

Intercomparison and validation of AVHRR and MODIS fire products over Northern Eurasia



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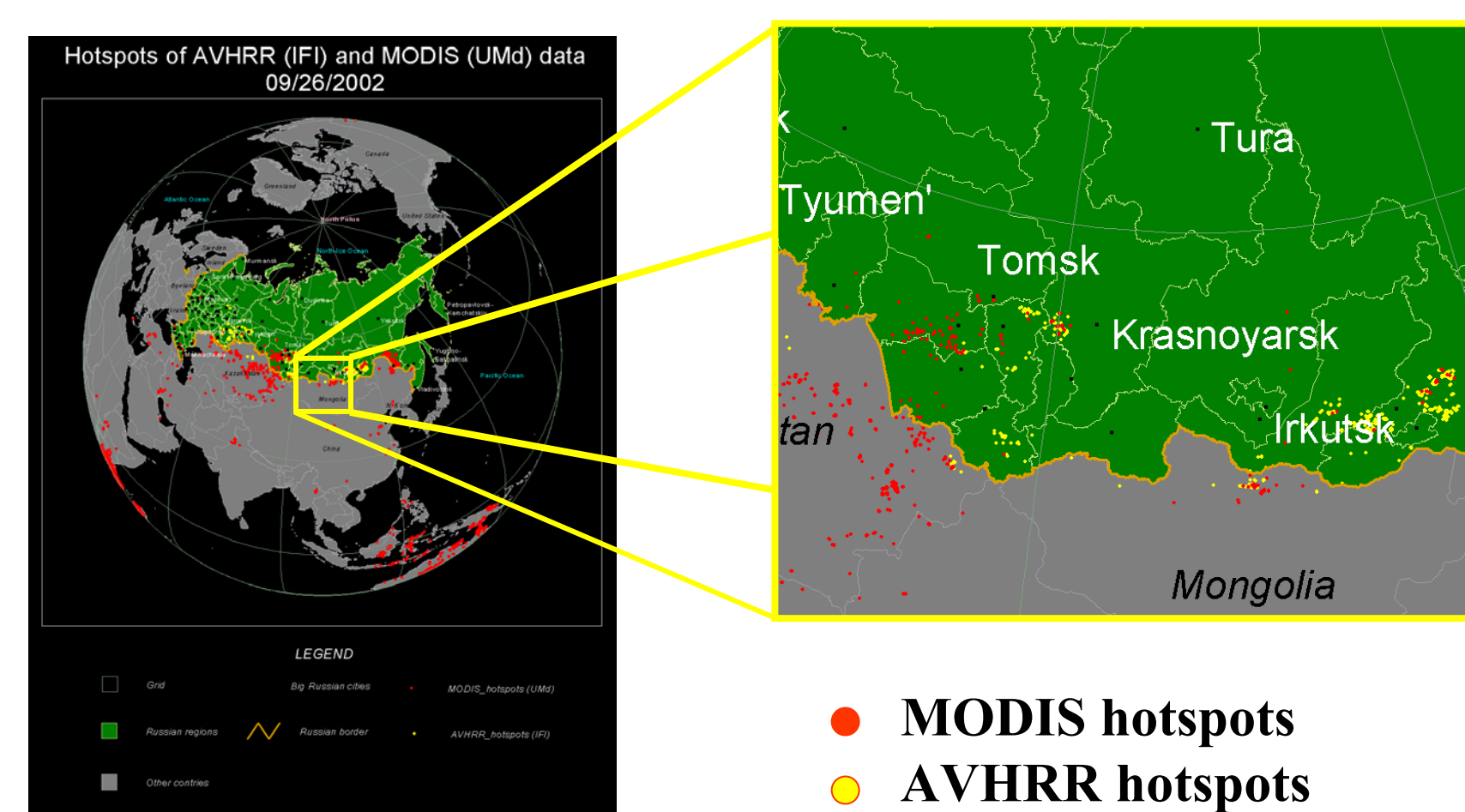
ABSTRACT – Research is carried out to ensure the continuity of the long-term space-based inventory of biomass burning from moderate resolution sensors on board polar orbiting environmental satellites. The current sensors are the Advanced Very High Resolution Radiometer (AVHRR) on board the operational NOAA environmental satellites and the Moderate Resolution Imaging Spectroradiometer (MODIS) on board the NASA Terra and Aqua satellites. The primary focus is on burned area estimates in the boreal forests of the Northern Eurasian part of Russia, where there is a particular need to obtain accurate information on the substantial biomass burning activity. The experimental MODIS burned area algorithms are adapted for the region and compared against in-situ fire inventories and validated using high-resolution satellite data (ASTER and Landsat). Then, burned area estimates from MODIS and AVHRR will be compared and the degradation of accuracy caused by the inferior instrument characteristics of AVHRR (coarser resolution, less accurate geolocation, spectral bandwidth etc.) will be evaluated. This AVHRR-MODIS cross-calibration during the overlap period of observations from the two instruments, starting in 2000, will be applied to assess the accuracy and precision, and to apply corrections to the AVHRR-based burned area estimates derived from the existing ~12-15 years of 1-km AVHRR data in the region. In addition to the comparison of burned area estimates which are calculated for a given time period (hours (am/pm) to months), a direct comparison of active fires will also be done when near-coincident mid-infrared data become available from AVHRR and MODIS. The results of this comparison will also be applied to the historical AVHRR data record. The improved time series with known accuracy and precision will provide useful information for the climate change user community on interannual variability and long-term trends of biomass burning in the region. The work has a number of linkages to activities in the NASA LCLUC and Biogeochemistry Programs and to NASA's international program partnerships (GOC/GOLD). Results of this investigation can also be used to define the continuity products for the Visible Infrared Imager/Radiometer Suite (VIIRS) instrument on board the future NPOESS (National Polar-orbiting Operational Environmental Satellite System) satellites and to set requirements for future space-based systems for the global observation of biomass burning.

OBJECTIVES

- Establish procedures to ensure the consistency, improve the accuracy and understand the uncertainties of the satellite-based record of biomass burning in the Northern Eurasian part of Russia.
- Create an improved, regional AVHRR-based inventory of active fires and burned areas for the 1989-2002 period.

AVHRR – MODIS comparison

MODIS hotspots from the MODIS Land Rapid Response System have been transferred daily from UMD to the Space Research Institute in Moscow.



Combined map over Russia of AVHRR (CFEP, Moscow) and MODIS (NASA/UMd Land Rapid Response System) active fire products.

Active fire validation with in-situ data

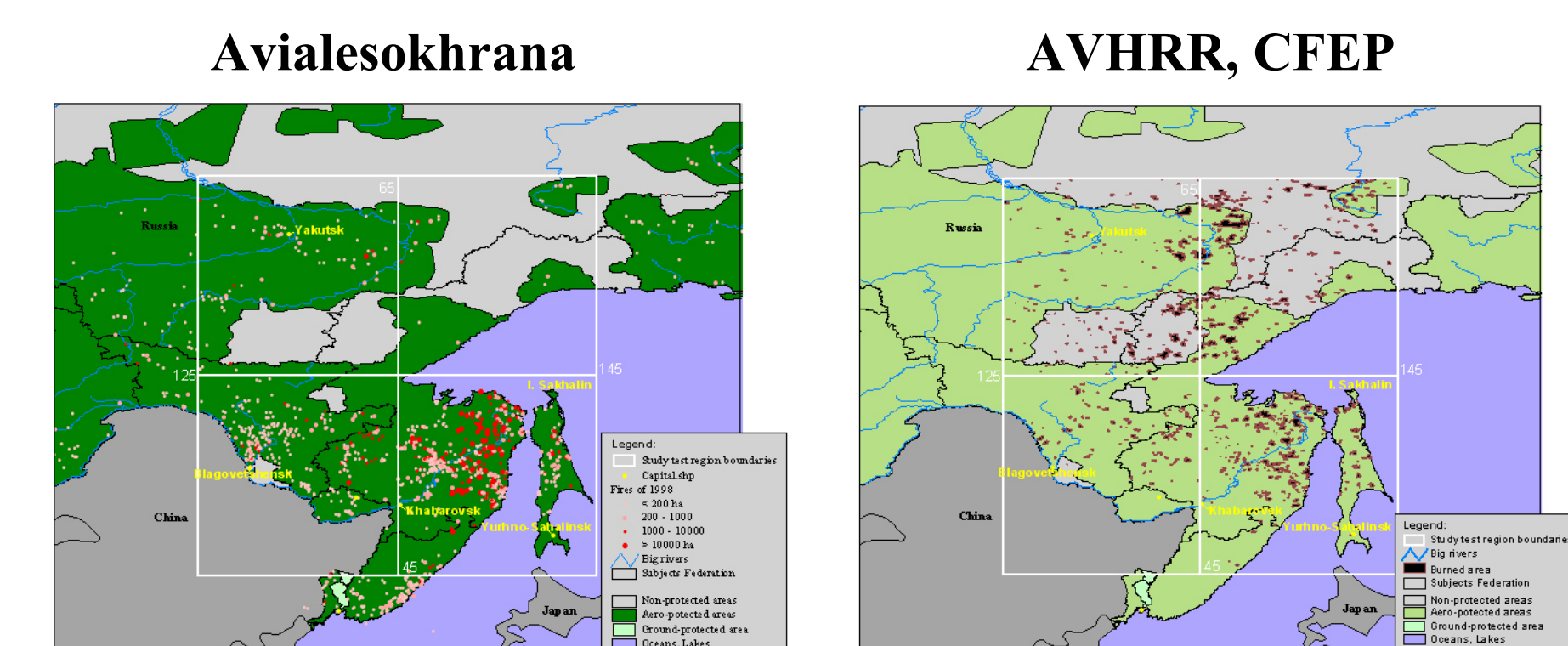
Fire data from the Russian Airborne Forest Fire Protection Service ("Avialesokhrana") have been collected into a digital database and merged with AVHRR and MODIS data for quantitative analysis at the Space Research Institute in Moscow.

MODIS thermal anomalies	
id	Id number of anomaly
dt	Date and time
lat	Latitude
lon	Longitude
temp	Temperature
lat_delta	Pixel size across track
lon_delta	Pixel size along track

AVHRR thermal anomalies	
id	Id number of anomaly
dt	Date and time
lat	Latitude
lon	Longitude
lat_delta	Pixel size across track
lon_delta	Pixel size along track

AFPS fire data ("Avialesokhrana")	
id	Id number of fire
dt	Date
lat	Latitude of fire (place of its detection)
lon	Longitude of fire (place of its detection)
area	Current burnt area
state	Class of fire condition (flaming/smoldering, localized etc.)
dt_disc	Date of detection of fire
area_disc	Burnt area in the moment of detection
id	Id number of fire
id_avia	Internal ID number of fire of Avialesokhrana
state	Code of fire condition
desc	Description of class of fire condition

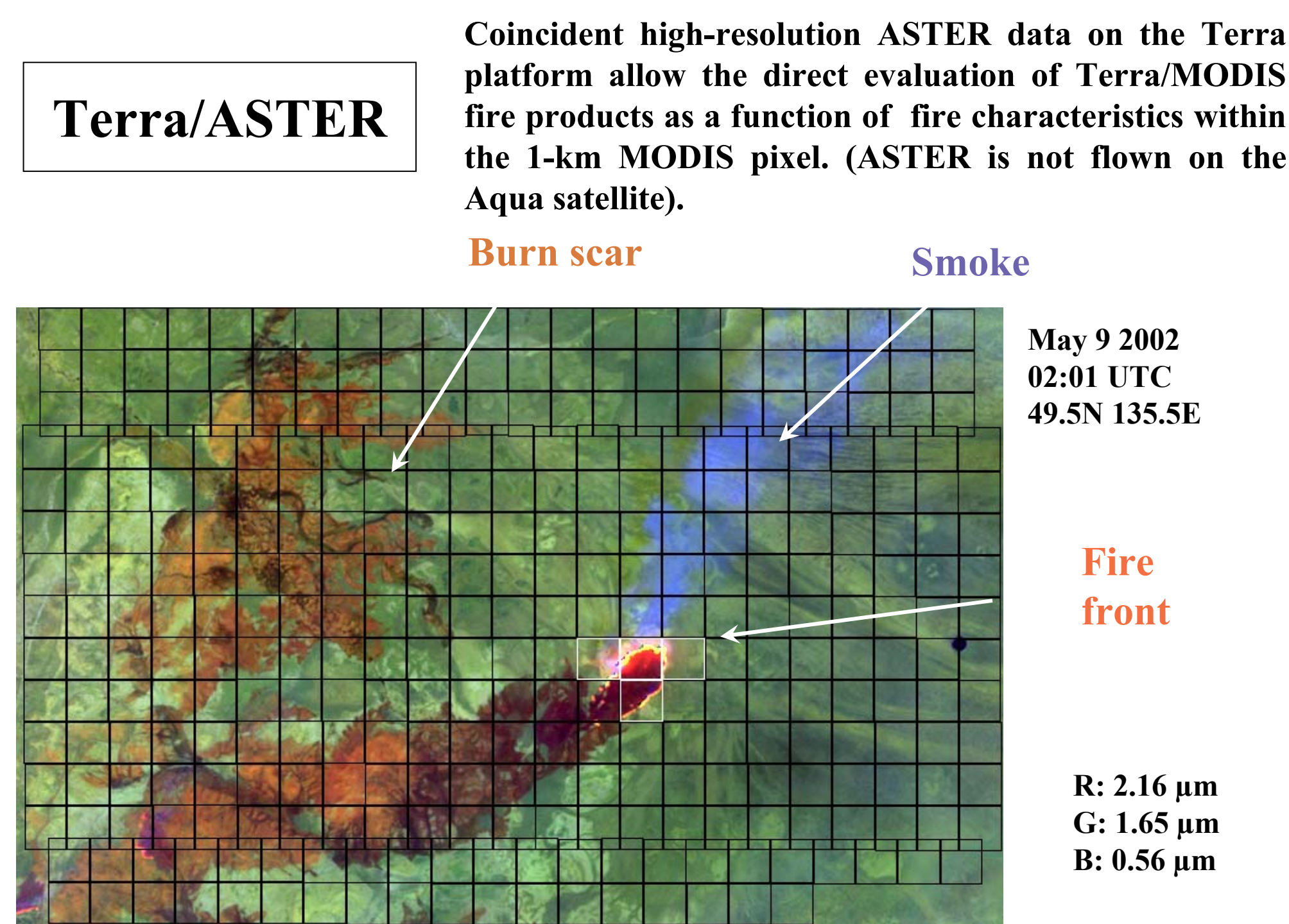
Structure of the prototype integrated fire database



Comparison of air- and space-based fire observations in the Russian Far East in 1998

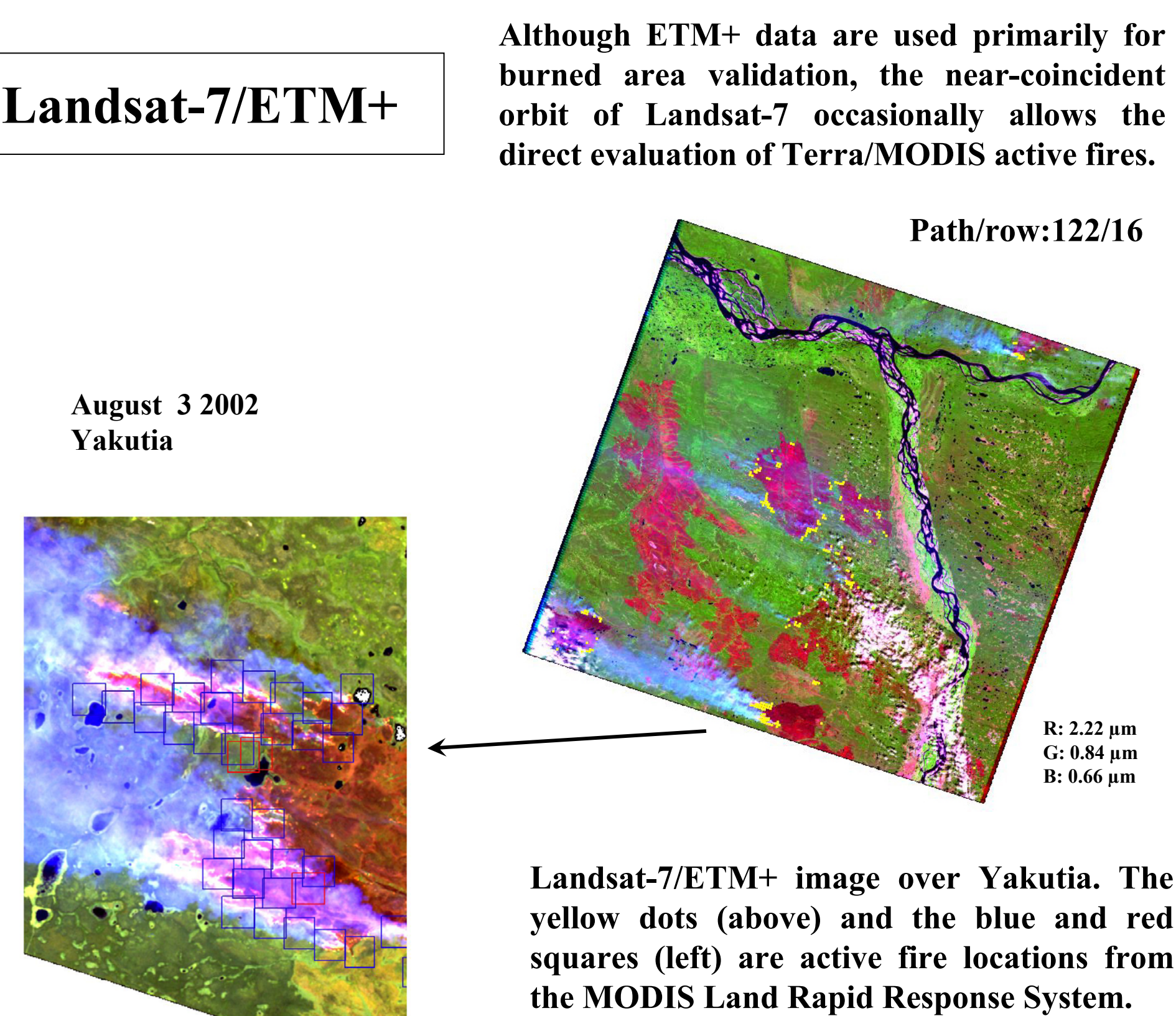
MODIS active fire validation with high resolution imagery

Terra/ASTER

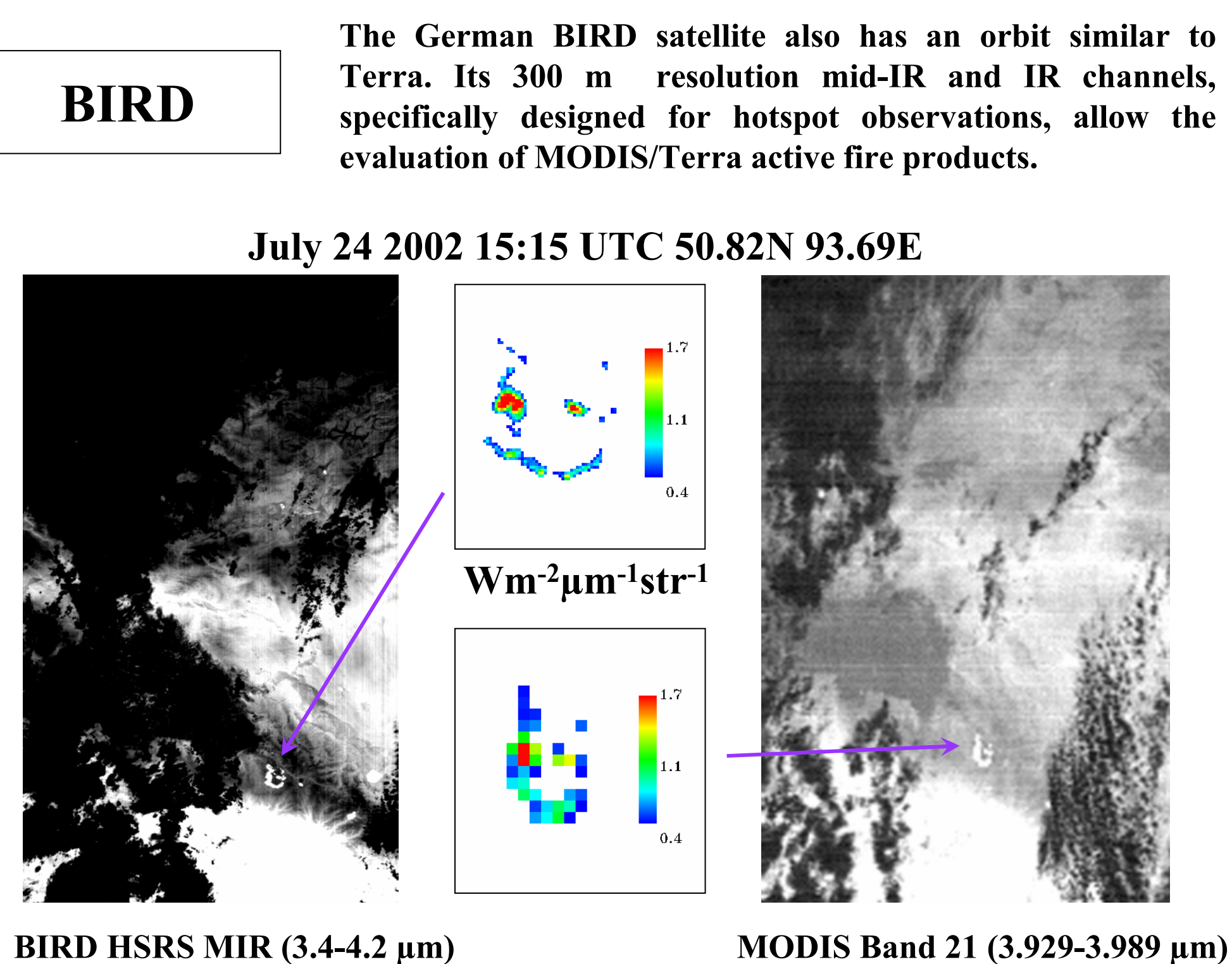


ASTER image of a fire complex in the Russian Far East. The overlay is the grid of nominal ~1km MODIS footprints. The white grid cells were flagged as "fire" by the MODIS version 3 active fire detection algorithm.

Landsat-7/ETM+



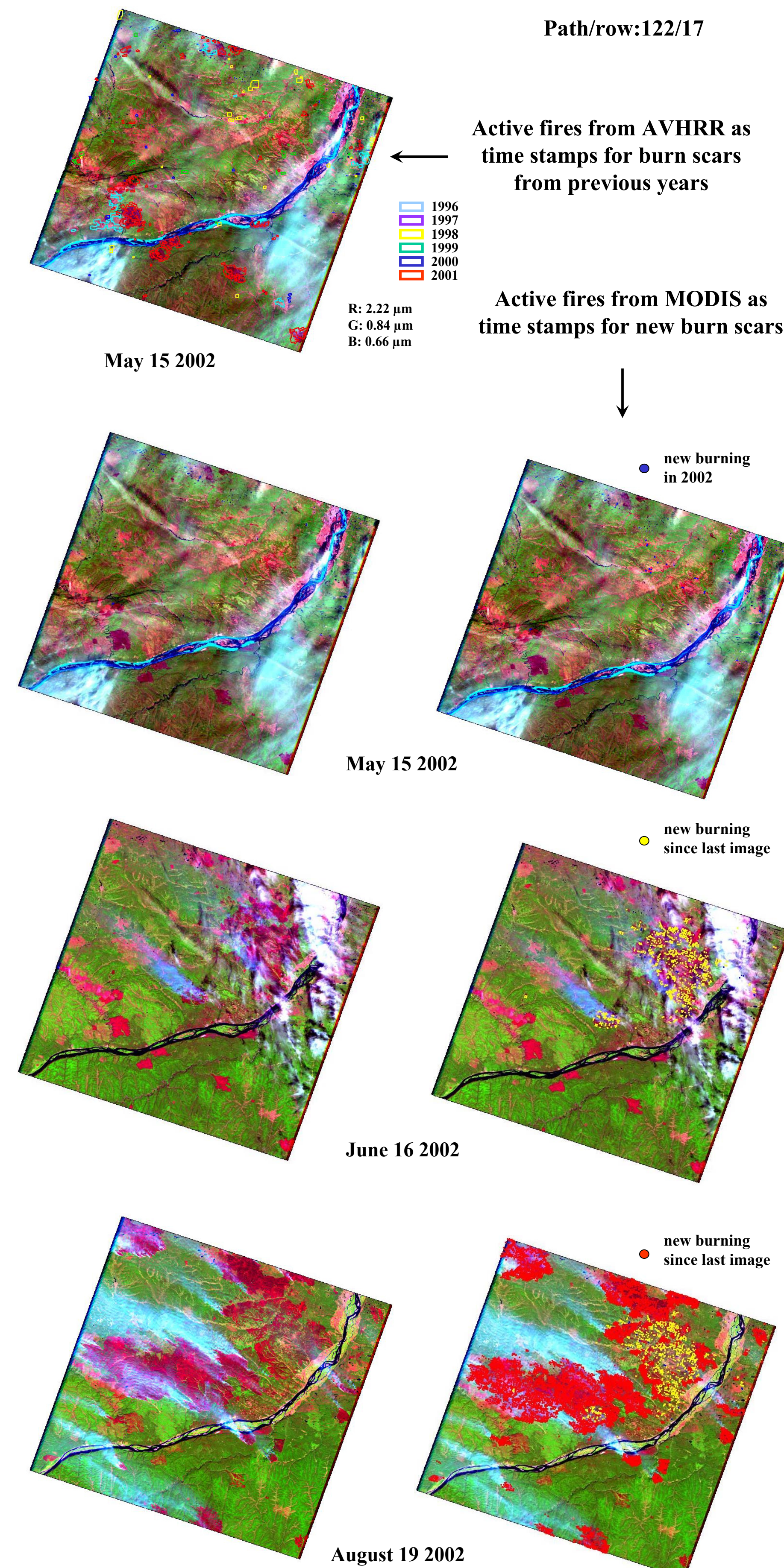
BIRD



BIRD (left) and MODIS (right) imagery of a fire complex near the Russian-Mongolian border. BIRD data courtesy of D. Oertel, DLR, Germany.

Biomass burning in Yakutia in 2002

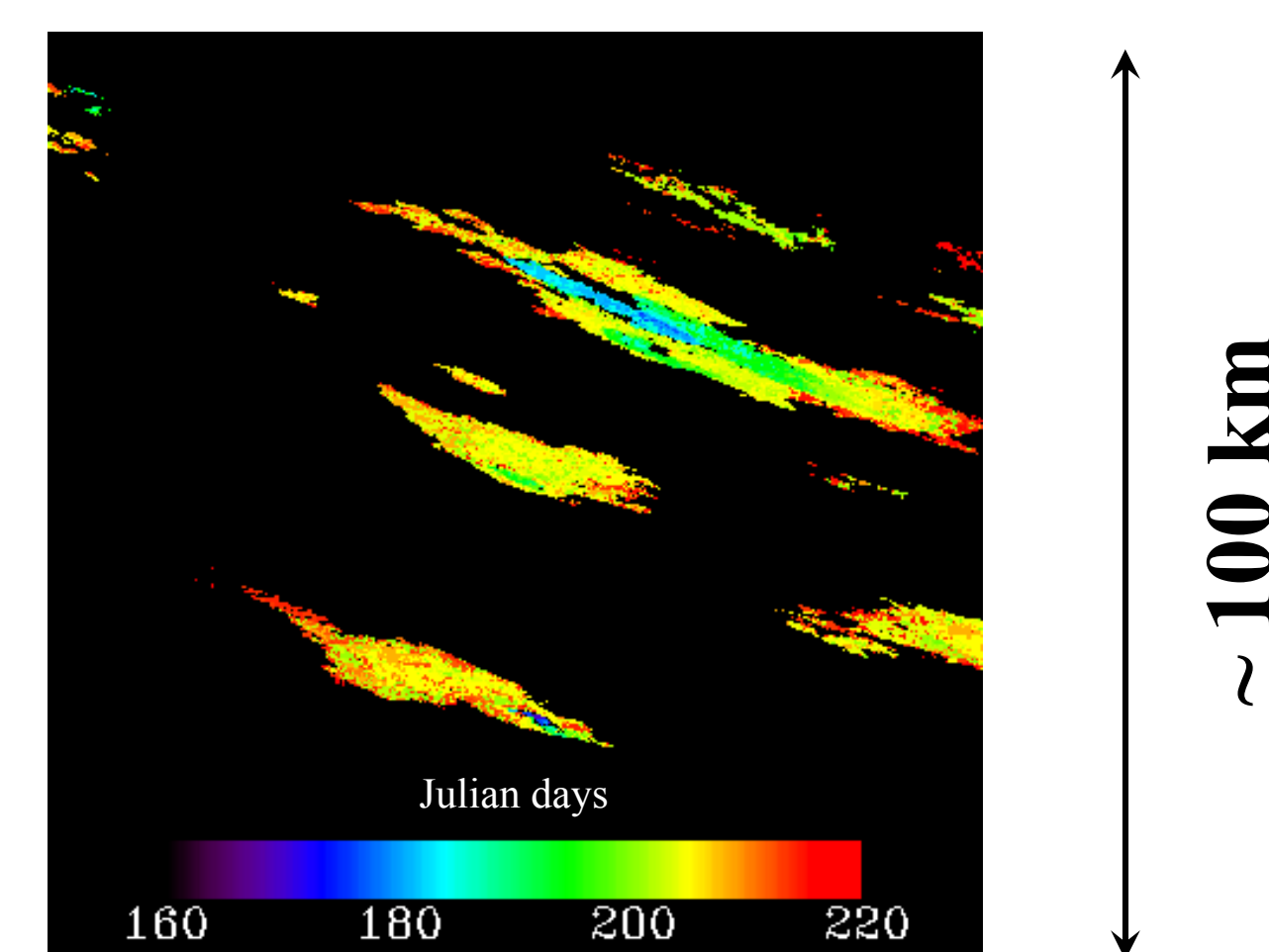
Below is an example of Landsat/ETM+ images showing the temporal sequence of biomass burning in Yakutia in summer 2002. They can be used for indirect evaluation of active fire products; on the other hand, active fires can be used to determine the time of burning.



MODIS burned area mapping

The production of experimental burned area maps has been started from 500m MODIS data over a 10 degree MODIS tile covering North-Eastern Russia.

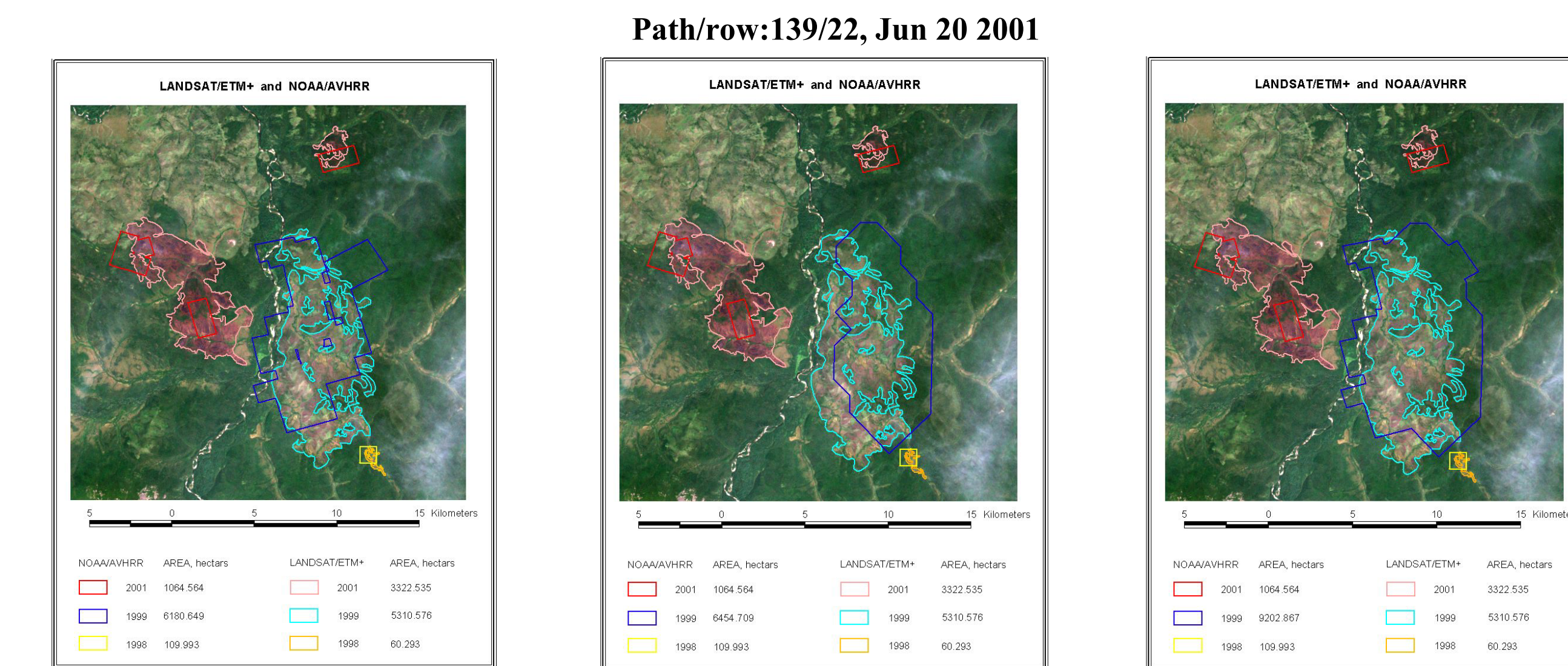
Yakutia, 2002, within tile v23h2 (ISIN projection).



Experimental algorithm, courtesy of L. Giglio, NASA/GSFC

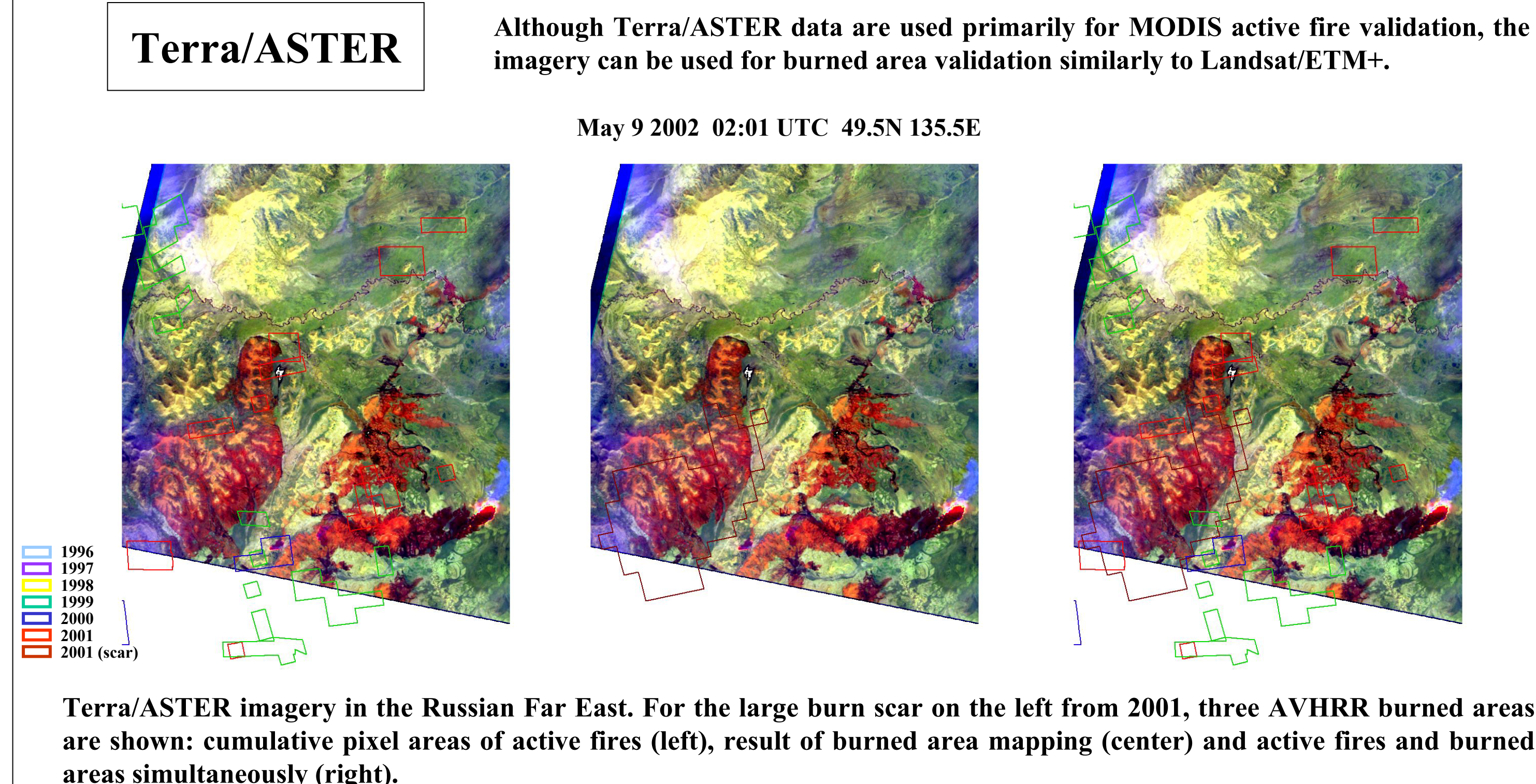
Burned area validation with high resolution imagery

Landsat-7/ETM+



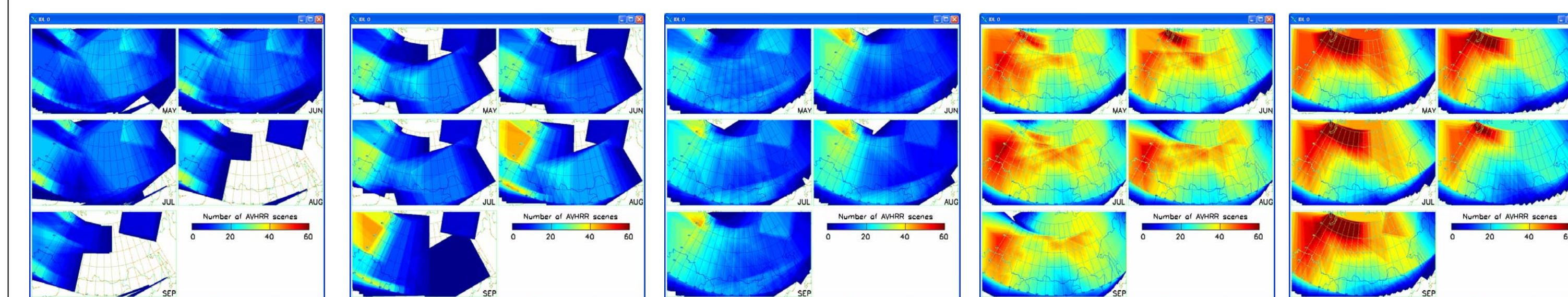
Landsat/ETM+ imagery in Central Siberia with perimeters of manually digitized burn scars. For the large burn scar in the center from 1999, three AVHRR burned areas are shown: cumulative pixel areas of active fires (left), result of burned area mapping (center) and the outer envelope of merged active fire-burned area perimeters (right).

Terra/ASTER



Historical AVHRR data over Northern Eurasia

The current 1-km AVHRR-based record of biomass burning in the Northern Eurasian region goes back to ~ 1996. We are exploring the possibility to extend this time series to the beginning of the continuous collection of 1-km AVHRR data. We have prepared an inventory of High Resolution Picture Transmission (HRPT) and Local Area Coverage (LAC) data available from NOAA Satellite Active Archive (SAA).



FUTURE PLANS

- Adapt and validate MODIS burned area mapping algorithms in the Northern Eurasian part of Russia.
- Validate and refine MODIS and AVHRR active fire and burned area algorithms if appropriate.
- Compare the MODIS and AVHRR burned area and active fire estimates during a data overlap period.
- Make adjustments to the AVHRR-based active fire and burned area algorithms.
- Define the requirements for continuity fire products from the NPP VIIRS instrument.

Acknowledgments

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MODIS and ASTER data were acquired from the Distributed Active Archive Centers. NOAA AVHRR data were obtained from the NOAA Satellite Active Archive. BIRD data were provided by the Deutsches Zentrum für Luft- und Raumfahrt (DLR).

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