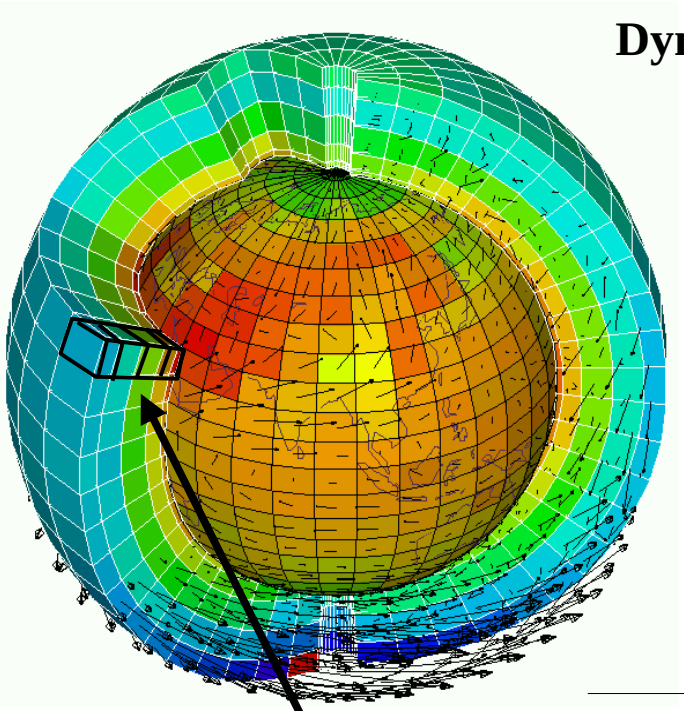
“Dynamics » and « Physics » tendencies

LMDZ team
Laboratoire de Météorology Dynamique / IPSL / CNRS /SU
LMDZ training, December 2024

During tutorial #1

Dynamical core : primitive equations discretized on the sphere



- Mass conservation

  $D\rho/Dt + \rho\,\mathrm{div}\underline{U} = 0$

- Potential temperature conservation

  $D\theta / Dt = Q / Cp \ (p0/p)^{\kappa}$

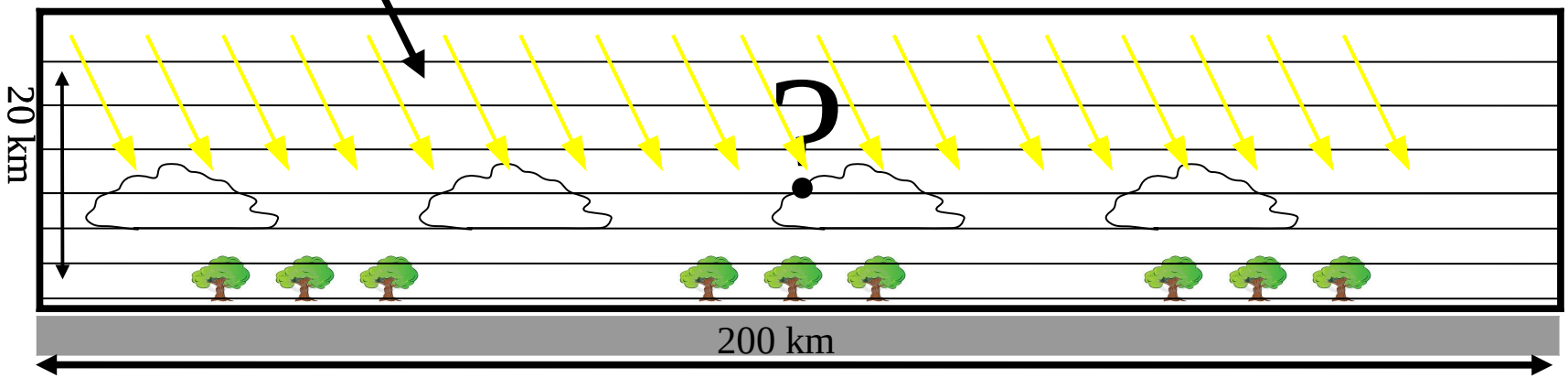
- Momentum conservation

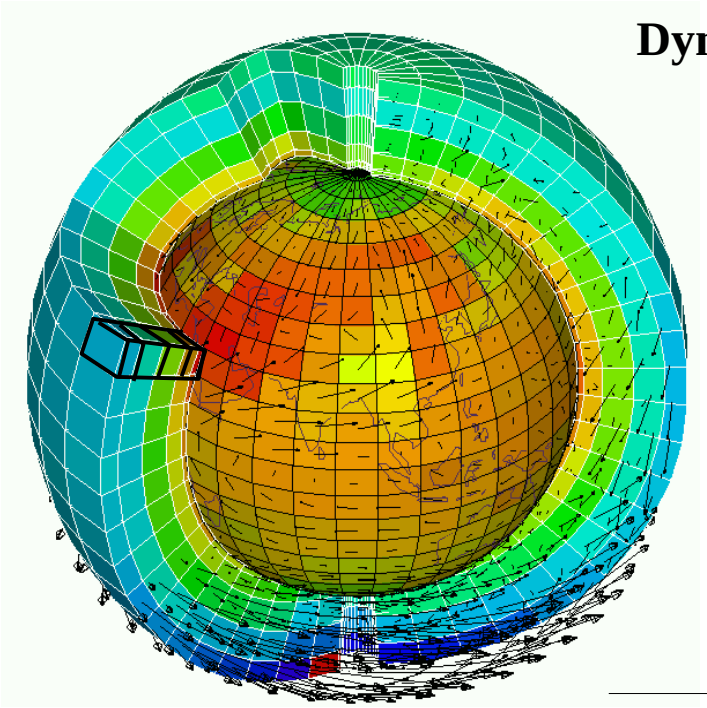
  $D\underline{U}/Dt + (1/\rho)\,\underline{\mathrm{grad}}p - \underline{g} + 2\,\underline{\Omega} \wedge \underline{U} = \underline{F}$

- Secondary components conservation

  $Dq/Dt = Sq$





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Parameterizations purpose : account for the effect of processes non resolved by the dynamical core

→ **Traditional « source » terms in the equations**

- Q : Heating by radiative exchanges, thermal conduction (neglected), condensation, sublimation, **subgrid-scale motions (turbulence, clouds, convection)**
- $\underline{F}$: Molecular viscosity (neglected), **subgrid-scale motions (turbulence, clouds, convection)**
- Sq : condensation/sublimation (q= water vapor or condensed), chemical reactions, photo-dissociation (ozone, chemical species), micro physics and scavenging (pollution aerosols, dust, ...), **subgrid-scale motions (turbulence, clouds, convection)**

Model tendencies

The integration of a given prognostic variable X $(T, \vec{v}(u,v,w), p, \rho, q_{vap})$ can be written as :

$$X_{t+\Delta t} = X_t + \left(\frac{\partial X}{\partial t}\right)_{\text{dyn}} \Delta t \text{ (dynamical core)} \quad (1)$$

$$+ \left(\frac{\partial X}{\partial t}\right)_{\text{param}} \Delta t \text{ (parameterizations)} \quad (2)$$

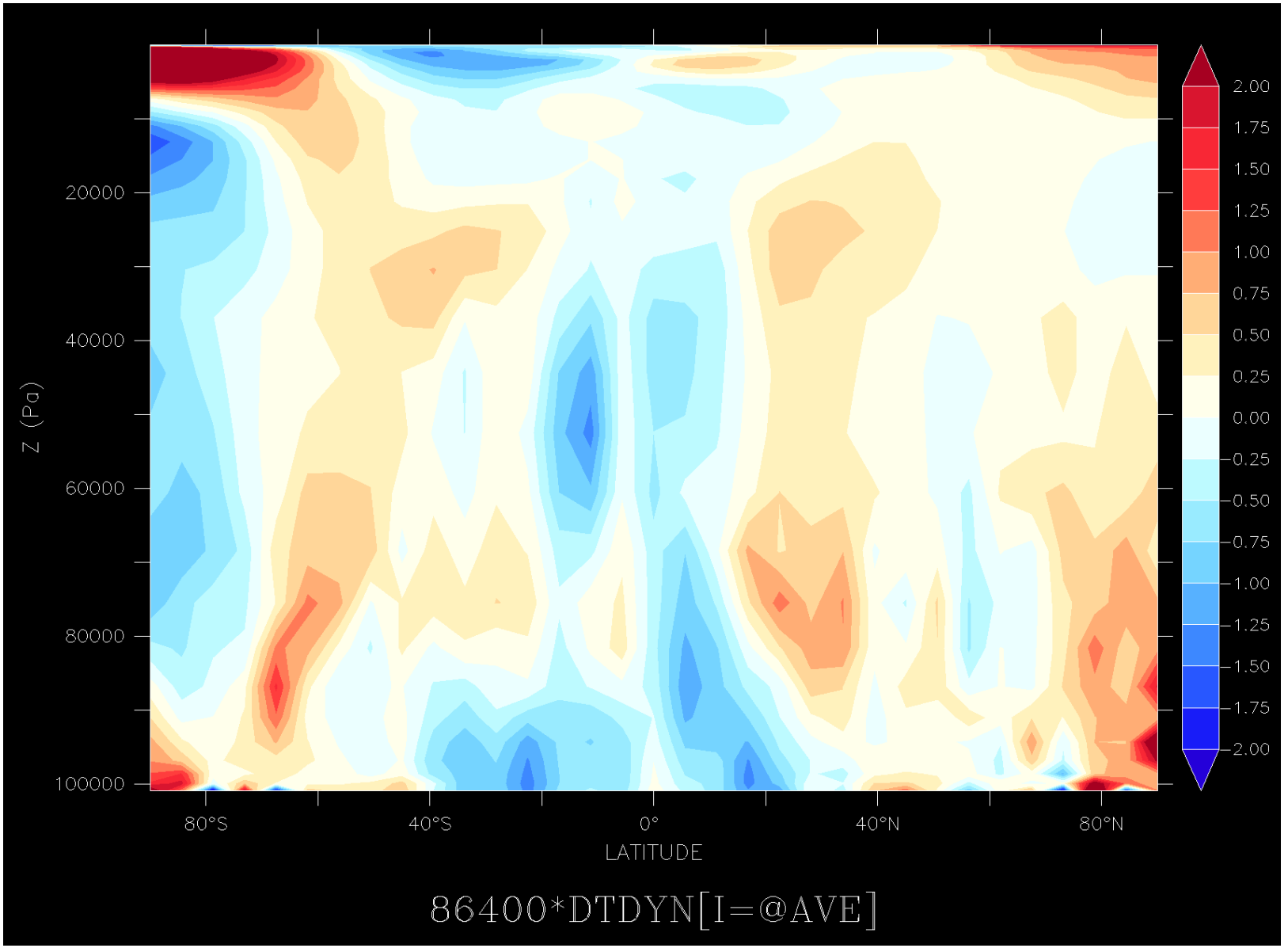
From model outputs

temp(t+dtphys)-temp(t)=dtdyn+dtphy
ovap(t+dtphys)-ovap(t)=dqdyn+dqphy
vit[u/v](t+dtphys)-vit[u/v](t)=dudyn+duphy

Physics time-step :
dtphys=daysec*iphysic/(day_step) , day_sec=86400

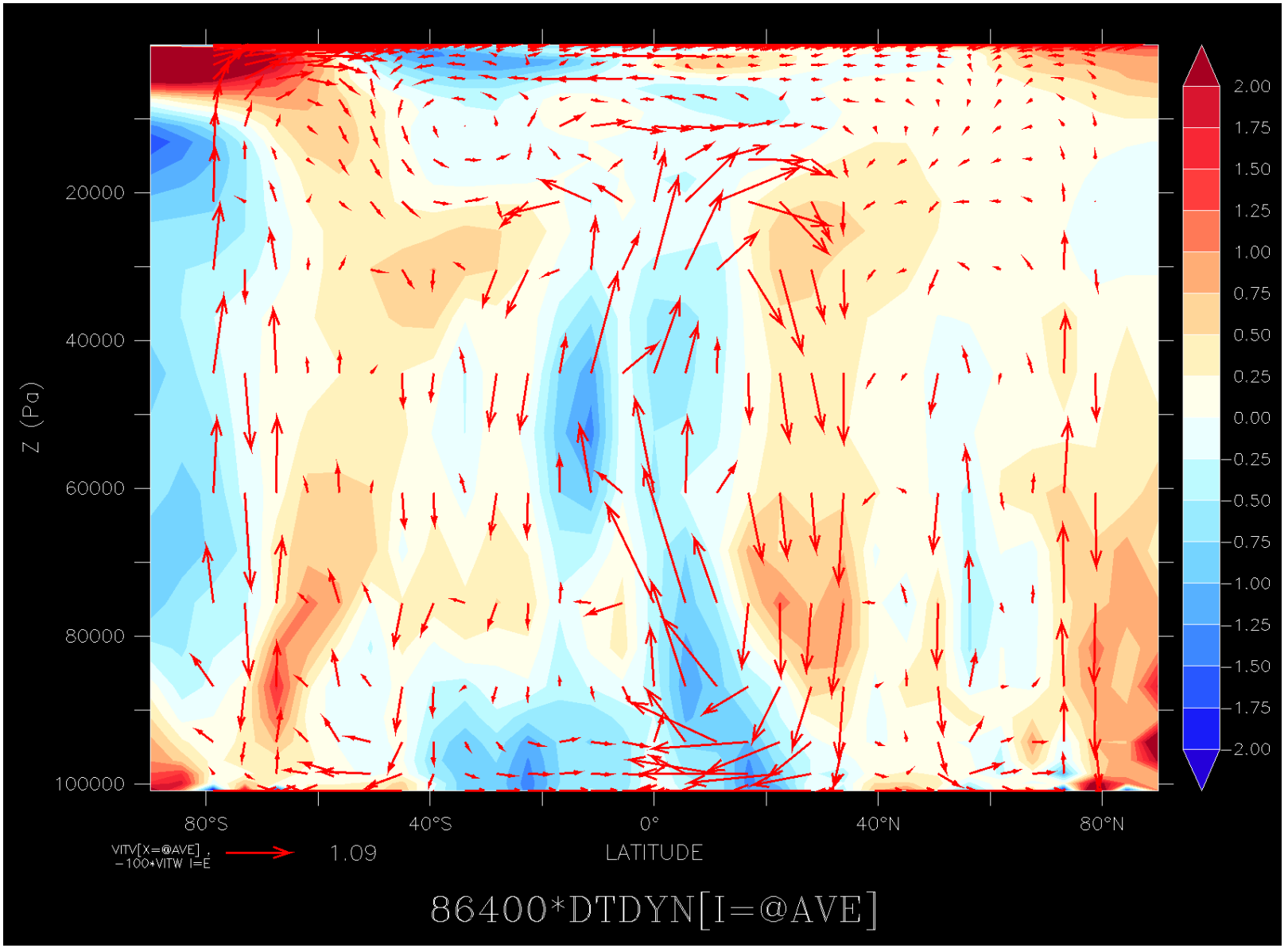
Zonal mean heating by large scale dynamics (K/day)

use histday.nc
reg/l=3
fill/lev=(-Inf)(-2,2,0.25)(inf)/pal=blue_darkred 86400***dtdyn**[i=@ave]
(prendre le temps d'expliciter la commande)



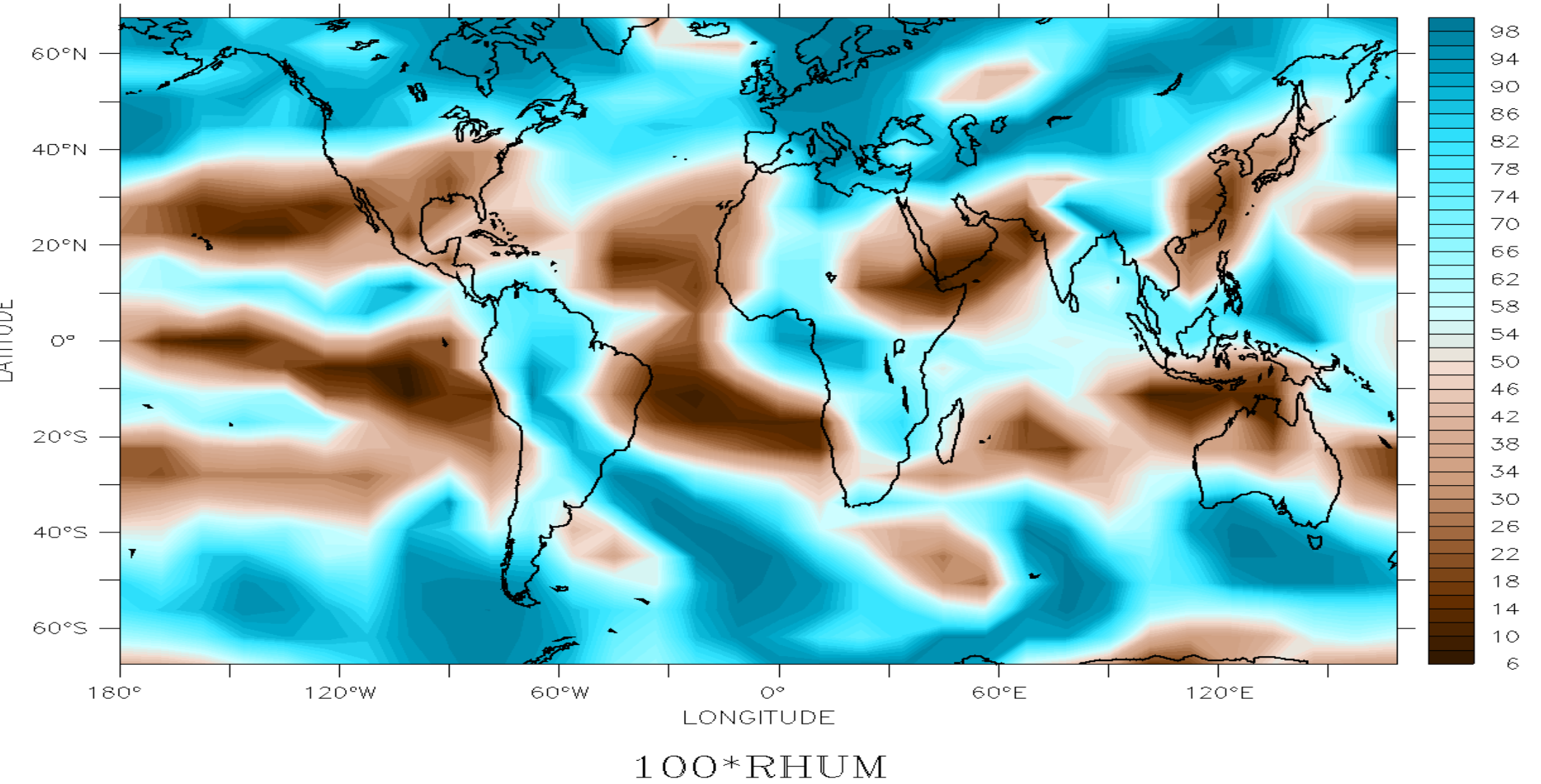
Mean meridional circulation

vector/o/l=3/col=14/y=-80:80 **vitv**[i=@ave],-100*__vitw__[i=@ave]



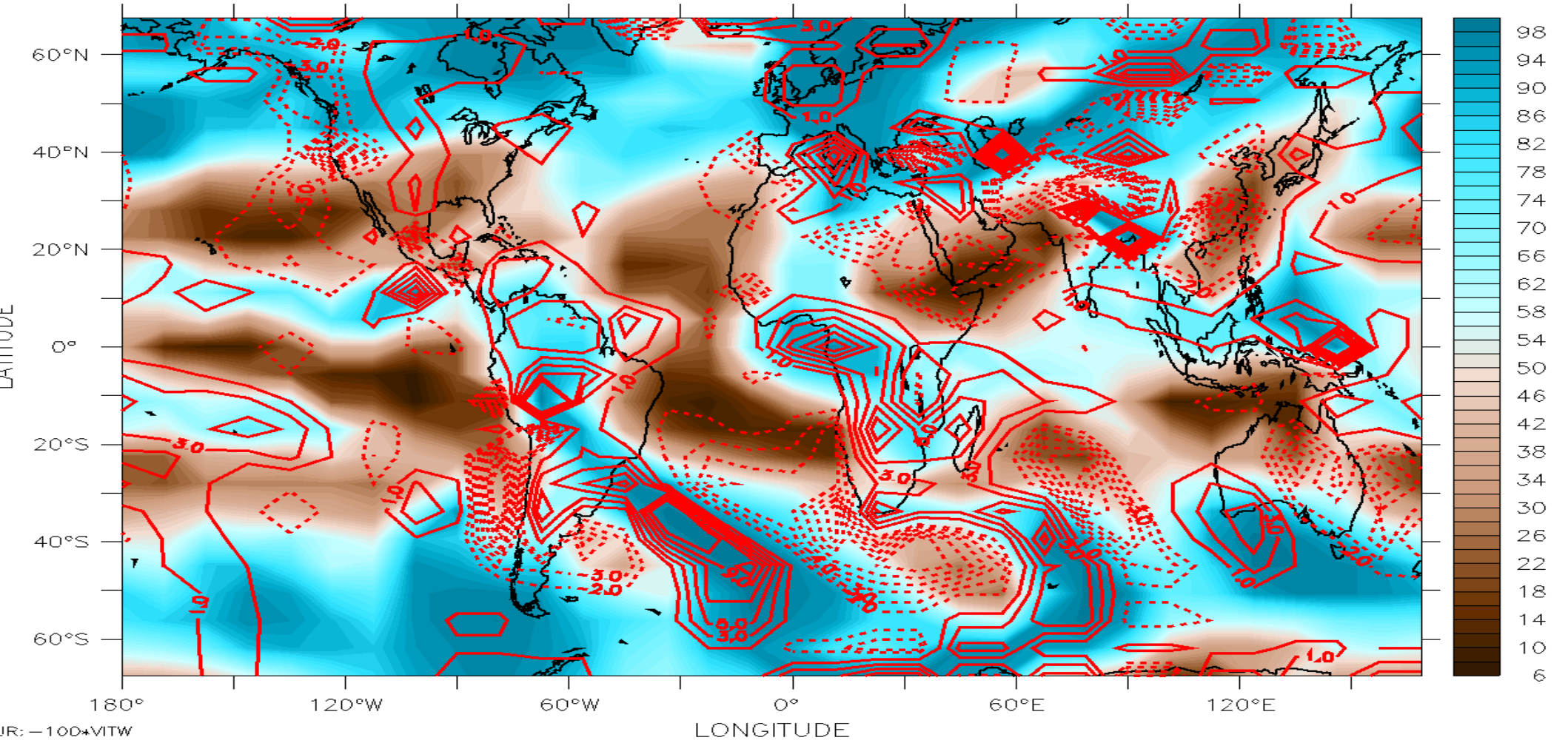
Troposheric relative humidity at 500 hPa (~5 km)

fill/z=50000/y=-70:70/pal=brown_blue 100***rhum*** ; go land thick



Vertical velocity

contour/z=50000/lev=(-10,-2,1)(1,10,2)/col=14/o **-100*vitw**



100*RHUM

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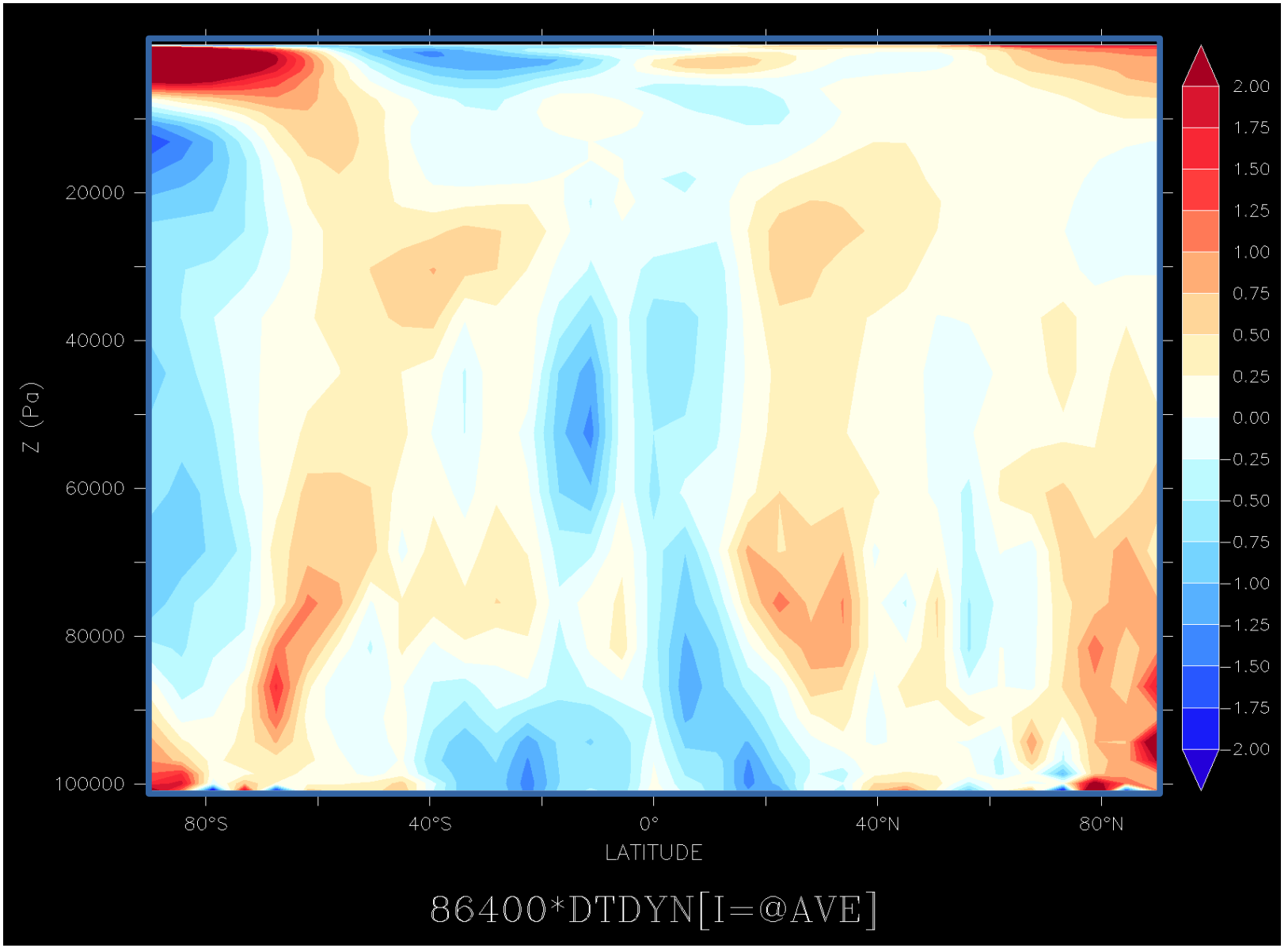

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