The State of the Climate 2024

Based on real observations

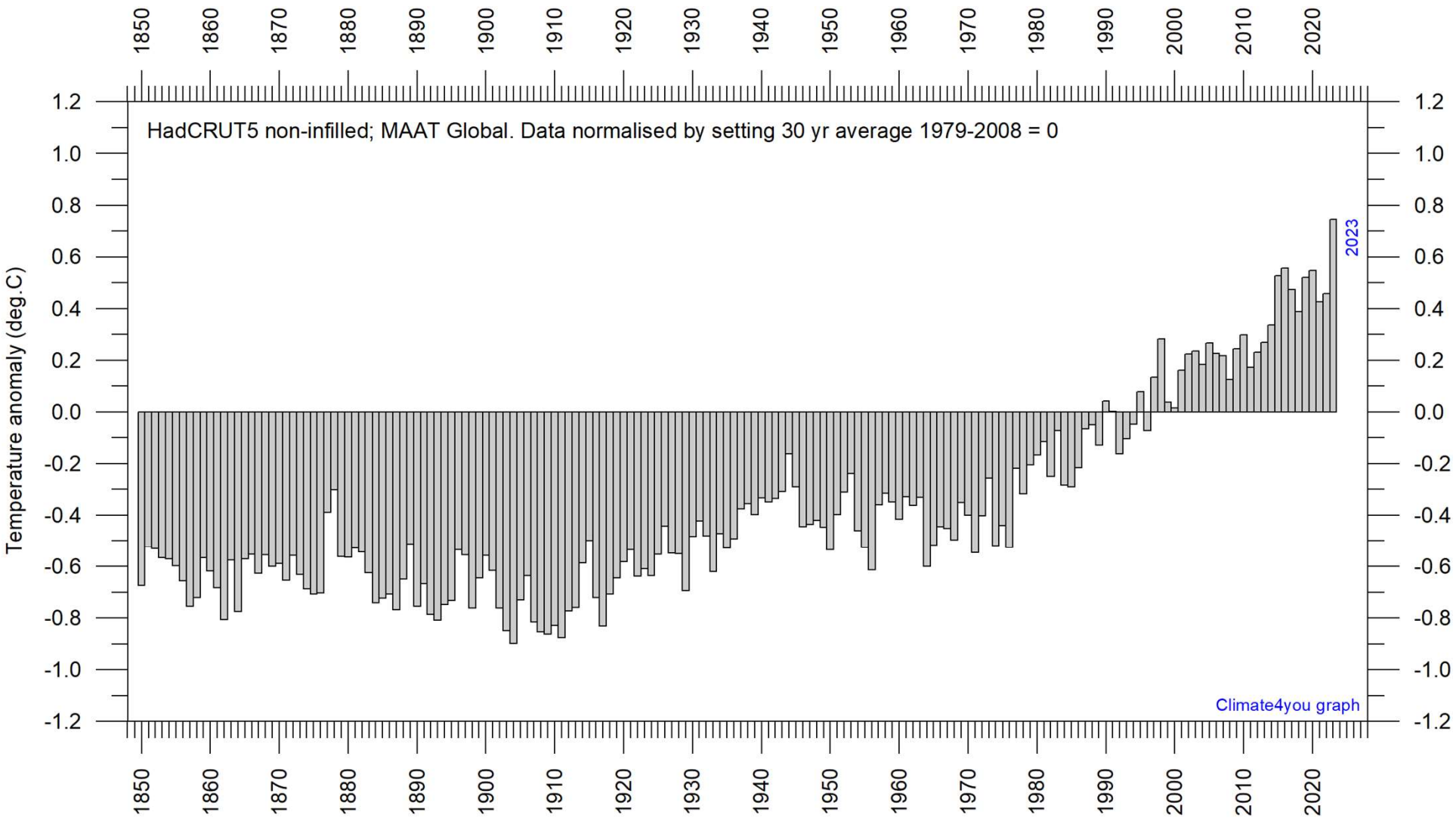
Ole Humlum

Principal question:
Are we currently in a climate crisis ?

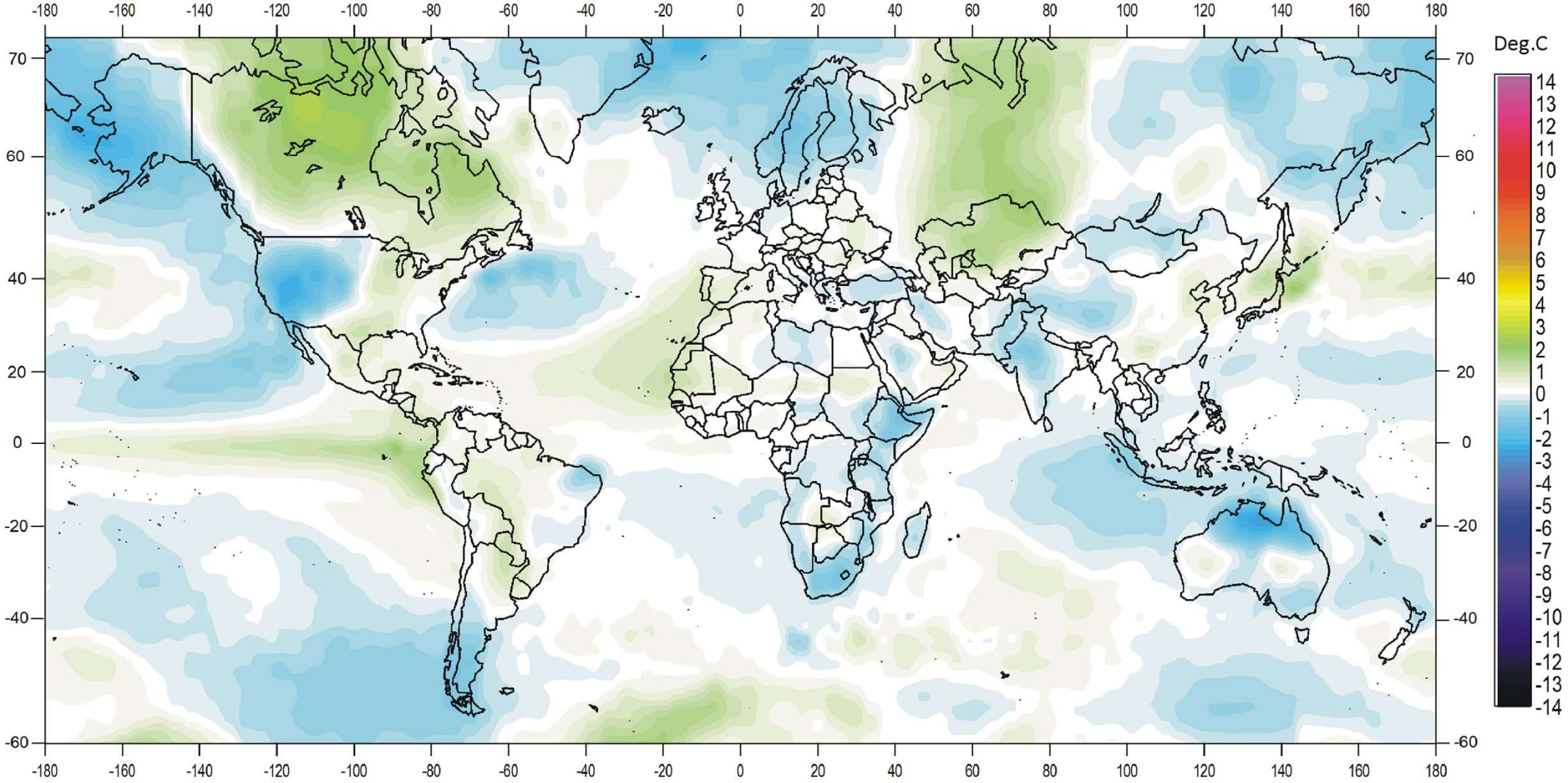
The State of the Climate 2024

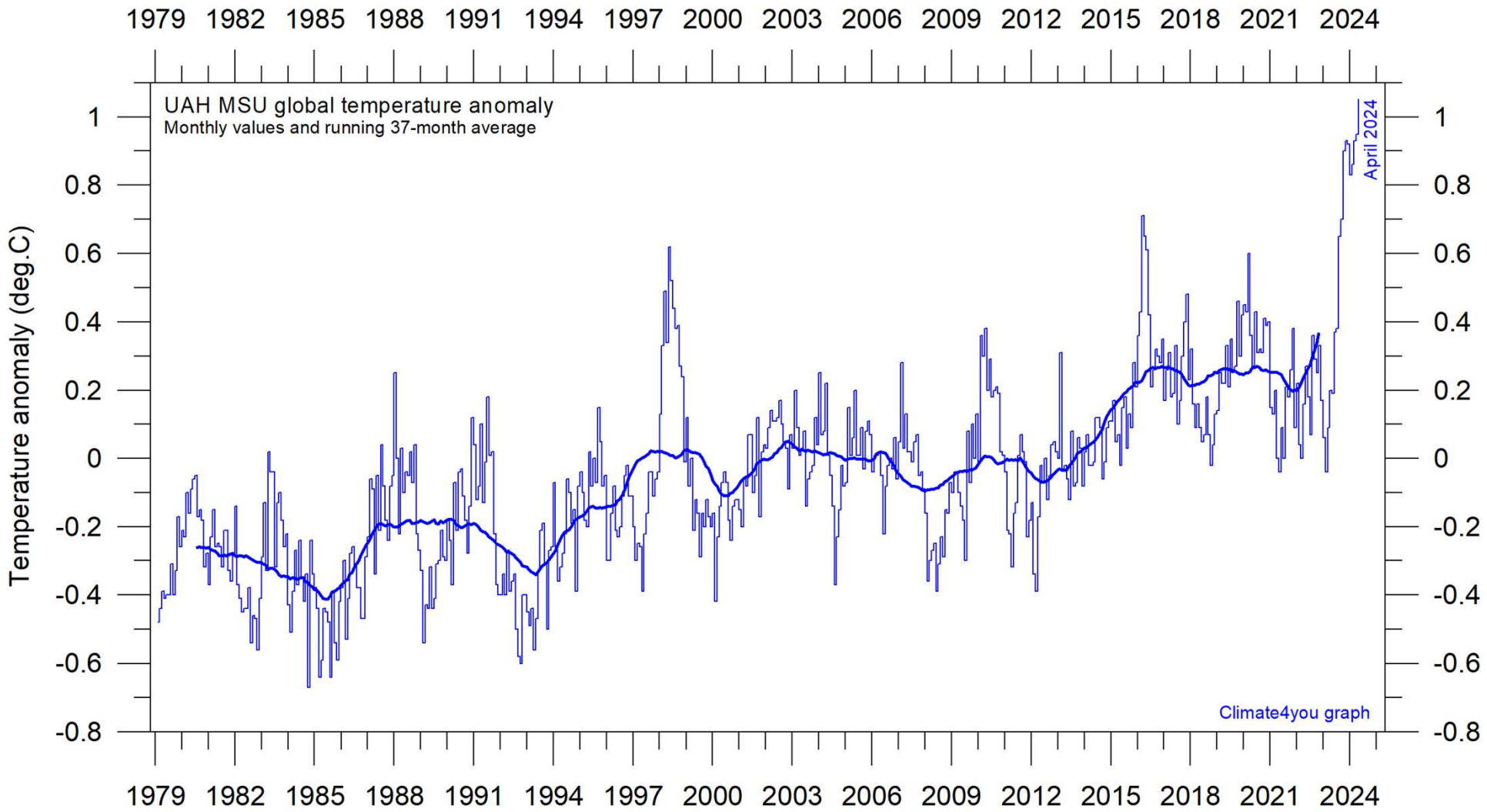
1. Atmospheric temperature
2. Ocean temperature
3. Sea level
4. Sea ice
5. Snow
6. Wind and storms
7. Global precipitation
8. Global cloud cover
9. Climate change: importance of oceans
10. Final reflections and conclusions

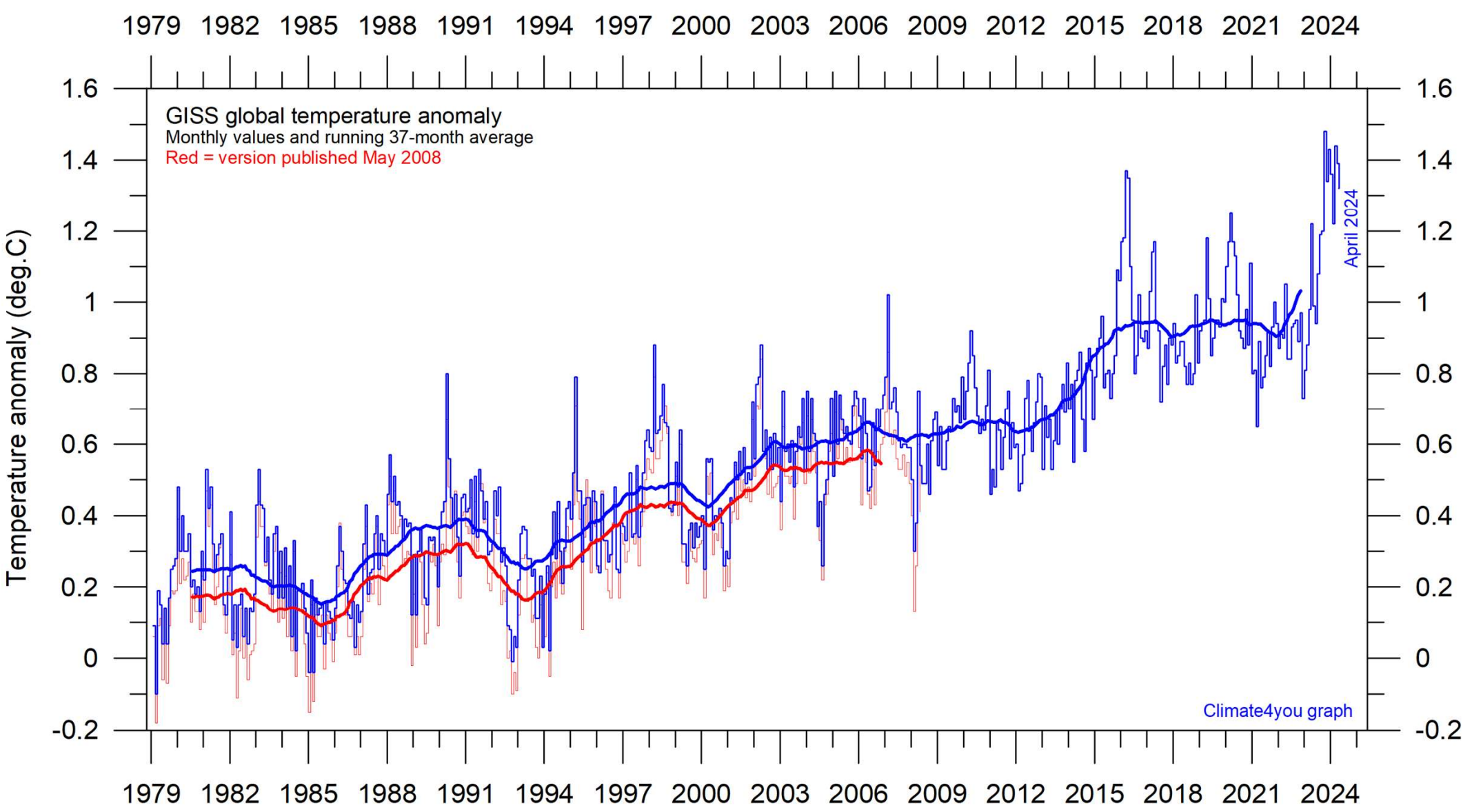
Atmospheric temperature

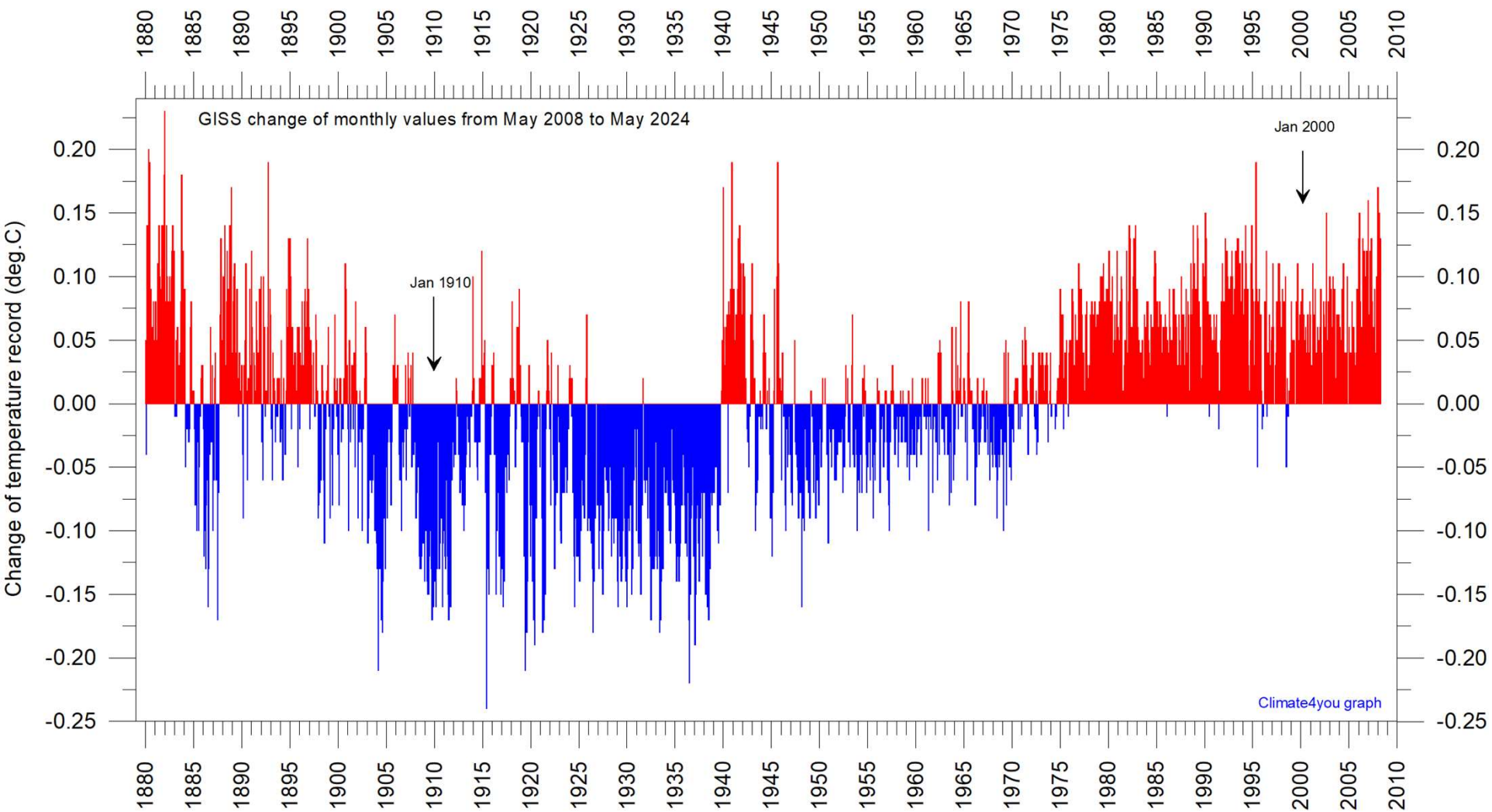

HadCRUT5 non-infilled; MAAT Global. Data normalised by setting 30 yr average 1979-2008 = 0
Temperature anomaly (deg.C)
2023
Climate4you graph
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2

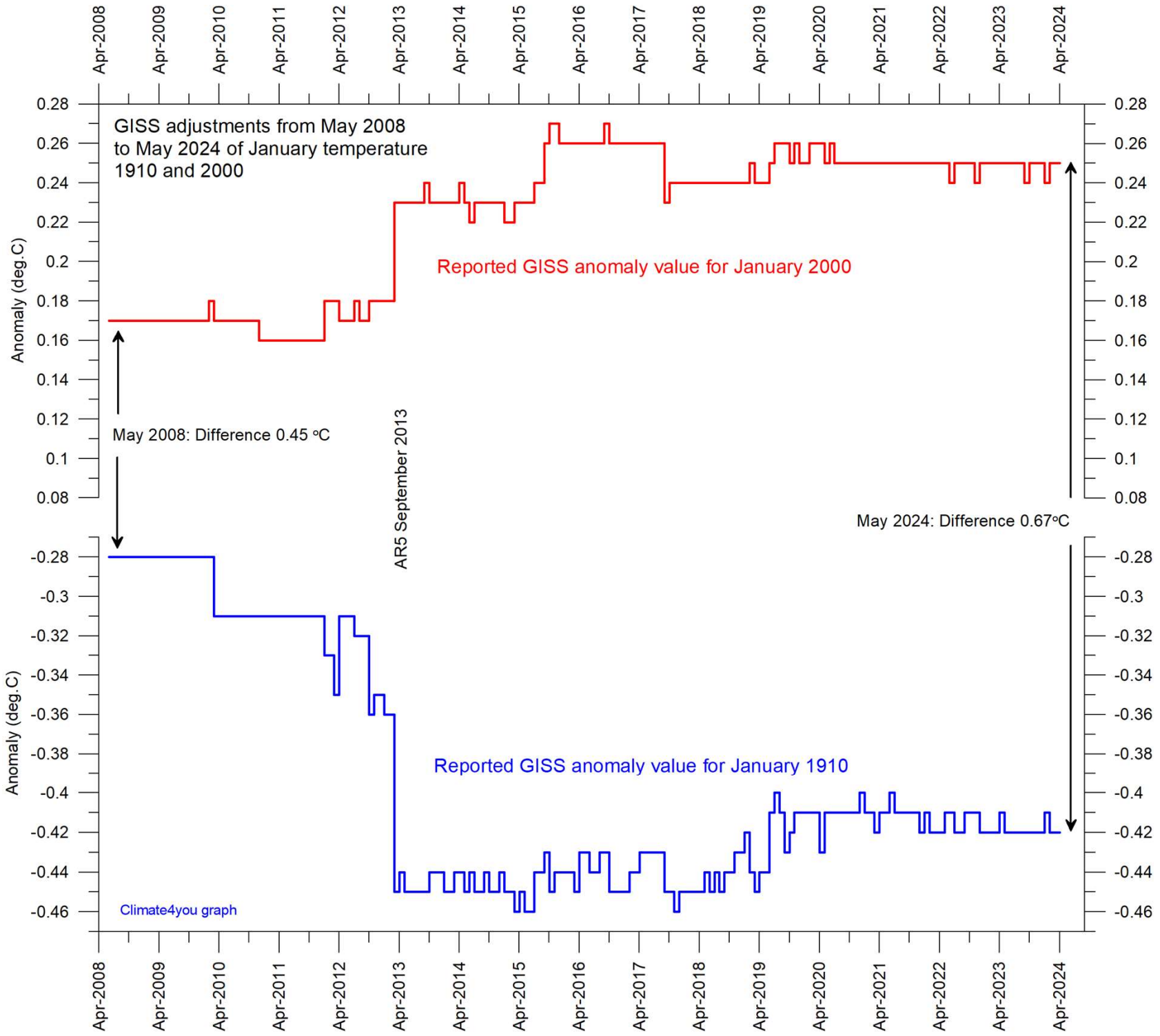
Surface air temperature anomaly YEAR 2023 vs last 10 yr




UAH MSU global temperature anomaly
Monthly values and running 37-month average
Temperature anomaly (deg.C)
April 2024
Climate4you graph
1979 1982 1985 1988 1991 1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8


GISS global temperature anomaly
Monthly values and running 37-month average
Red = version published May 2008
Temperature anomaly (deg.C)
April 2024
Climate4you graph
1979 1982 1985 1988 1991 1994 1997 2000 2003 2006 2009 2012 2015 2018 2021 2024
1.6 1.4 1.2 1 0.8 0.6 0.4 0.2 0 -0.2


GISS change of monthly values from May 2008 to May 2024
Change of temperature record (deg.C)
Jan 1910
Jan 2000
Climate4you graph
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
1880
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010


GISS adjustments from May 2008
to May 2024 of January temperature
1910 and 2000
Reported GISS anomaly value for January 2000
May 2008: Difference 0.45 °C
May 2024: Difference 0.67°C
AR5 September 2013
Reported GISS anomaly value for January 1910
Anomaly (deg.C)
Anomaly (deg.C)
Climate4you graph
Apr-2008
Apr-2009
Apr-2010
Apr-2011
Apr-2012
Apr-2013
Apr-2014
Apr-2015
Apr-2016
Apr-2017
Apr-2018
Apr-2019
Apr-2020
Apr-2021
Apr-2022
Apr-2023
Apr-2024
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
-0.28
-0.3
-0.32
-0.34
-0.36
-0.38
-0.4
-0.42
-0.44
-0.46

The effect of urban heat islands ?

NW

NE

Nordmarka

Oslo

Bærum

Asker

Sandvika

Lysaker

Nittedal

Gjerdrum

Kløfta

Ask

Lillestrøm

Fetsund

Rælingen

Løren-skog

Nesodd-tangen

Bunne-fjorden

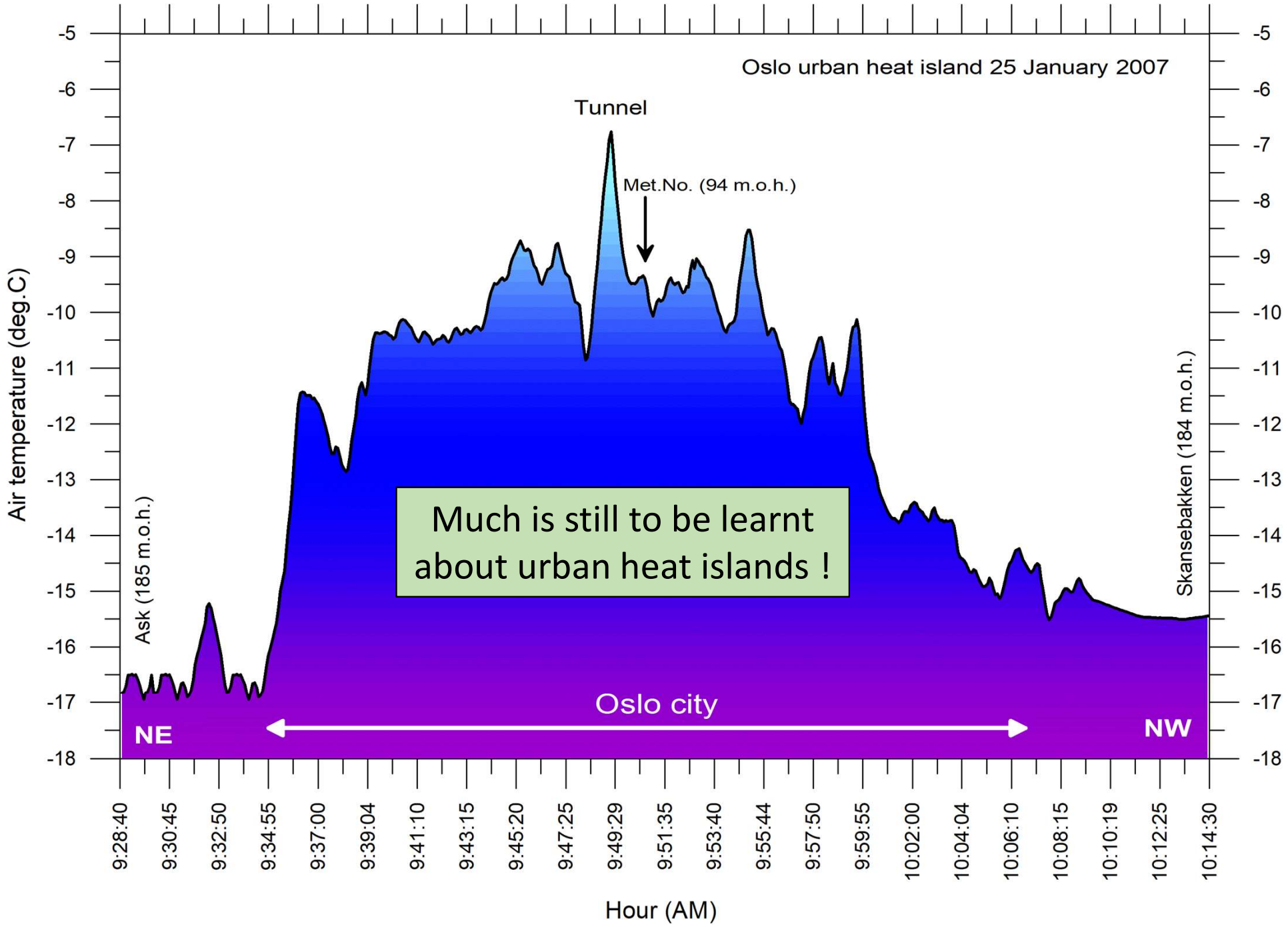
Øyeren

Østmarka nasjonalpark

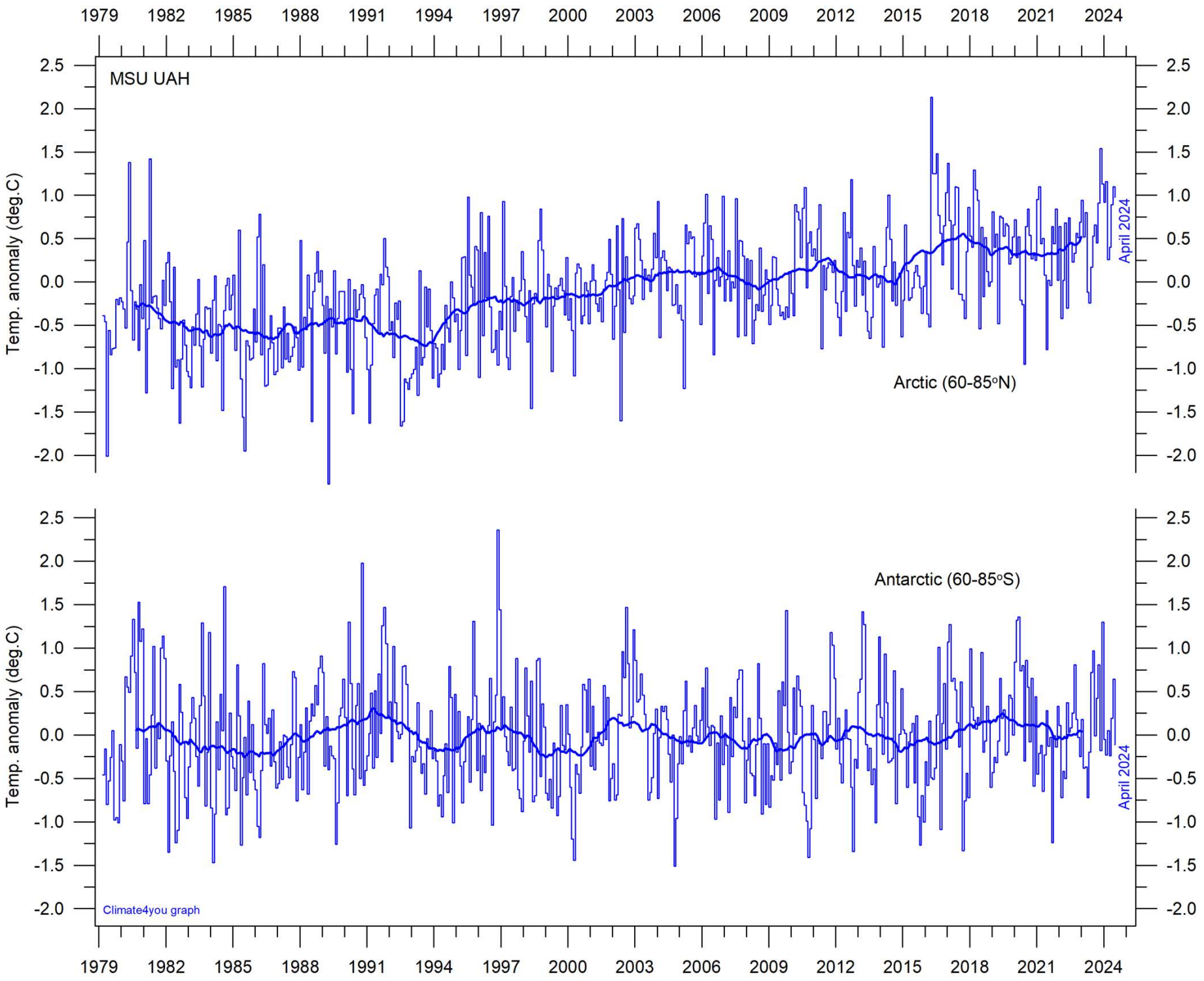
Tranby

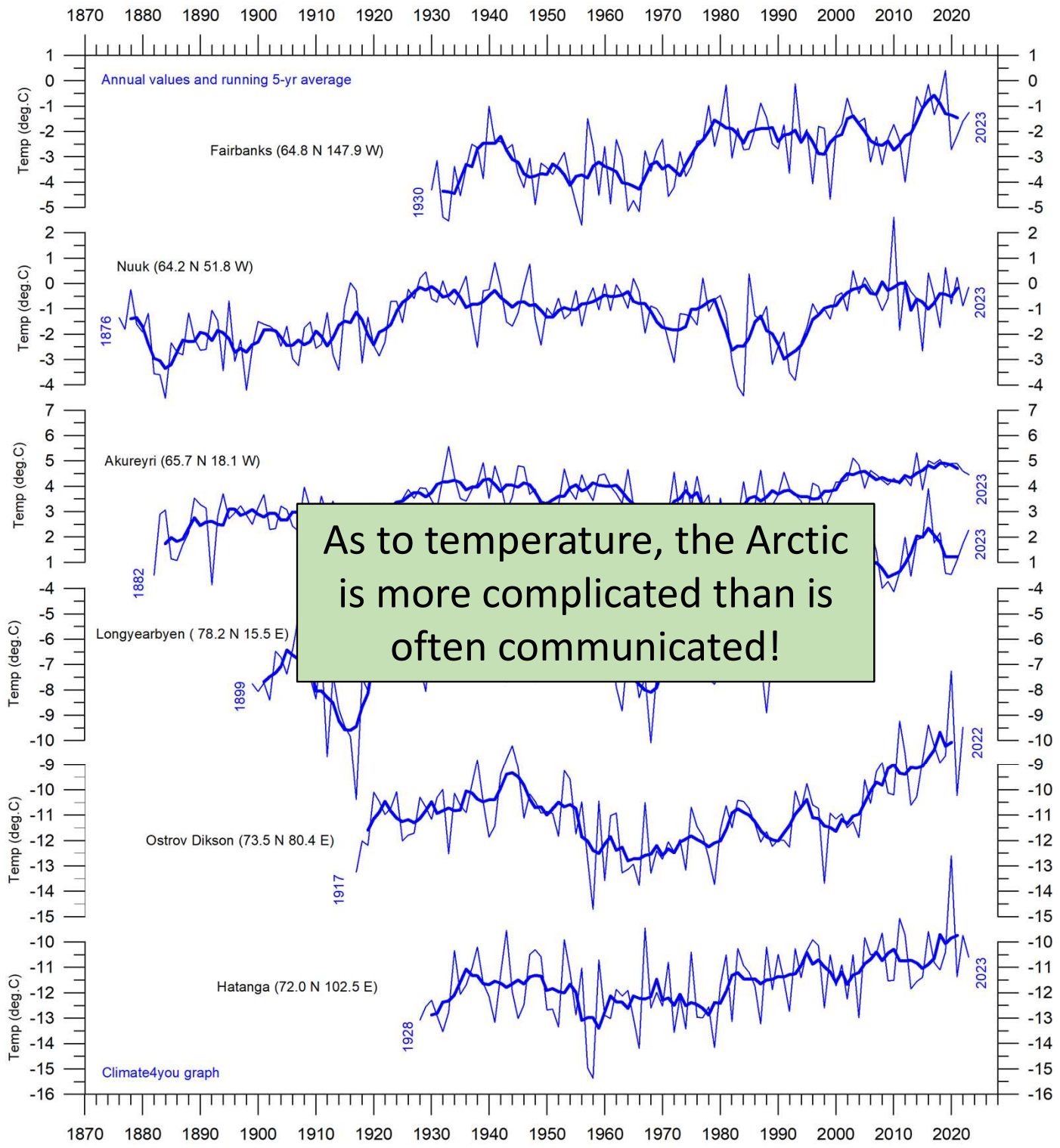
Kolbotn

5 km


Oslo urban heat island 25 January 2007
Tunnel
Met.No. (94 m.o.h.)
Much is still to be learnt about urban heat islands !
Ask (185 m.o.h.)
Skansebakken (184 m.o.h.)
Oslo city
NE
NW
Air temperature (deg.C)
Hour (AM)
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
-15
-16
-17
-18
9:28:40
9:30:45
9:32:50
9:34:55
9:37:00
9:39:04
9:41:10
9:43:15
9:45:20
9:47:25
9:49:29
9:51:35
9:53:40
9:55:44
9:57:50
9:59:55
10:02:00
10:04:04
10:06:10
10:08:15
10:10:19
10:12:25
10:14:30

Polar regions:
Atmospheric temperature


MSU UAH
Arctic (60-85°N)
Antarctic (60-85°S)
Temp. anomaly (deg.C)
April 2024
Climate4you graph
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0



As to temperature, the Arctic is more complicated than is often communicated!

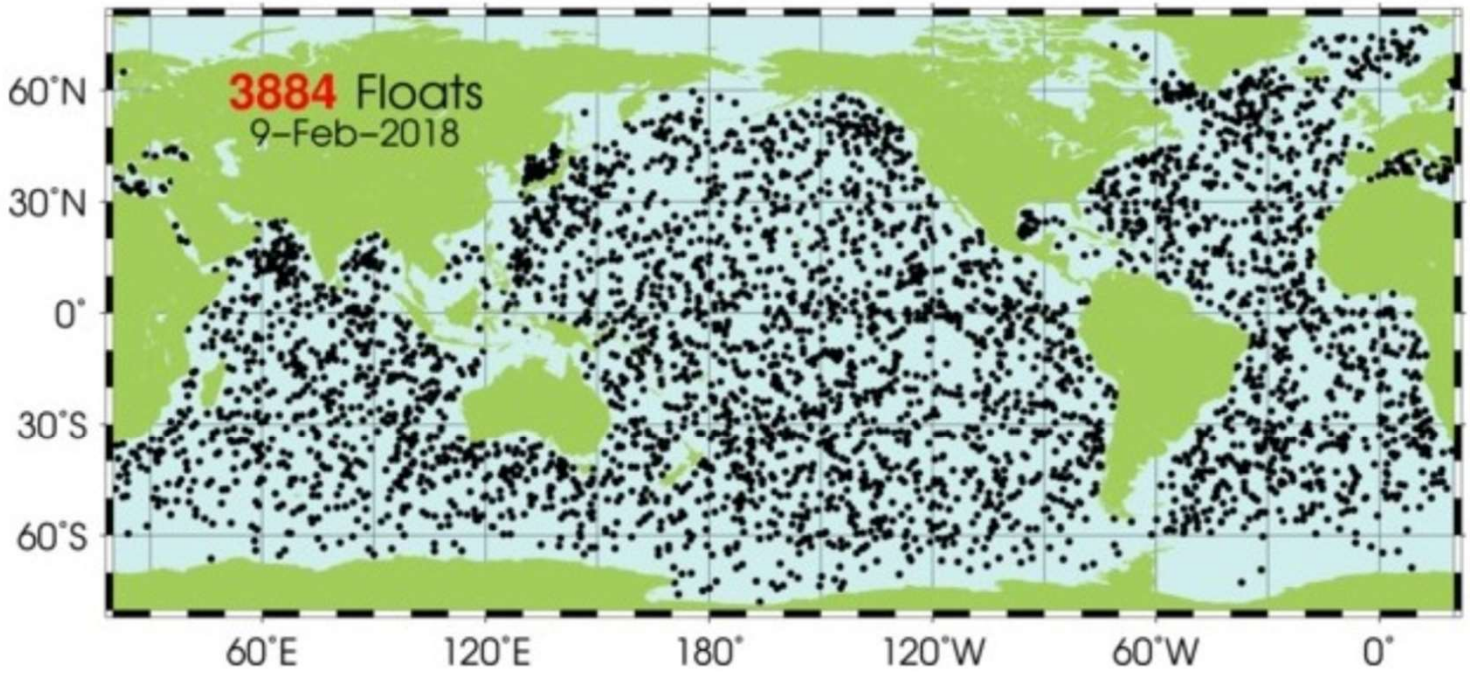
Ocean temperature

Argo profiling floats

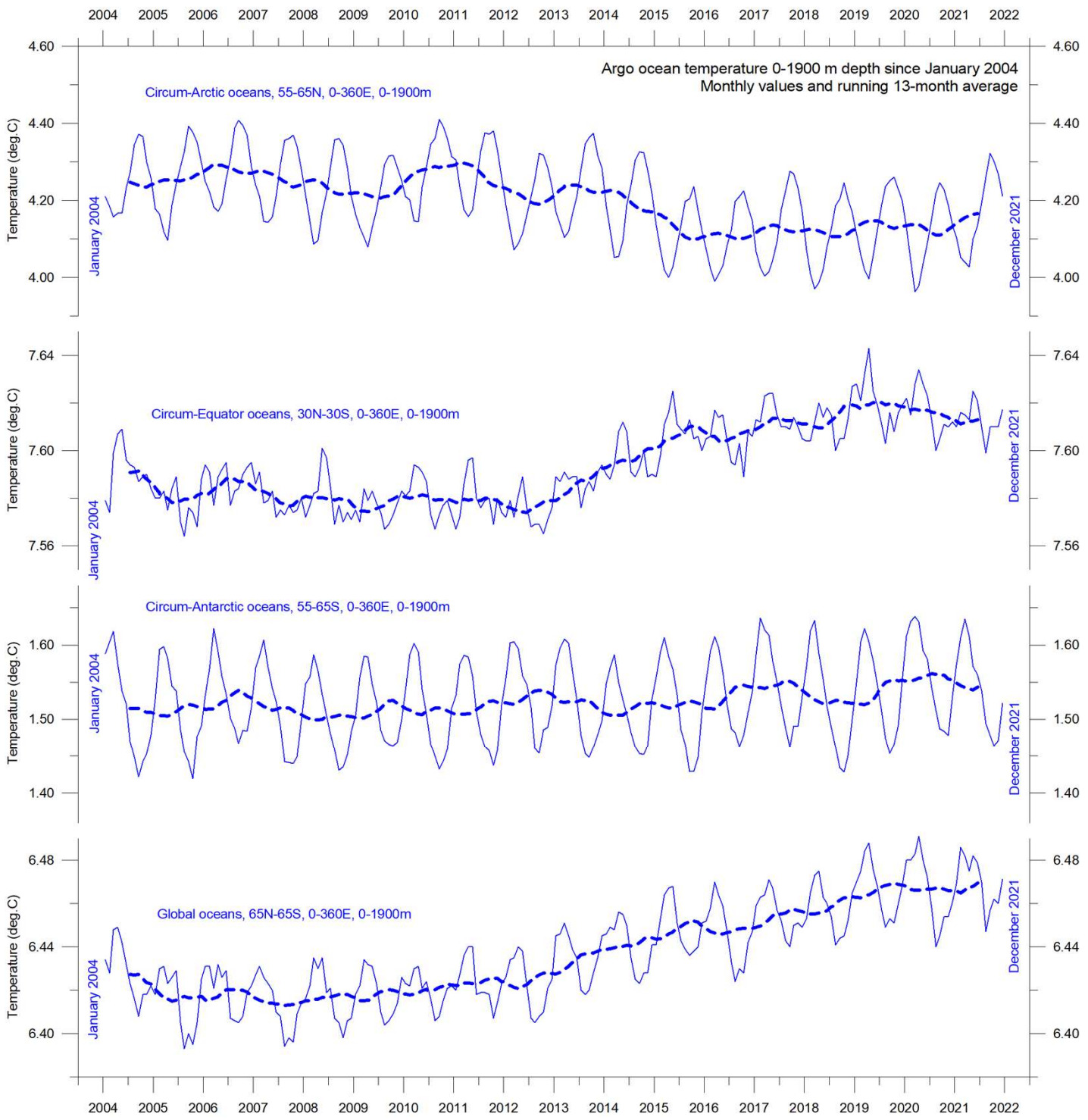
What is Argo?

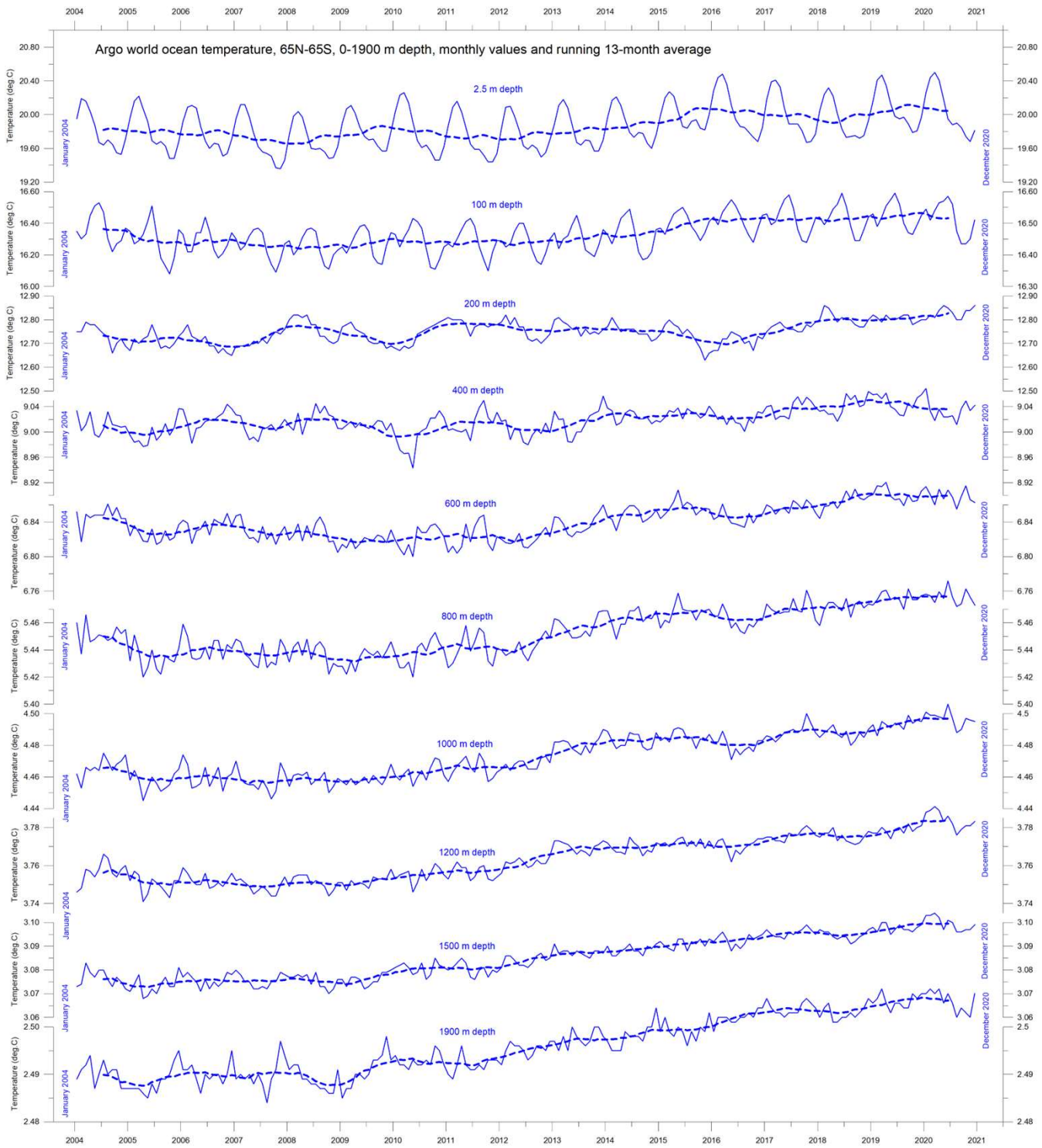
Argo is a global array of 3,800 free-drifting profiling floats that measures thetemperature and salinity of the upper 2000 m of the ocean. This allows, for the first time, continuous monitoring of the temperature, salinity, and velocity of the upper ocean, with all data being relayed and made publicly available within hours after collection.

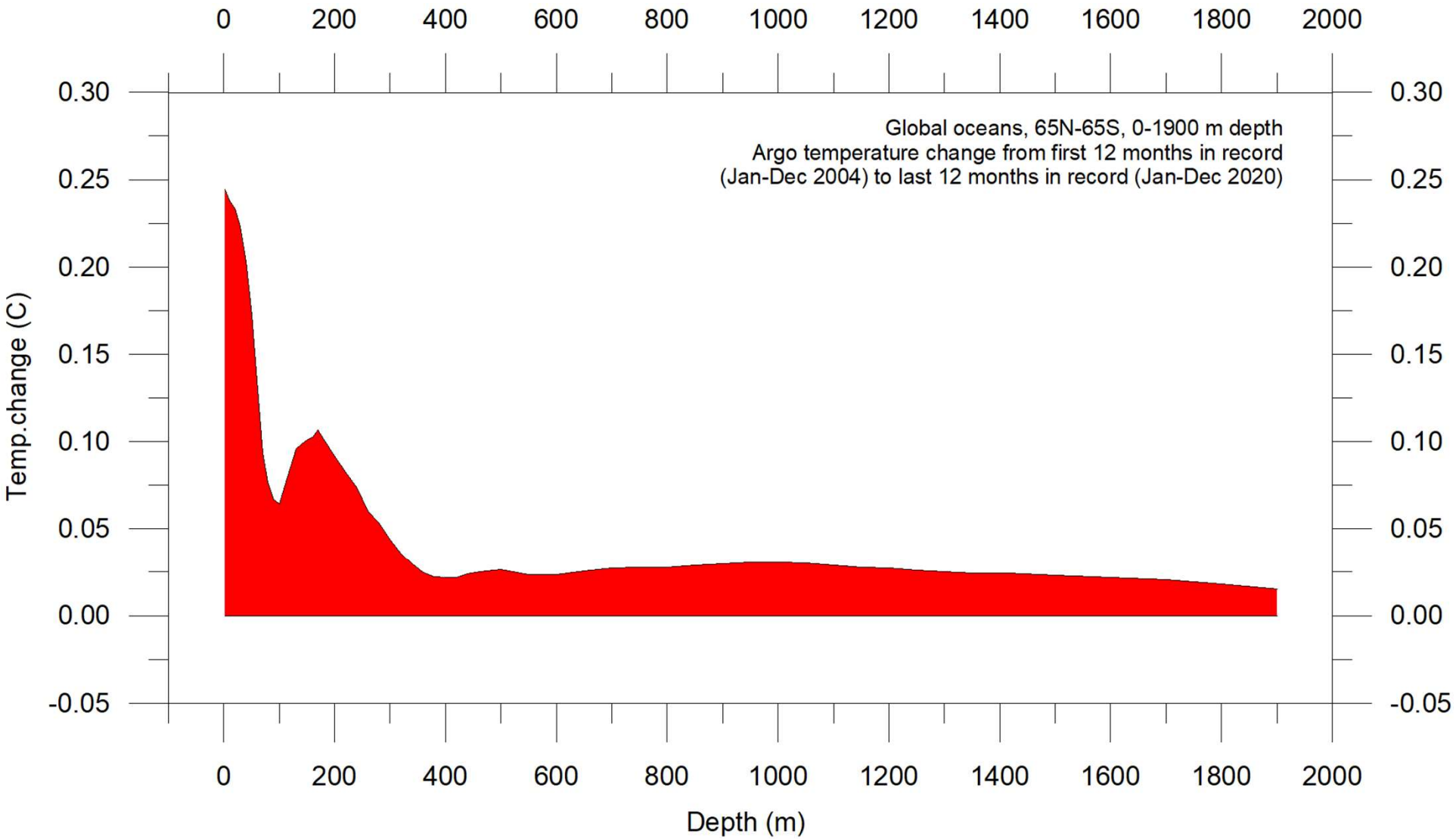
Positions of the floats that have delivered data within the last 30 days :

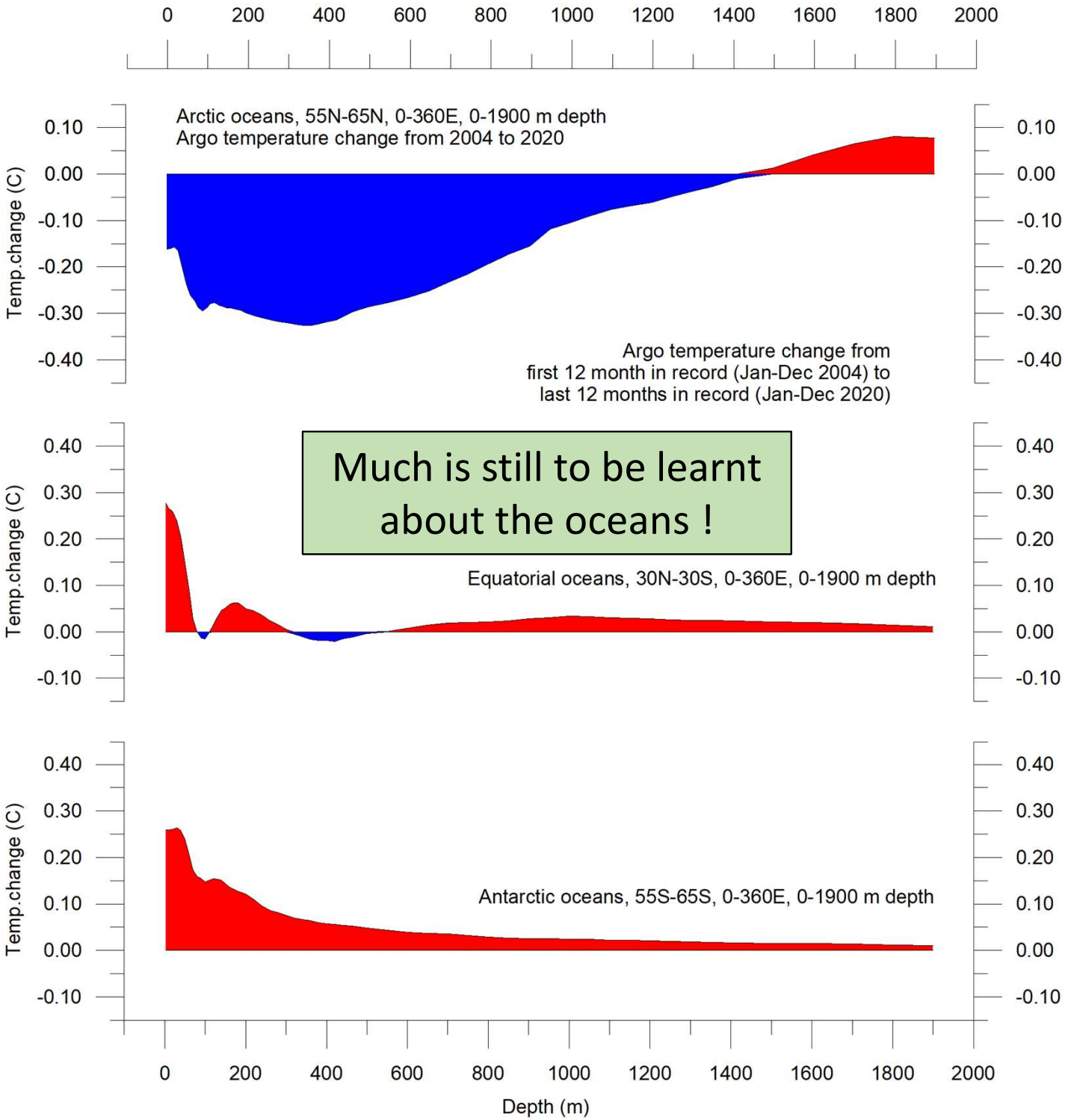


Maps displaying statistics about the Argo array, including its extensions into high latitudes and marginal seas, bio-geochemical sensors, communication systems, float type, etc., can be found in the **map section** on the Argo Information Centre website.

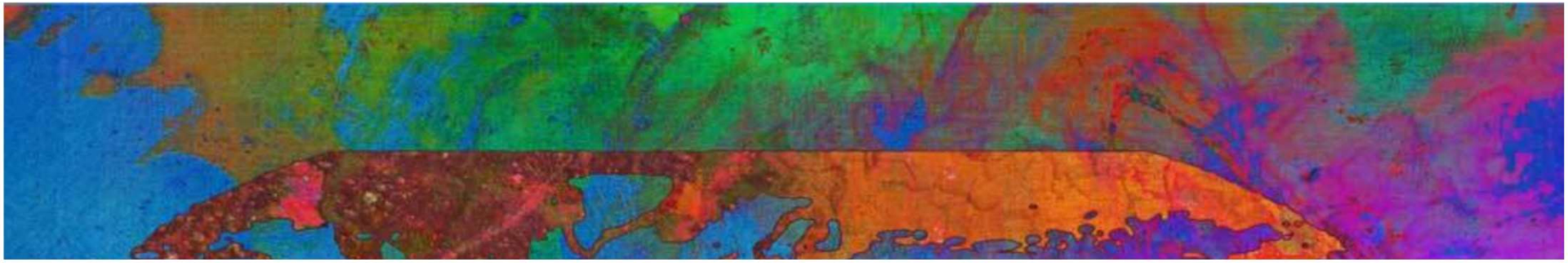

Argo ocean temperature 0-1900 m depth since January 2004
Monthly values and running 13-month average
Circum-Arctic oceans, 55-65N, 0-360E, 0-1900m
Circum-Equator oceans, 30N-30S, 0-360E, 0-1900m
Circum-Antarctic oceans, 55-65S, 0-360E, 0-1900m
Global oceans, 65N-65S, 0-360E, 0-1900m
Temperature (deg.C)
January 2004
December 2021
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
4.60 4.40 4.20 4.00
7.64 7.60 7.56
1.60 1.50 1.40
6.48 6.44 6.40


Argo world ocean temperature, 65N-65S, 0-1900 m depth, monthly values and running 13-month average
2.5 m depth
100 m depth
200 m depth
400 m depth
600 m depth
800 m depth
1000 m depth
1200 m depth
1500 m depth
1900 m depth
Temperature (deg C)
January 2004
December 2020
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021


Global oceans, 65N-65S, 0-1900 m depth
Argo temperature change from first 12 months in record
(Jan-Dec 2004) to last 12 months in record (Jan-Dec 2020)
Temp.change (C)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Depth (m)


0 200 400 600 800 1000 1200 1400 1600 1800 2000
Arctic oceans, 55N-65N, 0-360E, 0-1900 m depth
Argo temperature change from 2004 to 2020
Temp.change (C)
0.10 0.00 -0.10 -0.20 -0.30 -0.40
Argo temperature change from
first 12 month in record (Jan-Dec 2004) to
last 12 months in record (Jan-Dec 2020)
Much is still to be learnt
about the oceans !
Equatorial oceans, 30N-30S, 0-360E, 0-1900 m depth
0.40 0.30 0.20 0.10 0.00 -0.10
Antarctic oceans, 55S-65S, 0-360E, 0-1900 m depth
Depth (m)

Sea level



Projected global mean sea level rise under different SSP scenarios

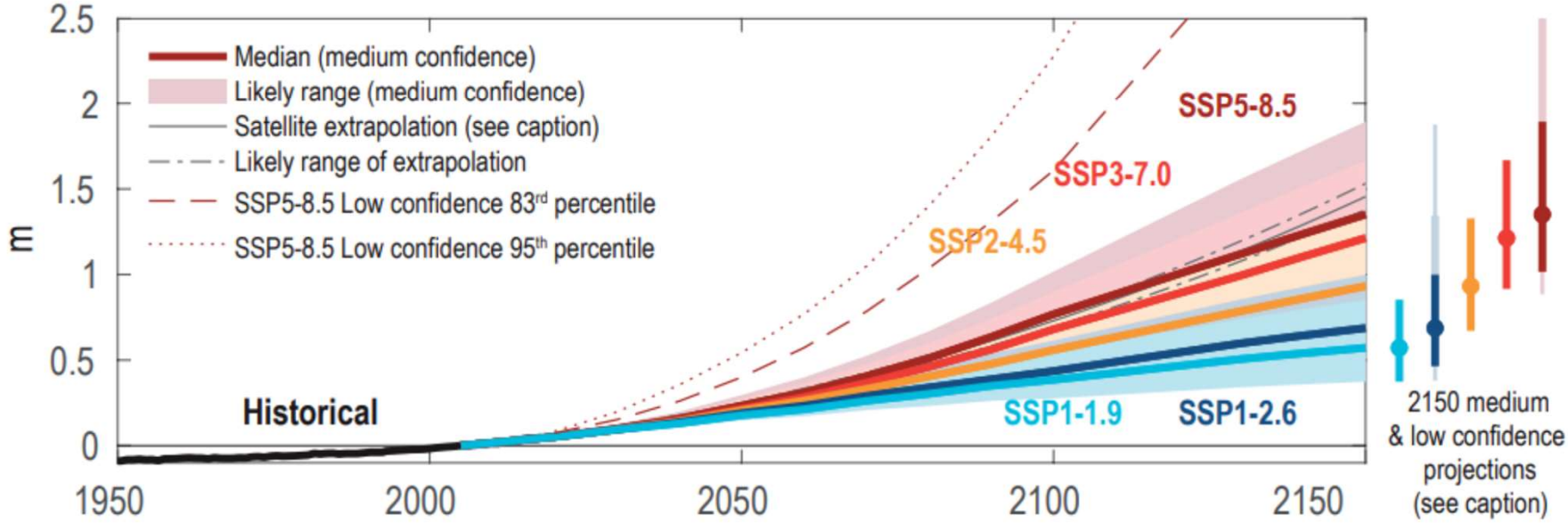
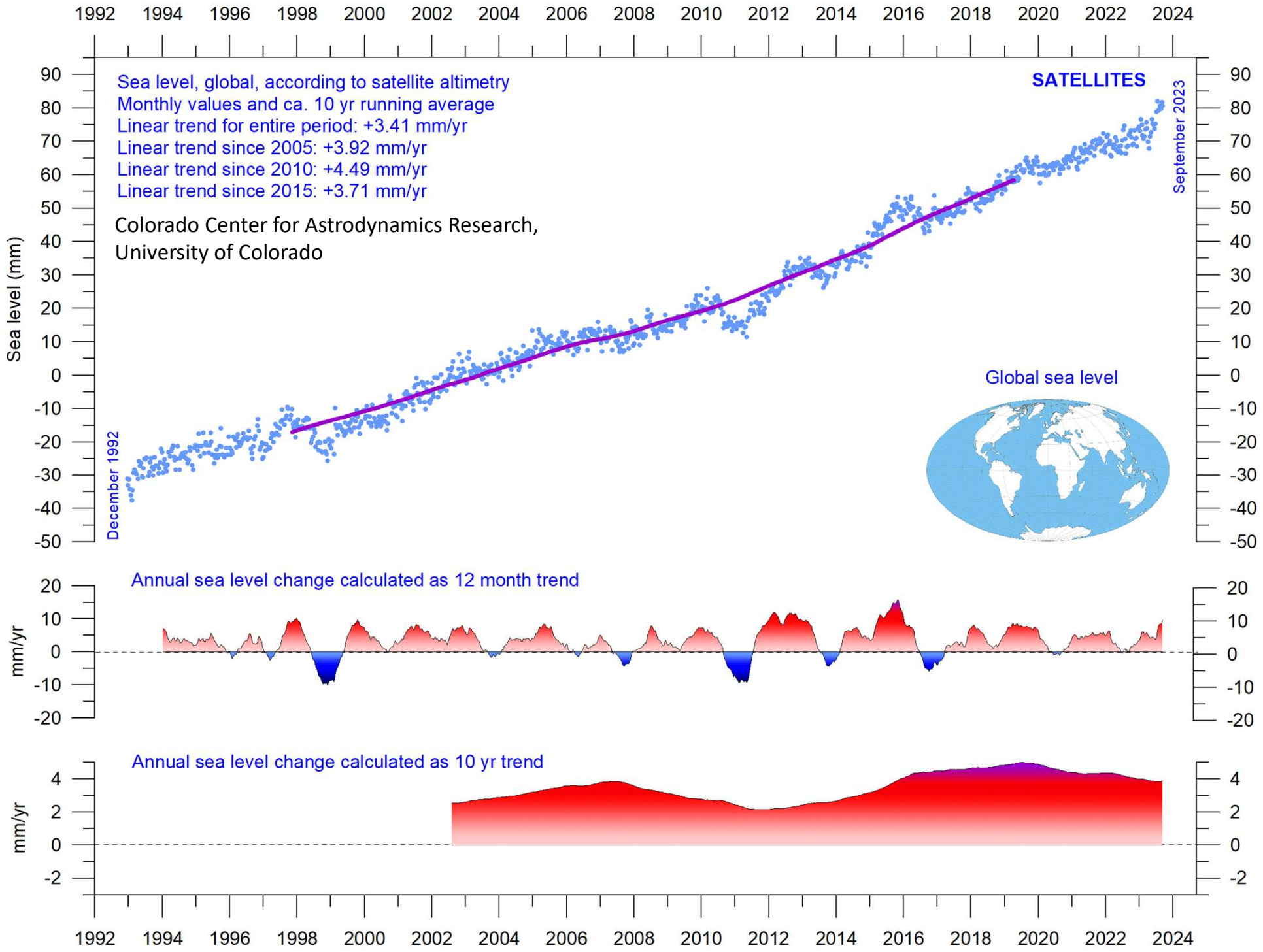
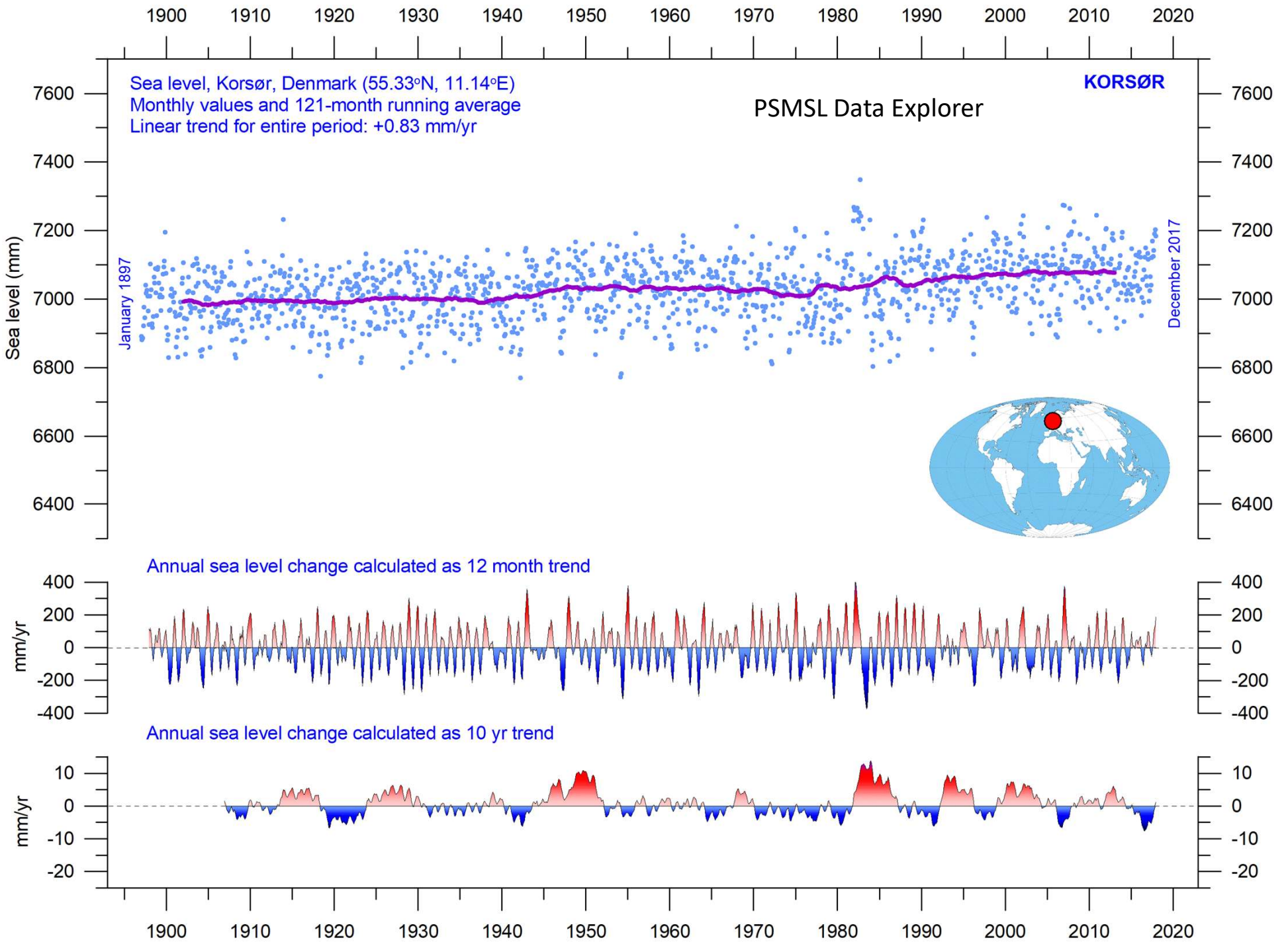
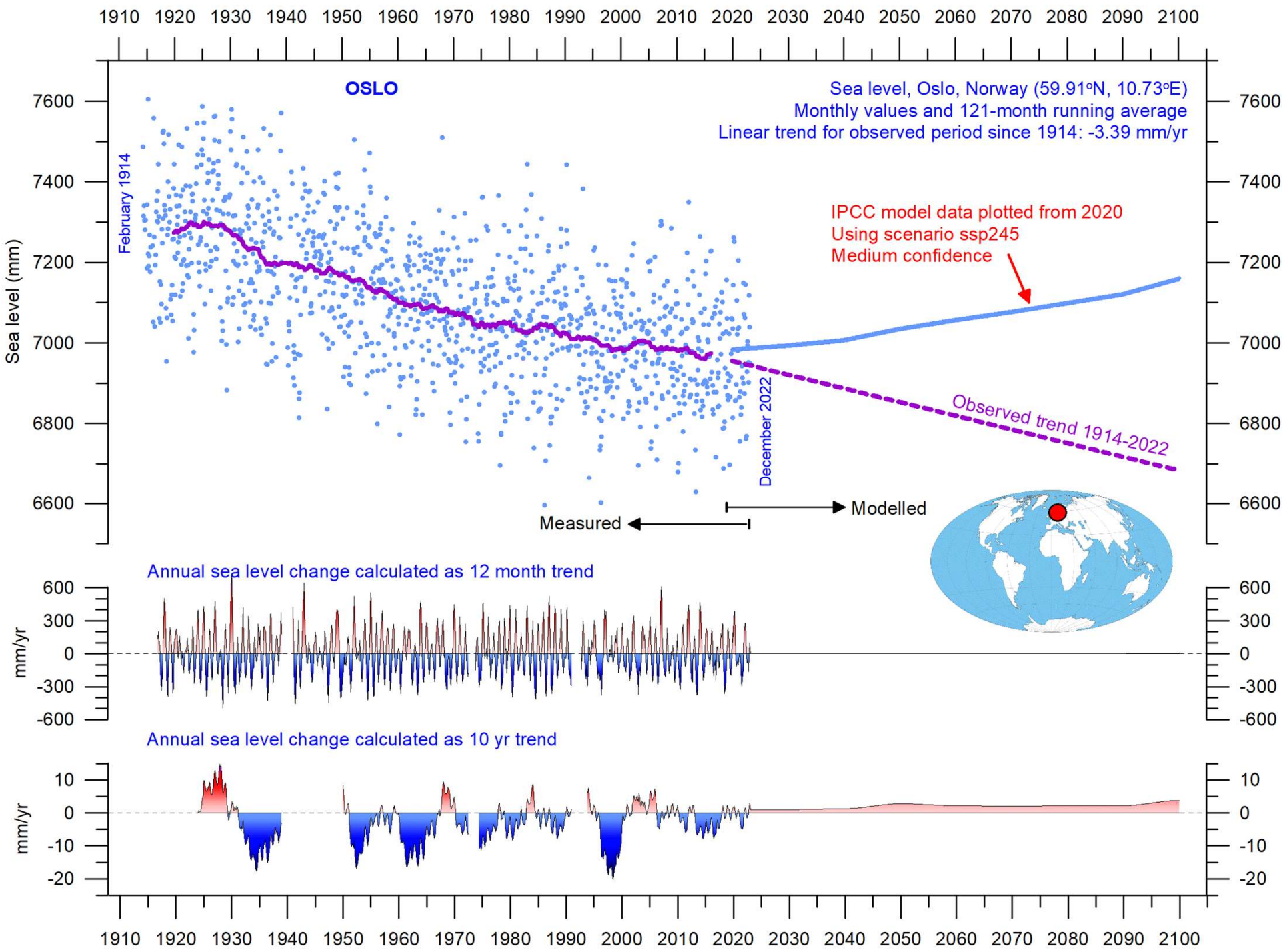


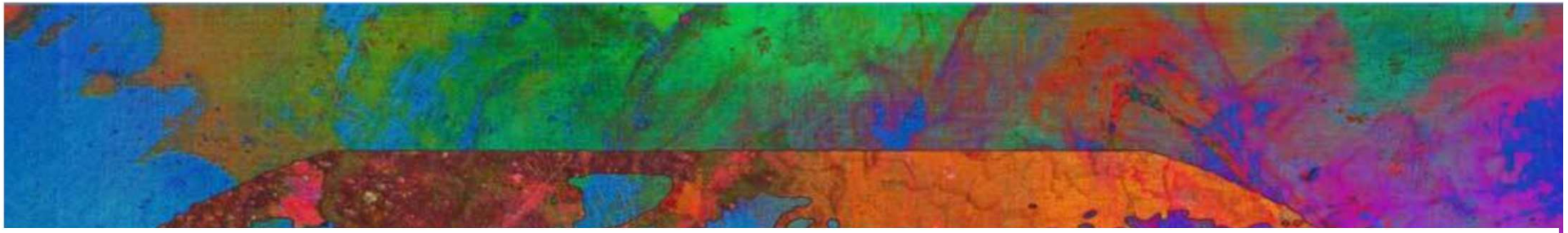
Figure 9.27 | Projected global mean sea level rise under different Shared Socio-economic Pathway (SSP) scenarios. *Likely* global mean sea level (GMSL) change for SSP scenarios resulting from processes in whose projection there is *medium confidence*. Projections and *likely* ranges at 2150 are shown on right. Lightly shaded ranges and thinner lightly shaded ranges on the right show the 17th–83rd and 5th–95th percentile ranges for projections including *low confidence* processes for SSP1-2.6 and SSP5-8.5 only, derived from a p-box including structured expert judgement and marine ice-cliff instability projections. Black lines show historical GMSL change, and thick solid and dash-dotted black lines show the mean and *likely* range extrapolating the 1993–2018 satellite altimeter trend and acceleration. Further details on data sources and processing are available in the chapter data table (Table 9.SM.9).

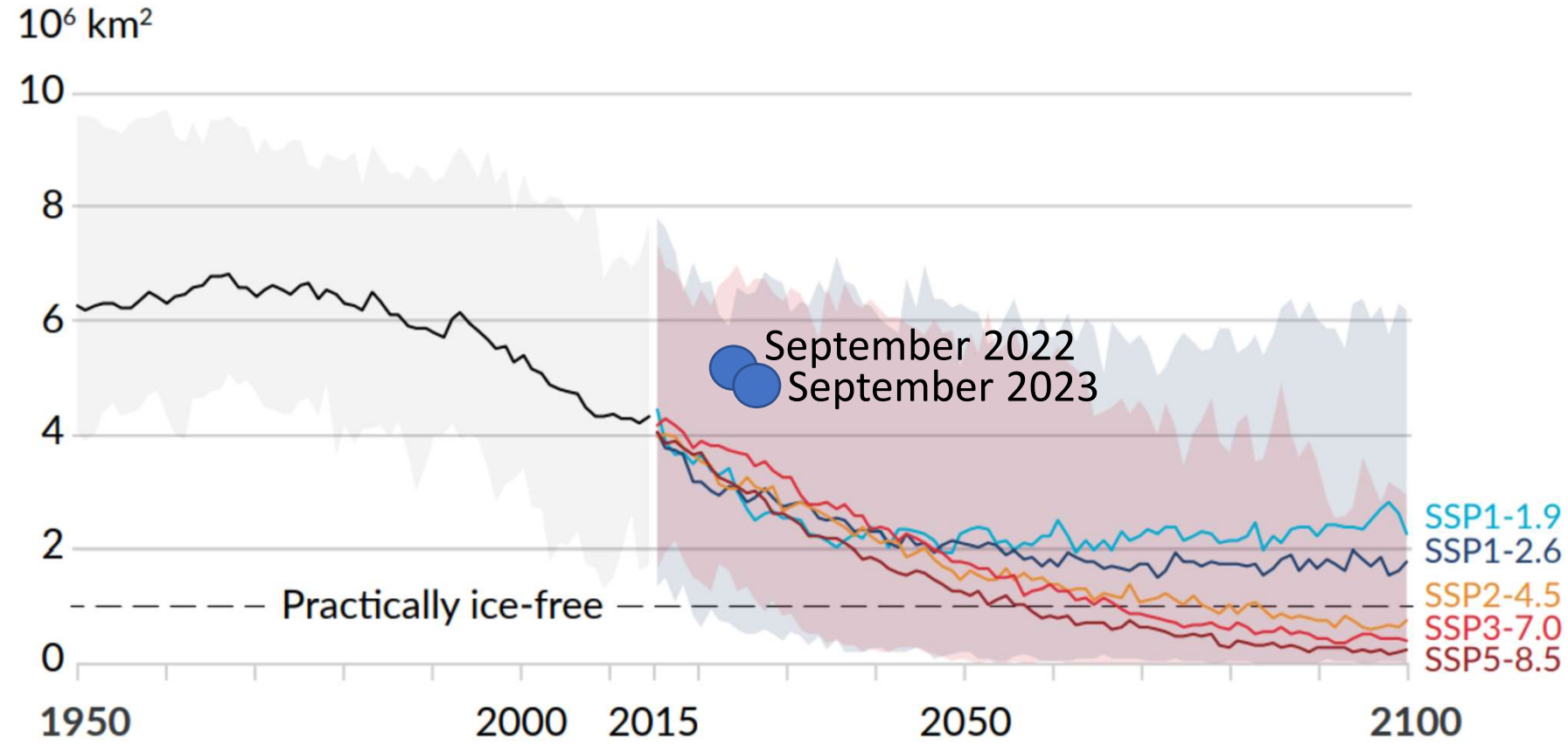

Sea level, global, according to satellite altimetry
Monthly values and ca. 10 yr running average
Linear trend for entire period: +3.41 mm/yr
Linear trend since 2005: +3.92 mm/yr
Linear trend since 2010: +4.49 mm/yr
Linear trend since 2015: +3.71 mm/yr
Colorado Center for Astrodynamics Research,
University of Colorado
SATELLITES
Sea level (mm)
December 1992
September 2023
Global sea level
Annual sea level change calculated as 12 month trend
mm/yr
Annual sea level change calculated as 10 yr trend
mm/yr
1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022 2024

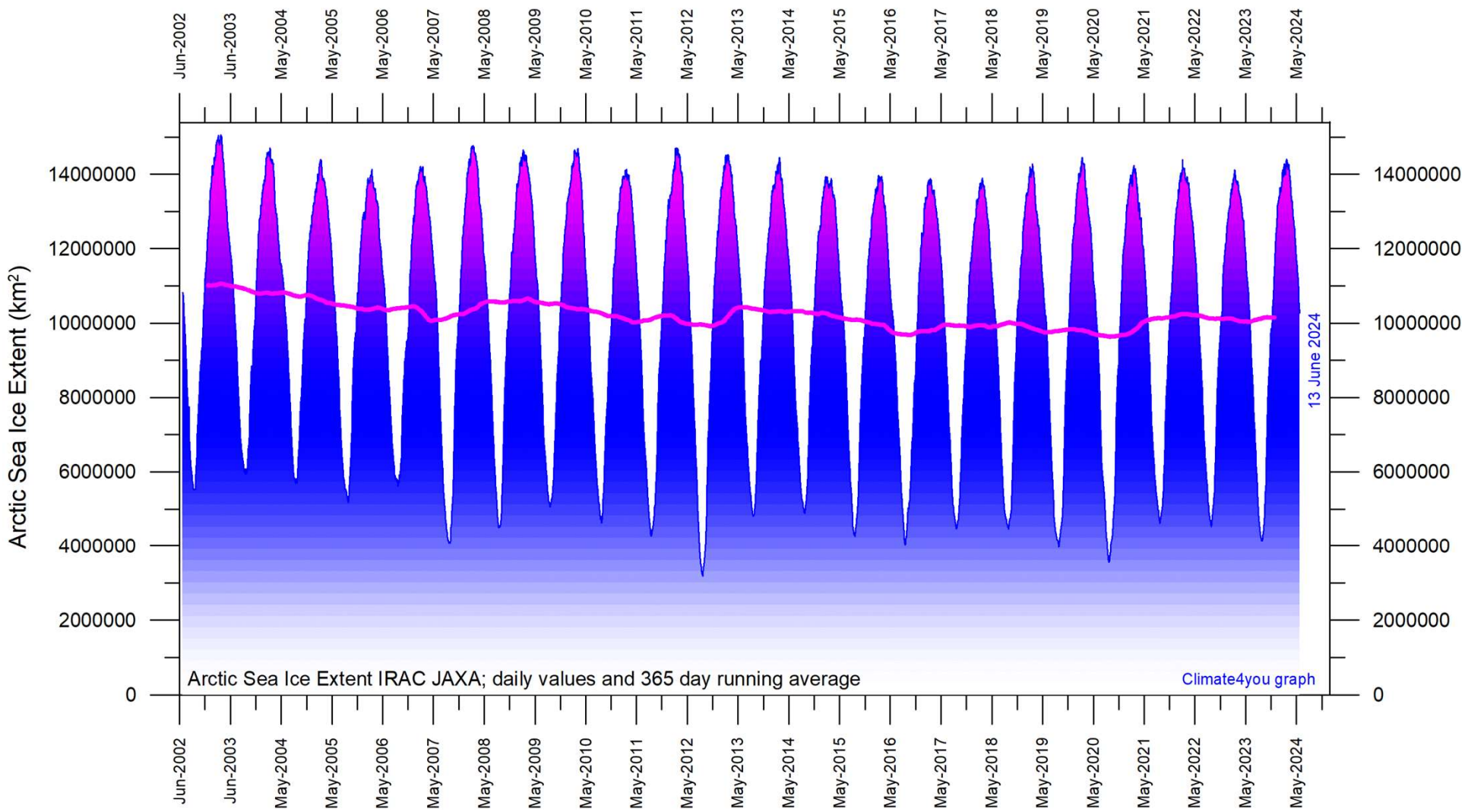

Sea level, Korsør, Denmark (55.33°N, 11.14°E)
Monthly values and 121-month running average
Linear trend for entire period: +0.83 mm/yr
KORSØR
PSMSL Data Explorer
Sea level (mm)
January 1897
December 2017
Annual sea level change calculated as 12 month trend
mm/yr
Annual sea level change calculated as 10 yr trend
mm/yr
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
7600
7400
7200
7000
6800
6600
6400
400
200
0
-200
-400
10
0
-10
-20

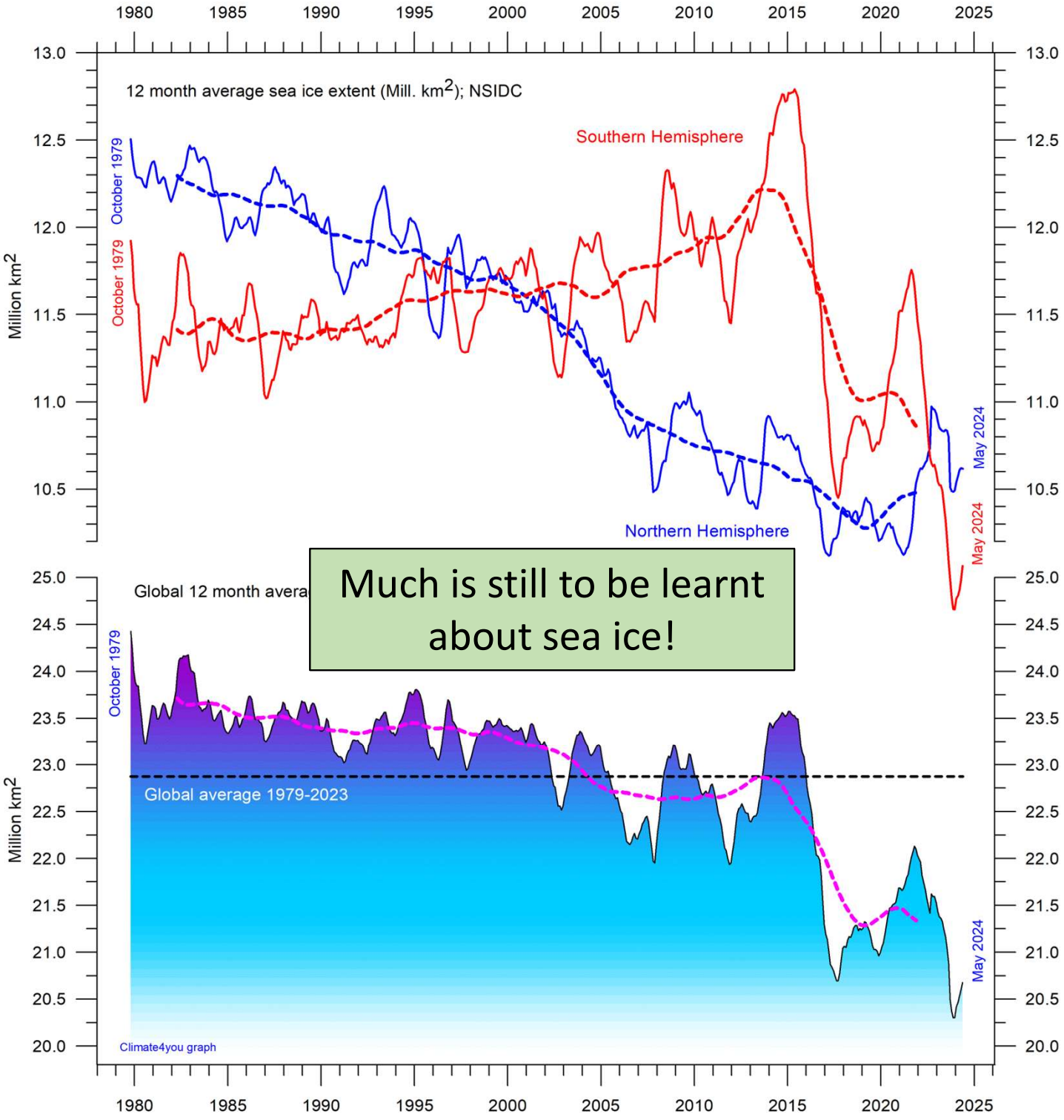

OSLO
Sea level, Oslo, Norway (59.91°N, 10.73°E)
Monthly values and 121-month running average
Linear trend for observed period since 1914: -3.39 mm/yr
February 1914
December 2022
IPCC model data plotted from 2020
Using scenario ssp245
Medium confidence
Observed trend 1914-2022
Measured
Modelled
Sea level (mm)
Annual sea level change calculated as 12 month trend
mm/yr
Annual sea level change calculated as 10 yr trend
mm/yr
1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
7600 7400 7200 7000 6800 6600
600 300 0 -300 -600
10 0 -10 -20

Sea ice




(b) September Arctic sea ice area
10⁶ km²
10
8
6
4
2
0
September 2022
September 2023
Practically ice-free
SSP1-1.9
SSP1-2.6
SSP2-4.5
SSP3-7.0
SSP5-8.5
1950
2000
2015
2050
2100


Arctic Sea Ice Extent (km²)
Jun-2002
Jun-2003
May-2004
May-2005
May-2006
May-2007
May-2008
May-2009
May-2010
May-2011
May-2012
May-2013
May-2014
May-2015
May-2016
May-2017
May-2018
May-2019
May-2020
May-2021
May-2022
May-2023
May-2024
14000000
12000000
10000000
8000000
6000000
4000000
2000000
0
13 June 2024
Arctic Sea Ice Extent IRAC JAXA; daily values and 365 day running average
Climate4you graph


12 month average sea ice extent (Mill. km2); NSIDC
Southern Hemisphere
Northern Hemisphere
October 1979
October 1979
May 2024
May 2024
Million km2
Much is still to be learnt about sea ice!
Global 12 month avera
October 1979
Global average 1979-2023
May 2024
Million km2
Climate4you graph
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
13.0
12.5
12.0
11.5
11.0
10.5
25.0
24.5
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0

Snow

ENVIRONMENT

Climate crisis: Mourning disappearing snow and winters

People living in snowy regions that are being transformed by global heating are experiencing ecological grief and anxiety. But could these feelings spur climate action?

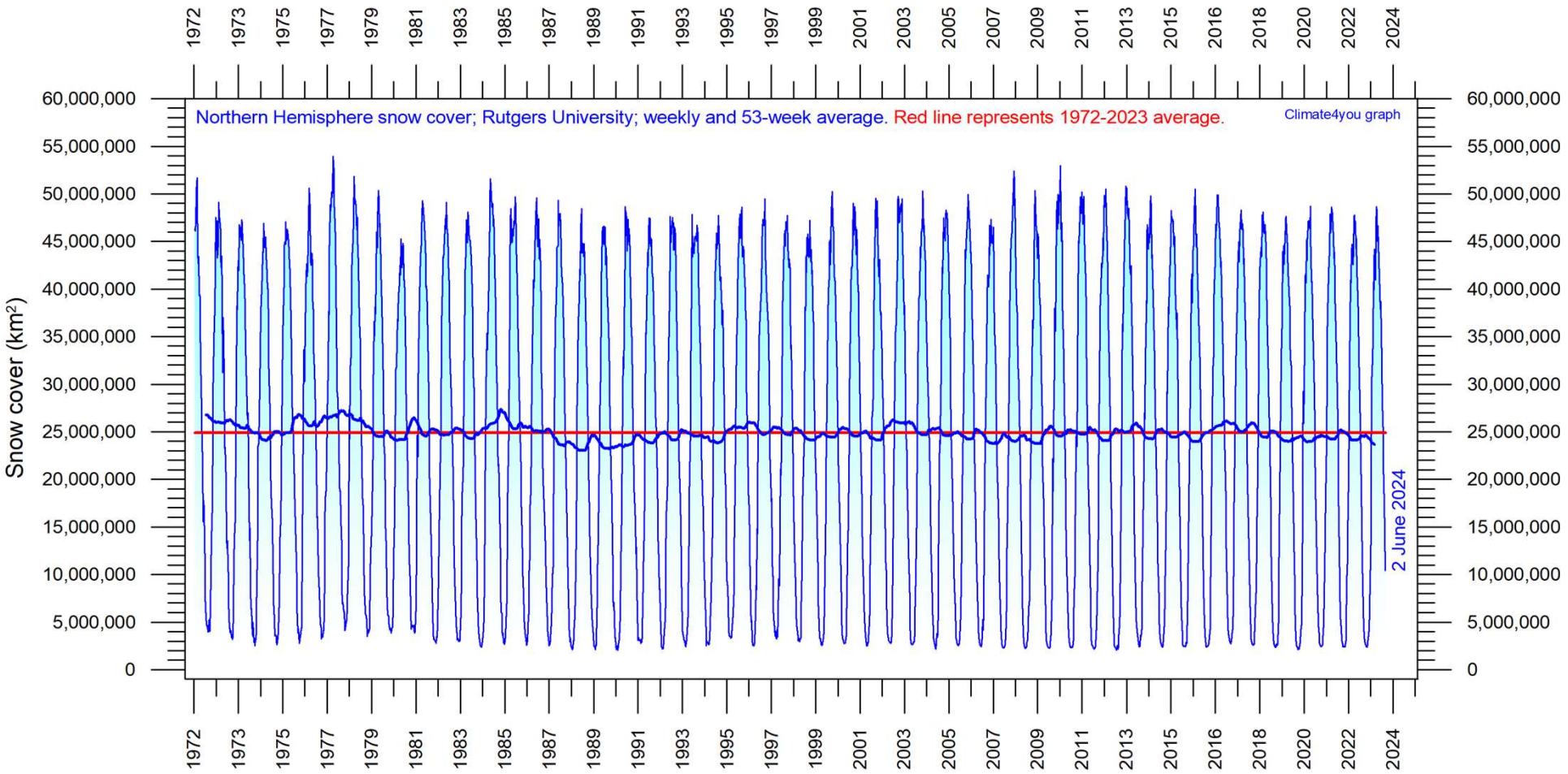
As the temperature rises, snowscapes and glaciers are vanishing

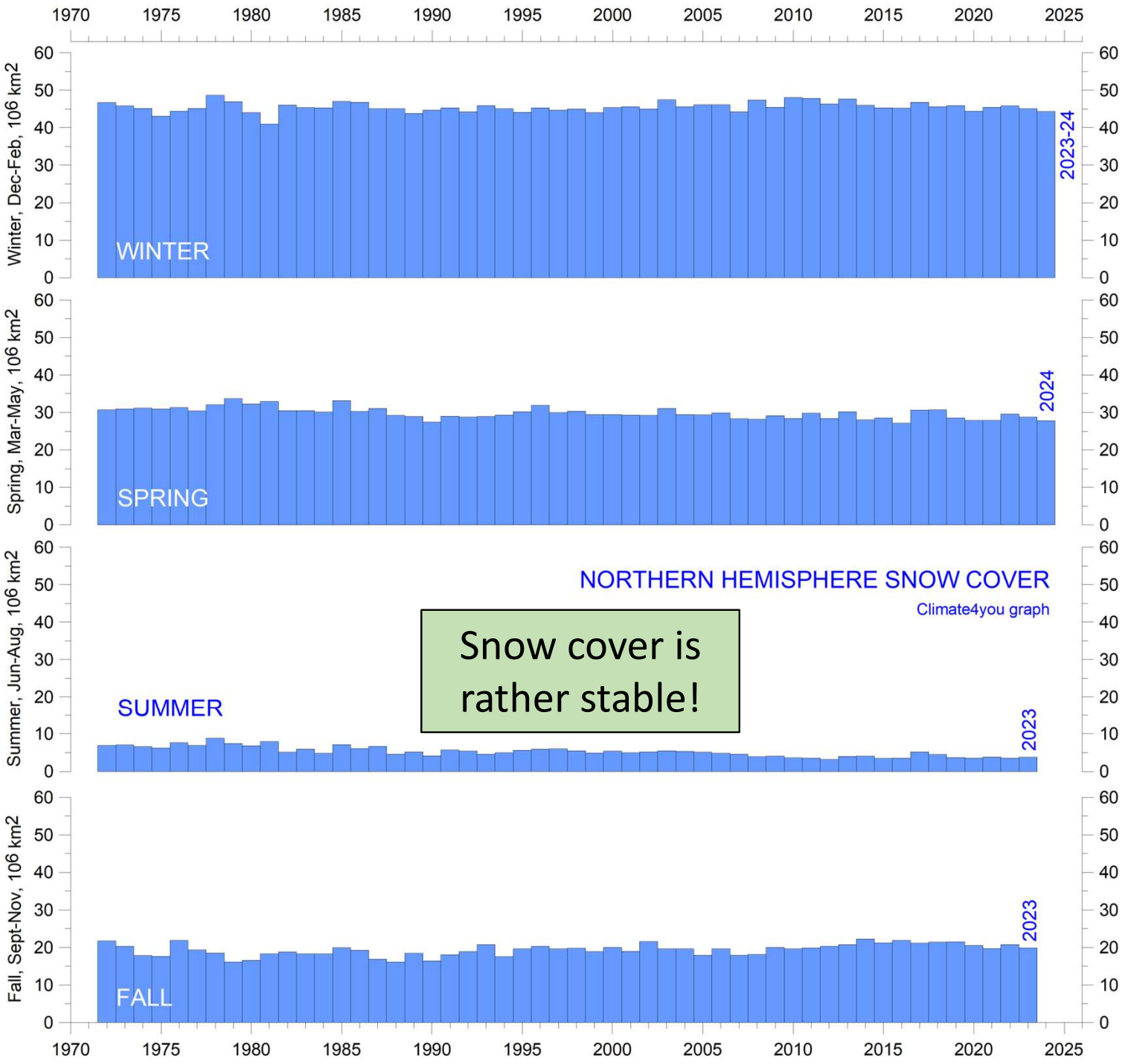
THE INDEPENDENT | ENVIRONMENT

Snowfalls are now just a thing of the past

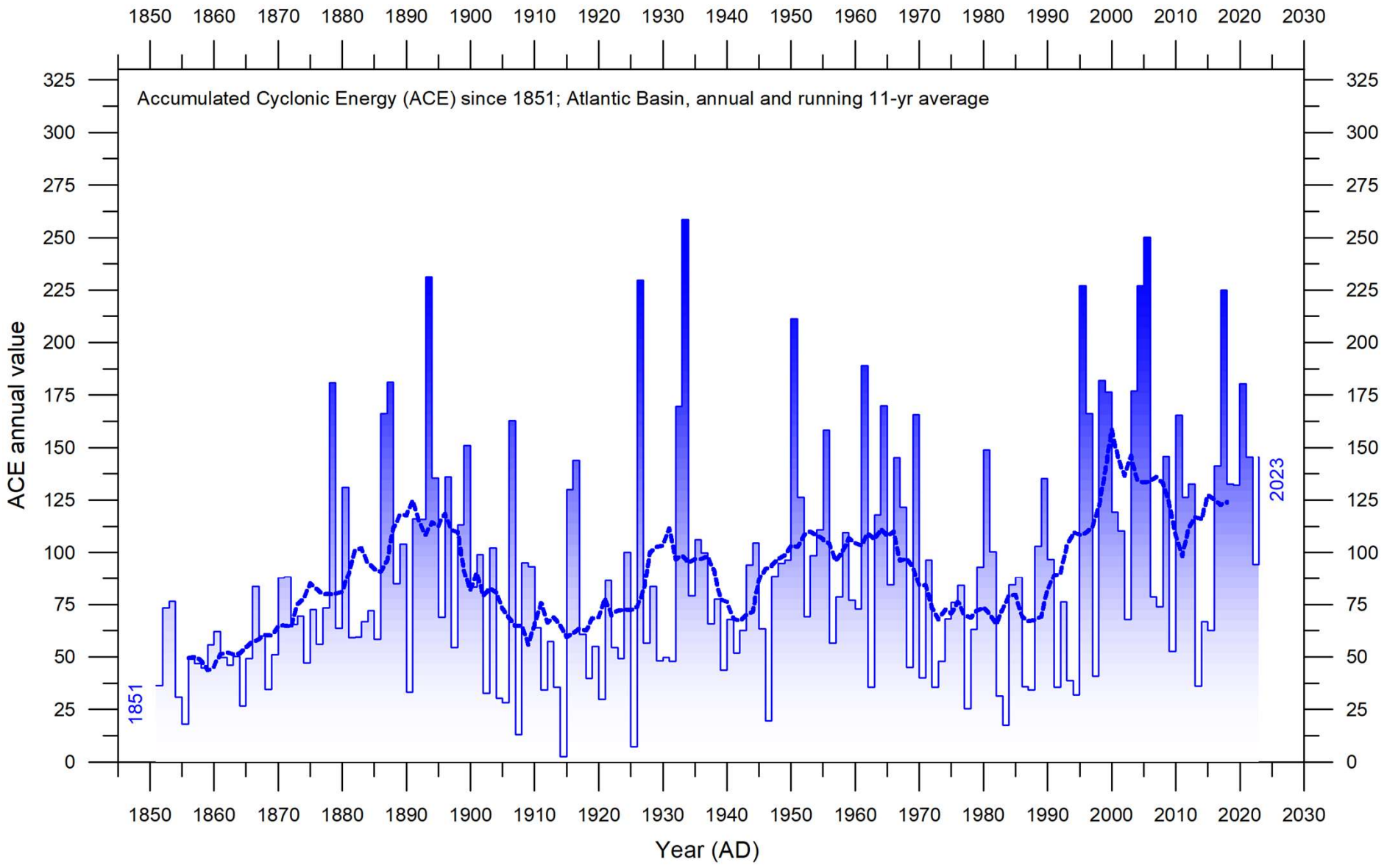
By Charles Onians

Monday, 20 March 2000

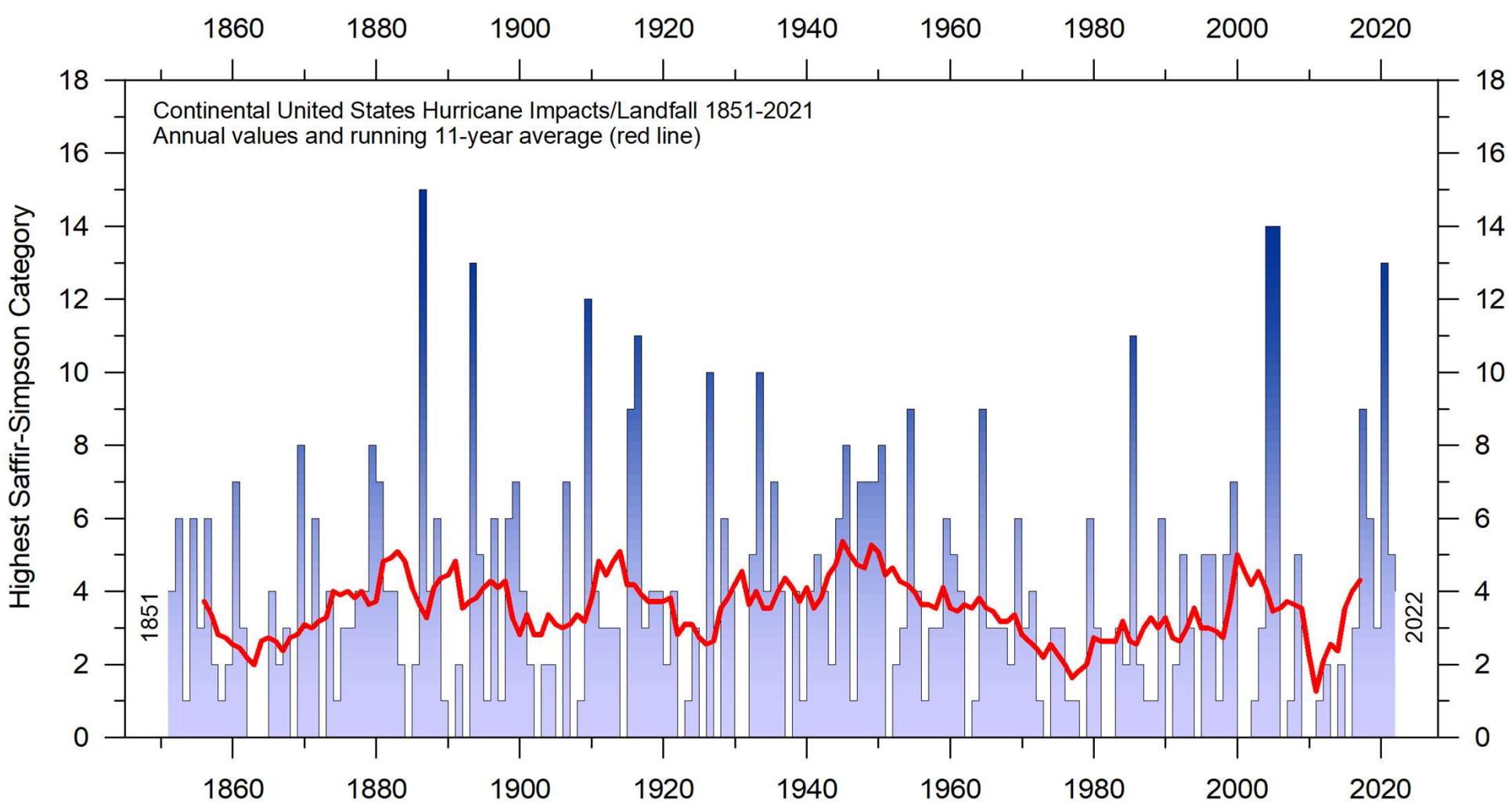

Northern Hemisphere snow cover; Rutgers University; weekly and 53-week average. Red line represents 1972-2023 average.
Climate4you graph
Snow cover (km²)
60,000,000
55,000,000
50,000,000
45,000,000
40,000,000
35,000,000
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
1972
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2016
2018
2020
2022
2024
2 June 2024


1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Winter, Dec-Feb, 10⁶ km2
WINTER
2023-24
Spring, Mar-May, 10⁶ km2
SPRING
2024
Summer, Jun-Aug, 10⁶ km2
SUMMER
2023
Fall, Sept-Nov, 10⁶ km2
FALL
2023
NORTHERN HEMISPHERE SNOW COVER
Climate4you graph
Snow cover is rather stable!

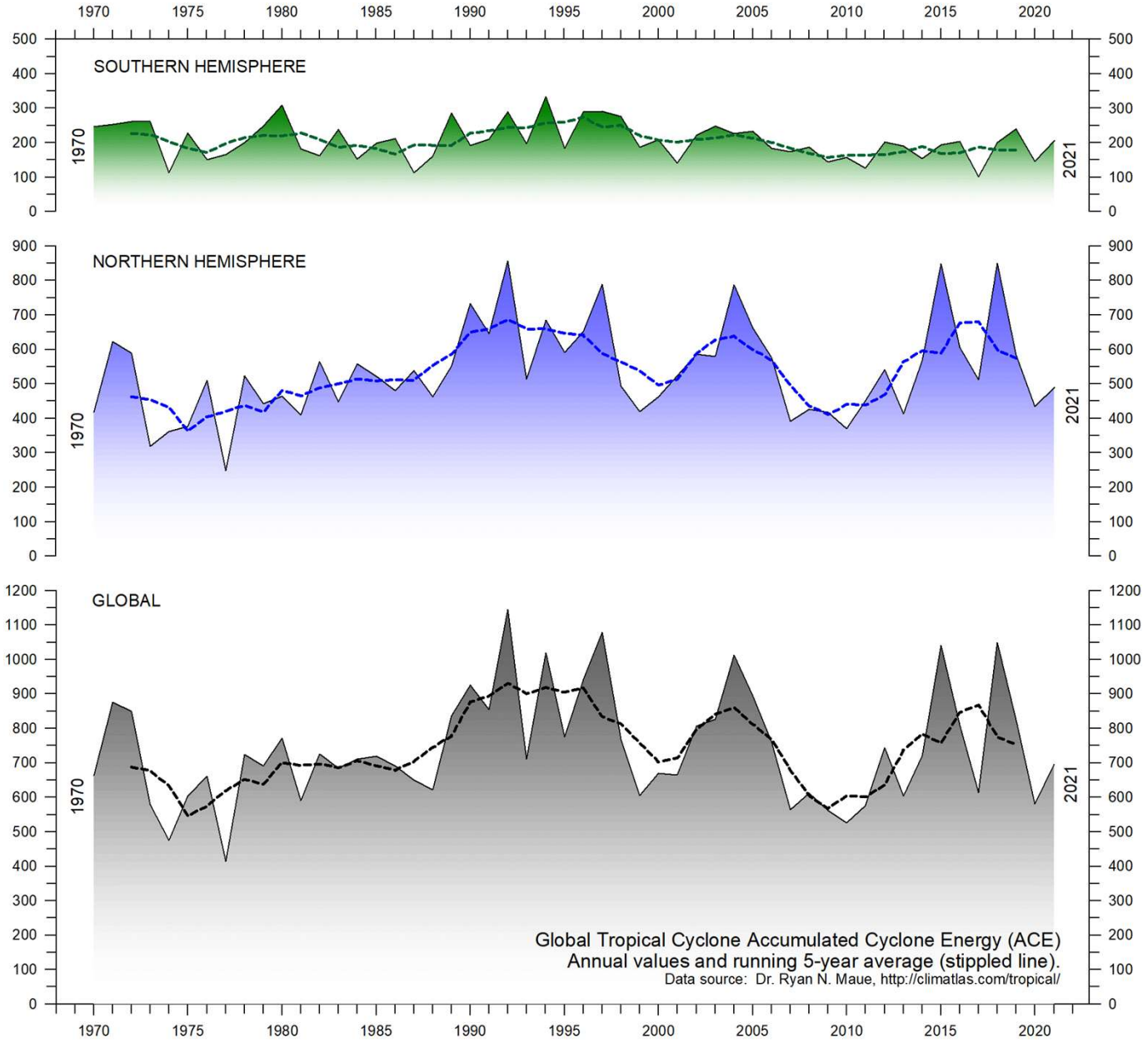
Wind and storms



A Fourier analysis shows the data to be influenced by an important periodic variation of 61.5 years' duration, and feasibly also by a 5.6-year period. The Atlantic Basin hurricane season often shows above-average activity when La Niña conditions are present in Pacific during late summer (August–October).

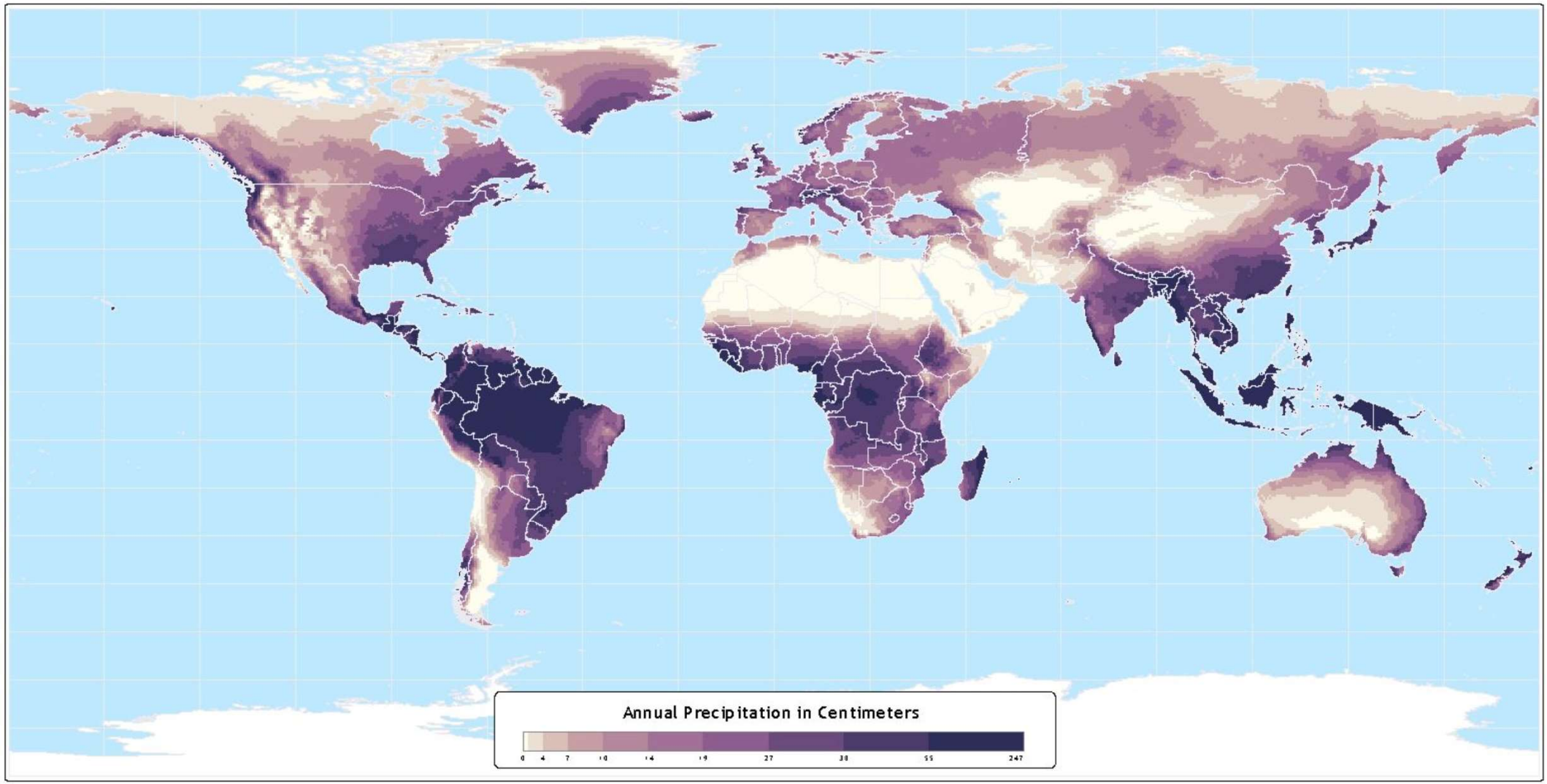


The series shows considerable variations from year to year, but it is not possible to detect any clear trend over time. A Fourier analysis reveals a statistically significant period of about 3.2 years.

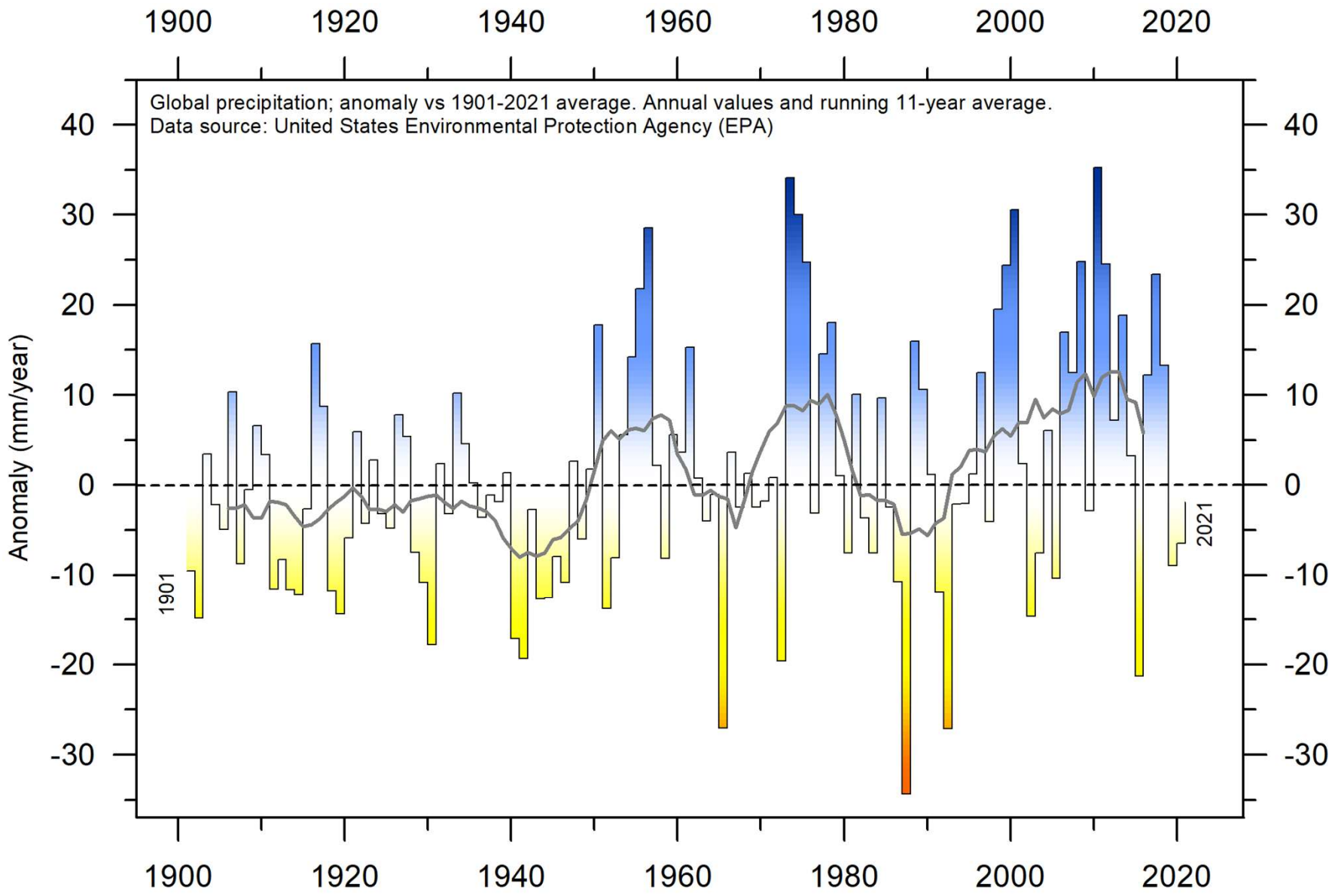


The Northern Hemisphere's main cyclone season is June–November. The Southern Hemisphere main cyclone season is December–April. The global ACE data since 1970 display a variable pattern over time, but without any clear trend. A Fourier analysis indicates oscillations of about 11.5- and 3.6-years' duration.

Global precipitation



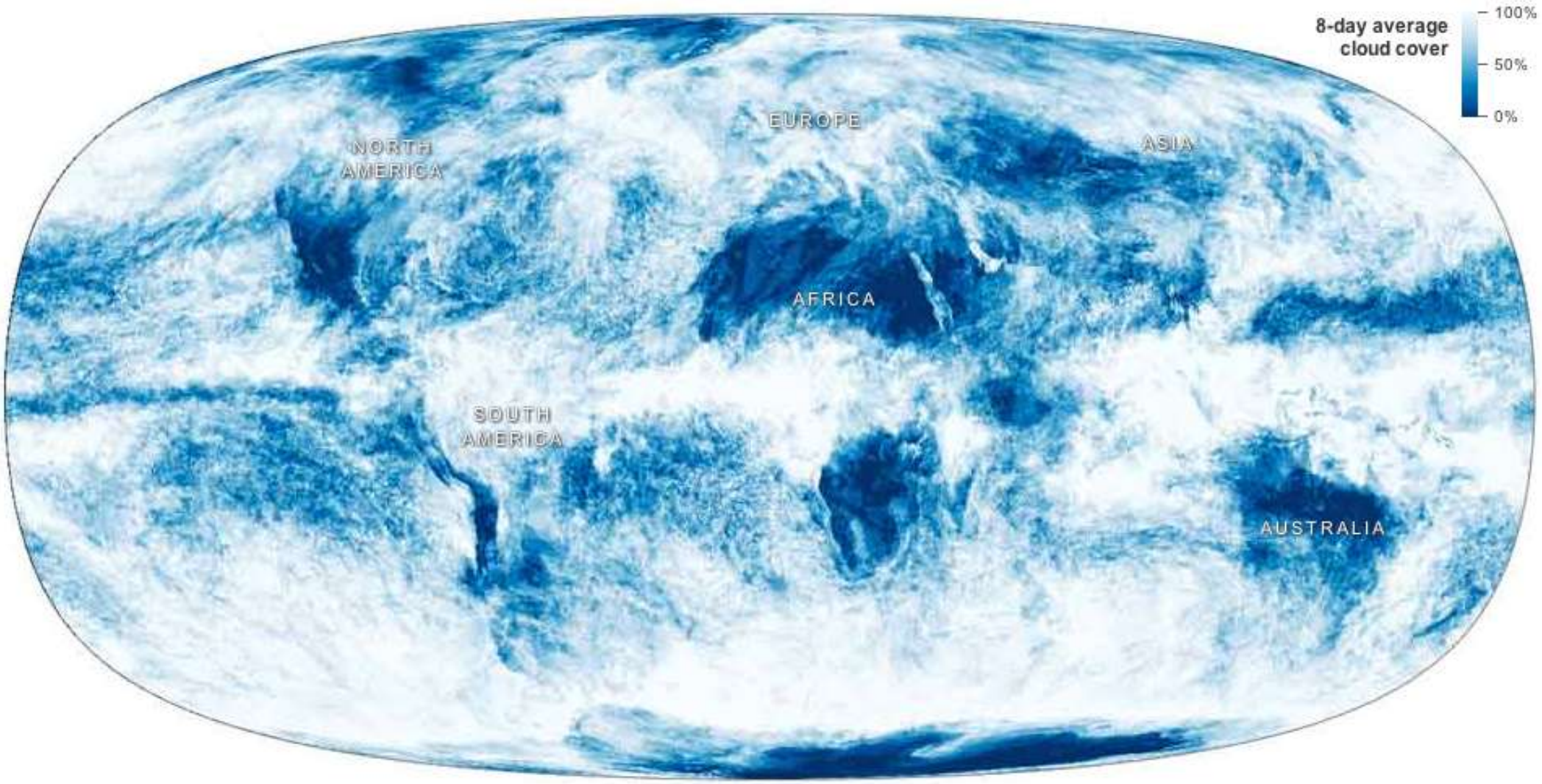
Average annual precipitation over land 1960-1990 (mm w.e.).
Source: NASA/Atlas of the biosphere.



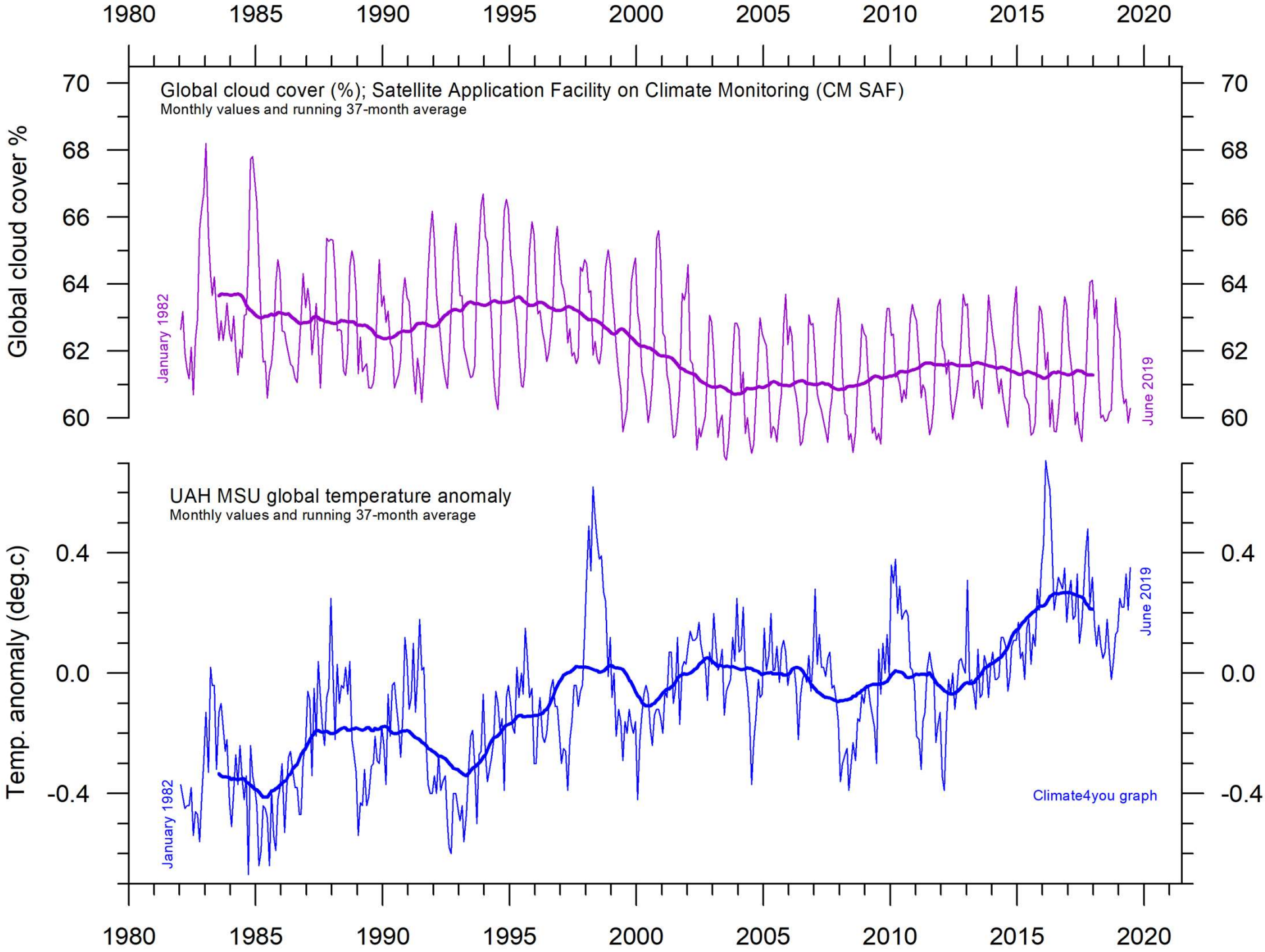
A Fourier frequency analysis shows the global precipitation anomaly to be influenced by a significant 5.6-year cycle, and feasibly also by a 3.6-year cycle.

Cloud cover

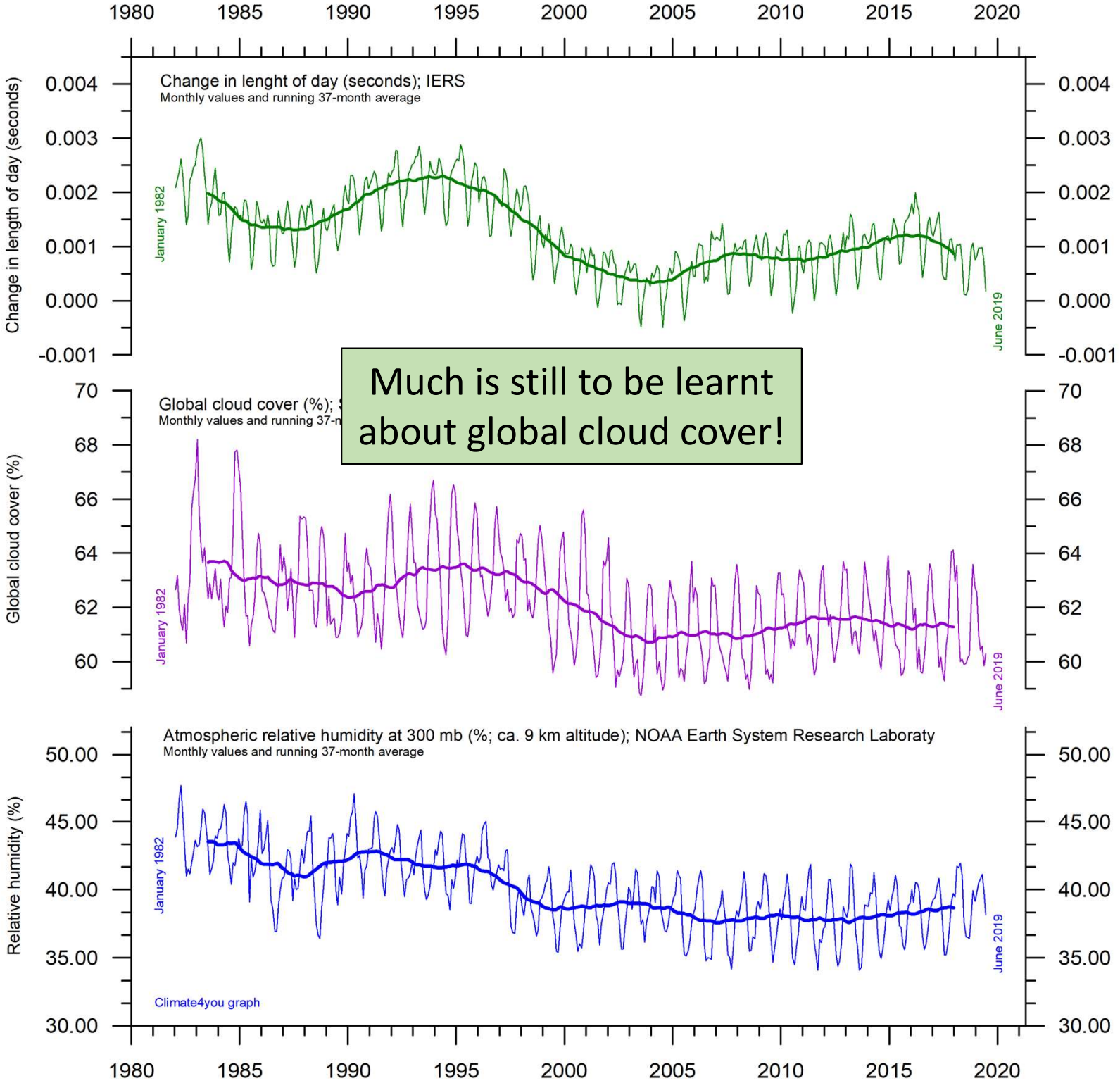
- and a few reflections



If all clouds suddenly were removed, then planet Earth would gain about 17 W/m^2 in net radiation and warm.


Global cloud cover (%); Satellite Application Facility on Climate Monitoring (CM SAF)
Monthly values and running 37-month average
Global cloud cover %
January 1982
June 2019
UAH MSU global temperature anomaly
Monthly values and running 37-month average
Temp. anomaly (deg.c)
January 1982
June 2019
Climate4you graph
1980
1985
1990
1995
2000
2005
2010
2015
2020
70
68
66
64
62
60
0.4
0.0
-0.4

Looking south at noon over the Frahm Strait between Spitsbergen and NE Greenland, 18 February 2015. Winds are from NW.


Change in lenght of day (seconds); IERS
Monthly values and running 37-month average
Change in length of day (seconds)
January 1982
June 2019
Much is still to be learnt about global cloud cover!
Global cloud cover (%)
Atmospheric relative humidity at 300 mb (%; ca. 9 km altitude); NOAA Earth System Research Laboraty
Relative humidity (%)
Climate4you graph
1980
1985
1990
1995
2000
2005
2010
2015
2020

Principal question:
Are we currently in a climate crisis ?

1. **Atmospheric temperatures:** Ongoing corrections in data. Possible global increase of up to 1.5^{o}C by 2100, and likely less. Antarctic temperatures remain stable.

2. **Ocean temperatures:** Much still to be learnt. Oceans are definitely not “boiling”.

3. **Sea Level:** 15-20 cm further global rise by 2100?

4. **Sea Ice:** Much still to be learnt. Arctic sea ice is not disappearing.

5. **Snow:** Snow cover is quasi-stable, and snow is not disappearing.

6. **Wind and Storms:** Recurrent (periodic?) variations. No trend in hurricanes.

7. **Precipitation:** Recurrent (periodic?) variations superimposed on upward trend since 1900.

8. **Cloud Cover:** Cloud cover declines since about 1980. This development is probably contributing to observed atmospheric and ocean warming.

Why did I not speak anything about CO_2?

This is because CO_2, although being very important for life, in my opinion, is not overly important to understand meteorology and climate.

Often nature provides us with simple answers to big questions

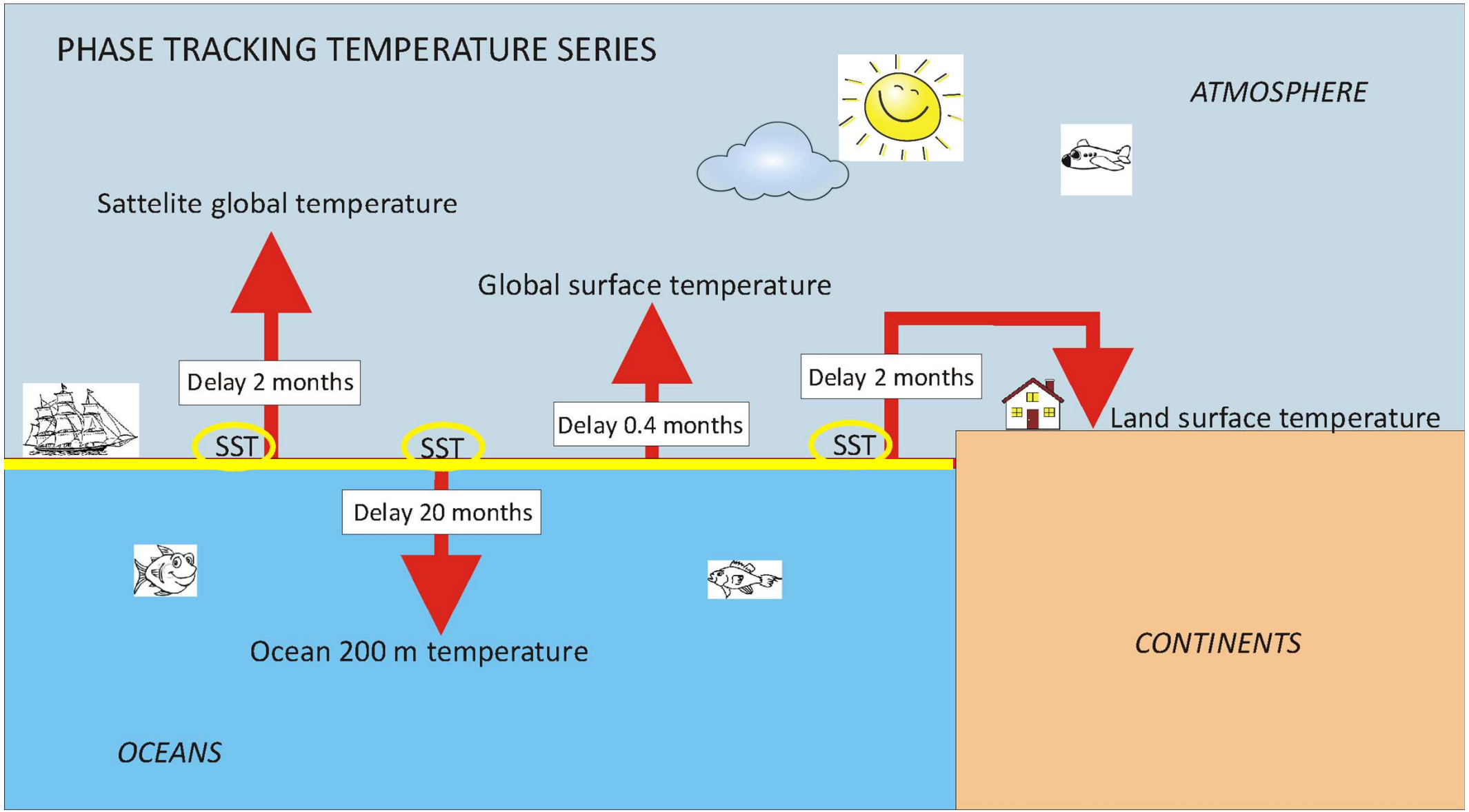
…continued from my last lecture December 2022…

One example:

In a simple way, observed data shows us what really matters for air temperature

The theoretical CO_2 signal originates in the upper troposphere

What controls ocean surface temperature ?



The global temperature signal originates at the ocean surface !


What controls the ocean surface temperature,
controls the global climate

Two overall conclusions and one suggestion for what should be the main climate research focus:

1: Observed data do not support the notion of a climate crisis, but reveils many and partly recurrent natural variations

2: Ocean surface temperature controls the atmospheric temperature

PROBABLY THE MOST IMPORTANT CLIMATE RESEARCH QUESTION:

What controls the ocean surface temperature?

Thank you very much for your attention !