WGCM 25
report from the French groups: IPSL and CNRM-CERFACS

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IPSL CMC

Fast progress on automatic tuning (LMDZ atm. model and IPSL-CM coupled model) and accelerated spin-up through Machine Learning

Ongoing work on IPSL-ESM versions, **water isotopes** in the coupled model and coupling with **ice-sheets**

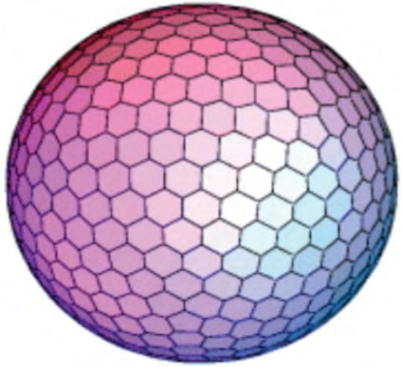
HR atmosphere-only simulations with LMDZ-DYNAMICO (**new dynamical core, icosahedral grid, 10 km uniform resolution)**

First coupling of LMDZ-DYNAMICO and NEMO v3.6

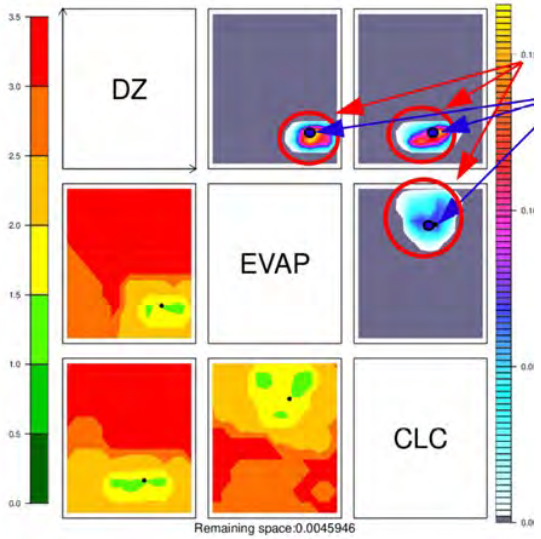
On-line bias corrections (i.e. **weak nudging** to average nudging error term) prove to be a pragmatic solution to correct some systematic biases in the model

Porting of climate models to GPU has started (but slow)

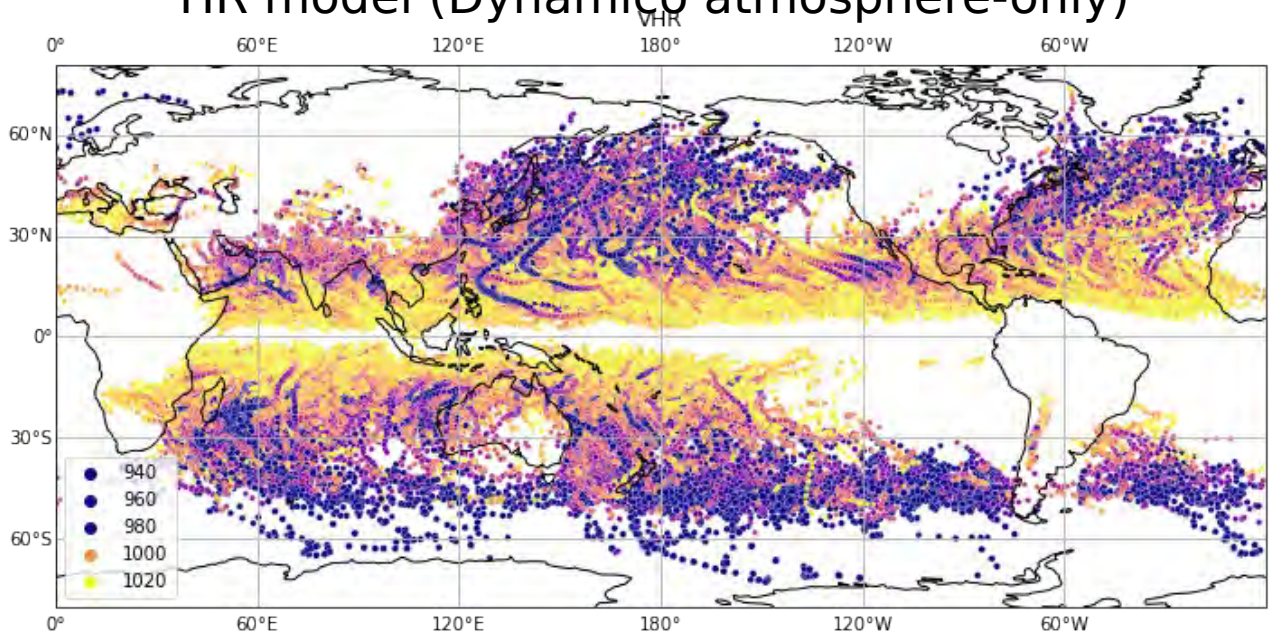
Dynamico



Model tuning



Density of trajectories of cyclone in HR model (Dynamico atmosphere-only)



CNRM - CERFACS

Global coupled models : new ongoing developments

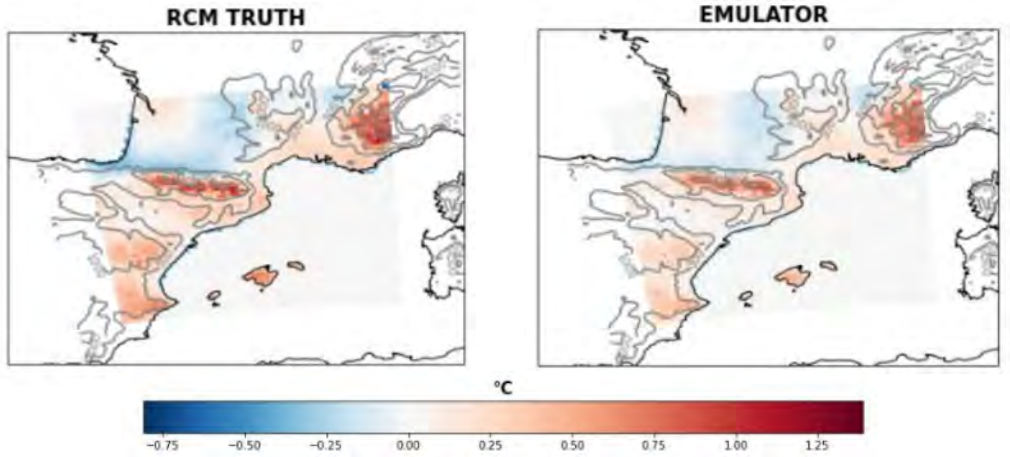
- A fast version of ARPEGE atm model has been developed (not ported on GPU) : 6 SYPD @10 km resolution, 70 SYPD @50 km, aim at 2-3 SYPD @5 km
- A fast version of CNRM-CM6 (~1° resolution), aim at 100 SYPD

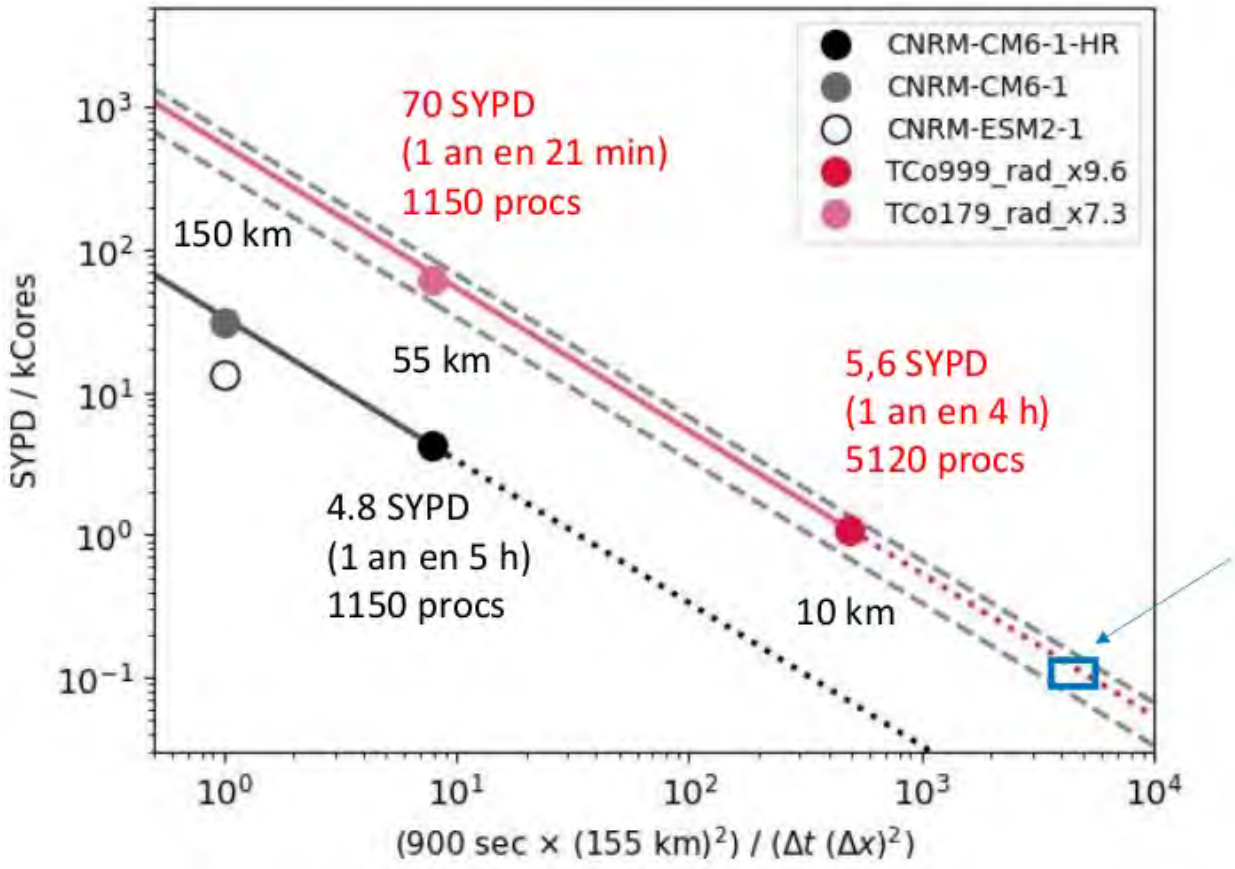
AI :

- Emulation of the GCM>RCM dynamical downscaling works for daily temperature and precipitation, new aim is to start emulating GCM>CPRCM (AROME – km-scale regional model)
- Defining (stable) parameterisations for the atmosphere (deep convection)

Adaptation of our codes to GPU :

- Ongoing intense activity to adapt AROME and ARPEGE to GPU (NWP)
- More work needed for climate versions of AROME & ARPEGE, and other components of CNRM-CM





XIOS 3: toward a new infrastructure unifying model coupling and HPC services

XIOS: library to manage “in situ” data flux produced by climate models

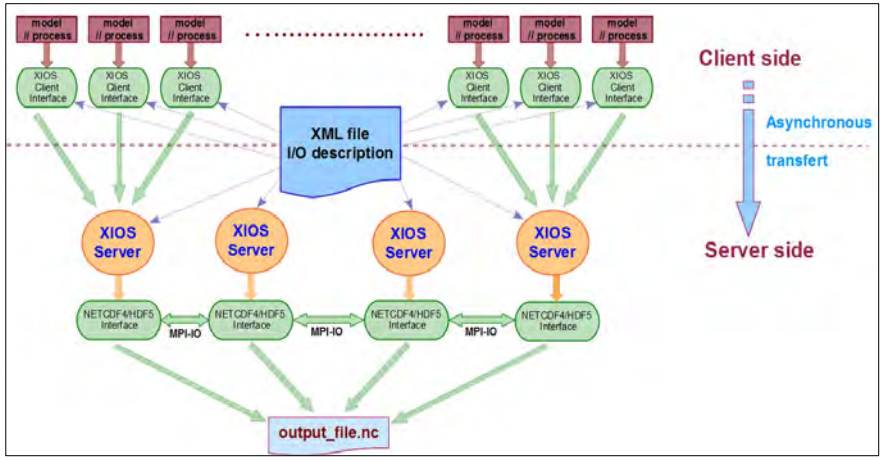
- Full description of models data workflow throw external XML files parsed at runtime
- Efficient data reading/writing by asynchronous I/O servers using parallel filesystem capability
- Transformation “on the fly” of data flux by chaining specific filters before writing
  - Performs combinations and arithmetic operations on incoming fields
  - Performs time integration (averaging, max, min, accumulation…)
  - Performs spatial transformations (ex : sub-part extraction, reduction, zonal means, vertical and horizontal interpolations…)

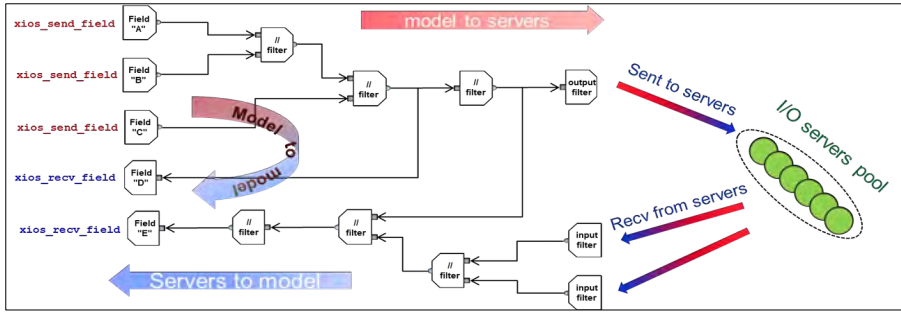
⇒ **Whole pre-processing and post-processing can be done at run-time all along the simulation (example: CMIP6 exercise)**

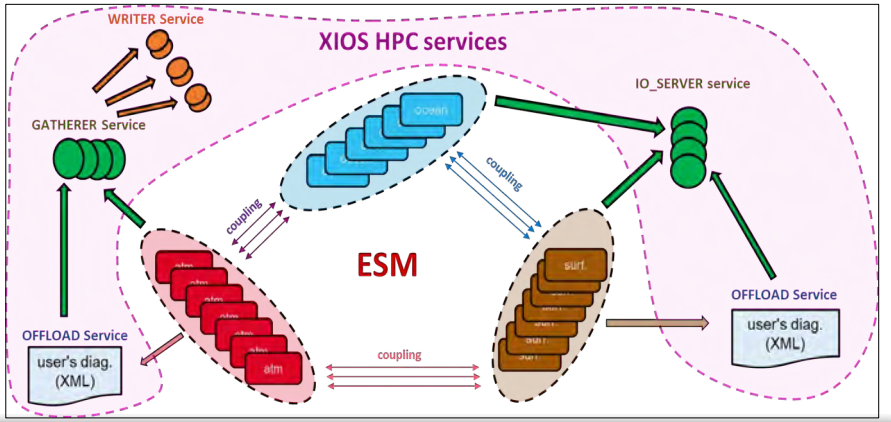
XIOS 3: major revision (released Sept. 2022), 3 years of work

- Major code rewrite of the internal engine (40% of whole code)
  - Improvement of the performances, huge reduction of memory footprint
- Introducing concepts of interconnected HPC services to offload asynchronously costly diagnostics on free pools of resources on the parallel partition.
  - Number of available services will increase in future (ensemble services, IA services, etc…)
- Adding coupling functionalities to the XIOS workflow, enabling data exchange between models using vertical and horizontal internal regridding.

Convergence of XIOS and OASIS functionalities into a single tool (TRACCS)



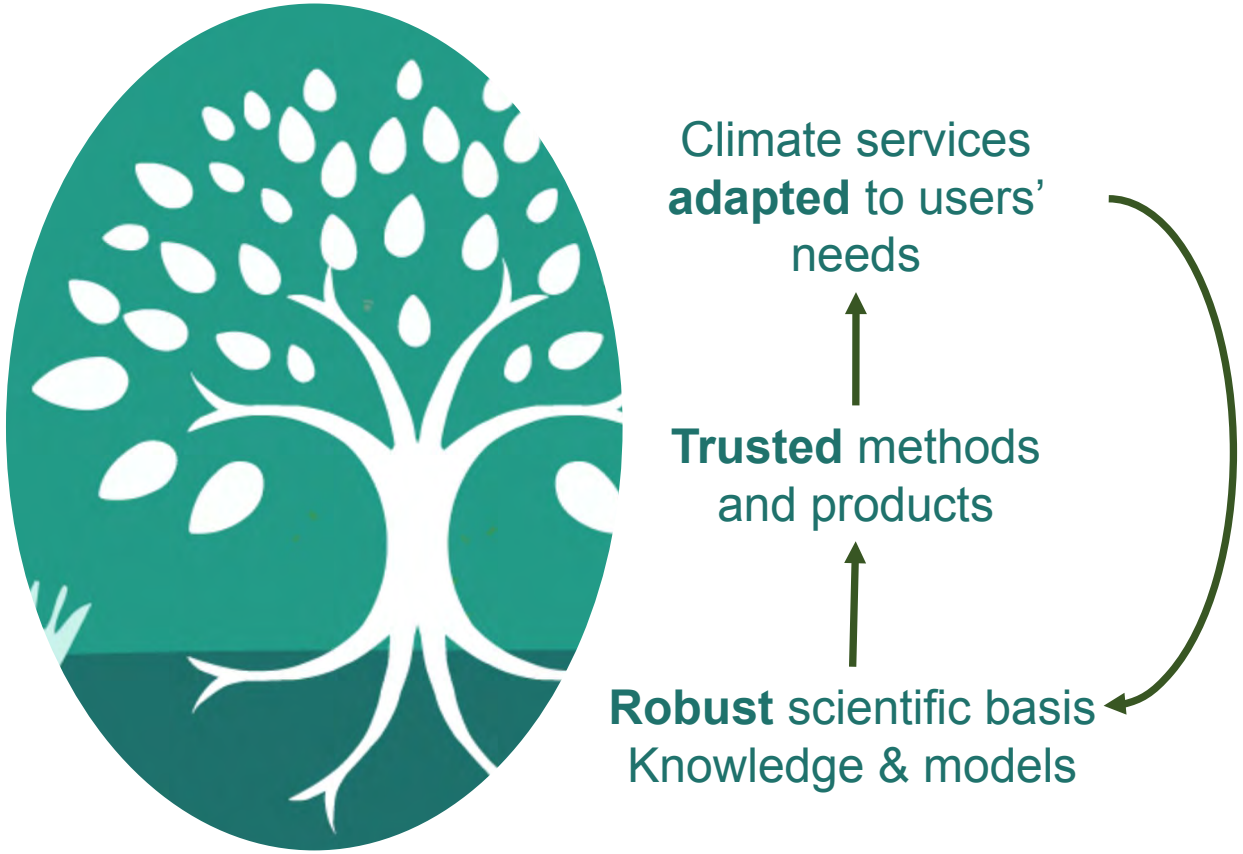




XIOS team: Y. Meurdesoif, J. Dérouillat, A. Caubel (LSCE)

A new French national programme : TRACCS

Transformative Advances in Climate modelling for Climate Services



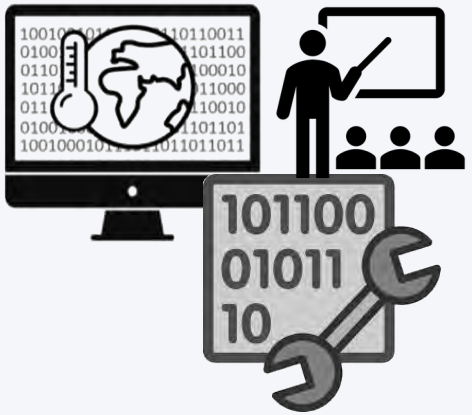
TRACCS is :

- a 8-year programme (51 M€ total funding, starting in 2023) – part of a 1000 M€ competitive call for transformative research as part of the post-Covid national French rescue plan
- 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 programme** interacting with other funded research & operational initiatives within the same call (OneWater, FAIRCarbon, others to come)
- **Strong international dimension** (connections & complementarities with Copernicus C3S, DestinE, WMO/WCRP).

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

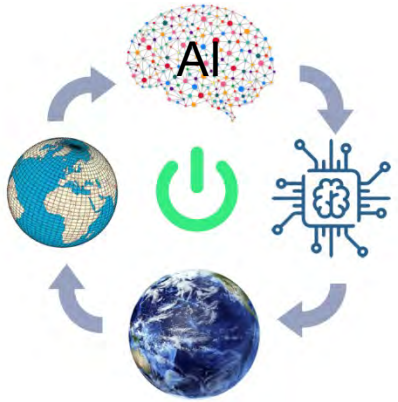
Future climate risks in France and elsewhere

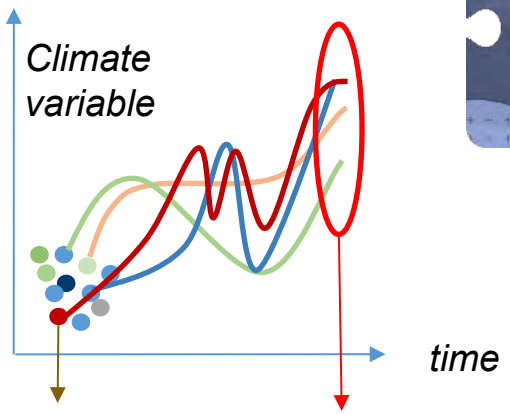
- **Actionable climate change information** for key sectors and territories (France mainland & overseas, foreign countries)
- **Special focus on extreme events**: quantification, attribution, compounds, future evolution
- Transformative, **interdisciplinary and transdisciplinary** advances towards climate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

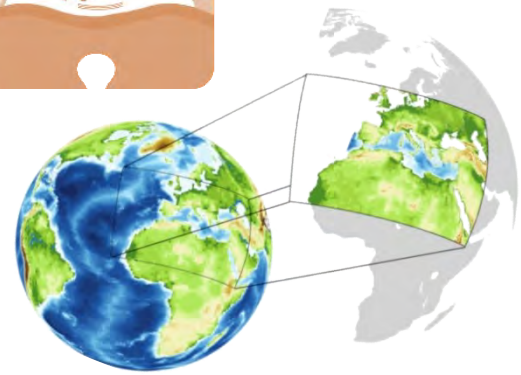
Transformative advances
in model design
- increased use of AI,
- addressing new HPC frameworks,
- quantifying confidence levels





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

Thoughts for CMIP7

- Still harvesting CMIP6 (new publications about CNRM-CM6 and IPSL-CM6)… no hurry !
- Need for an assessment of the use of the CMIP6 data (what is the useful part of the database distributed through the ESGF ?)
- Interest of the French climate modelling community for ensembles (in a broad sense, also including multi-model, multi-physics) to quantify uncertainties. Keep ensembles to a reasonable size and/or emulate some members (environmental footprint)
- Need for model hierarchy
- The French contribution to CMIP7 will depend on its timeline (new national supercomputer and new Météo-France supercomputers in ~2026)