A few examples for operating LMDZ in zoom and nudging modes

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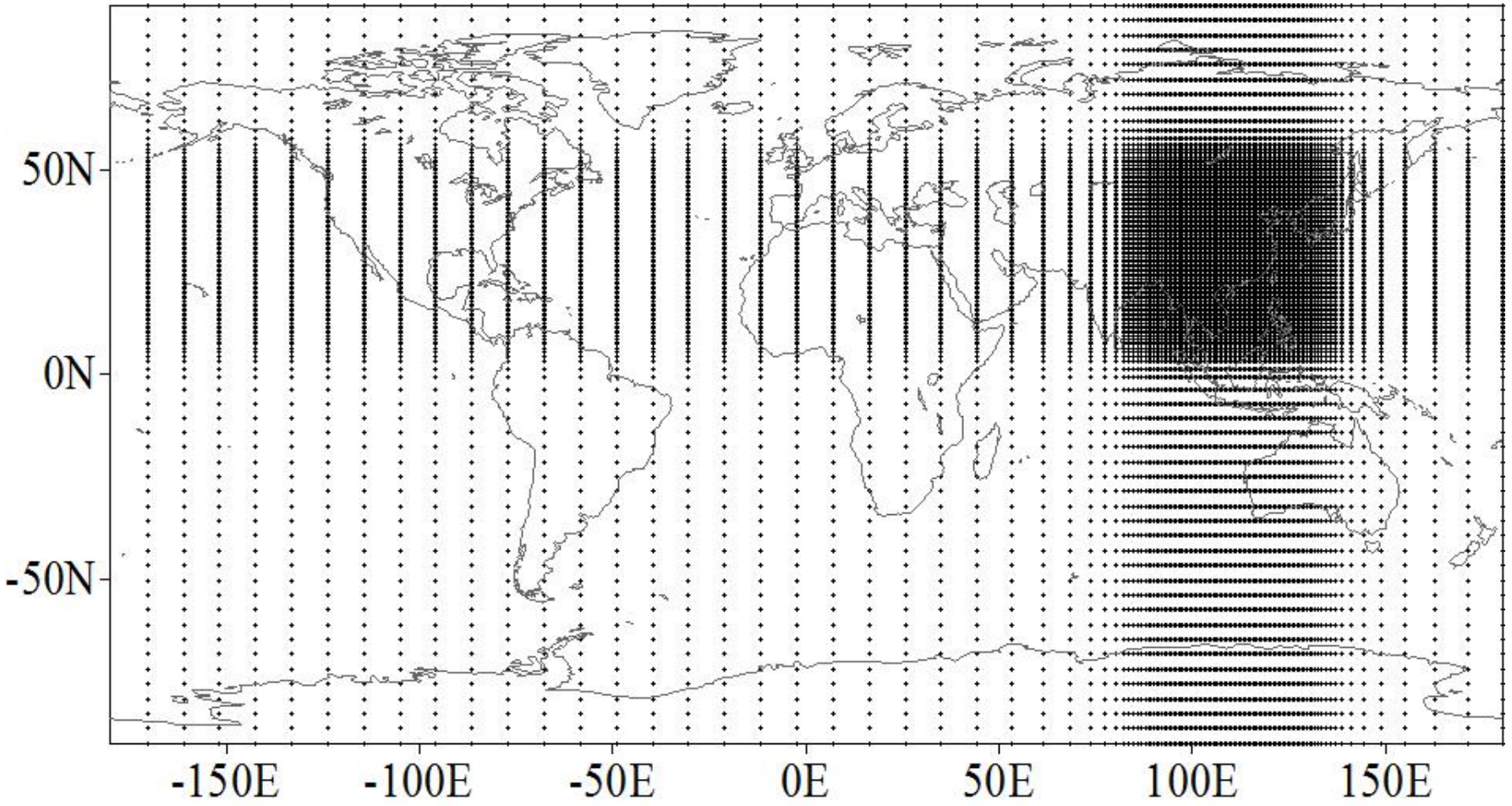
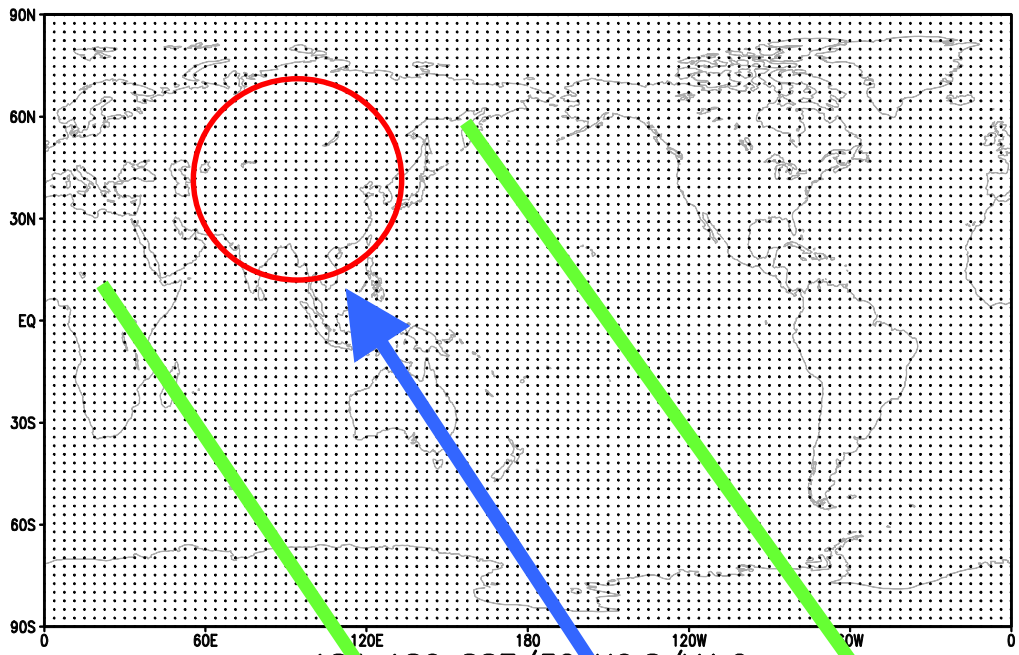
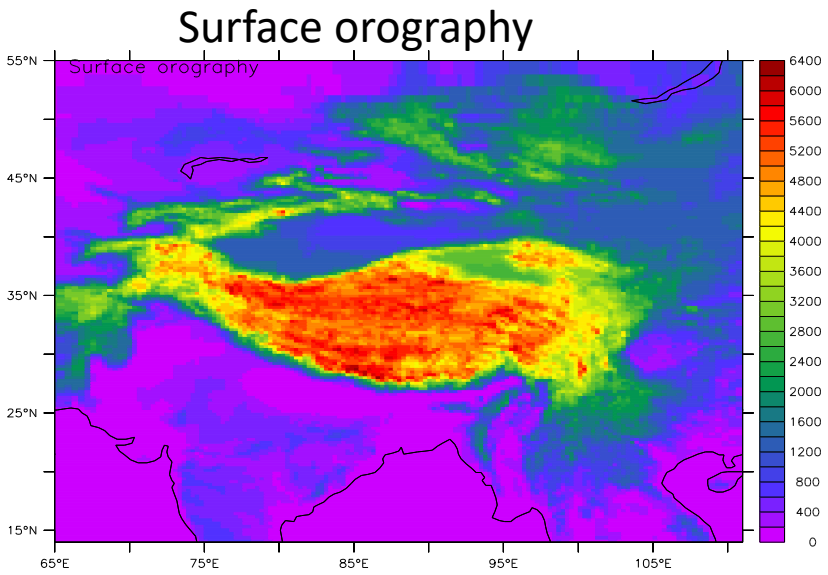
Zoom over East China

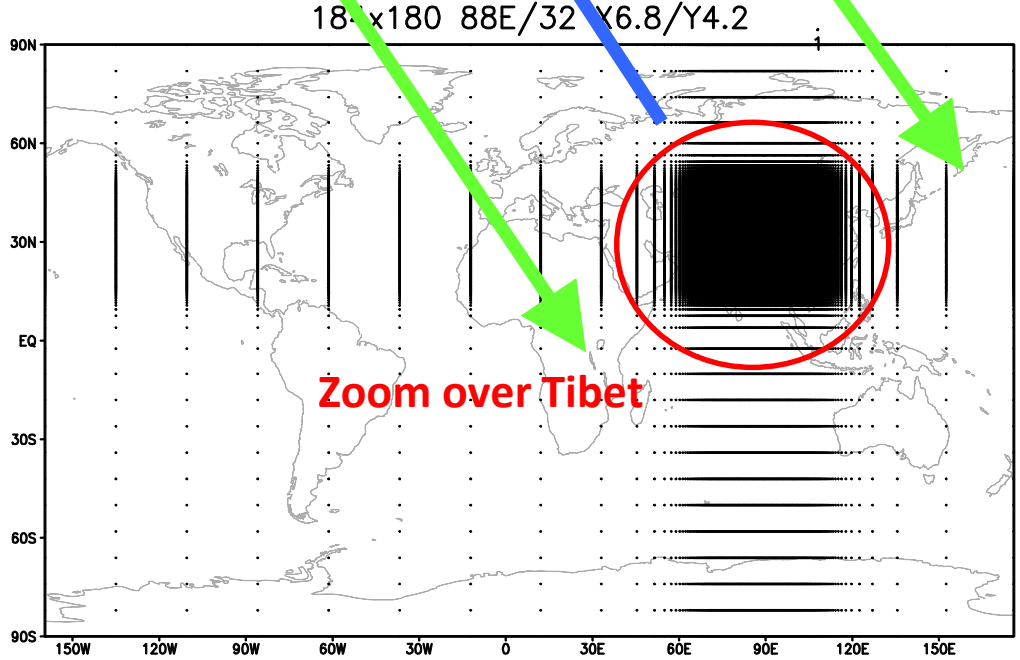


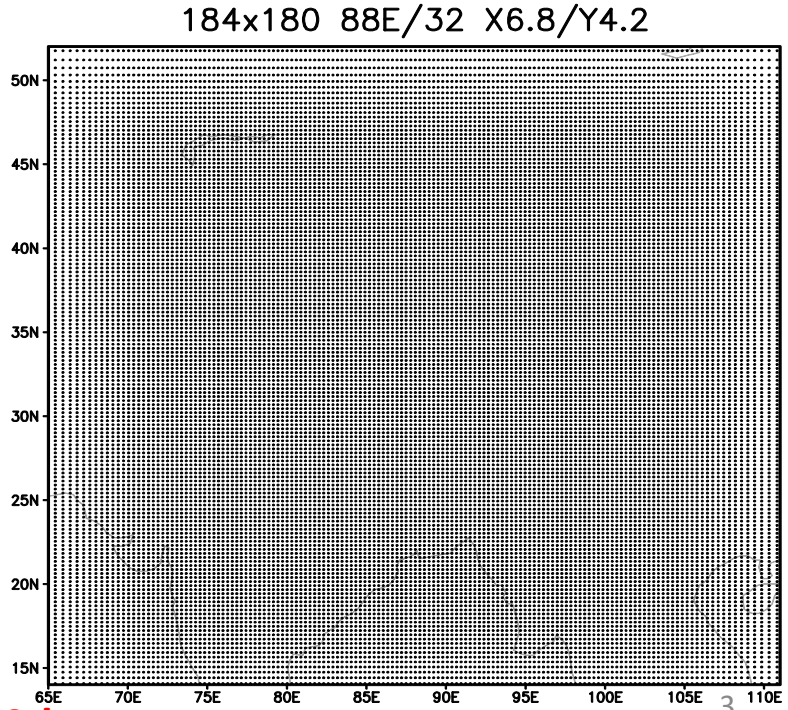
LMDZ is a global atmospheric GCM with variable grid and zoom. It can be run as a regional model, with nudging conditions outside the zoom. The model is free to have its own behaviors inside the zoom.

$$\frac{\partial X}{\partial t} = M(X) + \frac{X^a - X}{\boldsymbol{\tau}}$$

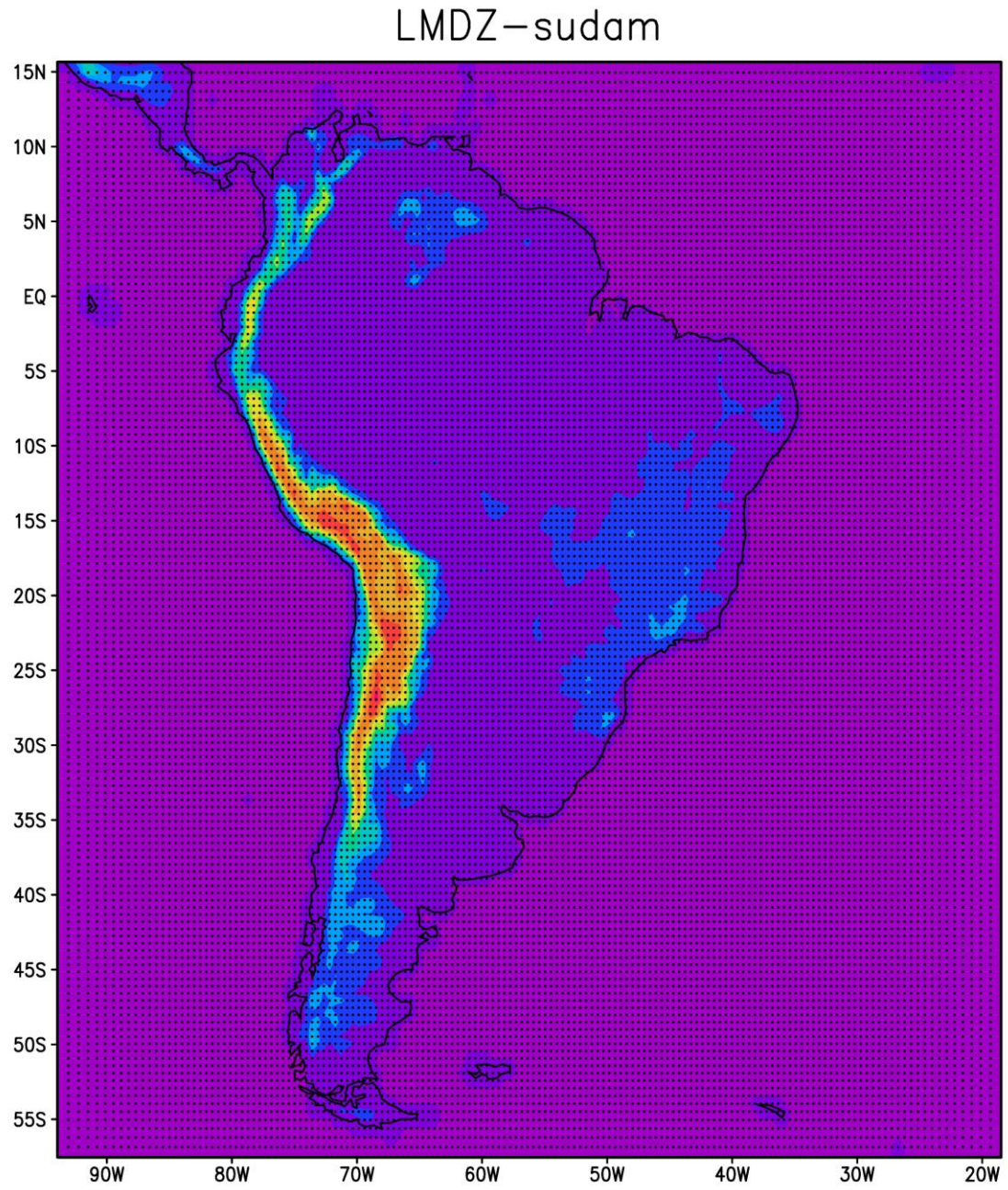








Regional 30-km



Configuration of LMDZ-sudam:
-irregular 180x180 lat/lon grid
-152x150 points in the domain
-about 0.48°
-very week relaxation inside

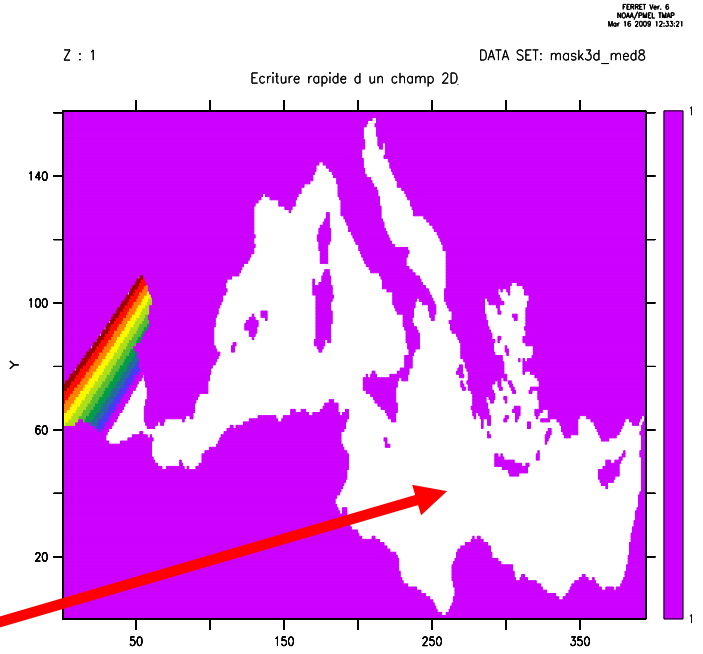
ERAinterim: Global 0.75° 4xdaily. Finished and post-processed (1989/2008, 20 years)

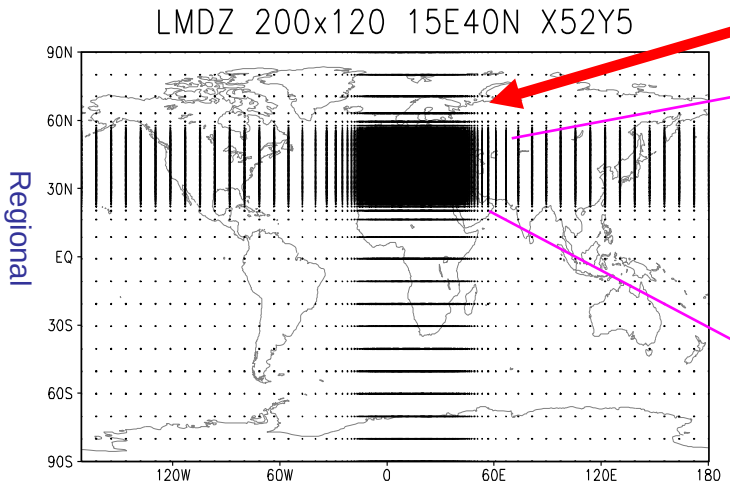
Scenario runs: 150 years from 1951 to 2100.Driven by global models:
- ECHAM5 (A1B),
- IPSL-CM4 (A1B) and
- IPSL-CM5 (RCP4.5)

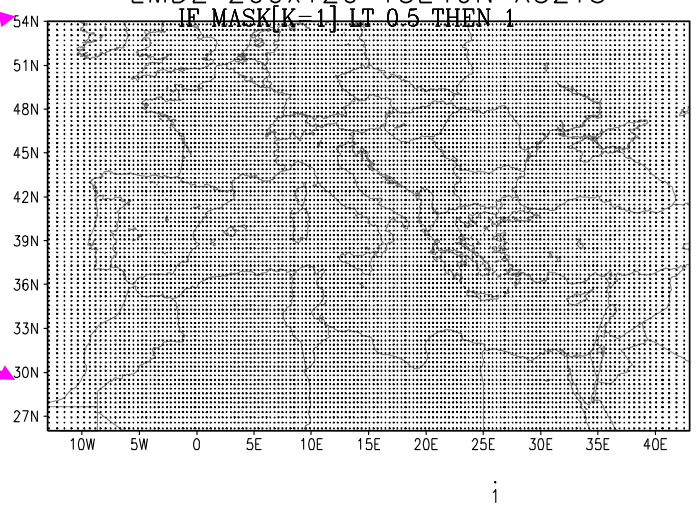
Data post-processed with CMOR,
Available either
- In the CLARIS server in BA
- In a web site from Paris
http://www.lmd.jussieu.fr/~li/claris

LMDZ-NEMO-med coupled model

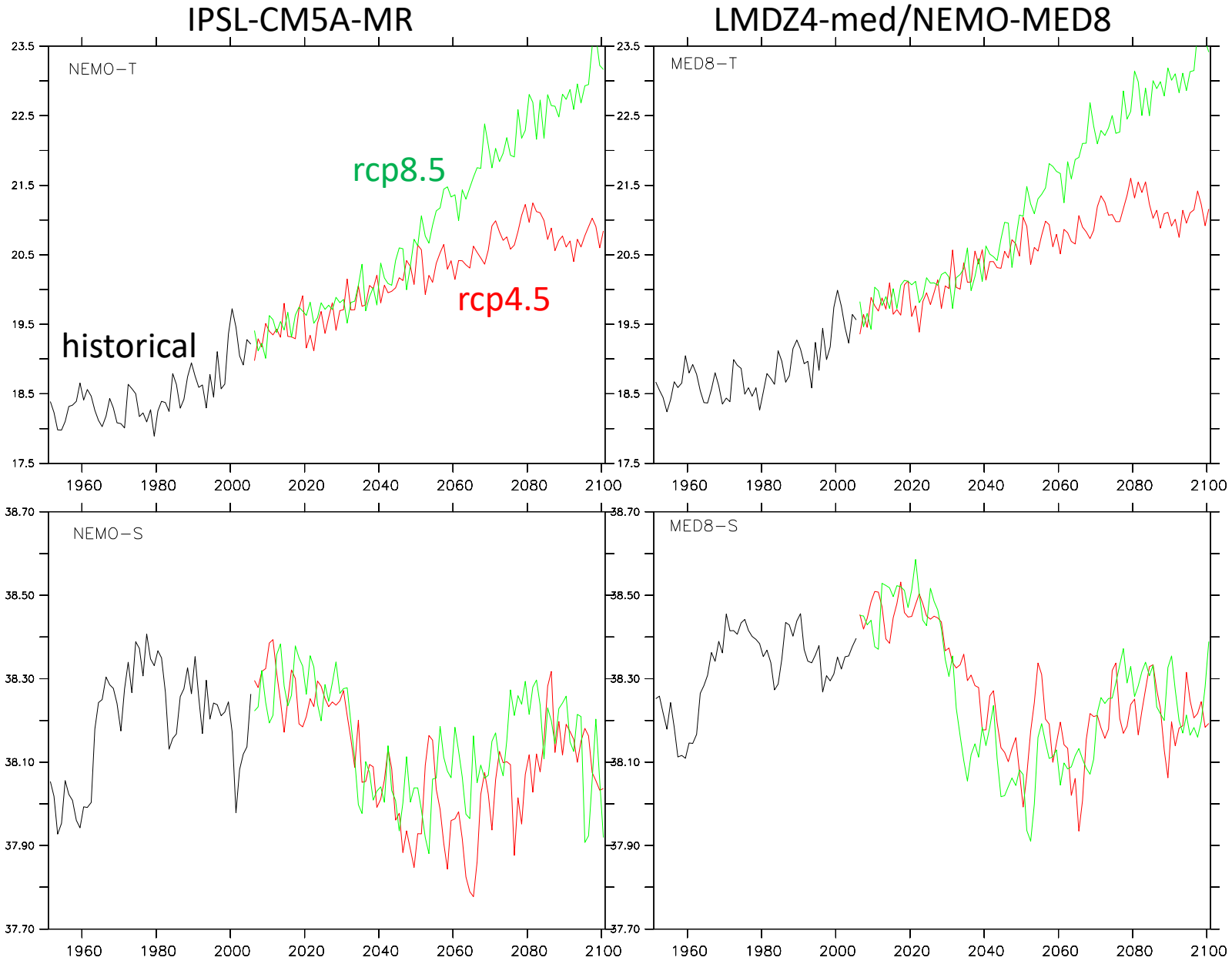
- LMDZ-Med : 200x120 with zoom. Local resolution: 35 km. It is run as a regional climate model.
- NEMO-Med8: 394x160x43. 1/8 degree (12km), with buffer zone.





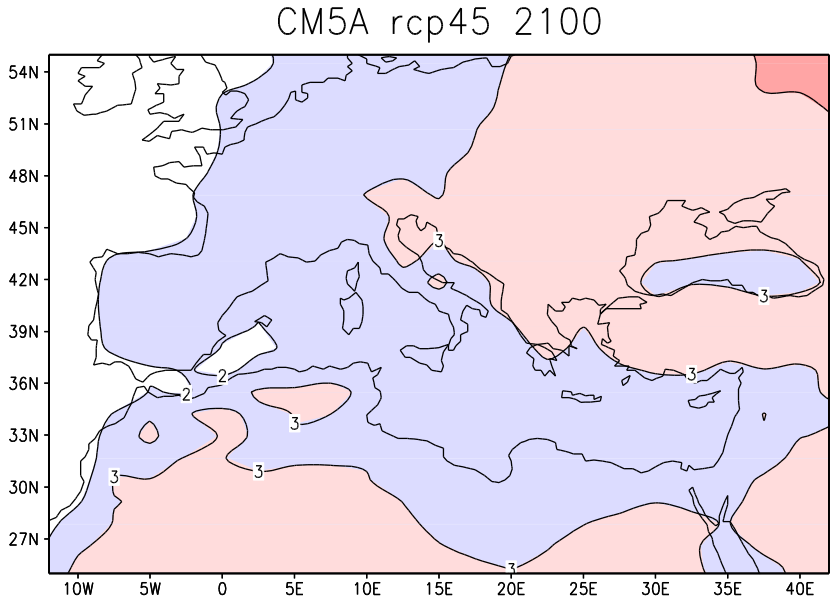


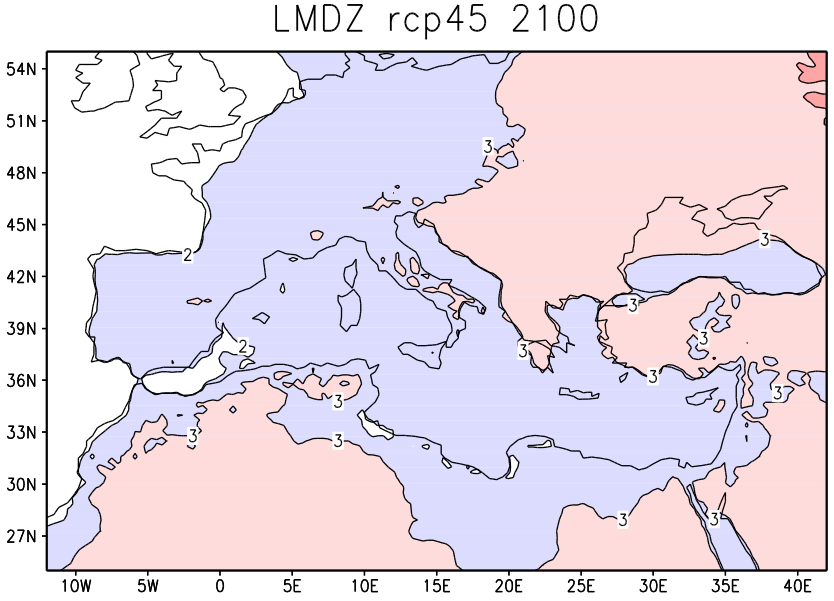
$$\frac{\partial X}{\partial t} = M(X) + \frac{X^a - X}{\tau}$$


IPSL-CM5A-MR
LMDZ4-med/NEMO-MED8
NEMO–T
MED8–T
rcp8.5
rcp4.5
historical
NEMO–S
MED8–S
All-Med Surf. T
All-Med Surf. S

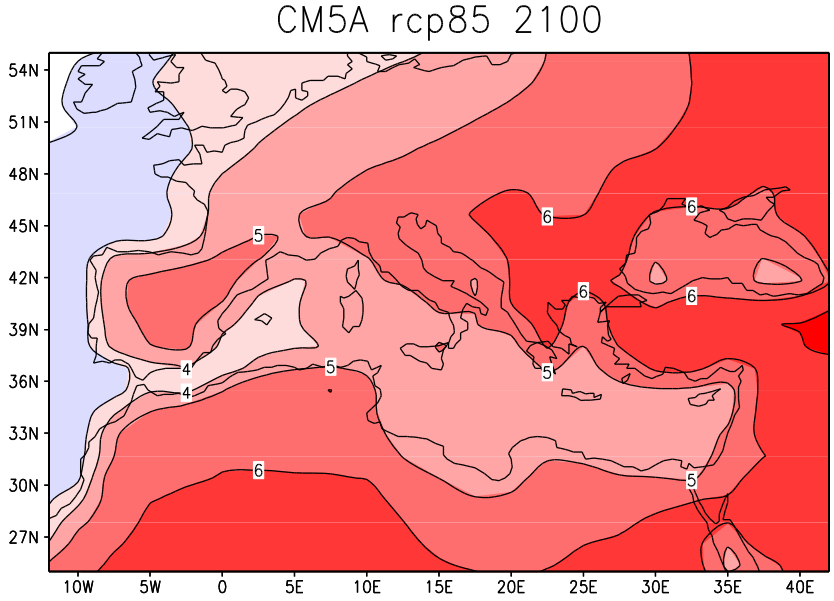
IPSL-CM5A-MR

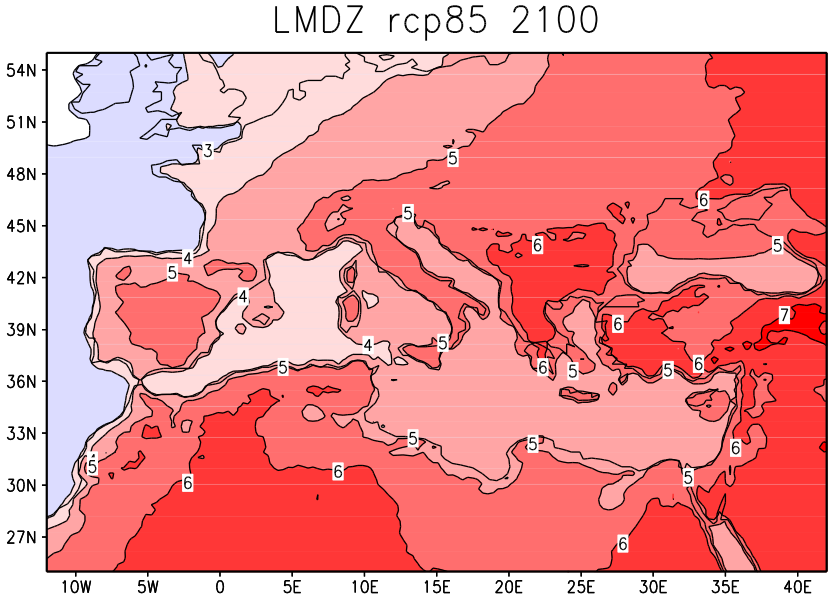
LMDZ4-med/NEMO-MED8





deltaTas rcp4.5

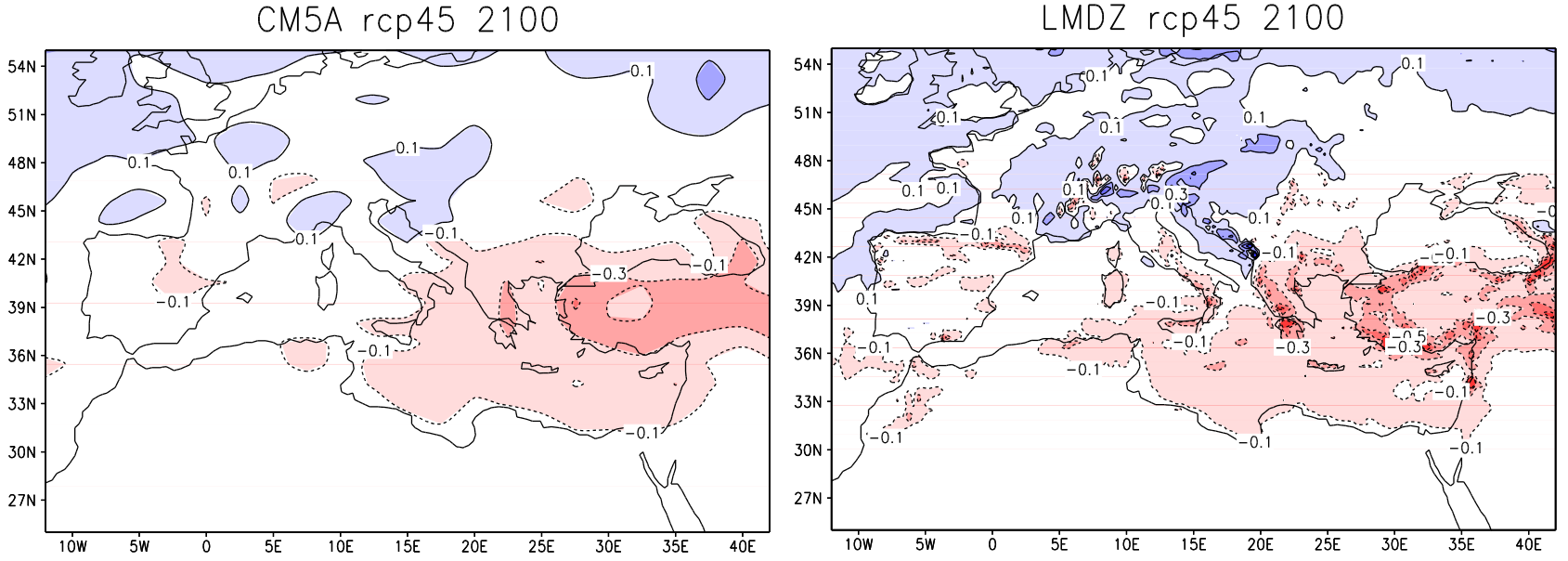




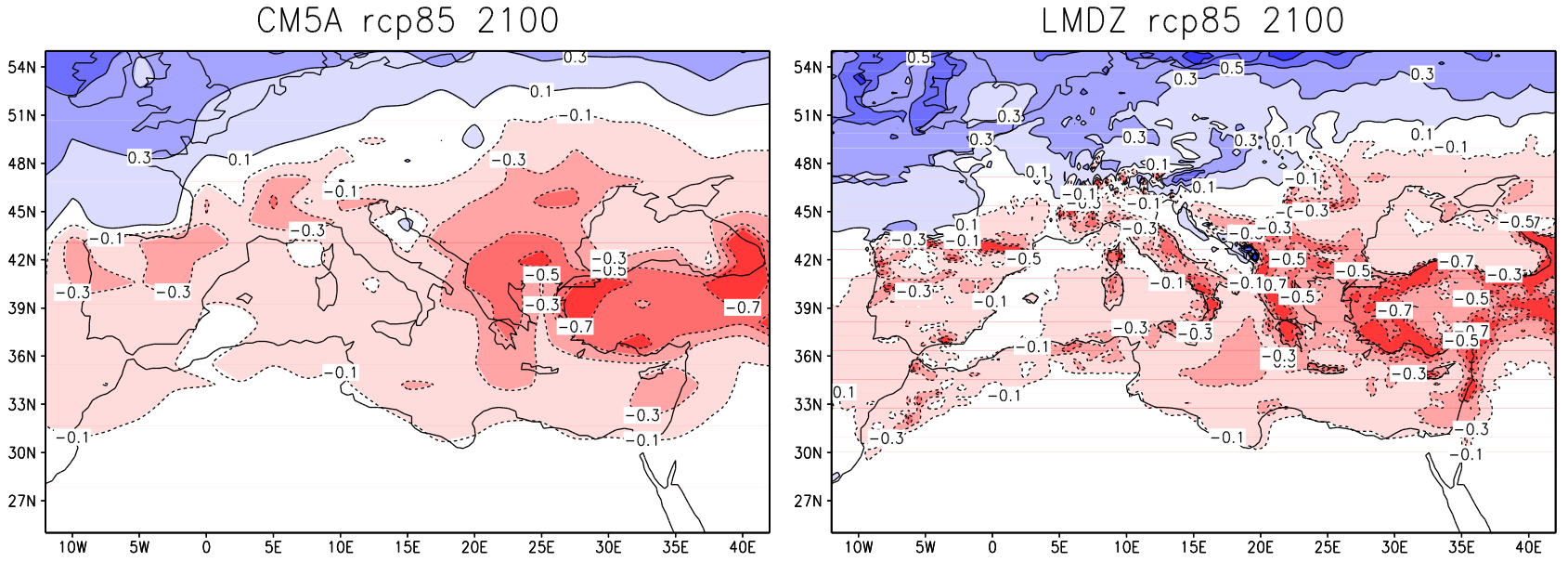
deltaTas rcp8.5

IPSL-CM5A-MR

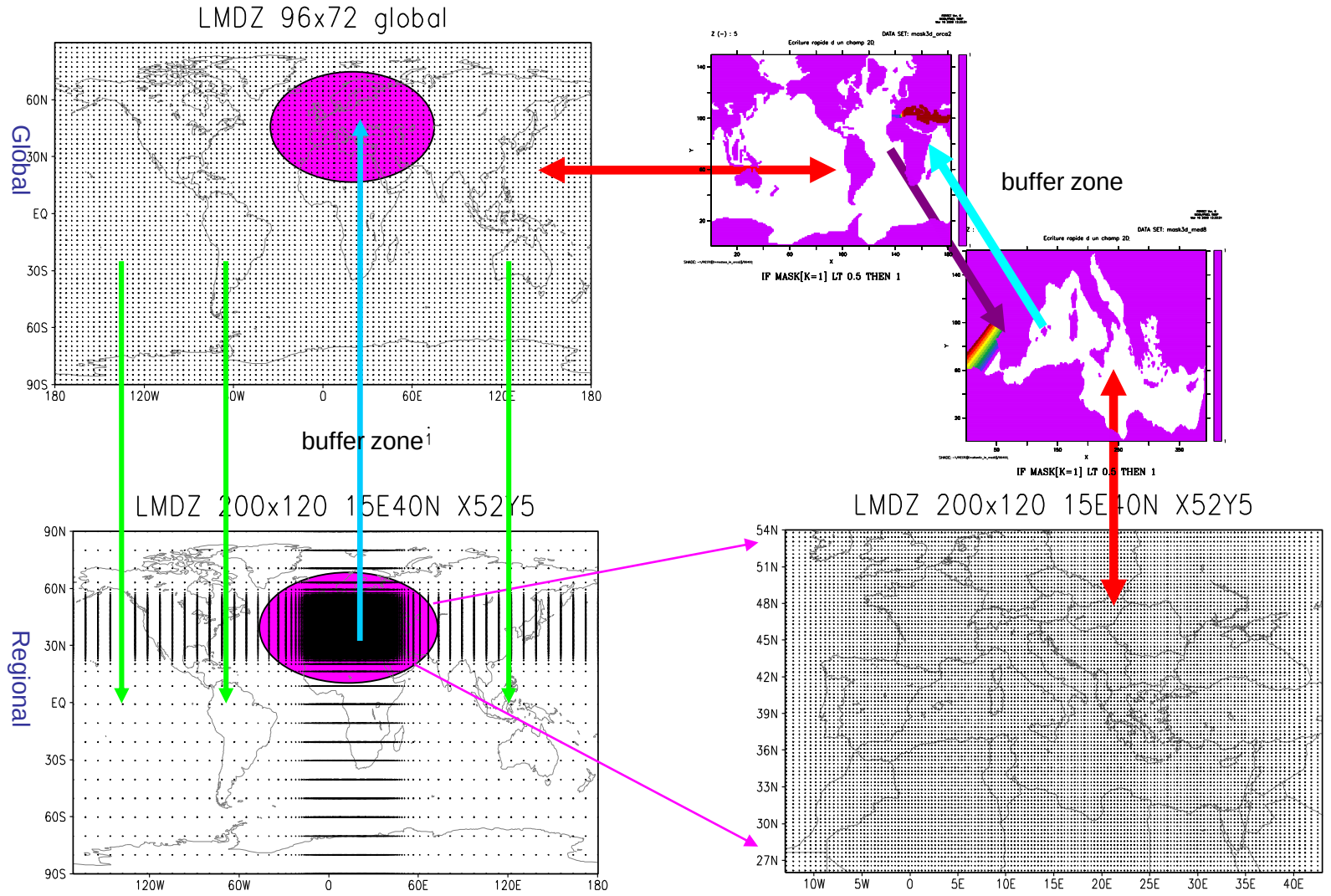
LMDZ4-med/NEMO-MED8



deltaPr rcp4.5



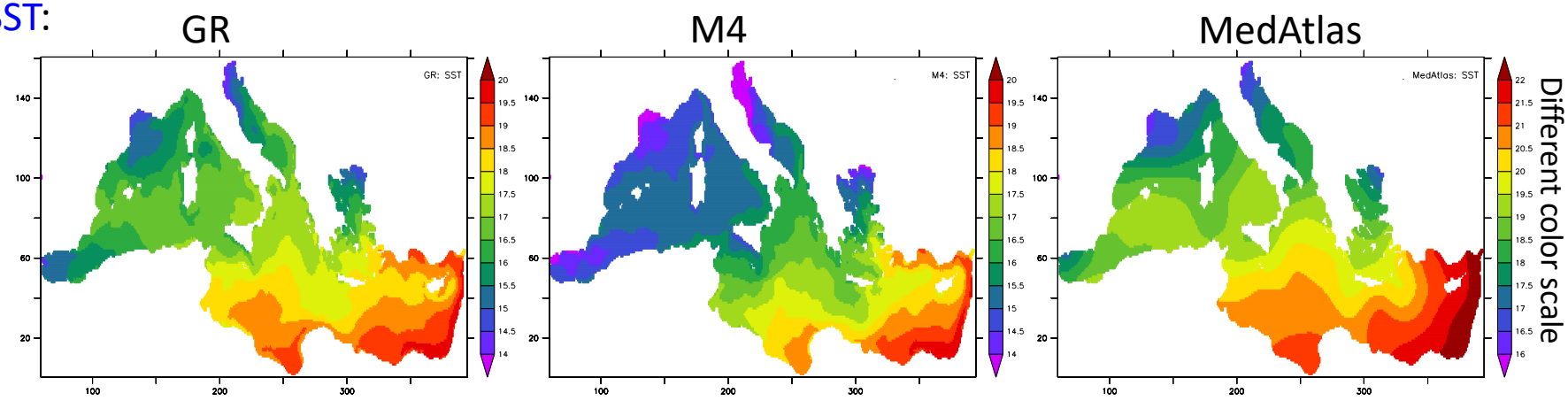
deltaPr rcp8.5



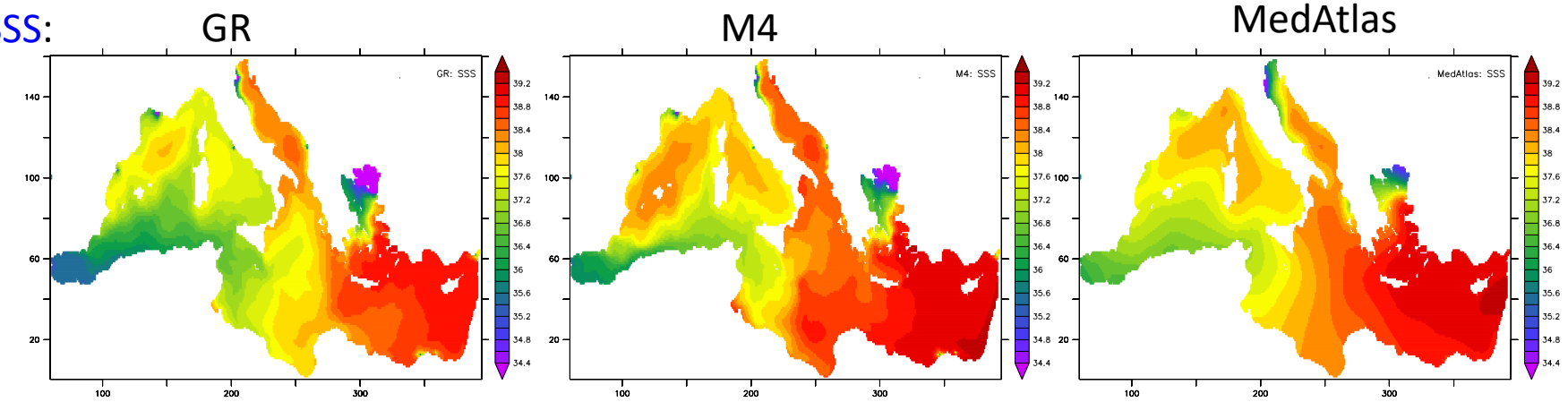
- **Global O-A coupled model: LMDZ-global / ORCA2**
- **Regional O-A coupled model: LMDZ-regional / MED8**
- **Two atmospheric models are coupled through buffer zones**
- **Two oceanic models are also coupled through buffer zones**

Schematic of the quadruple coupling: M4

SST:



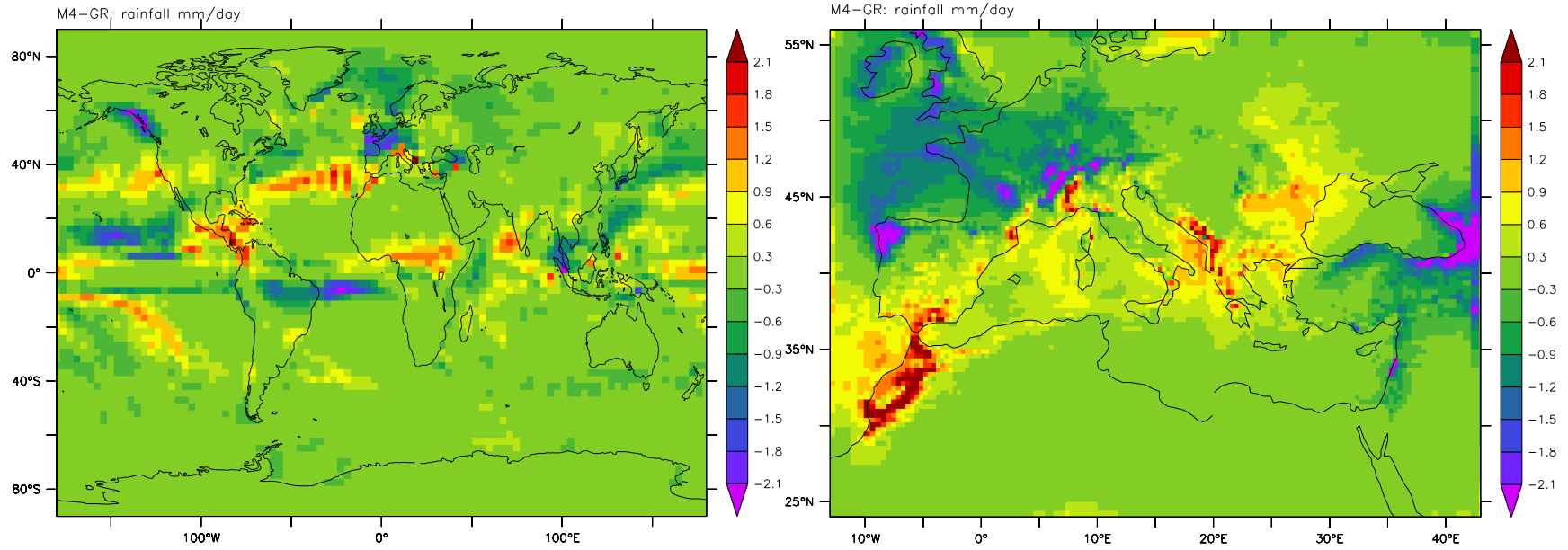
SSS:



Comparison between GR and M4

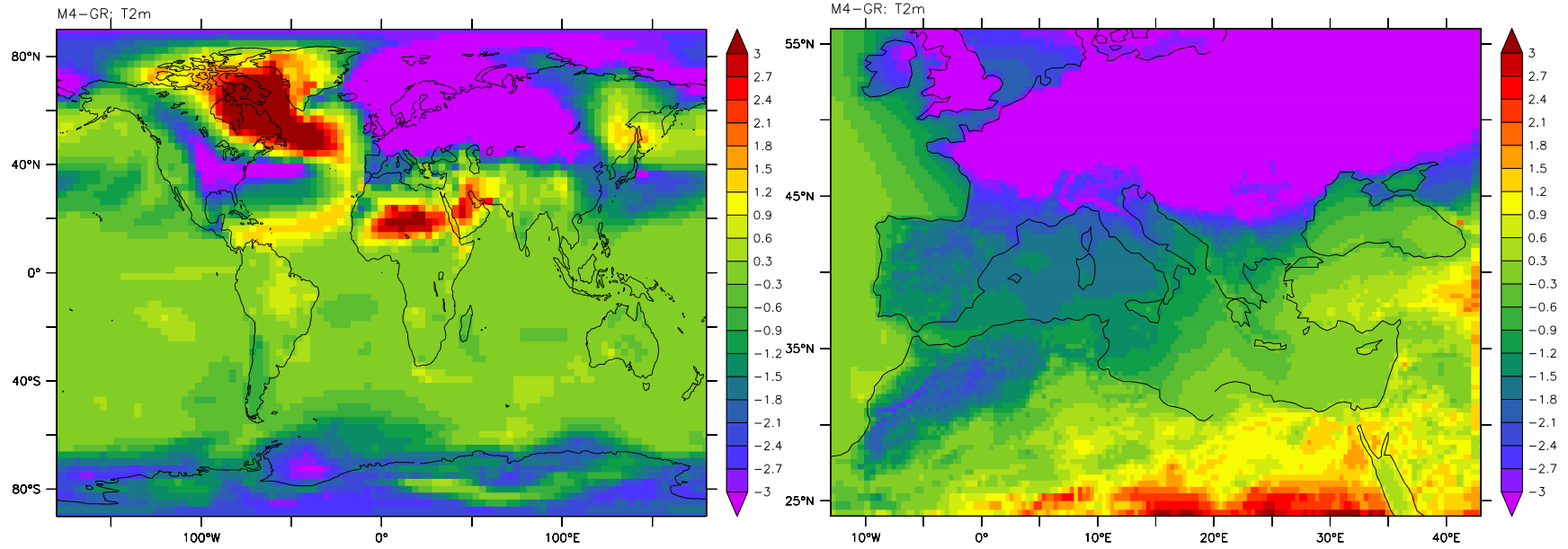
(global-regional feedbacks)

Precipitation rate (M4-GR)

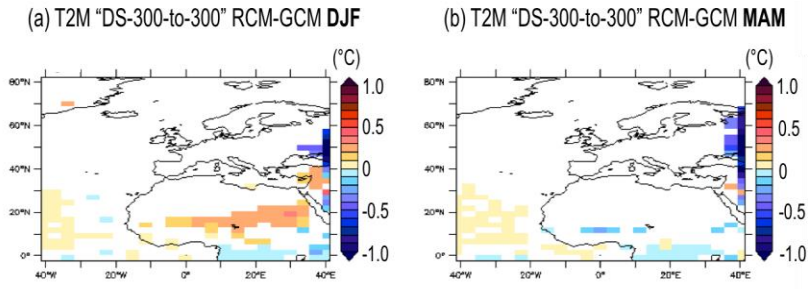


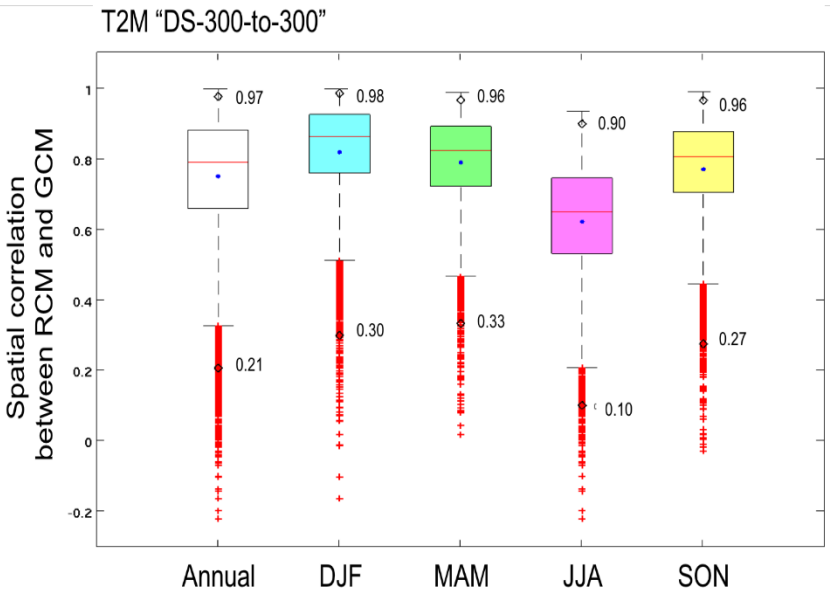
Global model

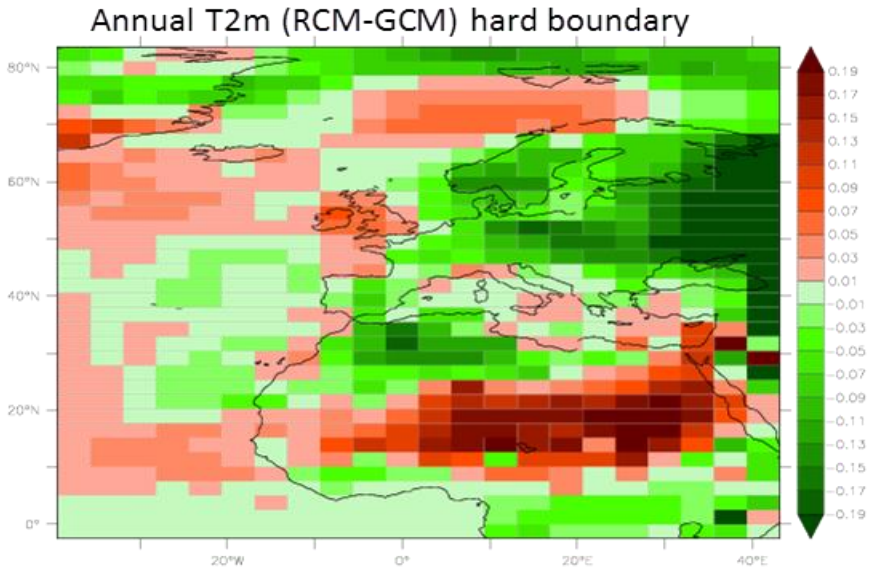
Regional model

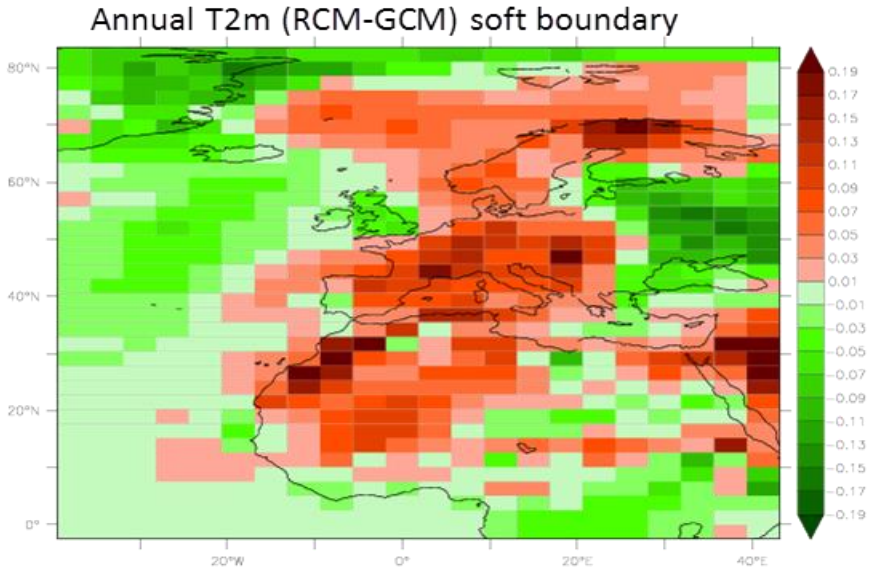


Surface air temperature (M4-GR)

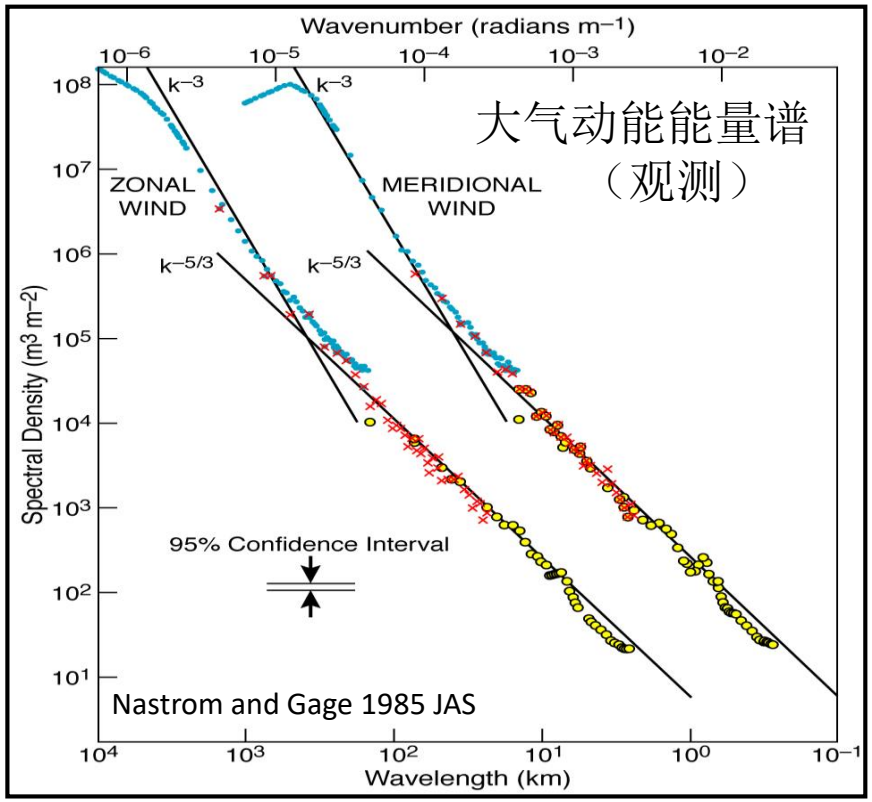

(a) T2M "DS-300-to-300" RCM-GCM DJF
(b) T2M "DS-300-to-300" RCM-GCM MAM
(c) T2M "DS-300-to-300" RCM-GCM JJA
(d) T2M "DS-300-to-300" RCM-GCM SON
(°C)
1.0
0.5
0
-0.5
-1.0

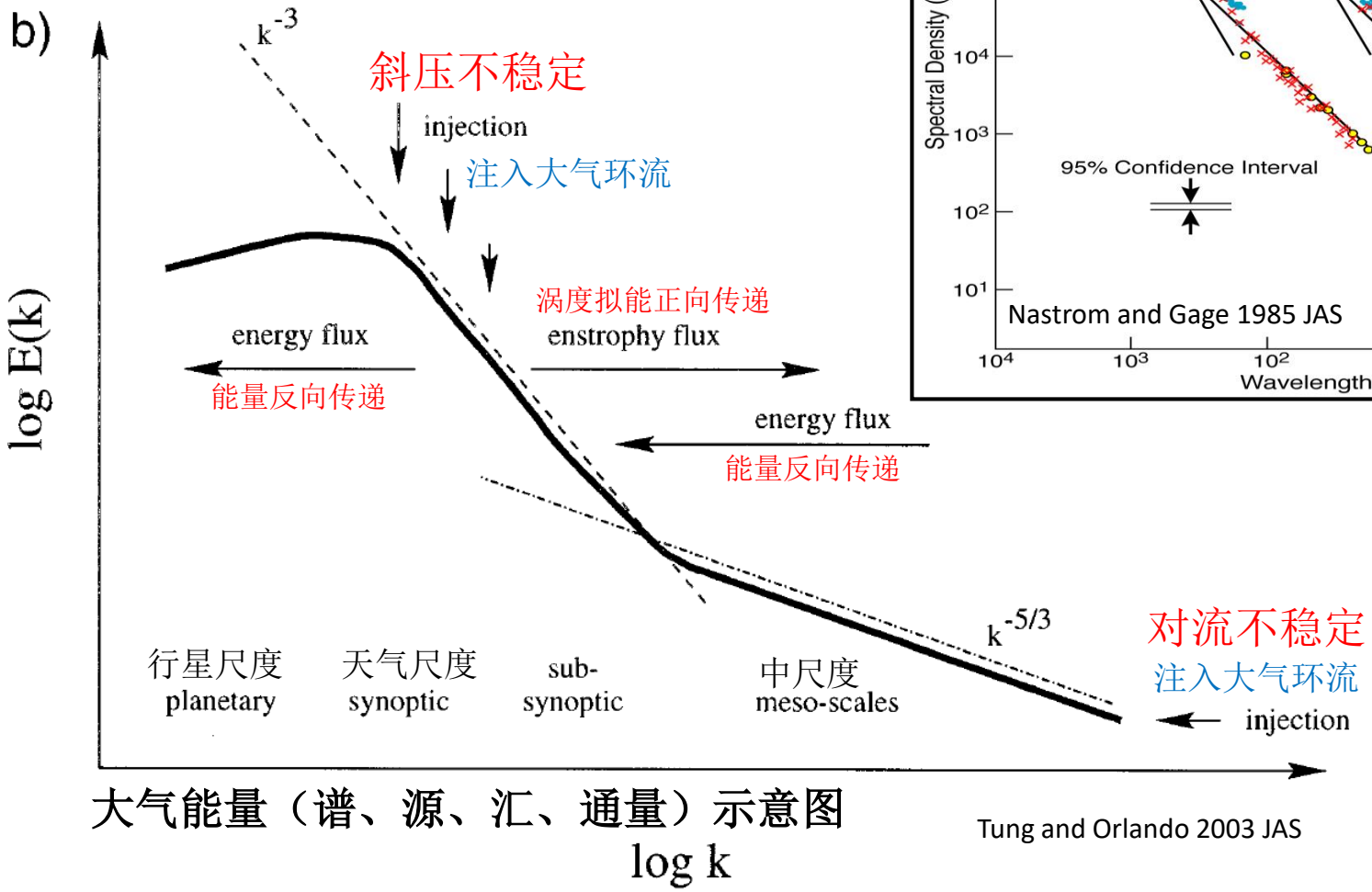

T2M "DS-300-to-300"
Spatial correlation between RCM and GCM
0.97
0.98
0.96
0.90
0.96
0.21
0.30
0.33
0.10
0.27
Annual
DJF
MAM
JJA
SON


Annual T2m (RCM-GCM) hard boundary


Annual T2m (RCM-GCM) soft boundary

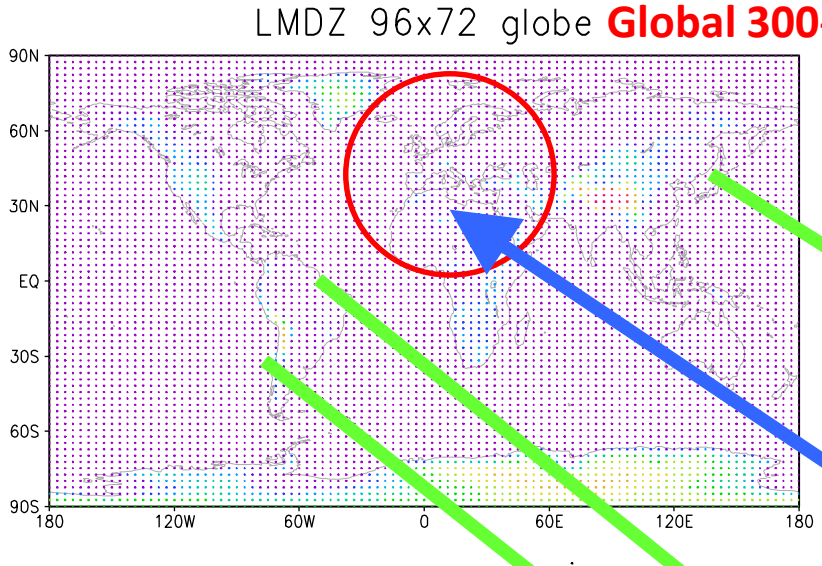
能量（动能）是速度的平方，**涡度拟能**是涡度的平方。它们是气候系统**不同尺度之间相互作用**的重要**载体**。能量从小尺度往大尺度呈**逆向阶梯式转移**，而涡度拟能则从大尺度往小尺度**正向阶梯式转移**。





大气能量（谱、源、汇、通量）示意图

Tung and Orlando 2003 JAS

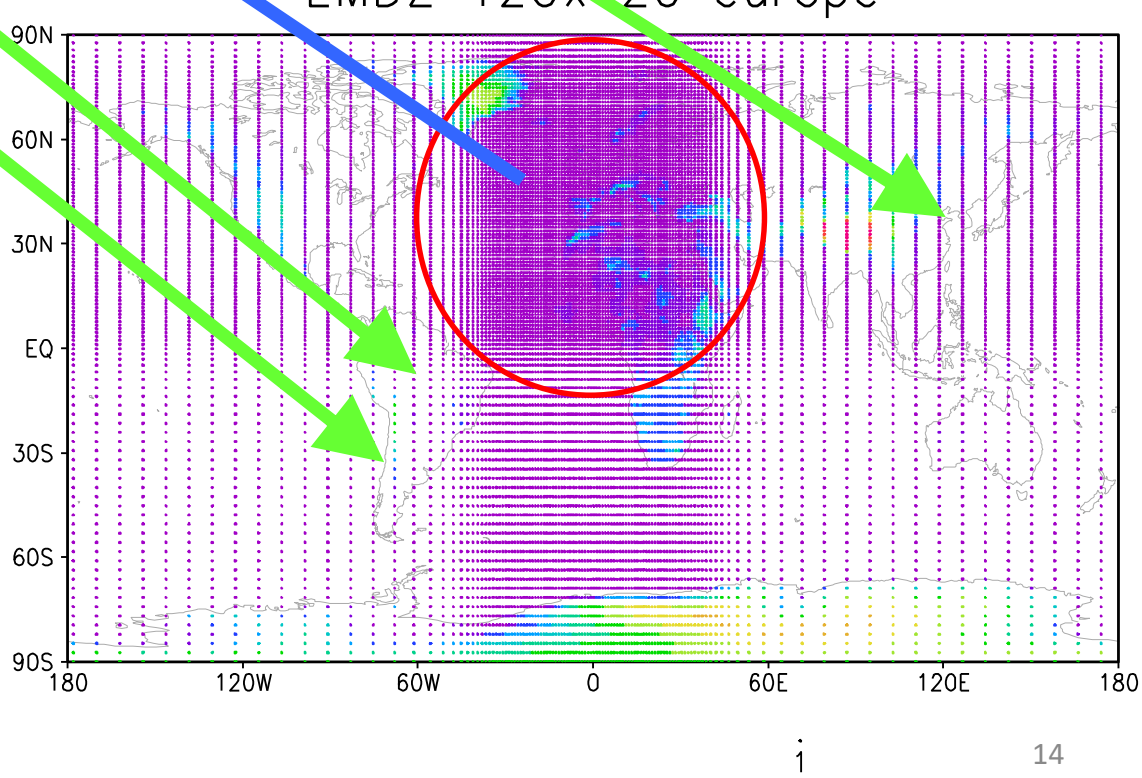


Global 300-km

Technical realization:
Currently MPI + fast online interpolation;
In future, XIOS + fast online interpolation

Two-Way Nesting between **LMDZ**-regional (Slave) and **LMDZ**-global (Master).

Regional 100-km



Advantages compared to pure zoom configuration:

- Numerical stability;
- Regular resolution at global scale;
- LMDZ-regional could be replaced by another regional model

Configuration files for relaxation and data interpolation:

relax_times.nc
biline_poids_s.nc
biline_poids_u.nc
biline_poids_v.nc

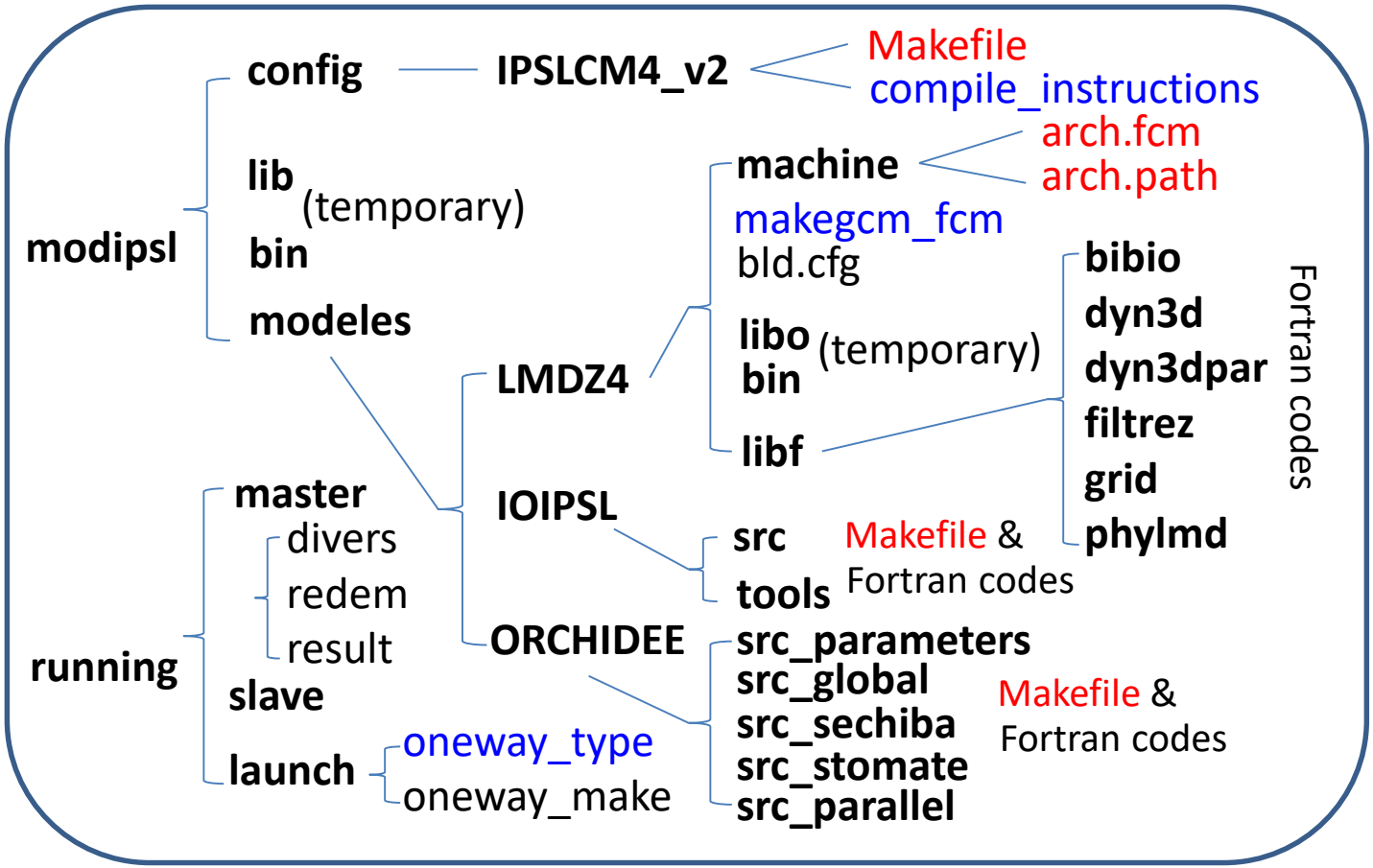
Nudging data in its original format:

era_t.nc
era_q.nc
era_u.nc
era_v.nc

How to realize the operation in Fortran code:

leapfrog_p.F
mod_const_para.F90
nudging_from_era_mod.F90
nudging_from_lmdz_hf_mod.F90
selfnesting_two_mod.F90

How to compile LMDZ4? The code in Fortran is retrievablewith the following link: http://www.lmd.jussieu.fr/~li/LMDZ4_code.tar.gz (volume size 1.5 Mb)



How to run simulations? Configuration files, initial data, boundary conditions and job launching shell scripts are stored in an archived file, and retrievable with the link: "http://www.lmd.jussieu.fr/~li/LMDZ4_data.tar.gz" (volume size 111 Mb).