

# NL-BOP results relevant to EMEP model improvement

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**TNO | Knowledge for business**



Schaap



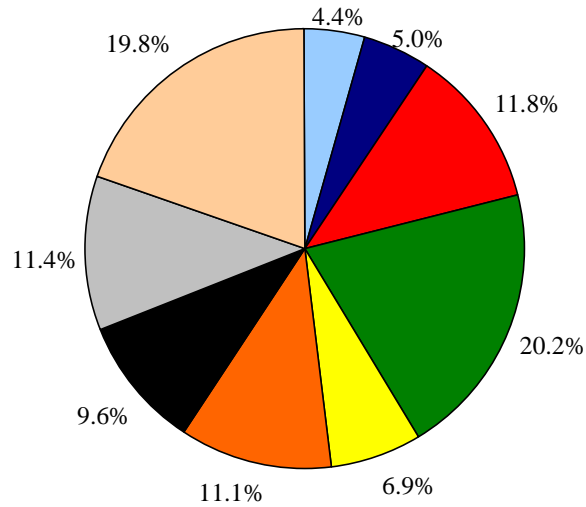
# Introduction

- Our model underestimate PM10 concentrations by a factor 2
- BOP study: “to improve our knowledge on the concentrations, composition and origin of PM in the Netherlands”
- One year campaign at 5 sites in the Netherlands – Aug07-Aug08
- Attention to model development: missing fractions and coarse mode
  - Mineral Dust & Sea Salt
- Here: SIA, Sea Salt & Mineral Dust



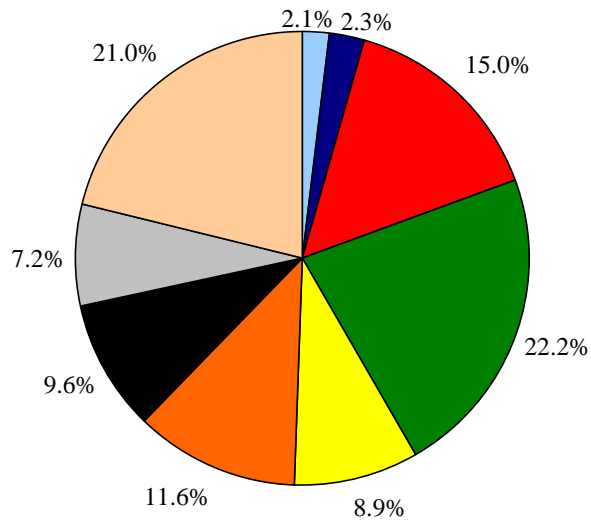
# Composition

PM10, Vredepeel

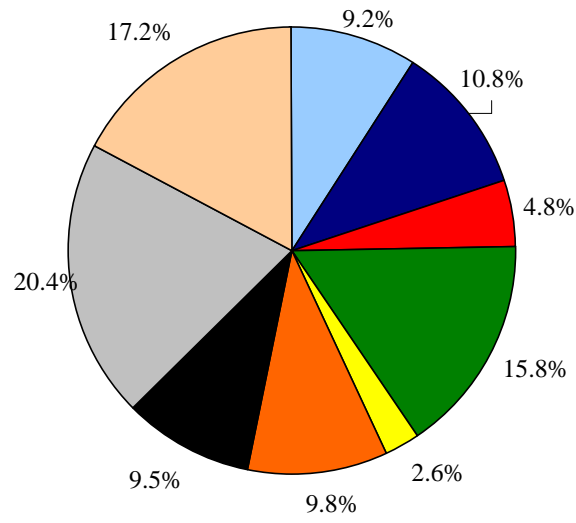


PM2.5, Vredepeel

23  $\mu\text{g}/\text{m}^3$



PM2.5-10, Vredepeel



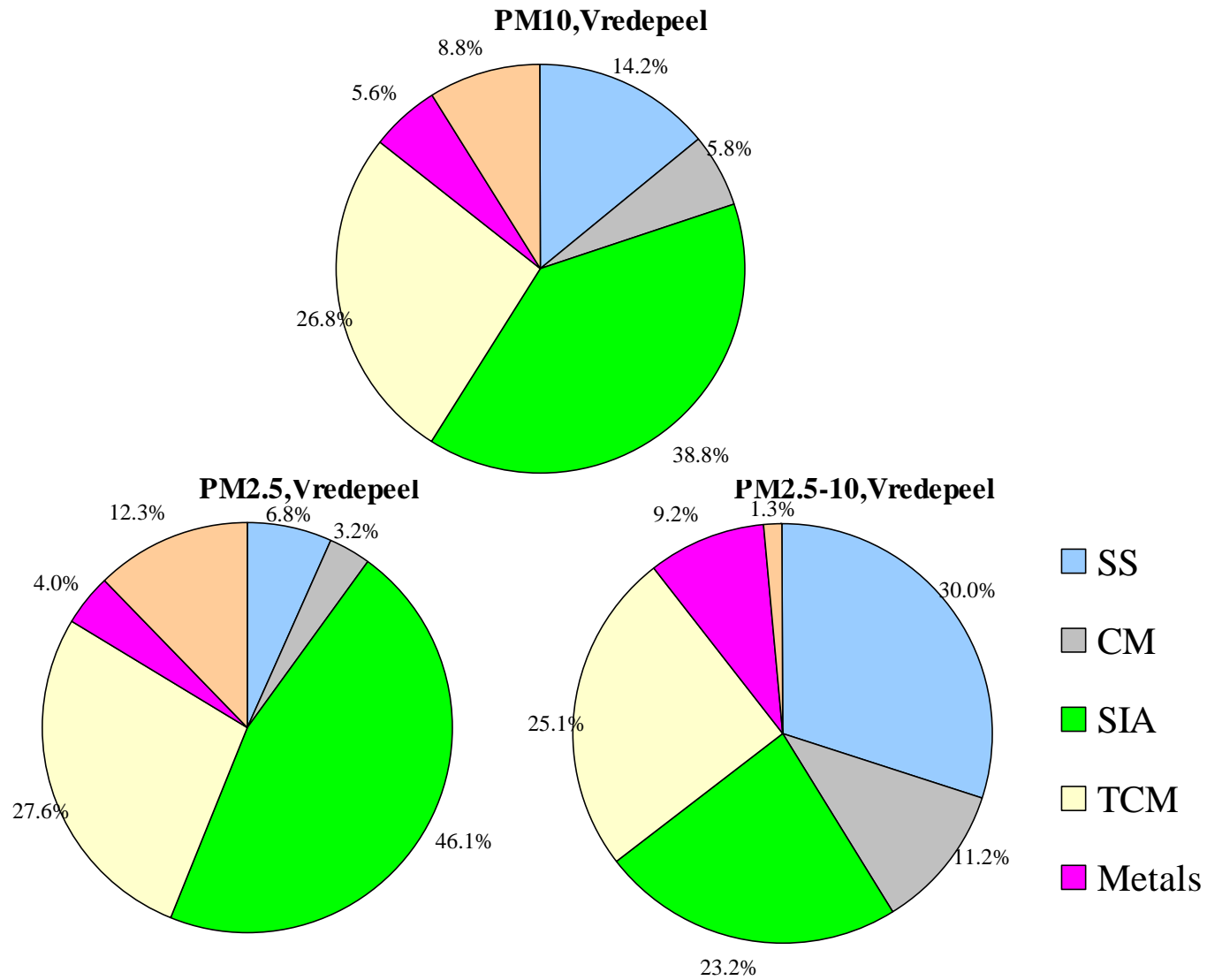
- Na
- Cl
- SO4
- NO3
- NH4
- OC
- EC
- Metals
- unknown

16  $\mu\text{g}/\text{m}^3$

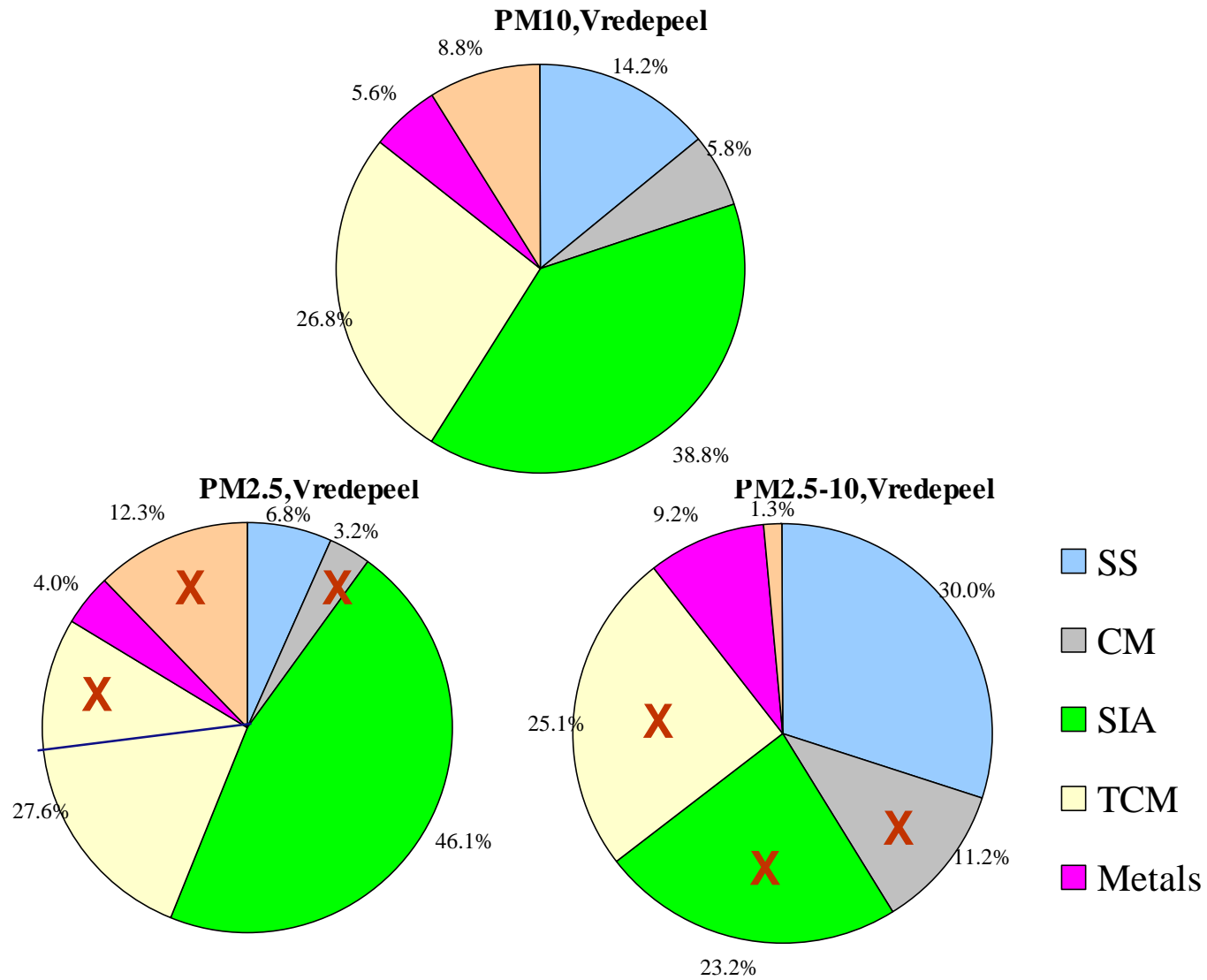
7  $\mu\text{g}/\text{m}^3$



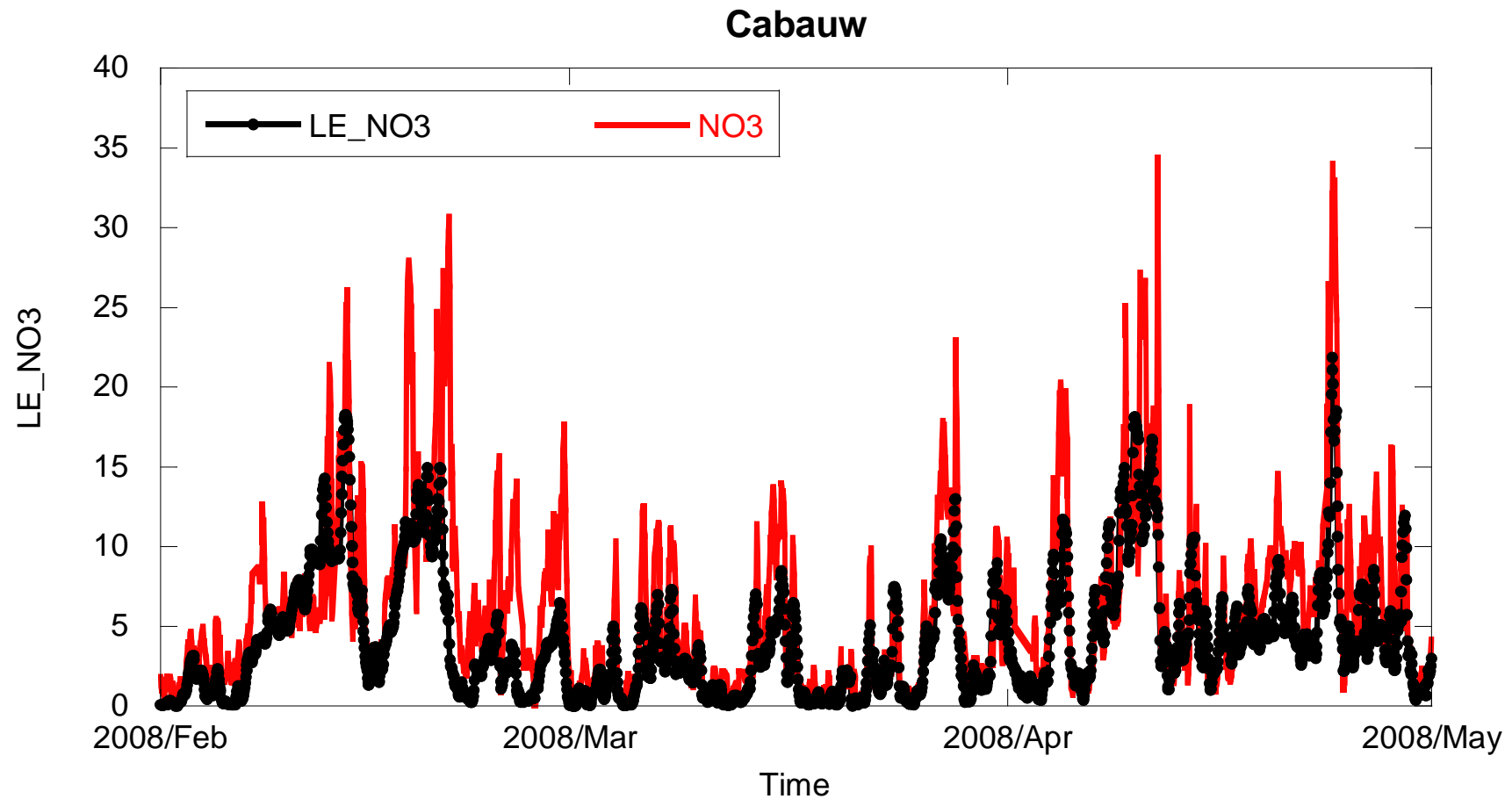
# Chemical mass closure



# Chemical mass closure

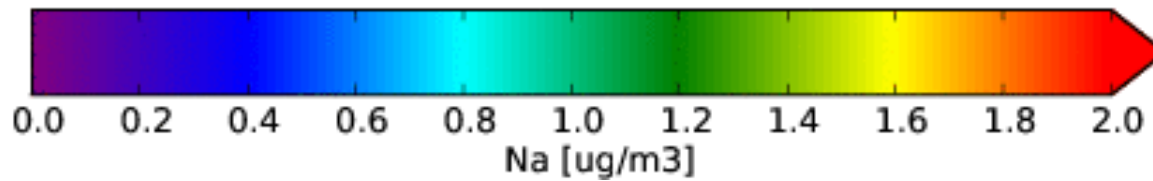
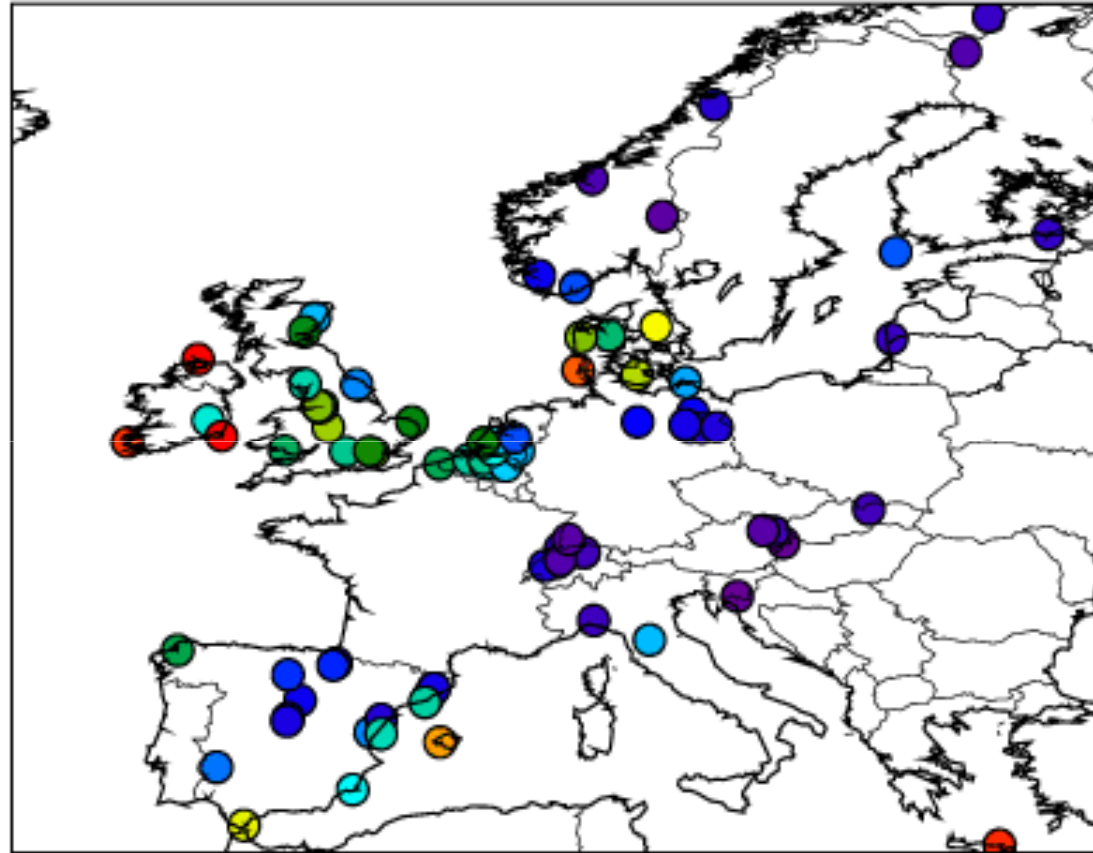


# Unique data on hourly concentrations for a whole year

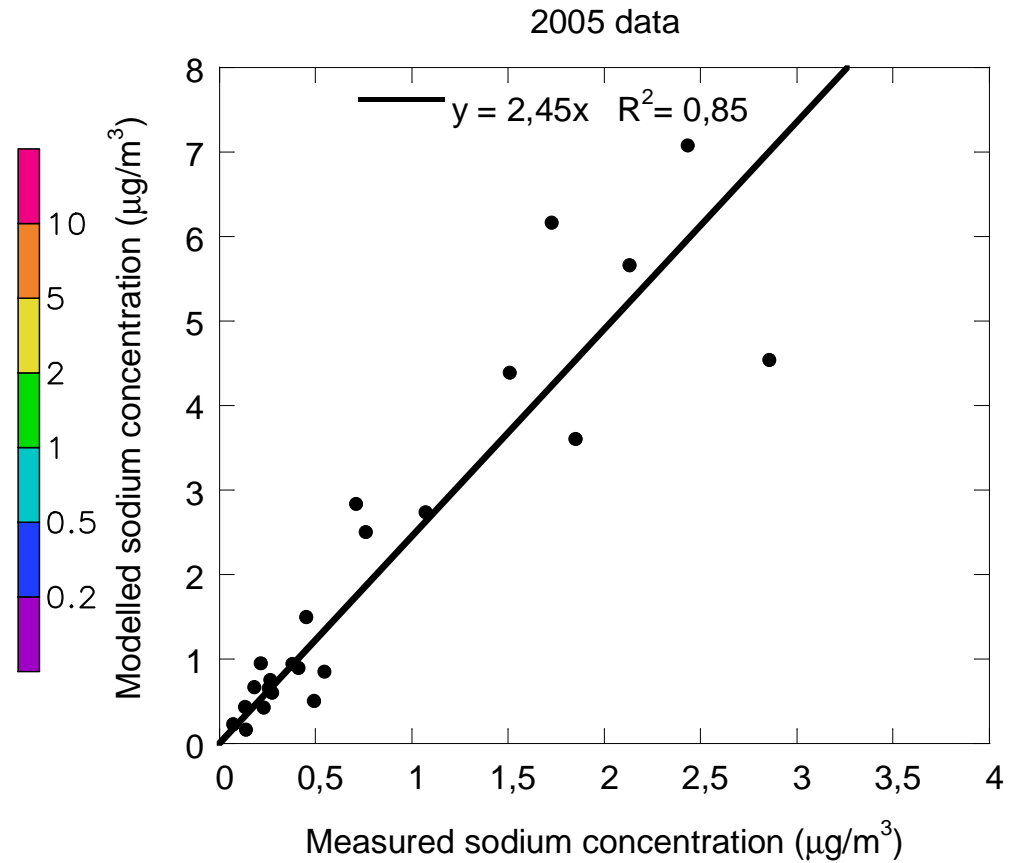
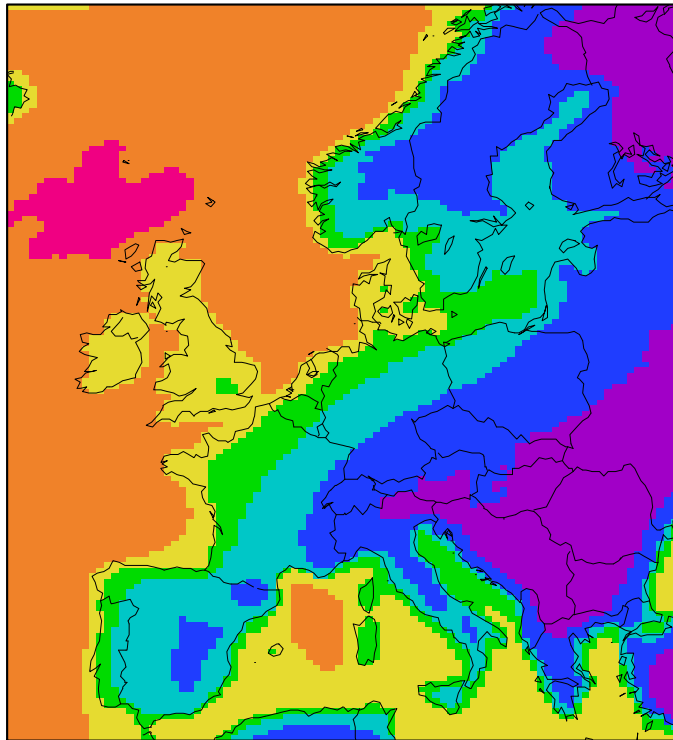


# Compilation of sea salt data: results

observed sodium concentrations

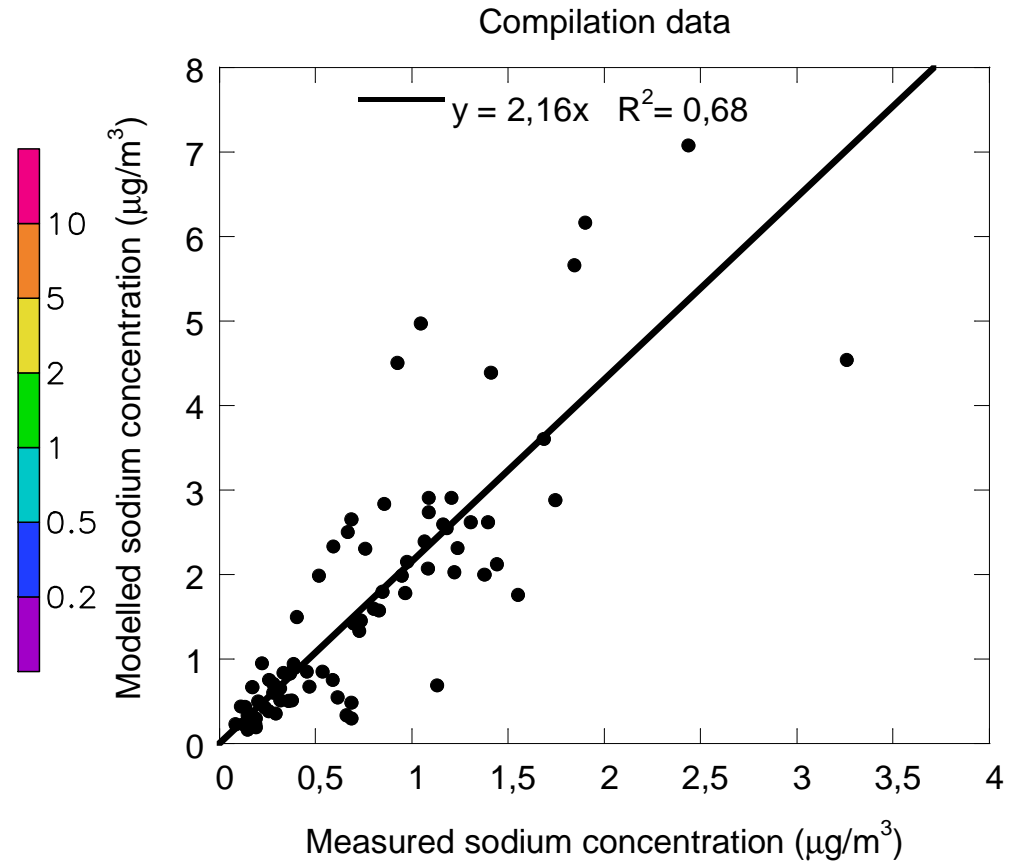
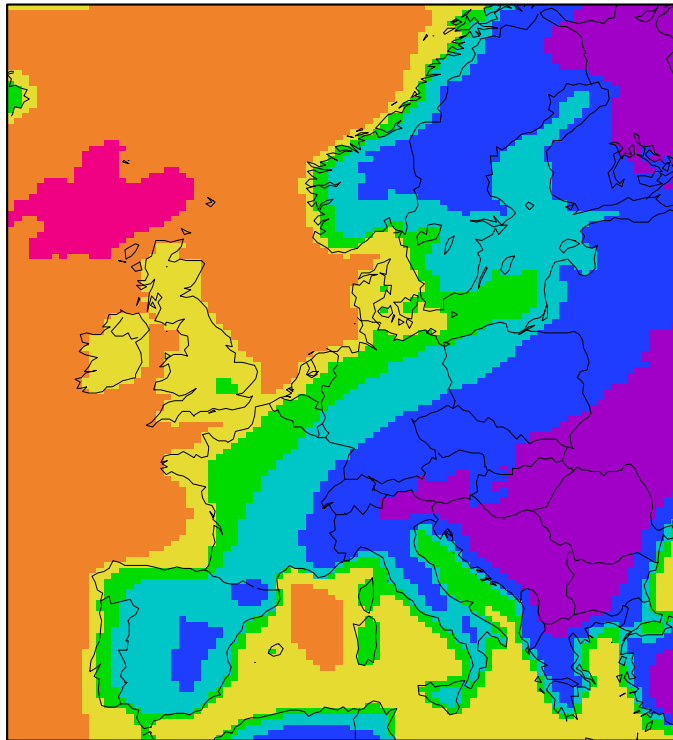


# Annual mean sodium field & verification





# Annual mean sodium field & verification



# Sources of mineral PM

## (Re)suspension of/by

- (partly) bare soils by wind
- road dust ← *new approach*
- agricultural land management ← *new*
- driving on unpaved roads
- handling of materials
- building and construction activities
- .....



Windblown dust



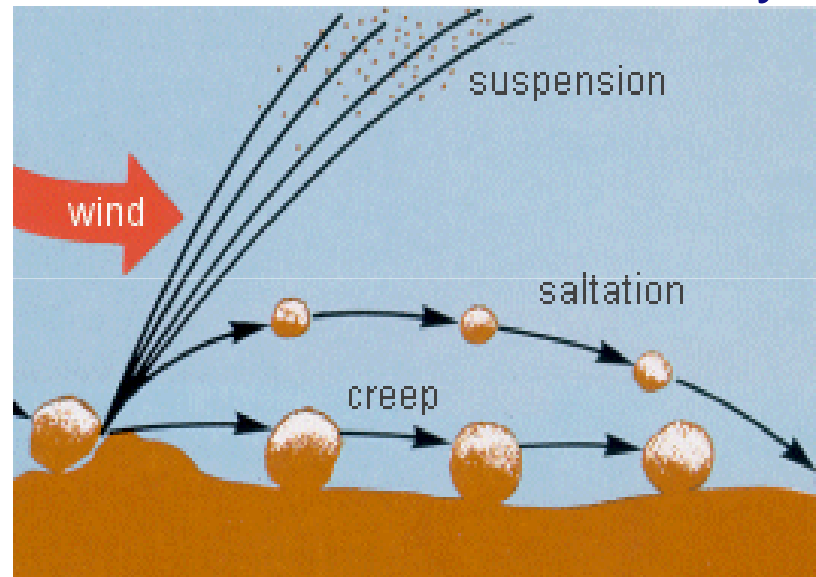
Agricultural activity



Traffic (re)suspension

# Windblown Dust

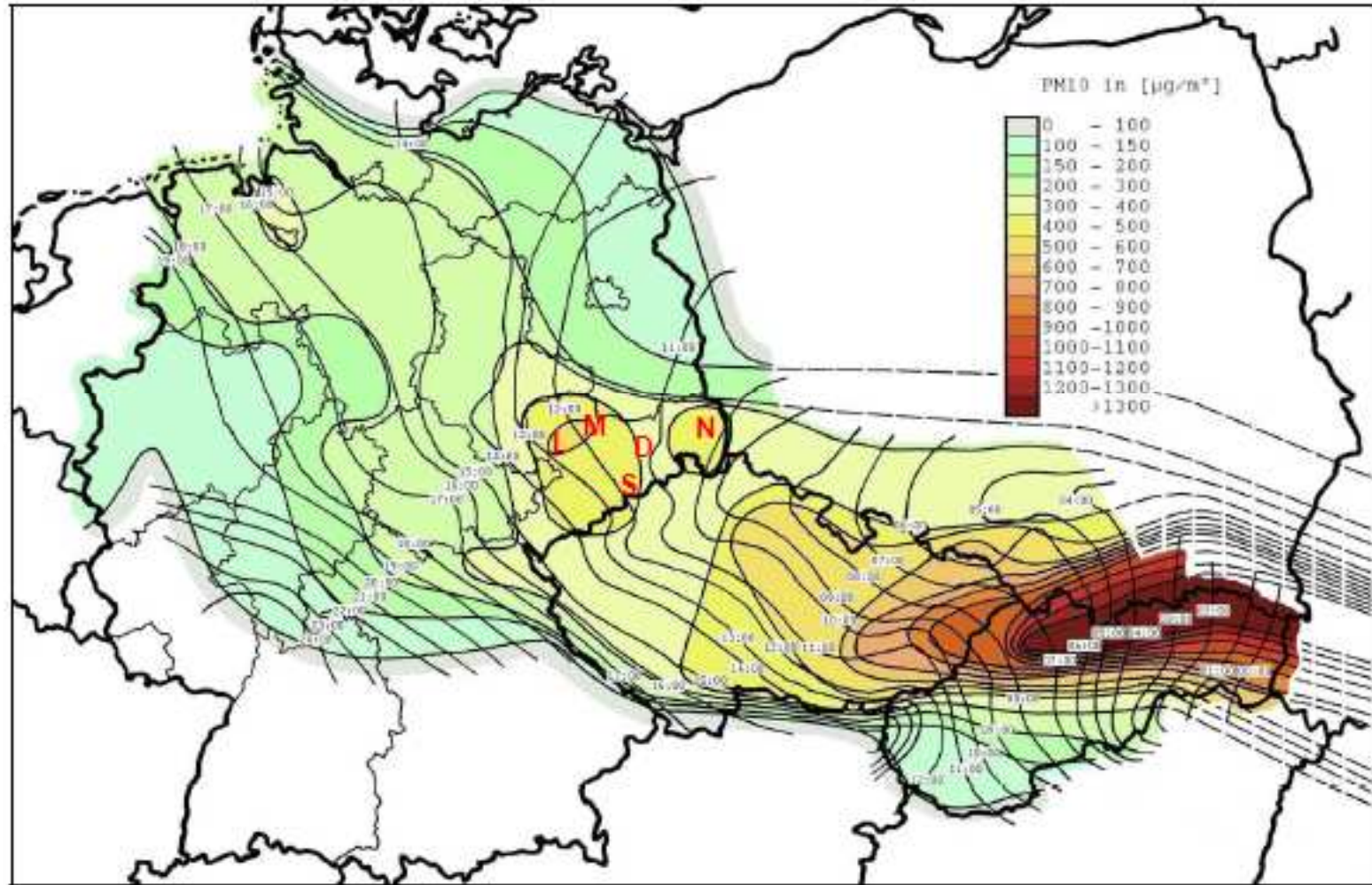
- Windblown dust through *saltation*. Vertical dust flux ( $F_V$ ) as a function of wind friction velocity ( $u^*$ ; for  $u^* > u_t^*(D_p)$ ):



- $F_V = \alpha \cdot F_H$  with  $F_H(D_p) = (K \rho_{\text{air}} / g) u^{*3} (1-R)(1+R)^2$

where  $R(D_p) = u^* / u_t^*(D_p)$  and

# Case Ukraine dust storm – March 24 2007



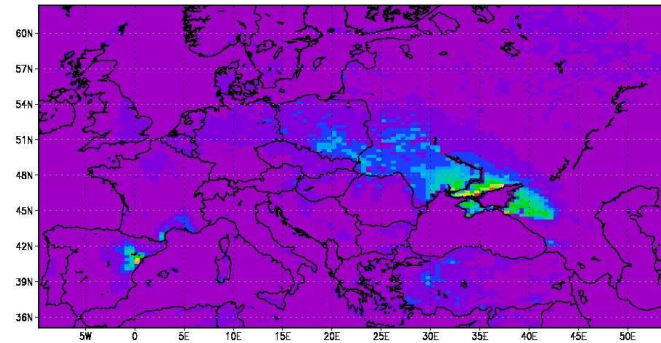


# Case:

## Ukraine dust storm 23-24 March 2007

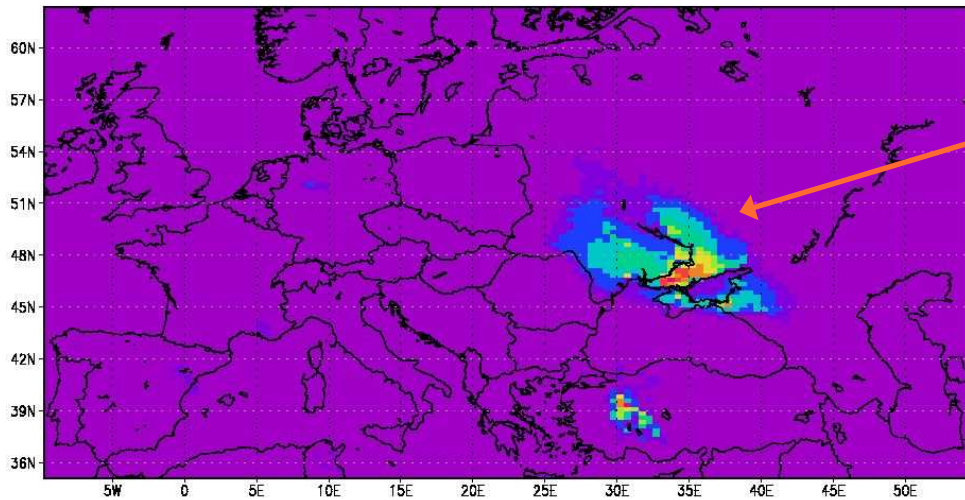
Maximum observed PM10:  
< 1400  $\mu\text{g.m}^{-3}$  (Slovakia)  
< 640  $\mu\text{g.m}^{-3}$  (Germany)

Total PM10 emission 23-24 March 2007

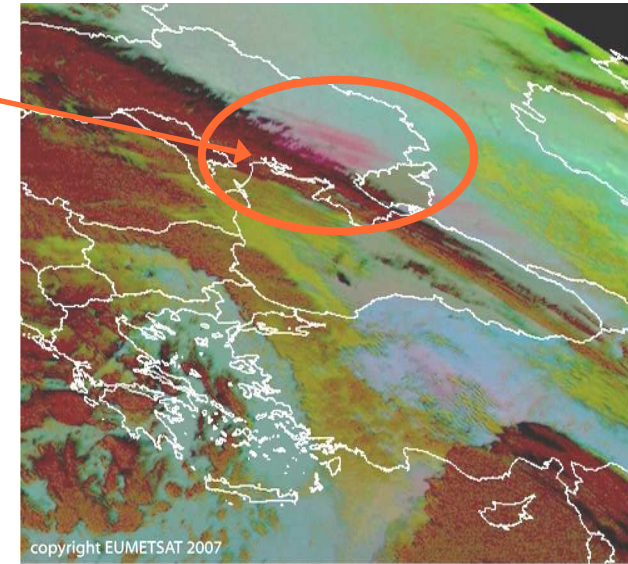


[\*10<sup>12</sup> ug.gridcell<sup>-1</sup>.s<sup>-1</sup>]

Windblown PM10, 23 March 2007, 11h UTC



[  $\mu\text{g.m}^{-3}$  ]



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thin high-level clouds    thick high-level clouds    thick mid-level clouds    low-level clouds    thin mid-level clouds    mineral dust cloud

Maximum modeled mineral PM10:  
< 300  $\mu\text{g.m}^{-3}$  (Ukraine)  
< 120  $\mu\text{g.m}^{-3}$  (Germany)

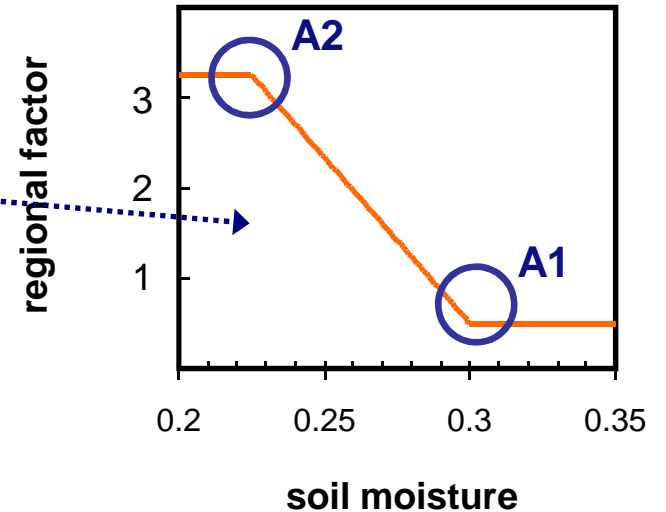
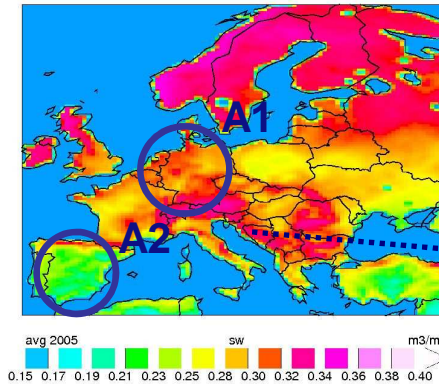
# Mineral PM (re)emitted by traffic

- Road and traffic type dependent EF's (literature):

EF PM2.5-10	HW	Rur	Urb
HDV	198	432	432
LDV	22	48	48

- Regional factor ; parameterization on basis of:

- soil moisture map
- observed mineral  $PM_{\Delta URB-RUR}$  (lit.)



- Correction for road sanding in Scandinavia

# Mineral PM (re)emitted by traffic

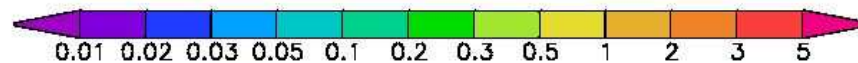
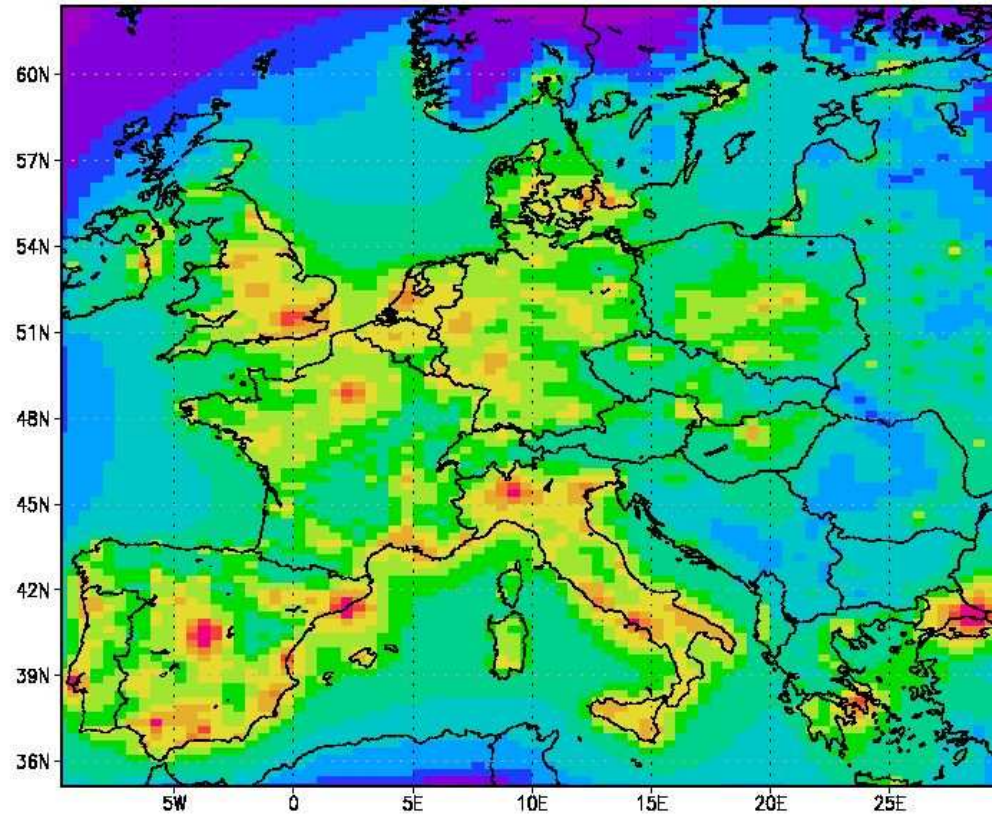
Annual average  
PM10:

NL 0.3-2  $\mu\text{g}\cdot\text{m}^{-3}$

Spain < 10  $\mu\text{g}\cdot\text{m}^{-3}$

Maximum  
concentrations near/in  
major cities

Traffic (re)suspension



# Mineral PM from agricultural activity

- Agricultural activities (ploughing etc): short periods, high PM emissions
- Separate EF's based upon accumulated PM emission observations averaged over land management periods

	EF PM2.5 (kg/ha)	EF PM10 (kg/ha)
Harrowing <sup>a</sup>	0.29	0.82
Discing <sup>a</sup>	0.12	1.37
Cultivating <sup>a</sup>	0.06	1.86
Ploughing dry <sup>a</sup>	1.86	10.5
Ploughing moist <sup>a</sup>	0.05	1.2
Harvesting Cereal <sup>b</sup>	?	4.1-6.9
Harvesting Corn <sup>c</sup>	?	1.9

<sup>a</sup>Öttl et al, 2005, Funk et al, 2007,  
<sup>b</sup>Funk et al, 2007, <sup>c</sup>Gaffney et al, 2006.

jan	Feb	Mrt	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
winter		land preparation		growing season			harvest			winter preparation	



# Mineral PM from agricultural activity

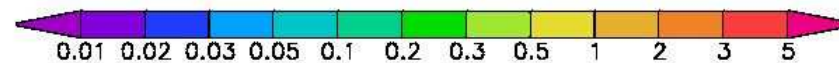
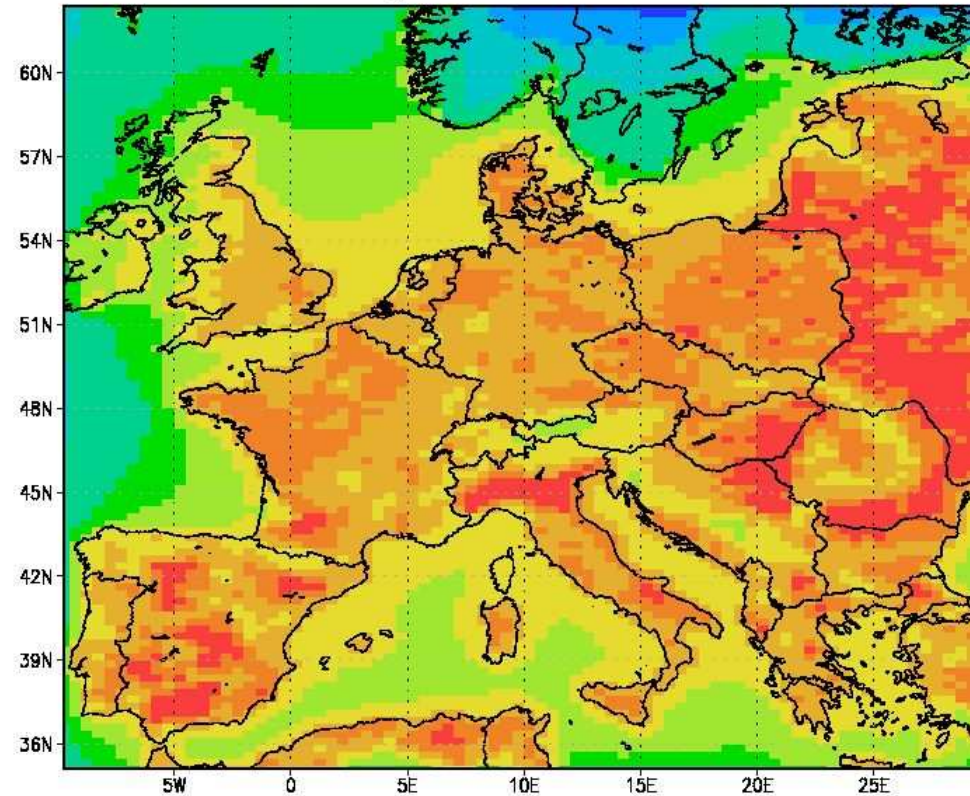
Annual average  
PM10:

NL 1-2  $\mu\text{g}\cdot\text{m}^{-3}$

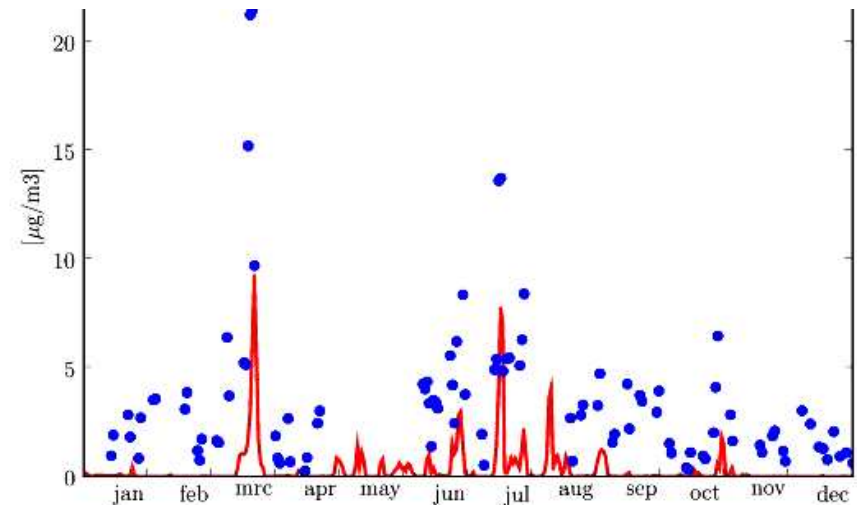
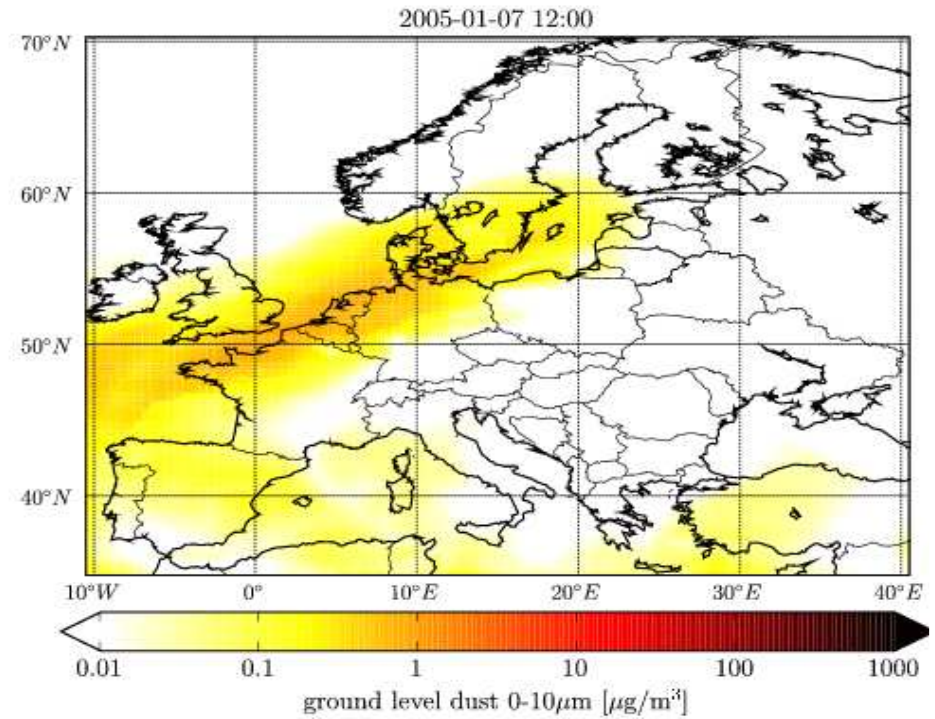
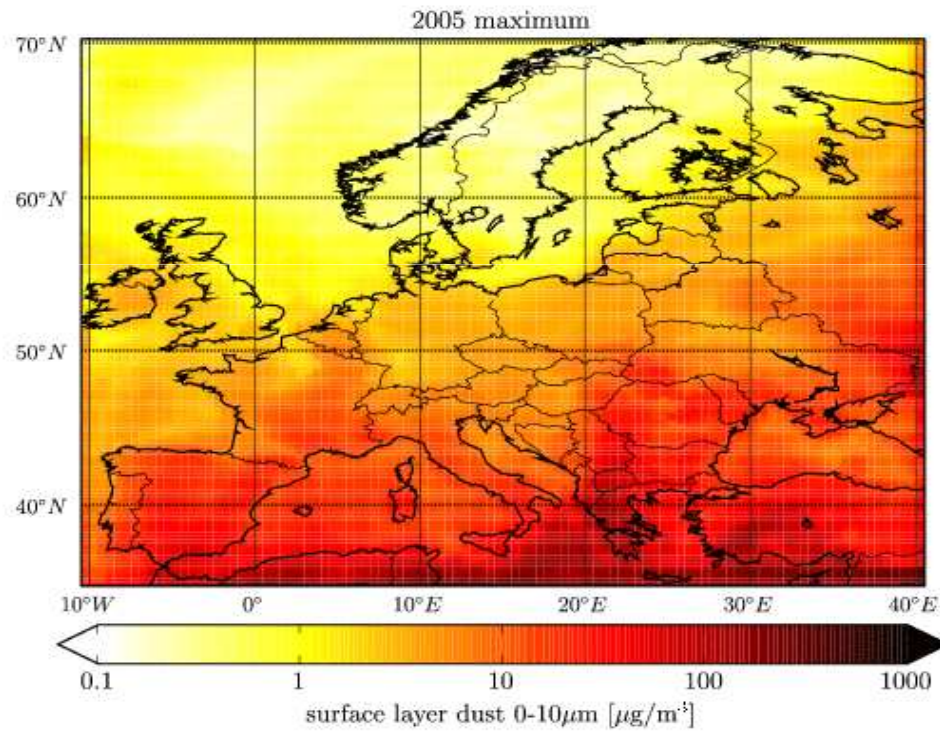
Spain 2-5  $\mu\text{g}\cdot\text{m}^{-3}$

Maximum  
concentrations over  
dry agricultural area;  
Spain, Northern Italy  
and Eastern Europe

Agricultural Dust

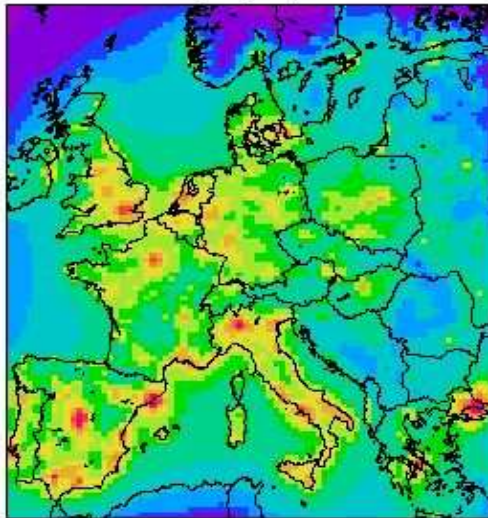


# Impact of TM5 boundary conditions Dust

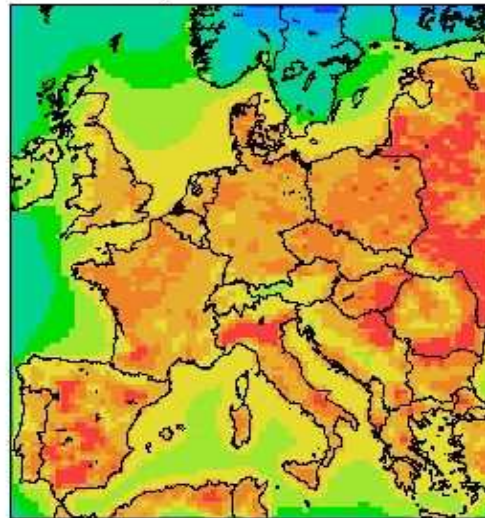




traffic (re)suspension



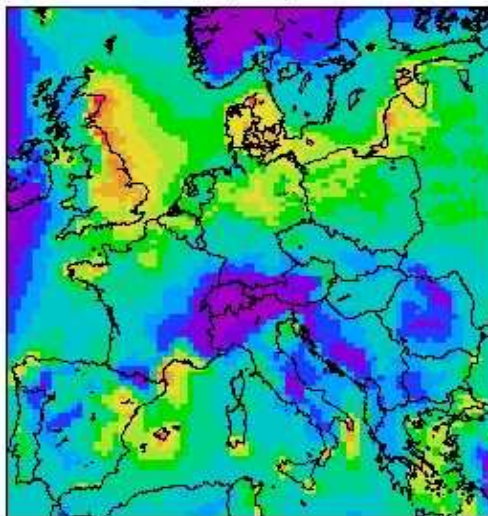
agricultural dust



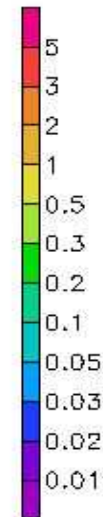
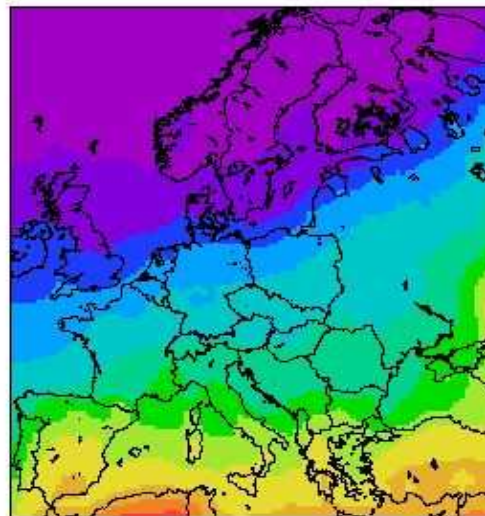
# Modeled mineral dust contribution to PM10 in 2005

## Mineral PM10 ( $\mu\text{g}\cdot\text{m}^{-3}$ )

wind (re)suspension



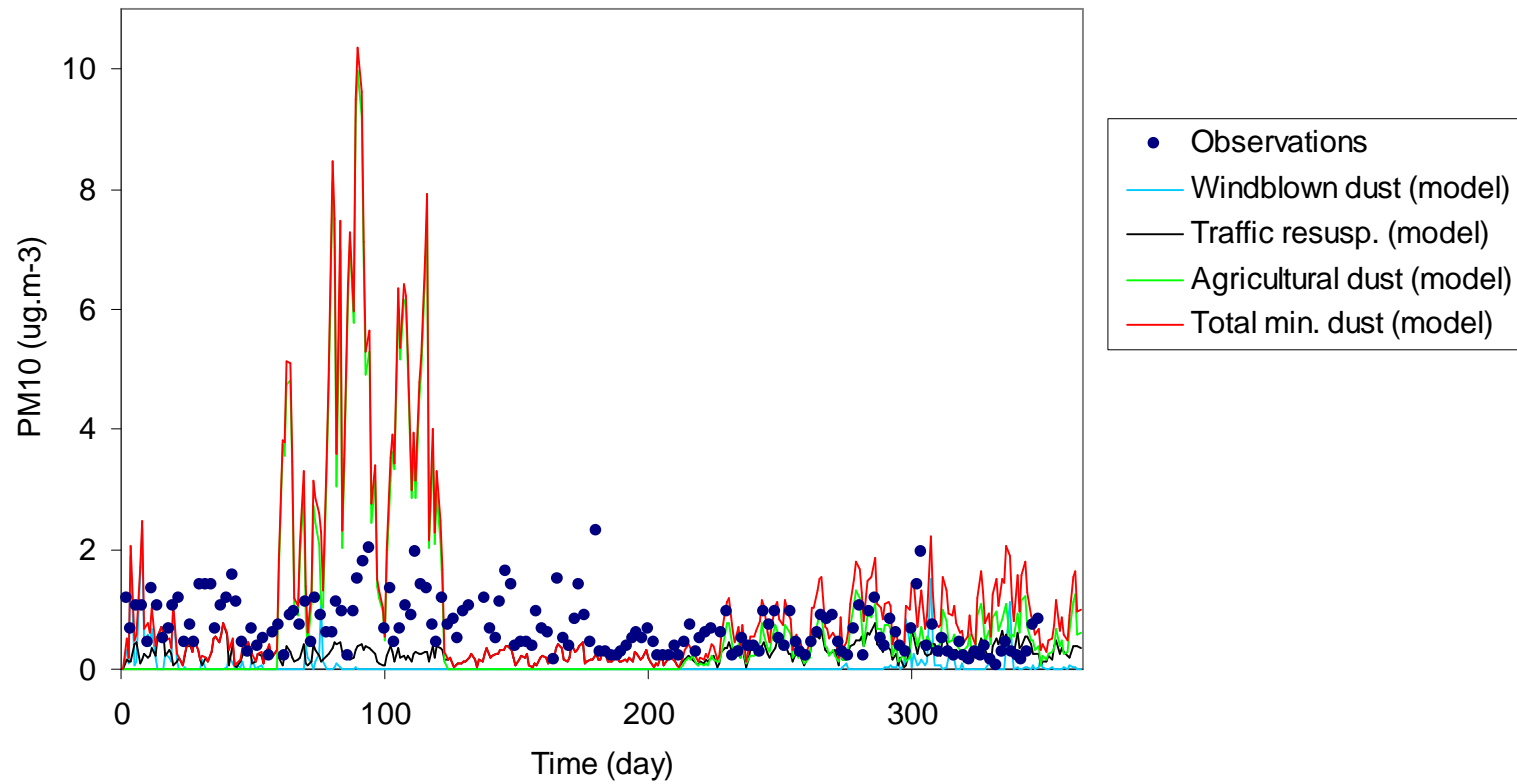
desert dust



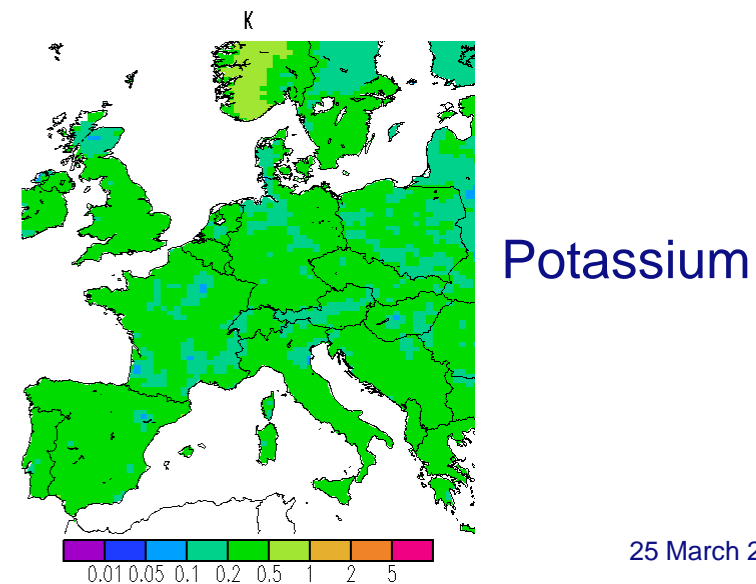
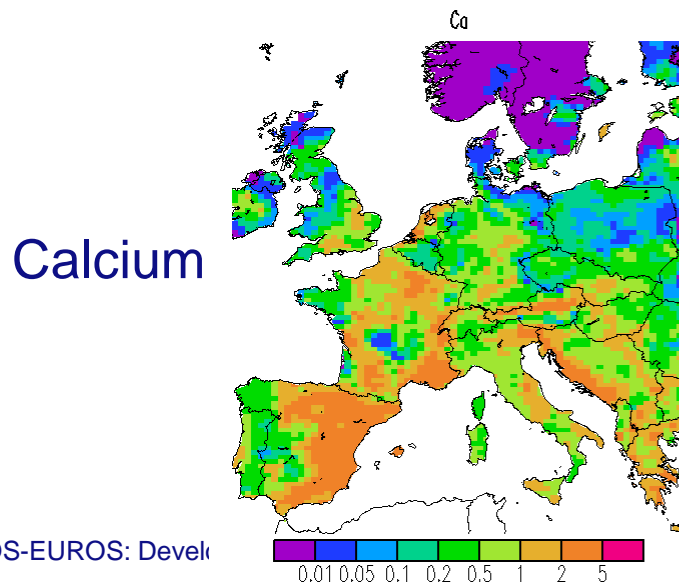
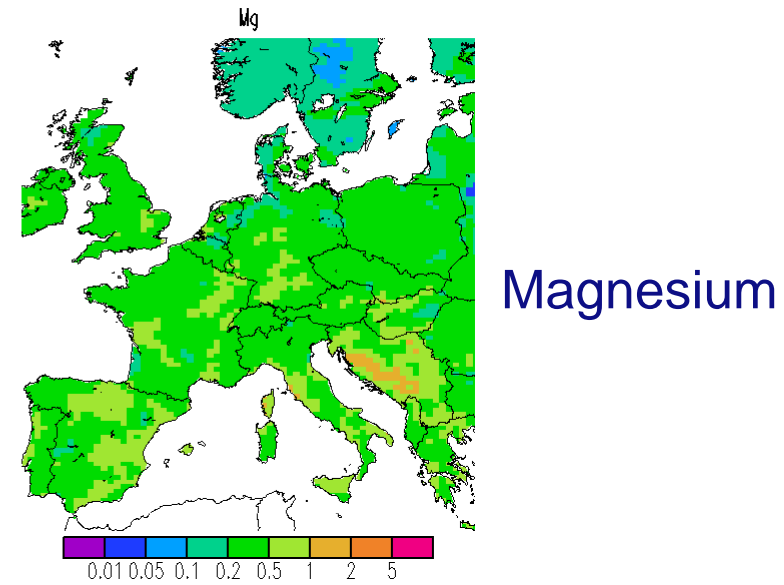
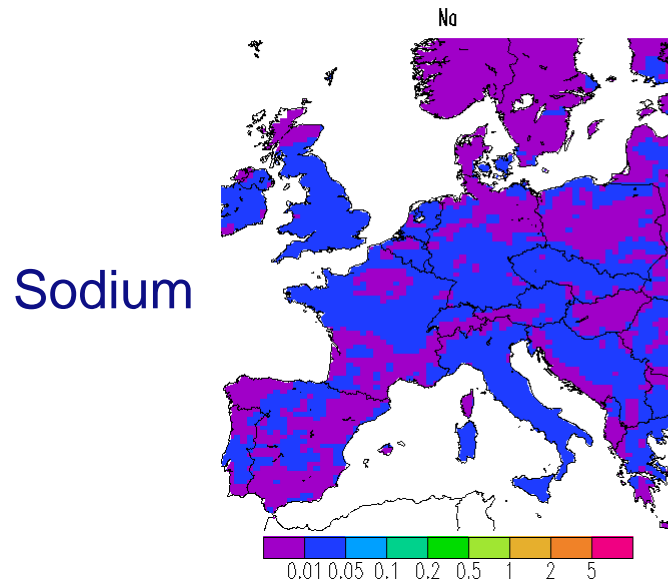
Total annual average mineral PM10  
2-3  $\mu\text{g}\cdot\text{m}^{-3}$

# Kolummerwaard: Dust = Ca \* 7.5

Mineral dust Kollumerwaard  
2005

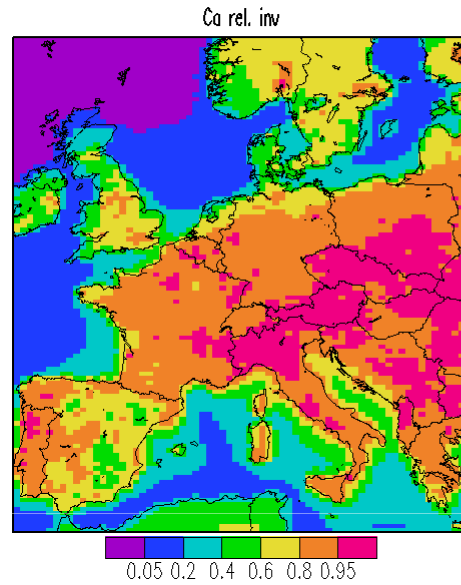


# Base Cation content of top soils in Europe

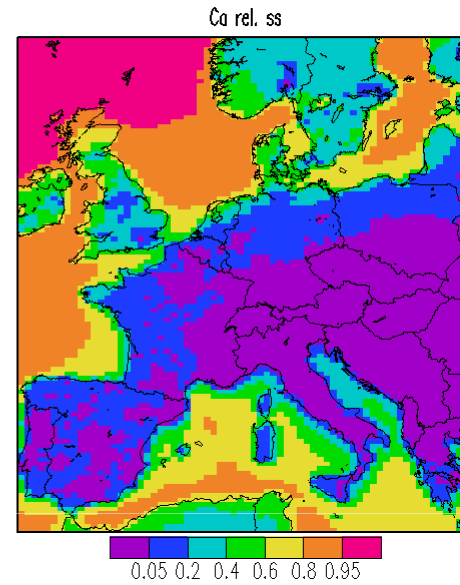


# Relative contributions of the sources to Calcium

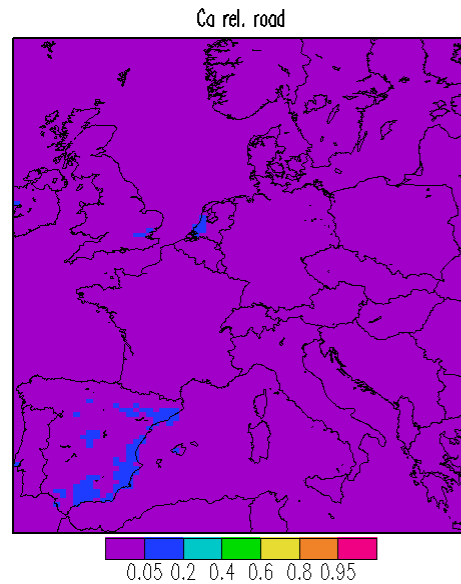
Inventory



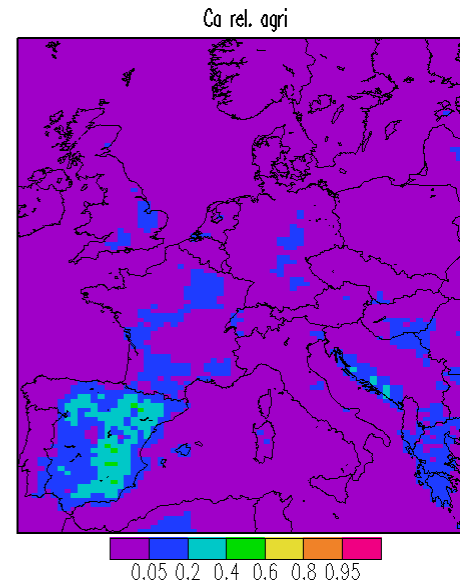
Sea

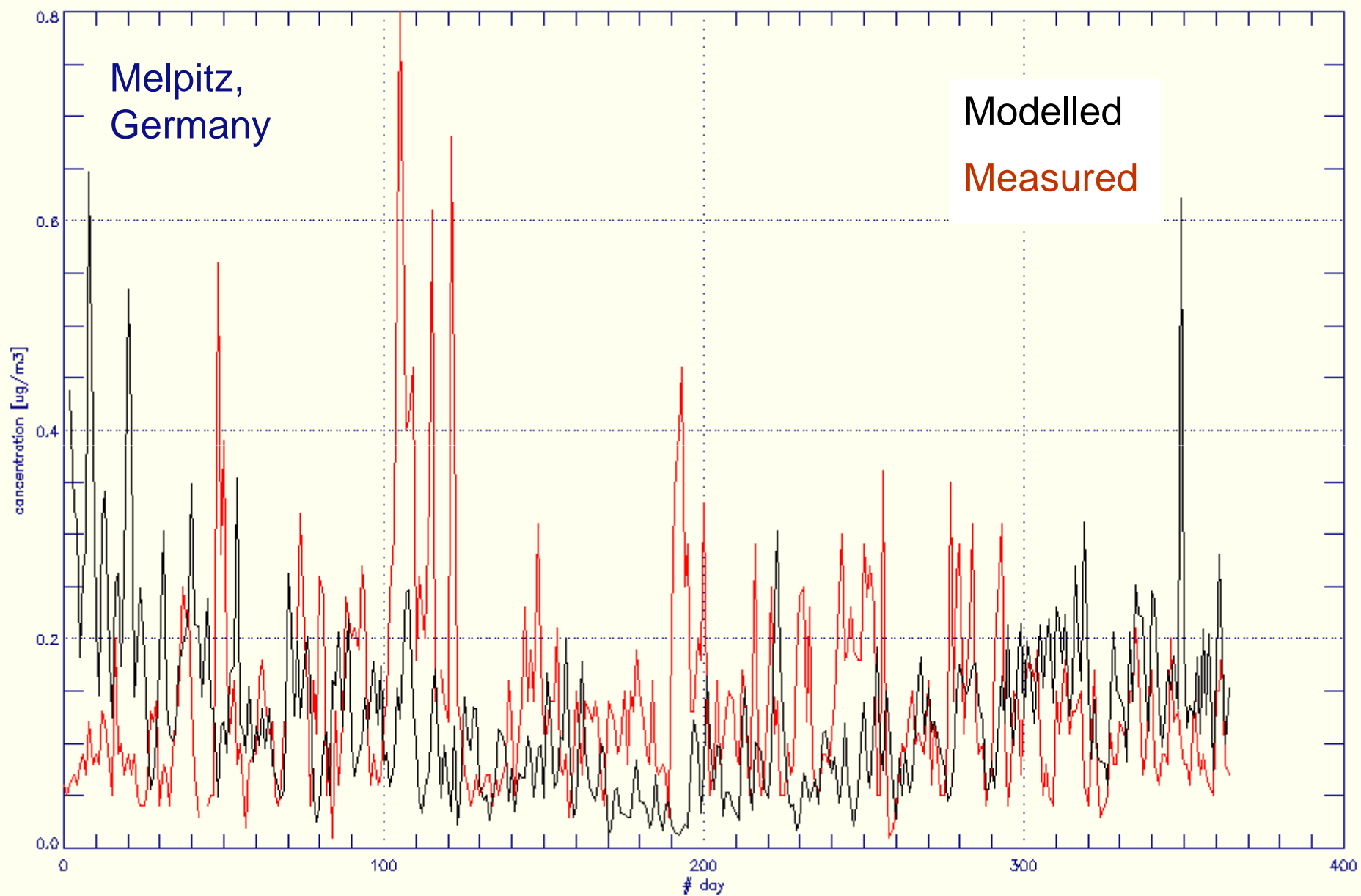


Resuspension



Agriculture





# Conclusions

- We have new insights in the PM composition and origin in the Netherlands
- SIA concentrations may have been underestimated for some time, implying a different conclusion with respect to model performance
- Sea salt modeling is strongly dependent on quality of emission function
- We have developed a new approach to model mineral dust concentrations over the Netherlands and Europe. It needs further validation but can be used to assess the relative importance of different sources.





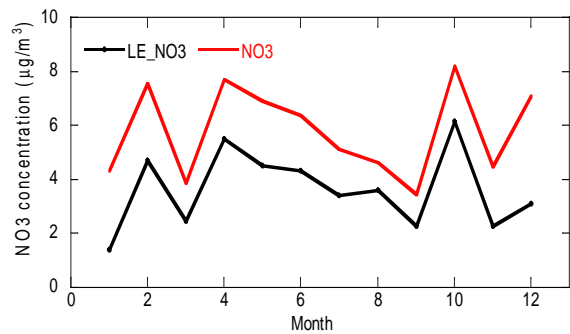
# Seasonal cycles



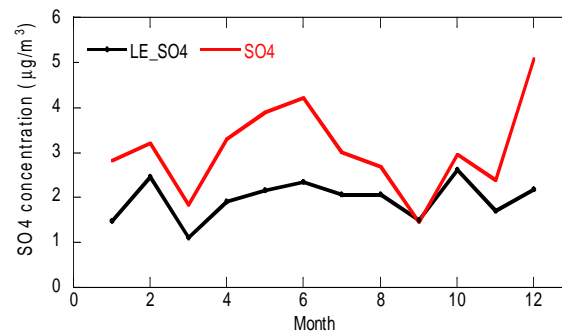
Fine mode

Coarse mode

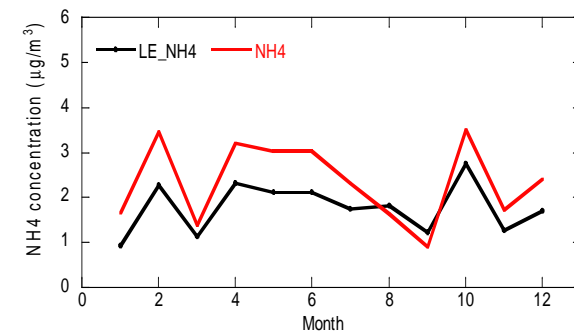
## NO3



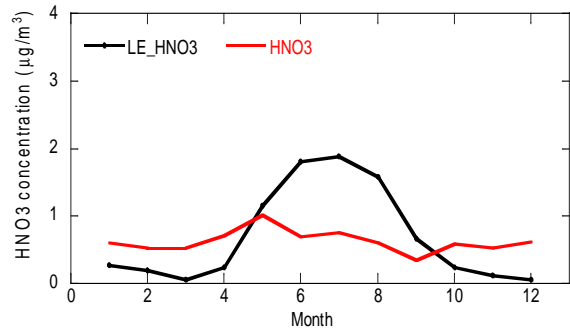
## SO4



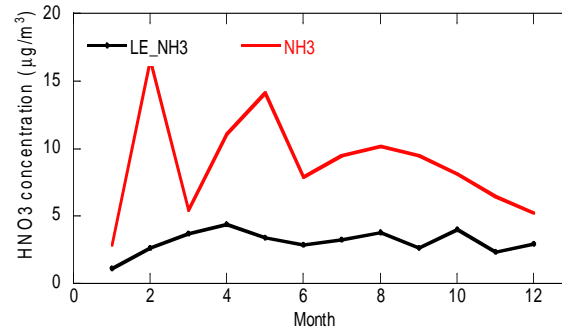
## NH4



## HNO3



## NH3



# Diurnal cycles



Fine mode



Coarse mode

