



Climate change and hydrology

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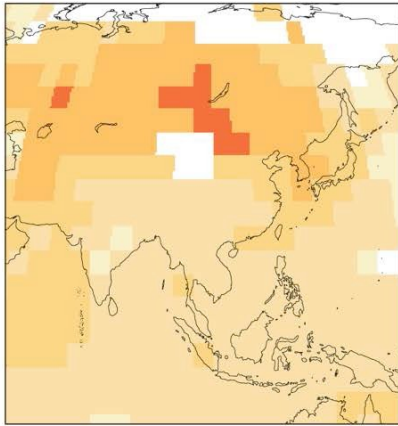
Climate change summary: Asia

Trend over 1901-2012
(°C over period)

Annual Temperature

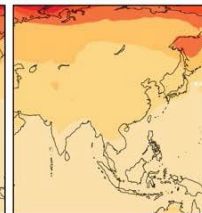
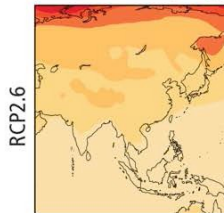
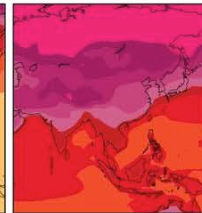
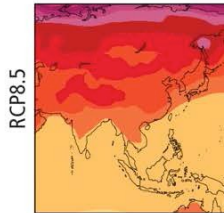


Difference from 1986-2005 mean
(°C)



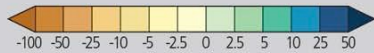
mid-21st century

late-21st century

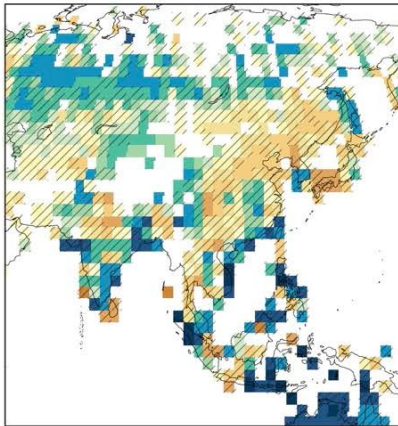


Trend over 1951-2012 (mm/year/decade)

Annual Precipitation

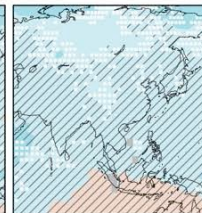
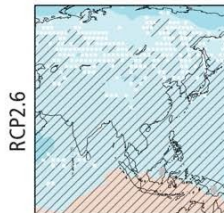
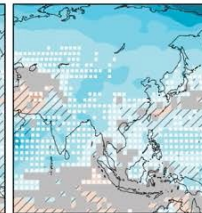
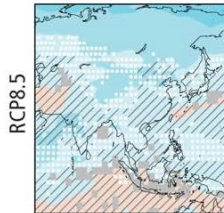


Difference from 1986-2005 mean (%)



mid-21st century

late-21st century



Solid Color Significant trend
White Insufficient data

Diagonal Lines Trend not statistically significant

Solid Color Very strong agreement
Gray Divergent changes

White Dots Strong agreement
Diagonal Lines Little or no change

- Clear warming trends everywhere we have good data
- Significantly more warming in the future but much less with aggressive mitigation

- Mixed trends in precipitation
- General tendency for increases in average precipitation
- Areas of uncertainty in some tropical and central Asian regions



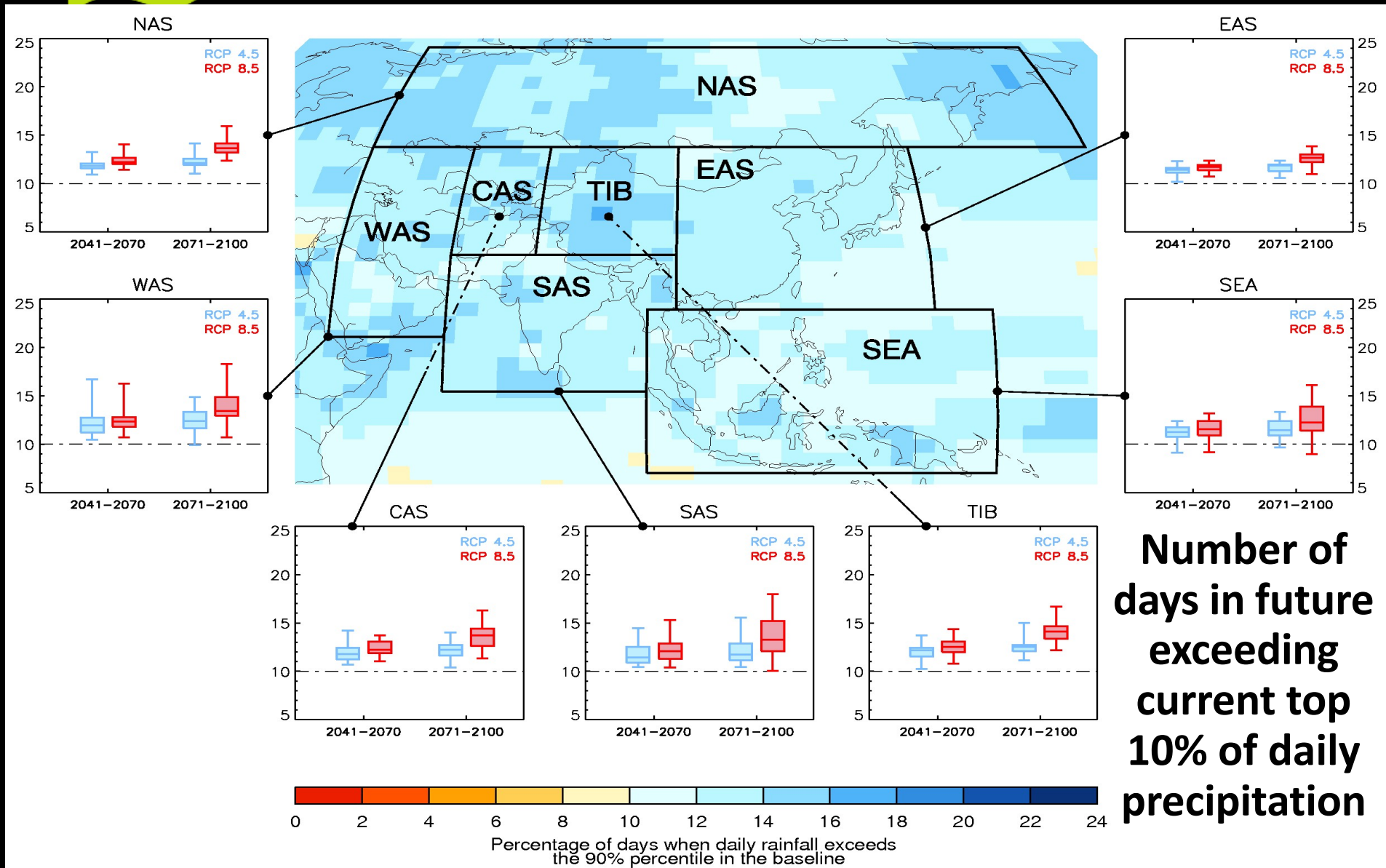
Met Office

Implications for hydrology

- Warming will increase evaporation and the moisture-holding capacity of the atmosphere – thus potentially both drought/water demand and (heavy) precipitation
- Warming will also change the balance between rain and snow and increase melting of snow and ice, e.g. so changing the hydrological regime of rivers
- Warming and warming patterns will change circulation patterns, storm tracks and intensities with implications for both average and extreme precipitation



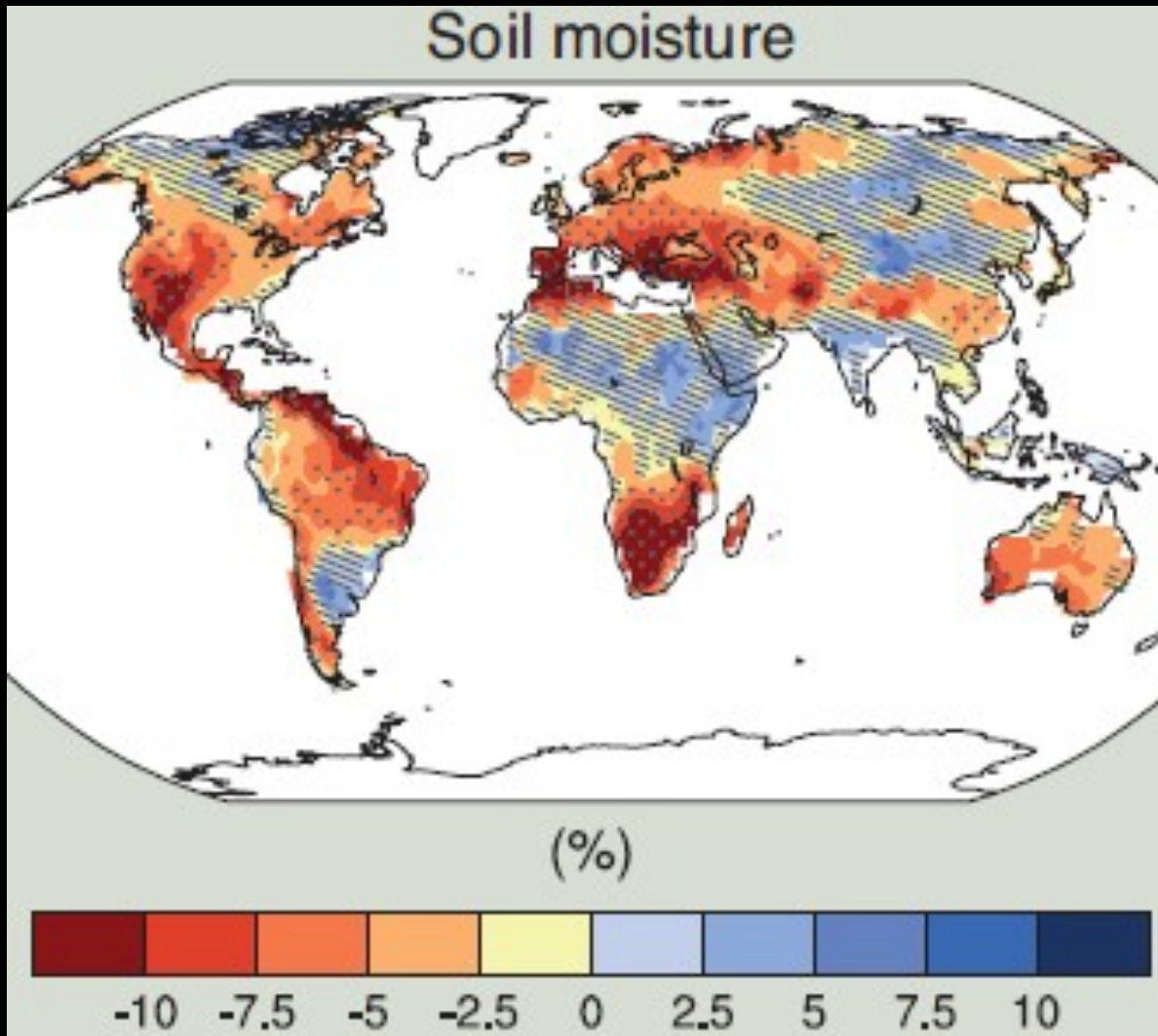
Clear messages on changes in heavy precipitation in the global climate models





Implications of precipitation and evaporation changes for soil moisture

Projected end of century soil moisture changes



Contrasting signals for S Asia:

- Drying in NW
- Wetter conditions in central regions

Note that this is an annual average picture and the seasonal behaviour may be different



Projected changes in days under hydrological drought conditions

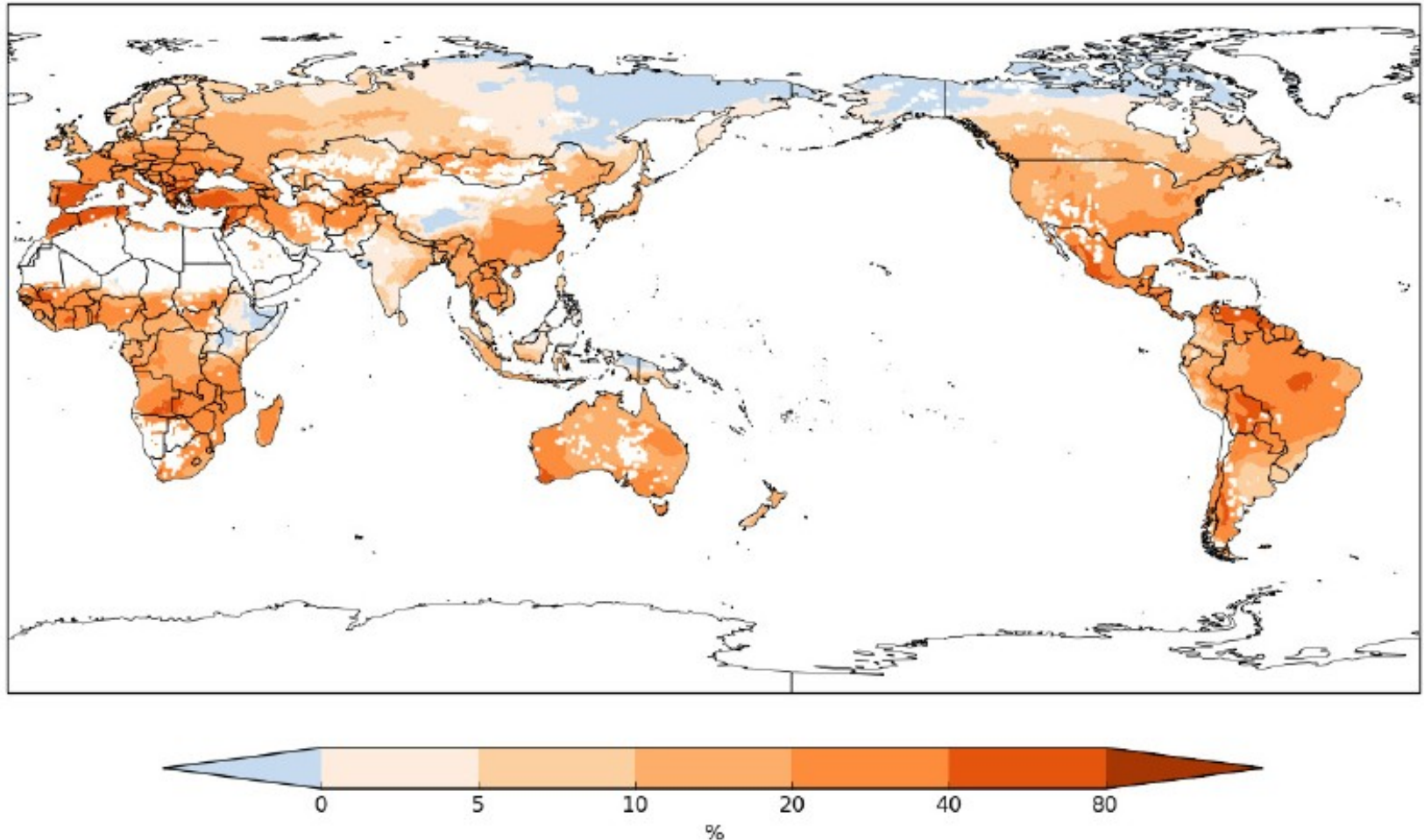
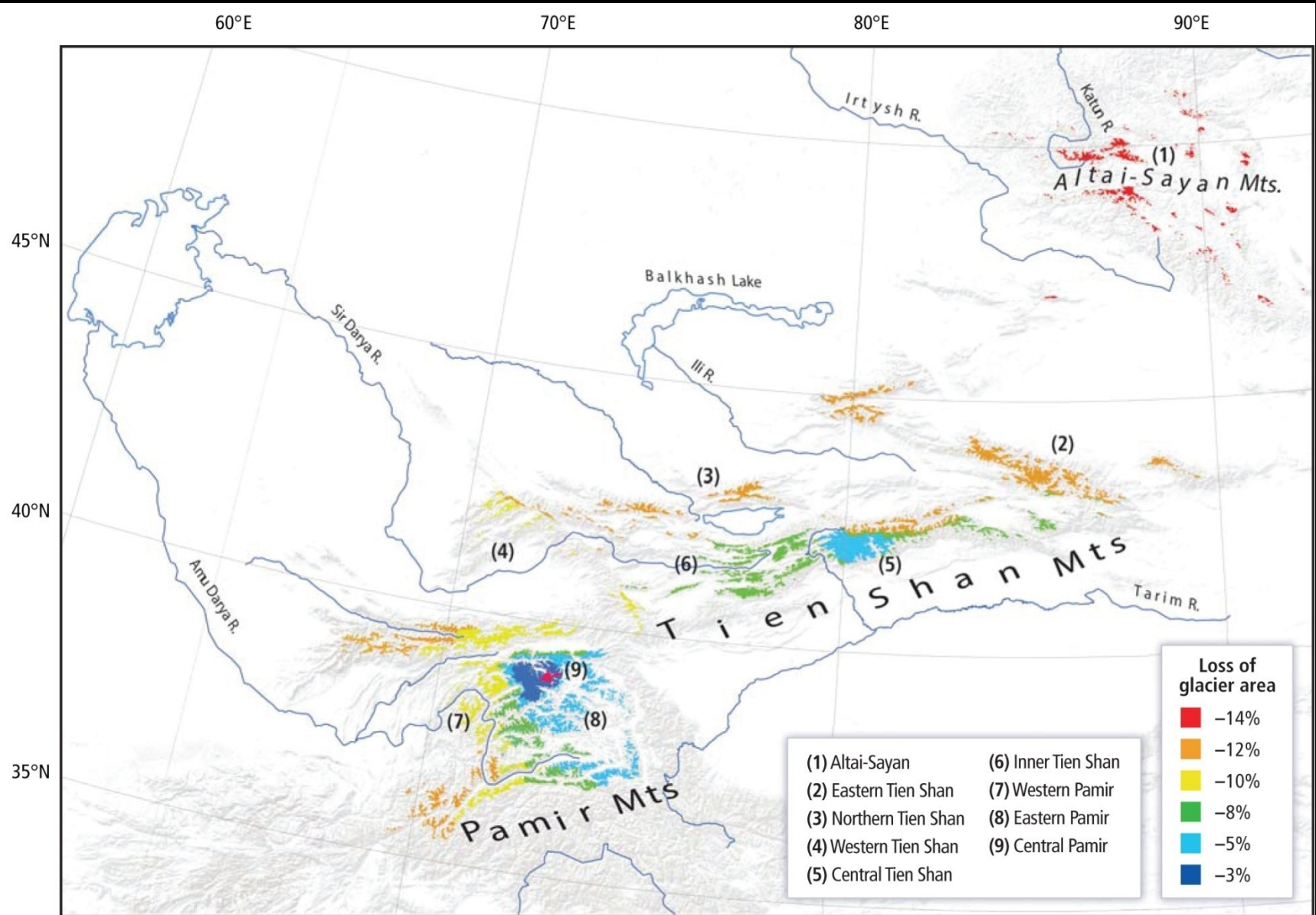


Figure 40 – Ensemble mean of the percentage change in days under drought conditions for 2070-2099 relative to 1976-2005 for RCP8.5. Data from Prudhomme *et al.* (2013).



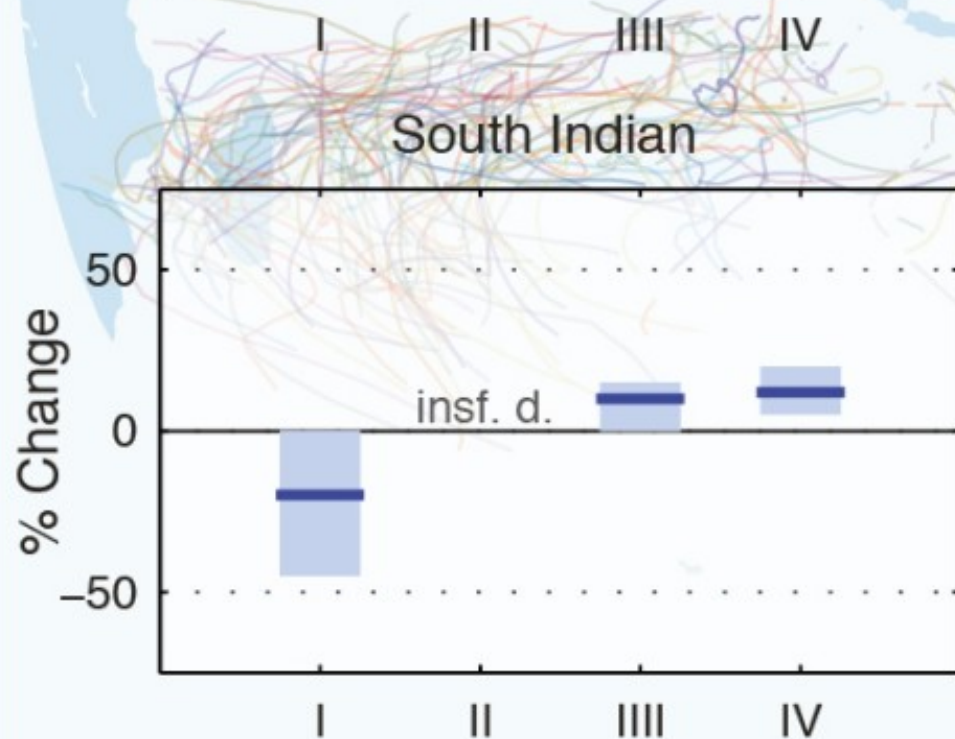
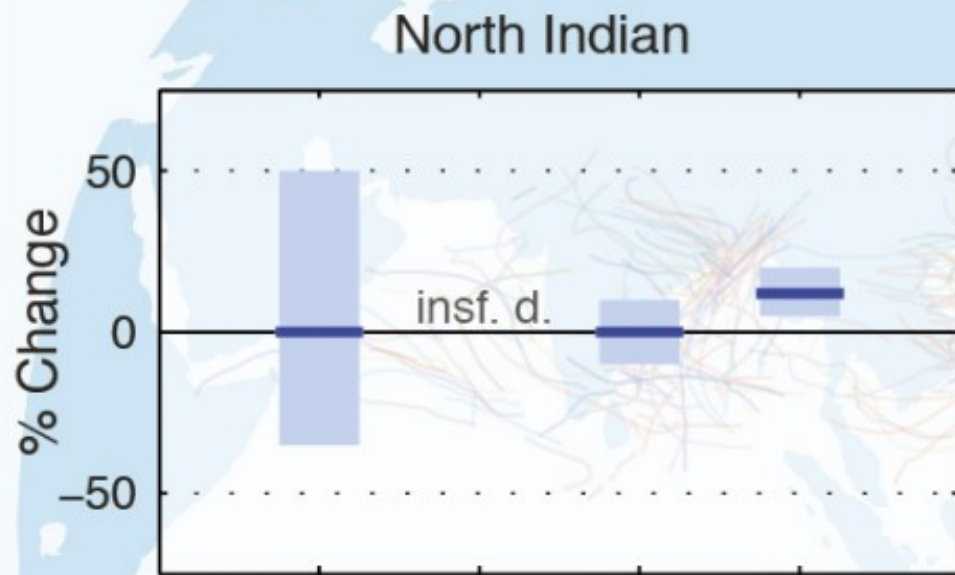
Loss of glacier area in the Altai-Sayan, Pamir and Tien Shan: 1960-2008



Projected changes in tropical cyclones

Climate models suggest:

- increases in intensity
- a clear signal of increased rainfall
- no clear change or a decrease in frequency (in the Indian ocean)



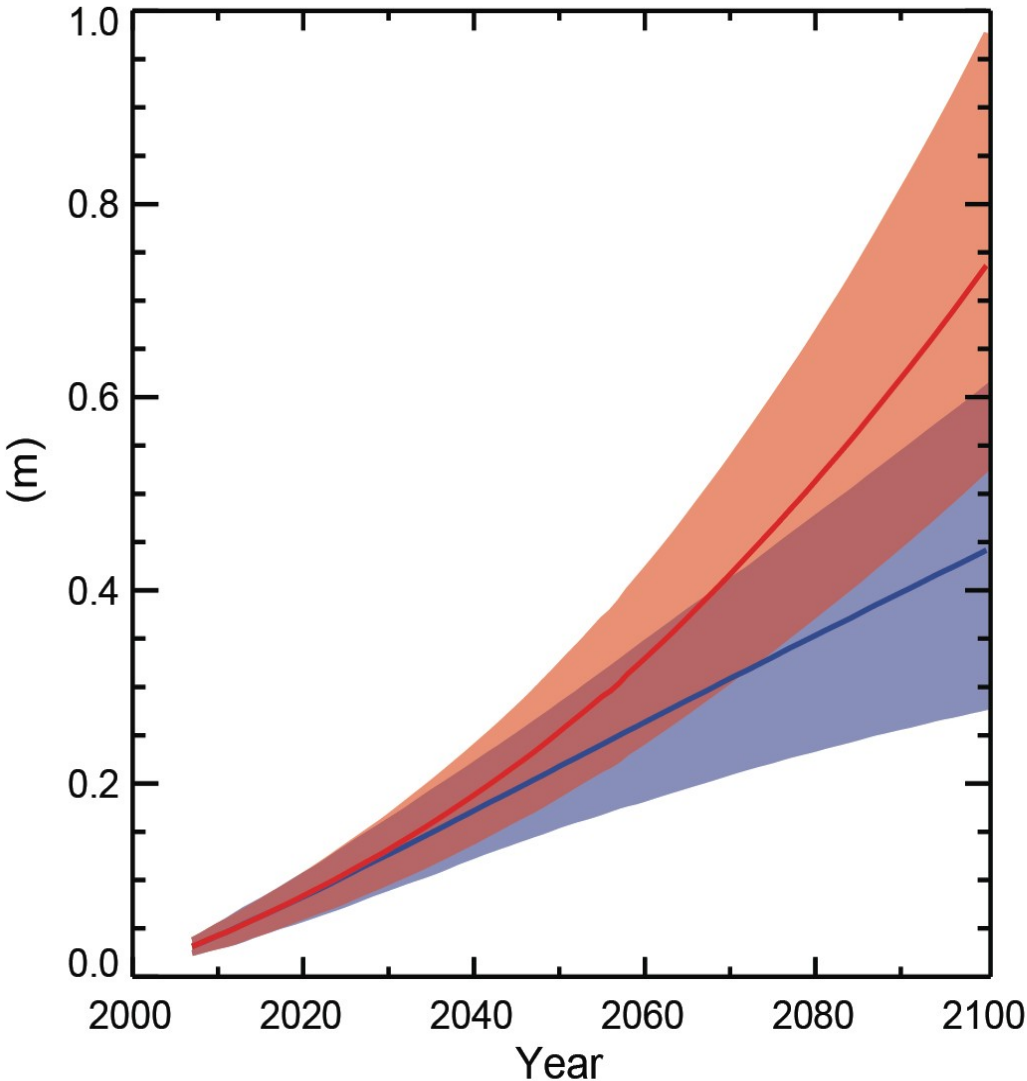
Tropical Cyclone (TC) Metrics:

- I All TC frequency
- II Category 4-5 TC frequency
- III Lifetime Maximum Intensity
- IV Precipitation rate



Sea-levels will continue to rise

Global mean sea level rise



Mean over 2081–2100

RCP2.6

RCP4.5

RCP6.0

RCP8.5

With large increases in global greenhouse gas emissions sea-levels will continue to rise exponentially

Even if global emissions peak within next few years then decline sea levels will continue to rise (for centuries)

Projections from multiple global climate models assessed in the IPCC AR5 using four Representative greenhouse gas Concentrations Pathways (RCPs)



Summary of risks for South Asia

Increased riverine, coastal, and urban flooding (leading to widespread damage to infrastructure, livelihoods and settlements)

Increased risk of drought-related water (and food) shortage (causing malnutrition)

Water shortages in arid areas of S Asia

The interaction of rising global mean sea level with high-water-level events will threaten low-lying coastal areas



Conclusions

Temperature and evaporation increases

Increased drought-related water/food shortages

Changes in rain/snow, runoff, glaciers

More extreme precipitation

Increased flood damage to infrastructure, livelihoods and settlements

Sea level rise

Coastal inundation – loss of habitat, livelihoods, settlements, infrastructure, eco-system services, economic stability (especially in small islands)