Generating a Regional-Scale AVHRR Active Fire Dataset from a Network of Direct-Readout Stations in Northern Eurasia

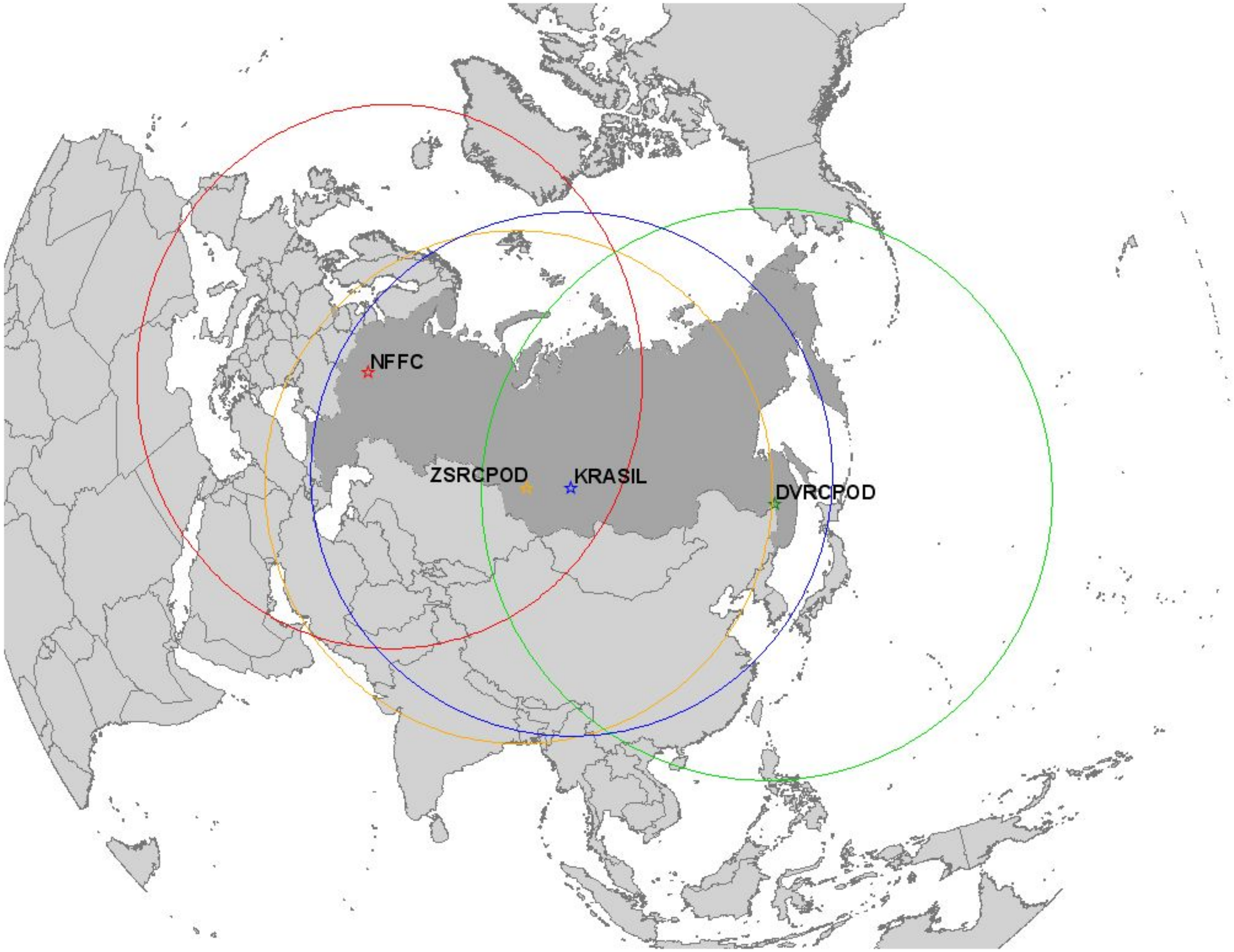
Csiszar, T. Loboda
U. of Maryland, Dept. of Geography;
icsiszar@hermes.geog.umd.edu
E. Loupian
RAS Space Research Institute

SUMMARY This poster summarizes some results from the LCLUC project "Development of an integrated system of ground- -air- and space-based observations of biomass burning in Northern Eurasia". In previous phases of the project, we evaluated airborne and MODIS-derived fire products. This posted presents our analysis of the active fire data generated from AVHRR by the Northern Eurasian Fire Monitoring Network, led by the Space Research Institute of the Russian Academy of Science. This activity is a prototype of generating science quality data from datasets collected at direct readout receiving stations, which is the only way of generating a long-term retrospective active fire dataset for most regions of the globe. This project is also a contributory project to the Northern Eurasia Regional Information Network (NERIN), a regional network of the Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) program.

Regional fire monitoring network

Input data

A multi-source database of active fire detections has been compiled at the Space Research Institute (SRI). The database includes the center location of MODIS and AVHRR pixels flagged as “fire” and auxiliary information. The MODIS data are generated within the MODIS Land Rapid Response System, whereas the AVHRR data are from local receiving stations operated by the Russian collaborators. In this analysis we focused on the AVHRR-derived active fire data from four High Resolution Picture Transmission (HRPT) receiving stations in Russia.



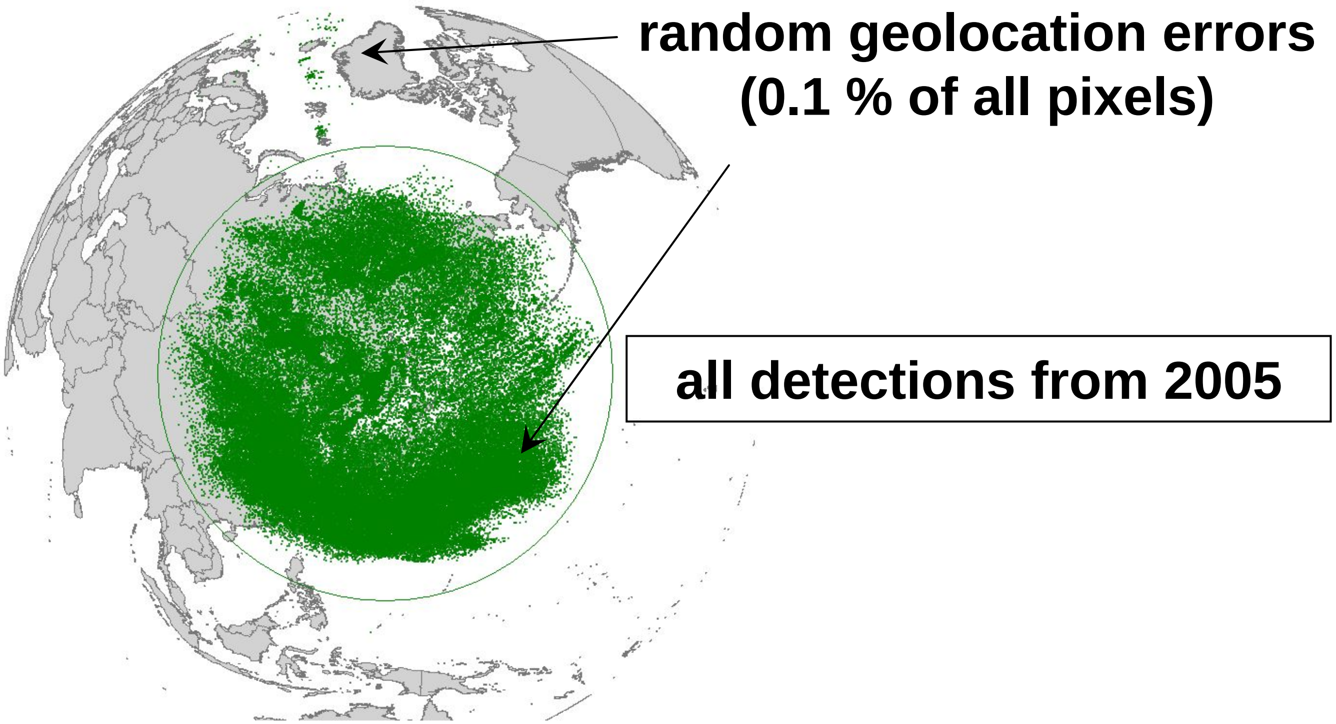
Approximate acquisition areas of the four NOAA/HRPT (AVHRR) receiving stations. NFFC: Moscow; ZSRCPOD: Novosibirsk; KRASIL: Krasnoyarsk; DVRCPOD: Khabarovsk.

Evaluation and preprocessing

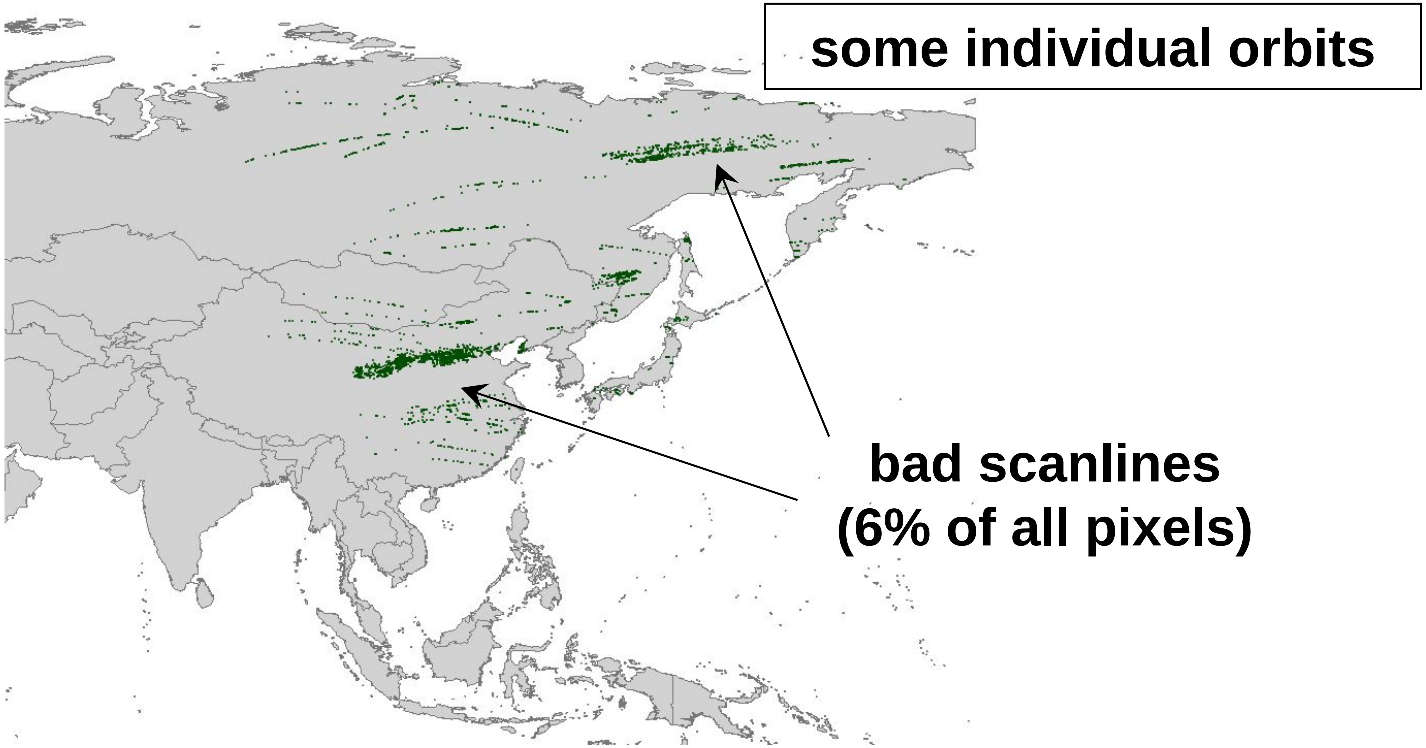
Individual orbits:

We found some fire detections outside the acquisition area and over water surfaces. This suggests the presence of random geolocation errors. Our analysis has shown however that the percentage of such misplaced fire pixels is below 0.1%.

A typical feature of direct-readout data is bad scanlines caused by transmission errors. Such bad scan lines can be identified by long clusters of fire pixels within individual scan lines. Our statistical and visual analysis of the data has shown that such bad scan lines typically included clusters of fire longer than eight pixels. Such screening eliminated approximately 6% of the data.



Unfiltered fire detection data form the Khabarovsk receiving station

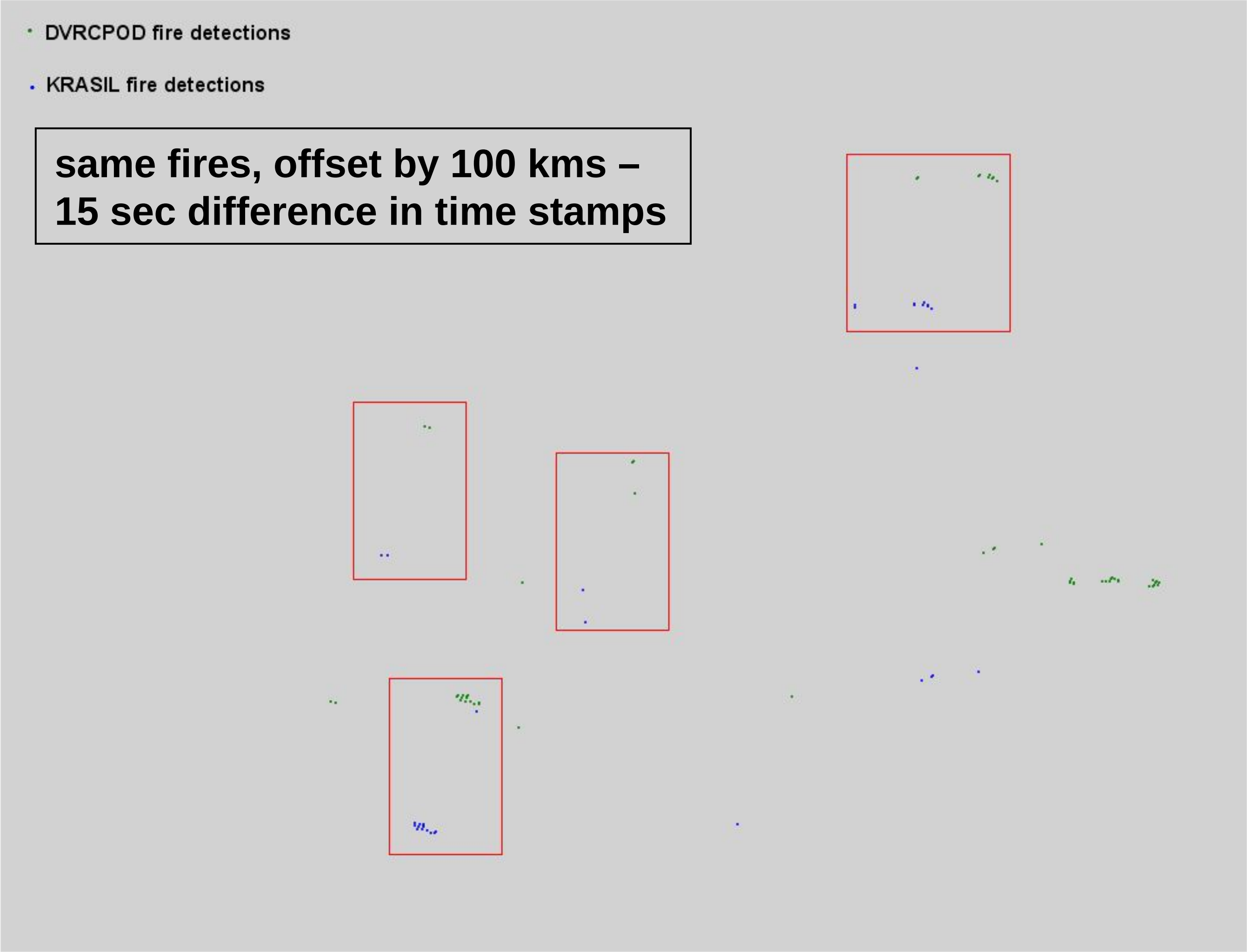


Unfiltered fire detection data form the Khabarovsk receiving station

Evaluation and preprocessing

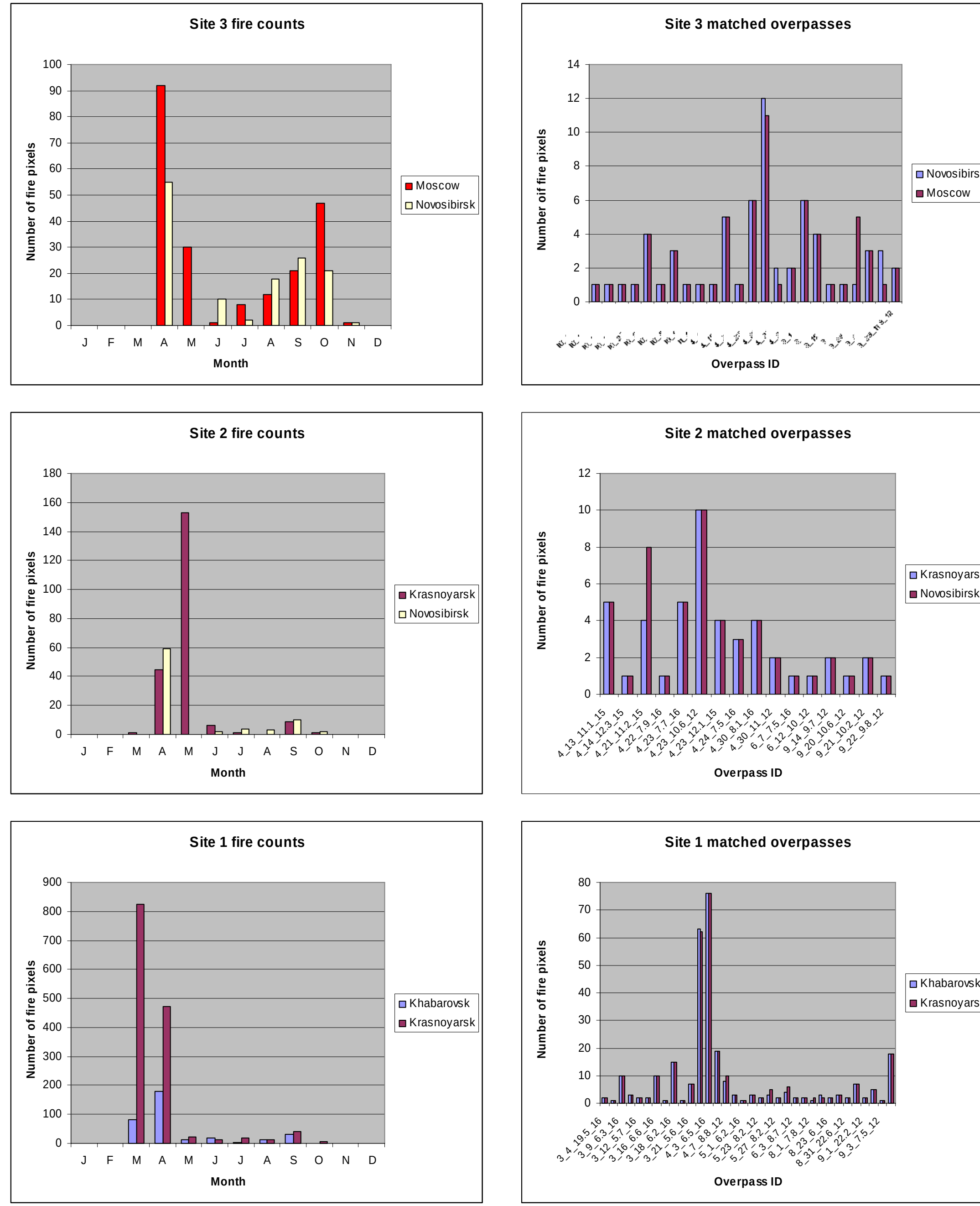
<u>Overlaps</u>:

Consistency of the fire products derived from the same input data is a basic requirement for a spatially homogeneous integrated product. We analyzed example fire detections derived from the same satellite overpasses. This figure shows an example of fire detections from the Khabarovsk and Krasnoyarsk stations. It is clearly visible that there is a shift of ~ 100 kms between the fire clusters. We found that shift is due to an ~ 15 second difference between the time stamps corresponding to the same pixels in the two datasets.



Fire detections from Krasnoyarsk and Khabarovsk

We selected three target areas to compare fire detections from adjacent receiving stations. The target areas were chosen to be approximately halfway between the stations to ensure similar viewing conditions and coverage of the areas.



Monthly total fire counts from the three sites. Left: counts from all orbits. Right: counts from orbits processed by both stations.

Although similar trends exist, there is clearly a large discrepancy between the monthly fire counts from adjacent stations. This is actually caused by the different temporal coverage from the various receiving stations.

	Moscow	Novosibirsk	Krasnoyarsk	Khabarovsk
Site 1	-	-	146	58
Site 2	-	34	68	-
Site 3	64	66	-	-

Yearly total number of overpasses with fire detections over the three sites

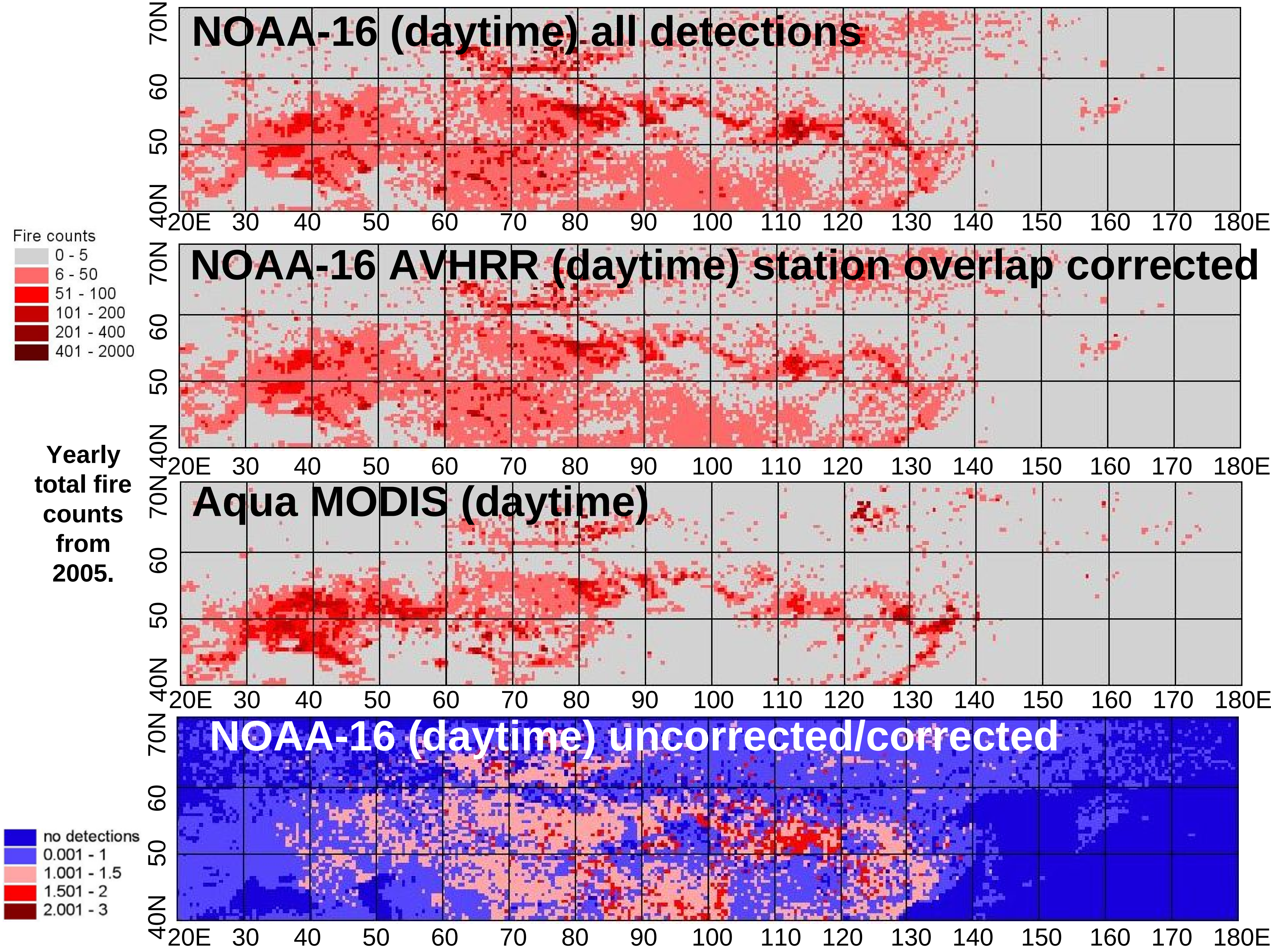
We narrowed the comparison to fire counts from orbits processed by both receiving stations adjacent to the specific sites. The fire counts from this subset are far more consistent.

Monthly Gridded Fire Counts

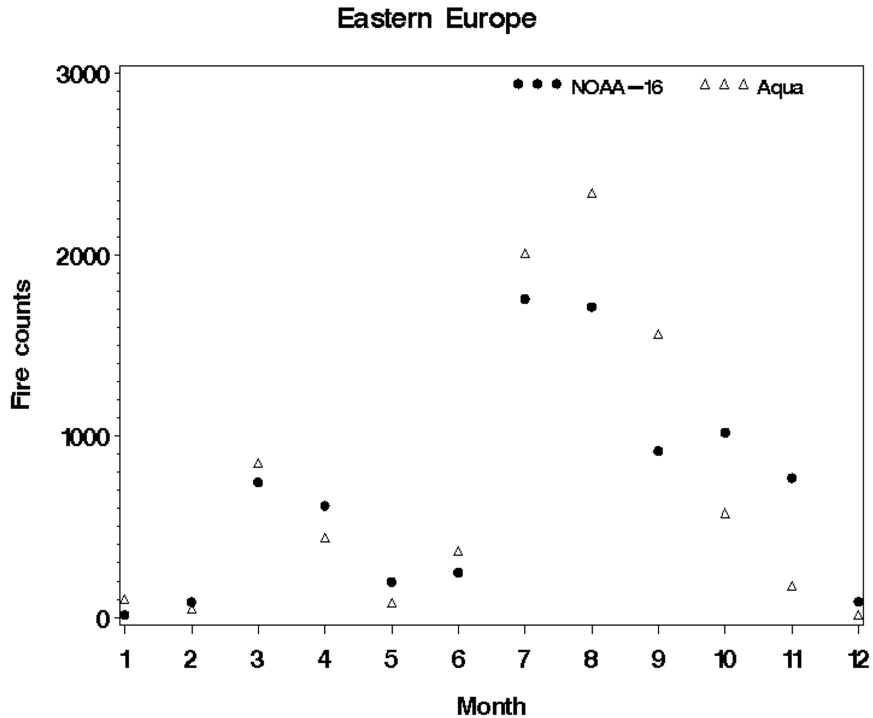
The potential additional value of AVHRR active fire is the sampling of the diurnal cycle of fire activity at different local times. We generated intermediate monthly 0.5^{o} gridded AVHRR active fire products from each satellite and ascending / descending orbits. Fire counts in this product were corrected for overlaps between multiple stations, but not corrected for orbital overlaps and cloud obscuration. The rate of oversampling is typically not uniform because of the uneven spatial and temporal coverage.

Station overlap correction and consistency between MODIS and AVHRR

The spatial distribution of fires from the two sensors is consistent. Fire counts from AVHRR are typically somewhat higher due to a less conservative detection algorithm and possible higher false alarm rate.

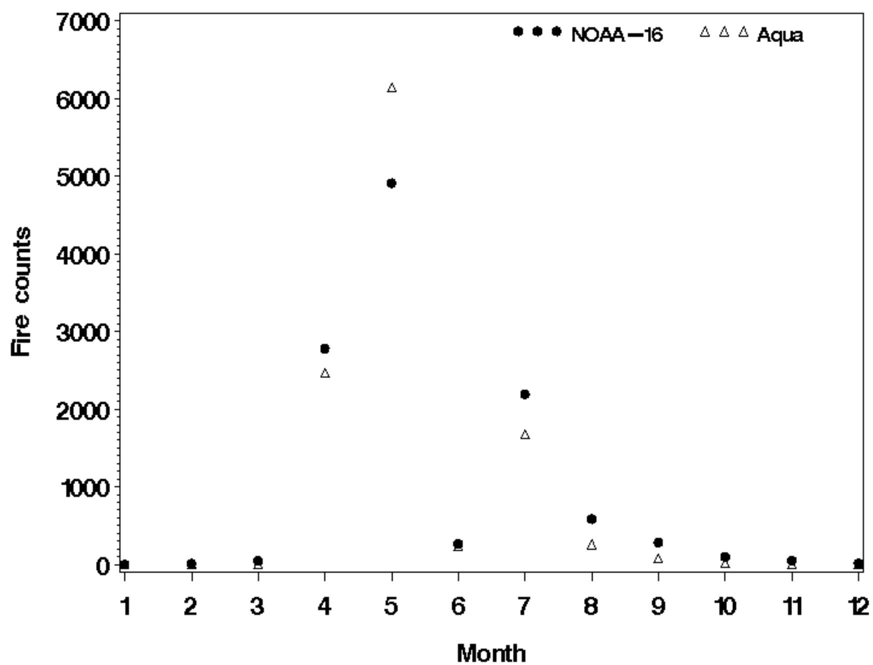


Yearly total fire counts from 2005.



40°-50° N;
40°-50° E
(agriculture)

consistent time series



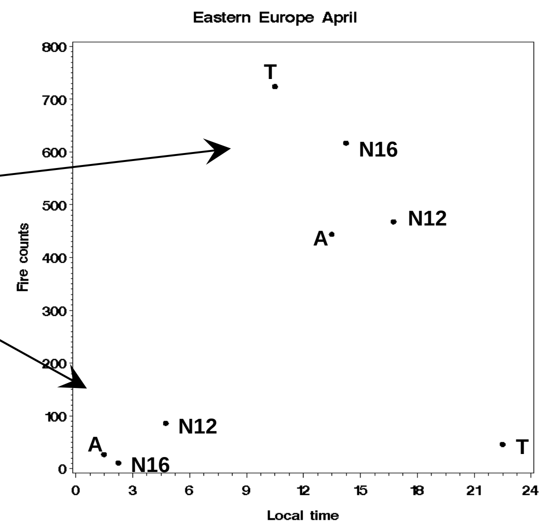
55°-65° N;
60°-70° E
(boreal forest)

Monthly total fire counts from daytime Aqua MODIS and NOAA-16 AVHRR in 2004.

Diurnal cycle signal from multiple satellites

Terra D	Aqua A	NOAA-16 A	NOAA-12 A	NOAA-15 A
10:30	13:30	14:45	16:50	18:00

diurnal cycle signal* + *detection differences

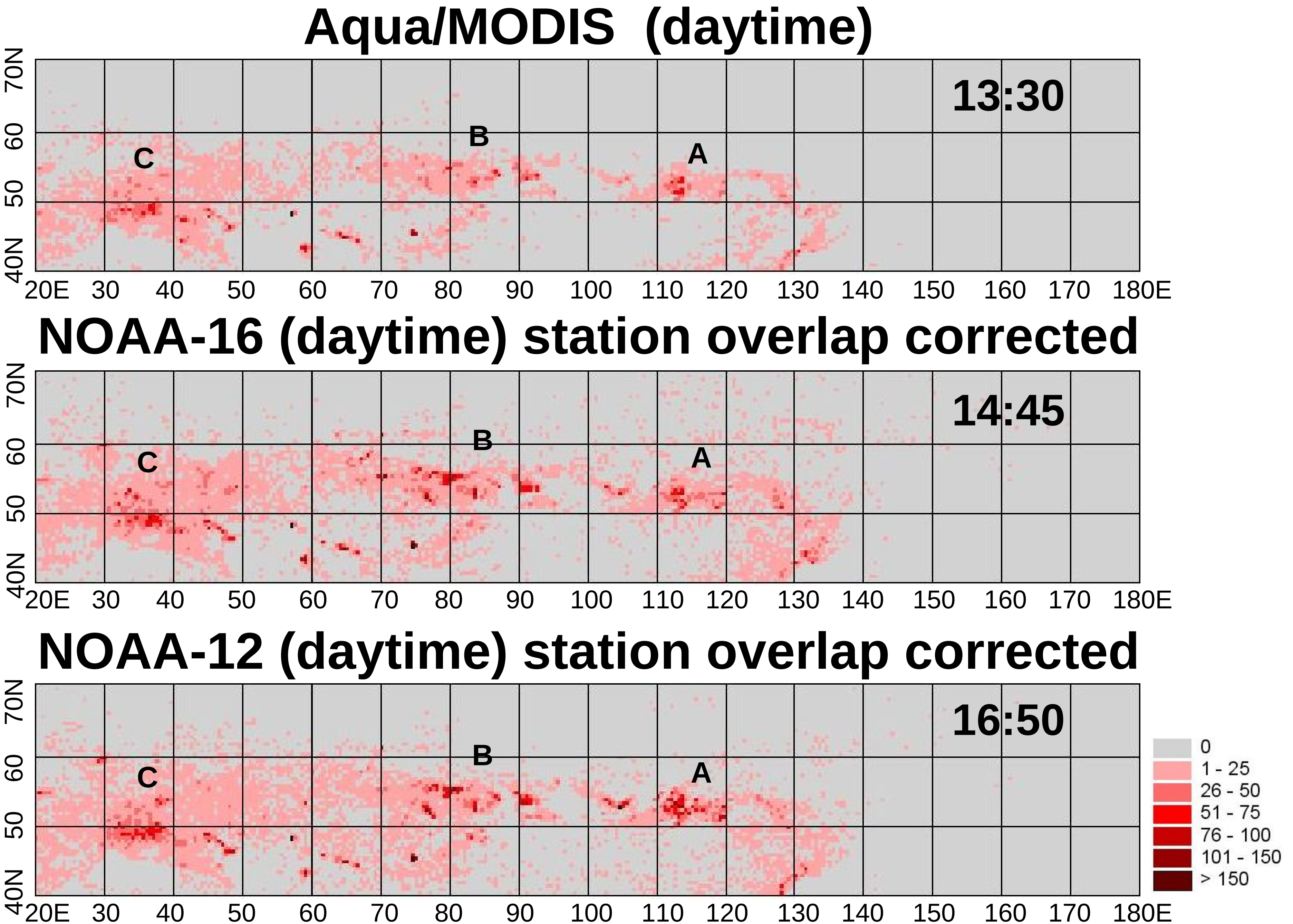


Approximate daytime equator crossing times of the satellites for the 2005 fire season. D: descending node; A: ascending node.

Monthly fire counts in April 2004 (bottom) from MODIS and AVHRR over Eastern Europe (40°-50° N; 40°-50° E) dominated by agriculture.

Comparison of fire distribution at different local times

While the overall spatial patterns of fire activity are similar, some obvious differences exist. For example, NOAA-12 produced more fire counts in the Chita area (A) compared to Western Siberia (B) than NOAA-16. No significant differences can be observed between the fire counts from the three sensors over Eastern Europe (C).



Total fire counts from April 2005

Conclusions and future plans (3/1)

For most areas in of the globe reprocessing of data from direct readout HRPT receiving stations is the only way to generate a (daytime) active fire data record for the pre-MODIS era. Requirements for such a data record were defined in the NASA Fire Earth System Data Record (ESDR) document; the Global Climate Observing System (GCOS) Implementation Plan (IP) and the Committee on Earth Observation Satellites (CEOS) response to the GCOS IP.

Conclusions and future plans (3/2)

Quality control and thorough preprocessing of the data are crucial for the generation of a science quality active fire dataset from AVHRR. Consistent spatial and temporal coverage and the removal of duplicate detections are also essential.

A caveat of the current analysis is that the fire counts were not corrected for orbital overlaps and for cloud obscuration. Orbital overlap correction is a straightforward task. However, for cloud correction the current format of the data (i.e. list of fire pixel locations) is insufficient.

Conclusions and future plans (3/3)

The main recommendation from this analysis is that the data should be distributed in the form of a fire mask. In the absence of this, cloud correction can be done only via indirect means (e.g. use of independent cloud cover products such as Pathfinder Atmosphere).

Future plans include the creation of a final product suite which includes corrections for orbital overlaps and cloud obscuration. Once tested and evaluated, the dataset will be distributed though the NASA NEESPI Data System. Some data can potentially be reprocessed starting from 1995, but further research on early data availability is needed.

Acknowledgment (2/1)

We thank for the contribution of all collaborators in Russia. Below is an incomplete list of partners within the Northern Eurasian Fire Monitoring Network:

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