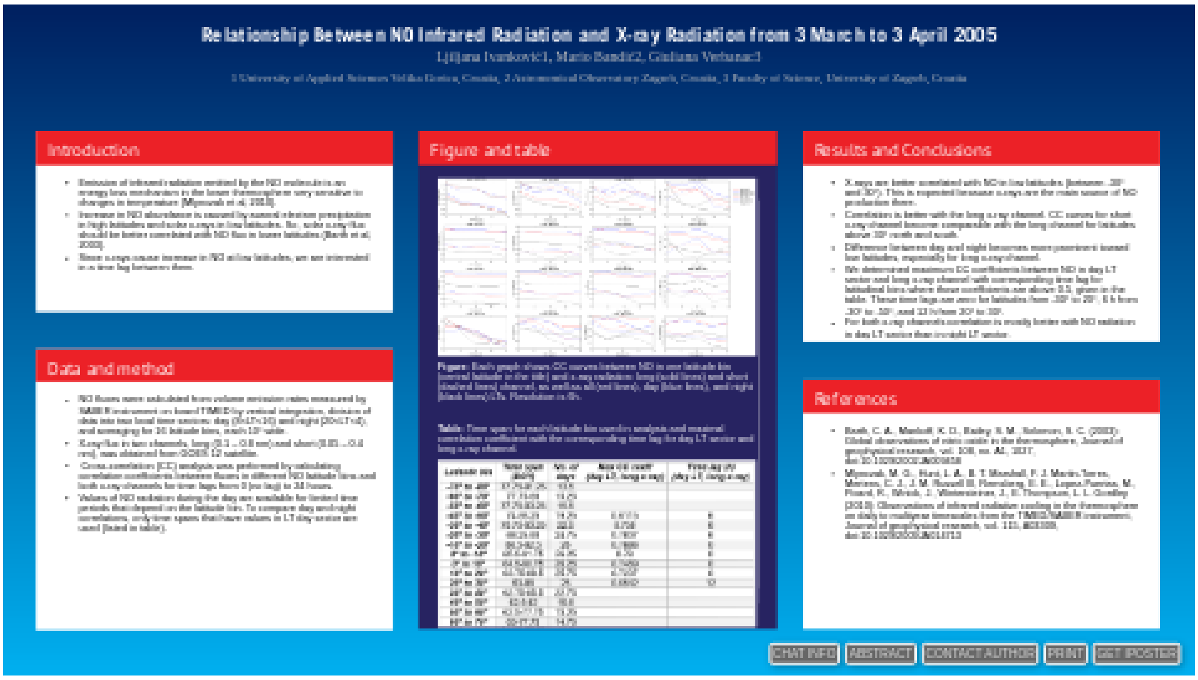
Relationship Between NO Infrared Radiation and X-ray Radiation from 3 March to 3 April 2005



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INTRODUCTION

- Emission of infrared radiation emitted by the NO molecule is an energy loss mechanism in the lower thermosphere very sensitive to changes in temperature (Mlynczak et al, 2010).
- Increase in NO abundance is caused by auroral electron precipitation in high latitudes and solar x-rays in low latitudes. So, solar x-ray flux should be better correlated with NO flux in lower latitudes (Barth et al, 2003).
- Since x-rays cause increase in NO at low latitudes, we are interested in a time lag between them.

DATA AND METHOD

- NO fluxes were calculated from volume emission rates measured by SABER instrument on board TIMED by vertical integration, division of data into two local time sectors: day (8 < LT < 16) and night (20 < LT < 4), and averaging for 16 latitude bins, each 10° wide.
- X-ray flux in two channels, long (0.1 – 0.8 nm) and short (0.05 – 0.4 nm), was obtained from GOES 12 satellite.
- Cross-correlation (CC) analysis was performed by calculating correlation coefficients between fluxes in different NO latitude bins and both x-ray channels for time lags from 0 (no lag) to 24 hours.
- Values of NO radiation during the day are available for limited time periods that depend on the latitude bin. To compare day and night correlations, only time spans that have values in LT day sector are used (listed in table).

FIGURE AND TABLE

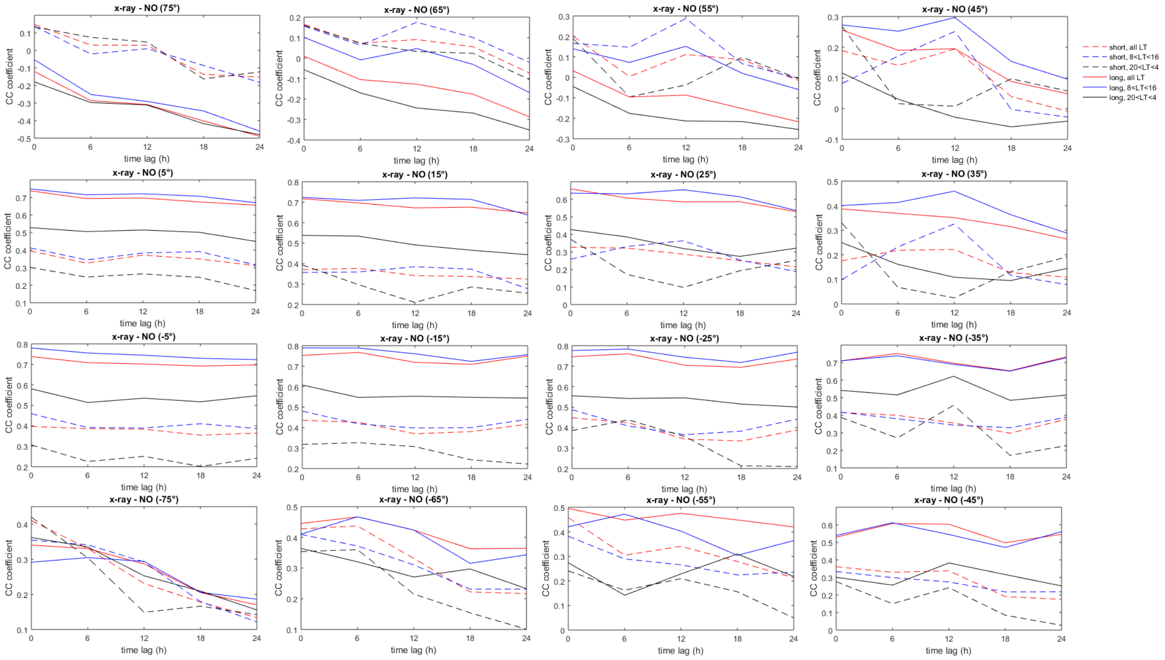

Figure: Each graph shows CC curves between NO in one latitude bin (central latitude in the title) and x-ray radiation: long (solid lines) and short (dashed lines) channel, as well as all (red lines), day (blue lines), and night (black lines) LTs. Resolution is 6h.

Table: Time span for each latitude bin used in analysis and maximal correlation coefficient with the corresponding time lag for day LT sector and long x-ray channel.

Latitude bin	*Time span (DOY)*	*No. of days*	*Max CC coeff (day LT, long x-ray)*	*Time lag (h) (day LT, long x-ray)*
-70° to -80°	77.75-91.25	13.5		
-60° to -70°	77.75-93	15.25		
-50° to -60°	77.75-93.25	15.5		
-40° to -50°	74-93.25	19.25	0.6115	6
-30° to -40°	70.75-93.25	22.5	0.739	6
-20° to -30°	68.25-93	24.75	0.7837	6
-10° to -20°	66.5-92.5	26	0.7888	0
0° to -10°	65.5-91.75	26.25	0.78	0
0° to 10°	64.5-90.75	26.25	0.7489	0
10° to 20°	63.75-89.5	25.75	0.7237	0
20° to 30°	63-88	25	0.6542	12
30° to 40°	62.75-85.5	22.75		
40° to 50°	62.5-82	19.5		
50° to 60°	62.5-77.75	15.25		
60° to 70°	63-77.75	14.75		
70° to 80°	64.25-77.75	13.5		

RESULTS AND CONCLUSIONS

- X-rays are better correlated with NO in low latitudes (between -30° and 30°). This is expected because x-rays are the main source of NO production there.
- Correlation is better with the long x-ray channel. CC curves for short x-ray channel become comparable with the long channel for latitudes above 30° north and south.
- Difference between day and night becomes more prominent toward low latitudes, especially for long x-ray channel.
- We determined maximum CC coefficients between NO in day LT sector and long x-ray channel with corresponding time lag for latitudinal bins where those coefficients are above 0.5, given in the table. These time lags are zero for latitudes from -30° to 20°, 6 h from -30° to -50°, and 12 h from 20° to 30°.
- For both x-ray channels correlation is mostly better with NO radiation in day LT sector than in night LT sector.
- Overall, highest correlation is between low latitudes, day LT, and long x-ray channel.

REFERENCES

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- Mlynczak, M. G., Hunt, L. A., B. T. Marshall, F. J. Martin-Torres, Mertens, C. J., J. M. Russell III, Remsberg, E. E., Lopez-Puertas, M., Picard, R., Winick, J., Wintersteiner, J., E. Thompson, L. L. Gordley (2010): Observations of infrared radiative cooling in the thermosphere on daily to multiyear timescales from the TIMED/SABER instrument, Journal of geophysical research, vol. 115, A03309, doi:10.1029/2009JA014713

ABSTRACT

We investigate the relationship between NO infrared radiation and x-ray radiation at different local time (LT) and latitudes of NO average fluxes.

The NO volume emission rates obtained by SABER instrument on board TIMED satellite and x-ray fluxes on long (0.1-0.8 nm) and short (0.05-0.4) channels measured by GOES 12 satellite were used. NO rates were vertically integrated to obtain fluxes, which are then separated into day (8<LT<16) and night (20<LT<4) LT sectors and averaged per 16 latitude bins each 10° wide.

The cross-correlation (CC) analysis between NO, for different latitude bins and LTs, and x-ray fluxes is performed. We found that x-ray fluxes are better correlated with NO at lower latitudes and during the day. Also, long x-ray fluxes are better correlated with NO than short ones. CC coefficients are maximal for both positive and negative time lags, depending on the latitude bin and LT span.