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ECPC/NCEP March 2008 Seasonal Fire Danger Forecasts

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1. NCEP CFS/GSM/RSM forecasts

In collaboration with the National Centers for Environmental Prediction (NCEP), the Experimental Climate Prediction Center (ECPC) at the Scripps Institution of Oceanography / Univ. CA, San Diego is currently making Climate Forecast System / Global Spectral Model / Regional Spectral Model (CFS/GSM/RSM) ensemble 7 month forecasts for applications to fire danger forecasting. At NCEP, the operational CFS currently starts from the operational atmospheric and ocean analysis and uses a coupled model - the Global Forecast System (GFS) for the atmosphere and the Modular Ocean Model (MOM3) for the ocean - for the coupled seasonal forecast. Corresponding climatology runs start from the NCEP/DOE atmospheric reanalysis II (Kanamitsu et al. 2002) and MOM3 ocean analyses (see Saha et al. 2006) The CFS produces a forecast sea surface temperature, which is then used as boundary conditions for the GSM, which in turn drives the RSM.

The RSM (Juang et al. 1997) was originally developed to emulate the global model but operates at regional scales and is now in operational use for the 10 km RSM daily weather forecast for Hawaii and as a contributor to the 48 km short-range ensemble forecast for the Coterminous US (CONUS). A newer version of the RSM has since been developed at NCEP to more closely emulate the new CFS physics and is similar to the ECPC RSM (e.g. Roads 2004). The NCEP RSM US domain covers the CONUS and its vicinity, from 130W to 65W and 20N to 55N with 50 km resolution. The GSM/RSM currently outputs binary restart files as well as GRIB files on pressure surfaces using the model grid every 6 hours. The standard output has been enhanced in order to develop the needed input for fire danger forecasts. All output, including binary restart files and GRIB files, are grouped together by file type and stored in the IBM HPSS mass storage site. A rotating archive is accessed by ECPC to drive the fire danger code, described below.

The new 7-month NCEP/ECPC CFS/GSM/RSM forecast archive began in Oct. 2004. Each month, three hindcasts for the appropriate month are made from 1982 to 2004, which provides a total of 23x3 members of hindcasts to develop the model forecast climatology. Ten forecasts starting on 5 different days at 0000 and 1200 UTC are also made as part of a 10-member ensemble forecast. More hindcasts may be added later in order to construct more-stable model climatology. The number of ensemble members is dependent upon available computer time. In addition, a continuous 1-day forecast run from Jan. 1982-present has now been developed. This run, along with observed precipitation, was required to initialize the fire danger code. This initialized fire danger code also serves as the validation (see Roads et al. 2005, 2008). We have also begun to replace this 1-day run with data from the recent North American Regional Reanalysis (NARR; Mesinger et al. 2006)

NCEP forecast data needed to develop the fire danger forecasts below include daily temperature (Tmax and Tmin), Relative Humidity (RHmax and RHmin), precipitation amount and duration, windspeed and cloud cover. Again, observed precipitation, rather than the GSM/RSM 1-day forecast values are used as input to the validating and initializing fire danger code. NARR precipitation can be used however since it assimilates precipitation and the model precipitation output is quite close to the input precipitation in most regions.

2. National Fire Danger Rating System

The NFDRS (Burgan 1988) indices describe characteristics of fire danger, given the conditions of fuel, topography, and weather. The standard weather input to the NFDRS comes from weather station data, which is assumed to apply to a large (~10^3 hectares) area surrounding each weather station; vegetation (fuel) types and slope are also defined for each weather station and assumed to apply to the same surrounding area. The Wildland Fire Assessment System (WFAS) (http://www.wfas.us/content/view/16/31/) features a current fire danger map based on observations and an experimental one-day forecast based on the NCEP 29km Eta forecast.

The major difference from standard NFDRS calculations by the WFAS is that the ECPC uses 25 km gridded fuels, weather forecasts and topography data, whereas WFAS uses fuels and topography resolved to a 1km grid and interpolates weather data to the same grid from either station observations or the 29km Eta forecast to develop the gridded US maps. The fuels and orography (slope) data used by ECPC also were initially defined at 1km spatial resolution, but the fuel type and elevation at the nearest 1km grid point was used for each point on ECPC's 25km grid. The use of a coarser grid is justified for forecasts in a weekly to seasonal timeframe, as opposed to the WFAS one-day forecast. Slope is important in assessing fire danger because fire generally burns faster spreading upslope than on flat ground. Vegetation type, quantity and structure are also important for describing fire danger. Sixteen of the twenty NFDRS fuel models are being used to represent the vegetation types across the U.S. (Burgan 1988) defining fuel characteristics such as depth, load by live and dead classes, heat content, fuel particle size, etc. Each fuel model in the fire danger rating system must necessarily represent a rather broad range of vegetation types. The basic vegetation data source was the 1km resolution land cover map released in 1991 by the EROS Data Center. The land cover map was converted to an NFDRS fuel model map through a combination of 2546 ground sample plots scattered across the U.S., and consultation with fire managers from across the country.

The ECPC/NCEP fire danger forecasts, which are initialized from a continuous validating Fire Danger Code (using observed precipitation and 1-day RSM forecasts), now consists of 8 indices:

the Fosberg Fire Weather Index (FWI; not a part of the NFDRS and an index that does not require any initialization); Burning Index (BI), Ignition Component (IC), Energy Release Component (ER), Spread Component (SC), and the Keetch/Byram (KB) drought index. It should be noted that individual fire and land managers have preferential disposition toward particular indices. Roads et al. (2005, 2008) and Reinbold et al. (2005) provide a summary description of the NFDRS fire danger variables being examined here.

We have since added two additional indices that may eventually be useful for global forecasts of fire danger - the Chandler Burning Index (CBI) and the Canadian Forest Fire Weather Index (CFFWI). The CBI uses the afternoon air temperature and relative humidity, which is simpler than the FWI that also includes wind variations. The CFFWI also includes wind and adds precipitation in order to define fuel moisture loads. The CFFWI is thus like the other NFDRS indices and requires an initialization from the previous day. We are therefore currently trying to establish a useful near real time source for global land precipitation in order to generate global forecasts of the CFFWI.

3. Fire Danger Forecasts

Shown in **Fig. 1** are the National Interagency Coordination Center (NICC) preliminary tabulation of large fires for Feb. 2008. Note the large fires in the Texas Oklahoma region as well as the Florida and East Coast region. The tabulated Feb. Texas/Oklahoma fires were reflected in relatively anomalous values of the validation FWI (**Fig. 2**) and 1 month forecast FWI (**Fig. 3**). These indices are similar to the other fire danger indices (not shown). None of the fire indices indicated a large potential for eastern and Florida large fires, although there was at least some indication that there would be above normal activity.

Shown in **Fig. 4** are forecast normalized anomalous CFFWI for Mar.-May. 2008 from Mar. 1, 2008 initial conditions. Normalization is defined here as the ratio of the anomaly mean to the standard deviation of all forecast anomalies (Mar.-May. 2008 from Mar. 1 conditions, 1982-present.) Except for the midwest most of the Eastern and Northwest US is forecast to have above normal fire activity. The US West still remains anomalously above normal. The ERC forecast shown in **Fig. 5** is similar.

The FWI and CBI global forecast for Mar. – May 2008 (**Figs. 6,7**) indicate that western Canada and perhaps part of Alaska are potentially problem spots during the coming months. Other countries in a broad belt from Eastern Europe to China may also be at risk.

The FWI global forecast for Apr.-June 2008 (**Fig. 8**) indicates that forecast fire danger risk will subsequently move to the high northern latitudes, affecting eventually Russia, northern Canada and Greenland in the May July 2008 time frame (**Fig. 9**).

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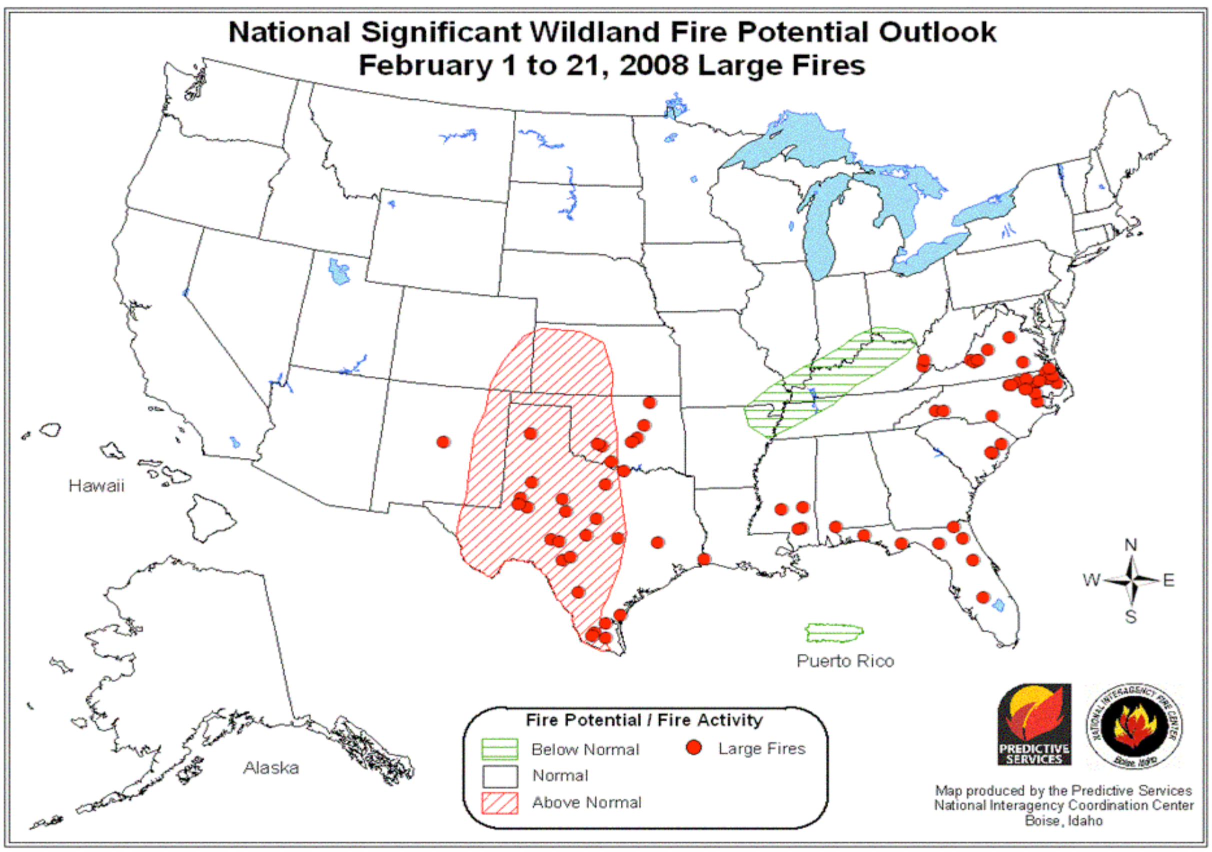

Fig. 1. NICC preliminary tabulation of large fires for Feb.

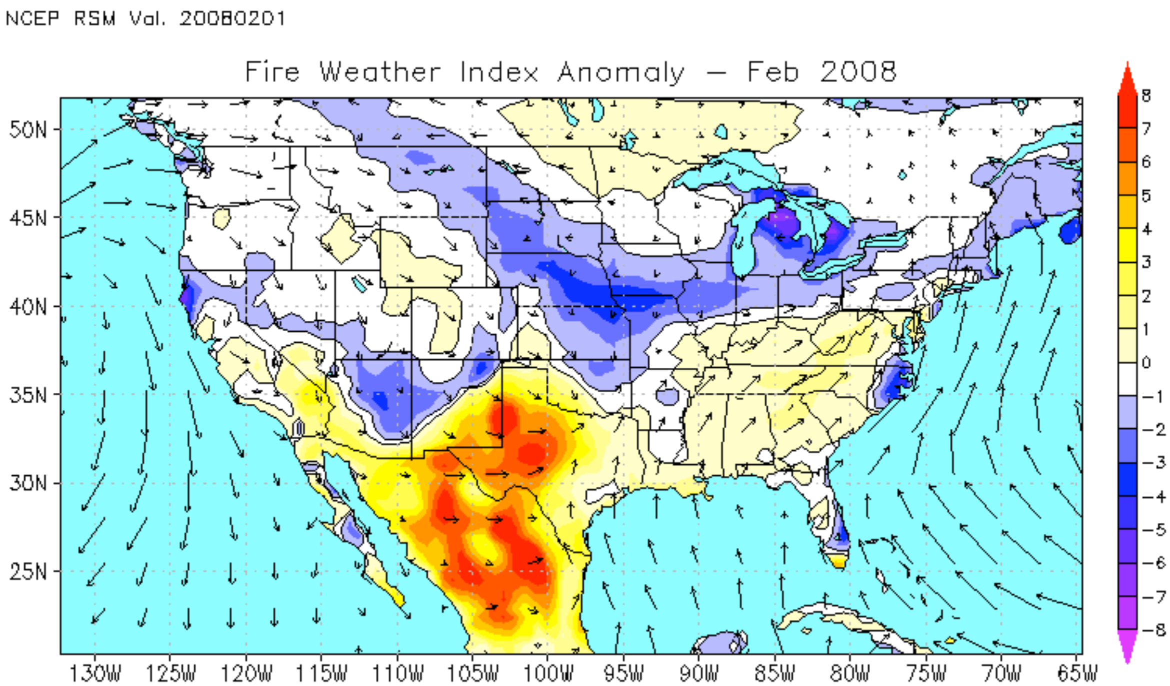

Fig. 2. Feb. 2008 FWI anomaly (total minus climatological mean)

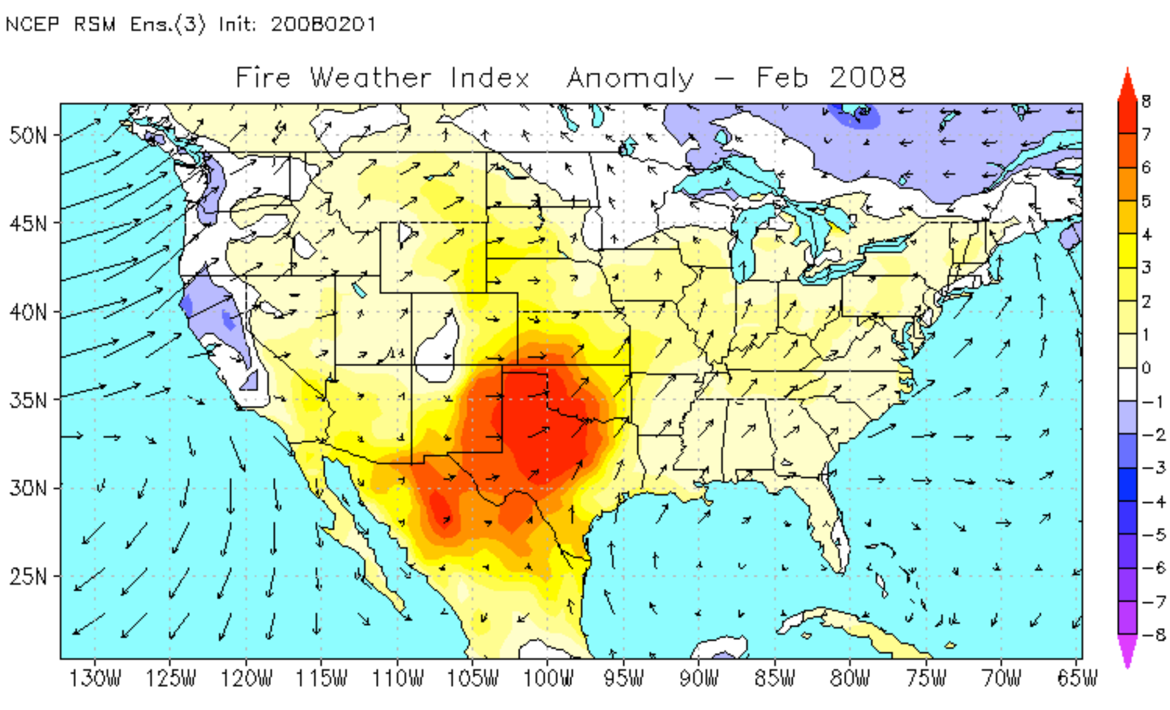

Fig. 3 Feb. 1 forecast of Feb. 2008 FWI anomaly.

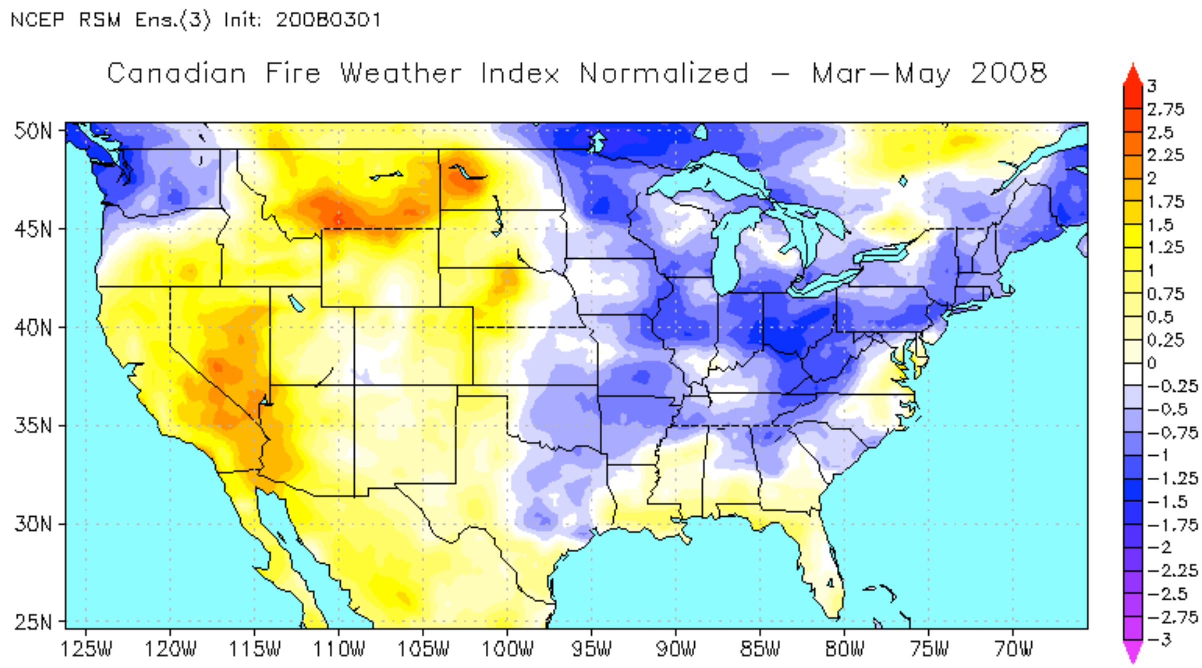

Fig. 4 Mar. 1 forecast of Mar.-May 2008 normalized FWI. Normalization is defined here as the ratio of the anomaly mean to the standard deviation of all ensemble mean forecast anomalies (Mar.-May. 1982-2008 from Mar. 1 conditions)

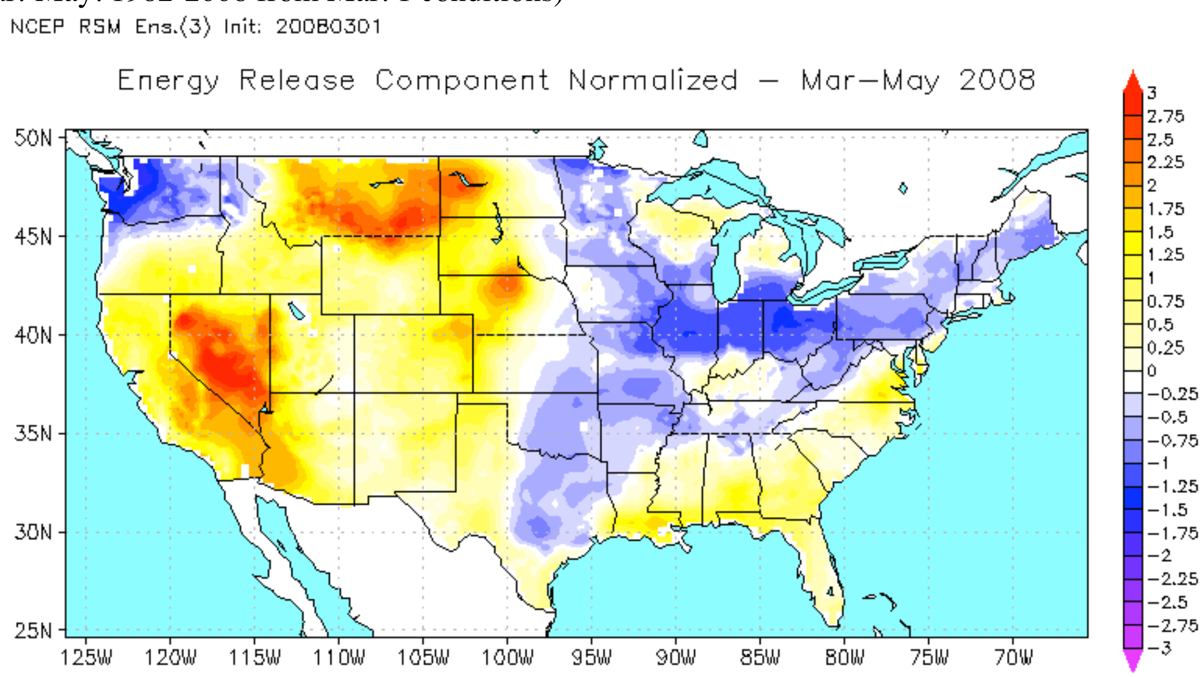

Fig. 5 Same as **Fig. 4** but for Mar. 1 forecast of Mar.-May 2008 normalized ERC.

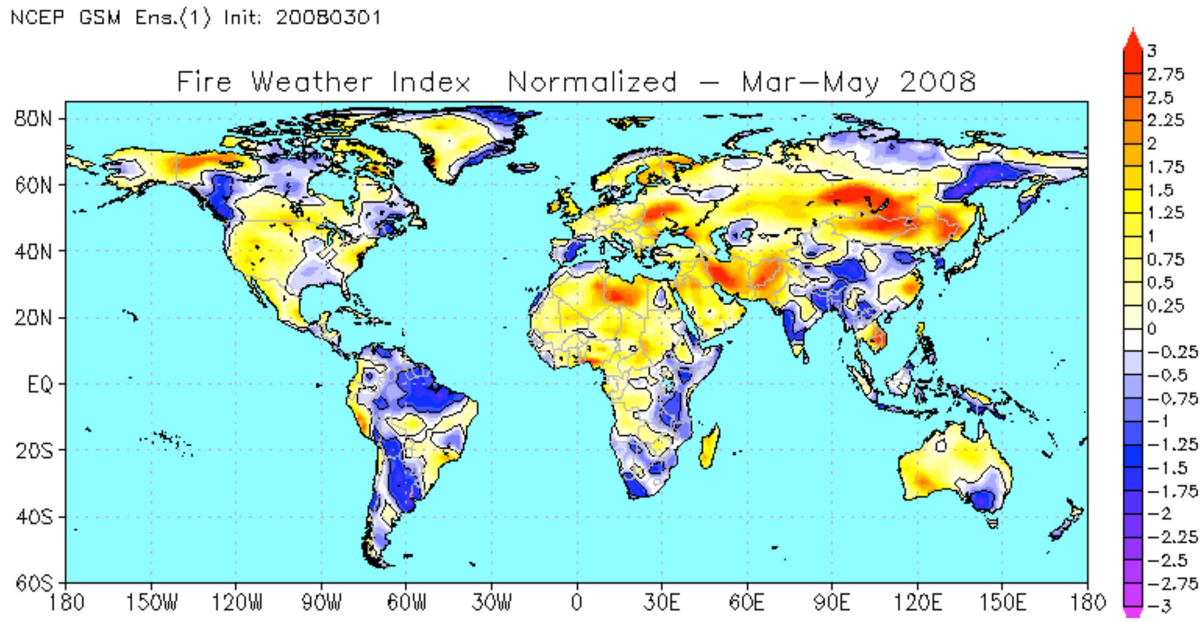

Fig. 6 Same as **Fig. 4** but for Mar. 1 forecast of Mar.-May 2008 global normalized FWI.

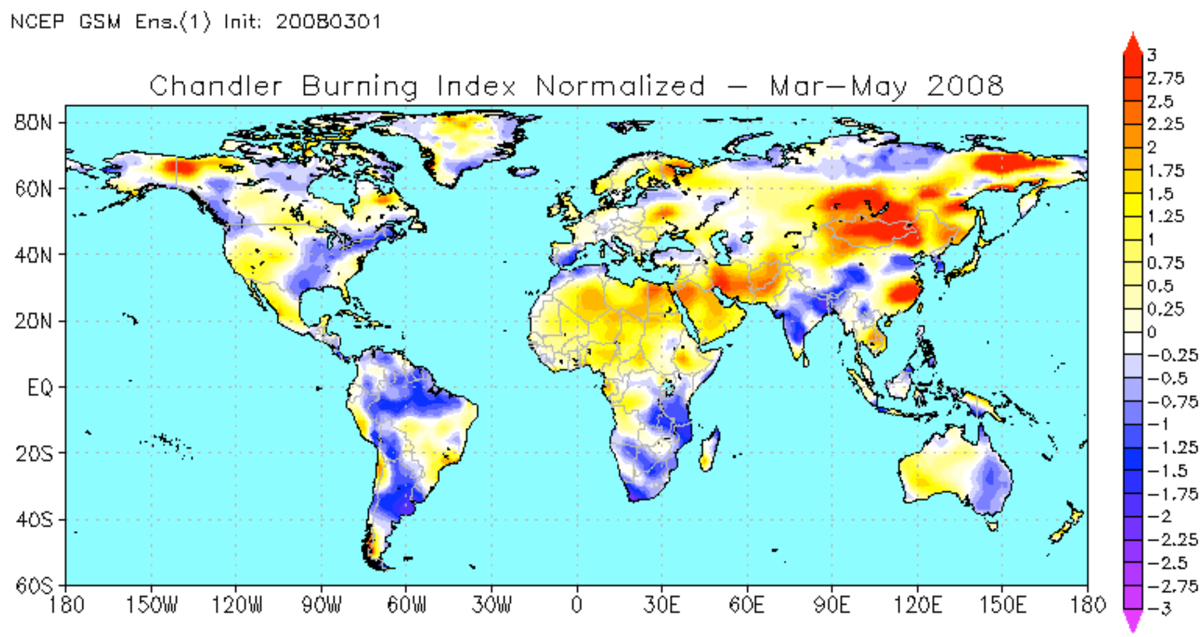

Fig. 7 Same as **Fig. 4** but for Mar. 1 forecast of Mar.-May 2008 global normalized CBI.

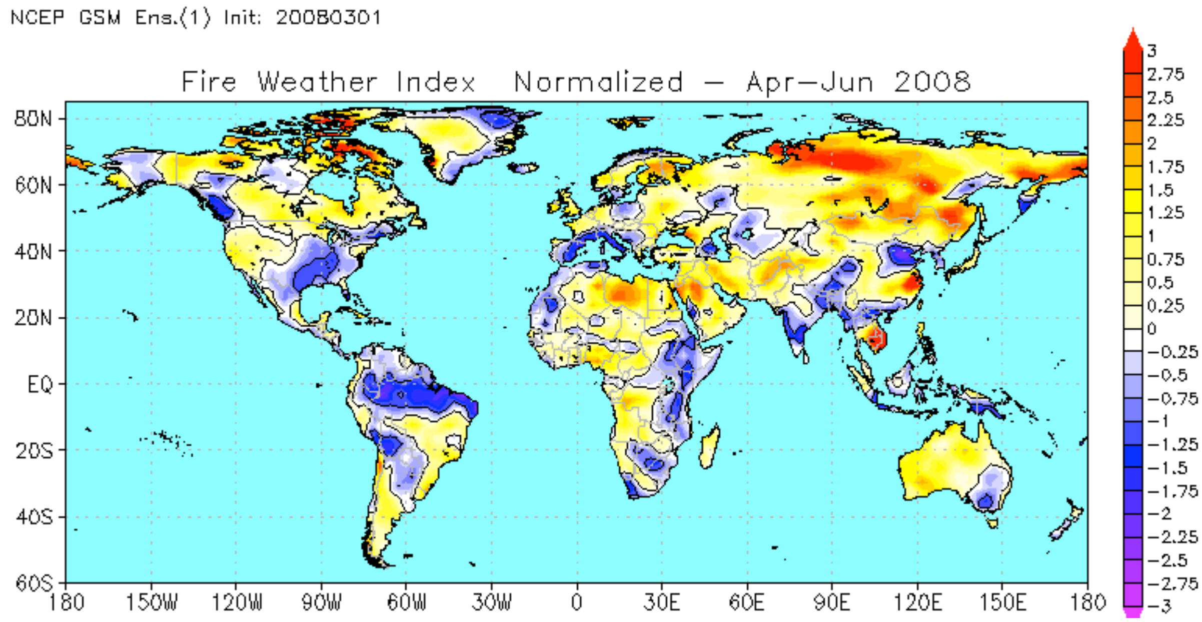

Fig. 8 Same as **Fig. 4** but for Mar. 1 forecast of Apr.-June 2008 global normalized FWI.

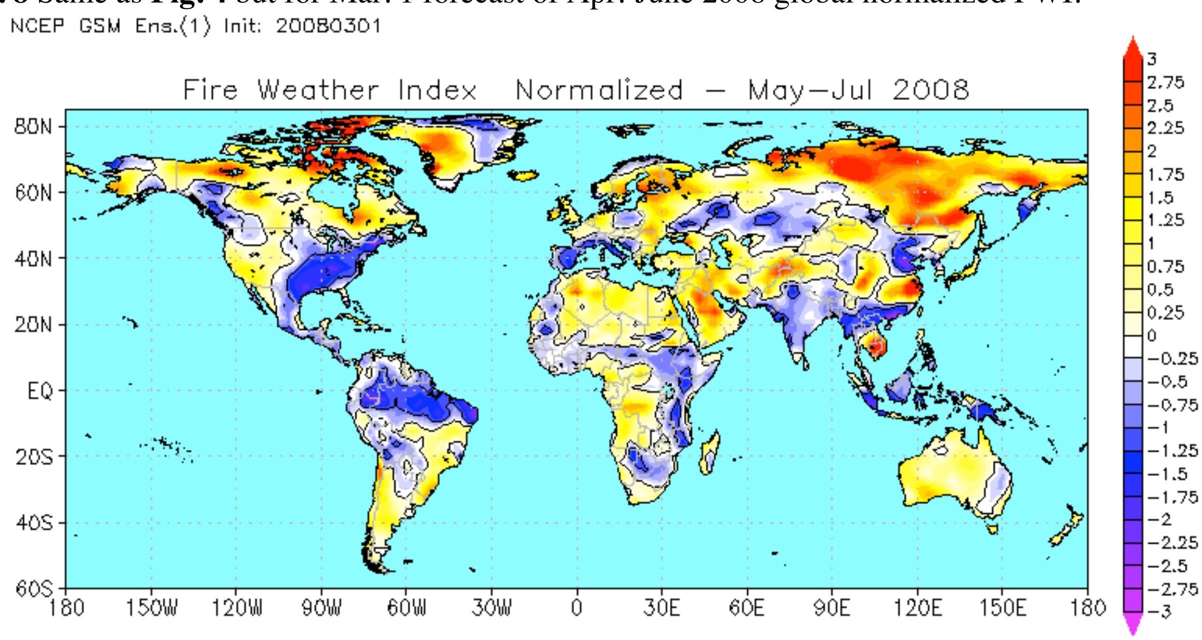

Fig. 9 Same as **Fig. 4** but for Mar. 1 forecast of May-Jul. 2008 global normalized FWI.