FORECASTING OF FIRE DANGER INDEX USING ENSEMBLE SEASONAL FORECASTS

ПРОГНОЗИРОВАНИЕ ИНДЕКСА ПОЖАРНОЙ ОПАСНОСТИ С ИСПОЛЬЗОВАНИЕМ СЕЗОННЫХ АНСАМБЛЕВЫХ ПРОГНОЗОВ

Valentina Khan, Peter Vasilev, Vladimir Tischenko

Hydrometcenter of Russia

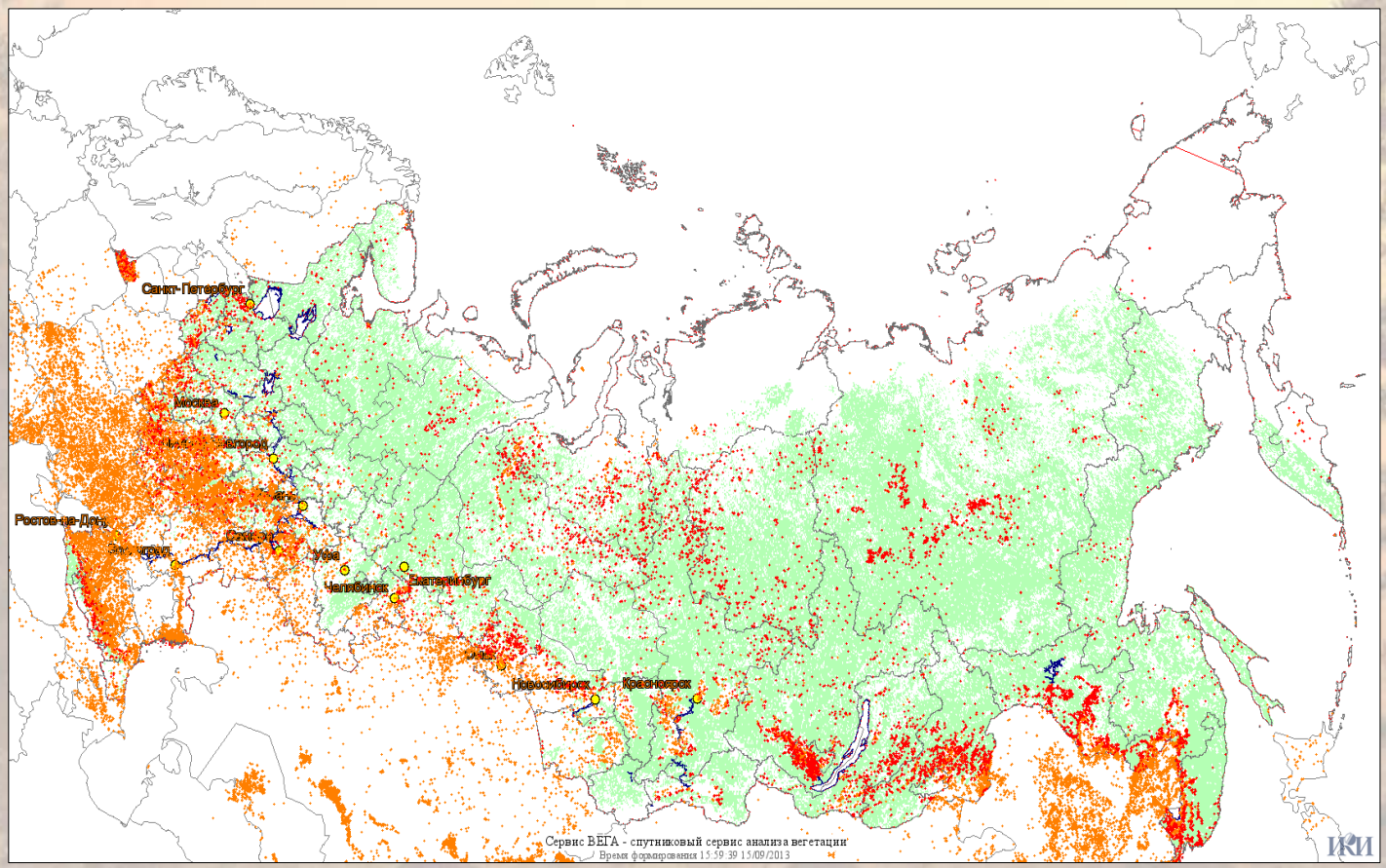
Fifth Session of North Eurasian Climate Outlook Forum (NEACOF-5)

28 October-1 November 2013, Moscow, Russia

Many countries facing forest fire problems. Forest fires have significant impact on the environment (biodiversity, biomass, land cover changes, climate change and ecosystems) and socio-economic system of affected regions.

In Russia extensive areas are under affect of forest fires.

Registered wild fires in 2013



Lupyan, Milehiin 2013

Satellite data from Terra u Aqua

Burned area over Russia

Averaged statistics of wild fires over territory of Russia for period from 2001 through 2013:

- 14,800 incidences of fires per season
- 8 billions Ga burned area
- 4,2 billions Ga burned forested area

Statistics of forest fires in high latitudes of Russia (> 60N)

Climate change that could result in drier and warmer conditions potentially would increase fire occurrence and intensify fire behavior

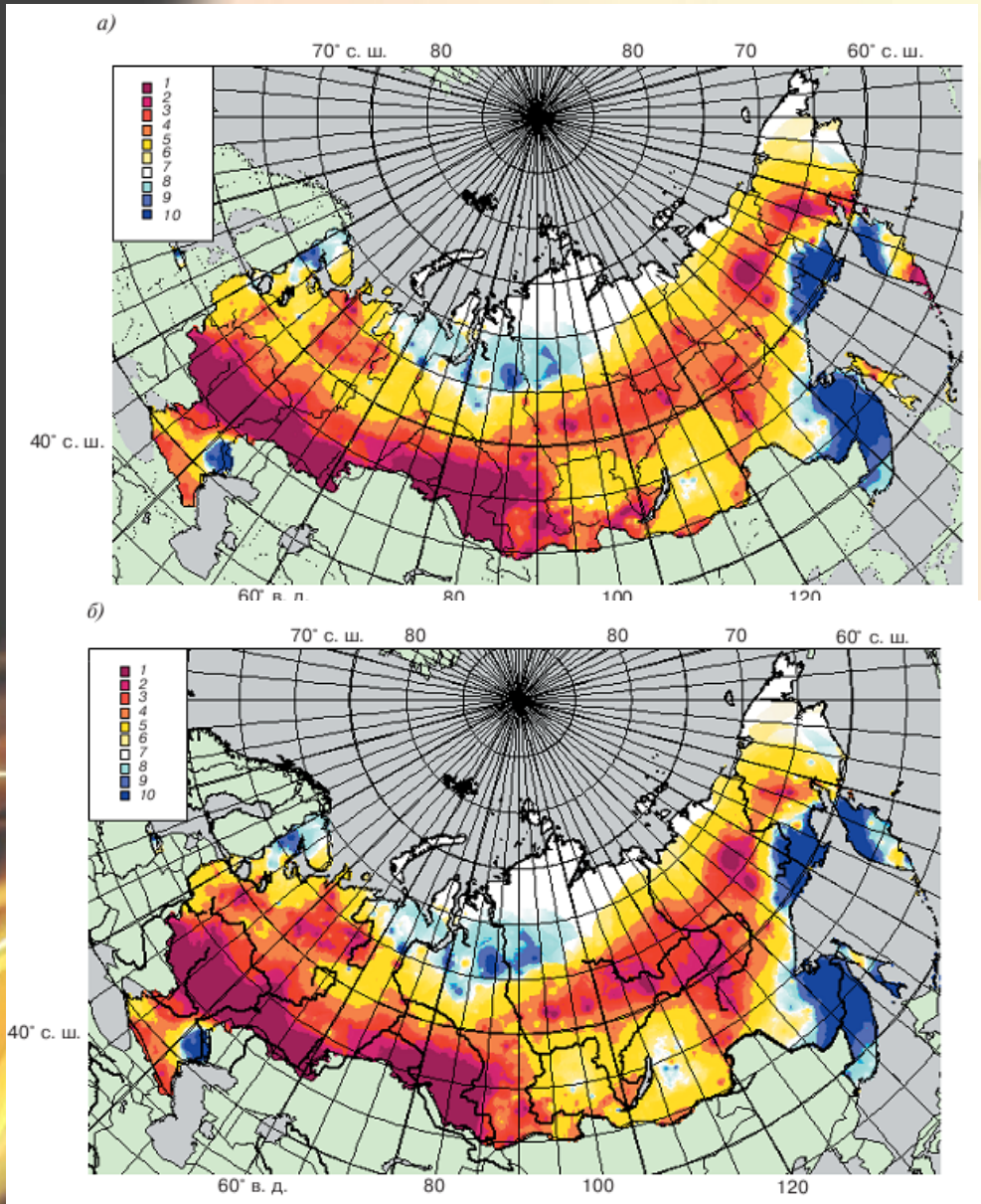


Рис. ТР13.5. Изменение (%) числа суток в году со значениями индекса горимости "высокий и больше" к 2025 г. (*а*) и к 2050 г. (*б*) относительно нормы 1961–1990 гг. *1*) 50–60; *2*) 40–50; *3*) 30–40; *4*) 20–30; *5*) 10–12; *6*) 1–10; *7*) 0; *8*) –1 – –10; *9*) –10 – –20; *10*) –20 – –30

Changes in a number of days with high fire risk under climate scenario

A2 to 2025

Outputs from climate models CGCM2, HadCM3 and ECHAM4 were used to make assessments of impact of climate change on forest fire danger situation

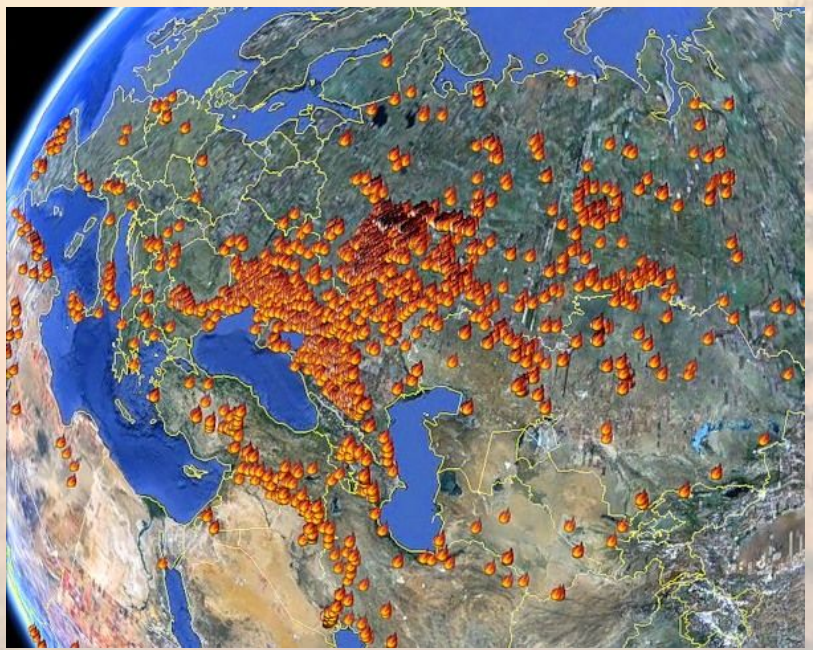
Changes in a number of days with high fire risk under climate scenario A2 to 2050

Assessment report on climate change over territory of Russia, Sherstyukov 2008

Unprecedented wildfires in Russia 2010 provoked activities in improvement the early warning system for fire

There was a big demand to develop seasonal fire danger predictions

Пожар в деревне Передельцы в Рязанской области // Итар-Тасс



2010 fires cost roughly $15 billion USD in damages. 56,000 people in all died from the effects of the smog and heat wave. 2,000 buildings were destroyed.

Practice to issue the monthly to seasonal fire danger forecasts

USA experience

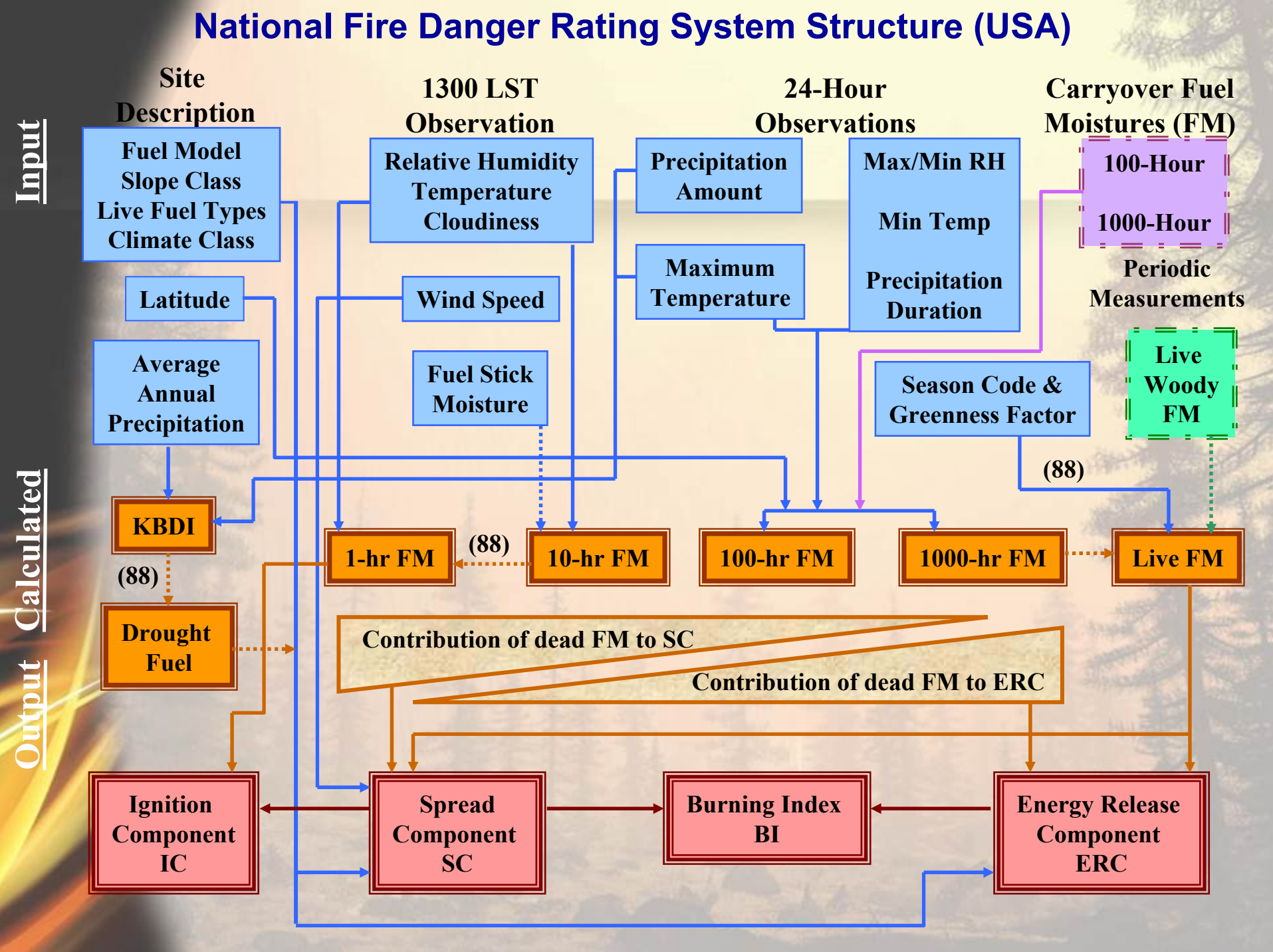
Over last few years, the Scripps Institution of Oceanography Experimental Climate Prediction Center (ECPC) began making experimental near real-time weekly to seasonal fire danger forecasts using the global spectral model (GSM) (Roads *et al* 2005).
Gridded output weather data are used for fire danger calculations.
The objective was to assess whether or not fire indices could be forecast on longer time scales (monthly and seasonal) using a state of the art dynamical seasonal prediction model, and producing these forecasts automatically.

Results of the analysis were positive, and forecast maps have been produced regularly to date since project initiation.

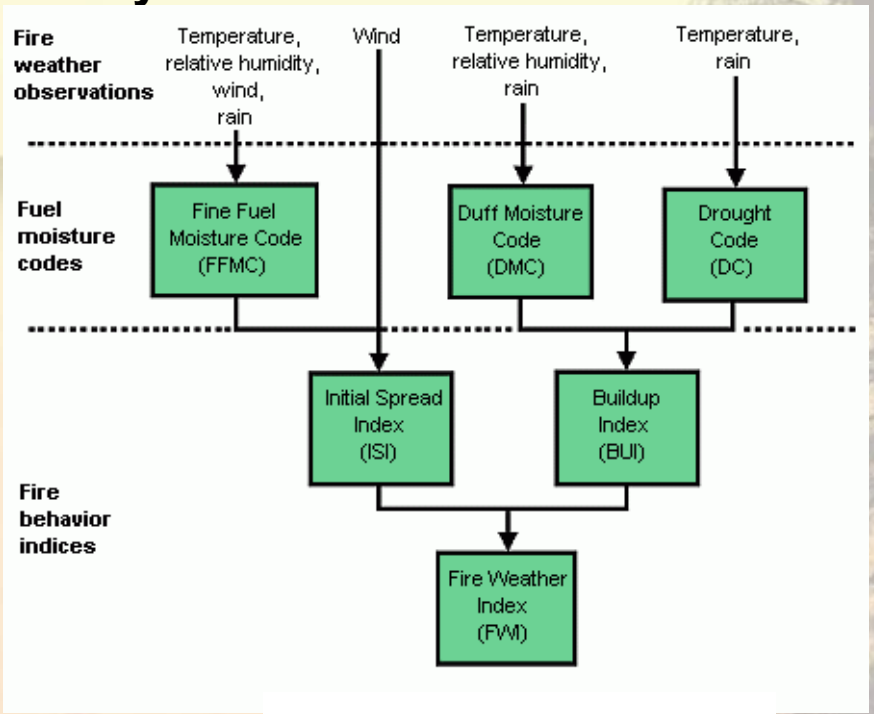
Roads, J., P.Tripp, H.Juang, J.Wang, F. Fujioka, S. Chen, 2010: NCEP-ECPC Monthly to seasonal US fire danger forecasts, *International Journal of Wildland Fire, 19(4), 399-414*

Roads, J., F. Fujioka, S. Chen, R. Burgan, 2005: Seasonal Fire Danger predictions for the USA. *International Journal of Wildland Fire, Special Issue: Fire and Forest Meteorology,* 14, 1-18.

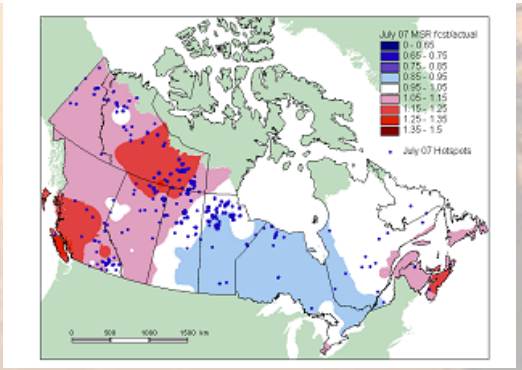
National Fire Danger Rating System Structure (USA)



Monthly and Seasonal Forecasts in Canadian Wildland Fire Information System

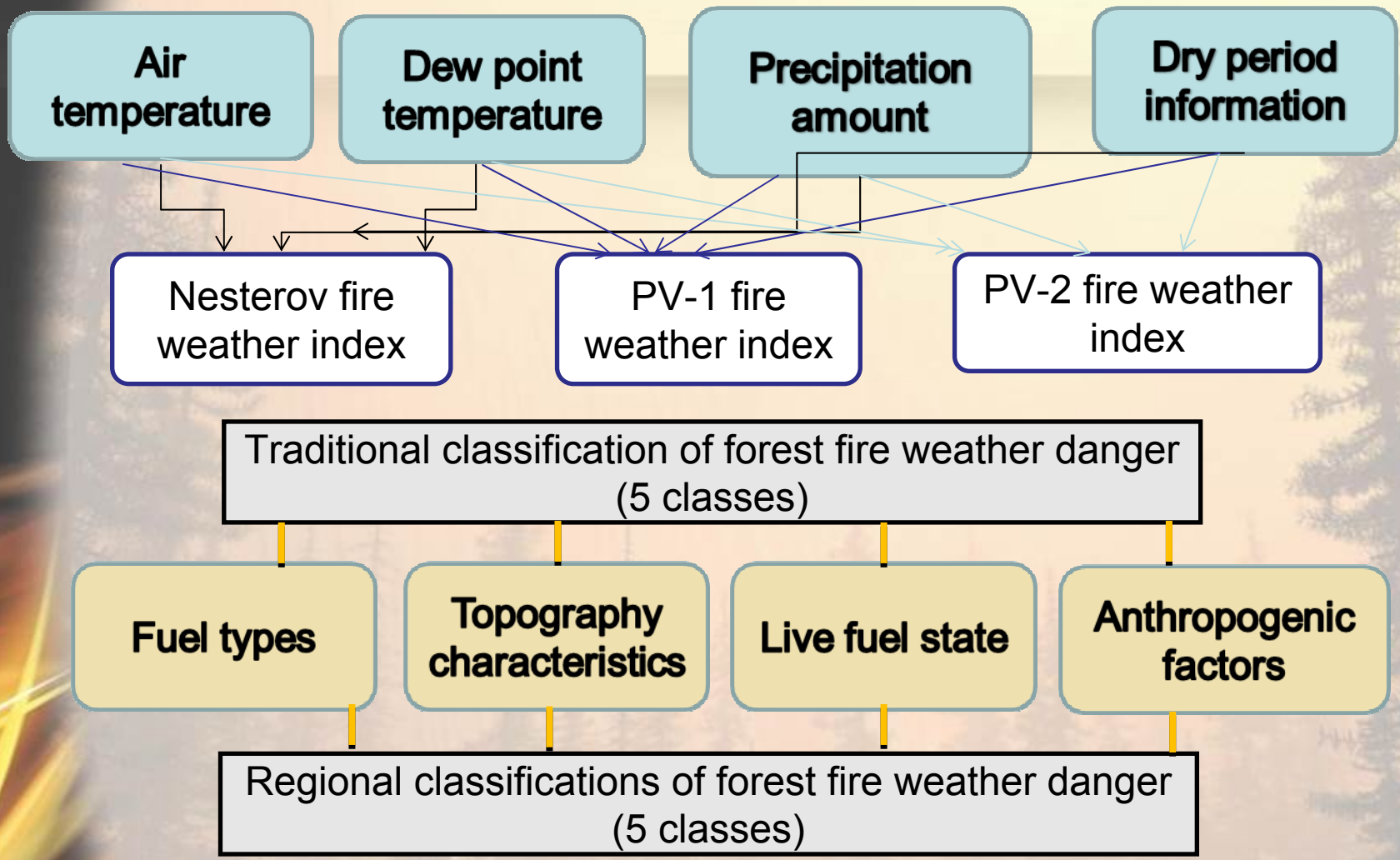


Predictions are based on Environment Canada's monthly and seasonal forecasts, information contained in the Canadian Wildland Fire Information System (CWFIS). The first 4 months fire weather predictions are based on a 40-member ensemble of predicted monthly temperature and precipitation anomalies using four numeric weather prediction models. Beyond the first 4 months, forecasts are produced using Environment Canada's statistical model.



Anderson, K.R.; Englefield, P.E.; Carr, R. 2007. **Predicting fire-weather severity using seasonal forecasts.** In 7th Symposium on Fire and Forest Meteorology, Bar Harbor, ME, 23–25 October 2007. Am. Meteorol. Soc., Boston, MA.

Russian Forest Fire Danger Information System



Classification of fire danger potential

There is traditional classification of fire danger alert in relation of Nesterov index

Fire danger index (Nesterov index)

Fire danger class	Nesterov index value	Degree of fire danger
I	1-300	No danger
II	301-1000	Low danger
III	1001-4000	Normal danger
IV	4001-10000	High danger
V	≥ 10 001	Extreme danger

We've proposed the new classification of fire danger potential in a scale of seasonal assessments

Classification of fire danger potential

There is a traditional classification of fire danger alert in relation of Nesterov index

We've proposed the new classification of fire danger potential in a scale of seasonal assessments

Fire danger index (Nesterov index)

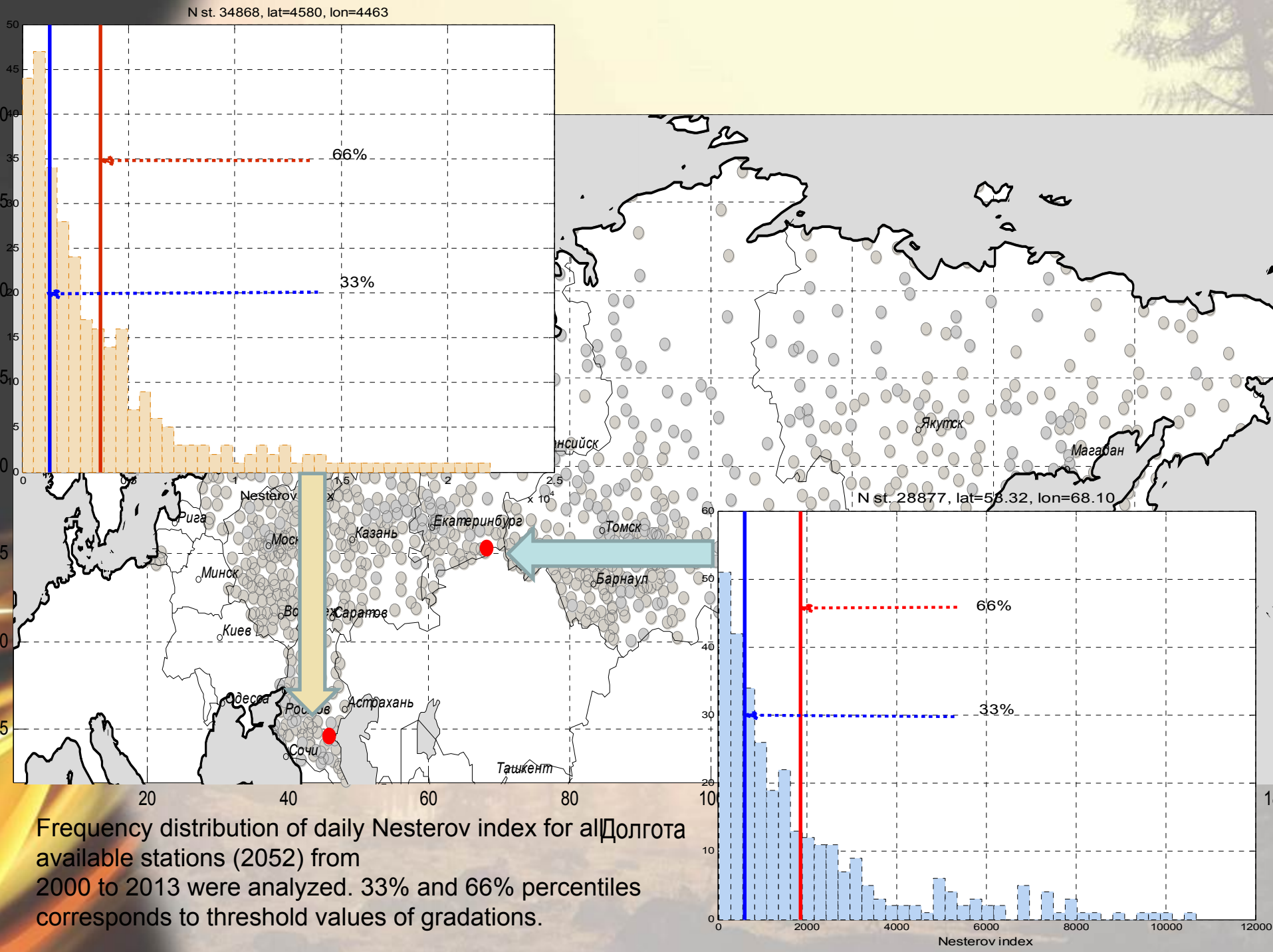
Fire danger class	Nesterov index value	Degree of fire danger
I	1-300	No danger
II	301-1000	Low danger
III	1001-4000	Normal danger
IV	4001-10000	High danger
V	≥ 10 001	Extreme danger

BELOW NORM

NEAR NORM

ABOVE NORM

New terminology was introduced to assess the fire risk in long-range scale "Gradation of fire danger risk"



Frequency distribution of daily Nesterov index for all available stations (2052) from 2000 to 2013 were analyzed. 33% and 66% percentiles corresponds to threshold values of gradations.

FIRE DANGER FORECAST TECHNOLOGY

Forecast ensemble fields from SLAV model

Decoding, formatting, calculation of ensemble mean values

Forecast ensemble fields from CFS v2 model

Decoding, formatting, calculation ensemble mean values

The calculation of average multimodel values. Interpolation to the coordinates of the 2,052 stations located over territory of Russia

Calculation of Nesterov index and classes of fire danger

Assimilation of medium-range forecasts of Nesterov index

Calculation of categories of fire danger in terms "below norm", "near norm", "above norm"

Snow cover satellite data
Decoding, formatting. Interpolation to the coordinates of the 2052 stations located over territory of Russia.

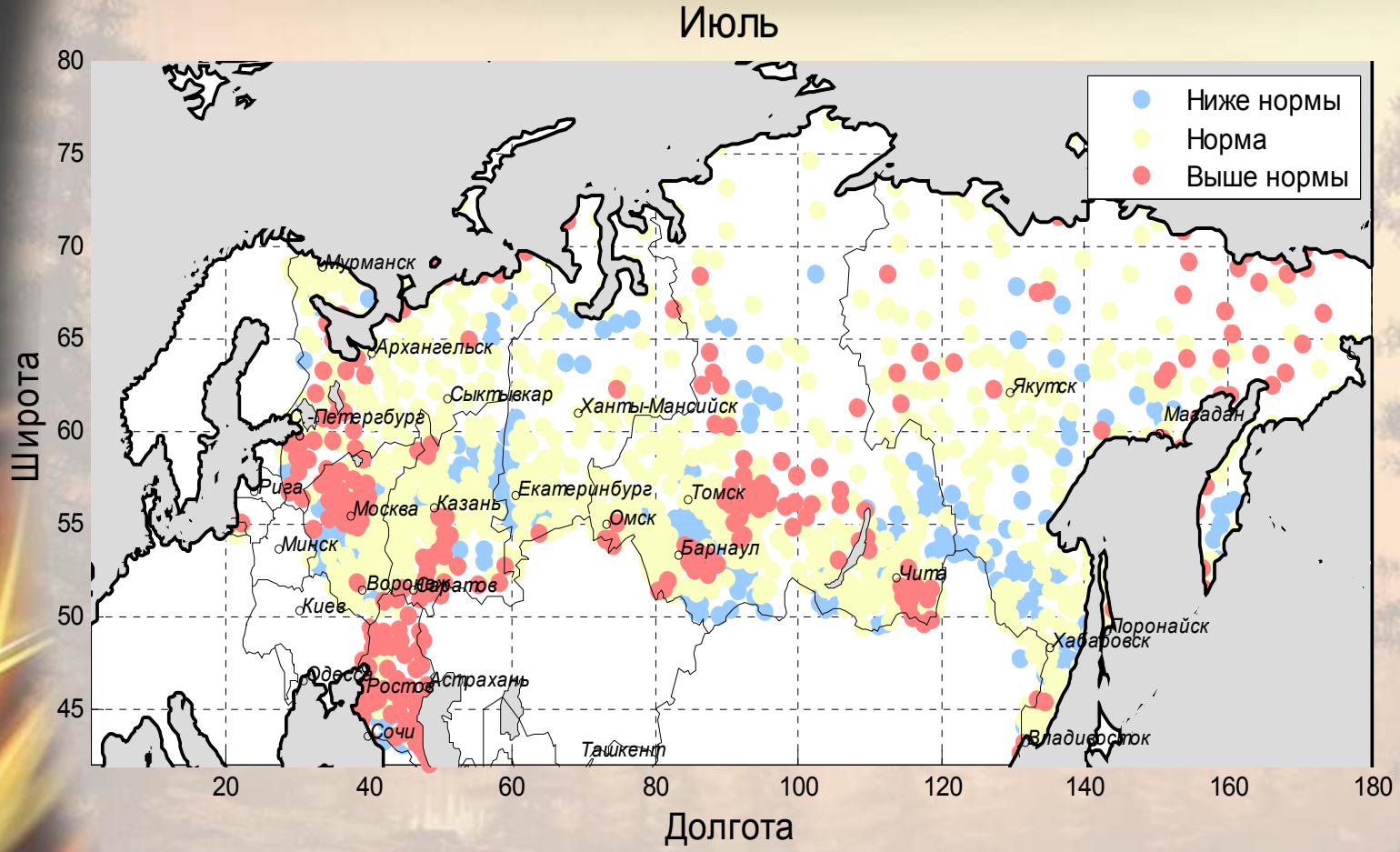
Correction of Nesterov index data with consideration climate snow cover data

Issue of fire danger forecast maps

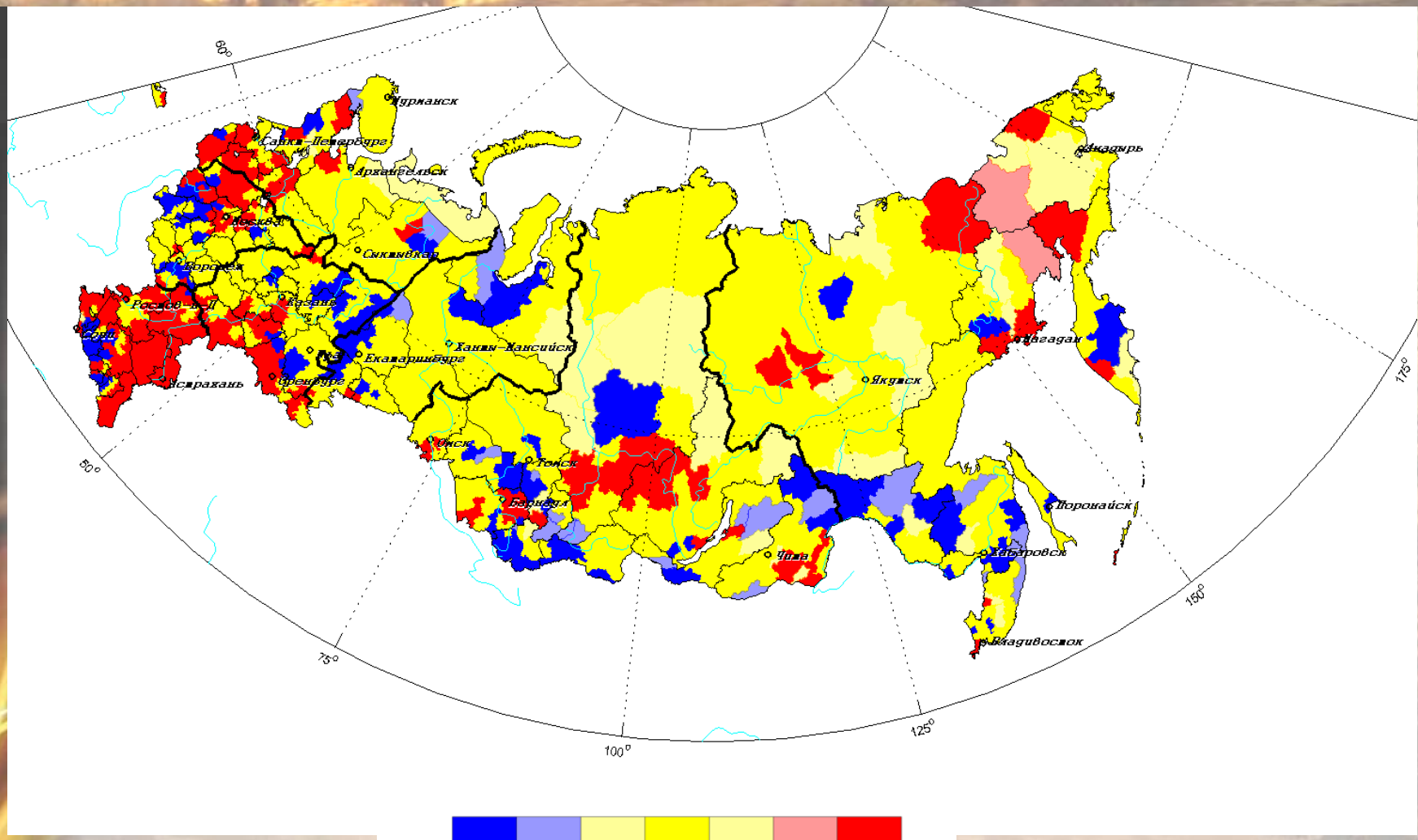
Verification of fire danger for previous month

User driven approach to identify the optimal type of visualization of fire danger forecast maps

Several types of map have been proposed

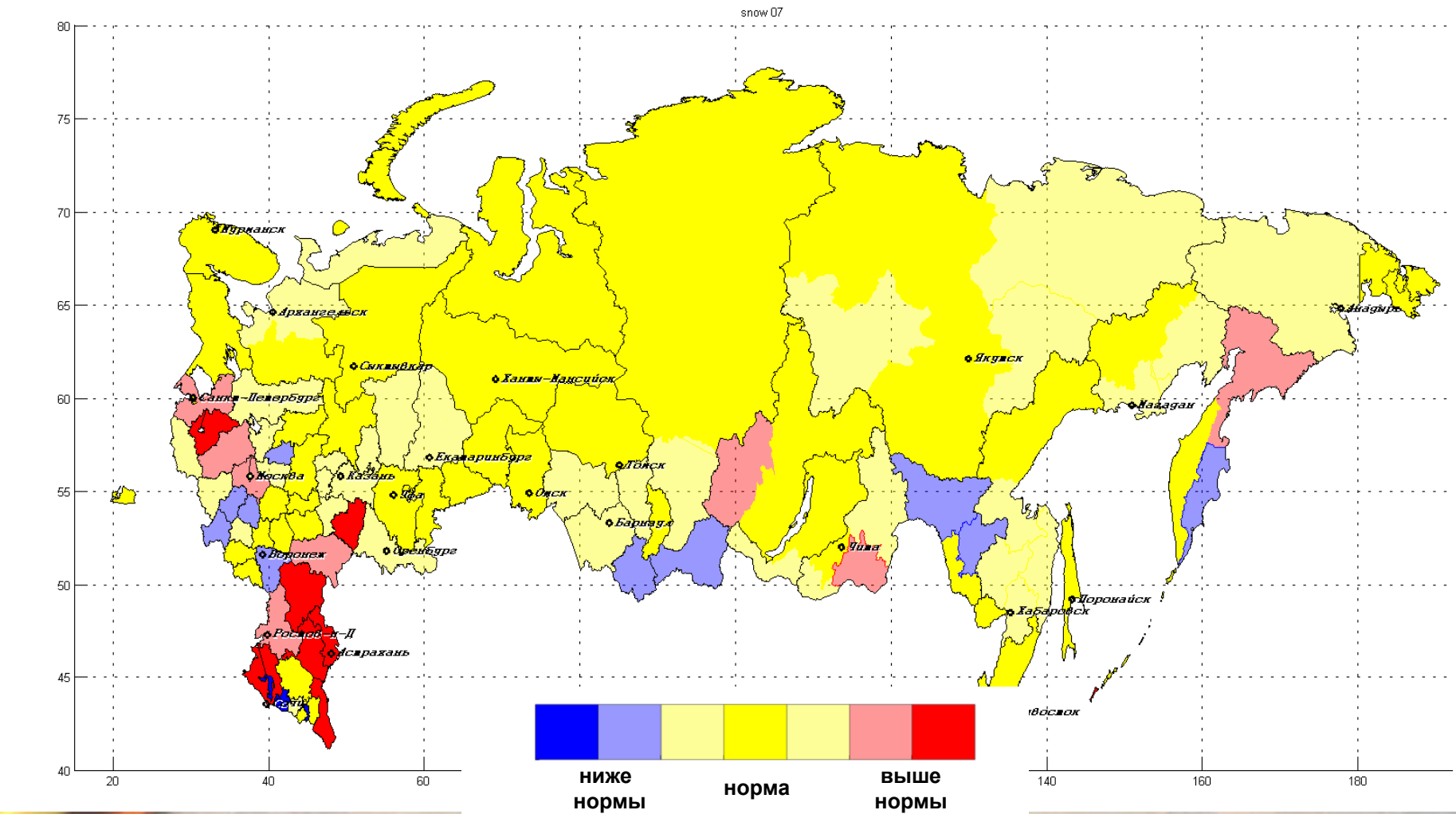


Type of graph visualization 1

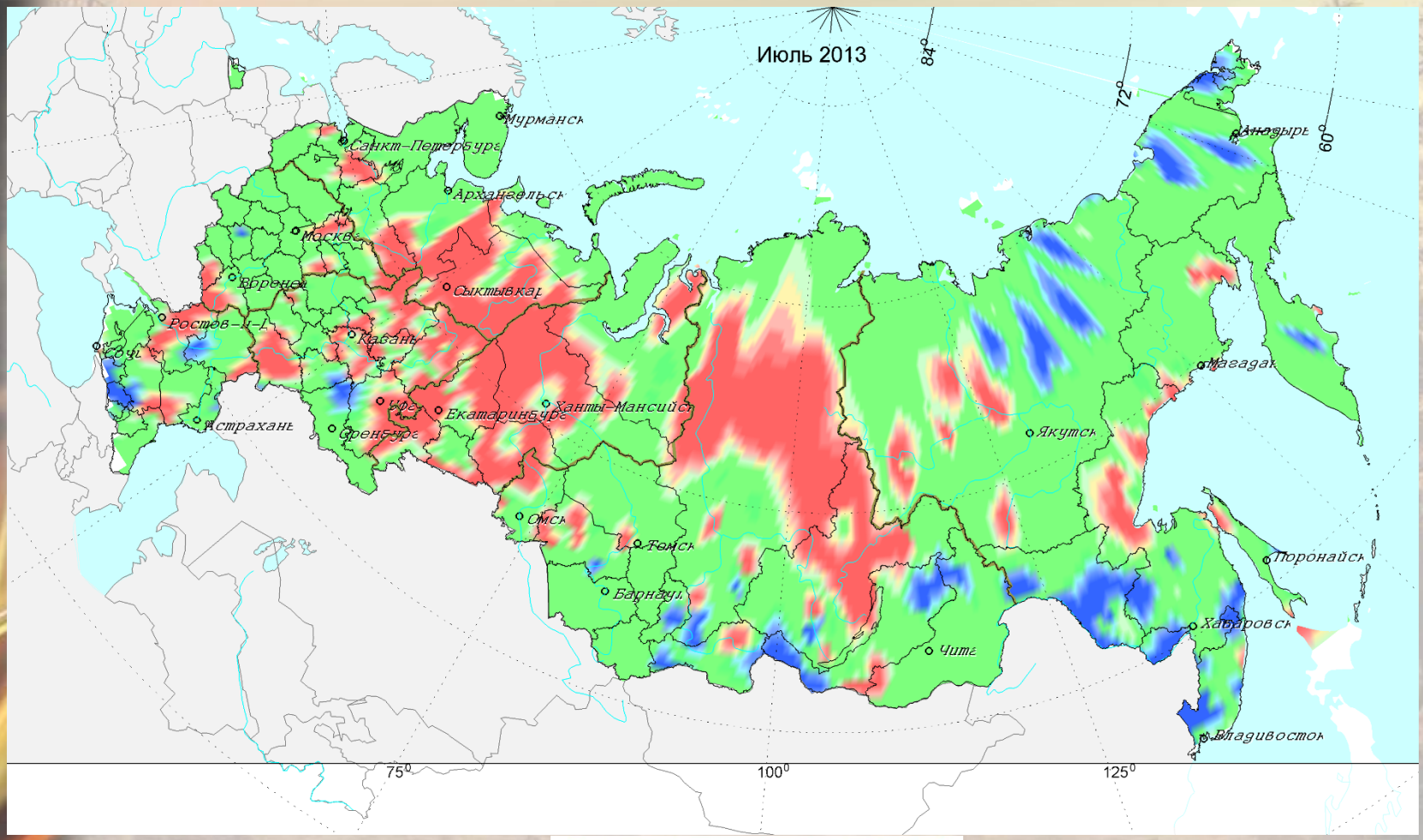


ниже нормы | норма | выше нормы

Type of graph visualization 2

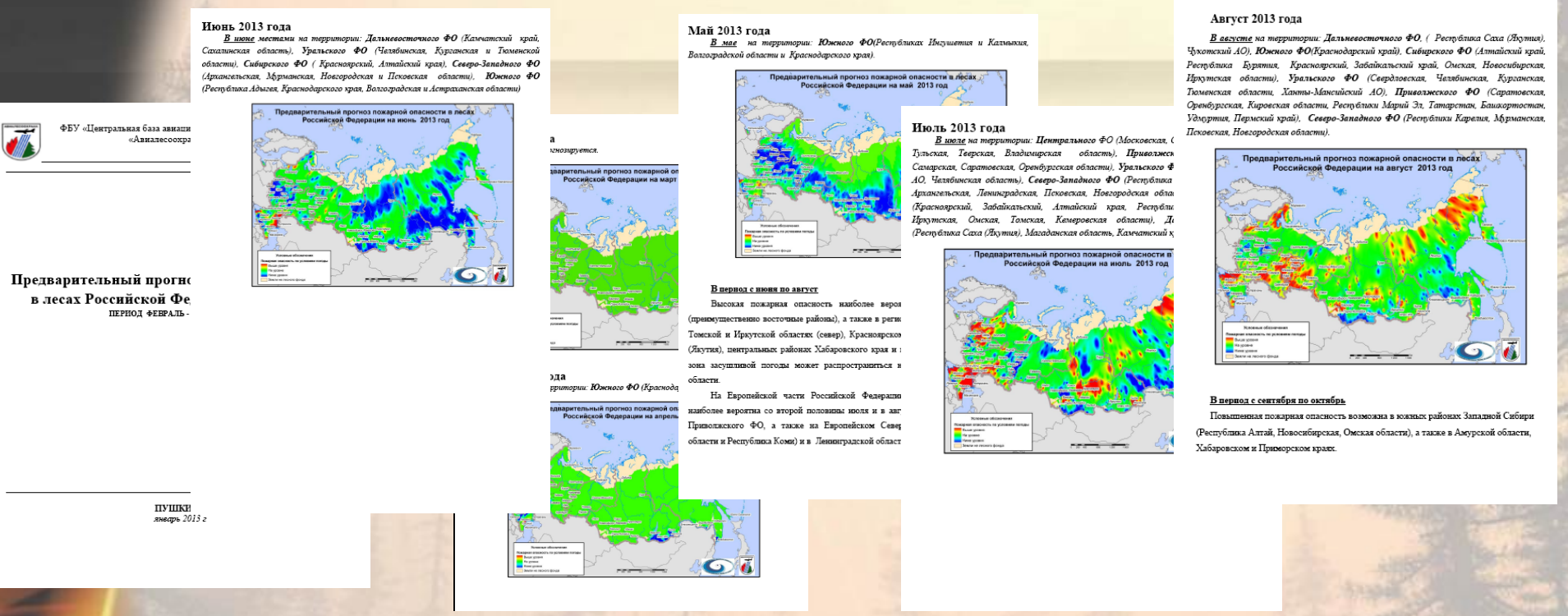


Type of graph visualization 3



Type of graph visualization 4

Examples of fire danger forecast products.
Forest fire danger outlook for 2013 fire season issued in March 2013.



Предварительный прогно
в лесах Российской Фе
ПЕРИОД ФЕВРАЛЬ -

ПУШКИ
январь 2013 г

Июнь 2013 года

В июне местами на территории: Дальневосточного ФО (Камчатский край, Сахалинская область), Уральского ФО (Челябинская, Курганская и Тюменской области), Сибирского ФО (Красноярский, Алтайский края), Северо-Западного ФО (Архангельская, Мурманская, Новгородская и Псковская области), Южного ФО (Республика Адыгея, Краснодарского края, Волгоградская и Астраханская области)

Предварительный прогноз пожарной опасности в лесах Российской Федерации на июнь 2013 год

Предварительный прогноз пожарной оп
Российской Федерации на март

Май 2013 года

В мае на территории: Южного ФО(Республиках Ингушетия и Калмыкия, Волгоградской области и Краснодарского края).

Предварительный прогноз пожарной опасности в лесах Российской Федерации на май 2013 год

В период с июня по август

Высокая пожарная опасность наиболее вероя
(преимущественно восточные районы), а также в регио
Томской и Иркутской областях (север), Красноярско
(Якутия), центральных районах Хабаровского края и
зона засушливой погоды может распространиться в
области.

На Европейской части Российской Федерации
наиболее вероятна со второй половины июля и в авг
Приволжского ФО, а также на Европейском Севе
области и Республика Коми) и в Ленинградской област

Июль 2013 года

В июле на территории: Центрального ФО (Московская, Тульская, Тверская, Владимирская область), Приволжск Самарская, Саратовская, Оренбургская области), Уральского Ф АО, Челябинская область), Северо-Западного ФО (Республика Архангельская, Ленинградская, Псковская, Новгородская обла (Красноярский, Забайкальский, Алтайский края, Республи Иркутская, Омская, Томская, Кемеровская области), Д (Республика Саха (Якутия), Магаданская область, Камчатский к

Предварительный прогноз пожарной опасности в
Российской Федерации на июль 2013 год

Август 2013 года

В августе на территории: Дальневосточного ФО, (Республика Саха (Якутия), Чукотский АО), Южного ФО(Краснодарский край), Сибирского ФО (Алтайский край, Республика Бурятия, Красноярский, Забайкальский край, Омская, Новосибирская, Иркутская области), Уральского ФО (Свердловская, Челябинская, Курганская, Тюменская области, Ханты-Мансийский АО), Приволжского ФО (Саратовская, Оренбургская, Кировская области, Республики Марий Эл, Татарстан, Башкортостан, Удмуртия, Пермский край), Северо-Западного ФО (Республики Карелия, Мурманская, Псковская, Новгородская области).

Предварительный прогноз пожарной опасности в лесах Российской Федерации на август 2013 год

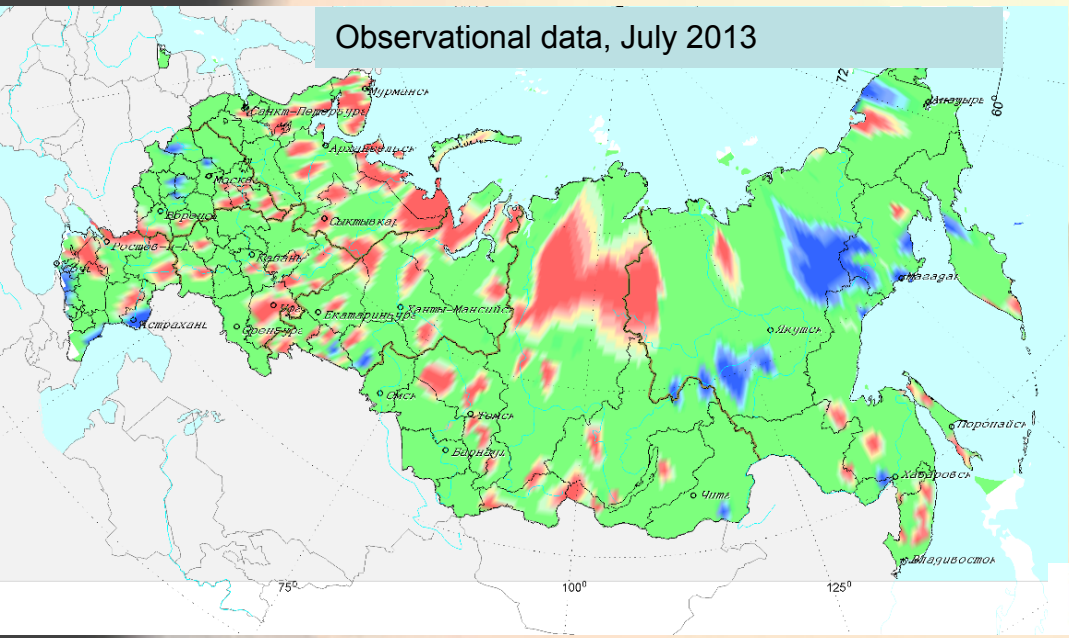
В период с сентября по октябрь

Повышенная пожарная опасность возможна в южных районах Западной Сибири (Республика Алтай, Новосибирская, Омская области), а также в Амурской области, Хабаровском и Приморском краях.

Before the fire season fire danger outlook from 1 to 6 months lead time has been issued.

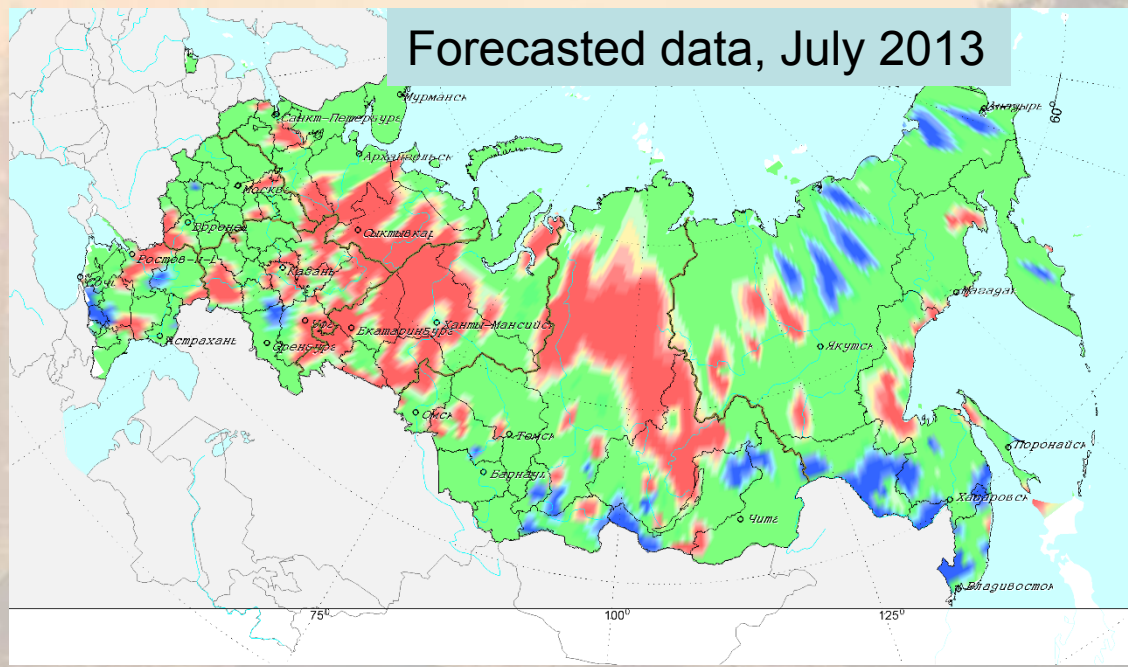
During fire season, monthly forecast maps are generated at the beginning of each month (i.e., April to October).

Observational data, July 2013

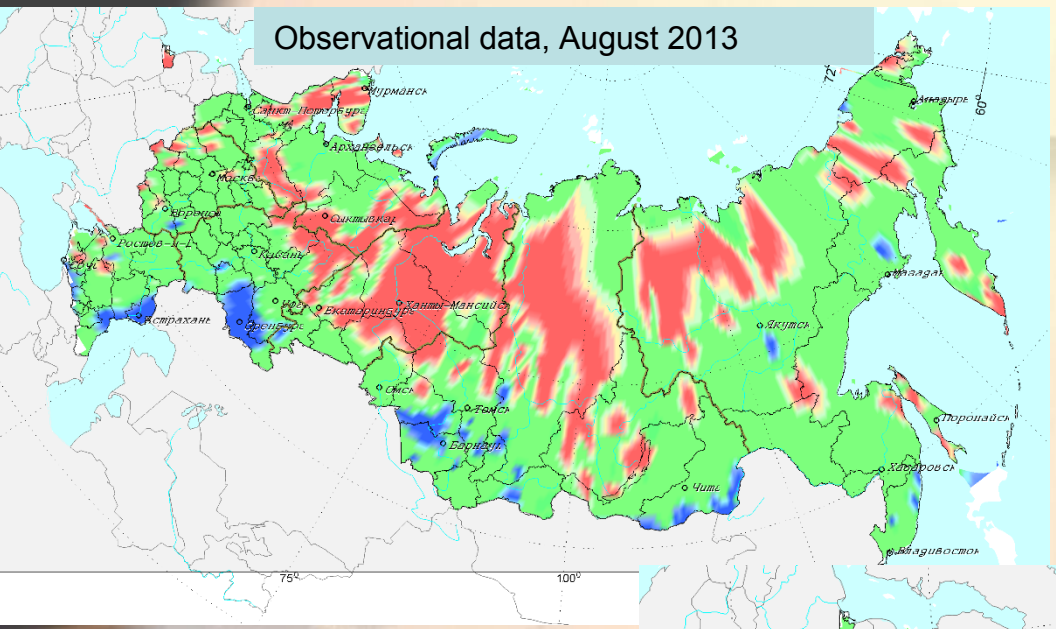


Skill score 74%

Forecasted data, July 2013

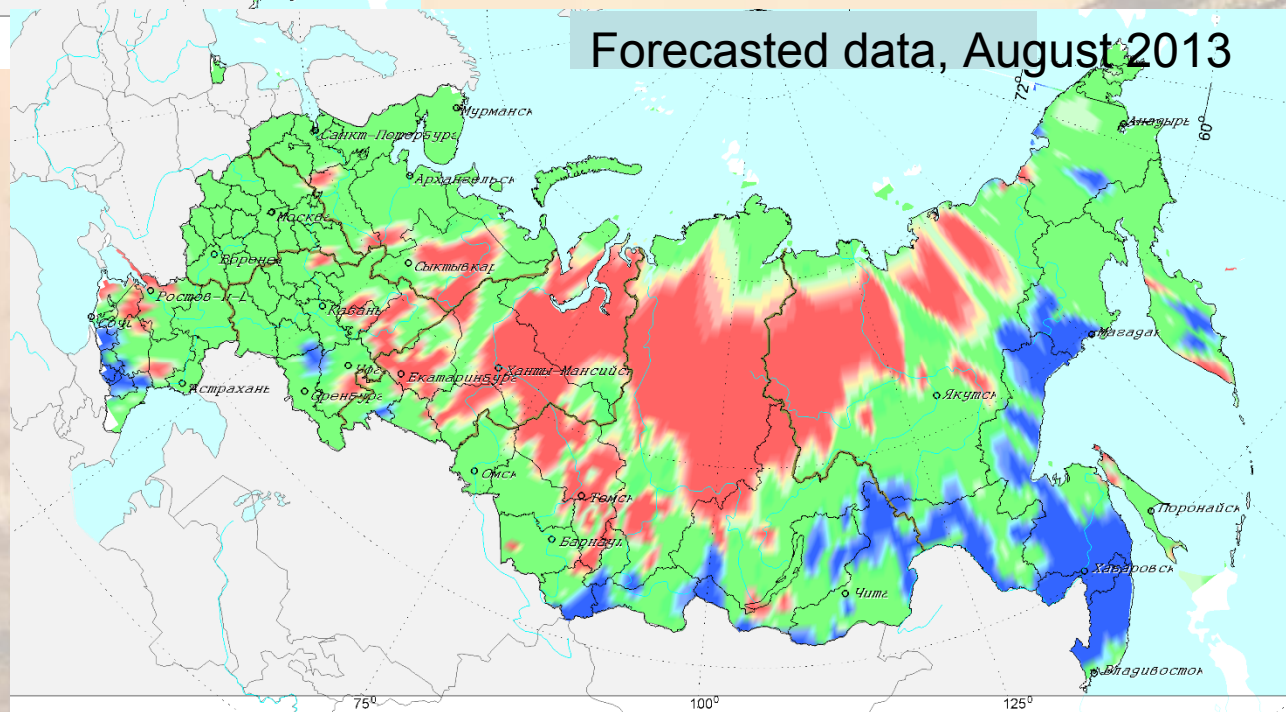


Observational data, August 2013



Skill score 76%

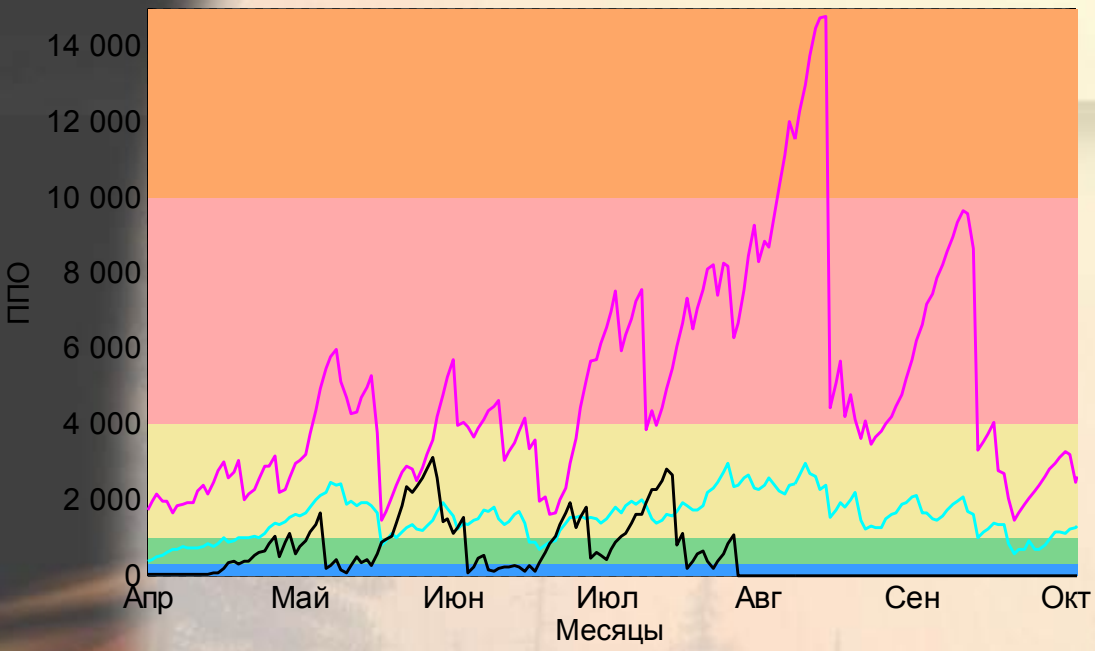
Forecasted data, August 2013

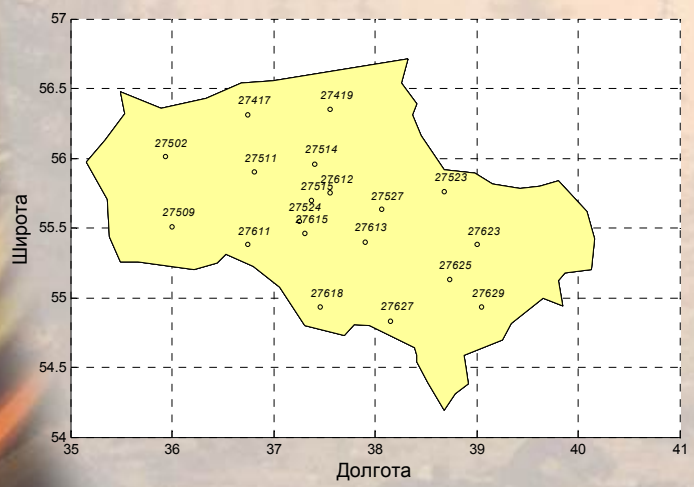


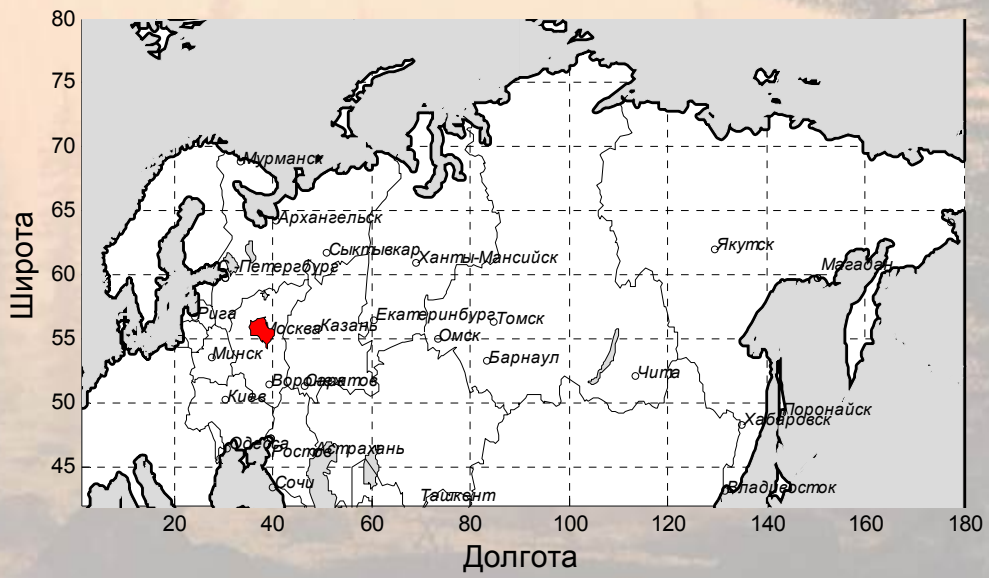
Evaluation of method using hindcast and real data for period (2001-2012 гг)

Month	Number of hits	Number of false	Number of coincidence in adjacent classes	Skill skore of forecast in %
April	1036	56	243	87
May	734	126	475	73
June	573	98	665	69
July	540	114	680	68
August	538	118	679	66
September	605	97	633	69

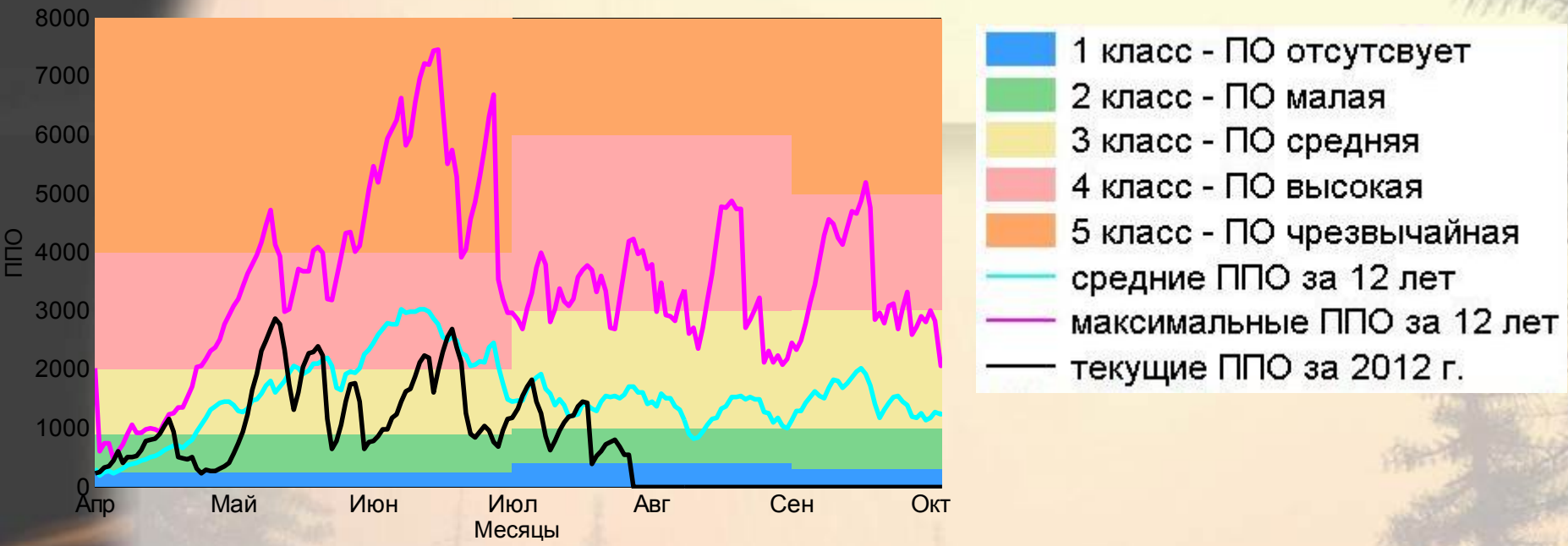
Monitoring of fire danger situation in Moscow region

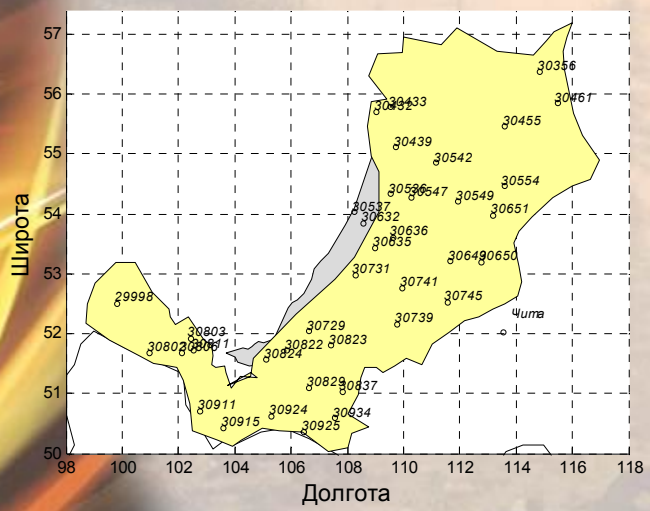


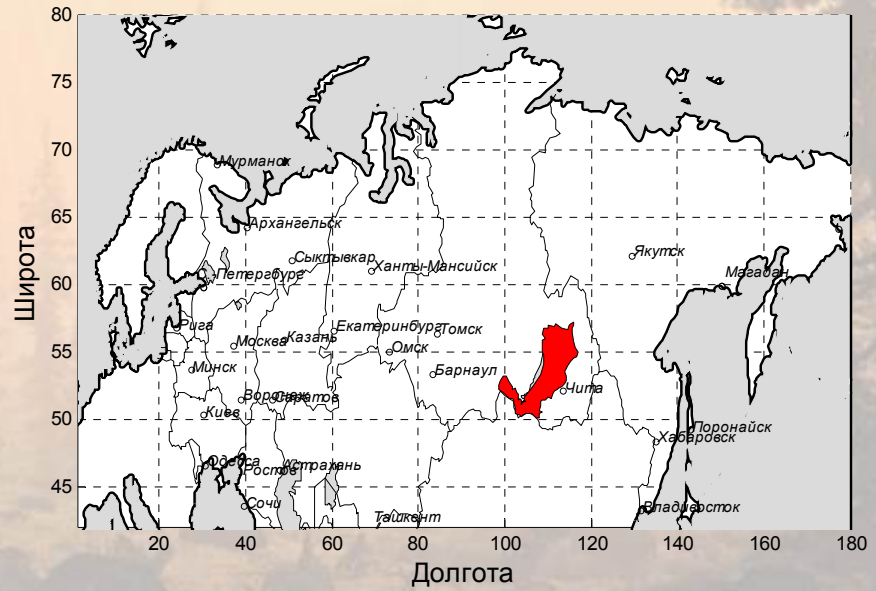




Monitoring of fire danger situation in Buryatiya region







Practical use of outlook of seasonal fire danger forecasts

The prognostic information about forest fire potential is in operational use of Aerial Forest Fire Center

This information is routinely used to

- **outlines an operational plan for the protection of resources from wildfire in different regions of Russia**
- **to assess preparedness levels, fire situation, resources for fire management personnel, incident managers, firefighters and support staff**
- **support resource allocation decisions and determining financial and human resource needs**
- **increase the technical effectiveness of fire protection work by the regions of the Russian Federation;**
- **help in forest fire prevention and mitigation program**

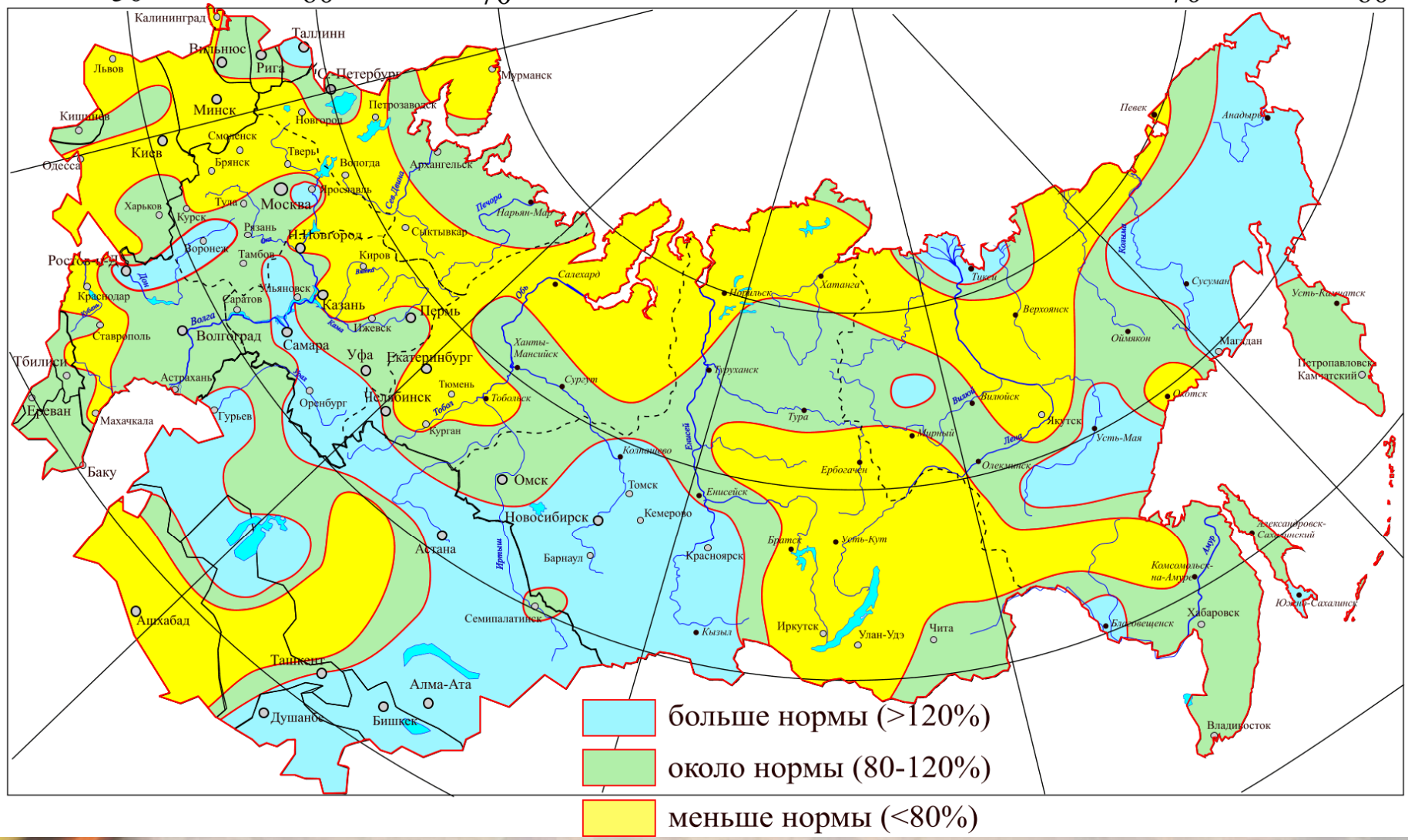
Future work aimed to improve the long-range forest fire danger forecasting

- implement probabilistic form of seasonal prediction of forest fire danger

- extend ensemble spread using additional model data

- synoptical-statistical analysis to understand the regional characteristics of skill scores of fire danger forecasts

Месячная сумма осадков (в % от нормы). Август 2013г.



Месячная сумма осадков (в % от нормы). Июль 2013г.