**CORDEX South Asia Datasets**

**Recommended Use**

The World Climate Research Programme (WCRP) Coordinated Regional Climate Downscaling Experiment (CORDEX; <http://www.cordex.org/>) dataset for South Asia region is provided to assist the science community in conducting studies of climate change impacts at regional scales, and to enhance public understanding of possible future climate patterns at the spatial scale of homogenous regions. This dataset is intended for use in scientific research only, and use of this dataset for other purposes, such as commercial applications, and engineering or design studies is not recommended without consultation with a qualified expert. User feedback to improve and validate the dataset for modeling usage is appreciated.

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**Dataset and Methods**

The WCRP CORDEX foster international partnership in order to produce an ensemble of high-resolution past and future climate projections at regional scale. This CORDEX dataset is comprised of downscaled climate scenarios for the South Asia region that are derived from the Atmosphere-Ocean coupled General Circulation Model (AOGCM) runs conducted under the Coupled Model Intercomparison Project Phase 5 (CMIP5) [Taylor et al. 2012] and using three of the four greenhouse gas emissions scenarios known as Representative Concentration Pathways (RCPs) [Meinshausen et al. 2011]. The CMIP5 AOGCM runs were developed in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5). The coarser spatial resolution ranging from 1.0° to 3.8°, and systematic error (called bias) of these AOGCMs limits the examination of possible impacts of climate change and adaptation strategies on a smaller scale. The CORDEX South Asia dataset includes dynamically downscaled projections from the 10 models and scenarios for which daily scenarios were produced and distributed under CMIP5. The purpose of these datasets is to provide a set of high resolution (50 km) regional climate change projections that can be used to evaluate climate change impacts on processes that are sensitive to finer-scale climate gradients and the effects of local topography on climate conditions.

The dynamical downscaling method using high resolution limited area regional climate models (RCMs) utilizes the outputs provided by AOGCMs as lateral boundary condition to provide physically consistent spatiotemporal variations of climatic parameters at spatial scales much smaller than the AOGCMs’ grid. The RCMs by resolving the topographical details, coastlines, and land-surface heterogeneities allow the reproduction of small-scale processes and information that are most useful for impact assessment and in decision making for adaptation (Flato et al. 2013). An initial assessment of the ability of the CORDEX RCMs to simulate the general characteristics of the Indian climate indicated that the geographical distribution of surface air temperature and seasonal precipitation in the present climate for land areas in South Asia is strongly affected by the choice of the RCM and boundary conditions (i.e. driving AOGCMs), and the downscaled seasonal averages are not always improved (Sanjay et al. 2017).

**File Format and Data Access**

The CORDEX Archive Design document (<http://is-enes-data.github.io/cordex_archive_specifications.pdf>) specifies technical aspects of CORDEX archive file and data formats, as well as archive content. The data is published on the Earth System Grid Federation (ESGF; http://esgf.llnl.gov/) data nodes by the contributing CORDEX modeling centers after checking for their compliance with the specifications outlined in the archive design document using the tools available for automated quality assurance. The ESGF maintains a global system of federated data centers that allow access to the largest archive of climate data world-wide. Data files comply with the NetCDF format, version 4 compressed with zlib deflation, using the NetCDF 4 classic data model. The CF convention 1.4 is followed.

CCCR-IITM is the nodal agency for coordinating the CORDEX modeling activity in South Asia (<https://www.wcrp-climate.org/wcrp-regional-activities/ra-asia>). The CCCR-IITM and several international partner institutions have contributed towards generation and evaluation of regional climate simulations for CORDEX South Asia. Table 1 lists the details of the 17 CORDEX South Asia RCM outputs available on ESGF. This dataset includes the ensemble of high resolution (50 km) downscaled projections of regional climate and monsoon over South Asia until 2100 generated by CCCR-IITM using the RegCM4 RCM developed and maintained by ICTP (Giorgi et al. 2012). The CORDEX South Asia output from this IITM-RegCM4 RCM are archived and published on the CCCR-IITM ESGF data node (<http://cccr.tropmet.res.in/home/esgf_node.jsp> ) for dissemination to users. The list of CORDEX South Asia (domain WAS-44, WAS-44i) multi-model output variables available for download from ESGF and the details for data access are provided on the webpage: <http://cccr.tropmet.res.in/home/esgf_data.jsp> .

Additionally, the raw CORDEX South Asia RCM outputs shared by the modeling partners, which do not strictly conform to the CORDEX archive design specifications, are archived and published on the CCCR-IITM climate data portal designed to facilitate the dissemination of climate information using a publicly accessible FTP and web-based interface (<http://cccr.tropmet.res.in/home/old_portals.jsp> ). Table 2 lists the details of the RCM outputs available on this CORDEX South Asia regional data bank. The details of the few selected CORDEX South Asia multi-model output variables available for download are provided on the webpage: <http://cccr.tropmet.res.in/home/ftp_data.jsp> .

**Table 1: List of the 17 CORDEX South Asia RCM outputs available on ESGF.**

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| **CORDEX South Asia RCM** | **RCM Description** | **Contributing CORDEX Modeling Center** | **Driving CMIP5 AOGCM**(see details at https://verc.enes.org/data/enes-model-data/cmip5/resolution) | **Contributing** **CMIP5 Modeling Center** |
| IITM-RegCM4(6 ensemble members) | The Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climatic Model version 4.4.5 (RegCM4; Giorgi et al., 2012) | Centre for Climate Change Research (CCCR), Indian Institute of Tropical Meteorology (IITM), India | CanESM2 | Canadian Centre for Climate Modelling and Analysis (CCCma), Canada |
| GFDL-ESM2M | National Oceanic and Atmospheric Administration (NOAA), Geophysical Fluid Dynamics Laboratory (GFDL), USA |
| CNRM-CM5 | Centre National de Recherches Me´te´orologiques (CNRM), France |
| MPI-ESM-MR | Max Planck Institute for Meteorology (MPI-M), Germany |
| IPSL-CM5A-LR | Institut Pierre-Simon Laplace (IPSL), France |
| CSIRO-Mk3.6 | Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia |
| SMHI-RCA4(10 ensemble members) | Rossby Centre regional atmospheric model version 4 (RCA4; Samuelsson et al., 2011) | Rosssy Centre, Swedish Meteorological and Hydrological Institute (SMHI), Sweden | EC-EARTH | Irish Centre for High-End Computing (ICHEC), European Consortium (EC) |
| MIROC5 | Model for Interdisciplinary Research On Climate (MIROC), Japan Agency for Marine-Earth Sci. & Tech., Japan |
| NorESM1-M | Norwegian Climate Centre (NCC), Norway  |
| HadGEM2-ES  | Met Office Hadley Centre for Climate Change (MOHC), United Kingdom  |
| CanESM2  | CCCma, Canada  |
| GFDL-ESM2M | NOAA, GFDL, USA |
| CNRM-CM5 | CNRM, France |
| MPI-ESM-LR | MPI-M, Germany |
| IPSL-CM5A-MR | IPSL, France |
| CSIRO-Mk3.6  | CSIRO, Australia  |
| MPI-CSC-REMO2009(1 ensemble member) | MPI Regional model 2009 (REMO2009; Teichmann et al., 2013) | Climate Service Center (CSC), Germany | MPI-ESM-LR | MPI-M, Germany |

**Table 2: List of additional CORDEX South Asia RCM selected outputs available on CCCR-IITM Climate Data Portal.**

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| **CORDEX South Asia RCM** | **RCM Description** | **Contributing CORDEX Modeling Center** | **Driving CMIP5 AOGCM**(see details at https://verc.enes.org/data/enes-model-data/cmip5/resolution) | **Contributing** **CMIP5 Modeling Center** |
| CCLM4(1 ensemble member) | COnsortium for Small-scale MOdelling (COSMO) model in CLimate Mode version 4.8 (CCLM; Dobler and Ahrens, 2008) | Institute for Atmospheric and Environmental Sciences (IAES), Goethe University, Frankfurt am Main (GUF), Germany | MPI-ESM-LR | Max Planck Institute for Meteorology (MPI-M), Germany |
| CCAM(6 ensemble members) | Commonwealth Scientific and Industrial Research Organisation (CSIRO), Conformal-Cubic Atmospheric Model (CCAM; McGregor and Dix, 2001) | CSIRO Marine and Atmospheric Research, Melbourne, Australia | ACCESS1-0 | CSIRO, Australia |
| CCSM4 | National Center for Atmospheric Research (NCAR), USA |
| GFDL-CM3 | National Oceanic and Atmospheric Administration (NOAA), Geophysical Fluid Dynamics Laboratory (GFDL), USA |
| CNRM-CM5 | Centre National de Recherches Me´te´orologiques (CNRM), France |
| MPI-ESM-LR | MPI-M, Germany |
| NorESM1-M | Norwegian Climate Centre (NCC), Norway |
| LMDZ4(Global variable grid atmospheric model; 1 ensemble member) | Institut Pierre-Simon Laplace (IPSL) Laboratoire de Me´te´orologie Dynamique Zoomed version 4 (LMDZ4) atmospheric general circulation model ( Sabin et al., 2013) | Centre for Climate Change Research (CCCR), Indian Institute of Tropical Meteorology (IITM), India | IPSL-CM5A-LR | IPSL, France |
| RegCM411(2 ensemble members) | The Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climatic Model version 4.1.1 (RegCM4; Giorgi et al., 2012) | CCCR, IITM, India | LMDZ4(Global variable grid atmospheric model forced with bias-corrected SST; Sabin et al., 2013) | CCCR, IITM, India(Not a CMIP5 contribution) |
| GFDL-ESM2M | GFDL, USA |
| RCA4(full set of variables for 10 ensemble members available from ESGF; see Table 1) | Rossby Centre regional atmospheric model version 4 (RCA4; Samuelsson et al., 2011) | Rosssy Centre, Swedish Meteorological and Hydrological Institute (SMHI), Sweden | EC-EARTH | Irish Centre for High-End Computing (ICHEC), European Consortium (EC) |
| REMO2009(full set of variables available from ESGF; see Table 1) | MPI Regional model 2009 (REMO2009; Teichmann et al., 2013) | Climate Service Center (CSC), Germany | MPI-ESM-LR | MPI-M, Germany |

**Acknowledgments**

For publications that use the CORDEX South Asia model outputs, an appropriate credit as mentioned in the CORDEX terms of use (http://cordex.dmi.dk/joomla/images/CORDEX/cordex\_terms\_of\_use.pdf), must be given to the data providers by an acknowledgement similar to the following:

“The World Climate Research Programme's Working Group on Regional Climate, and the Working Group on Coupled Modelling, former coordinating body of CORDEX and responsible panel for CMIP5 are gratefully acknowledged. The climate modeling groups (listed in Table 1 and Table 2) are sincerely thanked for producing and making available their model output. The authors thank the Earth System Grid Federation (ESGF) infrastructure and the Climate Data Portal hosted at the Centre for Climate Change Research (CCCR), Indian Institute of Tropical Meteorology (IITM) for providing CORDEX South Asia data.”

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