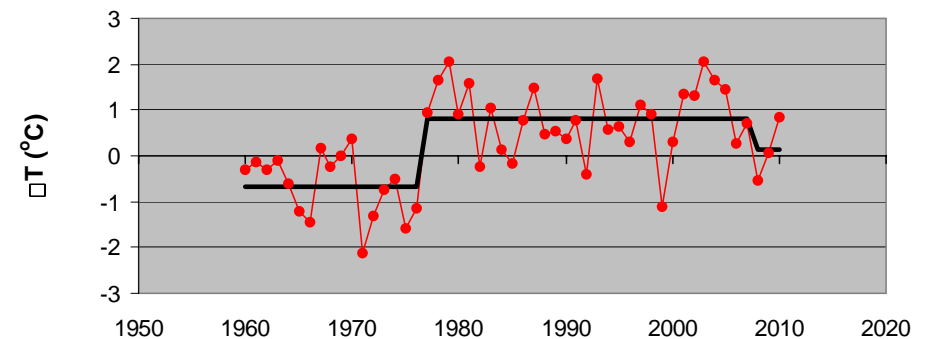


Temperature trends – an alternative analysis that challenges the ”consensus view”

Mean T-anomaly (ref. 1960-1989) for "Alaska" (n=9)



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Presented at the Researcher's Day workshop 15 Nov 2011 at the Faculty of Life Sciences, organised by the Climate Change Taskforce of danish research networks (Danish Development Research Network, Enreca Health, and Danish Water Forum).

*This is a story about how basic
observations can be at variance with
a consensus view*



(source: http://ponce.sdsu.edu/the_emperors_new_clothes.html)

Ban Ki-moon, UN General Secretary:

(citation in Danish newspaper, translated):

We must stop the unnecessary debate about the science, the climate changes much faster than expected

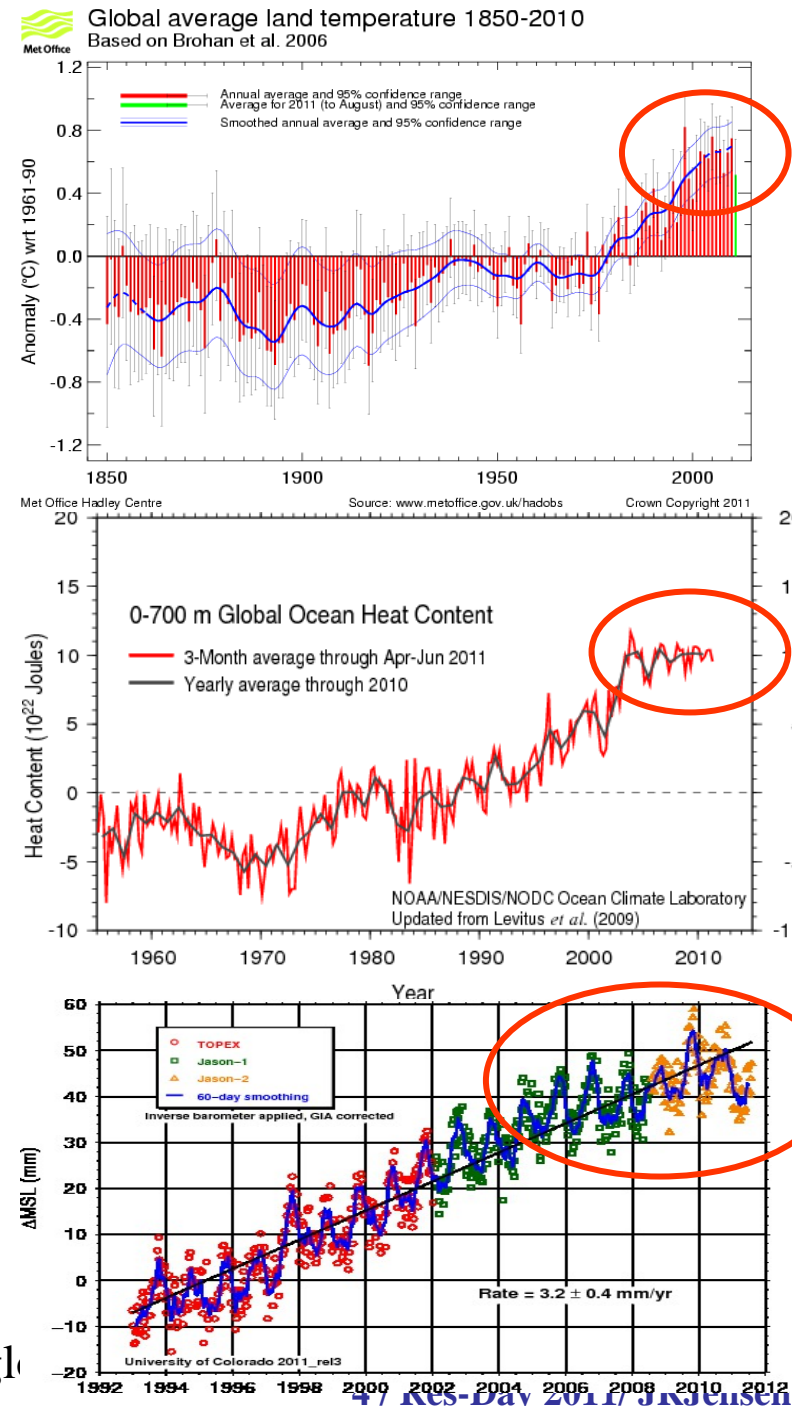
- ”Vi må sætte en stopper for den unødvendige debat om videnskaben. IPCC, det internationale klimapanel, der består af mindst 3.000 videnskabsfolk i verdensklasse, har gjort det meget klart, at **klimaforandringerne foregår meget hurtigere end forventet**. Der er ingen tid at spille. Vi er nødt til at gøre noget”.

Ban Ki-moon interview brought by Politiken.dk 08 October 2011



”Faster than expected” ? While CO₂-levels increases,

- **Temperature:**
 ”Hiatus” in global warming in recent ~ 10 -15 years now widely accepted (also by IPCC scientists)
- **Global Ocean Heat Content:**
 near-constant since ~ 2002
- **Global Mean Sea Level Change:**
 decreasing since ~ 2004



(Figs: <http://wattsupwiththat.com/reference-pages/gl>

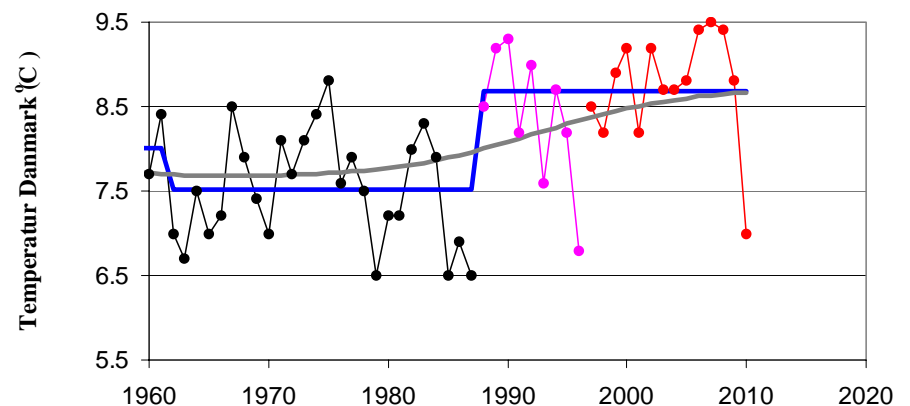
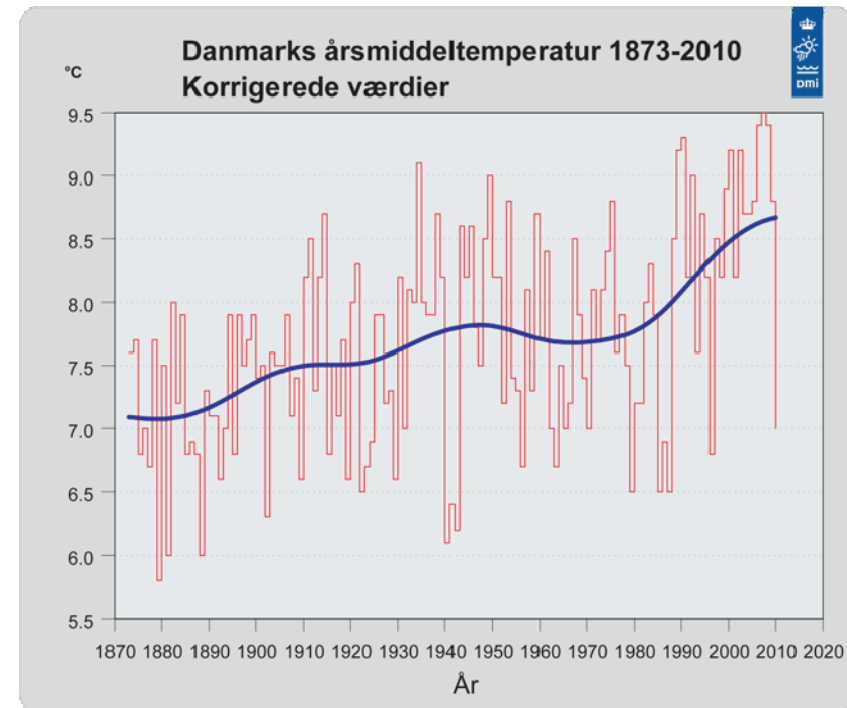
Sorry, Mr Ban Ki-moon and the "3000 scientists",

- But today I will engage in the "unnecessary debate" about the science;
- I will question the "consensus view" of globally increasing and accelerating temperature.
- Based on a station-level analysis in selected regions, I will inter alia conclude that
 - **Abrupt changes in temperature linked with natural climate events may be widely responsible for the temperature increase during the 2nd half of the 20th C**
 - About 50% of sample stations have not experienced increased mean temperature ("warming") for more than 20 years
 - The relative role of natural processes in global warming is very likely underestimated by IPCC
 - The global average temperature curve is "apples and oranges" and is widely misinterpreted

T-pattern ?

Smoothing or steps, different implications

- **Denmark temperature,DMI** (ref. www.dmi.dk/):
the fat curve is 9 years Gauss-filtered values. *"As for the global T, a clear increase in T is seen"*.
- **Alternative step-model** (here 1960-2010, neglecting drop in 2010):
abrupt T-change in 1988, followed by "no warming" for 23 years
- **If the step is real**, the smoothing is inappropriate for identifying the pattern



R^2 , 1960-2009:	Gauss-filtered,	0.38
	Step change,	0.45

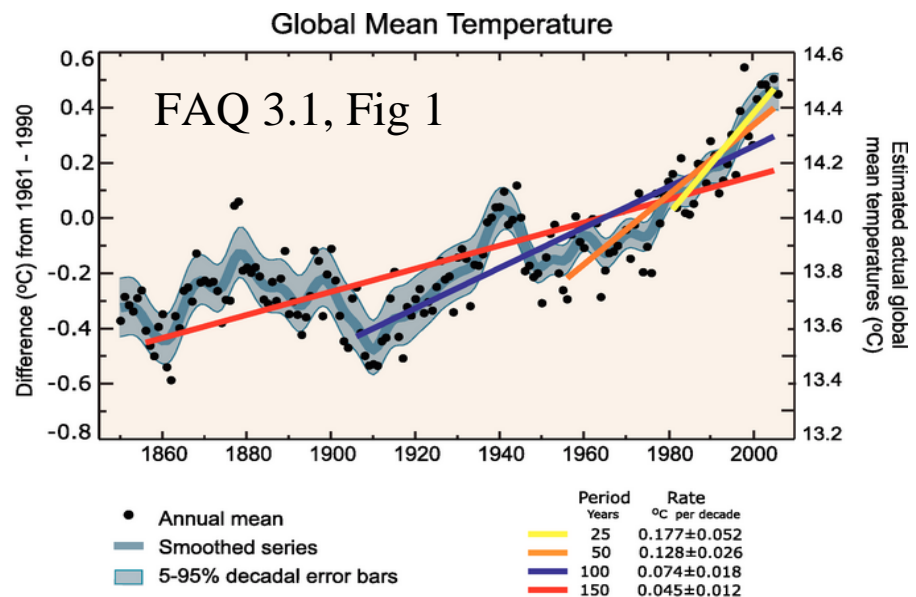
T-pattern ? Linear regression –

non-linearity of $T(t)$ questions the validity of this model and it's implications

- **IPCC (AR4, 2007):**

“Note that for shorter recent periods, the slope is greater, indicating accelerated warming”

- **BUT:** $T(t)$ is widely accepted to be **non-linear**, with cooling/warming periods and **abrupt changes** from eg. El Niño effects

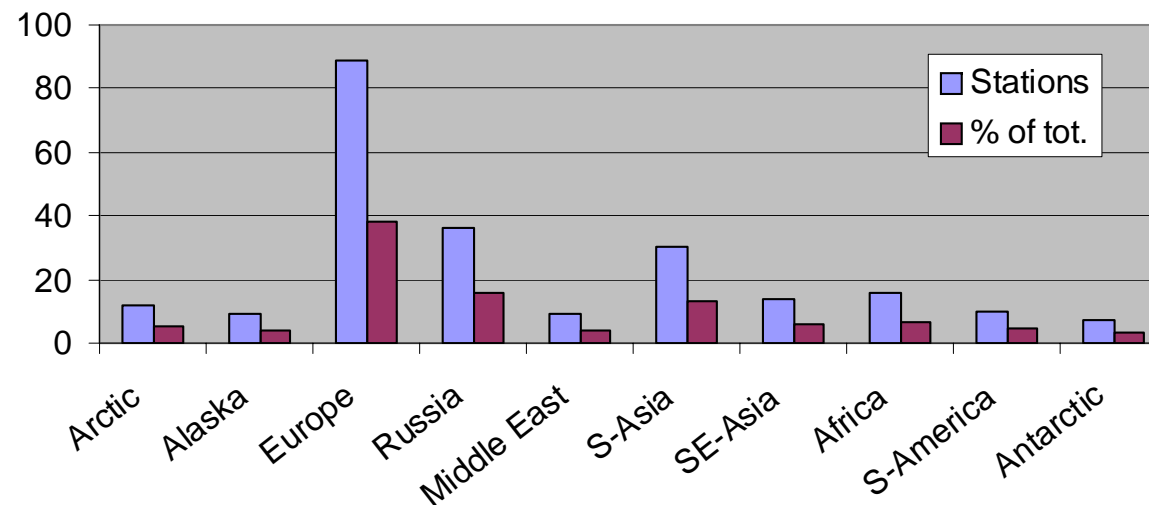
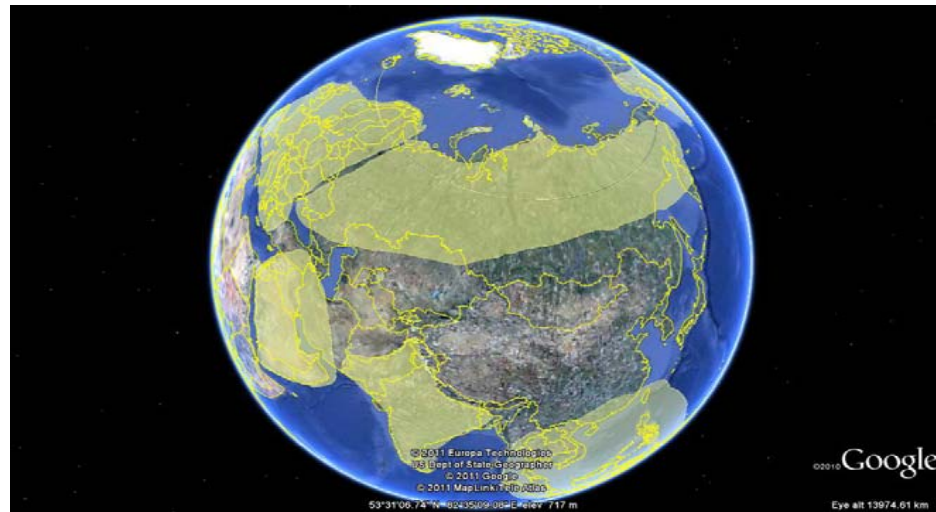


Research questions

- Are abrupt changes in mean temperature present in station-level temperature records 1960-2010?
- Are there other empirical/physical support for the existence of such step changes ?
- What are the implications for the interpretation of the global average T-curve and for the assessment of "global warming" ?
- Note: refer to additional slides for methodological details

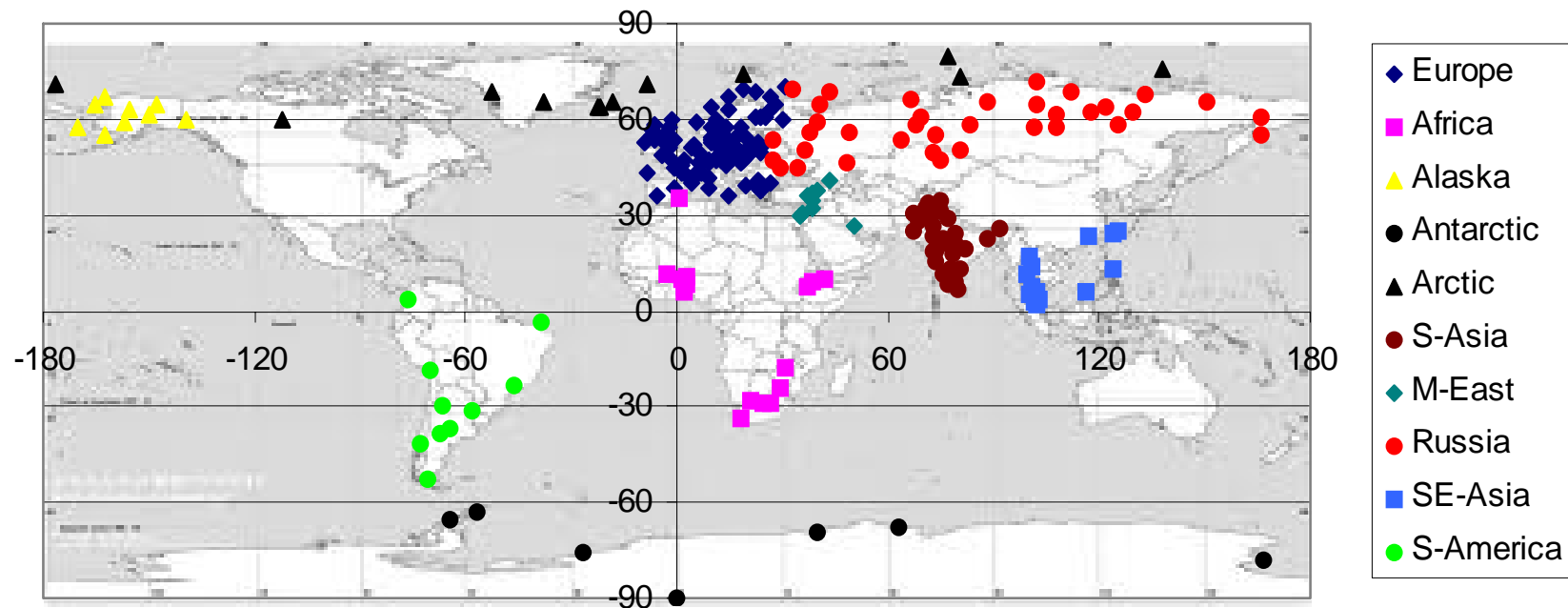
Station sample according to criteria: 232 stations in selected "regions"

(Europe + Russia, 54%; n very small for Africa, S-America, central/east-Asia)



Spatial distribution of stations

(Note: global and national avg. data for US and AUS have also been analysed, ref. below and the additional material)



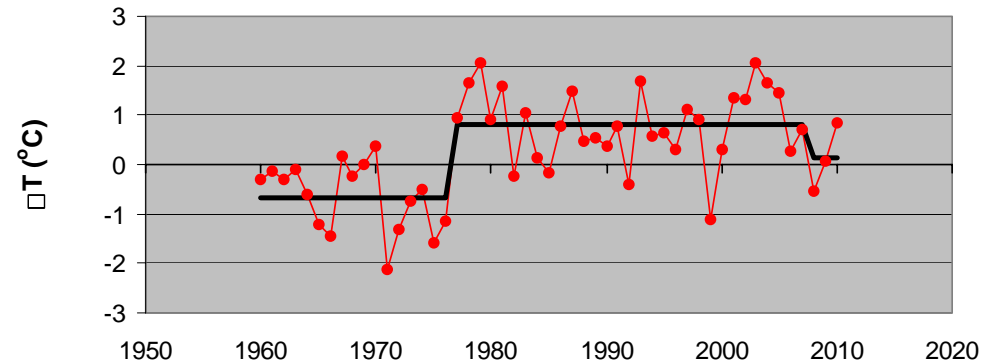
(underlying map from www.travelportal.info)

Step changes and different step-patterns are evident

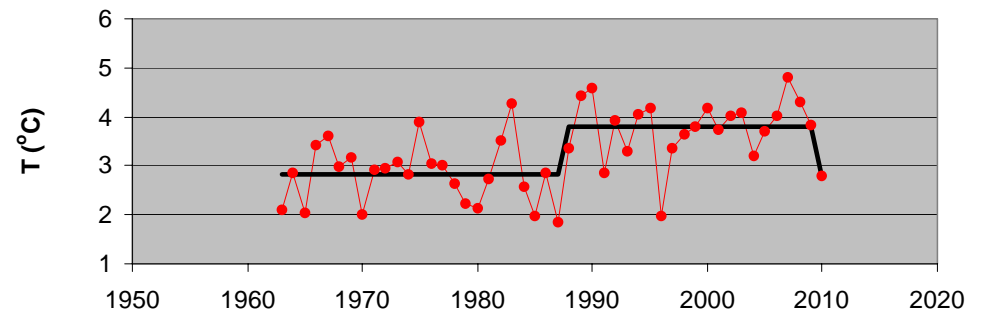
Examples:

- **Alaska** (mean anomaly):
 - Step: 1977
 - ΔT : 1.5 °C
 - Significance: 0.000001
- **Europe, Fichtelberg:**
 - Step: 1988
 - ΔT : 1.0 °C
 - Significance: 0.00009
- **South-East Asia, Malacca:**
 - Steps: 1978, 1990, 1998
 - ΔT : $0.4 + 0.3 + 0.4 = 1.1$ °C
 - Significance: 0.0004, 0.007, 0.003

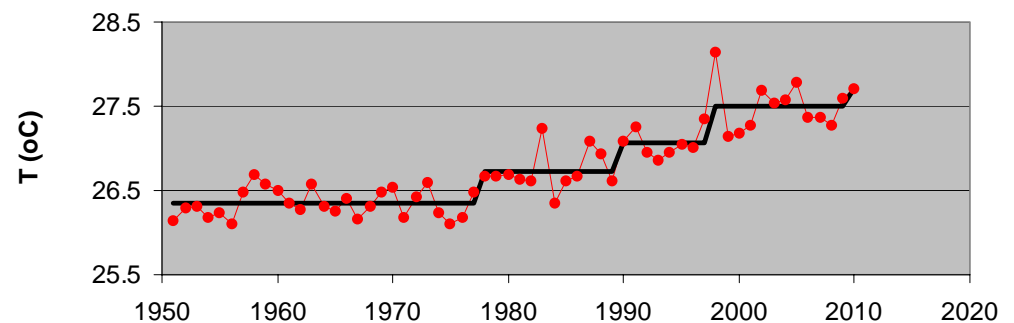
Mean T-anomaly (ref. 1960-1989) for "Alaska" (n=9)



Fichtelberg (GE), 1963-2010



Malacca, 1951 - 2010



Could the steps be spurious, a statistical artifact ?

(ref. Additional slides at end)

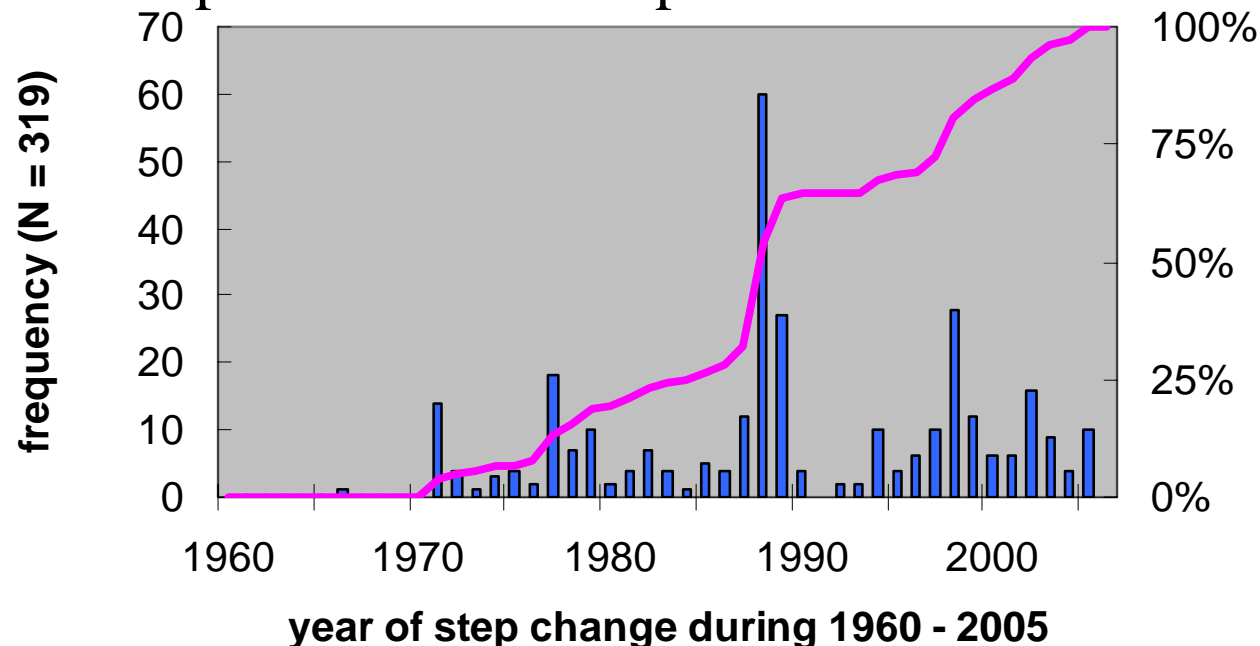
- *Not likely*, as
 - All stations and the global T-record tested for the assumption of constant variance: verified in all cases except two stations.
 - The potential influence of autocorrelation has been tested (AR1) and found negligible for the major part of sample stations tested (179, 73%: Europe, Russia, E-Asia, SE-Asia).
 - Steps are highly significant and occur in a systematic pattern, coinciding with documented major events in the ocean/atmosphere system (see below).

Step changes concentrate in 3 periods

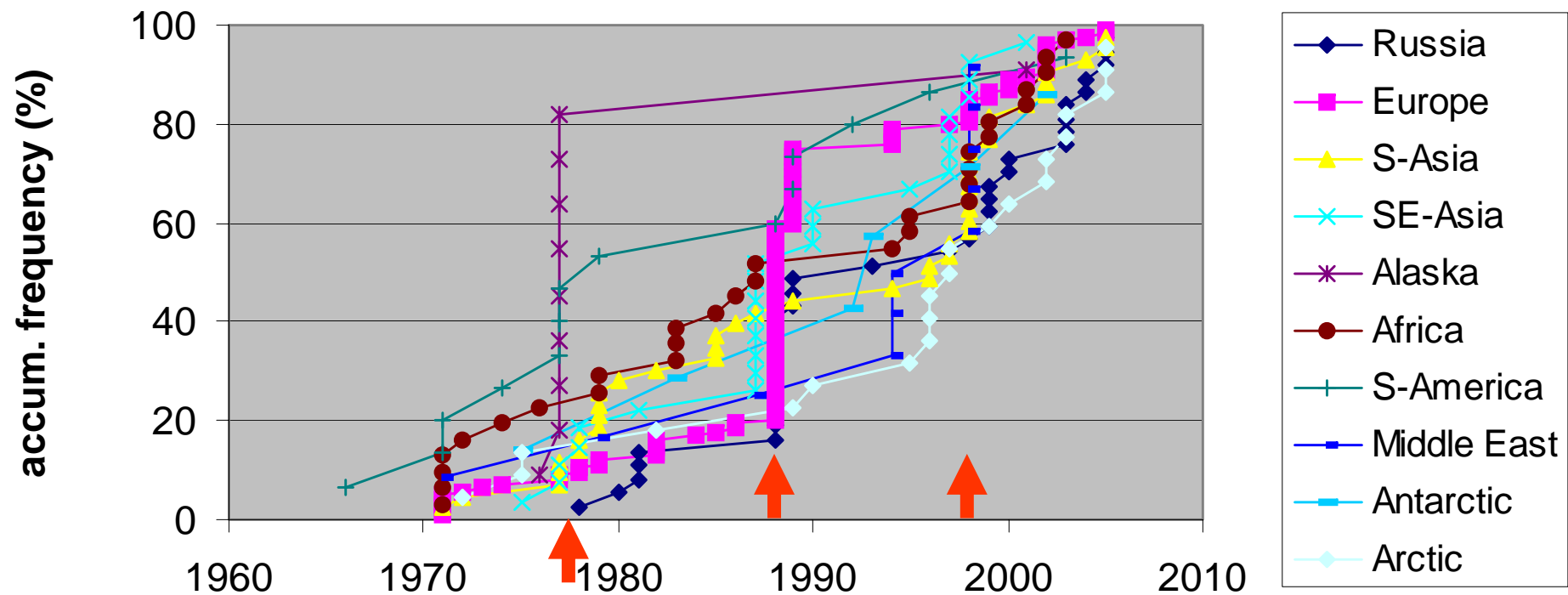
(disregarding uncertain steps, i.e. >2005 incl.)

39 "statistically significant" steps of which 2/3 are "up")

- 319 steps, avg. 1.4/station (range: 0 – 4, very few "down"), 50% accounted for by Europe and Russia
- **58% occur in 3 3-year periods: 1977/79, 1987/89, 1997/99**
- 72% of stations and 89% of Europe stations has one or more steps during these 3 periods
- 78% of Europe stations has step in 1987/89



Globally non-uniform step pattern –
warming mainly occurred in steps,
predominantly in a few brief periods and with different
regional patterns –
is this a likely outcome of
steadily increasing CO₂- levels ?

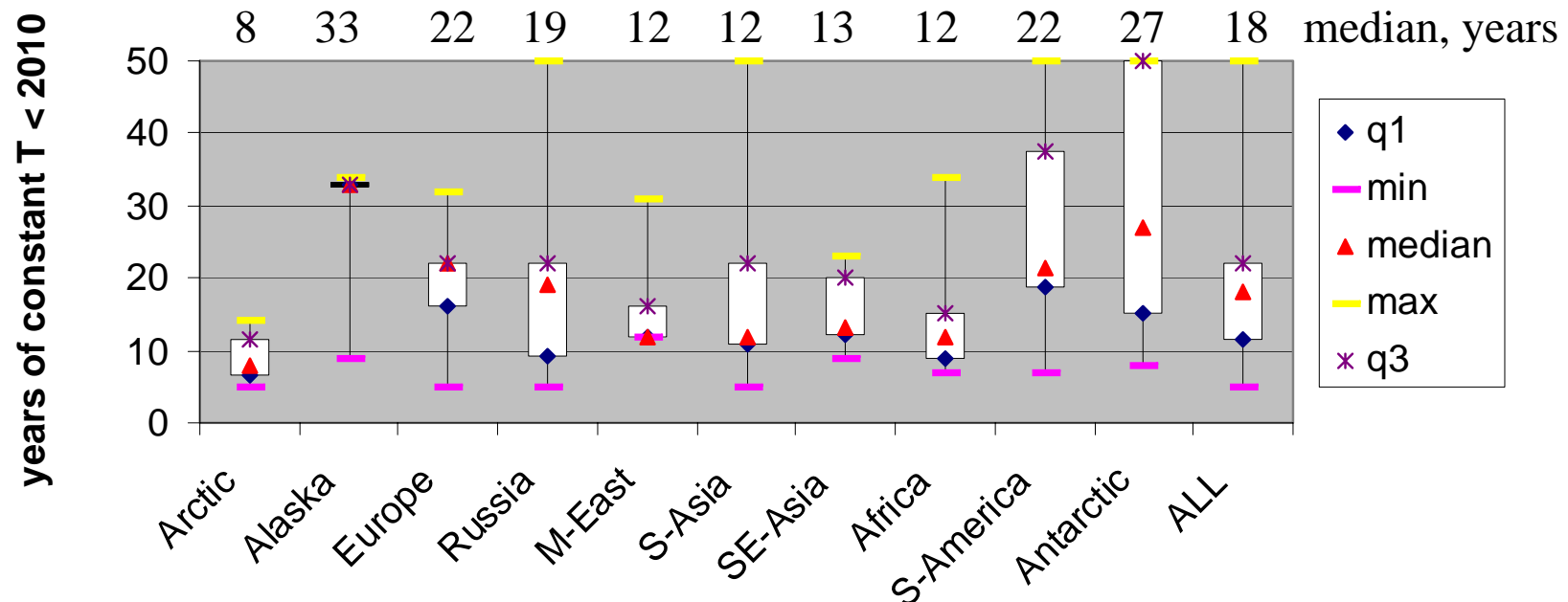


Frequency distribution of steps by "regions"

Accelerating temperatures ?

widespread "lack of warming" in recent years

- **Years of constant T-mean prior to 2010:**
50% of ALL sample stations > 18 years
70% of Europe stations > 20 years
Arctic stations, median: 8 years (warming "started" ~ mid 1990s)
- **Caution:** an underlying – albeit small - warming/cooling trend could be "hidden" by the step-model, but any such trend can probably not be statistically identified because of steps and inter-annual variability

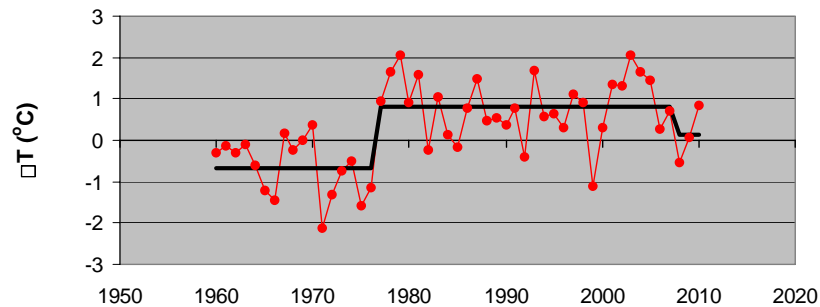


Box-Whisker plot, 1st and 3rd quartiles

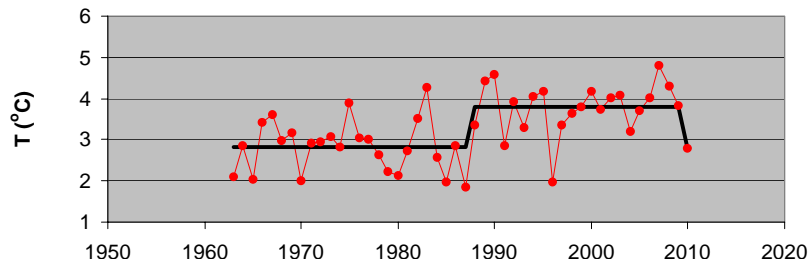
What about the global T-anomaly curve ?

Can we average across these different step patterns, or is it "apples and oranges" ?

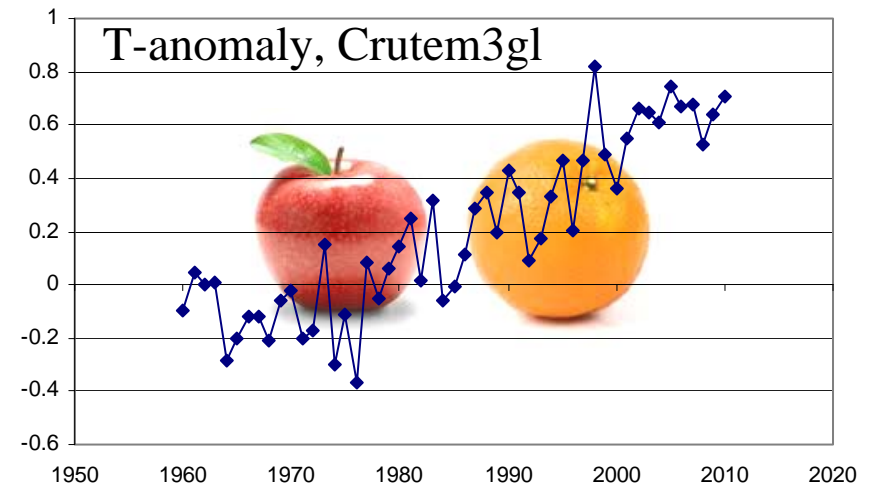
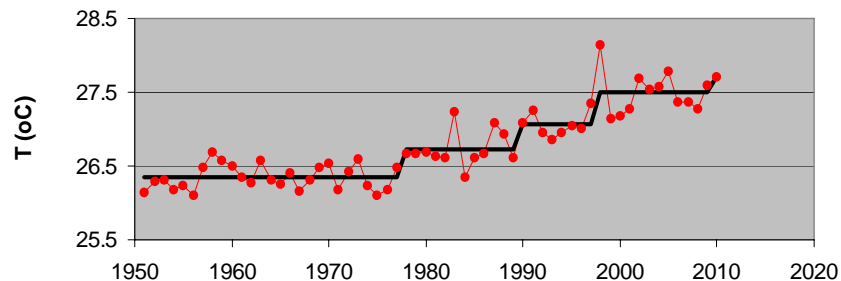
Mean T-anomaly (ref. 1960-1989) for "Alaska" (n=9)



Fichtelberg (GE), 1963-2010



Malacca, 1951 - 2010



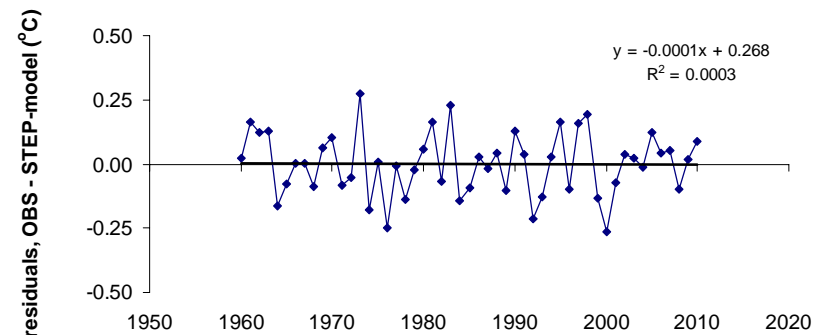
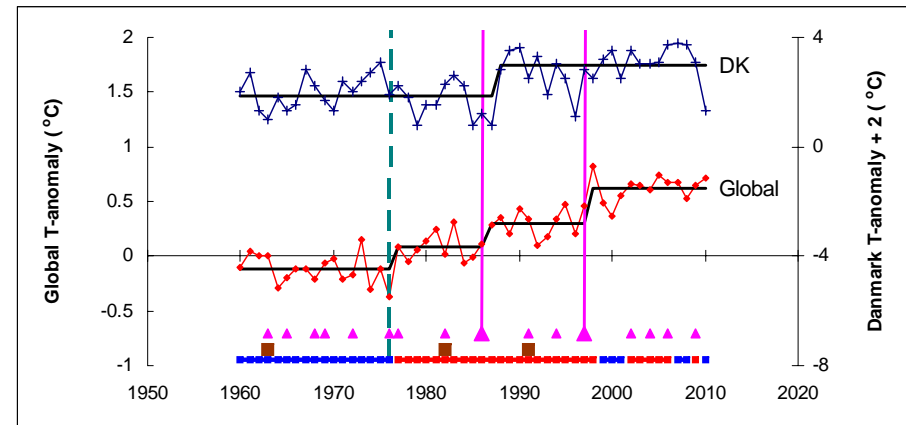
The avg. Global T-curve is deceptive by propagating a wrong message of widespread steady T-increases

Step changes in the global land-based T-anomaly (Crutem3gl)

1977, 1987, 1998 ($p < 0.002$)

- R^2 Step-model = 0.85, residuals with mean = 0.00 and zero trend.
- **Warming in steps, ΔT (1960 - 2010) °C :**
Global: $0.2 + 0.2 + 0.3 = 0.7$
Denmark: 1.1

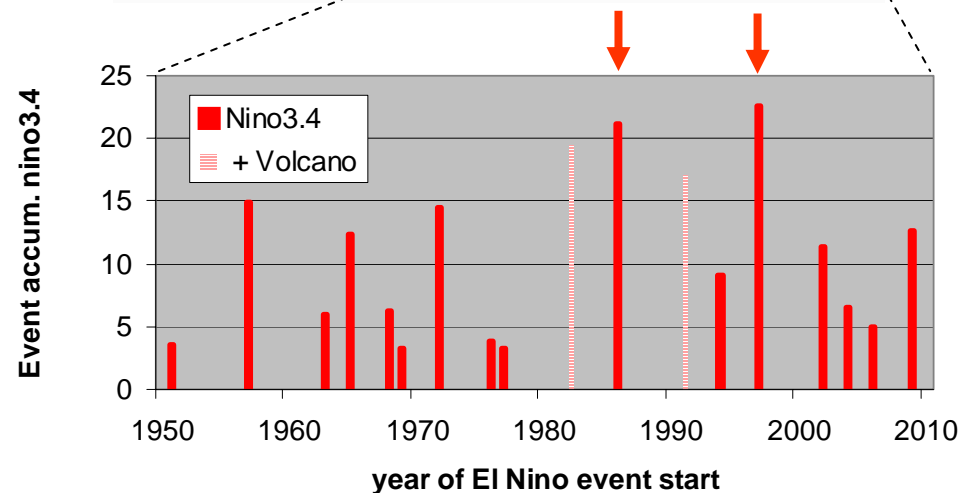
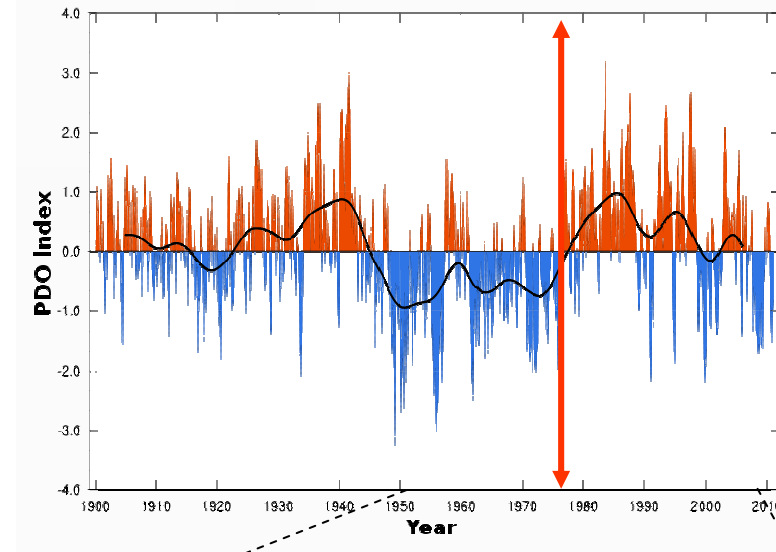
- Figure legend:
 - DK, Denmark T-curve
 - PDO cool/warm phases as blue/red line
 - Volcanoes as squares
 - El Niños as triangles



Note: Basically the same result is obtained for global T combining land and ocean temperature from GISS (1977/87/97/(09)) and Hadcrut3 (1977/90/97/(10)).

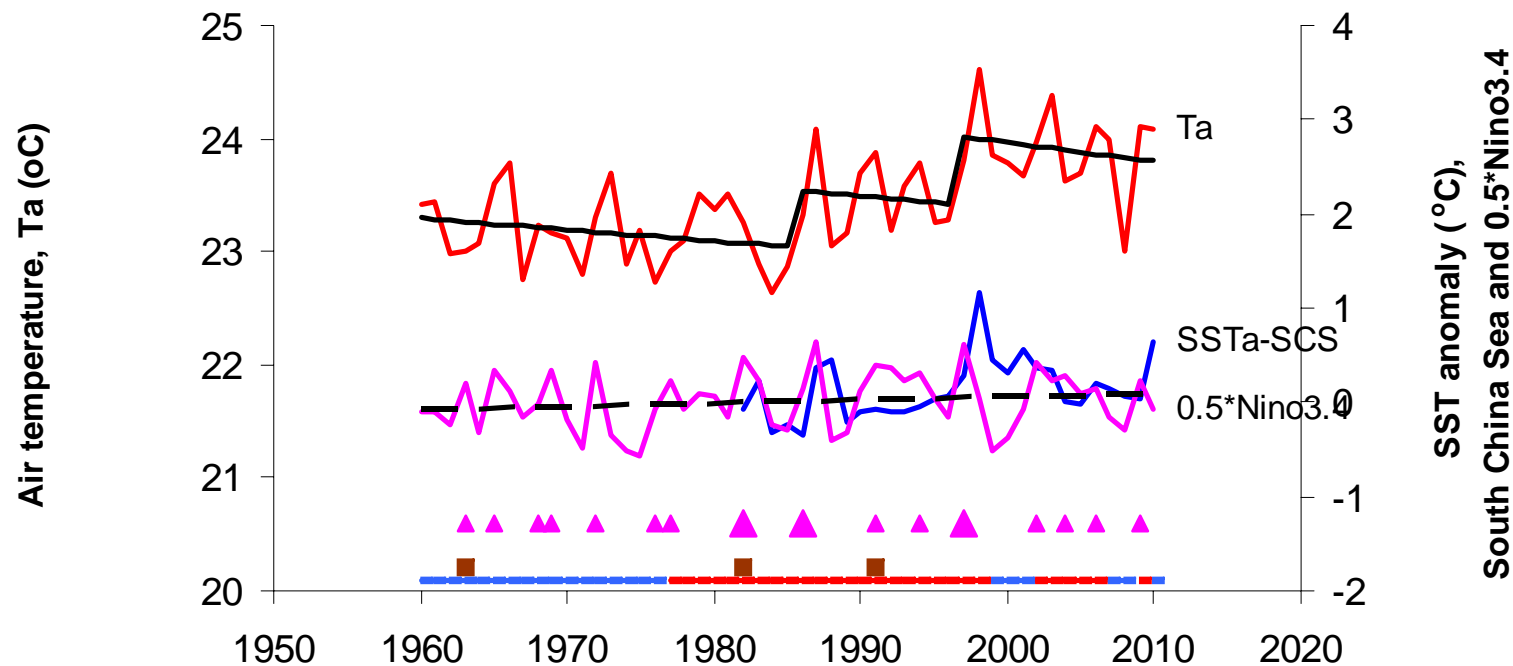
Other empirical support for step changes coincidence with documented major climate events in the Pacific

- **1976/77**: the great pacific shift, with the Pacific Decadal Oscillation (PDO) changing from cool to warm phase (may have shifted to cool phase ~2005)
- **1986/88 and 1997/98**: the two most intense El Niño events of the last 50 years (nino3.4 data from NOAA).
- Links with AMO? Mechanism ?



Example of ENSO related teleconnections, SE-Asia, Vietnam

(Bac Giang, ~ 50km east of Hanoi; on-going research project,
not in the GHCN sample)



(legend: PDO cool/warm phases by blue/red lines, major volcanos by squares and El Niños by triangles)

Step changes in 1986 and 1997 are apparently associated with fluctuations in the sea surface temperatures (SST) in the pacific (nino3.4; NOAA) and south-china sea (SCS; KNMI); linear segments from linear regression, n.s.

Conclusion

- The T-increase ("global warming") during the 2. half of the 20th C can largely be explained by a few "sudden" steps in mean temperature, occurring around 1976/77, 1988/89 and/or 1998/99 and likely related to natural events in the ocean-atmosphere system.
- 50% of sample stations may not have experienced any significant warming for more than 18 years.
- Regional or global average T-curves are prone to misinterpretations: the T-increase has not been a continuous process or a globally uniform phenomenon.
- The presence of steps invalidates the use of simple linear trend and smoothing analysis for identifying the pattern of T-change.
- This analysis does not lend support for general statements like "the global temperature is increasing and accelerating".

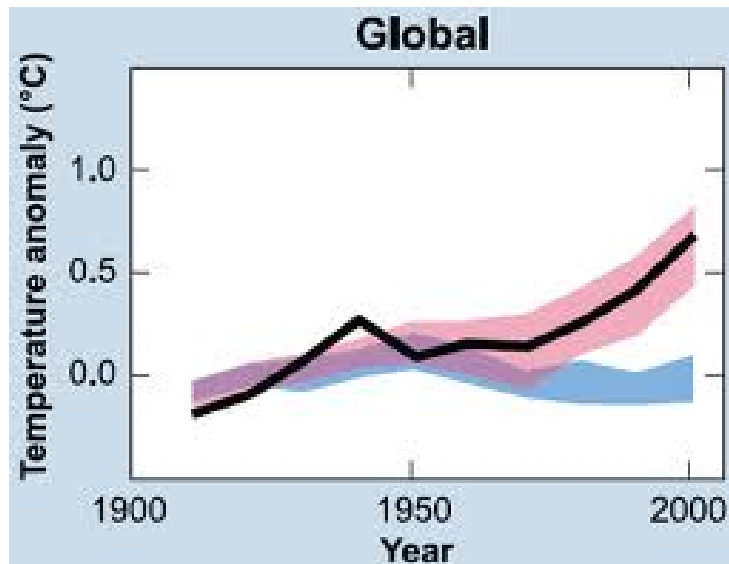
Implications for IPCC "consensus view":

"Most of the observed increase in global average temperature since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse-gas concentrations". (AR4, 2007)

- **Evidence 1:**
Unprecedented temperature increases (global warming).
- **Evidence 2:** "greenhouse physics" and feed-backs (no comment to day)
- **But,** unprecedented or not: the main T-increase has *very likely* occurred in a few sudden steps, related to known natural phenomena and unlikely to be caused by uniformly increasing CO₂-level.

cont. ... implications for the IPCC ”consensus view”:

- **Evidence 3:** IPCC GCM models fail to reproduce the **global T-curve** considering only **natural forcings** - **GHG-effects** must be included.
- **But** the main T-increase has *very likely* resulted from natural phenomena, so if the GCM models can not at all reproduce the T-curve using natural forcings only, then logically something must be wrong with the IPCC models.



Consequently

i.e., accepting the outcome of the step change analysis

- either the IPCC models do not adequately represent the natural processes,
- or/and IPCC has overestimated the climate sensitivity to CO₂-changes

In either case, **the relative importance of natural processes for the T-changes has *likely* been underestimated by IPCC.**

- **Question:** then what about the credibility of many predictions/projections regarding future temperature, melting of ice, sea level change, etc... ??

*Thank you for
your attention*



*and please try
to prove me wrong !*

(fig: www.sodahead.com/)

Additional material

- An alternative analysis
- The Step model
- Sample step curves from station sample
- Step curves from national data, US and AUS
- Autocorrelation issue
- Step pattern diversity
- Ocean oscillation indeces

An alternative analysis – Air temperature patterns at land-based stations during 1960-2010 using a step change model

- **Objective:** to test the HO hypothesis that the T-record 1960-2010 is not influenced by step changes (Note: the objective has not been to establish a climate model or to find the best model for the T-variation or to find the physical mechanism or to make predictions or to dismiss any anthropogenic contribution).
- **Focus** on land-based station-level analysis and 1960-2010, the period of "global warming"
- **Station data:** GHCN data (GISS/NASA,"after combine", unadjusted): all stations in selected "regions" with complete annual records in at least 1960-2010; samples are therefore not well-distributed or numerous in all the "regions".
- **Additional** national and international standard temperature data for national and global analysis

Step model

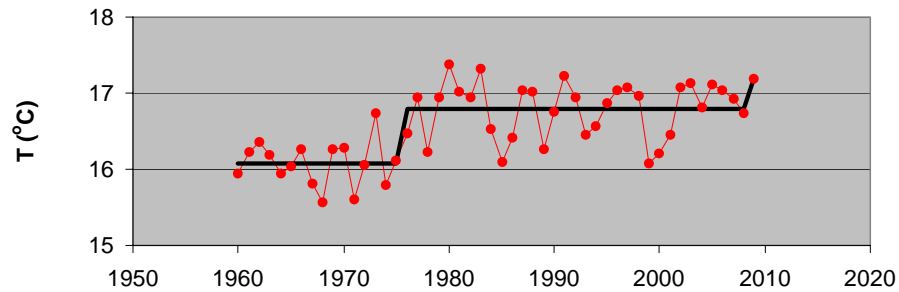
”all models are wrong, some are useful”

(G.E.P. Box, 1979)

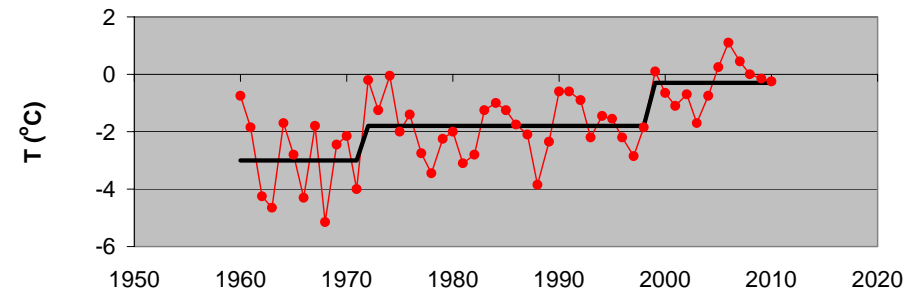
- **Model/statistical tool:** Regime Shift Detection
- **Ref.:** NOAA (National Oceanic and Atmospheric Administration, US), www.beringclimate.noaa.gov/, documented in peer-reviewed literature (Rodionov, GRL 2004; 2006).
- **Method:** identification of step change in T-mean, assuming the T-record consists of regimes of constant T separated by steps. This is not the first time that this or similar models are applied to T-data.
- **Parameter settings:** Trial runs on different annual temperature datasets suggest, that a robust solution (maximum correlation and low sensitivity to parameter setting) is obtained when using: a cut-off length parameter in the interval of 8 to 14 years (12 selected), a correction for autocorrelation by the IPN4 method, and an outlier definition of 3σ in order to effectively give equal weight to all observations. The assumption of constant variance has been verified and autocorrelation found to exert only a negligible effect on main results.

Additional examples ---

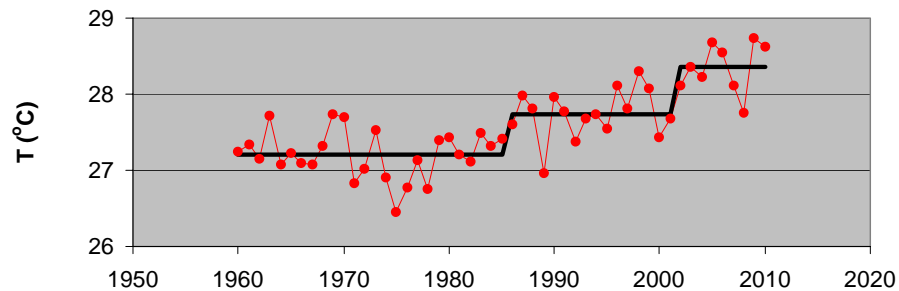
Addis Ababa, 1960 - 2009



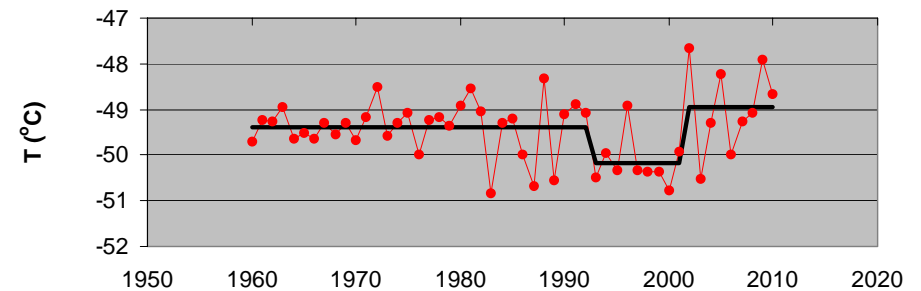
Bjornoya, Arctic, 1960 - 2010 (autocorrelation ?)



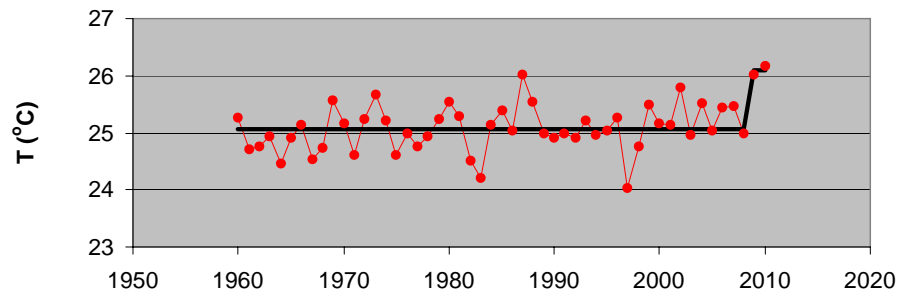
Kandi (north Benin), 1960 - 2010 (autocorrelation ?)



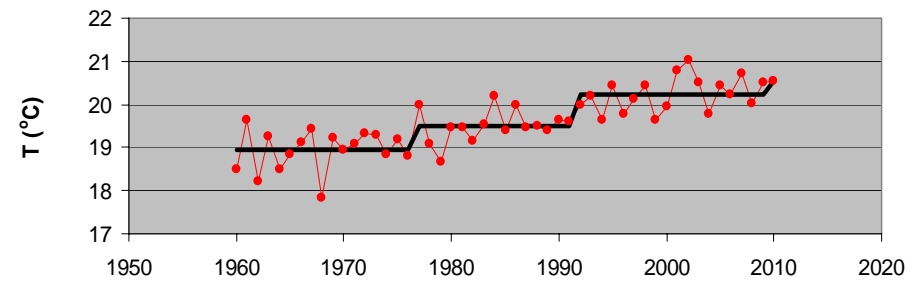
Amundsen-Scot, South Pole, 1969 - 2010



New Delhi, 1960 - 2010



Sao Paulo, 1960 - 2010



National T-curves for US and AUS

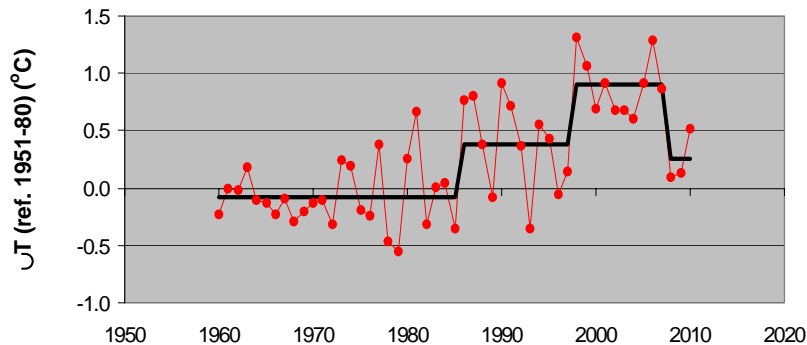
1960 – 2010 and complete records

US 48 contiguous states (GISS data)

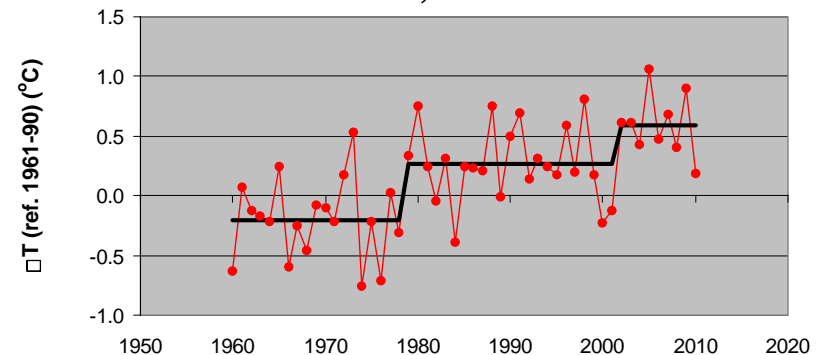
Australia (BOM-data)

Step changes:

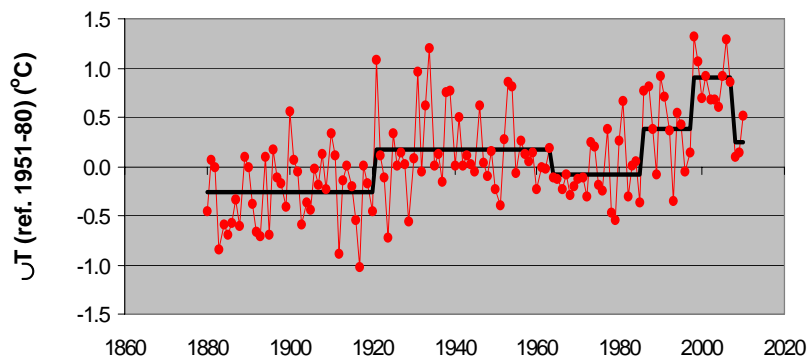
1986, 1998, (2008)



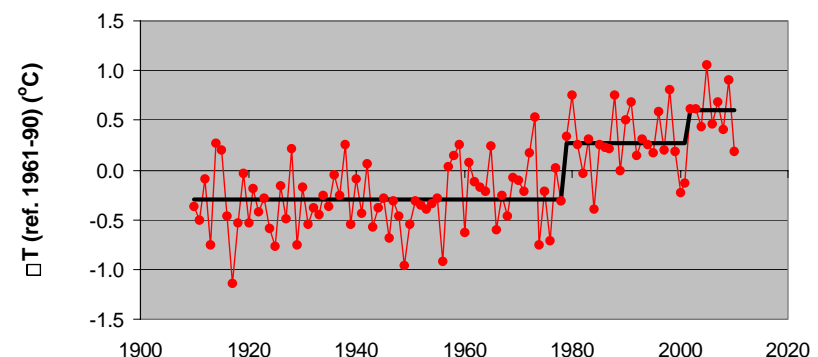
1979, 2002



1880 - 2010



1910 - 2010



Spurious ?

Could it be a realisation of a "red noise" process?

- Assuming and removing AR1 autocorrelation (prewhitening, IP4 method):
 - Alaska and Fichtelberg: same steps, i.e. no change
 - Malacca: some change, from 1978, 1990, 1998
to 1978, 1990, 2002
but now w. 1998 as outlier

Global T-anomaly, crutem3gl:

- from 1977, 1987, 1998 to 1977, 1987, 1997

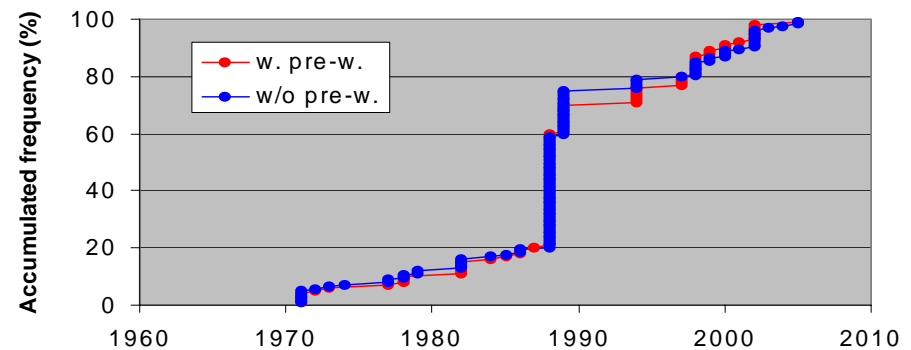
European and Russian stations, see next slide

- Note: removal of autocorrelation reduce the risk of non-rejection of **false steps**, but increase the risk of rejection of **real steps**

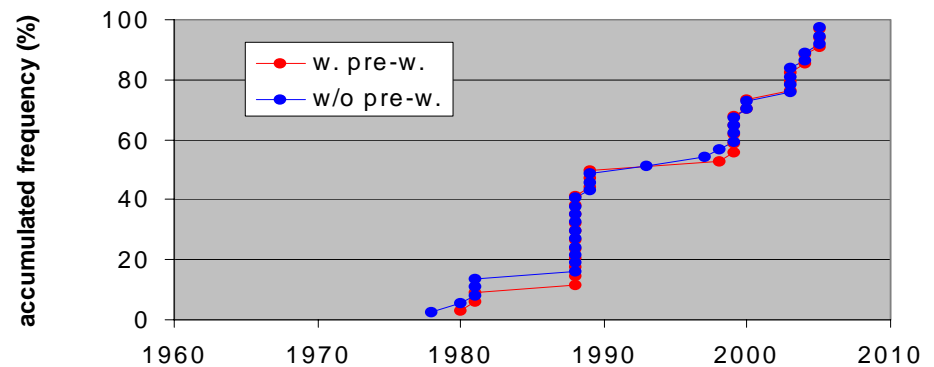
Autocorrelation cont.:

Step distributions in European and Russian samples are nearly identical with (w) or without (w/o) removal of "red noise"

- Europe:
 - One-step stations 1987/89: 48, 47
 - avg. years of no T-change before 2010: 18.8, 21.1

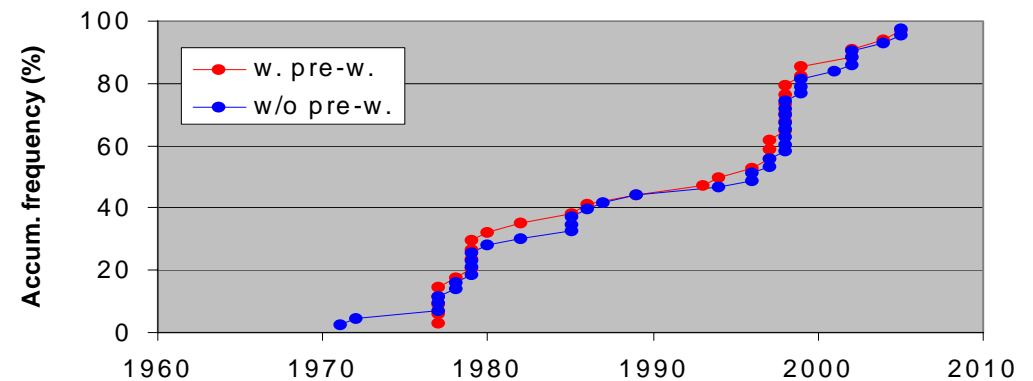


- Russia:
 - One-step stations 1987/89: 12, 14
 - avg. years of no T-change before 2010: 17.8, 20.2

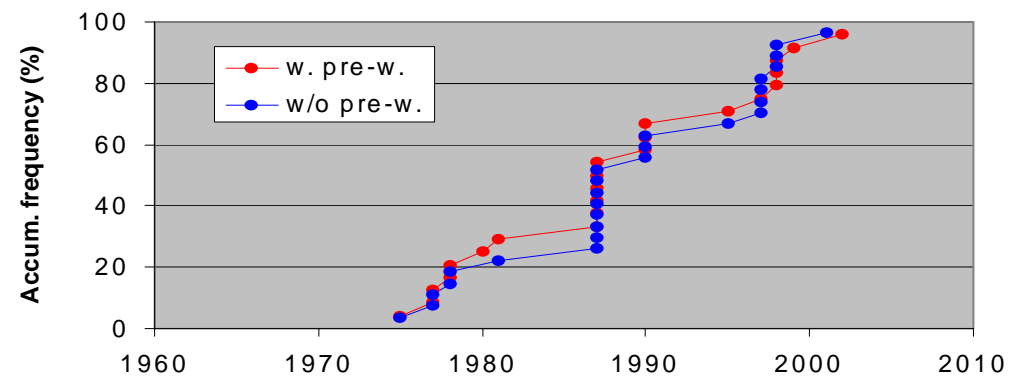


... same for step distributions for E-Asia and SE-Asia

- E-Asia



- SE-Asia



”regional” step pattern diversity – eg.:

Europe: 78% of stations have step in 1987/89
 S-Asia: only 7% of station have step in 1987/89
 SE-Asia: 2-steps common, especially 1987/89 and 1997/99
 S-America: no step in 1997/99
 Antarctic: 43% of stations has constant T during 1960-2010

Stations (n) with one or more steps in indicated 3 periods:						
"region"	N	n	%	% of N stations with step in		
				1977/79	1987/89	1997/99
Arctic	12	4	33	0	8	25
Alaska	9	8	89	89	0	0
Europe	89	79	89	7	78	10
Russia	36	20	56	3	36	17
Middle east	9	6	67	11	11	56
S-Asia	30	17	57	30	7	43
SE-Asia	14	13	93	29	57	50
Africa	16	8	50	13	13	38
S-America	10	6	60	40	30	0
Antarctic	7	6	86	0	0	14
Total	232	167	72	15	43	22

Single-step stations -

60% of all stations has only one step, at which time the entire local "warming" during 1960-2010 apparently took place.

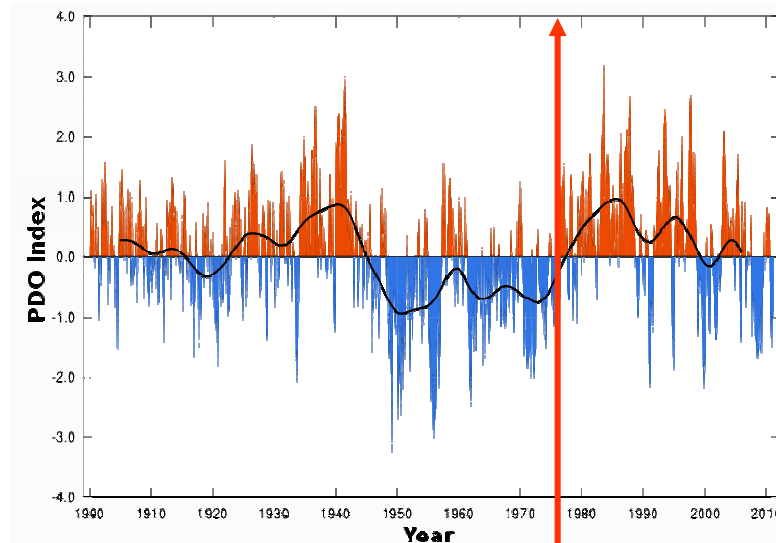
Europe: 92% of single-step stations had step in 1988/89

Alaska: 100% of single-step stations had step in 1977

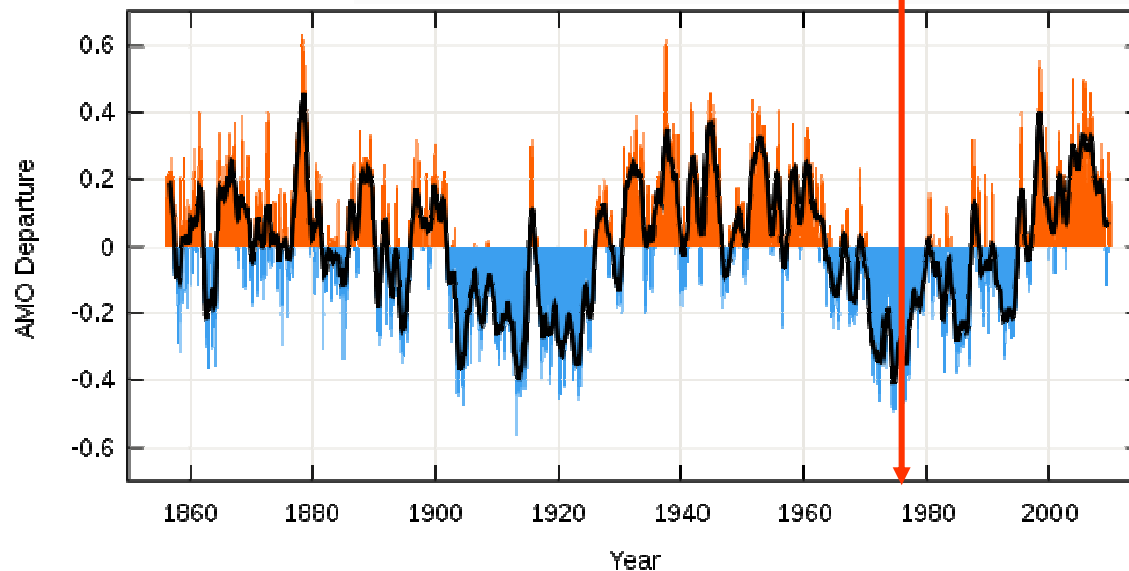
Stations (n) with only one step (1960-05) in the 3 periods:						
"region"	N	n	%	% of N stations with step in		
				1977/79	1987/89	1997/99
Arctic	12	1	8	0	0	8
Alaska	9	7	78	78	0	0
Europe	89	52	58	2	54	2
Russia	36	18	50	3	33	14
Middle East	9	1	11	11	0	0
S-Asia	30	3	10	3	0	7
SE-Asia	14	3	21	0	21	0
Africa	16	1	6	6	0	0
S-America	10	2	20	10	10	0
Antarctic	7	0	0	0	0	0
Total	232	88	38	6	28	4

Ocean oscillation indices – periodicity ?

(figs. from Wikipedia)



PDO:
Pacific decadal
oscillation, warm and
cool phases, PDO shift
1976/77



AMO:
Atlantic multidecadal
oscillation, warm and
cool phases.