How does global warming influence on temperature?

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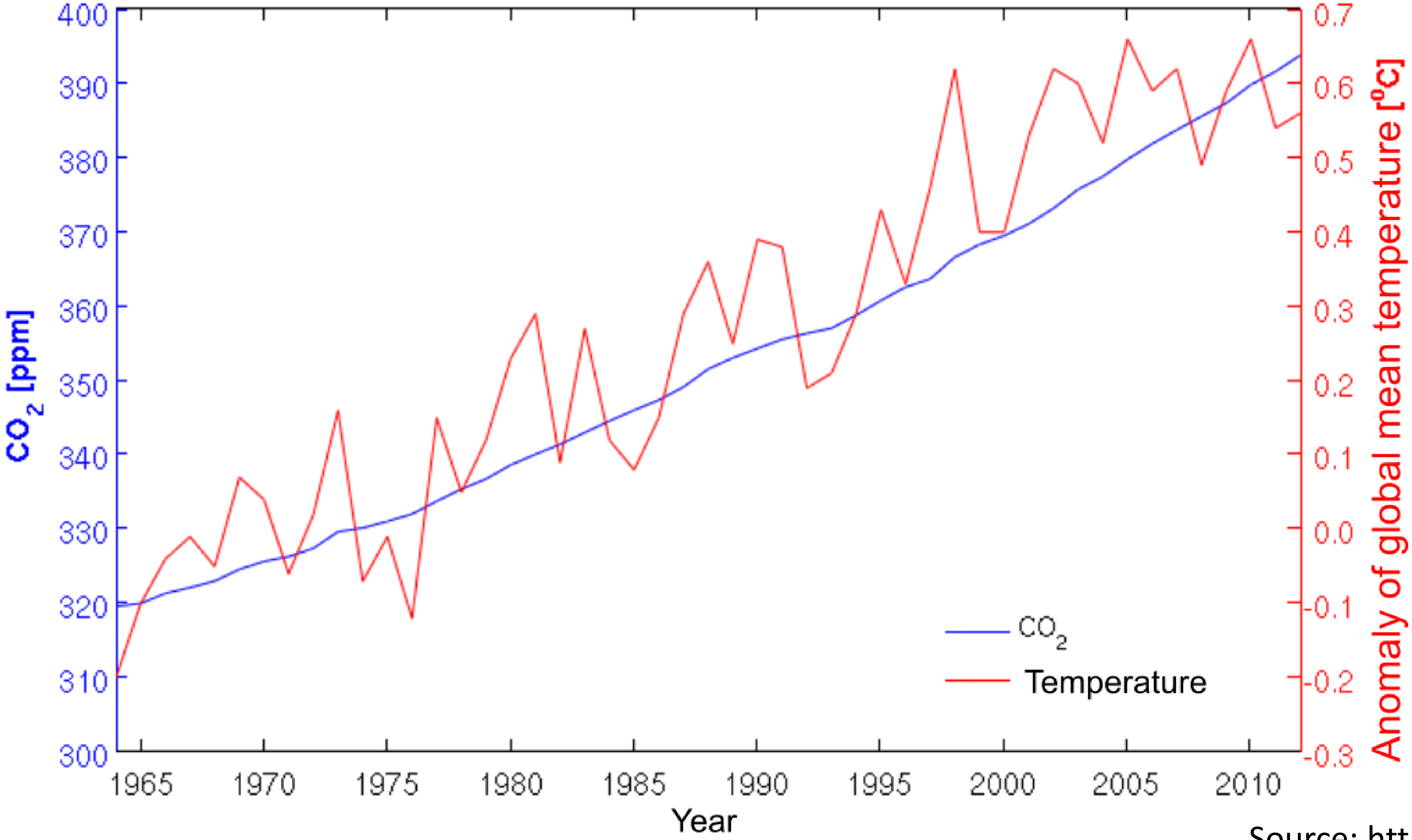
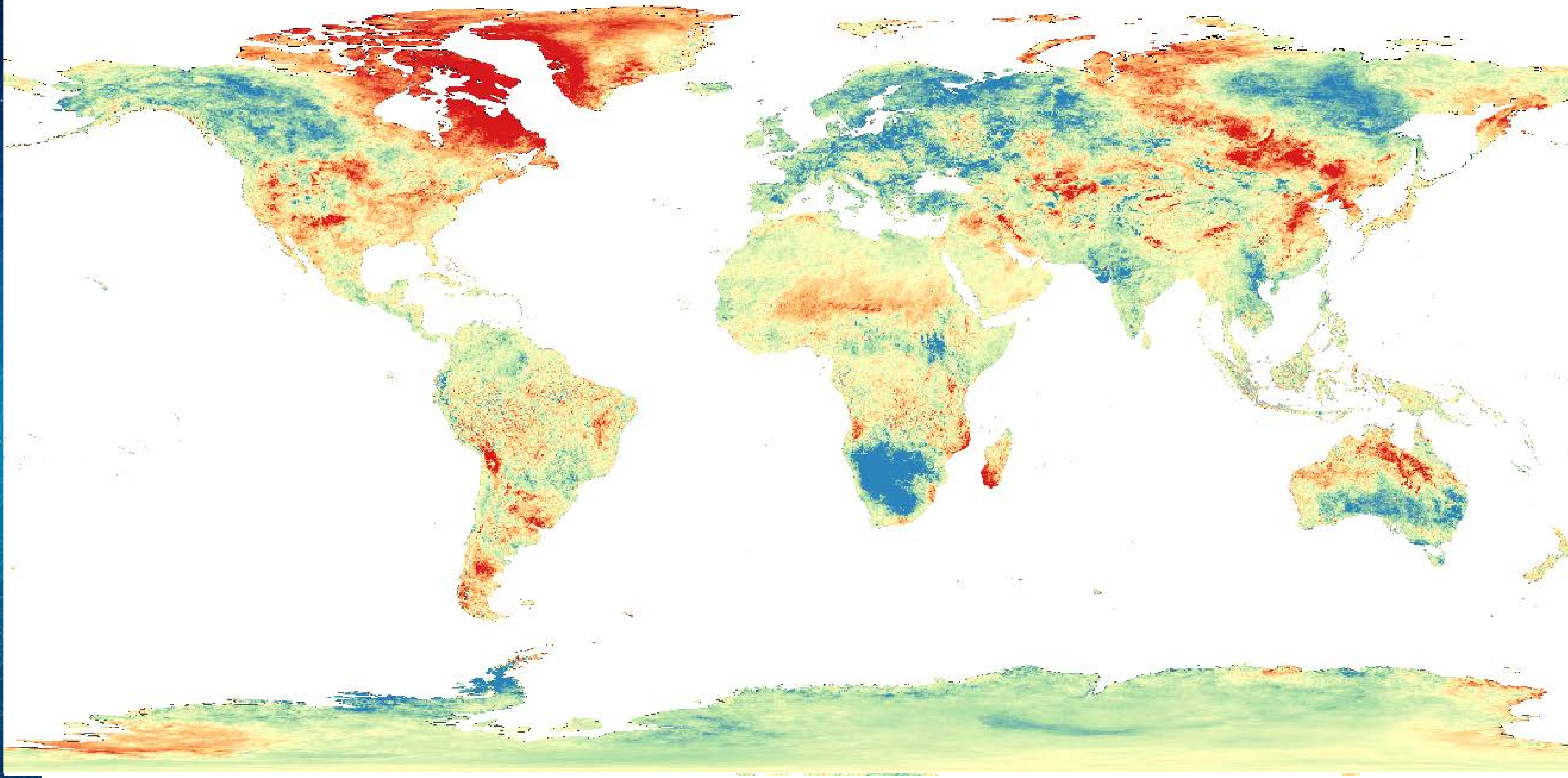
Meeting title, date of meeting, venue of meeting

Do you believe that the temperature raise is connected CO_2 emissions?



Source: https://naukaoklimacie.pl/

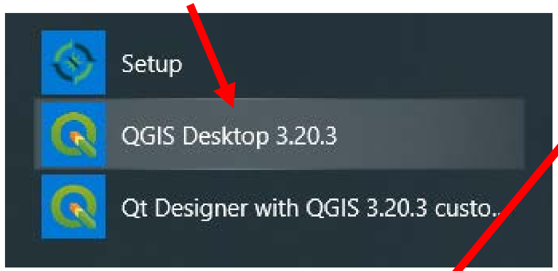


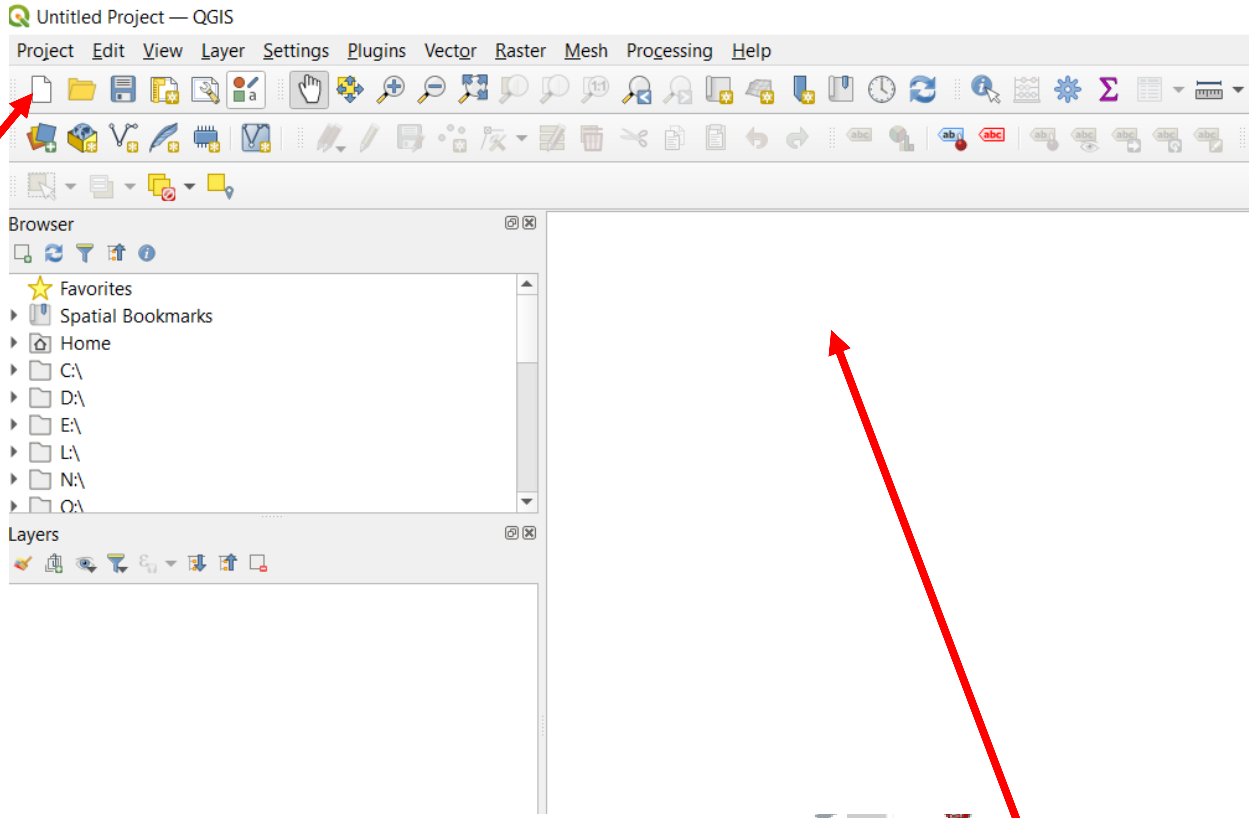
Difference between mean monthly temperature in January 2021 and 2001

What’s the difference between mean monthly temperature in July 2021 and 2001

Opening software and data

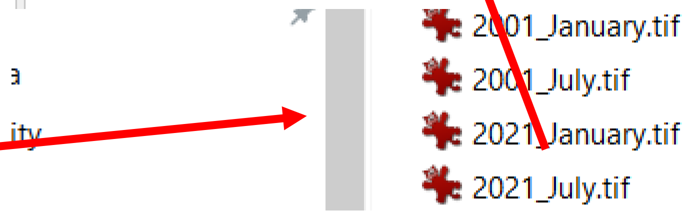
1. Open QGIS

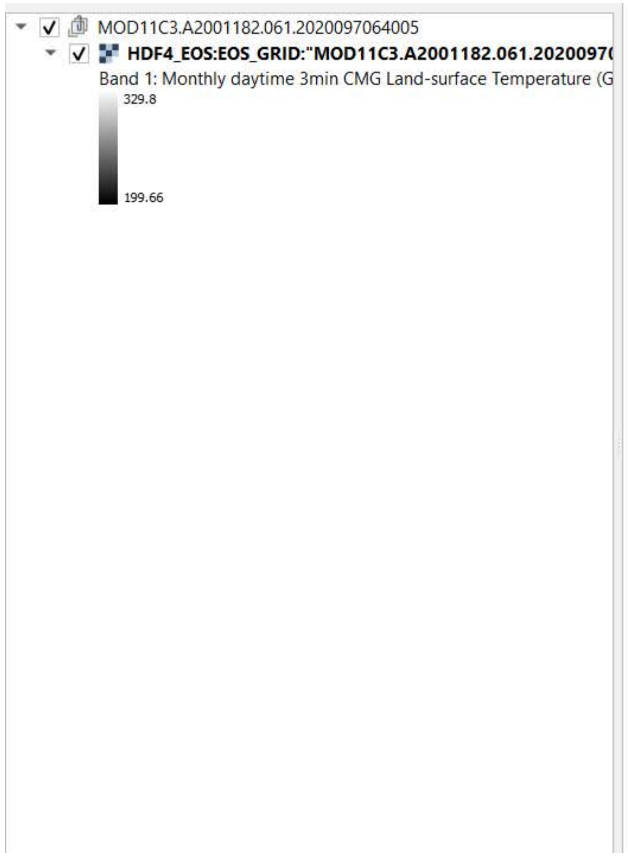


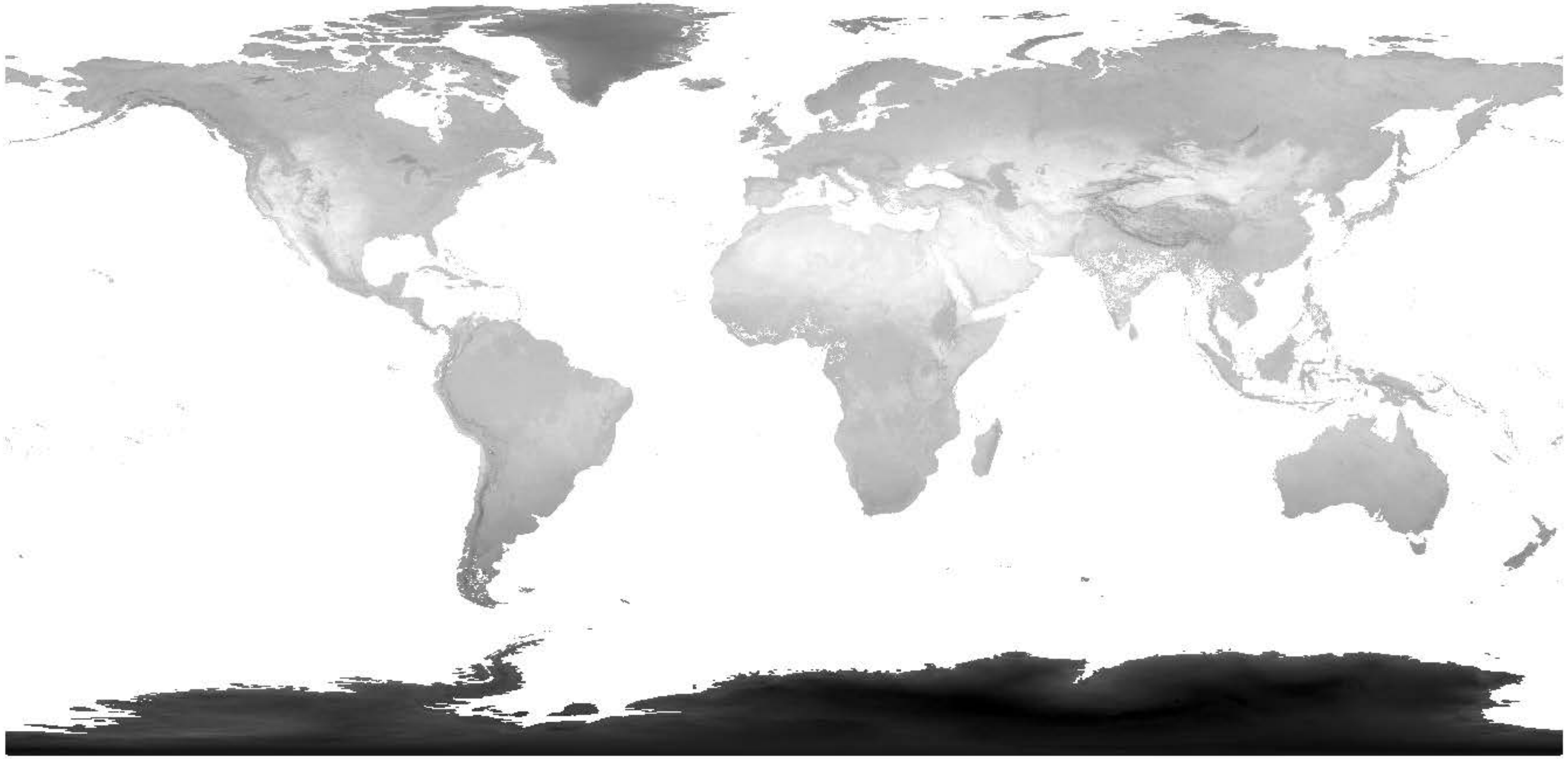


2. Create New Project

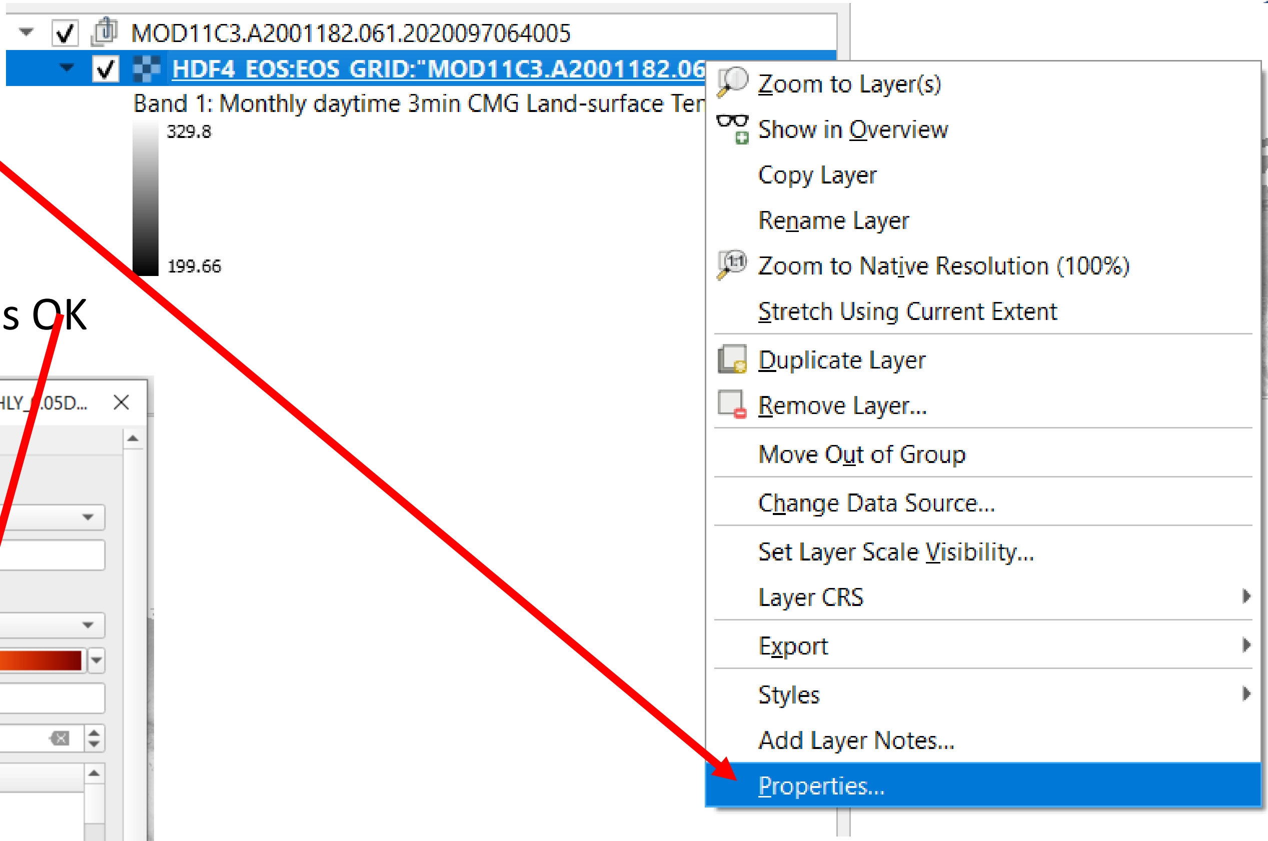
3. Drag an image of Global mean monthly land Surface temperature in 2001 „*2021_July.tif*”



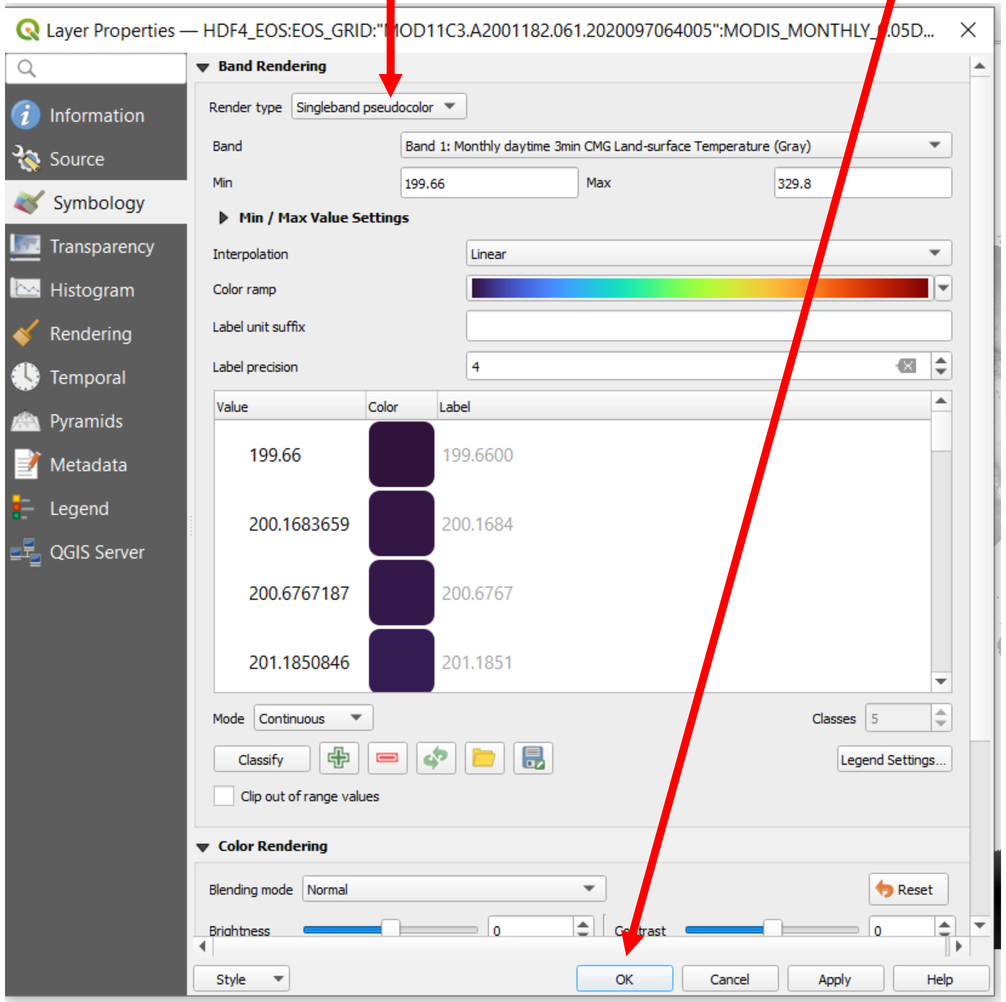

MOD11C3.A2001182.061.2020097064005
HDF4_EOS:EOS_GRID:"MOD11C3.A2001182.061.202009
Band 1: Monthly daytime 3min CMG Land-surface Temperature (G
329.8
199.66

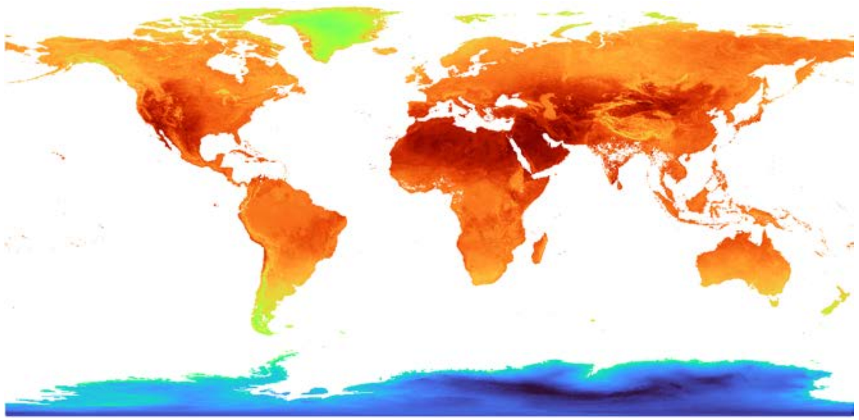


4. Pres right bottom of the mouse on the image and select Properties from the list



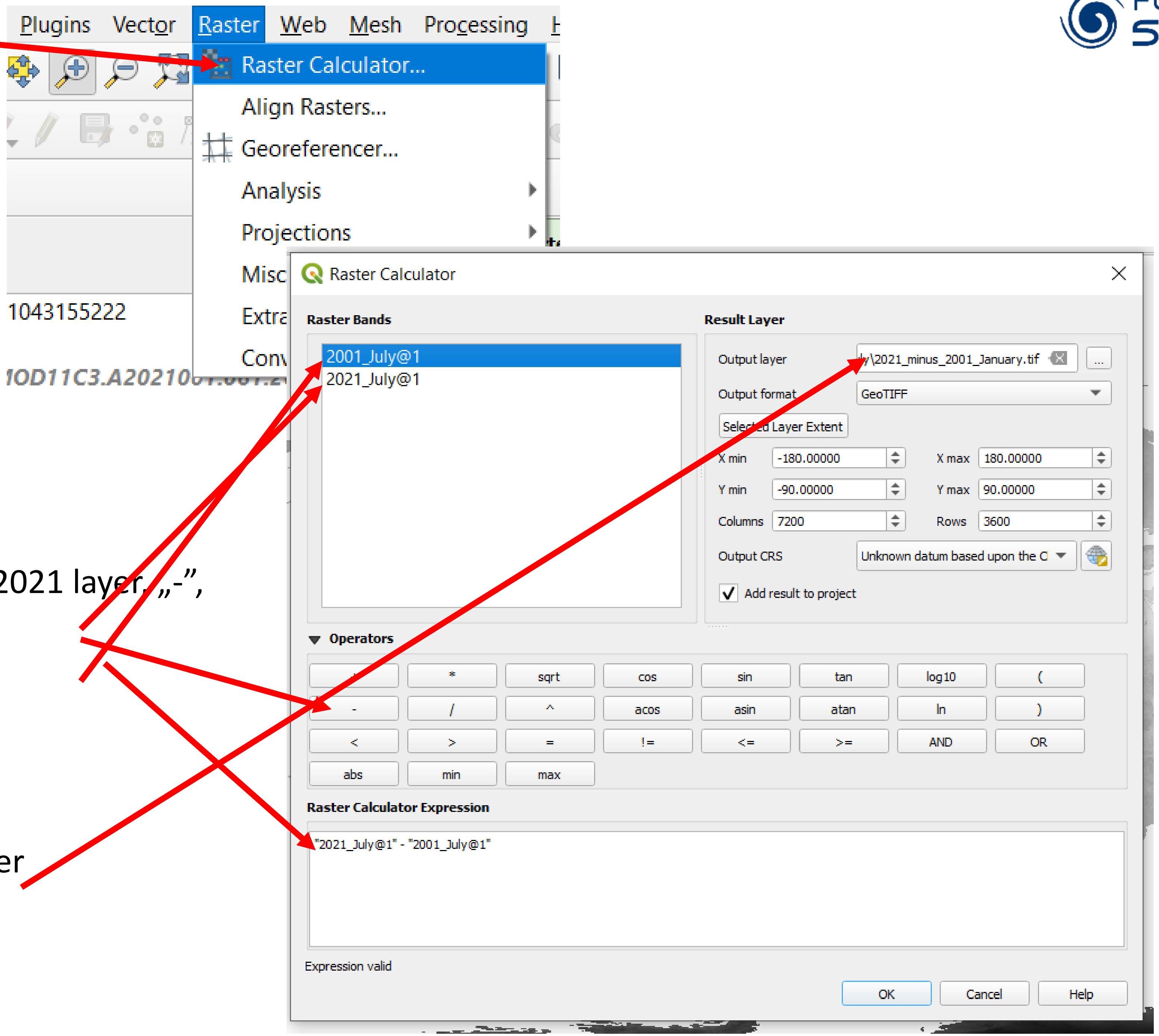
5. Select Singleband pseudocolor and press OK





6. Repeat the procedure for the image from 2021

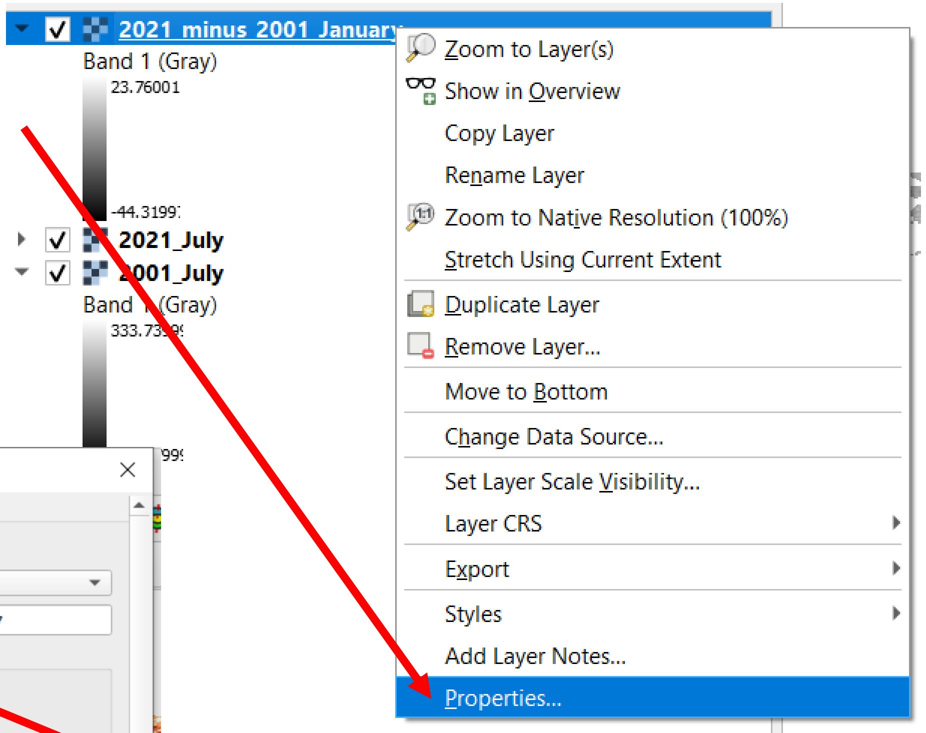
6. Open Raster Calculator

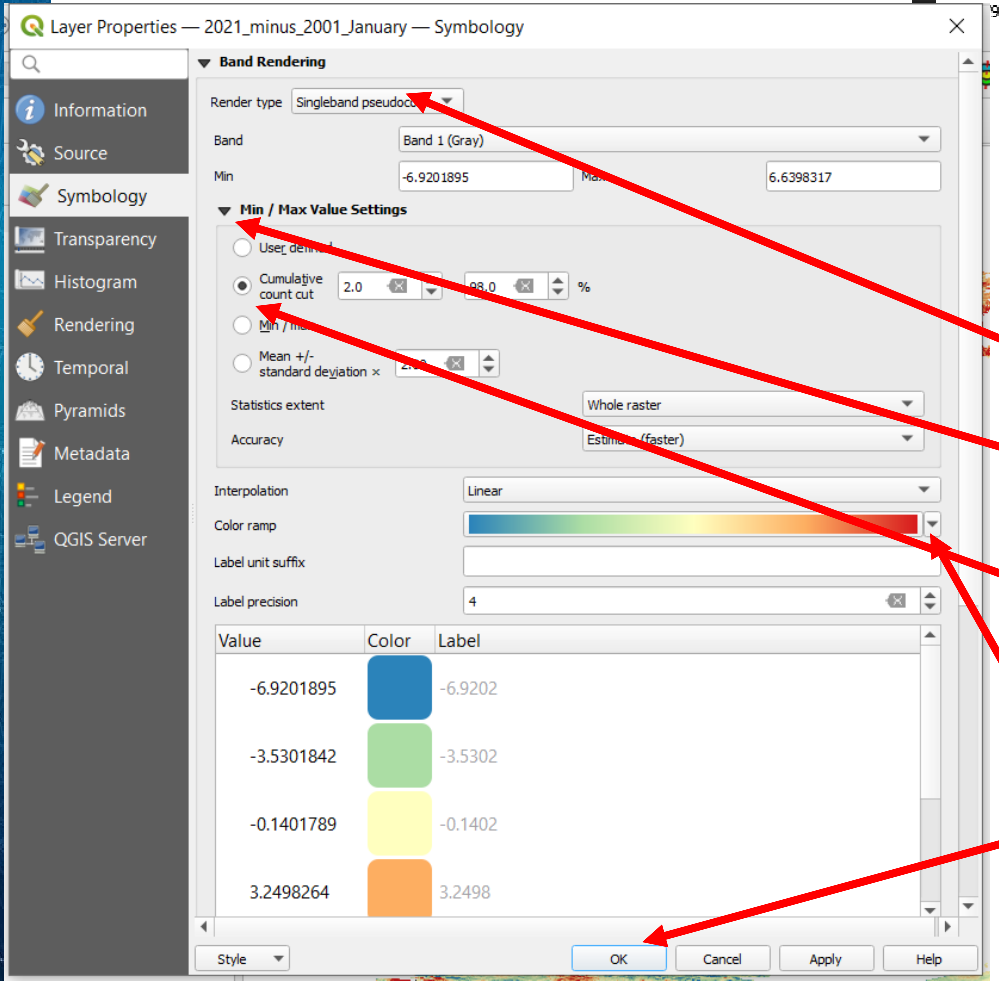


7. Insert equation (doble clic on 2021 layer, „-", doble click on 2001 layer)

8. Insert name of the output layer

4. Pres right bottom of the mouse on the difference and select Properties from the list





5. Select Singleband pseudocolor

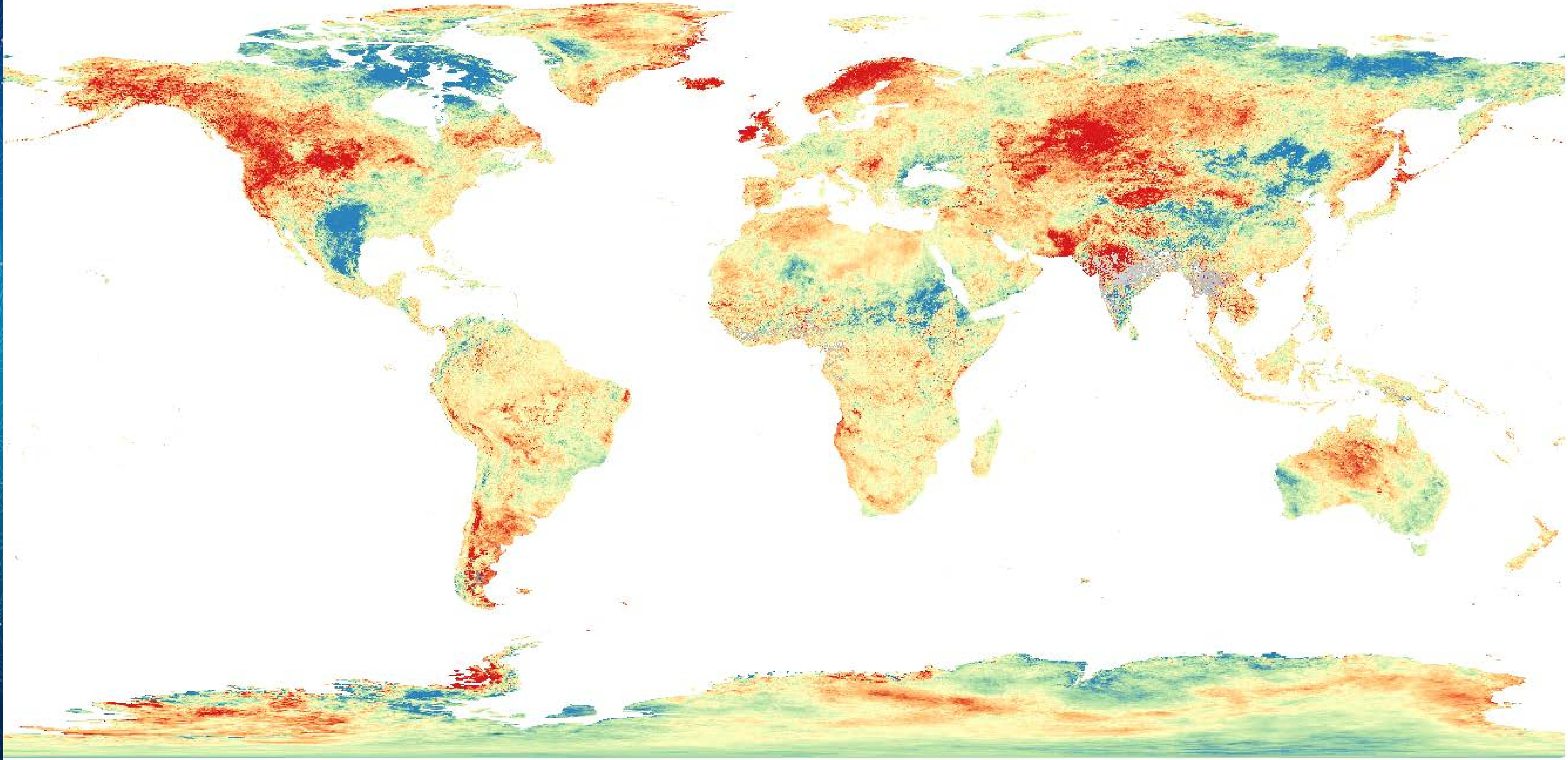
6. Expand by pressing the arrow

7. Select cumulative cutout option

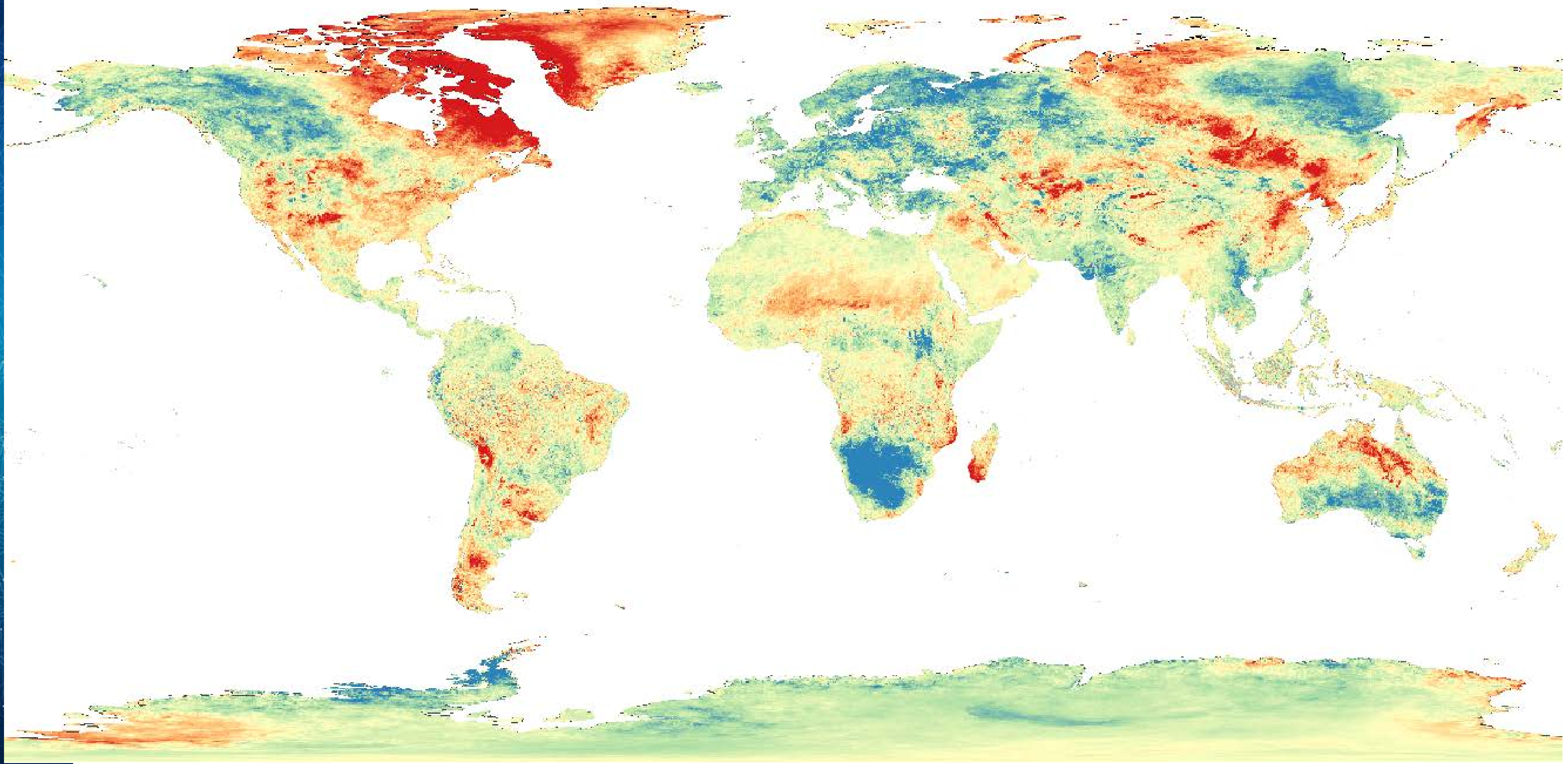
8. Expand and select invert color map option

9. Press OK

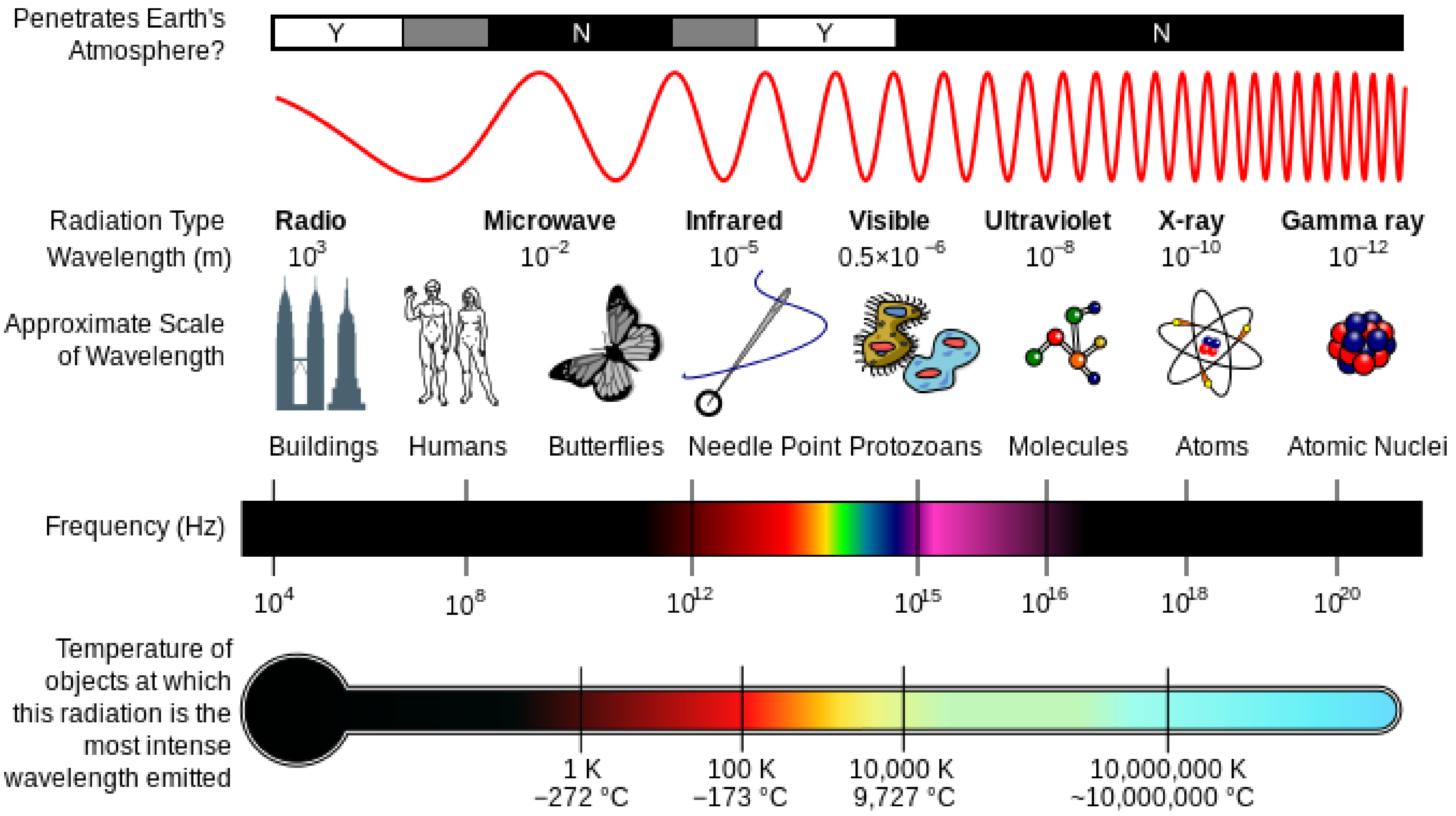
Difference between mean monthly temperature in July 2021 and 2001



Difference between mean monthly temperature in January 2021 and 2001



Remote sensing uses properties of electromagnetic spectrum for objects observation



How can we monitor land surface temperature using satellite images?

The theory of remote sensing is based on three physical laws:

- Planck law
- Wien displacement law
- Stefan-Boltzmann law

Planck's law

Planck's law defines the dependence of the radiation energy (E (λ)) on the kinetic temperature of the body (T) and the wavelength (λ). In general, it concerns the so-called a black body that completely absorbs and also completely emits radiation.

$$E(\lambda) = c1 / (\lambda^5 e^{c2/(\lambda T)} - 1)$$

Where E is the radiation energy, T is the temperature, λ is the wavelenght, c1 and c2 are the first and the second radiation constant values defined as follows:

$$c1 = 3{,}74 * 10^{-16}\ Wm^2$$

$$c2 = 1{,}44 * 10^{-2}\ Km$$

Wien's law

Wien's law, also known as Wien’s displacement law, states that as the body temperature increases, the maximum radiation shifts towards shorter wavelengths:

$$\lambda_{MAX} = 2898 / T$$

The Stefan-Boltzmann

The Stefan-Boltzmann law connects the total radiation power emitted by a body at temperature (T) and is the integral (sum) of the radiation power for all wavelengths:

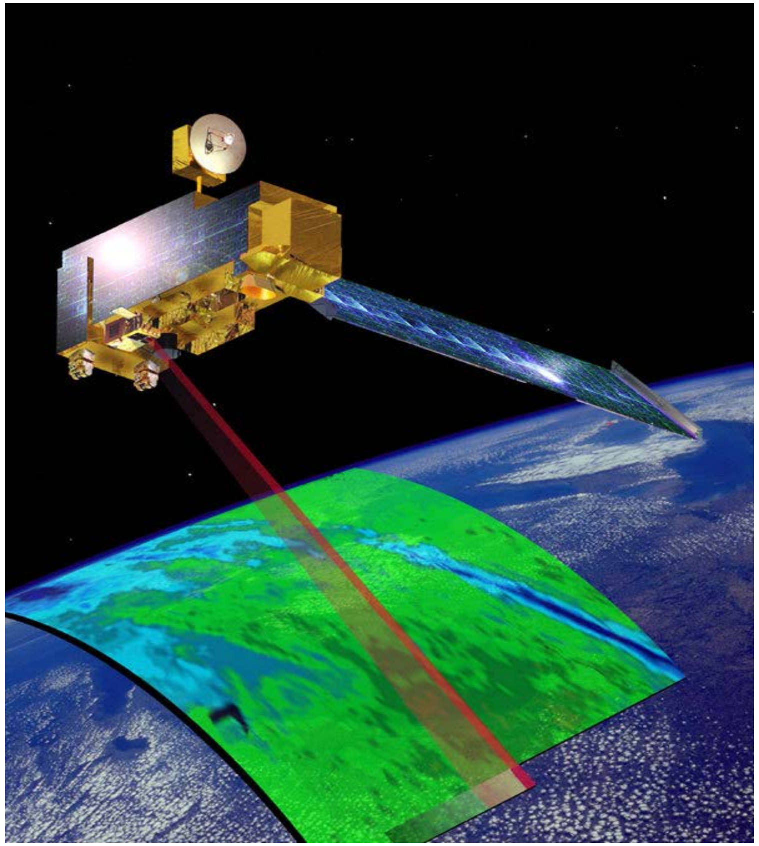
$$E = \varepsilon \sigma T^4$$

where $\sigma = 5{,}67 \cdot 10^{-8}$ W/(m^{2}K^4) is the Stefan-Boltzmann constant, ε is the emissitivy factor which equals 1 for the black body, and less than 1 for the real body.

MODIS

Moderate Resolution Imaging Spectroradiometer

- MODIS satellites are viewing the entire Earth's surface every 1 to 2 days
- acquiring data in 36 spectral bands ranging in wavelength from 0.4 µm to 14.4 µm
- varying spatial resolutions (2 bands at 250 m, 5 bands at 500 m and 29 bands at 1 km)
- operating from 1999 (global products available from spring 2000)



We will use:

- MODIS Land Surface Temperature and Emissivity (MOD11)

Trend analysis of temperature

1. Open .xlxs file in excel for your region

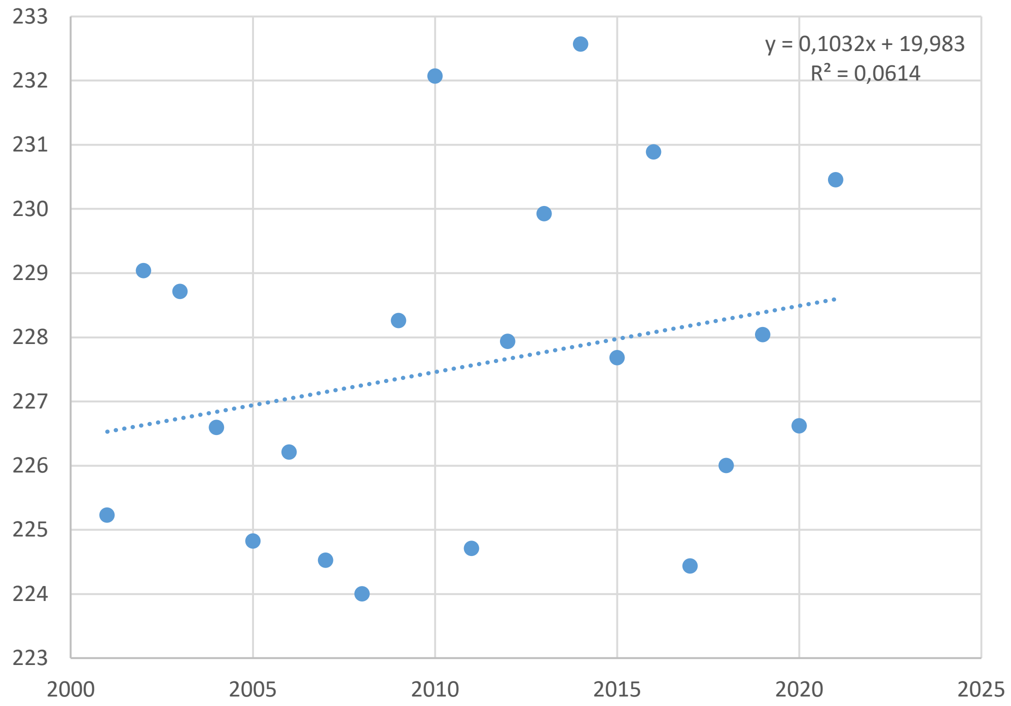
2. Calculate mean value per year separately for January and July

3. Finding anomalies in average annual data for given months:

- calculate the long-term average μ (based on the values calculated at the 2 step) and the standard deviation σ
- delete values > μ+3*σ lub < μ-3*σ (these values are not always present)

3. Create a graph and add trend line

4. Compare your results with other regions

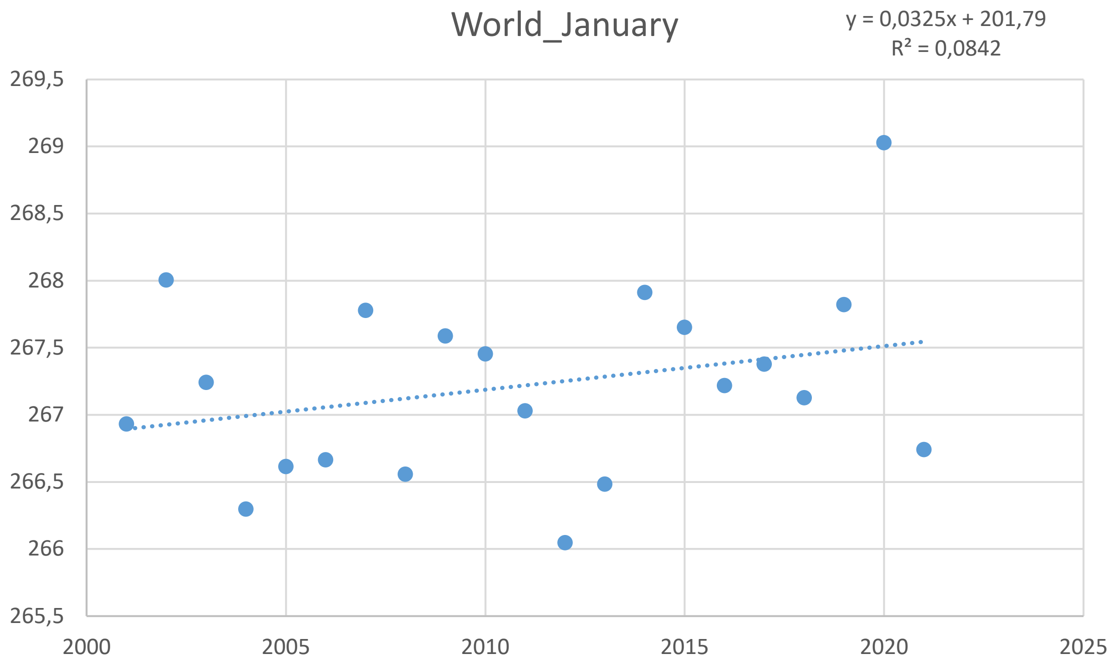


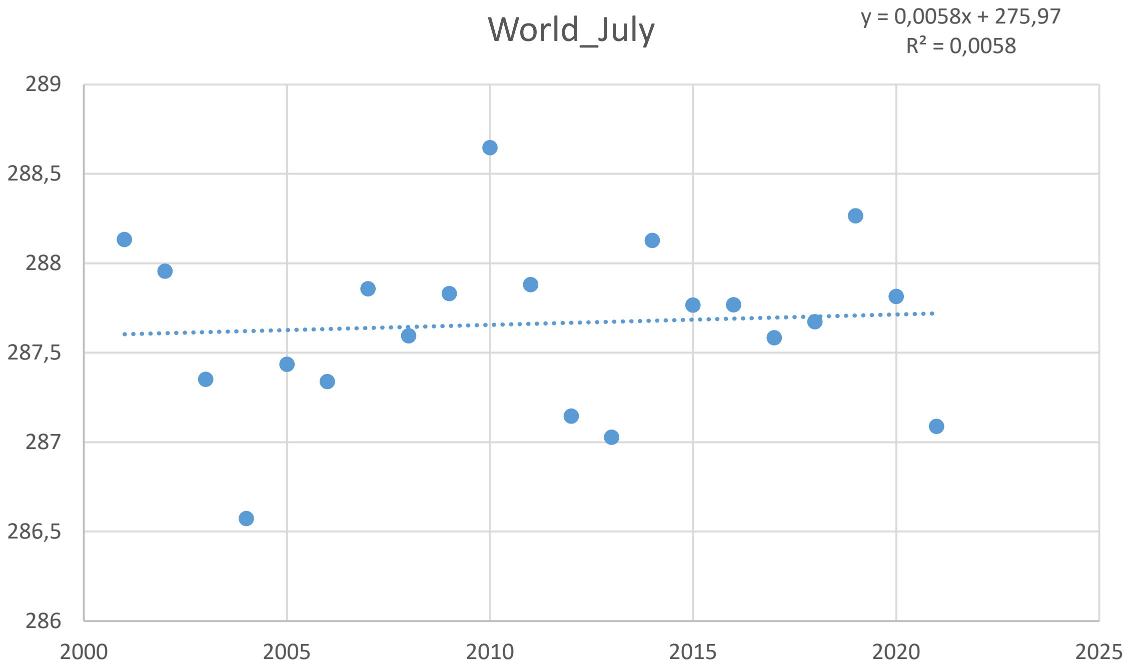
Discussion and conclusions

- Individual groups present their conclusions regarding the changes in temperature in the region in the period 2001 – 2021.
- If there are regional trends of changes? If yes, if they are similar for all regions?
- What factors influence, in they opinion, on changes
- What should be done to ensure that the conclusions are correct?
- etc.

World trends (1)

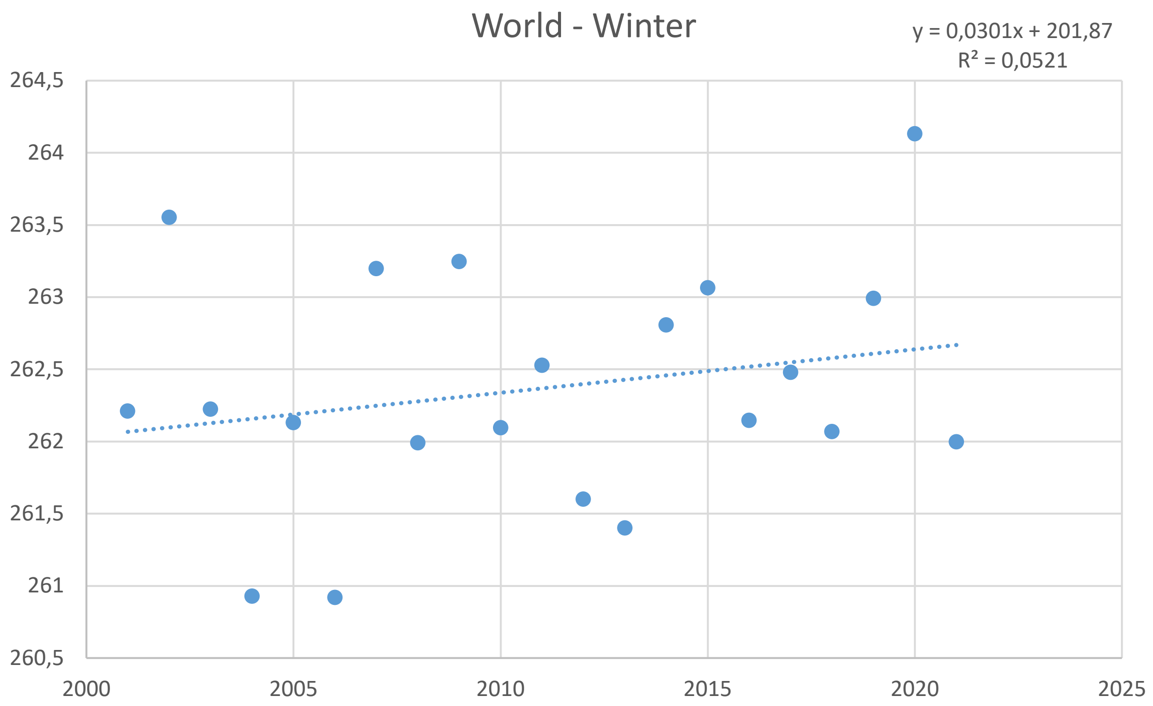
- At global level LST raises in January and in July in the world – both positive trend lines
- The positive trend is more visible in January

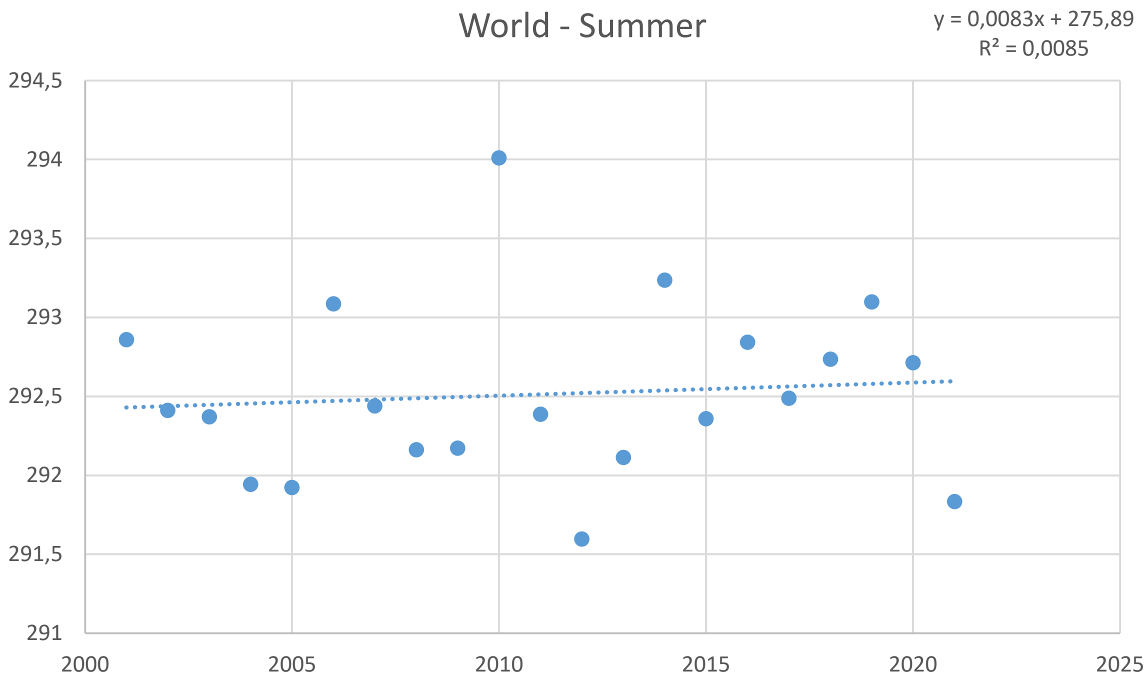




World trends (2)

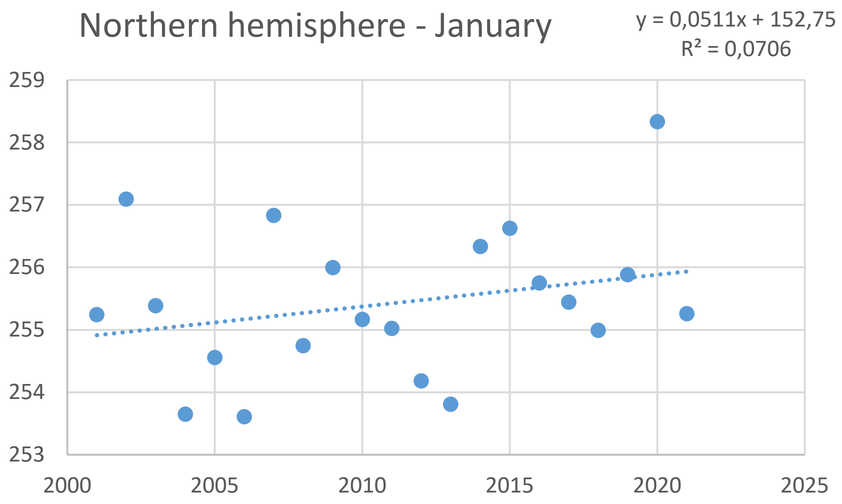
- At global level LST raises both in winter and in summer
- The positive trend is more visible in winter

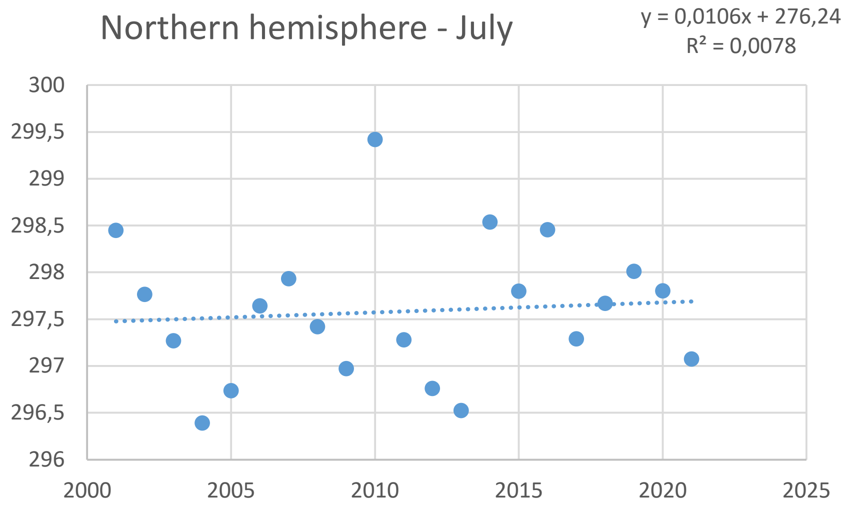


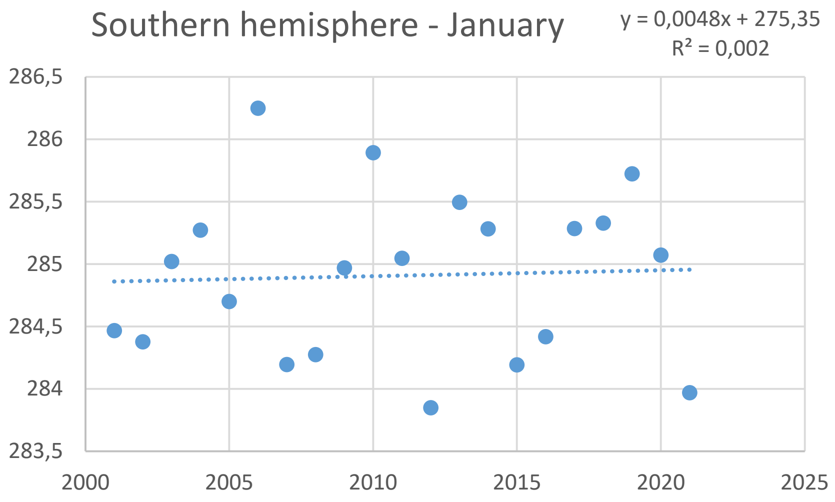


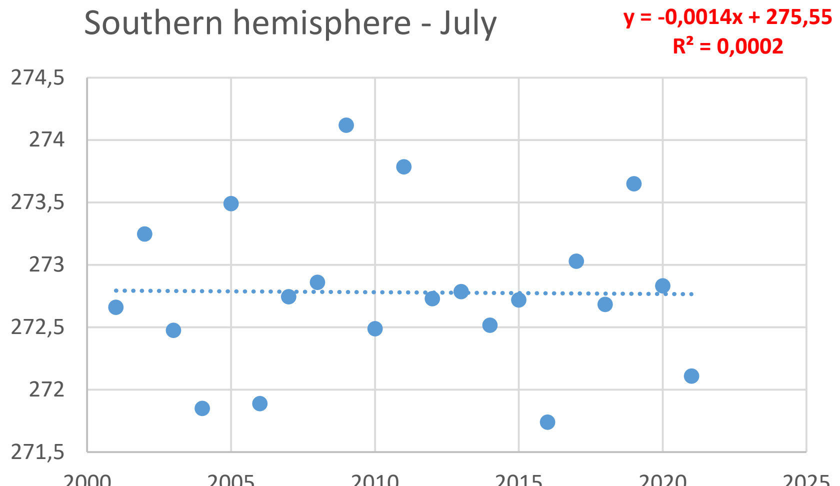
World trends (3)

- LST increases in Juanuary in both hemispheres
- LST increases in July in northern hemisphere, but it decreases in the southern one.









World trends (4)

- The most visible positive trend (increase of LST) is visible for surfaces not covered by vegetation - for deserts and glaciers
- The trend is more visible in January.