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Geoengineering Risks

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Can Dr. Evil Save The World?

Forget about a future filled with wind farms and hydrogen cars. The Pentagon's top weaponeer says he has a radical solution that would stop global warming now -- no matter how much oil we burn.

Jeff Goodell
Rolling Stone
November 3, 2006

Reasons geoengineering may be a bad idea

Climate system response

1. **Regional climate change, including temperature and precipitation**
2. Rapid warming when it stops
3. How rapidly could effects be stopped?
4. Continued ocean acidification
5. Ozone depletion
6. Enhanced acid precipitation
7. Whitening of the sky (but nice sunsets)
8. Less solar radiation for solar power, especially for those requiring direct radiation
9. Effects on plants of changing the amount of solar radiation and partitioning between direct and diffuse
10. Effects on cirrus clouds as aerosols fall into the troposphere
11. Environmental impacts of aerosol injection, including producing and delivering aerosols

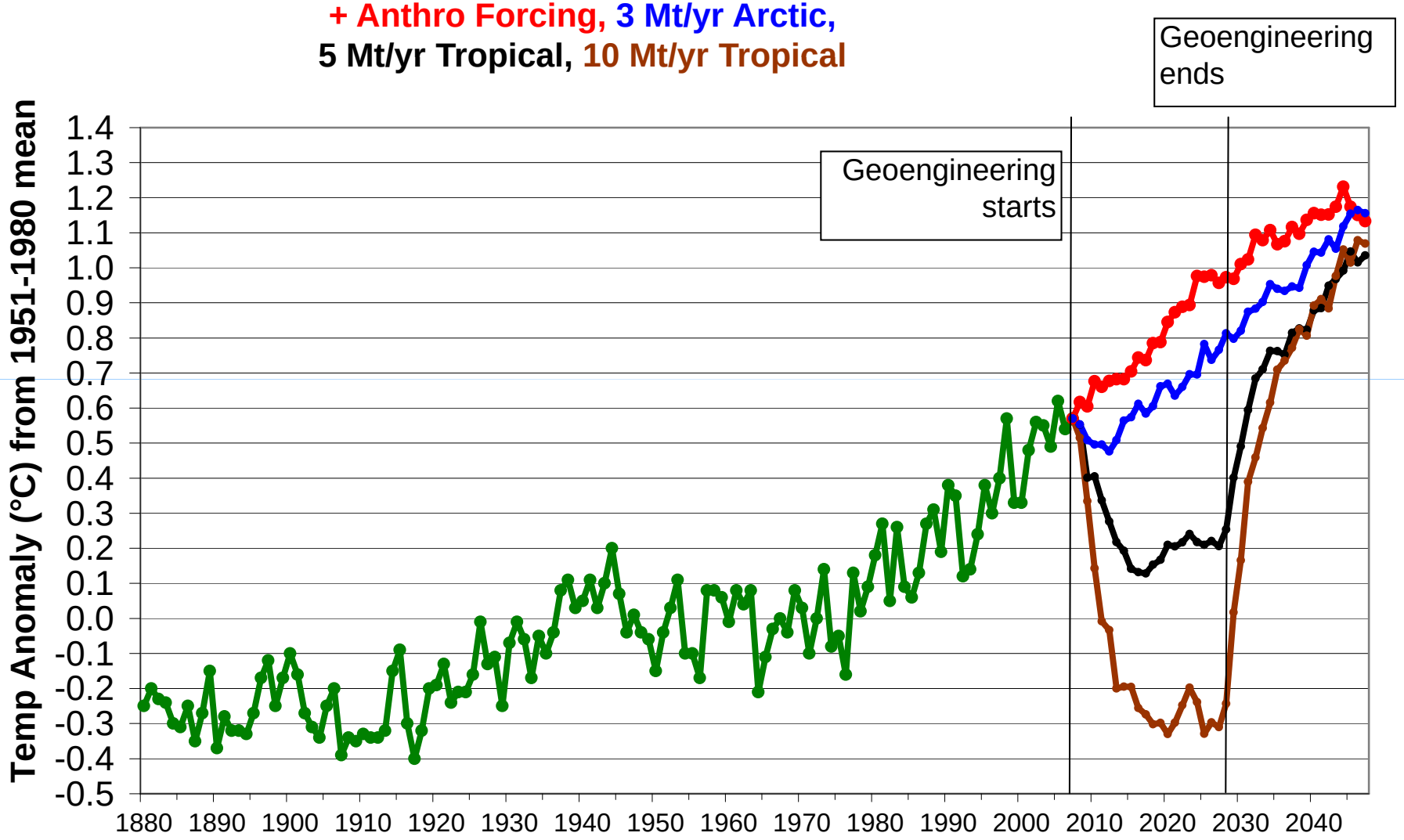
Robock, Alan, 2008: 20 reasons why geoengineering may be a bad idea. *Bull. Atomic Scientists*, **64**, No. 2, 14-18, 59, doi:10.2968/064002006.

We conducted the following geoengineering simulations with the NASA GISS ModelE atmosphere-ocean general circulation model run at 4°x 5° horizontal resolution with 23 vertical levels up to 80 km, coupled to a 4°x 5° dynamic ocean with 13 vertical levels and an online chemistry and transport module:

- 80-yr control run
- 40-yr anthropogenic forcing, IPCC A1B scenario: greenhouse gases (CO_2, CH_4, N_2O, O_3) and tropospheric aerosols (sulfate, biogenic, and soot), 3-member ensemble
- 40-yr IPCC A1B + Arctic lower stratospheric injection of 3 Mt SO_2/yr, 3-member ensemble
- 40-yr IPCC A1B + Tropical lower stratospheric injection of 5 Mt SO_2/yr, 3-member ensemble
- 40-yr IPCC A1B + Tropical lower stratospheric injection of 10 Mt SO_2/yr

Robock, Alan, Luke Oman, and Georgiy Stenchikov, 2008: Regional climate responses to geoengineering with tropical and Arctic SO_2 injections. *J. Geophys. Res.*, **113**, D16101, doi:10.1029/2008JD010050

GISS Global Average Temperature Anomaly
+ Anthro Forcing, 3 Mt/yr Arctic,
5 Mt/yr Tropical, 10 Mt/yr Tropical



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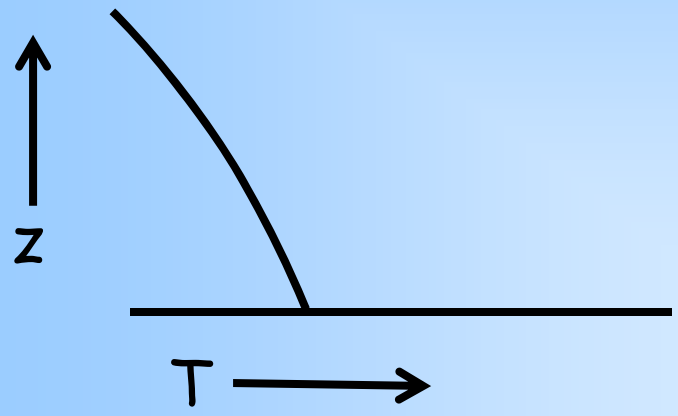
Reducing solar radiation to keep temperature constant **reduces precipitation**



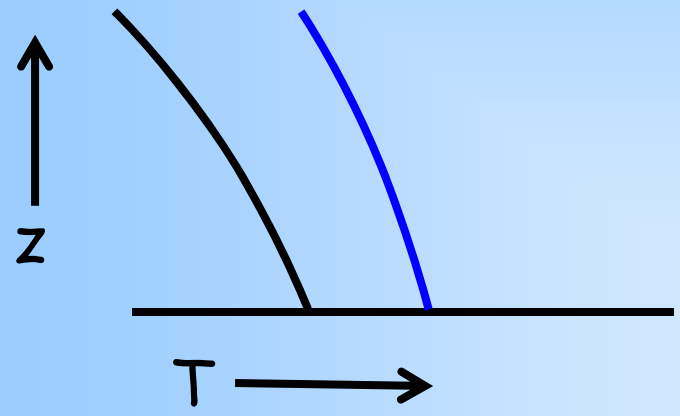
If we compensate for the increased downward longwave radiation from greenhouse gases by reducing solar radiation by the same amount, we can produce a net radiation balance at the surface so temperature will not change.

However, this will result in a reduction of precipitation, since changing solar radiation has a larger impact on precipitation than changing longwave radiation.

This will produce warming from drier surfaces requiring even more solar reduction and more drying.

Reducing solar radiation to keep temperature constant **reduces precipitation**

Increasing short wave to warm surface



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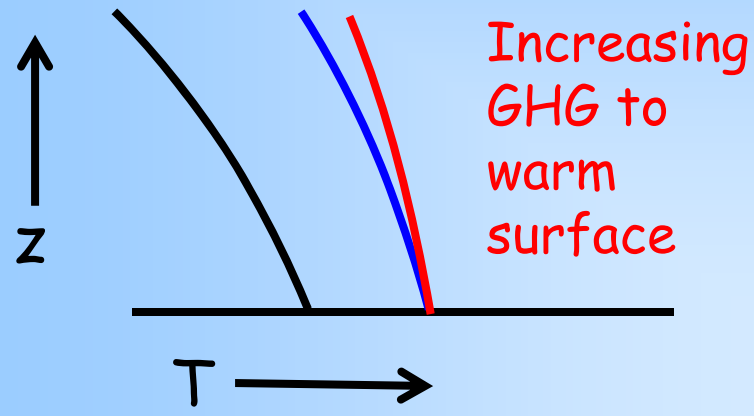

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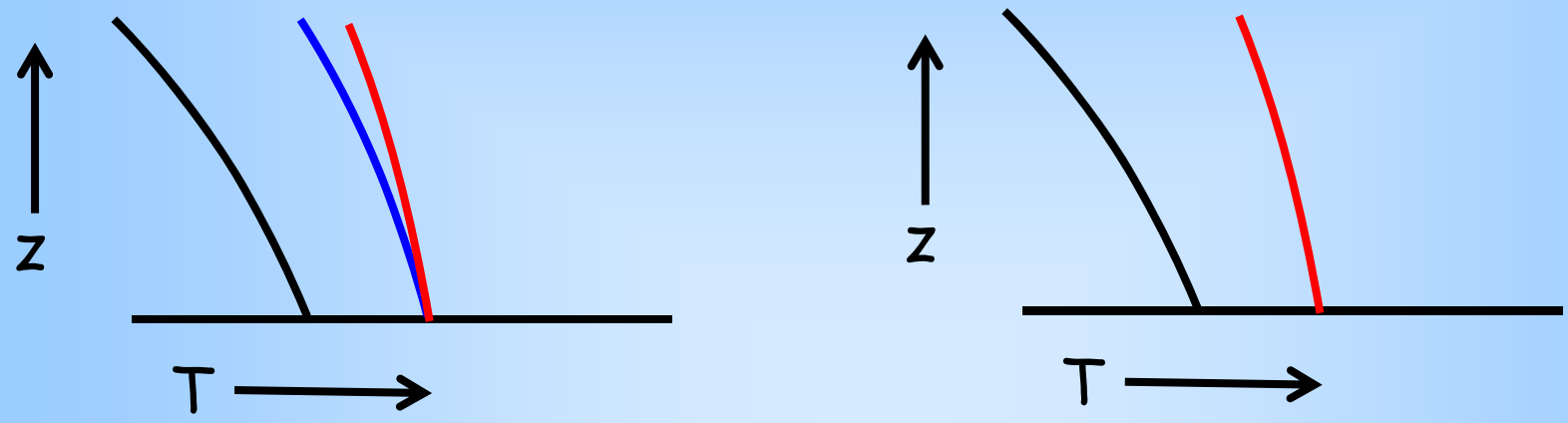

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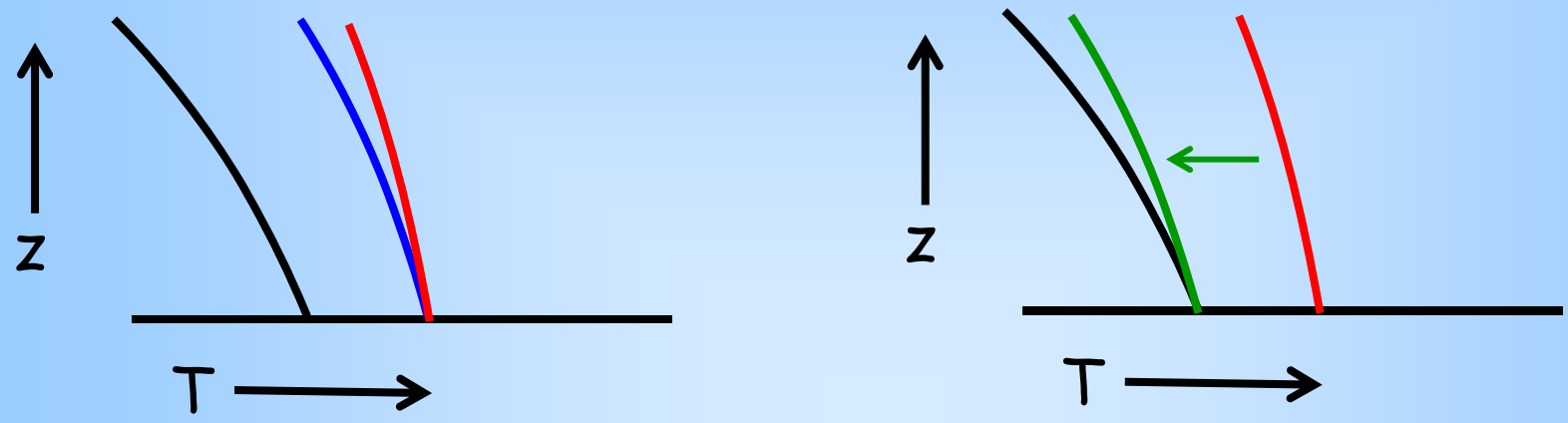
Reducing solar radiation to keep temperature constant **reduces precipitation**

Decreasing short wave to cool surface



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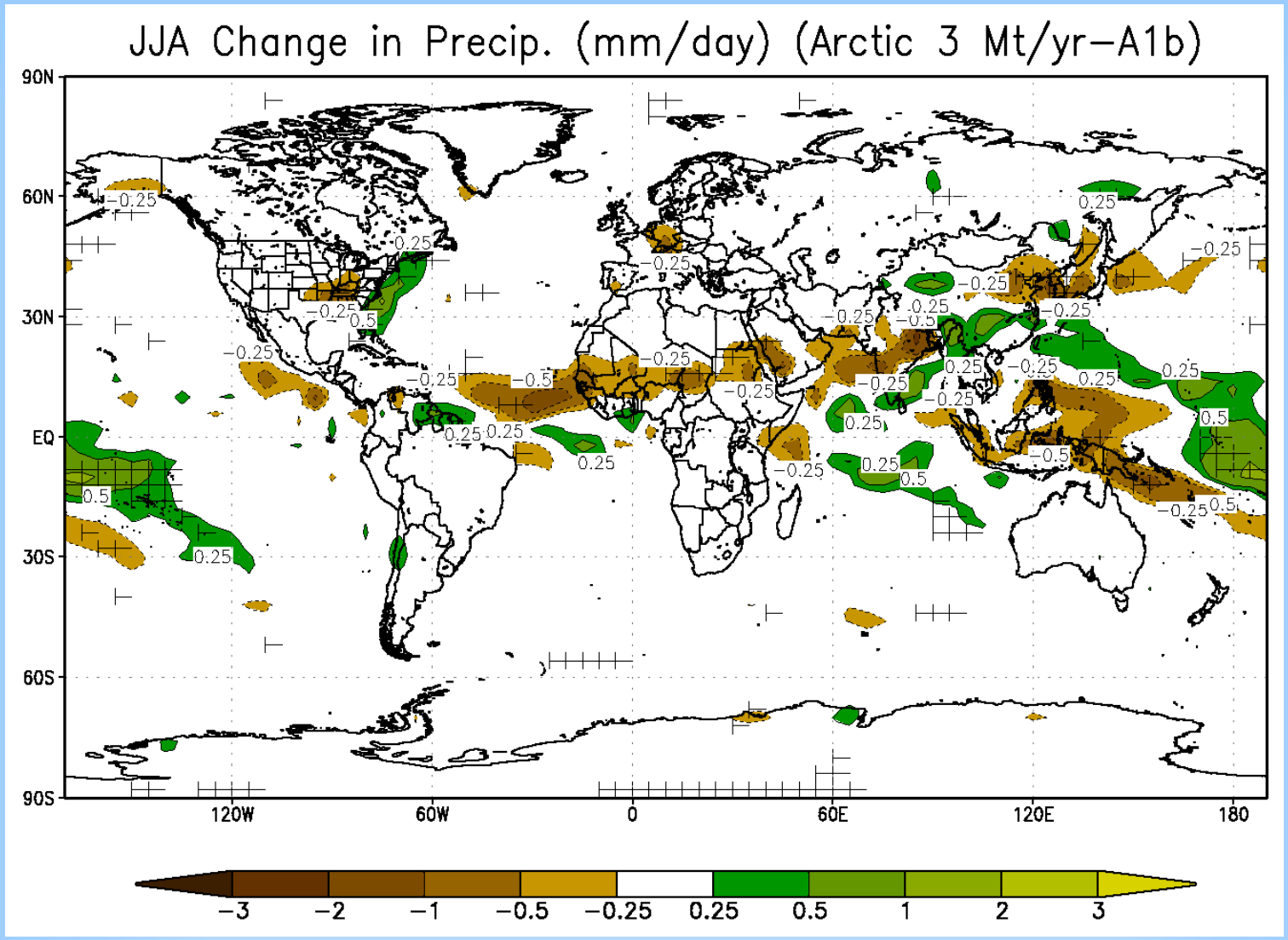

= significant at the 95% level

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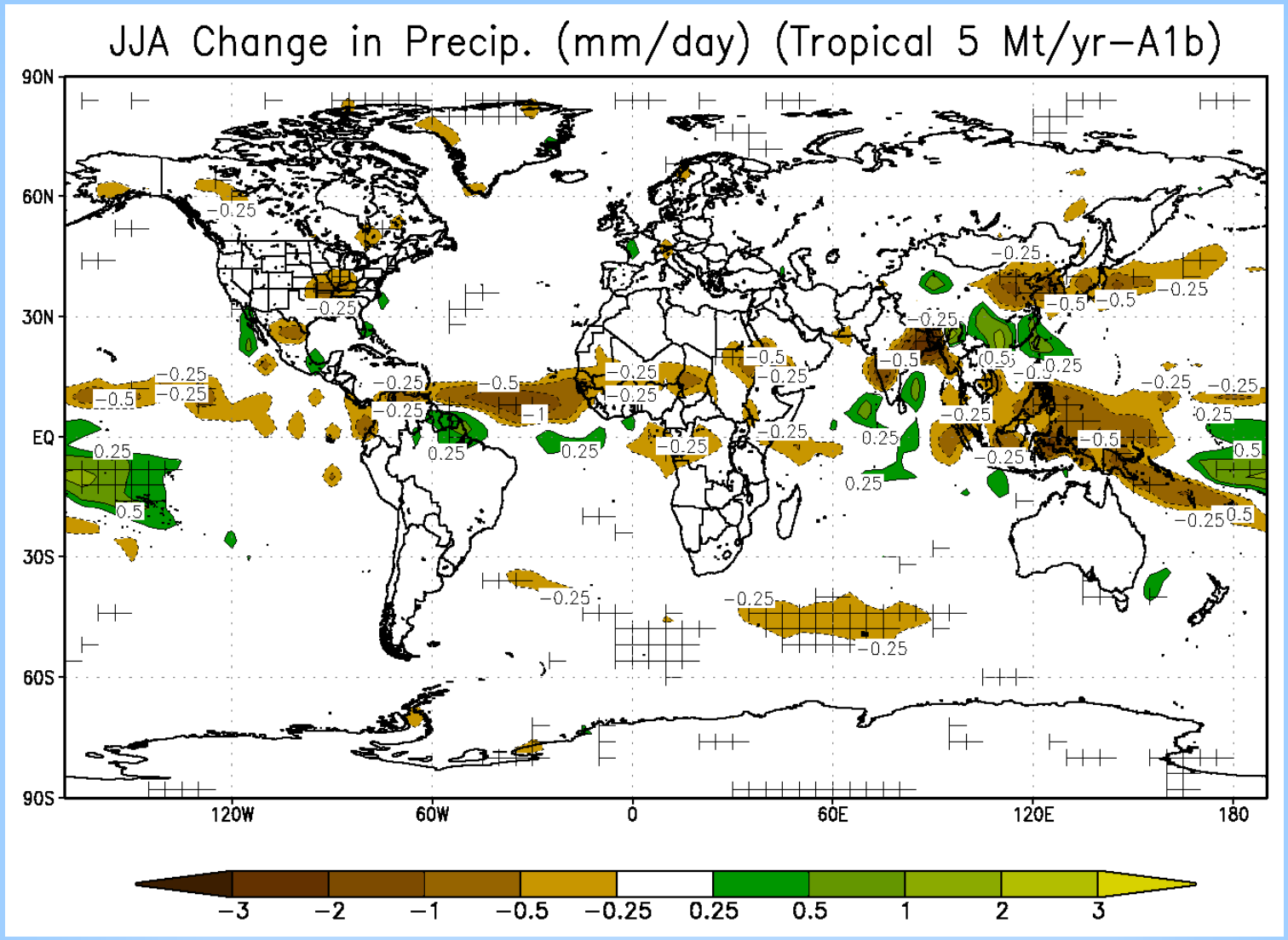

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Reasons geoengineering may be a bad idea

Unknowns

✓12. Human error
✓13. Unexpected consequences (How well can we predict the expected effects of geoengineering? What about unforeseen effects?)

Political, ethical and moral issues

✓14. Schemes perceived to work will lessen the incentive to mitigate greenhouse gas emissions
✓15. Use of the technology for military purposes. Are we developing weapons?
✓16. Commercial control of technology
✓17. Violates UN Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques
18. Could be tremendously expensive
19. Even if it works, whose hand will be on the thermostat? How could the world agree on the optimal climate?
20. Who has the moral right to advertently modify the global climate?

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Stratospheric Geoengineering

Benefits

1. Cool planet
2. Reduce or reverse sea ice melting
3. Reduce or reverse ice sheet melting
4. Reduce or reverse sea level rise
5. Increase plant productivity
6. Increase terrestrial CO_2 sink
7. Beautiful red and yellow sunsets
8. Control of precipitation?
9. Unexpected benefits

Each of these needs to be quantified so that society can make informed decisions.

Risks

1. Drought in Africa and Asia
2. Perturb ecology with more diffuse radiation
3. Ozone depletion
4. Continued ocean acidification
5. Impacts on tropospheric chemistry
6. Whiter skies
7. Less solar electricity generation
8. Degrade passive solar heating
9. Rapid warming if stopped
10. Cannot stop effects quickly
11. Human error
12. Unexpected consequences
13. Commercial control
14. Military use of technology
15. Conflicts with current treaties
16. Whose hand on the thermostat?
17. Effects on airplanes flying in stratosphere
18. Effects on electrical properties of atmosphere
19. Environmental impact of implementation
20. Degrade terrestrial optical astronomy
21. Affect stargazing
22. Affect satellite remote sensing
23. More sunburn
24. Moral hazard – the prospect of it working would reduce drive for mitigation
25. Moral authority – do we have the right to do this?

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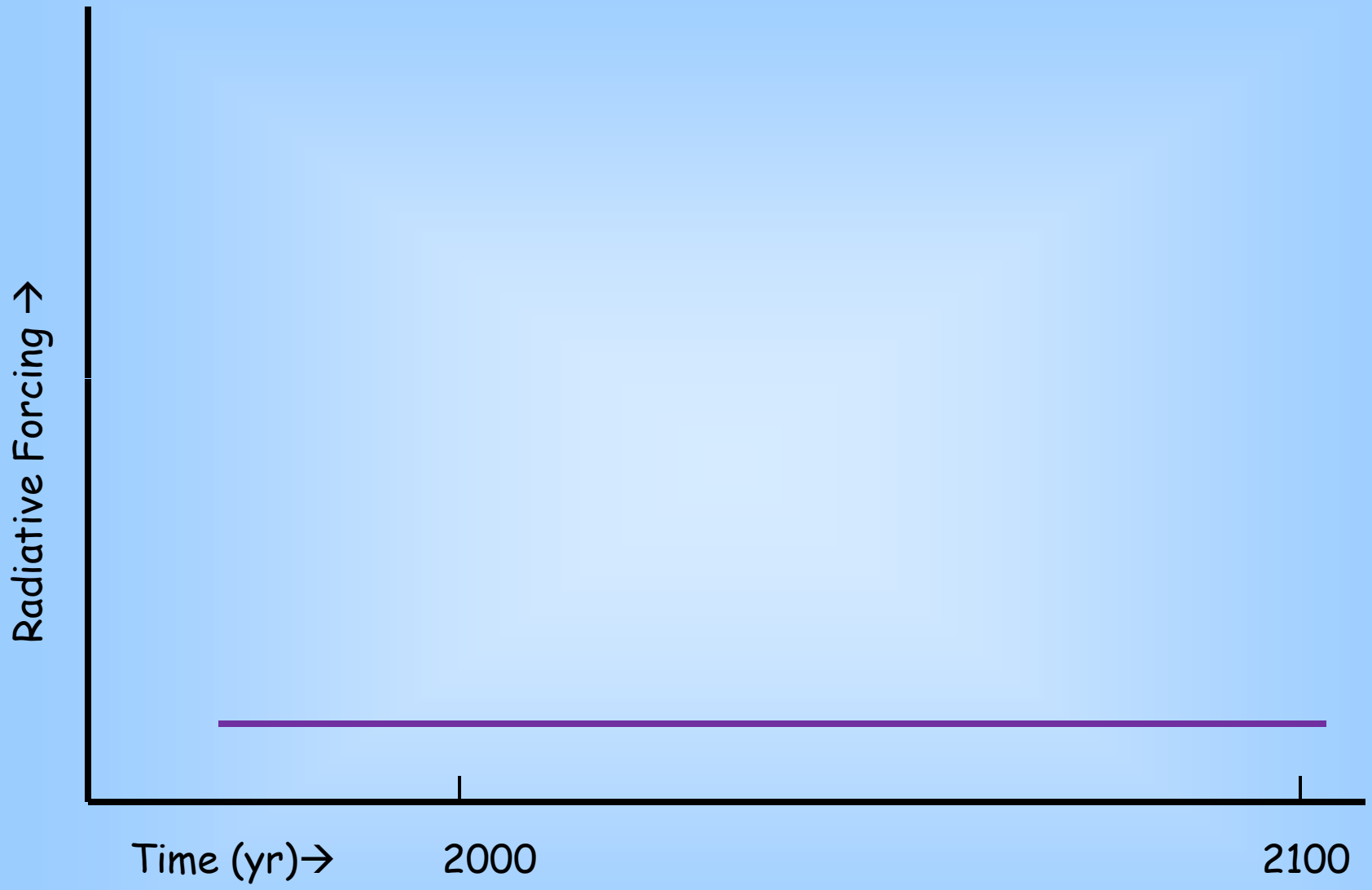
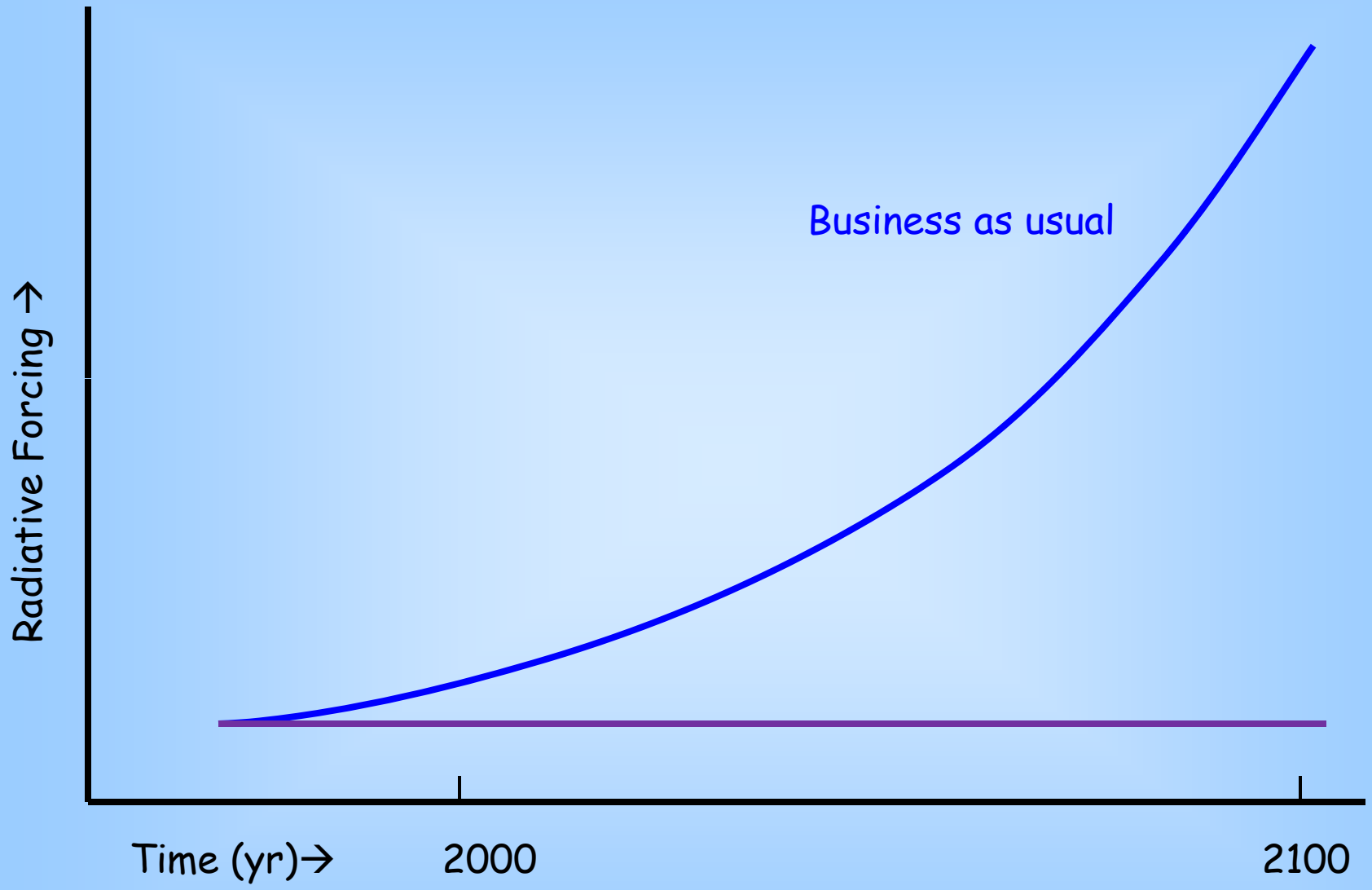
Robock, Alan, Allison B. Marquardt, Ben Kravitz, and Georgiy Stenchikov, 2009: The benefits, risks, and costs of stratospheric geoengineering. *Geophys. Res. Lett.*, **36**, L19703, doi:10.1029/2009GL039209.


Radiative Forcing →
Time (yr)→
2000
2100



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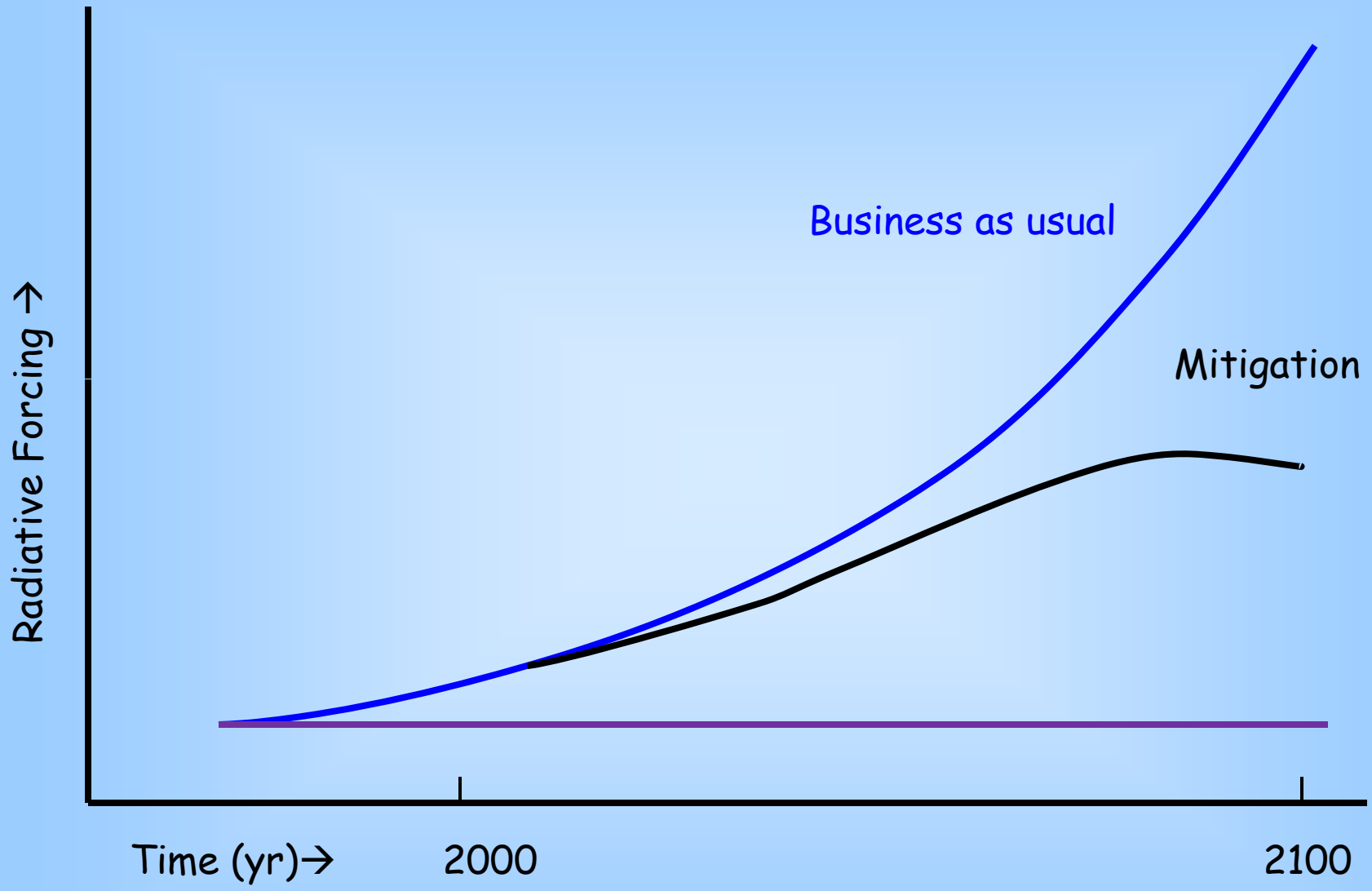

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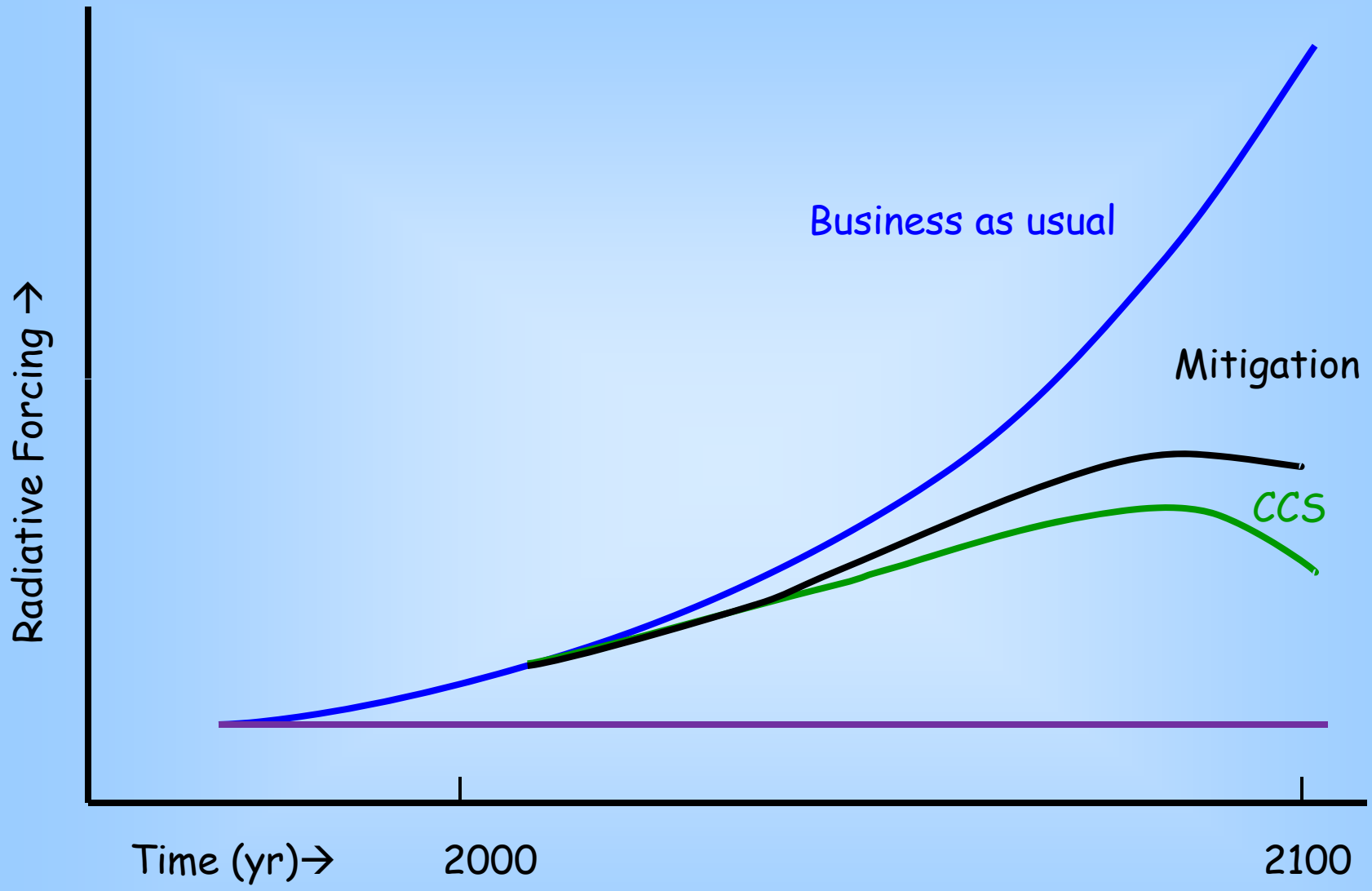

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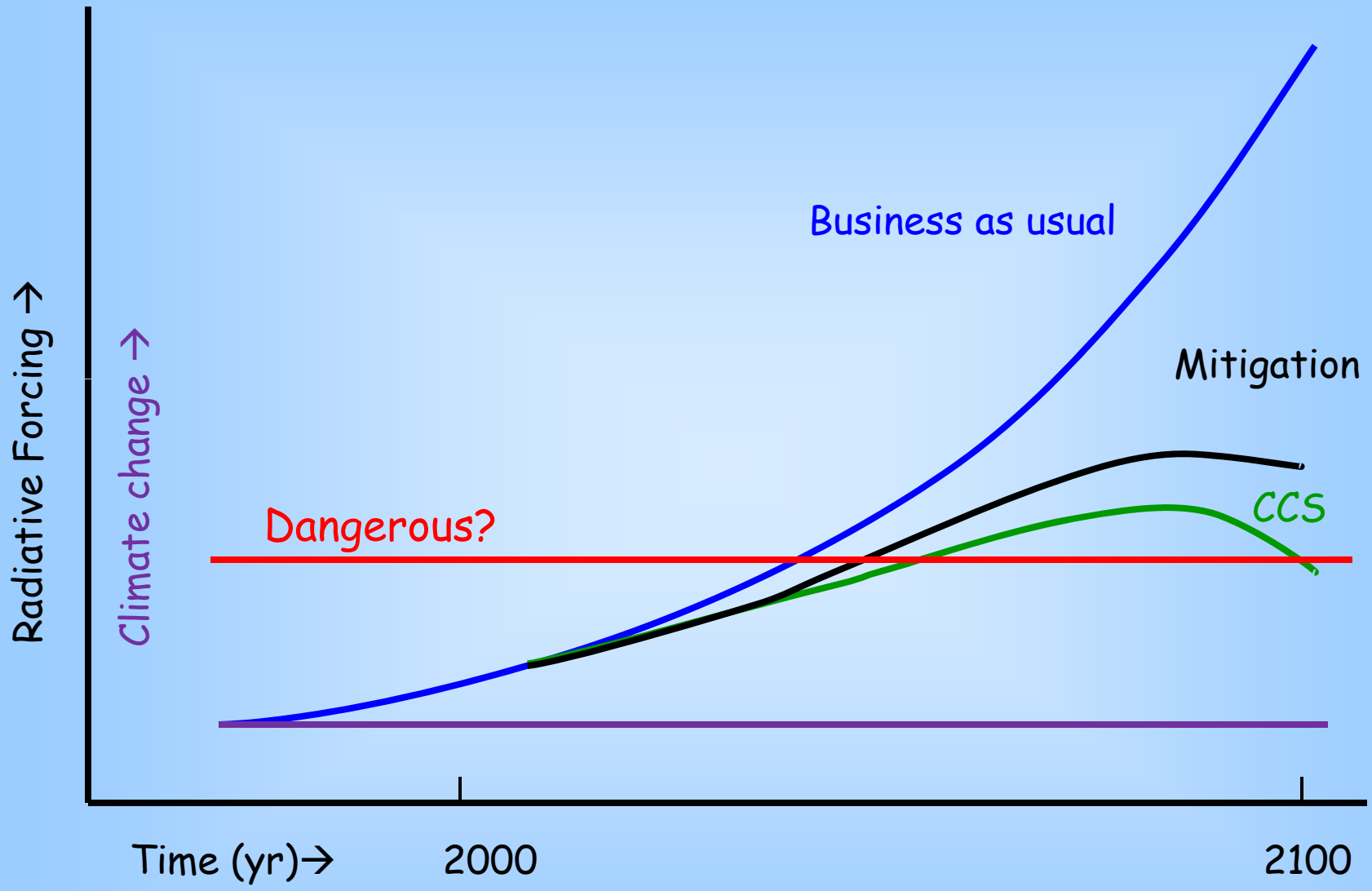

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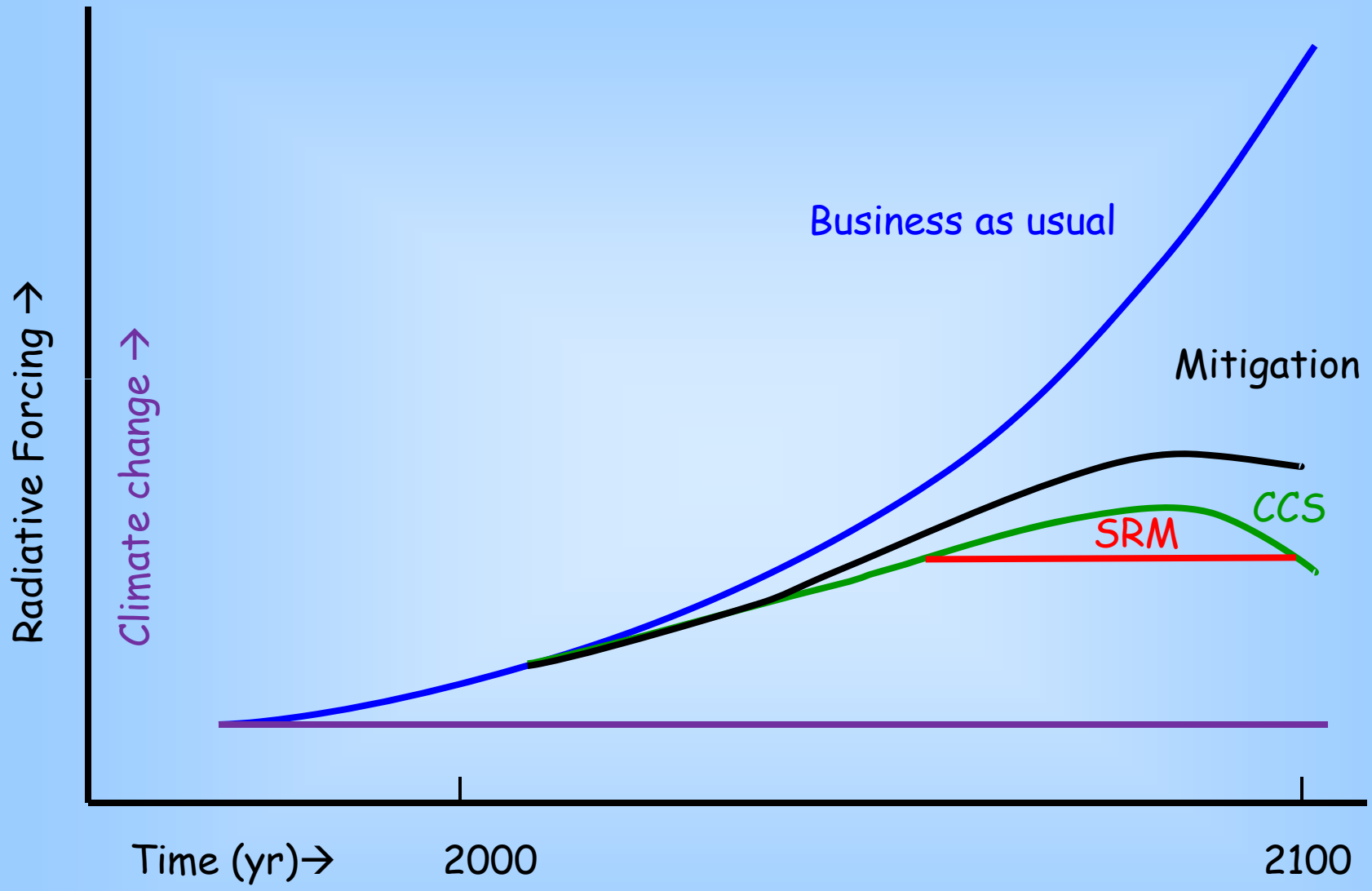

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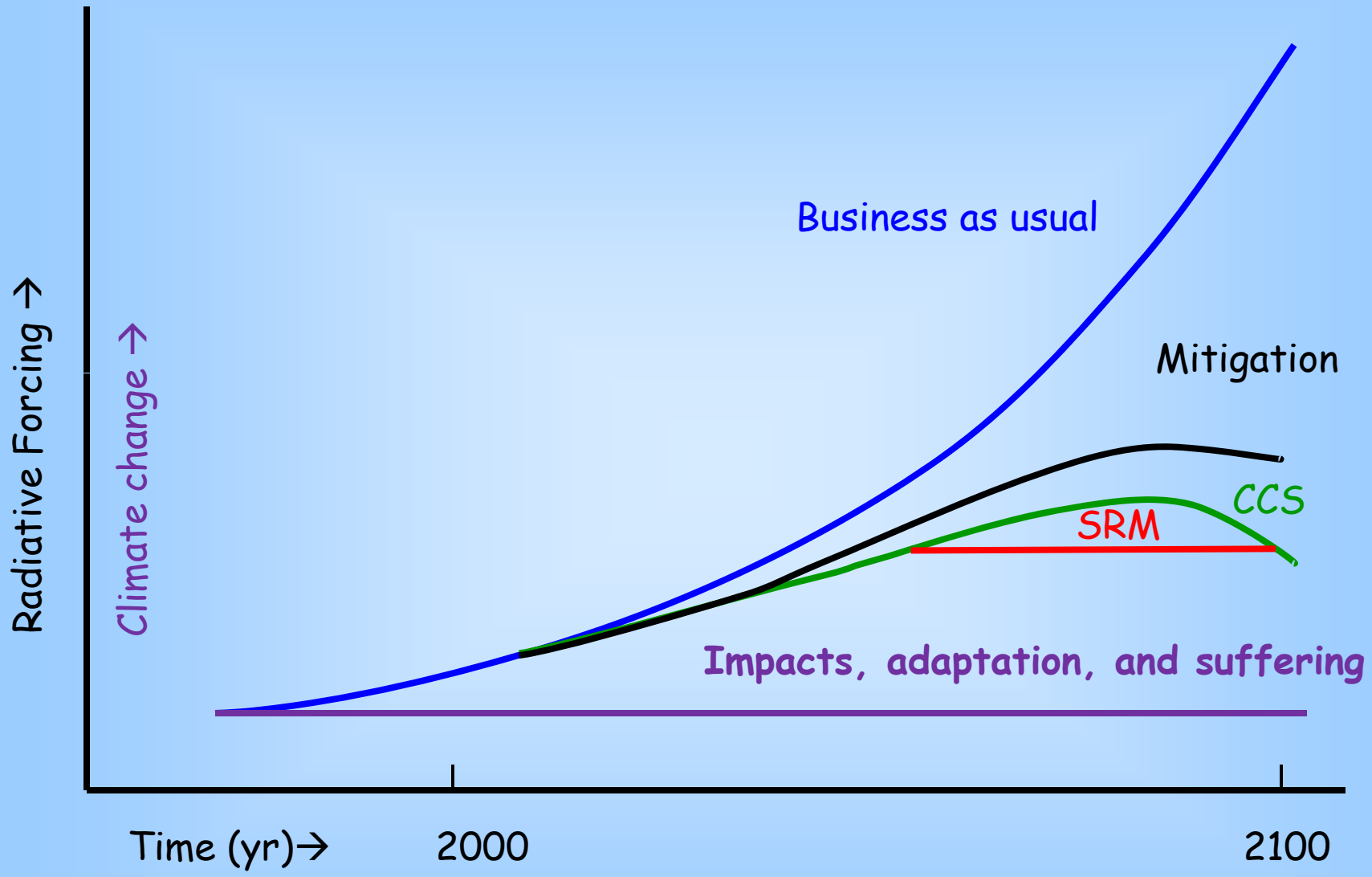

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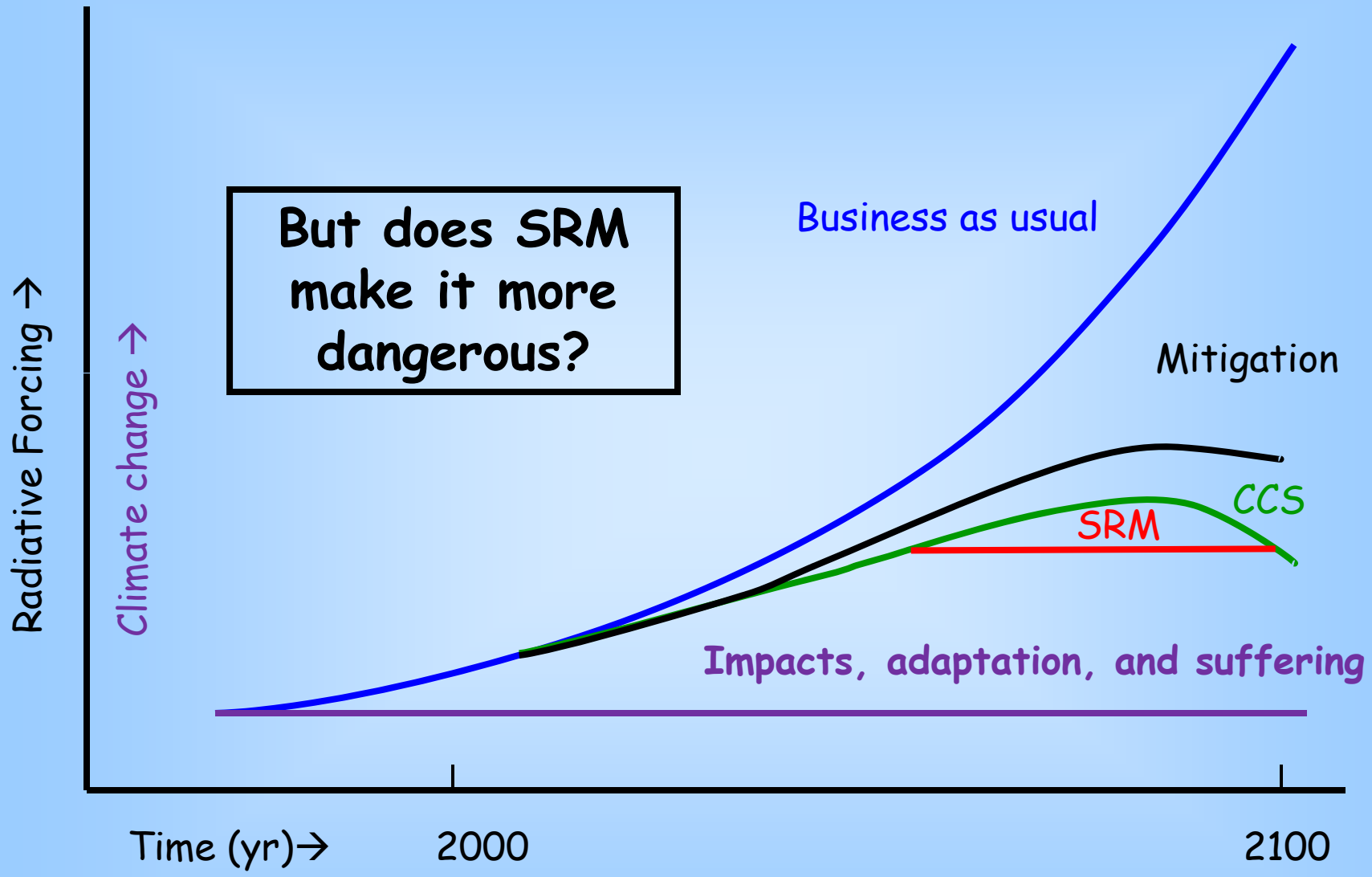

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