Monitoring a changing climate

High quality data is the key to good environmental research. Here, **Dr Albert Klein Tank** discusses work on building a knowledge base of information about Europe's climate; efforts that will help improve understanding and prediction of climate variability and change

Can you begin by outlining the history and objectives of the European Reanalysis and Observations for Monitoring (EURO4M) project?

The goal of EURO4M is to meet the need for timely and reliable monitoring information about the state of the climate in Europe. The focus is on weather and climate extremes. Working with consortium members who have a long track record in observational data, we set out to develop the capacity for, and to deliver, the best possible and most complete gridded climate change time series and monitoring services covering all of Europe. This will address the current situation of fragmentation and scarcity of long-term climate change information for Europe.

Who are the primary target users of this project?

EURO4M will reach out with innovative and integrated data products and climate change services to policy makers, researchers, planners and citizens at European, national and local levels. The project results will directly address the needs of stakeholders such as the European Commission for their climate actions and the European Environment Agency for their environmental assessment reports. At the national (and local) level, a wide range of users in different societal areas benefit from the project outcomes as these provide a reference for coordination across country borders and across different sectors.

Could you describe which observation techniques you have employed?

The reference historical databases developed in EURO4M contain climate data records from satellites (which are spatially extensive but short), in situ observations (which consist of long-term records but are spatially sparse) and regional reanalyses of past weather (which are complete but expensive). Due to computational constraints and input data limitations, regional reanalyses typically cover a time period up to 20-30 years. Most users need information about longer-term changes too. In particular, information about secular trends and changing probabilities of high-impact extremes (such as flooding or heat waves) cannot be derived from relatively short reanalyses datasets only. Therefore, in EURO4M the reanalyses will be combined with multi-decadal satellite data and century-scale (interpolated/gridded) station observations.

Can you offer an insight into some of the innovative and tailored products that you are producing to improve climate change services for society?

To improve the climate change services for society we will develop Climate Information Bulletins or CIBs. These are user-orientated bulletins which add value through the integration of different data sources and provision of impact relevant indicators. The CIBs are based on basic data, but overcome the barriers to utilising the high data volumes available in most databases. The bulletins present and describe trend patterns for a core set of impact relevant indicators. The initial set of climate change indicators chosen for this purpose will follow the globally defined list of indices reported in the IPCC reports. Future CIBs will respond to evolving user requirements defined by different stakeholders in Europe. The bulletins will be disseminated through a web interface and as hardcopy. They will be issued in near real-time during emerging extreme events.

How will you disseminate the data gathered to the user community, stakeholders, policy makers and the general public?

The basic data products developed in EURO4M will be distributed mainly through existing systems and the scientific results will be published in peer-reviewed scientific and technical journals. The multi-purpose products are disseminated through the regularly issued CIBs which will focus on user groups and downstream services that do not have the required expertise and knowledge to access and process the terabytes of raw observation data or reanalysis data. CIBs will provide simple, effective and timely knowledge abstractions from EURO4M data and activities. The CIBs will be flexible and optimal products that will be responsive to current environmental and climatic events, extremes and also user needs.

How will your work help shape future climate research?

The ideas for climate information services developed and tested in EURO4M will help pave the way for a future climate component of Global Monitoring for Environment and Security (GMES), the European initiative for the establishment of a European capacity for Earth observation. The datasets and information products which will be developed in the project are key building blocks for the knowledge base of a future GMES Climate Service, which has the ambition to provide information that meets the user needs on an operational basis.

Reanalysing and observing the Earth's climate

EURO4M brings together a consortium of climate experts who are evaluating data on the state and evolution of Europe's weather; research which will enable access to timely and reliable climate change information

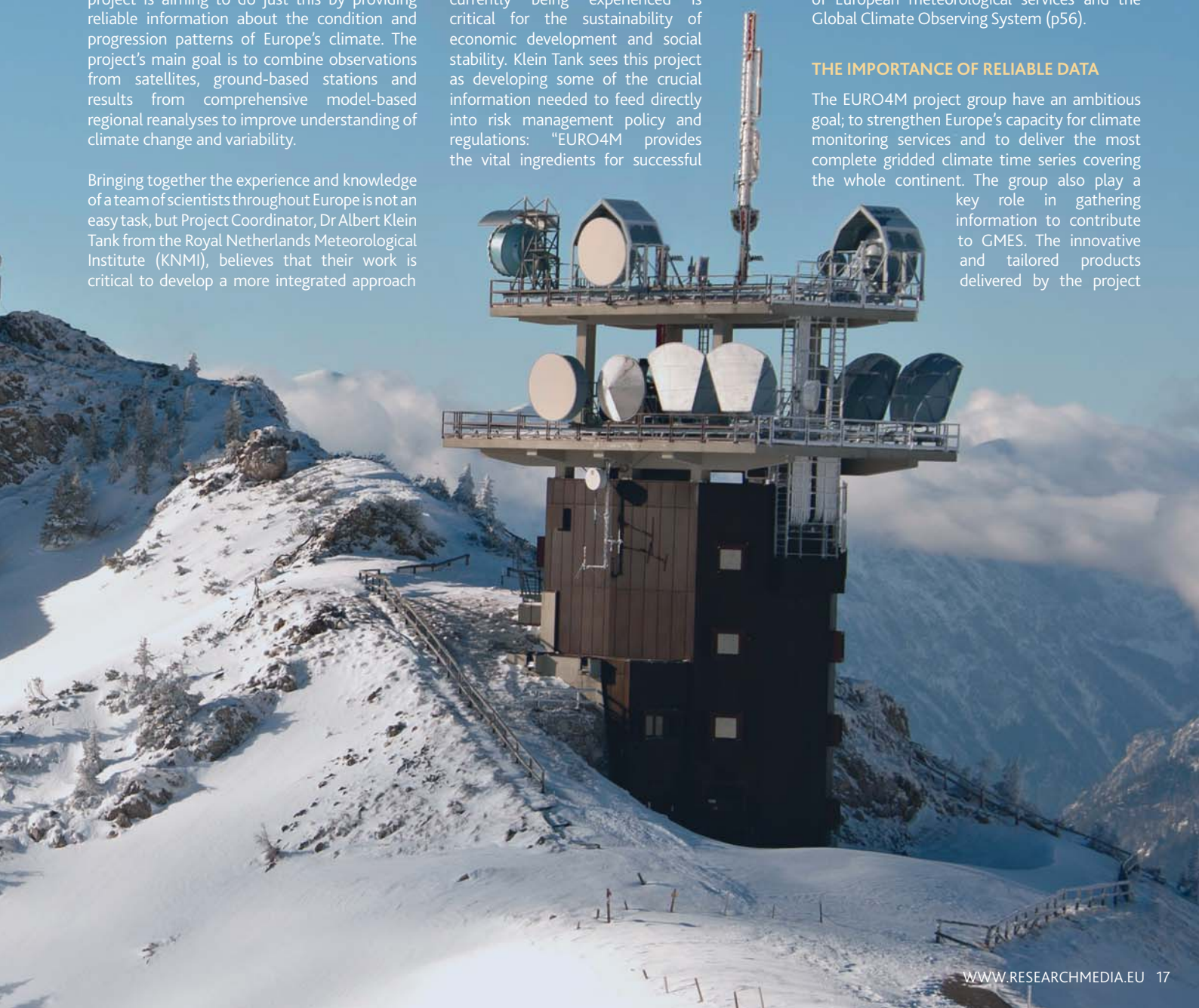
CLIMATE CHANGE IS one of the highest profile topics currently facing environmental scientists around the globe. As part of the Europe's adaptation response to the world's changing climate, researchers are gathering data and building knowledge about changes in weather patterns and cycles. In order to understand the impact these changes are having on the weather, and to be able to more accurately predict the future climate, there is a pressing need to build a picture of how recent changes, fluctuations and extremes are related to longer-term cycles and patterns. The European Reanalysis and Observations for Monitoring (EURO4M) project is aiming to do just this by providing reliable information about the condition and progression patterns of Europe's climate. The project's main goal is to combine observations from satellites, ground-based stations and results from comprehensive model-based regional reanalyses to improve understanding of climate change and variability.

Bringing together the experience and knowledge of a team of scientists throughout Europe is not an easy task, but Project Coordinator, Dr Albert Klein Tank from the Royal Netherlands Meteorological Institute (KNMI), believes that their work is critical to develop a more integrated approach towards climate observations: "This project will develop the capacity required for state-of-the-art and user-orientated products for monitoring of climate change at the European scale". In addition, he says that EURO4M will also focus on liaison with the user community to find out what their requirements are and how the project can respond in the best possible way, which means that the climate change monitoring services being developed will be fully complimentary and supportive of existing operational services.

Society's ability to manage the risks associated with the extreme weather and climate events currently being experienced is critical for the sustainability of economic development and social stability. Klein Tank sees this project as developing some of the crucial information needed to feed directly into risk management policy and regulations: "EURO4M provides the vital ingredients for successful monitoring of weather and climate extremes across Europe". This includes information about changes in the statistics, such as return values for events that occur up to once in 20 to 50 years, which Klein Tank emphasises is important to ensure an optimal level of adaptation. EURO4M is funded by the European Union and is a collaborative effort of nine partners, based in the UK, Holland, Spain, Romania, Switzerland, Germany, Sweden and France. The team also has special arrangements with key international organisations, including the European Environment Agency, the European Centre for Medium-Range Weather Forecasts, the network of European meteorological services and the Global Climate Observing System (p56).

THE IMPORTANCE OF RELIABLE DATA

The EURO4M project group have an ambitious goal; to strengthen Europe's capacity for climate monitoring services and to deliver the most complete gridded climate time series covering the whole continent. The group also play a key role in gathering information to contribute to GMES. The innovative and tailored products delivered by the project



INTELLIGENCE

EURO4M

EUROPEAN REANALYSIS AND OBSERVATIONS FOR MONITORING

OBJECTIVES

To develop the capacity for and deliver the best possible and most complete gridded climate change time series and monitoring services covering all of Europe.

PARTNERS

Royal Netherlands Meteorological Institute, The Netherlands • **Met Office**, UK • **University Rovira i Virgili**, Spain • **National Meteorological Administration**, Romania • **Federal Office of Meteorology and Climatology MeteoSwiss**, Switzerland • **Deutscher Wetterdienst**, Germany • **Swedish Meteorological and Hydrological Institute**, Sweden • **Climatic Research Unit, University of East Anglia**, UK • **Météo France**, France

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improve the climate change services for society and support adaptation to a changing environment. "Whilst EURO4M provides a time series showing the changes in climate over time," explains Klein Tank, "the project also enables reporting in near real-time during emerging extreme events". Through the high-resolution datasets that are being produced by EURO4M, observed high-impact weather and extreme events can be placed in a long-term historical context. This is being done by optimising the use of all conventional and satellite sources through seamless integration of data from the satellite era (back to the 1970s) with early instrumental observations (back to the mid-19th Century).

Being able to access real-time data about the climate is a critical part of providing the user community, stakeholders and policy makers with the up-to-date information that they vitally need. However, the processing and integration of this kind of data often requires a considerable amount of time. Klein Tank believes that the way to satisfy the need for near real-time data will be achieved through producing different versions of the datasets and information products: "With this strategy we will be able to provide online reporting during emerging extreme events as well as high quality summary statements at regular intervals". He explains that they will be developing a quick version which can be used immediately after the observation is taken, as well as a delayed version which optimally integrates all available observational information.

> EURO4M provides the vital ingredients for successful monitoring of weather and climate extremes across Europe

SUCCESS LIES IN REANALYSIS

In addition to delivering real-time data, the EURO4M project team is also keenly aware of the need to make sure that the information they offer is as accurate and reliable as possible. The difficulties lie in the quality and availability of the historical data on climate extremes and also that people have high expectations about how easily accessible data on weather and climate is. Klein Tank likes to use the recent debate about the quality of the global surface temperature record to illustrate the continuous work which is needed to derive 'climate quality' datasets of essential climate variables, such as temperature and precipitation. Approaches to achieve quality assurance within the EURO4M project include comparing and evaluating the data from different sources as well as assimilating climate observations into very detailed and state-of-the-art weather forecasting models for the European domain: "The great benefit of reanalysis is that it provides a complete and consistent picture of the atmosphere, covering the whole of the three-dimensional domain, not only of the observed variables, but also of those that are not directly measured," Klein Tank states.

The EURO4M project has been underway since April 2010 and after little over a year, the project group has achieved some successful results. Existing station-based gridded datasets for Europe have been further developed, updated and published through the project work. EURO4M partners have worked with existing data recovery and digitisation activities to improve the climate databases for the European region and extend the time series backwards. In addition, model-based European regional reanalysis capabilities have been further developed. Klein Tank feels some of the most promising results are being seen in the first evaluations of some of these reanalysis systems against in situ observations: "A comparison of existing methods for further downscaling has been completed and work has started to improve the input data for the regional reanalyses in the project". To aid the dissemination of the user-orientated information and products, a Climate Liaison Team has been set up. One of the important roles of this team is to implement a user feedback loop by compiling user requirements and providing scientific guidance on the best ways to communicate and use the EURO4M products and services. With just under three years of project time remaining, it would seem that EURO4M will be eminently capable of delivering the much needed improvements in Europe's understanding and prediction about climate variability and change.