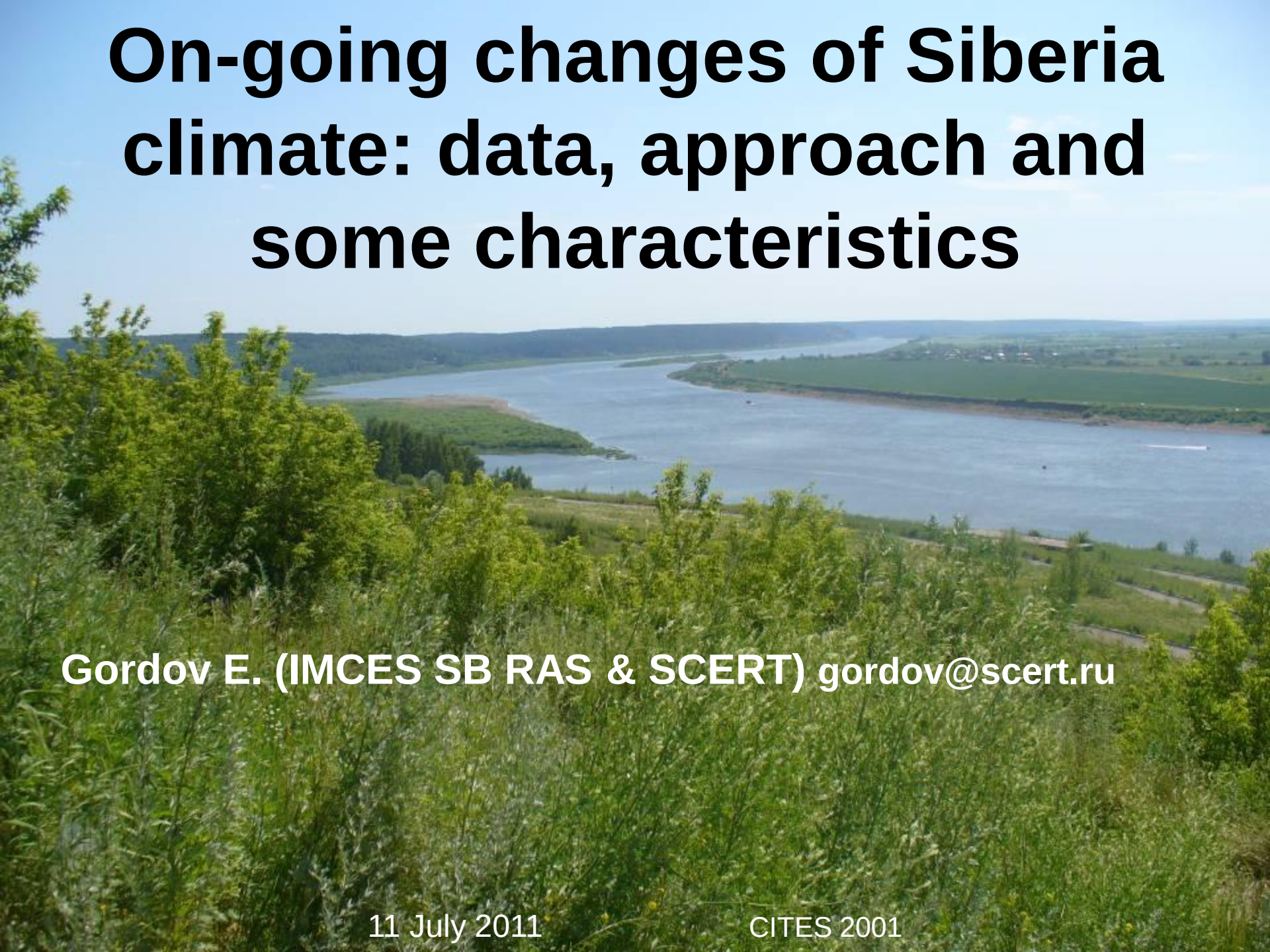
On-going changes of Siberia climate: data, approach and some characteristics



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Outline:

- Framework: SIRS, NEESPI, EU
- Data/ Approach
- Some results
- Conclusions

Siberia Integrated Regional Study: multidisciplinary investigations of the dynamic relationship between the Siberian environment and global climate change

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Journal Environmental Research Letters Create an alert RSS this journal

Issue Volume 5, Number 1

Citation E P Gordov and E A Vaganov 2010 *Environ. Res. Lett.* **5** 015007

doi: 10.1088/1748-9326/5/1/015007

This is an editorial overview of the Siberia Integrated Regional Study (SIRS), which is a large-scale investigation of ongoing and future environmental change in Siberia and its relationship to global processes, approaches, existing challenges and future direction.

Introduction

The SIRS is a mega-project within the Northern Eurasia Earth Science Partnership Initiative (NEESPI), which

Recent developments/perspectives

•SB RAS Presidium decision – contract SB RAS integrated project is promised

•Government RF Megagrant to Pr. Schultze and SFU – new towers (Yenisey transect) and new data on greenhouse gasses

•Russian Climatic Doctrine and RAS and Roshydromet agreement – joint projects (laboratories?) would be appreciated

•July 2011 – new EU FP7 Call Environment & Climate (**ENV.2011.1.1.3-1 Vulnerability of Arctic permafrost to climate change and implications for global GHG emissions and future climate**)

Major regional challenges/risks:

- **Permafrost fate, especially its border shift (serious threats to infrastructure and significant potential carbon source);**
- **Desert - steppe- forest-tundra ecosystems borders shifts (change of region carbon cycle and serious socio-economical consequences for local population; and**
- **Temperature/precipitation/hydrology regime change (increase risks of forest and peat fires leading to enormous carbon release from the region).**

Major potential Global Change drivers:

- **Permafrost fate, especially its border shift (threats to infrastructure and carbon source);**

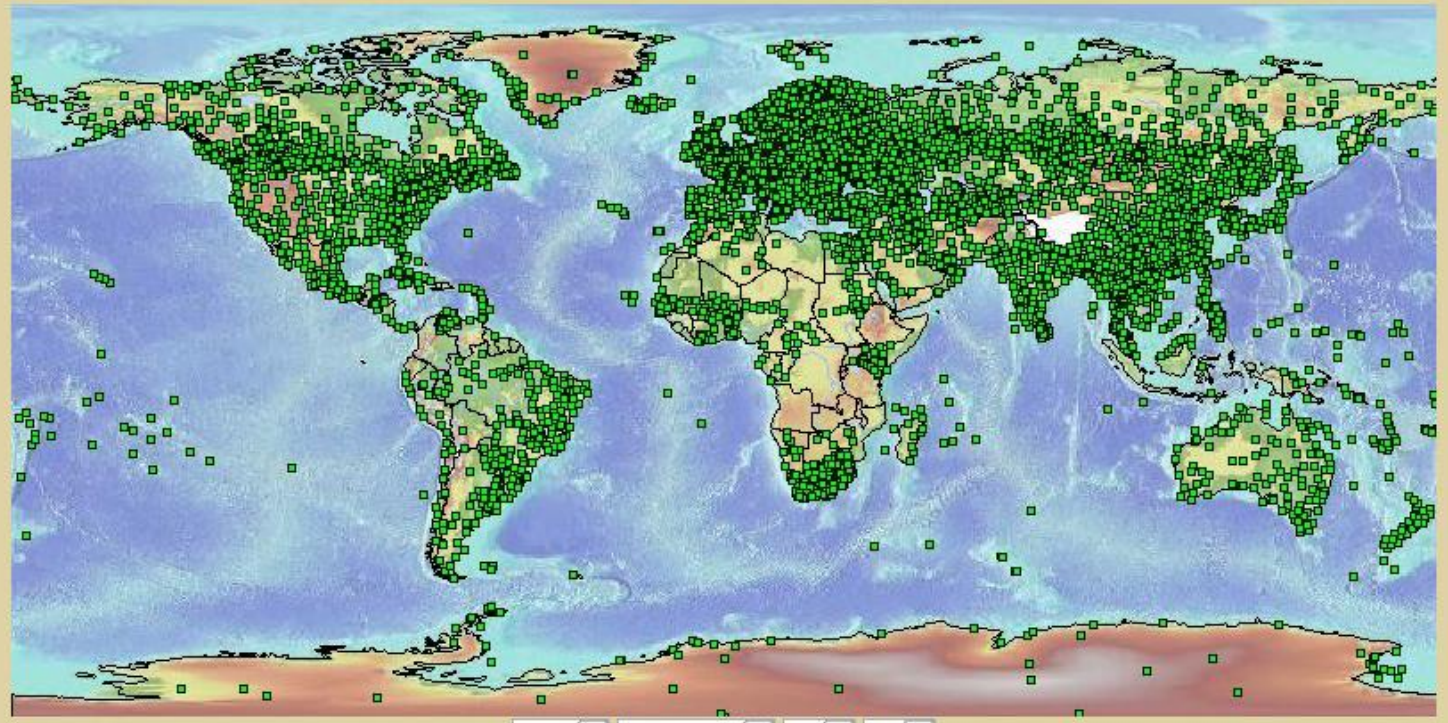
- **Desert - steppe- forest-tundra ecosystems borders shifts (region carbon cycle change and socio-economical consequences; and**

- **Temperature/precipitation/hydrology regime change (increase of forest and peat fires leading to extra carbon release).**

CliWare

Синоптические данные

Количество синоптических сообщений:6060



2011 Июнь 28 00

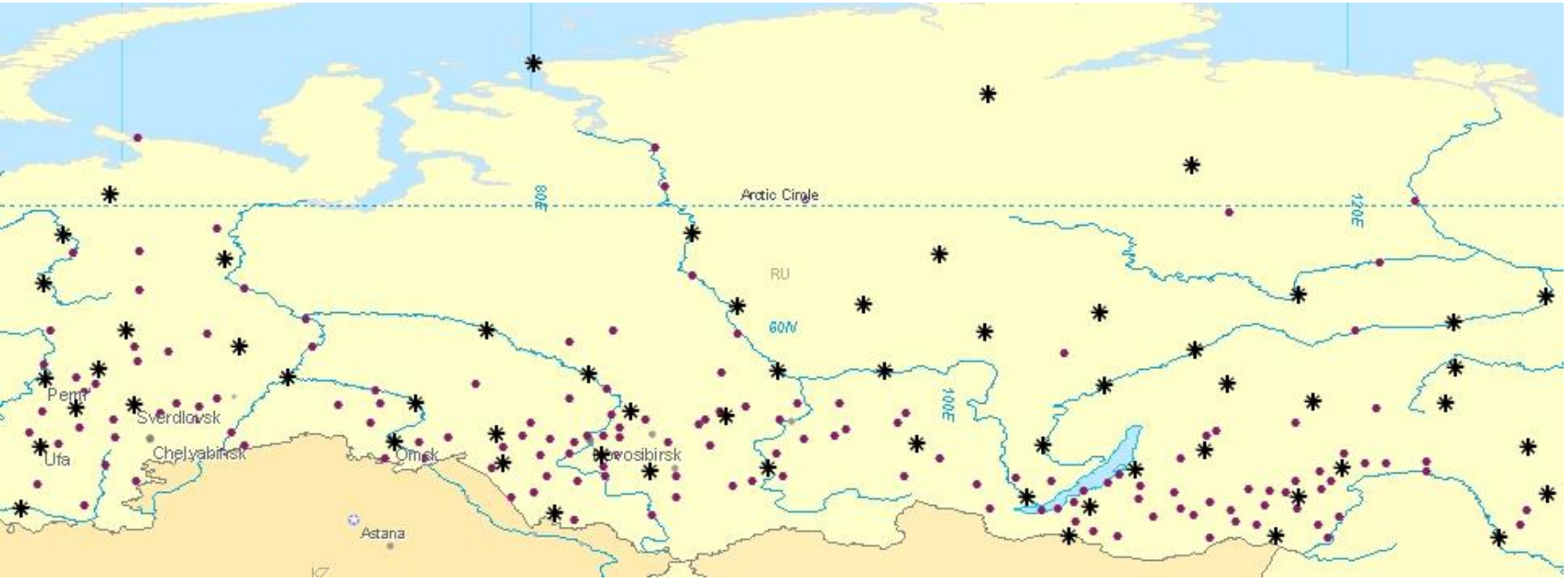
Обновить

Автоматическое обновление (5 мин.)

Weather station data

Network of weather stations in Siberia (archive of NCDC/NOAA Global Synoptic Network).

Near to reliable Weather station data



212 weather stations located in Siberia *"valid" for 1951 – 2000. Asterisks indicate those with continuous surface temperature measurements (T. Shulgina).*

Meteo-fields for Siberia territory obtained by interpolation of these observations are not reliable.

However these data can be used for modeling data sets validation and for regional scale modeling

Modeling data

Reanalysis	Organization	Period covered	Temporal and spatial resolution	Data assimilation used
NCEP/NCAR Reanalysis	NCEP/NCAR	1950–2001	2T: 00, 12 h 2.5°×2.5°	3D-Var
NCEP/DOE AMIP II	NCEP/DOE	1979–2003	4T:00,06,12,18h 2.5°×2.5°	3D-Var
ECMWF ERA-40	ECMWF	1957-2002	4T:00,06,12,18h 2.5°×2.5°	3D-Var
ECMWF ERA INTERIM	ECMWF	1989–2010	4T:00,06,12,18h 0.25°×0.25°	4D-Var
JRA-25	JMA/CRIEPI	1979-2009	4T:00,06,12,18h 2.5°×2.5°	3D-Var

Temperature

Analysis shows that ECMWF ERA-40 dataset the most closely describes temperature regime in Siberia (the homogeneity hypothesis is accepted at 5% probability of error).

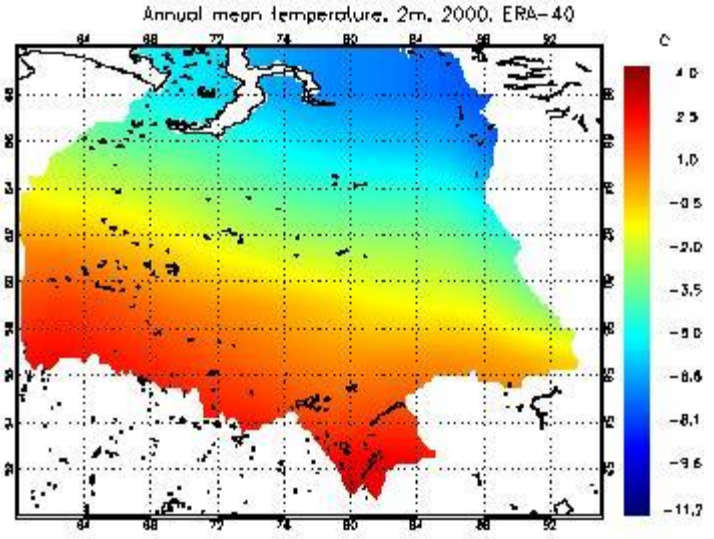
Precipitation

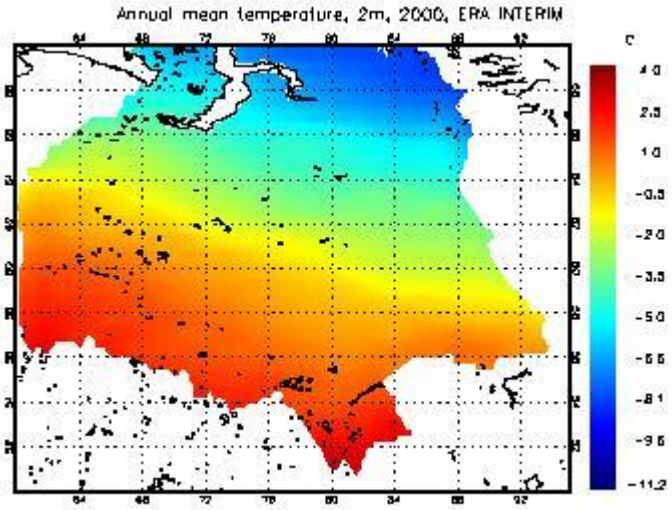
Comparison of precipitation fields calculated on the basis of ECMWF ERA INTERIM (advanced model calculations), and APHRODITE JMA (interpolation of weather station observations), has shown essential distinctions between these datasets.

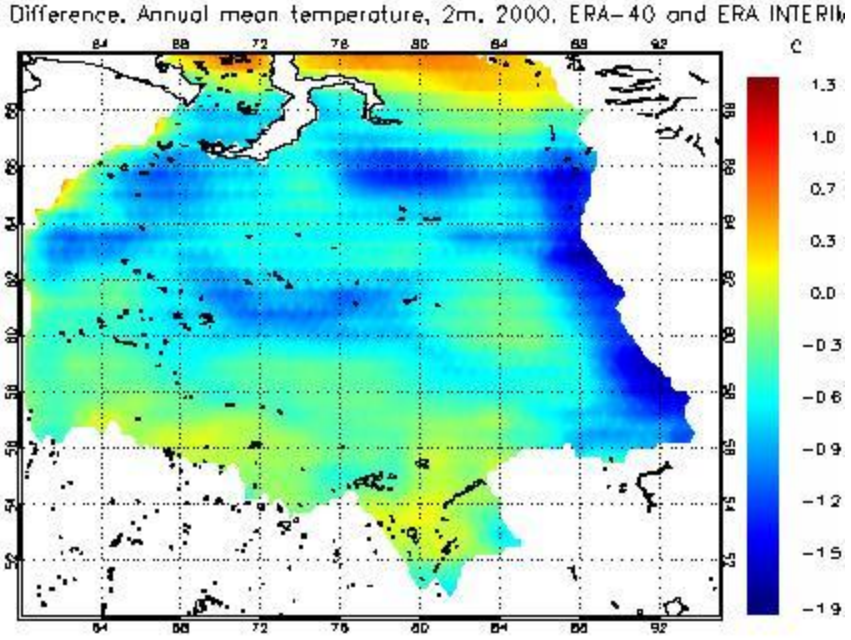
Thus, to study precipitation dynamics in Siberia, observation series from 62 weather stations and APHRODITE JMA dataset for 1958 – 2000 are selected.

New Reanalysis – new opportunities (resolution)/problems (size)

Comparison ERA-40 and ERA Interim annual mean temperature



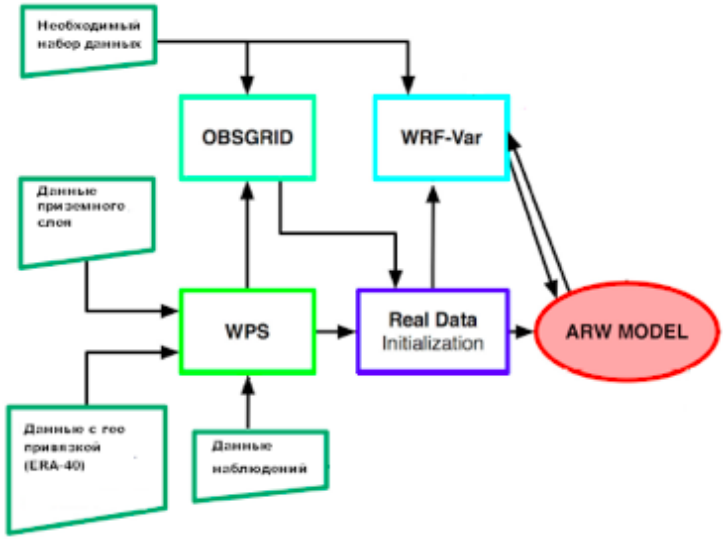




Way to reliable high resolution regional meteofields:
based on mesoscale meteorological model downscaling (station data assimilation is required !)

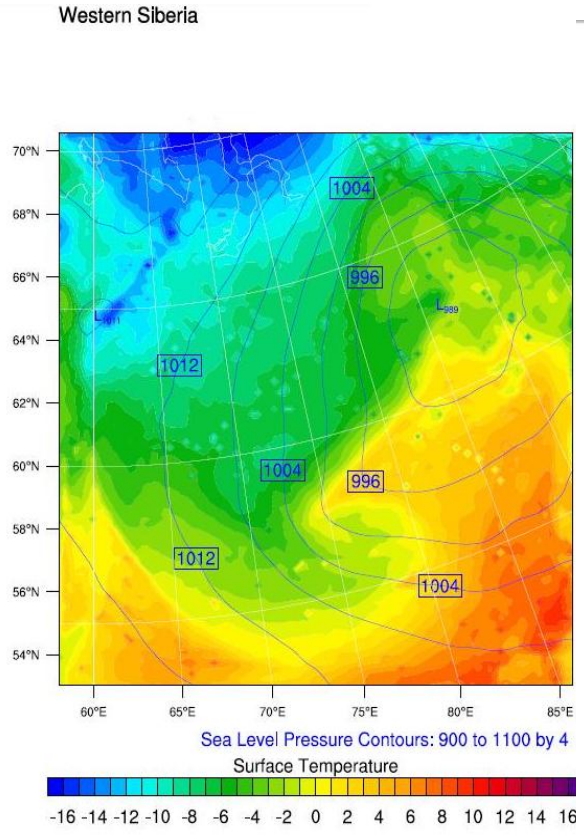
WRF ARW 3.1 and WRF FDDA system to generate a prototype of “Siberian” Reanalysis (will be near 15 Tb) (V. Bogomolov)

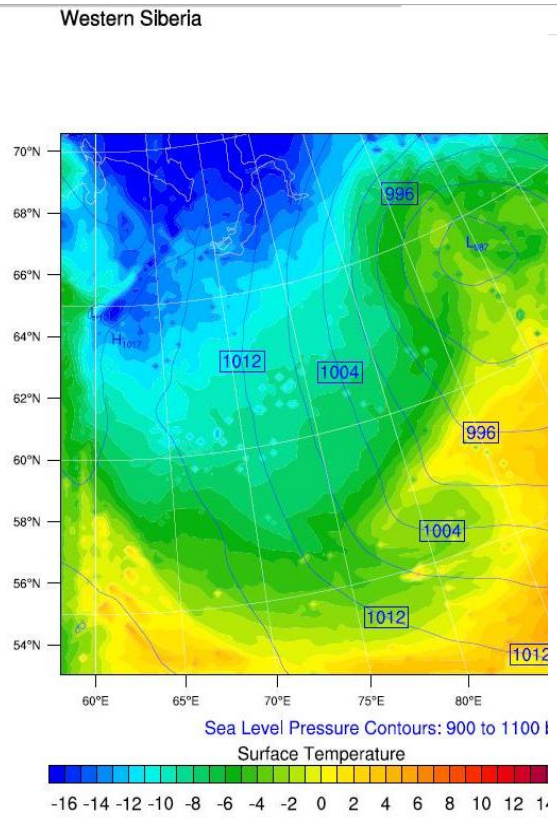
First step
West Siberia (N-S 2500 km; W-E 2000 km), resolution 20 – 10 km;
Measurements from weather stations are assimilated;
Boundaries from ERA-40, skin temperature ERA Interim;
USGS LULC map (9,925 km, 24 land use types)

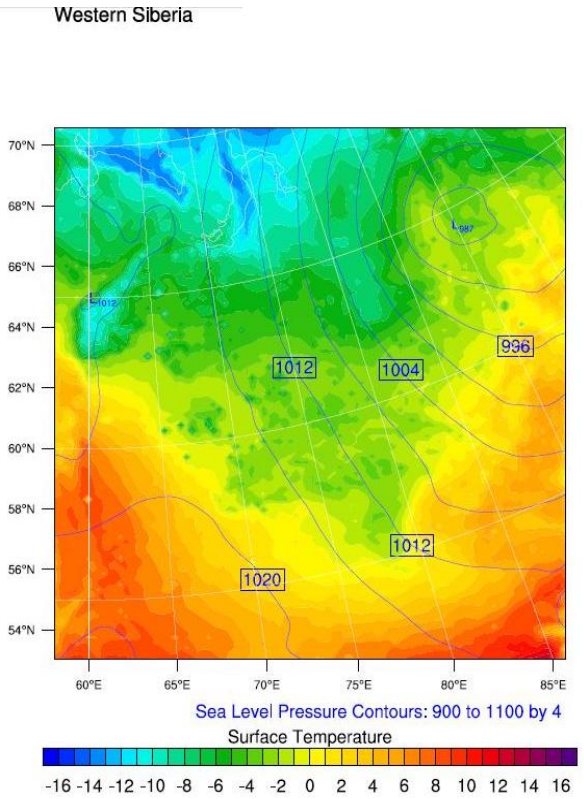


IMCES SB RAS with cooperation of SibNIGMI and HydrometCenter

Examples of calculated fields







2 meter temperature from 6 PM November 1, 1990, with time step 6 hours

Way to reliable high resolution regional meteofields:
based on mesoscale meteorological model downscaling

RCC MSU mesoscale model (V.Stepanenko) might be used as well

Positives:
Tested in applications for Siberia:
Atmosphere dynamics;
Surface model (soil, hydrology, snow, permafrost)

Meteodata assimilasion?

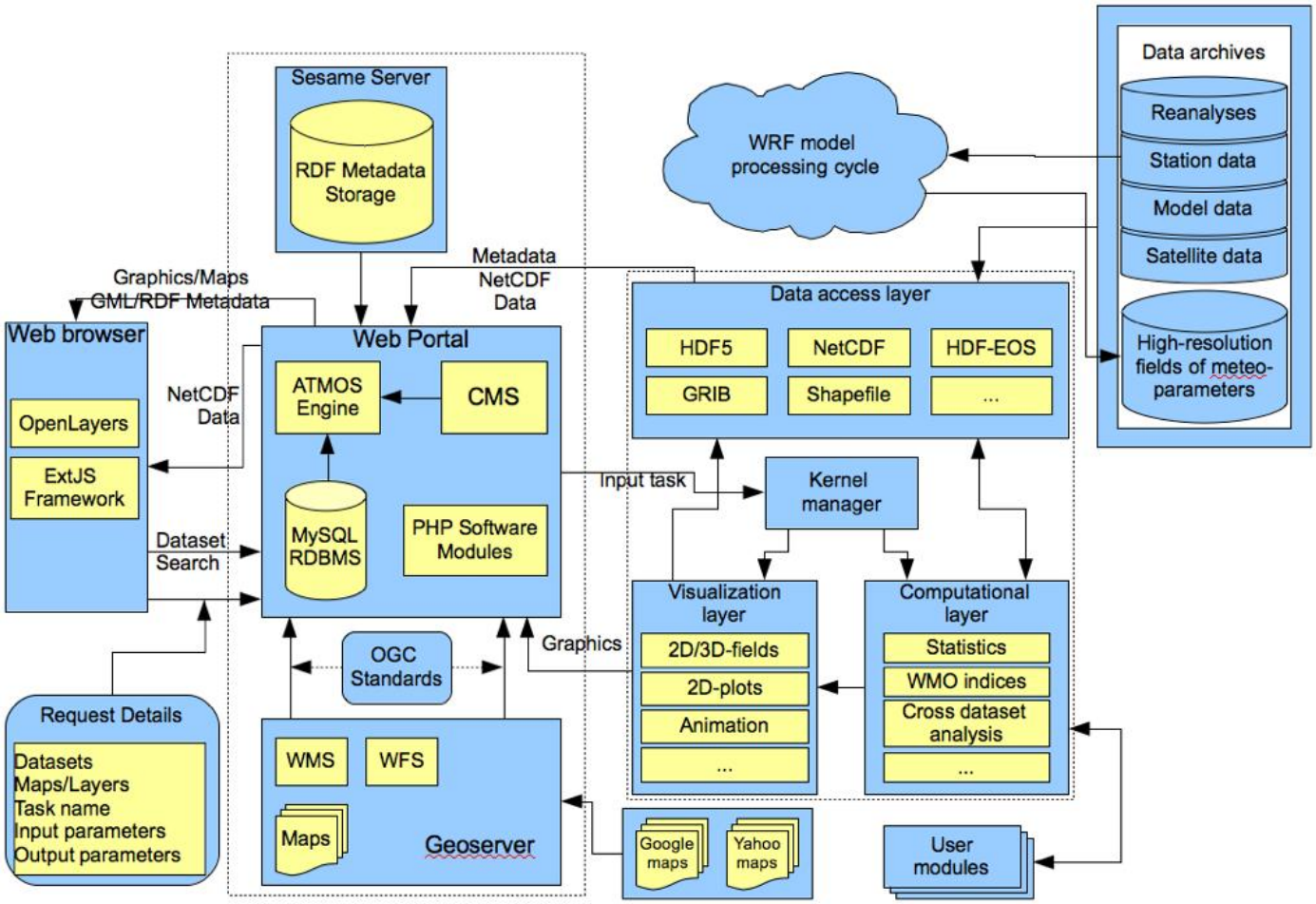
"Siberian"/"Russian" Reanalysis: a task for joint RAS and Roshydromet activity

Approach to deal with huge data arrays: web - GIS Information-computational system

- Unified set of archives of geophysical data (NetCDF/HDF5) on high-performance storage
- High-speed access
- Algorithms for searching and accessing the data (metadata search and retrieval)
- Extensible modular computational core with verified algorithms for data processing , user modules support
- Unified user-friendly interface supplied with well-commented climate science guide

ICS CLIMATE scheme

I. Okladnikov, A. Titov

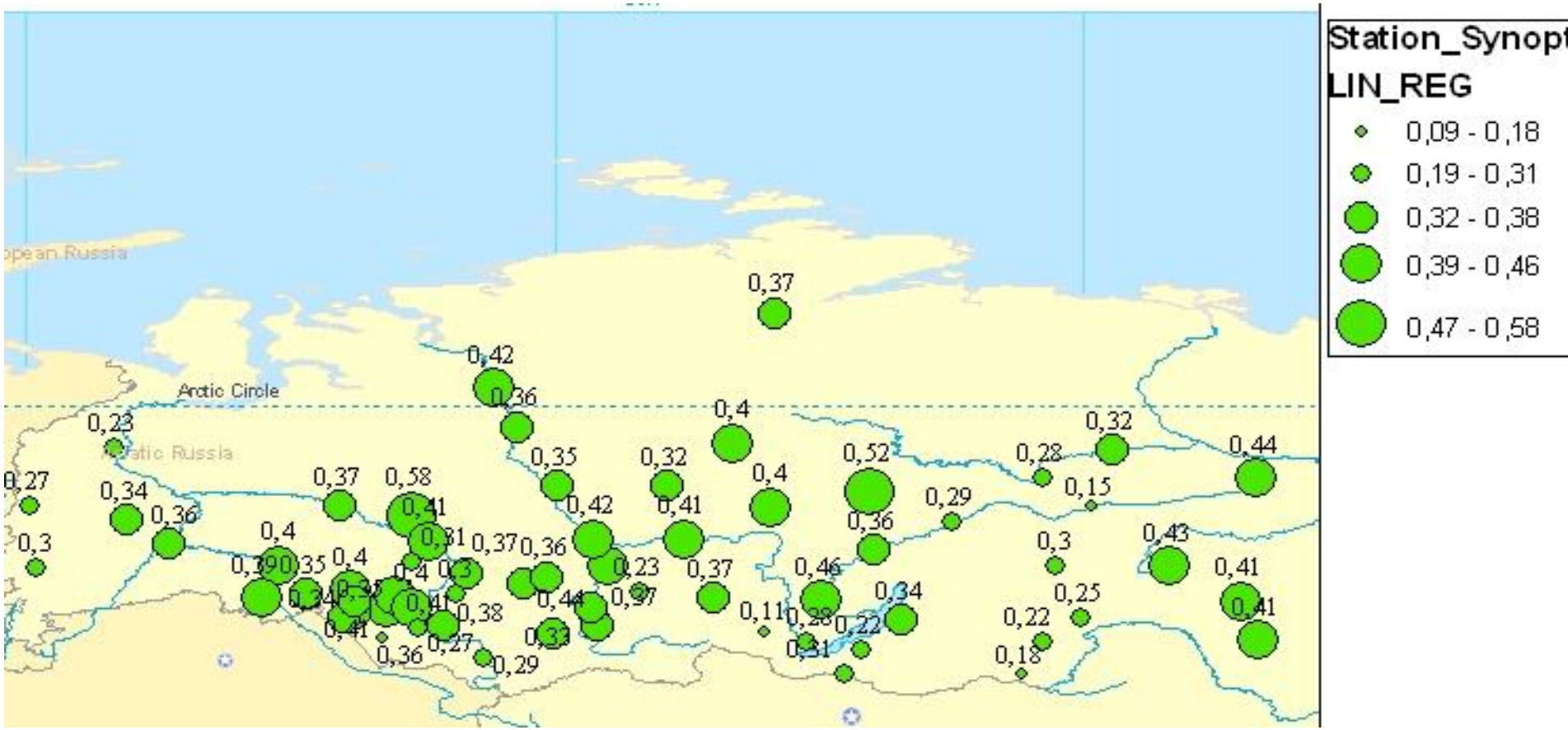


Some illustrations

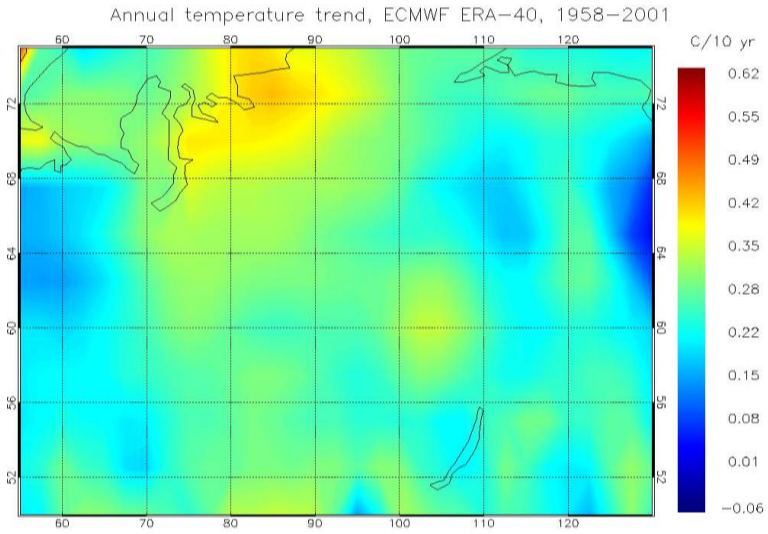
Calculations are done using computational module of an information-computational web-GIS system. The system allows user to perform an interactive analysis and visualization of results without preliminary data downloading and preparation. Besides visualization, calculation results are saved in special archive (files of the preset format which are suitable for further analysis).

Stations (1958 – 2009)

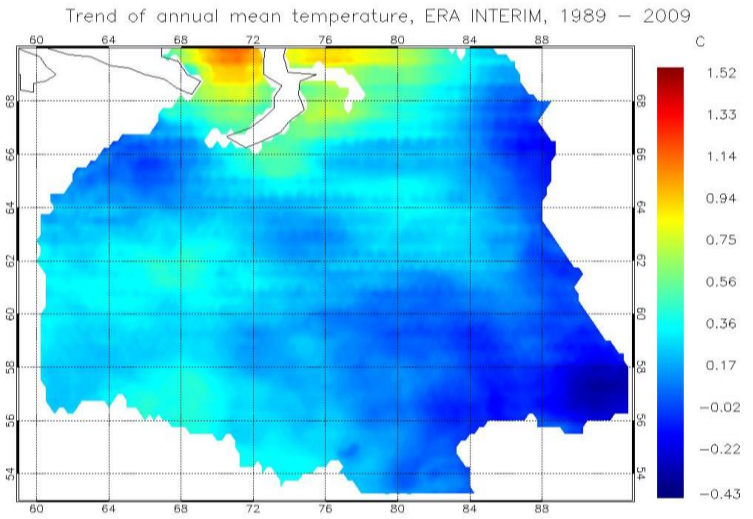
Annual and seasonal mean linear trends grow from 0,3 to 0,5 oC/10 years;
For Southern part of West Siberia 0,4 oC/10 year, for South of East Siberia trend is below a 0,3 oC/10 years.



Reanalysis



Annual mean temperature trend for 1958 – 2001 (ERA-40)



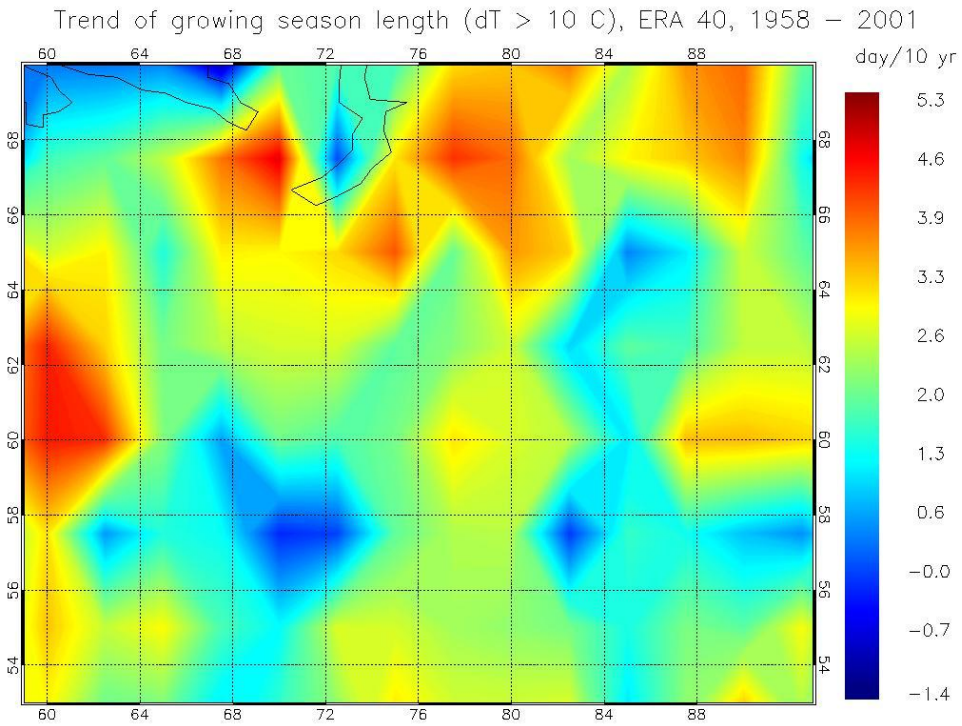
Annual mean temperature trend for 1989 – 2009 (ERA INTERIM)

ERA-40 (1958 - 2001) dataset revealed positive annual mean temperature trend (from 0.18 to 0,18 – 0,42 °C/10 years) with the most pronounced warming in the Northern regions of Siberia (0.3 – 0.42°C/10 years). As a whole, warming is the most pronounced in winter (0.5 – 0.75 °C/10 years) and in spring (0.5 – 0.6 °C/10 years).

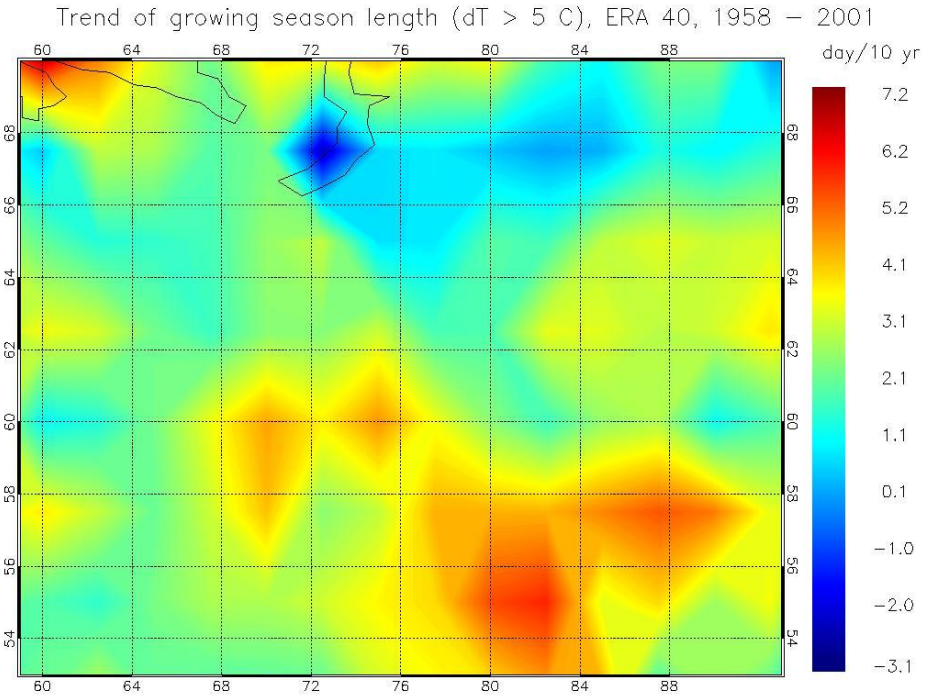
ERA INTERIM dataset has shown more inhomogeneous pattern of temperature increase (0.25 – 0.55 °C/10 years) in the Northern and Western parts of West Siberia and its' decrease (up to –0.4 °C/10 years) in the south-east for 1989–2009.

Accelerated warming of the Northern part exists during the whole analyzed period

Dynamics of growth season length when daily mean temperature is above 5 °C (left panel) and 10 °C (right panel) calculated on the basis of ERA-40 Reanalysis dataset for 1958 – 2002. Moderate increase in growth season length (2-4 days per 10 years, in average) is seen in the both cases.



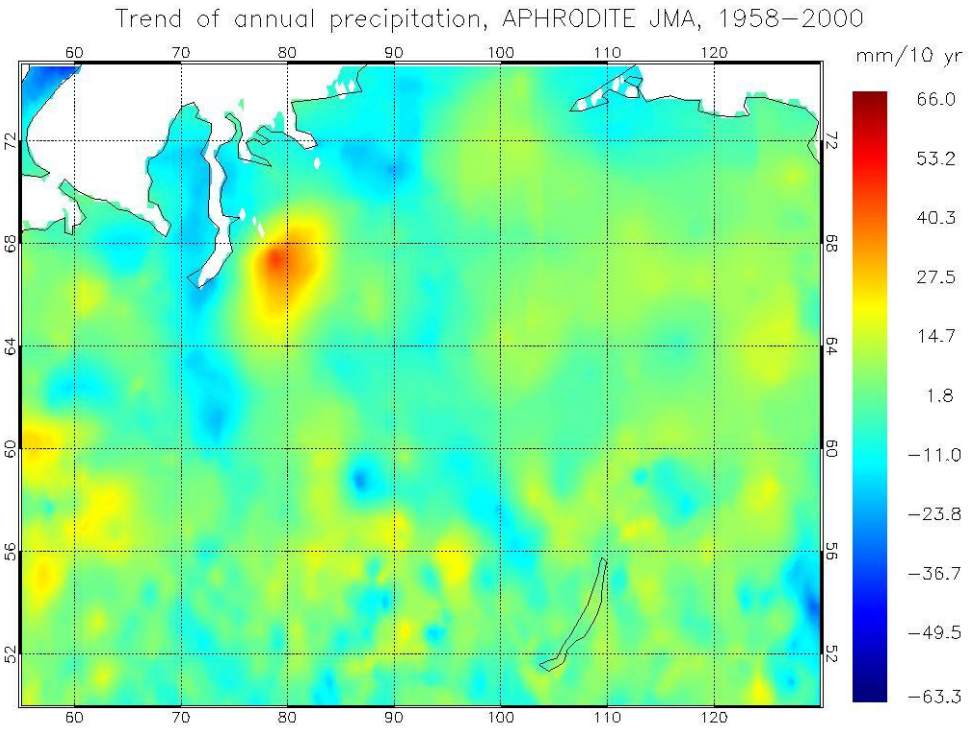
Trend of growth season length with daily mean temperature > 5 °C.



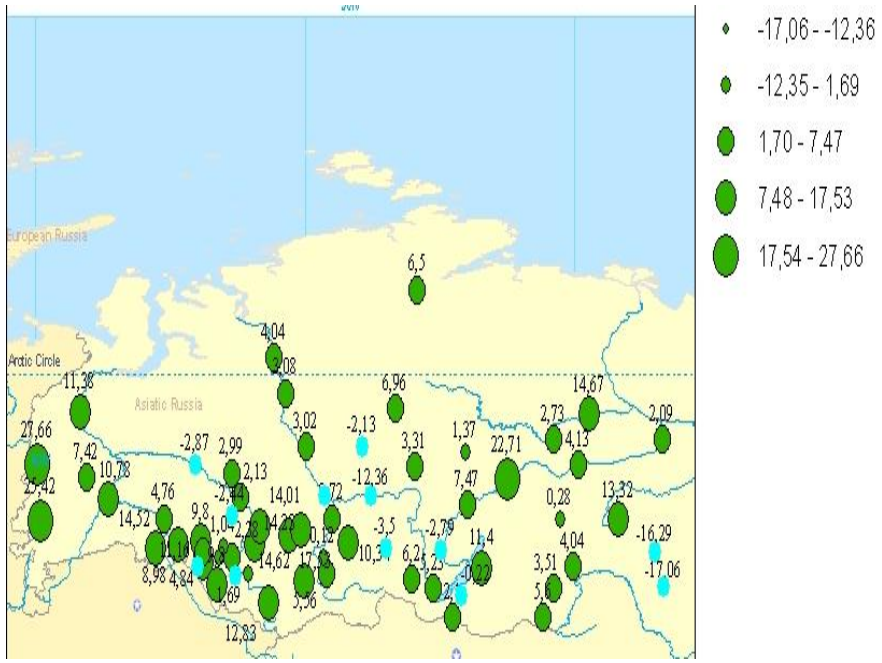
Trend of growth season length with daily mean temperature > 10 °C.

Trend of annual total precipitation varies within –11 mm/10 years and 16 mm/10years. Increase in total precipitation in the North of Siberia (left panel) equals to 30 mm/10 years mainly due to winter (November – April, up to 27.3 mm/10 years) and the second half of warm season (August – October, up to 15 mm/10 years) precipitation.

Weather stations present similar pattern. Total precipitation decreases in the central part of Siberia (12 stations, marked with blue color), while other stations present positive trend reaching 17 mm/ 10 years.



Trend of annual total precipitation.
APHRODITE JMA dataset.



Trend of annual total precipitation.
Observations of 62 weather stations.

Conclusions

- Available data sources are analyzed and compared with instrumental measurements
- Program of regional Reanalysis is started, which should yield in archive of reliable meteorological fields for the region
- Approach to deal with growing volumes of regional data is elaborated and instruments for verified analysis of those are developed
- Analysis performed confirmed reported earlier tendencies of regional climate dynamics and significantly improve the both, localization and level of heterogeneity of recent climatic characteristics changes
- An input into story of on-going Siberia climate change is done in a form of relevant climatic characteristics archive ready for use in thematic applications (vegetation productivity dynamics, carbon,.

Thank you for attention!