



ASIA-PACIFIC NETWORK FOR
GLOBAL CHANGE RESEARCH

Project Final Report

2020

Project Reference Number: CBA2019-08SY-Wang

Project Title:

ICRC CORDEX 2019: Promoting Involvement of Early Career
Scientists from the Asia-Pacific Region in Regional Integrated and
Sustainable Development through Active Participation and
Networking

Remarks: Single-year CAPaBLE project.

1. Project information

1.1 Project duration

The project started from March 2019 and lasted to September 2020.

1.2 Funding, collaborators and key organizations involved

This APN project, which was part of the CORDEX International Conference on Regional Climate (ICRC-CORDEX 2019) in Beijing, 14-18 October 2019 was sponsored by APN with \$42.125. The rest of fundings came from the Institute of Atmospheric Sciences, Chinese Academy of Sciences, World Climate Research Project (WCRP), National Science Foundation of China (NSFC), China National Committee of WCRP (CNC-WCRP) hosted by China Association for Science and Technology (CAST), Alliance of International Science Organizations (ANSO), Nanjing University. The sponsors that supported the realisation of the conference included Swedish Environmental Protection Agency (SEPA), Monsoon Asia Integrated Research for Sustainability of Future Earth (MAIRS-FE), European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), Third Pole Environment (TPE), Institute for Global Learning (IPSL).

The major collaborators and key organizations of project includes the Institute of Atmospheric Sciences, the International Project Office for CORDEX (IPOC), World Climate Research Project (WCRP), Nanjing University, Swedish Meteorological and Hydrological Institute (SMHI), and The Young Earth System Scientists Community (YESS).

1.2.1 Title for level-3 sub-heading (if any)

Please follow the format in this template. You are requested to refrain from changing the layout and format.

2. Project summary

Please summarize the original goals and objectives of the project and what has been achieved in relation to these (200 words)

Facing the urgent requirement of regional VIA and policy makers in taking actions to mitigate climate change, the **International Conference on Regional Climate–CORDEX 2019** was to address the key topics of:

- 1) Benefits and added values of downscalings, including newly developed downscaling techniques;
- 2) Frontiers in regional climate sciences and processes, including convective permitting modeling, regional earth system process such as biochemical, regional ocean and other

human-climate interactions;

- 3) CORDEX in Action, including presenting its scientific and capacity-building achievements, summarizing lessons learned, and prospecting its future perspectives and status in global climate research communities;

By registration 253 climatologists and stakeholders from 44 countries joined the ICRC-CORDEX 2019 22 sessions, APN ECS event and a side event on climate and risk. Among them 138 participants and 26 ECS were from APN countries and regions.

With implementation and completion of project, ECS from Asia-Pacific region had an opportunity to 1) interact and exchange experiences, 2) boost the capacity development and advance the knowledge exchange, and 3) expand existing and build new collaborations. The project contributed to promoting the CORDEX vision of advancing the regional climate science coordination and application of downscaling results, and it help to improve the networking within the Asia-Pacific region.

Please indicate the project's current status:

- Complete
- Proceeding according to work plan and logical framework matrix
- Ahead of schedule
- Behind schedule
- Proceeding with some modifications (Please specify): Click or tap here to enter text.

3. Project activities

Reporting period: 03.2019 – 09.2020

3.1 Activities completed

List the project activities completed and an overview of the project outcomes during the reporting period.

With APN financial support, the completed activities of project includes:

- 1) ECS and students from APN member and developing countries to join ICRC-CORDEX 2019. With APN project fund, totally 21 ECS from 9 countries attended the ICRC-CORDEX 2019. Their qualifications were assessed by the SAT of WCRP CORDEX and the organizing committee of ICRC-CORDEX 2019, based on their scientific backgrounds, scientific quality and relevance and potential scientific impact of research.
- 2) Supported by APN fund and coordinated by conference organizing committee and Young Earth System Scientists Community, ICRC CORDEX 2019's Early Career Science Event was successfully held on the topics of climate science and society, climate information and user interaction. In addition to APN selected ECS, more than 100 ECS and senior scientists from non-Asian countries showed up for the ECS

event. Invited speakers addressed the issues of bringing regional climate science to society, how to better bridge the knowledge gap between end-users and climatologists. The discussion emphasized the need to engage in user interaction to further develop regional climate science and also highlighted the challenge to foster the next generation of early career scientists with a user-aware scope while retaining a scientifically solid disciplinary foundation. Selected ECS presented their work, shared their research and ideas with peer young scientists and senior experts. ECS event was closed by an interactive Q&A session.

- 3) ECS commitment to ECS event and conference sessions. To further motivate their senses of active involvement in global academic event and science communication, selected ECS will commit to be part of conference sessions and ECS event coordination, including acting as the assistant session rapporteurs and coordinators alongside with the regular ones. The selection will be made by conference science committee, CORDEX Science Advisory Team, and local conference organizing committee. ECS rapporteurs contributed to the preparation of the session and ECS event reports. The activity initiated the partnership and leadership in their research and career, and strengthen ECS's capability in science communication and knowledge transfer. All ECS were active in conference sessions and ECS event.
- 4) Organized discussion to tighten existing connections among Asia-Pacific CORDEX teams. Face-to-face discussion among Asian CORDEX teams and scientists were carried out as to how to further enhance the capacity building at institutional level, the strategy and plan to establish the connections with VIA sections. The discussion was meant to promote collaboration among Asia-Pacific CORDEX teams through on-site discussions on new cross-domain experiments, preparation of joint research plans and projects on subjects of common interests, and future plans for training workshops/programs on regional climate downscaling technique and data analysis. Jointed workshop was proposed by CORDEX-EA, SEA teams and MAIRS during the ICRC-CORDEX on climate change and regional development and human well-beings.

3.3 Challenges or issues

List any challenges or issues in project implementation in relation to the goals and objectives. Briefly explain how you addressed the challenges or issues.

In all proposed project objectives, one of them is to raise the awareness of the scientific and social challenges that are unique to the Asia-Pacific region. For example, how the changes in monsoon variability affecting the magnitude and frequency of precipitation extremes and consequently regional water-related disaster management, agriculture development and human wellbeing, the influence of regional aerosol on model's cloud microphysics (and rainfall simulation), the air quality and human health, and relationship between regional fine-scale climate variability and future development of renewable energy, etc.

The various sessions in the ICRC-CORDEX 2019 addressed the scientific questions on how to improve the understanding of regional climate processes and thus improve the reliability of downscaled climate change information, etc. The ICRC-CORDEX 2019, along with its APN ECS event and a side event on future risk, had the purpose to promote the collaboration

between communities on natural and man-made climate change and the human-natural components interactions at regional-to-global levels. But the topics of climate science that specific to Asia-Pacific region, especially those related to the interaction with the natural resources (e.g., water resource, ecosystem security, regional cryosphere) and social-economical development (e.g., ever-growing urbanization, industrial restructuring to reduce greenhouse and aerosol emissions, growing development and application of renewable energy) were seldom mentioned. For example, more and more renewable energy of wind farm, solar and hydro-power will be designed and put into use in the future in Pacific Asian countries. Yet few presentation and poster were to address the issue, which indicates the lack of solid connection between regional climate change community and energy section. Such combined climate forcings act on various temporal-special scales and will induce the changes in surface climate extremes, influencing the regional welfare especially over the regions that have less resilience.

Now the challenge is, in what way can Asian RCD communities and global CORDEX community integrate above natural and anthropogenic factors in their researches. How to produce more efficient, down-to-reality, and applicable collaboration and connection between social and physical communities. One option is to keep develop and apply high resolution Regional Earth System Model, which could address regional physical and biogeochemical processes in more details (e.g., regional ocean, biomass emission, ecosystem management), and provide more reliable and thorough assessment of regional natural resources. CORDEX next step simulation of high resolution (~10km) will provide opportunities and dataset to study the impacts of future changes at local to regional scales on clean energy industries, and to evaluate the regional climate and environment effects of establishing clean energy facilities. Moreover, closer collaboration with the Asian regional global change research network and programme, including APN, Future Earth-Asia projects, ANSO, will be crucial to ensure the implement of CORDEX objective to advance and coordinate the science and application of regional climate downscaling through global partnerships.

4. List of project deliverables to date

Referring to the logical framework matrix in your project contract, please state whether the expected deliverables have been met.

The expected outcomes from the proposed project are mainly capacity building at multiple levels, as well as knowledge creation and transfer on regional climate studies. According to the proposed logical framework the expected deliverable includes

- Conference program and reflection report from early career scientists
- Participation lists of ECS event and reflection report
- Conference program, abstract book
- Website with information on scientific publications (Provide a platform so Asian Pacific teams can develop collaborative work with other CORDEX initiatives and global change programme)

4.1 Project products delivered or completed

Please list the project products delivered or completed to date and the corresponding outcomes achieved. Enumerate them in bullet form, indicate their metadata as applicable, and provide a brief description of how the product has been disseminated so far.

Please ensure that you attach all completed deliverables as appendices.

As listed in the proposal, the deliverables with project completion are as following:

- (1) Conference programme, ECS flyer, abstract book;
- (2) Oral and poster presentations from APN funded participants;
- (3) Reflection reports by participating ECS;
- (4) Conference's session summary and related news and reports;
- (5) session reports with contribution of APN supported ECS;

5. List of pending project deliverables

A list of project products that are work-in-progress or expected. Note that this is for the purpose of reporting expected project outputs, such as publications, even after the project duration. For multi-year continuing projects, please list the expected deliverables in the succeeding year (e.g., papers in press or in review, etc.).

Due to the outbreak of pandemic and the partial closing down of institutions and universities in earlier 2020 in China and around the world, the scheduled discussion and drafting of jointed paper and scientific project were delayed. The project team is scheduled to continue its proposed activities including:

- The collaborative work with global change programme such as Future Earth and other CORDEX initiatives by Asian Pacific teams. For example, the workshop jointly hosted CORDEX East Asia Team, Southeast Asia Team CORDEX IPOC and Monsoon Asia Integrated Research for Sustainable development, a core project of Future Earth, was initiated during ICRC-CORDEX 2019, and scheduled to held in April, 2020. Due to COVID-19, the workshop is postponed until November 2020.
- Increased exposure and involvement of ECS in global research projects. Due to the outbreak of pandemic, the international science events such as EGU and AGU were postpone and will be held on line. The situation caused/IMPEDED the face-to-face discussion, and with the support of WCRP, CORDEX-IPOC and YESS, we should continually use YESS as a platform to increase the visibility and international activities of Asian ECS. This can be listed as the future and following up of this project.

Items to be delivered in the future mainly includes jointed proposal and peer-reviewed scientific papers.

6. Future directions

Please provide an explanation as to how you expect the related activities, project products and impacts can or will continue after project completion.

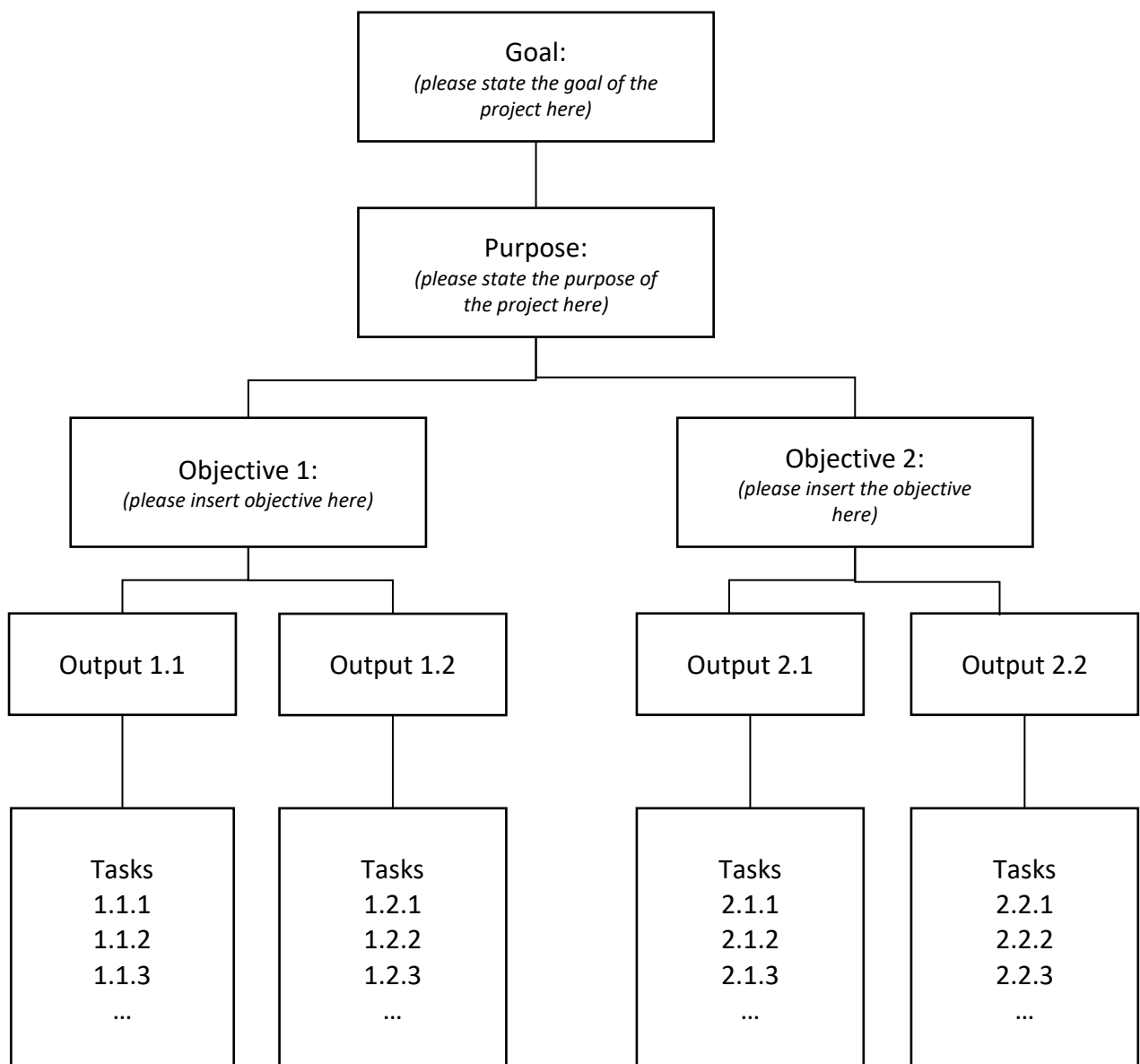
- 1) The common goals of this project and the CORDEX in general is to increase the coordination in the Asia Pacific region and worldwide, and to foster communication and knowledge exchange with users of regional climate information. Along with ICRC-CORDEX 2019, This APN funded project provided such a platform for communication

and exchange. With completion of project, the WCRP, CORDEX Asian teams and YESS will continue their joint efforts to increase the visibilities, engagement of Asian ECS in global science community. The APN project funded ECS can thus contribute in networking and engaging their peers and colleagues, and having a sustained impact on worldwide CORDEX regions.

- 2) It's also scheduled to advance and coordinate the science and application of regional climate downscaling through jointed project by CORDEX Asian Teams and Future Earth core projects.

7. Special requirements

For continuing multi-year projects, please refer to your logical framework matrix and report your progress using the diagram below. You may add boxes as necessary.



Briefly explain the activities, outputs and outcomes achieved to date (200 words).

Acknowledgement

Acknowledgment of collaborating institutions, resource persons, etc.

The project team would like to express its acknowledgment to the local host of Institute of Atmospheric Sciences, and several Chinese universities and funding agencies, namely: Nanjing University, National Science Foundation of China (NSFC), China National Committee of WCRP (CNC-WCRP) hosted by China Association for Science and Technology (CAST), Alliance of International Science Organizations (ANSO). Special thanks to CORDEX International Project Office (CORDEX-IPOC), WCRP and the Young Earth System Scientists community (YESS) for international coordination and technical supports that guarantee the success of ECS event and project implementation. All sponsors that provided financial and in-kind supports are greatly appreciated.

The first organisation that the project team would like to thank is The Asia-Pacific Network for Global Change Research (APN), with which CORDEX teams and scientists have been working for many years. Without the support from the APN, this project could not be realised.

Project team would like to thank the contributions of Miss Wenling Zhou from Institute of Atmospheric Sciences, Ms. Anna Eronn, Linhda Nilsson from CORDEX IPOC and SMHI, and Catherine Michaut from IPSL, Drs. Christmas de Guzman and Victor Dike from YESS, Ms. Liping Shen from Nanjing University. Their support and coordination on logistic and finance guaranteed the final completion of project.

Appendices

- All project products produced.
 - Appendice 1: Oral and poster presentations from APN funded participants;
 - Appendice 2: Reflection reports by participating ECS;
 - Appendice 3: ECS event summary report, ECS event sign-in sheet and photos
 - Appendice 4: Session reports with contribution of APN supported ECS;

Appendice 5: Conference session programme, ECS flyer, abstract book;

Appendice 6: Conference summary, news/reports and webcast information;

(Appendices 4-6 can be acquired by request from APN Secretariat)

- List of young scientists involved in the project. Include their name, institution and contact details.

Dr. Yan Yan from School of Atmospheric Sciences, Nanjing University, dg1928026@smail.nju.edu.cn. Working with conference local host, she contributed by arranging ECS logistic, providing assistance to international ECS with their communication to local host and hotels.

Dr. Ester Salimun, National University of Malaysia, ester.coal@gmail.com, being active during ECS event and afterward discussion.

Dr. Dharendra Kumar, Jawaharlal Nehru University, dharendra.cub@gmail.com, being active during ECS event and afterward discussion, acting as conference ECR rapporteur (Session A2).

Dr. J.C. Peralta, Manila Observatory, jcperalta@observatory.ph, acting as conference ECR rapporteur (Session A1)

Dr. Adnan Arshad, Pakistani Meteorology Department/China Agricultural University, ad@cau.edu.cn, acting as conference ECR rapporteur (Session C1)

- Awards and honours received as a result of the project.

References

Please cite references used following the APA citation format.

Implementation of a new aging parameterisation scheme in RegCM4

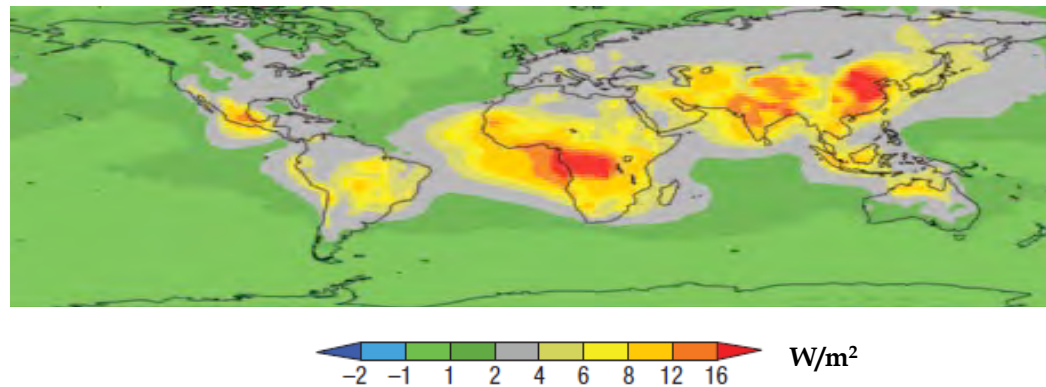
Sudipta Ghosh¹, Nicole Riemer², Graziano Giuliani³ and Sagnik Dey¹

¹Indian Institute of Technology Delhi, New Delhi, India, ²University of Illinois Urbana-Champaign, IL, USA, ³Abdus Salam International Centre for Theoretical Physics, Trieste, Italy

ICRC-CORDEX 2019, Beijing
October 17, 2019

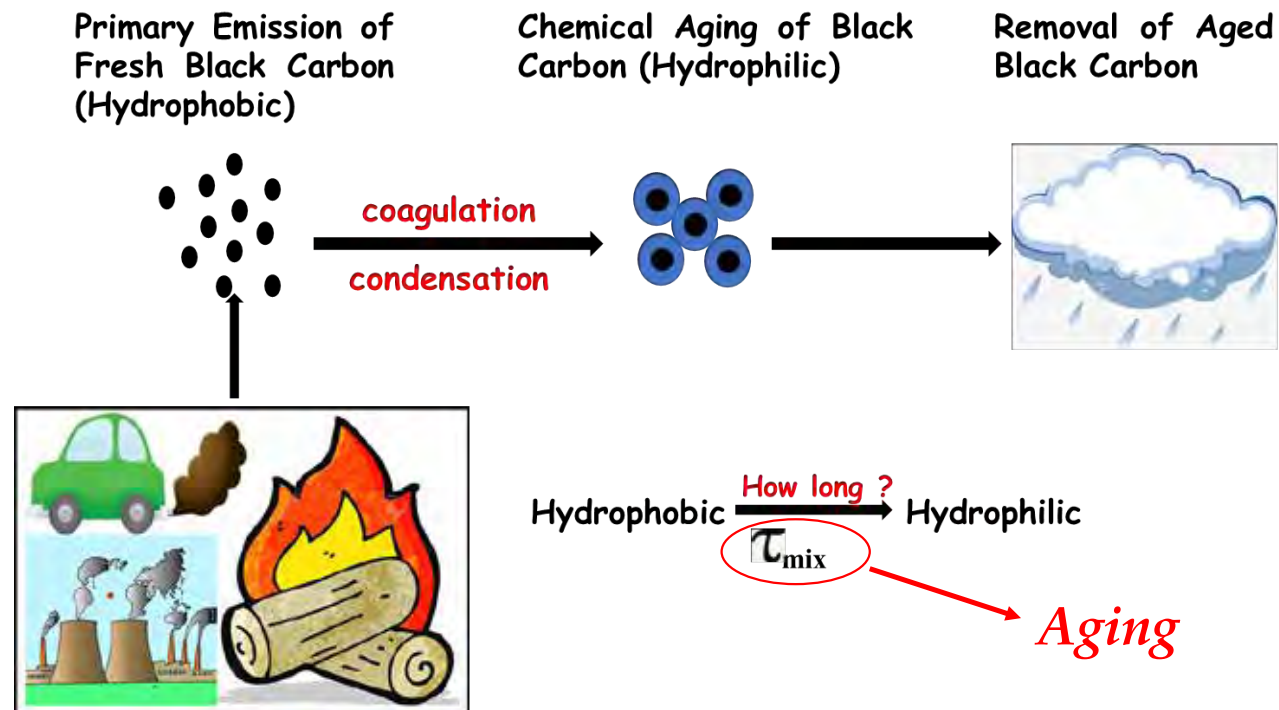
Why black carbon aerosols ?

- ❖ Aerosols produces cooling both at TOA and surface but black carbon warms the TOA due to absorption and produces dimming at the surface.
- ❖ Total radiative forcing of BC aerosols is 1.1 W/m^2 (Bond et al., 2013) which stands second to CO_2 forcing in warming the climate (Ramanathan and Charnichael, 2008).



Atmospheric solar heating due to black carbon.
[Chung et al. (2005)]

What is aging of black carbon aerosols ?



- ❖ Black Carbon radiative forcing can increase at the surface and decrease at the top of atmosphere after aging (Wu, Y. et al., 2016)

Methodology

Model name

Domain

Resolution

Time period

Atmospheric data , SST used

Anthropogenic aerosol module
Anthropogenic Components (BC,
hydrophilic and hydrophobic)
Emission Inventory

Cumulus parameterization

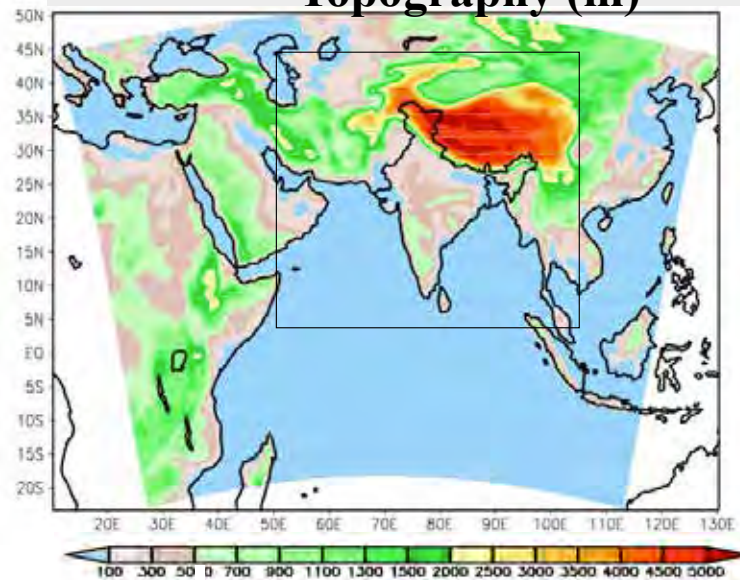
Land use

Planetary Boundary parameteriza

Large scale precipitation paramet

Region of Study

**CORDEX South Asian Domain
Topography (m)**



Co-ordinates of study region

Lat: 0° - 40° N, Lon: 50° - 105° E

Domain

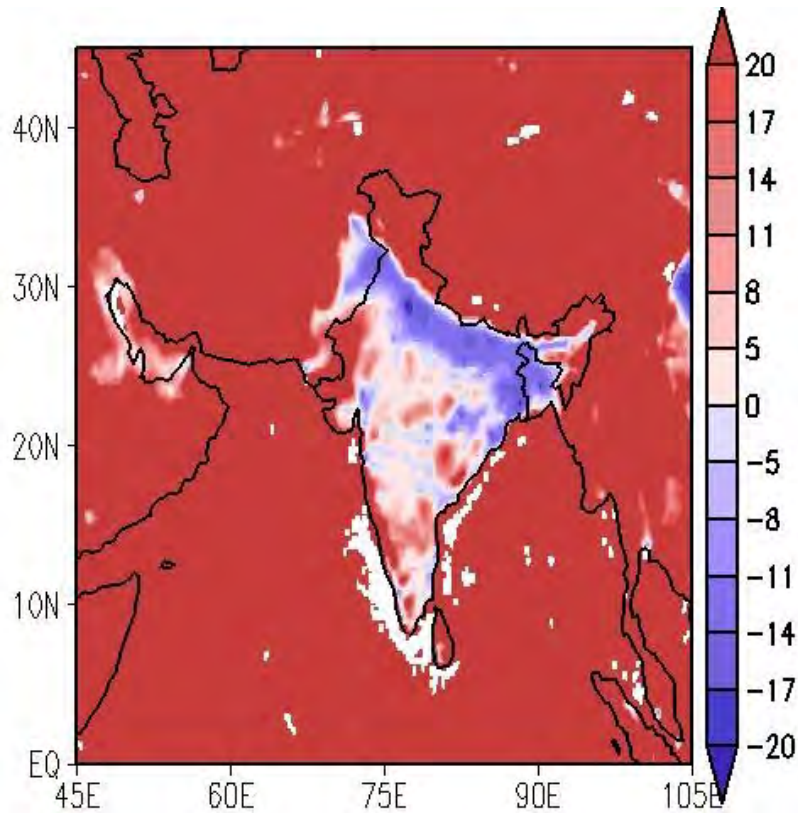
December, 2010

Interpolated SST data

Both land and Tiedtke over ocean

on

Anomaly of aging timescale (in hours) of carbonaceous aerosols



- ❖ Current aging process from hydrophobic to hydrophilic in RegCM4

$$\tau_{\text{mix}} = \text{fixed} = 27.6 \text{ hours [Cook et al., 1999]}$$

- ❖ Parameterization scheme introduced:

$$\tau_{\text{mix}} = (k_{\text{cond}} * I_{\text{cond}} + k_{\text{coag}} * N)^{-1} \text{ [Fierce et al., 2016]}$$

where N = total number concentration
of aerosols

$$k_{\text{cond}} = 0.01 \text{ nm}^{-1}$$

$$I_{\text{cond}} = \text{condensational flux}$$

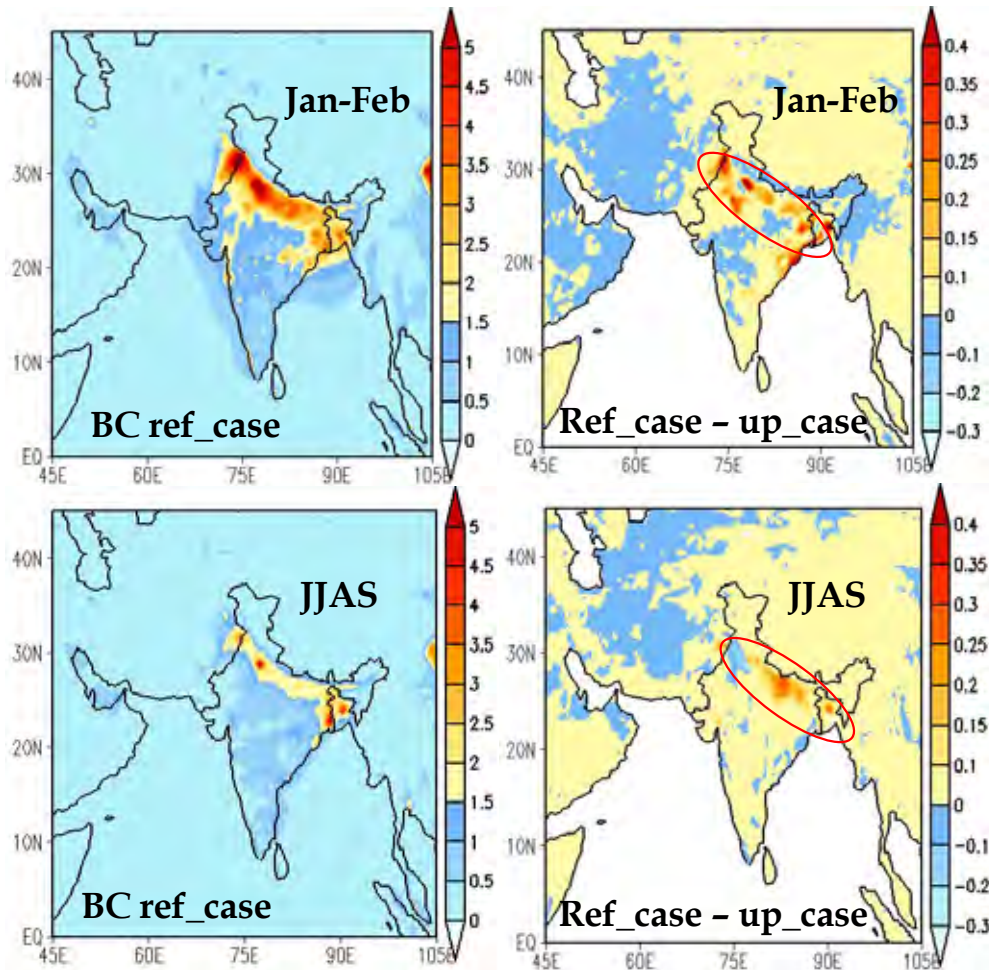
$$k_{\text{coag}} = 6 \times 10^{-6} \text{ cm}^3\text{h}^{-1}$$

Results and Discussion

Two set of simulations:

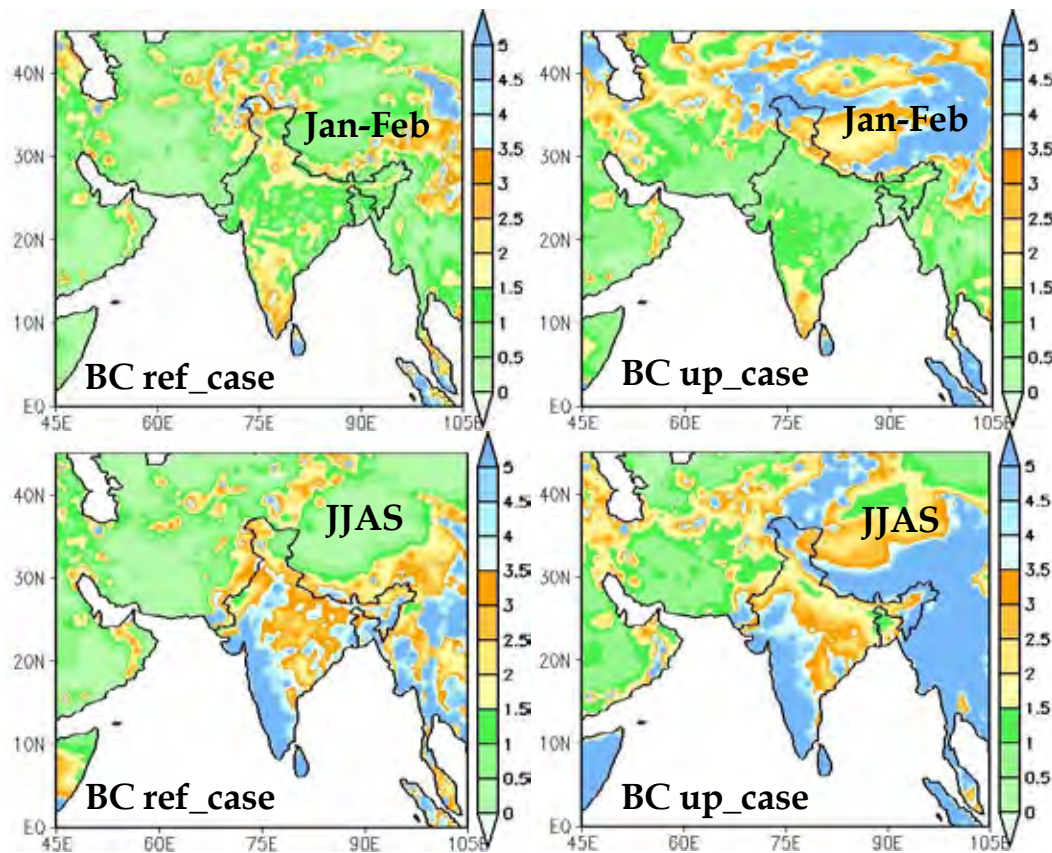
- **Reference_case (henceforth ref_case) with fixed tau value of 27.6 hours**
- **Updated_case (henceforth up_case) with dynamic tau values.**

Change in the surface mass concentration ($\mu\text{g}/\text{m}^3$)



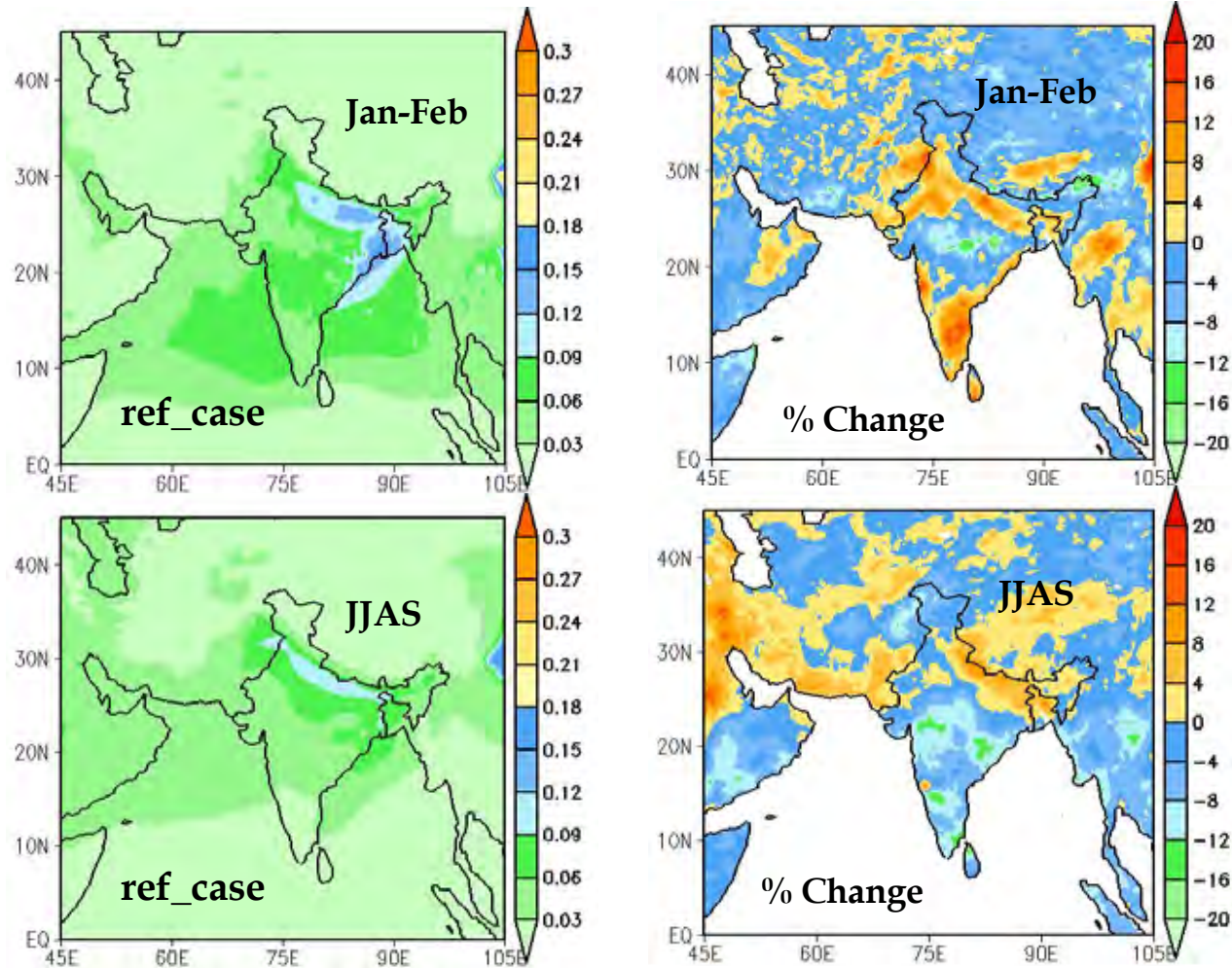
- There is an increase in surface mass concentration across IGB belt in both the seasons but the model estimation increased by only around 6 - 7 % .
- Similar results are observed for organic carbon estimation. However the surface mass concentration simulated by the model in both reference case and updated case is almost 3-times than that for black carbon.

Change in the ratio of surface mass concentration of Hydrophobic to Hydrophilic Tracers



- Although the surface mass concentration did not show some drastic differences in two simulations but the ratio from hydrophobic to hydrophilic tracers are changing.
- With the new aging scheme more amount of hydrophilic tracer is getting generated due to the presence of more condensing particles.

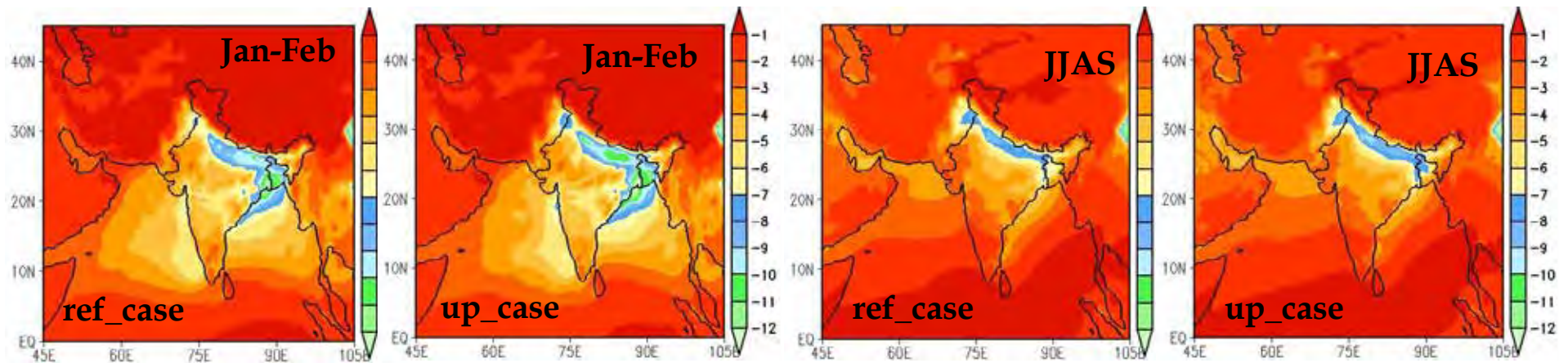
Anthropogenic AOD



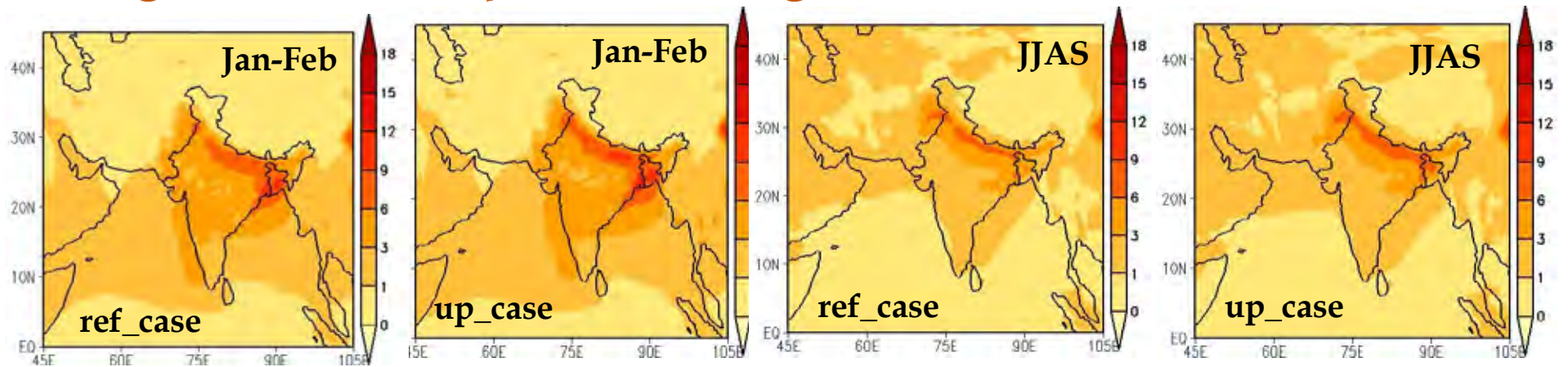
➤ Generation of more hydrophilic tracers are impacting the optical properties. An increase in total anthropogenic AOD over Indo Gangetic Basin is observed in two contrasting seasons.

➤ In contrast Peninsular India, which is not a source region is comparatively less polluted during monsoon due to washout but showing an increased AOD value during winter.

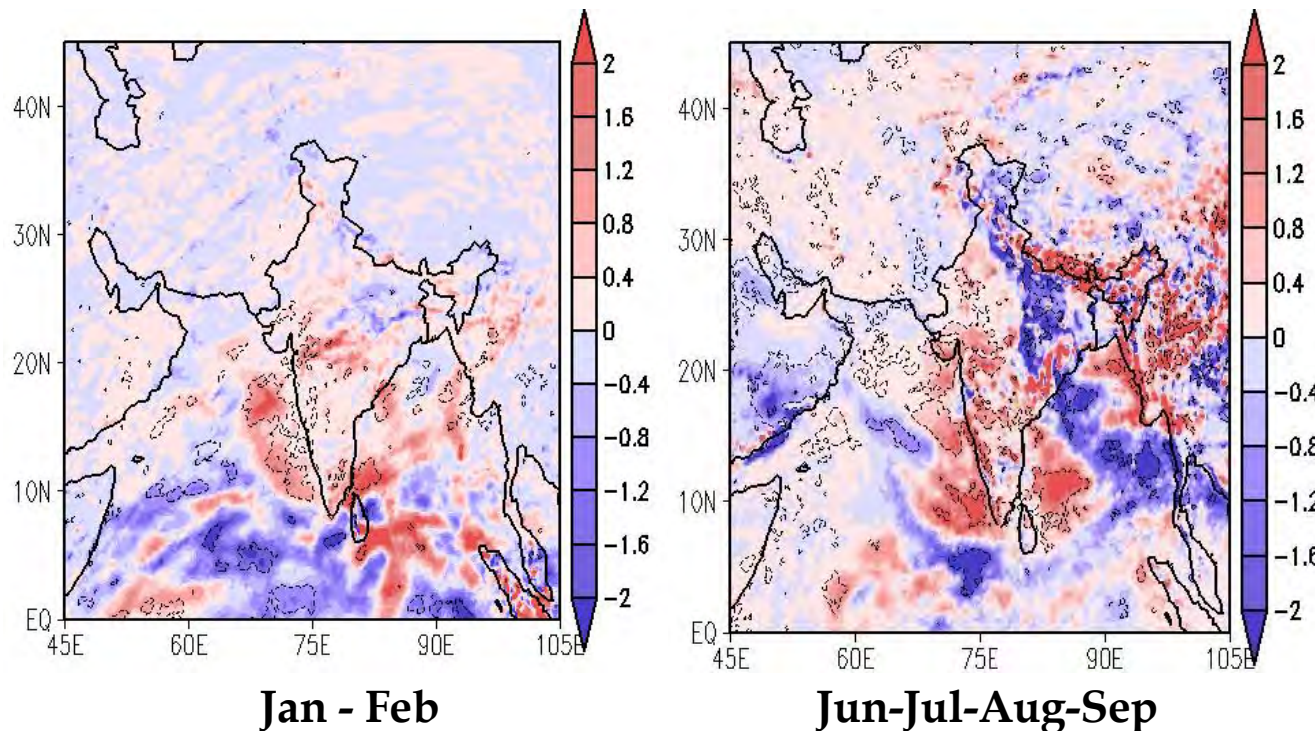
Change in the surface shortwave forcing (W/m^2)



Change in the atmospheric heating (W/m^2)



Change in Precipitation Rate (mm/day) with black dotted contour lines showing regions with 90% significance level



- Due to the implementation of the new aging scheme peninsular India is becoming wetter while the IGB region is showing dry bias.
- Analysis of other meteorological fields is under process.

Understanding and Future Work

- The actual e-folding time for aging of carbonaceous aerosols is less than the fixed 27.6 hours across most parts of a polluted country like India. Aging occurs more rapidly near the source regions like Indo-Gangetic basin than in the remote regions like the peninsular India.
- Formation of more hydrophilic tracers are impacting the optical properties although the actual surface mass concentration of the tracers are not changing dramatically.
- Model estimations are expected to improve with improved emissions, representation of mixing state and size distribution of carbonaceous aerosols.

Acknowledgment



सत्यमेव जयते

Department of Science & Technology
Govt. of India



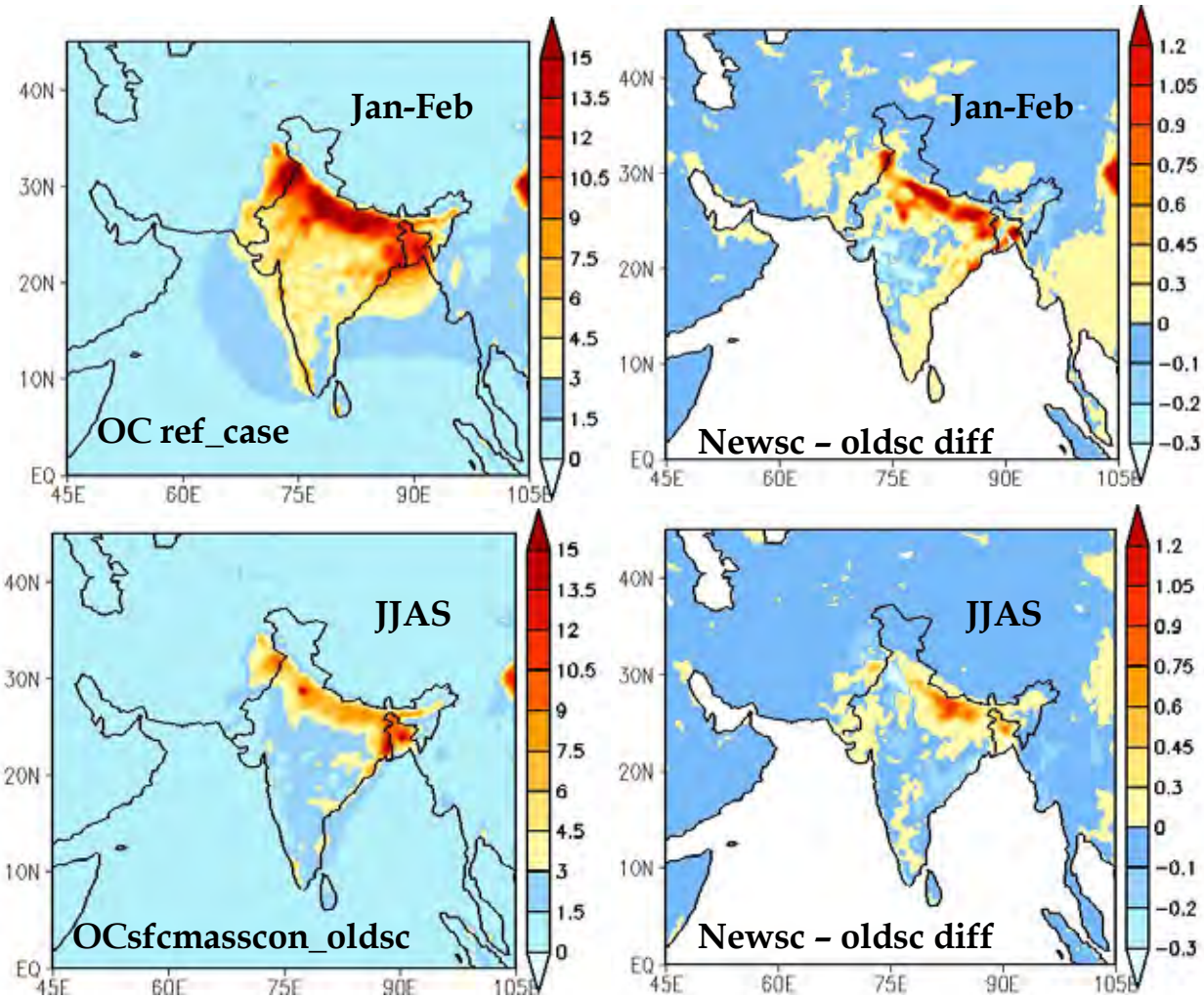
The Abdus Salam
International Centre
for Theoretical Physics

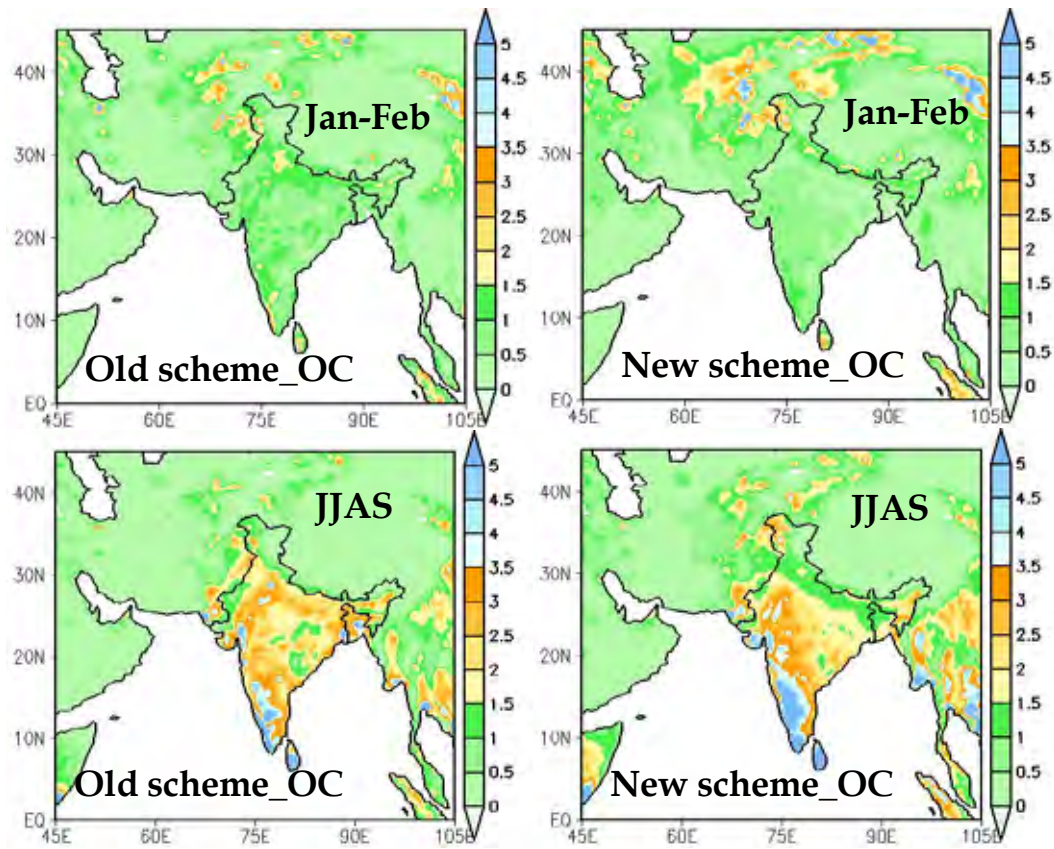


Thank you



Supplementary materials







ATENEO DE MANILA
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SCHOOL OF SCIENCE
AND ENGINEERING



MANILA OBSERVATORY

Characterizing the Historical and Projected Wind Energy Resource in the Philippines Using CORDEX-SEA Simulations

J. C. G. Nacpil, G. T. Narisma, F. T. Cruz, F. Tangang, L. Juneng, T. Ngo-Duc, T. Phan-Van, J. Santisirisomboon, P. Singhruck, D. Gunawan, and E. Aldrian



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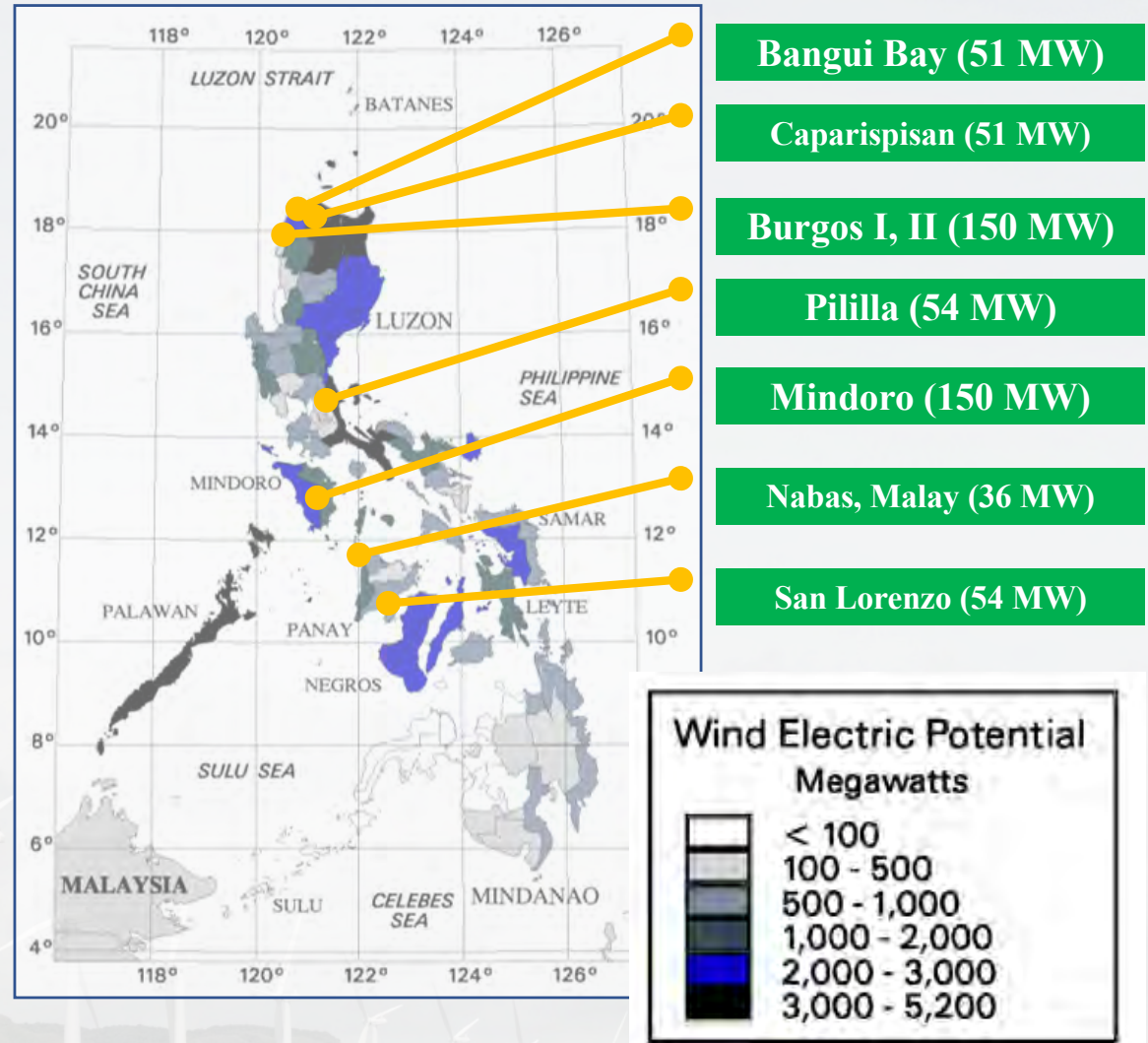


Wind Energy in the Philippines

1999 NREL Wind Energy Atlas: the Philippine region had **11,000 km²** of good windy land areas, which can provide roughly **76 GW** of power

Wind energy resource is expected to change due to climate change

Existing Wind Farms in the Philippines

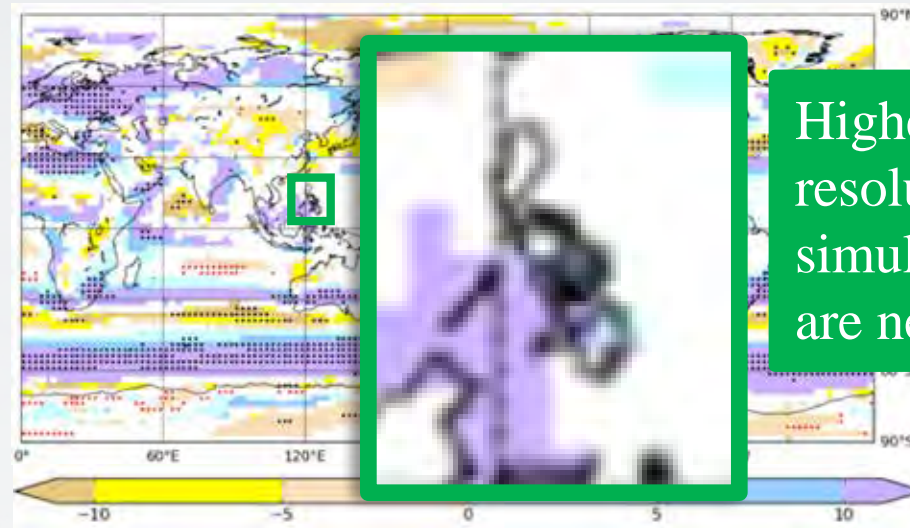


Climate Models to Assess Wind Energy?

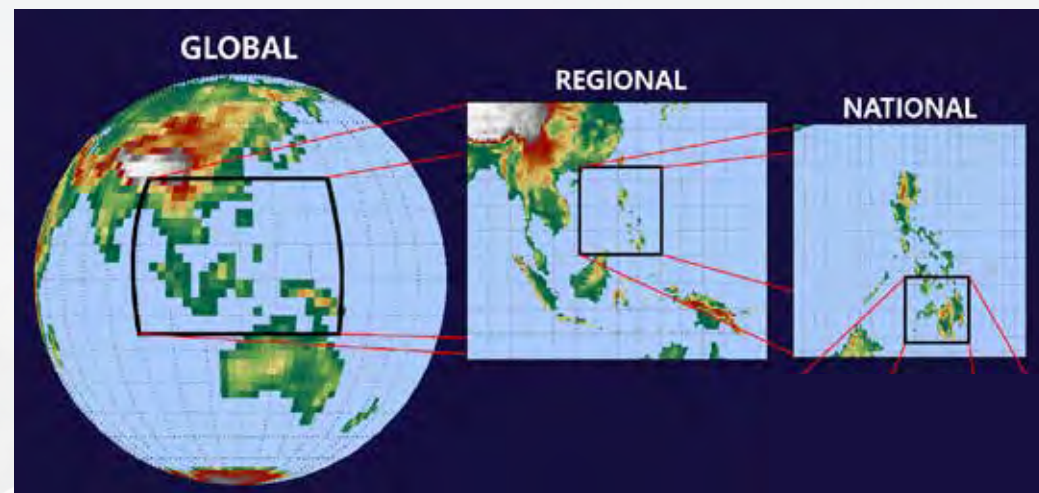
A study using 19 global models from CMIP3 found that SEA and PH wind resource may increase in the future

Right: Global annual surface wind speed change between 2081-2100 and 1981-2011 (McInnes et al. 2011)

Downscaling w/ CORDEX-SEA allows us to examine wind speeds at the regional scale

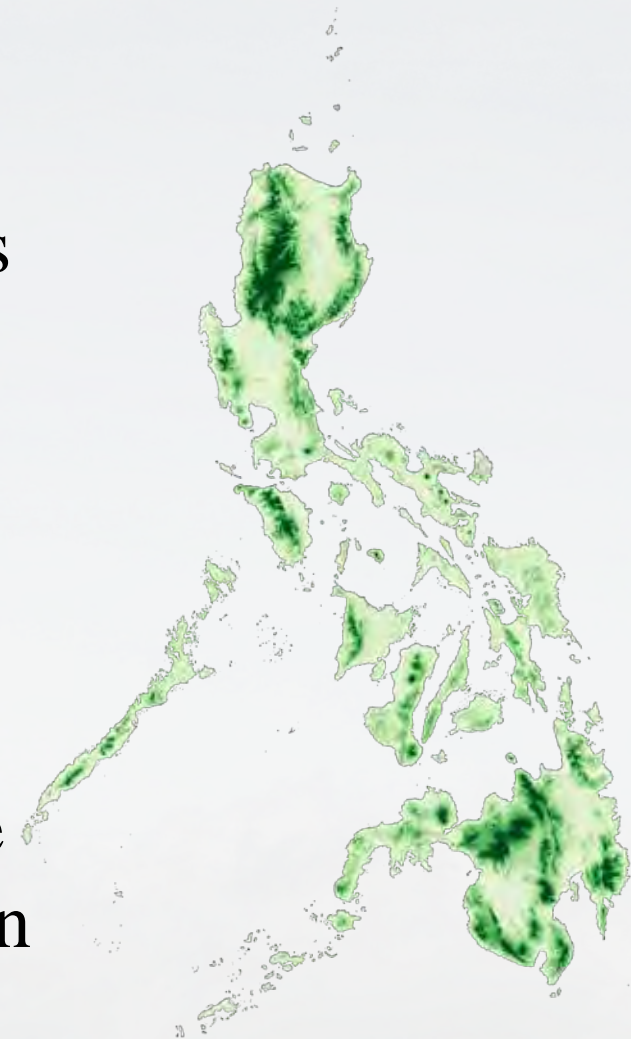


Higher-resolution simulations are needed



What Do We Want to Know?

1. How well do CORDEX-SEA models simulate historical winds in the Philippines (PH)?
2. How will the Philippine wind power potential change due to climate change?
3. Where are the current and future potential wind power locations in the Philippines?



Experiment Design

Datasets

**CORDEX-SEA Ensemble
(4 GCMs* downscaled by
RegCM 4.3.3)**



Baseline: ERA-Interim



Raw: 10m surface wind speed

Derived: 100m wind speed, 100m wind power density (WPD), extractable wind power (EWP)

***GCMs:** HADGEM2-ES, MPI-ESM-MR, CNRM-CM5, EC-EARTH

Methodology

Historical validation of ensemble wind simulation (1986-2005)

Bias Adjustment w/ Quantile Mapping (Boe et al, 2007)

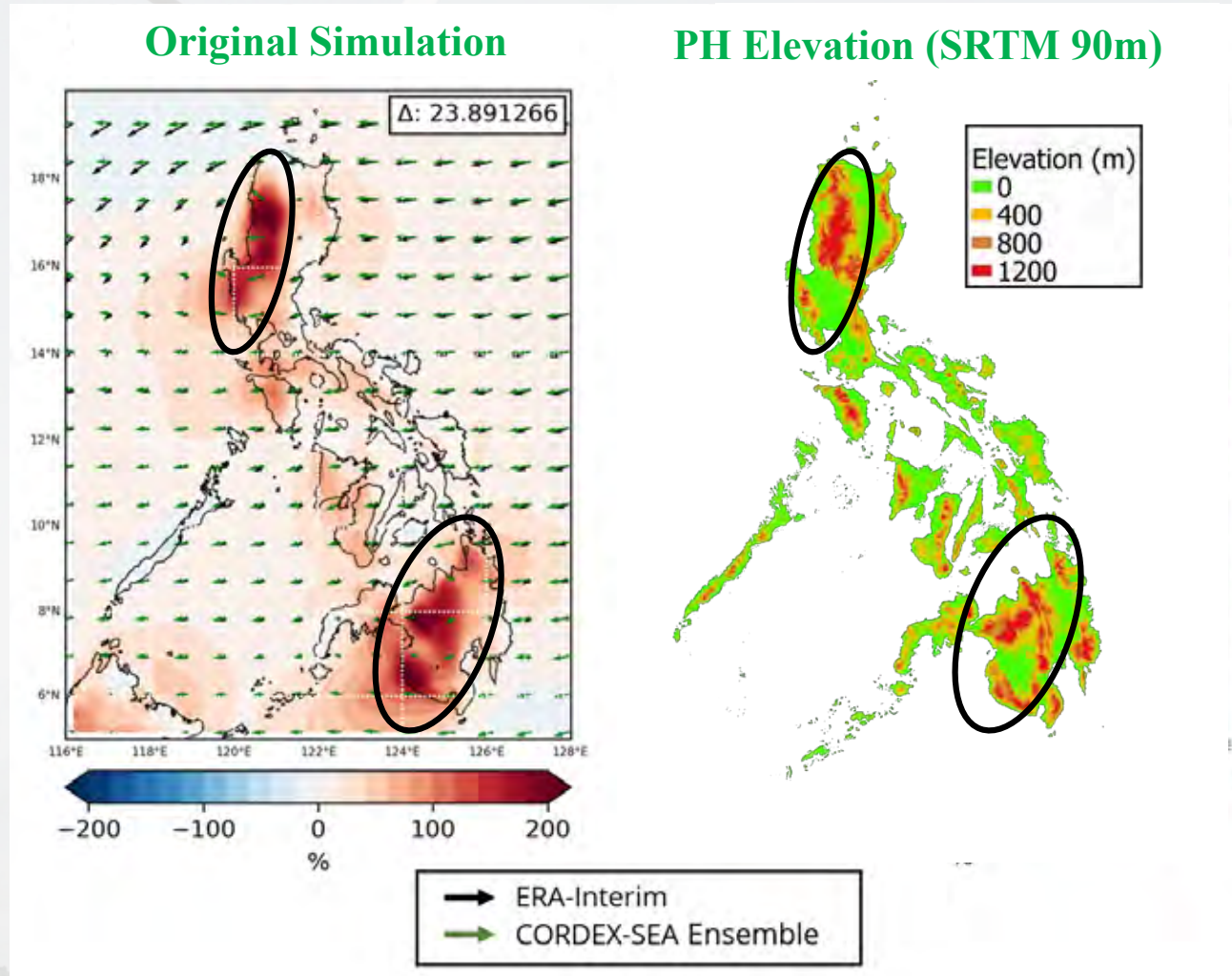
Calculation of Historical and Projected (2026-2045) Wind Power (WPD and EWP) at RCP4.5, RCP8.5

Identification and Analysis of Wind Power Hotspots

wind power hotspots: areas with significant changes in wind power density between the two time periods

How well does CORDEX-SEA simulate historical winds?

Percent (%) Difference of CORDEX average 10m winds from ERA-Interim baseline

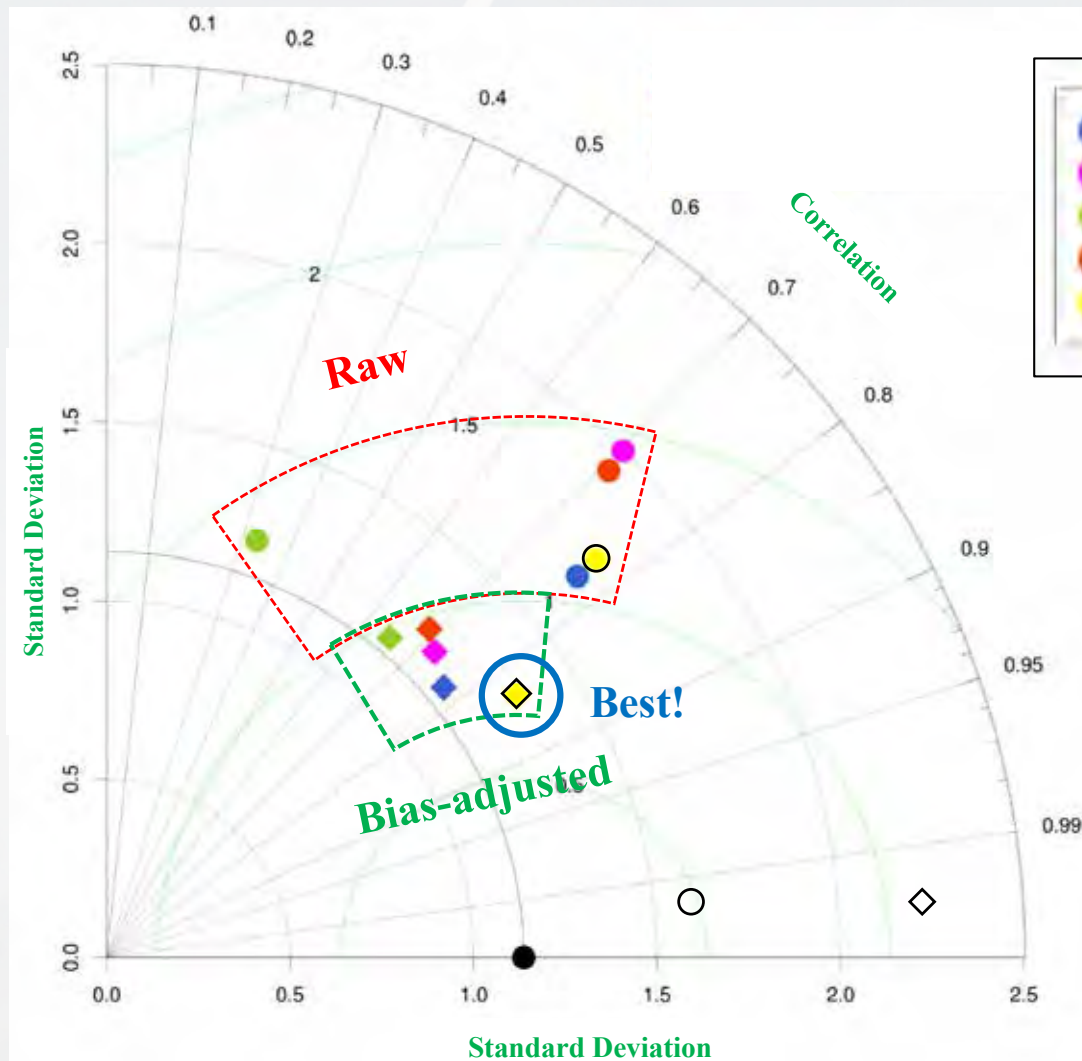


Original: Large overestimation (up to 200%) in W. Luzon & Mindanao (mountainous regions)

Bias-Adjusted: small underestimation (around 10%)

Bias-adjustment also improves wind direction

How well does CORDEX-SEA simulate historical winds?



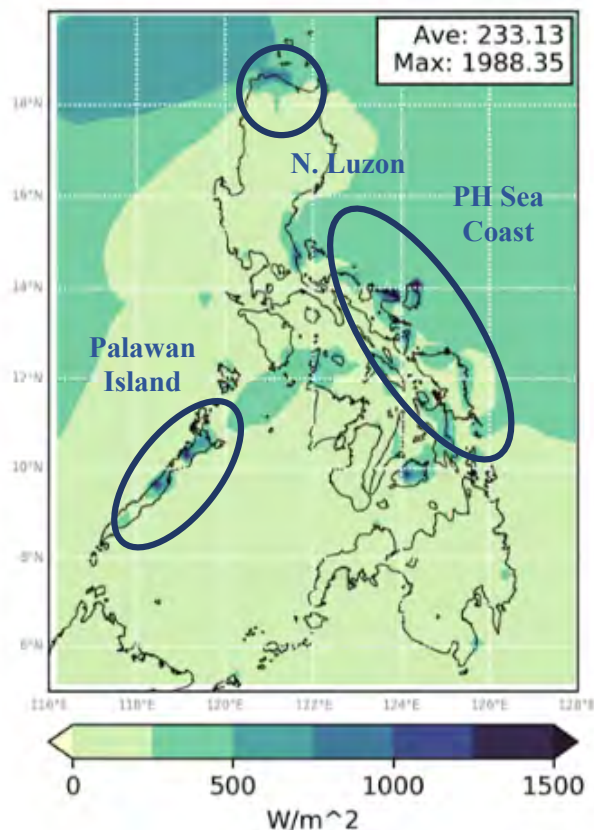
● MPI	◆ MPI (bc)
● EC_EARTH	◆ EC_EARTH (bc)
● HADGEM2	◆ HADGEM2 (bc)
● CNRMCM5	◆ CNRMCM5 (bc)
● ENSEMBLE	◆ ENSEMBLE (bc)

Bias-adjustment: lower bias, higher correlation, and closer variance for all models

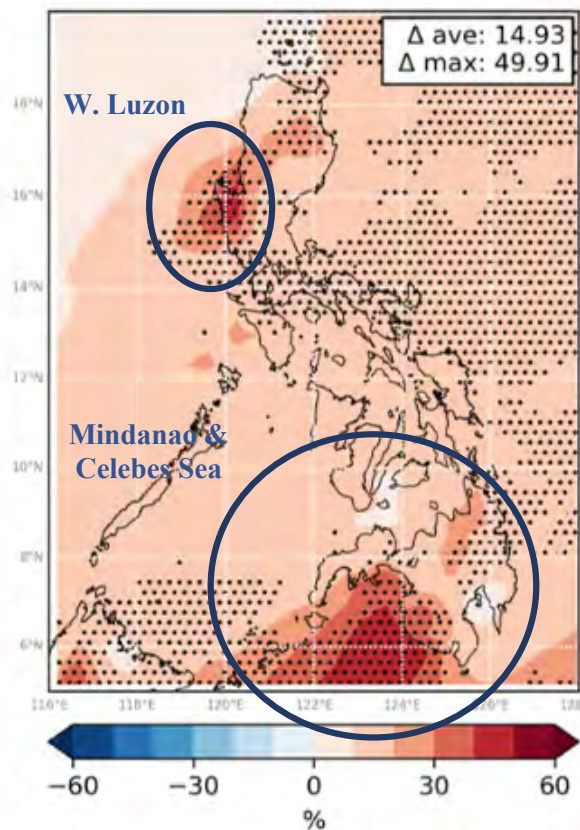
Bias-adjusted ENSEMBLE is best-performing out of all 10 datasets

How will PH wind power change over time?

100m WPD
(2026-2045)



100m WPD % Change
(rel. to 1986-2005)



Wind Power Density (WPD)

- Power generated per unit swept area of turbine blades

$$WPD = \frac{P}{A} = \frac{1}{2} \rho v^3$$

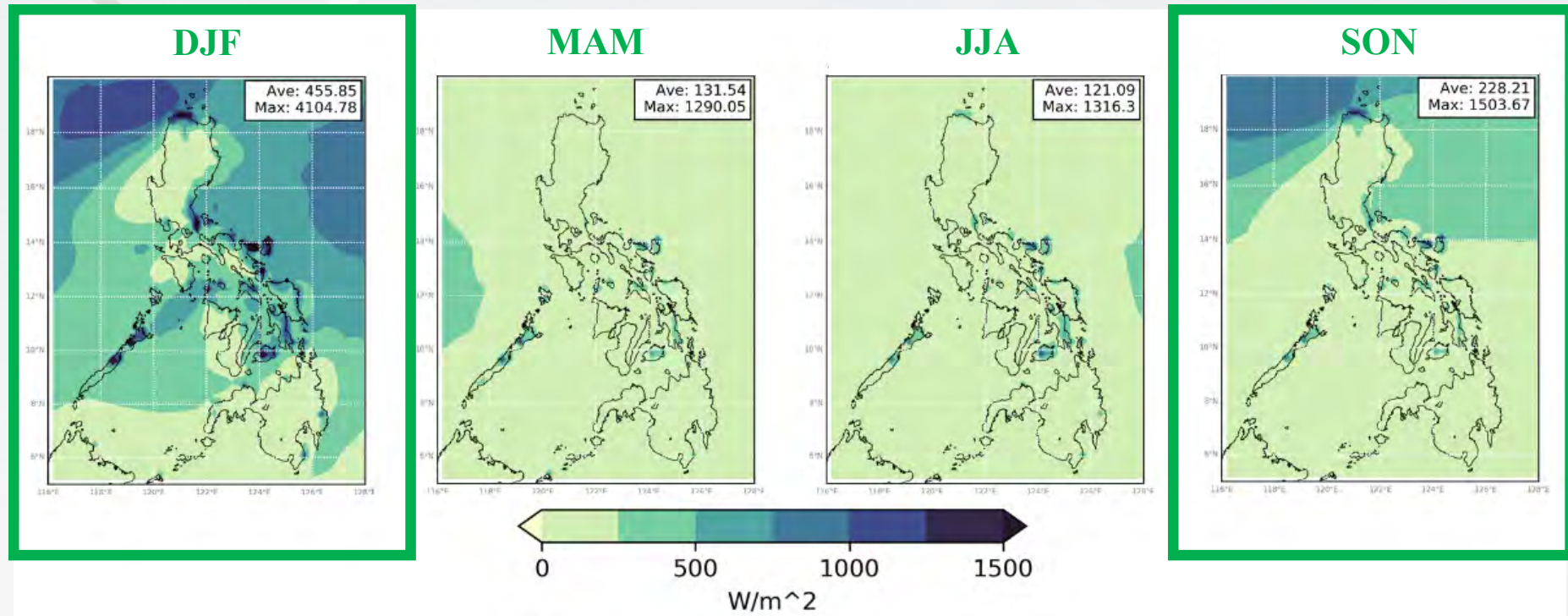
Increase in wind power density over whole Philippine domain

WPD is highest in Northern tip of Luzon, Palawan Island, PH Sea coast

Highest changes in West Luzon, Mindanao, Celebes Sea

How will PH wind power change over time?

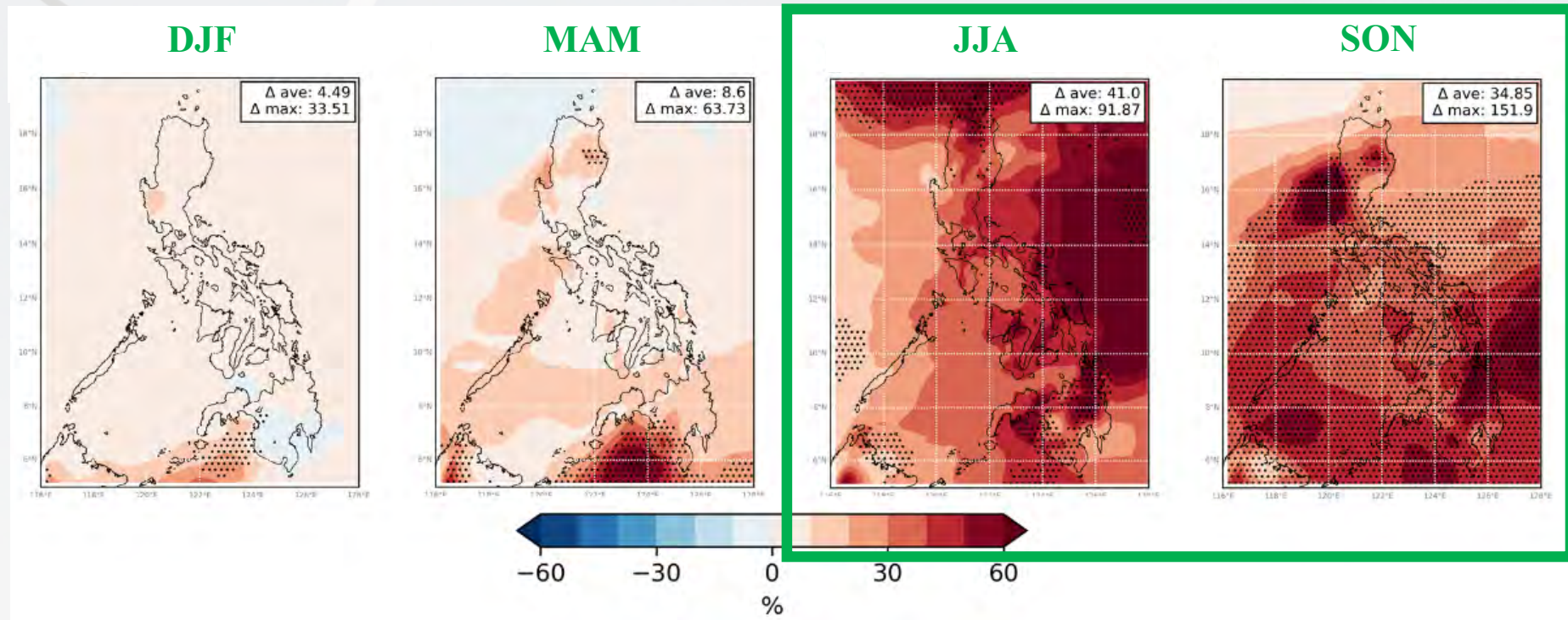
2026-2045 Seasonal 100m Wind Power Density (WPD)



Highest WPD in September – February

How will PH wind power change over time?

2026-2045 Seasonal 100m WPD % Change from Historical (1986-2005)

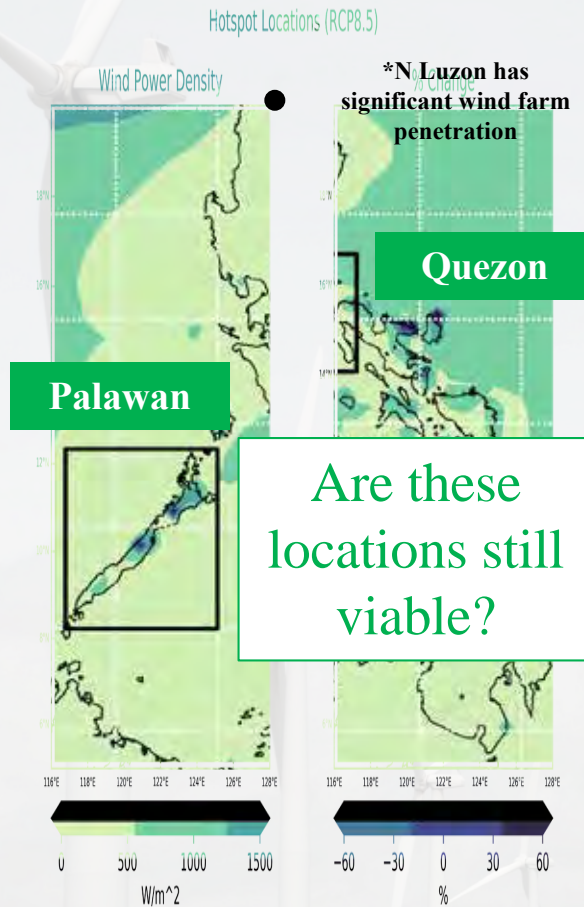


Highest significant WPD increase in June – November

Where are potential PH wind farm areas?

6 total hotspots studied!

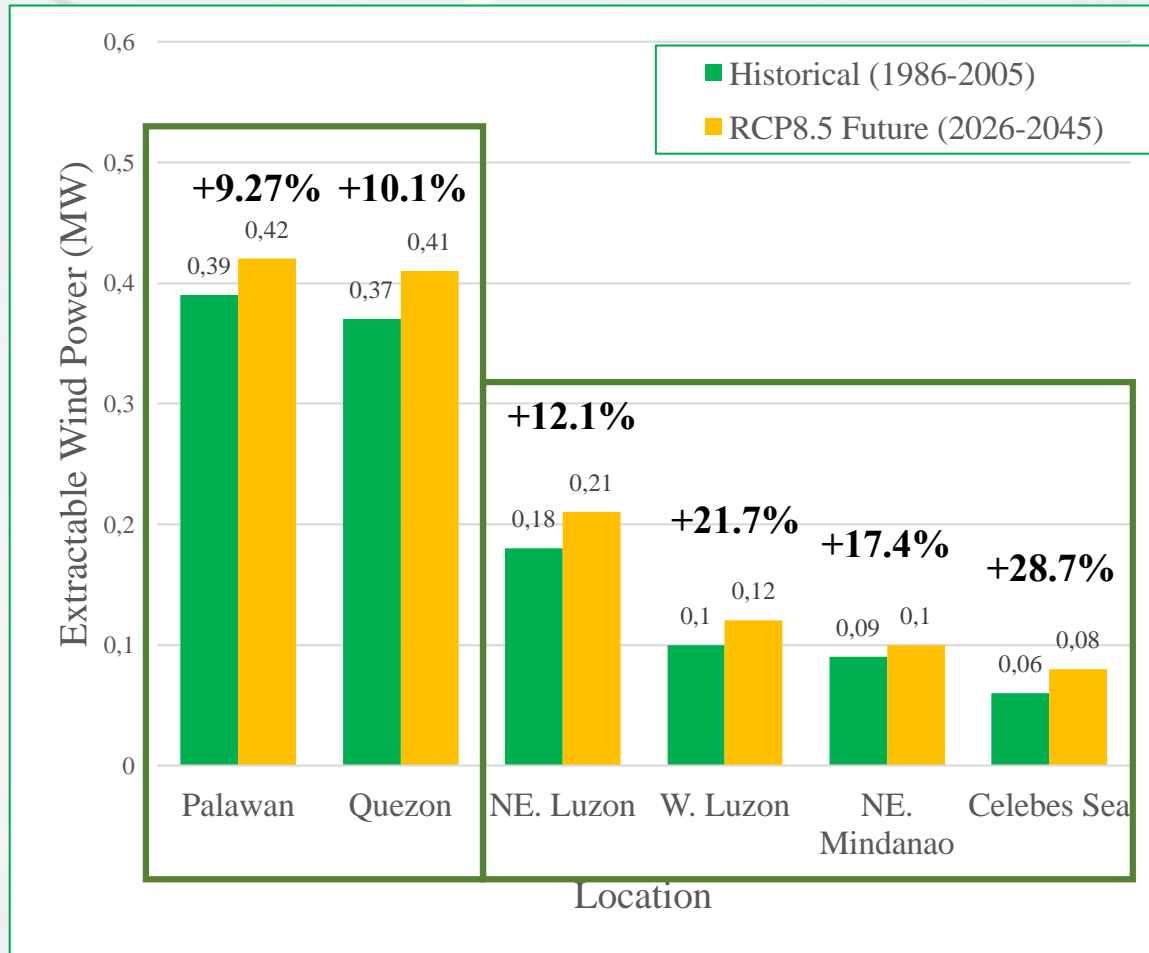
NREL Sites



High WPD % Change Sites

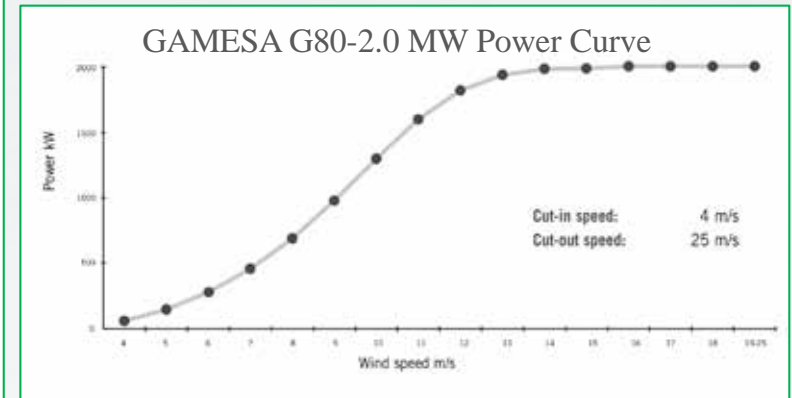


Where are potential PH wind farm areas?



Extractable Wind Power (EWP)

- Actual power generated by turbine (less than WPD)

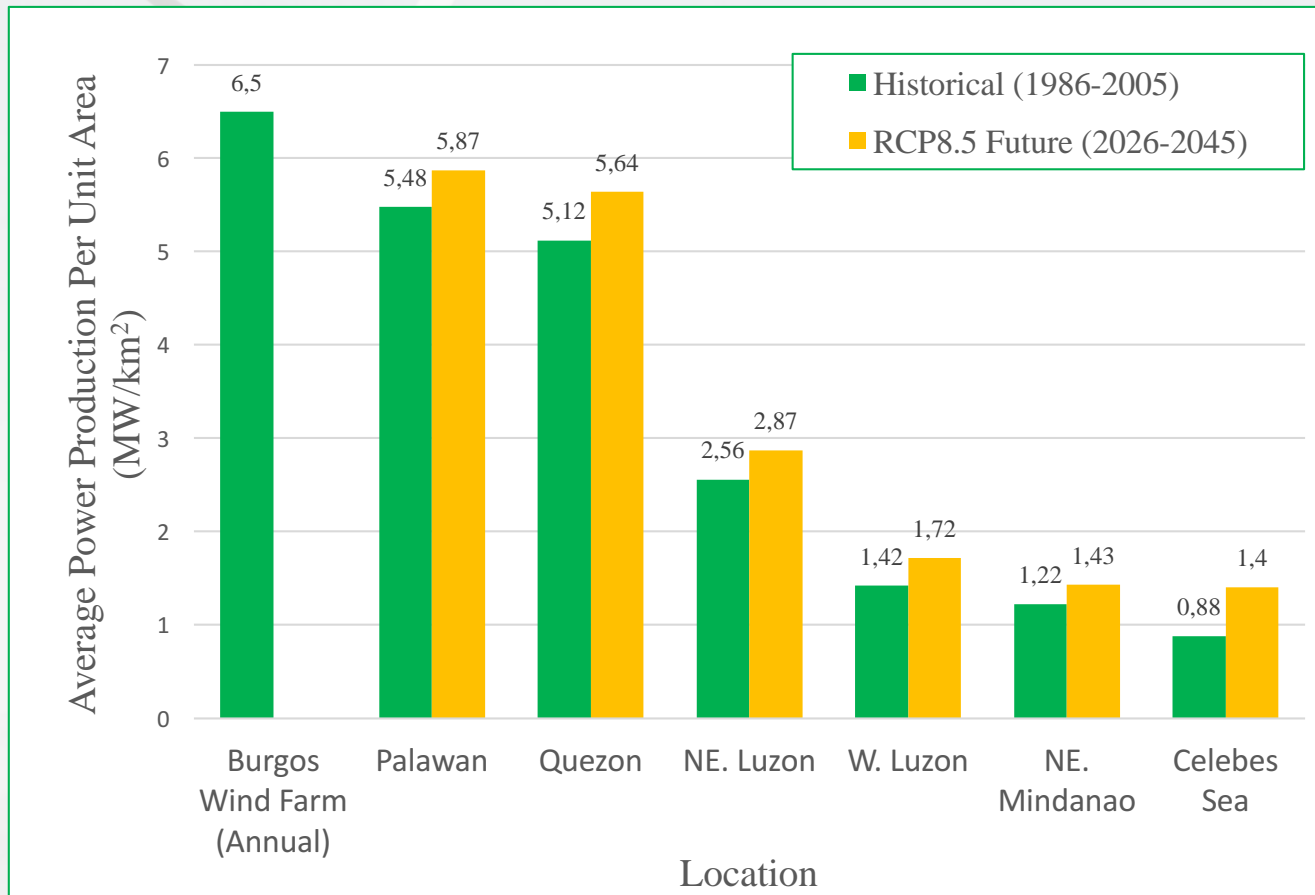


NREL Sites (Palawan & Quezon): high EWP, lesser % increase

Other sites: low EWP, higher % increase

How do areas compare w/ current PH wind farms?

Historical and Projected Potential Power Production



Burgos Wind Farm (150MW): Largest wind farm in SEA

Palawan and Quezon: comparable production to Burgos Wind Farm

Other hotspots have much lower production

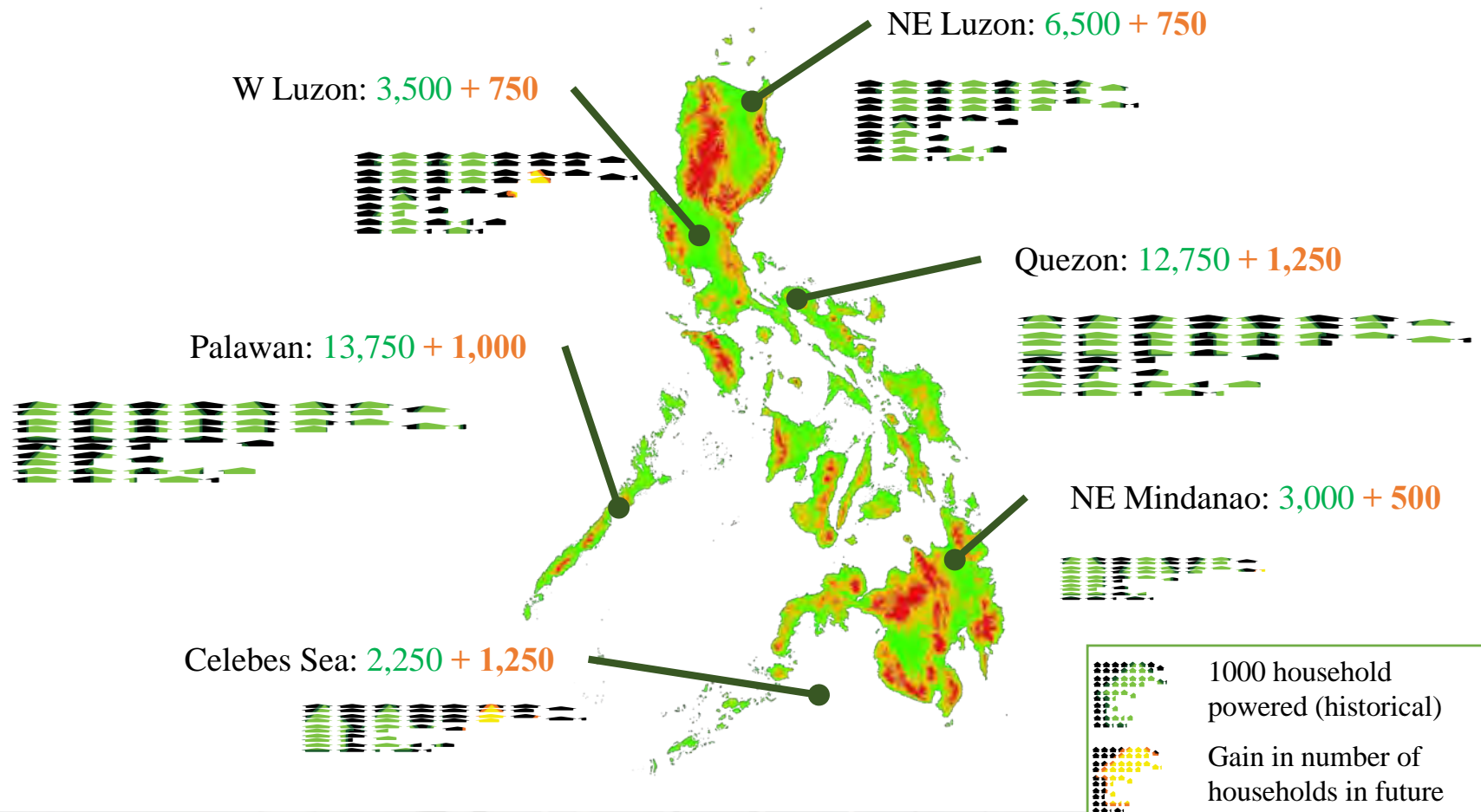
- *Worst: Celebes Sea*

Assumption: 13.9 turbines / sq. km (based on NREL Wind Power Atlas)

1 MW of wind power = 2500 PH households for a year (based on 2015 power consumption and census)

Gain in Households Powered

Households Powered by 1 sq.km of Wind Turbines
 (1 MW = 2500 households; 13.9 turbines per sq. km)



Conclusions

1. How well do CORDEX-SEA models simulate historical winds in the PH?

*CORDEX-SEA ensemble overestimated observed wind speeds by **more than 200%***

*Per-model Quantile-Mapping Bias-adjustment reduces ensemble bias to **around 10%***

Conclusions

2. How will the PH wind power potential change due to climate change?

*CORDEX-SEA projections show **increase in wind power density over whole PH domain***

WPD magnitude is strongest during September – February , with stronger WPD increase during June - November

Conclusions

3. Where are the current and future potential wind power locations in the Philippines?

Previously identified hotspots (Palawan, Quezon) will remain good wind farm areas

Despite large increases in wind power density, identified hotspots in this study are still not viable as good large-scale wind farm areas.

However, possibility of smaller scale generation can be explored.

Maraming Salamat Po!

Thank you very much!



ICRC-CORDEX 2019

Characterizing the Historical and Projected Wind Energy Resource in the Philippines using CORDEX-SEA Simulations

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Supplementary Slides



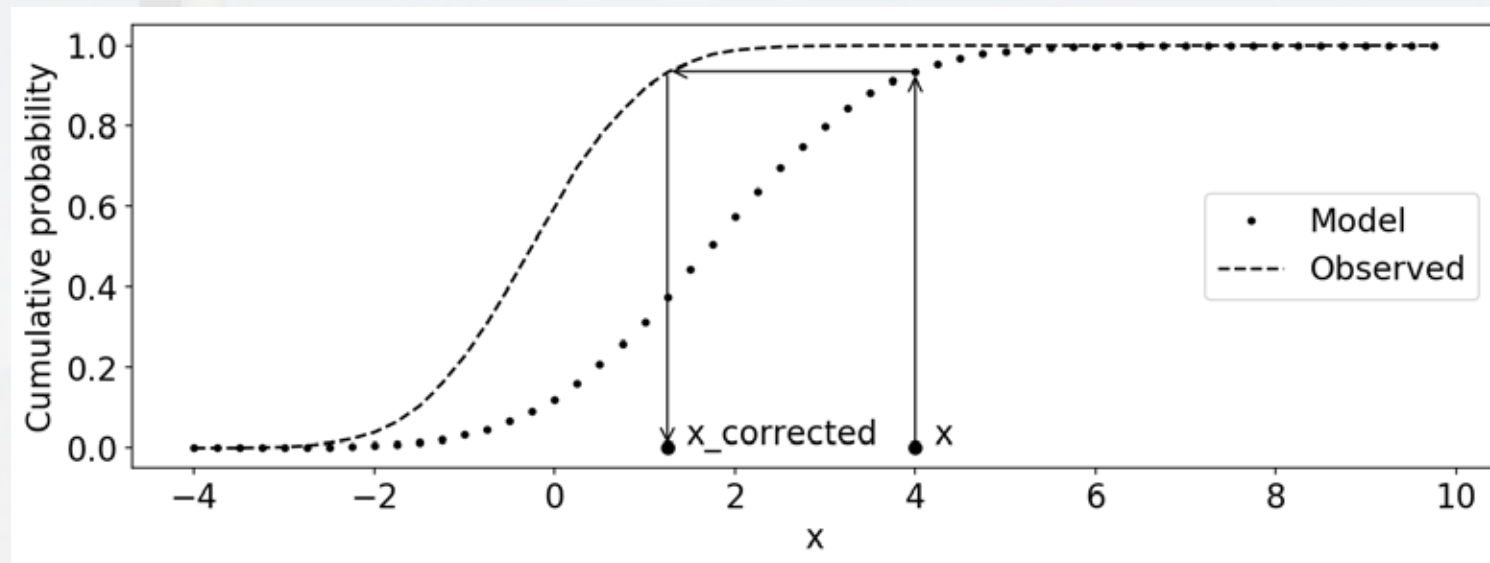
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Characterizing the Historical and Projected Wind Energy Resource in the Philippines using CORDEX-SEA Simulations

Bias Correction

Quantile-Quantile Mapping Method (Boe, et al. 2007)

- *Removes biases by equating the cumulative density functions of the model and observed data*
- *Generated transfer function can then be applied for model data of any period*



$$\hat{x}_{model,projected} = CDF_{obs,hist}^{-1} [CDF_{model,hist}(x_{model,projected})]$$

Extrapolating Wind Speeds

Logarithmic Wind Profile

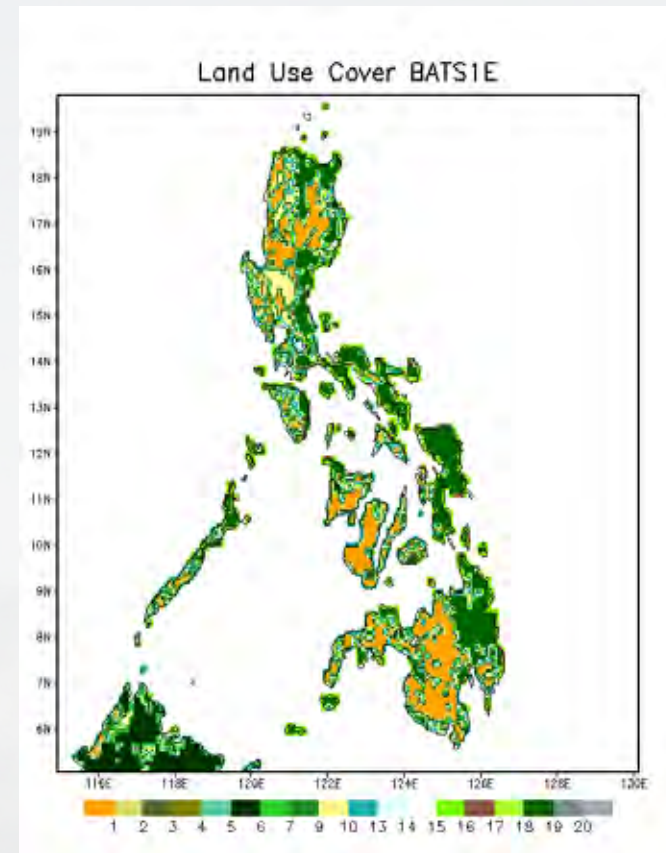
Semi-empirical relationship that allows us to extrapolate wind speeds at higher heights considering surface friction

$$v_{100} = v_{10} \frac{\ln(100m/z_0)}{\ln(10m/z_0)}$$

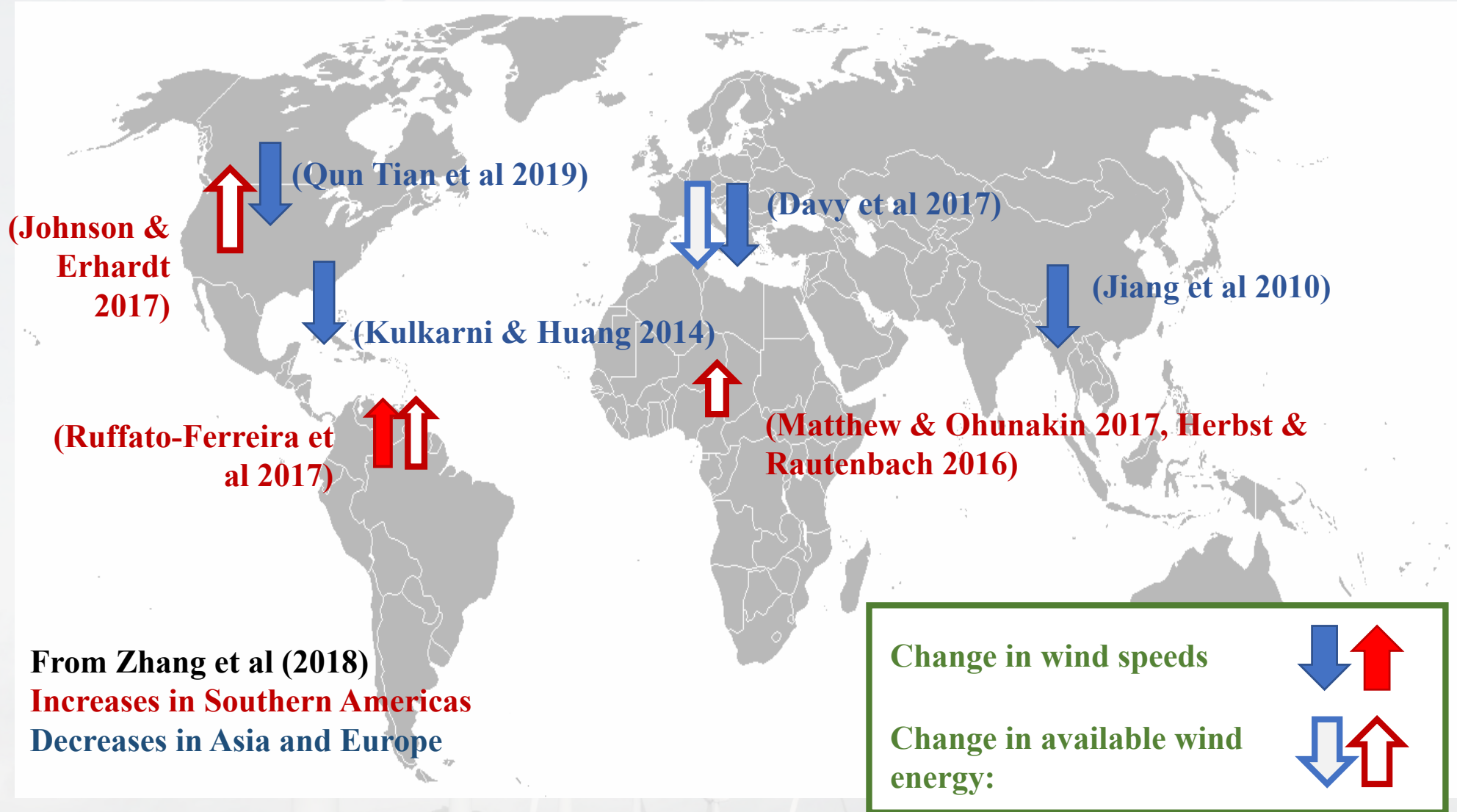
Roughness Length, z_0

Surfaces are rougher if they have more protrusions/obstacles to flow!

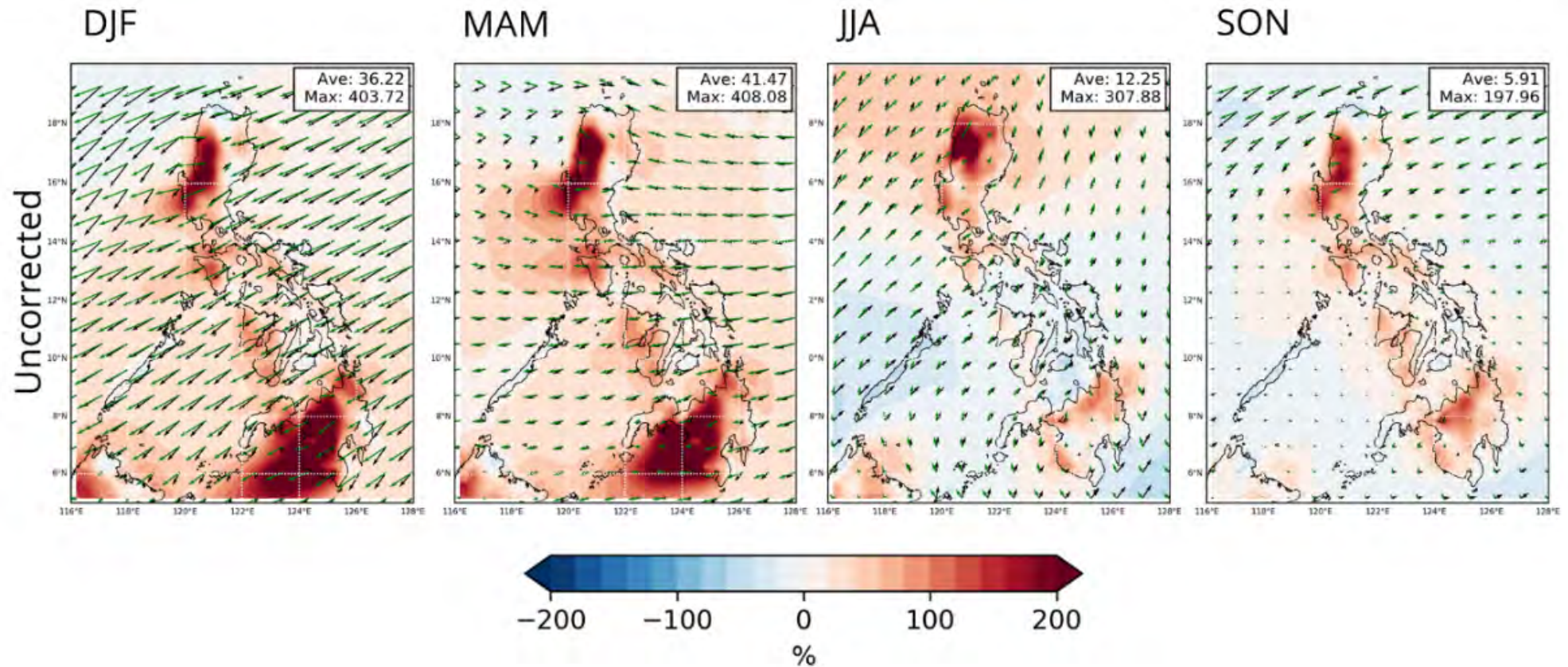
*Assigned per grid-point using **BATS1e***



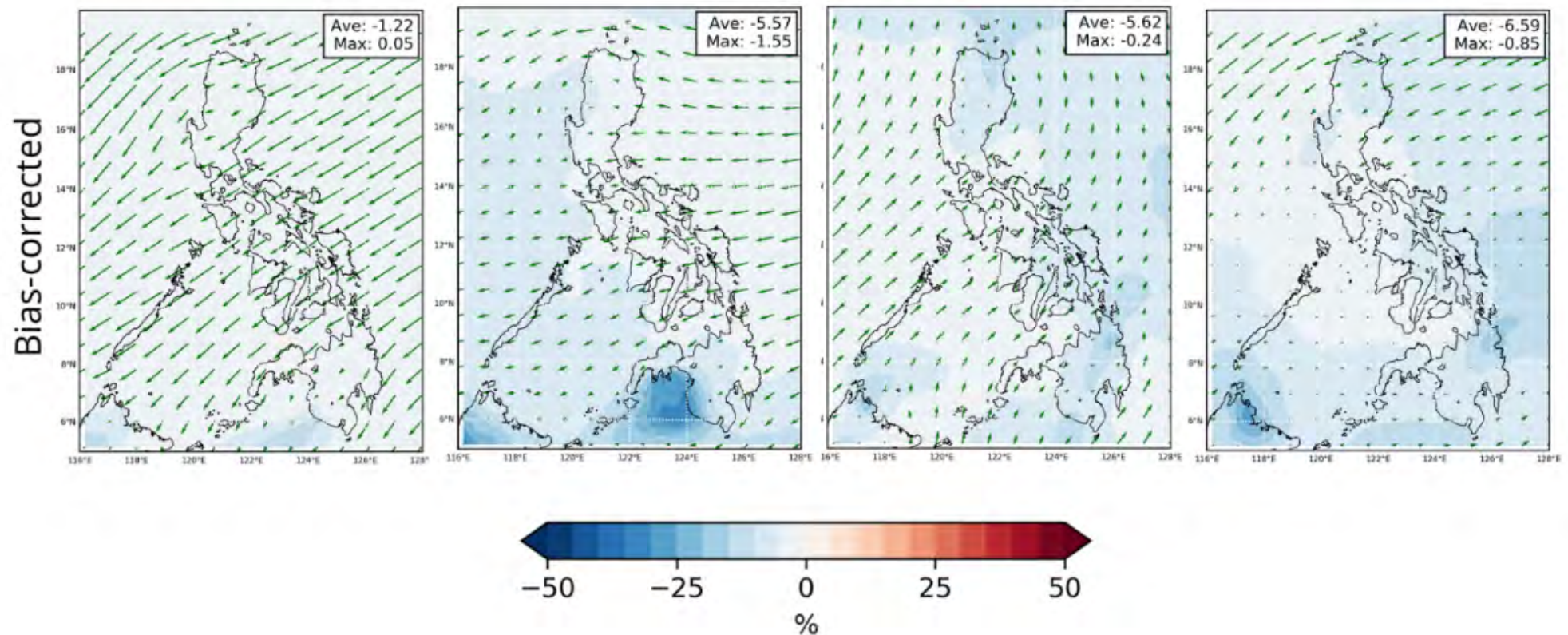
Climate Models to Assess Wind Energy?



% Difference in 10m winds (Ensemble-EIN25), Seasonal



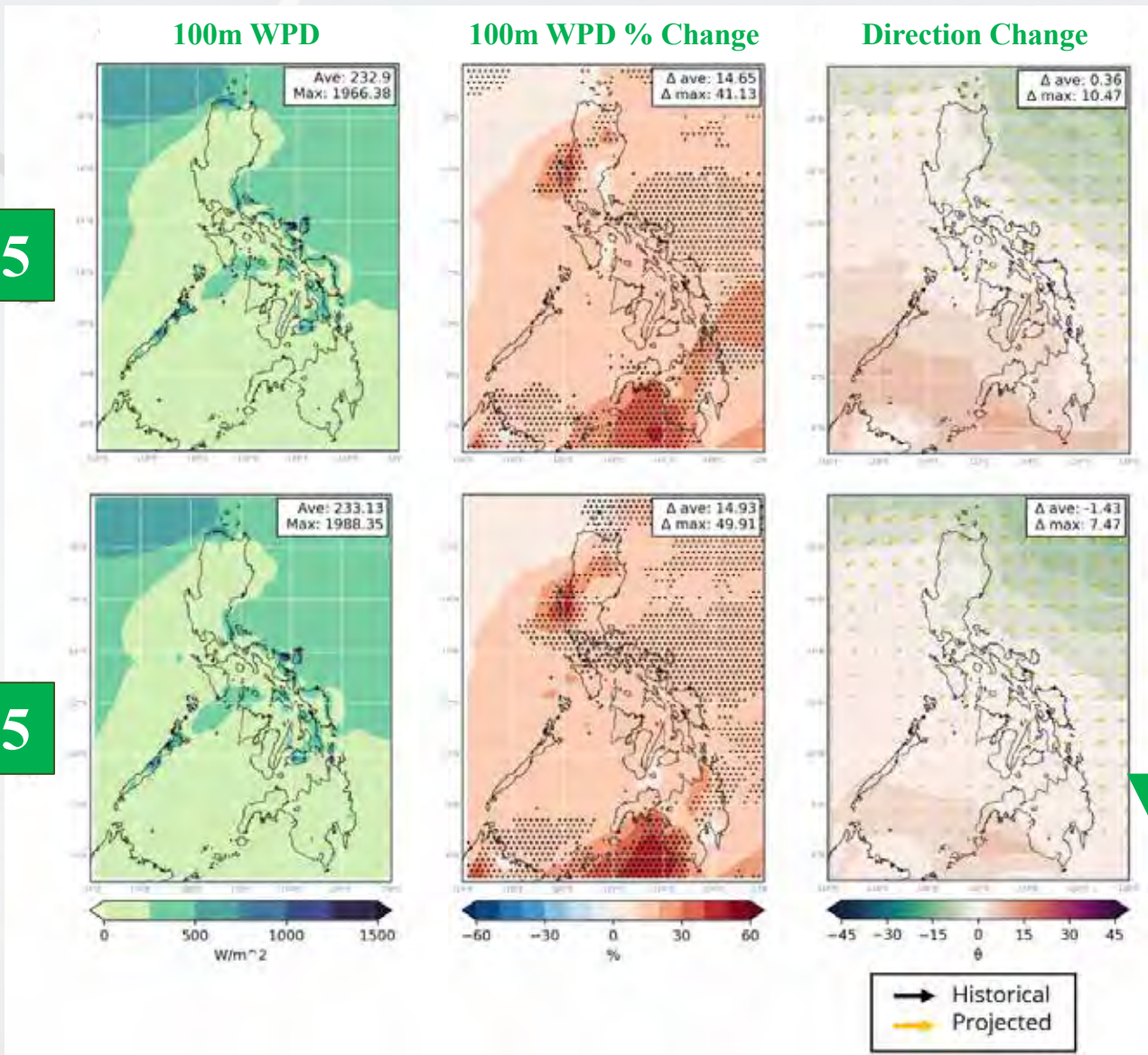
% Difference in 10m winds (Ensemble-EIN25), Seasonal



How does CORDEX simulate future wind?

RCP4.5

RCP8.5



No appreciable difference between RCP4.5 and RCP8.5

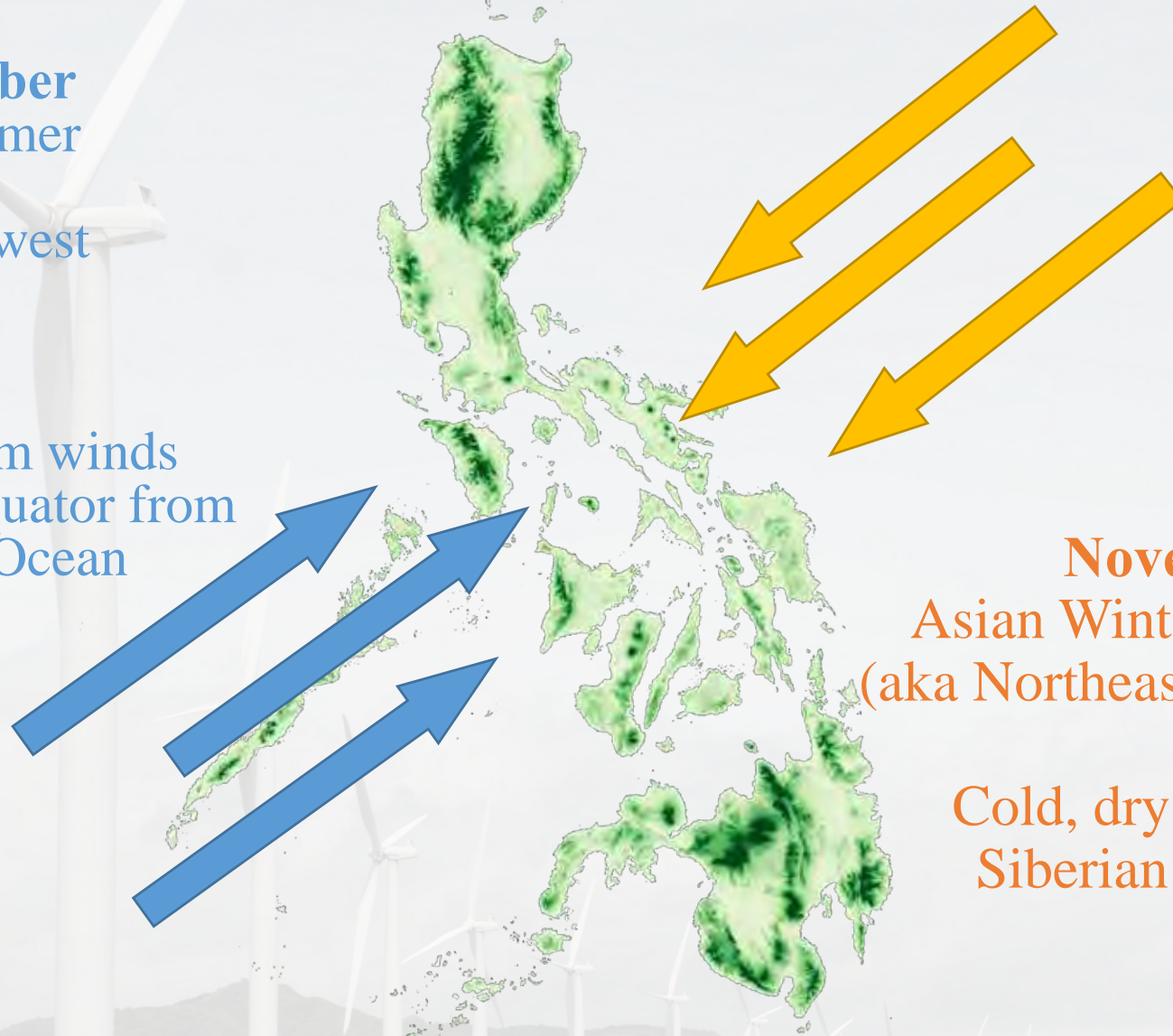
Wind Systems in the Philippines

June-October
Asian Summer
Monsoon
(aka Southwest
Monsoon)

Moist, warm winds
crossing equator from
the Indian Ocean

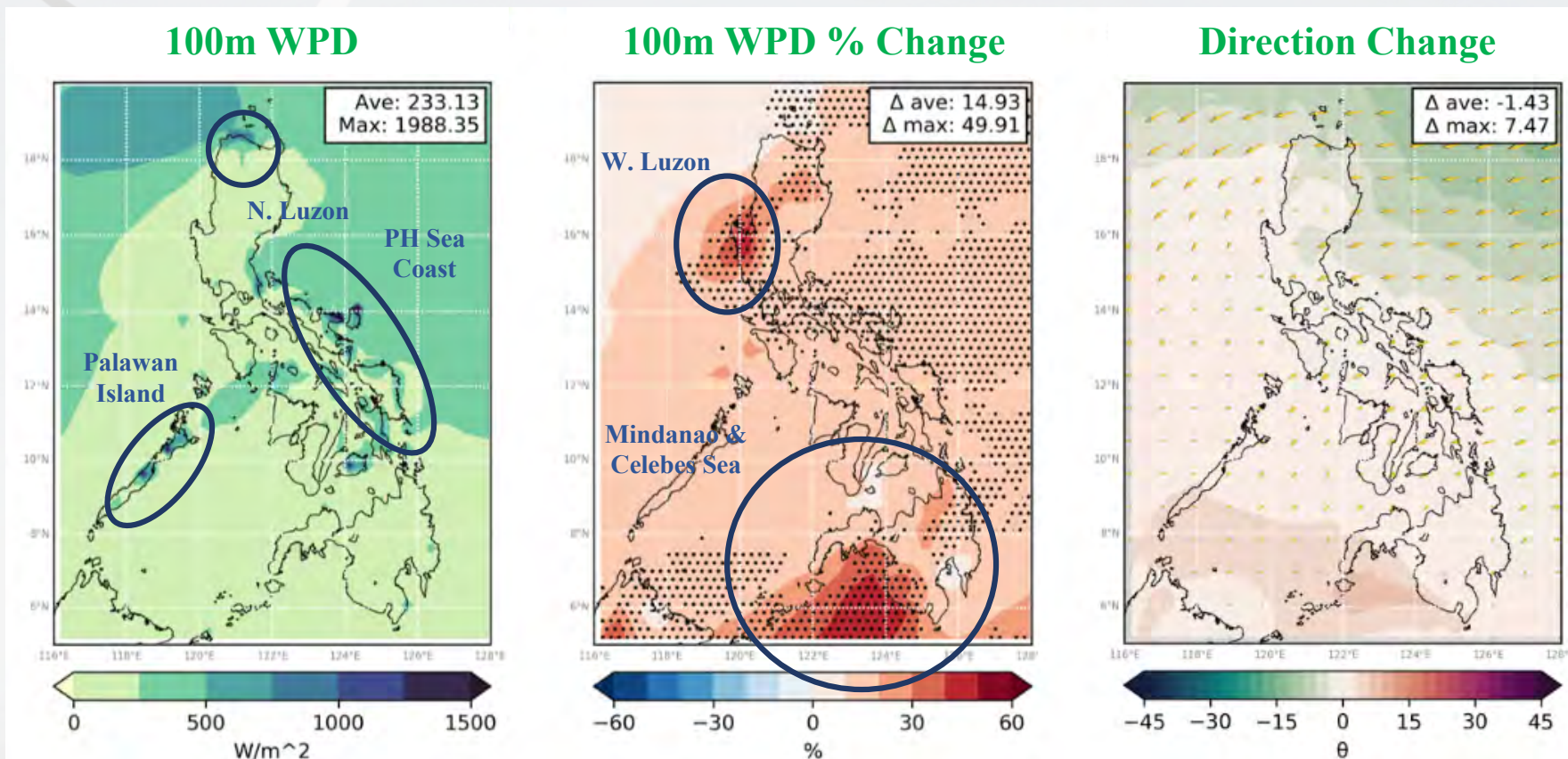
November-May
Asian Winter Monsoon
(aka Northeast Monsoon)

Cold, dry winds from
Siberian anticyclone



How will PH wind power change over time?

Figure 3: 2026-2045 100m Wind Power Density (WPD), WPD % Change and Wind Direction Change with respect to historical period 1986-2005



WPD is highest in Northern tip of Luzon, Palawan Island, PH Sea coast

Highest changes in West Luzon, Mindanao, Celebes Sea

No general change in average wind direction (max of 10°)

WCRP

CORDEX

14-18 OCTOBER 2019 BEIJING, CHINA

ICRC-CORDEX 2019

International Conference On Regional Climate

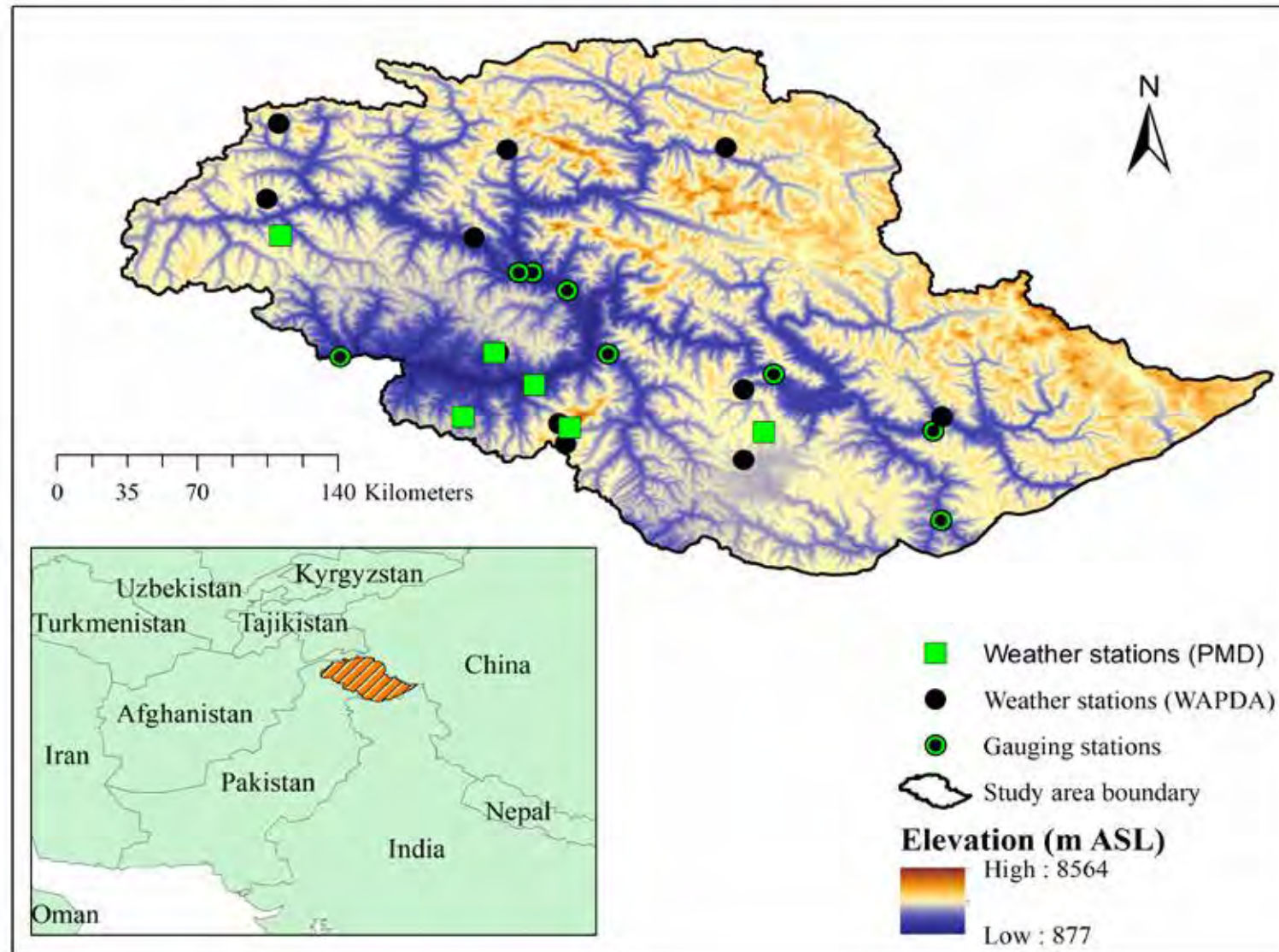
Projection of Indus River Flow under Changing Climate Conditions and its Implication to Future Hydropower Energy Generation

Hazrat Bilal¹, Chamhuri Siwar¹,
Mazlin Mokhtar¹

¹The National University of Malaysia, UKM

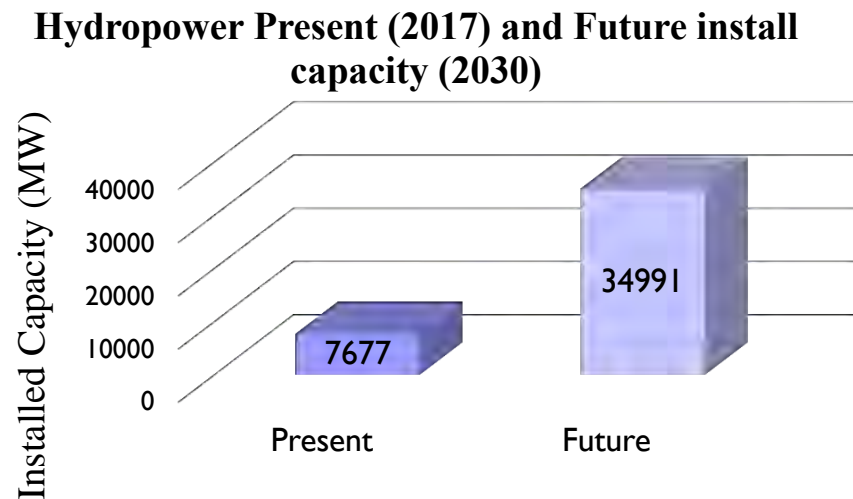


Study Area



Electricity production and consumption

- Thermal 63.59%, Hydroelectric 30.8%, Nuclear 3.76, Renewable 0.27% (Wind, Solar, Biogas) import 0.41%.
- Household 48%, Industry 27%, Agriculture 9% and commercial 8% other government 8% (Energy Year Book 2018-2019).



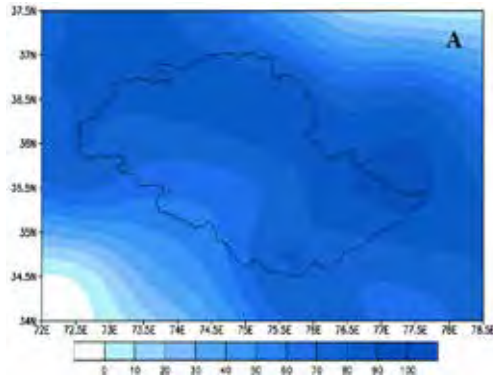
List of GCMs and RCMs used in this study.

RCM	Driving GCM	Institute	Domain
1 SMHI-RCA4	ICHEC-EC-EARTH	Swedish Meteorological and Hydrological Institute,	WAS-44
2 SMHI-RCA4	MOHC-HadGEM2-ES	Swedish Meteorological and Hydrological Institute,	WAS-44
3 SMHI-RCA4	MPI-M-MPI-ESM-LR	Swedish Meteorological and Hydrological Institute,	WAS-44
4 SMHI-RCA4	NCC-NorESM1-M	Swedish Meteorological and Hydrological Institute,	WAS-44

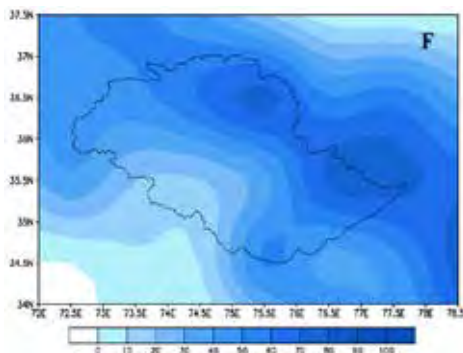
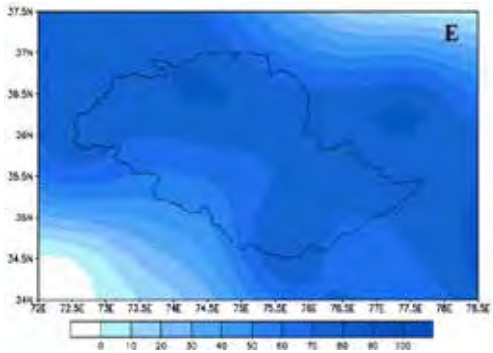
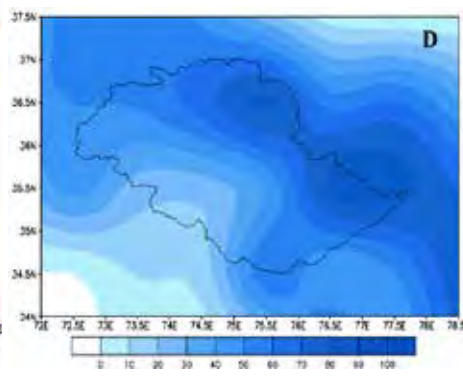
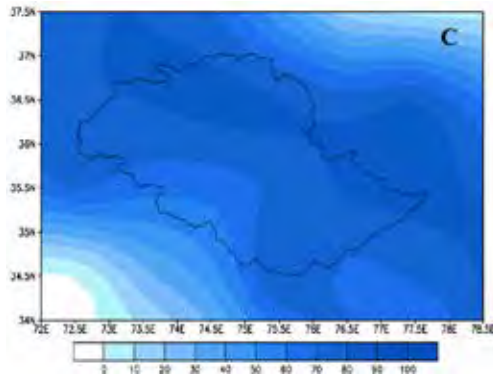
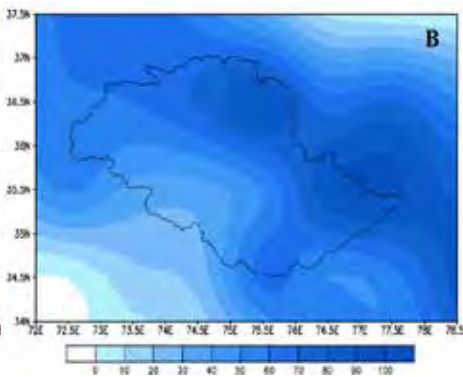
Snow Runoff Model-SRM

RCP 4.5

Snow accumulation

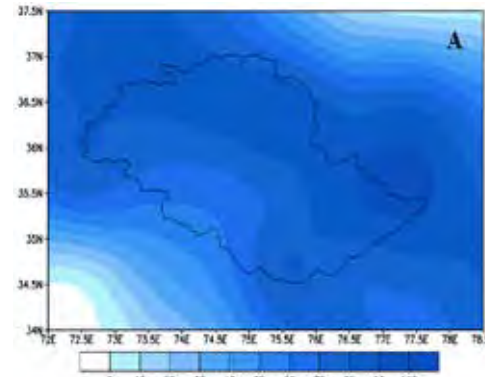


Snowmelt

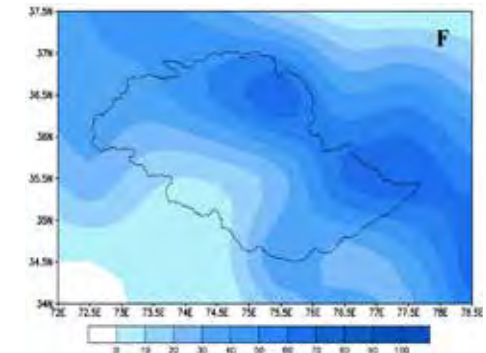
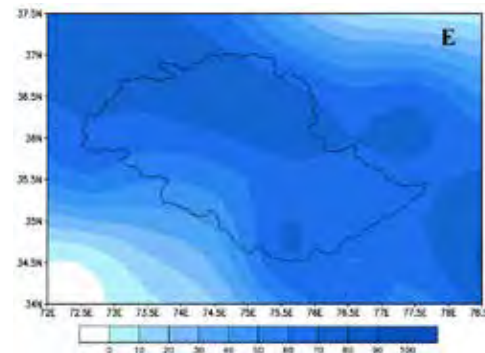
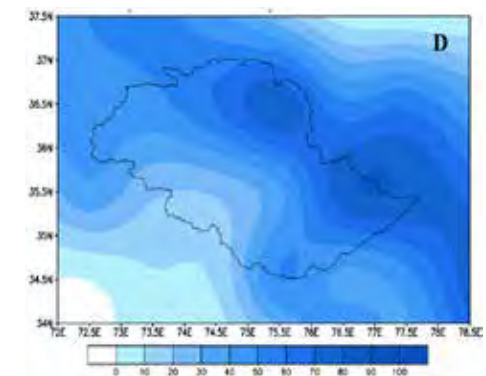
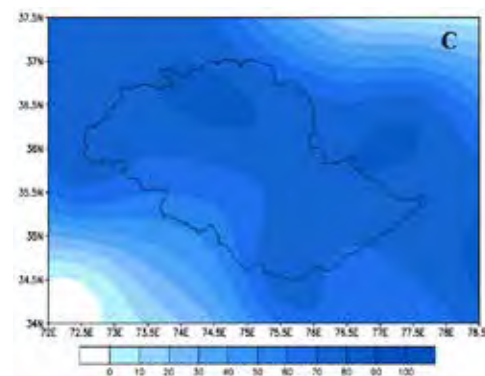
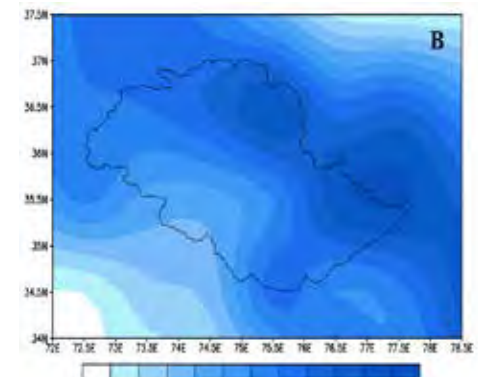


RCP8.5

Snow accumulation



Snowmelt



(A) average monthly snow covered area SCA (%) during snowmelt 1951-2005, (B) average monthly SCA during snow accumulation, (C) average monthly SCA during snow accumulation 2006-2065, (D) average monthly SCA during snowmelt 2006-2065, (E) average monthly SCA during snow accumulation 2066-2099, (F) average monthly SCA during snowmelt 2066-2099.

RCP 4.5

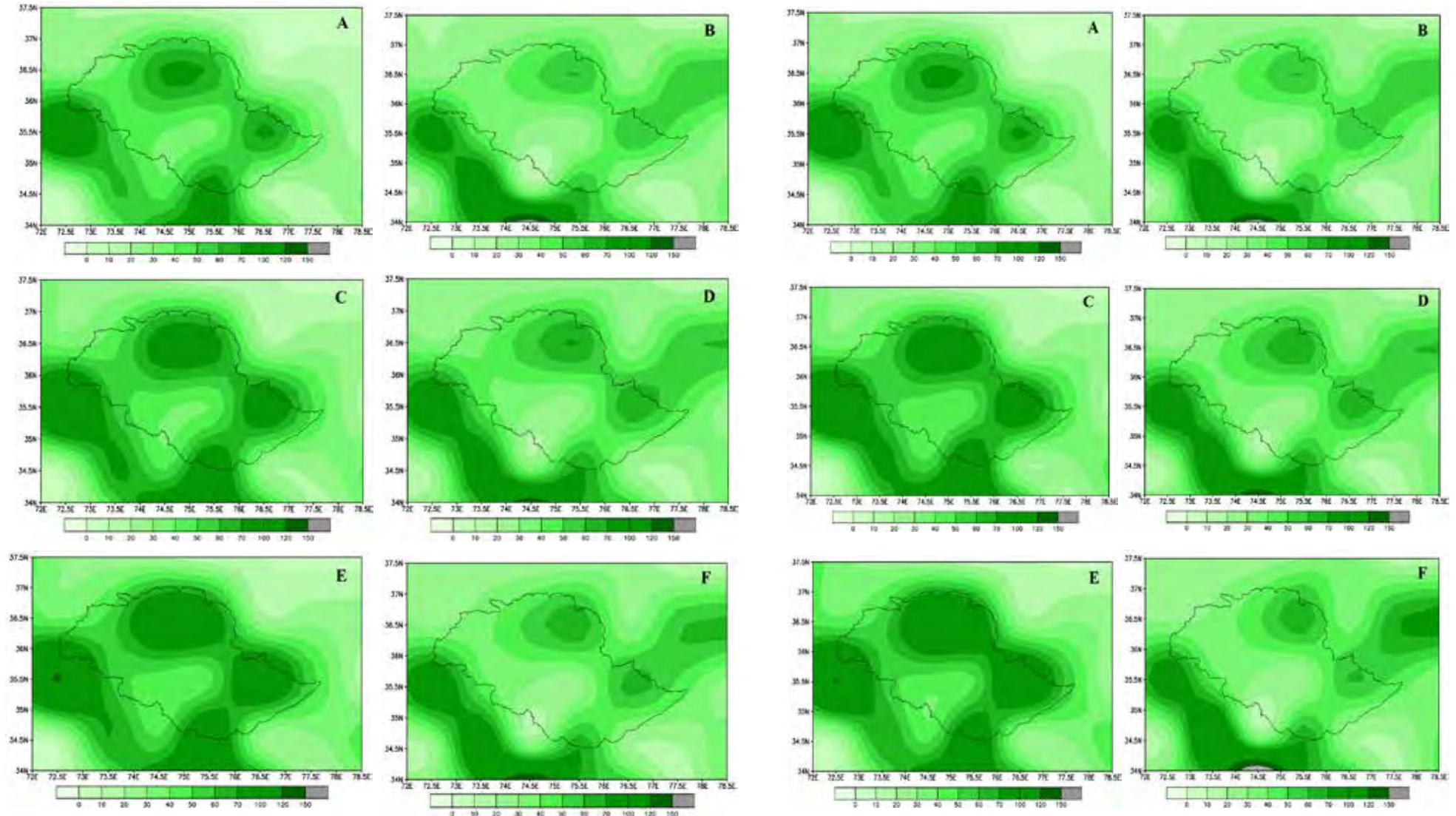
Snow accumulation

Snowmelt

RCP8.5

Snow accumulation

Snowmelt



(A) average monthly total precipitation (mm) during snowmelt 1951-2005, (B) average monthly total precipitation during snow accumulation, (C) average monthly total precipitation during snow accumulation 2006-2065, (D) average monthly total precipitation during snowmelt 2006-2065, (E) average monthly total precipitation during snow accumulation 2066-2099, (F) average monthly total precipitation during snowmelt 2066-2099.

RCP 4.5

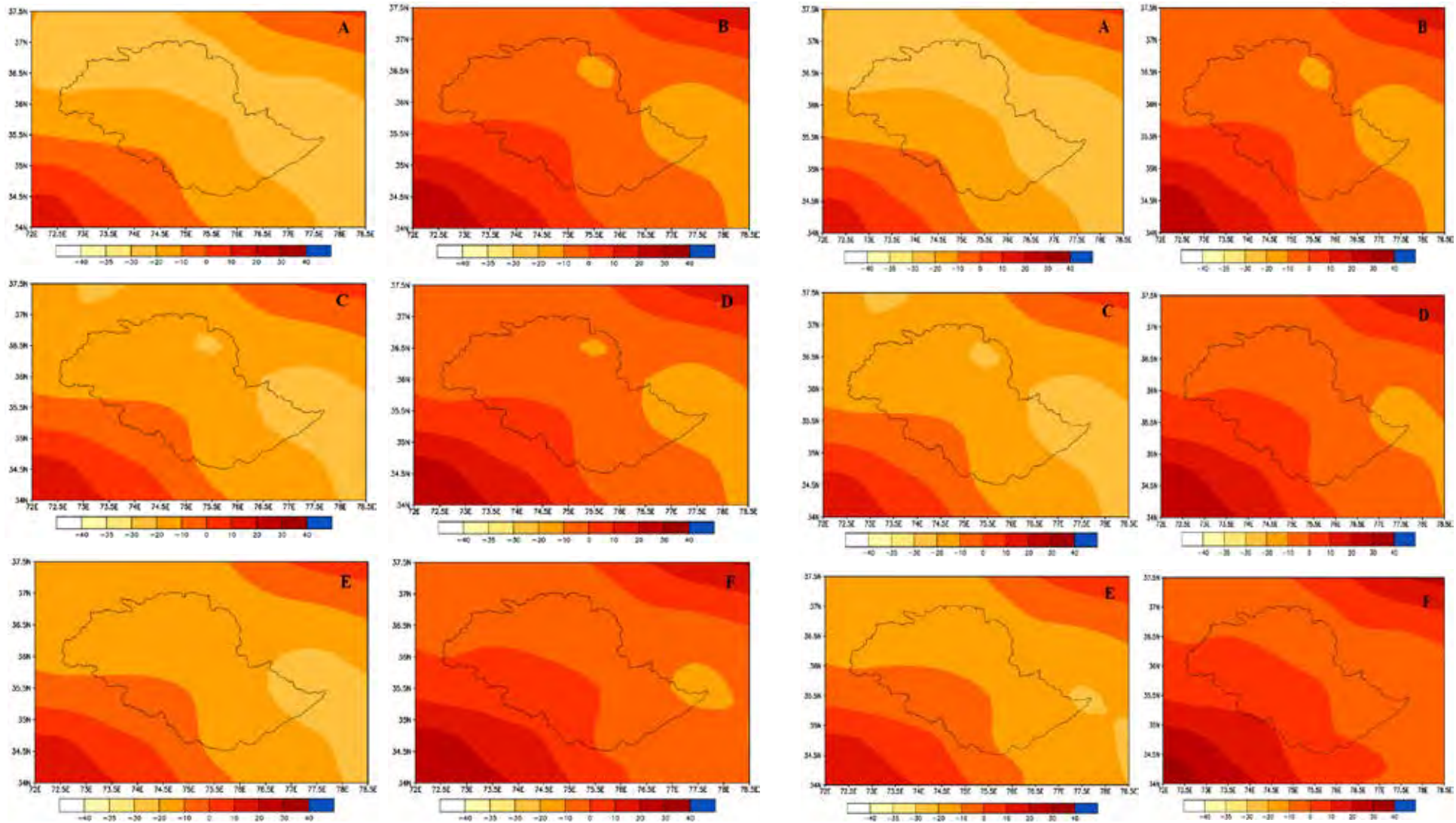
Snow accumulation

Snowmelt

RCP8.5

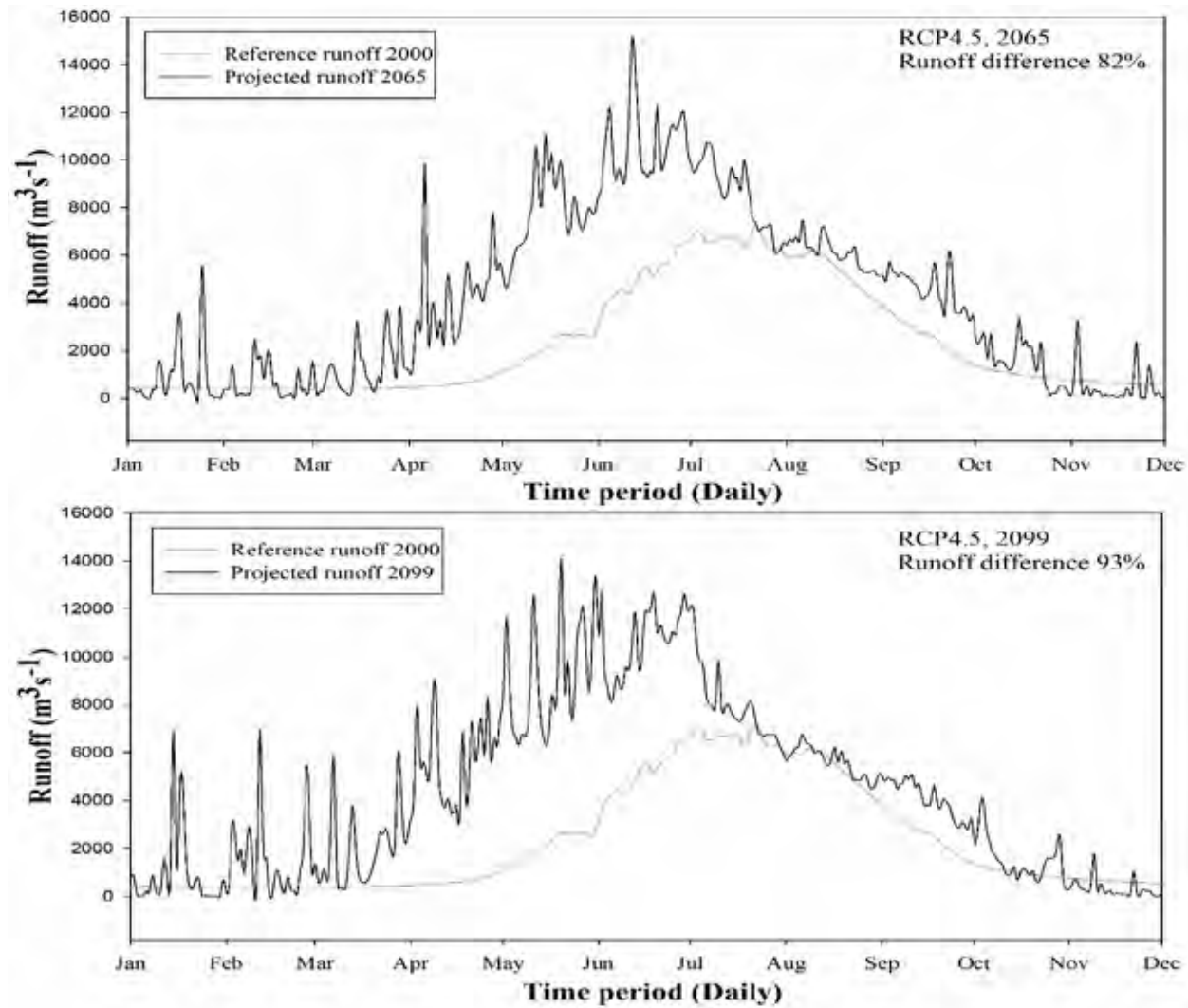
Snow accumulation

Snowmelt

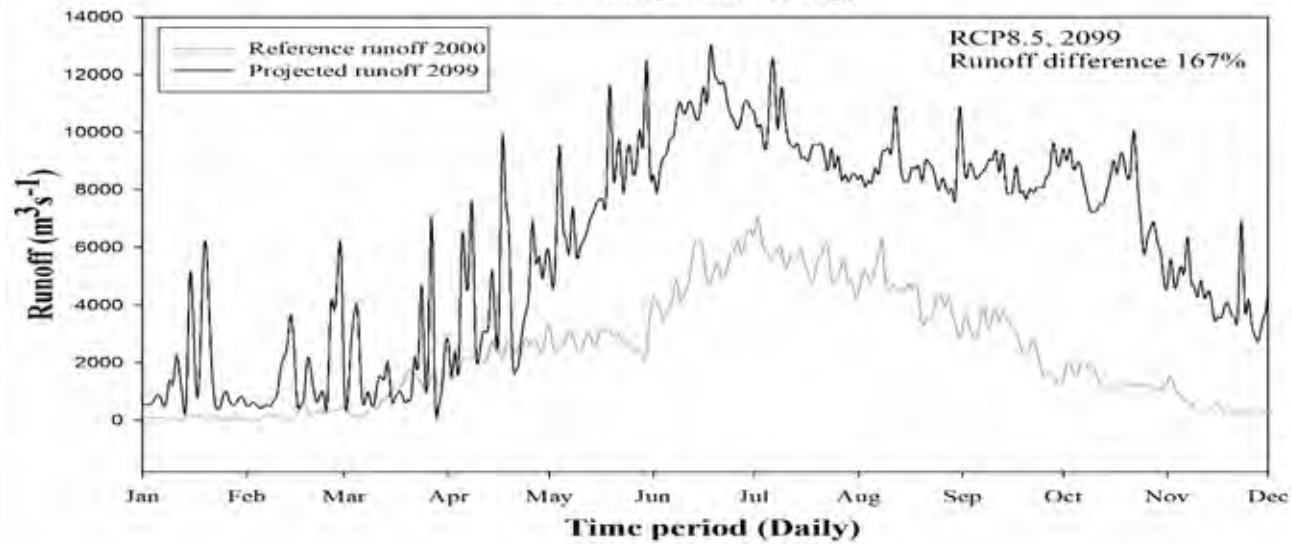
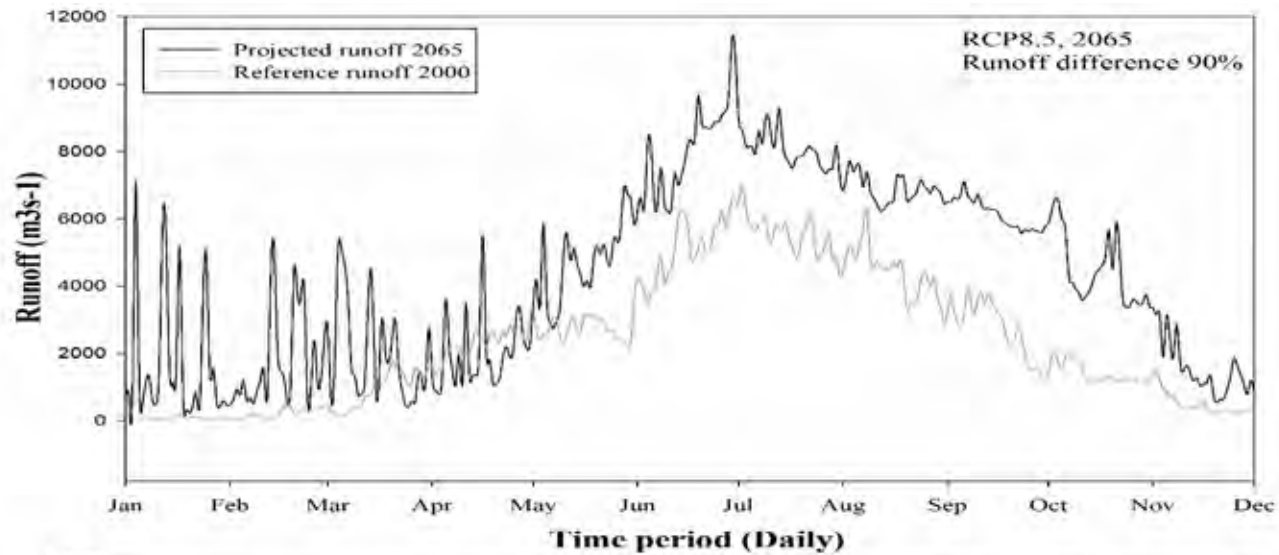


(A) Mean monthly temperature [$^{\circ}\text{C}$] during snowmelt 1951-2005, (B) Mean monthly temperature during snow accumulation, (C) Mean monthly temperature during snow accumulation 2006-2065, (D) Mean monthly temperature during snowmelt 2006-2065, (E) Mean monthly temperature during snow accumulation 2066-2099, (F) Mean monthly temperature during snowmelt 2066-2099.

Annual Runoff projection under RCP4.5



Annual runoff projection under RCP8.5



Projected hydropower generation under the RCP4.5 and RCP8.5 scenarios

Name	Planned	RCP4.5 2065	RCP4.5 2099	RCP8.4 2065	RCP8.5 2099
	Annual energy generation capacity (GWh)	Annual projected energy generation (GWh)	Annual projected energy generation (GWh)	Annual projected energy generation (GWh)	Annual projected energy generation (GWh)
Diamer	18097	32937	34927	34384	48319
Dasu	21495	39121	41485	40841	57392

Note: Energy generation is calculated for each hydropower plant with 60% generation efficiency.

Conclusion

- In the future more water will be available as a result of increase in the mean temperature.
- Increment in the Indus river flow will increase the hydroelectric power generation capacity of the planned future hydropower projects.
- The hydropower generation capacity of major future hydropower projects such as those from the Diamer Basha, Dasu and Bunji hydroelectric power stations are also expected to increase.

Thank
You

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Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-02

Performance of downscaled convective and stratiform precipitation over the Philippines during the East Asian Winter Monsoon

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University of the Philippines Diliman, Philippines*

***Paul Daniel Ang**, Institute of Environmental Science and Meteorology, University of the Philippines Diliman, Philippines, Philippines; **Gay Jane Perez**, Institute of Environmental Science and Meteorology, University of the Philippines Diliman, Philippines,*

We investigate the disagreement in the convective and stratiform pentad precipitation between the 0.25° x 0.25° Global Precipitation Measurement (GPM) Microwave Imager (GMI) and the 0.75° x 0.75° European Centre for Medium-Range Weather Forecasting (ECMWF) Reanalysis Interim (ERA-Interim) datasets. The study focuses on the East Asian Winter Monsoon period from 2014 to 2017 over the Philippine region. The ERA-Interim reanalyses are then downscaled to match the GMI resolution using the Regional Climate Model version 4.7 (RegCM4.7) with the MIT-Emanuel and Tiedtke cumulus parametrization schemes. Rainfall over ocean is better captured using the Tiedtke scheme although rainfall over land is generally overestimated for both schemes. Wet bias of stratiform rainfall is observed over the Cordilleran mountain range especially for the Tiedtke scheme.

Keywords: Dynamical downscaling, Rainfall, Philippines, East Asian Winter Monsoon

Parallel Session A: Advances in regional downscaling

A1: Uncertainties and added value

A1-P-32

Uncertainty in climate change projections over India using two dynamical downscaling techniques

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Ram Singh, Krishna Achuta Rao,
Centre for Atmospheric Sciences, Indian Institute of Technology Delhi, India

Uncertainty in future climate projections at regional and sub-regional scales is an issue of concern for the research and policymaker communities. Over regional scales, dynamic downscaling is still a preferred approach to produce useful information. The use of RCMs and high-resolution AGCMs are two approaches that are popular. In this study, we investigate the impact of various dynamical downscaling methodologies (using a RCM and AGCM) on the mean change and associated uncertainty over India. We use 9 selected CMIP5 AOGCMs downscaled (to 0.5°x0.5° resolution) using the Regional Climate Model (RCM) for the South Asia domain using the Rossby Center regional Atmospheric version (RCA4) by the Swedish Meteorological and Hydrological Institute (SMHI) as a part of CORDEX. We also downscaled the same 9 AOGCMs using NCAR's Community Atmosphere Model (CAM5.3 – the atmospheric component of CESM1.2.2, at 0.9°x1.25° resolution). We compare the downscaled outputs from RCP4.5 and RCP8.5 scenarios against relevant CMIP5 model output over the homogenous climatic zones of India. Spatial and seasonal features of present-day climate over Indian region are reasonably well simulated by both the RCM and AGCM with the signature of downscaling models evident in the biases. We analysed the impact of two dynamical downscaling on mean change and associated uncertainty over the regional and sub-regional scale and also investigated how the uncertainty is fundamentally different from AOGCMs.

Keywords: Dynamical Downscaling, Regional Climate Change, Uncertainty, Regional Climate Model, AOGCMs

Parallel Session A: Advances in regional downscaling A2: Convection permitting modelling

A2-P-08

Testing of non-hydrostatic core of RegCM and microphysics over the Carpathians

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This study is about testing of non-hydrostatic core of RegCM and microphysics over the Carpathian Mountains. Carpathians are a mountain range across the Eastern and Central Europe forming an arc of ~1,500 km long, with eastward continuation of Alps. The region of study comprises of the Carpathians with the Hungary-Slovakia domain at 4 km resolution for the years 2006-2015. The two setups with non-hydrostatic dynamical cores and microphysics under moisture scheme were made. Setup 1 used Kain-Fritsch for cumulus convective scheme while it is kept off for the setup 2. Average daily temperature and daily precipitation over the study region (Hungary-Slovakia) for 10 km observations and 20 km coarse domain were observed. Both setups and 20 km coarse resolution shows higher values of daily temperature over the Hungary as compared to observations whereas it shows lower values of precipitation as compared to observations. Similarly, both setups show higher values for daily temperature over Slovakia whereas lower values of precipitation as compared to observations. The results and comparisons show that the model performs better with the Slovakia domain. A larger domain for the high-resolution simulation may improve the results over the Carpathians. The long-time span experiments may show better results.

Keywords: microphysics, non-hydrostatic, temperature, precipitation, Carpathians

Parallel Session A: Advances in regional downscaling

A2: Convection permitting modelling

A2-P-09

Sensitivity of temperature and precipitation to physical parameterization schemes of RegCM4 over Mindanao, Philippines

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J.C. Albert I Peralta, Ateneo de Manila University, Regional Climate Systems Laboratory, Manila Observatory, Philippines; Jennifer Tibay, Julie Mae Dado, Faye Abigail Cruz, Regional Climate Systems Laboratory, Manila Observatory, Philippines; Gemma Teresa Narisma, Regional Climate Systems Laboratory, Manila Observatory/Ateneo de Manila University, Philippines; Fredolin Tangang, Juneng Liew, Centre for Earth Sciences and Environment, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, Malaysia, Malaysia; Thanh Ngo-Duc, Tan Phan-Van, Vietnam Academy of Science and Technology, Vietnam; Jerasorn Santisirisomboon, Department of Marine Science, Faculty of Science, Chulalongkorn University, Thailand; Patama Singhruck, Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RUCORE), Ramkhamhaeng University, Thailand, Thailand; Dodo Gunawan, Center for Climate Change Information, Agency for Meteorology Climatology and Geophysics (BMKG), Indonesia, Indonesia; Edwin Aldrian, Agency for Assessment and Application of Technology (BPPT), Indonesia, Indonesia

The island of Mindanao, Philippines is key agricultural region of the country known to be vulnerable to extreme climate events whose extent and dynamics are still poorly understood. As part of the Southeast Asia Regional Climate Downscaling/Coordinated Regional Climate Downscaling Experiment-Southeast Asia (SEACLID/CORDEX-Southeast Asia) project, this study first examines the sensitivity of simulated temperature and rainfall of Mindanao using 18 different cumulus parameterization schemes of the ICTP Regional Climate Model (RegCM) version 4.3 at 25km resolution for the period 1990-2007. The best-performing cumulus scheme is then used for simulations using RegCM 4.3.7 over the same domain at a finer 5km resolution and compared with output from the newly-introduced nonhydrostatic configuration. The observation datasets APHRODITEv1808 and CHIRPSv2 was used as basis for temperature and precipitation, respectively. For all configurations at 25km, consistent cold bias (1-4°C) and large rainfall RMSE values (>5mm/day) are observed over mountainous areas while warm bias (1-2°C) exists over southern coasts of the island. The parametrization that recorded the least bias and best metrics is Grell over land and Emanuel over ocean with Zeng ocean roughness parameter $\text{iocnrough}=2$. On the other hand, configurations using Grell over both land and ocean and the Kuo scheme ranked lowest among all metrics.

Keywords: Philippine climate, cumulus parametrization, nonhydrostatic model, CORDEX SEA

Parallel Session A: Advances in regional downscaling

A3: Downscaling tools and methods

RCMES-based Statistical Downscaling of CORDEX South Asia RCM output over India

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***Mahesh Ramadoss, Sanjay J, Sandip Ingle**, Indian Institute of Tropical Meteorology, India; **Huikyo Lee**, Jet Propulsion Laboratory, California Institute of Technology, United States; **Krishnan R**, Indian Institute of Tropical Meteorology, India*

The statistical downscaling toolkit provided as a part of the Jet Propulsion Laboratory (JPL)'s Regional Climate Model Evaluation System (RCMES) is utilized to develop a web-based interactive application for statistically downscaling the WCRP Coordinated Regional Climate Downscaling Experiment (CORDEX) South Asia regional climate model (RCM) output to the fine-scale required for local climate impact assessments. This web-application is useful to downscale daily maximum and minimum temperature and precipitation over selected locations in India. This web-application will address the users need for correcting the errors in the RCM output that deviates from observations, using four statistical downscaling methods viz., the delta addition, delta correction, quantile mapping, and asynchronous linear regression. This user-friendly application will also enhance the visibility and utilization of CORDEX South Asia RCM outputs in the climate impacts community.

Keywords: Region Climate Models, Statistical Downscaling, Climate change

Parallel Session B: Coupled Models

B1: Atmosphere-land

B1-P-01

Contribution of Urban Heat Island on Landscape Composition and Its Impact to the Land Surface Temperature (Case Study on Palembang City-Indonesia)

***Adelina Gaol**, Indonesian Agency of Meteorology Climatology and Geophysics, Indonesia*

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Palembang as the capital of South Sumatra Province, and also famous as the host of the Asian Games 2018 has high development activities along with the increasing population. Development carried out through the diversion of land functions into built-up land causes an increase in surface temperature which triggers the urban heat island phenomenon. This study aims to discuss the phenomenon of Urban Heat Island in Palembang City and its relation to land composition and population density on surface temperatures obtained from the processing of multi-temporal Landsat Images in 1989, 2001, 2018, with the specification of cloud-free (clear sky) using the Land Surface Temperature (LST) algorithm and guided classification (supervised). The results of surface temperature, population density, and land composition were then carried out simple regression tests. The distribution of the UHI phenomenon is obtained by classifying LST to obtain the UHI threshold. The results showed a link between changes in surface temperature, population density and land composition. The value of the determinant coefficient (R²) between the relationship of changes in surface temperature which is directly proportional to the increasing population, the increase in the area of each open land and built-up land reached 62.6%, 86.3%, and 55.0%. Conversely, there is a negative link between surface temperature and dense vegetation with a determinant coefficient reach 90.4%. The affected area of UHI is located in the center of Palembang, reaching 33.5 km² of the total area of Palembang City in 2018. It is necessary to have an ideal city mitigation and arrangement by calculating the green area with the increasing population in Palembang City.

Keywords: Urban Heat Island, LST, Landsat

Parallel Session B: Coupled Models

B1: Atmosphere-land

B1-P-05

Indian Summer Monsoon in a coupled land-atmosphere regional downscaling experiment

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One of the visions of the CORDEX project is to evaluate and improve different regional climate downscaling techniques through testing different models over a common area. In this regard, the capability of regional climate model RegCM4 forced with two different GCMs and three different land-surface parameterization schemes (i.e. BATS, CLM4.5, and Subgrid-BATS) in simulating the mean features of Indian Summer Monsoon is tested for the present climate (1975-2005). The selection of the GCMs (MIROC5 and CCSM4) were made on the basis of their ability in representing the seasonal mean, inter-annual and the intra-seasonal variability of monsoon over the Indian region based on the available literature. In total, 6 different long term simulations were carried out and assessed in terms of seasonal mean near surface air temperature, precipitation and low level wind fields for June-September season over CORDEX-South Asia domain. Among all the experiments, MIROC-RegCM-CLM4.5 experiments outperform others in simulating the JJAS seasonal mean precipitation and wind climatology with comparatively less dry bias over the Indian region. The model performance were assessed in terms of Taylor's metric (for seasonal mean precipitation, temperature, zonal wind, meridional wind and total cloud fraction), mean annual cycle, Index of Agreement, Normalized Root Mean Squared Deviation, and Probability distribution function over the Indian landmass region. The model experiments were found to simulate the moderate precipitation events more accurately than higher intensity precipitation events when compared with IMD observations. The inherent biases in the model simulations are attributed to the weaker meridional wind simulation in the experiments along with restrained vertical motion during monsoon especially in case of those forced with CCSM4 GCM. This emphasizes the importance of appropriate GCM forcing as well as land surface parameterization scheme for the simulation of a coupled land-ocean-atmosphere system such as Indian Summer Monsoon.

Keywords: RegCM4, CLM4.5, CORDEX-South Asia, Monsoon, Downscaling

Parallel Session B: Coupled Models

B1: Atmosphere-land

B1-P-15

Institutionalization of Climate Adaptation Practices: A Case Study of Planned city of Chandigarh, India

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Cities seem to be very vulnerable to disasters and climate related risks occurring more frequently in recent past. The potential risks of disasters are putting pressure on city governments for devising knowledge based innovative tools to cope with the emerging challenges. Chandigarh, the most attractive planned city in Northwestern India has initiated very remarkable and participatory initiatives for improving environmental conditions in poor neighborhoods and institutionalize climate adaptation practices. The major climate friendly initiatives of the city are introduction of Garbage Bin Free Scheme, Sahej Safai Kendras (Easy Sanitation Centres), Scientific Landfill of Waste, Setting up of Waste to Energy Plant, revitalization of green belts, parks and roundabouts, opting for energy saving street lights, augmentation of secondary and tertiary treatment of liquid waste, SCADA for water management, construction of dedicated bicycle lanes, switchover to CNG/ LPG based automobiles, modernization of fire services and a very important initiative of making solar energy systems compulsory in the larger housing units, institutions and offices etc. The results of the initiatives in Chandigarh have been remarkable. The city has been adopted as a model city for the solar energy and it has been moving very fast in making city a 'solar city'. It has also been adjudged the greenest city in the country. Chandigarh has received awards for providing quality sanitation in 2010, best performance award for providing water supply, waste water management and drainage in 2008, an award for increasing forest and tree cover in 2010 and six award on e-governance during last five years. The paper based on some studies by the author is an effort to describe the initiatives of Chandigarh towards institutionalization of climate adaptation practices.

Keywords: Institutionalization , Climate Adaptation

Parallel Session B: Coupled Models

B1: Atmosphere-land

B1-P-18

Impact of Equatorial and Northern Bay of Bengal SST's on the Indian summer monsoon rainfall

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The influence of East equatorial Indian Ocean and the northern Bay of Bengal SST's on the rainfall pattern over monsoon core zone during Indian summer monsoon is investigated. During Indian summer monsoon, rainfall over monsoon core zone and the SST at the East equatorial Indian Ocean are negatively correlated, whereas it is positively correlated with Northern Bay of Bengal. A new index, the summer monsoon SST index from the SST difference between the East equatorial Indian Ocean and the Northern Bay of Bengal regions is formulated. Summer monsoon SST index shows strong correspondence with the intraseasonal oscillation of Indian summer monsoon and, rainfall over Monsoon core zone varies in coherent with the increasing/decreasing periods of summer monsoon SST index. The rising limb of the monsoon Hadley cell and the associated atmospheric convection shows north-south shifting according to the increasing/decreasing trends of summer monsoon SST index. This coherent variation of rainfall over monsoon core zone with summer monsoon SST index suggests that SST's at East equatorial Indian Ocean and Northern Bay of Bengal are teleconnected with Monsoon core zone and consequently modulate the rainfall pattern over Monsoon core zone

Keywords: Monsoon core zone, Summer monsoon SST index, Indian Summer monsoon

Parallel Session B: Coupled Models B2: Ocean-Ice-Atmosphere

B2-P-07

Effect of sea level rise on metro city: lessons from urban coastal communities from India

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Societies have lived with the vibrant nature of land and coastal environments for ages. Vulnerability of coastal areas to climate change is an important issue, which has gained attention recently. Faced with rising sea levels and the likelihood of increasing storminess, coastal communities are on the front line of climate change impacts. Coastal areas face multiple risks and stresses related to climate change and variability. Impacts of sea level rise are expected to have predominantly adverse effects on natural and human systems. Coastal communities are highly vulnerable to climate change impacts, mainly because of three main reasons, high resource dependency, high exposure and limited adaptive capacity. This raises concerns about coastal community's sustainability. India has a 7,517 km long coastline with many low-lying and densely populated areas with nearly 260 million people living within 50 km of the seacoast. These highly vulnerable areas house a network of infrastructures. It is highly pertinent to start climate adaptive infrastructure and services, given the climate sensitive nature of the existing infrastructure systems in the coastal area. It could be maintained and managed in such a way that it is prepared to withstand sea level changes impacts.

This paper discusses on approaches that can increase resilience of infrastructure and the services in coastal urban areas of developing nations. It also highlights the Identification of vulnerable hot spots in the coastal areas, recommendations for climate proofing infrastructure and services and methodology for vulnerability assessment of coastal communities to climate variability and sea-level changes. It also recommends appropriate policy and institutional reform, capacity building and improved knowledge management towards increasing the resilience and adaptive capacity of these coastal communities to current and future sea level changes.

Keywords: Climate change, Sea level rise, Coastal communities, Vulnerability mapping, Climate adaptive infrastructure

Parallel Session B: Coupled Models

B3: Biogeochemical processes

B3-P-02

Spatio-temporal distribution of Aerosol Optical Depth over South Asia using MODIS data

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Aerosols play an important role in climate of the region. In this paper an effort has been made to study the spatio-temporal trends of aerosol optical depth (AOD) over South Asia. For this purpose, we have used AOD at 550 nm from Moderate Resolution Imaging Spectroradiometer (MODIS) during the period September 2002-August 2015. We have also compared AOD from Aqua-MODIS with those of Terra-MODIS, MISR and SeaWiFS. The highest value (0.973) of correlation coefficient (R) was found between Terra-AOD and Aqua-AOD while for MISR and SeaWiFS, values of R were found to be 0.711 and 0.520 respectively. During winter, the highest values (~ 1) of AOD were recorded over eastern part of Indo-Gangatic Belt (IGB) while during monsoon, highest values (~ 1) of AOD were found over western part of IGB consisting of Indus river basin in Pakistan. AOD anomaly were also calculated for the study region. Maximum values (~ 0.4) of AOD anomaly were detected over western parts of IGB in monsoon season. Time series of monthly deep blue Aqua-AOD over South Asia showed increasing trend with $\Delta AOD=9.75\%$. Annual mean AOD was found to be 0.290 ± 0.048 with maximum value in the month of June and lowest in September.

Keywords: Aerosols, Remote sensing, South Asia

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-01

Seasonal and interannual variations of the ITCZ in the Indian Ocean

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The climate of tropical regions on the monthly and longer time scales is significantly affected by migration of the intertropical convergence zone (ITCZ), while the ITCZ position depends on the cross-equatorial atmospheric energy transport (AET) and the equatorial net energy input (NEIO). Using the ERA-Interim dataset for the period 1980-2018, the ITCZ position in the Indian Ocean and its migration on the seasonal and interannual time scales are investigated. In addition, the cross-equatorial AET and the NEIO in the Indian Ocean are analyzed to determine position of the ITCZ based on the atmospheric energy balance. Results indicated that the annual mean position of the ITCZ in the Indian Ocean is in the Southern Hemisphere (approximately at 5.5°S), while in some seasons, a double ITCZ forms. It is also found that during the period 1980-2018, the annual mean position of the ITCZ in the Indian Ocean is migrated toward the equator by approximately 1° . The largest meridional migration of the ITCZ in the Indian Ocean occurs with the period of 1 year, showing seasonal migration of the ITCZ associated with the monsoon circulation. Our analysis indicated that position of the maximum precipitation in the Indian Ocean is different from the energy flux equator (EFE, where the column-integrated meridional energy flux vanishes), such that the EFE is always located at north of the position of maximum precipitation. It is found that variations of the cross-equatorial AET and the ONI are not consistently correlated, while variations of the NEIO in the Indian Ocean and the ONI are quite consistent. Variations of the cross-equatorial AET dominate interannual variations of the ITCZ position, while variations of the NEIO dominate seasonal variations of the ITCZ position in the Indian Ocean.

Keywords: ITCZ, cross-equatorial atmospheric energy transport, equatorial net energy input, energy flux equator, Indian Ocean

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-04

Quantification of future climate risks and onset of extreme weather events to metropolitan cities in Asia

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More than 50% (~3.5 billion) of the global and 49.6% Asian population is living in cities becoming increasingly urbanized, and population in Asia is equivalent to 59.66% of the total world population. Current growth simulations indicated that the relative magnitude will increase to 58% by 2030, and by 2050 nearly 6.3 billion out of an estimated global population of 9.1 billion will live in urban territory. Cities consume 75% of the world's energy use and produce more than 76% of all CO₂. Warming of just 1.5 degrees Celsius could bring on the most severe consequences of climate change. During 2010 to 2018 people's lives were disrupted by heat waves, floods, drought, erratic rains and sea level rise. Changes in temperature, precipitation, sea level, and coastal storms will likely increase the vulnerability of infrastructure across the Asia. Each city has its own particular reaction under the stress of extreme weather events, and weather poses one of the biggest risks to human health and economy. Cities have direct linkages with climate change, and urban centers are major drivers of global warming because they concentrate transportation, industries, households and many of the emitters of greenhouse gases. Already, a third of the urban population in developing countries is living in slum, this usually implies a lack of safe drinking water, sanitation, and highly vulnerable to natural disasters. In Asia more than 18% of urban population living in Low Elevation Coastal Zone that is less than 10 meters above sea level (Mumbai, Karachi & Jakarta). Marginalized urban residents such as labor migrants in, for instance Manila, Colombo and Dhaka are forced to live in highly exposed locations which are highly susceptible to extreme weather. Using regional research and to analyze vulnerability, impacts, and adaptation practices, this paper estimates impacts to human health, economy, coastal properties, and urban infrastructure and investigates sensitivity to varying greenhouse gas emission scenarios and climate sensitivities. The study will provide better understanding to policy makers to rethink what and where a central business district is in the 21st century to reduce our GHG emissions by 45% before 2030 and reach net zero emissions by 2075.

Keywords: Climate Warming, Extreme Weather, Future Risks, Urbanization

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-06

Investigation and projection of Human Thermal Comfort Stress over West Bengal, India using observations and CORDEX climate model experiments

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Numerous studies feature the extreme human bio-meteorological conditions in terms of human thermal comfort index in India for the last few decades. This research highlights the human bio-meteorological conditions and its variability in West Bengal (one of the densely populated state of India) for the last 50 years by using Universal Thermal Climate Index (UTCI). The meteorological variables from meteorological stations in West Bengal are used to calculate UTCI and the computed UTCI is also compared with the UTCI calculated from the regional climate model from the CORDEX-south Asia experiments. The results showed increasing trend of UTCI in almost all the stations of West Bengal during the study period. In addition, future human thermal comfort is projected for Kolkata and its neighbouring districts (capital city of West Bengal) under the scenarios of RCP4.5 and RCP8.5. The future projection of UTCI in Kolkata and its rural outskirts with climate change taken into account suggests that annual aggregate of heat stress days will increase significantly while the no thermal stress days or cold stress days will reduce.

Keywords: Urban Heat Island, Human Thermal Stress

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-07

Predicting Dengue cases in Kolkata, India based on variation of climate using Zero-Inflated Regression Model

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Dengue is one of the most serious vector-borne infectious diseases in Kolkata, India and its viruses and their vectors are sensitive to climate change. The widespread characteristics of dengue in Kolkata are identified with some key meteorological factors such as maximum temperature, minimum temperature, relative humidity and rainfall on the basis of statistically significant cross-correlation coefficient values. The statistical model on dengue cases was framed with the key factors for the first 120 months of the data set from 2005-2016. The remaining months were used to validate the model. Finally, climate variables from the Coordinated Regional Climate Downscaling Experiment (CORDEX) for South Asia region were input into the developed statistical model to project the occurrences of dengue infections under different climate scenarios (RCP2.6, RCP4.5, and RCP8.5). It has been estimated that from 2020-2100, dengue cases will always be higher from September to November with more cases in RCP8.5 (871 cases per year) than RCP4.5 (530 cases per year). This study further evaluates that from December to February, increases in carbon dioxide concentration under RCP8.5 leads to warmer weather conditions essential for the survival and multiplication of vectors, with more than two times the dengue cases than in RCP4.5.

Keywords: Mosquito borne disease, Dengue

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-11

Evaluation of the numerical model with CORDEX Regional Climate Models for heavy precipitation in the Meghna Basin region

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Prediction of heavy precipitation (HP) induced flood incidents is challenging when they happen on the high terrain of Meghalaya Plateau and nearby areas. Improving the simulation of the Pre-monsoon (March-May) mesoscale convective systems (MCSs) is important as such events routinely result in rainstorms, flash flood, flooding events and significant loss of lives and properties over Bangladesh, Indian eastern, northeastern region and neighborhood. The influx of moisture from the Bay of Bengal (BoB) energizes these rainstorms systems as it passes over Meghalaya and northern parts of Bangladesh and thus produces heavy convective and stratiform rain over Meghalaya and the surrounding areas. Although extreme precipitation and runoff are the root causes of the flash flood, the stretches of valley and highland plateaus of Indo-Bangla region play an important role in the weather system due to its extraordinary geography and climate. The valley and plateaus of Indo-Bangla region is the wettest place on planet earth. It is important to predict heavy precipitation precisely for assessing floods and flash flood over the region of the Meghna basin. The global precipitation products are helpful for understanding rainfall pattern over a data scarce region. For the regional study, the mesoscale numerical model Advanced Research version of the Weather Research and Forecasting (WRF-ARW) is used for estimating heavy precipitation in a finer resolution for the HP event of pre-monsoon season 2004, 2010, 2016 and 2017. Sensitivity analyses of different parameterization schemes are applied in this study. The model simulated precipitation is assessed with the available rain gauge observation along with India Meteorological Department (IMD) Global Precipitation Measurement (GPM) mission merged datasets. The best and worst performing parameterizations combination schemes are identified after doing statistical analyses. In the study, the WRF model simulated precipitation are evaluated with the Coordinated Regional Climate Downscaling Experiment (CORDEX) models data for a better understanding of regional analysis. To understand the influence model grid resolution, global to regional (g2r-1:3) and global to convection-permitting (g2c-1:9) scale ratios are tested in the present study.

Keywords: Heavy precipitation, flood, Parameterization, WRF ARW, CORDEX models

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-17

An analysis of the abnormal flood and its impact on environment and socio-economic conditions in Kerala

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Climate change and its impact are evident in the State of Kerala in India. In August 2018, abnormally heavy monsoon rains led to the worst flooding in a century, killing around 500 people and thousands of livestock, displacing one million people and damaging 50000 houses, roads and other infrastructures. Estimated losses amount to more than US \$3 billion. Seasonal rainfall was 42% above normal and rainfall during 1 to 19 August was 164% above normal. Around 414 mm rainfall occurred during August 15-17, which led to severe flooding. Steep slopes and destruction of wetlands added to its severity. All 39 major dams had reached their full reservoir level by the end of July, and were incapable of absorbing the torrential volumes in August. After flood, surface water bodies, especially rivers are drying up fast because of abnormal landslides and sedimentation. Around 8 to 10% of all reservoirs were already filled with sand because of deforestation and urbanization. As a result of the loss of surface soil and failure of northeast monsoon, groundwater level in the state fell by 3 metres and the state experienced serious water crisis in the beginning of 2019 itself. Destruction of check dams and erosion and deepening of rivers allow fast flow of groundwater towards the sea. Decrease in runoff now permits salinity intrusion far inland. State was not prepared to cope with the unexpected situation and flood initiated several socio-economic issues such as shortage of reliable water, hiking price of food and water, conflicts over allocation, spread of contagious diseases and large investment to rebuild infrastructure and rehabilitate the displaced population. This study analyses the hydrometeorological extremes in Kerala during 2018, trends in extremes and their impacts on different facets of life. Results show an increasing trend in extremes in near future. Guidelines for developing a better climate policy and adaptation strategy have been provided.

Keywords: Climate change, Kerala, flood, socio-economic, adaptation

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-23

Rainfall and temperature scenarios over Bangladesh based on RCP scenarios using RegCM

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Rainfall and surface temperature are the most important climatic variables in the context of climate change. Thus, these variables simulated from ICTP RegCM models have been compared against observed (raingauge) data and projected for the middle of twenty first century under the Representative Concentration Pathway (RCP) 4.5 emission scenario. Through calibration and validation of RegCM was adapted for Bangladesh for generating rainfall and temperature scenarios. The model generated rainfall was calibrated with ground based observed data in Bangladesh during the period of 1981-2000. Better performance of RegCM obtained through validation process increased confidence in utilizing it in the future rainfall and temperature projection for Bangladesh. Rainfall, maximum and minimum surface air temperature projection for Bangladesh is experimentally obtained for the period of 2041-2060. This work finds that the RegCM simulated Rainfall and temperature are not directly useful in application purpose. However, after validation and calibration, acceptable performance is obtained in estimating annual rainfall and maximum and minimum surface air temperature in Bangladesh. Change of rainfall is projected about -1.2 percent in pre-monsoon (MAM), -1.4 percent in monsoon season (JJAS), 1.90 percent in post-monsoon Season (ON) and 0.46 percent in winter season (DJF) during the period of 2041-2060. Similarly, change of maximum and minimum surface air temperature is projected about 1.4 and 1.5 degrees Celsius for the same period.

Keywords: Rainfall forecast, temperature forecast, climate change, calibration, validation

Parallel Session C: Climate Change Impacts

C1: High Impact regional phenomena

C1-P-24

Impact of regional climate model projected changes on maize yield over Southern India

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Maize is one of the major cereals grown in southern state of Tamil Nadu, India and produces about 1.2 million tones which contribute 14 percent to total cereal production in Tamil Nadu. There was an increasing demand for maize grains for poultry feed and also for human consumption due to structural changes of consumption pattern. In Tamil Nadu, about 43 percent of cropping area under rain fed and nearly 40 percent of maize production comes from rainfed regions. Presently, global warming has become a great challenge for the agrarian economy of India. Among various factors, maize yield depends on the vagaries associated with rainfall and surface temperature. These two primary climate variables are expected to change in a warmer climate. To understand the projected monsoon changes impact on maize production is carried out by performing high-resolution regional model climate simulations (IPRC_RegCM) with multiple lateral forcing, and the climate variables from regional model serve as input into economic model. To predict the impact of climate change on maize yield in the future, we used the coefficients of Indian Meteorological Department (IMD) data and European Reanalysis Interim (Era-Interim) data as baseline and predicted the current yield. The projections taken from CCSM4 (Community Climate System Model) forced high-resolution regional model climate simulations and computed the climate change impacts on maize yield. This paper predicts the maize yield for the RCP6.0 scenario under the CCSM4 model by employing the panel data regression model. The model estimates the impact of maize yield is projected to decrease by 11 and 23 percent for the IMD and Era-Interim reanalysis data respectively during end of the 21st century. However, we have compared the IMD maize yield projections with ERA-Interim reanalyses outputs which is also a proxy for observations, both the models projects in similar trend gives more confidence and precise estimate on our projections.

Keywords: Climate change impact, Maize yield, Southern India

Parallel Session C: Climate Change Impacts

C2: High mountain environments

C2-P-01

Application of CORDEX South Asia climate product to assess the impacts of climate change on water availability in Karnali River Basin of Nepal Himalaya.

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The Himalayas are water towers for Asia and water source to major rivers which provide water for about 1.3 billion people inhabiting the mountain and downstream. Basin-level water availability assessment in the context of climate change is now a major concern for many regional planners and decision makers in this area. The main objective of this research is to evaluate the projected impacts of climate change on water availability in Karnali River Basin of Nepal Himalaya. We applied the Soil and Water Assessment Tool (SWAT), a basin-level hydrological model to determine future water availability based on climate scenarios. We used an ensemble product of CORDEX South Asia future climate data for 2040-2069 and 2070-2099 for 2 emission scenarios – RCP4.5 and RCP8.5. Results indicate that the average annual temperature could rise by at least 1.4°C by the mid-21st century (2040-2069) and can exceed by 3.4°C by the late 21st century (2070-2099) under a high-emissions scenario compared to the baseline 1971-2000. The warming trend is projected to be stronger in northern highland than lowland. Our analysis shows that precipitation will increase during the monsoon but decrease during the winter, indicating increasing extreme events. Annual precipitation could increase by 12% and 30% under RCP4.5 RCP8.5 scenarios respectively. This change in precipitation has been reflected in streamflow change. An increase in streamflow is expected for both the mid- and late-century compared to the baseline period in pre-monsoon (March-May) and monsoon (June-September) seasons and that flooding will become more extreme and projected to decrease streamflow during the early winter.

Keywords: Climate Change, Water Resource, Hydrological Model, Himalaya

Parallel Session C: Climate Change Impacts

C3: Implications for renewable energy

Characterizing the Historical and Projected Wind Energy Resource in the Philippines Using CORDEX-SEA Simulations

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Wind energy is a viable resource for power generation in the Philippines, but the wind resource will likely change over time due to climate change. This study determined the historical and projected trends in both wind speeds and available wind energy in established and potential wind farm locations in the Philippine region. The wind resource was assessed using an ensemble model output from the Coordinated Regional Climate Downscaling Experiment – Southeast Asia (CORDEX-SEA). Large positive biases in the modeled surface wind speeds of up to 200% with respect to ECMWF Re-Analysis (ERA)-Interim dataset, especially in mountainous regions, were observed and later bias-corrected using the Quantile Mapping Method. Seasonally for all periods, wind power peaks during January-December and August, coinciding with peaks of the Northeast and Southwest monsoons, respectively. Both Representative Concentration Path (RCP)4.5 scenarios for the 2046-2045 period show an increase in wind power density with respect to 1986-2005 values over the whole Philippine domain, with stronger increase during Southwest monsoon months. Analysis of several regions in the Philippines reveal that Palawan and Quezon, which were identified in previous studies to be areas with excellent wind resources, remain to be viable wind farm locations. However, potential sites (Northeast and West Luzon, Mindanao, Celebes Sea) that show large and significant ($\alpha = 0.05$) projected increase in wind resources were determined to be poor wind farm locations, as both the available and extractable wind power are still quite low despite this large increase.

Keywords: CORDEX-SEA, Philippines, Wind Energy, climate change, RegCM4.3

Parallel Session C: Climate Change Impacts

C3: Implications for renewable energy

Sustainability of the hydropower generation capacity of Pakistan in changing climate conditions

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Pakistan's hydropower sector depends heavily on glacier and snowmelt water that originate from the Upper Indus Basin (UIB). It is expected that climate change will have adverse effects on future hydropower generation capacity as a result of fluctuations in the magnitude, seasonality and hydrological extremes of the Indus River runoff. The possible effects of climate change on the Indus River flow had been investigated through the use of Snowmelt-Runoff Model (SRM) along with the Moderate Resolution Imaging Spectroradiometer MODIS snow product and daily ground-based hydro-meteorological data. The results had indicated a significant increase in the annual and seasonal runoff, hence suggesting more water availability in the future. As a stronger increase of seasonal runoff had been shown under the RCP4.5 rather than the RCP8.5 scenario, this difference had, therefore, revealed a significant possible loss of permanent snow and glacier masses by early warming. However, the rise of annual and seasonal river flow is expected to increase the electricity generation capacity of future hydropower projects since the overall generation capacity had been projected to increase between 25% to 69% under the RCP4.5 and RCP8.5 scenarios, respectively. As a case in point, the hydroelectric generation capacity of the Diamer Basha hydropower project is expected to increase from the respective current power generation capacity of 6053 GWh to 7748 GWh and 10224 GWh under the RCP4.5 and RCP8.5 setups by the end of the 21st century. Since the increase of runoff during peak river flow has now become a great concern, there is a pressing need for better water conservation through the building of more robust dams in catering for extreme weathers as well as to supply adequate water for hydroelectric power generation during low flows. As such, apart from improving the storage capacity of future hydropower projects, the spillway discharge capacity of future dams should also be upgraded to deal with peak flows. Likewise, reforestation and afforestation in the upstream areas can help regulate water flow and reduce siltation, while the construction of more dams can mitigate flood risks in downstream areas, hence increasing the resilience of hydropower sector to climate change.

Keywords: Climate Change,Hydropower,Upper Indus Basin,Snow,SRM

Parallel Session C: Climate Change Impacts

C3: Implications for renewable energy

C3-P-01

Possibilities of renewable energy technologies to address the pollution hazard due to backwater tourism in Kuttanad area of Kerala, India

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Background of the Study: Climate Change is emerged as the major threat to the environment. However, its negative impacts are primarily affected by the poor peoples in the developing countries because they mainly rely on the natural resources for their livelihood. Furthermore, tourism is an important sector among the other climate sensitive economic sectors. The study location Kerala state comprises of a unique geographical features that have made it one of the most exclusive tourist destinations in Asia. Even though there is positive impact on the economy, however environmental pollution is the major problem associated with this industry. The improper and irresponsible way of houseboat tourism development affecting the water quality, ecosystems, agricultural production and traditional livelihoods. Further, the seepage of oil, sewage and other engine driven waste from the houseboats are directly discharged into the agricultural land. Moreover, the farmers were affected by the incidences of health problems when prolonged contact with polluted water.

Objectives: The study was conducted to analyze the pollution hazard due to backwater tourism in Kerala state of Southern India

Keywords: Climate Change, Backwater Tourism, Environmental Pollution, Renewable Energy, Green Economy

Parallel Session C: Climate Change Impacts

C3: Implications for renewable energy

C3-P-02

Climate Information Services and Its Potential on Adaptation and Mitigation, Local Adaptation Plan of Action (LAPA), Intended Nationally Determined Contributions (INCD) and Bangladesh Climate Change Strategy and Action Plan (BCCSAP): Experience from Flood Affected Region of Bangladesh

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Climate services are the use of climate knowledge and information in climate-smart development. The study aims to explore the understanding and level of resilience at community level, potentials of climate information services in promoting INDC, BCCSAP, LAPA and also adaptation and mitigation paradigm with smart mobile phone along with internet scheme via SMS, Outbound Dial (OBD), Apps and Call Centre services on agriculture, agro meteorology, weather forecast and early warning system. The study was conducted in South Kharibari village of Dimla upazila under Nilphamari district in where 100 climate vulnerable households are using customized system for increasing resilience in household level through climate information services. The study was conducted through explanatory methods including case studies, best practice documentation, FGD, KII and PVA (household vulnerability index). The study reveals that climate information plays a vital role in climate resilient development at household level of the study area through increased women's participation in participatory action research and formulation of LAPA, helps to strengthen their leadership role in food security and energy sector which are the major focus area of INDC and BCCSAP. It also helping climate vulnerable women to adapt with changing climate through resilient crop farming, homestead gardening, fisheries, livestock, horticulture and poultry and helps them to develop resilient planning for alternate energy sources in cooking, lighting and another purpose which meets the mitigation needs at household levels.

Keywords: Climate service, adaptation, mitigation, INDC, BCCSAP, LAPA

**Parallel Session D: Domain/cross-domain meetings,
Convection permitting models
D1: Third Pole Environment: high resolution
simulation/reanalysis and its implication/application**

D1-P-03

**Sensitivity of soil moisture to rainfall simulations associated with
western disturbances over north India**

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Winter precipitation over north India is important for agriculture, horticulture, transport, domestic use and power generation. North India mainly gets winter precipitation mainly from the Western Disturbances (WDs). The sensitivity of soil moisture to the simulation of rainfall during eight WDs are investigated using Weather Research and Forecasting model. For this purpose one control experiment is done for each of eight cases of WDs with the suitable combination of parameterization schemes. Then the simulations are repeated with 10 % increase and 10 % decrease in the soil moisture respectively. The area averaged rainfall encompassing domain (72° E-83° E to 27.5° N-38.5° N) from model simulations are compared with the TRMM observations. Results indicate that there is 1.7% increase in precipitation from the control simulation by the enhancement of 10% soil moisture. The rainfall is decreased by 1.4% when soil moisture is reduced by 10%. Model simulated values of rainfall are also compared with corresponding India Meteorological Department observed values at different stations. It is observed that the simulated rainfall corresponding to station observations increase with the enhancement in soil moisture and rainfall decreases with the reduction in soil moisture. The winds at various levels, mean sea level pressure and relative humidity patterns are reasonably well simulated by model.

Keywords: western disturbances, rainfall, soil moisture

**Parallel Session D: Domain/cross-domain meetings,
Convection permitting models
D3: Regional responses to global warmings of 1.5 and 2°C**

**Projected changes in seasonal precipitation extremes in Malaysia under
global warming of 2°C and 4°C**

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This study provides assessment impact of climate change on projected changes in seasonal precipitation extremes in Malaysia at warming levels of 2°C and 4°C based on the multi-model simulations of the Southeast Asia Regional Climate Downscaling / Coordinated Regional Climate Downscaling Experiment Southeast Asia (SEACLID/CORDEX-SEA). Three indices of extreme precipitation are considered i.e., are the consecutive dry days (CDD), the number of days daily precipitation exceeded 20mm (R20mm) and the maximum 1-day precipitation total (RX1day). The ensemble mean of 10 simulations showed reasonable performance in simulating observed characteristics of extreme precipitation during the historical period of 1986–2005. The year 2041 was taken as the year when global mean temperature reaches 2°C and year 2084 for 4°C warming above pre-industrial level under unmitigated climate change scenario based on Karmalkar and Bradley (2017). Results indicate that both period (2031-2051 and 2074 – 2094) have large significant prominent changes especially during the period of 2074–2094. Robust increases in CDD imply impending drier condition over both Peninsular and East Malaysia and enhanced under 4°C global warming. Increases in RX1day suggest more intense rainfall events over most of Malaysia and intensified under 4°C global warming especially over East Malaysia during JJA and MAM seasons. Both Peninsular and East Malaysia are projected to experience increases in CDD, R20mm and RX1day, suggesting Malaysia may face more serious repercussions in future.

Keywords: Precipitation Extremes, regional climate downscaling, multi-model ensemble, future changes, Global warming

**Parallel Session D: Domain/cross-domain meetings,
Convection permitting models
D4: Urban environment and regional climate**

D4-P-04

**Impact of climate change on extreme rainfall events on
coastal cities in the Philippines**

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***Emilio Gozo, Faye Abigail Cruz,**
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Developing country such as the Philippines, are highly vulnerable to flooding caused by extreme rainfall events such as the enhanced Southwest Monsoon (SWM) and typhoons. Major cities especially those that are in the coastal region, are even more vulnerable primarily because of how this kind of land cover can modify heat and moisture fluxes in the area. With the continued growth and development of these cities along with increasing population, it is very important to understand how these climate hazards will change in a globally warmer future. The aim of this study is to analyze the projected changes in extreme rainfall events due to climate change for the major cities in the Philippines. Historical and future multi-model projections from two scenarios (Representative Concentration Pathway 4.5 and 8.5) from the Southeast Asia Regional Climate Downscaling (SEACLID) / Coordinated Regional Climate Downscaling Experiment (CORDEX) Southeast Asia project is used in the climate change analysis. Comparison of the intensity, frequency and duration of rainy days from the reference period (1971 to 2000) to early (2016 to 2035), middle (2046 to 2065), and late (2080 to 2099) future periods is carried out in this study. Finally, extreme rainfall shifts particularly at return periods of 50 and above is measured and analyzed.

Keywords: climate change, urbanization, extreme rainfall, regional climate models

Reflection reports of ICRC-CORDEX 2019

Ang, Paul Daniel S. Ang, an APN-supported ECS from the Philippines, reviewed his experiences during ICRC-CORDEX 2019, and said that the ECS event was a good way to support future science undertaken by young scientists and help them think about how to communicate for the public. There is still a long way to make our research understandable and acceptable for the government and the public.

Paul works in a project on drought, wherein he downscale seasonal forecasts of land surface temperature, precipitation, and soil moisture for the Philippines. Other team members work on satellite-derived drought indices, crop damage reports, and statistical forecasting. During their studies, they went to fieldwork and interviewed farmers affected by drought. When they asked farmers if they knew about the coming El Niño, some replied that they knew the news that the recent El Niño can induce drier conditions in their country which would not stop them from planting. In general, most farmers adjust their farming practices based on gut feeling, regardless of drought advisories coming from the local government units due to their limited educational background. He believed that things will change once the forecasts are reliable for their specific farms, which is a great challenge for the coarse downscaled forecasts at present. It will take time for researchers to understand the relationship between the drought parameters and actual crop damages, which should not be limited to a 3-year project but should be sustained until the forecasts earn trust from the farmers.

He felt thankful for the project for exposing him to the reality of climate services and proving an opportunity to learn from other experts concentrating on climate services. Also, he is grateful for the people who have made the ECS event possible including Dr. Shuyu, Ms. Gaby, and all the staff and organizers. Paul wished that the APN and YESS would continue to help connect young people like him to such gatherings and networks.

Mehesh Romadoss reviewed his experiences during ICRC-CORDEX 2019, and gave some suggestions. Firstly, after publishing research findings, researchers can

present their research outcome by applications or tools to enhance the visibility of CORDEX and research findings. Also, researchers can publish their research findings with pseudo-code or benchmark problem of the methodology, which is helpful to compare the existing methods and create an application. In addition, acknowledgment is one of the important points to increase the CORDEX visibility. Finally, in research projects, adding some objectives on climate services and collaborating with application scientists and social scientists can fill the gap between scientific findings and needs of business communities and stakeholders. Application scientists can understand the scientific findings and verify the application output with climate scientists. Social scientists can collect the user requirement from the stakeholders and then cooperate with application scientist to fulfill the end user's need.

Mohan Kumar Das reviewed his experiences during ICRC-CORDEX 2019, and gave some suggestions. He pointed that the present career path of the majority of Early-career Scientists (ECSs) are almost floating, uncertain (as like as climate projection uncertainty), directionless, and socially undignified compare to other disciplines' career path. We need a priority basis discussion on the present barriers in the career path of ECSs, including financial difficulty, to go on a sustainable career path. Secondly, the ECS can promote some group-wise (from different countries) field study in the hotspot regions to understand the users' needs, especially local farmers. In such an endeavor, the World Climate Research Program (WCRP) needs to launch a collaborative framework with specialists on special programs and educating weather, ocean and climate science. Then, establishing user-friendly user manual is essential for beginners and various data user groups. By considering different user group needs, various short and simple manuals need to be prepared for better and effectively understanding. Fourthly, the WCRP is supposed to make efforts to narrow the gap of computational facilities among developed and developing countries. In addition, he hoped that a dedicated research group can be established to focus on Finance base research opportunity, scientific paper writing workshop, project proposal preparation and science ethics. More importantly, an effective hands-on training program is suggested

to be conducted to give an opportunity for the young scientists and dedicated researchers around the world to train their professional skills, such as data analysis, Python, R, Matlab, CDO and NCO, and improve their understanding on the climate and weather model forecasts. After training, the participants should be certified and disburse training in their respective countries. Also, a report should be submitted to the WCRP about how the participants present their work or knowledge in the training program to end-users or non-professional within the time-frame (approximate in 2-3 months). Such a kind of effort can generate changes on the attitude of the public towards meteorological agencies and could get applause from society. Finally, effective and innovative networking with promotional campaigns is needed to attract young researchers by improving the strength of the ECSs and YESS groups and their activities.

John Christian Nacpil reviewed his experiences during ICRC-CORDEX 2019, and felt that it is difficult for an undergraduate majoring in other fields like him to understand the terminology and concept of meteorology. The young scientist struggled to understand reports in the conference according to daily experience, but failed and suggested that it is necessary for climate scientists to share their work in less formal way which is familiar to the outsiders. During the Early Career Scientist event, he was impressed by the idea of climate services and bringing climate knowledge to the end-user. He thought the concentration on the end-user can help us recognize the effect of humans on climate change, which leads to the best applied science, rather than merely research for curiosity's sake.

In dealing with climate change, he thought that the advantage of young scientists is infinite possibilities in their future careers and horizons. It is important because the problem of climate change adaptation isn't simply a matter of getting the science right, but also of connecting and empathizing with other people, especially the marginalized who will be most impacted by the changing climate. Dealing with climate change needs to learn from other disciplines, such as physics, social sciences, psychology, economics, and so on. Young people can more readily dip their toes into different fields, which

equip them with interdisciplinary approaches that gear them towards new ideas.

Finally, he thanked APN for providing an opportunity to learn from other peers and creating the interest of climate science and science communication for him leading the direction of his career path. He would like to contribute to broadcast knowledge of climate model uncertainties and establish better end-user services. And he was glad and excited to learn from other younger generation in the future.

JC Albert Peralta went through his experiences during ICRC-CORDEX 2019, and said that the communication between scientists and the public need to be turned to an easily understood way. In addition, more projections and programs should focus on climate change to provide efficient climate information for local policymakers, particularly for climate-vulnerable countries like Philippines. However, the output of climate models shows strong uncertainties, which can be largely suppressed by regional climate model development and validation using novel observation methods. He suggested that more financing should be devoted to this field rather than other impact-driven or quick-profit projects to reap long-term rewards.

Furthermore, he thought the funding agencies should fund projects training young scientists with the skills of proper science communication and exhibition. It is different for a scientist when sharing works with society comparing with sharing works with peers. Giving advice for local politics and teaching scientific concepts for communities with appropriate expression are as important as giving a speech in a conference. Except for skill training of science communication, an alternative is to establish a specific science communication team dedicated to packaging scientists' research for communities and governments so that the scientists can concentrate on investigating scientific problems.

In the end, he felt very grateful to the CORDEX organizing committee for arranging a very fruitful conference and to APN for providing a grant which made his participation possible. He hoped to join again and contribute to the community in the future.

Ester Salimum reviewed his experiences during ICRC-CORDEX 2019, and felt very grateful to be chosen as one of the participants to give reflections and involved in the Q&A session during the CORDEX ESC event. He thought the ESC event is very interesting, informative, and useful for the young scientist to be alerted on the issues happening among CORDEX communities. In addition, the ESC event has been a great platform for all young scientists to share their knowledge, ideas, experiences to one specific topic about challenges from CORDEX data to information and users' reaction, which could gather as much as possible ways to face and solve this problem. Also, he emphasized that the ECS event provides valuable opportunities for young scientists to find new friends from other countries and start research collaboration, which is worth to continue and develop. Finally, he suggested that science studies should interact with the users and be benefit to the interactive groups, which would help us solve or reduce the challenges that we are facing nowadays.

Hazarat Bllal reviewed his experiences during ICRC-CORDEX 2019, and was honored and grateful for attending such a big venue and having an opportunity to learn from other experts in his field. In the conference, he discussed with other young people on various climate problems, including climate change, the limitations of climate models, and future models development. He said that the CORDEX ECS was a fantastic event to have a knowledge of YES community, ANSO and associated programs for early-career scientists.

Yanyan reviewed her experiences during ICRC-CORDEX 2019, and thought that the conference was an excellent attempt and high-level international event engaging scientists and users, particularly early career scientists. With support, the young generation was eager to attend this international event, present their work, build new partnerships and collaborations, and gain new experience and skill. In the conference, she attended all the lectures in Parallel Session B1 and gave her first presentation

entitled “Effects of Vegetation Fraction Variation on Regional Climate over Eastern China” in front of such a large audience. Yanyan was excited to communicate with so many young participants and share on-going work with the elite scientists. In the conference, she not only gained a lot of experience and achieved gratifying results, but also felt impressed by the ECS (early career scientist) event. Through expert reports and ECS thinking, the theme on the application of climate data in science and social development has attracted audience’s attention and led to interactive discussions of the challenges and opportunities in the future, as well as the responsibilities of young scientists. Finally, she said that the ICRC-CORDEX 2019 highlighted cooperation among young scientists which was different from other conferences and made it a fulfilling, creative and energetic experience.

WCRP

CORDEX

Coordinated Regional Climate Downscaling Experiment

14-18 OCTOBER 2019 BEIJING, CHINA

ICRC-CORDEX 2019

International Conference On Regional Climate



Picture source: CNCC

Report from the Early Career Scientist Event

SMHI

WCRP
World Climate Research Programme



Let's focus on the user: CORDEX datasets for climate projections and applications - an early career dialogue

International Conference for Regional Climate, CORDEX, 14-18 October, Beijing, China

'Users can motivate your work'. User interaction and the suitability of CORDEX data and information products to accommodate user needs were the main focus of the early career scientist event, during the CORDEX International Conference for Regional Climate 2019 (ICRC-CORDEX 2019). Challenges and opportunities were discussed through an expert presentation, short reflections by early career researchers, as well as an interactive dialogue with the audience.

Dr. Ailikun, an expert scientist on regional climate currently working at the Alliance of International Scientific Organisations in the Belt and Road Region (ANSO), presented her vision on ways forward to bring relevant regional climate science to society. The climate information shall be credible, salient and legitimate. This demands robust climate change data and information products. One important challenge to consider in the future would be to include a human component in regional climate models. To tailor climate information to users, Dr. Ailikun stressed that a co-production and co-design approach would be desired to better understand the user needs and work on a continuous iterative basis towards useful climate information to support mitigation and adaptation to climate change.

Four early career scientists presented their short reflections on challenges and opportunities on the application of CORDEX data and user interactions. Ester Salimun outlined that users could be made more aware of the available data and how to process it, as well as that open access to the data should be improved for IAV communities. Anubhav Choudhary and Dharendra Kumar jointly discussed to further ensure users understand the biases and uncertainties in the projections, as well as to become further aware of user needs in user-oriented workshops. Improved understanding of who the user exactly is, was highlighted by Miriam Murambadoro. She also elaborated on the need for continuous engagement and for the integration of participatory approaches in knowledge production.

An interactive dialogue between the audience and the presenters took place after the presentations. A wide range of topics were discussed. The discussion emphasized the need to engage in user interaction to further develop regional climate science and also highlighted the challenge to foster the next generation of early career scientists with a user-aware scope while retaining a scientifically solid disciplinary foundation. Notably, the need for capacity building and interactive platform for users of CORDEX products was also highlighted.

The early career event was an opportunity to share ideas and discuss ways forward among early career researchers on how to interact with the user and to explore the suitability of CORDEX data and information products to accommodate user needs. After the event drinks and bites were served to enable direct interaction between the early career scientists as well as between the more senior scientists present.

Organizers: Young Earth System Scientists Community (YESS) & CORDEX Organising Committee

Sponsors: WCRP, CORDEX, APN, NJU

Presentations by:

Dr. Ailikun – ANSO, Alliance of International Scientific Organisations in the Belt and Road Region.
Title presentation: ‘From CORDEX data to information and user interaction’

Ester Salimun - Ken Bangsaan University, Malaysia

Anubhav Choudhary - Karlsruhe Institute of Technology, Germany
& **Dhirendra Kumar** - Jawaharlal Nehru University, India (joint presentation)

Miriam Murambadoro - South African Weather Service, South-Africa

Moderators:

Gaby Langendijk - Climate Service Center Germany (GERICS), HZG, Germany

Victor Dike – Institute of Atmospheric Physics (IAP), CAS, China