STRATOSPHERIC O_3-INTRUSIONS CAUSE TROPOSPHERIC O_3-BACKGROUND IN MIDDLE EUROPE

by

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1. Summery

Simultaneous measurements of air pollutants and meteorological components with telemetrical measuring systems have shown, that cold weather frontiers of cyclones, coming from western directions, are nearly always accompanied with increasing Ozone concentrations in middle Europe. This Ozone is a contamination of stratospheric cold and dry air masses, which are transported by jet streams into the biosphere during tropospheric air folding. It comes from lower stratospheric regions and forms mainly the tropospheric O_3-background. Therefor the biosphere was already in pre industrial times exposed by O_3. This known O_3-production seems to be underestimated. In the following paper some examples of measurements with the earth near telemetrical measuring system ZIMEN in Germany show, that these natural O_3-Intrusion is producing monthly averages of at least 20 to 40 µg/m^3. Short time fluctuations of this intruded stratospheric Ozone have concentrations which are lying within the range of the lower limiting values to protect plants. Therefor this phenomenon should be considered by a new definition of Ozone limiting values to protect the human beings and the nature.

2. Telemetrical Measuring Network ZIMEN of Rheinland-Pfalz.

To control the development of air pollution, in all sixteen federal countries of Germany telemetric networks had been installed. In the country Rheinland-Pfalz are located 32 measuring stations. Control centre of this system, called ZIMEN, is located in the capital Mainz. It gives information about expansion, transportation and sources of air pollution. In the industrialised towns the measurements had been started in 1977 to get information about the development of air pollution in urban areas. To study the causes of forest decline, measurements of air pollution had been started 1984 at five places in the forested highlands of Rheinland-Pfalz. Long time results of ZIMEN are published 1998 at 11.th Clean Air Congress in Durban /1/. Short time data are published in monthly reports since 1978 /2/. Actual data **from all 17 German air pollution networks** one can get by internet calling **"http://www.umad.de".**

3. Long-time Measurement Results of Ozone (O_3)

Since about 1982 Ozone as an air pollutant becomes important. O_3 is one of the strongest gaseous oxidiser. It attacks the needles of conifers and reduces the assimilation of CO2. Therefore the first measurements of O_3 had been started to study the cause of forest decline in Germany. Fig. 1 shows monthly averages of O_3, averaged about five forested places and six urban stations. Seasonal alternations of O_3 correspond with the curves of global rays and air temperature. Mechanism of the photochemical production and transportation of O_3 are very good known: Tropospherical O_3 mainly origins by photolysis of NO_2 in the presence of peroxides produced from mainly anthropogeneous hydrocarbons. These precursors NO and hydrocarbons are mainly produced by traffic, gas power plants and households.

O_3 is a harmful respiration gas and attacks the lungs. Therefore the measurements of O_3 had been started in towns too. Sliding annual concentrations of O_3 in forests are nearly twofold of these in urban regions (Fig. 1).

It is remarkable, that in winter-times with relative small photochemical production of tropospherical O_3 because of low global rays and at places far away from sources of anthropogenic precursors, the monthly averages are relative high (between 30 and 50 µg/m^3).

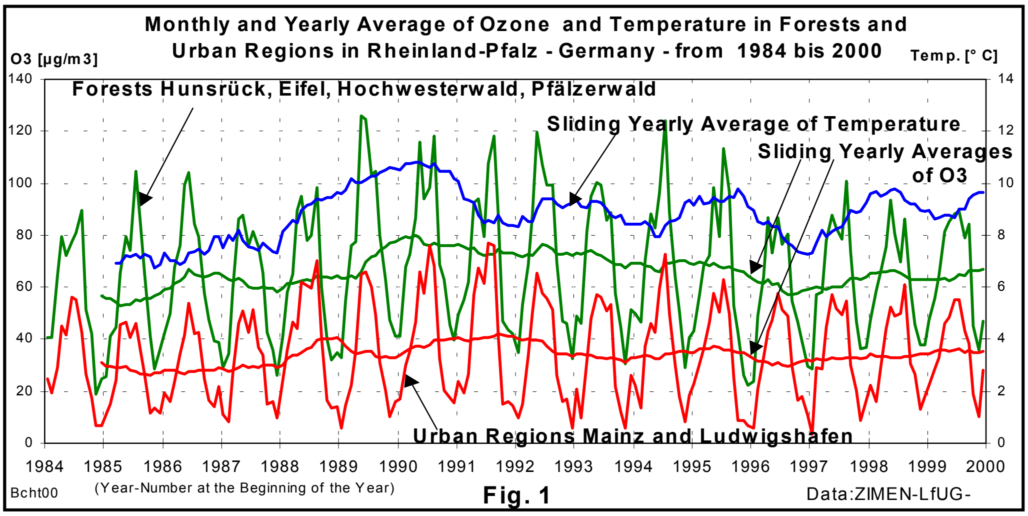

Fig. 1: Monthly and Annual Averages of O_3- Concentrations in Towns and Forests

Therefore it is of interest, to look for the cause of this phenomena. **It was found, that during every intrusion of cold and dry western winds, beginning with increasing pressure after its minimum, relative high Ozone-concentrations occur.**
As an example Fig.2 shows the course of half hour averages of O_3, pressure, absolute humidity and wind-direction in the month November 1991, measured in a suburb of Mainz.

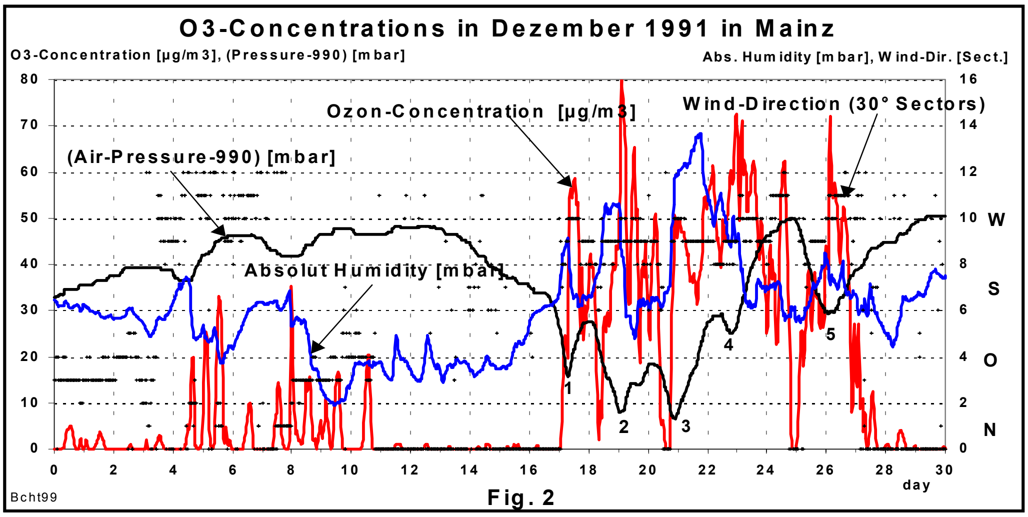

Fig. 2: Half-hour Averages of Ozone, NO_2, air-pressure, humidity and Wind-direction.

A "family" of 5 cyclones occurs with intrusions of dry and cold western winds. Each cyclone is signified by a minimum of pressure. **Generally at this points the O_3-concentrations increase.** Such O_3 - Intrusions are observed as well in urban regions as in forests: Cold dry air, which comes during the cold-front of the cyclone by the yet stream from stratospheric regions, is contaminated with Ozon /3/. Such frontal-cyclones are often shown in the daily weather forecast at the Television. Cyclones occur, when cold air masses are coming from the north-western region into eastern directions and are meeting warm air masses, which are coming from south west directions to Europe /4/.

4. O_3-Intrusion during Frontal-Cyclones in Detail

In the following Fig. 3 and 4 a typical example of intrusions of stratospheric Ozone during two frontal-cyclones (No. 1 and 2 in Fig. 2) is shown together with simultaneously measured meteorological parameters at urban and forested measuring places.

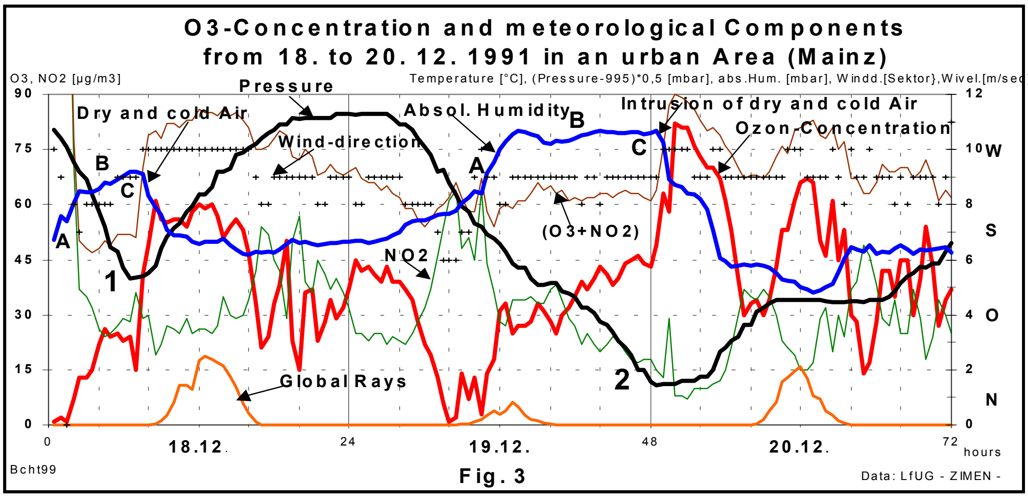

Fig. 3: O_3-Intrusion during two frontal-cyclones, measured at the suburb station Mainz

Frontal-cyclones start with slow increasing temperature and absolute humidity of the air, which comes mainly from south-western directions (sector 8) into the country, accompanied with some precipitation (Warm-front at Point A). Normally follows a region with nearly constant warm and humid air masses (Warm-region B). This region ends again with precipitation. Than follows with increasing and changing winds from more western directions (sector 9 to 12) the intrusion of cold air masses, which are accompanied with increasing O_3-Concentrations (Point C). Temperature and absolute humidity are decreasing very strong (about 2 °C/h resp. 2 mbar/h). Air-pressure has at this moment its minimum and starts to

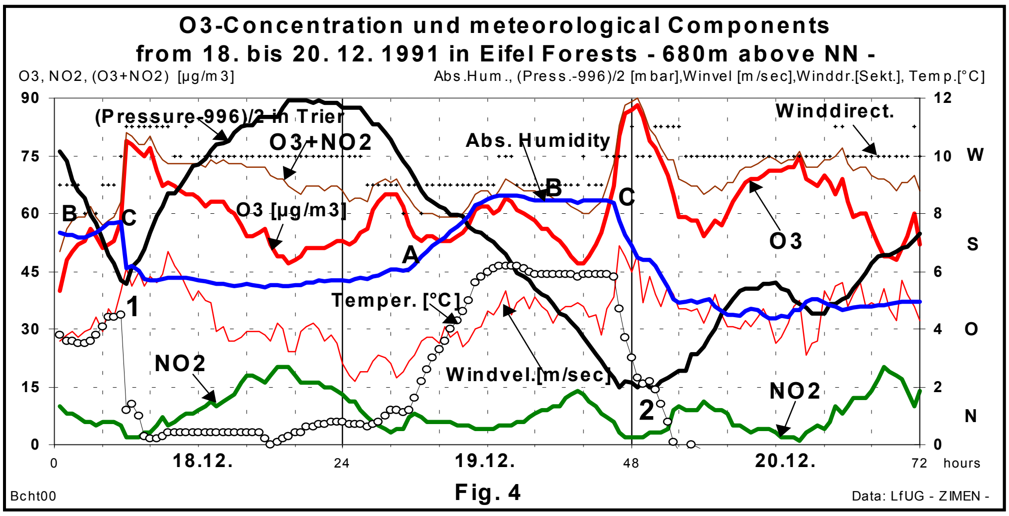

Fig. 4: O_3-Intrusion during two frontal-cyclones, measured at the Forests Eifel

increase with about 2 mbar per hour. This cold and dry air is the outcome of a tropospheric air folding and originates mainly from stratospheric cold regions, transported by a jet stream /5/. Fig. 4. shows in comparison to the urban station in Fig. 3 the same frontal-cyclones in the forest region of the Eifel-mountains.

The comparison shows that the averaged concentrations of O_3 in the forests are about double of this in urban regions. **This fact is the consequence of the oxidation between the intruded O_3 and mainly anthropogenic NO in the lower troposphere**. In forest regions, this influence of NO is relatively small. In urban regions this influence is high: Concentrations of the intruded stratospheric O_3 are reduced by this relative quick oxidation with the velocity of about v = 27 [1/(ppm*min)]. **That means, the real O_3-concentration intruded into the lower troposphere is given by the sum (O_3 + NO_2).** This is guilty, so long the measured NO_2 is not produced direct within the source (ca 5% of the NOx-Emission of the motor car) or the production of NO_2 is not possible by the quicker oxidation of NO with Peroxides (RO2) (v =.2300 [1/(ppm*min)]), which are produced by anthropogeneous hydrocarbons. So far there is no other relevant NO_2-Production, the real intruded stratospheric O_3-concentration by yet streams is given by the sum (O_3+NO_2). Using the units [µg/m^3], the failure is lower than the statistical failure of the measurements of both components. NO_2-production by the very slow oxidation of NO with O2 is not very relevant.

5. O_3-Flux into the Lower Troposphere.

To estimate the quantity of O_3-molecules transported by such events into the lower biosphere, one can made the assumption, that the O_3-concentrations of the air masses at the measuring high of wind velocity at 10 m above ground (measuring point of wind components) have within 10 percent the same O_3-concentration like at measuring high of 3.5 m above ground (sucking point of the station). Multiplying the half hour average of O_3 with the averaged wind velocity, one gets the current of O_3 through a vertical square meter per second in units [g/(m2*sec)] at the high of 10 m. Fig. 5 shows that there is no relevant difference of the accumulated O_3-Flux between forests and towns with the assumption, anthropogenic NO is changing a part of the intruded O_3 into NO_2. Only the relative high situated forest station in the Eifel shows some higher values. At this place the intruded O_3 first appears with air masses from western directions.

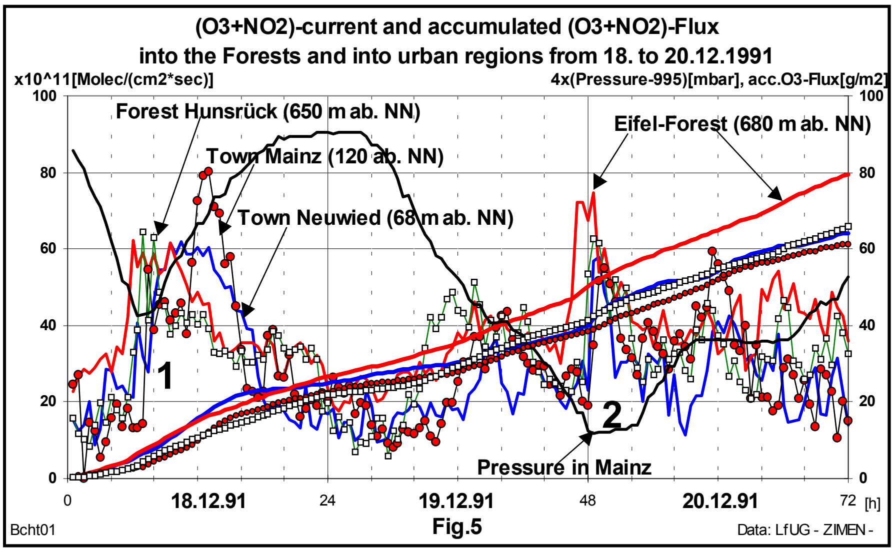

Fig. 5: O_3-Flux, caused by two frontal-cyclones into forest and urban region**.**

With the assumption, these O_3 contaminated air masses will reach the soil, the down load of O_3 lies between 4 and 40 g/m2 per frontal-cyclone in middle Europe. Stratospheric O_3-currents reach in this example values till 80x10^11 [molec./(cm2*sec)] with in the jet stream in the biosphere. That lies small above ranges of earlier published estimations /6/.

6. The Monthly Concentration of Stratospheric Ozone-Background .

To estimate the toxic relevance of this intruded O_3 the caused monthly background is to calculate. Smallest possible monthly O_3-background concentrations are given by these measuring values of O_3 and NO_2, which are correlated with decreasing **absolute** humidity and which are coming from **western directions** (wind sector 8 to 12 of the 30 degree wind-scale between 1 (North) and 12, marked by bigger points in Fig. 6).

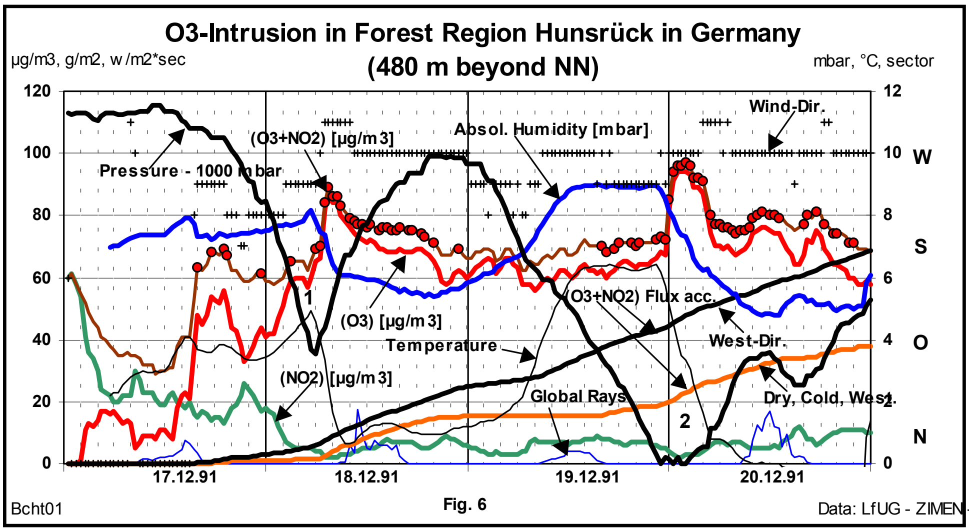

Fig. 6: O_3-Intrusion in Forest Region Hunsrück in Germany

Result is, that intrusions of stratospheric Ozon by frontal cyclones into the troposphere produces a natural O_3-background with monthly averages of at least 10 to 30 µg/m^3 countrywide (Fig. 7). Surely the natural O_3-background is higher, fore the stratospheric air masses of the jet stream become mixed partly with air masses of the next upcoming western warm-front, which is on this way transporting rests of stratospheric O_3 into the biosphere.

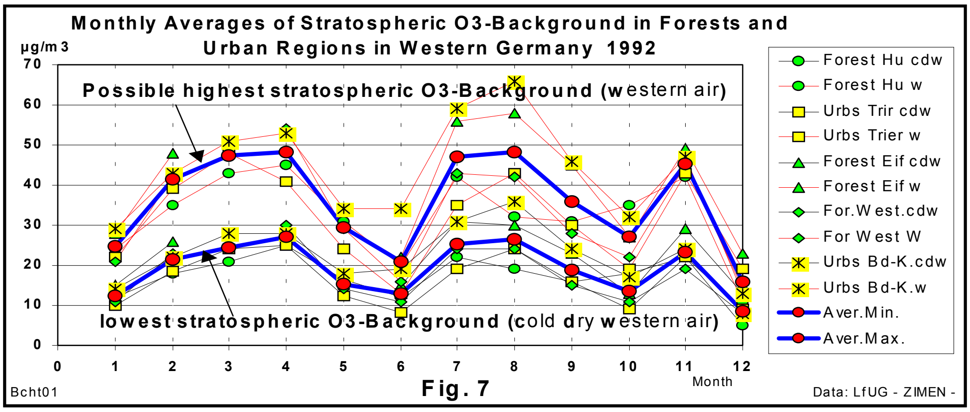

Fig. 7: Monthly averages of O_3, produced by frontal cyclones in towns and forests.

This condition leads to an estimation of the possibly highest values of the O_3-concentration produced by western frontal cyclones. This argumentation is supported by the fact, that both, the lowest and the possibly highest values of these O_3 are respectively nearly equal in forests and towns (Fig. 7). The Quantity of the monthly stratospheric O_3-background depends on the intensity and on the number of frontal cyclones per month. Fig. 8 shows a correlation between the Number of frontal-cyclones and lowest resp. possible highest stratospheric O_3-background countrywide.

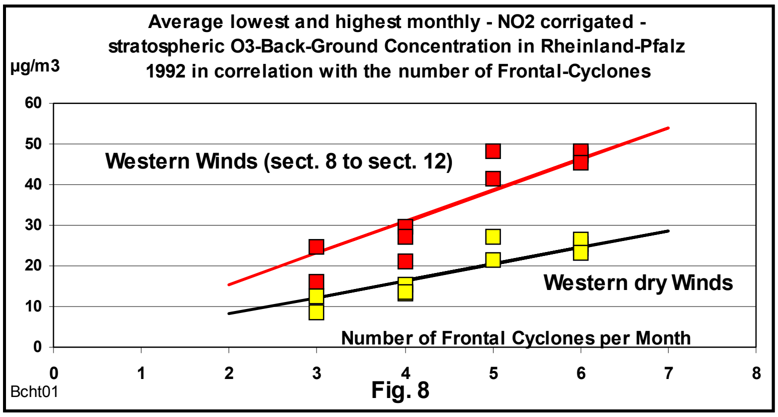

Fig. 8: Correlation between Number of frontal cyclones and stratospheric O_3-background

It seems, the more frontal cyclones occur per month, the lower is the intensity of intruded stratospheric O_3 per frontal cyclone till a certain saturation.

7. Conclusion

Studying the concentrations of O_3 and NO_2 together with the meteorological components at several different points in the lower troposphere (3,5 to 10 m above ground) one can find, that there is a natural background of O_3 with a monthly average between 20 to 50 µg/m^3, produced by cold and dry western air masses, which are contaminated with stratospheric O_3. and which are transported by jet streams, caused by tropospheric folding into the biosphere. In the lower troposphere the O_3-concentrations are reduced by anthropogenic NO, which is to consider by estimating the quantity of intruded stratospheric Ozone. Examples show, that stratospheric O_3 produces such background concentrations all over the year. The magnitude depends on the frequency of frontal cyclones per month. This phenomenon already existed before industrial times and surely every where in the world caused by frontal cyclones. This Ozone is coming from the lower region of the stratosphere. It should be of interest to prove these results by correlation with cosmogenic radio nuclides /7/.

8. Literature

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