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How Economists Can Contribute into Climate Change Studies?

Luciano Gutierrez
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University of Sassari

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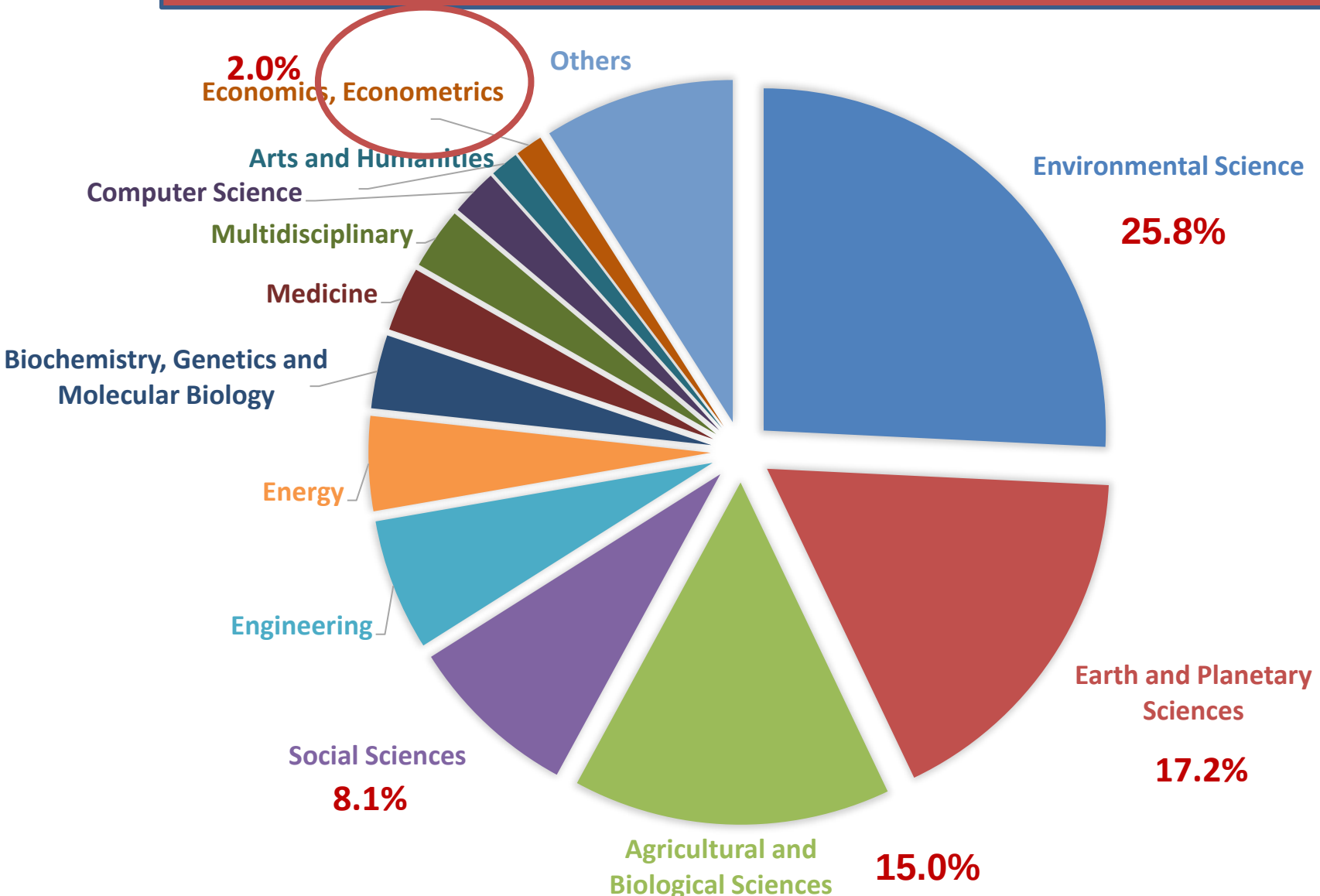
SCOPUS % of papers with a keyword "Climate Change" (n. 411728 – 1950/2021)



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Global Warming and Local Dimming: The Statistical Evidence

Jan R. MAGNUS, Bertrand MELENBERG, and Chris MURIS *J. Am. Stats Ass.* **2011**

nature geoscience **2016**

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nature › nature geoscience › letters › article

Published: 14 March 2016

Disentangling greenhouse warming and aerosol cooling to reveal Earth's climate sensitivity

T. Storelvmo, T. Leirvik, U. Lohmann, P. C. B. Phillips & M. Wild

Contents lists available at ScienceDirect

Journal of Econometrics **2020**

journal homepage: www.elsevier.com/locate/jeconom

ELSEVIER

Econometric estimates of Earth's transient climate sensitivity☆

Peter C.B. Phillips [a,b,c,d,*], Thomas Leirvik [e], Trude Storelvmo [f]

Check for updates

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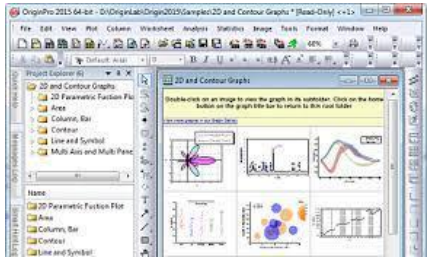
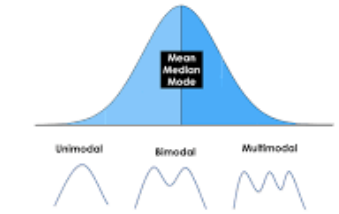
Lecture's Aims

- Introducing (some) geographical databases that are useful in studying the global warming.

- Presenting (some) software we need to analyze global warming



- Discussing simple statistical techniques for the analysis of the global warming



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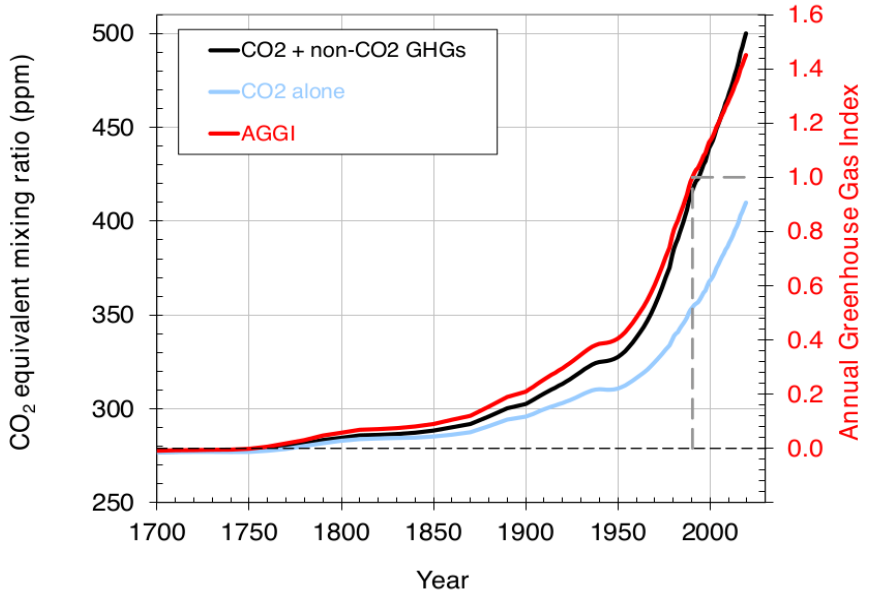
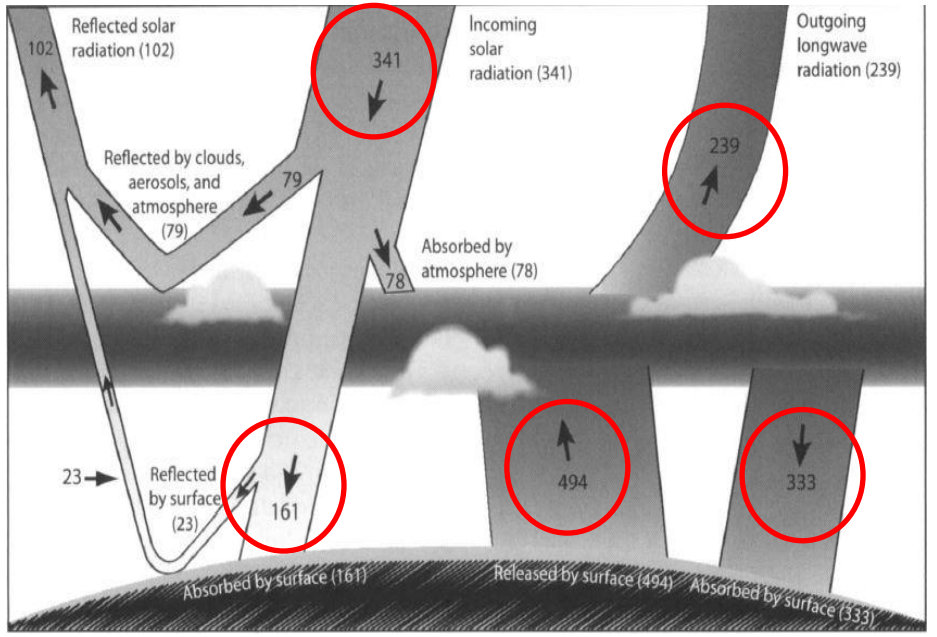
GLOBAL WARMING

Aerosols and CO_2 in action:

- The first effect, not well understood by public, is the solar radiation effect, mainly connected with pollution. As we know, pollution consists of small particles called aerosols which reflect and absorb sunlight in the atmosphere and make clouds more reflective. Areosols are able to scatter sunlight. More aerosols less sunlight reaches the Earth: the dimming effect, which is mainly a local effect!!

- The greenhouse gases act as a blanket, thus contributing to global warming: the greenhouse effect. Because of the long lifetime of CO_2 in the atmosphere this effect is global!





GLOBAL WARMING

Let me propose a simple energy balance equation:

$$\left(TEMP_{t+1} - TEMP_t\right) \approx ENERGY^{swIN} - ENERGY^{lwOUT}$$

$$ENERGY^{sIN} = f\left(\overset{+}{SolarRadiation}\right)$$

$$ENERGY^{lOUT} = f\left(\overset{-}{CO_2}, \overset{+}{TEMP}\right)$$

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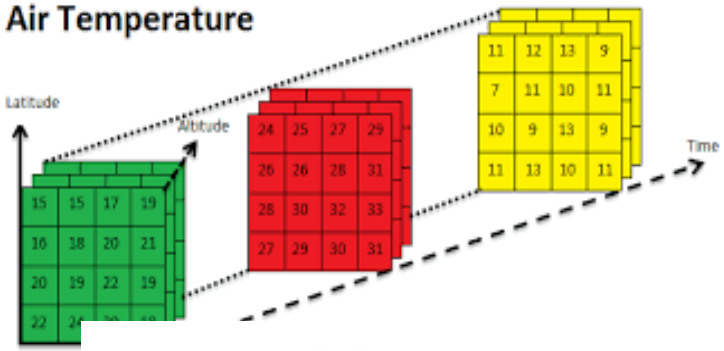
GLOBAL WARMING

- Here, we concentrate on temperature, solar radiation and greenhouse gases. Specifically, we will provide information on how this data can be accessed at global/ local level.



- netCDF (.nc) is the common format used for climate data. The format is supported in major programming languages as MATLAB, Python or R.

- We will see how to read, mapping and doing some statistical analysis on climate data. We use MATLAB and its Maptool toolbox.

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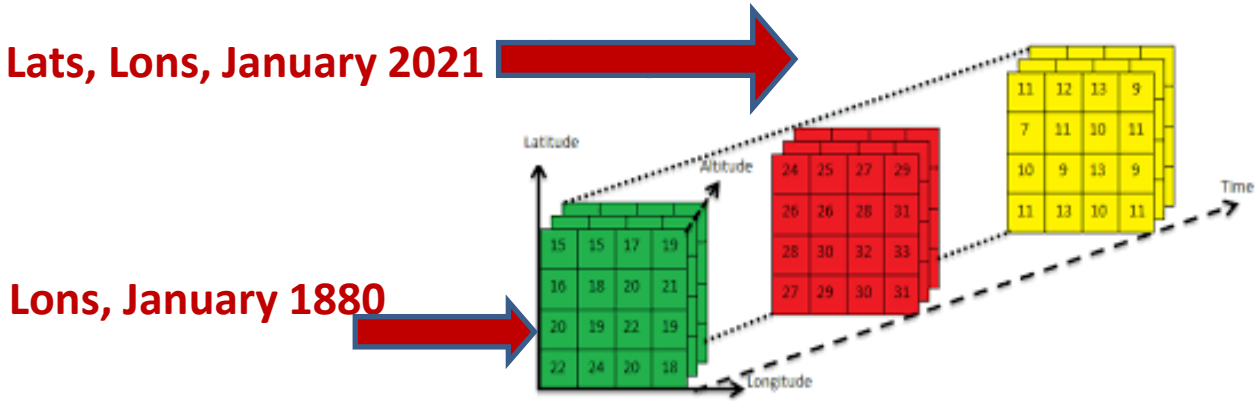
TEMPERATURE

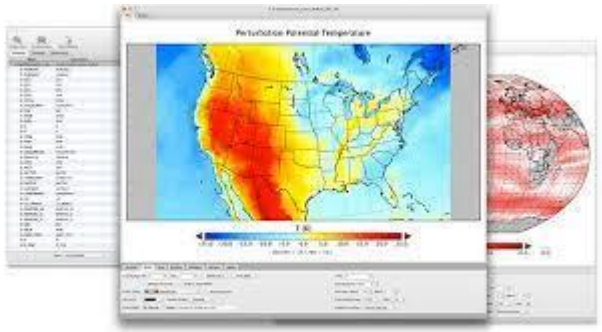
NASA : GISTEMP https://data.giss.nasa.gov/gistemp/

National Aeronautics and Space Administration
Goddard Institute for Space Studies

- The GISS Surface Temperature Anomalies
- Monthly gridded (2°×2° grid)data starting from 1880 January-2021 January.
- Dimension : 90(lat) x 180 (lon) x 1693 (months)

gistemp1200_GHCNv4_ERSSTv5.nc





- Mapping using PANOPLY, https://www.giss.nasa.gov/tools/panoply/ a free program which can be used for mapping netCDF format data.

TEMPERATURE

MATLAB script :

Editor - C:\Climate_Change\MatlabWork\Temperature\Routines\MAPs\MapTemperatureNASA.m

Map_Anomalies_final_period.m | average_annual.m | Temperature.m | MapTemperatureNASA.m | Maplevel.m

```
clc;
clear;
cd('c:\Climate_Change\MatlabWork\Temperature\Dataset\NASA')
%***************** READING DATASETs ************************************
filename='gistemp1200_GHCNv4_ERSSTv5.nc';
ncdisp(filename)
[tdt, tnum, unit, refdate] = ncdateread(filename, 'time');
lon=double(ncread(filename,'lon'));
lat=double(ncread(filename,'lat'));
T = ncread(filename,'tempanomaly');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Turn lat,lon arrays into grids:
[Lat,Lon] = meshgrid(lat,lon);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
pos=[0.05, 0.50, 0.40, 0.4
     0.54, 0.50, 0.40, 0.4
     0.05, 0.07, 0.40, 0.4
     0.54, 0.07, 0.40, 0.4];
figure
load coastlines
x1=1961;
x2=1975;
for i=1:4
m1=(x1-1880+1)*12;
m2=(x2-1880+1)*12;
T1=T(:,:,m1:m2);
z=mean(T1,3);
```

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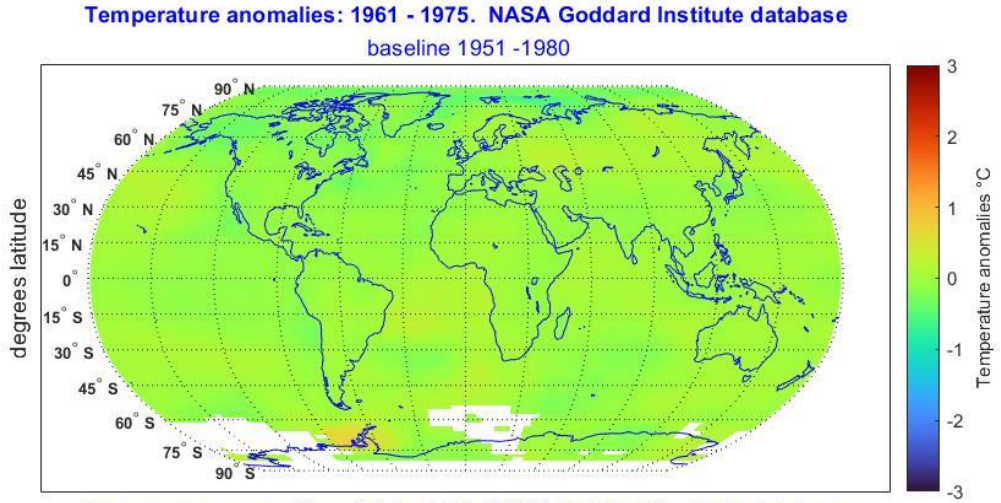
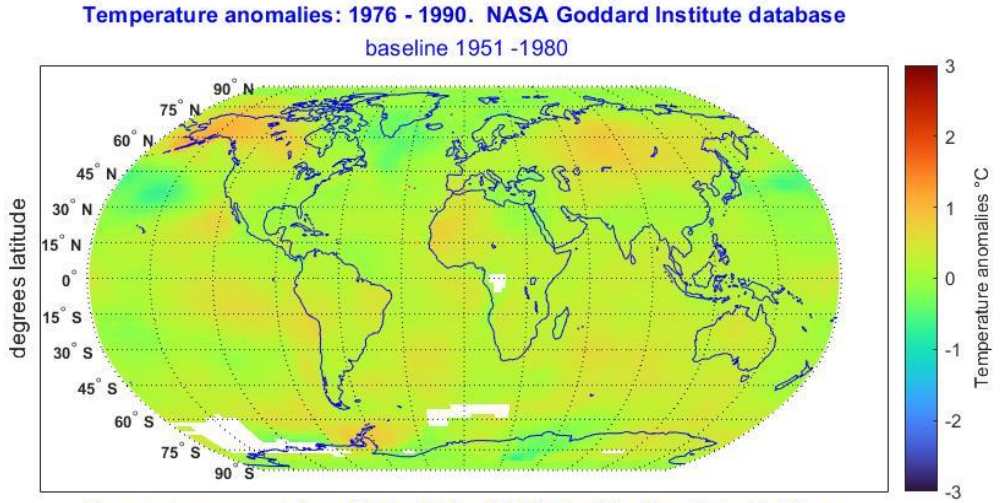
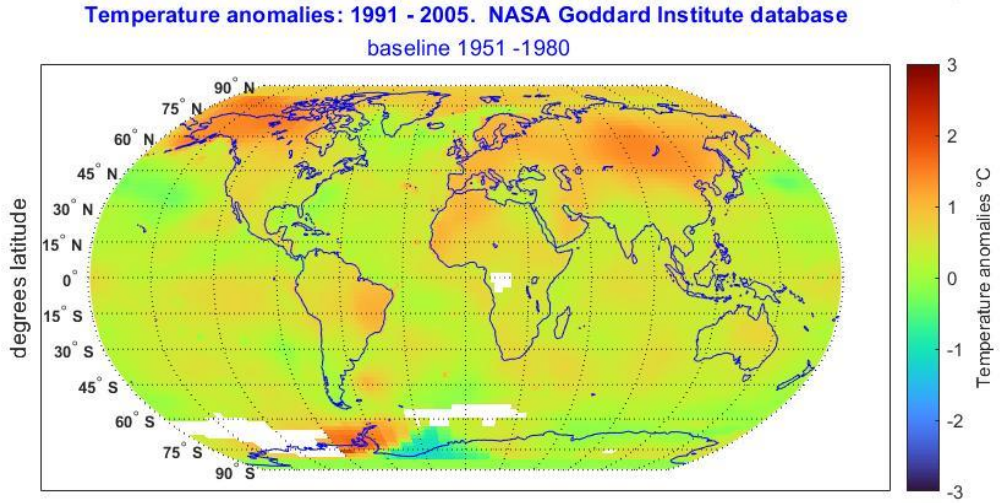
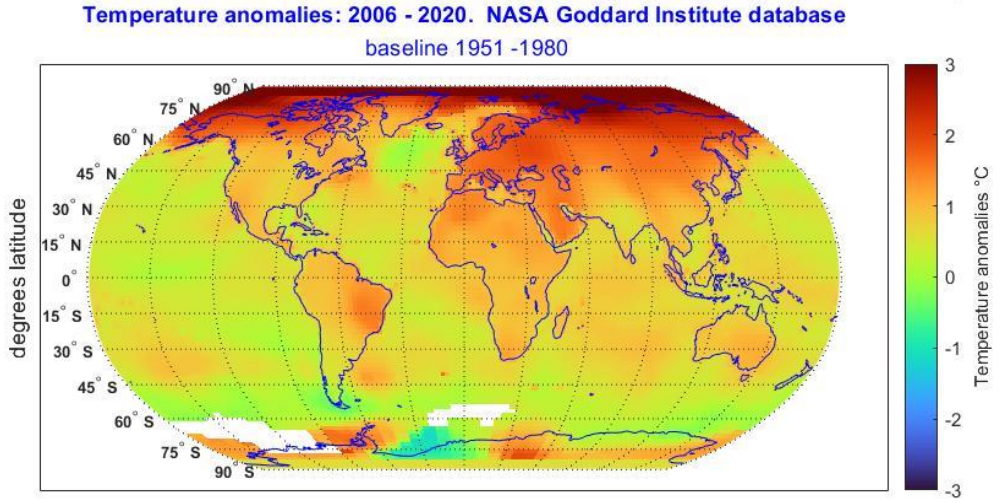
TEMPERATURE ANOMALIES 1961-2020









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TEMPERATURE

University of East Anglia — Climatic Research Unit

CRU TS: level temperature

https://crudata.uea.ac.uk/cru/data/temperature/

- These datasets have been developed by the Climatic Research Unit (University of East Anglia and NCAS).

- Coverage: Only land areas (excluding Antarctica) at (0.5°x0.5°) grid resolution *(interpolated data) from 1901.1. Matrix dimension : 360 x 720 x 1448*
- *The CRU TS supply also data for precipitation, vapor pressure, cloud cover*

cru_ts4.04.1901.2019.tmp.dat.nc

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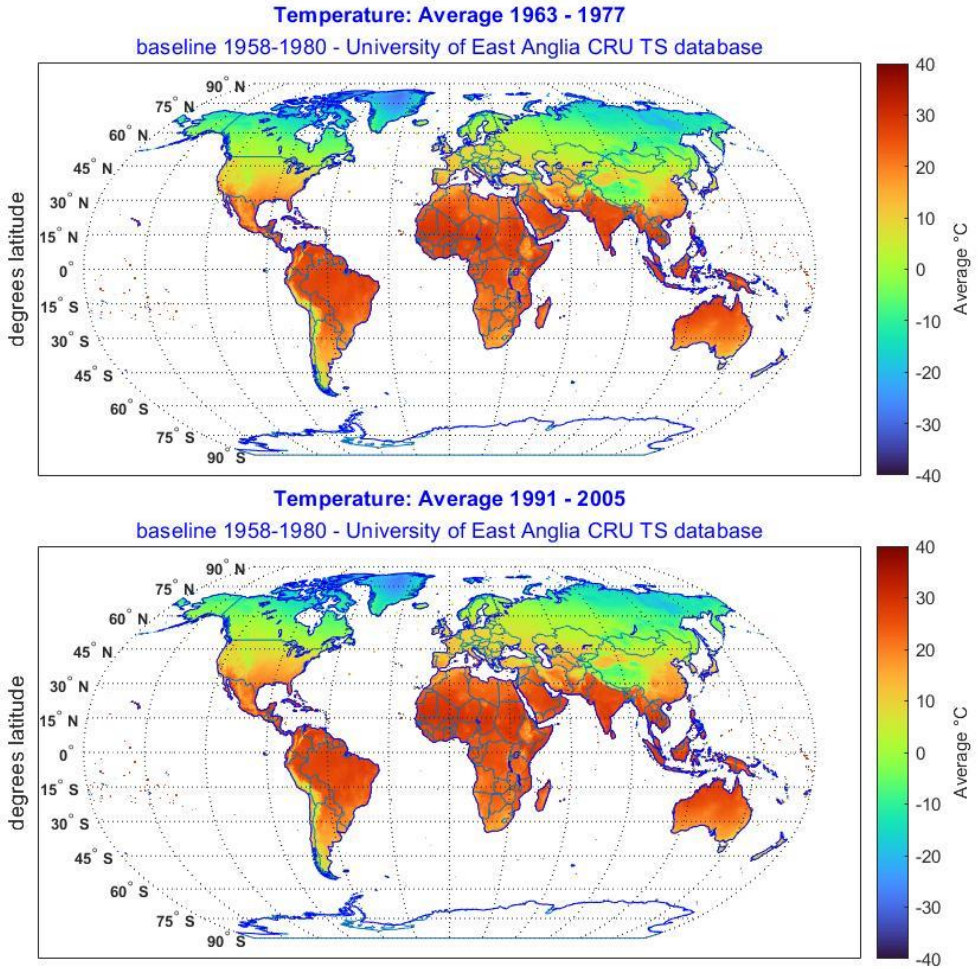
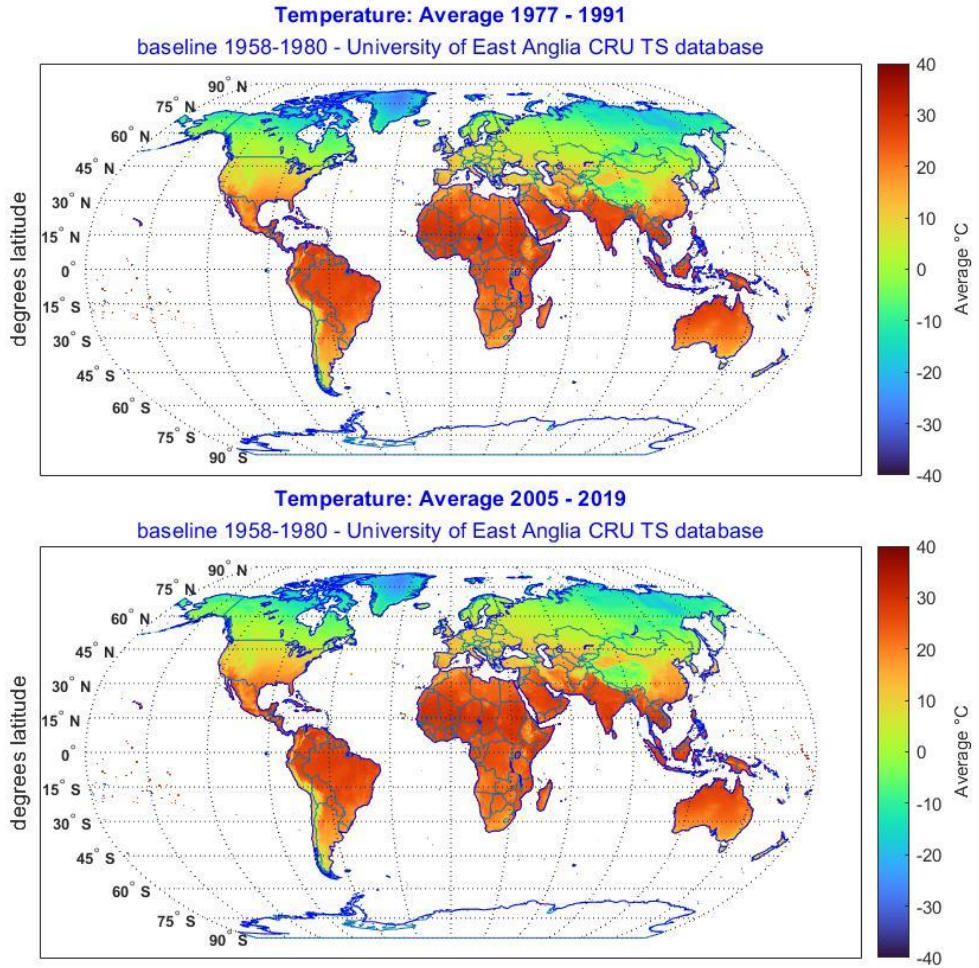
SURFACE TEMPERATURE - LEVEL





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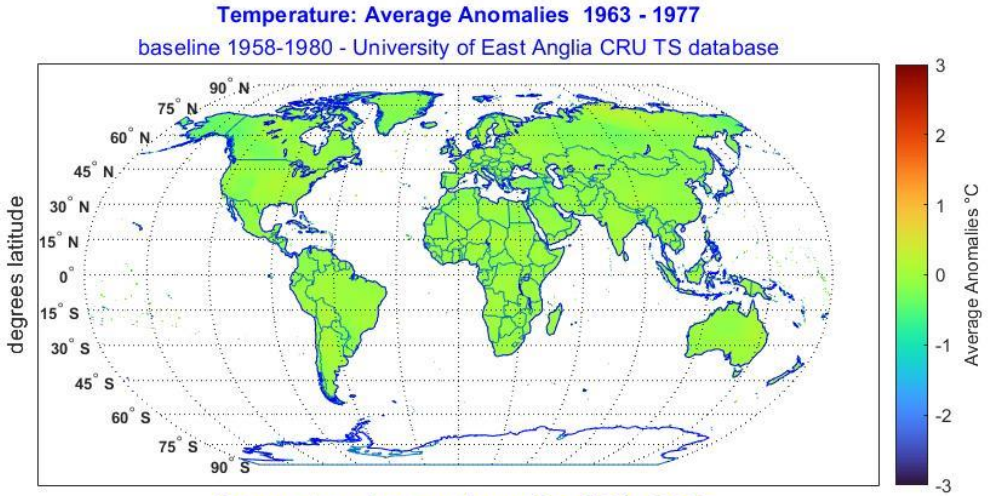
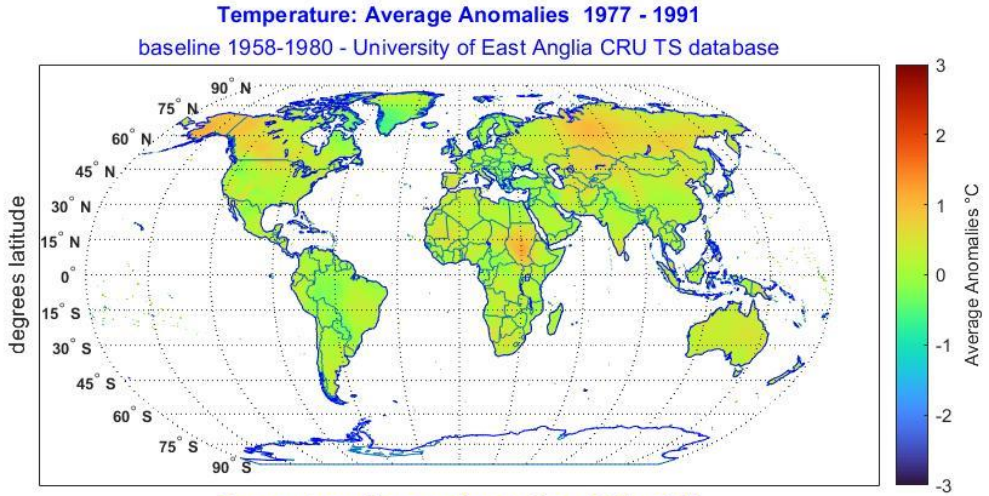
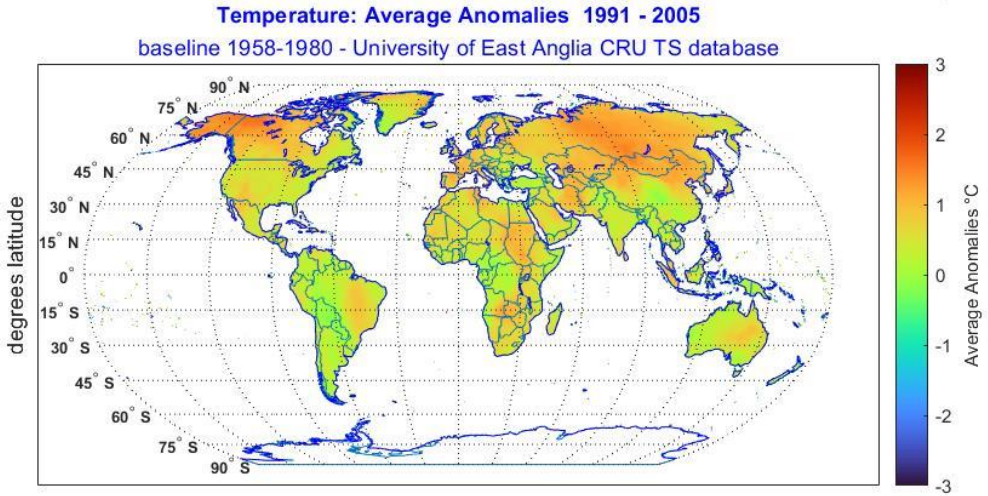
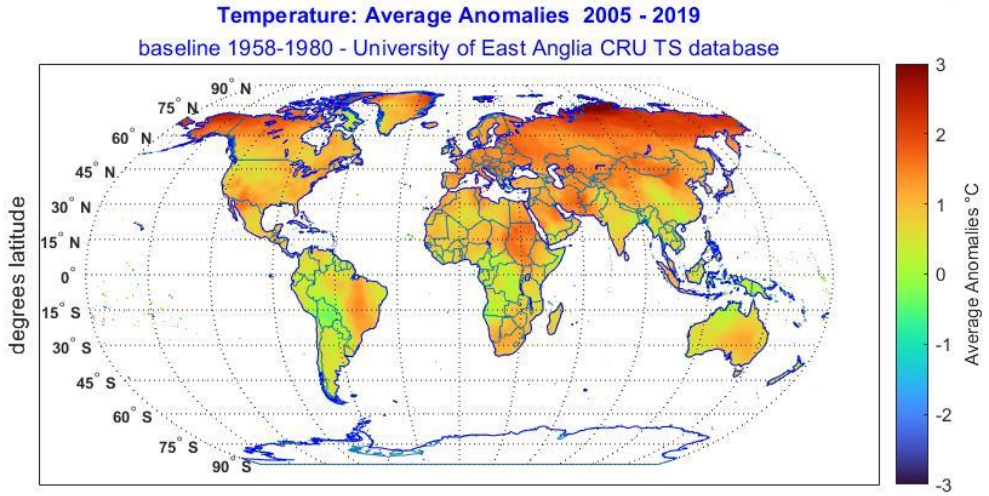
SURFACE TEMPERATURE - ANOMALIES









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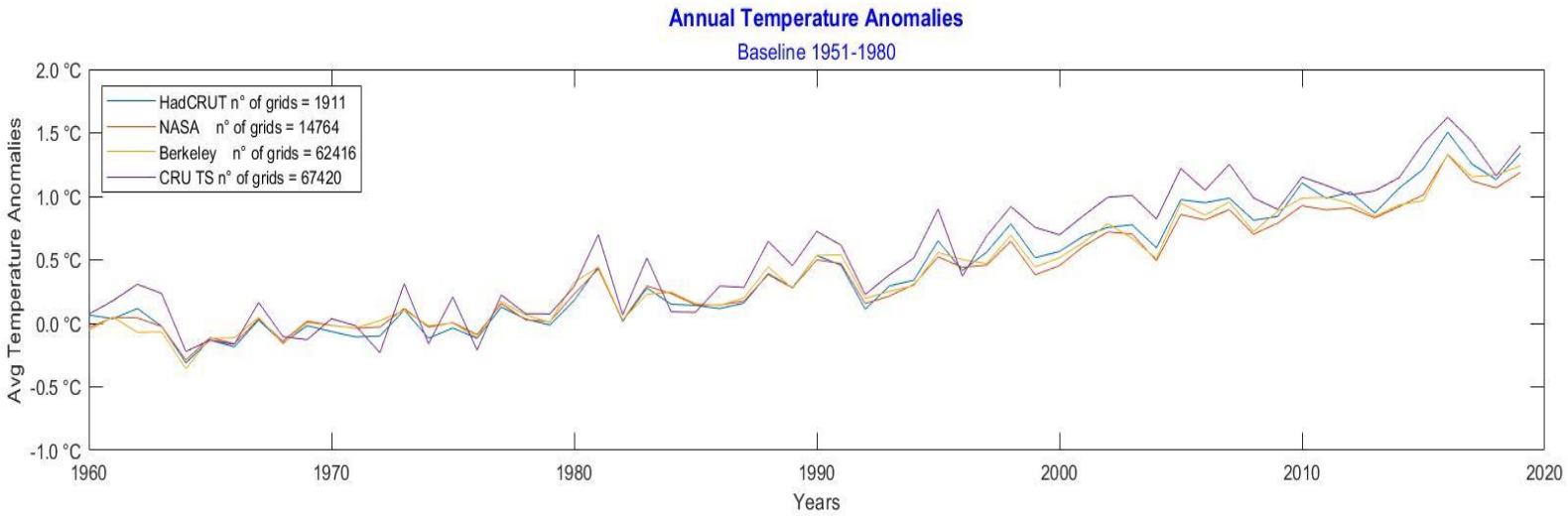
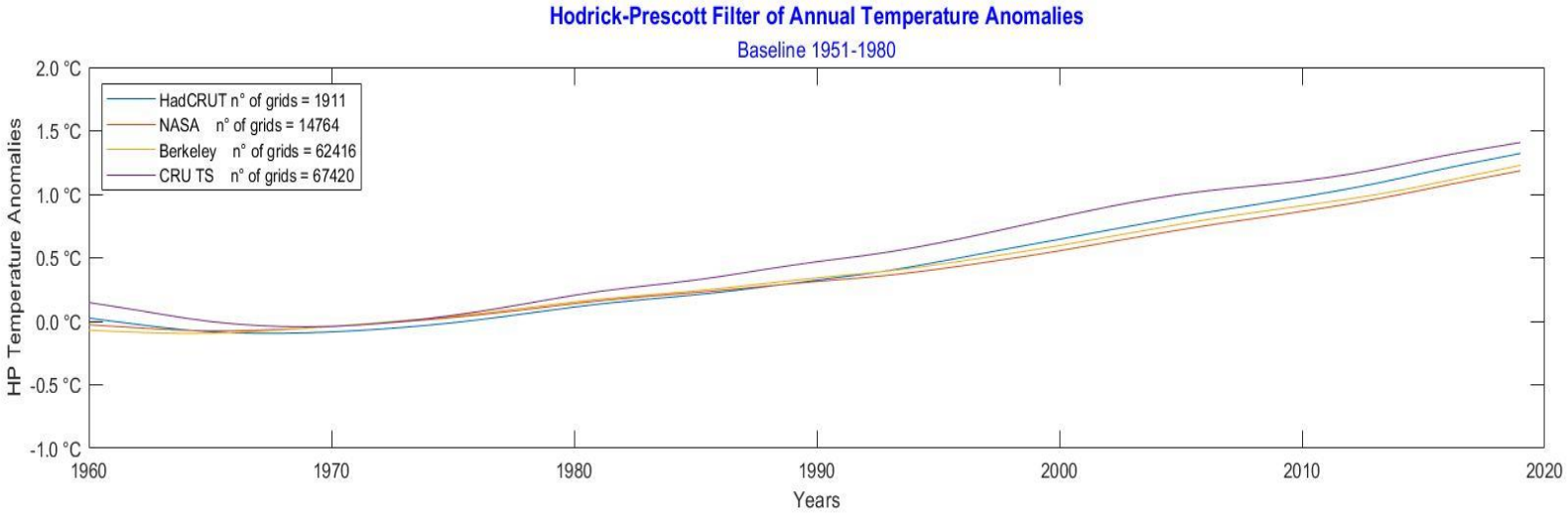
TEMPERATURE INCREASE (baseline 1951-1980)

Average Temperature anomalies across grids (with no missing values) 1960-2020



Hodrick-Prescott (trend) temperature anomalies



SOLAR RADIATION

- Solar radiation data are collected from the Global Energy Balance Archive (GEBA) from the ETH Zurig.

- Monthly data are avalaible from 1950-2017 for 2284 stations. They are expressed as W/m^2

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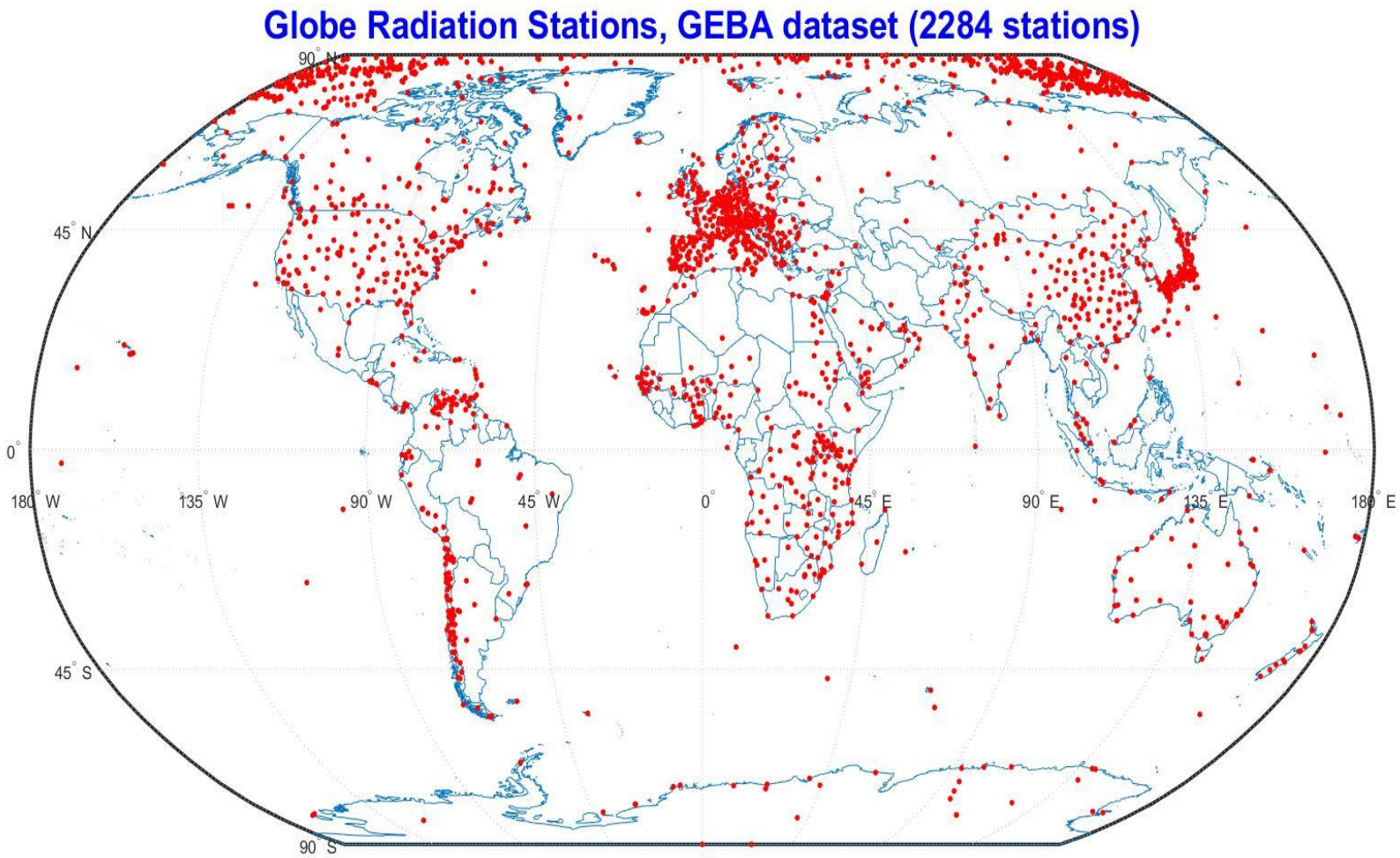
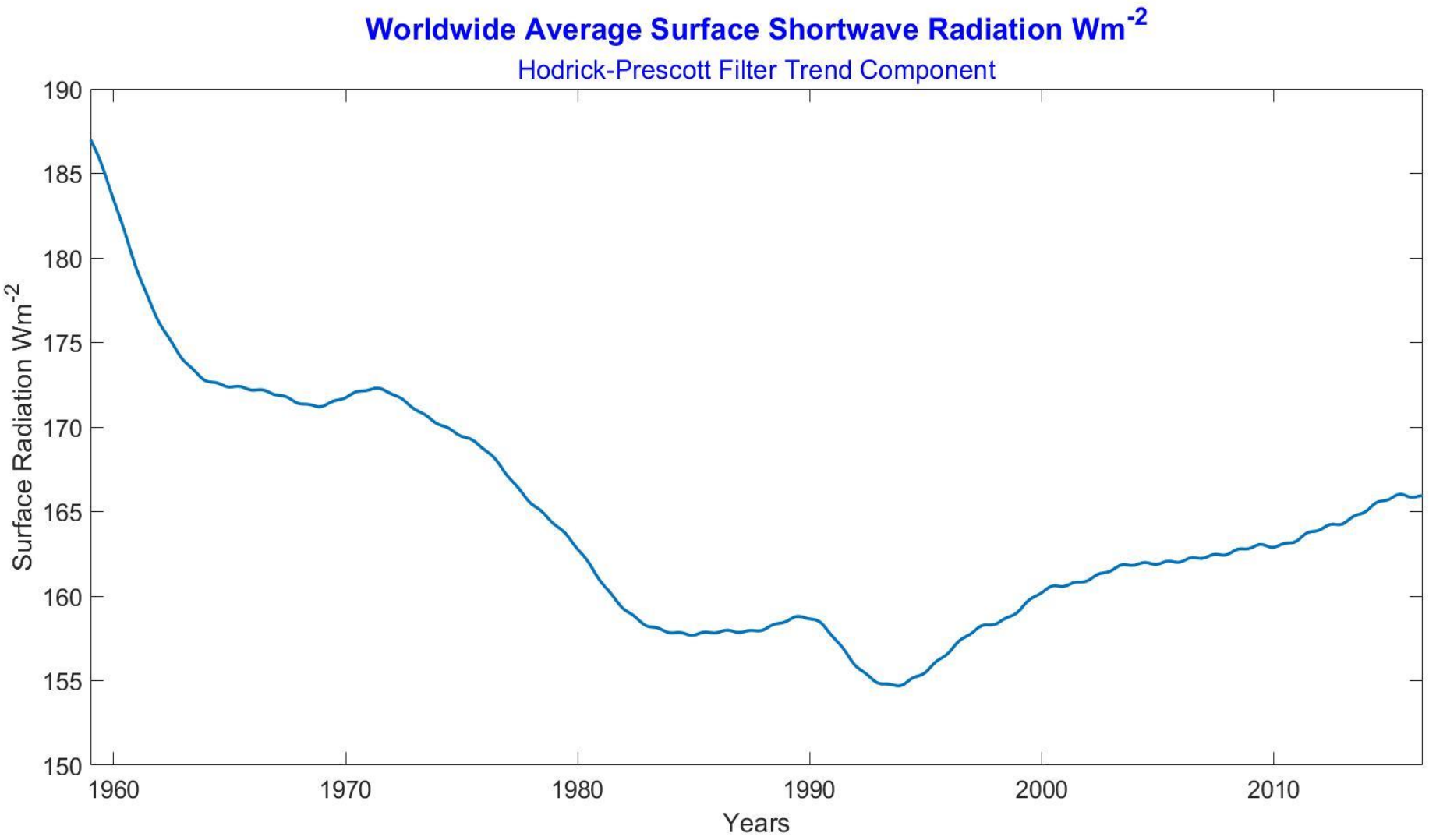
SOLAR RADIATION



SOLAR RADIATION



CARBON DIOXIDE (CO_2) and other GREENHOUSE CONCENTRATION

- One of the best database for the carbon dioxide (CO_2) and other greenhouse concentration can be found in https://www.esrl.noaa.gov/gmd/aggi/
- The AGGI index provides a synthetic information of the trend of greenhouse gases
- Unfortunately this index start from 1979.1
- Longer and trusted information on (only) CO_2 are available from the Manau Loa Observatory, starting from 1959.1. As CO_2 concentration is global, we can use this information as a global indicator of greenhouse gases

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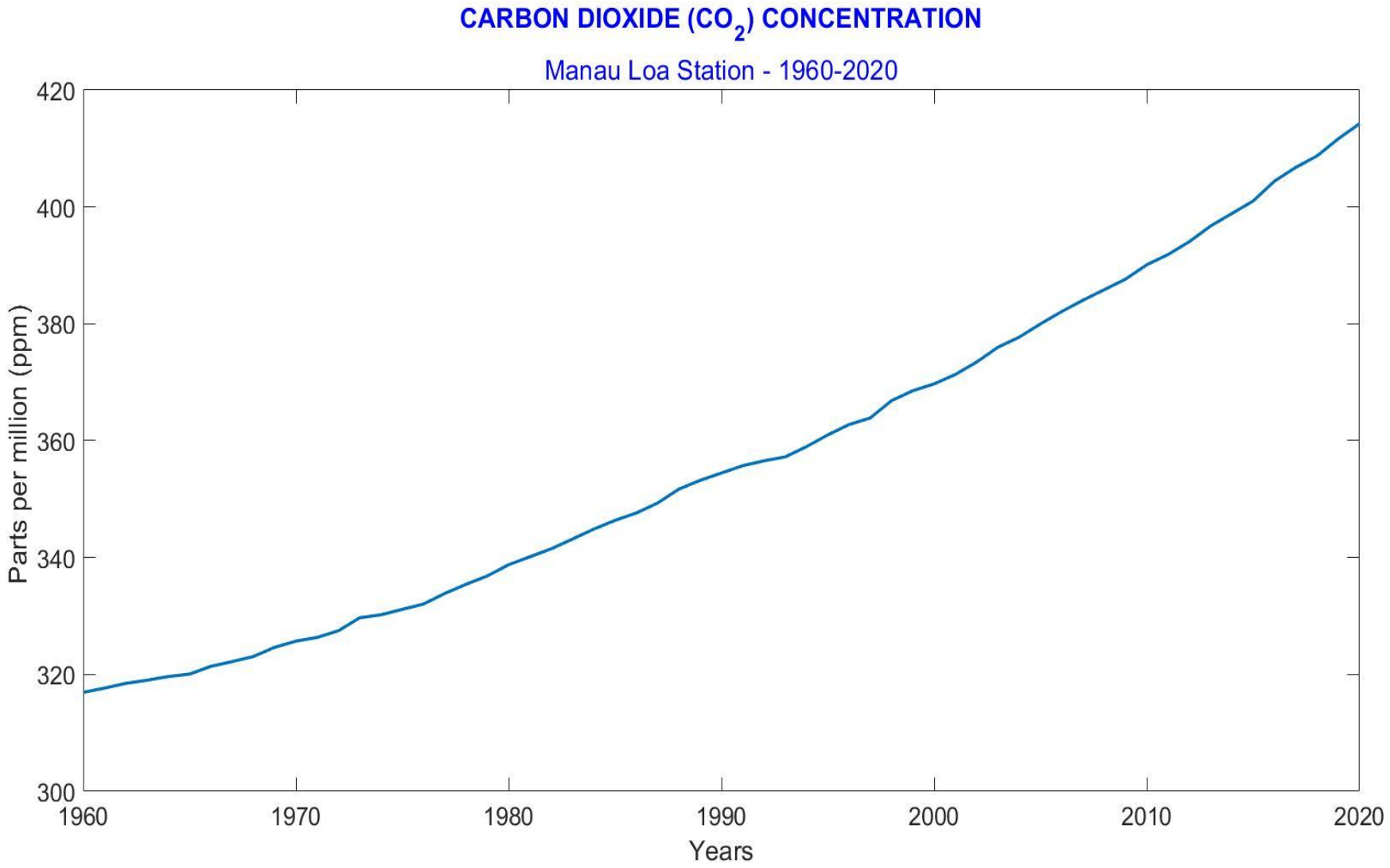
CARBON DIOXIDE (CO_2) CONCENTRATION



GLOBAL WARMING

- Impact on the energy balance equation:

$$\left(TEMP_{t+1} - TEMP_t\right) \approx ENERGY^{sIN} - ENERGY^{lOUT}$$

$$ENERGY^{sIN} = f\left(\overset{+}{SolarRadiation}\right)$$

SolarRadiation reduction until 1990s had a cooling impact on Temperature. This cooling impact is being reduced thanks to national/local pollution reduction policies

$$ENERGY^{lOUT} = f\left(\overset{+}{TEMP}, \overset{-}{CO_2}\right)$$

CO_2 continues to exert its impact on blocking the Lw radiation. Global actions are needed!

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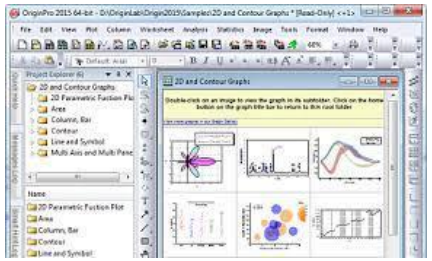
Conclusions

- (Free) Geographical databases are available for studying the global warming.



- Simple scripts can be used for displaying the main variables which affects the global warming

- Econometric statistical techniques (not only global meteorological models) are available to compute and forecast the global warming