אוניברסיטת חיפה
University of Haifa
جامعة حيفا

ON THE ASSOCIATION BETWEEN ALAN (ESPECIALLY OF SHORT WAVELENGHT) AND BREAST CANCER IN HAIFA REGION

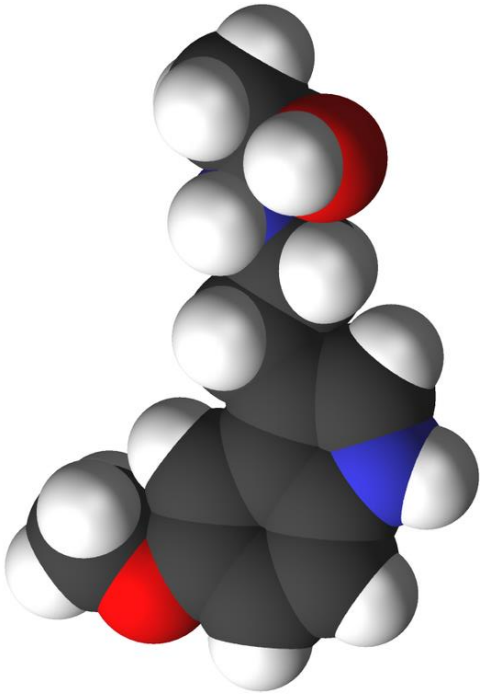
A TALK TO THE MEMORY OF PROFESSOR ABRAHAM HAIM

ALAN is linked to:

- sleep disturbance
  (Martin et al., 2012; Obayashi et al., 2014)
- obesity
  (Obayashi et al., 2012; McFadden et al., 2014)
- hormone-dependent cancers, including breast cancer (BC)
  (Schernhammer et al., 2003; Haim & Portnov, 2013; Hurley et al., 2014; Rybnikova et al., 2015, 2016*a*)

ALAN-BC: mechanisms behind

- working as a general stressor and endocrine disruptor
  (Ashkenazi & Haim, 2012; Haim & Portnov, 2013)
- daily rhythm disruption
  (Stevens & Rea, 2001; Haim & Portnov, 2013)
- suppression of nocturnal melatonin production
  (Blask et al., 2011; Haim & Portnov, 2013)



Melatonin $C_{13}H_{16}N_2O_2$

Blue light suppresses melatonin the most

Brainard et al., 2001:

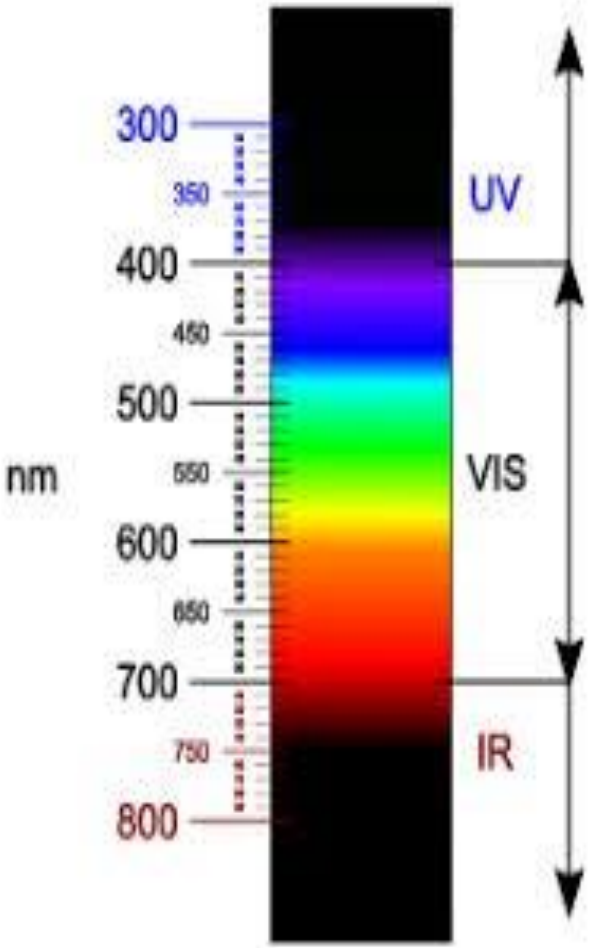
72 males and females (24.5 ± 0.3 yo)
exposure to ALAN of different spectrum
melatonin blood tests at 2:00-3:30 am
Results: 446–477 nm ALAN - circadian input for regulating melatonin secretion

Wright et al., 2004:

42 females and males (27.6 ± 9.1 yo)
exposure to ALAN of 470, 495, 525, 595 and 660 nm
Results: 470, 495 and 525 nm ALAN was most effective in suppressing nocturnal melatonin

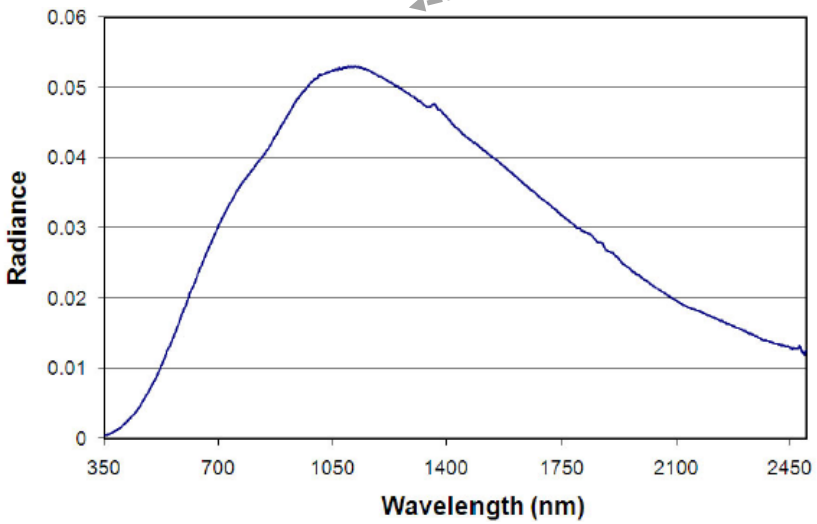
Cajochen et al., 2005:

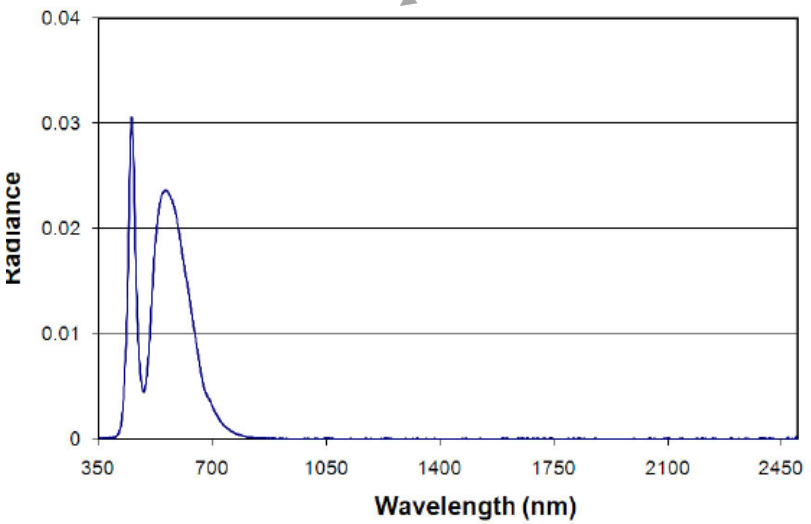
10 males (25.9 ± 3.8 yo)
exposure to ALAN of 460 and 550 nm
Results: 460 nm ALAN induced a significantly greater MLT suppression.



Research hypothesis

Elevated BC rates in high income populations groups might be attributed to their elevated exposures to short wave-length ALAN





Source: Elvidge & Keith, 2014

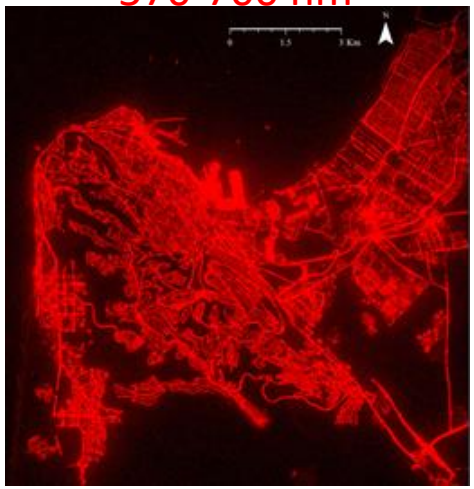
Study aims

- To determine whether residents of **high income urban areas** are exposed to more **blue ALAN** than people residing in **low income areas**
- To determine the extent to which hormone-dependent **BC** incidence can be explained by **short wavelength ALAN** exposure

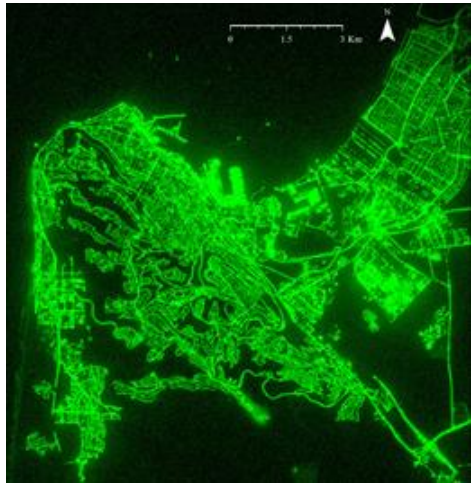
Data on ALAN exposure

400-700 nm

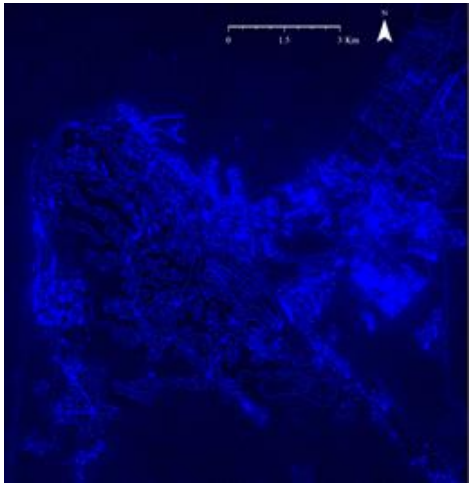
570-700 nm



490-570 nm



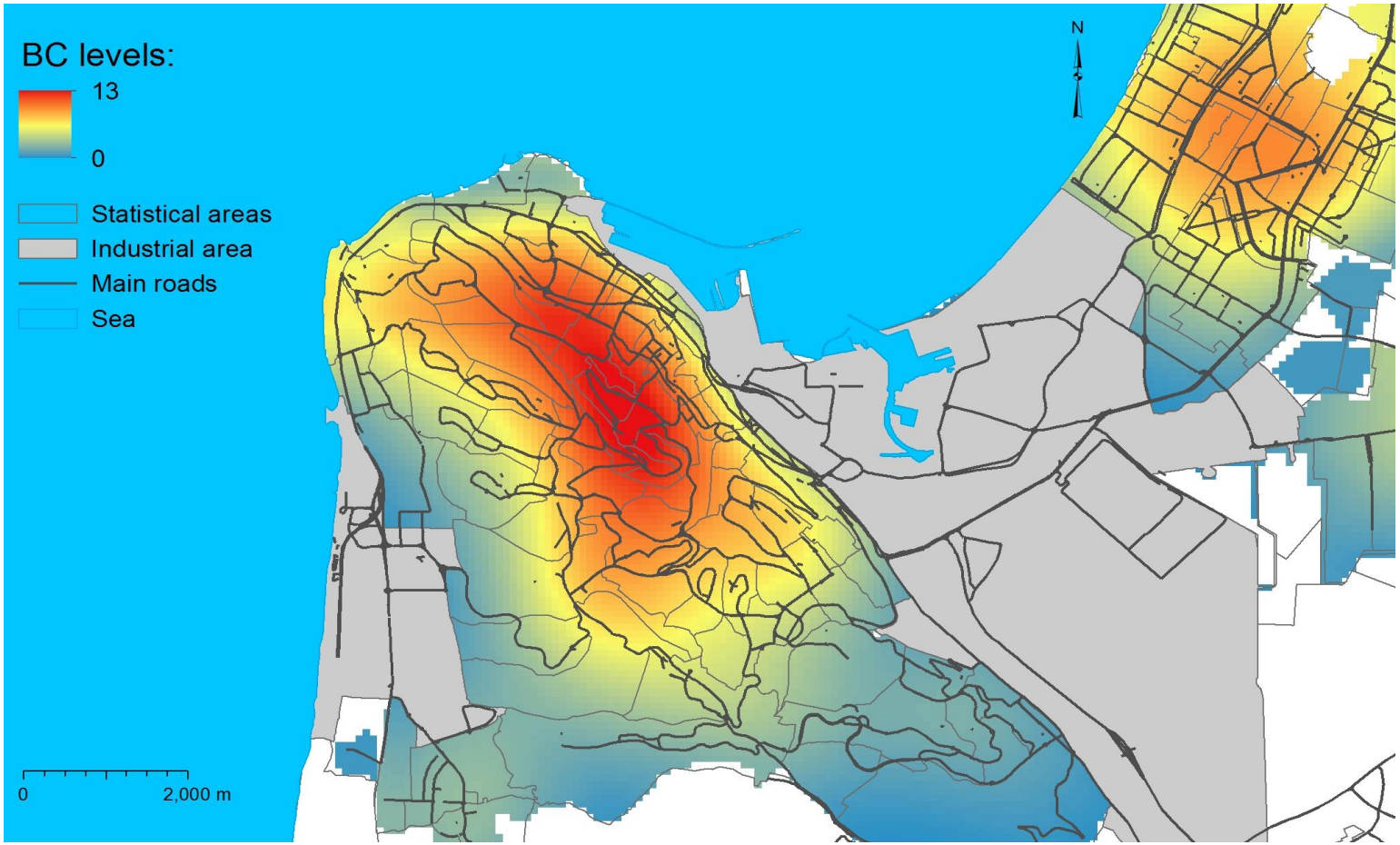
400-490 nm



Intensities of ALAN (DN) emitted from the Greater Haifa Metropolitan Area
and its red, green and blue bands
(*Source*: JSC, 2016; Image ID ISS045-E-148262: date/time taken – 29 Nov 2015/01:53:22 GMT

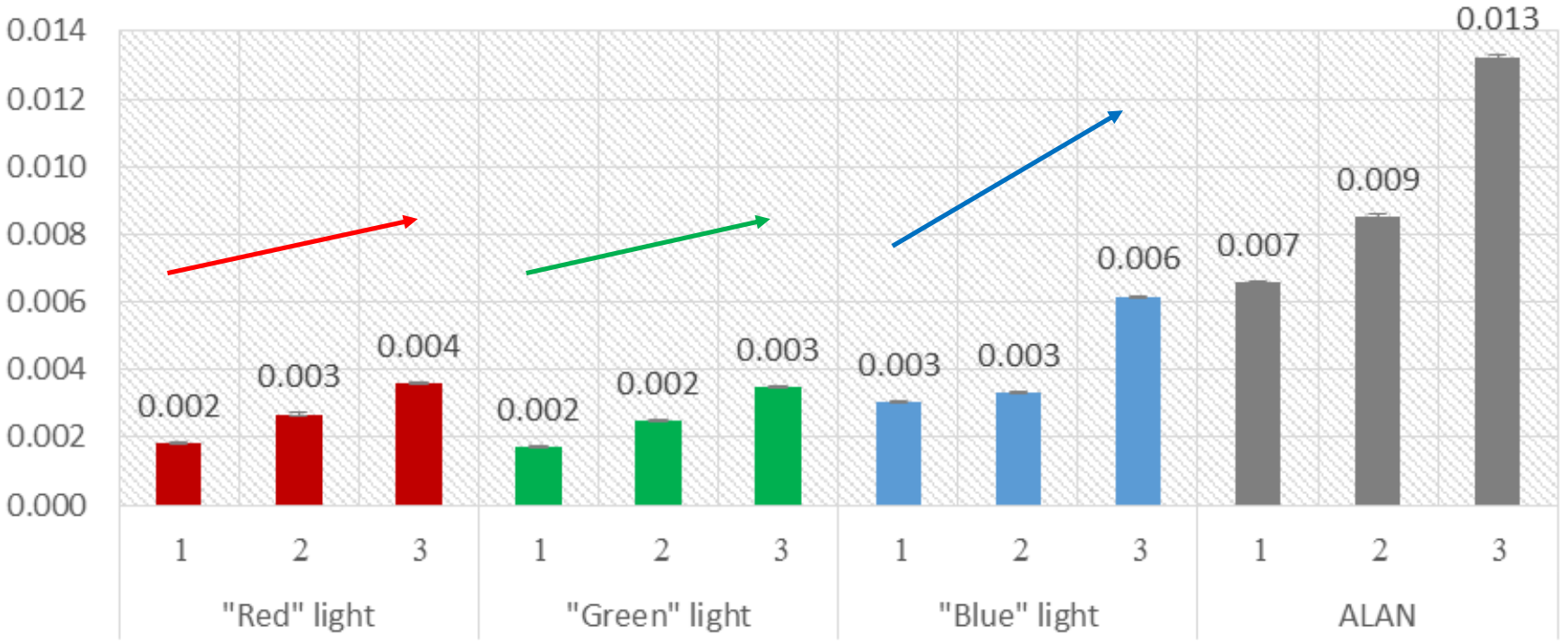
Variable	N	Minimum	Maximum	Mean	Std. Deviation
ALAN intensity (DN)	611,664	0	765	47.372	70.074
Red light intensity (DN)	611,664	0	255	14.017	31.152
Green light intensity (DN)	611,664	0	255	12.951	25.226
Blue light intensity (DN)	611,664	0	255	20.404	16.353

Data on BC incidence



BC incidence (number of cases per km^2) in the Greater Haifa Metropolitan Area
(*Source*: the Israel National Cancer Registry, year-2013
Notes: Smooth surface of BC incidence values was obtained using *Kernel* interpolation technique in ArcGIS software)

Results (I):
ALAN across areas of different SES levels



Average intensities of ALAN and its sub-spectra (per population densities)
for the populations of different SES levels
("1"= relatively lower SES, N=109,656;
"2"=middle SES, N=201,166;
"3"= relatively higher SES, N=300,837)

Results (II):
Pearson's correlations

Variables	SES	ALAN (lg)	"Red" ALAN (lg)	"Green" ALAN (lg)	"Blue" ALAN (lg)
BC incidence	0.347	0.399	0.102	0.403	0.418

Results (III): OLS regressions

Predictors	Basic Model		BC vs. SES		BC vs. ALAN	
	(B)	*Beta*	*(B)*	*Beta*	*(B)*	*Beta*
(Constant)	(0.820)***	-	(0.954)***	-	(-0.072)***	-
Population density (persons per km^2)	(0.065)***	0.470	(0.063)***	0.460	(0.058)***	0.418
Women over 65 yo (% of total population)	(0.006)***	0.113	(0.005)***	0.095	(0.007)***	0.139
Average size of the household (persons)	(-0.100)***	-0.108	(-0.098)***	-0.106	(-0.084)***	-0.090
Jewish population (% of total population)	(1.31E-04)***	0.007	(-0.001)***	-0.029	(-1.12E-05)***	-0.006
Distance to the closest main road (m)	(-0.001)***	-0.267	(-0.001)***	-0.275	(-4.14E-05)***	-0.181
Distance to the industrial zone (m)	(2.13E-04)***	0.594	1.21E-04)***	0.337	(2.66E-05)***	0.743
Squared distance to the industrial zone (m^2)	(-3.73E-08)***	-0.574	(-2.09E-08)***	-0.322	(-4.27E-08)***	-0.658
SES	-	-	(0.103)***	0.188	-	-
ALAN (ln)	-	-	-	-	(0.351)***	0.257
N of obs.	366,383		366,383		366,383	
R^2-adjusted	0.589		0.613		0.634	
SEE	0.378		0.366		0.356	
F	7.51E+04		7.27E+04		7.94E+04	

Data Sources: the Israel Central Bureau of Statistics; calculations based on the data from the national mapping company (MAPI).

Results (III): OLS regressions

Predictors	BC vs. BLUE ALAN		BC vs. GREEN ALAN		BC vs. RED ALAN	
	(B)	*Beta*	*(B)*	*Beta*	*(B)*	*Beta*
(Constant)	(0.123)***	-	(0.133)***	-	(0.726)***	-
Population density (persons per km^2)	(0.057)***	0.416	(0.058)***	0.421	(0.064)***	0.467
Women over 65 yo (% of total population)	(0.007)***	0.139	(0.007)***	0.139	(0.006)***	0.116
Average size of the household (persons)	(-0.087)***	-0.094	(-0.081)***	-0.087	(-0.094)***	-0.102
Jewish population (% of total population)	(-4.32E-04)***	-0.025	(-2.06E-04)***	-0.012	(2.72E-04)***	0.015
Distance to the closest main road (m)	(-3.88E-04)***	-0.170	(-4.13E-04)***	-0.181	(-0.001)***	-0.263
Distance to the industrial zone (m)	(2.58E-04)***	0.719	(2.59E-04)***	0.723	(2.24E-04)***	0.626
Squared distance to the industrial zone (m^2)	(-4.11E-08)***	-0.633	(-4.16E-08)***	-0.640	(-3.88E-08)***	-0.597
Blue band of ALAN	**(0.332)*** **	**0.280**	-	-	-	-
Green band of ALAN	-	-	**(0.327)*** **	**0.259**	-	-
Red band of ALAN	-	-	-	-	**(0.042)*** **	**0.038**
N of obs.	366,383		366,383		366,383	
R^2-adjusted	**0.642**		**0.635**		**0.591**	
SEE	0.352		0.356		0.377	
F	8.22E+04		7.97E+04		6.61E+04	

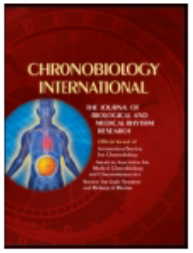
Results (III): OLS regressions

Predictors	BC vs. SES & BLUE ALAN		BC vs. SES & GREEN ALAN		BC vs. SES & RED ALAN	
	(B)	*Beta*	*(B)*	*Beta*	*(B)*	*Beta*
(Constant)	(0.252)***	-	(0.256)***	-	(0.830)***	-
Population density	(0.056)***	0.405	(0.056)***	0.409	(0.063)***	0.455
Women over 65 yo	(0.006)***	0.121	(0.006)***	0.121	(0.005)***	0.098
Average size of the household	(-0.085)***	-0.092	(-0.078)***	-0.084	(-0.090)***	-0.098
Jewish population	(-0.001)***	-0.062	(-0.001)***	-0.050	(-3.37E-04)***	-0.019
Distance to the closest main road	(-4.03E-04)***	-0.177	(-4.26E-04)***	-0.187	(-0.001)***	-0.270
Distance to the industrial zone	(1.64E-04)***	0.457	(1.64E-04)***	0.456	(1.34E-04)***	0.373
Squared distance to the industrial zone	(-2.44E-08)***	-0.375	(-2.45E-08)***	-0.378	(-2.26E-08)***	-0.348
SES	**(0.105)*** **	**0.193**	**(0.108)*** **	**0.197**	**(0.105)*** **	**0.192**
Blue band of ALAN	**(0.336)*** **	**0.284**	**–**	**-**	**–**	**-**
Green band of ALAN	**–**	**-**	**(0.335)*** **	**0.265**	**–**	**-**
Red band of ALAN	**–**	**-**	**–**	**-**	**(0.056)*** **	**0.051**
N of obs.	366,383		366,383		366,383	
R^2-adjusted	**0.668**		**0.662**		**0.616**	
SEE	0.340		0.342		0.365	
F	(81767.842)***		(79574.559)***		(65206.323)***	
Moran's *I*	**(1181.593)*** **		**(1180.989)*** **		**(1184.887)*** **	

Conclusions

- The **intensity of s**hort wavelength ("blue") ALAN is **higher in higher SES areas** than in lower SES ones

- In multiple regressions, "green" and "**blue" ALAN add more** to the explanation of BC incidence than SES



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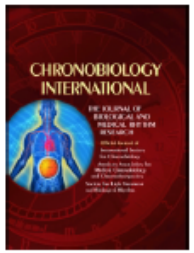

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Population-level study links short-wavelength nighttime illumination with breast cancer incidence in a major metropolitan area

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Thank you for your attention!

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