MODIS Science Team Meeting

Land Surface Temperature and Emissivity MOD11 Status

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MODIS LST Products

Credit also to:

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Outline of the Presentation

MODIS LST Algorithms

Products and a scheme to remove cloud-contaminated LST values

Validations of L1B TIR bands and LST products

Applications of the MODIS LST products

Plan for 2002

Conclusion of the MOD11 Status

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MODIS LST Algorithms

1. The generalized split-window algorithm
   (Wan & Dozier, 1996)
   - coefficients depend on view angle, atmospheric column water vapor, and surface air temperature.
   - emissivities estimated from land cover types.
     (Snyder et al., 1998; Snyder & Wan, 1998)
2. The MODIS day/night LST algorithm (Wan & Li, 1997)
   - retrieve daytime, nighttime, & band emissivities simultaneously with day/night data in seven bands.
   - be able to adjust the input cwv and Ta values.
   - the range of viewing zenith angle separated into 4 sub-ranges (0-40, 40-52, 52-60, 60-65).

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MODIS LST Products

1. The daily daytime & nighttime 1km LST product retrieved by the split-window method using b31 & b32.

   - MOD11_L2 as granules

   - MOD11A1, L3, as 1km-grid ISIN tiles

   - two SDSs in MOD11B1 for 1km LST aggregated at 5km grids.

2. MOD11A2 – 8-day 1km LST product in ISIN tiles.

3. MOD11B1 - daily LST/emissivity product retrieved by the day/night LST method with bands 20, 22-23, 29, 31-33.

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MODIS LST Products (cont.)

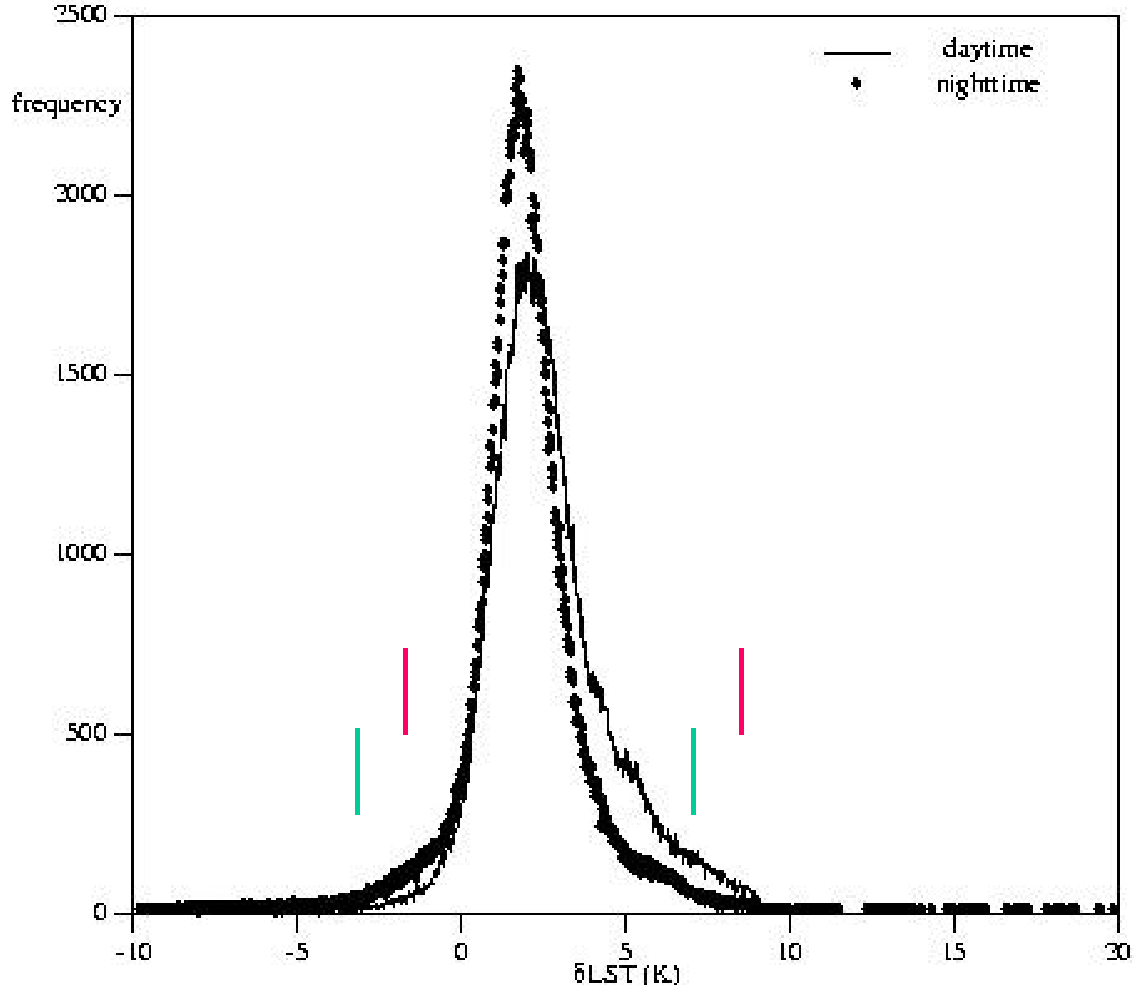
A. MODIS data used in the LST production: MOD021KM, MOD03, MOD07_L2, MOD10_L2, MOD12Q1, and MOD35_L2.

B. Only clear-sky pixels at 99% confidence defined by MOD35_L2 are processed in the LST production.

C. A double-screen scheme can be used to remove the LST values contaminated with cloud effects

- screen off 1% by the lower and upper ends of __ distributions of the LSTs retrieved by the two methods.
- screen off 0.5% by the lower and upper ends of the _(_$_{day}$-T$_{night}$) distribution .

Screening off the cloud-contaminated LST values (I)



Histgram of the difference between the 5km and 1km LSTs over the North America Continent between latitudes 20-50° on 21 July 2001.

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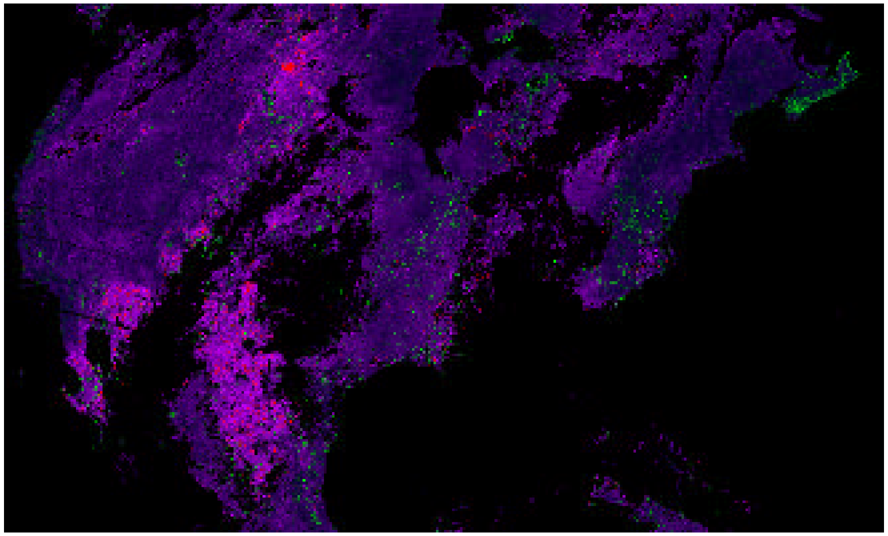
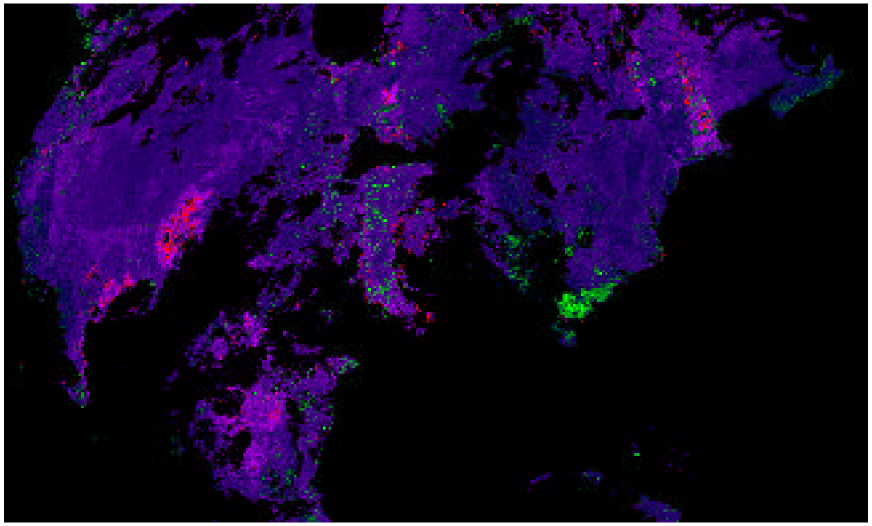
Screening off the cloud-contaminated LST values (II)



The positive and negative components of the daytime _(_5km – _1km) distribution as RGB. The points in brightest red and green will be screened off (left image)

®these brightest points are close to the cloud edges!

Similarly for the nighttime LST (image in right)



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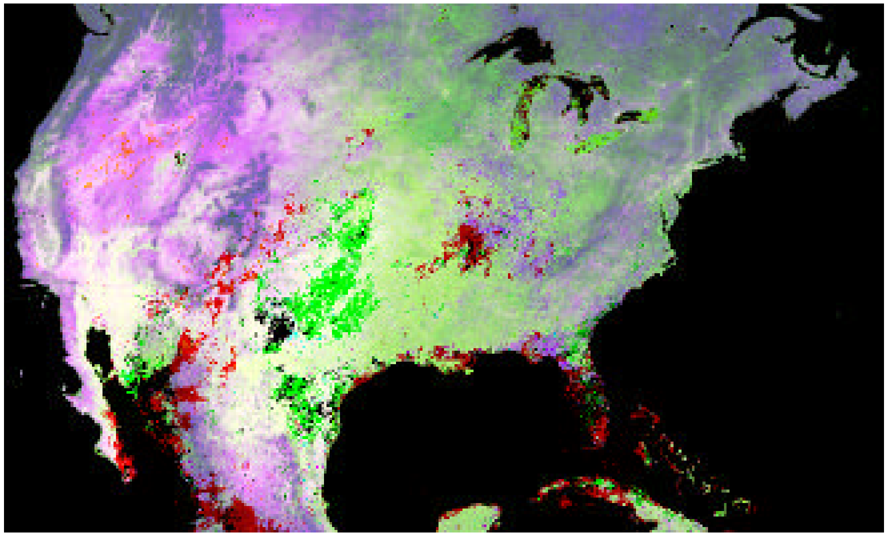
Screening off the cloud-contaminated LST values (III)



Color composite of the 5km daytime and nighttime LSTs and their difference as RGB in 8-day period of July 20-27, 2001 after the double-screen scheme is applied.

Color composite of the 5km emissivities in bands 29, 22, and 20 (image in right).

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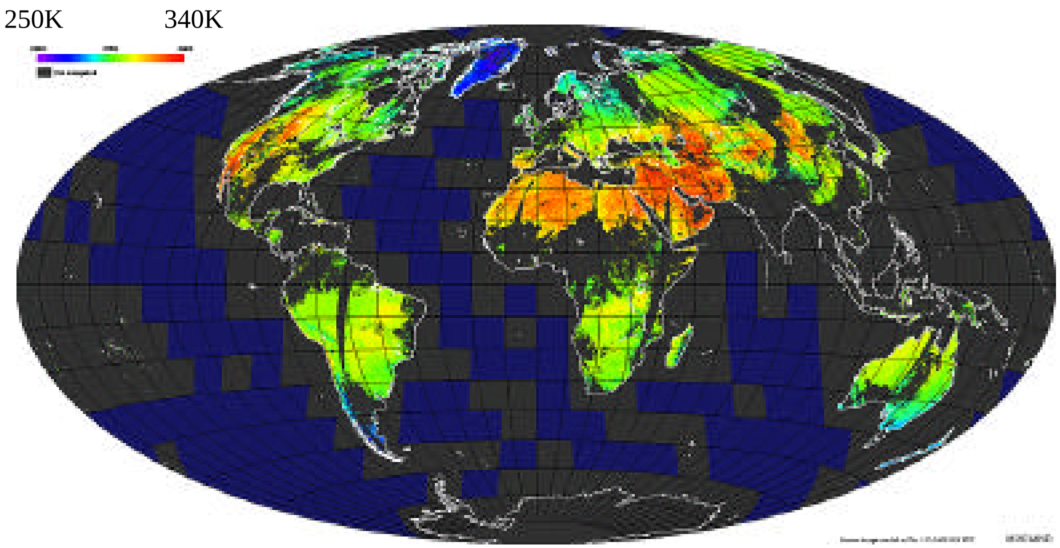
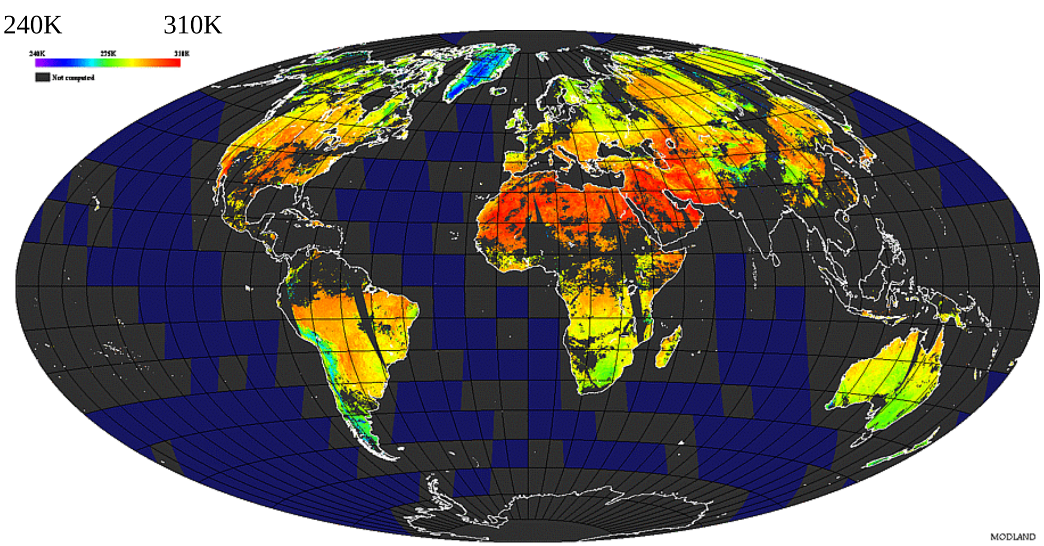
Examples of the Global MODIS LST Product

(courtesy of the MODLAND browse page)



(daytime 3 Aug 2001)



(nighttime 3 Aug 2001)

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Validation of the MODIS TIR data and LST products

Four field campaigns in 2000:

1. Early April in Mono Lake and Bridgeport grassland, CA;
2. May/June in Lake Titicaca, Bolivia;
3. Late July in Railroad Valley NV, Mono Lake, the grassland and a rice field in CA;
4. Early October in Mono Lake and Bridgeport, CA.

Four field campaigns in 2001:

1. March-April in Bridgeport CA and Walker Lake in NV;
2. mid-late July in Railroad, Mono Lake, and Bridgeport;
3. August in Bridgeport and Walker Lake;
4. October in Walker Lake and Bridgeport.

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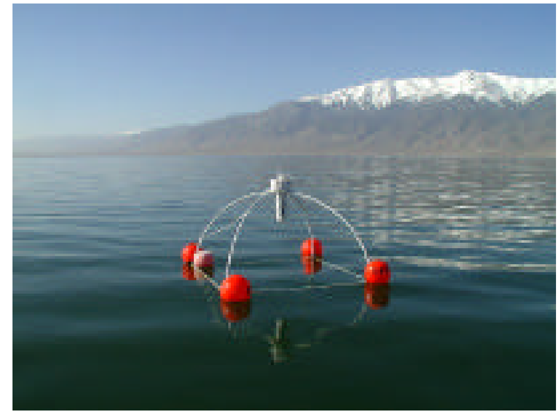
Validation of the MODIS TIR data and LST products (test sites)

Lake Titicaca

Mono Lake, CA



Walker Lake, NV

Rice field in Chico, CA

Bridgeport grassland, CA

Snowcover, Bridgeport, CA

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Estimated Calibration Bias in MODIS L1B Data

Band no.	20	21	22	23	29	31	32
A __(K)	+0.63	+0.70	+0.15	-0.08	-0.12	+0.09	+0.05
B __(K)	+0.61	+0.46	+0.55	+0.40	+0.02	+0.12	-0.19

A, __ in new A-side MODIS L1B data based on Walker Lake, NV field campaign, 10/18/01.
B, __ in old A-side MODIS L1B data based on Lake Titicaca, Bolivia campaign in June 2000.

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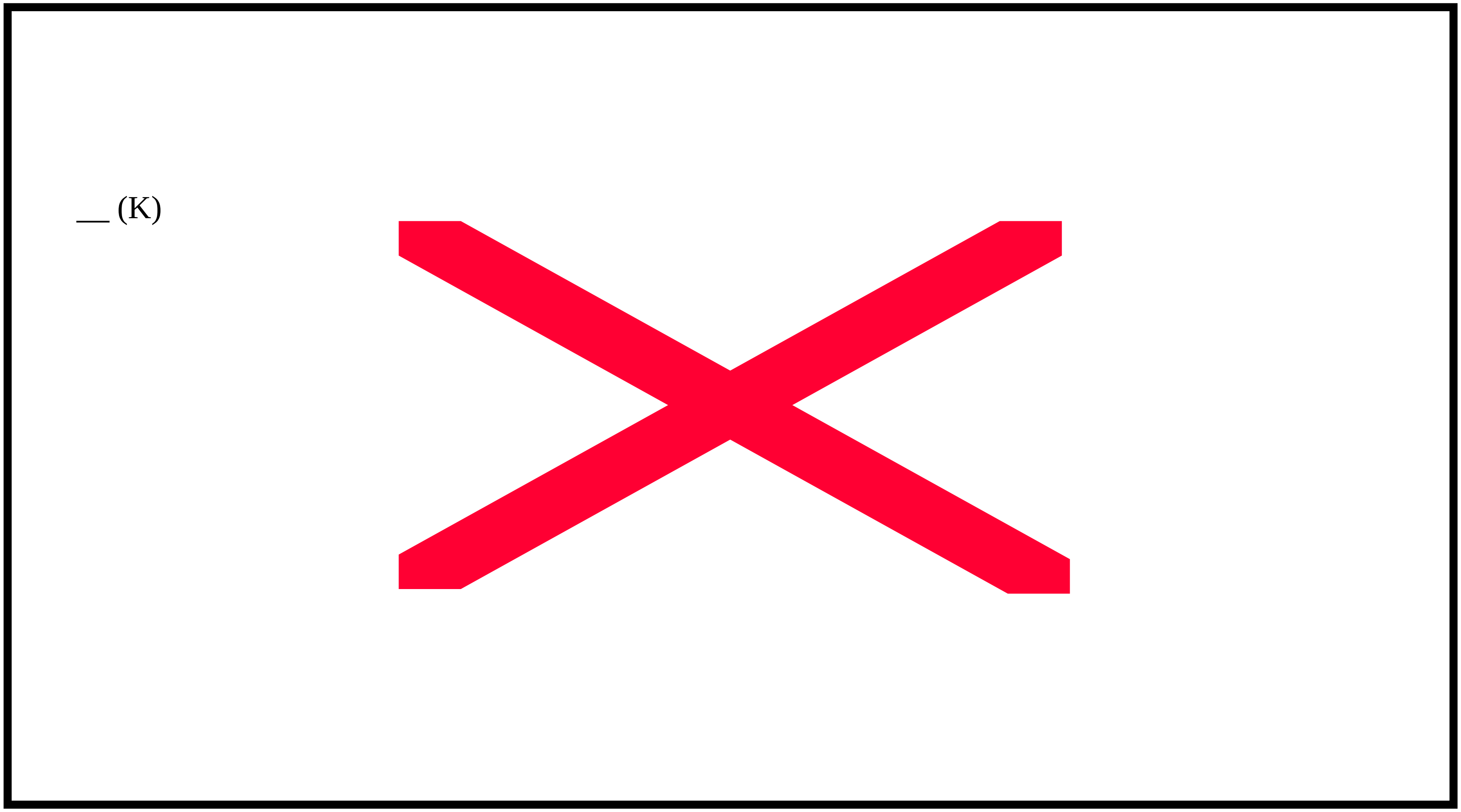
Estimated Calibration Bias in MODIS TIR Bands



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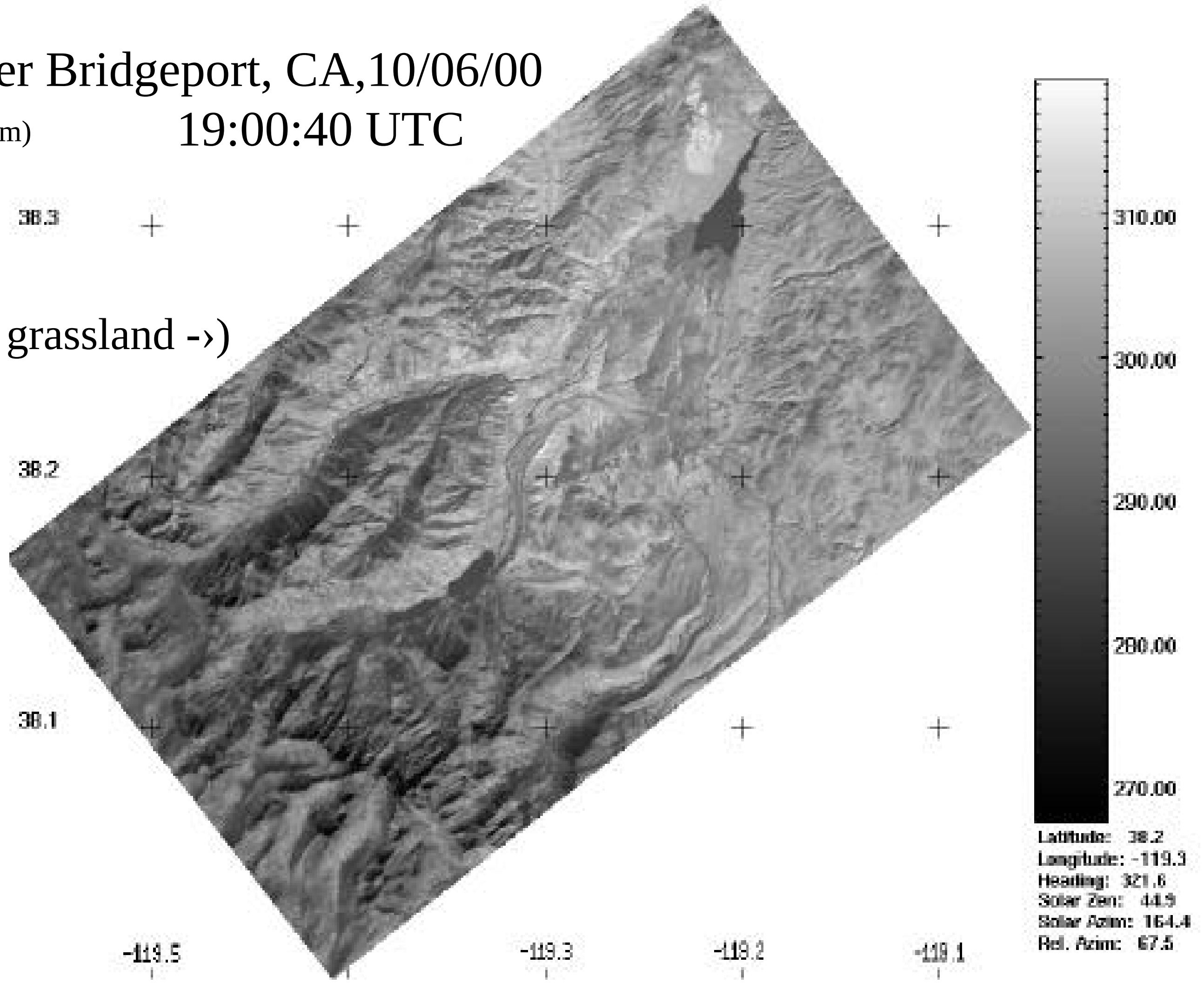
Validation of the MODIS LST products

(spatial variations in daytime LST shown in MAS data - 1)

MAS data over Bridgeport, CA,10/06/00

(band 45 at 10.95_m) 19:00:40 UTC

(variation of ± 5K in grassland -›)



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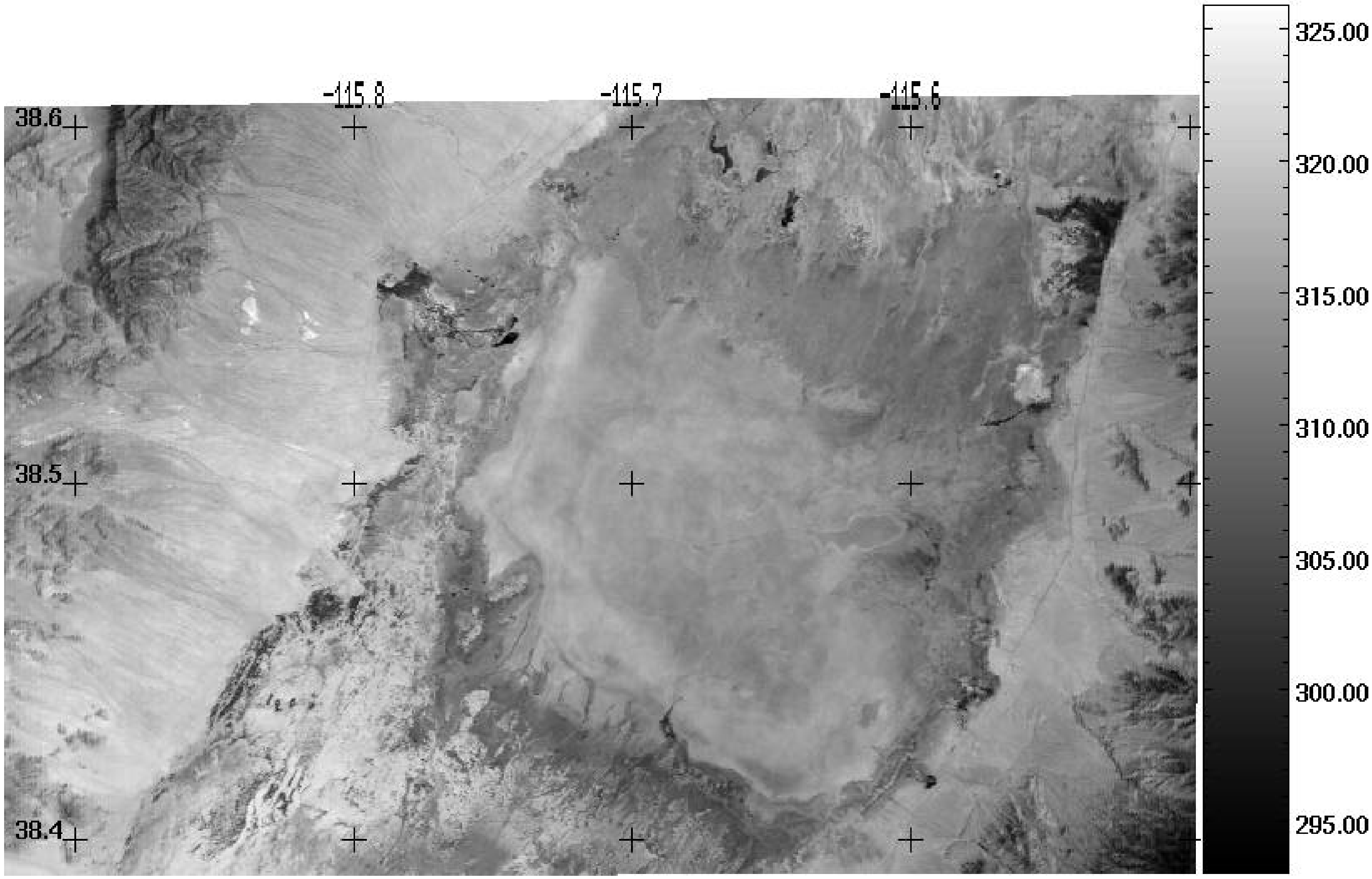
Validation of the MODIS LST products

(spatial variations in daytime LST shown in MAS data - 2)

(about a few K in the central part of playa)



MAS data over Railroad Valley, NV, 23 June 1997

(band 45 at 10.95_m) 18:11:18 UTC

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Validation of the 1km MODIS LST Product (I)
(in lake sites)

case no.	site	Lat. Lon.	date (m/d/y) time	view zenith azimuth	atmos. cwv (cm)	in situ T_s (K) (no.)	In situ δT_s (K)	MODIS T_s (δT_s) version	MODIS -in situ T_s(K)
1	A	37.9712ºN 119.0014ºW	4/04/00 11:19 PST	22.38º -78.35º	2.2 (0.36)	283.81 (4)	0.52	284.7 (0.2) 2.4.2	+0.9
2	A	37.9930ºN 118.9646ºW	7/25/00 11:18 PST	22.09º -79.37º	2.1	296.01 (3)	0.15	296.3 (0.2) 2.5.4	+0.3
3	A	38.0105ºN 118.9695ºW	10/06/00 11:11 PST	11.35º -78.19º	1.4 (0.62)	290.17 (4)	0.23	290.4 (0.1) 2.4.3	+0.2
4	B	16.2470ºS 68.7230ºW	6/15/00 15:26 UTC	34.3º -82.7º	1.1 (0.29)	285.0 (5)	0.3	285.5 (0.5) 2.5.4	+0.5
5	C	38.6972ºN 118.70802ºW	10/18/01 10:57 PST	0.74º -100.23º	0.81 (0.95)	290.56 (4)	0.1	290.74 (0.2) 3.0.0	+0.2

A. Mono Lake, California
B. Lake Titicaca, Bolivia
C. Walker Lake, Nevada

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Validation of the 1km MODIS LST Product (II)

(over grassland and rice field)

case no.	site	Lat. Lon.	date (m/d/y) time	view zenith azimuth	atmos. cwv (cm)	in situ T_s (K) (no.)	In situ δT_s (K)	MODIS T_s (δT_s) version	MODIS -in situ T_s(K)
6	A	38.2255°N 119.2680°W	4/04/00 11:19 PST	20.00° -79.38°	2.6	308.2 (4)	0.9	307.3 (2.3) 2.4.2	-0.9
7	B	38.2202°N 119.2693°W	7/27/00 22:09 PST	11.81° 81.33°	1.6	281.63 (4)	0.6	282.4 (0.4) 2.5.4	+0.8
8	B	38.2202N 119.2693°W	7/29/00 21:57 PST	32.36° 77.56°	2.4	283.24 (4)	0.6	283.0 (0.2) 2.5.4	-0.2
9	C	39.5073°N 121.8107°W	7/27/00 22:10 PST	26.1° 77.3°	1.4	291.20 (1)		292.1 (0.5) 2.5.4	+0.9
10	C	39.5073°N 121.8107°W	7/29/00 21:57 PST	42.67° 75.8°	3.0	293.02 (1)		292.9 (0.8) 2.5.4	-0.1
11	D	38.2199°N 119.2683°W	3/11/01 22:36 PST	40.48° -97.32°	0.4	263.50 (2)	0.2	263.7 (0.2) 3.0.0	+0.2

A. Bridgeport, California
B. Bridgeport, grassland
C. Rice field, California
D. Bridgeport, snowcover

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Validation of the 1km MODIS LST Product Corrected with 5km LST

(for the errors due to uncertainties in emissivities, cwv, and Ta)

case no.	site	Lat. Lon.	date (m/d/y) time	view zenith azimuth	atmos. cwv (cm)	in situ T_s (K) (no.)	In situ δT_s (K)	MODIS T_s (δT_s) (K)	MODIS T_s^c (K)	T_s^c - in situ T_s(K)
1	A	38.2199ºN 119.2683ºW	3/11/01 22:36 PST	40.48º -97.32º	0.4	263.5 (2)	(0.2)	263.7 (0.2)	264.0	+0.5
2	B	38.4614ºN 115.6914ºW	7/27/00 22:09 PST	15.68º -98.85º	0.77 (1.04)	289.9 (2)	(0.3)	288.7 (0.1)	289.3	-0.6
3	B	38.4617ºN 115.6927ºW	7/18/01 10:35 PST	22.25º 99.48º	1.25 (0.86)	321.2 (3)	0.8	318.5 (0.7)	321.3	+0.1
4	B	38.4617ºN 115.6925ºW	7/19/01 11:17 PST	47.36º -75.12º	1.12	321.3 (3)	2.7	319.2 (0.5)	322.0	+0.7
5	B	38.4617ºN 115.6926ºW	7/19/01 22:21 PST	43.78º -96.05º	0.64	287.4 (3)	0.3	286.1 (0.4)	287.4	+0.0
6	B	38.4617ºN 115.6926ºW	7/20/01 21:26 PST	44.40º 75.49º	0.69	289.7 (4)	0.3	287.5 (0.2)	289.6	-0.1
7	B	38.4630ºN 115.6930ºW	7/21/01 11:05 PST	32.54º -77.26º	0.68 (0.92)	320.1 (7)	0.4	317.7 (0.4)	319.8	-0.3
8	B	38.4630ºN 115.6930ºW	7/23/01 21:57 PST	5.0º -98.04º	1.01	290.7 (4)	0.5	288.8 (0.6)	290.6	-0.1

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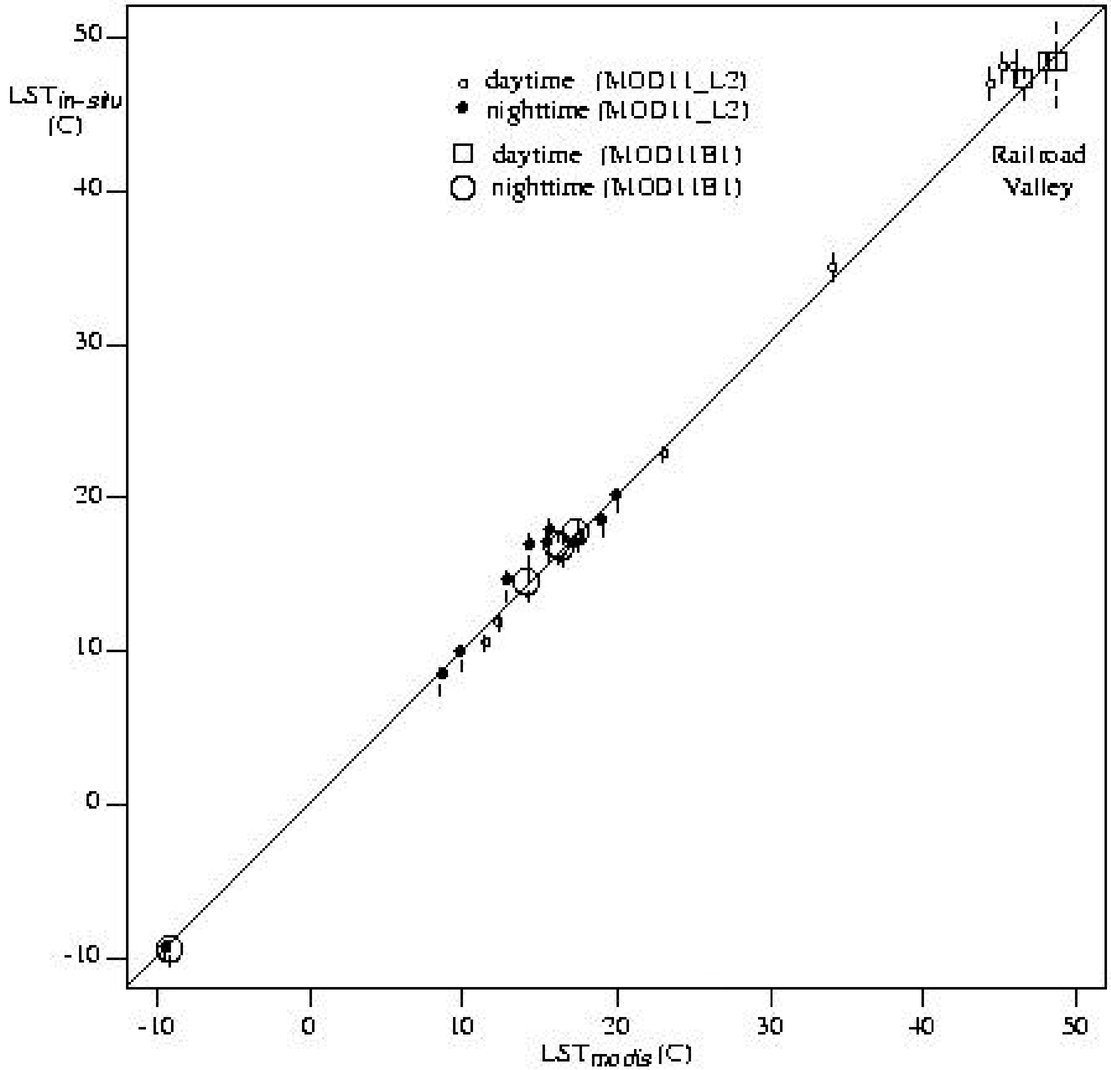
A. Bridgeport snowcover

B. Silt playa in Railroad Valley, Nevada

Validation results of the MODIS LST products



Comparison between the MODIS LSTs and the LSTs from in-situ measurements.

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Applications of the MODIS LST product

- to validate and improve the global meteorological model prediction
- to estimate the diurnal cycle for global change studies
- in estimate and parameterization of surface fluxes
- used in land cover classification and change studies
- to evaluate water requirements of crops
- to estimate drought-ness and surface soil moisture

Plan for 2002

1. To validate the MODIS LST products with in situ data in the Australia topical site (Hook &Prata).

2. To conduct field campaigns in the CA central valley and a few site in the heart land of US in wet seasons.

3. To generate LST products from Aqua MODIS data.

4. To provide validated LST products.

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Conclusion of the MOD11 Product Status

1. The LST products were validated within 1K with in situ LSTs in 19 cases (including 14 cases over land sites) in the LST range of 263-322K and the atmospheric cwv range of 0.4-3.0cm.

2. Validated MODIS LST products will be generated in the next reprocessing (July 2002?).

3. It is expected that the combined use of Terra and Aqua MODIS data will improve the LST quality significantly.

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