

# Seasonal and interannual variations of surface climate elements over Vietnam

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**Abstract:** The 1991-2000 climate over Vietnam and the Indochina Peninsula is simulated using the Regional Climate Model version 3.0 (RegCM3). The domain of interest extends from 80° E to 130° E and 5° S to 40° N. The model is driven by the ERA-40 reanalysis data as initial and lateral boundary conditions, and is forced by the Optimum Interpolation Sea Surface Temperature (OISST) data over the oceans. Validations were carried out by comparing the simulated circulation fields, 2 m air temperatures, and precipitation to globally available observation data, and data from 50 meteorological stations over 7 sub-regions of Vietnam. In general, the simulated patterns of the interested fields are in good agreement with observed data. Although being somewhat wetter or dryer and cooler, RegCM3 reproduces relatively well the observed annual cycle and the inter-annual variability of surface air temperature and precipitation. A large proportion of the negative biases in temperature over Vietnam is explained by the lapse rate correction process. After correction for elevation differences, the model still underestimates air temperature over most of the sub-regions. In rainy and dry seasons, RegCM3 generally underestimates and overestimates precipitation, respectively.

**Author Keywords:** Climate variability; Model-performance measures; Regional climate model

**Index Keywords:** Air temperature; Annual cycle; Climate variability; Dry seasons; Indochina Peninsula; Interannual variability; Lapse rate; Lateral boundary conditions; Meteorological station; Negative bias; Observation data; Observed data; Optimum interpolation; Reanalysis; Regional climate model; Regional climate models; Sea surface temperatures; Seasonal and interannual variations; Sub-regions; Surface air temperatures; Surface climate; Viet Nam; Climatology; Drought; Oceanography; Atmospheric temperature; agrometeorology; air temperature; annual cycle; annual variation; climate modeling; precipitation (climatology); regional climate; seasonal variation; Asia; Eurasia; Indochina; Southeast Asia; Viet Nam

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References:

- Arakawa, A., Schubert, W.H., Interaction of a cumulus cloud ensemble with the large-scale environment: Part 1 (1974) *J Atmos Sci*, 31, pp. 674-701
- Anthes, R.A., A cumulus parameterization scheme utilizing a one-dimensional cloud model (1977) *Mon Weather Rev*, 105, pp. 270-286
- Christensen, J.H., Hewitson, B., Busuioc, A., Chen, A., Regional climate projections (2007) *Climate Change 2007: The Physical Science Basis*, , Solomon SD, Qin M, Manning Z, Chen M and others (eds) Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge
- Dash, S.K., Shekhar, M.S., Singh, G.P., Simulation of Indian summer monsoon circulation and rainfall using RegCM3 (2006) *Theor Appl Climatol*, 86, pp. 161-172
- Dickinson, R.E., Errico, R.M., Giorgi, F., Bates, G., A regional climate model for the western United States (1989) *Clim Change*, 15, pp. 383-422
- Dickinson, R.E., Henderson-Sellers, A., Kennedy, P.J., Biosphere-Atmosphere Transfer Scheme (BATS) version 1E as coupled to the NCAR Community Climate Model (1993) NCAR Tech. Note. National Center for Atmospheric Research, , Boulder, CO
- Diffenbaugh, N., Pal, J., Trapp, R., Giorgi, F., Fine-scale processes regulate the response of extreme events to global climate change (2005) *Proc Natl Acad Sci*, 102, pp. 15774-15778
- Emanuel, K.A., A scheme for representing cumulus convection in large-scale models (1991) *J Atmos Sci*, 48, pp. 2313-2335
- Emanuel, K.A., Zivkovic-Rothman, M., Development and evaluation of a convection scheme for use in climate models (1999) *J Atmos Sci*, 56, pp. 1766-1782
- Fritsch, J.M., Chappell, C.F., Numerical prediction of convectively driven mesoscale pressure systems. I. Convective parameterization (1980) *J Atmos Sci*, 37, pp. 1722-1733
- Gallée, H., Moufouma-Okia, W., Bechtold, P., Brasseur, O., A high-resolution simulation of a West African rainy season using a regional climate model (2004) *J Geophys Res*, 109, pp. D05108. , doi:10.1029/2003JD004020
- Gao, X.J., Pal, J.S., Giorgi, F., Projected changes in mean and extreme precipitation over the Mediterranean region from a high-resolution double nested RCM simulation (2006) *Geophys Res Lett*, 33, pp. L03706. , doi:10.1029/2005GL024954
- Gao, X.J., Xu, Y., Zhao, Z.C., Pal, J.S., Giorgi, F., On the role of resolution and topography in the simulation of East Asia precipitation (2006) *Theor Appl Climatol*, 86, pp. 173-185
- Giorgi, F., Bates, G.T., The climatological skill of a regional climate model over complex terrain (1989) *Mon Weather Rev*, 117, pp. 2325-2347
- Giorgi, F., Marinucci, M.R., Bates, G.T., Development of a second-generation regional climate model (RegCM2). I. Boundary-

layer and radiative transfer processes (1993) *Mon Weather Rev*, 121, pp. 2749-2813

- Giorgi, F., Marinucci, M.R., Bates, G.T., De, C., Anio, G., Development of a second generation regional climate model (RegCM2). II. Convective processes and assimilation of lateral boundary conditions (1993) *Mon Weather Rev*, 121, pp. 2814-2832
- Giorgi, F., Mearns, L.O., Introduction to special section: Regional climate modelling revisited (1999) *J Geophys Res*, 104, pp. 6335-6352
- Giorgi, F., Shields, C., Tests of precipitation parameterizations available in the latest version of the NCAR regional climate model (RegCM) over the Continental US (1999) *J Geophys Res*, 104, pp. 6353-6375
- Grell, G.A., Prognostic evaluation of assumptions used by cumulus parameterization (1993) *Mon Weather Rev*, 121, pp. 764-787
- Jones, R.G., Murphy, J.M., Noguer, M., Simulation of climate change over Europe using a nested regional-climate model. I. Assessment of control climate, including sensitivity to location of boundaries (1995) *QJR Meteorol Soc*, 121, pp. 1413-1450
- Kiehl, J.T., James, J.H., Gordon, B.B., Byron, A.B., (1996) Description of the NCAR Community Climate Model (CCM3), p. 152. , Boulder, Colorado: Tech. Note, NCAR/TN-420+ STR
- Legates, D.R., Willmott, C.J., Mean seasonal and spatial variability in gauge-corrected, global precipitation (1990) *Int J Climatol*, 10, pp. 111-127
- New, M., Hulme, M., Jones, P., Representing twentieth-century space-time climate variability. I. Development of a 1961-90 mean monthly terrestrial climatology (1999) *J Clim*, 12, pp. 829-856
- New, M., Hulme, M., Jones, P., Representing twentieth-century space-time climate variability. II. Development of a 1901-90 mean monthly grids of terrestrial surface climate (2000) *J Clim*, 13, pp. 2217-2238
- Nguyen, D.N., Nguyen, T.H., (2004) *Climate and Climate Resources of Vietnam*, , Agriculture Publisher, Hanoi
- Nicholls, R.J., Wong, P.P., Burkett, V.R., Codignotto, J.O., Coastal systems and low-lying areas (2007) *Climate Change 2007: Impacts, Adaptation and Vulnerability*, pp. 315-356. , Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge
- Nicolini, M., Salio, P., Katzfey, J.J., McGregor, J.L., Saulo, A.C., January and July regional climate simulation over South America (2002) *J Geophys Res*, 107 (22 D), p. 4637. , doi:10.1029/2001JD000736
- Octanviani, M., Application of regional climate model RegCM3 to Thailand and performance evaluation (2008) MPhil Thesis, The Joint Graduate School of Energy and Environment at King Mongkut's University of Technology, , Thon-buri, Thailand
- Pal, J.S., Small, E.E., Eltahir, E.A.B., Simulation of regional scale water and energy budgets: Influence of a new moist physics scheme within RegCM (2000) *J Geophys Res*, 105, pp. 29579-29594
- Pal, J.S., Giorgi, F., Bi, X., Elguindi, N., Regional climate modeling for the developing world: The ICTP RegCM3 and RegCNET (2007) *Bull Am Meteorol Soc*, 88, pp. 1395-1409
- Park, S., Hong, S.-Y., The role of surface boundary forcing over south Asia in the Indian summer monsoon circulation: A regional climate model sensitivity study (2004) *Geophysical Research Letters*, 31 (12), pp. L121121-L121124. , DOI 10.1029/2004GL019729
- Qian, J.H., Seth, A., Zebiak, S., Reinitialized versus continuous simulations for regional climate downscaling (2003) *Mon Weather Rev*, 131, pp. 2857-2874
- Ramel, R., Gallee, H., Messenger, C., On the northward shift of the West African monsoon (2006) *Clim Dyn*, 26, pp. 429-440
- Rauscher, S.A., Seth, A., Qian, J.H., Camargo, S.J., Regional climate model domain choice in the tropics based on process considerations (2006) *Theor Appl Climatol*, 86, pp. 229-246

- Rauscher, S.A., Seth, A., Liebmann, B., Qian, J.H., Carmargo, S.J., Regional climate model-simulated timing and character of seasonal rains in South America (2007) *Mon Weather Rev*, 135, pp. 2642-2657
- Reynolds, R.W., Rayner, N.A., Smith, T.M., Stokes, D.C., Wang, W., An improved in situ and satellite SST analysis for climate (2002) *J Clim*, 15, pp. 1609-1625
- Seth, A., Rojas, M., Simulation and sensitivity in a nested modeling system for South America. Part I: Reanalyses boundary forcing (2003) *Journal of Climate*, 16 (15), pp. 2437-2453. , DOI 10.1175/1520-0442(2003)0162.0.CO
- 2
- Seth, A., Rauscher, S.A., Carmago, S.J., Qian, J.H., Pal, J.S., RegCM3 regional climatologies using reanalysis and ECHAM global model driving fields (2007) *Clim Dyn*, 28, pp. 461-480
- Solmon, F., Giorgi, F., Liousse, C., Aerosol modeling for regional climate studies: Application to anthropogenic particles and evaluation over a European/African domain (2006) *Tellus*, 58, pp. 51-72
- Uppala, S.M., Kallberg, P.W., Simmons, A.J., Andrae, U., The ERA-40 reanalysis (2005) *QJR Meteorol Soc*, 131, pp. 2961-3012
- Webster, P.J., Magana, V.O., Palmer, T.N., Shukla, J., Tomas, R.A., Yanai, M., Yasunari, T., Monsoons: Processes, predictability, and the prospects for prediction (1998) *J Geophys Res*, 103, pp. 14451-14510