Extreme Precipitation and Climate Change

Shaw Chen Liu
Research Center for Environmental Change
Academia Sinica, Taipei

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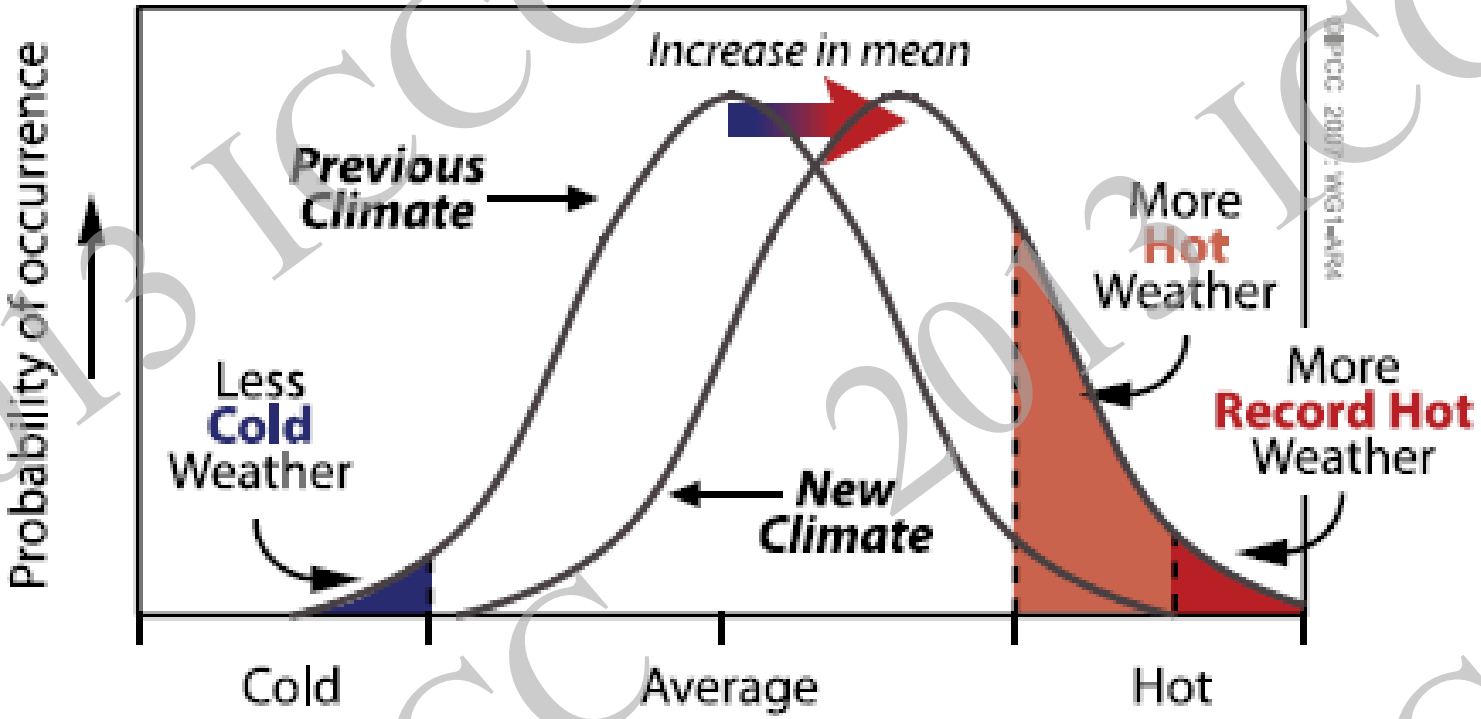
- Increases in very heavy precipitation, and sometimes with decreases in light precipitation have been reported in recent years over most land areas (e.g. Karl & Knight, 1998; Liu et al., 2005; Goswami et al., 2006) as well as the tropical oceans (Lau and Wu, 2007).
- Increases in heavy precipitation can lead to more and worse floods and mudslides.
- Light and moderate precipitation is a critical source of soil moisture, its reduction increases the risk of droughts.

How should precipitation intensity change in a warming globe?

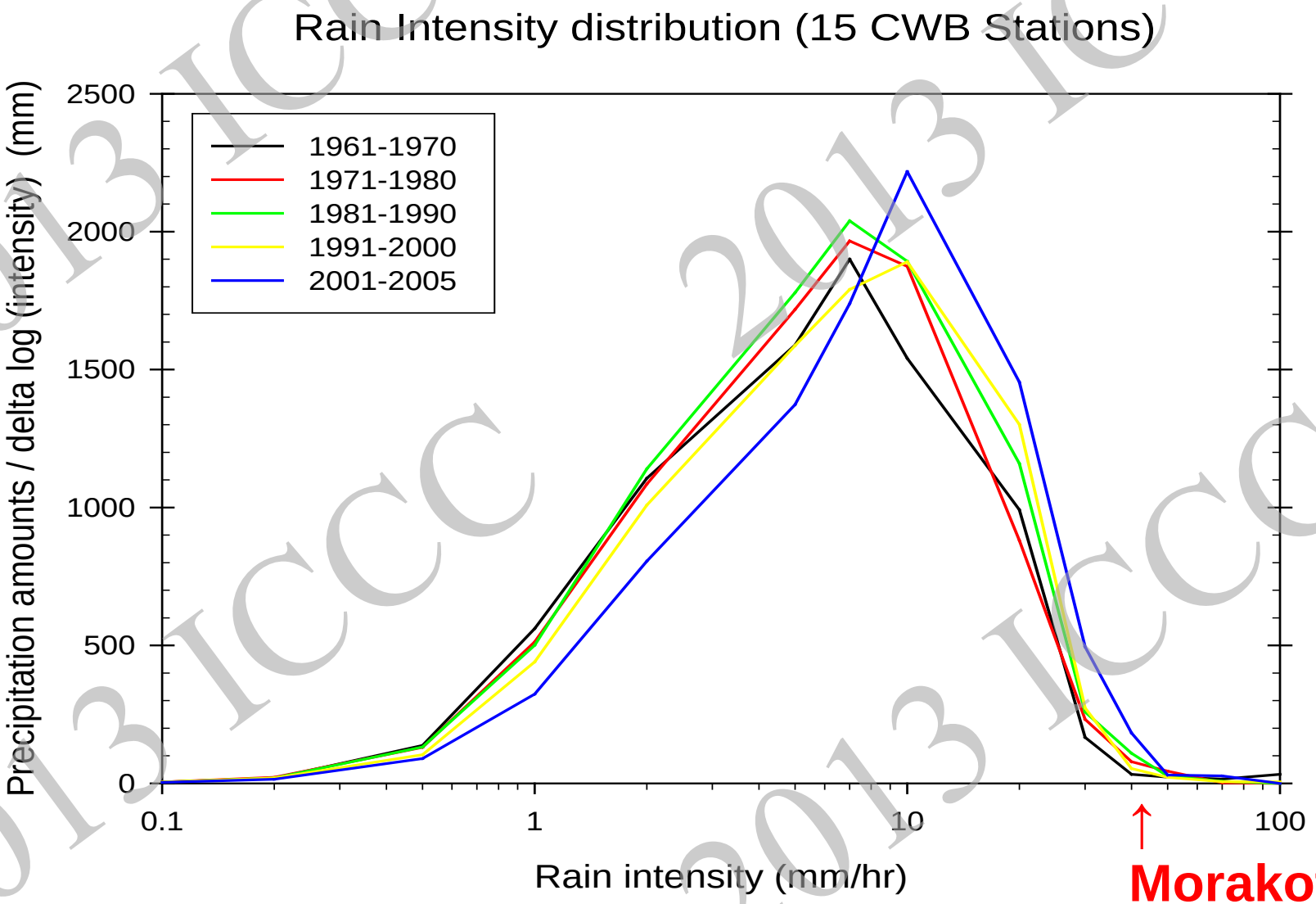
- Trenberth et al. (2003) hypothesized that the precipitation intensity should increase at about the same rate as atmospheric moisture, i.e. about 7%/K according to the Clausius-Clapeyron equation, because precipitation rates from storms were determined by low-level moisture convergence.
- Furthermore, they argued that the increase of heavy rainfalls could even exceed the moisture increase because additional latent heat released from the increased water vapor could feed back and invigorate the storms.
- Since large storms in the tropics are a major process transporting heat from the boundary layer to the upper troposphere, the invigorated storms can increase the stability of the atmosphere, thereby suppressing light and moderate precipitation.



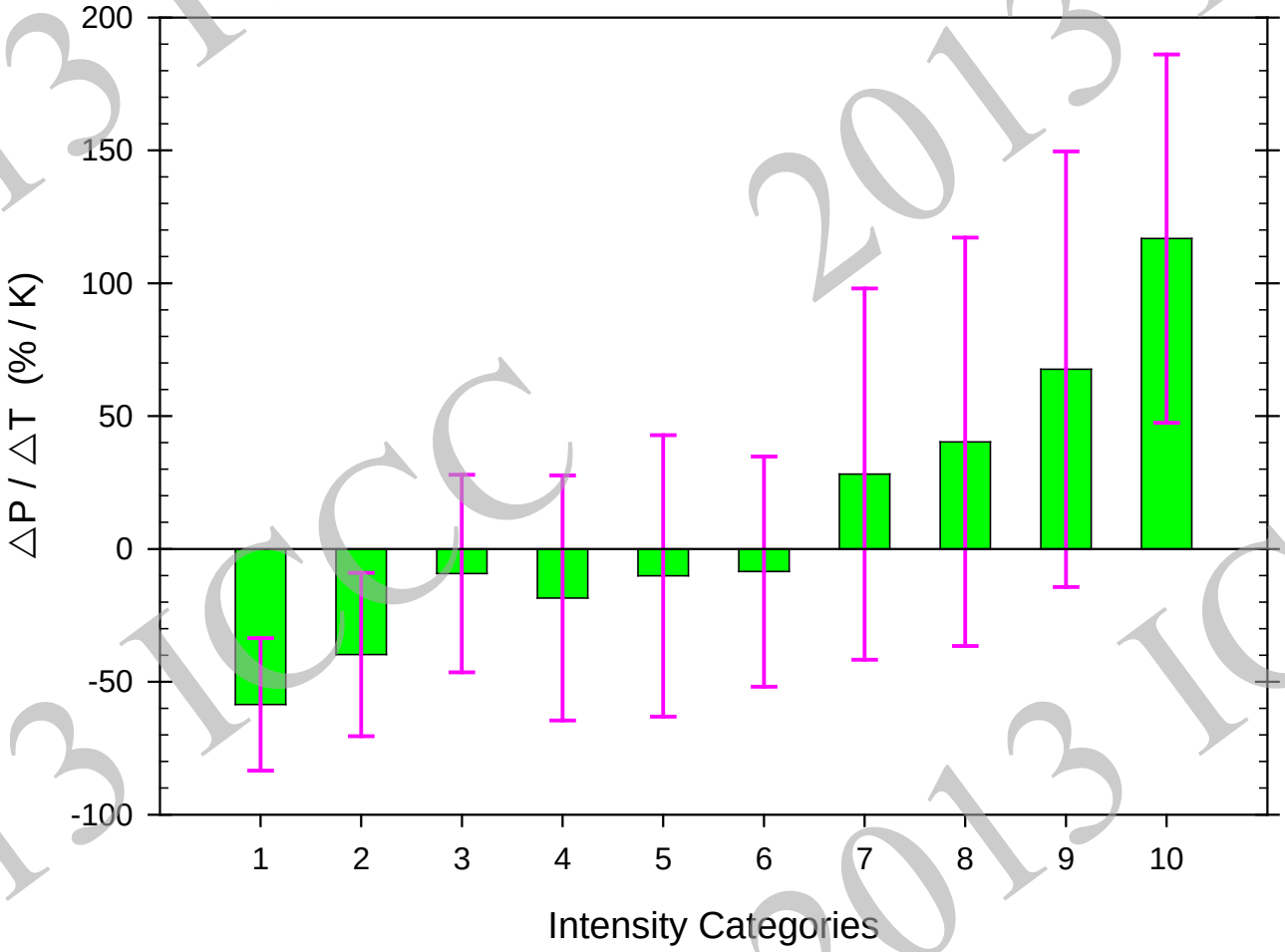
Box TS.5, Figure 1. *Schematic showing the effect on extreme temperatures when the mean temperature increases, for a normal temperature distribution.*

From IPCC2007

Rain intensity distribution averaged over every ten years (1961-2005)

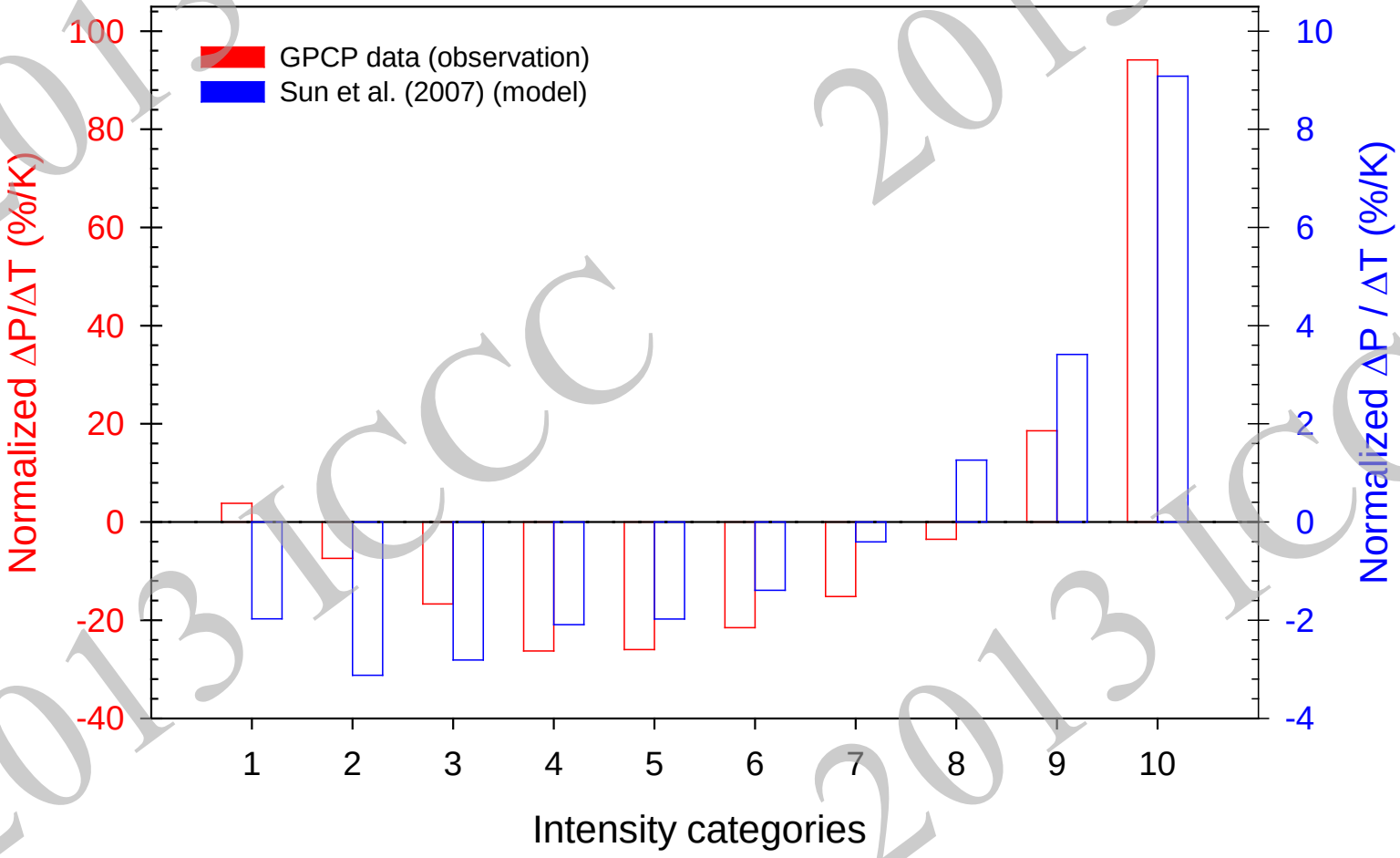


中央氣象局15站資料 1961~2011

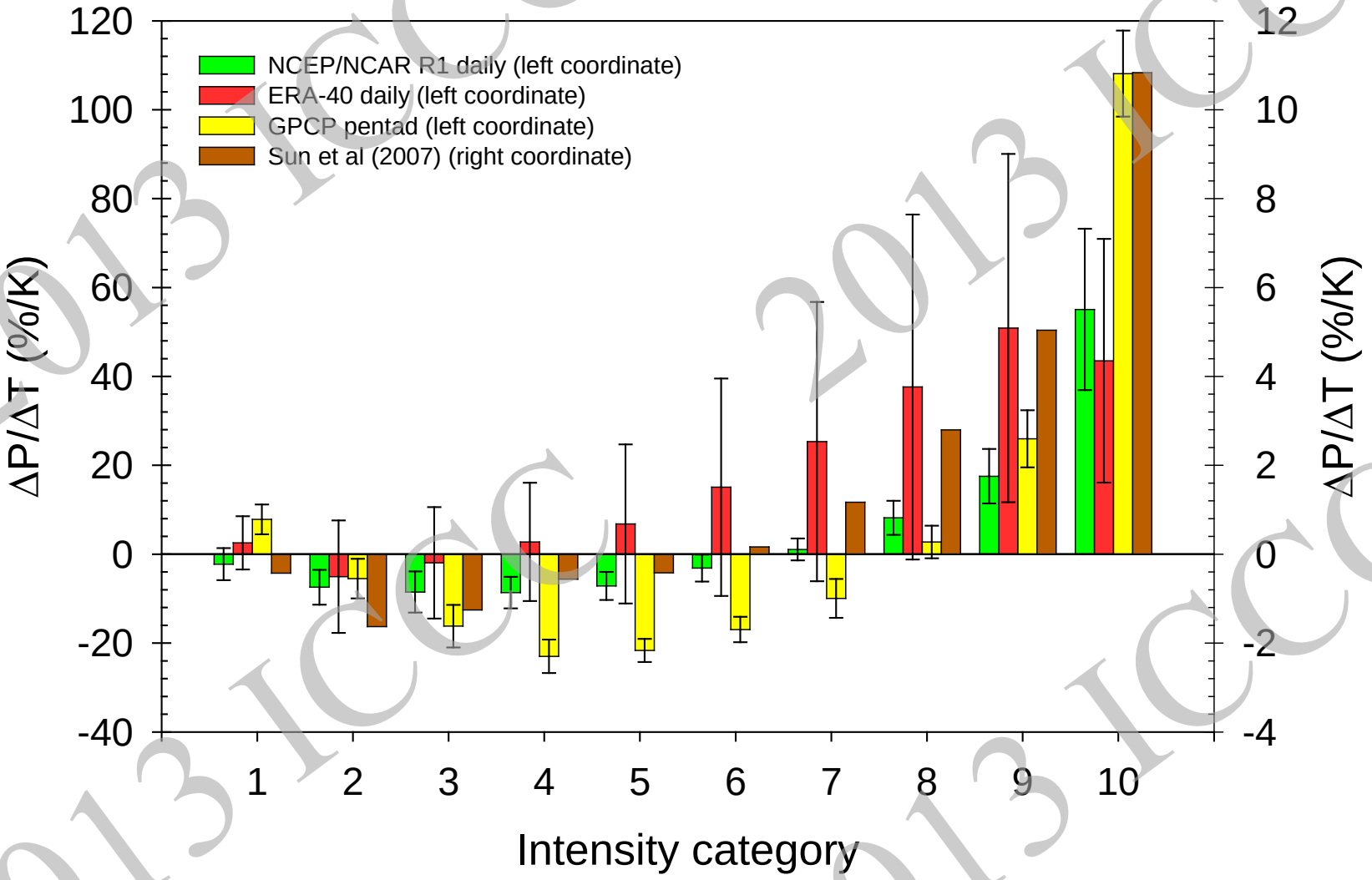


2012.12

From Liu et al. (GRL, 2009)

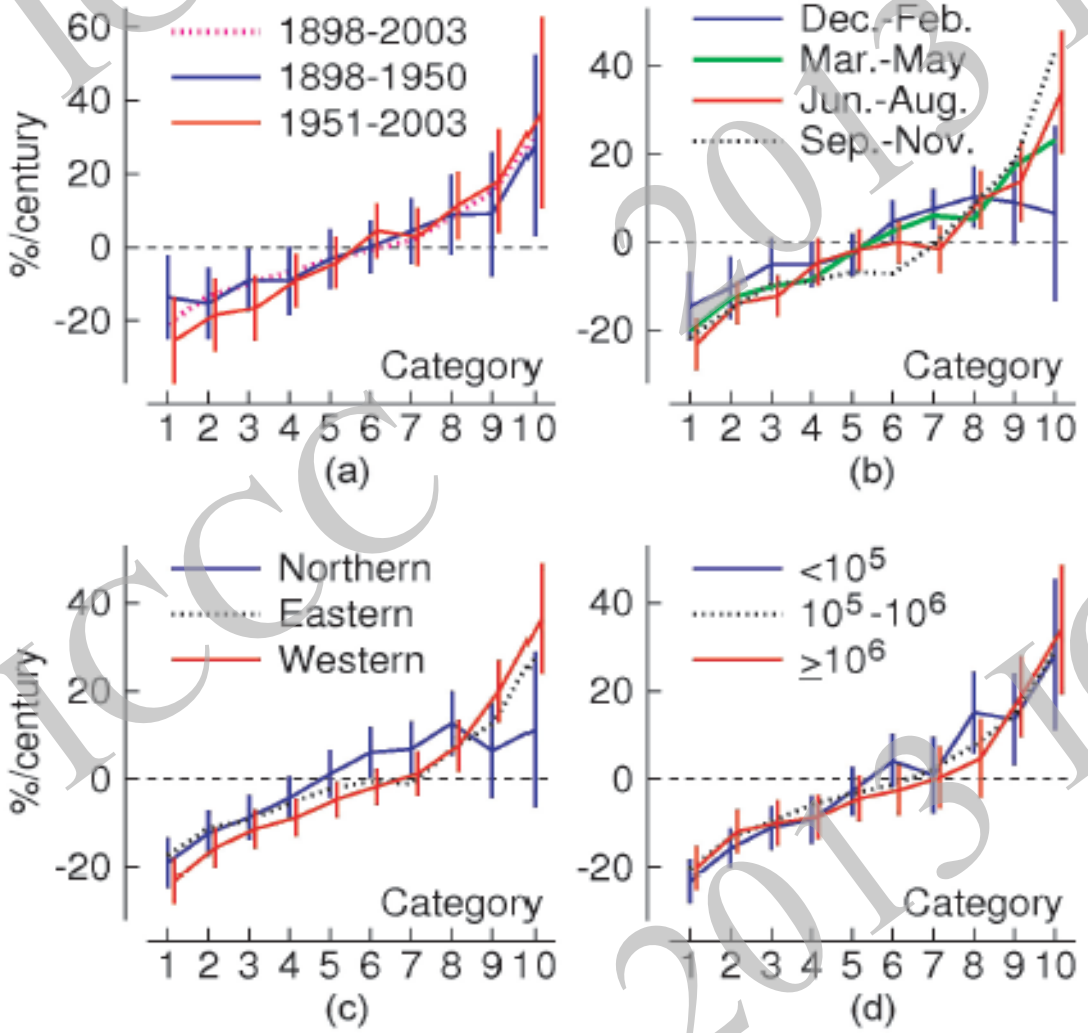


From Shiu et al (2012)

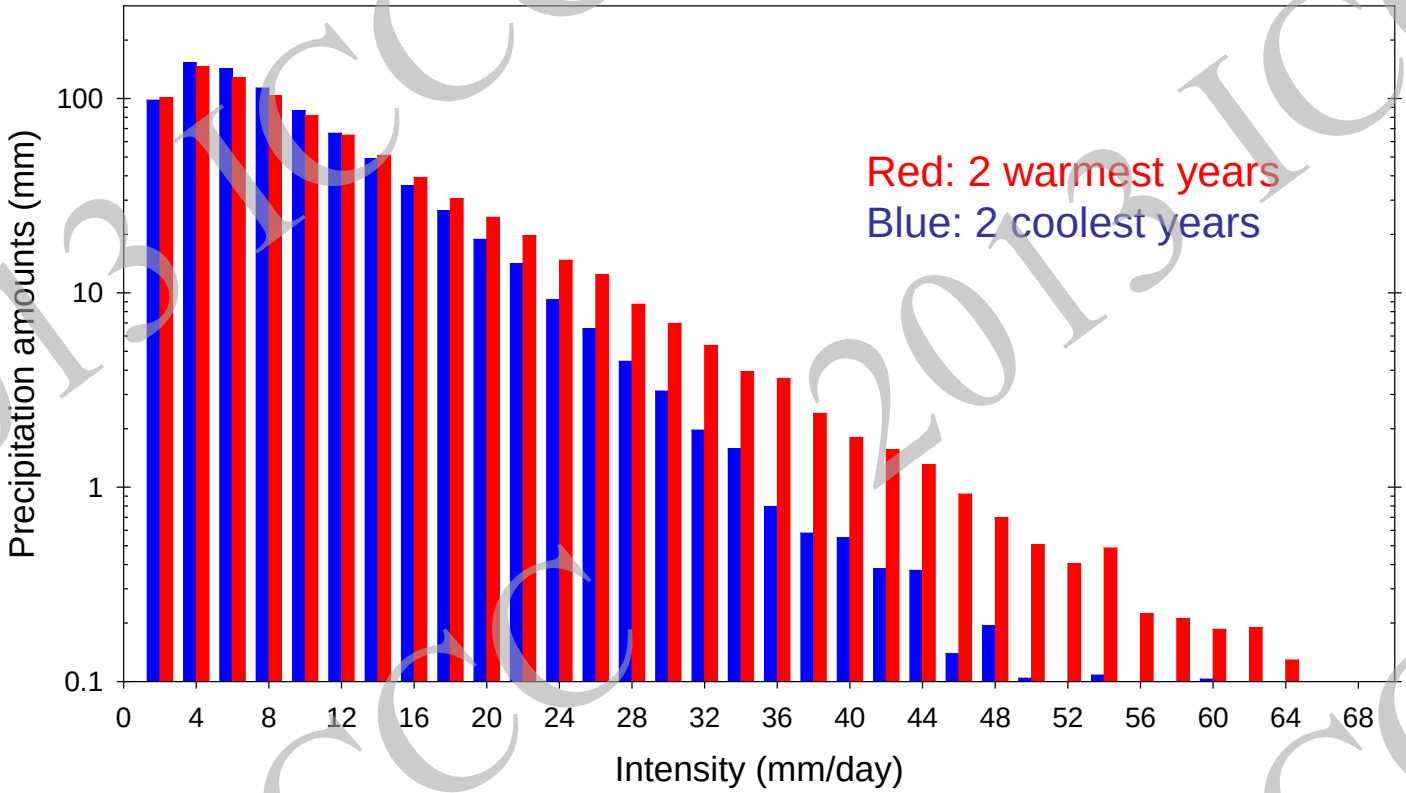


- Atmospheric models used in the reanalysis mode, with the benefit of observed wind and moisture fields, are capable of realistically simulating the change of precipitation intensity with global temperature.
- Climate models are capable of simulating the shape of the change in precipitation intensity, but underestimate the magnitude of the change by about one order of magnitude.
- The most likely reason of the underestimation is that the typical spatial resolution of climate models is too coarse to resolve atmospheric convection.

Linear trends of precipitations (in mm/4 hours) at different intensities in Japan, (a) for 3 time periods, (b) for 4 seasons, (c) for 3 regions, and (d) for 3 urban population ranges. (Fujibe et al., 2005)



Global Average (GPCP 1979-2007)



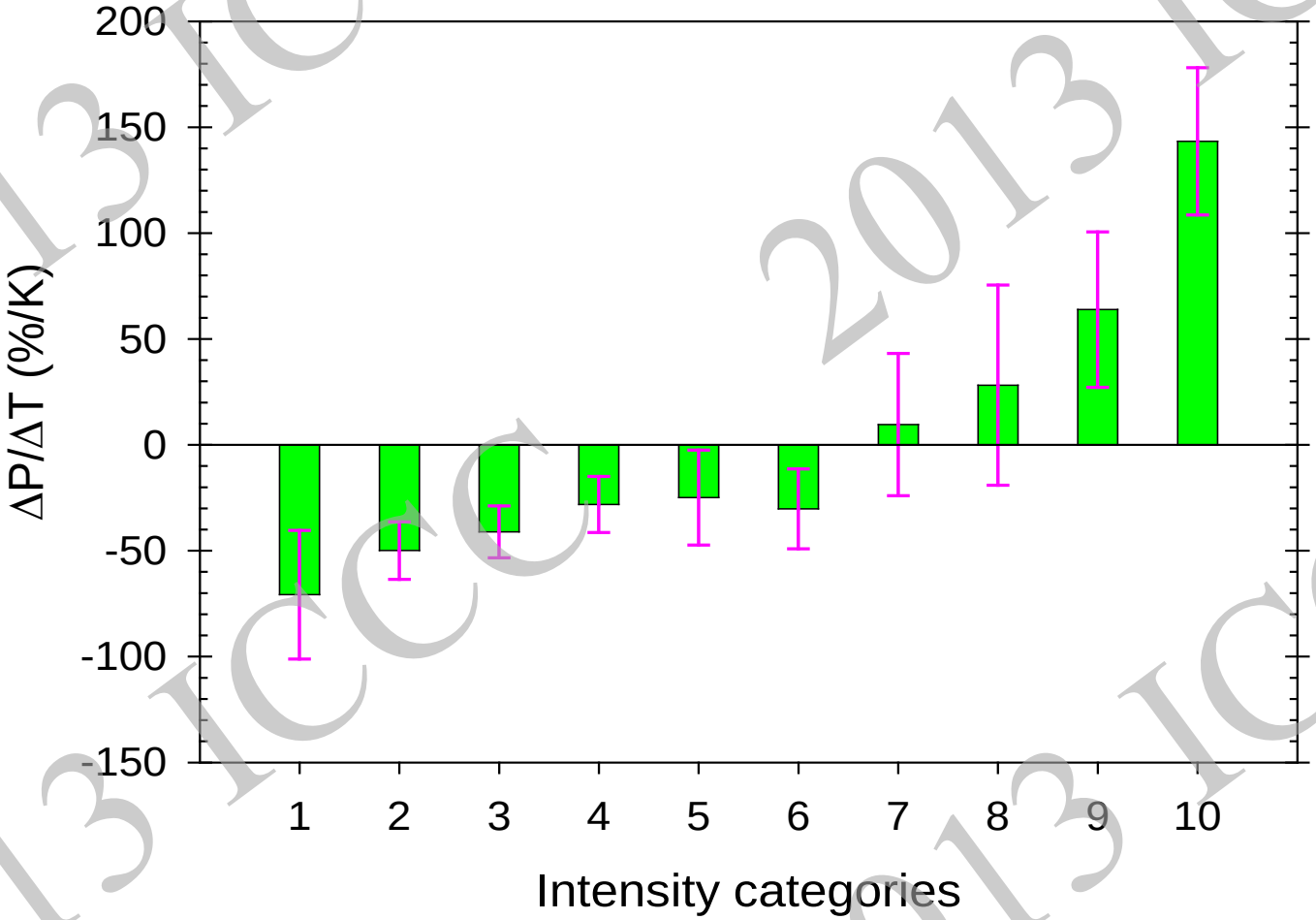
Amounts of precipitation vs. precipitation intensity in 2mm/day bin-width, blue bars being the average values of two coolest years (1984, 1985), red bars are the average values of two warmest years (1998, 2005).

Thank you!

台灣降雨強度隨全球溫度之變化

中央氣象局15站資料 (mm/hr)

1961~2005



降雨強度(十等份)