MEDSCOPE

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MEDiterranean Services Chain based On climate PrEdictions

ERA4CS Joint Call on Researching and Advancing Climate Services Development – Topic B

(GRANT AGREEMENT 689029)

European Climate Observations, Monitoring and Services initiative (2)

Milestone M2.2

MEDSCOPE Sensitivity Experiments: final status and data sharing

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		SP – Software Package
		D – Dataset
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Version	Date	Modified by	Comments
1	20/01/2020	Silvio Gualdi	Submitted version with each partners' contribution

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Executive Summary

WP2 partners involved in tasks 2.1 and 2.2 have designed a set of common sensitivity experiments to explore the role of snow cover, soil moisture, El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) on the climate variability at seasonal-to-interannual time scales over the Mediterranean region. In this document a short summary of the performed experiments will be presented. The experimental rationale and protocol have been already described in milestone M2.1. Some changes to the initial protocol have been discussed and agreed upon across partners during the computational phase. These modifications will be shortly reported in this document. At the end of this document a summary table will be presented.

1 Experimental Organization and Setup

All the proposed experiments have been run in atmosphere-only mode (hereafter AMIP[1], in concordance with the international community), in order to emphasize the atmospheric signal due to the different forcings taken into account. A recursive AMIP-like run has been performed, including a common reference 1981-2010 sea surface temperature (SST) and sea ice cover climatology and reference year-2000 conditions for radiative forcings (greenhouse gas, solar forcing, ozone and aerosols). This run provides a benchmark control simulation and produces the initial states for the different forced experiments. After a proper spinup, this baseline simulation (denoted as B0) has been run for 50 years, providing a set of 50 different but statistically and physically equivalent initial conditions. As far as the sensitivity experiments are concerned, as discussed in M2.1 each experiment has been organized over different tiers, allowing each partner to participate depending on the available computational resources and on the individual research interest.

1.1 Soil moisture experiments

The soil moisture experiments have been designed to study the impact of dry and wet soil moisture conditions on summer atmospheric state over the Euro-Mediterranean domain. The aim of this set of experiments is twofold: together with an analysis of the summer signal due to extreme soil moisture conditions, the role of soil moisture model initialization is explored.
For this reason, there is a set of AMIP simulations with dry, climatological, and wet soil moisture initial conditions but considering a fully coupled land surface interaction (respectively denoted SM-D1, SM-C1, SM-W1), together with a set of AMIP runs with dry, climatological, and wet soil moisture conditions prescribed for the whole duration of the simulation (respectively denoted SM-D2, SM-C2, SM-W2). Each simulation is initialized on the 1st of May and lasts for six months. Each experiment includes 50 ensemble members, with atmospheric initial conditions coming from the baseline (B0) run.
To derive the soil moisture dry, climatological, and wet initial conditions for experiments SM-D1, SM-C1, and SM-W1, and the soil moisture dry, climatological, and wet climatology for experiments SM-D2, SM-C2, and SM-W2 three land-only ensembles have been performed. Together with observed atmospheric forcing (surface radiation, temperature, and winds), for the dry case a zero-precipitation field has been included in the land-only model, for the climatological case the climatological precipitation field has been considered, and for the wet case the climatological precipitation forcing has been amplified by three standard deviations. These changes to the precipitation forcings have been applied over the enlarged Mediterranean region (as defined in the original protocol).
With respect to M2.1 some changes in the protocol have been discussed and decided by the partners involved. The original plan was to include the model wilting point as prescribed dry soil moisture conditions in experiment SM-D2, and to include the model field capacity as prescribed wet soil moisture conditions in experiment SM-W2. In order to better guarantee numerical consistency, it has been decided to extend in time the land-only simulations and to exploit them

[1] Atmospheric Model Intercomparison Project (AMIP), endorsed by WGNE/WCRP.

also to define the soil moisture climatologies for the prescribed General Circulation Model (GCM) runs.
Indeed, the original three-month land-only ensemble simulations have been replaced by land-only ensemble simulations lasting one year (from May to April) in order to derive a set of stable initial conditions, followed by other 7 months of simulations (May to November) in order to compute the dry, climatological, and wet soil moisture reference states to be included in the GCM runs. These prescribed conditions have been analytically defined as a 30-day running mean daily climatology of the ensemble average soil moisture fields, respectively from the dry, climatological, and wet land only simulations.

Since the need of this extra numerical effort, it has been decided to leave as tier 1 the dry and the climatological GCM experiments (SM-D1/D2, and SM-C1/C2), and to include in tier 2 only the wet GCM experiments (SM-W1/W2), excluding the simulations looking at the sensitivity of the system to the value of Leaf Area Index (LAI).

1.2 Snow cover experiments

The goal of the snow cover experiments is to explore the atmospheric response to snow cover anomalies over Siberia, with a special focus on stratospheric processes. Also in this case the simulations last six months (October to March), and there are 50 ensemble members for each experiment with initial conditions derived from the baseline run (B0).
From a composite analysis of the observed snow conditions, two reference states representative of a strong positive snow cover anomaly in November and of a strong negative snow cover anomaly in October are defined, as described in M2.1. These strong positive and negative anomalous fields (in terms of snow water equivalent conditions) have been prescribed and kept constant in the AMIP experiments for both October and November, and then the system is let free to evolve. The major difference with respect to the original protocol is the definition of the region where the snow anomalies are computed and prescribed into the model. Compared to the region identified in M2.1, the target box has now been shifted slightly to the north (i.e. 42.5N-72.5N, 40E-180E), in order to fully represent the different snow spatial distributions.
Since the potential constructive interference between snow conditions and the Artic sea ice state, also some sensitivity analysis to ice-free Barents and Kara seas is included. A common mask for sea-ice free conditions has been adopted by the teams involved in this activity.
For this experiment the tier 1 includes the simulations accounting for the positive (SC-1a) and negative (SC-1b) snow anomalies with climatological sea ice conditions, and with Barents and Kara sea-ice free conditions (SC-2a and SC-2b). Following some discussions across the partners, it has been decided to replace the experiments originally foreseen for tier 2 with an ensemble describing the system response to Barents and Kara sea-ice free conditions, without any snow forcing. This experiment has been denoted as SC0.

1.3 ENSO/PDO experiments

For ENSO/PDO experiments, the protocol has not been modified with respect to the one proposed in M2.1. A set of AMIP runs including different combinations of SST conditions representing idealized ENSO and PDO states have been performed. Each simulation lasts one year (June to May)

and for each experiment 50 ensemble members are computed. Also in this case the initial conditions come from the baseline run (B0).
The whole experiment is organized in three tiers: in tier 1 the role of positive ENSO forcing alone (OC-1a), and in combination with the positive (OC-1b) and negative (OC-1c) phases of PDO is considered. In tier 2 simulations including just the positive (OC-2a) and negative (OC-2b) PDO signal have been run. Finally, tier 3 mimics tier 1 structure but for a negative ENSO forcing (OC-3a – negative ENSO alone, OC-3b negative ENSO/positive PDO, OC-3c negative ENSO/negative PDO).
The SST forcings included in these experiments have been described in M2.1 and a common set of SST fields has been exploited by all the modelling groups.

2 Final status of the experiments and data sharing

In the following table the experiments performed by each partner are summarized.

	CMCC	MF	BSC/UB
BASELINE (B0)	✓	✓	✓
SOIL MOISTURE EXP			
Tier 1 (SM-C1/C2, SM-D1/D2)	✓	✓	X
Tier 2 (SM-W1/W2)	✓	✓	X
SNOW COVER EXP			
Tier 1 (SC1a/b, SC2a/b)	✓	✓	X
Tier 2 (SC0)	X	✓	X
ENSO/PDO EXP			
Tier 1 (OC-1a/b/c)	✓	✓	✓
Tier 2 (OC-2a/b)	✓	✓	✓
Tier 3 (OC-3a/b/c)	✓	✓	only OC-3a

For each experiment a preliminary list of the variables to be shared across partners was included in M2.1. The final selection of variables has been discussed and finalized during the computational phase, in a more mature stage of the analysis. These variables are available for all the experiments on the MEDSCOPE data storage archive on CINECA servers.