STATE OF THE ARCTIC
16 - 19 March 2010 • Hyatt Regency Miami

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International Arctic Research Center
International Arctic Research Center was established in 1999 jointly supported by US Government and Japanese Government.
Joint IARC/JAXA Research Program on Arctic Wild Fire using Multi Satellite Sensors

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Frostfire: A Successful Experimental Burn in the Boreal Forest in 1999

FROSTFIRE: An experimental approach to predicting the climate feedbacks from the changing boreal fire regime J. Geophys. Res., 108(D1), 8153

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Active layer (cm)

- Site 1 unburn
- Site 1
- Site 2
- Site 10 unburn
- Site 10

$d_{org}$: thickness of organic layer

$\lambda$: thermal conductivity (thawed)

$It$: thawing index
Field Experiment in east Siberia after FrostFire experiment 2000-2004
Joint Research Program between RAS and Hokkaido Univ.
5-month total budget in 2002 (gC m⁻²)

(a) larch forest

- NEP
  - 81

- NPP
  - 254

- microbial decomposition
  - 173

(b) cutover

- NEP
  - -237

- NPP
  - -9

- microbial decomposition
  - 228
Changes in Active Layer Thickness

![Graph showing changes in active layer thickness with years and thaw depth measurements for different sites, marked as F site and C site. The graph indicates a decrease in thaw depth over time, with a notable 'cutover' point in 2001, followed by a recovery in 2002 and 2003.]
Changes in soil moisture profiles (00’—02’)

2000 Wet Forest 2001 Forest 2002 Forest

Data from calibrated TDR probes at 6 depths

Cutover 1-year Cutover 2-year

Vol %
Boundary Fire July 30, 2004
Severely burned Experiment
On going joint research programs
2005-2009
Method

• Three transects on Heavily, Moderately, and Lightly burned sites

• Ground temperature monitoring (2, 50, 100, 150 cm at H, M) (2, 10, 20, 30, 40, 50 cm at L)
  Duration: 2006.8 – 2009.8

• Pit survey and 1D DC resistivity soundings along the survey line
Vegetation along the survey line

Ratio of dead / live Sphagnum

Ratio of burned area (running mean of 3 data)

Relative height (m)

Legend:
- Yellow: ground cover except Sphagnum (e.g. tussocks)
- Green: Alive sphagnum
- Beige: Dead sphagnum

Lightly-burned site

Heavily-burned site
Annual range of ground temperature

Heavily-burned

Moderately-burned

Permafrost probably absent
Soil water content

Volumetric soil water content of Sand-Gravel layer by TDR method

(August 2007)
1D DC resistivity soundings
1D DC resistivity soundings

Soil may be desiccated in heavily-burned sites
Fire disturbance and active layer

- Permafrost has disappeared in the Heavily-burned site.
- This deep-thaw can be triggered by combustion of organic soil and low heat capacity of soil due to small water content.
- According to the resistivity data, permafrost-disappeared area is restricted only in heavily-burned area in lower slope.
Soil profile and thaw depth

(August 2007)
Organic soil thickness and thaw-depth

![Image of organic soil and mineral soil layers]

- **Organic soil (litter)**
- **Mineral soil**

Graph showing the relationship between the thickness of the organic layer and thaw depth. The equation of the line is $R^2 = 0.7633$.

(August 2007)
Detection of Soil Moisture by Microwave L-band

PALSAR observation on permafrost

ALOS

Advanced Land Observing Satellite
2006 Jan.

phased array type L-band synthetic aperture radar (PALSAR)
Field experiment

Map showing the locations of ANWR and Dalton Highway.
Field experiment

ANWR test site

Corner reflector deployment for PALSAR observation

Surface roughness & TDR measurement

Data logger (August 2007 - July 2008)
Develop a ground based portable full polarimetric scatterometer

Radar measurement parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>VNA</td>
<td>Anritsu</td>
</tr>
<tr>
<td>Antenna</td>
<td>Vivaldi antenna array</td>
</tr>
<tr>
<td>Frequency</td>
<td>0.5-4GHz</td>
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<tr>
<td>Polarization</td>
<td>HH, HV, VH, VV</td>
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<tr>
<td>Num. of points</td>
<td>551</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>High</td>
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</tbody>
</table>
Radar signal from the permafrost

![Graphs showing radar signals with labels HH, HV, and VV with time in ns on the x-axis and amplitude on the y-axis.]

- **HH**
- **HV**
- **VV**

Antenna

\( \sim 10 \text{ n sec.} \)
Compare satellite data with IEM model

(Single(HH) polarization data of Alaska)

Data logger in Alaska for 1 year

Red : Off-nair : 34.3°
Pink : Off-nair : 21.5°

~5dB lower than IEM model (Thaw)
2~3dB lower than IEM model (Frozen)
Detection of forest decline and burned area using ALOS imagery in Kenai Peninsula
Collecting basic data

“Reflectance of Individual tree level”

1) healthy branch with green needle
2) fire damaged branch with brown needle
3) grey branch without needle
4) charred branch

- Distribution of each component
  scorched/ not scorched, foliage %, branch %, brown
  needle %

Collecting basic data

Measurement of reflectance
From the observation in 2007

Two images were obtained before and after wildfire which burned trees withered by an attack of spruce bark beetle.
Summary

Wild Fire Impact to Physical and Biological Environment in Alaska

FrostFire Experiment → Siberian field Experiment → IARC/JAXA program

Field monitoring and Satellite remote sensing

25 members from Japan and 10 members from UAF join this program
Elucidation of the role of sea-ice cover change on the marine ecosystem using multi-sensor remote sensing approaches
IPY Ocean Field Campaign 2007-2008
http://odyssey.fish.hokudai.ac.jp/IPY
Second International Symposium on the Arctic Research  ISAR-2

December 7-10  2010 Tokyo JAPAN

hosted by National Polar Research Institute

First Circular April 20, 2010
Submission of Abstract  Sept. 30 2010
contact:  isar2@nipr.ac.jp

First International Symposium on the Arctic Research was held Nov. 4-6 2008 in Tokyo    http://www.jamstec.go.jp/iorgc/sympo/isar1/.

“Drastic change in the recent global warming”

190 participants from 12 countries