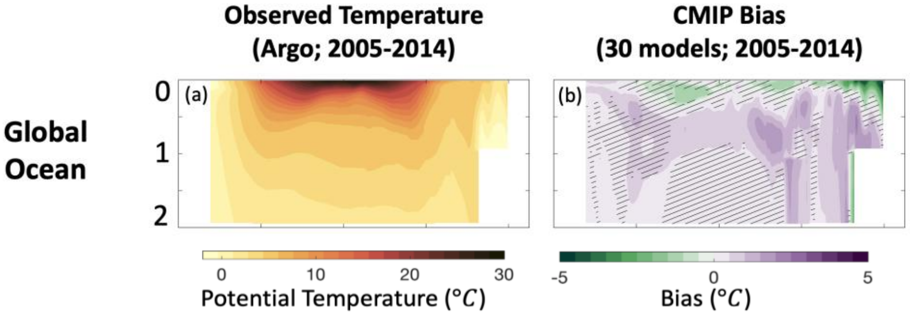
Secrétariat général pour l'investissement

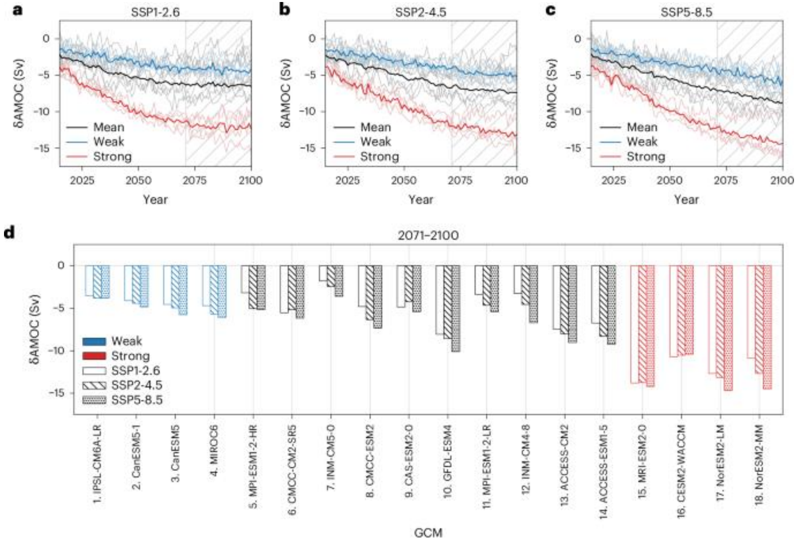
LEAP-HCS

LEveraging differentiAble Programming and online learning for Hybrid Climate Simulators

LEAP-HCS Context & motivation

- Earth System Models are cornerstones of climate science
- Their skill depends on numerous uncertain parameters
- Calibration remains mostly manual and time-consuming





From Bonan et al., 2025

LEAP-HCS project objectives

Overall objective: Study new computing paradigms, tools, and calibration methods for designing ESMs that are closely aligned with observations, faster, and augmented with AI-based models and computing infrastructure.

PyTorch

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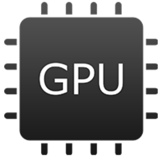

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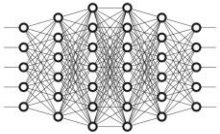

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z} - fv = -\frac{1}{\rho_0}\frac{\partial p}{\partial x} + \frac{\partial}{\partial x}\left(A\frac{\partial u}{\partial x}\right) + \frac{\partial}{\partial y}\left(A\frac{\partial u}{\partial y}\right) + \frac{\partial}{\partial z}\left(\nu_E\frac{\partial u}{\partial z}\right)$$

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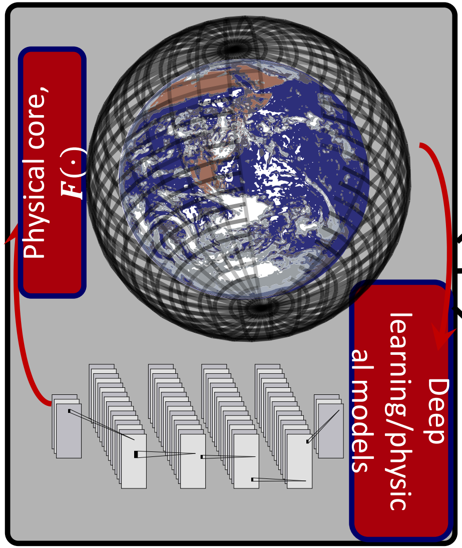
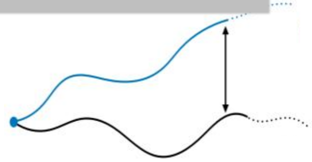
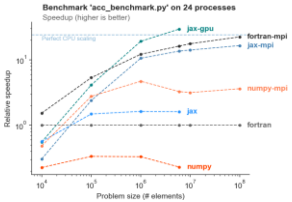


Fit historical data



accelerated simulations



Automated tuning

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O1: Development of an AI-native ocean modeling benchmark

- AI native
- Supports Automatic differentiation
- Gradient based optimization

O2: Development of automated tuning methods for climate models

- Developoement of gradient based optimization for climate models
- Lack of Automatic differentiation

O3: Application on the ocean component of the IPSL climate model

- Subgrid scale parameterization tuning
- Spinup acceleration

LEAP-HCS poster

Session posters n°1 Mardi 3 février à 17h30, Salle Marie Curie