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Terrestrial analogues of the glaciers on Mars: possible test sites for FlyRadar survey

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FlyRadar is a project funded by the Horizon 2020 research and innovation program of the European Union. The project aims the production of a low-frequency dual-mode radar (synthetic aperture and ground penetrating) installed on board of a lightweight unmanned aerial vehicle (or drone) and their testing for future usage in Earth and planetary investigations.

Currently, one of the most important issues in the study of Mars is the understanding of the so-called viscous flow features, which, according to the modern hypothesis, are debris-covered glaciers (DCG) and consist of near-surface water ice and represent part of Martian cryosphere. These glaciers could be a source of water for future human exploration in-situ, as well as a source of hydrogen and oxygen for fuel.

Besides, ice of DCG contain historical records of climatic and geologic changes and can preserve ancient microbial life or even living organisms, if Mars ever harboured life. However, there are still no detailed studies on the thickness of the debris cover and the structure and thickness of DCG on Mars. The use of FlyRadar type probe on Mars could partially fill this gap. That is why one of the directions of the FlyRadar project is to test the use and capabilities of such an instrument in the study of DCG on Earth for further use on Mars.

Based on the synthesized information on the mid-latitude DCS of Mars and their terrestrial analogues previously proposed in the published literature, the following types of possible analogues of the Martian DCG on Earth are considered in this work as test sites for FlyRadar surveys:

1) Rock glaciers – very good external similarity of surface morphology, but low content of pure ice (up to 30%).

2) DCG with maximum covered area due to ablation and slope processes – high content of pure ice (more than 80-90%), possibility of conservation ice in permafrost, but not always very good external similarity of debris-covered areas and surface morphology due to processes associated with melting and melt waters, irregular accumulation of debris material (usually only the lower part of the glacier in the ablation zone is covered by debris).

3) Ice-cored moraines and parts of DCG with limited melting due to conservation of ice (partly relict) in permafrost – high content of pure ice and good preservation potential of relict ice, but the complete absence of external similarity.

4) Completely DCG due to volcanic sedimentation from atmosphere (ashfall) – high content of pure ice, good preservation potential of relict ice due to permafrost, completely debris coverage of the glacier surface except for newly formed ice in the accumulation zone. Possibly, it is the closest analogue to Martian DCG.

5) Pleistocene massive ground ice (possible glaciers) buried by marine and aeolian sedimentation: high content of pure ice, good preservation potential of relict ice due to permafrost, completely debris coverage of the glacier surface, but the complete absence of external similarity, since most often morphologically buried glacier is not expressed in land surface.