Poster No. 626

95th AMS Annual Meeting, Phoenix, Arizona, 6 January 2015

Testing the new land data sets in the NCEP parallel GFS

Helin Wei [1,2], Michael B. Ek[1], Jesse Meng[1,2], and Weizhong Zheng [1,2]

[1]Environmental Modeling Center (EMC), NOAA/NWS/NCEP, College Park, Maryland, USA

[2]IMSG at NCEP/EMC, College Park, Maryland, USA

Contact Information: Helin.Wei@noaa.gov

ABSTRACT

The land surface interacts with the atmosphere across many time scales including the medium-range NWP. Accurate representation of the land surface is very important because it provides the lower boundary condition for the atmospheric model. During the last two decades, many physics upgrades and the increasing of both horizontal and vertical resolution have been carried out to the NCEP Global Forecast System (GFS). However, some out-of-date and low-resolution land surface data sets such as vegetation/soil types, and surface albedo are still used without any update. In this study, the MODIS-based global 1-km IGBP vegetation classification data, STATSGO soil classification data, monthly snow-free albedo, and the global 0.05o maximum snow albedo data will be used in the current parallel GFS to replace the corresponding old data sets. The impact of the new data sets on the surface variables and the upper atmospheric conditions will be investigated for both summer and winter seasons. The results of this study will provide some guidance for the next land surface upgrades in the next NCEP GFS implementation.

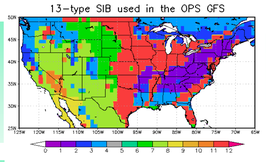
Changes inside the test

- IGBP 20-type land classifications and STASGO 19-type soil classifications
- The new MODIS-based snow free albedo from BostonU/Mark-Friedl (JCSDA funded)
- The new MODIS-based maximum snow albedo from UAZ/Xubin (JCSDA funded)
- Fanglin's new diurnal albedo treatment
- Unify two aspects between radiation driver and Noah LSM
  - Snow cover
  - Snow albedo

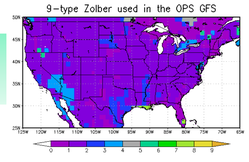
Veg/Soil type data

- Old data:
  - Global 1 degree
  - SSIB 13-type veg and Zolber 9-type soil
- New data:
  - Global 1km
  - IGBP 20-type veg and STASGO 19-type soil

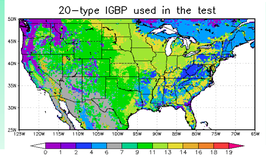
1: broadleaf-evergreen trees!
2: broadleaf-deciduous trees
3: broadleaf and needleleaf trees!
4: needleleaf-evergreen trees
5: needleleaf-deciduous trees (larch)
6: broadleaf trees with groundcover
7: groundcover only (perennial)
8: broadleaf shrubs with perennial groundcover
9: broadleaf shrubs with bare soil
10: dwarf trees and shrubs with groundcover (tundra)
11: bare soil
12: cultivations (the same parameters as for type 7)
13: glacial ice



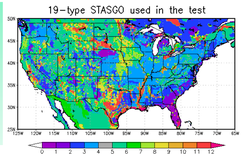
1 loamy sand
2 silty clay loam
3 light clay
4 sandy loam
5 sandy clay
6 clay loam
7 sandy clay loam
8 loam
9 loamy sand



1:Evergreen Needleleaf Forest
2:Evergreen Broadleaf Forest
3:Deciduous Needleleaf Forest
4:Deciduous Broadleaf Forest
5:Mixed Forests
6:Closed Shrublands
7:Open Shrublands
8:Woody Savannas
9:Savannas
10:Grasslands
11:Permanent wetlands
12:Croplands
13:Urban and Built-Up
14:Cropland/natural vegetation mosaic
15:Snow and Ice
16:Barren or Sparsely Vegetated
17:Water
18:Wooded Tundra
19:Mixed Tundra
20:Bare Ground Tundra



1: sand
2: loamy sand
3: sandy loam
4: silt loam
5: silt
6:loam
7:sandy clay loam
8:silty clay loam
9:clay loam
10:sandy clay
11: silty clay
12: clay
13: organic material
14: water
15: bedrock
16: other (land-ice)
17: playa
18: lava
19: white sand



Snow free albedo

- Old data:
  - Contains 6 fields: vis/nir with strong/weak cosz dependency, fractional coverage with strong/weak cosz dependency
  - Quarterly, global 1-deg, Briegleb et al. (1992,1986), E. Matthews (1984).
- New data:
  - Contains 4 fields: vis/nir black/white sky
  - Monthly, global 5-km, based on 4-yr MODIS BRDF/albedo.

Maximum snow albedo

- Old data
  - Global 1 degree, based on 1-yr of DMSP observation from 1979.
- New data
  - Global 0.05 degree, based on 4-yr MODIS BRDF/albedo.

- Radiation driver
  - Diffuse Albedo: 0.90(vis) 0.75(nir)
  - Direct Albedo:
  - -- low zenith angle same as diffuse
  - -- high zenith angle: 0.98~1
  - Usually substantially higher than that in Noah LSM (below)
- Noah LSM
  - Based on global field of Maximum Snow albedo

Snow fraction

Deriving Snow Cover Fraction from Snow Water-Equivalent (SWE): Needed to compute albedo over snow

- Radiation driver: snow cover fraction
  - Ops GFS -Based on SWE, roughness length, standard deviation of terrain height
  - Test GFS – As computed in Noah LSM (below)
- Noah LSM: snow cover fraction
  - Based on SWE and two vegetation-dependent parameters

1. Parallel GFS and Experiments

Highlights of the parallel GFS

Analysis Highlights

- **Structure**
  - T574 (35 km) analysis for T1534 (13 km) deterministic
  - Code optimization
- **Observations**
  - GPSRO enhancements – improve quality control
  - Updates to radiance assimilation
    - Assimilate SSM/IS UPP LAS and MetOp-B IASI radiances
    - CRTM v2.1.3
    - New enhanced radiance bias correction scheme
    - Additional satellite wind data – hourly GOES, EUMETSAT
- **EnKF modifications**
  - Stochastic physics in ensemble forecast
  - T574L64 EnKF ensembles

Model Highlights

- T1534 Semi-Lagrangian (~13 km)
- Use of high resolution daily SST and sea ice analysis
- High resolution until 10 days
- Dynamics and structure upgrades
  - Hermite interpolation in the vertical to reduce stratospheric temperature cold bias.
  - Restructured physics and dynamics restart fields and updated sigio library
  - Divergence damping in the stratosphere to reduce noise
  - Added a tracer fixer for maintaining global column ozone mass
  - Major effort to make code reproducible
- Physics upgrades
  - Radiation modifications -- McICA
  - Reduced drag coefficient at high wind speeds
  - Hybrid EDMF PBL scheme and TKE dissipative heating
  - Retuned ice and water cloud conversion rates, background diffusion of momentum and heat, orographic gravity-wave forcing and mountain block etc
  - Stationary convective gravity wave drag
  - Modified initialization to reduce a sharp decrease in cloud water in the first model time step
  - Correct a bug in the condensation calculation after the digital filter is applied
- Boundary condition input and output upgrades
  - Consistent diagnosis of snow accumulation in post and model
  - Compute and output frozen precipitation fraction
  - New blended snow analysis to reduce reliance on AFWA snow
  - Changes to treatment of lake ice to remove unfrozen lake in winter
  - Land Surface
    - Replace Bucket soil moisture climatology by CFS/GLDAS
    - Add the vegetation dependence to the ratio of the thermal and momentum roughness, Fixed a momentum roughness issue

Experiments

Two cases: Winter (February of 2014) and summer (July of 2013)

- One 6-day GFS forecast per day
- Without cycling (initial conditions from Russ Treadon PRY)
- T1534 on Zeus

Comparison:

- PRHW14 and PRHS13: current parallel GFS
- PRHW14N and PRHS13N: adjusted roughness length and RSMIN
- PRHW14V and PRHS13V: new LSC test
- Sometimes the current OPS will be used for comparison.

2. Winter case (February, 2014)

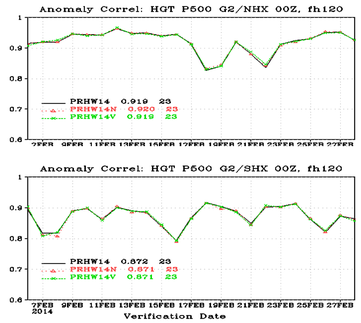


Figure 2.1: *Anomaly Correction of 500mb height*

Impact on the upper atmospheric circulation is limited

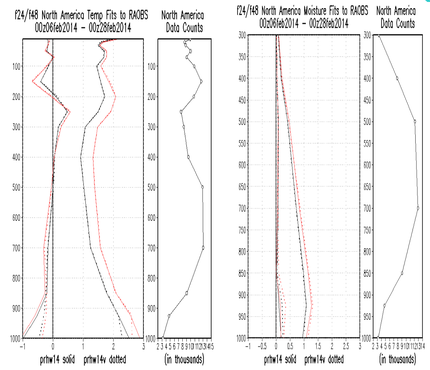


Figure 2.2: *Vertical profile of T and Q bias and rmse over North America(black is 24h fcst and red is 48h fcst, solid is OPS and dash is test)*

The cold low level temperature bias is significantly reduced

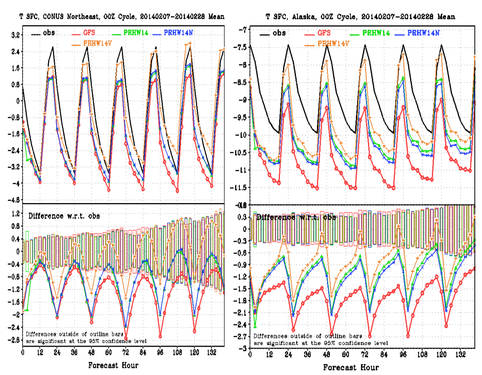


Figure 2.3: *Diurnal variation of 2-m temperature over NE CONUS and Alaska.*

New land dataset help significantly reduce daytime cold bias over snow region.

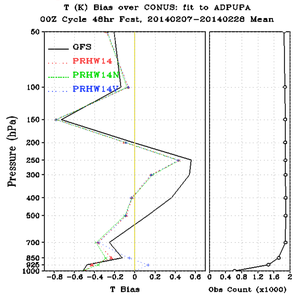


Figure 2.4: Vertical profile of T over CONUS

Compared to other changes, New land dataset further improve low troposphere temperature forecast.

3. Summer case (July, 2013)

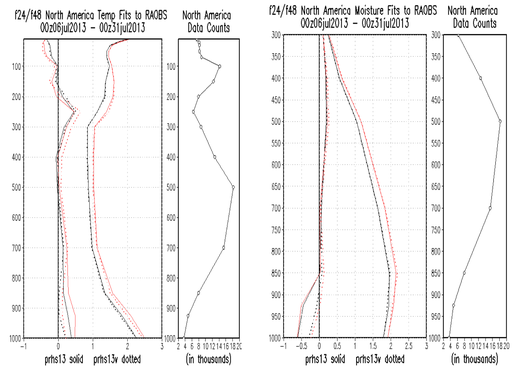


Figure 3.1: *Vertical profile of T and Q bias and rmse over North America(black is 24h fcst and red is 48h fcst, solid is OPS and dash is test)*

Both low level warm and dry biases have been reduced significantly.

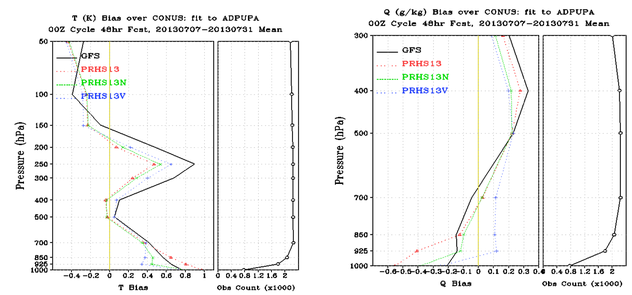


Figure 3.2: Vertical profile of T and Q over CONUS

New land dataset have further improved the low level T and Q forecast over CONUS

4. Future Work

(1) More land surface parameter refinements with the new dataset are necessary to further improve near surface forecast.

(2) Re-test the new dataset with GLDAS spin-up of the initial land states.

(3) Further tests are necessary with the new land dataset also being used in the data analysis (the nudged soil moisture climatology was also produced by the old dataset).