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Detection of mesoscale zones of atmospheric instabilities using remote sensing and weather forecasting model data

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The paper presents elements of research conducted in the Faculty of Civil Engineering and Geodesy of the Military University of Technology, Warsaw, Poland, concerning application of mesoscale models and remote sensing data to determining meteorological conditions of aircraft flight directly related with atmospheric instabilities. The quality of meteorological support of aviation depends on prompt and effective forecasting of weather conditions changes. The paper presents a computer module for detecting and monitoring zones of cloud cover, precipitation and turbulence along the aircraft flight route. It consists of programs and scripts for managing, processing and visualizing meteorological and remote sensing databases. The application was developed in Matlab® for Windows®. The module uses products of COAMPS (Coupled Ocean/Atmosphere Mesoscale Prediction System) mesoscale non-hydrostatic model of the atmosphere developed by the US Naval Research Laboratory, satellite images acquisition system from the MSG-2 (Meteosat Second Generation) of the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and meteorological radars data acquired from the Institute of Meteorology and Water Management (IMGW), Warsaw, Poland. The satellite images acquisition system and the COAMPS model are run operationally in the Faculty of Civil Engineering and Geodesy. The mesoscale model is run on an IA64 Feniks multiprocessor 64-bit computer cluster. The basic task of the module is to enable a complex analysis of data sets of miscellaneous information structure and to verify COAMPS results using satellite and radar data. The research is conducted using uniform cartographic projection of all elements of the database. Satellite and radar images are transformed into the Lambert Conformal projection of COAMPS. This facilitates simultaneous interpretation and supports decision making process for safe execution of flights. Forecasts are based on horizontal distributions and vertical profiles of meteorological parameters produced by the module. Verification of forecasts includes research of spatial and temporal correlations of structures generated by the model, e.g.: cloudiness, meteorological phenomena (fogs, precipitation, turbulence) and structures identified on current satellite images. The developed module determines meteorological parameters fields for vertical profiles of the atmosphere. Interpolation procedures run at user selected standard (pressure) or height levels of the model enable to determine weather conditions along any route of aircraft. Basic parameters of the procedures determining e.g. flight safety include: cloud base, visibility, cloud cover, turbulence coefficient, icing and precipitation intensity. Determining icing and turbulence characteristics is based on standard and new methods (from other mesoscale models). The research includes also investigating new generation mesoscale models, especially remote sensing data assimilation. This is required by necessity to develop and introduce objective methods of forecasting weather conditions. Current research in the Faculty of Civil Engineering and Geodesy concerns validation of the mesoscale module performance.