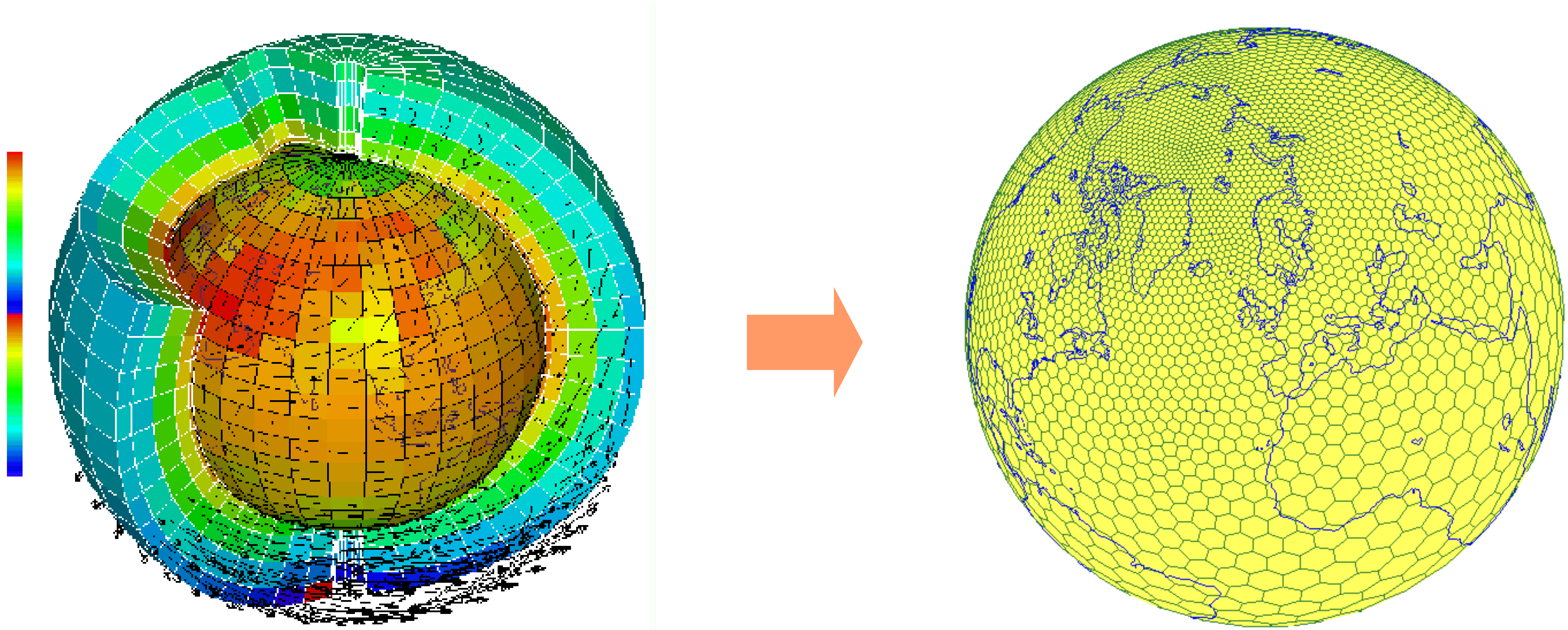
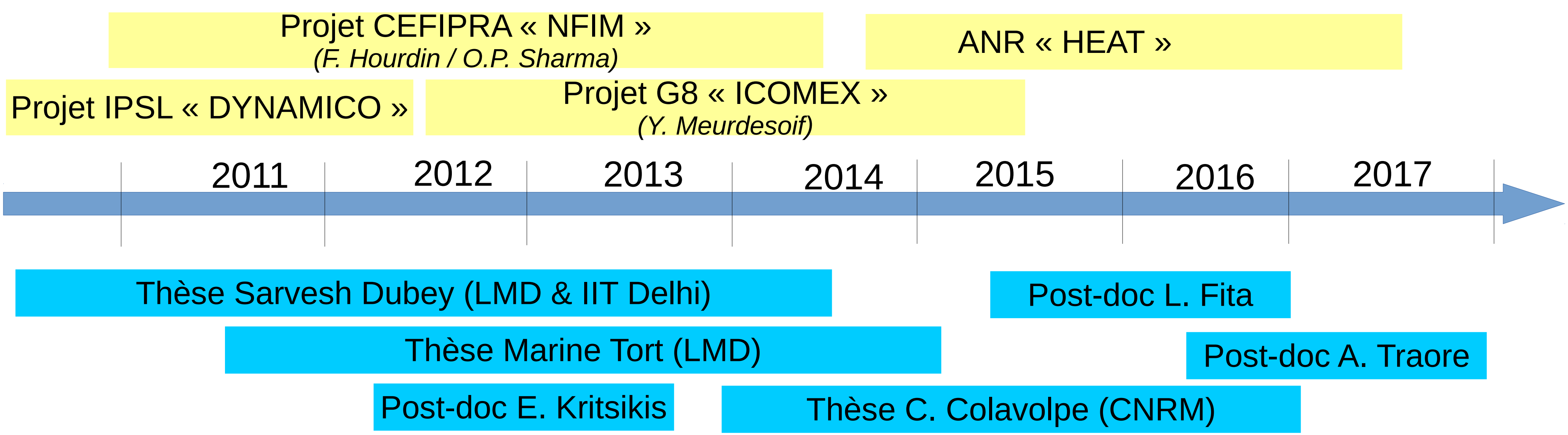
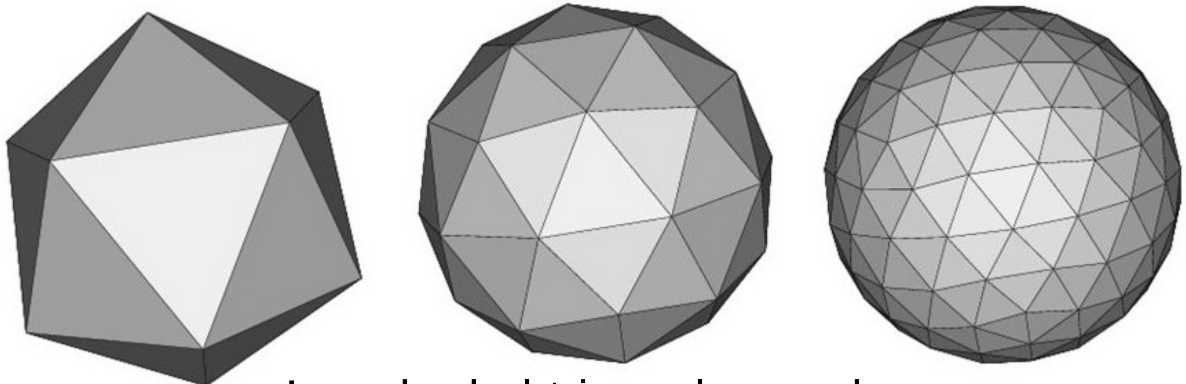




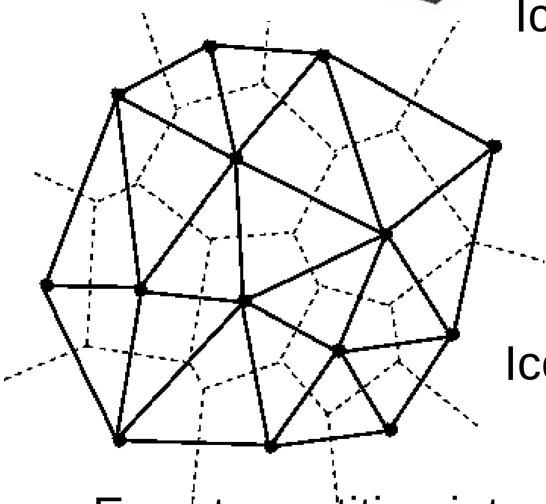
Projet CEFIPRA « NFIM »
(F. Hourdin / O.P. Sharma)
ANR « HEAT »
Projet IPSL « DYNAMICO »
Projet G8 « ICOMEX »
(Y. Meurdesoif)
2011
2012
2013
2014
2015
2016
2017
Thèse Sarvesh Dubey (LMD & IIT Delhi)
Post-doc L. Fita
Thèse Marine Tort (LMD)
Post-doc A. Traore
Post-doc E. Kritsikis
Thèse C. Colavolpe (CNRM)

Mesh partitioning for parallel computing

nbp=1 *nbp=2* *nbp=4*

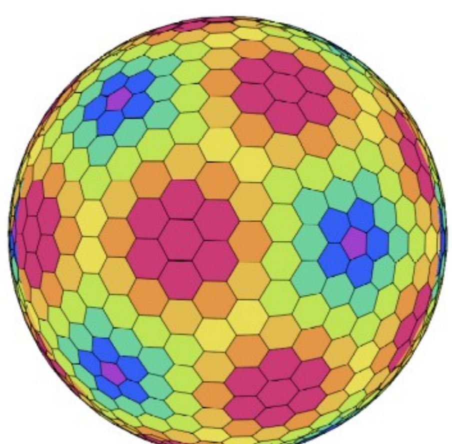


Icosahedral-triangular mesh
$10*nbp^2+2$ *vertices*

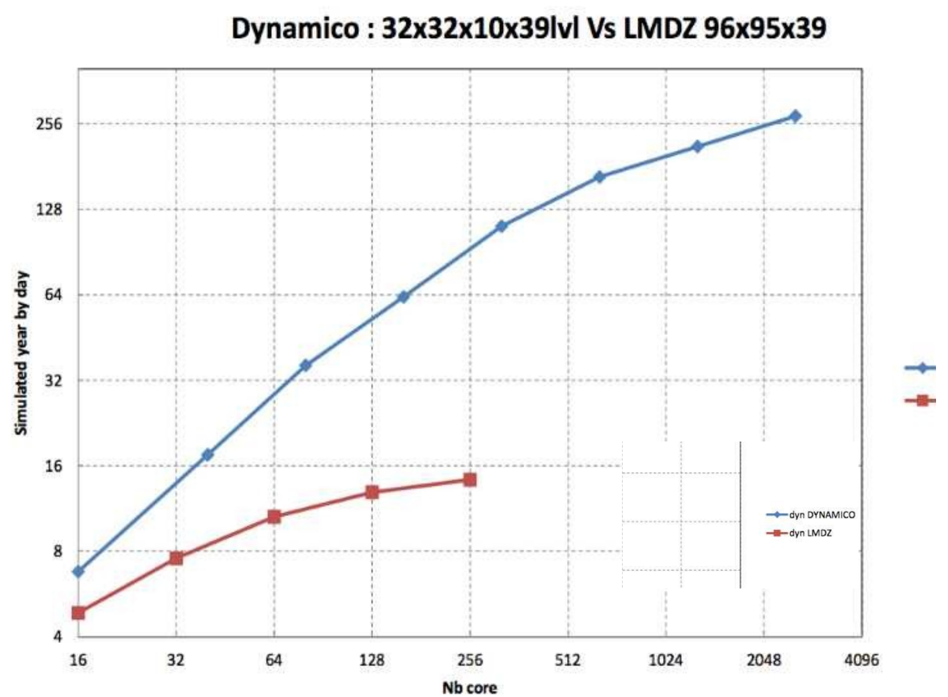


Voronoi dual

Icosahedral-hexagonal mesh
$10*nbp^2+2$ *cells*



- Easy to partition into $10 \times nsplit^2$ domains
- About $(nbp/nsplit)^2$ cells per domain = MPI process
- Nbp/nsplit>10 for performance



Y. Meurdesoif, 2013

Physical space

$$\lambda, \varphi, \Phi, g$$
$$u, v, w$$
$$\alpha = 1/\rho,\ s,\ r$$

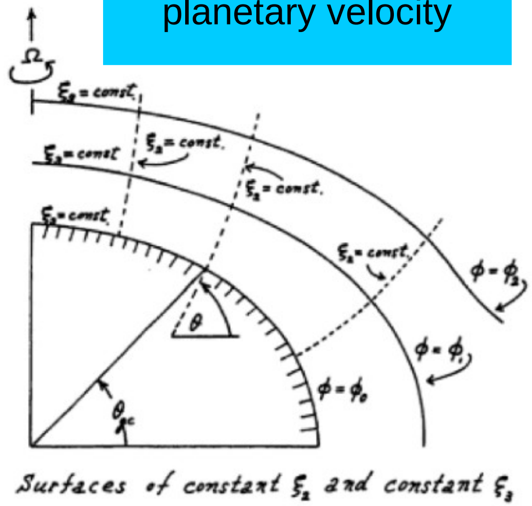
Thermodynamics

$$p, T, \chi$$

Geopotential Coordinates
Metric, gravity, planetary velocity

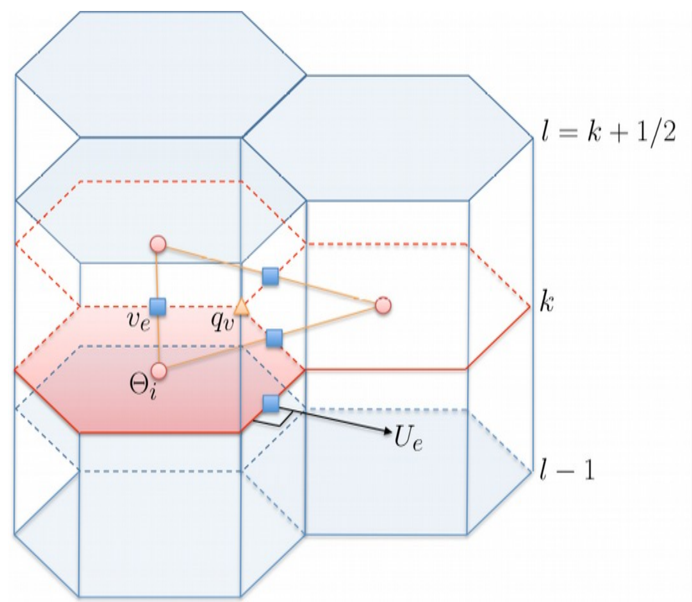
Computational space $S^2 \times [0,1]$

$$\mathbf{v} = \mathbf{G}(\mathbf{n}, \Phi) \cdot \dot{\mathbf{n}} + \mathbf{R}(\mathbf{n}, \Phi)$$
$$\Phi(\mathbf{n}, \eta, t), \mu,$$
$$\mathbf{n} \qquad \eta$$



Horizontal mesh
Icosahedral C-grid

Vertical mesh
Lorenz



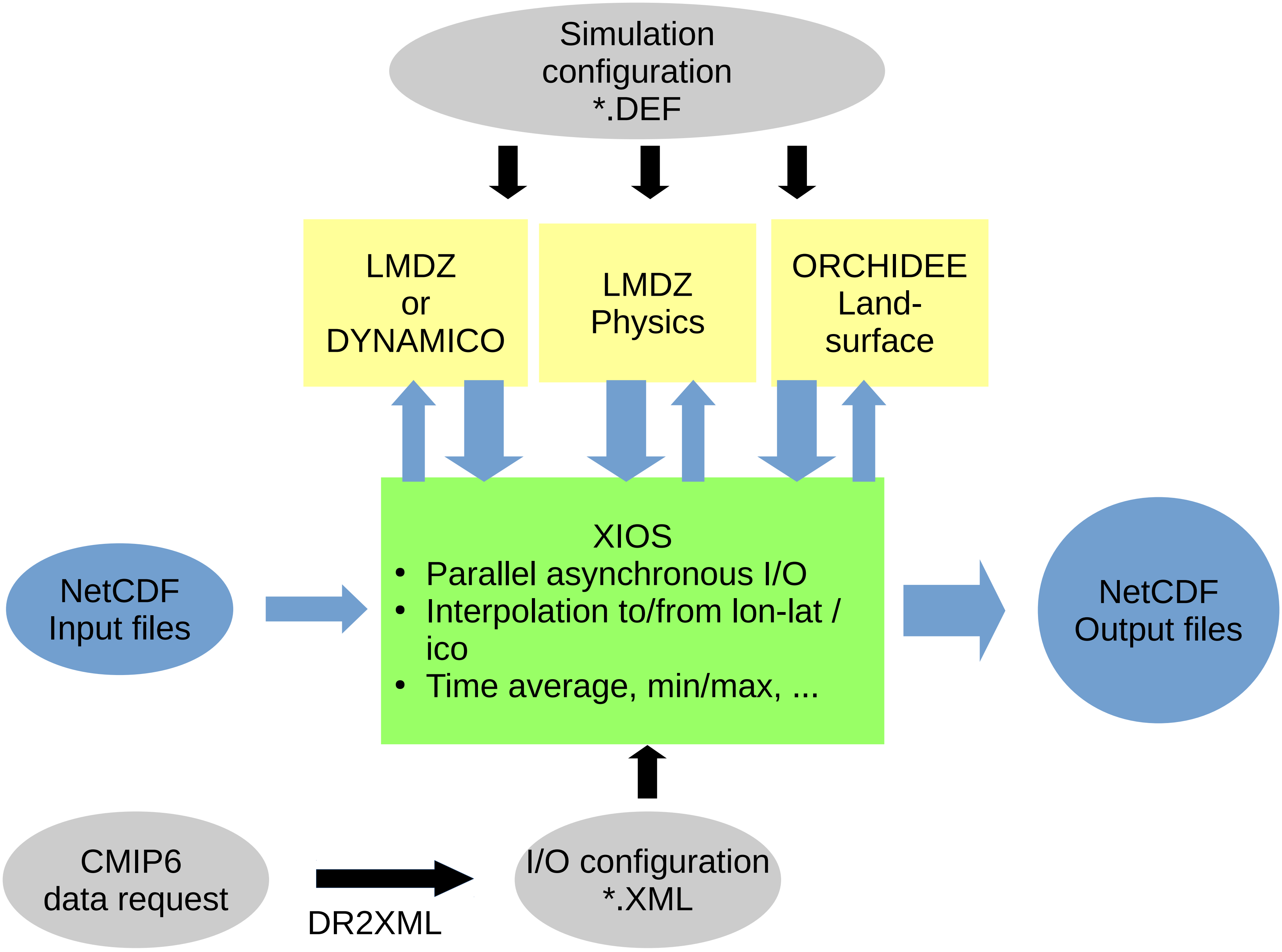
Discrete space

$$m_{ik} = \int\int\int \mu \mathrm{d}\mathbf{n} \mathrm{d}\eta$$
$$W_{il} = \int\int \mu\dot{\eta} \mathrm{d}\mathbf{n}$$
$$v_{ek} = \int \mathbf{v} \cdot \mathrm{d}\mathbf{n}$$
$$\alpha_{ik} = \alpha(p_{ik}, s_{ik}),$$

- Discrete integration by parts (Bonaventura & Ringler, 2005 ; Taylor, 2010)
- Energy- and vorticity- conserving Coriolis discretization (TRiSK : Thuburn et al., 2009 ; Ringler et al., 2010)

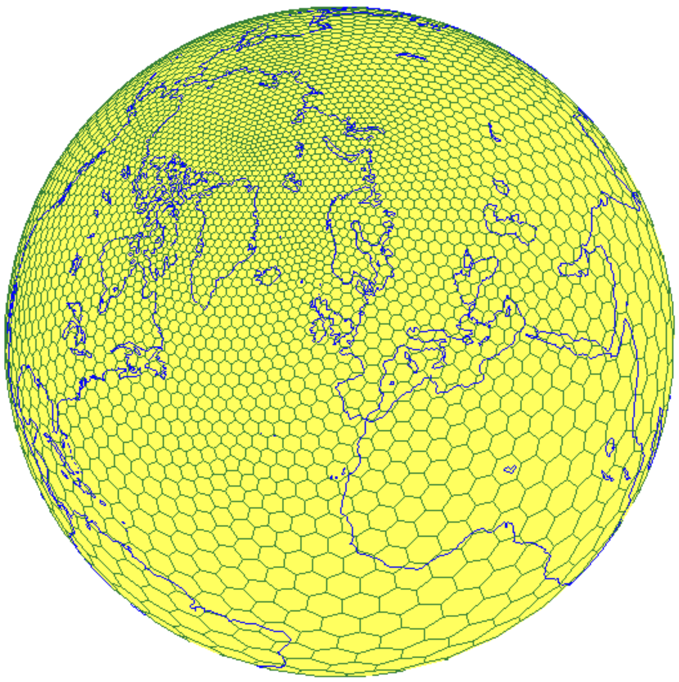
Energy-conserving 3D core

Atmosphere-only configurations

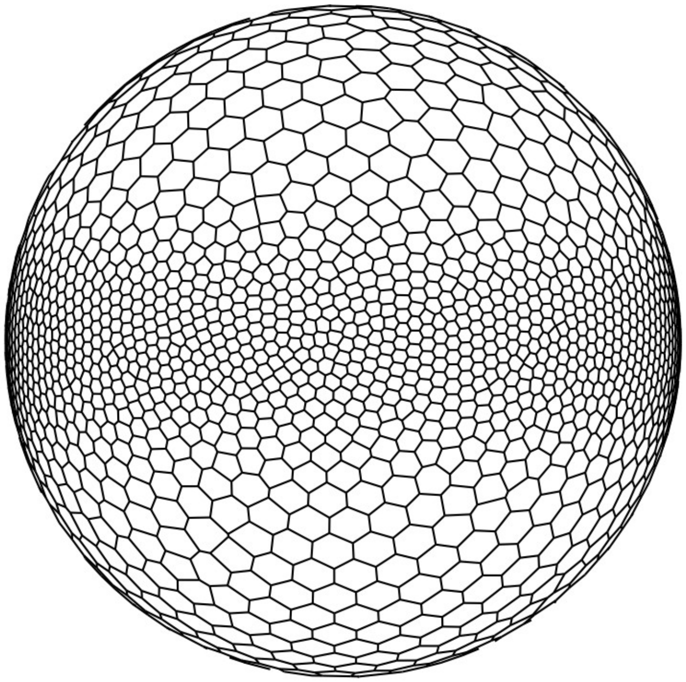


Towards regional configurations with DYNAMICO

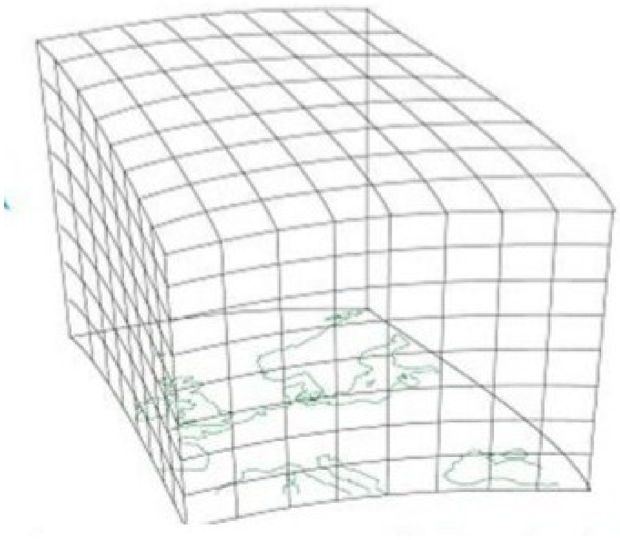
https://lmdz.lmd.jussieu.fr/le-coin-des-developpeurs/reunions/2020-01-13
https://cmc.ipsl.fr/online-session-on-ipsl-cm-configurations/



Zoom (Schmidt transform)



Zoom (unstructured mesh)



Limited area (LAM)

Status : many pieces of the puzzle there, nothing operational yet

Work could start now with the Schmidt transform (some tuning of dissipation needed)

AWACA science-driven modelling goals

Past

- Goal : go beyond simple statistical relationships (e.g. isotopic thermometer) to reconstruct past variability from isotopic records
- How : inverse modelling, e.g. Steiger (2017)
- Requires : isotope-aware model, multi-centennial simulations

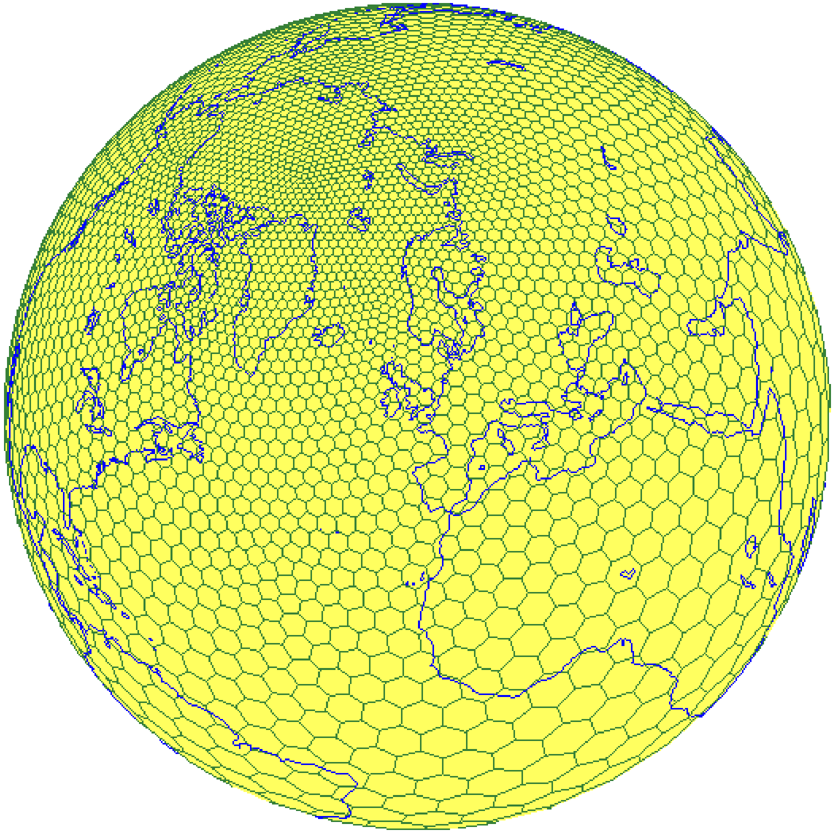
Present

- Goal : reduce biases in simulated present-day Antarctic precipitation ; characterize contribution of moist processes to uncertainty
- How : characterization, understanding and representation (parameterization) of small-scale moist processes
- Requires : process-rich, high resolution, limited-area modelling (+tailored observations …)

Future

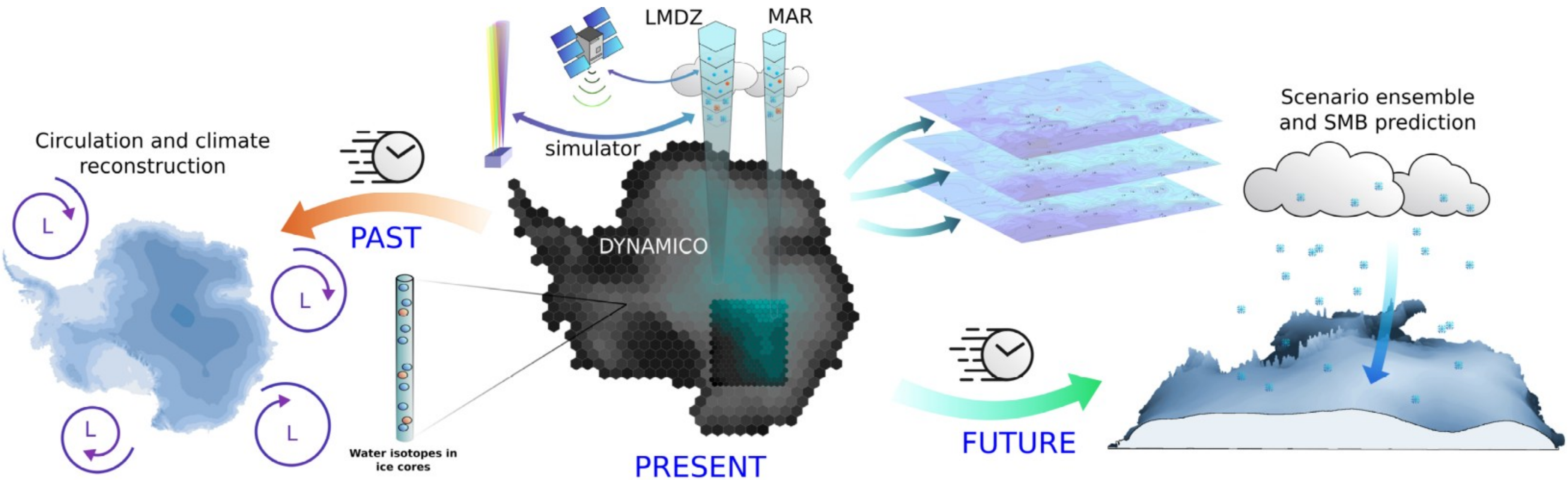
- Goal : disentangle contributions to future changes in Antarctic precipitation from ocean and sea-state, atmospheric circulation, small-scale processes
- Goal : deliver high-resolution projections of Antarctic precipitation, with quantiified uncertainty, for use beyond AWACA, especially for ice sheet modelling
- How : ensembles of simulations 1800-2100
- Requires : large multi-centennial ensembles, integration wiith CMIP-class ESM

A modelling portfolio for AWACA



LMDZ	the atmospheric component of the IPSL-CM ESM
MAR	regional atmospheric model with particular focus on polar regions
DYNAMICO	Dynamical Core on Icosahedral mesh : a massively parallel atmospheric solver

	Existing			AWACA	
	MAR	DYNAMICO	LMDZ	MAR+ICO	LMDZ+ICO
Polar processes	√			√	√
Massively parallel		√		√	√
LAM	√	(√)		√	√
Isotope-aware	√	(√)	√	√	√
CMIP-capable		√	√		√


LMDZ
MAR
simulator
Circulation and climate reconstruction
PAST
DYNAMICO
Water isotopes in ice cores
PRESENT
Scenario ensemble and SMB prediction
FUTURE