# Climate Change and Forest Fire

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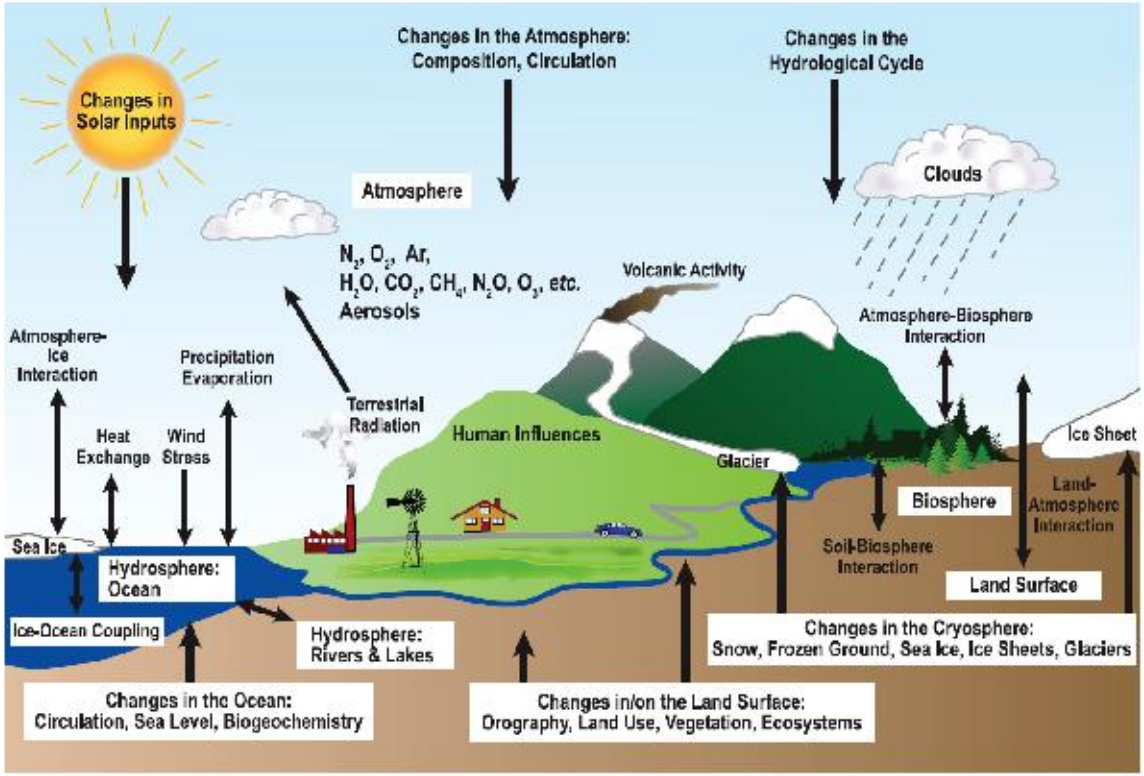
# Climate System

## What is the Relationship between Climate Change and Weather?

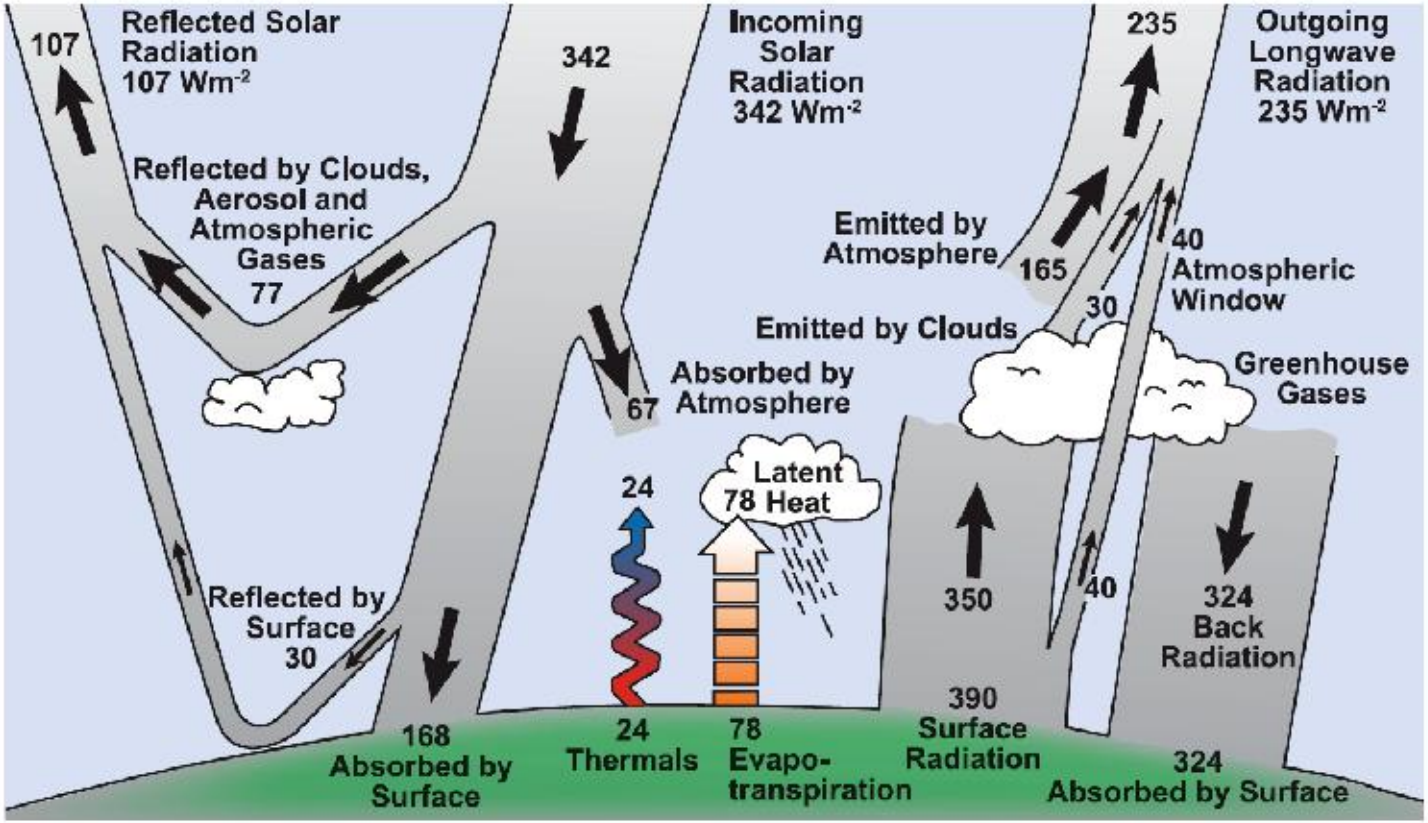
- **Schematic view of the components of the climate system, their processes and interactions**



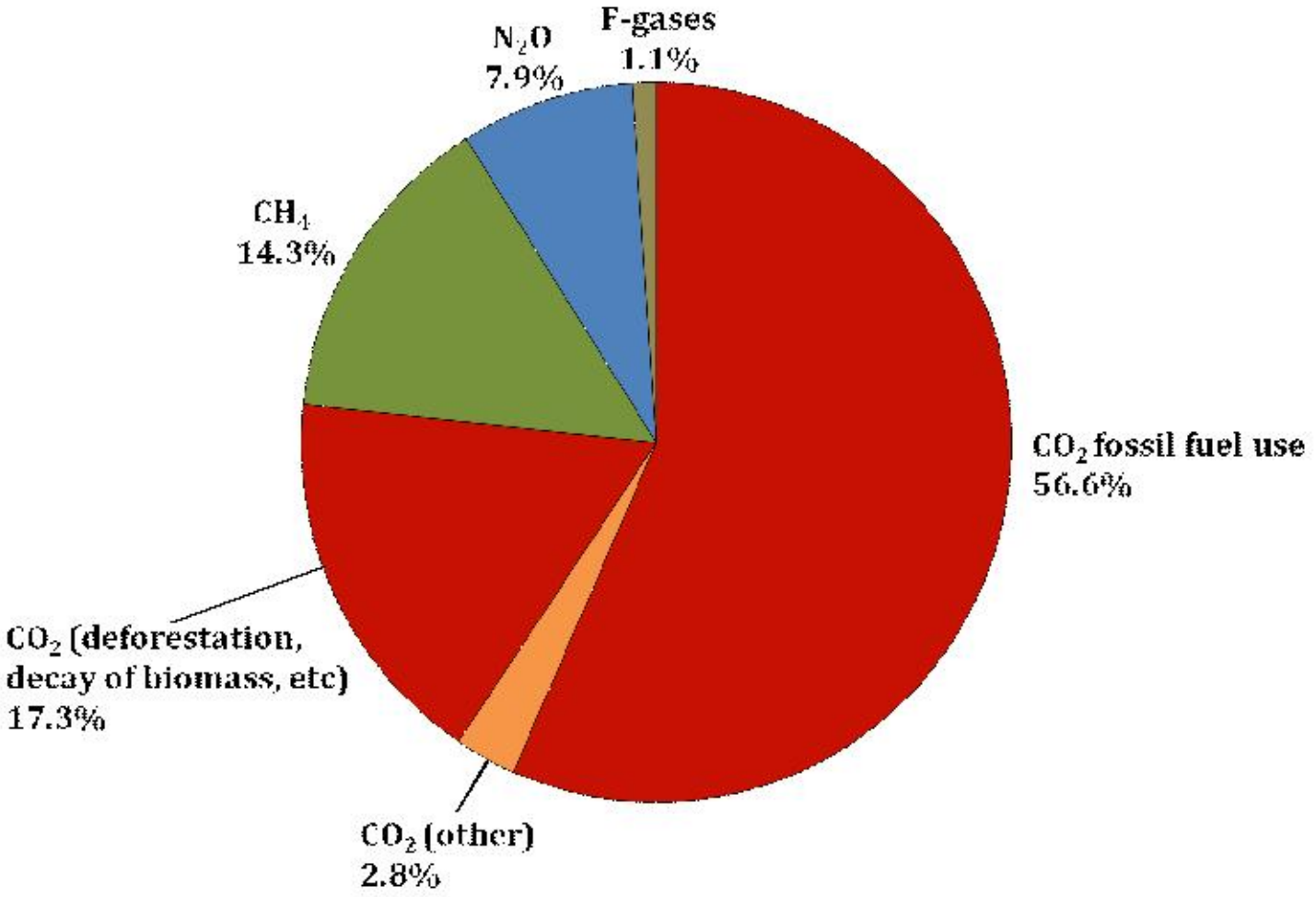
# Climate System

## What Factors Determine Earth's Climate?

- **Earth's annual and global mean energy balance**

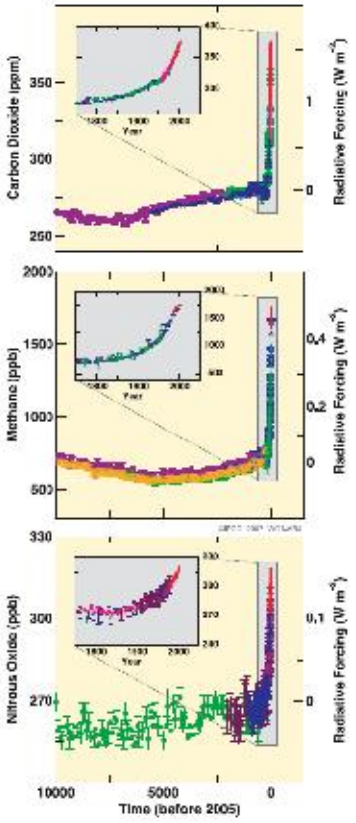


## Global anthropogenic greenhouse gas emissions in 2004 (IPCC2007c)



## Human and Natural Drivers of Climate Change

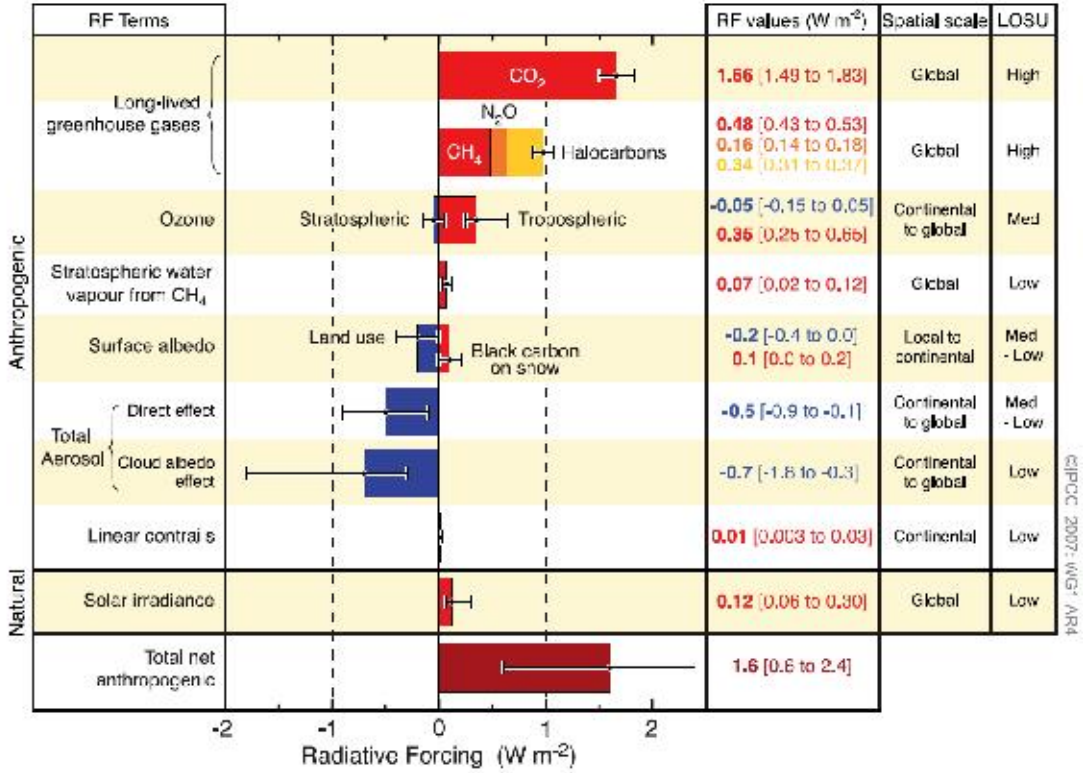
### Changes in Greenhouse Gases from Ice Core and Modern Data




☞ Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years.

# Climate Change; The Physical Science Basic

## Radiative Forcing Components

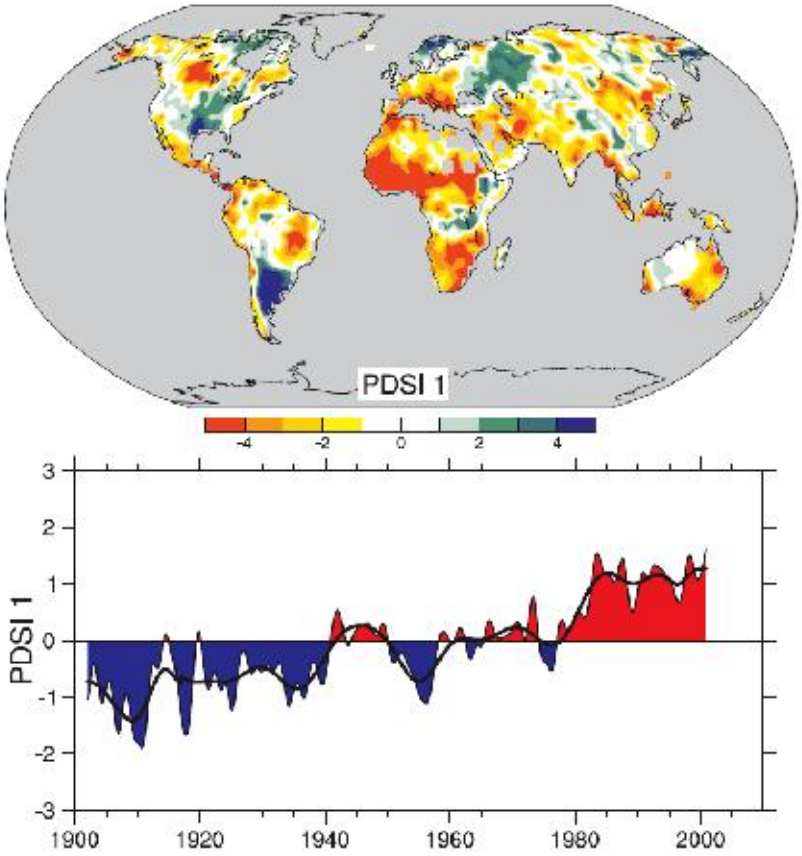



☞ The understanding of anthropogenic warming and cooling influences on climate has improved since the TAR, leading to very high confidence that the global average net effect of human activities since 1750 has been on of warming, with a radiative forcing of +1.6[+0.6 to +2.4] $Wm^{-2}$

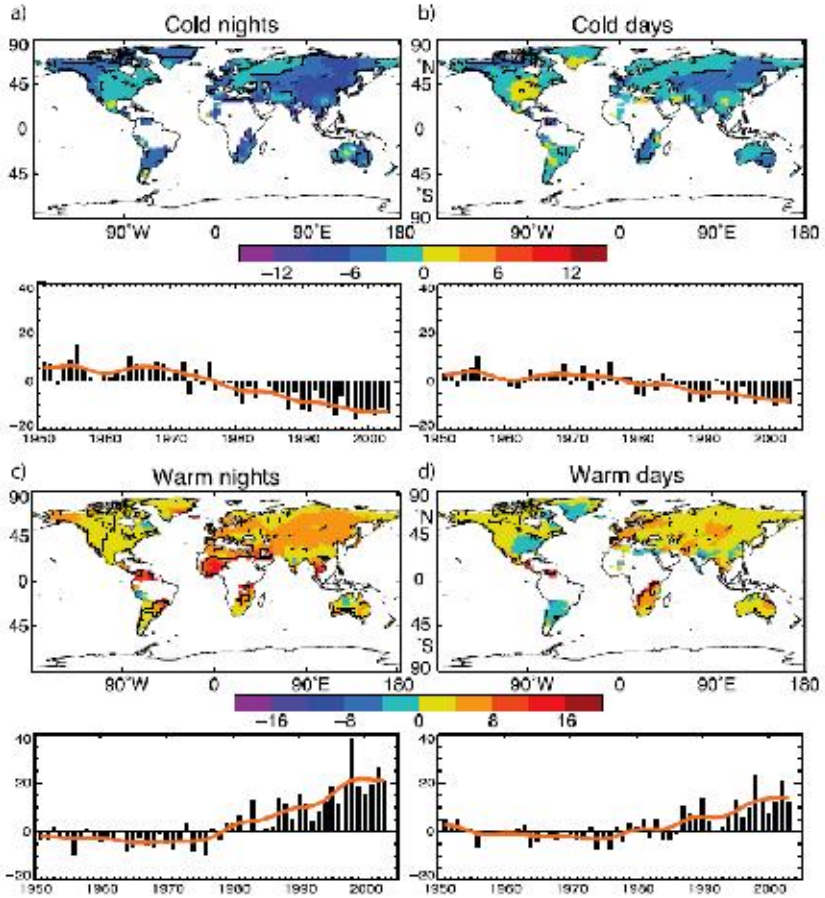
# Climate Change; Precipitation

## How is Precipitation Changing?

- Monthly Palmer Drought Severity Index for 1900 to 2002

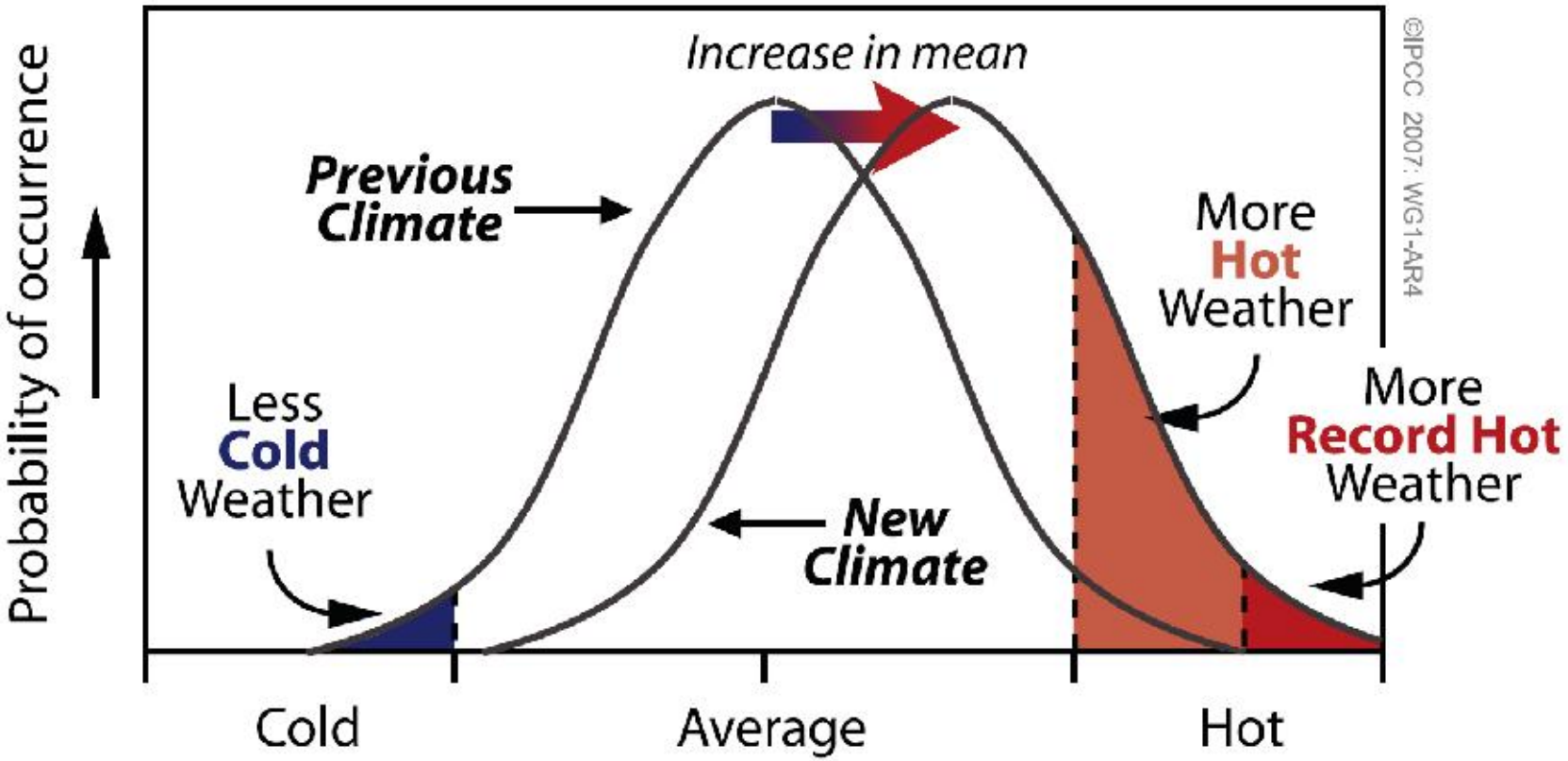


# Has there been a change in Extreme Events like Heat Waves, Drought, Floods and Hurricanes?



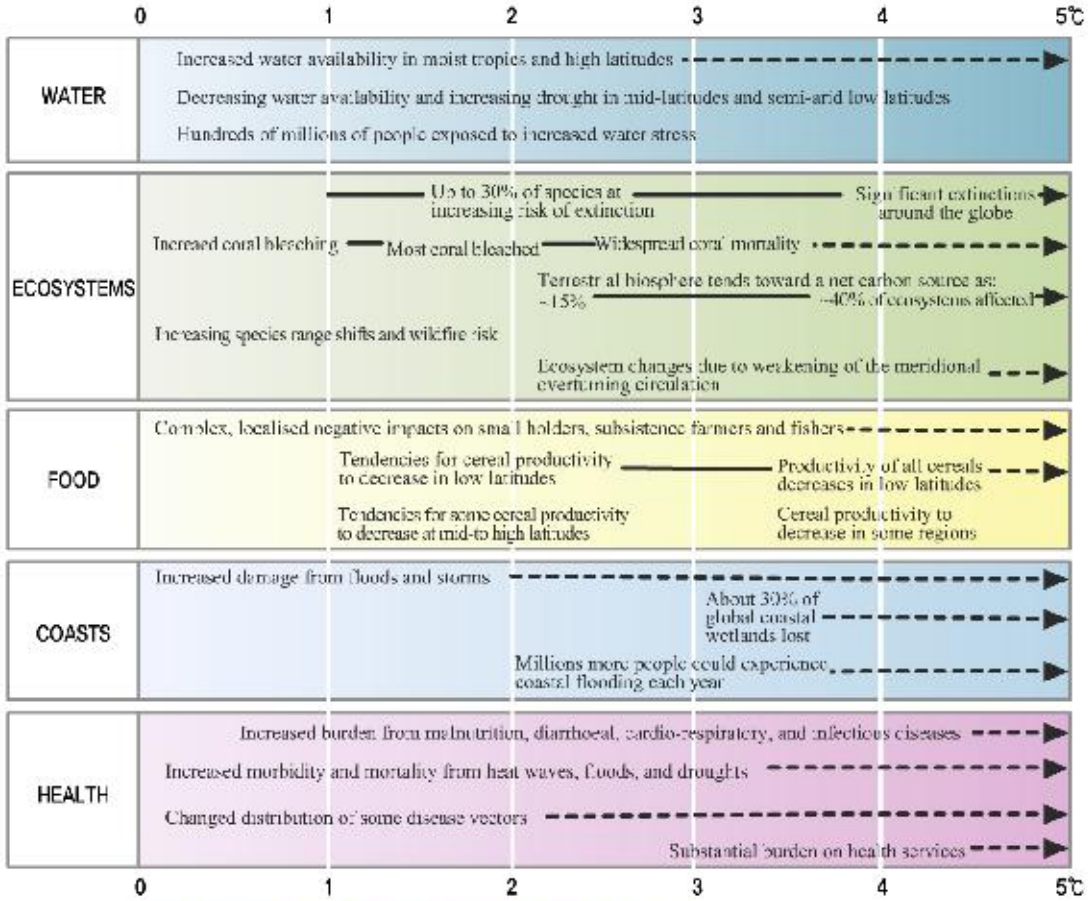
# Extreme Weather Index

**The effect on extreme temperatures when the mean temperature increases, for a normal temperature distribution**



# Climate Change; Impacts, Adaption and Vulnerability

## Global mean annual temperature change relative to 1980-1999

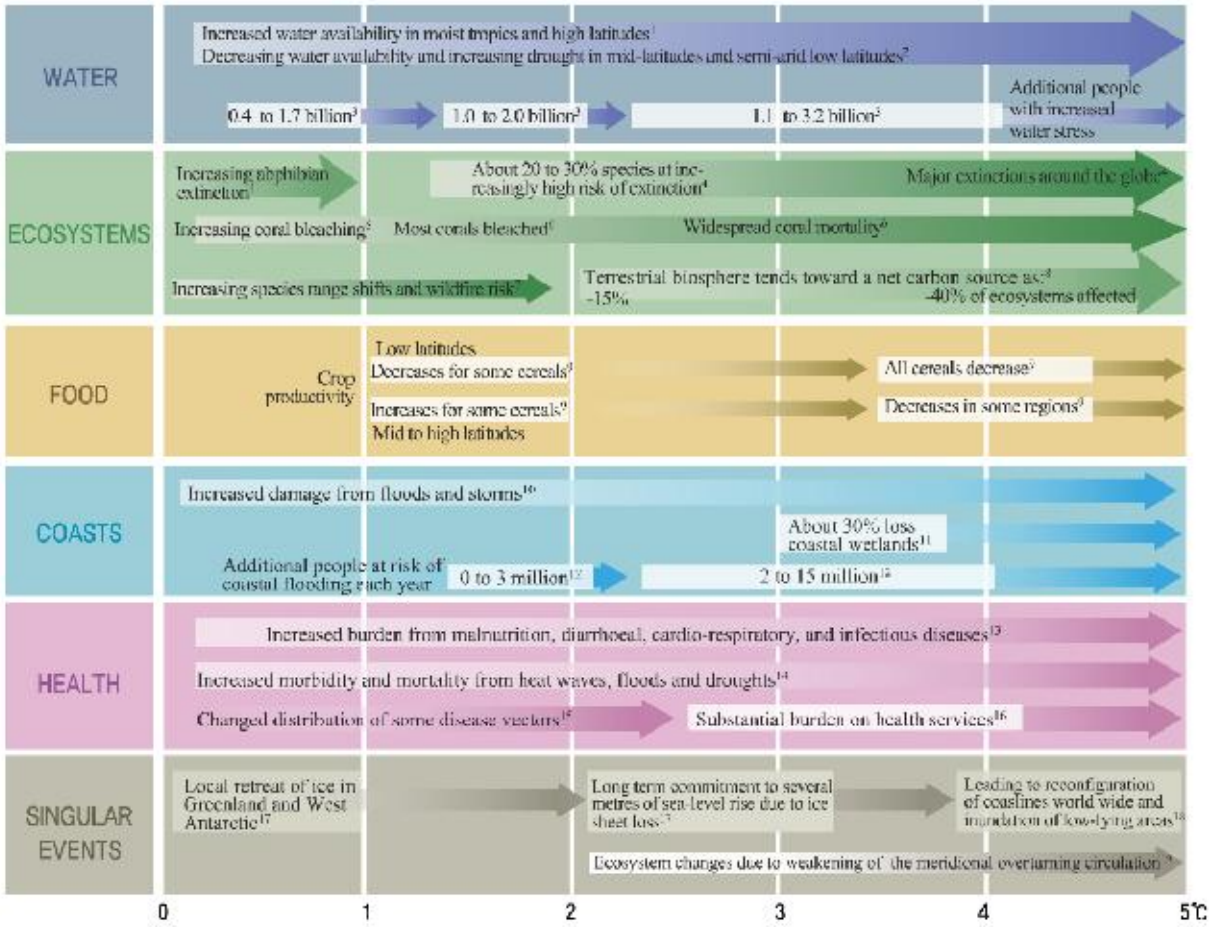



†Significant is defined here as more than 40%.

‡Based on average rate of sea level rise of 4.2 mm/year from 2000 to 2080.

# Climate Change; Impacts, Adaption and Vulnerability

## Global mean annual temperature change relative to 1980-1999



# Climate Change; Impacts, Adaption and Vulnerability

## Example of possible of climate change due to changes in extreme weather and climate events, based on projections to the mid-to late 21st century

| Phenomenon[a] and direction of trend | Likelihood of future trends based on projections for 21st century using SRES scenarios | Examples of major projected impacts by sector | | |
|---|---|---|---|---|
| | | Agriculture, forestry And ecosystems | Water resources | Industry, settlement and society |
| Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights | Virtually certain[b] | Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks | Effects on water resources relying on snow melt; effects on some water supplies | Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice; effects on winter tourism |
| Warm spells/heat waves. Frequency increases over most land areas | Very likely | Reduced yields in warmer regions due to heat stress; increased danger of wildfire | Increased water demand; water quality problems, e.g., algal blooms | Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor |

# Climate Change; Impacts, Adaption and Vulnerability

| Phenomenon[a] and direction of trend | Likelihood of future trends based on projections for 21st century using SRES scenarios | Examples of major projected impacts by sector | | |
|---|---|---|---|---|
| | | Agriculture, forestry and ecosystems | Water resources | Industry, settlement and society |
| Heavy precipitation events. Frequency increases over most areas | Very likely | Damage to crops; soil erosion, inability to cultivate land due to water logging of soils | Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved | Disruption of settlements, commerce, transport and societies due to flooding; pressures on urban and rural infrastructures; loss of property |
| Area affected by drought increases | Likely | Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire | More widespread water stress | Water shortages for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration |
| Intense tropical cyclone activity increases | Likely | Damage to crops; windthrow (uprooting) of trees; damage to coral reefs | Power outages causing disruption of public water supply | Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers, potential for population migration, loss of property |

# *Ten myths about fire policy and fire ecology (Wuerthner 2006)*

1. Fire is bad and needs to be suppressed.
2. Big fires are the result of too much fuel.
3. Logging mimics fire.
4. Big fires can be stopped.
5. Fire "Destroys" forests and wildfire.

# *Ten myths about fire policy and fire ecology (Wuerthner 2006)*

6. Fire "Sterilizes" the land.

7. North American landscapes were widely managed by native American fire use.

8. Livestock Grazing can prevent fires.

9. Salvage logging after a fire is necessary to restore forests.

10. Prescribed burning is an adequate substitute for wildfire.

## Nitschke and Innes (2008)

*Increased warming and drying*

- drier forest fuel
- increasing fire ignition and propagation
- increasing the risk of extreme fire
- increasing fire season length
- increasing the costs of fire suppression
- increasing the risks faced by ecosystems and biodiversity to climate change
- increasing the costs and difficulty of achieving SFM

# Climate Change and Forest Fire

## Sierra Nevada mountains, California

### Matthew and Malcolm (2008)

*Nitrogen deposition + Climate change*

- herb and shrub biomass increase
- increasing fire severity and size

## Kilimanjaro mountain

### Hemp (2005)

**In contrast to common belief, global warming does not cause upward migration of plants and animals**

*Warmer and drier climate*

- increase of frequency and intensity of fires + downward shift of the upper forest line by several hundred meters

# Climate Change and Forest Fire

## European Alps

### Schumacher and Bugmann (2006)

Climate change

- extensive forest cover changes
  And fire is as important for shaping the landscape
  as the direct effects of climate change

## Pitman et al. (2007)

- the likelihood of a significant increase in fire risk over Australia

  resulting from climate change is very high

## Savanna biome

### Beerling and Osborne (2006)

- Fire accelerates forest loss and C4 grassland expansion
  the ingress of C4 grasses increase ecosystem flammability

  promote and sustain savannas for million of years

## Boreal Forests in Alaska

## Waldrop and Harden (2008)

Changes in microbial biomass, activity, or community structure induced by fire also affect decomposition and heterotrophic respiration at the ecosystem scale in boreal forests.

Five years following fire, organic surface horizons had lower microbial biomass, fungal biomass, and dissolved organic carbon concentrations compared with control soils.

Reductions in soil fungi were associated with reductions in phenol oxidase activity and lignin decomposition.

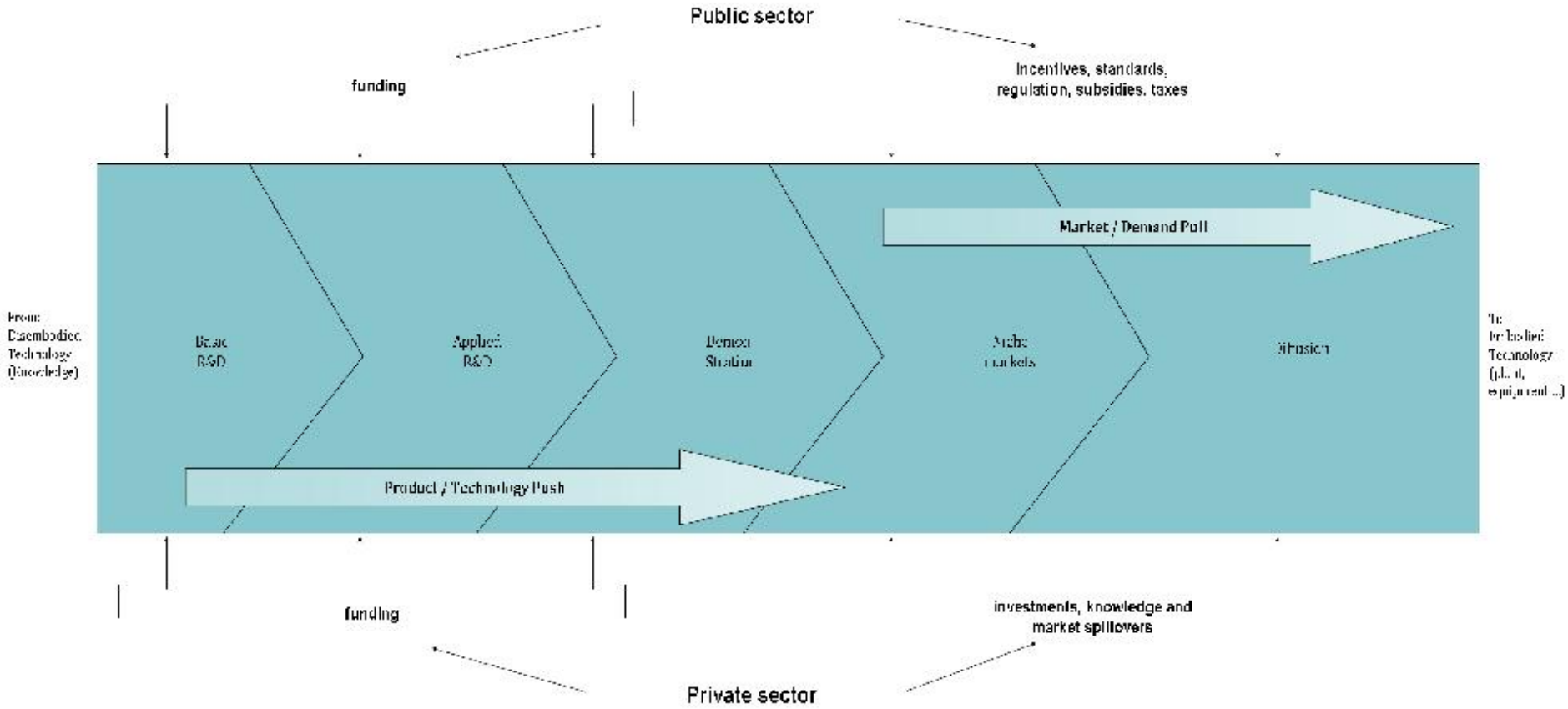
Fungal abundance and moisture were strong predictors of phenol oxidase enzyme activity in soil.

Phenol oxidase enzyme activity, in turn, was linearly related to both 13C lignin decomposition and microbial respiration

- reductions in fungal biomass in post fire soils reduced the potential of soil heterotrophs to decompose soil carbon

# Discussion and Conclusion

## The technology development cycle and its main driving forces



# Discussion and Conclusion

## Conclusion

The incidence and severity of forest fire are linked to the interaction between climate, fuel and topography.

- Ecosystem scale + social and economic aspects
- Ecosystem approach