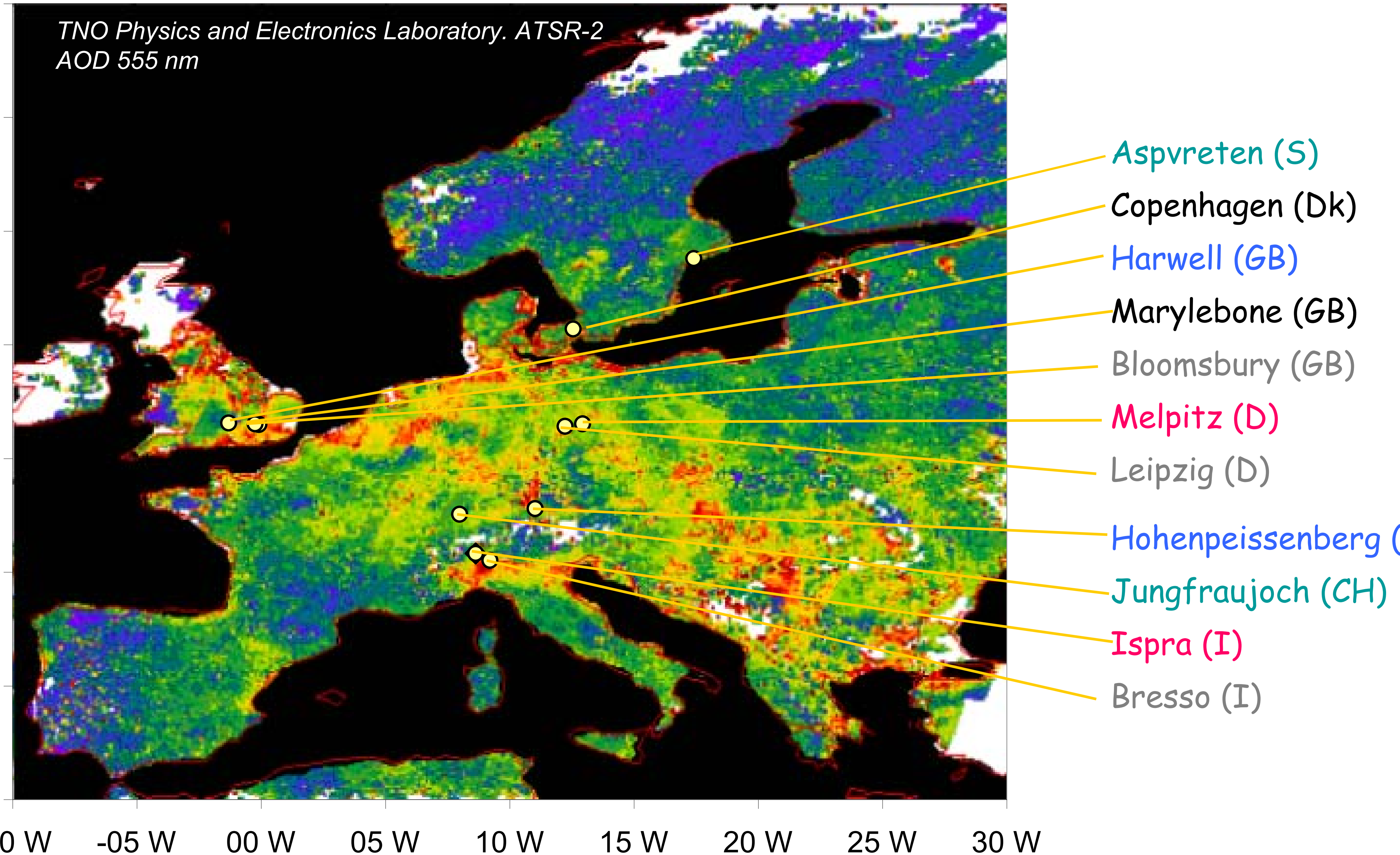
European Phenomenology of aerosol number size distribtions

- Part of "A European Aerosol Phenomenology" by Putaud et al.
- For kerbside, urban, rural and background sites in Europe:
  - Physical aerosol characteristics:
    - PM1.5 and PM10 mass, number size distributions, number concentrations
  - Chemical aerosol characteristics:
    - Chemical mass balance
    - Some chemical size distributions

Data on http://carbodat.ei.jrc.it/ccu/

ocation sites with size distribution dat



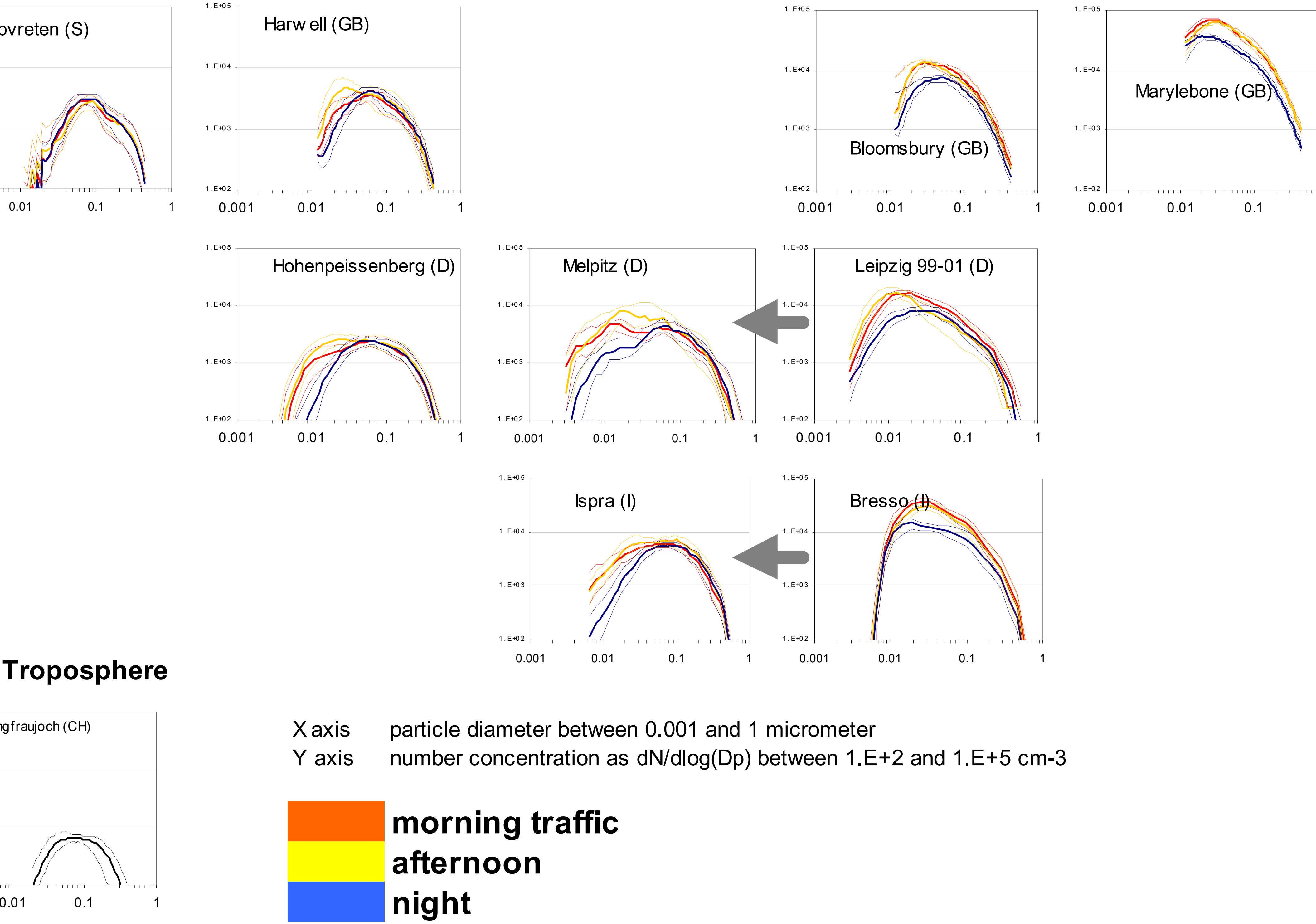

ovreten (S)
Harw ell (GB)
Bloomsbury (GB)
Marylebone (GB)
Hohenpeissenberg (D)
Melpitz (D)
Leipzig 99-01 (D)
Ispra (I)
Bresso (I)
Troposphere
ngfraujoch (CH)
1.E+05
1.E+04
1.E+03
1.E+02
0.001
0.01
0.1
1
X axis particle diameter between 0.001 and 1 micrometer
Y axis number concentration as dN/dlog(Dp) between 1.E+2 and 1.E+5 cm-3
morning traffic
afternoon
night

Fig. 6a: summ

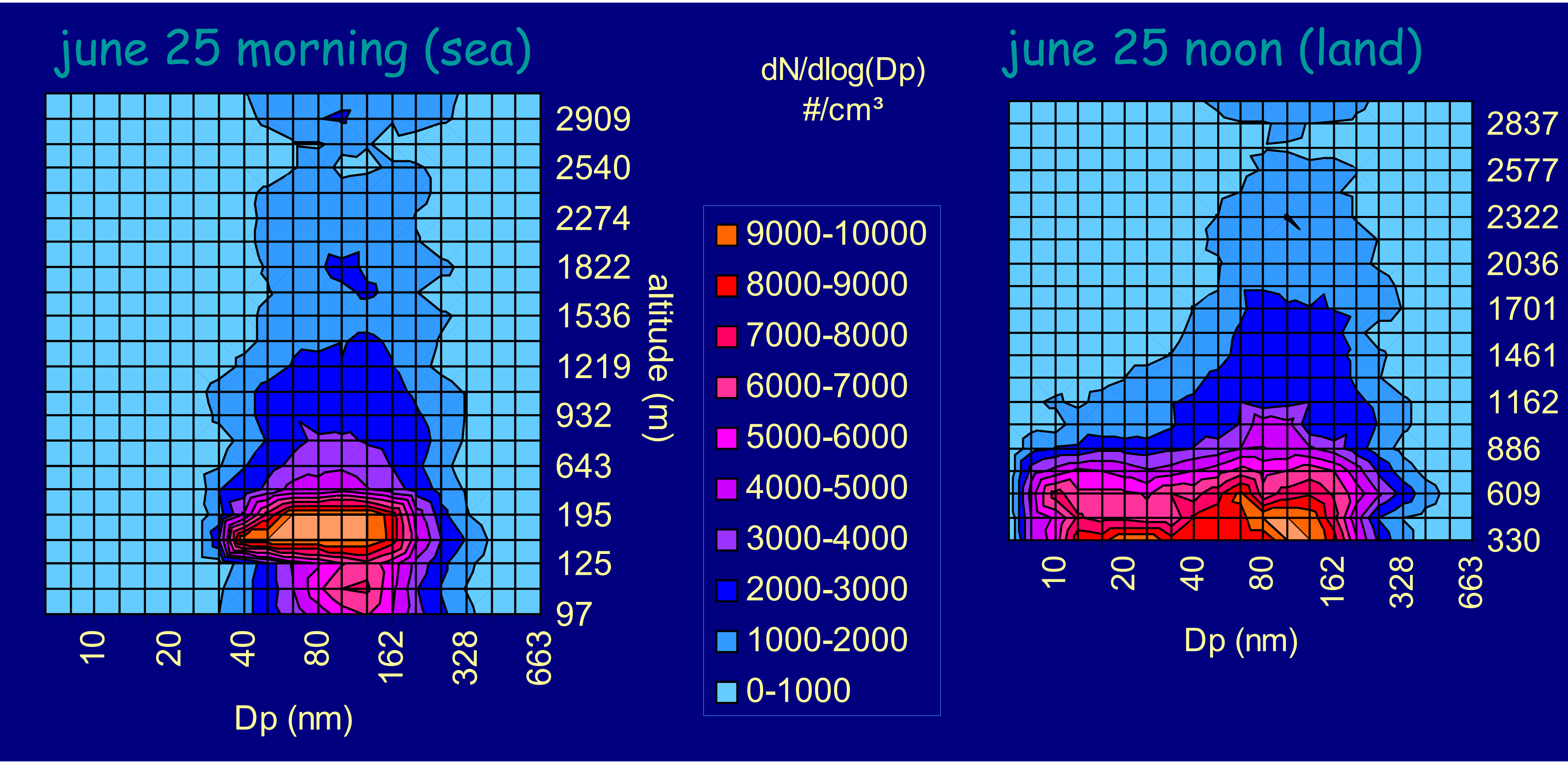
	morning				343	0.059	1.76	180	0.149	1.61	524	1.02	562
Jungfraujoch (CH)	afternoon				358	0.053	1.71	286	0.139	1.54	643	1.02	636
	night				389	0.060	1.75	178	0.154	1.56	568	1.01	562
	morning	71	0.024	1.53	1534	0.073	1.63	324	0.232	1.39	1929	4.40	1937
Aspvreten (S)	afternoon	185	0.026	1.56	1364	0.085	1.61	276	0.246	1.38	1825	4.63	1834
	night	160	0.040	1.56	1718	0.082	1.70	224	0.245	1.38	2101	4.48	2114
	morning	993	0.027	1.54	639	0.059	1.38	1415	0.104	1.86	3047	4.83	3005
Harwell (GB)	afternoon	2089	0.028	1.53	553	0.060	1.36	1459	0.114	1.69	4101	4.10	4050
	night	1790	0.047	1.76	553	0.070	1.42	773	0.153	1.61	3116	4.57	3106
	morning	367	0.012	1.52	1192	0.036	2.00	1185	0.105	1.99	2743	6.36	2713
Hohenpeissenberg (D)	afternoon	468	0.013	1.61	1629	0.030	2.00	1241	0.115	1.90	3337	6.59	3316
	night	94	0.024	1.74	1668	0.051	1.94	557	0.161	1.64	2319	4.55	2307
	morning	3467	0.013	2.00	1142	0.056	1.49	1460	0.117	1.84	6069	6.78	6035
Melpitz (D)	afternoon	2938	0.013	1.95	3989	0.032	2.00	1356	0.123	1.73	8283	5.66	8260
	night	1011	0.014	1.73	2228	0.058	1.65	1023	0.158	1.66	4262	7.53	4242
	morning	632	0.010	1.93	2575	0.030	1.87	3609	0.095	1.89	6817	10.25	6658
Ispra (I)	afternoon	638	0.010	1.69	2508	0.027	1.61	4863	0.093	1.90	8010	13.03	7949
	night	256	0.018	1.73	2084	0.047	1.71	2859	0.120	1.81	5199	12.80	5185
	morning				3461	0.025	1.49	7412	0.059	2.00	10873	7.04	10776
London-B (GB)	afternoon				4933	0.027	1.56	5572	0.067	2.00	10505	7.64	10308
	night				3047	0.033	1.85	3373	0.073	2.00	6421	6.19	6140
	morning	12921	0.016	1.99	3360	0.050	1.65	2431	0.113	1.97	18712	15.65	18441
Leipzig (D)	afternoon	7751	0.011	1.78	5422	0.041	2.00	599	0.189	1.55	13773	6.69	13713
	night	3711	0.015	2.00	5118	0.043	1.96	676	0.185	1.62	9505	7.96	9314
	morning	3664	0.014	1.37	12914	0.025	1.56	13961	0.059	2.00	30539	13.41	30700
Milano-Bresso (I)	afternoon	3187	0.014	1.40	10981	0.027	1.58	11527	0.061	2.00	25696	12.34	25874
	night	2917	0.014	1.40	5233	0.024	1.68	6178	0.068	2.00	14329	9.05	14313
	morning	24092	0.021	1.77	26919	0.037	2.00	6872	0.111	1.74	57883	26.28	53479
London-M (GB)	afternoon	23586	0.020	2.00	13734	0.030	1.57	18452	0.074	1.97	55771	32.19	50134
	night	16333	0.017	1.84	8192	0.029	1.79	9670	0.072	2.00	34195	16.89	29173

Data on http://carbodat.ei.jrc.it/ccu/

Important remarks:

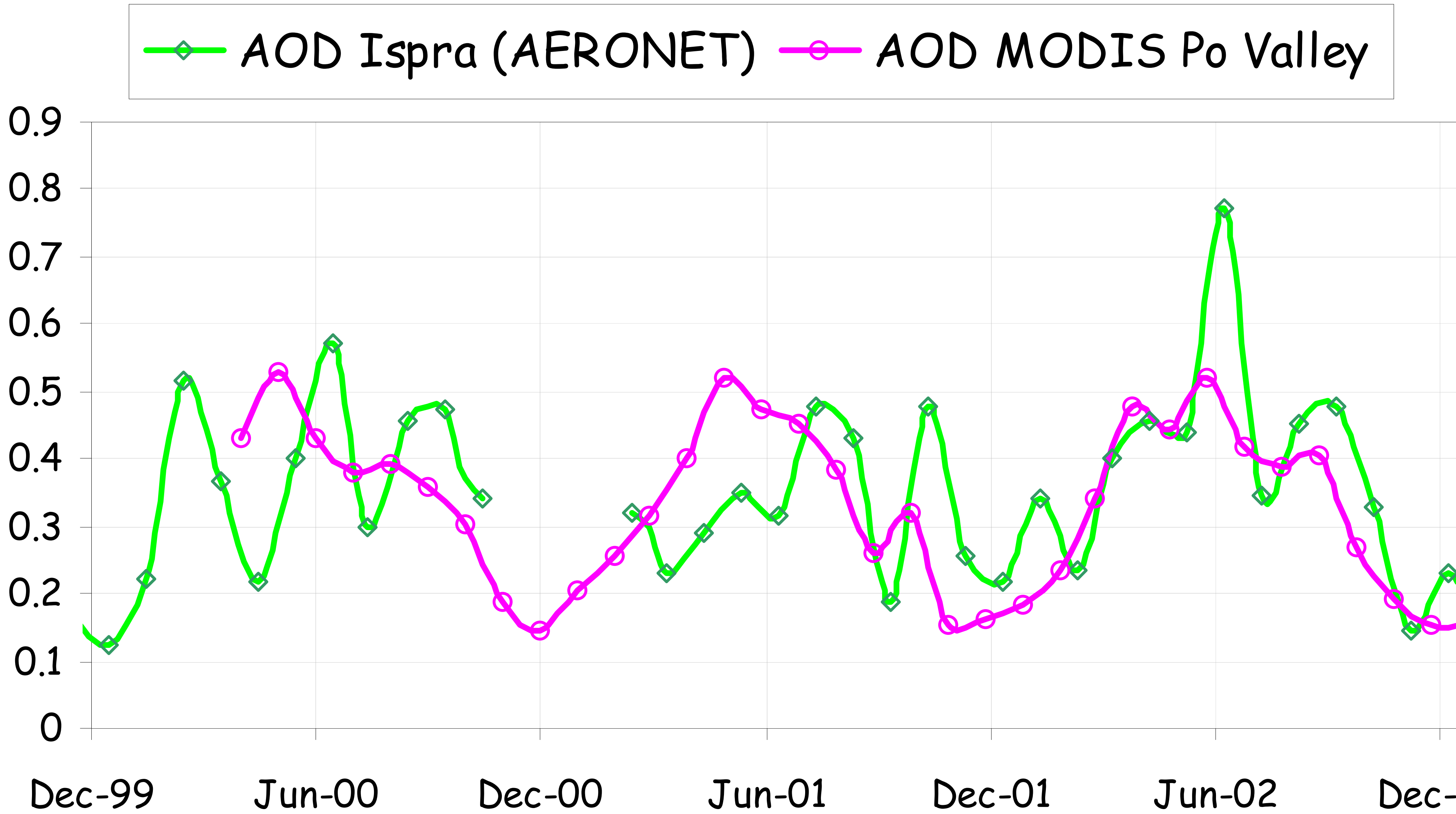
- Distributions are seasonal averages
- Apply to $< 1\mu m$ size range, i.e. <u>no coarse mode</u>
  - Volume can be up to factor 2 underestimated
- Size distributions are DRY, except GB data
  - Intercomparison with remote sensed AOD & derive
    properties requires RH correction!
- Distributions are point-measurements and not necessarily representative for whole column or horizontal area

Vertical distribution aerosol size distribution ESCOMPTE, Marseille 2001

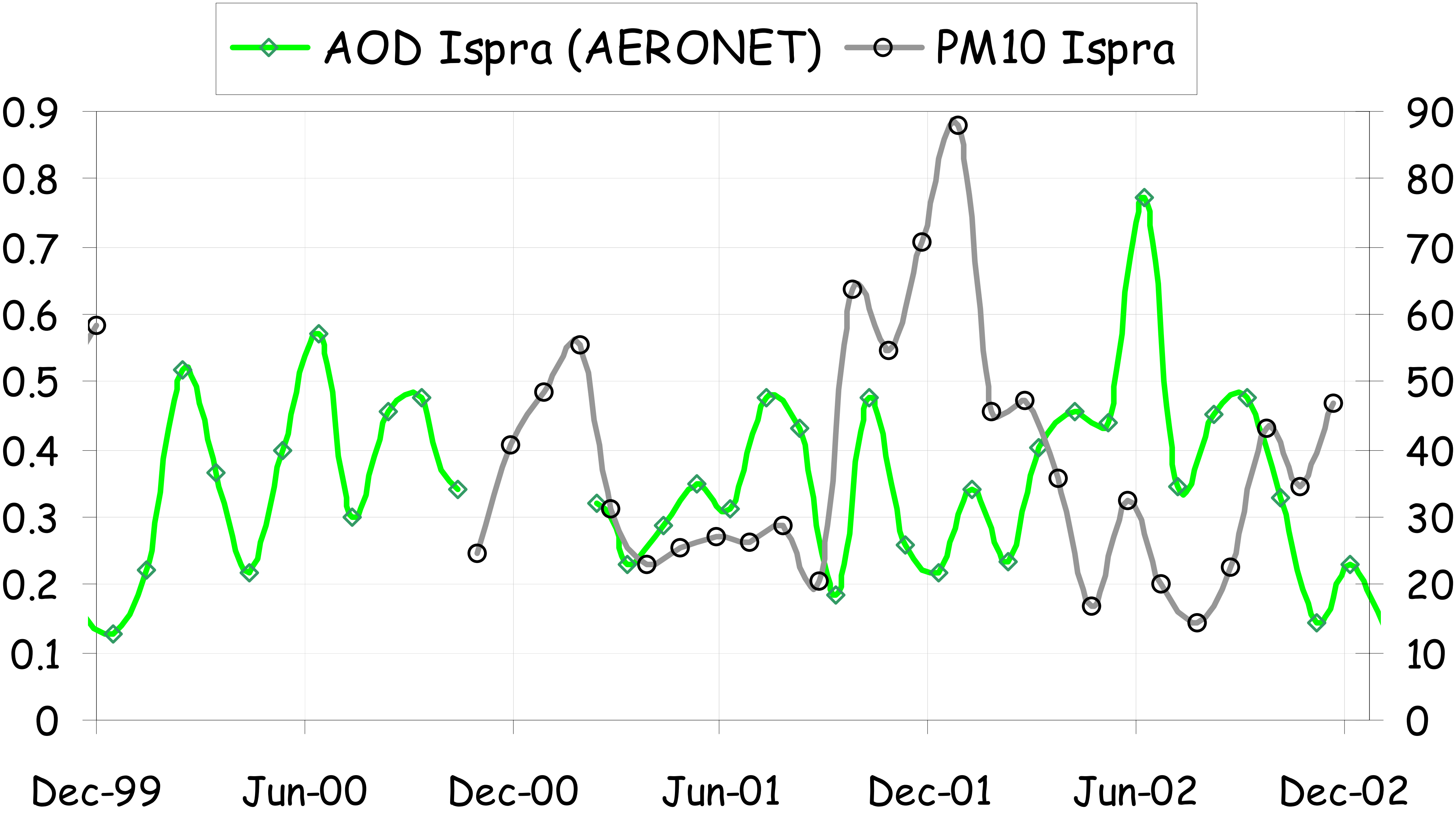


Mallet, Van Dingenen, Putaud et al., manuscript in preparation

Aerosol Optical Depth from surface and from space



Aerosol Optical Depth and PM Ispra



Hygroscopic growth of aerosol particle

Many data on hygroscopic growth factor available:

$GF(D) = D(90\%)/D_{dry}$

Convert GF to ambient RH: model salt assumption

- Assume resulting GF(90%) is due to mixing of insoluble + ammonium sulfate

- Calculate soluble fraction:

$$\varepsilon = \frac{GF_{90}^3 - 1}{GF_{AS,90}^3 - 1}$$

- With known properties of A.S at RH, calculate GF(RH):

$$GF_{RH}^3 = \varepsilon\left(GF_{AS,RH}^3\right.$$

Which GF to apply?

Many data in literature for various aerosol types

- Swietlicki et al., 2000 (marine, marine influenced, continental influenced)
- Cocker et al, 2001 (Urban, + overview)
- Vakeva et al., 2002 (Urban, rural, boreal forest)
- Baltensperger et al., 2002 (Urban, + overview)
- Massling et al., 2003 (marine, marine+dust, marine + BB)

- And many, many more

(reference list available on request)

Rules of Thumb

Urban aerosol

GF(90%) 1.0 - 1.2

Aged continental aerosol

GF(90%) 1.4 - 1.6 (A.S.: 1.7)

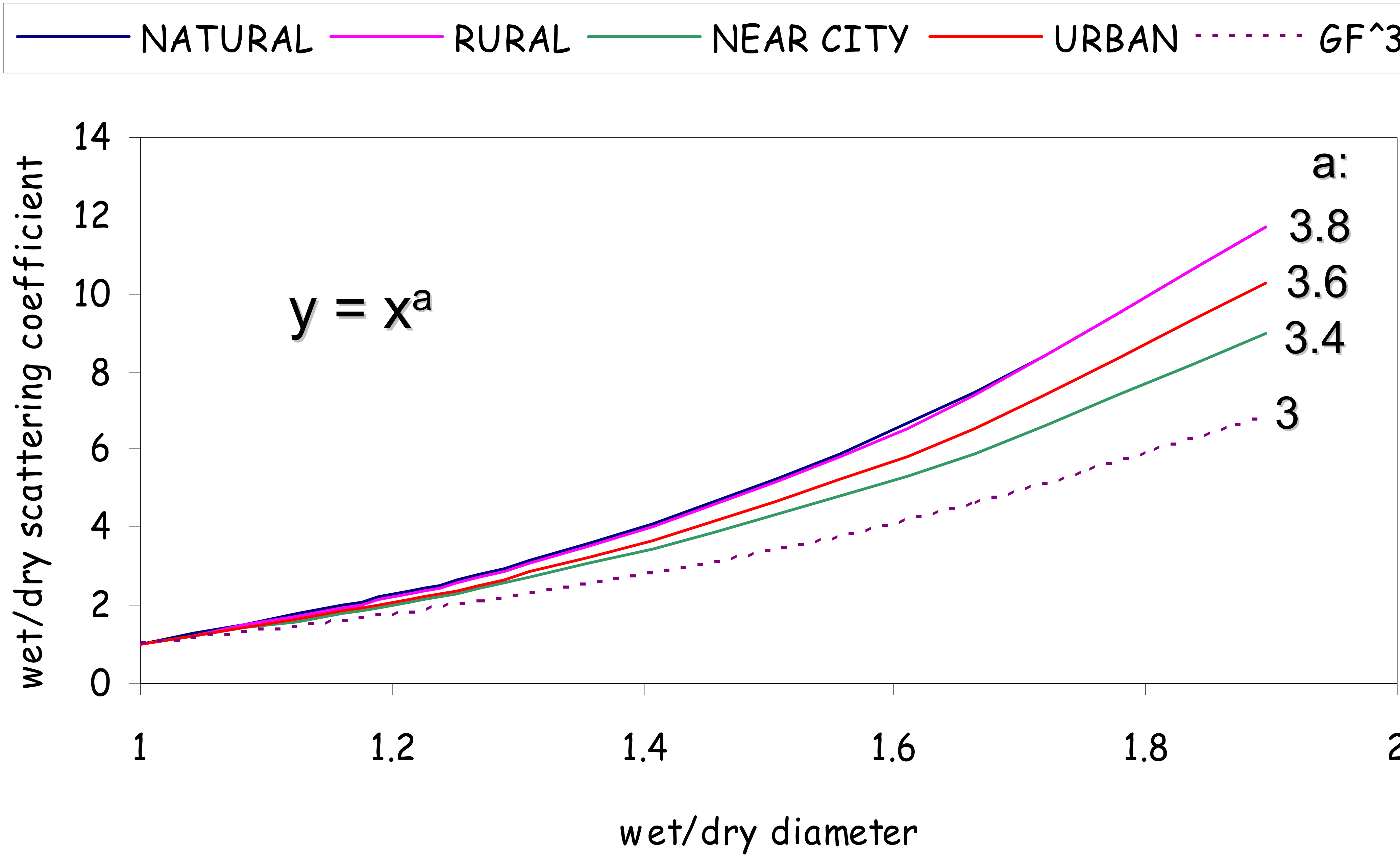
Boreal and Amazone forest:

GF(90%) 1.15 - 1.20

Marine aerosol: mainly A.S. + seasalt

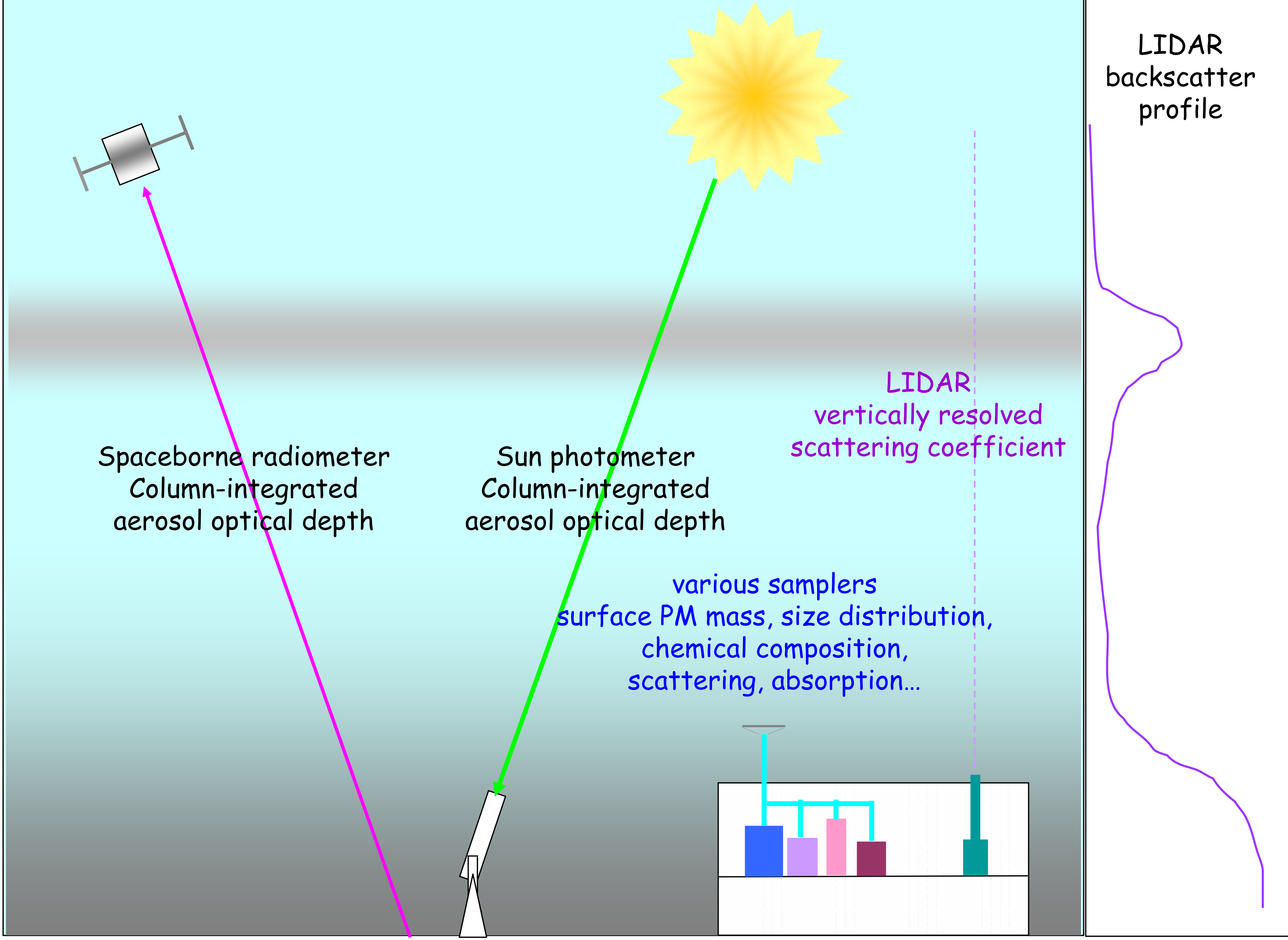
GF(90%) 1.5 - 1.8

What happens to scattering coefficient when particles take up water?



	AIR QUALITY, CLRTAP	CLIMATE CHANGE	MODEL VALIDATION	SATELLI RETRIEV VALIDAT
	●		●	●
	●		●	●
	●		●	●
	●	●	●	●
	●	●	●	●
cal composition		●	●	
er size on	●	●	●	●
ttering		●	●	●
orption	●	●	●	●
ntegrated AOD ET)		●	●	●
y resolved light g (LIDAR) 004)		●	●	●

ally: aerosol hygroscopicity



LIDAR backscatter profile
LIDAR vertically resolved scattering coefficient
Spaceborne radiometer Column-integrated aerosol optical depth
Sun photometer Column-integrated aerosol optical depth
various samplers surface PM mass, size distribution, chemical composition, scattering, absorption…