Climate modelling:
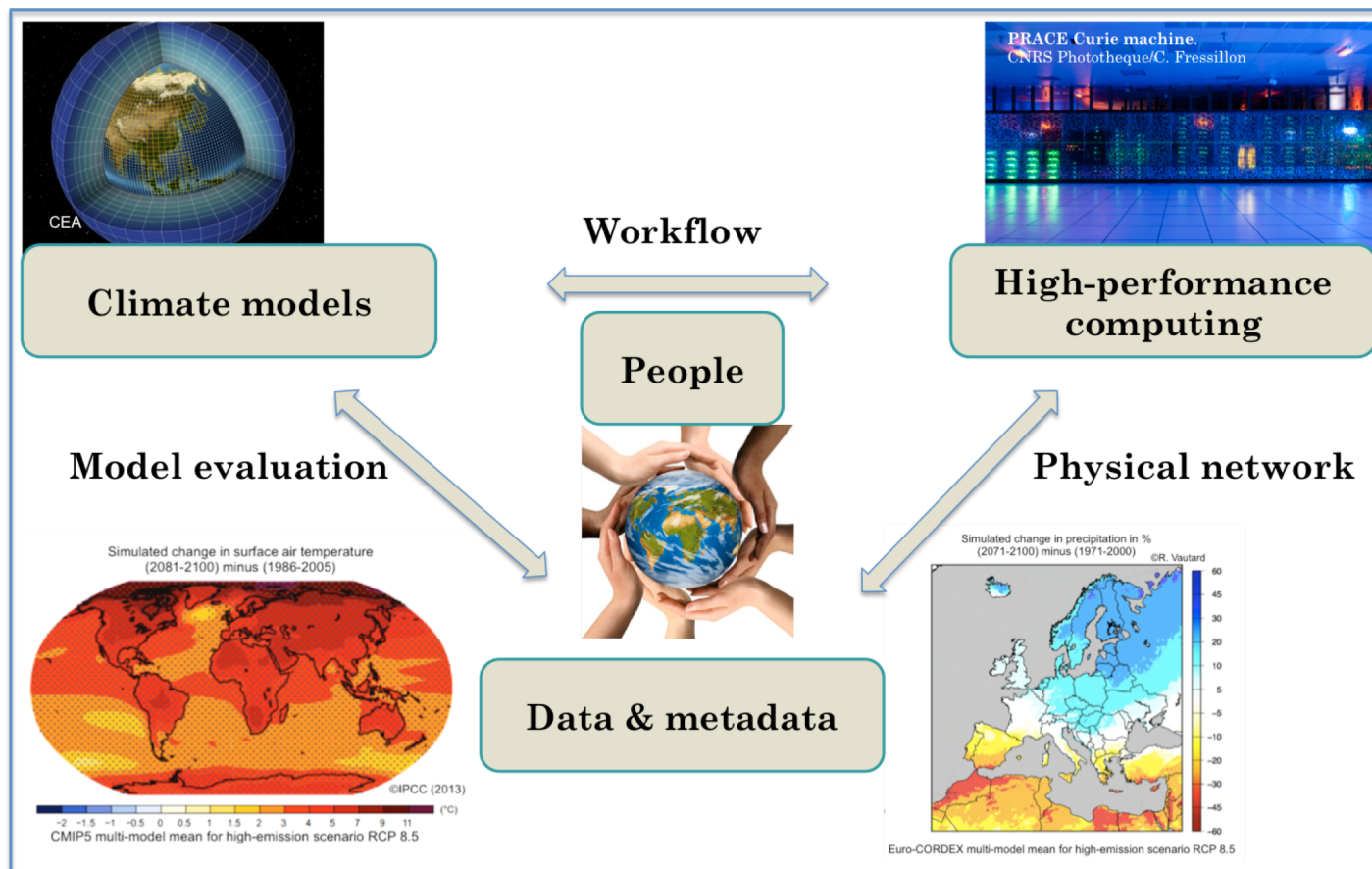# computing and data infrastructure needs

Sylvie Joussaume

CNRS, Institut Pierre Simon Laplace, Saclay, France

Coordinator of H2020 IS-ENES3

Main recommendations

- **Models**: Accelerate preparation of exascale

- **HPC:** Exploit blend of facilities & Access to world-class HPC

- **Big data challenge**: Access, documentation, analyses

- **Physical network**: Maximize bandwidth

- **People**: Training at all levels for researchers & engineers

- **New** - **Model** e**valuation:** supporting the infrastructure

- **New** - **Sustainable infrastructure**
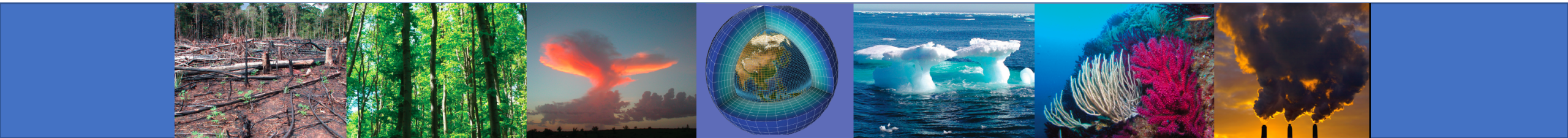
ENES Infrastructure strategy
2012-2022, update 2017 (https://enes.org)

is-enes
INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

**Running current models and
facilitating the use of the associated data**
to progress understanding of climate, improve models, and inform society

esiwace
CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER AND CLIMATE IN EUROPE

Preparing for future generation models and data exploitation
running on **future computer architectures**

- IS-ENES   (2009-2013)
- IS-ENES2 (2013-2017)   https://is.enes.org
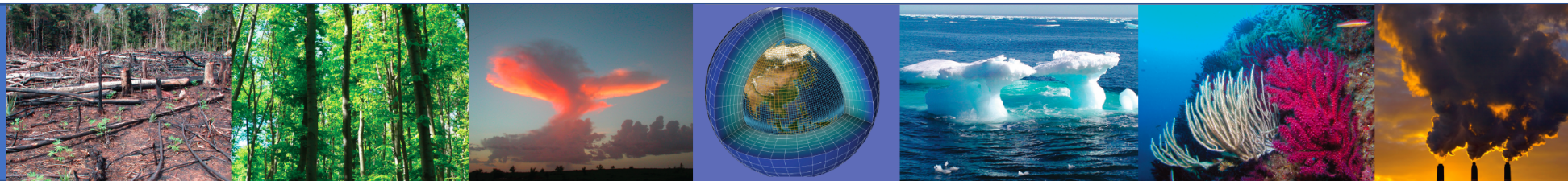- **IS-ENES3 (2019-2022)**

**Support WCRP internationally coordinated climate
model experiments (CMIP & CORDEX)**

**Support sharing of expertise on
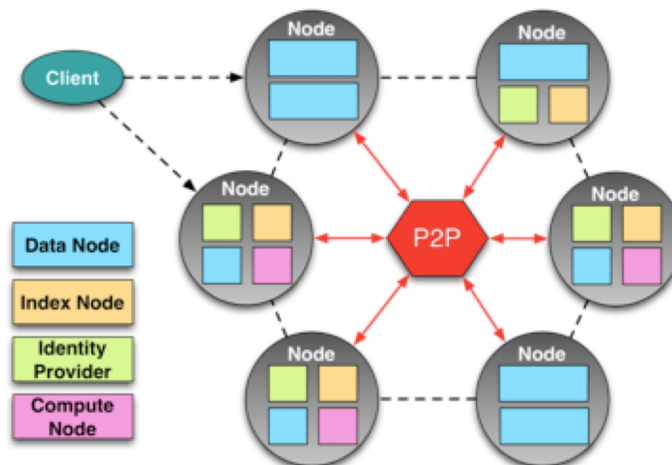climate models, tools & HPC**

- ESiWACE (2015-2019)   https://www.esiwace.eu
- **ESiWACE2 (2019-2022)**

Center of excellence in HPC for weather and climate

**Prepare for pre-exascale architectures
(models, tools, data)**

Earth system grid federation: A common data infrastructure

ESGF Earth System Grid Federation

is-enes INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

Dashboard stat
ESGF: 8 M datasets
23,4 PB (w/o replica 12,7)
CMIP6: 7 M datasets
16,1 PB (w/o replica **9,3**)
CMIP5: 5,3 PB (**1,5**)

A wide range of users
Climate science
Climate impacts
Climate services

FAIR data
Open source software, common data and metadata standards
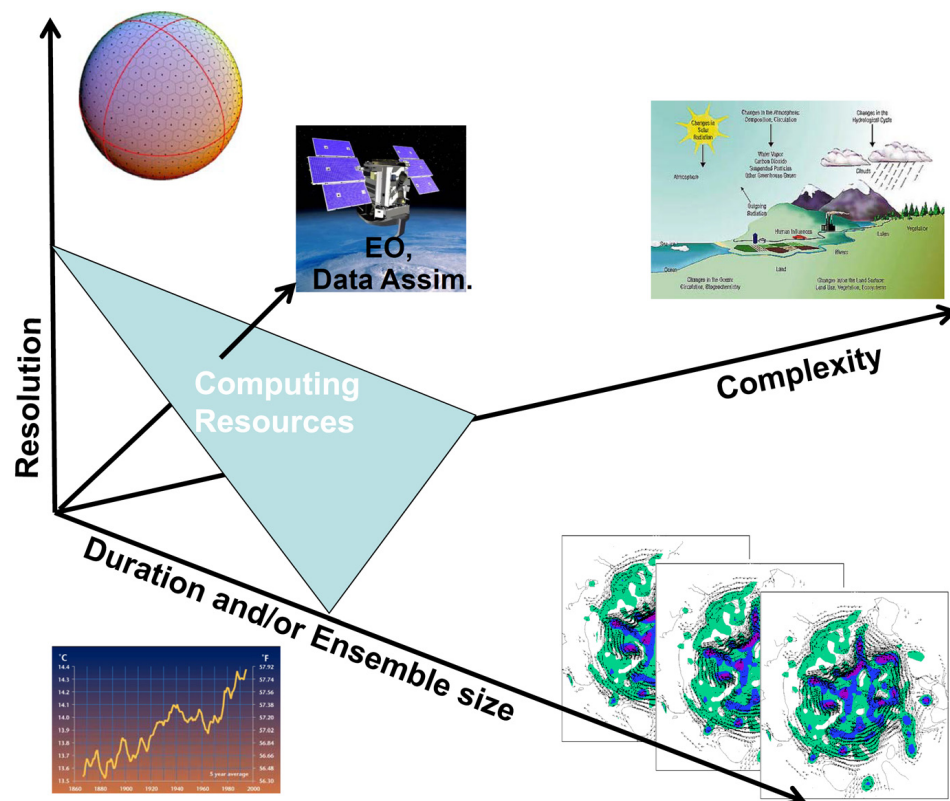International, Community led : GO-ESSP, WIP
Multi-agencies support: *DOE, NOAA, NASA, IS-ENES, NCI*

⬅ ESGF: still on project funding

**is-enes** INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

➡ Climate projections @ climate data store

Climate Change Service

Copernicus Europe's eyes on Earth

Infrastructure Strategy Roadmap
2012-2022

Grand challenge:

Towards global 1 km climate models

World modelling summit 2008

ENES : major dimensioning challenge for the infrastructure (Codes & Data)

- **Science**: resolve deep convection and ocean eddies
- **Technology**: highly scalable climate models for future extreme computing architectures
- **Society**: need more reliable information at regional scale

Adapted from Jim Kinter, the World Modelling Summit, 2008

First step
but effort needed beyond COE
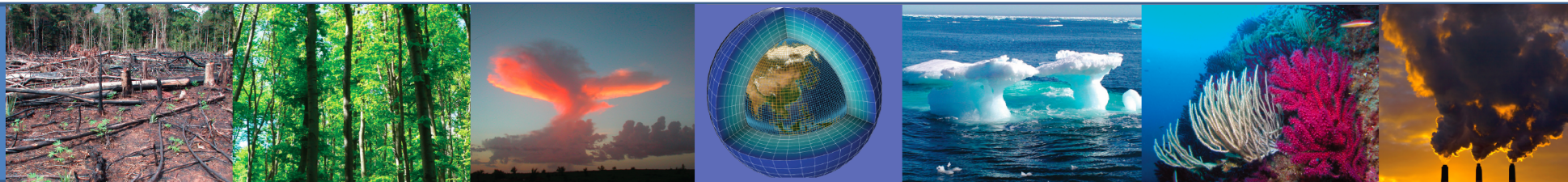
To address climate research challenges:

- **Need for a sustained European climate modelling infrastructure** :
  support data infrastructure, development of codes, sharing of expertise
  Key for IPCC assessment reports and Copernicus C3S

- **Future HPC architectures (EuroHPC):**
  An opportunity (resolution, complexity, ensembles) but also
  challenging for climate codes (how to use heterogeneous architectures for our complex/legacy codes)

Key for Mitigation and Adaptation policy

Adaptation → towards global 1 to 10s km, better integrated with sectorial impacts
Mitigation → large ensembles, 10s to 100 km models, carbon and chemistry cycles

Strong need to revisit model codes (porting to rewriting),
Enhance their HPC efficiency (algorithms, co-design),
Manage big data (exabyte will be reached before exaflops)
Use of AI for parameterizations and data analyses

Climate models will increasingly be at the core of climate information for society
Joint research needed with Destination Earth

To know more on IS-ENES3 and ESiWACE2:

websites

https://is.enes.org/

https://esiwace.eu/

Follow us on Twitter !

@ISENES_RI

@ESIWACE

Join the community on ZENODO !

**is-enes
esiwace**

is-enes
INFRASTRUCTURE FOR THE EUROPEAN NETWORK
FOR EARTH SYSTEM MODELLING

esiwace
CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER
AND CLIMATE IN EUROPE