WRF step-by-step

A step-by-step guide for running WRF on Stallo

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Lecture topics

1 Running WRF on Stallo

1.1 Terrestrial input data

Terrestrial data: Downloaded from the National Centre for Atmospheric Reseach (NCAR): `http://www2.mmm.ucar.edu/wrf/users/download/get_sources_wps_geog.html`

The complete terrestrial dataset is large and it might be a good idea not to download, but to create a link to already existing terrestrial files on Stallo.

1.2 Meteorological input data I

Meteorological boundary conditions: In this case, ERA-Interim is used. Can also use f.ex. on-site measurements or remote sensing dataproducts. The ERA-Interim data used in this case has a temporal and spatial resolution of 6 hours and approximately 80 km at 60 vertical levels. Procedure for downloading ERA-Interim data from the Research Data Archive. The user has to log in and register for data access. The meteorological boudary conditions consists of both pressure files and surface variables.

1. Go to `http://rda.ucar.edu/datasets/ds627.0/`
   - Click data access and scroll to *ERA Interim atmospheric model analysis interpolated to pressure levels*. Click *Web File Listing*.
   - Select *Faceted Browse*.
2.
   - Select start and end date and time and select *continue*.
   - Choose *on* for *range selection*.
   - Select all `ei.oper...`-variables
   - Click on *create a unix* file using `Wget`.

   The script will open in a new window.

1.2 Meteorological input data II

3. Log in to Stallo, make a directory for the met. input data and move into that directory

```
ssh -X <username>@stallo.uit.no
mkdir <directory name>
cd <directory name>
```

4. Create a empty file

```
vi MetDownload_Pressurelevels.sh
```

and copy-paste the generated unix-script in the empty file.

5. Change the password to the one used at UCAR (line 19). Write the changes to the file and quit, hitting `esc`, then `:wq` (write and quit)
6. Make it executable

```
chmod 777 MetDownload_Pressurelevels.sh
```

1.2 Meteorological input data III

7. Log into a computational node and run the file

```
srun --nodes=1 --ntasks-per-node=1 --time=01:00:00 --pty
    bash -i
./MetDownload_Pressurelevels.sh
```

Note: If the download does not work, try changing `Wget` to `cURL`.

Re-run step 1-7, but select *ERA Interim atmospheric model analysis for surface*. After running the file, all meteorological input files should be created and located in the same directory.

1.3 WPS I

1. Edit `namelist.wps`. Remember to check:
   - Number of domains: `max_dom`
   - Start and end date
   - Check size of biggest domain: `dx` and `dy`
   - Path to terrestrial data: `geog_data_path`
2. Edit `namelist.input` (in the WRFV3 directory). Remember to check:
   - Duration of the simulation, i.e. number of days, hours and minutes
   - Start and end date
   - How many timesteps one outfile should contain: `frames_per_outfile`
   - Timestep (remember the time step contraints)
   - Check size of both/all domains: `dx` and `dy`
3. Move to the jobscript directory and edit the WPS jobscript. Remember to change the path to the meteorological input data!

1.3 WPS II

```
#!/bin/bash
#:-----------------------------------------------------------------
# Jobscript for running the WRF-preprocessing (WPS) system
# plus the real.exe program.
#
# Last edite: 25.April.2018, Torgeir
#:-----------------------------------------------------------------



#:---- Estimated resources ----
#SBATCH --job-name=WRFjobscript_testcase
# Stallo account to charge
#SBATCH -A uit-hin-002
# Computation resources; nodes and cores
#SBATCH --nodes=1
#SBATCH --ntasks-per-node=8
# Runtime: d-hh:mm:ss (set a bit higher than expected)
```

1.3 WPS III

```
#SBATCH --time 0-01:00:00

# Give priority to this job (requires shorter jobs than 4h, and
    is used for testing scripts)
# SBATCH --qos=devel

# Delete all loaded modules (for avoiding conflicts with
    previously loaded modules)
module purge

#:---- WPS ----
# Move into the WPS directory and load modules
cd /global/work/blasterdalen/WindCoE/WPS/
# Load WPS modules
module load WPS/3.9.1-intel-2017a-dmpar

# Run geogrid
geogrid.exe
```

1.3 WPS IV

```
# Make a soft-link to the data secription file (V-table)
ln -sf ungrib/Variable_Tables/Vtable.ERA-interim.pl Vtable
# Make a link to the GRIB data (input meteorological files)
./link_grib.csh
    /global/work/blasterdalen/WindCoE/MetInput/April19/ei.oper*
# Run ungrib
ungrib.exe

# Run metgrid
metgrid.exe

#:---- WRF ----
# Move to the WRFV3 directory and load WRF model
cd /global/work/blasterdalen/WindCoE/WRFV3
module load WRF/3.9.1-intel-2017a-dmpar

# Make soft-links to the met.-files from the WPS directory
```

1.3 WPS V

```
ln -sf ../WPS/met_em.d0* .

# Run real
mpirun -np $SLURM_NTASKS real.exe

exit 0
```

Run the jobscript using the command

```
sbatch JobscriptWPS.sh
```

1.4 WRF I

Edit the WRF jobscript. Make sure the walltime is set a bit higher than expected. Then submit the jobscript.

```
#!/bin/bash
#:-----------------------------------------------------------------
# Jobscript for running WRF-simulations
#
# Last edite: 25.April.2018, Torgeir
#:-----------------------------------------------------------------

#:---- Estimated resources ----
#SBATCH --job-name=WRF-simulation
# Stallo account to charge
#SBATCH -A uit-hin-002
# Computation resources; nodes and cores
#SBATCH --nodes=3
#SBATCH --ntasks-per-node=14
# Runtime: d-hh:mm:ss (set a bit higher than expected)
#SBATCH --time 0-03:00:00
```

1.4 WRF II

```
# Give priority to this job (requires shorter jobs than 4h, and
    is used for testing scripts)
# SBATCH --qos=devel

# Delete all loaded modules (for avoiding conflicts with
    previously loaded modules)
module purge

# Move to the WRFV3 directory and load WRF model
cd /global/work/blasterdalen/WindCoE/WRFV3
module load WRF/3.9.1-intel-2017a-dmpar

# Run WRF
mpirun -np $SLURM_NTASKS wrf.exe

exit 0
```

2. Monitoring jobs

One can check the job status by entering

```
squeue -u <username>
```

If the job is running, one will typically get something like

```
JOBID PARTITION   NAME     USER ST       TIME  NODES NODELIST(REASON)
876314    normal WRFjobsc blasterd R       1:43      3 c52-1,c53-[7-8]
```

If necessary, a job can be deleted/removed by entering

```
scancel <jobid>
```

3. Inspecting output files I

Check if the job went as planned by investigating the log file from Stallo

```
less slurm-<job id>.out
```

The log file is located in the same directory as the jobscript (if not declared otherwise in the jobscript). The log file will contain information on running the executables and if they were successful or not, e.g. a part of the WPS log file will contain

```
%!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
%!  Successful completion of metgrid.  !
%!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

NetCDF files can be examined using

```
module load netCDF
ncdump -h met_em.d02.2008-03-04_12:00:00.nc
```

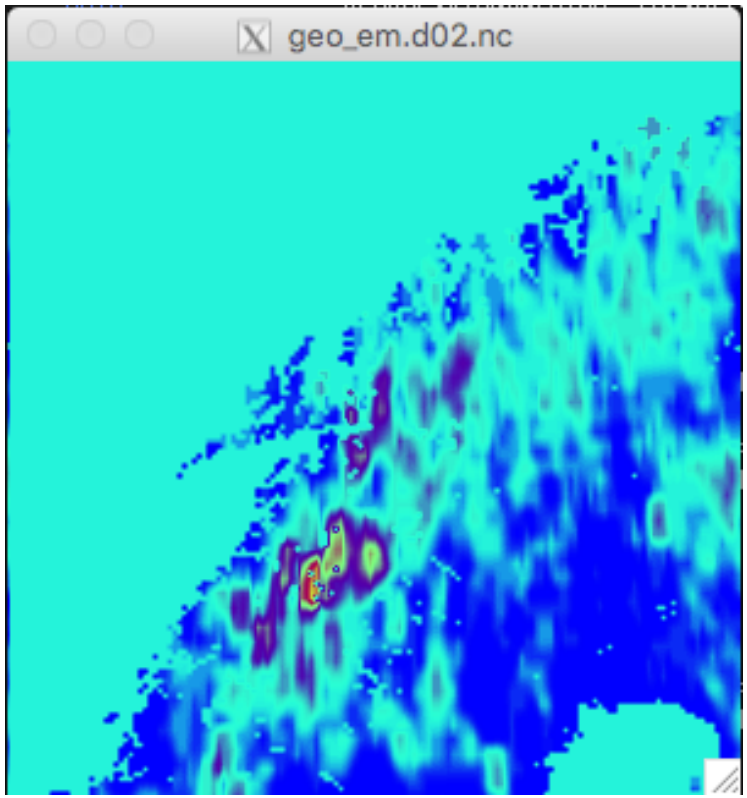
3. Inspecting output files II

Inspect files graphically using the `ncview` utility. This requires a X-window. For Unix, `XQuarts` is a good alternative. For Windows, `Xming`

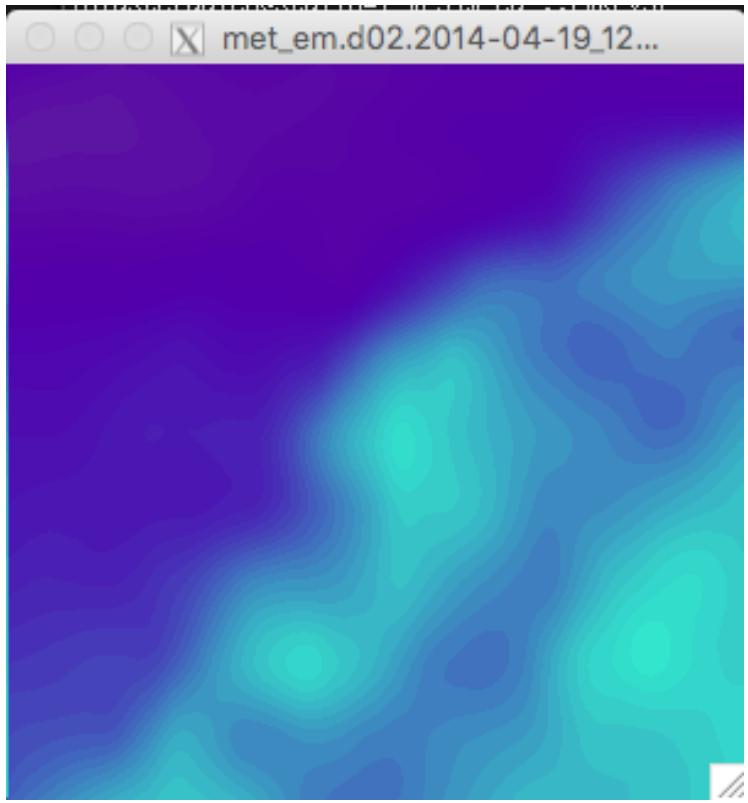
```
module load ncview/2.1.7-intel-2016b
ncview <filename>
```

Example: Plotted below is a visualization of the simulation output from `geogrid.exe`, `metgrid.exe`, `real.exe` and `wrf.exe` for domain 2.

3. Inspecting output files III

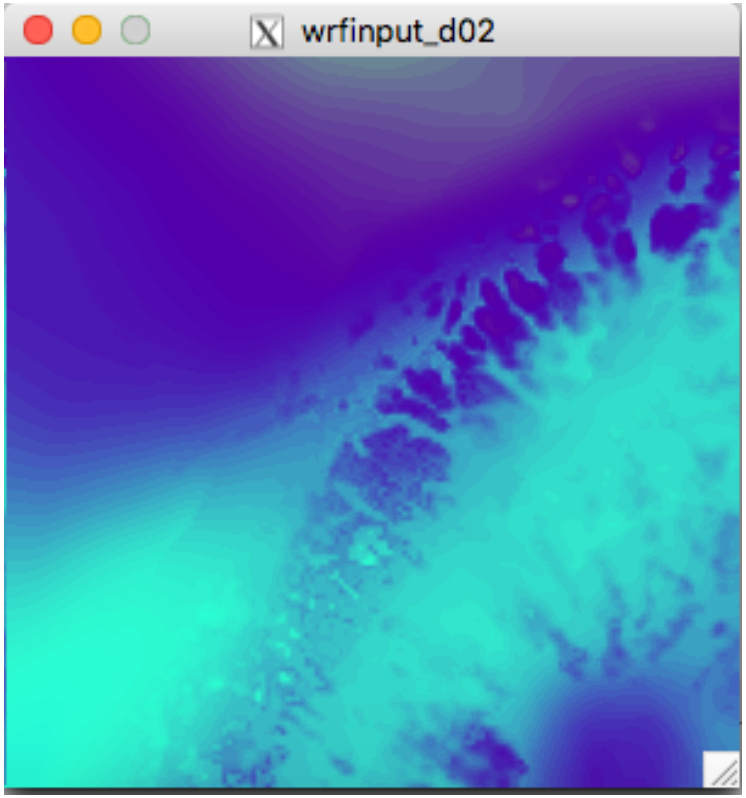


(a) Outfile from `geogrid.exe`

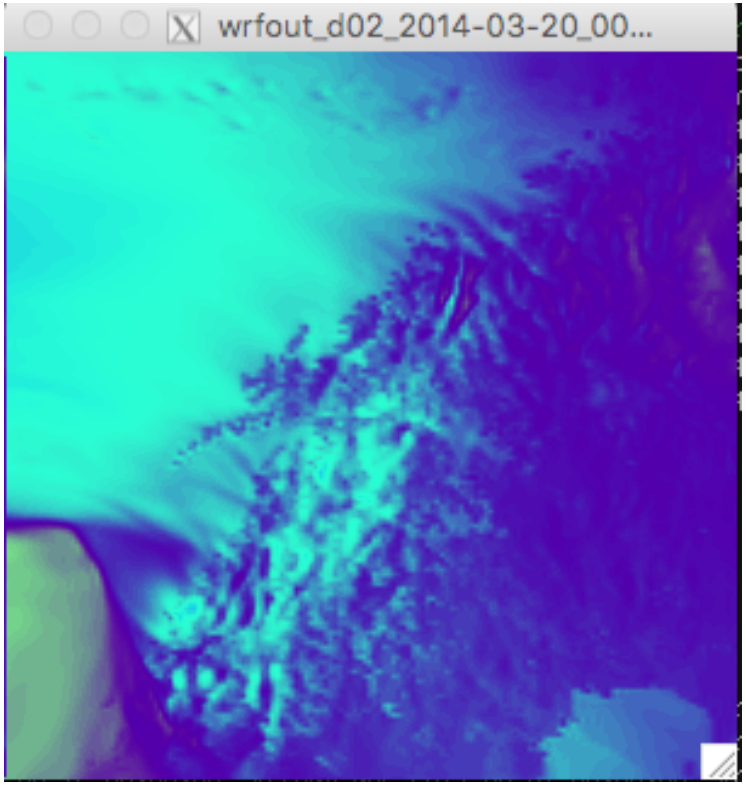


(b) Outfile from `metgrid.exe`

3. Inspecting output files IV



(c) Outfile from `real.exe`



(d) Outfile from `wrf.exe`

4. Summary of (some) WRF configurations I

WRF model	WRF V3.9.1
WRF dynamical solver	ARW
Domains	2 telescoping nests
2-way nesting	D01: False D02: True
Domain grid spacing*	D01: dx = 15000 m, dy = 15000 m D02: dx = 5000 m, dy = 5000 m
Map projection	Polar stereographic
Time step	80 seconds[1]
Frames per outfile	144 (for both domains)
Adaptive time step	False
Integration scheme	RK3
Advection scheme	5th order advection
Temporal resolution of out-files	10 minutes intervals

4. Summary of (some) WRF configurations II

Number of vertical levels*	51
Microphysics	WSM5
SL scheme	Monin Obhukhov
Land-surface model	Noah Land-Surface model
PBL scheme	MYJ, TKE scheme
Cumulus	Betts-Miller-Janic scheme
Number of soil layers	4
Longwave radiation	New Goddard
Shortwave radiation	New Goddard
Urban physics	Multi-layer BEP scheme (works only with the MYJ and BouLac PBL schemes)
Grid nudging (Newtonian relaxation)	No grid nudging
Eddy coefficient option	Horizontal Smagorinsky 1st order closure (recommended for real-data cases)

4. Summary of (some) WRF configurations III

Turbulence and mixing	2nd order diffusion term (recommended for real-data cases)
Base-state sea level temperature	290 K
Vertical damping	On

[1] Small time stepss due to high speed icing events

5. Useful Unix/Linux commands

`cd`	Change directory
`chmod 777 <filename>`	Give permission to read, write and execute file/folder
`cost`	View account and core hours
`du -sh *`	List of elements in folder and how large they are
`ll, ls`	List of elements in directory
`ln -sf <path/filename>`	Create soft-link
`mkdir`	Make directory
`module avail`	Check of module is available in the Stallo system
`mv`	Move file
`ncdump -h <filename>`	View specifications of NetCDF-file
`pwd`	Present work directory
`rm, rmdir`	Remove file or directory, respectively
`scp`	Copy/download from remote to local host
`squeue -u <username>`	See status of the submitted job(s)

6. Useful links

- WRF user 's guide:
  `http://www2.mmm.ucar.edu/wrf/users/docs/user_guide_V3/contents.html`
- ARW technical note: (pdf-download)
  `http://opensky.ucar.edu/islandora/object/technotes:500`
- A link to the lecture notes and some uploaded files (like jobscripts and some post-processing scripts) can be viewed and downloaded from my GitHub-account at
  `https://github.com/torgeirtb?tab=repositories`