A first training course in Landslide-HySEA

EDANYA TEAM

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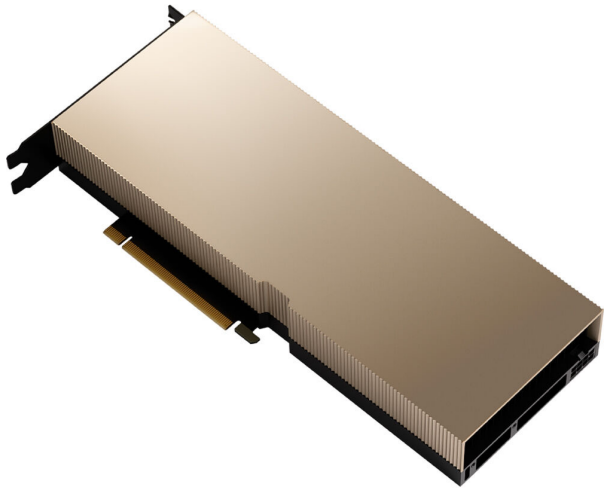
Installation

Requirements

- A CUDA-capable GPU
- CUDA version >= 8.0
- NetCDF
  - Parallel NetCDF
- OpenMPI version >= 2.1.2
- CMake

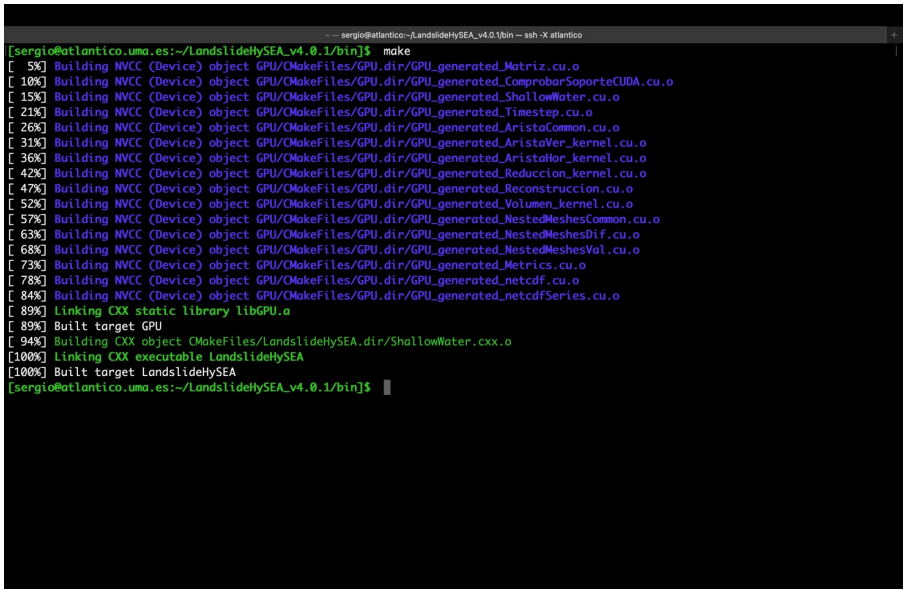


Compilation

- Modify accordingly the file makefile.
- make (An executable file L-HySEA.exe should be created).

OR

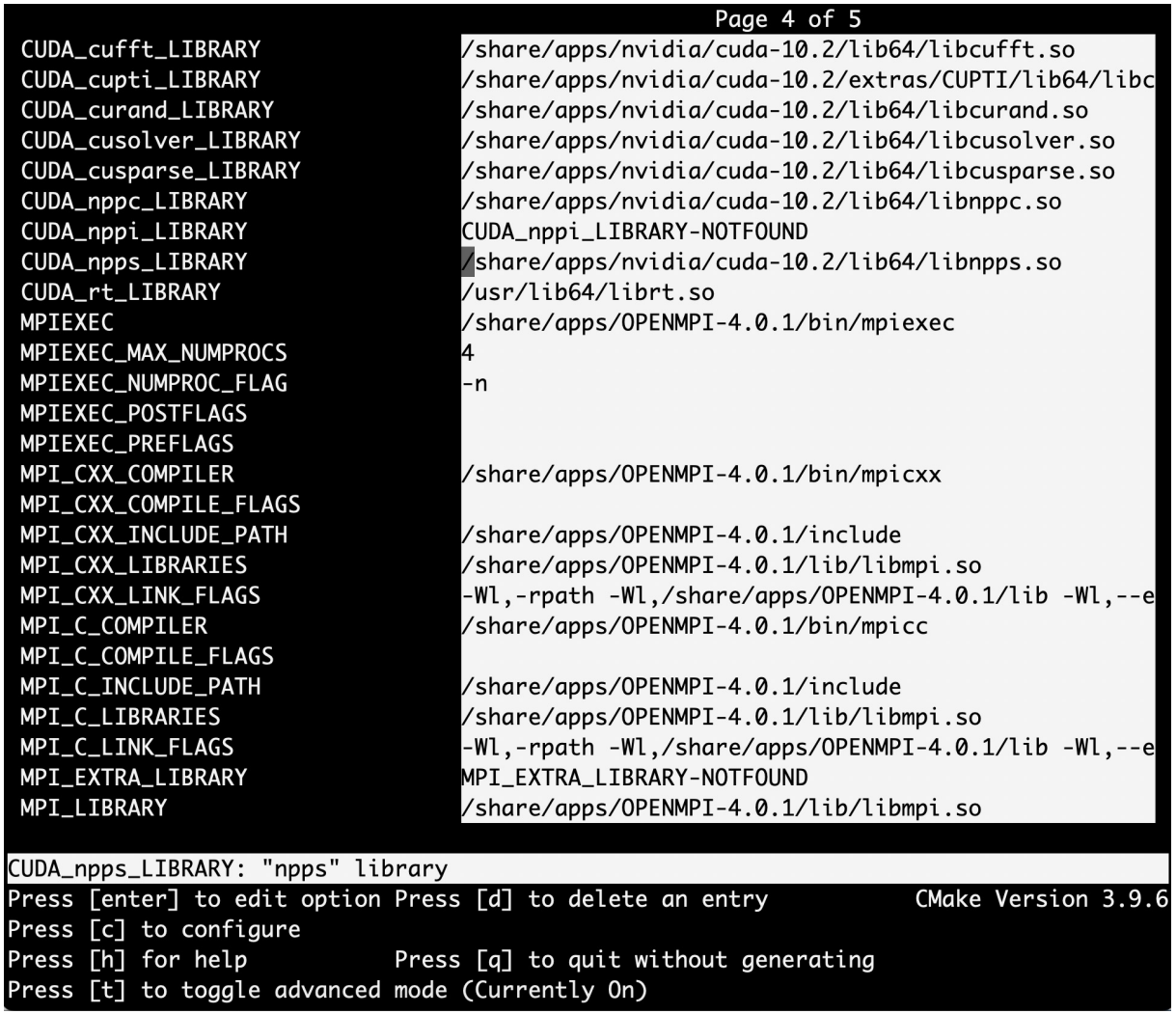
- cmake src //which creates a makefile
- make



Makefile

```
.SUFFIXES:      .cu .c

export UNAME = $(shell uname -m)

# MODIFY ONLY HERE
export ROOT             = /share/apps/nvidia/cuda-8.0
export OPENMPI          = /share/apps/OPENMPI-2.1.2

# Compilers and Libraries
export NVCC     = $(ROOT)/bin/nvcc
export CXX              = $(OPENMPI)/bin/mpic++
export CXX_LIB                  = $(OPENMPI)/lib
export XX_INCLUDE              = $(OPENMPI)/include

export CXXFLAGS         = -O3 -DNDEBUG
export CXXINC           = -I./ -I$(ROOT)/include -I$(CXX_INCLUDE)
export CXXLIBS          =-L$(CXX_LIB) -L./GPU -l2D_AVALANCHAS_MGPU_NETCDF -L$(ROOT)/lib
64 -lcudart -lpnetcdf

OBJSC   := cond_ini.o

%.o:    %.cxx
        $(CXX) $(CXXINC) -c $*.cxx

all: L-HySEA.exe

L-HySEA.exe: $(OBJSC)
        $(CXX) $(CXXFLAGS) -o $@ $(CXXLIBS) $(CXXINC)

.PHONY: clean
clean:
        rm -rf *.o *~ *.exe
```

CMake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CUDA_cufft_LIBRARY /share/apps/nvidia/cuda-10.2/lib64/libcufft.so
CUDA_cupti_LIBRARY /share/apps/nvidia/cuda-10.2/extras/CUPTI/lib64/libc
CUDA_curand_LIBRARY /share/apps/nvidia/cuda-10.2/lib64/libcurand.so
CUDA_cusolver_LIBRARY /share/apps/nvidia/cuda-10.2/lib64/libcusolver.so
CUDA_cusparse_LIBRARY /share/apps/nvidia/cuda-10.2/lib64/libcusparse.so
CUDA_nppc_LIBRARY /share/apps/nvidia/cuda-10.2/lib64/libnppc.so
CUDA_nppi_LIBRARY CUDA_nppi_LIBRARY-NOTFOUND
CUDA_npps_LIBRARY /share/apps/nvidia/cuda-10.2/lib64/libnpps.so
CUDA_rt_LIBRARY /usr/lib64/librt.so
MPIEXEC /share/apps/OPENMPI-4.0.1/bin/mpiexec
MPIEXEC_MAX_NUMPROCS 4
MPIEXEC_NUMPROC_FLAG -n
MPIEXEC_POSTFLAGS
MPIEXEC_PREFLAGS
MPI_CXX_COMPILER /share/apps/OPENMPI-4.0.1/bin/mpicxx
MPI_CXX_COMPILE_FLAGS
MPI_CXX_INCLUDE_PATH /share/apps/OPENMPI-4.0.1/include
MPI_CXX_LIBRARIES /share/apps/OPENMPI-4.0.1/lib/libmpi.so
MPI_CXX_LINK_FLAGS -Wl,-rpath -Wl,/share/apps/OPENMPI-4.0.1/lib -Wl,--e
MPI_C_COMPILER /share/apps/OPENMPI-4.0.1/bin/mpicc
MPI_C_COMPILE_FLAGS
MPI_C_INCLUDE_PATH /share/apps/OPENMPI-4.0.1/include
MPI_C_LIBRARIES /share/apps/OPENMPI-4.0.1/lib/libmpi.so
MPI_C_LINK_FLAGS -Wl,-rpath -Wl,/share/apps/OPENMPI-4.0.1/lib -Wl,--e
MPI_EXTRA_LIBRARY MPI_EXTRA_LIBRARY-NOTFOUND
MPI_LIBRARY /share/apps/OPENMPI-4.0.1/lib/libmpi.so
CUDA_npps_LIBRARY: "npps" library
Press [enter] to edit option Press [d] to delete an entry CMake Version 3.9.6
Press [c] to configure
Press [h] for help Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently On)

Parameters file

It is a text file with the parameters to be used by the code.

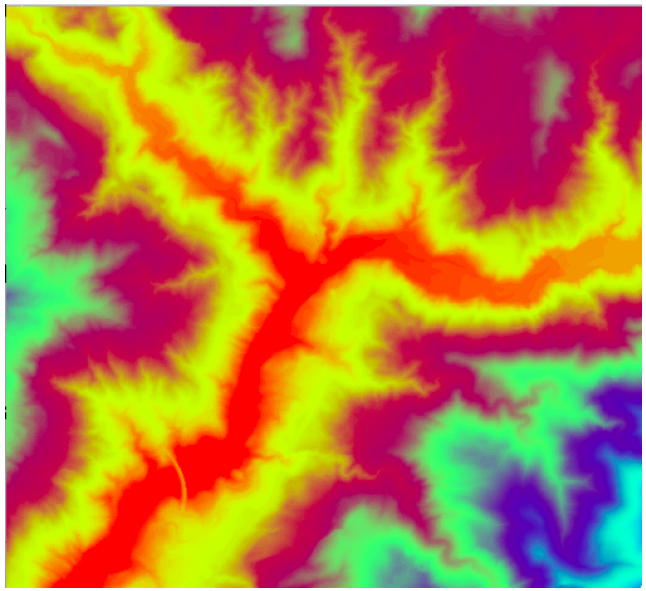
```
Rules                # Experiment name
1                    # Initialization type (0: from functions; 1: from file)
rules_bat.grd        # Non-erodible bathymetry
rules_ini.grd        # Bathymetry (Non-erodible + sediment layer)
rules                # NetCDF file prefix for level 0
1 1 1 1 0 0 0 0 0 1 # Variables saved (eta, maximum_eta, velocities, maximum_velocities,
modulus_of_velocity, maximum_modulus_of_velocity, maximum_modulus_of_mass_flow, momentum_
flux, maximum_momentum_flux, arrival_times) (1: save, 0: do not save)
1                    # Number of nested meshes
1                    # Upper border condition (1: open, -1: wall)
1                    # Lower border condition
1                    # Left border condition
1                    # Right border condition
101.0                # Simulation time (sec)
15                   # Saving time of NetCDF files (sec) (-1: do not save)
0                    # Read points from file (0: no, 1: yes). Used for time series
0.8                  # CFL
5e-3                 # Epsilon h (m)
0.4                  # Ratio of densities of the layers
10                   # Coulomb angle (degrees)
1e-4                 # Friction between layers
5e-2                 # Granular material-bottom friction (Manning coefficient)
4e-1                 # Water-bottom friction (Manning coefficient)
12                   # Maximum allowed velocity of water
60                   # Maximum allowed velocity of granular material
1000                 # L (typical length)
100                  # H (typical height)
0.03                 # Threshold for arrival times (m)
```

```
Rules                # Experiment name
1                    # Initialization type (0: from functions; 1: from file)
rules_bat.grd        # Non-erodible bathymetry
rules_ini.grd        # Bathymetry (Non-erodible + sediment layer)
```

Inputs

The **Non-erodible bathymetry** (.grd): For each volume, are stored, ordered by rows and starting from the upper left corner. This is non-erodible bathymetry (without the sediment layer).

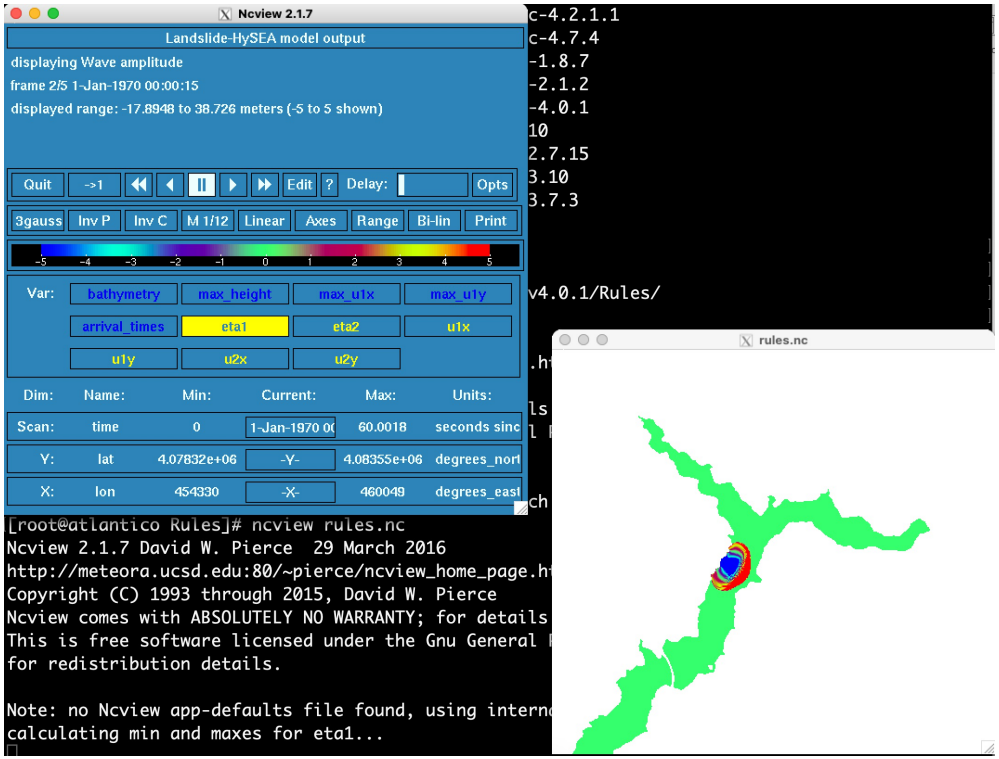
The **Bathymetry** (.grd): The file with the bathymetry. Non-erodible bathymetry and the sediment layer.



```
rules                # NetCDF file prefix for level 0
1 1 1 1 0 0 0 0 0 1 # Variables saved (eta, maximum_eta, velocities, maximum_velocities, modulus_of_velocity,
maximum_modulus_of_velocity, maximum_modulus_of_mass_flow, momentum_flux, maximum_momentum_flux, arrival_times
) (1: save, 0: do not save)
```

Output

After running the experiment, a netCDF file, *rules.nc*, will be created with the selected variables saved.



```
1                   # Number of nested meshes
1                   # Upper border condition (1: open, -1: wall)
1                   # Lower border condition
1                   # Left border condition
1                   # Right border condition
101.0               # Simulation time (sec)
15                  # Saving time of NetCDF files (sec) (-1: do not save)
```

- **Number of nested meshes**: 1 if only one level is used.
- **Boundary conditions**: Wall type is normally used to simulate laboratory experiments. It refers to the boundaries of the domain.
- **Simulation time:** Total time for the experiment.
- **Saving time:** Time between saves, in the netCDF resulting file.

```
0                    # Read points from file (0: no, 1: yes). Used for time series
```

Time series

```
1                    # Read points from file (0: no, 1: yes). Used for time series
virtual_buoys.txt    # File with points
1.0                  # Saving time of time series (sec)
```

```
6
4100.0 4300.0
3600.0 3800.0
3200.0 2700.0
2900.0 1600.0
2300.0 600.0
2900.0 140.0
```

Number of points

Virtual buoys (x, y)

```
0.8                     # CFL
5e-3                    # Epsilon h (m)
0.4                     # Ratio of densities of the layers
10                      # Coulomb angle (degrees)
```

- **CFL**: Stability condition
- **Epsilon h**: To consider a cell as dry or wet.
- **Ratio of densities**: Water density over sediment density.
- **Coulomb angle**: Angle of repose. Angle at which the sediment does not move.

```
1e-4                    # Friction between layers
5e-2                    # Granular material-bottom friction (Manning coefficient)
4e-1                    # Water-bottom friction (Manning coefficient)
12                      # Maximum allowed velocity of water
60                      # Maximum allowed velocity of granular material
1000                    # L (typical length)
100                     # H (typical height)
0.03                    # Threshold for arrival times (m)
```

Execution

Finally, for the execution, we will use the command

./L-HySEA.exe rules.txt

If a queuing system is used in the cluster, the necessary script must be configured.

```
Iteration 15124, deltaT = 6.811621e-03 sec, Time = 100.803 sec
Iteration 15125, deltaT = 6.811621e-03 sec, Time = 100.81 sec
Iteration 15126, deltaT = 6.811621e-03 sec, Time = 100.817 sec
Iteration 15127, deltaT = 6.811621e-03 sec, Time = 100.824 sec
Iteration 15128, deltaT = 6.811621e-03 sec, Time = 100.831 sec
Iteration 15129, deltaT = 6.811621e-03 sec, Time = 100.837 sec
Iteration 15130, deltaT = 6.811621e-03 sec, Time = 100.844 sec
Iteration 15131, deltaT = 6.811621e-03 sec, Time = 100.851 sec
Iteration 15132, deltaT = 6.811621e-03 sec, Time = 100.858 sec
Iteration 15133, deltaT = 6.811621e-03 sec, Time = 100.865 sec
Iteration 15134, deltaT = 6.811621e-03 sec, Time = 100.871 sec
Iteration 15135, deltaT = 6.811621e-03 sec, Time = 100.878 sec
Iteration 15136, deltaT = 6.811621e-03 sec, Time = 100.885 sec
Iteration 15137, deltaT = 6.811621e-03 sec, Time = 100.892 sec
Iteration 15138, deltaT = 6.811621e-03 sec, Time = 100.899 sec
Iteration 15139, deltaT = 6.811621e-03 sec, Time = 100.906 sec
Iteration 15140, deltaT = 6.811621e-03 sec, Time = 100.912 sec
Iteration 15141, deltaT = 6.811621e-03 sec, Time = 100.919 sec
Iteration 15142, deltaT = 6.811621e-03 sec, Time = 100.926 sec
Iteration 15143, deltaT = 6.811621e-03 sec, Time = 100.933 sec
Iteration 15144, deltaT = 6.811621e-03 sec, Time = 100.94 sec
Iteration 15145, deltaT = 6.811621e-03 sec, Time = 100.946 sec
Iteration 15146, deltaT = 6.811621e-03 sec, Time = 100.953 sec
Iteration 15147, deltaT = 6.811621e-03 sec, Time = 100.96 sec
Iteration 15148, deltaT = 6.811621e-03 sec, Time = 100.967 sec
Iteration 15149, deltaT = 6.811621e-03 sec, Time = 100.974 sec
Iteration 15150, deltaT = 6.811621e-03 sec, Time = 100.98 sec
Iteration 15151, deltaT = 6.811621e-03 sec, Time = 100.987 sec
Iteration 15152, deltaT = 6.811621e-03 sec, Time = 100.994 sec
Iteration 15153, deltaT = 6.811621e-03 sec, Time = 101.001 sec

Runtime: 1.084365e+03 sec
[sergio@compute-1-0.local:~/LandslideHySEA_v4.0.1/Rules]$
```

Thank you for your attention!

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