



Land Surface Temperature Retrieval with Himawari-8 Advanced Himawari Imager (AHI) Data

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Outline



Background

- Definition

—— Requirement & status

- Himawari-8 Data



3

2

Theoretical base & Algorithm

Validation analysis

Concluding remarks



Background



- Land Surface Temperature (LST) is a measure of how hot or cold the surface of the Earth would feel to the touch.
- Global Climate Observation System (GCOS) has recognized LST as the Essential Climate Variables (ECV).

Applications:

- Climate monitoring
- Drought monitoring
- Surface energy balance
- • •

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GOES-E LST: 2017-04-01 02:45



Type Value EOS MODIS Horizontal Threshold 0.05 degree

resolution	1110011010	oloo dogloo	
Temporal	Threshold	Daily	
resolution	Target	<3-hourly	
Accuracy	Threshold	<1 K	
Precision	Threshold	<1 K	
Ctobiliter	Threshold	<0.3 K/decade	
Stability	Target	<0.1 K/decade	
Length of	Threshold	20 years	
record	Target	>30 years	

GCOS's Requirements for LST as ECV

Status of current LST products is mainly constraint by **sensor data quality** and algorithm uncertainty.

Requirement & Status Of LST Products cics-md

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Status of current LST products







	W/avelengt	Him	awari	MTSAT		
h		Band	Resolution	Channel	Resolution	
		number	(km)	name	(km)	
	0.47	1	1	-	-	
	0.51	2	1	-	-	
	0.64	3	0.5	VIS	1	
	0.86	4	1	-	-	
	1.6	5	2	-	-	
	2.3	6	2	-	-	
	3.9	7	2	IR4	4	
	6.2	8	2	IR3	4	
	6.9	9	2	-	-	
	7.3	10	2	-	-	
	8.6	11	2	-	-	
	9.6	12	2	-	-	
	10.4	13	2	IR1	4	
	11.2	14	2	-	-	
	12.4	15	2	IR2	4	
	13.3	16	2	- Atm		

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Wavenumber (cm⁻¹)

Wavenumber (cm^{-1})



2

Outline



Background

Theoretical base & Algorithm

- Theoretical base (Radiative Transfer)

Algorithm development







Algorithm Development



$$T_{s} = \underline{C_{0} + C_{1}BT_{11}} + \underline{C_{2}(BT_{11} - BT_{12})} + \underline{C_{3}\varepsilon} + \underline{C_{4}\varepsilon}(BT_{11} - BT_{12}) + \underline{C_{5}\Delta\varepsilon}$$

Day/Night separation Look-up-table

$oldsymbol{C}_0 {\sim} oldsymbol{C}_5$		Satellite zenith angle			
		STZ 1	STZ 2		STZ 5
Total	TPW1				
precipita	TPW2				
ble water	TPW3				

Coefficient Look-up-table dimension: 2*3*5







Outline



Sample AHI LST data



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in situ Data





- OzFlux network field measurements at Australia (<u>http://ozflux.org.au/</u>);
- Measurements of upward (LWU) and downward longwave (LWD) radiation every 30 mins;
- ➤ Time: 2015.04-2016.03

$$T_{s} = \left(\frac{LWU - (1 - \varepsilon)LWD}{\sigma\varepsilon}\right)^{1/4}$$

Note: Time differences between satellite and ground observations will be limited to less than 5 minutes;



Validation comparing with VIIRS





20150401 - 20160331

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Diurnal error pattern





Error dependence





- Strong dependence between LST retrieval bias with the BT11 over daytime;
- This bias could be corrected by using linear model built from ground-satellite data pairs;
 - 75% data pairs for training, while 25% data pairs for evaluating;



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Calibrated LST validation results

















Concluding remarks



 Promising data: Higher spatial & temporal resolutions, better sensor characteristics;

- <u>Achievable target</u>: Combining with the GOES-R series and MTG data, we could approach the target requirement from GCOS;
- <u>More effort required</u>: better ground observations, reduce daytime overestimation.



Concluding remarks

	Himawa	i-8 AHI	GOES-	R ABI		Comparison of Spectral Response Function
Channel	Wavelength	Bandwidth	Wavelength	Bandwidth		for ABI/AHI (Ch1/ & 15)
1	0.47	0.04	0.47	0.04	1	
2	0.51	0.03	0.64	0.1	-	AHI Ch14
3	0.64	0.08	0.865	0.04	0.9	
4	0.86	0.03	1.378	0.015	0.8	
5	1.61	0.04	1.61	0.06	0.7	ABI Ch14
6	2.26	0.04	2.25	0.05	.È ∩ 6	ABI CH15
7	3.88	0.2	3.9	0.2	<u>si</u> 0.0	
8	6.24	0.82	6.19	0.83	log 0.5	
9	6.94	0.4	6.95	0.4	Se 0.4	
10	7.35	0.19	7.34	0.2	0.3	
11	8.59	0.37	8.5	0.4	0.0	
12	9.63	0.38	9.61	0.38	0.2	
13	10.4	0.42	10.35	0.5	0.1	
14	11.24	0.67	11.2	0.8	0	
15	12.38	0.97	12.3	1	10	11 12 13 14
16	13.28	0.56	13.3	0.6		Wavelength (um)

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Thanks!



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19

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Theoretical Basis





Factors related to LST retrieval

- <u>Sensor Radiance</u>
- Surface Emissivity
- Atmosphere condition

