Observation of OH (6-2) Meinel and O2 (0-1) atmospheric airglow emissions with Spectral Airglow Temperature Imager in King Sejong Station (62.22˚S 58.75˚W), Antarctica

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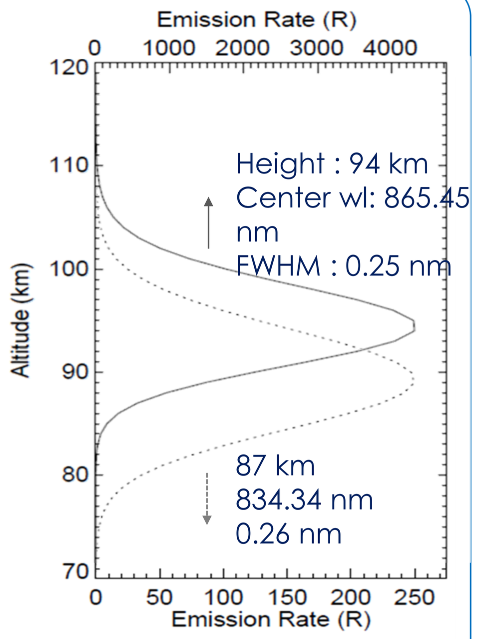
Abstract

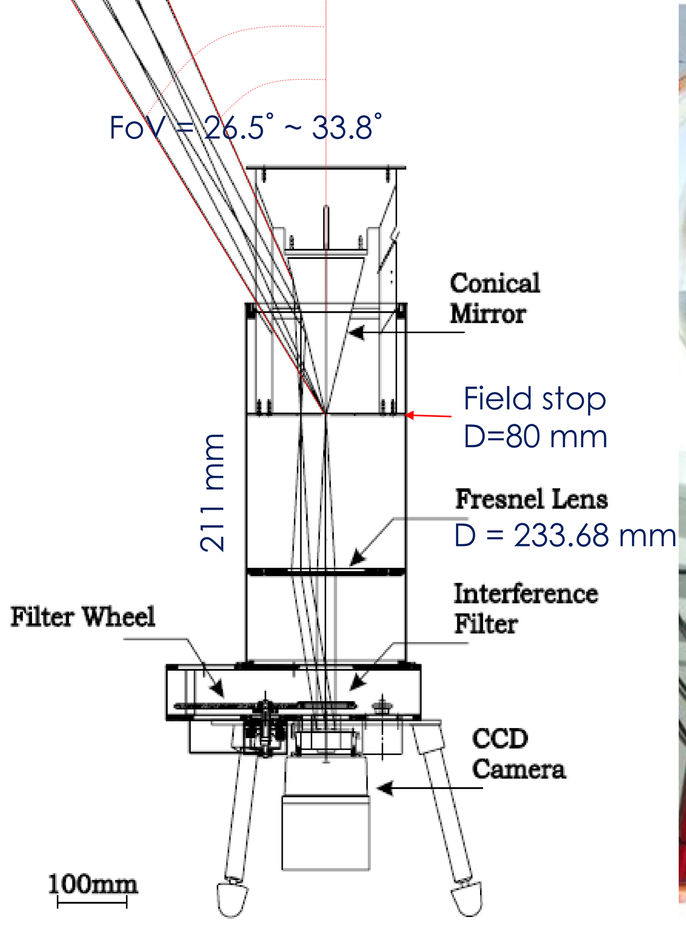
The airglow emissions can represent the physical features at the atmospheric layer where the peak emission occurs. A Spectral Airglow Temperature Imager (SATI), a ground-based spectral scanning and imaging spectrometer, is designed for the investigation of mesopause temperature by observing OH (6-2) Meinel and O2 (0-1) atmospheric airglows which are known to be the peak emission heights of about 87 km and 94 km altitudes, respectively. Since the installation of SATI at King Sejong Station (KSS) in the beginning of 2002, it has been continually operated and produced a significant amount of data of airglow emission until 2016 when the CCD camera eventually failed. The rotational temperatures at around two peak heights are derived from the emission rates. In this paper, we describe the entire data set obtained for over a decade by SATI and provide a modification of the existing data analysis procedure to improve the accuracy of the derived temperature. The resulting temperatures are compared with satellite observations by Microwave Limb Sounder (MLS) on NASA's EOS Aura satellite. It is confirmed that the seasonal variations of the temperatures derived from SATI using the modified analysis code are relatively in good agreement with the satellite observations. The reprocessed temperature data from long-term SATI measurements of airglow emissions will be a valuable data set that can be utilized for various studies on the thermal and dynamical structures of the mesopause region in the Antarctic peninsula..

Introduction

- Spectral Airglow Temperature Imager (SATI)
- Developed to investigate atmospheric dynamics of the mesosphere and low thermosphere (MLT) region
- A spatial scanning Fabry-Perot spectrometer producing the temperature data in dark sky condition according to the solar and lunar zenith angles.
- Installed at King Sejong Station (62.22ºS, 58.78ºW) in February 2002.
- O2 (0-1) Atmospheric band and OH (6-2) Meinel band centered at about 94 and 87 km altitudes.
- The measurements can be used to infer the rotational temperature from the line ratios.

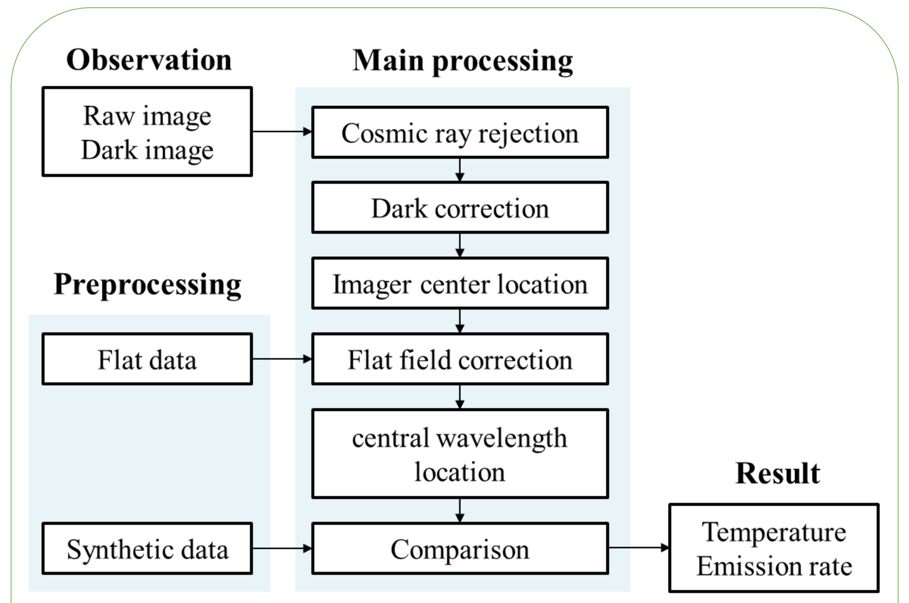


Peak altitude of O2 and OH emission



- Schematic diagram of SATI instrument and field of view

Analysis process



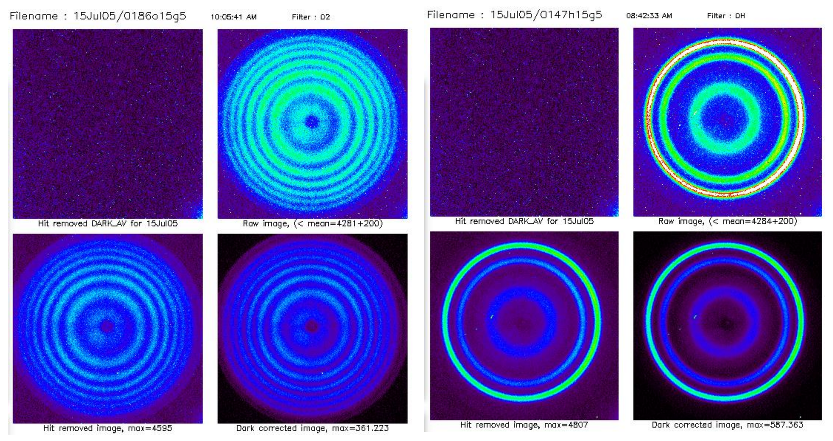
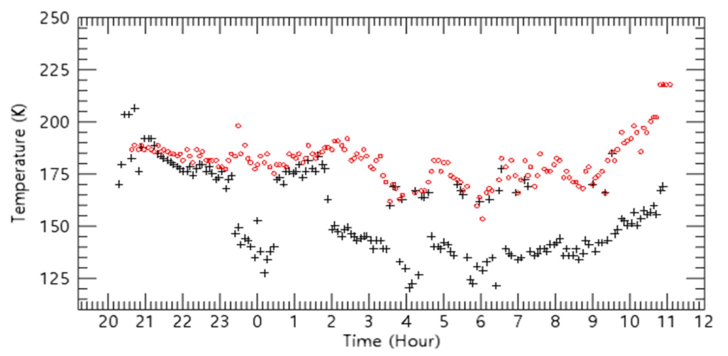
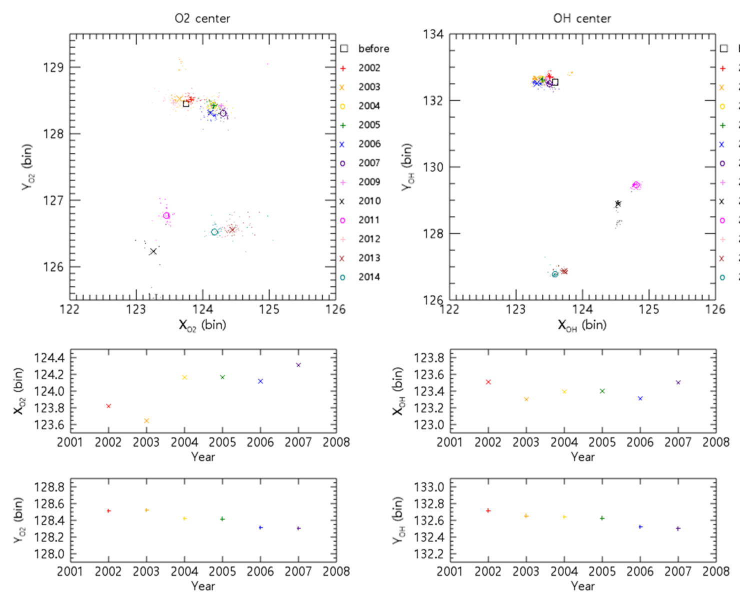


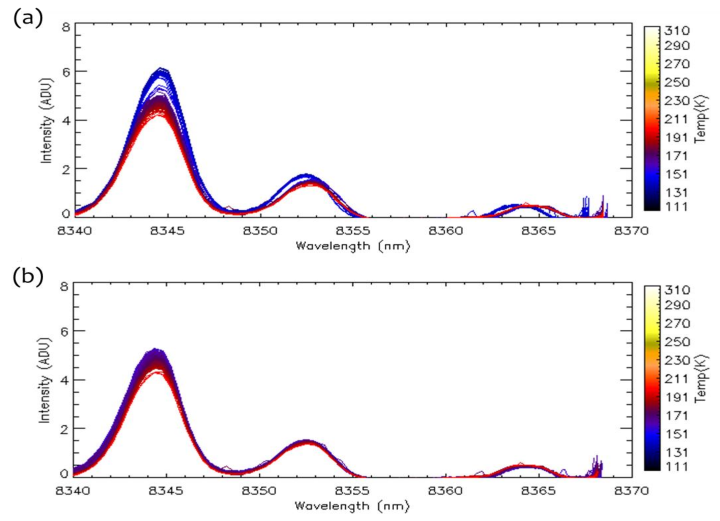
Image correction



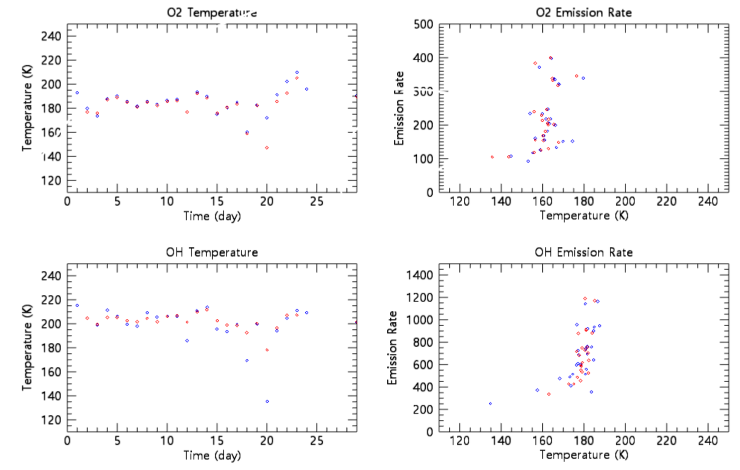
The difference in OH temperature before (cross) and after (circle) peak position correction with data collected on the night of July 8-9, 2005.



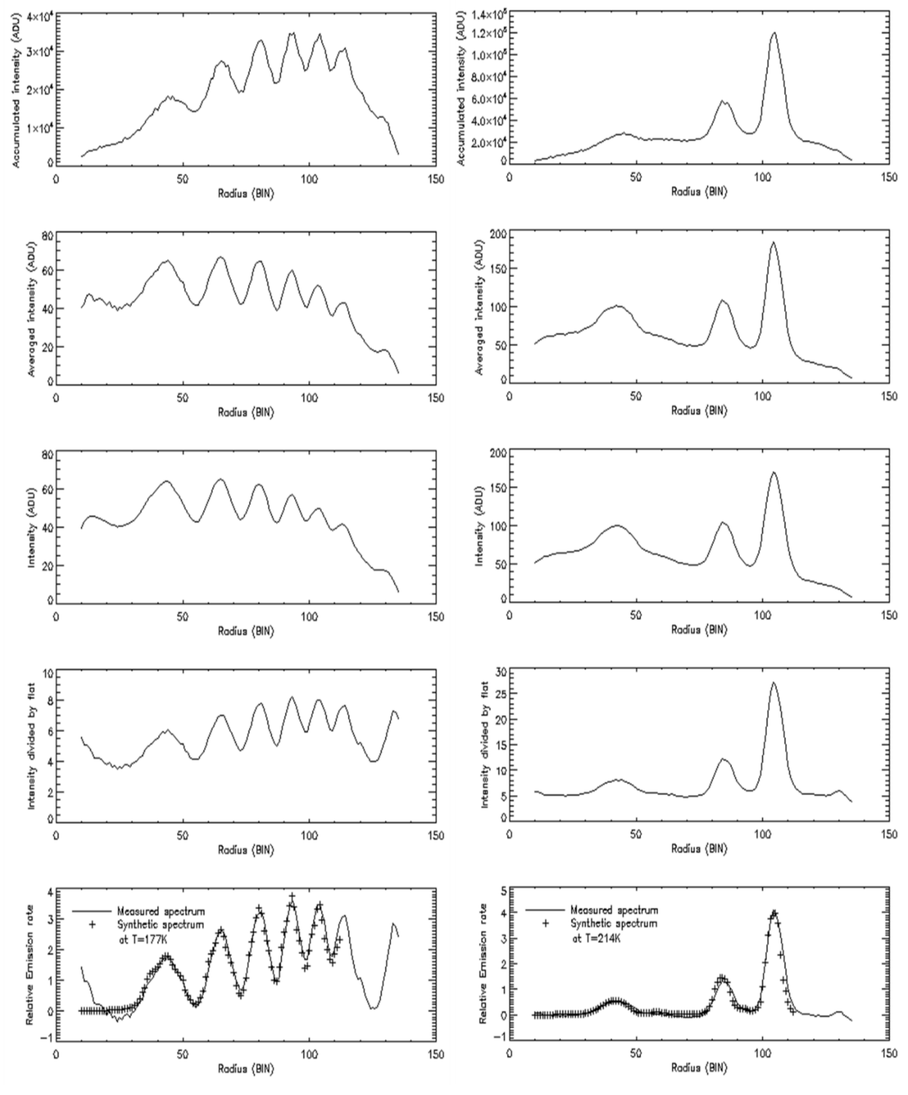
Annular center correction from 2002 to 2014



The difference in OH temperature before (a) and after (b) peak position correction with data collected on the night of July 8-9, 2005



The difference in OH monthly temperature before (blue) and after (red) with data in April 2004



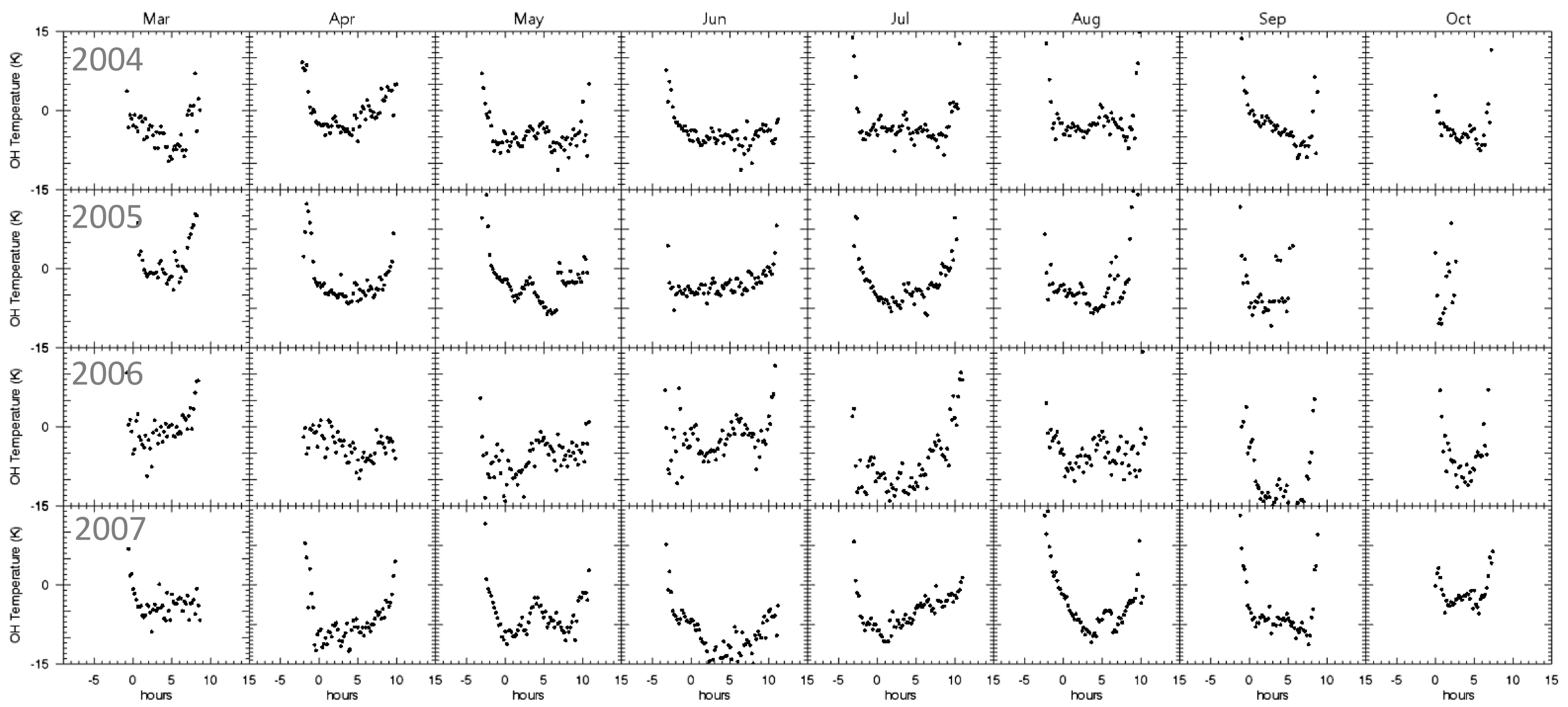
The result of flat filed correction for the O2 (left) and OH (right) emission

Result

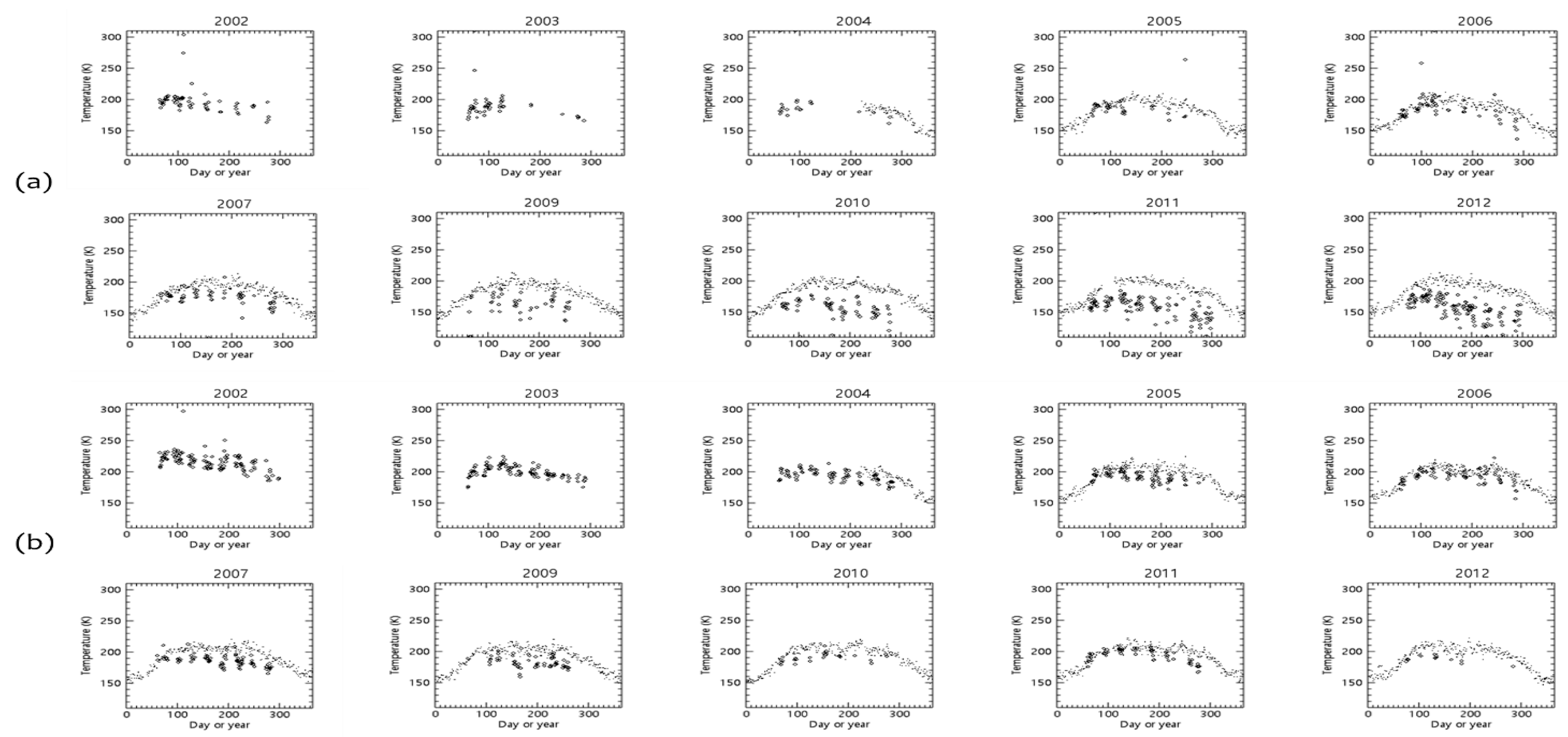
Number of days with more than 4 hours of available measurement

	OH										O2									
	2002	2003	2004	2005	2006	2007	2009	2010	2011	2012	2002	2003	2004	2005	2006	2007	2009	2010	2011	2012
Mar	13	16	7	8	8	9	1	2	10	4	13	15	6	11	11	9	3	9	16	13
Apr	13	10	3	11	10	6	5	4	7	1	12	9	3	7	11	7	6	7	11	15
May	8	15	10	11	7	6	6	1	7	4	3	7	3	7	7	5	6	2	17	20
Jun	14	6	7	11	8	10	9	4	3	1	7	0	0	0	2	7	6	12	10	14
Jul	11	10	11	16	5	11	4	3	8	0	1	1	0	2	2	2	3	7	13	21
Aug	17	9	6	8	11	13	12	1	7	0	5	0	1	3	1	8	8	7	8	15
Sep	9	6	10	5	7	7	9	0	6	0	4	1	1	4	4	1	7	9	12	8
Oct	4	2	9	0	3	8	9	2	2	0	1	2	2	0	4	9	7	5	7	11
N_{total}	**89**	**74**	**63**	**70**	**59**	**70**	**55**	**17**	**50**	**10**	**46**	**35**	**16**	**34**	**42**	**48**	**46**	**58**	**94**	**117**

The table lists the number of nights used for each month from 2002 to 2012 and the total number of nights for the whole period. The observational nighttime periods range from approximately 6h in October to 15h in June..



Nighttime variability of OH temperature for each of year from 2004 to 2007. The 3:00 UT is midnight. Y axis represents the residual temperature to the monthly mean.



- Compare the temperature data with Aura-MLS satellite
- Night mean (LT 18-06), 2004-2012, latitude 62.22S ±5, Longitude 58.78W±5
  Height : grid 46: 88.5087 km, grid 47:94.0349 km

Summary

- Since the installation of SATI at King Sejong Station (KSS) in the beginning of 2002, it has been continually operated and produced a significant amount of data of airglow emission until 2016.
- The analysis approach needs to be modified to improve the accuracy of the temperature for the KSS-SATI-data set.
- Center of each image is calculated routinely and peak position correction is applied in the procedure.
- The result shows daily, monthly variation as well as seasonal variation.
- The seasonal variations of the temperatures derived from SATI using the modified analysis code are relatively in good agreement with the satellite observations.
- The data set obtained from the long-term operation will play a significant role in unravelling questions on the thermal and dynamical characteristics of the MLT region in Antarctica.