Simulated HyspIRI Volcanology Data Sets

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Goals of Project

The primary objective of this proposal is to create precursor HyspIRI-like data sets to address several important volcanological questions:

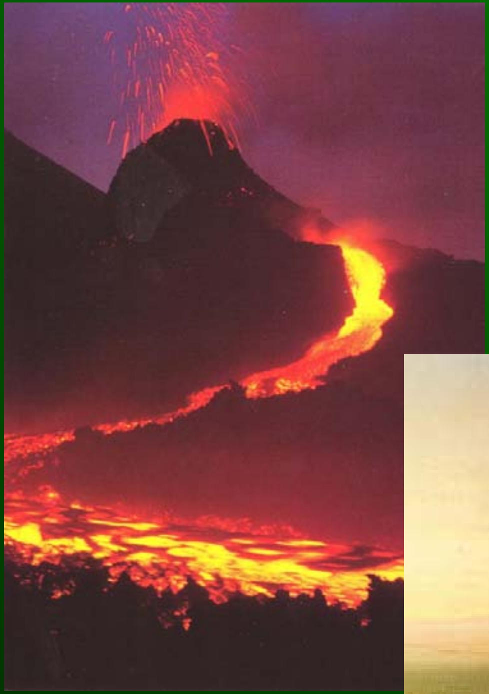
1 What do changes in SO_2 emissions tell us about a volcano's activity?

2 How do we use measurements of lava flow temperatures and volume to predict advances of the flow front?

3 What do changes in lava lake temperatures and energy emissions tell us about possible eruptive behavior?

A second objective is to determine the saturation temperature for the Mid-IR band

ETNA



Why Mt. Etna?

- Europe’s most active volcano
- Explosive and effusive eruptions
- Massive SO_2 emitter
- Extraordinarily frequent remote sensing data acquisitions
- Very well monitored by INGV
- Co-I at INGV will provide all ancillary data needed

Characteristics of Input Data Sets

	MIVIS	EO-1 Hyperion	ASTER TIR
Bands	92 in VSWIR, 10 TIR	196 unique in 0.4-2.5 micron region	5 in 8-12 micron region
Spatial resolution	6-12 m	30 m	90 m
Swath	4-9 km	7.5 km	60 km
Quantization	12 bit	16 bit	12 bit

Ancillary Data Sets

	COSPEC SO_2	Flow field Topography	Eruption chronology
Eruptions and gas emissions	X		X
Lava flow modeling		X	X
Lava lake energy release			X

ASTER Daytime Scenes (1 2 3)

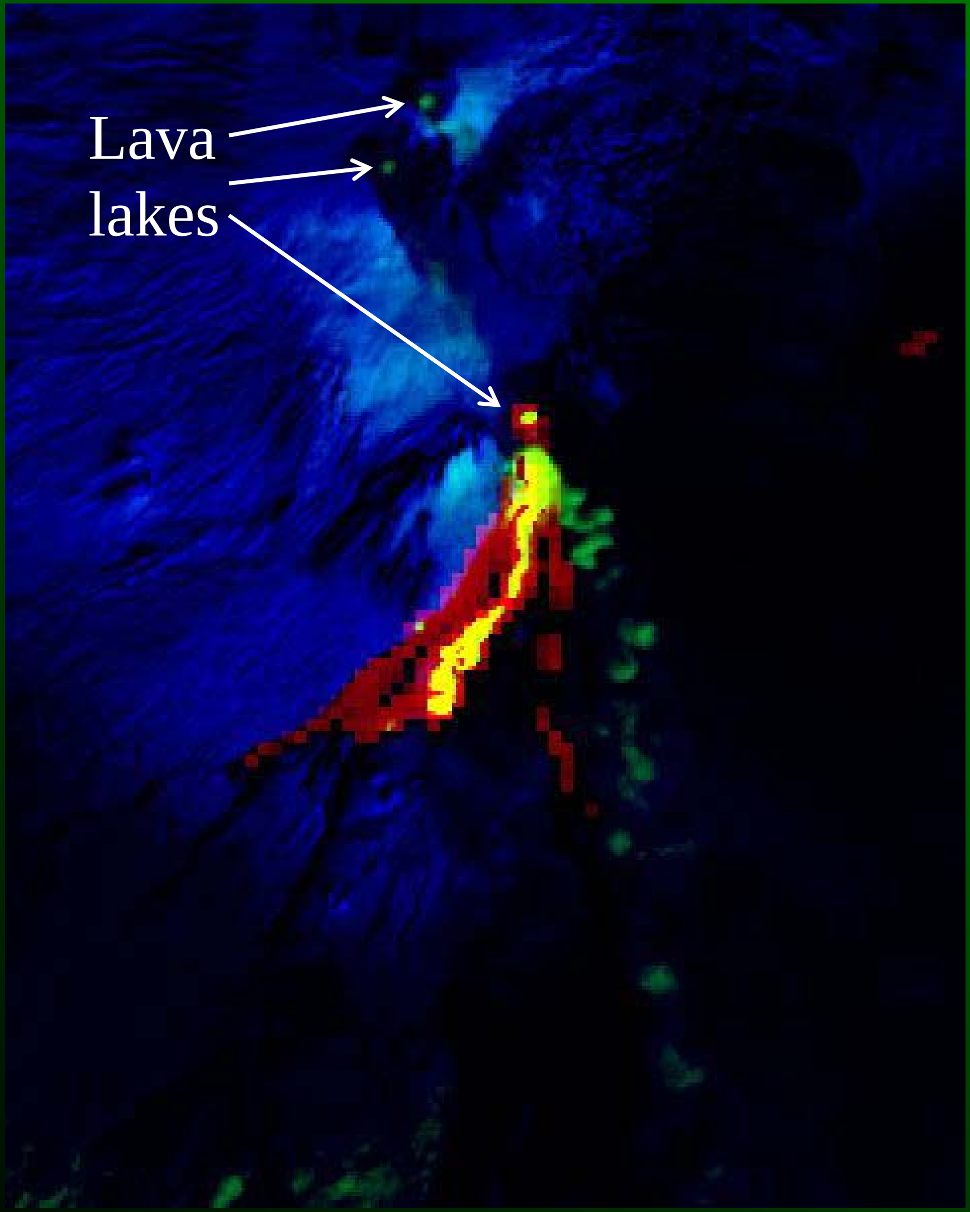
2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
7 May	29 July	5 June	15 Jan	7 Apr	26 Apr	3 Aug	19 Jun	21 Jun	7 Oct	26 May
		7 July	13 Mar	10 June		12 Aug	21 Jun	8 Aug		7 Aug
		23 July	19 July	26 June		7 Nov	14 Jul	21 Nov		
		3 Nov	11 Aug	6 Aug			21 Jul			
		30 Dec		13 Aug			30 Jul			
				22 Aug			2 Oct			

Multispectral TIR from Daytime ASTER (1 2 3)

VNIR image: plume is gray; flows are not incandescent

TIR image: plume composition is mostly ash; flows are obvious

Multispectral Daytime ASTER (2 3)



R=11um G=1.5um B=0.84um

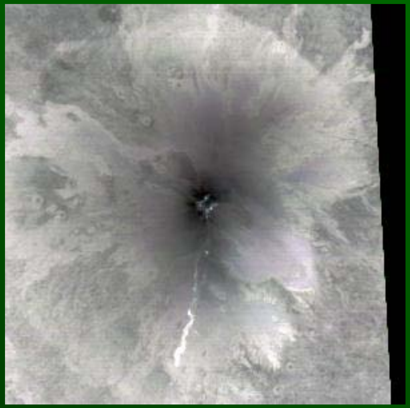
Lava flows vary in temperature; multispectral data allow better estimation of temperatures than TIR alone.

ASTER Nighttime TIR Scenes (1 2 3)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
6-Jun	9-Jan	19-Jan	7-Feb	13-Mar	5-Feb	29-Apr	15-Mar	21-Jun	6-Jan	2-Jan
22-Jun	25-Jun	22-Jan	20-Mar	15-Jun	4-Nov	31-May	18-May	11-Oct	15-Jun	3-Feb
8-Jul	11-Jul	28-Jan	14-May	26-Jun	11-Nov	2-Jul	19-Jun	5-Dec	24-Jun	1-May
24-Jul	15-Oct	4-Feb	17-Jul	3-Jul	27-Nov	25-Jul	26-Jun		10-Jul	10-May
10-Sep	24-Oct	12-Jan	26-Jul	14-Sep		3-Aug	12-Jul		2-Aug	
28-Oct		11-May	18-Aug			10-Aug	12-Dec		15-Nov	
		20-May				4-Sep				
		28-Jun				13-Oct				
		23-Jul				7-Nov				
		16-Sep								
		18-Oct								
		27-Oct								
		19-Nov								
		28-Nov								

Selected 2002 ASTER Night TIR (1 2 3)

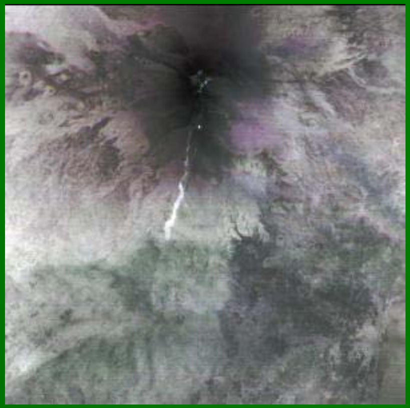
January 19



January 28

May 11

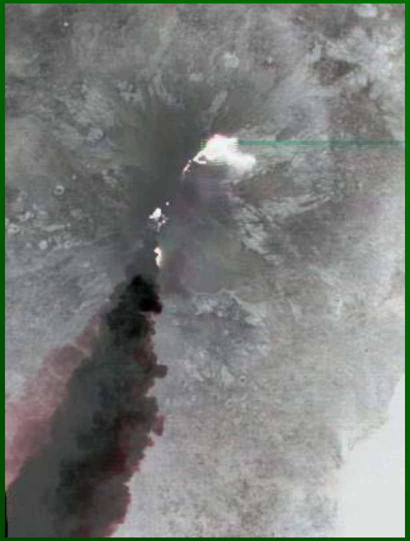
May 20



June 28

July 23

October 27

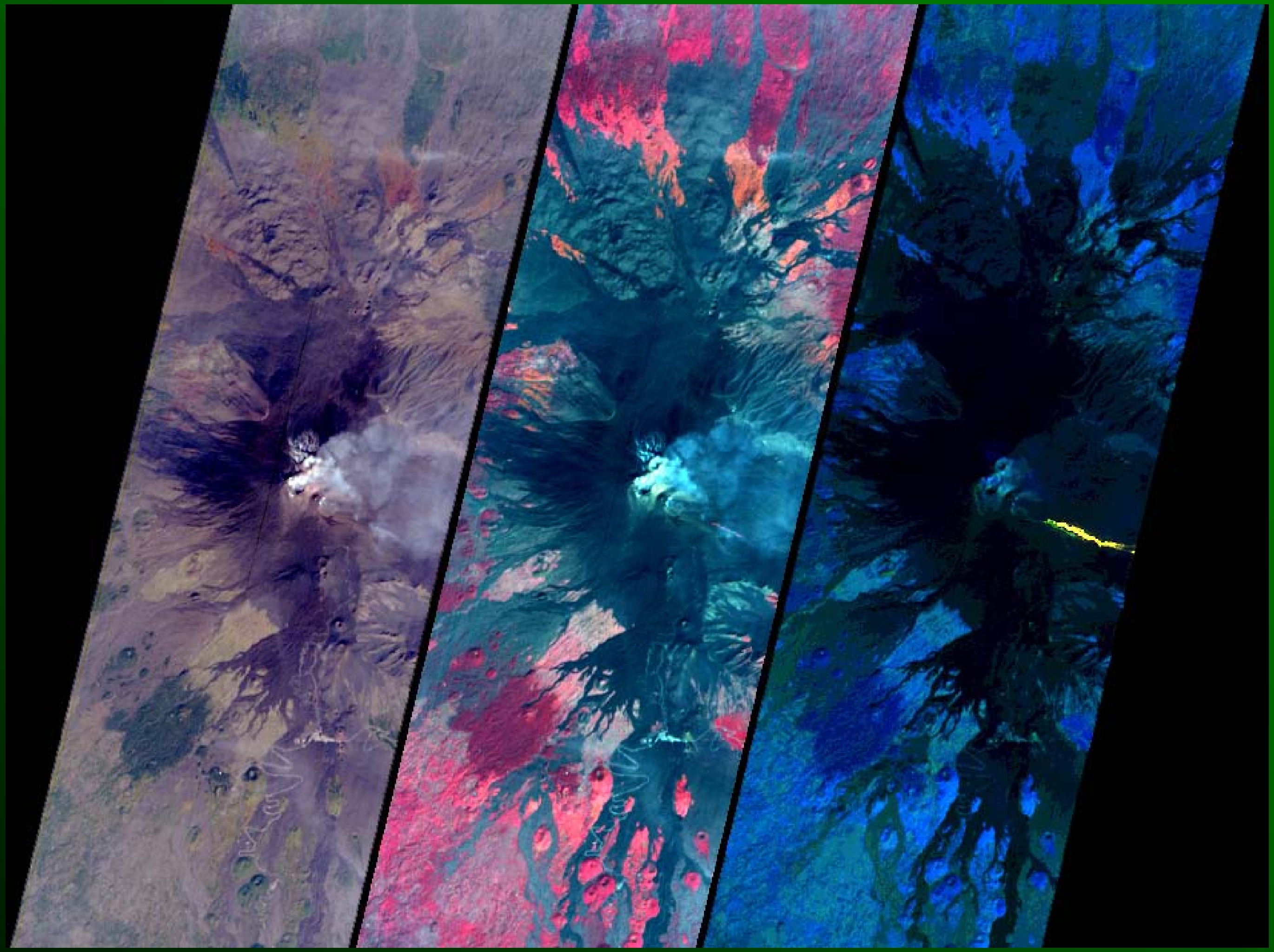


EO-1 Hyperion Daytime Scenes (2 3)

EO1H1880342009281110pf_sgs_01
EO1H1880342008206110kf_sgs_01
EO1H1880342008152110kf_sgs_01
EO1H18803420071901110kf_sgs_01
EO1H1880342007134110kf_sgs_01
EO1H1880342006303110pf_sgs_01
EO1H1880342006298110pf_sgs_01
EO1H1880342005316110kf_sgs
EO1H1880342005302110kf_sgs
EO1H1880342005205110pf_hgs
EO1H1880342004283110pw_sgs
EO1H1880342004260110kw_pf1
EO1H1880342003223110kf_sgs
EO1H1880342003207110kx_hgs
EO1H1880342003177110ky_sgs
EO1H1880342001267110kp_sgs
EO1H1880342001242110po_sgs
EO1H1880342001203110kp_sgs
EO1H1880342001194110po_sgs

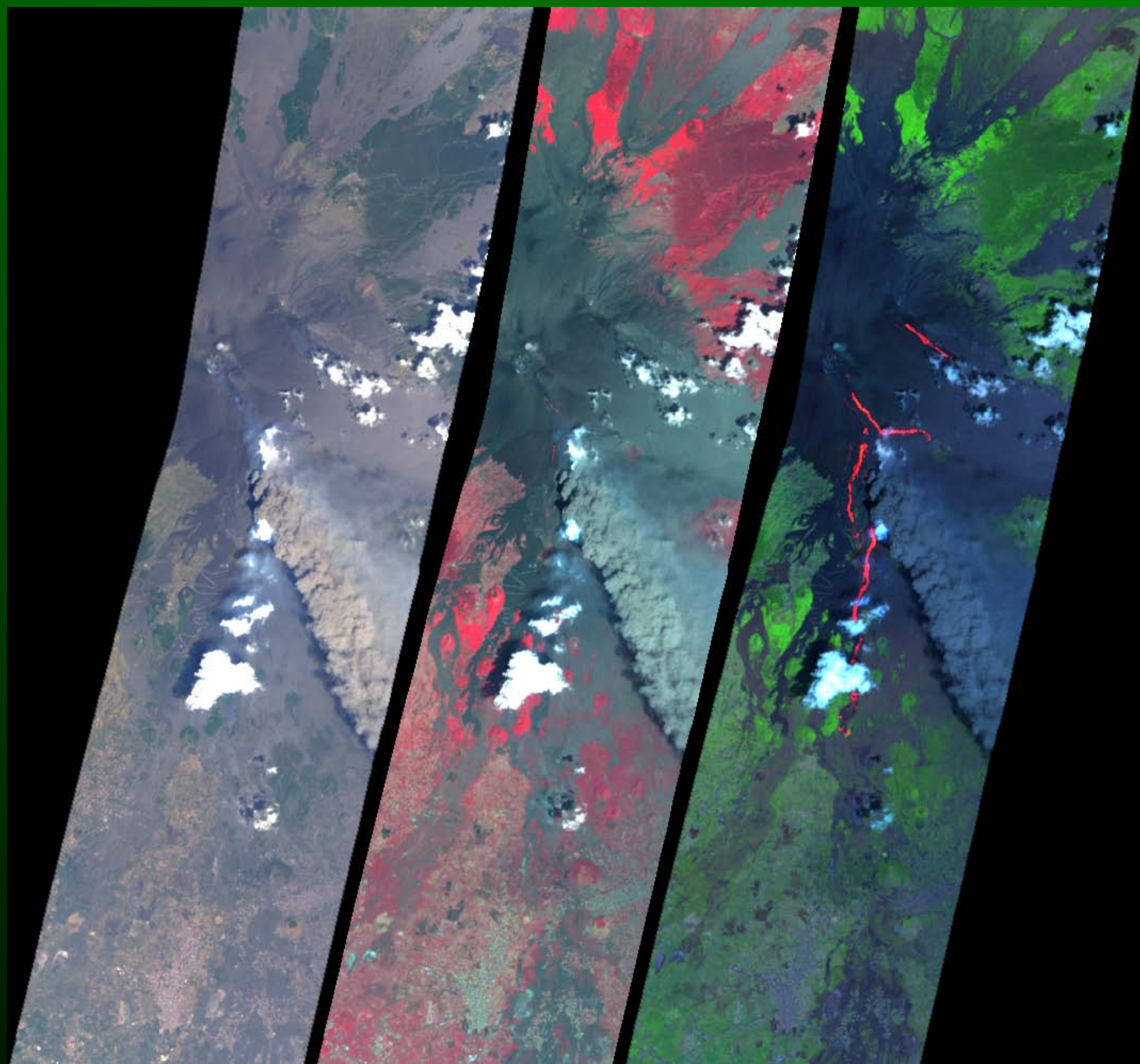
October 26, 2006 Hyperion Etna Data (2 3)

0.65-0.55-0.44 0.87-0.65-0.55 2.20-1.65-0.87



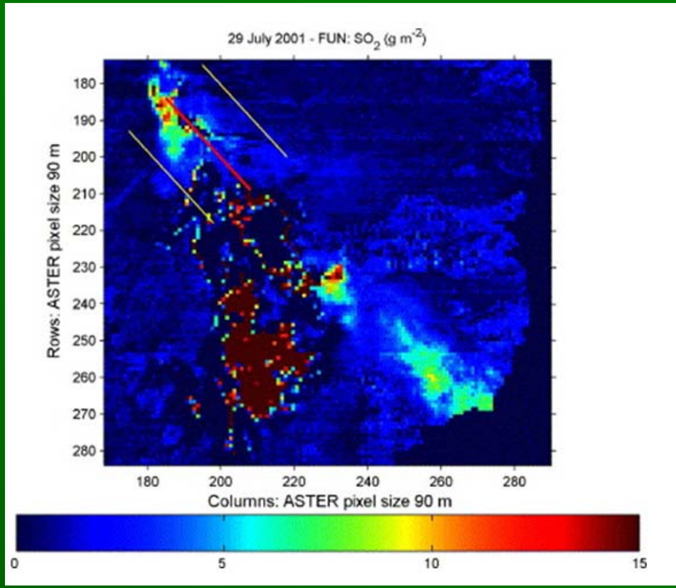
July 22, 2001 Hyperion Etna Data (2 3)

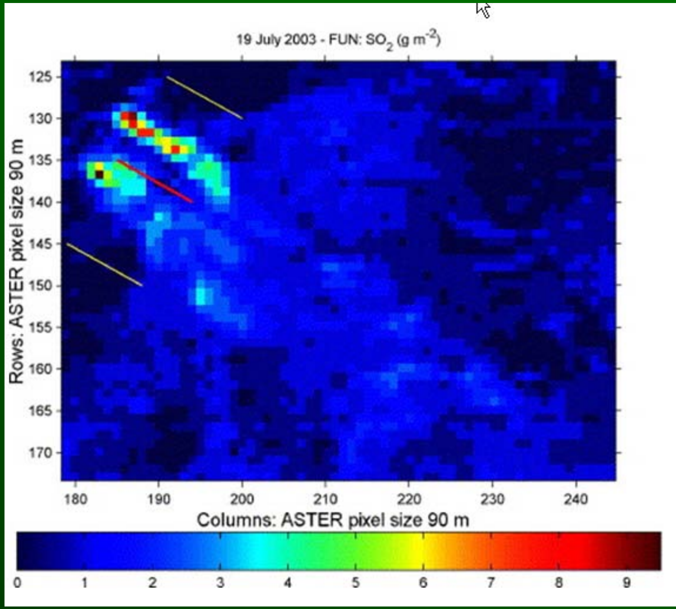
0.65-0.55-0.44 0.87-0.65-0.55 1.65-0.87-0.65



SO_2 Determination with ASTER TIR(1)

Multispectral TIR allows determination of SO_2 column abundance. With wind speed estimate, a total flux can be estimated.

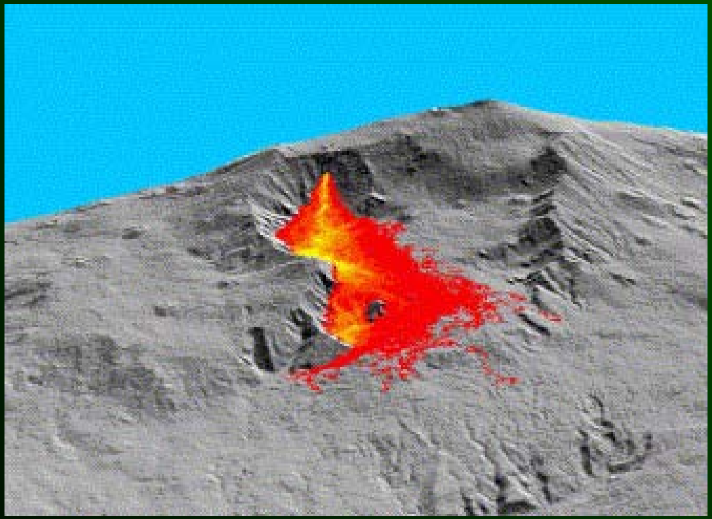




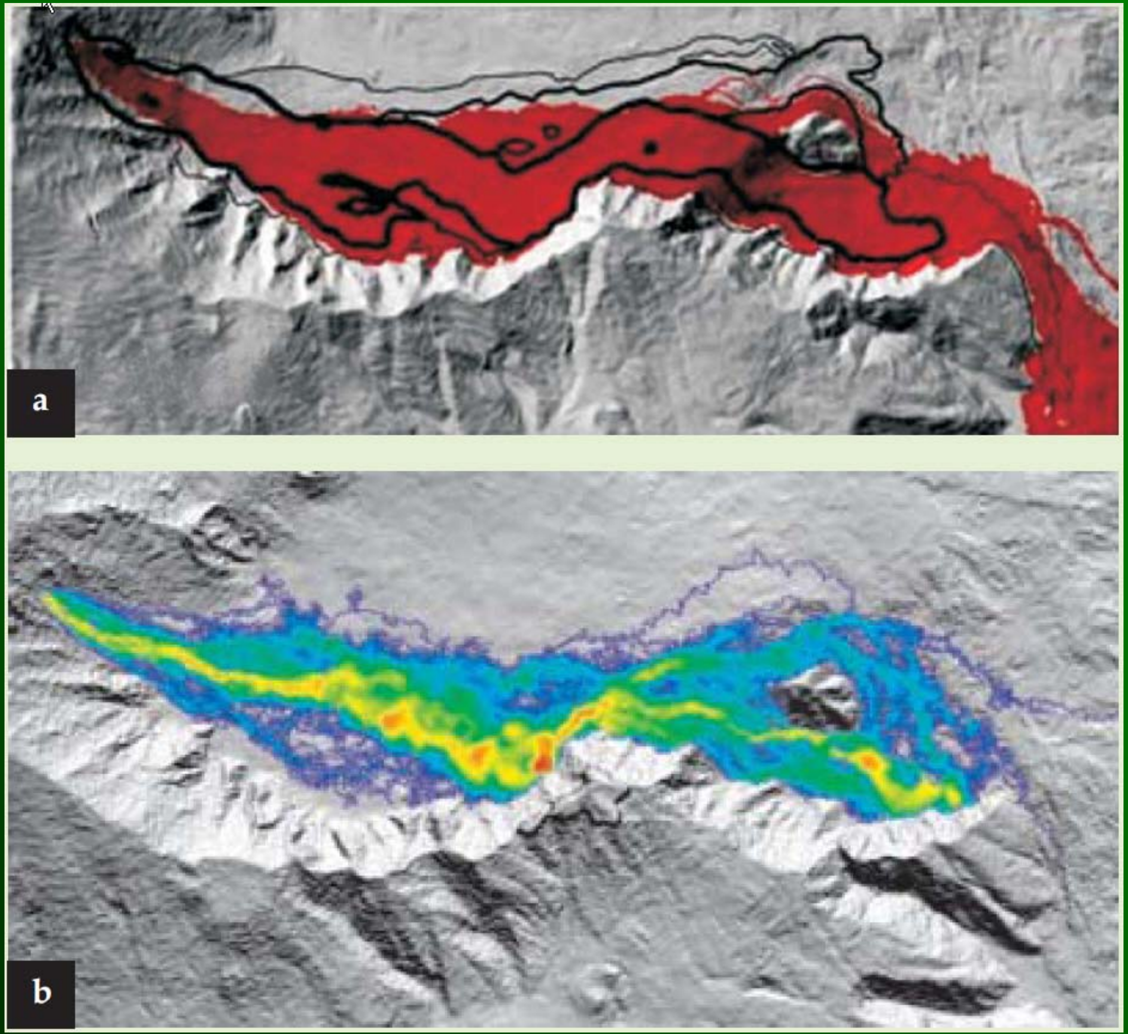
Pugnaghi et al., 2005

Lava Flows, Energy Radiated, Extent (2)

Lava flow models require DEM data, effusion rates, and Temperature distributions



Damiani et al., 2006



Wright et al., 2008

Lava Lakes, Energy Fluxes (3)

Radiant flux vs time for Lascar volcano:Landsat TM bands 5 & 7

OPPENHEIMER ET AL.: ANALYSIS OF VOLCANIC THERMAL FEATURES

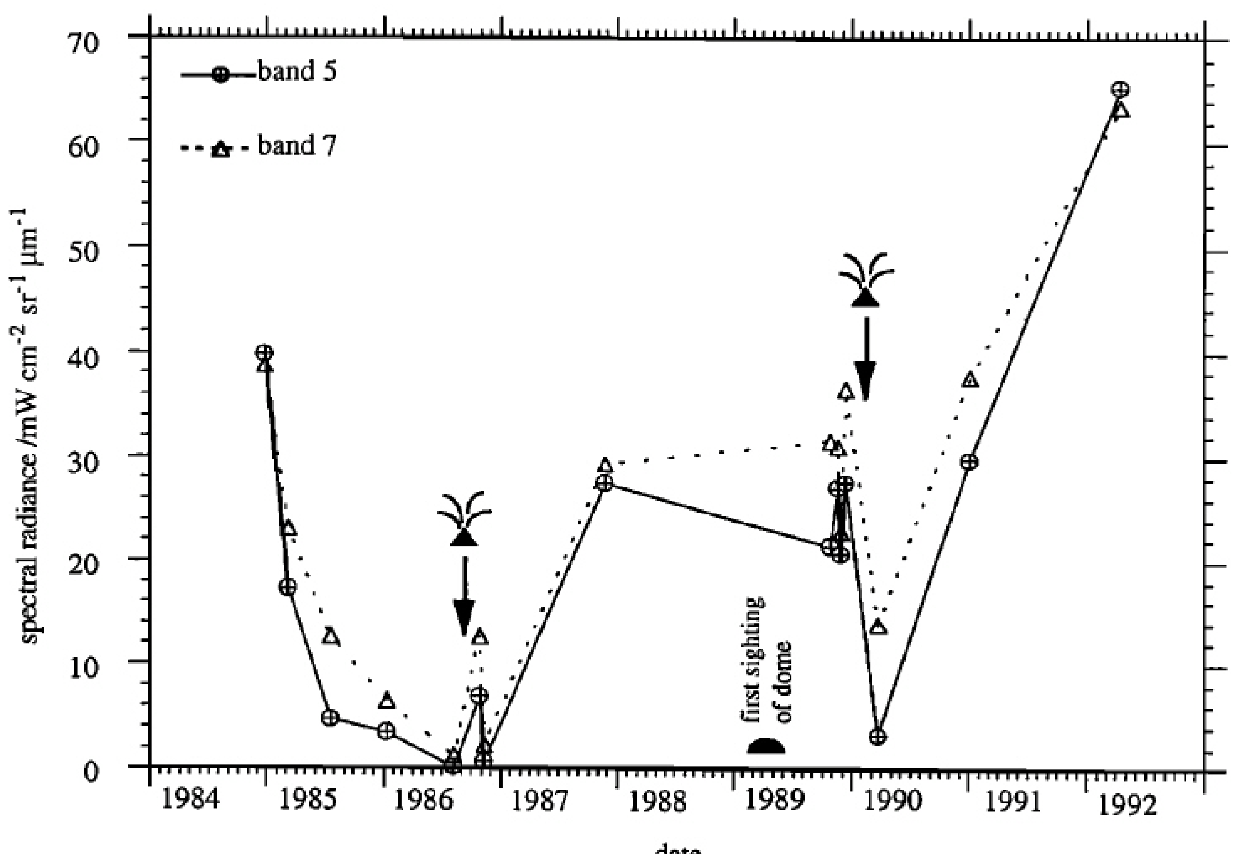
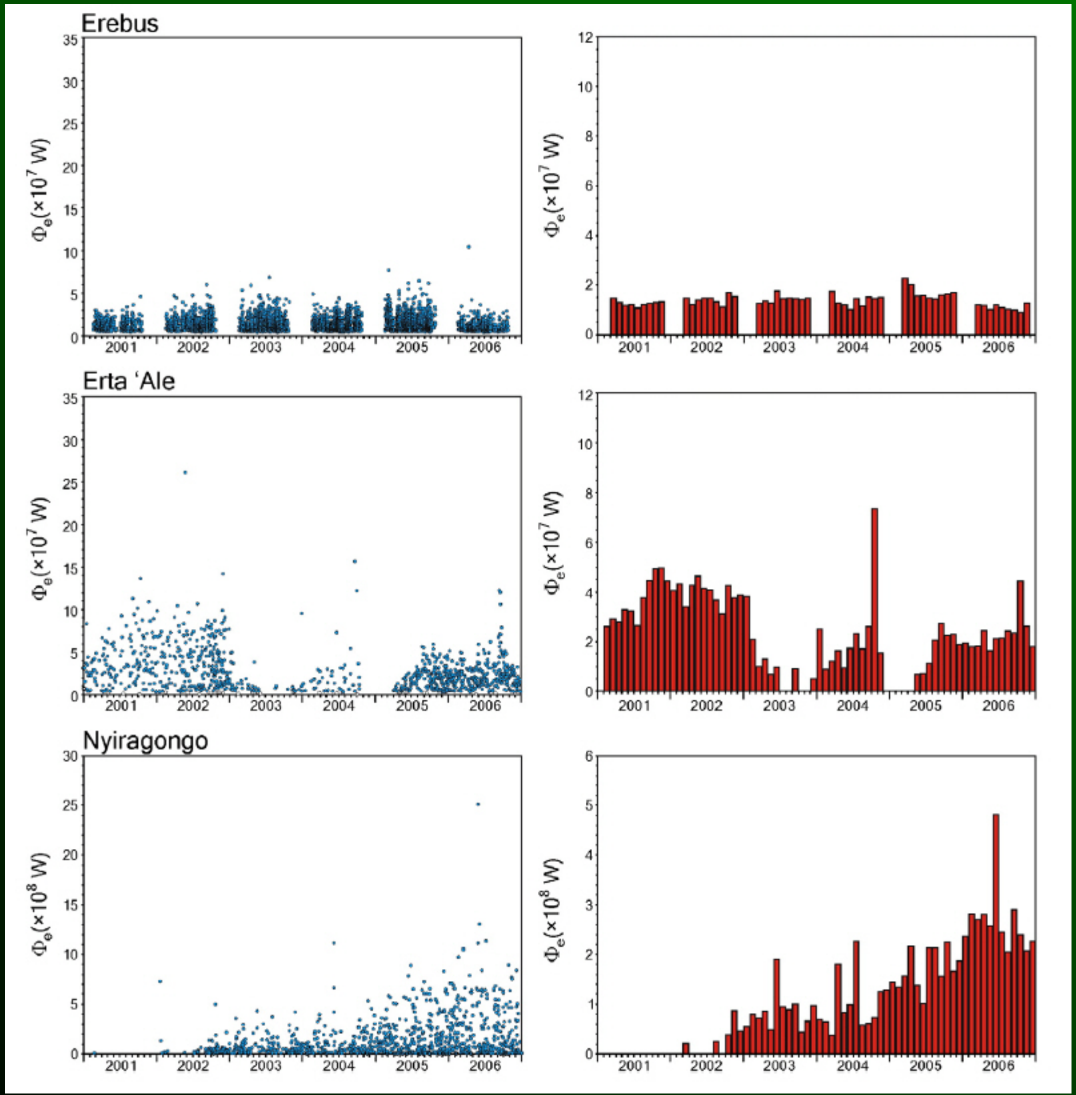


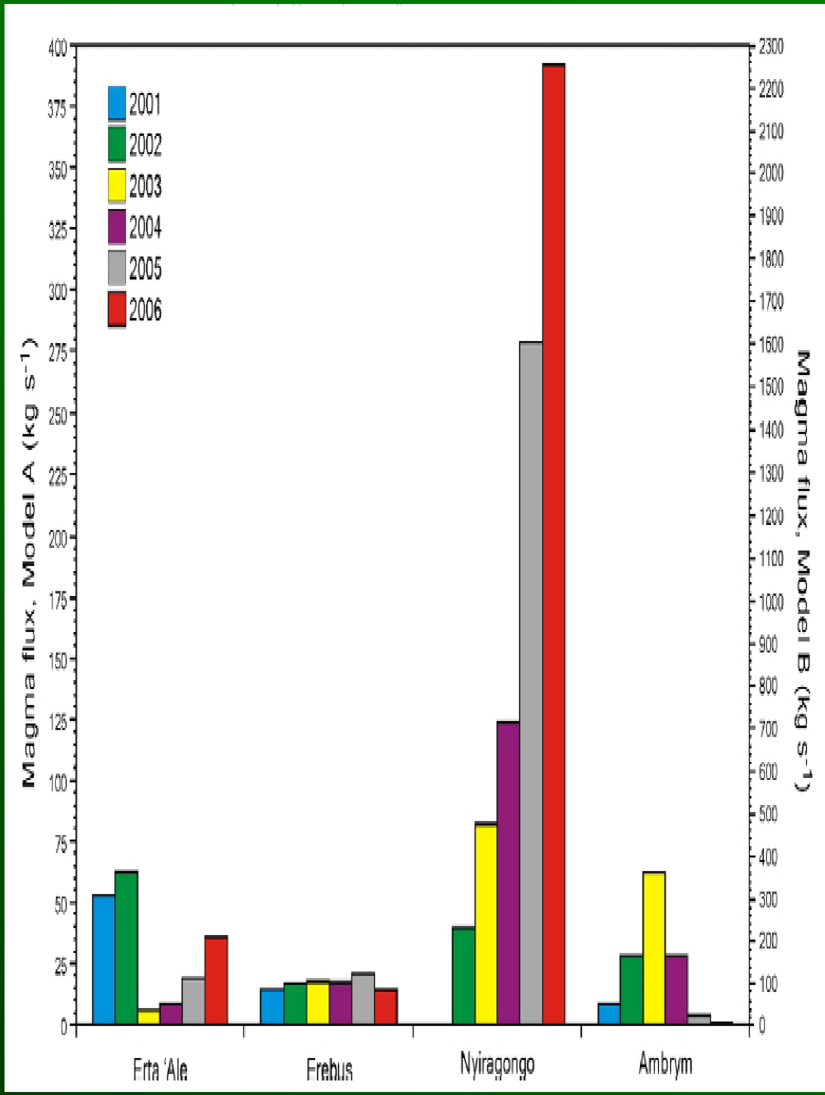
Fig.18. Bands 5 and 7 spectral radiance through time for each TM image. All $DN_{\lambda,\mathrm{thermal}}$ greater than or equal to 10 were summed, except when band 5 anomalies lacked corresponding radiance in band 7, since such pixels had most probably been inadequately corrected for reflected sunlight. Volcano symbols mark September 16, 1986, and February 20, 1990, eruptions.

Lava Lakes, Energy Fluxes, Mass Losses (3)

Mass fluxes to sustain estimated energy losses

Radiant Fluxes





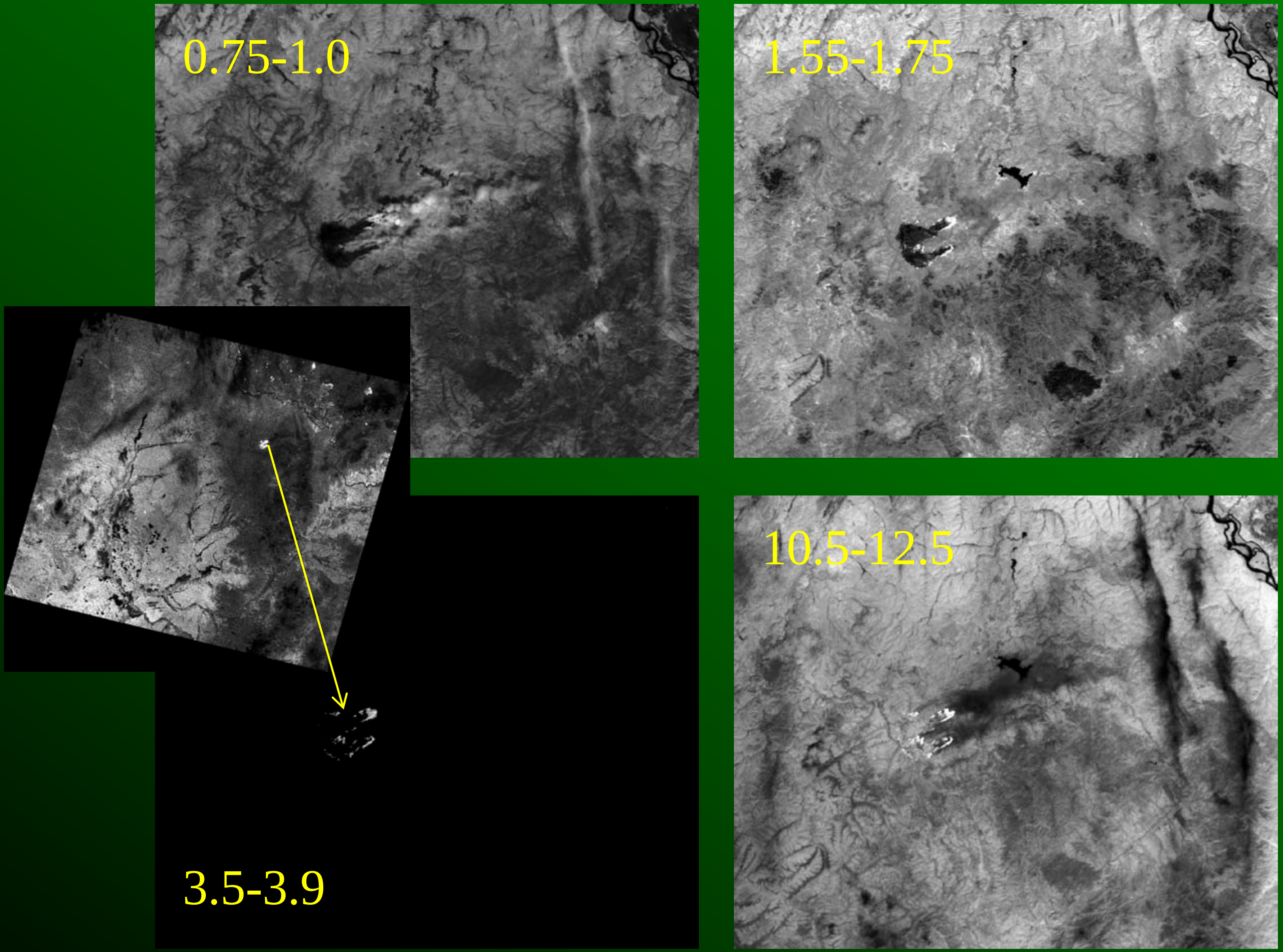
Saturation of 3-5 um Channel

- Extensive work by Co-I Rob Wright will be reported later in the workshop covering volcanoes.
- More complete report will be given by Vince Realmuto later in workshop covering volcanoes and fires.
- Recent (yesterday) discovery of China’s HJ-1B IRS sensor

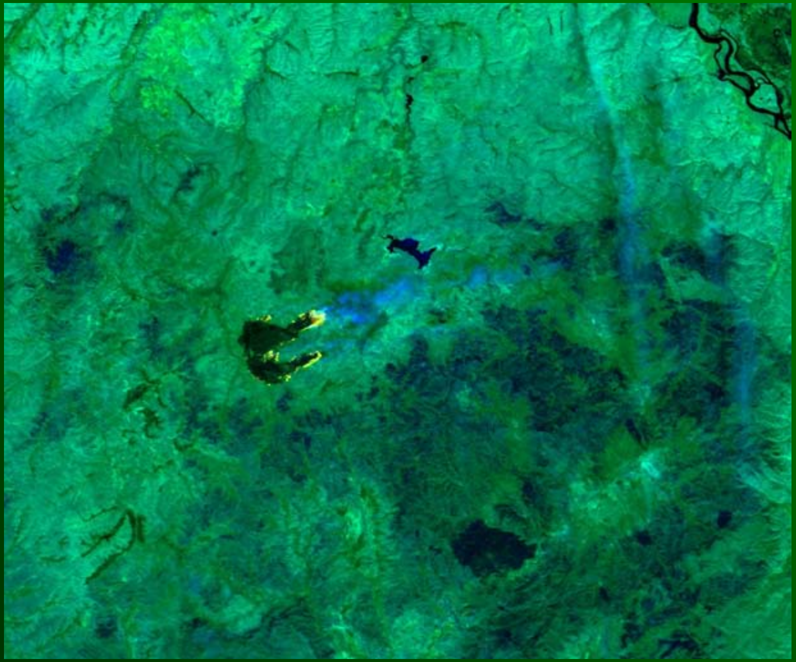
China's HJ-1B IRS Instrument

	Spectral range	Pixel size	Swath, km
1	0.75-1.0	150	720
2	1.55-1.75	150	720
3	3.5-3.9	150	720
4	10.5-12.5	300	720

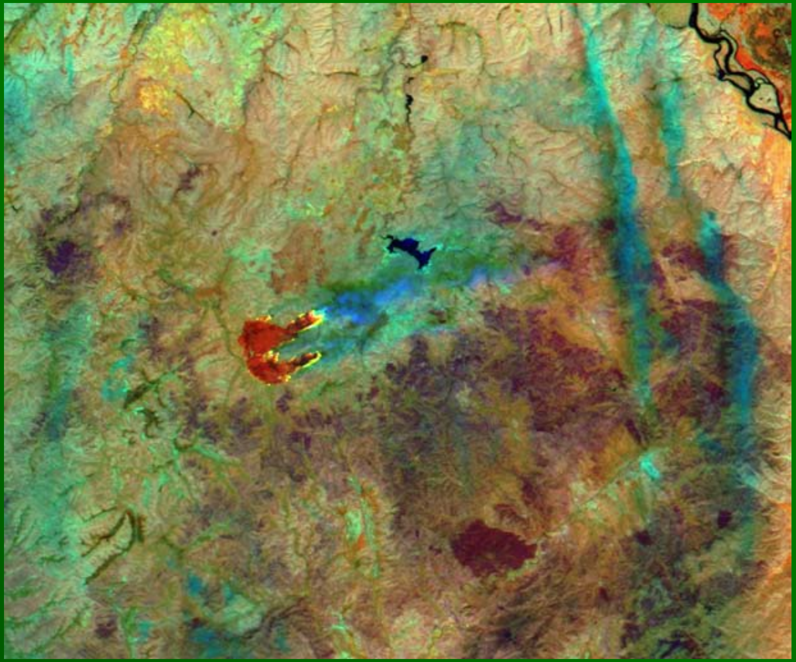
China’s HJ-1B IRS Instrument



China's HJ-1B IRS Instrument



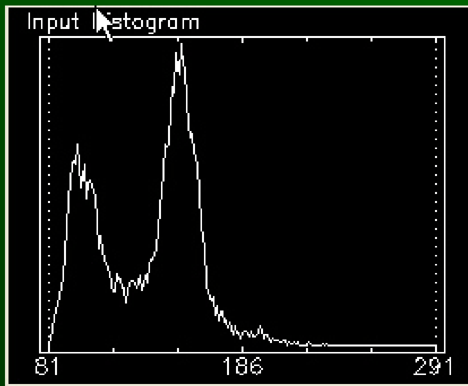
3.7, 1.65, .87



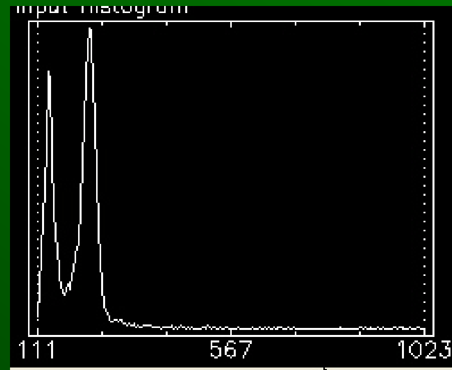
11.5, 1.65, .87

China's HJ-1B IRS Instrument

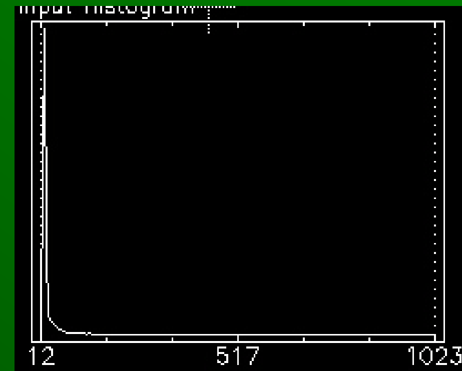
.87



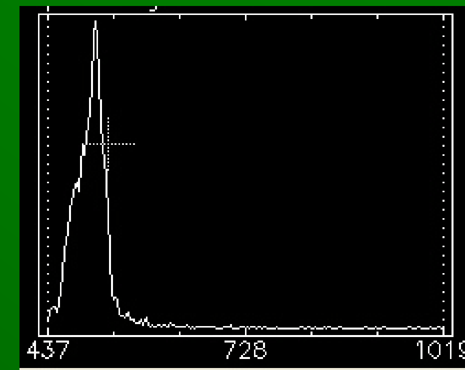
1.65

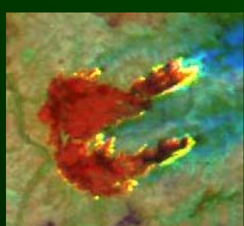


3.7



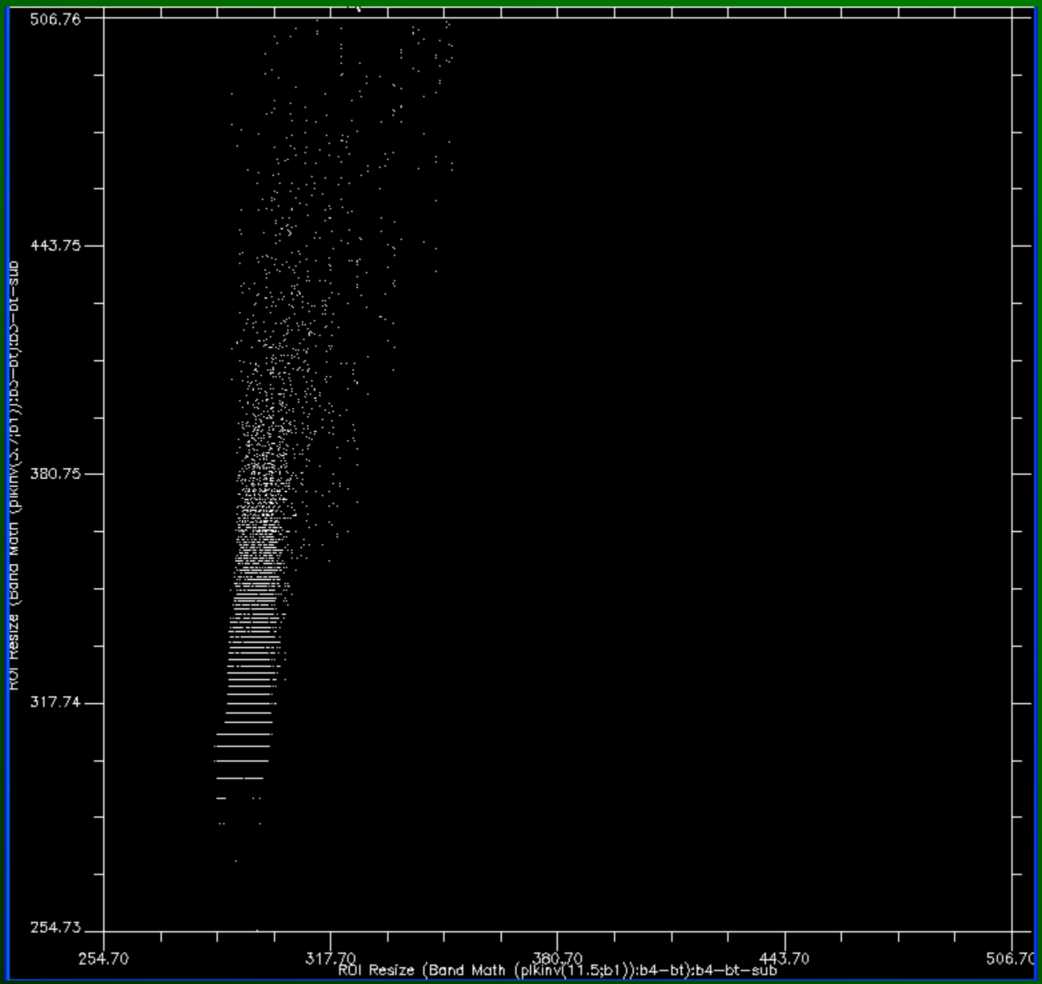
11.5





	Low DN	High DN	W/m2*sr* um (low)	W/m2*sr* um (high)
1: .75-1.0	81	291	18.9	67.9
2: 1.55-1.75	111	1023	5.98	55.1
3: 3.5-3.9	12	1023	0	80.3
4: 10.5-12.5	437	1019	7.8	17.3

China’s HJ-1B IRS Instrument



Brightness temperature: B4-xaxis, B3-yaxis

Pakistan Flood