WGCM 24
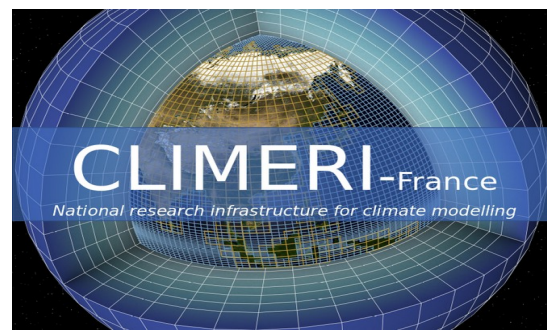# report from the French groups:
IPSL and CNRM-CERFACS

David Salas y Mélia, CNRM
Olivier Boucher, Masa Kageyama, IPSL

7 December 2021

Many ongoing model developments:
- model tuning using emulators: atmosphere-only, ocean, coupled model (as a multi-timescaled problem)
- online bias correction
- model physics informed by LES
- planned transition to new atmospheric dynamical core
- more ESM: N cycle, couplings between C, N and aerosol cycles, water isotopes, river temperatures, coupling to ice sheets

IPSL—CM7—DYNAMICO (50km)
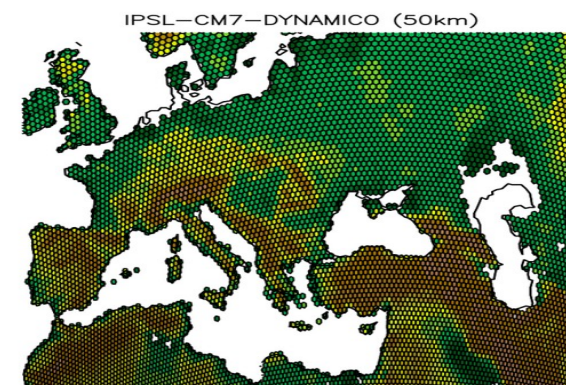
Dynamico

Dynamico-LAM
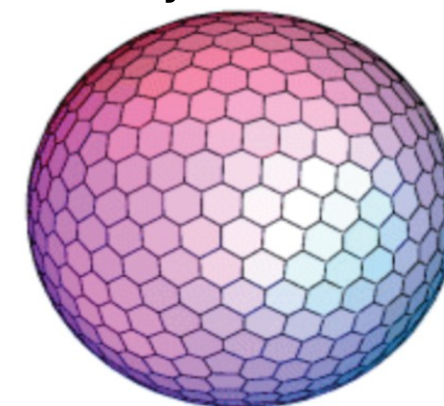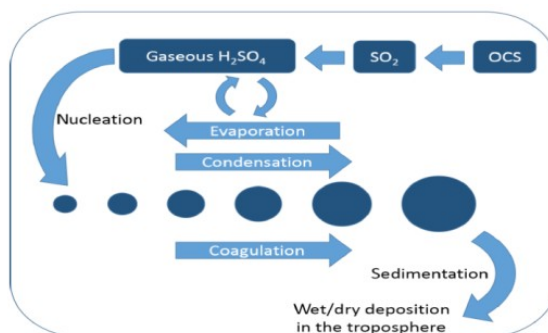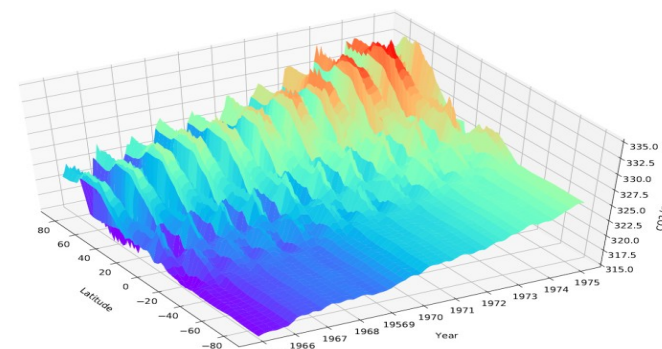
$$\frac{\partial X}{\partial t} = F(X) + G$$
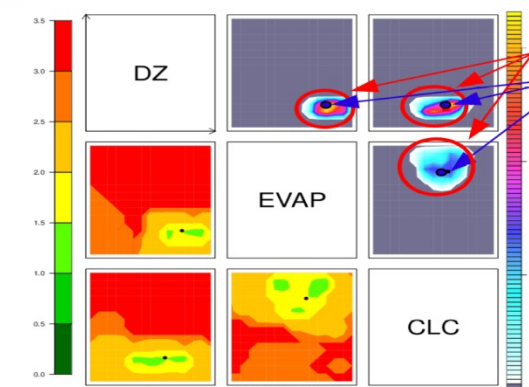
where G is the empirical bias correction

$$G = -\frac{1}{\tau}\overline{(X - X_R)}^{AC}.$$

Stratospheric aerosols

Interactive CO$_2$

Model tuning

Average river temperature (in K) in 1980 over all hydrological transfer units in gridbox

$$T_{i,stream}^{t+1} = \frac{W_{i,stream}^{t}}{W_{i,stream}^{t+1}} T_{i,stream}^{t} + \frac{\Delta t}{W_{i,stream}^{t+1}} \cdot \sum_{j\in\{i-1\}} (Q_{j,slow}^{t} T_{j,slow}^{t} + Q_{j,fast}^{t} T_{j,fast}^{t} + Q_{j,stream}^{t} T_{j,stream}^{t}) - \frac{\Delta t}{W_{i,stream}^{t+1}} \cdot Q_{i,stream}^{t} T_{i,stream}^{t}$$

Predicting river temperatures is beneficial for :
- coupling to the ocean model in fully coupled simulations
- the ORCHIDEE model when used offline
- future climate services


E. Dupont & J. Polcher, IPSL, 2021

IPSL-CMC
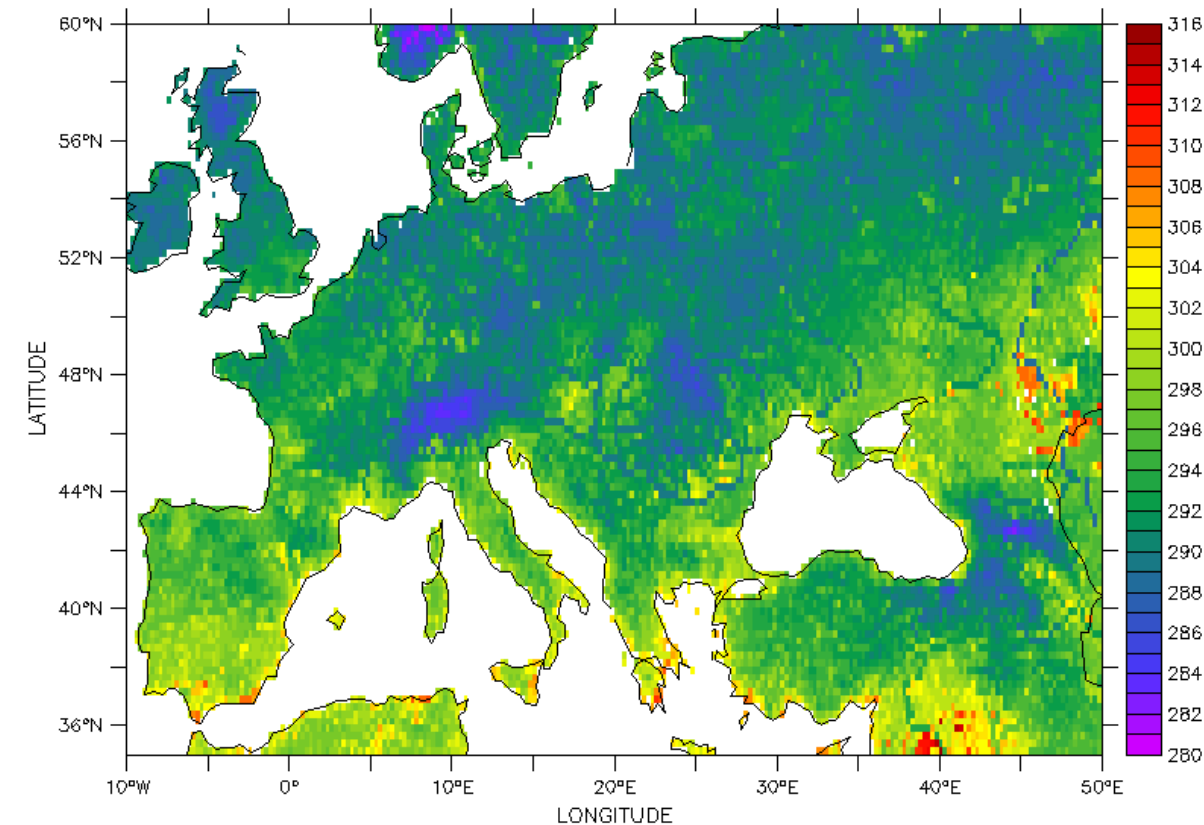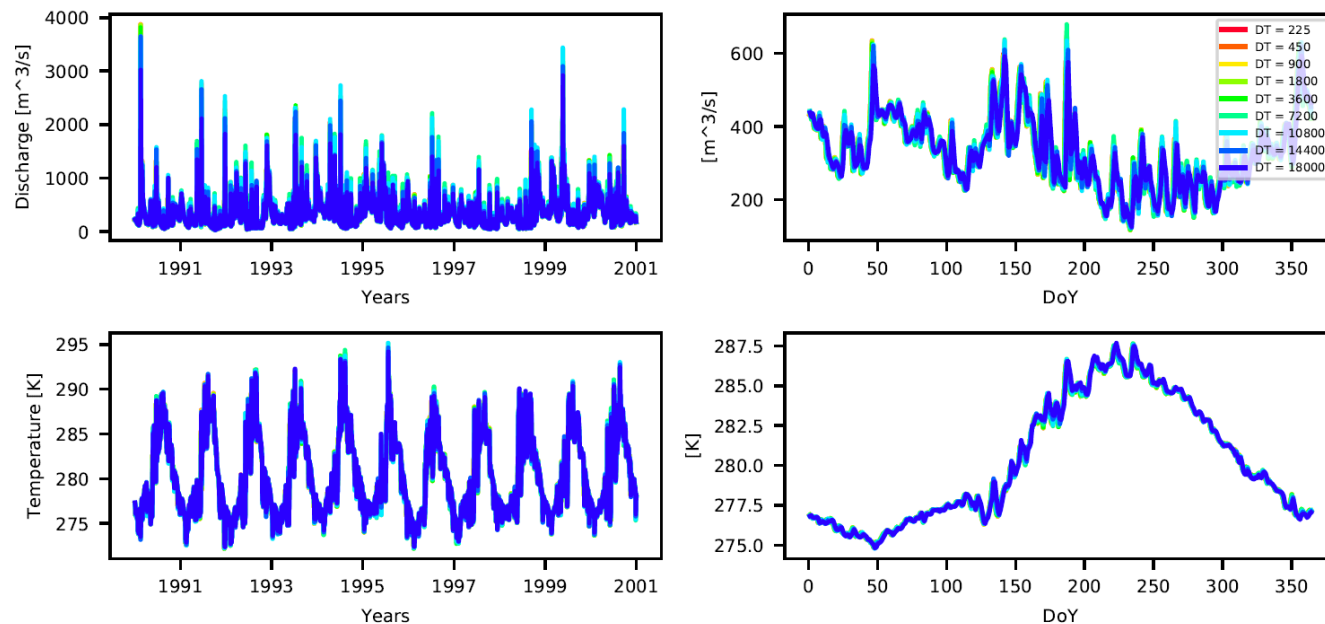
- **Our vision of exascale computing is geared towards large ensembles of 20-50 km resol simulations**

  - Use of LES up to ~0.1 km to develop parametrisations

  - AI / ML to transfer information across scales

  - Focus on model tuning & uncertainty characterisation

  - 20-50 km resolution for the global Earth's system model

  - Simulations >> 100 yrs for uncertainties & slow components

  - Consistent limited area modelling (*Funding limited and scattered*)

- **Porting on GPU only starting and starting slowly**

IPSL-CM7-DYNAMICO (50km)
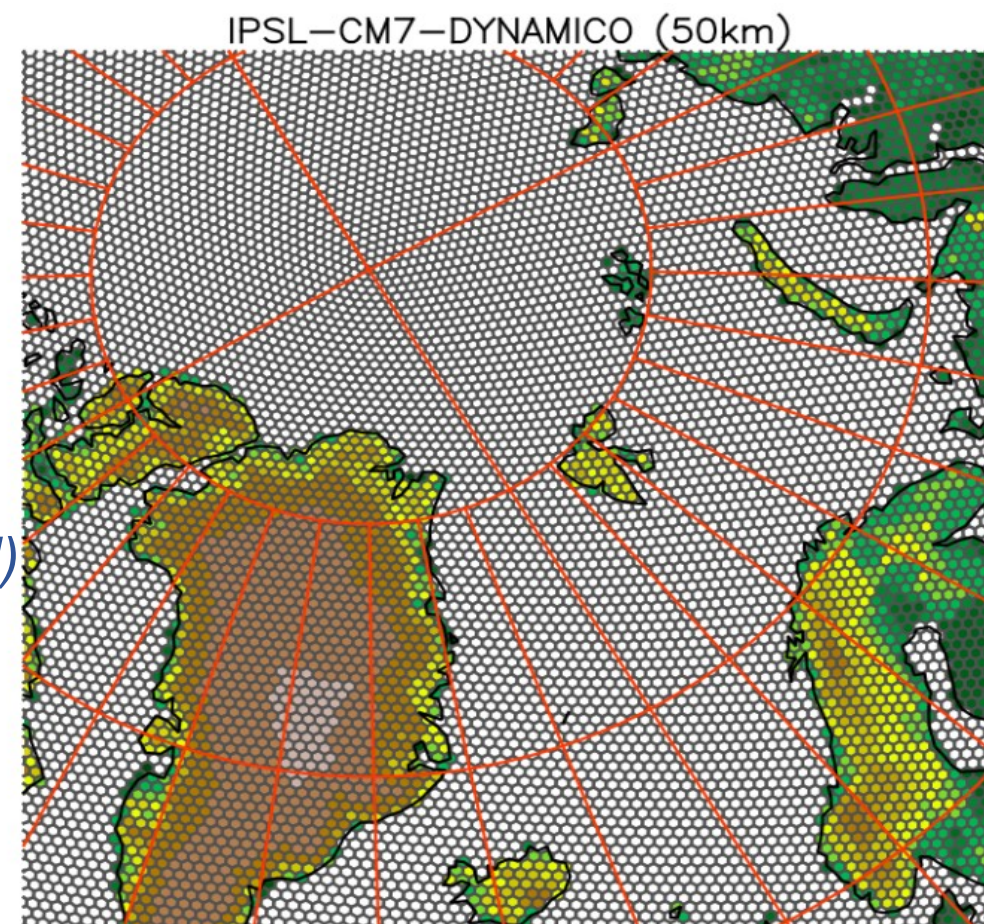
New developments in CNRM-CM's components

Low cloud fraction (%)
Tiedke-Bechtold deep convection / AROME shallow convection in ARPEGE
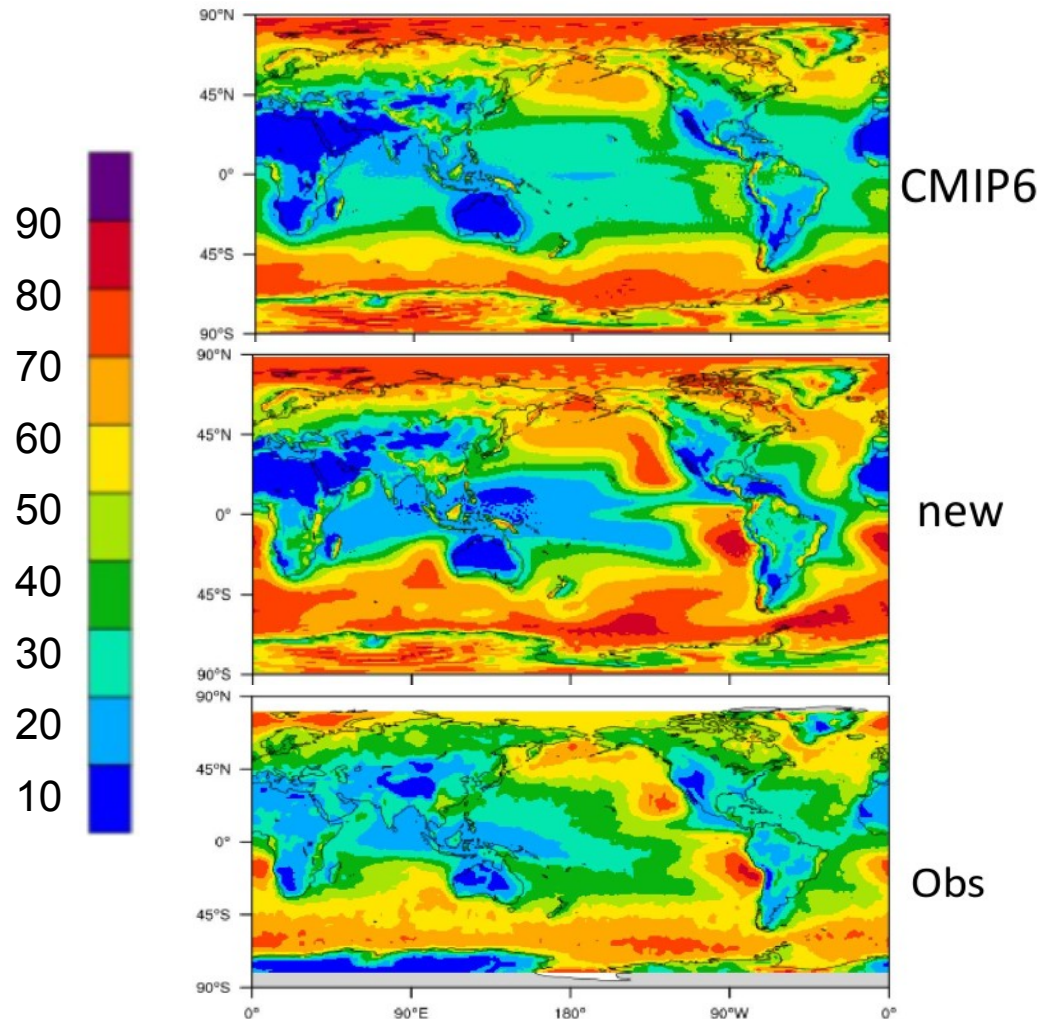
- **Atmosphere (ARPEGE) :**
  - new developments in ARPEGE (version 7 in 2022)
  - investigations about the overestimated intensity of tropical cyclones in CNRM-CM6-HR (50 km resolution)
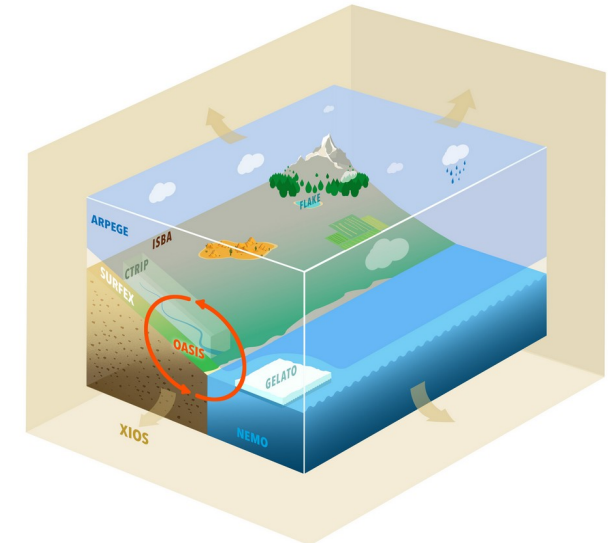
- **Land-surface (SURFEX) :**
  - vertical dynamics of soil carbon
  - biomass burning

- **Ocean :**
  - EDMF (convection) in NEMO 3.6

- **Machine Learning :**
  - numerical stability of parameterizations based on ML (toy models – Lorenz)
  - Successful emulation of GCM>RCM downscaling (ARPEGE 150 km>ALADIN 10 km)

Appetite for CMIP7

- **Finish harvesting CMIP6**

- **Learn the lessons from CMIP6 before preparing CMIP7** (no need to prepare now)

- **Wish for a more 'frugal' CMIP7** (simplified design)