# ANIMATION CARTOGRAPHY OF THE ENVIRONMENT

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**Abstract**

Animation cartography is a powerful tool for visualization of the featers and changes of the environmental objects and processes. However there are no common approaches towards animation cartography. This paper points out the directions of the development of the animation cartography such as the creation of the dynamic symbols and the ways to visualize them, the research on general rules of spatial and temporal generalization, etc.

Experiment methods of animation cartography of dynamic geographic fields are discussed based on multitemporal digital models. The suggested methods were realized in practice on different examples. Display-films were created depicting the dynamics of the surface temperature of North-Western Pacific and changes of the seasonal snow cover depth on the European part of Russia.

## 1 Animation techniques. New possibilities

Recently active developments in computer animation one can see all over the world. This is a new stage both for marketing business, and different training systems particularly in military and medical applications. Other applications include car design, marketing of complex objects (new models of aircrafts in the flight), development of museum guides, etc.

Modern cartography computer animation for GIS cartography becomes as widely used analysis tool as regular paper maps, aero-space photography and electronic maps. There are two different methods of computer animation: in one case, the frames sequentially represent maps (models, photographs, etc.) reflecting the state of events at fixed intervals; in another case, there is a stationary cartographic base, on which animation is used to change symbols and background colorings, move boundaries of events, shrink and swell pulsating areas, spread pollution regions, etc.

Animation sequences are widely used now in Earth sciences (geography, geology, oceanology, meteorology, etc.). They comprise a special class of geoimages - spatial and temporal scaled and generalized models of the environmental objects and processes in graphic form. Animation sequences are most suitable for monitoring and dynamic carthometry [1, 2, 8].

Animation sequences can consist of temporarily different images, maps. They can be planimetric or stereoscopic and can represent real objects or abstract models. Their properties depend on the features of primary maps and images, on peculiarities of the surveying and on speed of frame change (temporal scale). Cinema films are displayed with normal speed of 24 frames per second, slow speed - less than 24 frames per second, and fast speed - 500-1000 frames per second. For cartographic films one can use special time scales. For example the scale of 1:86 000 means that 1 second of the film display equals (approximately) to one 24-hour day; 1:600 000 means approximately 1 second : 1 week; 1:2 500 000 - 1 second : 1 month; 1:31 500 000 - 1 second : 1 year. Thus we can classify slow- , medium- and fast-scale cartographic films.

Hence, there may develop absolutely new dynamic generalization problems, i.e. special generalization of images which permits to observe primary, most stable in time properties, typical or long-term tendencies of event and process development. Dynamic generalization adds to the traditional cartographic generalization the needed temporal aspect, but it still unclear, how it can be utilized by researchers. The problem of correlation between the spatial and temporal resolutions of dynamic images and the assessment of visual perception peculiarities when dealing with various dynamic symbols, background colorings, etc. still remain to be addressed within the framework of the operative geoinformational cartography.

## 2 Modeling of dynamics

Correct interactive computer modeling of dynamics can be fulfilled on the base of special software and different temporal images.

The authors in their research used digital models as a base for representation of data for different frames of dynamic sequences, while dynamic sequences consisted of discrete series of temporarily different digital models.

Multitemporal digital models of the geographic fields give comprehensive and correct information on dynamics of the investigated processes, i.e. data on the appearance, development, temporal changes and spatial movements. Obligatory circumstance is the correspondence of multitemporal digital models (including Z parameter or applicate). In this case each digital model can be a base for a precise digital analysis of the modeled objects and processes, while dynamic sequence of the multitemporal digital models allows to determine the changes in spatial position and characteristics of the objects and processes, and to evaluate qualitatively their features and tendencies of the development.

## 3 Dynamic cartomethry

Digital models based on the correct approximation allow to *calculate surface line lengths*, squares of the polygons, volumes, angle of exposition, etc. The ability for operative interactive calculation of these parameters using temporal digital models allows to produce dynamic cartomethry of different events. Real-time comparative cartometric measurements can characterize the quantity and trends of the changes, their rate, relationships between events and, as a result, can produce recommendations to manage these changes. Current parameters of the dynamic event on the display can help calculate carthometric and morphometric characteristics for different periods of time and to extrapolate them.

## 4 Animation maps of the environment

The authors developed methods to produce cartographic images of dynamic digital models using AM system of image processing Pericolor and such software as Arc/Info, ArcCAD and AutoCAD. These methods were tested on series of examples. The authors produced display-films of the dynamics of surface distribution of temperature and gradients of the frontal zone of the north-western part of the Pacific Ocean which characterized seasonal and spatial distribution of these parameters. The authors produced the maps of the dynamics of snow cover depths for the European part of Russia which illustrate spatial and temporal changes of decade values of the mean annual snow depths and depict formation of centers of snow accumulation.

### *4.1 The temperature of ocean*

North-western part of the Pacific Ocean near the shores of Japan and Kurily Islands is characterized by presence of a strong hydrologic front. This front is produced as a result of interaction of subarctic water of the cold current Oiyasio, warm subtropical water of Kurosio current, and deep water of the Pacific Ocean. This zone is often referred as "Subpolar Front" or "Kurosio Front".

The authors of this paper created animation sequences of temperature and temperature gradient changes for the surface layer of the water in north-western part of the Pacific Ocean. They were created on automated system of image processing Pericolor-3000. We used as a data base the decade maps of the surface temperature for the interested part of the Pacific Ocean produced by the Japanese Meteorological Agency for February-July 1983. We processed this data using special software for linear interpolation and calculated 15 multitemporal digital models of surface temperature distribution. As a result we obtained map-frames of temperature distribution for the period from 21 February to 20 July 1983. Each digital model allows to create map-frames of surface temperature and gradients distribution and to obtain different parameters of statistics and probability [8].

Produced animation sequences allow to detect mesoscale peculiarities of surface temperature distribution and their spatial and temporal changes. Continuous animation sequences produced on the display at any speed much better characterize spatial distribution and seasonal changes in surface temperature of ocean comparing with static maps. The frontal zone can be deciphered most successfully while looking at the display film of temperature gradient, since its mean value equals 0.035° C/km here exceeding by more, than the order the mean longitude climatic gradient, which equals to 0.003° C/km for the northern part of the Pacific Ocean. Frontal zone is characterized by the seasonal complex horizontal structure of the vortex type. The series of the well defined frontal zones are outlined with sharp temperature gradients an order exceeding the mean value of the gradient. Maximum horizontal gradients do not differ seriously from summer to winter. Maximum horizontal gradients in northern and southern fronts of Kurošio have close values. Maximum changes of the gradients along the fronts occur between 143° and 146° e.l.

*4.2 The snow cover of Russia*

The authors carried out modeling of spatial and temporal modeling of the distribution of the mean decade annual depths of the seasonal snow cover on the European part of Russia.

Digital models were produced basing on the information from meteostations and their coordinates. TIN (Triangular Irregular Network) module of Arc/Info (version 6.1.1) has been used to create digital models using linear and polynomial interpolation. The last produced the better result. Algorithm of polynomial interpolation was based on two-parametric polynoms of the fifth order. The smoothness of isolines was provided by the division of the each triangle by 100 smaller triangles.

Local variations of the snow depths were smoothed during the transformation of the triangular digital model into regular lattice (2500x2550, i.e. 6 250 000 nodes) using GRID module of Arc/Info and by processing of the grid by two iterations of the standard smoothing weighted filter.

Animation sequence depicts spatial and temporal of the geographic region of the maximum of snow cover accumulation beginning from October and till the middle of April. By the end of April this center begins to move towards the North. Dynamic sequence shows the formation of the independent local maximum of snow accumulation in the upper parts of the basins of Severnaya Dvina and Mezen rivers from the end of December till the beginning of April as well as the formation of some other local centers. Comparing with the spatial stability of the center of the maximum snow cover accumulation, the southern snow line of snow cover extent and isolines of the low values of the snow cover depth (up to 10-15 cm) show severe spatial changes during the winter.

## Conclusion

Dynamic geoimages is a very powerful tool for visualization of the information. It is not a replacement of traditional static cartography, but a supplement which helps to analyze events or processes interrelations both spatially and temporarily.

Our results allow to outline the main tendencies in the development of computer dynamic cartography. First of all these are creation of the dynamic symbol systems and ways to visualize it (symbols or signs, diagrams, isolines, background shadows, fonts), implementation of audio files, as well as the research on the general principles of spatial and temporal generalization which depends on the speed of visualization of display films. The problems of impression of dynamic cartographic sequences as well as the choose of optimum media for storage and dissemination of dynamic cartographic films are of important concern.

The first experiments in creating display-films reflecting space-time landscape dynamics [1-4, 8 and others], glacier movements, changes in snow cover on wide territories, etc. promise further advances in their use for analysis of rapidly changing processes, hazardous situations monitoring, operative assessment of ecological situations.

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