The Pencil Code Newsletter

Issue 2024/1

May 3, 2024, Revision: 1.22

Contents

1 PCUM 2024 in Barcelona

Figure 1: The Institute of Space Sciences in Bellaterra (Barcelona).

As already advertised in the last newsletter 2023/3, the next Pencil Code User Meeting will be held at the Institute of Space Sciences on the Campus of University Autonoma de Barcelona during September 23–27, 2024; see Figures 1 and 2.

The organizers include Fabio Del Sordo and his team, who are in the process of finalizing the webpage for the event. A preliminary version can be found at the following address `https://indico.ice.csic.es/event/40/`. In May, the organizers will share on the webpage the most important information about the meeting and logistics and they will open the registration.

Finding accommodation in Barcelona might not be easy. If someone is interested in securing an accommodation already now, one possibility is the Residència d'Investigadors, downtown in Barcelona; see `https://www.residencia-investigadors.es/en/`. It is located close to the center and close to the train station (FGC, line S2) that takes you to the UAB Campus in 40–45 minutes, where the Pencil Code User Meeting will be.

For any preliminary inquire you can contact Fabio Del Sordo `<delsordo@ice.csic.es>`.

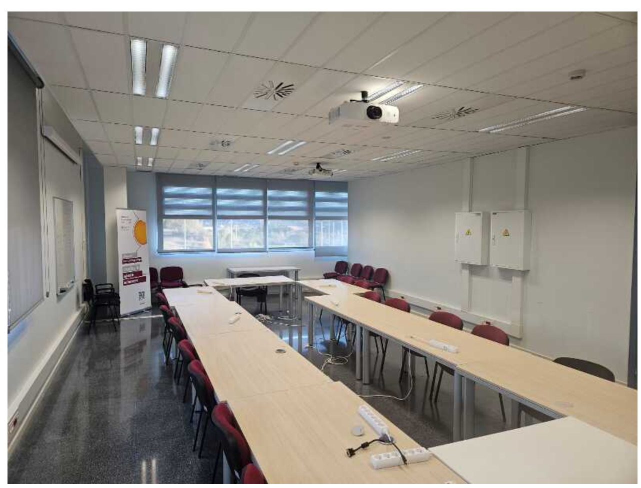

Figure 2: One of "our" meeting rooms at the Space Sciences in Bellaterra.

2 Proposals for PCUM 2025

At the last PCUM, we discussed the possibility to apply for hosting the PCUM in 2025 and thereafter. Thus, please come forward with suggestions to the editors of this newsletter. While this implies a significant amount of work, it can also be a real pleasure for those who are organizing a small meeting for the first time. If you are able to apply for additional funding, this would be great, but even without that, you can do it. The participants are usually paying their own accommodation and travel, as well as dinners and T-shirts, if the organizers design one. As before, the PCSC decides at the end of the PCUM where the next one will be.

3 Gfortran bug fixed

Kishore Gopalakrishnan informed us of the following: Gfortran users should note that a bug that affected cleaning up of 1D average files after an improperly terminated Pencil run has been fixed in GCC (`https://gcc.gnu.org/bugzilla/show_bug.cgi?id=107031`). The fix is expected to be included in the upcoming GCC 14.

4 Coding considerations

4.1 Where is the source code?

Most users will respond: "in `src/*.f90` and `src/*.h`". True, but there is more: We have also Fortran 77 and C sources (`src/*.f` and `src/*.c`). Additionally, some Fortran code dwells in `src/*.inc` files, which come in two flavors: `*_dummies.inc` are not in the repository but generated during the build. They contain dummy routines, which are needed for linking, but are otherwise without function. When named `*_common.inc`, the files *do* exist in the repository and contain code which is common to different implementations of a physics module, like, e.g., `chemistry`.

Don't forget that `src` has several source-code containing subdirectories. Examples include `src/magnetic`, `src/test_methods`, `src/special`, etc.

4.2 Grepping source code

During code development, one often uses grep, e.g., in the form

```
grep ind_glob ~/pencil-code/src/*.f90
```

but, as explained above, you will then miss the `*.inc` and `*.h` files. Therefore, we discussed having a

```
pc_grepsrc
```

command that would also grep in Astaroth files (in the subdirectory `src/astaroth/submodule`) if they are linked.

5 Call for help

At Aalto University in Finland, computer scientists from Prof. Maarit Korpi-Lagg's and Prof. Linh Truong's groups are running a one-year project (Inno4scale-202301-068) to create an "Opportunistic data operations platform" (ODOP). The idea is to identify *windows of opportunity* when running an application, which does not permanently make use of all compute resources on a node of a cluster. During such a window, there is then an opportunity to schedule an additional task to be processed. A typical example (and also the major application case for the development) is the Pencil Code, with GPU acceleration by Astaroth. In this case, most of the CPUs on a node are only from time to time busy for creating diagnostics and performing output, but are idle otherwise. An "additional task" would then naturally be some post-processing on data, created just by the running code, or even on data from another run. Consider as an example the execution of `src/read_all_videofiles.x`, which sometimes can take an hour or so. Another example could be 3-D rendering, which requires reading and processing of snapshots.

The community can be of significant help to the developers by digging into their past or recent work with the Pencil Code and identifying such post-processing tasks, which should, of course, be computationally somewhat heavy. If you find appropriate cases, please send corresponding Python or IDL scripts (or any other program tool) with a short explanation to `matthias.rheinhardt@aalto.fi`.

6 Random tips

6.1 Non-Cartesian averages

Kishore Gopalakrishnan wrote us the following: 1D and 2D diagnostic averages are now computed correctly for non-Cartesian coordinate systems (but the grid still needs to be equispaced). Earlier, e.g., the quantity reported in spherical coordinates as `+rhomx` was actually `((cos(y0) - cos(y1))/(y1-y0))*x**2*rhomx`.

6.2 Reading several subvolumes

Many tools have existed for a long time, but not everybody knows about them. It has long been clear that the reading of a subvolume can be useful if the data file is big, and it is easy if the relevant subvolume corresponds to that of a single processor and if each processor writes its own var files. But since 2012, employing the IDL script `pc_read_subvol_raw.pro`, one can also select *arbitrary index ranges*, for example like so:

```
ixs=1230 & ixe=ixs+255
iys= 315 & iye=iys+255
izs=1920 & ize=2047
pc_read_subvol_raw,obj=var,xs=ixs,xe=ixe, $
  ys=iys,ye=iye,zs=izs,ze=ize, $
  allprocs=0,/single,/addghost
```

This is an example where a $256 \times 256 \times 128$ mesh point subvolume is read from a 2048^3 simulation. Here, `s` and `e` in the variable names refer to start and end. As you see from the logs, this was coded and developed by Philippe in 2012 and 2013. Except for additional five `Merge branch 'master'` commits in the meantime, also Matthias worked on it in 2024.

The instruction `/single` helps to reduce the amount of data if the original data was in double precision. (It also doesn't hurt if the original data was already in single precision.) Finally, the `/addghost` is included to add the ghost zones. This is needed if you want to compute $\boldsymbol{B}$ and $\boldsymbol{J}$ from that data, e.g., like so:

```
bb=curl(var[*,*,*,4:6])
jj=curlcurl(var[*,*,*,4:6])
```

Note that `curlcurl` is the double curl and corresponds to $\boldsymbol{\nabla}\boldsymbol{\nabla}\cdot\boldsymbol{A}-\nabla^2\boldsymbol{A}$. This method was used in Brandenburg *et al.* (2024a) where the points from a small subvolume were visualized.

The script has also a "simulation mode" (`/simulate`), which doesn't read any data, but creates a list of the processor chunks needed for the subvolume and informs about the needed amount of main memory. This can be useful if one has to retrieve the data from some mass storage like Allas at CSC in Finland.

6.3 Kinematic sound waves

In the paper by Sharma *et al.* (2023), the driving of gravitational waves by stochastic sound waves was studied. In their repertoire of different cases, they also studied *linear* random sound waves. Instead of solving the hydrodynamic equations without nonlinearity, they just constructed sound waves from their dispersion relation with random phases. They did this using `HYDRO = hydro_kinematic` with the entry:

```
&hydro_run_pars
  kinematic_flow='sound3D'
  lkinflow_as_comaux=T, power1_kinflow=4.,
  power2_kinflow=-2., kpeak_kinflow=30.
  cs21_kinflow=3.
/
```

The full details of this run are given in `http://norlx65.nordita.org/~brandenb/projects/ShallowGW/run_directories/512a_2nd_dt5c_cos_dt/`.

7 Papers since December 2023

As usual, we look here at new papers that make use of the Pencil Code. Since the last newsletter of December 15st, 10 new papers have appeared on the arXiv, plus 15 others, some of which were just preprints and have now been published in a journal. We list both here, 25 altogether. A browsable ADS list of all Pencil Code papers can be found on: `https://ui.adsabs.harvard.edu/public-libraries/iGR7N570Sy6AlhDMQRTe_A`. If something is missing in those entries, you can also include it yourself in: `https://github.com/pencil-code/pencil-code/blob/master/doc/citations/ref.bib`, or otherwise just email brandenb@nordita.org. A compiled version of this file is available as `https://github.com/pencil-code/website/blob/master/doc/citations.pdf`, where we also list a total of now 112 code comparison papers in the last section "Code comparison & reference". Those are not included in our list below, nor among the now total number of 699 research papers that use the Pencil Code.

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