WRF step-by-step

Testcase at Nygårdsfjellet

Torgeir Blæsterdalen

Department of Industrial Engineering, UiT-The Arctic University of Norway

March 22, 2018

Lecture topics

1 Test-case 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 and onto a computational node

```
ssh -X <username>@stallo.uit.no
srun --nodes=1 --ntasks-per-node=1 --time=02:00:00
    --pty bash -i
```

4. Make a directory for the input met data and move into the directory

```
mkdir <directory name>
cd <directory name>
```

5. Create a empty file

```
vi PressureDownload.sh
```

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

6. 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)

1.2 Meteorological input data III

7. Make it executable

```
chmod 777 PressureDownload.sh
```

8. Run the file

```
./PressureDownload.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 in the same directory.

1.3 WPS I

Log in to Stallo.

1. Move into the `WPS` folder and load the module required to run WPS

```
module load WPS/3.9.1-intel-2017a-dmpar
```

2. Edit the wps namelist

```
vi namelist.wps
```

3. Run geogrid to create static data for the domain

```
geogrid.exe
```

The geogrid should produce the message

1.3 WPS II

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!  Successful completion of geogrid.                  !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

This should create the static file `geo_em.d01.nc` (`geo_em.d02.nc` for two domains, and similar for three).

4. Ungrib the data
   - Make a soft-link to the data description file (Vtable)

```
ln -sf ungrib/Variable_Tables/Vtable.ERA-interim.pl
    Vtable
```

   - Make a link to the GRIB data (met-files)

```
./link_grib.csh /<path to met input>/ei.oper*
```

1.3 WPS III

If the links are working, they should appear blue. Contrary red, if the files are not found.

5. Ungrib the meteorological data

```
ungrib.exe
```

This run should end with

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!  Successful completion of ungrib.      !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

6. Run metgrid

```
metgrid.exe
```

As the other WPS executables, this should end with

1.3 WPS IV

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

This step concludes the preprocessing.

1.4 WRF

Move to the WRF directory.

1. Create a softlink to the met.-files created in the metgrid-step

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

   The `met_em.d01*` - files will appear in the directory as links to the met files. Check that the links appear in a cyan-ish color, this indicates a functioning link. Non-functioning links appear red.

2. Edit/create namelist.input

```
vi namelist.input
```

Because the WRF-step requires parallellization, this is best to do in a jobscript, i.e. not on a interactive node.

2. Streamlining steps into a jobscript I

```
#!/bin/bash
#:-------------------------------------------------------------
# Jobscript for running WRF-simulations in the WRF_narvik folder
#
# Last edite: 22.March.2018, Torgeir
#:-------------------------------------------------------------

#:---- Estimated resources ----
#SBATCH --job-name=WRFjobscript_testcase
# Stallo account to charge
#SBATCH -A nn9426k
# Computation resources; nodes and cores
#SBATCH --nodes=3
#SBATCH --ntasks-per-node=20
# Runtime: d-hh:mm:ss (set a bit higher than expected)
#SBATCH --time 0-01:00:00
```

2. Streamlining steps into a jobscript II

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

#:---- WPS ----
# Move into the WPS test-directory and load modules
cd WPS
module load WPS/3.9.1-intel-2017a-dmpar

# Run geogrid
geogrid.exe

# 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/WRF_narvik/MetInput/ei.oper*
```

2. Streamlining steps into a jobscript III

```
# Run ungrib
ungrib.exe

# Run metgrid
metgrid.exe

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

# Make soft-links to the met.-files from the WPS directory
ln -sf ../WPS/met_em.d0* .

# Run real on paralell processes
mpirun -np real.exe
```

2. Streamlining steps into a jobscript IV

```
# Run wrf on all of the requested cores
# mpirun -np wrf.exe

exit 0
```

3. Inspecting output files

NetCDF files can be examined using

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

Or 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 met_em.d02.2008-03-04_12:00:00.nc
```

4. Summary of WRF configurations I

WRF model	WRF V3.9.1
WRF dynamical solver	ARW
Domains	3*, telescoping nests
2-way nesting	D01: False D02: True D03: True
Domain grid spacing*	D01: dx = 18000 m, dy = 18000 m D02: dx = 6000 m, dy = 6000 m D03: dx = 2000 m, dy = 2000 m
Map projection	Polar stereographic
Time step	90 seconds*
Adaptive time step	False
Integration scheme	RK3
Advection scheme	5th order advection

4. Summary of WRF configurations II

Temporal resolution of out-files	10 minutes intervals
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 th MYJ and BouLac PBL schemes)
Grid nudging (Newtonian relaxation)	No grid nudging

4. Summary of WRF configurations III

Eddy coefficient option	Horizontal Smagorinsky 1st order closure (recommended for real-data cases)
Turbulence and mixing	2nd order diffusion term (recommended for real-data cases)
Base-state sea level temperature	290 K

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_V3.8/contents.html`
- ARW technical note: (pdf-download)
  `http://opensky.ucar.edu/islandora/object/technotes:500`