The Experimental Climate Prediction Center (ECPC)’s Regional Spectral Model

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Dynamical downscaling became more popular in the last decade due to the improvements in the nesting approaches used in regional models to downscale the global analyses.

In contrast to the statistical downscaling, the regional downscaling through dynamically consistent numerical models can represent the evolution of non-linear systems from large-scale analyses.
global model

Well resolved

Insufficiently resolved

Spatial scales

Courtesy of Hans von Storch
Well resolved

Spatial scales

Insufficiently resolved

Added value

Courtesy of Hans von Storch
The ECPC-Regional Spectral Model (RSM) is a hydrostatic, primitive equation system, with “normalized pressure” or “sigma” as vertical coordinate.

In the ECPC’s system, regional and global models share most of their codes.

The new ECPC-RSM is coupled to an updated version of the 4-layer Noah Land-Surface Model (Noah LSM; Mitchell et al. 2004), and also includes the Scale-Selective Bias Correction (SSBC; Kanamaru and Kanamitsu 2007) that is similar to the spectral nudging technique described in von Storch et al. (2000).
One of the strategies used to improve high-resolution downscaled long-term simulations is the spectral nudging, which is an attempt to preserve the large-scale features from the global solution into the regional domain during long integrations.
Scale-Selective Bias Correction
(SSBC; Kanamaru and Kanamitsu 2007)

\[ \frac{dP_{new}}{dt} = \frac{1}{1 + \alpha} \frac{dP_{old}}{dt} \]

- Tendency of perturbation (dP/dt) is damped for U and V.
- Area average is corrected for T and q.
- Surface pressure (lnp_s) correction is also applied.

\( P: \) Perturbation
\( P = F - F_{anl} \)
\( \alpha = 0.9 \)
Advantages of Spectral Nudging: No dependency on domain size
Kanamaru and Kanamitsu, MWR 2007

Table 2. RMSD of 500-hPa height (m) between the regional model and the reanalysis field in winter of 2000/01 calculated for the common area (domain B). The model was run for different domain sizes shown in Fig. 3.

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<tr>
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<th>A</th>
<th>B</th>
<th>C</th>
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<tbody>
<tr>
<td>Control</td>
<td>5.9</td>
<td>15.1</td>
<td>7.6</td>
</tr>
<tr>
<td>SSBC</td>
<td>2.9</td>
<td>2.4</td>
<td>2.5</td>
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SSBC: Kanamaru and Kanamitsu, MWR 2007
Physics I

Description of IR and solar radiation schemes: SW radiation scheme based on Chou (1992) includes the absorption and scattering due to ozone, water vapor, oxygen, carbon dioxide, clouds, and aerosols. LW radiation scheme from Chou and Suarez, 1994.


Physics II


Description of boundary layer scheme: Boundary layer diffusion scheme based on Troen and Mahrt (1986) nonlocal diffusion. The turbulent diffusivity coefficients are function of the boundary layer heights and scale parameters derived from similarity (Hong and Pan, 1996).

Description of land surface scheme: Updated four-layer (0-10 cm, 10-40 cm, 40-100 cm, 100-200cm) soil model Noah (Mitchell et al., 2004).

### ECPC-Regional Spectral Model: NARCCAP General Configuration

| Hydrostatic, Primitive Equations (RSM; Juang et al. 1997) | 50-km resolution, 28 vertical layers | Noah Land-Surface Model (Mitchell et al. 2004); 4-soil layers | Simplified Arakawa-Schubert cumulus convection scheme (SAS; Hong and Pan 1998) | Boundary Forcing: Scale-Selective Bias Correction (SS BC; Kanamaru and Kanamitsu 2007) |
The 50-km/28-layer Model Domain
REGIONAL MEAN SEASONAL CYCLE

PRECIPITATION (mm day⁻¹)

Western U.S. | Central U.S. | Eastern U.S.

SOIL MOISTURE (mm)

Western U.S. | Central U.S. | Eastern U.S.

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RSM       | R-2        | NARR      | OBS

Jet Streak

Direct Transverse Circulation

Indirect Transverse Circulation

From Nunes and Roads JGR 2009
The 50-km/28-layer Model Domain
The NARCCAP ECPC-RSM shows more precipitation over the western and dryness over the central US in comparison to PIRCS, R-2 and NARR.
Both ECPC-RSMs show a weaker jet streak, with a precipitation core shifted northeast of the observed location pictured in NARR and R-2.
JJ 1988 200-hPa Wind (m s⁻¹) and QV (kg m⁻¹ s⁻¹)  
ECPC-RSM NARCCAP  
ECPC-RSM PIRCS  
JJ 1993 200-hPa Wind (m s⁻¹) and QV (kg m⁻¹ s⁻¹)  
ECPC-RSM NARCCAP  
ECPC-RSM PIRCS
ECPC-RSM AOGCM Forced Runs


- ECPC-RSM will be using initial and boundary conditions from the GFDL CM2.1 and the HADCM3, over a new domain, for the regional climate simulation of the present or control climate and SRES A2 future climate projections.
Reanalysis Forcing

AOGCM Forcing
This research used NCEP/DOA AMIP-II reanalysis obtained from the NCEP (NOMADS2) data server, and the NCEP North American Regional Reanalysis (NARR) data from http://www.emc.ncep.noaa.gov/mmb/rreanl. The NOAA/Climate Prediction Center provided daily precipitation values.

Acknowledgments