

Assessment of change of synoptical situations and meteorological conditions associated with catastrophic floods in the mouth of rivers in the European part of Russia in Future Climate



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Purposes

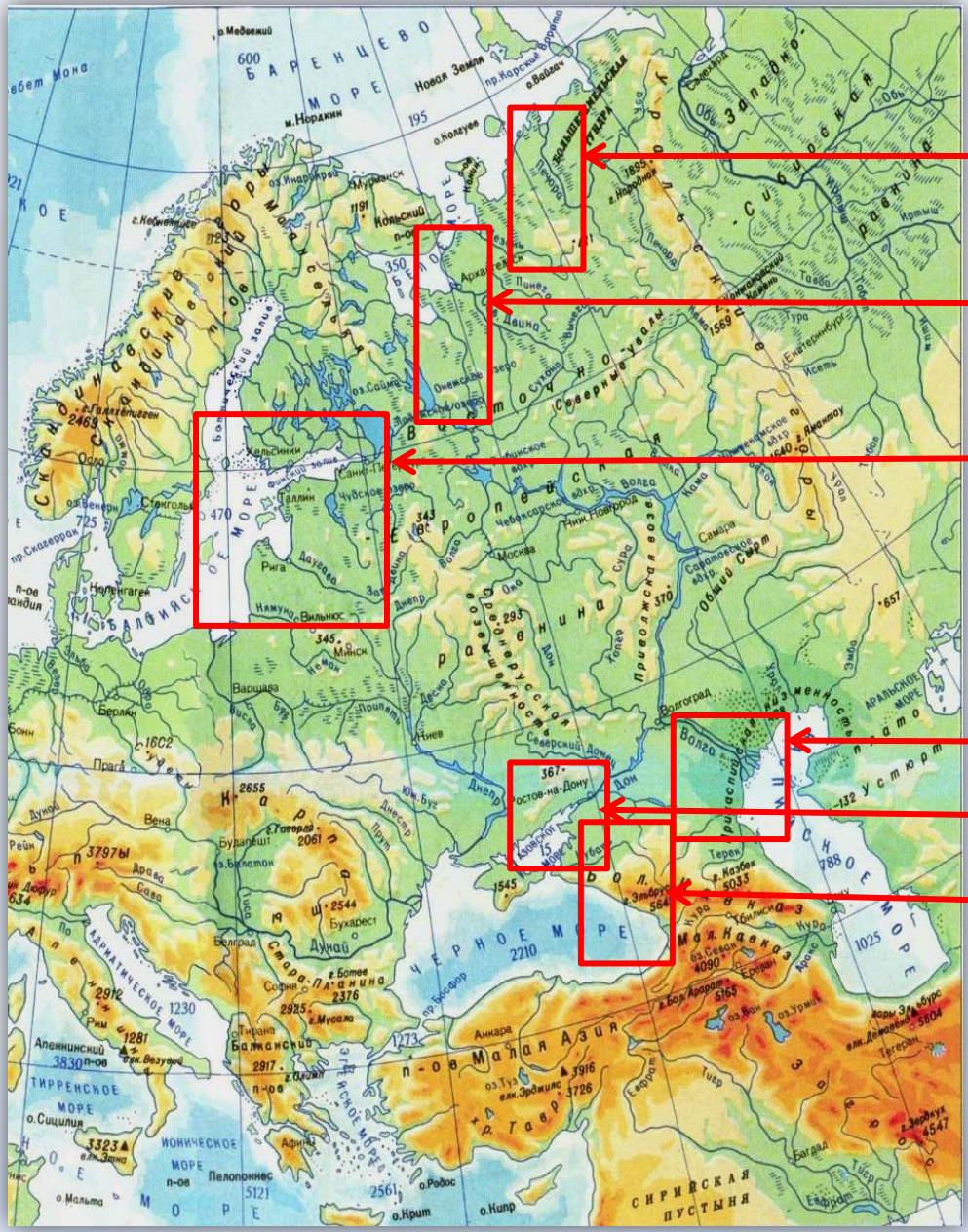
- **Classify** synoptic situations associated with various types of floods
- **Assessment** the changes of synoptic conditions favorable for inundations in a Future Climate

The synoptic situations associated with the various type of floods in the mouth of rivers in European part of Russia are described. The **storm surges**, **water flows** and **ice-jams** are considered for Baltic sea, Barents sea, White sea, Azov sea, Black sea and Caspian sea regions. It is shown that the specific types of flood may be associated to various synoptic situations. Therefore it is unlikely to introduce the classification of synoptic regimes resulting in specific type of floods. However for each zone and for each specific flood type it is possible to determine the potential predictors of inundation: i.e. meteorological parameters that characterize all cases of specific flood.

Data

- **Map Maker GIS-Meteo system**
- **NCEP/NCAR Reanalysis**
- **Archive of meteorological observations**
- **GPCP daily precipitation data**
- **GCM ECHAM5/OM (1961-2000, 2046-2065)**
- **Storm-tracking (P.P. Shirshov Institute of Oceanology RAS, Moscow, Russia)**

Sea areas



Barents
White
Baltic
Caspian
Azov
Black

Coastal regions

- Pechora river
- Northern Dvina river
- Pregolya river
- Neva river
- Kuban river
- Don river
- Kalmykia

Method

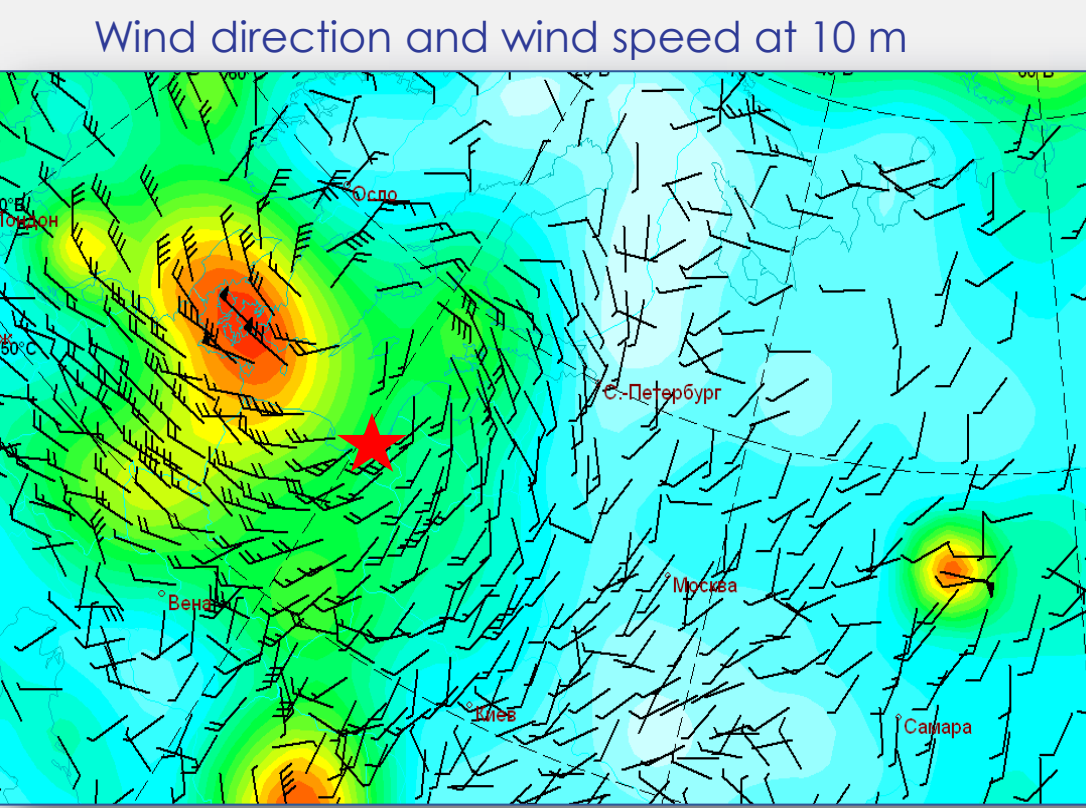
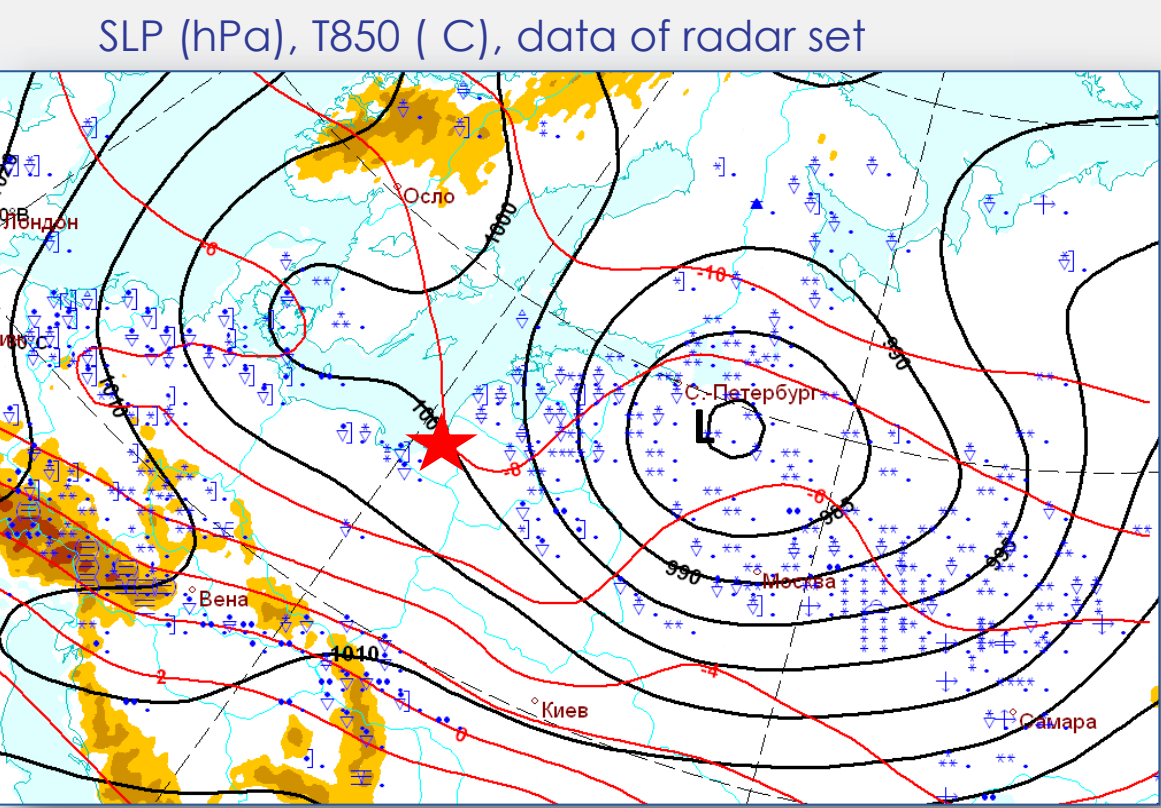
- **For storm surges:** threshold values of wind conditions, storm-tracking in Baltic, Caspian and Azov sea areas
- **For water flows:** threshold values of total daily precipitation, of temperature gradient and synoptic situations in Black sea area
- **For ice-jam:** configuration of frontal zone in basin of river in Barents, White and Baltic sea regions

Storm surges

Meteorological and synoptic predictors

- long term wind forcing resulting in seiches in the sea
- strong wind speed (the threshold varies in dependence of region)
- the wind direction orthogonal to the flow of river strong baric gradient

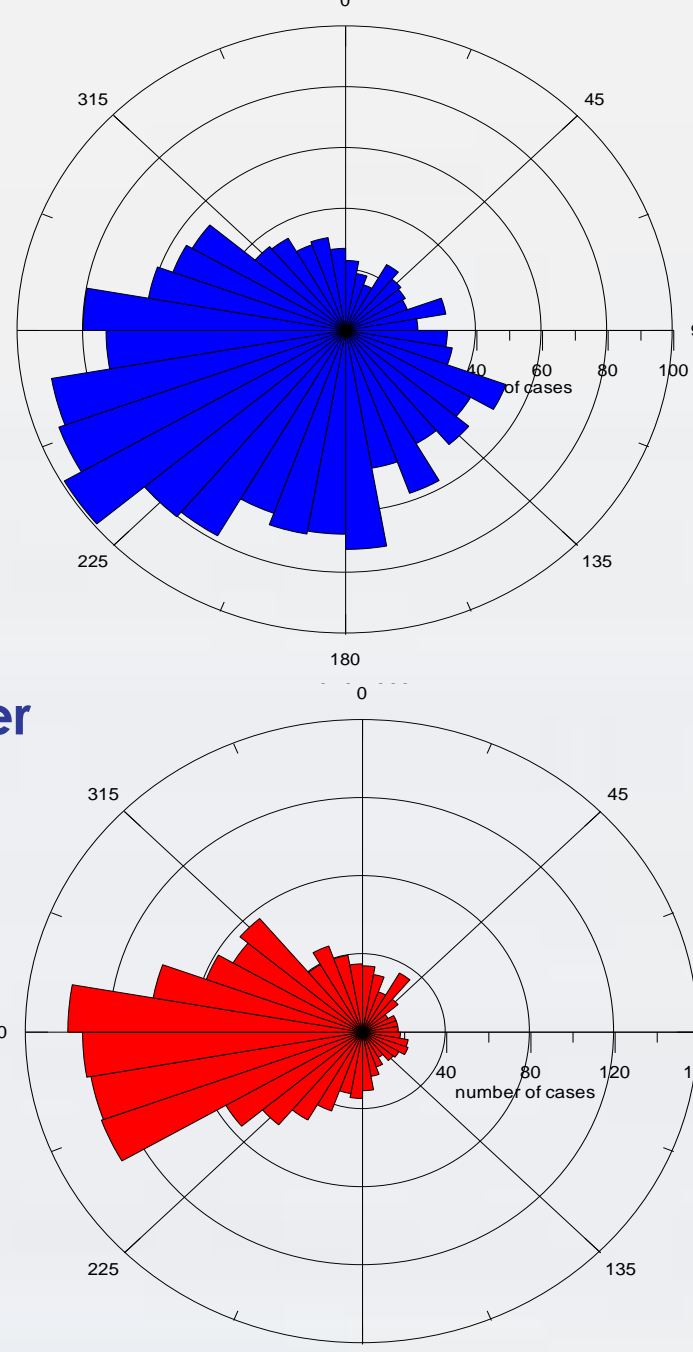
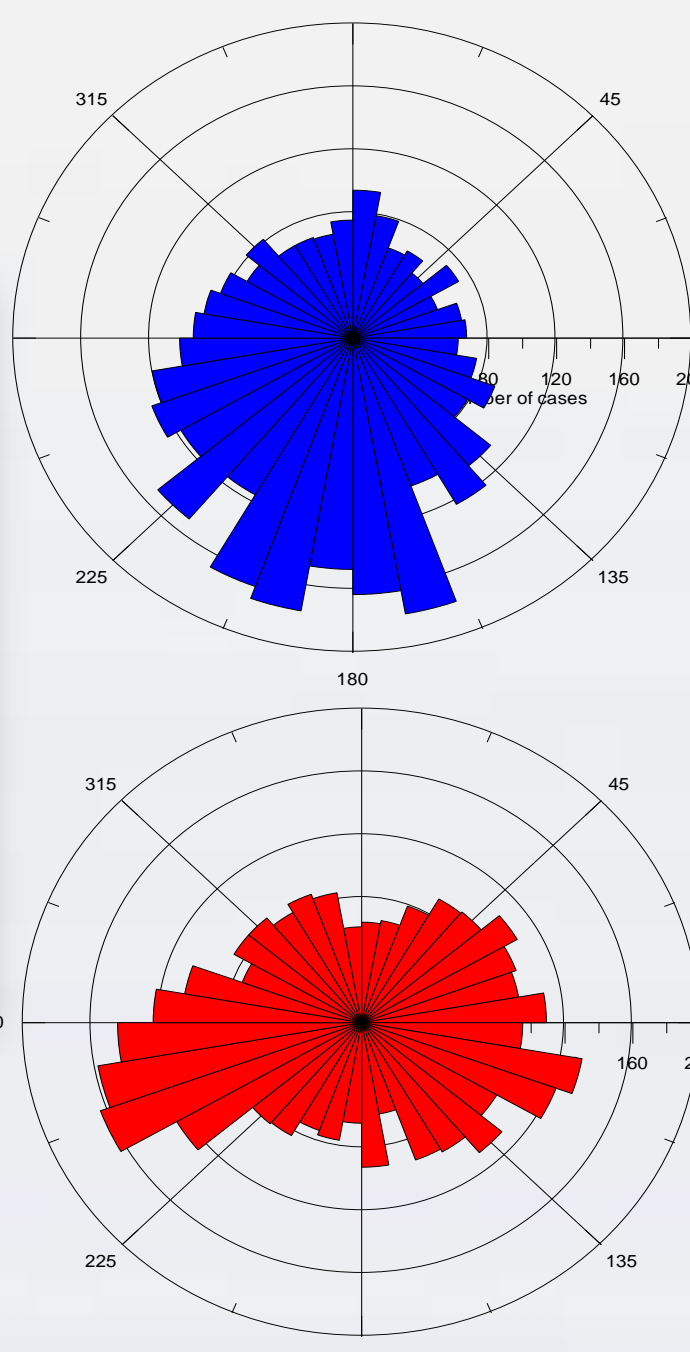
Pregolya 04.12.1999



Wind rose in mouth of Pregolya river

1961-2000

2046-2065

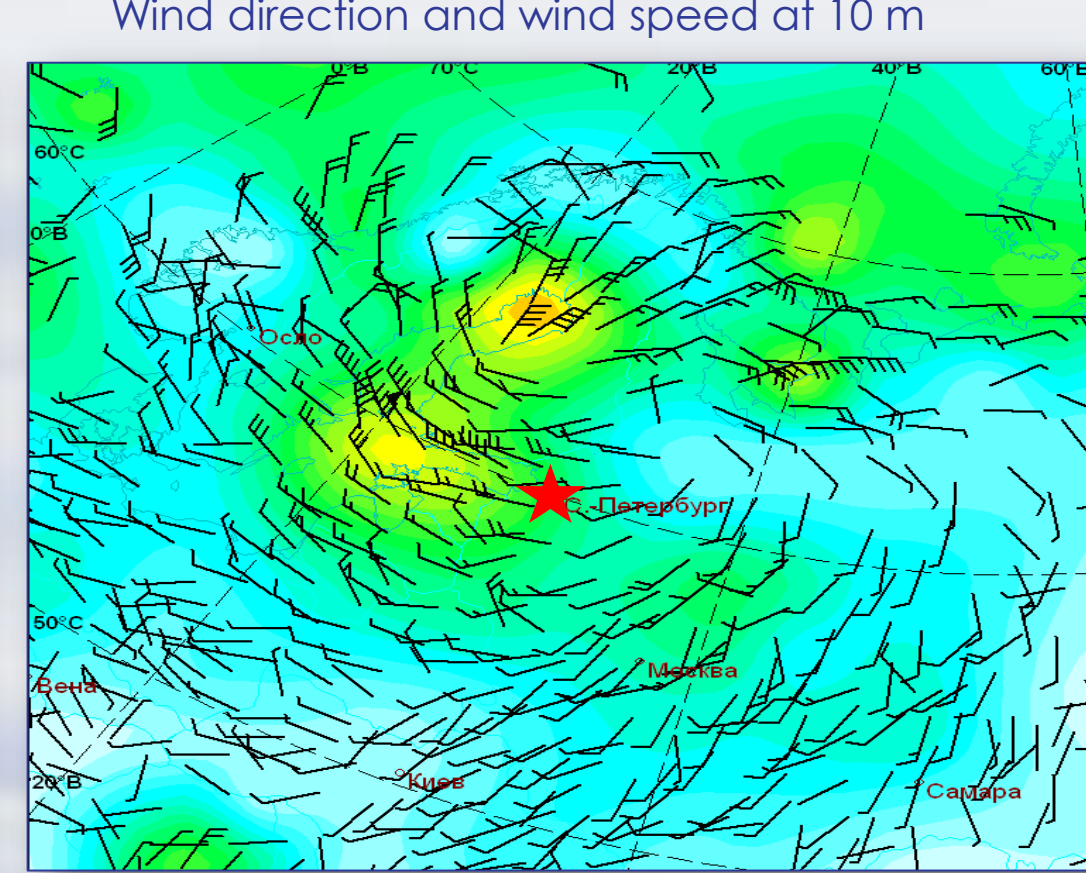
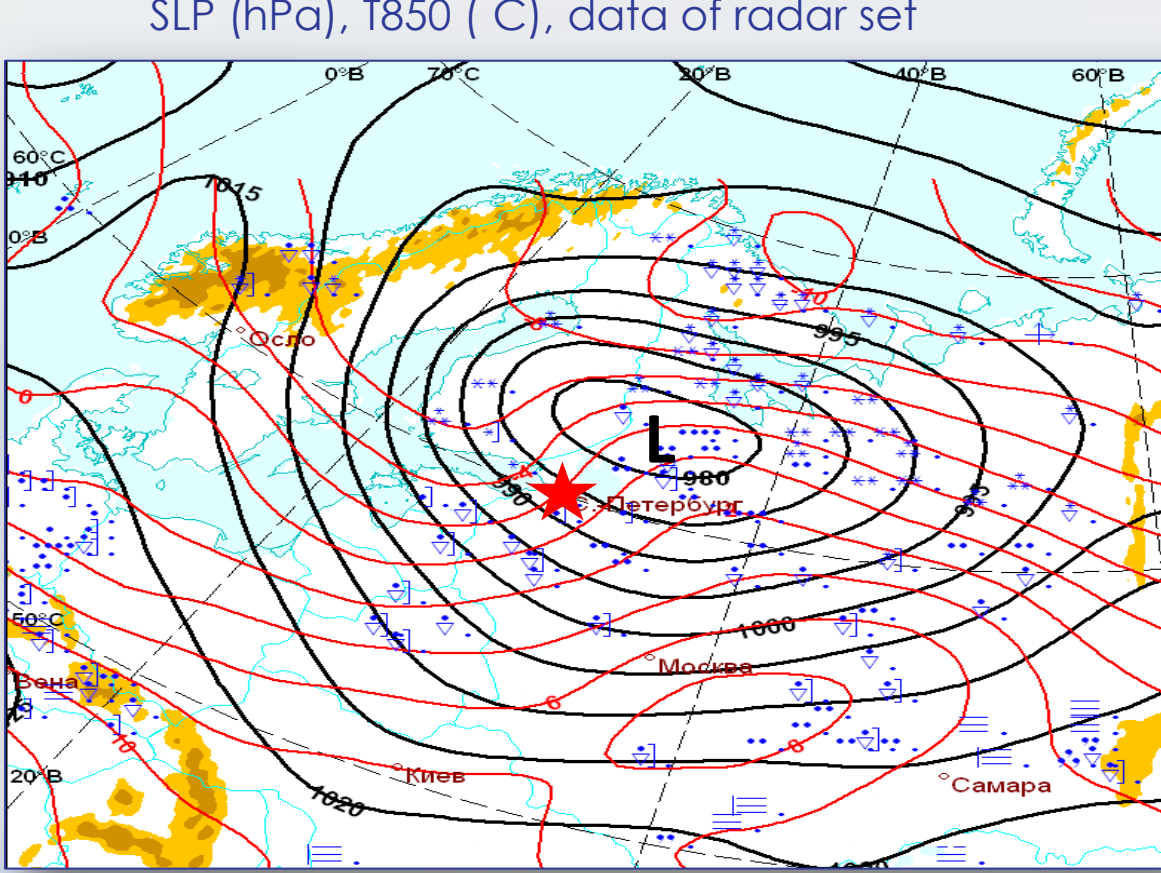


Increase of west and southwestern wind direction in future

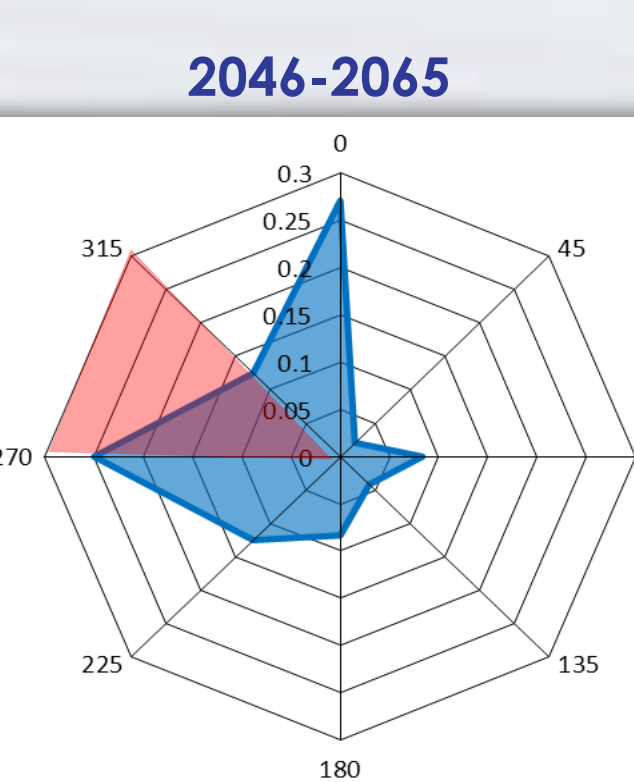
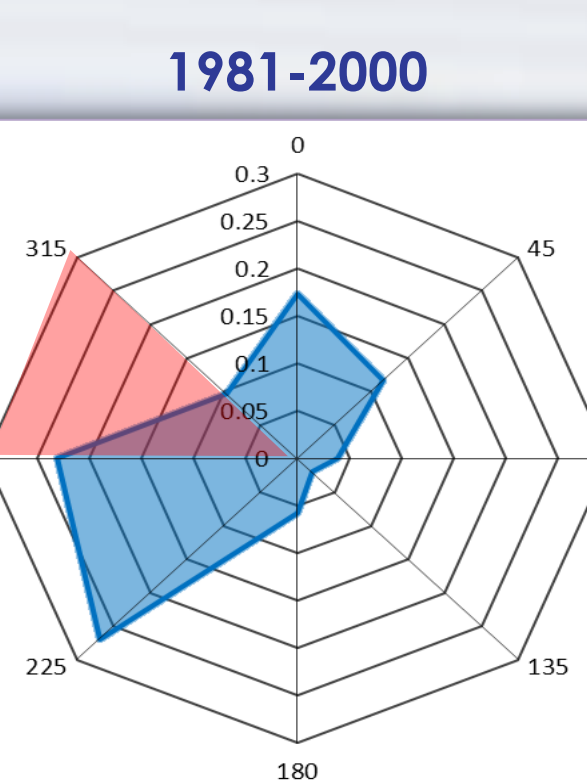
Threshold meteorological conditions associated with floods in mouth of Pregolya river:

- wind speed in mouth >12 m/s, wind direction in mouth – 235-270° (W-SW)
- wind speed in water area of Baltic Sea >10 m/s, wind direction in mouth and in water area – 225-270°(W-SW)

Neva 07.01.2005



Probability of cyclone trajectory in mouth Neva river



No change of trajectory «dangerous» from west or northwest (red field) in Future

Threshold meteorological conditions associated with floods in mouth of Neva river:

- wind speed in mouth >8 m/s, wind direction in mouth – 270-315° (W-NW)
- wind speed in Gulf of Finland >6 m/s, wind direction in mouth and in water area – 270-315°(W-NW)

Ice-jams

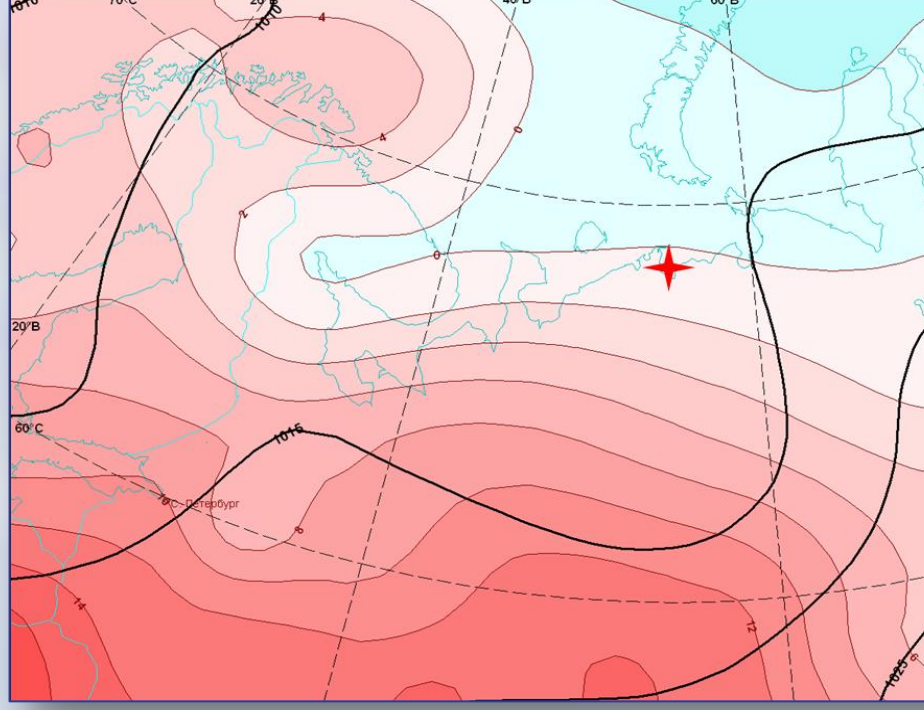
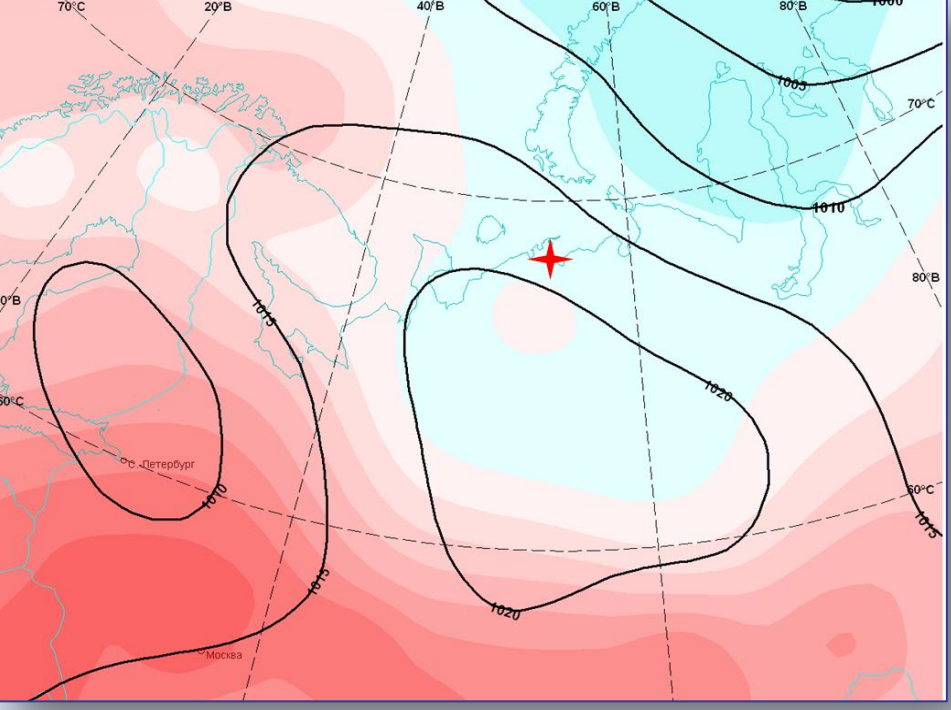
Meteorological and synoptic predictors:

- frontal zone expanded in north-south direction with positive temperature in river source and negative temperature – in the river mouth.

However, **other factors** may influence the ice-jam formation:

- temperature jumps
- Precipitations
- fall conditions
- wind direction in the mouth of river

air temperature 2m, C
Mouth of Pechora river
June 1998



Summary for storm surges

The probability of over-threshold meteorological conditions associated with floods:

- **increases** in mouth Pregolya river in winter and in summer and in mouth Don river in winter
 - **decreases** in mouth Kuban river and sea coast Kalmykia in winter and in summer
 - in the rest of cases – **no change**
- Note the trend of cyclone number is insignificant in mouth Neva river and Pregolya river in climate changing.

Summary for ice-jams

The probability of synoptic situations and meteorological conditions associated with floods:

- **diminishes** in mouth of Pechora river and Pregolya river (maximal diminution of cases)
- **decreases insignificantly** in mouth of Northern Dvina River

Water flows

Meteorological and synoptic predictors (Black sea)

- the abundant precipitation, usually associated with the intensive frontal zone
- the sudden change of air temperature resulting in snow melting in spring time

Intensive frontal zone at Black sea area – insufficient condition for development of floods!

Intensive frontal zone + precipitation

Intensive frontal zone + Synoptic situation - Low

Selection algorithm of threshold daily precipitation

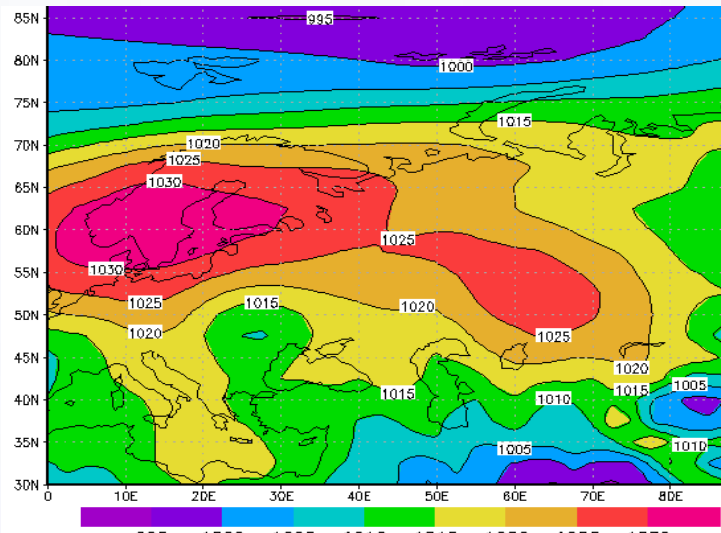
Station data extreme daily precipitation (35-45 mm/day)

GPCP daily precipitation distribution Extreme values - 99th percentile

MPI-ECHAM5 distribution of daily precipitation 99th percentile – 15 mm/day

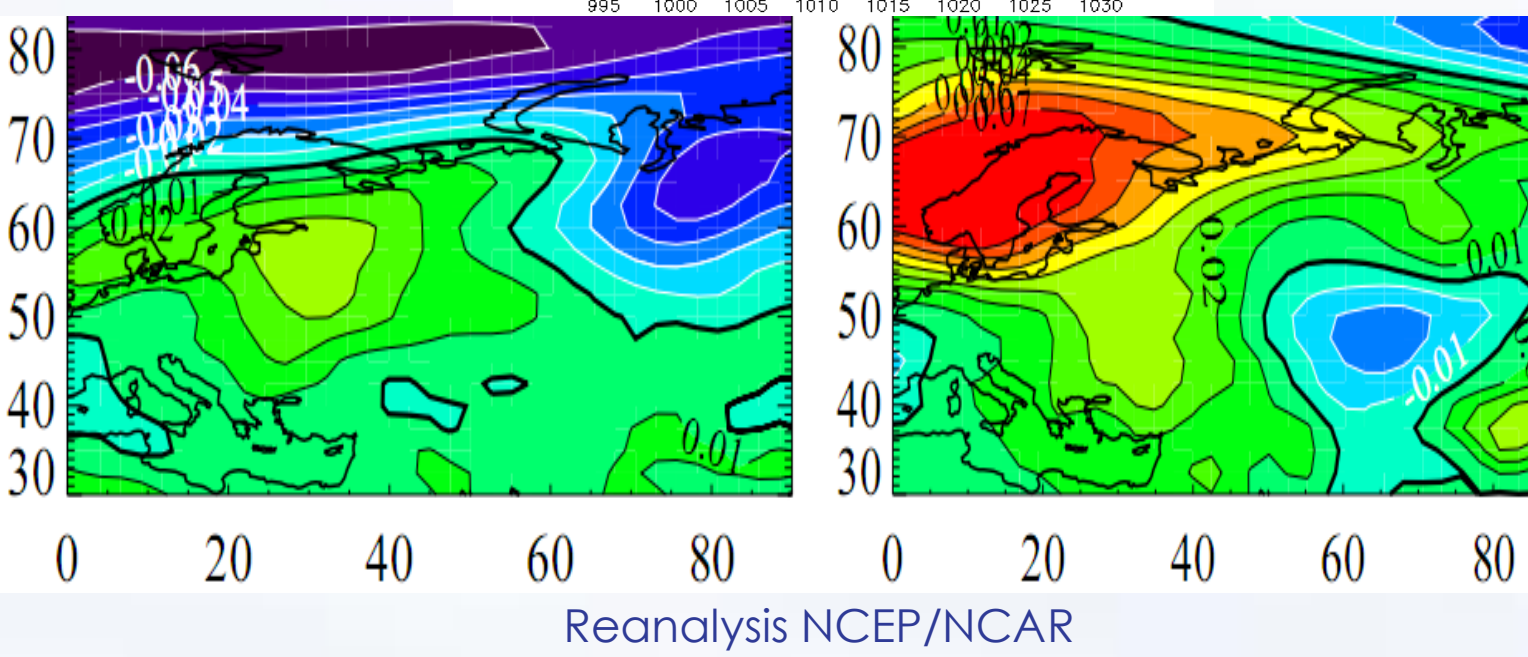
Sea level pressure associated with the intensive frontal zone

Anticyclonic type

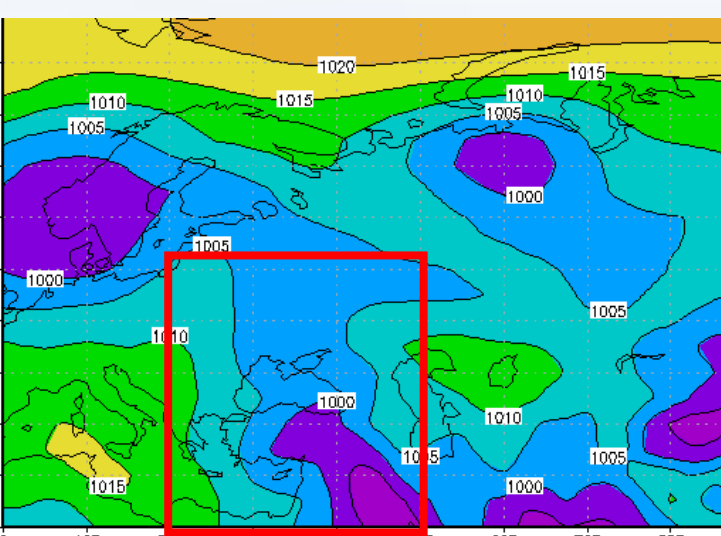


EOF 1 (48%)

EOF 2 (33%)

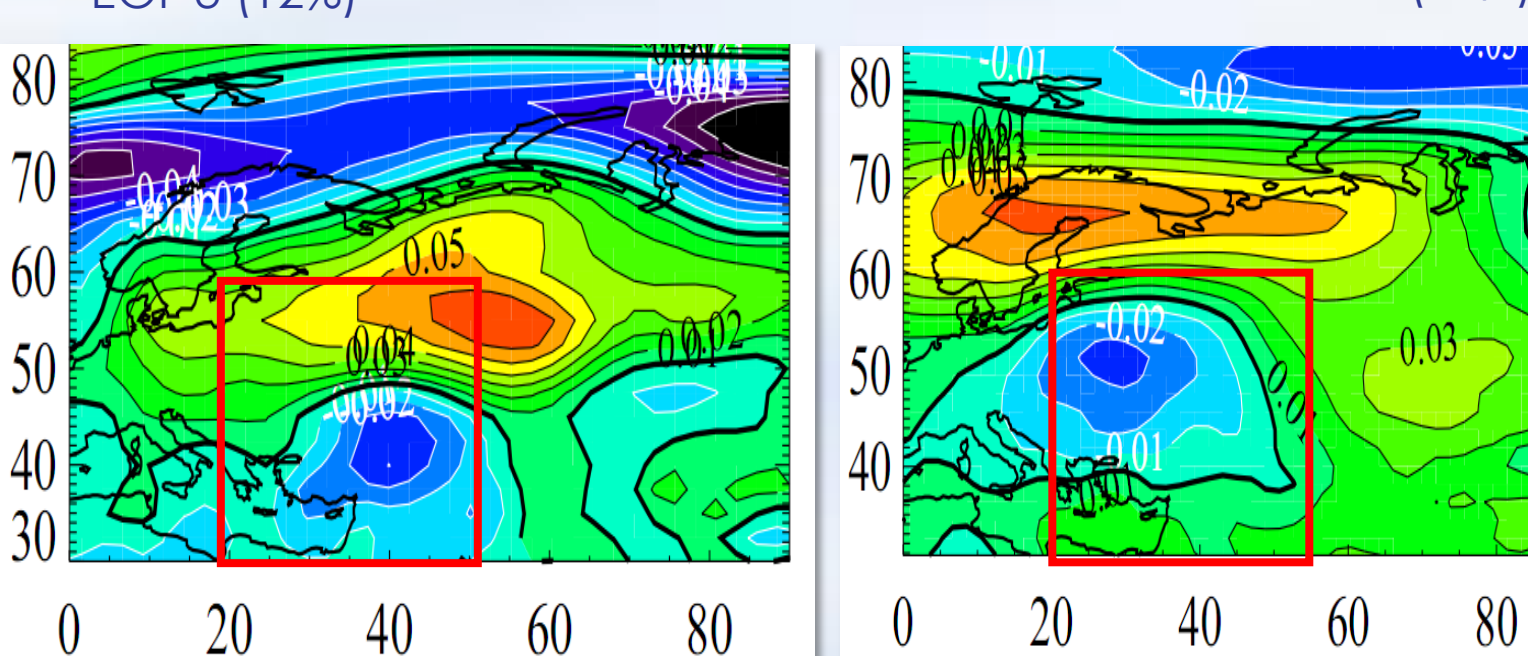


Cyclonic type



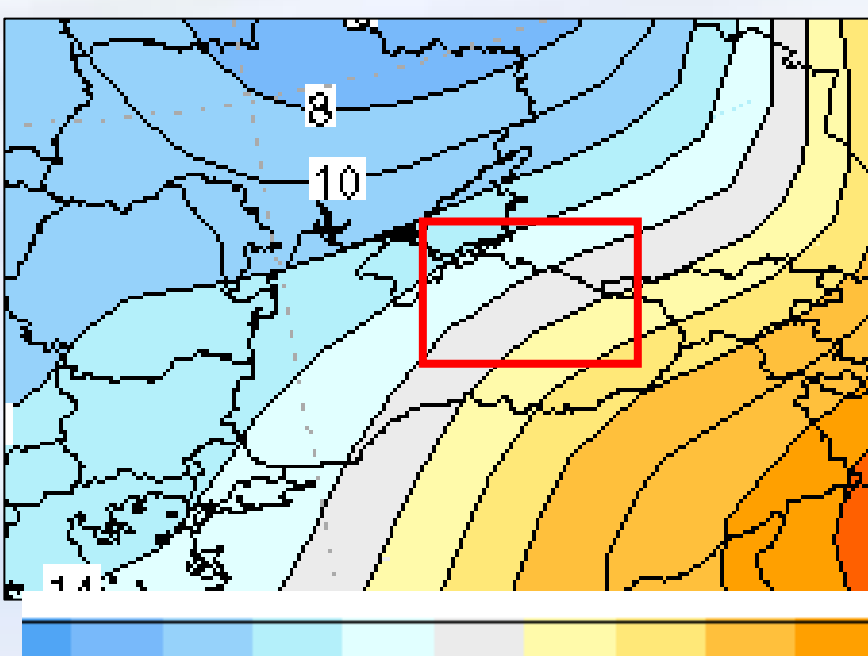
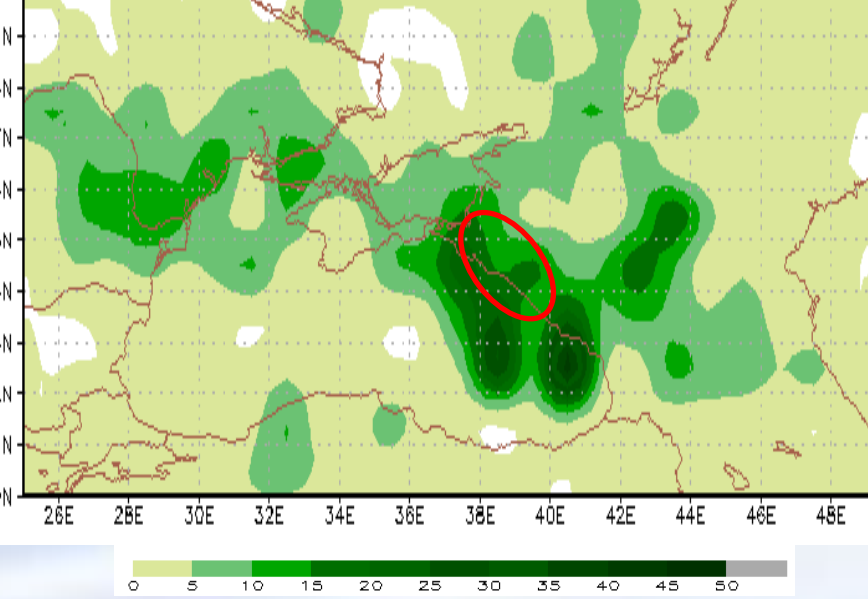
EOF 3 (12%)

EOF 3 (16%)



08.08.2002 Water flows in region Sochi-Tuapse

GPCP daily precipitation (mm)



Red rectangle – Black sea area

Summary for water flows

Intensive frontal zone + low only Intensive frontal zone Intensive frontal zone + precipitation

➤ increase the probability of cases over-threshold in summer

Conclusion

We expect potential increase of catastrophic floods risk in river estuaries in case of climate changes in sea area:

- Baltic (in summer and in winter)
- Azov (only in summer)
- Black (only in summer)