PolarRES
Exploring future polar climates

PolarRES Project

Coordinator: Priscilla A. Mooney

CRiceS Annual Meeting – 12 September 2023

@PolarRES_EU

www.PolarRES.eu

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Exploring future polar climates

Project name:
Polar Regions in the Earth System

Duration:
01.09.2021- 31.08.2025

Budget:
~ EUR 8 million

Consortium:
17 Consortium members

Coordinator:
Dr. Priscilla A. Mooney

Contact:
prmo@norceresearch.no

@PolarRES_EU

PolarRES has received funding from the European Unions Horizon 2020 Research and Innovation Programme under Grant Agreement No. 101003590

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PolarRES – An impressive Team!

PolarRES

Achieving our objective

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Core Ambition: To improve regional climate information for impact assessments in the Arctic and Antarctic

How will we achieve this?

1. By improving our understanding of the polar climate system and its role/position in the global climate system.
2. By applying new, innovative "storylines" approach to improve the way we deal with and communicate uncertainty to broader audiences/end-users.
3. Working together with end-users to ensure that our climate projections are useful and relevant.

Polar Regions in a Global Context

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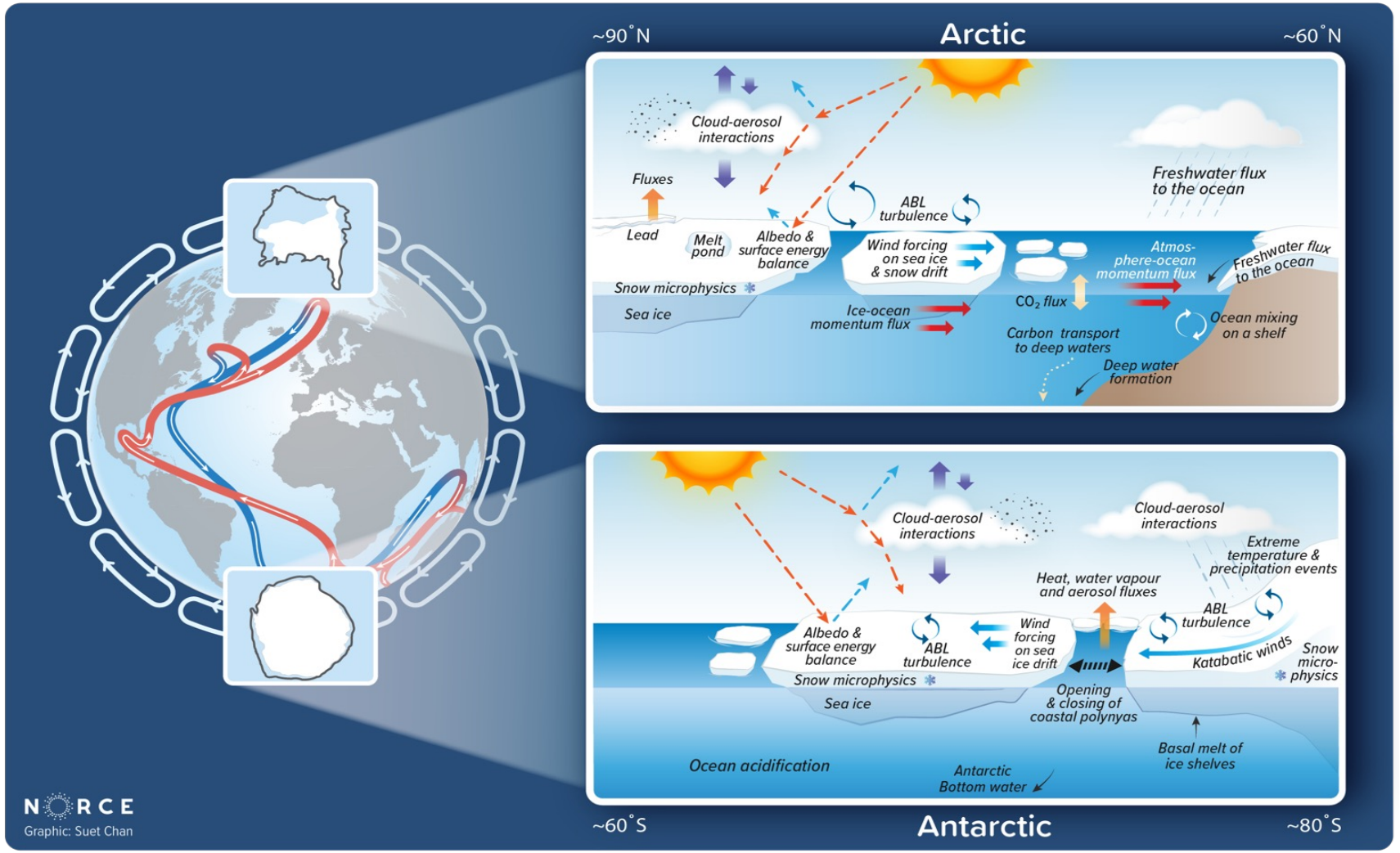

Climate projections for impact assessments

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Pairs of storylines that influence the polar climates are downscaled with a regional climate model ensemble, and applied to a range of impacts in the polar regions.

WP1: Global Circulation Storylines

WP3: Future Polar Climate

WP6: Polar Climate Change Impacts

What are Storylines? – Good Q!

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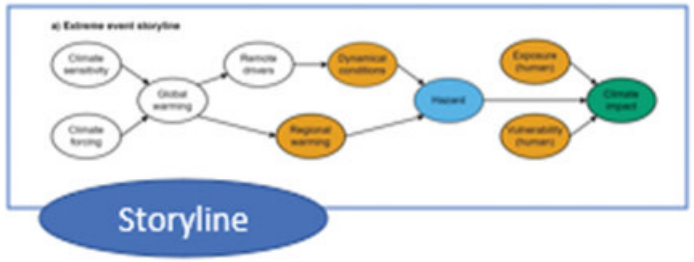
Discourse-analytical approaches

(illustrated here only argumentative discourse analysis)

Definition: *"condensed statement summarising complex narratives" (Hajer, 1995; 2005).* E.g. The statement "nuclear energy is the solution", implies a narrative preferencing e.g., technological advancements rather than changing energy consumption patterns, which is within a certain discourse (see 'Results').

Physical climate storylines

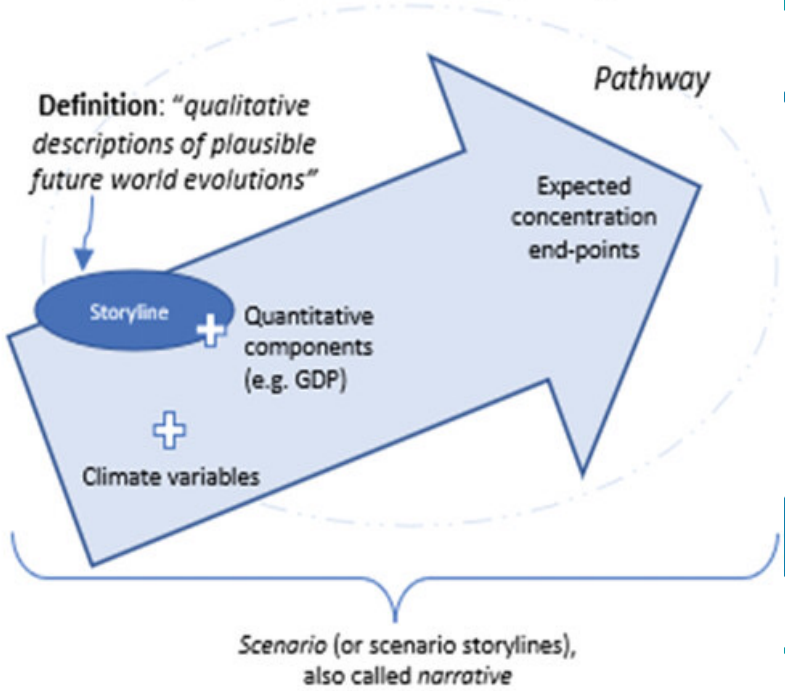
(illustrated here only extreme events)



Definition: *"physically self-consistent unfolding of past events, or of plausible future events or pathways".* See Figure 5 for reference.

Scenario-based

(or 'story-and-simulation' approach)



Global Challenges, Volume: 7, Issue: 7, First published: 23 May 2023, DOI: (10.1002/gch2.202200183)

What are Storylines? – Good Q!

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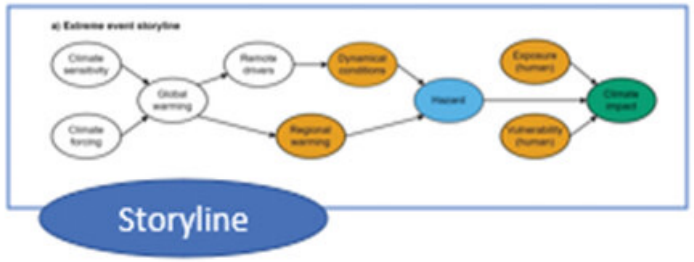

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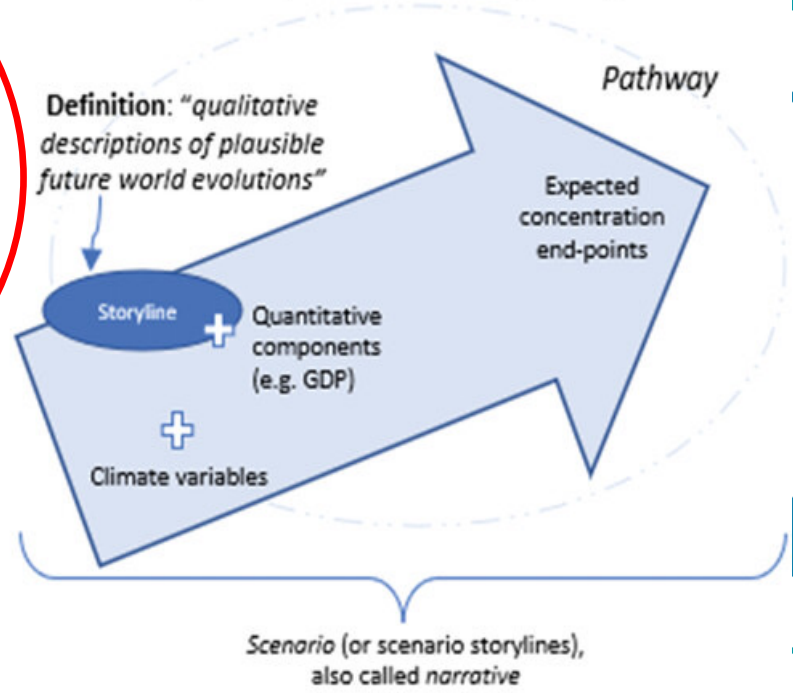

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The *Physical climate storylines* approach

- IPCC AR6 (based on the works of Shepherd et al)
- "Physically self consistent unfolding of past events, or of plausible future events or pathways".

(i) improving risk awareness by framing risk in an event-oriented way instead of the usual probabilistic manner; it is a more relatable perspective for non-scientists;

(ii) strengthening decision-making by allowing one to work backward from a particular vulnerability or decision point, combining climate change information with other relevant factors to address compound risk and develop appropriate stress tests;

(iii) providing a physical basis for partitioning uncertainty, thereby allowing the use of more credible regional models in a conditioned manner.

Climate projections for impact assessments

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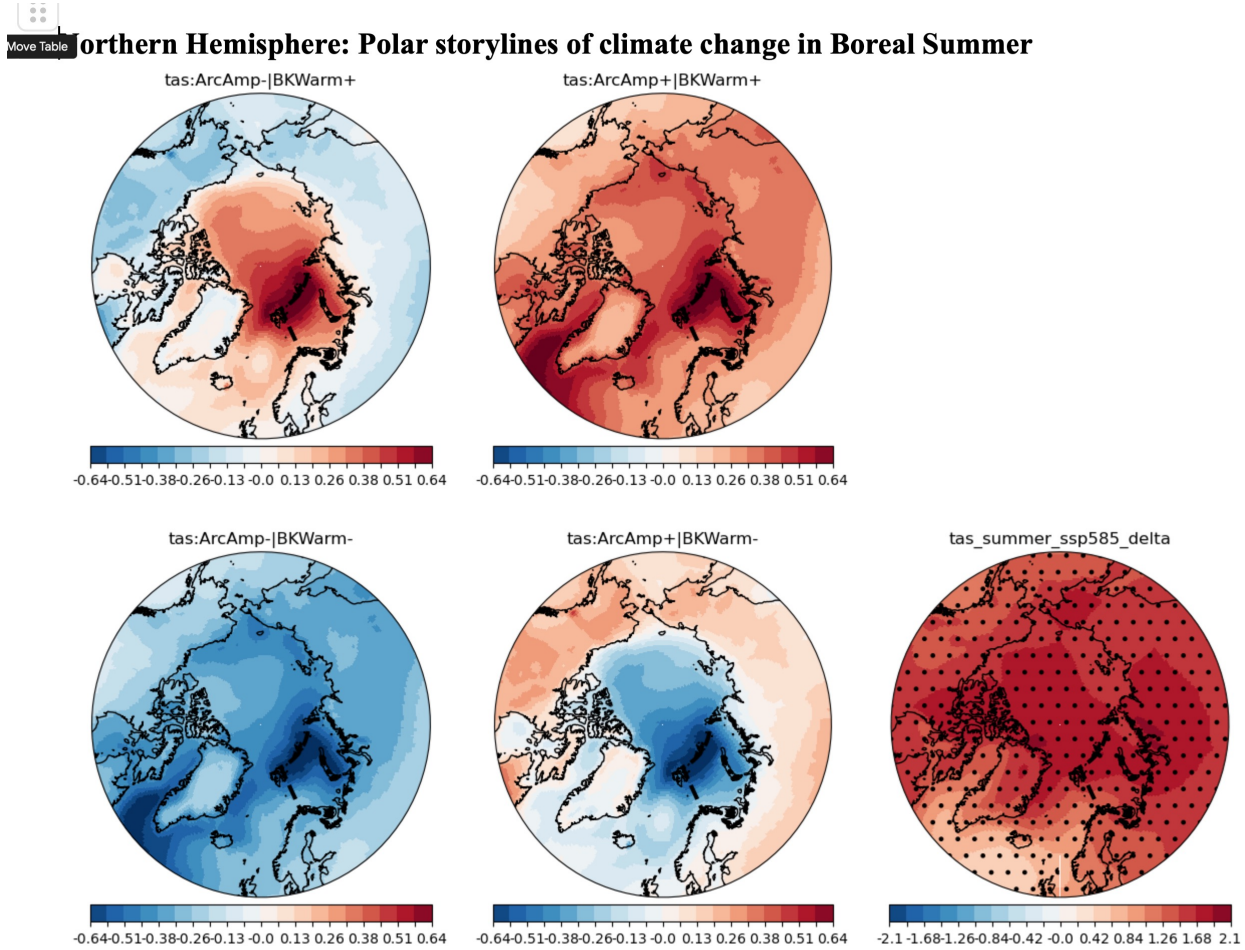
Storylines Approach

Storylines of a target variable emerge by regressing that variable onto two predictors, to explain differences in model projections within a large ensemble of climate simulations.



1. Williams *et al.* (in review), *Future Antarctic Climate: Storylines of Southern Hemisphere mid-latitude jet strengthening and shift emergent from CMIP6*, JClim.
2. Levine *et al.* (in prep.), *Storylines of Arctic Climate Change for impact assessments/studies using CMIP6*, ESD.
3. Graff *et al.* (in prep.), *A simple climatology score for climate model evaluation*, JAMC.

Climate projections for impact assessments

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Pairs of storylines that influence the polar climates are downscaled with a regional climate model ensemble, and applied to a range of impacts in the polar regions.

WP1: Global Circulation Storylines

WP3: Future Polar Climate

WP6: Polar Climate Change Impacts

Climate projections for impact assessments

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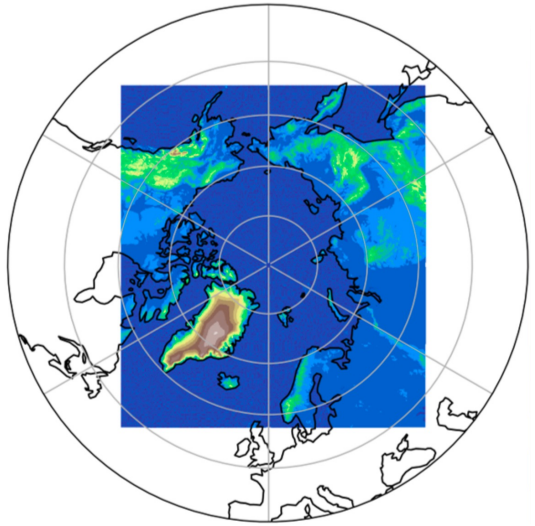
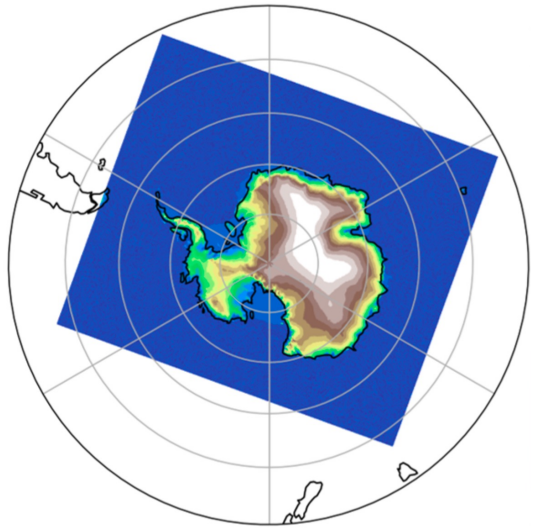
Experiments

- Domain
  - Grid spacing: 10-12 km
  - Spatial extent ➔
- Evaluation
  - Boundaries: ERA5
  - Duration: 2001 – 2022
- Future projections
  - Boundaries: 2 GCMs selected using Storylines Approach
  - Scenario: SSP3-70
  - Duration: 2001 - 2100





Climate projections for impact assessments

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Experiments

- Evaluation
  - Boundaries: ERA5
  - Duration: 2001 – 2022
- Future projections
  - Boundaries: 2 GCMs selected using Storylines Approach
  - Scenario: SSP3-70
  - Duration: century long i.e. until 2100

Ensemble of RCMs (10km) for high resolution future projections and impacts									
Model	HCLIM	ICON	MAR	MetUM	RACMO2	WRF	MAR-NEMO	HCLIM	ROMS
Atmosphere	ALARO/ ALADIN	ICON	MAR	MetUM	RACMO2	WRF	MAR	ALADIN	-
Ocean	-	-	-	-	-		NEMO	NEMO	ROMS
Sea-ice	SICE	-	-	-	-		LIM	CICE	CICE
Region	Arctic	Arctic	Both	Both	Both	Arctic	Both	Both	Antarctic
Partner	METNO	AWI	ULiége	BAS	UUtrecht	NORCE	ULiége	DMI	UHelsinki

Climate projections for impact assessments

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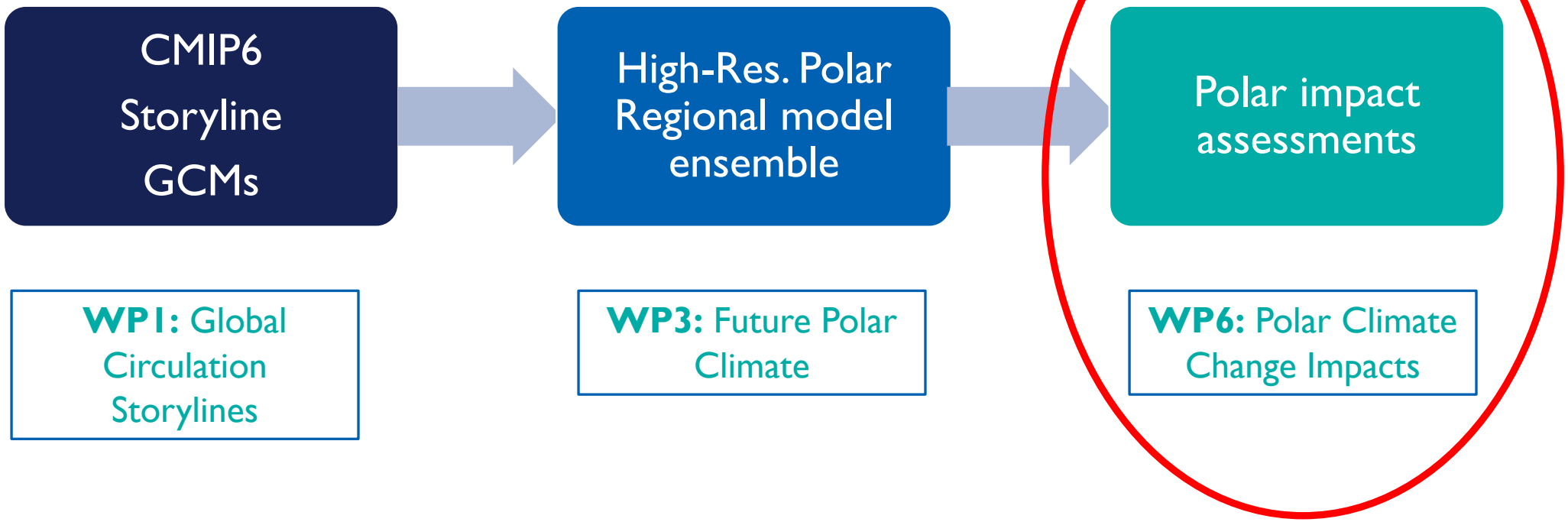

Climate Change Impacts

The polar regions are changing rapidly which has important consequences for society and nature.

1. Develop a framework that brings together climate scientists and impact modellers
2. Use this framework to develop new understanding on how climate change impacts
    1. Permafrost
    2. Boreal wildfires
    3. Marine ecology
    4. Trans-Arctic navigation
    5. Radionuclide dispersion in the Arctic

WP6: Polar Climate Change impacts

Climate Change Impacts

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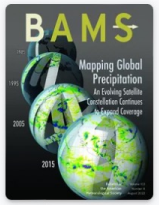
Developing a framework that brings together climate scientists and impact modellers.



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Article Type: Research Article

Toward Effective Collaborations between Regional Climate Modeling and Impacts-Relevant Modeling Studies in Polar Regions

Hanna Lee, Nadine Johnston, Lars Nieradzik, Andrew Orr, Ruth H. Mottram, Willem Jan van de Berg, and Priscilla A. Mooney

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Spatial scales needed to best support local climate adaptation and mitigation decisions

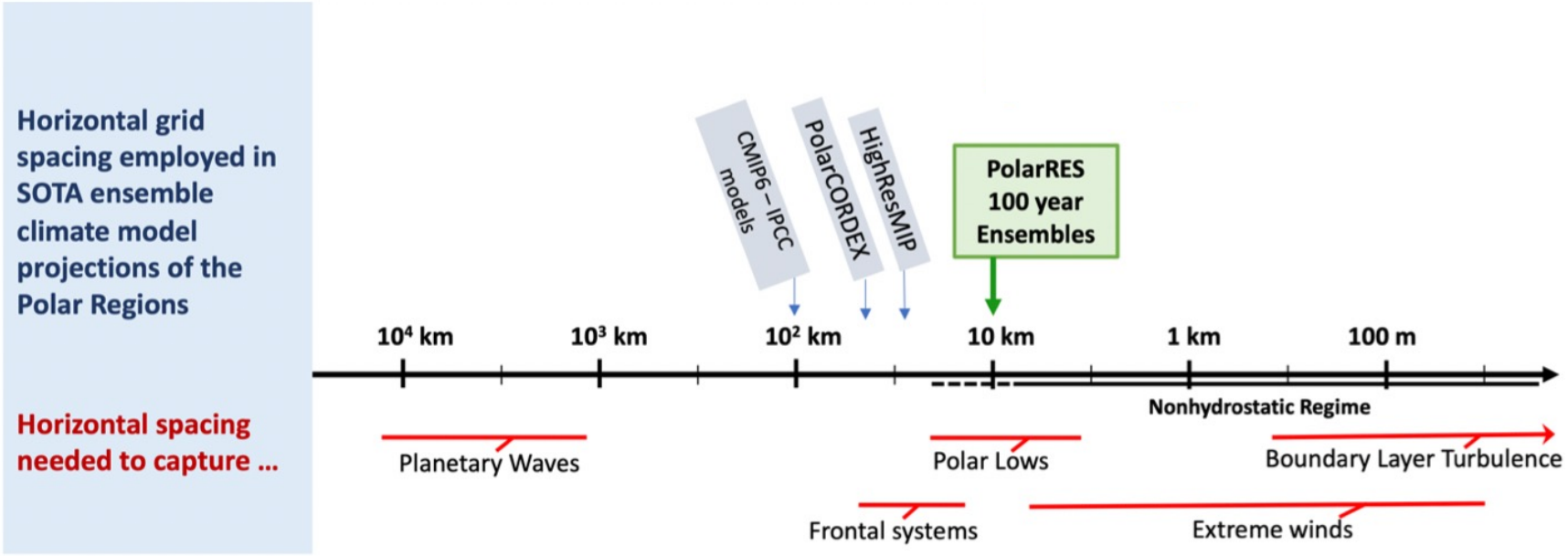
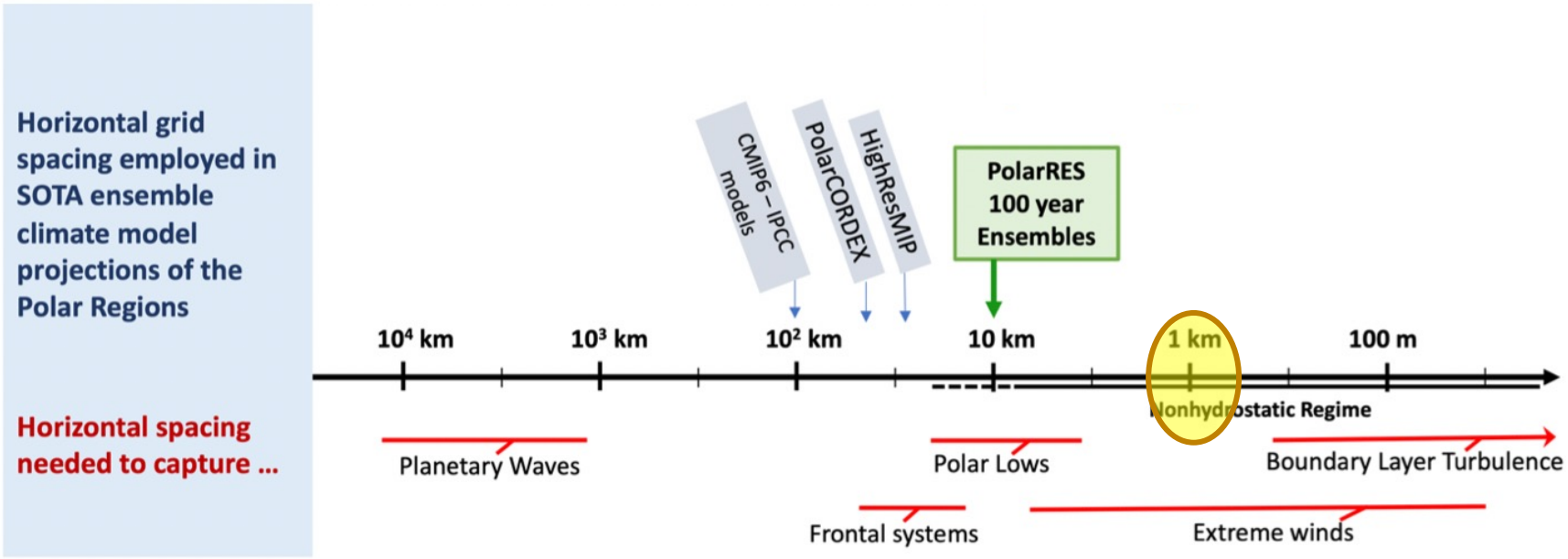


Figure 1.4a *Horizontal grid spacing employed in state-of-the-art GCM and RCM projects/initiatives and the approximate grid spacing needed to capture key Global and Polar processes that span a range of spatial scales. PolarRES modelling activities will be positioned beyond the state-of-the-art (SOTA) to deliver new scientific knowledge and support impact assessments.*

Spatial scales needed to best support local climate adaptation and mitigation decisions



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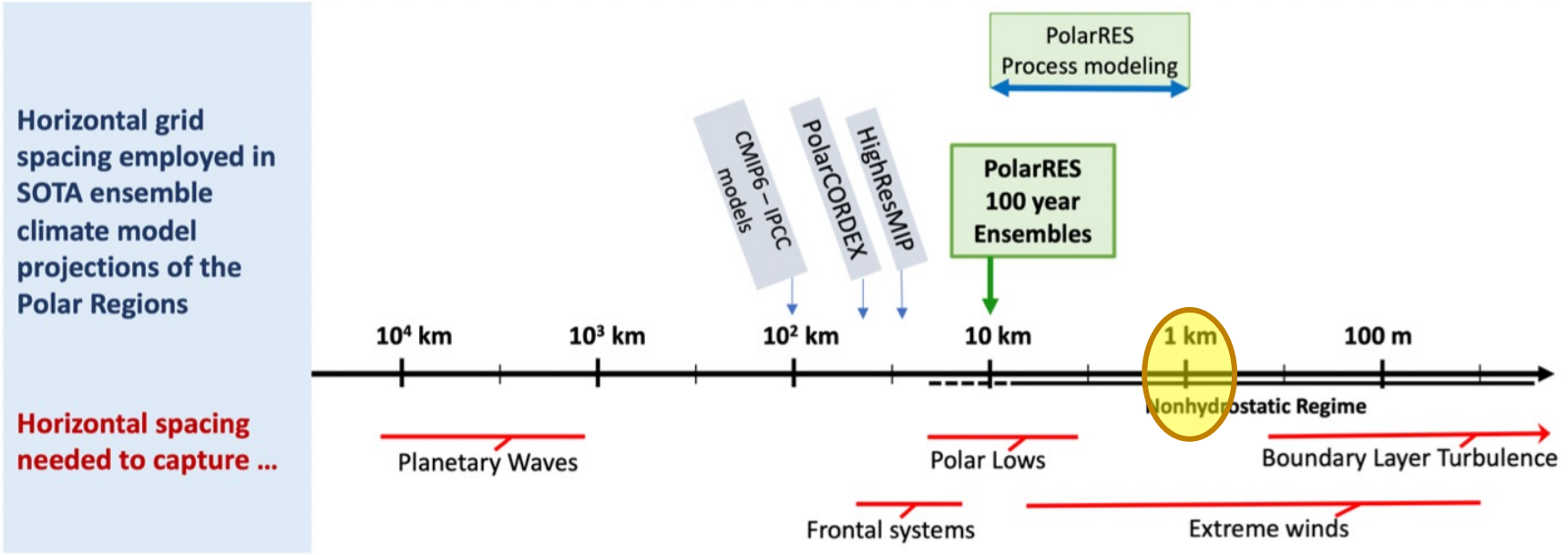
PolarRES: paving the way forward.



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PolarRES : paving the way forward

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Ocean	-	-	-	-	-		NEMO	NEMO	ROMS
Sea-ice	SICE	-	-	-	-		LIM	CICE	CICE
Region	Arctic	Arctic	Both	Both	Both	Arctic	Both	Both	Antarctic
Partner	METNO	AWI	ULiége	BAS	UUtrecht	NORCE	ULiége	DMI	UHelsinki

Polar Processes Shaping Polar Climate

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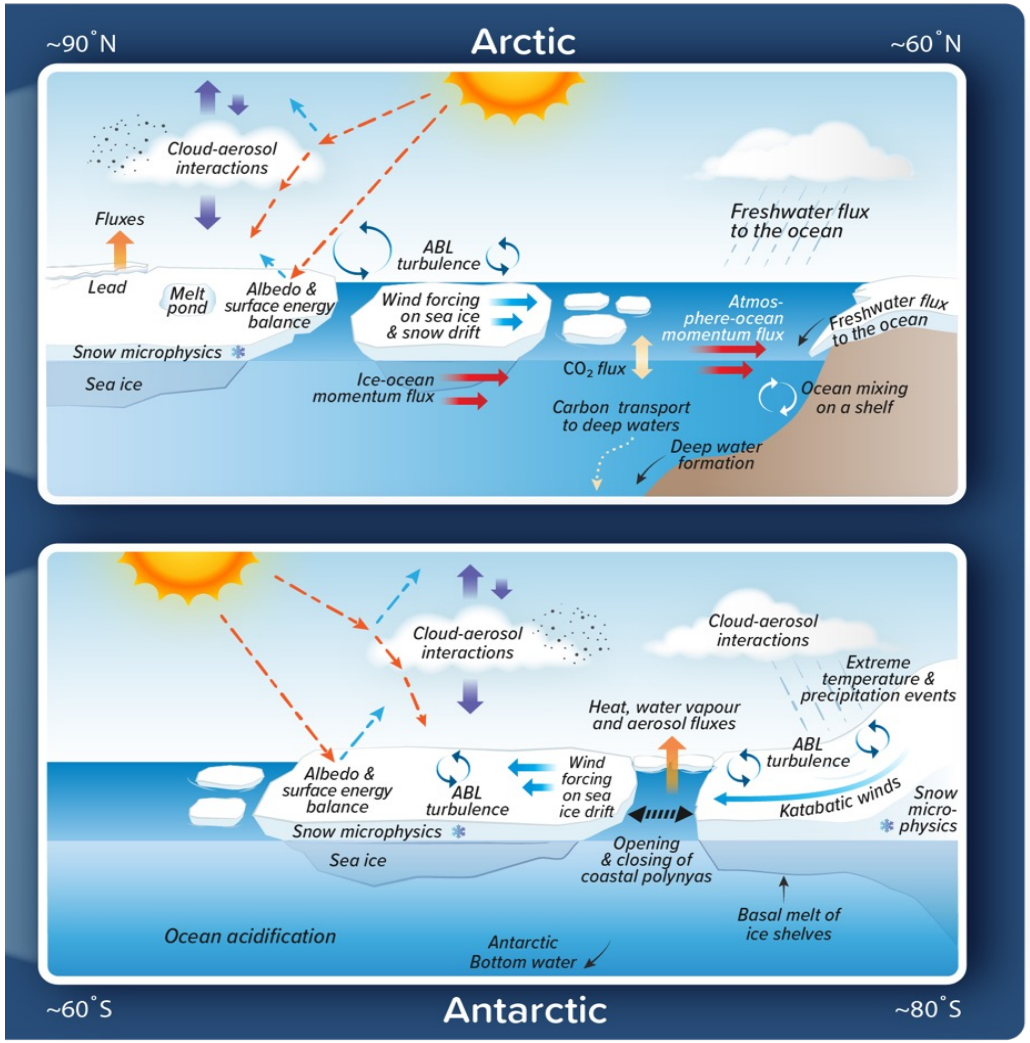
- Task 5.1: Aerosol-cloud interactions over polynyas
- Task 5.2: Atmospheric boundary layer over sea ice
- Task 5.3: Extreme precipitation and temperature events over coastal West Antarctica
- Task 5.4: Sea-ice albedo and surface energy balance
- Task 5.5: Wind-driven sea-ice drift and thermodynamics
- Task 5.6: Ice shelf-ocean interactions and bottom water formation
- Task 5.7: Interactions between ocean physics and biogeochemistry
- Task 5.8: Synthesising new understandings and interactions in the fully coupled climate model

WP4: Arctic Processes

WP5: Antarctic Processes



Polar Processes Shaping Global Climate

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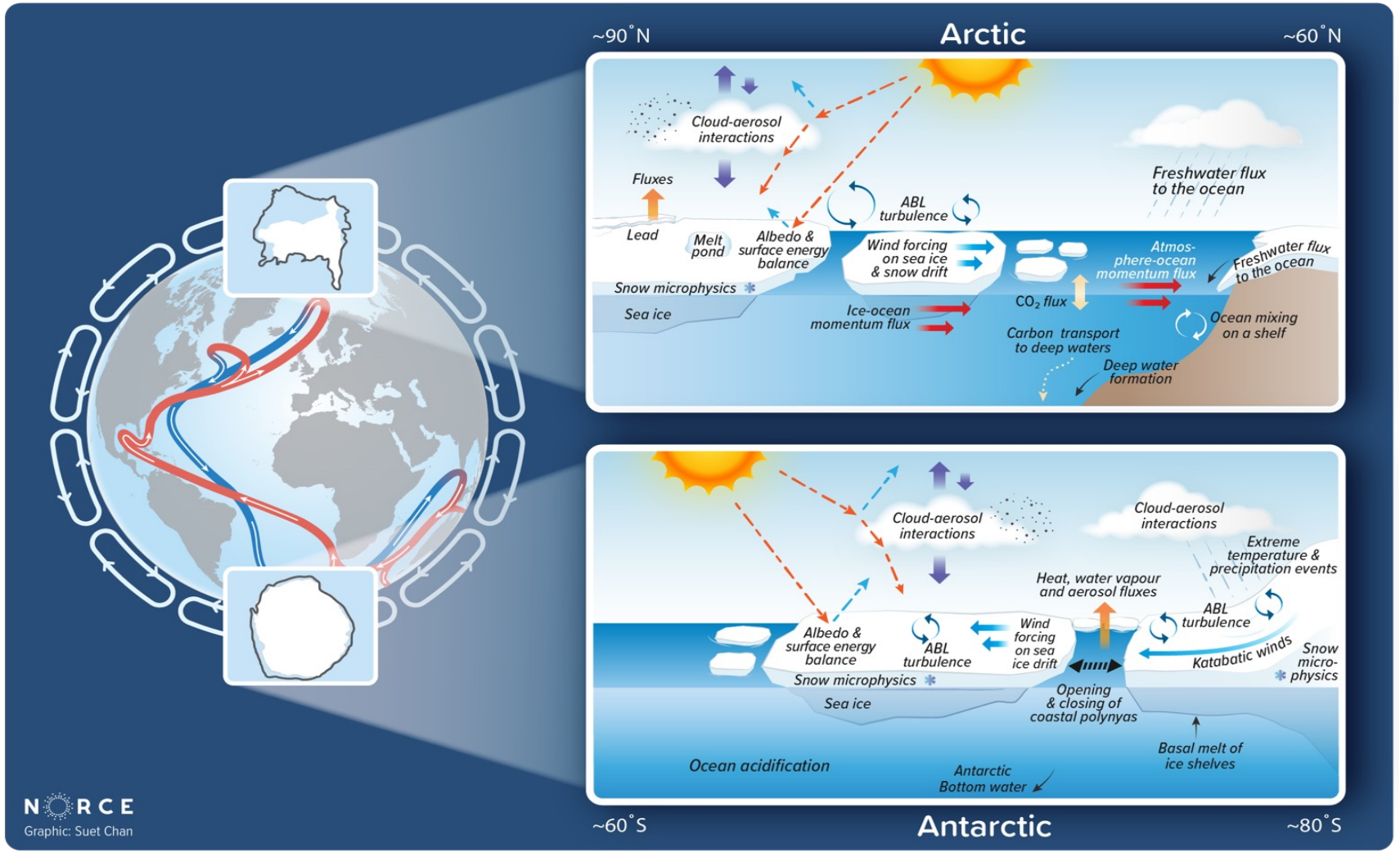
WP2: Polar-lower latitude linkages



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