

MOLDOVA STATE UNIVERSITY
Research and Innovation Institute
Scientific Research Laboratory
Environmental Physics & Modeling Complex Systems

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HR EXCELLENCE IN RESEARCH

On the equilibrium states of thermodynamic systems in a small vicinity of the equilibrium values of parameters

NARD&MSU supported research project #20.80009.7007.05

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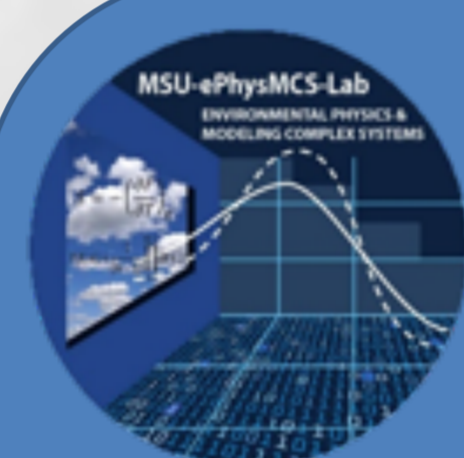
APPLICATION FIELD: Modeling of complex systems, Dynamical systems, Computer modeling and forecasting of the impact of biotic and abiotic factors

AIM: NARD&MSU supported applied research project “Monitor3D” (#20.80009.7007.05, 2020-2023) is focused on the development of civil applications based on UAV with high potential in environmental monitoring and pollution control in the real-time regime, as well as systemic analysis and interpretation of the monitoring results. Development of the related applications for computational modeling and forecasting of the environmental factors based on the complex system concepts, in connection with modern optical technologies and different types of UAV-based sensors for the real-time precise measurements, will facilitate the analysis and interpretation of the monitoring results.

Dynamic behavior of thermodynamic systems described by a single order parameter and several control parameters is studied in a small neighborhood of ordinary and bifurcation equilibrium values of the system parameters.

We performed an exhaustive analysis of the order parameter dependences on the control parameters in a small vicinity of the equilibrium values of parameters, including the stability analysis of the equilibrium states, and the asymptotic behavior of the order parameter dependences on the control parameters (bifurcation diagrams).

The novelty value of the research results refers indeed to the complete list of canonical forms and bifurcation diagrams, as well as the sensitivity analyses of the ordinary and bifurcation equilibrium values of the order parameter as a function of control parameters, and the estimation of the phase transition time. We also consider important from both theoretical and practical point of view represented in a general form results relating to the analysis of the sensitivity of parameters describing the equilibrium states of dynamical (thermodynamic) systems for both ordinary and bifurcation values of parameters. These results are an important generalization of the well-known form of the equation of state in differential form, which is referred to as the “cyclic identity” in thermodynamics (A.A. Barsuk, F. Paladi, J. Stat. Phys. 171 (2018) 361), that is, one can rewrite the partials in terms of other partials using the cyclic and reciprocity relationships.



Advanced physical technologies with the UVS application in monitoring and modelling of environmental factors (Monitor3D, 2020-2023)

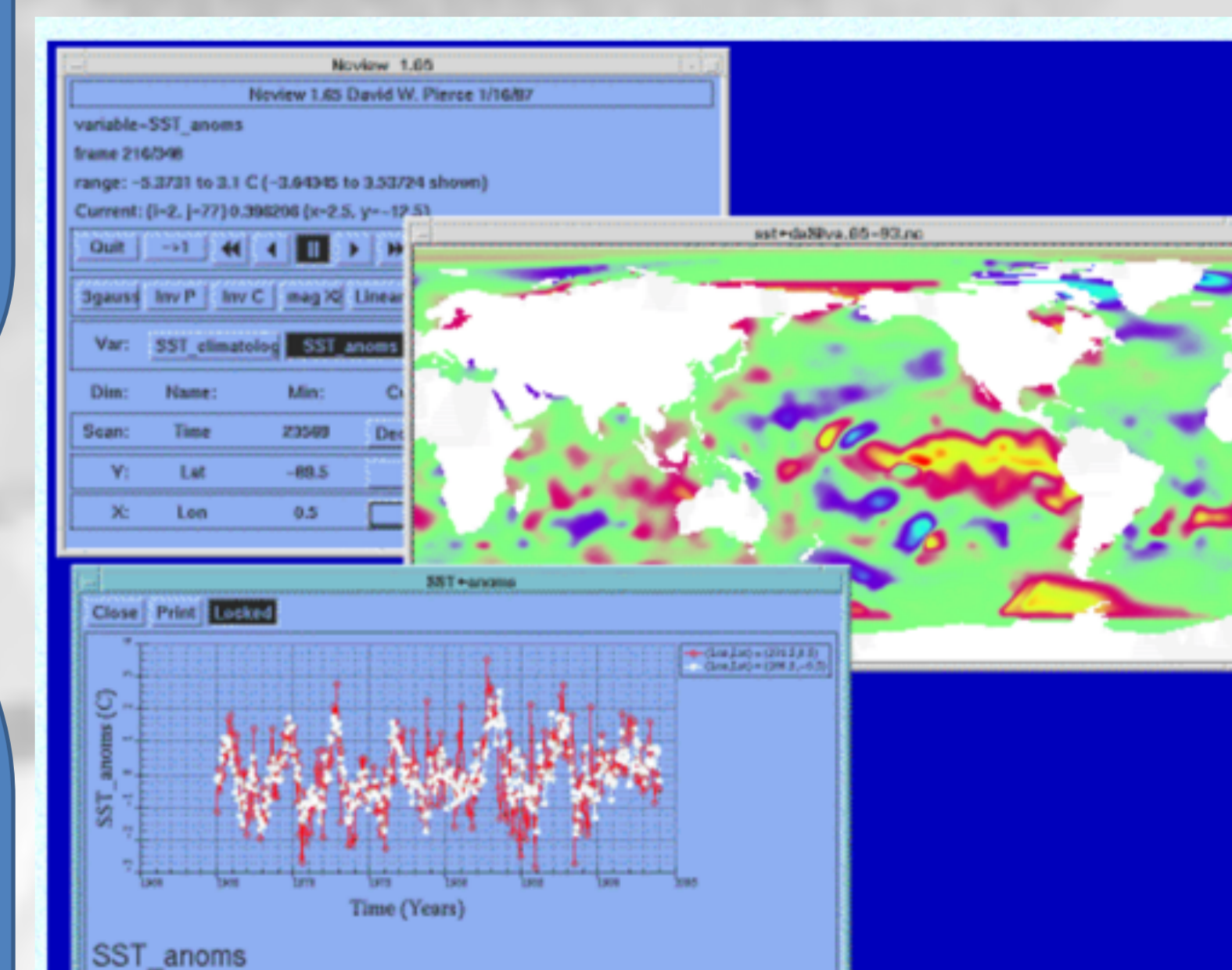
Main NOVELTY of the project is the symbiosis of advanced physical technologies developed in the research laboratories of the Moldova State University (MSU/USM) in environmental factors monitoring with the application of drones, and the use of these exact data obtained in the real-time regime for modeling the impact of biotic and abiotic factors on the environment and society with the possibility of forecasting dangerous natural hazards and health effects of the PM-pollution.

Monitoring, modeling and forecasting of the environmental factors:

- Application of drones in the air quality monitoring with dust and gas sensors.
- Collection of current and historical metrological data.
- Use of drones to investigate remotely the health of plants, based on the excitation of fluorescence spectra under the influence of laser radiation.
- Determination of the exact location of environmental pollution sources, composition and concentration of gases emitted into the atmosphere, time and frequency of these emissions.
- Development of the related computer modeling software for analysis and interpretation of the monitoring results, as well as for forecasting environmental conditions.
- Provide with effective and efficient instruments to transfer new knowledge to professionals through the Program of Professional Continued Education “Educational for Drone”, developed in the Office for Education for Drones at the Moldova State University, <http://moodle.usm.md/moodle/course/index.php?categoryid=208>

GEOS-Chem

Advance understanding of human and natural influences on the environment through a comprehensive, state-of-the-science, readily accessible global model of atmospheric composition.

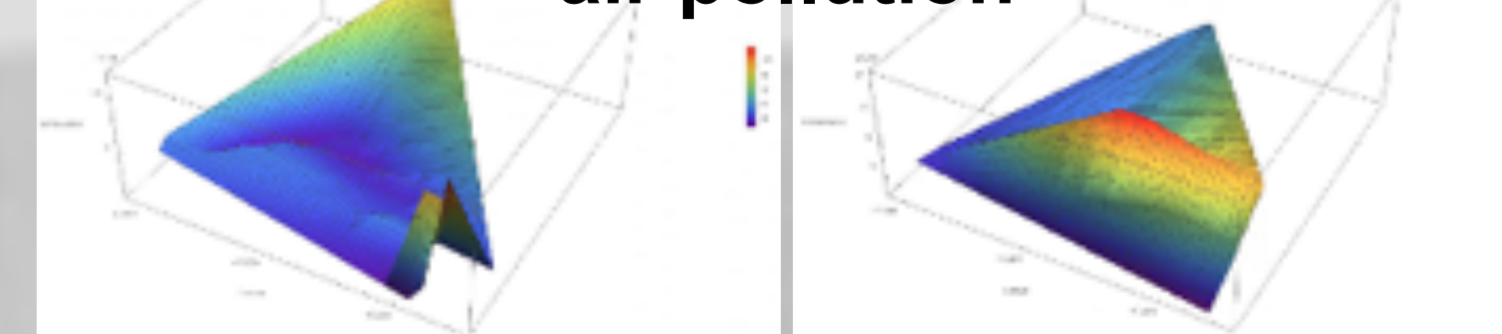


MSU lab “Environmental Metrology and Astronomy” in Lozova, Strasenii



Pix4DMapper photogrammetry

Concentration of PM₁₀ and PM_{2.5} air pollution



ADVANTAGES: Application of the advanced physical and computational techniques for solving the problems in environmental monitoring and complex system modeling

IMPLEMENTATION STAGE: Ongoing applied research project. WEB: <http://ephsimlab.usm.md>