I REACT

IMPROVING RESILIENCE TO EMERGENCIES THROUGH

ADVANCED CYBER TECHNOLOGIES

Climate Change Model

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[1] **PU** = Public, **PP** = Restricted to other programme participants (including the Commission Services),
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1 INTRODUCTION

Climatic change is the name used to refer to variations in the Earth's climate. Throughout our history, the planet has undergone numerous climate changes due to natural phenomena. In the last 650.000 years, there have been many cycles of glacial advance and retreat with the last retreat occurring approximately 7.000 years ago when our modern climate era began. This last climate changes probably responded to Earth's orbit variations that changed the amount of incoming solar energy.

The analysis of long-term weather observations available throughout the 20th and 21th centuries clearly shows significant trends in global temperature rise, ocean warming, ice sheet retreat, increases in extreme weather events, and sea level rise among other evidences. By contrast with previous climate changes in Earth's history, the current climate change is particularly significant because it is highly related to human activity since the mid-20th century. The reason is clear: the increase of natural greenhouse gases caused by burning fossil fuels has a physical impact on the transfer of infrared energy through the atmosphere and therefore causing the Earth to warm-up. This fact today is not questionable because there is extensive scientific background support. Indeed, the current global warming is especially alarming because it is occurring about 10 times faster than the average rate of ice-age-recovery warming[1]. Consequently, mitigation and adaptation measures need to be implemented globally. On the one hand, mitigation measures will help to slow down and reverse the current anthropogenic contribution to climate change whereas adaptation measures will help to be prepared for that climate change which is expected to be irreversible.

According to the European Environment Agency (EEA), climate-related extreme weather events such as heat waves, heavy precipitation and droughts are increasing in frequency and intensity in many European regions. The Fifth Assessment Report (AR5) of Intergovernmental Panel on Climate Change (IPCC) has projected that surface temperature is expected to rise in 21st century for any analysed scenario. As the world has warmed up (Figure 1-1), the resulting increase in evaporation has led to increased water vapour in the atmosphere resulting in more intense precipitation. This, together with rapid snow melting, increases the likelihood of floods.

[1] https://climate.nasa.gov/evidence/

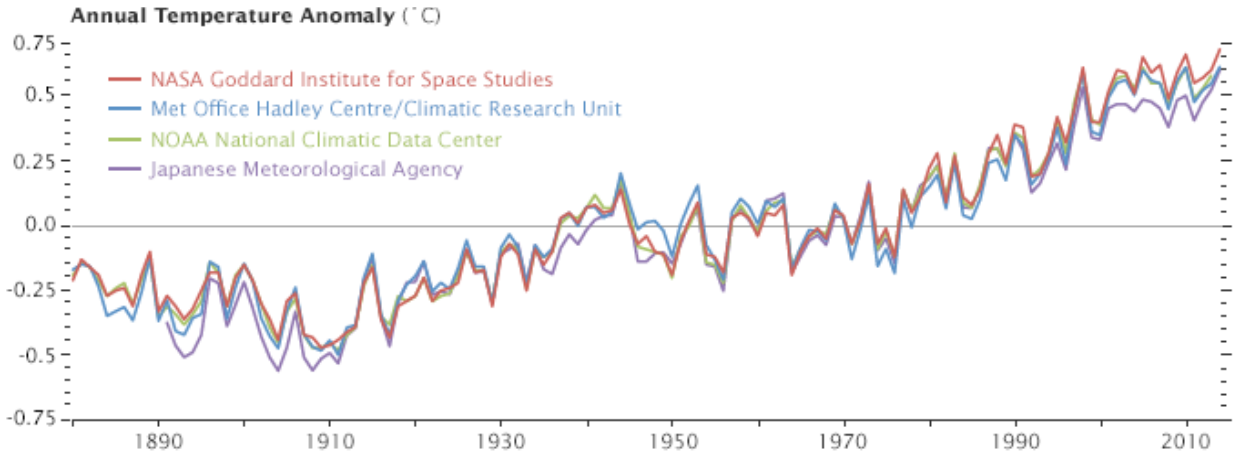

Figure 1-1: Yearly temperature anomalies from 1880 to 2014 as recorded by NASA, NOAA, the Japan Meteorological Agency, and the Met Office Hadley Centre[2].

Being aware that natural hazards related to increases of extreme events in terms of both frequency and intensity, the I-REACT project is an innovation tool that makes European countries more prepared and resilient to those threats based on the current climate and future climate. In this context, I-REACT has performed climate change projections that are expected to be an important input for long-term planning response to naturally occurring extreme events.

Climate change is global and the impacts are not focused only where the major emission regions are found. For this reason, the approach to climate change analysis must account for global influences but provide highly detailed local outputs. During the last decades, the scientific community has made many efforts to develop climate modelling tools which have been very useful for the understanding of climate evolution at global and continent level. However, they are still not useful to evaluate climate change from a local scale, which is required for designing local adaptation measures. For this, the scientific community has been working on downscaling tools to bridge the gap between global climate projections and local scale projections. Following this line, I-REACT has implemented the most reliable downscaling approaches for different regions across Europe beginning with Catalonia (Spain) as a first demonstration site.

As a result, I-REACT has obtained high resolution climate projections for daily mean, maximum and minimum temperature and daily precipitation. This has been achieved following a standard methodology, designed according to the scientific community standards and can be replicated for any other region of interest.

[2] https://earthobservatory.nasa.gov/Features/WorldOfChange/decadaltemp.php

1.1 PURPOSE OF THE DOCUMENT

Within the framework of I-REACT project, Meteosim has the goal of providing an assessment of climate changes in precipitation and temperature over different regions across Europe using a local scale approach. Precipitation and temperature were chosen as the most affecting variables to extreme weather events, floods and wildfires. The purpose of this document is to describe the data, methods and algorithms to reach this objective.

1.2 STRUCTURE OF THE DOCUMENT

This report has been organised as follows:

- **Chapter 1** includes this introduction and purpose and structure of the report;
- **Chapter 2** provides a schematic of the data flow including the input data and their sources, the processing blocks, the output data, and their integration into the I-REACT system;
- **Chapter 3** describes the input data in detail;
- **Chapter 4** describes the processing blocks shown in the architecture and the implemented models and algorithms;
- **Chapter 5** describes the output in terms of format and contents.

1.3 ACRONYMS LIST

BNU	Beijing Normal University
BOM	Bureau of Meteorology
CC	Climate Change
CCCMA	Canadian Centre for Climate Modelling and Analysis
CMIP5	Coupled Model Intercomparison Project Phase 5
CSIRO	Commonwealth Scientific and Industrial Research Organization
DIB	Data Input Block
DAB	Data Analysis Block
ECMWF	European Centre for Medium-Range Weather Forecasts
EEA	European Environment Agency
EOF	Empirical Orthogonal Functions
ESD	Empirical-Statistical Downscaling
EU	European Commission
EUMETNET	European Meteorological Services Network
GCESS	College of Global Change and Earth System Science
GCM	Global Climate Models
GCV	Generalized Cross-validation
GHG	Greenhouse gas
GLM	Generalized linear model
GTOPO30	Global 30 Arc-Second Elevation
IPCC	Intergovernmental Panel on Climate Change
NCAR	National Centre for Atmospheric Research
MOHC	Met Office Hadley Centre
PCA	Principal Component Analysis

QCCCE	Queensland Climate Change Centre of Excellence
RCM	Regional Climate Model
RCP	Representative Concentration Pathways
RR	Precipitation
TG	Mean temperature
TN	Minimum temperature
TPS	Thin Plate Splines
TX	Maximum temperature
4D-VAR	4-dimensional variational analysis

1.4 REFERENCE AND APPLICABLE DOCUMENTS

ID	Title	Revision	Date
[RD01]	D2.6 Report on Design of Data Interfaces	-	31/10/2016
[RD02]	D2.7 Report on Technical Requirements and Overall System Architecture	-	30/11/2016