Meeting Summary
The Third International Workshop on CORDEX-East Asia

August 11-12, 2014
National Institute of Meteorological Research, Seogwipo, Jeju, Korea

The 3rd International Workshop on CORDEX-East Asia was held during 11-12 August 2014 at Jeju, Korea, hosted by National Institute of Meteorological Research (NIMR). As a co-sponsor of the workshop, Monsoon Asia Integrated Regional Study (MAIRS) supported travel funding for a few invitees. In total, 35 participants attended from Australia, China, India, Indonesia, Japan, Korea, and Malaysia (see the separate file for list of participants). In the opening, Dr. Jae-Cheol Nam, Director-general of NIMR, welcomed all participants and encouraged their active discussion, comments, and even debates by stressing the importance of the workshop.

The major objectives of the workshop are to make general consensus on the plans for next phase CORDEX-East Asia experiments and stimulate more groups to join with CORDEX-EA and its nearby regions such as South Asia, Southeast Asia, and Australasia. Most importantly, during the workshop, domain size with 25 km resolution aimed to be confirmed. In this context, the workshop consists of three sessions featured by combination of short presentation given by chair persons and open discussion with audience on a range of following themes (Also, see the separate file for the workshop program);

1. Summary and updates on the CORDEX and its relevant issues
2. Key scientific issues on the modeling and analysis issues
3. Practical issues on the experiments

All the presentation files are available at http://cordex-ea.climate.go.kr

Session 1: Summary and Updates on Recent Activities

Eight talks on the recent activities of CORDEX and relevant projects were given, which are listed up below. Following the talk to overview the CORDEX activities in Asia and their link for collaboration by Dr. Ailikun, RMIP and SOUSEI programs led by Drs. S. Wang (Nanjing University, China) and I. Takayabu (MRI, Japan), respectively, were introduced. After then, progresses on CORDEX for East Asia (Dr. H.-S. Kang), Southeast Asia (Dr. F. Tangang), South Asia (Dr. M. Mujumdar), and Australasia (Dr. J. McGregor) were presented. Finally, Prof. D.-P. Min, as a member of Science Advisory Board (SAB) of UN Secretary-General, gave a talk on the SAB's functions and efforts for sustainable development goals.

This session well addressed current status of each community in Asia and provided basic understanding on where we are, which is essential to prepare next phase of CORDEX-EA.

- Report of meeting related to CORDEX Asia (Dr. Ailikun)
- From RMIP to CORDEX using multi-models in regional climate study (Dr. Shuyu Wang)
- SOUSEI program (Dr. Hiroaki Kawase)
- Summary of CORDEX-East Asia and the SAT meeting (Dr. Hyun-Suk Kang)
- The Southeast Asia regional climate downscaling (SEACLID)/CORDEX South East Asia project (Dr. Fredolin Tangang)
- CORDEX-South Asia (Dr. Milind Mujumdar)
- Recent CCAM activities for CORDEX (Dr. John McGregor)
- Efforts of UNSG-SAB on UN-SDGs (Dr. Dong-Pil Min)

Session 2: Scientific Issues for CORDEX-EA Phase II

Three themes were discussed in this session, which are domain/resolution issue, modeling, and analysis issues.

Domain and resolution

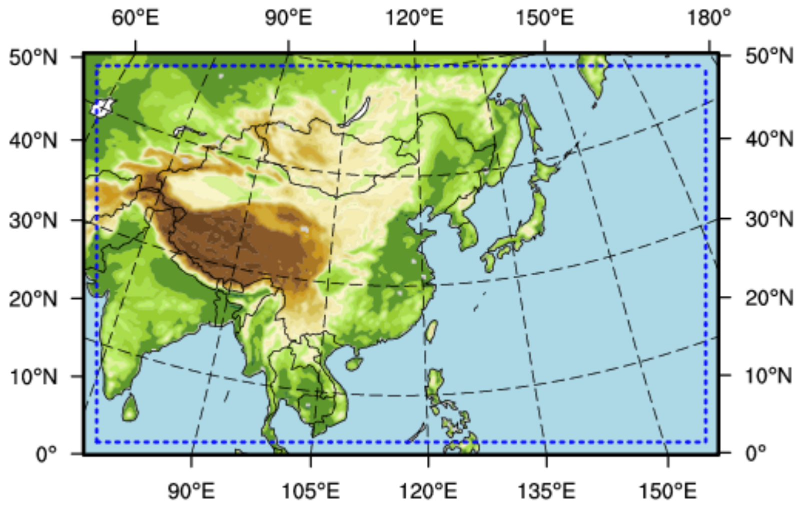
Since the side meeting at ICRC2013 in Brussel, there has been overall consensus to reduce domain size with higher resolution (25 km) for the East Asia domain. Discussion in this session was focusing on 1) whether or not the new domain is enough to cover tropical cyclones activity (genesis and track) and 2) computing resources to deal with the new domain. As a chair of this session, Dr. X. Gao proposed the new domain with 25 km's resolution and presented climatology on genesis and track density of tropical cyclones. Dr. H.-S. Kang also proposed two additional domains with the expectation of increased computing resources compared to the original domain. Through the active discussion with all participants, slight adjustments were made on proposed domain so that the EAS-22 was finally confirmed and agreed.

According to the domain definition[1], the EAS-22 domain is defined by the following parameters.

[1] See the document "CORDEX domains for model integrations" at http://wcrp-cordex.ipsl.jussieu.fr/images/pdf/cordex_regions.pdf. The latest update was made on 17/6/2013

A. Parameters needed by an RCM using a rotated pole coordinate system:
   - Coordinates of the rotated pole (longitude, latitude): (296.3; 61.0)
   - Coordinates of the TLC (longitude, latitude): (316.77; 32.90)
   - Number of grid points in the East-West direction (Nx): 396
   - Number of grid points in the North-South direction (Ny): 251

B. Parameters for RCM using other system coordinates (in non-rotated coordinates):
   - TLC (51.59; 50.50), CNB (116.70; 61.90), TRC (181.50; 50.31)
   - CWB (67.11; 25.72), CPD (116.57; 34.40), CEB (165.94; 25.56)
   - BLC (76.91; -0.10), CSB (116.51; 6.90), BRC (156.08; -0.24)



Modeling Issues

Dr. S.-Y. Hong gave a presentation on several issues in regional climate downscaling based on his recent review paper (*Asia-Pacific J. Atmos. Sci*., **50(1)**, 83-104). It covers model development, grey zone issue, domain and resolution issues, regional ocean processes, role of Tibetan Plateau, large-scale forcing issue, and others. He emphasized that development and/or improvement of regional climate models should be in line with the strategy for the short-range numerical weather prediction by avoiding tuning for specific physics component in a particular model. Recommendations for further study were 1) to use of non-hydrostatic model, 2) to improve the model physics and verify short-range forecasts against observations, 3) not to expect the regional model to produce better large-scale features but avoid their error growth within the domain, 4) to develop more mathematically rigorous lateral boundary conditions, 5) to develop atmosphere-ocean coupled model, and 6) to develop skill evaluation metrics.

A few suggestions were given for Flagship of Pilot Study (FPS) in phase II, which are 1) sensitivity study to the large-scale forcing with a given regional climate model driven by multi-reanalysis data, 2) very high-resolution simulation up to more or less 5 km's resolution for the common interests (e.g., tropical cyclone and heavy rainfall that could lead to disasters), and 3) sensitivity study to investigate attribution of anthropogenic forcing (e.g., aerosol impact in East Asia Urban areas). Participants agreed to discuss further for FPS until its proposal is developed by the world-wide CORDEX community.

The participants also agreed it is necessary to set up "CORDEX Asia statistical downscaling group" by linking with CORDEX statistical group. We will get in touch with Dr. Bertrand Timbal from Australia and Dr. M. Nishimori from Japan for further arrangement.

Analysis issues

The themes discussed in this session are:

- GCM analysis to choose LBC forcing (Dr. H. Kawase),
- Added value from high resolution simulations particularly for climate extremes of precipitation and temperature (Drs. H. Kawase and S.-K. Min) and extreme phenomena (e.g., Tropical cyclone) (Dr. D.-H. Cha), and
- Ensemble method and uncertainty assessment (Dr. M.-S. Suh).

In order to find better GCM forcing to drive the regional climate model for CORDEX-EA domain, skill score in Taylor diagram can be useful in terms of statistical performance. Nevertheless, several questions to be answered are still remained: 1) what variables we should analyze? (e.g., precipitation, atmospheric circulation, SST), 2) what GCM variables are available?, and 3) which GCMs we are going to use (e.g., CMIP5?, high-resolution AGCM? or CMIP6?). Dr. Kawase introduced cluster method to make SST forcing to drive a high-resolution AGCM and experimental configuration to investigate its added value for tropical cyclone and Asian summer/winter monsoon systems. Dr. McGregor also proposed a method for ranking the GCM performance in terms of goodness of present climate simulations, SST, and spread of climate change signals by combining several methods from individual studies.

By analyzing extremes of precipitation and temperature simulated by CORDEX-EA experiments, Dr. S.-K. Min found clear added value in precipitation extremes and close relationship between mean and extreme for model errors and future projections. In summary of his study, surface air temperature has better skill in mean than in extreme because of higher spatial correlation whereas precipitation shows better skill in extreme than in mean due to better spatial variability. Multi-model ensemble helps to capture reliable behavior of interannual variability of tropical cyclone's activities; however, there are significant discrepancies between individual models due to different physical processes. Experiences from high-resolution AGCM implied horizontal resolution is critical to capture realistic behavior of tropical cyclones.

Dr. M.-S. Suh introduced a deterministic ensemble average method to reduce model biases and uncertainties. All ensemble methods based on PEA (performance-based ensemble average) are efficient to improve the simulation skills both in accuracy and reliability; however, limitation still exists on the validity of stationary assumption in statistical method and significant reduction of variability. Use of multi-GCM/RCM metrics and recovering method of variability were strongly suggested by his study.

Session 3: Practical Issues for CORDEX-EA Phase II

This session covers four themes, arrangement of simulations, data center, task sharing, and preparations for the next CORDEX-SEA meeting.

All participants, in general, agreed to follow the two-stream approach of CORDEX in which the experimental types are AMIP-like driven by reanalysis forcing and CMIP-like driven by

GCM forcing. Dr. H.-S. Kang explained that CMIP6 has been already started and CORDEX-SAT is preparing a proposal to make CORDEX be one of the CMIP-endorsed MIPs. In this context, he suggested additional framework for FPS until CMIP6 outputs are available. Detail configuration for FPS framework needs to be discussed further. In order to expand GCM/RCM metrics for CORDEX-EA, we decided to share available CMIP5 GCM forcings archived by each group. As of August 2014, we figured out 17 GCMs are available to drive regional climate models (see Appendix 1). Regarding the very-core variable list to be shared for fast analysis, we agreed that each group is supposed to select most preferable variables based on the CORDEX archive design[2], and then circulate to confirm after the workshop. The available GCM datasets will be shared not only in CORDEX East Asia group, but also South Asia and Southeast Asia.

There was strong consensus that ESGF nodes are efficient way to share CORDEX outputs for not only the regional climate scientists but also the IAV sectors. As of August 2014, IITM/India has been approved to be one of the ESGF nodes and NIMR/Korea will apply for new ESGF node very soon in this year. Beijing Normal University of China has been approved as an ESGF node, but need to discuss with BNU if they would like to host the CORDEX Asia data or not. Other potential partner from China is under discussion. Based on the discussion in the workshop, Dr. Ailikun summarized the agreements on the ESGF issues in Asia as following:

- To share the burden of ESGF nodes and fix the big gaps of internet speed among different Asian countries, we will try to ask all the CORDEX related ESGF nodes in Asia to host the CORDEX-Asia datasets in all three regions: South Asia, East Asia, and Southeast Asia.
- All the CORDEX related ESGF nodes will share the information on IT support, data formats and users' platform.
- CORDEX Asian groups need technical capacity building on how to build up an ESGF node. We propose a small training workshop (around 10-15 participants) for CORDEX Asian groups in late 2014. Scientists and IT supporters from current and potential ESGF nodes will be invited to the training. MAIRS IPO and WCRP will financially support the training workshop.
- For the ESGF capacity building workshop in Asia, we need strong support from WCRP/CORDEX to recommend/send 1-2 technical experts to this training.
- After Jeju workshop, Nanjing University of Information, Science and Technology (NUIST) expressed their willingness to host the ESGF training workshop in its WMO Regional Training Center in Nanjing. Local host: Prof. Zhihong JIANG, vice-president of NIUST, zhjiang@nuist.edu.cn.

In Jeju workshop, we recognized the number of potential participating groups for CORDEX-EA Phase II. Number of regional climate models could be 3~6 from China, 3 from Japan, and 5 from Korea. Three more high-resolution AGCMs could be also involved from Australia, Japan, and Korea. We are now looking for 14 RCMs to join the CORDEX EA phase II experiment, the details of each RCMs will be also summarized (Dr. Ailikun will distribute the information sheet soon).

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[2] See the document "CORDEX Archive Design" at http://cordex.dmi.dk/joomla/images/CORDEX/cordex_archve_specifications.pdf. Latest version is 3.1 updated on 3rd March 2014

We concluded that it is not easy to collect station measurements from each country due to the data policy. Instead, use of gridded-observation datasets, TRMM, APHRODITE, GPCP, CMAP, CRU etc., is encouraged.

There was a discussion for the 1st WCRP CORDEX Science and Training Workshop in Southeast Asia that will be held in 17-20 November 2014 at Citeko Bogor, Indonesia. It will consist of two-day training and two-day science conference. The official announcement of this workshop can be found at http://www.ukm.edu.my/seaclid-cordex/wcrp_cordexsea_bogor.html.

APPENDIX 1. Information of CMIP5 GCMs for CORDEX-East Asia Phase II Experiments
(designed by Xuejie Gao, August 2014)

	Model	Resolution	Scenarios	Period	Available Institute	Data Size (TB)	Contact Person
1	CanESM2	Spectral T42L35 (~ 2.8°, 128× 64)	Historical, RCP4.5, 8.5	1950~2005~2100	NCC/CMA, from ICTP	1.6	Xuejie Gao gaoxuejie@mail.iap.ac.cn
2	CSIRO-Mk3.6.0	Spectral T63L18 (~1.875°, 192× 96)	As Above	1950~2005~2100	As Above	1.9	As Above
3	EC-EARTH	1.125° longitudinal spacing, Gaussian grid T159L62 (320× 160)	As Above	1969~2005~2100	As Above	5.0	As Above
4	GFDL-ESM2M	2.5° lon × 2.0° lat M45L24 (144 × 90)	As Above	1951~2005~2100	As Above	1.8	As Above
5	HadGEM2-ES	1.875° lon × 1.25° lat N96L38 (192 × 145)	As Above	1950~2005~2099	As Above	5.1	As Above
6	IPSL-CM5A-LR	96× 95 equivalent to 1.9° lat × 3.75° lon L39	As Above	1940~2005~2105	As Above	2.2	As Above
7	MPI-ESM-MR	T63L47 (~1.875°, 192× 96)	As Above	1970~2005~2099	As Above	5.5	As Above
8	FGOALS-g2	2.8125° × 2.8125° (128× 60)	As Above	1950~2005~2099	NCC/CMA	1.2	As Above
9	BCC-CSM1.1	T42L26 (~2.8°, 128× 64)	As Above	1950~2005~2099	NCC/CMA	1.2	As Above
10	IPSL-CM5A-MR	Global (2.5°×1.2676°)	Hist, RCP4.5, 8.5	1951 ~ 2005 ~ 2100	France, IPSL	2.2	Zhihong Jiang: zhjiang@nuist.edu.cn,
11	MPI-ESM-LR	T63L47 (~1.875, 192×96)	As Above	1979~2005 2019~2050 (will be extended to 2100)	UNIST, from ????	1.2	Dong-Hyun Cha dhcha@unist.ac.kr
12	HadGEM2-AO	1.875° lon ×1.25° lat N96L38 (192 ×145)	Historical, RCP2.6, 4.5, 6.0, 8.5	1970~2005~2100	NIMR/KMA	14.9	Hyun-Suk Kang hyunskang@korea.kr

13	MRI-CGCM3*1	TL159 L48 （～1.12°, 160x320）	Hist, RCP4.5 (2.6, 6.0, 8.5) *1	1980-2000 2080-2100	MRI	1	Hiroaki Kawase (MRI) hkawase@mri-jma.go.jp
14	MIROC5*2	TL85 L40 （～1.4°　128×256）	Hist, RCP4.5 (2.6, 6.0, 8.5) *2	1980-2000 2040-2060, 2080-2100	MRI	0.15	As above
15	NCAR CCSM4*3	（～1.0°　192×288）	Hist, RCP4.5	1980-2000 2080-2100	MRI	0.5	Asuka Suzuki-Parker (University of Tsukuba) suzuki.asuka.fp@u.tsukuba.ac.jp
16	MRI-AGC3.2*4	TL959 L60 （～20km　1920×960）	Hist, RCP2.6, 4.5, 6.0, 8.5	1979-2003 2075-2099	MRI	36	Hiroaki Kawase (MRI) hkawase@mri-jma.go.jp
17	MRI- AGCM3.2*5	TL319 L60 （～60km　640×320）	Hist, RCP2.6, 4.5, 6.0, 8.5	1979-2003 2075-2099	MRI	6	As above

- Note (cells filled with yellow color): Only higher-resolution models are suitable to drive the 25km RCMs
- Please send this information back to Drs. Ailikun (aili@mairs-essp.org), Hyun-Suk Kang (hyunskang@korea.kr), and Xuejie Gao (gaoxuejie@mail.iap.ac.cn), if you have any more.

*1 30E-150W 20S-70N can be available soon. The other datasets, that is the other regions and RCP, are now under consideration.
*2 70-180E 10N-60N can be available soon.
The other datasets, e.g., the other periods, regions, and RCPs, are also available, but they are stored in JAMSTEC (not MRI).
*3 90E-180E 10N-60N can be available.
*4 Now, under consideration. 50S-70N Atmospheric general circulation model using warmed SST.
*5 Now, under consideration. Atmospheric general circulation model using warmed SST.