

**Prüfung:** <sup>20</sup>  
30 Minuten mündlich  
tbd { 22./23. Dezember Semesterendprüfungen  
5./6. Januar Semesterendprüfungen

**Note:** Ihre Leistung wird benotet:  
1/3 Übungen, 2/3 Prüfung  
oder  
1/2 Übungen, 1/2 Prüfung <sup>default</sup>  
(vor Beginn der mündlichen Prüfung festzulegen)

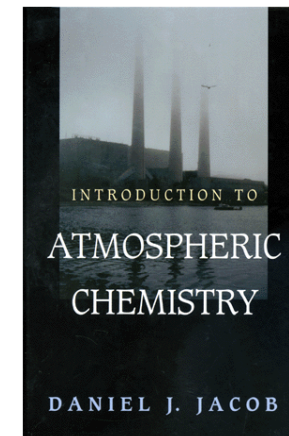
<sup>27</sup>  
~~22~~ Studierende in diesem Kurs  
(eingeschrieben am 19. Sept):

10 UWIS BSc  
6 Geogr. BSc  
3 Erdw. BSc  
3 MSc UWIS

## Vorlesung Atmosphärenchemie – empfohlene Literatur:

### Exzellenter Standard:

*basics* → Daniel J. Jacob, Introduction to Atmospheric Chemistry, Princeton University Press, 1999.  
<http://acmg.seas.harvard.edu/publications/jacobbook/index.html>



### Blick über den Tellerrand:

Thomas E. Graedel and Paul J. Crutzen, Chemie der Atmosphäre: Eine Systemperspektive, Spektrum Akad. Verlag, Berlin, 1994.

### Breites Allgemeinwerk, gute Anknüpfung mit Laborexperimenten (auch MSc):

Barbara Finnlayson-Pitts and James N. Pitts, Jr., Atmospheric Chemistry: Fundamentals and Experimental Techniques, Wiley, New York, 1986.

### Lesbares Nachschlagewerk (auch MSc):

*best* → John H. Seinfeld and Spyros N. Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, Wiley, New York, 1998.  
*advanced*

### Unter dem Kopfkissen:

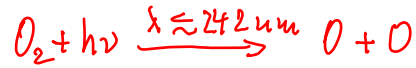
Stefan Brönnimann, Ozon in der Atmosphäre, Hauptverlag, Bern, 2002.

### Notes to this lecture (in English):

Every 3<sup>rd</sup> to 5<sup>th</sup> page of the handout contains information in English language  
→ recommended in particular for Johannes Staehelin's parts of the lecture

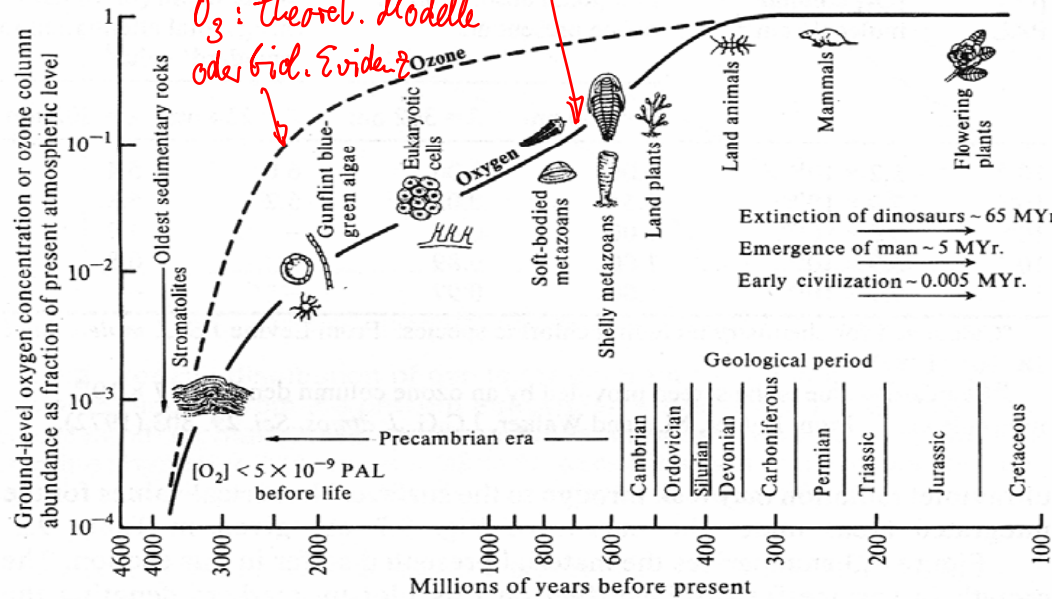
# Introduction:

## The evolution of the atmosphere

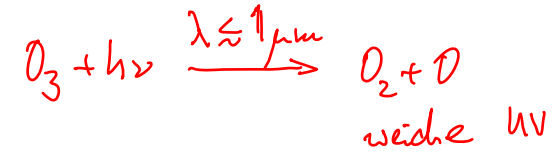


$O_2$ : Info z.B. aus Fe-Schicht

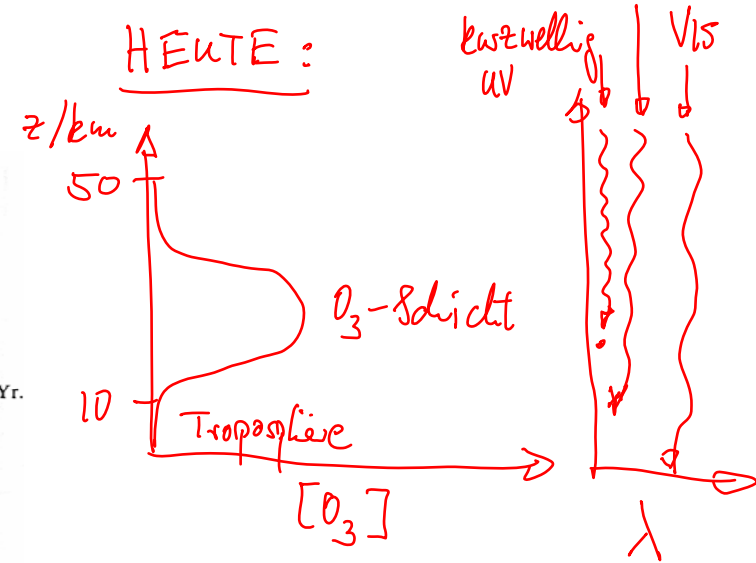
$O_3$ : theoret. Modelle oder bid. Evidenz?



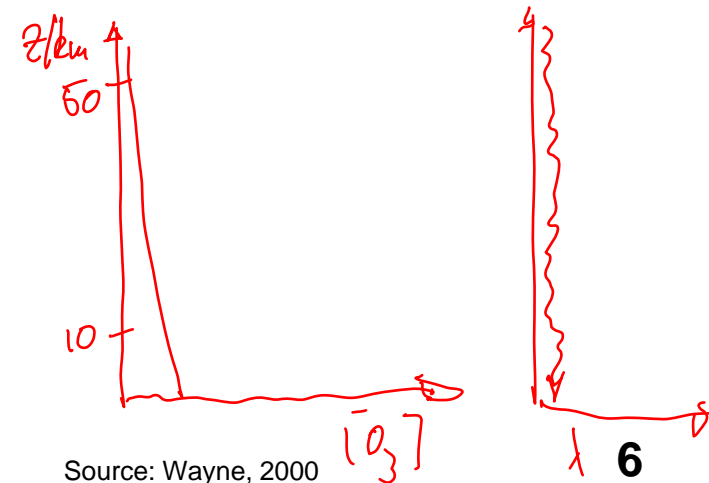
**Fig. 9.3.** Evolution of oxygen, ozone, and life on Earth. In the absence of life, surface oxygen concentrations are unlikely to have exceeded  $\sim 5 \times 10^{-9}$  of the present value. The build-up of oxygen to its present level is largely a result of photosynthesis. Early organisms would have found high oxygen concentrations toxic, but eukaryotic (nucleated) cells require at least several per cent of the present level for their respiration. Soft-bodied metazoans could have survived at similar oxygen levels, but the reduced surface oxygen uptake area available once the species had developed shells must mean that the concentration was approaching one-tenth of its current value about 570 Myr ago. Considerations such as these are used in drawing up the oxygen growth curve. Ozone concentrations can be derived from a photochemical model. Life could not have become established on land until there was enough ozone to afford protection from solar ultraviolet radiation.



HEUTE:



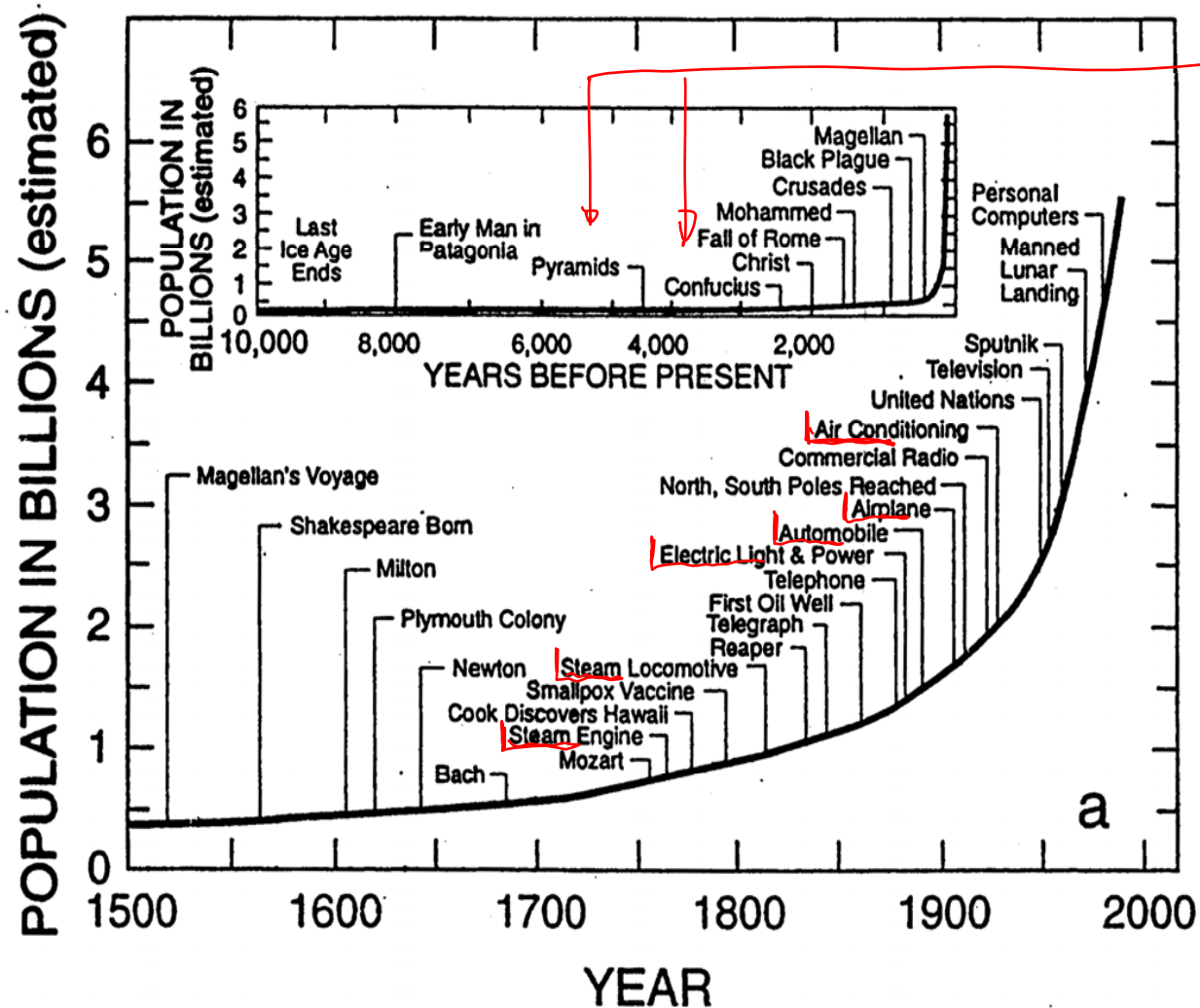
Vor 2 Mrd. a



Source: Wayne, 2000



# Atmospheric chemistry and the evolution of world population



Rice paddies  
vor 6000 a

↓  
CH<sub>4</sub> ↑

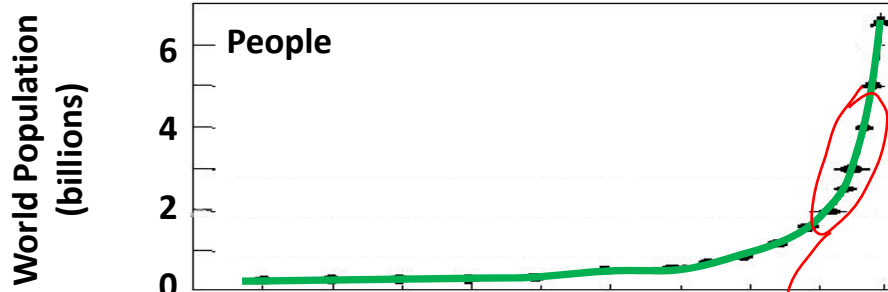
gibt es Evidenz für den  
anthropogenen Anstieg des  
CH<sub>4</sub> durch Reisbau vor  
6000 a?

⇒ wiss. Disput

From Graedel & Crutzen

# The most recent millennium

## World Population



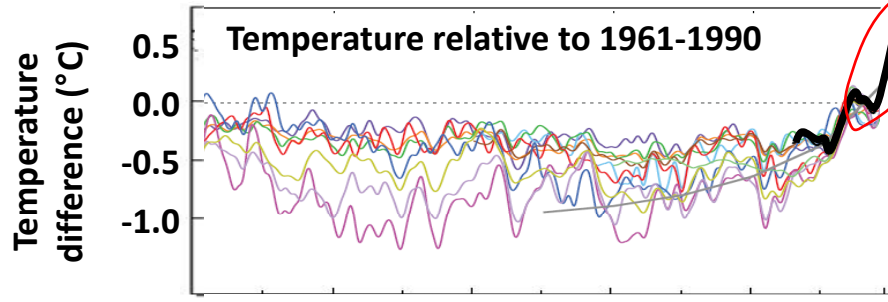
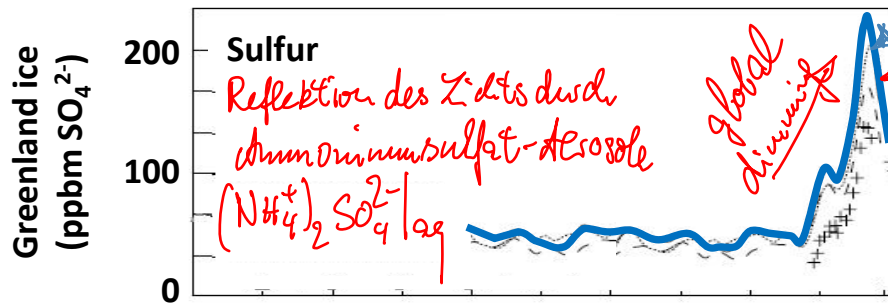
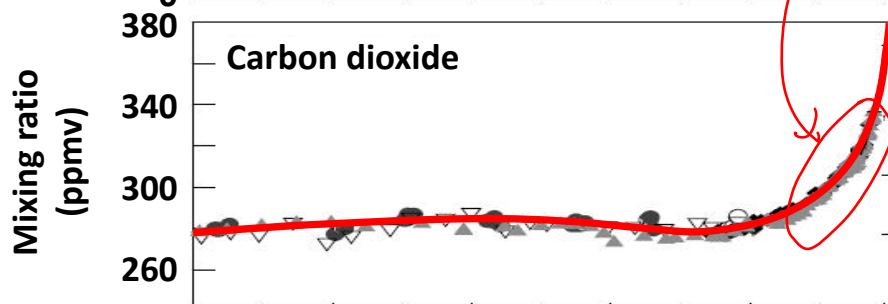
## Heating the Planet

IPCC: anthropogene Ursache ist "sehr wahrscheinlich"

## Cooling the Planet

$SO_2 \xrightarrow{Oxi.} H_2SO_4$  (Wolke)  
 $H_2SO_4 + H_2O \rightarrow 2H^+ + SO_4^{2-} + H_2O$   
 Tröpfchen: ammoniak  $NH_3$

## Temperature Change



Luftreinhaltungsmaßnahmen  
 Clean Air Act  
 global dimming  
 global brightening  
 SO<sub>2</sub> emissions (Mt S/yr)



# The atmosphere as a UV filter

Source: Falkowski et al., Science, 2000

