TRACCS
TRansformative Advances in Climate modelling for Climate Services

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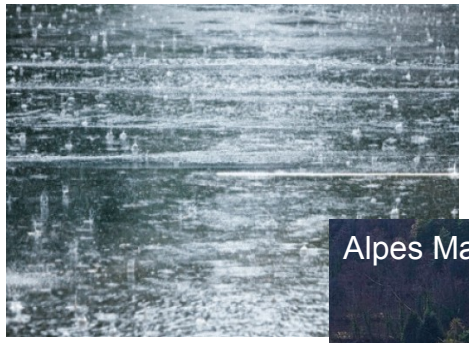
WGNE/WGSIP joint meeting
Nov. 4th 2024

Key societal demand for climate information is unmet by current approaches

Stakeholders

Governments, local authorities, NGOs, Industries, …

Demand for climate change information for decision making & climate action (adaptation, mitigation, interventions)



Diversity of demands

- local, regional
- decadal, centennial
- statistics, worst case scenarios
- sectoral, territorial

- not only data, but also expertise & trust

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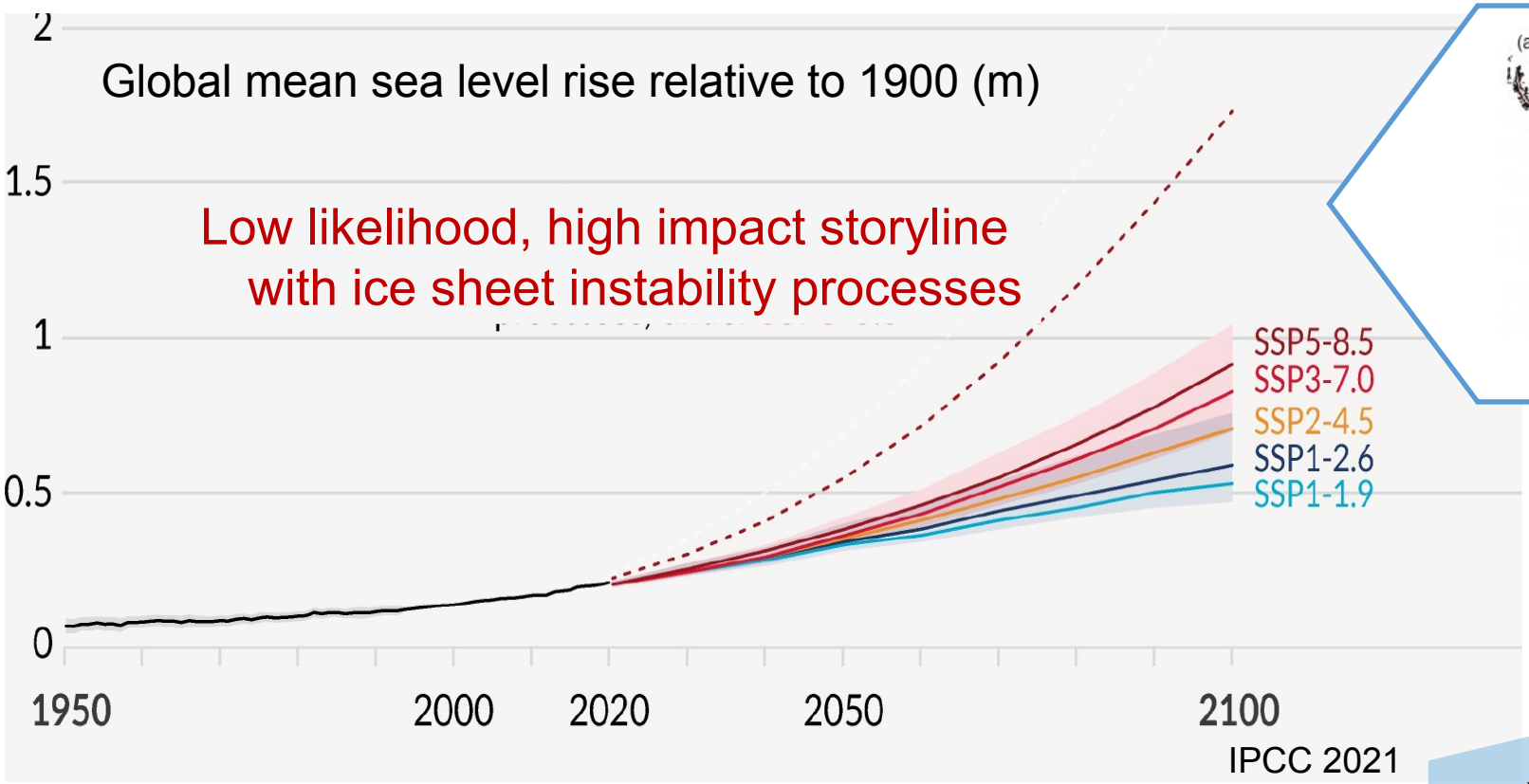
Physical science basis

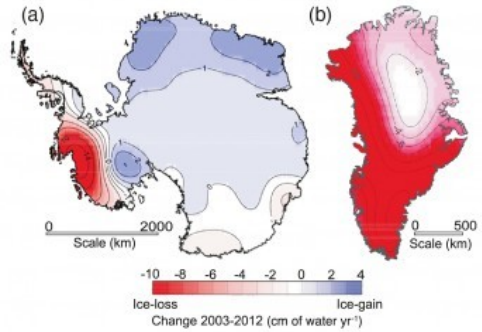
Climate models

➔ knowledge on climate change at global and regional scales

Missing components in climate models



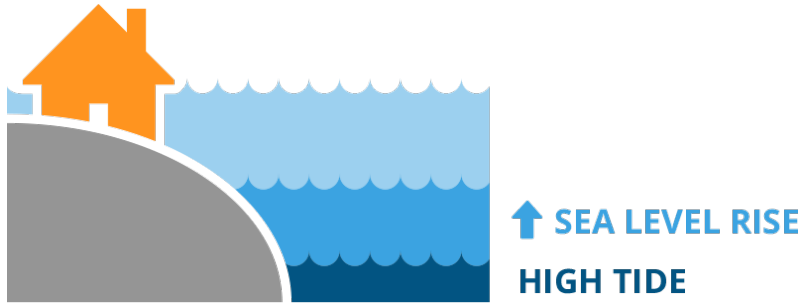
IPCC 2021



IPCC 2013

Ice sheets
+ glaciers
+ ocean
thermal
expansion

Threats related to sea level rise



Climate models

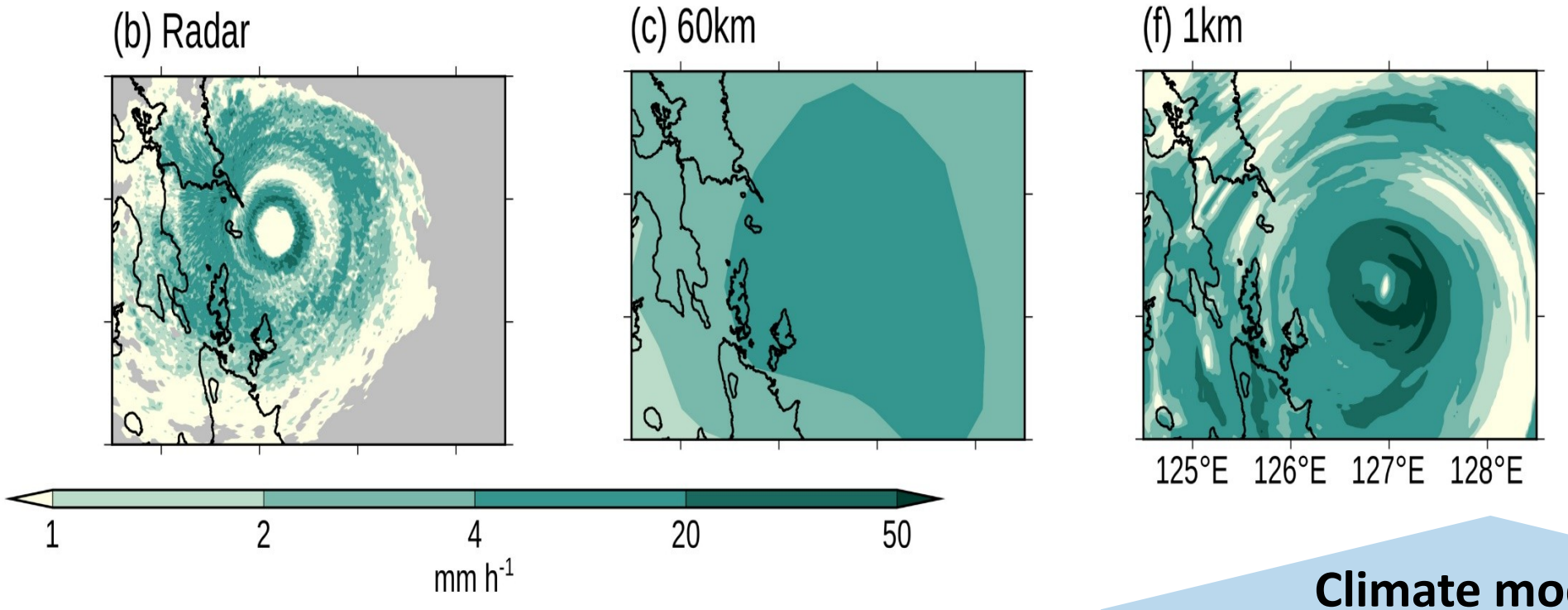
➔ knowledge on climate change at global and regional scales

But currently

- miss key components

Missing small scale phenomena in climate models

observations **models**

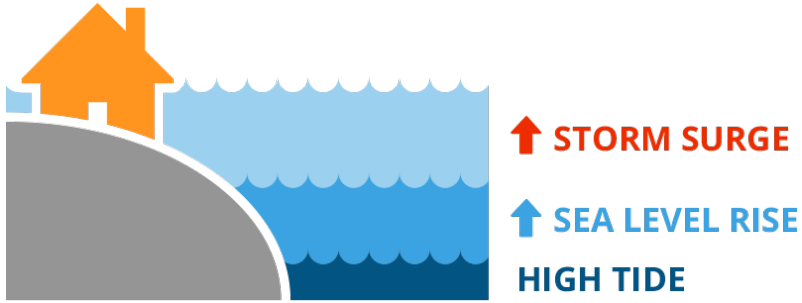


Haiyan super typhoon 8/11/2013

Philippines 4Mpersons displaced

IPCC 2021

Threats related to sea level rise



Climate models

➔ knowledge on climate change at global and regional scales

But currently

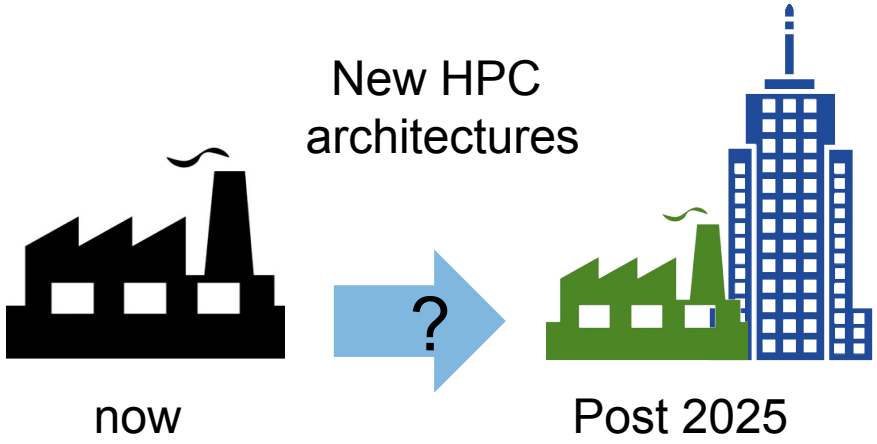
- miss key components
- misrepresent local scale phenomena and extremes

Key societal demand for climate information is unmet by current approaches

Stakeholders
Governments, local authorities, NGOs, Industries, …

Demand for climate change information for decision making & climate action (adaptation, mitigation, interventions)

Physical science basis
- Met. services
- Research scientists (physics, model developers)
- …



Climate models

➔ knowledge on climate change at global and regional scales

But currently
- miss key components
- misrepresent local scale phenomena and extremes
- need major rewriting to benefit from new computing architectures

Key societal demand for climate information is unmet by current approaches

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Governments, local authorities, NGOs, Industries, …

Demand for climate change information for decision making & climate action (adaptation, mitigation, interventions)

Physical science basis
- Met. services
- Research scientists (physics, model developers)
- …

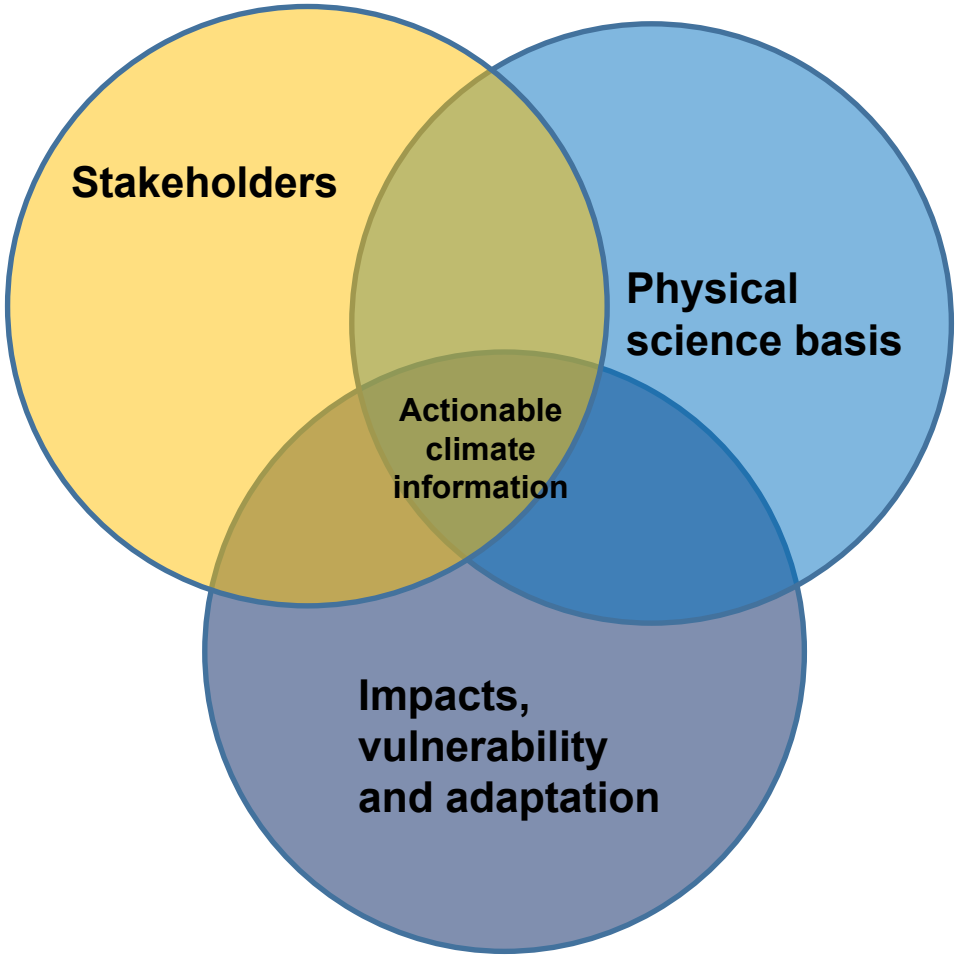
Impacts, vulnerability and adaptation
- Research scientists
- Consultancy
- …

Climate data alone is not enough for stakeholders

- Disconnection between users and producers
- Quality/appropriateness of data and information

➔ **Problem for decision making**

TRACCS :
TRansformative Advances in Climate modelling for Climate Services



TRACCS main objectives

1/ Foster actionable climate change information co-designed between the scientific community and relevant stakeholders

to meet the users needs, from policy makers to industries, services and the general public

2/ Improve knowledge and tools on climate change processes, impacts and risks, from the global to the local scale

to deliver the best possible climate information for decision making;

3/ Train the next generation of professionals in model development, data distribution, climate science co-production, use and support of climate services

to ensure the sustainability of this enlarged climate science ecosystem.

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TRACCS Organization ; 8 years ; 51 M€

FRANCE 2030 PROGRAMME DE RECHERCHE CLIMAT

Operational coordination, executive office, communication and dissemination – 3 M€

International activities, training – 1.7 M€

Fostering the exploitation of climate science data and the development of climate services
« Impacts, adaptation and vulnerabilities »

PC 1 to 4 - 10 M€

Addressing scientific and technical bottlenecks in climate modelling
« The physical science basis »

PC 5 to 10 – 26.3 M€

Calls for projects

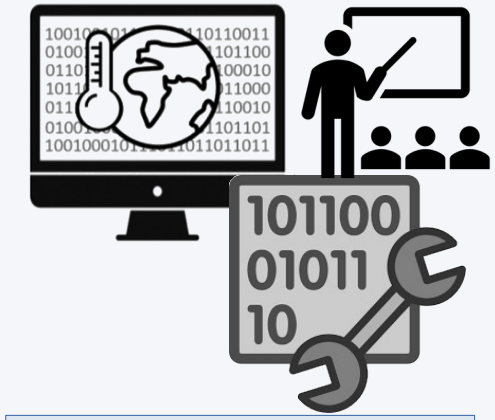
10 M€

- **AO1 –** Interdisciplinary approaches for climate change impacts, adaptation and services – 5 M€
- **AO2 –** Evaluation of climate interventions – 1 M€
- **AO3 –** AI for climate sciences – 2 M€
- **AO4 –** Model evaluation – 2 M€

Fostering the exploitation of climate science data and the development of climate services

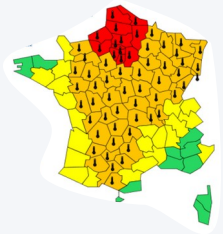
PC1. Co-design with stakeholders

PC2. Brokerage of data & methods



PC3. Territorial information

PC4. Extreme events



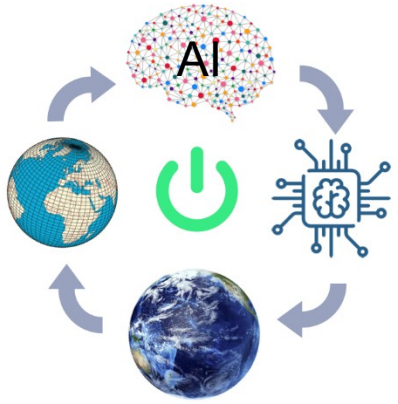
Future climate risks in France and elsewhere

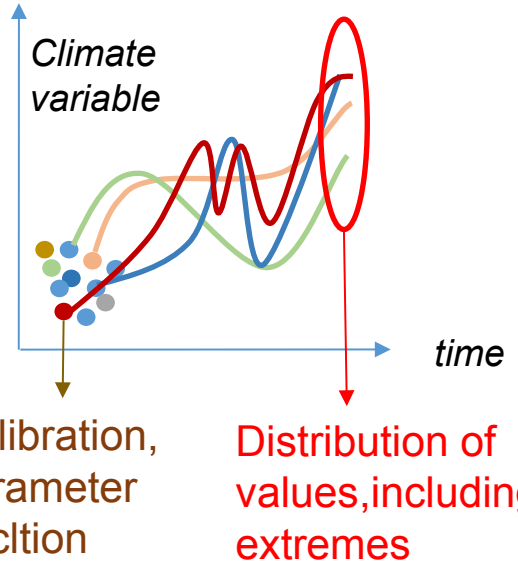
- **Actionable climate change information** for key sectors and territories (France mainland & overseas, foreign countries)
- **Special focus on extreme events**: quantification, attribution, compounds, future evolution
- Transformative, **interdisciplinary and transdisciplinary** advances towards climate services

Addressing scientific and technical bottlenecks in climate modelling

PC5. New computing paradigms	PC6. Calibration & uncertainties	PC7. Physical processes	PC8. Biogeo-chemistry	PC9. Polar ice sheets	PC10. km-scale climate information

Transformative advances
in model design
- increased use of IA,
- addressing new HPC frameworks,
- quantifying confidence levels





Addressing scientific and technical bottlenecks in climate modelling

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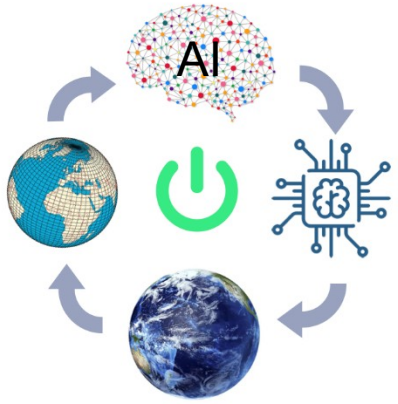
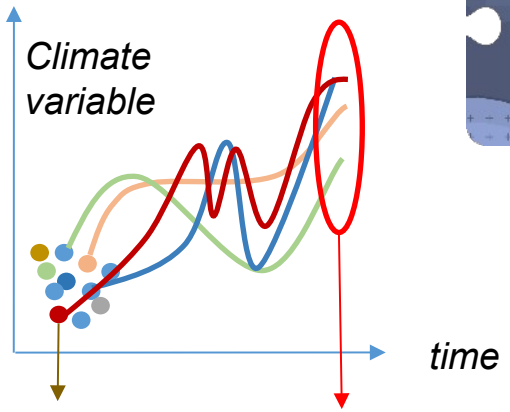
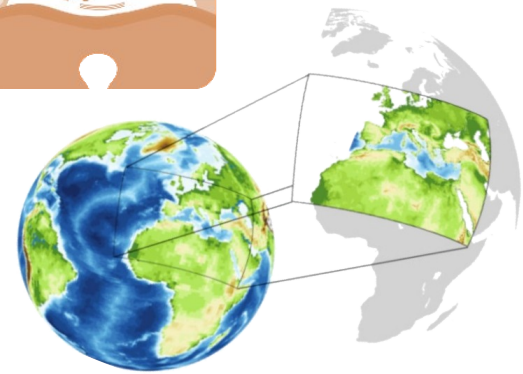




Calibration, parameter secltion

Distribution of values,including extremes



TRACCS will develop and contribute
- a consistent set of improved climate models
- operating across all spatial (100-1 km scale) and temporal scales of the climate system,
- enabling long simulations & large ensembles.

Robust basis for science and climate services

TRACCS in a nutshell

Climate services **adapted** to users' needs

↑

Trusted methods and products

↑

Robust scientific basis Knowledge & models

TRACCS is:

- an 8 year programme (51 M€ total cost)
- an unprecedented effort by the French climate research organizations to join forces and develop **a strategic roadmap for transforming climate modeling frameworks and unleash the development of genuine and actionable climate services.**
- a **cornerstone PEPR** interacting with other PEPRs and research & operational initiatives requiring trustable and fit-for-purpose climate change information much beyond the current state-of-the-art (OneWater, FAIRCarbon, others to come)

Relevant to national frameworks (National Low Carbon Strategy SNBC, National Adaptation Plans PNACC) and **institutions** (ONERC, High Council for Climate, relevant ministries and agencies)

Strong international dimension (connections & complementarities with Copernicus C3S, DestinE, WMO/WCRP).

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cnrs

METEO FRANCE
À VOS CÔTÉS, DANS UN CLIMAT QUI CHANGE

Secrétariat général pour l'investissement

anr

FRANCE 2030 PROGRAMME DE RECHERCHE CLIMAT

Thank you for your attention !

Et abonnez-vous à la newsletter
pour recevoir toute l'actualité TRACCS !

contacts-traccs@listes.ipsl.fr

TRACCS Core Projects

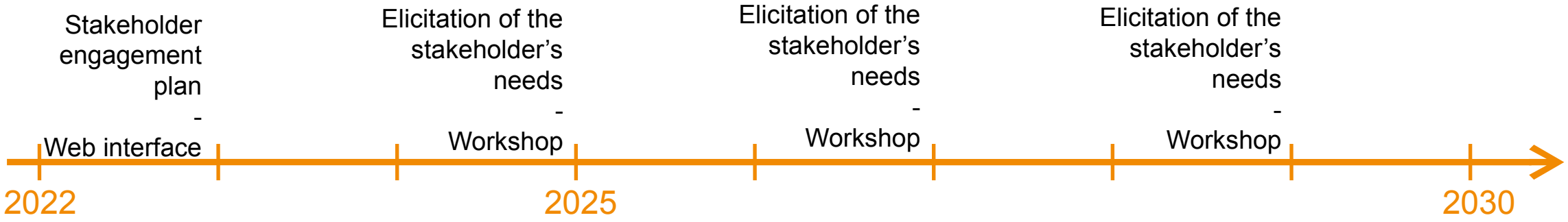
PC1: Stakeholder interaction platform

5 permanent staff, 3 long-term positions – 1680 k€

Develop a dialogue platform **to translate stakeholder's needs into scientific questions**, taking into account up-to-date knowledge about the models' capacities and performance.

Engage a wide range of stakeholders: local and regional authorities; governmental and international agencies; industry; NGOs; water-agriculture-forestry management (Europe and tropical countries).

Co-design new climate services – Strengthen science with and for society



PC2: Brokerage of data and methods

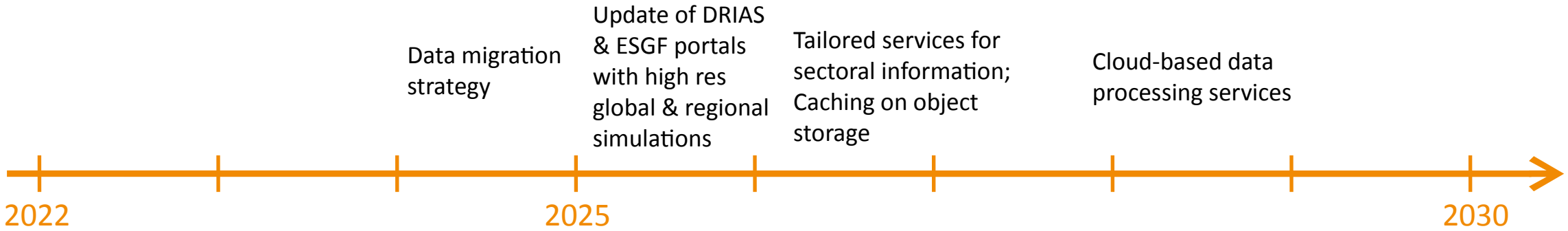
4 permanent staff, 3 long-term positions – 1825 k€

The amount of data generated by climate models will increase tremendously with the advent of exascale computing. These large volumes of data to be shared will **require** paradigm changes.

Provide a robust and sustainable infrastructure to distribute climate data and software for scientific and societal stakeholders

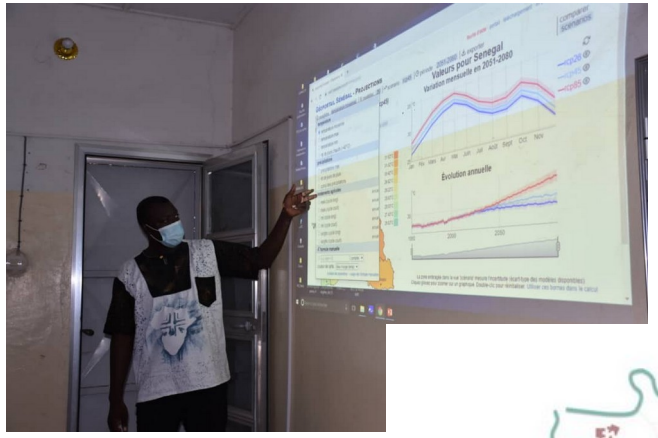
- New actionable datasets , redesign of DRIAS portal to better meet sectorial needs
- First-class services for advanced users to access innovations developed in TRACCS, build upon the national GAIA-DATA infrastructure and interfaced with generic European Infrastructures EOSC, EGI, Copernicus, DestinE and EUDAT
- Preparation of data-ready analyses for 'less advanced' users, relying on cloud-based technologies and formats.

Provide access to very high resolution datasets with on-demand analytics – Support adjusted and actionable climate change data



PC3: Territorial climate services demonstrators – the added value of integrated climate information

10 permanent staff, 4 long-term positions, 5 post-docs, Stakeholders Engagement – 3270 k€



Stakeholders'values should be the starting point of climate information and service development, not the end point.

1) Engage multi-disciplinary teams of stakeholders to co-construct and co-produce decision-relevant and scale-relevant information,
2) Foster co-designed information portals and climate services,
3) Perform inter-disciplinary and multi-sectoral analyses.

Climate services demonstrators prototyped in France, and two highly vulnerable countries, Senegal and Ivory Coast

The French network of Regional Groups of Climate Expert (GRECs) supported

Regular meetings with GRECs

Regular meetings with Senegal and Ivory Coast Authorities

2022 — 2025 — 2030

PC4: Extreme events under climate change – statistical methods, attribution, projections

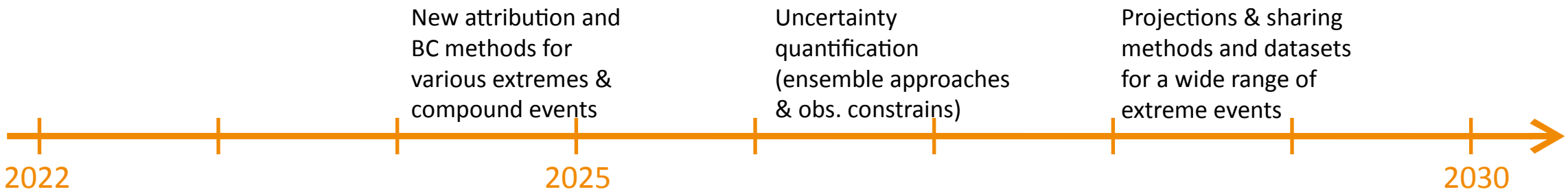
8 permanent staff, 2 long-term positions, 3 post-doc, 2 PhD – 3219 k€

- Extreme events are very **impactful** for many activities and ecosystems
- Projected to be **more frequent** in the future

=> Need of **robust hazard projections** for a large range of extremes:

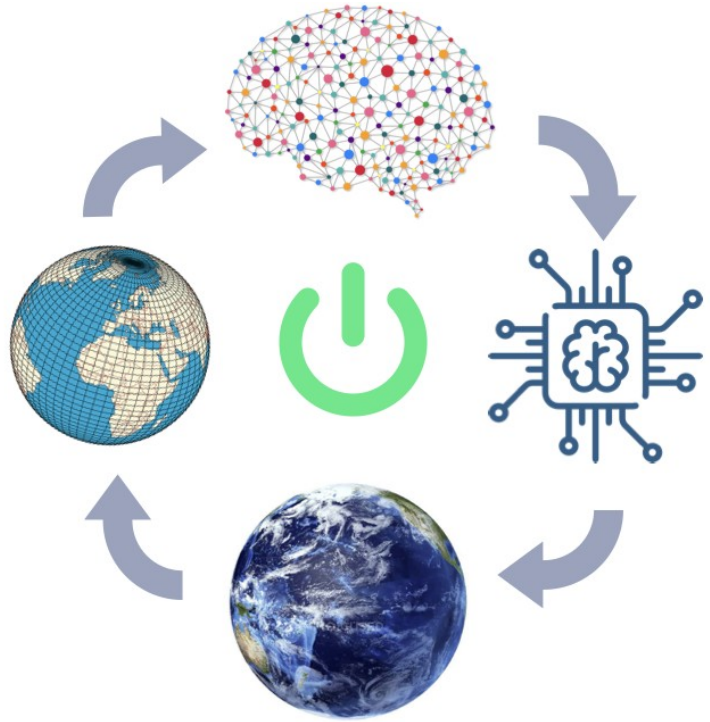
- ✓ e.g., heat/cold waves, heavy rainfall, droughts, storms, etc.
- ✓ including **more unusual events** and "***Compound events***"

New statistical & ML methods (bias correction/obs. constraints/attribution/uncertainties) & projections



PC5: New computig paradigms – designing efficient, modular & trainable climate models

7 permanent staff, 6 long-term positions, 1 post-doc – 3521 k€



Climate models : key **numerical tools** for climate services.

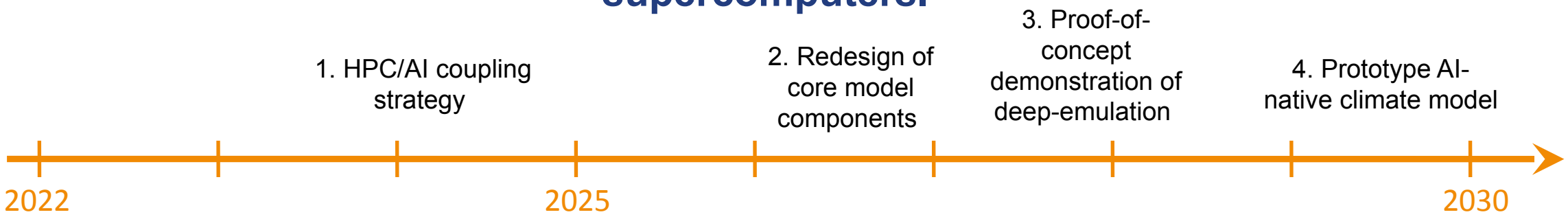
Challenges : exascale, km-scale, AI/ML, uncertainties, fit-for-purpose

=> Need to redesign models and prepare their (R)evolution

Objectives

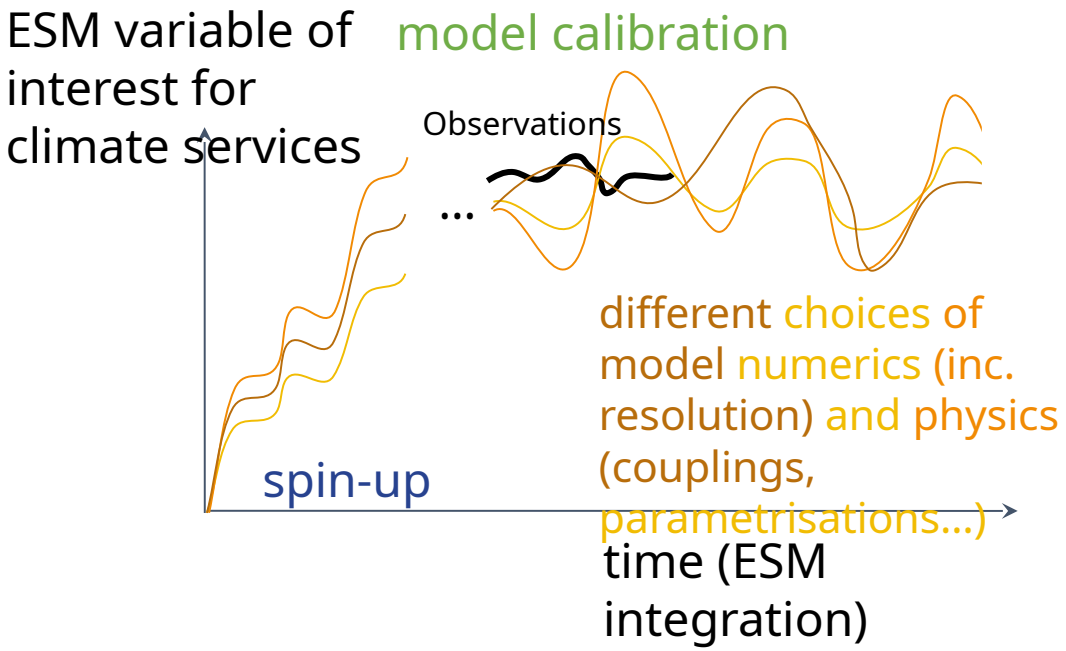
- develop robust protocols for leveraging AI in climate models
- redesign compute-intensive model components and interfaces
- explore disruptive paradigms for longer-term evolutions

Core technologies for leveraging AI in climate models and exploiting upcoming supercomputers.



PC6: Exploring uncertainties – advancing model development for climate services

13 permanent staff, 4 long-term positions, 1 post-doc, 1 PhD – 3383 k€



Model calibration: a long-standing bottleneck in Earth system modelling

Need to tackle all modelling uncertainties to deliver appropriate climate information

Recent and original scientific advances from the French community

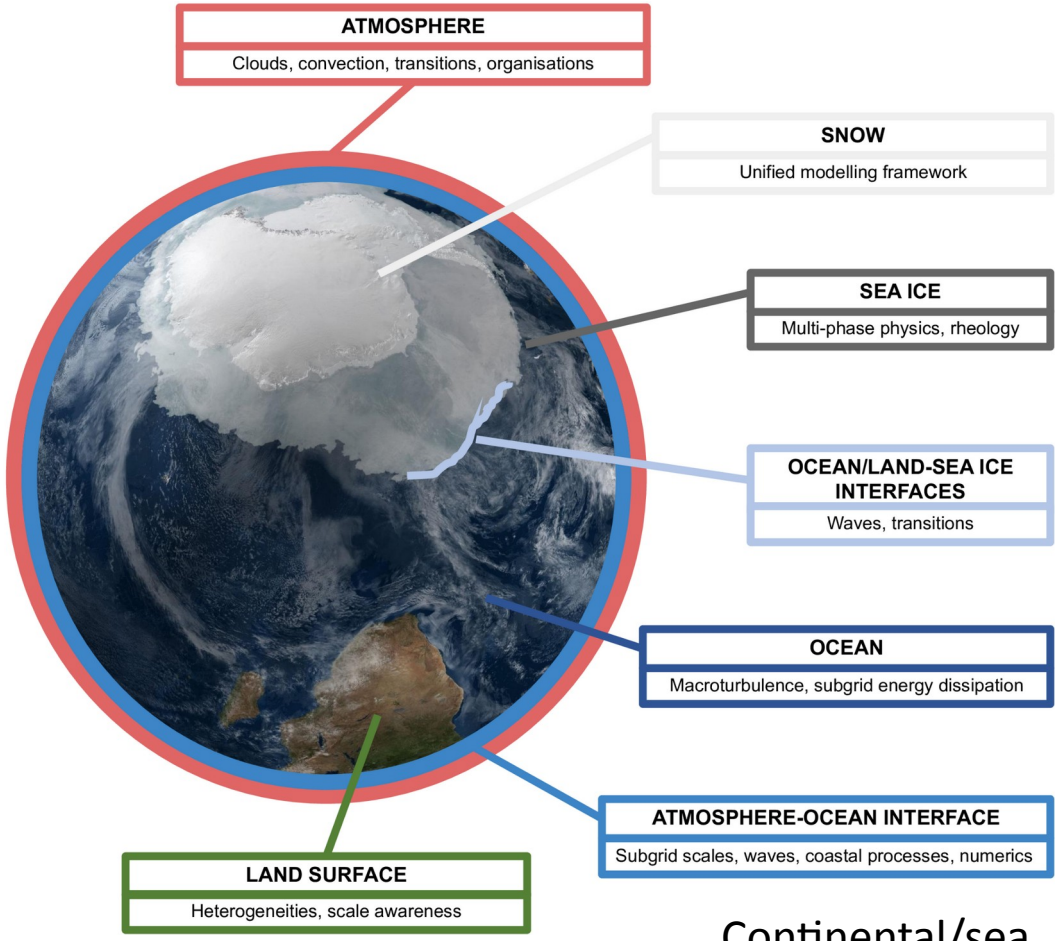
- **Develop innovative strategies for ESM spin-up**
- **Objective and efficient ESM calibration, benefiting from AI**
- **Fully address ESM parametric uncertainty**
- **Narrow projections with observational constraints**

Accelerating feedbacks between model development/validation/climate services

Solid basis to coordinate model hierarchies (resolution, complexity)

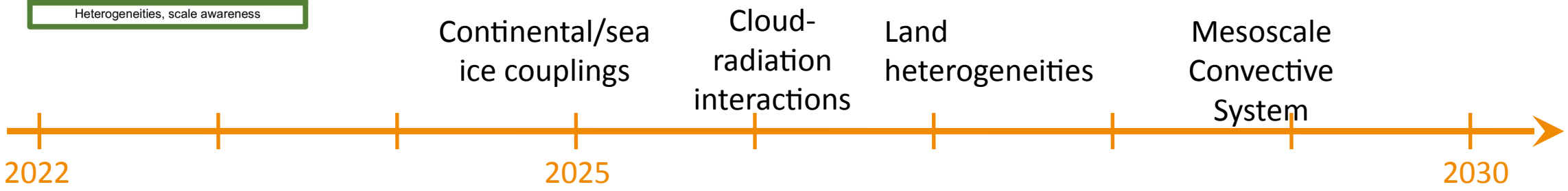
PC7: Enhanced representation of physical processes – Increasing the ESM reliability for climate studies and projections

17 permanent staff, 7 long-term positions, 4 post-docs, 1 PhD – 5706 k€



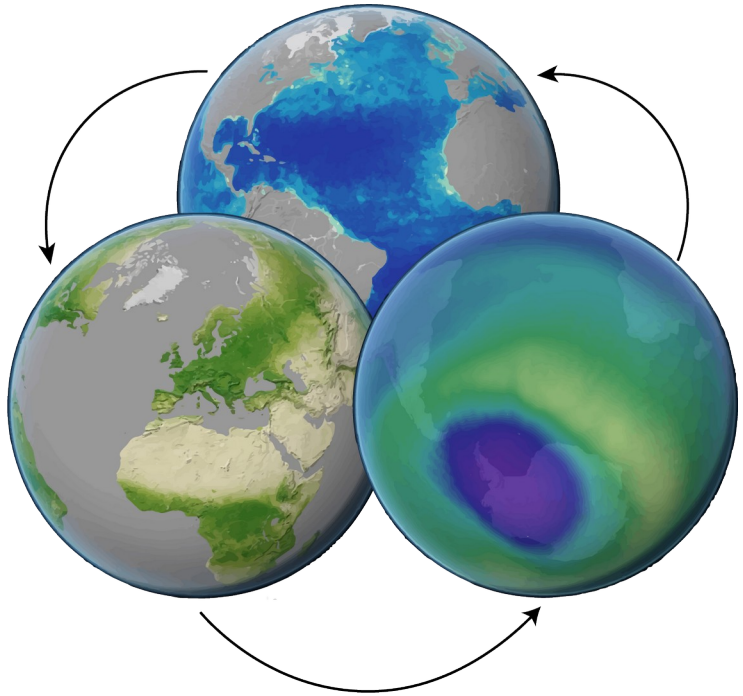
- **Advance theoretical models of physical processes**
- **Fully benefit from process/high-resolution models and most recent observations**
- **Explore the potentiality of AI-based techniques**

Novel, consistent and scale-aware representations of Earth system processes



PC8: Enhanced treatment of biogeochemical processes – climate feedbacks, impacts and vulnerabilities

13 permanent staff, 4 long-term positions, 2 post-docs, 1 PhD – 4517 k€



The current level of integration of these processes is lagging behind the most up-to-date knowledge, limiting our ability to deliver information on climate/Earth system feedbacks, impacts and vulnerabilities.

The aim is to explore a wider range of approaches to make a step change in the representation of biogeochemical responses in ESMs and analyze their interactions.

The focus will be on components of high level of interest for their impacts on the Earth system: P, N, C, and Fe cycles and their isotopes, fires, biogenic volatile organic compounds, and the dynamics of semi-arid ecosystems.

Transformative aspects include co-developing new inter-operable biogeochemical process modules between IPSL /CNRM ESMs, making use of advanced tools such as emulators to speed up biogeochemical processes

PC9: Polar Ice Sheets in the climate system – addressing high-end sea-level scenarios

12 permanent staff, 5 long-term positions – 3947 k€

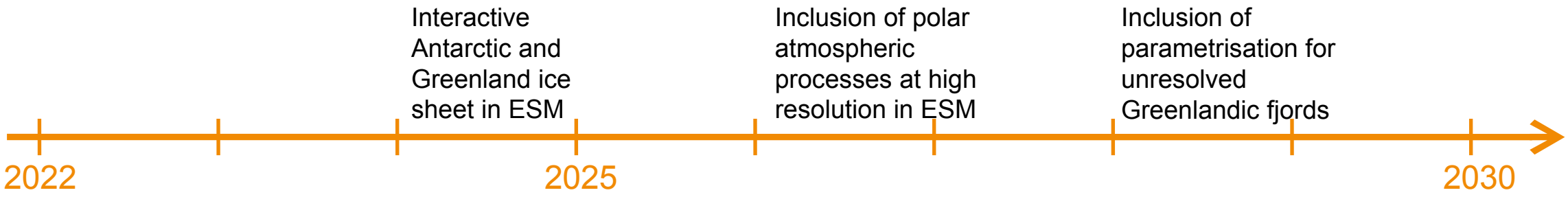
Greenland and Antarctica mass loss: the main uncertainty in the projections of the forthcoming mean sea-level rise.

The national community: a recognized leader in ice sheet model developments.

Include ice sheet model in ESM, the last missing climate component not represented in ESMs worldwide.

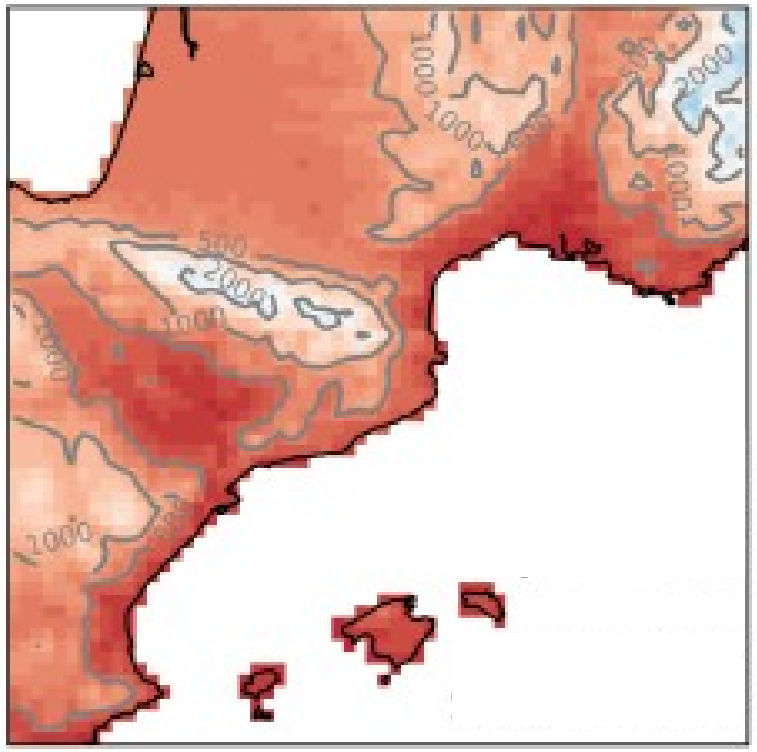
Ice sheets in CNRM and IPSL ESMs Implemented -

Improved understanding of ice sheets tipping points



PC10: Reaching the local scale in climate studies – towards reliable climate information for local adaptation strategies

15 permanent staff, 5 long-term positions, 2 post-docs, 2 PhD – 4705 k€



- Reliable local-scale (~1 km) climate projections and information = unreached (technical & scientific) challenge so far
- Needed for specific areas (eg, mountains, cities, islands coasts) & climate services (eg, for institutions, citizens, companies)

=> We need to:

- ✓ increase the resolution while preserving consistency b/ scales
- ✓ add new HR processes parametrization and coupling (eg, aerosol-cloud radiation, city-climate, etc), including w/ machine learning techniques
- ✓ better understand local phenomena for risk assessment

Beyond current local-scale climate modelling – integration of the French communities & projections