Regional fact sheet - Asia

Common regional changes

The observed mean surface temperature increase has clearly emerged out of the range of internal variability compared to 1850-1900. Heat extremes have increased while cold extremes have decreased, and these trends will continue over the coming decades (*high confidence*).

Marine heatwaves will continue to increase (*high confidence*).

Fire weather seasons will lengthen and intensify, particularly in North Asia regions (*medium confidence*).

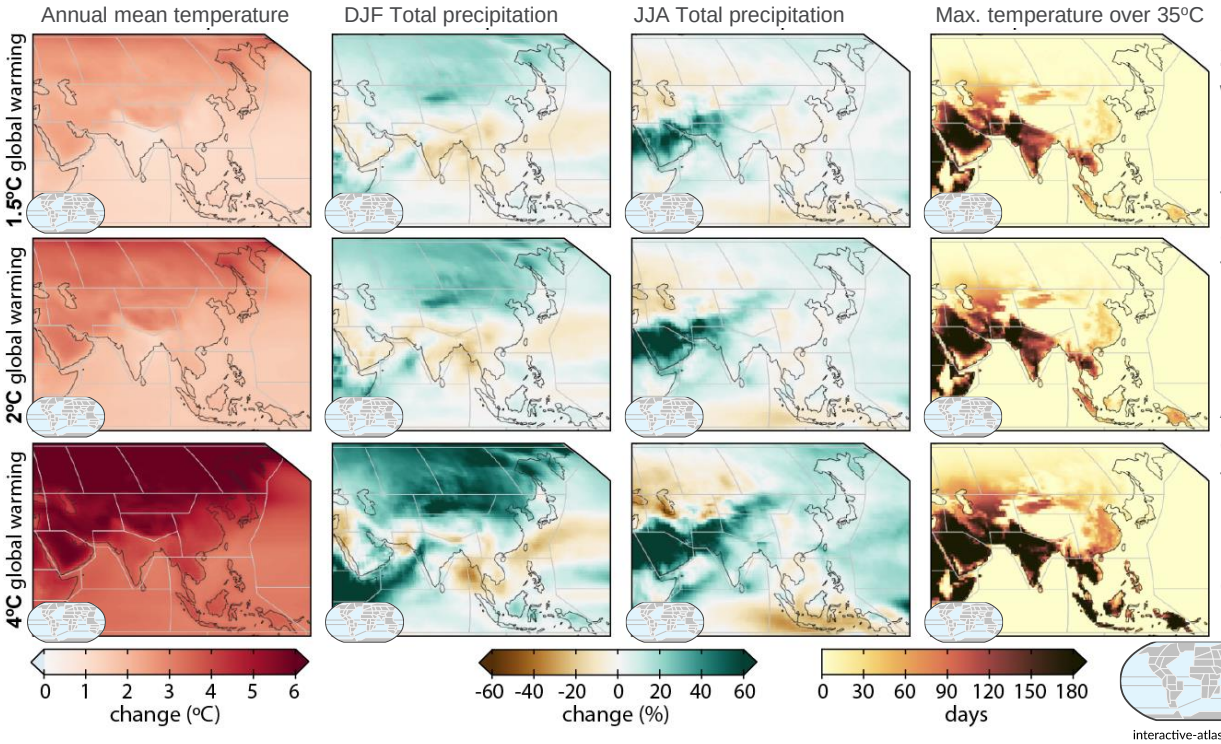
Average and heavy precipitation will increase over much of Asia (*high to medium confidence*).

Mean surface wind speeds have decreased (*high confidence*) and will continue to decrease in central and northern parts of Asia (*medium confidence*).

Glaciers are declining and permafrost is thawing. Seasonal snow duration, glacial mass, and permafrost area will decline further by the mid-21st century (*high confidence*).

Glacier runoff in the Asian high mountains will increase up to mid-21st century (*medium confidence*), and subsequently runoff may decrease due to the loss of glacier storage.

Relative sea level around Asia has increased faster than global average, with coastal area loss and shoreline retreat. Regional-mean sea level will continue to rise (*high confidence*).



Projections at 1.5ºC, 2ºC, and 4ºC global warming

Changes relative to the 1850–1900 in annual mean surface temperature, total precipitation (Dec–Feb, DJF), and total precipitation (Jun–Aug, JJA). Last column shows the total number of days per year with maximum temperature exceeding 35ºC.

Results expanded in the Interactive Atlas (active links)

Asian Monsoons

- The South and Southeast Asian monsoon has weakened in the second half of the 20th century (*high confidence*). The dominant cause of the observed decrease of South and Southeast Asian monsoon precipitation since mid-20th century is anthropogenic aerosol forcing.
- The dry-north and wet-south pattern of East Asian summer monsoon precipitation change results from the combined effects of greenhouse gases and aerosols (*high confidence*).
- In the near-term, South and Southeast Asian monsoon and East Asian summer monsoon precipitation will be dominated by the effects of internal variability (*medium confidence*).
- In the long-term, South and Southeast Asian monsoon and East Asian summer monsoon precipitation will increase (*medium confidence*).

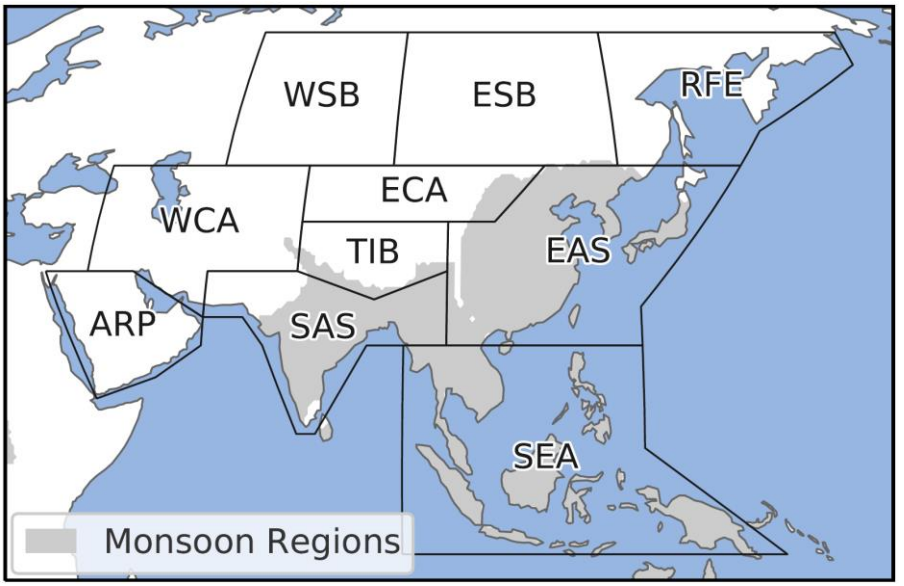
Common change: TS.4.3.1, TS.4.3.2.2, Box 9.2; 9.5; 11.5.5; 12.4.2. **Asia monsoon**: 8.3.2.4, Box 8.1, 8.4.2.4, Box TS.13. **North Asia:** 2.3.2, 8.2, 8.3, 8.4, Table 11.7, Table 11.8, Table 11.9, 12.4.2, Table 12.4, Atlas.5.2, TS.4.3.2.2, TS Table 4, TS Table 5. **East Asia**: TS4.3.2.2; 11.4; 11.7.1; Table 11.8; Table 11.9; 12.4.2; Atlas.5.1. **Tibetan Plateau**: CCB10.4, 11.4.5. **South Asia**: TS 4.3.2, 8.4.1, 11.3.2, 11.3.5, Table 11.5, 12.4.2, 12.5.2.1. Atlas 5.3.2, Atlas 5.3.5, Atlas 5.10. **Southeast Asia**: TS.4.3.2.2; 11.5.5; 11.7.1; 12.4.2; Atlas.5.4 **Southwest Asia**: 8.2, 8.3, 8.4, 9.5, Table 11.7, Table 11.8, Table 11.9, 12.4.2, Table 12.4, Atlas.5.5, TS.4.3.2.2, Table TS.4, Table TS.5

North Asia (WSB, ESB, RFE)

- Permafrost has thawed, its temperature increased, and seasonal snow duration and extent decreased while maximal snow depth has increased over the past 3 to 4 decades (*high confidence*). It is *virtually certain* that permafrost extent and volume will shrink with further global warming.
- Annual precipitation has increased since the mid-1970s (*very high confidence*) and rising heavy convective showers caused more intense floods (*medium confidence*). Projected increase in precipitation almost doubles the annual maximum river discharge with increased flooded area in major Siberian rivers by mid-21st century (*medium confidence*).
- The number of dry days has decreased for much of the region but increased in southwestern parts, where total soil moisture will decline and the fire season will lengthen (*medium confidence*).

Southwest Asia (WCA, ARP)

- Anthropogenic warming has amplified droughts since the 1980s (*high confidence*). An increase in extreme precipitation has been observed, mostly in elevated areas.
- Mountain permafrost degradation at high altitudes has increased the instability of mountain slopes in the past decade (*medium confidence*). Reduction of the annual maximum amount of snow increases with elevation in mountain areas.
- Annual precipitation totals, intensity, and frequency of heavy precipitation are projected to increase with increasing warming levels. Strong spatiotemporal differences with overall decreasing precipitation are projected in summer with the opposite tendency in winter.



Tibetan Plateau (TIB)

- Over most of the Hindu Kush Himalayan region, snow cover has reduced since the early 21st century, and glaciers have retreated and lost mass since the 1970s. The Karakoram glaciers have remained either in a balanced state or slightly gained mass. During the 21st century, snow-covered areas and snow volumes will decrease in most of the Hindu Kush Himalayan, and snowline elevations will rise and glacier volumes will decline (*high confidence*).
- A general wetting across the whole Tibetan Plateau and the Himalaya is projected, with increases in heavy precipitation in the 21st century.

South Asia (SAS)

- Heatwaves and humid heat stress will be more intense and frequent during the 21st century (*medium confidence*).
- Both annual and summer monsoon precipitation will increase during the 21st century, with enhanced interannual variability (*medium confidence*).

East Asia (EAS, ECA)

- Daily precipitation extremes have increased over parts of the region (*high confidence*). Heavy precipitation will increase in frequency and intensity (*high confidence*), leading to more frequent landslides in some mountain areas.
- Droughts have become more frequent in much of continental East Asia while arid Eastern Central Asia has become wetter (*medium confidence*).
- The rate of intensification and number of strong tropical cyclones have increased (*medium confidence*), and tropical cyclone tracks *likely* migrated poleward.

Southeast Asia (SEA)

- Future warming will be slightly less than the global average (*high confidence*).
- Observed mean rainfall trends are not spatially coherent or consistent across datasets and seasons (*high confidence*). Rainfall will increase in northern parts and decrease in the Maritime Continent (*medium confidence*).
- Compound impacts of climate change, land subsidence, and local human activities will lead to higher flood levels and prolonged inundation in the Mekong Delta (*high confidence*).
- Although there has been no significant long-term trend in the overall number of tropical cyclones, fewer but more extreme tropical cyclones have affected the region.

Regional fact sheet - Mountains

Common regional changes

The freezing level height in mountain areas is projected to rise and will alter snow and ice conditions (*high confidence*).

Warming has occurred in the Himalayas, the Swiss Alps, and the central Andes and has increased with altitude. Such elevation-dependent warming could lead to faster changes in the snowline, the glacier equilibrium-line altitude and the snow/rain transition height (*high confidence*).

With few exceptions, mountain glaciers have retreated since the second half of the 19th century (*very high confidence*). This retreat has occurred at increased rates since the 1990s, with human influence *very likely* being the main driver. This behaviour is unprecedented in at least the last 2,000 years (*medium confidence*). Furthermore, glaciers will continue to lose mass at least for several decades even if global temperature is stabilized (*very high confidence*).

The global warming-induced earlier onset of spring snowmelt and increased melting of glaciers have already contributed to seasonal changes in streamflow in low-elevation mountain catchments (*high confidence*).

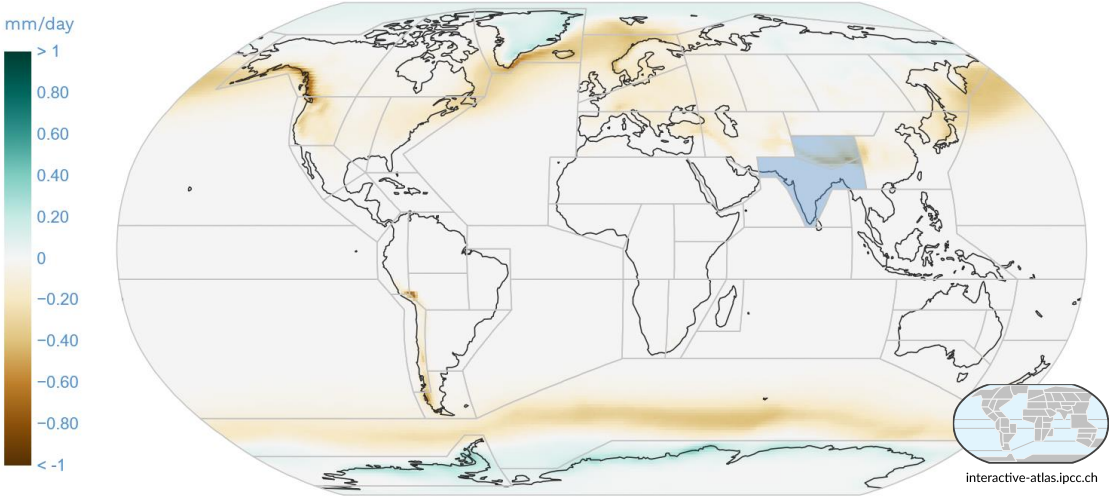
Mountain glaciers will continue to shrink and permafrost to thaw in all regions where they are present (*high confidence*). Mountain glaciers are projected to lose more mass in higher greenhouse gas emissions scenario over the 21st century (*medium confidence*).

It is *virtually certain* that snow cover will decline over most land regions during the 21st century, in terms of water equivalent, extent and annual duration.

Extreme precipitation is projected to increase in major mountainous regions (*medium to high confidence*, depending on location), with potential cascading consequences of floods, landslides and lake outbursts in all scenarios (*medium confidence*).

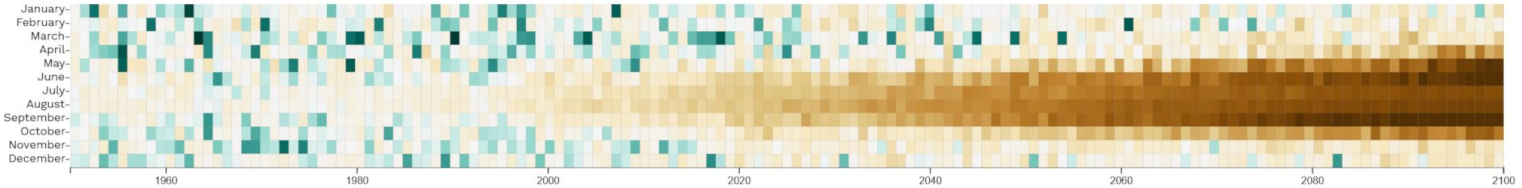
Projected runoff is typically decreased by contributions from small glaciers because of glacier mass loss, while runoff from larger glaciers will generally increase with increasing global warming levels until their mass becomes depleted (*high confidence*).

All the above-mentioned changes will pose challenges for water supply, energy production, ecosystems integrity, agricultural and forestry production, disaster preparedness, and ecotourism (*high confidence*) that will be assessed in the IPCC Working Group II report.

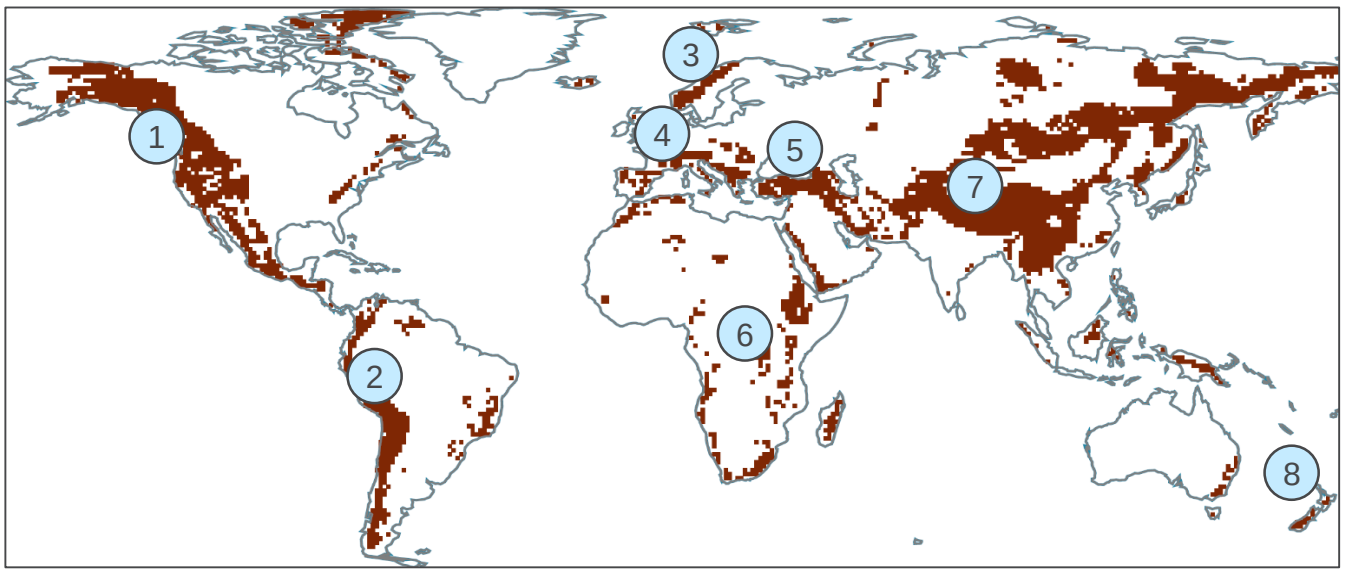


Projected annual snowfall change (mm/day) for 2°C global warming compared to 1850–1900 using the SSP5-8.5 scenario.

Results expanded in the Interactive Atlas (active links)



Projected changes in seasonal mountain snowfall (mm/day) in High Mountain Asia for GWL 2ºC using the very high emissions scenario (SSP5 8.5), relative to 1850–1900.



Typological mountain regions used in the report's Interactive Atlas. Labels correspond to the regions described below.

1 Rocky Mountains & Alaska

- Reduction in glaciers, seasonality of snow and ice formation, loss of shallow permafrost, and shifts in the rain/snow transition line are projected to alter the seasonal and geographic range of snow and ice conditions in the coming decades (*very high confidence*).
- Continued shrinkage of glaciers is projected to create further glacial lakes (*medium confidence*).

2 Andes

- Glacier volume loss and permafrost thawing will *likely* continue, causing important reductions in river flow and potentially high-magnitude glacial lake outburst floods.

3 Scandinavian Mountains

- Most periglacial debris-flow processes are projected to disappear by the end of 21st century, even for low-warming scenarios (*medium confidence*).

4 European Alps

- Elevation-enhanced long-term trends in maximum near-surface air temperature and diurnal temperature range were observed in the Swiss Alps.
- Snow cover will decrease below elevations of 1500–2000 m throughout the 21st century (*high confidence*). A reduction of glacier ice volume is projected with *high confidence*.

5 Caucasus & Pontic Mountains

- Mountain permafrost degradation at high altitudes has increased the instability of mountain slopes in the past decade (*medium confidence*).

6 East African Mountains

- African snow and glaciers have very significantly decreased in the last decades and this trend will continue over the 21st century (*high confidence*).

7 High Mountain Asia

- Snow cover has reduced since the early 21st century, and glaciers have thinned, retreated, and lost mass since the 1970s (*high confidence*), although the Karakoram glaciers have either slightly gained mass or are in an approximately balanced state (*medium confidence*).
- Snow-covered areas and snow volumes will decrease during the 21st century, snowline elevations will rise (*high confidence*) and glacier mass is *likely* to decline with greater mass loss in higher greenhouse gas emissions scenarios.
- Rising temperature and precipitation can increase the occurrence of glacial lake outburst floods and landslides over moraine-dammed lakes (*high confidence*).

8 Southern Alps

- Glacier ice volume in New Zealand has decreased in the last decades.

Links for further details:
Common changes: 12.4.10.4, TS.2.5, TS.4.3.1, TS.4.3.2.10, Box TS.6.
Rocky Mountains & Alaska: 12.4.6.4. **Andes:** 12.4.4.4. **Scandinavian Mountains. and European Alps**: 12.4.5.4 and 12.4.10.4. **Caucasus & Pontic Mountains**: TS.4.3.2.2. **East African Mountains**: 12.4.1.4.
High Mountain Asia: 12.4.2.4. **Southern Alps**: 12.4.3.4.