Royaume du Maroc

Ministère délégué auprès du Ministre de l'Energie des Mines de l'Eau et de l'Environnement, chargé de l'Eau

Direction de la Météorologie Nationale

المملكة المغربية

الوزارة المنتدبة لدى وزير الطاقة و المعادن و الماء و البيئة المكلفة بالماء

مديرية الأرصاد الجوية الوطنية

Dynamical seasonal forecast at Maroc-Météo

Version: January 2014

Dynamical seasonal forecasts at Maroc-Météo are performed using version 5.2 of the atmospheric French model ARPEGE-Climat coupled with the oceanic model OPA developed at LOCEAN (Oceanography and climate laboratory) and implemented in NEMO3.2 version at MERCATOR center (Ocean analysis and forecasting center). OASIS3 coupler developed at CERFACS (European Centre for Research and Advanced Training in Scientific Computation) is used to synchronize, interpolate and exchange fields between atmospheric and oceanic models. This version is used also to elaborate seasonal forecast products for the Regional Climate Center of North Africa.

Given the sources of uncertainty, including the state of the climate system and numerical process, seasonal forecasting is an inherently probabilistic prediction. These uncertainties are taken into account by making an ensemble of forecasts, intended to cover the range of possible outcomes consistent with imperfections in the initialization and modeling systems. Then in this version, using this ensemble technique, sets of 27 forecasts are initialized by 9 atmospheric analysis, taken from the ECMWF (European Center for Medium-Range Weather Forecasts) database, and 3 ocean analysis (PSY2G3R3) issued from MERCATOR center.

Probabilistic forecasting is then presented as a prediction of scenarios associated with the probability of realization. Three classes of scenarios are defined: near, below or above the average. This gives for the temperature «hot», «normal» or «cold» and «wet», «normal» or «dry» for precipitation.

In the following section, we describe briefly the characteristics of that version we use in seasonal forecast. It contains three main components: atmospheric model ARPEGE-Climat V5.2 including surface model SURFEX, oceanic model NEMO and a runoff model TRIP.

ARPEGE-Climat V5.2

The Météo-France (Déqué et al., 1994) ARPEGE-Climat model is the climate version of the ARPEGE spectral numerical model used for short and medium range forecasting. For the dynamics, the horizontal discretization is based on a continuous representation by series of functions (spherical harmonics) which allow an easy treatment of the poles (isotropic resolution) and an exact calculation of horizontal derivatives. In the vertical, the discretization is based on a hybrid coordinate which follows the terrain near the surface and becomes proportional to pressure in the upper troposphere. 31 levels are used in the vertical.

The time discretization is a two-level semi-lagrangian advection scheme, with a semi implicit treatment of the planetary gravity waves. Such a scheme allows a large time step (30 min). The diabatic part of the equations is calculated by physical parametrization schemes. The convection scheme is a mass-flux scheme with convergence of humidity closure described by Bougeault (1985) in its original formulation. The cloud-diffusion precipitation scheme is presented in Ricard and Royer (1993). The radiative scheme is derived from Morcrette (1990). The orographic gravity wave scheme is based on Lott (1999) developments. The soil-vegetation-snow scheme is ISBA (Douville et al., 2000).

The surface model SURFEX (SURFace EXTernalisée), which is run using a standardized interface within the atmospheric component ARPEGE-Climat, simulates the exchanges of heat, water, chemical species between the surface and the atmosphere..

The main feature of the ARPEGE-Climat model is that its grid has the ability to be tilted to change the position of the pole and stretched to increase the resolution in an area of interest. It's helped to develop regional climate studies (Déqué and Piedelievre 1995; Ghibelline and Déqué, 2003).

This ability to zoom is the principal characteristic for ARPEGE-Climat V5.2. It has been used in RCC seasonal forecast product since January 2014. The pole is placed in the Atlantic Ocean with a stretch factor of 3 and a horizontal resolution between ~55 km in Morocco and ~100km in Egypt as we can see it in the image below.

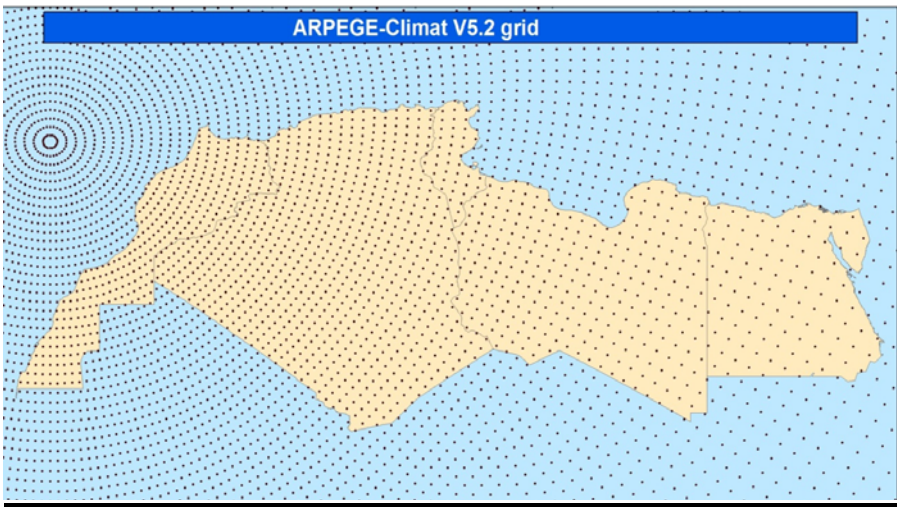

Fig 1: ARPEGE-Climat V5.2 high resolution grid

Full documentation of this version is available in the site of Météo-France http://www.cnrm.meteo.fr/gmgec/arpege-climat/ARPCLI-V5.2/index.html:

Oceanic model NEMO3.2

NEMO (Nucleus for European Modeling of the Ocean) (Madec, 2006) is an oceanic system responsible to reproduce the global ocean circulation. It is intended to be a flexible tool for studying the ocean and its interactions with the others components of the earth climate system (atmosphere, sea-ice, biogeochemical tracers, ...). Prognostic variables are the three-dimensional velocity field, a linear or non-linear sea surface height, the temperature and the salinity. In the horizontal direction, the model uses a curvilinear orthogonal grid and in the vertical direction, a full or partial step z-coordinate, or s-coordinate, or a mixture of the two. (Source: Antoinette Alias, Michel Déqué, CNRM/GMGEC/EAC Sophie Valcke, CERFACS: CNRM-CM5 Earth System Model March 2010).

More description of the ocean model NEMO and PSY2G3R3 analysis can be found at MERCATOR website: http://www.mercator-ocean.fr/science/systemes-operationnels/

Runoff model TRIP

TRIP (Total Runoff Integrating Pathways) (Taikan, 1997) is a runoff model developed by the University of Tokyo. The main aim of TRIP is to provide information of lateral water movement over land following the paths of river channels. TRIP is used in a coupled model to assess the changes in the history of the water cycle on the Earth. It introduces a carefully crafted river channel network to investigate the runoff part of the global water cycle.

For more details, it is recommended to refer to Taikan (1997) and Maisonnave & Terray (2008).

References:

•Antoinette Alias, Michel Déqué, CNRM/GMGEC/EAC Sophie Valcke, CERFACS Rapport :CNRM-CM5 Earth System Model March 2010

•Bougeault, P. (1985): A simple parameterization of the large-scale effects of cumulus convection. Monthly Weather Review, 113:2108-2121.

• G. Madec. NEMO Reference manual, ocean dynamic component: NEMO-OPA. Number 27. Institut Pierre Simon Laplace (IPSL), 2006. ISSN 1288-1619.

•M. Deque, C. Dreveton, A. Braun, and D. Cariolle. The ARPEGE/IFS atmosphere model: a contribution to the french community climate modeling. Clim Dyn, 10:249{266, 1994.

•M. Deque and Piedelievre J.-P. (1995) : High-Resolution climate simulation over Europe. Climate Dynamics 11:321-339

•Douville, H., Royer, J.-F. and Mahfouf, J.-F. (1995a) : A new snow parametrization for the Météo-France climate model. Part I : Validation in stand-alone experiments, Clim.Dyn. 12, 21-35

•Douville, H., Royer, J.-F. and Mahfouf, J.-F. (1995b) : A new snow parametrization for the Météo-France climate model. Part II : Validation in a 3-D GCM experiments, Clim.Dyn. 12, 37-52.

•Douville, H., Planton, S., Royer, J., Stephenson, D., Tyteca, S., Kergoat, L., Lafont, S., and Betts, R. (2000): The importance of vegetation feedbacks in doubled-co2 timesliceexperiments. Journal of Geophysical Research, 105:14841-14861

•Lott, F. (1999): Alleviation of stationary biases in a gcm through a mountain drag parameterization scheme and a simple representation of mountain lift forces. Monthly Weather Review, 127:788-801

•Maisonnave, E. and L. Terray (2008) Runoff: couplage conservatif par anomalie,Technical Report TR/CMGC/08/71, CERFACS, Toulouse, France.

•Morcrette, J. (1990): Impact of changes to the radiation transfer parameterizations plus cloud optical properties in the ecmwf model. Monthly Weather Review, 118:847- 873

•Ricard, J. and Royer, J. (1993): A statistical cloud scheme for use in an agcm. Annales Geophysicae, 11:1095-1115.

•Taikan O. and Sud Y. C. 1997 : Design of Total Runoff Integrating Pathways (TRIP)-A Global River Channel Network. NASA/Goddard Space Flight Center, Greenbelt, Maryland