# Tables:

Table S1: Table of studies on UAS applications to cold region hazards.

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| **Study** | **Location** | **UAV Platform** | **Sensor Types** | **UAS Data Products** |
| **Snowmelt Flooding** | | | | |
| King, Kelly, and Fletcher (2023) | Ontario, Canada | DJI Phantom 4 Pro | iPhone 12 Pro iLiDAR | Lidar-based triangulated irregular network surface mesh |
| McGrath et al. (2022) | Colorado, USA | DJI Mavic 2 Pro | Unspecified camera | SfM-created DSMs, orthomosaics, dense point clouds |
| Karamuz et al. (2020) | River Świder, Warsaw, Poland | DJI Phantom 4 | 1/2.300 12.4 MP CMOS | SfM-created DTMs, orthomosaics |
| Koutalakis et al. (2019) | Aggitis River in Greece | DJI Spark | 1/2.3 CMOS FOV 81.9◦ 25 mm | Image-based video |
| Niedzielski et al. (2019) | Kwisa river, Izerskie Mountains, southwestern Poland | Fixed-wing UAVs (swinglet CAM, eBee, and Birdie) | Canon PowerShot S110 RGB camera (1/1.7” CMOS) | SfM-created DSMs, orthomosaics |
| Perks et al. (2016) | Alyth Burn, Perthshire, Scotland | DJI Phantom Vision 2 | FC200 camera,  Leica GS14 GNSS system | Image-based video |
| Flener et al. (2013) | Pulmanki river,  northernmost Finnish Lapland | Minicopter Maxi-Joker 3DD  Align T-Rex 700E | Nikon D5000 camera (2010),  Nikon D5100 (2011) | SfM-created DSMs, orthomosaics |
| **Glacial Lake Outburst Flooding** | | | | |
| Dømgaard et al. (2023) | West Greenland | (1) WingtraOne  (2) DJI Phantom 4 Pro | (1) Unspecified camera, multi-frequency L1/L2 GNSS receiver  (2) Unspecified camera, KlauPPK 7700CGNSS receiver | SfM-created DEMs, orthomosaics |
| He et al. (2023) | Southeastern Tibetan Plateau | (1) eBee Plus RTK  (2) DJI Phantom 4 RTK | (1, 2) Unspecified camera | SfM-created DEMs, orthomosaics, glacial surface velocity |
| Healy and Khan (2022) | Sholes Glacier, Washington, USA | DJI Phantom 3 Standard quadcopter | DJI camera,  MAPIR Survey3 multispectral camera | SfM-created DEMs, orthomosaics |
| Hu et al. (2022) | Namche Barwa syntaxis, eastern termination point of the Great Himalayan arc | DJI Mavic 2 | Unspecified camera | UAS imagery |
| Bazai et al. (2021) | Shimshal & Hunza valley, Karakoram & Ishkoman valley, Hindu Kush | DJI Mavic 2 Pro | RGB camera | SfM-created DEMs |
| Nie et al. (2020) | Chongbaxia Tsho,  eastern Himalaya | DJI Phantom 4 | DJI FC330 RGB camera | SfM-created DSMs, digital orthophoto maps (DOMs) |

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| **Glacial Lake Outburst Flooding (continued)** | | | | |
| Jouvet et al. (2017) | Bowdoin Glacier, Greenland | Skywalker X8 equipped with Pixhawk flight controller | Sony Alpha 6000 RGB camera | SfM-created 3D model and orthophotos |
| Wigmore and Mark (2017) | Llaca Glacier & the proglacial, Cordillera Blanca, Peru | Custom designed  hexa-multirotor UAV | Canon S110 Powershot RGB camera | SfM-created DEMs, orthomosaics |
| **Coastal and River Erosion** | | | | |
| Stopak, Nordio, and Fagherazzi (2022) | Plum Island Estuary, Massachusetts, USA | 3DR Solo | Ricoh GRII digital RGB camera, MicaSense RedEdge 3 5-band multispectral camera, RTK | SfM-created DEMs, orthomosaics |
| Roland et al. (2021) | Lake Michigan, USA | Unspecified sUAS | Unspecified camera, RTK GPS | SfM-created DEMs, orthophotos |
| Troy et al. (2021) | Lake Michigan, USA | DJI M600 Pro  (details in Lin et al. (2019)) | LiDAR laser scanner, Sony Alpha ILCE-7R RGB camera, APX-15 V2 GNSS INS | Lidar-based DSM, orthomosaics |
| Novikova et al. (2020) | Kara Sea coast, Russia | DJI Phantom 4 Pro | Unspecified RGB camera, Javad Sigma DGPS with external GRANT J3T antenna in RTK mode for GCP surveys | DEMs, orthomosaics |
| Cunliffe et al. (2019) | Qikiqtaruk – Herschel Island, Canadian Beaufort Sea | (1) Zeta Phantom FX-61 with Pixhawk flight controller (2) DJI Phantom 4 Pro | (1) Sony RX-100ii RGB camera  (2) DJI Phantom 4 Pro RGB camera  Leica Geosystems RTK GNSS | SfM-created DSMs, orthomosaics |
| Hamshaw et al. (2019) | Central Vermont, USA | (1) eBee  (2) eBee RTK  (3) eBee + | (1) Canon S110  (2) Sony WX  (3) SenseFly SODA | SfM-created DEMs, orthomosaics |
| Mury, Collin, and James (2019) | Bay of Mont-Saint-Michel, France | DJI Mavic Pro Platinum | 1/2.3” (CMOS) RGB camera | SfM-created DEMs, point clouds, orthomosaics |
| Kilfoil et al. (2018) | Great Northern Peninsula, Newfoundland & Labrador | DJI Inspire 1  (replaced by DJI Inspire 2) | RGB camera,  Leica GS09 RTK system | SfM-created DSMs, orthophotos,  3-D model |
| Turner, Harley, and Drummond (2016) | Narrabeen Beach, Sydney, Australia | SenseFly eBee-RTK | Unspecified camera | SfM-created point clouds, orthomosaics |
| **Ice Jams** | | | | |
| Wang et al. (2022) | Heilongjiang River,  northern China | DJI Mavic 2 Pro | Hasselblad L1d-20c (CMOS) 4K HDR aerial camera | Orthophotos |
| Palomaki and Sproles (2022) | Yellowstone River, Glendive, Montana, USA | Vision Aerial Switchblade-Elite tricopter RTK UAV | Sony Alpha 6000 RGB camera | SfM-created DEMs, orthomosaics |
| Rødtang, Alfredsen, and Juárez (2021) | Sokna River, Norway | DJI Phantom 4 RTK | DJI FC6310R camera | SfM-created DEMs, orthomosaics |

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| **Ice Jams (continued)** | | | | |
| Alfredsen and Juárez (2020) | Gaula River Haga bridge south of Trondheim, Norway | (1) DJI Phantom 3 Pro  (2) DJI Phantom 4 RTK combined with Norwegian C-pos system | Camera, Leica VIVA RTK GPS for GCP measurements | SfM-created DEMs, orthomosaics |
| Quirk and Haack (2019) | Plymouth, NH | Unspecified UAS | Unspecified sensor | Georeferenced image mosaic, unspecified UAS data |
| Alfredsen et al. (2018) | Trondheim, Norway | DJI Phantom 3 Pro | RGB camera, Leica Viva RTK-GPS for GCP surveys | SfM-created DEMs, orthomosaics |
| Garver et al. (2018) | Mohawk River, NY | Unspecified UAS | Unspecified camera | SfM-created DSMs, georeferenced orthophoto composite |
| Song et al. (2015) | Yellow River, northern China | Unspecified unmanned helicopter | Wireless GPR with integrated radar control unit and antenna system | GPR-derived ice layer thickness |
| Lin et al. (2012) | Yellow River, China | Fixed-wing UAV with flight control system | Canon 5D Mark II DSLR RGB camera, ground station system | UAV altitude data (ASL & AGL), georegistered orthomosaics |
| **Abrupt Permafrost Collapse and Event-based Thaw** | | | | |
| Barreda-Bautista et al. (2022) | Northern Sweden | Sensefly eBee | Parrot Sequoia multispectral sensor, Sony WX & Canon G9X RGB cameras | SfM-created DEMs, orthophotos |
| Fraser et al. (2022) | Mer Bleue Conservation Area, Ottawa, Canada | (1) DJI Phantom 4 RTK  (2) DJI Mavic 2 Pro  (3) DJI Mavic Mini | (1) Onboard GNSS receiver, DJI Phantom 4 CMOS sensor/RGB camera  (2) 1” CMOS sensor/RGB camera  (3) 1/2.3” CMOS sensor/RGB camera | SfM-created DEMs, orthomosaics |
| Freitas et al. (2022) | KWAK Valley, Quebec, Canada | Sensefly eBee | Parrot Sequoia RGB & multispectral sensor, Canon IXUS 127HS RGB camera | SfM-created DSMs, orthomosaics |
| Hendrickx et al. (2022) | Matter valley, Swiss Alps | DJI Phantom 4 Pro | Unspecified camera | SfM-created 3D model, orthophotos |
| Kaiser et al. (2022) | Dalton Highway, North Slope of Alaska | DJI Mavic Pro | Off-the-shelf GPS and RGB camera mounted on a gimbal | SfM-created DEMs, orthophotos, and 3-D point clouds |
| Christensen et al. (2021) | Zackenberg, Northeast Greenland | (1) Sensefly eBee  (2) Sensefly eBee  (3) DJI Phantom 4 Pro  (4) DJI Mavic Pro | (1) Canon S110  (2) Parrot Sequoia 4.0  (3) Built-in sensor  (4) Built-in sensor | SfM-created DEMs, orthophotos |
| Gao et al. (2021) | Eastern Tibetan Plateau | DJI Inspire 2 | ZENMUSE X4s camera | SfM-created DSMs, orthophotos |
| Turner, Pearce, & Hughes (2021) | Old Crow River in Old Crow Flats, Yukon, Canada | (1) 3DR Solo  (2) eBee +  (3) DJI Phantom 4 | (1) GoPro 4  (2) SODA RGB camera, Parrot Sequoia multisensory, Sensefly ThermoMap thermal sensor  (3) FC6310 camera | SfM-created DSMs, orthophotos |
| Varner et al. (2021) | Stordalen Mire, Sweden | Unspecified UAS | Unspecified camera | UAS imagery |
| Zhong et al. (2021) | HeiHe River Basin, QTP | DJI Phantom 3 Pro | DJI Phantom 3 Pro 4K RGB camera | Orthophotos |

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| **Abrupt Permafrost Collapse and Event-based Thaw (continued)** | | | | |
| Mu et al. (2020) | Eboling Mountain, Qinghai-Tibetan Plateau (QTP) | Unspecified UAV with RTK | Unspecified camera | SfM-created DEMs, orthophotos |
| Vivero & Lambiel (2019) | Arolla valley, Valais Alps | SenseFly eBee RTK | Sony WX RGB camera or S.O.D.A. camera, RTK GNSS antenna | SfM-created 3-D point clouds, orthomosaics |
| Van der Sluijs et al. (2018) | Northwest Territories, Canada | (1) Bradatech Spyder PX8 Plus (2) Bradatech RX4-S Surveyor (3) DJI Inspire 1 Pro  (4) Sensefly eBee Plus RTK/PPK  (5) DJI Phantom 4 Pro | (1) Sony a6000  (2) Sony RX100 III  (3) Zenmuse X5  (4) Sensefly S.O.D.A. & Sensefly ThermoMAP Thermal Camera, RTK & GS14 GNSS base receiver  (5) DJI FC6310  Trimble NetR9 with Zephyr 2 Geodetic Antennas or Leica GS14 for GCP measurements | SfM-created DSMs, DTMs, color orthomosaics, thermal image mosaic co-registered to true-color orthomosaic |
| **Snow Avalanches** | | | | |
| Miller et al. (2022) | Bridger Range, southwest Montana, USA | DJI Phantom 4 RTK | RGB camera, DJI DRTK2 GNSS mobile station | SfM-created DSMs |
| Masný, Weis et al. (2021) | Tatra Mountains in northern Slovakia | SenseFly eBee Plus RTK/PPK | SenseFly S.O.D.A. RGB Camera | SfM-created DSMs, orthophotos |
| Deschamps-Berger et al. (2020) | Tuolumne river basin, Sierra Nevada mountain range, California, USA | Unspecified UASs | Unspecified cameras | SfM-created DEMs for validation |
| Walter et al. (2020) | Gotschnagrat mountain ridge, Davos-Klosters, Switzerland | SenseFly eBee + RTK | Unspecified camera, unspecified GNSS | SfM-created DSMs |
| McCormack and Vaa (2019) | Central Norway | (1) UAS mounted GPR systems provided by NORUT and Romvesen  (2) SkyRobot RX100  (3) Drona HL  (4) C-Astral Bramor C4Eye system  (5) Camflight T X8 ROBOT  (6) MR MC001  (7) MR Dolphin  (8) AscTec Falcon 8  (9) eBee  (10) Lockheed Martin Indago 2 | (1) GPR Systems provided by NORUT and Romvesen  (2) Sony a7R and Flir Vue IR  (3) Sony a7R and Flir Vue IR  (4) Video and longwave IR  (5) Nikon Coolpix camera  (6) Sony A6000  (7) Video and still camera  (8) Video and still camera  (9) Still camera  (10) Video and longwave IR | GPR data, Real time UAS imagery and video, SfM outputs |

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| **Snow Avalanches (continued)** | | | | |
| Adams, Bühler et al. (2018) | Tuxer Alps of North Tyrol, Austria | Multiplex Mentor Elapor | Sony NEX5R RGB, NIR Digital Camera | SfM-created DSMs, orthophotos |
| Cimoli et al. (2017) | Svalbard and Greenland | (1) Walkera X350 Pro quadcopter  (2) DJI s900 hexacopter | (1) GoPro® Hero 3  (2) Nikon D3200 DSLR RGB camera with a NIKKOR 18–55 mm lens | SfM-created DSMs, orthomosaics |
| Van Tilburg (2017) | Columbia Gorge National Scenic Area, Oregon, USA | (1) DJI Phantom 3 4K  (2) Aerial Technology International SAR Bot  (3) DJI Inspire 1 version 2.0 | (1) DJI Phantom 3 4K RGB camera  (2) Unspecified 1080-pixel RGB video camera, VUE PRO 640 thermal imager  (3) DJI Inspire 1 RGB camera | Video used for search and rescue surveys |
| Wolfe et al. (2015) | Denver, Colorado, USA | Leptron unmanned helicopter | 4G LTE receiving device (Samsung Galaxy Tab 2.0 model SCH-1705 tablet) | 4G LTE signal strength & proof of concept |
| **Winter Storms** | | | | |
| Inoue and Sato (2022) | Laboratory experiments, field experiments in Kitami, Hokkaido, Japan and Rikubetsu, Japan | (1) DJI Mavic 2 Enterprise Dual (main UAS used in study)  (2) Type-S ACSL-PF2 R-SWM  (3) Meteomatics Meteodrone MM-670 | **Temperature Sensor:**  (1) PB5-41E (Shibaura)  (2) NFR CF3-0508-30 (Vaisala)  (3) Undisclosed  **Humidity Sensor:**  (1) HYT 271 (Innovative Sensor Tech.)  (2) HMP155 (Vaisala)  (3) Undisclosed  **Pressure Sensor:**  (1) MS5607 (Measurement Specialties)  (2) PTB210 (Vaisala)  (3) Undisclosed  **Wind Sensor:**  (2) WXT532 (Vaisala)  (3) Dynamical calculation | Meteorological profiles: air temperature, relative humidity, wind speed, and wind direction |
| Tripp, Martin, & Reeves (2021) | Oklahoma, USA | University of Oklahoma Center for Autonomous Sensing and Sampling CopterSonde 2.5 rotary-wing UAV | IMET-XF PT-100 temperature sensor  HYT-271 humidity sensor | Vertical profiles of temperature and relative humidity |
| Gultepe et al. (2019) | PanAm University of Ontario Institute of Technology Meteorological Supersite, Oshawa, Ontario, Canada | Weather & Environmental UAV (WE-UAV) | Unspecified sensors for: air temperature, relative humidity, pressure, horizontal wind and wind gust, aerosol number concentration, CO2, miniOFS visibility sensor, and UAV position angles | Aerosol, wind speed & direction, temperature, relative humidity |

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| **Winter Storms (continued)** | | | | |
| Choi et al. (2018) | Aviation Centre of Korean Aerospace Research Institute, Institute, Goheung-gun, Jeollanam-do, South coast of Republic of Korea | High-Altitude, Long Endurance (HALE) UAV “HyBird” | Compact High Altitude Imager and  Sounding Radiometer (CHAISR):  3 microwave radiometers, radiosonde quality PTU sensors, medium resolution compact visible and IR cameras | Brightness temperature (Tb) for calibration, total precipitable water in the atmosphere, temperature profiles |
| Dunion et al. (2018) | Summary of multiple studies | Global Hawk UAV | **Primary Sensors Selected:**  Airborne Vertical Atmospheric Profiling System (AVAPS or dropsondes), High-Altitude Monolithic Microwave Integrated Circuit (MMIC) Sounding Radiometer (HAMSR), High-altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) | Summary of multiple studies  Data used for forecast improvements |
| Guo and Hu (2017) | Laboratory experiments | Unspecified UAV | Binocular camera | UAV-based on-binocular stereo vision imagery & proof of concept |