

Change in thunderstorm activity in a projected warmer future climate over Bangladesh

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Summary of the research

- Introduction
- Objective
- Methodology
- Results and Discussion
- Conclusion

Introduction

- The severe thunderstorms associated with thunder squall, hail, tornado, and lightning cause extensive damage and losses to lives, especially in the densely populated sub-tropical countries like Bangladesh.
- Bangladesh Bureau of Statistics (BBS) indicated that thunderstorms, tornadoes and hailstorm have resulted in a total loss of 26710 million USD (14.5% of the total loss due to natural hazards) between 2009 and 2014.

Introduction

- Anthropogenic increases in Greenhouse gas (GHG) concentrations are expected to raise global mean temperature 2°C to 6°C by the end of this century (Trapp et al., 2007)
- With this greater warming, increase in atmospheric water vapor and a higher frequency of extreme precipitation events are expected.
- However, given the unique set of atmospheric conditions that foster thunderstorm development, it is not straightforward to assume that the extreme precipitation will also be accompanied with intense and frequent thunderstorms.
- None of the past studies focused on temporal and spatial variability of atmospheric instability and thunderstorm in Bangladesh due to global warming in the 21st century, thereby motivating this study.

Data

- Monthly Thunderstorm data has been taken (1979-2017) from **Bangladesh Meteorological Department**.
- ALL observed data (Four dimensional atmospheric variables at different pressure levels, CAPE and climate variables (convective precipitation) at surface level (1979-2017) has been taken from **European Centre for Medium-Range Weather Forecasts**.
- Climate data for 21st century (2006-2100) has been taken from **CMCC-CM (Centro Euro-Mediterraneo per Cambiamenti Climatici Climate Model)** datasets under RCP 8.5 from **CMIP5 portal**.
 - Four dimensional atmospheric variables at 17 different pressure levels

Methodology

- Convective available potential energy (CAPE) is a physical quantity that is used by the meteorologists to evaluate the potential for thunderstorm development and to issue severe-weather warnings.
- In this research a statistical thunderstorm prediction model has been developed based on observed CAPE and observed convective precipitation.
- Non-linear regression analysis was performed to develop this statistical model.
- For future thunderstorm prediction, future CAPE computation has been done by using Metpy.
- A bias between the observed (ERA interim) variables and the corresponding CMCC model derived CAPE was noticed for the historic period (1979-2005) .

Methodology

- Quantile mapping bias correction techniques has been applied for each of the variables to reduce bias.
- After the bias correction, future thunderstorm frequency for 21st century due to global warming is projected by using the bias corrected future CAPE and convective precipitation in the statistical model developed previously.

Results and Discussion

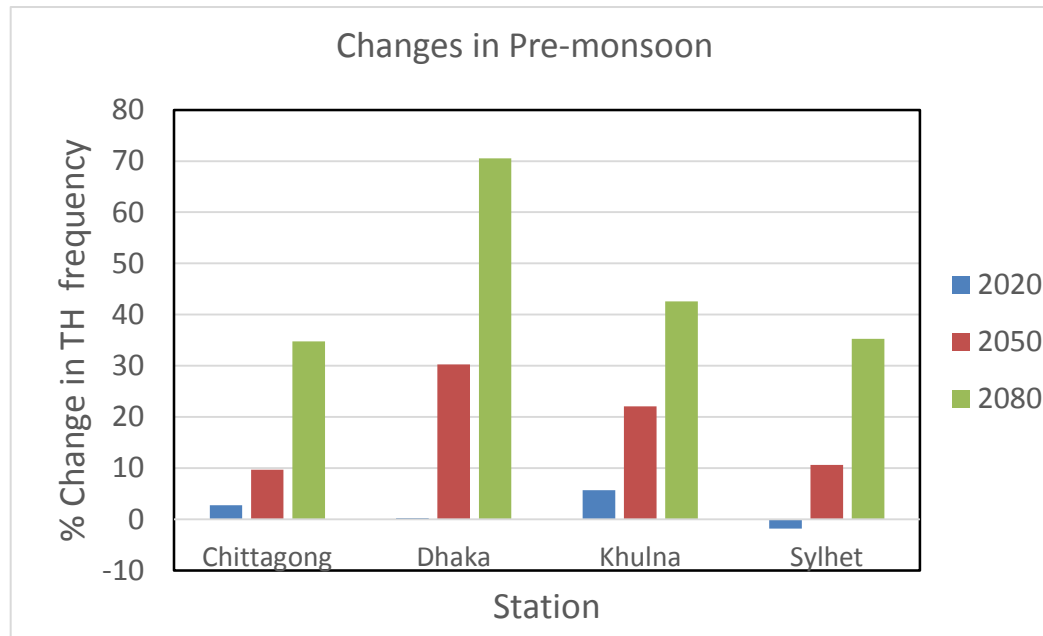
Seasonal and annual CAPE for future (2080s) and observed period (showed in bracket) in Bangladesh in major cities

	CAPE(Jkg-1)			
Seasons	Cities			
	Dhaka	Chittagong	Khulna	Sylhet
Pre-monsoon	2100 (1417)	1135 (1113)	2740 (1762)	1867 (1206)
Monsoon	1507 (783)	1143 (733)	2055 (1040)	1515 (617)
Post-monsoon	534 (292)	321 (338)	331 (256)	328 (277)
Winter	85 (59)	119 (54)	80 (68)	102 (71)
Annual	1138 (673)	798 (587)	1445 (840)	1052 (564)

- This results shows an increase in CAPE for the selected cities and in the range of 44% -106 %.

Results and Discussion

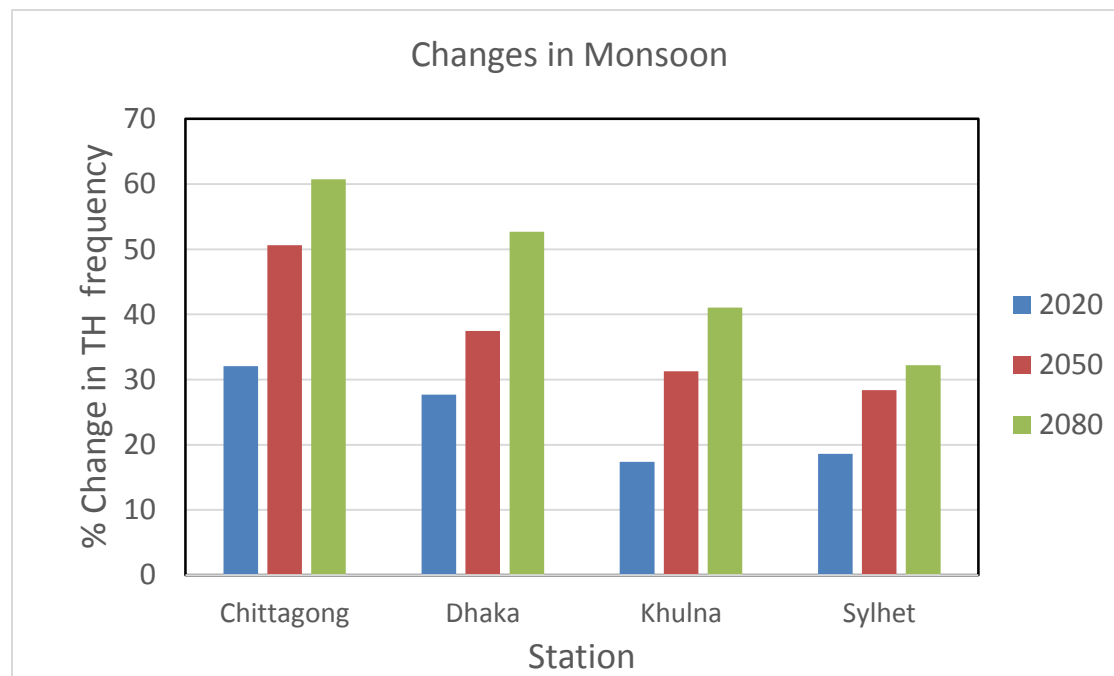
Seasonal Thunderstorm frequency change(%) for future period in Bangladesh



This results shows Dhaka has the highest thunderstorm frequency change in pre-monsoon among all the cities and more prone to thunderstorm.

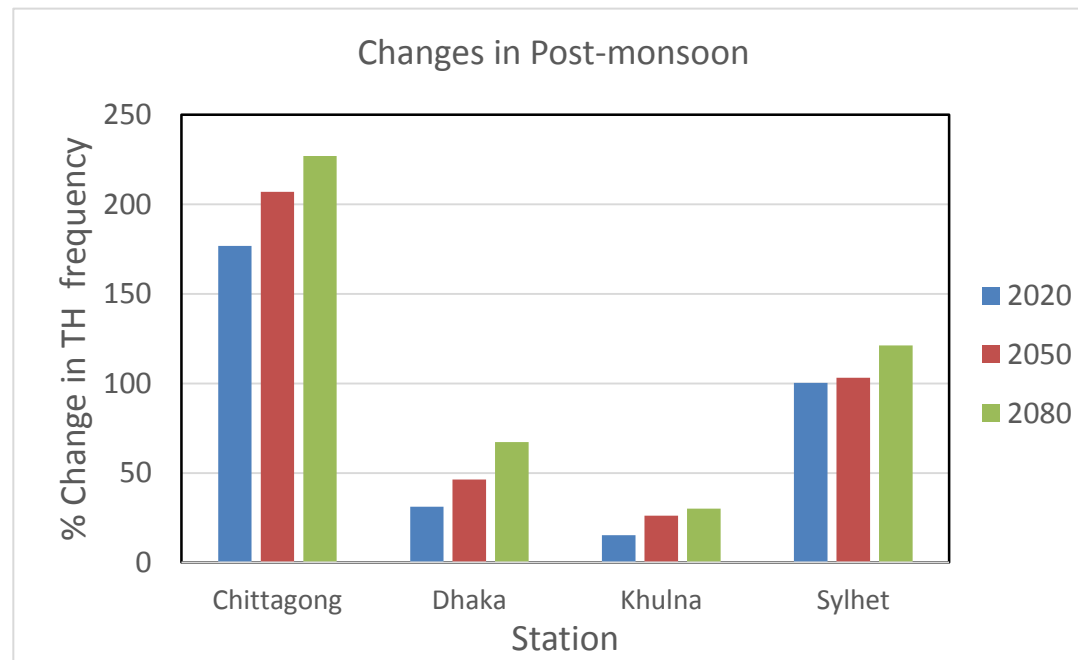
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Seasonal Thunderstorm frequency change(%) for future period in Bangladesh



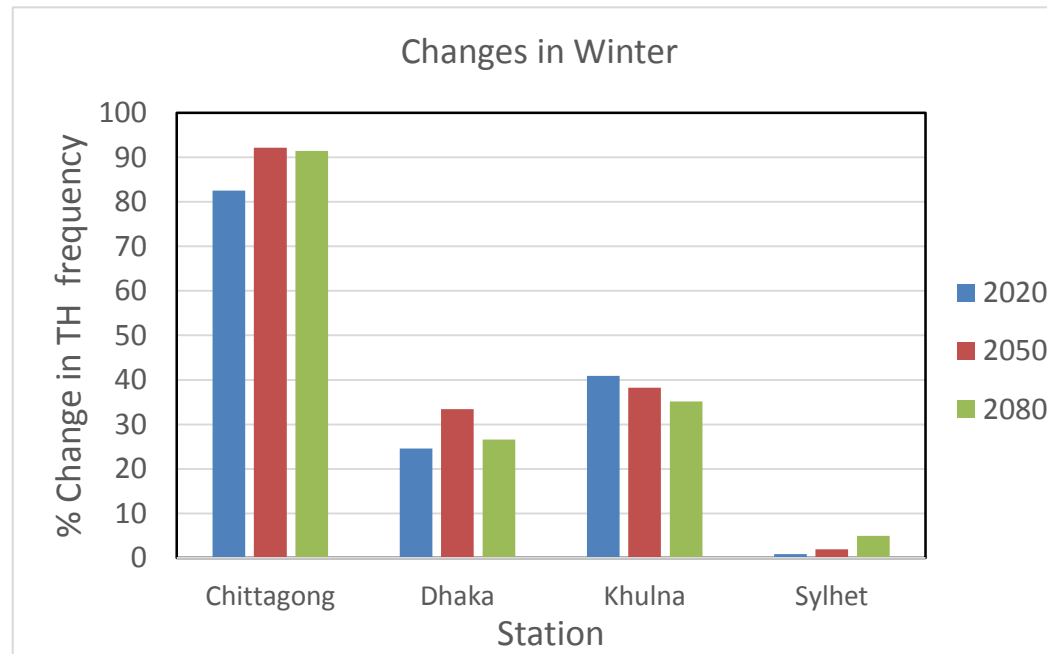
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Results and Discussion

Seasonal Thunderstorm frequency change(%) for future period in Bangladesh



Conclusion

- The projected seasonal change reveal that thunderstorm will increase by 35% to 71% in pre-monsoon and 32% to 61% in monsoon in 2080 among the selected cities.
- Results shows Dhaka has the highest thunderstorm frequency change in pre-monsoon among all the cities.
- Future thunderstorm depicts that Sylhet city will remain as the most vulnerable part in the country also in the 21st century.
- In summary, this study adds to the rising consensus that there will be more frequent thunderstorm in the coming decades due to increasing atmospheric instability due to increased moisture and CAPE in a warm future Bangladesh.
- Thus, the outcome of this study is expected to contribute to disaster preparedness, management and mitigation.

References

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