Supplement A: Amine concentrations in field samples

Table A1. Amine concentrations measured in a Scots pine forest humus and mineral soils and fungal hyphae restricted from humus soil.

Supplement B: Modeling the mean flow field, momentum flux and turbulent diffusivity with the canopy

Figure B1. Leaf area density and flow statistics in the studied forest.

Supplement C: Pure fungal cultured strains and their amine concentrations

Table C1. Fungal strains used for pure culture and their amine concentrations.

Table C2. Mean amine concentrations of ecological fungal groups used in pure cultures.

Supplement D: Sensitivities of resistances to environmental variables

Figure D1. Sensitivities of soil, quasi-laminar flow and aerodynamic resistances to environmental variables used in the resistance analogy calculations.

Supplement A: Modeling the mean flow field, momentum flux and turbulent diffusivity with the canopy

Table A1. Alkylamine concentrations in soil fungal biomass, humus soil and mineral soil collected from a Scots pine forest.

	Diethylamine	2-amino-1-butanol	DL-2-aminobutyric acid
	µg g^{-1} FW	µg g^{-1} FW	µg g^{-1} FW
Soil fungal biomass	2.9	9.7	10
Humus soil	0.3	3.7	0.7
Mineral soil	>0.01	>0.01	>0.01

Supplement B: Modeling the mean flow field, momentum flux and turbulent diffusivity with the canopy

Much of this material is presented in Launiainen et al. (2013, 2015); however, the salient features are reviewed for completeness. In a stationary and planar-homogeneous flow at high Reynolds number in near-neutral conditions, the mean momentum budget within the canopy reduces to

$$\frac{\partial \overline{u'w'}}{\partial z} = -C_d a(z) U^2,$$

(B1)

where C_d is the foliage drag coefficient (here 0.15) usually between 0.1-0.3 (Katul et al., 2004), *U* the mean horizontal velocity and *a(z)* the local leaf-area density ($\mathrm{m}^2\,\mathrm{m}^{-3}$). Using the first-order closure principles the momentum flux $\overline{u'w'}$ is written as

$$\overline{u'w'} = -K_m \frac{\partial U}{\partial z}.$$

(B2)

Inserting equation B2 into equation B1 results in a homogeneous second-order nonlinear ordinary differential equation

$$K_m \frac{\partial^2 U}{\partial z^2} + \frac{\partial K_m}{\partial z}\frac{\partial U}{\partial z} - C_d a(z) U^2 = 0,$$

(B3)

where the eddy diffusivity for momentum (K_m) is related to local gradient of *U* through the mixing length *l* as

$$K_m = l^2 \left|\frac{\partial U}{\partial z}\right|.$$

(B4)

The effective mixing length (*l*) is given as

$$l = \begin{cases} k_v z, & z < \alpha' h / k_v \\ \alpha' h, & \alpha' h / k_v \le z < h \\ k_v (z - d), & z \ge h \end{cases},$$

(B5)

where d is the zero-plane displacement height (determined as the centroid of drag force by the iterative solution of B3), $k_v = 0.41$ is the von Karman constant and h the canopy height (15 m). The parameter $\alpha' = (d - h)\, k_v/h$ ensures continuity (but not smoothness) in the mixing length. The eq. B2 can be solved when the leaf-area density profile and two boundary conditions on the mean velocity are provided. For a, we use estimated leaf-area density profile with one-sided LAI = 3.5 $m^2\,m^{-2}$ for the Hyytiälä SMEAR II –site (Launiainen et al., 2013). The upper boundary condition is set as the mean normalized horizontal velocity at z/h ~1.5 ($U/u^* = 5.06$) representing near-neutral conditions at the Hyytiälä site (Launiainen et al. 2007). A no-slip boundary condition was assumed at the ground.

Figure B1 shows the leaf-area density and resulting u_*-normalized U, $\overline{u'w'}$, K_m and l profiles. The momentary values of U, $\overline{u'w'}$ and K_m for each measurement period are then derived by multiplying the normalized profiles by the measured above-canopy u_*. For calculating r_a (eq. 10) the scalar eddy diffusivity (K_s) was taken equal to K_m, i.e. assigning the turbulent Schmidt number to unity. The near-ground friction velocity $u_{*g} = \overline{u'w'}^{1/2}$ for computing soil boundary layer resistance (eq. 9) is taken from the first computational node (z = 0.23 m) above the soil surface.

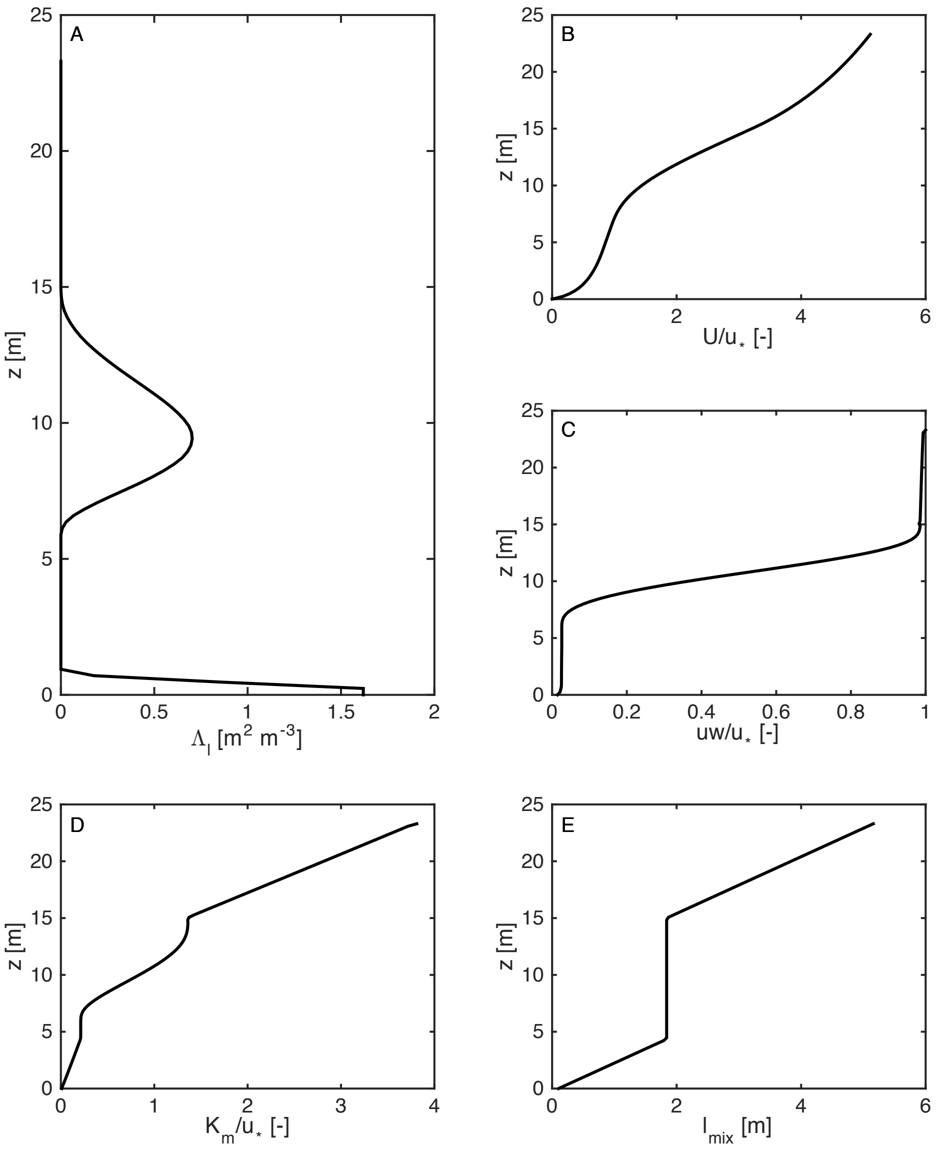
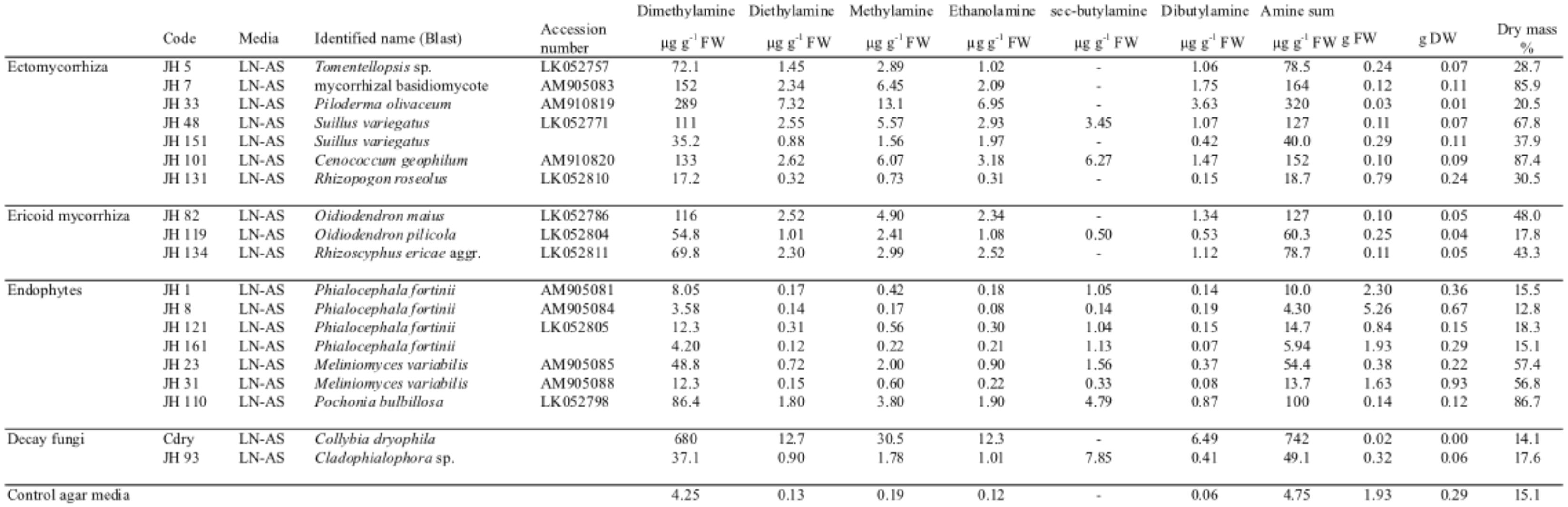


Figure B1: The leaf-area density (Λ_l, panel A) and resulting friction velocity (u_*) normalized mean horizontal velocity (U, panel B), momentum flux ($\overline{u'w'}$, panel C), eddy diffusivity of momentum (K_m, panel D), and effective mixing length (l_{mix}, panel E) profiles. In the studied forest, the canopy top is at 15 m.

Supplement C: Modeling the mean flow field, momentum flux and turbulent diffusivity with the canopy

Table C1. Fungal strains used in pure cultures and their accession numbers, alkylamine concentration (μg g^{-1} FW), fresh and dry weights (g) of samples and dry mass percentages.



					Dimethylamine	Diethylamine	Methylamine	Ethanolamine	sec-butylamine	Dibutylamine	Amine sum			
	Code	Media	Identified name (Blast)	Accession number	μg g^{-1} FW	μg g^{-1} FW	μg g^{-1} FW	μg g^{-1} FW	μg g^{-1} FW	μg g^{-1} FW	μg g^{-1} FW	g FW	g DW	Dry mass %
Ectomycorrhiza	JH 5	LN-AS	*Tomentellopsis* sp.	LK052757	72.1	1.45	2.89	1.02	-	1.06	78.5	0.24	0.07	28.7
	JH 7	LN-AS	mycorrhizal basidiomycote	AM905083	152	2.34	6.45	2.09	-	1.75	164	0.12	0.11	85.9
	JH 33	LN-AS	*Piloderma olivaceum*	AM910819	289	7.32	13.1	6.95	-	3.63	320	0.03	0.01	20.5
	JH 48	LN-AS	*Suillus variegatus*	LK052771	111	2.55	5.57	2.93	3.45	1.07	127	0.11	0.07	67.8
	JH 151	LN-AS	*Suillus variegatus*		35.2	0.88	1.56	1.97	-	0.42	40.0	0.29	0.11	37.9
	JH 101	LN-AS	*Cenococcum geophilum*	AM910820	133	2.62	6.07	3.18	6.27	1.47	152	0.10	0.09	87.4
	JH 131	LN-AS	*Rhizopogon roseolus*	LK052810	17.2	0.32	0.73	0.31	-	0.15	18.7	0.79	0.24	30.5
Ericoid mycorrhiza	JH 82	LN-AS	*Oidiodendron maius*	LK052786	116	2.52	4.90	2.34	-	1.34	127	0.10	0.05	48.0
	JH 119	LN-AS	*Oidiodendron pilicola*	LK052804	54.8	1.01	2.41	1.08	0.50	0.53	60.3	0.25	0.04	17.8
	JH 134	LN-AS	*Rhizoscyphus ericae* aggr.	LK052811	69.8	2.30	2.99	2.52	-	1.12	78.7	0.11	0.05	43.3
Endophytes	JH 1	LN-AS	*Phialocephala fortinii*	AM905081	8.05	0.17	0.42	0.18	1.05	0.14	10.0	2.30	0.36	15.5
	JH 8	LN-AS	*Phialocephala fortinii*	AM905084	3.58	0.14	0.17	0.08	0.14	0.19	4.30	5.26	0.67	12.8
	JH 121	LN-AS	*Phialocephala fortinii*	LK052805	12.3	0.31	0.56	0.30	1.04	0.15	14.7	0.84	0.15	18.3
	JH 161	LN-AS	*Phialocephala fortinii*		4.20	0.12	0.22	0.21	1.13	0.07	5.94	1.93	0.29	15.1
	JH 23	LN-AS	*Meliniomyces variabilis*	AM905085	48.8	0.72	2.00	0.90	1.56	0.37	54.4	0.38	0.22	57.4
	JH 31	LN-AS	*Meliniomyces variabilis*	AM905088	12.3	0.15	0.60	0.22	0.33	0.08	13.7	1.63	0.93	56.8
	JH 110	LN-AS	*Pochonia bulbillosa*	LK052798	86.4	1.80	3.80	1.90	4.79	0.87	100	0.14	0.12	86.7
Decay fungi	Cdry	LN-AS	*Collybia dryophila*		680	12.7	30.5	12.3	-	6.49	742	0.02	0.00	14.1
	JH 93	LN-AS	*Cladophialophora* sp.		37.1	0.90	1.78	1.01	7.85	0.41	49.1	0.32	0.06	17.6
Control agar media					4.25	0.13	0.19	0.12	-	0.06	4.75	1.93	0.29	15.1

Table C2. Alkyl amine concentrations (µg g^{-1} FW) of ecological fungal functional groups. The concentration is mean (±standard deviation) of strains in each fungal functional group used in pure fungal cultures.

		Dimethylamine	Diethylamine	Methylamine	Ethanolamine	sec-Butylamine	Dibutylamine
	n	µg g^{-1} FW	µg g^{-1} FW	µg g^{-1} FW	µg g^{-1} FW	µg g^{-1} FW	µg g^{-1} FW
Ectomycorrhiza	7	116 (±34)	2.50 (±0.87)	5.20 (±1.57)	2.63 (±0.81)	1.39 (±0.95)	1.36 (±0.43)
Ericoid mycorrhiza	3	80.1 (±18.3)	1.94 (±0.47)	3.43 (±0.75)	1.98 (±0.45)	0.17 (±0.17)	0.10 (±0.24)
Endophyta	7	25.1 (±11.8)	0.49 (±0.23)	1.11 (±0.51)	0.54 (±0.25)	1.44 (±0.59)	0.27 (±0.11)
Decay fungi	2	359 (±322)	6.79 (±5.89)	16.1 (±14.4)	6.65 (±5.64)	3.93 (±3.93)	3.45 (±3.04)
Control agar media		4.25	0.13	0.19	0.12	n.d.	0.06

Supplement D: Sensitivities of resistances to environmental variables

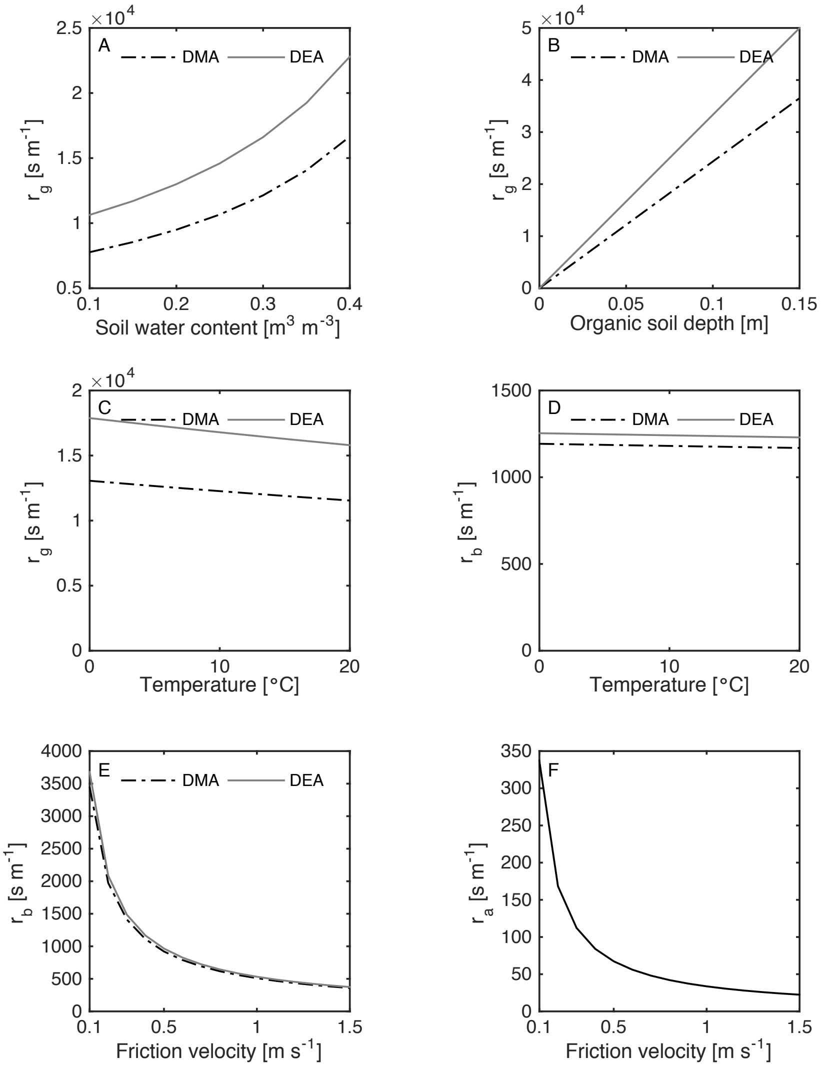


Figure D1. Sensitivities of soil resistances (r_s) to soil water content, soil depth and temperature are shown in panels A, B, and C, respectively. Sensitivity of quasi-laminar resistance (r_b) to temperature is shown in panel D and to friction velocity in panel E. Sensitivity of aerodynamic resistance (r_a) to friction velocity is in panel F.