Variable resolution and time-slice AGCMs: status and open issues

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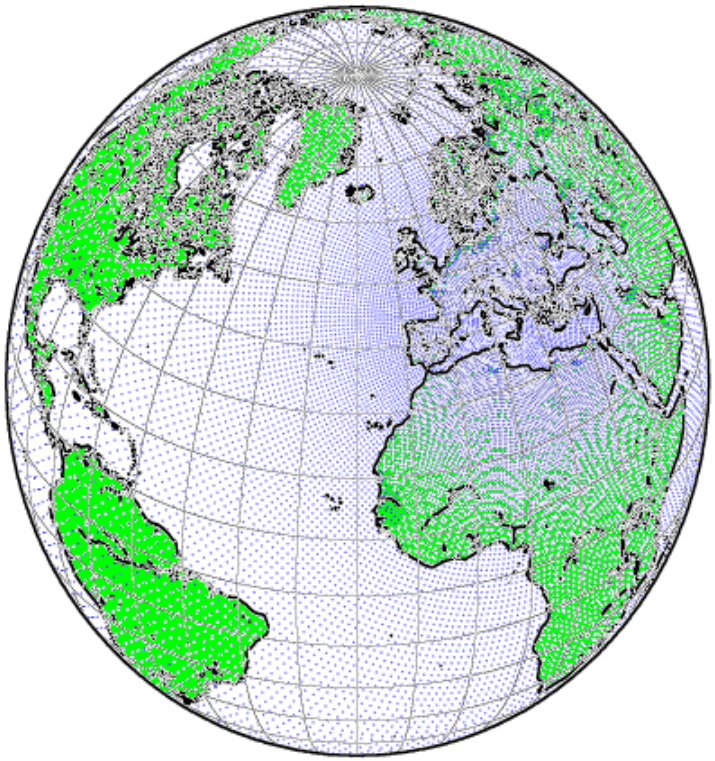
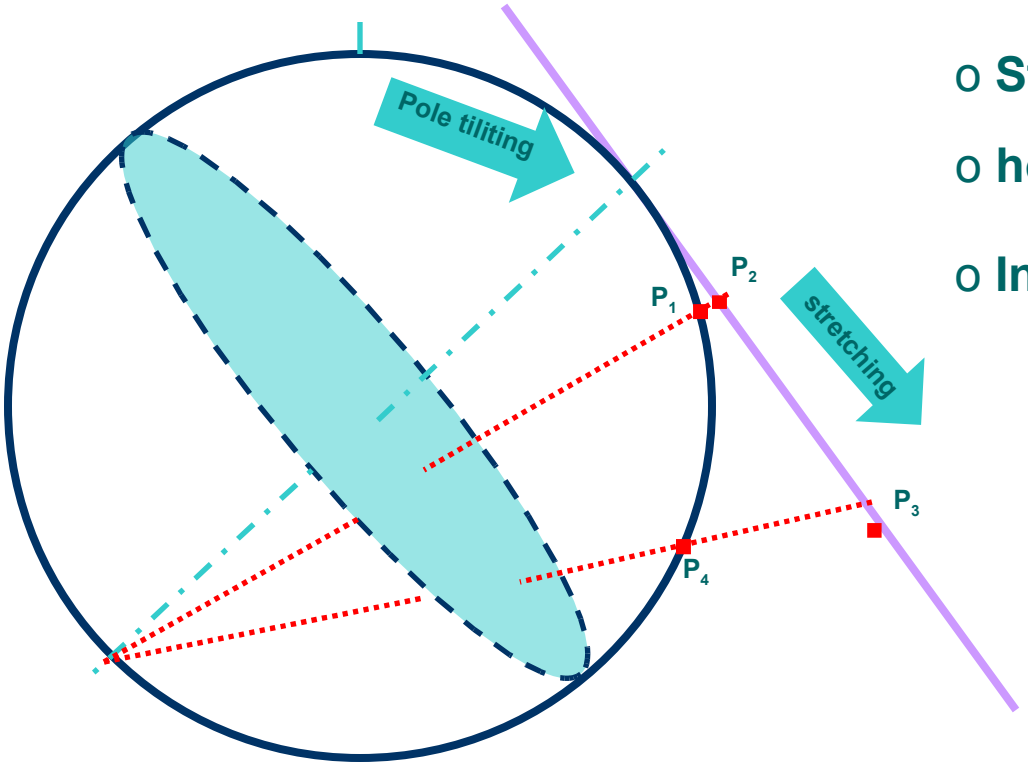
Some historical considerations

- Global versus Limited Area Models
- Schmidt (1977)
- Staniforth and Mitchell (1978)
- Bennert Machenhauer (1982)
- Courtier and Geleyn (1988)
- Déqué and Piedelievre (1995)

Variable resolution



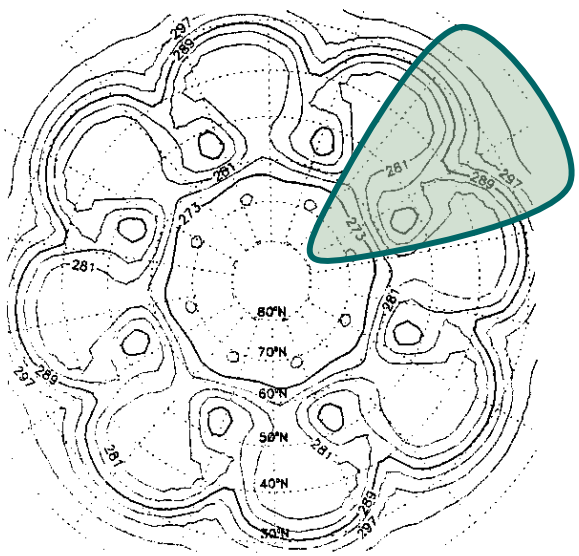
Principle of stretching in ARPEGE



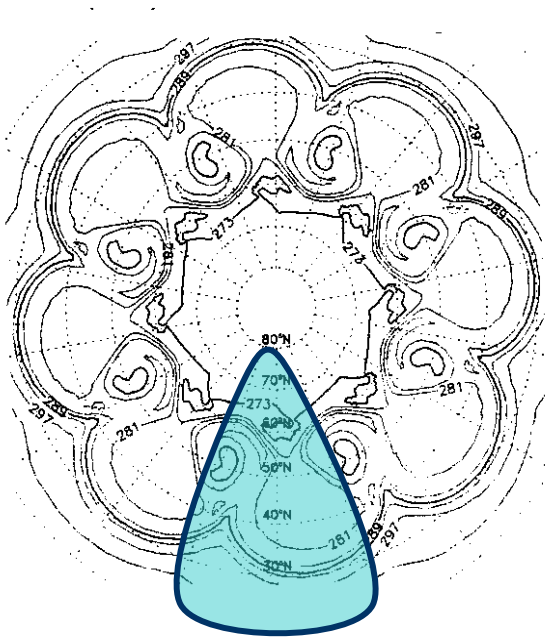
- Stereographic projection
- homothecy
- Inverse projection

Validation (1): adiabatic model

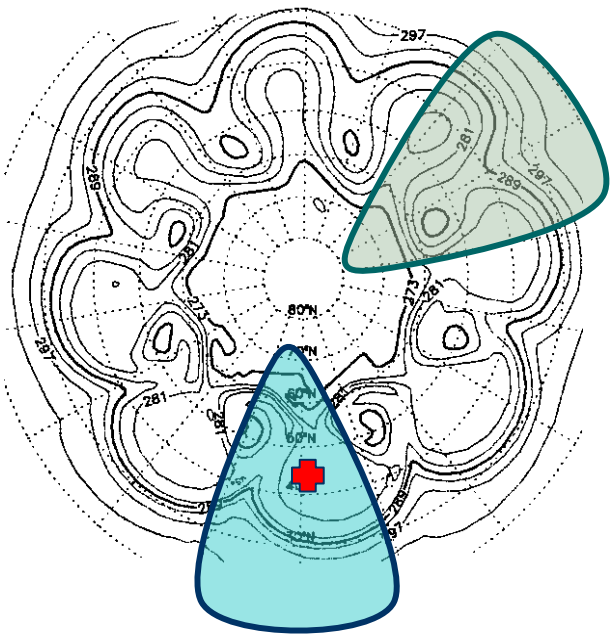
T42



T106



T42 c=3



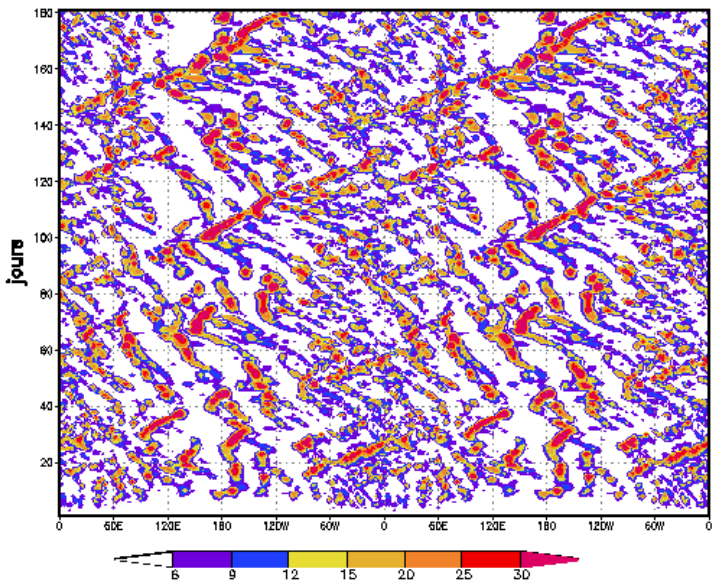
C. Freydier, 1991

Zonal baroclinic mode
+perturbation of wavenumber n=8
Day 6 of integration

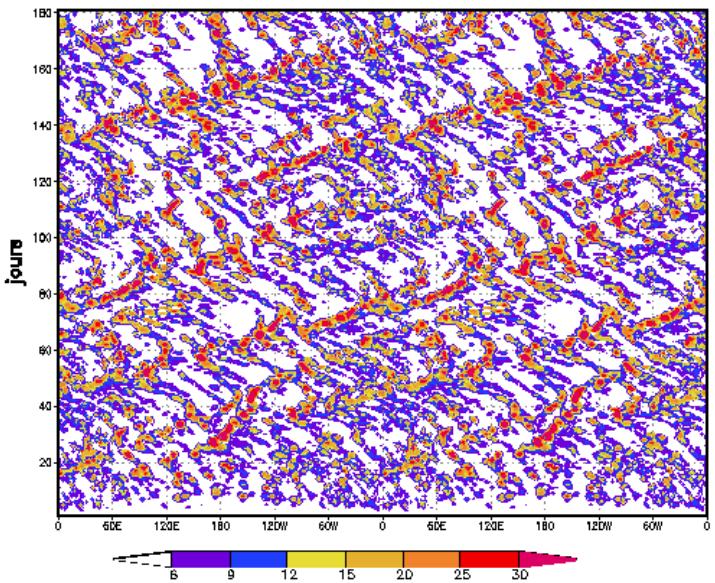
Validation (2): Aquaplanete experiment

Pole at the equator: longitude x time precipitation

T63 c=3



T79 c=2.5

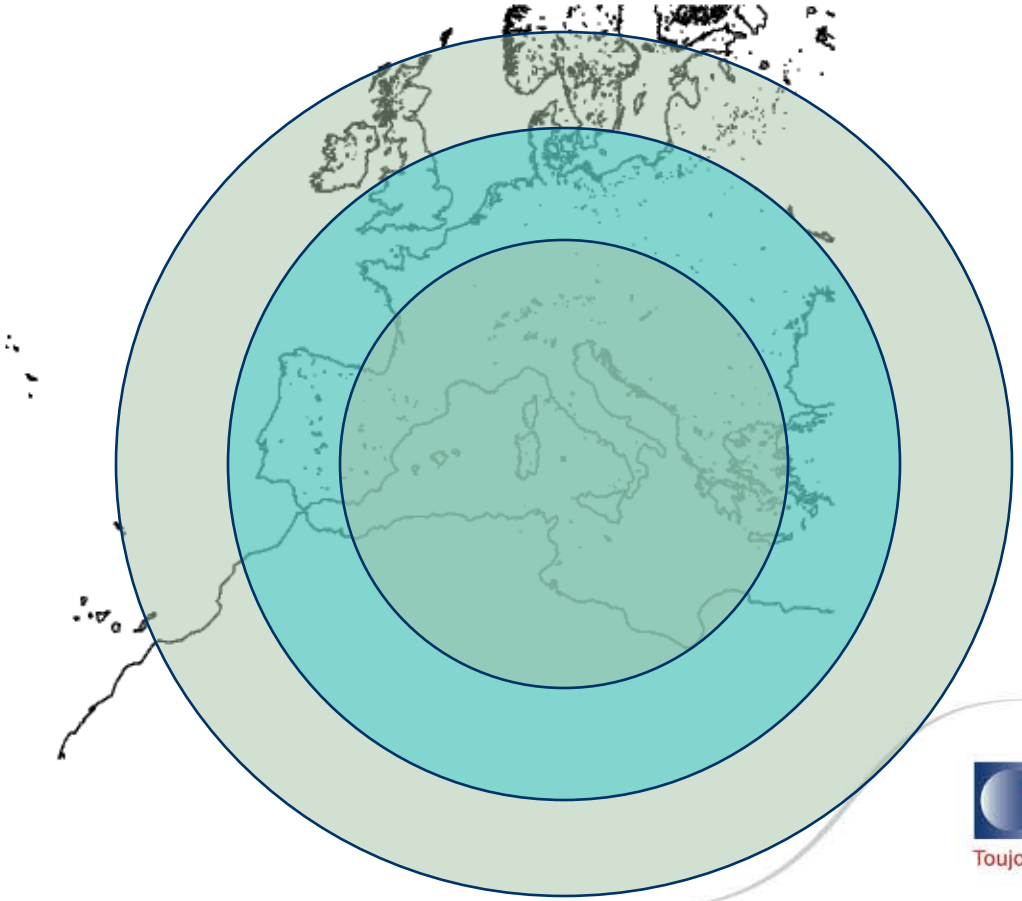


V. Lorant, 2000

Validation (3): Big brother experiment

10 year AMIP simulations:

- **TL63**
- **T106c3**
- **T319**



M. Déqué, 2003

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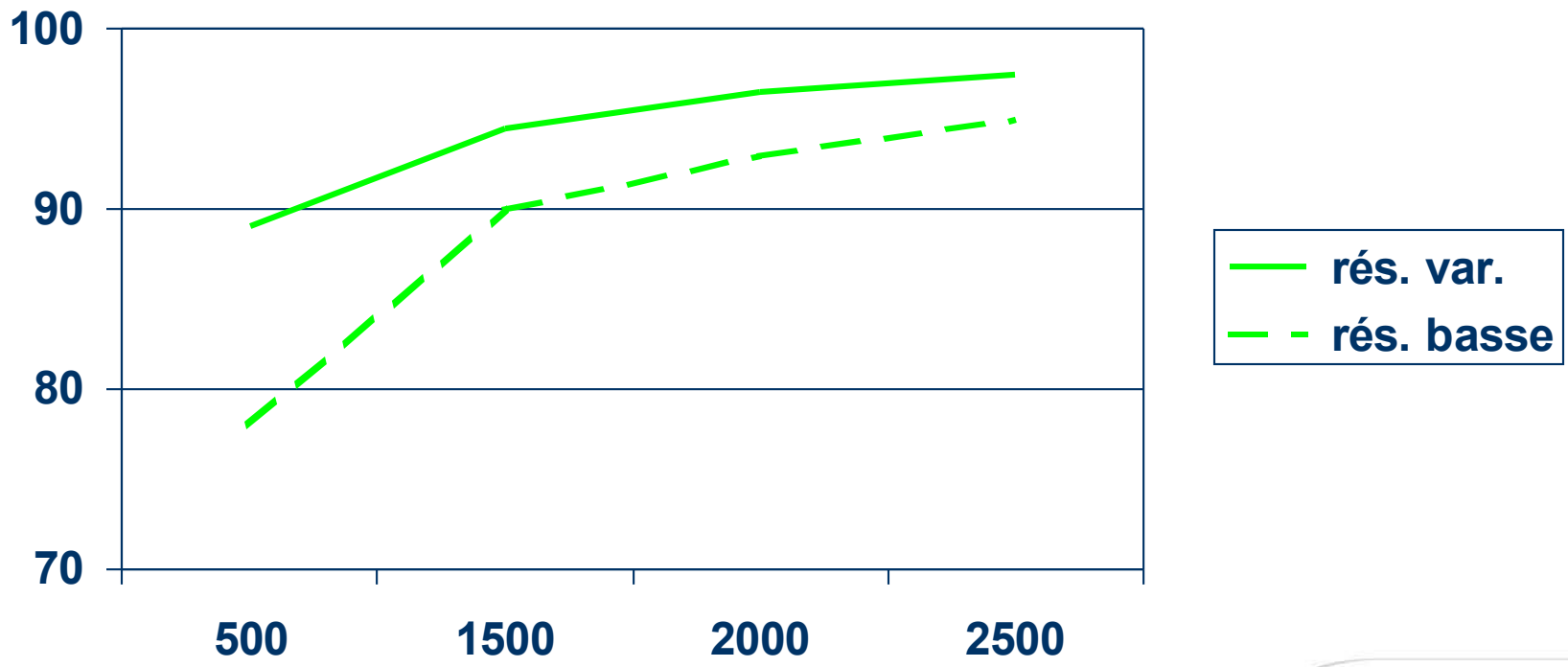
Validation (3): Big brother experiment

Spatial correlation with high resolution as a function of the distance to the pole of streteching (DJF precipitation)



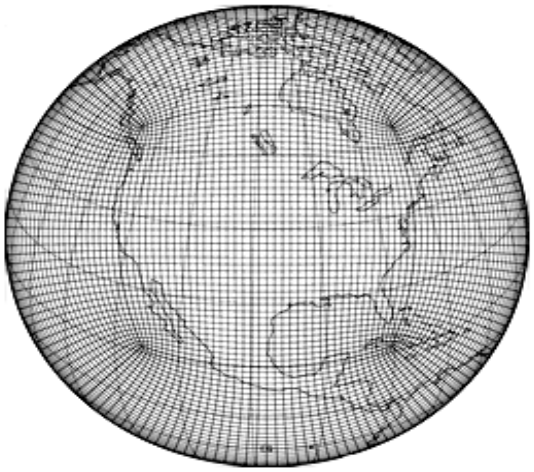
Stretched Grid Model Intercomparison Project

- Lead by Michael Fox Rabinowitz
- Intercomparison over the US
  1. C-CAM, CSIRO (Australia),
  2. GEM, RPN (Environment Canada),
  3. ARPEGE, Météo-France,
  4. GEOS, NASA/GSFC
- 3 resolution:
  1. 50 km global
  2. 50 km over US
  3. 120 km global (same cost as 2.)
- Last publication: Fox-Rabinowitz, M., Cote, J., Dugas, B., Déqué, M., Mc Gregor, J.L. And Belochitski, A., 2008. Stretched-grid Model Intercomparison Project: decadal regional climate simulations with enhanced variable and uniform-resolution GCMs. Meteorol. Atmos. Phys., 100, 159-177
- Web site:

http://essic.umd.edu/~foxrab/sgmip.html

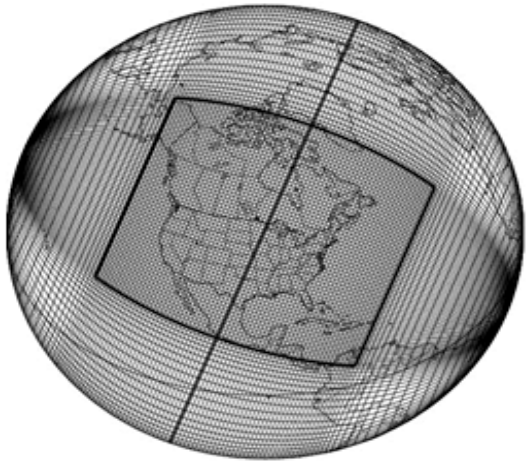
SGMIP grids

(a)



C-CAM

(b)

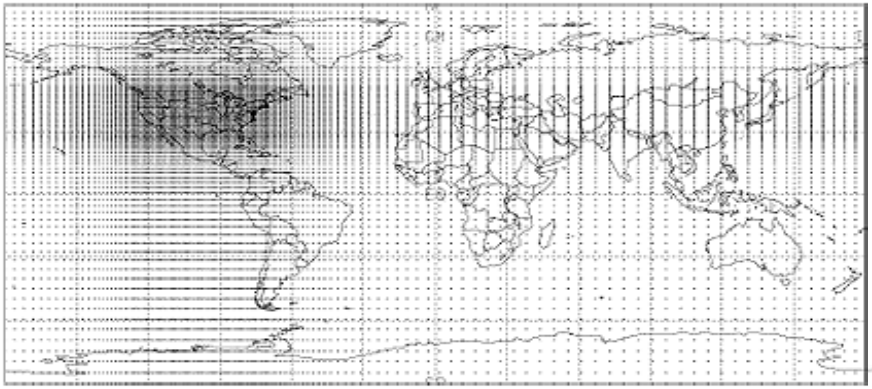


GEM

(c)

ARPEGE

(d)



GEOS

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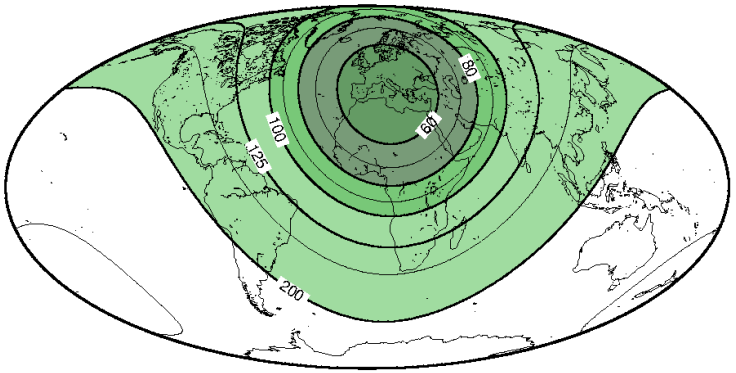
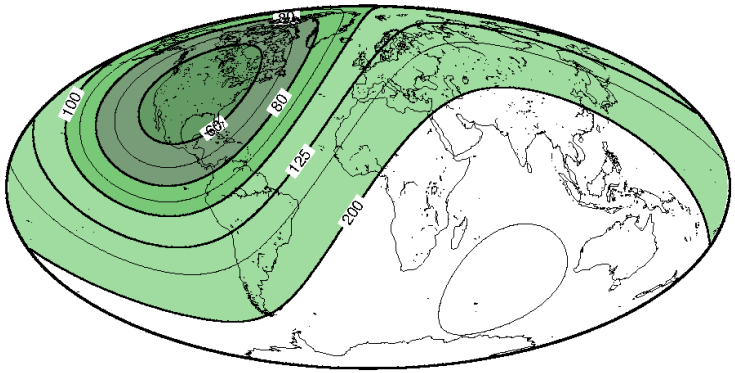
Multipole approach

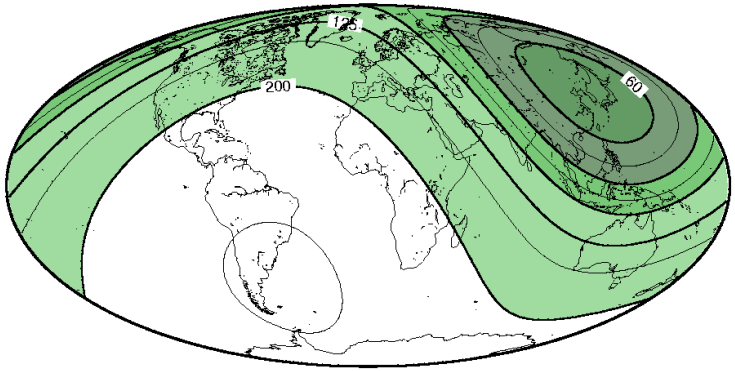
Europe



USA



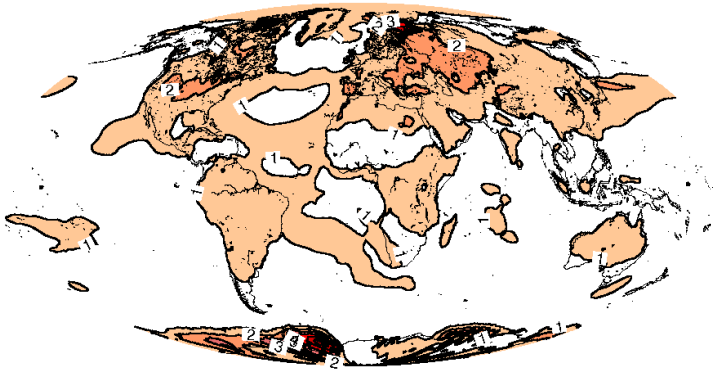
Japan



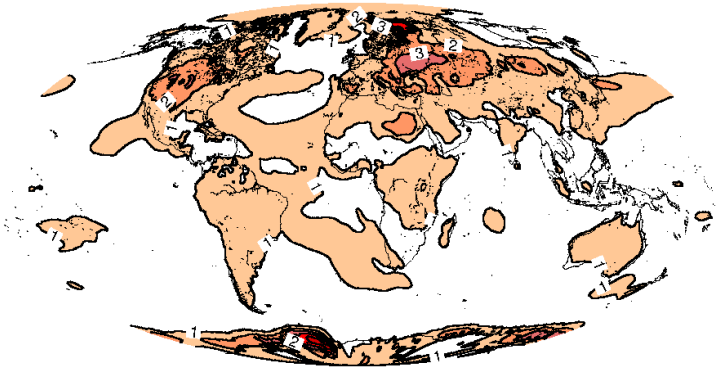
Horizontal resolution (km)
TL159 c=2.5
poles at 40°N

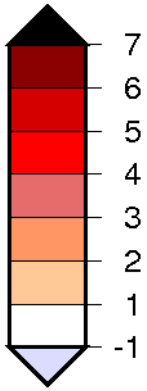
Multipole approach: scenario

Europe

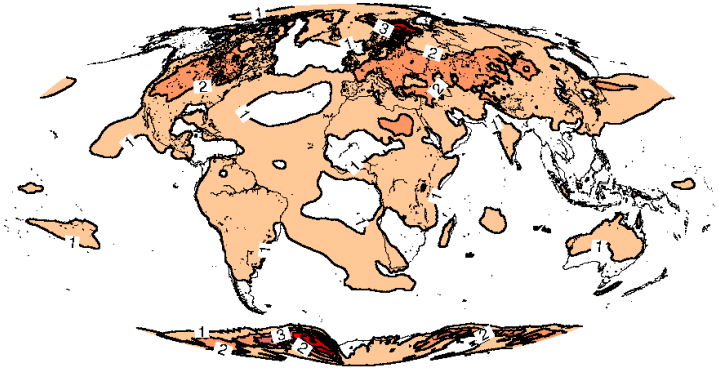


USA





Japan



Temperature response
JJA 2021-2050
A1B scenario
(ENSEMBLES stream2)

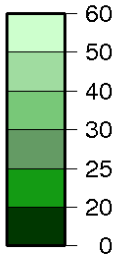
Stretched models driven

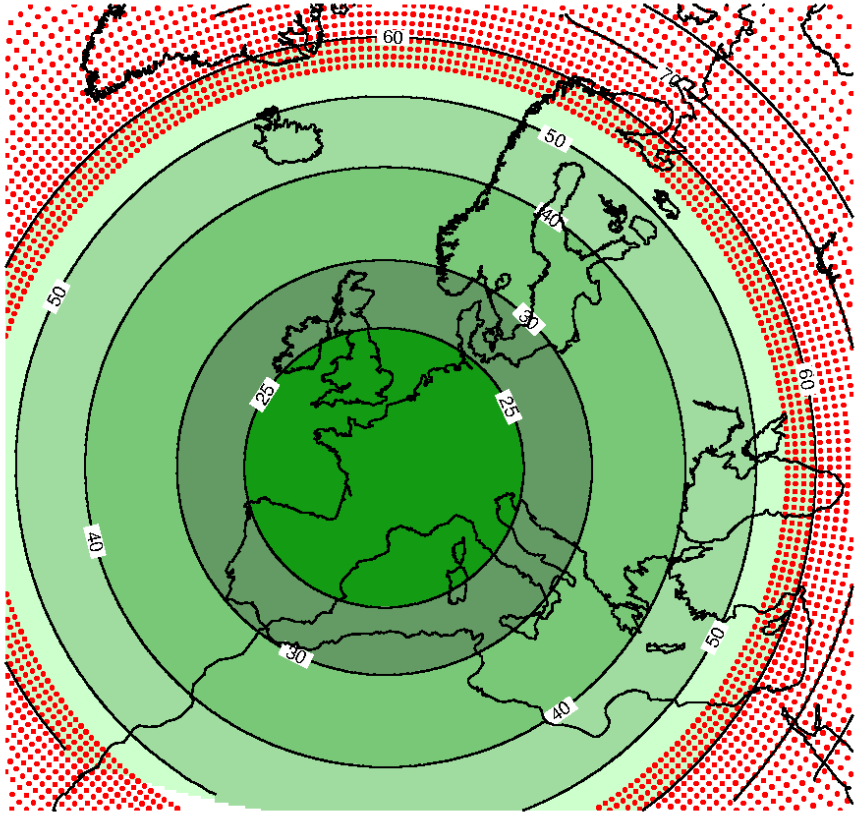
- In spectral space (smallest waves let free)
- In grid-point space
  1. Rectangular mask
  2. Mask as a function of resolution
  3. Inverted mask (two-way nesting)

High stretching over France

Horizontal resolution (km)

TL159 c=6





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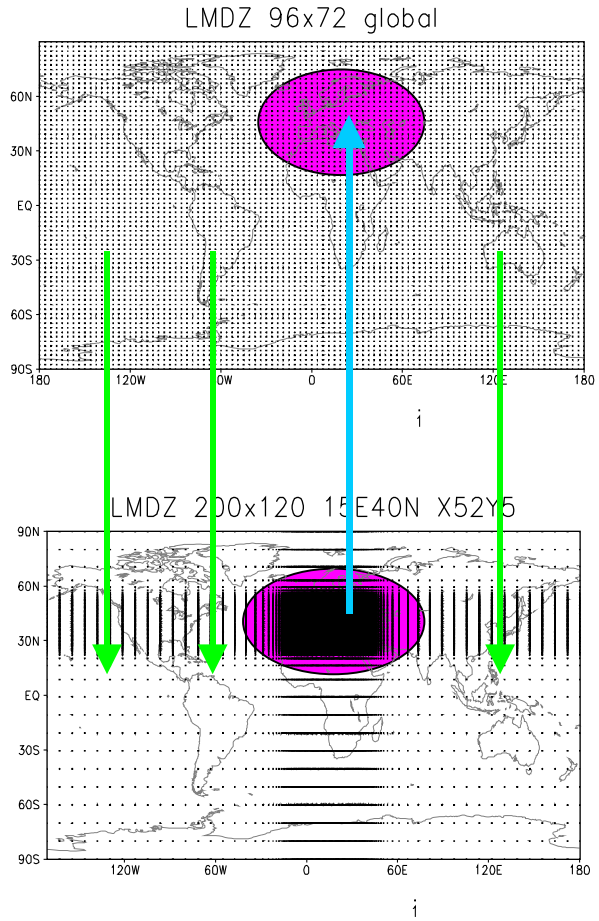
DJF MSLP bias

TL159 c=2.5

TL159 c=6

1961-1990 driven by ERA40 outside Europe

Two-way nesting with LMDZ



Coupling frequency: 6 hours
Local resolution: 30 km
Global resolution: 300km

global

regional

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Conclusions

- A variable resolution model can replace a high resolution GCM
- A variable resolution model can replace a LAM
- One must be very careful with the physical parameterizations:
  - Advantage: robust to climate change
  - Inconvenient:: hard to tune regionally