ipcc
INTERGOVERNMENTAL PANEL ON climate change

FORTY-FIFTH SESSION OF THE IPCC
Guadalajara, Mexico, 28 - 31 March 2017

IPCC-XLV/INF. 2
(27.II.2017)
Agenda Item: 6.1
ENGLISH ONLY

SIXTH ASSESSMENT REPORT (AR6) PRODUCTS

Outline of the Special Report on Climate Change and Oceans and the Cryosphere

(Prepared by the Scientific Steering Committee for the Scoping of the Special Report)

(Submitted by the Secretary of the IPCC)

IPCC Secretariat

c/o WMO • 7bis, Avenue de la Paix • C.P. 2300 • 1211 Geneva 2 • Switzerland
telephone : +41 (0) 22 730 8208 / 54 / 84 • fax : +41 (0) 22 730 8025 / 13 • email : IPCC-Sec@wmo.int • **www.ipcc.ch**

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Box 1: Special Report Proposed Outline

Summary for Policy Makers (~15 pages)

Chapter 1: Framing and Context of the Report (~15 pages)
Chapter 2: High Mountain Areas (~20 pages)
Chapter 3: Polar Regions (~50 pages)
Chapter 4: Sea Level Rise and Implications for Coasts and Communities (~50 pages)
Chapter 5: Changing Ocean, Marine Ecosystems, and Dependent Communities (~65 pages)
Chapter 6: Extremes, Abrupt Changes and Managing Risks (~20 pages)

Case Studies, Frequently Asked Questions and Boxes (~20 pages)
Cross-Chapter Box: Low Lying Islands and Coasts (up to 5 pages)

7. ANNOTATED PROPOSED OUTLINE OF CHAPTERS FROM THE SCOPING MEETING

The following text provides additional information on the annotated Special Report outline, based on expert discussions reported throughout the scoping meeting, and particularly those discussions emerging during Breakout Group Session III and the final plenary.

Chapter 1: Framing and Context of the Report

- Integrated storyline of the report, chapter narrative, chapter sequence and their linkages (including coverage of extremes and abrupt change and irreversible changes)
- Definition of ocean and cryosphere and their components
- Observing capacities, progress and limitations (e.g., time series and spatial coverage)
- Assessment methodologies, including indigenous and community knowledge, risk, and applications of detection and attribution
- Role of ocean and cryosphere in the climate system, including characteristics, key feedbacks and time scales
- Implications of ocean and cryosphere change for resources, natural systems (e.g., loss of habitat, extinctions) and human systems (e.g., psychological, social, political, cultural and economic aspects)
- Linkages of this report to relevant institutional and policy contexts (e.g., Paris Agreement and SDGs, Sendai Framework)
- Treatment of vulnerabilities and marginalized areas and people (e.g., gender) in this report
- Scenarios and time frames considered in this report
- Treatment of uncertainty

The first bullet introduces the reader to the way the report is structured and the content presented. It explains the narrative that each chapter follows, i.e., from key processes and feedbacks to impacts to responses. The rationale for the chapter order will also be introduced, representing the flow of water from mountain areas and polar regions towards the oceans. The linkages between the chapters are to be made explicit.

The second bullet point addresses the need to clarify upfront the meaning of key terms used in the report. As different audiences may understand these terms differently, it was considered important to establish a shared understanding at the onset of the report.

The third bullet point makes explicit the challenges for research on ocean, cryosphere and people. This includes the limitations of observational data, gaps in data, and the challenges of integrating natural and social sciences.

The fourth bullet point describes and explains the underlying core methodologies used to assess changes in the ocean and cryosphere as well as the methodologies used to assess the literature referred to in the report. This includes the use of forms of knowledge such as indigenous and local/community knowledge, which has been identified as a cross-cutting theme across all chapters.

The fifth bullet point provides essential background information for understanding the rest of the report. In particular, it explains the role of the oceans and cryosphere in the climate system. Based on discussions it was decided that the inclusion of this fundamental information upfront would improve the readability of the overall report, free up space in the subsequent chapters, and thus create a tighter report.

The sixth bullet point introduces the implications of change for natural and human systems. For human systems this includes psychosocial, political, cultural and economic aspects. This information helps the reader to understand the interactions between processes that will be discussed in greater detail in the subsequent chapters.

The seventh bullet point positions the report and its content in the wider context within which policy and decision making occurs. These contexts include intergovernmental agreements and frameworks as well as other relevant institutional agendas.

The eight bullet point makes it explicit how vulnerability and marginalization are both defined and treated in the report, in relation to places and people.

The ninth bullet point clarifies the time frames that are considered in the report (including paleo perspectives, horizons for future projects, etc.), and provides a brief explanation of the range of scenarios that have been included in the chapters.

The tenth bullet point clarifies how uncertainty is treated in the report. This is important to establish at the outset so that the reader is aware of the different types of uncertainty and understands how to interpret the language used to communicate the degree of certainty in the assessment findings throughout the report.

Chapter 2: High Mountain Areas

- Common drivers for changes in mountain cryosphere (glaciers, permafrost, and snow, including tropical regions) and feedbacks (e.g., CH4 emissions, albedo) to regional and global climate
- Effects of a changing mountain cryosphere on natural hazards and management options for protecting lives, livelihoods, infrastructure, and ecosystems
- Impacts from changes in the mountain environment (e.g., snow cover) on habitability, community livelihoods and culture, and adaptation options
- Risks for societies that depend on mountain cryosphere for water resources (e.g., human consumption, ecosystems and agriculture) and potential response strategies (e.g., national and international water resource management and technologies)
- Impacts of variability and trends in water supply on hydropower production and implications for energy policy and water governance
- Influence of mountain cryosphere run-off on coastal systems and sea level

The chapter is intended to provide a wide-ranging assessment of impacts and risks associated with cryosphere changes in high mountain areas. The scope of the chapter includes all mountain areas across the globe where snow, glaciers, or permafrost are important components, including coverage of tropical regions.

The first bullet recognizes that there are fundamental changes occurring in the mountain cryosphere that effect many of the impacts and risks addressed in the subsequent bullets. This bullet therefore addresses these fundamental drivers upfront, including observed and projected changes in glaciers, permafrost, and snow. Key overarching issues of data scarcity and uneven distribution of data in mountain regions are to be addressed. The group discussed the need for the chapter to address the potential release of CH_4 emissions from thawing permafrost in high mountain Asia. Other important feedback mechanisms that were identified included the role of black carbon and other aerosols in reducing surface albedo, and the effects of a changing cryosphere on monsoon.

The second bullet relates to flood and landslide (slides, rockfalls, avalanches, etc.) hazards resulting from or influenced by a changing mountain cryosphere. Floods include both glacial lake outburst floods, but also other flash floods or seasonal floods that could relate to rapid melting of snow and ice. The chapter is tasked with assessing the potential impact of such hazards on lives, livelihoods, transportation, infrastructure, and ecosystems. Management options were discussed within a framework of risk management and governance, and included community based adaptation options that draw on local and indigenous knowledge.

The third bullet is intended to cover those impacts which directly affect people living in the mountain regions. The example of snow cover was provided, as it was discussed how a change in snow cover could influence local farming practices. Equally, changes in glaciers or permafrost could also impact on food security, economic viability, settlements, and cultural identity. The adaptation options discussed by the group highlighted alternative livelihood strategies, migration, participatory adaptive planning, incl. engineering measures, promotion of ecotourism, financial and other support mechanisms.

The fourth bullet, by contrast, addresses those far-reaching impacts that affect downstream societies who depend on or get benefit from water resources emerging from the mountain cryosphere. Such downstream societies may use this water for consumption, and for sustaining ecosystems and agriculture. The need for a trans-boundary perspective to issues of water resource management was discussed.

The fifth bullet recognises the particular threat that changes in the high mountain cryosphere pose to the hydro-power sector. This relates to changes in the quantity, timing, and quality of runoff coming from the cryosphere. The group discussed how the relative importance of different runoff components (e.g, from glaciers, snow or even permafrost) will vary across different high mountain regions. The chapter will assess implications for national and international energy policy and issues of water governance.

The final bullet serves as input primarily for chapter 4, providing an assessment of the total runoff that will come from the mountain cryosphere and make its way to the ocean. The importance of freshwater runoff potentially changing coastal systems or influencing ocean circulation was also identified as a cross-chapter issue to be addressed (e.g., the influence of the Patagonian ice-cap contribution to ocean circulation).

Tropical mountain glaciers were noted as a particularly relevant theme for a case study, given the unique processes and impacts occurring in these regions.

Chapter 3: Polar Regions

- Changes in atmospheric and ocean circulation that influence polar regions, including regional feedbacks and teleconnections and paleo perspectives
- Greenland and Antarctic ice sheets and ice shelves, Arctic glaciers, mass change, physics of dynamical instability and accelerated ice discharge; consequences for ocean circulation and biogeochemistry, and sea level
- Changing snow cover and thawing permafrost (terrestrial and subsea); carbon flux and climate feedbacks; impacts on infrastructure and ecosystems; community-based adaptation
- Changing sea ice; effects on climate; implications for ecosystems, coastal communities, transportation and industry
- Changing polar ocean (physical, dynamical and biogeochemical properties), implications for acidification, carbon uptake and release; impacts on ecosystems and fisheries; adaptation options (e.g., ecosystem-based management and habitat protection) and limits to adaptation
- Access to resources and ecological, institutional, social, economic, and cultural consequences of polar change, including issues of international cooperation
- Responses to enhance resilience

The main objective of the chapter is an integrated assessment in the polar regions across natural, social and human dimensions. Knowledge should be synthesized in a holistic manner related to biological and social vulnerability, considering adaptation options and limits.

The first bullet point recognizes the importance of understanding how the changes in the atmospheric and ocean circulation influence polar regions, and how changes in polar climate and regional feedbacks can affect climate at mid latitudes. Atmospheric changes are related to changes in air-sea fluxes and heat transport and redistribution, with implications for biogeochemical feedbacks (e.g., deoxygenation, acidification, dimethylsulphide). Teleconnections are important for regional processes including deep water formation and convection, and ice shelf ocean–sea ice interactions, with major implications for global ocean circulation. The participants discussed how information from past climates can provide knowledge relevant to key uncertainties in future projections, including potential irreversible changes.

The second bullet point addresses the climate-related responses of the Greenland and Antarctic ice sheets and ice shelves, and Arctic glaciers. Topics discussed included the components and drivers of mass balance and flow changes, temporal and spatial patterns of observed and projected changes, new process based understanding (e.g., submarine melt, iceberg calving, instability mechanisms), the detection of the onset of rapid ice sheet retreat and implications for sea level change, as an input for Chapter 4. Progress has been identified in recognising small-scale processes that drive overall large-scale processes.

The third bullet point is related to changing snow cover, snow on sea ice, drivers of changes in snow albedo (including aerosols and black carbon), and regional-specific firn processes in the snowpack that can affect sea level rise (e.g., capacity of Greenland firn to buffer runoff). The discussion included impacts of albedo and black carbon on terrestrial permafrost and the global implications through an assessment of knowledge on carbon feedbacks. Subsea permafrost was highlighted, including impacts of thawing on infrastructure, coastal erosion, ecosystems, health, and implications for community-based adaptation.

The fourth bullet point relates to the impacts of changing sea ice in a broad sense across biological-social-economic systems: implications for sea-ice ecosystems, coastal communities, indigenous people, transportation and industry, resource extraction, pollution, movement, hunting, fishing, changes in Arctic economy, with substantial differences between the Arctic and the Antarctic regions.

The fifth bullet point deals with changes in the polar oceans that are increasingly vulnerable to warming and ocean acidification, with resulting changes in physical, dynamical and biogeochemical properties (including irreversible impacts on carbon uptake, storage and release). The most substantial changes pertain to the impacts on ecosystems and fisheries, with potential loss of functional and structural components of the ecosystems and biodiversity. It was discussed that large uncertainties relate to the impacts of multiple stressors with potentially additive, non-linear effects and associated thresholds. Impacts related to the fisheries and shellfish industry were highlighted, given the regional and/or global economic consequences. Adaptation and its limits needs to be addressed on regional scales with a focus on ecosystem-based management and habitat protection, while considering governance frameworks.

The sixth bullet point focuses on the consequences of access to resources and their extraction in terms of ecological, institutional, social, economic, and cultural aspects. Addressing issues such as associated ecosystem damages (e.g., from deep sea bed mining) through governance frameworks and collaboration on national and international levels was considered.

The seventh bullet point is cross-cutting (cross-chapter) and interdisciplinary in trying to identify responses to enhance resilience in the polar regions, related to either biological, ecological or social resilience.

Several themes for case studies were proposed, including relocation of communities as a consequence of thawing permafrost and coastal erosion; glaciers and/or ice sheets in Greenland or at Pine Island and Thwaites in Antarctica; assessment of the co-production of knowledge concerning sea ice; territorial claims and national boundaries.

Chapter 4: Sea Level Rise and Implications for Coasts and Communities

- Observations and projections of sea level at global and regional scale, attribution to drivers, factors that influence relative sea level change, and long-term commitment and paleo perspective
- Demographic and socio-economic factors that drive vulnerability and exposure to sea level rise
- Current and future sea level rise risks resulting in biophysical, ecological, economic, political, cultural, social and psychological impacts
- Implications of sea level rise for highly vulnerable coastal zones, particularly SIDS, coastal cities and infrastructure, deltas and low-elevation areas
- Pathways to resilience and sustainable development: measures, safety margins, barriers and enablers

This chapter is aimed at an integrative assessment of new findings (since AR5) on the effect of global and regional sea-level changes on human and natural systems. New knowledge including the synthetic understanding of drivers, impacts, and adaptation. Moreover, the chapter needs to consider the different geographic and time scales of sea-level change, impacts, and adaptation challenges.

The first bullet refers to new developments on global, regional and relative sea level change, including the discussion of issues such as subsidence/glacial isostatic adjustment, committed change, natural variability, uncertainties, rapid/abrupt change (e.g., due to the collapse of ice sheets), regional variations, anthropogenic drivers, past sea level changes / paleo-evidence, and attribution.

The second bullet encompasses demographic and socio-economic processes that drive vulnerability and exposure to sea level rise and amplify risk (e.g., land use changes, tourism, settlement/ urbanisation, ports/trade). Social settlement patterns should be described as a key process in the human system influencing vulnerability and impacts of sea level change. Moreover, this bullet refers to feedbacks, such as “coastal squeeze” and implications for the hinterland, and cascading effects, involving, e.g., changing coastlines, the spread of diseases, impacts on biodiversity, poverty and inequality.

The third bullet focuses on the various dimensions of impacts observed and future risks, encompassing biophysical (e.g., frequency and intensity of storm surges and peak tides, coastal erosion, coastal flooding, water supply, saline intrusion); ecological (e.g., mangroves, saltmarshes, biodiversity); economic (e.g., tourism, trade, livelihoods, food security); infrastructural (e.g., coastal protection, energy, ports, and transportation); political (e.g., changes to and loss of territory, security); cultural, social, and psychological (e.g., impacts on communities, health, poverty, migration, relocation).

The fourth bullet specifically addresses observed and future risks affecting highly vulnerable coastal zones, particularly SIDS, low-elevation areas, deltas, coastal cities, the built environment and infrastructure. The bullet considers biophysical, ecological, social, and economic dimensions, and including case studies.

The last bullet refers to adaptation options and interventions (i.e., protect, accommodate, retreat), including a discussion of alternative response strategies, involved barriers, enablers, capacities for resilience and sustainable development (e.g., data and information, institutional, economic, cultural, social, technological, financial), pathways to resilience (e.g., coastal zone management, safety margins, costs, lock-in, flexibility), linking Climate Change to Disaster Risk Management and Sustainable Development Goals.

Chapter 5: Changing Ocean, Marine Ecosystems, and Dependent Communities

- Changes in key physical and biogeochemical properties and processes, including the deep ocean, their feedbacks on the climate system
- Specific and combined effects of changes in climate related variables (e.g., warming, acidification, and oxygen loss) on e.g., species distribution and exclusion, habitat compression, food webs
- Impacts of ecosystem changes on key ecosystem services (e.g., carbon uptake, biodiversity, coastal protection, food security and tourism)
- Degradation in benthic habitat (e.g., storm-driven) and improved resilience through conservation and restoration
- Interactions of climate and non-climatic drivers (e.g., pollution, fishing practices, resource extraction, habitat changes); impacts on marine environments, ecosystems, and human health
- Blue carbon, nature-based solutions, and ocean implications of different mitigation measures
- Climate change impacts and trade-offs in ocean economies and governance across all scales
- Adaptation options for marine ecosystem dependent communities and their livelihoods

The first bullet refers to past, current and possible future changes in marine physical and biogeochemical processes and properties, within the context of anthropogenic emissions of greenhouse gases and consequences for marine ecosystems. Warming, freshening/salinification, deoxygenation and acidification were identified as key climatic stressors. Salinity was noted to be particularly relevant in the context of cryospheric change, linking to Chapter 3, being influenced by freshwater inputs from sea and land ice melt. Participants highlighted the role of salinity and temperature in controlling ocean stratification and resulting effects on surface nutrient concentrations and marine ecosystems (e.g., warming reducing mixing/upwelling through enhanced stratification, resulting in decline in surface nutrients and primary productivity). Participants stressed consideration of deep sea environments and habitats (e.g., low oxygen areas), in addition to those in surface waters. The importance of considering modes of climate variability (e.g., Pacific Decadal Oscillation, North Atlantic Oscillation) was also noted. Finally, the bullet also makes explicit reference to ocean feedbacks on the climate system, such as those related to the ocean's role in heat and carbon uptake.

The second bullet considers how change in the key physical and biogeochemical processes and parameters referenced in the first bullet can, singularly and in tandem, affect marine organisms and ecosystems. Types of impacts highlighted included disruption of organismal physiology, alteration of species abundances, compositions and distributions (laterally and vertically), modification of harmful algal blooms, propagation of invasive species and marine diseases, and development of novel food webs. Participants highlighted that insight into future changes may come from knowledge of past climate events (e.g., acidification events from the geological history), along with recent developments in marine biogeochemical modelling. Several ecosystems and regions were identified being particularly vulnerable to climate change including sea ice and deep sea ecosystems, mangroves, coral reefs (warm and cold) and deltas.

The third bullet refers to how the impacts on marine organisms and ecosystems considered in the second bullet can affect related ecosystem services. Types of ecosystem services highlighted in this context included provisional (e.g., fisheries) and regulatory (e.g., heat and carbon uptake, coastal protection). An example would be sea level rise causing salinization of coastal and estuarine systems, with resulting implications for coastal protection. Fisheries (both catch and aquaculture) were noted to be a key ecosystem service (affecting food security), and one potentially vulnerable to climate change through impacts on species and primary productivity, among other mechanisms.

The fourth bullet concerns degradation of coastal and deep ocean benthic habitats in the context of climate change (e.g., increased storm intensity driving loss of benthic species, with resulting implications for coastal protection). An example provided for the deep ocean was warming and organic matter increase leading to oxygen decline and habitat loss, and resulting consequences for fisheries. Participants highlighted ecosystem conservation (e.g., abatement of nutrient pollution to reduce eutrophication) and habitat restoration (e.g., of mangrove swamps) as examples of response strategies for increasing resilience.

The fifth bullet concerns the broader context of human impacts on the marine environment into which climatic stressors fit. Human activities noted in this regard included fisheries and aquaculture, marine transportation, resource extraction (e.g., oil, gas, mineral) and marine renewable energy. Participants highlighted chemical and noise pollution and overfishing as examples of impacts that can result from these activities. The bullet point recognises that interactions between such non-climatic stressors and those from climate change can result in synergistic effects, different from those that would result if only the climatic stressors operated in isolation.

The sixth bullet refers to strategies for enhancing the carbon storage capabilities of marine ecosystems (i.e., 'blue carbon') through conservation and restoration measures. Carbon-rich coastal ecosystems are a particular focus of such mitigation methods (e.g., mangroves, saltmarshes and seagrasses). The bullet also more generally considers the effects that these so-called 'nature-based solutions' and other (e.g., non-marine) mitigation strategies can have on the marine environment.

The seventh bullet references the challenge of managing climatic risks (and benefits) to marine ecosystems in light of their trans-boundary nature (e.g., coastal to open ocean) and possible presence of multiple-stressors. Several governance frameworks spanning a range of scales were identified by participants in this context, including coastal zone management, marine spatial planning, and the UN Sustainable Development Goals. Participants noted that trade-offs can exist between marine economic activities and strategies to enhance resilience to climate change (e.g., trade-offs between marine protected areas and fishing activities).

The final bullet addresses possible response strategies that communities dependent upon marine ecosystem services (e.g., through food security and livelihoods) can take to enhance their resilience to climate change. Such strategies were noted to range from short-term preventative measures to more in-depth transformational change actions. Examples provided included amelioration of existing non-climatic stressors (e.g., abatement of nutrient pollution to reduce eutrophication, use of sustainable fishing and aquaculture practices), real-time monitoring of physical and biogeochemical properties, education and capacity building. The importance of considering social, economic and cultural elements in adaptation planning was also noted, including use of relevant indigenous knowledge where available (e.g., from SIDS and Arctic communities).

Case studies were proposed on several regions/communities, including regional marginal seas; eastern boundary upwelling regions; deep ocean; deltas; blue belts; mangroves; coral reefs; and SIDS.

Chapter 6: Extremes, Abrupt Changes and Managing Risks

- Risks of abrupt change in ocean circulation and cryosphere and potential consequences
- Extreme ENSO events and other modes of variability and their implications
- Marine heat waves and implications
- Changes in tracks, intensity, and frequency of tropical storms and associated wave height
- Cascading risks, irreversibility, and tipping points
- Monitoring systems for extremes, early warning and forecasting systems in the context of climate change
- Risk management, including disaster risk reduction and enhancing resilience

The rationale for this chapter is that while certain classes of marine and cryospheric extreme and abrupt change events could logically be integrated elsewhere within the report, several cannot due to their inherently cross-cutting nature. Types of events fitting this category include those cross-cutting across multiple aspects, including drivers, polar regions, impacts (e.g., related to meridional ocean overturning circulation processes), and those with implications of broader scope than could adequately be addressed elsewhere (e.g., marine heat waves). A dedicated chapter was thus seen as allowing for more holistic and synergistic coverage of such events, spanning the common chapter narrative from key processes and feedbacks to impacts and responses. Meeting discussions touched upon the broad-range of impacts of recent marine and cryospheric extremes on human and natural systems, and how risks from abrupt changes may be particularly challenging to manage in comparison to those from more gradual shifts.

The first bullet pertains to possible rapid transitions in the ocean overturning circulation and, in addition, abrupt shifts in components of the cryosphere. Abrupt change in the Atlantic Meridional Overturning Circulation (AMOC) was discussed, including beyond 2100, with relevant monitoring networks and early warning systems highlighted. Participants noted a broad range of potential impacts from abrupt changes in AMOC including alteration in the uptake and distribution of ocean heat and carbon. Various types of cryospheric abrupt changes were discussed including rapid sea ice retreat, abrupt releases of CH_4 and CO_2 from permafrost/hydrates and collapse of the WAIS. Each was recognized as an important cross-cutting theme requiring coordination with other chapters, particularly with Chapters 3 and 4.

The second bullet concerns extremes in modes of atmosphere-ocean variability such as the El Niño Southern Oscillation (ENSO), Tropical Atlantic Variability and the Indian Ocean Dipole. Participants discussed information from paleoclimate archives as well as recent examples of extreme ENSO events, including the 2015/2016 El Niño. It was noted that such extremes can have broad-ranging, wide-scale impacts, with effects upon tropical cyclones, heatwaves, floods, droughts, forest fires, disease, and marine ecosystems such as coral reefs, and implications for fisheries and agriculture. Examples of possible response strategies included enhancement of water storage, use of desalinization, prevention of forest clearing, modification of agricultural practices and disease prevention.

The third bullet refers to marine heatwaves – episodes of unusual ocean warmth that are the subject of an emerging field of literature since AR5 and SREX. Like extremes in atmosphere-ocean modes, these were recognized as potentially having wide-ranging consequences, including impacts upon marine ecosystems, fisheries, and human health. Participants highlighted the recent heatwave-related marine ecosystem regime shift in Western Australia, impacts upon fisheries from the so-called North Pacific 'warm blob', and human health effects from *vibrio* outbreaks in the Baltic Sea. Although a cold rather than a warm extreme, the so-called North Atlantic 'cold blob' was also identified as a relevant topic.

The fourth bullet relates to the influence of climate change on key characteristics of tropical cyclones. These form and evolve through complex coupled atmosphere-ocean interactions, with potential influence from atmospheric teleconnections (e.g., El Niño); processes largely beyond the scope of other chapters. Corresponding impacts discussed included disruption of marine economic activities (e.g., shipping) and coastal inundation. The recent 2013–2015 record-setting tropical cyclone seasons in the Pacific were highlighted as a strong candidate for a case study.

The fifth bullet references cascading risks resulting from so-called compound extreme events (e.g., storm surges superimposed on sea level rise and resulting implications for flooding and coastal inundation). Phenomena within this theme include ice sheet instabilities, complete loss of sea ice and glaciers, and stability of the AMOC. This bullet also highlights the theme of irreversibility and tipping points, a subject that was not explicitly mentioned in the context of the other chapters.

The sixth bullet concerns the importance of monitoring and forecasting systems within the context of risk management of ocean and cryosphere extremes influenced by climate change. Participants noted the need to assess the state of existing monitoring systems, including gaps, as well as current forecasting, preparation and risk management capabilities. Predictability of abrupt events was noted as a key challenge, particularly early warning within the context of transitions between states. It was suggested the chapter be explicit about current limits to knowledge, making clear what can and cannot be said from the literature about abrupt changes, tipping points and irreversibility.

The final bullet emphasizes the expressed desire of combining output from the Physical Sciences with knowledge from Disaster Risk Reduction/Management in the context of managing risks from marine/cryosphere extremes/abrupt changes, including dealing with compounding effects and compounding risks. Discussions recognized that response and recovery can involve multiple scales of governance (e.g., community-level, national, international), with the recently adopted Sendai Framework for Disaster Risk Reduction highlighted as important example of intergovernmental cooperation. The importance of considering event duration was also stressed, with time-scales noted to vary widely both within and between different event types (months to seasons in the case of ENSO).

Cross-Chapter Box: Low Lying Islands and Coasts

- Key climate drivers and changes relevant for low lying islands and low lying coastal areas
- Impacts and cascading risks of climate driven changes (e.g., sea level rise, ocean circulation, extreme events), interacting with other drivers, on habitability, infrastructure, communities, livelihoods, loss of lives and assets and territories, infrastructure, ecosystems, coral reefs, access to resources, and on institutional, social, economic, and cultural aspects
- Resilience pathways and adaptation options and their limits to address these changes

The cross-chapter box will benefit from a wide range of expertise drawn from across the report author teams to provide a summary of key assessment findings relating to Low Lying Islands and Coasts. The authors will require a clear and workable definition of *Low Lying Coasts*, to ensure the geographical scope of the box does not become too wide.

The first bullet will summarize the key climate drivers and changes that lead to impacts and risks for low lying islands and coastal areas. This is also intended as an opportunity to identify specific knowledge gaps or challenges that may hinder scientific understanding of these drivers.

The second bullet recognizes the wide-ranging impacts and risks faced by low lying Islands and Coasts, with emphasis given to cascading risks.

Lastly, adaptation options and pathways to a sustainable and resilient future will be summarized under the final bullet. Locally managed adaptation was highlighted, including, e.g., the use of risk planning tools by local communities. The box will consider key knowledge requirements to inform such adaptation options, and will summarize limits to adaptation that are evident in highly vulnerable environments.

8. TIME SCHEDULE

A call for the nominations of experts to serve as Coordinating Lead Authors, Lead Authors and Review Editors will be issued in early April 2016, immediately following the 45th Session of the IPCC. Approval and acceptance of the Special Report is planned for the 51st Session of the IPCC in September 2019. In order to achieve this, the timetable for the Special Report is as follows: