# Future change of heavy precipitation frequency : potential error in climate models

Young-Min Yang and Bin Wang

IPRC, University of Hawaii



# **Economic cost for extreme weather**



Estimated costs of extreme weather events in the US [bn USD in 2013 values]

It is very valuable to predi ct future change of heavy precipitation

# Coupled Model Intercomparison Project (CMIP)

CMIP5



#### CMIP6



# Future change of Frequency of daily precipitation



CMIP5 models



## Frequency of precipitation in CMIP5 models (Tropics)



## Horizontal pattern of light/medium/heavy precipitation



## Horizontal pattern of light/medium/heavy precipitation





#### Poor model (Inmcm4)



#### (Inmcm4)



## Future change of Frequency of daily precipitation

precipitation frequency at future climate

precipitation frequency at present climate



Small spread, monotonic increasing trends according to precipitation intensity

Ratio =

Large spread, discontinuous trends according to precipitation intensity = > Why the trends decreases during at precipitation ?

# Key processes for heavy precipitation



## Composite of SST, PRCP & BLMC for heavy precipitation events





## Vertical profile of diabatic heating profile : Good v.s. Poor models



# Future change of heavy precipitation : potential problems in poor models.

CMIP5 models

NESM3.0 (CTL,MOD)

Historical run v.s. RCP85 (last 10yr- data for analysis)

## Future change of Frequency of daily precipitation



NESM3.0 model results

#### Ratio of future (4CO2) to present heavy precipitation frequency



## Future change of Frequency of daily precipitation

CTL ( Poor model)



## Horizontal pattern of light/medium/heavy precipitation

Convective precipitation

Large-scalce precipitation



#### Future change of Frequency of daily precipitation



Precipitation (mm/day)

#### Horizontal pattern of light/medium/heavy precipitation

Convective precipitation MOD 4CO2\_MOD Large-scalce precipitation

MOD

4CO2\_MOD



#### Change of mean RH profile



10% of RH is reduced due to strong warming by 4CO2 forcing

#### Summary



# Thank you!



Is the Top-heavy heating profiles represented in a cloud resolving model?

## Heavy precipitation processes in Cloud Resolving Model



✓ Goddard Cumulus Ensemble model (Tao et al. 1993) simulation





#### Summary

Poor model

**Good model** 





#### Horizontal pattern of light/medium/heavy precipitation at 4co2 forcing

TRMM





4CO2\_MOD



#### Horizontal pattern of light/medium/heavy precipitation at 4co2 forcing

#### TRMM



#### CTL



#### 4CO2\_CTL

