Assessing the Risk of Floods in a Warming Globe

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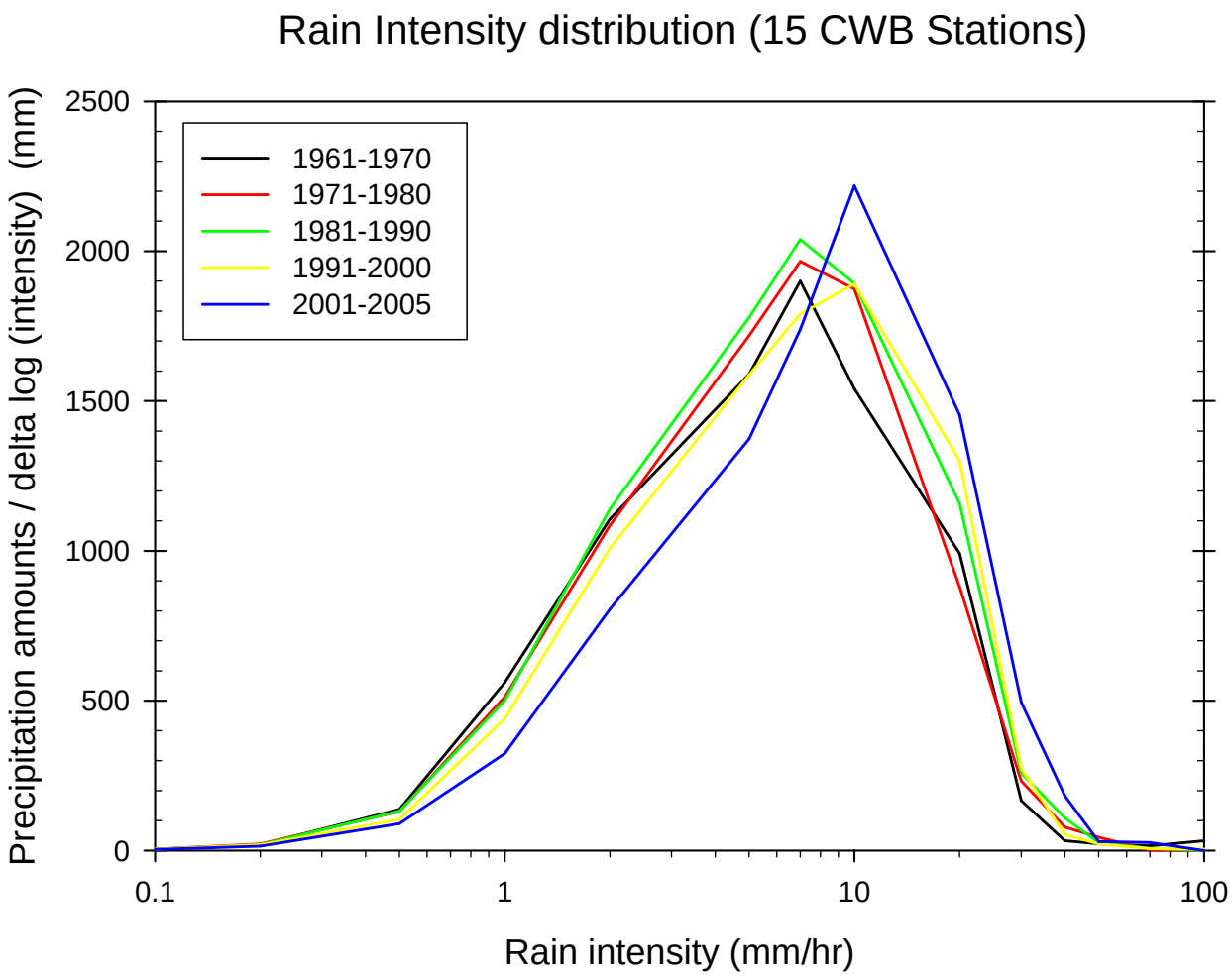
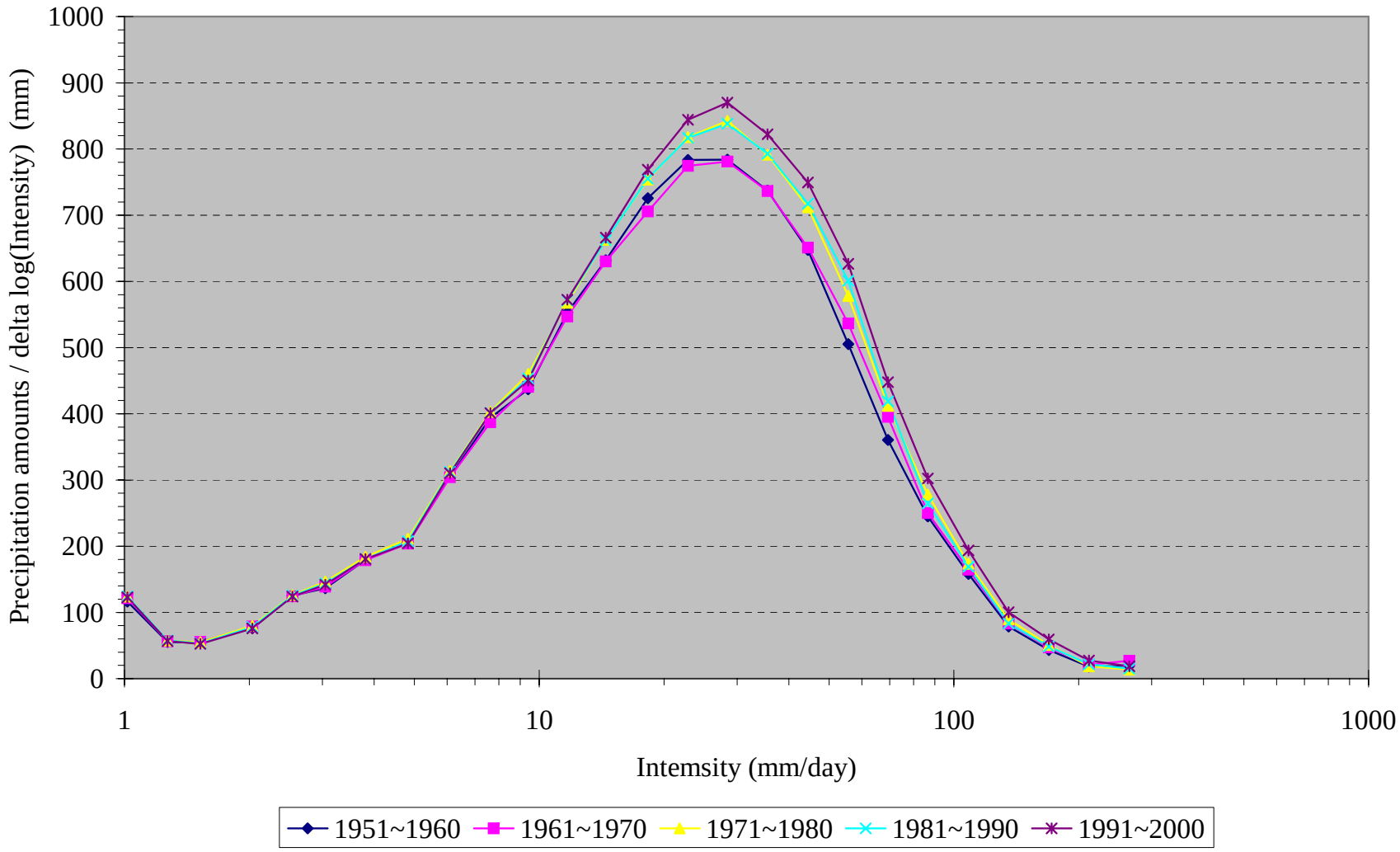
- With rising global temperature, increasing trends in heavy precipitation, and sometimes with decreasing trends in light precipitation have been reported in recent years over most land areas as well as the tropical oceans.


Rain Intensity distribution (15 CWB Stations)
Precipitation amounts / delta log (intensity) (mm)
2500
2000
1500
1000
500
0
0.1
1
10
100
Rain intensity (mm/hr)
1961-1970
1971-1980
1981-1990
1991-2000
2001-2005

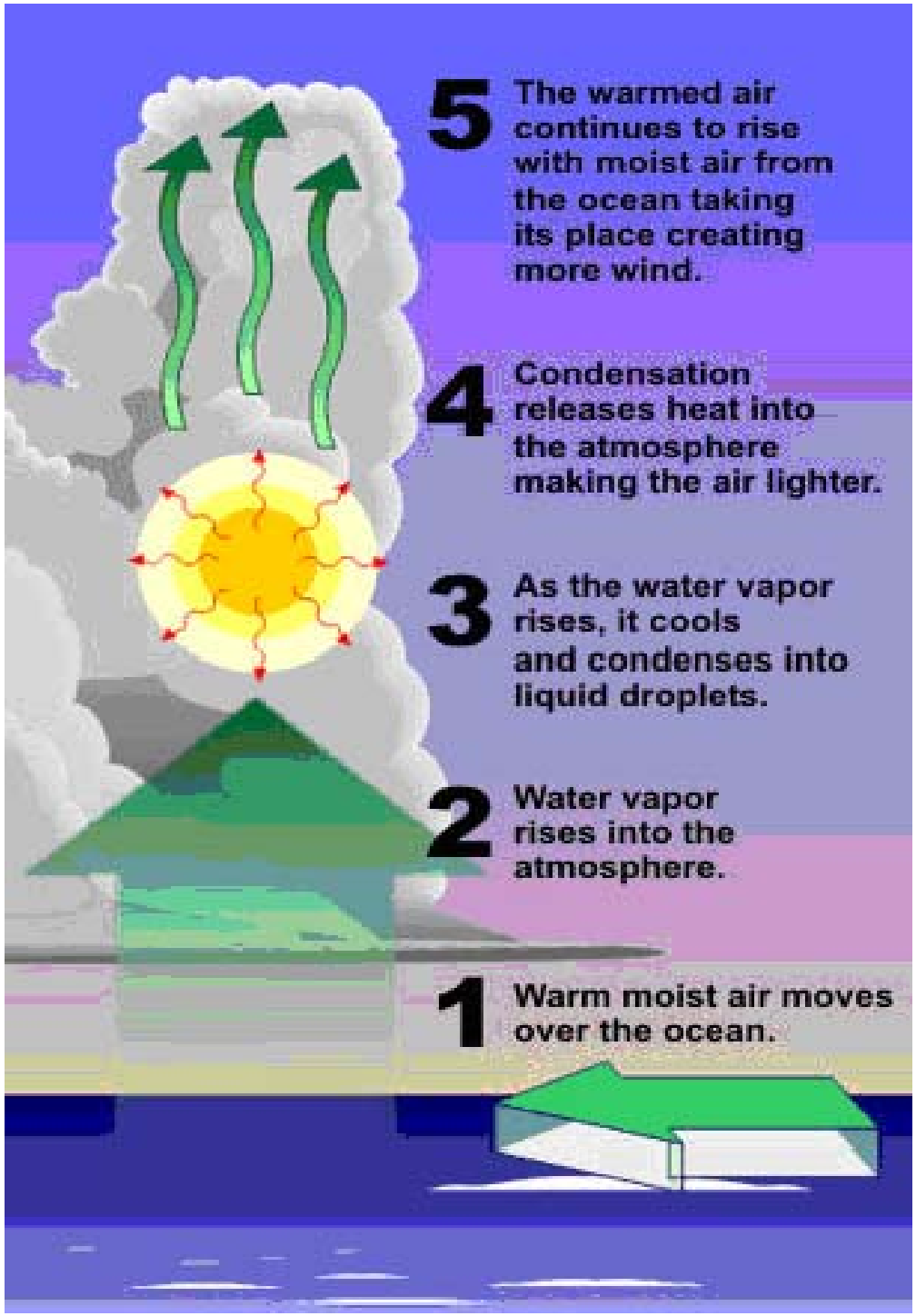
Changes of Precipitation Spectra

US (48 states)



Theoretical Basis for Changes in Precipitation Intensity

- In a global warming environment, Trenberth et al. (2003) theorized that the precipitation intensity should exceed the 7%/K moisture increase rate estimated by the Clausius-Clapeyron equation, because the additional latent heat released from the increased moisture could invigorate the storms.
- The increased latent heat release will increase atmospheric stability. So light and moderate precipitation should decrease with global temperature.



Convection that Powers Tropical Cyclones (National Weather Service)

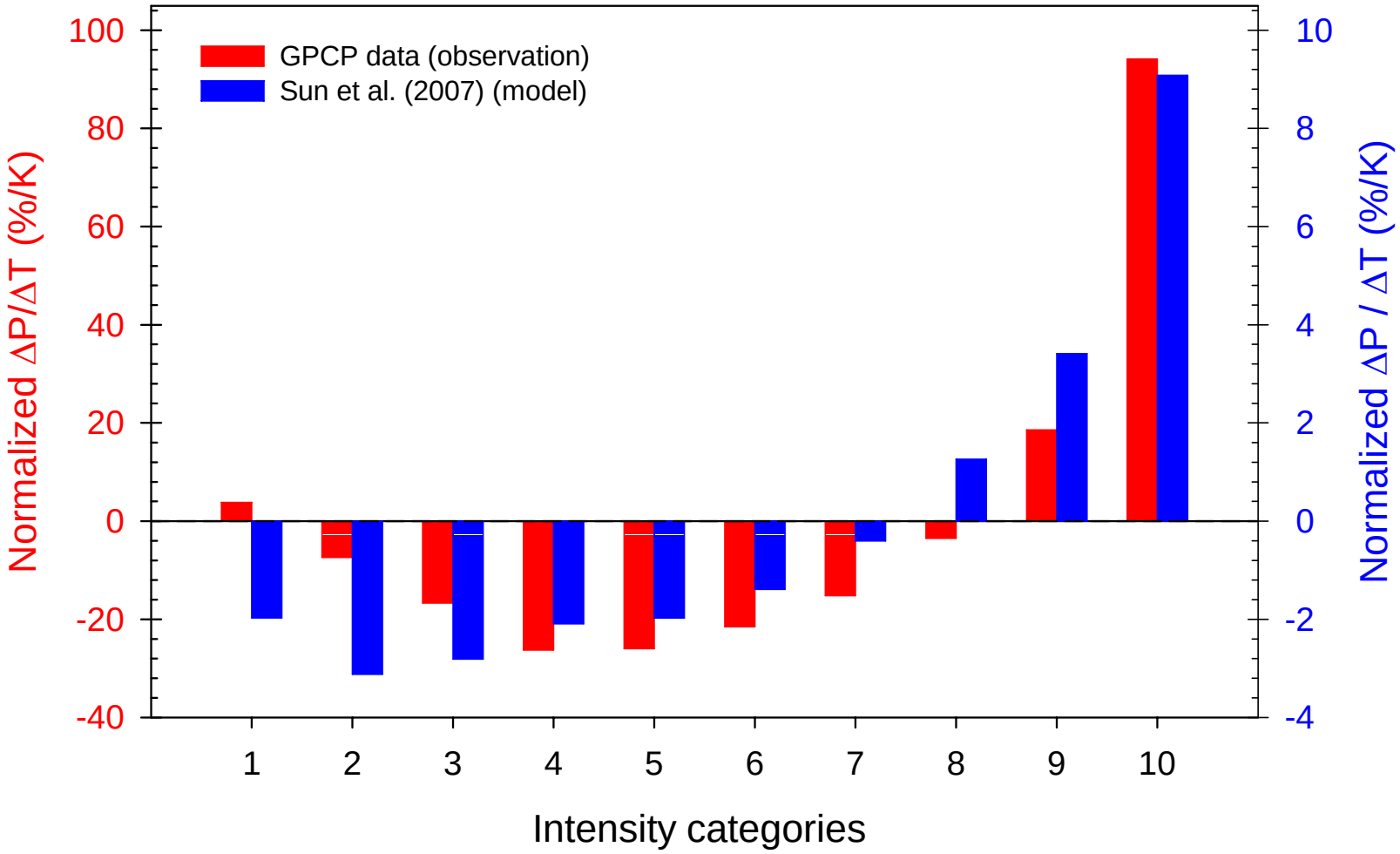
We found a quantitative link between observed changes in precipitation extremes and global warming in 2009.

Temperature dependence of global precipitation extremes

Liu, S.C., Congbin Fu, C-J Shiu, J-P Chen, and Futing Wu

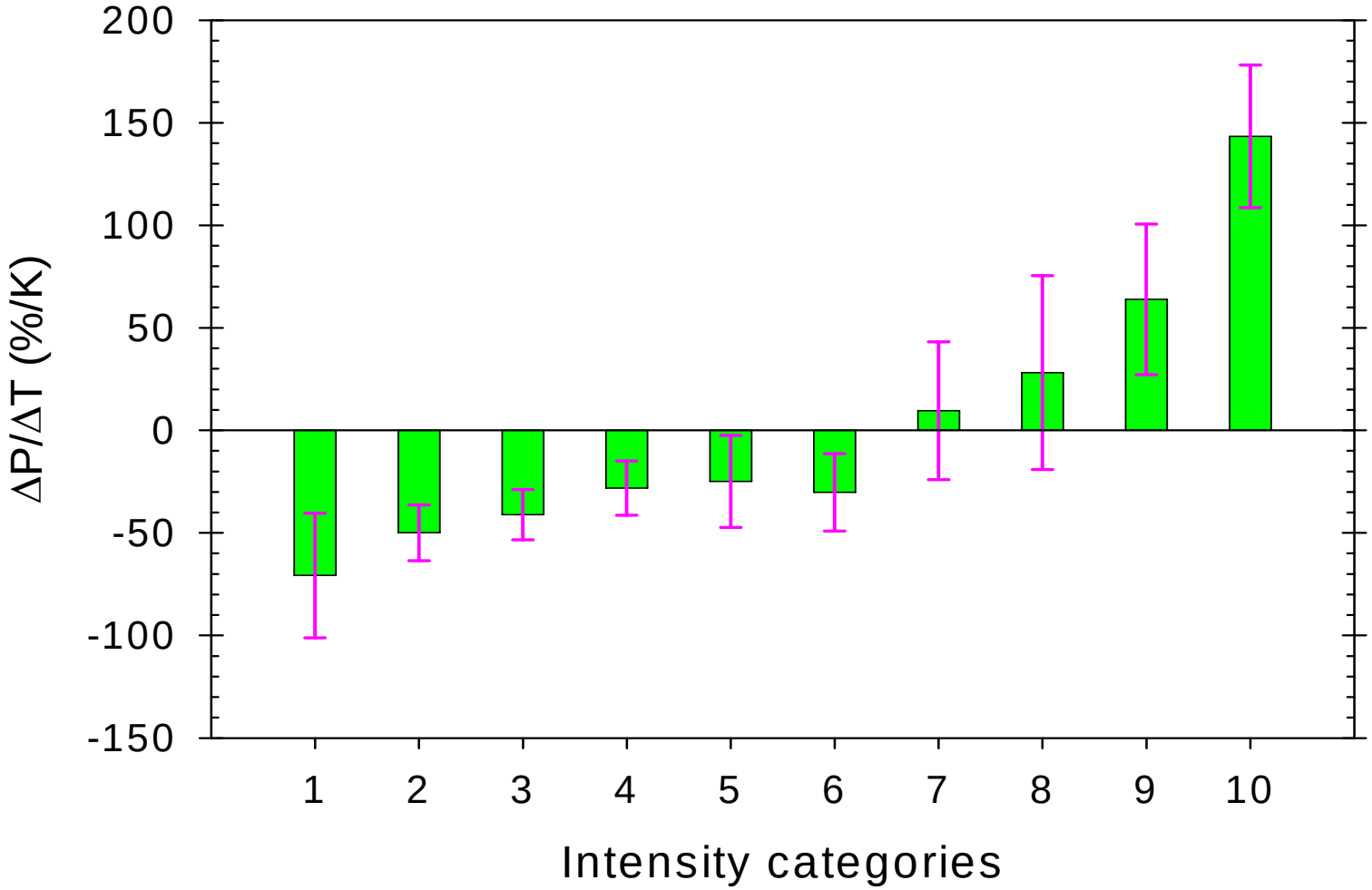
Geophysical Research Letters, 36, L17702, doi:10.1029/2009GL040218, 2009

Changes in global precipitation intensity derived from observations (red) compared to results from an ensemble of 11 coupled climate models (blue)

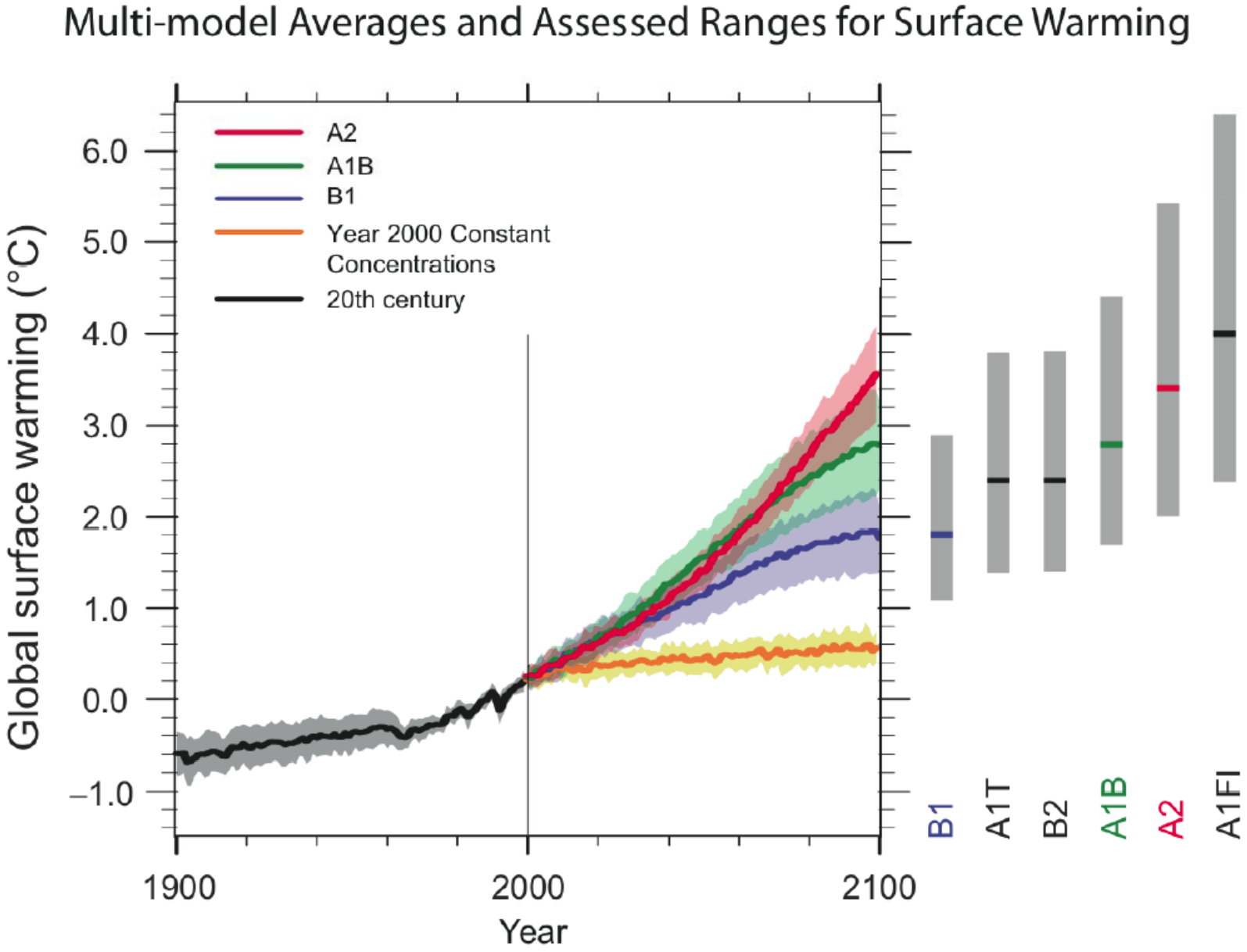


From Liu et al. (2009)

Changes in Taiwan's rain intensity (mm/hr) for each degree warming in global temperature



From Liu et al. (2009)


Multi-model Averages and Assessed Ranges for Surface Warming
Global surface warming (°C)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
–1.0
1900
2000
2100
Year
A2
A1B
B1
Year 2000 Constant Concentrations
20th century
B1
A1T
B2
A1B
A2
A1FI

Research Approaches

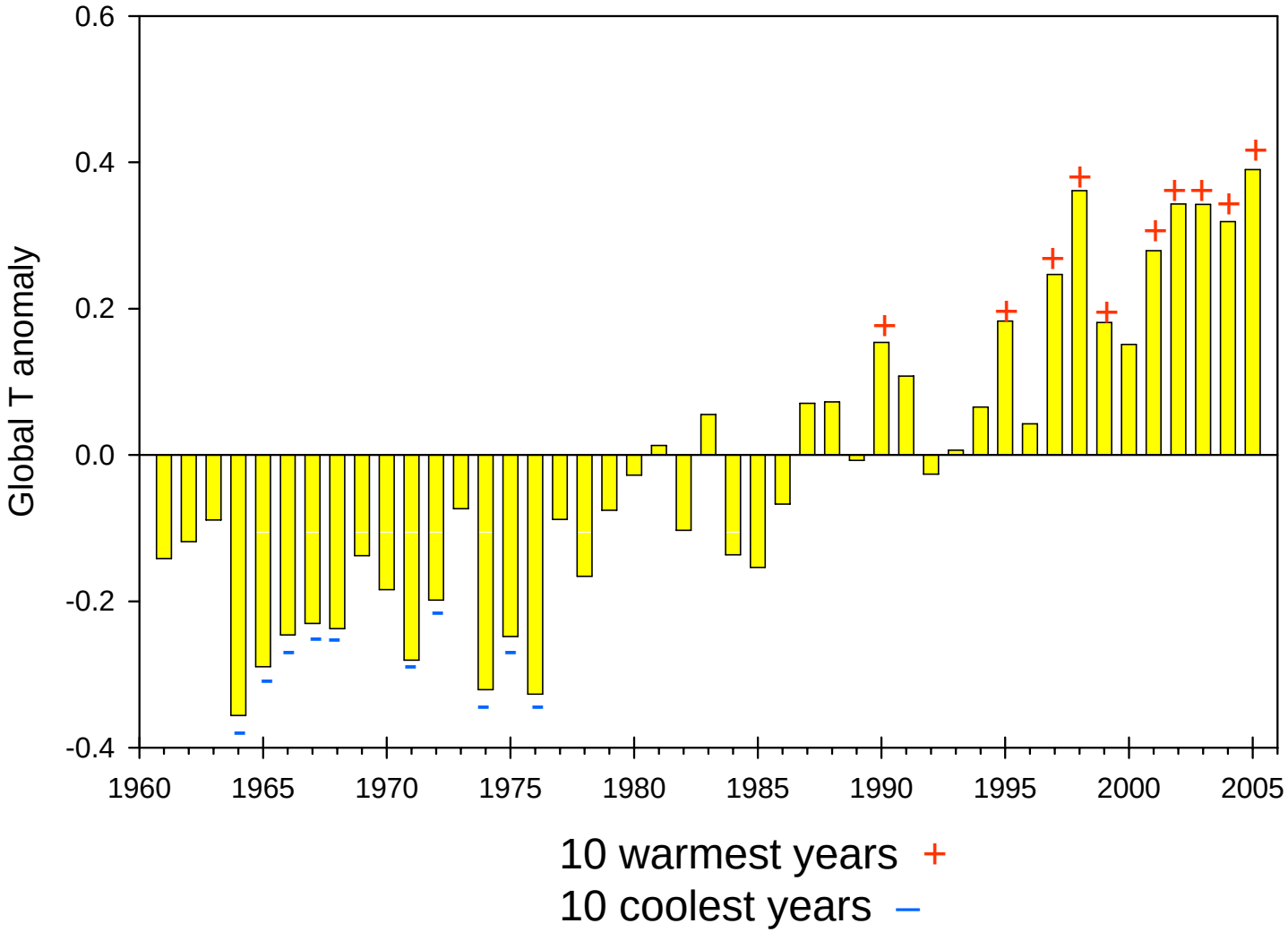
(A) Empirical projection

Analyze existing climate change data; develop empirical projection methods; use the results as model constraints for evaluating and improving climate models

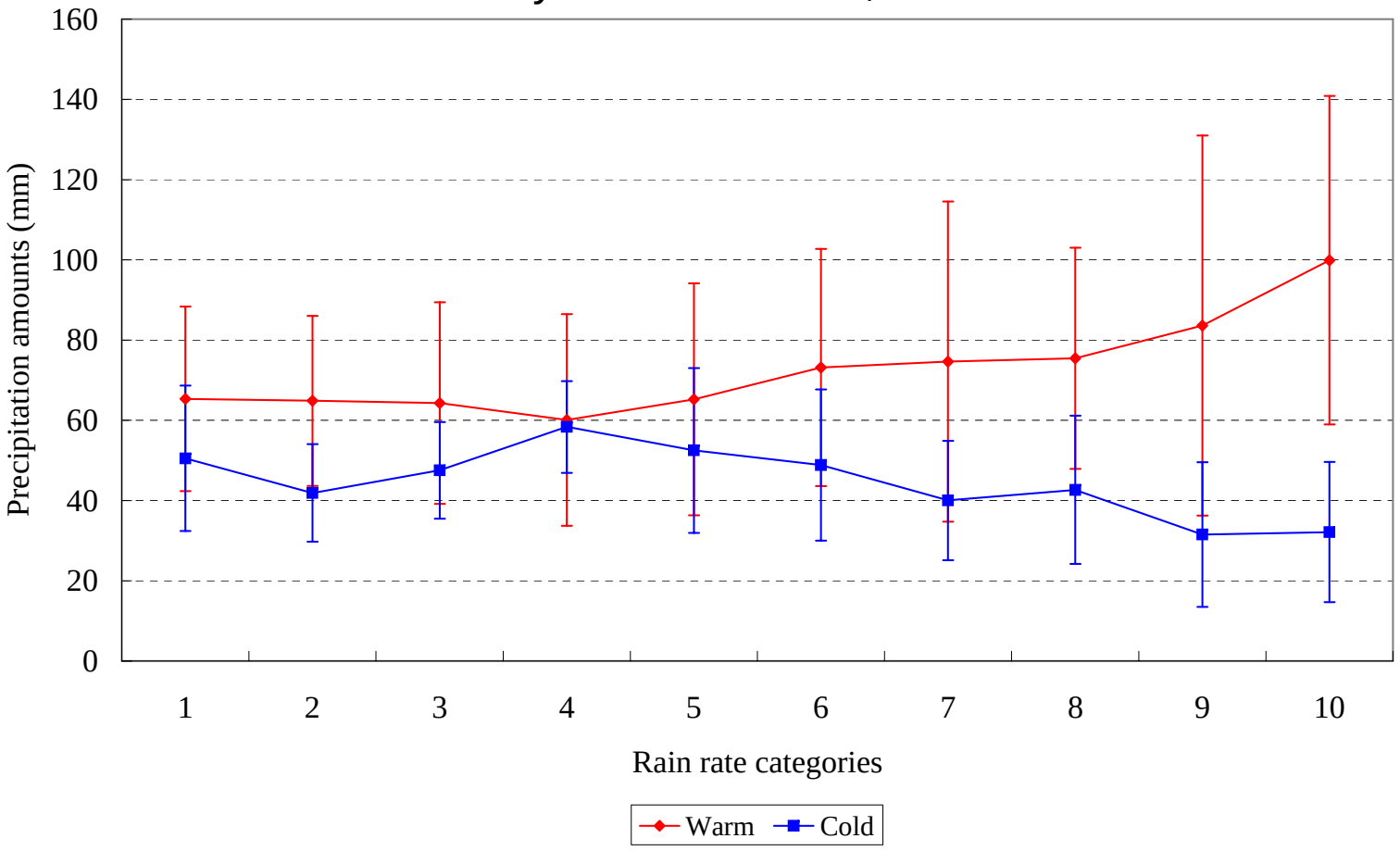
(B) Climate modeling

Develop climate models; evaluate and improve the climate models by comparing to observed climate changes.

Global Temperature Anomaly 1961 - 2005

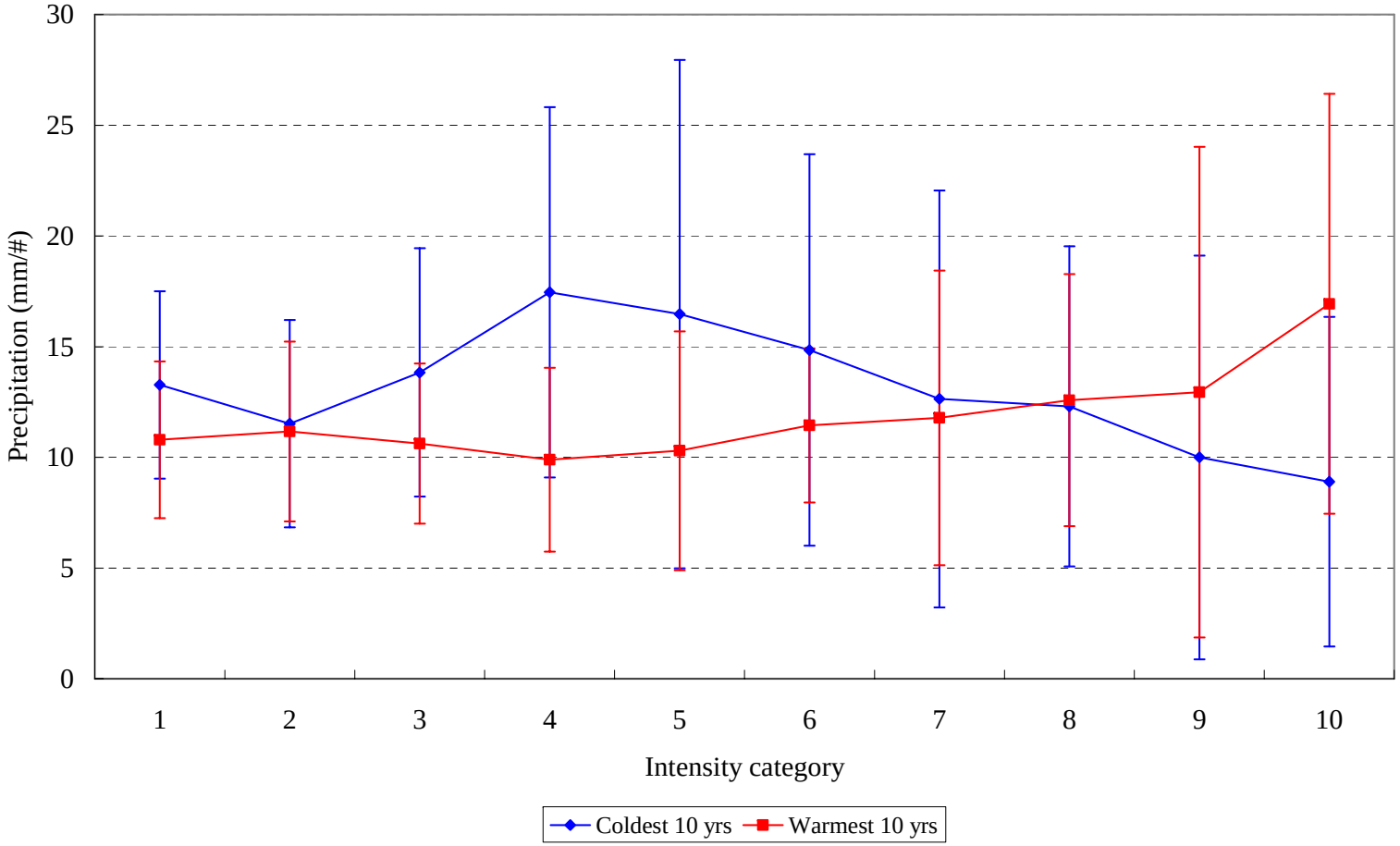


Rain intensity of typhoons landed in Taiwan
15 CWB stations (in mm/hr)
Warm years: 728.2 mm , # = 5.9
Cold years: 445.9 mm, # = 3.3



	1	2	3	4	5	6	7	8	9	10
P-values	0.2670	0.0474	0.1905	0.8921	0.4279	0.1341	0.0826	0.0382	0.0326	0.0029

15 CWB stations (in mm/hr)
Composite according to global T
Typhoon



Precipitation amounts of each category of each year normalized by its typhoon numbers

Thank you for your attention!