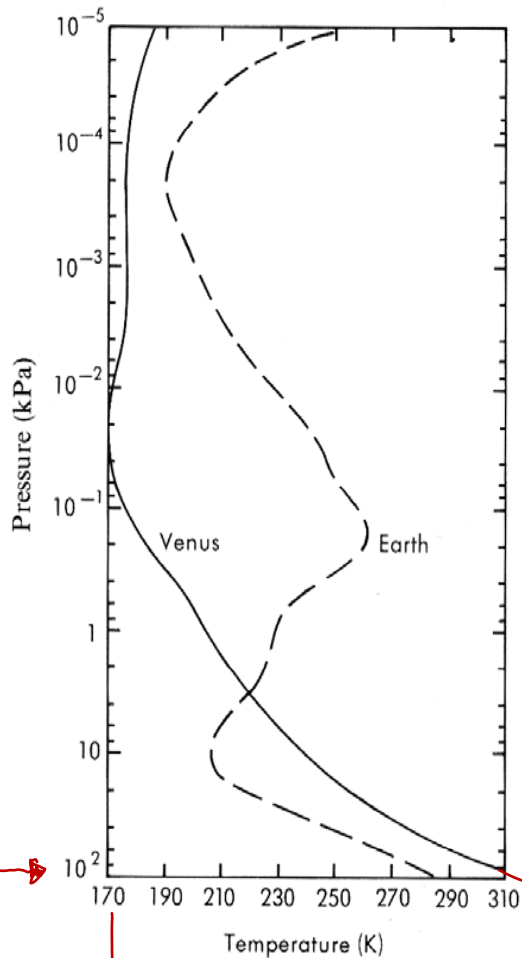


Fig. 12.16. Vertical temperatures profiles of temperature versus pressure at 30N latitude as measured on Venus by the VORTEX experiment and on earth by the Nimbus 7 Stratospheric and Mesospheric sounder. Further details of both instruments in Houghton, Taylor & Rodgers 1984.

Source:
Houghton, 1989



1 atm
= 1 bar



100 bar



Venus-Treibhaus:

"Run-Away-Greenhouse"



H₂O kann nicht kondensieren:

je mehr H₂O die Venus ausgast, desto stärker wird der Treibhauseffekt

750K

Temperature Profile in the Atmosphere

- Surface: Transformation of incoming shortwave radiation into outgoing infrared radiation („hot plate“)
- Middle Atmosphere (Stratosphere): Photolysis of ozone and recombination to ozone via reaction of oxygen and atomic oxygen, thereby transformation of photon energy into kinetic energy which increases temperature
- Thermosphere: Heating through ionisation of N_2 and O_2
- On other planets (e.g. Venus) the O_2 / O_3 – heating mechanism is missing and hence the related warming in the middle atmosphere is missing

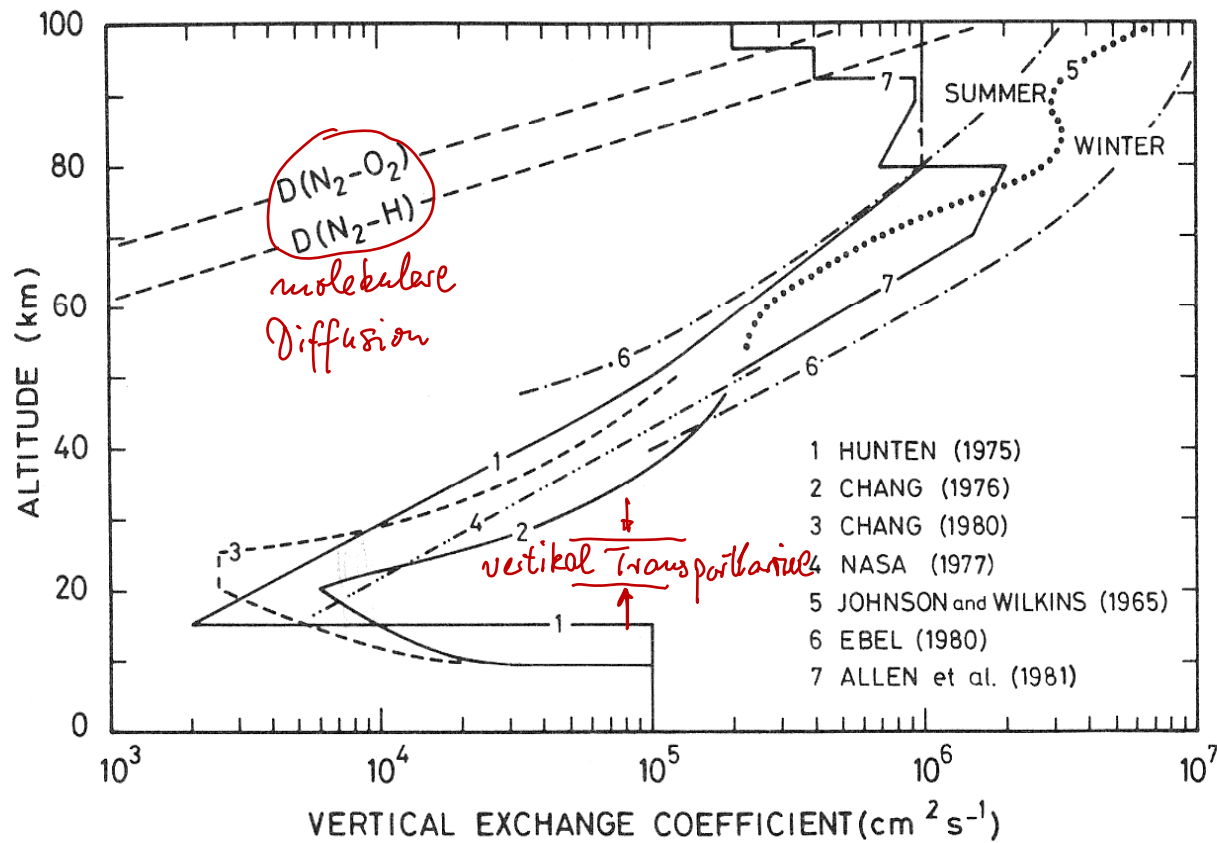


Fig. 3.22. One-dimensional eddy diffusion coefficients used in various aeronomic models.

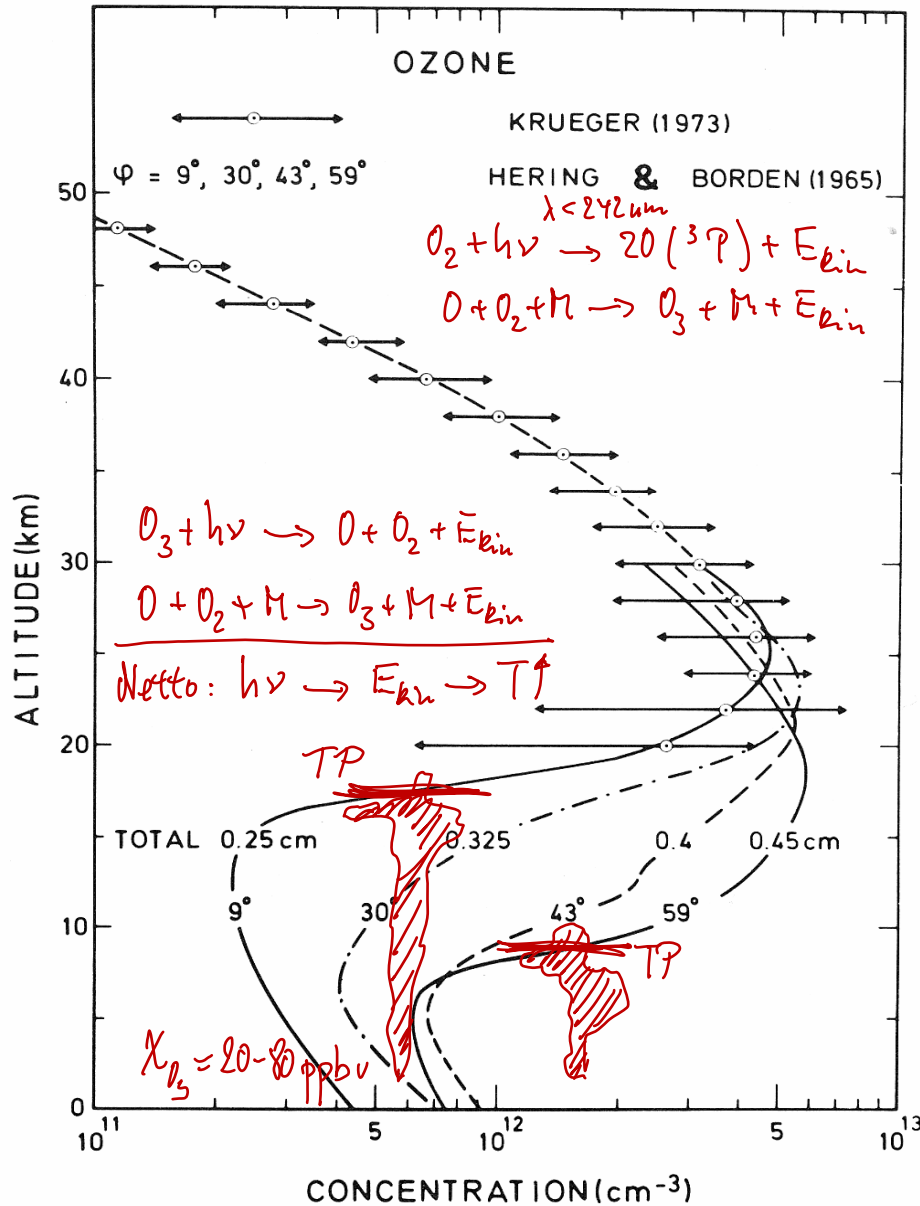
Diffusion durch Wirbel
 (Turbulenz)

Vertical Exchange in the Atmosphere

- Vertical Exchange Coefficient = Eddy Diffusion Coefficient
- In the lower stratosphere the Eddy diffusion coefficient is at its minimum and hence vertical mixing is very low („stratified“). The vertical exchange coefficient strongly increases with altitude because the air is getting thinner, upward traveling waves develop larger amplitudes and lead to more mixing upon breaking (and hence more vertical exchange).
- The troposphere exhibits much stronger vertical mixing than the lower stratosphere. The reason is the development of deep convection (i.e. high-rising thunderstorms transport air quickly from the boundary layer to the upper troposphere). The tropopause acts as a distinct transport barrier.

The Ozone Layer

Source: Brasseur and Solomon, 1986



Tropen → O_3 -Bildungsregion
 → höchsten Mischungsverhältnisse
 $X_{O_3} \approx 10 \text{ ppmv}$

Transport ← O_3 -Zerstörung

hohen Breiten:

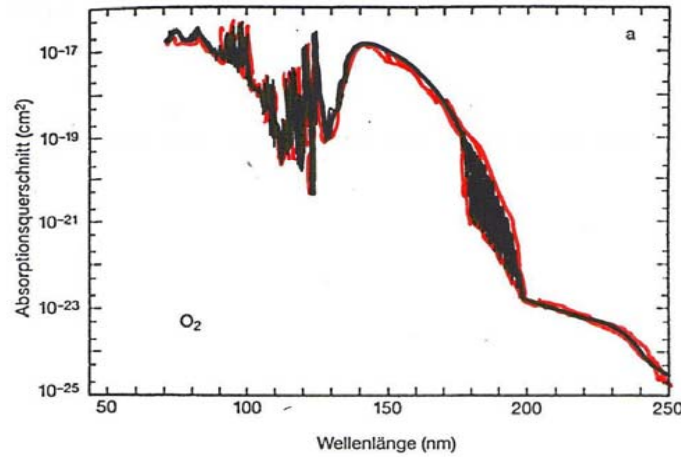
→ niedrigere Mischungsverhältnisse
 ABER: $X_{O_3} \approx 5 \text{ ppmv}$

O_3 -säule ist in den hohen Breiten
 trotzdem höher als am Äq., weil
 Tropopause niedriger ist

Fig. 5.7. Mean vertical distribution of the ozone concentration according to observations at different latitudes. Note the variations in total column abundance.

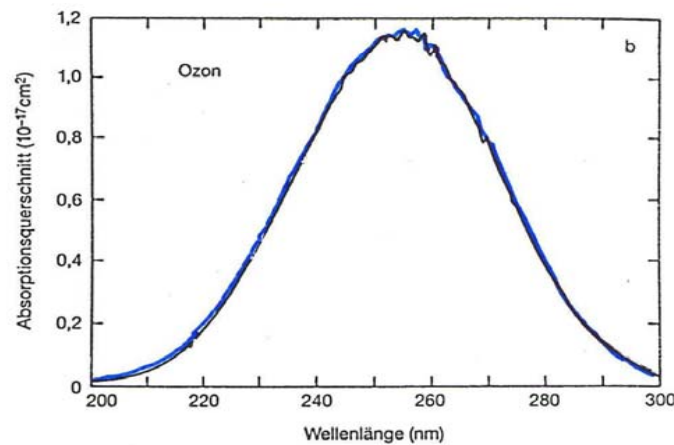
The Ozone Layer

- Vertical profiles derived from ozone sondes and satellite measurements.
- The ozone concentration (number of molecules per cm^3) shows a maximum at 20 to 25 km altitude, depending on latitude.
- The „ozone layer“ is regarded as the layer between 20 and 40 km, where ozone concentration is most abundant.
- The ozone minimum at the tropopause (also referred to as the „ozonopause“) varies with latitude, reflecting the height of the tropopause (increasing from the Poles towards Equator)



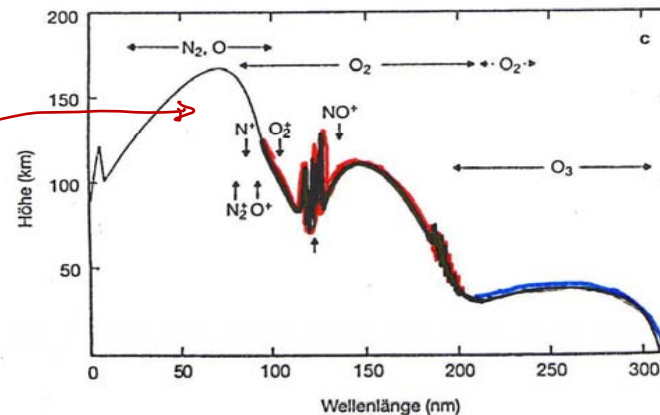
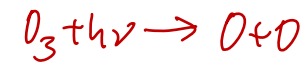
Absorptionsquerschnitt
von molekularem
Sauerstoff (O_2)

$$\lambda < 242 \text{ nm}$$



Absorptionsquerschnitt
von Ozon (O_3)

Ausschnitt, die Absorption
geht bis 1140 nm



Eindringtiefe von Sonnen-
strahlung in Abhängigkeit
von der Wellenlänge in
die Erdatmosphäre.

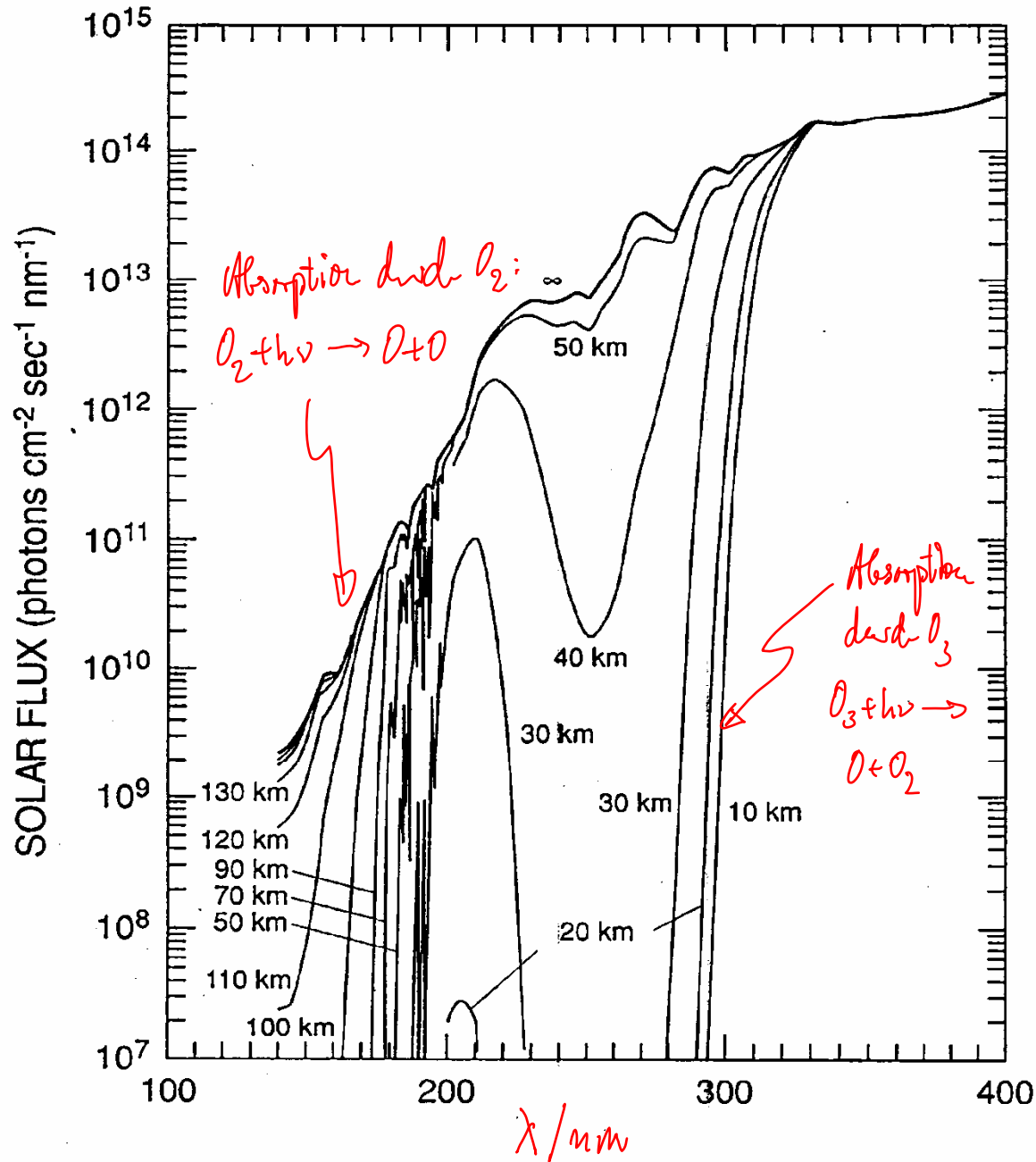
Source: Brasseur and Solomon, 1986

Absorption of shortwave solar radiation

- Absorption cross section of molecular oxygen (a), ozone (b) (only part of the whole wavelength band) and depth of solar radiation penetrating into the Earth's atmosphere (c) as a function of wavelength
- Strong dependence of absorption cross section upon wavelength
- For wavelengths below 100 nm radiation is almost completely absorbed above 100 km by atomic and molecular oxygen and molecular nitrogen
- Between 100 and 300 nm, the main drivers in the absorption of UV solar radiation are O_2 ($O_2 + h\nu \rightarrow O + O$) and O_3 ($O_3 + h\nu \rightarrow O_2 + O$).
- O_2 effectively absorbs UV in distinct bands:
Lyman- α line: 121.6 nm
Schumann-Runge band: 175 – 200 nm
Herzberg continuum: 200 – 242 nm
- O_3 absorbs in the Hartley band: 200 – 310 nm

The atmosphere as a UV filter

Source: Falkowski et al., Science, 2000



Coupling vertical and latitudinal coordinates

The Brewer-Dobson circulation or mean meridional circulation

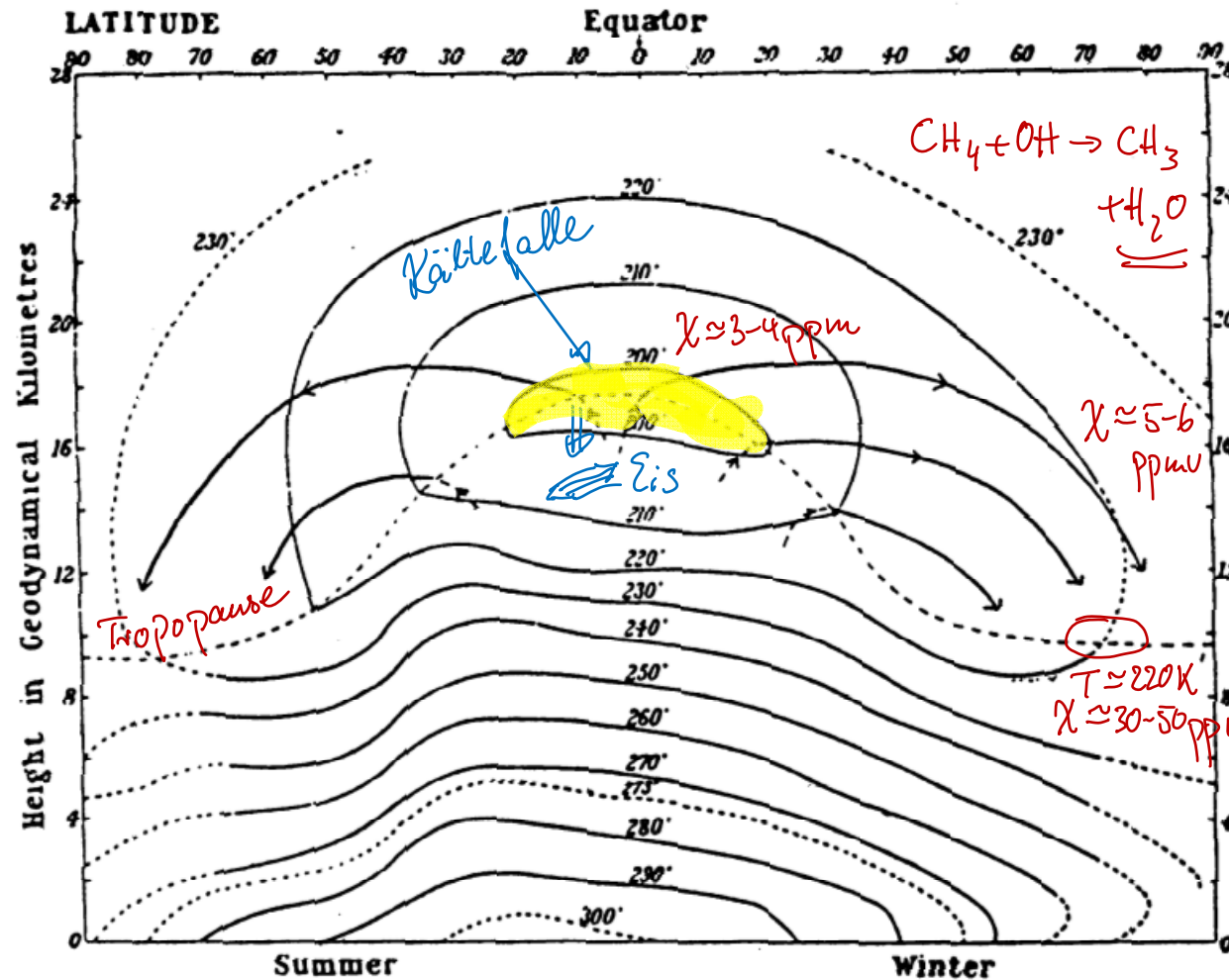


FIG. 5. Isotherms over the Globe
A supply of dry air is maintained by a slow mean circulation from the equatorial tropopause.

"World circulation"

Fundtemessungen
↳ this is an art!

200K → $\chi_{H_2O}^{equi} \approx 4 \text{ ppmv}$

↓

Brewer fand $\chi_{strat} \approx 4 \text{ ppmv}$

↓

Weltzirkulation

From Brewer's
original work 1949