

Analysis and Modeling of the North and Tropical Pacific SST Variability

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Content

- Climatic variability in the tropical and North Pacific
- EOF analysis of the SST during the period 1981-1999
- Cluster analysis of the SST during the period 1948-2002:
 - Spatial classification
 - Temporal classification
- Numerical modelling
- Conclusion

Objectives

The Pacific Ocean is the source of the climatic variability influencing to the atmospheric processes not only in local, but also in global scales. The mostly strong signal is the El-Nino-South Oscillation (ENSO) representing the inter-annual variability in tropics. In the same time, in the middle latitude there exist the inter-decadal signal, so called the Pacific Decadal Oscillations (PDO) centered over the Pacific Ocean and North America. This variability can be analyzed in the sea surface temperature patterns with the use some statistical processing.

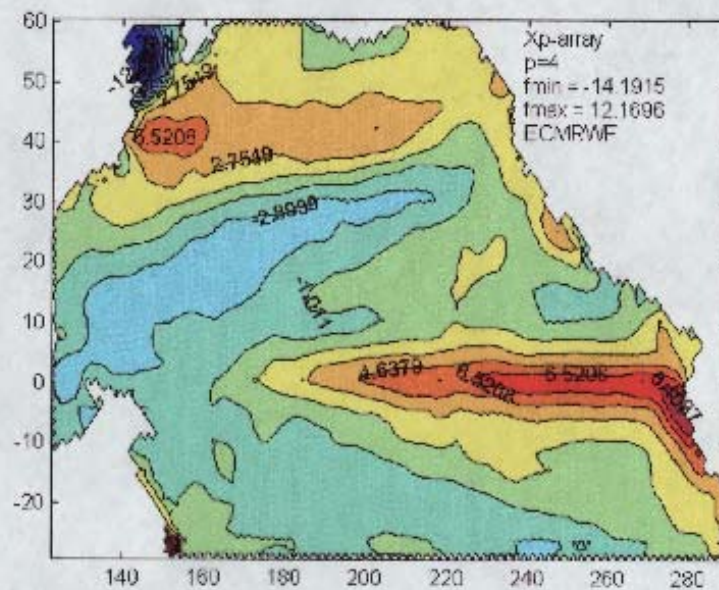
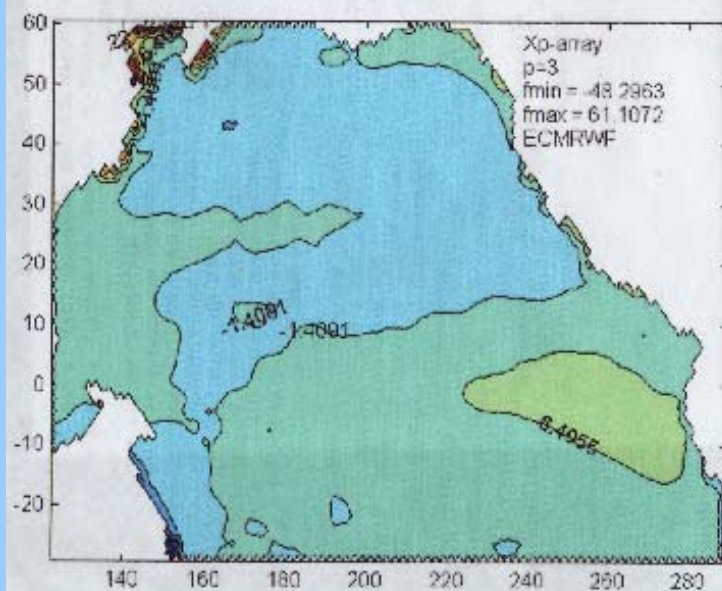
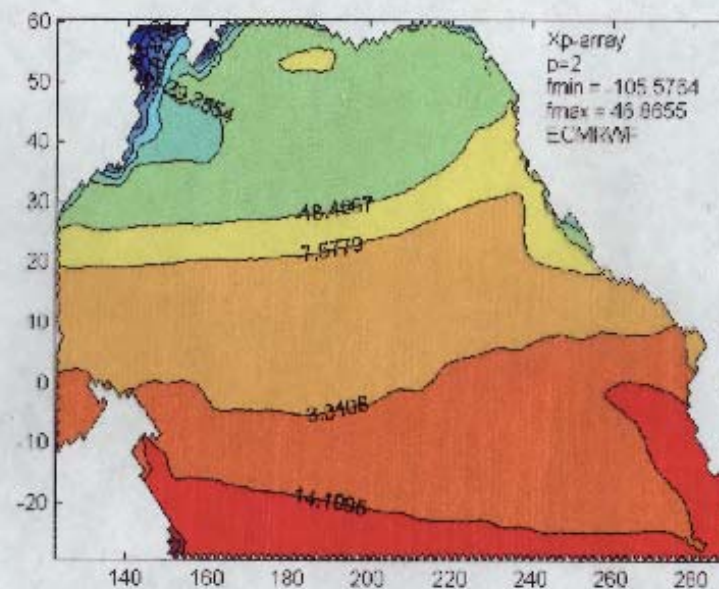
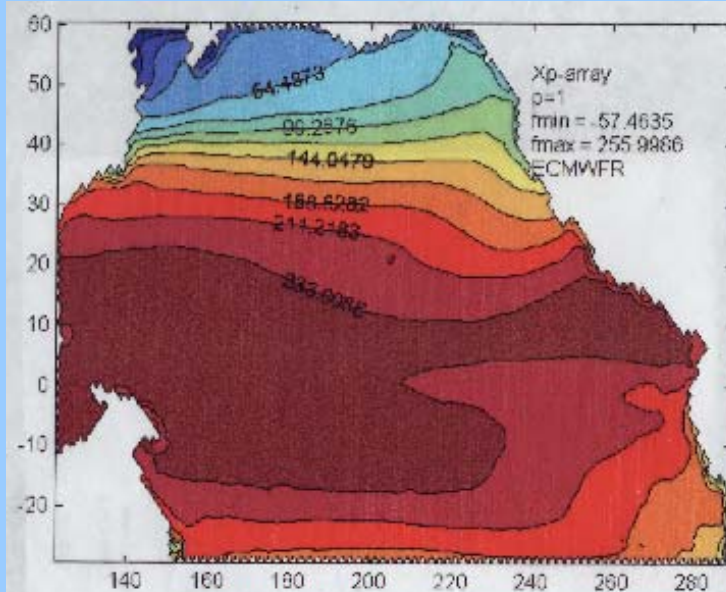
Data sources

- ECMRWF SST dataset 1981-1999
- NCEP/NCAR SST dataset 1948-2002

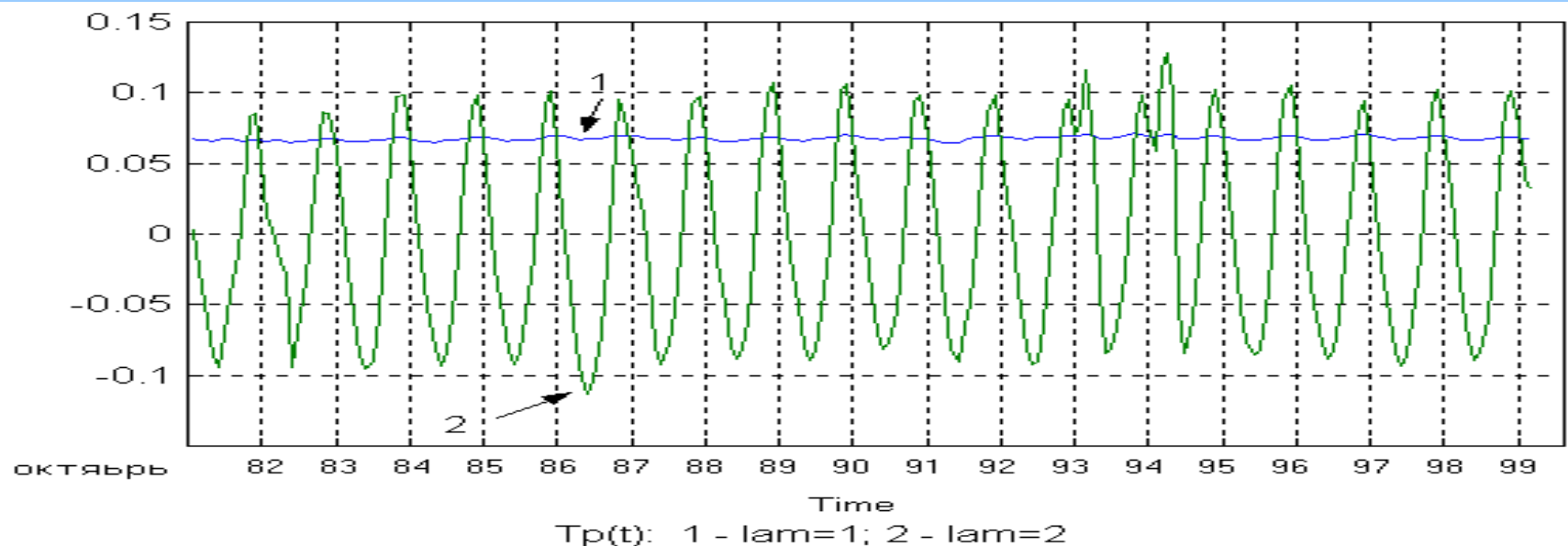
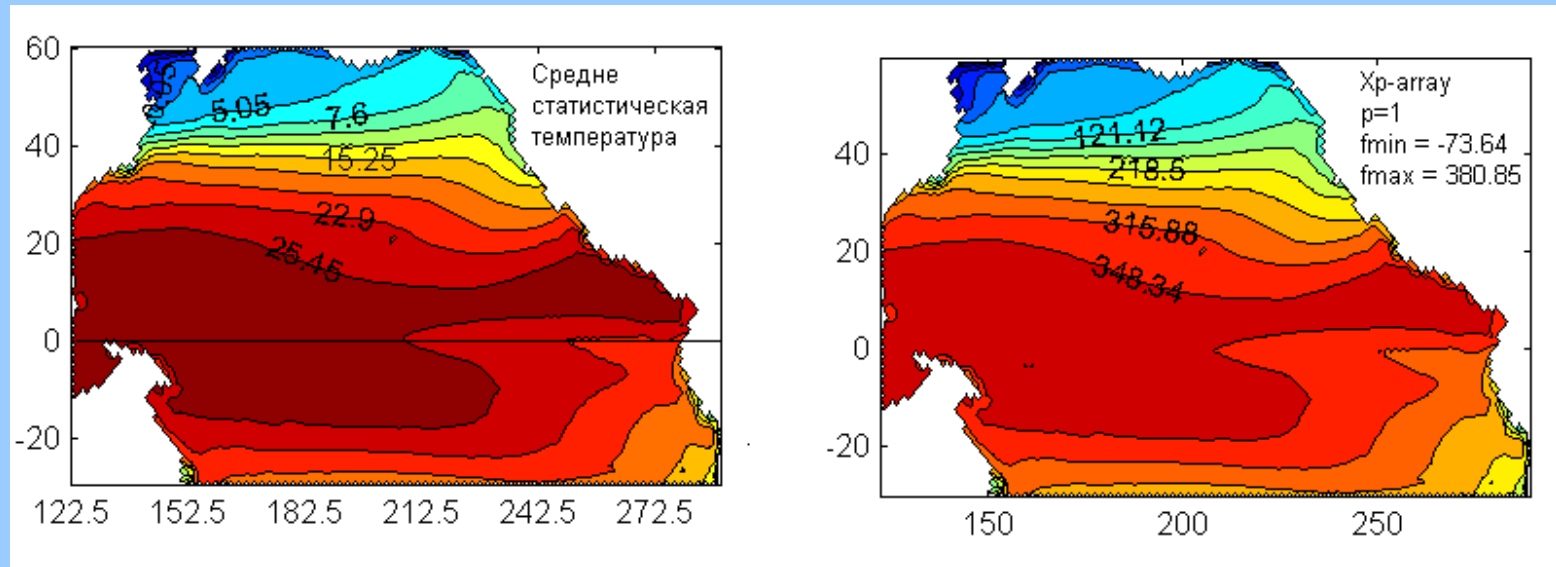
Methods

- Empirical Orthogonal Function (EOF) Analysis
(classical variant without ortogonalization)
- Cluster Analysis (spatial & temporal classification of
zones with high correlation)
- Numerical FEM ocean circulation model

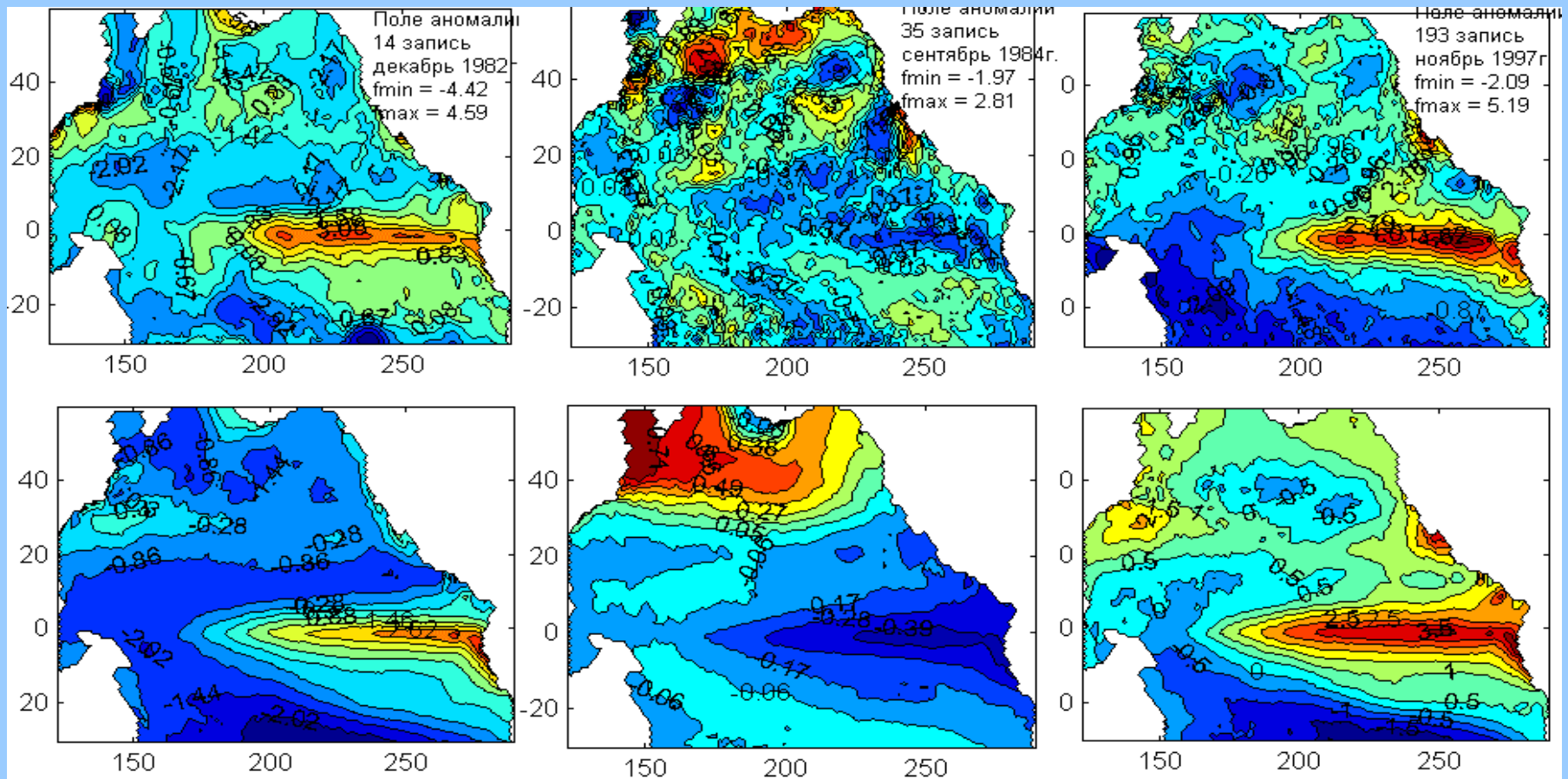
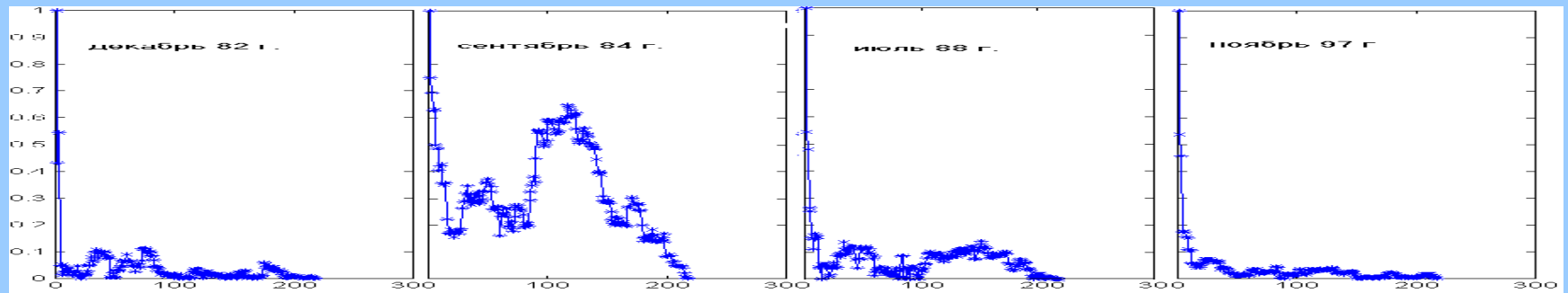
The first four EOF



Climatically averaged state, First EOF & temporal behavior



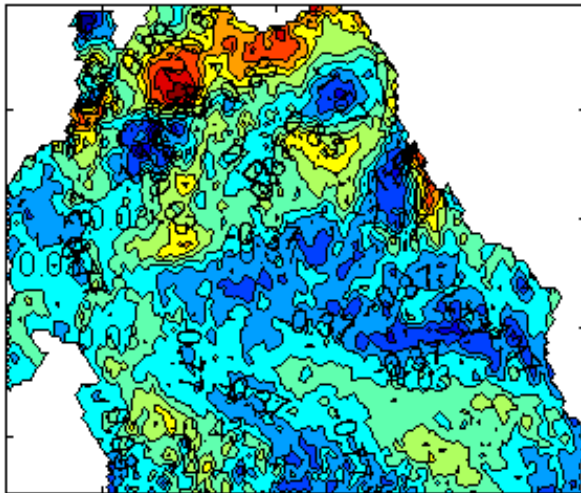
Reconstruction of the SST field with the use of four EOF



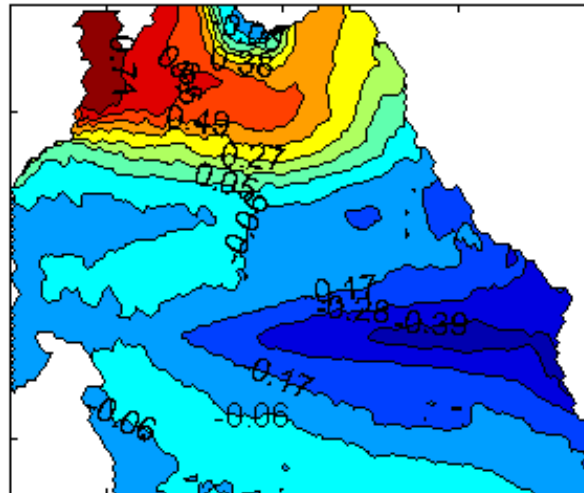
Reconstruction of the SST in September 1984

сентябрь 1984 г.

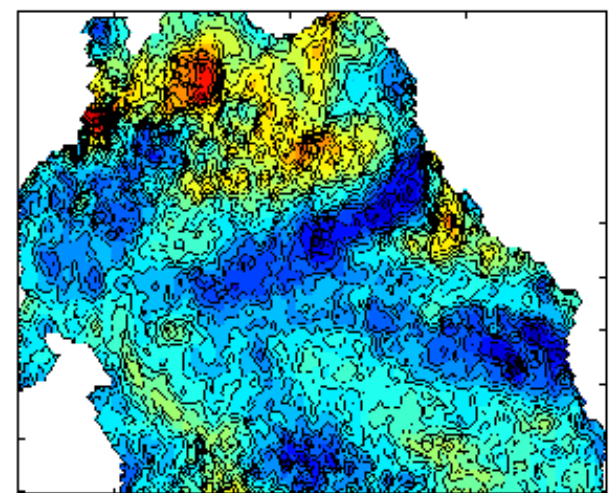
Исходное поле аномалии



Восстановленное по первым 4 гармоникам



Восстановленное по 1-4,15-36,91-141 гарм.



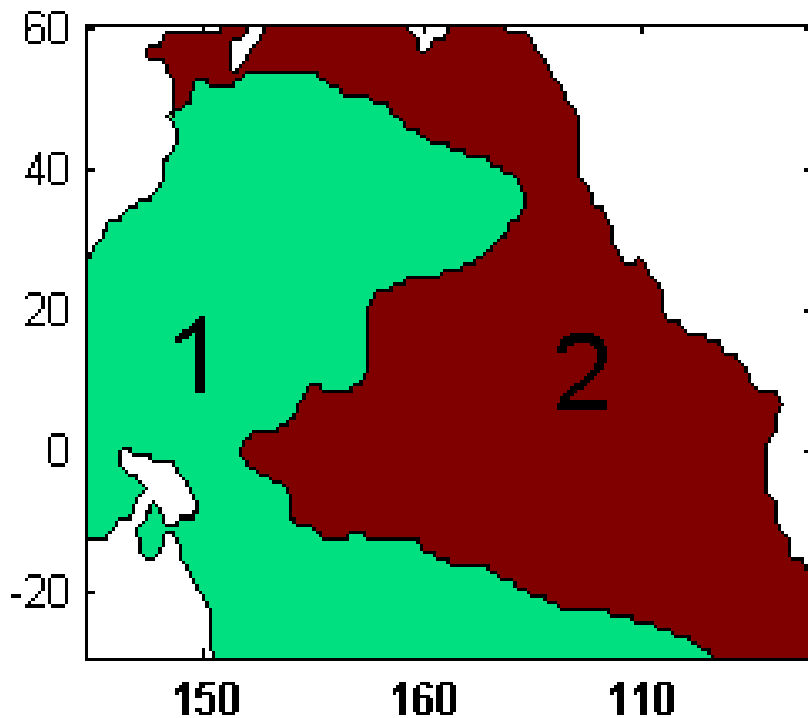
Cluster analysis of SST for the period 1948-2002

Cluster analysis is a method of combining of the data by the criterion correlation between the spatial points or the time points.

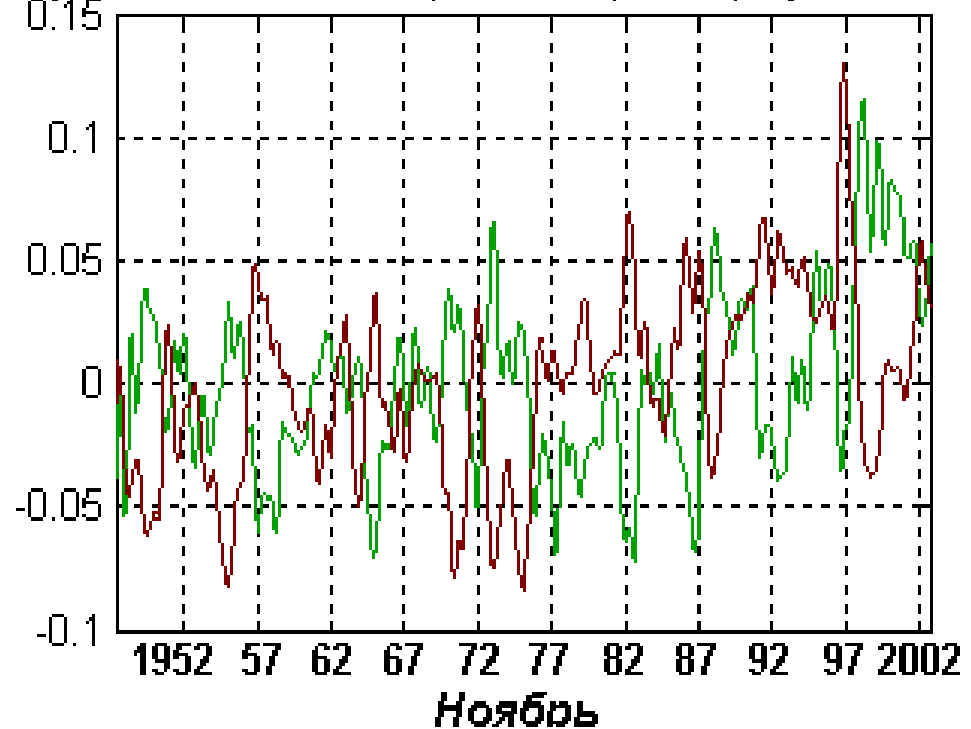
Cluster analysis method allows one to solve the problems:

- To classify the objects with taking into account the main features of the objects;
- To check some hypothesis about occurrence of some structure in the aggregate of the objects;
- Construction of the new classification for the poor investigated events, when it is necessary to establish the relations in the aggregate and to introduce some structure into it.

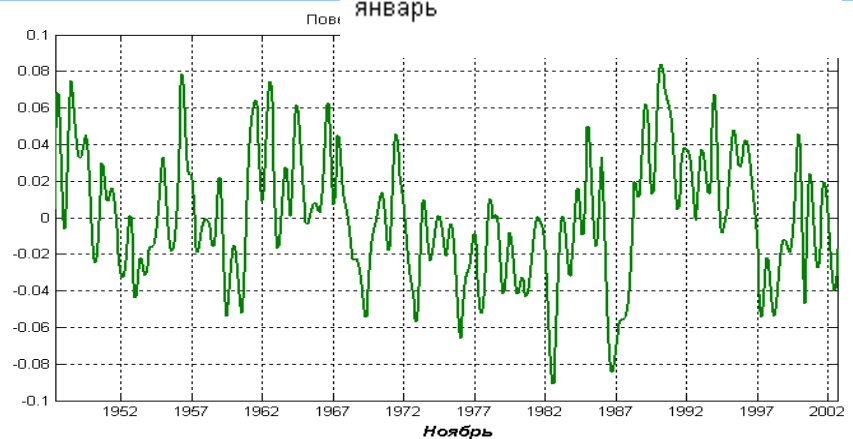
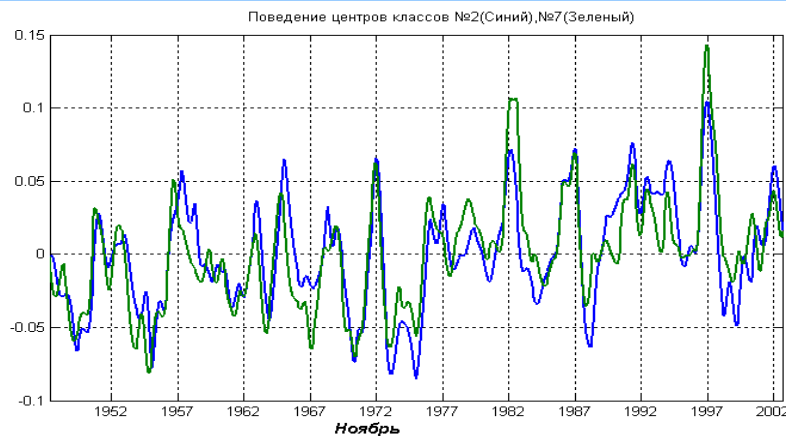
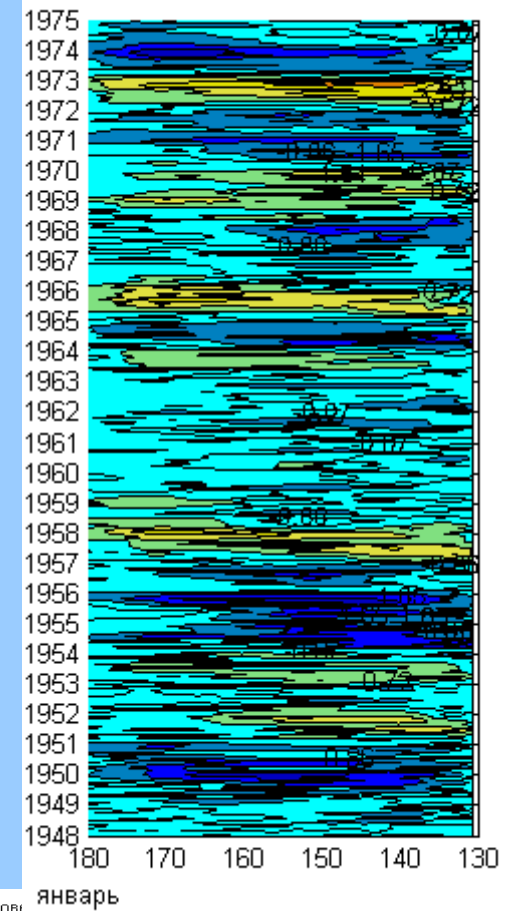
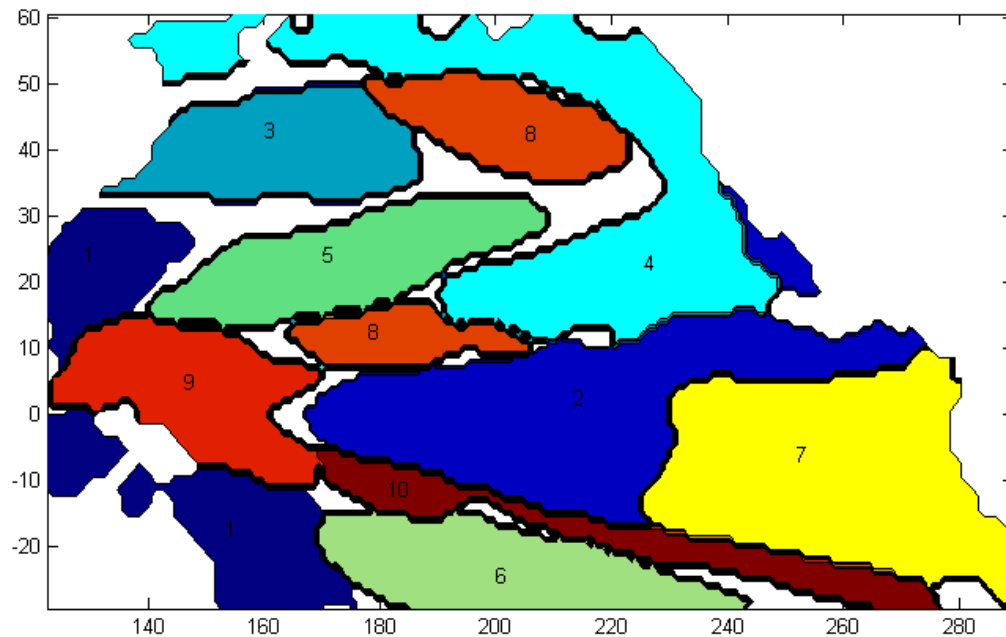
Two initial classes & temporal behavior



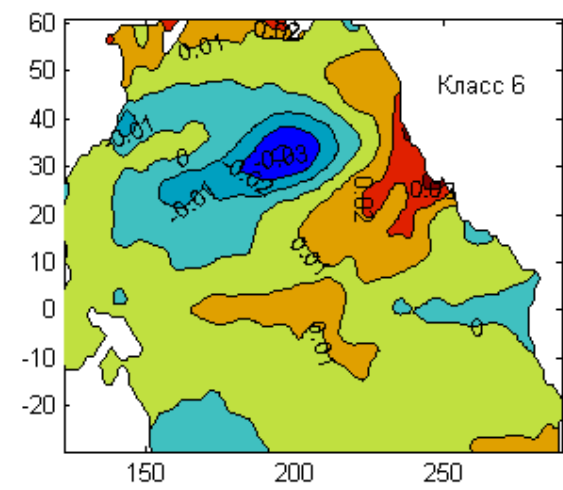
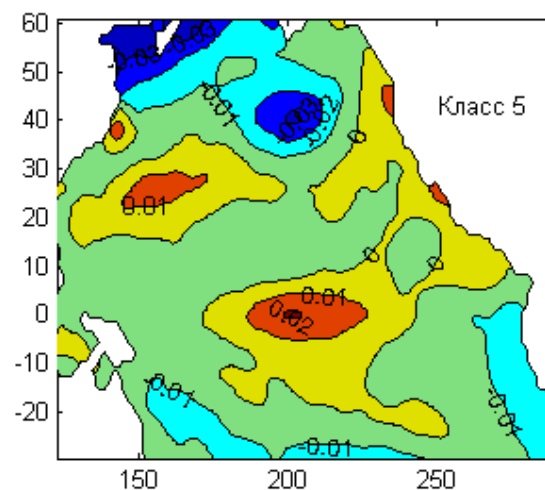
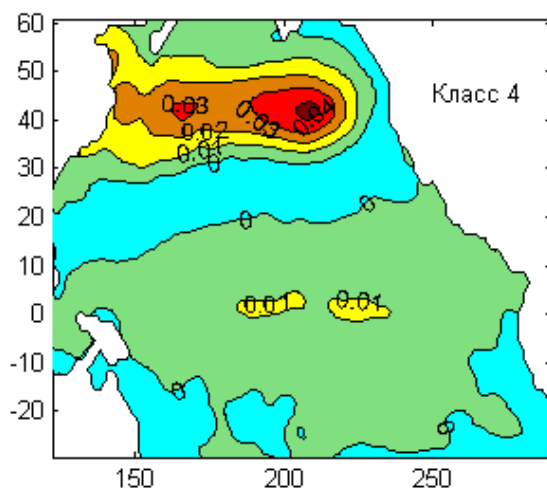
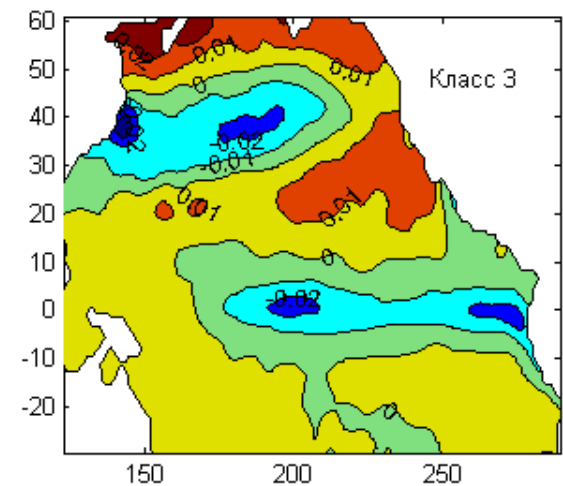
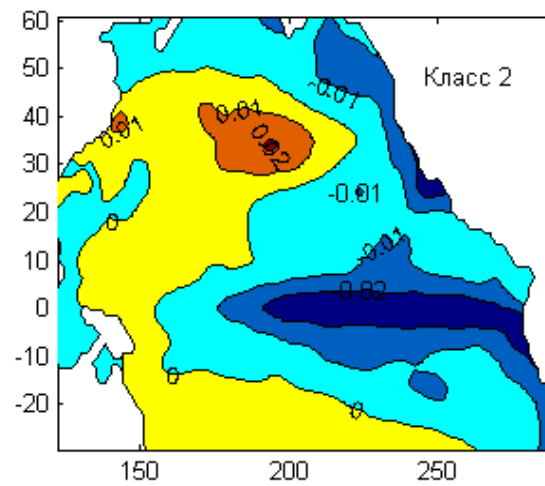
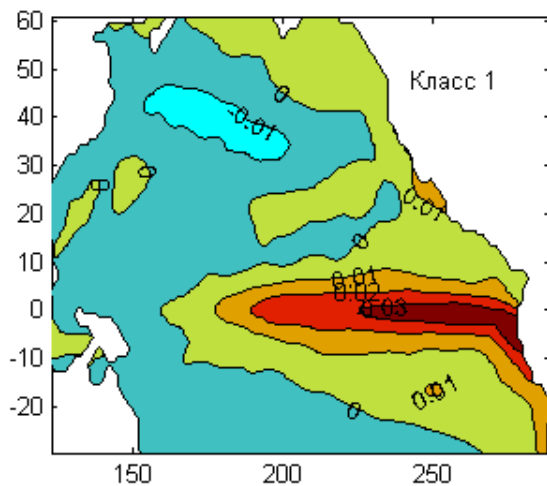
Образцы классов №1(Зеленый), №2 (Коричневый)



Ten spatial classification classes & temporal behavior

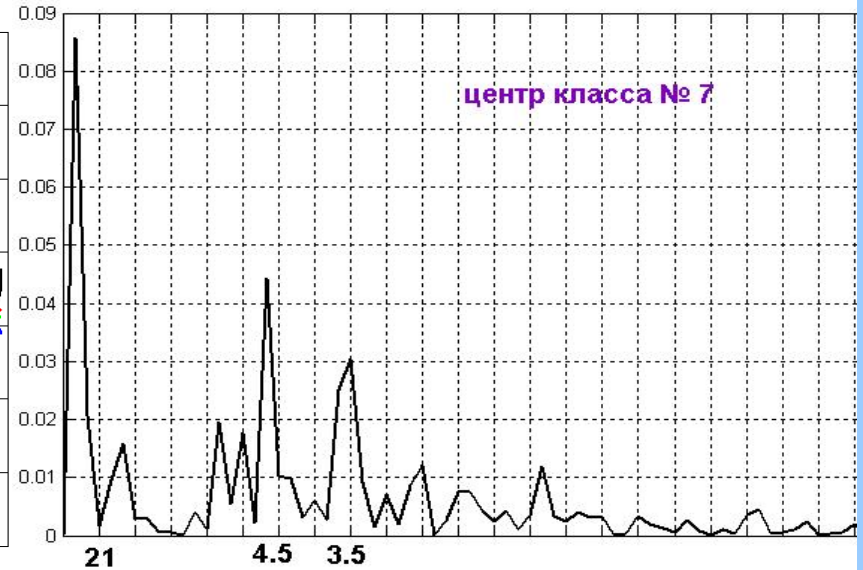
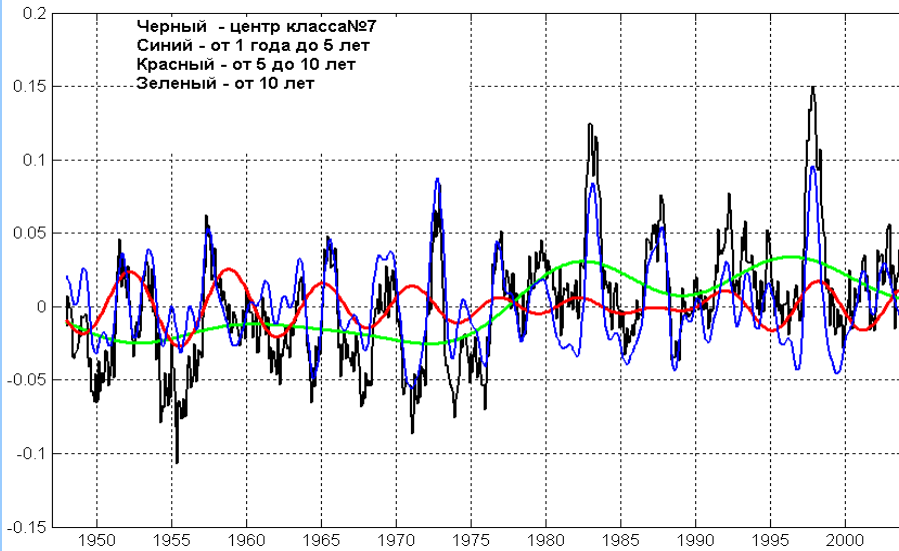


Six classes of the temporal classification

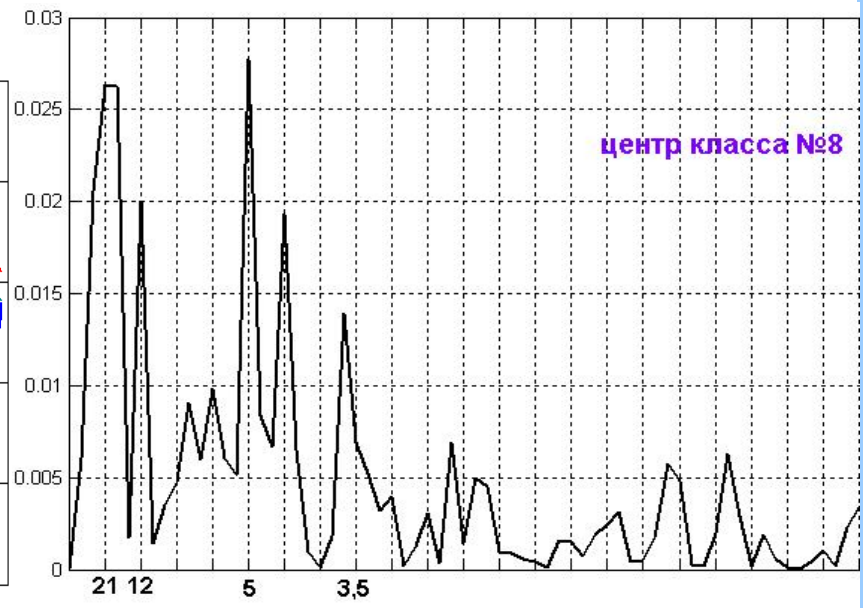
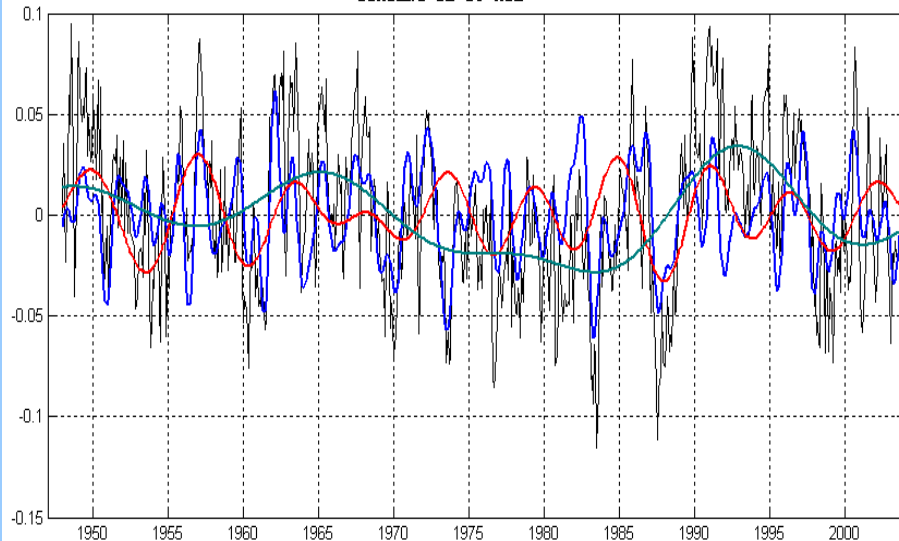


Temporal behavior & spectrum for the classes 7, 8

Центр класса №7



Черный - Центр класса № 8
Синий от 1 до 5 лет
Красный от 5 до 10 лет
Зеленый от 10 лет



Main features of the North Pacific circulation experiment

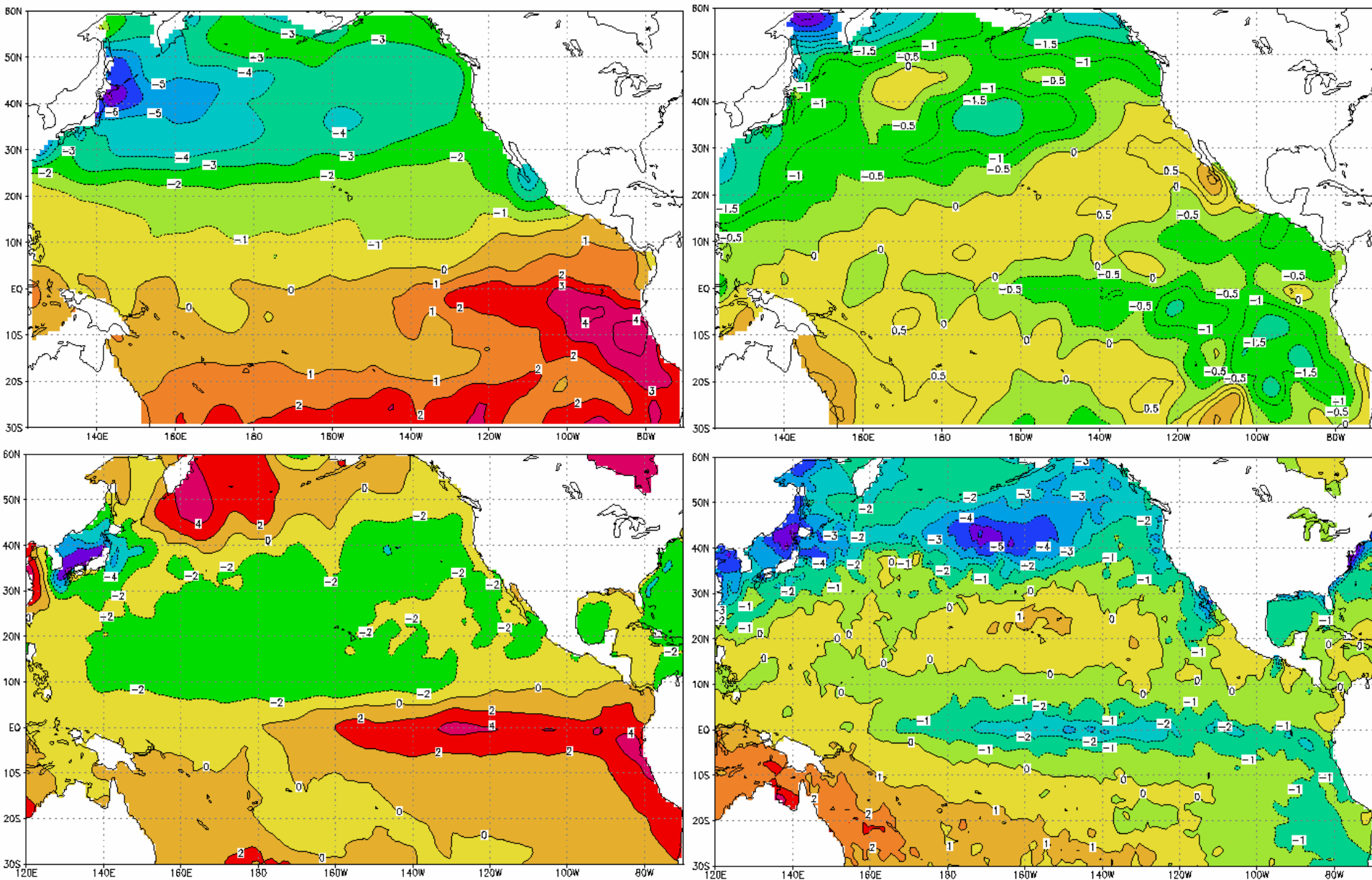
Mathematical model is based on the complete “primitive” nonlinear equations of the thermo-hydrodynamics of the ocean;

The numerical technique is based on a combination of the finite element and splitting methods;

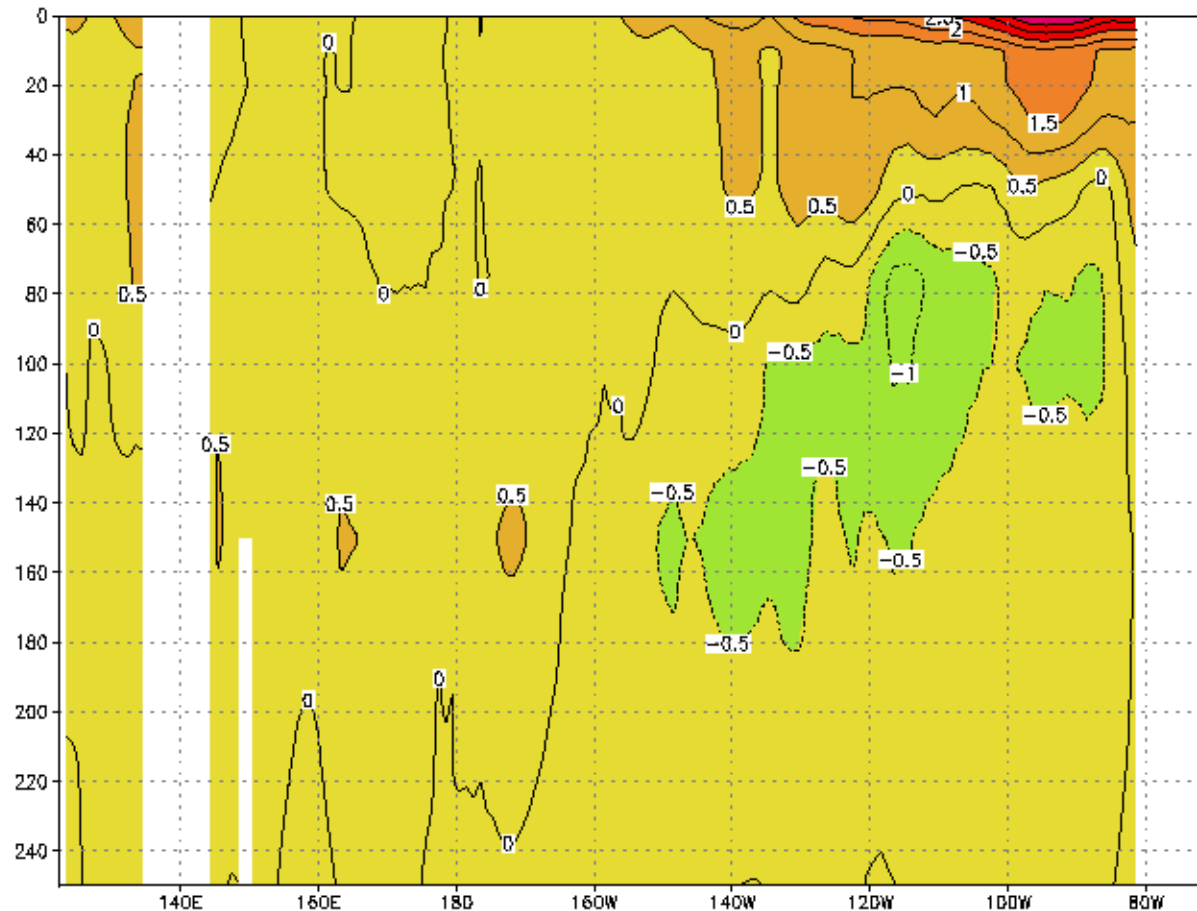
The wind-stress & temperature, salinity fluxes at the surface was taken from ECMRWF reanalysis;

Integration period starts from November 1981 until October 1988 (contains el-Nino 1982, 1986 & La-Nina 1988)

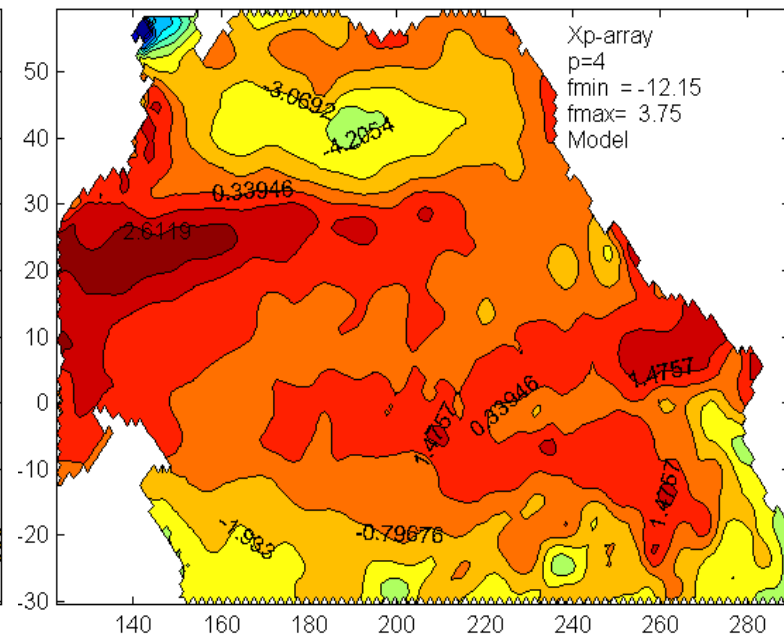
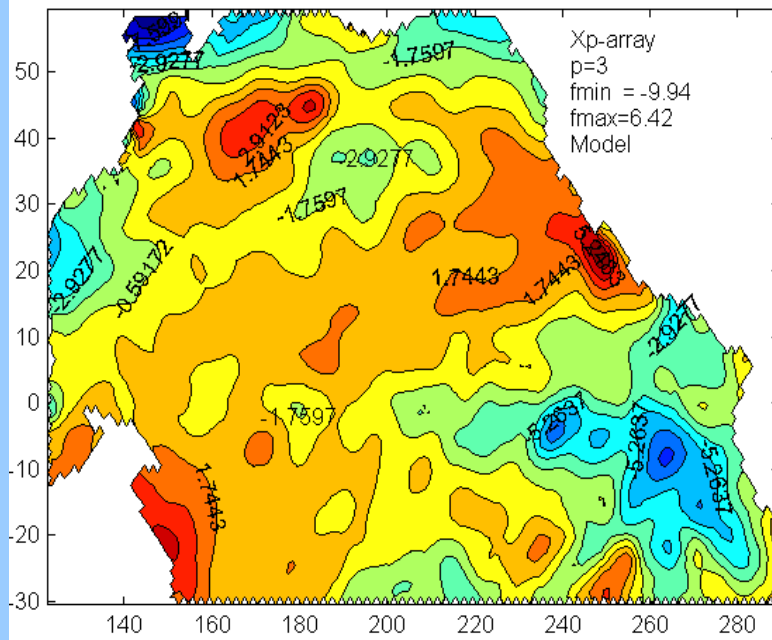
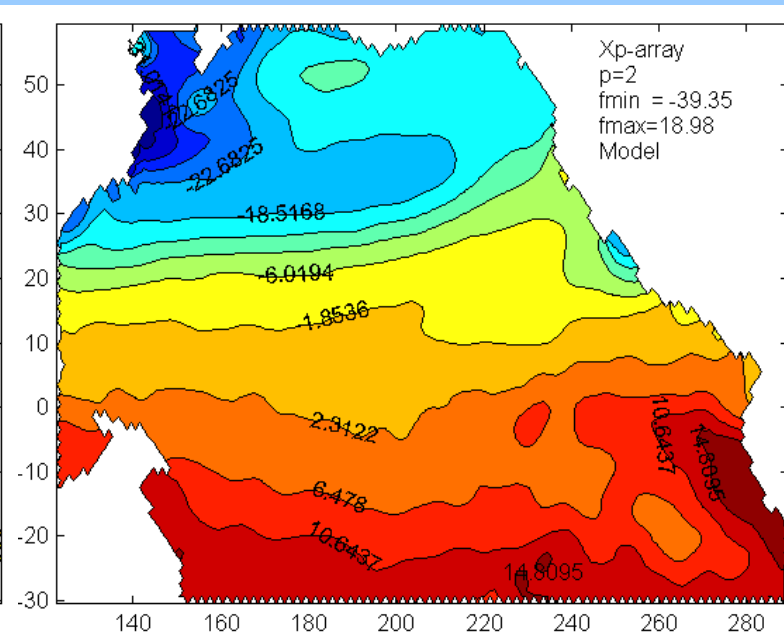
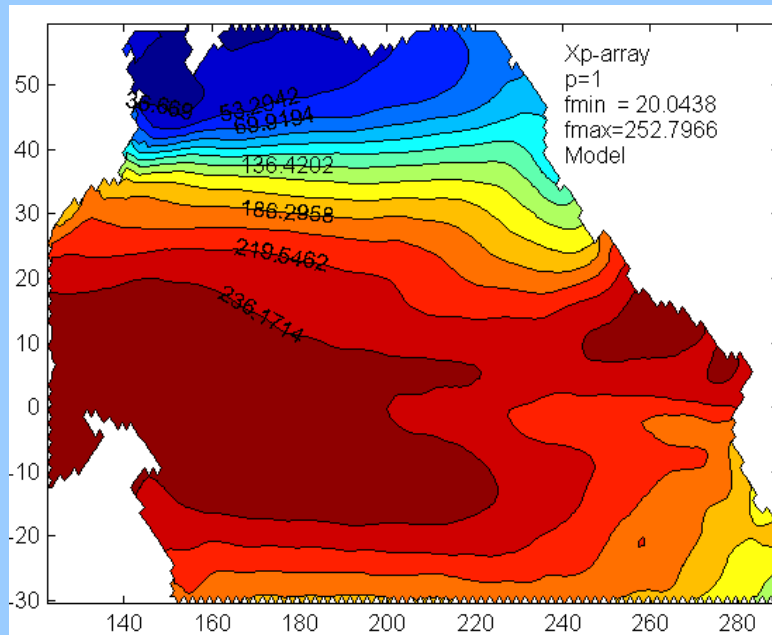
El-Nino 1982 & La-Nina 1988, model (upper), ECMRWF data (low)



El-Nino modelling on the basis of the North Pacific circulation model



The first four EOF for the modeling results



Conclusion

- The EOF analysis enables us to separate the strongest signal in the Pacific Ocean and to reconstruct it with a few first harmonics. The periods between the El-Nino and the La-Nina events need a greater number of harmonics for reconstruction of the anomalies. This indicates that the state in these periods is governed by the first two climatic harmonics and finer processes form the anomalies. The PDO variability in the subtropics and in the subpolar regions is damped by a stronger tropical signal
- The spatial-temporal cluster analysis allows us to separate the typical structures of the SST variability, to indicate the variability in the subtropical and the subpolar regions and to establish the relations between the regions. It also allows us to indicate the marked signal of the inter-decadal variability in the subpolar-subtropical zones.

- The simulation results show the temperature anomaly formation in the tropical zone during the El-Nino, 1982. The temperature anomaly has formed in the central part of the tropical zone, and propagates from west to east at the thermocline level and comes up near the eastern coast, forming the surface anomaly in the eastern part of the tropical Pacific, which is in agreement with the observations.
- The continuation of the numerical experiment until June 1988 shows a good reconstruction by the model of the El-Nino, 1987 and the La-Nina in phase with a stronger deviation in the amplitude. As in the case of the El-Nino, 1982, the model results have wider and shorter pool of the anomalies.
- In the midlatitudes the description of the anomalies is not adequate.