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Appendix 1

Cross-spectral analysis is an extension of spectral analysis to two data series (Jenkins and Watts 1968). The cross-spectrum estimator was defined in a manner similar to that of the smoothed spectrum, using the cross-periodogram (Brillinger 1981). Consequently, the cross-spectrum is a complex function obtained by computing a pair of smoothed spectra (S_x and S_y) and a cross-correlation function. The latter complex function can be represented by:

$$S_{xy}{}^2(f_k) = C_{xy}(f_k) - iQ_{xy}(f_k)$$

where $C_{xy}(f_k)$ is the co-spectrum and $Q_{xy}(f_k)$ is the quadrature (quad-) spectrum, which are the respective in-phase and out-of-phase covariances of spatial series x and y (Legendre and Legendre 1998). Squared-coherence is a dimensionless measure of the correlation between two data series at a given wave number (Legendre and Legendre 1998, Shumway and Stoffer 2006):

$$\gamma_{xy(f_k)} = \frac{C_{xy}(f_k) + iQ_{xy}(f_k)}{S_x{}^2(f_k) S_y{}^2(f_k)}$$

Statistical significance for the coherency spectra was indicated for peaks corresponding to distances over which cycles common to both data series repeated in tandem; the critical value for coherency (0.68 at p = 0.0125) was calculated from equations given by Shumway and Stoffer

(2006). The aforementioned co-spectrum further indicates if relationships between two data series are positive or negative (Kachanoski et al. 1985).

References

Brillinger, D. R. 1981. Time series, data analysis and theory. Expanded edition. – Holden-Day Inc.

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Kachanoski, R. G. et al. 1985. Spatial and spectral relationships of soil properties and microtopography: I. Density and thickness of A horizon. – Soil Sci. Soc. Am. J. 49: 804–812.

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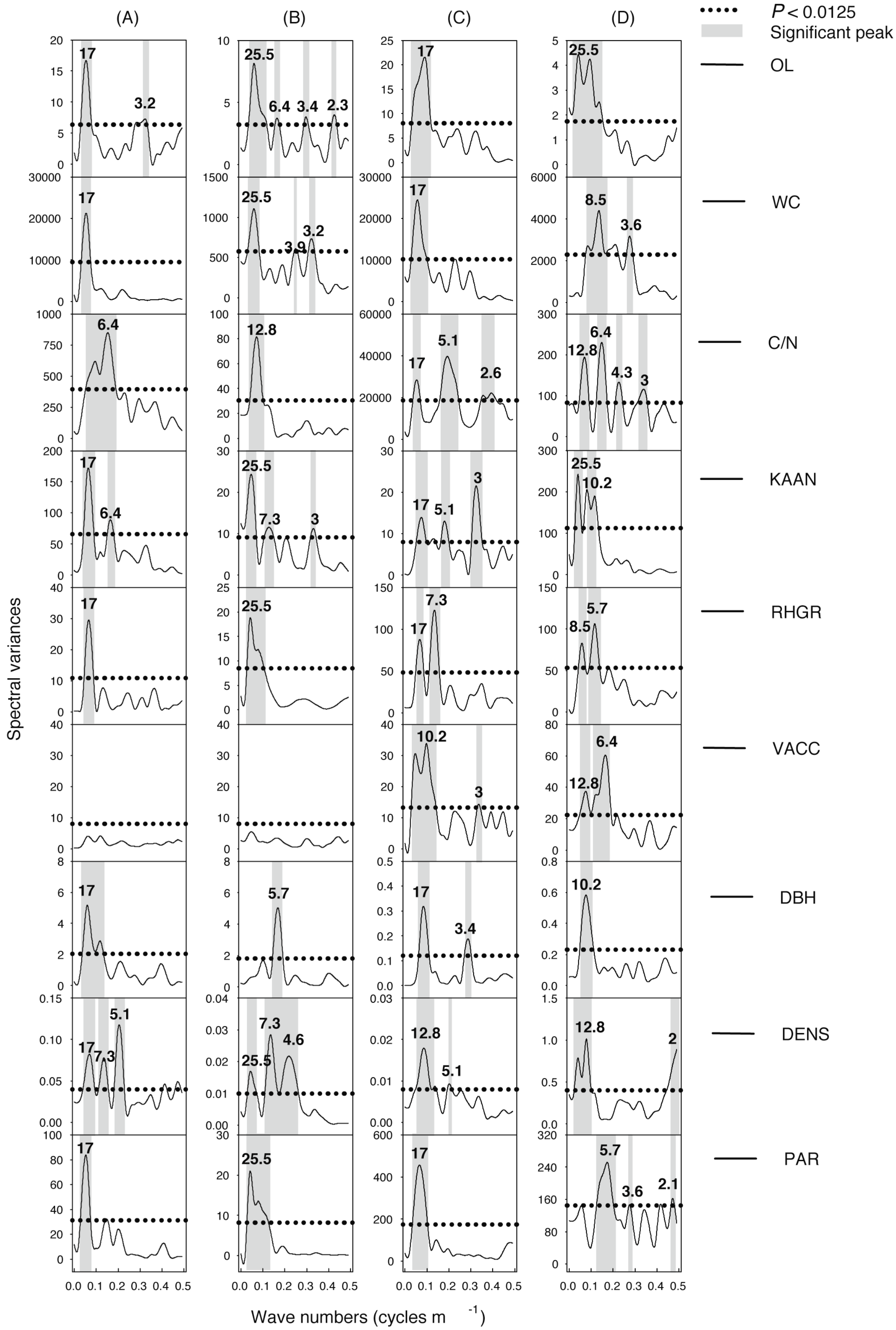
Appendix 2

Spectral variances (solid line) of data series, i.e. significant (Fig. 1) soil and vegetation properties (defined in Table 1) obtained along one transect (1-m intervals, n = 51 for each transect) on four disturbance types in central Quebec: (A) old harvest (1942), (B) old burn (1906), (C) recent harvest (1988), and (D) recent burn (1986). Dotted horizontal line delimits statistical significance with Bonferroni correction. Shading represents significant peaks, with distances (in m) indicated above each curve. Peaks correspond to distances over which cycles repeat. Distances are the inverse of wave numbers (abscissas).


(A)
(B)
(C)
(D)
P < 0.0125
Significant peak
OL
WC
C/N
KAAN
RHGR
VACC
DBH
DENS
PAR
Spectral variances
Wave numbers (cycles m -1)

Appendix 3

Significant co-spectral peaks identified by *F*-tests with Bonferroni correction (i.e.p = 0.0125) for data series obtained along one transect (1-m intervals, n = 51 for each transect) on four disturbance types in central Quebec: old harvest (1942), old burn (1906) recent harvest (1988) and recent burn (1986). For each pair of variables, the first line indicates whether relation between data series is positive or negative at each significant peak, the distance corresponding to this peak and squared-coherence. Peaks represent distances over which cycles common to both data series repeat and squared-coherence is a dimensionless measure of the correlation between both data series at significant peaks (critical value of 0.68 at p = 0.0125; calculated from equations given by Shumway and Stoffer (2006)). The second line indicates the distance band related to these significant peaks. Successive lines represent subsequent significant peaks.

	Old harvest									Old burn								
Data series[a]	OL	WC	C/N	KAAN	RHGR	VACC	DBH	DENS	PAR	OL	WC	C/N	KAAN	RHGR	VACC	DBH	DENS	PAR
MICROT	+/ 17/.91 14.9-21.3	+/ 17/.89 15.9 -21.1	+/ 17/.99 15.6-25	+/ 17/.93 15.7-21.2	+/ 17/.89 16.7-17.4	N.D.	+/ 8.5/.72 8.1-8.9	-/ 17/.91 11.5-21	+/ 17/.86 15-21	-/ 25.5/.94 14.9-36.5	+/ 25.5/.96 21.4-31		+/ 25.5/.93 21.3-38		N.D.		-/ 25.5/.99 21.3-26	+/ 25.5/.97 21.3-33
OL		+/ 17/.93 15.7-25	+/ 17/.93 11.5-21	+/ 17/.99 11.6-26.5	+/ 17/.82 16.5-17.4	N.D.	-/ 17/.79 16.3-25.4	-/ 17/.9 14.9-21	+/17/.96 15-23.7		-/ 25.5/.83 15-35	-/ 10.2/.73 9.4-14.9	-/ 25.5/.91 20.3-36		N.D.	-/ 5.7/.99 5.4-6.8	-/ 25.5/.82 21-26	+/ 12.8/.8 7.9-14.9
WC			+/ 17/.99 15.7-21	+/ 17/.99 15.7-26.5	+/ 17/.86 15.7-17.4	N.D.	+/ 17/.82 15.7-25.4	+/ 17/.87 16.7-21	-/ 17/.99 15-23.7			+/ 12.8/.96 11.4-20	+/ 25.5/.9 20.3-40	+/ 17/.93 14.9-18.4	N.D.		+/ 25.5/.99 21.3-26 +/ 4.5/.89 4.3-4.5	-/ 12.8/.93 11.4-37
C/N				+/ 17/.94 14.9-21 +/ 6.4/.79 6.6-6.8	+/ 17.4/.79 17-17.4	N.D.	+/12.8/.73 11.5-14.9	-/17/.91 14.9-21 -/5.5/.9 5.4-5.5	+/ 17/.9 15-21.1					-/ 18.4/.76 16.2-18.4	N.D.			+/ 12.8/.87 9.4-14.9
KAAN					+/ 12.8/.98 11.6-14.8	N.D.	-/ 17/.93 12.5-21	-/17/.98 15.4-21	+/ 17.6/.99 15-23.7						N.D.		-/ 7.3/.76 6.8-7.9 +/ 25.5/.93 22.2-25.6	+/ 25.5/.83 20.3-37.6
RHGR						N.D.	-/ 12.8/.9 11-17.4		+/ 17.3/.79 17-17.4						N.D.			-/ 10.2/.68 9.5-11.5
VACC							N.D.	N.D.	N.D.							N.D.	N.D.	N.D.
DBH									-/ 17/.68 15-23.7									
DENS									-/ 17.6/.92 17.2-21									-/ 25.5/.92 23.4-26.7
	Recent harvest									Recent burn								
MICROT	-/ 17/.95 16.8-21	+/ 17/.88 11.5-17	+/ 2.9/.9 2.6-2.9	-/ 12.8/.97 11.6-13.9 -/7.3/.99 7.3-7.9	-/ 12.8/.91 12.4-15.6 +/2.9/.99 2.9-3	+/ 8.5/.9 7.7-11.2	-/ 17/.9 14.8-21.4	-/ 10.2/.8 8.8-11.5	+/ 12.8/.83 11-14.8			-/ 10.2/.78 10-18.2		+/ 17/.97 12.6-25.4			-/ 21.3/.95 14.9-25	
OL		+/ 17/.9		+/	-/	+/ 17/.89		+/	-/		+/					+/	-/	

	16.5-22 +/10.2/.91 9.5-10.7	12.8/.82 9.4-16.1	12.8/.79 11.8-15.6	9.4-23		12.8/.77 12-14.9	10.2/.82 9.7-11.5	10.2/.9 9-14.9					24.3/.99 21.3-24.5	25.5/.74 21.4-31.2	
WC		+/ 12.8/.99 11.5-14.9	+/ 12.8/.94 12-15.6	+/ 17/.81 16.5-23 +/10.2/.78 9.4-11.5		+/ 10.2/.71 9.2-11.5	-/ 12.8/.81 11.5-15		+/ 6.4/.7 6-6.9		+/ 7.3/.76 6.9-7.9				-/ 3.5/.72 3.3-3.5
C/N		+/ 16/.82 15.6-16.1 +/2.9/.97 2.9-3	+/ 11.8/.97 11.8-15.6	+/ 23/.97 17.3-23 +/2.9/.87 2.9-3		-/ 17/.93 14.6-19 -/5.1/.85 4.9-5.4	+/ 17/.99 14.6-23			-/ 12.8/.72 11.6-15.4	+/ 21/.8 14.9-21	-/ 6/.69 6-6.2 -/ 12.8/.79 11.6-14.9		-/ 21/.69 14.5-21	+/ 7.3/.91 6.8-7.9
KAAN			-/ 12.8/.95 11.8-15.6 -/ 7.3/.8 6.9-9.4	-/ 10.2/.73 9.4-11.5 -/2.9/.97 2.9-3.2	-/ 17/.9 12.8-17	-/ 10.2/.75 8.8-16.1 -/5.4/.75 4.9-5.4	-/ 12.8/.86 9.7-16.1				+/ 8.5/.74 7.5-15.4		+/ 8.5/.8 8.5-15.4	-/ 25.5/.95 19.5-35.9	
RHGR				+/ 8.5/.8 6.8-9.4	-/ 17/.99 14.8-17.6								-/ 12.8/.91 8.5-14.9		+/ 5.1/.84 4.9-5.4
VACC					-/ 17/.93 8.7-17	+/ 10.2/.99 8.8-11.5	+/ 10.2/.97 9.7-11.5								
DBH						+/ 10.2/.95 8.8-11.5	-/ 10.2/.87 9.7-11.5								
DENS							-/ 10.2/.96 9.7-11.5								-/ 2.1/.93 2.1-2.2

[a] MICROT = Microtopography, height above the lowest point on the transect (cm); OL = Organic layer thickness (cm); WC = Soil water content (%); NMIN = N-mineralization potential (g N kg^{-1} soil 10 $days^{-1}$); KAAN = *Kalmia angustifolia* cover (%); RHGR = *Rhododendron groenlandicum* cover (%); VACC = *Vaccinium* spp. cover (%); DBH = Mean diameter at breast height (DBH> 1 cm) of the four closest surrounding black spruce stems (cm); DENS = black spruce (DBH > 1 cm) density (trees m^{-2}); PAR = Fractional photosynthetically active radiation transmission (%) .N.D. = Not determined for VACC on old disturbed sites since data series did not show repeating patterns.