Utilization of Remote Sensing and Atmospheric Modeling to Determine Dynamics of 2010 Russian Forest Fires
NASA Langley Research Center
Earthzine/DEVELOP Virtual Poster Session, Summer 2011
Video Transcript

Community Concerns Slide
"In the summer of 2010, Russia experienced a series of sustained and severe forest fires. Just to give an idea of the scope of the fire, over 800,000 hectares were thought to have been burned; that's around the size of Connecticut. A total of 56,000 people were thought to have died from the fires and the heat wave present at the time and an estimated $15 billion in damages were thought to have been incurred from this fire."

"We studied the period of July 24, 2010- August 24th 2010 as it was the time frame when the majority of the fires burned."

"It was our hope that through the completion of this project we could provide better forecasting and analysis methods, ultimately improving public health."

"We would also like to thank our science advisors Dr. Richard Ferrare and Jaime Favors for their assistance in the completion of this project."

Methodology Slide
"In the upper right of the screen you can see a MODIS-derived fire map. This map is a compilation of all the fires during our study period, overlaid with our study region seen in red. We took a three-pronged approach to analyzing these fires by looking at background surface conditions, land scarring, and air quality resulting from the burn."

Surface Conditions Slide
"In the summer of 2010, Russian experienced an unusually severe heat wave which created conditions leading to the prolonged period of fires. The two images on the left show land surface temperature data from June-July in 2009 and 2010. There was a visible temperature increase between the two years and for the cities of Moscow, Ryazan, and Nizhny Novgorod there was a 4.2 degree Celsius increase. The image on the right shows a moisture change index image, generated form Landsat, between September 2009 and August 2010 when the fires occurred. Tan indicates no change, blue indicates a moisture gain, and red indicates a moisture loss. When the purple fire locations from August 2010 are added, you can see that they align with the areas of moisture loss."

Land Scarring Slide
"We created a Differenced Normalized Burn Ratio (dNBR) for Nizhny Novgorod using pre-fire and post-fire images. Digital numbers for Landsat bands 4 and 7 were converted to radiance and reflectance. These values were used to calculate the normalized burn ratio using the following equation (Band 4 – Band 7 / Band 4 + Band 7). The post-fire NBR was subtracted from the pre-fire NBR to arrive at our final image. Severely burned areas are illustrated in orange and red."

Fire Risk Map

"Working backwards from the GFIMS fire mapper points, we also derived a preliminary fire risk map for the regions affected by fire. Four factors were considered as an indication of human activity: 1.) proximity to peat, 2.) land cover type, 3.) soil moisture, and 4.) proximity to roads. Peat was identified using a composite of bands 2, 3, and 5. A land cover layer was created using an unsupervised classification of the region in ERDAS IMAGINE software alongside existing land cover data. Weights were assigned to the different factors to map areas of concern using background literature, as well as locations of existing fires. This risk map will need to be further refined to better illustrate fire risk for use in the future."

Air Quality Slide

"In analyzing air quality we used the HYSPLIT Trajectory Model to track the smoke plumes produced by these fires. The image in the top right shows two forward trajectories run at 48 hour intervals and heights of 500, 1500, and 3000 meters above ground level. The trajectories are run on the 24th of July, 2010 from two fire locations in Nizhny Novgorod obtained from the MODIS GFIMS Fire Mapper. As you can see the smoke plume trajectories intersect with the yellow line, which represents the CALIPSO swath seen at the bottom of the slide. CALIPSO allowed us to obtain a vertical composition of the smoke plume as well as track their heights into the atmosphere. The area that has been magnified and emphasized in red shows the specific portion of the swath that crosses through our study area. You can see the presence of the yellow coloration indicative of aerosols/smoke at an altitude of 5km."

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Air Quality Slide, Continued

"We also used AIRS to examine the aerosol optical depth in our study area for 2010. The images on the top show AOD in our region before, during, and after the fires with purple being low AOD and red being very high AOD. It is apparent that in August, during the fires, AOD was extremely high and unhealthy."

"The image below was obtained from an air quality monitoring station in Moscow. The graph measures Carbon Monoxide in parts per million. You can see that in August CO levels were very high at 50ppm, which was extremely unhealthy for the general public. In fact, it was estimated that going outside in Moscow for only 1 hour was the equivalent of smoking 2 packs of cigarettes."

Validations Slide

"During our project we combined several NASA technologies in order to validate each other. The image on the top left shows two HYSPLIT trajectories run from different locations using the GFIMS fire mapper. The trajectories were run on August 8, 2010 for 48 hours. As you can see, the trajectories pass through Moscow and correlate to the graph below. Using data from Weather Underground, we found that on August 8th Moscow experienced one of the lowest visibility days during our study period."

"The picture on the right is a MODIS image with a high volume of fires located in the red circle. The smoke plumes from the fires travel up and intersect with the CALIPSO swath where you can see the smoke plume and the presence of aerosols at approximately 5 ½ km high."