NOAA Earth System Research Laboratory

Reforecasts: what are they good for?

Using multi-decadal reforecasts from the NCEP Global Ensemble Forecast System.

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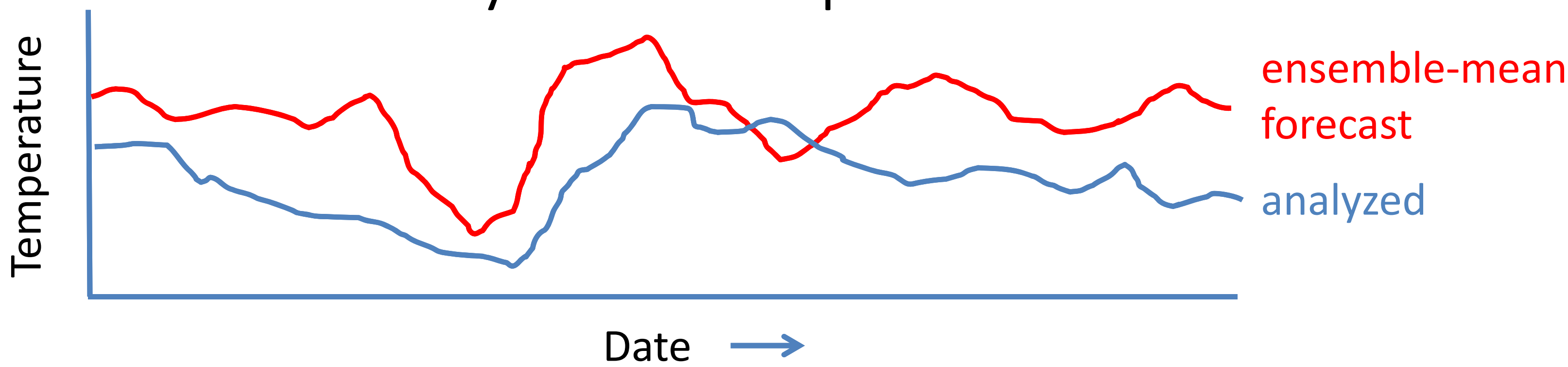
also: Jeff Whitaker, Gary Bates, Don Murray, Francisco Alvarez, Mike Fiorino, Tom Galarneau

What's to be covered here

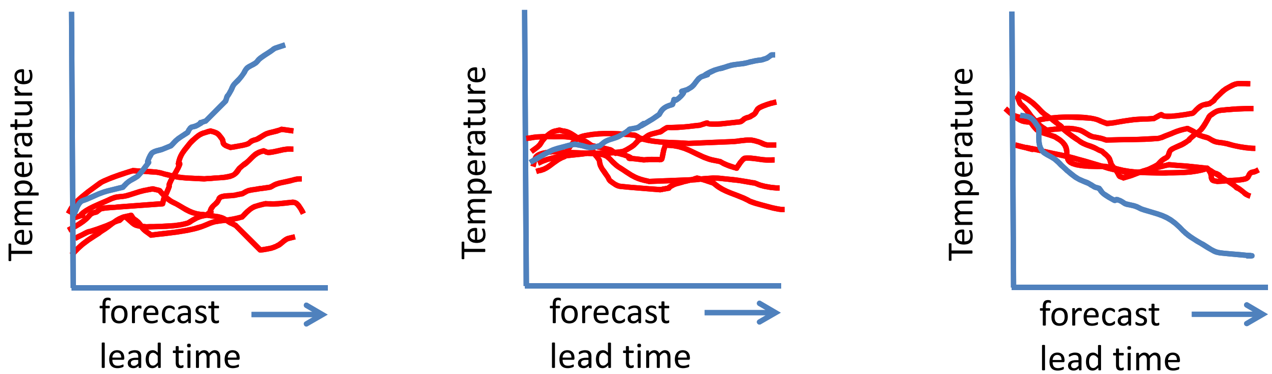
- A quick descriptions of the why / what of this reforecast database.
- Skill of raw reforecasts
- Post-processing method and examples
- How you can access the reforecast data for your own applications.

Ensemble simulations of the weather and climate commonly have systematic errors.

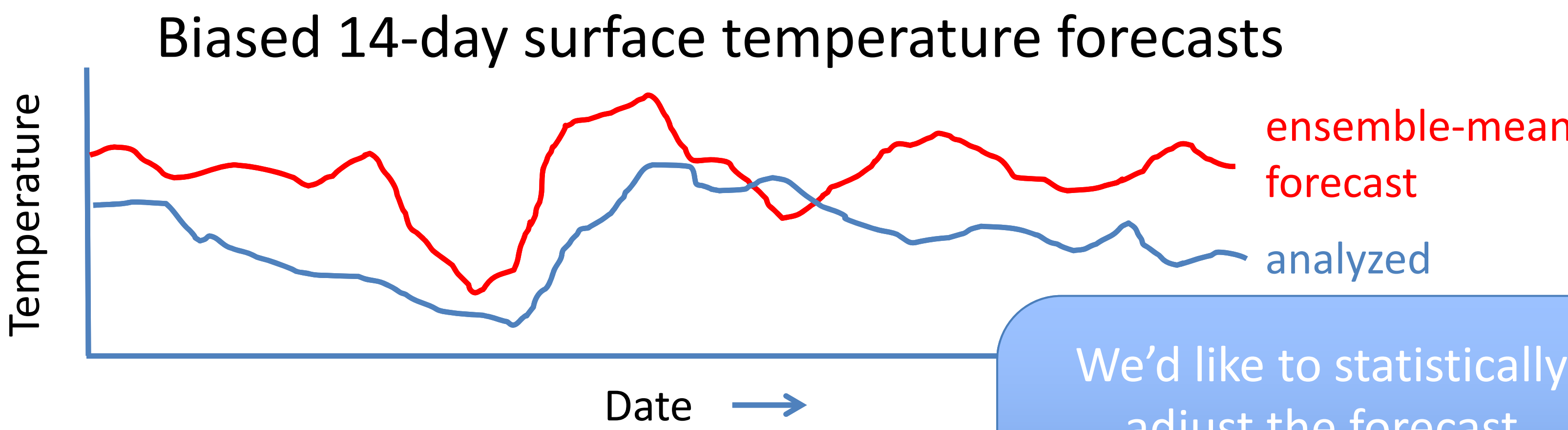
Biased 14-day surface temperature forecasts



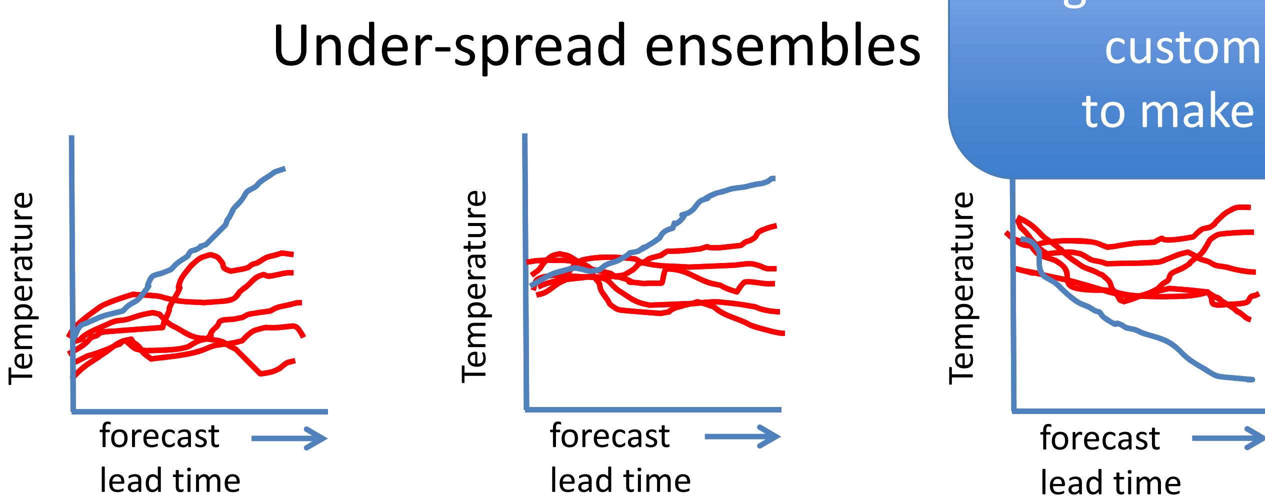
Under-spread ensembles



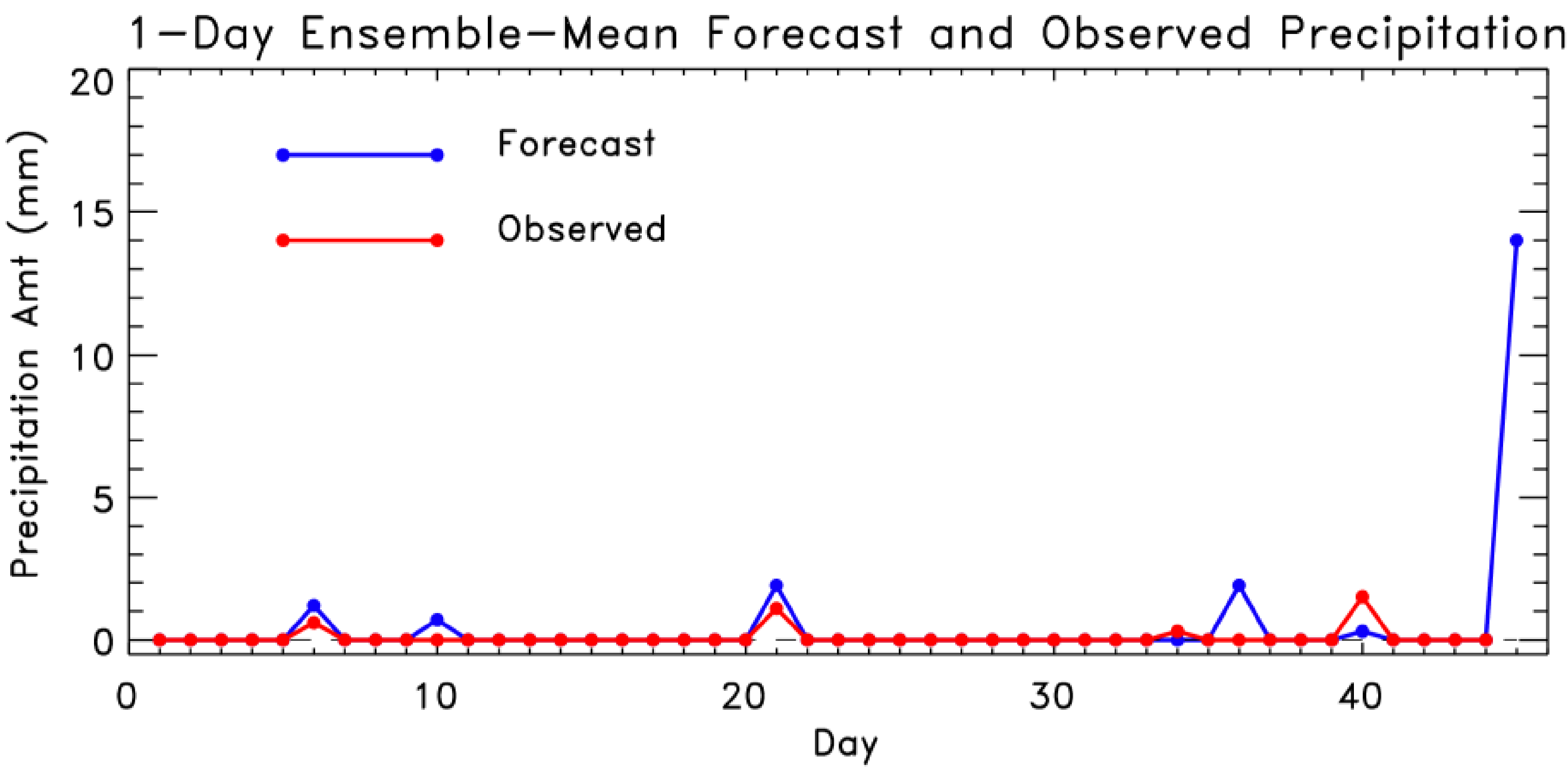
Ensemble simulations of the weather and climate commonly have systematic errors.



We'd like to statistically adjust the forecast guidance before our customers use it to make decisions.



Statistical post-processing for rare events is challenging without a large training sample



Say you want to statistically post-process your model precipitation forecast to improve it. Heavy precipitation events like the one today are the ones you care about the most. How do you calibrate today's forecast given past short sample of forecasts and observations?

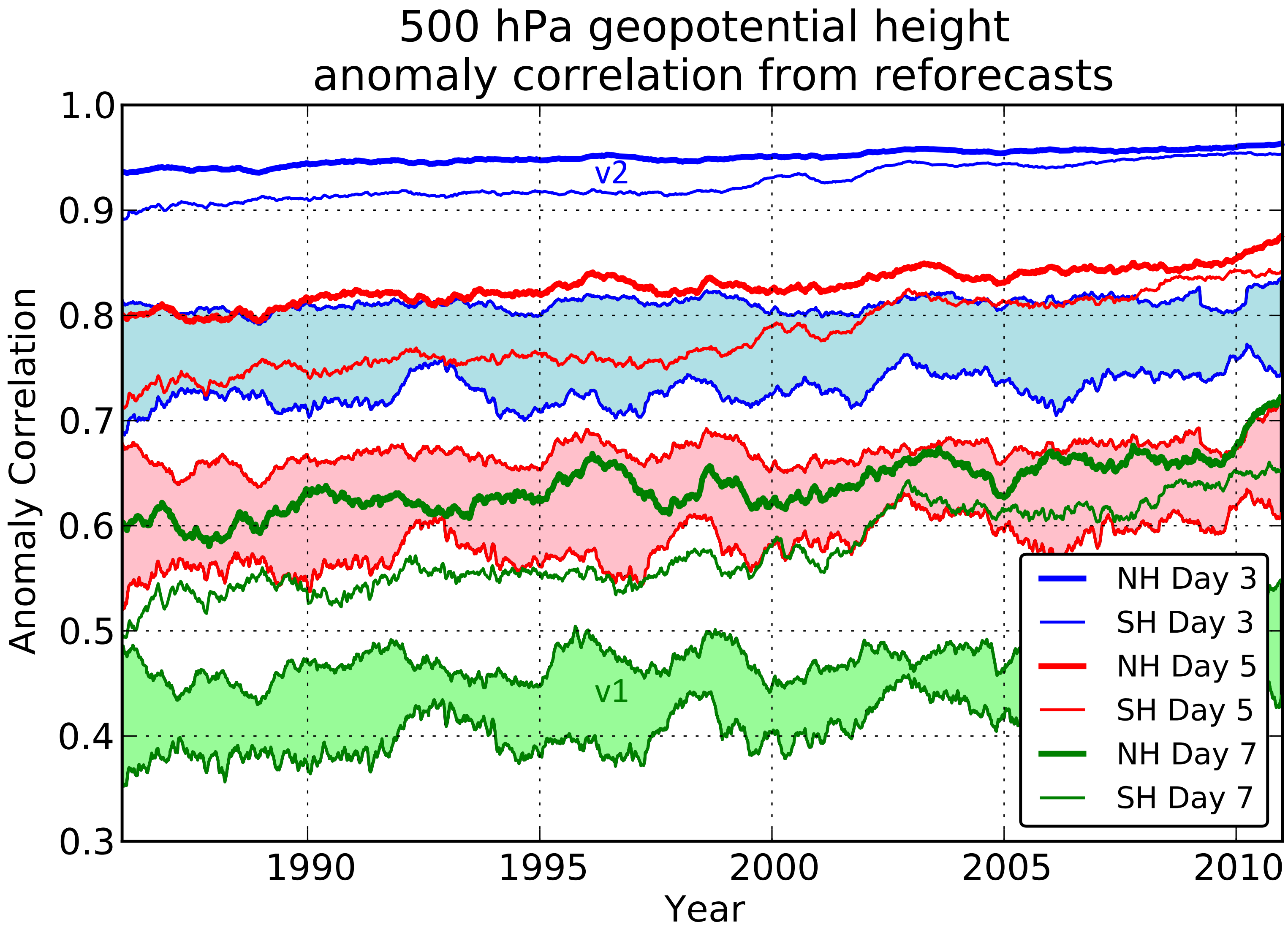
Reforecasts (hindcasts)

- Numerical simulations of the past weather (or climate) using the same forecast model and assimilation system that (ideally) is used operationally.
- Common with climate, uncommon with weather models.

GEFS reforecast v2 details

- Seeks to mimic GEFS (NCEP Global Ensemble Forecast System) operational configuration as of February 2012.
- Once daily at 00 UTC, we produce an 11-member forecast, 1 control + 10 perturbed.
- These reforecasts were produced every day, for 1984120100 to current.
- CFSR (NCEP's Climate Forecast System Reanalysis) initial conditions (3D-Var) + ETR perturbations (cycled with 10 perturbed members). After ~ 22 May 2012, initial conditions from hybrid EnKF/3D-Var.
- Resolution: T254L42 to day 8 (~47-km grid spacing), T190L42 (~ 70 km) from days 7.5 to day 16.
- Fast data archive at ESRL of 99 variables, 28 of which stored at original ~1/2-degree resolution during week 1. All stored at 1 degree. Also: mean and spread to be stored.
- Full archive at DOE/Lawrence Berkeley Lab, where data set was created under DOE grant.

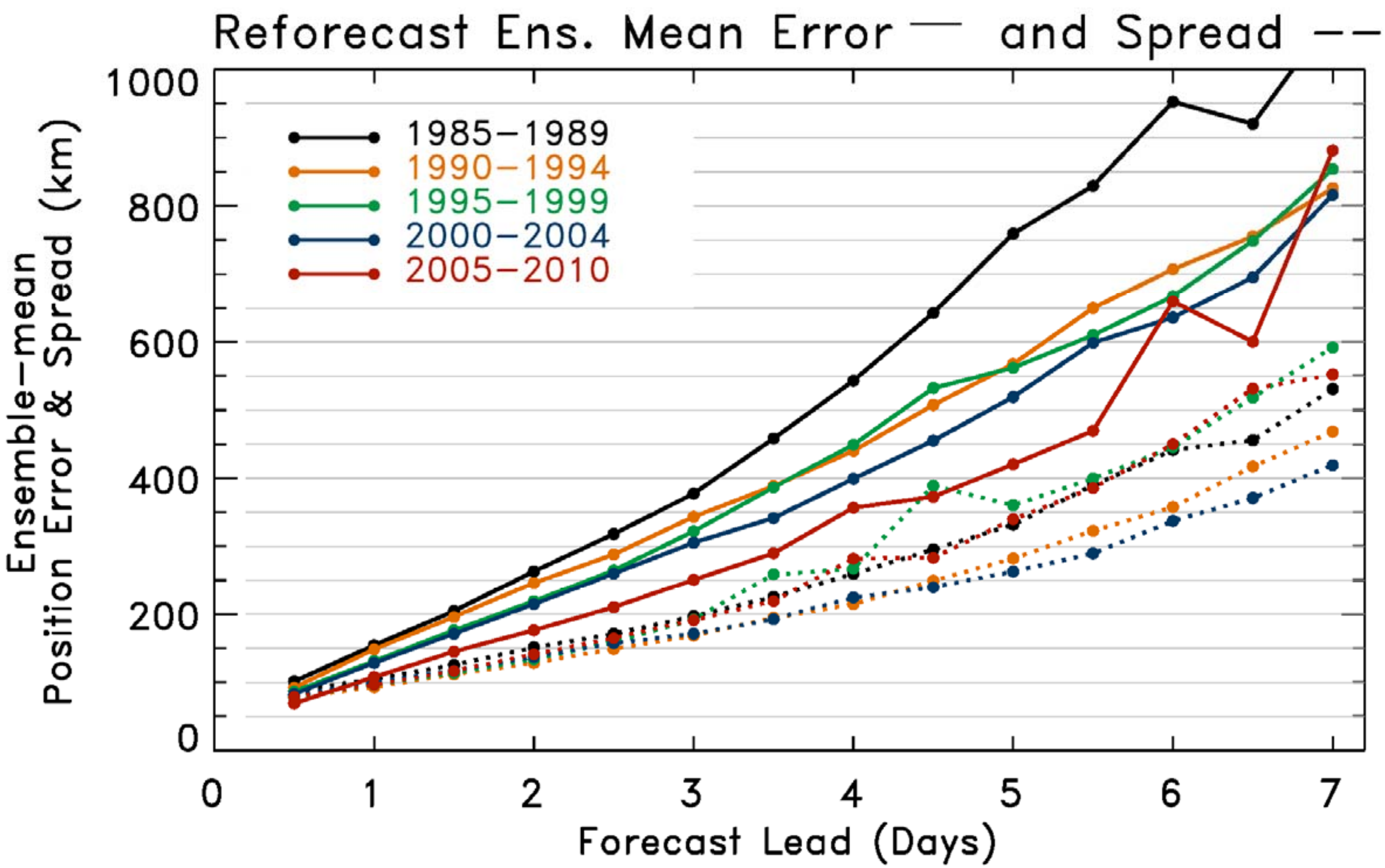
A few characteristics of the raw reforecasts



(1) CFSR initial conditions used in GEFS generally improve over the decades, leading to slight improvements in GEFS skill.

(2) About a +2 day improvement relative to 1998 GEFS T62 reforecasts.

Tropical cyclone track error and spread

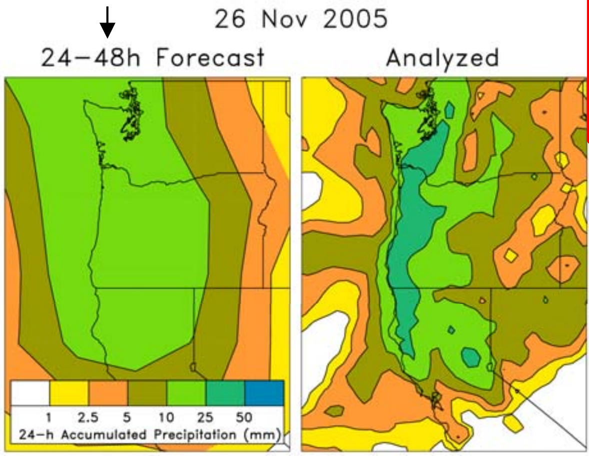


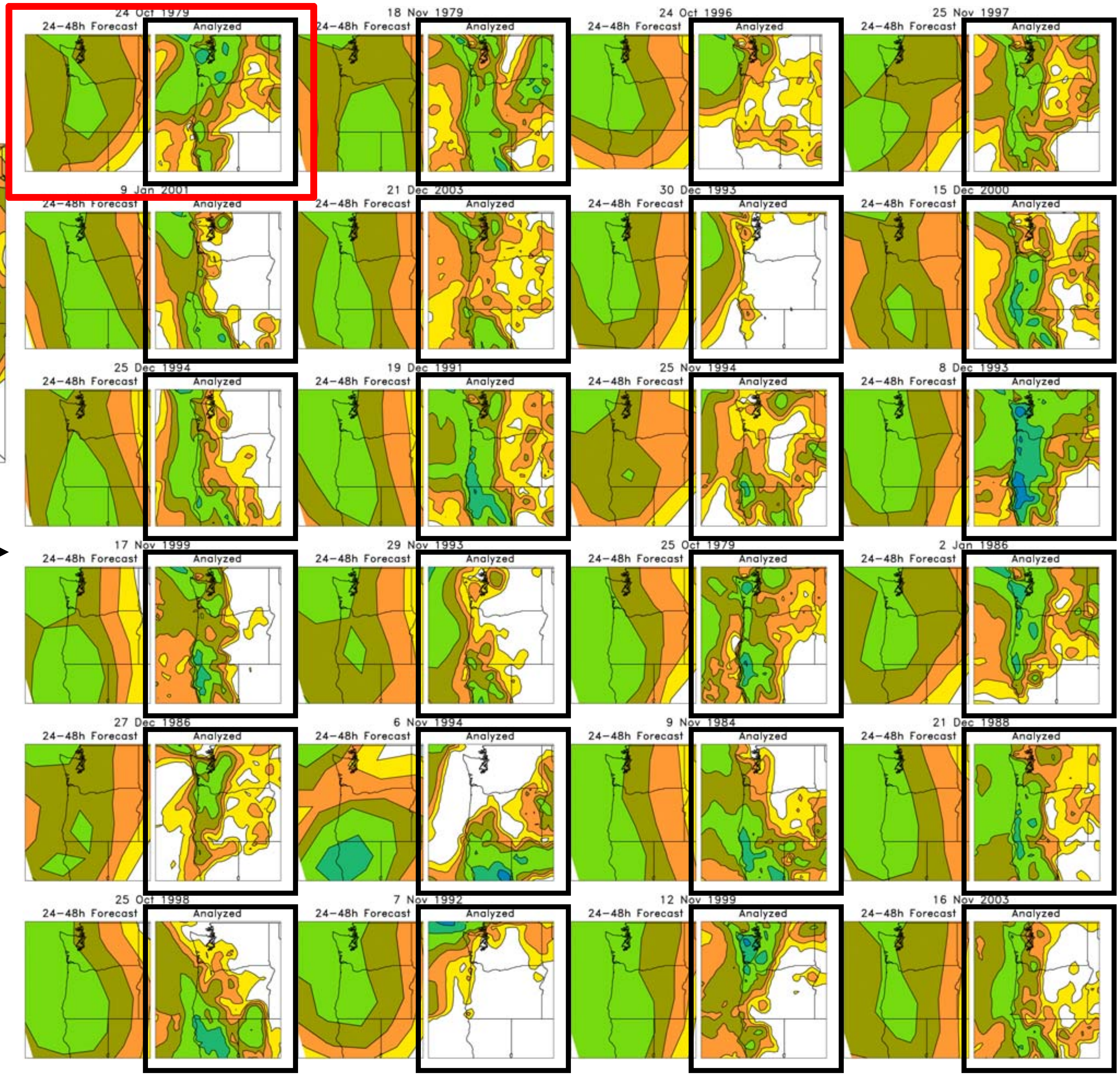
A change in skill over time more evident with TCs, and in general with the tropical atmosphere relative to the extratropics.

Application: statistical post-processing using reforecasts

An example of a statistical correction technique using those reforecasts

Today's forecast (& observed)

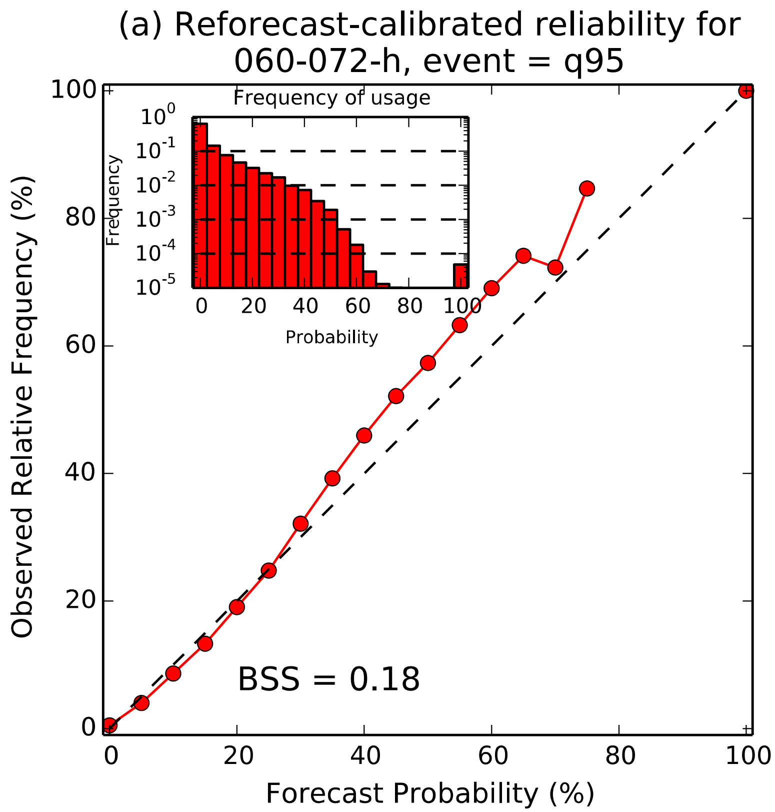


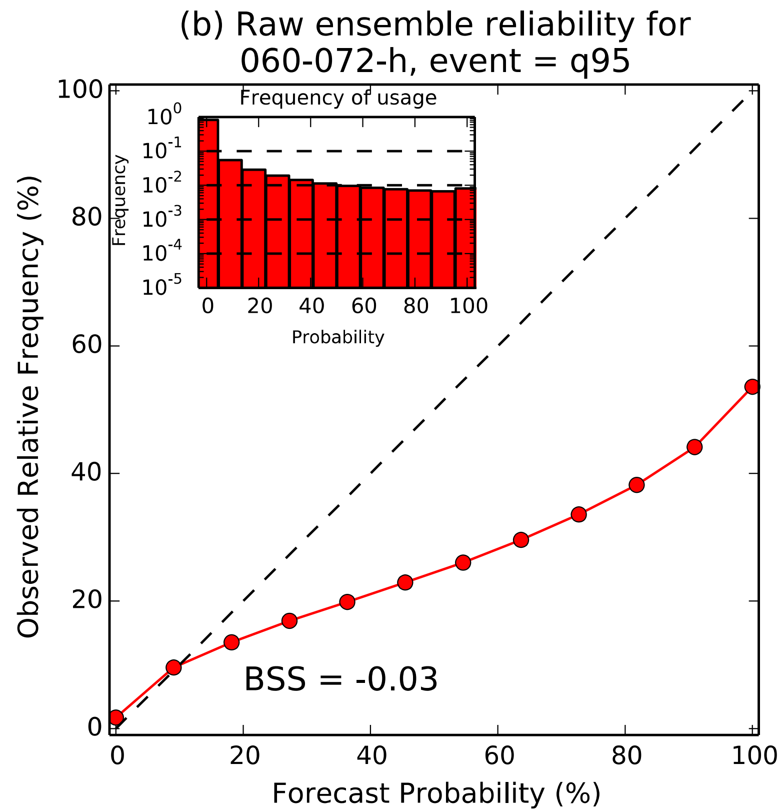


For each pair (e.g. red box), on the left are old forecasts that are somewhat similar to this day's ensemble-mean forecast. The boxed data on the right, the analyzed precipitation for the same dates as the chosen analog forecasts, can be used to statistically adjust and downscale the forecast.

Analog approaches like this may be particularly useful for hydrologic ensemble applications, where an ensemble of weather realizations is needed as inputs to a hydrologic ensemble streamflow system.

Reliability, > 95% climatological quantile

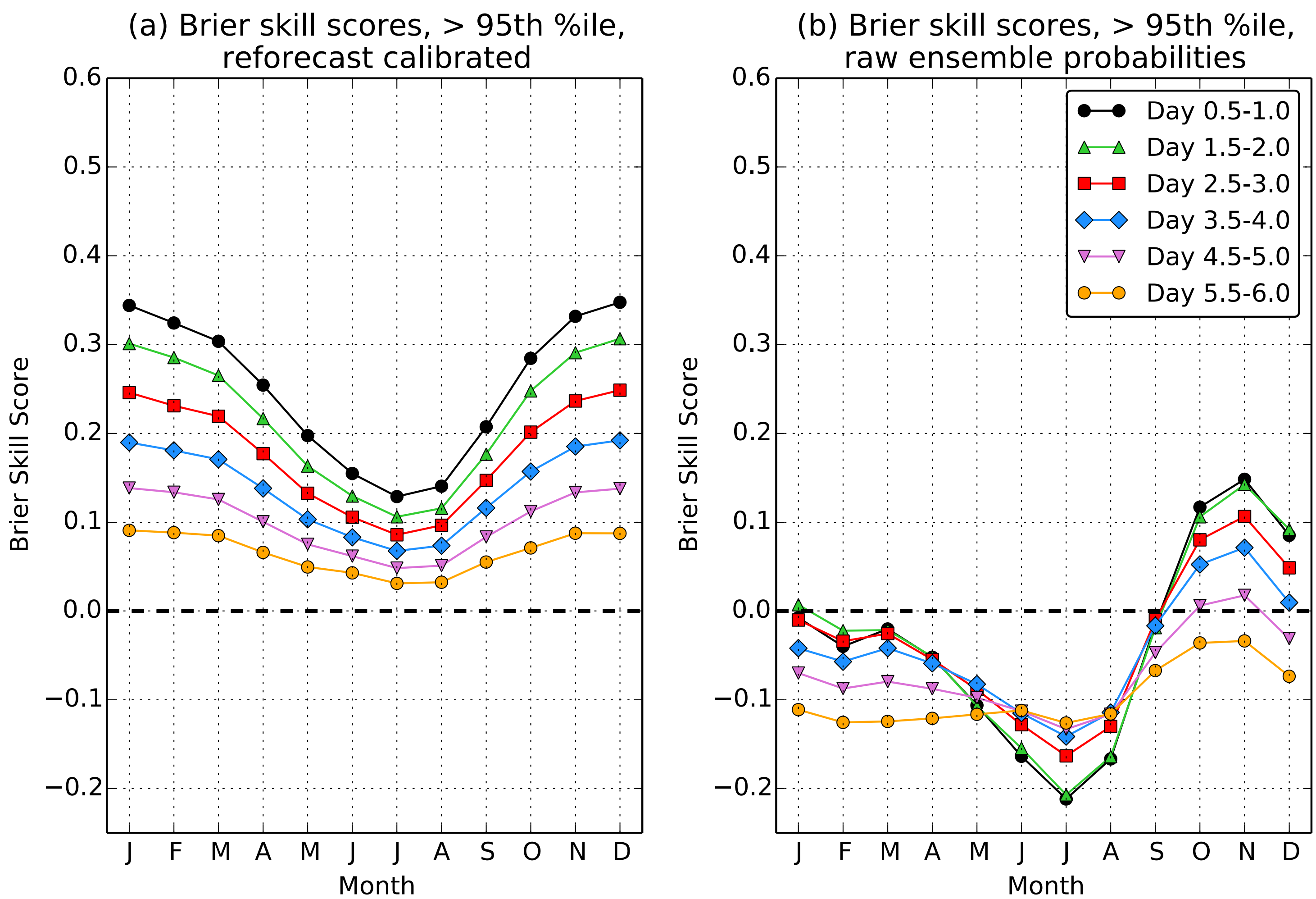




The analog-based calibration dramatically improves reliability and skill over the probabilistic forecasts derived from the raw ensemble.

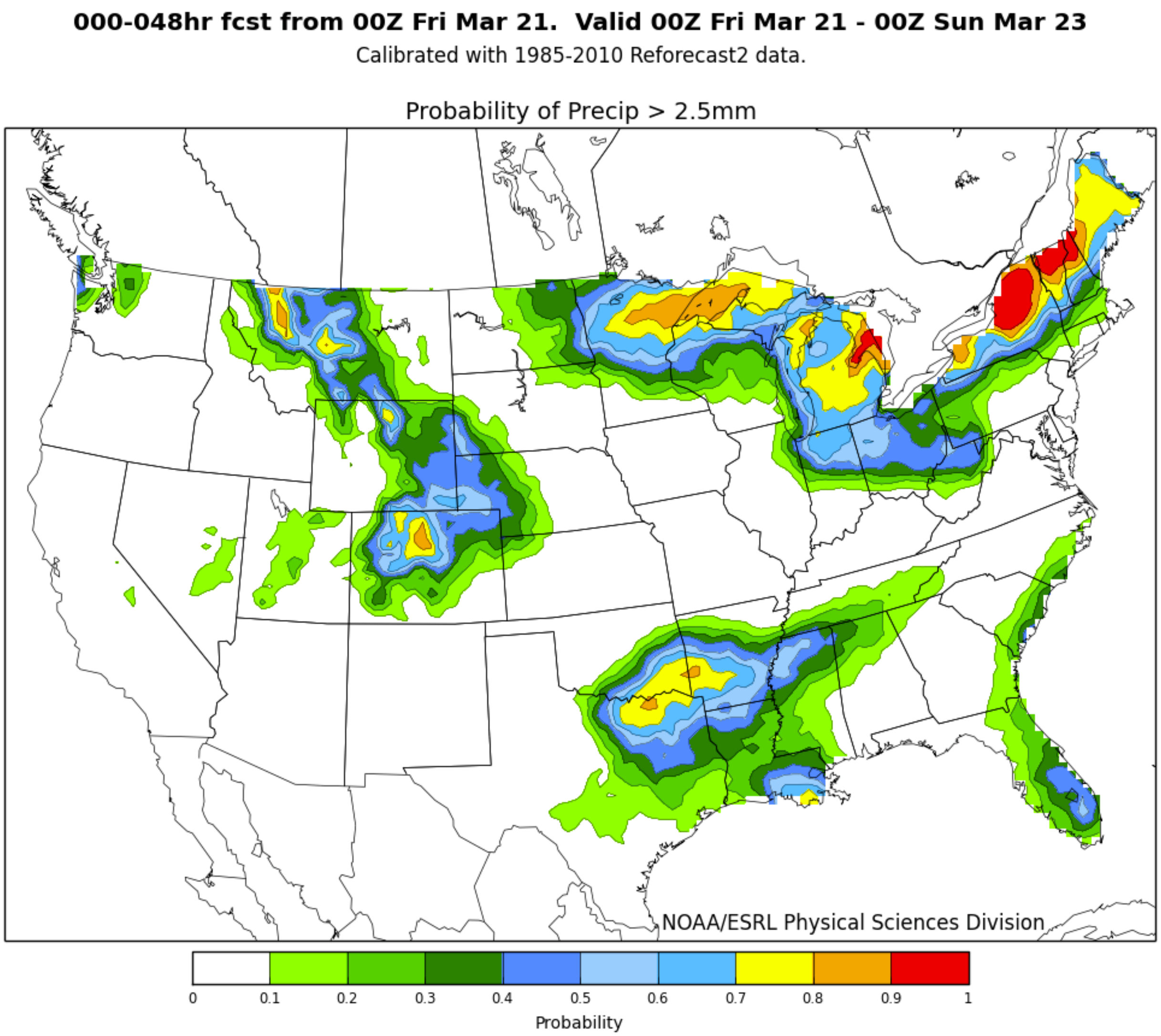
I'd note that this "reforecast" ≠ "analog." You can apply whatever post-processing method you choose to design, and I suspect many could do even better.

Precipitation reforecast skill



Reforecast skill of post-processed precipitation forecasts and forecast probabilities derived from the raw ensemble without post-processing.

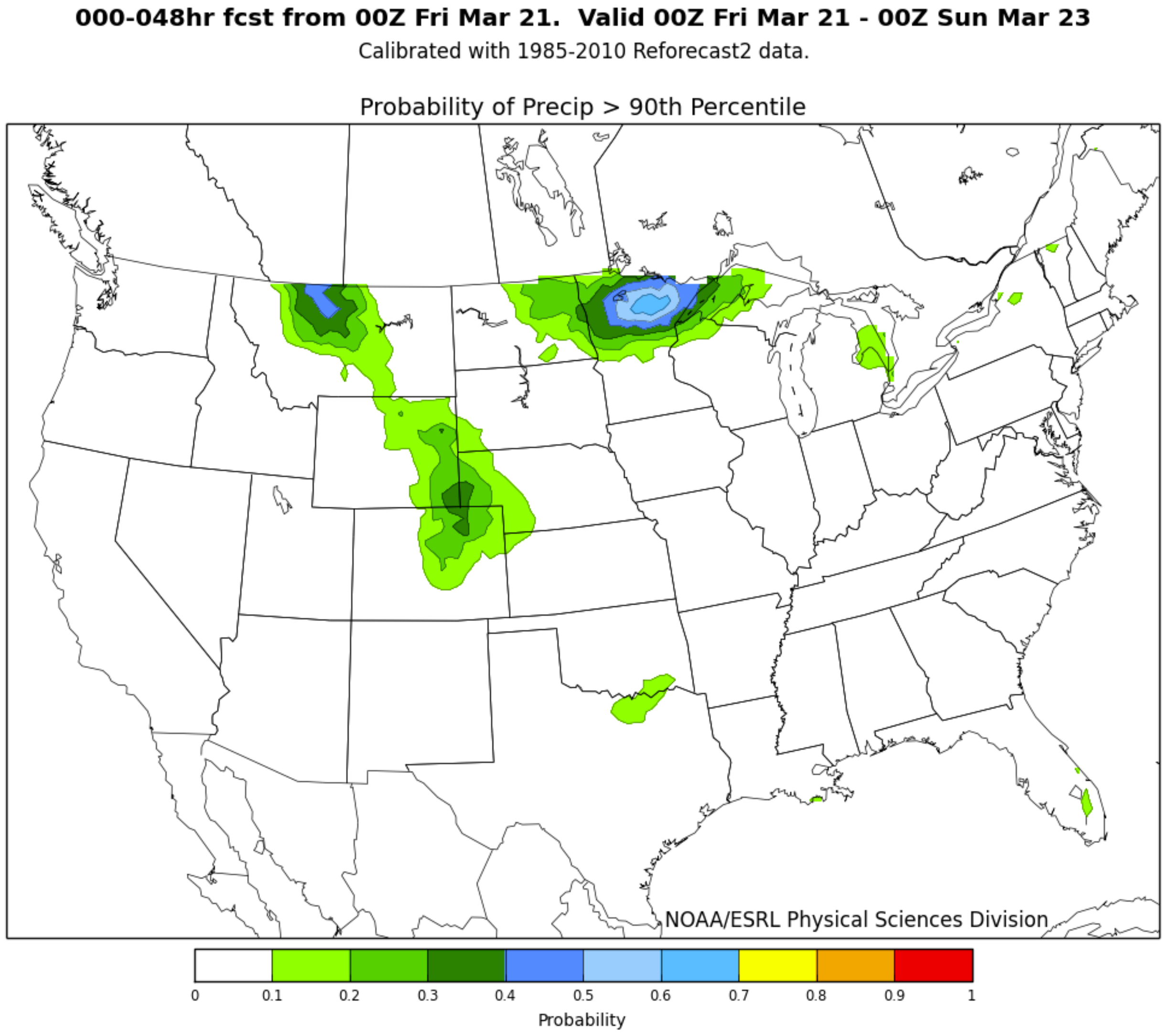
Example: recent forecast graphics



This plot shows the probability of getting more than 2.5mm of precipitation within the 48hrs following 00Z Fri Mar 21.

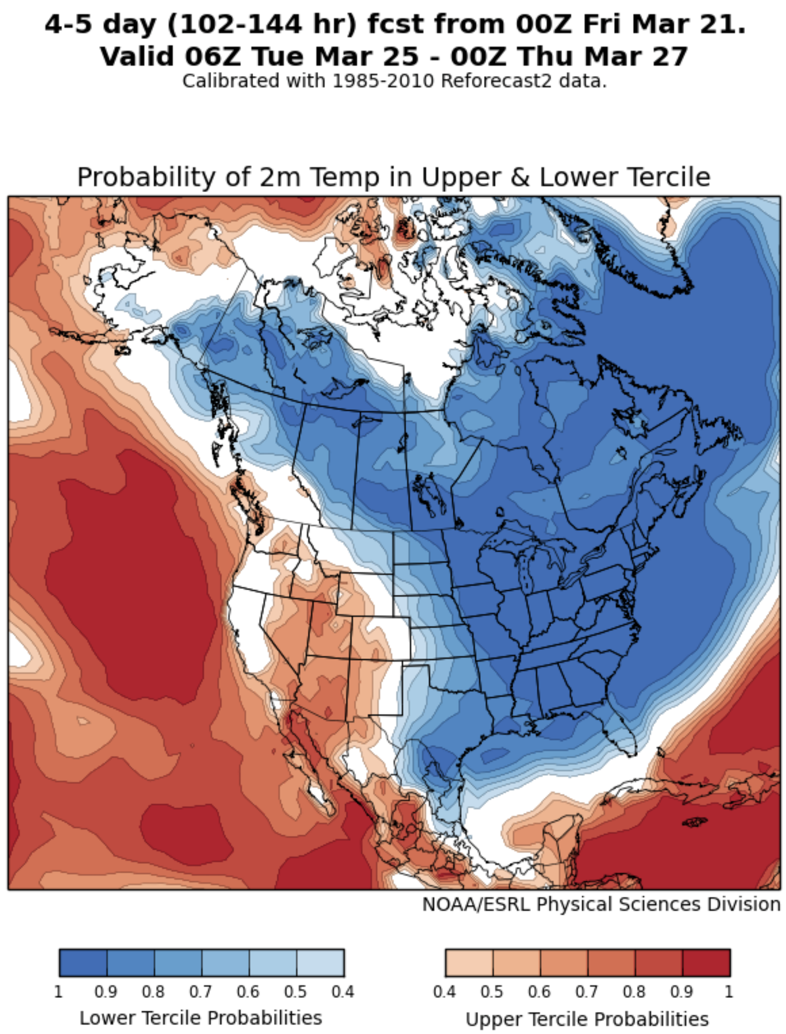
http://www.esrl.noaa.gov/psd/forecasts/reforecast2/analogs/index.html

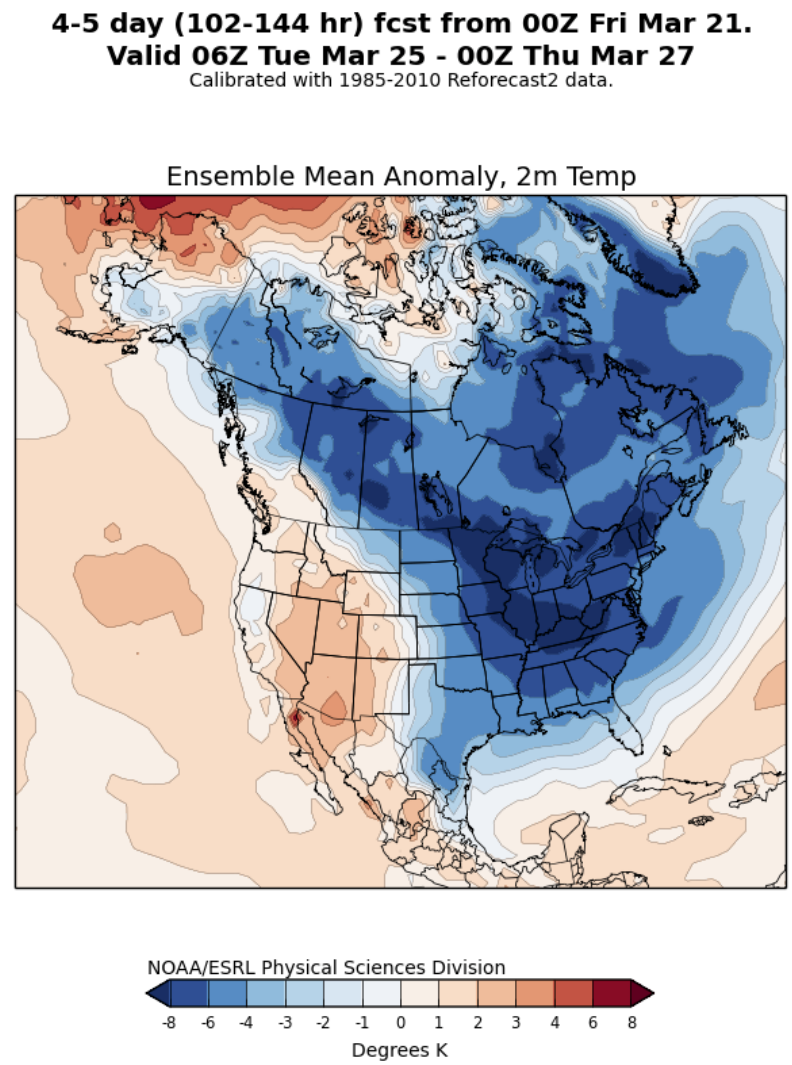
Example: recent forecast graphics



Here are probabilities of exceeding the 90th percentile of the climatological distribution, a way of normalizing for how dry each location is.

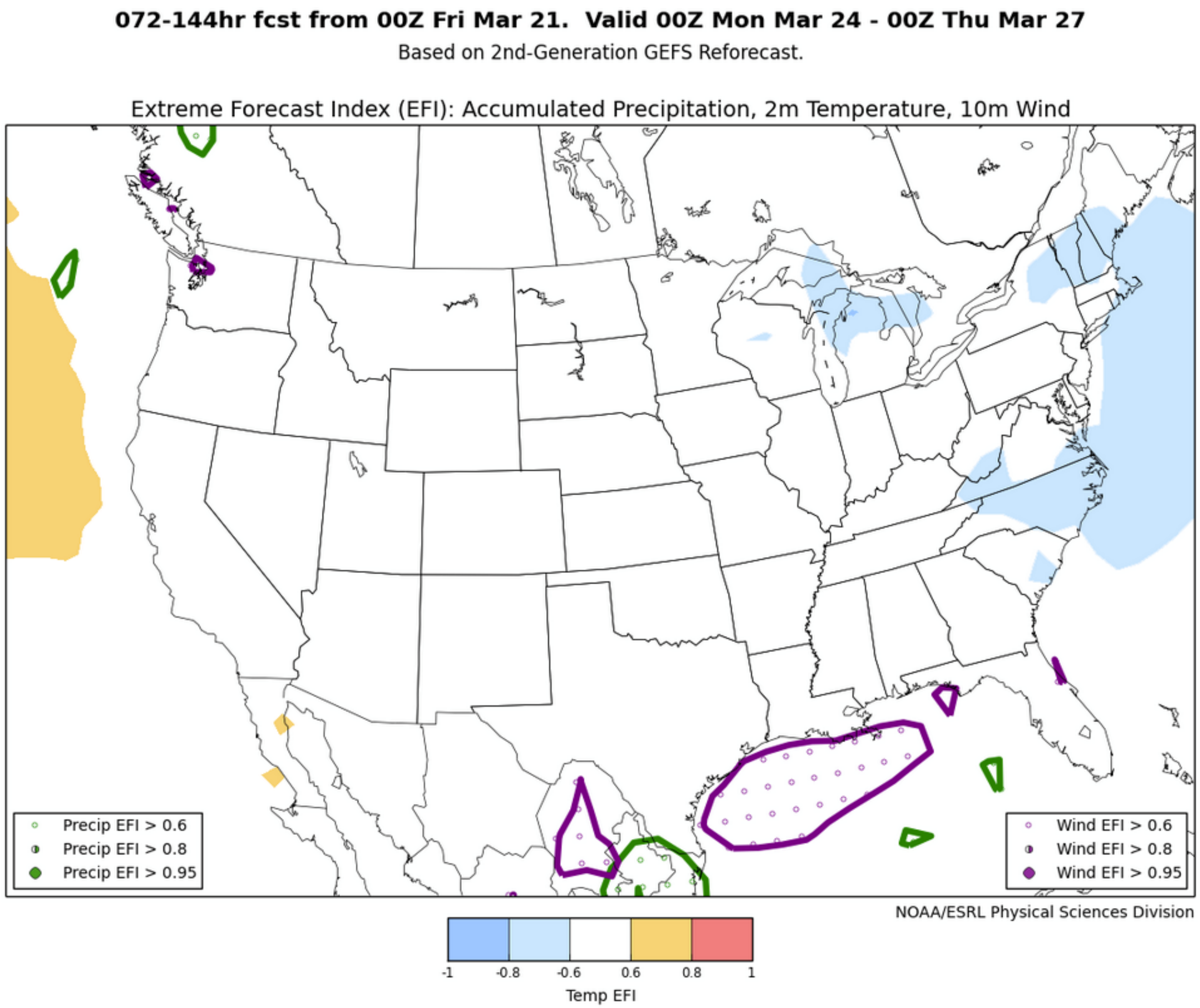
Example: post-processed 2-meter temperature forecasts





http://www.esrl.noaa.gov/psd/forecasts/reforecast2/medrange/index.html

Extreme forecast index

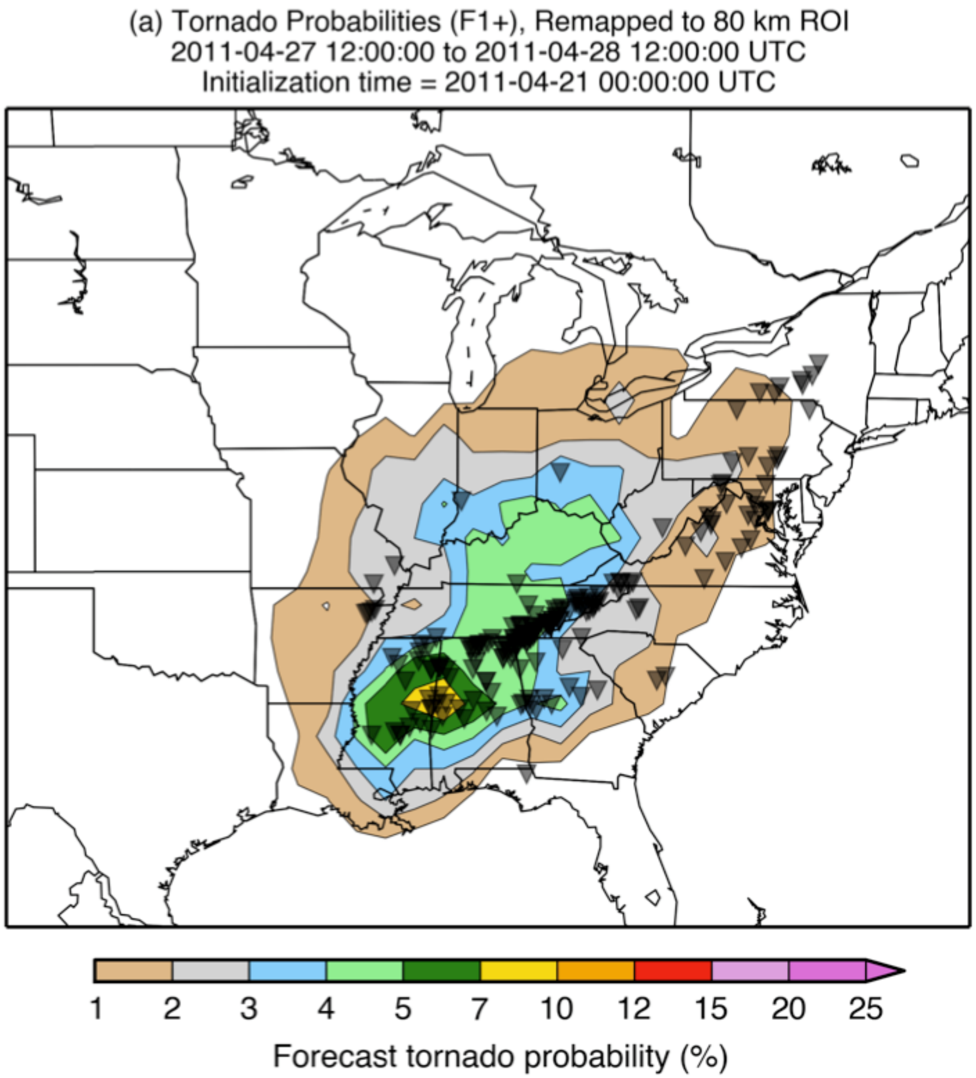


In the absence of reliable verification data for training a post-processing method, one can at least compare today's forecast and see how unusual it is relative to the model climatology.

This EFI plot is calculated following ECMWF's methodology.

http://www.esrl.noaa.gov/psd/forecasts/reforecast2/analogs/index.html

Application: extended-range tornado forecasting



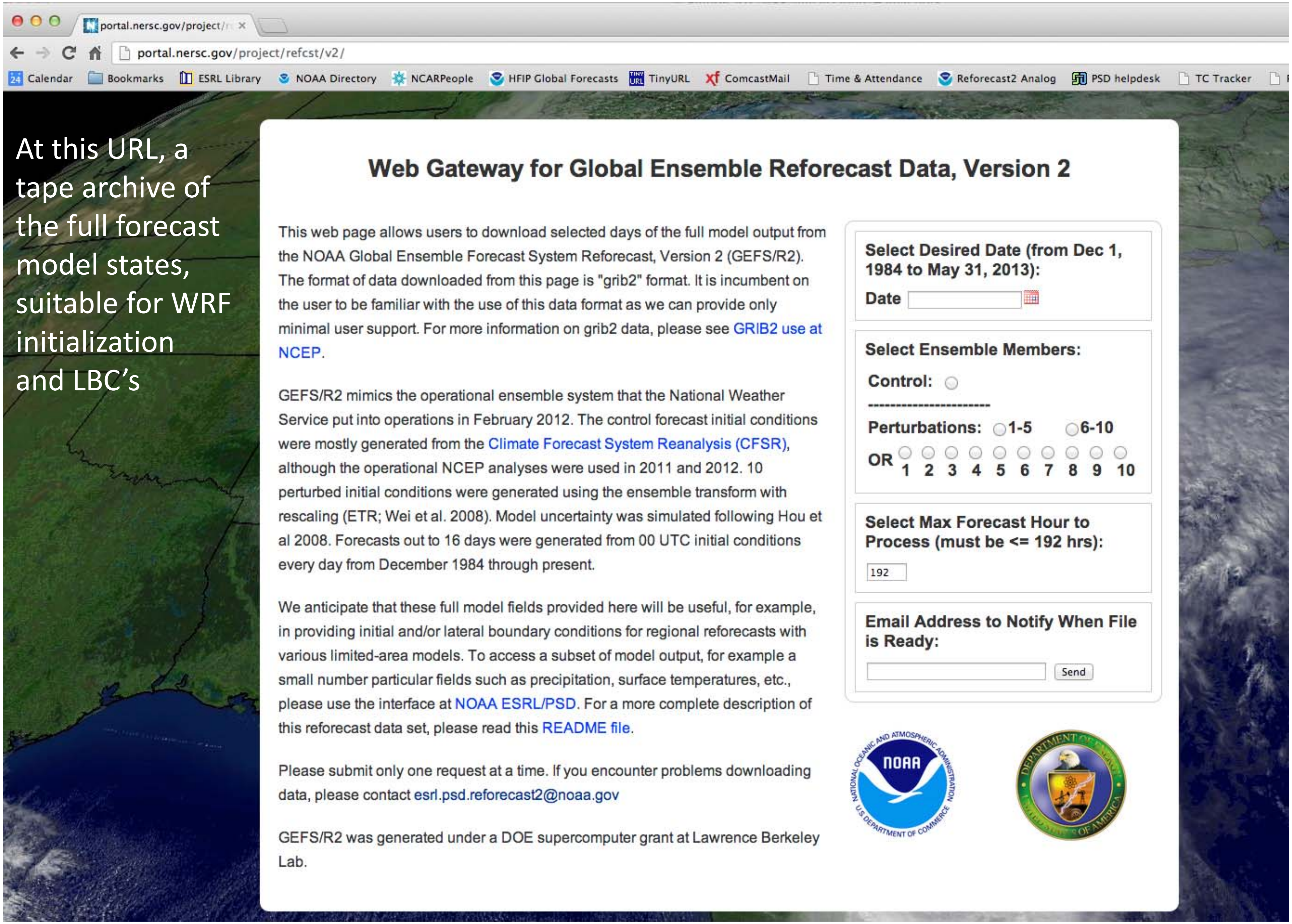
Francisco Alvarez at St. Louis University, is working with Tom Hamill and others on using the reforecasts to make extended-range predictions of tornado probabilities.

Ph.D. work, in progress.

http://tinyurl.com/reforecast-tornado

Application: providing initial and lateral boundary conditions to permit WRF retrospective forecasts

At this URL, a tape archive of the full forecast model states, suitable for WRF initialization and LBC's



portal.nersc.gov/project/refcst/v2/

Web Gateway for Global Ensemble Reforecast Data, Version 2

This web page allows users to download selected days of the full model output from the NOAA Global Ensemble Forecast System Reforecast, Version 2 (GEFS/R2). The format of data downloaded from this page is "grib2" format. It is incumbent on the user to be familiar with the use of this data format as we can provide only minimal user support. For more information on grib2 data, please see GRIB2 use at NCEP.

GEFS/R2 mimics the operational ensemble system that the National Weather Service put into operations in February 2012. The control forecast initial conditions were mostly generated from the Climate Forecast System Reanalysis (CFSR), although the operational NCEP analyses were used in 2011 and 2012. 10 perturbed initial conditions were generated using the ensemble transform with rescaling (ETR; Wei et al. 2008). Model uncertainty was simulated following Hou et al 2008. Forecasts out to 16 days were generated from 00 UTC initial conditions every day from December 1984 through present.

We anticipate that these full model fields provided here will be useful, for example, in providing initial and/or lateral boundary conditions for regional reforecasts with various limited-area models. To access a subset of model output, for example a small number particular fields such as precipitation, surface temperatures, etc., please use the interface at NOAA ESRL/PSD. For a more complete description of this reforecast data set, please read this README file.

Please submit only one request at a time. If you encounter problems downloading data, please contact esrl.psd.reforecast2@noaa.gov

GEFS/R2 was generated under a DOE supercomputer grant at Lawrence Berkeley Lab.

Select Desired Date (from Dec 1, 1984 to May 31, 2013):

Date

Select Ensemble Members:

Control:

Perturbations: 1-5 6-10

OR 1 2 3 4 5 6 7 8 9 10

Select Max Forecast Hour to Process (must be <= 192 hrs):

192

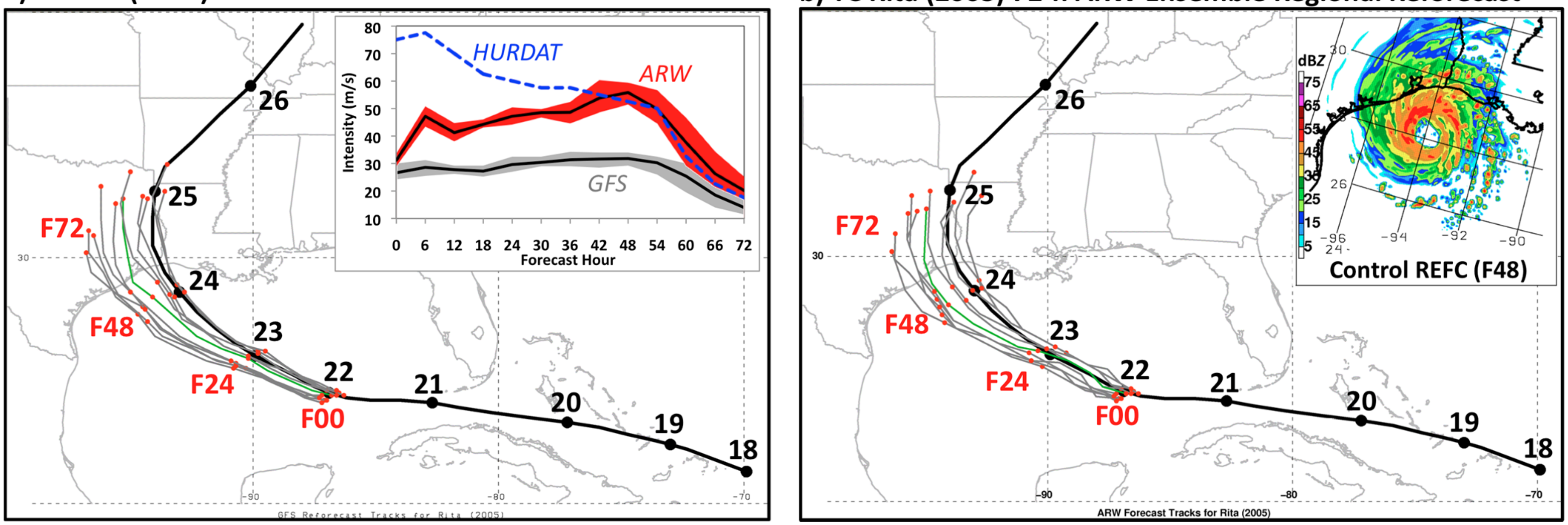
Email Address to Notify When File is Ready:

Send

WRF-ARW reforecast ensemble results

a) TC Rita (2005) 72-h GFS Ensemble Reforecast

b) TC Rita (2005) 72-h ARW Ensemble Regional Reforecast



- Global reforecast ensemble is consistent with NHC forecast; indicating potential impact on Houston
- Significant left-of-track error and intensity was underestimated
- Rita vortex intensified in ARW regional reforecast despite terrible initial vortex
- Similar left-of-track error in ARW; suggests large-scale control on TC motion

Accessing reforecast data

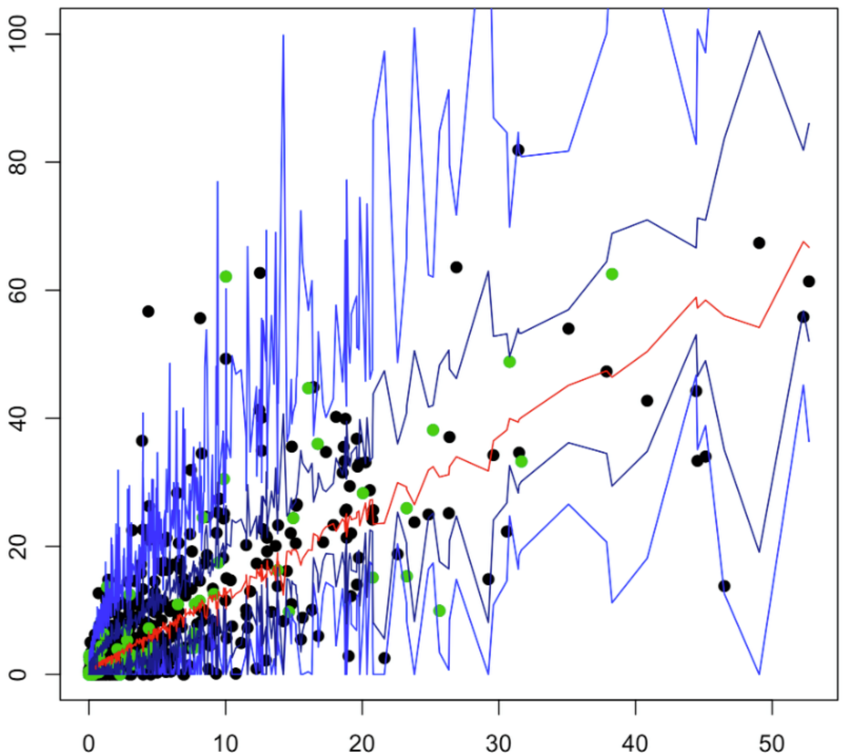
URL: http://www.esrl.noaa.gov/psd/forecasts/reforecast2/download.html

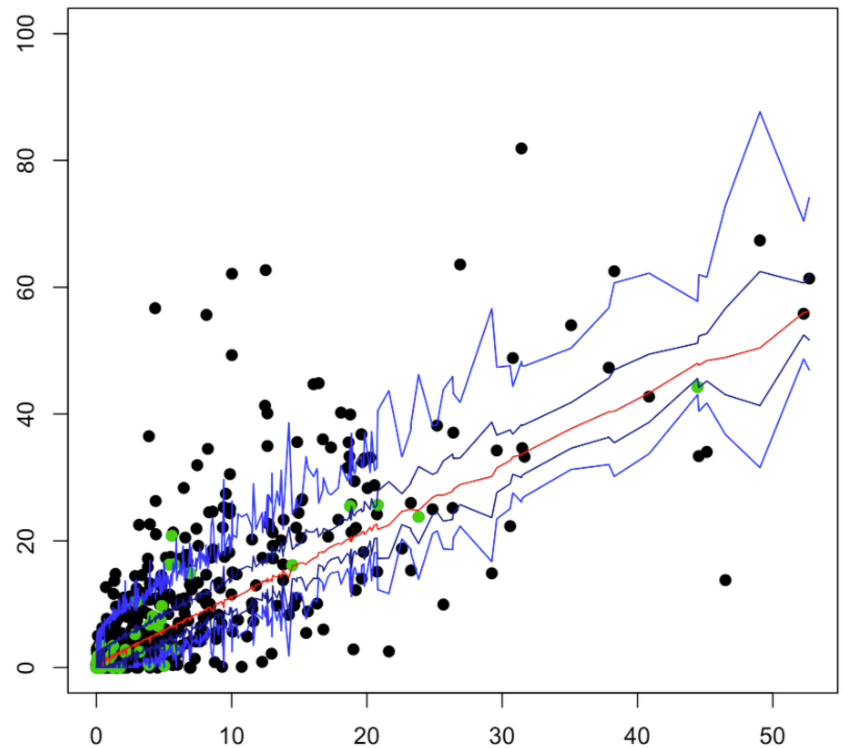
-> download reforecast data in netCDF-4 format

FTP: ftp://ftp.cdc.noaa.gov/Projects/Reforecast2

-> access GRIB2 data

Example: Probabilistic QPF Forecast using a distribution-fitting approach





Predictive median (red), 50% (dark blue) and 90% (blue) prediction intervals for 12h precipitation amounts, where the subset of green forecast-observation pairs (≈ 1y worth of data) where used for training. When those pairs happen to be close to a straight line during the training period, prediction uncertainty can be dramatically underestimated.

Some notes running WRF using data from this archive

(from http://www.esrl.noaa.gov/psd/forecasts/reforecast2/README.GEFS_Reforecast2.pdf)

- The proper Vtable file must be created prior to preprocessing the GEFS reforecast data. To do this, copy Vtable.GFS to your working directory for preprocessing the GRIB2 GEFS reforecast data. Rename the Vtable.GFS file as Vtable.reforecast, and modify the file as follows. First, add a line for specific humidity on pressure levels and at 2 m. The specifications for specific humidity should be as follows:

  metgrid Description: Specific Humidity
  metgrid units: kg kg1
  metgrid Name: SPECHUMD
  GRIB2 Discp=0, Catgy=1, Param=0, Level=100
  GRIB1 Param=52, Level Type=100, From Level1=*
  metgrid Description: Specific Humidity at 2 m
  metgrid units: kg kg1
  metgrid Name: SPECHUMD
  GRIB2 Discp=0, Catgy=1, Param=0, Level=103
  GRIB1 Param=52, Level Type=105, From Level1=2

- Second, remove the GRIB2 parameter number for relative humidity on pressure levels and at 2m. Note that ungrib.exe and metgrid.exe will calculate relative humidity for you if you have specific humidity. Finally, change the GRIB2 parameter number for PMSL from 1 to 0. No other known modifications to the Vtable are needed. Now that the Vtable.reforecast file is properly created, follow the instructions for running WRFARW on the WRF Users' Page [http://www.mmm.ucar.edu/wrf/users/].

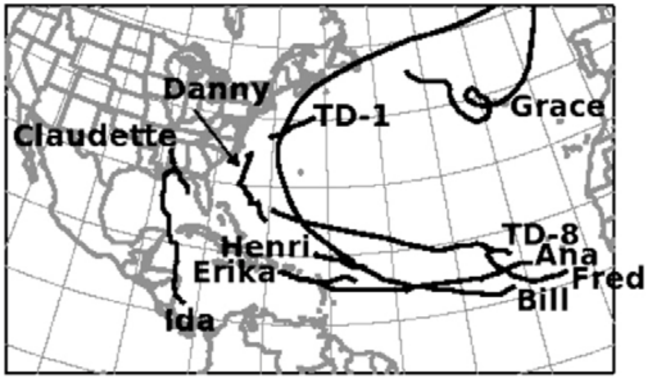
- The files downloaded from DOE will have the fields for the different forecast lead times merged into one grib file. It will be your responsibility to break up that into separate grib files for each lead time.

- Multi-level soil moisture wasn't saved. README file indicates how to deal with this.

Details of reforecast with WRF ARW v3.4 using GEFS for initial, boundary conditions

- Nested simulation 36-, 12- and 4-km with 36 vertical levels
  - 12- and 4-km moving nests
- Time steps: 180, 60, and 20 s
- Initial and boundary conditions from GFS reforecast ensemble members
- Tiedtke cumulus scheme on 36 and 12 km; explicit on 4 km
- YSU PBL scheme
- HYCOM ocean analysis
- WSM6 microphysics
- Noah land surface
- 2D Smagorinsky turbulence scheme
- Goddard shortwave radiation
- RRTM longwave radiation
- Second order diffusion
- Positive definite scalar advection
- Donelan wind-dependent drag formulation
- Garratt wind-dependent enthalpy surface fluxes

outer WRF domain



Data that is readily available from ESRL

Table 1: Reforecast variables available for selected mandatory and other vertical levels. Φ indicates geopotential height, and an X indicates that this variable is available from the reforecast data set at 1-degree resolution; a Y indicates that the variable is available at the native ~0.5 degree resolution. AGL indicates "above ground level."

Vertical Level	U	V	T	Φ	q	Wind Power
10 hPa	X	X	X	X		
50 hPa	X	X	X	X		
100 hPa	X	X	X	X		
200 hPa	X	X	X	X		
250 hPa	X	X	X	X		
300 hPa	X	X	X	X	X	
500 hPa	X	X	X	X	X	
700 hPa	X	X	X	X	X	
850 hPa	X	X	X	X	X	
925 hPa	X	X	X	X	X	
1000 hPa	X	X	X	X	X	
$\sigma \cong 0.996$	X	X		X		
$\sigma \cong 0.987$	X	X		X		
$\sigma \cong 0.977$	X	X		X		
$\sigma \cong 0.965$	X	X		X		
80m AGL	X,Y	X,Y				X,Y

Also: hurricane track files

Data that is readily available from ESRL

Table 2: Single-level reforecast variables archived (and their units). Where an [Y] is displayed, this indicates that this variable is available at the native ~0.5-degree resolution as well as the 1-degree resolution.

Variable (units)
Mean sea-level pressure (Pa) [Y]
Skin temperature (K) [Y]
Soil temperature, 0.0 to 0.1 m depth (K) [Y]
Volumetric soil moisture content 0.0 to 0.1 m depth (fraction between wilting and saturation) [Y]
Water equivalent of accumulated snow depth (kg m^{-2}, i.e., mm) [Y]
2-meter temperature (K) [Y]
2-meter specific humidity (kg kg^{-1} dry air) [Y]
Maximum temperature (K) [Y]
Minimum temperature (K) [Y]
10-m u wind component (ms^{-1}) [Y]
10-m v wind component (ms^{-1}) [Y]
Total precipitation (kg m^{-2}, i.e., mm) [Y]
Water runoff (kg m^{-2}, i.e., mm) [Y]
Average surface latent heat net flux (W m^{-2}) [Y]
Average sensible heat net flux (W m^{-2}) [Y]
Average ground heat net flux (W m^{-2}) [Y]
Sunshine
Convective available potential energy (J kg^{-1}) [Y]
Convective inhibition (J kg^{-1}) [Y]
Precipitable water (kg m^{-2}, i.e., mm) [Y]
Total-column integrated condensate (kg m^{-2}, i.e., mm) [Y]
Total cloud cover (%)
Downward short-wave radiation flux at the surface (W m^{-2}) [Y]
Downward long-wave radiation flux at the surface (W m^{-2}) [Y]
Upward short-wave radiation flux at the surface (W m^{-2}) [Y]
Upward long-wave radiation flux at the surface (W m^{-2}) [Y]
Potential vorticity on θ = 320K isentropic surface (K m^2 kg^{-1} s^{-1})
U component on 2 PVU (1 PVU = 1 K m^2 kg^{-1} s^{-1}) isentropic surface (ms^{-1})
V component on 2 PVU isentropic surface (ms^{-1})
Temperature on 2 PVU isentropic surface
Pressure on 2 PVU isentropic surface

esrl.noaa.gov/psd/forecasts/reforecast2/download.html

Select Desired Variables and Associated Levels:

Single Level (1°x1°) | Pressure Levels (1°x1°) | Hybrid Levels (1°x1°) | Single Level (Gaussian ~.5°)

- Total Accumulated Precipitation
- U-Component of Wind at 10 meters
- U-Component of Wind at 80 meters
- Convective Available Potential Energy
- Surface Downward Long-Wave Radiation Flux
- Surface Upward Long-Wave Radiation Flux
- Ground Heat Flux
- Surface Sensible Heat Net Flux
- Surface Pressure
- Volumetric Soil Moisture Content
- Total Cloud Cover
- Skin Temperature
- Minimum Temperature
- Upward Long-Wave Radiation Flux
- Water Equivalent of Accumulated Snow Depth
- Vertical Velocity at 850 hPa Surface
- Pressure on 2 PVU Surface
- V-Component of Wind on 2 PVU Surface
- Temperature at 2 meters
- V-Component of Wind at 10 meters
- V-Component of Wind at 80 meters
- Convective Inhibition
- Surface Downward Short-Wave Radiation Flux
- Surface Upward Short-Wave Radiation Flux
- Surface Latent Heat Net Flux
- Mean Sea Level Pressure
- Precipitable Water
- Specific Humidity at 2 meters
- Total Column-Integrated Condensate
- Maximum Temperature
- Soil Temperature (0-10 cm below surface)
- Water Runoff
- Wind Mixing Energy
- Temperature on 2 PVU Surface
- U-Component of Wind on 2 PVU Surface
- Potential Vorticity on 320 K Isentrope

Select Desired Dates (Available from Dec 1 1984 to Dec 31 2010):

From: **To:**

- Download all the forecasts within the chosen time period. Help
- Download forecasts within the month-days range for the chosen years. Help

Select Desired Forecast Hour(s):

High Resolution: (Select All or Clear)

0	3	6	9	12	15	18	21	24	27
30	33	36	39	42	45	48	51	54	57
60	63	66	69	72	78	84	90	96	102
108	114	120	126	132	138	144	150	156	162
168	174	180	186	192					

Low Resolution: (Select All or Clear)

186	192	198	204	210	216	222	228	234	240
246	252	258	264	270	276	282	288	294	300
306	312	318	324	330	336	342	348	354	360
366	372	378	384						

Produces netCDF files.

Also: direct ftp access to allow you to read the raw grib files.

ftp access is also easy.

- $ ftp –i ftp.cdc.noaa.gov
- [user anonymous, pass=email address]
- cd /Projects/Reforecast2
- cd to YYYY/YYYYMM/YYYYMMDDHH of interest, e.g.,
  - $ cd 2000
  - $ cd 200001
  - $ cd 2000010100
  - $ ls

directory listing

- 150 Here comes the directory listing.
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 c00
- drwxrwxr-x 3 99 1201 80 Jun 27 2012 mean
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p01
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p02
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p03
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p04
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p05
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p06
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p07
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p08
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p09
- drwxr-xr-x 4 99 1201 80 Mar 11 2012 p10
- drwxrwxr-x 3 99 1201 80 Jun 27 2012 sprd
- 226 Directory send OK.
- ftp>

top level director listing, with subdirectories for each perturbation number, the mean, and the spread

more directory listings

- ftp> cd c00
- 250 Directory successfully changed.
- ftp> ls
- 229 Entering Extended Passive Mode (|||53711|).
- 150 Here comes the directory listing.
- drwxr-xr-x 2 99 1201 13312 Aug 13 2012 gaussian
- drwxr-xr-x 2 99 1201 21504 Aug 13 2012 latlon
- 226 Directory send OK.
- ftp> cd latlon
- 250 Directory successfully changed.
- ftp> ls
- 229 Entering Extended Passive Mode (|||36968|).
- 150 Here comes the directory listing.
- -rw-rw-r-- 1 99 1201 4236525 Mar 28 2012 apcp_sfc_2000010100_c00.grib2
- -rw-rw-r-- 1 99 1201 3277 Aug 13 2012 apcp_sfc_2000010100_c00.grib2.inv
- -rw-rw-r-- 1 99 1201 1547 Jun 11 2012 apcp_sfc_2000010100_c00.grib2.pyidx
- -rw-rw-r-- 1 99 1201 3419759 Mar 28 2012 apcp_sfc_2000010100_c00_t190.grib2
- -rw-rw-r-- 1 99 1201 2525 Aug 13 2012 apcp_sfc_2000010100_c00_t190.grib2.inv
- -rw-rw-r-- 1 99 1201 1261 Jun 11 2012 apcp_sfc_2000010100_c00_t190.grib2.pyidx
- -rw-rw-r-- 1 99 1201 4447215 Mar 28 2012 cape_sfc_2000010100_c00.grib2
- -rw-rw-r-- 1 99 1201 2948 Aug 13 2012 cape_sfc_2000010100_c00.grib2.inv
- -rw-rw-r-- 1 99 1201 1547 Jun 11 2012 cape_sfc_2000010100_c00.grib2.pyidx
- -rw-rw-r-- 1 99 1201 3394508 Mar 28 2012 cape_sfc_2000010100_c00_t190.grib2
- -rw-rw-r-- 1 99 1201 2252 Aug 13 2012 cape_sfc_2000010100_c00_t190.grib2.inv
- -rw-rw-r-- 1 99 1201 1261 Jun 11 2012 cape_sfc_2000010100_c00_t190.grib2.pyidx
- -rw-rw-r-- 1 99 1201 4683420 Mar 28 2012 cin_sfc_2000010100_c00.grib2
- -rw-rw-r-- 1 99 1201 2905 Aug 13 2012 cin_sfc_2000010100_c00.grib2.inv

a select set of fields available on original Gaussian grid

a larger set available on the 1-degree lat/lon grid

more directory listings

- ftp> cd c00
- 250 Directory successfully changed.
- ftp> ls
- 229 Entering Extended Passive Mode (|||53711|).
- 150 Here comes the directory listing.
- drwxr-xr-x 2 99 1201 13312 Aug 13 2012 gaussian
- drwxr-xr-x 2 99 1201 21504 Aug 13 2012 latlon
- 226 Directory send OK.
- ftp> cd latlon
- 250 Directory successfully changed.
- ftp> ls
- 229 Entering Extended Passive Mode (|||36968|).
- 150 Here comes the directory listing.
- -rw-rw-r-- 1 99 1201 4236525 Mar 28 2012 apcp_sfc_2000010100_c00.grib2
- -rw-rw-r-- 1 99 1201 3277 Aug 13 2012 apcp_sfc_2000010100_c00.grib2.inv
- -rw-rw-r-- 1 99 1201 1547 Jun 11 2012 apcp_sfc_2000010100_c00.grib2.pyidx
- -rw-rw-r-- 1 99 1201 3419759 Mar 28 2012 apcp_sfc_2000010100_c00_t190.grib2
- -rw-rw-r-- 1 99 1201 2525 Aug 13 2012 apcp_sfc_2000010100_c00_t190.grib2.inv
- -rw-rw-r-- 1 99 1201 1261 Jun 11 2012 apcp_sfc_2000010100_c00_t190.grib2.pyidx
- -rw-rw-r-- 1 99 1201 4447215 Mar 28 2012 cape_sfc_2000010100_c00.grib2
- -rw-rw-r-- 1 99 1201 2948 Aug 13 2012 cape_sfc_2000010100_c00.grib2.inv
- -rw-rw-r-- 1 99 1201 1547 Jun 11 2012 cape_sfc_2000010100_c00.grib2.pyidx
- -rw-rw-r-- 1 99 1201 3394508 Mar 28 2012 cape_sfc_2000010100_c00_t190.grib2
- -rw-rw-r-- 1 99 1201 2252 Aug 13 2012 cape_sfc_2000010100_c00_t190.grib2.inv
- -rw-rw-r-- 1 99 1201 1261 Jun 11 2012 cape_sfc_2000010100_c00_t190.grib2.pyidx
- -rw-rw-r-- 1 99 1201 4683420 Mar 28 2012 cin_sfc_2000010100_c00.grib2
- -rw-rw-r-- 1 99 1201 2905 Aug 13 2012 cin_sfc_2000010100_c00.grib2.inv

these are the week +1 and week +2 grib files for accumulated precip.
other variables have other (hopefully obvious) names.

more directory listings

- ftp> cd c00
- 250 Directory successfully changed.
- ftp> ls
- 229 Entering Extended Passive Mode (|||53711|).
- 150 Here comes the directory listing.
- drwxr-xr-x 2 99 1201 13312 Aug 13 2012 gaussian
- drwxr-xr-x 2 99 1201 21504 Aug 13 2012 latlon
- 226 Directory send OK.
- ftp> cd latlon
- 250 Directory successfully changed.
- ftp> ls
- 229 Entering Extended Passive Mode (|||36968|).
- 150 Here comes the directory listing.
- -rw-rw-r-- 1 99 1201 4236525 Mar 28 2012 apcp_sfc_2000010100_c00.grib2
- -rw-rw-r-- 1 99 1201 3277 Aug 13 2012 apcp_sfc_2000010100_c00.grib2.inv
- -rw-rw-r-- 1 99 1201 1547 Jun 11 2012 apcp_sfc_2000010100_c00.grib2.pyidx
- -rw-rw-r-- 1 99 1201 3419759 Mar 28 2012 apcp_sfc_2000010100_c00_t190.grib2
- -rw-rw-r-- 1 99 1201 2525 Aug 13 2012 apcp_sfc_2000010100_c00_t190.grib2.inv
- -rw-rw-r-- 1 99 1201 1261 Jun 11 2012 apcp_sfc_2000010100_c00_t190.grib2.pyidx
- -rw-rw-r-- 1 99 1201 4447215 Mar 28 2012 cape_sfc_2000010100_c00.grib2
- -rw-rw-r-- 1 99 1201 2948 Aug 13 2012 cape_sfc_2000010100_c00.grib2.inv
- -rw-rw-r-- 1 99 1201 1547 Jun 11 2012 cape_sfc_2000010100_c00.grib2.pyidx
- -rw-rw-r-- 1 99 1201 3394508 Mar 28 2012 cape_sfc_2000010100_c00_t190.grib2
- -rw-rw-r-- 1 99 1201 2252 Aug 13 2012 cape_sfc_2000010100_c00_t190.grib2.inv
- -rw-rw-r-- 1 99 1201 1261 Jun 11 2012 cape_sfc_2000010100_c00_t190.grib2.pyidx
- -rw-rw-r-- 1 99 1201 4683420 Mar 28 2012 cin_sfc_2000010100_c00.grib2
- -rw-rw-r-- 1 99 1201 2905 Aug 13 2012 cin_sfc_2000010100_c00.grib2.inv

these precomputed inventory files allow *much* faster loading with wgrib2 or python.

Other files of interest

- in /Public/thamill you have netCDF files like

refcstv2_precip_ccpa_BBB_to_EEE.nc where BBB is the beginning lead time in hours, EEE is the end lead time in hours. These have 2002-2013 1/8-degree CCPA precipitation analyses and associated forecast information.

(note, if you downloaded these files earlier, please download again, as I corrected some bugs)

Some netCDF file detail

- [mac24:~/refcst2] thamill% ncdump -h /Rf2_tests/ccpa/netcdf/refcstv2_precip_ccpa_120_to_132.nc
- netcdf refcstv2_precip_ccpa_120_to_132 {
- dimensions:
- xa = 464 ;
- ya = 224 ;
- xf = 128 ; grid dimensions of analysis (xa, ya) and forecast (xf, yf)
- yf = 61 ;
- time = UNLIMITED ; // (4228 currently) number of dates stored
- ens = 11 ; number of ensemble members
- variables:
- float xa(xa) ;
- xa:long_name = "eastward grid point number, precip analysis" ;
- xa:units = "n/a" ;
- float ya(ya) ;
- ya:long_name = "northward grid point number, precip analysis" ;
- ya:units = "n/a" ;
- float xf(xf) ;
- xf:long_name = "eastward grid point number, precip forecast" ;
- xf:units = "n/a" ;
- float yf(yf) ;
- yf:long_name = "northward grid point number, precip forecast" ;
- yf:units = "n/a" ;
- float time(time) ;
- time:units = "hours since 1-1-1 00:00:0.0" ;
- int ensv(ens) ;
- ensv:long_name = "Ensemble member number (control, perts 1-10)" ;
- ensv:units = " " ;

more netCDF file detail

- float lons_anal(ya, xa) ;
  - lons_anal:long_name = "longitude" ;
  - lons_anal:units = "degrees_east" ;
- float lats_anal(ya, xa) ;
  - lats_anal:long_name = "latitude" ;
  - lats_anal:units = "degrees_north" ;
- float lons_fcst(yf, xf) ;
  - lons_fcst:long_name = "longitude" ;
  - lons_fcst:units = "degrees_east" ;
- float lats_fcst(yf, xf) ;
  - lats_fcst:long_name = "latitude" ;
  - lats_fcst:units = "degrees_north" ;
- int yyyymmddhh_init(time) ;
  - yyyymmddhh_init:longname = "Initial condition date/time in yyyymmddhh format" ;
- int yyyymmddhh_fcstb(time) ;
  - yyyymmddhh_fcstb:longname = "Forecast valid date/time in yyyymmddhh format" ;
- int yyyymmddhh_fcste(time) ;
  - yyyymmddhh_fcste:longname = "Forecast valid date/time in yyyymmddhh format" ;
- float apcp_anal(time, ya, xa) ;
  - apcp_anal:least_significant_digit = 2 ;
  - apcp_anal:units = "mm" ;
  - apcp_anal:long_name = "Analyzed Accumulated Precipitation from CCPA" ;
  - apcp_anal:valid_range = 0., 1000. ;
  - apcp_anal:missing_value = -99.99f ;
- float apcp_fcst_ens(time, ens, yf, xf) ;
  - apcp_fcst_ens:least_significant_digit = 2 ;
  - apcp_fcst_ens:units = "mm" ;
  - apcp_fcst_ens:long_name = "Ensemble member forecast accumulated precipitation" ;
  - apcp_fcst_ens:valid_range = 0., 1000. ;
  - apcp_fcst_ens:missing_value = -99.99f ;

longitudes, latitudes of analysis grid; note that when you read this in via fortran, the internal (y,x) storage gets flipped to (x,y), but not so when you read it in via python.

longitudes, latitudes of forecasts

precipitation analyses

precipitation forecast

more netCDF file detail

- float pwat_fcst_mean(time, yf, xf) ;
  - pwat_fcst_mean:least_significant_digit = 2 ;
  - pwat_fcst_mean:units = "mm" ;
  - pwat_fcst_mean:long_name = "Ensemble precipitable water forecast mean, time averaged" ;
  - pwat_fcst_mean:valid_range = 0., 1000. ;
  - pwat_fcst_mean:missing_value = -99.99f ;
- float CAPE_fcst_mean(time, yf, xf) ;
  - CAPE_fcst_mean:least_significant_digit = 2 ;
  - CAPE_fcst_mean:units = "J/kg" ;
  - CAPE_fcst_mean:long_name = "Ensemble CAPE (convective availble potential energy) forecast mean, time averaged" ;
  - CAPE_fcst_mean:valid_range = 0., 7000. ;
  - CAPE_fcst_mean:missing_value = -99.99f ;
- float CIN_fcst_mean(time, yf, xf) ;
  - CIN_fcst_mean:least_significant_digit = 2 ;
  - CIN_fcst_mean:units = "J/kg" ;
  - CIN_fcst_mean:long_name = "Ensemble CIN (convective inhibition) forecast mean, time averaged" ;
  - CIN_fcst_mean:valid_range = -3000, 3000 ;
  - CIN_fcst_mean:missing_value = -9999.99f ;
- float T2m_fcst_mean(time, yf, xf) ;
  - T2m_fcst_mean:least_significant_digit = 2 ;
  - T2m_fcst_mean:units = "K" ;
  - T2m_fcst_mean:long_name = "2-meter temperature forecast mean, time averaged" ;
  - T2m_fcst_mean:valid_range = 200, 350 ;
  - T2m_fcst_mean:missing_value = -9999.99f ;
- float MSLP_fcst_mean(time, yf, xf) ;
  - MSLP_fcst_mean:least_significant_digit = 2 ;
  - MSLP_fcst_mean:units = "Pa" ;
  - MSLP_fcst_mean:long_name = "Mean sea-level pressure forecast mean, time averaged" ;
  - MSLP_fcst_mean:valid_range = 85000., 108000. ;
  - MSLP_fcst_mean:missing_value = -9999.99f ;