Thermodynamic vs. Radiative Climate Change

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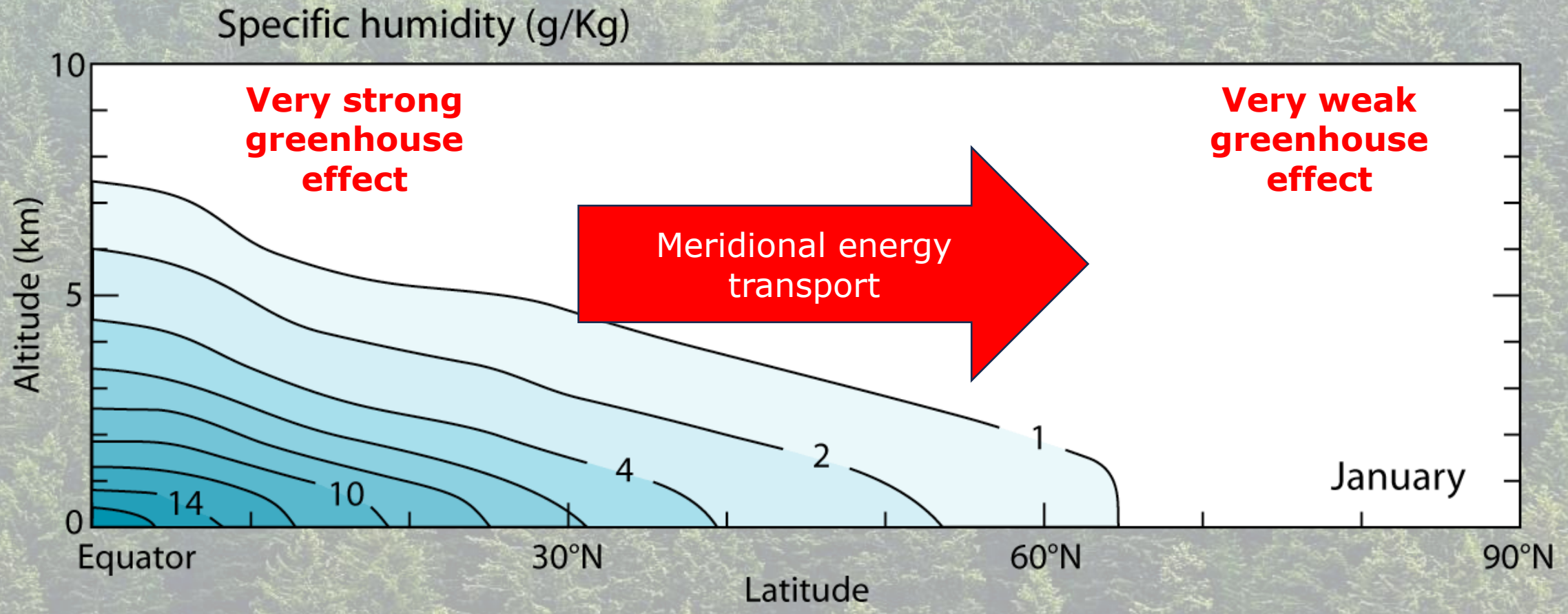
Thermodynamic Theory of Climate Change

Based on two arguments:

- **Diferential strength of the Greenhouse Effect**
- **Meridional heat transport variability**

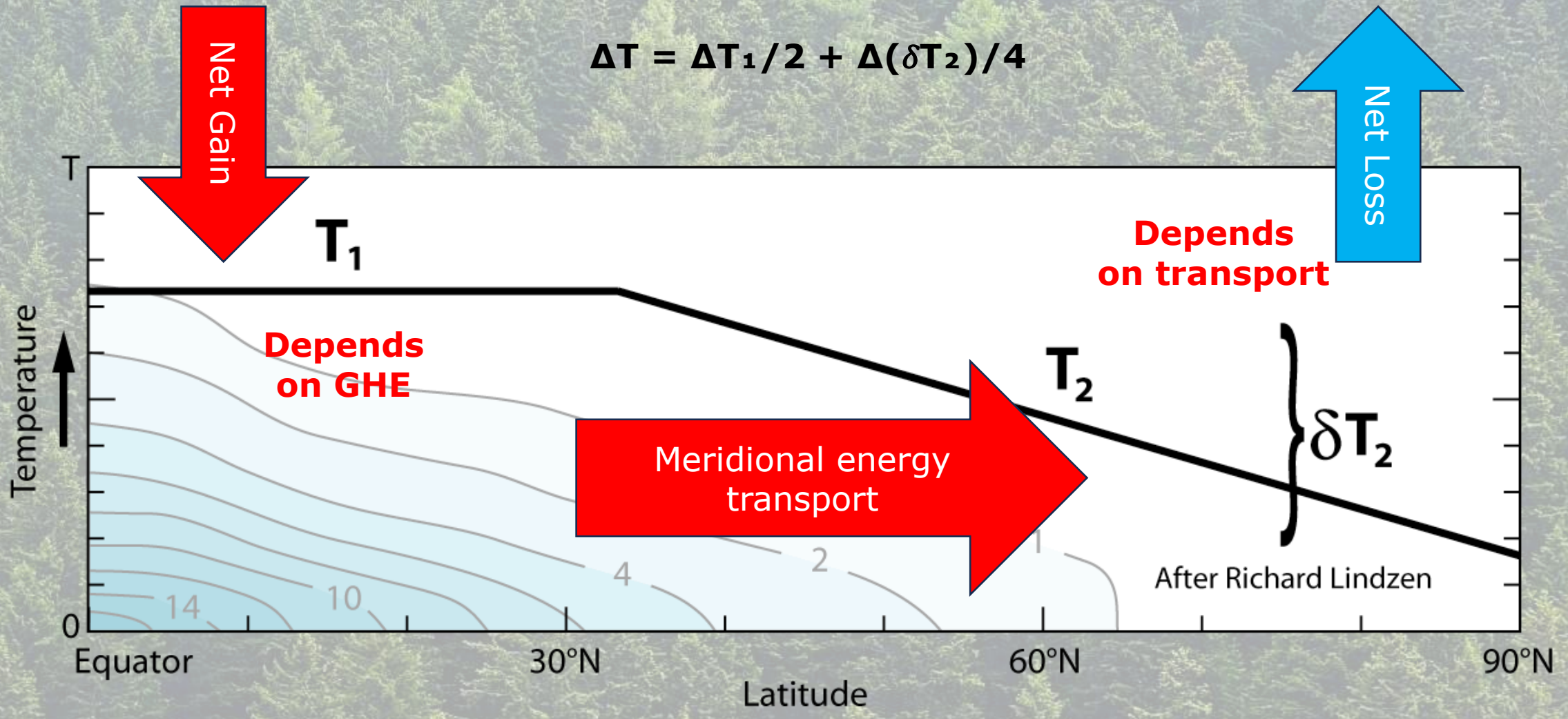
Changing the amount of heat transported between two regions with different GHE, changes the outgoing emissions, the energy content, and the climate

The greenhouse effect is very uneven on Earth due to water vapor differences



The gradient is key for temperature changes

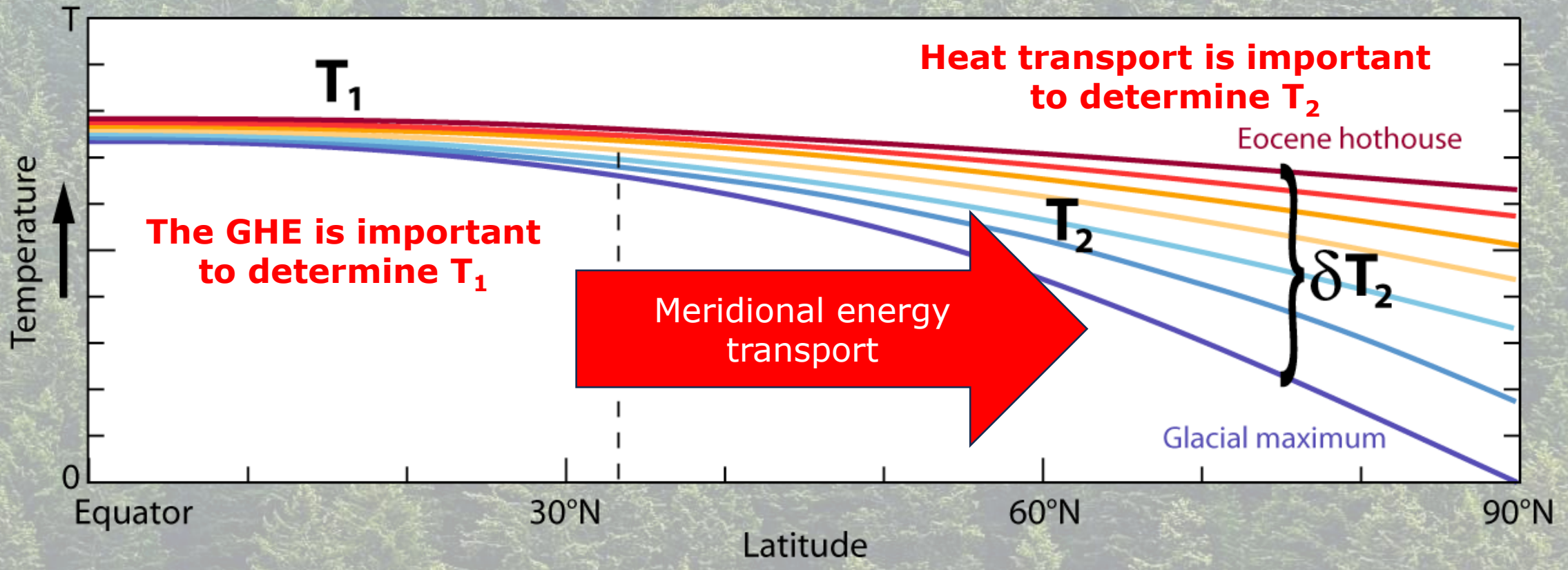
$$\Delta T = \Delta T_1/2 + \Delta(\delta T_2)/4$$



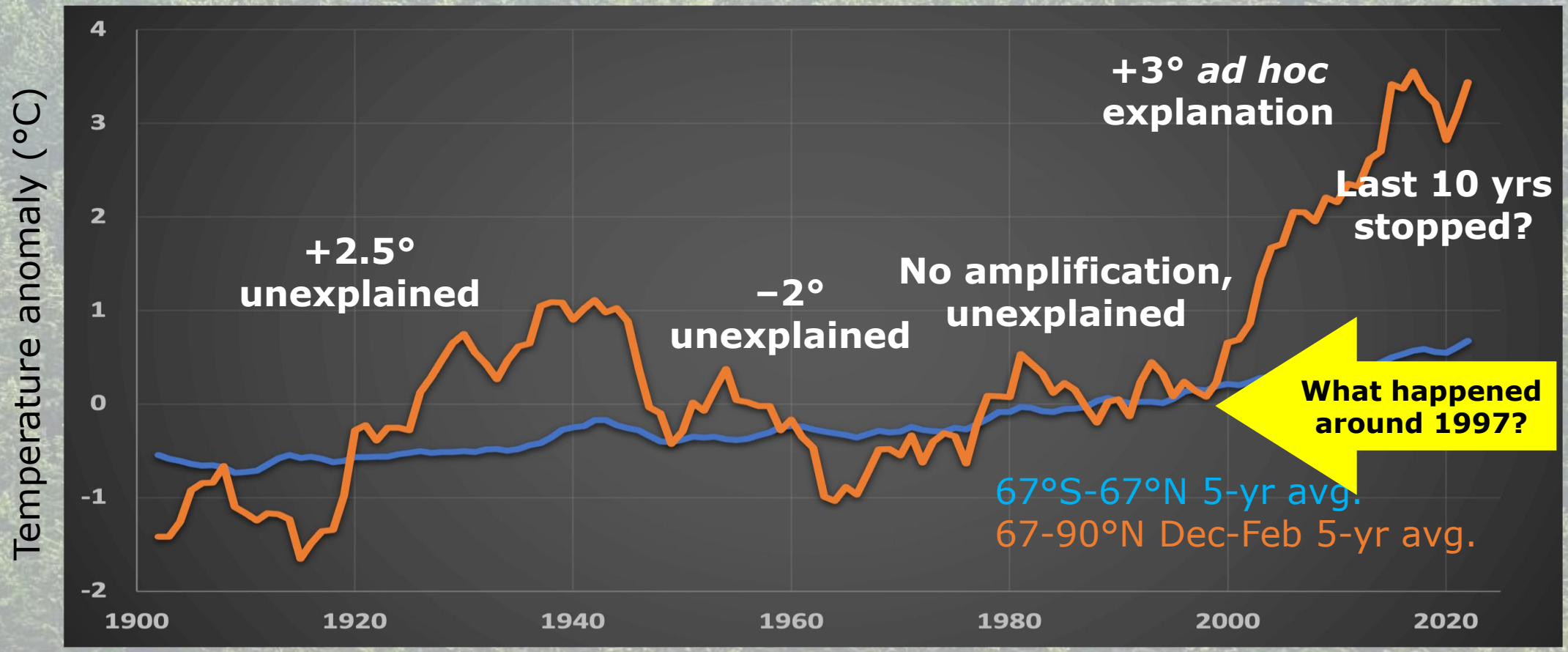
The gradient is key for temperature changes

$$\Delta T = \Delta T_1/2 + \Delta(\delta T_2)/4$$

Glaciation to interglacial: $\Delta T_1 = +1°$, $\Delta(\delta T_2) = +20°$



Consensus theory does not explain Arctic winter temperature changes, meridional transport does

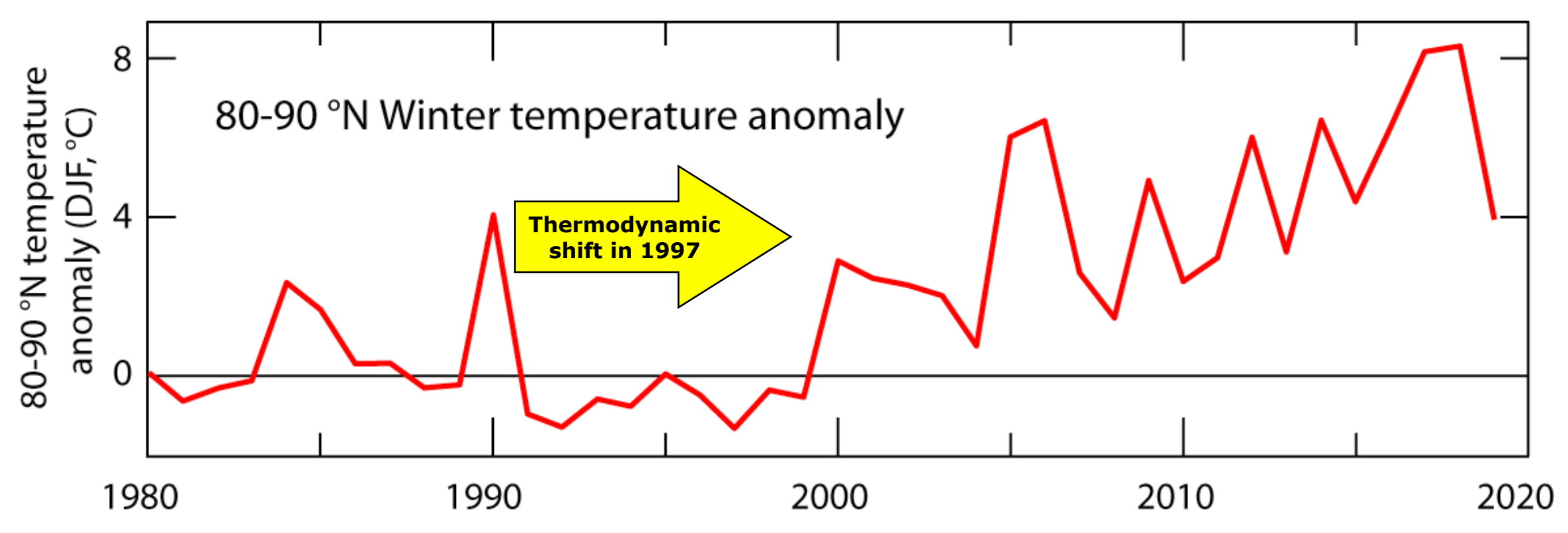


https://psl.noaa.gov/data/atmoswrit/timeseries/index.html

Evidence of Thermodynamic Changes in the Climate

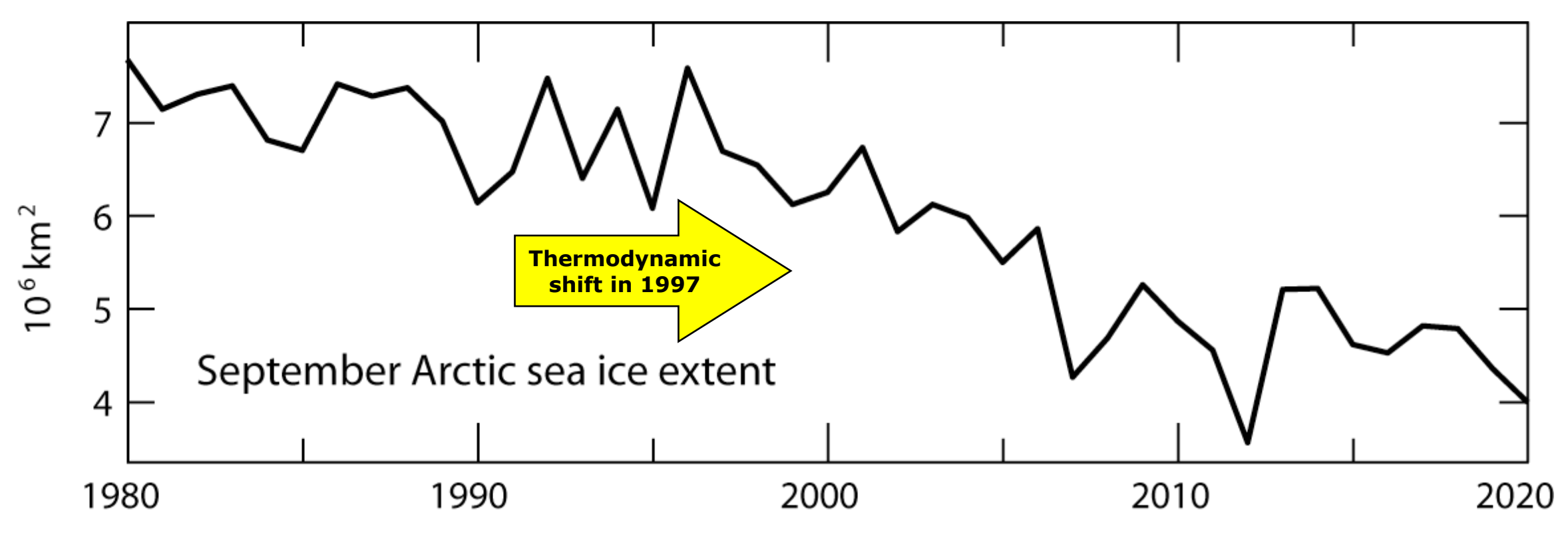
- The Arctic climate shift of 1997
- Changes in meridional heat transport
- The global climate shift of 1997

An Arctic climate shift in 1997



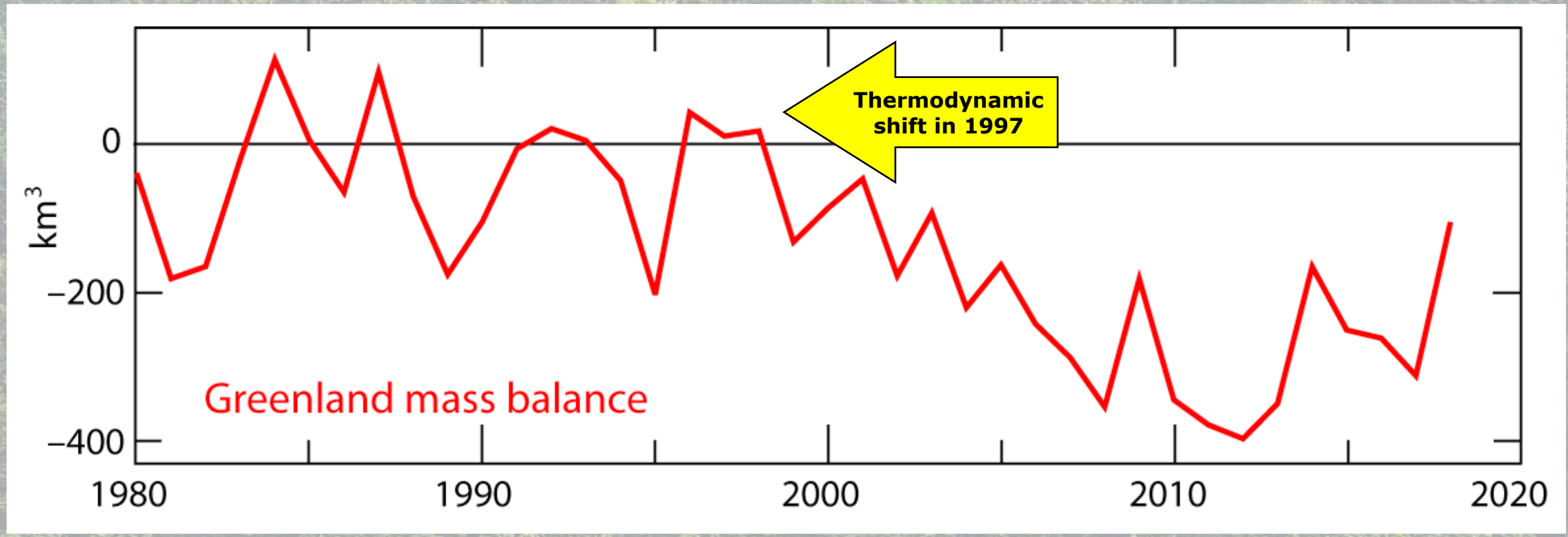
The winter Arctic temperature shifted its trend and increased rapidly

An Arctic climate shift in 1997



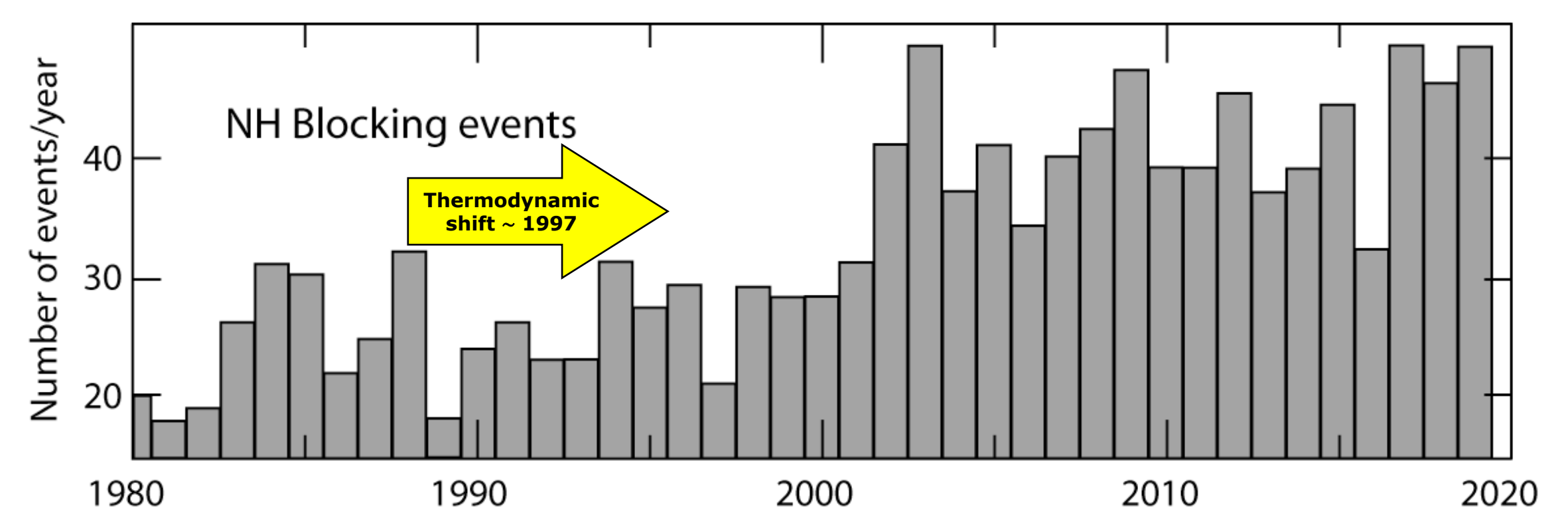
The extent of Arctic sea ice began to decline much more rapidly

An Arctic climate shift in 1997



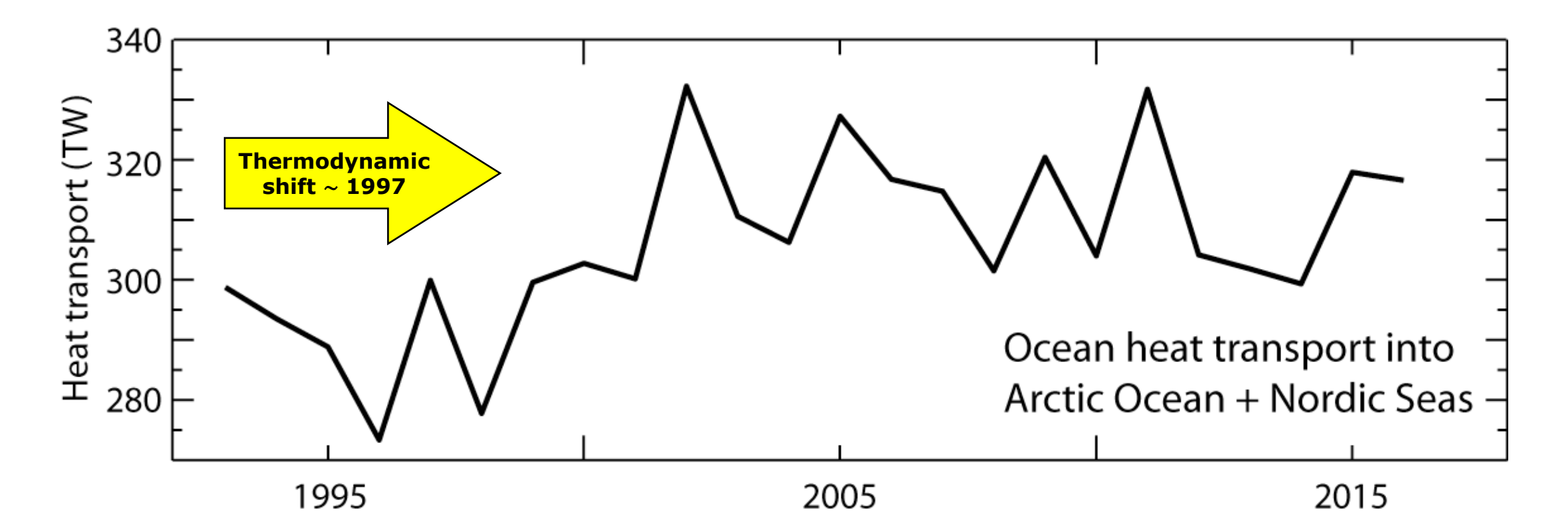
The Greenland ice cap strongly accelerated its decline

A thermodynamic transport shift in 1997



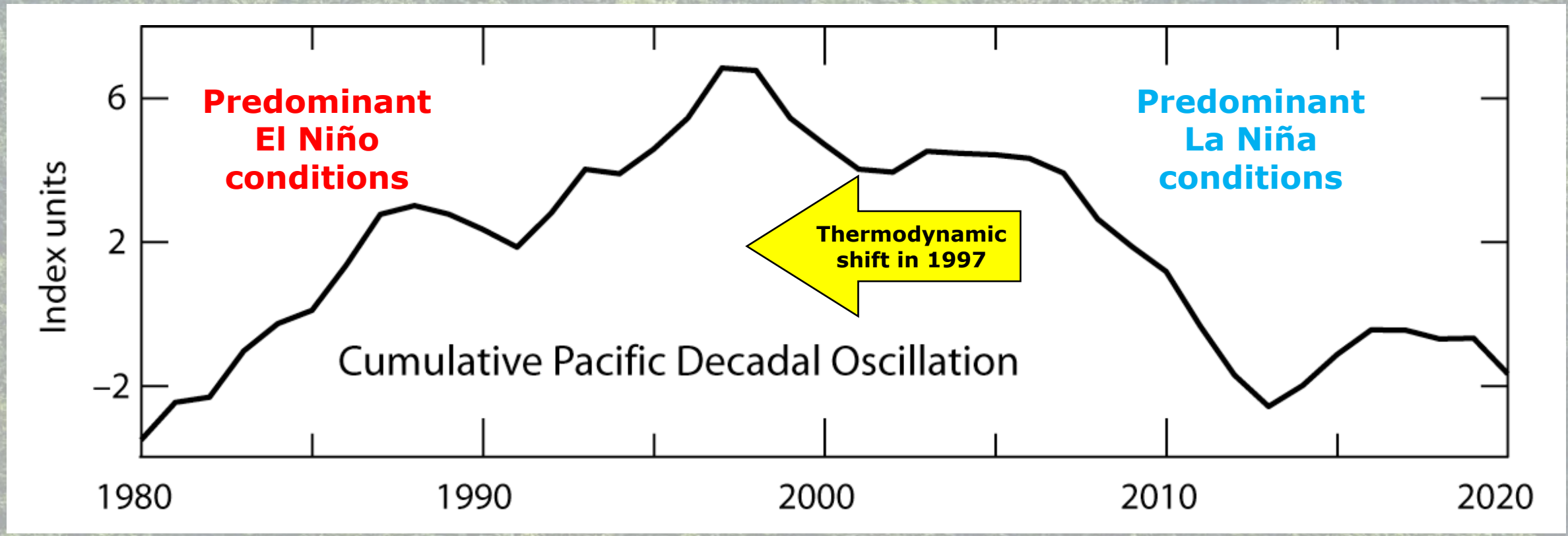
Atmospheric blocking greatly increases the amount of heat transported to the Arctic by the atmosphere

A thermodynamic transport shift in 1997



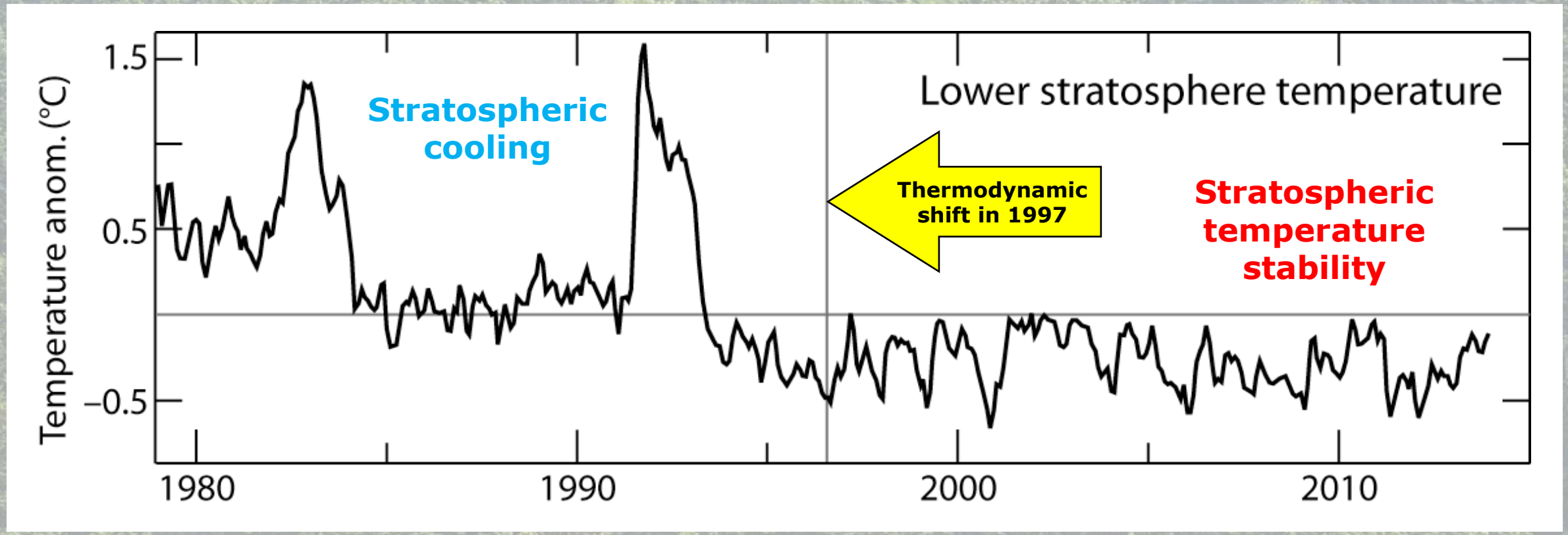
The amount of heat transported to the Arctic by the ocean increased by almost 10 %

A global climate shift in 1997



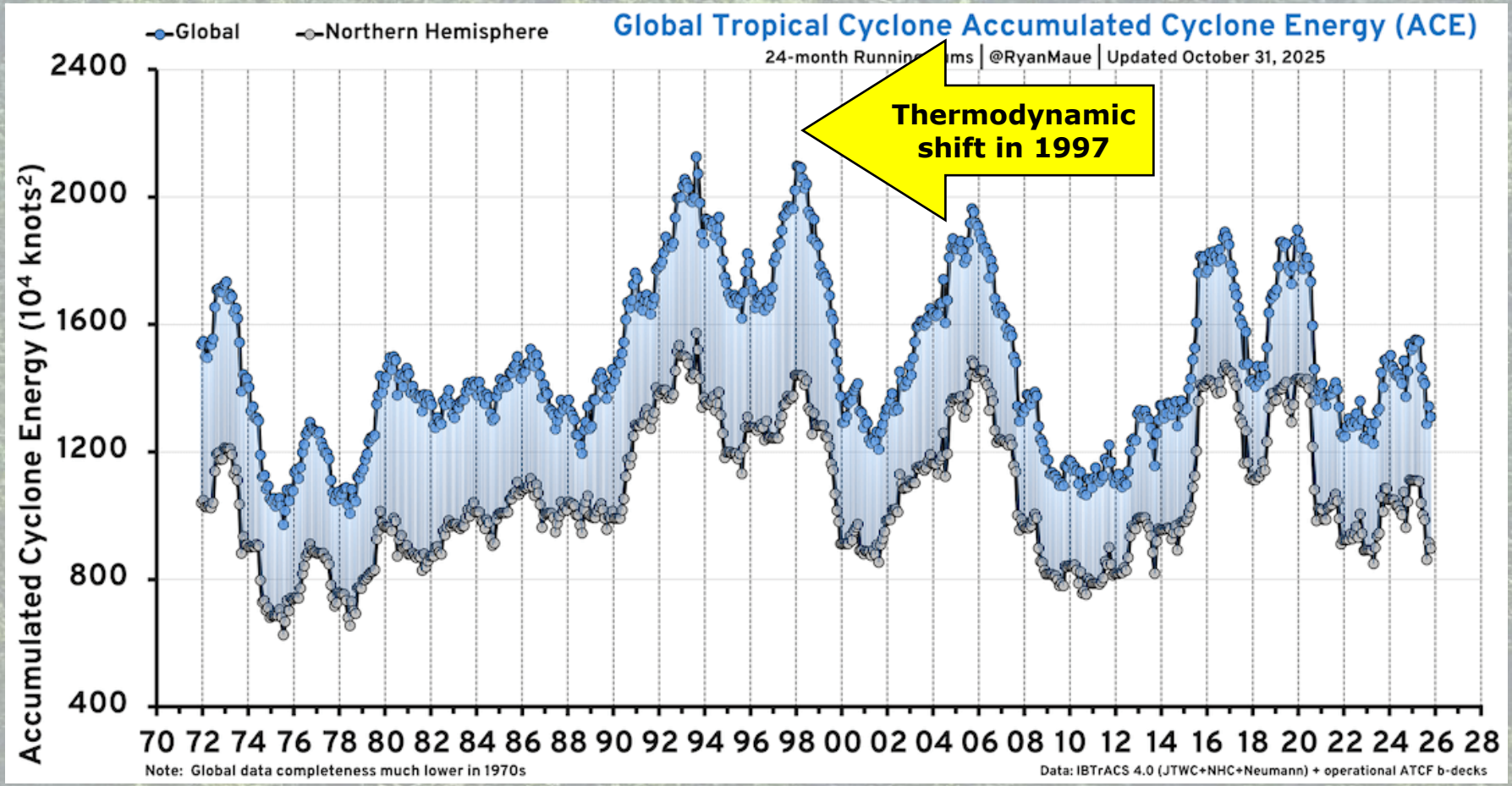
The Pacific Ocean shifted its regime from El Niño to La Niña predominant

A global climate shift in 1997



The lower stratosphere stopped cooling, shifting its previous trend
This was supposed to be a fingerprint of anthropogenic climate change

A global climate shift in 1997



The energy from hurricanes and storms shifted its trend and began decreasing
This is what the theory predicts from a decrease in the temperature gradient

A global climate shift in 1997

CHAPTER 33
1997, THE CLIMATE CHANGED AGAIN

The year 1998 is often cited as the beginning of a controversial "pause" in global warming. What many people don't know is that important and abrupt changes in several climate variables occurred soon after 1997. These changes made 1997 the most important climate shift in decades, affecting not only global temperatures but also Pacific Ocean climate patterns and global atmospheric circulation. This shift caused changes in tropical extent, cloudiness, wind speed, and the Earth's rotation rate. Even more puzzling were unexplained changes in the stratosphere, including a change in its cooling trend and a decrease in water vapor, suggesting an increase in poleward heat transport. Unfortunately, scientists have yet to fully understand these changes, and the significance of the 1997 climate shift remains unrecognized.

The Pause

In 1997-98, there was an El Niño event in the Pacific Ocean. Eight years later, a scientist reported in a newspaper that there had been no warming since El Niño and questioned whether human emissions were solely responsible for climate change.[241] This sparked controversy, with other scientists arguing that eight years was too short to draw conclusions. By 2012, however, many scientists acknowledged a pause in global warming and began investigating its cause. In 2014, two scientific journals jointly published a special issue dedicated to the pause, which included several articles with different explanations. Despite the many proposed explanations, there is still no consensus on the cause of the pause.[242]

The major El Niño event of 2015-16 marked the end of the global warming pause observed from 1998-2014. Subsequently, changes were made to several temperature datasets, transforming the pause into a period of continued global warming in surface temperature data. While some scientists argued in 2016 that the pause was real, it is no longer mentioned in publications.[243] As a result, the concept of a global warming pause is no longer recognized in mainstream climate science.

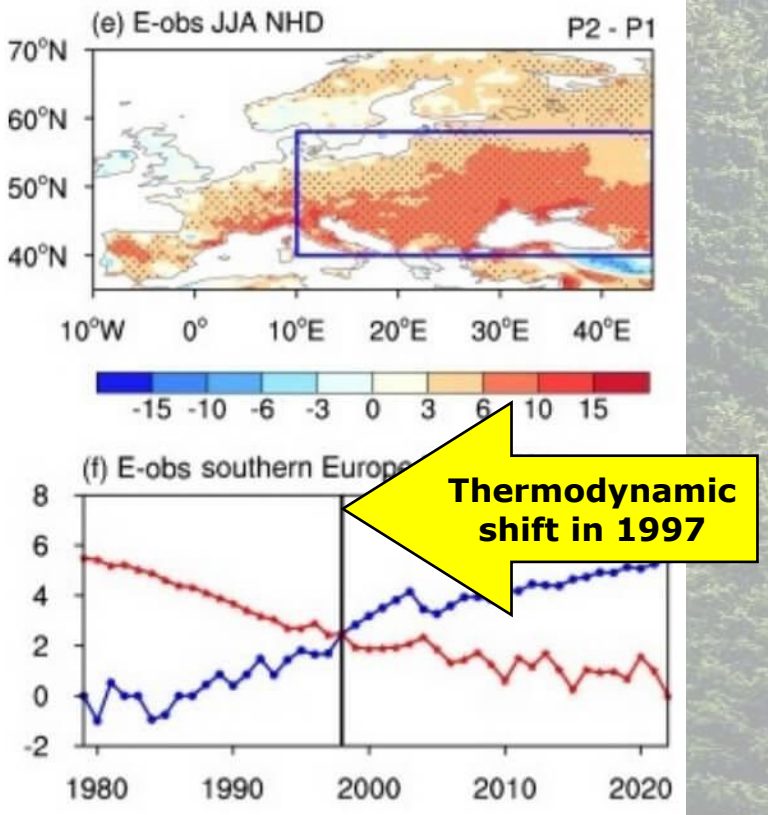
However, the global warming pause was only one of several effects of a major climate shift that occurred in 1997. Nevertheless, climate scientists have yet to fully explain or acknowledge many of these other effects because they do not meet their expectations.

[241] Carter, R.M., There IS a problem with global warming... it stopped in 1998. The Telegraph, 09 April 2006.
[242] Springer Nature (2014) Focus: Recent slowdown in global warming. www.nature.com/collections/sthnxgntvp
[243] Fyfe, J.C., et al., 2016. Nat. Clim. Change, 6 (3), pp.224–228. doi.org/10.1038/nclimate2938

KeAi
Atmospheric and Oceanic Science Letters
Available online 24 October 2025, 100732
In Press, Corrected Proof ⓘ What's this?

Unveiling remote and local drivers for the interdecadal shift of European hot days

Lianlian Xu [a b], Song Yang [a b]



The Thermodynamic Theory of Climate Change Has Been Demonstrated

It is based on two facts:

- Diferential strength of the Greenhouse Effect
- Meridional heat transport variability

It is supported by the evidence

The Thermodynamic Theory of Climate Change Solves Several Climate Mysteries

- The missing forcing for the Little Ice Age
- How the equable hothouse climates were possible
- The effect of Milanković forcing on climate
- How solar activity changes the climate

Mystery No. 1 — The missing forcing for the Little Ice Age

The Relationship between ITCZ Location and Cross-Equatorial Atmospheric Heat Transport: From the Seasonal Cycle to the Last Glacial Maximum

AARON DONOHOE, JOHN MARSHALL, DAVID FERREIRA, AND DAVID MCGEE

the southward ITCZ shift on the order of 5° during the Little Ice Age suggested by Sachs et al. (2009) implies an AHT_{EQ} change of approximately 1.7 PW; presently, there is no known climate forcing or feedback during that time period that could account for such a large energy perturbation at the hemispheric scale.

The Inter-Tropical Convergence Zone (ITCZ) divides energy transport in the planet.

Its southward shift during the LIA implies a large thermodynamic reorganization.

Mystery No. 1 — The missing forcing for the Little Ice Age

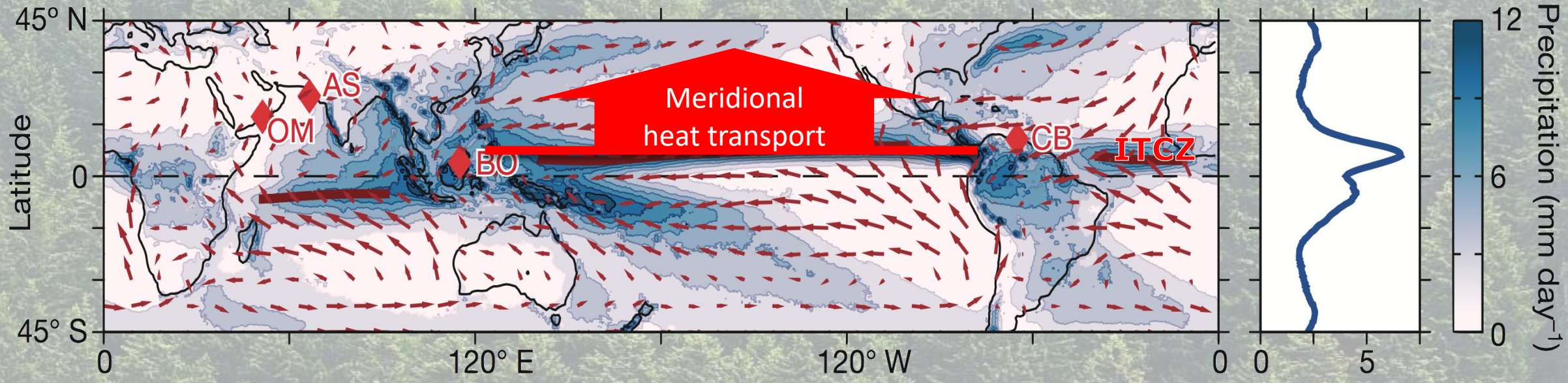
Southward movement of the Pacific intertropical convergence zone AD 1400–1850

Julian P. Sachs[1]*, Dirk Sachse[1†], Rienk H. Smittenberg[1†], Zhaohui Zhang[1†], David S. Battisti[2] and Stjepko Golubic[3]

the Pacific intertropical convergence zone was south of its modern position for most of the past millennium, by as much as 500 km during the Little Ice Age. A colder Northern Hemisphere at that time, possibly resulting from lower solar irradiance, may have driven the intertropical convergence zone south.

Lower solar activity during the LIA has been proposed as the cause of the ITCZ southward shift

Solution to No. 1 — The missing forcing for the Little Ice Age

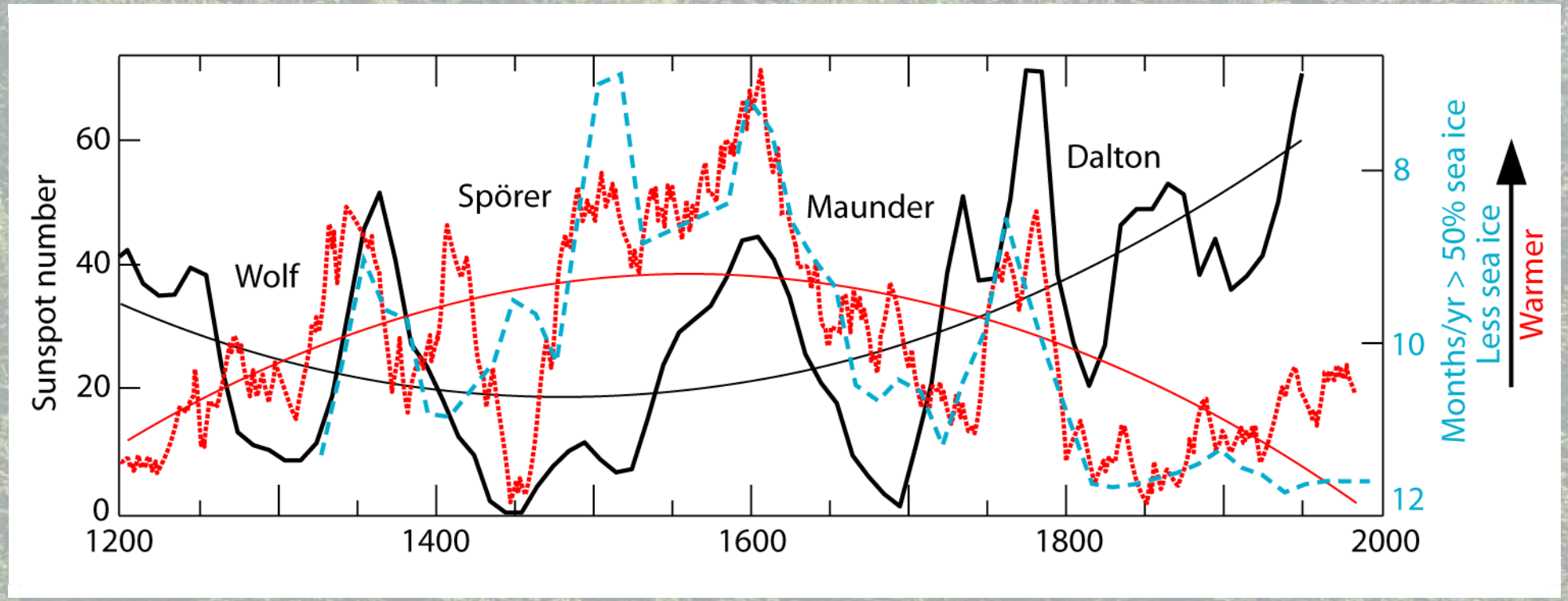


The cooling of the NH during the LIA steepened the temperature gradient.

More energy was transported toward the colder hemisphere by the ITCZ displacement.

The LIA is not explained by the radiative theory because it implies thermodynamic changes.

Evidence for No. 1 — The Arctic warmed during the LIA correlating with solar activity



Arctic warming during the LIA was due to enhanced meridional transport.

The radiative theory of climate change is unable to explain the LIA.

Mystery No. 2 — The equable hothouse climates and the "low gradient paradox"

Ocean Heat Transport and Water Vapor Greenhouse in a Warm Equable Climate: A New Look at the Low Gradient Paradox

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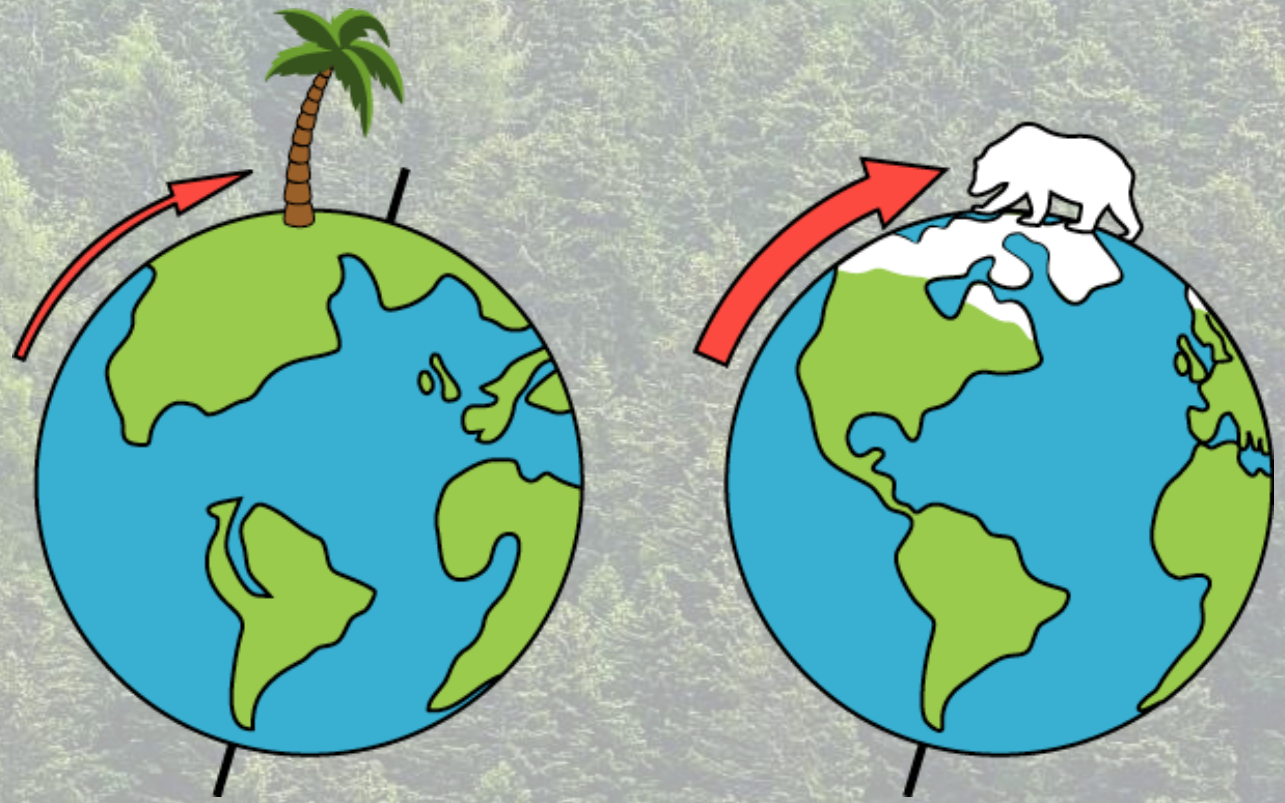
DAVID FERREIRA

Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts

characterize the low gradient paradox as follows: weak ΔT seems to demand increased poleward heat transport, while simultaneously implying weak poleward heat transport, since much of the transport in the present climate is effected by atmospheric eddies resulting from baroclinic instability

To have warm poles a lot of heat is needed, but the resulting shallow gradient makes it impossible to transport it

Mystery No. 2 — The equable hothouse climates and the “low gradient paradox”



To have warm poles a lot of heat is needed, but the resulting low gradient makes it impossible to transport it

Solution to No. 2 — The inequality of the Greenhouse Effect was lower

Due to the warm conditions the Arctic in winter was covered by a thick radiative fog, making the greenhouse effect very strong so, little heat transport was needed

Mystery No. 3 — Milanković insolation forcing is too small for its climate effect

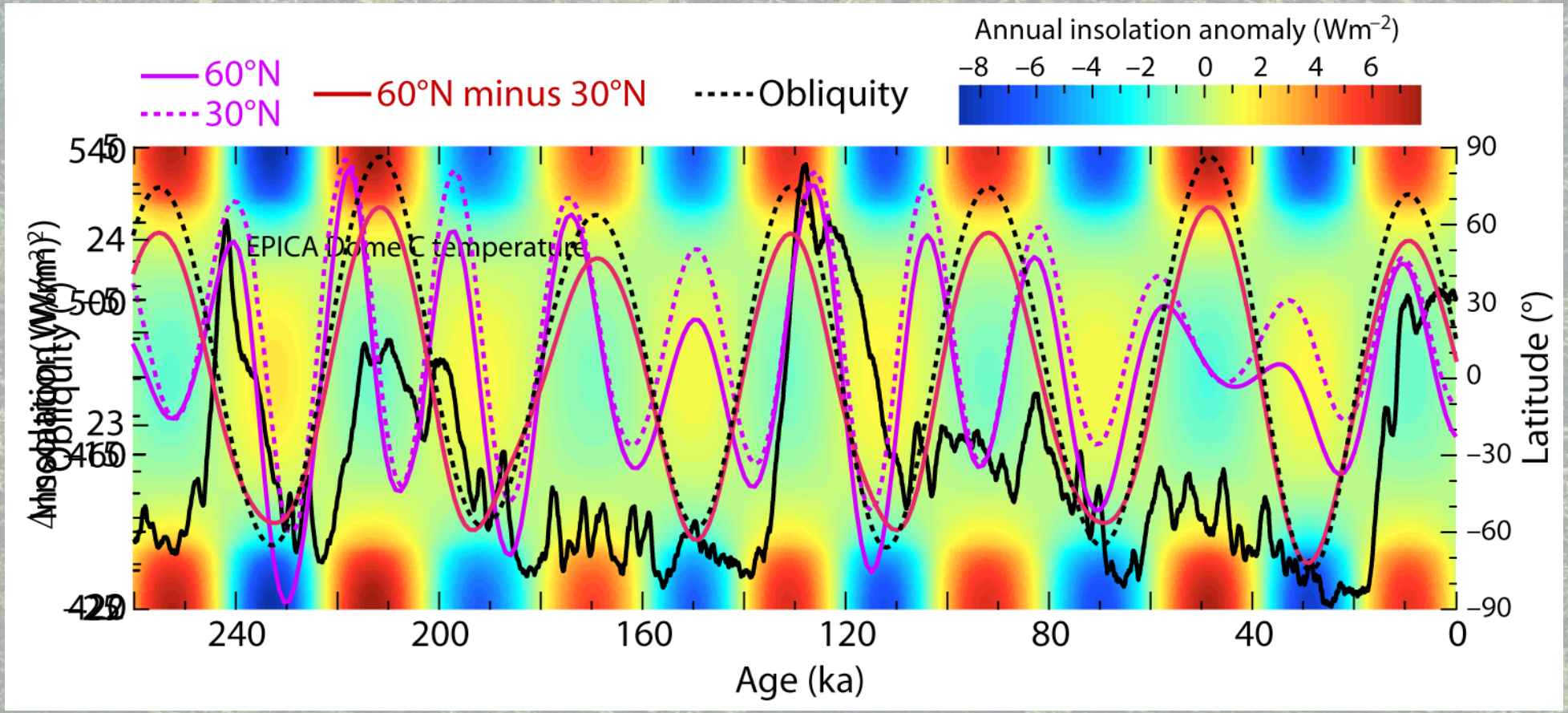
Quantitative estimate of the Milankovitch-forced contribution to observed Quaternary climate change

Carl Wunsch*

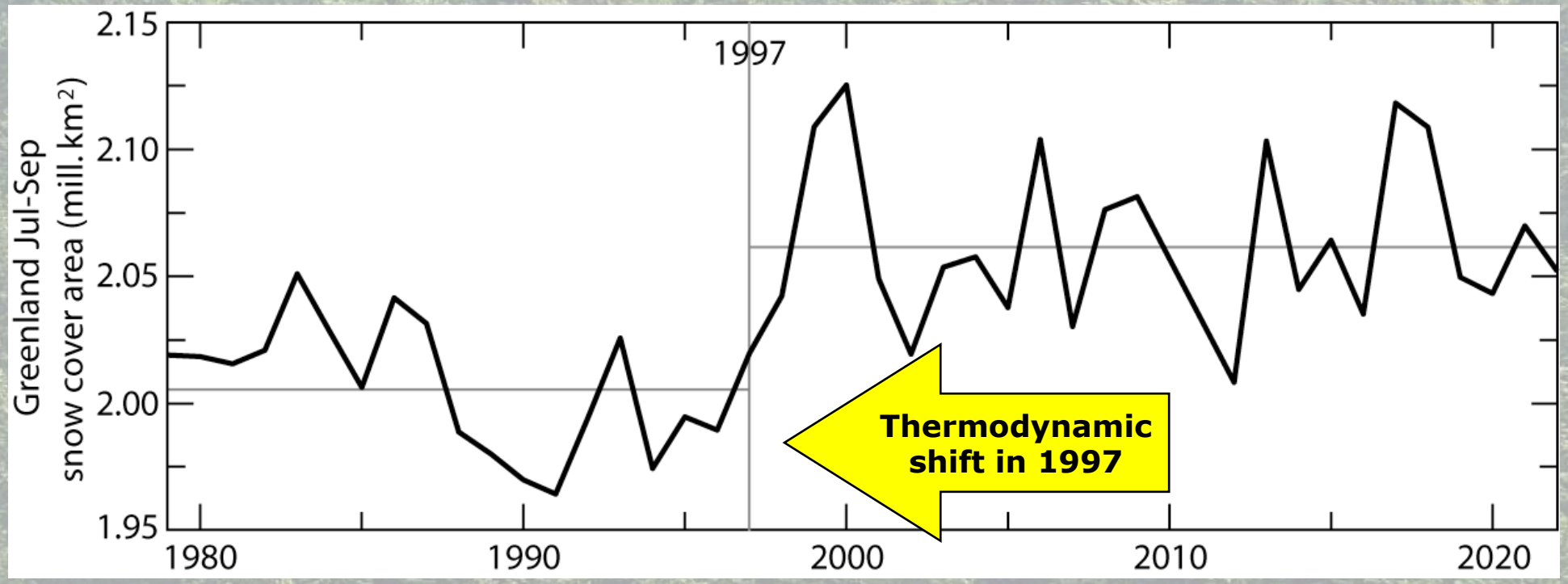
a very small amount (less than 20% and sometimes less than 1%) of the variance attributable to insolation forcing.

Only a small % of the effect is attributable to the cause

Solution to No. 3 — Milanković forcing alters the insolation and temperature gradients, recruiting meridional transport



Evidence for No. 3 — An increase in meridional heat transport leads to snow accumulation in Greenland



The climate effects of Milankovitch orbital changes do not result from radiative changes, but rather from thermodynamic changes within the climate system

Mystery No. 4 — The effect of solar variability on climate

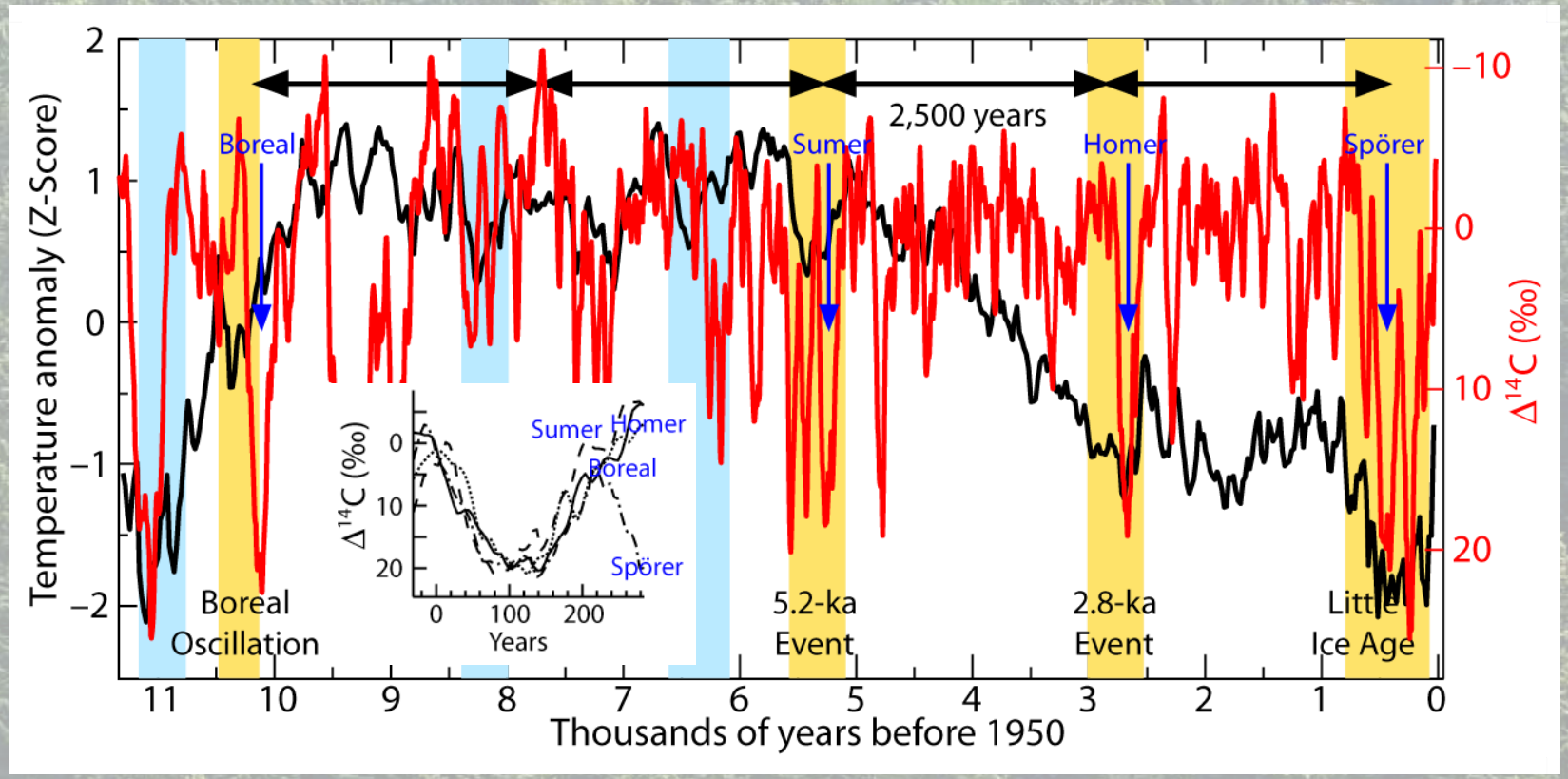
Frequently Asked Questions

FAQ 5.1 | Is the Sun a Major Driver of Recent Changes in Climate?

Despite uncertainties in future solar activity, there is *high confidence* that the effects of solar activity within the range of grand solar maxima and minima will be much smaller than the changes due to anthropogenic effects.

As with Milanković forcing, the IPCC only considers the change in total solar irradiation and finds that it is too small to have an important climate effect

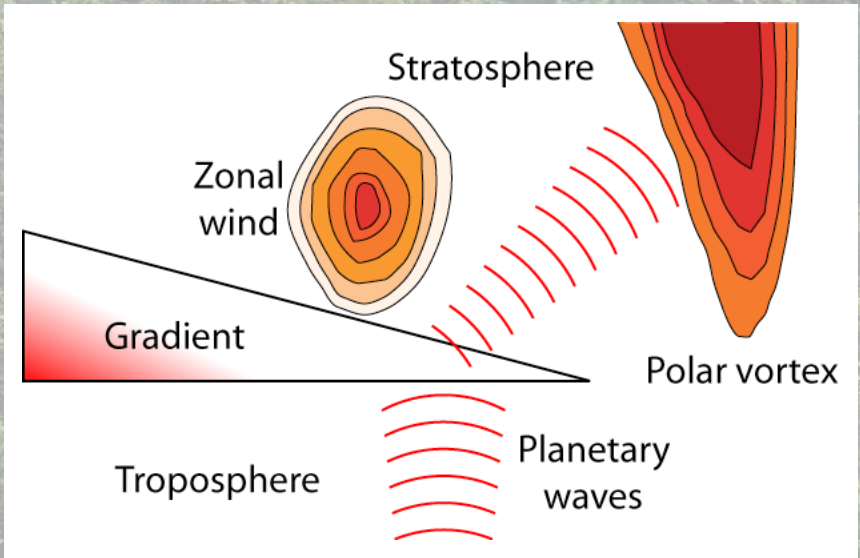
Mystery No. 4 — The effect of solar variability on climate



There is a strong correlation between solar activity and climate, and an absolute correlation between grand solar minima of the Spörer type and major climate events

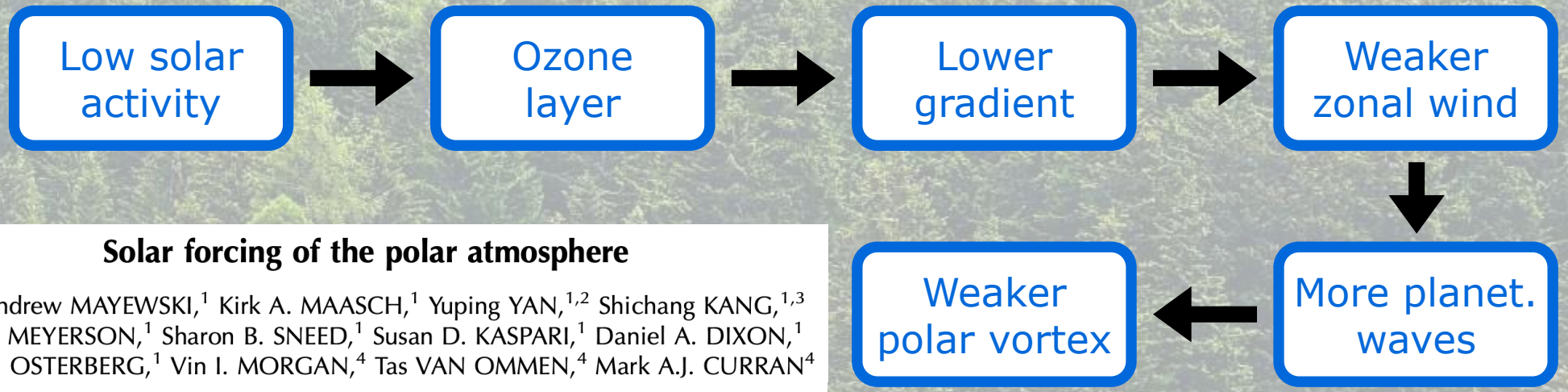
Solution to No. 4 — Solar variability affects the meridional transport of energy

Low solar activity → Ozone layer → Lower gradient → Weaker zonal wind → More planet. waves → Weaker polar vortex



A nonlinear, indirect mechanism is difficult to elucidate, demonstrate, and understand

Solution to No. 4 — Solar variability modulation of the polar vortex is known



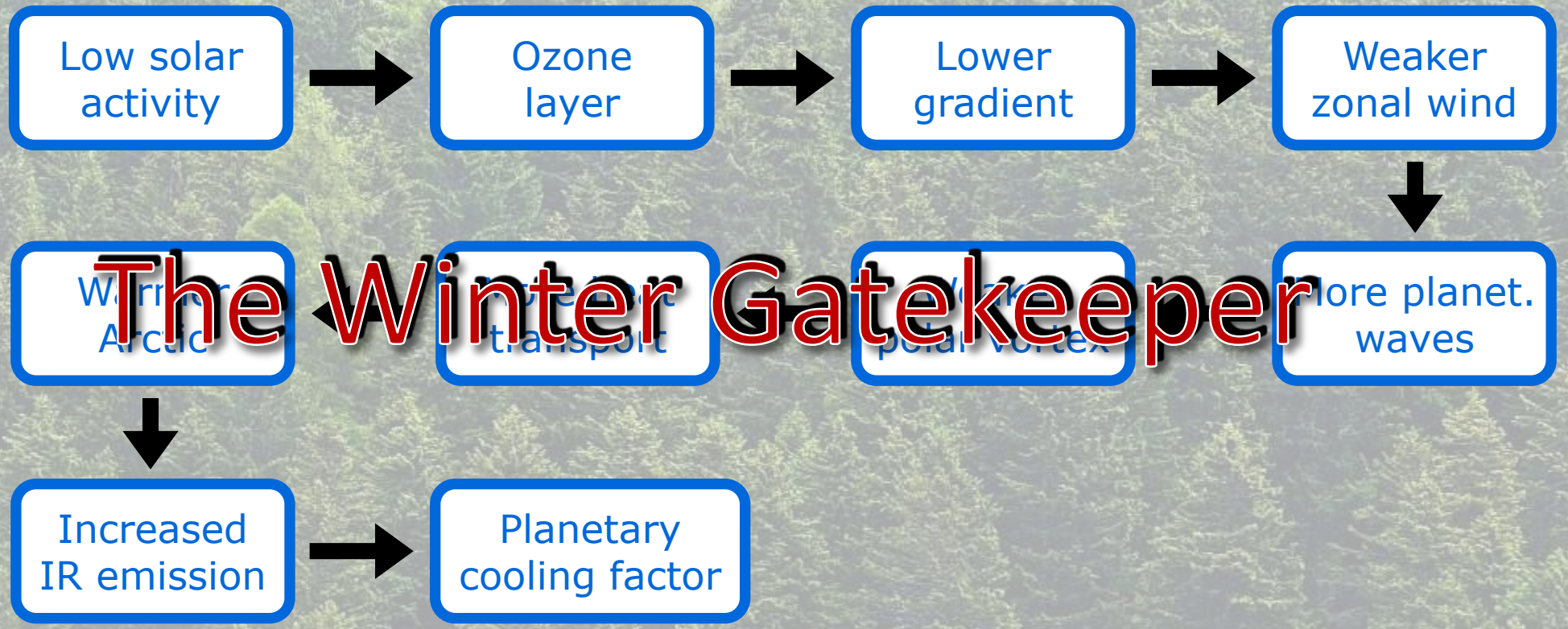
Solar forcing of the polar atmosphere

Paul Andrew MAYEWSKI,[1] Kirk A. MAASCH,[1] Yuping YAN,[1,2] Shichang KANG,[1,3] Eric A. MEYERSON,[1] Sharon B. SNEED,[1] Susan D. KASPARI,[1] Daniel A. DIXON,[1] Erich C. OSTERBERG,[1] Vin I. MORGAN,[4] Tas VAN OMMEN,[4] Mark A.J. CURRAN[4]

In this paper we demonstrate that, on multi-decadal to annual timescales, increases in solar irradiance lead to intensification of zonal winds near the edge of the polar vortex

A nonlinear, indirect mechanism is difficult to elucidate, demonstrate, and understand

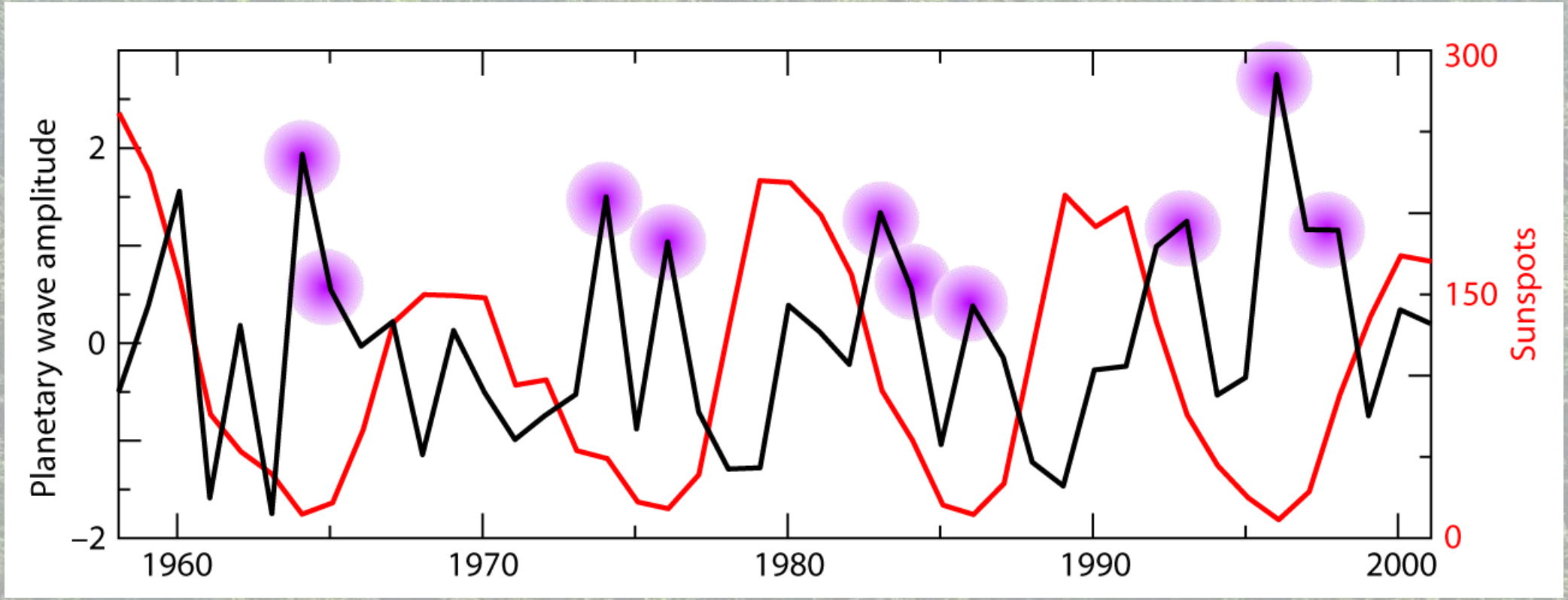
Solution to No. 4 — Solar variability affects the meridional transport of energy



The Winter Gatekeeper

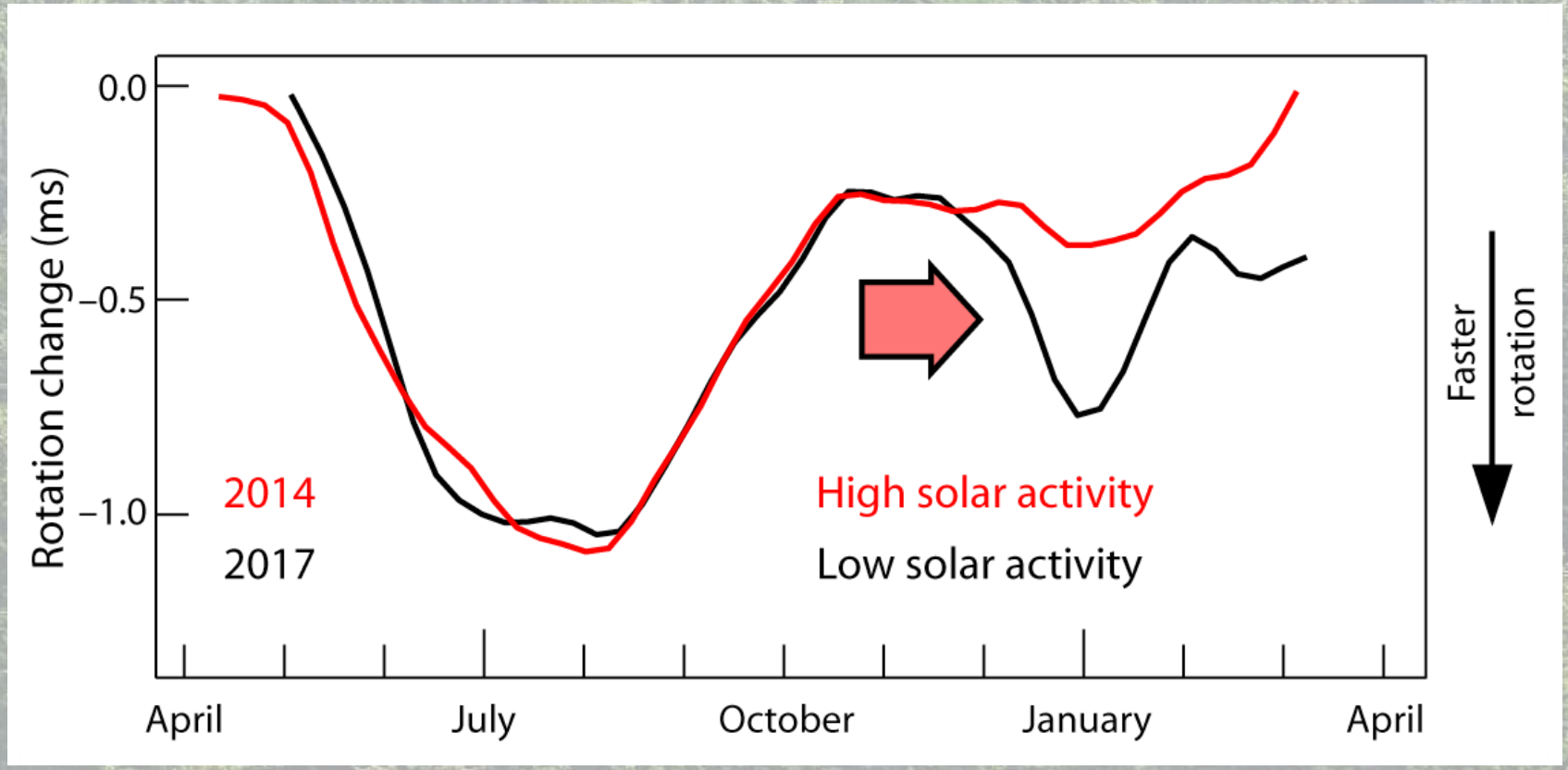
A nonlinear, indirect mechanism is difficult to elucidate, demonstrate, and understand

Evidence for No. 4 — Planetary waves provide the energy



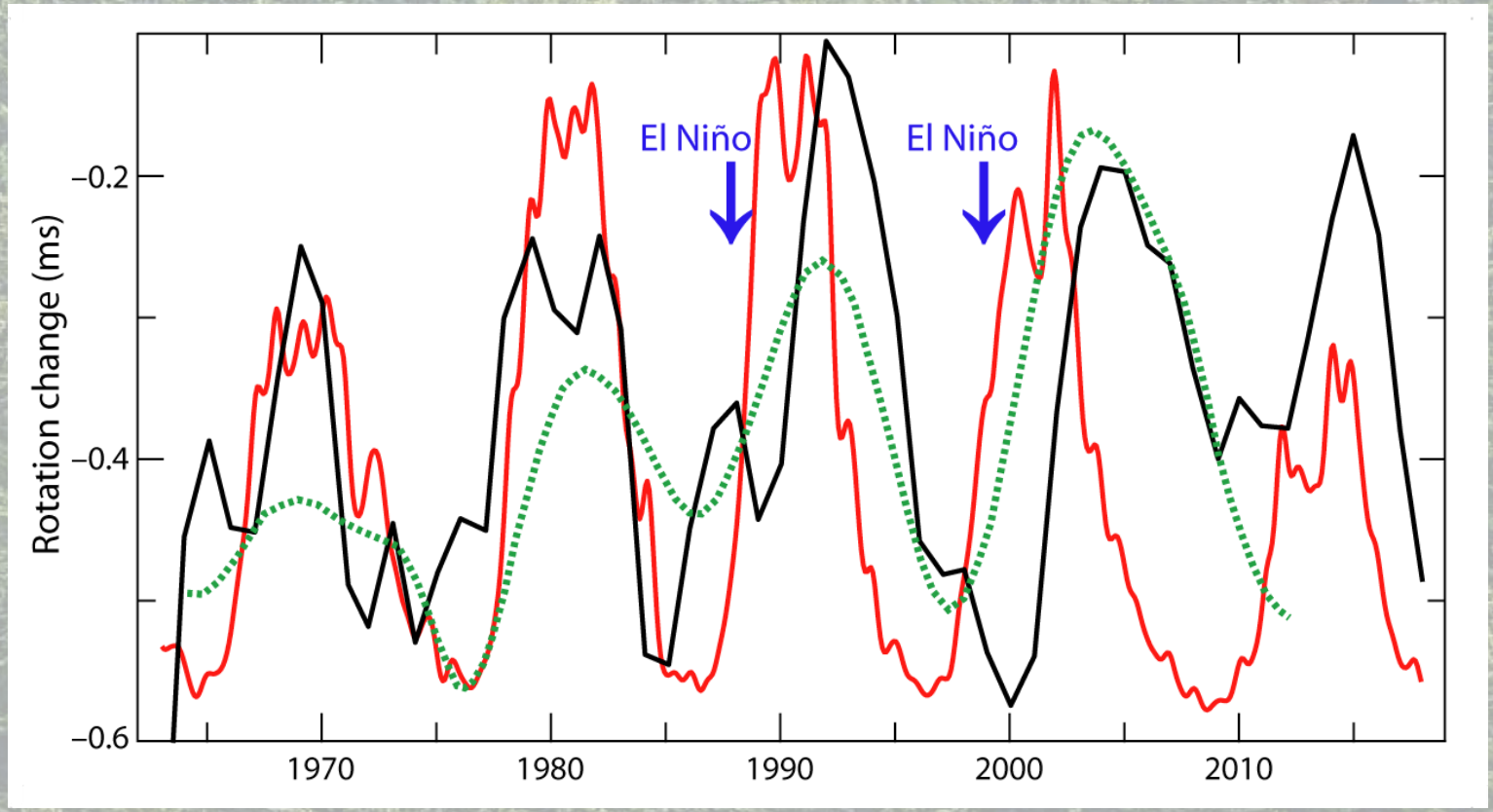
The Sun only provides the signal,
the energy to change the climate comes from within the climate system

Evidence for No. 4 — The solar effect alters the Earth's rotation



The effect of solar variability on Earth's rotation speed has been known since the 1960s and reported multiple times

Evidence for No. 4 — The Earth's rotation changes with the solar cycle in winter



The Sun is very stable, and solar changes imply very little energy change.
Changes in rotation speed are due to changes in meridional atmospheric circulation.

The Thermodynamic theory of Climate Change

- **Is a viable theory based on the differential strength of the GHE and the variability in the meridional energy transport**
- **Is supported by a large amount of evidence**
- **Has a bigger explanatory power than the radiative theory, solving several climate mysteries**
- **Explains the solar effect on climate through the Winter Gatekeeper hypothesis**