ECPC/NCEP March 2007 Seasonal Fire Danger Forecasts

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1. NCEP CFS/RSM forecasts

In collaboration with the National Centers for Environmental Prediction (NCEP), we are 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 the Experimental Climate Prediction Center (ECPC). At NCEP, the operational CFS currently starts from the operational atmospheric and ocean analysis and uses a coupled model, Global Forecast System (GFS) for the atmosphere and Modular Ocean Model (MOM3) for 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. 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 RSM short-range ensemble forecast for the 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 A newer version of the RSM has since been developed at NCEP to more closely emulate the new CFS physics and is similar to the ECPC RSM. 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 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 per year are made from 1982 to 2004, which provides a total of 23x3 members of hindcasts to develop the model climatology. Ten forecasts starting on 5 different days at 0000 and 1200 UTC are also made as part of the 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).

3. National Fire Danger Rating System

The NFDRS (Burgan 1988) indices describe characteristics of fire danger, given the conditions of fuel, topography, and weather. The basic inputs to the NFDRS include precipitation (P), temperature (T), relative humidity (RH), cloud cover (CC) and wind speed (WS) as well as fuels and slope. 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), consists of 6 indices: Fosberg Fire Weather Index (FWI; not a part of the NFDRS and the only 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) and Reinbold et al. (2005) provide a summary description of the NFDRS fire danger variables being examined here.

NCEP forecast data needed to develop the fire danger forecasts 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 RSM 1-day forecast values is used as input to the validating and initializing fire danger code.

4. Fire Danger Forecasts

Shown in **Figs. 1-2** are 2month lag (initialization on Mar. 1, 2007) 5-month forecasts (May-Sept. 2007) normalized anomalies of some of the basic input variables. Daily values of these input variables are used to drive the NFDRS fire danger code. It should also be noted that the normalization uses the standard deviation of the forecast anomalies.

Temperature is being forecast to be above normal over most of the US West and below normal over most of the US East during this period by both the GSM (**Fig. 1**) and RSM (**Fig. 2**). In a similar dipole-like vein, the RH is forecast to be below normal over the US West and above normal over the US East. A tendency for forecast above normal Tmax over Florida in the RSM forecasts is especially related to below normal RH centered over Florida in the RSM forecast, which is also found in the GSM forecasts. The cool wet dipole appears to be related the precipitation pattern, which also indicates a tendency for northern California and Nevada to have above normal summertime rainfall (small amounts nonetheless). Cloud cover follows the precipitation and relative humidity pattern. Interestingly, the windspeed also follows the dipole pattern, with relatively high windspeed being forecast over the US East and relatively low over the US West.

Shown in **Figs. 3-4** are 2month lag (initialization on Mar. 1, 2007) 5-month forecasts (May-Sept. 2007) normalized anomalies of some of the basic input variables. There does appear to be some relation of the GSM (**Fig. 3**) and RSM (**Fig. 4**) forecast fire danger indices to these meteorological changes. A large-scale pattern of forecast fire danger over the upper Midwest and decreased danger over the US East as well as the increased danger over the US Southeast Gulf and Atlantic coasts appears in almost all indices. The Keetch/Bryam index further stresses the southern California Nevada region, as well as the New England states.

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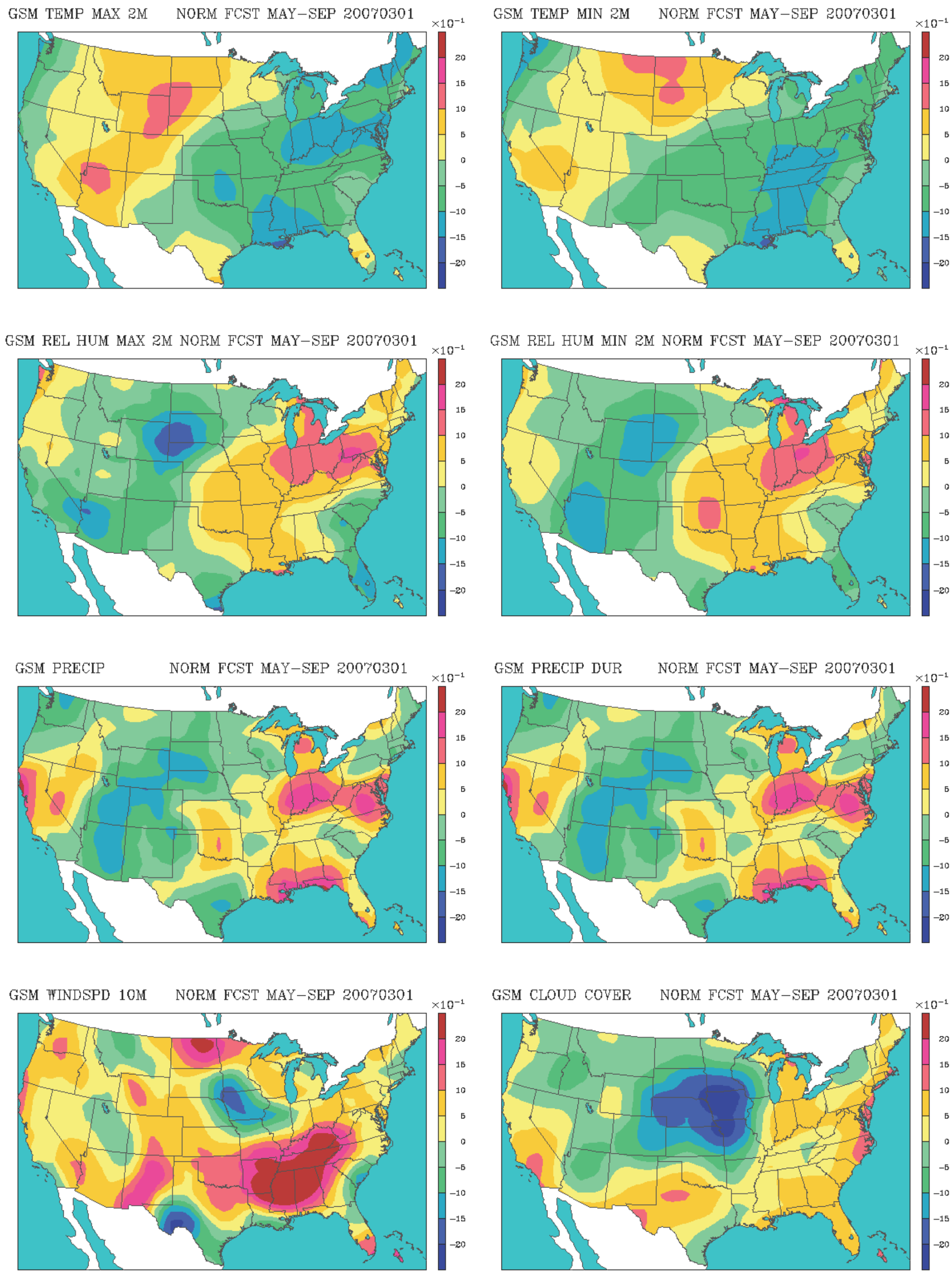

Fig. 1 ECPC/NCEP CFS/GSM T, RH, P, WSP, CC 5 month forecast anomalies, initialized 03/01/07.

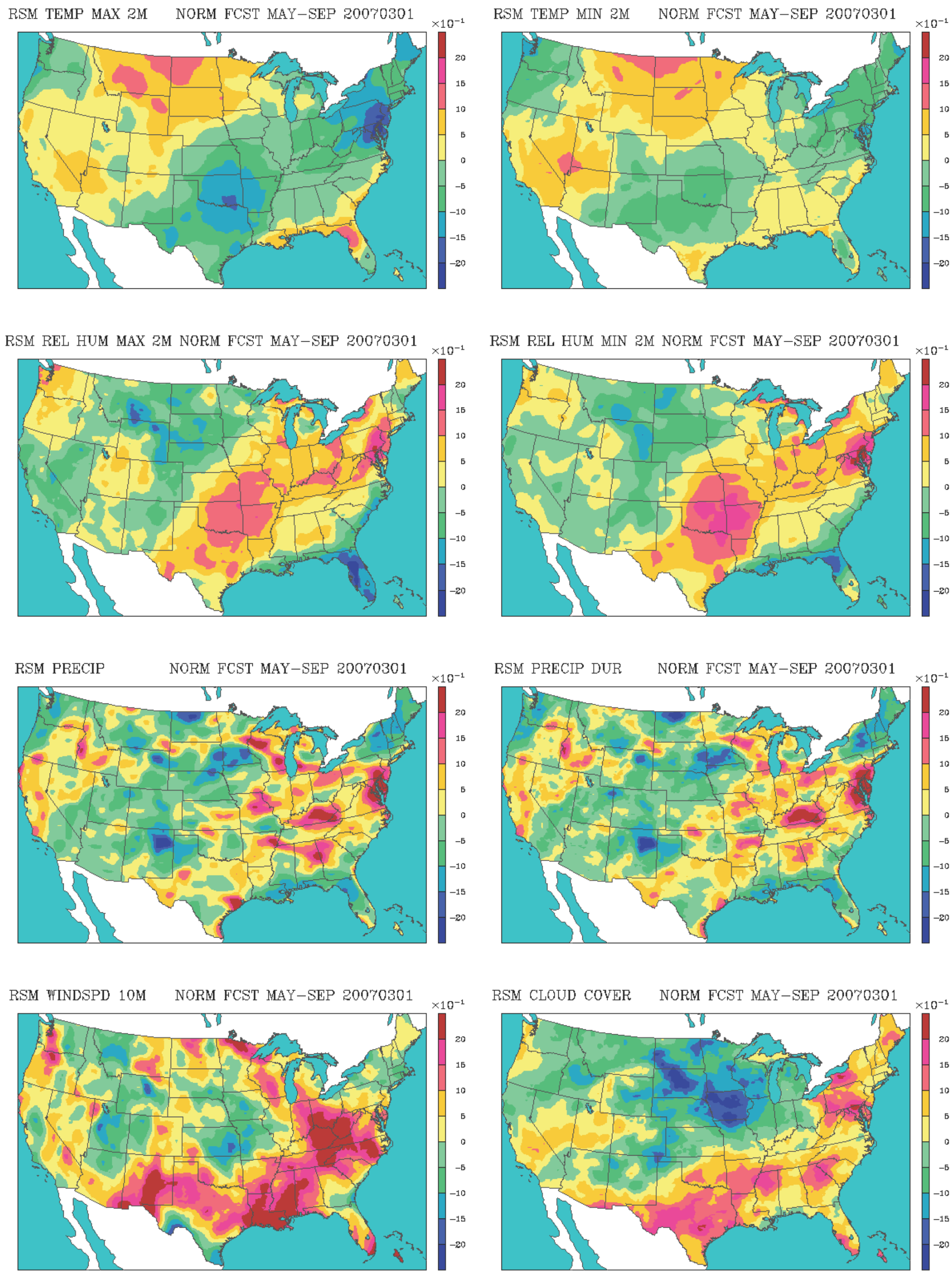

Fig. 2 ECPC/NCEP CFS/GSM/RSM T, RH, P, WSP, CC 5 month forecast anomalies, initialized 03/01/07.

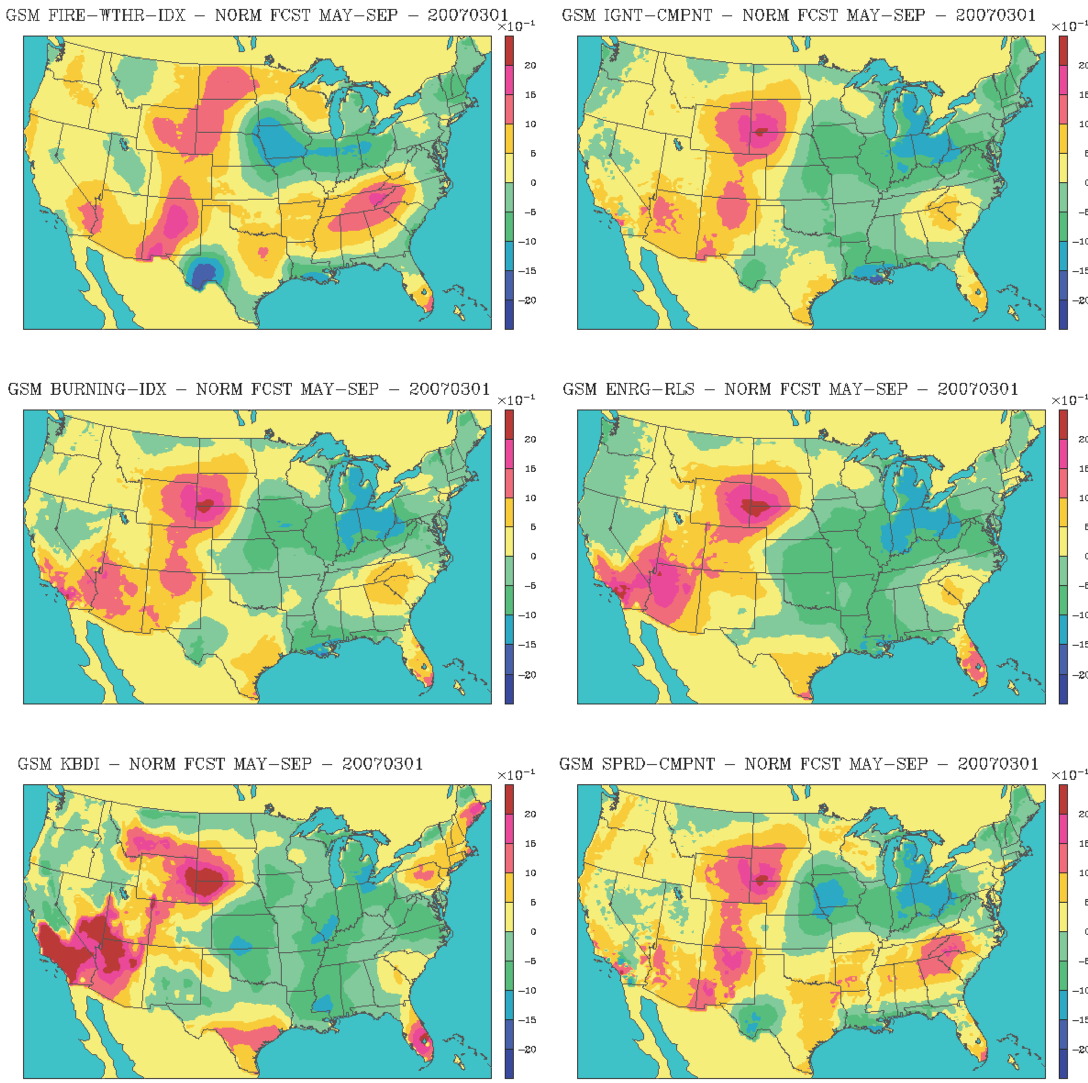

Fig. 3 ECPC/NCEP CFS/GSM FWI, IC, ERC, BI, SC, KB 5 month forecast anomalies, initialized 03/01/07.

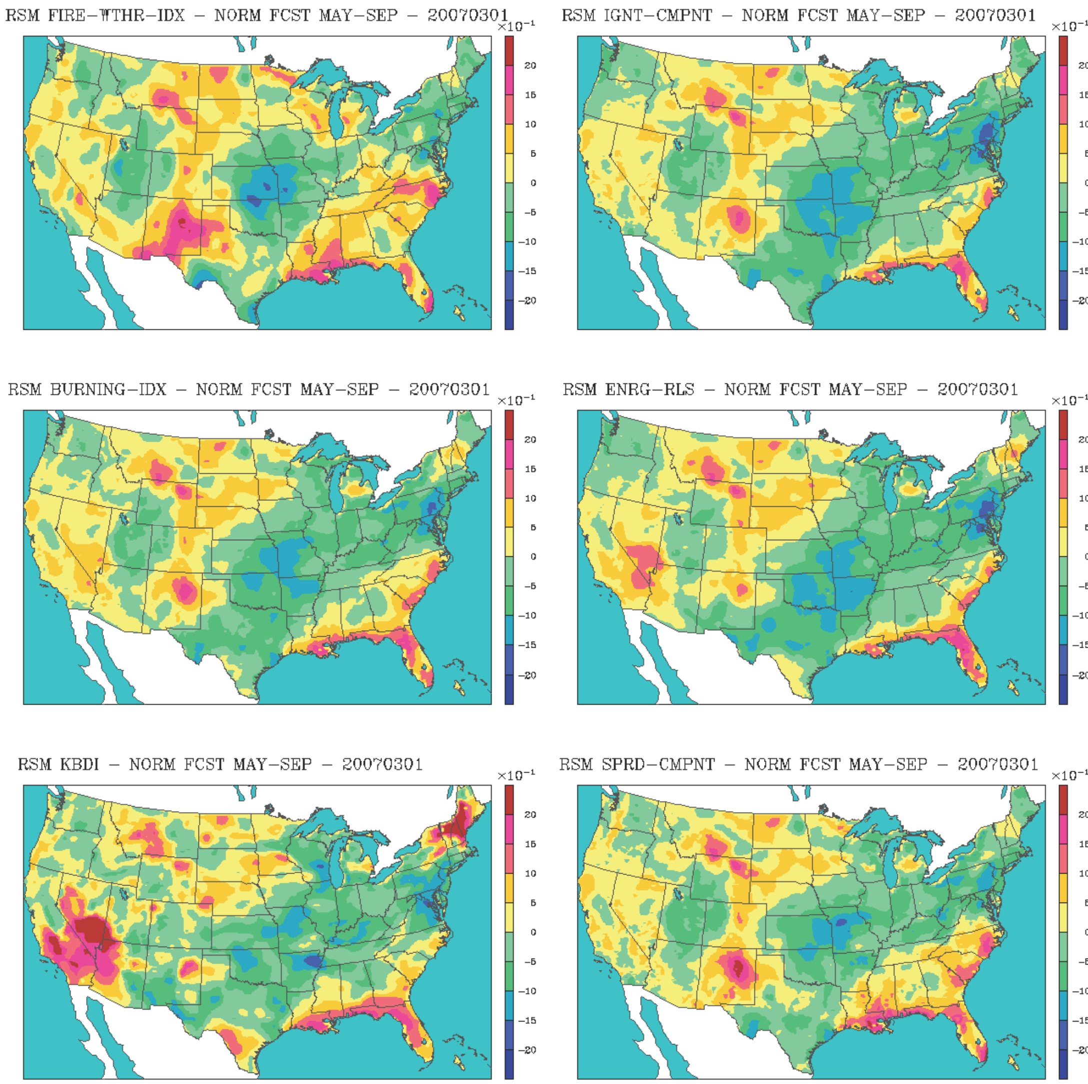

Fig. 4 ECPC/NCEP CFS/GSM/RSM FWI, IC, ERC, BI, SC, KB 5 month forecast anomalies, initialized 03/01/07.