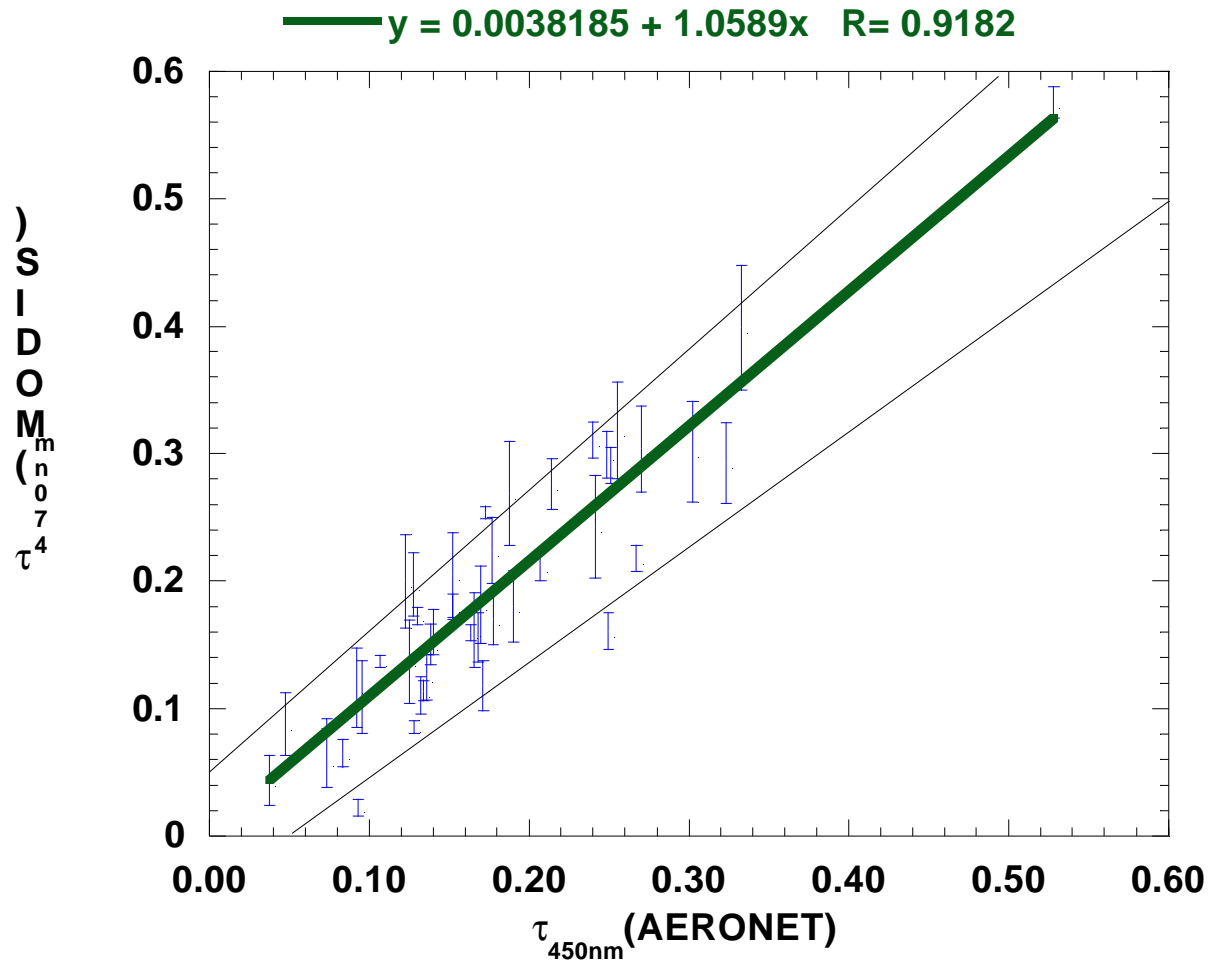# MODIS surface reflectance product status and validation

Vermote et al.

University of Maryland/ Dept of Geography
and
NASA/GSFC Code 923

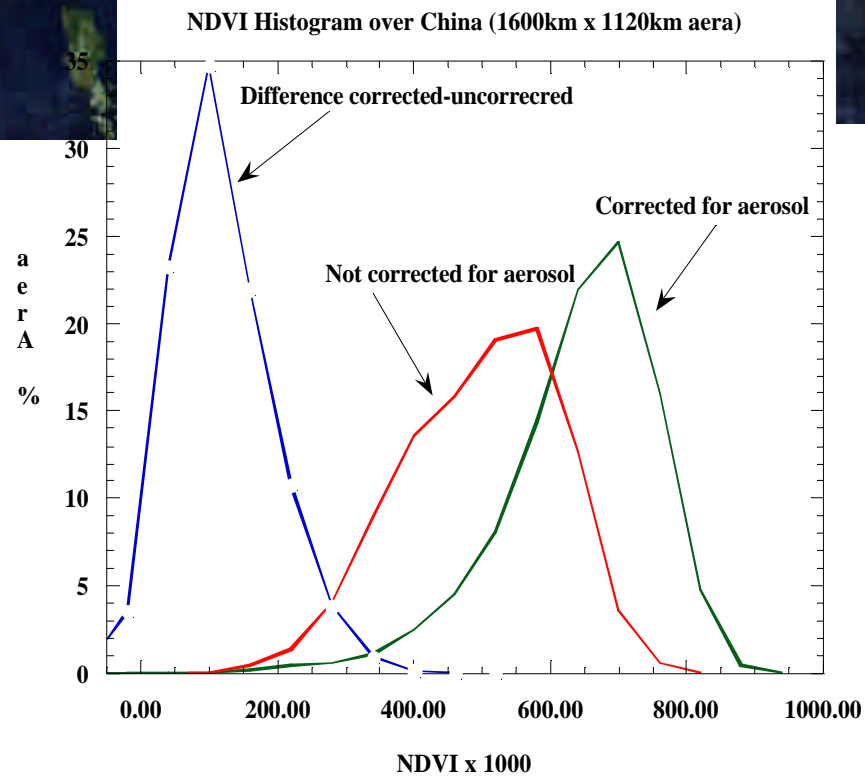# MODIS aerosol optical depth validation

Comparison of aerosol optical thickness retrieved by MODIS blue channel
with AERONET sunphotometer measurements during the April,24,2000 to June,10,2000
period

Prototype correction details over China (monthly composite)
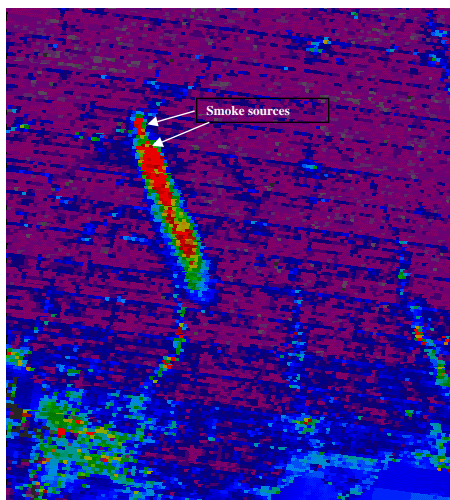
No aerosol correction

Aerosol correction

NDVI Histogram over China (1600km x 1120km aera)

Difference corrected-uncorrecred

Corrected for aerosol

Not corrected for aerosol

aerA %

NDVI x 1000

MODIS 1km aerosol product

Uncorrected for aerosol

Smoke plume

Mississippi

Baton Rouge

Corrected for aerosol

Residual aerosol contamination
near the sources (fires)

Mississippi

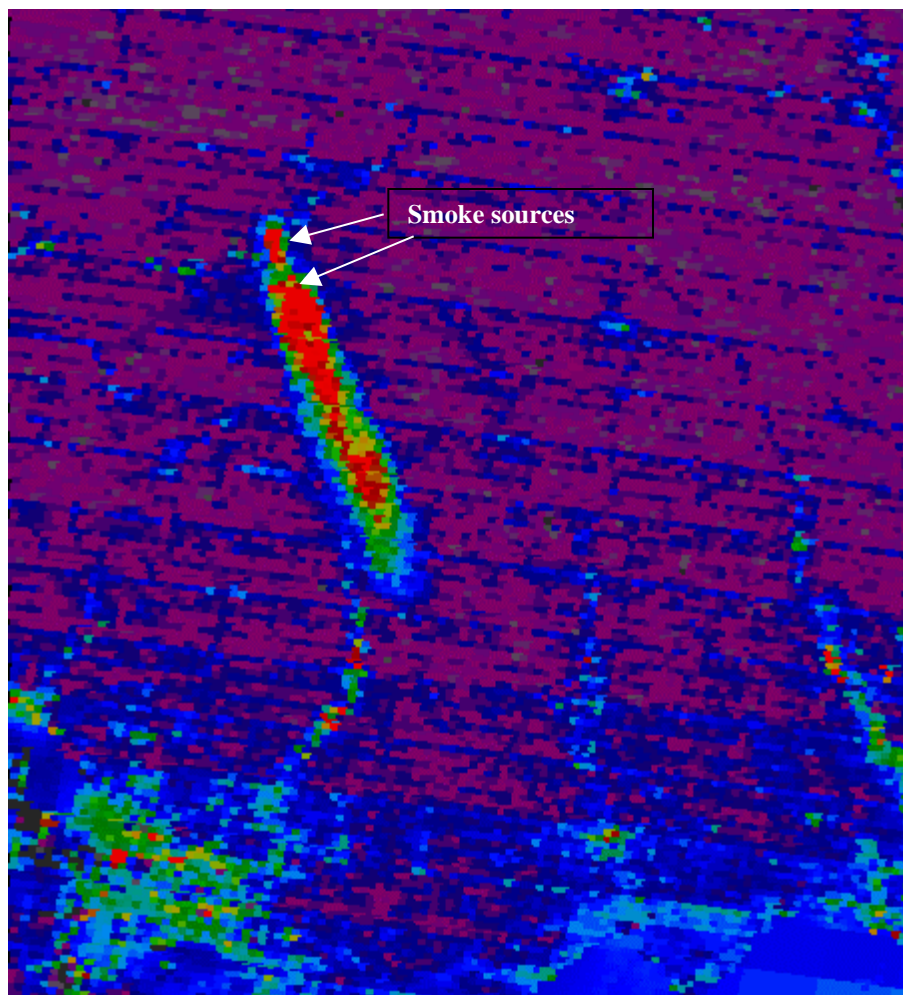Baton rouge

Smoke sources

Aerosol optical thickness (1km resolution)
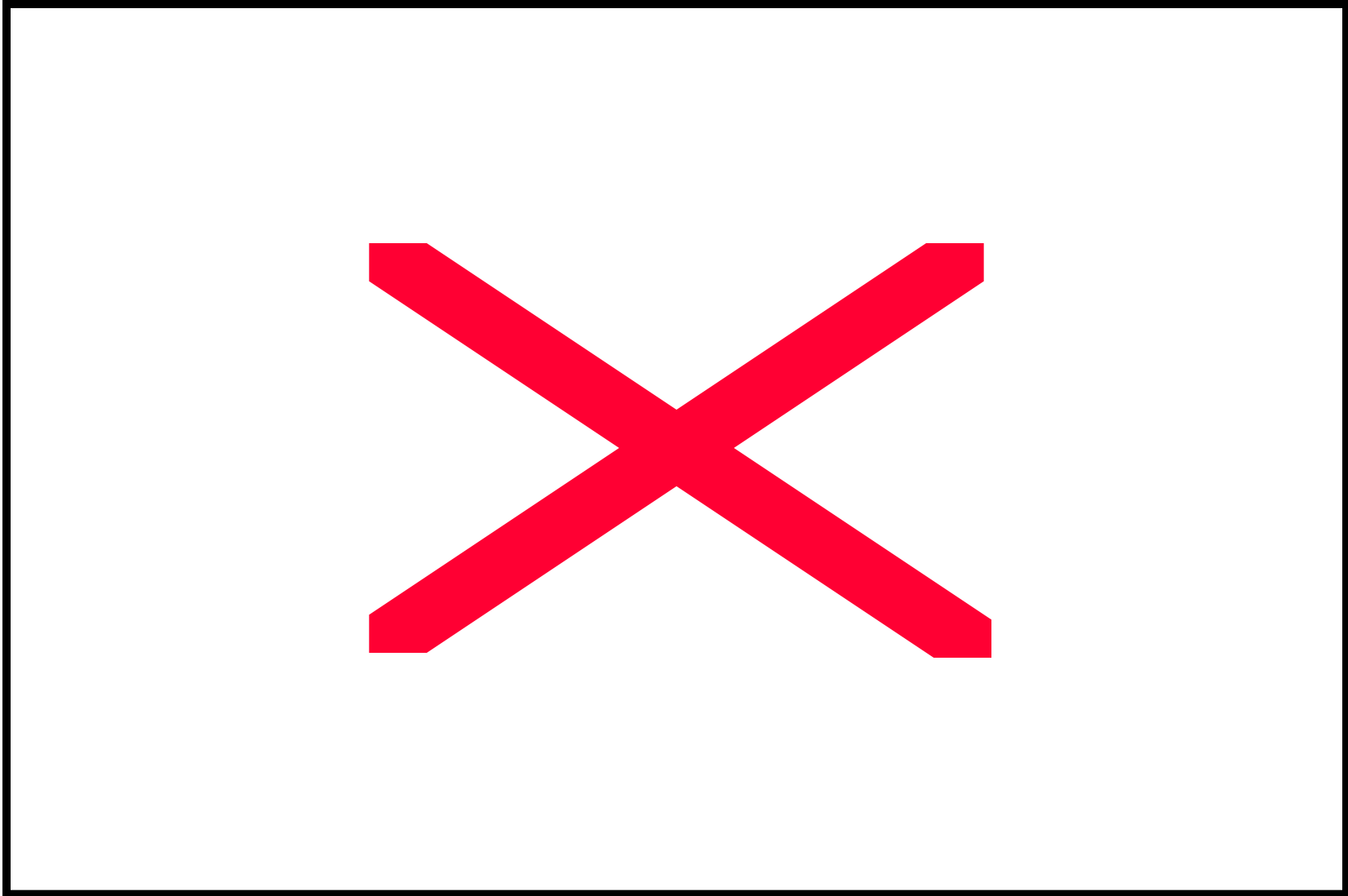
MODIS 1km aerosol product

Aerosol optical thickness (1km resolution)

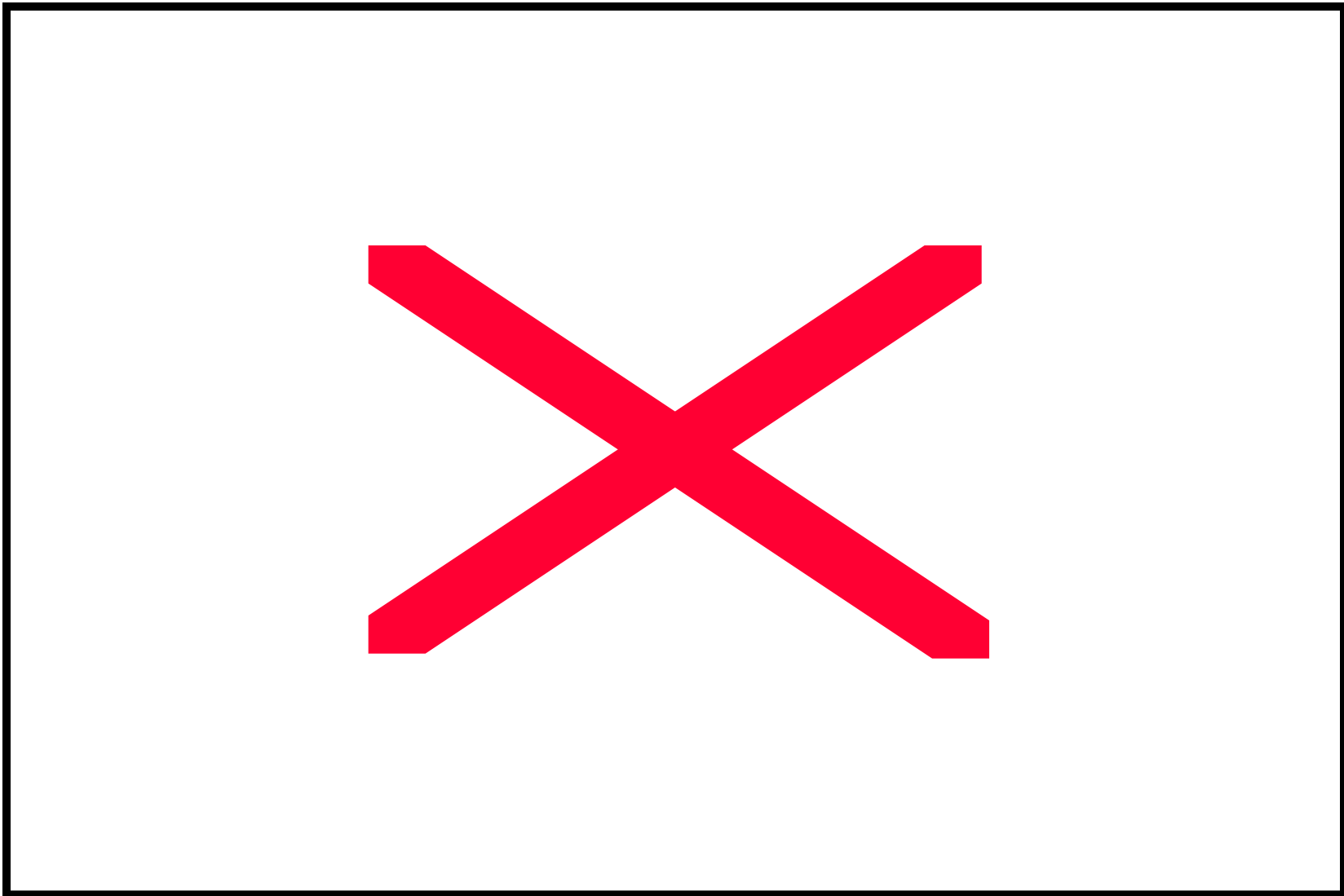**Thermal anomaly RGB (4mic,1.6mic,2.1mic)**
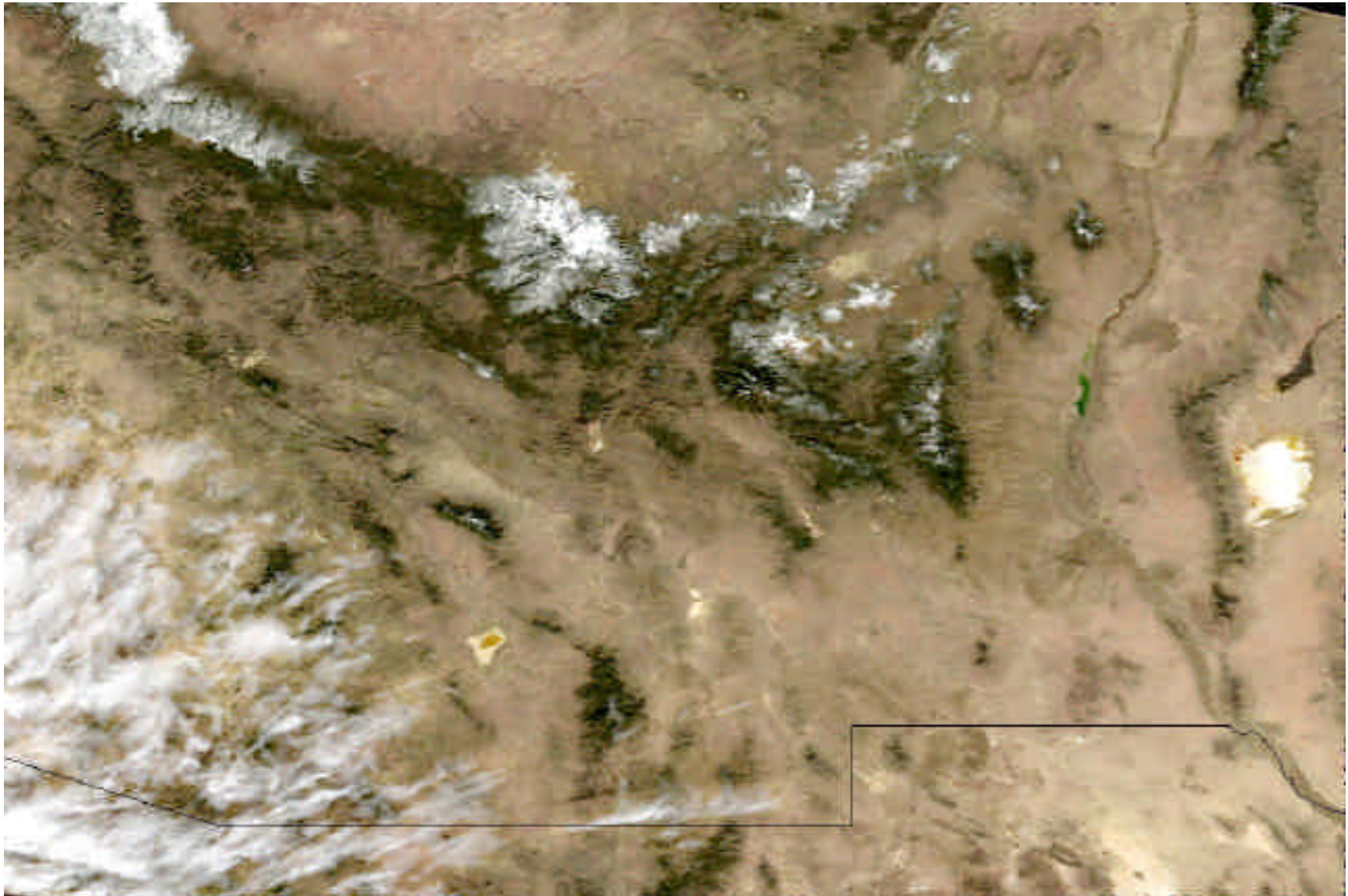
Uncorrected for aerosol

Internal masks have been developed to filter out snow, cloud and fire contaminations

corrected for aerosol (collection 1)

corrected for aerosol (collection 3)

The surface reflectance algorithm uses internal 1km aerosol optical depth since collection 3 processing.
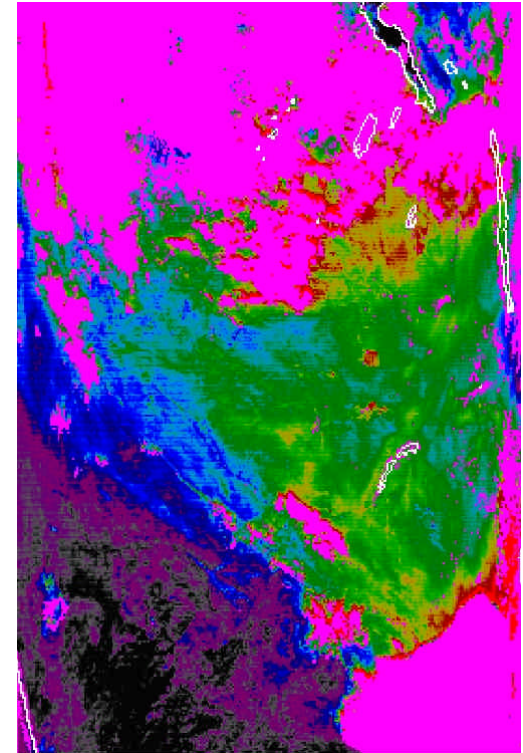
MODIS Granule over South Africa (Sept,13,2001, 8:45 to 8:50 GMT)
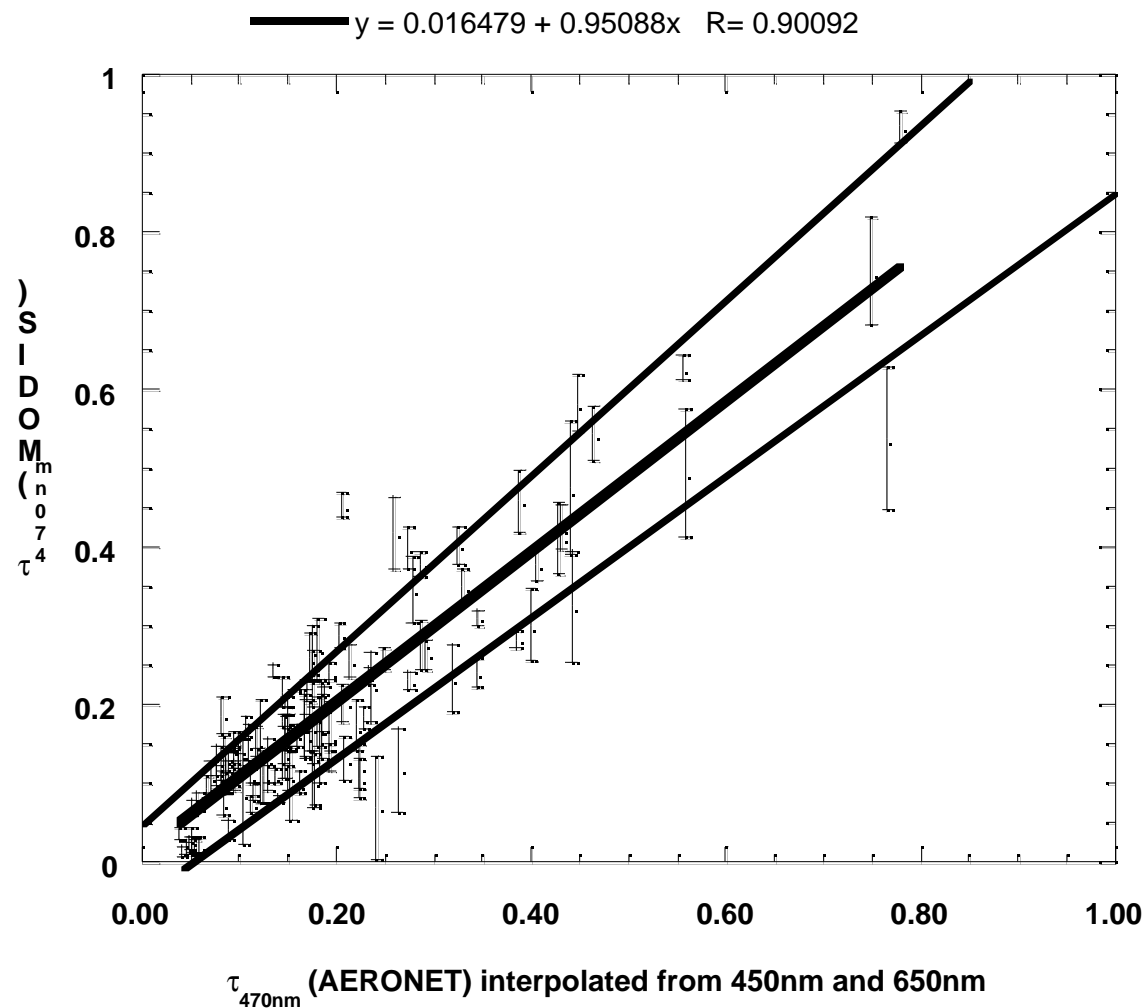

RGB no correction
for aerosol effect

RGB surface reflectance
(corrected for aerosol)

Corresponding aerosol optical thickness at 670nm (0 black, 1.0 and above red) linear rainbow scale. Clouds are in magenta, water bodies are outlined in white.

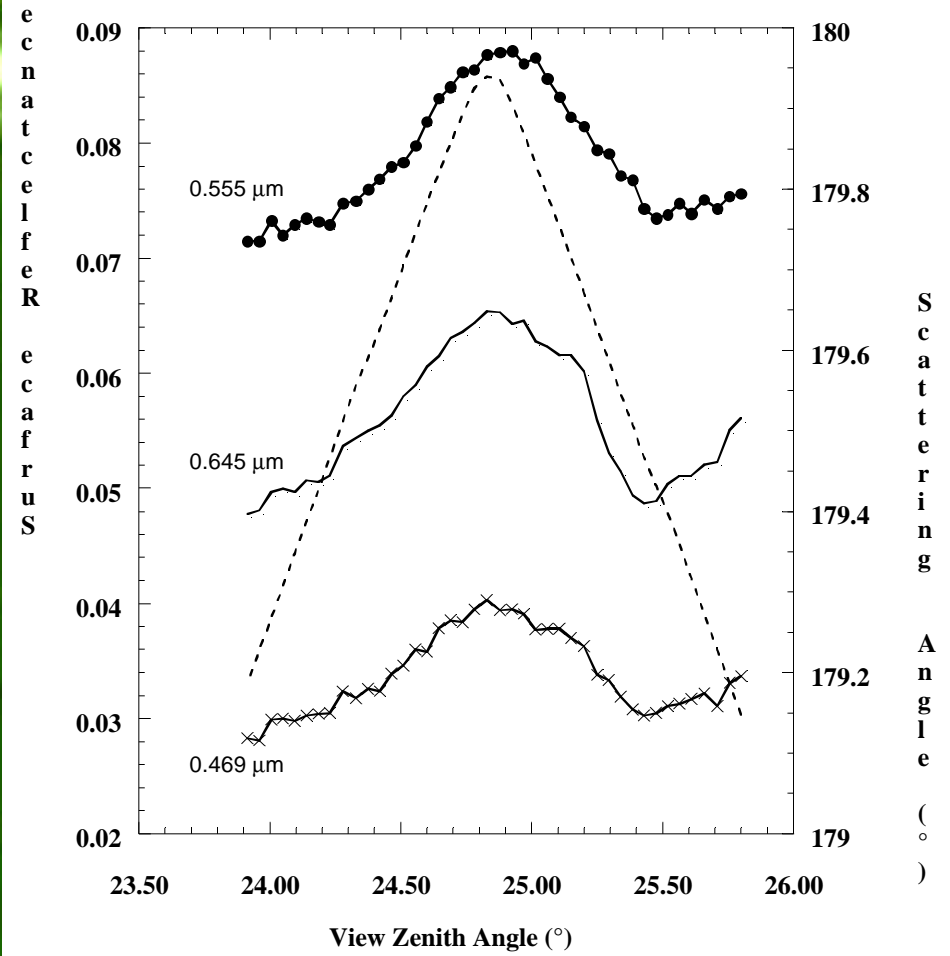# Aerosol 1km retrieval validation is on-going

Comparison of 1km operational aerosol optical thickness retrieved by MODIS blue channel (~120 matches) with AERONET sun photometer measurements during the March, April, May 2001 period
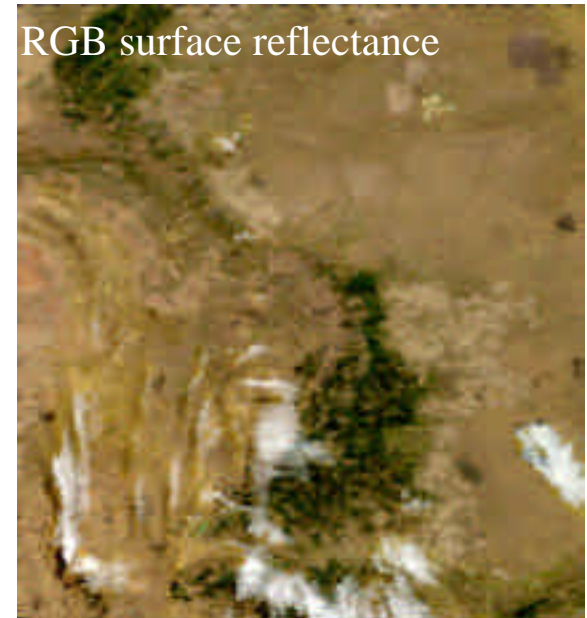
MODIS data illustrating the hot-spot over dense vegetation
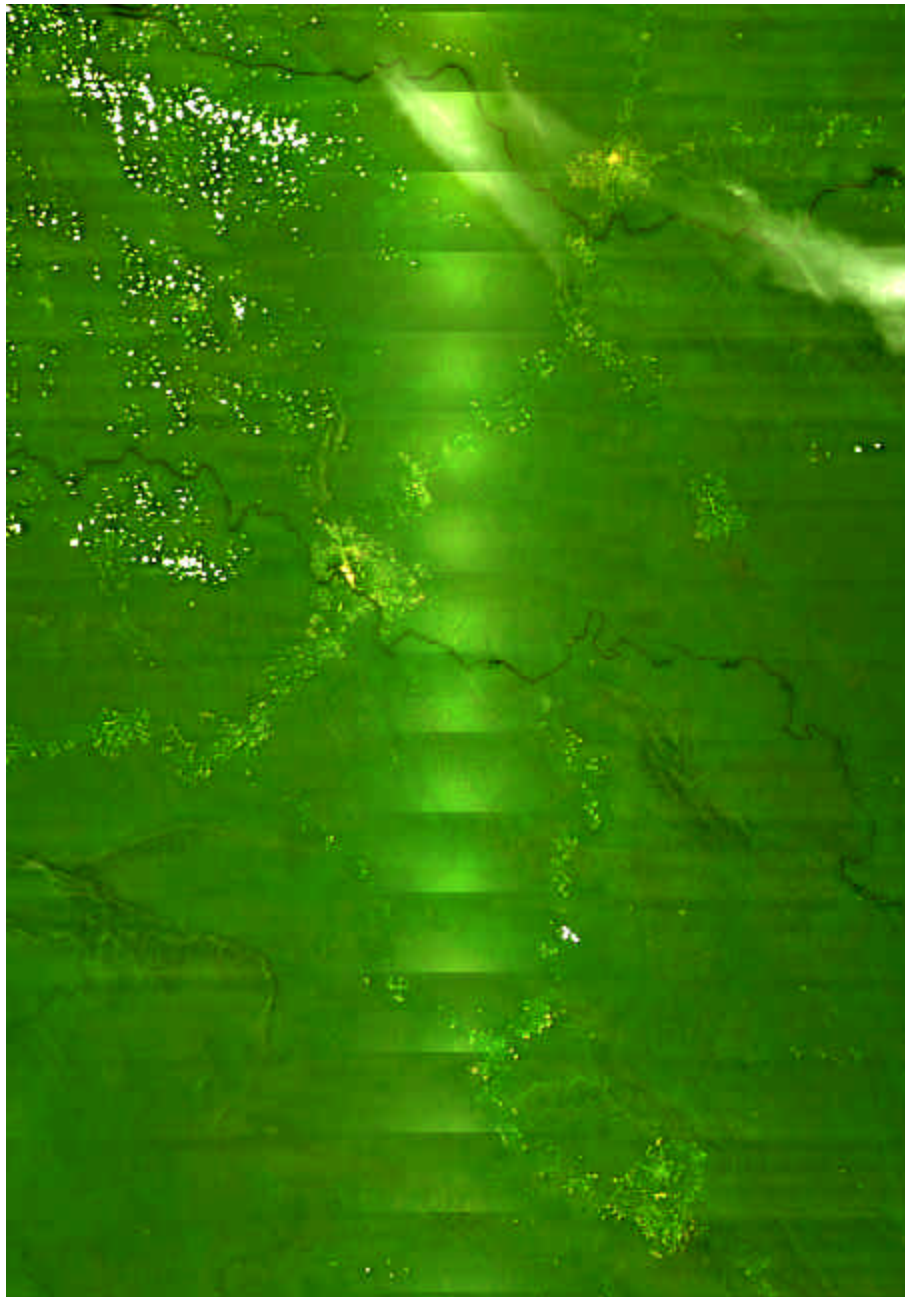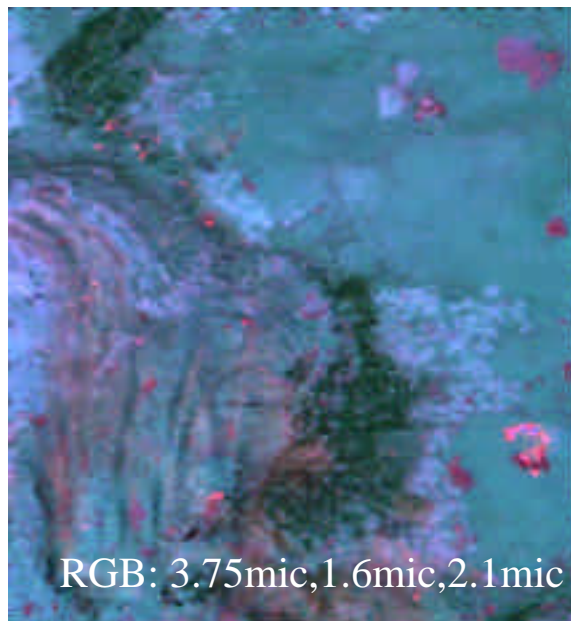
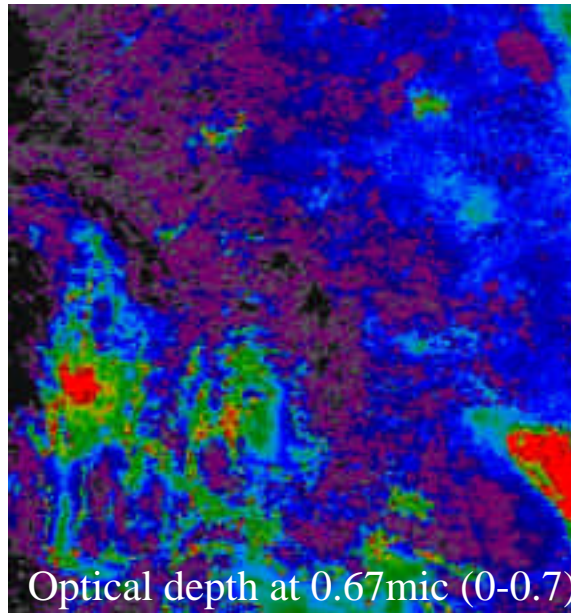**(Vermote and Roy, IJRS, 2002)**

Example: Fire/Scars/Smoke monitoring (1/3) using 3.75mic reflectance product (post-launch)

RGB corrected reflectance

Optical depth at 0.67mic (0-0.7)

RGB surface reflectance

RGB: 3.75mic,1.6mic,2.1mic

August,31,2000

Optical depth at 0.67mic (0-0.7)

RGB corrected reflectance

RGB: 3.75mic,1.6mic,2.1mic

RGB surface reflectance
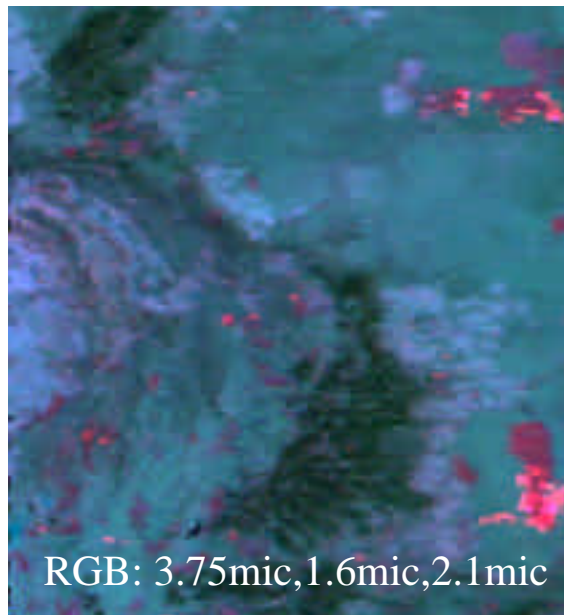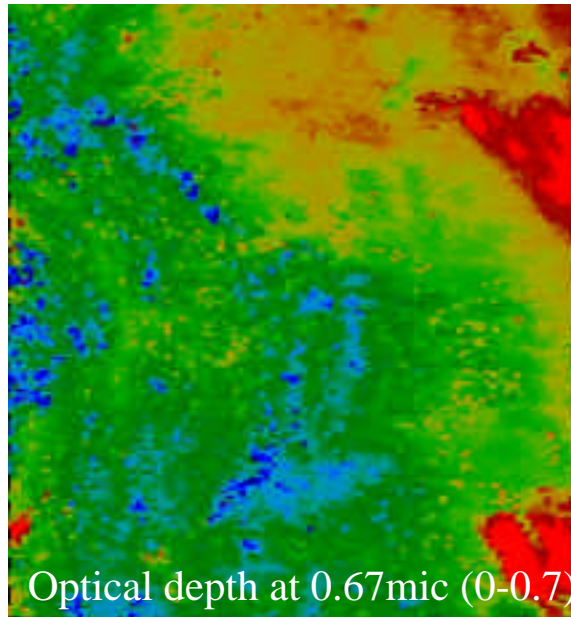
Sept,3,2000

Example: Fire/Scars/Smoke monitoring (3/3)

Optical depth at 0.67mic (0-0.7)

RGB corrected reflectance

RGB: 3.75mic,1.6mic,2.1mic

RGB surface reflectance
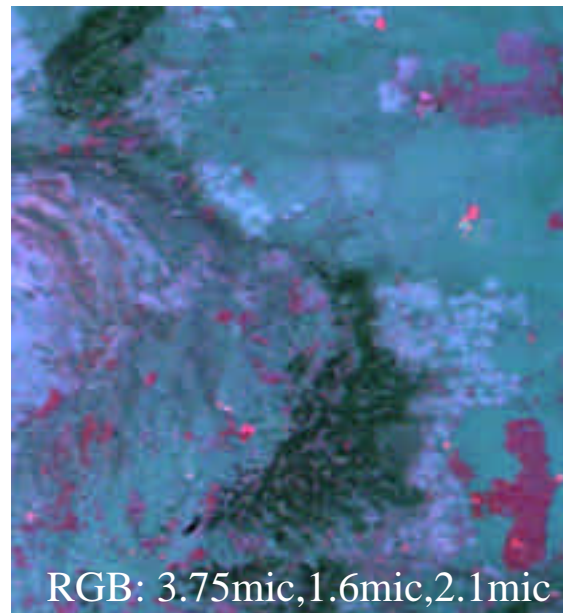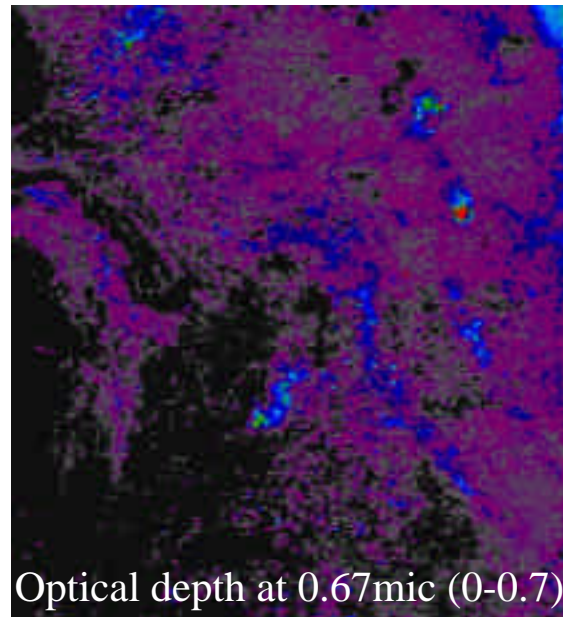
Sept,7,2000

TISI: Temperature Independent Spectral Indices

(Becker and Li, 1990)

Method adapted to MODIS (Petitcolin and Vermote, RSE, 2002)

Jornada, New Mexico (2001-132)

20010512 @ 180633 : Our radiometric temperature
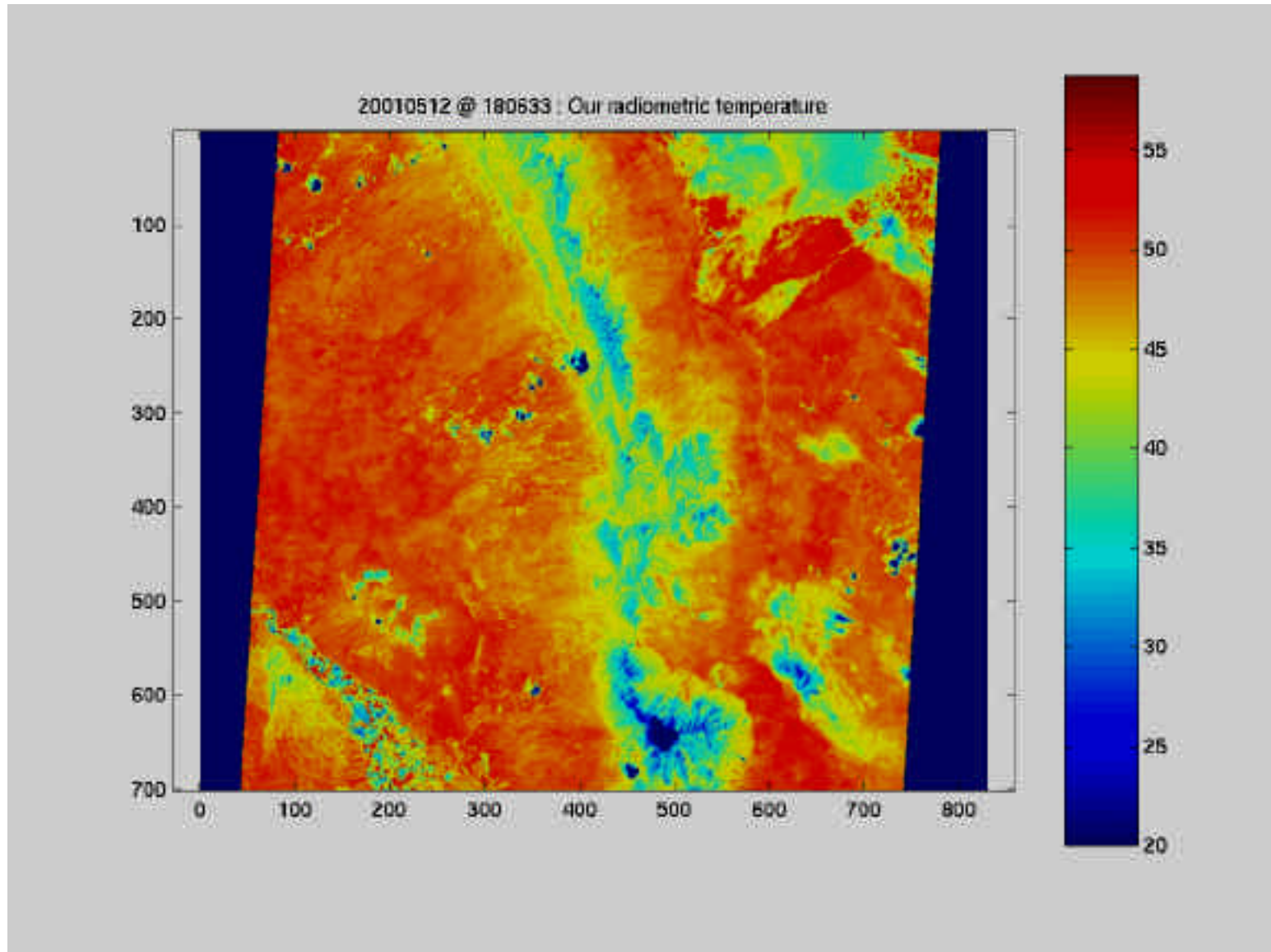
Jornada Site: Land Surface Temperature, ASTER (USDA-ARS method) versus MODIS

Ground level Temperatures MODIS / ASTER
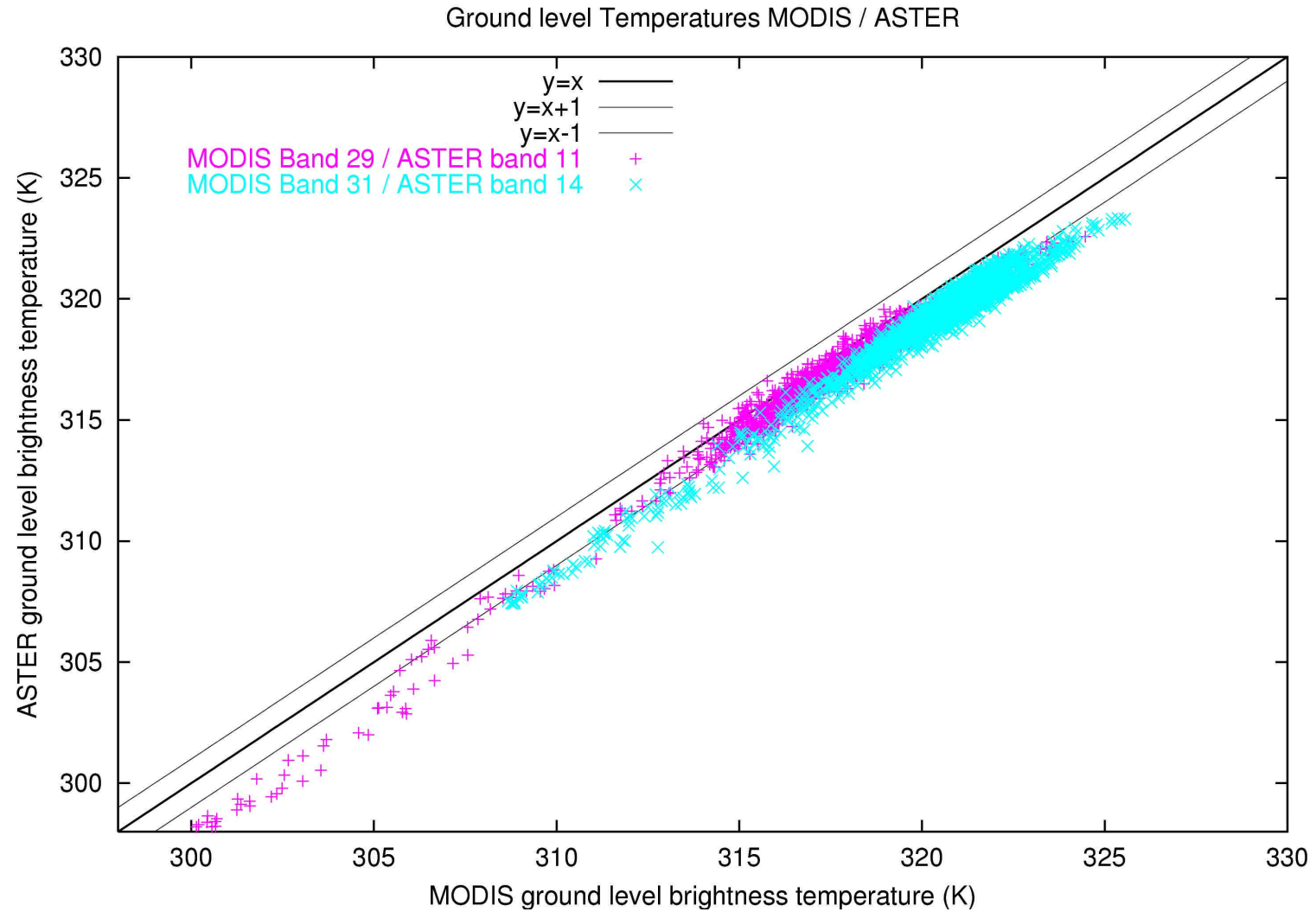
Jornada Site: Emissivities   ASTER (USDA-UARS method) versus MODIS

Spectral emissivity MODIS / ASTER from aggregated ASTER data

Legend:
- y=x
- y=x+0.01
- y=x−0.01
- MODIS Band 29 / ASTER band 11   +
- MODIS Band 31 / ASTER band 14   ×

X-axis: MODIS emissivity
Y-axis: ASTER emissivity
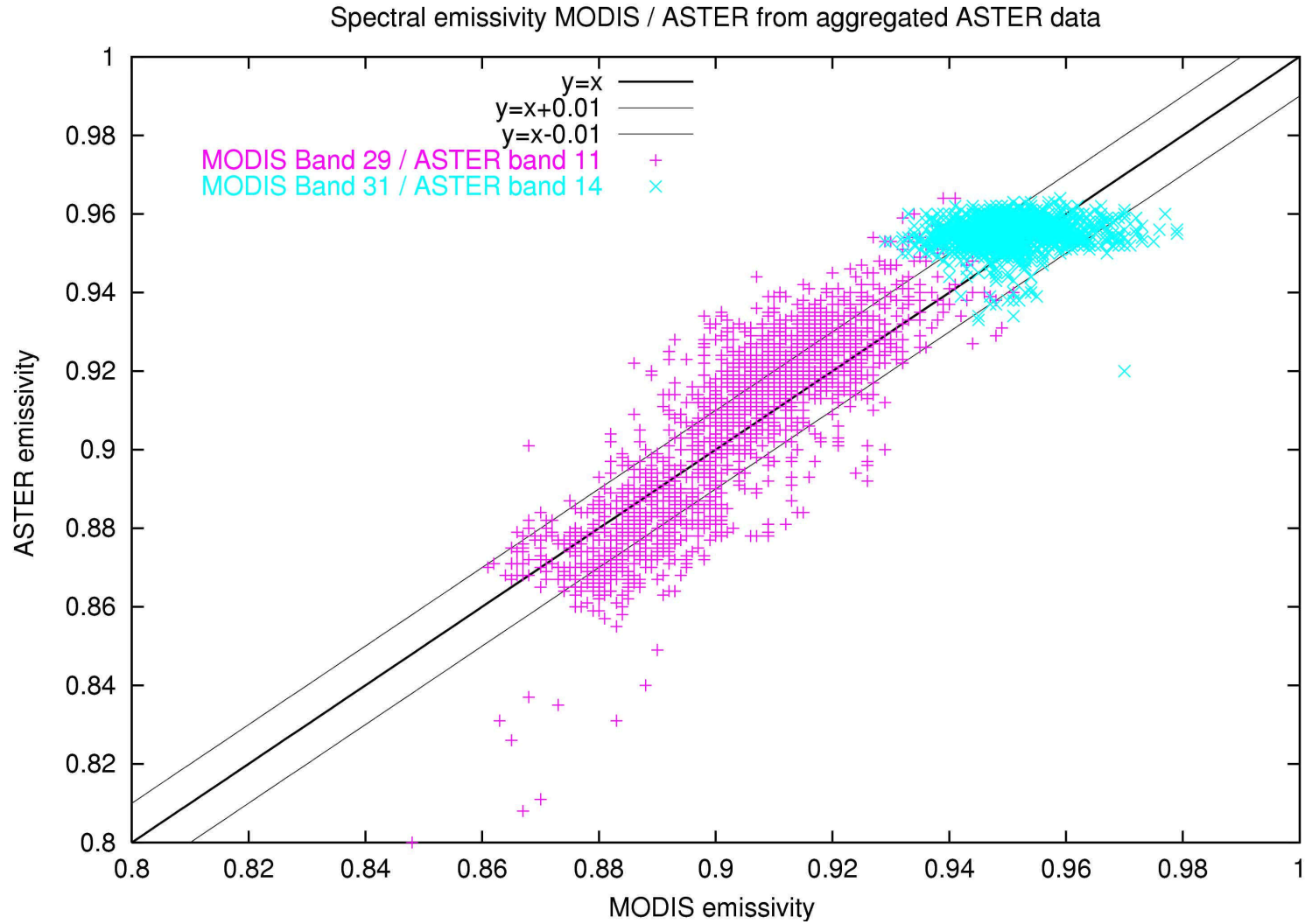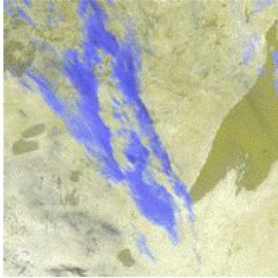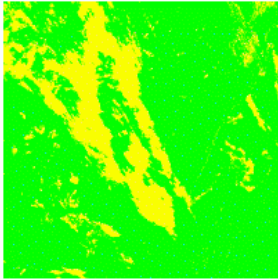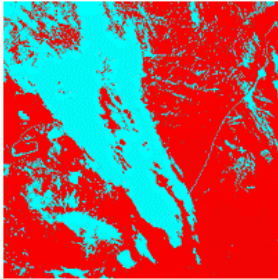
Internal Cloud mask evaluation (LDOPE) Collection 3, Collection 4 (test system)

Example of one of the comparison to MOD 35 (out of 76)

CaseID: FC_MOD35_GEN_001	Date: 05/20/2002
Subset of image from North America (Canada).	Enlarge Images

1km Surface Reflectance in MOD09
MOD09.A2002123.1725.003.2002125232608.hdf

1km thermal bands in MOD09
MOD09.A2002123.1725.003.2002125232608.hdf

MOD09 internal cloud mask
MOD09.A2002123.1725.003.2002125232608.hdf

Cloud mask from MOD35
MOD35.A2002123.1725.003.2002124170856.hdf

Internal Cloud Shadow mask (geometric/ predictive approach)
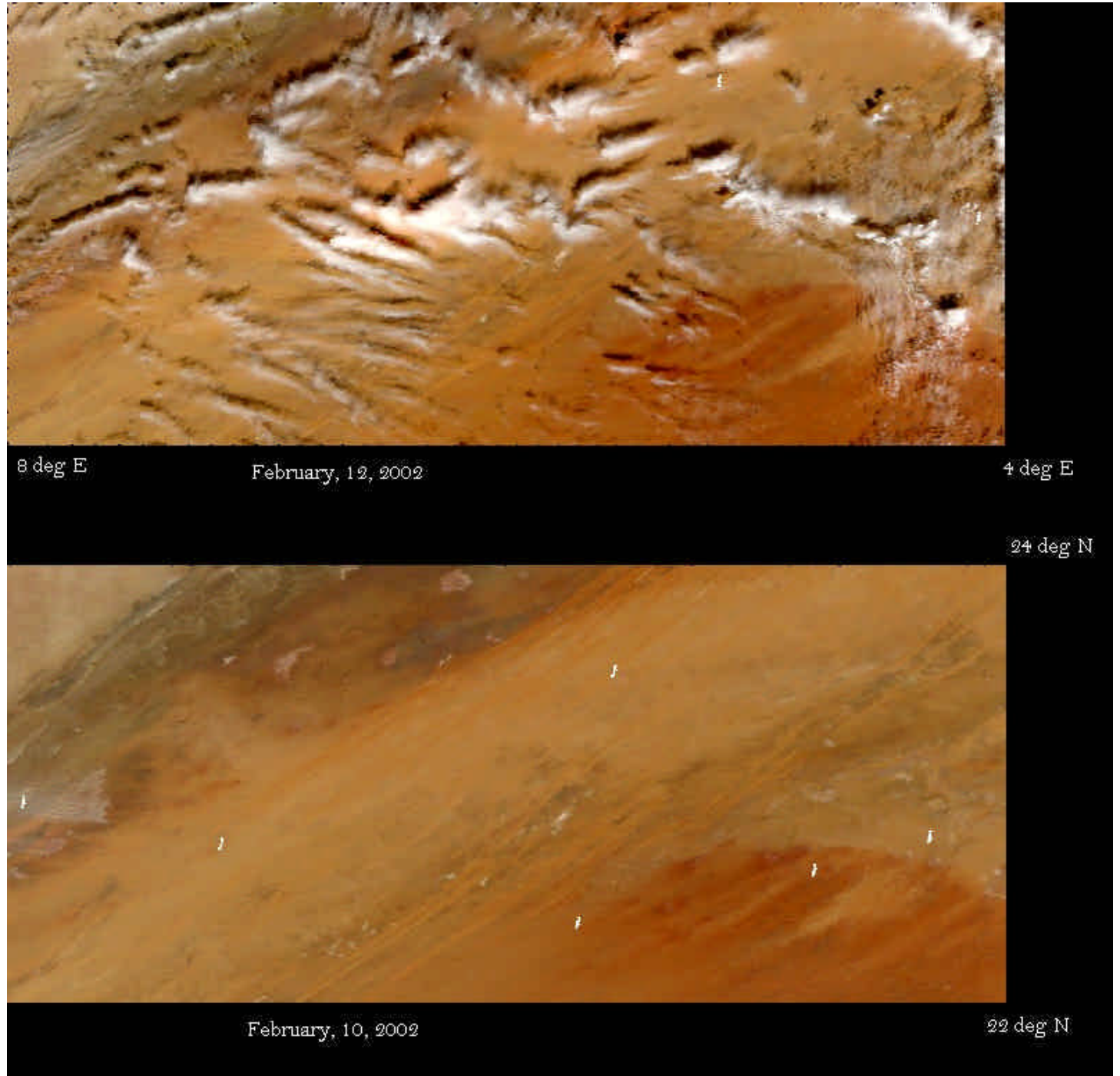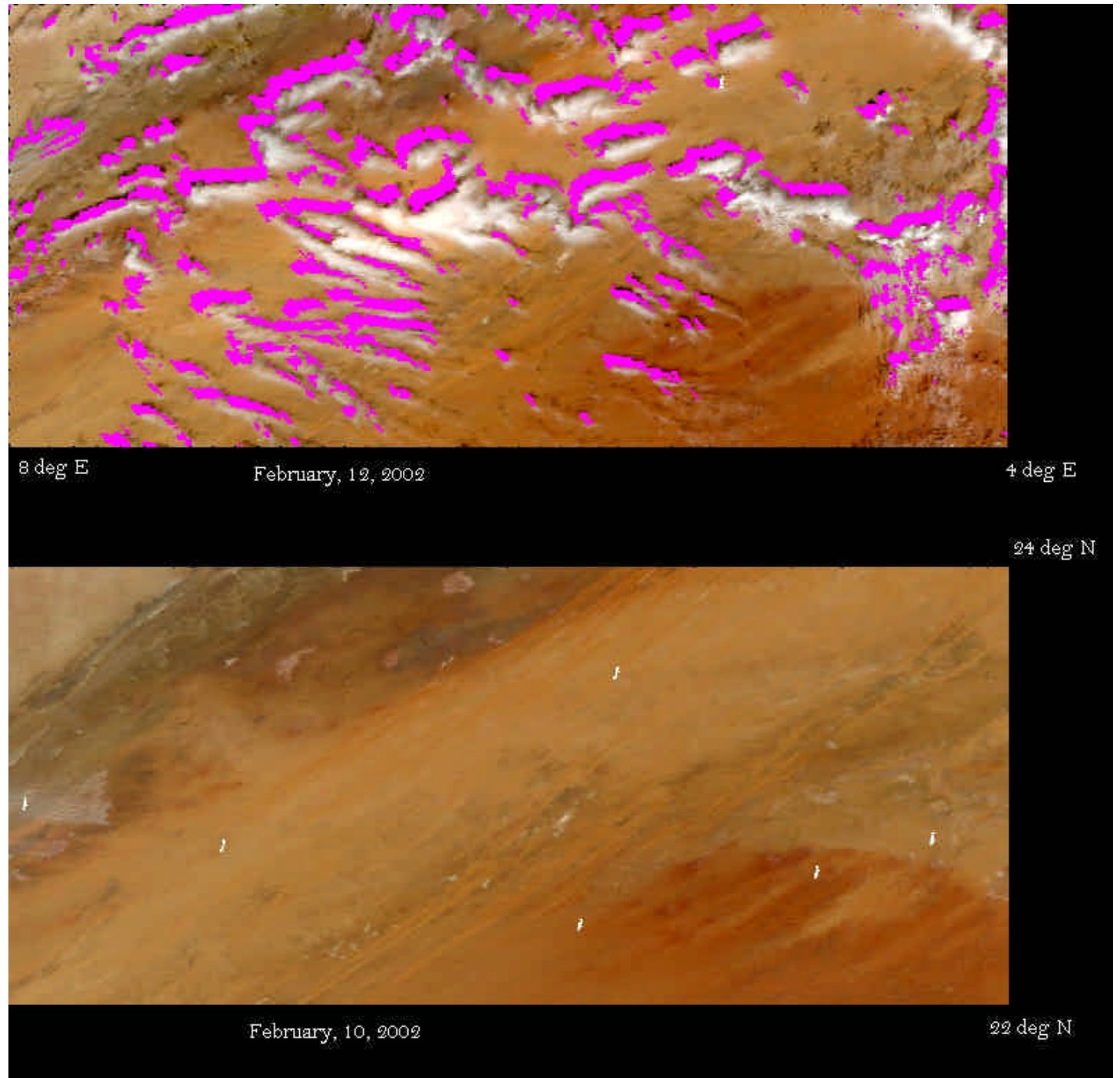
8 deg E   February, 12, 2002   4 deg E

24 deg N

February, 10, 2002   22 deg N

Internal Cloud Shadow mask (geometric/ predictive approach)

Internal Cloud mask (green)

8 deg E   February, 12, 2002   4 deg E

24 deg N

February, 10, 2002   22 deg N

Internal Cloud Shadow mask (geometric/ predictive approach)

Internal Cloud shadow mask (magenta)

8 deg E   February, 12, 2002   4 deg E

24 deg N

February, 10, 2002   22 deg N
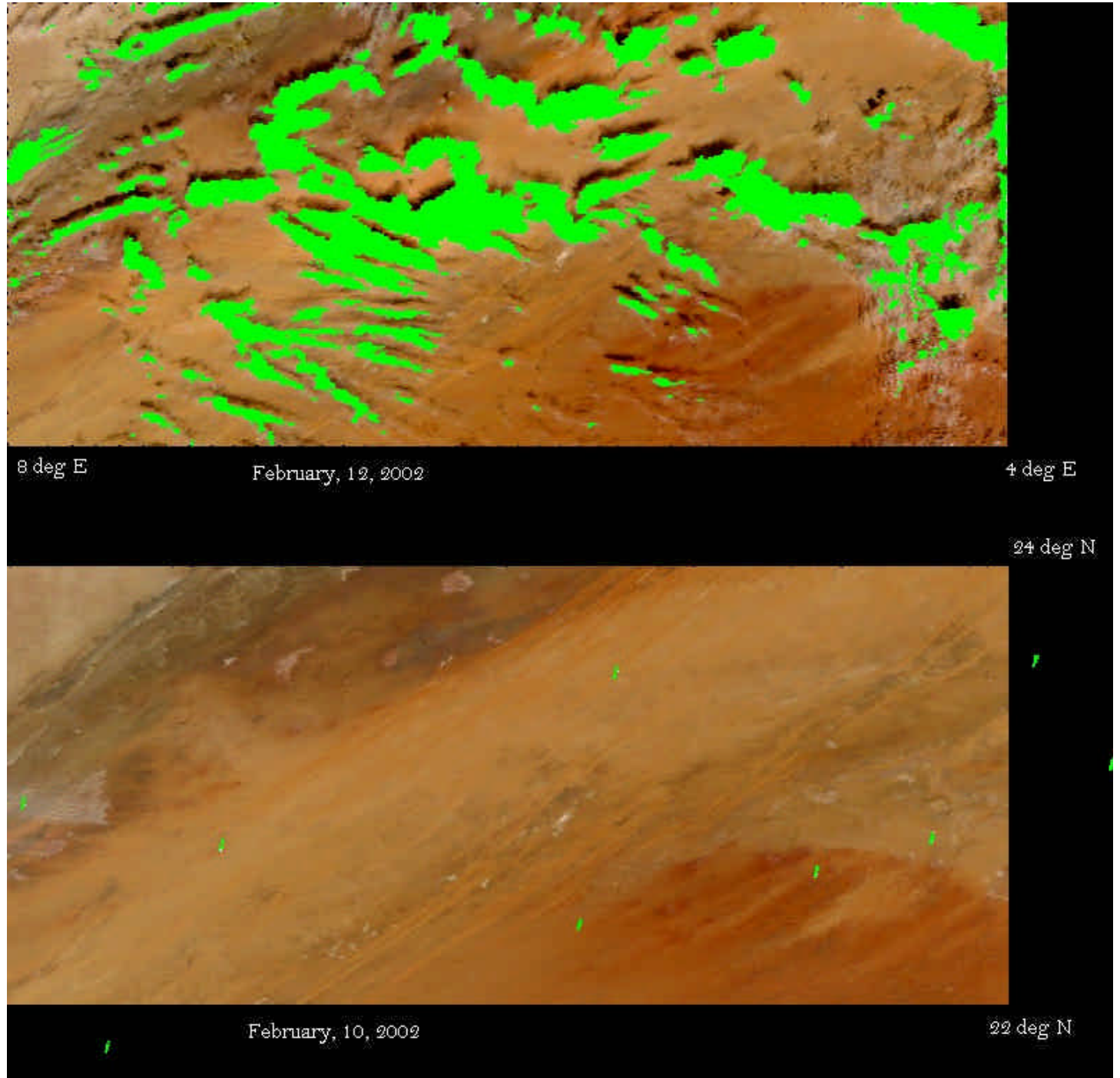
Internal Cloud Shadow mask (geometric/ predictive approach)

Evaluation strategy: Using differences Between clear and cloudy days

Blue's for cloud
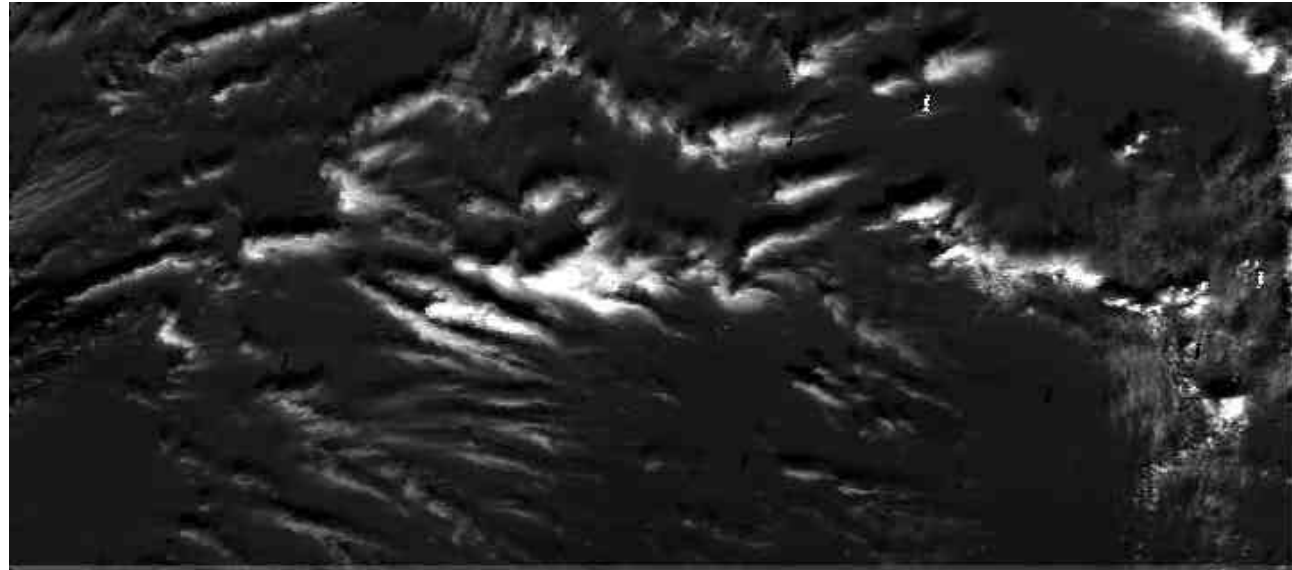
Blue (12/2/02) – Blue(10/2/02)
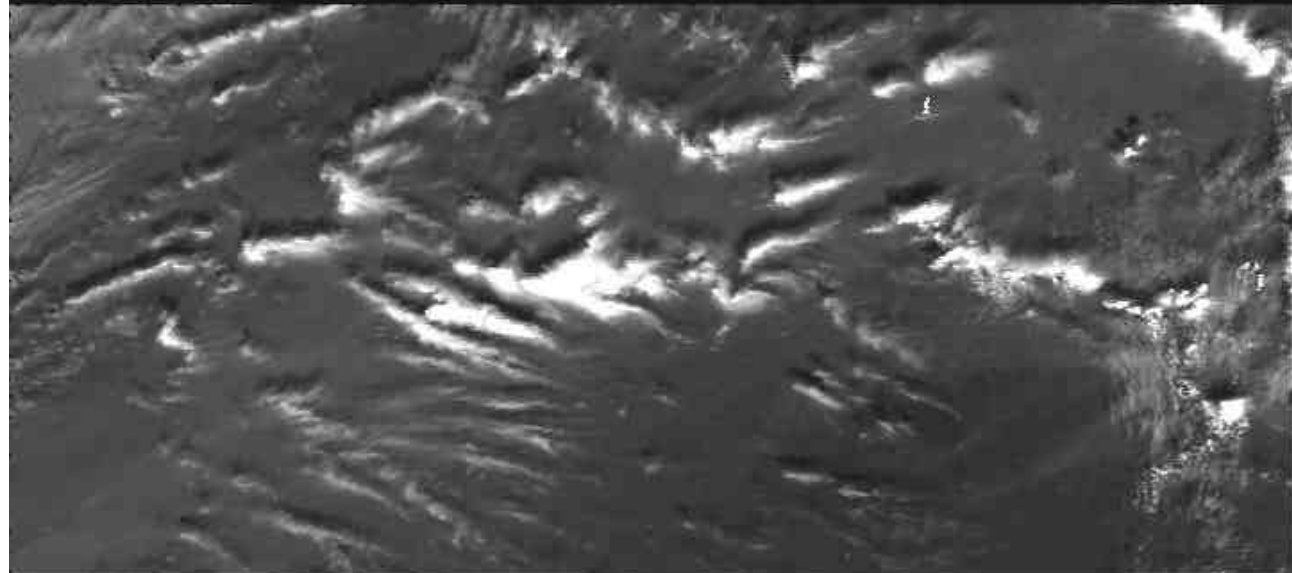
Blue (12/2/02)

Internal Cloud Shadow mask (geometric/ predictive approach)

Evaluation strategy: Using differences Between clear and cloudy days

Nir's for shadows

Band 5 (2/12/02) – Band 5 (2/10/02)

6000

-3000

Band 5 (2/12/02)
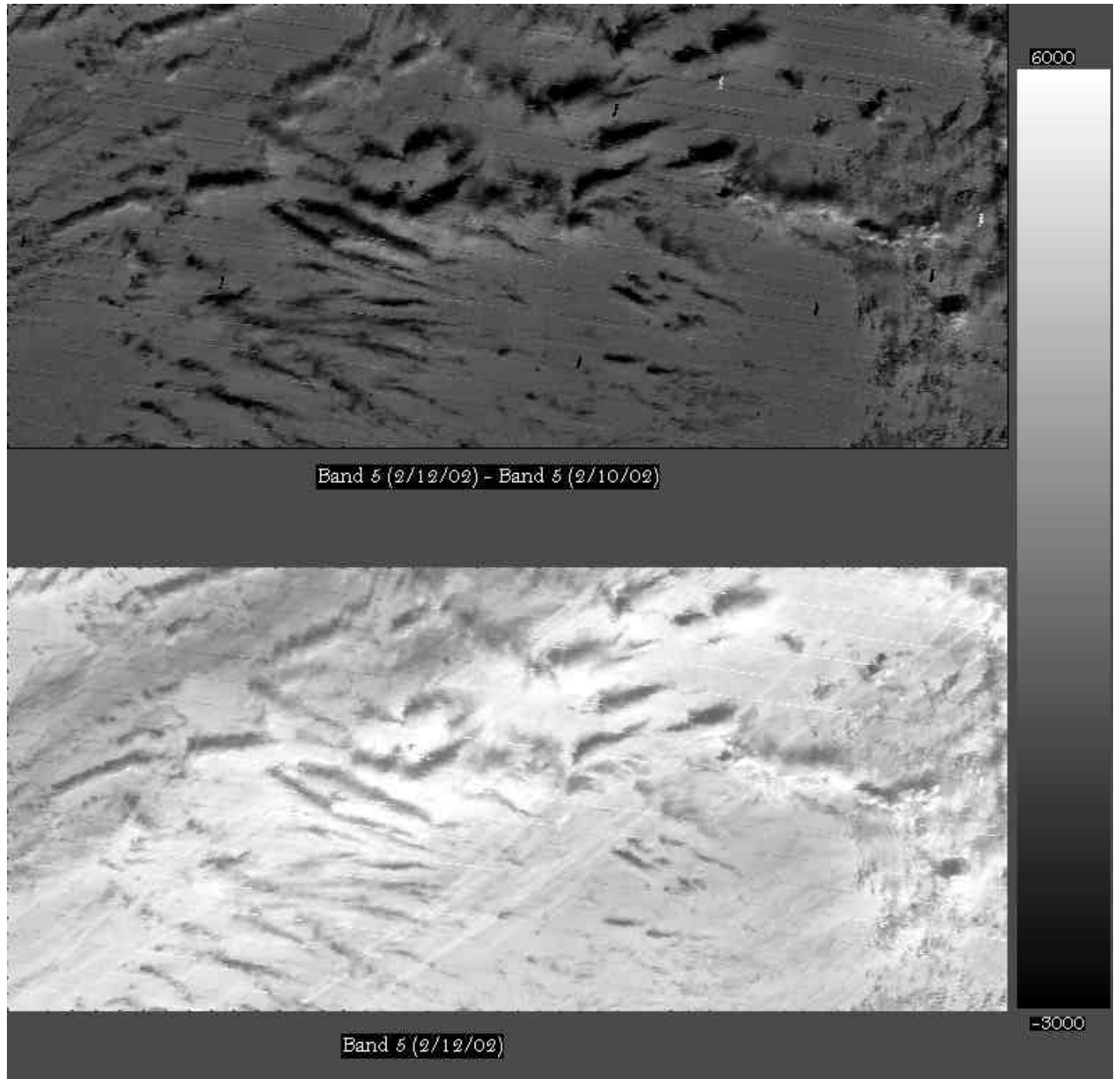
Internal Cloud Shadow mask (geometric/ predictive approach)
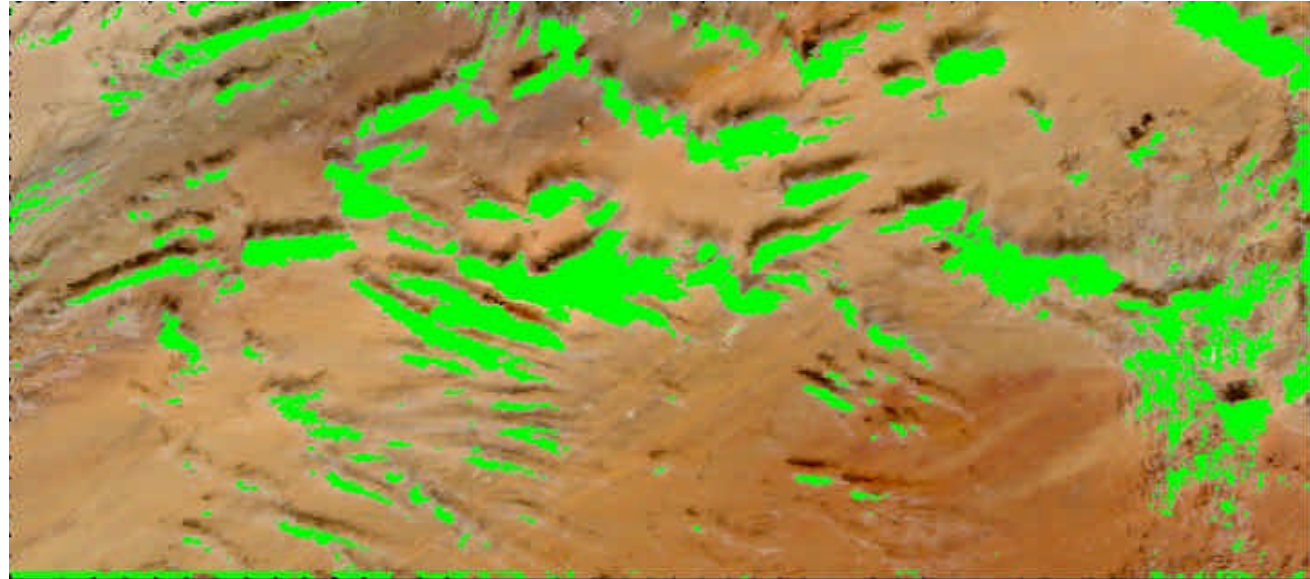
Cloud Mask Based on Blue's difference

Cloud mask from differences (500m)

Internal Cloud
Shadow mask
(geometric/
predictive
approach)

**Internal Cloud
mask (green) 1km**

8 deg E   February, 12, 2002   4 deg E

24 deg N

February, 10, 2002   22 deg N
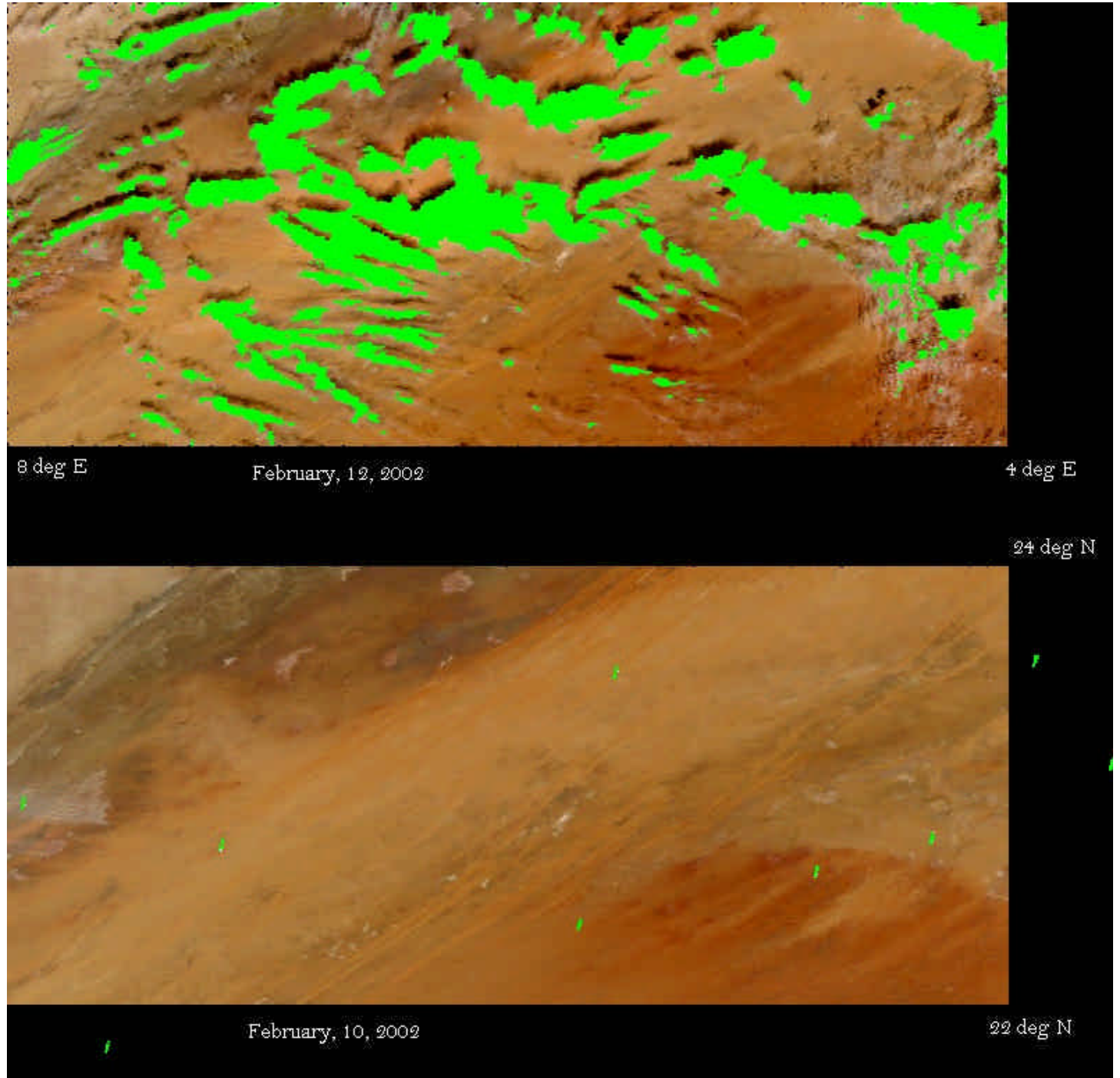
Internal Cloud Shadow mask (geometric/ predictive approach)

Cloud shadow from differences (500m)
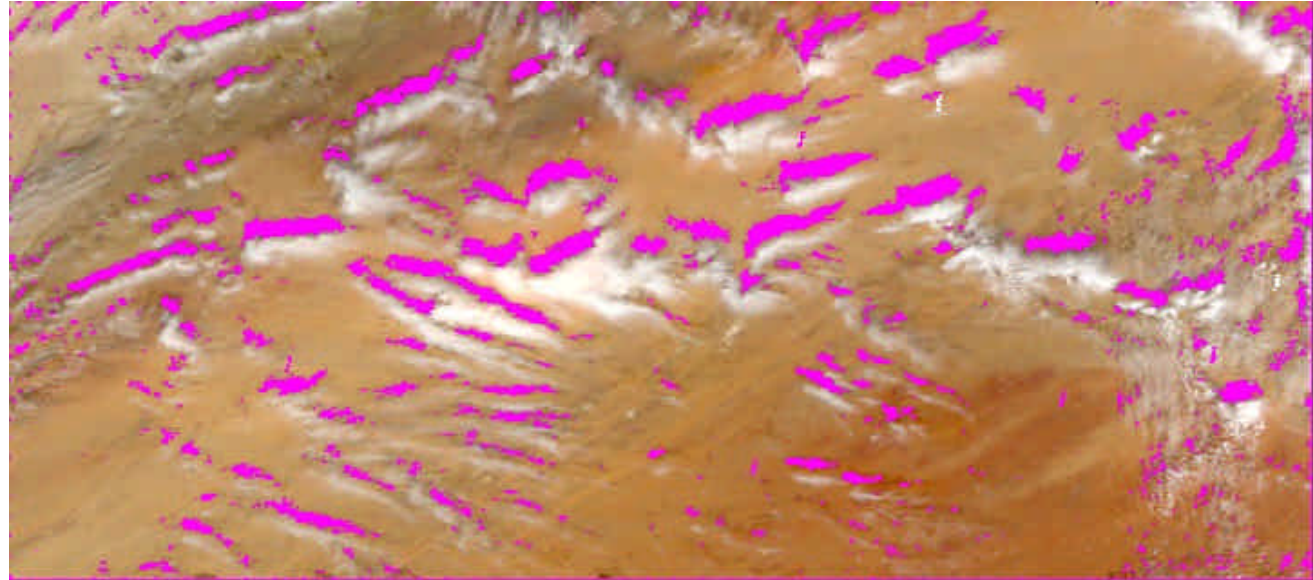
Cloud Shadow Based on Band5's difference

Internal Cloud Shadow mask (geometric/ predictive approach)

Internal Cloud shadow mask (magenta)

8 deg E   February, 12, 2002   4 deg E

24 deg N

February, 10, 2002   22 deg N

MODIS Surface reflectance validation (1/2)

21km x 18km Uniform Area

470nm Standard deviation: 34.8315
Correlation: 0.91163 a = 0.864949

555nm Standard deviation: 41.2206
Correlation: 0.958076 a = 1.05176

670nm Standard deviation: 37.7275
Correlation: 0.962383 a = 0.973688

870nm Standard deviation: 151.603
Correlation: 0.927262 a = 1.00599

1600nm Standard deviation: 104.1
Correlation: 0.930239 a = 1.02959

2130nm Standard deviation: 60.4908
Correlation: 0.931588 a = 0.884841

MODIS Reflectance x 10000 x 10³

ETM Reflectance x 10000 x 10³

Comparison of the surface reflectance derived from ETM+ (using AERONET data) with the operational MODIS surface reflectance product.

MODIS Surface reflectance validation (2/2)

Harvested corn

ETM+ surface reflectance
□ ASD reflectance integrated over ETM+ band
ETM+ top of the atmosphere reflectance

Yellow grass

ETM+ reflectance
□ ASD reflectance integrated over ETM+ band
ETM+ top of the atmosphere reflectance

Bare soil

ETM+ reflectance
□ ASD reflectance integrated over ETM+ band
ETM+ top of the atmosphere reflectance

λ [nanometers]
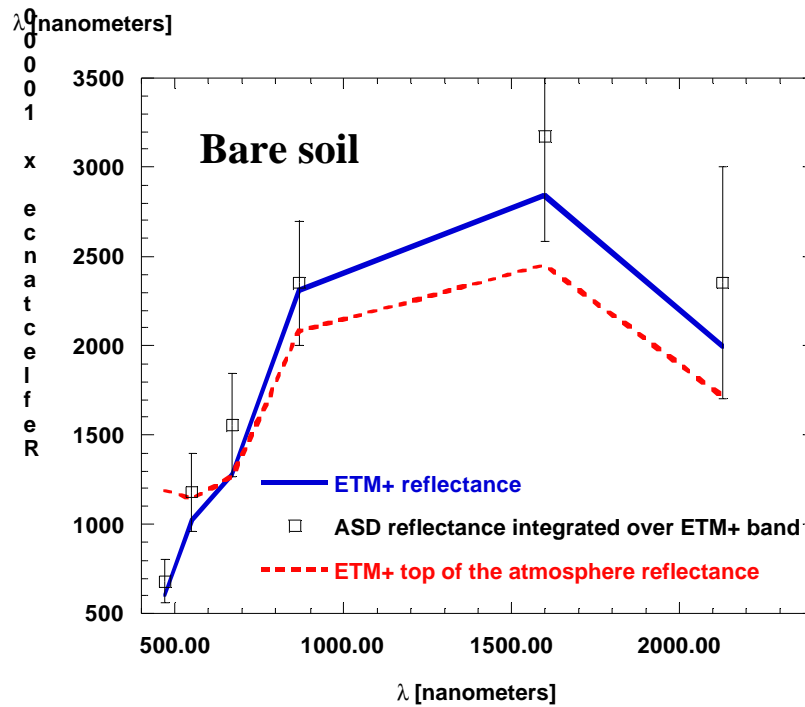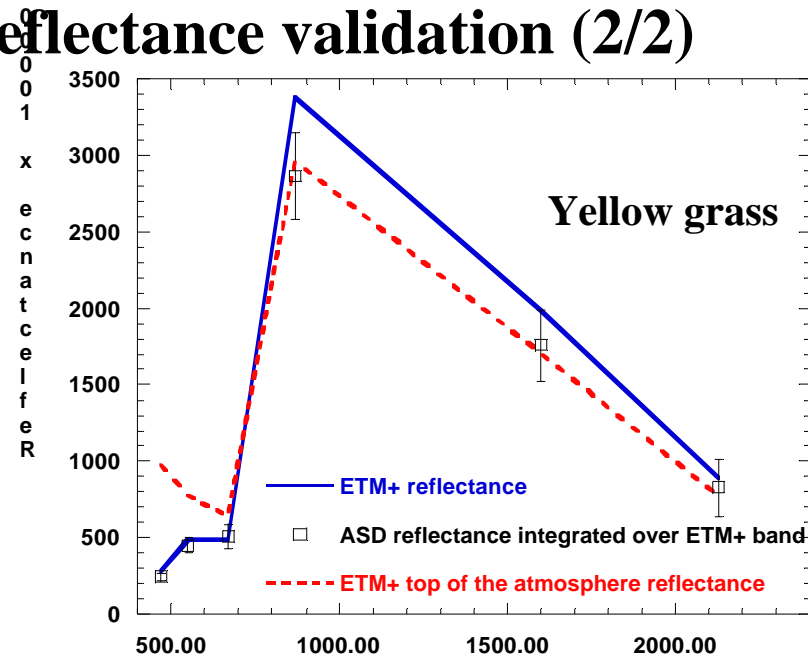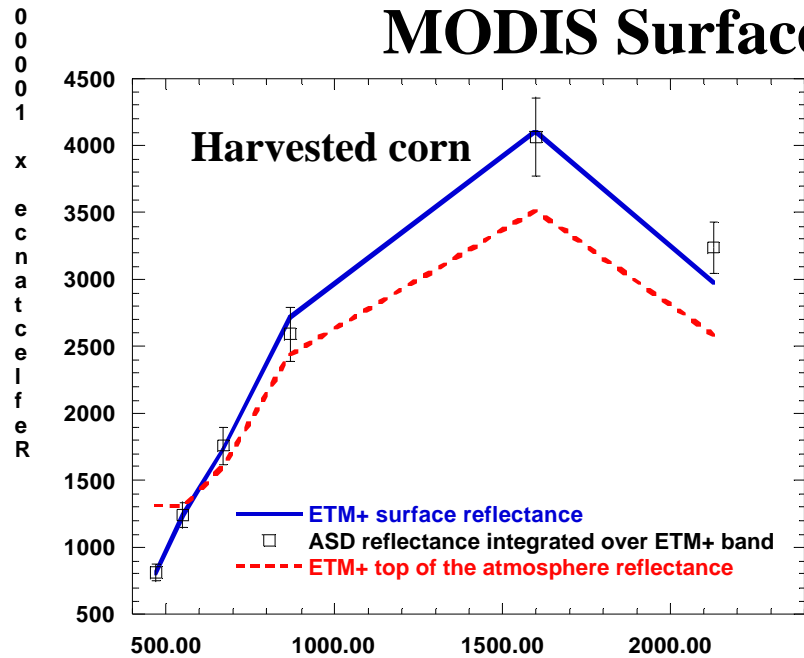
Analysis will be extended/automated to the following possible cases (92 possible)

|					
ARM/CART SGP	07/12/01	Konza Prairie	04/04/00	USDA	11/03/00
Barrow	07/14/00	Konza Prairie	06/07/00	USDA	12/15/00
Barrow	07/07/01	Konza Prairie	07/09/00	USDA	01/22/01
BERMS/SSA	08/12/01	Konza Prairie	07/25/00	USDA	02/23/01
Bondville	07/29/99	Konza Prairie	09/11/00	USDA BARC	04/28/01
Bondville	03/25/00	Krasnoyarsk	05/03/00	USDA BARC	02/07/01
Bondville	07/15/00	Krasnoyarsk	06/20/00	USDA BARC	08/02/01
Bondville	06/29/00	Krasnoyarsk, Russia	26-Aug-2001	VCR	08/27/01
Bondville	04/26/00	Lake Tahoe	02/27/01	VCR	04/05/01
Bondville	09/01/00	Lake Tahoe	03/12/00	VCR	14-Oct-01
Bondville	09/17/00	Lake Tahoe	08/19/00	VCR	26-May-02
Bondville	5/15/01	Lake Tahoe	11/07/00	Walker Branch	10/01/01
Bondville	6/16/01	Lake Tahoe	04/29/00		
Bondville	9/401	Mandalgobi	08/10/99		
Boreas NSA	07/10/99	Mongu	08/30/99		
Boreas NSA	03/13/00	Mongu	11/02/99		
Boreas NSA	06/10/00	Mongu	04/10/00		
BOREAS NSA, Canada	31-Jul-2001	Mongu	07/31/00		
Cascades	18-Sep-2000	Mongu	06/29/00		
Cascades-Young Pine	03/29/01	Mongu	08/16/00		
Harvard	09/05/01	Mongu	09/01/00		
Harvard	3-Jul-2001	Mongu	11/04/00		
Harvard Forest	03/26/00	Mongu	6-Oct-01		
Harvard Forest	08/26/00	Park Falls	09/25/01		
Harvard Forest	10/13/00	SALSA	04/08/01		
Harvard Forest	08/31/00	Sevilleta	07/28/00		
Harvard Forest	07/28/01	Sevilleta	05/09/00		
Harvard Forest (Keene, NH)	04/14/01	Skukuza	08/31/00		
Harvard Forest/Keene, NH	12/23/00	Skukuza	10/18/00		
Howland	09/07/01	Skukuza	10/16/99		
Ji-Parana	08/11/01	Skukuza	04/09/00		
Jornada	06/10/00	Skukuza	06/12/00		
Jornada	05/09/00	Skukuza	08/15/00		
Jornada	07/28/00	Skukuza	04/28/01		
Jornada	09/30/00	Tapajos	07/30/01		
Jornada	07/15/01	Uardry	09/05/01		
Konza	13-Aug-2001	USDA	5-Oct-01		
Konza	30-Sep-2001	USDA	05/11/00		
Konza	9-May-2001	USDA	10/02/00		
		USDA	05/11/00		

MODIS
Aqua
first
data
(10min)
over Australia

processed by
the Goddard
DAAC

(image:
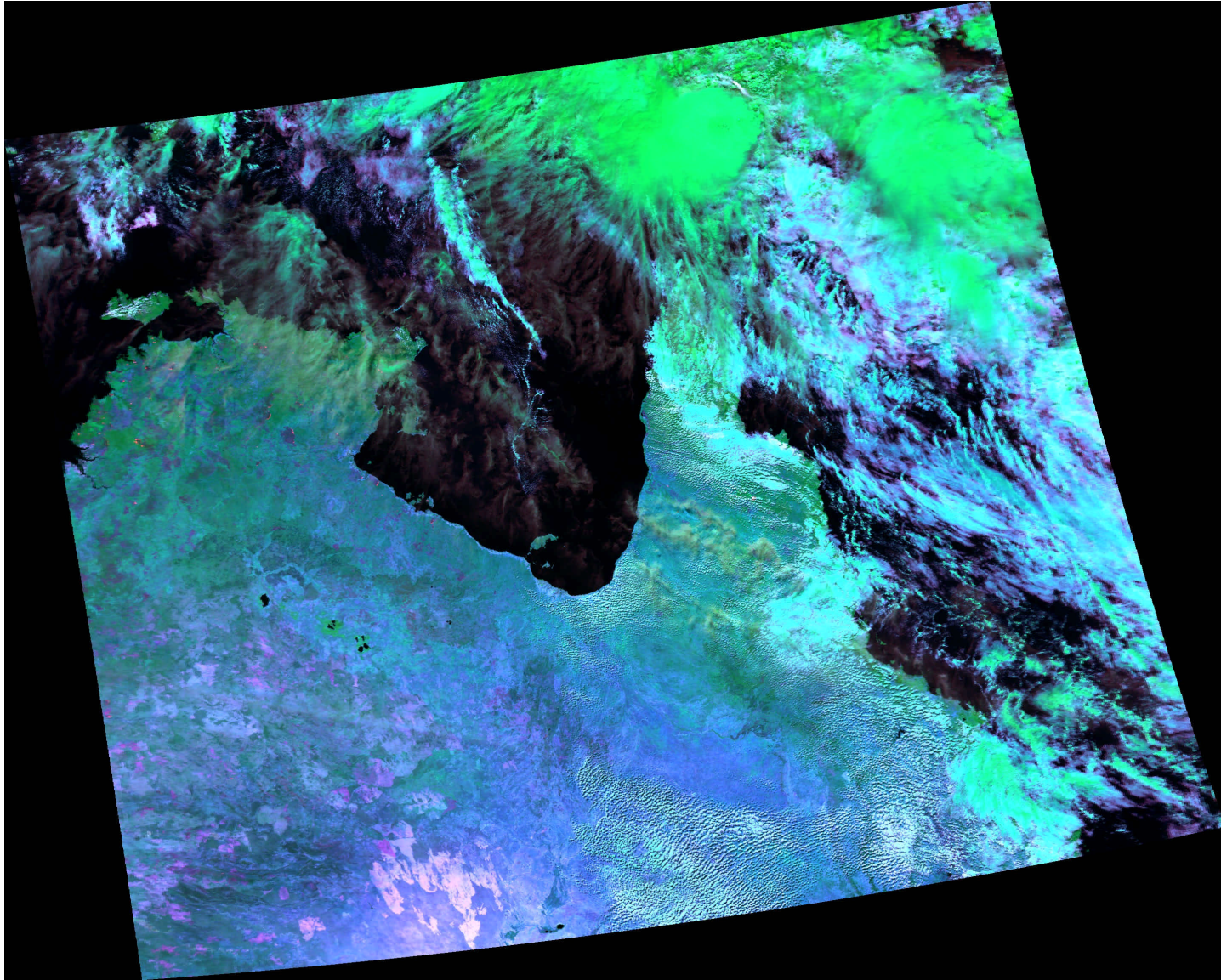El Saleous/HDFLook
MODIS
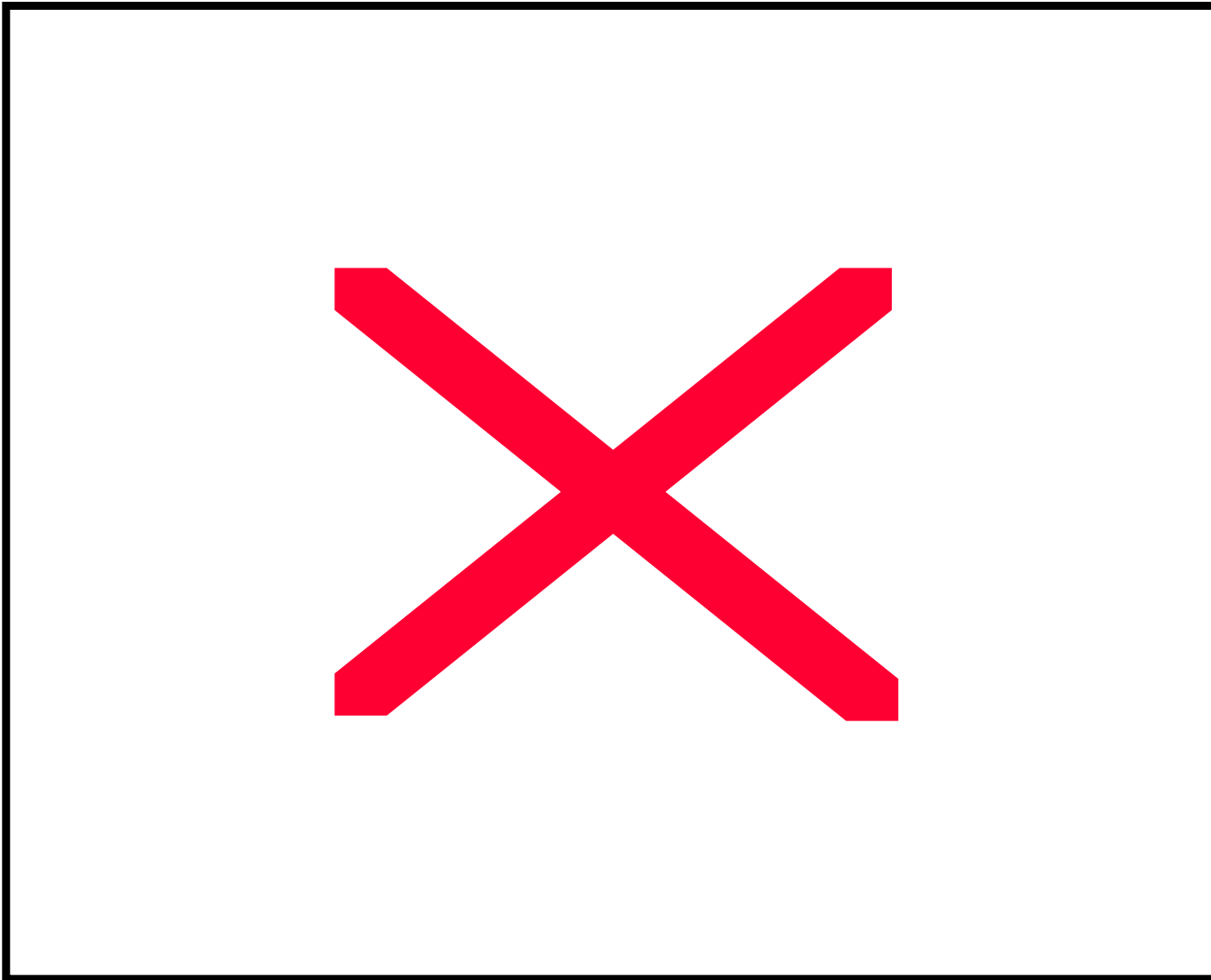
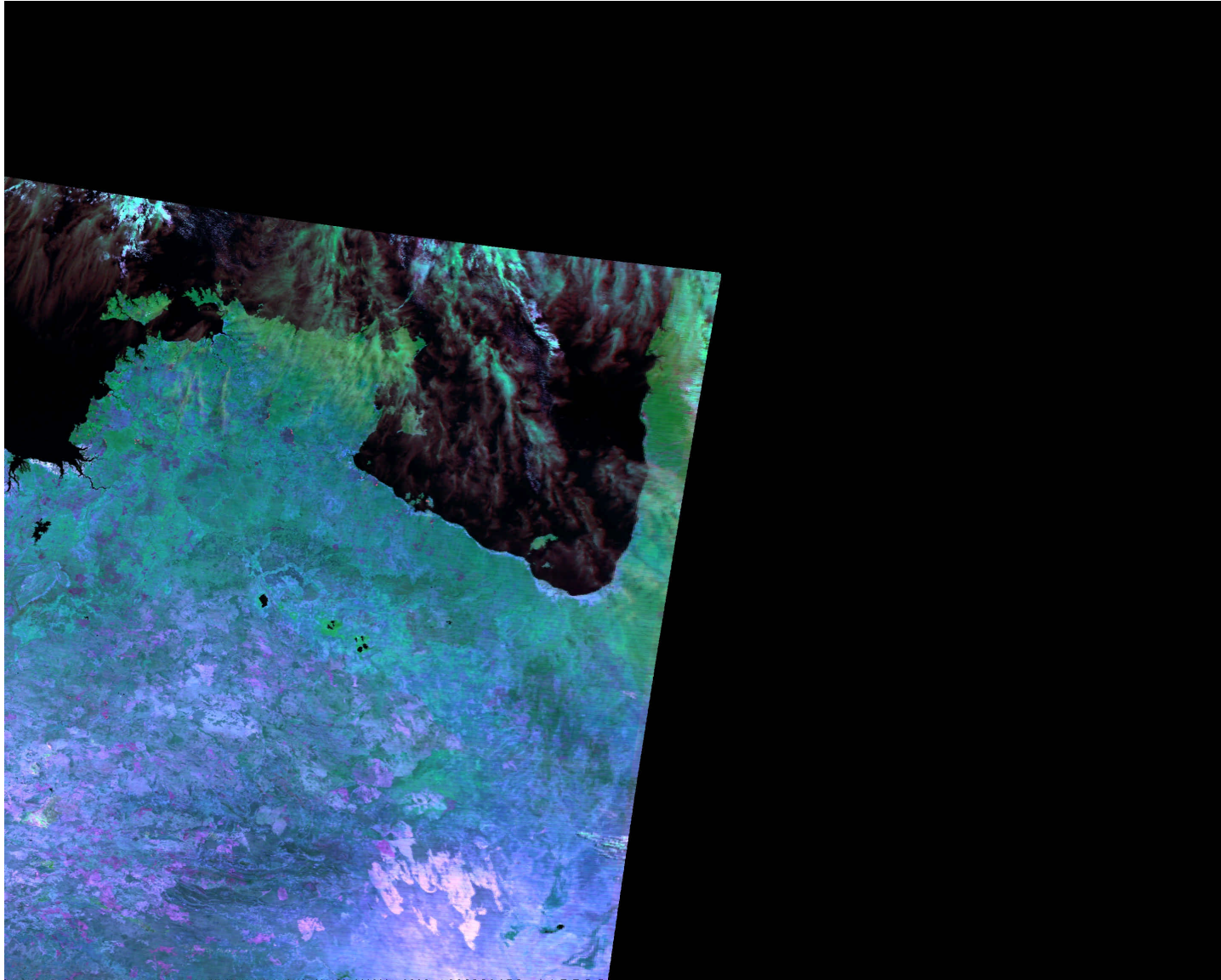AQUA Level 1B (RGB corrected reflectances)
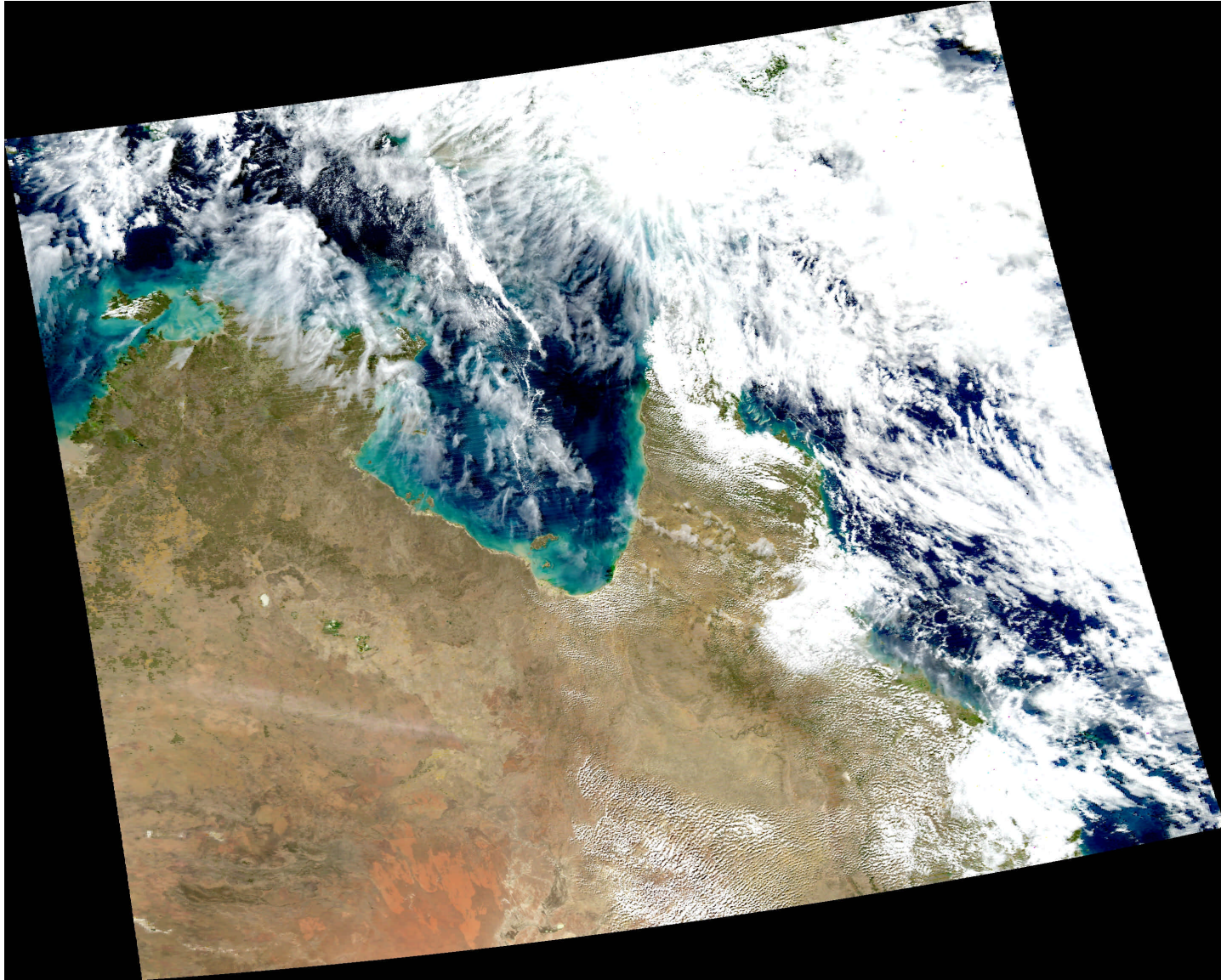
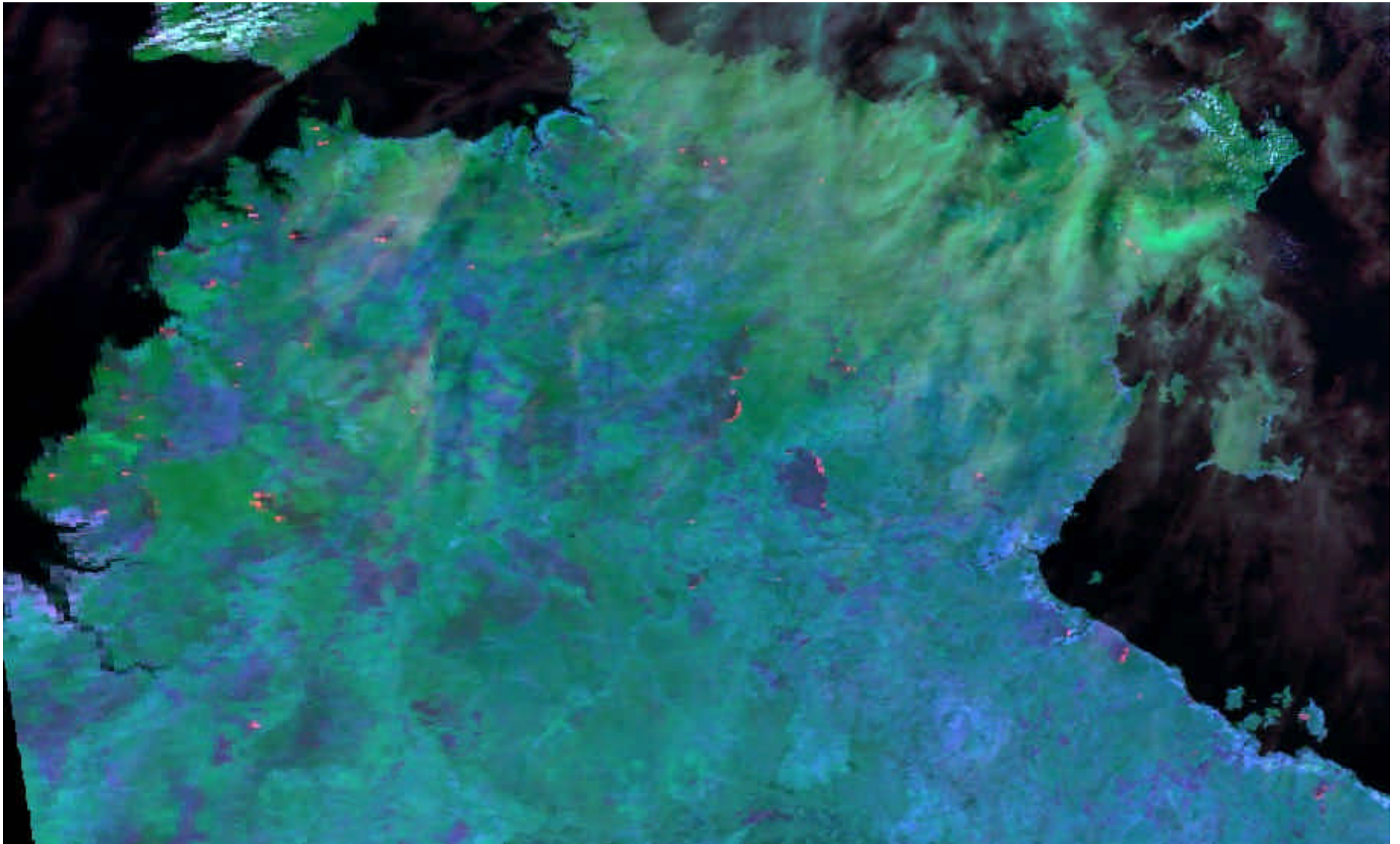AQUA RGB MOD09 surface reflectance's, at launch PGE

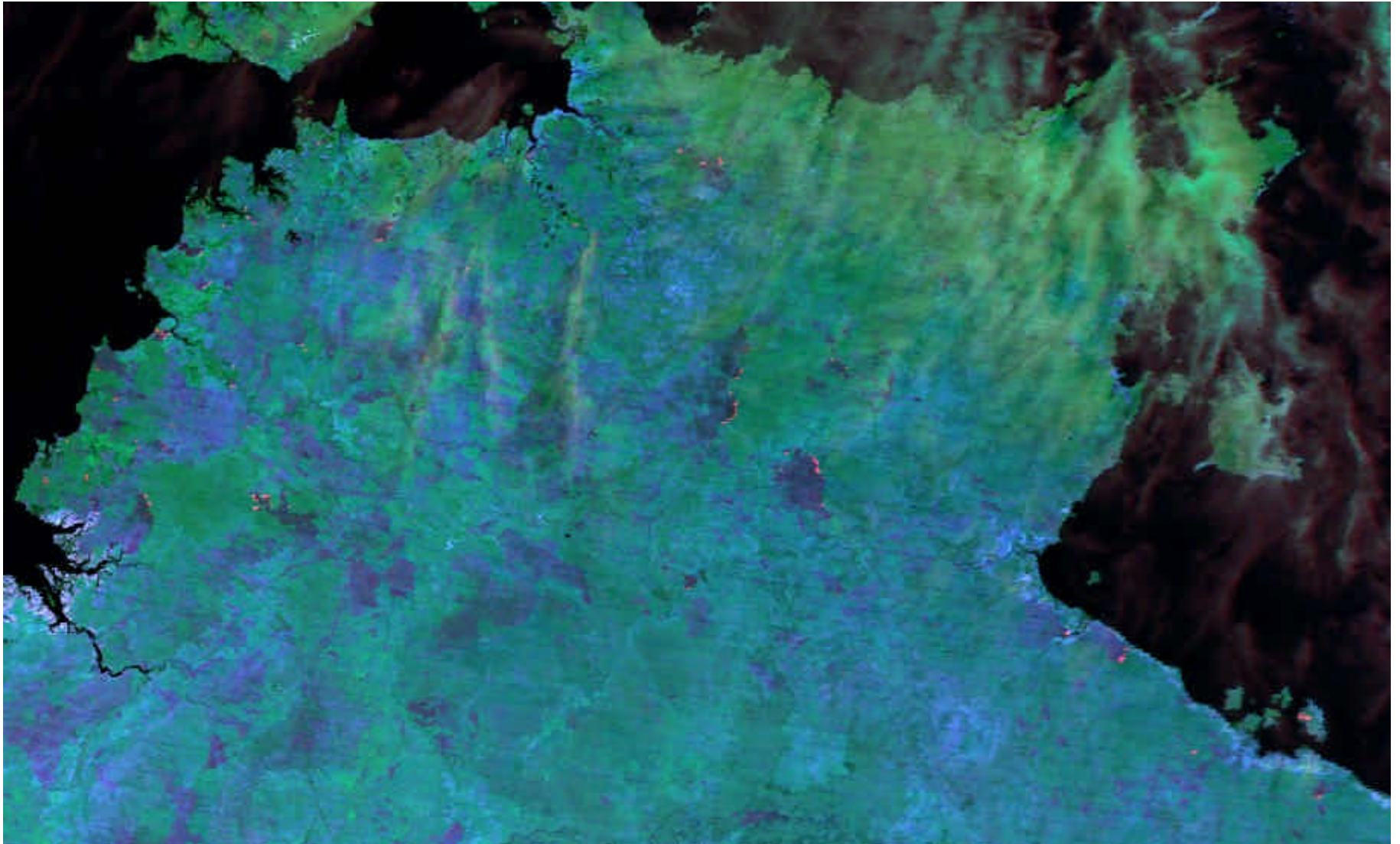AQUA Thermal anomaly (red: 20, green: 5, blue:7)

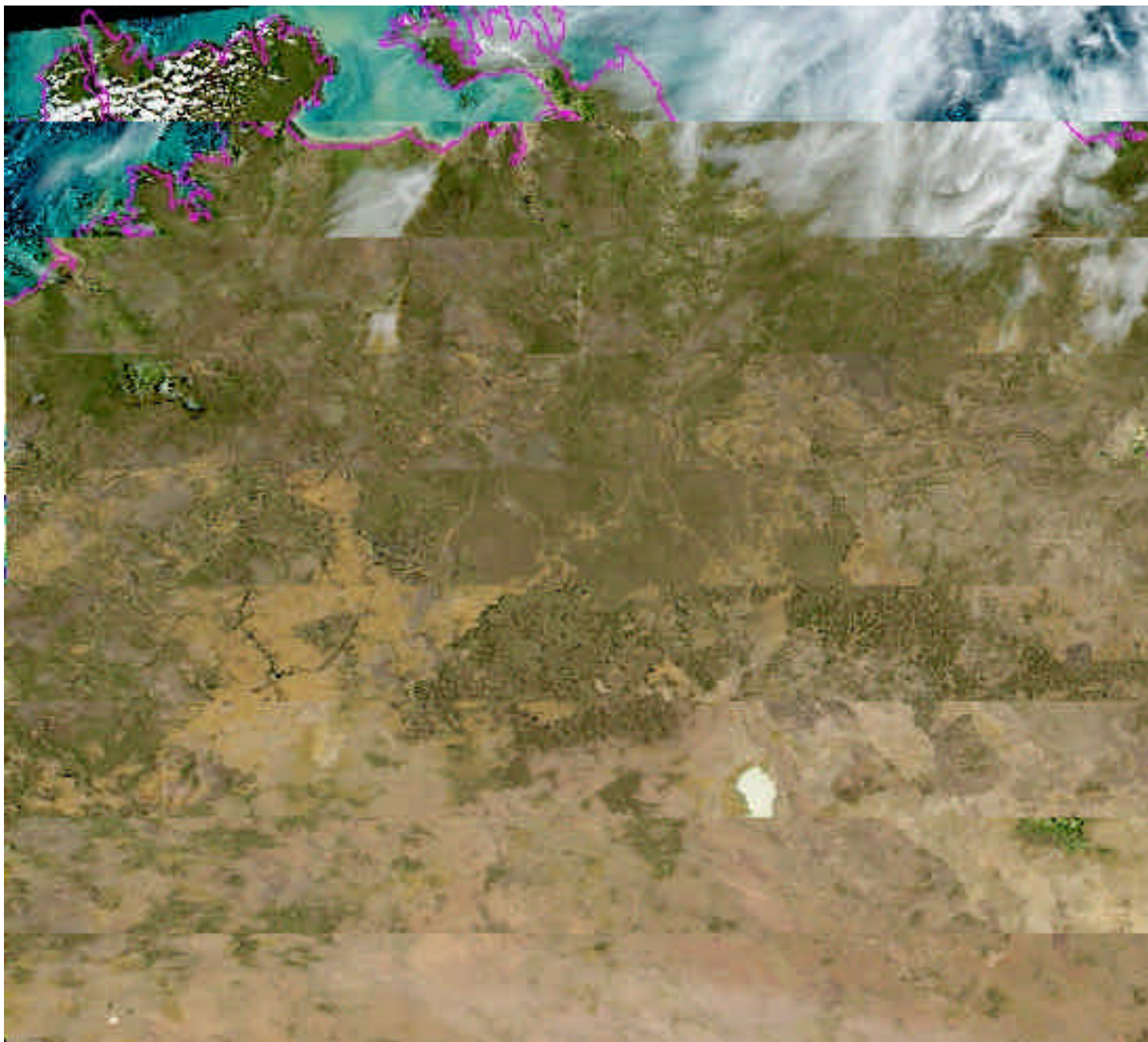TERRA Thermal anomaly (red: 20, green: 5, blue:7)
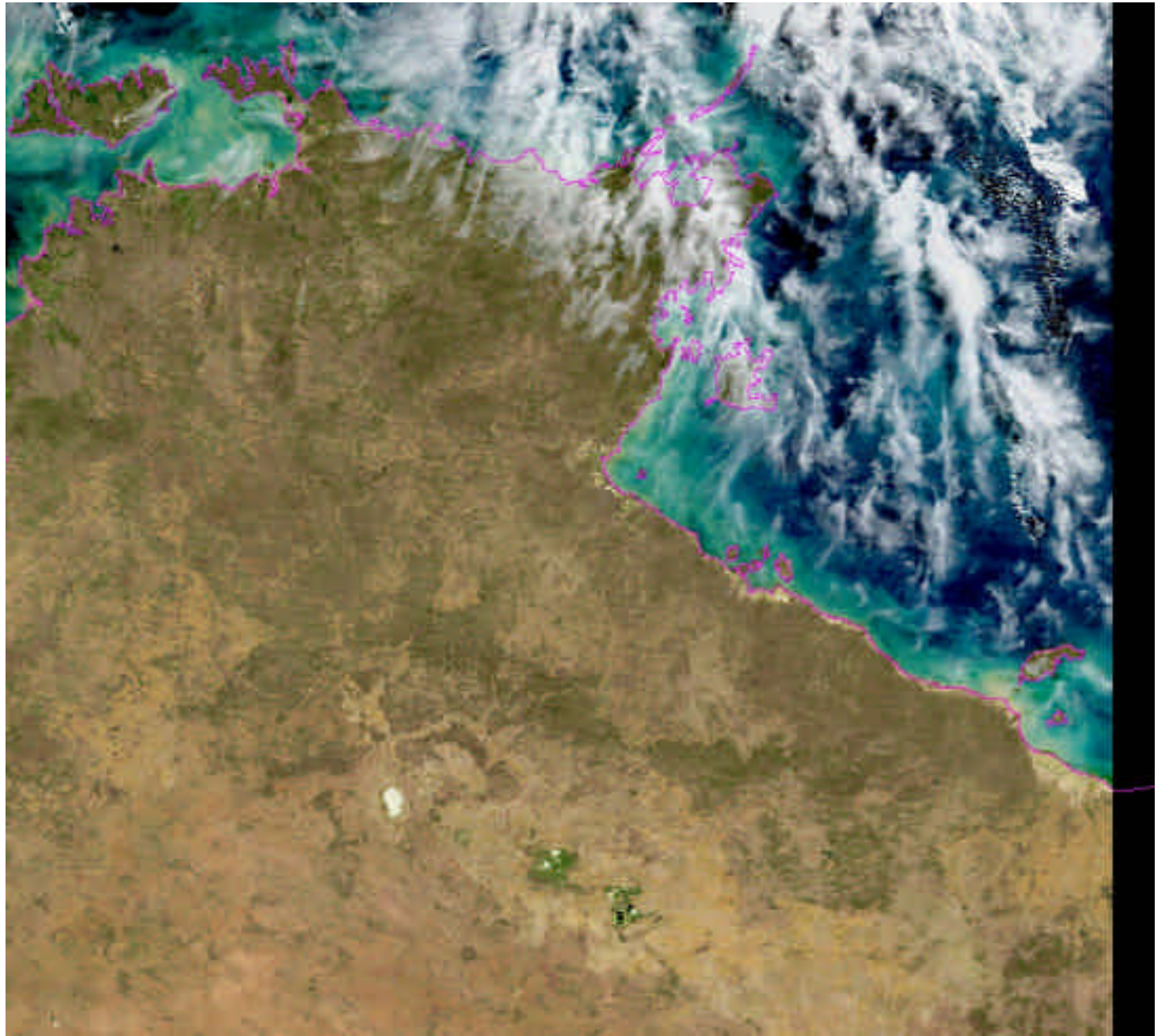
AQUA: Afternoon, thermal anomaly

TERRA: Morning thermal anomaly

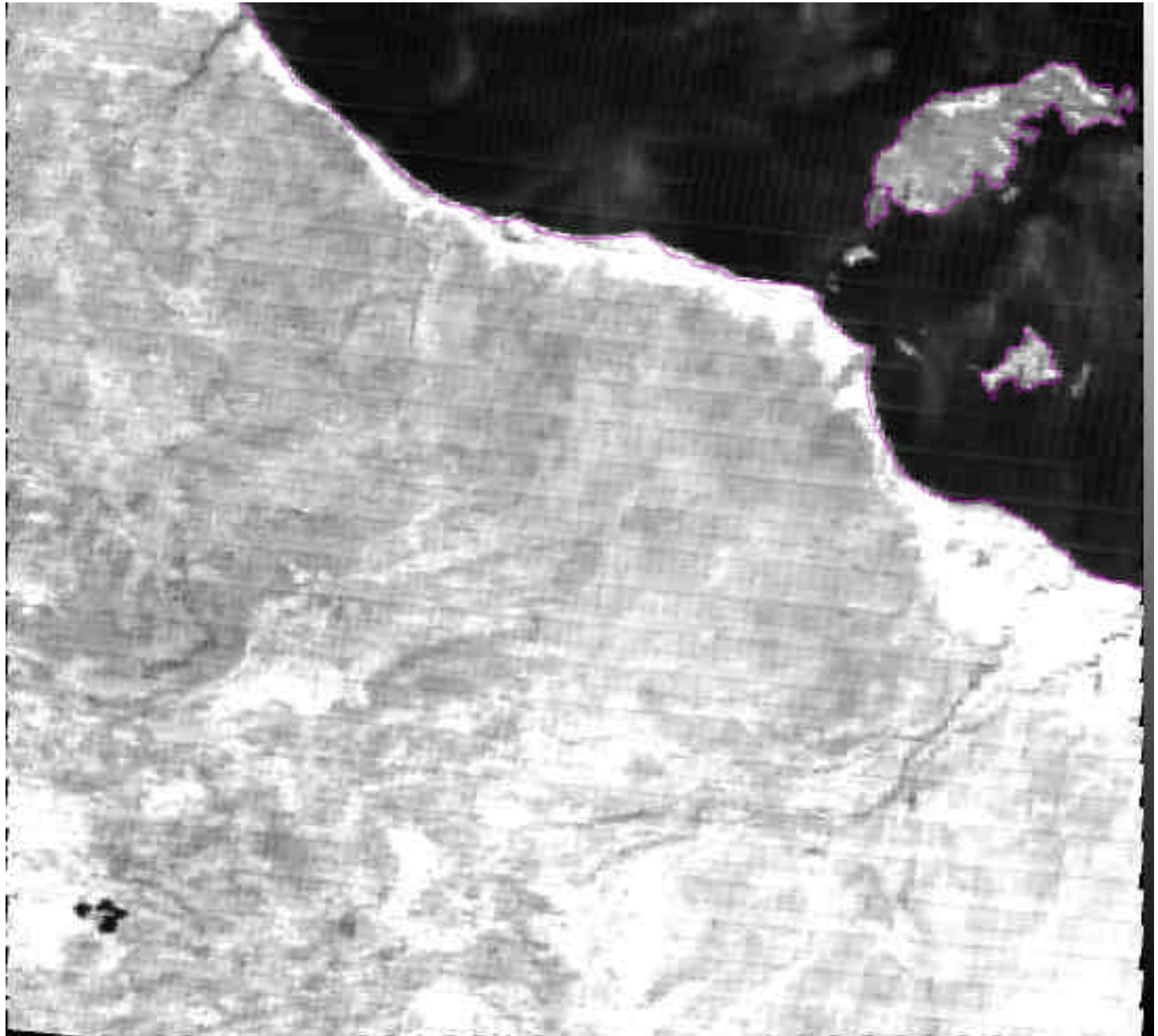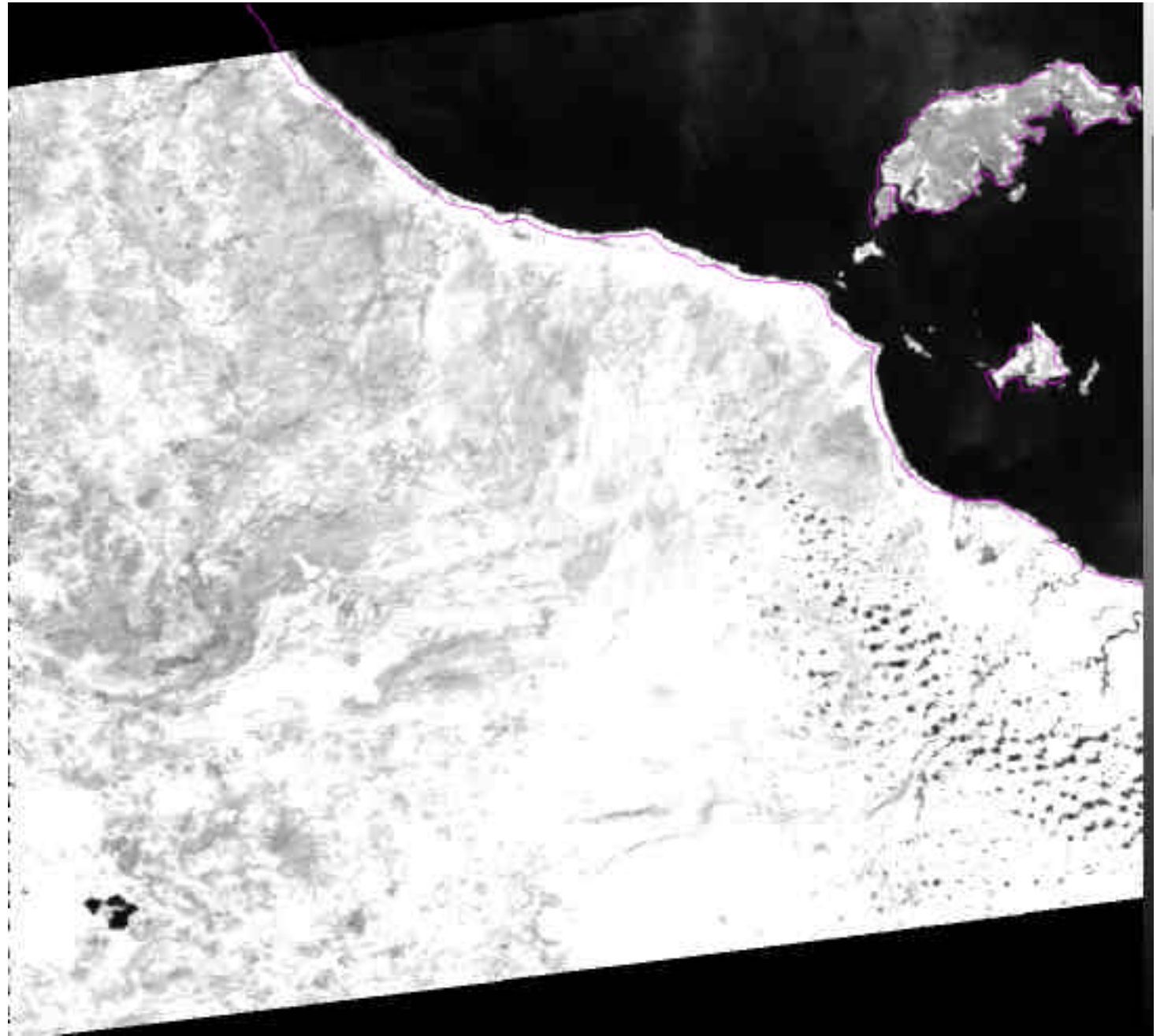**AQUA surface reflectance product 250m (V.3.1.9 in production since 7/12/02)**

TERRA surface reflectance product (V.3.1.7)
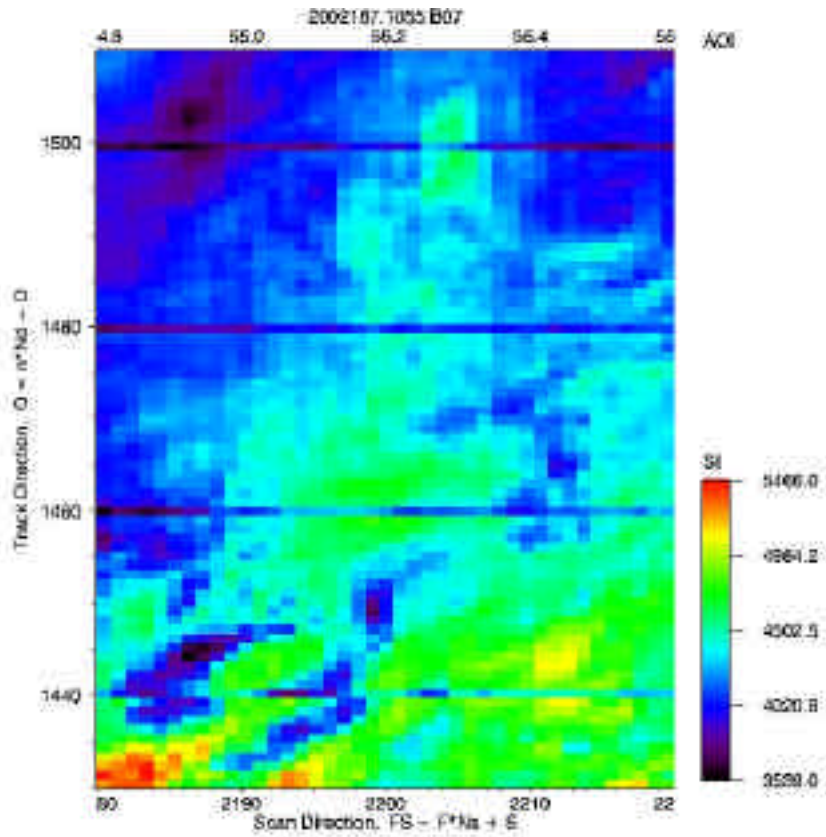
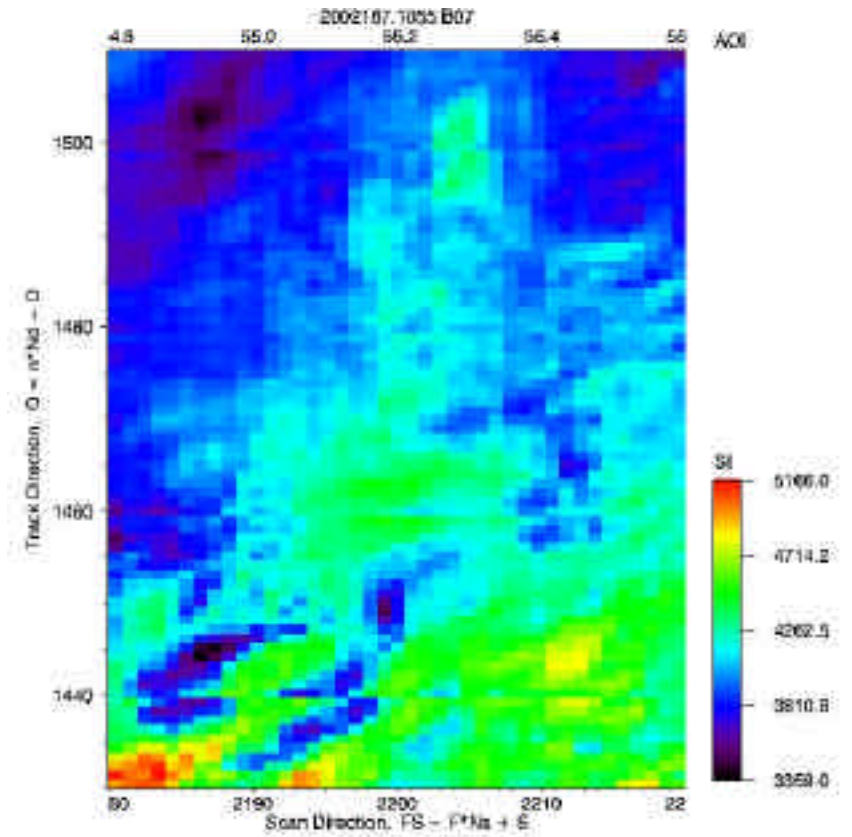**TERRA band 7 detail**

AQUA band 7 detail

AQUA band 7 revised calibration coefficients to be applied after 7/31/02

Pre-launch calibration

SD calibration

CONCLUSIONS

- MODIS narrow land bands located outside strong gaseous absorption features and an operational aerosol retrieval method make it possible to produce surface reflectance at a global scale on a daily basis. This enables the inversion of directional surface properties and computation of climate model parameters (albedo).

- The wide spectral range of MODIS offers unique opportunity to study surface and aerosol properties (reflectance from 0.412mic to 4.0mic, emissivity at 8.55mic,11mic and 12mic).

- Validation of the reflectance product is on-going to produce a realistic estimate of error bars under representative atmospheric and geometric conditions.

- AQUA first results looks very good at this early stage, SWIR (except for band 6) looks better radiometrically than TERRA.