3D MODELLING OF THE CLIMATIC IMPACT OF OUTFLOW CHANNEL EVENTS ON HESPERIAN MARS.

M. Turbet[1], F. Forget[1], R. Wordsworth[2] and J. W. Head[3], [1]Laboratoire de Météorologie Dynamique, Université Pierre et Marie Curie, 4 place Jussieu, 75252 Paris, FRANCE (martin.turbet@ens.fr), [2]Harvard University, Boston, USA, [3]Dpt of Geological Sciences, Brown University, Providence, RI, USA.

Introduction: During Hesperian, large outflow channels are thought to have been carved by catastrophic water floods [1,2], in particular in the Chryse Planitia area. It has been speculated that such events may have modified the climate (at least locally) and could have induced precipitation and even rain that could explain the formation of contemporaneous valley networks [3,4].

We present below 3D modeling of a sudden and extreme release of warm liquid water in the Chryse Planitia area on ancient mars, assuming a faint young Sun and a CO_2-dominated atmosphere thicker than today.

As discussed by Forget [5] and Wordsworth [6], 3D climate modeling under these conditions - CO_2-dominated atmosphere, faint young Sun – and performed with a water cycle taking into account water vapor and clouds, have not been able yet to produce liquid water or at least significant precipitations by climatic processes anywhere on the planet, even when maximizing the greenhouse effect of CO_2 ice clouds.

Method: The study was lead thanks to a complete Mars 3 Dimensions Global Circulation Model that takes into account generalized radiative transfer and cloud physics. The model works with a water cycle, including the formation of water and ice clouds, CO_2 ice clouds but also precipitations. The version we use here is designed to work under CO_2 atmospheres and is described by Forget [5] and Wordsworth [6].

We started from a converging initial state with stabilized surface water ice reservoir as described in Wordsworth's paper [6]. We then assumed that a hot source of liquid water suddenly appears around 10°N, -30°W. Various water temperature, water depth and surface area, as well as various release rate have been explored.

The water reservoir is represented by a 18 layers model used to compute the heat conduction and the phases changes, above a multilayer regolith. The initial liquid water heat is then lost through the following processes : **1.** Latent heat during the freezing of the water and the evaporation at the surface. **2.** Thermal infrared cooling from the hot surface. **3.** Conduction down to the initially cold regolith.

Results and Discussion: Figure 1 presents the results of a simulation performed assuming an initial 10-m thick very hot (350 K) liquid water source covering an area of $1{,}3.10^{12}$ m^2 located in Chryse Planitia. In this case, the amount of heat liberated by the source is about 10^{22} J.

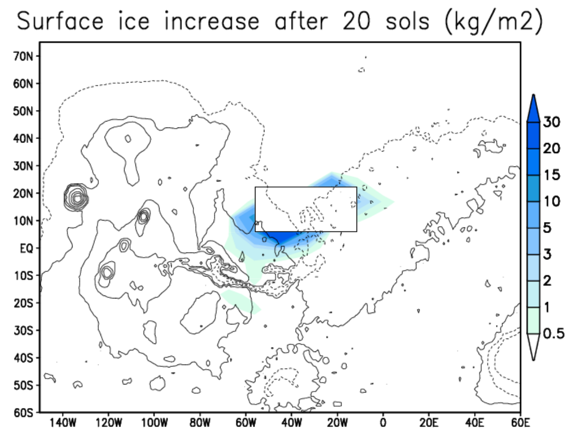

Figure 1 : Total accumulation of surface ice in kg.m^{-2} induced by the precipitations resulting from the outflow channel (outside the channel itself, represented by the black rectangle). This corresponds to the difference between the surface ice in the outflow channel GCM simulation after 20 days – which is approximately in this case the amount of time necessary to start the freezing of the surface of the outflow channel source but also to stop the precipitations – with the surface ice in a control simulation (whithout outflow channel)

In spite of the fact that the intensity of the outflow events and the temperature of the water has been overestimated, we found that the modeled precipitations – mostly snowfalls – were not only very low and occurring during a short period, but also localized very close to the source.

For this particular source, the cooling characteristic time of the source and also of the precipitations (Figure 2) is about several days, which seems to be very short compared to the considerable amount of heat liberated.

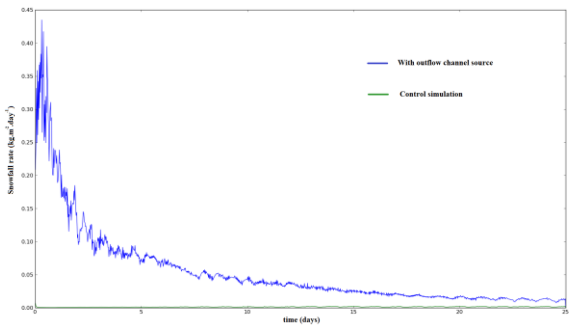

Figure 2 : Globally averaged snowfall rates (in kg.m^{-2}.day^{-1}) in blue for the outflow channel case, in green for the control GCM simulation. Most of the precipitations occur during the first days, starting from the date of the emergence of the source.

Figure 3 shows the relative importance of the different physical processes involved in the loss of the heat of the source. In this case, soil conduction and thermal emission dominate from far the water evaporation, which is consistent with the low amount of precipitations and thereby the very low thickness of the deposit ice layer presented in figure 1.

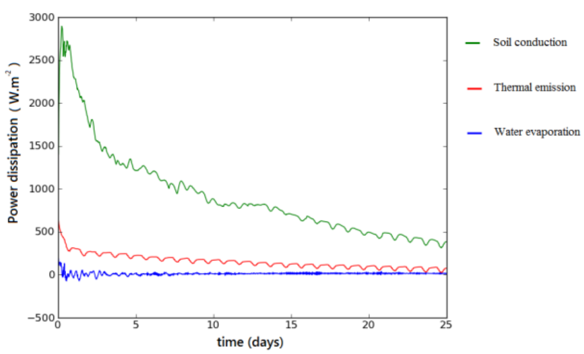

Figure 3 : Dissipated power in W.m^{-2} over time at the outflow channel source grid points corresponding to the difference between the dissipated powers in the outflow channel GCM simulation and a control simulation. The processes involved in the dissipation of the heat of the source are respectively ***1.*** *the soil conduction in green,* ***2.*** *the thermal emission in red and* ***3.*** *the water evaporation in blue.*

Several parameterizations of the source were tested. In particular, we found that a source of hot water (350K, 10m depth) needs to represent more than 10% of the martian planet to obtain at least small amount of rains.

Further results obtained in differenre conditions (surface pressure, intensity of the outflow event, seasons, etc.) will be presented at LPSC.

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