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Climate service development, delivery and use in Europe at monthly to inter-annual timescales

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ABSTRACT

Climate services have become the focus of major international coordination activities over the past few years. In 2012 the Global Framework for Climate Services (GFCS) was approved and will be led by several United Nations Agencies, to strengthen and coordinate existing initiatives and develop new infrastructure where needed to meet society's climate-related challenges. At European level the European Commission has allocated almost 27 million Euros from 2012 to 2016 towards the science behind seasonal and decadal climate services effectively putting Europe at the forefront of the international effort in developing this field.

One of the main challenges climate service will face is the bridging of the so called valley of death: the divide still existing between climate science and decision-makers. Managing the multiple boundaries between producers and users of climate information is now of crucial importance. The concept of codesign and more generally of co-generation of knowledge is key to success of the new generation of climate services which need to be perceived as being not only credible scientifically but also salient and legitimate. In order to improve on the current setup it is essential for researchers to work on topics which could directly impact on the decision making process.

The paper presents some of the key challenges and open questions climate service science will face in the coming years.

Climate services have become the focus of major international coordination and development activities over the past few years. In 2009 the World Climate Conference-3 brought together heads of states, government ministers, industry representatives, and scientific and technical experts who laid out the clear need for climate services. In 2012 the Global Framework for Climate Services (GFCS) was approved by governments worldwide at the Extraordinary World Meteorological Congress. In parallel to the GFCS, climate service providers, users and funders are collaborating through an informal Climate Services Partnership, to further ensure climate services are effectively developed, delivered and used (see Vaughan and Dessai, 2014 for a recent review).

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Building upon such international efforts, there are major research projects underway to improve the underpinning climate science, promote the development of new applications and actively engage with users of climate services. Here we present some of the key challenges and open questions climate service science will face in the coming years.

Improved scientific knowledge of the processes controlling climate predictability has the potential to improve climate-influenced decisions. Whilst it is essential to improve our understanding of the climate and its impact on our activities, this cannot occur in isolation and should instead ensure that users and producers of climate information effectively work together. Bridging the so-called 'valley of death' between users and providers is recognised as a key priority for climate services but currently there is limited understanding on how this should be done (Cash et al., 2006). Empirical research has shown that a range of contextual and intrinsic factors affect the use of information in decision making, e.g., informal and formal institutional barriers, decision and policy goals, spatial and temporal resolution, quality-level required to utilise the information and the level of trust between information producers and users.

One challenge is that climate scientists are often motivated by curiosity and a desire for a deeper understanding of the processes controlling weather and climate and their variability, whilst the majority of decision makers require the minimum amount of, or easiest to obtain, knowledge to sufficiently inform their decisions. This motivational divide can create a disconnection between real and perceived needs of decision makers.

Working on the interactions between providers and users of climate information is thus of crucial importance. Identifying effective ways to co-design and co-generate climate services with the users is becoming one of the most important challenges that climate service science needs to tackle (Lemos and Morehouse, 2005; McNie, 2008). The co-design process is needed to develop knowledge that is scientifically credible, trustworthy, relevant and actionable (Cash et al., 2003).

The current situation can be improved by researchers prioritising work on topics which directly impact on decision-making processes; for example focusing research effort on the parameters, timescales, and spatial scales that are most relevant to users. Rather than undermining the need for fundamental research, this shift in priority should be seen as an attempt to focus some of the international research effort on user-relevant science (Stokes, 1997). This can in turn help making some essential observational and modelling activities more visible and attractive to a wider community. In order to be effective in addressing specific problems the development of scientific knowledge needs to become more flexible, iterative and interactive (Kirchhoff et al., 2013).

There are a number of challenges climate science is facing in the generation of reliable and skilful predictions on decision-relevant time horizons. Climate simulations try to represent the future, and past, evolution of the climate system over timescales that range from a few weeks, through seasons, years, decades and centuries. For many climate-influenced decisions, prediction times of months to a decade are likely to be the most important. Making predictions with such lead times largely relies on the existence of relatively slow, and hence predictable, variations in quantities such as the moisture in the soil, snow cover, sea-ice and ocean temperatures (Shukla and Kinter, 2006), and how the atmosphere interacts with and is affected by these conditions. In addition, the observed evolution of temperature and other climate variables at the seasonal and longer timescales can also be considered as externally forced low-frequency variability due to human-induced changes in greenhouse gas (GHG) and aerosol concentrations, land-use changes as well as natural variations in solar activity and volcanic eruptions, superimposed on the natural variability of the system.

At seasonal timescales, the El Niño-Southern Oscillation (ENSO; Chang et al., 2006) is the main process that contributes to the forecast quality on seasonal timescales (van Oldenborgh et al., 2005) and its understanding and modelling has been the main target of the scientific community. Efforts to formulate forecasts at the sub-seasonal timescale have only recently begun with the development of a Madden–Julian Oscillation (MJO) prediction metric and a common approach to its application amongst a number of international forecast centres (e.g., Gottschalck et al., 2010) and operational dynamical forecast systems that target predictions of both intra-seasonal tropical variability (Rashid et al., 2010), tropical cyclones (Elsberry et al., 2009) and extra-tropical weather types (Vitart and Molteni, 2010). The recently created Sub-seasonal-to-Seasonal Prediction Research Project[1] aims to create a multi-model operational system for climate prediction at those timescales.

Timescales beyond a few months have also been considered in dynamical predictions (e.g., Smith et al., 2007; Doblas-Reyes et al., 2013a). These efforts bridge the timescales between seasonal and multi-decadal forecasting problems, and show that other modes of variability, particularly in the North Atlantic, have skill with respect to simple benchmarks beyond the first forecast year.

Two types of prediction methods are typically used, those based on either statistical-empirical approaches or on process-based dynamical systems. Scientists developing each method might feel tempted to compete to demonstrate which one is best, but both types are complementary because advances in statistical prediction are often associated with enhanced understanding, which usually leads to improved dynamical prediction, and vice versa (Doblas-Reyes et al., 2013b; Kirtman et al., 2013). This collaborative approach should be favoured for the users' benefit.

Due to the chaotic nature of the climate system and the inadequacy of current forecast systems, quantifying forecast uncertainty plays an important role in climate forecasting (Palmer, 2000). This is because a priori estimates of the uncertainty can be used as predictors of the forecast error, a fundamental element of a forecast when making informed decisions. Two of the main sources of uncertainty in dynamical climate prediction are the lack of perfect knowledge of the initial conditions of the climate system and the inability to perfectly model this system (Slingo and Palmer, 2011).

[1] http://www.wmo.int/pages/prog/arep/wwrp/new/thorpex_new.html