter be discussed in the context of global climate model output and available observations, including measurements of ocean heat content.

The second bullet discusses the natural and anthropogenic perturbations to the Earth's energy budget, which introduces the concept of radiative forcing and effective radiative forcing, and comprehensively assesses the treatment of radiative forcing with respect to definitions and updates. Updated historical estimates of radiative forcing and effective radiative forcing can be assessed based on results from the Radiative Forcing Model Intercomparison Project (RFMIP)[13], as well as new observational constraints that have emerged since the AR5. This chapter follows logically Chapter 5 (on the carbon budget and long-lived climate forcers) and Chapter 6 (on short-lived climate forcers), which informs the discussion of radiative forcing / effective radiative forcing estimates.

The third bullet continues with a discussion of the climate feedback mechanism that determines the Earth's climate response to a given forcing. A synthesis of post-AR5 results from observational and modeling studies of feedback mechanisms relevant on decadal to centennial timescales can be presented, including surface albedo feedbacks, the water vapor and lapse rate feedbacks, and cloud feedbacks. Emphasis can be placed on emergent constraints on the latter feedback, given the large uncertainty that has been associated with cloud feedback mechanisms in the past. Results from the Cloud Feedback Modeling Intercomparison Project (CFMIP)[14] can be covered extensively in this discussion.

The fourth bullet introduces the various measures of Earth's transient and equilibrium climate sensitivities, the methods by which they are calculated in climate models, and their ranges as calculated based on the Coupled Model Intercomparison Project, Phase 6 (CMIP6). Empirical constraints on the different climate sensitivities can thereafter be discussed under bullet five, separated into constraints based on (i) present-day and 20th century observations, and (ii) paleoclimate archives.

Finally, bullet six indicates that the chapter is expected to provide an assessment of policy-relevant metrics like the global warming potential, the global temperature change potential and the transient climate response to emissions, linked to Chapter 5. Usually the metrics have been updated in each report based on new studies and in relation to the changing atmospheric composition. Here, an update with a table in supplementary material could be an option. Coordination with WGIII is would be required. Furthermore, there is the potential for coordination with UNEP and WMO (GAP report, Ozone Assessment).

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13 https://rfmip.leeds.ac.uk/

14 http://cfmip.metoffice.com/

Chapter 8:
Water cycle changes

Executive Summary

- Observations, models, methods and their reliability
- Past, present and projected changes, trends, variability and feedbacks in the water cycle
- Circulation, processes and phenomena affecting moisture and precipitation patterns (e.g. cloud-aerosol processes, monsoon)
- Extremes
- Changes in seasonality of natural storage and water availability
- Abrupt change
- Confidence in projections

Frequently Asked Questions

The charge of this chapter is to provide an assessment of the changes in all water cycle components including condensation, precipitation, evapotranspiration, infiltration, runoff, melting, and storage, and considering the linkages between land, ocean and ice, as well as the different processes and feedbacks involved. The integration of information from paleoclimate, present day and future climate projections provides a state of the art estimate of likely changes in patterns and characteristics of precipitation and the physical factors affecting water availability.

The first bullet is intended to provide an assessment of the different types of observations, simulations and methodologies that are used to monitor, understand and project changes in the water cycle, highlighting their strengths and limitations. The scoping considers all sources of information, including paleoclimate.

The second bullet focuses on the different elements of the water cycle, considering the relative contributions of the changes in different water bodies to the overall changes in the water budgets and the interactions or water fluxes between them. The evolution of the ocean fresh water budget and fresh water exchange between ocean, land, cryosphere and atmosphere can be considered to fully document past trends and future projection of the water cycle intensity.

The third bullet recognizes that the different components of the water cycle are related by the large scale atmospheric and oceanic dynamics that have important fingerprints on the changes in pattern and characteristics of precipitation. How different factors drive large-scale changes in moisture transport, convergence zones and monsoon in the tropics, or storm tracks in mid latitudes is of interest in this context. It includes the processes and feedbacks within the atmosphere, involving, for example, clouds and aerosols, or between the Earth's system components, such as evapotranspiration amongst the surface and atmosphere. Climate phenomena acting on interannual time scales, such as ENSO, as well as land-atmosphere interactions, also drive the water cycle components and precipitation variability in different regions. This bullet is connected to the assessment of Chapters 2 and 4, assessing the state of climate and future change respectively, and with Chapter 10, on the links to regional climate.

The fourth bullet is on the assessment of understanding of processes related to changing extremes in the water cycle arising from large-scale dynamical patterns. This chapter focuses on precipitation extremes, which are directly connected to the processes and feedbacks addressed in this chapter, while a more comprehensive extreme assessment, including drought, is covered in Chapter 11.

The fifth bullet focuses on changes in seasonality to provide a full assessment of elements contributing to changes of natural storage (e.g. soil, ground water, rivers, including the corresponding cryosphere) and water availability that are of interest for adaptation in WGII or different sectors in WGIII.

Abrupt events in the water cycle that could arise for example from fresh water discharge from ice sheets in the ocean may have profound impact on the ocean circulation and on large scale atmospheric patterns. The sixth bullet builds on knowledge of past conditions as well as climate projections, to assess the implications of such event on the water cycle considering for example the location of the tropical rainbelt or mid-latitude stormtracks and feedacks from soil moisture, snow and ice.

The final, seventh bullet is on the assessment of the confidence in projections within this chapter.

Chapter 9:
Ocean, cryosphere, and sea level change

Executive Summary

- Past and future changes in ocean circulation and properties (trends, variability and extremes)
- Past and future changes in marine and terrestrial cryosphere
- Evaluation of models and projection methods
- Detection and attribution
- Past global and regional sea level changes
- Projections of global and regional sea level change
- Abrupt change and long-term commitment
- Extreme water levels (tides, surge and ocean waves)

Frequently Asked Questions

The first bullet covers paleoclimate, historical, current and projected changes in patterns of ocean circulation such as the Atlantic meridional overturning circulation and ocean properties such as temperature and salinity. These changes include trends and variability in the mean state, as well as changes in extremes such as ocean heat waves. This chapter is expected to provide a concise overview of material assessed in more detail in the SROCC together with updates from the literature, such as that based on CMIP6 model results, not available for the SROCC assessment.

The second bullet includes paleoclimate, historical, ongoing and projected changes in glaciers, ice sheets, snow, and sea ice. As these topics are to be assessed in the SROCC, the material in this chapter is expected to primarily be an updated based on new findings since the literature cutoff for SROCC. This is expected to include simulation results from CMIP6, including the Ice Sheet Model Intercomparison Project (ISMIP6)[15].

The third bullet addresses the evaluation of models used to produce projections in terms of changes in the ocean and the cryosphere. It also encompasses the evaluation of methods use to produce projections of sea-level change that integrate different kinds of models or use statistical relationships between sea level and other variables of interest (e.g., semi-empirical models).

[15] http://www.climate-cryosphere.org/activities/targeted/ismip6

The fourth bullet addresses the detection and attribution of changes in the ocean and cryosphere (ocean circulation and properties, the terrestrial and marine cryosphere, as well as sea level).

The fifth bullet addresses past changes in global mean and regional sea level on a variety of time scales, including past warm periods, the last few millennia, and the instrumental period. It includes interpretation of observations in terms of the various factors contributing to the sea-level budget, such as thermal expansion, land ice changes and associated static-equilibrium effects, atmosphere-ocean dynamics, and groundwater withdrawal.

The sixth bullet addresses projections, in particular new projections from CMIP6, of changes in global mean and regional sea-level and the various contributing processes, updating the AR5 and SROCC findings.

The seventh bullet addresses possible abrupt changes, for example related to ocean circulation or in the factors that drive sea level. These abrupt changes are related to various instability mechanisms, for example marine ice sheet instability and marine ice cliff instability that affect ice sheets and may significantly alter rates of sea-level change. It also incorporates the concept of long-term (multi-millennial) sea-level commitments arising from various levels of warming. This assessment will build on the SROCC and is expected to include simulation results from CMIP6.

The eighth bullet addresses the effects of changes in sea level, as well as in storminess, on extreme water levels, which augment mean sea level with the effects of tides, storm surges, and ocean waves.

Chapter 10:
Linking global to regional climate change

Executive Summary

- Regional phenomena, drivers, feedbacks and teleconnections
- Regional scale observations and reanalyses
- Interplay between internal variability and forced change at the regional scale, including attribution
- Evaluation of methods, including downscaling and bias adjustment
- Confidence in regional climate information, including quantification of uncertainties
- Scale specific methodologies e.g. urban, mountains, coastal, catchments
- Approaches to synthesizing information from multiple lines of evidence

Frequently Asked Questions

This chapter builds on the foundations of prior chapters and extends the overall narrative of the WGI report to explicitly address the regional scale. The term “region” is used here in a generic sense to indicate the range of scales of importance for impact and adaptation, and is not prescriptive of formal region boundaries. The chapter is intended to be the first of a complementary set of three chapters (10, 11, 12) that address different aspects of information relevant to regions, and which support Chapter 12’s key handshake with the WGII report (including any additional outputs, such as an Atlas of regional information).

The overarching purpose of the chapter is to assess the key foundations for information about regional climate change. First are the climate processes that condition the expression of climate change at local and regional climate scales. Second are the range of methods and approaches available for developing more detailed information for regions than is typically possible from global models. Third, the chapter assesses the frameworks for integrating the collective understanding of changes in regional processes along with downscaling approaches in order to build regional messages. The time-scales of past changes, near-term prediction and longer-term projections should be equally incorporated.

The first three bullets form the first substantial part of the chapter, and are in line with the approach used in AR5 Chapter 14. These bullets build directly on the preceding chapters and include the assessment of important regional phenomena (e.g., monsoons, mid-latitude blocking, etc.), important regional drivers (e.g., aerosols, land surface change, regional ocean processes), as well as the role, stability and variability of important teleconnections to global modes of variability. This section assesses the quality of observational and reanalysis data for regional applications and how this impacts the assessment of climate change at regional scales, as well as how this affects the assessment of the interplay between natural variability and forced change, including attribution, at regional scales.

The fourth, fifth and sixth bullets form the second substantial part of the chapter assess the methods for deriving more detailed information at scales of policy and decision relevance, as well as the associated issues of confidence, uncertainty and scale dependencies. The methods assessed include variable and very high resolution global climate models, dynamical and statistical downscaling, and other spatial disaggregation techniques. This includes assessing the factors contributing to the confidence and uncertainty of regional information in relation to the different methods (e.g., stationarity, assumptions, bias adjustment, and the role of elevation), and the different frameworks for evaluating methods, identifying added value, and reconciling outputs from dissimilar approaches (e.g., regional climate models and empirical statistical downscaling). This part of the chapter should include assessments of any methods and treatment required for special spatial scales (e.g., mountains, coastlines, urban, small island states, etc.).

The seventh bullet is on the development of an assessment of the range of approaches and conceptual frameworks available to integrate output from multi-model, multi-method, and multi-resolution data along with the physical understanding of changes in processes and phenomena, in order to facilitate the construction of consolidated regional climate change information. This could include paleoclimate data as appropriate and will build on the assessment of predictions and projections in Chapter 4.

In all of the above, examples of method applications (case studies) may be appropriately used to illustrate key points.

Chapter 11:
Weather and climate extreme events in a changing climate

Executive Summary

- Event type definitions including weather and climate timescales and compound events
- Observations for extremes and their limitations, including paleo
- Mechanisms, drivers and feedbacks leading to extremes
- Ability of models to simulate extremes and related processes

- Attribution of changes in extremes and extreme events
- Assessment of projected changes of extremes and potential surprises
- Case studies across timescales

Frequently Asked Questions

This chapter treats weather and climate extremes within a regional context, with a focus on the relevance for the WGII assessment. Changes in large-scale patterns of extremes, viewed as a fingerprint of climate change, are expected to be covered in Chapters 2 and 3, whilst changes in large-scale patterns of extremes related to the water cycle can be covered in Chapter 8 and those linked with ocean, cryosphere and sea level in Chapter 9. Within the group of three regionally oriented chapters, Chapter 11 acts as a bridge between the process-oriented treatment of regional change in Chapter 10 and the climate-change information for changing hazards in Chapter 12. Note that sea-level extremes, including storm surges, can be covered in Chapter 9, and air pollution extremes can be covered in Chapter 6, thus neither need be considered here.

Since the literature on extreme events in a changing climate is evolving rapidly and given the heterogeneous nature of the different kinds of extreme events, this chapter considers a wide variety of methodological approaches in order to provide a balanced and robust assessment.

The first bullet defines the various types of extreme events to be considered within the chapter, and the implications of those definitions. This includes traceability to SREX and AR5, where possible. Compound events, including droughts, could be considered here, given their importance for impacts and adaptation.

The second bullet concerns the nature and limitations of the observational record as it relates to extremes, including evidence from paleoclimate and archaeology.

The third bullet addresses the physical drivers relevant for the different types of extremes, including the role of natural variability and the interplay between dynamic and thermodynamic processes.

The fourth bullet addresses the issue of model fitness-for-purpose with regard to simulation of extreme events, which is quite different for the many kinds of extremes. Understanding of and uncertainty in regional aspects of climate change, discussed in Chapter 10, can be included into this assessment.

The fifth bullet relates to bringing observations, process understanding, model evaluation, and model simulations together to provide an integrated assessment, where possible, of observed changes in the different types of extreme events within a regional context. This includes the attribution of single extreme events in this context. This assessment supports the treatment in Chapter 12 of present-day hazards for risk assessment, and thus may involve qualitative approaches, as well as quantitative approaches.

The sixth bullet considers future projected changes in the context of the assessment of past changes, drawing on physical understanding and model simulations, and including the potential for low probability high impact events.

The final bullet states that a number of case studies can be provided considering past, present and future together because of the diversity of methods used in extreme-event attribution, and the fact

that results can depend strongly on how the analysis is framed. These illustrate how different perspectives can be brought together in particular contexts.

Chapter 12:
Climate change information for regional impacts and risk assessment

Executive Summary

- Framing: physical climate system and hazards
- Region-specific-integration of information, including confidence
- Information (quantitative and qualitative) on changing hazards: present day, near term and long term
- Region-specific methodologies
- Relationship between changing hazards, global mean temperature change, scenarios and emissions

Frequently Asked Questions

Chapter 12 is the last of the three regional chapters with the main objective to provide a comprehensive, region-specific assessment of the meteorological and climatological impacts of anthropogenic climate change today and in a warming world under key future scenarios.

The first bullet relates to framing for a chapter that is novel within the WGI assessment. The products provided in this chapter will contribute to the hazard component of a quantitative assessment of present and future climate risks, resulting in a key ‘handshake’ point between WG I and II. This chapter and the information provided can therefore be framed in a risk context.

Region-specific information on specific hazards and regions for impact and risk assessment, information can be drawn primarily from the previous two chapters but also from all previous chapters in the WGI report (e.g., on sea level rise, air quality, land use) as well as from the special reports within the AR6 cycle. The second bullet highlights the fact that our ability to assess these hazards varies from region to region and that information for every region comes from a variety of assessments, global and local, which need to be combined and synthesised for each region. A transparent integration of region-specific information is needed so that sources of information are traceable and an assessment of uncertainty, quantitative or qualitative, and its propagation in the regionalisation process is provided.

The third bullet relates to the key products provided in this chapter. The form these products take can be defined in close and continued collaboration with WGII. This bullet also highlights information being provided over all time scales, assessing and, if possible, quantifying specific hazards today, how they have changed from the past and are likely to change under different future scenarios, with an important recognition of the near-term policy relevant timescales.

The fourth bullet relates to the fact that not all methodologies to develop regional climate information are applicable in all regions, and a key requirement for this chapter is to highlight which methodologies do not provide reliable information (and also refers to the assessment in Chapter 10). This includes an assessment of the growing literature about the practices and products available in the context of climate services.

The last bullet point highlights putting the regional information in the context of their assessment. For example, information drawn from the SR15 will likely be conditioned on global mean temperature while other information may depend on other dimensions of change (e.g. concentration, emission and socio-economic scenarios). Thus, how the assessment is carried out with respect to the selection and treatment of the available studies and scenarios, and how these factors are represented in the information provided to the WGII report, can be discussed.

9. Timeline

A call for the nominations of experts to serve as Coordinating Lead Authors, Lead Authors and Review Editors will be issued in September 2017, immediately following the 46th Session of the IPCC. Approval and acceptance of the Working Group I contribution to the IPCC Sixth Assessment Report (WGI AR6) is planned for April 2021. In order to achieve this, the timetable for the WGI AR6 is as follows:

2017	
15 September – 27 October	Call for author nominations
2018	
29 January – 4 February	Decision on Selection of authors
25 June – 1 July	First Lead Author Meeting
2019	
7 – 13 January	Second Lead Author Meeting
29 April – 23 June	Expert Review of the First Order Draft
26 August – 1 September	Third Lead Author Meeting
2020	
2 March – 26 April	Expert and Government Review of the Second Order Draft
1 – 7 June	Fourth Lead Author Meeting
7 December – 31 January	Final Government Distribution of the Final Draft and Final Government Review of the Summary for Policy Makers
2021	
12 – 18 April	Submission to the WGI Session for approval of the Summary for Policymakers and acceptance of the underlying Report, location TBC

To conserve resources and reduce both the carbon footprint and the demands on the time of the volunteer author teams, efforts will be made to hold all individual chapter meetings and TS/SPM writing team meetings in conjunction with Lead Author Meetings. The TSU will also help support the use of technology, such as video and web conferencing, to enhance chapter communication and reduce travel.

10. Annexes

Annex 1: Analysis of the pre-scoping questionnaire on the Working Group I contribution to AR6

Ahead of the AR6 scoping meeting, invited 51 international scientific organizations and 30 CLAs of the AR5 WGI report (excluding current WGI bureau members) to respond to a pre-scoping questionnaire. A total of 62 responses were received, of which 35% were organizational responses and 65% individual responses. Responses were received from 12 organizations and 15 CLAs, representing organizational and personal response rates of 24% and 50%, respectively.

To assess the nature of the responses, the questionnaire requested a statement on the expertise or sector of the responding organization or individual, to which a set of expertise types were subsequently assigned. The most prominent expertise types identified were 'climate variability & monitoring' (56% of respondents), 'climate modelling' (32%), 'cryosphere' (29%) and 'oceanography' (27%). Given the limited number and lack of diversity in expertise of the respondents, it was not possible to take the results as being generally-representative. They did, however provide a useful set of comments and ideas to feed into the scoping process.

The questionnaire consisted of 7 questions, focusing on topics for inclusion and the structure of the AR6 WGI report. Analyses of the responses to each question are provided below.

1. In your vision, which are the main topics/questions that should be addressed in the AR6 WGI report? Please highlight emerging knowledge that you consider highly relevant.

To identify any broad-scale patterns, a set of 41 topic labels were assigned to the question responses. Of the 57 responses, the topics most frequently-identified were 'climate monitoring' (assigned for 40% of responses), 'sea level change' (39%), 'projections & predictability (39%)', 'regional & local aspects (37%)', ice sheets/shelves (32%), 'impacts, adaptation & vulnerability' (30%), and 'detection and attribution' (28%).
Links between pairs of topic labels were also assigned. The most common were 'sea level change - ice sheets/shelves' (18% of responses), 'sea level change – regional & local aspects' (16%) and 'near-term future – projections & predictability (14%).

The following subjects emerged after detailed comparison of the separate responses:

- **Climate variability –** *natural variability (observed and modelled), including decadal variability and the hiatus*
- **Cryosphere -** *ice sheet components in climate models, mass balance observations*
- **Extreme & abrupt change -** *abrupt, extreme and irreversible changes, including the paleo context*
- **Regional and local aspects** – *projections, hydrological cycle and water resources, detection and attribution*
- **Sea level change** – *ice sheet/glacier contributions, long-term commitment, regional aspects (e.g. historical trends and budgets)*

2. **Are there any potential overlaps or synergies with assessment reports being undertaken by other bodies?**

Recent and forthcoming reports noted included the 2nd State of the Carbon Cycle Report (SOCCR2), the Snow, Water, Ice, Permafrost in the Arctic (SWIPA) report, the 4th US National Climate Assessment (NCA4), the WMO/UNEP Scientific Assessment of Ozone Depletion, and the Climate Science Special Report (CCSR).

3. **Considering the chapter structure of the AR5 WGI report do you have any recommendations for the chapter structure of AR6 WGI? (e.g. *adopting the AR5 structure, combining chapters, including additional chapters, or an alternative chapter structure*)? If so, why?**

Seven individuals and three organizations thought that the AR5 WGI report was generally well-structured. Four personal responses and one organizational response argued that the report be shortened. Three personal responses suggested the report only provide an update on developments since AR5 rather than reiterating the conclusions of previous Assessment Reports.

Four personal responses suggested the report pursue greater policy-relevance, suggestions including the adoption of a risk-framing approach and focusing on questions around adaptation and mitigation. One response argued that, given the outcome of COP21, there was scope for a major shift in the chapter narrative, with detection and attribution being placed at the front. Three personal responses and one organizational response suggested more focus and synergy around the themes of energy and/or water cycles.
Four personal responses argued the report should remain comprehensive in scope and not withdraw coverage of any topics. One personal response suggested a need to share the workload between regional coverage in AR6 and that in national assessments, citing the fact that this often relies on the same literature and authors.

Fig.1 summarizes the suggestions for changes to the AR5 structure proposed by the responses. These include splitting up chapter 14 into two chapters on ‘climate phenomena’ and ‘regional change’, and merging chapters 3, 4 and 6 into a chapter on ‘observed changes in biogeochemical cycles and other processes’. Other suggestions included merging the four observational chapters into a single chapter, and combining the ocean observation chapter with chapter 13 on sea level change.

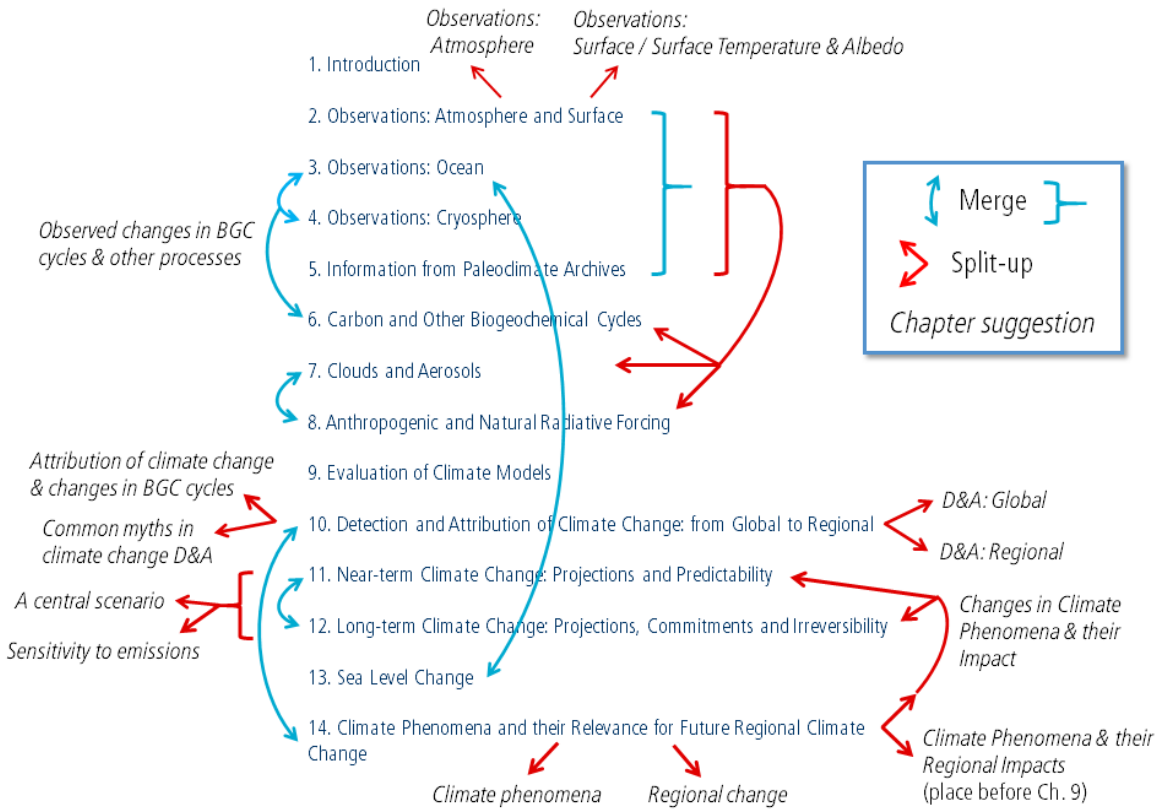


Figure 1: Schematic summarizing the various suggested changes to the AR5 chapter structure proposed by the respondents

4. Considering the three Special Reports of the Sixth Assessment cycle, along with the WGII and WGIII contributions to AR6, please highlight WGI topics you view as requiring careful handling to ensure consistent assessment across reports

To identify any general patterns, the topic labels used in qu. 1 were again assigned to the responses (with multiple labels allowed for each). Of the 40 responses, the resulting most frequently-identified topics were 'projections and predictability' (appearing in 38% of responses), '1.5°C / 2°C scenarios' (30%), 'impacts, adaptation and vulnerability' (30%), 'sea level change' (28%), and 'regional and local aspects (23%).

Subtopics identified under the label'1.5°C / 2°C scenarios' included the definition of 1.5°C / 2°C, carbon budgets for achieving 1.5°C, and assessment of the amount of warming already observed.

Specific suggestions for careful handling included:

- Holding cross-WG expert meetings and workshops
- Improved coordination of WGI with WGII on provision of analyses/datasets, and with WGIII on scenarios
- Assigning contributing authors to cross-WG coordination tasks

5. Do you have any recommendations for the treatment of WGI aspects of regional climate change within the AR6 report?

There was little convergence in the suggestions for handling regional aspects, but the following bullets capture the scope of the different ideas:

- Using risk-based framing with WGI providing the physical science input (e.g. projections of extremes)
- Focusing on areas at greatest risk
- Avoiding grouping areas of different characteristics/processes into the same region
- More clearly elucidating connections between regions
- Placing regional information throughout chapters and framing it within processes/phenomena
- Exploring the usage of regional projections for policy decisions in light of uncertainties and natural variability
- Assessing the utility of approaches to providing regional projections, and identifying ways forward for improving their skill
- Developing joint WGI/II regional chapters and atlases
- Assigning Designated Contributing Authors to serve as bridges between WGs

6. Has your organization used previous IPCC products (e.g. AR5, SREX) and if so, what for?

Four categories were assigned to the responses. The prevalence of each differed markedly between the individual and organizational responses. Of the 32 individual respondents, 47% used IPCC products as reference material, 41% for teaching, 25% for research work and 25% for work planning. Of the 16 responding organizations, 79% used IPCC products as a reference, 14% for teaching, 50% for work planning, and 29% for teaching and outreach.

Thus the usage of IPCC products as a reference and for work planning was more prevalent among the organizational responses, while use of them for research and in teaching and outreach was more prevalent among the individual responses (reflective of the personal respondents being scientific researchers).

7. Do you have any other comments or suggestions?

There was little convergence in the suggestions, but the following bullets capture the more novel ideas proposed:

Accessibility of materials

- Use of a coding system for finding information on the same topic across chapters
- Use of zoomable maps
- Development of education-friendly versions of graphics
- Provision of a separate compilation of boxes

IPCC procedures

- Making headline statements in SPMs a feature of all AR6 products and producing simplified figures to accompany them
- Providing easy access to the review process to receive feedback from a wide community

Annex 2: WGI process of selection of participants for the AR6 Scoping Meeting.

Objective

The objective of the selection process was to select 60 experts per Working Group (WG) considering all criteria as stated in Appendix A of Principles Governing IPCC Work:

> *"In selecting scoping meeting participants, consideration should be given to the following criteria: scientific, technical and socio-economic expertise, including the range of views; geographical representation; a mixture of experts with and without previous experience in IPCC; gender balance; experts with a background from relevant stakeholder and user groups, including governments."*

Each Working Group Bureau focused on the selection of a core group of participants (40) to support their respective Working Group needs and of a cross-WG group of participants (20) to support the cross-WG topics. A cross-WG consultation was included to finalize the selection of the cross-WG list of participants.

Full list of nominations across WGs

1301 applications were received (among which 51 were nominated twice ➔ list of 1250 names) from six regions.

WGI Full list of nominations

Construction of the WGI Full List
The three WG TSUs, under the guidance of the Co-Chairs, divided the nominations by Working Group based the areas of expertise that were selected by the nominees.
637 candidates (among which 34 were nominated twice ➔ list of 603 names) selected at least one area of expertise out of the five related to WGI and composed the WGI Full List.
Among these 603 candidates:

- 75 countries over 6 regions were represented;
- 23% of the applicants were women;
- 41% of the applications came from developing countries;
- The majority of the candidates came from the Academia/Research sector and almost 50% did not have any IPCC experience.

See Appendix 1 for further details

In most cases, candidates selected areas of expertise also related to WGII and/or WGIII. This information was included in the spreadsheet with a weighting of expertise indicated by each nominee across the three WGs). Candidates that were nominated twice were identified and the second nominator information was indicated in a column “TSU comment”. Finally, candidates who had already participated in one or more scoping meetings before (AR5/SR1.5/SROCC) were identified.

Selection process
Each WGI Bureau Member was asked to consider the nominations and to provide a maximum of 10 high priority candidates and a maximum of 15 second priority candidates focusing on their own area of expertise and providing a regional perspective on nominees, as appropriate, as well as considering all criteria as stated in Appendix A of Principles Governing IPCC Work. Explanatory comments for each selection were also requested.

WGI Preliminary List

Construction of the Preliminary List
164 candidates obtained at least 1 point after the first round of selections (priority "1" rankings = 3 points, and secondary "2" rankings = 1 point). Scores went from 0 to 10 (1 candidate got 10 points, 3 got 9 points, 1 got 7 points and 5 got 6 points – the remaining candidates had 5 or less).
7 out of the 8 top ranked candidates had participated to a previous scoping meeting.

The objective, at this stage (also in coordination with the TSUs of WGII and WGIII), was to reach a 'core list' of 40 out of the 60 each WG was expected to select. The priority was on identifying representatives for all areas of expertise solicited in the call for nominations. The next stage would target a refinement of balance across all aspects of the list - expertise, geographical origin, gender - as well as addressing cross-cutting nominations in discussion with WGII and III and identifying a short list of government representatives.

Only 10 names received some consensus in the first round, receiving 3 or more votes, with a high degree of overlap with those who had (or will) participated in the scoping meetings of the Special Reports, as well as a long history of previous IPCC involvement.

The following gaps in WGI-specific expertise were identified in the top 10, but also more broadly in the Preliminary List (e.g. considering the top 34 names, scores 4 or above):

- observations of a changing climate and reanalysis
- process based understanding
- climate modelling, including development and evaluation
- decadal prediction
- climate sensitivity
- global energy balance
- global water cycle
- extremes

Selection process
The following set of selection guidelines was provided to the WGI Bureau for the second phase of selections:

- Selection from the 'top 10' list of the applicants considered as a high priority for the scoping meeting;
- Selection of two priority names (from the Preliminary List, reconsidering the Full List, or providing additional nominations) for each area of expertise, considering highlighted gaps;
- Highlight emerging leaders new to the IPCC (from the Preliminary List, reconsidering the Full List, or providing additional nominations);
- Provide supporting comments.

WGI Core List and Cross Cutting List

The outcomes of the second round of selection by the WGI Bureau was compiled and discussed at length by the Co-Chairs and TSU to propose a WGI Core List or participants and a Cross-Cutting List. Two new nominations were proposed, both Focal Points with a strong background in WGI areas of expertise. Attention was given to foster a renewal in experts participating in the IPCC process.

Selection process
The priority was to agree on a Core List that would bring the breadth of expertise and vision needed for the scoping of the WGI AR6. Views and suggestions of the WGI Bureau were solicited to:

1. Address some key outstanding issues, including:
    - Gaps for countries including India, Eastern Europe, Russia, East Africa
    - Over-representation of US, UK, Germany, France, Australia
    - Low proportion of women

2. Highlight any gaps in WGI expertise that was missing in the Core List.

WGI Bureau members could also propose alternative participants for the lists, identifying who they would replace and including some explanation on their choices. The WGI TSU then developed a revised Core and Cross-Cutting List build on this feedback, also exchanging information with WGII and WGIII TSUs to finalize the Cross-Cutting List.

WGI Final List

A refined list of Core and Cross-Cutting participants was proposed based on the feedback provided by the WGI Bureau, following WGI Co-Chair and TSU discussions and also based on a cross-WG Co-Chair exchange. The revisions addressed duplication and gaps in expertise and balance, in particular in geographical and gender distribution.
In the Final WGI List of 60 participants:

- 31 countries from 6 regions were represented;
- 25% of the selected candidates were women;
- 38% of the selected applications came from developing countries.

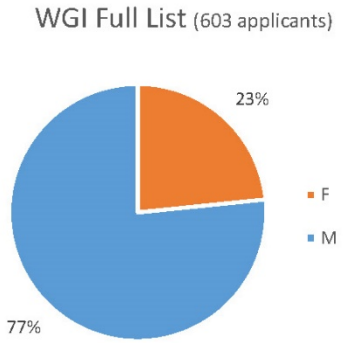
See Appendix 1 for detailed statistics.
See Appendix 2 for detailed WGI Final List.

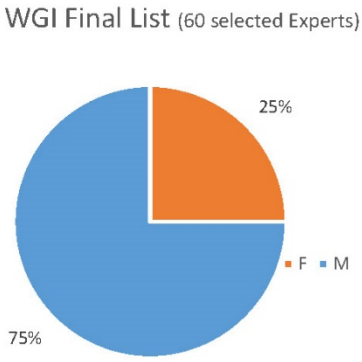
Effective participation

One selected candidate cancelled his venue at the last minute due to professional issues.
In addition to the selected experts, the WGI Co Chairs as well as five WGI Vice Chairs attended the meeting.
See Appendix 3 for general statistics on WGI Scoping meeting participants.

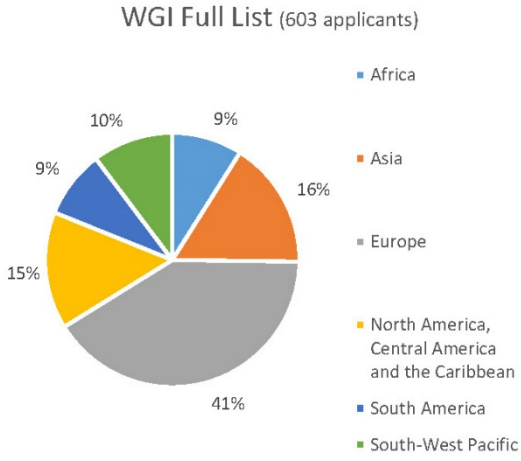
APPENDIX 1 - AR6 WGI Scoping Meeting nominations breakdown

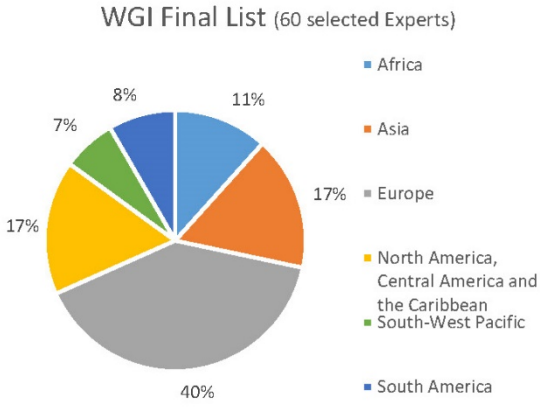
GENDER



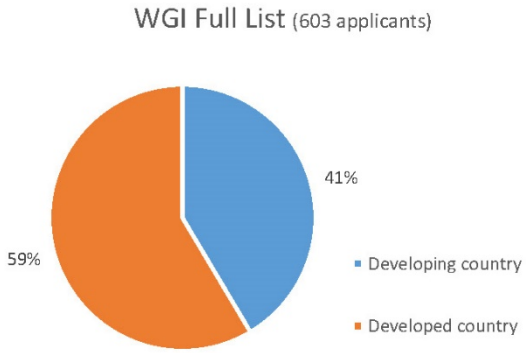


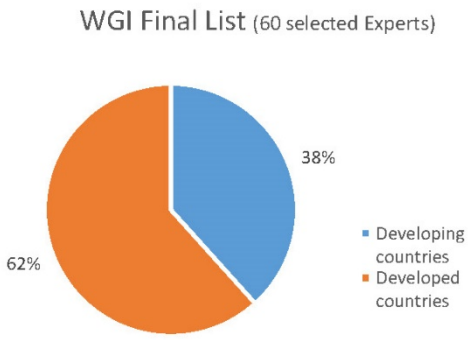
REGION



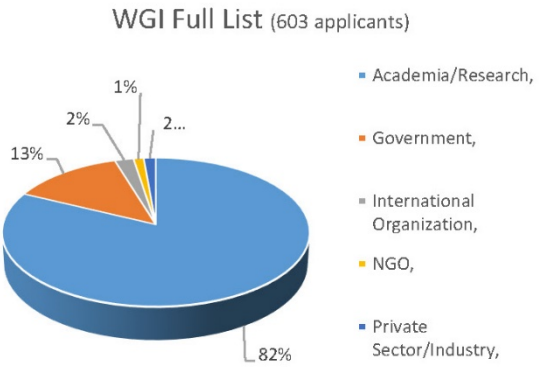


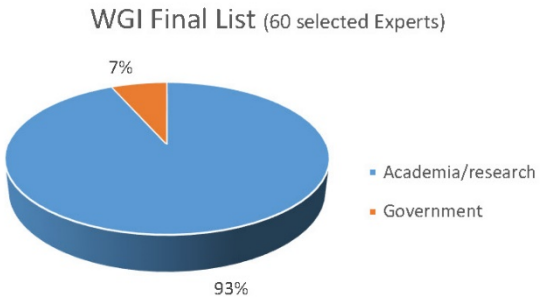
TYPE OF COUNTRY



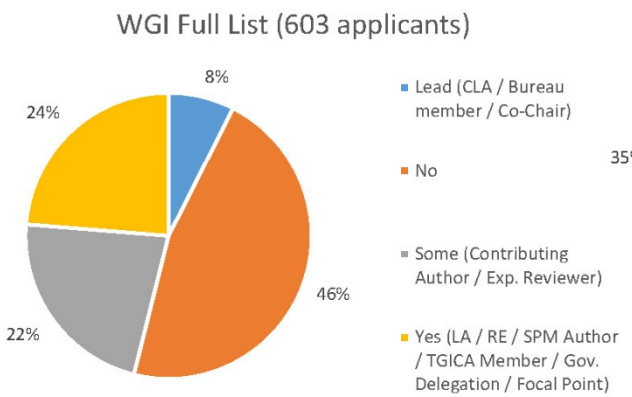


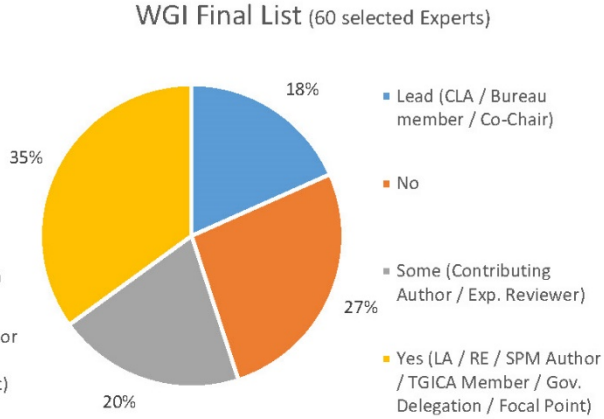
SECTOR



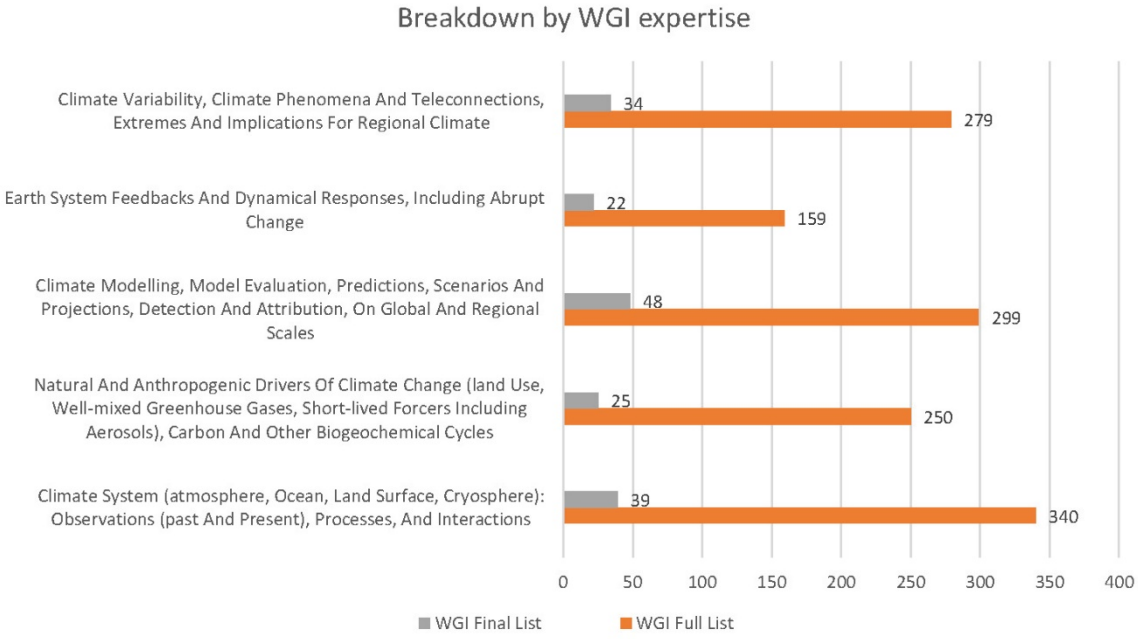


IPCC EXPERIENCE





EXPERTISE



Country of origin (based on Citizenship)

Country	WGI Full List	WGI Final List		Country	WGI Full List	WGI Final List
Argentina	9	2		Mexico	2	1
Armenia	1			Morocco	2	1
Australia	25	2		Myanmar	5	
Austria	3			Nepal	2	
Belgium	7	2		Netherlands	5	1
Bosnia and Herzegovina	1			New Zealand	7	
Brazil	29	2		Niger	1	
Burkina Faso	1	1		Nigeria	3	
Canada	6	3		Norway	3	2
Chad	1			Pakistan	2	
Chile	10	1		Peru	1	
China	34	4		Philippines	4	
Croatia	1			Portugal	1	
Cuba	2			Republic of Korea	5	1
Cyprus	1			Romania	2	
Czech Republic	4			Russian Federation	10	1
Denmark	2	1		Rwanda	1	
Ecuador	2			Senegal	9	3
Egypt	3			Singapore	4	
Finland	1			Slovenia	1	
France	20	5		South Africa	5	1
Germany	56	5		Spain	4	1
Ghana	2	1		Sudan	5	
Greece	3			Sweden	10	
Hungary	1			Switzerland	8	1
India	8	1		Thailand	11	
Indonesia	20	1		Togo	1	
Iran	4			Trinidad and Tobago	1	
Ireland	7			Turkey	6	
Israel	8	1		Uganda	1	
Italy	25	1		Ukraine	11	
Jamaica	2			United Kingdom	51	3
Japan	14	3		United Rep. of Tanzania	8	
Jordan	2	1		United States of America	77	6
Kenya	5			Venezuela	1	
Malaysia	2	1		Vietnam	4	
Maldives	1			Zimbabwe	3	
Mauritius	3			**Total**	**603**	**60**

APPENDIX 2

AR6 SCOPING MEETING - WGI FINAL LIST OF SELECTED EXPERTS / PARTICIPANTS

Last Name	First Name	Affiliation	Country/Residence	Gender	Citizenship	Nomination Source
ABDULLA	Fayez	Jordan University of Science and Technology	Jordan	M	Jordan	Ministry of Environment
AMBRIZZI	Tercio	University of São Paulo	Brazil	M	Brazil	Division of Climate Change and Ozone, Ministry of External Relations of Brazil
ARTAXO	Paulo	University of Sao Paulo	Brazil	M	Brazil	Division of Climate Change and Ozone, Ministry of External Relations of Brazil
BARBANTE	Carlo	Institute for the Dynamics of Environmental Processes	Italy	M	Italy	European Union (EU)
BERNTSEN	Terje	University of Oslo	Norway	M	Norway	Norwegian Pollution Control Authority
BRACONNOT	Pascale	Laboratoire des Sciences du Climat et de l'Environnement / IPSL	France	F	France	Ministry for Ecology, Sustainable Development and Energy MEDDE DGEC-ONERC
BRUN	Eric	Ministry of Environment, Energy and Ocean	France	M	France	WGI Bureau
CANADELL	Josep	CSIRO Oceans and Atmosphere	Australia	M	Australia	Australian Government - Department of Environment
CAVAZOS PEREZ	Maria Tereza	Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE)	Mexico	F	Mexico	International Council for Science (ICSU)
CHAO	Qingchen	China Meteorological Administration	China	F	China	China Meteorological Administration
CHRISTENSEN	Jens	Danish Meteorological Institute	Denmark	M	Denmark	DMI
CHURCH	John	-	Australia	M	Australia	Australian Government - Department of Environment
COLLINS	William	University of California, Berkeley	United States of America	M	United States of America	U.S. Department of State
DIALLO	ISMAILA	University of California, Los Angeles (UCLA)	United States of America	M	Senegal	Senegalese Meteorological Agency
DIASSO	Ulrich Jacques	African Centre of Meteorological Applications for Development (ACMAD)	Burkina Faso	M	Burkina Faso	African Center of Meteorological Applications to Development (ACMAD)
DIONGUE NIANG	Aida	Agence nationale de l'aviation civile et de la météorologie (ANACIM)	Senegal	F	Senegal	WGI Bureau
DOBLAS REYES	Francisco Javier	Barcelona Supercomputing Center (BSC)	Spain	M	Spain	Área de Estrategias de Adaptación, Oficina Espanola de Cambio Climatico, Ministerio de Agricultura, Alimentación y Medio Ambiente
DRIJFHOUT	Sybren	Royal Netherlands Meteorological Institute	Netherlands	M	Netherlands	Focal Point Netherlands
DURAND	gael	Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE)	France	M	France	Ministry for Ecology, Sustainable Development and Energy MEDDE DGEC-ONERC
EMORI	Seita	National Institute for Environmental Studies	Japan	M	Japan	Climate Change Division, Ministry of Foreign Affairs
EYRING	Veronika	Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)	Germany	F	Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy
FRIEDLINGSTEIN	Pierre	University of Exeter	United Kingdom	M	Belgium	World Climate Research Programme
GREGORICH	Edward	Agriculture & Agr-Food Canada	Canada	M	Canada	Science and Technology Branch Environment Canada
HAMDI	Rafiq	Royal Meteorological Institute	Belgium	M	Belgium	Belgian Federal Science Policy (BELSPO)
HAYWOOD	Alan	University of Leeds	United Kingdom	M	United Kingdom	Department of Energy and Climate Change (DECC)

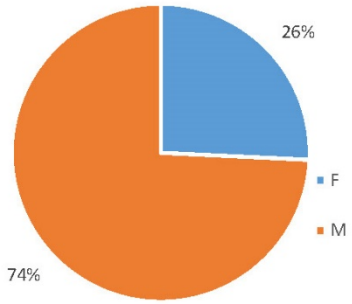
Last Name	First Name	Affiliation	Country/Residence	Gender	Citizenship	Nomination Source
HEWITSON	Bruce	University of Cape Town	South Africa	M	South Africa	International Council for Science (ICSU)
KATTSOV	Vladimir	Voeikov Main Geophysical Observatory	Russian Federation	M	Russian Federation	Institute of Global Climate and Ecology
KAWAMIYA	Michio	Japan Agency for Marine-earth Science and Technology	Japan	M	Japan	Climate Change Division, Ministry of Foreign Affairs
KLUTSE	Nana Ama Browne	Ghana Space Science Technology Institute, Ghana Atomic Energy Commission	Ghana	F	Ghana	Direction de la Meteorologie Nationale
KOPP	Robert	Rutgers University	United States of America	M	United States of America	U.S. Department of State
LEE	June-Yi	Pusan National University	Republic of Korea	F	Republic of Korea	Korea Meteorological Administration (KMA)
LIAO	Hong	Nanjing University of Information Science and Technology	China	F	China	China Meteorological Administration
MAROTZKE	Jochem	Max Planck Institute for Meteorology	Germany	M	Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy
MARZUKI	Marzuki	Andalas University	Indonesia	M	Indonesia	Agency for Meteorology, Climatology and Geophysics (BMKG)
MEARNS	Linda	National Center for Atmospheric Research	United States of America	F	United States of America	U.S. Department of State
MEINSHAUSEN	Malte	Potsdam Institute for Climate Impact Research	Australia	M	Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety International Climate Policy
MENÉNDEZ	Claudio Guillermo	Universidty of Buenos Aires	Argentina	M	Argentina	Department of Environment and Sustainable Development
OTTO	Friederike	University of Oxford	United Kingdom	F	Germany	Department of Energy and Climate Change (DECC)
PIAO	Shilong	Peking University	China	M	China	China Meteorological Administration
PLATTNER	Gian-Kasper	Swiss Federal Research Institute for Forest, Snow and Landscape WSL	Switzerland	M	Switzerland	Swiss Federal Office for the Environment Federal Department of the Environment, Transport, Energy and Communications DETEC Federal Office for the Environment FOEN International Affairs Division
PRATHER	Michael	University of California Irvine	United States of America	M	United States of America	U.S. Department of State
RAGHAVAN	KRISHNAN	Indian Institute of Tropical Meteorology, Centre for Climate Change Research	India	M	India	WGI Bureau
ROJAS	Maisa	Universidad de Chile	Chile	F	Chile	Ministry of Environment
ROSENFELD	Daniel	The Hebrew University of Jerusalem	Israel	M	Israel	Israel Meteorological Service (IMS)
SALLÉE	Jean-Baptiste	Centre national de la recherche scientifique (CNRS)	France	M	France	Ministry for Ecology, Sustainable Development and Energy MEDDE DGEC-ONERC
SHEPHERD	Theodore	University of Reading	United Kingdom	M	Canada	International Council for Science (ICSU)
SHERWOOD	Steven	University of New South Wales (UNSW) Australia	Australia	M	United States of America	Australian Government - Department of Environment
SILLMANN	Jana	Center for International Climate and Environmental Research Oslo (CICERO)	Norway	F	Germany	Future Earth Secretariat
SÖRENSSON	Anna	Center for Ocean and Atmosphere Sciences(CIMA / CONICET-UBA), Franco-Argentinian Institute for the Study of Climate and its Impacts (UMI-IFAECI/CNRS-CONICET-UBA)	Argentina	F	Argentina	Department of Environment and Sustainable Development
STORELVMO	Trude	Yale University	United States of America	F	Norway	

Last Name	First Name	Affiliation	Country/Residence	Gender	Citizenship	Nomination Source
SUTTON	Rowan	University of Reading	United Kingdom	M	United Kingdom	Department of Energy and Climate Change (DECC)
SYLLA	Mouhamadou Bamba	West African Science Service Center on Climate Change and Adapted Land use	Burkina Faso	M	Senegal	Senegal
TAKAYABU	Izuru	Japan Meteorological Agency	Japan	M	Japan	Climate Change Division, Ministry of Foreign Affairs
TANGANG	Fredolin	The National University of Malaysia	Malaysia	M	Malaysia	International Council for Science (ICSU)
TEBALDI	Claudia	National Center for Atmospheric Research (NCAR)	United States of America	F	United States of America	U.S. Department of State
THORNE	Peter	Maynooth University	Ireland	M	United Kingdom	Global Climate Observing System (GCOS)
VAUTARD	Robert	Centre national de la recherche scientifique (CNRS)	France	M	France	Ministry for Ecology, Sustainable Development and Energy MEDDE DGEC-ONERC
ZAABOUL	RASHYD	International Center for Biosaline Agriculture	United Arab Emirates	M	Morocco	Direction de la Meteorologie Nationale
ZHOU	Tianjun	Chinese Academy of Sciences	China	M	China	China Meteorological Administration
ZWIERS	Francis	University of Victoria	Canada	M	Canada	Science and Technology Branch Environment Canada
WGI Bureau Members						
ALDRIAN	Edvin	Vice-Chair of WG I	Indonesia	M	Indonesia	n/a
DRIOUECH	Fatima	Vice-Chair of WG I	Morocco	F	Morocco	n/a
FLATO	Gregory	Vice-Chair of WG I	Canada	M	Canada	n/a
FUGLESTVEDT	Jan	Vice-Chair of WG I	Norway	M	Norway	n/a
MASSON-DELMOTTE	Valérie	Co-Chair WG I	France	F	France	n/a
TARIQ	Muhammad	Vice-Chair of WG I	Pakistan	M	Pakistan	n/a
VERA	Carolina	Vice-Chair of WG I	Argentina	F	Argentina	n/a
YASSA	Noureddine	Vice-Chair of WG I	Algeria	M	Algeria	n/a
ZHAI	Panmao	Co-Chair WG I	China	M	China	n/a

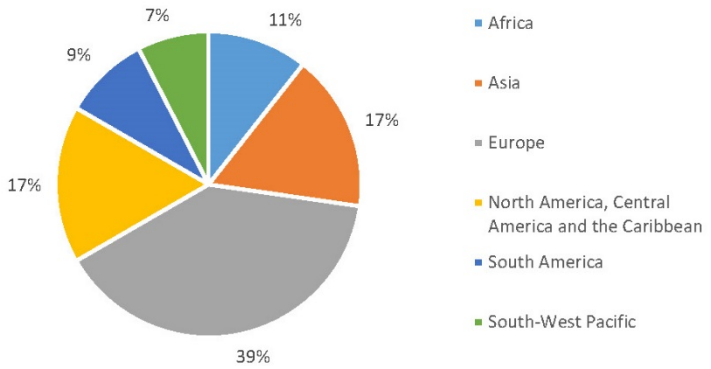
Invited but could not attend

APPENDIX 3 - AR6 WGI Scoping Meeting Participants
66 persons including 59 Experts, 2 Co Chairs and 5 Vice Chairs

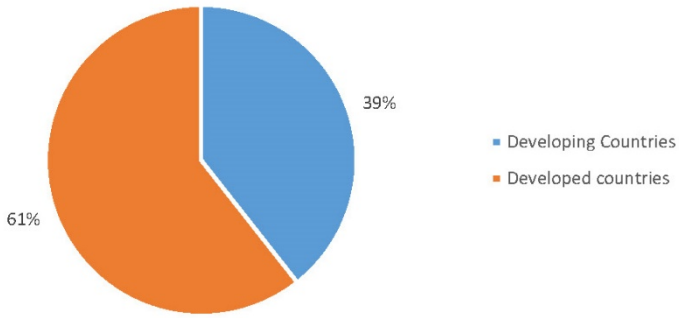
Breakdown by gender



Breakdown by Region



Breakdown by Type of Country



Annex 3: AR6 Scoping Meeting – Addis Ababa, Ethiopia, 1-5 May 2017, WGI Agenda

Day 0 Sunday 30 April

16:00-17:00 Co-chair meeting
16:00-18:30 Early Registration
17:00-18:00 SSC meeting
17:00-18:00 IPCC Secretariat and TSU coordination meeting
18:00-21:00 WG1 Bureau meeting

Day 1 Monday 1 May

7:30- Registration

09:00 - 09:45 Opening ceremony
Hoesung Lee, IPCC Chair
Abdalah Mokssit, IPCC Secretary
Ethiopian Government Representative
ECA Representative

10:15-10:45 Coffee Break

10:45-11:00 6th Assessment Report (AR6) vision and meeting objectives
Chair: Hoesung Lee
Presentation of AR6 vision
Expectations expressed by governments
Expected results of this meeting: three Working Group (WG) report outlines and vision for Synthesis Report (SYR)

11:00-12:15 Working group visions
20 mins + 5 mins clarifying questions per WG:
11:00-11:25 WG1 Valérie Masson Delmotte and Panmao Zhai, WGI Co-Chairs
11:25-11:50 WG2 Debra Roberts and Hans Pörtner, WGII Co-chairs
11:50-12:15 WG3 Jim Skea and Priyadarshi R. Shukla, WGIII Co-chairs

12:15-12:30 Synthesis storyline, tackling cross cutting issues
Chair: Ko Barret

12:30- 12:45 Role and structure of the meeting
Chair: Hoesung Lee
How this meeting feeds into IPCC work flow for the AR6 cycle
The scoping process
Milestone

12:45-13:00 Information on the afternoon programme and room allocation
IPCC secretariat

13:00-14:00 Lunch Cafeteria 2nd floor

14:00-14:30 WGI Meeting: Introduction and Discussion
Valérie Masson Delmotte and Panmao Zhai
Anna Pirani
Meeting Structure and Milestones
WGI Pre-Scoping Questionnaire Feedback
WGI AR6 Background Document

14:30-16:00 WGI Plenary Session I - Scene-Setting Presentations
Chairs: Jan Fuglestvedt, Edvin Aldrian
Facilitator: Sarah Connors
Rapporteur: Robin Matthews

14:30-14:45	Historical Radiative Forcing And The Global Energy Budget Malte Meinshausen, Peter Thorne
14:45-15:00	Climate Sensitivity Seita Emori, Steven Sherwood
15:00-15:15	Carbon and Biogeochemical Feedbacks Pep Canadell, Jean-Baptiste Salée
15:15-15:30	Overview of CMIP6 Activities Veronika Eyring, Alan Haywood
15:30-16:00	Plenary Discussion

16:00-16:30 Coffee break

16:30-18:00 WGI Break out Groups (BOG) Session I
Facilitators: WGI Vice Chairs
Rapporteurs: selected from experts
BOG1: Historical Radiative Forcing And The Global Energy Budget
BOG2: Climate Sensitivity
BOG3: Carbon and Biogeochemical Feedbacks
BOG4: Overview of CMIP6 Activities

18:00-19:00 WGI Bureau Meeting

Day 2 Tuesday 2 May

08:30-09:00 Informal Q&A for new participants
Chair: IPCC Vice-chairs
IPCC + how it works

09:00-10:30 WGI Meeting Plenary Session II - Scene Setting Presentations
Chair: Fatima Driouech, Greg Flato
Facilitator: Wilfran Moufouma Okia
Rapporteur: Sarah Connors

09:00-09:15	Climate Variability Jochem Marotzke, Tianjun Zhou
09:15-09:30	Extreme Events Friedrike Otto, Rashyd Zaaboul

09:30-09:45 Near Term Climate Predictability and Prediction
June-Yi Lee, Francisco Doblas-Reyes
09:45-10:00 Regional Climate Projections
Bruce Hewitson, Izuru Takayabu
10:00-10:30 Plenary Discussion

10:30-11:00 Coffee break

11:00-12:30 WGI BOG Session II
Facilitators: WGI Vice Chairs
Rapporteurs: selected from experts
BOG1: Climate Variability
BOG2: Extreme Events
BOG3: Near Term Climate Predictability and Prediction
BOG4: Regional Climate Projections

12:30 - 14:00 Lunch

13:30-14:00 Q&A on SYR - lessons learnt from AR5
Chair: IPCC Vice-chairs
Jan Fuglestvedt (WGI), Joy Pereira (WGII), Andy Reisinger (WGIII)

14:00- 16:00 WGI Meeting Plenary Session III
Chairs: Panmao Zhai, Greg Flato
Facilitator: Robin Matthews
Rapporteur: Wilfran Moufouma-Okia
Report back from BOG Session I by the rapporteurs (5mn per report – 10 mn questions)
Report back from BOG Session II by the rapporteurs (5mn per report – 10 mn questions)
Core Elements and Story Line of WGI Report
Potential chapters
Identifying Cross-WG Topics for BOGs

16:00-16:30 Coffee break

16:30-18:00 Plenary
Chair: Hoesung Lee
Moderators: Ko Barret, Thelma Krug, Youba Sokona
Report back on cross cut issues

18:00-19:00 SSC meeting

Day 3 Wednesday 3 May

09:00 - 10:15 Plenary - Report back on Content of WG discussion
Chair: Hoesung Lee
Moderators: Ko Barret, Thelma Krug, Youba Sokona
What is status of WG discussions
SSC report back on decision and rational for cross cut BOGS
Cross-WG coordination and consistency

10:15-10:45 Coffee break

10:45 - 12:15 Cross cut BOGs
XBOG1: Risk
XBOG2: Cities
XBOG3: Global Stocktake
XBOG4: Regions
XBOG5: Scenarios

12:15 - 13:45 Lunch

13:45-15:15 Cross cut BOGs
XBOG4 (continued): Regions
XBOG5 (continued): Scenarios
XBOG6: Geoengineering
XBOG7: Adaptation and Mitigation
XBOG8 : Process

15:15-15:45 Coffee break

15:45-18:30 WGI Meeting Plenary Session IV
Chair: Noureddine Yassa, Carolina Vera
Facilitator: Sarah Connors
Rapporteur: Anna Pirani
From Core elements of WGI
Implementation of cross cuts
SYR considerations

18:30-19:00 Break

19:00-20:00 Evening session - brainstorm on SYR storyline
Chair: Hoesung Lee, IPCC Chair
Moderator: Ko Barret, Thelma Krug, Youba Sokona

Day 4 Thursday 4 May

09:00-10:30 WGI Meeting Plenary Session V
Chairs: Panmao Zhai, Valérie Masson-Delmotte
Facilitator: Wilfran Moufouma-Okia
Rapporteur: Robin Matthews
Proposed List of Chapters

Clustering of Chapters to form BOGs III

09:00-10:30 SYR BOG

SYR BOG1: Global Stocktake

SYR BOG2: Interaction among emissions, climate, risks and development Pathways

SYR BOG3: Economic and social costs and benefits of mitigation and adaptation in the context of development pathways

SYR BOG4: Adaptation and mitigation actions in the context of sustainable development

10:30-11:00 Coffee break

11:00-12:30 WGI Meeting BOG Session III

Facilitators selected from experts

BOGs around chapter clusters - chapter content:

BOG1: Chapters 1-2-3

BOG2: Chapters 5-6-7

BOG3: Chapters 8-9

BOG4: Chapters 4-10

BOG5: Chapters 11-12

11:00-12:30 SYR BOG

SYR BOG1: Global Stocktake

SYR BOG2: Interaction among emissions, climate, risks and development Pathways

SYR BOG3: Economic and social costs and benefits of mitigation and adaptation in the context of development pathways

SYR BOG4: Adaptation and mitigation actions in the context of sustainable development

12:30 - 14:00 Lunch

14:00-16:00 WGI Meeting Plenary VI

Facilitators selected from experts

Report back from BOGs - chapter content

14:00-16:00 SYR BOG

SYR BOG1: Global Stocktake

SYR BOG2: Interaction among emissions, climate, risks and development Pathways

SYR BOG3: Economic and social costs and benefits of mitigation and adaptation in the context of development pathways

SYR BOG4: Adaptation and mitigation actions in the context of sustainable development

16:00-16:30 Coffee break

16:30-18:00 Plenary Stocktake - Report back from SYR Session

Chair: Hoesung Lee

Moderators: Ko Barret, Thelma Krug, Youba Sokona

Day 5 Friday 5 May

09:00-10:30 WGI Meeting Plenary Session VII
Chair: Valerie Masson-Delmotte, Panmao Zhai
Faciltator: Anna Pirani
Rapporteur: Wilfran Moufouma-Okia
Overview of Report Outline

10:30-11:00 Coffee break

11:00 - 12:30 WGI Meeting Plenary Session VII continued
Chair: Valerie Masson-Delmotte, Panmao Zhai – WGI Co-chairs
Faciltator: Anna Pirani, WGI TSU
Rapporteur: Wilfran Moufouma-Okia, WGI TSU
Overview of Report Outline

12:30 - 14:00 Lunch

14:00 - 17:30 Concluding plenary
Chair: Hoesung Lee, IPCC Chair
Draft outlines for WG reports
Preliminary vision for SYR
Suggestions for guidance notes, Expert Meetings

Annex 4: Mapping of AR6 topics compared to the AR5

To facilitate an overview of the distribution of topics within the AR6 WGI structure, compared to the AR5 report, the table maps the treatment of topics across the AR5 (horizontal lines) and AR6 chapters (vertical columns). The table highlights topics covered in several chapters that will require cross-chapter coordination. All topics covered in the AR6 outline have been incorporated into the table. The text in blue highlights topics that were not present in AR5 but may be covered in AR6. Blank cells indicate that topics from the highlighted AR6 chapter outline would not be reflected in the selected AR5 chapter, for example, no topics covered in the AR6 Chapter 4 outline (Future global climate) would have been covered in the AR5 Observations Chapters (Chapter 2-4) thus these cells remain blank.

Table 1: AR6 bullets mapped onto the AR5 outline, as described on page 56.

	AR6											
AR5	1. Framing, context, methods	2. Changing state of the climate system	3. Human influence on the climate system	4. Future global climate: scenario-based projections & near-term information	5. Carbon budgets, biogeochemical cycles & feedbacks	6. Short-Lived Climate Forcers & Air Quality	7. The Earth's Energy Budget, Climate Feedbacks, & Climate Sensitivity	8. Water Cycle Changes	9. Ocean, Cryosphere, & Sea Level Change	10. Linking Global to Regional Climate Change	11. Weather & Climate Extreme Events in a Changing Climate	12. Climate change information for regional impacts & risk assessment
1. Introduction	Key findings from observational & reanalysis developments since last assessment & AR6 Special Reports. Framing (GST, mitigation, adaptation, & risk assessment). Treatment of										Event type definitions inc. Weather, climate timescales, compound events. Observations for extremes & their limitations, inc. paleo.	Framing: physical climate system & hazards
2. Observations: Atmospheric & Surface & Climate Change	Emissions & forcing scenarios. Observational & reanalysis developments since previous assessment		Simulated large-scale indicators of change		Historical trends & variability of CO2, CH4 & N2O; sources & sinks	Key emissions: natural, anthropogenic, historical & scenarios. GHG lifetimes.	Energy budget & its changes through time.*	Changes in seasonality of natural storage & water availability		Regional phenomena, drivers, feedbacks & teleconnections. Regional scale observations & regional reanalyses.	Event type definitions inc. weather & climate timescales & compound events	Quantitative & qualitative info on changing hazards: present day, near term & long term.
3. Observations: Ocean	Observational & reanalysis developments since the last assessment. Treatement of uncertainty.				Ocean acidification				Past & future changes in ocean circulation & properties. Extreme water levels.			
4. Observations: Cryosphere									Past & future changes in marine & terrestrial cryosphere			
5. Information from Paleoclimate Archives		Multi-millenial context, pre-industrial to present day			Feedbacks, inc. paleoclimate info. Abrupt change, irreversibility.		Empirical constraints on climate system sensitivity, inc. paleo.		Abrupt change & long-term commitment.		Observations for extremes & their limitations, inc. Paleo.	
6. Carbon & Other Biogeochemical Cycles		Large-scale indicators of chang. Modes of Variability.	Simulated large-scale indicators of change	GHG removal & SRM.	Feedbacks, inc. paleo info. Impacts of mitigation options inc. GHG removal & SRM. Ocean acidification.	Key emissions: natural, anthropogenic, historical & scenarios. GHG lifetimes.	Climate feedbacks.	Changes in seasonality of natural storage & water availability. Abrupt change. Confidence in projections.				
7. Clouds & Aerosols						Key emissions: natural, anthropogenic, historical & scenarios. Direct & indirect-aerosol forcing.		Changes in seasonality of natural storage & water availability				
8. Anthropogenic & Natural RF	Emissions & forcing scenarios. Treatment of uncertainty.	Natural & anthropogenic forcings. RF.				Observed & reconstructed concentrations & RF. Direct & indirect-aerosol forcing. Earth's energy budget.	Energy budget & its changes through time*. RF: definitions, estimates, & its representation in models. GWP, global temperature change potential, & other metrics.					
9. Evaluation of Climate Models	Assessment approach. Model & experimental design since the last assessment. Treatment of uncertainty.		Model performance & development since last assessment. Natural variability versus anthropogenically-forced change.	Evaluation of multi-model ensemble methods	Model evaluation, emergent constraints		RF: definitions, estimates, & its representation in models. Climate system sensitivity: methods & uncertainty. Empirical constraints on climate system sensitivity, inc. paleo.		Evaluation of models & projection methods	Evaluation of methods, inc. downscaling & bias. Scale specific methodologies. Confidence in regional climate information, inc. quantification of uncertainties. Synthesizing multiple lines of evidence	Mechanisms, drivers & feedbacks leading to extremes. Ability of models to simulate extremes & related processes.	Region-specific methodologies. Region-specific integration of information, inc. confidence.

	AR6											
AR5	1. Framing, context, methods	2. Changing state of the climate system	3. Human influence on the climate system	4. Future global climate: scenario-based projections & near-term information	5. Carbon budgets, biogeochemical cycles & feedbacks	6. Short-Lived Climate Forcers & Air Quality	7. The Earth's Energy Budget, Climate Feedbacks, & Climate Sensitivity	8. Water Cycle Changes	9. Ocean, Cryosphere, & Sea Level Change	10. Linking Global to Regional Climate Change	11. Weather & Climate Extreme Events in a Changing Climate	12. Climate change information for regional impacts & risk assessment
10. Detection & Attribution of Climate Change: from Global to Regional	Treatment of uncertainty.		Attribution of large-scale observed changes. Simulated modes of variability.				Climate system sensitivity: methods & uncertainty. Empirical constraints on climate system sensitivity, inc. paleo.	Observations, models, methods & their reliability. Water cycle past, present & projected changes, trends, variability & feedbacks. Circulation, processes & phenomena affecting moisture & precipitation patterns. Extremes	Detection & attribution	Internal variability & forced change interplay at the regional scale, inc. attribution.	Attribution of changes in extremes & extreme events.	
11. Near-term Climate Change: Projections & Predictability			Natural variability vs. anthropogenically-forced change.	Projections of key global indicators. Large scale patterns of CC. Commitment, climate targets, overshoot, irreversibility, abrupt change. Internal variability & forced change interplay. Variability & unexpected changes of GMST. Predictability, sources & capabilities. Near-term climate info.	Projections of global biogeochemical cycles from near-term to long-term	Future air pollution, inc. cities.		Changes in seasonality of natural storage & water availability. Abrupt change. Confidence in projections			Projected changes of extremes & potential surprises	
12. Long-term Climate Change: Projections, Commitments & Irreversibility			Simulated large-scale indicators of change.	Commitment, climate targets, overshoot, irreversibility, abrupt change.	Projections of global biogeochemical cycles from near-term to long-term. Transient climate response to cumulative emissions & remaining carbon budgets for climate targets. Abrupt change, irreversibility		Energy budget & its changes through time.* Climate feedbacks. Climate system sensitivity: methods & uncertainty. Empirical constraints on climate system sensitivity, inc. paleo	Changes in seasonality of natural storage & water availability. Abrupt change. Confidence in projections	Abrupt change & long-term commitment.		Projected changes of extremes & potential surprises	
13. Sea Level Change		Large-scale indicators of change.		Projections of GMST & other key global indicators.			Energy budget & its changes through time.*		Past global & regional sea level changes. Projections of global & regional sea level change. Abrupt change & long-term commitment. Extreme water levels.			
14. Climate Phenomena & their Relevance for Future Regional Climate Change		Modes of Variability	Simulated large-scale indicators of change. Natural variability vs anthropogenically-forced change.	Commitment, climate targets, overshoot, irreversibility, abrupt change. Variability & unexpected changes of GMST. Responses to SLCFs, inc. volcanoes.					Extreme water levels (tides, surge & ocean waves).	Regional phenomena, drivers, feedbacks & teleconnections. Internal variability & forced change interplay at the regional scale, inc. attribution.	Case studies across timescales	Region-specific integration of information, inc. confidence. Quantitative & qualitative info on changing hazards: present day, near term & long term. Region-specific

* Was a box in Ch13.

CC = Climate Change, GHG = Greenhouse Gas, GMST = Global Mean Surface Temperature, GST = Global Stocktake, GWP = Global Warming Potential, RF = Radiative Forcing, SLCF = Short Lived Climate Forcer, SRM = Solar Radiation Management.