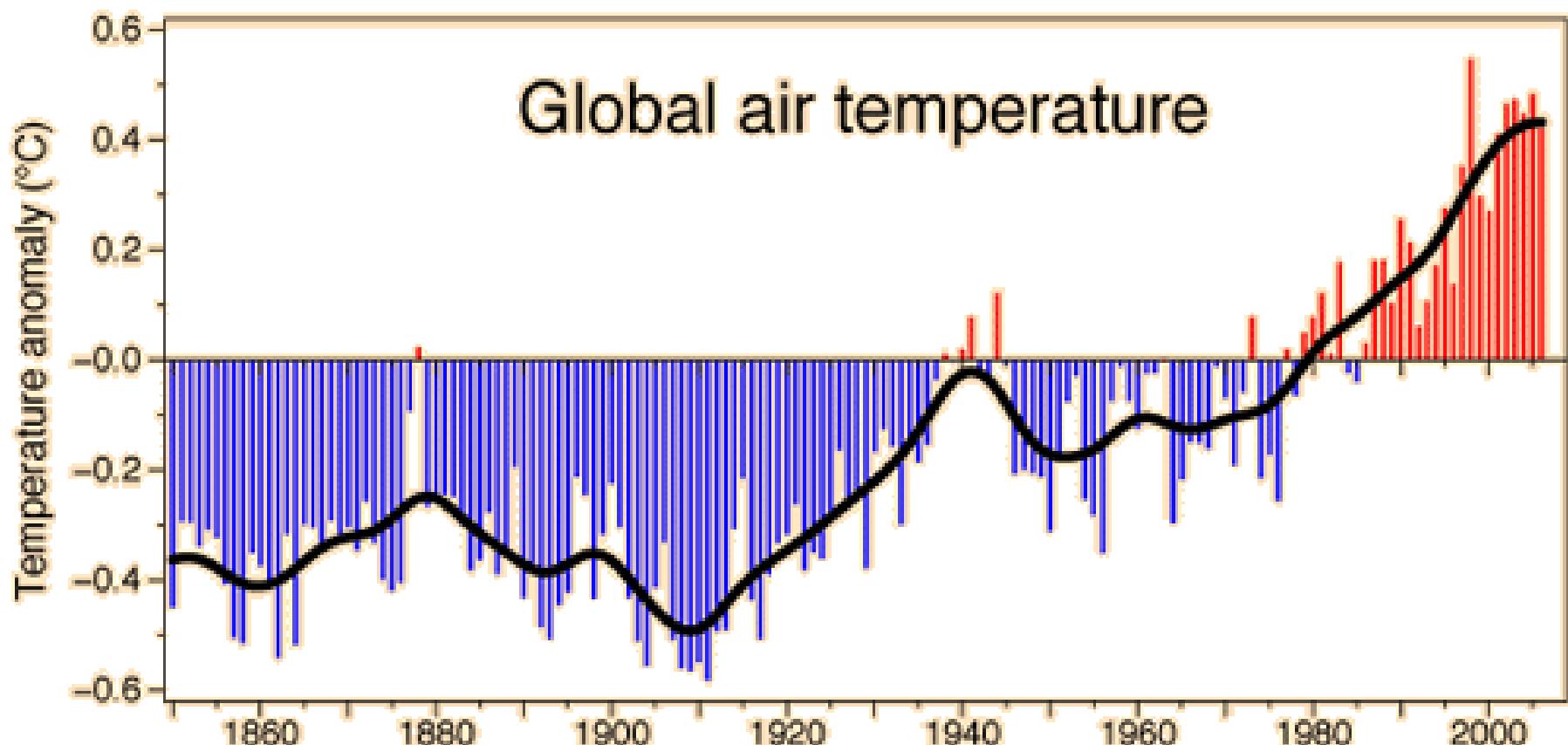


# Ilmastonmuutoksen suurimmat aiheuttajat selvitetty

Jyrki Kauppinen

Fysiikan ja tähtitieteen laitos

Turun yliopisto





## Ilmaston herkkyys

$$R = \frac{dT}{dQ}$$

ja lämpötilan muutos

$$\Delta T = R\Delta Q$$

$\Delta Q$  = säteilypakote

Herkkyyttä mitataan myöskin:

$$\Delta T_{2co_2} = R \cdot \Delta Q_{2co_2}$$

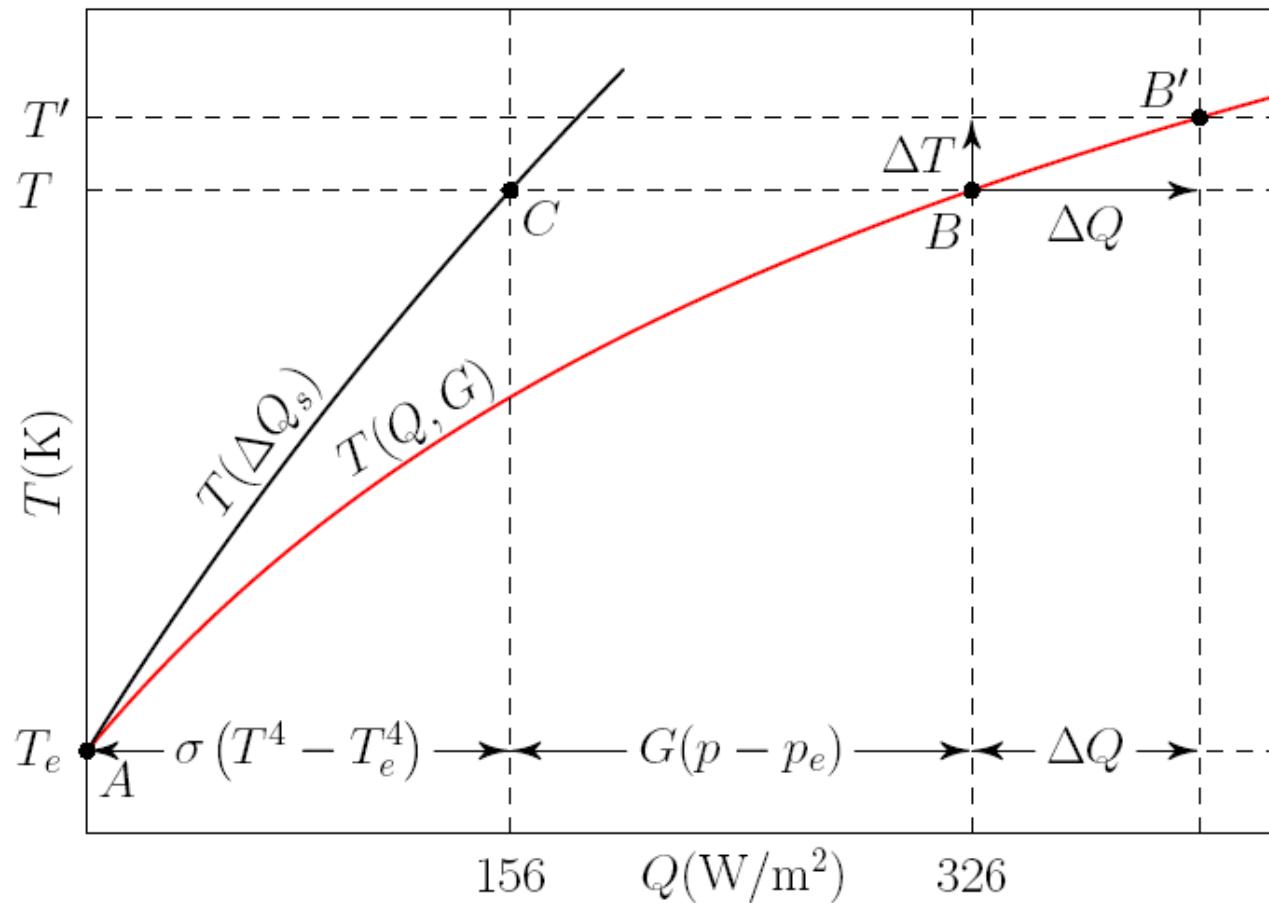


Figure 2.  $Q_s = \sigma T^4$ ,  $\Delta Q_s = \sigma(T^4 - T_e^4)$ ,  $\sigma$  is the Stefan-Boltzmann constant,  $T=289$  K, and  $T_e=255$  K. The total forcing is  $Q = \sigma(T^4 - T_e^4) + G(p - p_e)$ .  $\Delta T = T' - T = R\Delta Q$ .

Meidän tulos (käyttäen IPCC arvoa  $3.78 \frac{W}{m^2}$ )

$$\Delta T_{2CO_2} = 0.058 \frac{\text{ }^\circ\text{C}}{W/m^2} \cdot 3.78 \frac{W}{m^2} = 0.22 \text{ }^\circ\text{C}$$

IPCC:n tulos  $\Delta T_{2CO_2} \sim 2 \dots 4.5 \text{ }^\circ\text{C}$

*todennäköisin arvo*  $\Delta T_{2CO_2} \sim 3.2 \text{ }^\circ\text{C}$

=> *IPCC arvioi herkkyyden vähintään 14-kertaiseksi meidän laskemaan arvoon verrattuna*

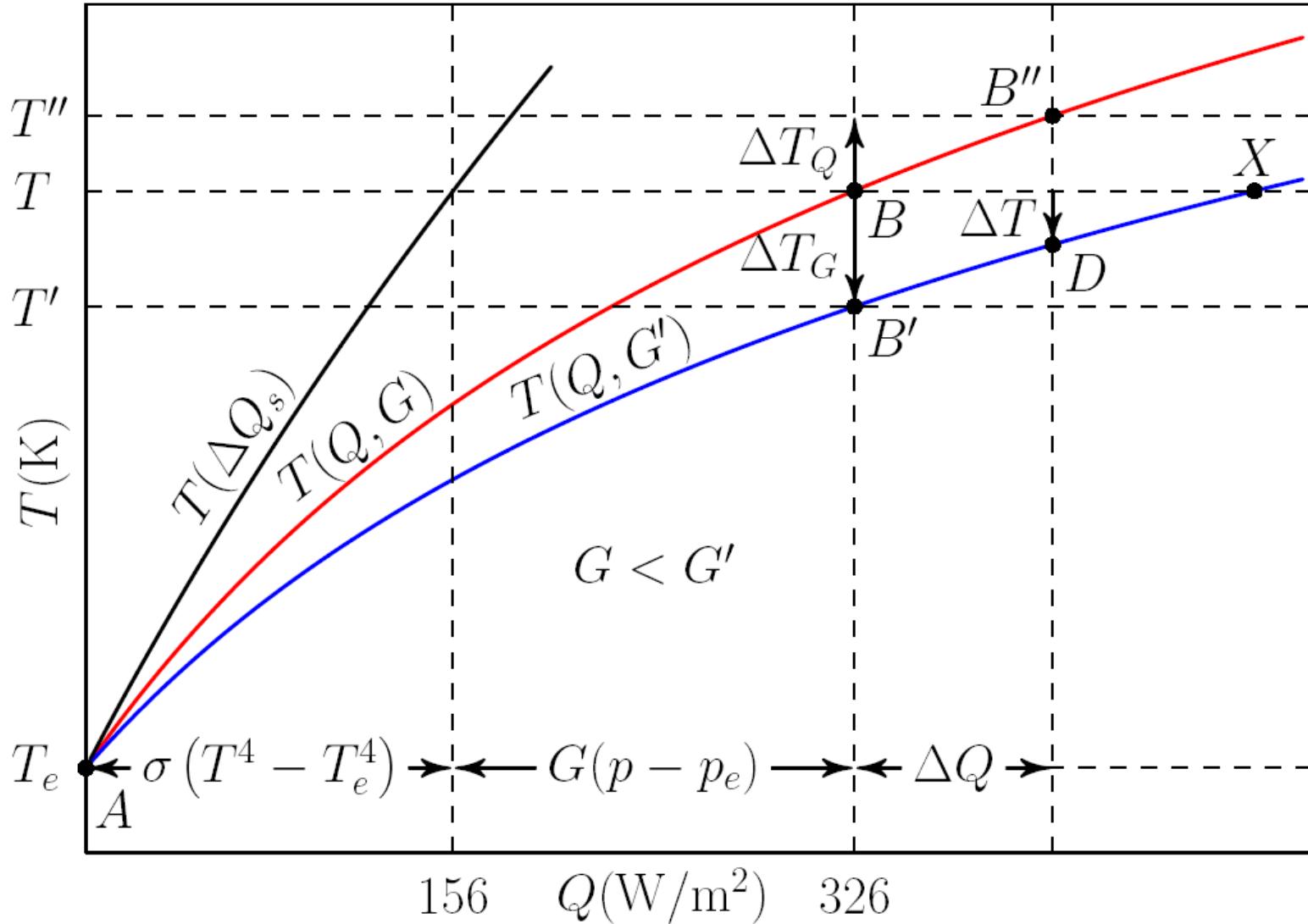


Figure 4.  $Q_s = \sigma T^4$ ,  $\Delta Q_s = \sigma(T^4 - T_e^4)$ ,  $\sigma$  is the Stefan-Boltzmann constant,  $T=289$  K, and  $T_e=255$  K. The total forcing is  $Q=\sigma T^4 - T_e^4 + G(p-p_e)$ . The total temperature change in the process BB''D or BB'D is  $\Delta T = \Delta T_Q + \Delta T_G$ . Note that  $\Delta T_Q$  is positive and  $\Delta T_G$  is negative in this figure. In the process BB'  $\Delta Q=0$ , but  $G$  and  $R$  are changing.

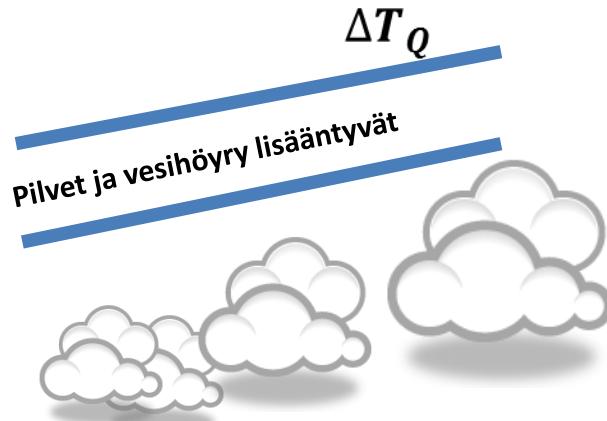
$$\Delta T = R\Delta Q - R[\Delta G(p - p_e)] = \Delta T_Q + \Delta T_G. \quad (1)$$

$$G = G_0 \emptyset \quad \text{ja} \quad \emptyset = p_a/p \quad (2)$$

$$\Delta G = G \frac{\Delta \phi}{\phi} = G \frac{\Delta c}{c} = - \frac{\Delta R}{R^2 \frac{dp}{dT}} \quad (3)$$

$$\Delta T_Q = R \cdot \Delta Q$$

$$\Delta G = 0$$

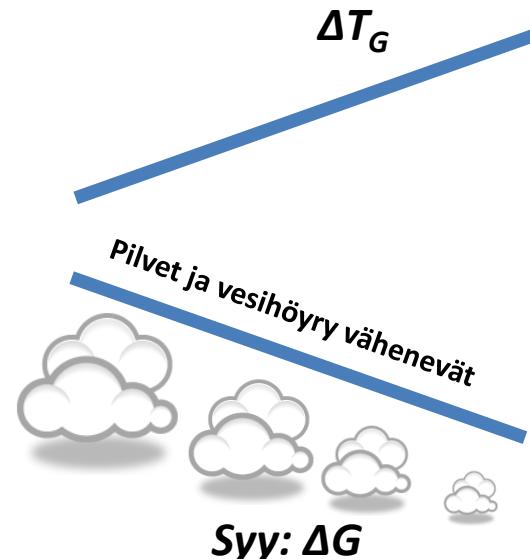


Syy:  $\Delta Q$

Kasvihuoneilmiö

$$\Delta T_G = -R \Delta G(p-p_e)$$

$$\Delta Q = 0$$



Syy:  $\Delta G$

Ilmakehän vesimäärään muutos

$$\Delta T = \Delta T_Q + \Delta T_G \approx \Delta T_G, \text{ koska } \Delta T_Q \ll \Delta T_G$$

Tarkastelu osoittaa, että  $\text{CO}_2$ :n vaikutus ilmastonmuutokseen on merkityksetön.

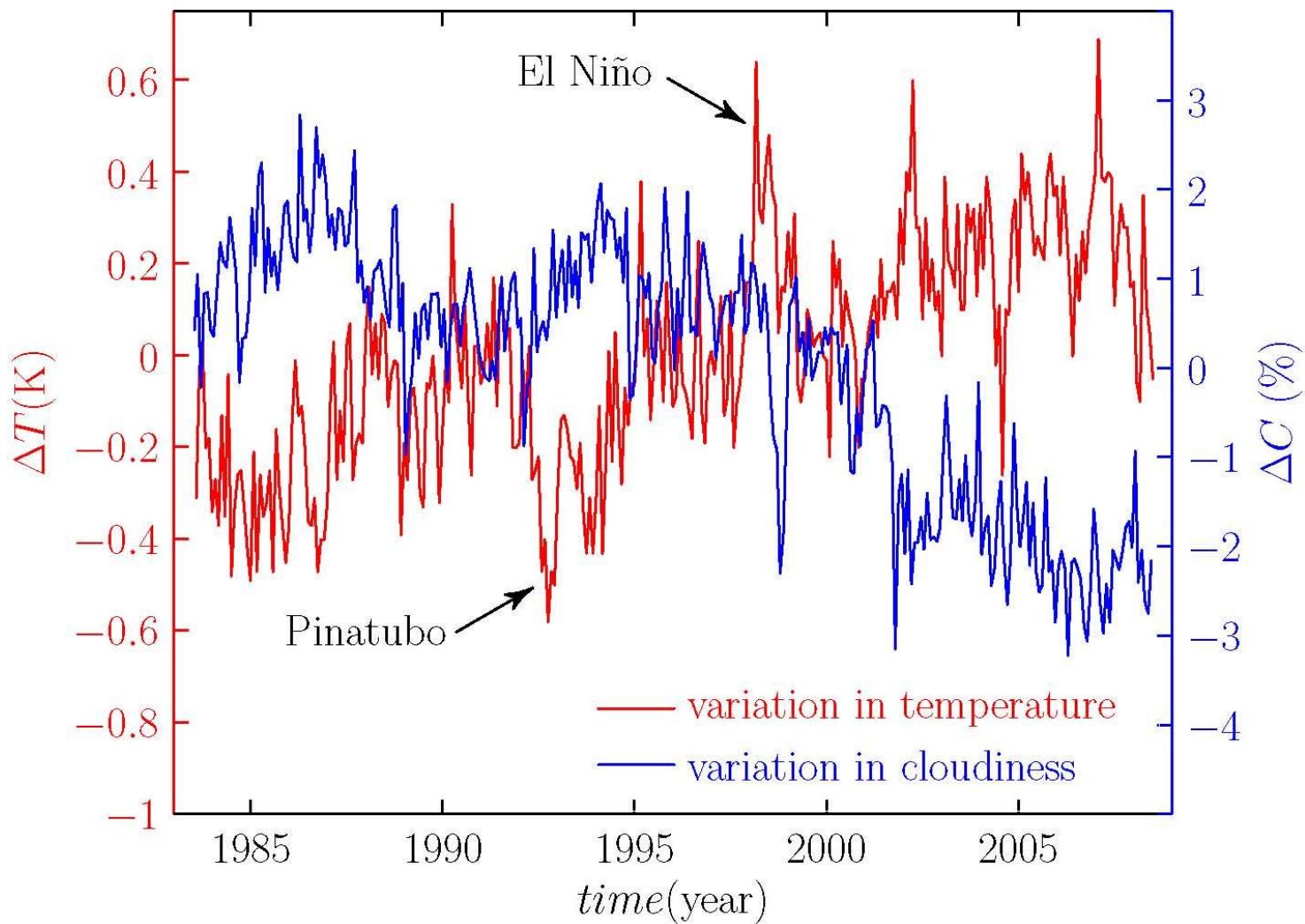


Figure 5. Global temperature anomaly (red) and the global low cloud cover changes (blue) [15], [17]. The time resolution of the data is one month.

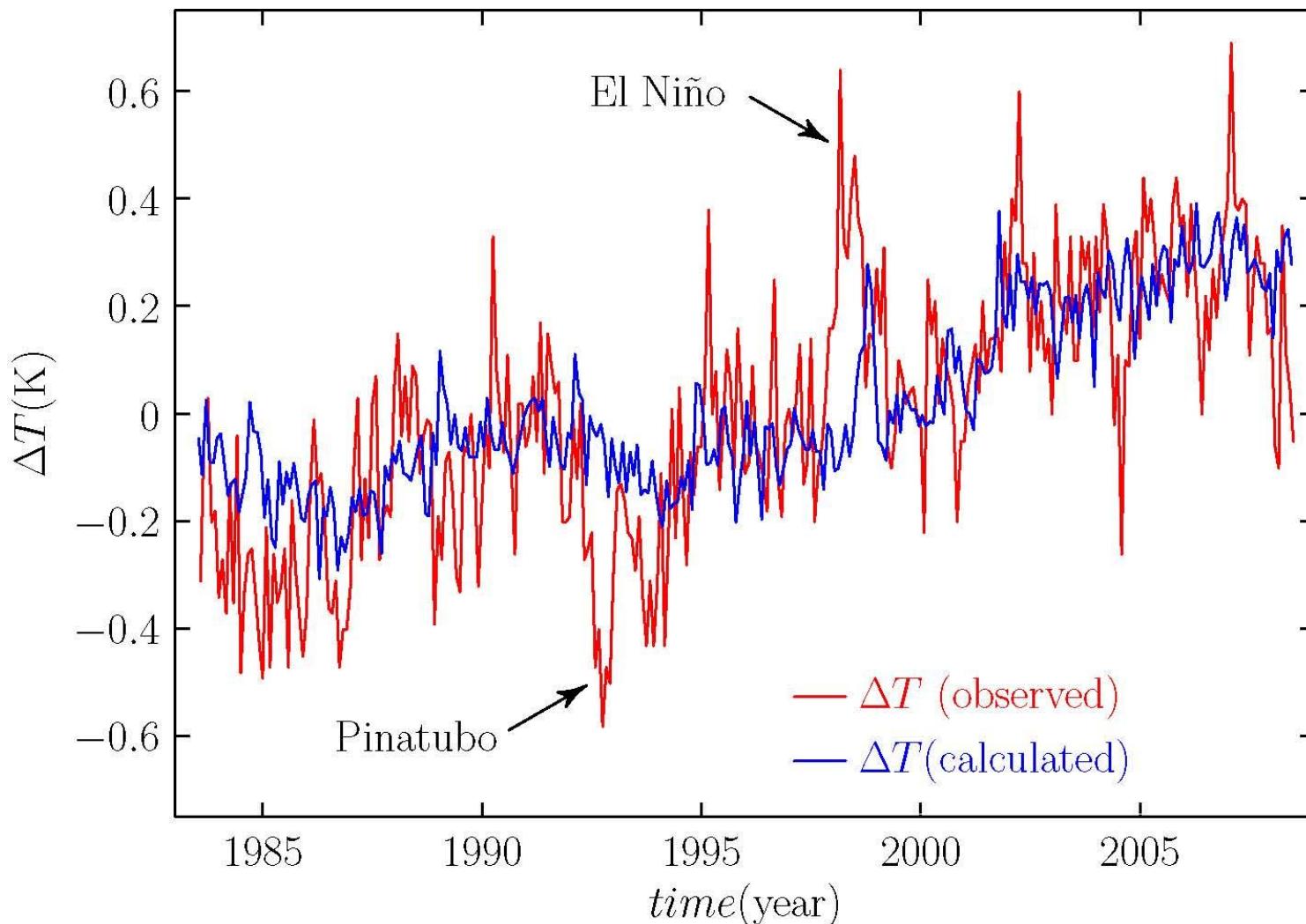
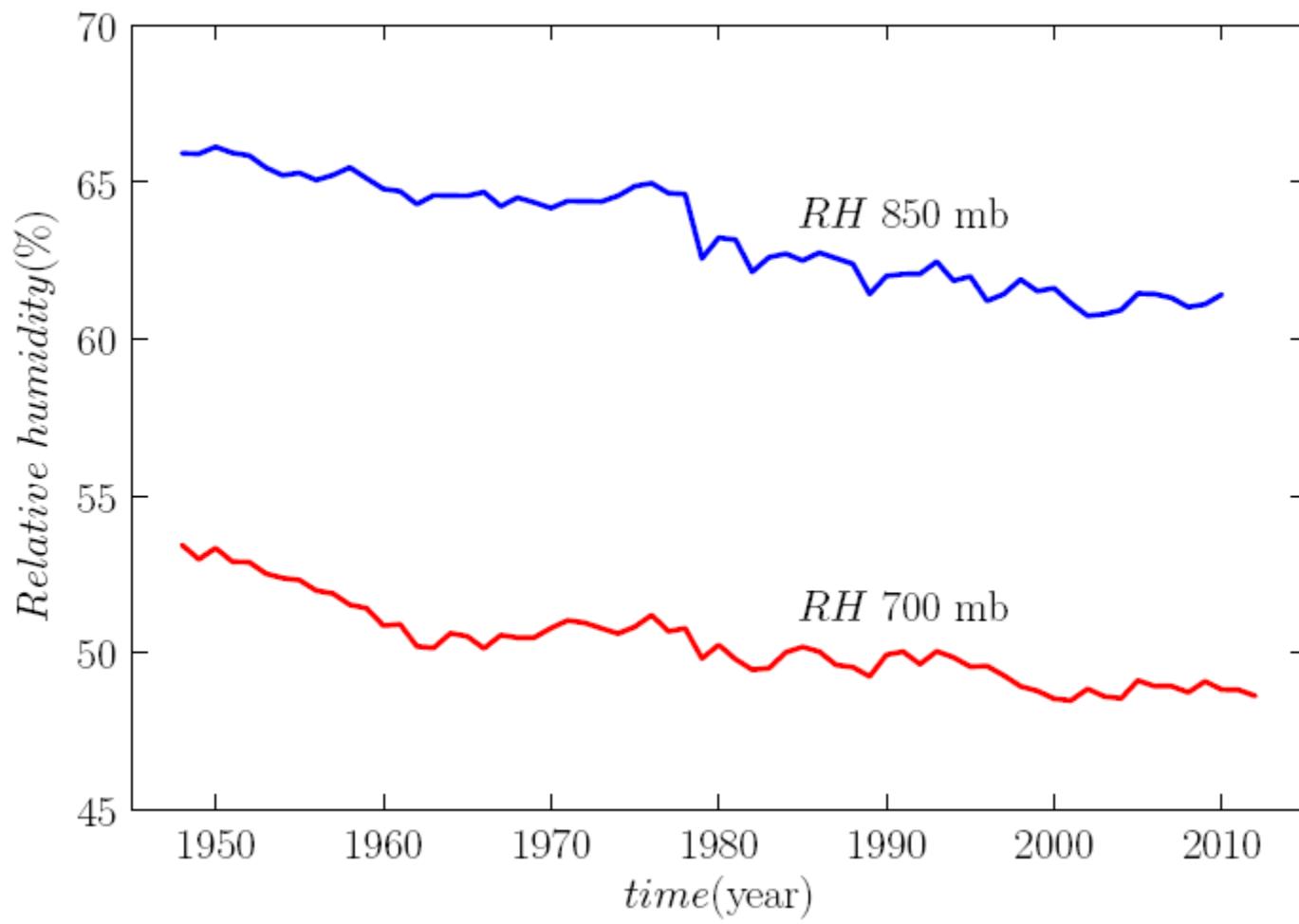
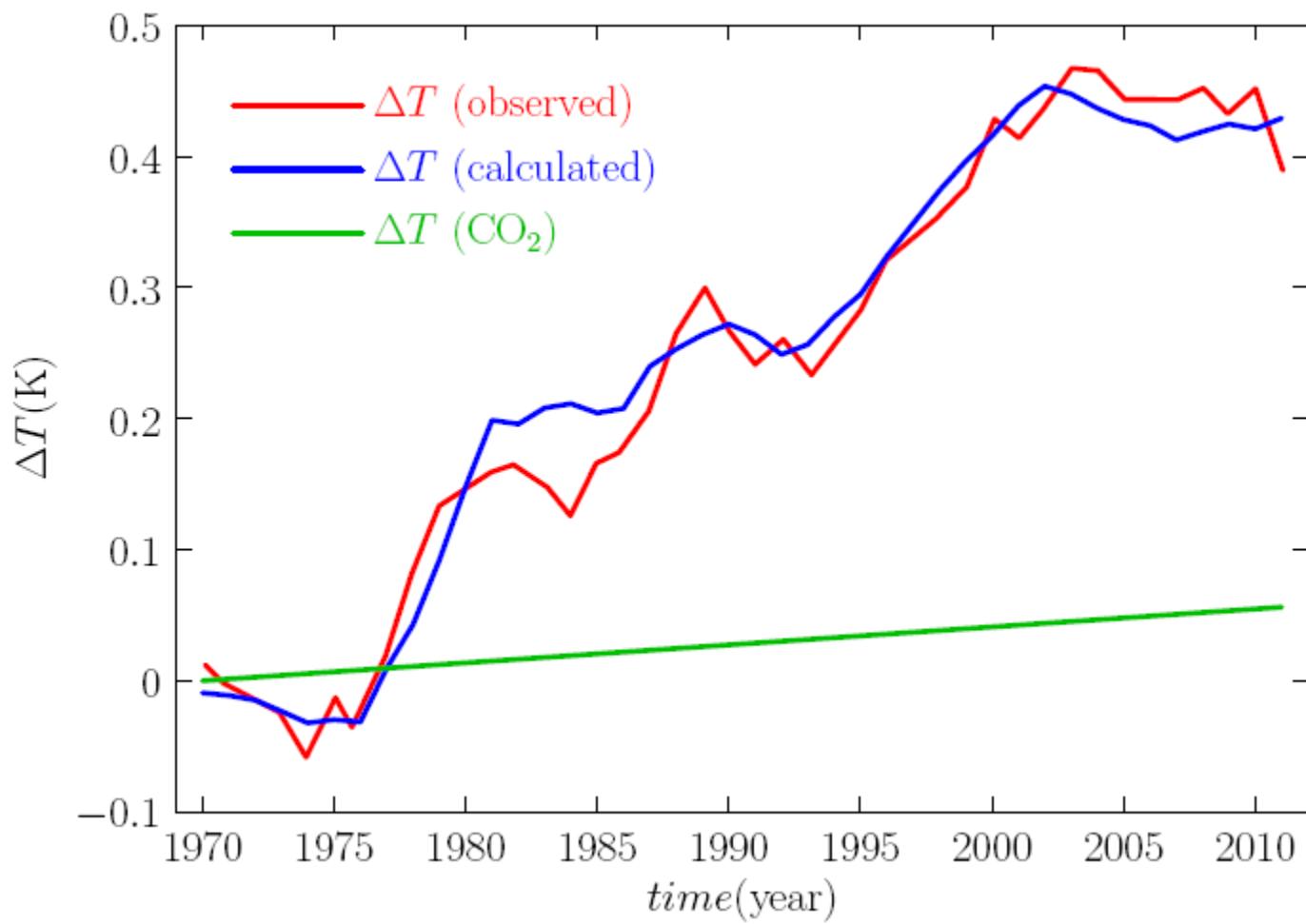
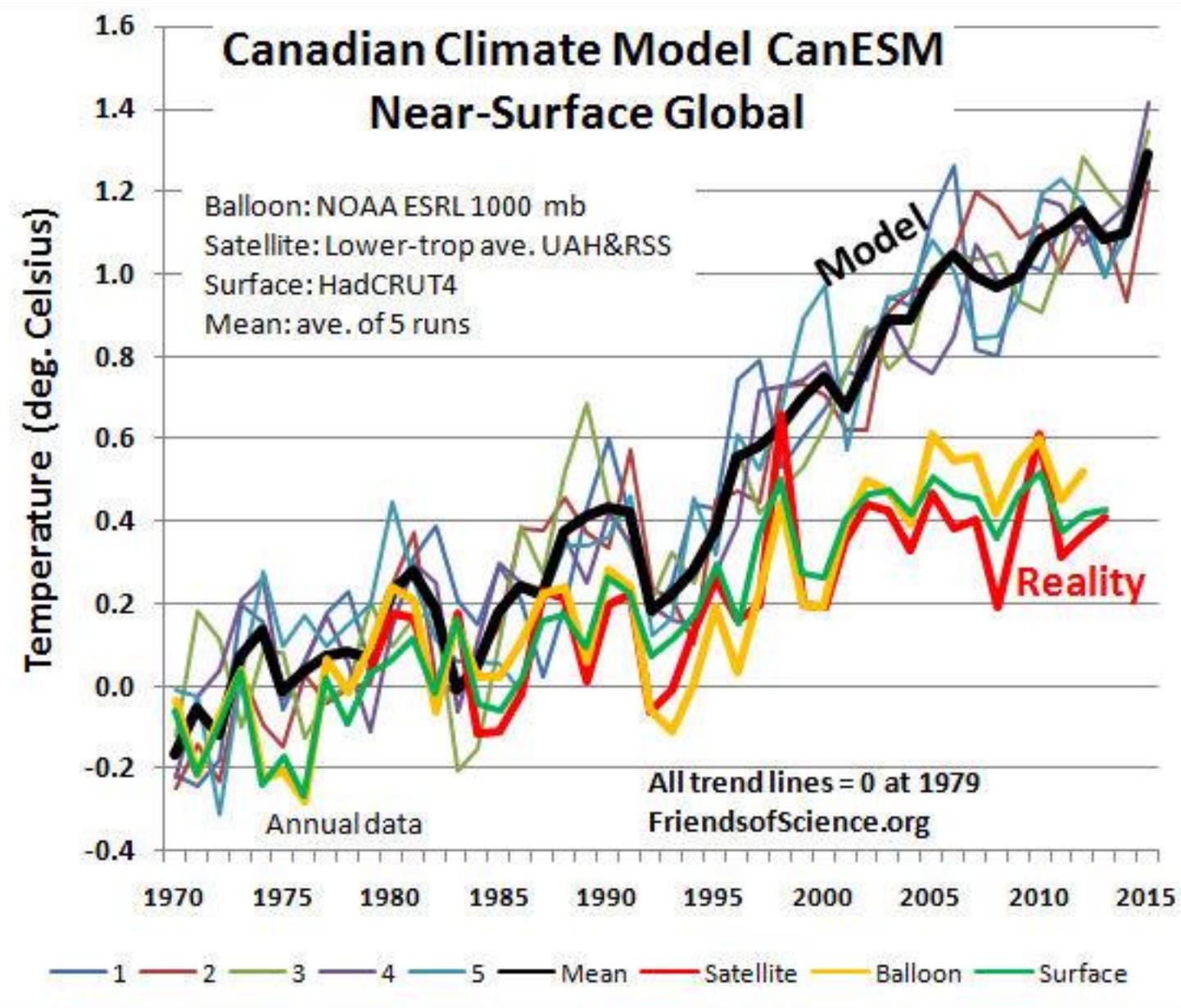
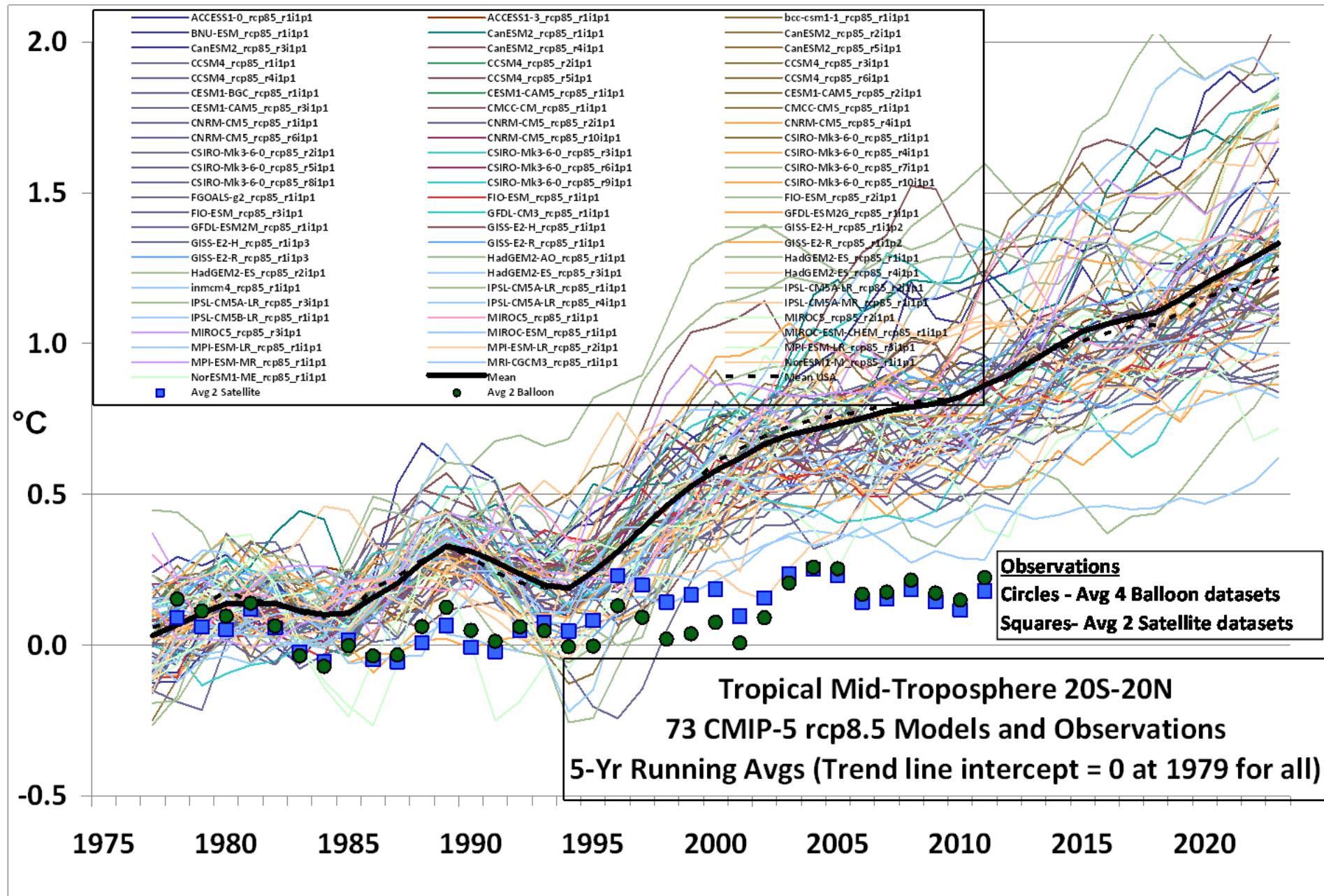


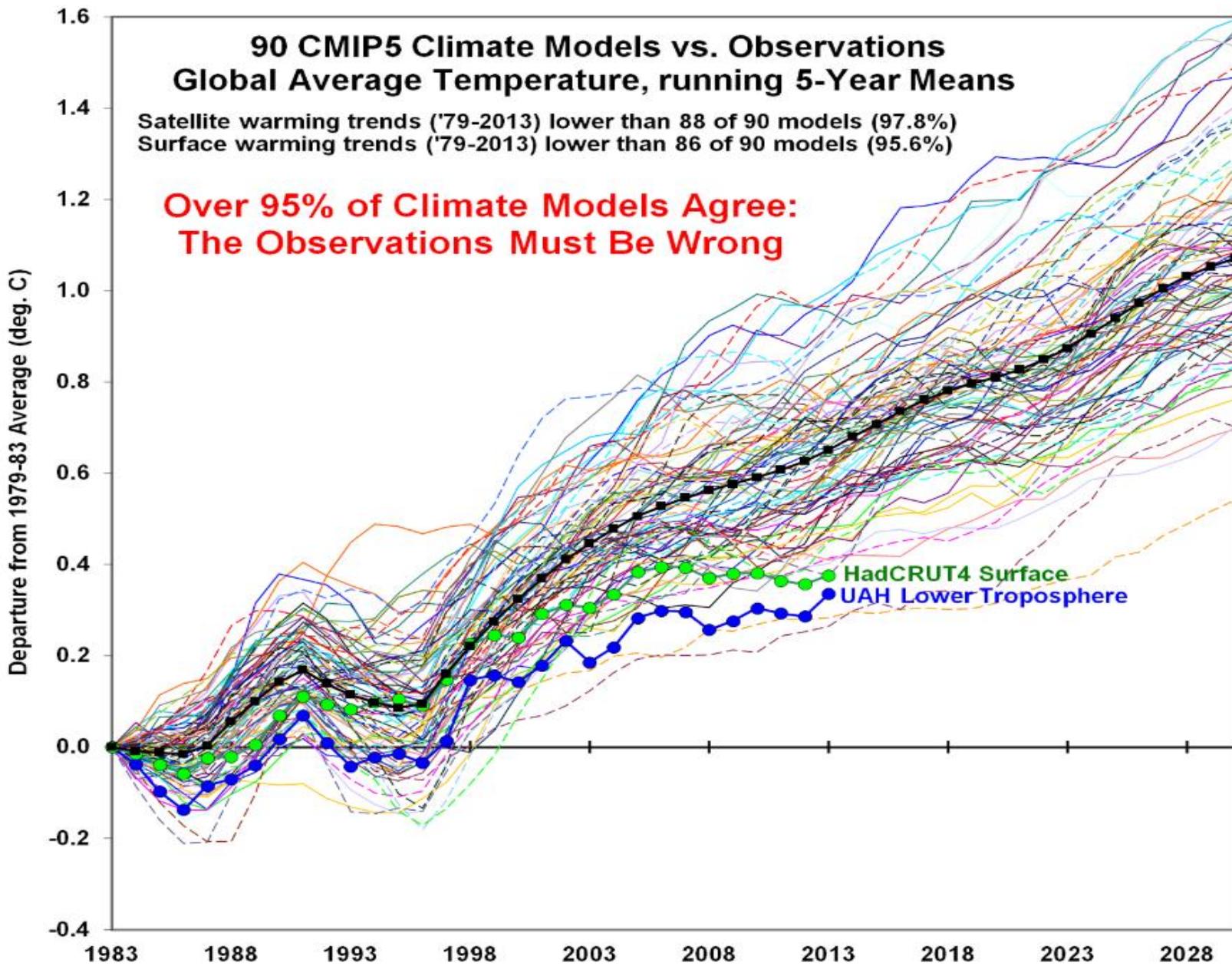
Figure 6. Global temperature anomaly (blue) calculated superimposed on the observed global temperature anomaly (red) [17]. There are half a dozen very sharp ghost spikes in the observed (red) temperature anomaly. The Pinatubo eruption and the strongest El Niño are clearly seen.







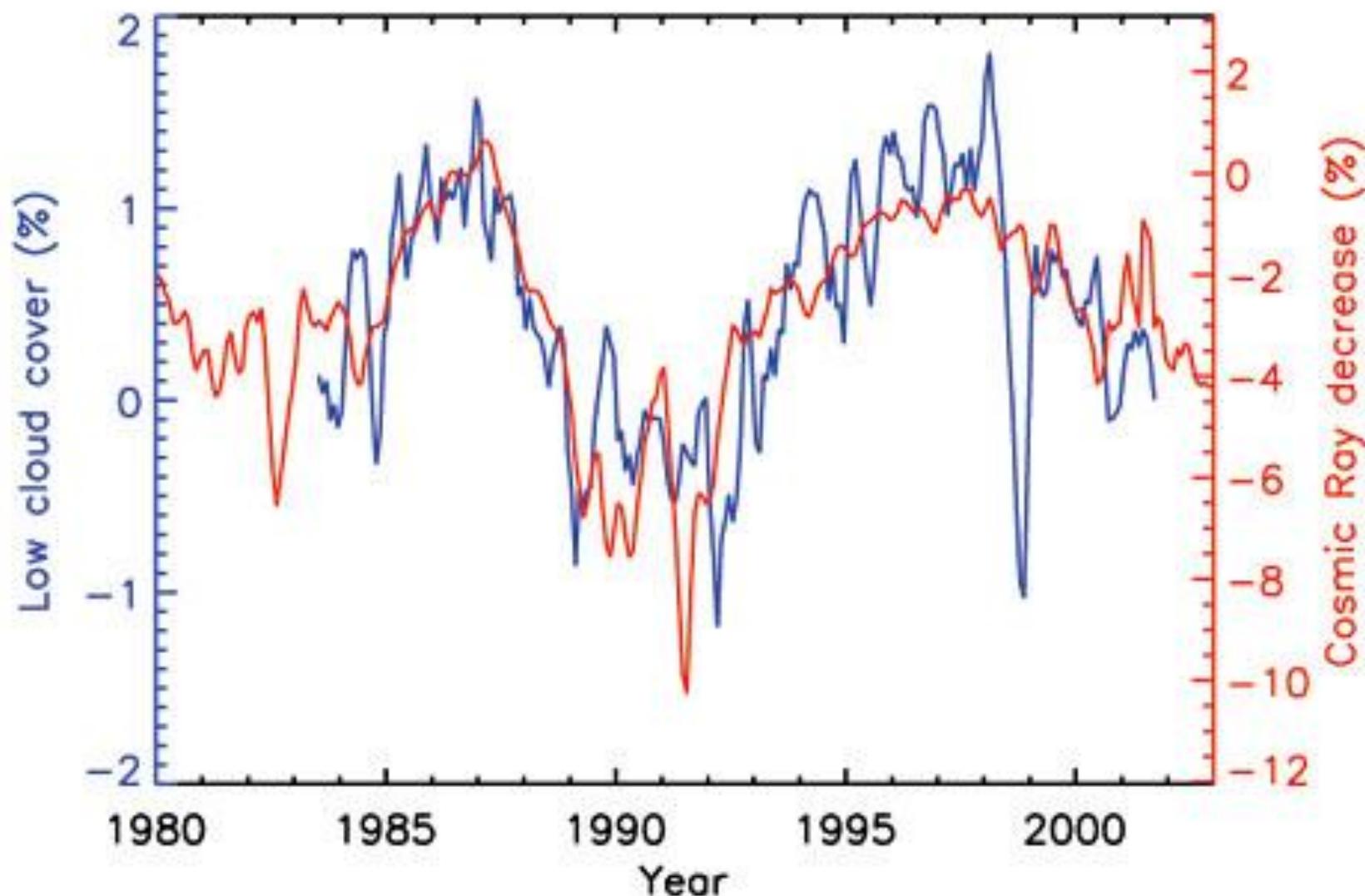




Reports of IPCC do not refer to many scientific papers, which disagree with IPCC.

For example: Schneider S. H., Cloudiness as a global Feedback Mechanism: The Effects on the Radiation Balance and Surface Temperature Variations in Cloudiness, *Journal of Atmospheric Sciences*, 1972, 29, 1413-1422.

The main result of the previous paper is that one percent increase of cloudiness decreases temperature about 0.15 °C



Tiivistyminen

Pilvi

Höyry

Höyrystyminen

Tiivistymis-  
keskukset

Sade

Veden kiertäminen ilmastoissa

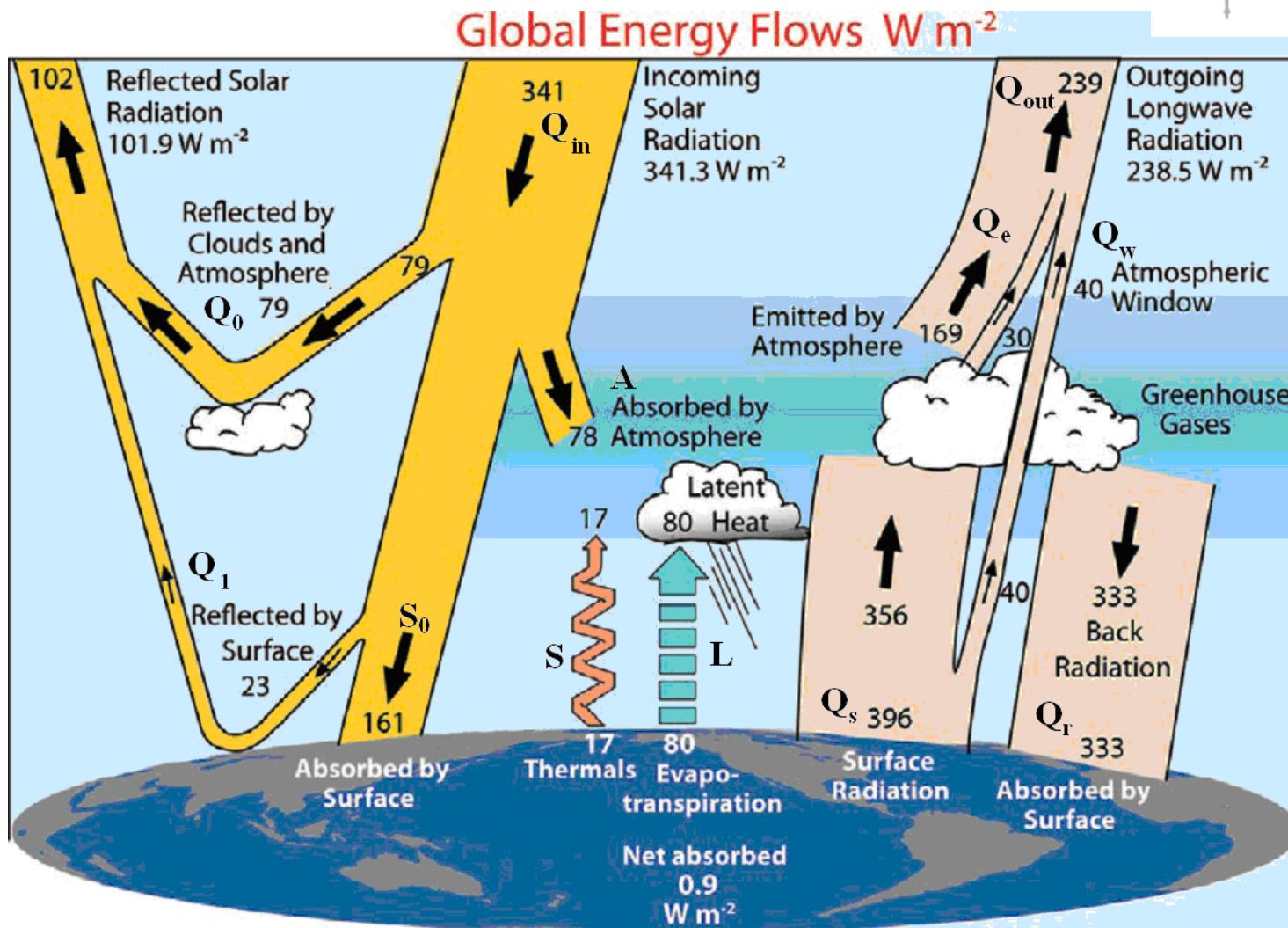


Figure 3. Global energy flows  $\text{W}/\text{m}^2$ . Explanation of the symbols:

$Q_{in} = 341 \text{ W m}^{-2}$ ,  $Q_0 = 79 \text{ W m}^{-2}$ ,  $A = 78 \text{ W m}^{-2}$ ,  $Q_1 = 23 \text{ W m}^{-2}$ ,  $S_0 = 161 \text{ W m}^{-2}$ ,  
 $S = 17 \text{ W m}^{-2}$ ,  $L = 80 \text{ W m}^{-2}$ ,  $Q_s = 396 \text{ W m}^{-2}$ ,  $Q_r = 333 \text{ W m}^{-2}$ ,  $Q_w = 40 \text{ W m}^{-2}$ ,  
 $Q_e = 169 \text{ W m}^{-2}$ ,  $Q_{out} = 239 \text{ W m}^{-2}$

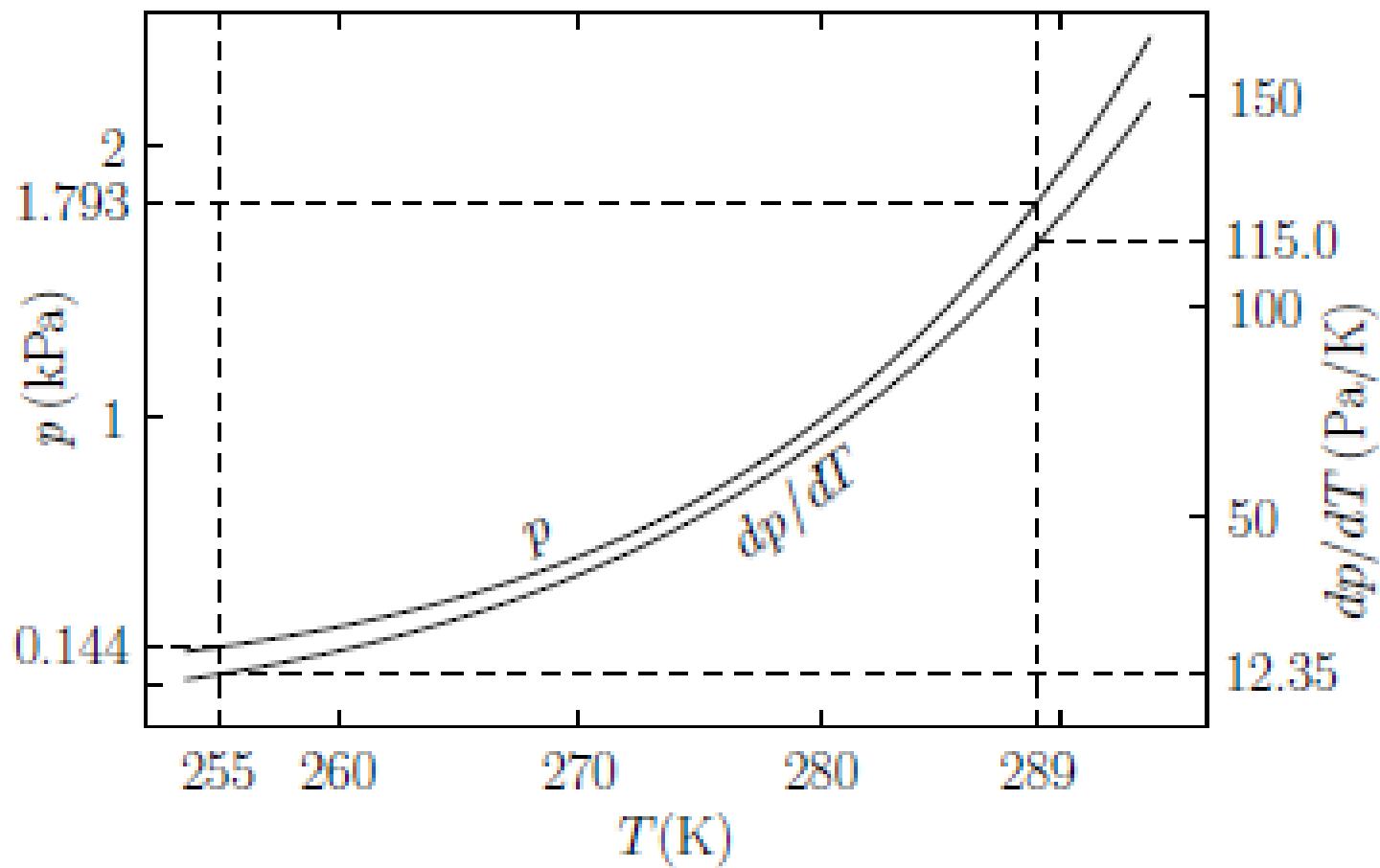


Figure 2: The partial pressure of the saturated water vapor  $p$  and the derivative  $dp/dT$  as a function of temperature, according to Antoine equation.

$$T - T_0 = R_{av}Q$$
$$= 0.104 \frac{\text{ }^{\circ}\text{C}}{\text{W/m}^2} \cdot 326 \frac{\text{W}}{\text{m}^2} = 34 \text{ }^{\circ}\text{C}$$

*Lämpötilan muutos edellisestä yhtälöstä*

$$\Delta T = R_{av} \Delta Q + \Delta R_{av} Q$$
$$Q \approx 326 \text{ ja } \Delta Q \approx 2...4 \text{ W/m}^2$$

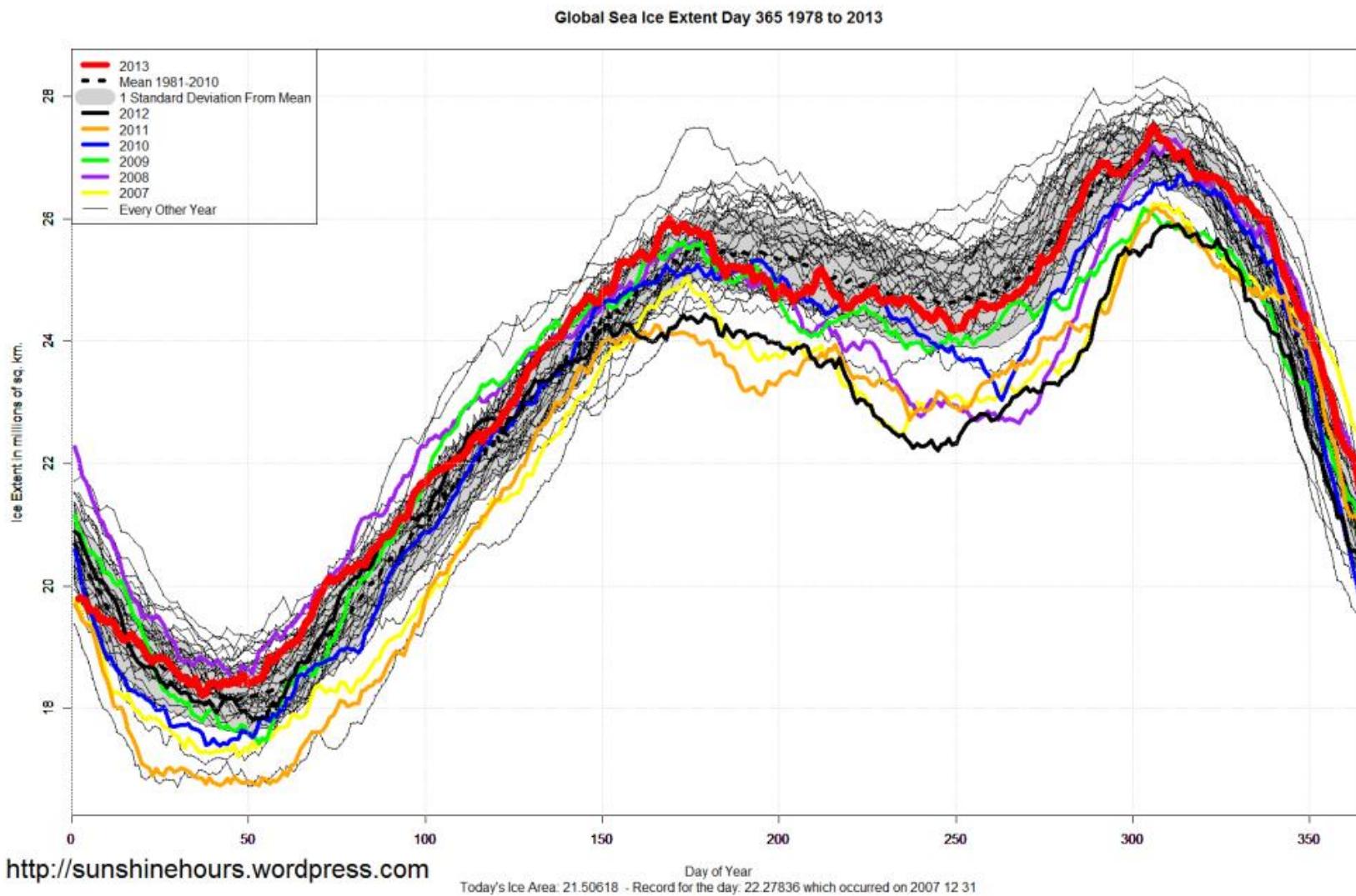
*IPCC ei huomioi termejä  $\Delta R_{av} Q$ .*

## Lämpötilakehitys meren pinnassa ja sen molemmin puolin

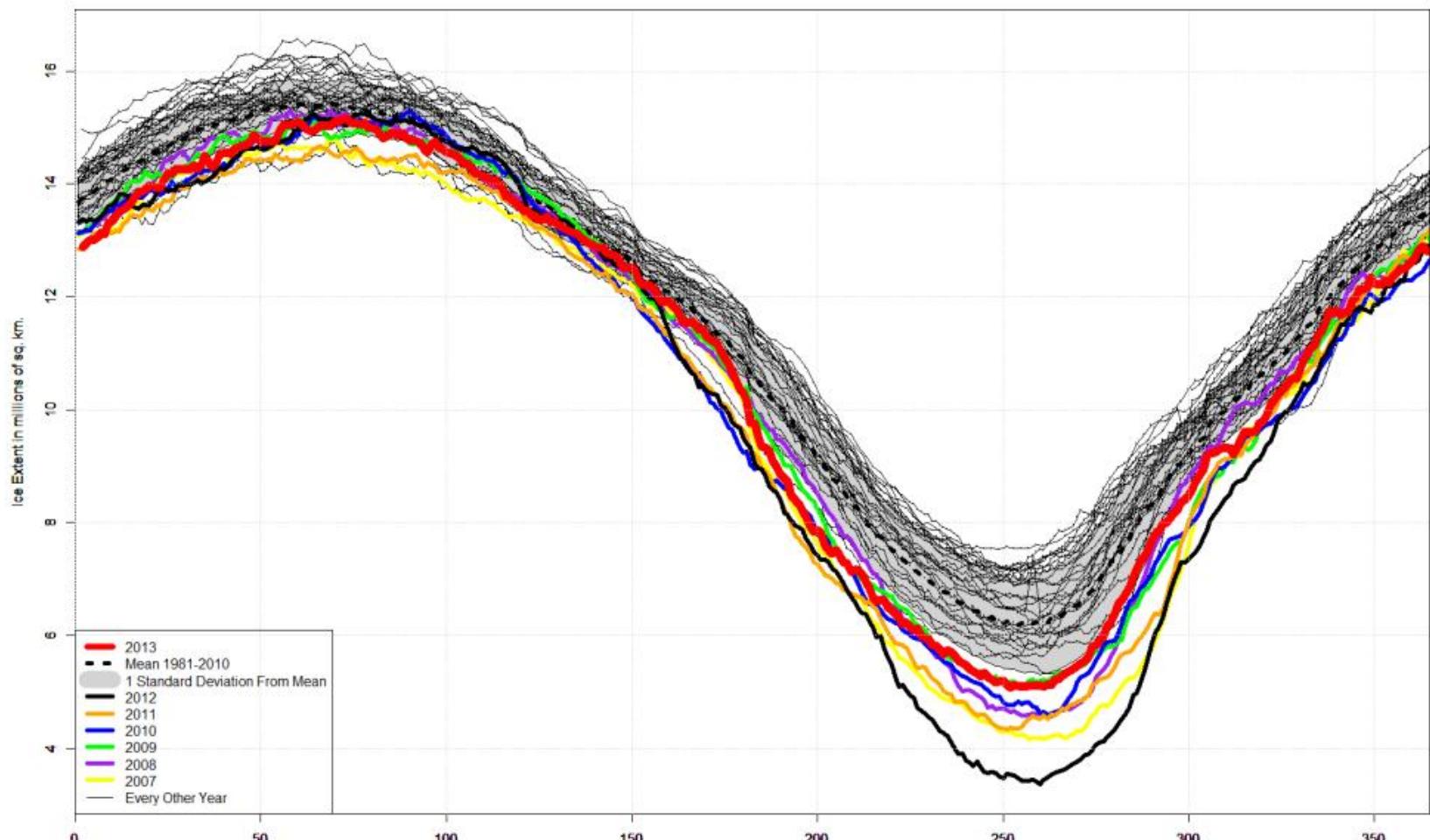


Kuvassa on kolme globaalaa kuvajaa esitettyynä yhtenäisillä murtoviivoilla ja niiden lineaariset trendit paksummilla katkoviivoilla:

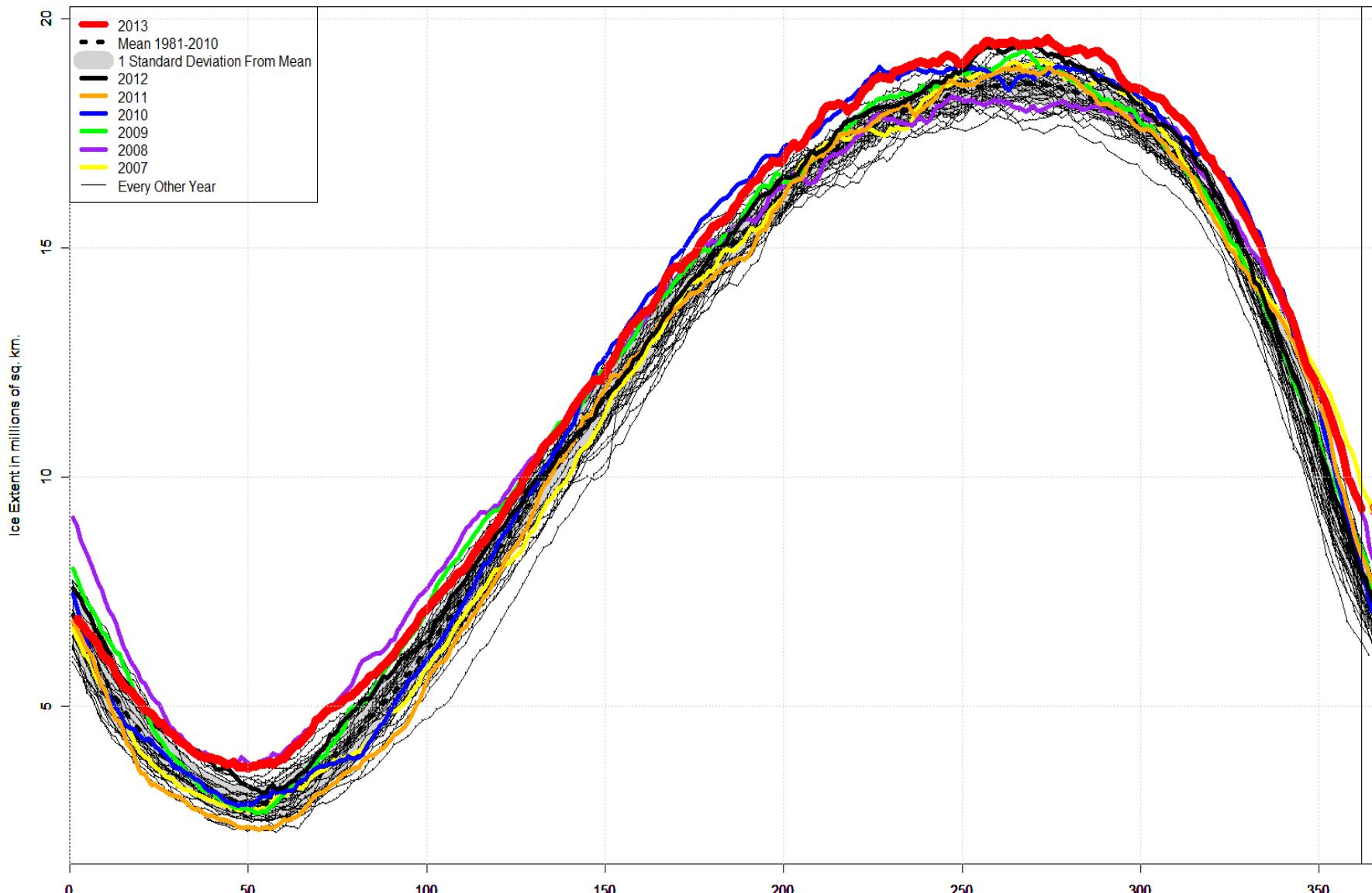
1. **Punaisella** on kuvattu satelliittien mittaama maapallon alailmakehän vuosikeskilämpötilan poikkeama vertailuajankohdan keskimääräisestä siten, kuin se yhdysvaltalaisessa **RSS-aikasarjassa** esitetään.
2. **Sinisellä** on kuvattu maailman merien pintalämpötilan kesiarvon poikkeama vertailuajankohdan keskimääräisestä siten, kuin se brittien **HadSST3-aikasarjassa** esitetään. Tuo aikasarja on mitattu pääosin ankkuroiduista ja ajelehtivista pojista.
3. **Vihreällä** on kuvattu maailman merien päälimmäisen 100 metrin vesikerroksen keskilämpötilan poikkeama vertailuajankohdan keskimääräisestä siten, kuin se yhdysvaltain NOAA:n **OHC-aikasarjassa** esitetään. Tuo aikasarja on mitattu pääosin ajelehtivista ja sukeltavista Argo-pojista.



### Arctic Sea Ice Extent Day 365 1978 to 2013



### Antarctic Sea Ice Extent Day 362 1978 to 2013



11-1984  
200-10630  
JG-127  
348



CLIMATE SENSITIVITY: ANALYSIS OF FEEDBACK MECHANISMS

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**Abstract.** We study climate sensitivity and feedback processes in three independent ways: (1) by using a three dimensional (3-D) global climate model for experiments in which solar irradiance  $S_0$  is increased 2 percent or  $\text{CO}_2$  is doubled, (2) by using the CLIMAP climate boundary conditions to analyze the contributions of different physical processes to the cooling of the last ice age (18k years ago), and (3) by using estimated changes in global temperature and the abundance of atmospheric greenhouse gases to deduce an empirical climate sensitivity for the period 1850-1980.

Our 3-D global climate model yields a warming of  $\sim 4^\circ\text{C}$  for either a 2 percent increase of  $S_0$  or doubled  $\text{CO}_2$ . This indicates a net feedback factor of  $f = 3-4$ , because either of these forcings would cause the earth's surface temperature to warm  $1.2-1.3^\circ\text{C}$  to restore radiative balance with space, if other factors remained unchanged. Principal positive feedback processes in the model are changes in atmospheric water vapor, clouds and snow/ice cover. Feedback factors calculated for these processes, with atmospheric dynamical feedbacks implicitly incorporated, are respectively  $f_{\text{water vapor}} \sim 1.6$ ,  $f_{\text{clouds}} \sim 1.3$  and  $f_{\text{snow/ice}} \sim 1.1$ , with the latter mainly caused by sea ice changes. A number of potential feedbacks, such as land ice cover, vegetation cover and ocean heat transport were held fixed in these experiments.

We calculate land ice, sea ice and vegetation

feedbacks for the 18K climate to be  $f_{\text{land ice}} \sim 1.2-1.3$ ,  $f_{\text{sea ice}} \sim 1.2$ , and  $f_{\text{vegetation}} \sim 1.05-1.1$  from their effect on the radiation budget at the top of the atmosphere. This sea ice feedback at 18K is consistent with the smaller  $f_{\text{snow/ice}} \sim 1.1$  in the  $S_0$  and  $\text{CO}_2$  experiments, which applied to a warmer earth with less sea ice. We also obtain an empirical estimate of  $f = 2-4$  for the fast feedback processes (water vapor, clouds, sea ice) operating on 10-100 year time scales by comparing the cooling due to slow or specified changes (land ice,  $\text{CO}_2$ , vegetation) to the total cooling at 18K.

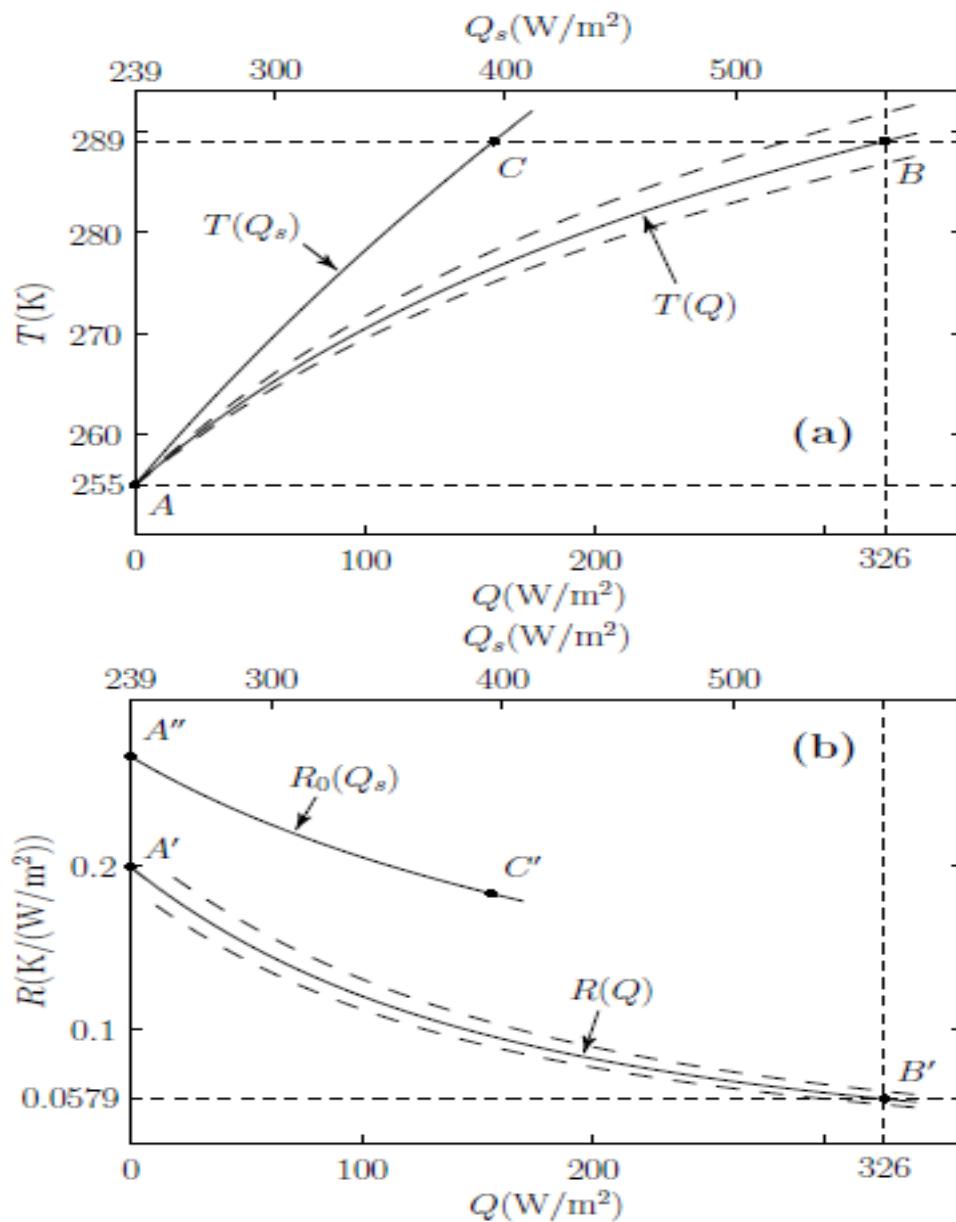
The temperature increase believed to have occurred in the past 130 years (approximately  $0.5^\circ\text{C}$ ) is also found to imply a climate sensitivity of  $2.5-5^\circ\text{C}$  for doubled  $\text{CO}_2$  ( $f = 2-4$ ), if (1) the temperature increase is due to the added greenhouse gases, (2) the 1850  $\text{CO}_2$  abundance was  $270 \pm 10$  ppm, and (3) the heat perturbation is mixed like a passive tracer in the ocean with vertical mixing coefficient  $k \sim 1 \text{ cm}^2 \text{ s}^{-1}$ .

These analyses indicate that  $f$  is substantially greater than unity on all time scales. Our best estimate for the current climate due to processes operating on the 10-100 year time scale is  $f = 2-4$ , corresponding to a climate sensitivity of  $2.5-5^\circ\text{C}$  for doubled  $\text{CO}_2$ . The physical process contributing the greatest uncertainty to  $f$  on this time scale appears to be the cloud feedback.

We show that the ocean's thermal relaxation time depends strongly on  $f$ . The e-folding time

The temperature increase believed to have occurred in the past 130 years (approximately  $0.5^\circ\text{C}$ ) is also found to imply a climate sensitivity of  $2.5-5^\circ\text{C}$  for doubled  $\text{CO}_2$  ( $f = 2-4$ ), if (1) the temperature increase is due to the added greenhouse gases, (2) the 1850  $\text{CO}_2$  abundance was  $270 \pm 10$  ppm, and (3) the heat perturbation is mixed like a passive tracer in the ocean with vertical mixing coefficient  $k \sim 1 \text{ cm}^2 \text{ s}^{-1}$ .

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$$Q(T) = \Delta Q_s(T) + Gp(T)$$

$$R(T) = \frac{R_o(T)}{1 + G \frac{\partial p}{\partial T} R_o(T)}$$

$$\Delta T = R\Delta Q - R\Delta Gp(T)$$

$\Delta RQ$

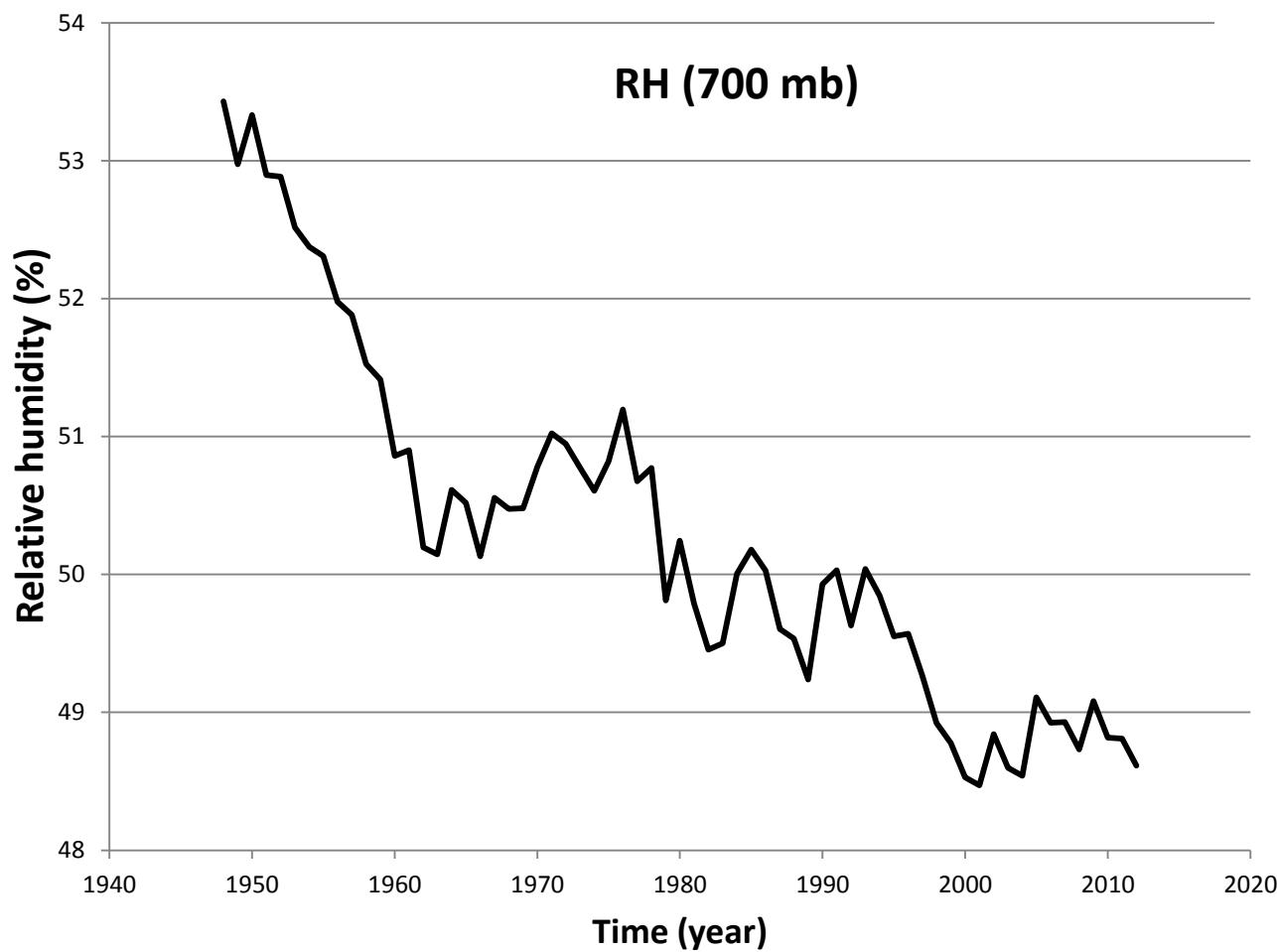


Figure 7. Relative humidity at 700 mb level between years 1990 and 2011.

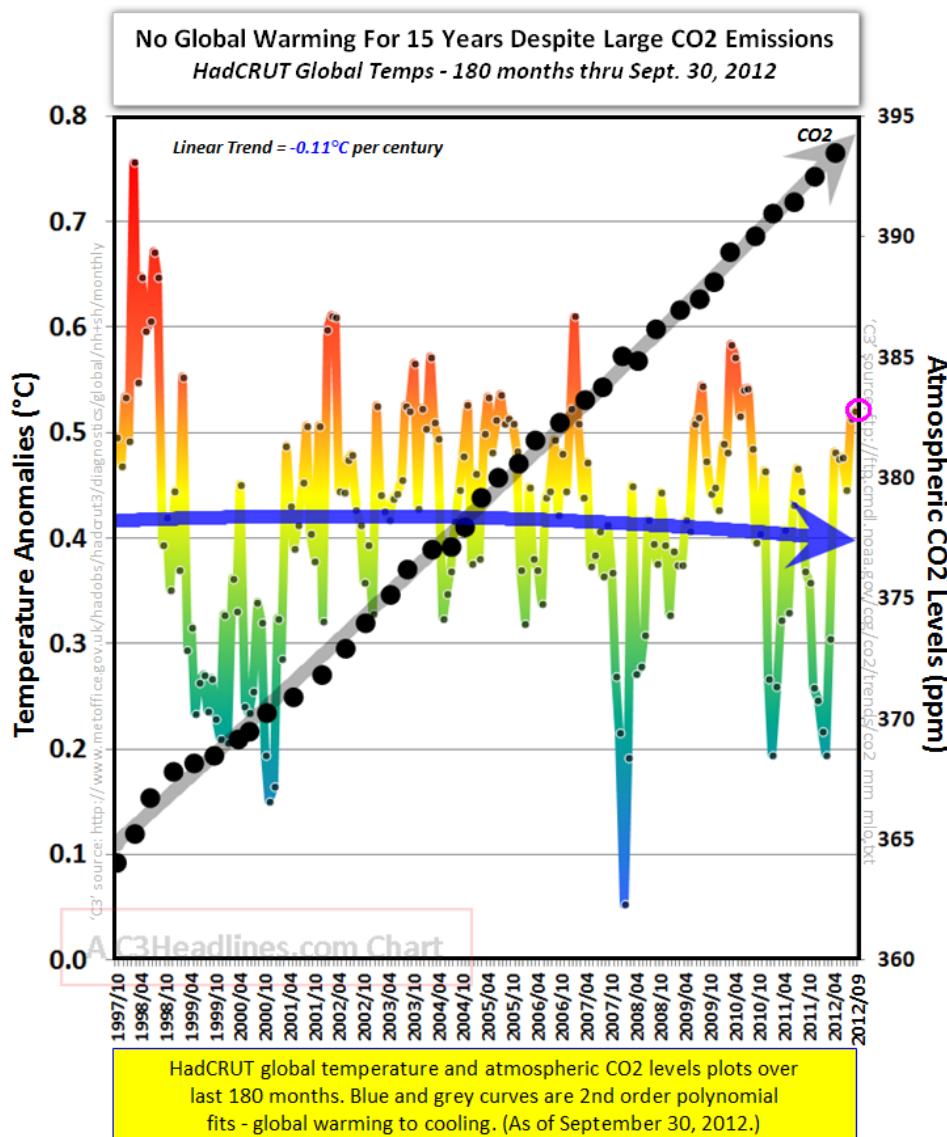


Figure 1b The global mean temperature has slightly declined after year 1998.  
[\[http://www.c3headlines.com/global-cooling-dataevidencetrends/\]](http://www.c3headlines.com/global-cooling-dataevidencetrends/)

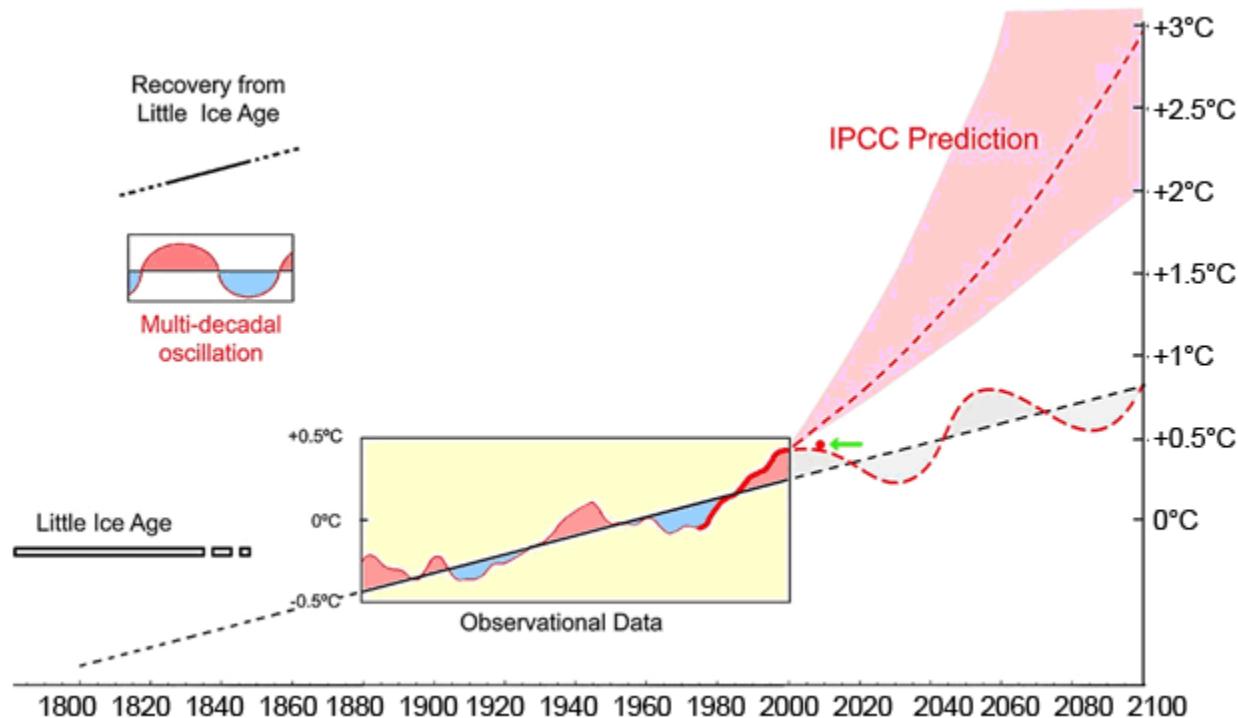
Ilmaston keskimääräiset globaalisen lämpötilan muutokset  $\Delta T$  on laskettavissa noin  $+- 0.04^{\circ}\text{C}$ :n tarkkuudella hiilidioksidin ja suhteellisen kosteuden  $\emptyset$  muutoksiin avulla. Suhteellisen kosteuden muutokset voidaan korvata pilvisyyden muutoksilla. Tarkkuuden rajoittavat suhteellisen kosteuden tai pilvisyyden mittausvirheet. Ensimmäisen julkaisumme [1] mukaan globaalisen lämpötilan muutos  $\Delta T$  saadaan lausekkeesta

$$\Delta T = R\Delta Q - R\Delta G(p-pe), \quad (1)$$

joka saa seuraavan muodon suhteellisen kosteuden avulla

$$\Delta T = R\Delta Q - RG\Delta\emptyset(p-pe)/\emptyset. \quad (2)$$

Edellisessä kaavassa ilmastonherkkyyss kasvihuonekaasuille  $R = 0.063 \text{ } ^{\circ}\text{C}/\text{W/m}^2$  ja hiilidioksidin säteilypakotteen muutos vuotta kohden  $\Delta Q = 0.022 \text{ W/m}^2$  vuosi. Lisäksi  $G = 82\text{W}/(\text{m}^2\text{kPa})$ , kylläisen vesihöyryyn keskimääräinen osapaine keskimääräisessä lämpötilassa  $p=1.79 \text{ kPa}$  ja osapaine lämpötilassa  $-18 \text{ } ^{\circ}\text{C}$   $pe = 0.14 \text{ kPa}$  ( ilman kasvihuonekaasuja ja vettä). Uudessa käskirjoituksessa [2]  $R$  ja  $G$  on laskettu kokeellisesti mitatuista ilmakehän energiavirtabudjetin arvoista.



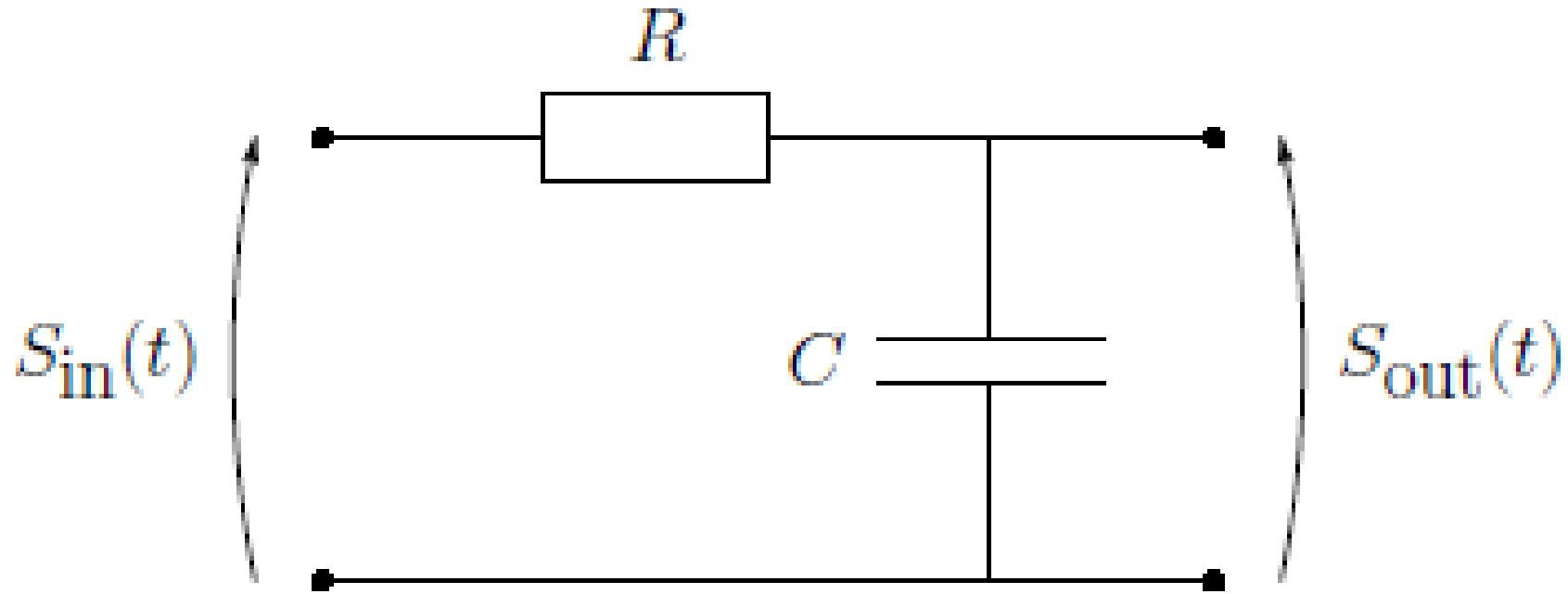


Figure 5: *RC*-circuit model of the climate system.

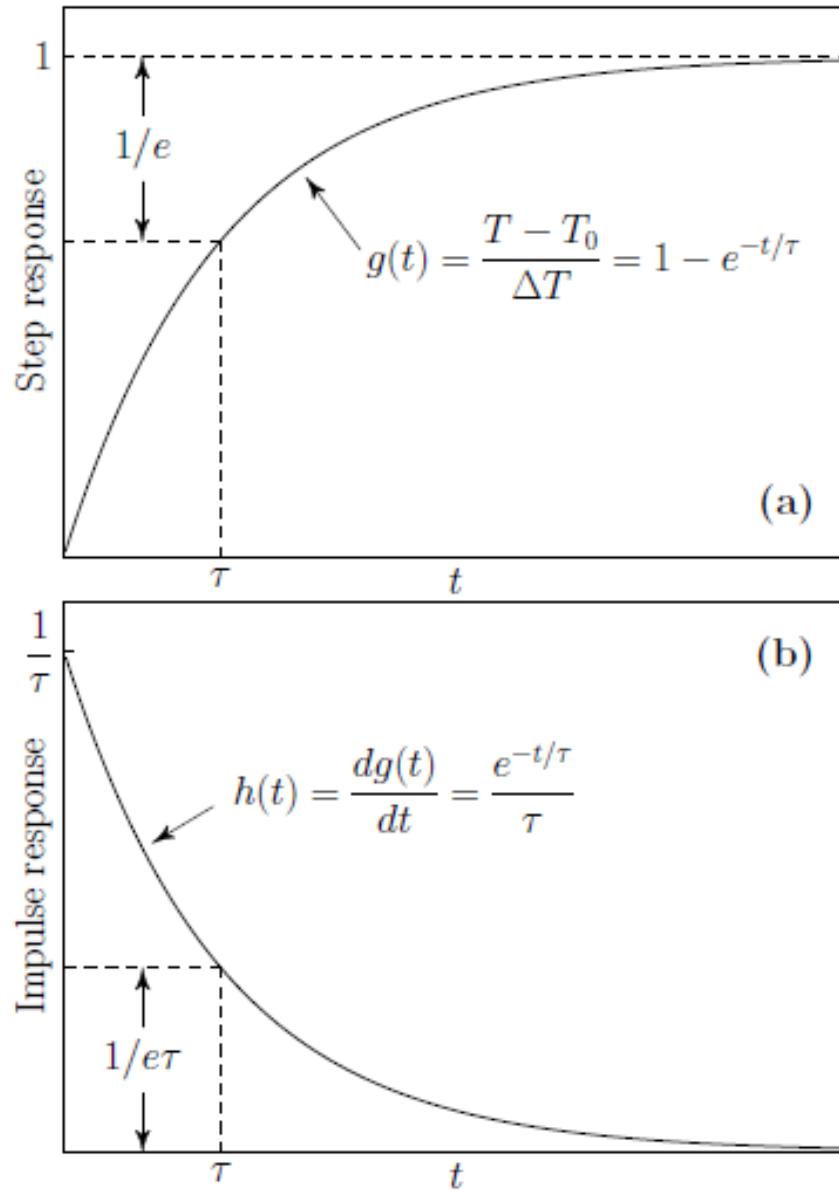


Figure 4: (a) The step response  $g(t)$  and (b) the impulse response  $h(t)$  of the climate system.

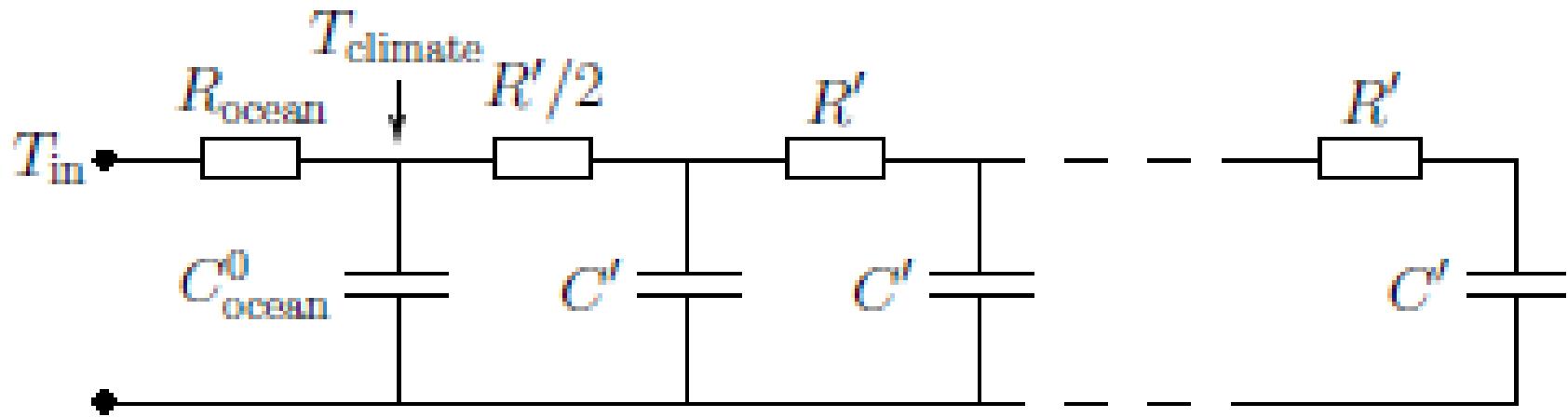
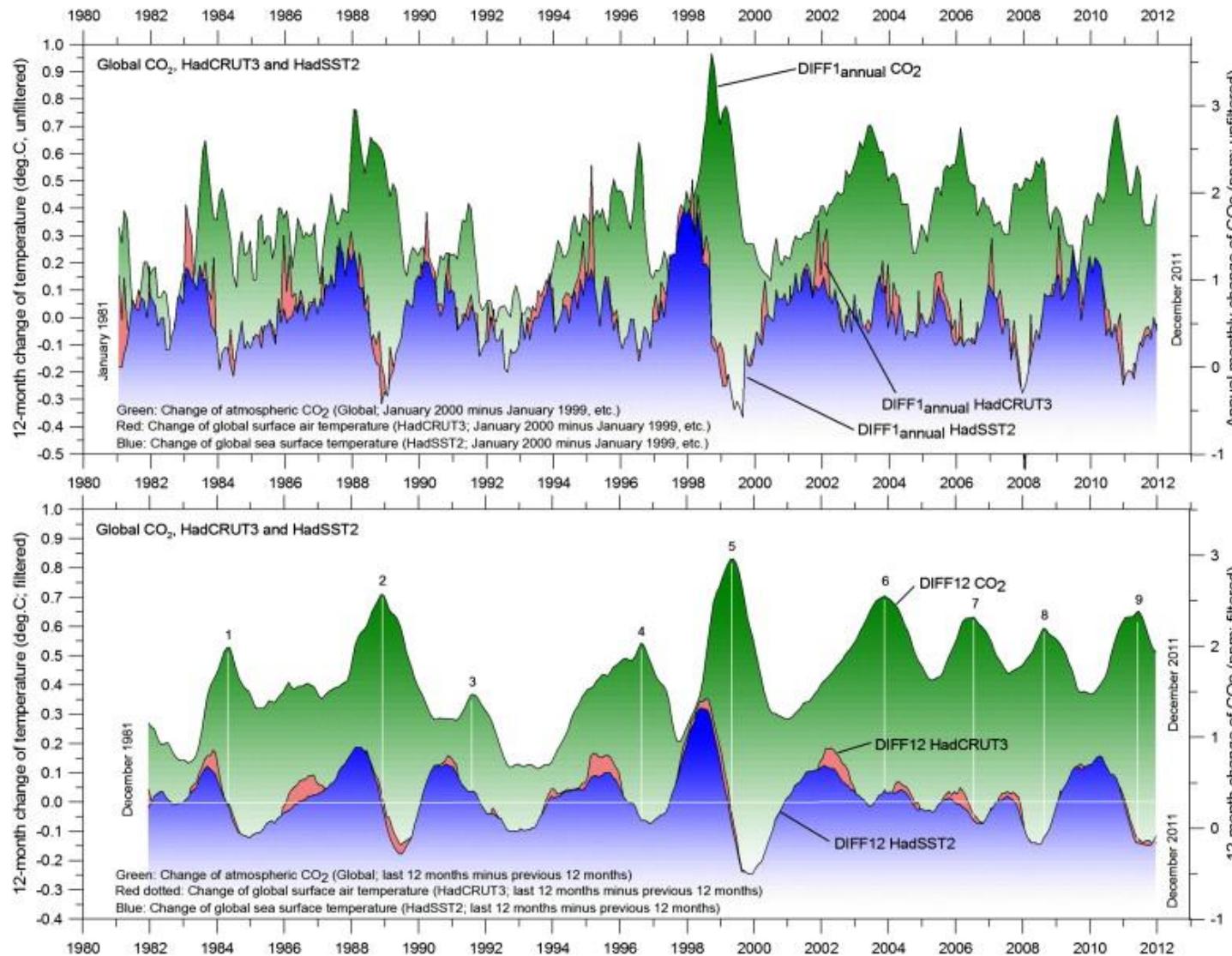
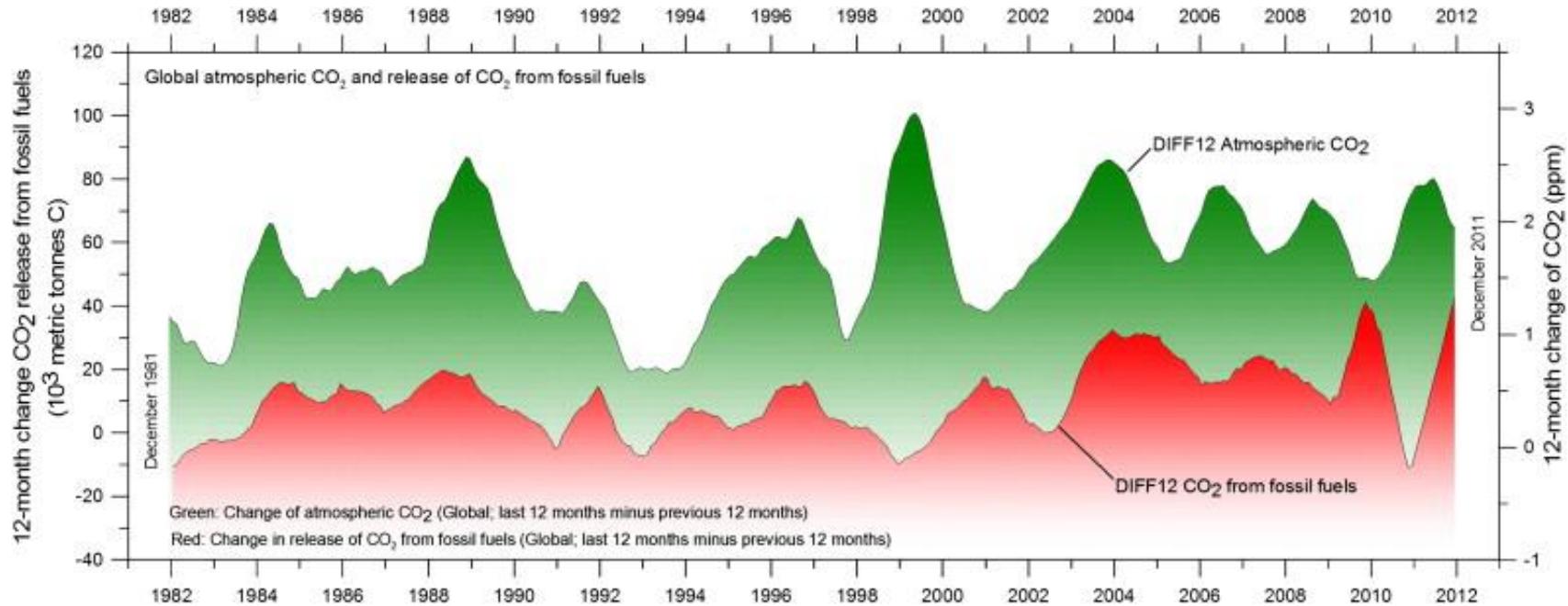


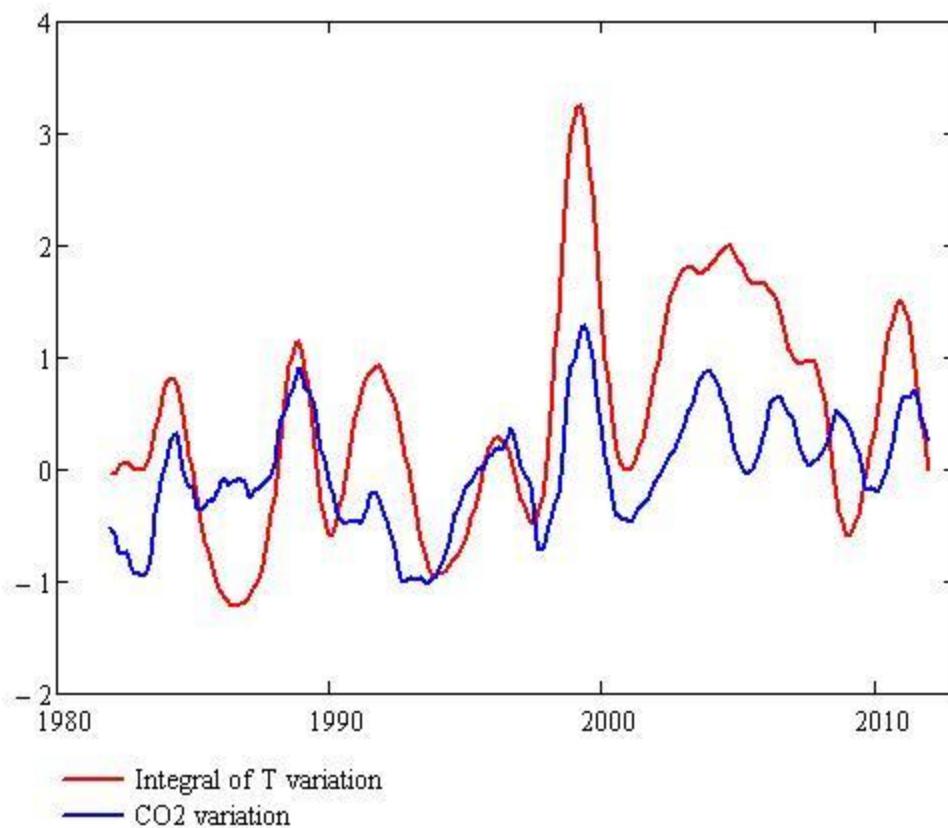
Figure 6:  $R'C'$ -chain connected to the climate system.



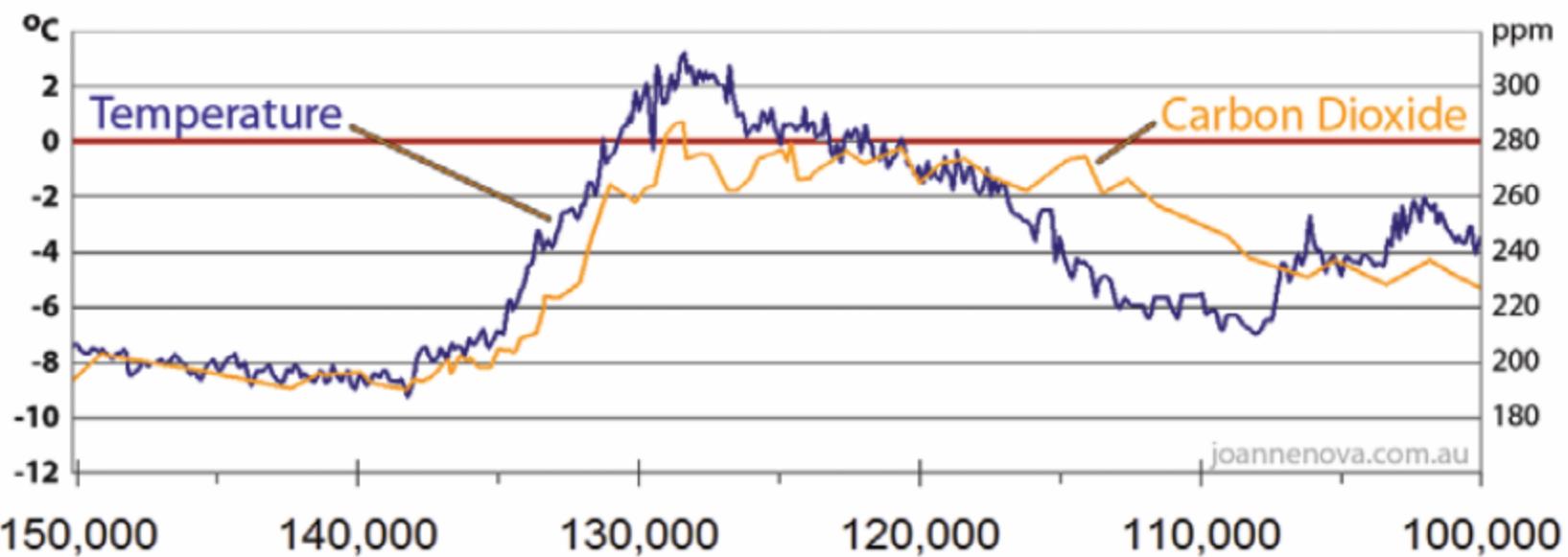
Ole Humlum, Kjell Stordahl, Jan-Erik Solheim, "The phase relation between atmospheric carbon dioxide and global temperature", Global and Planetary Change Vol 100, Jan 2013, Pp 51–69



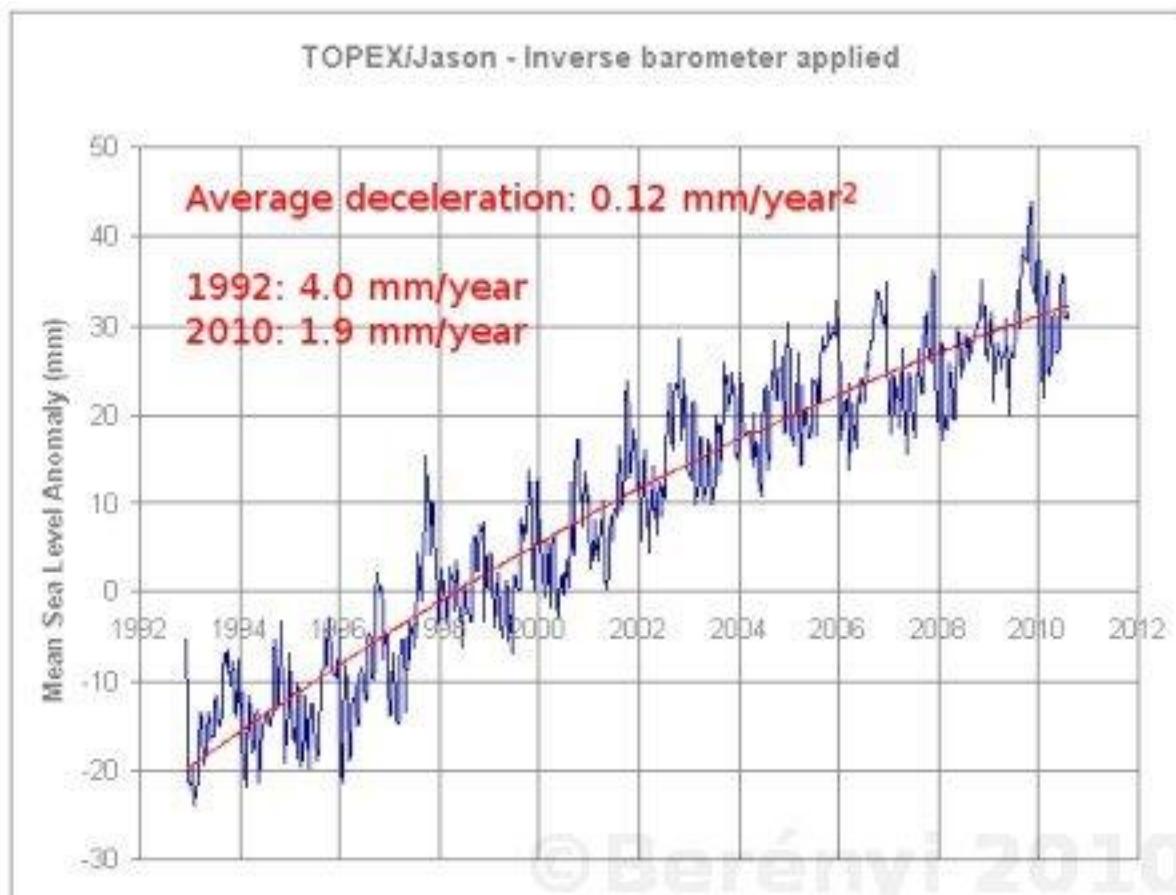
Ole Humlum, Kjell Stordahl, Jan-Erik Solheim, “The phase relation between atmospheric carbon dioxide and global temperature”, Global and Planetary Change Vol 100, Jan 2013, Pp 51–69



## Vostok Ice Cores 150,000 - 100,000 years ago



On average CO<sub>2</sub> rises and falls hundreds of years after temperature does.





### Growth Response to 300 ppm Additional CO<sub>2</sub>



Turun yliopisto  
University of Turku

	Means % Increase	Number of Studies
<b>Grains</b>		
Barley	41.5	15
Rice	34.3	137
Wheat	33	214
Average: 36.3%		
<b>Vegetables</b>		
Green Beans	64.3	17
Soybeans	47.6	162
White potatoes	29.5	33
Sweet potatoes	33.7	6
Corn	21.3	20
Carrots	77.8	5
Average: 45.7%		
<b>Fruits</b>		
Cantaloupe	4.7	3
Sweet Cherries	59.8	8
Strawberries	42.8	4
Tomatoes	31.9	35
Average: 32.8%		
<b>Trees</b>		
Black Cottonwood	124	5
Red Maple	44.2	13
Northern Red Oak	53.3	7
Loblolly Pine	61.9	65
Average: 70.8%		

Source:

[http://www.co2science.org/data/plant\\_growth/plantgrowth.php](http://www.co2science.org/data/plant_growth/plantgrowth.php)

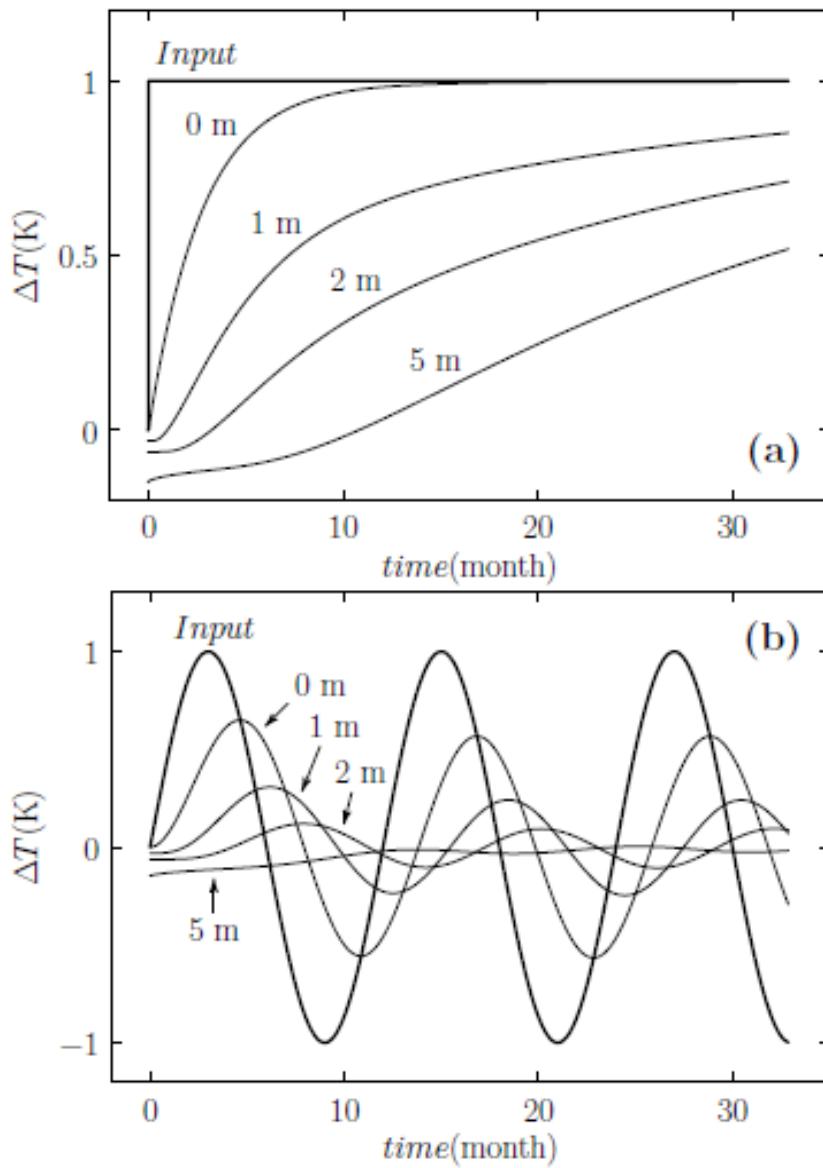


Figure 7: (a) The step response of the climate coupled to the diffusion layer, and temperatures at different water layers  $T_{\text{climate}}$  (0 m), 1 m, 2 m and 5 m below the mixed layer.  
(b) The same demonstration using sinusoidal input with a year period. The phase difference between Input and  $T_{\text{climate}}$  (0 m) is  $55.2^\circ$ .

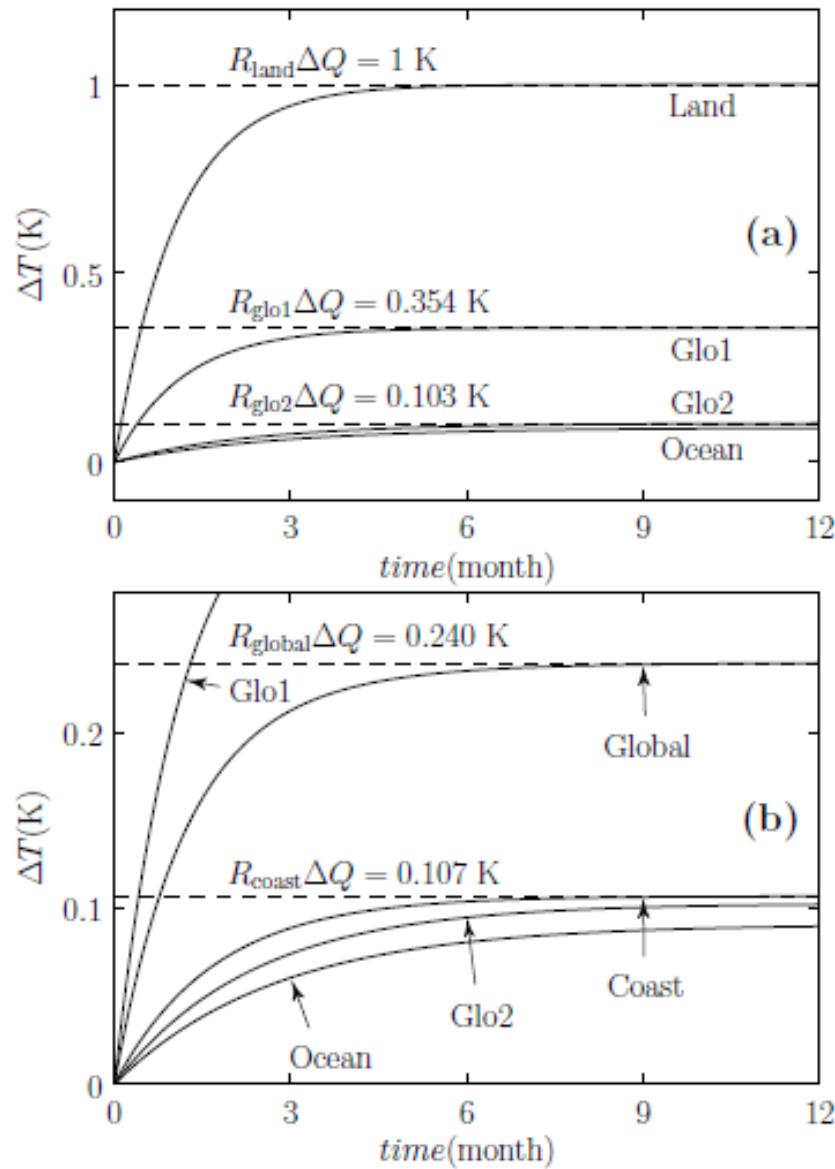
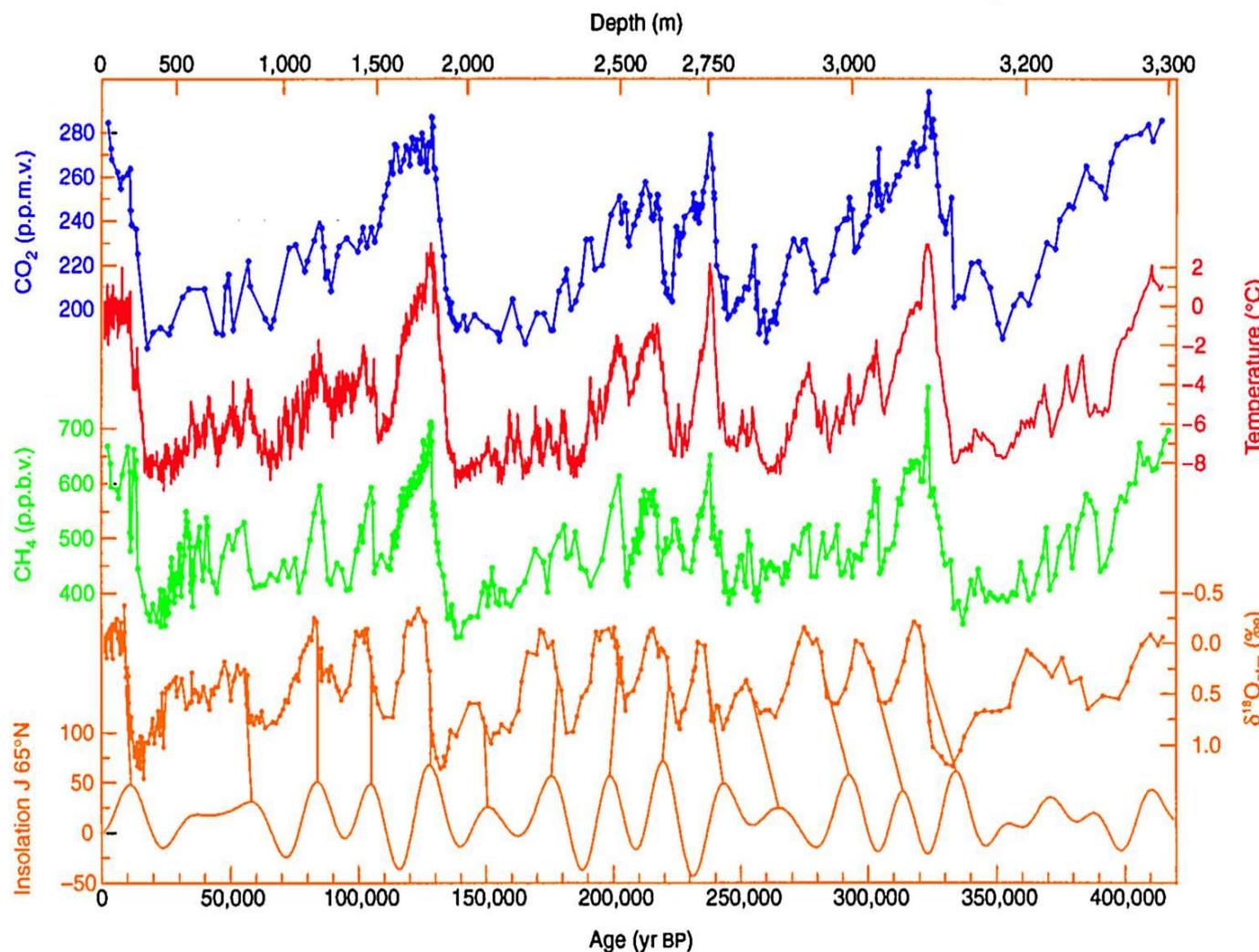


Figure 8: All the step responses are drawn with the forcing of  $\Delta Q = 1K/R_{\text{land}} = 4.12 \text{ W/m}^2$ . (a) The step responses over the land and over the ocean. The step response Glo1 is the average weighted by the areas of land and ocean. The step response Glo2 is the average when the temperature difference between land and ocean is smoothed. (b) The extended part including the step response on the coast and the final global step response.

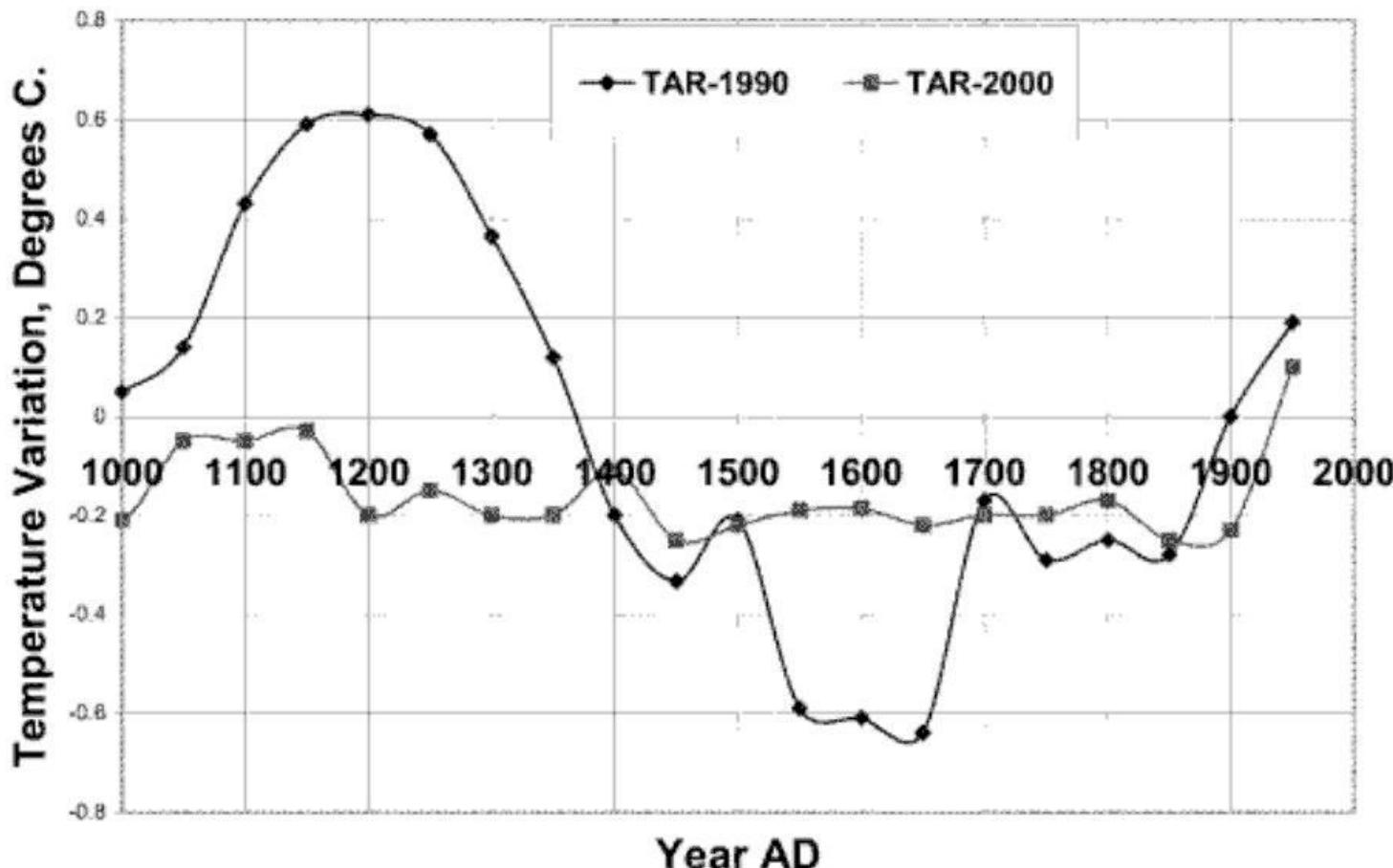
## 420,000 years of ice core data from Vostok, Antarctica research station

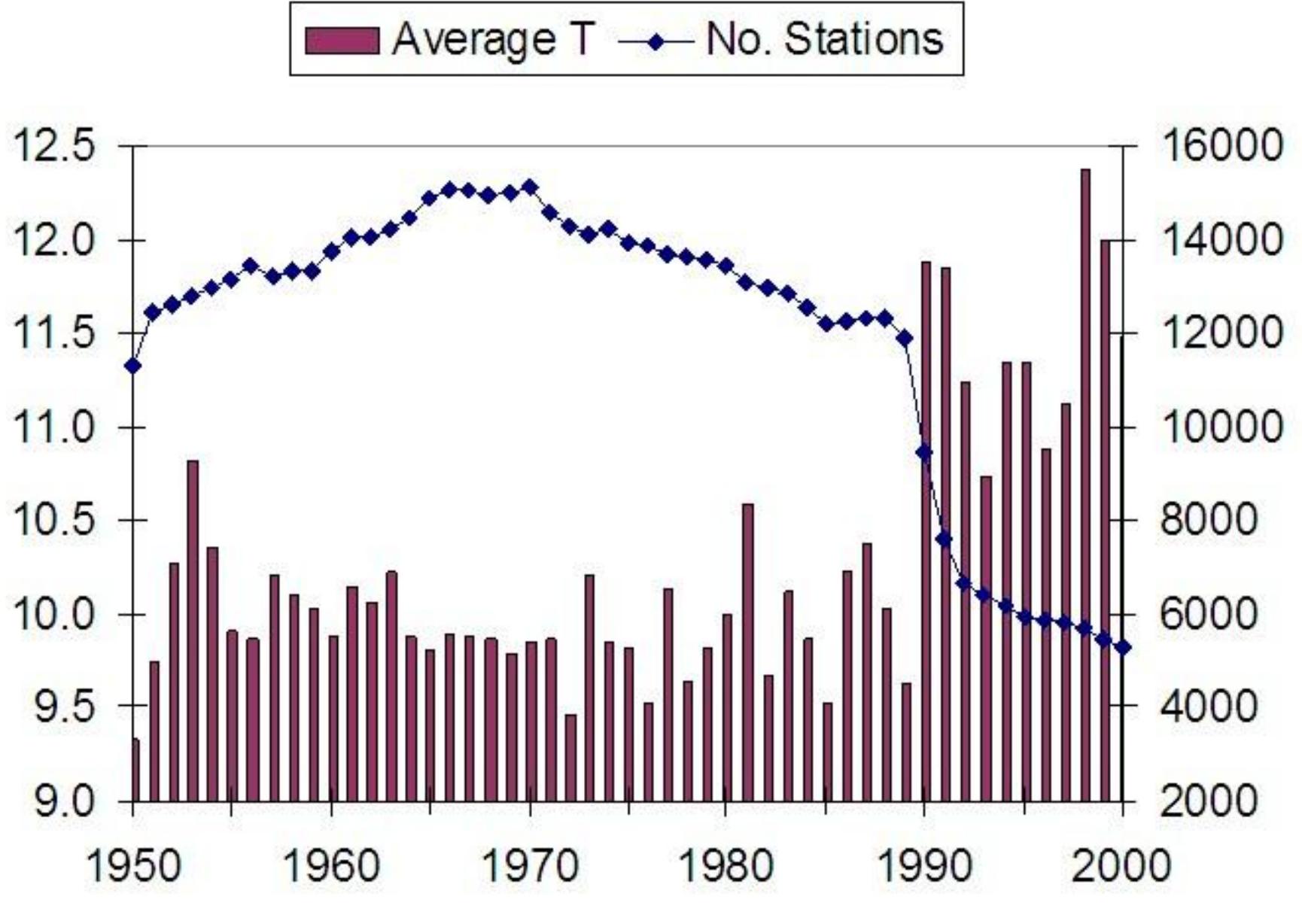


Current period is at left.  
From top to bottom:  
Levels of carbon dioxide ( $\text{CO}_2$ ).  
Relative temperature.  
Levels of methane ( $\text{CH}_4$ ).  
 $^{18}\text{O}$  isotope of oxygen.  
Solar variation at  $65^{\circ}\text{N}$   
due to [Milankovitch cycles](#) (connected to  $^{18}\text{O}$ ).

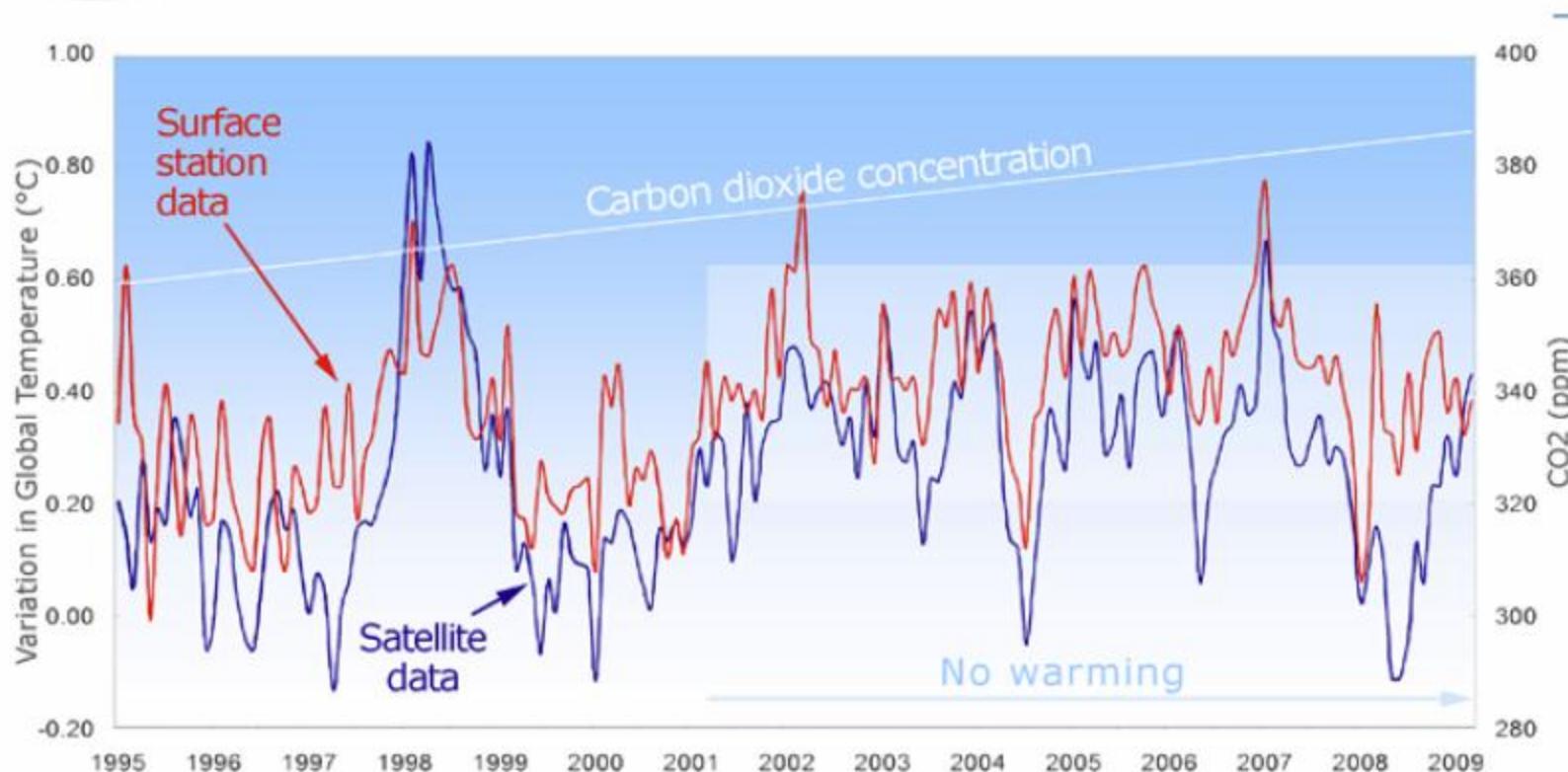
Figure 3, TAR-2000 vs TAR-1990

This is a comparison of IPCC data reported in Y1990 and Y2000. Data from plots taken at 50 year periods, were charted via Excel rounding.





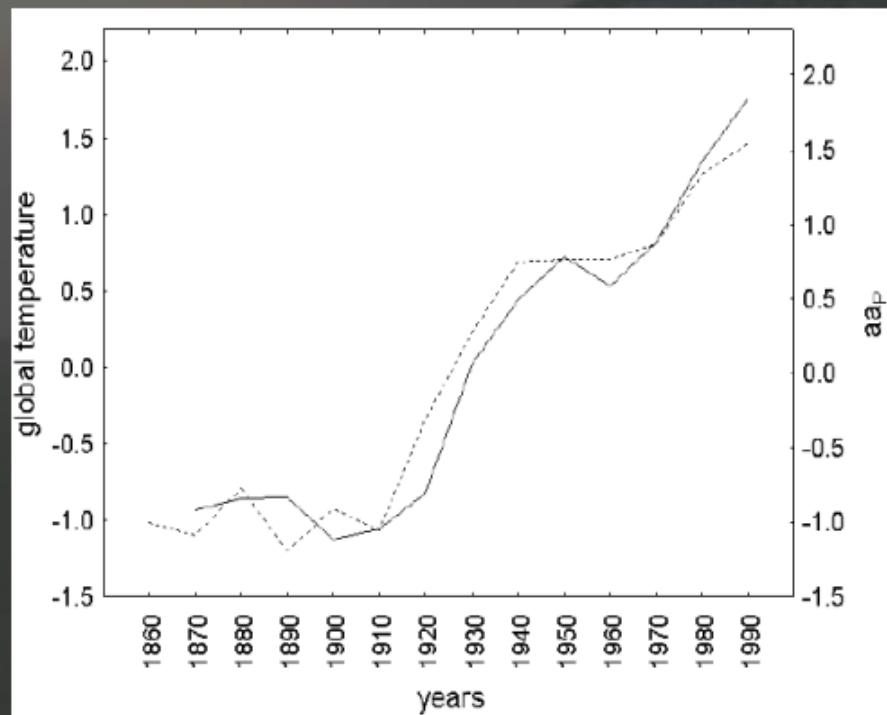
## The world is not warming any more



**Aurinkotuulen häiriöt ovat kasvaneet 100 viime vuoden aikana, mukaan lukien viimeiset 30 vuotta, jolloin Auringon säteilymäärä ei ole enää kasvanut!**

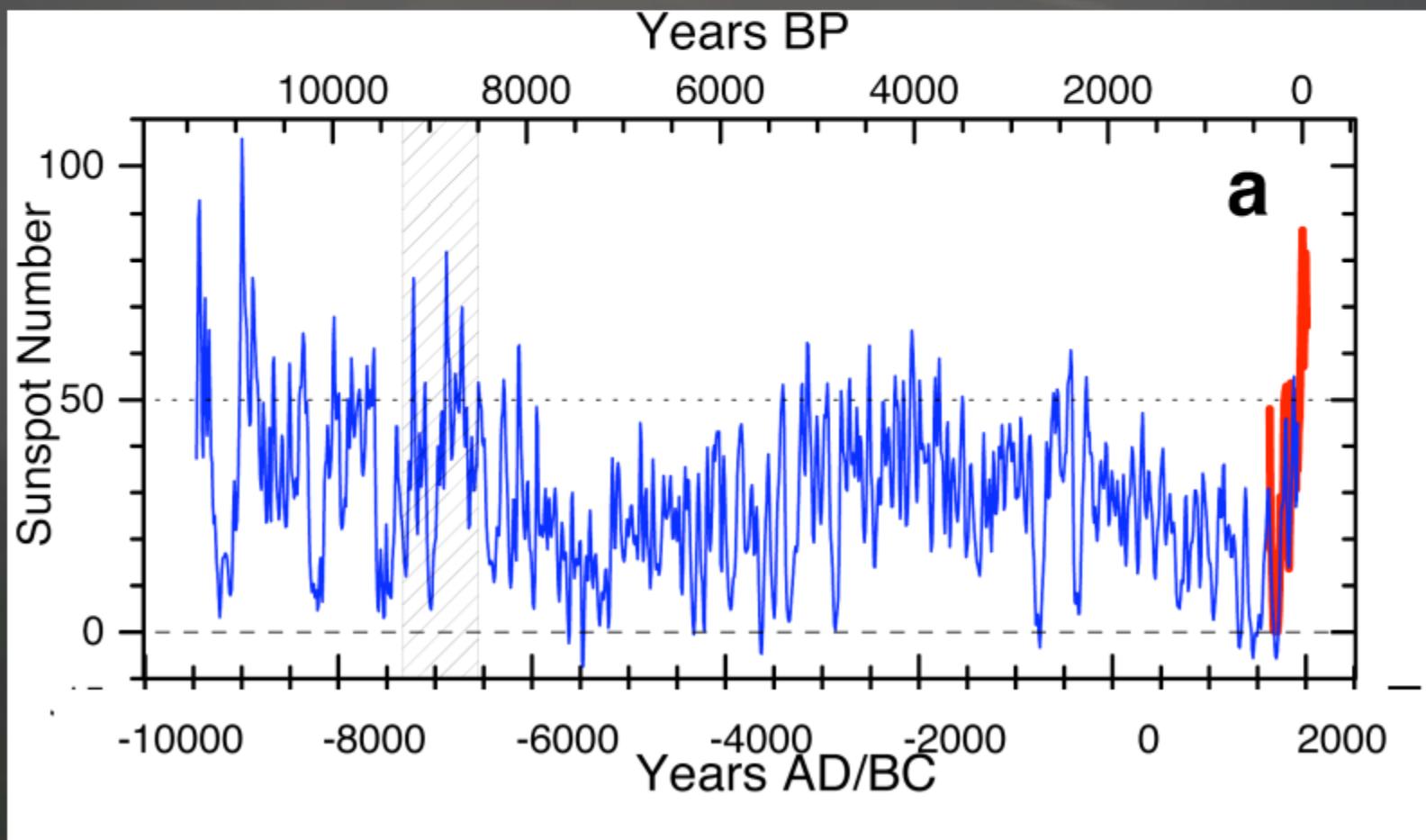
Näillä on havaittu myös uusia merkittäviä ilmastollisia vaikuttuksia. On mahdollista, että Auringon muutos voi hallita ilmastonmuutosta näiden kautta!

Aurinkotuuli ja globaali lämpötila seuraavat toisiaan tarkasti koko 140 vuoden ajan.



# Auringon nykyinen aktiivisuustaso on suurinta lähes 9000 vuoteen.

Aktiivisuudessa jatkuvaa nopeaa vaihtelua, lukuisia lyhyehköjä suuria minimejä ja aktiivisempia kausia.



# Ilmatieteen laitos tyrmää kohuprofessorin väitteet

15.04.2010 09:13

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Kauppinen ei ole esitellyt tutkimusmenetelmiään, minkä vuoksi hänen väitteitään hiilidioksidin pienestä vaikutuksesta on mahdotonta kommentoida tai arvioda tarkemmin. Ilmatieteen laitoksen tutkijat korostavat kuitenkin, että maapallon keskilämpötila on noussut esiteolliselta ajalta nykypäivään noin 0,8 astetta, kun ilman hiilidioksidipitoisuus on samanaikaisesti kasvanut yli kolmanneksella.

Havaittua nopeaa lämpötilan nousua ei ole kyetty selittämään mitenkään muuten kuin ottamalla huomioon kasvihuonekaasujen määrän kasvu. Sen on taas osoitettu voivan johtua vain ihmiskunnan fossiilisten polttoaineiden käytöstä ja maankäytön muutoksista trooppisissa metsissä.