"Storm of the Century" (SOC) experiment (Experiment #4)
ATM 419/563 – Fovell – Spring 2021

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, control_file.2D, control_file.real, compare.gs, cut_east.gs, nesis.ncl, ncl_slp_narr.ncl, ncl_slp_nnrp.ncl, analyze.sh, read_wrfinput.py}`

Domain setup – `namelist.wps` file **pre-configured**:

• 03-12-1993 at 12Z to 03-15-1993 at 00Z (2.5 days)
• Domain is 85 x 56 points, 90 km resolution
• Lambert projection
• Reference latitude: 39.5˚N
• True latitudes: 30 and 60˚N [now we're spreading them apart]
• Reference and standard longitudes: 100˚W
• **Use `plotgrids.ncl` to inspect domain and run `geogrid.exe`**
• **Use `ncview` on `geo_em.d01.nc` or `max.csh` to inspect `MAPFAC_M` extrema**

Initialization data source

• NNRP initialization data: `$LAB/DATA/NNRP_199303/*`
• Make sure you are using **`Vtable.NNRP`** as your Vtable
• If you need new or replacement Vtables, get them from `$LAB/SOFTWARE/VTABLES`

WPS and WRF real.exe for initial run RUN01

• Link to NNRP files
• In the **&ungrib** and **&metgrid** sections, call your output files '**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. This includes
    • time_step = 240 sec
    • 51 vertical levels
    • p_top_requested = 1000 (10 mb model top)
    • mp_physics = 3
    • LW and SW radiation option 1, with 10 min time step (radt)
    • MYJ PBL and surface layer (pbl = sfclay = 2)
    • Noah LSM (sf_surface_physics = 2) with 4 soil layers
    • Cumulus option 3 in both domains, with 0 min cudt time step (standard for Grell schemes)
    • max_dom = 1
    • interval_seconds = 21600
    • 6-hourly outputs will be written to a single `wrfout` file

• The `namelist.input` file has a new option: **`all_ic_times = .true.`**. See PPT slide 12.
• The `namelist.input` has two new sections: **`&fdda`** and **`&stoch`**. See PPT slides 26, 27, 30, and 35.
• Submit the `submit_real` script.
• **This will create 11 files called wrfinput_d01***, one for each 6-hourly period within the simulation time window. 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
```

• Use the **`control_file.real`** script to create GrADS files. Call the outputs "**`nnrp_reanalysis`**".
    - This file contains the NNRP reanalysis fields, interpolated to the WRF grid, every 6 h during simulation period. All times are available owing to the **`all_ic_times = .true.`** switch. This creates a GrADS file consisting of the NNRP reanalysis, interpolated to our WRF grid, for easy comparison with our WRF simulations.

• Open **`nnrp_reanalysis`** and do **`step.gs slvl 1 11 4`** to look at evolution of SLP field in NNRP reanalysis over the 11 available times during the simulation period.

• See PPT slide 13 for NNRP SLP field at 18Z on March 13 (and commands needed to make that field).

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`

• **`control_file.2D`** creates a GrADS file from your `wrfout` file, at the same times available in "**`nnrp_reanalysis`**" created above. Just the 2D fields are retained. Call it "**RUN01**".

• The `cut_east.gs` script windows into the eastern part of the US

• Use **`step.gs slvl 1 11 4`** to track cyclone as it develops in the Gulf and moves up the east coast

• With TWO files open (**RUN01.ctl** and **nnrp_reanalysis.ctl**), the GrADS script **`compare.gs`** will superimpose SLP files at the current time. The second file opened will be color shaded/contoured and first will be superimposed with thick contours.

- set t 6
- cut_east.gs
- compare.gs
- [this compares SLP fields in east part of domain at 18Z13MAR1993. See PPT slides 16 and 17.]

• 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 = 2.01 mb per gridpoint.** See PPT slide 20.

FDDA (grid nudging: regular and spectral versions)

• 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`.

• Use `control_file.2D` to create GrADS file **RUN02**
• Slide 29 shows RUN01 and RUN02's SLP fields at t=6 superimposed
[open RUN01, then RUN02, set t 6, cut_east.gs, compare.gs]
• Execute `analyze.sh` script. **RMSE SLP = 1.74 mb per gridpoint.**

• **OPTIONAL: try grid_fdda = 2, 0**, activating *spectral* grid nudging. Do real and WRF and `analyze.sh`. Call it **RUN03**. See slides 30-31.

SKEBS (stochastic backscatter perturbation scheme)

• 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.`**

• **Homework (EXP04)**: redo RUN01 with SKEBS active
- make sure `grid_fdda = 0`. **FDDA OFF.**
- In the **&stoch** section, turn SKEBS [`skebs = 1`] and perturb boundaries [`perturb_bdy = 1`] on.
- Set `nens` to your assigned value (see PPT slide 36).
- Submit the real and wrf jobs again, and execute `analyze.sh`.
- **Report NESIS and error values with respect to NNRP and NARR for your `nens` settings to us by email. 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 4**
- Link also on slide 36