Fires in Russian forests

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Fire

- threatens sustainable development
- alters land / atmosphere exchange and releases greenhouse gases
- causes air pollution
- is expected to accelerate under climate change scenarios in some biomes (Amazon, Siberia)
- creates a dynamic mosaic of regenerating patches (heterogeneity, forest edges)
- exhibits high spatial and temporal variability

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Research projects

- **Burned area mapping for greenhouse gas accounting** - SIBERIA-2 (EU FP5)
- **Earth Observation for assessment of forest disturbances induced Carbon emissions in Central Siberia** – SibFORD (EU INTAS FP6)
- **Environmental assessment methods** - GEOLAND (EU GMES FP6)
- **CARBOAFRICA** (EU FP6)
- **Forest fire intensity dynamics** - FFID (NERC)
- **Forest structure retrieval from RADAR** - CORSAR (NERC)
- **Statistical modelling of fire incidence**- Climate and Land Surface Systems Interaction Centre (CLASSIC)
- **PhD: Post-fire photosynthetic activity** - Maria Cuevas Gonzalez (Alcala, Spain)
- **PhD: Pre-fire biomass accumulation** – Daniel Smith (Leicester)
- **PhD: Land-surface modelling and Earth observation of fire/climate interactions** – Darren Ghent (Leicester)
- **PhD: Fire intensity** - Gareth Mottram (KCL)

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Forest structure

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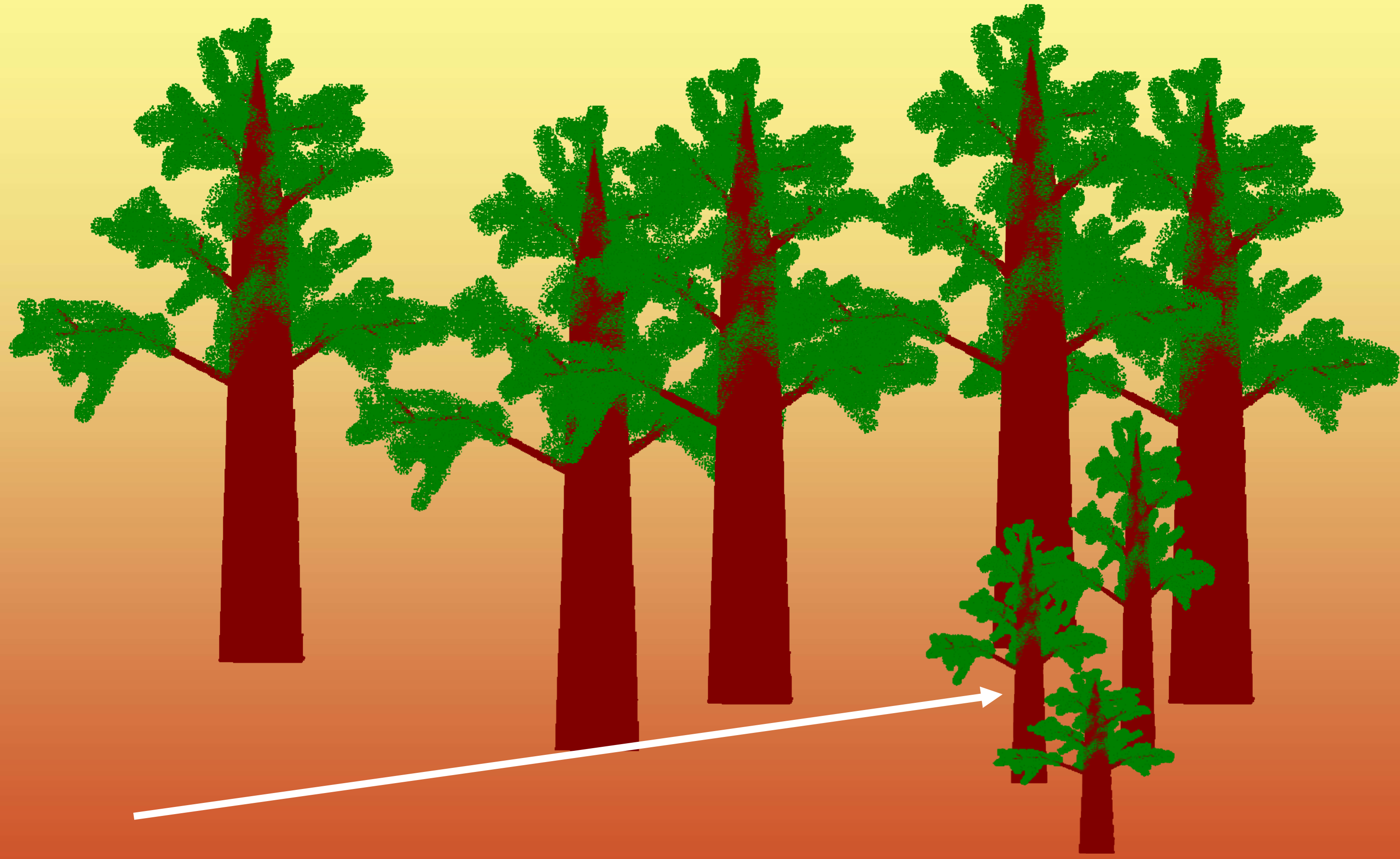
Surface vs. crown fires



ladder fuels can determine whether a surface fire develops into a stand-replacing crown fire

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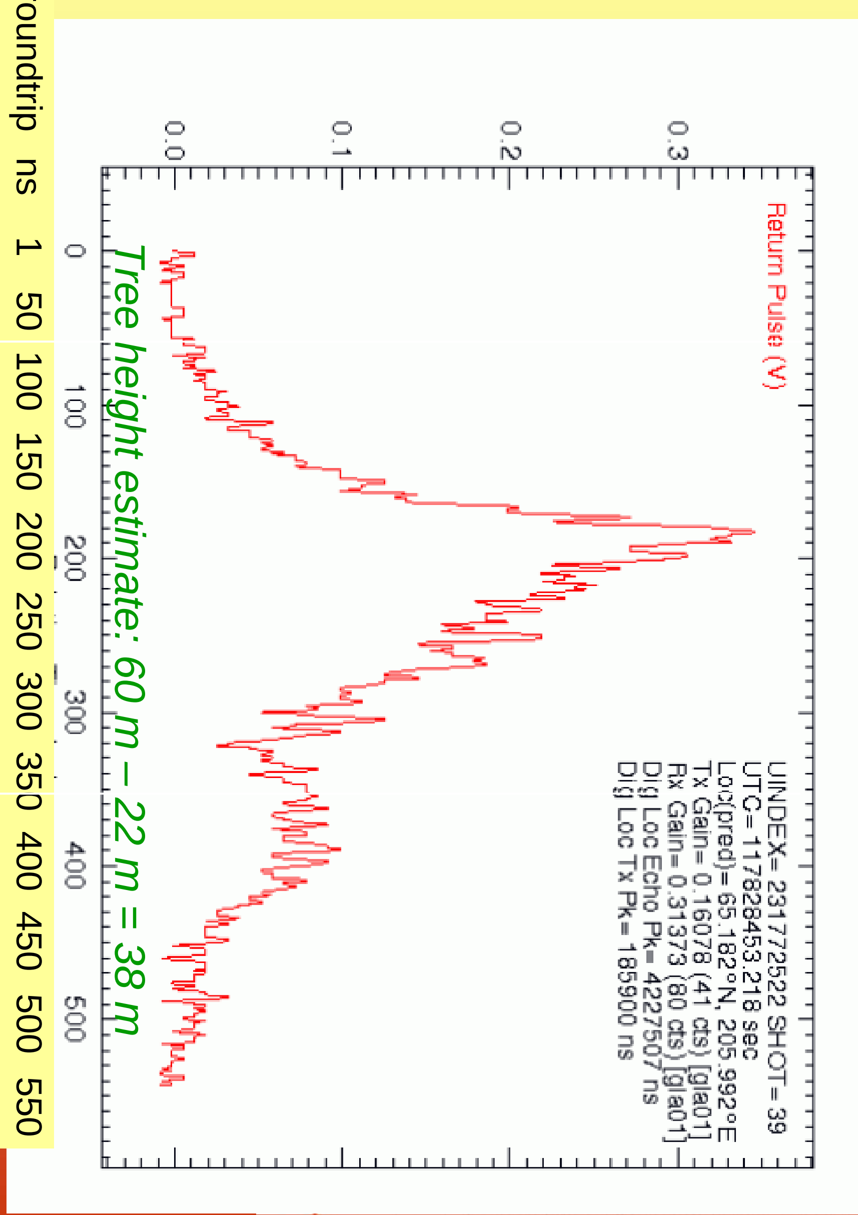
ICESAT-GLAS

- Full waveform over a site in Alaska

Profiling LiDAR can potentially retrieve undergrowth information.



roundtrip	ns	1	50	100	150	200	250	300	350	400	450	500	550
one way	ns	1	25	50	75	100	125	150	175	200	225	250	275
	m	0	7	15	22	30	37	45	52	60	67	75	82

ICESAT-GLAS

- Waveform model of a simulated profile

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Results of the waveform modelling:
This waveform can be modelled as a sum of two Gaussian distributions.
WV ~ N(14.290133, 9.7300970) + N(43.994922, 1.9650509)
where the parameters of the Normal distributions are given as mean and standard deviation.

95% of the first target layer is located between 33.750327 and -5.1700613.
95% of the second target layer is located between 47.925024 and 40.064820.

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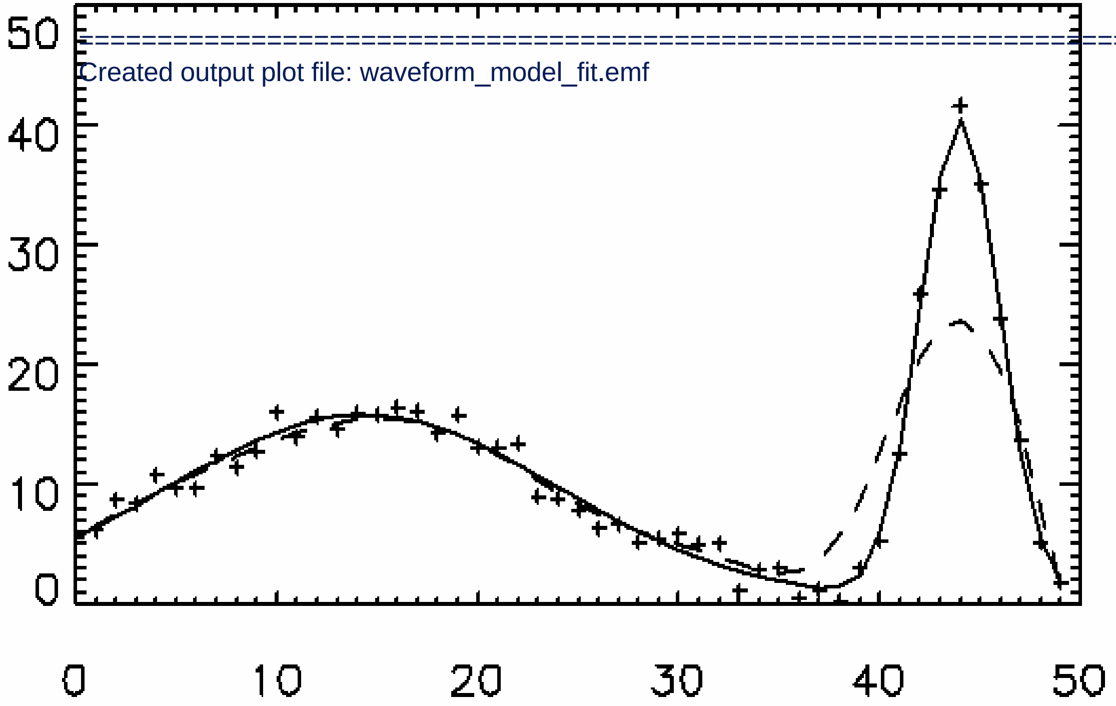
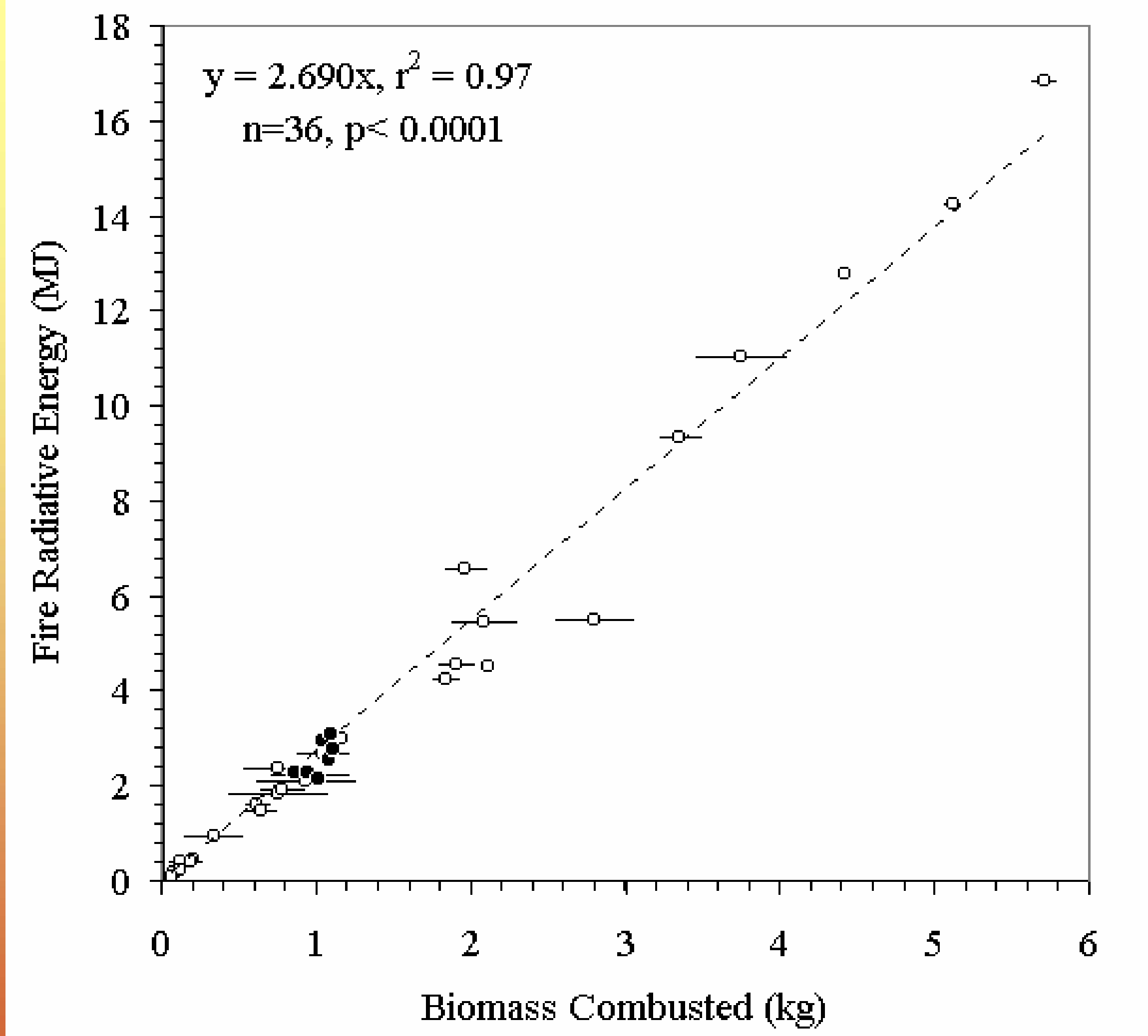
Created output plot file: waveform_model_fit.emf



Energy emissions



Fire radiative energy is proportional to burned biomass

Open points – grassy fuels
Solid points – woody fuels

Slide by M. Wooster, KCL

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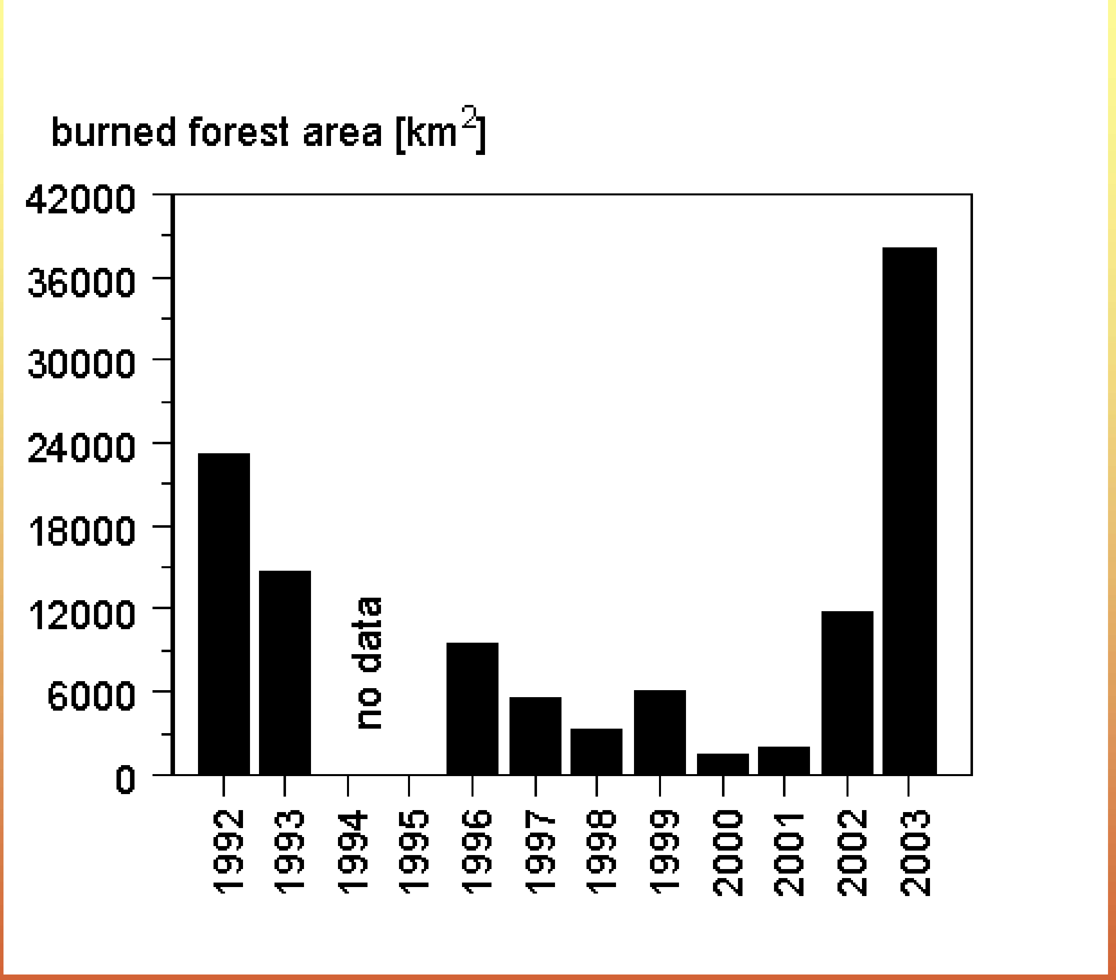
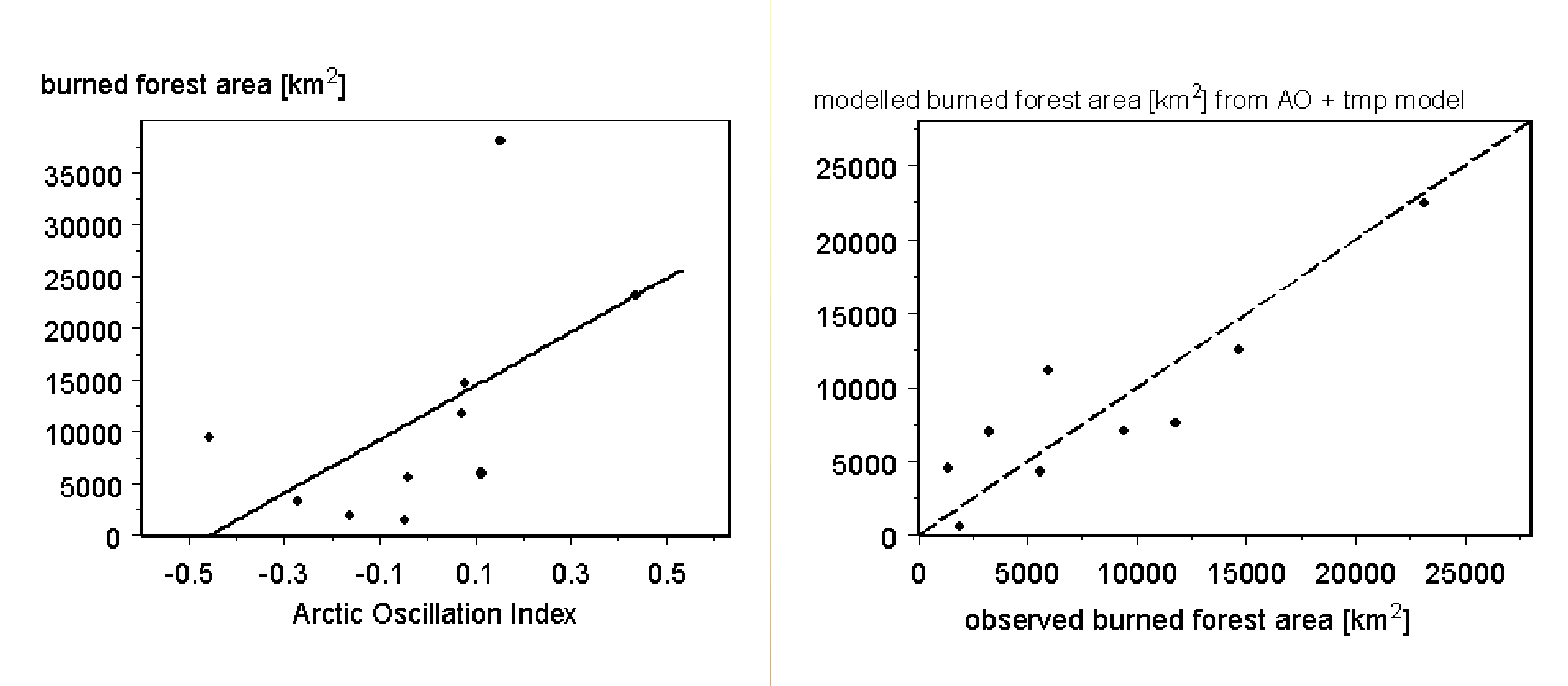
Burned area

Forest fires in Central Siberia from remote sensing



Balzter et al. (2005), *Geophysical Research Letters 32, L14709.1-L14709.4, doi:10.1029/2005GL022526*



Burned area can be modelled as a function of the Arctic Oscillation and temperature anomalies.

Balzter et al. (2005), ***Geophysical Research Letters 32, L14709.1-L14709.4, doi:10.1029/2005GL022526***

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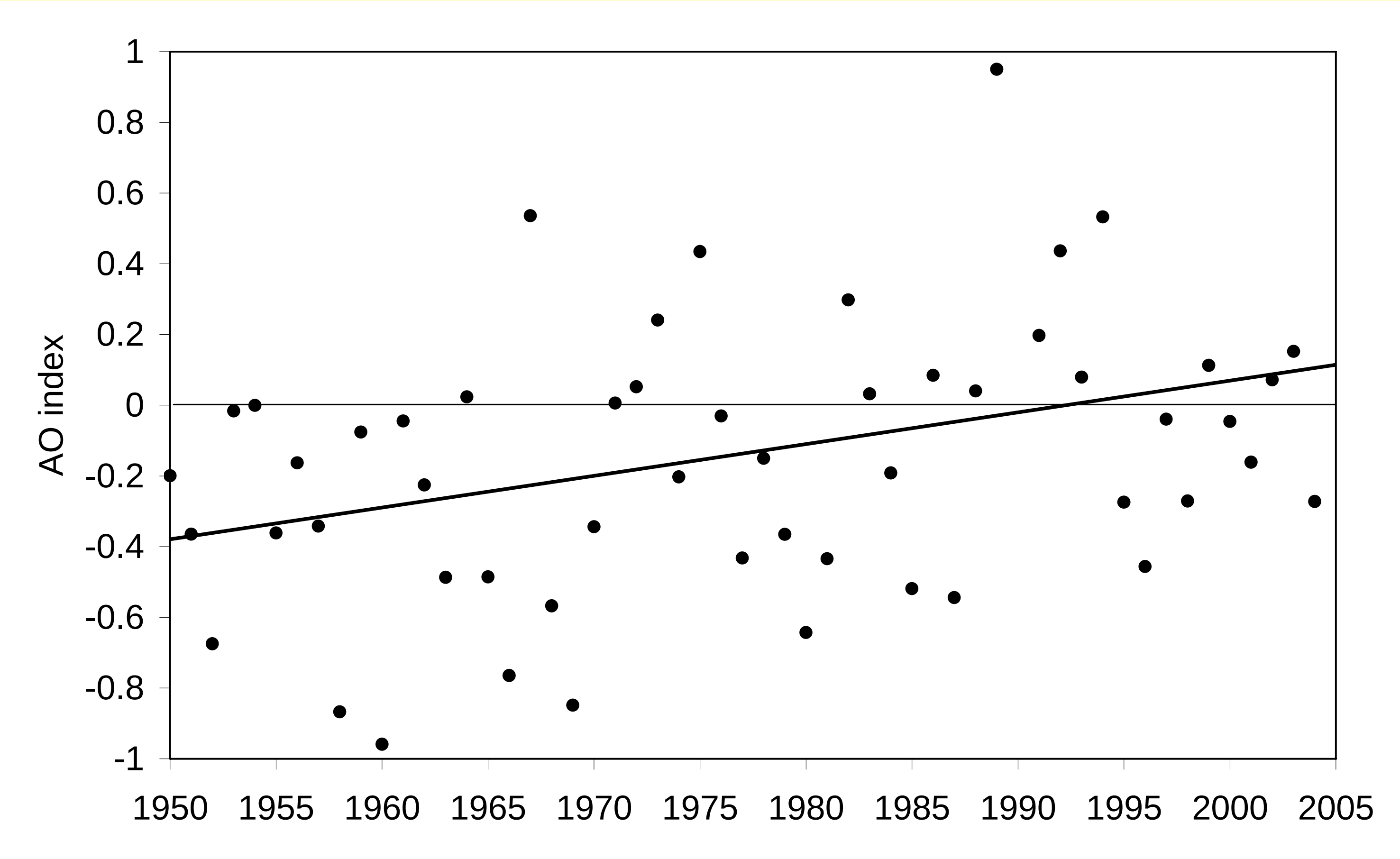
The Arctic Oscillation is changing towards its positive phase



AO Index (source: NOAA Climate Prediction Center)

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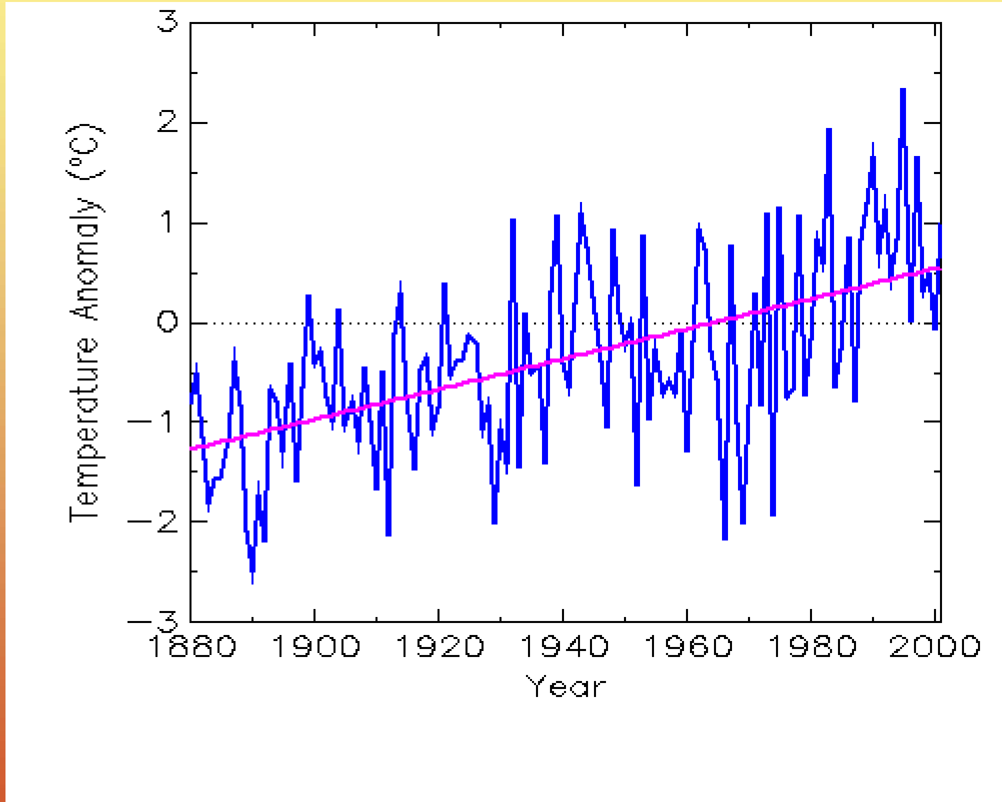
Siberia is warming

1880-2001 Temperature Time Series



Number of Years	122
Temperature increase (slope)	1.5°C / 100 yrs

Averaged over 50°-80° N; 80° to 120° E (source: Global Historical Climatology Network)

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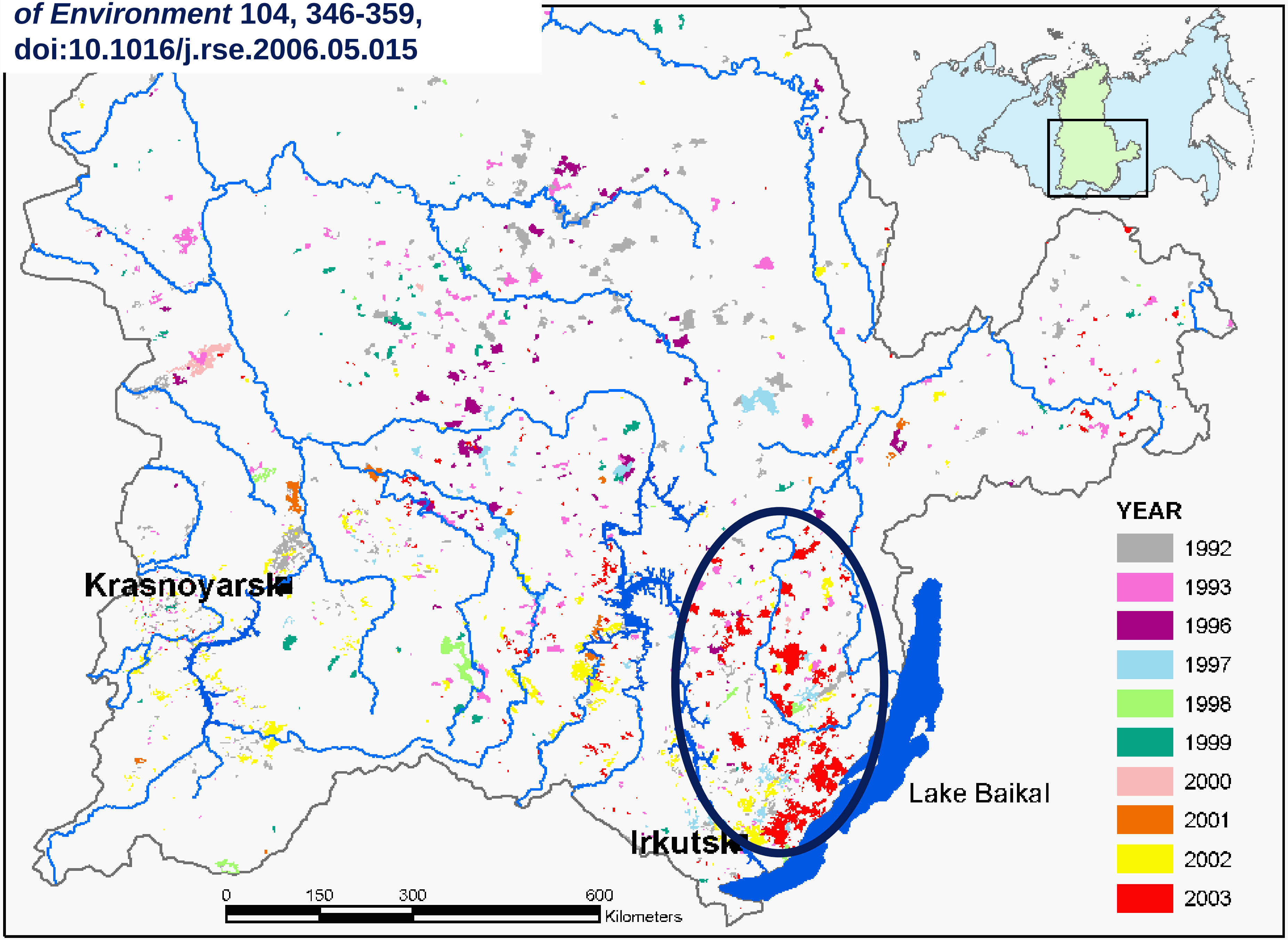
George et al. (2006) ***Remote Sensing of Environment*** **104, 346-359, doi:10.1016/j.rse.2006.05.015**



Regional clustering of fire scars

- Poisson modelling of fire frequency per 2.5° grid box suggests that local fire frequency is influenced by
  - Local summer rainfall anomalies
  - Human population density

Jupp et al. (2006) *Geophysical Research Letters* 33:14, L14701.1-L14701.5, doi: 10.1029/2006GL026679

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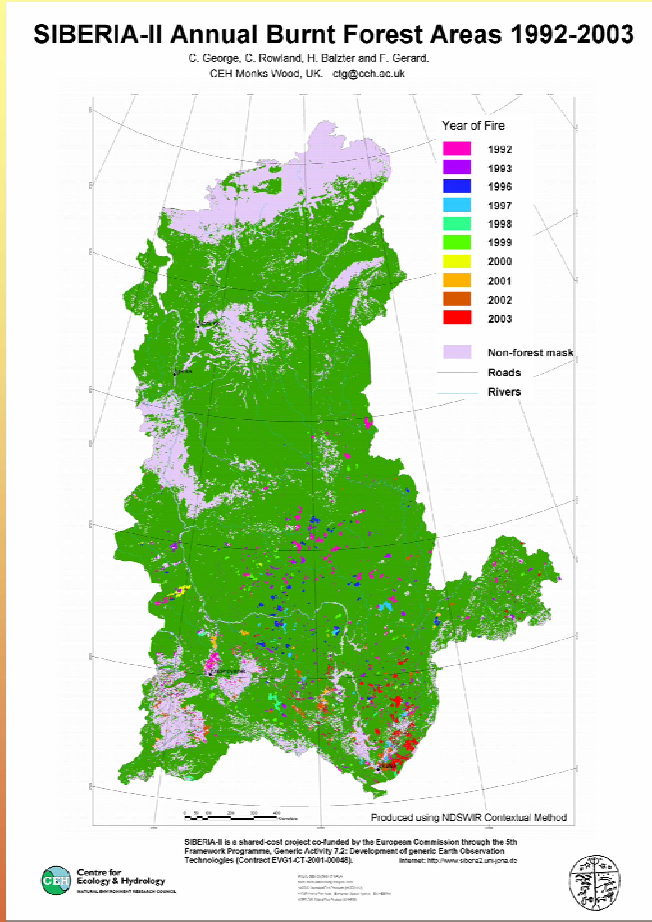
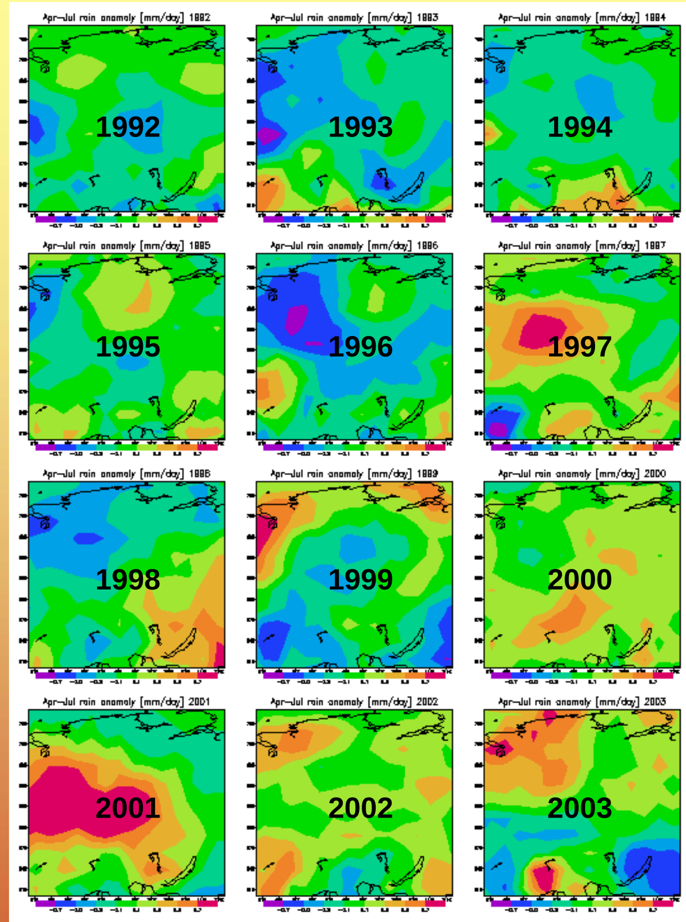


Forest fires



Apr – Jul rainfall anomalies in mm / day

Chris Taylor (*CLASSIC*, CEH Wallingford) suggested that the fires might correlate spatially with rainfall <u>*anomalies*</u>

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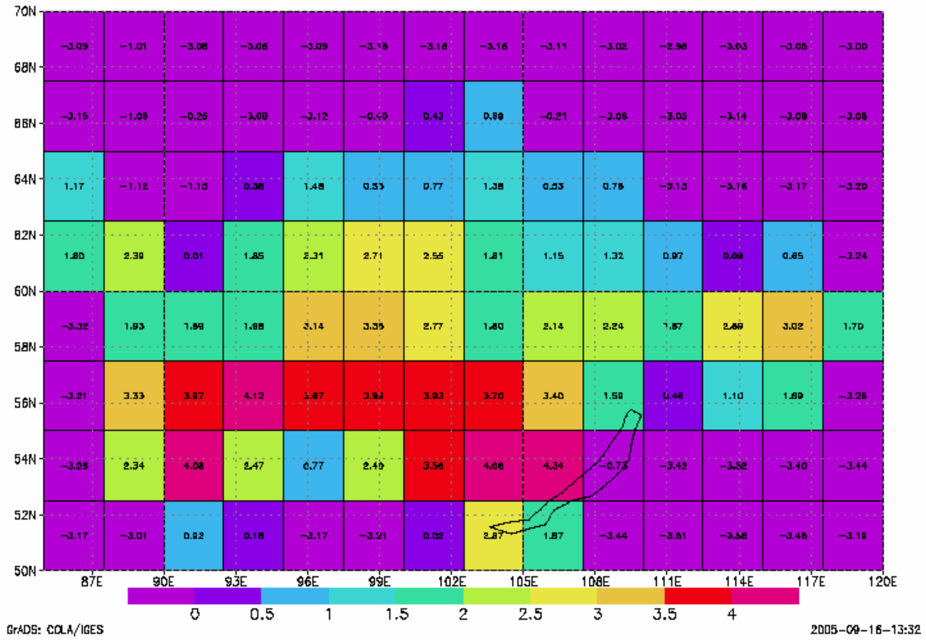
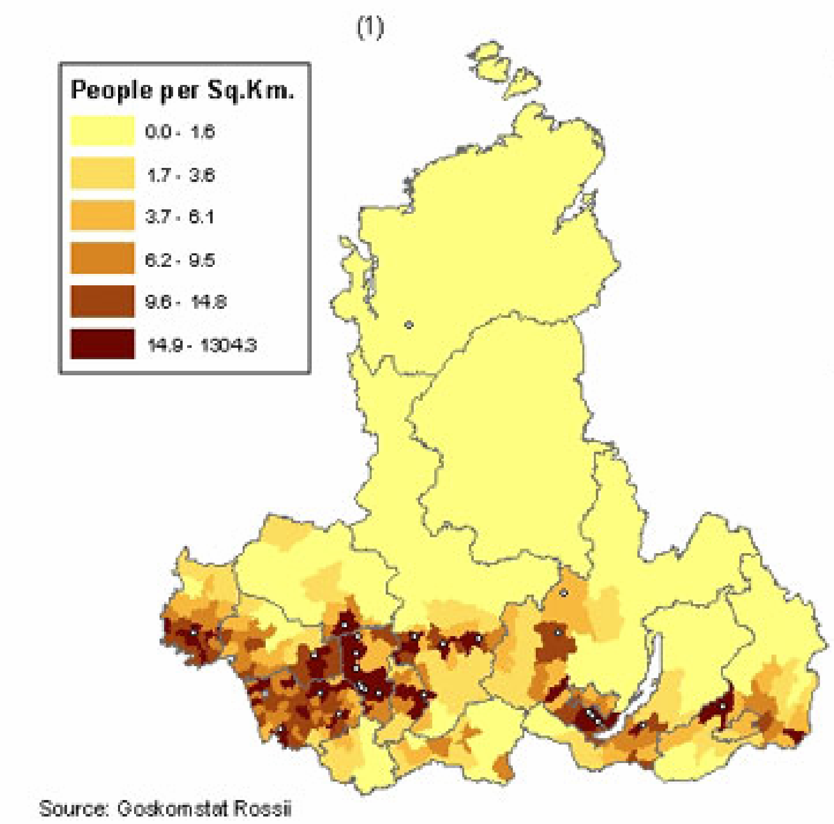
Cause of spatial variability?

Posterior mean a[i]





http://www.geog.le.ac.uk/russianheartland/DemographicMaps/Raions.html

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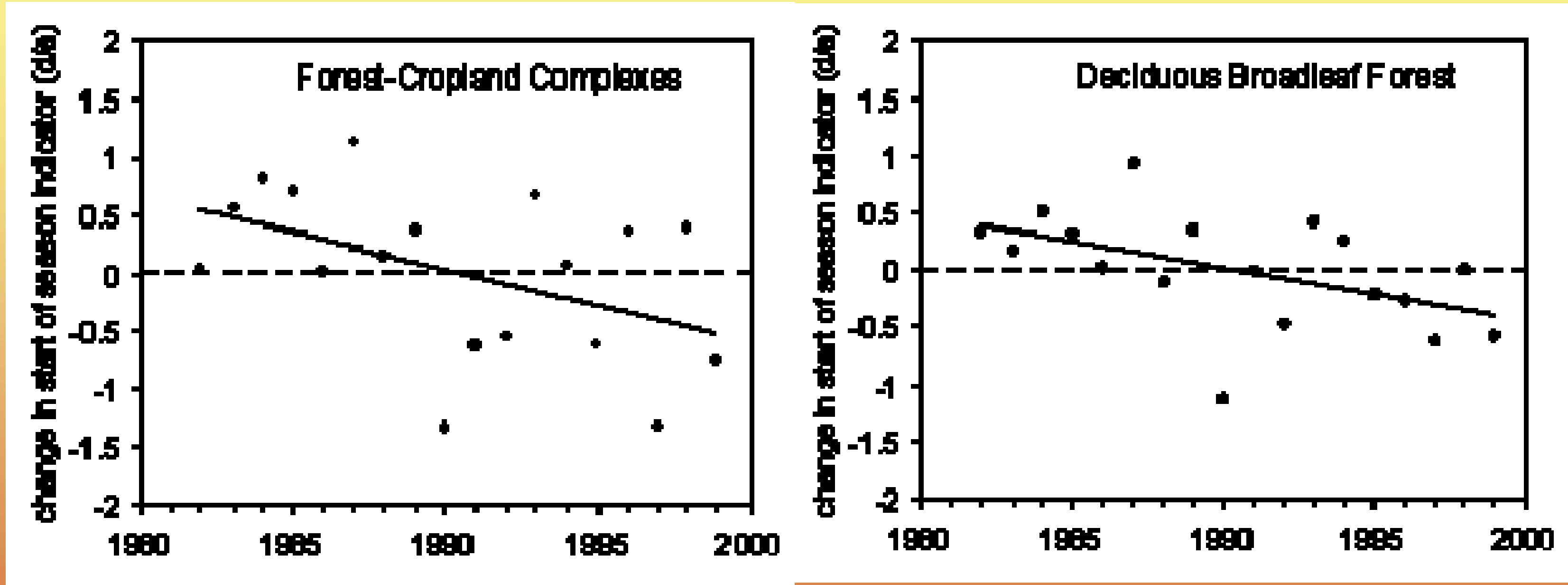
Vegetation phenology

Studies of vegetation phenology



- Advance of the onset of spring from remote sensing over Siberia

Balzter et al. (2007) *Journal of Climate*, doi: 10.1175/JCLI4226

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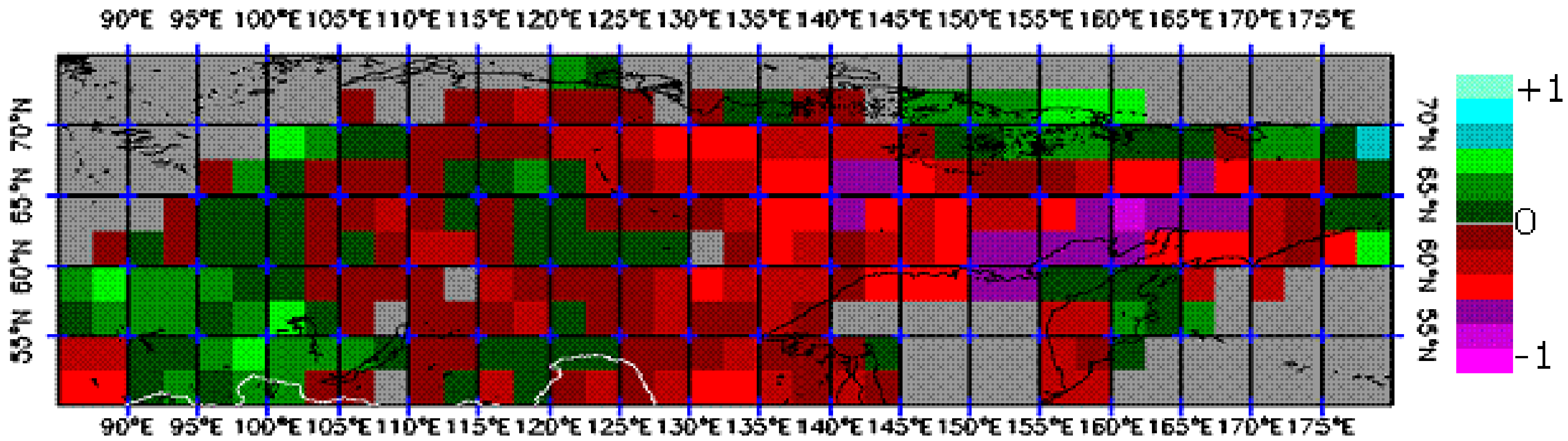
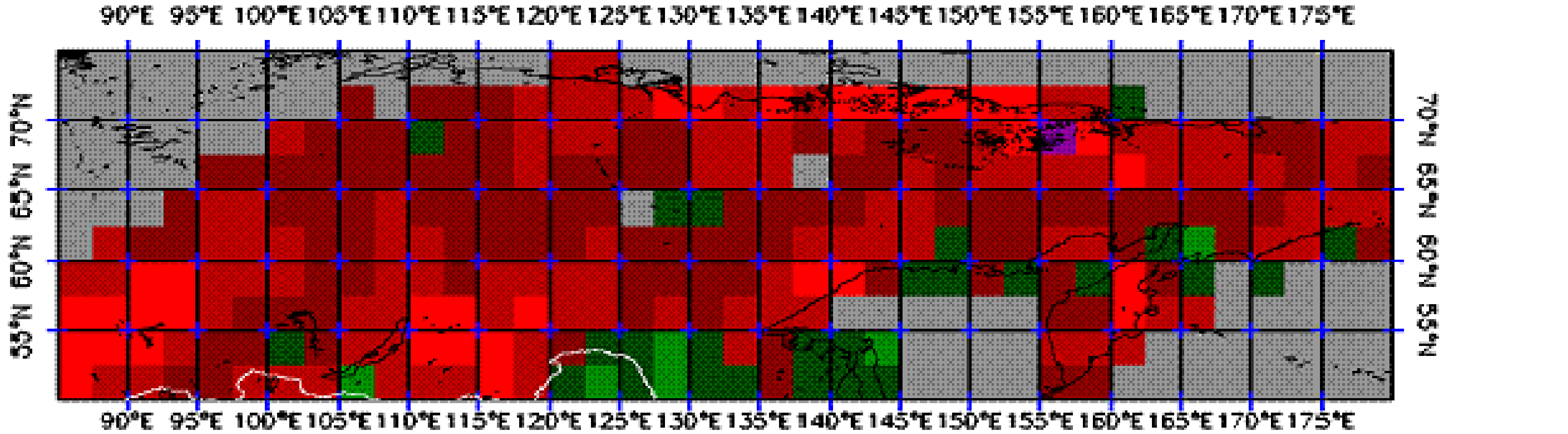


(a) NINO3 Index and length of season anomalies



(b) Arctic Oscillation Index and start of season anomalies

- Length of the growing season is correlated with climate indices.

Balzter et al. (2007) *Journal of Climate*, doi: 10.1175/JCLI4226

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Conclusions - 1

1. Vegetation (fuel) structure information may help inform JULES.
2. Burned area data are now available globally (e.g. L3JRC, GLOBCARBON, MODIS) and can be used to validate fire model predictions.
3. Satellite data analysis can help generate process knowledge and quantify parameters (e.g. ignition probability).

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Conclusions - 2

Open questions:

- Dynamics of fuel mass build-up before fire
- Fuel moisture content dynamics and extreme fire seasons
- Modelling human / natural ignition sources

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