Architectural Design Document for the Martian Atmospheric General Circulation Model.

As explained in the SRD, the requirements specified in the URD will be met by bringing of number of improvements to the General Circulation Model (GCM) of the Martian atmosphere developed jointly at LMD and AOPP. Both the AOPP and LMD versions will be used to generate the database but only the LMD version will be delivered to ESA.

The present document gives the general architecture of the LMD version of the GCM focussing at where and how the change will be made. It also emphasizes on the way in which the users of the GCM will have access to the input/outputs.

1 The General Circulation Model

The martian GCM can be seen as two coupled models. The first one is a dynamical code which integrates in time and space the equations of hydrodynamics on the sphere. The second one computes from a state of the atmosphere the "physical tendencies", i. e. the time evolution of the different variables resulting from radiative transfer, convection, thermal conduction in the soil... Both codes have their own initialization programs and their own input/output files. This global architecture is illustrated in Fig. 1.

The dynamical code considers four independent variables: temperature, and the two components of the horizontal wind which are 3-dimensional and the surface pressure (this set of variables is designed as X on the figure). This variables are read at the beginning of the simulation in an "initial file" and stored at the end for initialization of a following simulation. The dynamical package also produces two "history files" composed of states containing at least the independent variables and stored at regular time intervals: the first one contains instantaneous fields and the second one fields which have been averaged between two consecutive writings.

At regular time intervals, the variable X is passed through an interface to the physical package which computes the time derivative of X. This "physical tendency" is then returned to the physics and used as a source term for the dynamical code.

In parallel to the interface variables, the physical package manages its own internal variables (Y in the Figure) such as the surface temperature or ice coverage. This variables must be read in an "initial file" and stored at the end of the simulation for reinitialization. The physical package also creates its own history file which can contain either instantaneous or cumulated variables. These variables can be directly the independent variables of the physics and dynamics or intermediate variables computed in one of the parametrizations of the physics.

The physical package is composed of a succession of physical parametrizations which compute time derivatives of the variables. The names of the parametrizations which will be directly developed or modified for the present project are underlined in Fig. 1.

2 Coding

All the model is coded in Fortran-77. It is compatible at least with the HP-9000, IBM-Risk, Sun-Spark and Cray compilers.

The physical package is managed through a unique subroutine which successively calls the various subroutine corresponding to the various parametrizations. The source of this subroutine fully documented will be provided with the model. This will allow a user to add parametrizations or new diagnostics in the physical package.

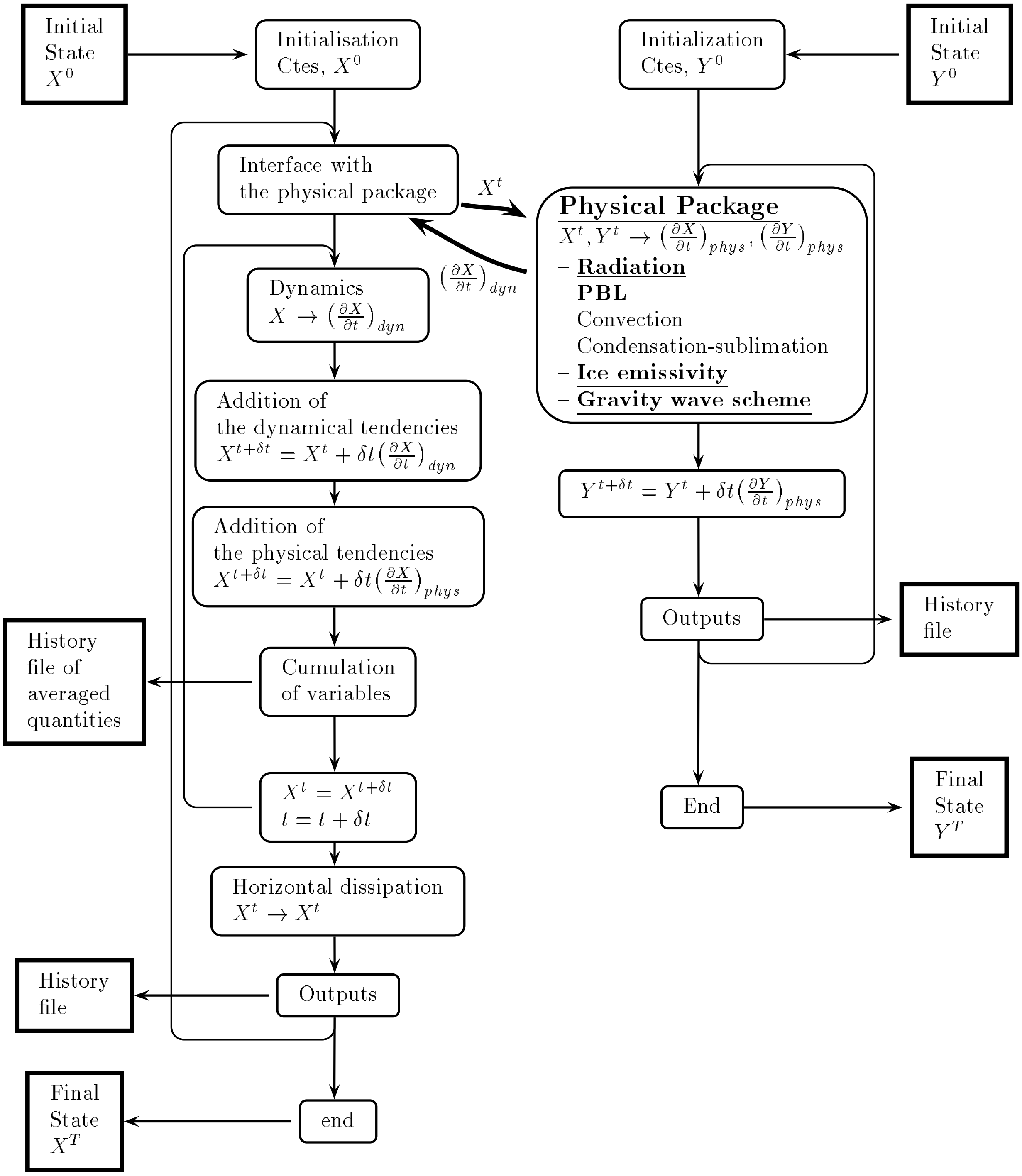

Figure 1: Flow chart of the General Circulation Model. The DRS files correspond to the bolded scares. The modifications which will be done for ESA are underlined.

The sources of the various parametrizations developed or modified for the project will also be provided and documented.

The variables will be passed to the various subroutines as Fortran arguments.

3 Input/outputs

The input output will use the format of the Data Retrieval System developed at Lawrence Livermore in the frame of the Atmospheric Model Intercomparison Program. A routine which allows to store a field at any level in the physics (either directly in the physical monitor or much more internally in one of the parametrizations) will be provided which will allow to very easily modify the content of the history file. With this, the user of the model will be able to build history files adapted to its particular purpose.

In addition, a series of at least 12 atmospheric states corresponding to 12 different seasons will be provided in DRS format with a utility to create an "initial file" for the simulation in the chosen resolution of at least 150 km.

4 Compilation and management

The model will be delivered with a UNIX script which allows to compile the model in any resolution. This script uses the make command available on standard UNIX.