Inter-calibration of HY-1B/COCTS Thermal Infrared Channels with MetOp-A/IASI

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➢ HY-1B COCTS

- HY-1B satellite was launched in April 2007, operated by the National Ocean Satellite Application Center (NSOAS) of the State Oceanic Administration (SOA) of China
- The satellite operated in a near sun-synchronous polar orbit.
- The main payloads on board HY-1B were the Chinese Ocean Color and Temperature Scanner (COCTS) and Coastal Zone Imager (CZI).
- COCTS has thermal infrared split window channels for SST observations.

➢ MetOp-A IASI

- The calibration accuracy of IASI is stable and accurate.
- Due to its hyperspectral nature and high-quality radiance measurements, IASI can serve as the reference for in-orbit re-calibration of other instruments.

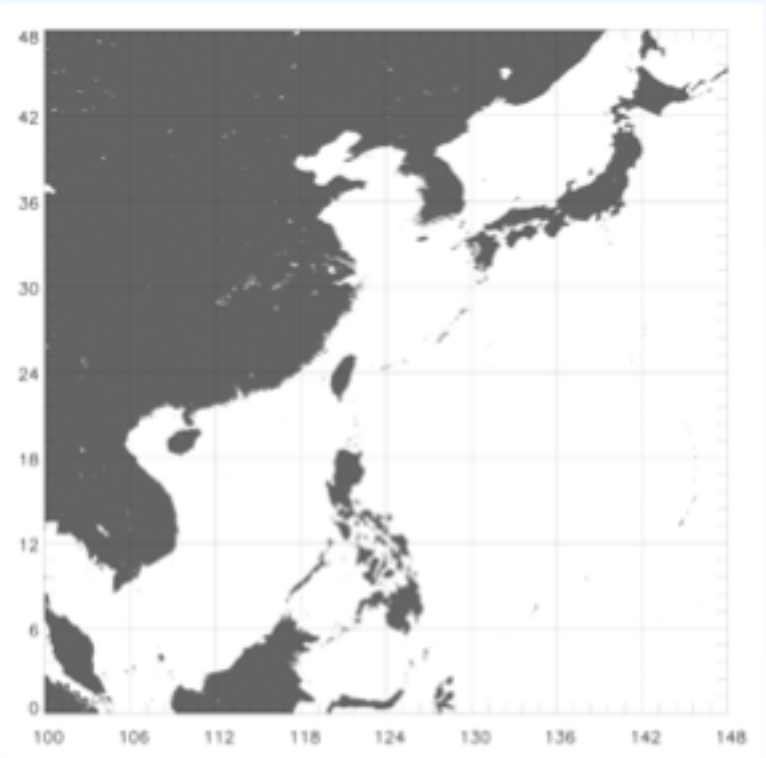
Instrument characteristics of COCTS and IASI

	COCTS	IASI
Spectral coverage	8 visible near infrared channels (0.41-0.865μm) 2 thermal infrared channels (10.30-11.40 μm, 11.40-12.5 μm)	8461 channels (3.6-15.5μm with a spectral binning of 0.25 cm^{-1})
Spatial resolution	1.1km (near nadir)	12km (near nadir)
Scan angle	±55° from nadir	±48.3° from nadir
Cross track scan samplings	1664	30 footprints (each containing 4 IFOV)

research region

- In this study, we use IASI radiance as the reference to evaluate and correct HY-1B COCTS radiance of thermal infrared channels from 2009 to 2011 in the northwest Pacific.

- The data we used include the COCTS Level 1B radiance data provided by NSOAS and IASI Level 1C radiance data provided by EUMETSAT.



—— Inter-calibration method ——

- Calculation of IASI-convolved radiance
- Generation of matchups
- Filtering of matchups

Inter-calibration method

1. Calculation of IASI-convolved radiance

IASI spectral radiance

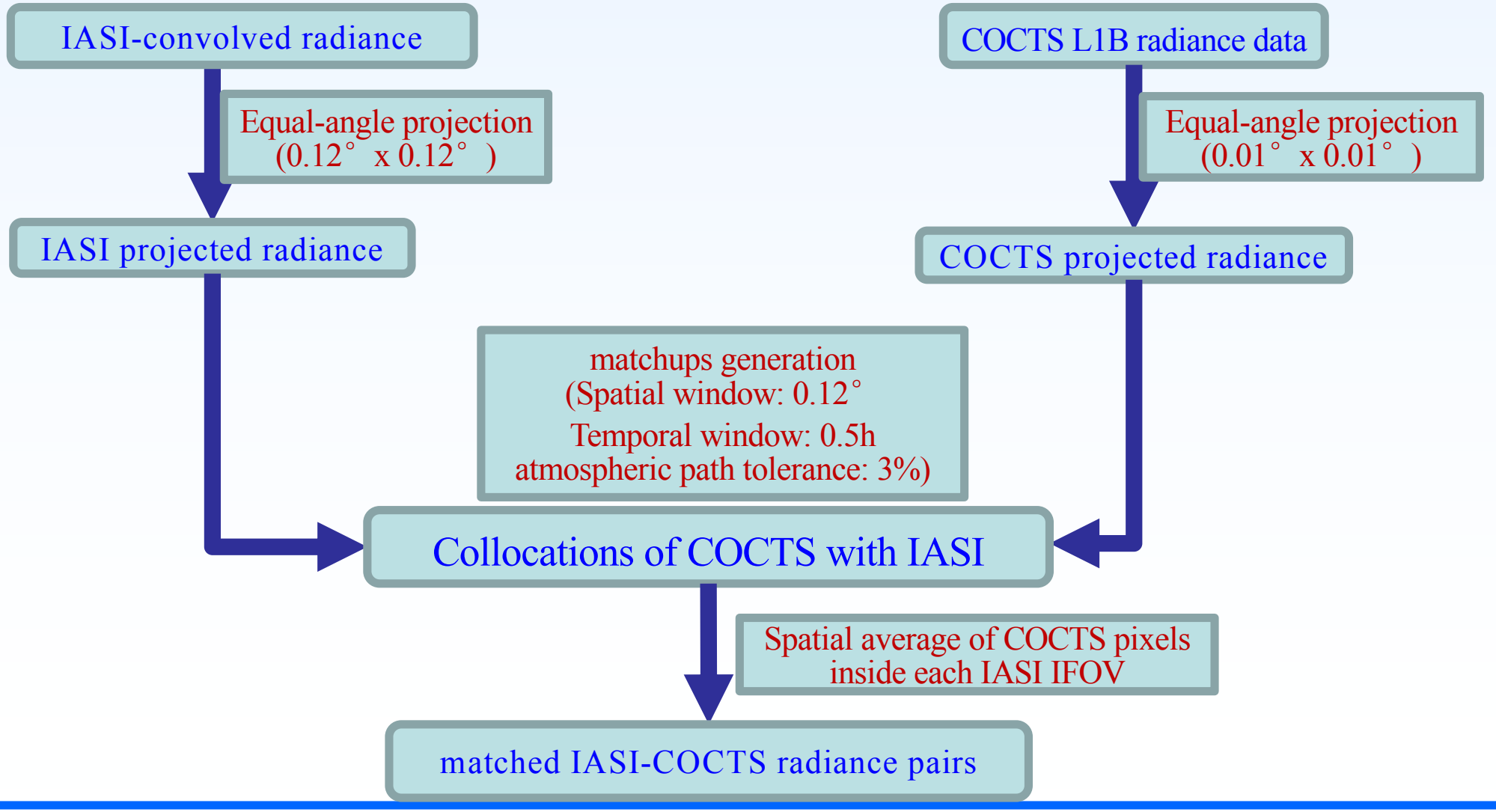
$$L_i = \frac{\int_{\lambda_1}^{\lambda_2} L(\lambda) S_i(\lambda) d\lambda}{\int_{\lambda_1}^{\lambda_2} S_i(\lambda) d\lambda}$$

IASI-convolved radiance

COCTS spectral response function

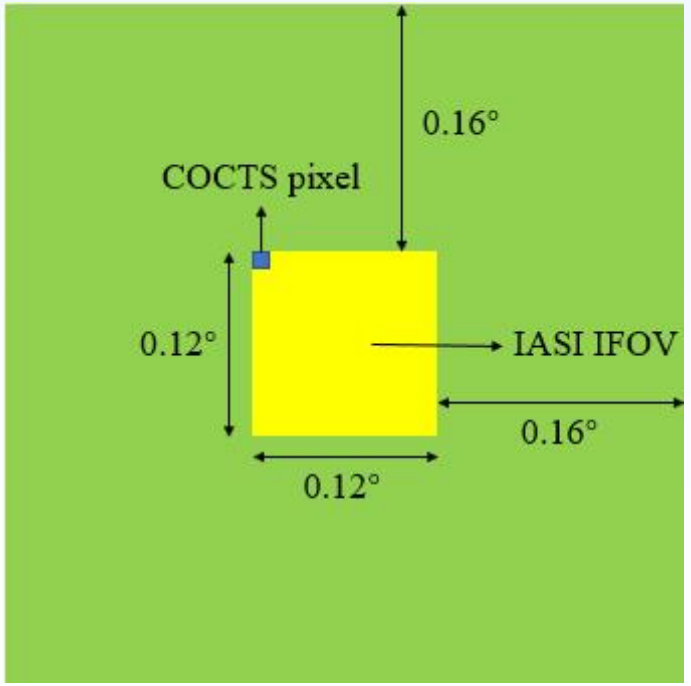
Inter-calibration method

2. Generation of matchups



3. Filtering of matchups

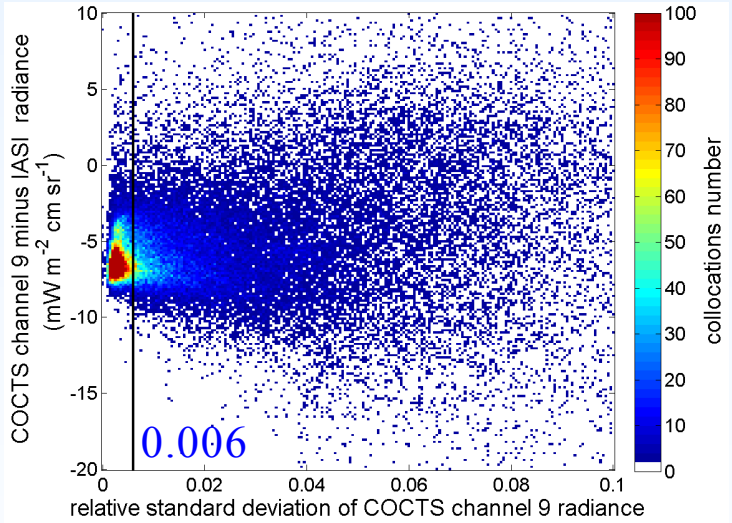
- Radiance nonuniformity within the IASI IFOV increases the spatial uncertainties of matchups.
- relative standard deviation → quantify the homogeneity.
- perimeter region → reduce the likelihood of time variable components.

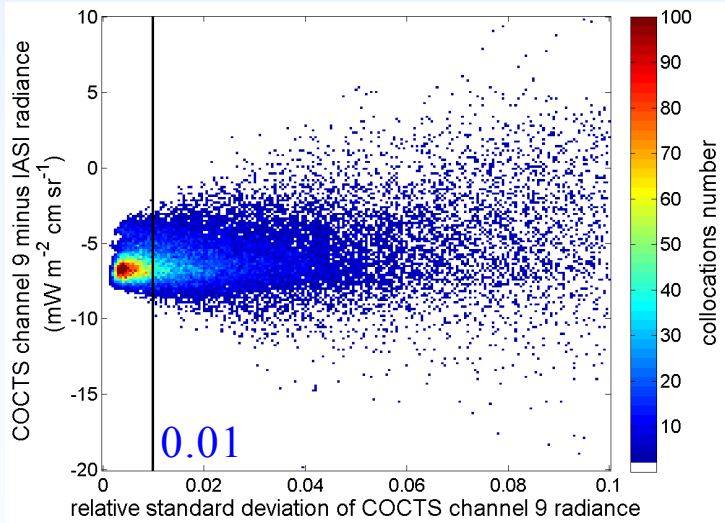


collocated central region

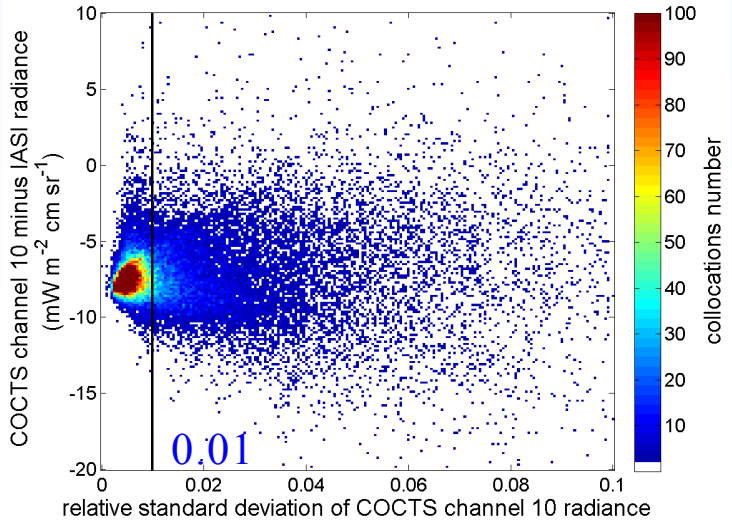
perimeter region

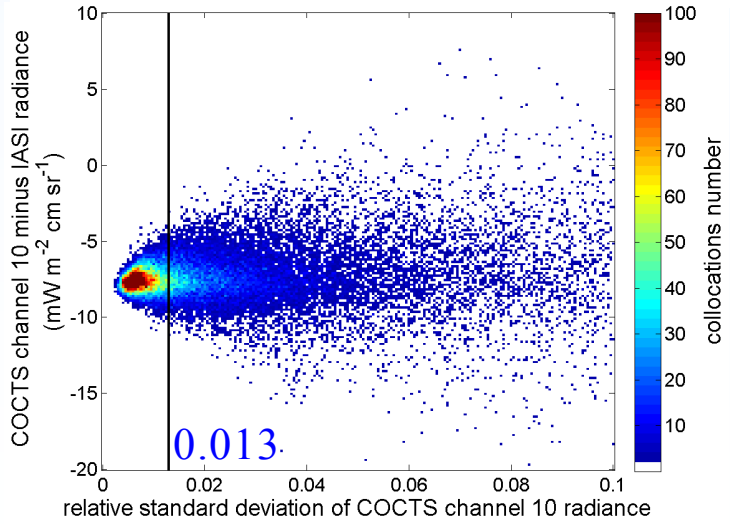
Channel 9





Channel 10

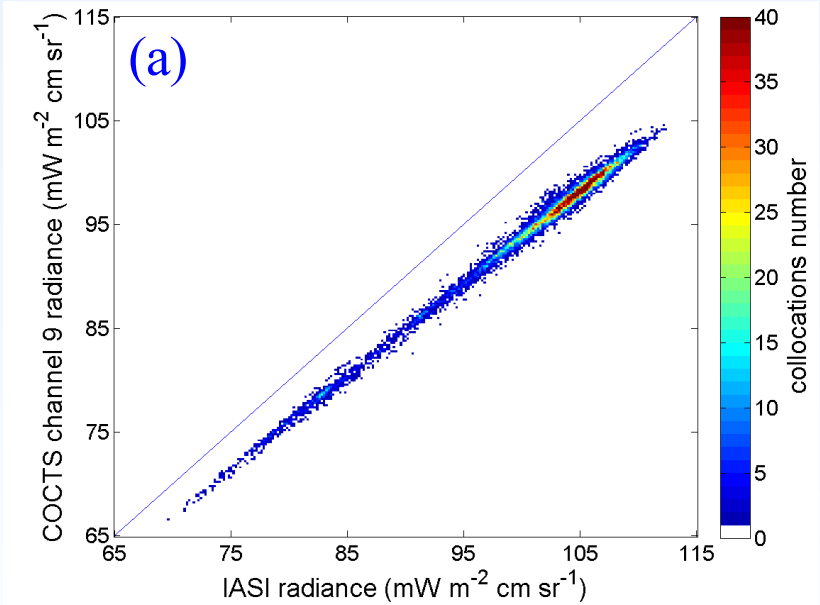


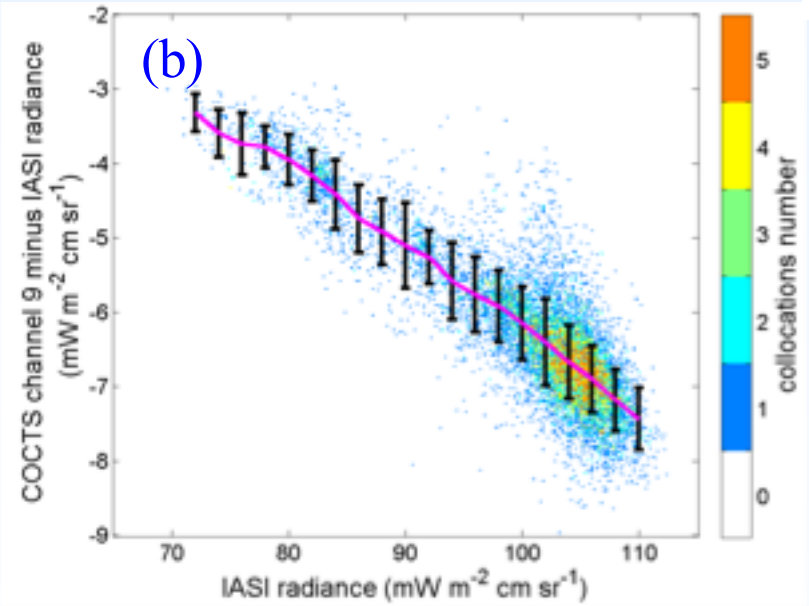


the variations of COCTS minus IASI radiance difference against relative standard deviations of COCTS radiance

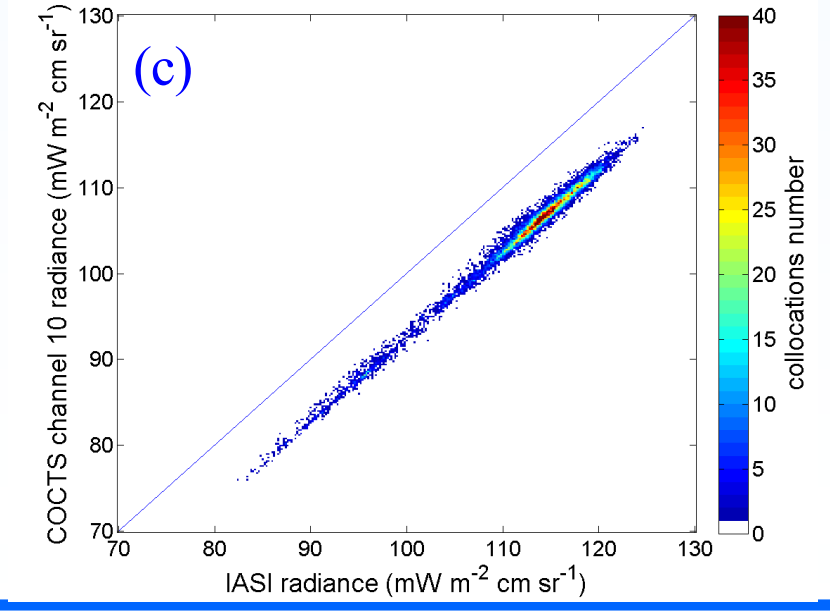
—— Comparison of COCTS radiance with IASI——

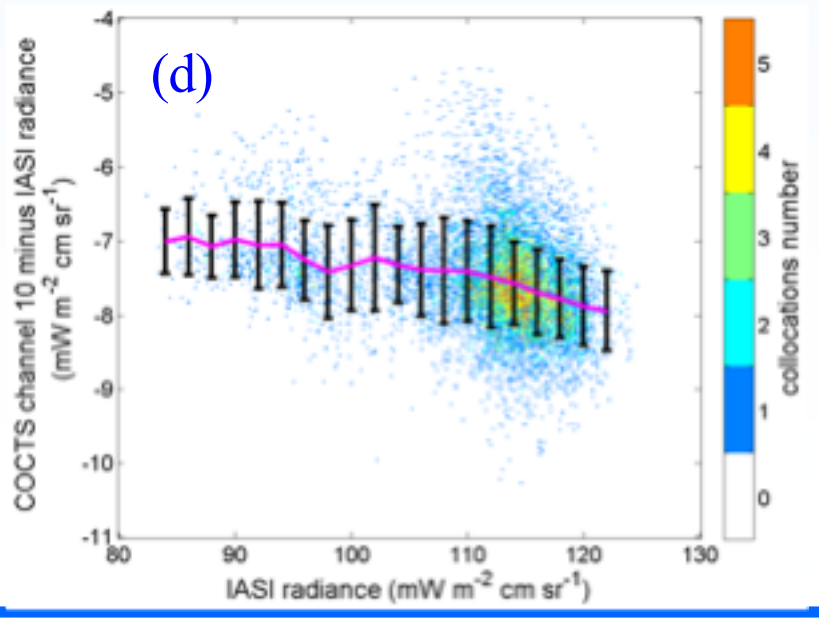
Channel 9





Channel 10

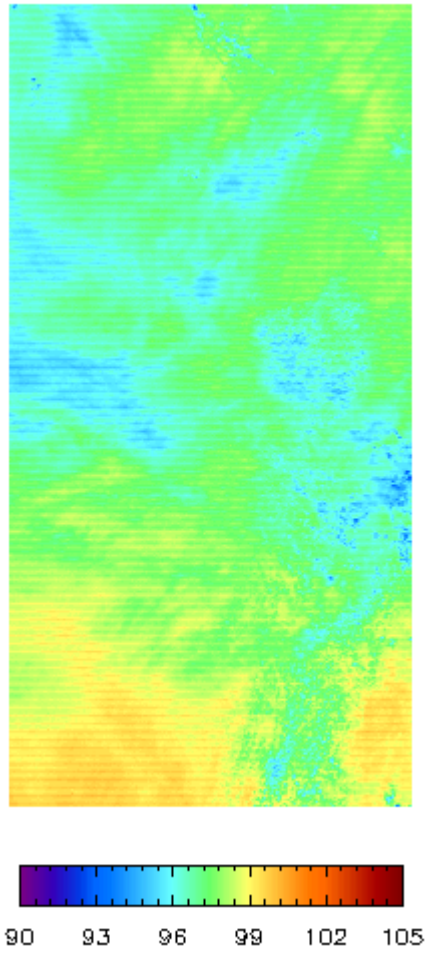




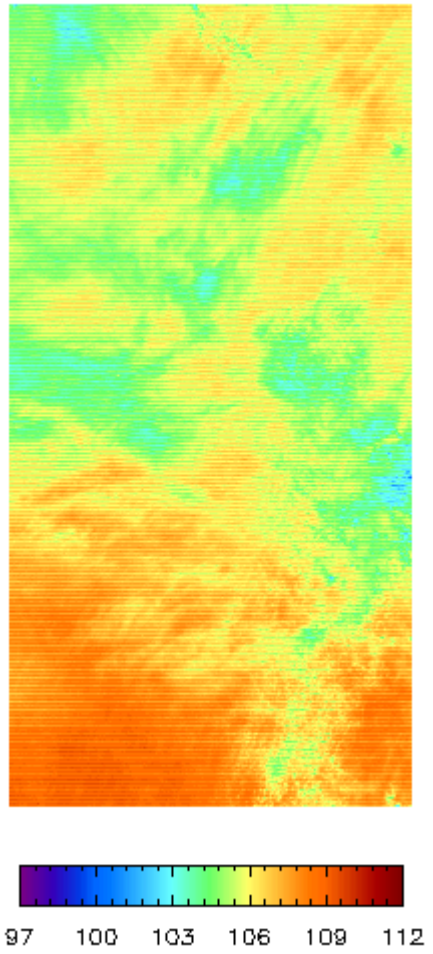
—— Comparison of COCTS radiance with IASI——

There is distinct striped noise with a pattern approximately repeating every four scan lines in COCTS radiance image, due to the inconsistency between four parallel detectors

COCTS channel 9 radiance



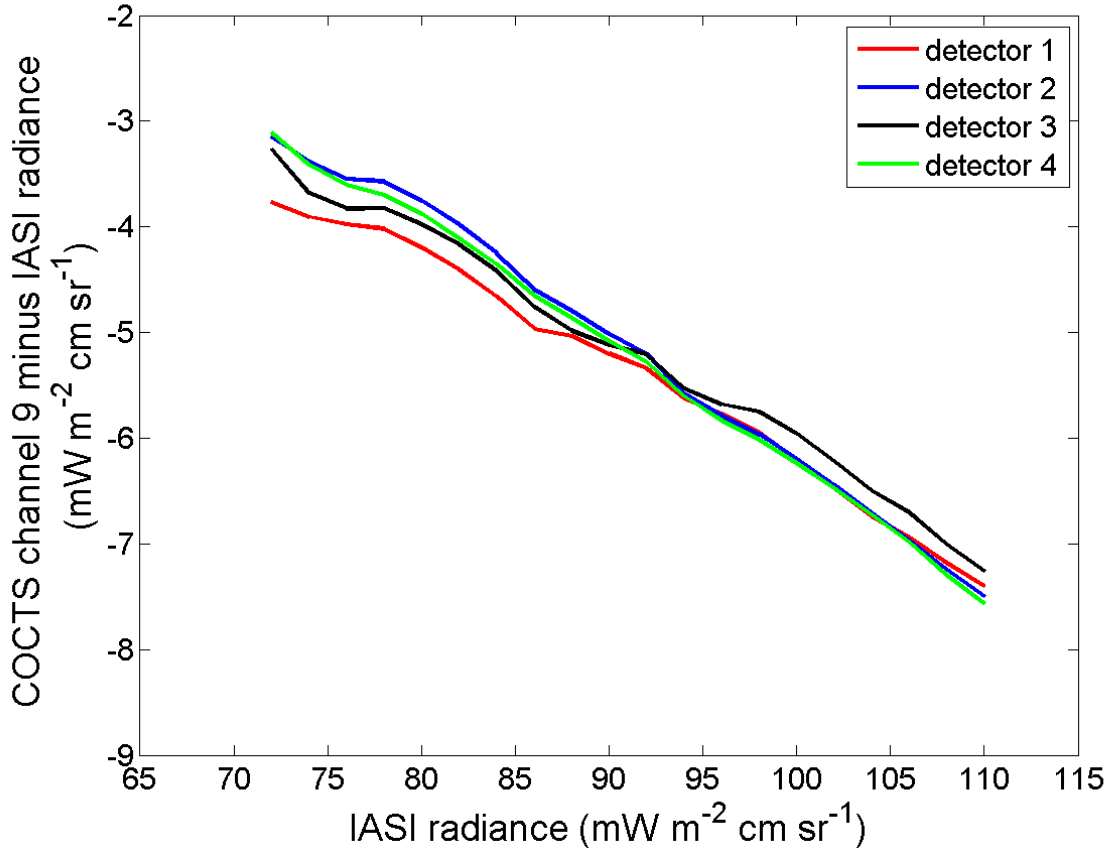
COCTS channel 10 radiance



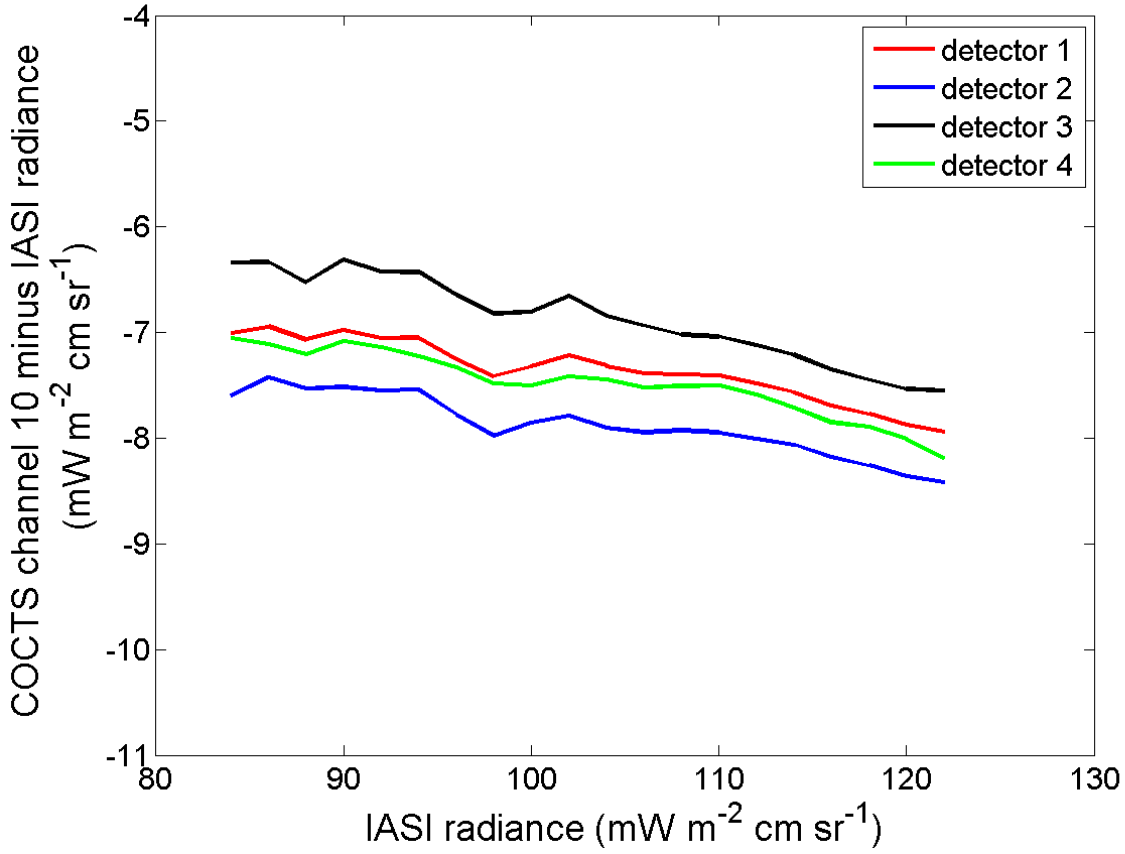
—— Comparison of COCTS radiance with IASI——

Difference among COCTS four detectors

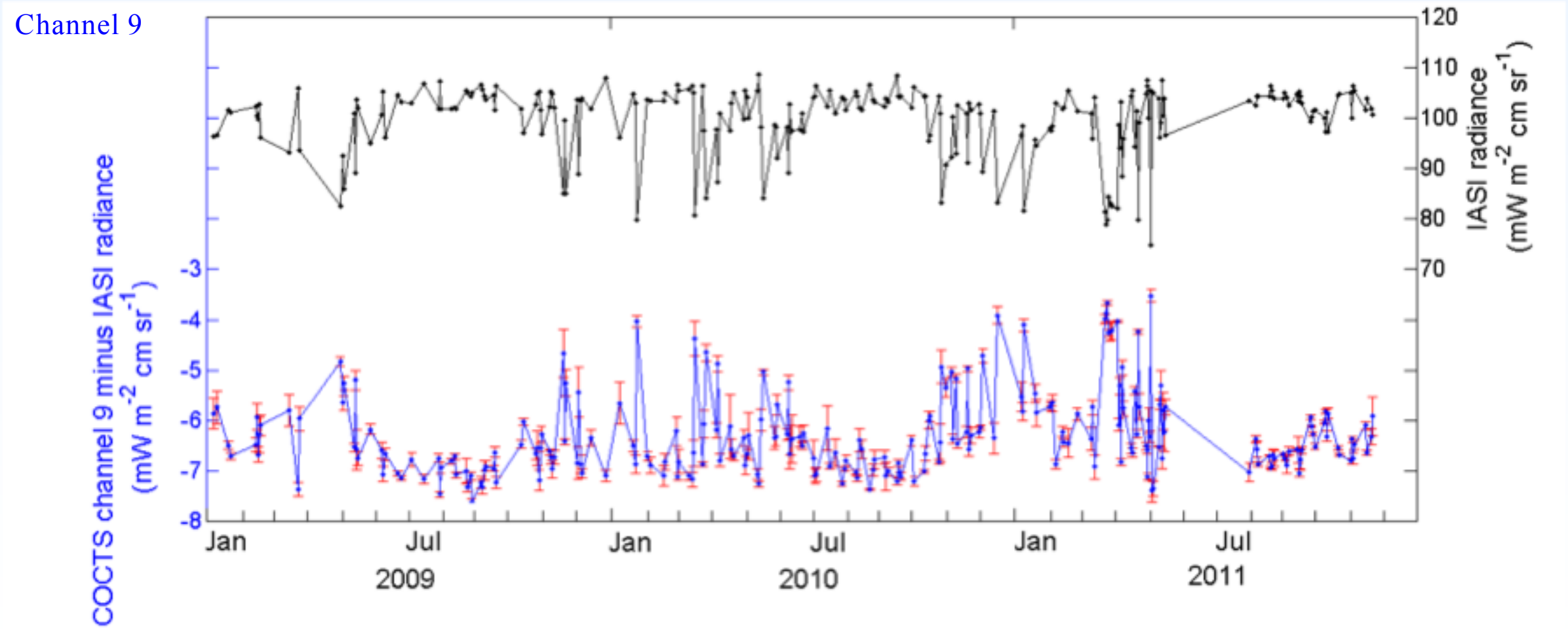
Channel 9



Channel 10

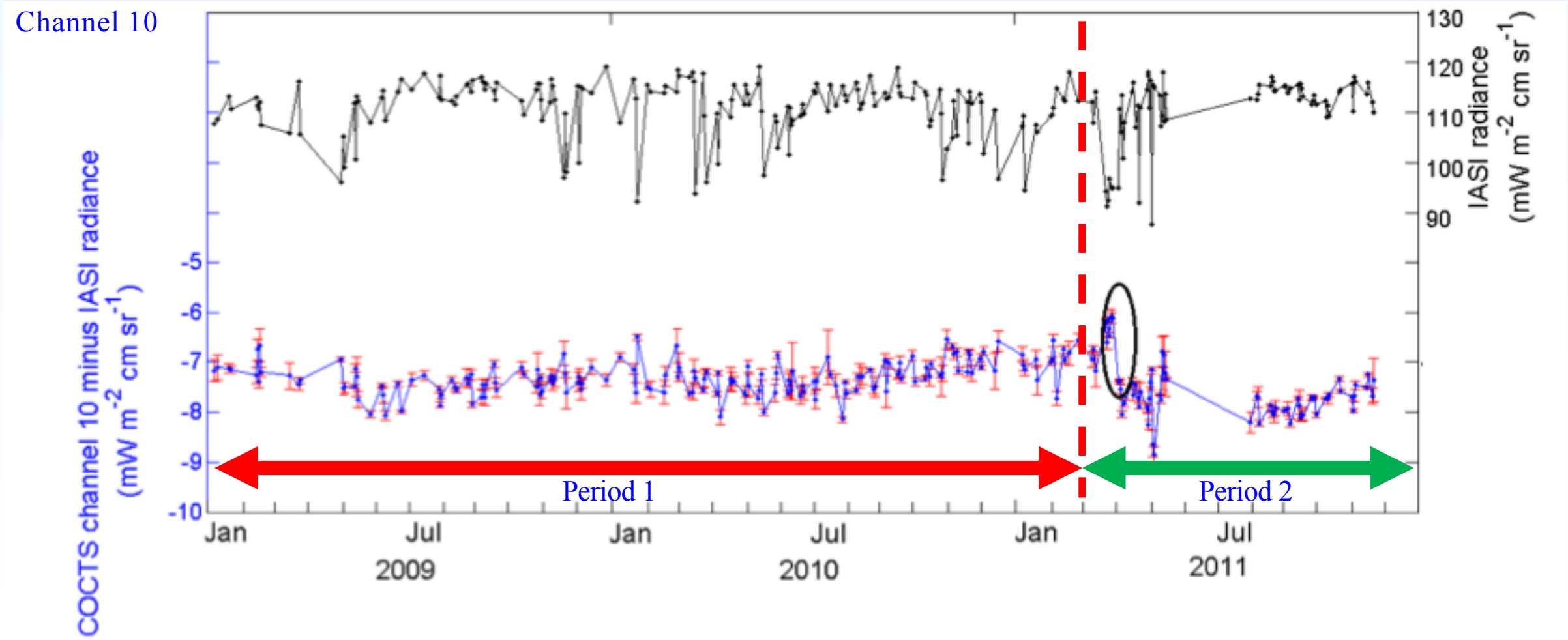


—— Comparison of COCTS radiance with IASI——



time series plot of COCTS minus IASI radiance difference from 2009 to 2011

—— Comparison of COCTS radiance with IASI——



time series plot of COCTS minus IASI radiance difference from 2009 to 2011

—Calculation of coefficients for COCTS radiance correction—

- Linear robust regression:

$$L_{COCTS} - L_{IASI} = a \times L_{IASI} + b$$

$$L_{COCTS'} = \frac{L_{COCTS} - b}{a + 1}$$

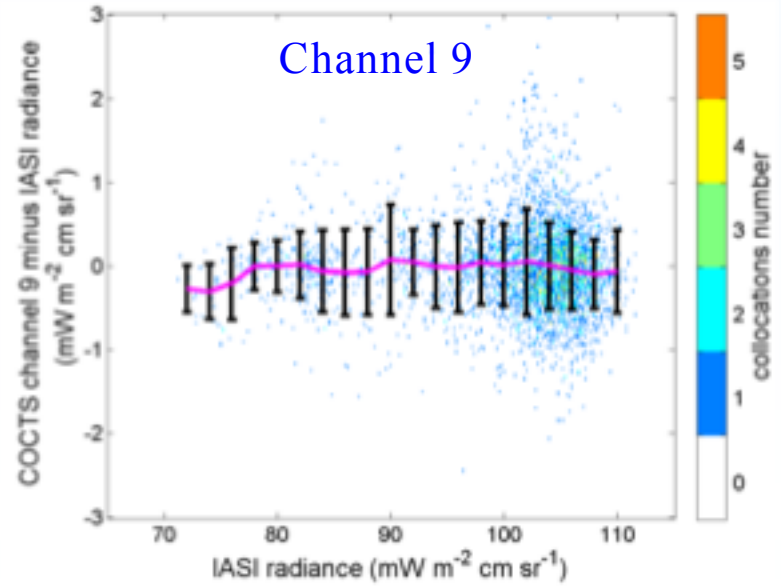
- Different coefficients for 4 different detectors

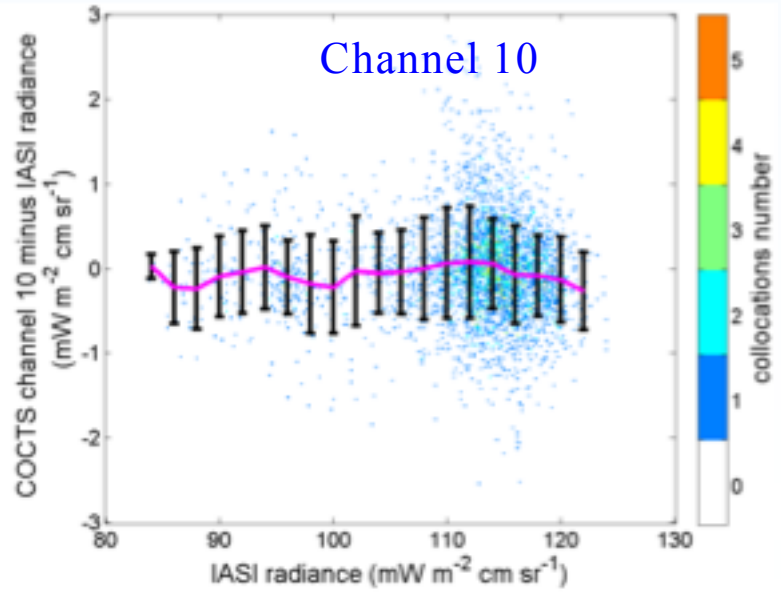
- Different coefficients for 2 different periods

- 2/3 matchups for coefficients calculation and 1/3 matchups for validation

Validation of COCTS corrected radiance

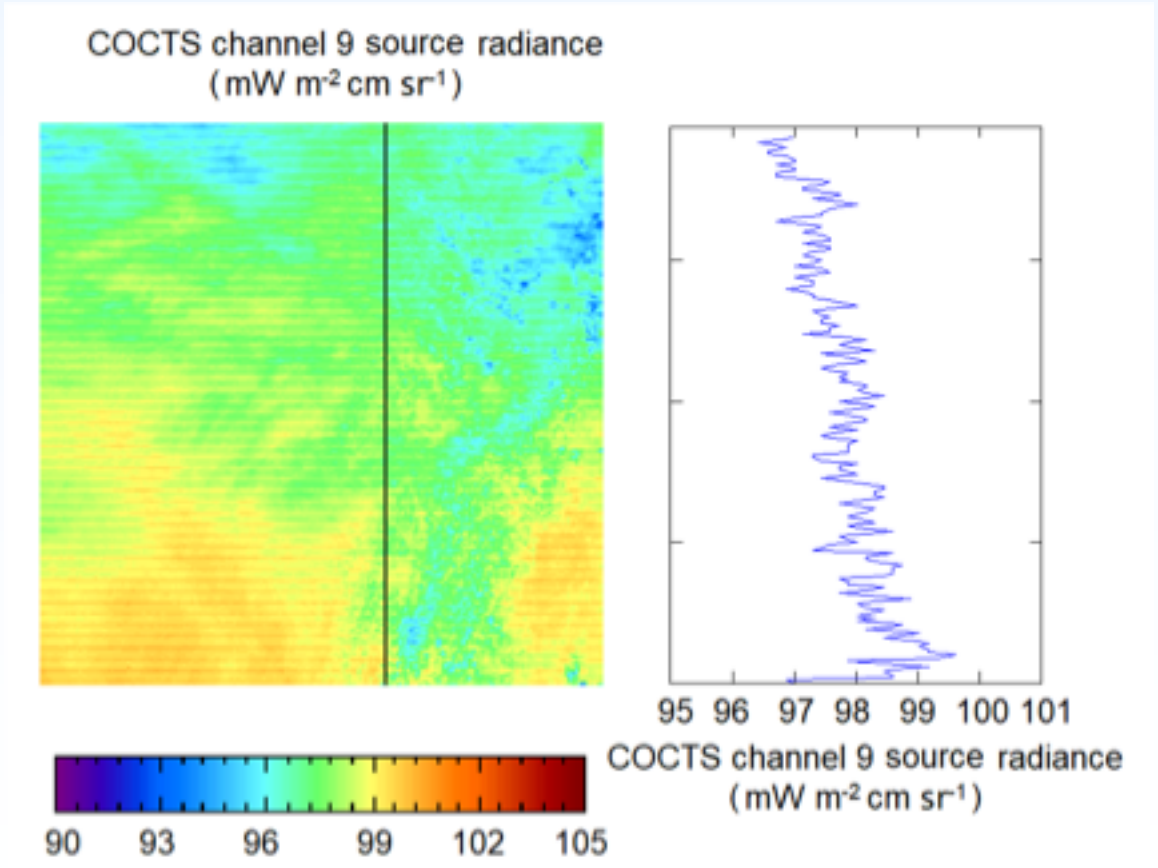
	Channel 9 radiance difference (mW m-2 cm sr-1)		Channel 9 BT difference (K)		Channel 10 radiance difference (mW m-2 cm sr-1)		Channel 10 BT difference (K)	
	Bias	Std.Dev	Bias	Std.Dev	Bias	Std.Dev	Bias	Std.Dev
Before correction	-6.37	0.95	-4.08	0.50	-7.57	0.62	-4.76	0.39
After correction	-0.02	0.51	-0.01	0.33	-0.01	0.57	-0.01	0.35

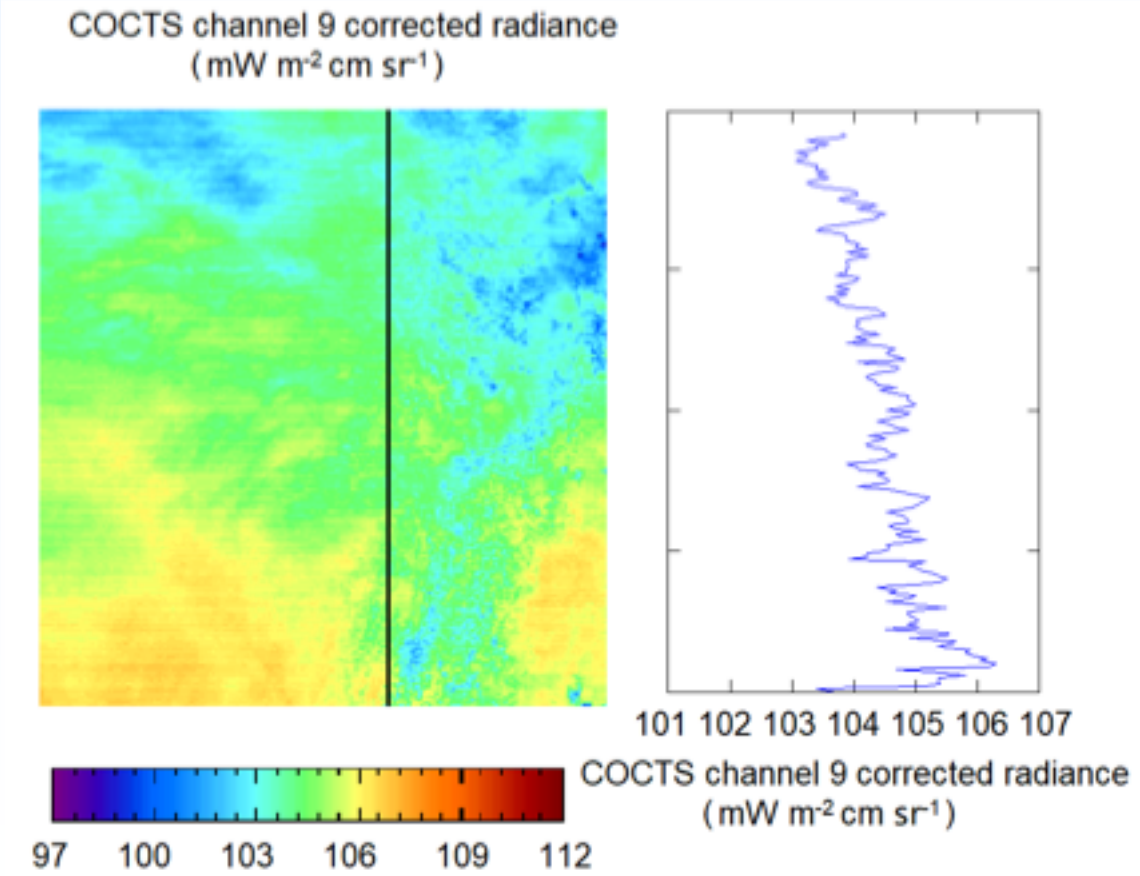




Striped noise analysis

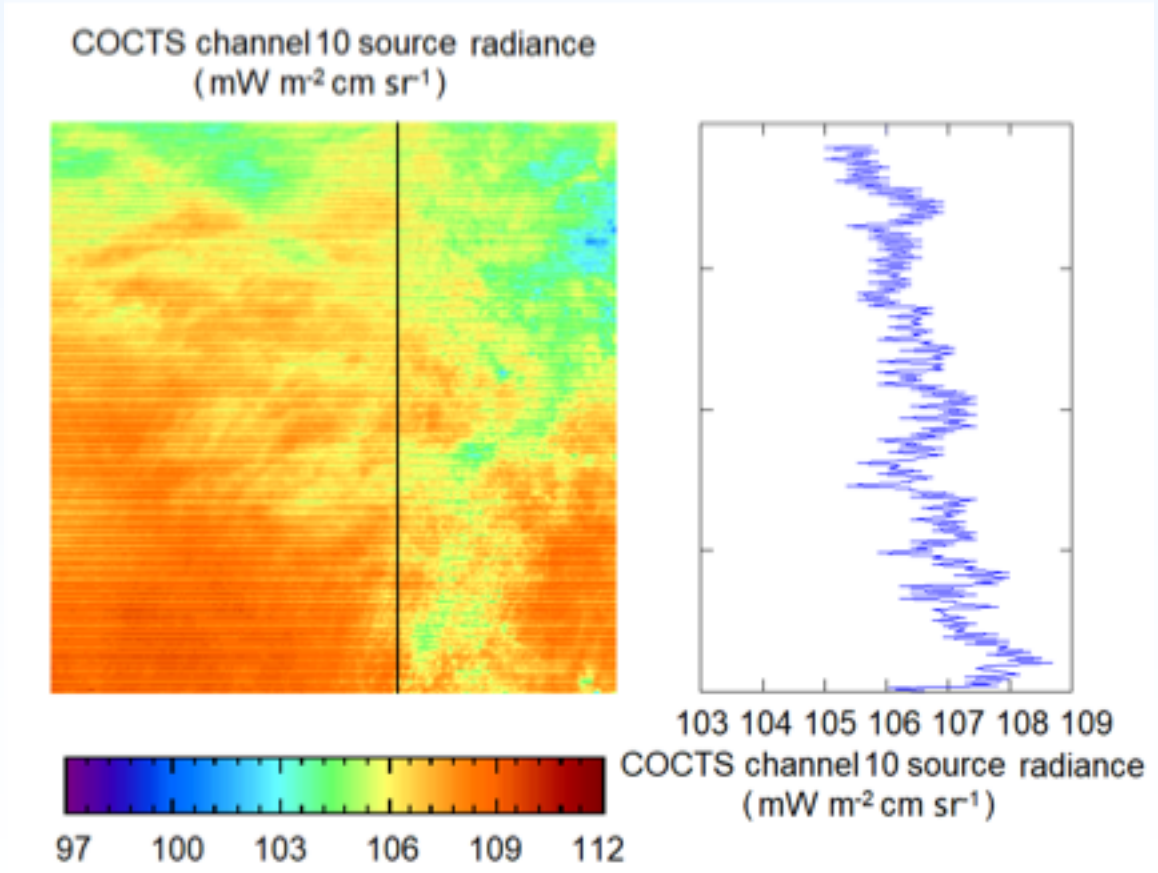
Channel 9

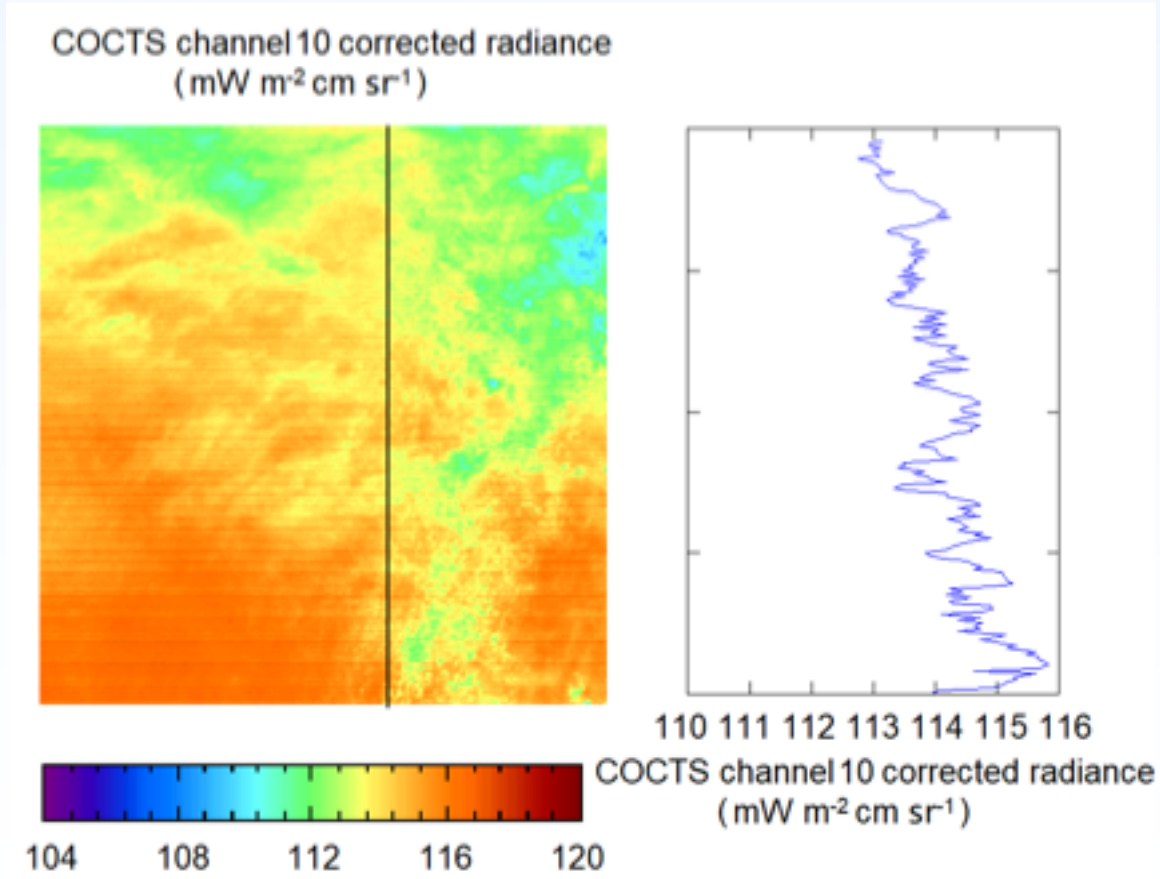




Stripe noise analysis

Channel 10

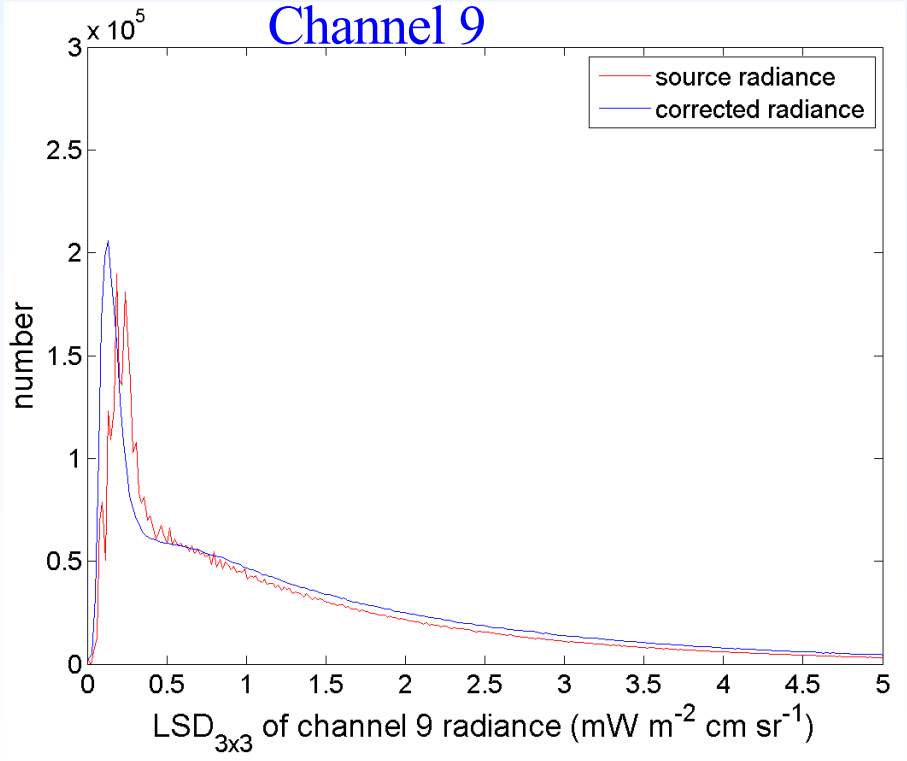




Stripe noise analysis

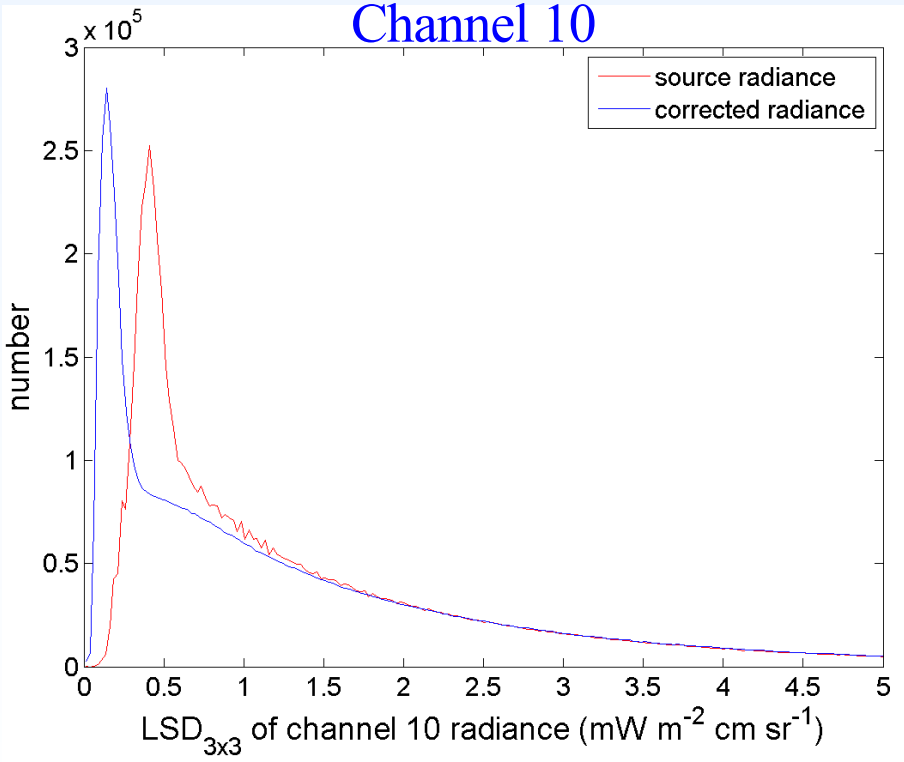
Histogram statistics of local standard deviation (LSD) over 3by3 box

Channel 9



LSD peak values:
Source radiance: 0.18 mW m^{-2} cm sr^{-1}
Corrected radiance: 0.13 mW m^{-2} cm sr^{-1}

Channel 10



LSD peak values:
Source radiance: 0.41 mW m^{-2} cm sr^{-1}
Corrected radiance: 0.11 mW m^{-2} cm sr^{-1}

Conclusion

- COCTS source radiance: lower than IASI with relatively large biases
  strong radiance-dependence in the case of channel 9

- The inter-calibration coefficients: linear robust regression
  individual detectors separately
  two periods separately

- COCTS corrected BT: channel 9 0.01K±0.33K
  channel 10 0.01K±0.35K
  radiance-dependence difference pattern is corrected
  stripe noise is reduced

- The calibration accuracy of COCTS is improved.

Thank you!