CHANGES OF AIR POLLUTION IN CENTRAL EUROPE IN CORRELATION WITH CHANGES OF CLIMATE AND SUN ACTIVITIES

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1. INTRODUCTION

Since 1974, when the law of environmental protection was enacted in Germany, air pollution in combination with meteorological components has been continuously measured. The widely forested country Rhineland-Palatine with its large industrialised towns Mainz and Ludwigshafen seems to be an area representative for Central Europe. The components SO2, Particular Matter (PMx), O3 and NO2 are there measured by the telemetrical controlled system ZIMEN [1]. Therefore we already have an experience over 30 years of pollution measurements in towns and forested regions and can compare trends in air pollutants and meteorological parameters and find possible correlation with meteorological events or the enactment of emission reduction regulations. Often it is not easy to separate both inf1uences in the development of air pollution. But during the relative short time between 1987 and 1990 we see remarkable coincidental changes of air pollutants and meteorological components: The immissions of SO2 and PMx decreased by more than 30 %, while Ozone concentrations, temperature and global radiation increased remarkable strong within this short time interval of only about 4 years (Fig.1).

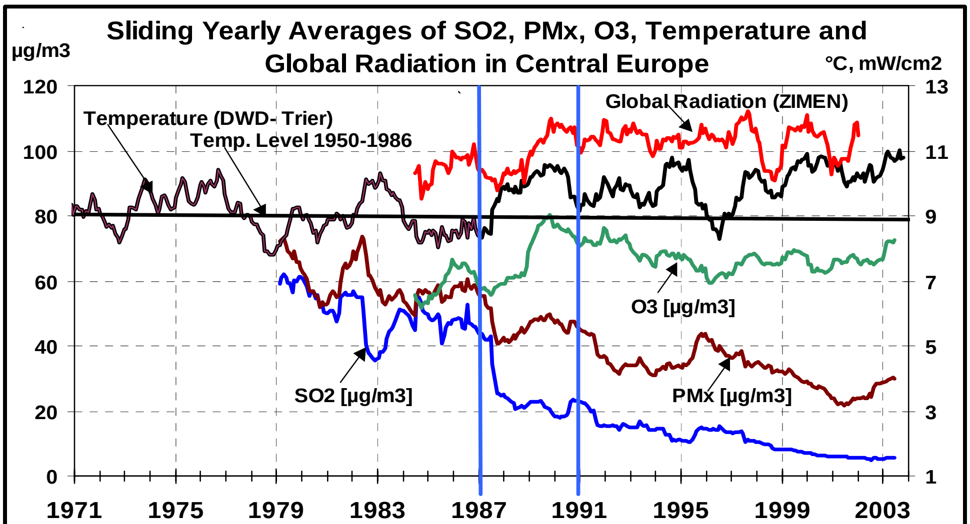

Fig.1

As a consequence winter-smog-alert systems (introduced in 1985 and concerning SO2, PMx, NO2 and CO) were cancelled and summertime smog-alert systems concerning O3 were introduced. The strong decrease of SO2 and PMx was seen mainly as a result of successful legal management, e.g. regulations to reduce the emission of power plants. The strong increase of anthropogenic O3-concentrations was seen as a result of the increase in traffic [2].
But these strong changes of pollutants since 1987 have been accompanied by a very strong increase of air temperature and of intensity and duration of sunshine, caused by reduction of cloud cover [3]. It seems that in this short time interval between 1987 and 1990 the sudden great change of anthropogenic air pollution was mainly destined by strong meteorological alternations, which were strongly combined with climate change in Central Europe.
These observation was giving rise to look for possible causes of these correlative changes of climate and air pollution.

2. TEMPERATURE AND SO2

The simplest method to describe climate is to study temperature. The sliding yearly averages of the published temperatures of the "Deutscher Wetterdienst" (DWD) in Germany do not show any significant increase of the long time trend between about 1940 and 1986. The main increase in temperature in Central Europe happened between 1987 and 1990. During this time the summer temperatures increased continuously, the winter temperatures increased abrupt from 1987 to 1988 (Fig. 2). After this since about 1991 the sliding yearly averages of the ground near temperatures were oscillating around a level of about 1,5 to 2 °C higher than the old level until 1986. Now it remains nearly constant with only a weak trend upwards.

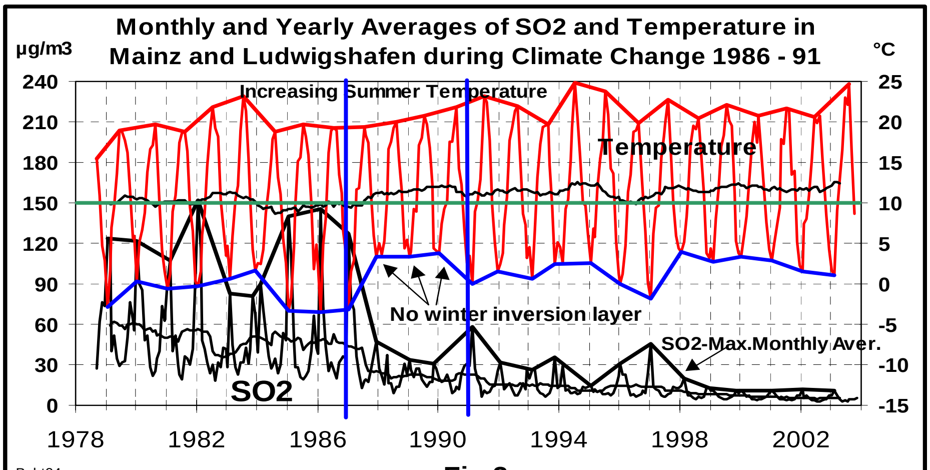

Fig.2

SO2 had until 1987 relative high concentrations in winter times (Fig. 2). They were good correlated with PMx. The main part of these pollution came during this time from power plants of the eastern COMECON countries, transported by cold and dry north eastern winds beneath inversion layers of about 800 m height. Since 1987 the concentrations of SO2 and also PMx decreased very strong by sudden disappearance of these meteorological events. After 1990 the immissions of SO2 and dust became small mainly by the collapse of the emitting industries in former COMECON countries and also by the effects of the emission reduction laws.

3. NO2 AND PMx

Sliding yearly averages of NO2 in the industrialised towns Mainz and Ludwigshafen show the typical development of mainly traffic-induced immissions in western Germany (Fig3). NO2 increased in the early eighties very strongly and reached in 1984 nearly the legal limit value of 80 µg/m3 (annual mean) in these towns. With the introduction of more efficient motors and legal emission control of vehicles and of industry the immissions of NO2 decreased since 1984. But with increasing temperature since 1988 NO2 goes up again and we observe a new maximum in 1990 during this warm period. After this since about 1992 NO2 shows a continuous reduction, caused mainly by the introduction of the catalyst.
PMx-concentrations show till 1988 a behaviour similar to SO2. Since 1987 PMx decreases in consequence of the above mentioned disappearance of pollution transports out of eastern regions. With further increasing temperature in 1988 PMx increases again, but now parallel with NO2. This phenomenon points to traffic as a common source of both components. PMx was until 1988 mainly caused by industry and power plants, after this until now it seems to be more caused by traffic.

The actual PMx-level is less than half of the level of 1987, but it is now regarded as more dangerous for human health than former knowledge believed - especially its finer parts.

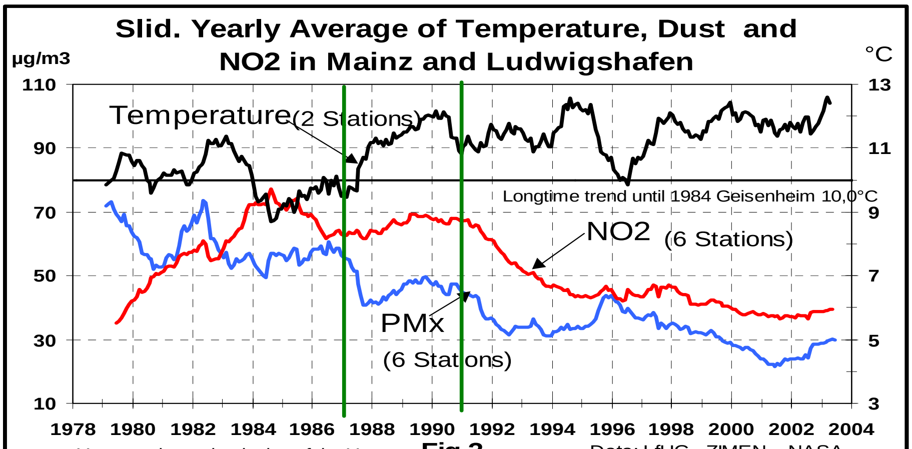

Fig.3

The new legal PM10-limits of the European Union are sometimes exceeded in towns /1/.

4. TROPOSPHERICAL O3 AND GLOBAL RADIATION

Measurements of O3, NOx, SO2, PMx and meteorological components had been started at fife forested background stations in 1984 to study possible causes of the observed new forest decline. O3 is mainly produced by photolysis of the precursor NO2 in presence of Hydrocarbons mainly in traffic regions and towns. O3 is transported into the forested regions far away from the anthropogenious precursor emissions. Local NO leads to a certain loss of O3 by oxidation to NO2. Therefore the oxidative potential of the air can be estimated by adding the local measured NO2 to measured O3-Values [4]. The strong increase of O3 in the

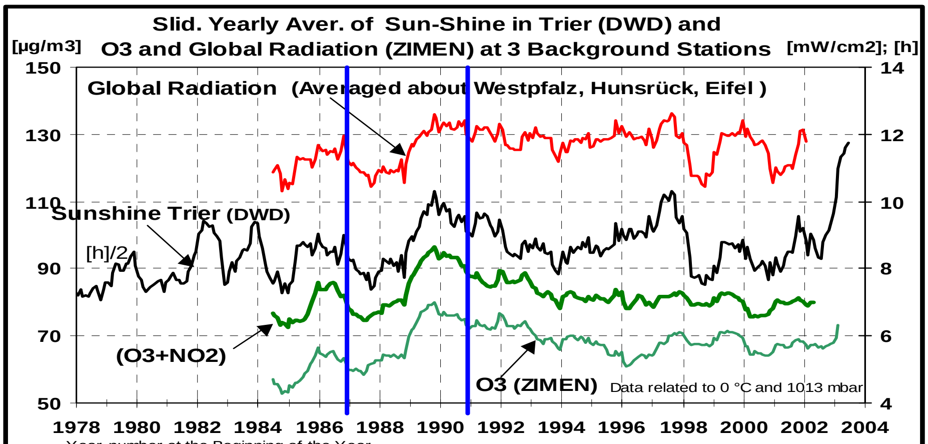

Fig.4

short period between 1987 and 1990 at all background stations is mainly caused by the strong increase of Global Radiation and Temperature. (Fig. 4), while cloudiness decreased during this period (Fig. 6). Sliding yearly averages of Sunshine Duration, measured by DWD, corresponds qualitatively good with Global Radiation (ZIMEN). After 1990 O3 decreased continuously as a consequence of the reduction of anthropogenic precursors by controlling the emissions of cars (ASU-controlling) and legal introduction of the controlled catalyst. Today the yearly averages of O3 are nearly constant in towns and forests at a relative low level. Yearly averages in towns are about half of that in the forested background stations.

Long time trend of Sun Intensity, represented by Global Radiation and Sunshine Duration remains since 1990 at a higher level then before 1986, similar to the trend of Temperature.

5. SUNSPOTS, TROPOSPHERICAL O3, NEUTRON RATES, CLOUDINESS

The above shown observations were giving rise to look for possible causes of these correlative changes of climate and air pollution: Fig 5 compares the curves of sliding averages of Ozone, Temperature and Global Radiation at background stations with the number of Sunspots, published by the World Data Centre [5]. Since 1987 the strong increase of the earth near meteorological components correspondent relative closely with the increasing sunspot number, which represents the alteration of the total sun energy emission (of about 0, 1 %) during the 11,5 years cycles. O3 follows closely the Global Radiation. The intensity of the sun

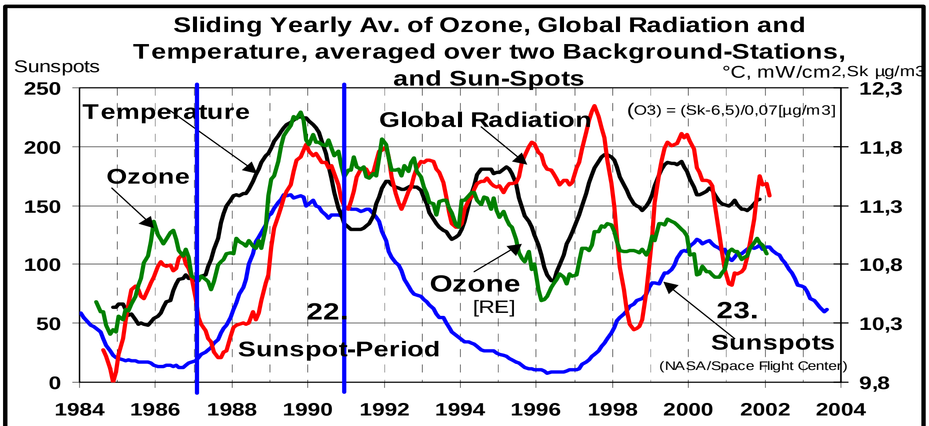

Fig.5

is strongly modulated by cloudiness (Fig. 6). Therefore we must also take into account possible extraterrestrial influences on cloudiness, sunshine and in consequence on anthropogenious O3. In Fig. 6 the sliding yearly averages of Global Radiation, of Neutron – rates (measured by University of Kiel) [6] and Cloudiness (DWD Trier) are compared with the curve of sunspot numbers. Neutrons are formed through nuclear collision of extra galactic

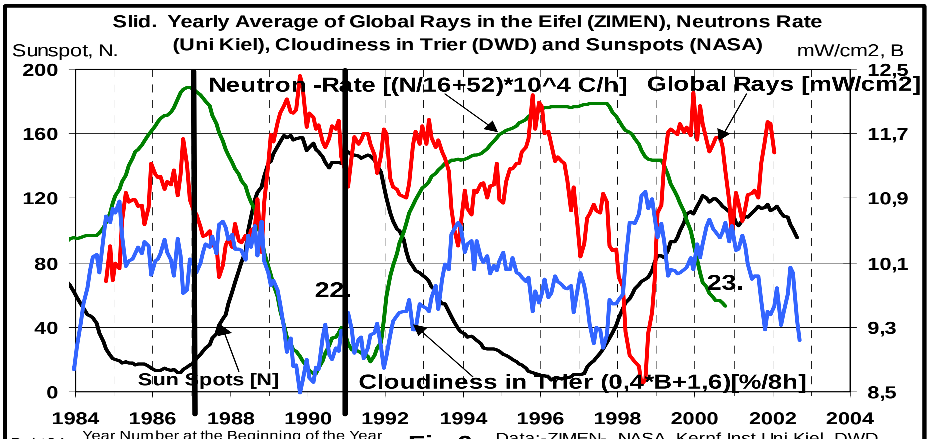

Fig 6

cosmic radiation interacting with the atmosphere. Neutron rates represent the intensity of secondary particles, which are condensation nuclei for clouds [7]. Data collected from satellites also show that the amount of low clouds over the earth closely follows the amount of secondary particles of extra galactic cosmic radiation. Stronger solar winds during the maxima of sunspots shields the earth from extra galactic cosmic rays, therefore neutron rates are opposite correlated to the sunspot curve. Sunspots are accompanied by solar f1ares, which are the most energetic explosions in the solar system and are supposed to have a direct effect on the earth's upper atmosphere, which becomes ionised and expands.

Just during the 22. and the actual 23. sun period relative often extremely high energetic eruptions have been observed, so that the periods since 1986 are to be distinguish in sun effects from previous periods [9]: With the beginning of the 22. Sunspot period cloudiness decreased and global radiation increased as well as temperature and tropospherical O3. The increase of primary solar radiation and the reduction of cloudiness, caused by these sun activities, leads to an amplified increase of the yearly average of ground near sun intensity of more than 0,8 mW/cm2 between 1988 and 1990 (Fig 6). It follows, that the strong alterations of air pollution and climate components between 1986 and 1991 are consequences of increasing sun activities. As a consequence of the actual strong decrease of sunspots, if there exist no greater flares, we suppose a stagnation of global temperatures in the next years.

6. TEMPERATURE AND SUNSPOTS

The course of the running yearly means of temperature in Mainz and Ludwigshafen is qualitatively similar to the course of the global temperature in the northern hemisphere since 1978, when the measurement of ZIMEN started (Fig. 7). From 1935 to about 1980 the global

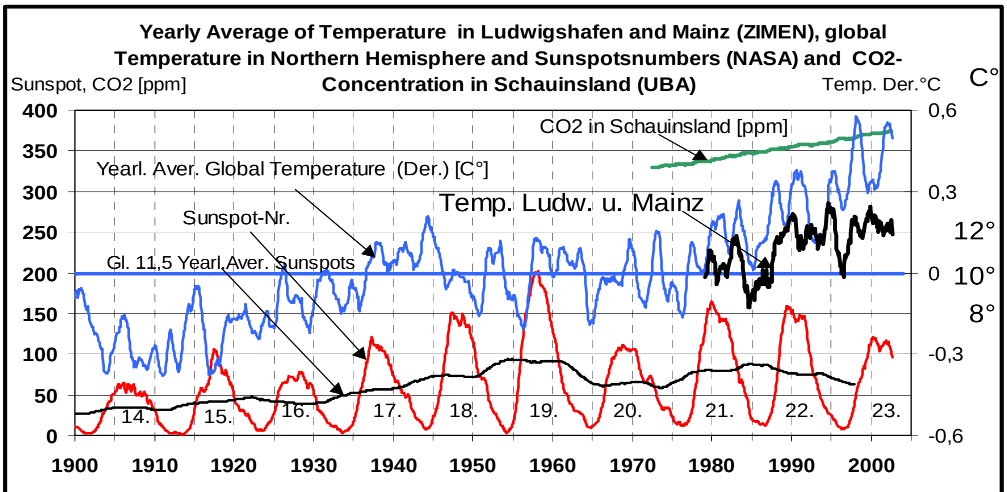

Fig. 7

temperature shows no significant alteration of the long time trend too. In the eighties it increased very strongly and qualitatively very similar to the course of the ground near temperature in Central Europe. Since 1991 the global temperature lies about 0,5 °C above the "climatological mean" of 1951 –1980. The supposed cause of this change of global temperature is today the combination of the effects of greenhouse gases, aerosols and sun activities [10]. But it appears that the main cause of the sudden climate change during the eighties was the sudden increasing number of extremely height energetic sun flares (X-Seize) which also cause the following continuous high values of temperature [11], [12].

The following observation may give further information to explain this phenomenon: Smoothing the observed three yearly oscillation of temperature by forming sliding three years averages you can find a resonance with the sunspot numbers since 1986, where the 22. Sunspot-Period started (Fig. 8). This resonantly behaviour is shown by all rows of ground near temperature in Germany only since 1986 and not in sunspot periods between 1935 and 1986. The global temperature increased in the nineties qualitatively similar to the ground near temperature, only intermitted by the "Pinatubo-break" in 1992/1993, and shows also the resonance of 3-years running means with sun spot oscillation. This points to resonantly effects of meteorological periodicals and sun activities as a cause of the strong climate change between 1987 and 1990. If it was mainly caused by the change of sun activity than the behaviour of air pollutants was influenced by extraterrestrial events too.

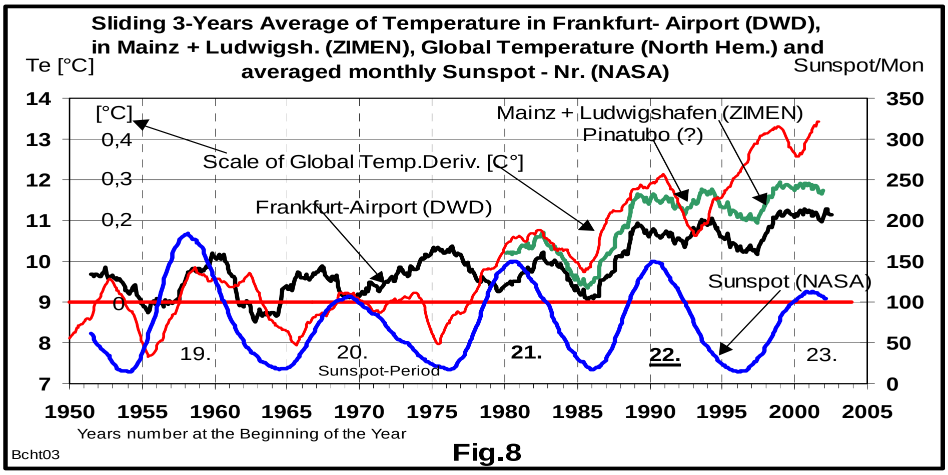

Fig.8

Further studying these phenomena with measured data may lead also to answer the question, why the global warming seems to tend today to lag behind the increase in greenhouse gases.

7. SUMMARY

In the last twenty years the main change of measured air pollution in Rhineland-Palatine in Central Europe happened within the short period of 5 years between 1987 and 1991. The main change of climate, represented by temperature and global radiation, happened during the same time interval. These events coincide with increasing sun activities, represented by increasing sunspot numbers and flare intensities and with decreasing cosmic radiation (neutron rates) with its consequence of reduced cloudiness. The conclusion is that mainly extraterrestrial effects during this short time interval strongly influenced climate and by this transportation, production and concentration of air pollution, even more than anthropogenic activities.

8. REFERENCES

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