"Storm of the Century" (SOC) experiment (Experiment #3)
ATM 419/563 – Fovell – Fall 2024

Workspace
• Create a directory called `SOC`.
• Copy **`$LAB/SOC/SETUP.TAR`** into that directory and unpack. TAR file contains: `{make_all_links.sh submit_real submit_wrf submit_ungrib submit_metgrid submit_geogrid namelist.input namelist.wps nesis.ncl ncl_slp_narr.ncl ncl_slp_nnrp.ncl analyze.sh read_wrfinput.py max.csh plot_WRF_domain.ipynb plot_WRF_terrain.ipynb plot_WRF_SOC.ipynb doncl.sh}`
• Execute `make_all_links.sh`

Domain setup – `namelist.wps` file **is pre-configured** for:
• 1 domain (so only first column matters)
• 03-12-1993 at 12Z to 03-15-1993 at 00Z (2.5 days)
• interval_seconds 21600
• Domain is 85 west-east x 56 south-north points, 90 km grid spacing
• Lambert projection with reference latitude: 39.5˚N
• True latitudes: 30 and 60˚N [*now* we're spreading them apart]
• Reference and standard longitudes: 100˚W [i.e., -100.0]

Create model grid
• **Use `plot_WRF_domain.ipynb` to inspect domain [see slide 10]**
• **Run `geogrid.exe`**
• **Use `plot_WRF_terrain.ipynb` to inspect terrain and map factors**
[alter plt.Normalize to enhance plot]

Initialization data source *[also see WRF REAL CHECKLIST for guidance]*
• NNRP initialization data: `$LAB/DATA/NNRP_199303/*`
• Make sure you are using **`Vtable.NNRP`** as your Vtable
• If you ever need new or replacement Vtables, get them from `$LAB/SOFTWARE/VTABLES or $LAB/SCRIPTS`

WPS and WRF real.exe for initial run RUN01
• Link to NNRP files
• In the **&ungrib** and **&metgrid** sections, note output files are called '**NNRP**'

prefix='NNRP'
fg_name='NNRP'

• Do `srun -p burst-daes ungrib.exe` and `srun -p burst-daes metgrid.exe`, as usual.
[you can submit the batch scripts, but these run **very quickly**, especially ungrib, because the resolution of NNRP is so very low]

• Check on `num_metgrid_levels`. *Note the number of soil levels!*
• The `namelist.input` file **is pre-configured** for RUN01. Highlights:

In &time_control section
• all_ic_times = .true., {new addition to our namelist}
• run_days = 2 and run_hours = 12
• interval_seconds = 21600
• history_interval = 360 {6-hourly outputs}

In &domains section
• time_step = 240 sec
• max_dom = 1
• 51 vertical levels
• p_top_requested = 1000 (10 mb model top)
• note num_metgrid_levels and num_metgrid_soil_levels

In &physics section
• mp_physics = 3
• LW (ra_lw_physics) and SW (ra_sw_physics) radiation option 1,
• 10 min time step (radt)
• MYJ PBL and surface layer (bl_pbl_physics= sf_sfclay_physics= 2)
• Noah LSM (sf_surface_physics = 2) with num_soil_layers=4
• Cumulus option 3 [cu_physics] with 0 min cudt time step

In &dynamics section
• diff_6th_opt = 2
• diff_6th_factor = 0.12

• This is (intentionally) not the "best" physics configuration
• The `namelist.input` file has a new option: **`all_ic_times = .true.`**.
See PPT slide **13**.
• The `namelist.input` has two new sections: **`&fdda`** and **`&stoch`**. See PPT slides **29-30, 38, 44**.

• Submit the `submit_real` script or `srun -p burst-daes ./real.exe`

• **This will create 11 files called wrfinput_d01***, one for each 6-hourly period within the simulation time window (see slide 13). All times are available owing to the **`all_ic_times = .true.`** switch.

• When the real program has completed, concatenate these 11 files with:

```
ncrcat wrfinput_d01* SOC_NNRP_reanalysis.nc
```

WRF run and analysis of RUN01

• Submit the `submit_wrf` script. Should take less than 5 min. This makes your run RUN01 output. Six-hourly output is stored into a single file: `wrfout_d01_1993-03-12_12:00:00`

When WRF has finished

• Launch ARCC Jupyterlab – batch OK, minimal resources suffice.
• Launch `plot_WRF_SOC.ipynb`
• Cell #3 reads in your wrfout file and the SOC_NNRP_reanalysis.nc file
→ no changes to this cell needed yet
• See PPT slide 16 for NNRP SLP field at 18Z on March and slide 17 for WRF's rendition. See also slides 18-20.

• The script `analyze.sh` calls two NCL scripts and computes NESIS and sea-level pressure root-mean-square error (RMSE SLP) relative to the NNRP reanalysis. It requires a WRF output file called `wrfout_d01_1993-03-12_12:00:00`. Execute the script below, and in the output note the NESIS and RMSE SLP

```
$ source doncl.sh      [not sh doncl.sh]
$ analyze.sh
```

• If it works properly, `analyze.sh` writes out a NESIS value and an RMSE SLP value to the screen. For RUN01: **RMSE SLP = 2.02 mb per gridpoint.** See PPT slide 23.

• Make a folder called RUN01. Move your wrfout file into it.

FDDA (grid nudging: regular and spectral versions) – *RUN02, RUN03*

• Edit namelist.input and set **`grid_fdda = 1, 0`**. This turns on regular grid nudging in D1 (the only domain).

• Redo `submit_real` (**NECESSARY!!**), check output. In addition to `wrfinput_d01`, this creates a file called **`wrffdda_d01`**. Then `submit_wrf`.

• Run analyze.sh after WRF completes. **RMSE SLP = 1.74 mb per gridpoint.**

• Create folder RUN02 and move your wrfout file into it

• In `plot_WRF_SOC.ipynb`, modify Cell #3 for
  (a) location of first wrfout file (RUN01/)
  (b) location of your second wrfout file (RUN02/)
  (c) name of your second wrfout file, and
  (d) name of this simulation ("RUN02")
  … and re-execute

• Slides 33-35 show RUN01 and RUN02's SLP fields at t=6 superimposed and the difference field

• **OPTIONAL: try grid_fdda = 2, 0**, activating *spectral* grid nudging. Do real and WRF and `analyze.sh`. Call it **RUN03**. See slides 35-37.

SKEBS (stochastic backscatter perturbation scheme) and EXP #3

• SKEBS infuses random noise during the run, controlled in the **`&stoch`** namelist section, and is activated by setting **`skebs = 1`**. Boundary conditions ALSO perturbed if **`perturb_bdy = 1`**.

• **WARNING: Even if `skebs = 0`, perturbations are still active if `perturb_bdy` = 1. So, once `&stoch` is added, turning off perturbations requires setting `skebs = 0` AND `perturb_bdy = 0`.**

- **Experiment #3**: redo RUN01 with SKEBS active
  - (1) Make sure `grid_fdda = 0`. **FDDA OFF.**
  - (2) In the **&stoch** section, turn SKEBS [`skebs = 1`] AND perturb boundaries [`perturb_bdy = 1`] ON.
  - (3) In the **&stoch** section, set **`nens`** to one of your assigned values (see PPT slide 42 for link to spreadsheet).
  - (4) Submit the **real** and **wrf** jobs again, and execute `analyze.sh` when the wrf job is complete
  - (5) **Report NESIS and error values with respect to NNRP and NARR for each of your `nens` settings to us by email, and enter the information on the spreadsheet.**
  - **These are three separate runs, made by changing the value of `nens`.**
  - You do NOT need to re-run real.exe after changing `nens`. **BUT, do rerun real.exe after turning fdda off.**
  - **Google Docs spreadsheet for Experiment 3 [see slide 45]**