The WRF Model: 2012 Annual Update

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NCAR/MMM

WRF Community Model

- Version 1.0 WRF was released December 2000
- Version 2.0: May 2004 (NMM added, EM nesting released)
- Version 2.1: August 2005 (EM becomes ARW)
- Version 2.2: December 2006 (WPS released)
- Version 3.0: April 2008 (add global ARW version)
- Version 3.1: April 2009
- Version 3.2: April 2010
- Version 3.3: April 2011
  - Version 3.3.1: September 2011
- Version 3.4: April 2012

V3.3 Highlights (2011)

- Microphysics option: Stony Brook University (Lin and Colle) (mp_physics=13)
- CESM (Climate model) Physics:
  - Zhang-McFarlane cumulus parameterization (cu_physics=7)
  - Bretherton-Park (UW) PBL (bl_pbl_physics=9)
  - Park-Bretherton (UW) shallow cumulus (shcu_physics=2)
- Radiation option: New Goddard longwave and shortwave (ra_lw_physics = 5, ra_sw_physics = 5)
- PBL option: TEMF (Angevine et al.) PBL (bl_pbl_-physics=10)
- Cumulus options: SAS added for ARW (cu_physics=4), NSAS (cu_physics=14), Tiedtke (cu_physics=6)

Other New Options in V3.3

- New Kain-Fritsch trigger option
- Wind farm parameterization
- Stochastic KE backscatter perturbation method
- Idealized tropical cyclone case

WRF-Chem options added to existing schemes

  - Morrison microphysics
  - RRTMG longwave and shortwave

Version 3.3.1 (Sept 2011)

- Regional climate diagnostics
  - Provided by L.Fita, J. Fernandez and M.Garcia-Diez of U. Cantabria (Spain)
  - *output_diagnostics=1*
  - *wrfxtrm_d01* output file contains
    - Surface max, min, std, mean at each grid point of 2m T, 2m Q, 10m wind, rainfall
    - Output frequency could be chosen to be daily to give daily max, etc.

Hypsometric Option

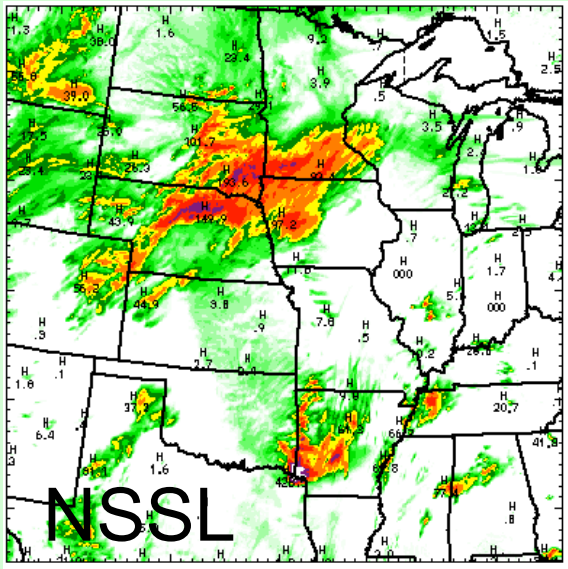
- Vertical interpolation/integration method (Tae-Kwon Wee et al. 2012, MWR)
  - *hypsometric_option=2* (new default in V3.4)
    - Up till now $df/dp=-a$ is used to compute inverse dry density (a). This implicitly assumes a varies linearly with *p.*
    - Option uses $df/d\ln p=-RT$ mathematically the same because $a=RT/p$ but assumption that *T* varies linearly with *ln p* gives better consistency with operational height analyses such as GFS
    - Also *interp_theta=.false.* in real.exe interpolates temperature with *ln p* rather than q (V3.4)

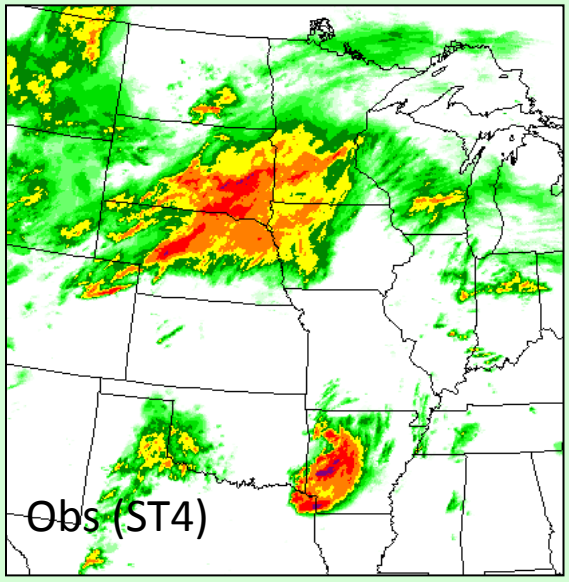
New in Version 3.4

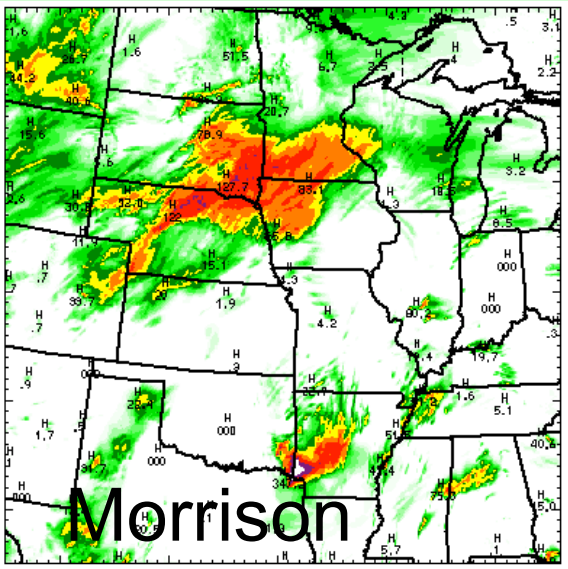
- NSSL microphysics (mp_physics=17)
  - 2-moment, 4-ice scheme (adds hail)
  - Also idealized CCN option (mp_physics=18)
  - Provided by Ted Mansell (National Severe Storms Lab)
  - Ref: Mansell. Ziegler and Bruning (2010, JAS)
- WENO advection (option 3):
  - Weighted Essentially Non-Oscillatory method (also provided by Ted Mansell)

NSSL v Morrison MP

12 h rainfall starting 2010061100, 4 km RUC IC







NSSL slightly more light rain

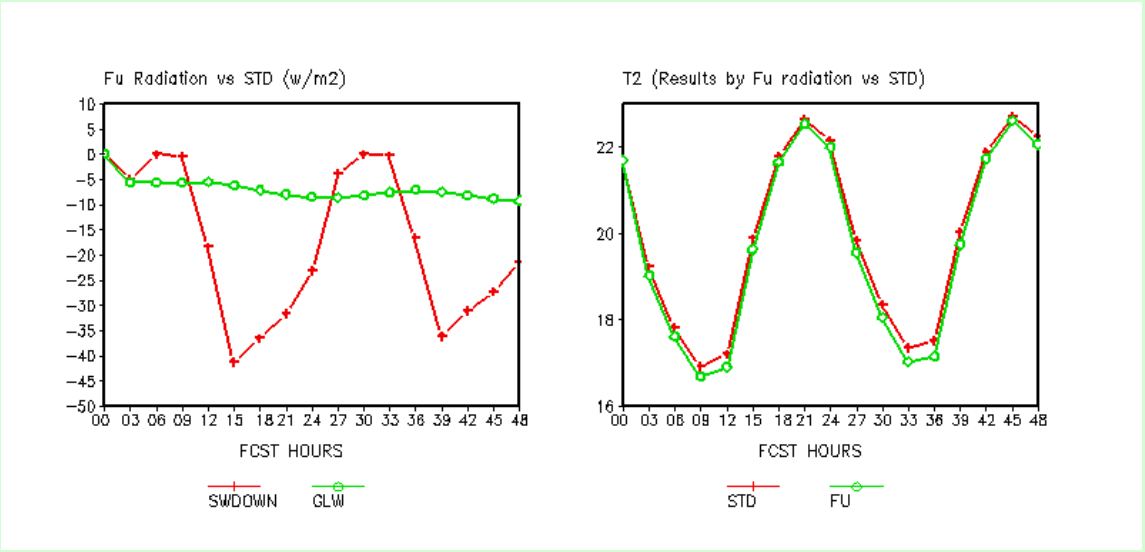
New in Version 3.4

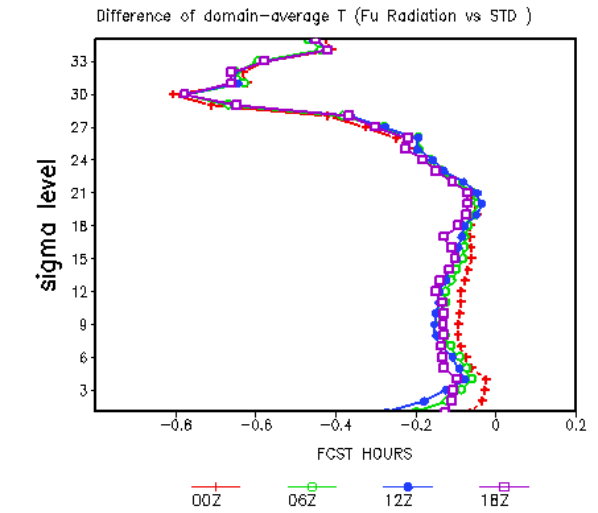
- Fu-Liu-Gu (FLG) radiation option (ra_sw_physics=7, ra_lw_physics=7)
- Simple SiB (SSiB) land-surface model (sf_surface_physics=8) from Y. Xue and F. de Sales (UCLA)
- Both from physics used in UCLA global climate model

New-physics tests

- 10 simulations from June 2010 over US at 20 km grid size
- Results show averages compared to standard options

Fu et al. (FLG) radiation





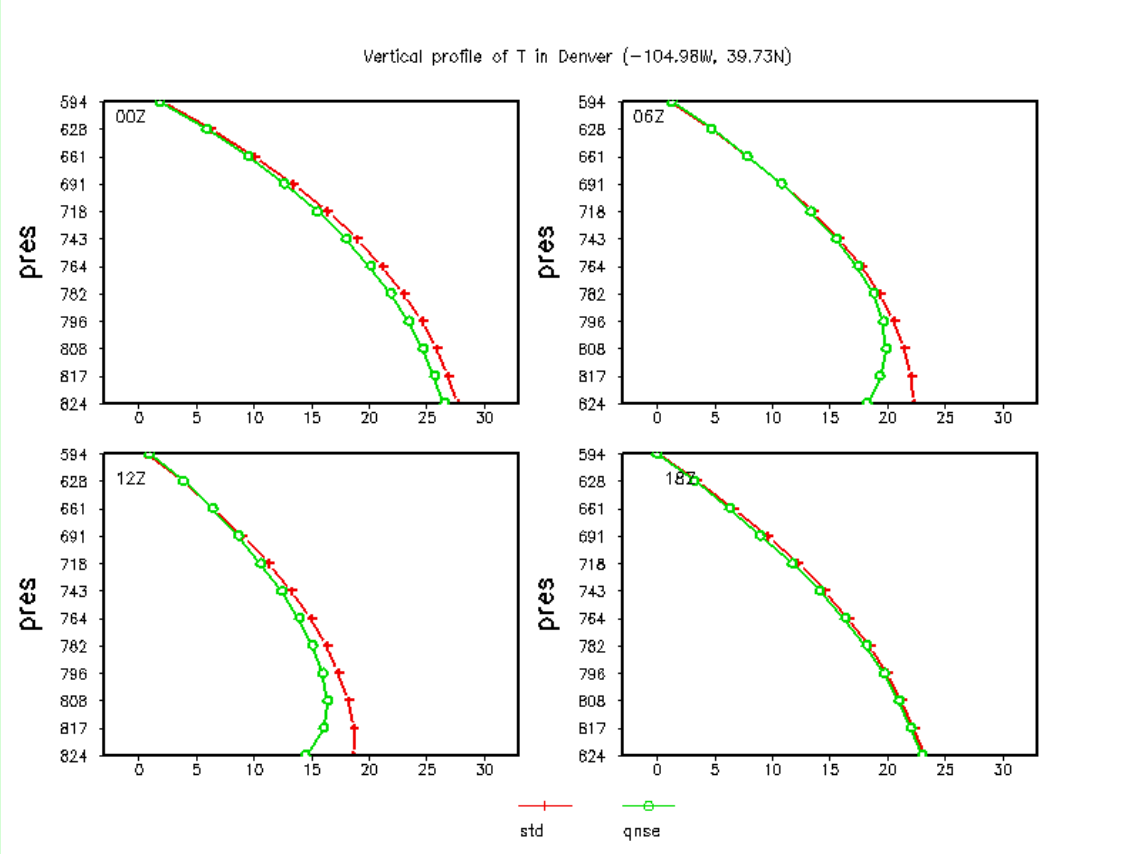
Compared to RRTM and Goddard SW

- Less downward visible and IR
- Cooler surface and atmospheric temps

New in Version 3.4

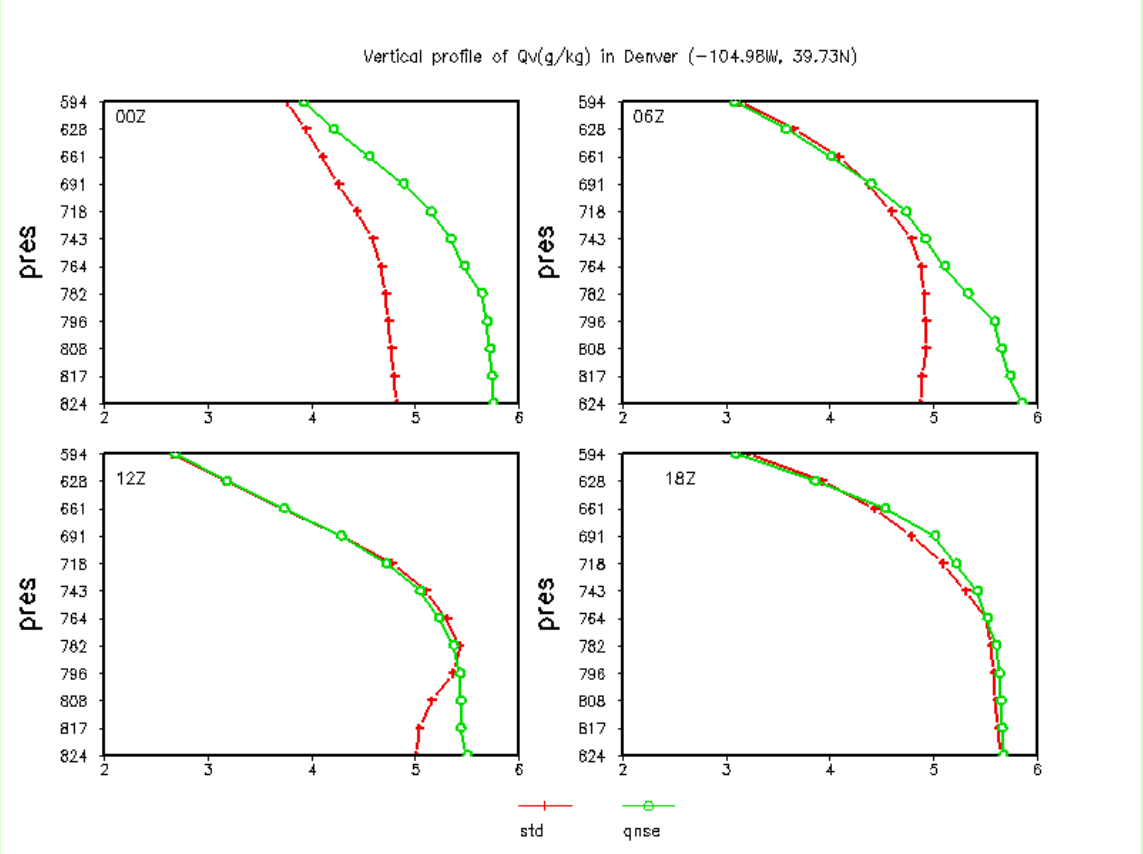
- New Version of QNSE PBL (bl_pbl_physics=4) $\frac{\partial}{\partial z}\left(K_v \frac{\partial}{\partial z}\theta + M(\theta_u - \theta) \right)$
  - Eddy-Diffusivity-Mass-Flux (EDMF) daytime convective BL method
    - From Julien Pergaud (Numtech, France)
  - Stable BL as in QNSE
  - Old version kept temporarily as option bl_pbl_physics=94 but turning of EDMF reverts to old version

EDMF QNSE v YSU PBL



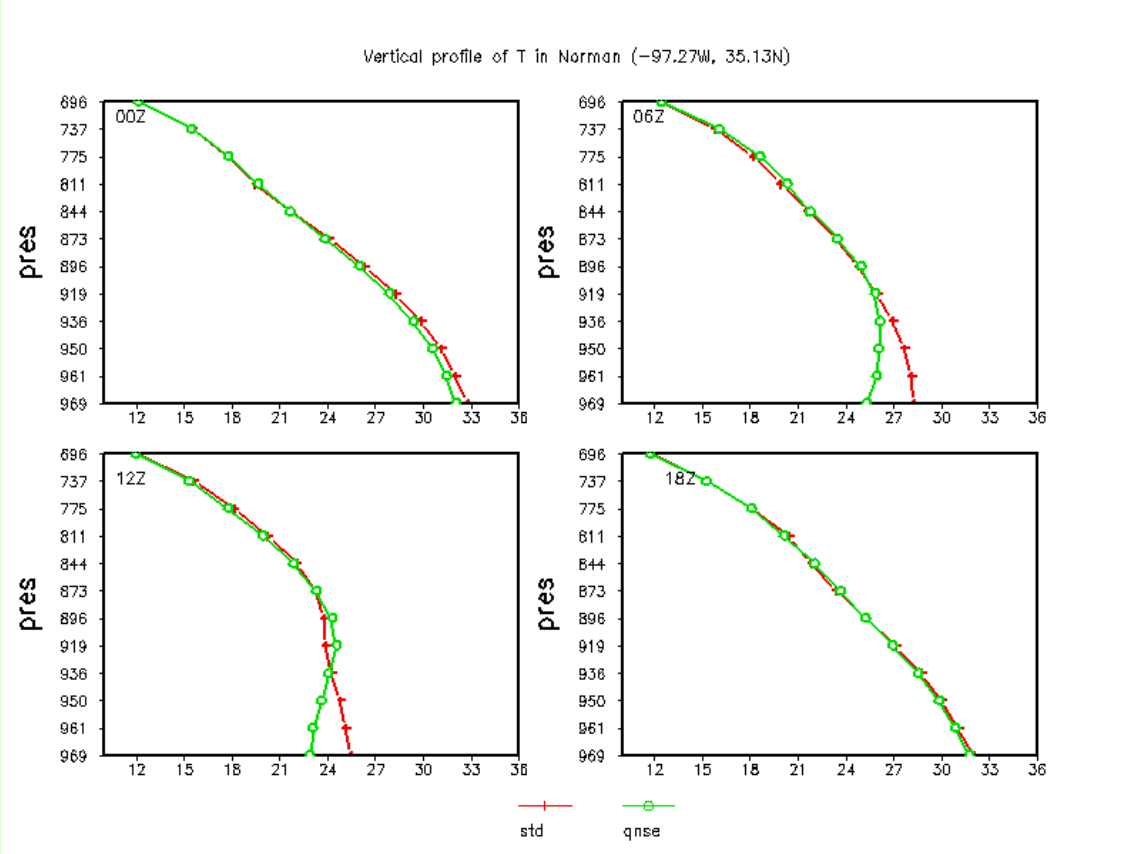
Denver sounding: QNSE cooler at night

EDMF QNSE v YSU PBL



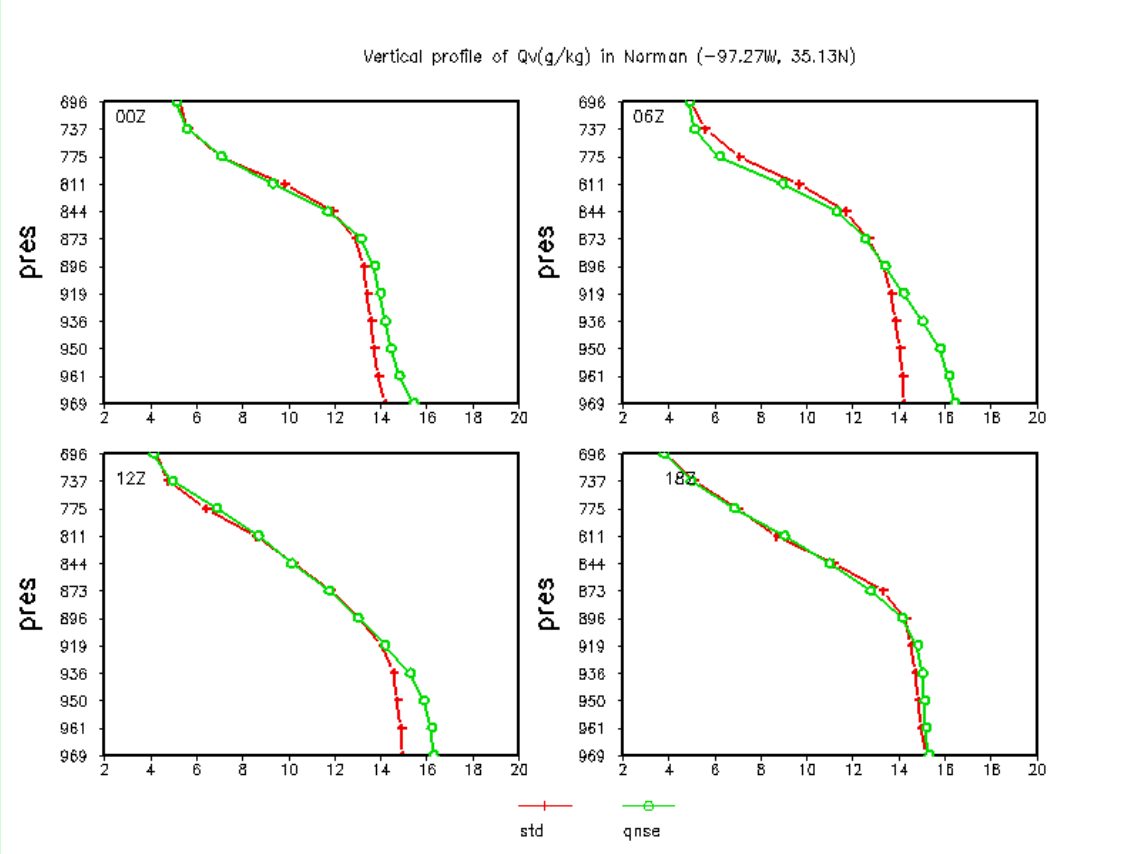
QNSE moister except 18Z during day

EDMF QNSE v YSU PBL



Norman sounding: QNSE cooler at night

EDMF QNSE v YSU PBL

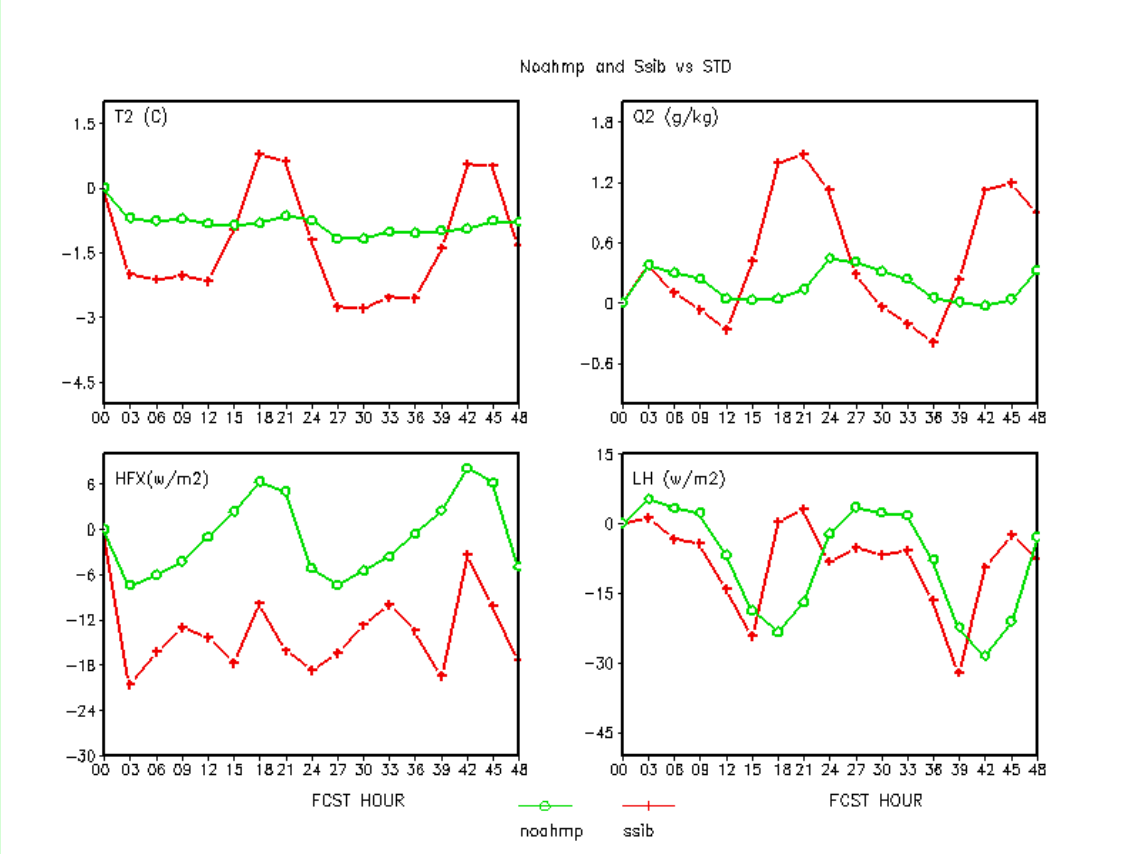


QNSE again moister except 18Z

New in Version 3.4

- Noah MP (multi-physics) land-surface model (sf_surface_physics=4)
  - Jointly developed at NCAR and Guo-Ye Niu (U. Texas/U. Arizona)
  - Advanced snow model and other features
- seaice_albedo_opt=1
  - Allows variation of sea-ice albedo with T
  - For Noah and Noah MP in new shared sea-ice module

NoahMP and SSiB v Noah LSM



SSiB larger diurnal cycle, moister in daytime

New in Version 3.4

- New version of surface-layer physics (sf_sfclay_physics=11)
  - Modifies and cleans up sfclay option 1 code and should replace it in the future
  - Ref: Jimenez et al. (2012, MWR)
- New option to improve topographic effects on surface wind (topo_wind=1) using sub-grid and resolved topography
  - Ref: Jimenez and Dudhia (2012, JAMC)

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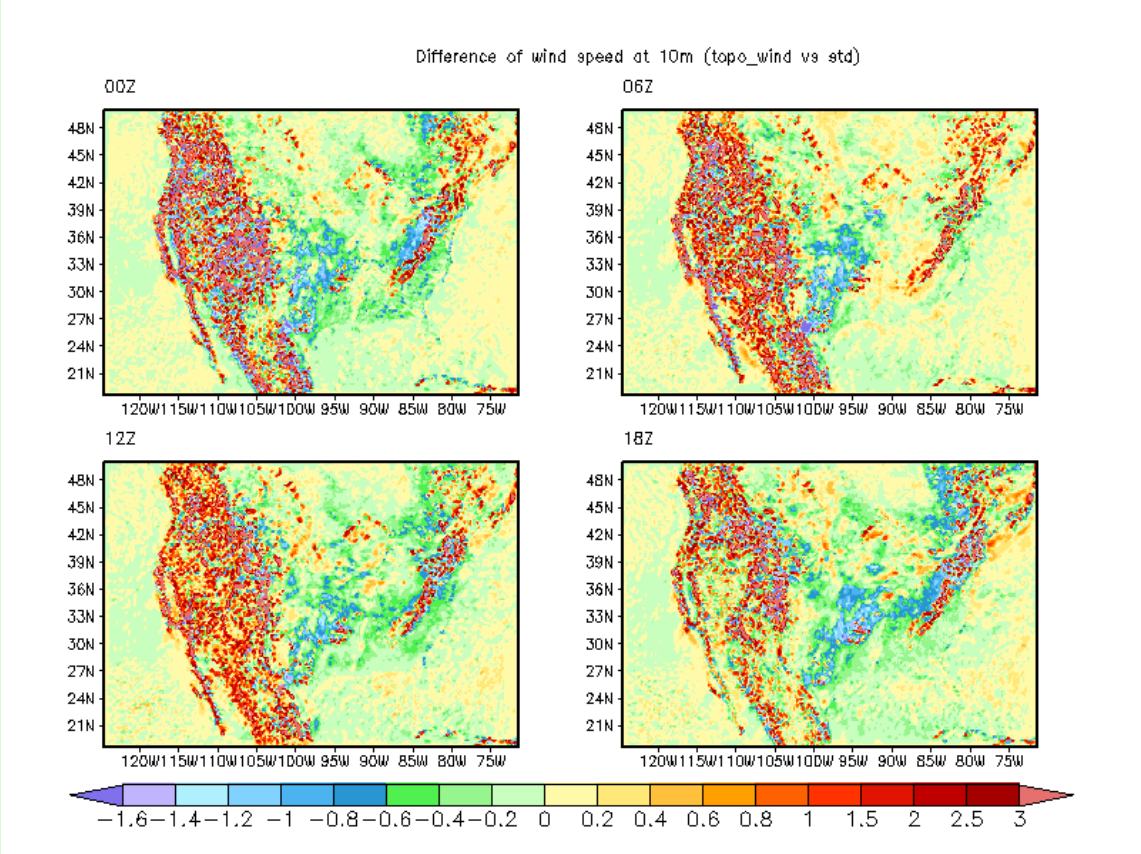
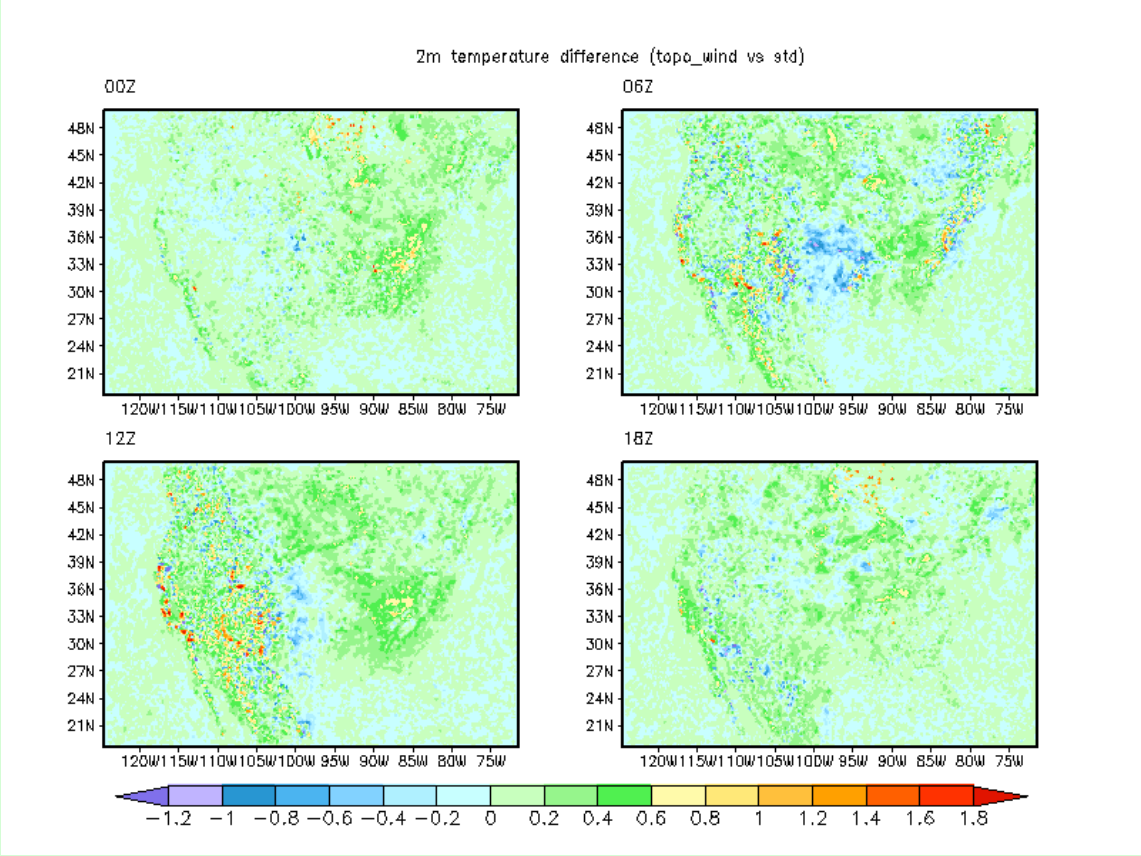
topo_wind 1 and sfclay 11



Winds stronger over mountains, weaker in plains

topo_wind 1 and sfclay 11



Some warmer and cooler areas at night (sfclayrev)

Planned

- CESM microphysics Morrison-Gettelman (mp_physics=11)
  - From CESM climate model
  - Interacts with WRF-Chem
- Reflectivity output computed from each scheme's microphysics parameters
- Hybrid eta-pressure vertical coordinate in ARW (pressure levels at top)

Contributions for next release

- New options for contribution should come to NCAR by October 2012
- We may send test cases to developers
- Code freeze and final test phase starts December 2012
- Release planned for April 2013

Thanks