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EDITORIAL

Special Issue on the use of GIS in Climatology and Meteorology

Over the last decade, research has greatly increased into the use of Geographical Information Systems (GIS) in a variety of applications that involve the processing of climatological and meteorological data. This upsurge of interest is related directly to the fall in price of 'commercial off-the-shelf' GIS products together with large advances in computer processing ability. Add to this the proliferation of the Internet and the result is a set of fast real-time bespoke solutions and visualisations for many national meterological services and end-users.

This Special Issue of Meteorological Applications would not have been possible without the help of Guest Editors Izabela Dyras (Polish Meteorological Institute) and Olga Wilhelmi (National Center for Atmospheric Research, USA) to whom I express my sincere thanks. I would also like to thank all members of the COST719 programme, especially the Management Committee and Chairperson Hartwig Dobesch.

Direct meteorological observations (e.g. from rain gauges, thermometers and anemometers), or indirect observations (e.g. from satellites or weather radars) provide different thematic layers of information that can be useful new parameters describing the state of the atmosphere. In particular, GIS methods allow the detailed analysis of spatial patterns of various atmospheric parameters, providing an in depth look into the regularities and variability of weather and climate over time and space. Many climatic parameters are strongly dependent on geographical factors such as topography, land use and vegetation height (to name the most important ones). This is why GIS applications in meteorology and climatology have been successful, bridging the gap between scientists developing GIS techniques, geographers and atmospheric scientists. GIS has been used in meteorology and climatology in both the USA (see the NCAR GIS website: http://www.gis.ucar.edu/) and Europe (see the COST719 website: http://www.knmi.nl/samenw/cost719/). This special issue highlights some frontier work in GIS Applications in Europe. The collection of European papers presented in this issue came from individual contributions to the *Session GIS in meteorology and climatology* held at the EGU Congresses in 2003 and 2004.

The issue begins with the paper *The Use of Geographical Information Systems In Climatology and Meteorology, COST719* (Dyras et al.) summarising the main objectives of the Action COST719. These include establishing interfaces between GIS and meteorological data; assessing the availability, contents and accessibility of meteorological and climatological data sets; and finally encouraging and fostering European co-operation. The article also depicts the work structure through three working groups and describes the state of the demonstration projects. The Action COST719 is expected to result in recommendations for better data sharing and common file formats and more cost-effective production of meteorological and climatological information. The implemented workplan so far has already improved co-operation between the European countries in GIS applications in the field of meteorology, climatology and environmental sciences.

The general structure of COST719 sets the format of this publication, dividing the articles info three categories. The first series of articles deal with data standards, accessibility and interoperability issues and technology. The next series refer to spatialisation techniques, and finally examples of GIS applications show the potential of GIS for meteorology and climatology.

The paper *Spatial data infrastructure for meteorological and climatic data* (van der Wel) describes the UNIDART project. This project aims to connect heterogeneous databases from different locations, access them from a simple web interface, and present them to an end user as one virtual database. The next paper *Standards based data interoperability in the Climate Sciences (GIS)* (Woolf et al.) concentrates on developments in GIS and distributed computing leading to a spatial data infrastructure in the climate sciences. Using ISO standards, an abstract data model is developed and applied to a range of climate data – both observational and modelled. A Web Map Server interface is constructed and a W3C web service for the remote access of gridded climate data is illustrated. Such an approach is not free of challenges. However, broad data interoperability for the climate sciences does seem possible. The next paper, *Developing A*

Model For GIS Applications In The National Hydro-Meteorological Service Of Poland (Barszczynska et al.) discusses the background and recent developments of GIS applications in the national hydro-meteorological service of Poland (IMWM). Several examples of GIS use are included. A combination of hydrological and hydraulic analysis with spatial analysis allows the determination of flood risk areas, dividing them into zones and comparing information about buildings at risk.

The article *Ecoclimap: a global database of land surface parameters at 1-km resolution* (Champeaux et al.) bridges aspects of data distribution over the World Wide Web and spatialisation techniques. It presents the ECOCLIMAP database available online to the research community. The method used to derive leaf area index, vegetation fraction, albedo and other parameters from land cover maps, climate maps and NDVI data is presented. The vegetation parameters are deduced from satellite data for each month, climate and continent. The dataset is useful for grid-nested models, providing a coherent surface between all the models. The next paper *GIS based regionalisation of radiation, temperature and coupling measures in complex terrain for low mountain ranges* (Häntzschel et al.) focuses on the interactions between relief and land use in low mountain range areas with complex topography and their impact on climate. GIS is used to study the radiation balance, temperature and evapotranspiration by combining a radiation model and a vegetation-atmosphere model. The coupling and feedback mechanism between vegetation and atmosphere of small-scale heterogeneous areas are studied. The results are applicable to water budget modelling, forest management, and alternative energy supply or downscaling of satellite information. *Application of GIS for the development of climatological air temperature maps: an example from Poland* (Ustrnul et al.) is focused on the construction of air temperature maps for the territory of Poland. Several spatial interpolation methods are presented, however, the residual kriging – was chosen for mapping. Several geographic parameters, including elevation, latitude, longitude, and distance to the Baltic coast were used as predictor variables for air temperature interpolation. The results are demonstrated using temperature parameters such as length of growing season, duration of thermal summer and winter, and degree day accumulation. The paper shows that GIS tools enable the easy calculation and display of the area with specified thermal conditions in addition to using GIS maps for climate monitoring.

The paper *Champagne GIS paper (GIS)* (Madelin et al.) presents a spatial interpolation method for estimating impacts of the minimum temperatures and geographic and topographic factors on Champagne production. The maps of the frost hazard in the vineyard were created from data collected for five recent springs (1998–2003). This made it possible to create a map of the average estimated minimal temperatures for the whole vineyard, so wine growers can identify the frost sensitive areas. The model estimations are compared with the observed frost damage to the yield during spring 2003 and a fairly good agreement between observed and predicted frost is found.

The introduction of GIS has opened new possibilities which enable the combination of data from the different sources. The paper *A GIS-based agro-ecological decision system based on gridded climatology* (Tveito, et al.) describes recent achievements in Norway concerning the development of an agro-meteorological decision system. Such a system combines gridded weather information with soil and crop data. The interpolation schemes take advantage of terrain information. The soil moisture model is used to estimate the soil water content, determining the soil suitability for tillage and sowing. The system also includes a phenological model for identification of suitable days for cereals harvesting. This approach shows the benefits of applying GIS and distributed geo-data in interdisciplinary applications. It is a valuable contribution to soil capability assessments. The paper *Application of GIS technology for precipitation mapping* (Dyras & Serafin-Rek) presents research undertaken for the Central Europe region for the estimation of stratiform and convective precipitation from satellite microwave data. The results of regression analysis are presented in the form of maps of precipitation intensity and range distribution. The temperature and precipitation thematic layers are created from the Numerical Weather Prediction model gridded data. Other data such as synoptic observations and air temperature are converted into thematic layers and used for validation and verification.

The paper *Site Selection for a Very Large Telescope using GIS techniques* (Graham et al.) describes how GIS techniques can be used to select an ideal site for a giant telescope. A composite database, mainly consisting of ECMWF and NCEP-NCAR Reanalysis data, has been designed and built. A preliminary version of the interactive GIS interface and a database is available on the World Wide Web. The authors have shown that the Java computing language can create user-friendly interfaces, as well as perform simple mathematical and GIS examination of climatological and geomorphological databases. Another GIS application for the winter maintenance of roads is discussed in *XRWIS in Poland* (*GIS*) (Thornes et al.) The IceMiser GIS model has been used to study the microclimate of the road between the City of Krakow and the mountainous border with Slovakia. The results indicate that the model was able to forecast road surface temperature (RST) for the study route with a high level of accuracy. At best, the model forecast RST with 100% accuracy, with a bias of just 0.15°C. Additionally, the model was able to forecast the time of freezing and daily minimum RST accurately.

The final paper *Application of GIS for processing and establishing the correlation between weather radar*

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reflectivity and precipitation data (Gorokhovich & Villarini) uses GIS to calculate the correlation between weather radar reflectivity and precipitation data, an application useful for distributed hydrologic modelling and early warning systems for flood management.

The future for the use of GIS by atmospheric scientists is bright but increased collaboration between the GIS and atmospheric communities is limited by information infrastructures that don't easily interoperate. For example, data sharing is hampered by a host of different file formats and delivery services, often vendor specific. While the 'same data' may be available in a GeoTIFF file or a netCDF file, or through an OPeNDAP or ArcIMS service, completely different software and APIs are needed for each case. As well, there are often incompatibilities between underlying conceptual models used in the two communities (for example traditional GIS are typically two-dimensional, while atmospheric data are fundamentally four-dimensional). A number of recent standards developments offer renewed hope for pervasive GIS-atmospheric data interoperability. Such interoperability requires agreements on metadata schemas, data structures, and network services. New ISO standards for geographic information and geomatics address these issues in detail. Together with the standards for online services being developed by the Open Geospatial Consortium (OGC) and World Wide Web Consortium (W3C), a new era of data interoperability seems feasible. Enhanced data sharing will provide considerable benefits, particularly for climate change impact studies and decision support systems (Woolf, personal communication).

The papers presented here illustrate the use of GIS in meteorology and climatology and address the issues of spatial data management and distribution. Once again, we thank all the authors for their contributions. Thanks should be also sent to the reviewers for their efforts in editing and improving the quality of the manuscripts.

John Thornes
University of Birmingham

Guest Editors: Izabela Dyras (Polish Meteorological Institute) and Olga Wilhelmi (National Center for Atmospheric Research, USA)

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