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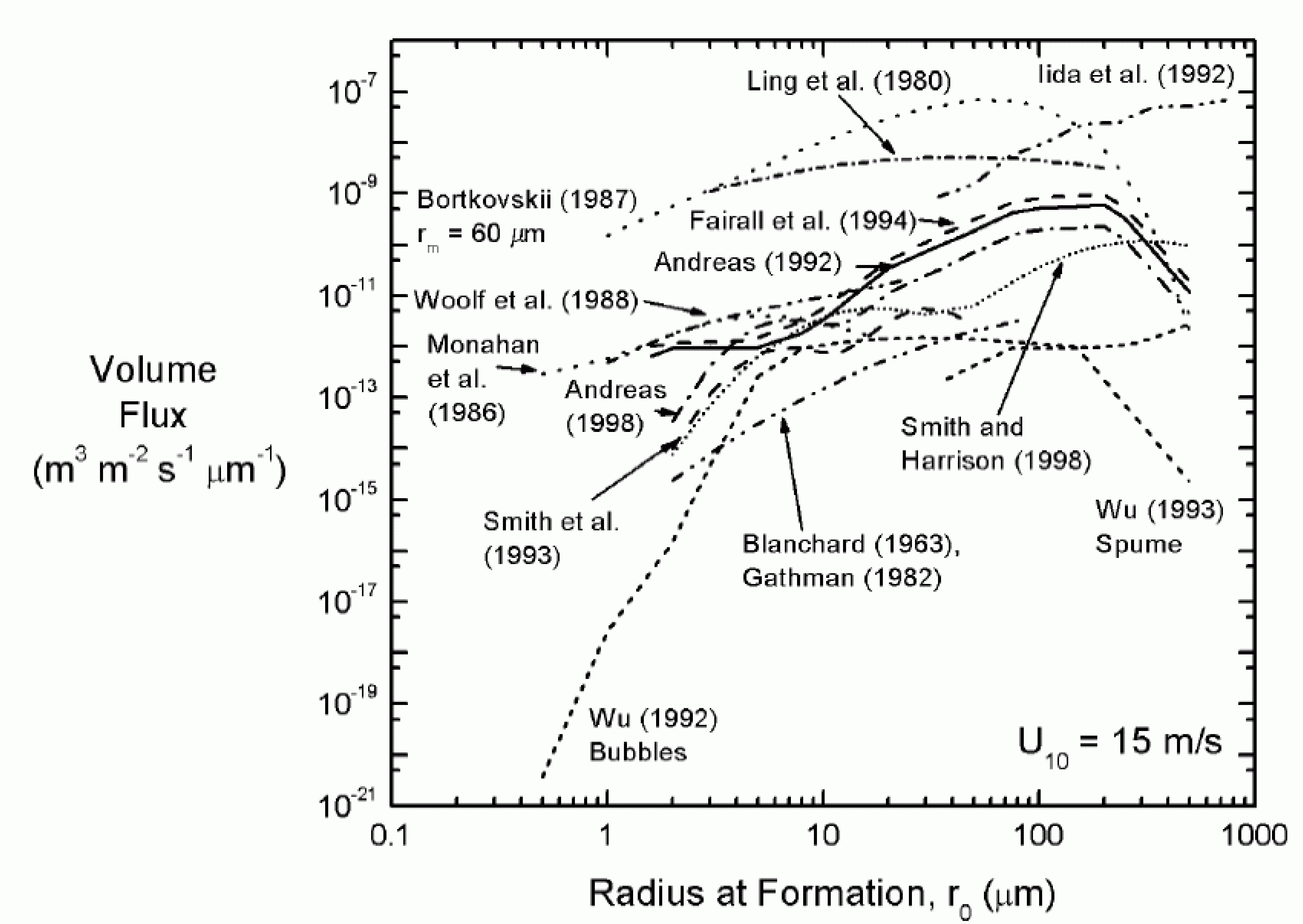
Studies of marine aerosols

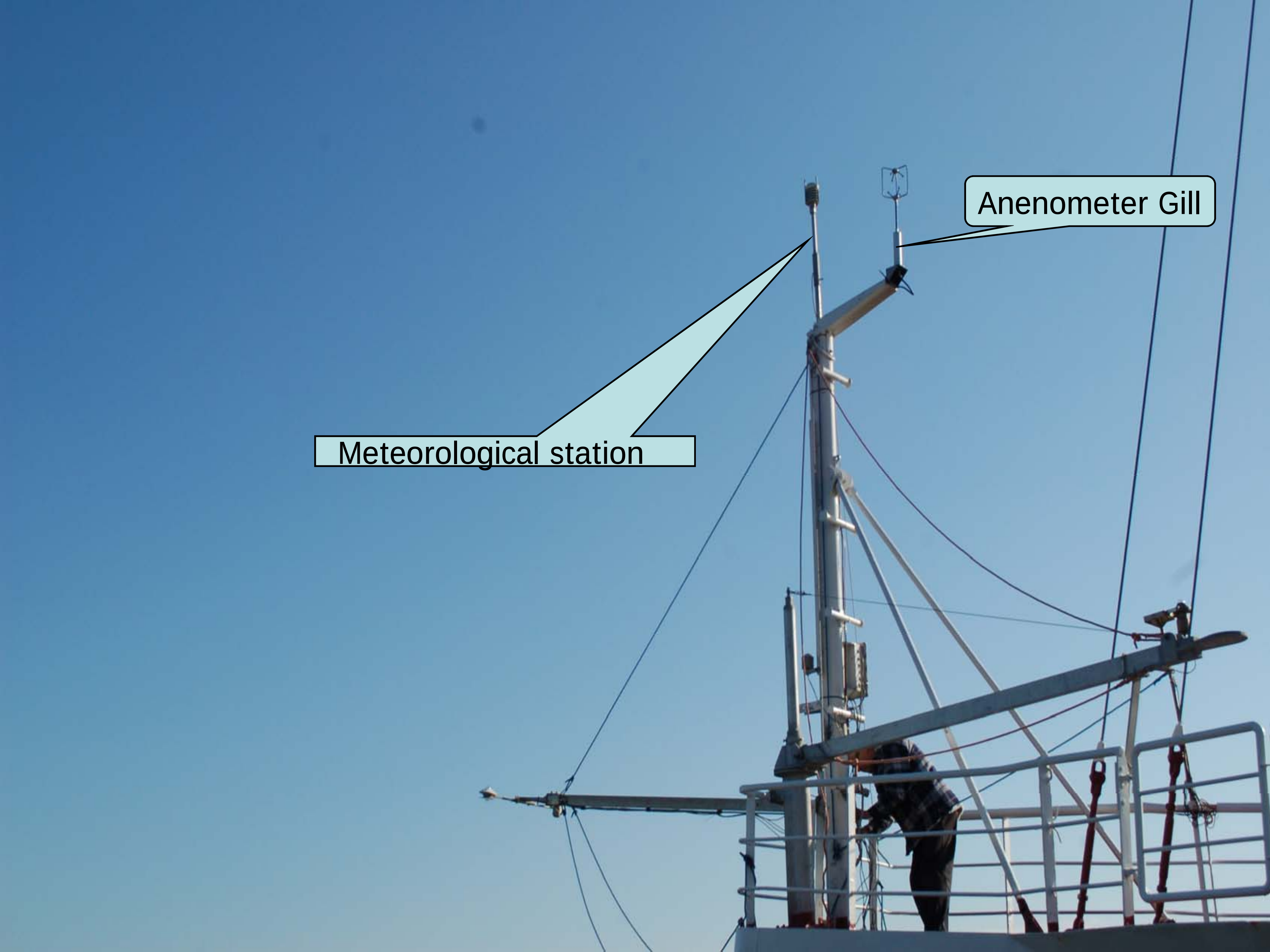
5th Workshop on Optoelectronic Techniques for Environmental Monitoring

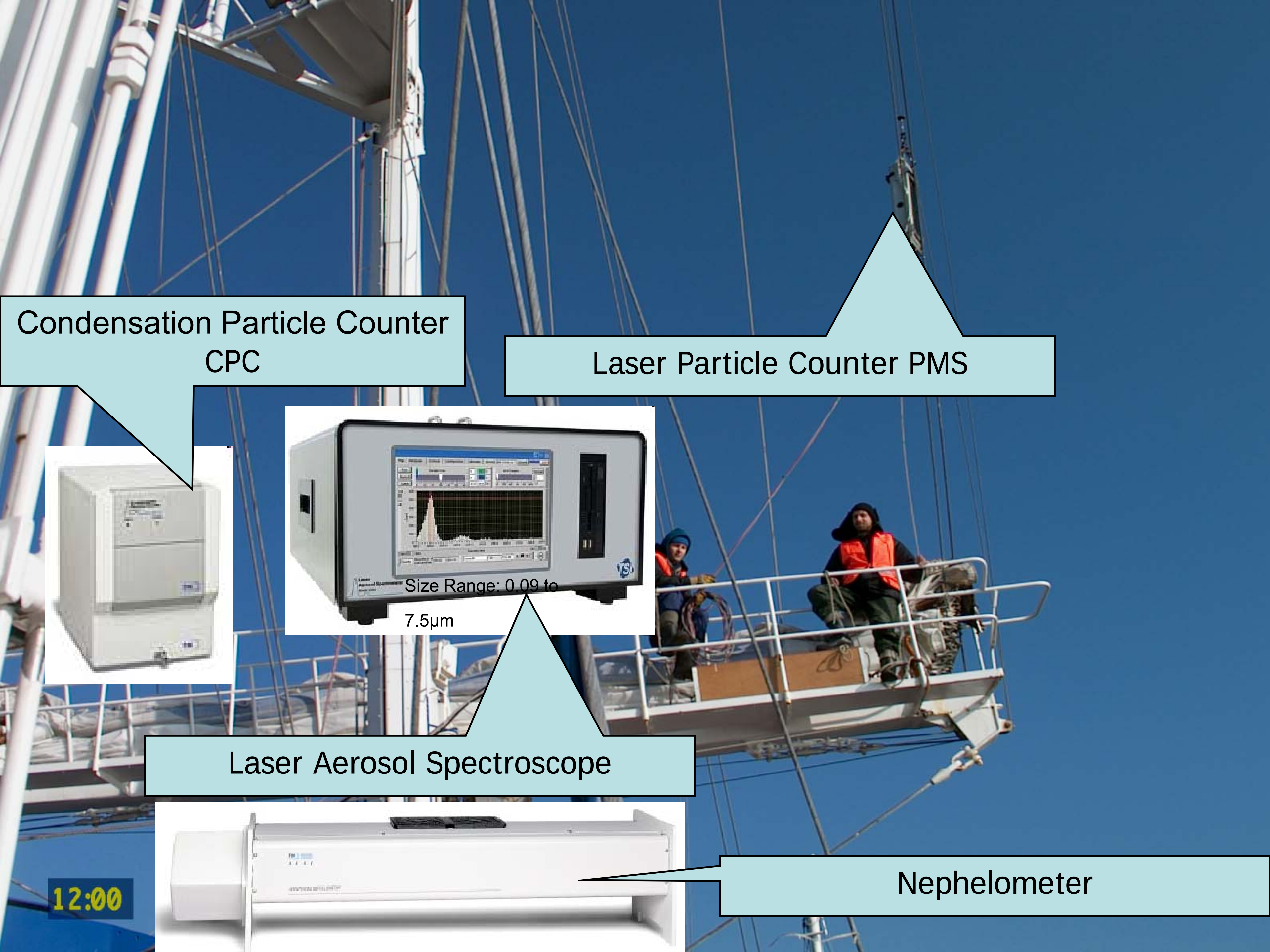
Air –Sea Interaction Laboratory

Motivation: How far we are from consensus on aerosol fluxes…



Andreas “A review of sea spray generation function for the open ocean”, Skipton, 2004


Anenometer Gill
Meteorological station



Condensation Particle Counter CPC

Laser Particle Counter PMS

Size Range: 0.09 to 7.5µm

Laser Aerosol Spectroscope

Nephelometer

$$\frac{\partial}{\partial z}\overline{(n'w')}=0$$

$$\frac{\partial F(r)}{\partial r}=\overline{n'(r)w'}$$

$$\tau/\rho \qquad Q \qquad \beta$$

$$u_*=(\tau/\rho)^{1/2}$$

$$T_*=\frac{-Q}{\kappa u_*}$$

$$L=\frac{-u_*^3}{\kappa\beta Q}$$

$$\frac{\kappa z}{u_*}\frac{\partial u}{\partial z}=\varphi(z/L)$$

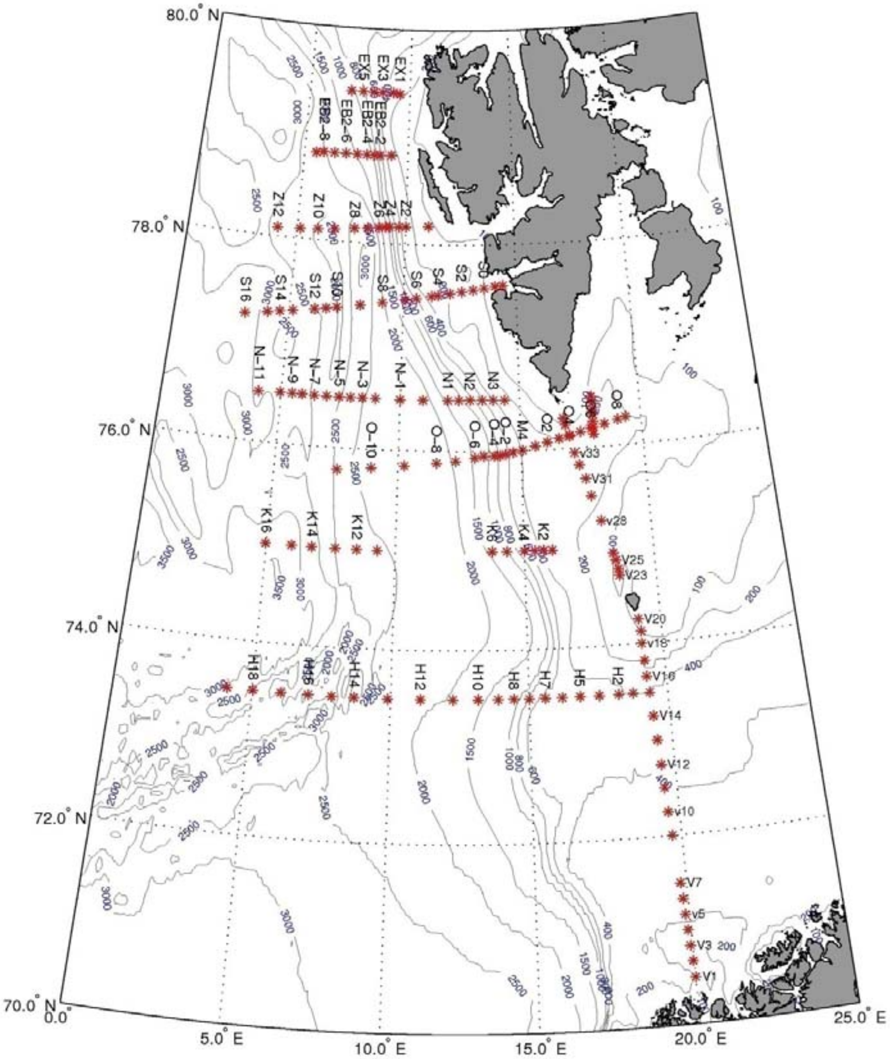
$$\frac{z}{T_*}\frac{\partial\theta}{\partial z}=\varphi(z/L)$$

$$N_*=\frac{F_N}{u_*}$$

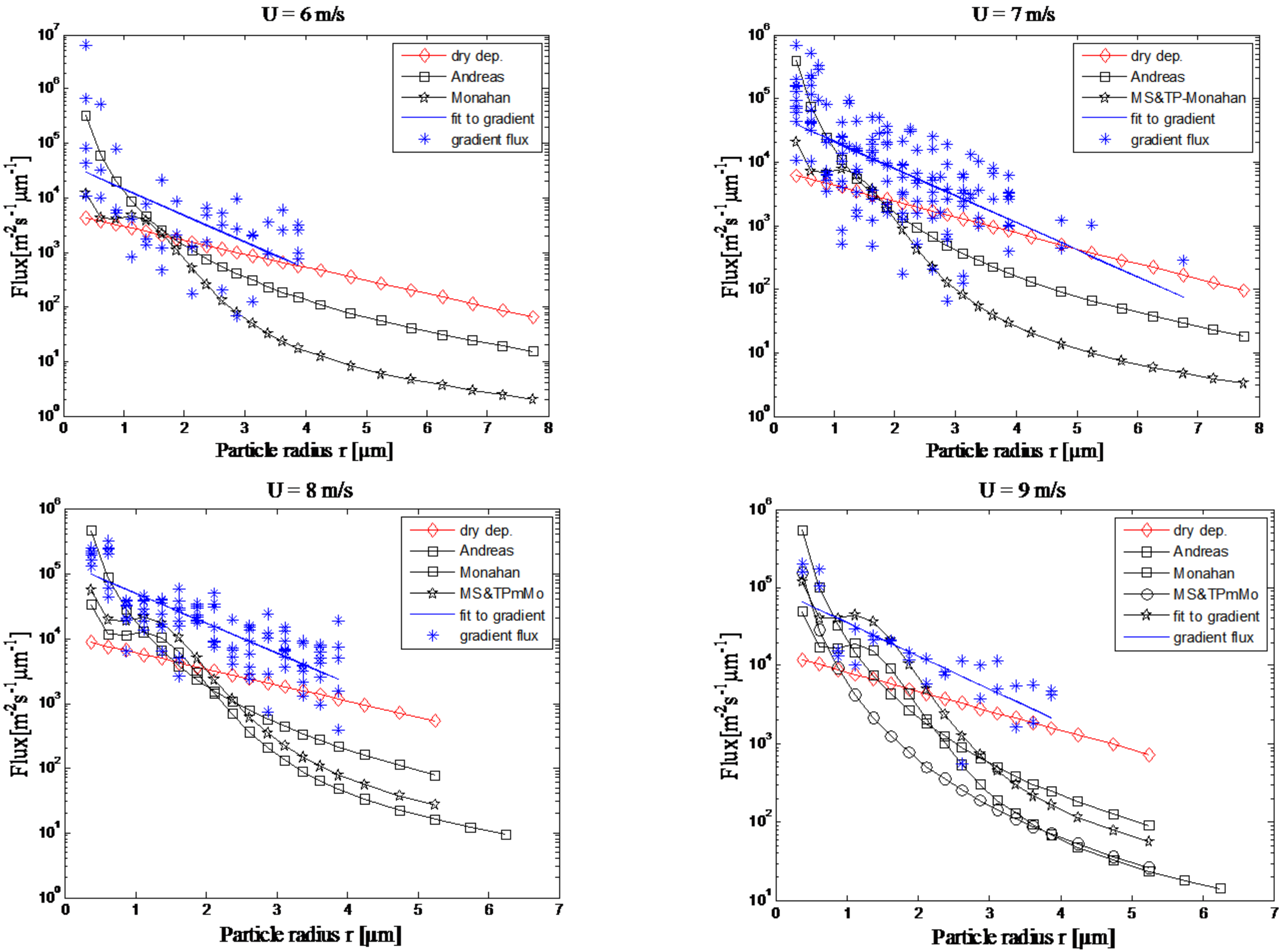
$$\frac{z}{N_*}\frac{\partial N}{\partial z}=\Phi\left({}^{z}\!/_{L}\right)$$

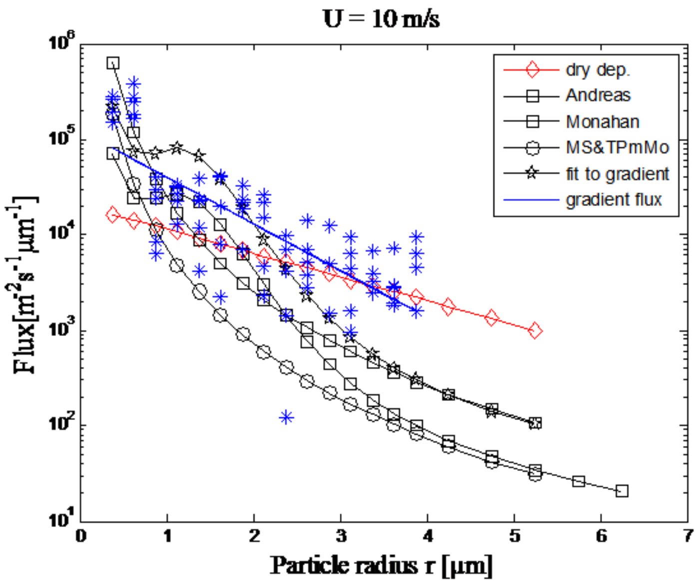
$$N(z)=N_*\ln(z)+C$$

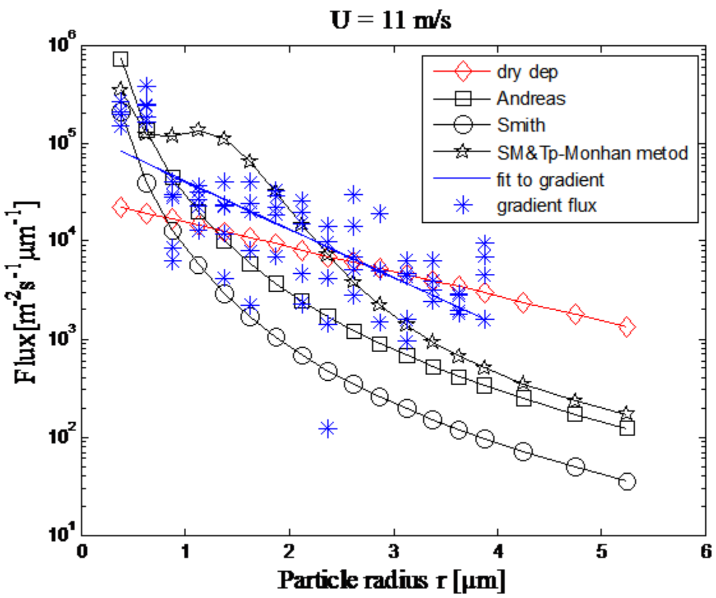
Measurement stations of r/v "Oceania" in the Norwegian and Greenland Seas

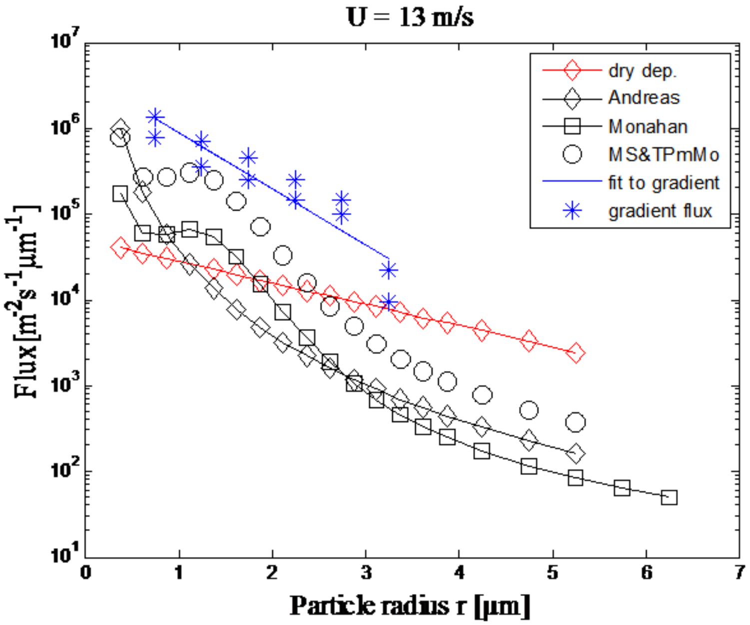


Sea Spray Generation Function (SGF) for different wind speed: comparison of our North Atlantic data (stars) and calculated functions to literature functions



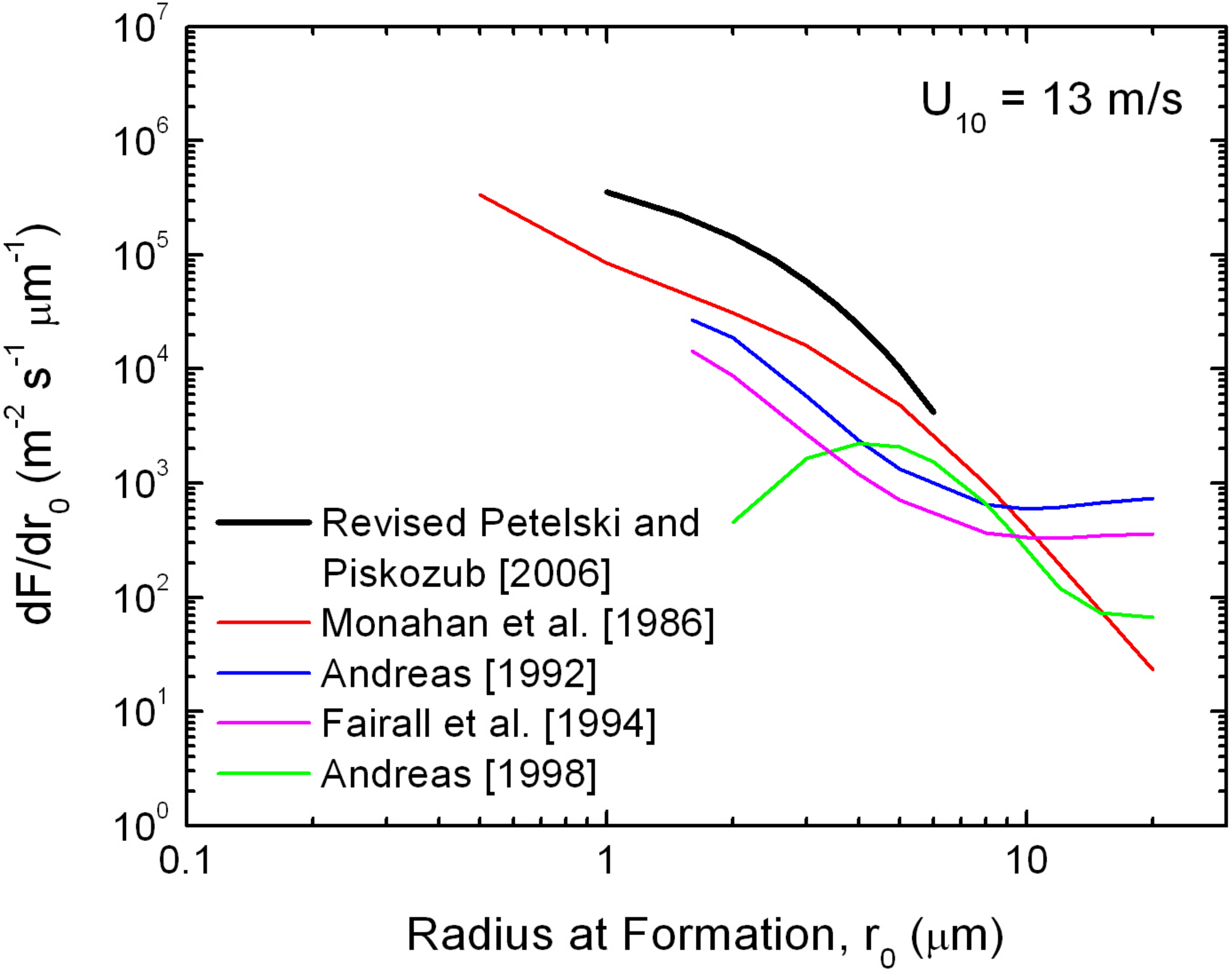




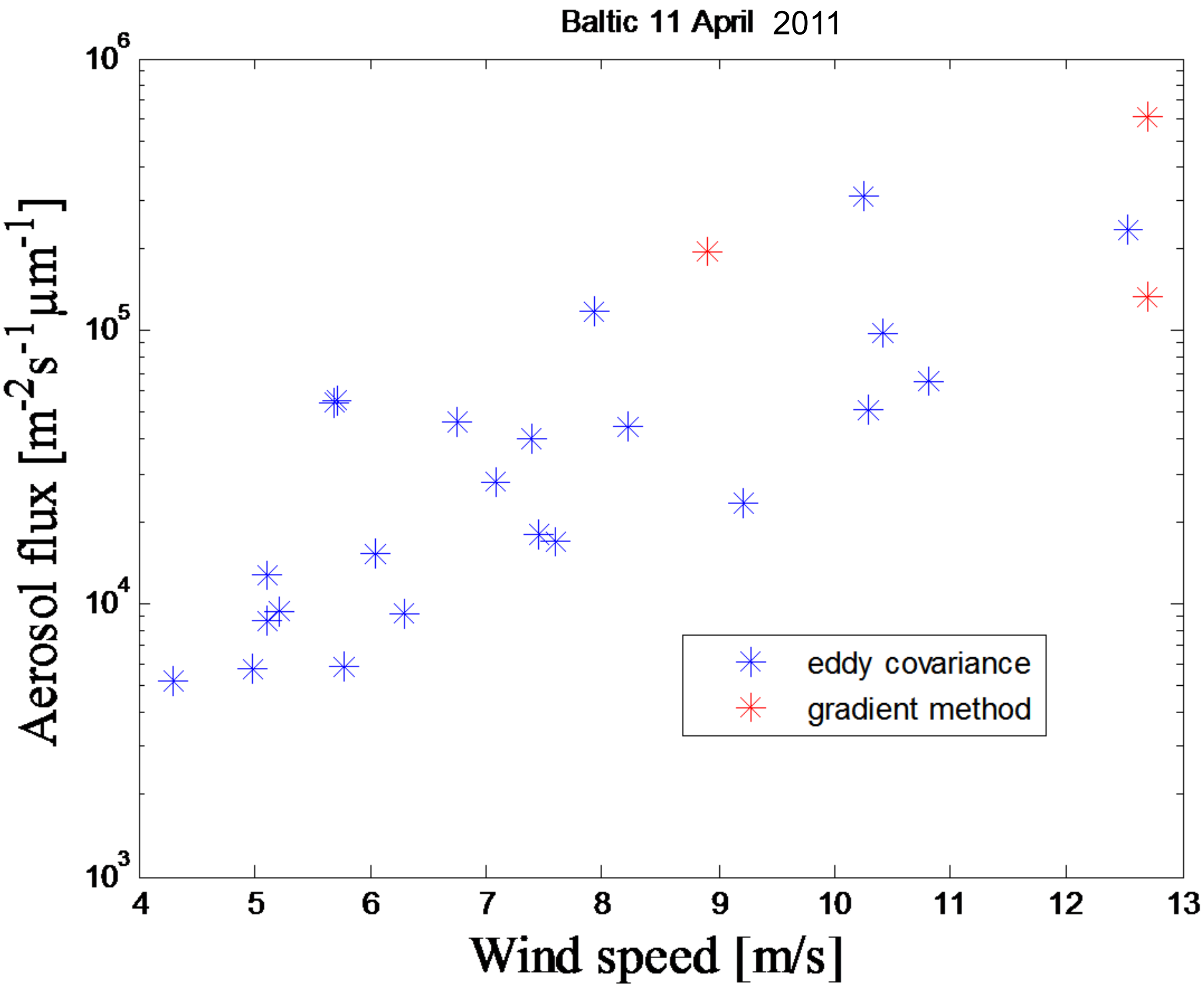


Dry deposition method

$$F = U_d(r) * n(r)$$

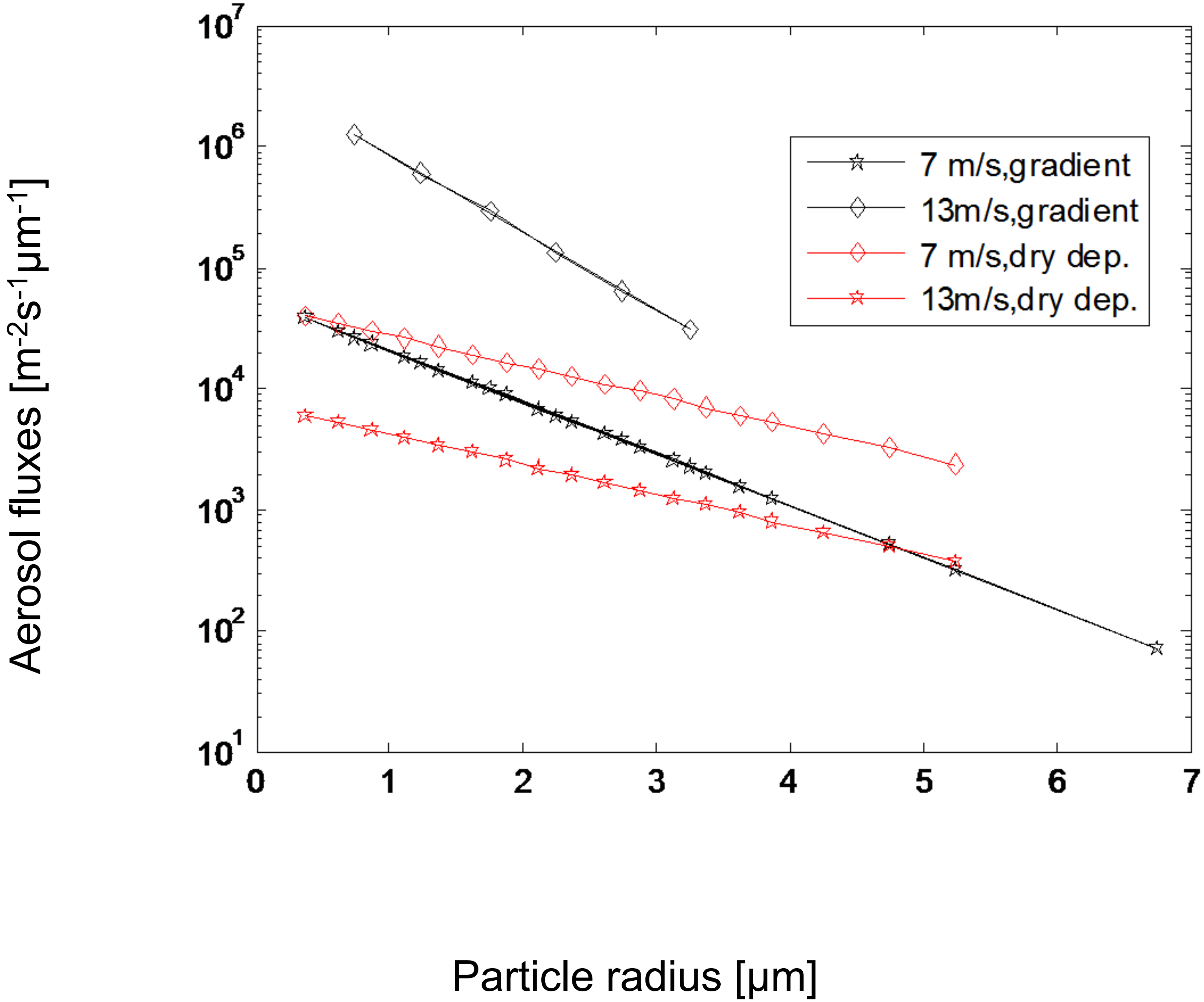


Andreas 2007 (JGR)

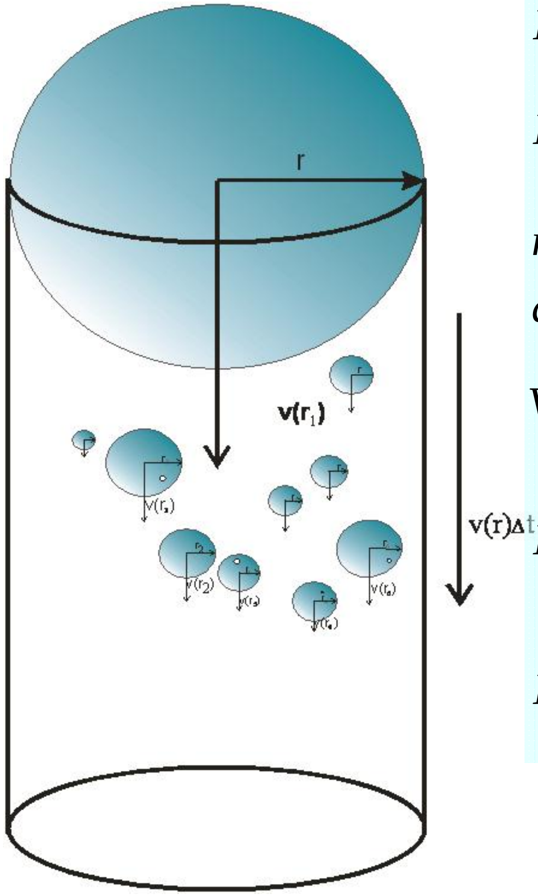


Baltic 11 April 2011

Comparison SGF fitted to gradient data with estimated by dry deposition method



Scavenging



$$F_C(r,r_1)=\pi\cdot r^2 n(r)n(r_1)[V_s(r)-V_s(r_1)]$$

$$F_c(r)=\pi\cdot n(r_1)\cdot\int_{r_1}^{\infty} r^2 n(r)[V_s(r)-V_s(r_1)]dr$$

$$n(r)=\exp(-ar+b)$$

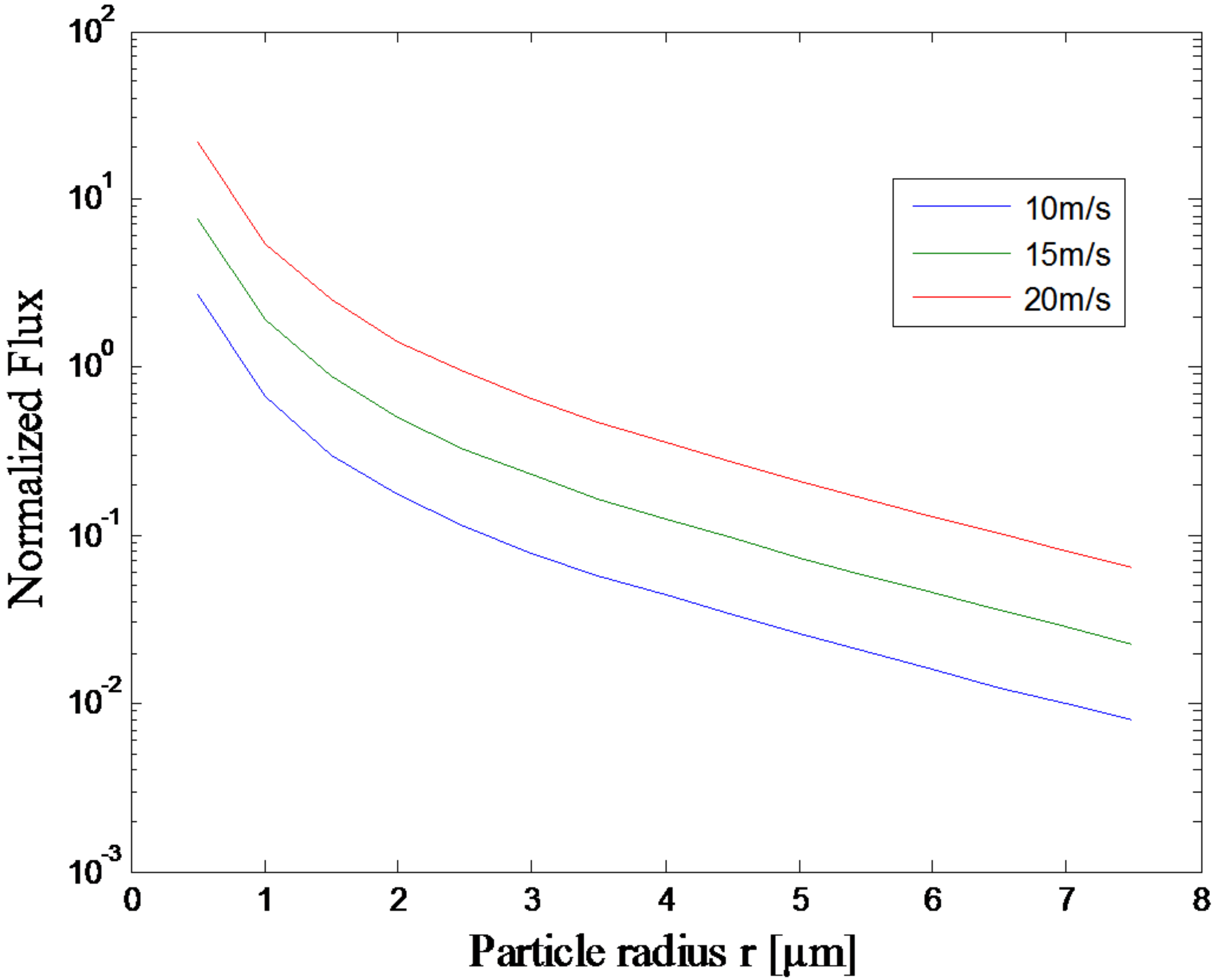
$$a=0.29;\qquad b=0.2082\cdot U_{10}+12.2985$$

$$V_s=\frac{2g\rho}{9\eta}r^2$$

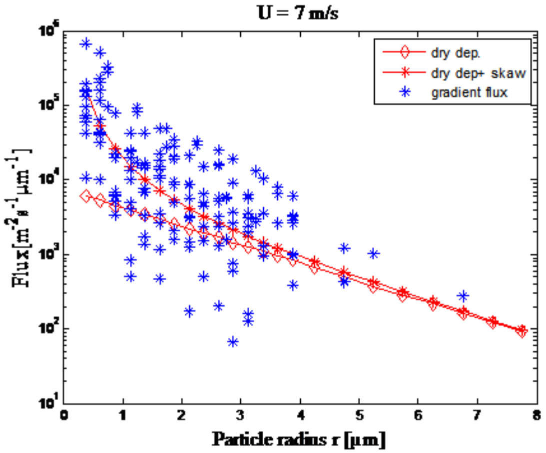
$$F_c(r)=\pi\cdot n(r_1)\cdot\int_{r_1}^{\infty} r^2\exp(-0.29r+0.2089\cdot U_{10}+12.2985)[\frac{2g\rho}{9\eta}(r^2-r_1^2)]dr$$

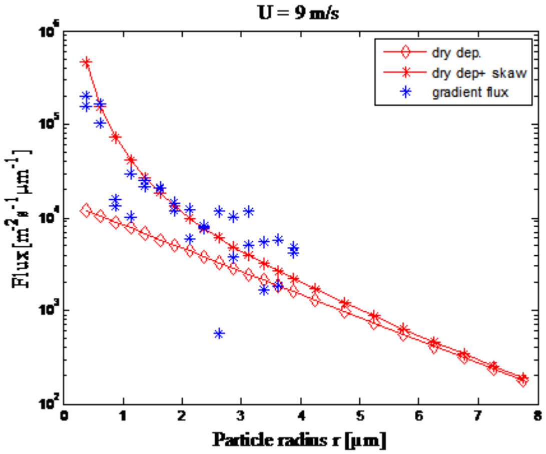
$$F_c(r_1)=\cdot n(r_1)^2\cdot\left\{\frac{2r_1^4}{0.29}+\frac{6r_1^3}{(0.29)^2}+\frac{14r_1^2}{(0.29)^3}+\frac{24r_1}{(0.29)^4}+\frac{24}{(0.29)^5}\right\}\pi\frac{2g\rho}{9\eta}$$

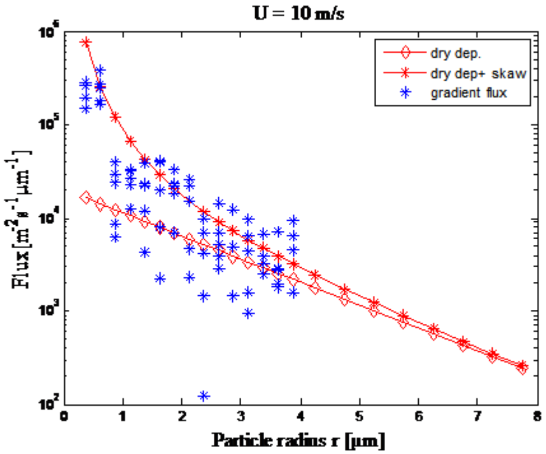
The change in a flux caused by scavenging which is normalized by gravity fall out function.

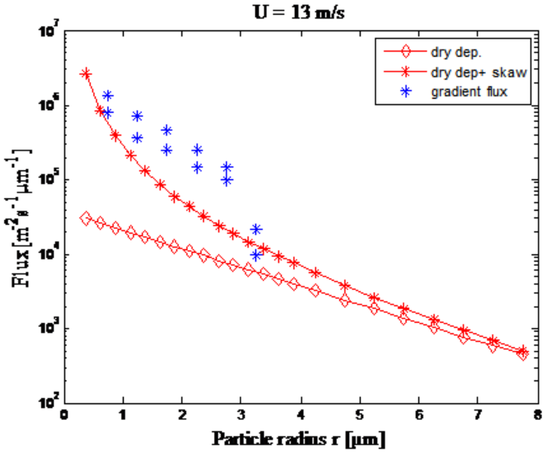


SGF estimeted by dry deposition and dry deposition corrected by scavenging

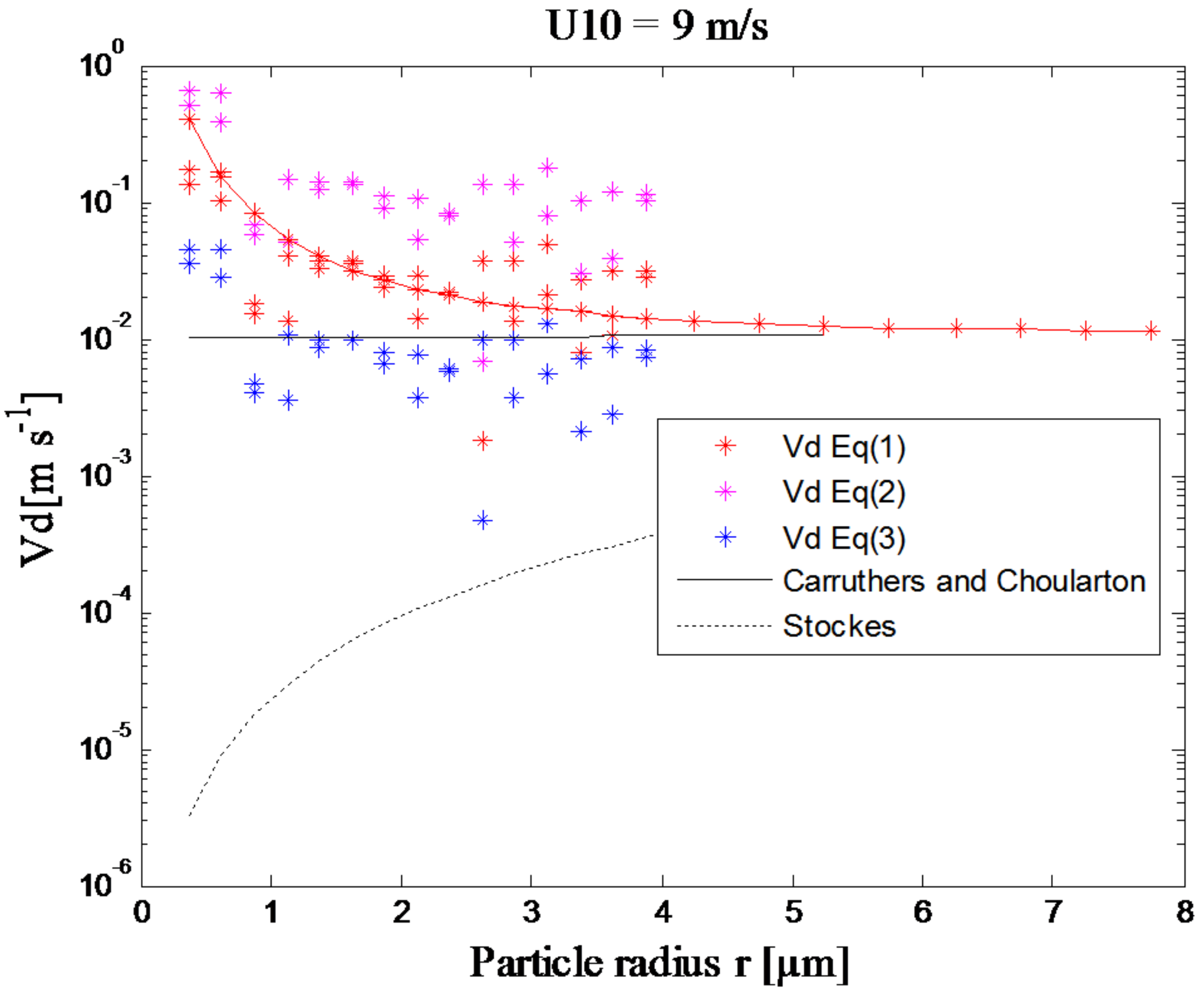


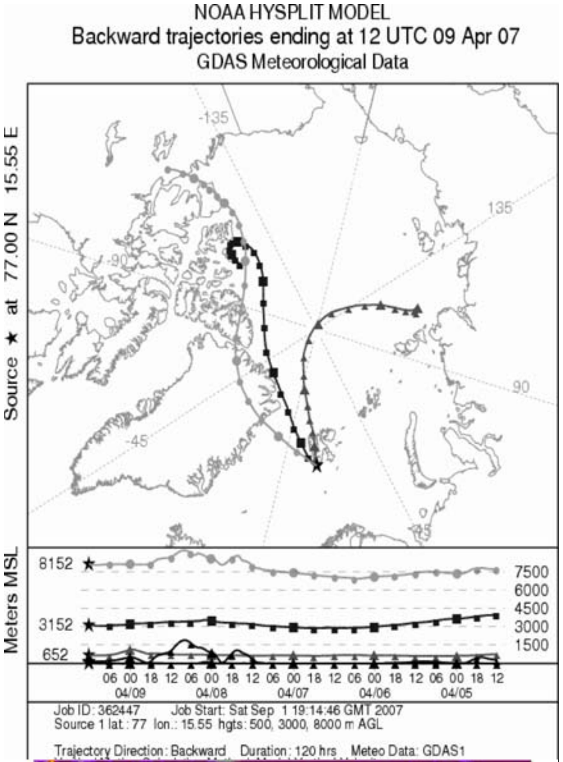


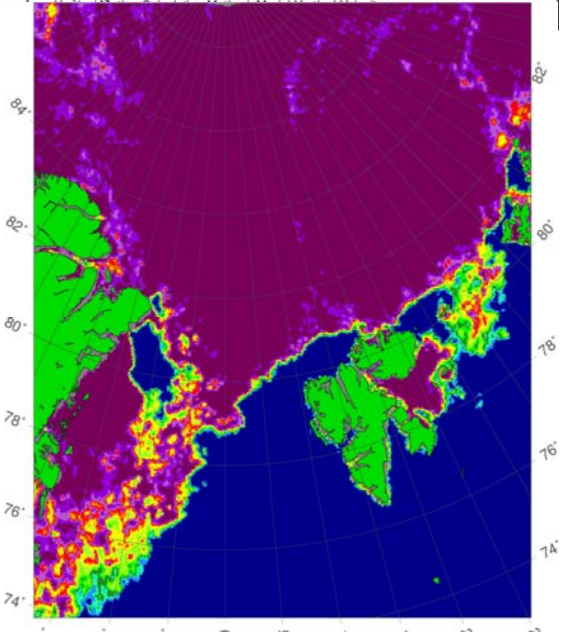


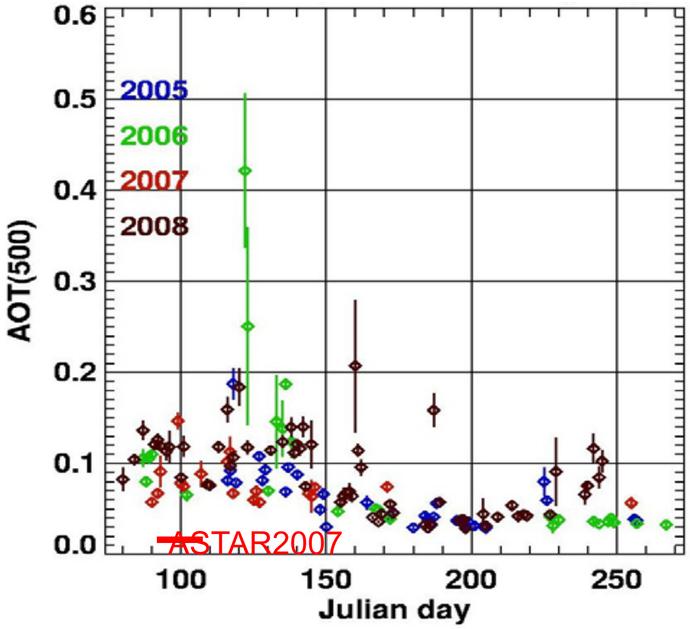


deposition velocity

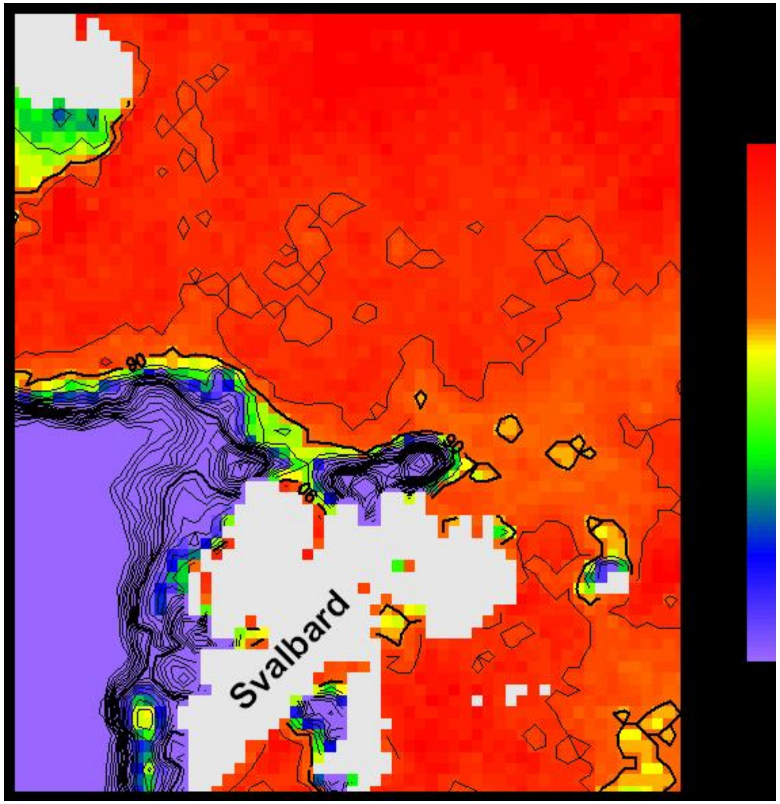



NOAA HYSPLIT MODEL
Backward trajectories ending at 12 UTC 09 Apr 07
GDAS Meteorological Data
Source ★ at 77.00 N 15.55 E
-135
135
-90
90
-45
45
Meters MSL
8152
3152
652
7500
6000
4500
3000
1500
06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12
04/09
04/08
04/07
04/06
04/05
Job ID: 362447 Job Start: Sat Sep 1 19:14:46 GMT 2007
Source 1 lat.: 77 lon.: 15.55 hgts: 500, 3000, 8000 m AGL
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1

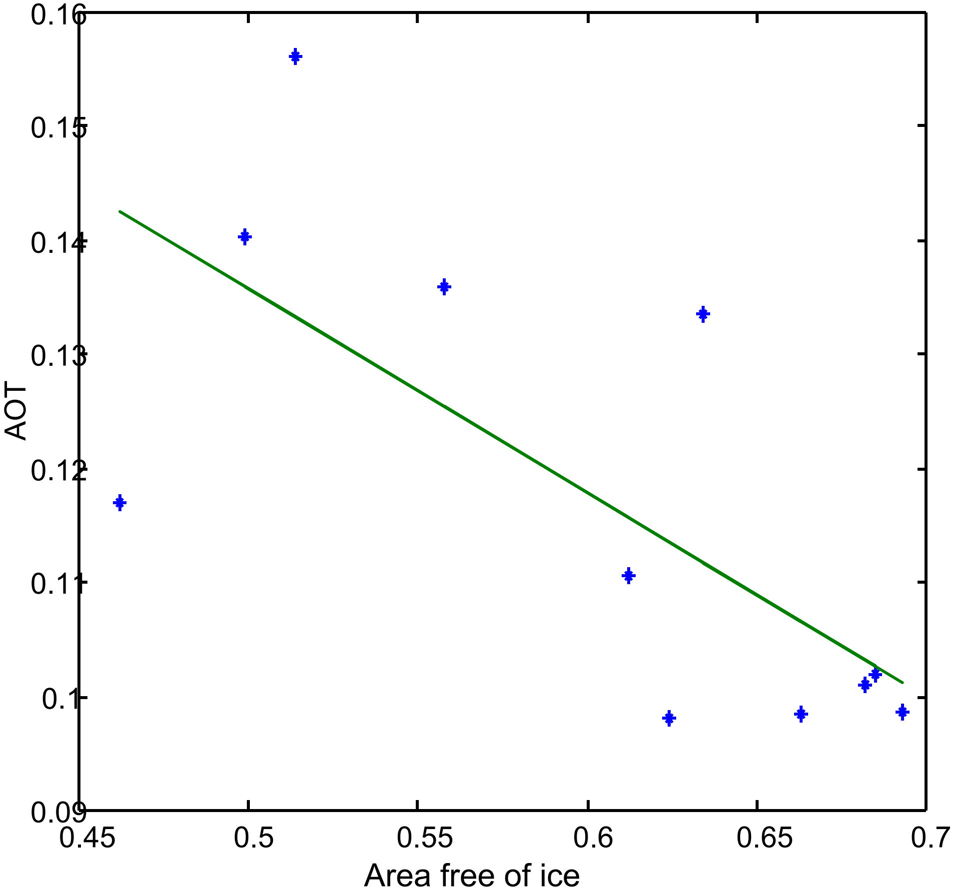

84°
82°
80°
78°
76°
74°
82°
80°
78°
76°
74°


AOT(500)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
100
150
200
250
Julian day
2005
2006
2007
2008
ASTAR2007

Correlation between maximum ice coverage in winter and April mean AOT



Area around Svalbard used in ice coverage calculations



Mean April AOT vs. March ice coverage

Conclusions

- Aerosol flux values calculated from measured vertical concentration profiles may indicate an underestimation of emission values by literature SGFs for particles with radii between 1 and 8 µm.

- The above presented estimations of vertical aerosol fluxes and their comparison with experimental fluxes allow to conclude that aerosol scavenging by larger aerosol droplets is an important factor which modifies aerosol vertical fluxes in the near water layer.

- The formula we propose allows for much better estimation of aerosol vertical fluxes in the range of 0.5 to 4 µm than the parameterizations used at present

deposition velocity

The ratio of flux density (often given in units of gcm–2 s–1) of a substance at a sink surface to its concentration in the atmosphere (corresponding units of g cm–3). While the units of this ratio are clearly those of velocity (inthis case cm s–1), the ratio is not a flow velocity in the normal sense of the word.

$$V_D(r) \equiv \left(\frac{F(r)\big|_{z=0}}{n(r)\big|_{z=h}} \right)$$

$$F(r, z=0) = n(r, z=0) * V_t$$

$$V_D(r) = \frac{n(r, z=0) * V_t}{n(r, z=h)}$$

$$V_D = \frac{\left(n(r,h) - \int_0^h \frac{\overline{n'w'}}{k(z)} dz \right)}{n(r,h)} * V_t$$


16:11