


Increased hydroclimatic intensity with global warming


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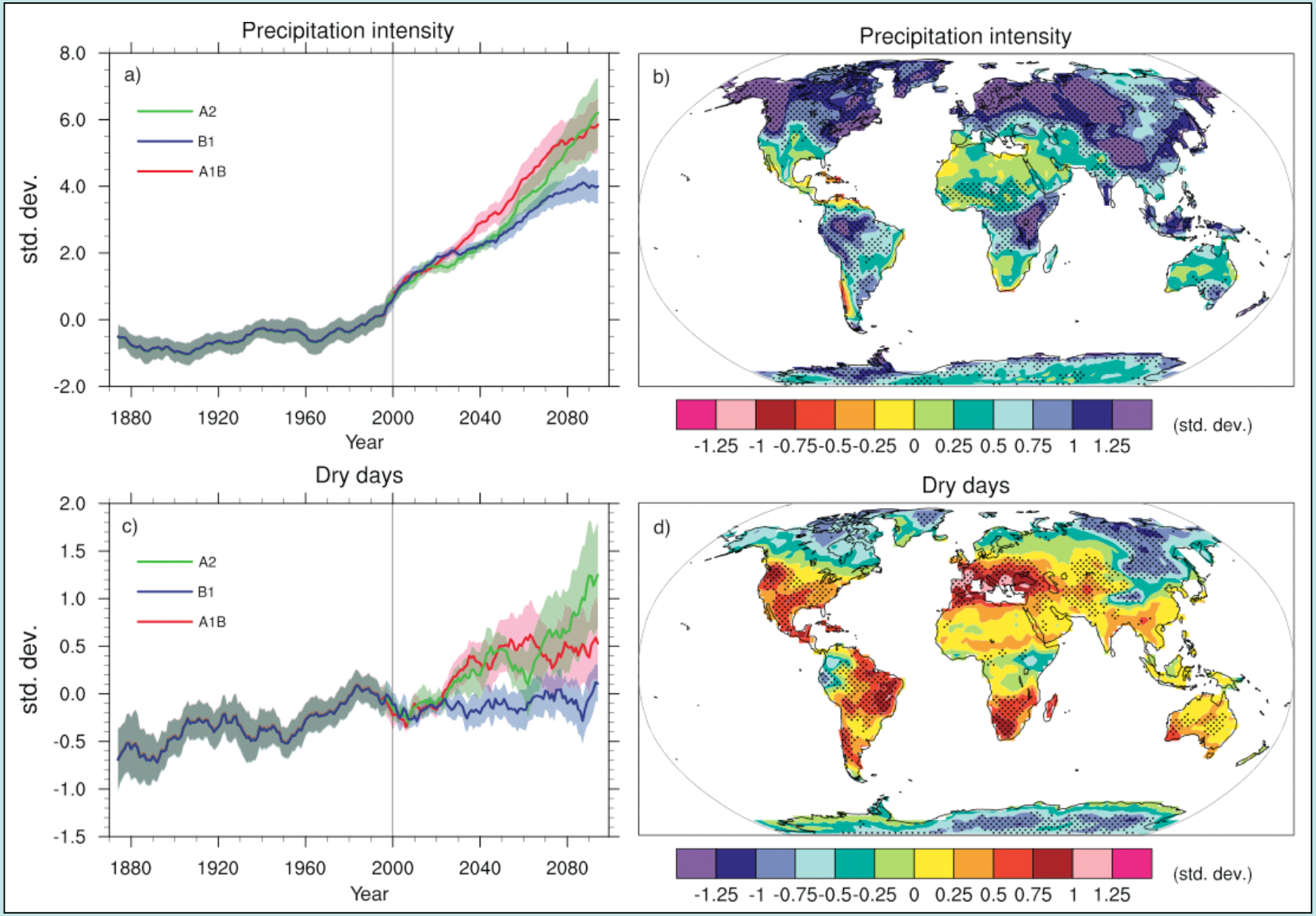
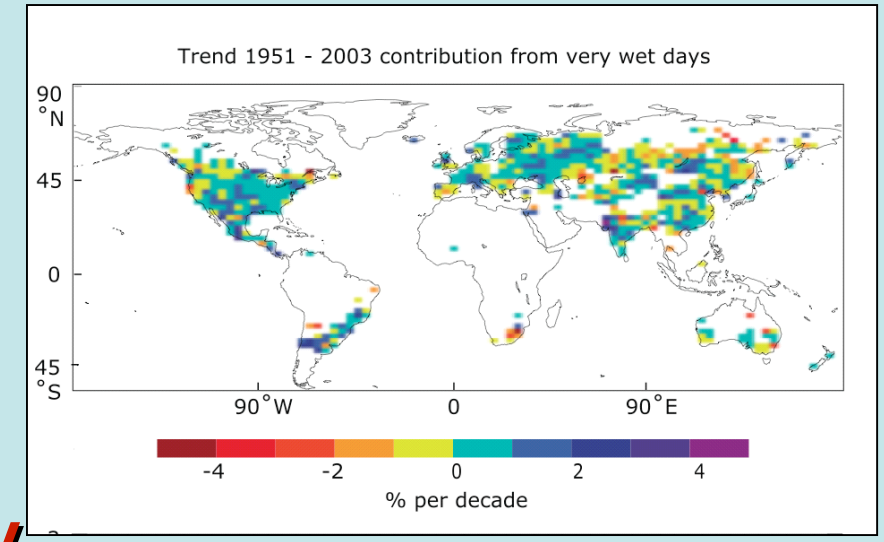
- Giorgi, F., E.S. Im, E. Coppola, N.S. Diffenbaugh, X.J. Gao, L. Mariotti, and Y. Shi, 2011: Higher hydroclimatic intensity with global warming. J. Climate, 24, 5309-5324.

Projected changes in precipitation characteristics IPCC (2007)



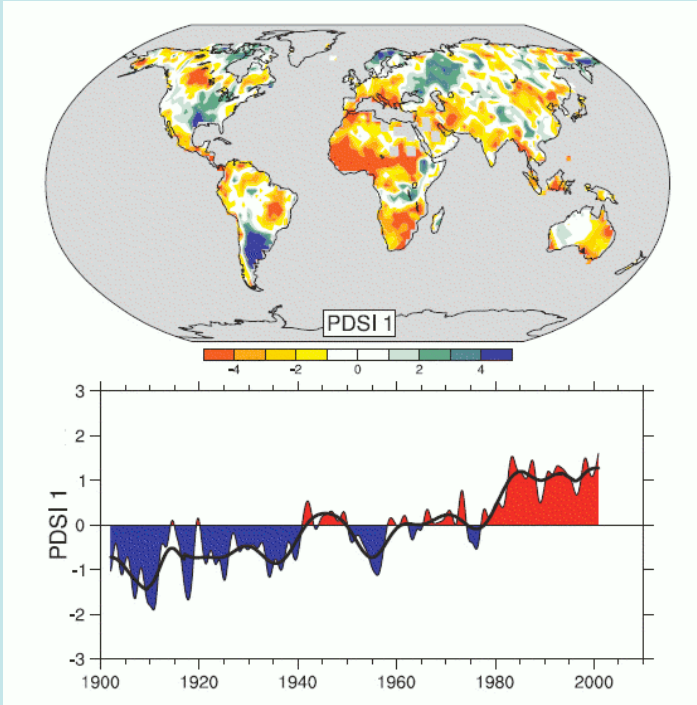
Observed trends in precipitation characteristics IPCC (2007)



It rains less frequently but more intensely

IPCC 2007: “More intense and longer droughts have been observed over wider areas since the 1970s”

IPCC 2007: “The frequency of heavy precipitation events has increased over most land areas”



Hypothesis: The increases in dry day frequency and precipitation intensity are deeply interconnected and can be seen as a combined hydroclimatic signature of global warming

Define an index of hydroclimatic intensity that combines precipitation intensity and dry spell length

$$\text{HY-INT} = I \bullet DSL$$

I = Normalized Precipitation Intensity
DSL = Normalized Dry Spell Length

HY-INT is NOT an index of extremes
HY-INT is calculated from daily precipitation on an annual basis

Alternate interpretation of HY-INT

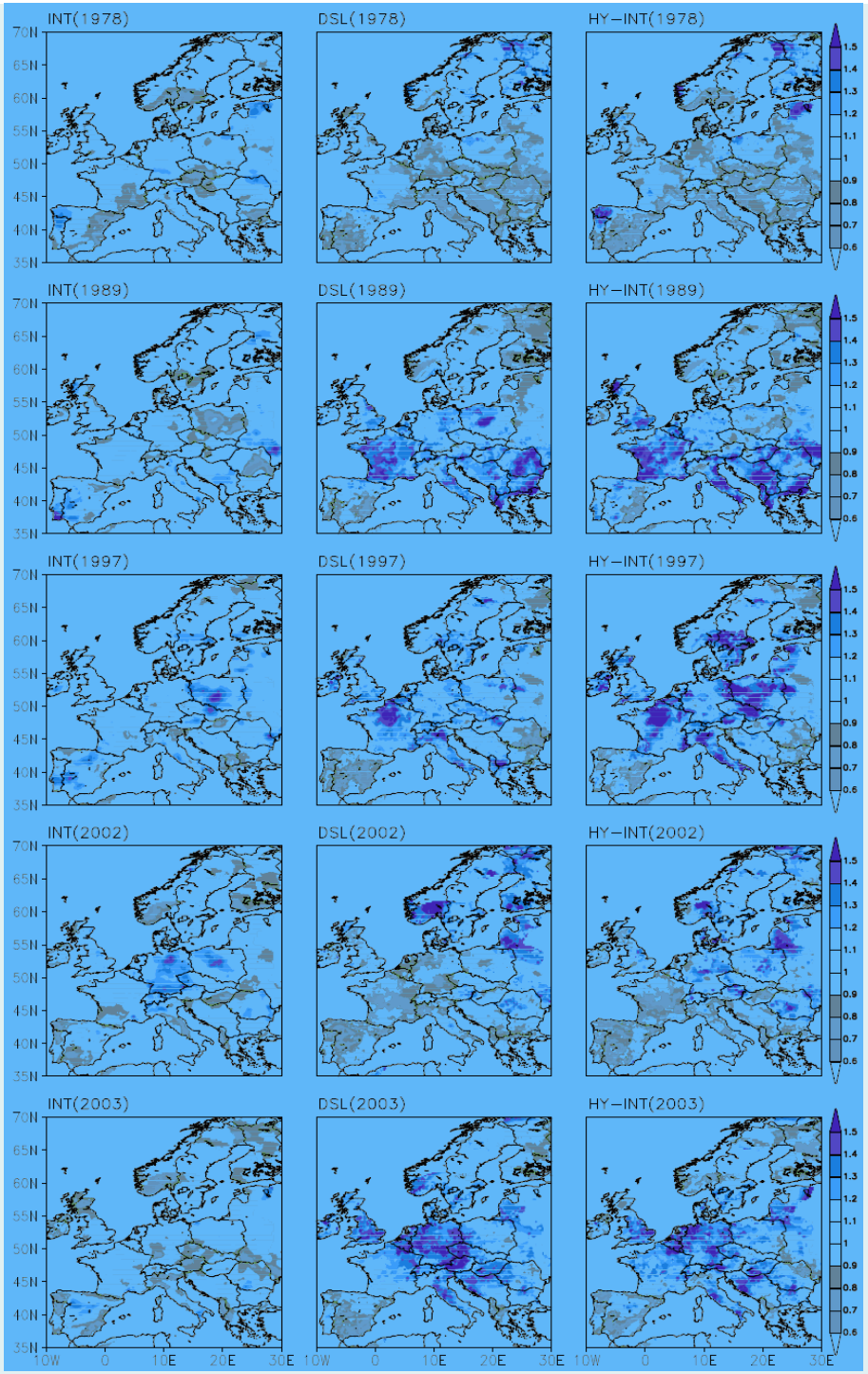
$$Fd = Ld \bullet Nd,\ Fw = Lw \bullet Nw$$

$$HY\text{-}INT = 1/Nd \bullet (P/Fw - P)$$

$$HY\text{-}INT = P/Nw \bullet Ld/Lw$$

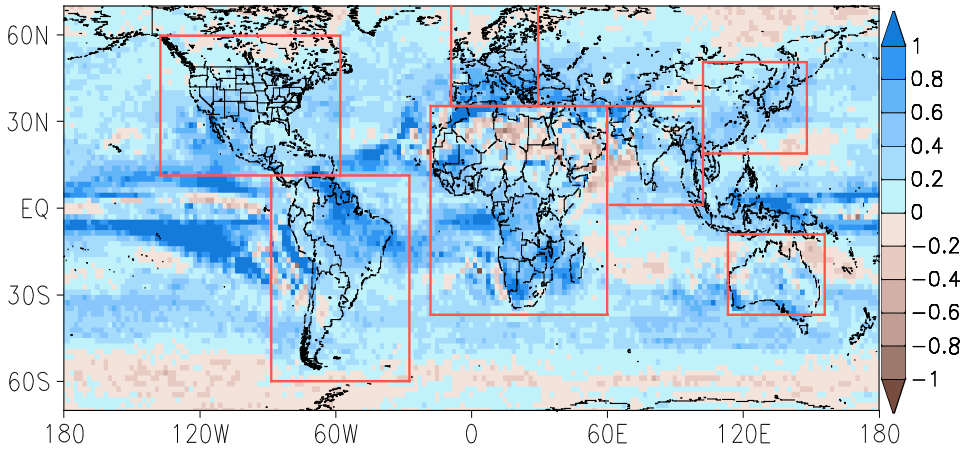
Fd(w) = Frequency of dry (wet) days
Ld(w) = Average length of dry (wet) spells
Nd(w) = Number of dry (wet) spells

HY-INT is the average accumulated wet spell precipitation multiplied by the ratio of the average length of dry and wet spell

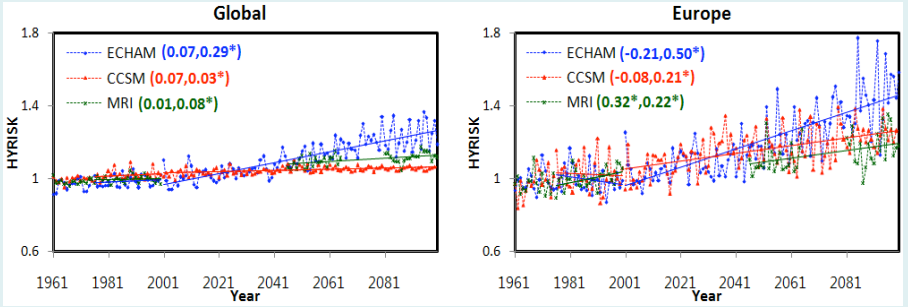


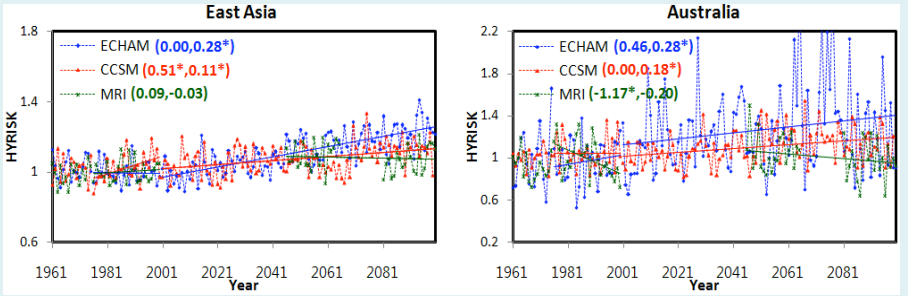
Examples of HY-INT for specific years in Europe

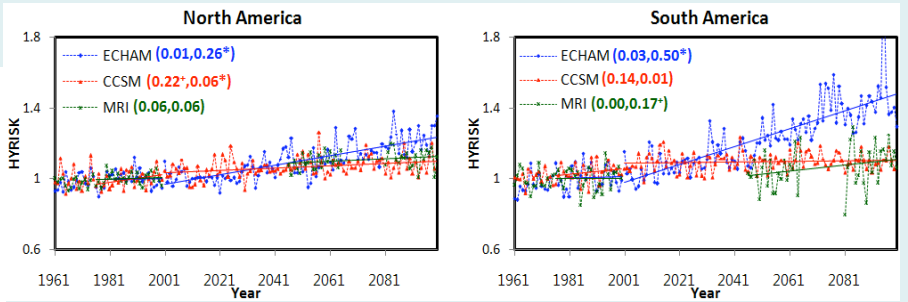
21st Century trend of HY-INT for three GCM projections, A1B Scenario

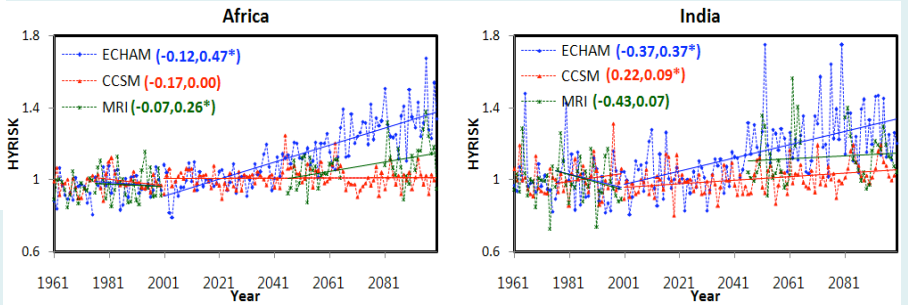


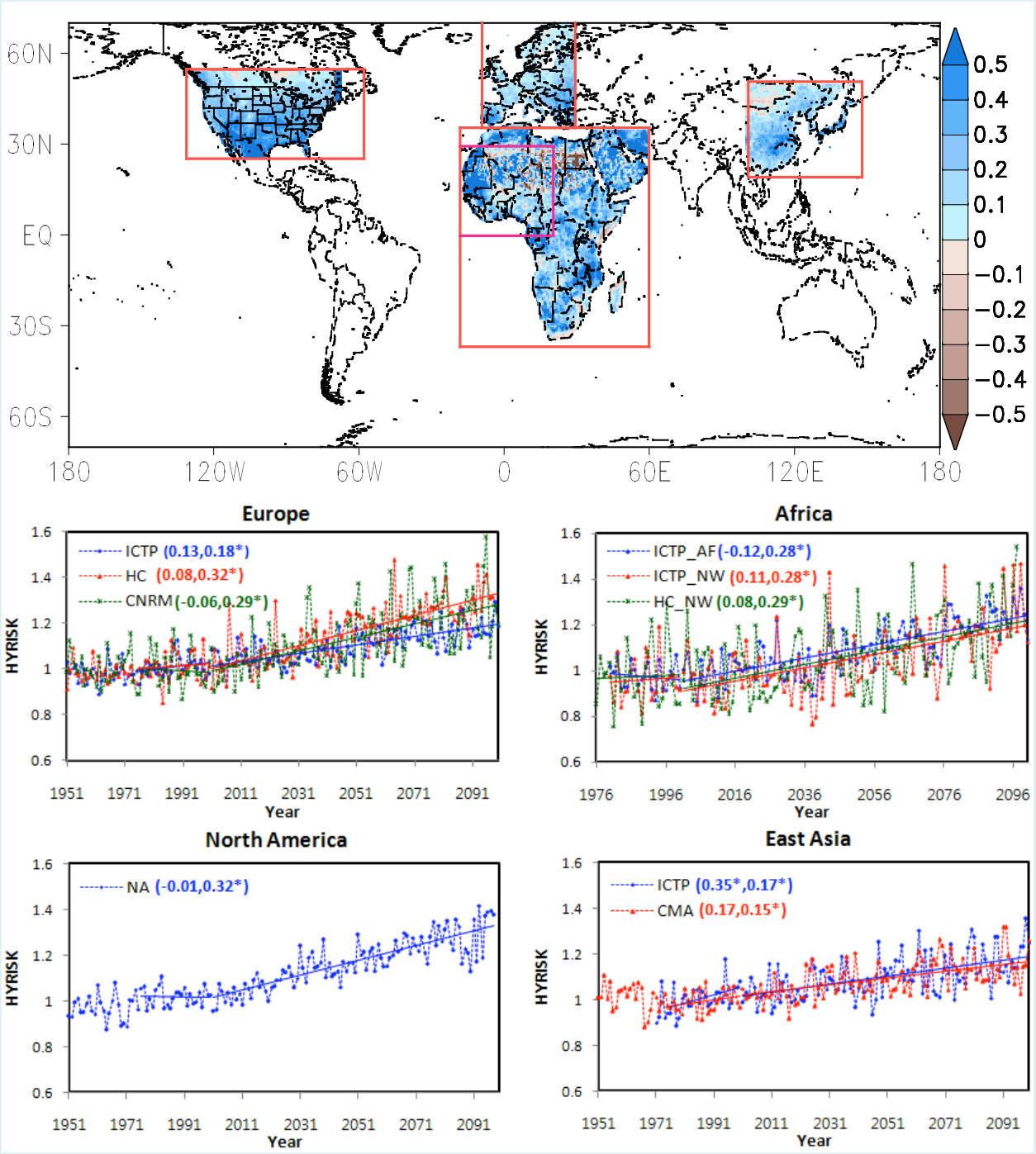
ECHAM5





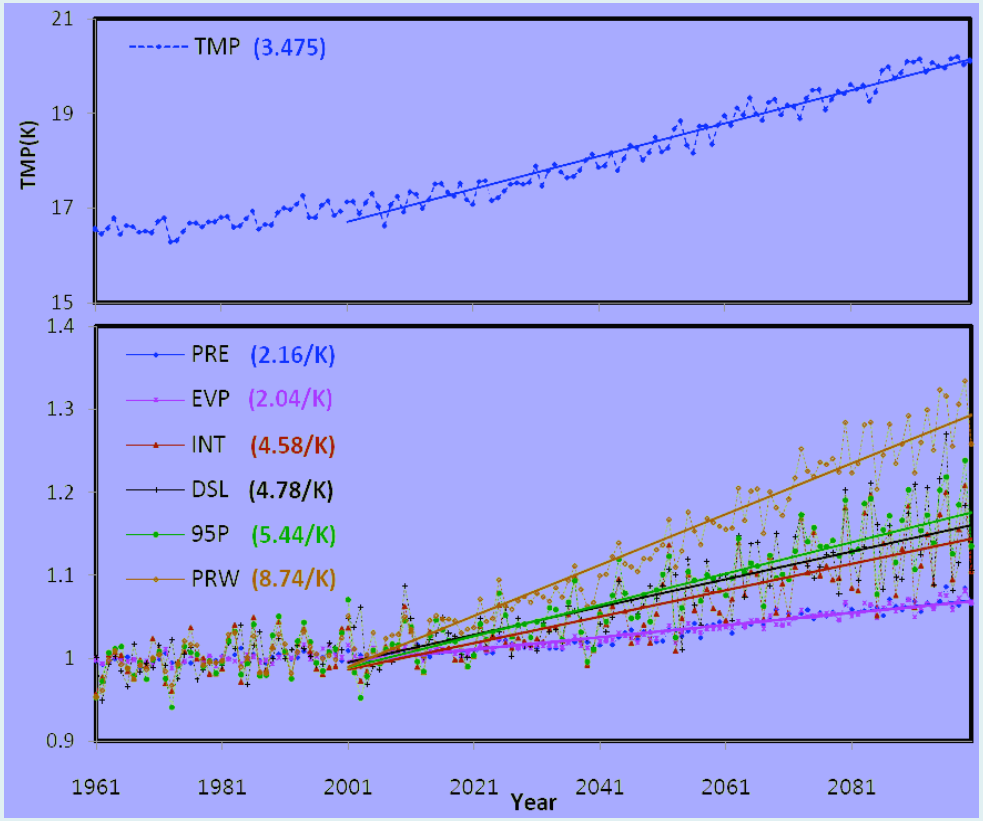


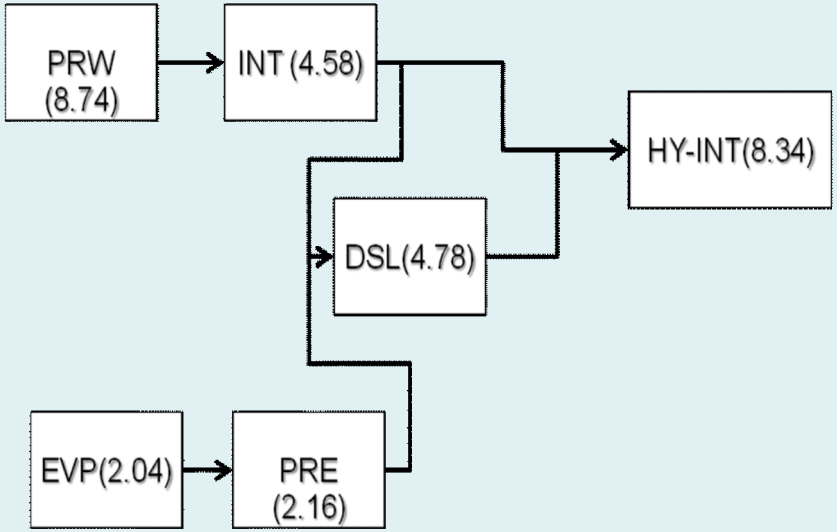


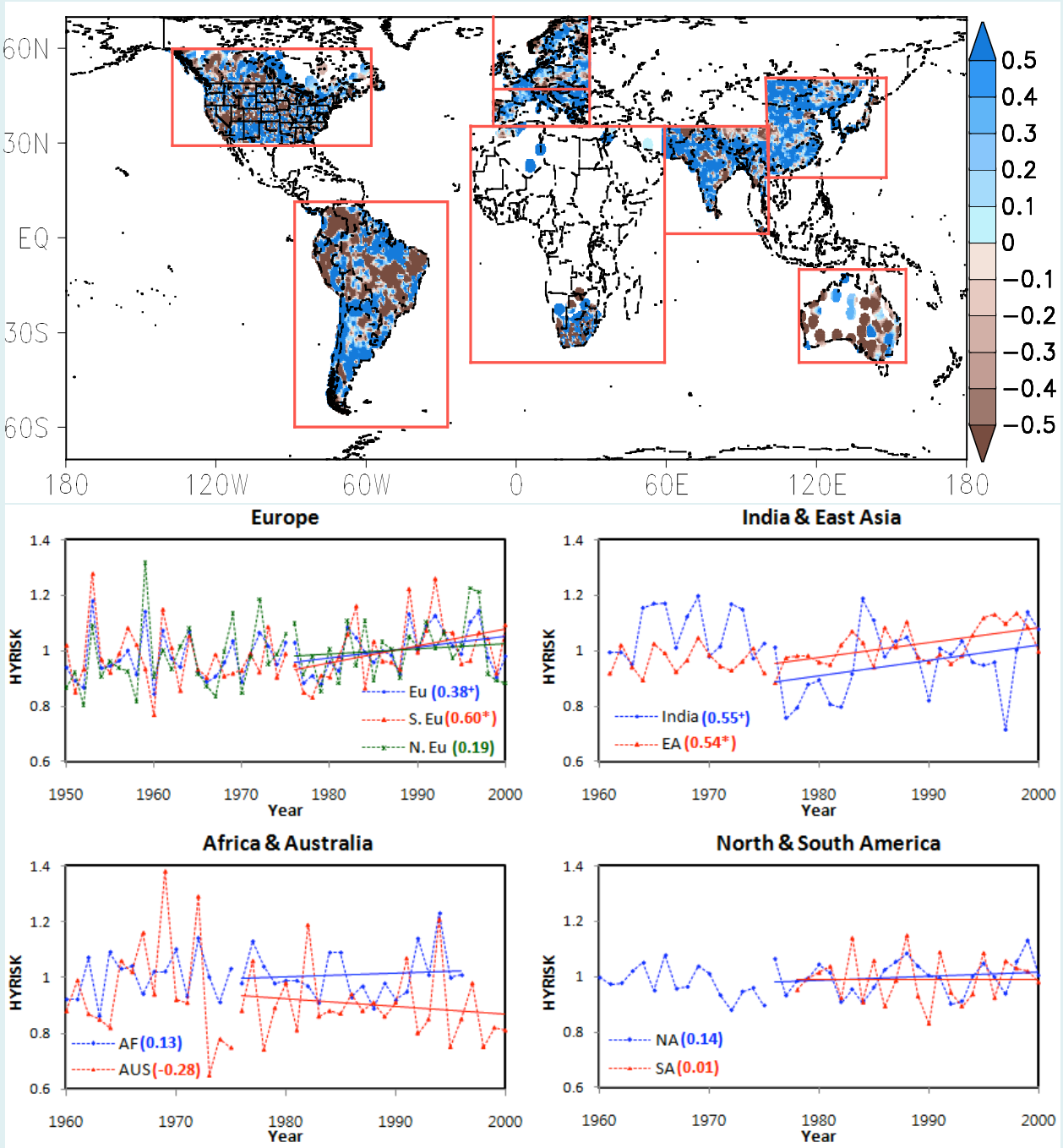


21st Century trend of HY-INT for three RCMs

Change of HY-INT within the context of changes in the global hydrologic cycle. ECHAM5 model, A1B scenario







Late 20th Century trend of HY-INT from station observations

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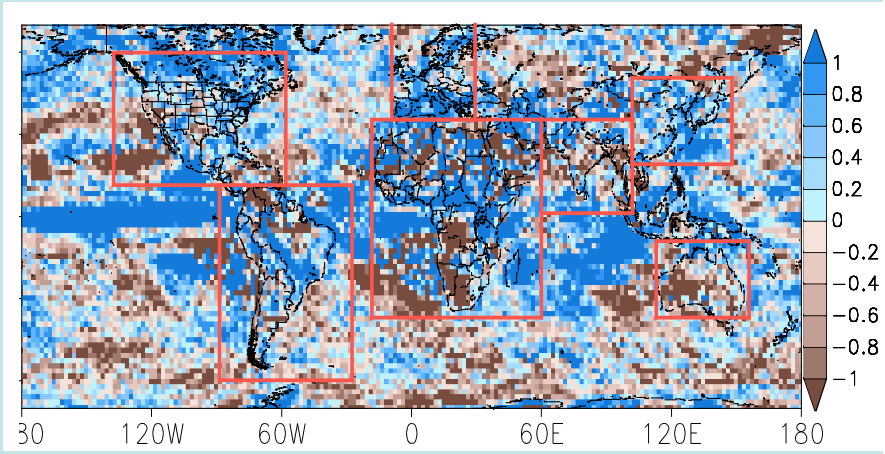
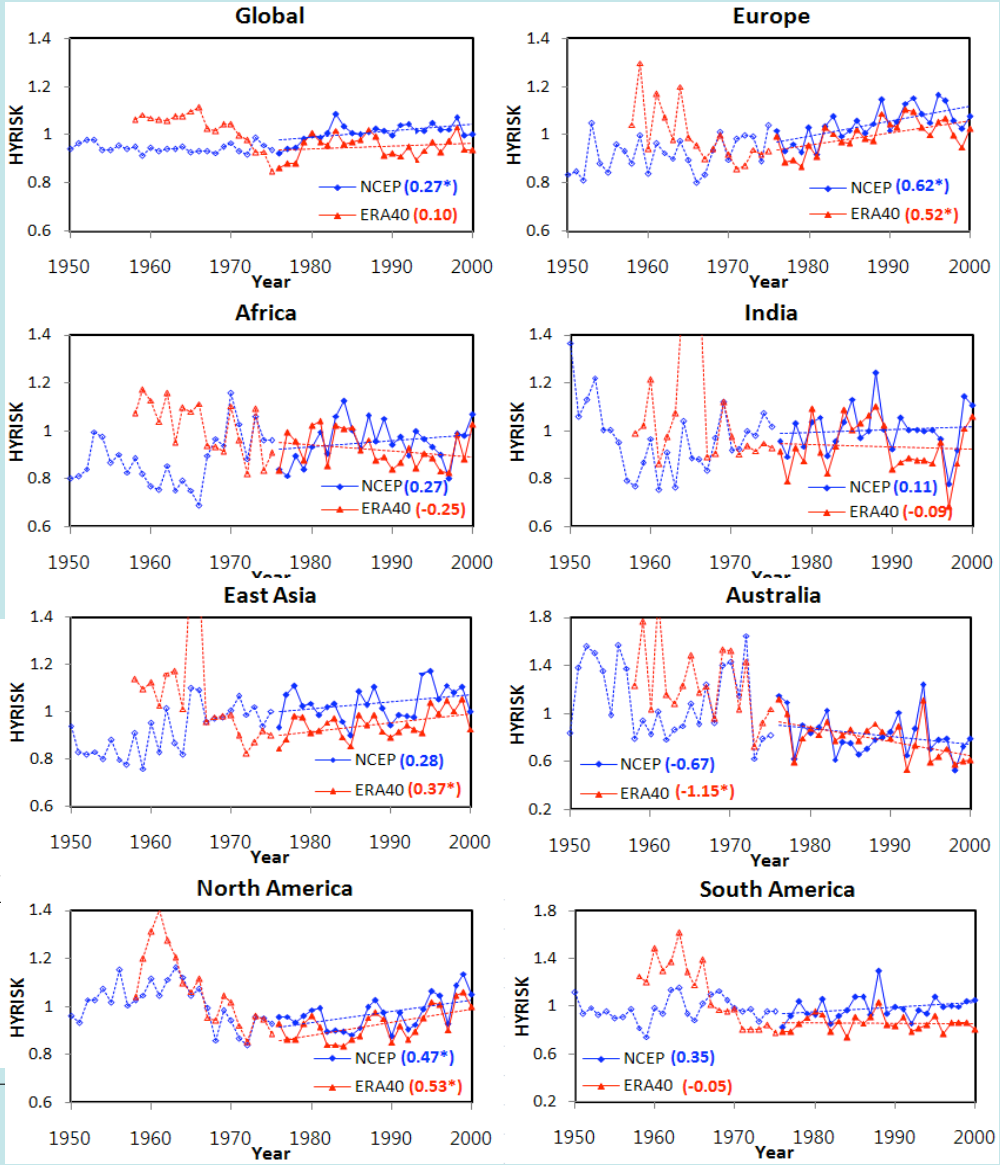
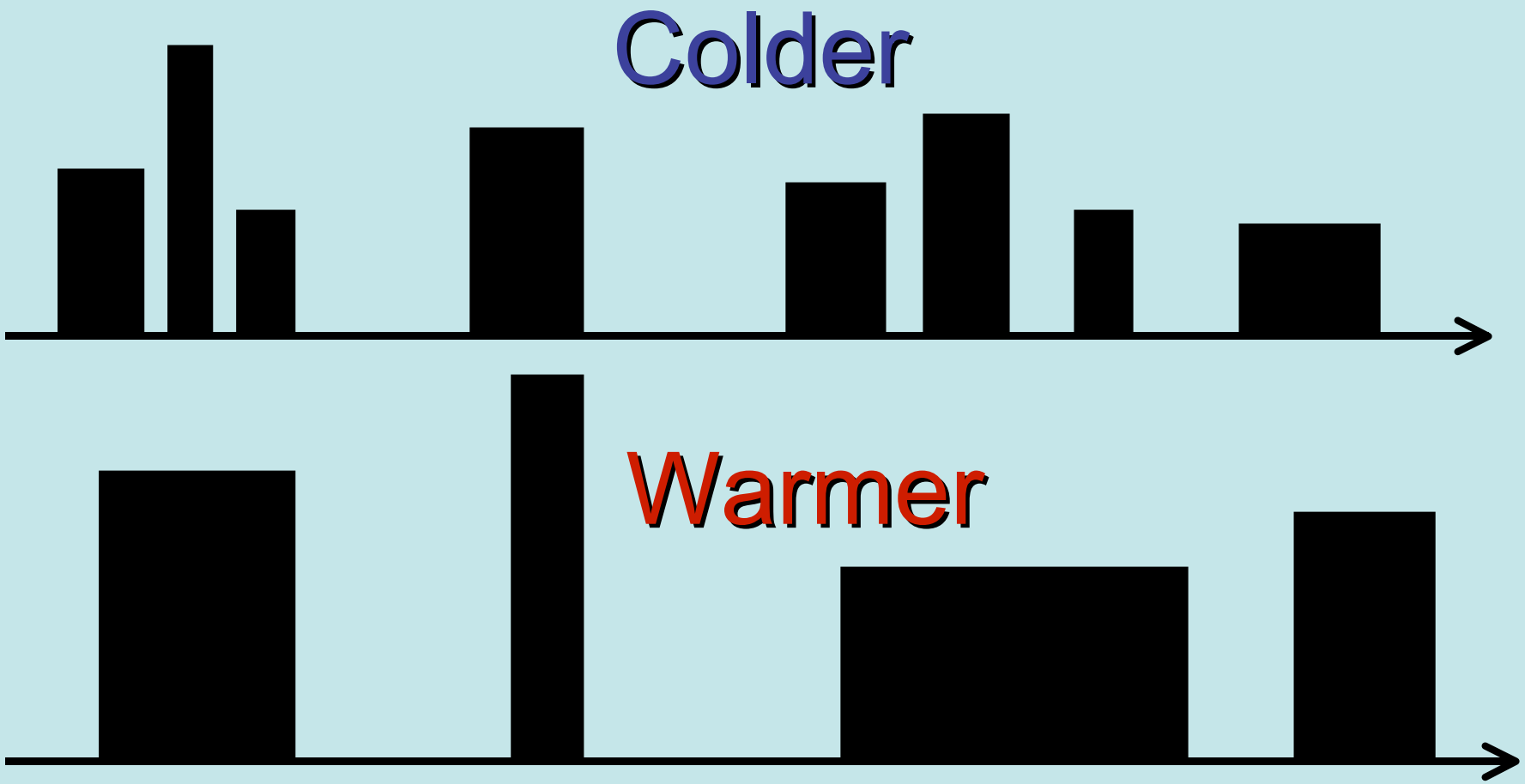


NCEP Reanalysis



Does the HY-INT response to global warming reflect an inherent behavior (regime shift) of the Earth's hydrologic cycle?

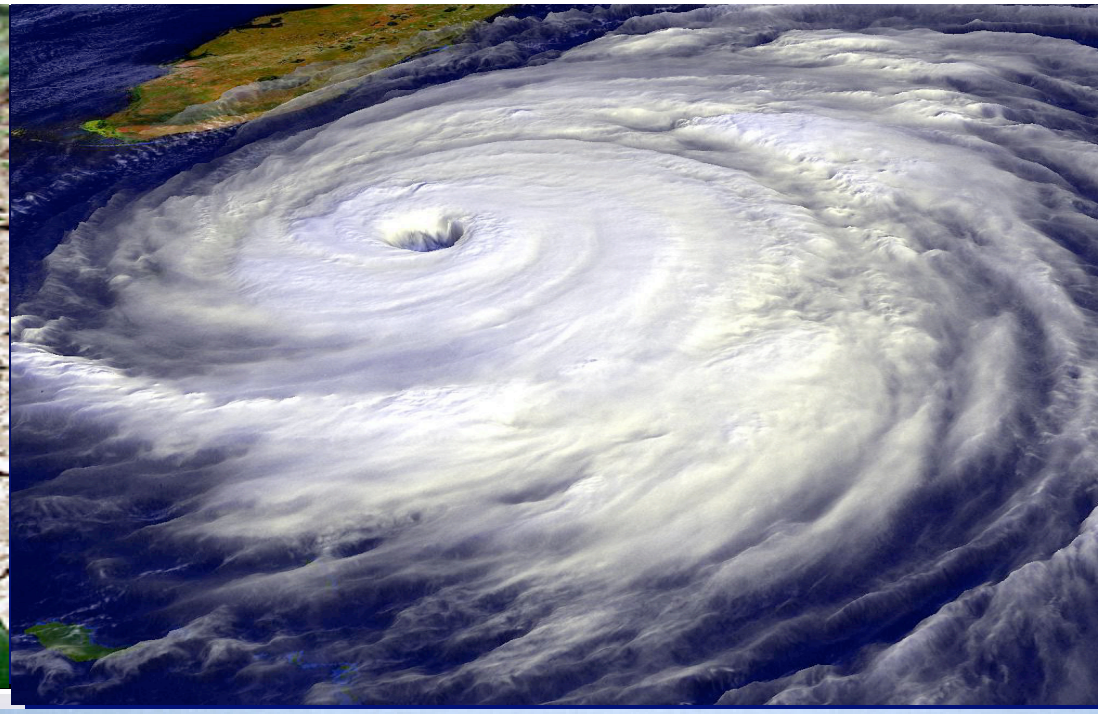


Conclusions

- We introduce the HY-INT index as a measure of hydroclimatic intensity combining information of mean dry spell length and precipitation intensity and viewing the response of these variables to global warming as deeply interconnected
- The increase in HY-INT appears to be a hydroclimatic signature of global warming in 21st century model projections and in observations for the late 20th century.
- HY-INT can be used as a useful hydroclimatic detection and attribution tool
- Understanding the HY-INT response to global warming can provide important physical insights into the behavior of the Earth's hydrologic cycle
- HY-INT can be useful as an assessment tool of hydroclimatic stress

Future work

- HY-INT trend analysis in the next generation model projections
  - CMIP5
  - CORDEX
- Improved physical understanding of the HY-INT response to global warming
- Application to detection/attribution studies
- Implications for weather predictability?



THANK YOU