Long-term Trends and Variability of Rainfall Extremes in the Philippines

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MOTIVATION

Extreme precipitation events have been observed recently in many countries around the world. The Philippines, for example, has recently experienced extreme rainfall events that resulted to disasters. Since the series of reports given by the Intergovernmental Panel on Climate Change (IPCC) are projecting an increase in occurrence and/or intensity of climatic extremes due to global warming, it is important to investigate trends in extreme precipitation as well as identify the factors that influence their variability; so that adaptation strategy can be made in a disaster vulnerable country like the Philippines. Thus, this study investigates trends and variability in extreme precipitation indices by using historical rainfall data in the Philippines.

OBJECTIVES

1. To investigate temporal and spatial variability of extreme precipitation in the Philippines.
2. To identify long-term trends of extreme precipitation in the Philippines.

DATA AND METHODS

The data sets utilized in this study include:

1. Daily rainfall from PAGASA synoptic stations (Fig. 1)
2. SST data from UKMO (Rayner et al., 2003)
3. Wind and specific humidity from NCEP/NCAR reanalysis (Kalnay et al., 1996)
4. OLR from NOAA (Liebmann and Smith, 1996)

METHODS:

The steps taken to address our objectives are illustrated in Fig. 2.

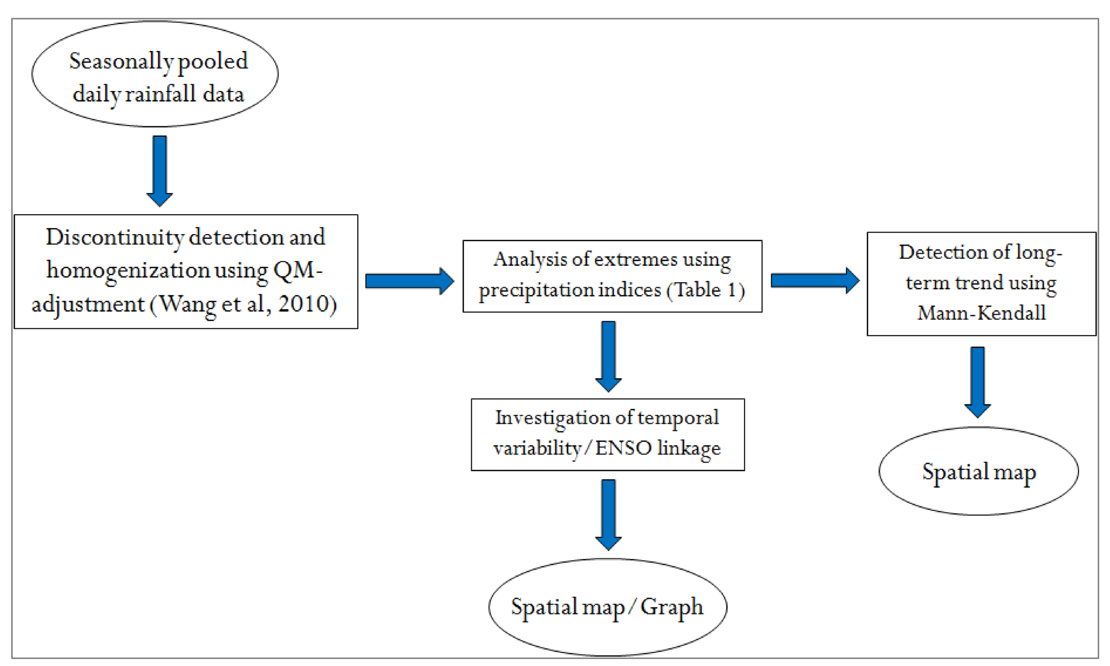


Fig. 2. Flow chart illustration of methodology.

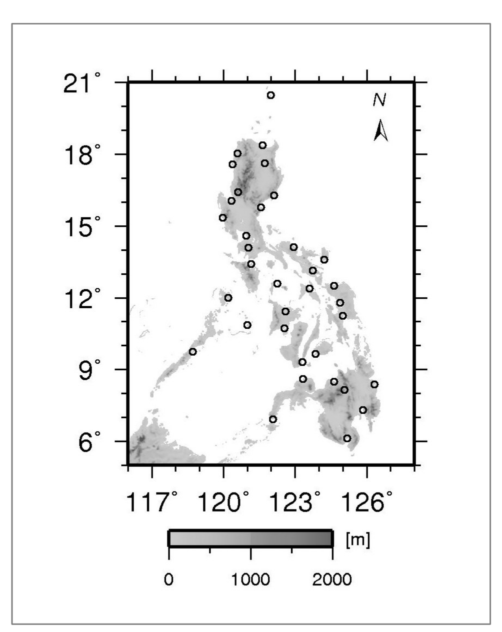


Fig. 1. Geographical distribution of gauge stations used in this study.

Table 1. Extreme precipitation indices and their definitions.

Index (acronym)	Definitions	Units
p95	95th percentile of wet days	mm/day
Rx1D	Maximum 1-day rainfall	mm/day
Rx5D	Maximum consecutive 5-day total rainfall	mm
ptot	Seasonal wet days' total rainfall	mm
p95D	Count of days exceeding the base period's p95	day
WSDx	Longest wet spell duration*	day
DSDx	Longest dry spell duration**	day

* wet spell refers to consecutive days with rainfall ≥ base period's mean daily rainfall

** dry spell refers to consecutive days with rainfall < base period's mean daily rainfall

RESULTS

ENSO influence on extreme precipitation variability:

❖ ENSO influence is well pronounced during OND but not during JAS (Fig. 3)

❖ ENSO and Rx5D are negatively correlated and show significant common power during mid-1960s to 1990 at the 2-6 year band, 2-4 year band during the late '90s and 10-15 year band from mid-'70s to 1990 (Fig. 4).

❖ El Niño (La Niña) composite is characterized with westerly (easterly) wind anomalies associated with moisture surplus (deficit) favorable (unfavorable) for convective activity over the vicinity of the Philippines during JAS while the opposite characteristic during OND (Fig. 5).

Long-term trends:

❖ Significant increasing trend in Rx5D over the central and northwestern section of the Philippines is observed during JAS (Fig. 6a).

❖ Decreasing trend is observed at most stations in the central and southern parts of the country during OND (Fig. 6b).

❖ There are mixtures of significant increasing and decreasing trends in the extreme precipitation indices (Fig. 7).

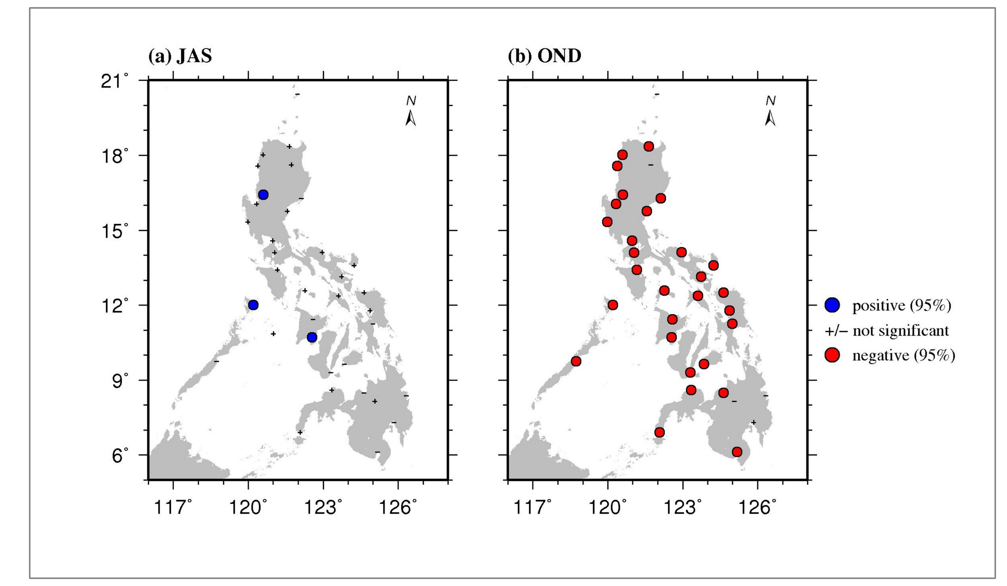


Fig. 3. Rank correlation (Kendall's τ) between the Niño 3.4 index (DJF) and the Rx5D during (a) JAS and (b) OND.

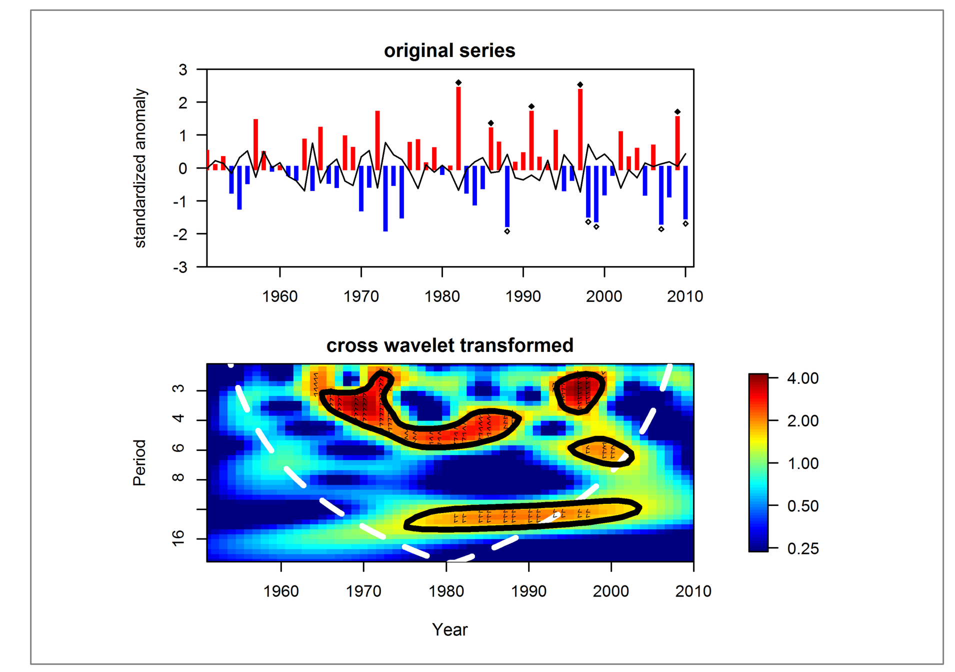


Fig. 4. Time series of Rx5D during OND (taken as the mean standardized anomaly of the 35 stations; solid line, upper panel), standardized Niño 3.4 index (bars, upper panel) and their transformed cross wavelet (lower panel).

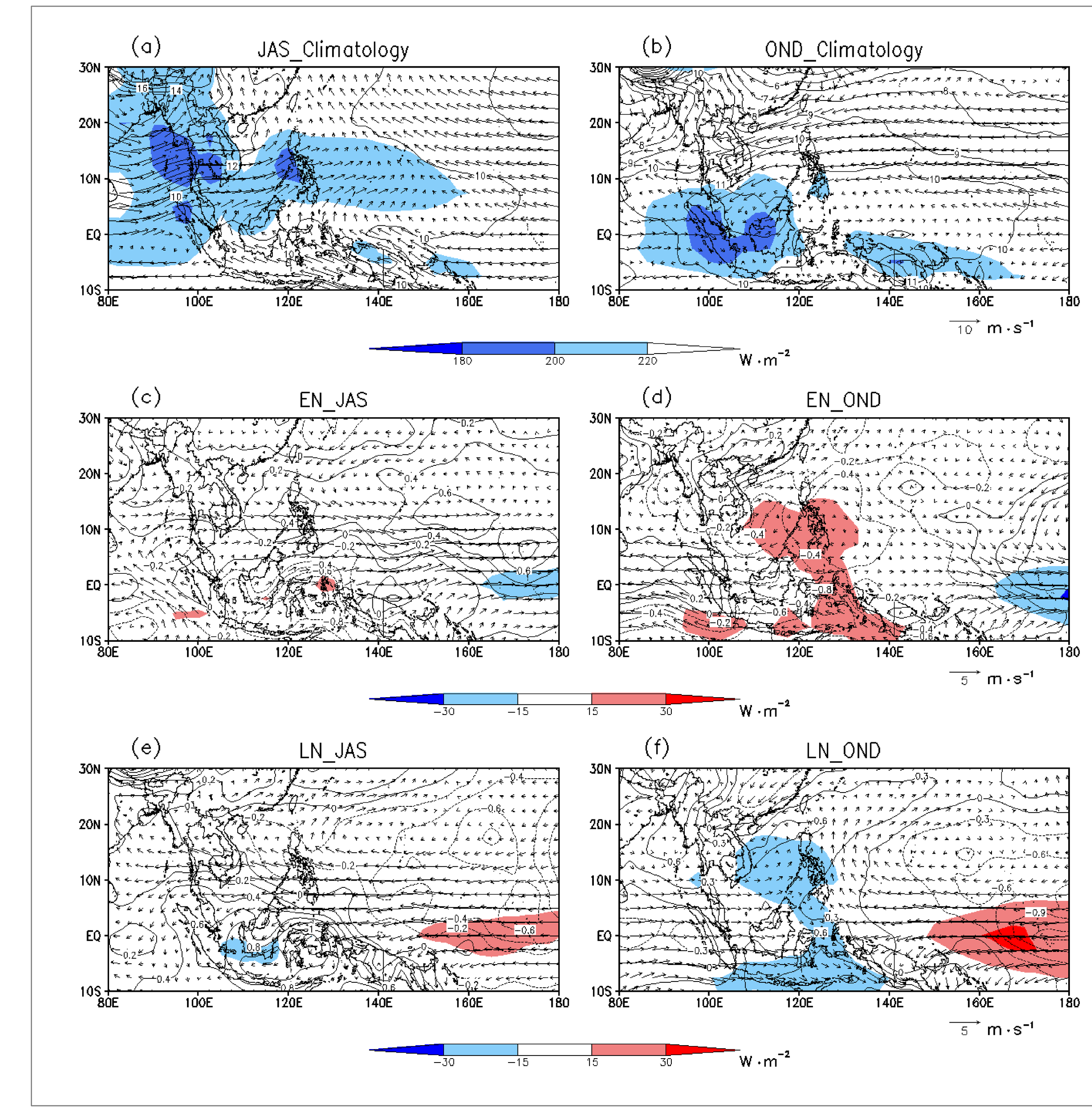


Fig. 5. Large-scale atmospheric conditions during JAS and OND climatology (taken as the 1975-2010 mean value, upper panels), composite anomalies during El Niño (middle panels) and La Niña (lower panels). Five El Niño and La Niña years are marked with solid and open diamonds, respectively in Fig. 4. Contours denote specific humidity at 850 hPa, unit is g/kg; vectors are 850 hPa wind and shadings are outgoing longwave radiation.

Fig. 6. Long-term trends (1951-2010) in maximum 5-day rainfall during (a) JAS and (b) OND.

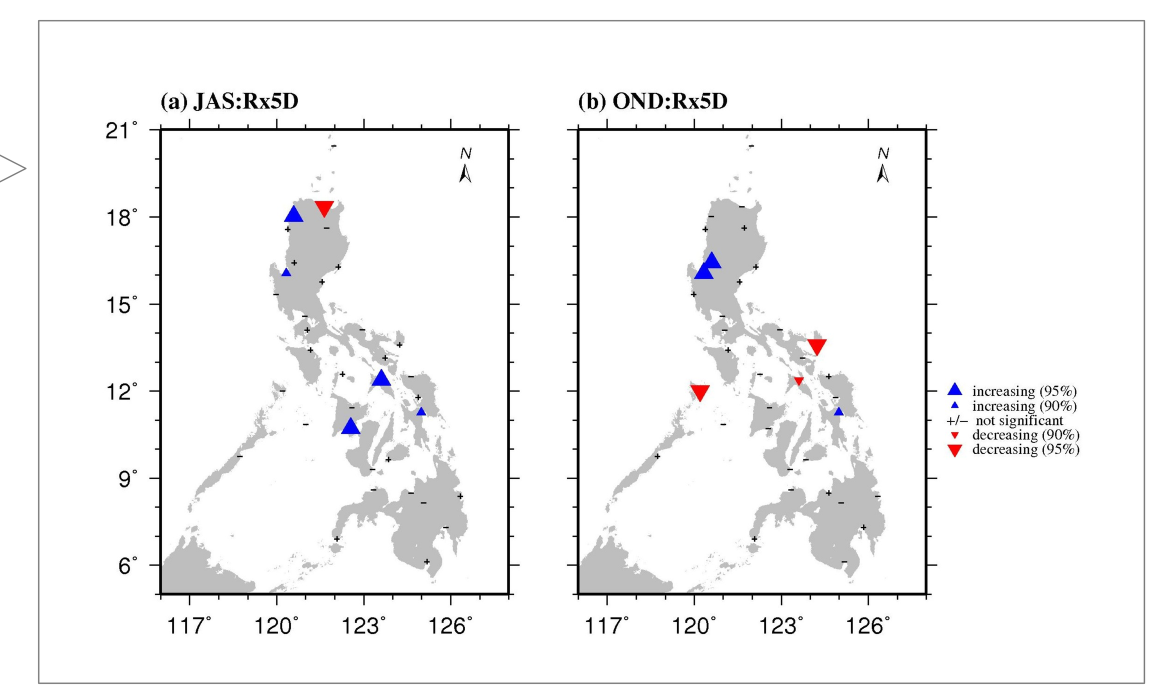
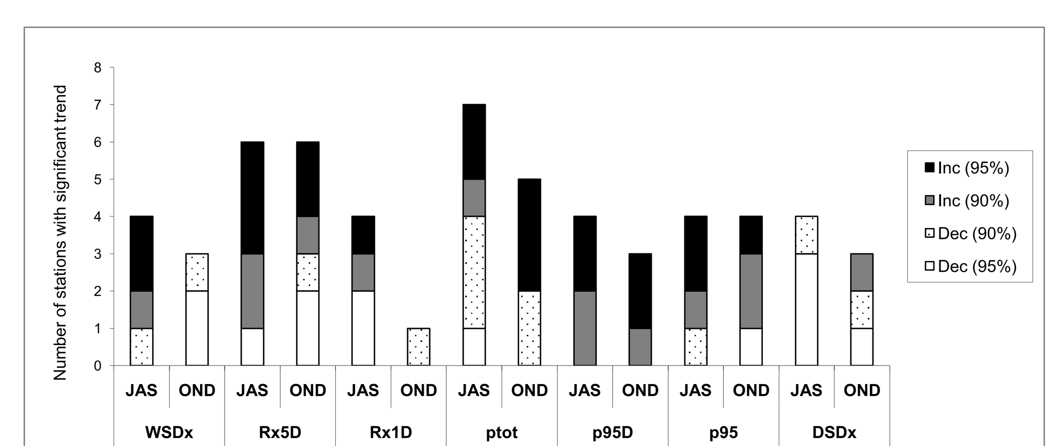


Fig. 7. Number of stations with significant trends in all of the indices during JAS and OND.



CONCLUSIONS

❖ Extreme precipitations' response to ENSO showed opposite signs during JAS and OND.

❖ Interannual and interdecadal variation of extreme precipitation in the Philippines is linked to ENSO.

❖ Trends in extreme precipitation indices denote a wetter (drier) condition during JAS (OND).

❖ Found trends are spatially incoherent with mixtures of positive and negative signs.

ACKNOWLEDGMENT

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