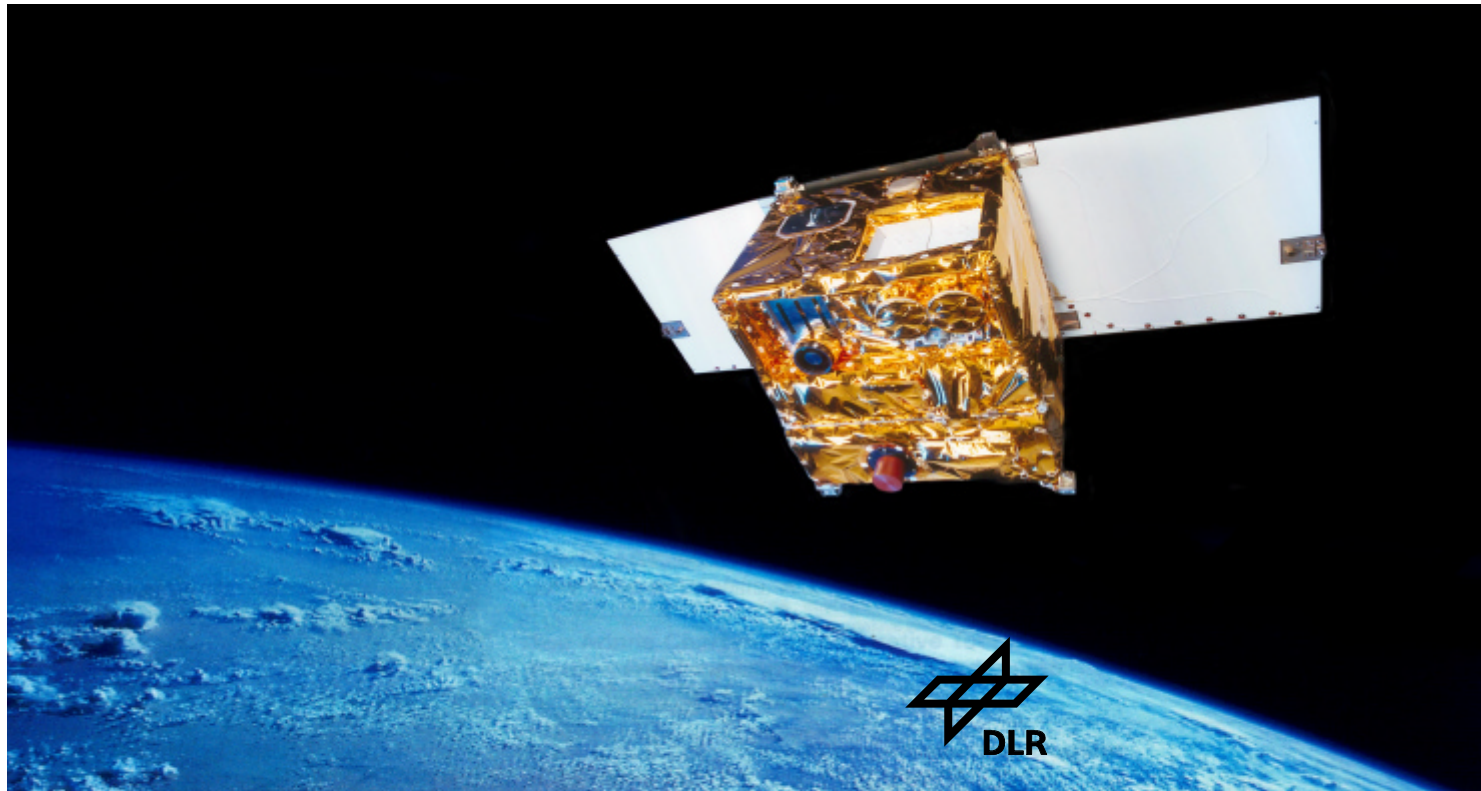




## DLR Micro-Satellite BIRD Mission - Hot Spot Detection Results



Global Fire Monitoring Center





## Rationale

- ▶ **Every year burn**
  - **Ca.  $10^9$  ha savannah area**
  - **Ca  $10^7$  ha tropical rain forest**
  - **Ca.  $10^6$  ha Mediterranean vegetation**
  - **Ca.  $10^8$  ha boreal forests**
  
- ▶ **The impacts on**
  - **atmosphere (green house effect, ozone, aerosol, relation CO/CO<sub>2</sub>),**
  - **climate**
  - **global carbon cycle**

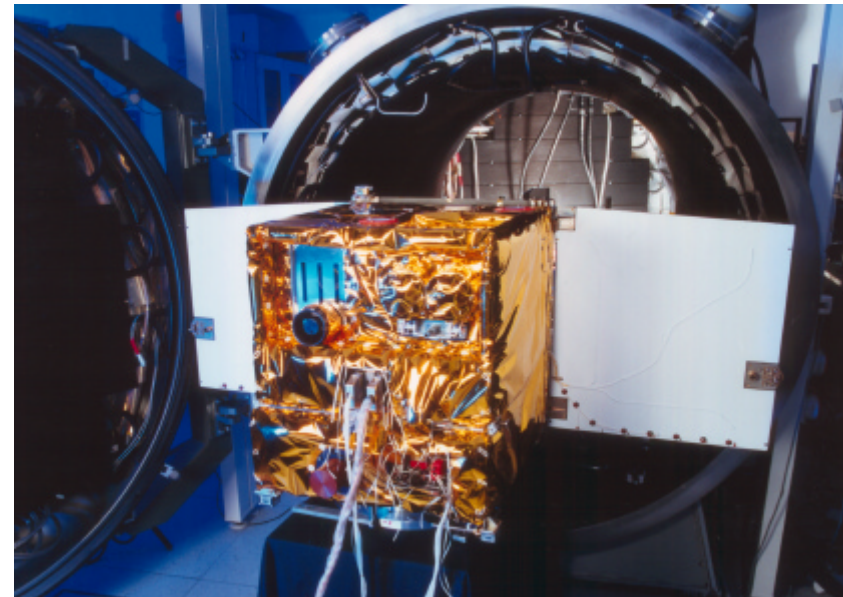
**are poorly investigated**
  
- ▶ **Up to now - there exists no system in orbit**  
**dedicated to fire observation**





## Mission Objectives (BIRD = Bi-spectral Infra-Red Detection)

- ▶ Test of a new generation of infrared sensors dedicated for fire investigation from space
- ▶ Remote sensing of fires and of the land surface
- ▶ Space demonstration of new micro-satellite technologies





## The BIRD Payload

	<b>WAOSS-B</b>	<b>MWIR</b>	<b>TIR</b>
Wavelength	600-670nm 840-900nm	3.4-4.2 $\mu$ m	8.5-9.3 $\mu$ m
Focal length	21.65mm	46.39mm	46.39 mm
Detector	CCD	CdHgTe	CdHgTe
Ground pixel size	185m	370m	370m
Ground sampling distance	185m	185m	185m
Swath width	533km	190km	190km

<sup>1</sup> at 572km Orbit altitude



**Payload platform of the flight model with assembling tools**  
**Total mass: 30.2 kg**

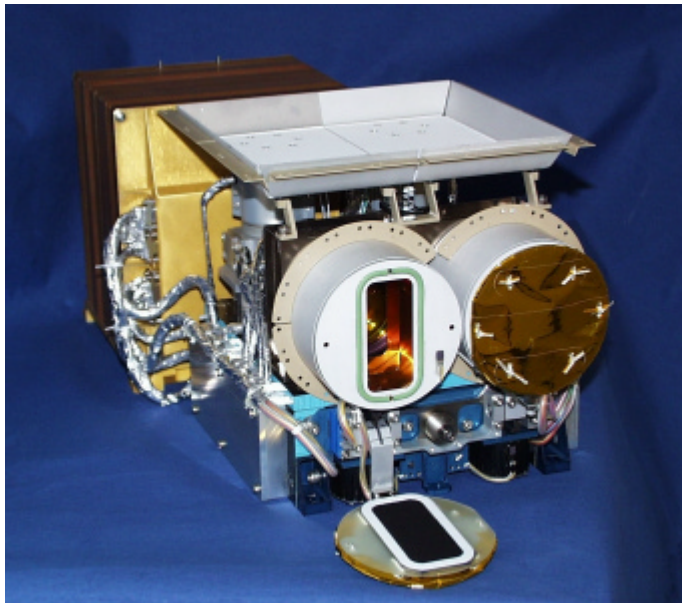




## The BIRD Scientific Instruments

**The 2-channel-Infra-Red Sensor System (15kg, 90W)**

**2x 512pixel HgHgTe detectors  
Ground sampling Distance (GSD):  
185m**

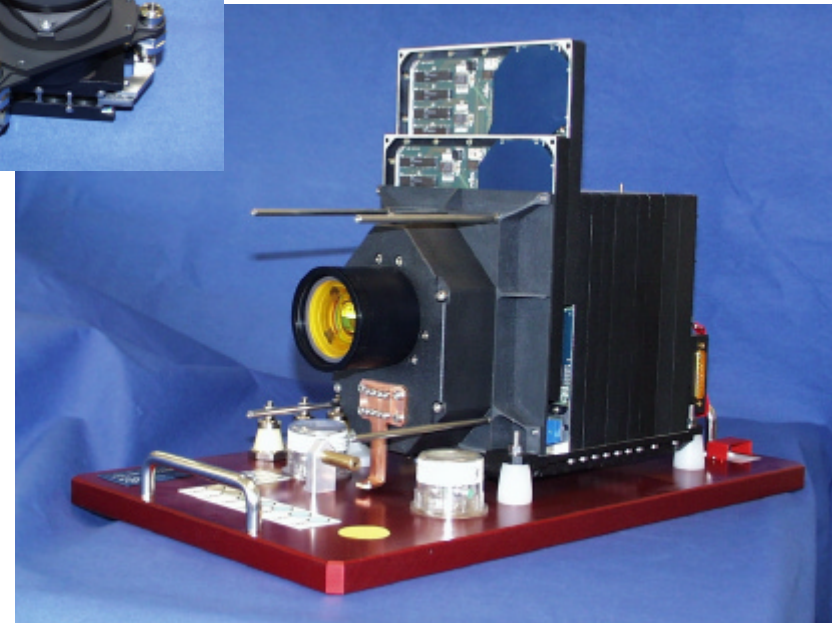


**The CCD-matrix camera  
HORUS**



**The 3-line-CCD-stereo camera  
WAOSS-B (10kg, 18W)**

**3 lines x 2480 pixels, GSD:185m**





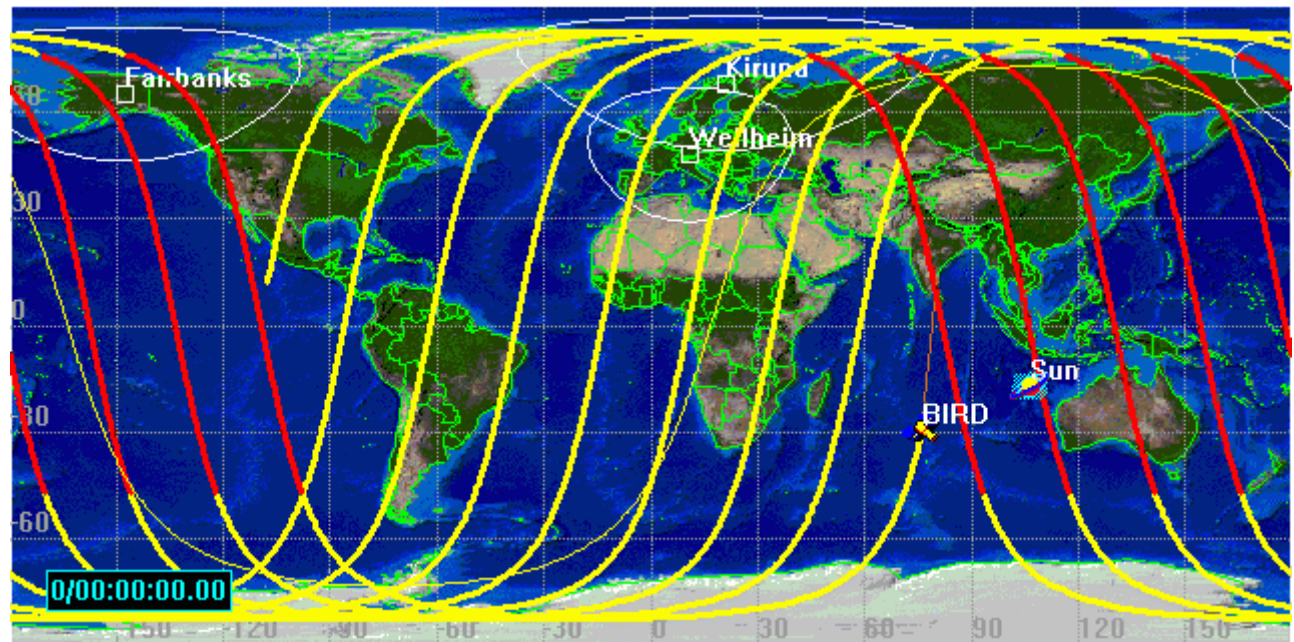
## BIRD Launch: 22 October 2001 (piggy back)



Launcher: PSLV-C3 (India)

Launcher payloads: TES (ISRO), PROBA (ESA), BIRD (DLR)

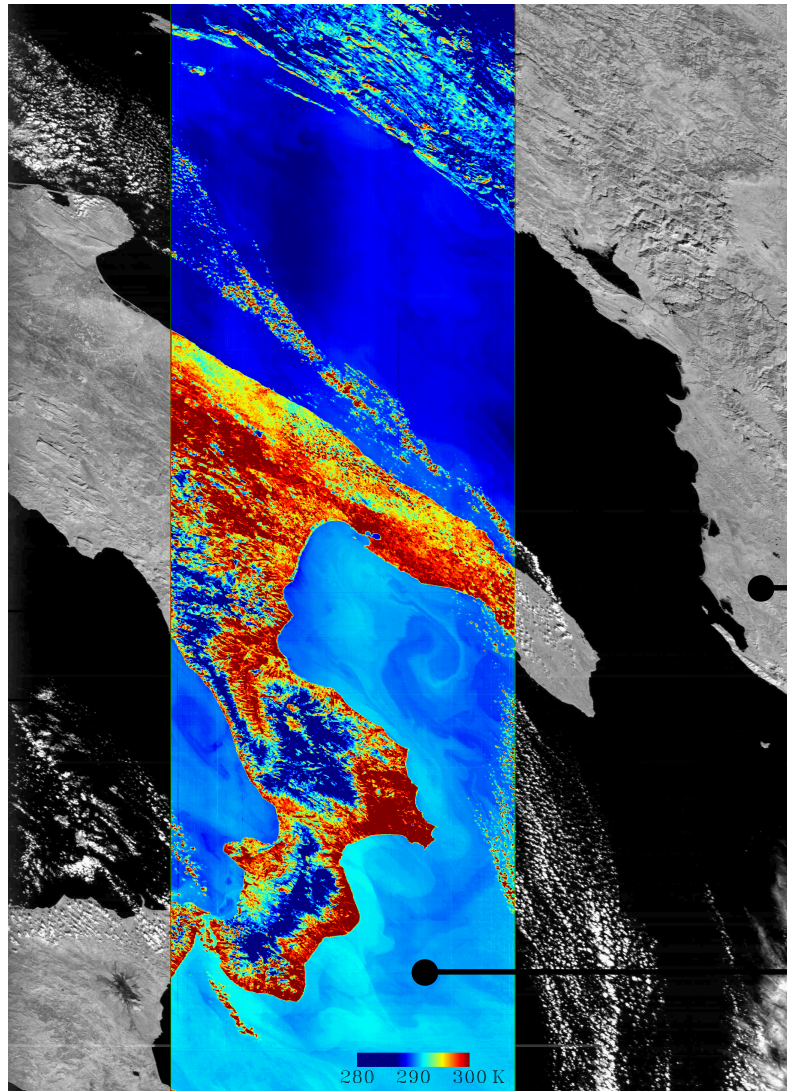
BIRD Orbit: 568km circ.,  $i = 97.8$  (sun-







## First Image: 05/11/2001, 9:42 UTC Investigation of Pixel Co-registration



● WAOSS- nadir channel (840-900nm)

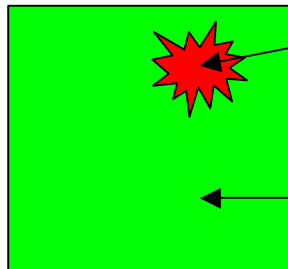
● Mid-wave Infra-Red channel (3.4-4.2 $\mu$ m)  
(semi-transparency overlay)



## BIRD-Highlight:

# Hot-Spot-Detection Within the Sub-Pixel Range

*(Dozier, 1981: Bi-spectral Technique for retrieving temperature and area of sub-pixel hot spots)*



$q$  - relative area of the hot spot

$T_F$  - absolute temperature of the hot spot

$1-q$  - relative area of the background

$T_{bg}$  - absolute temperature of the background

$$L_{MIR}(T_F, q) = q B_{MIR}(T_F) + (1-q) L_{MIR-bg}$$

$$L_{TIR}(T_F, q) = q B_{TIR}(T_F) + (1-q) L_{TIR-bg}$$

$B_{MIR/TIR}$  - integral Planck-Function within each channel

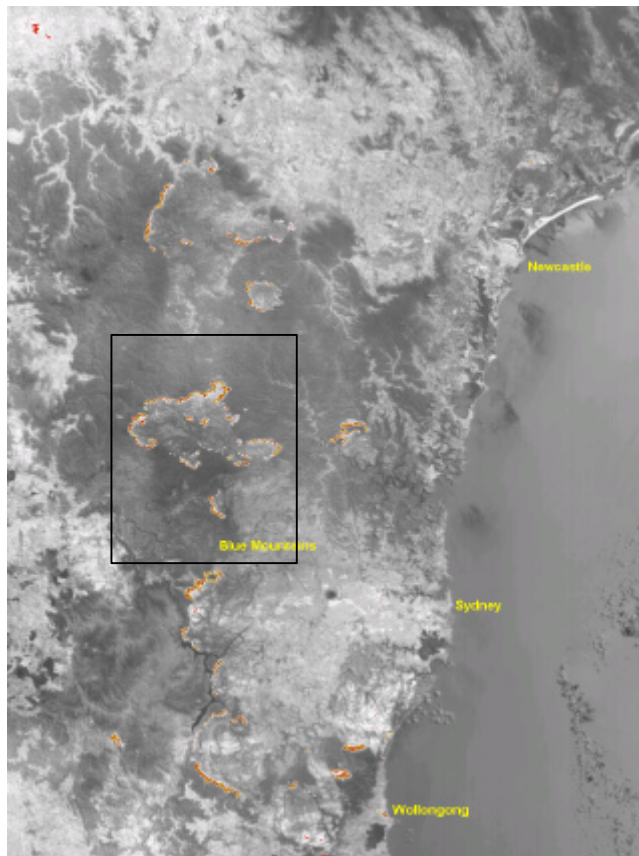
$L_{MIR/TIR-bg}$  - estimated radiance of background from the surroundings





## Quantitative Fire Evaluation from Space

**BIRD data allow to retrieve characteristics of Australian bush fires**



4.Jan.2002  
10:08 local time

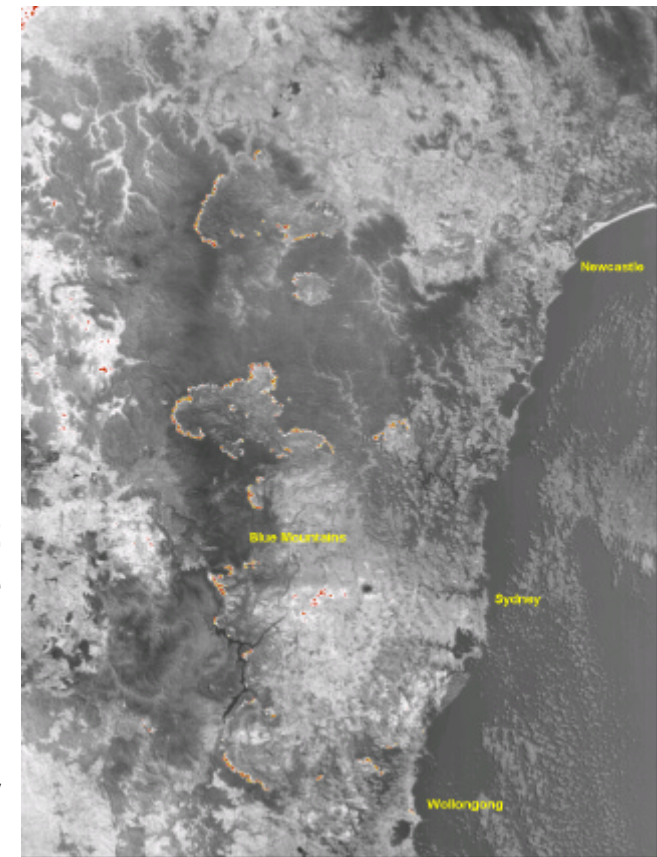
BIRD-image,  
MIR-channel

Fire colour  
coded

5.Jan.2002  
10:08 local time

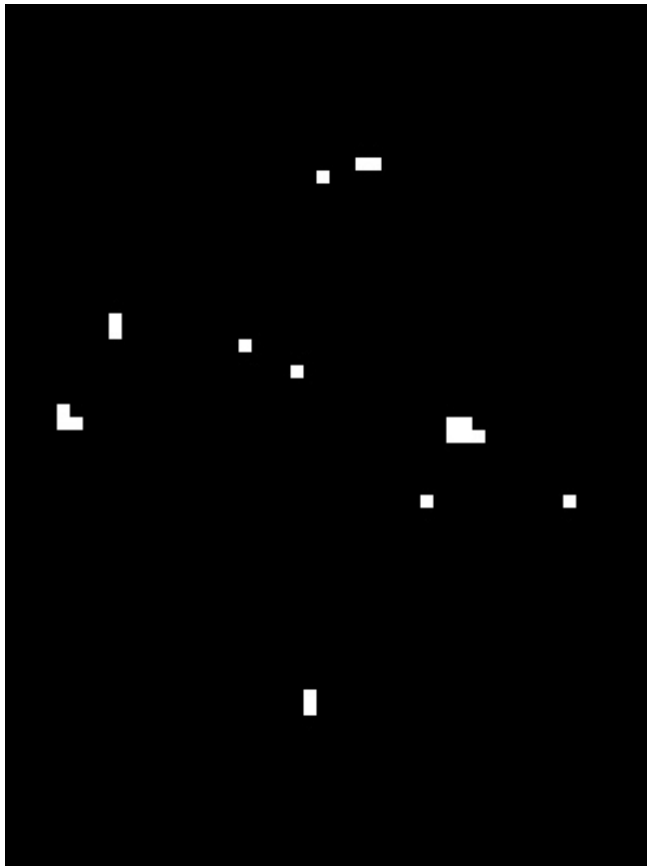
BIRD-image,  
MIR-channel

Fire colour  
coded

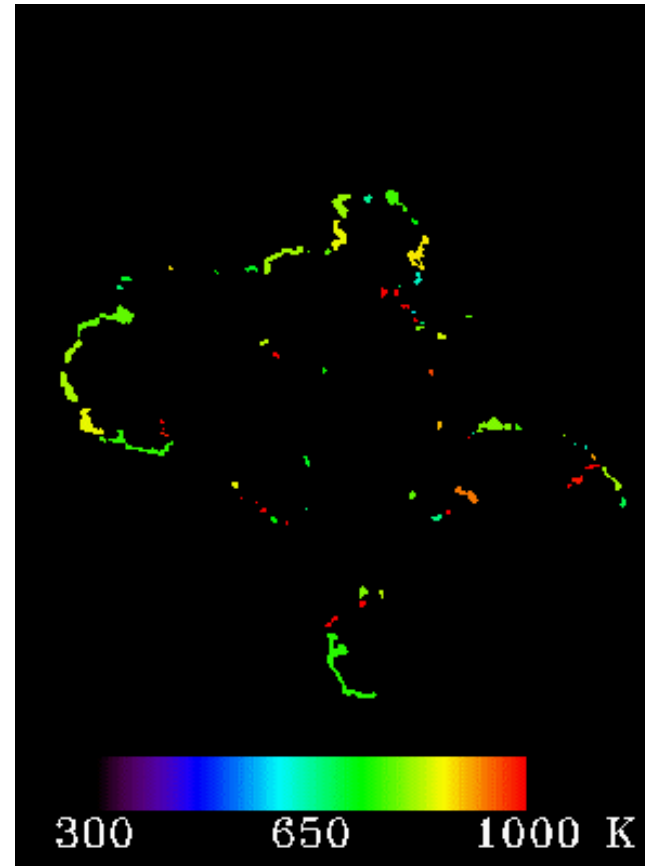




## Simultaneous Fire detection by MODIS and BIRD (Australia, January 5, 2002)



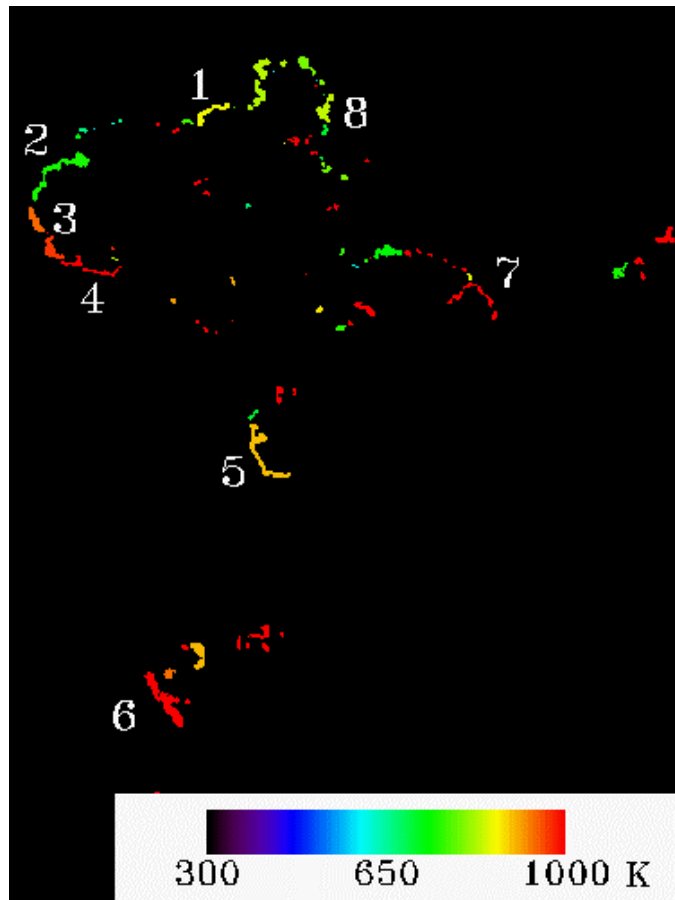
MODIS: Fire map



BIRD: Fire map



## Typical characteristics of fire fronts (BIRD, Australia, January 5, 2002)



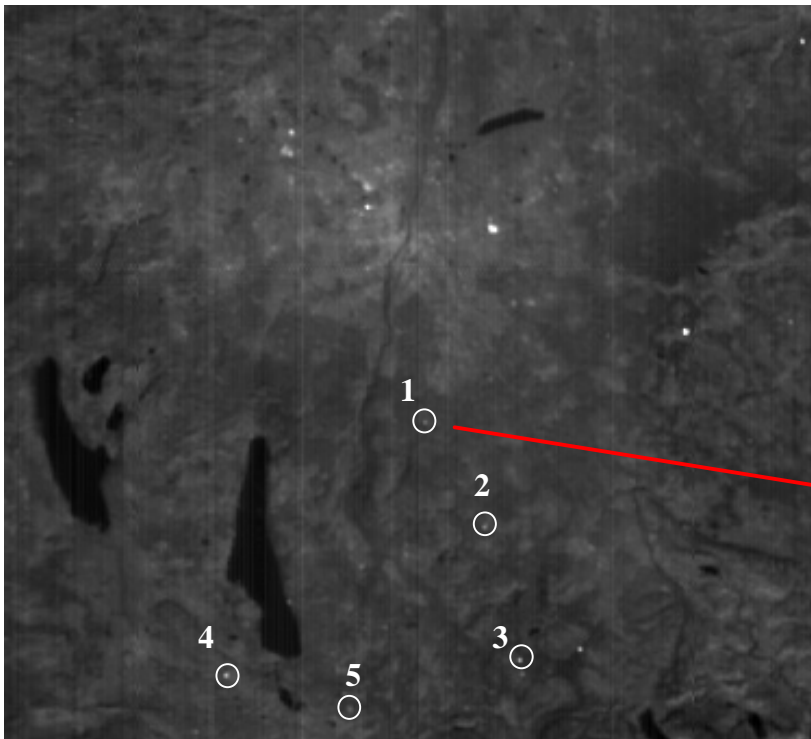
No	Eff. fire temp., K	Eff. fire area, Ha	Front length, km	Energy release, MW	Front strength, kW/m
1	815	0.48	4	130	30
2	715	2.3	7.5	310	40
3	893	0.59	3	210	70
4	>670	<0.78	5	79	15
5	852	0.92	10	300	30
6	957	1.0	9	530	60
7	>690	<0.51	4	62	15
8	796	0.39	3	96	30





## BIRD Detects Hot Spots in and around Munich (29 January 2002)

Infrared Image of region Munich  
at 29 January 2002, local time:  
10:10



**Hot spot Nr. 1 – In-situ verification:**  
at this time at this place wooden waste  
has burned for several hours (4m  
diameter, hot temperature) by Farmer J.  
Kranz  
(written in his working diary)

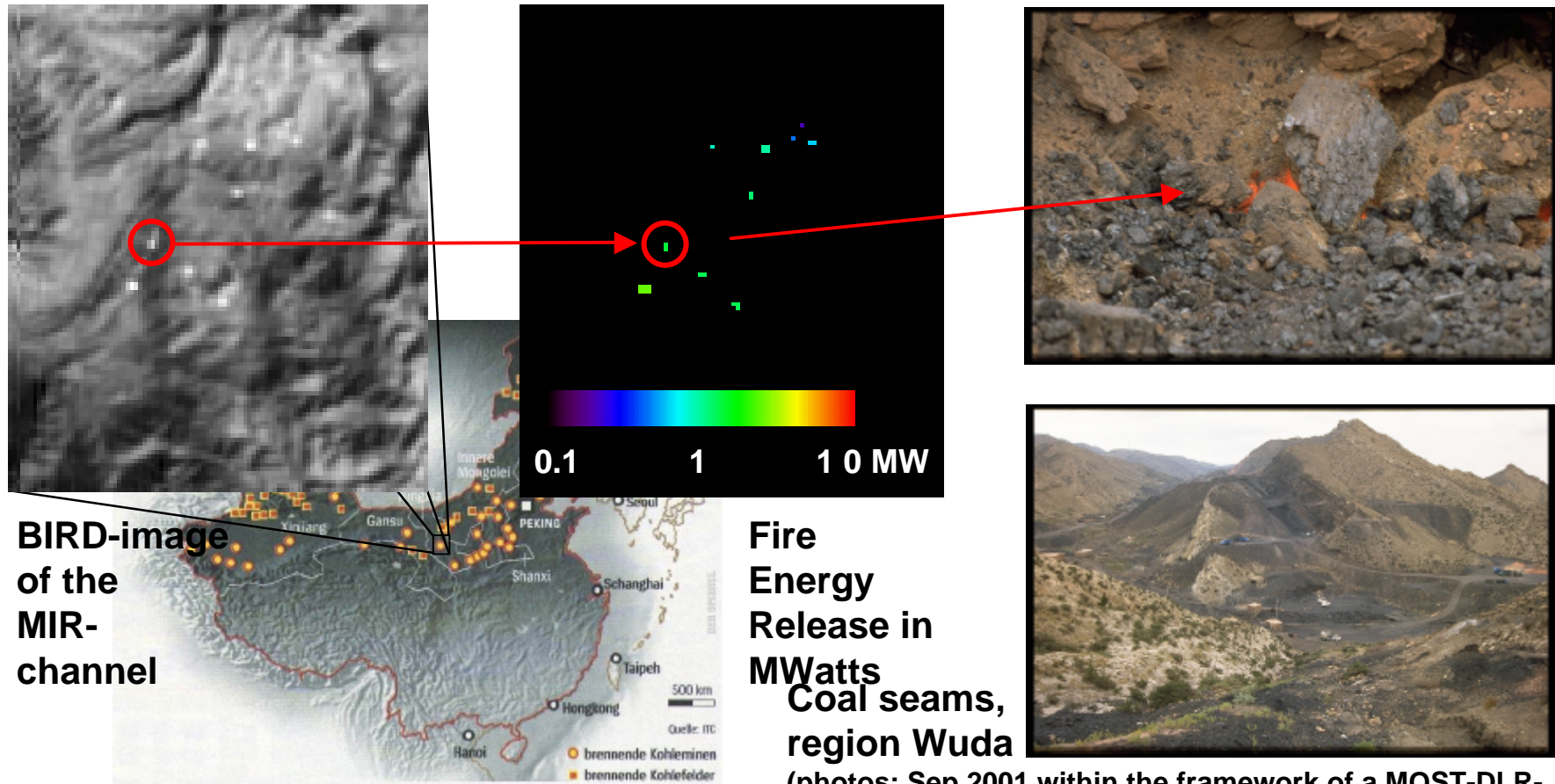




# BIRD Detects Coal Seam Fires in Ningxia Area, China (6 February 2002)



(BIRD is the first space borne system providing data for daytime coal seam fire energy and emission analysis)

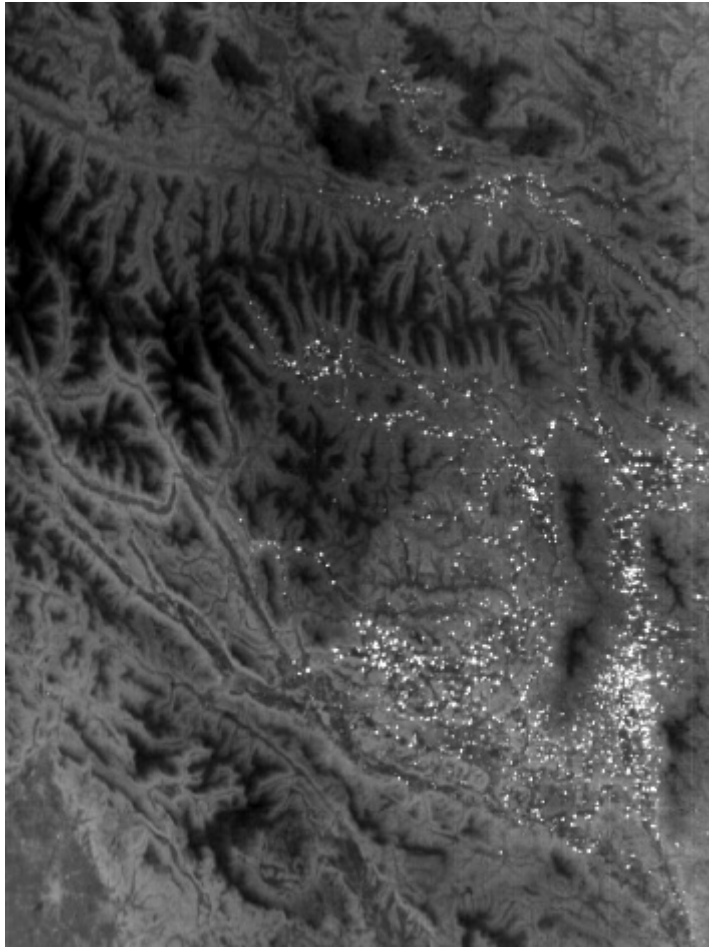


BIRD-image of the MIR-channel

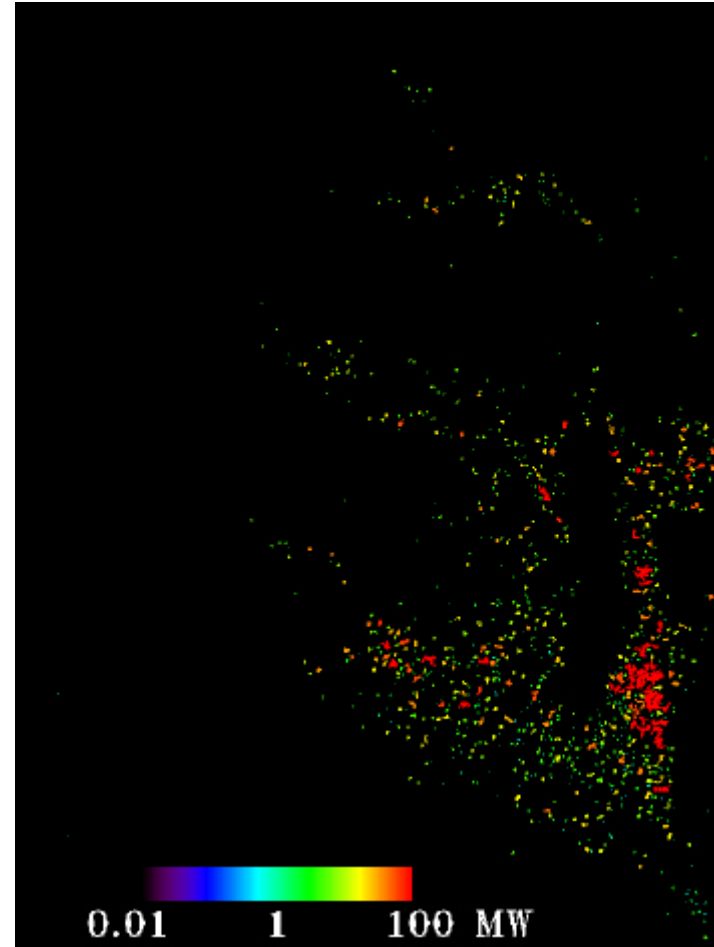
Fire Energy Release in MWatts  
Coal seams, region Wuda  
(photos: Sep.2001 within the framework of a MOST-DLR-Cooperation)



## BIRD Detects Easter Fires in the Steiermark -Kaernten, Austria, 30 March 2002)



MIR

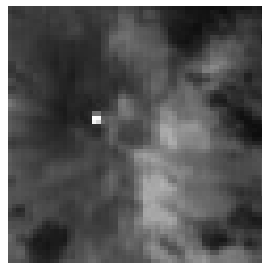


Energy release



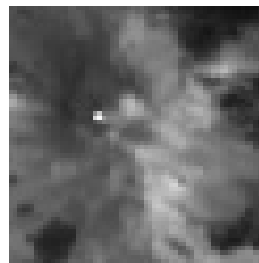


## Etna Summit Hot Event Characteristics Recognised by BIRD (3.8 $\mu\text{m}$ channel shown)



$T > 595 \text{ K}$   
 $A < 0.45 \text{ ha}$   
 $E = 12 \text{ MW}$

18 July 2002



$T > 406 \text{ K}$   
 $A < 1.4 \text{ ha}$   
 $E = 8.5 \text{ MW}$

19 July 2002



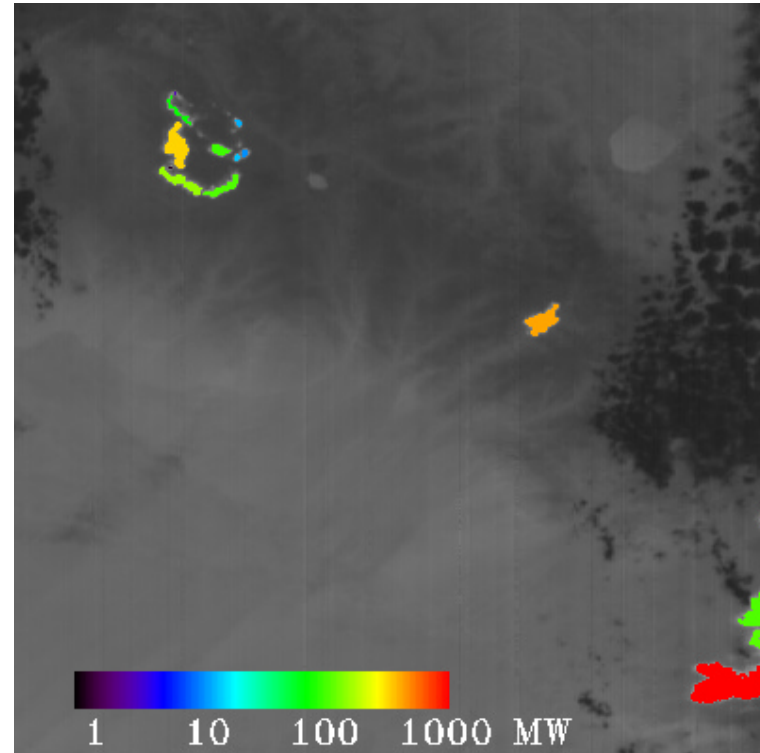
20 July 2002



## BIRD Recognised Fires in Tannu Mountains, Russia, 24 July 2002)



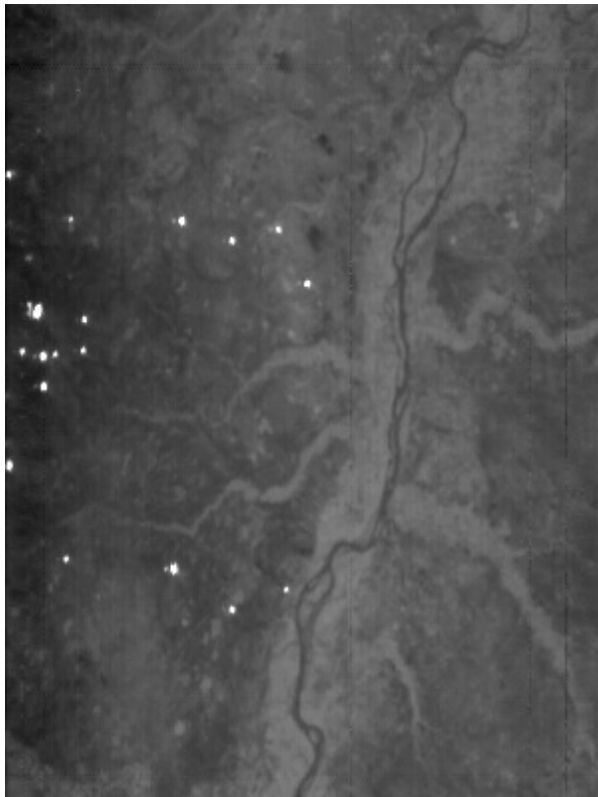
MIR-channel at 3.8  $\mu\text{m}$



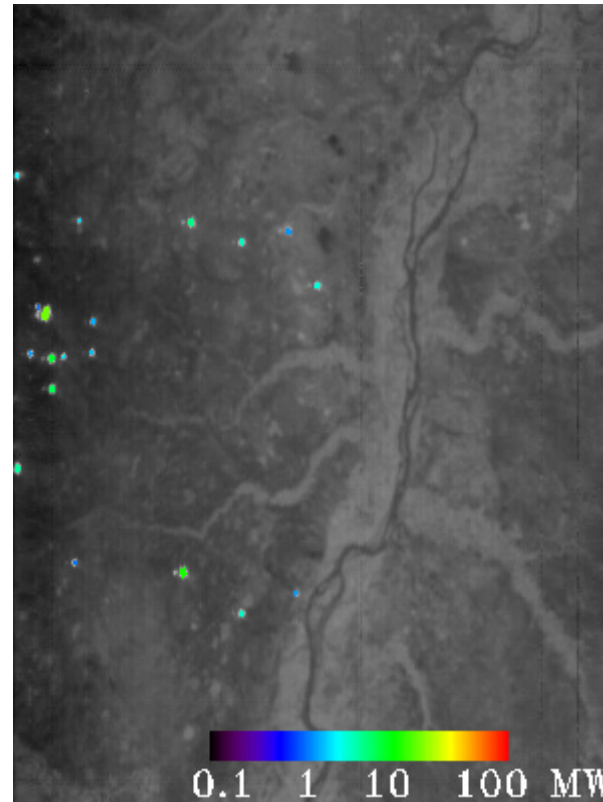
Radiative energy release retrieval



## BIRD Observed Gas Prospecting Area of Urengoy, Russia, 27 July 2002)



MIR channel

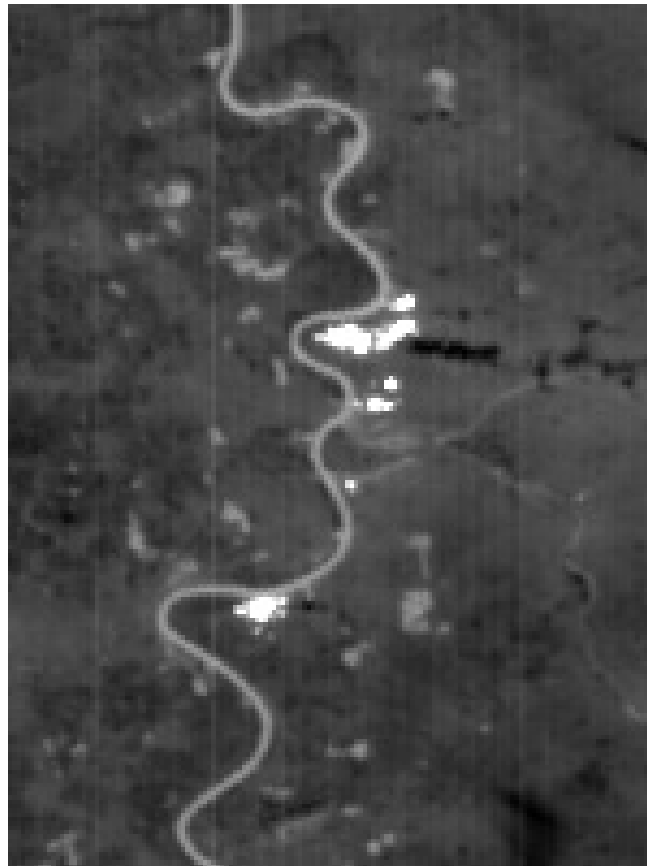


Radiative energy release

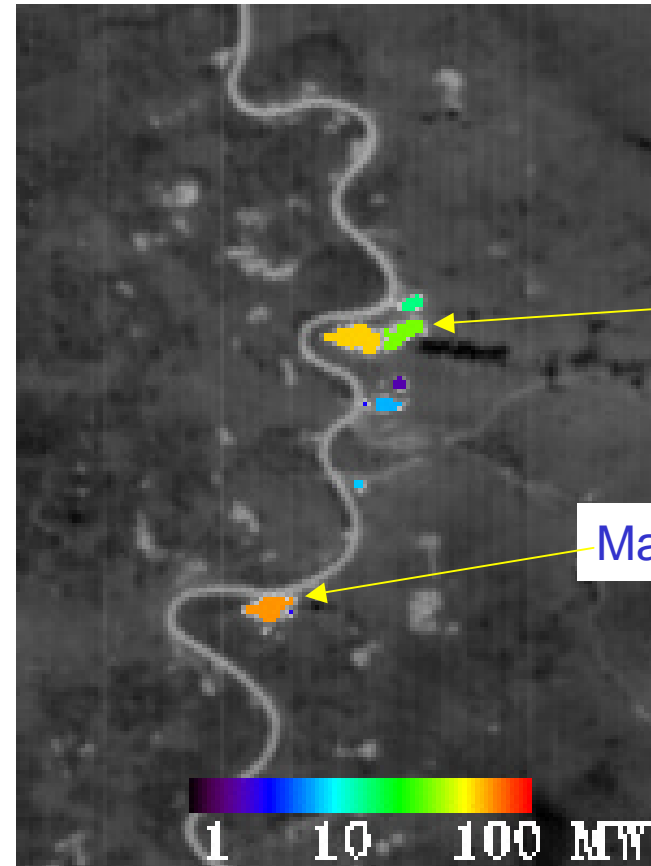




## BIRD Detects Industrial Hotspots in the Rhein-Ruhr area, Germany, 1 August 2002)



MIR channel



Radiative energy release