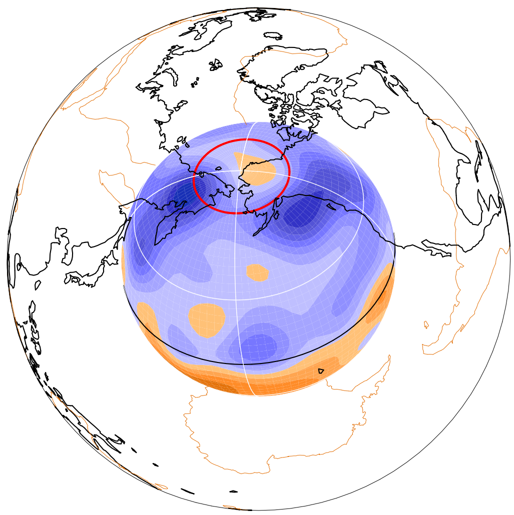
LEOPACK



iic2cicsc

Insulating **I**nner **C**ore **2** **C**onducting **I**nner **C**ore **S**olution **C**onvert

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1 iic2cicsc

Insulating **I**nner **C**ore **2** **C**onducting **I**nner **C**ore **S**olution **C**onvert

This program takes in a solution vector (i.e. a `.ints`, `.vecs` and `.xarr` file) for a full convective dynamo code with insulating inner core (for example `o2ubcdts2`) and forms a suitable solution vector, with a conducting inner core, which can be used as an initial condition for the conducting inner core code.

By setting the number of inner core radial grid nodes (`NRIC`) to zero, it can also be used to simply separate out an insulating inner core solution vector into separate solution vectors for velocity/temperature and magnetic field.

The inputs file must have the following format.

```
* input file for iic2cicsc
*
case1.ints          : Harmonics file
case1.vecs          : Vector file
case1.xarr          : Radial spacings file
  18             3  : NRIC  ISPIC
```

Any line in the input file beginning with an asterisk, `*`, is ignored by the program and can thus be used to enter comments and notes.

The arguments are as follows

- `Harmonics file`: name of already existing indices file describing a solution vector for an insulating inner core system.
- `Vector file`: name of already existing vector file describing initial solution. Must contain the same number of radial functions as indicated in the `.ints` file.
- `Radial spacings file`: name of already existing radial spacings file describing initial solution. Must contain the same number of radial grid nodes as indicated in the `.vecs` file.
- `filename stem`: First characters in output files to be generated by current run. Running `iic2cicsc` with the above input file will create the files `example_aOUTPUT.intsm`, `example_aOUTPUT.vecsm` and `example_aOUTPUT.xarrm`, describing the magnetic field and `example_aOUTPUT.intsv`, `example_aOUTPUT.vecsv` and `example_aOUTPUT.xarrv`, describing the velocity and temperature.

- `NRIC`: Number of radial grid nodes to represent magnetic field in the inner core. Note that `NRIC` can be zero: this merely has the effect that we then have an insulating inner core solution in two sets of vectors which can still be run by the conducting inner core code.

- `ISPIC`: Flag for the spacing of inner core radial grid nodes. Can take the options

  1. Forces evenly spaced grid nodes from `ESNAAS`.
  2. Forces Chebyshev-zero spaced nodes from `ZCPAAS`
  3. Forces Chebyshev-zero spaced nodes from `ZCPAA2`

  See Figure (1) and for details. `ISPIC` is probably the most natural choice here, giving far finer coverage close to the inner core/outer core boundary where the greatest changes are most likely to be. (The field can only diffuse in the inner core and should have smallest variations at the centre.)

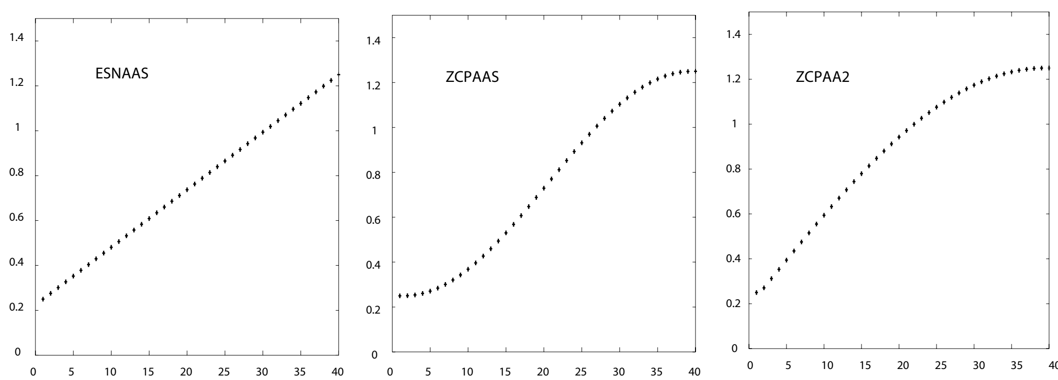

Figure 1: Distributions of radial grid nodes with $r_{\rm i} = 0.25$, $r_{\rm o} = 1.25$ and $N_r = 40$. Subroutine used to generate r values as shown.

1.1 Subprograms required for iic2cicsc

SUBS subroutines

```
vecop.f hmfrd.f svfrd.f xarrrd.f esnaas.f zcpaas.f
zcpaa2.f hmfwt.f xarrwt.f svfwt.f fopen.f fclose.f
fnamer.f
```

SUBS integer function

```
indfun.f
```

1.2 Run-time limitations

Several parameters are set at the outset which limit the physical size of the problem.

```
 INTEGER NRMAX, NHMAX, ISVMAX, LHMAX, NDCS
 PARAMETER ( NRMAX = 300, NHMAX = 2500, LHMAX = 100,
1            NDCS = LHMAX+4, ISVMAX = NRMAX*NHMAX )
```

If the values are insufficient, then change them and recompile.

- `NRMAX` is the maximum permitted number of radial grid nodes (for both inner and outer cores combined).
- `NHMAX` is the maximum number spherical harmonic radial functions.
- `LHMAX` is the highest permitted spherical harmonic degree, l.

1.3 Sample runs of iic2cicsc

The directory

`$LEOPACK_DIR/SAMPLERUNS/IIC2CICSC`

contains example input files and model output. Do not under any circumstances edit these files, as these examples should serve as a control for the correct working of the code. After compiling the program, copy the `.input` files to another directory, run the code and confirm that the output agrees with that in the directory.

1.3.1 Example a

The file `example_a.input` adds smooth functions into the inner core for the Case 1 benchmark solution of [CAC+01]. This can be used as an initial condition for running a conducting inner-core time-step code (e.g. `cicibcdts2`, `cicmibcdts2`, `cicmubcdts2`, `cicubcdts2` and `cicmubcdts2`.)

There are 18 radial grid nodes in the inner core such that they are most concentrated at the IC/OC boundary. The velocity has exactly the same number of grid nodes, `NRV`, (40 in this case) as it did prior to the change (the nodes are given in the file `example_aOUTPUT.xarrv`). The magnetic field has 58 grid nodes which are given in the file `example_aOUTPUT.xarrm`. For a set of solution vectors to be a valid input for the conducting inner core code, the last `NRV` grid nodes for the magnetic field must be exactly the same has the `NRV` nodes at which the velocity is stored.

1.3.2 Example b

The file `example_b.input` simply returns separate files describing the velocity and temperature, and the magnetic field. The inner core is still insulating however, as no grid nodes were specified.

References

[CAC+01] U. R. Christensen, J. Aubert, P. Cardin, E. Dormy, S. Gibbons, G. A. Glatzmaier, E. Grote, Y. Honkura, C. Jones, M. Kono, M. Matsushima, A. Sakuraba, F. Takahashi, A. Tilgner, J. Wicht, and K. Zhang. A numerical dynamo benchmark. *Phys. Earth Planet. Inter.*, 128:25–34, 2001.