

## “Storm of the Century” (SOC) experiment (Experiment #3)

ATM 419/563 – Fovell – Spring 2024

### Workspace

- Create a directory called SOC.
- Copy `$LAB/SOC/SETUP.TAR` into that directory and unpack. **TAR file contains:** {`make_all_links_SNOW.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`}
- Execute `make_all_links_SNOW.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]
- **Use `plotgrids.ncl` OR `plot_WRF_domain.ipynb` to inspect domain [see slide 10] and then run `geogrid.exe`**
- **Use `ncview` ON `geo_em.d01.nc` OR `max.csh` to inspect `MAPFAC_M` extrema**

*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 snow ungrib.exe` and `srun -p snow 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 **25-41**.

- Submit the `submit_real` script or `srun -p snow ./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:

```
nccrcat wrfinput_d01* SOC_NNRP_reanalysis.nc
```

### *WRF run and analysis of RUN01*

- Submit the `submit_wrf` script. 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

```
$ 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 to read in your `wrfout` file from `RUN02` folder as your second file, and execute the notebook
- Slides 33-34 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 \[see slide 42\]](#)**