Workshop Series Urban and Regional Air Chemistry

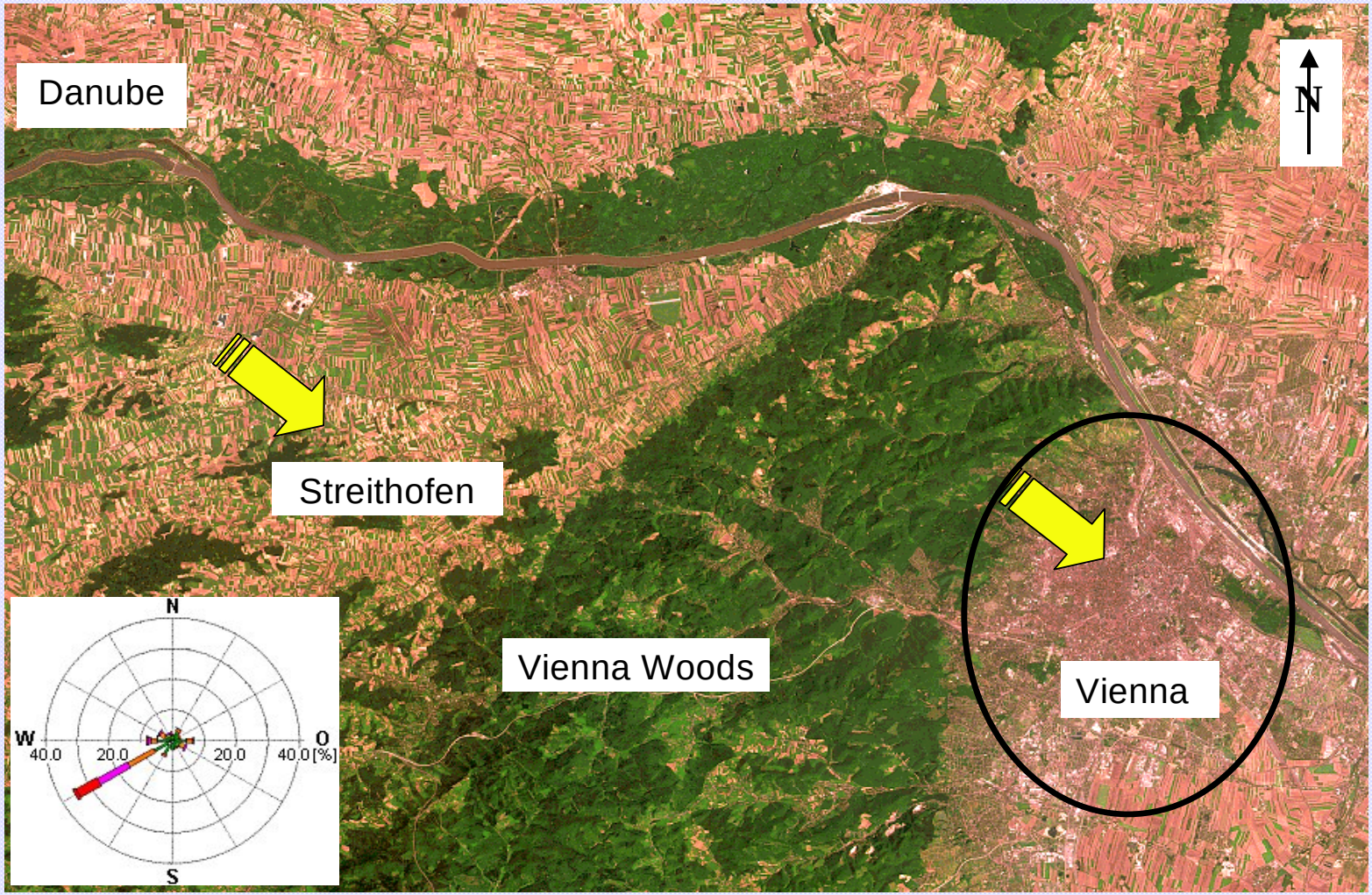
Sources and Impact of Urban Air Pollution

October 25-27, 2004, Palazzo Papadopoli, Venice, Italy

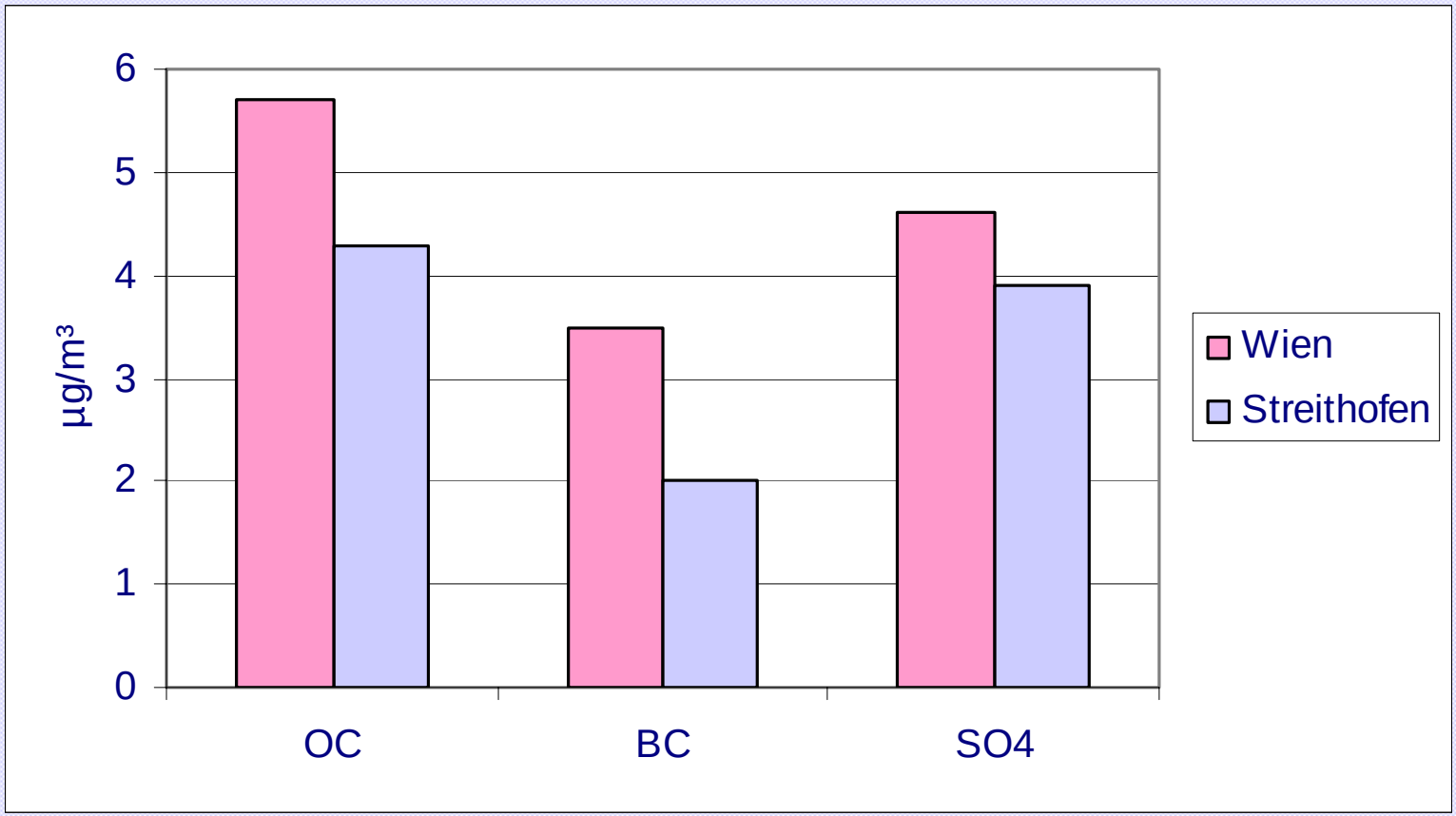
„Progress in Aerosol Source Analysis of Urban PM10 Aerosol “

Compiled by H. Puxbaum, H.Bauer and A. Kasper

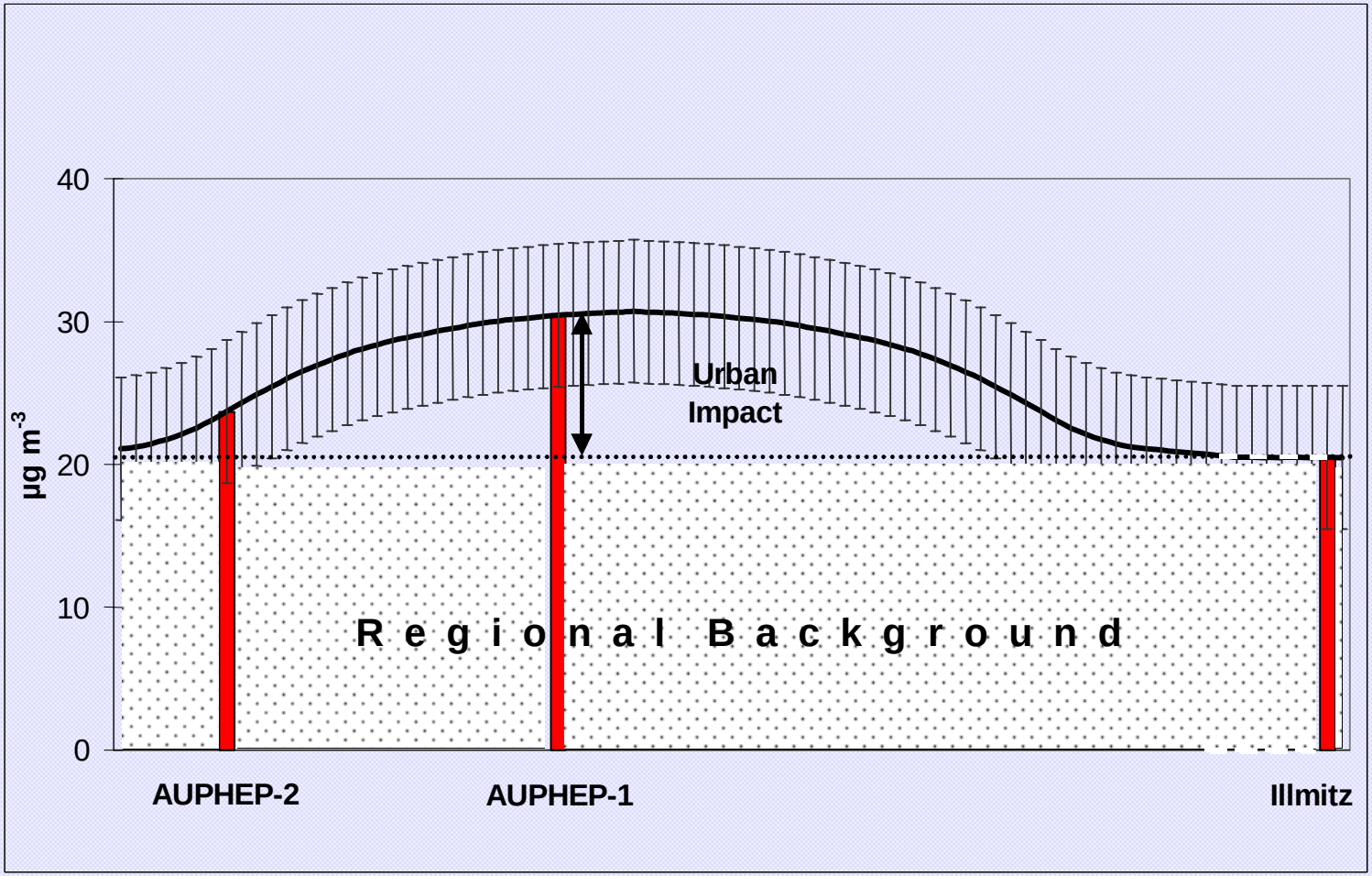
Institute for Chemical Technologies and Analytics
Vienna University of Technology

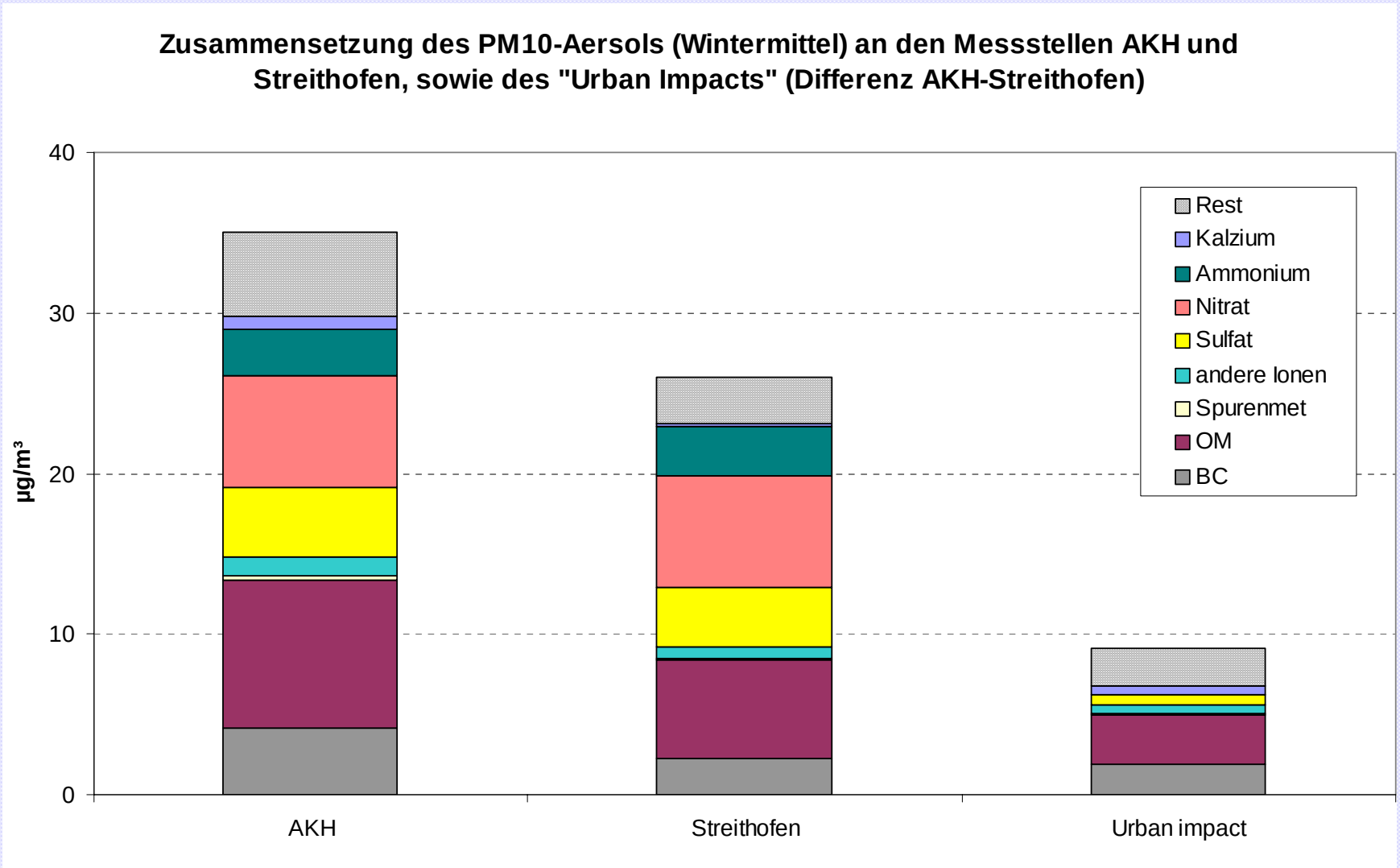

Danube
N
Streithofen
Vienna Woods
Vienna
N
W
O
S
40.0
20.0
20.0
40.0 [%]

OC, BC and Sulfate in PM10
Dual Sites Vienna and Streithofen (6/99-5/00)



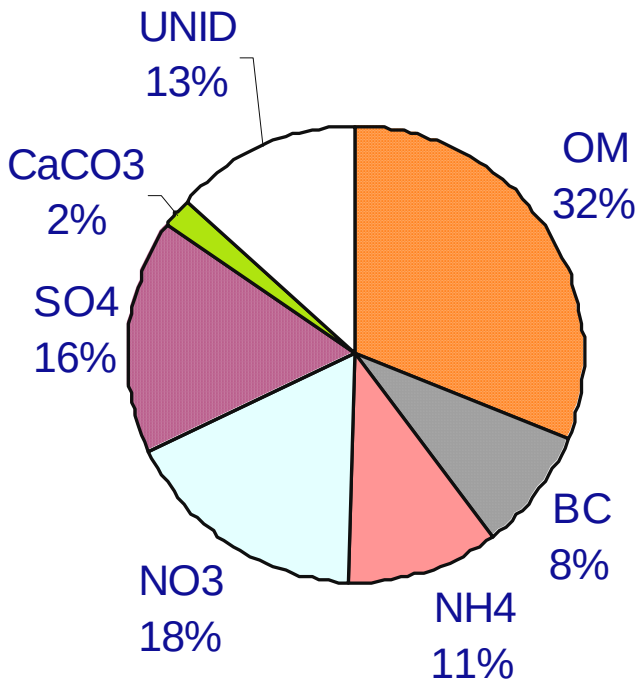
Conceptual model for the “urban impact”





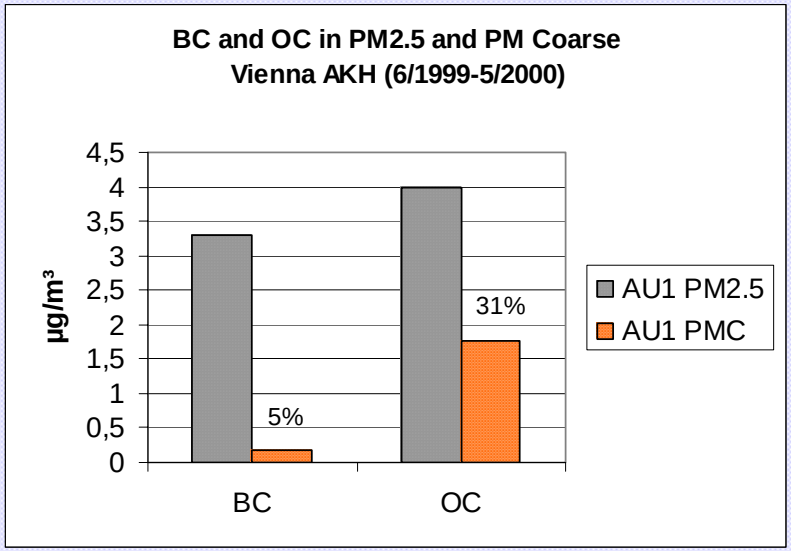
Puxbaum et al. (2004) Atmos. Environ. 38, 3949-3958

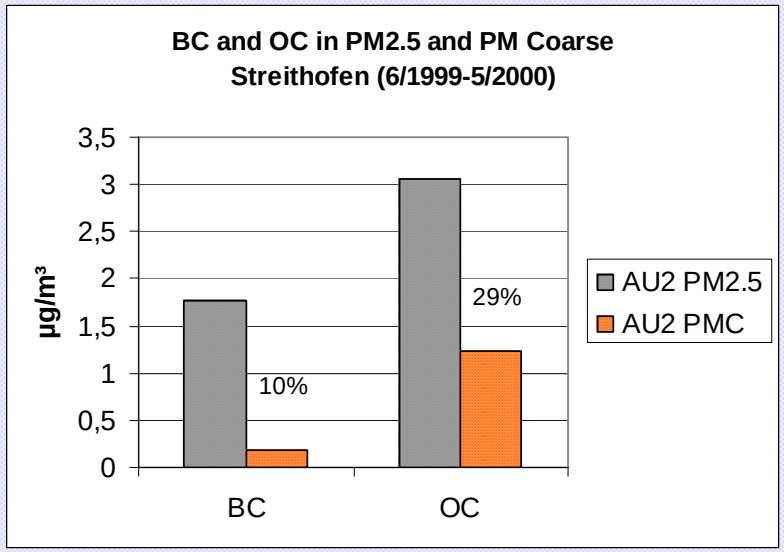
Major Components PM10 Streithofen (6/99-5/00) Mass 23.7 µg/m³



Puxbaum et al. (2004) Atmos. Environ. 38, 3949-3958

Black and Organic Carbon in PM2.5 and PM Coarse in VIENNA – AKH and Streithofen (30 km west of Vienna)





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Macro – Tracers for Atmospheric Aerosol Source Apportionnement

- Definition of Macro-Tracers:

Tracer Concentration in Source Component > 1%

- Example for Mineral Dust:

Si*3.6 ~ Mineral Dust Mason & Moore (1982)

- Example for Biomass Smoke:

Levoglucosan*10 ~ Biomass Smoke Fine et al. (2001)

Components of the „Macro Tracer„ Approach for OC

(H. Bauer, H. Puxbaum, A. Kasper-Giebl)

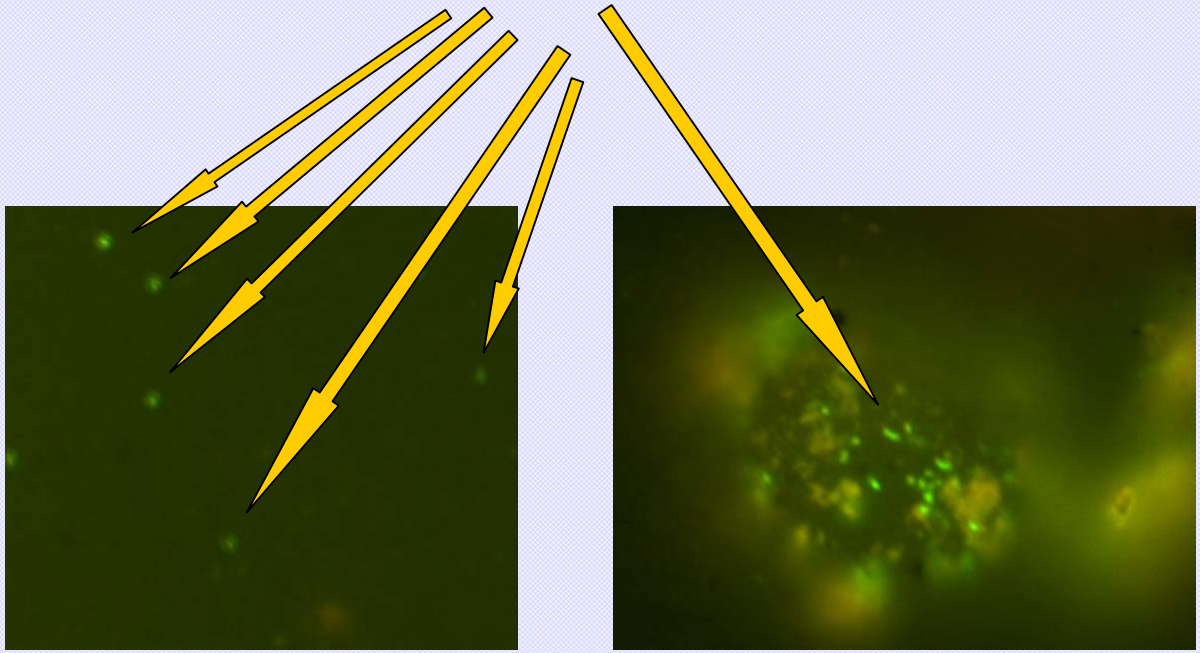
Component	f	Source	Group
Levoglucosan	7-10	Biomass Smoke	Fine et al. (2001)
Cellulose	2	Plant Debris	Kunit & Puxbaum (1996)
Fungal Spores	13 pg C/Spore	Bio Aerosol	Bauer et al. (2002)
HULIS	1	SOA?	Handler (2003)
Traffic OC	BC_t*0.4	Traffic	Schmid et al. (2001)

Method for Sampling and Determination of Atmospheric Bacteria and Fungal Spores

- Collection of Bioaerosols with Impingers (AGI-4) in Water/Glycerol
- Dyeing with SYBR®Gold Nucleic Acid Gel Stain
- Filtration on Anodisc 0.2 µm Pore Size Filters
- Count with Epifluorescence Microscope (Excitation Wavelength: 450 nm, Emission Wavelength: 550 nm)
- Calculation of Fungal Carbon: Spore*13 pg

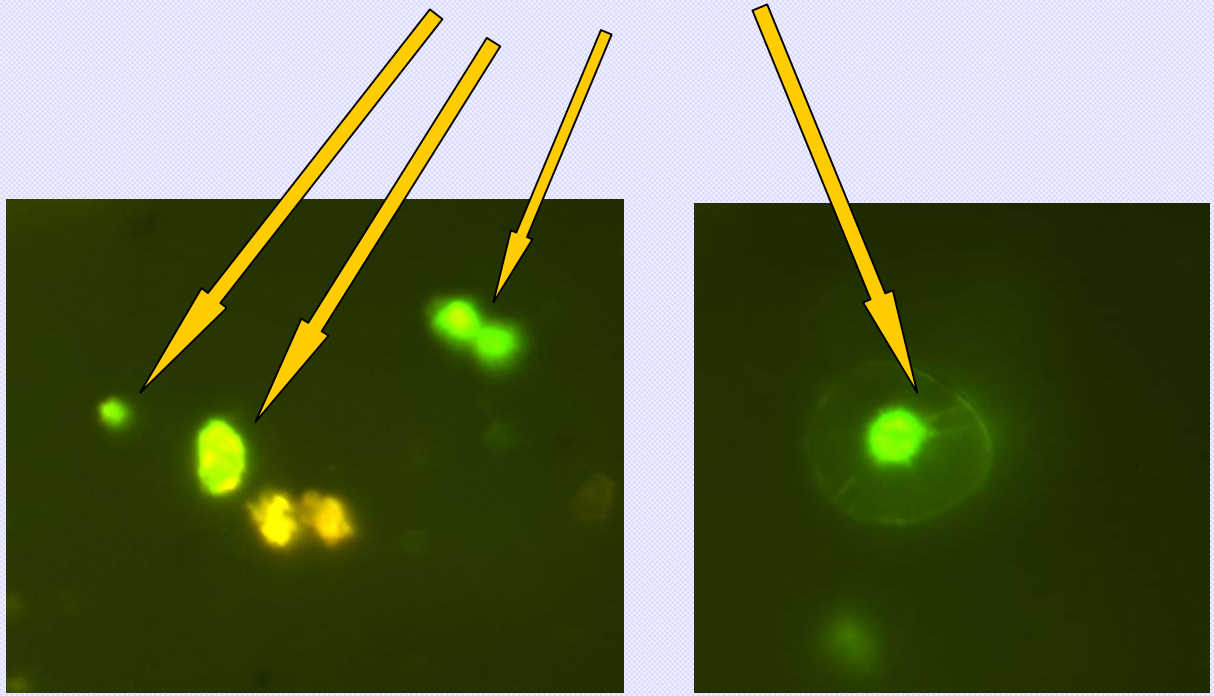
H. Bauer

Bacteria



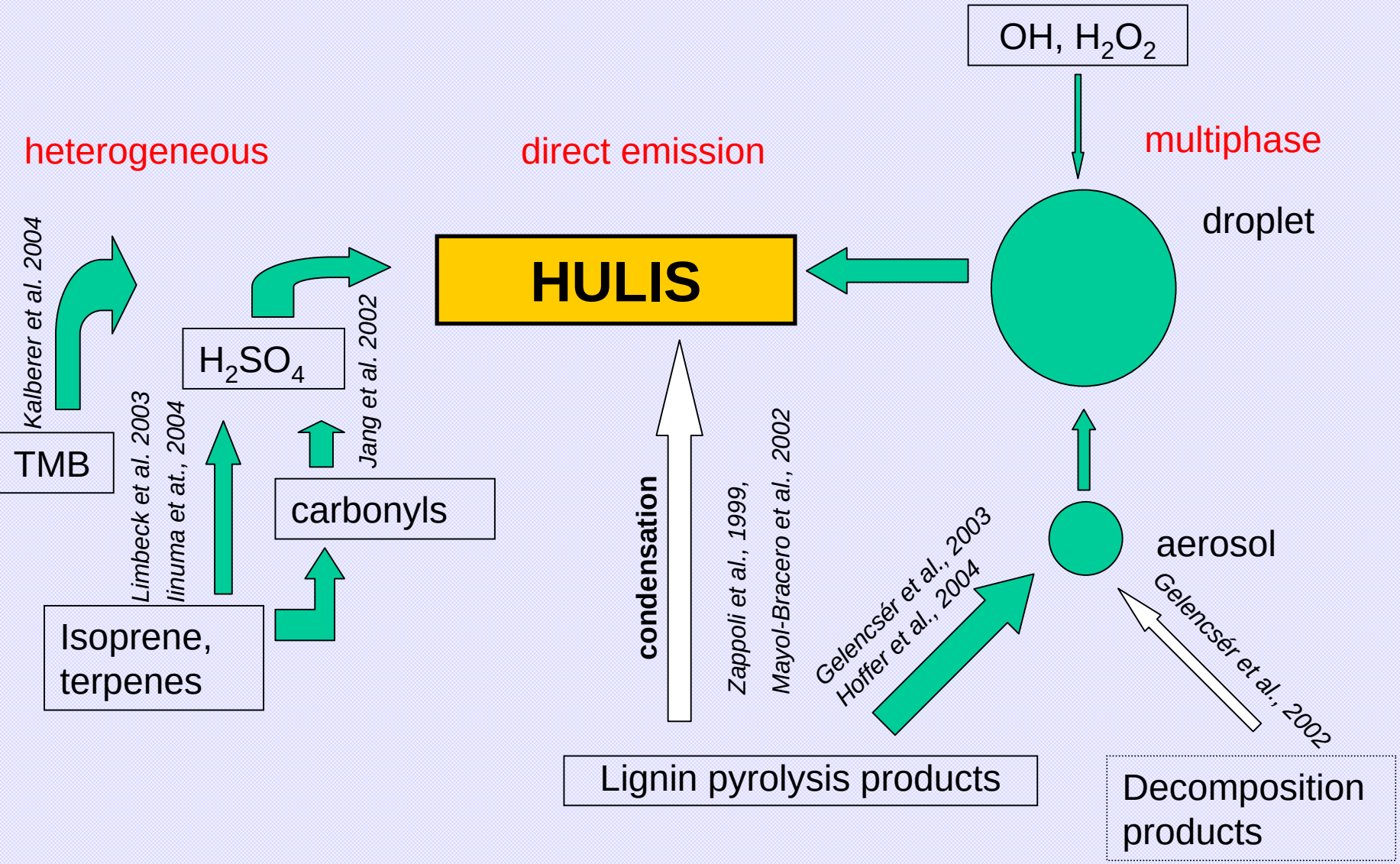
dyed with SYBR® Gold Nucleic Acid Gel Stain

Fungal Spores



dyed with SYBR® Gold Nucleic Acid Gel Stain

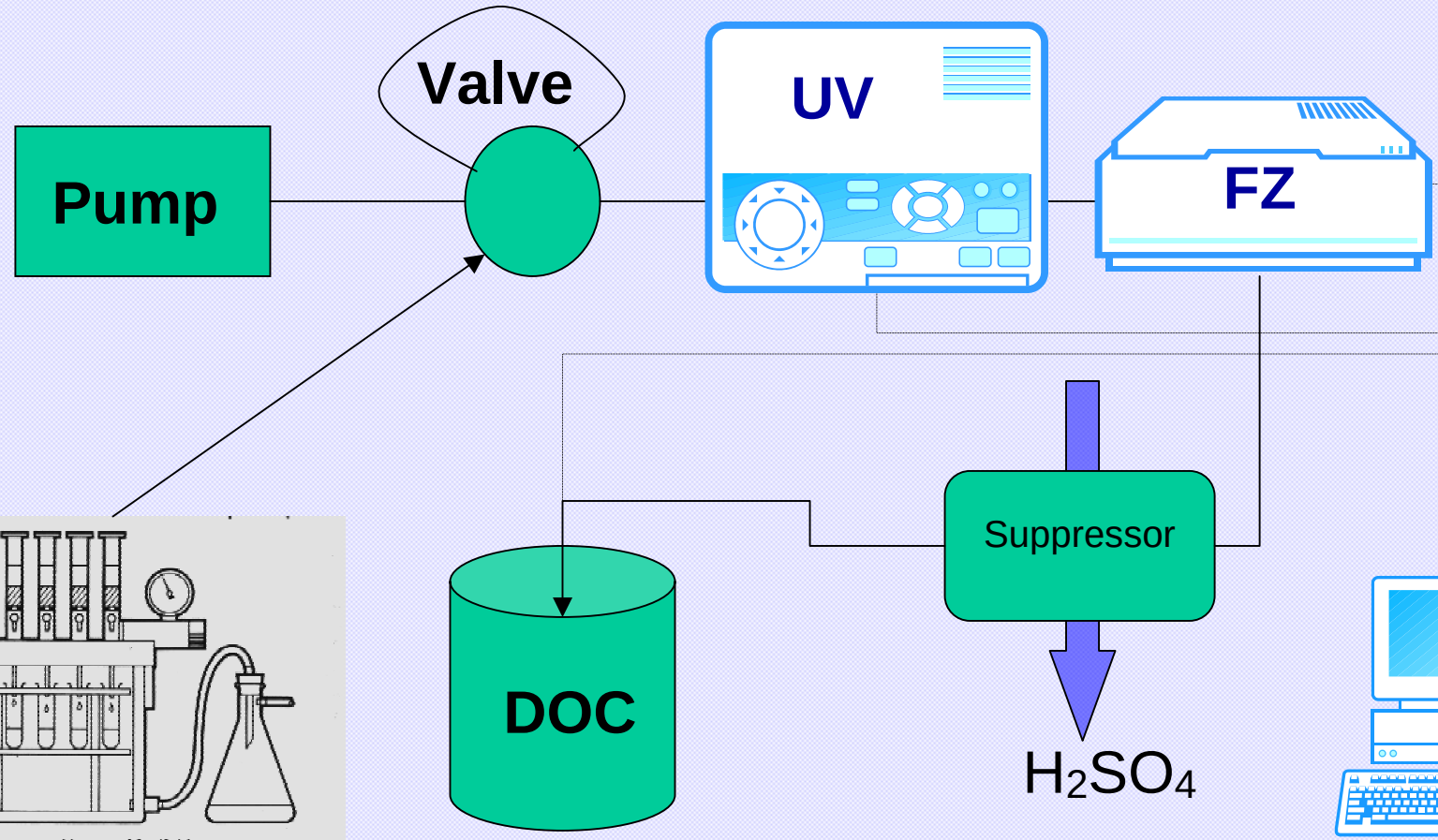
Suggested routes for HULIS formation



Scheme by A. Gelencser

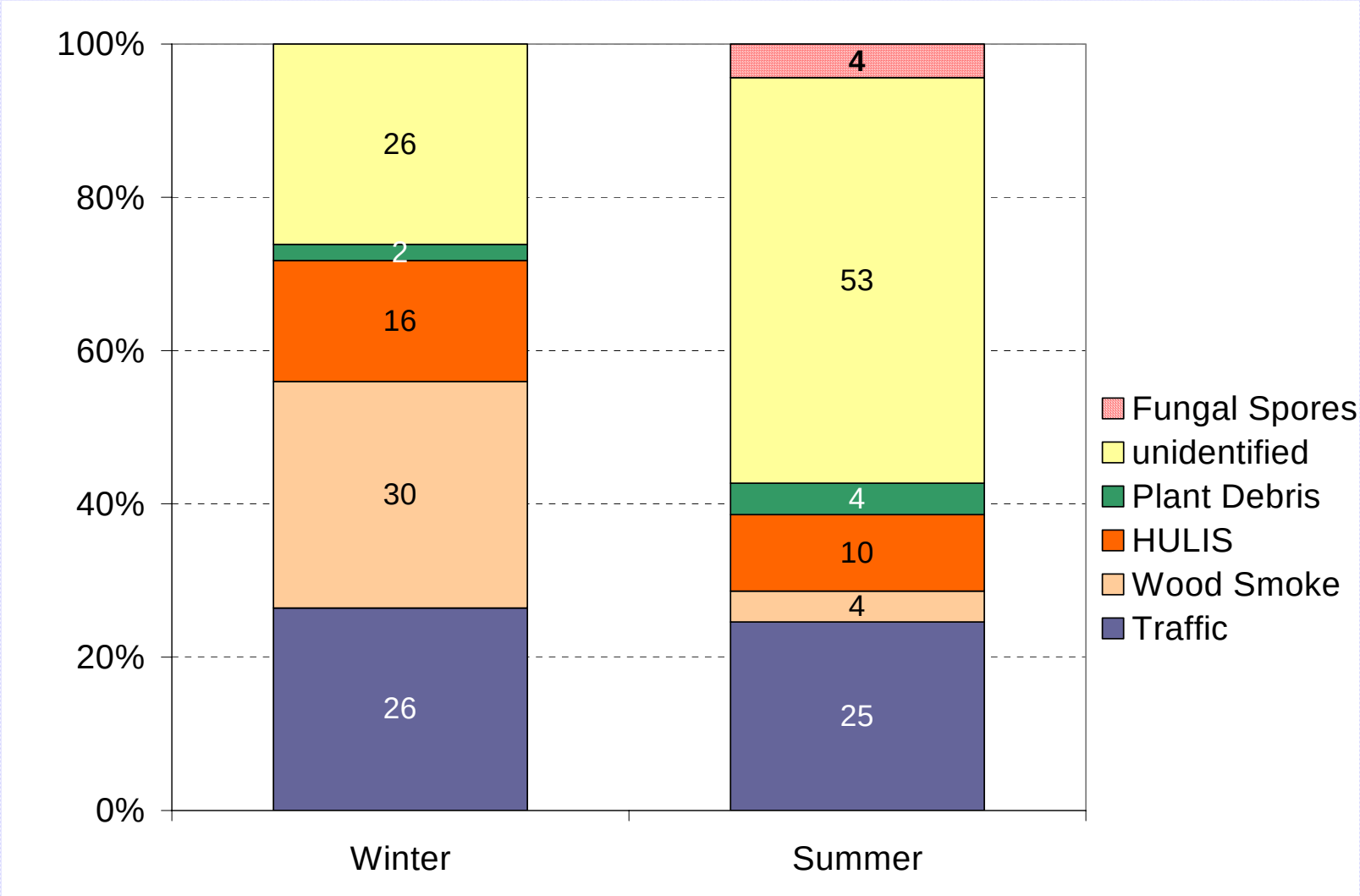
Analytical System

(Handler Diploma Thesis 2003)

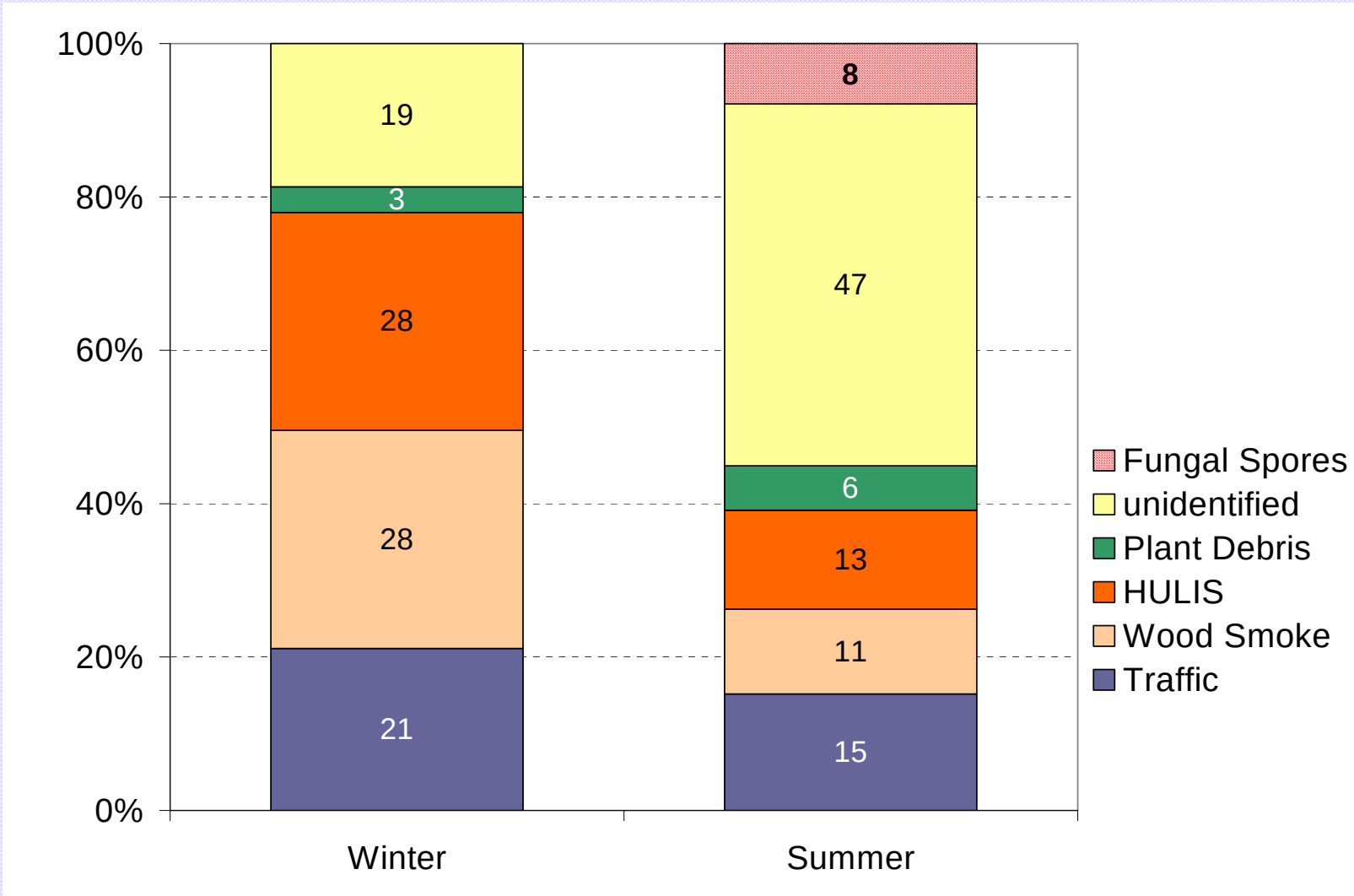


1. SPE C18(EC)
2. SPE SAX

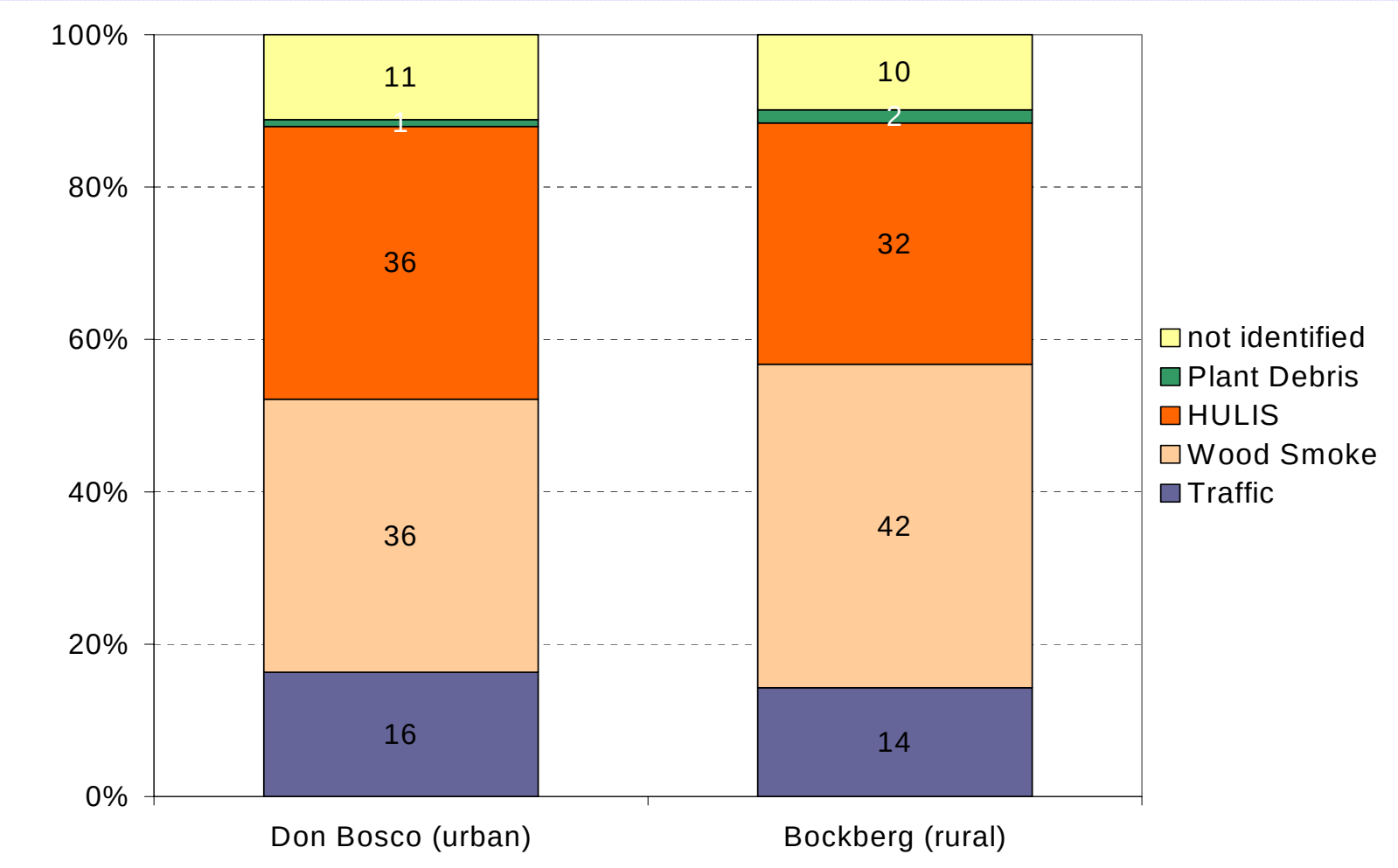
Composition of OC (PM_{10}) at an Urban Site (Vienna-AKH)



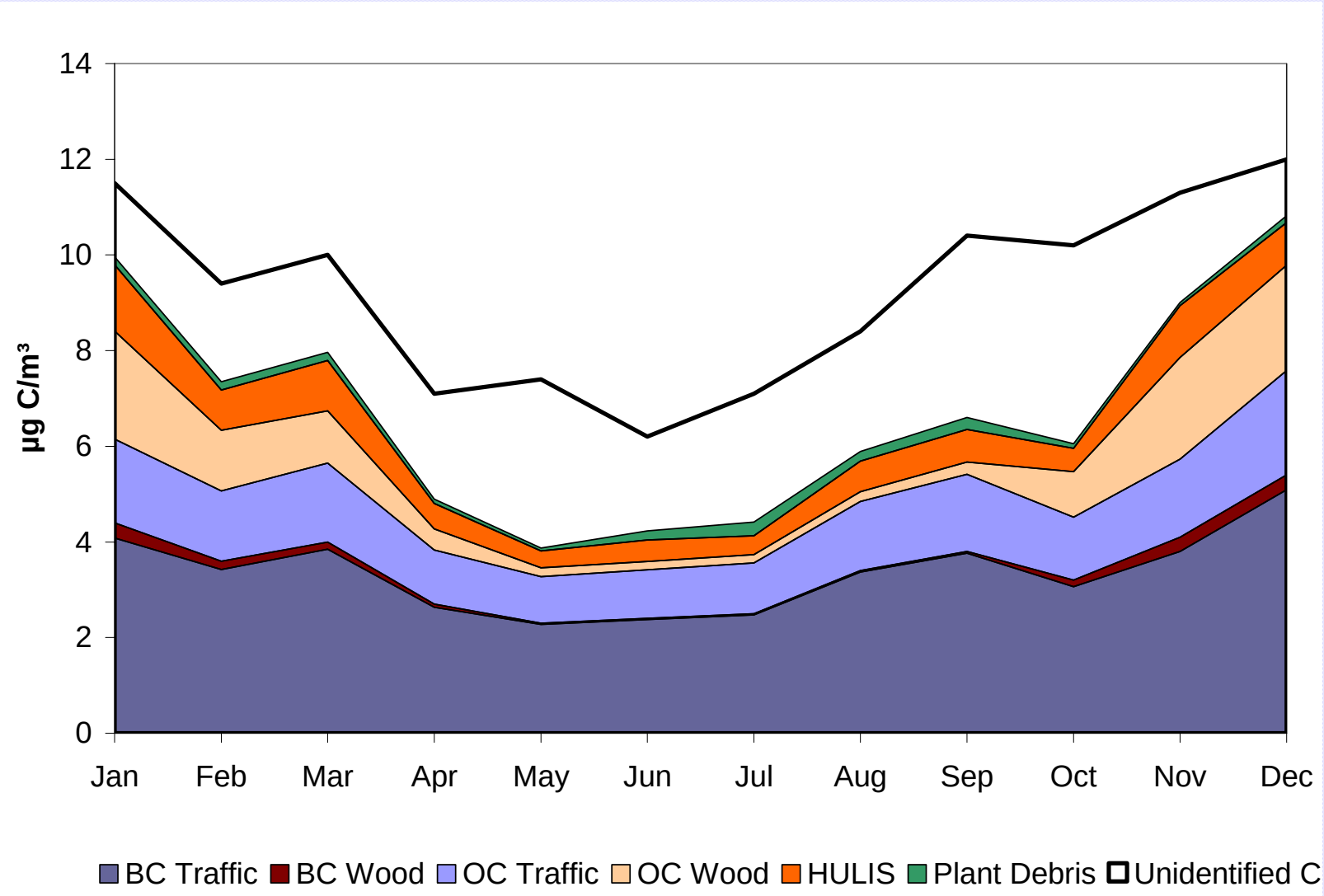
Composition of OC (PM_{10}) at a Rural Site (Streithofen, Austria)



Composition of OC (PM_{10}) at an Urban and a Rural Site in Austria (February 2004; AQUELLA Steiermark)



Annual Trend of the composition of TC (PM_{10}) in Vienna (AKH), Austria



Application of the Macro Tracer Approach for OC Apportionnement

(Data from AKH VIENNA - Streithofen)

• The organic fraction of PM10 in the greater Vienna area consists predominantly of

	Summer	Winter	
„HULIS“	10	- 28 %	
Traffic Emissions	15	- 25 %	
Wood Smoke	4	- 31%	
Plant-Debris	6	- 2 %	
Bio-Aerosols/Spores	4	- 8 %	
Unidentified	50	- 20 %	(Compound C of OC)

• During winter wood smoke is the dominant organic source of OC in PM10 aerosol.

•Emissions from traffic exhaust emissions (BC_t+OM_t) contribute only 12% to PM10 (AKH-urban site)

Primary and Secondary Atmospheric Polymers

- Primary atmospheric polymers in PM10 (Cellulose/Debris, Spores) are contributing up to 10% to the organic aerosol (Eastern Austria)

- „HULIS“ (Secondary atmospheric polymers) contribute 20-50% to the organic aerosol.
  HULIS form in secondary reactions (SOA)
  A) from biogenic emissions (e.g. isoprene, terpenes)
  B) from phenolic substances from biomass combustion.

- The secondary formation is due to acid catalysed or radical induced polymerisation or oligomerisation of reactive biogenic and anthropogenic VOC.

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AUPHEP Project

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HULIS - Ubiquitous Substances

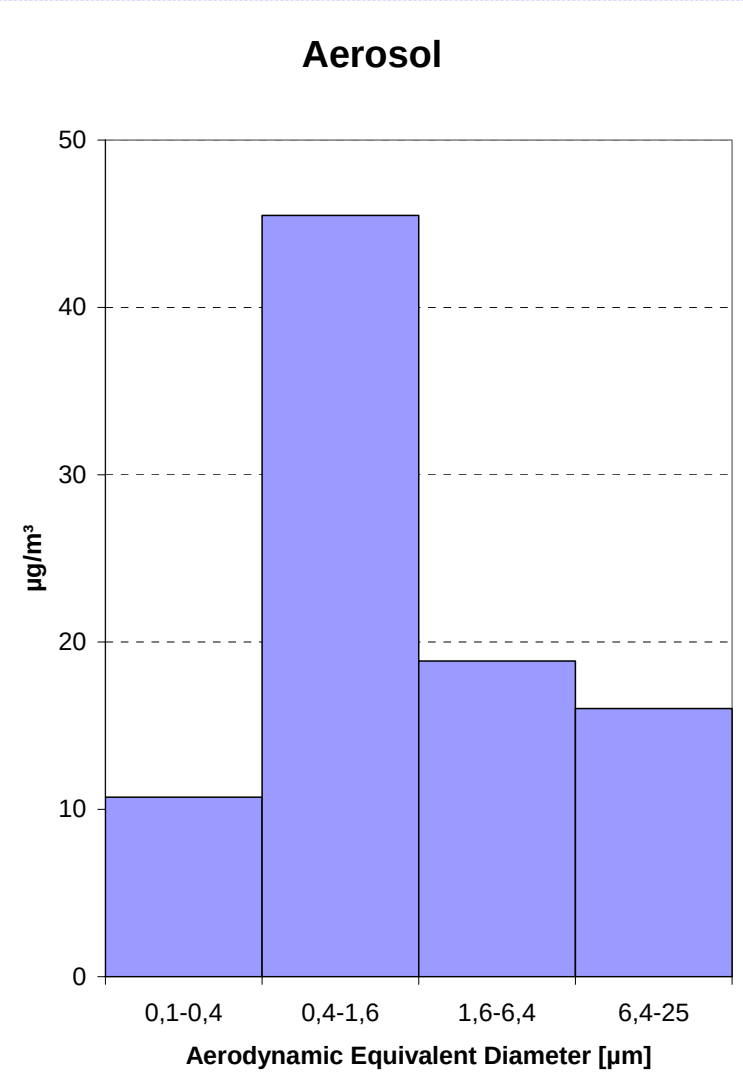
Airborne Particulate Polymers

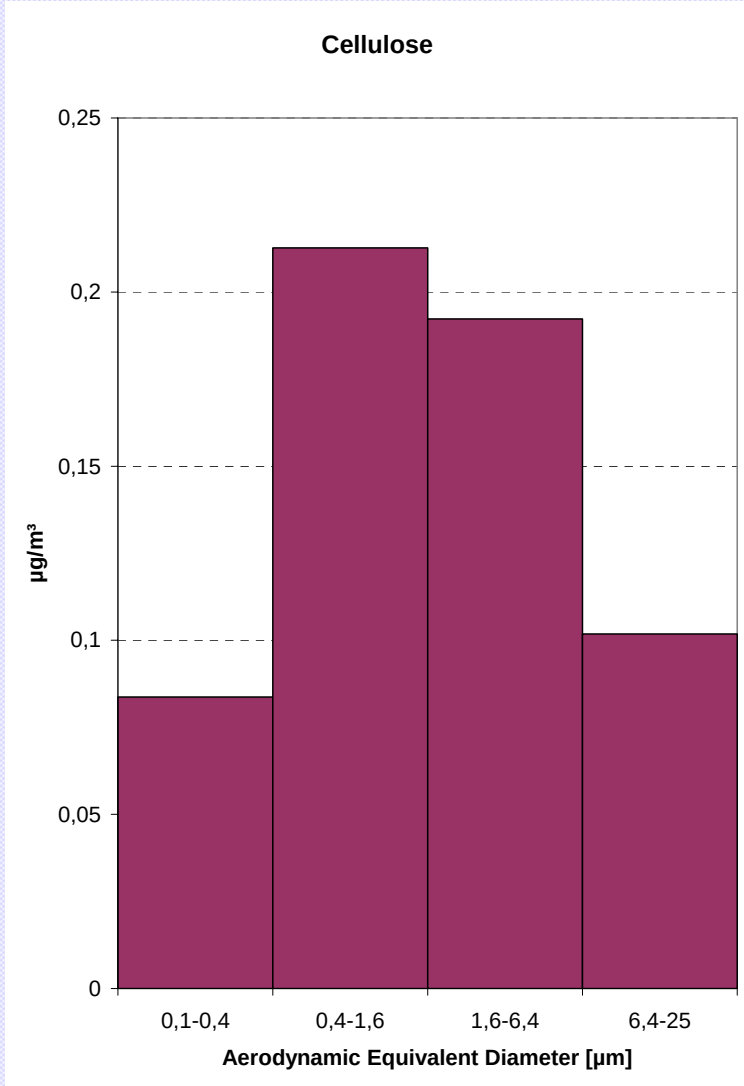
Aerosol	OC	**HULIS C/OC %**	**DEBRIS C/OC %**	Author
NIST 1648 „Urban particulate“	11.6 %	**6.5 (AWE) +8.6 humin**	-	Havers et al. 1998
Dortmund spr/sum	14 %	**11 (AWE)**	-	Havers et al. 1998
Sauerland spr/sum	22 %	**9 (AWE)**	-	Havers et al. 1998
Hungary sum	5 µg/m³	**10 (WE)**	-	Zappoli et al. 1999
Italy aut	6 µg/m³	**7 (WE)**	-	Zappoli et al. 1999
Po Valley wint	11 µg/m³	**24 (WE)**	-	Facchini et al. 1999
South Africa aut	7 µg/m³	-	**3**	Puxbaum et al. 2000
Kierling AT spr	3.4 µg/m³	-	**7**	Twaroch 1999
Kierling AT aut	10 µg/m³	-	**2**	Twaroch 1999
Sonnblick AT spr	2.2 µg/m³	-	**3**	Twaroch 1999
Linz AT sum	3 µg/m³	**23 (AWE)**	**11**	CTA New Data
Linz AT win	5 µg/m³	**35 (AWE)**	**5**	CTA New Data

HULIS: AWE - Extraction with 0.1 m NaOH; WE Water Extract DEBRIS: Cellulose x 2
Carbon Contents: Cellulose 44.4%, Humic Acids 45%

Size Distribution of Aerosol and Cellulose

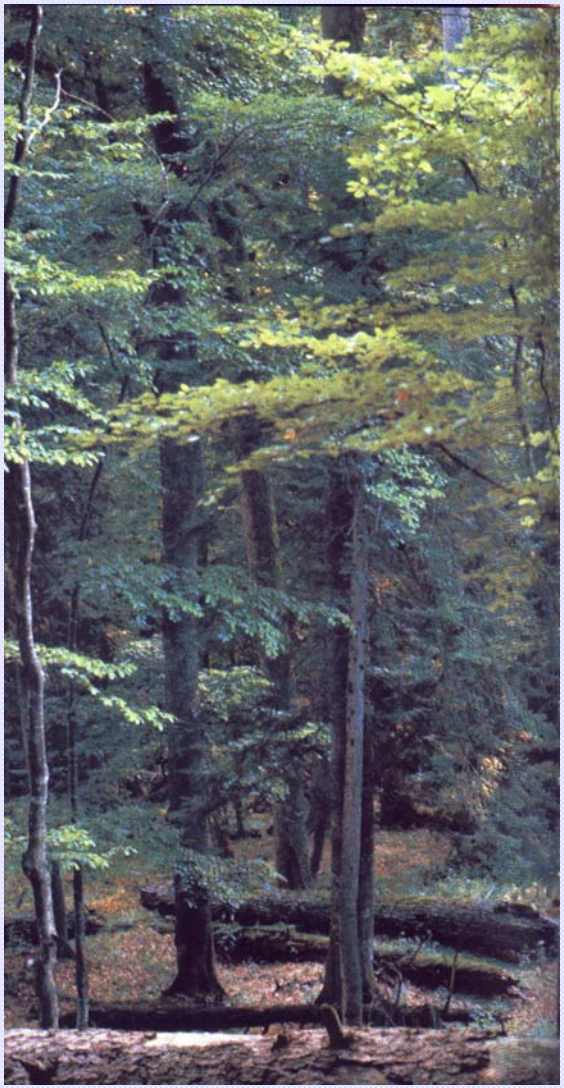
Nov. 26-30 1993
Vienna, TU





Puxbaum & Tenze-Kunit, Atmos. Environ. **37,** 3693-3699 (2003)

Cellulose – a Tracer for Plant Debris



Main Components in Leaves	
	% of Dry Weight
Cellulose	40-50
Hemicellulose	20-30
Lignin	< 20

Nikitin (1955), Butler and Bailey (1973)

Annual Trend of the composition of TC (PM_{10}) at Streithofen, Austria