MagIC

MagIC Control

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MagIC Input

Namelists

1. &grid for resolution
2. &control for control parameters and numerical parameters.
3. &phys_param for the physical parameters.
4. &B_external for setting up an external field contribution
5. &start_field to define the starting fields.
6. &output_control for defining the output.
7. &mantle for setting mantle parameters.
8. &inner_core for setting inner core parameters.

Numerical Grid

```
&grid
 n_r_max       =33,
 n_cheb_max    =33,
 l_max         =16,
 m_max         =16,
 n_r_ic_max    =17,
n_cheb_ic_max=17,
 nalias        =20,
 minc          =1,
/
```

n_r_max =33,	radial grid points in outer core
n_cheb_max =33,	degree of Chebychev polynomials in outer core
l_max =16,	max. spherical harmonic order
m_max =16,	max. spherical harmonic degree
n_r_ic_max =17,	radial grid points in inner core
n_cheb_ic_max=17,	degree of Chebychev polynomials in inner core
nalias =20,	dialiazing parameter for spherical harmonics
minc =1,	azimuthal symmetry wave number, number of 'slices'

- Instead of *l_max*/ *m_max* we can use *n_phi_tot*
- Only certain *n_phi_tot* allowed:
  16,32,48,64,96,128,192,256,288,320,384,400,512,576,640,768,864,1024,...
- Only certain *n_r_max* allowed:
  17,21,25,33,37,41,49,61,65,73,81,97,101,109,121,129,145,161,...

Numerics Control

```
&control
 mode          =0,
 tag           ="test",
 n_time_steps=1000,
 courfac       =2.5D0,
 alffac        =1.0D0,
 dtmax         =1.0D-4,
 alpha         =0.6D0,
 runHours      =12,
 runMinutes    =00,
 anelastic_flavour='SINGLEMAT',
/
```

tells MagIC which problem this is (dynamo/convection ...)

run identifyer, tag of all output files

number of time step to be run

factors for Courant-Friedrich-Levy criterion

max allowed value of time step

weight for time stepping scheme

run time in hours and minutes when MagIC will shut down

Modes

This namelist defines the numerical parameters of the problem plus the variables that control and organize the run.

- **mode** (default `mode=0`) is an integer which controls the type of calculation performed.

mode=0	Self-consistent dynamo
mode=1	Convection
mode=2	Kinematic dynamo
mode=3	Magnetic decay modes
mode=4	Magneto convection
mode=5	Linear onset of convection
mode=6	Self-consistent dynamo, but with no Lorentz force
mode=7	Super-rotating inner core or mantle, no convection and no magnetic field
mode=8	Super-rotating inner core or mantle, no convection
mode=9	Super-rotating inner core or mantle, no convection and no Lorentz force
mode=10	Super-rotating inner core or mantle, no convection, no magnetic field, no Lorentz force and no advection

Physics Parameters

```
&phys_param
 ra           =1.0D5,     Rayleigh number
 ek           =1.0D-3,    Ekman number
 pr           =1.0D0,     Prandtl number
 prmag        =5.0D0,     magnetic Prandtl number
 radratio     =0.35D0,    aspect ratio
 ktops        =1,         outer thermal boundary condition
 kbots        =1,         inner thermal boundary condition
 ktopv        =2,         outer flow boundary condition
 kbotv        =2,         inner flow boundary condition
/
```

Thermal Boundary Conditions

Boundary conditions

Thermal boundary conditions

- **ktops** (default `ktops=1`) is an integer to specify the outer boundary entropy (or temperature) boundary condition:

`ktops=1`	Fixed temperature (Boussinesq) or entropy (anelastic) at outer boundary: $s(r_o) = s_{top}$
`ktops=2`	Fixed temperature gradient (Boussinesq) or entropy gradient at outer boundary: $\partial s(r_o)/\partial r = q_t$
`ktops=3`	Only use it in anelastic models: fixed temperature at outer boundary: $T(r_o) = T_{top}$
`ktops=4`	Only use it in anelastic models: fixed temperature gradient at outer boundary: $\partial T(r_o)/\partial r = q_t$

- **kbots** (default `ktops=1`) is an integer to specify the inner boundary entropy (or temperature) boundary condition.
- **s_top** (default `s_top= 0 0 0.0 0.0`) is a real array of lateraly varying outer heat boundary conditions. Each four consecutive numbers are interpreted as follows:

  1. Spherical harmonic degree ℓ
  2. Spherical harmonic order m
  3. Real amplitude ($\cos$ contribution)
  4. Imaginary amplitude ($\sin$ contribution)

  For example, if the boundary condition should be a combination of an $(\ell = 1, m = 0)$ sherical harmonic with the amplitude 1 and an $(\ell = 2, m = 1)$ spherical harmonic with the amplitude (0.5,0.5) the respective namelist entry could read:

```
s_top = 1, 0, 1.0, 0.0, 2, 1, 0.5, 0.5, ! The comas could be left away.
```

Flow Boundary Conditions

Mechanical boundary conditions ¶

- **ktopv** (default `ktopv=2`) is an integer, which corresponds to the mechanical boundary condition for $r = r_o$.

`ktopv=1`	Stress-free outer boundary for $r = r_o$: $$W_{\ell m}(r=r_o) = 0, \quad \frac{\partial}{\partial r}\left(\frac{1}{r^2\tilde{\rho}}\frac{\partial W_{\ell m}}{\partial r}\right) = 0$$ $$\frac{\partial}{\partial r}\left(\frac{1}{r^2\tilde{\rho}} Z_{\ell m}\right) = 0$$
`ktopv=2`	Rigid outer boundary for $r = r_o$: $$W_{\ell m} = 0, \quad \frac{\partial W_{\ell m}}{\partial r} = 0,$$ $$Z_{\ell m} = 0$$

- **kbotv** (default `kbotv=2`) is an integer, which corresponds to the mechanical boundary condition for $r = r_i$.

Magnetic Boundary Conditions

Magnetic boundary conditions

- **ktopb** (default `ktopb=1`) is an integer, which corresponds to the magnetic boundary condition for $r = r_o$.

`ktopb=1`	Insulating outer boundary: $$\frac{\partial g_{\ell m}}{\partial r} + \frac{\ell}{r}\, g_{\ell m} = 0, \quad \frac{\partial h_{\ell m}}{\partial r} = 0$$
`ktopb=2`	Perfect condutor: $$g_{\ell m} = \frac{\partial^2 g_{\ell m}}{\partial r^2} = 0, \quad \frac{\partial h_{\ell m}}{\partial r} = 0$$
`ktopb=3`	Finitely conducting mantle
`ktopb=4`	Pseudo-vacuum outer boundary: $$\frac{\partial g_{\ell m}}{\partial r} = 0, \quad h_{\ell m} = 0$$

Initial Condition

```
&start_field
 l_start_file=.false.,  Use a checkpoint file?
 start_file  =”None”,   name of checkpoint file
 init_b1     =3,        parameter for analytical initial magnetic field
 amp_b1      =5,        amplitude of initial magnetic field
 init_s1     =0404,     initial entropy field with degree 4 and order 4
 amp_s1      =0.1,      amplitude of initial entropy field
/
```

Output Control

```
&output_control
 n_log_step  =1,                steps between log output
 n_graphs    =1,                number of graphic output files
 n_rsts      =1,                number of restart/checkpoint files
 n_stores    =0,                number of checkpoint stores
 runid       =”Benchmark 1”,    id (name) of run on system
 l_movie     =.true.,           produce movie output?
 movie(1)    =”Bp AX”,          produce movie files for axisymm. azimuthal field
 l_RMS       =.false.,
/
```