



WG1&2 Questionnaire results

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FINNISH METEOROLOGICAL INSTITUTE

Answers total 95 from 27 counties

Andorra	1	(Snow and Mountain Research Center)
Austria	4	(2 ZAMG (1 Institute for Meteorology and Geodynamics), 1 University of Graz, 1 LWD (Avalanche warning Centre Tirol),
Belgium	1	(KU Leuven)
Bosnia and Herzegovina	1	(Federal hidrometeorological institute)
Bulgaria	3	(National Institute of Meteorology and Hydrology)
Cyprus	1	(Cyprus Department of Meteorology)
Czech Republic	1	(University of Life Sciences)
Denmark	0	?
Estonia	2	(Estonian Environment Agency)
Finland	12	(8 FMI, 2 FGI, 1 SYKE, 1 University of Oulu)
France	9	(2 CNRS, 2 Météo-France, 2 LGGE, 1 Grenoble Alps University, 1 IRSTEA (National Research Institute of Science and Technology for Environment and Agriculture), 1 EDF (Electricité de France))
Germany	2	(1 Alfred Wegener Institute, 1 German Weather Service)
Hungary	2	(Hungarian Met Service)
Iceland	3	(1 Icelandic Met Service, 1 Reykjavik University, 1 Landsvirkjun)
Italy	11	(3 ARPA (Regional Environmental Protection Agency, Lombardia, Piemonte, Veneto), 1 CNR, 1 University of Pavia, 1 Insubria University, 1 Regional Administration (Friuli Venezia Giulia), 1 Civil Protection (Marche Region), 1 Province Administration (Bolzan), 2 Snow and Avalanche Warning Service (Valle d'Aosta))
Latvija	1	(Latvian Environment, Geology and Meteorology Centre)
Lithuania	2	(1 Lithuanian Hydrometeorological Service, 1 Vilnius University)
Norway	2	(NVE (Norwegian Water Resource and Energy Directorate))
Poland	6	(1 Institute of Meteorology and Water Management - National Research Institute (NMS), 1 University of Silesia, 2 Institute of Geophysics - Polish Academy of Sciences, 1 Nicolaus Copernicus University in Toruń, N.Copernicus Polar Station on Spitsbergen, 1 University of Wrocław)
Portugal	1	(IPMA (Portuguese Institute of the Sea and the Atmosphere))
Russia	1	(Russian Hydrometeorological University)
Slovakia	3	(1 Earth Science Institute, 1 Technical University in Zvolen, 1 Institute of Hydrology Slovak Academy of Sciences)
Spain	8	(1 CSIC (Spanish National Research Council), 1 Spanish State Meteorology Agency (AEMET), 1 University of Salamanca, 1 Spanish Geological Survey (IGME), 1 University of the Basque Country, 1 University of Granada, 1 General Water Directorate, 1 Environment and Water Agency of Andalusia)
UK	7	(3 Met Office, 1 Scottish Environment Protection Agency, 1 Scottish Avalanche Information Centre, 1 University of Edimburg, 1 Northumbria University)
Sweden	1	(SMHI)
Switzerland	5	(2 WSL Institute for Snow and Avalanche Research, 1 University of Bern, Institute of Geography, 1 MeteoSwiss, 1 University of Zurich)
The Netherlands	1	(Institute for Marine and Atmospheric research Utrecht, Utrecht University)
Turkey	2	(1 METU (Middle East Technical University), 1 Anadolu University)

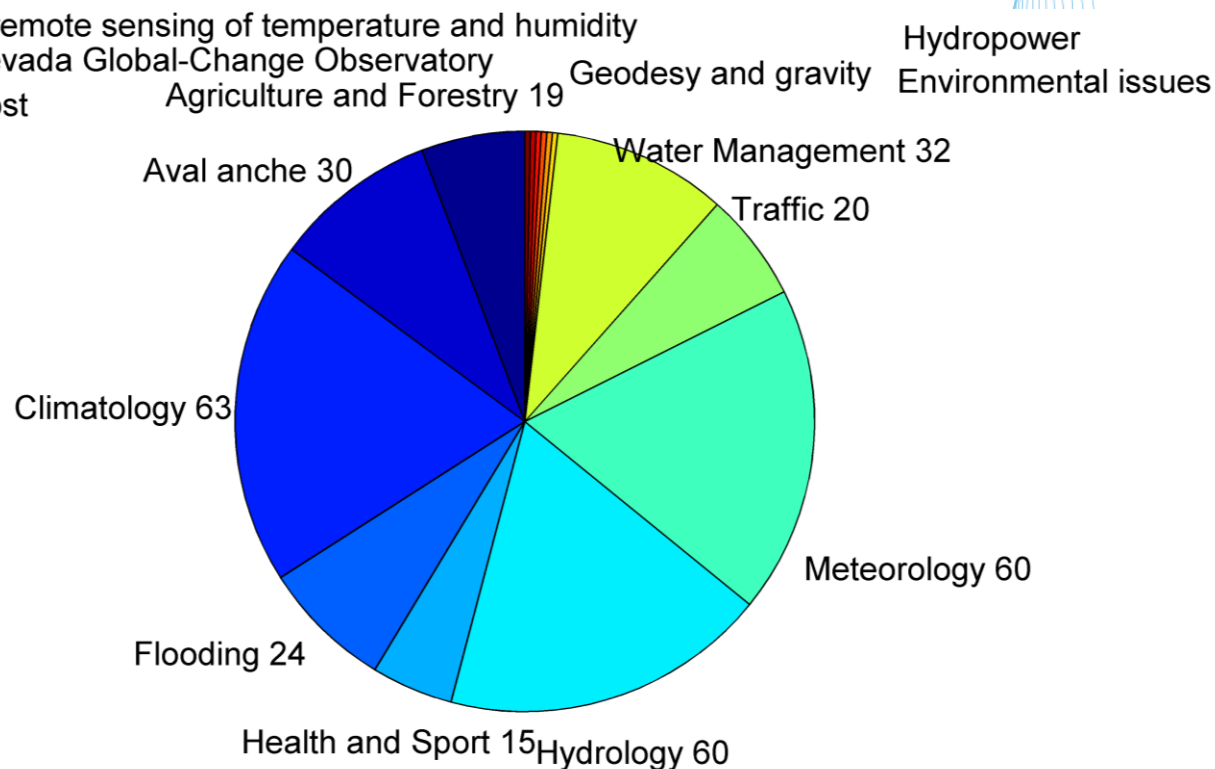
+ Canada, 1 Japan, 2, Pakistan, 1 Republic of Korea, 1 South Africa.



For what purpose the snow parameters are measured?

Research	74	61.6%
Operational	46	38.3%

For which application the snow parameters are measured?





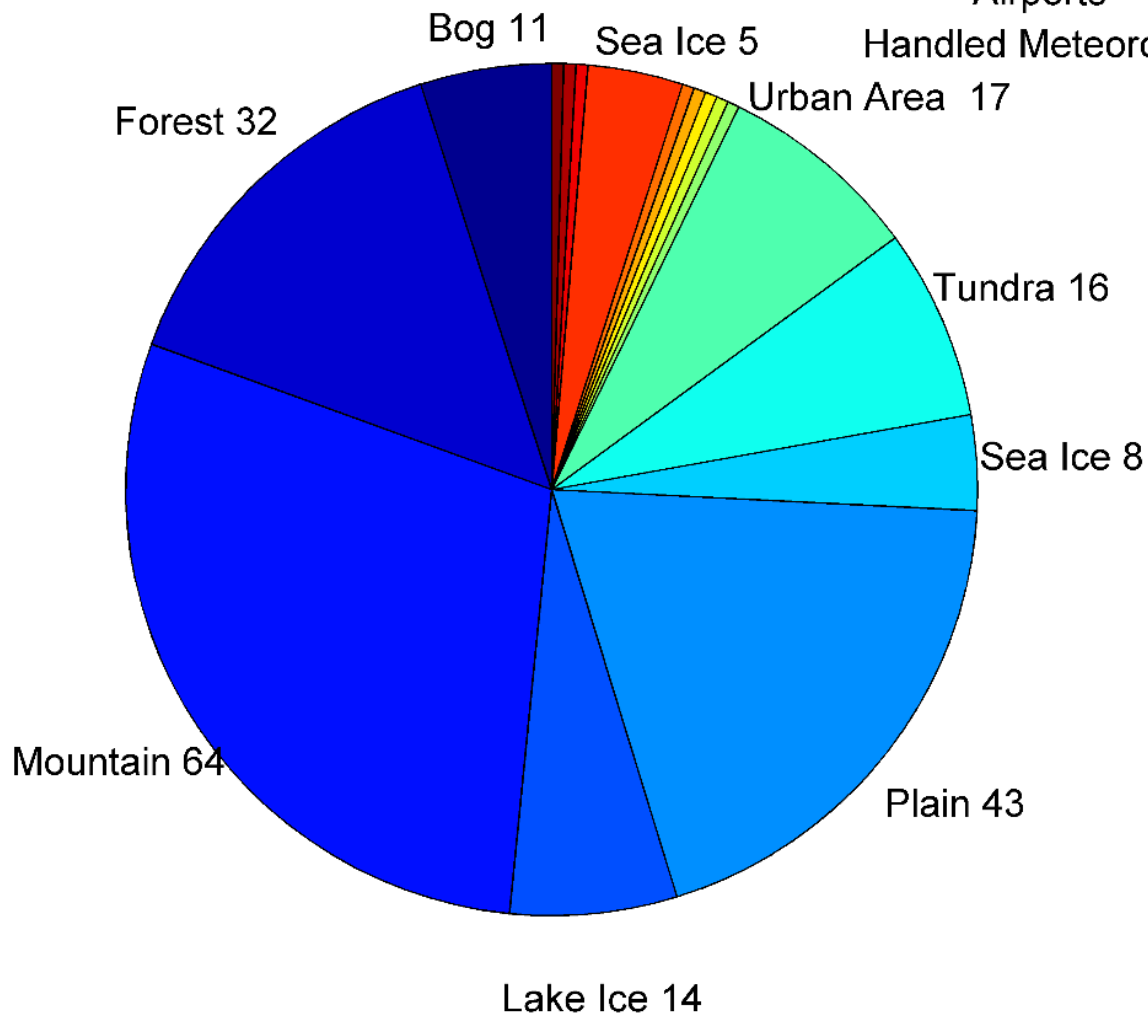
Location

Open mire and boreal fell slope at forest and tree line
Multiple surroundings

Ice selfs Antarctic ice sheet
differntly positioned stations Laboratory

Airports

Handled Meteorological Stations

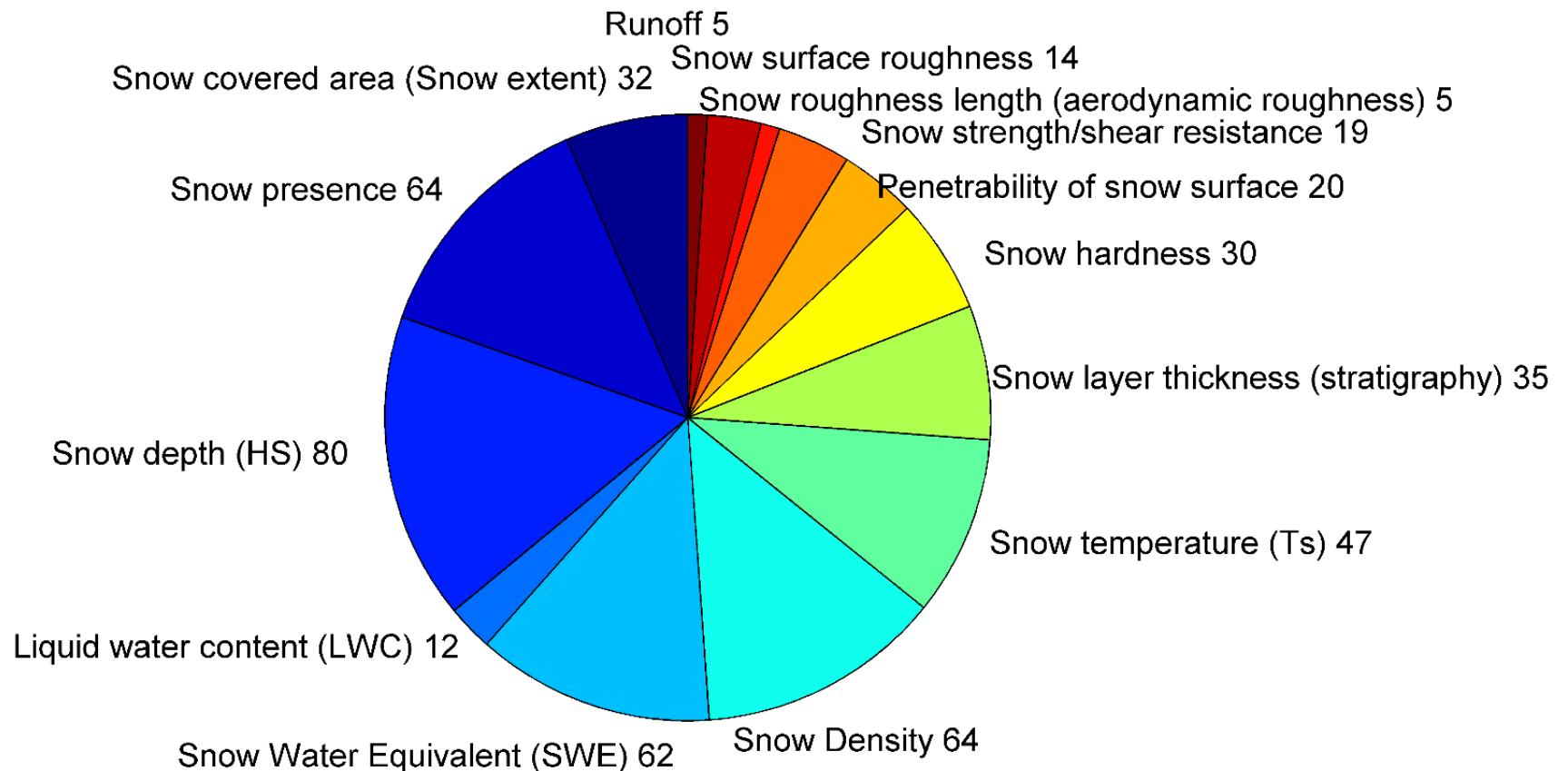




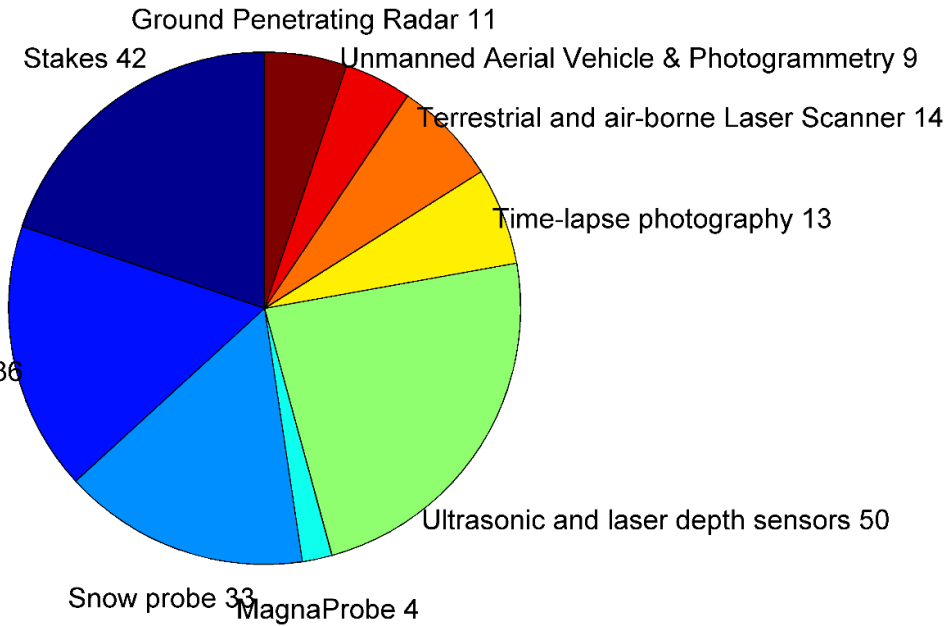
Macrophysical parameters

Yes	86	91.4 %
No	8	8.5 %

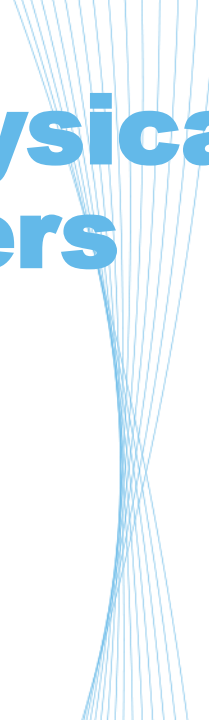
They are mostly manual measurements. Snow depth and snow temperature are the most automatize snow macrophysical measurements. Snow cover area is mostly retrieved from satellite.



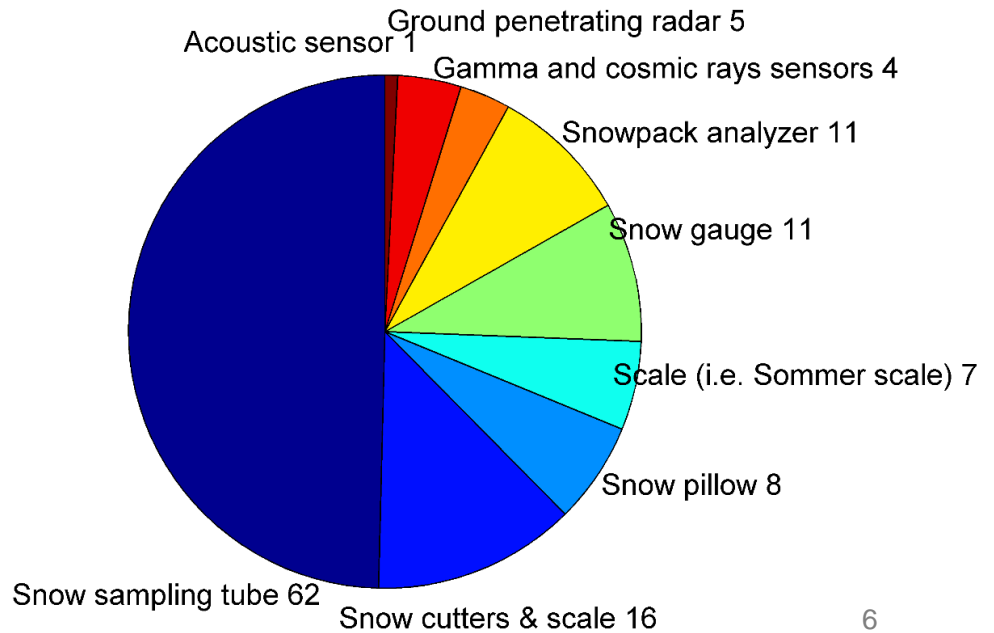
Snow depth (HS)



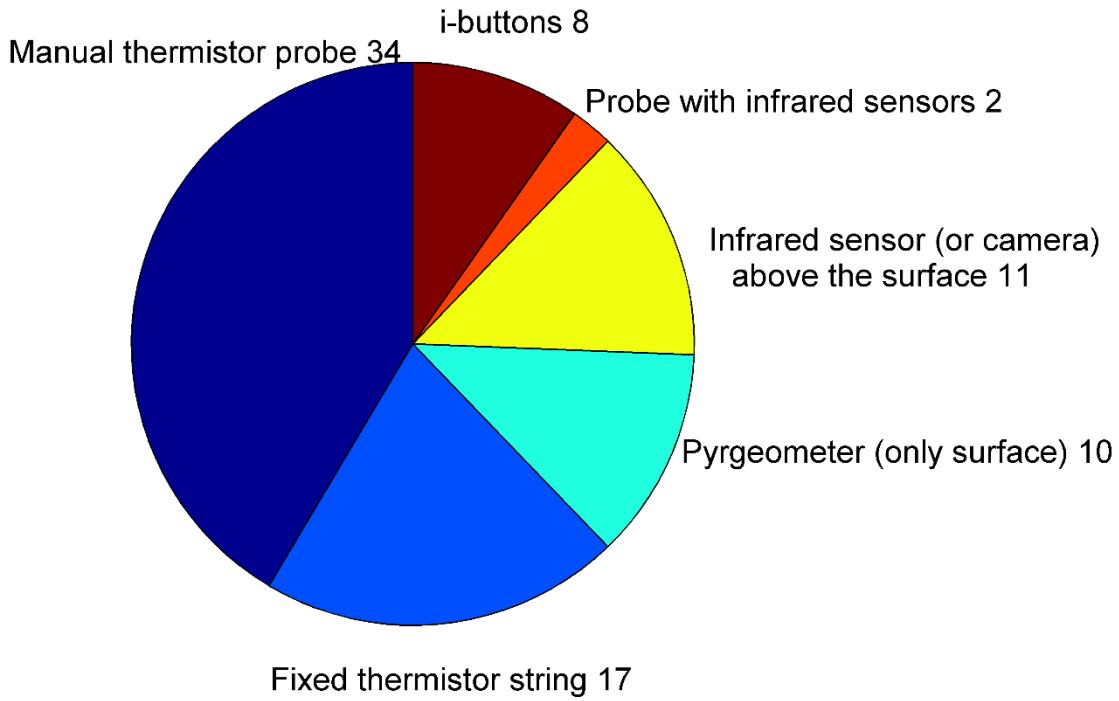
Macrophysical parameters



SWE

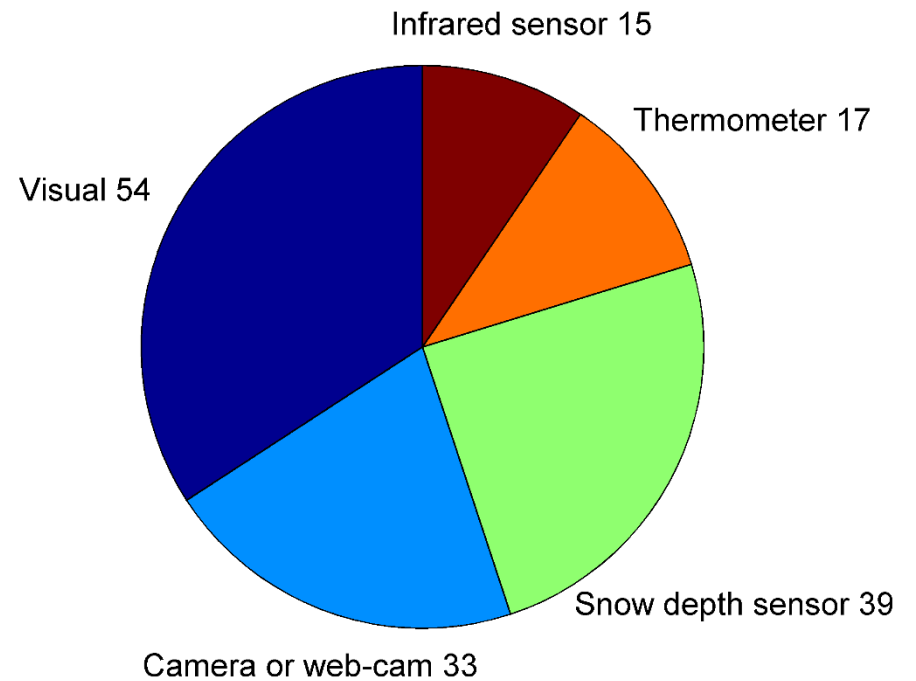


Snow temperature



Macrophysical parameters

Snow presence





Macrophysical parameters

Snow covered area (Snow extent)		
Optical remote sensing	23	26%
Camera or web-cam	20	22%
Liquid water content (LWC)		
Melting/freezing calorimetry	2	22.9%
Alcohol calorimetry	0	0%
Dilution method	1	11.4%
Time Domain Reflectometry (TDR)	0	0%
Snow Fork	6	68.8%
Denoth meter	3	3.4%
Snow Density		
Snow sampling tube	53	60%
Snow cutter & scale	28	32%
Scale (i.e. Sommer scale)	5	5.7%
Neutron probe	1	1.1%
Snow MicroPen	3	3.4%
Snow hardness		
Hand test	29	33.2%
Push-pull gauges	2	22.9%
SnowMicroPen	4	45.8%

Snow layer thickness (stratigraphy)		
Visual observations & ruler	35	40.1%
NIR photography	3	3.4%
Translucent profile	1	1.1%
Penetrability of snow surface		
Foot penetration	12	13.7%
Ski penetration	12	13.7%
Snow strength/shear resistance		
Shovel Shear test	10	11.4%
Loaded column test	14	16.0%
Trapezoidal Tensile test	0	0%
Flat jack Shear test	0	0%
Shear frame test	0	0%
Rutschblock test	14	16.0%
SnowMicroPen	2	2.2%
Snow roughness length (aerodynamic roughness)		
Wind profile	5	5.7%
Snow surface roughness		
Laser scanner	8	9.1%
Photography	11	12.6%
Runoff - Lysimeter		
	5	5.7%

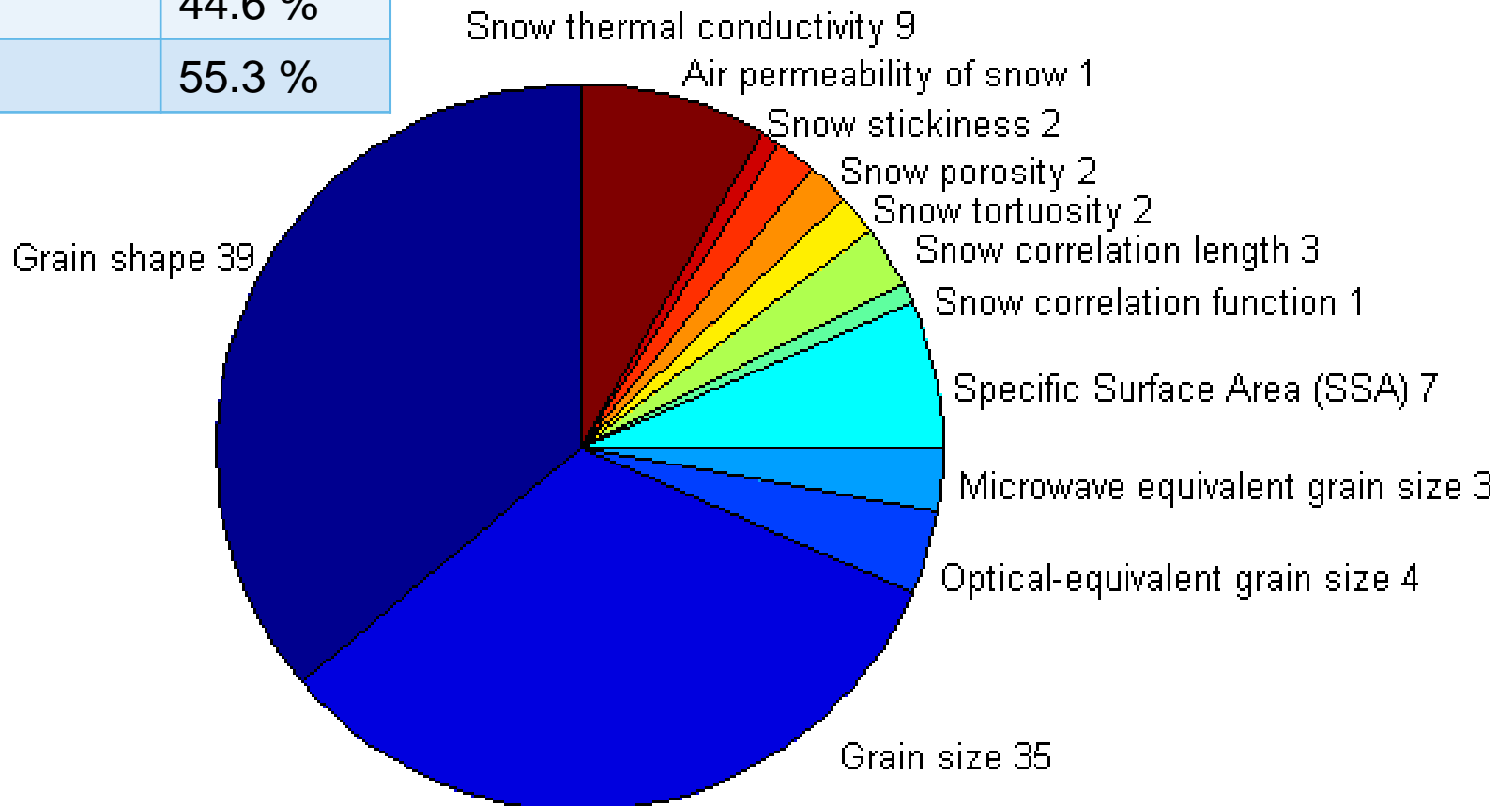
Other macrophysical parameters which were not presented in previous pie plots



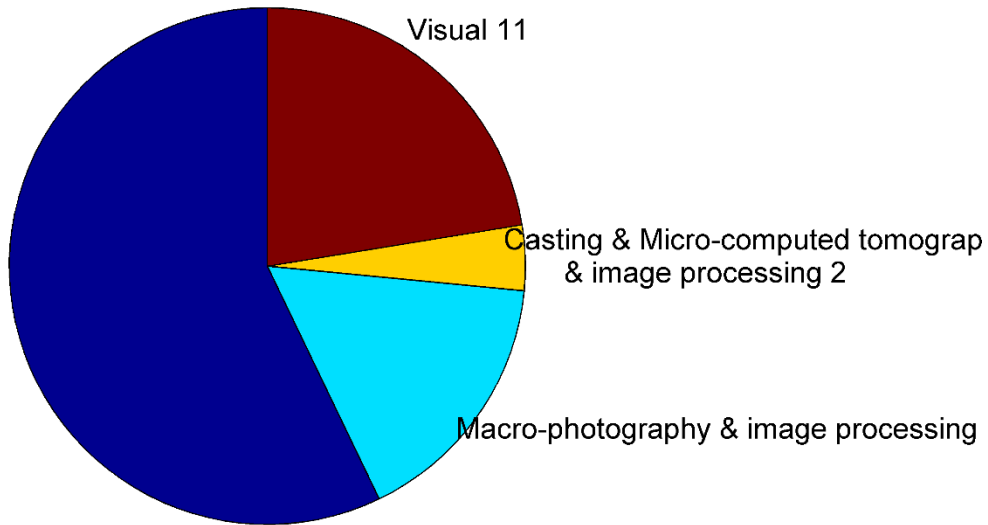
Microphysical parameters

Most people do mainly the traditional visual measurements, only few groups perform specialized measurements using quite sophisticated tools.

Yes	42	44.6 %
No	52	55.3 %

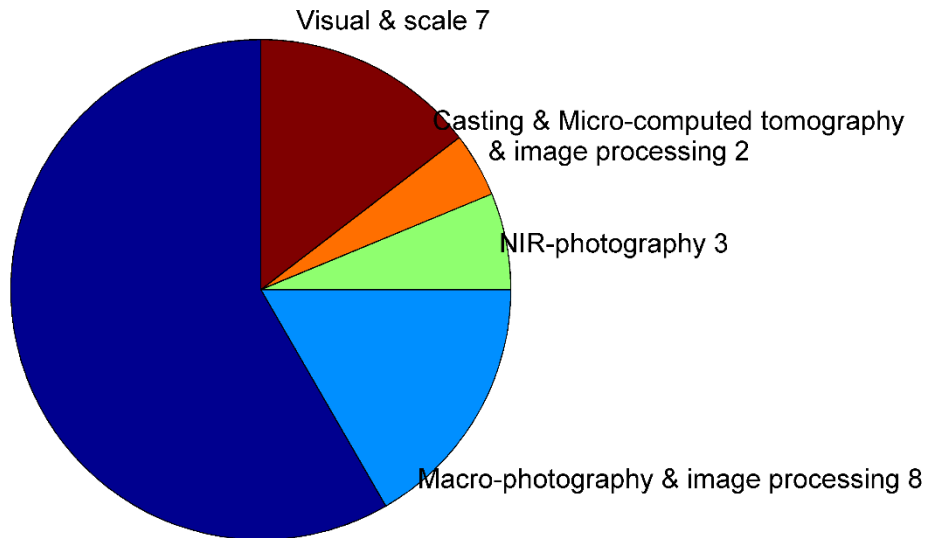


Grain size



Visual & magnifying glasses 28

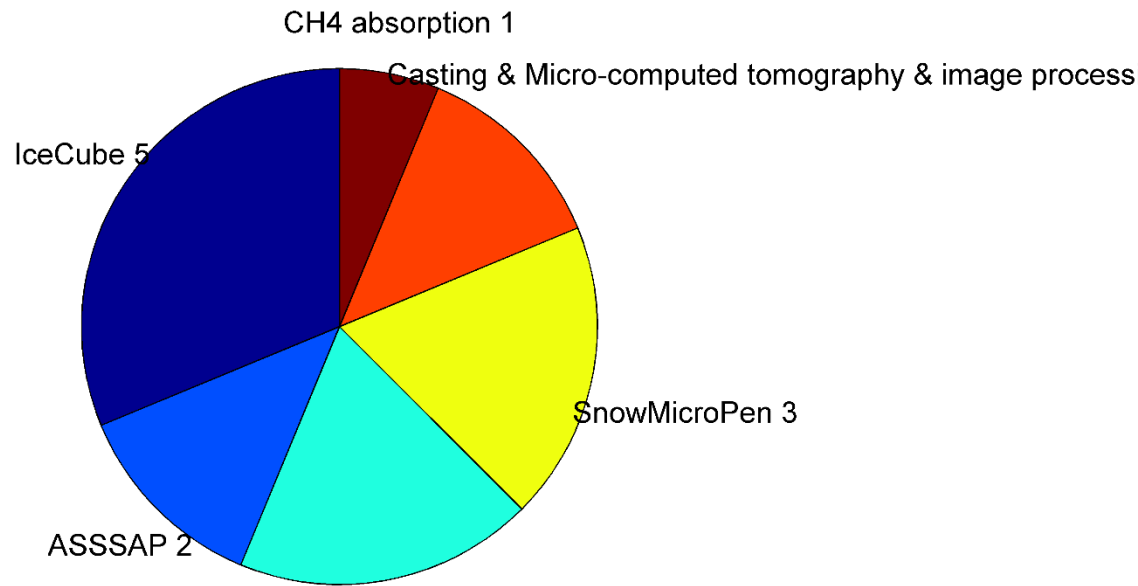
Grain type



Visual & scale & magnifying glasses 28

Microphysical parameters

SSA

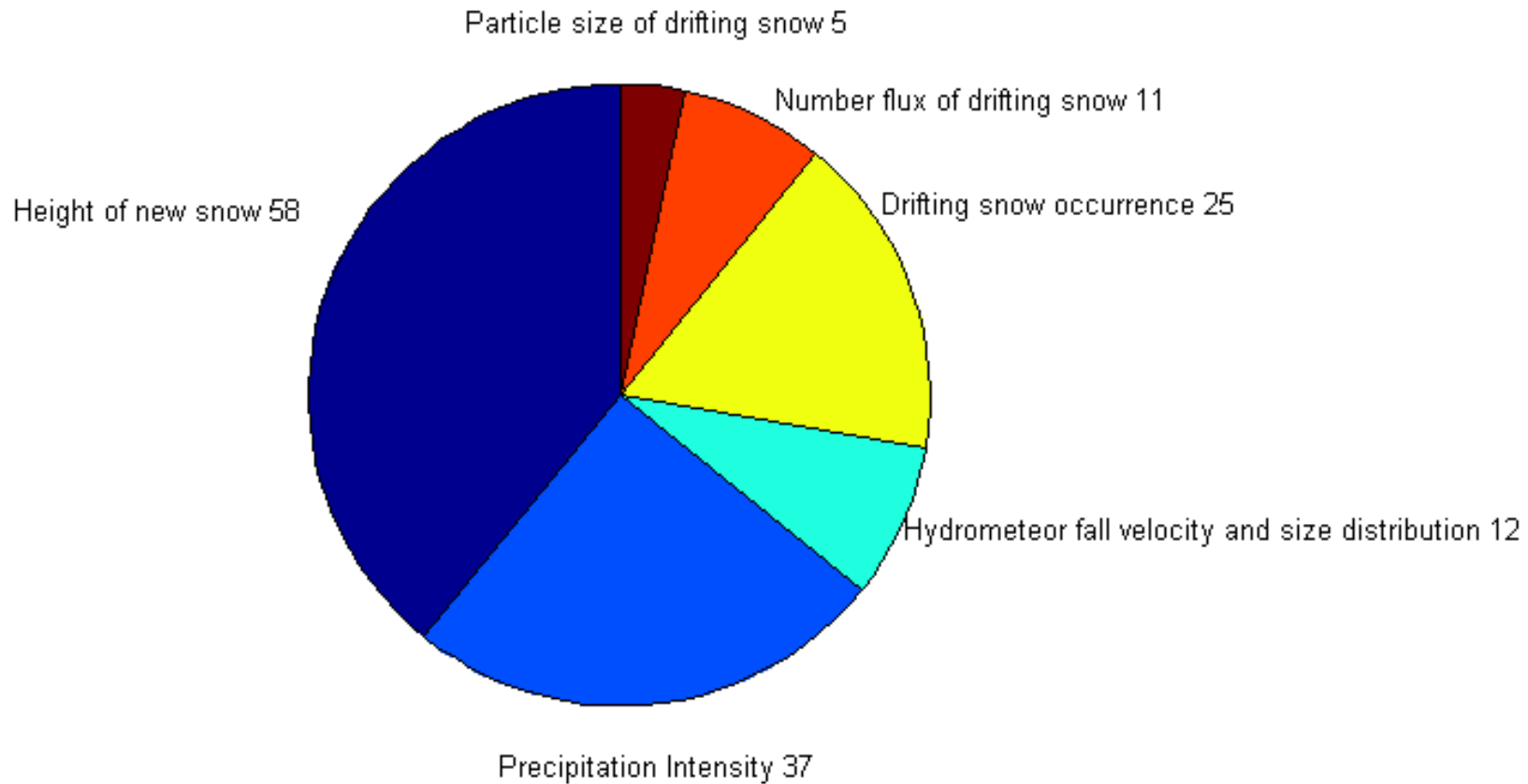


NIR-photography 3



Precipitation

Yes	67	71.2 %
No	27	28.7 %





Electromagnetic properties

Yes	29	30.8 %
No	65	69.1 %

Most applied instruments are pyranometers (to measure broadband albedo). Then radar (for backscattering) and microwave radiometers (for brightness temperature) follow.

Snow Bidirectional Reflectance Distribution Function (BRDF)		
	Gonio-spectro-radiometer	3 6,3 %
Snow Spectral Albedo		
	Spectro-radiometer connected to cosine receptor or integrating sphere	6 12,7%
Snow broadband albedo		
	Spectro-radiometer connected to cosine receptor or integrating sphere	4 8,5%
	Pyranometers	20 42,5%
Snow e-folding depth		
	Fiber-optic probes	2 4.2%
Snow optical transmittance		
	Array of spectro-radiometers (two or more)	2 4,2%
Snow brightness temperature		
	Microwave radiometer	7 14,8%
Snow backscattering		
	Radar	10 21.2%
Snow electrical conductivity		
	Snow fork	6 12.7%



Snow Composition

Yes	14	14.8 %
No	80	85.1 %

Snow electrical conductivity		
Snow fork	4	8,5%
Ion chromatography	5	20,8%
Organic and Elemental Carbon analyzer (OC/EC)	3	12,5%
Single Particle Soot Photometer (SP2)	3	12,5%
Filter & spectrophotometer	4	16,6%
Snow isotopes		
Mass spectrometer	7	29,1%
Laser absorption methods (Cavity ring down-spectroscopy-analyzer, Integrated cavity output spectroscopy-analyzer)	2	8,3%



Summary

- The results mostly reflect the activities of the countries that have given more answers (Finland, France, Italy, Spain, and UK >6, Austria, Bulgaria, Iceland, Poland, Slovakia, and Switzerland > 2). No answers from Denmark, only 1 from Sweden, and 2 from Norway. Can we still get more answers?
- Most answers from researchers, but operational services (47% of answers) are also well represented.
- Applications of the snow measurements are mostly climatology, meteorology and hydrology, followed by water management, avalanche forecast, flooding forecast, and traffic management.
- Data collection sites are mostly mountains (quite obvious for European countries), followed by plain and forest.
- **Mostly measured snow parameters are macrophysical parameters (91.4% of participants measured them), followed by snow precipitation (71.2% of participants), microphysical snow properties (44.6% of participants) electromagnetic properties (30.8% of participants), and snow composition (14.8% of participants):**
 - **Macrophysical parameters:** Snow depth, snow presence and SWE
 - **Precipitation:** Height of new snow and precipitation intensity
 - **Microphysical parameters:** Grain size, shape and SSA
 - **Electromagnetic properties:** broadband and spectral albedo, and microwave radiometry
 - **Snow composition:** snow impurity



What follows

- Template of a publication will be prepared. Possible journals are SPICE special issue in “Atmospheric Measurement Techniques”, and “Geoscientific Instrumentation, Methods, and Data systems” (both are EGU open access journals).