CLIMATE CHANGE CHALLENGES

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Risks in the Agriculture-Food sectors, Bratislava, October 17, 2018

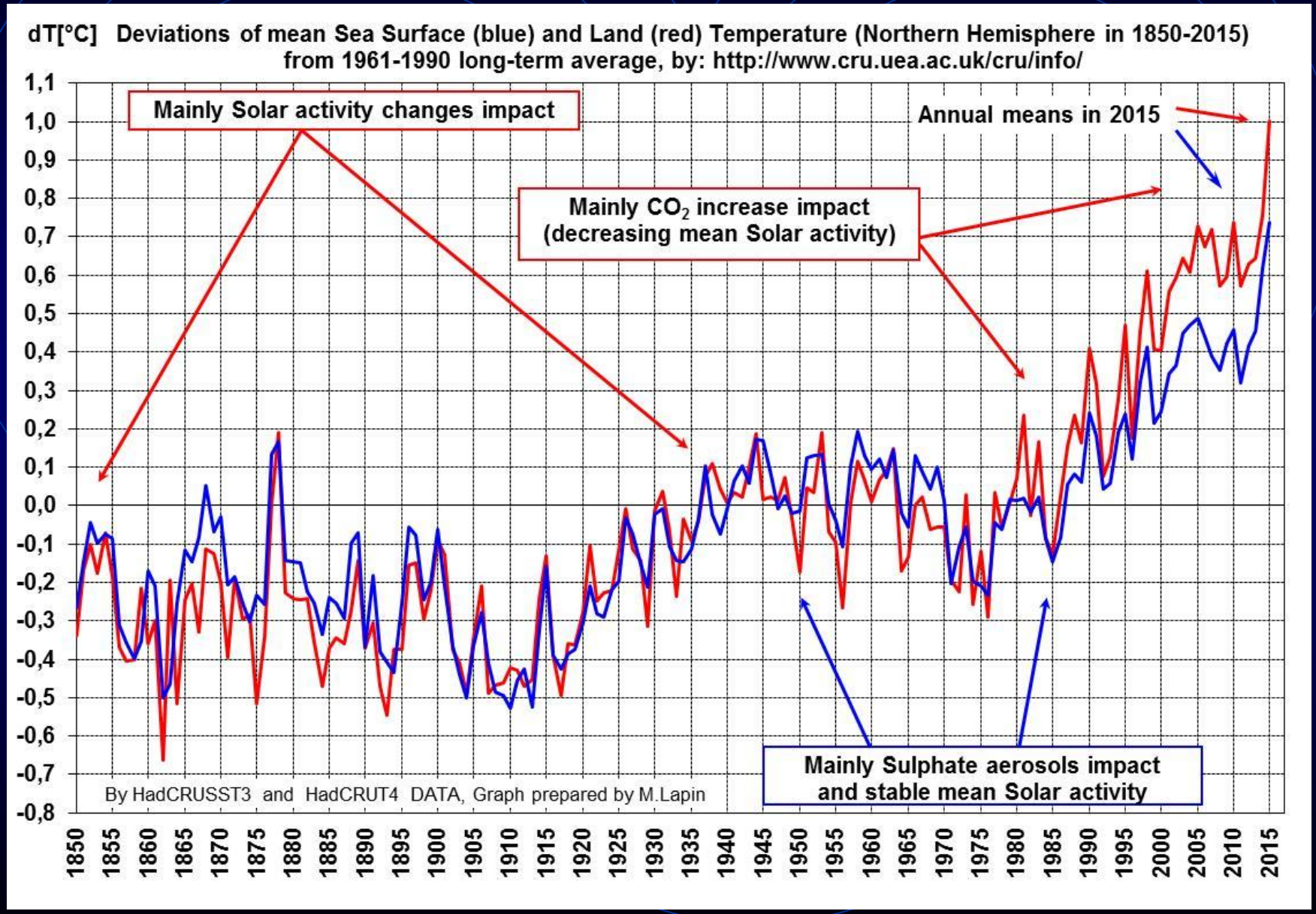
INTRODUCTION 1

- „Climate change“ due to anthropogenic enhancement of greenhouse effect (besides of several other „climatic changes“ caused naturally)
- Up to 1945 the natural causes (Solar radiation changes, volcanoes, oceanic and air circulation oscillations…) are considered as principal
- In 1945-1985 the humans interference (CO_2, sulfates, land use change…) was probably comparable with the natural ones
- **Since 1985 the greenhouse gases (GHGs) emission by human activities (fossil fuels use, industry, transport, agriculture, land use…) surely exceeded the natural causes in greenhouse effect rise and climatic changes**
- **The period 1991-2018 – significant in exceptional weather events occurrence (heat waves, flash floods, drought, desertification, Arctic seaice decrease …)**

INTRODUCTION 2

- **Reliable time series of daily meteorological, hydrologic and other data are used at assessments of climate change vulnerability and impacts (in Slovakia since 1900)**
- **In Slovakia: Twelve GCMs outputs from 7 World Modeling Centers applied – CGCM2/3 (Canada) and GISS 1998 (USA) the most frequently used before 2010, 15 other tested, the newest ones used in Slovakia now are: GCMs CGCM3.1 and ECHAM5, and RCMs KNMI and MPI, all also with daily data and extremes**
- **Water cycle, water resources, water management, agriculture, field ecosystems, forestry, forest ecosystems – vulnerability and impacts studied**
- **Mitigation measures and their co-ordination with adaptation options in the Slovak National Reports on Climate Change (1995, 1997, 2001, 2005, 2009, 2014, 2017)**

VARIABILITY OF ANNUAL TEMPERATURE DEVIATIONS FROM THE 1961-1990 AVERAGE IN THE NORTHERN HEMISPHERE IN 1850-2015 (Sea surface T a and Land air T, HADLEY-CRU UK DATA)



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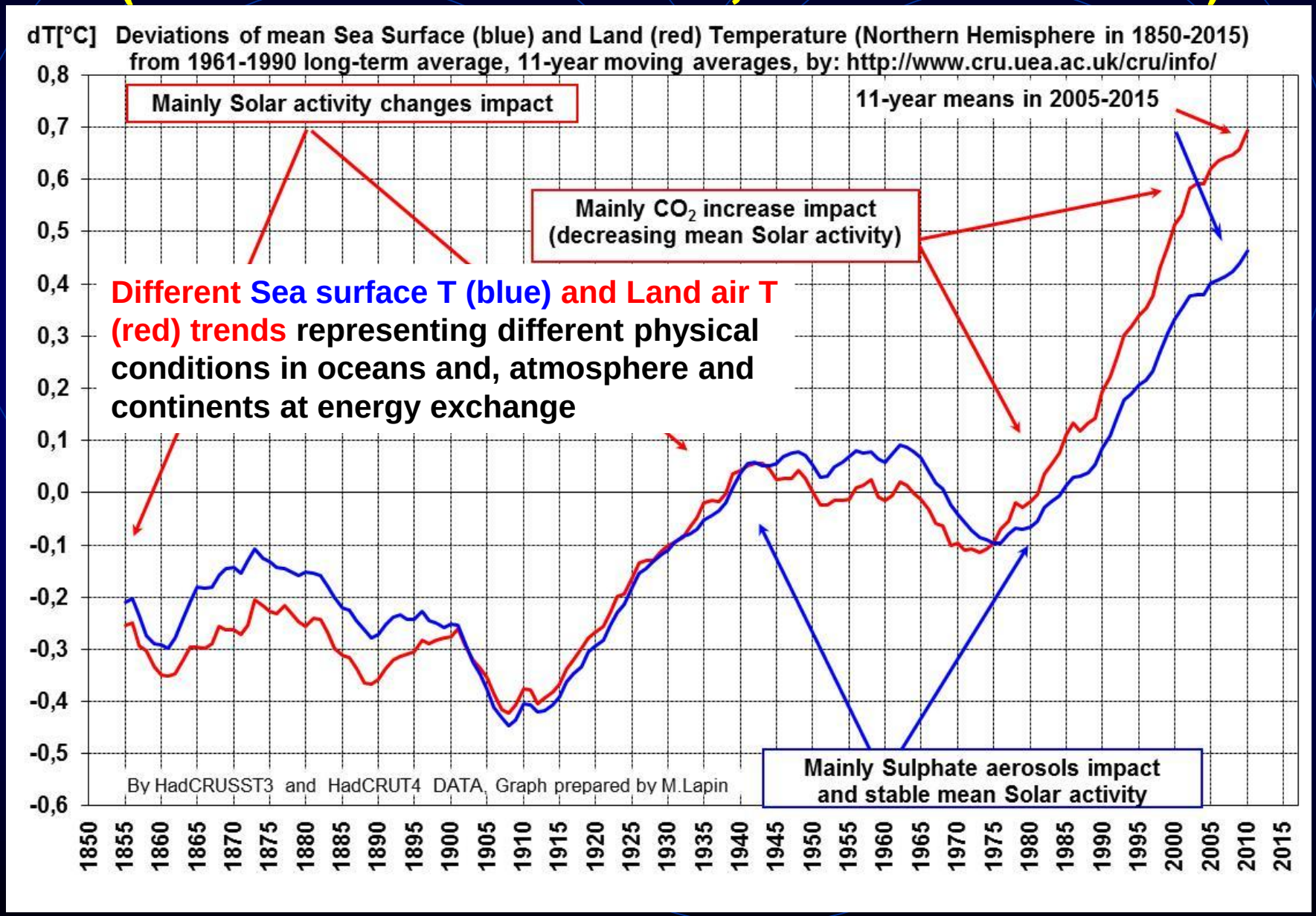
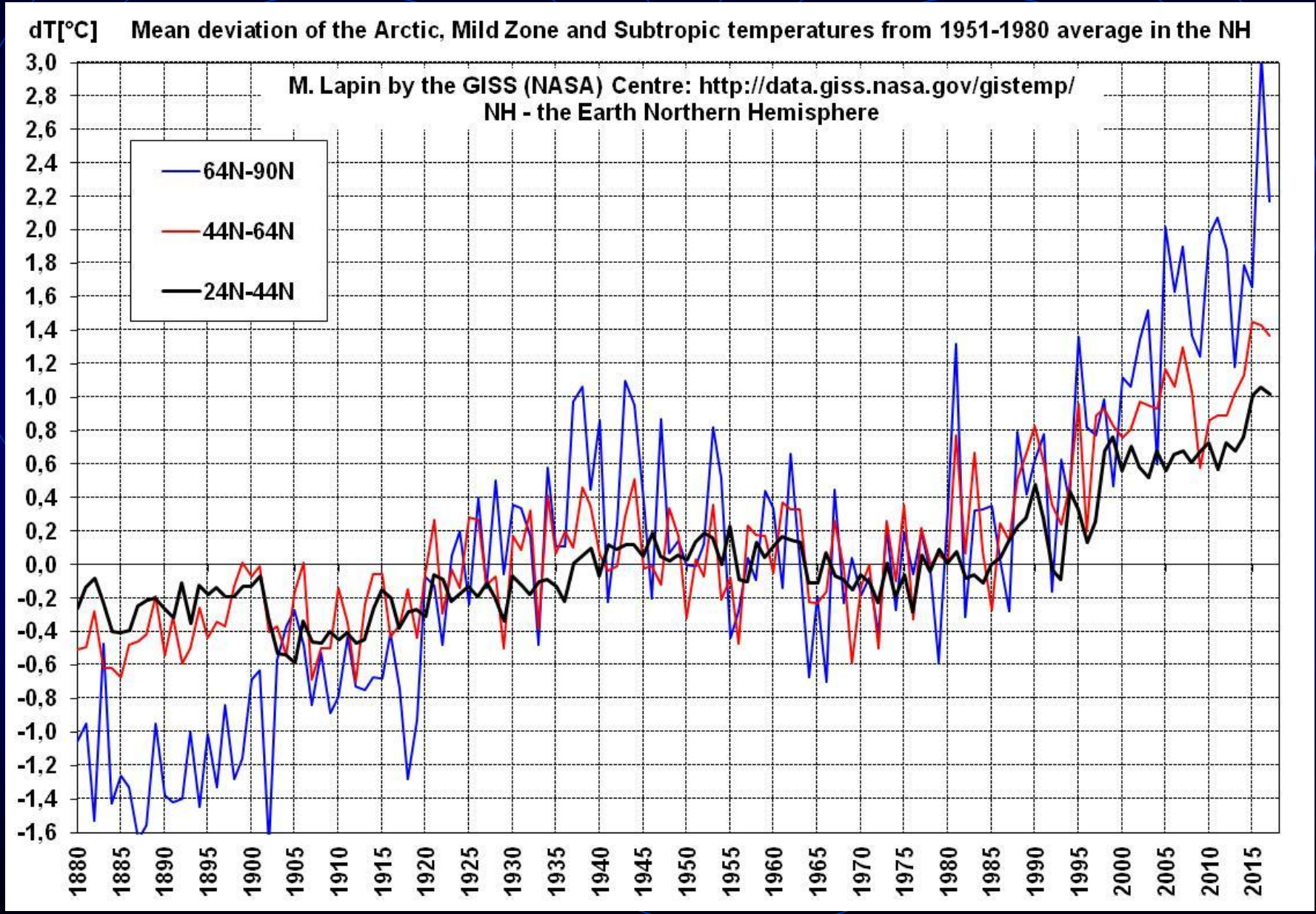
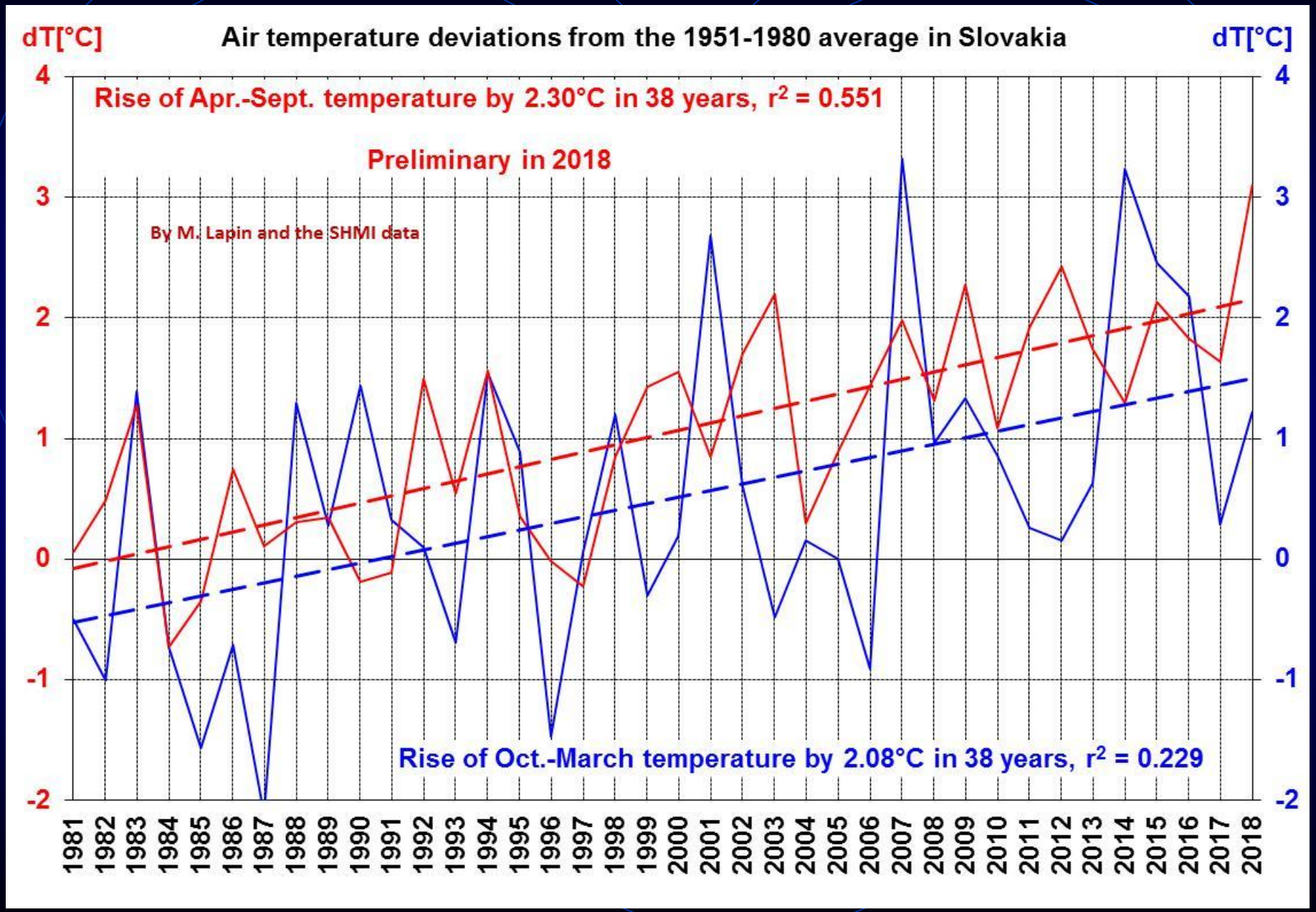


TRENDS OF TEMPERATURE SINCE 1880 NH L+O

Subtropics, Mild zone and the Arctic of the Northern Hemisphere



TRENDS OF TEMPERATURE AND PRECIPITATION - SLOVAKIA



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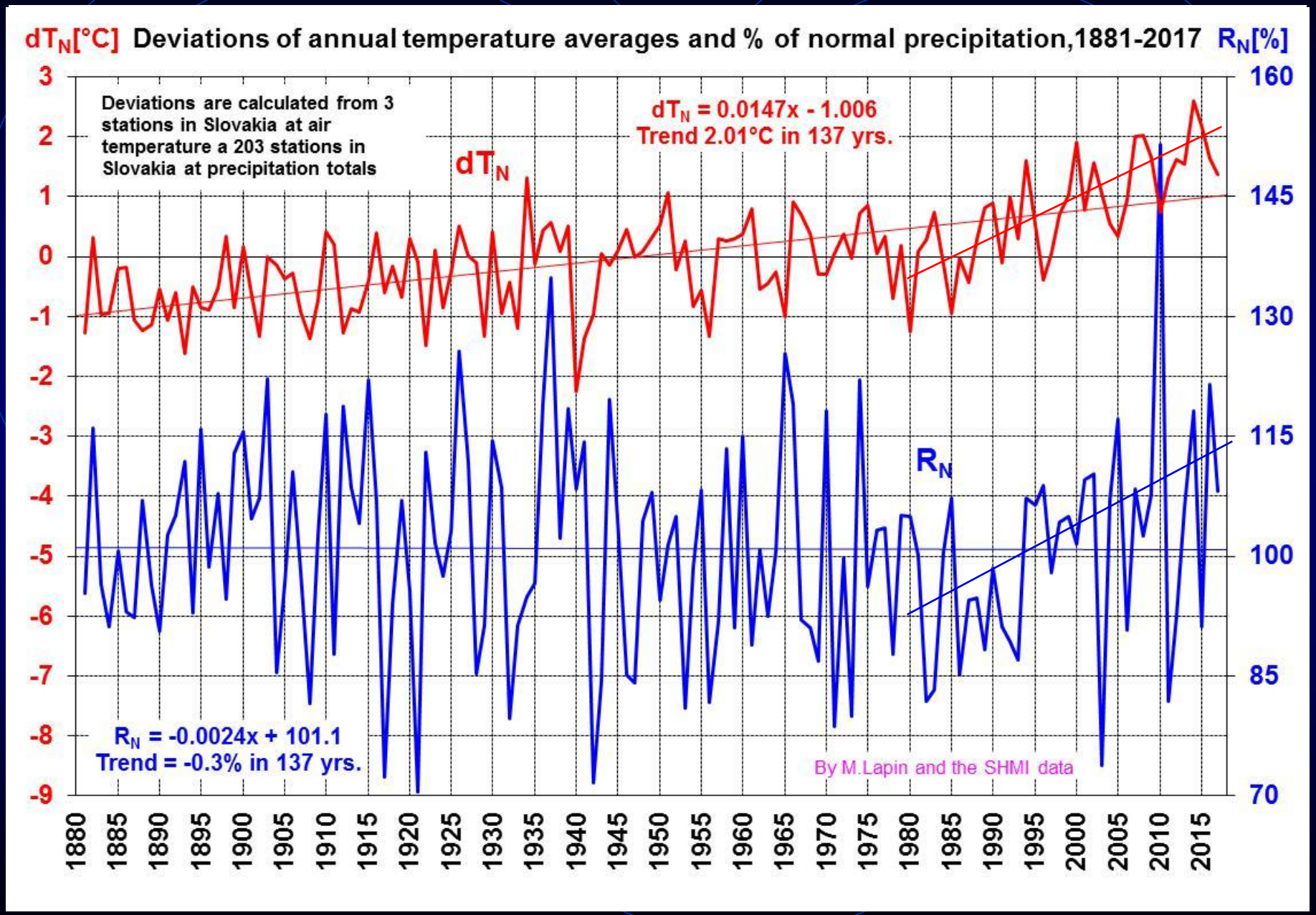
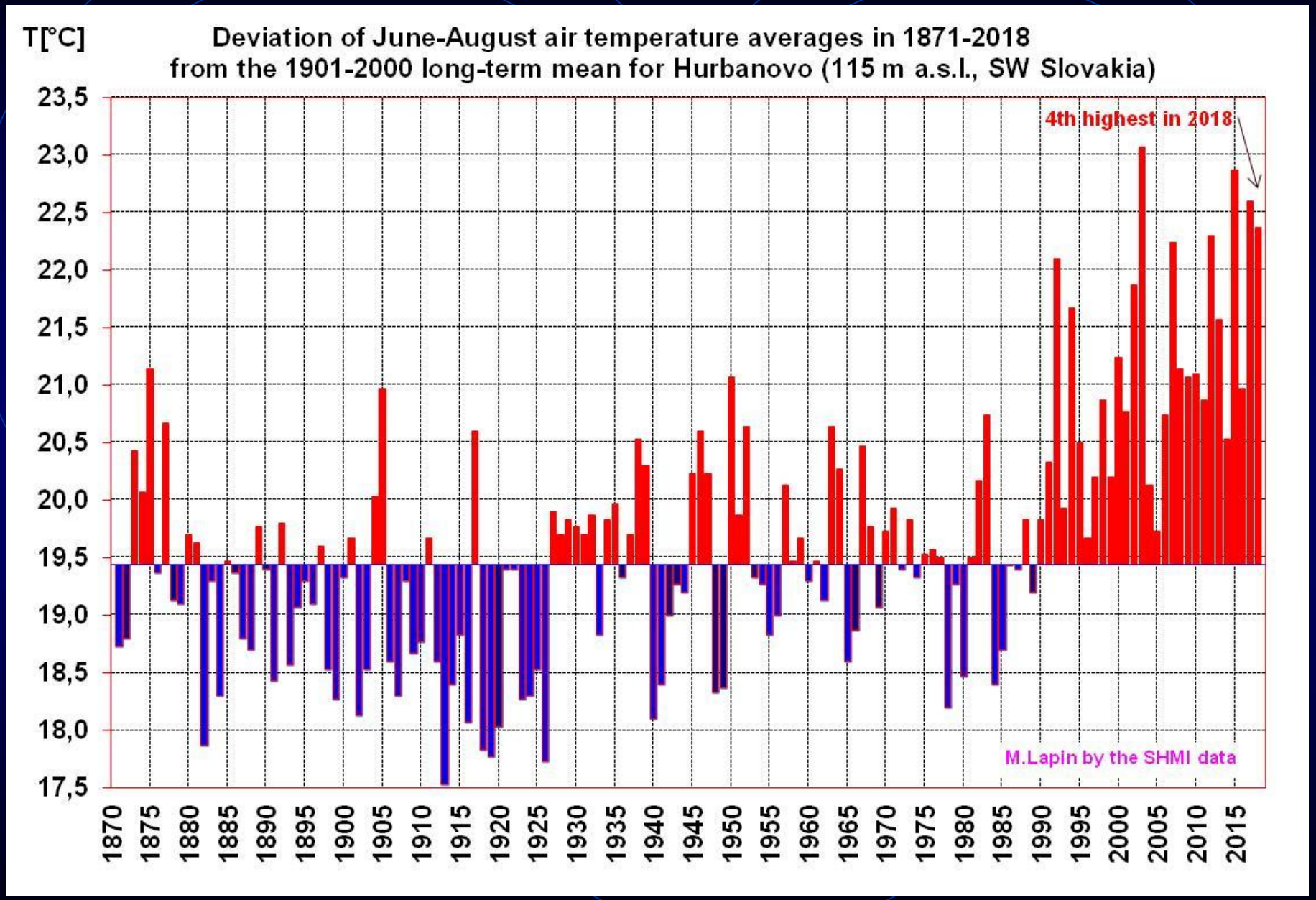
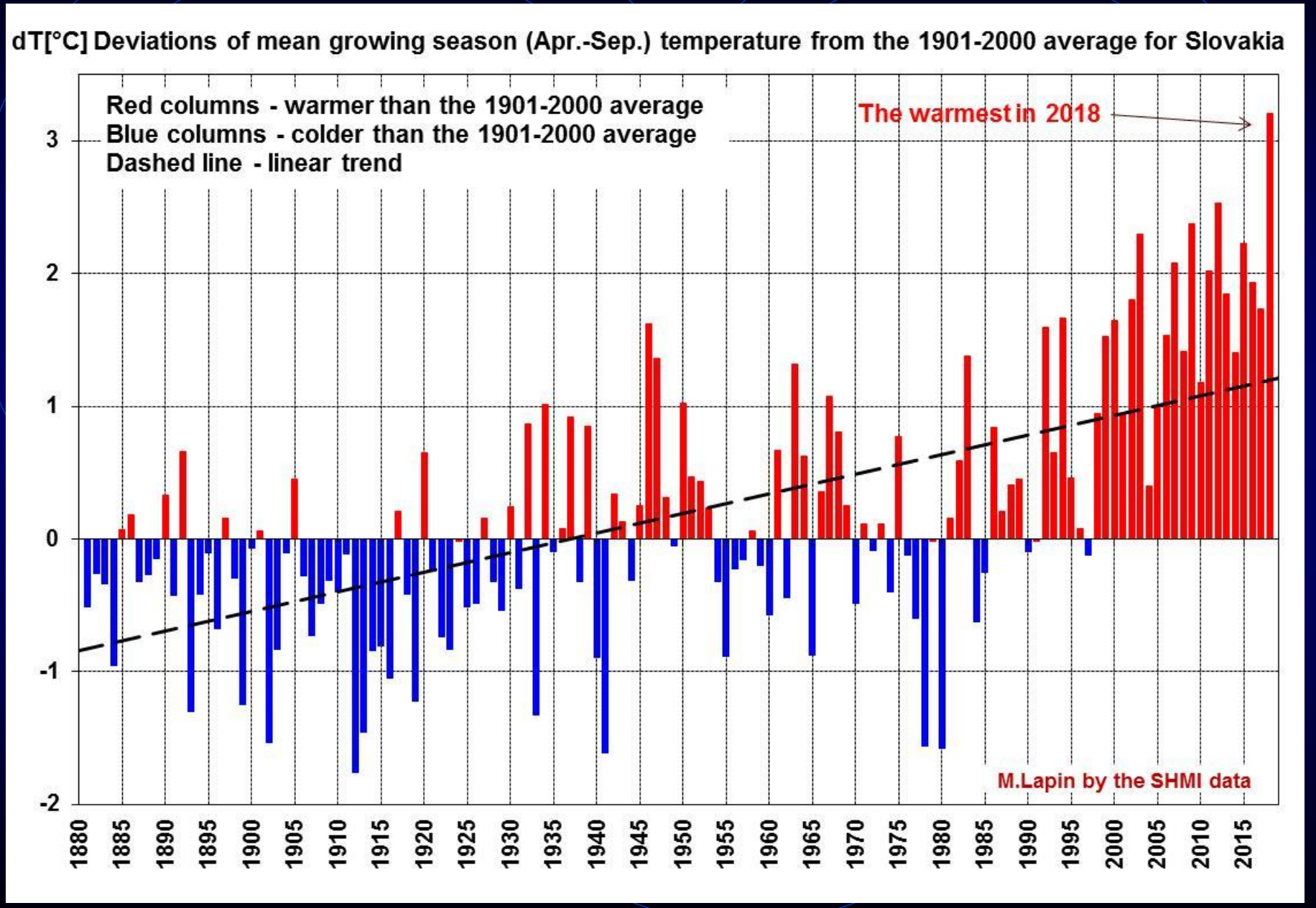


TEMPERATURE – SUMMER – HURBANOVO, SW SLOVAKIA, 115 m a.s.l.

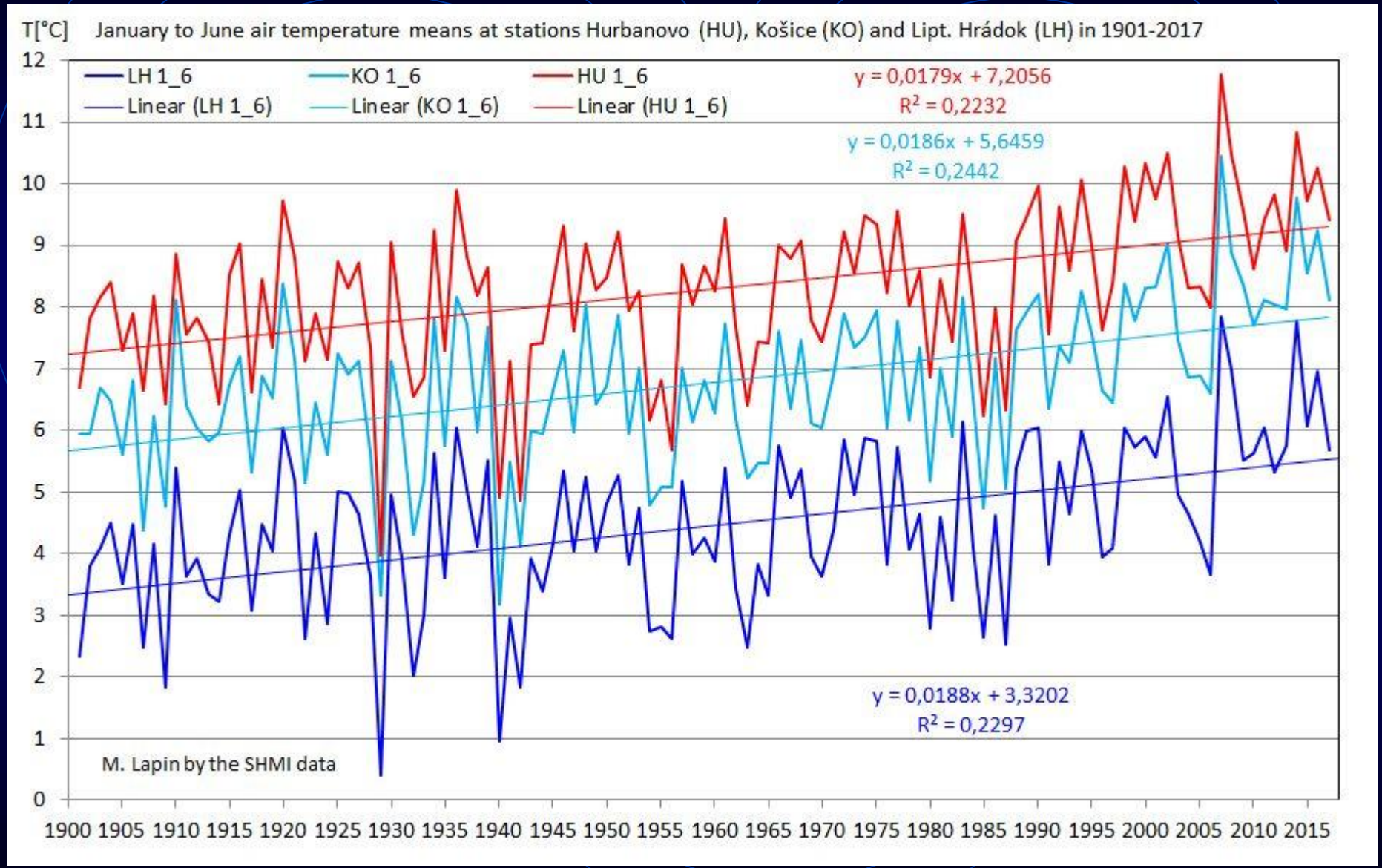


TEMPERATURE – APRIL-SEPTEMBER – SLOVAKIA



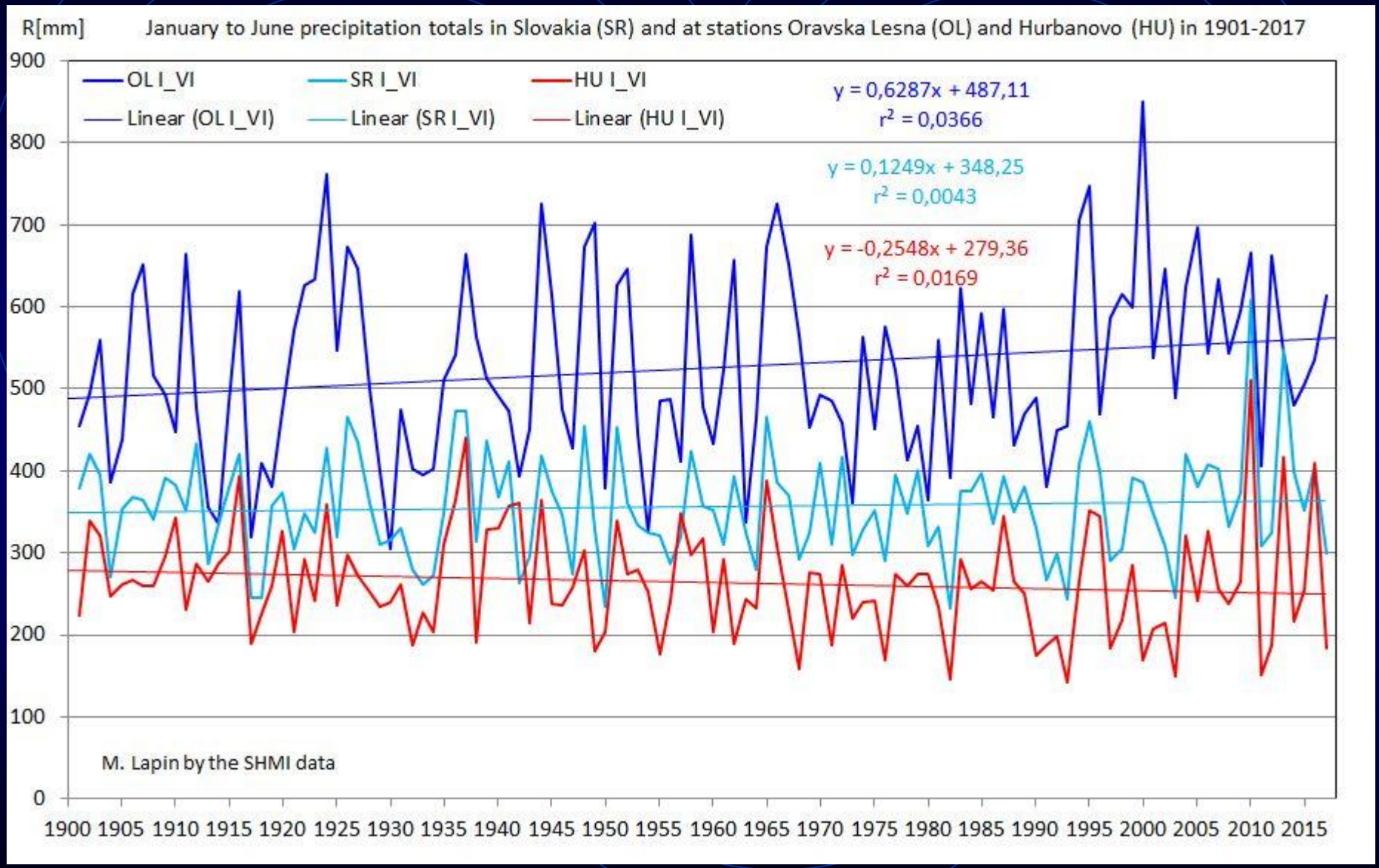
TRENDS OF TEMPERATURE – SLOVAKIA

Hurbanovo, 115 m SW, Košice 230 m SE, L. Hrádok 640 m N Slovakia



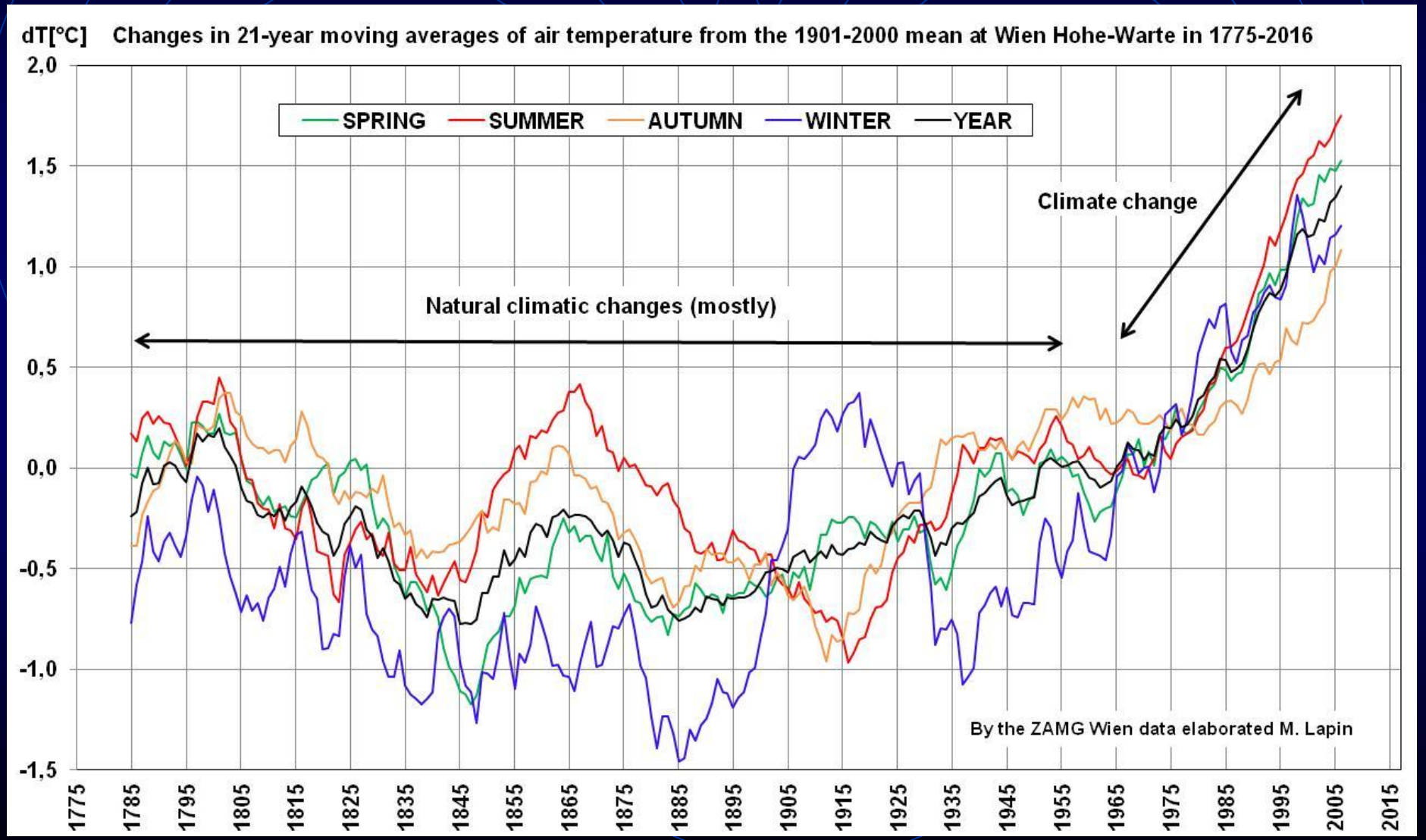
TRENDS OF PRECIPITATION – SLOVAKIA (SR)

Hurbanovo, 115 m SW, O. Lesná 780 m NW Slovakia

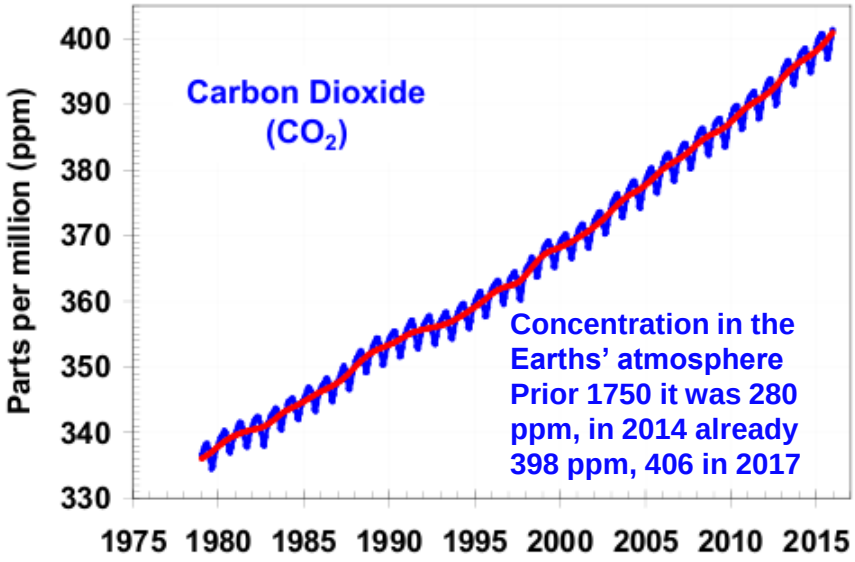


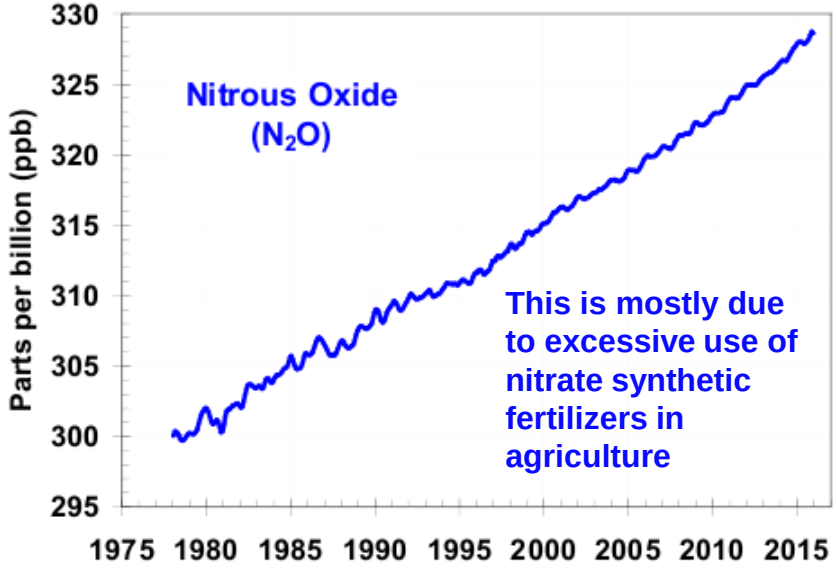
TRENDS OF TEMPERATURE SINCE 1775 IN VIENNA

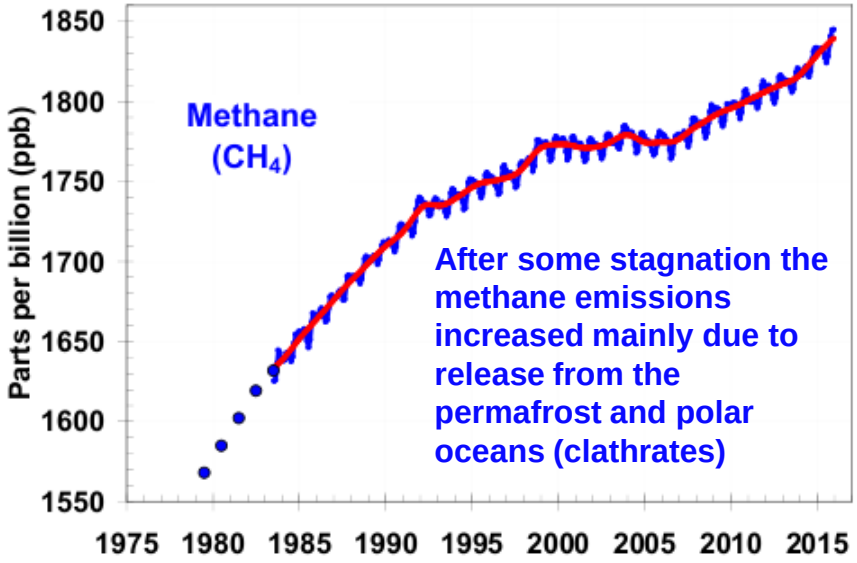
In 1775-1965 mostly natural reasons of climatic changes – different changes in seasons Spring, Summer, Autumn and Winter

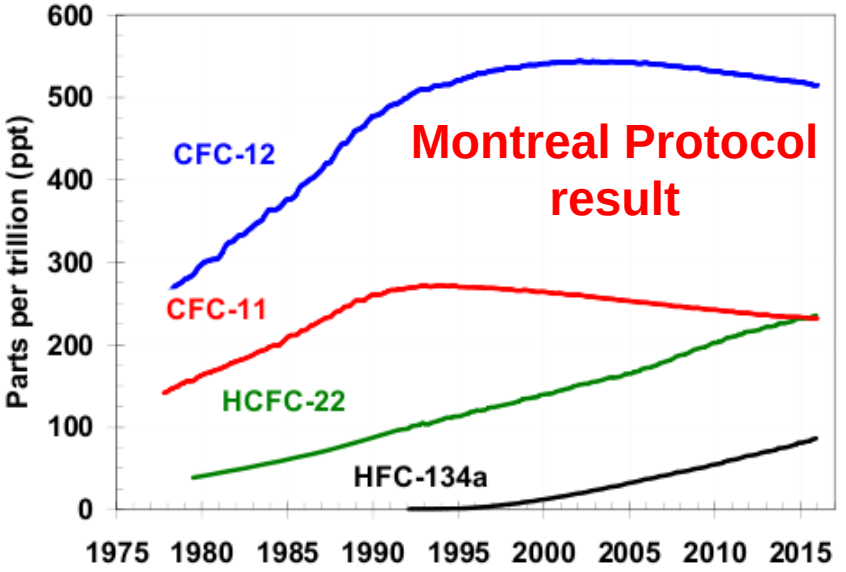


TREND OF MAIN GREENHOUSE GASES

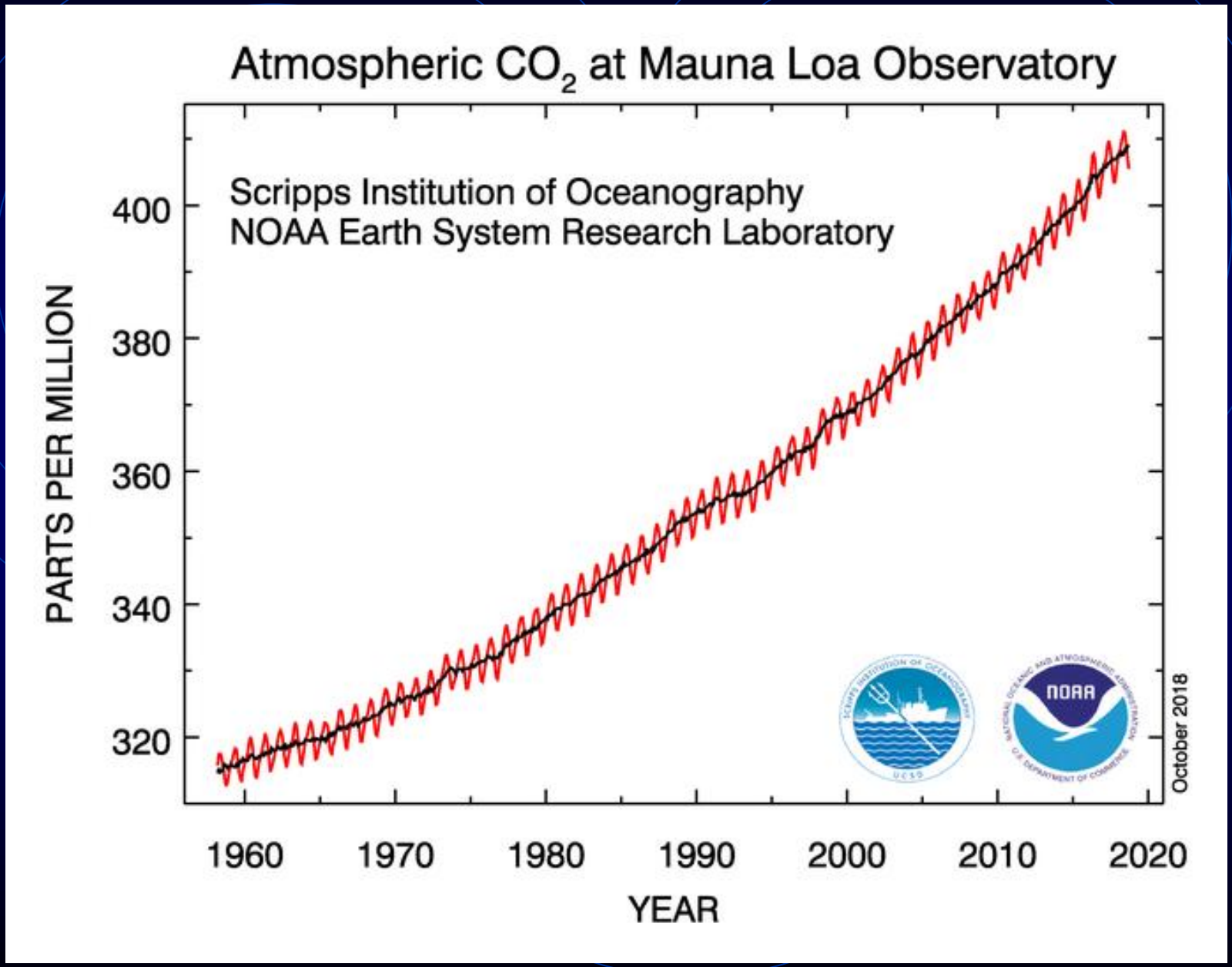








TREND OF CARBON DIOXIDE – MAUNA LOA



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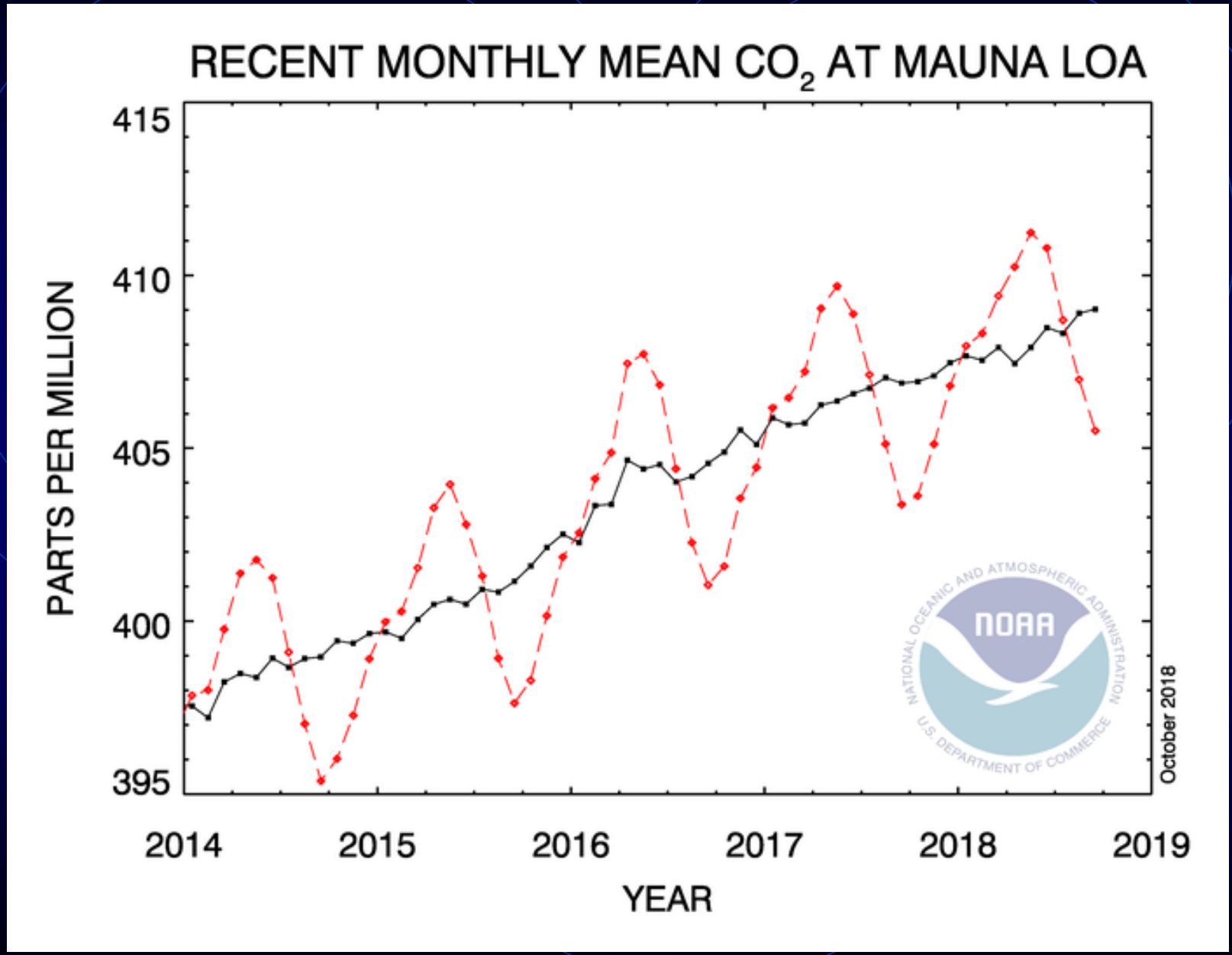
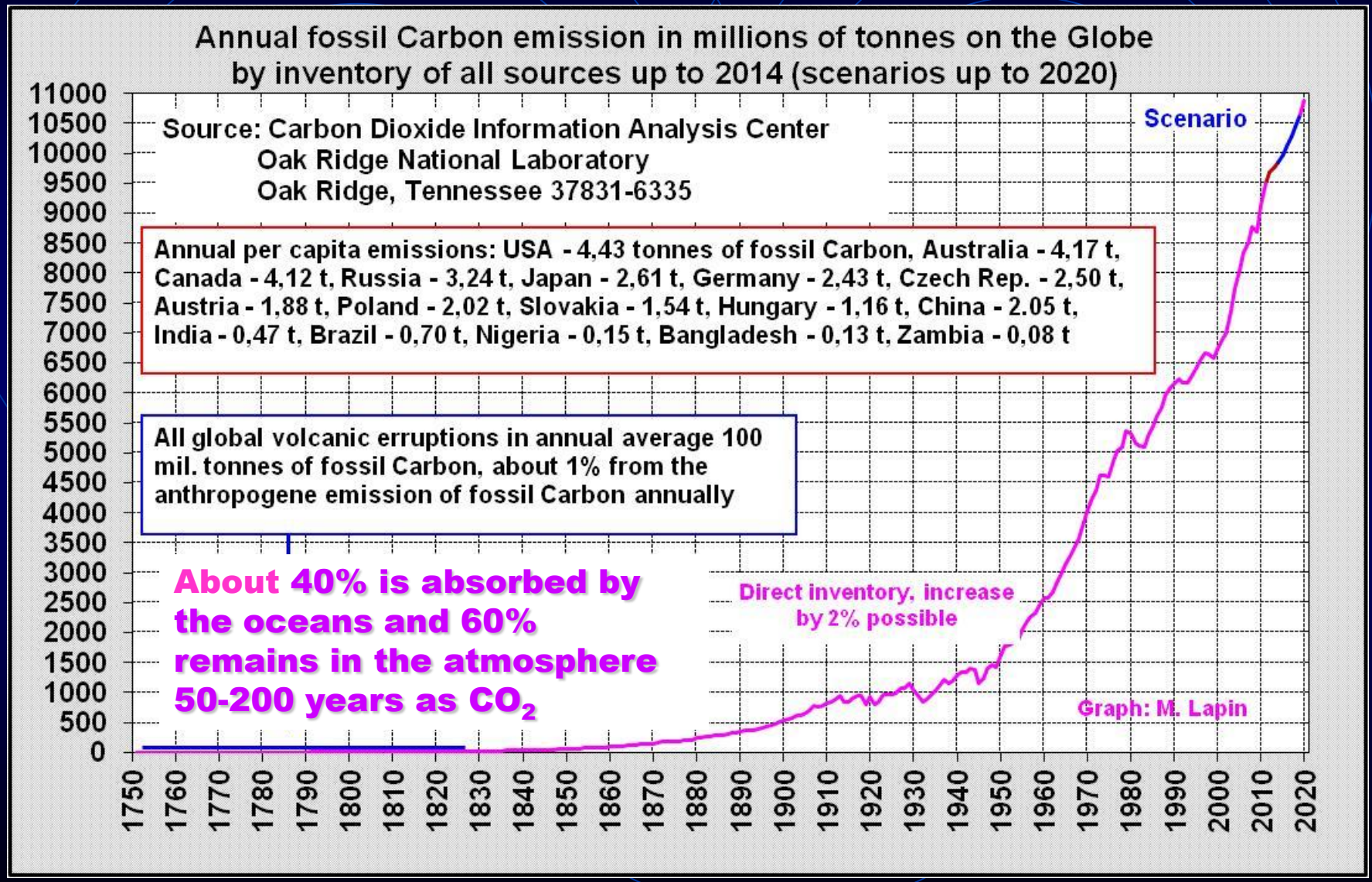
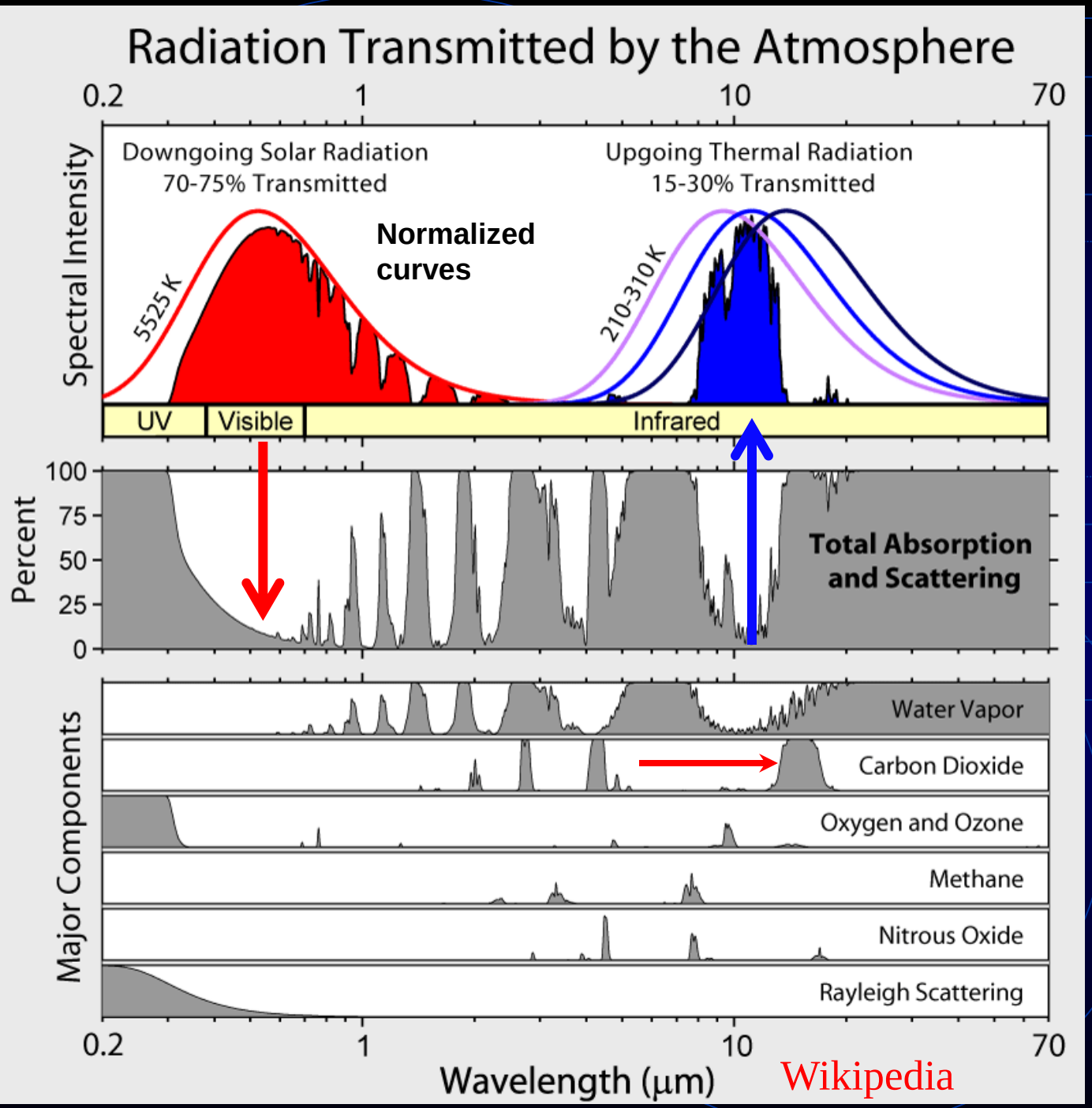


GLOBAL EMISSION OF FOSSIL CARBON MILLION TONNES IN 1751-2020 (inventory up to 2014, assessment up to 2020, possible uplift by 2% + land use change addition)





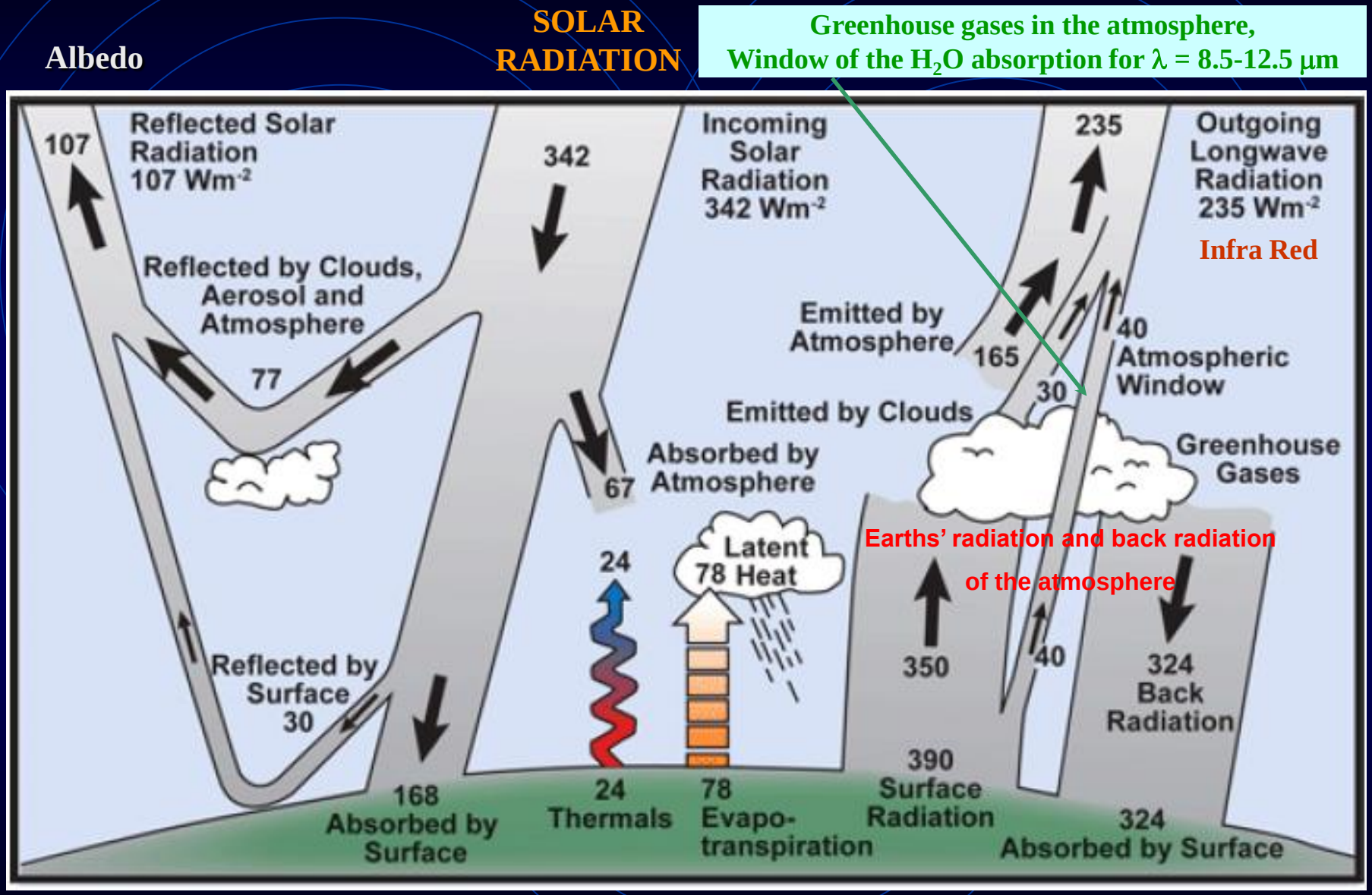
Wikipedia

It is important, that total IR radiation can be absorbed in lower layer of the atmosphere, if some GHG increases its concentration.

The atmosphere produce IR radiation as well, and the absorption process continues up to the top of the atmosphere.

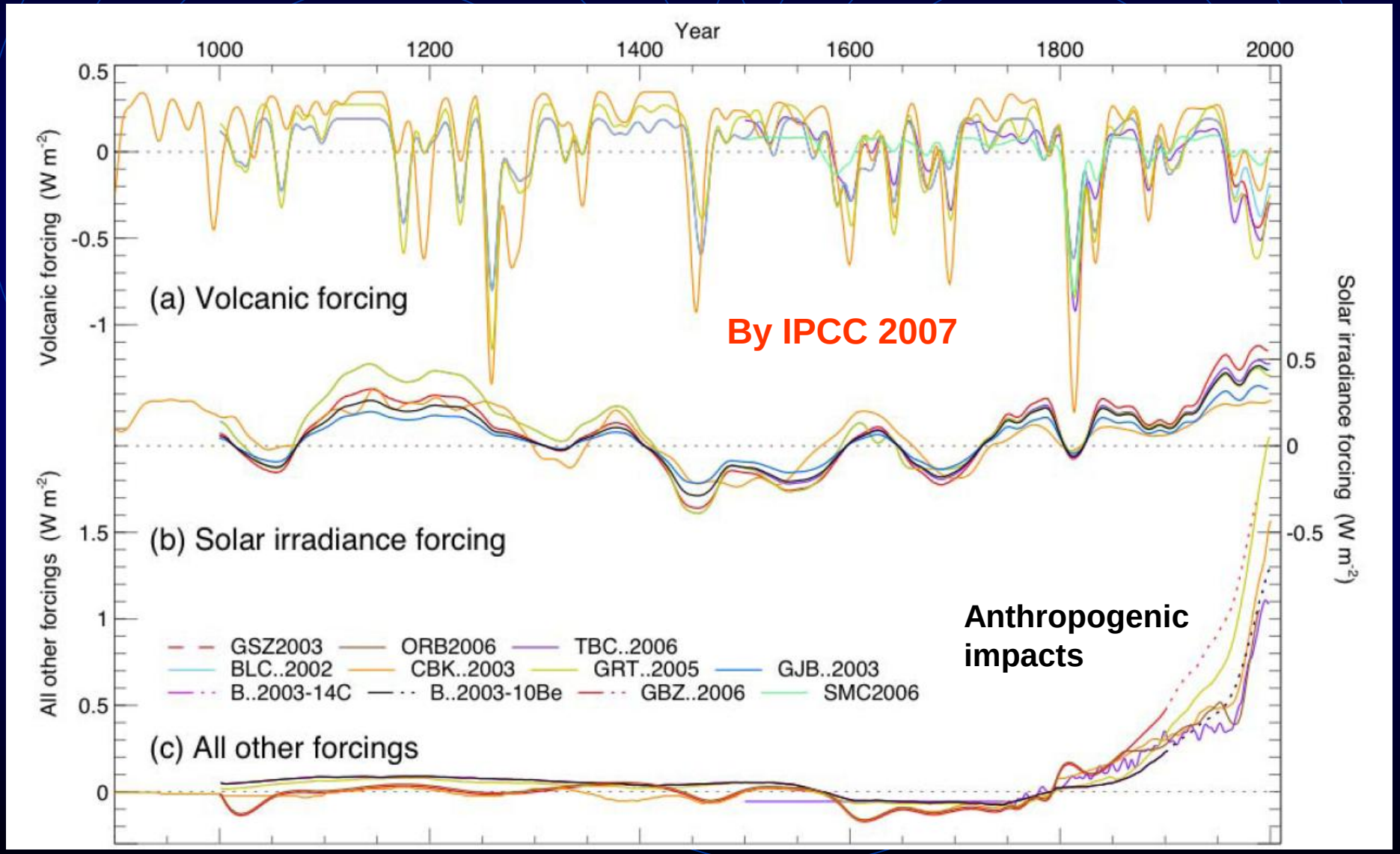
The higher is GHGs concentration in the atmosphere, the greater is increase of surface atmosphere temperature.

Annual means of the Earths' radiation and heat balance



By IPCC 2007

MAIN CLIMATE FORMING FACTORS SINCE 900 – VOLCANIC ACTIVITY, SOLAR ACTIVITY AND ANTHROPOGENIC ENHANCEMENT

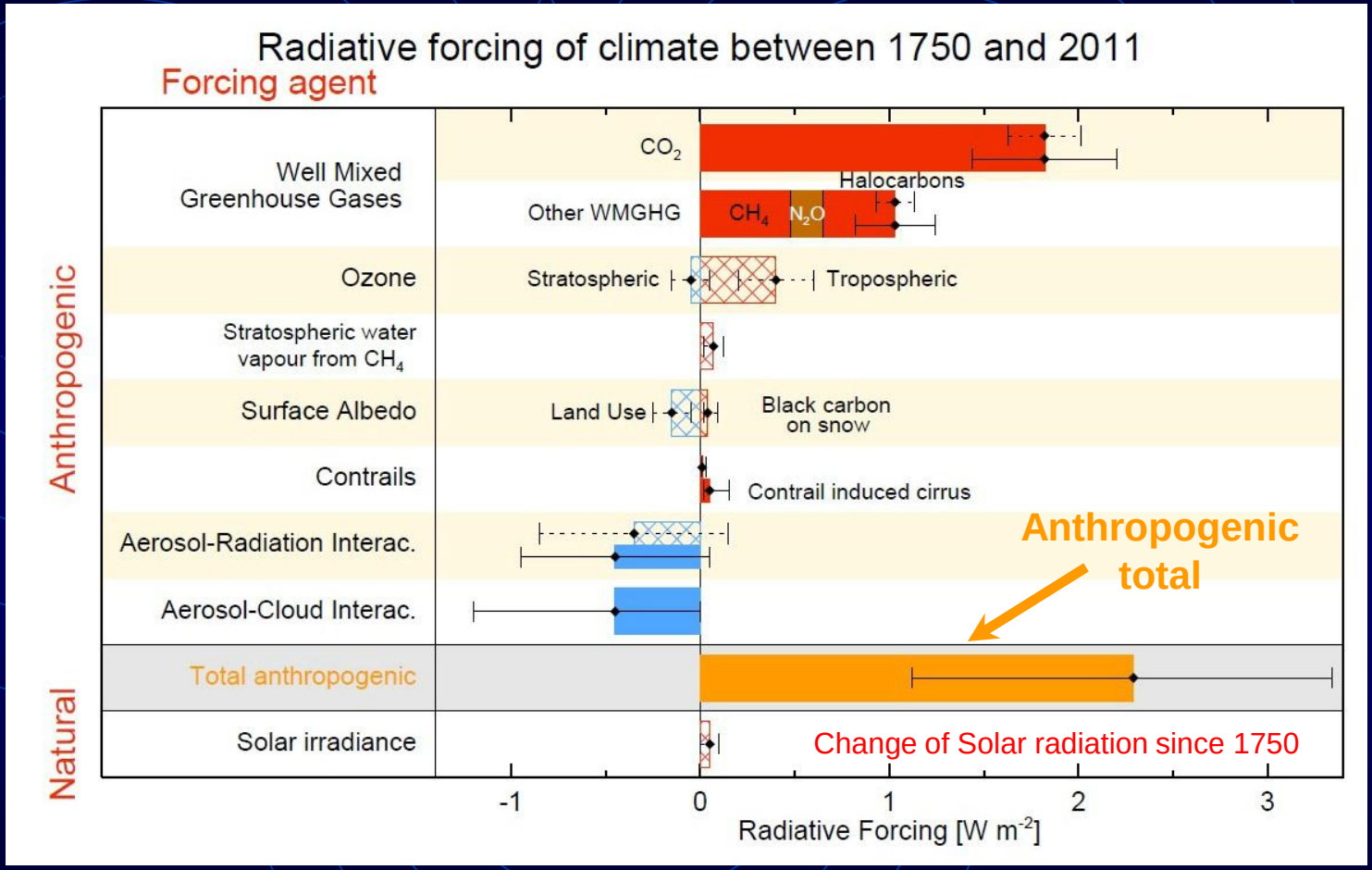


SHARE OF ALL ANTHROPOGENIC FORCINGS ON CLIMATE CHANGE SINCE 1750 (IPCC 2013)

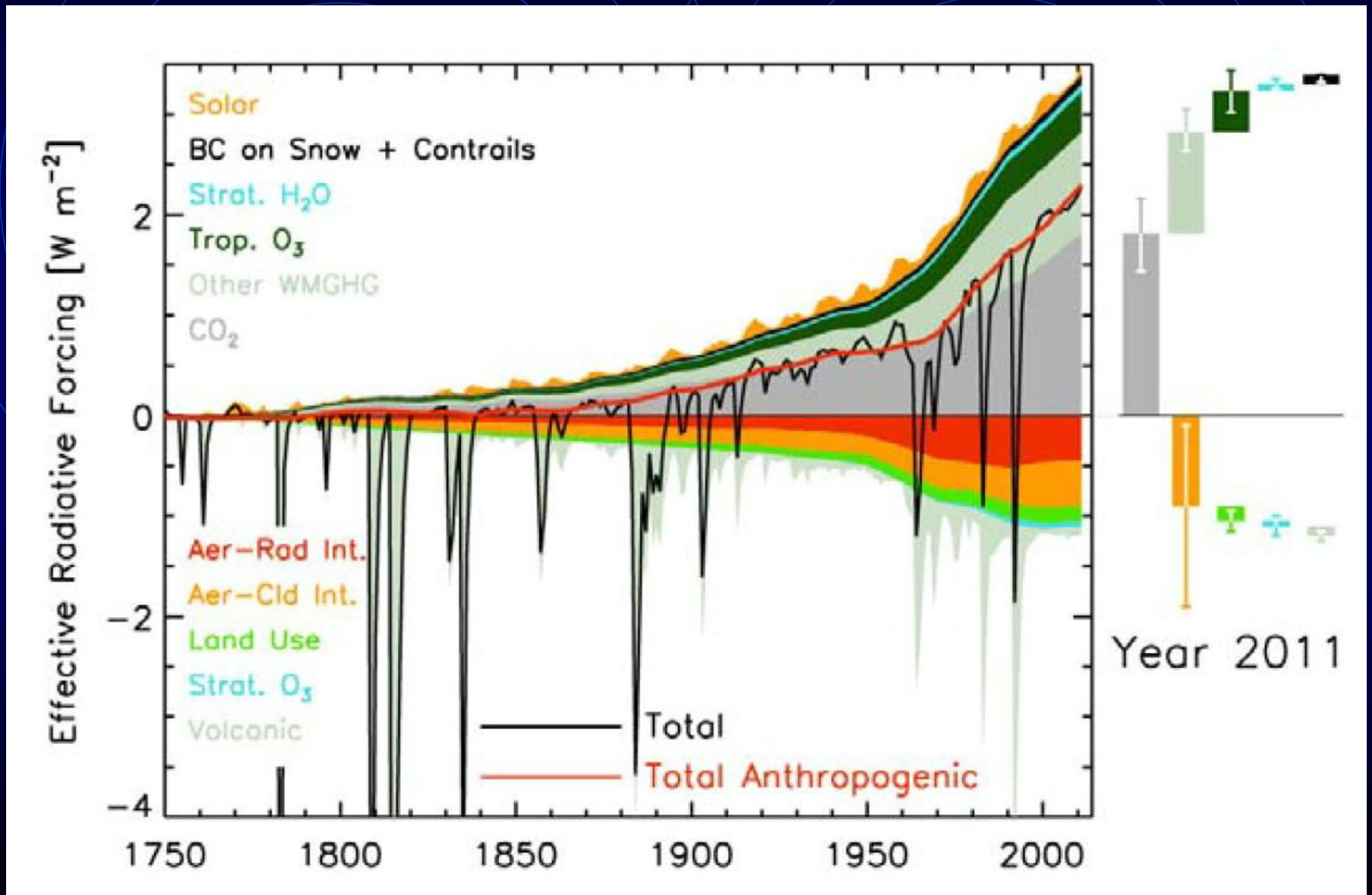
Greenhouse gases with positive forcing on climate change

Aerosols and change in land use with negative forcing on climate change

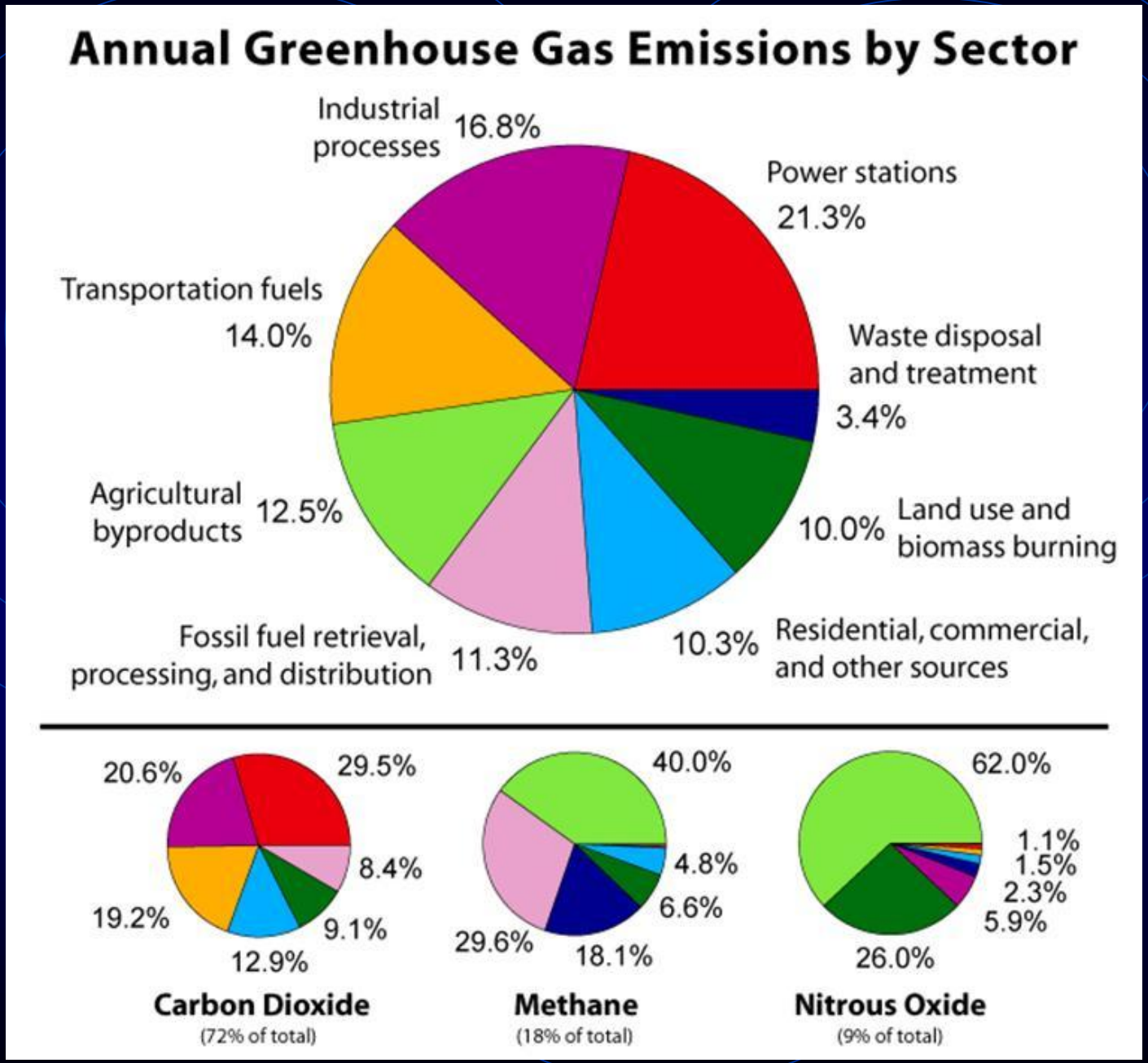
Comparison of anthropogeni-cally based forcing and naturally based forcing since 1750



COMPARISON OF MAIN FORCINGS ON CLIMATE CHANGE IN 1750-2011 (Black line represents the final result of all radiative forcings, at present (2016) it is about 2,5 W.m^{-2}, rapid variations by volcanoes)



COMPARISON OF MAIN SOURCES OF GREENHOUSE GASES, 2000



IMPACTS IN SOCIO-ECONOMIC SECTORS & ENVIRONMENT

- Climate (monitoring, analysis, scenarios…)
- Hydrological Cycle (runoff, evaporation, ground water…)
- Water Economy (management of water supply…)
- Water Resources (drinking water, irrigation…)
- Agricultural Economy (management, plant production)
- Agricultural Ecosystems (pest, diseases, weeds…)
- Forestry (management, uniformity…)
- Forest Ecosystems (instability, pest, diseases…)
- Biodiversity (instability, new species…)

Important Sectors – seldom participating in analyses in Slovakia

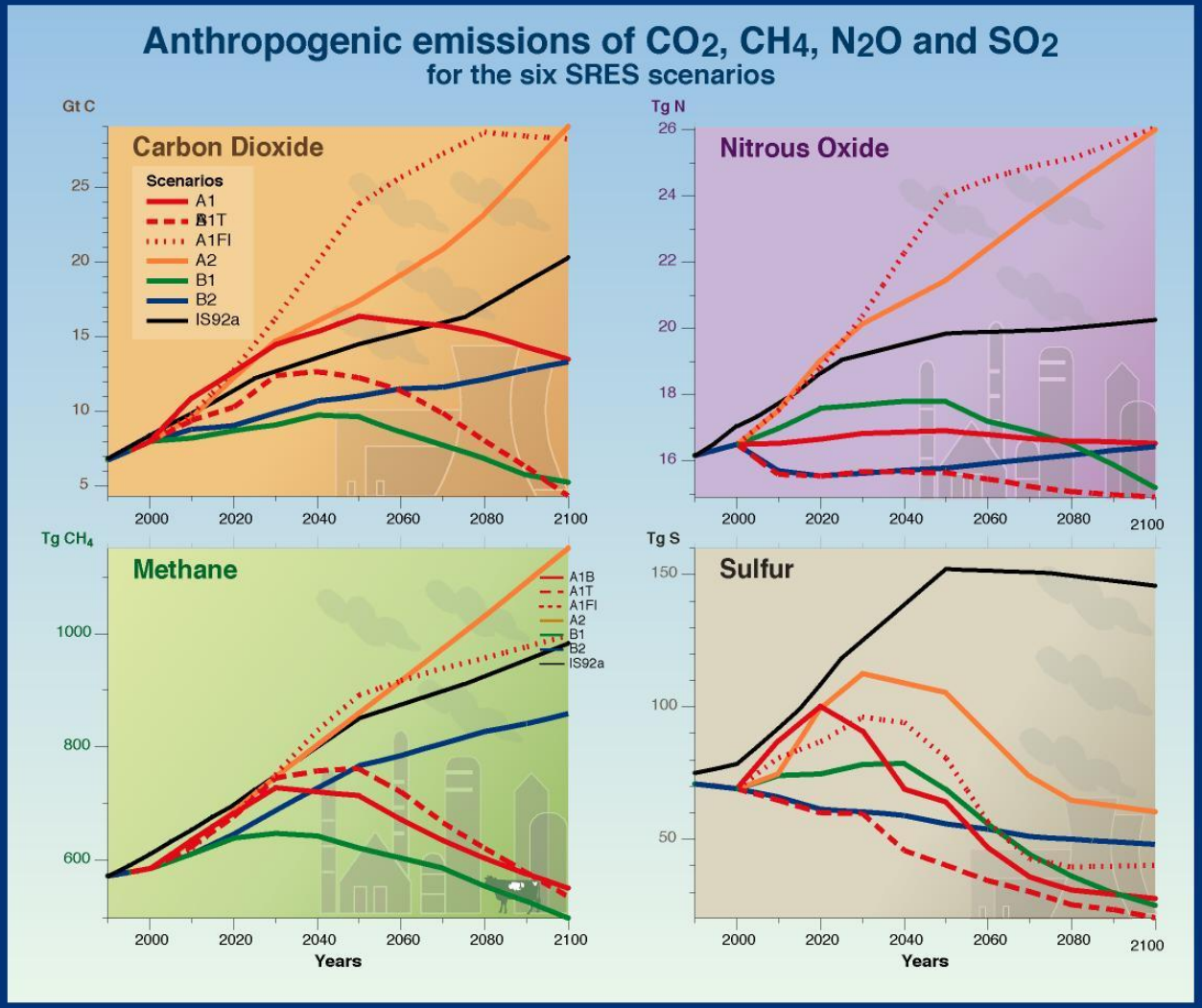
- Recreation and Tourism
- Health and Hygiene
- Economy, Civil engineering and Energy supply
- Transport and Telecommunications

COMMENT: Sea level rise; Coastal regions; Fisheries; Glaciers; Permafrost; Tropical cyclones and some others – not solved in Slovakia

CLIMATE CHANGE SCENARIOS SUMMARY

- Scenarios based on the Atmosphere General Circulation Models - GCMs (Atmosphere-Ocean Models and Regional Models at present – also 10x10 km resolution)
- Scenarios based on historical analogues
- Incremental scenarios – acceptable for impact models testing only
- Stochastic weather generator based time series as scenarios
- Combined scenarios – 1. Step: selection of reliable T (temperature), R (precipitation) and s (specific humidity) GCMs scenarios and; 2. Step: calculation of analogs for other climatic/hydrologic elements using correlation/regression and simple modeling – scenarios for whole distribution range – **Priority in Slovakia**
- Scenarios for time frames, time series, events, extremes...
- The first series of scenarios in 1995, the second in 1997, then in 2000, 2010 and 2014 (comparison for 2010 time frame)

Emission scenarios
A1, B1T, A1F1, A2, B1, B2 and older IS92a represent different ways of Climate Change mitigation



WG1 TS FIGURE 17

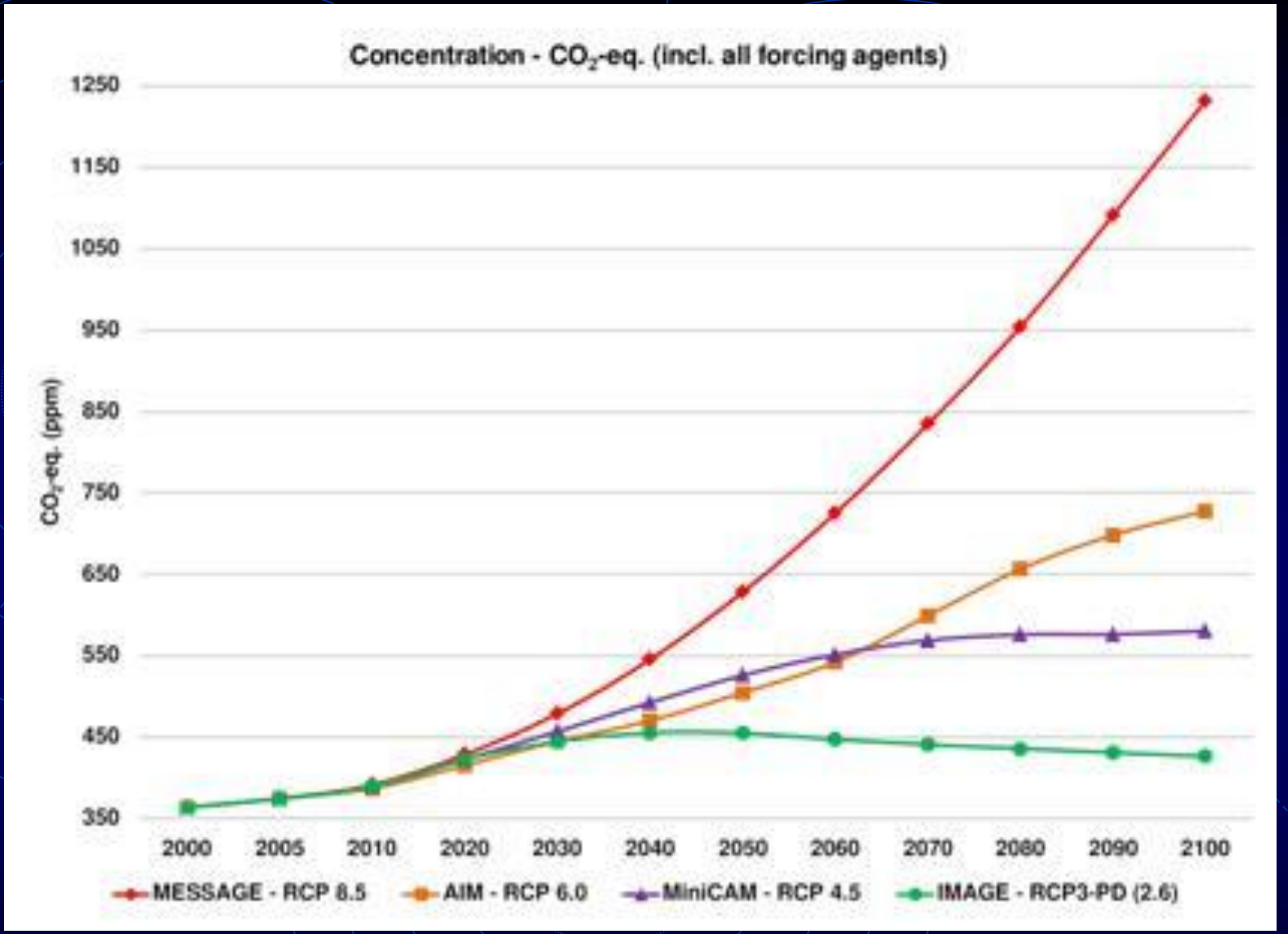
Alternative scenarios prepared by 6 different centers

Emission scenarios RCP 8.5, RCP 6.0, RCP 4.5, RCP 2.6

Older

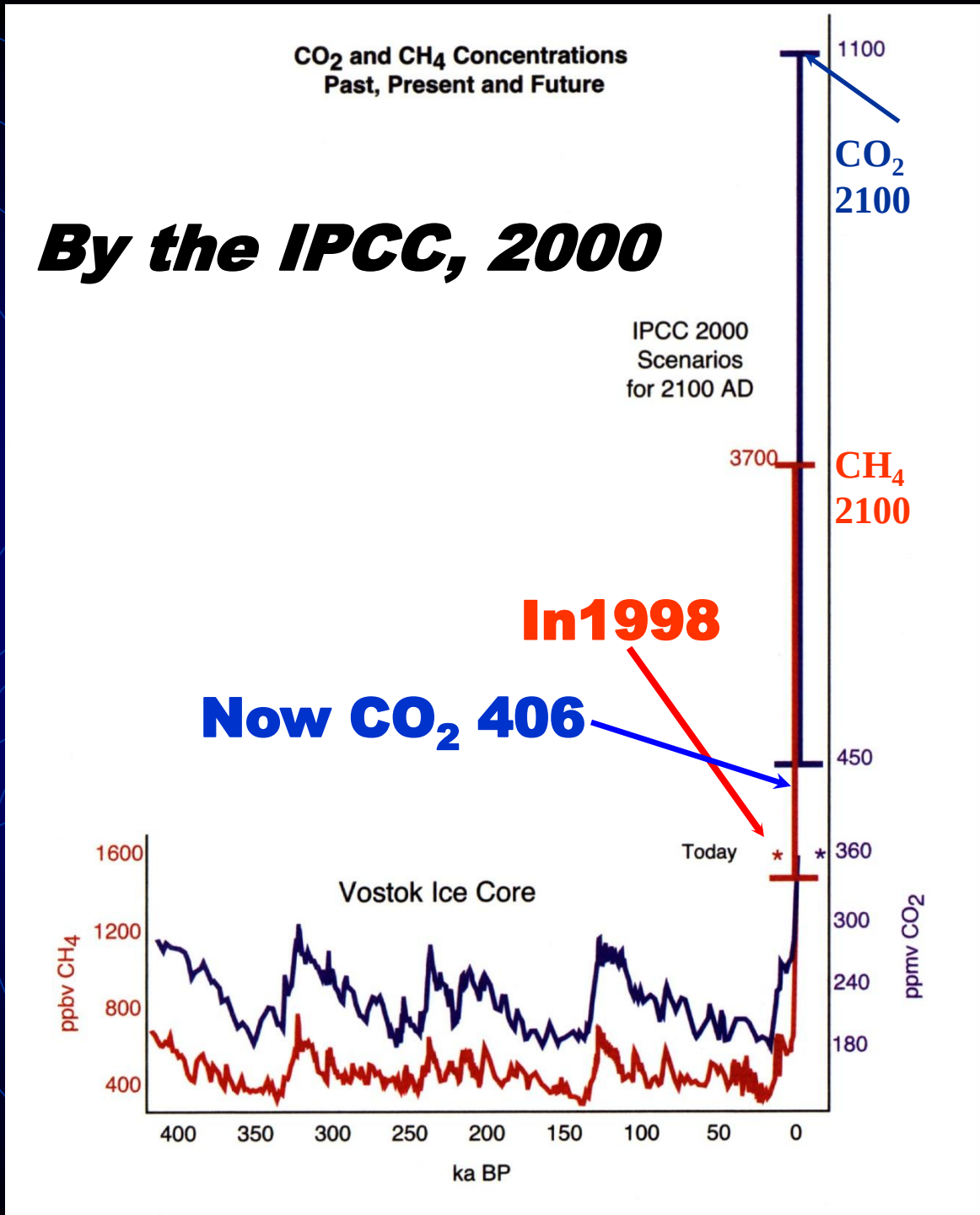
A1, B1T, A1F1, A1B, A2, B1, B2

and more older IS92a, IS92b, IS92c represent different ways of Climate Change mitigation

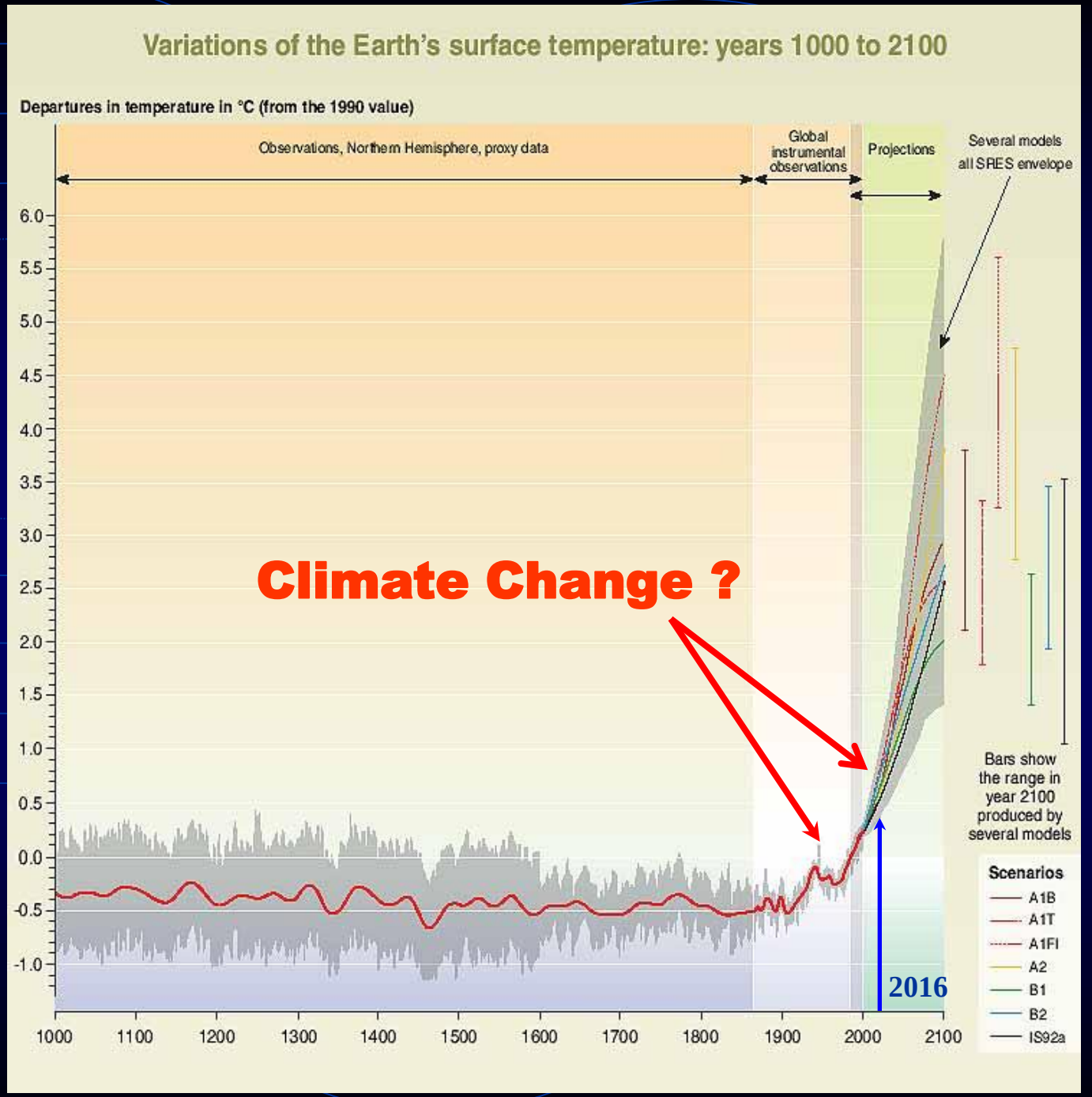


Alternative scenarios prepared by different centers and published in IPCC AR 5

Atmospheric CO_2 and CH_4 concen- tration in the last 400 thousand yrs. Based on Vostok (Antarctic) data Possible scenarios up to the year 2100

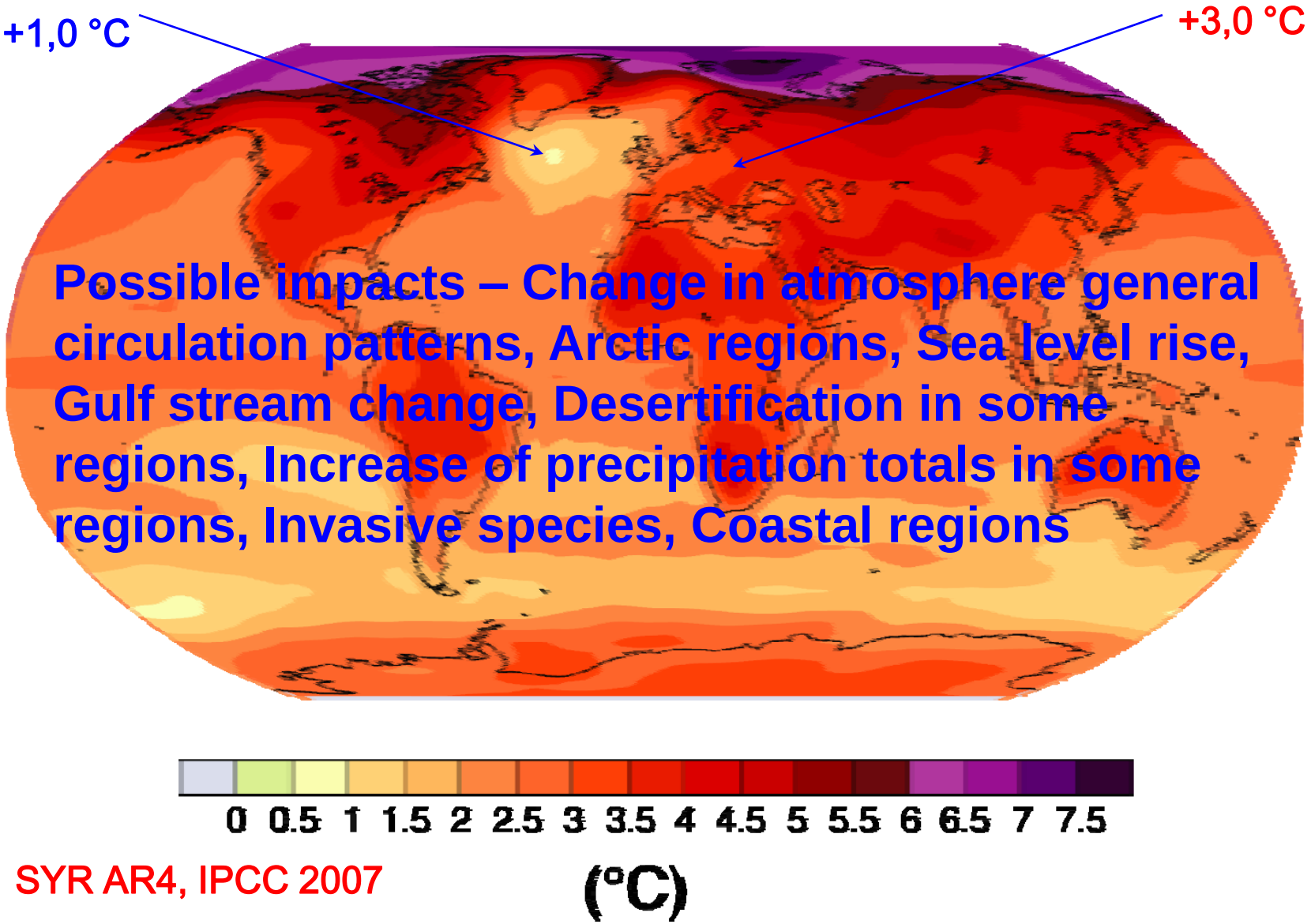


From year 1000 to year 1850 variations in average surface temperature of the Northern Hemisphere are shown (corresponding data from the Southern Hemisphere not available) reconstructed from proxy data (tree rings, corals, ice cores, and historical records). The line shows the 50-year average, the grey region the 95% confidence limit in the annual data. 1850-2000 measured data, 2001-2100 are scenarios (by: IPCC).



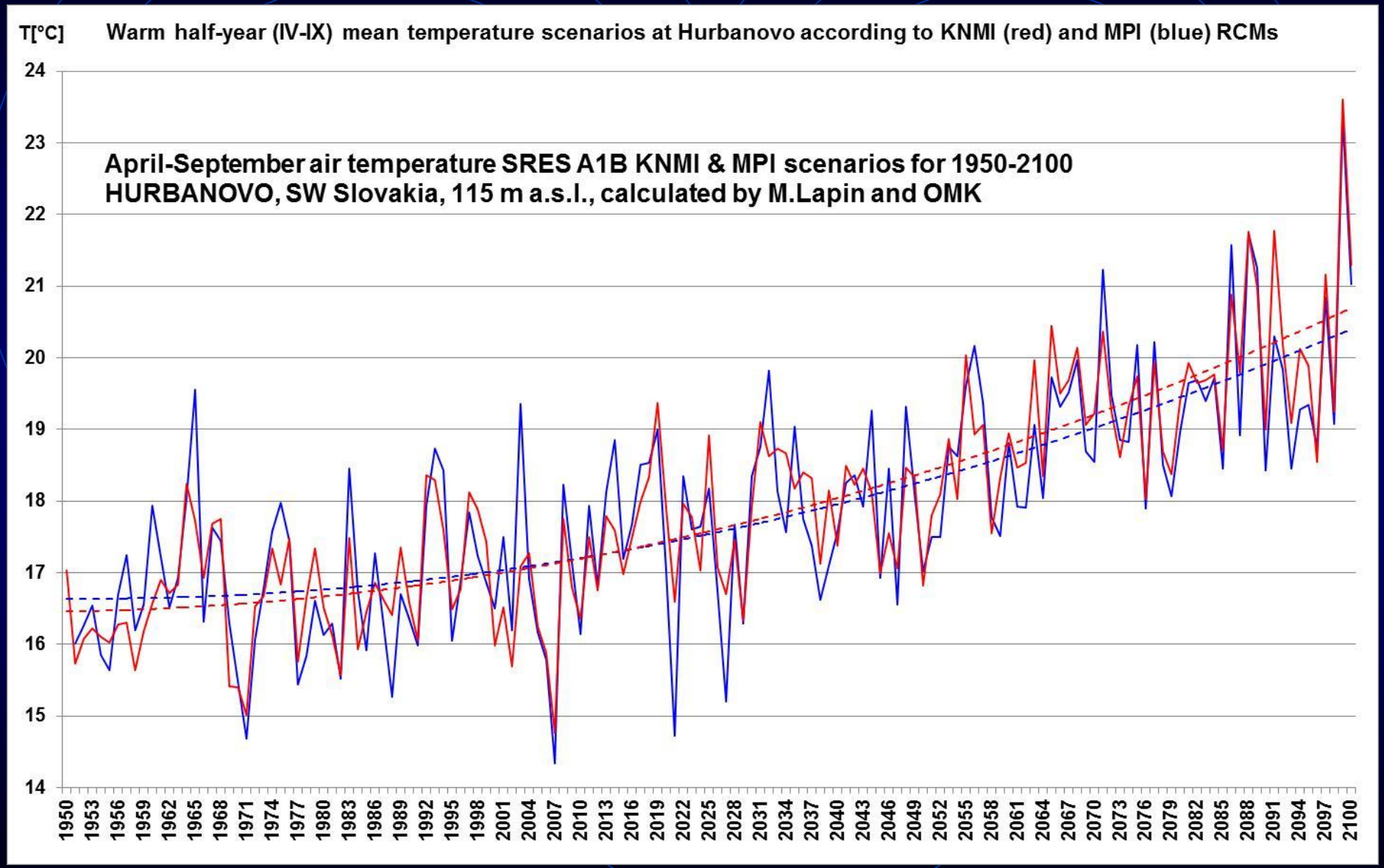
10-year mean warming in 2090-2099 compared to 1980-1999, A1B SRES

Geographical pattern of surface warming



SYR AR4, IPCC 2007

AIR TEMPERATURE SCENARIOS FOR HURBANOVO (115 m)



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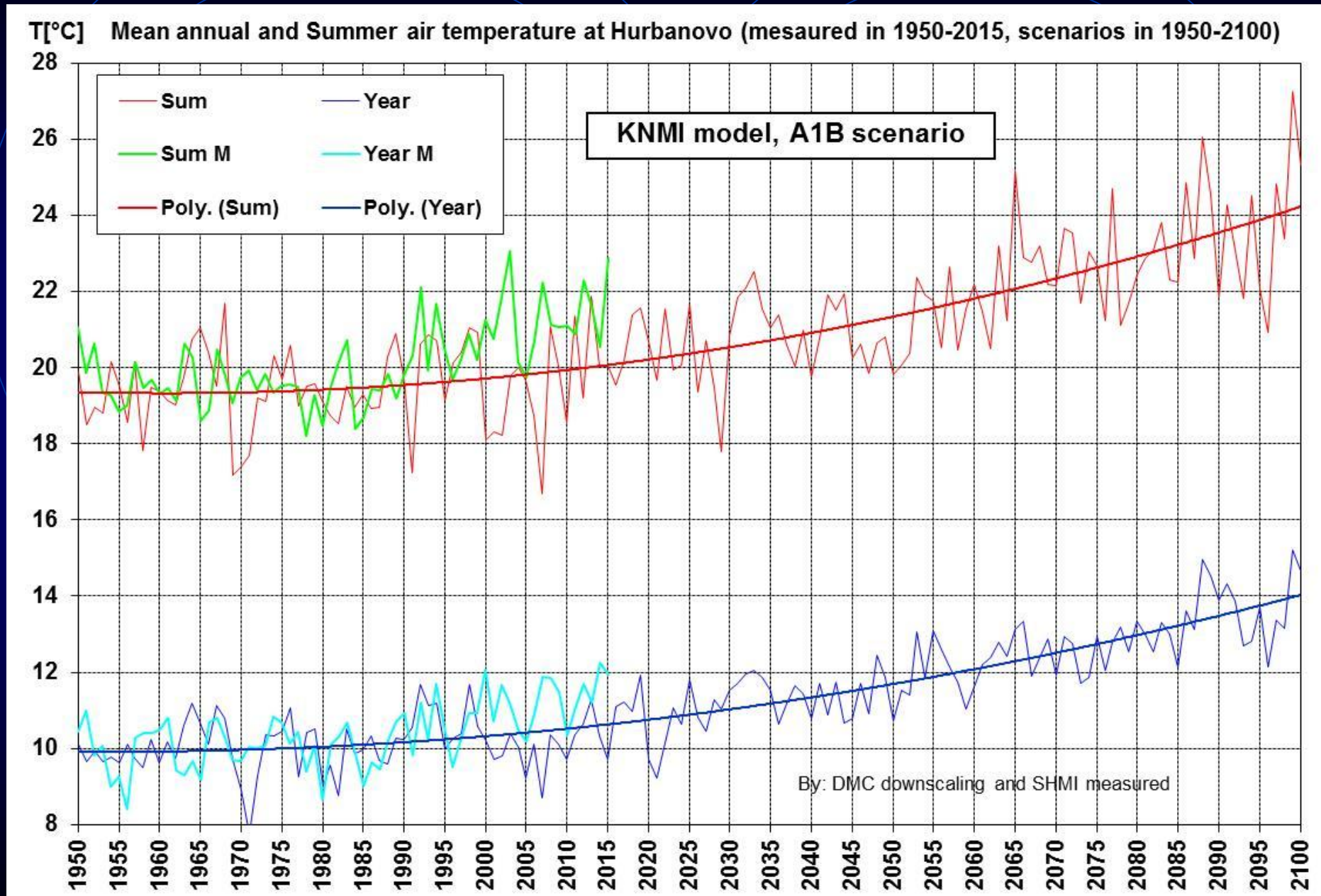

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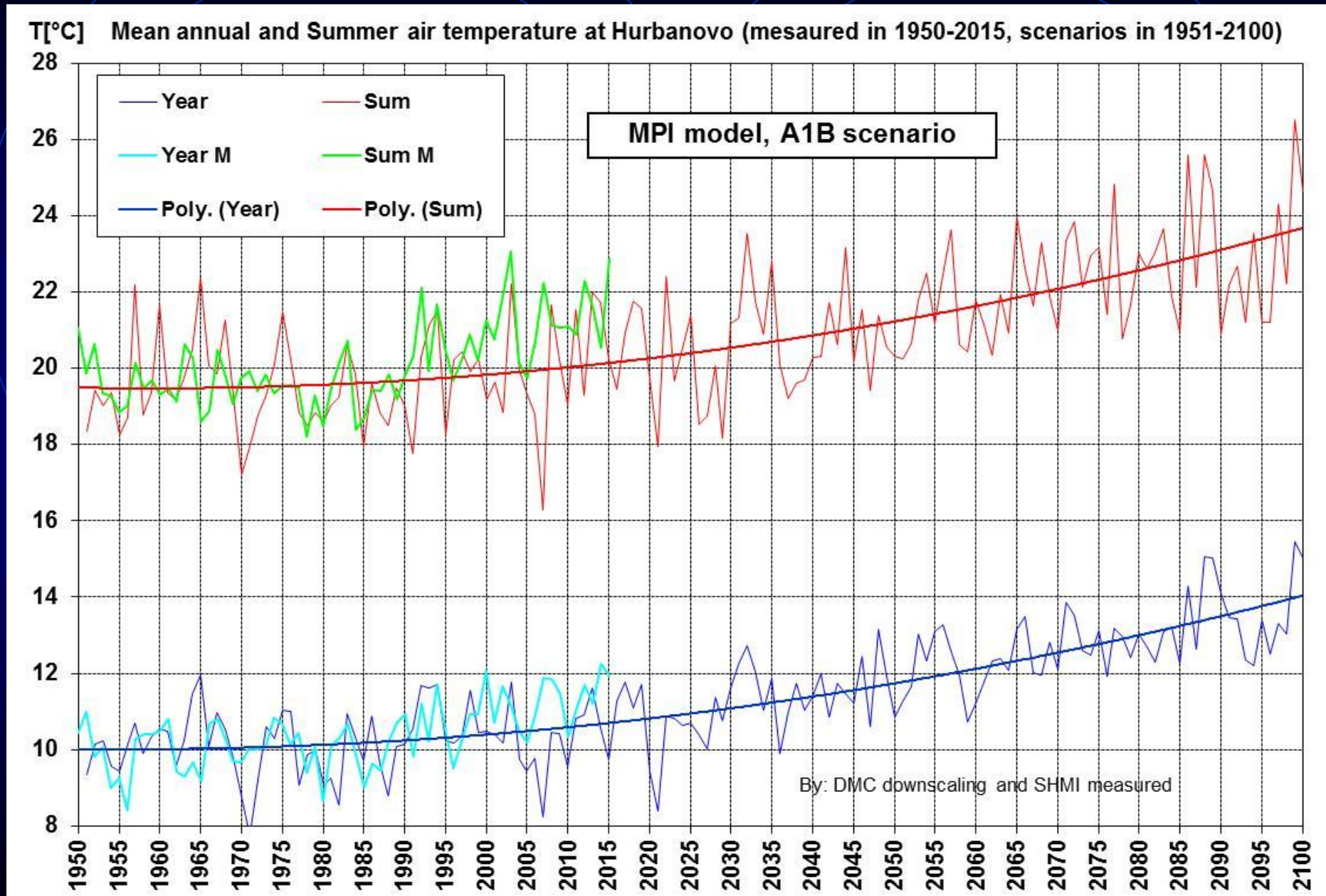
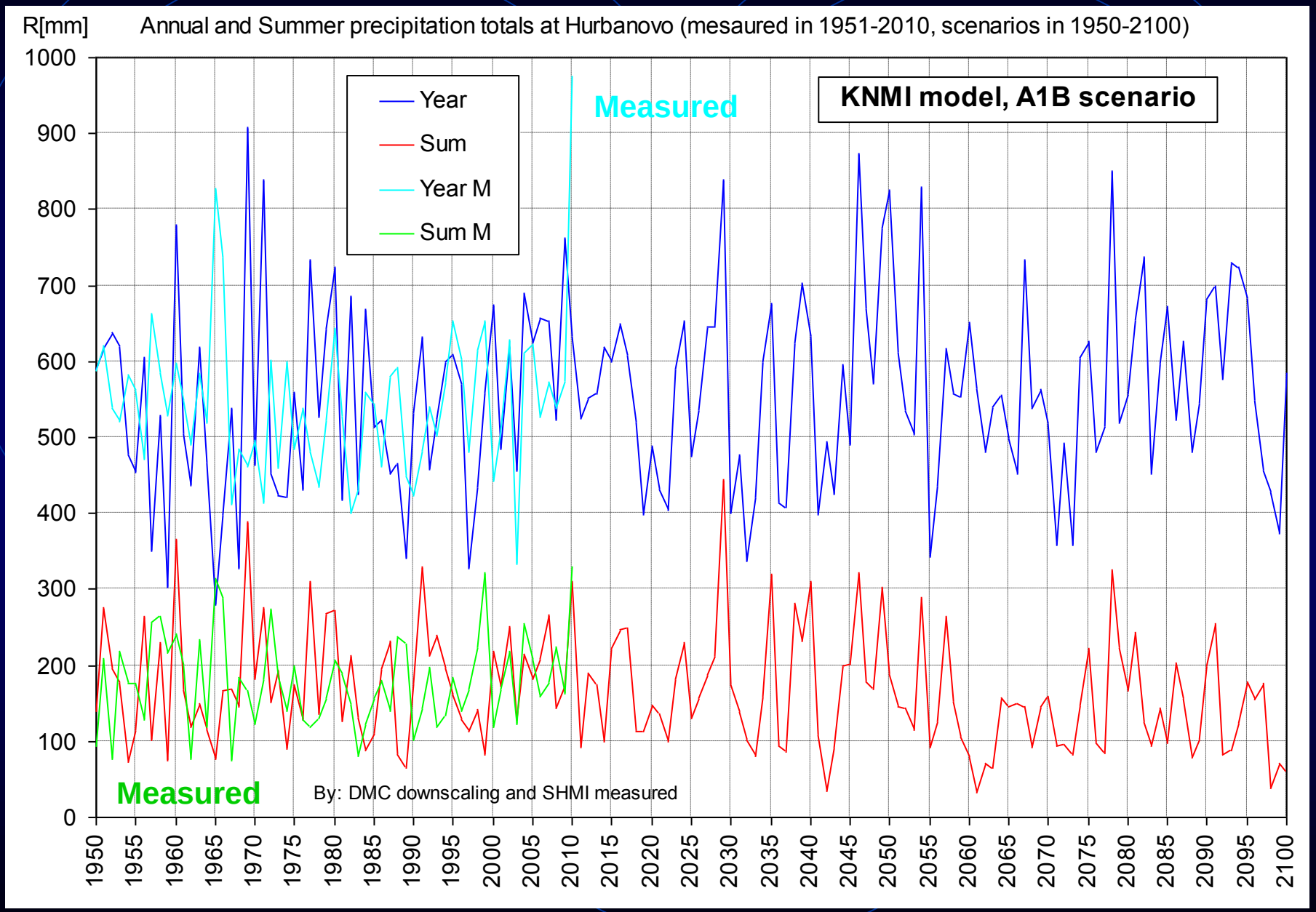
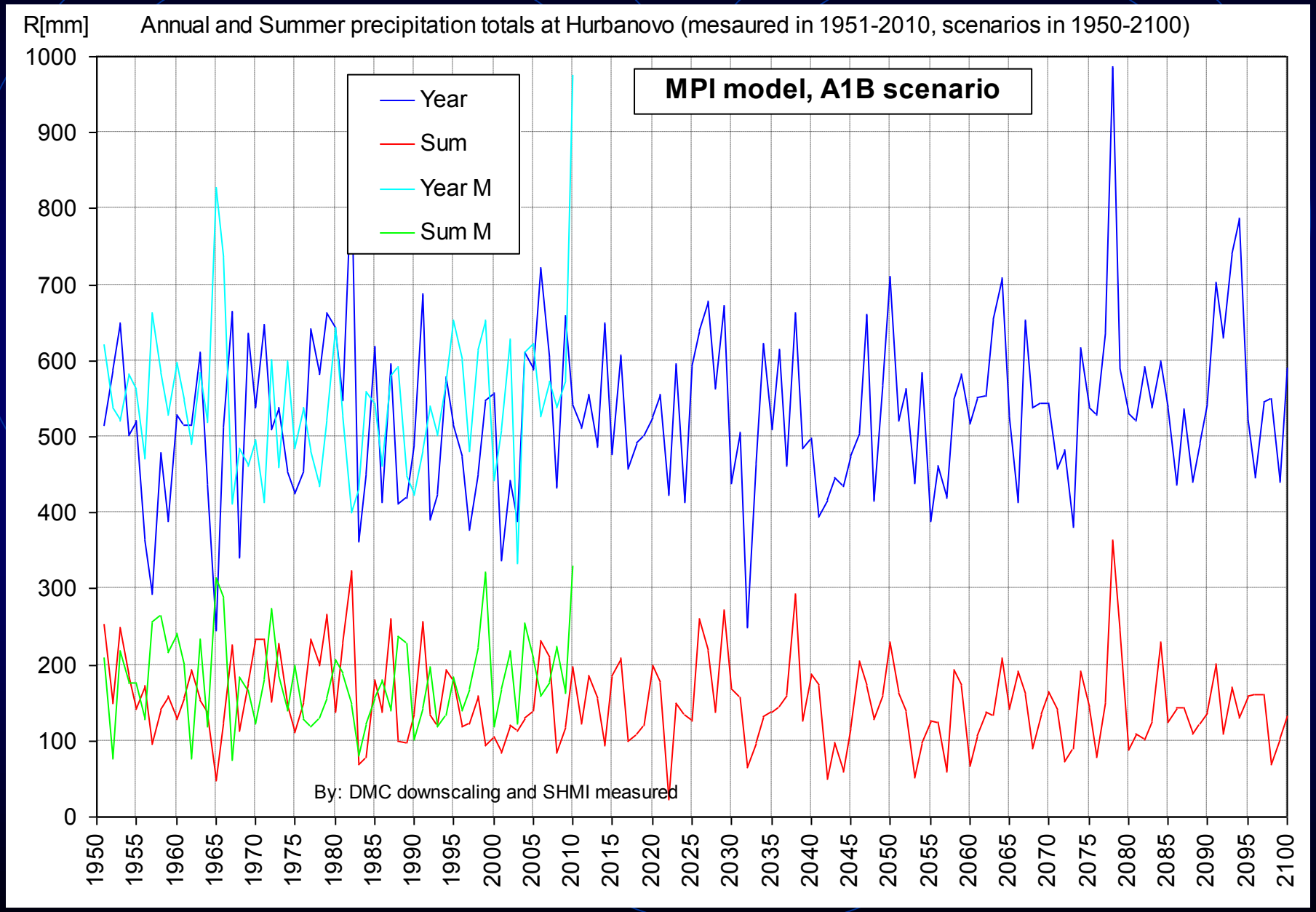


PRECIPITATION SCENARIOS FOR HURBANOVO, ANNUAL AND SUMMER



PRECIPITATION SCENARIOS FOR HURBANOVO, ANNUAL AND SUMMER



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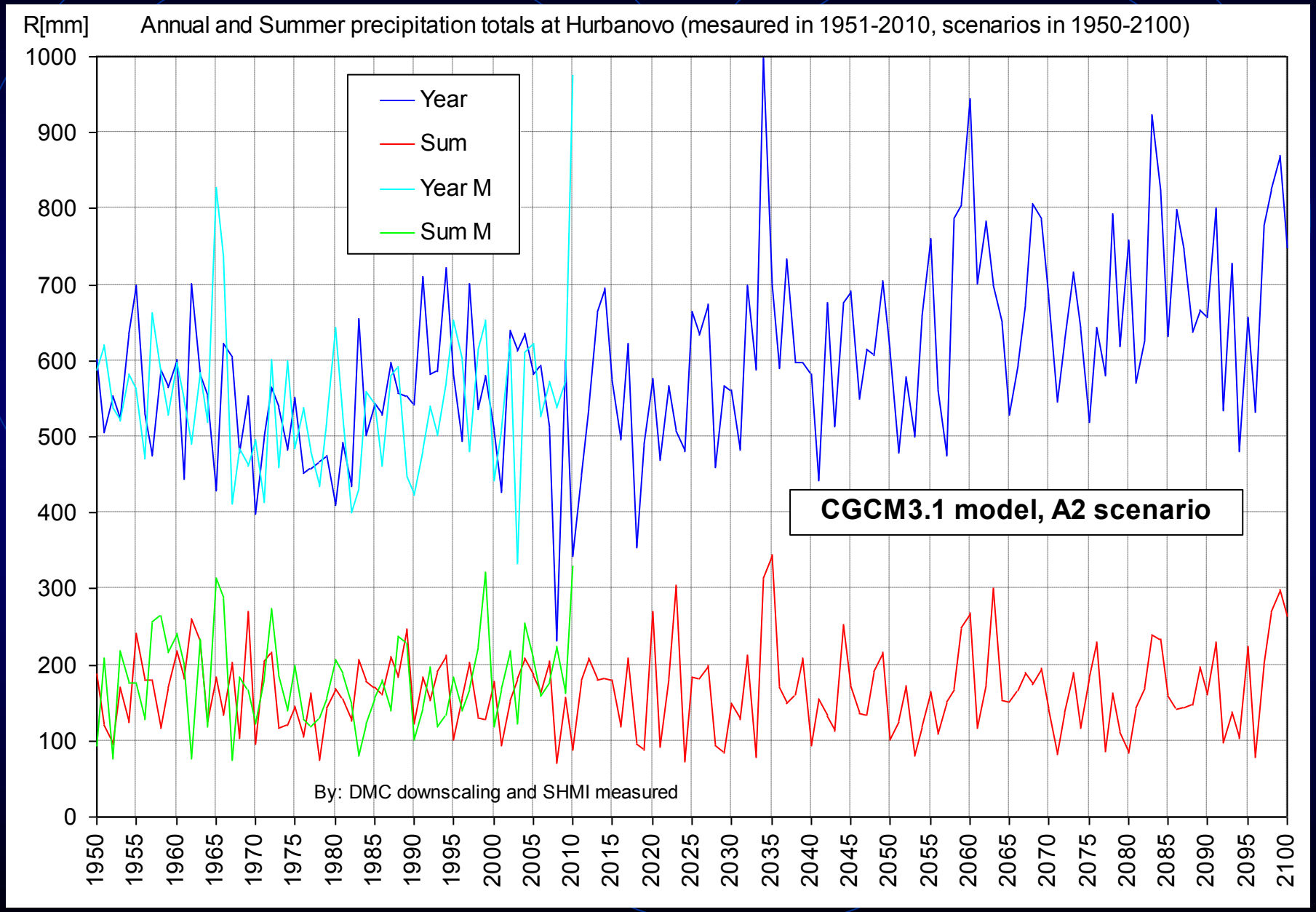

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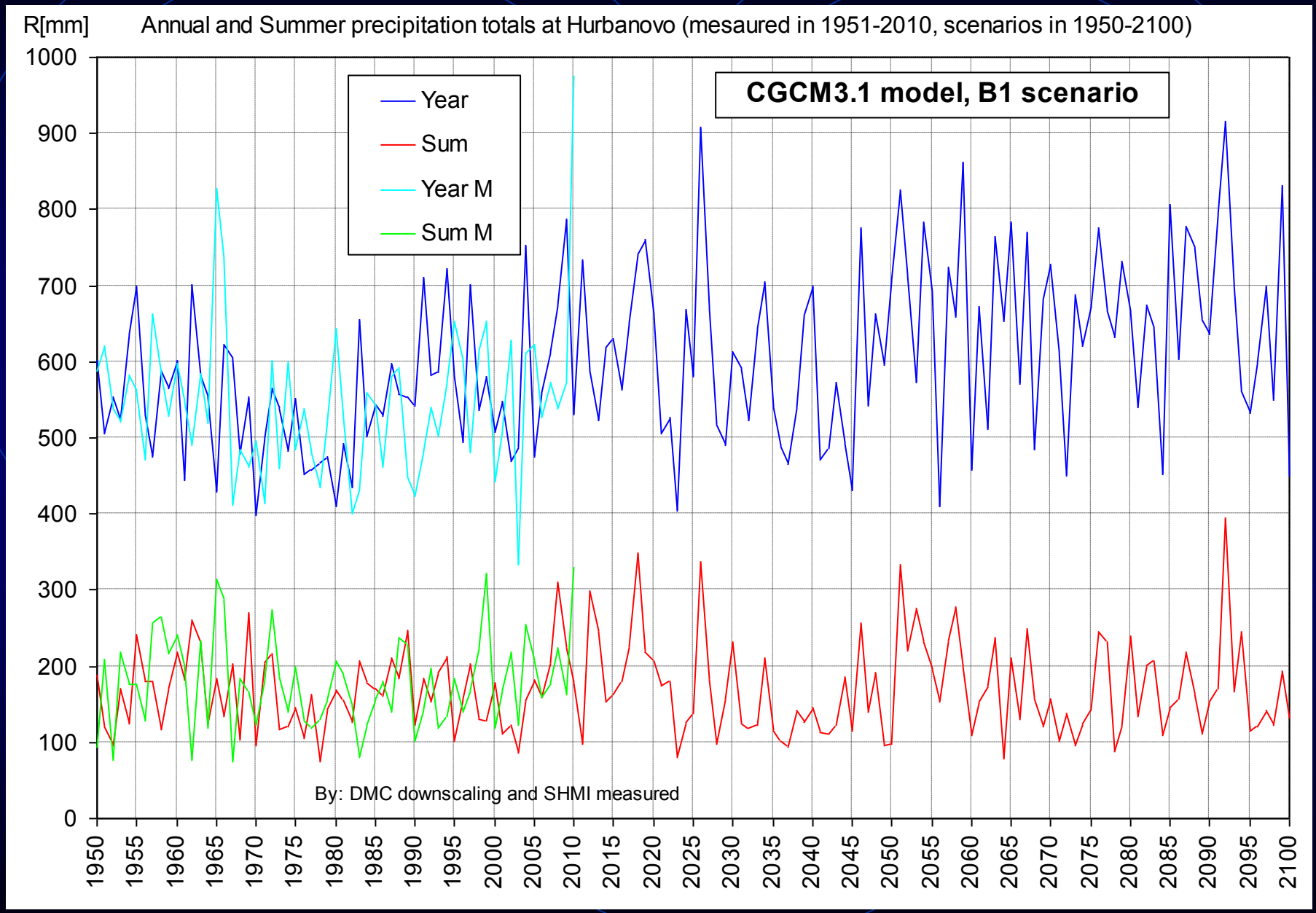
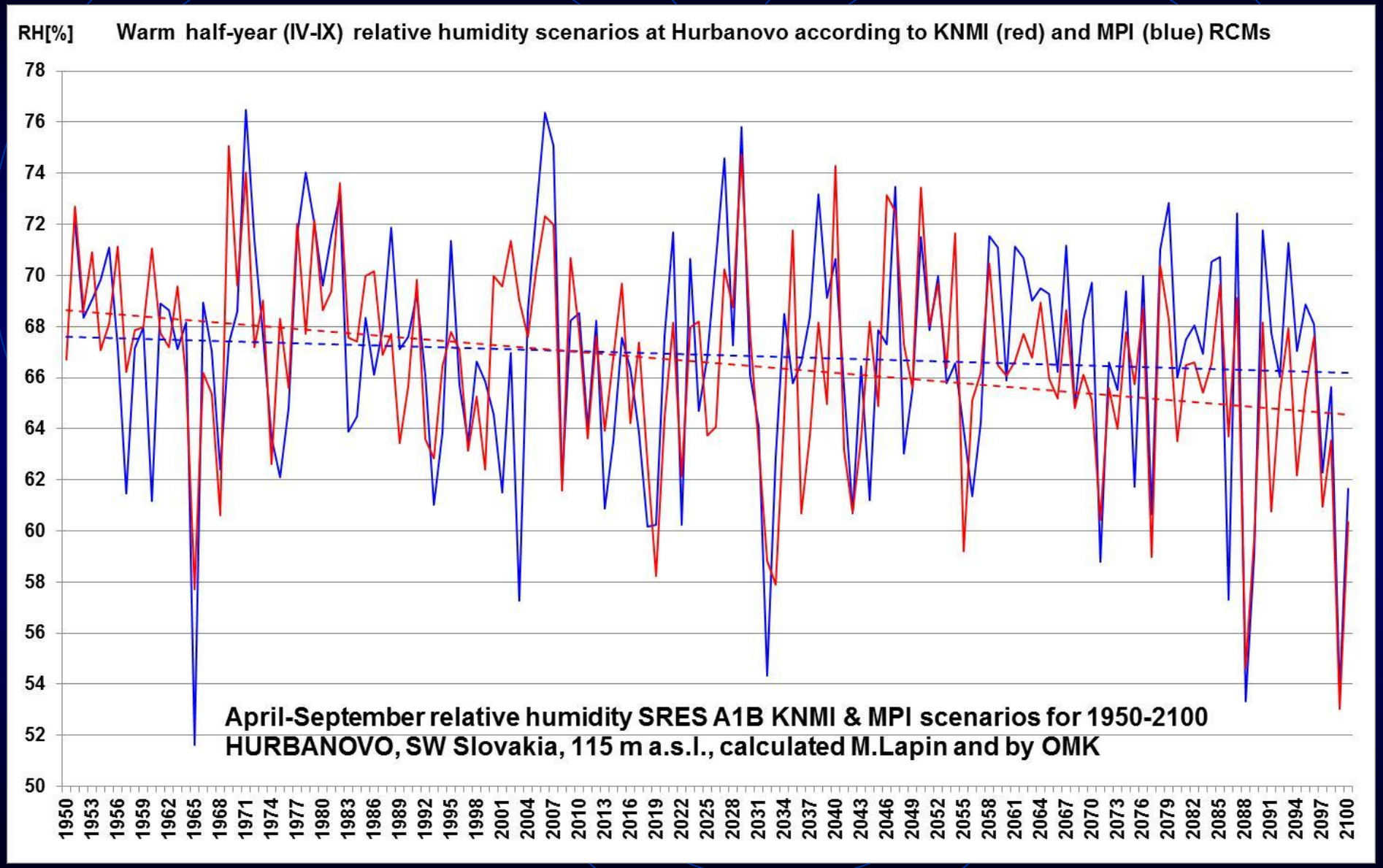
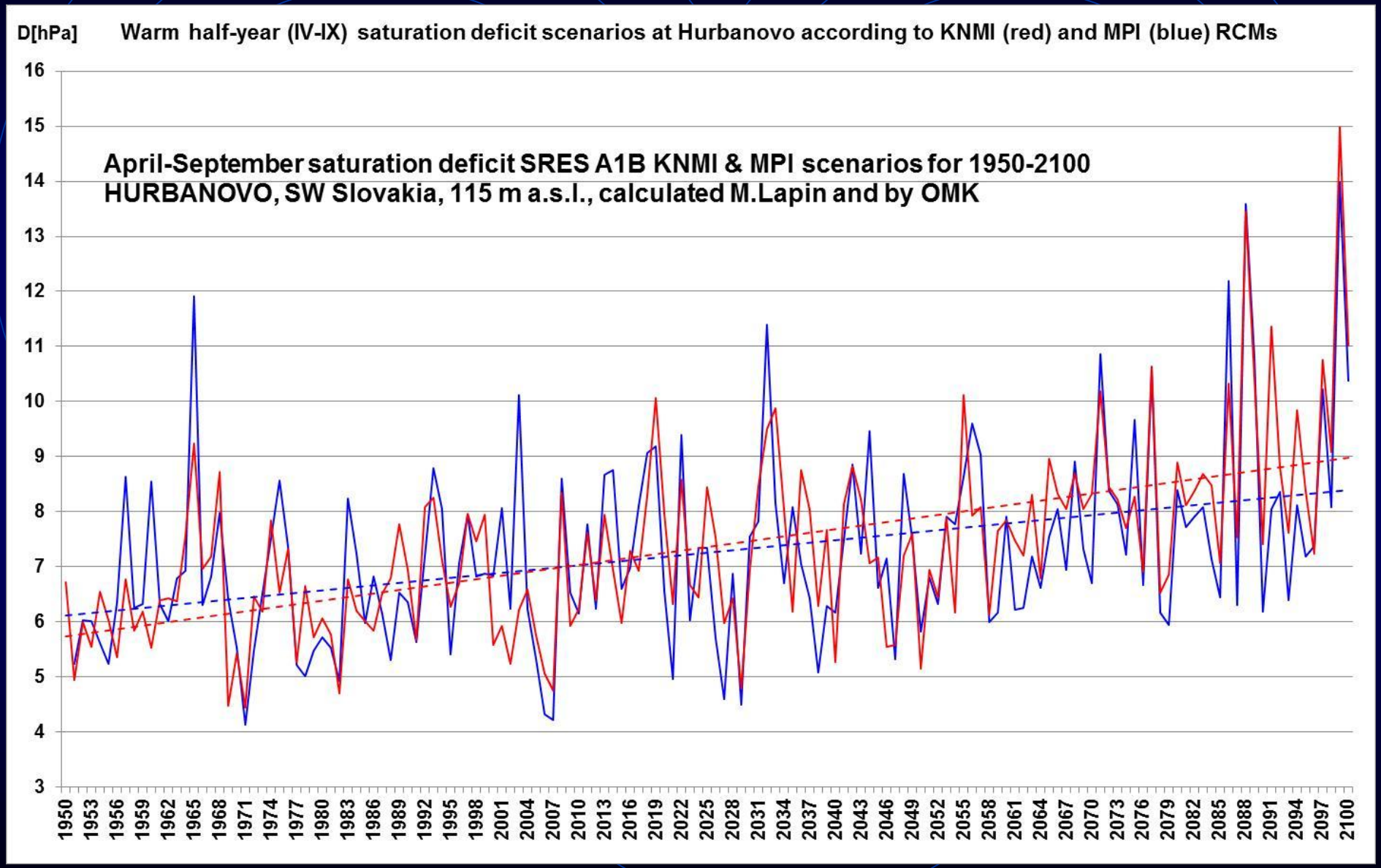


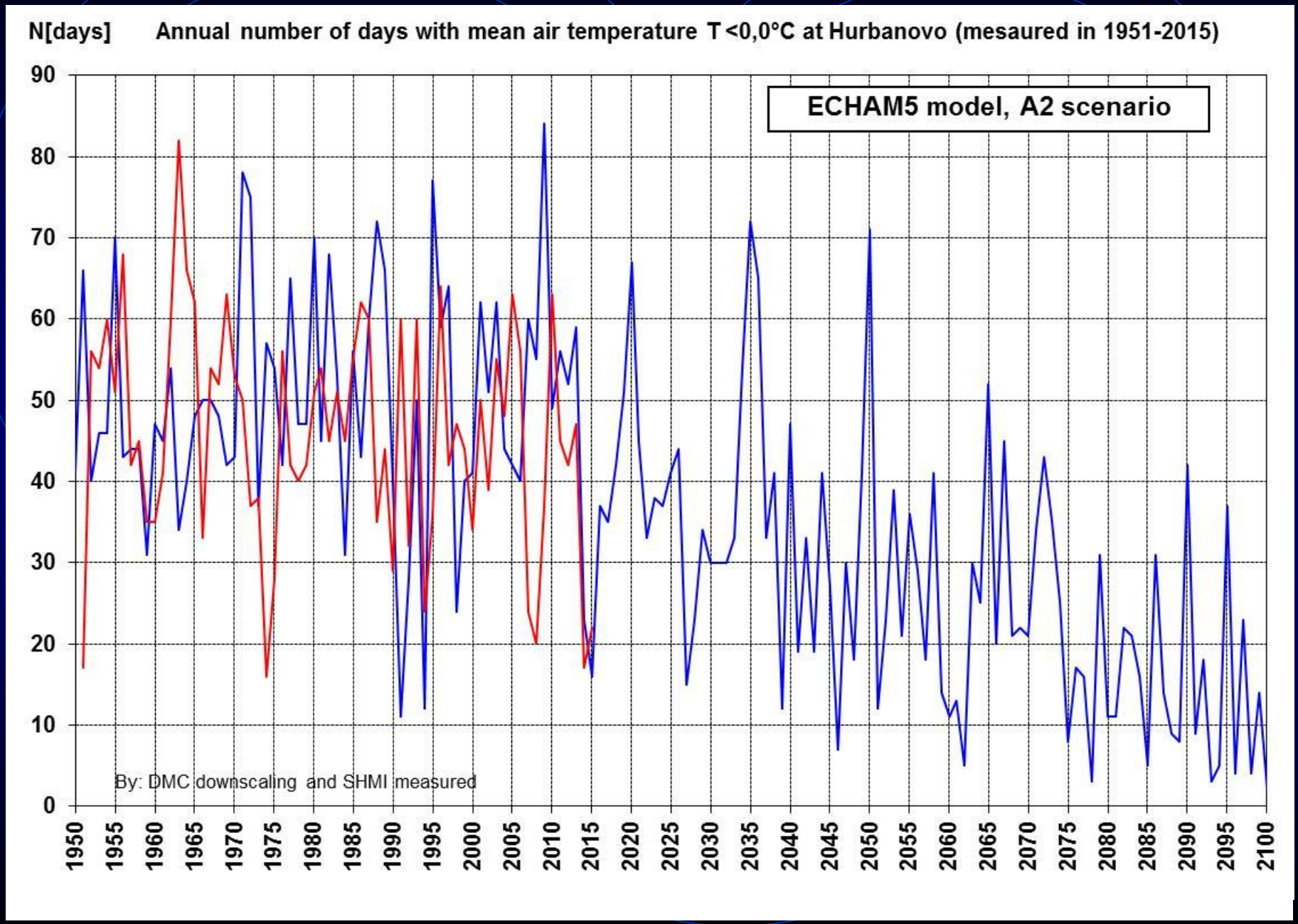
RELATIVE HUMIDITY SCENARIOS FOR HURBANOVO



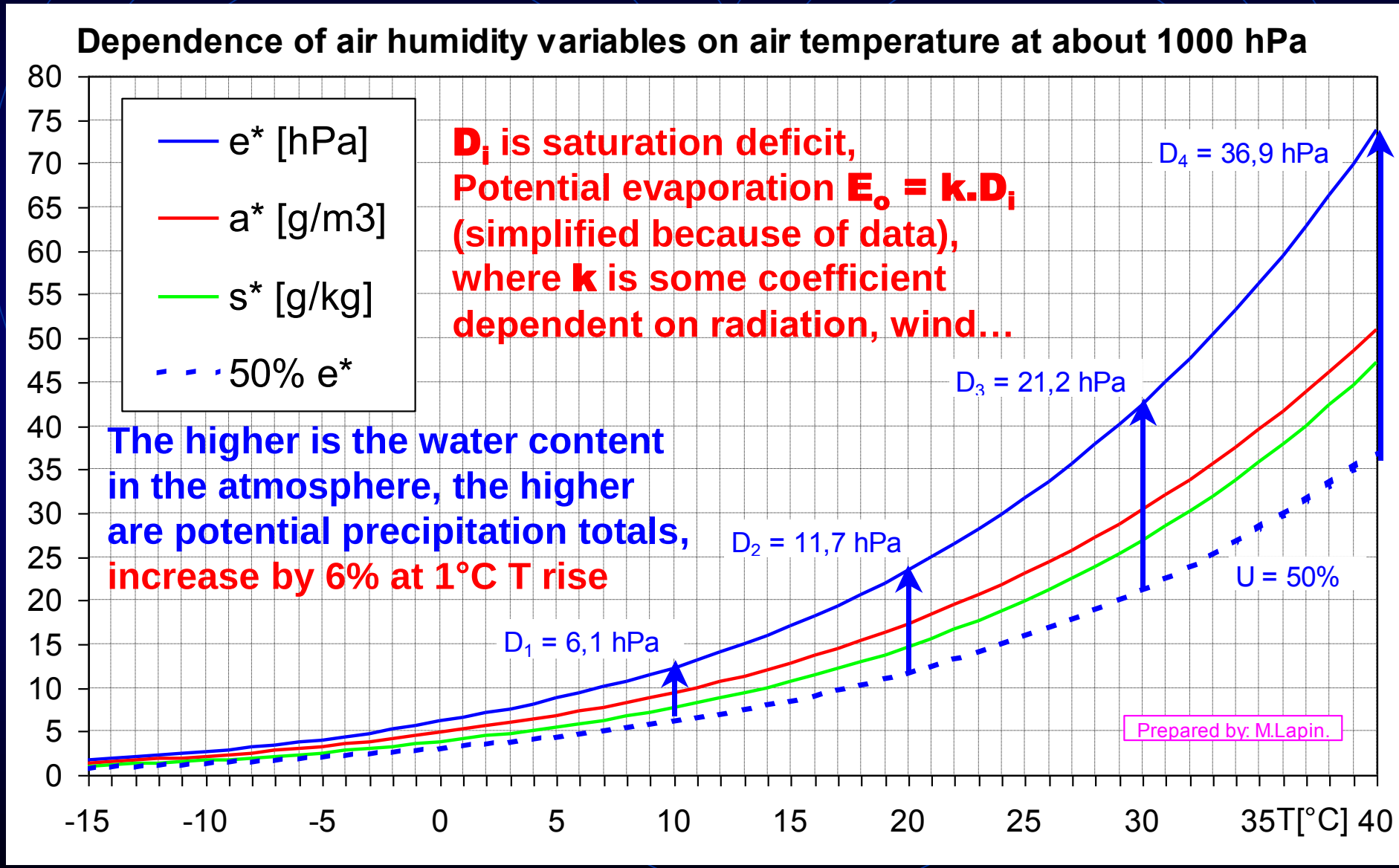
SATURATION DEFICIT SCENARIOS FOR HURBANOVO



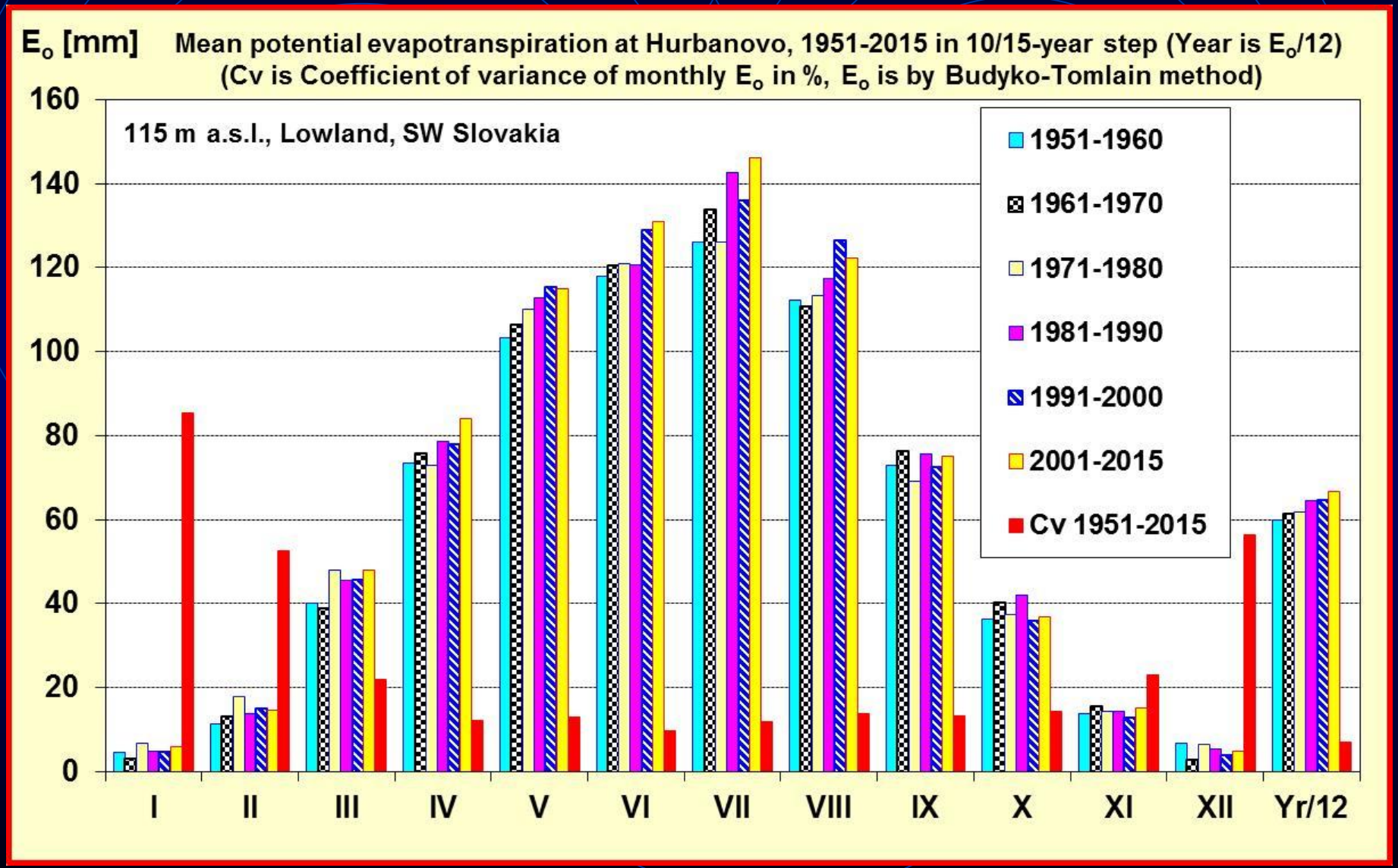
TEMPERATURE SCENARIOS FOR HURBANOVO (115 m)



AIR HUMIDITY AND AIR TEMPERATURE



POTENTIAL EVAPOTRANSPIRATION TRENDS AT HURBANOVO, 1951-2015



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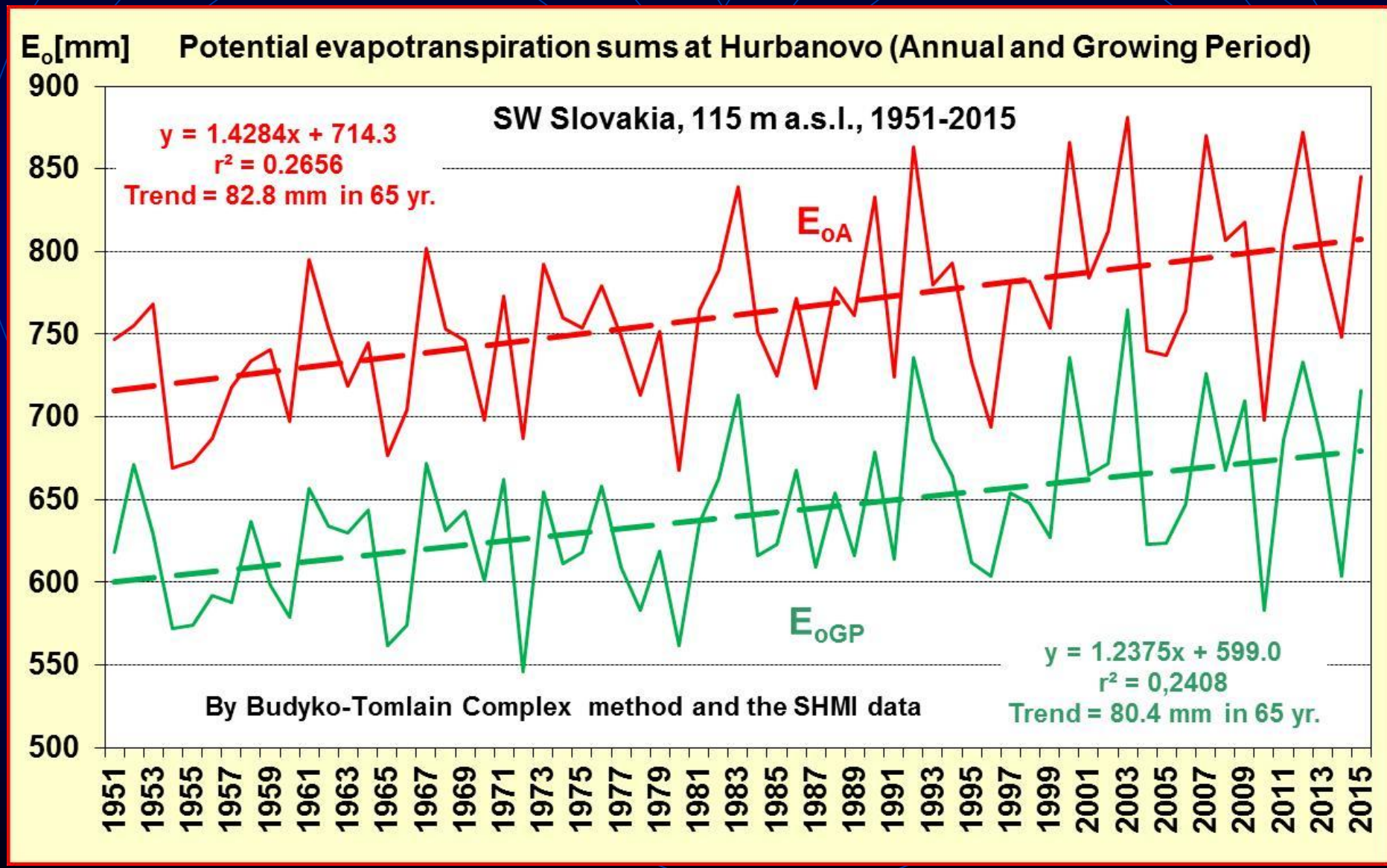
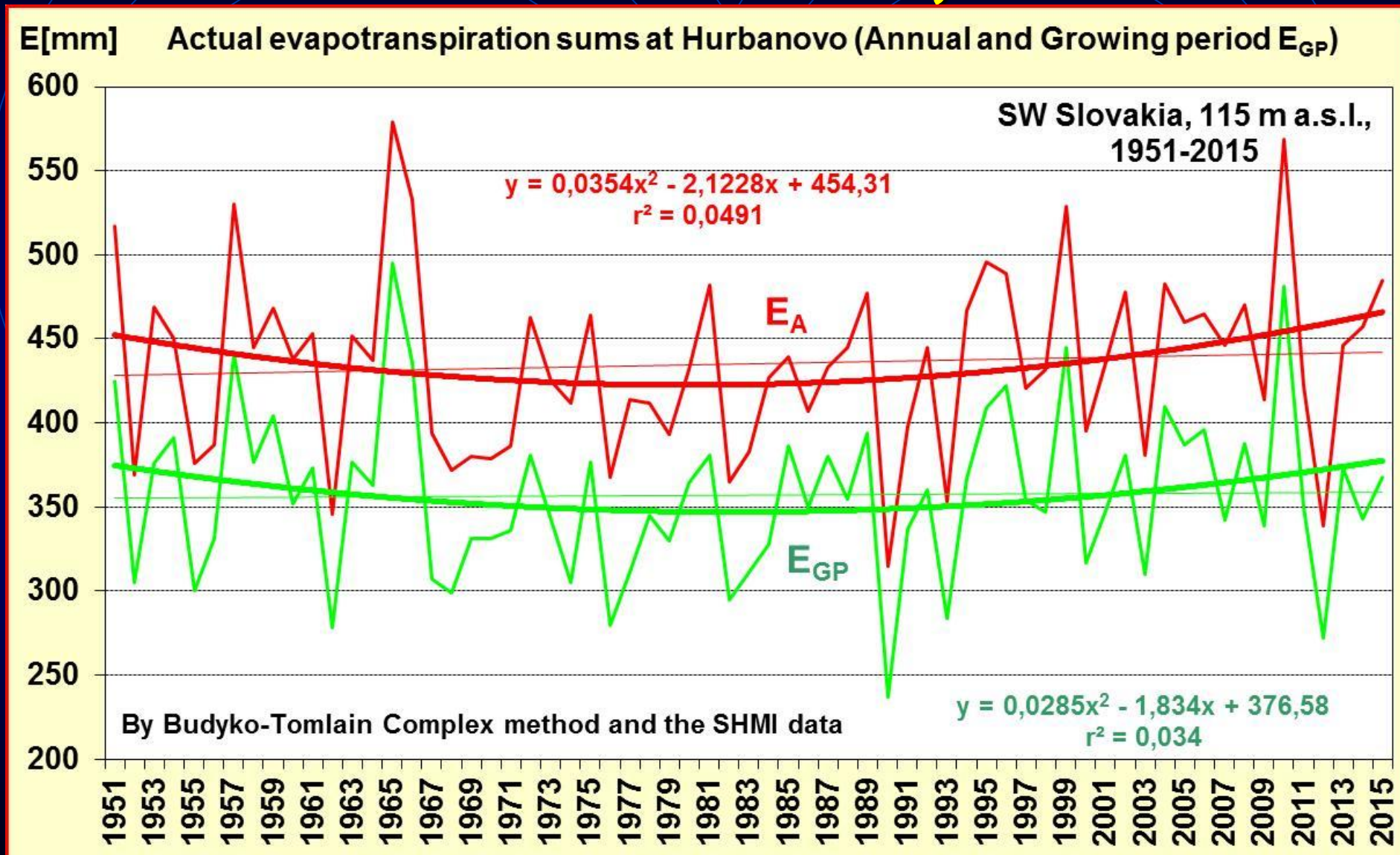


ACTUAL EVAPOTRANSPIRATION TRENDS AT HURBANOVO, 1951-2015



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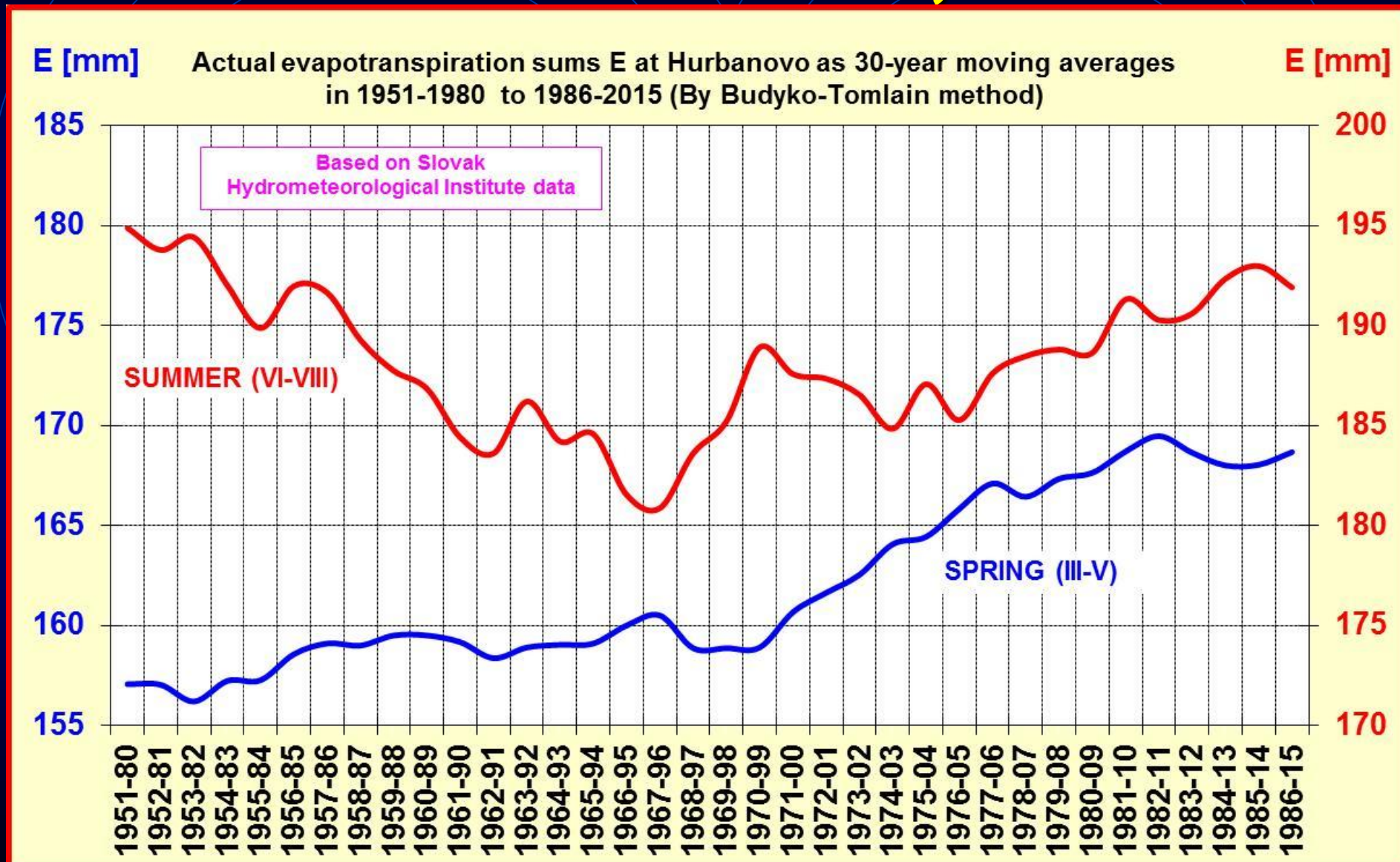
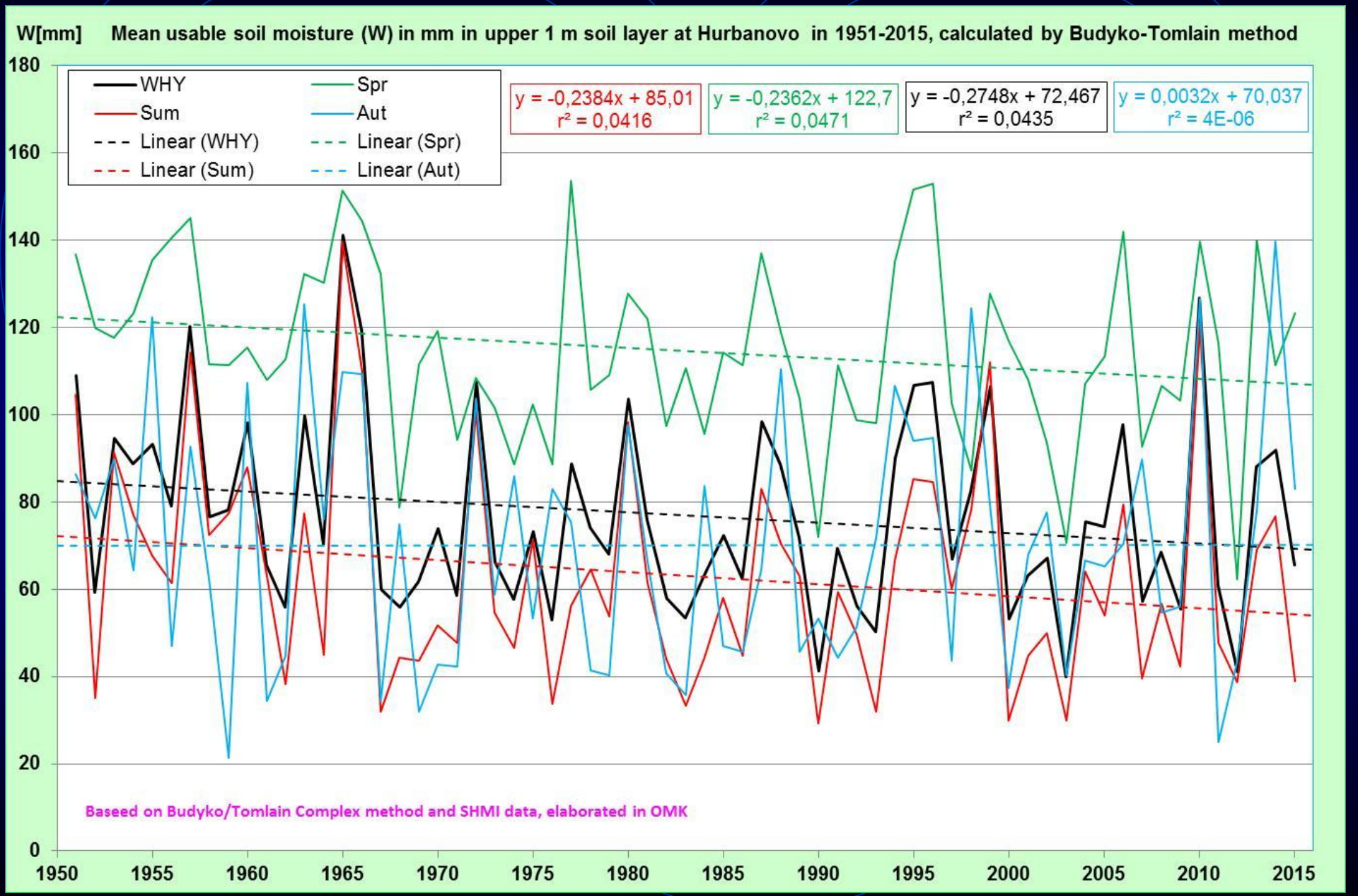
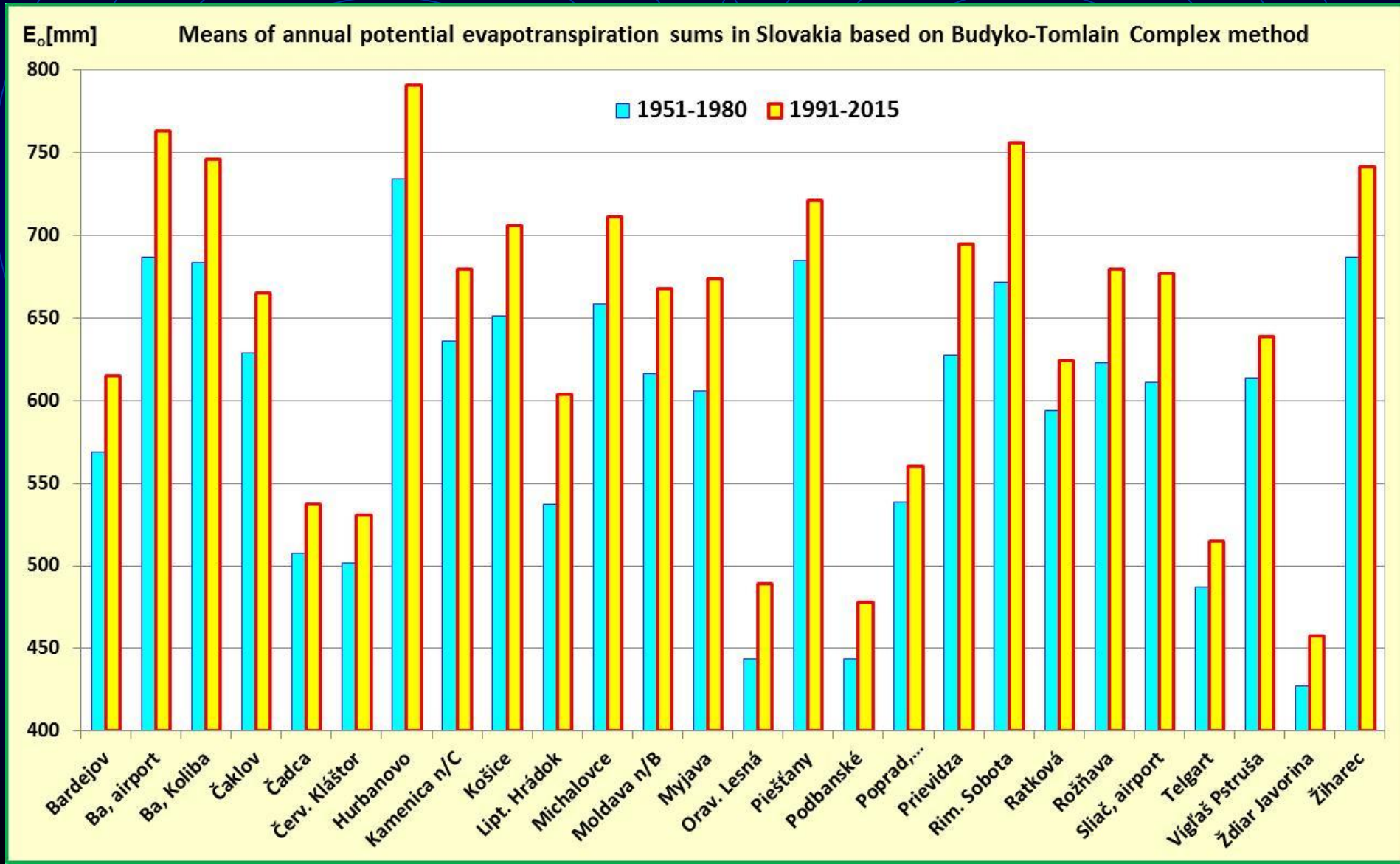


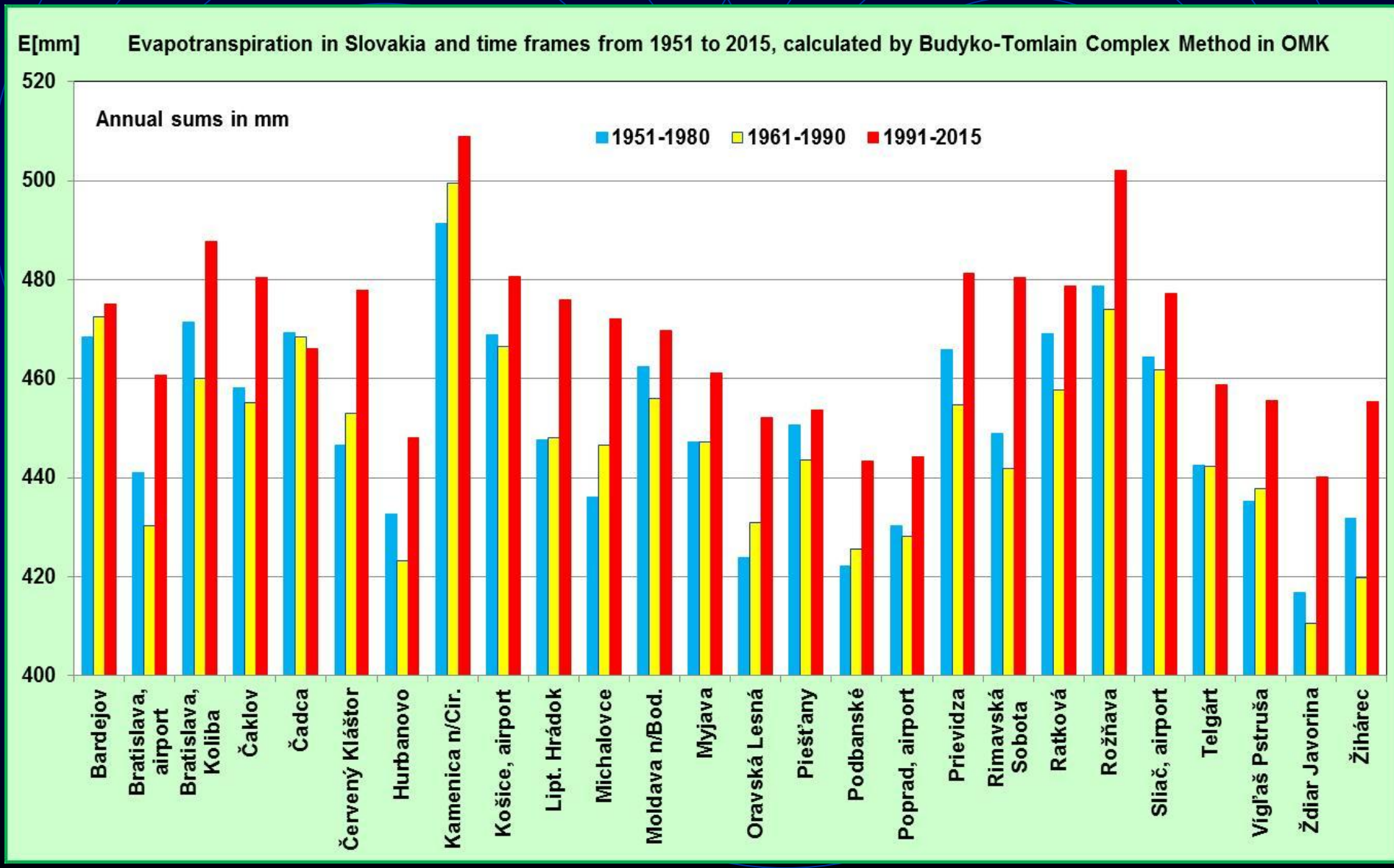
USABLE SOIL MOISTURE AT HURBANOVO



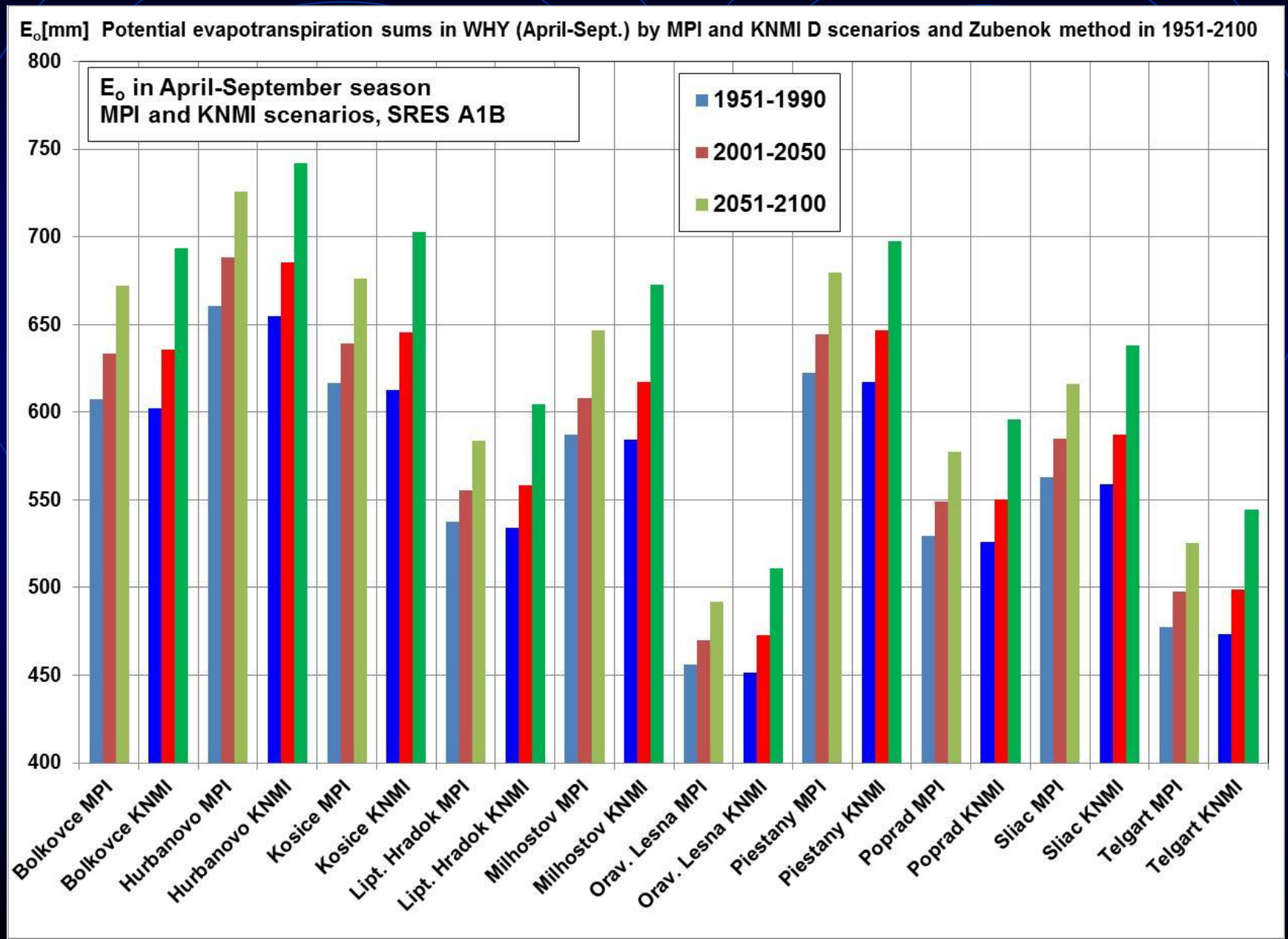
POTENTIAL EVAPOTRANSPIRATION TRENDS IN SLOVAKIA BY THE DMC AND SHMI DATA



ACTUAL EVAPOTRANSPIRATION TRENDS IN SLOVAKIA BY THE DMC AND SHMI DATA



POTENTIAL EVAPOTRANSPIRATION SCENARIOS FOR 10 STATIONS BY MPI & KNMI RCMs, SRES A1B



WE EXPECT CONTINUATION OF CLIMATE CHANGE, WHAT IMPACTS CAN OCCUR?

- **It is sure that the GHGs emission will continue and therefore also the warming of the atmosphere remains (at least lower 5 km of it):**
  - Natural climatic changes can partly modify this effect
  - Climate change and warming will be the fastest in the Arctic
  - This will cause decrease of the Arctic sea ice extent and change of the mild zone general atmospheric circulation
  - On the other hand this will cause increase of water vapor content in the atmosphere (6%/1°C), mainly up to 5 km
  - The characteristics of tropical and extratropical cyclones will change significantly (strong wind, rain, storms, new snow…)
  - In the CEE countries increase of long droughts episodes risk and short intense precipitation events from April to September season – important not only in Agriculture

WHAT CAN WE DO?

- Basically there are 3 possibilities how to manage the Climate Change impacts (in fact the anthropogenic + natural climatic changes ones) – no examples are listed here!
- **1) Not to take into account any anthropogenic climate change** and our actions determine only on the basis of natural climatic changes – as stable state as before (skeptical expertises basic attributes)
- **2) To prepare adapting options according to accepted scenarios** – in case of less important activities the average scenarios, at very important ones the highest (pessimistic) assessments
- **3) To prepare also measures how to slow down the ongoing climate change (MITIGATION OPTIONS)** – reduction of greenhouse gases (GHGs) emission into the atmosphere, manage our negative impacts in land use change, increase of biospheric sinks of atmospheric GHGs, slow down of GHGs emission from the natural and artificial sources (reservoirs)

Comment: While the adapting measures can do everybody independently (state, city, firm, person…) without taking into account the rest of Globe, the mitigation options need to be **co-ordinated on all over the World (UNO)**, it is important that the social and historical equity must be taken into the account also among the regions

ADAPTING OPTIONS

- There are several steps how to prepare adapting options for the reduction of negative a utilize of positive climate change impacts – no detail examples are listed here!
- **1) We need to estimate the potential future development of climate in at least two variants (climate change scenarios)** – scenarios of daily values of several climatic and hydrologic elements in 1951-2100 are based on different emission scenarios and different physical models of general circulation of the atmosphere and oceans; the 1951-2017 period is a control period for comparisons with measured data
- **2) Evaluation of vulnerability and impacts to climate change in different Agriculture and Food sectors –** positive and negative impacts based on alternative scenarios of climate change (mean pessimistic to mean optimistic)
- **3) Requirements for adaptation measures are based mostly on economic assessments (cost-benefit)** – economic evaluation of adapting measures taken in different sectors; cost of adapting measures – benefit compared to possibility with no adapting options
- 4) Adaptation measures can be taken by individual countries, sectors, regions, cities, enterprises, as well as individuals independently
- 5) Adaptation measures may continuously be evaluated from the economic point of view in the next 50 years – climate change is represented by slow increase in mean temperatures (by about 0.2 to 0.4 °C per decade) and slow changes in other climatic elements; in 50 years it means warming by 1 to 2°C

CONCLUSIONS

- Climate change (CC) must be correctly defined, scientifically analyzed and the results properly applied by involved users, otherwise cannot be reliable any conclusion on CC
- CC impacts are expected mostly as negative and only partly as positive also in Agriculture sector (differently in some regions)
- Shift of bioclimatic borders and changes in return periods of dangerous weather design values are considered as important
- Adapting and mitigation options are based on correct impacts analysis; to differentiate of natural climate changes from the anthropogenic ones and to analyze of cost/benefit is needed
- **Reduction of the atmospheric greenhouse gases concentration is the only possibility how to slow down the rapid global air temperature increase and to reduce the consequent CC impacts, adaptation measures do not solve the rapid CC slow down**
- Renewables solve the problem of CC mitigation only partially
- **Developing countries are much more vulnerable to CC impacts**

Thank You for the Attention

Further details on the websites:
www.milanlapin.estranky.sk,
www.dmc.fmph.uniba.sk, www.ipcc.ch
or use
E-mail: lapin@fmph.uniba.sk