A description of the WRFv3.1 single-column model

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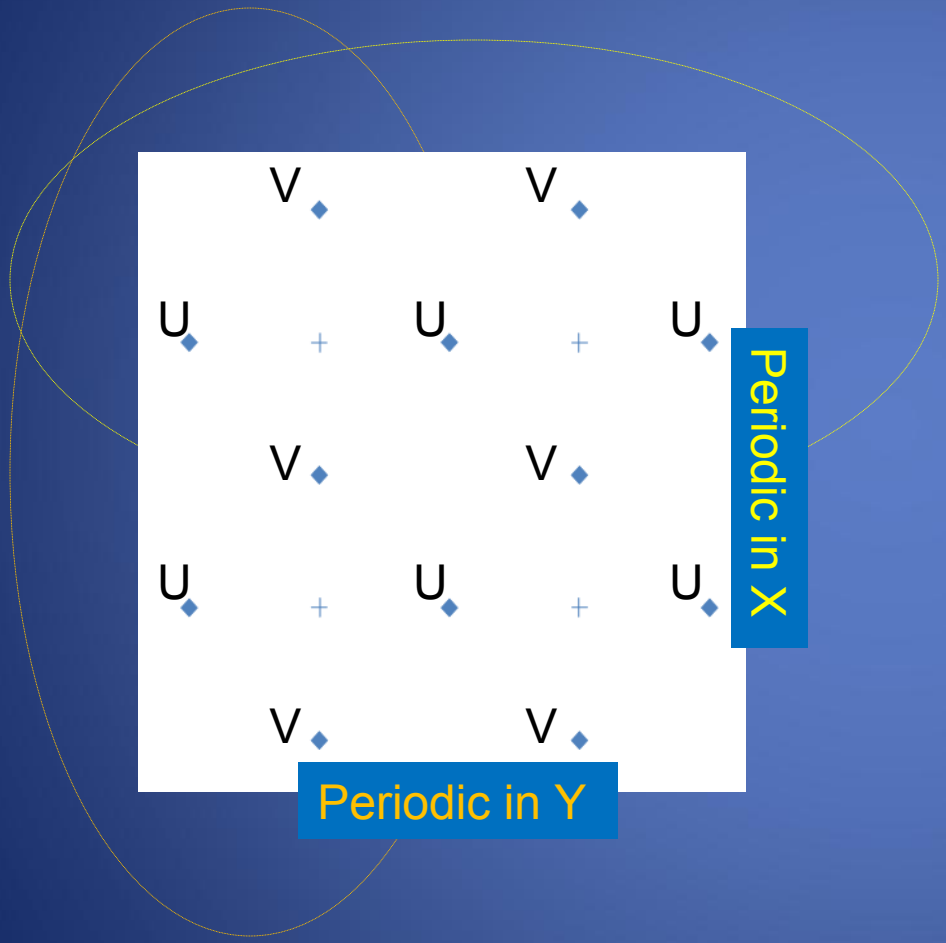
Thanks to W. Wang and J. Dudhia for helping get the SCM into the WRF release.

Possible R&D topics for a WRF-SCM

- Process studies
- Physics evaluation
- Physics development
- Data assimilation in the PBL

Configuration



- 2x2 mass-grid stencil
- Periodic in X and Y
- All terrain heights equal but can be non-zero
- Other physics and dynamics set as usual (except Coriolis)

Initialization

- Initialized with ideal.exe, similar to other idealized cases
  - Requires input_sounding ASCII file
  - Requires input_soil ASCII file
- Initializes soil using the real-data initialization subroutine.
- Initializes the atmosphere like other ideal cases, but allows for non-zero terrain height and corresponding surface pressure

Run-time input

- Forcing can be idealized or from real data
- Forcing via auxiliary input stream; looks a lot like a lateral boundary condition file
  - *W*, and tendencies
  - U_g, V_g, and tendencies
  - Advection information, and tendencies
- Here a tendency is the time rate of change of the forcing over the specified interval

More forcing details

- Forcing is 1D on arbitrary and time-varying height coordinates (AMSL). W, U_g, V_g are required but could be set to 0.
- External advection (optional) for variable ψ computed as:

$$\frac{\psi_{upstream} - \psi}{\tau_a}$$

- Both the advection time scale τ and the upstream values are computed from an external data set (e.g. a 3D WRF simulation)
- Effect is to relax the SCM toward a prescribed state

Namelist

```
&time_control
    auxinput3_inname          = "force_ideal.nc"
    auxinput3_interval_h      = 59
```

Namelist

```
&scm
    scm_force                = 1
    scm_force_dx             = 10000
    num_force_layers         = 8
    scm_lu_index             = 2
    scm_isltyp               = 4
    scm_vegfra               = 0.5
    scm_lat                  = 37.600
    scm_lon                  = -96.700
    scm_th_adv               = .false.
    scm_wind_adv             = .false.
    scm_qv_adv               = .false.
    scm_vert_adv             = .false.
```

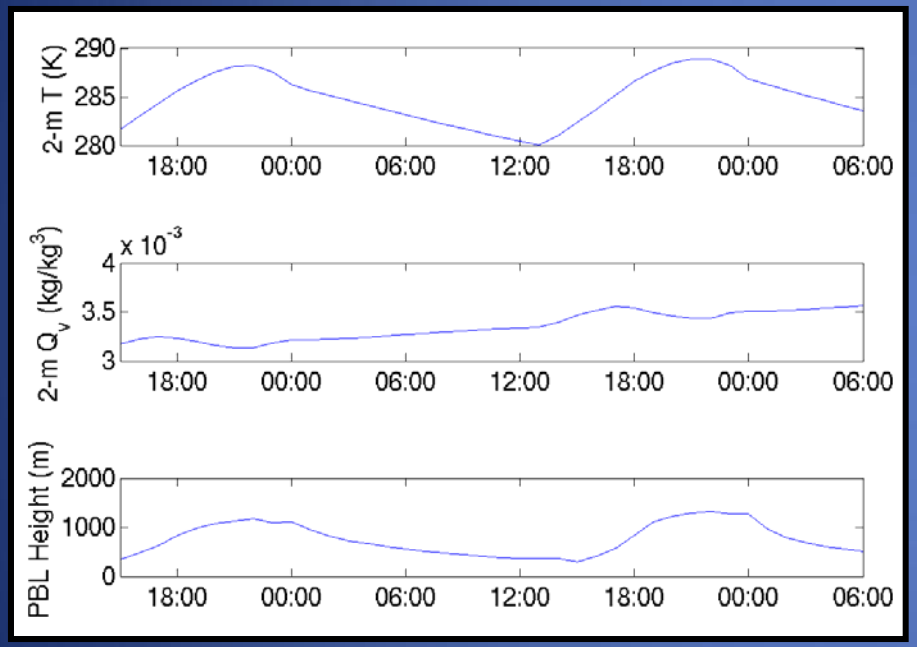
Namelist

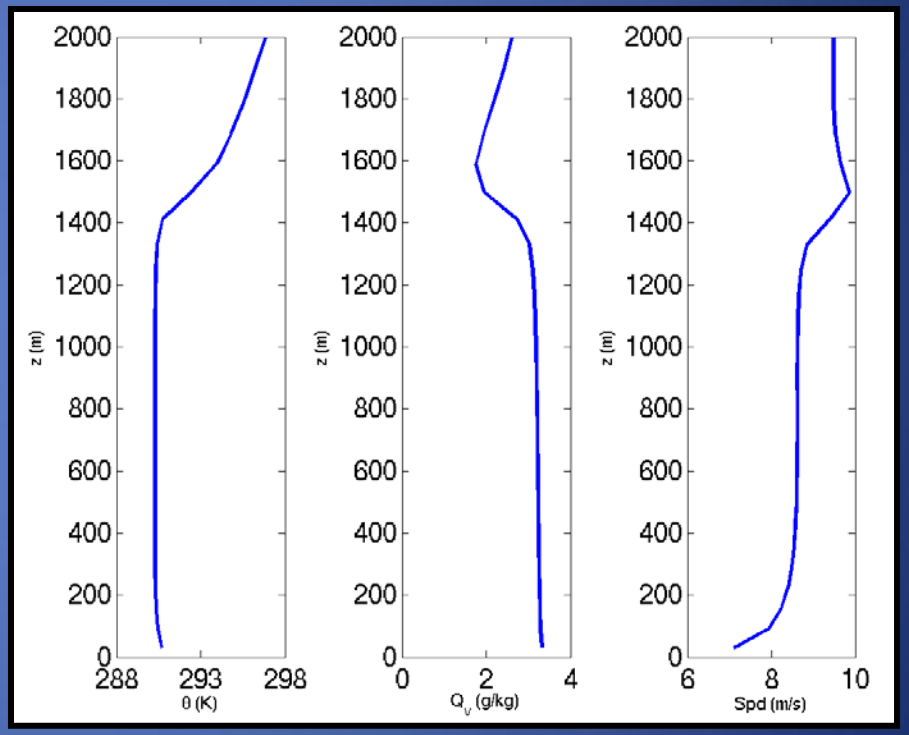
```
&dynamics
   pert_coriolis                 = .true.

&bdy_control
   periodic_x                    = .true.
   periodic_y                    = .true.
```

Canned example (almost GABLS II)

- Initial conditions as in GABLS II
- Forcing as in GABLS II except during initial period (i.e. no transition)
- No advection (method for GABLS advection not available right now, but an easy extension)
- Runs an LSM instead of specified surface fluxes

Almost-GABLS II output





Valid 2100 UTC on the second day.

Real-data strategy

WPS
- Create domain centered at SCM location
- Create met_em* for simulation period

Input
- Extract center profiles from met_em*
- Put into initial and forcing formats

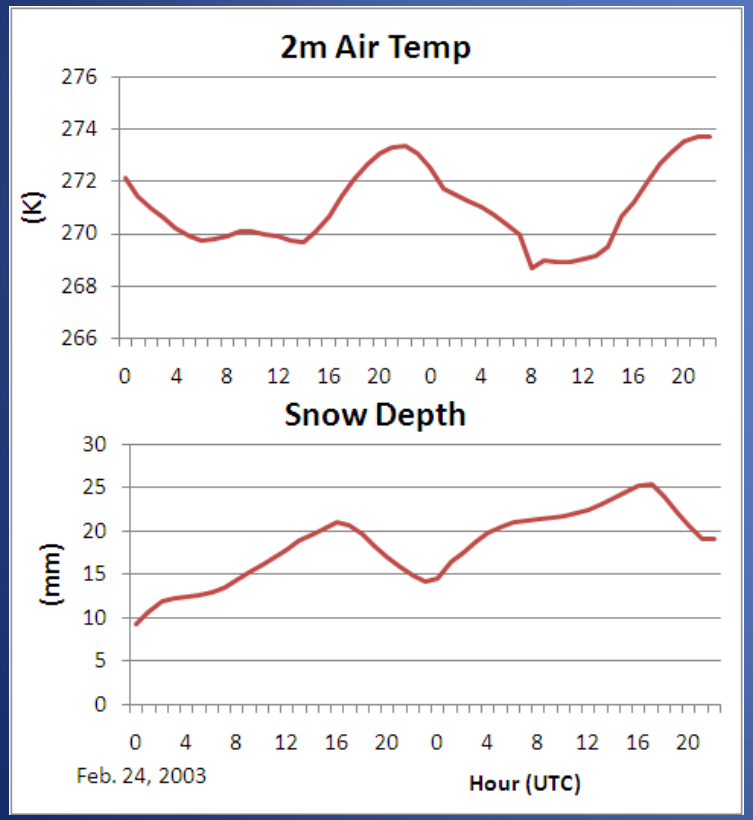
Run
- Set up namelist
- Run ideal.exe and wrf.exe

Scripts (csh/NCL) for met_em* to initial condition and forcing file available from J. Hacker (unsupported)

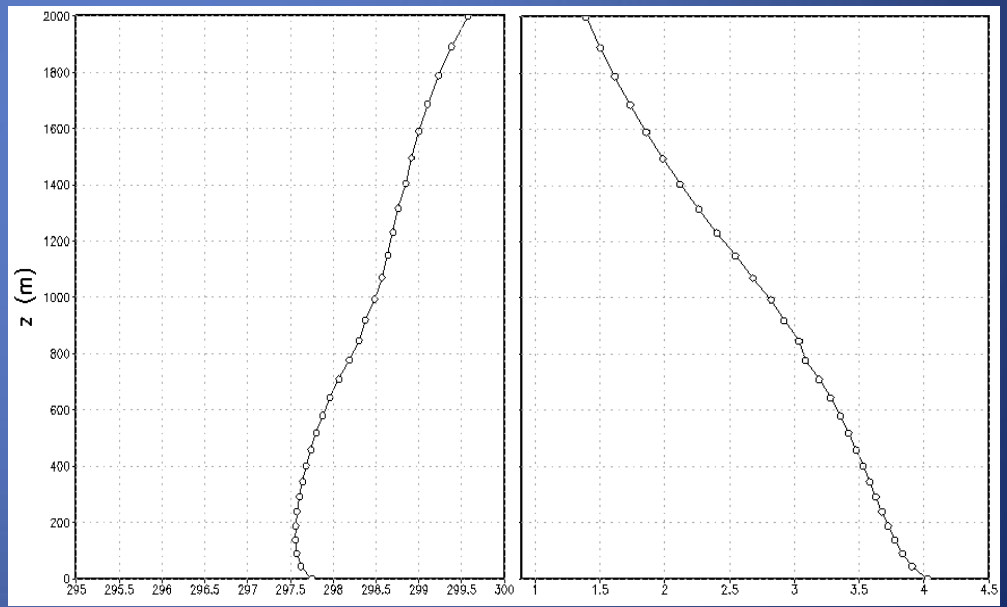
WPS → NCL/*.csh Scripts → WRF SCM

Real Data Case Using WPS and Scripts

North Park, CO (FLOSS2) – Feb. 23-25, 2003



- NARR Initial and Boundary Conditions
- YSU; Noah LSM; Lin MP
- 1 Ensemble Member
- Profiles Below at 21Z, Feb. 24, 2003



- Also, data downloading and subsetting scripts available for running daily to seasonal WRF SCM simulations (K. Arsenault)

Included in release: em_scm_xy

- make_scm_forcing.ncl to turn an ASCII profile into a netCDF forcing file
- ASCII input to make_scm_forcing.ncl, for testing
- input_sounding and input_soil files for testing
- Namelist that runs with example

Once-Asked Questions (OAQ)

- Q: Can I specify surface-flux time series?
- A: Not right now, but possibly in the near future
- Q: How are clouds handled?
- A: The same way as in the WRF. The flow is non-divergent so they may not be realistic without advecting in cloud hydrometeors, which would be a trivial extension.

Additional notes

- Compatible with the Data Assimilation Research Testbed (DART); scripts to generate ensemble forcing available (unsupported)

- Specifying surface flux time series instead of running an LSM is an expected capability within the next year