ASTER CalVal Status

Hirokazu YAMAMOTO and Satoshi TSUCHIDA
AIST members for the Radiometric Calibration

National Institute of Advanced Industrial Science and Technology

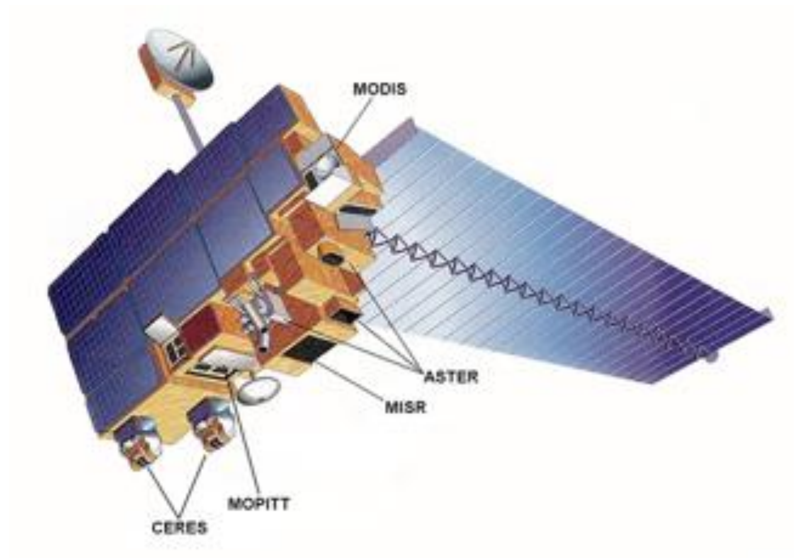
AIST

CEOS WGCV IVOS meetings

Mar. 28, 2019 Perth, Australia

Terra ASTER

- ASTER is developed by Ministry of Economy, Trade and Industry (METI), Japan and is on TERRA satellite managed by NASA.
- The calibration WG in the US-Japan ASTER science team steer the radiometric calibration, and AIST plays a role in many parts in this WG.



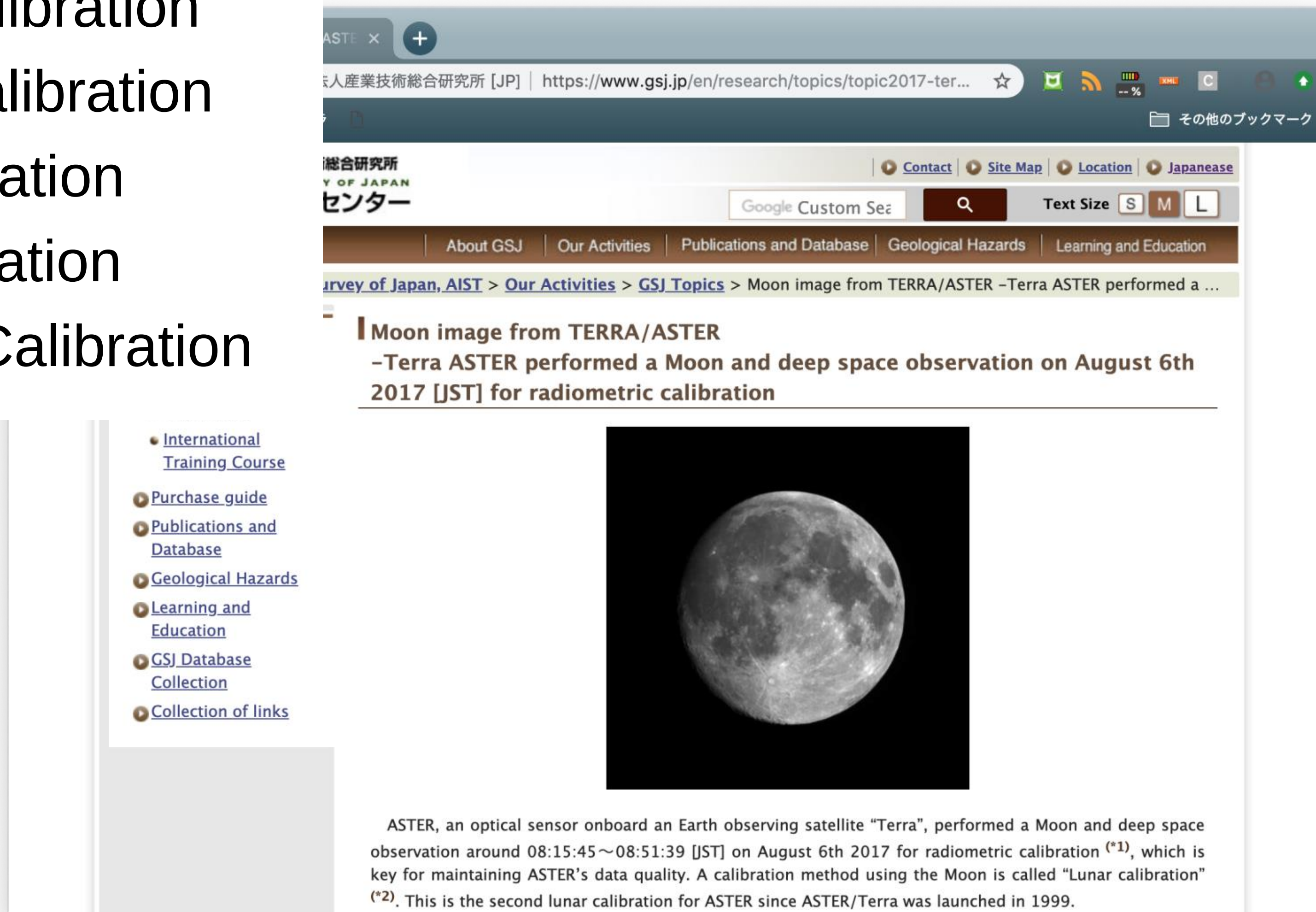
https://www.nasa.gov/mission_pages/terra/spacecraft/index.html

Table 1: ASTER VNIR and SWIR (Band 1∼9)

	Band	Wavelength[μm]
VNIR	Band1	0.520-0.600
	Band2	0.630-0.690
	Band3N	0.760-0.860
	Band3B	0.760-0.860
SWIR	Band4	1.600-1.700
	Band5	2.145-2.185
	Band6	2.185-2.225
	Band7	2.235-2.285
	Band8	2.295-2.365
	Band9	2.360-2.430
	...	...

ASTER radiometric calibration

1. Pre-launch calibration
2. Onboard calibration
3. Vicarious calibration
4. Cross calibration
5. Lunar calibration
6. Inter-band Calibration



ISS HISUI (Hyperspectral Imager)

- Hyperspectral Imager Suite (HISUI) is a future spaceborne hyperspectral Earth imaging system being developed by Japanese Ministry of Economy, Trade, and Industry (METI).
- METI decided the deployment of HISUI on International Space Station (ISS) rather than a dedicated polar orbiting sun synchronous satellite.
- HISUI instrument will be completed and ready for launch by Space X's Dragon in FY2019.

Table 1. HISUI Specifications.

Spatial resolution	20 m (CT) x 30 m(AT)
Swath	20 km
Spectral coverage	0.4 - 2.5 μm
Spectral resolution	10 nm (VNIR) 12.5 nm (SWIR)
Number of band	185
Signal to noise ratio	>450 @ 620 nm >300 @ 2100 nm
MTF	> 0.2
Dynamic range	12 bits
Data compression	Lossless (70%)
Data rate (70 % compression)	0.4 Gbps

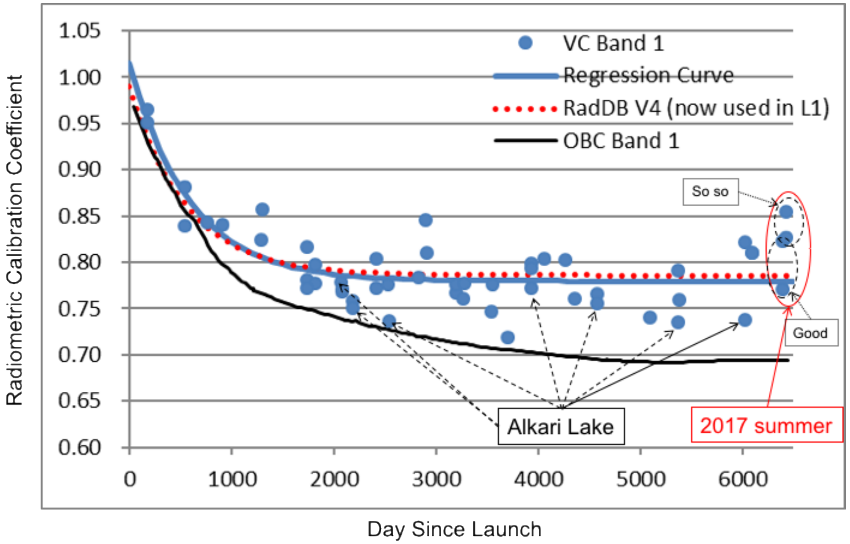
The altitude of ISS is assumed to be 400 km.

Observation frequency of the ISS HISUI will be limited to a few times over each calibration site in one year because of its orbital characteristics.

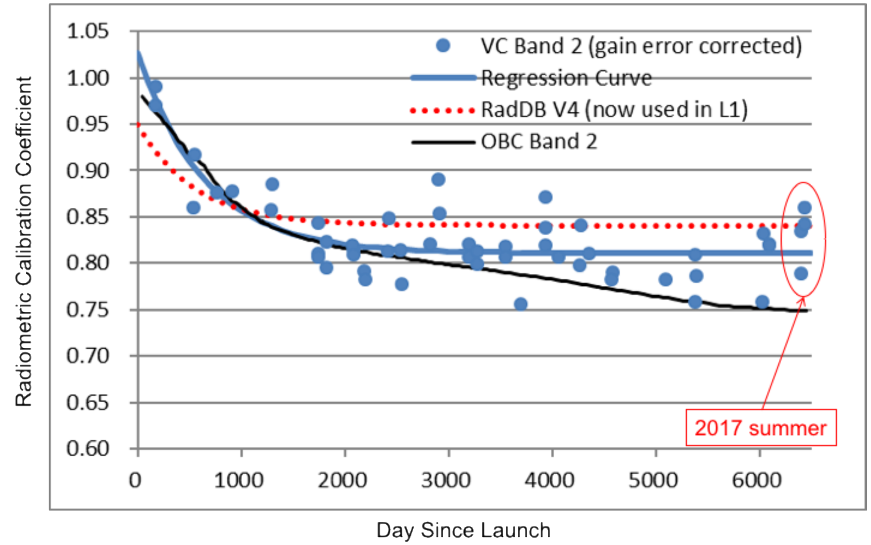
Matsunaga *et al.*, IGARSS, 2018

ASTER degradation curve

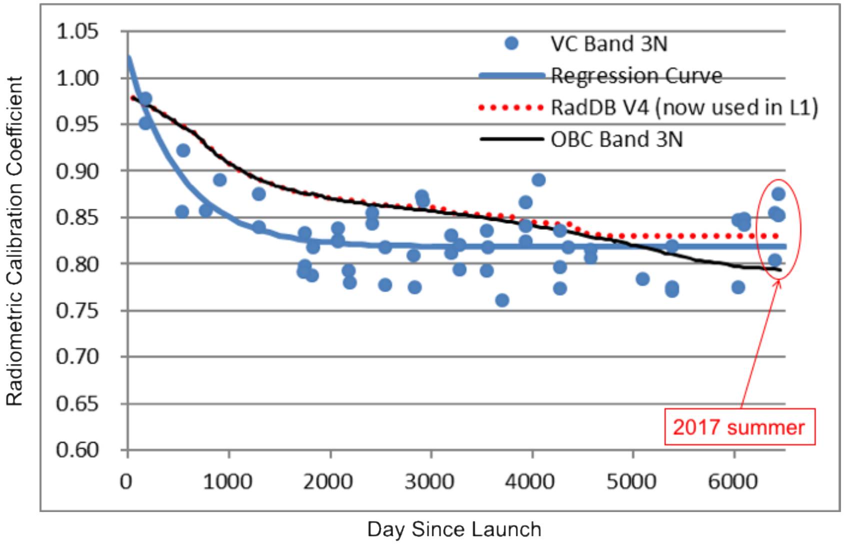
Band 1



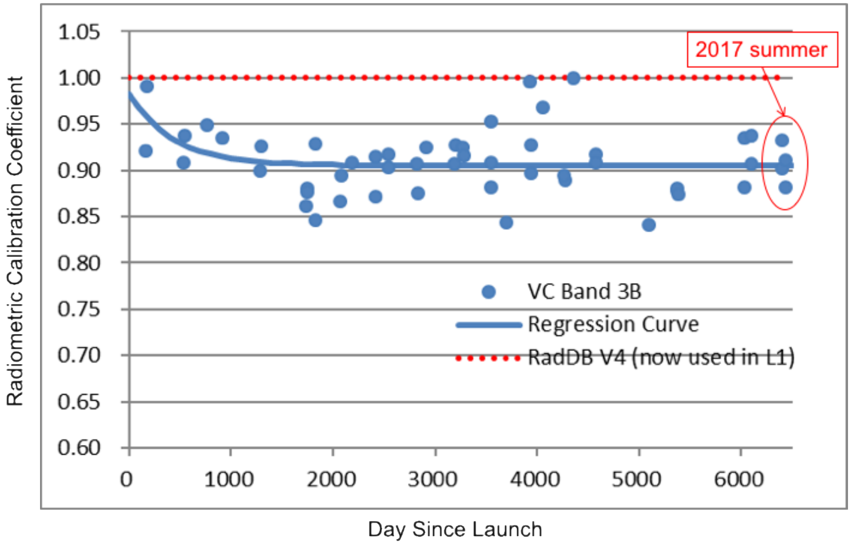
Band 2



Band 3N



Band 3B



Available on both of ASTER and RadCalNet data (RVUS)

Date	Gain	Path/ Row/ VIEW	Nadir	Date	Gain	Path/ Row/ VIEW	Nadir
2013/ 9/ 19	HGH/ HGH/ NOR/ NOR	40-96-4	◎□	2017/ 3/ 22	NOR/ NOR/ NOR/ NOR	40-96-4	◎□
2014/ 9/ 22	NOR/ NOR/ NOR/ NOR	40-96-4	◎□	2017/ 5/ 25	NOR/ NOR/ NOR/ NOR	40-96-4	◎□
2015/ 6/ 5	HGH/ HGH/ NOR/ NOR	40-96-3	▲	2017/ 6/ 24	NOR/ NOR/ NOR/ NOR	42-95-1	✕
2015/ 9/ 25	NOR/ NOR/ NOR/ NOR	40-96-4	◎□	2017/ 6/ 26	NOR/ NOR/ NOR/ NOR	40-96-4	◎□
2015/ 10/ 11	HGH/ HGH/ NOR/ NOR	40-96-4	◎□	2017/ 7/ 19	HGH/ HGH/ NOR/ NOR	41-95-7	✕
2016/ 5/ 29	HGH/ HGH/ NOR/ NOR	41-95-7	✕	2017/ 7/ 26	NOR/ NOR/ NOR/ NOR	42-95-1	✕
2016/ 5/ 29	HGH/ HGH/ NOR/ NOR	41-96-7	✕	2017/ 8/ 29	NOR/ NOR/ NOR/ NOR	40-96-4	◎□
2016/ 7/ 2	NOR/ NOR/ NOR/ NOR	39-96-1	✕	2017/ 9/ 30	NOR/ NOR/ NOR/ NOR	40-96-4	◎□
2016/ 8/ 24	NOR/ NOR/ NOR/ NOR	42-95-1	✕	2018/ 7/ 17	NOR/ NOR/ NOR/ NOR	38-96-1	✕
2016/ 8/ 26	NOR/ NOR/ NOR/ NOR	40-96-4	◎□	2018/ 7/ 17	NOR/ NOR/ NOR/ NOR	38-97-1	✕
2016/ 9/ 11	NOR/ NOR/ NOR/ NOR	40-96-4	◎□	2018/ 7/ 31	NOR/ NOR/ NOR/ NOR	40-96-4	◎□
				2018/ 8/ 16	NOR/ NOR/ NOR/ NOR	40-96-4	◎□
				2018/ 9/ 1	NOR/ NOR/ NOR/ NOR	40-96-4	◎□
				2018/ 10/ 3	NOR/ NOR/ NOR/ NOR	40-96-4	◎□
				2018/ 10/ 19	NOR/ NOR/ NOR/ NOR	40-96-4	◎□

Available on both of ASTER and RadCalNet data (LCFR)

Date	Gain	Path/ Row/ VIEW	Nadir
2016/ 4/ 25	HGH/ HGH/ NOR/ NOR	196-86-3	▲
2017/ 2/ 23	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2017/ 3/ 27	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2017/ 4/ 28	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2017/ 5/ 14	HGH/ HGH/ NOR/ NOR	196-86-3	▲
2017/ 5/ 30	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2017/ 8/ 2	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2017/ 10/ 5	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2017/ 11/ 6	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2017/ 11/ 22	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2018/ 2/ 10	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2018/ 7/ 27	HGH/ HGH/ NOR/ NOR	197-86-7	×
2018/ 8/ 5	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2018/ 8/ 21	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2018/ 9/ 22	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2018/ 10/ 24	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2018/ 11/ 9	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2018/ 12/ 11	NOR/ NOR/ NOR/ NOR	196-86-4	◎□
2018/ 12/ 27	NOR/ NOR/ NOR/ NOR	196-86-4	◎□

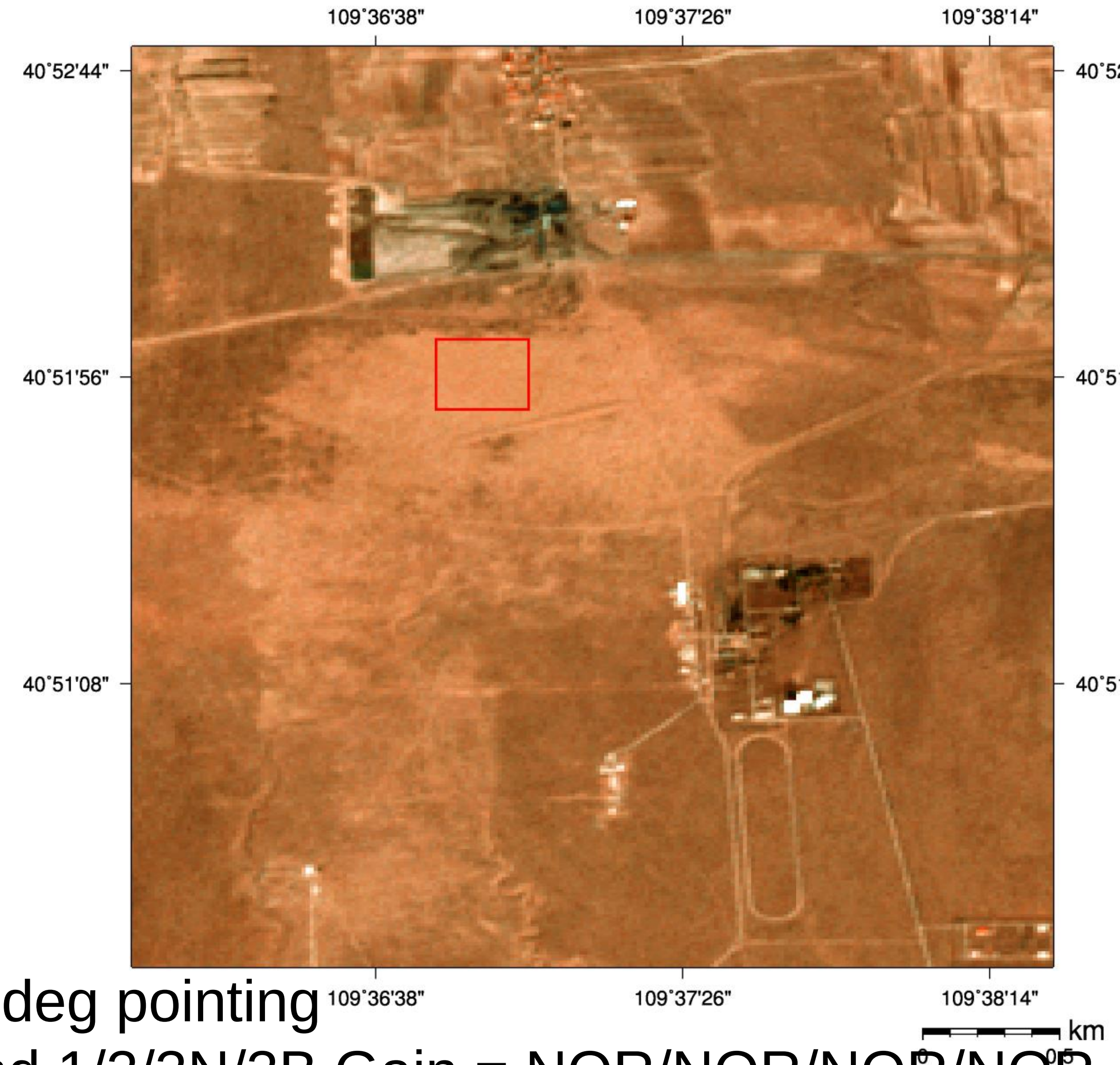
ASTER observation over Gobabeb

Date	Gain	Path/ Row/ VIEW	Nadir
2017/ 9/ 12	HGH/ HGH/ NOR/ NOR	179-212-3	▲
2017/ 10/ 30	HGH/ HGH/ NOR/ NOR	179-212-3	✕
2017/ 11/ 6	HGH/ HGH/ NOR/ NOR	180-212-7	✕
2018/ 3/ 30	NOR/ NOR/ NOR/ NOR	180-212-7	✕
2019/ 3/ 26	NOR/ NOR/ NOR/ NOR	179-212-4	○ □

ASTER observation request

Category : STAR Local
Objective : Calibration
Duration : 3yrs.
Observation : FULL mode (VNIR/SWIR/TIR)
VNIR Gain : NOR/NOR/NOR
Frequency : 1 obs. / 32days (11 obs. / yr)
Usual frequency is 1 obs. / 48 days
Both area of west and east cannot be observed in case of 1 obs. / 16 days.
Cloud : 1~100%
GC : ON
EDS(Expedited Data Set) Flag : OFF
Urgent Flag : OFF

Baotou on Jun 3, 2017

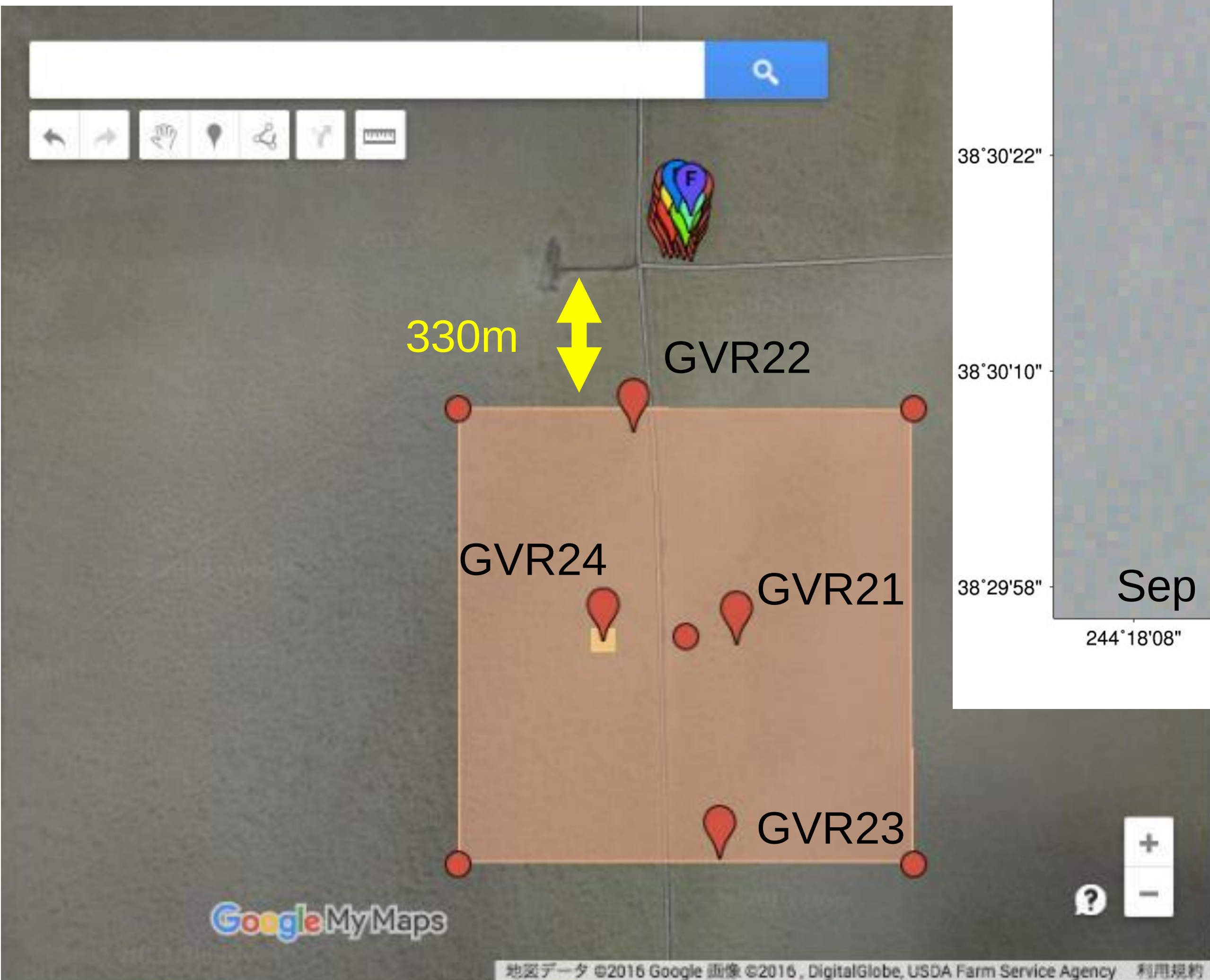


37 ASTER scenes is available over BSCN since 2017 (~Mar 5, 2019).

2.8 deg pointing

Band 1/2/3N/3B Gain = NOR/NOR/NOR/NOR

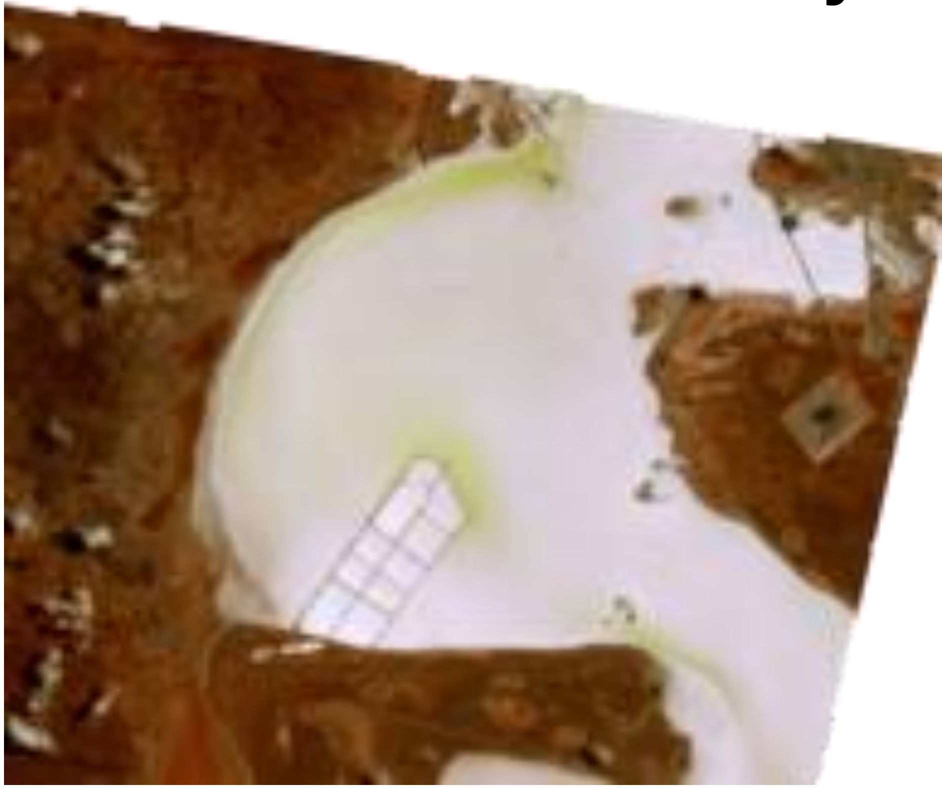
RadCaTS and AIST Vicarious calibration area

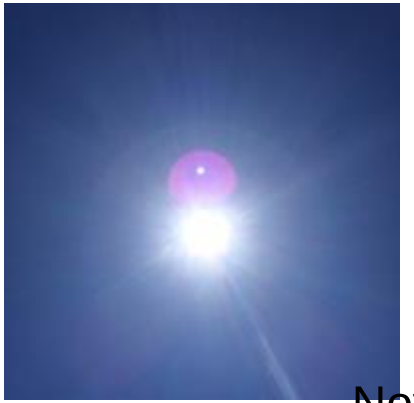


ground-viewing radiometer (GVR)

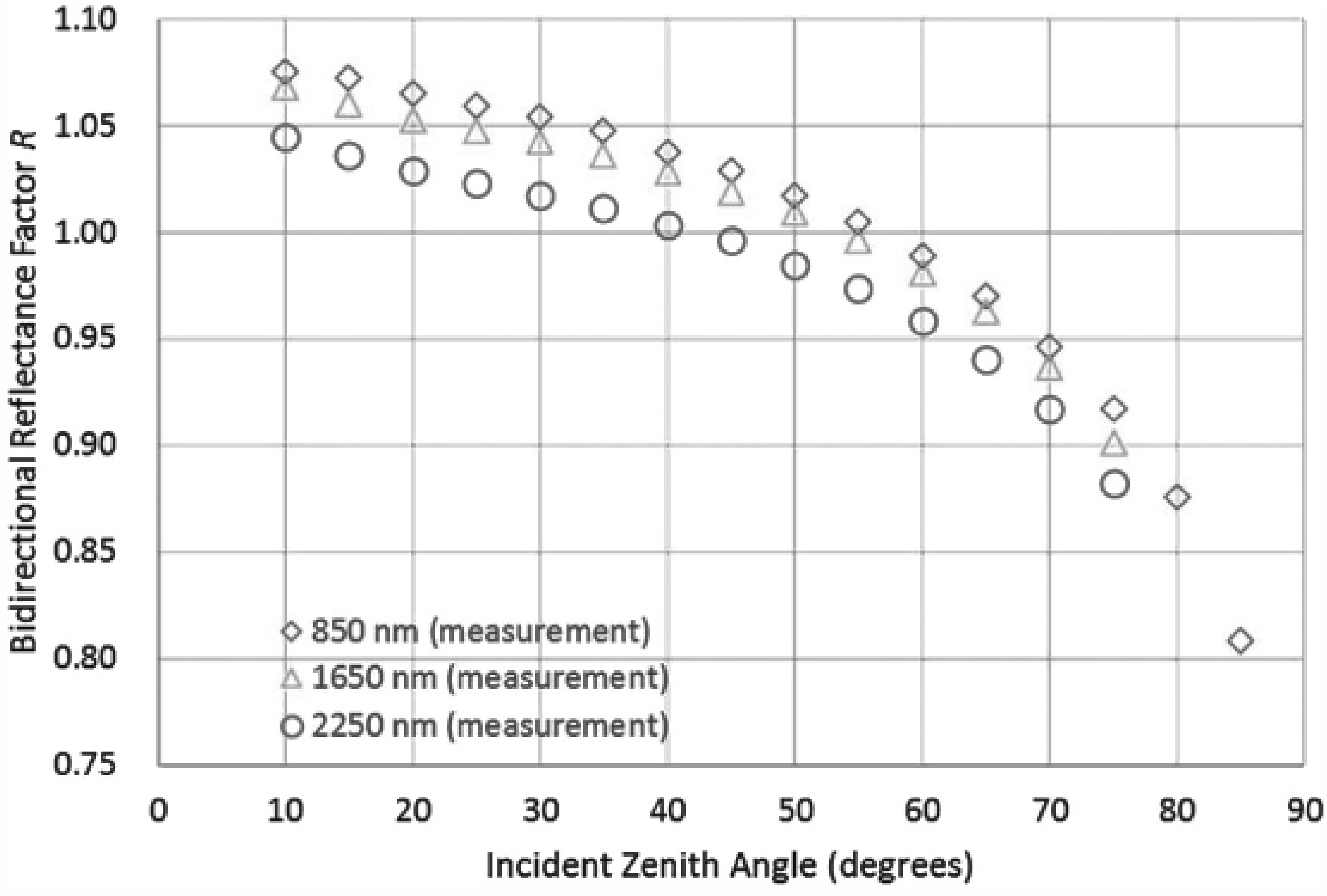
Vicarious calibration experiment over Lake Lefroy


Nov 28, 2014

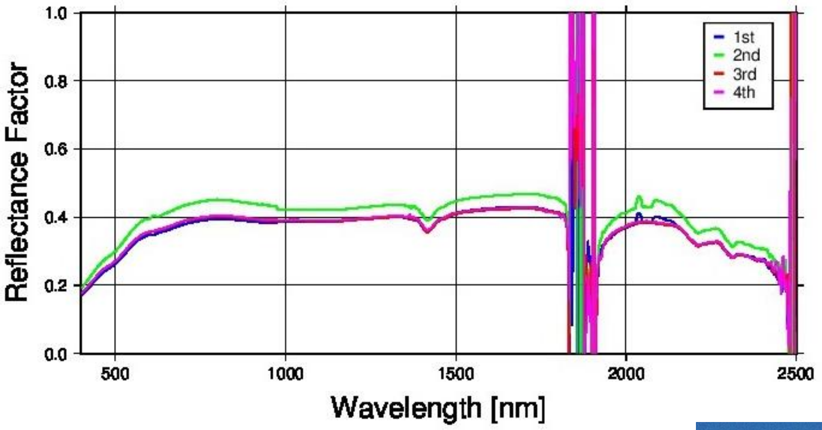


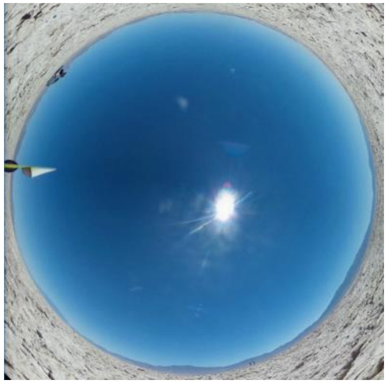



Nov 29, 2014



99% panel, BRDF characterized





Railroad valley

- Vicarious calibration experiment needs very clear sky, and needs various resources (human, time, cost, …)
- When is best time to go to the calibration sites ?

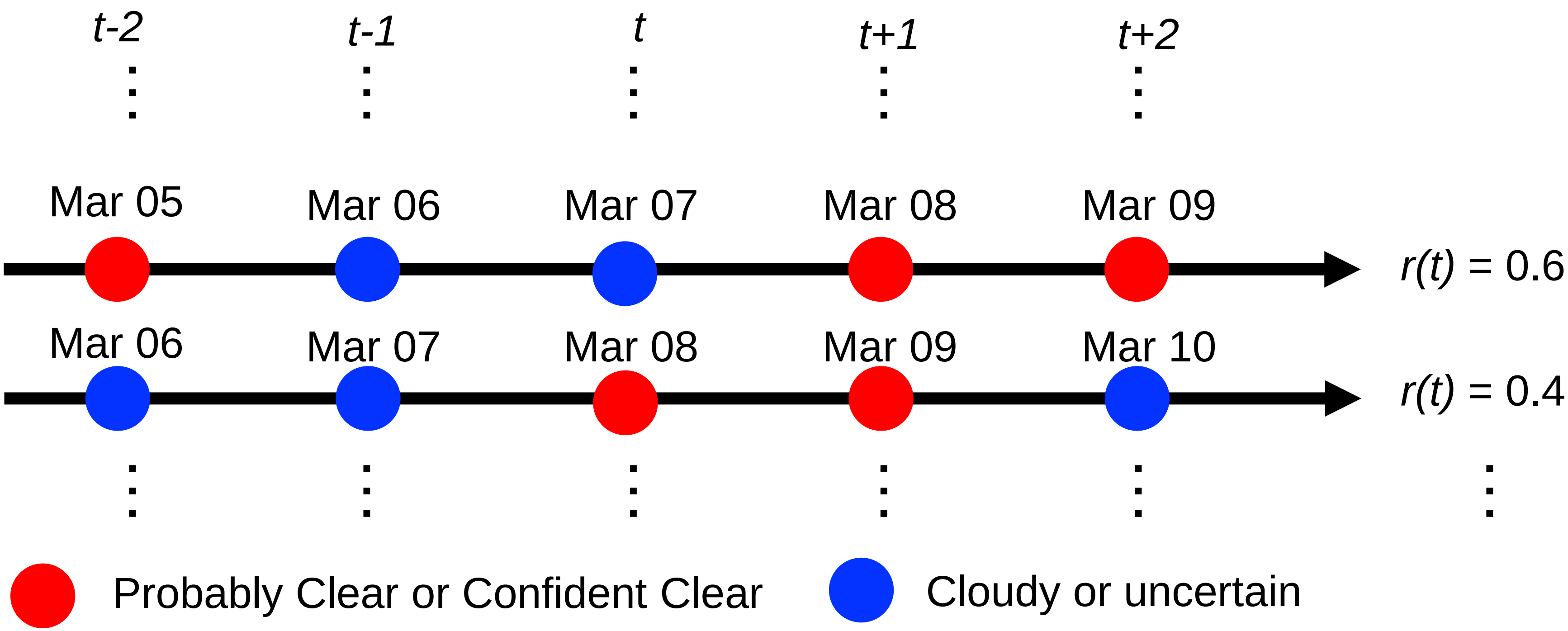
MODIS Cloud Mask product

- The MODIS Cloud Mask product (MOD35_L2 and MYD35_L2) are daily global Level 2 products, and provide 48-bits (6 bytes) field in each 1km pixel.
- The version of all products we used is collection 6.1, which is the latest MODIS cloud mask product.
- This research define "Confident Clear" and "Probably Clear" as clear-sky.
- We use MOD35_L2 from 2000 to 2018, and MYD35_L2 from 2002 to 2018.

Bit fields within first bite of the 48-bit MODIS cloud mask

Bit field	Description	Key
0	Cloud Mask Flag	0 = Not determined 1 = Determined
2, 1	Unobstructed FOV Quality Flag	00 = Cloudy 01 = Uncertain 10 = Probably Clear 11 = Confident Clear
3	Day or Night Path	0 = Night 1 = Day
4	Sunglint Path	0 = Yes 1 = No
5	Snow/Ice Background Path	0 = Yes 1 = No
7, 6	Land or Water Path	00 = Water 01 = Coastal 10 = Desert 11 = Land

Methodology



$$r(t) = \frac{N(t)}{5}.$$

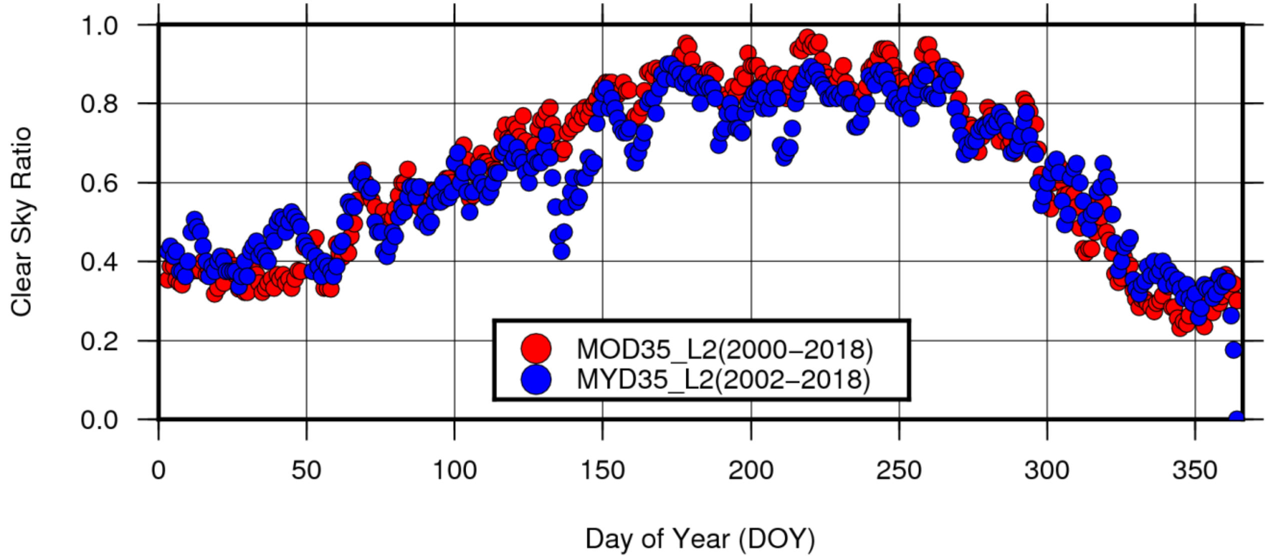
t : Day Of Year (DOY, t=3∼ 363 or 364)

$r(t)$: Clear sky ratio at t

$N(t)$: The number of clear sky days ("Probably Clear" or "Confident Clear" in MOD35_L2 or MYD35_L2 flag) in five days($t-2 \sim t+2$)

- All products are downloaded from the NASA LAADS.
- 10,838 MOD35_L2 and 9,721 MYD35_L2 products were processed.

Mean value of clear sky ratio



Clear sky ratio (>0.900) in the morning :
Jun 25 ~ Sep 18

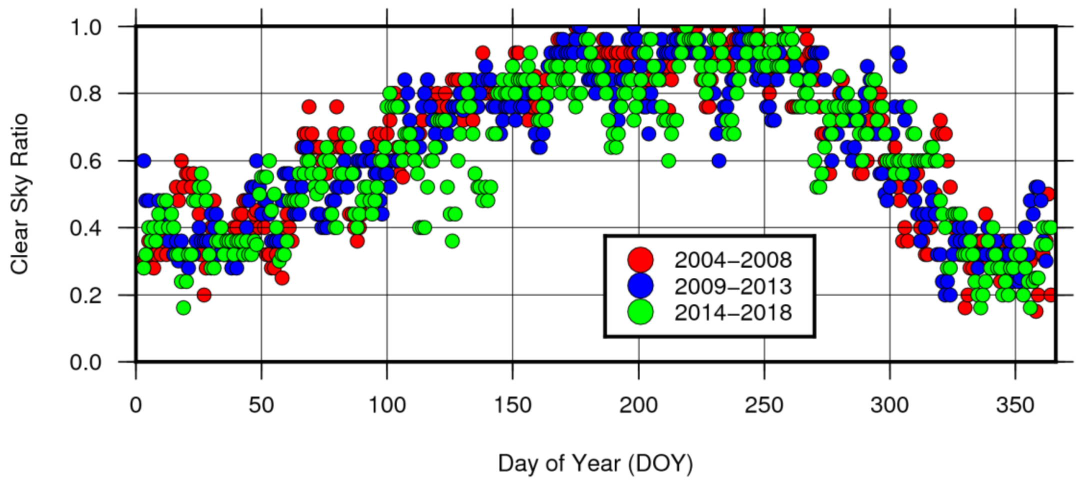
Clear sky ratio (>0.850) in the afternoon:
Jun 19 ~ Sep 25

Season	Product	Mean	Standard Deviation
Spring (Mar,Apr,May)	MOD35_L2	0.641	0.106
	MYD35_L2	0.584	0.090
Summer (Jun,Jul,Aug)	MOD35_L2	0.866	0.045
	MYD35_L2	0.801	0.061
Autumn (Sep,Oct,Nov)	MOD35_L2	0.670	0.192
	MYD35_L2	0.669	0.153
Winter (Dec,Jan,Feb)	MOD35_L2	0.343	0.048
	MYD35_L2	0.387	0.077

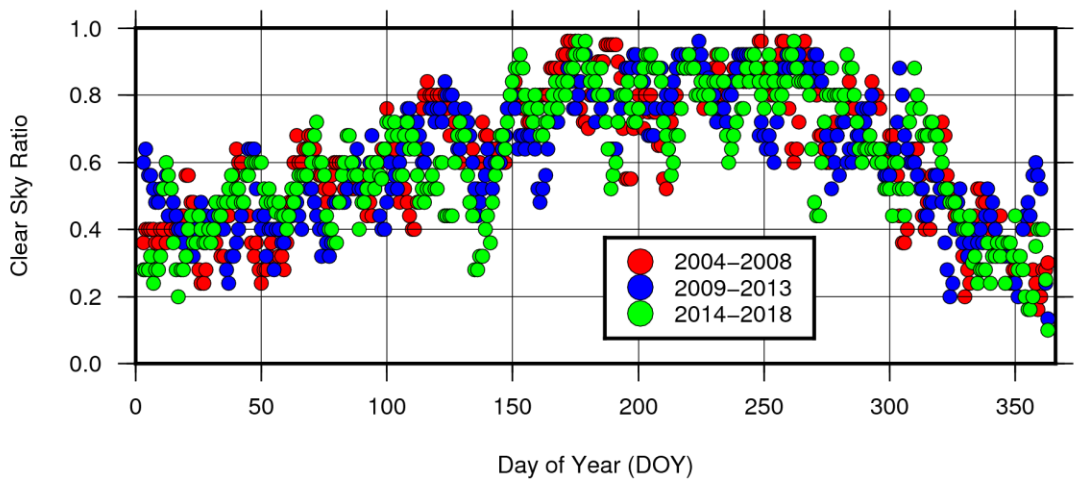
Mean value of clear sky ratio on specific date is calculated from 2000 – 2018 (2002 – 2018).

Clear sky ratio is higher in the morning than afternoon.

Mean value for a five year period of clear sky ratio over Railroad Valley



MOD35_L2



MYD35_L2

Past trend of clear sky ratio is almost same as the current trend.

Conclusions

- Available on both ASTER and RadCalNet data over RVUS and LCFR.
- ASTER over BSCN is available since 2017.
- ASTER observation request over Gobabeb site.
- We plan to compare between ASTER degradation and RadCalNet data.
- ---
- The preferable period for the vicarious calibration experiments over Railroad valley playa is from late June to late September (RVUS).
- Experiments in the morning could have slightly advantages to afternoon experiments (RVUS).