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Evidence & Causes 2020

over winter in some regions, where beetle outbreaks have destroyed forests.

the balance of ecosystems; for example, warmer temperatures have allowed more bark beetles to survive

possible) or rapidly adapt. Other species may fare better in the new conditions, causing abrupt shifts in

ocean corals—will no longer be able to survive in their current habitats and will be forced to relocate (if

natural systems, as air and water temperatures rise, some species—such as the mountain pika and many

sea walls, or when thawing permafrost causes the sudden collapse of pipelines, buildings, or roads. In

cause abrupt changes in the utility of the infrastructure—such as when rising sea levels suddenly surpass

built to accommodate the climate variability at the time of construction. Gradual climate changes can

trigger abrupt changes in other systems. In human systems, for example, infrastructure has typically been

In addition to abrupt changes in the climate system itself, steady climate change can cross thresholds that

we risk large and abrupt changes.

Scientists are therefore continuing to study the possibility of exceeding such tipping points, beyond which

ensue. Such high-risk changes are considered unlikely in this century, but are by deﬁnition hard to predict.

a large amount of methane. If such a rapid release occurred, then major, fast climate changes would

greenhouse gas) trapped in ocean sediments and permafrost, potentially leading to a rapid release of

Another concern relates to the Arctic, where substantial warming could destabilise methane (a

sheet is gradual, however, and hence is not expected to cause abrupt changes.

around the Northern Hemisphere. Freshening of the North Atlantic from the melting of the Greenland ice

led to slowing down of this overturning circulation. This in turn caused widespread changes in climate

Gulf Stream. During the last ice age, pulses of freshwater from the melting ice sheet over North America

water sinking in the North Atlantic and involves the transport of extra heat to the North Atlantic via the

A well-known example is the south-north ocean overturning circulation, which is maintained by cold salty

has been exceeded.

involves many competing processes that could switch the climate into a different state once a threshold

millions of years, so we are headed for unknown territory, and uncertainty is large. The climate system

The composition of the atmosphere is changing towards conditions that have not been experienced for

major abrupt changes cannot be ruled out.

Arctic sea ice extent (see Question 12), and as warming increases, the possibility of other

of scientiﬁc research. Some abrupt changes are already underway, such as the decrease in

the release of methane and carbon dioxide from thawing permafrost, remain active areas

Stream, in the near future. However, this and other potential high-risk abrupt changes, like

collapse of) the Atlantic Meridional Overturning Circulation, which includes the Gulf

Results from the best available climate models do not predict an abrupt change in (or

the Arctic a cause for concern?

Stream” and release of methane from

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points like “turning off the Gulf

Are disaster scenarios about tipping

Q& A n

