PM10-TEQ
Approach to a Health-Oriented Descriptor of Particulate Air Pollution
(... to Rescue a Disputable Metric)

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11th ETH Conference on Combustion Generated Nanoparticles
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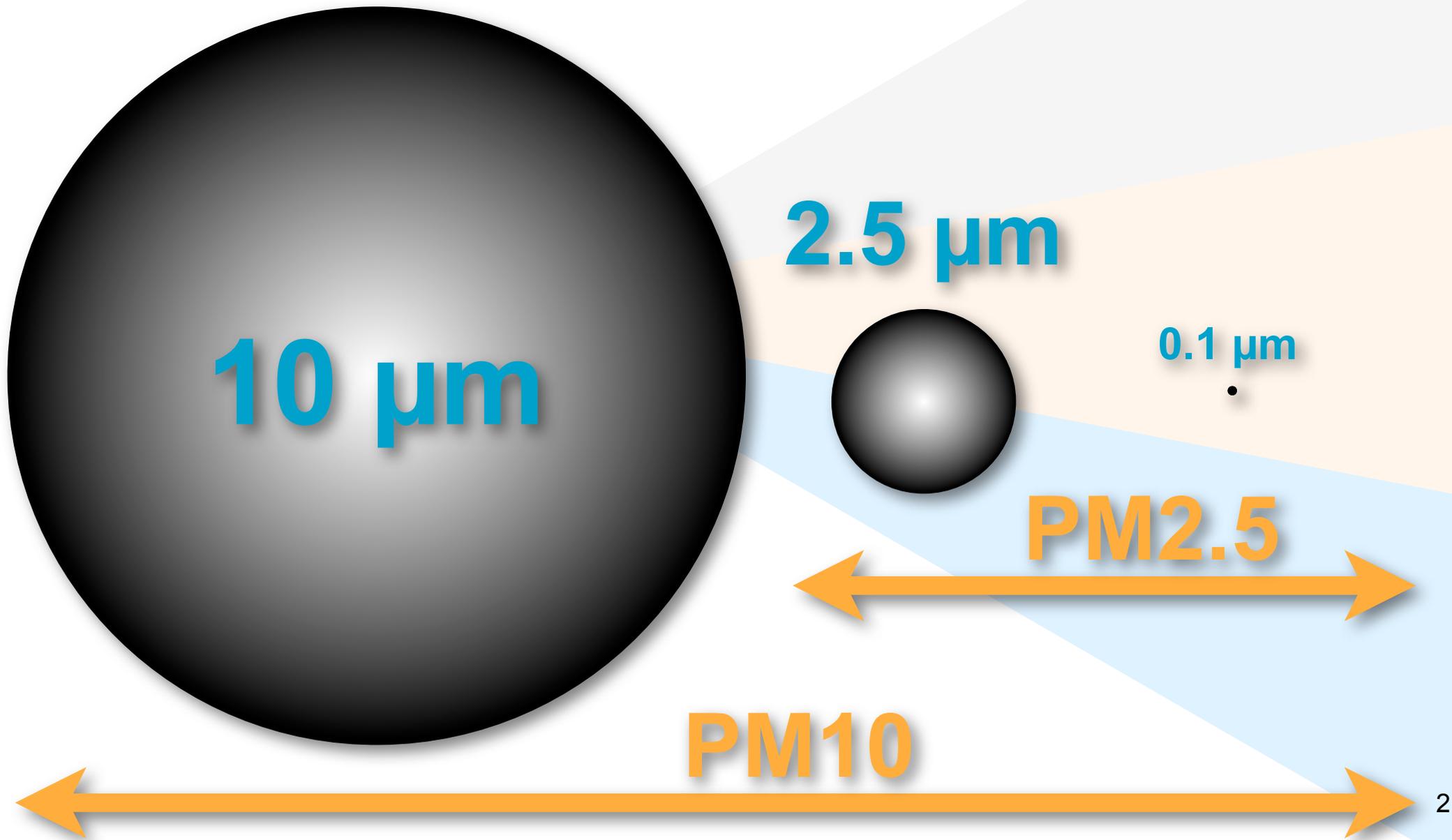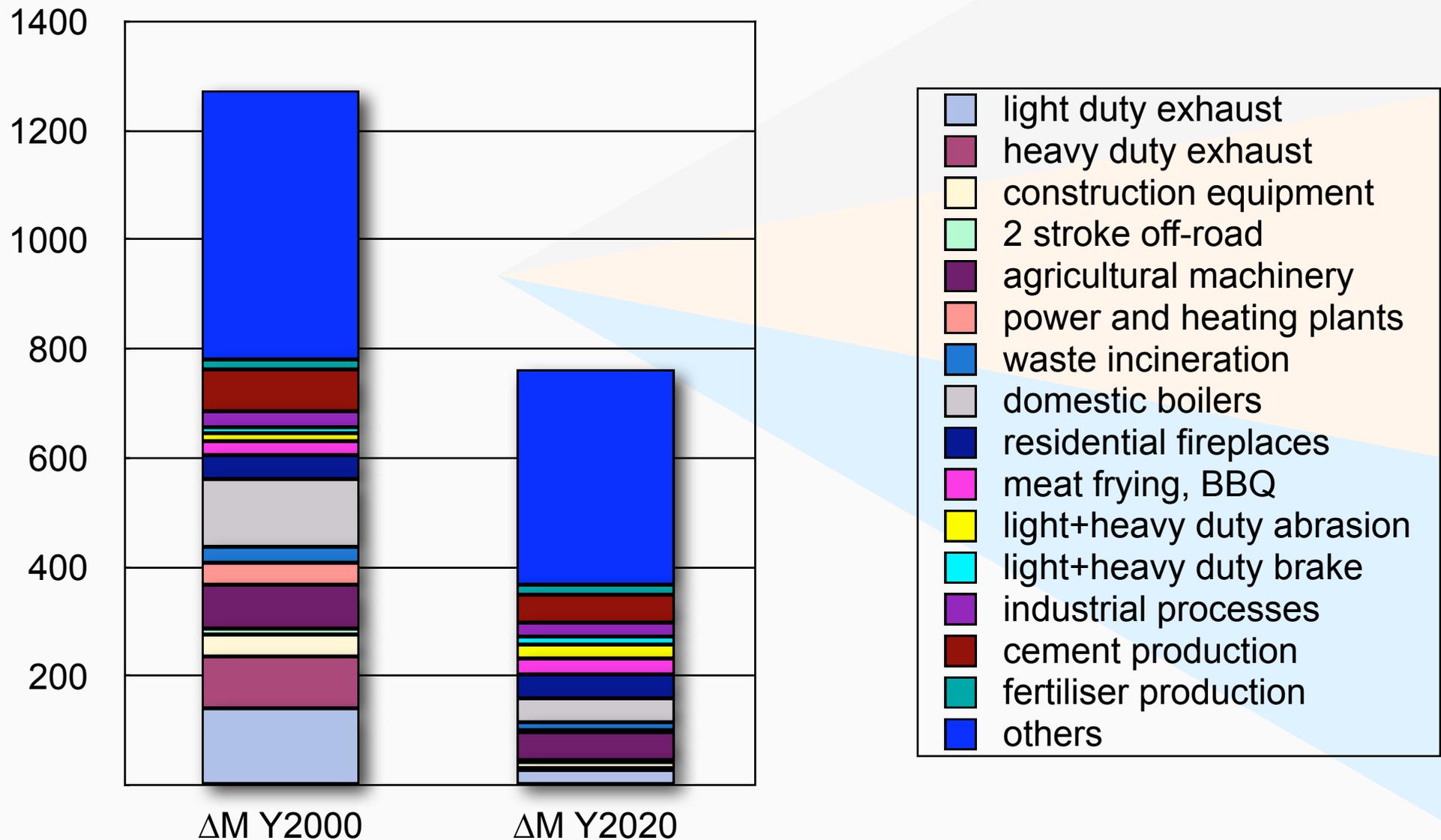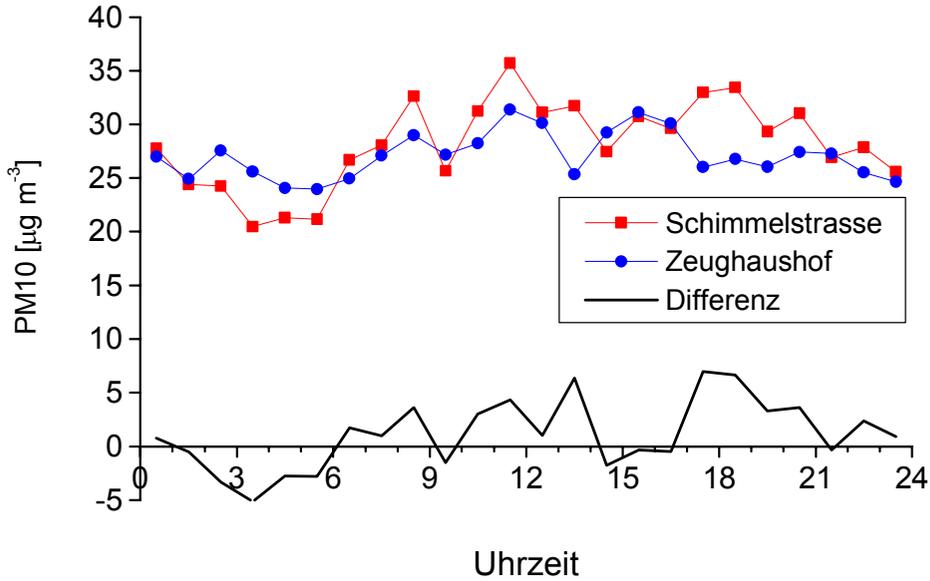
Vergleich PM10, NOx, Partikelanzahl

Quelle: D. Imhof/UGZ
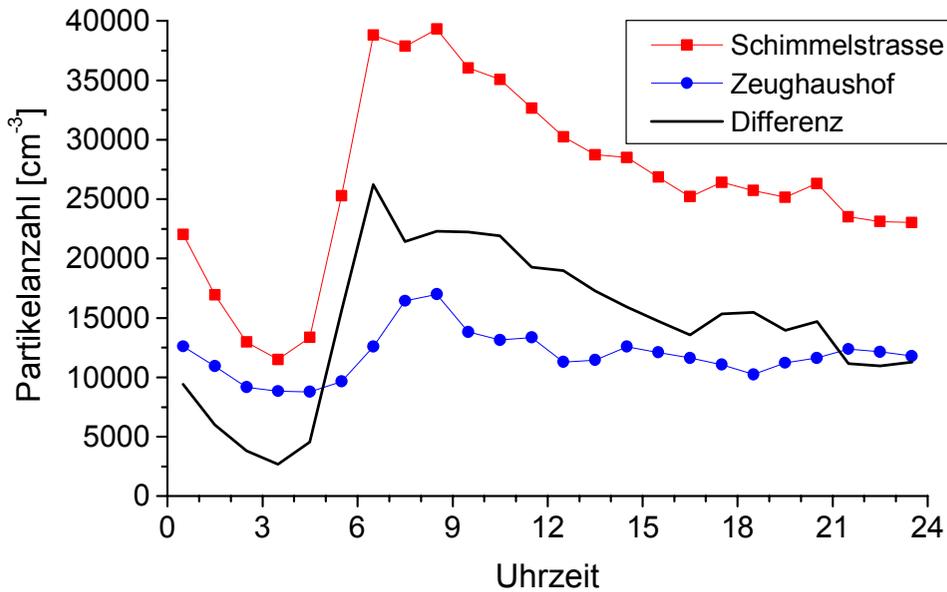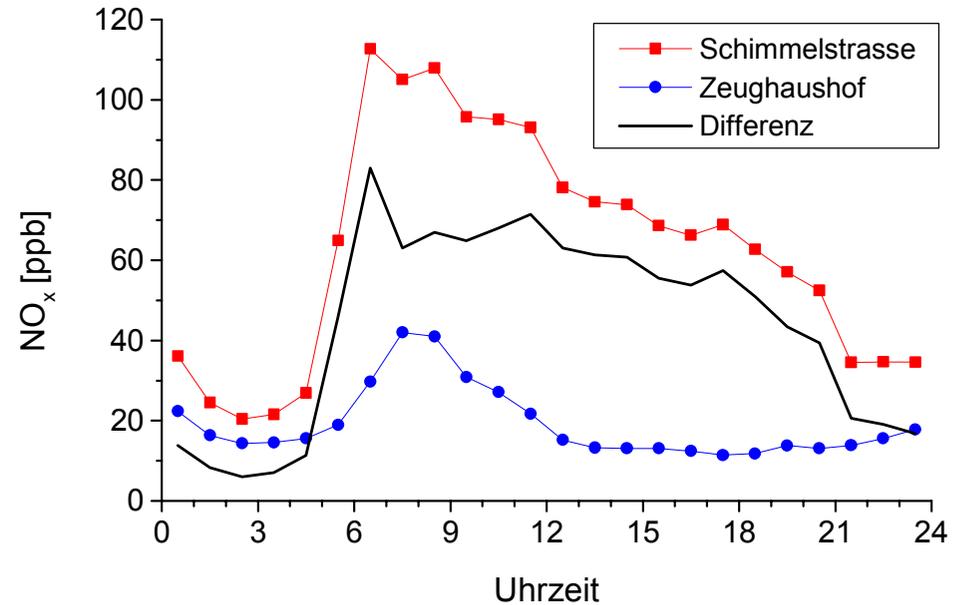
4

PM10-TEQ

- PM10 - dump in whatever you find below 10 μm?

- generic characterisation of the nano zoo

- the (in)complete TEQ matrix

- roadmap and request for support

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Chemische Zusammensetzung des Feinstaubs in Zürich (~50% sekundär!)
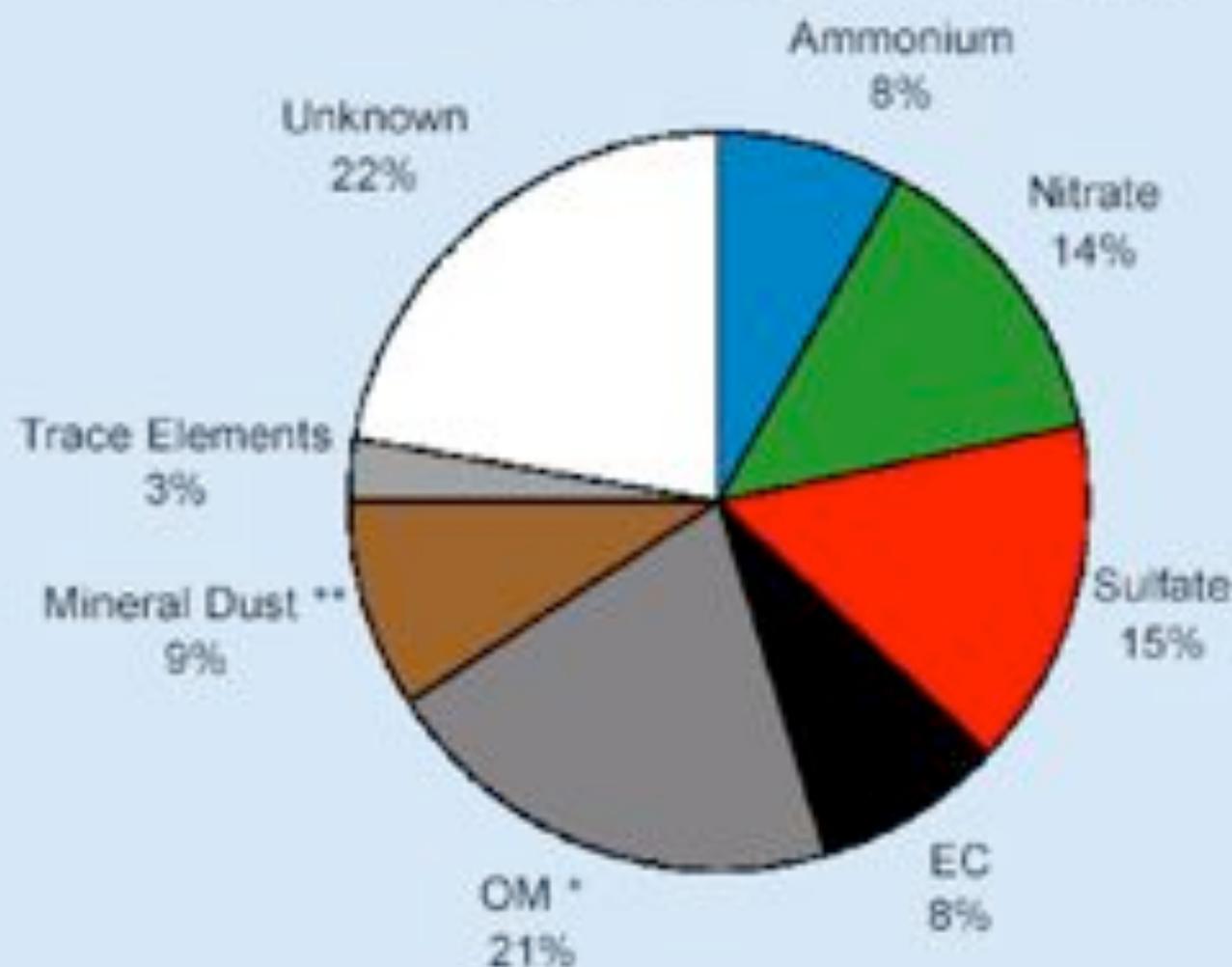
PCDD (Dioxines):
TEQ Sum is an Established Approach
only 7 out of 75 isomeres are highly toxic
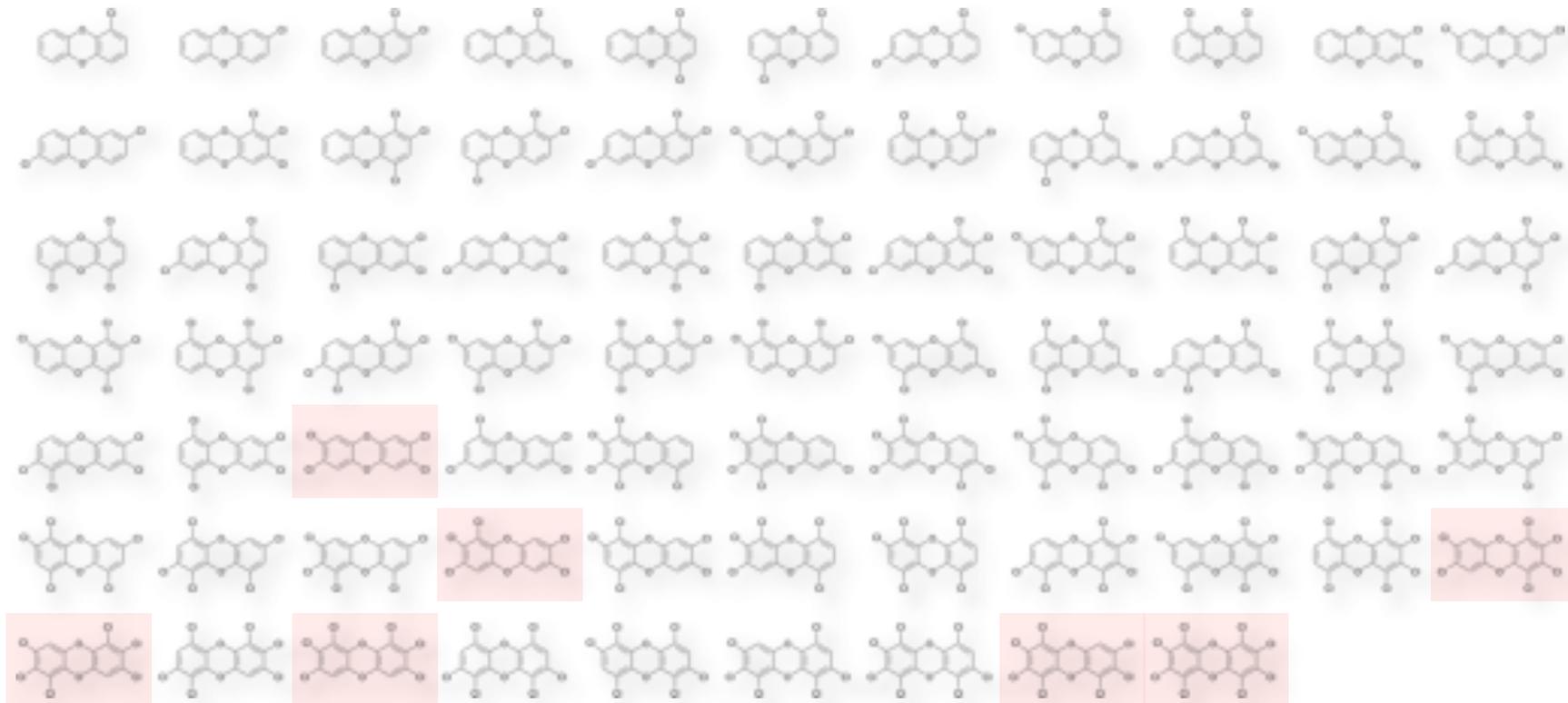
PM10 Substance Classes

- carbon:
  - **EC (fine, coarse)**
  - **OM / OC (overlap with pPAH)**
  - **pPAH**

- inorganics:
  - **NH4+**
  - **NO3-**
  - **SO4-**

- metals:
  - **transition metals (all; overlap with individual metal oxides)**
  - **FeO**
  - **MgO**
  - **CaO**
  - **noble metals (all; maybe individual: Pt, Pd, Rh)**

- minerals:
 - **mineral dust (silicates, incl. Al, Mg, ...)**

- ... ?

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Toxicity Contributors

process	parameters	quantify
location of deposition	diffusion behaviour	mobility
	mobility change	hygroscopicity
contact with body surface	soluble in water...	solubility
	... or in oil?	lipophility
translocation	diffusion; phagocytosis	mobility
interaction	bioavailability	
	cytotoxicity	
	radical generation potential	
	DNA reactivity	
	mutagenic potential	
	carcinogenic potential	
excretion	biopersistence; active vs. statistical	decay time

multiply

TEQ Index Value

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PM10-TEQ Matrix – preliminary

PM-Components	Carbon			Inorganics			Metals					Minerals
	EC (fine/coarse)	OM / OC (overlap with PAH)	pPAH	Ammonium NH_4^+	Nitrate NO_3^-	Sulfate SO_4^{2-}	Transition metals (Fe, Ni, V, Zn)	FeO	MgO	CaO	Noble Metals (Pt, Pd, Rh)	Mineral dust (Silicates, incl. Al, Mg)
Typical particle size [nm]												
MAK	0.02[1]	–	1[2]	0.00066[3]	–	0.00066[4]	–	0.00066[5]	0.00066[5]	0.001[6]	1[7]	0.00066[8]
Solubility	1	1	1[12]	0.0027[9]	0.0017[10]	0.5025[11]	–	1[12]	1[12]	0.6[13]	–	–
Hygroscopic	–	–	–	1[14]	–	1	–	–	–	1	–	1
Lipophilic[15]	1	1	1	0.001	0.001	0.001	–	0.001	0.001	0.001	–	–
Radical generating capacity[16]	1[17,18]	1[17,18]	1[18]	–	–	–	1[18]	–	–	–	–	–
DNA-reactivity	1[17,18]	1[17,18]	1[17,18]	–	–	–	1[17,18]	–	–	–	–	–
Mutagenic potential	1[18]	1[18]	1[18]	–	–	–	1[18]	–	–	–	–	–
Carcinogenic potential	1[17]	1[17]	1[17]	–	–	–	1[17]	–	–	–	–	–
Toxicity	1[17,18]	1[17,18]	1	0.001[19]	0.001[19]	0.001[19]	–	0.001[19]	0.001[19]	0.001[19]	–	–
TEQ product												

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Roadmap: Strategy and Next Steps

- ## complete the TEQ matrix

  - **substances / classes**
  - **toxicity contributors**
  - **assign values (table cells)**
  - **PLEASE HELP!**

PM-Components	Carbon			Inorganics			Metals					Minerals
	EC (fine/coarse)	OM / OC (overlap with PAH)	pPAH	Ammonium NH_4^+	Nitrate NO_3^-	Sulfate SO_4^{2-}	Transition metals (Fe, Ni, V, Zn)	FeO	MgO	CaO	Noble Metals (Pt, Pd, Rh)	Mineral dust (Silicates, incl. Al, Mg)
Typical particle size [nm]												
MAK	0.02[1]	–	1[2]	0.00066[3]	–	0.00066[4]	–	0.00066[5]	0.00066[5]	0.001[6]	1[7]	0.00066[8]
Solubility	1	1	1[12]	0.0027[9]	0.0017[10]	0.5025[11]	–	1[12]	1[12]	0.6[13]	–	–
Hygroscopic	–	–	–	1[14]	–	1	–	–	–	1	–	1
Lipophilic[15]	1	1	1	0.001	0.001	0.001	–	0.001	0.001	0.001	–	–
Radical generating capacity[16]	1[17,18]	1[17,18]	1[18]	–	–	–	1[18]	–	–	–	–	–
DNA-reactivity	1[17,18]	1[17,18]	1[17,18]	–	–	–	1[17,18]	–	–	–	–	–
Mutagenic potential	1[18]	1[18]	1[18]	–	–	–	1[18]	–	–	–	–	–
Carcinogenic potential	1[17]	1[17]	1[17]	–	–	–	1[17]	–	–	–	–	–
Toxicity	1[17,18]	1[17,18]	1	0.001[19]	0.001[19]	0.001[19]	–	0.001[19]	0.001[19]	0.001[19]	–	–
TEQ product												

- ## reduce the TEQ matrix

  - **which components make up for ~90% of TEQ?**
  - **omit components with low TEQ index**
  - **omit contributors with little variation**

Roadmap: Strategy and Next Steps

- complete the TEQ matrix
  - **substances / classes**
  - **toxicity contributors**
  - **assign values (table cells)**
  - **PLEASE HELP!**

PM-Components	Carbon			Inorganics			Metals				Noble Metals (Pt, Pd, Rh)	Minerals
	EC (fine/coarse)	OM / OC (overlap with PAH)	pPAH	Ammonium NH_4^+	Nitrate NO_3^-	Sulfate SO_4^{2-}	Transition metals (Fe, Ni, V, Zn)	FeO	MgO	CaO	Noble Metals (Pt, Pd, Rh)	Mineral dust (Silicates, incl. Al, Mg)
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MAK	0.02[1]	–	1[2]	0.00066[3]	–	0.00066[4]	–	0.00066[5]	0.00066[5]	0.001[6]	1[7]	0.00066[8]
Solubility	1	1	1[12]	0.0027[9]	0.0017[10]	0.5025[11]	–	1[12]	1[12]	0.6[13]	–	–
Hygroscopic	–	–	–	1[14]	–	1	–	–	–	1	–	1
Lipophilic[15]	1	1	1	0.001	0.001	0.001	–	0.001	0.001	0.001	–	–
Radical generating capacity[16]	1[17,18]	1[17,18]	1[18]	–	–	–	1[18]	–	–	–	–	–
DNA-reactivity	1[17,18]	1[17,18]	1[17,18]	–	–	–	1[17,18]	–	–	–	–	–
Mutagenic potential	1[18]	1[18]	1[18]	–	–	–	1[18]	–	–	–	–	–
Carcinogenic potential	1[17]	1[17]	1[17]	–	–	–	1[17]	–	–	–	–	–
Toxicity	1[17,18]	1[17,18]	1	0.001[19]	0.001[19]	0.001[19]	–	0.001[19]	0.001[19]	0.001[19]	–	–
TEQ product												

- reduce the TEQ matrix
  - **which components make up for ~90% of TEQ?**
  - **omit components with low TEQ index**
  - **omit contributors with little variation**

- replace PM10 by 1-5 more relevant metrics

Summary

- PM10 is a poor indicator of health effects

- consider main components of PM10 separately

- assign toxicity index to each fraction

- calculate PM10 TEQ sum as health indicator

- expected lead substances: carbon and other insolubles

take a breath...

... and discuss

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