

[Return to Bram's site.](#)

BRAMS - How to Install & Run small test cases

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1. Introduction

This document will guide You to install software infrastructure and BRAMS model. BRAMS code is distributed under CC-GPL License. You can download, copy, modify and redistribute the code. Some rights are reserved. We recommend the user to read the license terms on site Creative Commons. More information, documentation, etc You can see in [Bram's site](#).

BRAMS works with Linux or Unix like operational's systems. As a first approach, we recommend the Linux distribution UBUNTU. But You can use any other Linux/Unix flavous too.

For all operations You will need a superuser account or permissions for sudo (sudoers).

Please, in order to make the installation easier, make a install directory as You prefer.

```
mkdir ~/install
cd ~/install
```

PLEASE, READ CAREFULLY EACH OF THE STEPS BELOW IN ORDER TO INSTALL AND RUN THE MODEL.

2. Install Fortran & C Compilers and autoconf

BRAMS has been tested with the compilers: INTEL® compilers, PGI® compilers, IBM® XL, and GNU Fortran compiler (GPL ©). Follow the instructions of each vendor's site to install the compilers.

In case of uses GFORTRAN/GCC (Gnu compilers) and UBUNTU Linux You can use the "apt-get install" for compilers and libraries. Before all instalations we recommend:

Make an update of packages and install packages(Gfortran, build-essential, m4):

```
cd ~/install
sudo apt-get update
```

```
sudo apt install build-essential
sudo apt install gfortran
sudo apt install m4
```

Note:

- *If You prefer other compiler than gfortran/gcc You can do it*
- *For others Linux flavours use the specific installer instead 'apt get':*
 - *Ubuntu (kubuntu, xubuntu, lubuntu, etc) - apt, apt-get, dpkg, snap*
 - *Debian -- apt, apt-get, dpkg*
 - *Red Hat & CentOS - yum, rpm*
 - *Fedora - dnf*
 - *FreeBSD - pkg*
 - *Arch Linux - pacman*

3. Install MPI Libraries and Software

BRAMS works only in parallel mode. One can run the model using a single processor/core, but must do it using MPI with the MPICH command. We recommend download and install the last version of MPICH stable release. Also take care to choose the correct version to your OS.

```
cd ~/install
wget http://www.mpich.org/static/downloads/3.3.2/mpich-3.3.2.tar.gz
tar -zxvf mpich-3.3.2.tar.gz
cd mpich-3.3.2
./configure --disable-fast CFLAGS=-O2 FFLAGS=-O2 CXXFLAGS=-O2 FCFLAGS=-O2 --
prefix=/opt/mpich3
make
sudo make install
```

Notes about **configure** command above:

- --prefix= directory where mpich will be installed when You make the install command. We recommend in **/opt/mpich3**
- CC= C compiler according You use in system (gcc, ifort, etc);
- FC= Fortran compiler according You install on step (2) above;
- F77= Use the same as FC

Please, pay attention in mpich version number You download.

4. Install WGRIB2 API package from NCEP

In order to read grib2 (pattern data file), the model uses wgrib2 lib & API. Download and install it.

```
cd ~/install
wget https://www ftp.cpc.ncep.noaa.gov/wd51we/wgrib2/wgrib2.tgz
```

```
tar -zxvf wgrib2.tgz
cd grib2
```

Edit (use Your editor) the *makefile*, search the directives bellow and change accordingly the values:

```
USE_NETCDF3=0
USE_NETCDF4=0
USE_REGEX=1
USE_TIGGE=1
USE_MYSQL=0
USE_IPOLATES=3
USE_SPECTRAL=0
USE_UDF=0
USE_OPENMP=0
USE_PROJ4=0
USE_WMO_VALIDATION=0
DISABLE_TIMEZONE=0
MAKE_FTN_API=1
DISABLE_ALARM=0
USE_G2CLIB=0
USE_PNG=0
USE_JASPER=0
USE_AEC=0
```

Now continue the instalation:

```
make CC=gcc FC=gfortran
make CC=gcc FC=gfortran lib
cd ..
sudo mv grib2 /opt
```

5. Install Zlib

```
cd ~/install
wget https://www.zlib.net/zlib-1.2.11.tar.xz
export LD_LIBRARY_PATH=/usr/local/lib:$LD_LIBRARY_PATH
xz -d zlib-1.2.11.tar.xz
tar -xvf zlib-1.2.11.tar
cd zlib-1.2.11
./configure
make
sudo make install
```

6. Install Curl libraries

```
cd ~/install
wget https://curl.haxx.se/download/curl-7.65.0.tar.gz
```

```
tar -xzvf curl-7.65.0.tar.gz
cd curl-7.65.0
CC=gcc FC=gfortran ./configure
make
sudo make install
```

Note:

IMPORTANT: IF YOU ARE USING A CLUSTER ALL THE LIBRARIES MUST BE AVAILABLE ON NODES OR IN SHARED DIRECTORY AMONG NODES.

7. Install M4:

```
cd ~/install
wget http://ftp.gnu.org/gnu/m4/m4-latest.tar.gz
tar -xzvf m4-latest.tar.gz
export LD_LIBRARY_PATH=/usr/local/lib:$LD_LIBRARY_PATH
cd m4-1.4.17
./configure
make
sudo make install
```

Note:

See the correct version of m4. "1.4.17" is just an example.

8. Install HDF5

The model uses HDF5 to read some files and as a layer for parallel compact NetCDF format.

In your browser go to [HDF5 Download page](#).

Download the newest source code to install folder You create previously. Pay attention because sometimes the Download is performed inside "Download" system folder.

```
cd ~/install
mv ~/Downloads/hdf5-1.10.6.tar.bz2 .
bunzip2 hdf5-1.10.6.tar.bz2
tar -xvf hdf5-1.10.6.tar
cd hdf5-1.10.6.tar.bz2
./configure --
prefix=/opt/hdf5 CC=/opt/mpich3/bin/mpicc FC=/opt/mpich3/bin/mpif90 --with-
zlib=/usr/local/lib/ --enable-parallel --enable-fortran
make
sudo make install
```

Note:

- If your browser is set to Download in another folder than "Downloads" get it from the right place using the mv (move) command.
- In the case above the sources are in bzip2 compact format.

9. Install the NetCDF C libraries and packages

The model use NetCDF Unidata file format to read and write files. Get the C NetCDF C library and files at [Unidata NetCDF Download site](#)

Get the **Stable Release** of NETCDF-C Releases (Gzipped format). After download it:

```
cd ~/install
mv ~/Downloads/netcdf-c-4.7.3.tar.gz .
tar -xzvf netcdf-c-4.7.3.tar.gz
cd netcdf-c-4.7.3
./configure --
prefix=/opt/netcdfc FC=/opt/mpich3/bin/mpif90 CC=/opt/mpich3/bin/mpicc LT_SYS_L
IBRARY_PATH=/opt/hdf5/lib CFLAGS='-I/opt/hdf5/include' LIBS='-L/opt/hdf5/lib'
make
sudo make install
```

Notes:

- If your browser is set to Download in another folder than "Downloads" get it from the right place using the mv (move) command.
- The version 4.7.3 above is only an example. You must try newest if available.
- **Don't use a version < 4.7.3**
- **IMPORTANT: IF YOU ARE USING A CLUSTER ALL THE LIBRARIES MUST BE AVAILABLE ON NODES OR IN SHARED DIRECTORY AMONG NODES.**

10. Install the NetCDF Fortran libraries and packages

Get the Fortran NetCDF Fortran library and files at [Unidata NetCDF Download site](#)

Roll the page some lines.

Get the **Stable Release** of NetCDF-Fortran Releases (Gzipped format). After download it:

```
cd ~/install
mv ~/Downloads/netcdf-fortran-4.5.2.tar.gz .
tar -xzvf netcdf-fortran-4.5.2.tar.gz
cd netcdf-fortran-4.5.2
export LD_LIBRARY_PATH=/opt/netcdfc/lib:/opt/hdf5/lib:$LD_LIBRARY_PATH
export CC=/opt/mpich3/bin/mpicc
export FC=/opt/mpich3/bin/mpif90
export CPPFLAGS="-I/opt/netcdfc/include -I/opt/hdf5/include"
export LDFLAGS="-L/opt/netcdfc/lib -L/opt/hdf5/lib"
./configure --prefix=/opt/netcdfc
make
sudo make install
```

Notes:

- If your browser is set to Download in another folder than "Downloads" get it from the right place using the mv (move) command.
- The version 4.5.2 above is only an example. You must try newest if available.
- **IMPORTANT: IF YOU ARE USING A CLUSTER ALL THE LIBRARIES MUST BE AVAILABLE ON NODES OR IN SHARED DIRECTORY AMONG NODES.**

11. Building BRAMS' Model

Click here [Brams Model](#) to download model.

After download finished, move it to install directory.

```
cd ~/install
mv ~/Downloads/brams.tgz .
tar -xzvf brams.tgz
cd BRAMS_GEOS/build/
export LD_LIBRARY_PATH=/opt/grib2/lib:/opt/hdf5/lib:/opt/mpich3/lib:/opt/netcdf/lib:/opt/netcdf/lib:$LD_LIBRARY_PATH
./configure --program-prefix=BRAMS_5.4 --prefix=/home/<seu user> --enable-jules --with-chem=RELACS_TUV --with-aer=SIMPLE --with-fpcomp=/opt/mpich3/bin/mpif90 --with-cpcomp=/opt/mpich3/bin/mpicc --with-fcomp=gfortran --with-ccomp=gcc --with-wgrib2=/opt/grib2/lib --with-netcdf=/opt/netcdf --with-netcdfc=/opt/netcdfc --with-hdf5=/opt/hdf5
make
make install
```

Notes:

- If your browser is set to Download in another folder than "Downloads" get it from the right place using the mv (move) command.
- **--prefix** directory where BRAMS will be installed in a "bin directory" after end of compilation install
- **--with-chem** The chemical mechanism to be used (*RELACS_TUV, RELACS_MX, CB07_LUT, CB07_TUV, RACM_TUV*) - For the first time use RELACS_TUV
- **--with-aer** aerosol mechanism (SIMPLE or MATRIX(under test))

11. Download tables files

Tables files contains a lot of files that model uses for works. Is mandatory Download and install it inside "bin" folder created by "**--prefix**" above.

Please, click in [Brams tables](#) and Download the tables file. After Download finished copy the file to your user bin folder and unpack it.

```
cd /home/SeuUser/bin
mv ~/Downloads/bramsTables_Rev5.4.tgz .
tar -xzvf bramsTables_Rev5.4.tgz
```

Notes:

- If your browser is set to Download in another folder than "Downloads" get it from the right place using the mv (move) command.
- put it in Your **/home/SeuUser/bin** folder!

12. Download surface (Veg, topo, etc) fix files

Brams uses a lot of files with information about vegetation, topography, NDVI, etc. You must have all the data in your bin folder.

Click here or open your browser and download fix files: [Brams Fix Files](#)

After the Download finished uncompress the file.

```
cd /home/SeuUser/bin
mv ~/Downloads/datafix.tgz
tar -xzvf datafix.tgz
```

NOTES:

- If your browser is set to Download in another folder than "Downloads" get it from the right place using the mv (move) command.
- put it in Your **/home/SeuUser/bin** folder!
- The file size is **5.4 GB** - The download may takes a while

13. Download a Meteorological Test Case

The small case contains input data from GFS Model (NOAA) for one single day of forecast. The directory structure is complete and You can run the model in small computers or laptops.

The date of test case is Feb, 13, 2020. The namelist (RAMSIN_meteo-only_GFS) is set to 80 x 80 grid points and 35 levels. The surface resolution is 10km centered at 21.16S, and 44.93W.

Click here or open your browser and download the [Brams Small Case](#)

After the Download finished uncompress the file.

```
cd /home/SeuUser/bin
mv ~/Downloads/bramsGFSSmall.tgz .
tar -xzvf bramsGFSSmall.tgz
```

NOTES:

- If your browser is set to Download in another folder than "Downloads" get it from the right place using the mv (move) command.
- put it in Your **/home/SeuUser/bin** folder!
- The file size is **1.5 GB**

14. Run the Meteorological test case

BRAMS need a tmp directory. Before You run the model export a TMPDIR variable and put the system in memory ulimit conditions. Because the libraries You must set the LD_LIBRARY_PATH.

```
cd /home/SeuUser/bin
export LD_LIBRARY_PATH=/opt/grib2/lib:/opt/hdf5/lib:/opt/mpich3/lib:/opt/netcd
fc/lib:/opt/netcdf/lib:$LD_LIBRARY_PATH
export TMPDIR=./tmp
ulimit -s 65536
```

Now You can run the model. BRAMS needs 3 runs. The first one makes the surfaces files ("**MAKESFC**") using the information You put in RAMSIN namelist file. The second one BRAMS makes the initial conditions ("**MAKEVFILE**") for the model. The last one ("**INITIAL**") is for make the forecast. The MAKESFC and MAKEVFILE is made using just one processor. Edit the RAMSIN_meteo-only_GFS file and check if the line above is ok.If not, change it:

```
RUNTYPE = 'MAKESFC',      ! Type of run: MAKESFC, INITIAL,HISTORY,
                        !                       MAKEVFILE, or MEMORY
```

Save the file and go run the model:

```
cd /home/SeuUser/bin
/opt/mpich3/bin/mpirun -np 1 ./brams-5.4 -f RAMSIN_meteo-only_GFS
```

A lot of information will be printed in screen. Check if message of Integration ends is present.

```
MAKESFC run complete

Notice.!    === Time integration ends; Total run time = 1.1 [s]

Notice.!  **(main)** 5.4 BRAMS execution normal ends!
```

If present the MAKESFC fase ends. Some error may be present but is not a fatal. Now You can run the MAKEVFILE fase. Edit again the RAMSIN_meteo-only_GFS and change *RUNTYPE = 'MAKESFC'* to *RUNTYPE = 'MAKEVFILE'*. Save it and run again:

```
cd /home/SeuUser/bin
/opt/mpich3/bin/mpirun -np 1 ./brams-5.4 -f RAMSIN_meteo-only_GFS
```

Wait for the fase ends and check the output. The message will be similar as the show above.

Edit again the RAMSIN_meteo-only_GFS and change *RUNTYPE = 'MAKEVFILE'* to *RUNTYPE = 'INITIAL'*. Save it. But now You must use some more processors because the cpu requirements

of model.

To know the number the number of processors of your machine:

```
cat /proc/cpuinfo
```

A list of processors will be displayed. Suppose You have 4 processors. You can run the model with `"-np 4"`.

```
cd /home/SeuUser/bin  
/opt/mpich3/bin/mpirun -np 4 ./brams-5.4 -f RAMSIN_meteo-only_GFS
```

Now a long list of logs will be displayed at screen. The model will show the timesteps performed until the final timestep.

```
Timestep # 428; Sim Time 25680.0 [s]; Wall Time 0.961 [s]; DT 60.0  
00 [s]; sscourn 4.196  
Timestep # 429; Sim Time 25740.0 [s]; Wall Time 0.953 [s]; DT 60.0  
00 [s]; sscourn 4.196  
Timestep # 430; Sim Time 25800.0 [s]; Wall Time 0.961 [s]; DT 60.0  
00 [s]; sscourn 4.196  
Timestep # 431; Sim Time 25860.0 [s]; Wall Time 1.016 [s]; DT 60.0  
00 [s]; sscourn 4.196  
Timestep # 432; Sim Time 25920.0 [s]; Wall Time 1.008 [s]; DT 60.0  
00 [s]; sscourn 4.196
```

Wait for the simulation ends! it will takes a while. At end of simulation the message will be:

```
Notice.!    === Time integration ends; Total run time = 1844.8 [s]  
  
Notice.!  *(main)** 5.4 BRAMS execution normal ends!  
Notice.!  **  
(main)** 5.4 for more information about submission(non fatal errors, notices, w  
arnings), please, see the file bramsLog.out !
```

As results of Model, inside the **dataout/POSPROCESS** folder, You will have a lot of files in **grads** format. In test case they will be:

```
METEO-ONLY-A-2020-02-13-000000-g1.gra  
METEO-ONLY-A-2020-02-13-000000-g1ctl  
  
... until ...  
  
METEO-ONLY-A-2020-02-14-000000-g1.gra  
METEO-ONLY-A-2020-02-14-000000-g1ctl
```

You can see they using grads program. If You prefer You can make output using NetCDF file. To do this You must change the IPOS tag in namelist RAMSIN_meteo-only_GFS. Edit it and change the value to 3:

```
IPOS      = 3
```

Now run the model in fase INITIAL again:

```
cd /home/SeuUser/bin
/opt/mpich3/bin/mpirun -np 4 ./brams-5.4 -f RAMSIN_meteo-only_GFS
```

A new file will be present in **dataout/POSPROCESS**:

METEO-ONLY-A-2020-02-13-000000-g1.nc

You can open the file using a lot of others apps: ncdump (text mode - inside /opt/netcdf/bin), [ncview](#) (graphic), panoply4, etc. See a list [here](#). We recommend the [Panoply 4](#). See in the site how to download and run it.

Notes

- **np** is the numbers of cores You will use.
 - If You do not know how many processors (cores) You can use please, try the command: `$ lscpu` (see the information about CPU(s))
 - Some machine, mainly laptops, may present a **overheating** when run the model or, in old machines, the O.S. **can lock** because demands of CPU and memory.
- **RAMSIN_meteo-only_GFS** is the model namelist. It contains all information for model run. See the documentation to understand all fields in namelist.
 - **IMPORTANT: When the model start a lot of logs will be printed on your screen, Pay attention for errors that will be printed during the run. If you got an error and needs for help, please, send a e-mail to sciorbis@sciorbis.kinghost.net and inform the error. Please, attach the log printed on the screen.**

14. Run a Small chemical case (using RELACS_TUV) for laptops and desktops

a) Get data: `~/> wget http://ftp.cptec.inpe.br/brams/BRAMS/data/meteo-chem.tgz`

b) Unzip the data: `~/> tar -xzvf meteo-chem.tgz`

c) Run the model using mpirun installed on step 3: `~/>/opt/mpich3/bin/mpirun -np 4 ./brams-5.3 -f RAMSIN_meteo-chem`

Notes:

*1 Please, see the notes from *1 to *3 on (7) above.

*2 The size of this test is 462,77MB gzipped. The time of download (8.c above) depends on the network.

15. Visualize the results with GrADS

BRAMS, by default, writes the output in subdirectory dataout/POSPROCESS. Later you can set others directories and features on namelist file (expert users). The format of the output in POS is in GrADS software (COLA/IGES). You must install GrADS in your computer.

To see data:

```
a) Get the grads on http://cola.gmu.edu/grads/downloads.php. if You use UBUNTU
You can get grads using: ~\> sudo apt-get install grads
b) Goto pos directory: ~\> cd dataout/POSPROCESS
c) Run grads software: ~\> grads -l
d) When grads prompt appears on terminal (ga->), you can choose one of the
output files, check they by listing: ga-> !ls -latr *.ctl
e) Choose one and open it: ga->open METEO-ONLY-A-2015-08-27-030000-g1.ctl (the
name is just an example)
f)after the file is open You will see information about the file, LON, LAT,
LEV, etc.
g)list all the variables available in output: ga->q file
h) Choose one of them and proceed the plot: ga->d tempc (in this example
plotting tempc - temperature)
```

Notes:

*1 You can see more information about Grads on Cola: Grads User's Guide:
<http://cola.gmu.edu/grads/gadoc/users.html>

NOTICE: This document is part of BRAMS' Model. Do not distribute it without the entire model.
