SIMULATIONS OF MESOSCALE CIRCULATIONS AND WATER TRANSPORT IN REGIONS OF WATER ICE BEING EXPOSED: FIRST 2-D ENSEMBLE RESULTS. T. Siili, *Finnish Meteorological Institute, Geophysical Research Division, PO Box 503, FIN-00101 Helsinki, Finland (Tero.Siili@fmi.fi).*

Introduction and background The University of Helsinki's 2-D Mesoscale Circulation Model (MCM) [1] has been adapted for Martian conditions in early 1990s [2] to create the University of Helsinki (UH), Division of Amospheric Sciences (ATM) 2-D Mars MCM (MMCM). The model has subsequently been used and developed at both UH/ATM and Finnish Meteorological Institute (FMI), Geophysical Research (GEO) to study a number of martian mesoscale circulations, especially so-called *surface-induced* phenomena. Among the forcing and circulation types are slope and (CO_2 and H_2O) ice edge winds, winds driven by variations in albedo and thermal inertia and horizontal dust optical thickness [2–5]. A fairly comprehensive description of the model can be found in, *e.g.* [6].

Ensemble approach So far this model — and other MMCMs — has been used in what might be called *single-forecast* mode, producing a single simulation result or a forecast from essentially a single set of initial and boundary conditions. As those conditions are bound to have errors and the models are sensitive to initial conditions, *ensemble*-type approaches have, however, been and are being introduced to operational numerical weather prediction systems in the recent years. In these approaches a set of simulations with varied and disturbed initial or boundary conditions is run and the forecast is derived from the set of results using, *e.g.*, statistical analyses. These approaches provide improved confidence in the range of and perhaps better robustness of the results obtained. Such multi-run approaches naturally, however, multiply the requirements for computational resources and are hence in many cases prohibitively costly, even in terrestrial operational applications. For an introduction of the ensemble approaches, *see, e.g.*, the Web site (and links and references therein) of the European Centre for Medium-range Weather Forecasts (ECMWF) at `http://www.ecmwf.int/`.

For Mars research purposes the 3-D MMCMs are much more realistic, but in the foreseeable future computationally much too expensive for such systematical and more comprehensive statistical studies. The considerably lesser computational cost of the 2-D MMCM in comparison to 3-D models renders the 2-D MMCM, however, a much more feasible tool for use in studies using *parameter space mapping* and *ensemble*-type approaches with reasonable set or sample sizes — in this early phase from of the order of five (5) to perhaps few tens of simulations.

Parameter space mapping implies a set of simulations run using, *e.g.*, systematically and deterministically varied initial or boundary values of some parameters (essentially using a parameter space grid) to investigate and analyse — also with statistical methods — the domain and range of the results. Ensemble-type approach includes in addition or in stead introduction of random variations in selected parameters, creating essentially a Monte-Carlo type approach.

Case study: region of sublimating CO_2 over H_2O ice An environment enabling pilot study use of the 2-D MMCM in an ensemble mode is being developed and implemented at FMI/GEO. This environment comprises simulation preparation (including selection of variables to-be-perturbed) as well as analysis tools. Our first application of the system is an idealised sensitivity study of mesoscale circulation and water transport phenomena occurring and emerging in a polar cap region where H_2O ice is being exposed in the springtime from under the wintertime CO_2 cover — perhaps in a patchy and irregular fashion. Such processes occur regularly in the northern polar region and apparently also in the southern polar region [7–9].

In a configuration and situation such as this *sea-breeze* type forcings are caused by contrasts, discontinuities and variations in ice coverage (due to the difference in thermal of CO_2 and H_2O ice surfaces caused by CO_2 ice being held at saturation temperature), in surface albedo and in the thermal inertia of the near-surface layers. The exposed H_2O ice will exhibit higher temperatures than the adjacent or encircling CO_2 ice creating a horizontal thermal contrast. The resulting forcings in turn give rise to circulation cells over the interface regions; the sensitivity and range of onset and evolution of these circulation cells and their associated transport of H_2O sublimated from the exposed region is investigated here. The perturbed and varied quantities can include, *e.g.*, the fraction of CO_2 coverage in a given grid box, H_2O ice thermal inertia and ice surface albedo.

Our goals here include: initial testing of the feasibility of the ensemble approach as well as provision of improved (and perhaps more robust) insight into this type of regional features of the Martian mesoscale circulations and the associated water cycle.

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