NCEP Model Description

Name: NCEP Ensemble

The NCEP real-time forecasts consist of a 16-member ensemble run every day. The S2S archive contains all the NCEP real-time forecasts since 1st January 2015, and the associated re-forecasts.

1. ENSEMBLE VERSION

Ensemble identifier code: CFSv2
Short Description: Global ensemble forecast system for monthly and seasonal predictions
Research or operational: Operational
Data time of first forecast run: 15/03/2011. CFSv2 was operational at the end of March 2011. No forecasts before April 1, 2011 were given to the public.

2. Configuration of the EPS

Is the model coupled to an ocean model? Yes, from day 0
If yes, please describe ocean model briefly including frequency of coupling and any ensemble perturbation applied: Ocean model is GFDL MOM4 that has a spatial resolution in the zonal direction of 0.5° and in the meridional direction, 0.25° from 10°S to 10°N, progressively decreasing to 0.5° from 10° to 30°, and is fixed at 0.5° beyond 30° in both hemispheres. There are 40 levels in vertical.
Is the model coupled to a sea Ice model? Yes - Sea ice model is part of MOM4p0
If yes, please describe sea-ice model briefly including any ensemble perturbation applied: thermodynamic and dynamic sea ice model from the GFDL Sea Ice Simulator (Griffies, S. M.,M. J.Harrison, R. C. Pacanowski, and A. Rosati, 2004: Technical guide to MOM4.GFDLOcean Group Technical Rep. 5, 337 pp. [Available online at http://www.gfdl.noaa.gov/;fms.])
Is the model coupled to a wave model? No
If yes, please describe wave model briefly including any ensemble perturbation applied: ECMWF wave model. N/A
Ocean model: MOM4p0
Horizontal resolution of the atmospheric model: T126 (about 100 km) Number of model levels: 64
Top of model: 0.02 hPa
Type of model levels: sigma-pressure hybrid coordinates
Forecast length: 45 days (1080 hours)
Run Frequency: 4 cycles/day
Is there an unperturbed control forecast included?: Yes
Number of perturbed ensemble members: Three perturbed members each 6-hour cycle
Integration time step: 20 minutes

3. Initial conditions and perturbations

Data assimilation method for control analysis: Climate Forecast System Reanalysis (CFSR)
Resolution of model used to generate Control Analysis: T384/L64 for hindcast and T574/L64 for real-time forecasts after 2011
Ensemble initial perturbation strategy: Add a small perturbation into atmospheric, oceanic and land analysis at each cycle
Horizontal and vertical resolution of perturbations: 3D, all levels and variables
Perturbations in +/- pairs: Yes, there is one +/- pair

Initialization of land surface:

1. What is the land surface model (LSM) and version used in the forecast model, and what are the current/relevant references for the model? 4-layer Noah Land surface model 2.7.1 (Ek et al. 2003)

Are there any significant changes/deviations in the operational version of the LSM from the documentation of the LSM? No.

2. How is soil moisture initialized in the forecasts? (climatology / realistic / other) Realistic: From CFSR (Saha et al. 2010) and associated GLDAS land surface analysis (Meng et al. 2012).

Is there horizontal and/or vertical interpolation of initialization data onto the forecast model grid? If so, please give original data resolution(s). Yes. From the CFSR analysis resolution (T382) to the CFSv2 (T126) resolution.

Does the LSM differentiate between liquid and ice content of the soil? If so, how are each initialized? Yes. The Noah LSM defines two soil moisture state variables, liquid and ice (liquid + ice = total soil moisture). The amounts of liquid and ice within the soil layers are determined by soil temperature and the net thermal energy transition within each of the 4 soil layers.

If all model soil layers are not initialized in the same way or from the same source, please describe. All model soil layers are initialized in the same way of the Noah LSM driven GLDAS land analysis.

3. How is snow initialized in the forecasts? (climatology / realistic / other) Realistic: From the CFSR snow analysis using IMS (Interactive Multisensor Snow and Ice Mapping System) and Air Force Weather Agency (AFWA) SNODEP (Snow depth) analysis.

Is there horizontal and/or vertical interpolation of data onto the forecast model grid? If so, please give original data resolution(s) Horizontal interpolation. From the CFSR analysis resolution (T382) to the CFSv2 (T126) resolution.

Are snow mass, snow depth or both initialized? What about snow age, albedo, or other snow properties? Yes, both snow mass and snow depth are initialized. The Noah LSM defines two snow state variables, water equivalent snow mass (SWE) and actual snow depth. Snow depth is determined by SWE and snow age (days of snow pack on the ground). Albedo is calculated from the background albedo, snow albedo, and snow cover fraction.

4. How is soil temperature initialized in the forecasts? (climatology / realistic / other) Realistic: From CFSR (Saha et al. 2010) and associated GLDAS land surface analysis.

Is the soil temperature initialized consistently with soil moisture (frozen soil water where soil temperature 0°C) and snow cover (top layer soil temperature 0°C under snow)? Yes, some coherency checks are done in the GLDAS

Is there horizontal and/or vertical interpolation of data onto the forecast model grid? If so, please give original data resolution(s) Horizontal interpolation. From the CFSR analysis resolution (T382) to the CFSv2 (T126) resolution.

If all model soil layers are not initialized in the same way or from the same source, please describe. All model soil layers are initialized in the same way of the Noah LSM driven GLDAS land analysis.

5. How are time-varying vegetation properties represented in the LSM? Is phenology predicted by the LSM? If so, how is it initialized? Phenology is not predicted by the Noah LSM. It is represented in the Noah LSM via monthly climatology of green vegetation fraction derived from AVHRR data (Gutman and Ignatov, 1998).

6. What is the source of soil properties (texture, porosity, conductivity, etc.) used by the LSM? Soil texture is defined following Zobler (1986). Porosity, soil conductivity and other soil properties are prescribed as soil texture dependent empirical parameters.

7. If the initialization of the LSM for re-forecasts deviates from the procedure for forecasts, please describe the differences. The initialization procedure is in the same way.

4. Model Uncertainties perturbations:

Is model physics perturbed? No
Do all ensemble members use exactly the same model version? Yes
Is model dynamics perturbed? No
Are the above model perturbations applied to the control forecast? N/A

5. Surface Boundary perturbations

Perturbations to sea surface temperature? Yes
Perturbation to soil moisture? Yes
Perturbation to surface stress or roughness? Yes
Any other surface perturbation? Everything is changed through Initial condition perturbations, not physics perturbations
Are the above surface perturbations applied to the Control forecast? No
Additional comments

6. Other details of the models:

Description of model grid: Gaussian grid
List of model levels in appropriate coordinates: http://journals.ametsoc.org/doi/suppl/10.1175/2010BAMS3001.1/suppl_file/10.1175_2010bams3001.2.s1.pdf
What kind of large scale dynamics is used? Spectral
What kind of boundary layer parameterization is used? http://journals.ametsoc.org/doi/pdf/10.1175/2010BAMS3001.1
What kind of convective parameterization is used? Simplified Arakawa–Schubert convection with momentum mixing
What kind of large-scale precipitation scheme is used? RH Criteria
What cloud scheme is used? Prognostic cloud condensate from which cloud cover is diagnosed
What kind of land-surface scheme is used? NOAH Land model
How is radiation parametrized? See references below
Other relevant details? For further details on model configuration and physics, see citations below

7. Re-forecast Configuration

Number of years covered: 1999-2010
Produced on the fly or fix re-forecasts? Fix
Frequency: Everyday; 4 runs/day
Ensemble size: 1 member
Initial conditions: CFSR
Is the model physics and resolution the same as for the real-time forecasts: Yes
If not, what are the differences: NA
Is the ensemble generation the same as for real-time forecasts? CFSR analysis for each cycle
If not, what are the differences: NA

8. References:

Ek, M. B., K. E. Mitchell, Y. Lin, E. Rogers, P. Grunmann, V. Koren, G. Gayno, and J. D. Tarplay, 2003: Implementation of Noah land surface model advances in the National Centers for Environmental Prediction operational mesoscale Eta model. *J. Geophys. Res*., **108**, 8851, doi:10.1029 /2002JD003296.

Meng, J., et al., 2012: The land surface analysis in the NCEP Climate Forecast System Reanalysis. *J. Hydrometeor.*, **13**, 1621–1630, doi:10.1175/JHM-D-11-090.1.

Gutman, G., and A. Ignatov. 1998. “The Derivation of the Green Vegetation Fraction from NOAA/AVHRR Data for Use in Numerical Weather Prediction Models.” *International Journal of Remote Sensing* 19 (8): 1533–1543. doi:10.1080/014311698215333.

Comprehensive description of the model physics:

Saha, S., and Coauthors, 2010: The NCEP Climate Forecast System Reanalysis*. Bull. Amer. Meteor. Soc*., 91, 1015.1057. doi: 10.1175/2010BAMS3001.1

Saha, S. and Coauthors, 2014: The NCEP Climate Forecast System Version 2 *J. Climate*, 27, 2185–2208. doi: http://dx.doi.org/10.1175/JCLI-D-12-00823.1

http://www.ral.ucar.edu/research/land/technology/lsm/noah/Noah_LSM_USERGUIDE_2.7.1.pdf

Zobler, L. 1986. A World Soil File for Global Climate Modelling. NASA Technical Memorandum 87802. NASA Goddard Institute for Space Studies, New York, New York, U.S.A.

9. Configuration in the S2S archiving

The NCEP re-forecasts dataset is a "fixed" dataset which means that the re-forecasts are produced once from a "frozen" version of the model and are used for a number of years to calibrate real-time forecast. The NCEP re-forecasts consist of a 4-member ensemble run every day from 1st January 1999 to 31 December 2010.

As for the other models, NCEP re-forecasts are archived in the S2S database with 2 date attributes:

- hdate which corresponds to the actual starting date of the re-forecast
- date which correspond tot he ModelVersionDate.Since the NCEP re-forecasts are "fixed" re-forecasts this ModelVersiondate is the same for all the re-forecasts and equal to **20110301**. This variable will change when a new version of CFS will be implemented.

NCEP CFSv2 archives for the S2S project

- **Real time forecast:**
  - 16 runs every day, 4 runs each at 00z, 06z, 12z, 18z
  - Ensemble number (nnn) for S2S (e.g. initial date June10, 2014==20140610)

1. 000—run 01 started at 00z 20140610
2. 001—run 02 started at 00z 20140610
3. 002—run 03 started at 00z 20140610
4. 003—run 04 started at 00z 20140610
5. 004—run 01 started at 18z 20140609, archived as started at 00z 20140610
6. 005—run 02 started at 18z 20140609, archived as started at 00z 20140610
7. 006—run 03 started at 18z 20140609, archived as started at 00z 20140610
8. 007—run 04 started at 18z 20140609, archived as started at 00z 20140610
9. 008—run 01 started at 12z 20140609, archived as started at 00z 20140610
10. 009—run 02 started at 12z 20140609, archived as started at 00z 20140610
11. 010—run 03 started at 12z 20140609, archived as started at 00z 20140610
12. 011—run 04 started at 12z 20140609, archived as started at 00z 20140610
13. 012—run 01 started at 06z 20140609, archived as started at 00z 20140610
14. 013—run 02 started at 06z 20140609, archived as started at 00z 20140610
15. 014—run 03 started at 06z 20140609, archived as started at 00z 20140610
16. 015—run 04 started at 06z 20140609, archived as started at 00z 20140610

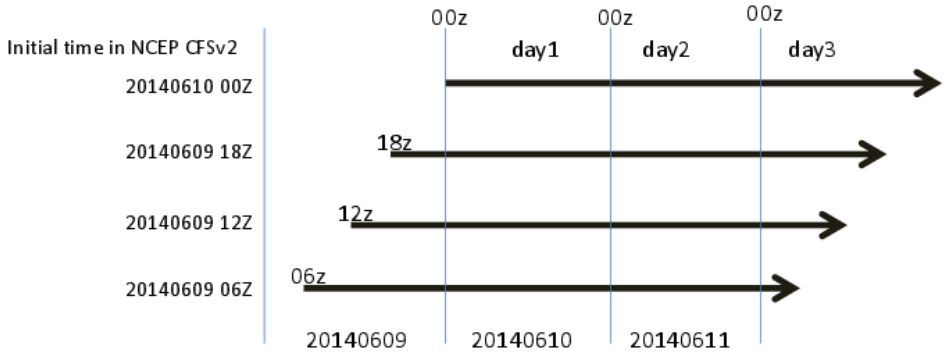
- **Retrospective forecast (hindcast):**
  - 4 runs every day, each run at 00z, 06z, 12z, 18z, from 1999 to 2010
  - Ensemble number (nnn) for S2S (e.g. initial date June10, yyyy ==yyyy0610)

1. 000—started at 00z yyyy0610
2. 001—started at 18z yyyy0609, archive as started at 00z yyyy0610
3. 002—started at 12z yyyy0609, archive as started at 00z yyyy0610
4. 003—started at 06z yyyy0609, archive as started at 00z yyyy0610

***See the schematic plot for the definition of forecast days in the next slide**

The forecast days in archives for S2S

e.g. the archive for initial date June 10, 2014 ==20140610



*** The forecast time steps for the forecast target days (day1, day2, day3…) from the above 4 initial times are archived as the same as that started at 00z 20140610. For example, day1 is step 0-24.**

10 Issues in the S2S database

- Step 0 is not available for all surface instantaneous fields, except for mean sea level pressure (msl)
- Step 0-24 (day 1) not available for all daily-mean fields except 2-metre dewpoint temperature, total cloud cover and Convective available Potential Energy (CAPE)

- For some re-forecast dates, only the 00Z runs could be recovered, which means that the control, ensemble members 1, 2 and 3 are identical and correspond tot he 00Z run.
  The list of affected dates is:

  19990101,

  19991110 -- 19991012,

  20001110 -- 20001119,

  20011110 -- 20011119,

  19990210 -- 19990221,

  20000210 -- 20000221,

  20010210 -- 20010221.