VEÐURSTOFA ÍSLANDS

Report
01019

Tómas Jóhannesson
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Results of the 2D avalanche model SAMOS for Siglufjörður

VÍ-ÚR10
Reykjavík
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BACKGROUND

The 2D avalanche model SAMOS, developed by the Advanced Simulation Technologies (AVL) of Graz, Austria, has been run for starting zones in the mountain above the village Siglufjörður, northern Iceland. The runs are intended to shed light on the following aspects of the avalanche hazard situation in the village:

1. The shortening of avalanche runout due to lateral spreading of avalanches. This is particularly relevant for the unconfined and partly convex slopes of the Hafnarhyrna and Gróuskarðshnjúkur ridges and also for avalanches that flow from the narrow Strengsgil gullies onto comparatively unconfined runout zones.
2. The difference in runout between avalanches from the main depressions Jörundarskál and Fífladalir compared with avalanches from other parts of the slope with a smaller snow accumulation potential, due to the different sizes of the starting zones and different degree of lateral spreading.
3. The direction of the main avalanche tongues from the starting areas that have been defined in the mountain as a part of the hazard zoning.
4. The shape of the main avalanche tongues from the gullies.
5. The effectiveness of the recently built deflecting dams below Jörundarskál and Strengsgil for deflecting avalanche away from the settlement.

The results of the runs will be used in the delineation of the hazard zones for the village. Similar results have previously been used for the same purpose for the villages Bolungarvík and Neskaupstaður (Jóhannesson *et al.*, 2001). The section about the application of the model to the 1995 avalanche at Flateyri is identical to a section in the report about Bolungarvík and Neskaupstaður in order to make the present report independent of the previous report.

The SAMOS model was developed for the Austrian Avalanche and Torrent Research Institute in Innsbruck by AVL and has recently been taken into operational use in some district offices of the Austrian Foresttechnical Service in Avalanche and Torrent Control. The model is based on similar assumptions regarding avalanche dynamics as other depth integrated 2D avalanche models that are used in Switzerland and France. Friction in the dense flow part of the model is assumed to be composed of a Coulomb friction term proportional to a coefficient $\mu = \tan(\delta)$ with $\delta = 16.0°$ ($\mu = 0.287$) and a turbulent friction term which may be represented by a coefficient $\xi = 446\,\mathrm{m^2/s}$ (Sampl and Zwinger, 1999). Rather than adding the two friction components as is done in the Swiss and French 2D models, the SAMOS model uses the maximum of the two friction terms and ignores the smaller term. This leads to slightly higher modelled velocities than for the Swiss and French 2D models for avalanches with similar runout. The velocities are, also, somewhat higher than corresponding velocities in the same path from the Swiss AVAL-1D model or the PCM model (Sauermoser, personal communication). The model runs are, furthermore, based on an assumed value $\rho = 200\,\mathrm{kg/m^3}$ for the density of flowing snow. The density is used to convert a given mass of snow in the starting zone to a corresponding volume or depth perpendicular to the terrain of the snow that is released at the start of the simulation.

MODELING OF AVALANCHE AT FLATEYRI ON 26.10.1995

The SAMOS model has not been used to model Icelandic avalanches before. The model was run for the catastrophic avalanche from Skollahvilft at Flateyri on 26 October 1995 (fig. 1) in order to check the applicability of the parameter values that are traditionally adopted for the model in Austria. The values for μ, ξ and ρ listed above were used. About 90,000 tons of snow were released from the starting zone between about 400 and 640 m a.s.l. based on measurements of the mass of the deposit of the avalanche and observations of the fracture height and density of the snow at the fracture line. The starting zone was divided into an upper and a lower area with a larger snow depth in the upper area. The run was defined by the following input data:

Input	Value
Map area of upper starting zone ($10^3 m^2$)	58
Map area of lower starting zone ($10^3 m^2$)	52
Total map area of starting zone ($10^3 m^2$)	110
Area of upper starting zone ($10^3 m^2$)	73
Area of lower starting zone ($10^3 m^2$)	63
Total area of starting zone ($10^3 m^2$)	136
Snow depth, upper area (d_u, m, $\rho = 200\,kg/m^3$)	4.3
Snow depth, lower area (d_l, m, $\rho = 200\,kg/m^3$)	2.0
Snow depth, average (m)	3.25
Mass ($10^3 t$)	89
Volume ($10^3 m^3$, $\rho = 200\,kg/m^3$)	440
Volume ($10^3 m^3$, $\rho = 350\,kg/m^3$)	220
Volume ($10^3 m^3$, $\rho = 420\,kg/m^3$)	210

The snow depth in the table is defined perpendicular to the terrain. The above values of the snow depth in the two subareas correspond to an average of 3.25 m with a density $\rho = 200\,kg/m^3$ over the whole starting zone or 1.85 m with a density $\rho = 350\,kg/m^3$. This higher value of the density may be assumed to have been close to the density of the snow in the fracture line before the release of the avalanche. The average density of the snow in the deposit in 1995 was close to $\rho = 420\,kg/m^3$.

No entrainment was specified and therefore the total mass of the avalanche in the model is smaller than for the real avalanche. This is typical in avalanche models of this kind.

The results of a run of the dense flow model for Flateyri with the above specification of input parameters are displayed as coloured contour plots of the depth and velocity of the flowing avalanche at 10 s intervals (file fl.ppt on the attached CD). The modelled location and geometry of the deposit at the end of the run (denoted as "h6") is in a fair agreement with the outlines of the 1995 avalanche (fig. 1). The eastward margin of the deposit is close to the buildings at Sólbakki, in a good agreement with the observed outline of the avalanche. The western margin extends slightly further to the west than the observed outline. This may be caused by the retarding effect of the buildings in the village on the runout of the avalanche, but it could also be caused by slightly too high modelled velocities as the avalanche flows out of the gully at about 200 m a.s.l. The outline to the east of the gully at about 300 m a.s.l. seems to be too high and too far from the centerline of the gully compared with the measured outline, indicating too high velocities at that location of the path. The maximum velocity of the avalanche below the Skollahvilft gully is close to 60 m/s, which is higher than obtained with the Swiss 2D model for the 1995 avalanche (about 45 m/s). The channelisation of the avalanche as it flows into the gully and the direction of the avalanche out of the gully seem to be well modelled.

A coupled dense flow/powder flow simulation was also made for the 1995 avalanche from Skollahvilft using a rather high grain size parameter (2 mm) which leads to a comparatively little transfer of snow into the powder part of the avalanche. This is believed to be appropriate for Icelandic conditions. The results for the dense core of the coupled dense flow/powder flow model were essentially the same as for the previously described run with dense core model. Maximum powder pressures reached about 10 kPa in the gully at 2.5 m above the avalanche and 2-3 kPa in the uppermost part of the village.

It was concluded from the runs for Flateyri that the same input parameters can be used for the SAMOS model for Icelandic conditions as are traditionally used in Austria. The dense core model can be used without the powder part for modeling the dense core of avalanches without this leading to significant changes in the model results. The model appears to take the effect of the geometry of the avalanche path on the flow of the avalanche into account in a realistic manner. This applies to the channelisation of the flow into the gully, the spreading of the avalanche on the unconfined slope and the deflection of the avalanche when it flows at an angle to the fall line of the terrain. The modelled speed of the avalanche may be slightly too high although it is not possible to determine whether the speeds of the SAMOS model or the Swiss 2D model are more realistic without further analysis.

RESULTS FOR SIGLUFJÖRÐUR

Avalanche starting zones were defined in the main bowls and gullies above the inhabited area in Siglufjörður. A total of 16 different subareas were defined and they are numbered from 1-16 on the maps. Area 11 was divided into two subareas with slightly different snow accumulation properties and these two subareas were denoted with the letters "a" and "b".

The main bowls and deepest gullies near the top of the mountain are believed to accumulate more snow than more shallow bowls and gullies at lower elevations. In particular, the deep and narrow Syðra- and Ytra-Strengsgil and Grindagil gullies are believed to accumulate very high amounts of drift snow, even more than the wider and larger depressions such as Jörundarskál and the slope above the Fífladalir shelf. The different snow accumulation conditions in the starting zones were described by classifying the zones into five classes as defined in the following table:

Class	Relative snow depth	Comment
I+	2	Deep and narrow gullies near the top of the mountain
I	1	Large deep bowls or gullies near the top of the mountain
II	2/3	Shallow bowls or relatively flat areas near the top of the mountain
III	1/2	Small and shallow bowls at comparatively low elevations
IV	1/4	Other parts of the mountain with a small snow accumulation potential

This classification is similar as the classification previously used in Bolungarvík and Neskaupstaður. The class "I+", with twice the reference snow depth, is added here in order to represent the high expected snow accumulation in the Strengsgil gullies and in Grindagil.

Seven runs with the SAMOS model were made in Siglufjörður. Two initial runs were made with a digital terrain model (DTM) representing the landscape before the construction of the deflecting dams in the southern part of the town and five runs were made with a DTM including the dams. The first two runs without the dams were started with uniform snow depth of 1.25 m in all the starting zones where snow was released in each run. The snow depth in the five remaining runs with the dams was determined from the relative snow depth class for the respective areas as given in the above table. The first three of these runs were started with a snow depth of 1.25 m in class I starting areas and the last two were started with a snow depth of 2.5 m in class I starting areas.

The following table gives the total mass and volume of snow for each of the runs:

Input	run1	run2	run3	run4	run5	run6	run7
Snow depth in class I areas (m)	1.25	1.25	1.25	1.25	1.25	2.5	2.5
Total mass (10^3t)	130	74	34	36	35	118	74
Total volume (10^3m^3, $\rho = 200\,\mathrm{kg/m^3}$)	649	370	170	182	174	588	369

The mass and volume are total values for all the avalanches that were released simultaneously in the different starting zones. The snow was released simultaneously from the multiple starting zones in each run in order to simplify the model computations and in order to make them more economical in terms of computer time and time needed to set up the runs. This aspect of the simulations should not be taken to indicate that simultaneous release of this kind is likely to occur in nature.

The table on the next page summarises the area and the relative snow depth for each of starting zones in Siglufjörður. The last column of the table lists the runs where snow was released from the zone.

It should be noted that avalanches from some of the starting zones in Siglufjörður, particularly in run1, interact with neighbouring avalanches and this leads to longer runout than would otherwise be obtained. This effect is especially strong for avalanches from starting zones 2 and 3 in run 1. This effect is, nevertheless, smaller than for the SAMOS runs for Bolungarvík and Neskaupstaður because the Siglufjörður runs were organised in such a way that avalanches in neighbouring starting areas were not often released in the same run. It should also be noted that starting zones 11a and 11b in Hafnarhyrna/Gimbraklettar cover a large area with protruding cliffs and ridges. One may expect that several independent avalanches, extending over a part of the area each, will be released rather than a single avalanche encompassing the entire area. Thus, the runout indicated by the SAMOS simulations for the Hafnarhyrna starting zones may be somewhat too long.

As in the simulations for Flateyri described above, and in the separate report for Bolungarvík and Neskaupstaður, snow entrained in the lower part of the path is not considered in the computations. Therefore, the volume of the avalanches from each starting zone is smaller than for real, large avalanches that might be released from the corresponding part of the mountain.

The results of the seven runs are displayed as coloured contour plots of the depth and velocity of the flowing avalanche at 10 s intervals as for Flateyri and Bolungarvík (files si_run1-7.ppt on the attached CD. The CD also contains similar files for other Icelandic villages where SAMOS computations have been carried out). Plots of the maximum dynamic pressure (given by $p = \rho u^2$) along the paths were also made (also on the CD). Some of the results are shown on figs. 2-15 (the flow depths are in m and the maximum pressure in kPa on the figures).

The runs illustrate a persistent tendency of the avalanches to form tongues below the gullies and bowls that constitute the main starting zones in the mountain. This is particularly evident from the results of runs 1 and 2 where a uniform snow depth of 1.25 m is used in all the starting zones and, therefore, no assumptions are made about a preferred accumulation of drift snow into the deepest bowls and gullies of the mountain.

Starting zone id	name	Map area ($10^3 m^2$)	Area ($10^3 m^2$)	Relative snow depth	Runs
1	Jörundarskál	68.8	89.8	1	1,3,6
2	Between Jörundarsk. and Strengsg.	19.7	24.0	2/3	1
3	Syðra-Strengsgil	18.5	22.8	2	2,4
4	Ytra-Strengsgil	14.7	18.1	2	1,5,7
5	S-Fífladalir, upper part	34.6	42.0	1/2	1,3
6	S-Fífladalir, lower part	29.2	34.6	1/2	2,4
7	Grindagil	5.7	6.9	2	5,6
8	Below Fífladalir, central part	14.9	17.7	1/4	2,4
9	N-Fífladalir, upper part	84.5	103.8	1	1,7
10	N-Fífladalir, lower part	85.7	104.0	1/2	2,4
11a	Hafnarhyrna ridge, upper part	17.8	22.8	1/4	1,5,6
11b	Hafnarhyrna ridge/Gimbraklettar	69.4	86.3	1/2	1,5,6
12	Below Hvanneyrarskál	40.9	47.4	1/2	2,3
13	S-Gróuskarðshnjúkur	39.1	46.4	1/2	1,4
14	N-Gróuskarðshnjúkur	50.8	64.5	1/2	2,5
15	Gully north of Gróuskarðshnjúkur	63.5	78.2	1	1,6
16	Small depression west of Gróuskarðshnjúkur	4.5	5.6	1	5,7
Total		662.3	815.0	—	—

The release volume ($\rho = 200\,\mathrm{kg/m^3}$) and runout index (Jónasson and others, 1999) for the avalanches from the different starting zones in the mountain for each of the seven Siglufjörður simulations is summarised in the table on the following page. Starting zones 11a and 11b are merged into one entry in the table. The columns labeled "rn1/2" summarise the results of runs 1 and 2 with uniform snow depth of 1.25 m in all starting zones. These runs were made for a DTM without the deflecting dams below Jörundarskál and Strengsgil. The columns labeled "rn3-5" and "rn7/7" summarise the results of runs 3 to 7 where the snow depth is scaled according to the snow accumulation potential of the respective starting zones as given in the above table and the DTM includes the deflecting dams below Jörundarskál and Strengsgil. The first of each pair of these columns corresponds to a snow depth of 1.25 m in class I starting zones and the second column corresponds to a snow depth of 2.5 m in class I starting zones. Results from runs 1 and 2 are in a few cases used to fill gaps in the columns for runs 3 to 7 in case an avalanche with an appropriate snow depth for a particular starting zone had not been released in runs 3 to 7 but a corresponding avalanche had been released in runs 1 or 2.

A runout index is not given in the table for the Jörundarskál and Strengsgil starting zones for runs 3 to 7 because the dams may be expected to influence the runout length of the avalanches in a way that makes the runout index concept inappropriate. A runout index is also not given in a few other cases where runs for the required snow depth in the corresponding starting zone were not carried out. A runout index is not given for avalanches starting in the small depression west of Gróuskarðshnjúkur (area 16) because the avalanches stopped in the Hvanneyrarskál bowl near 200 m a.s.l. and thus do not reach the village.

Starting zone id	name	Volume ($10^3 m^3$) rn1/2	rn3-5	rn6/7	Runout index rn1/2	rn3-5	rn6/7
1	Jörundarskál	112	112	224	16.7[1]	—	—
2	Between Jörundarsk. and Strengsg.	30	—	—	≈15[1]	—	—
3	Syðra-Strengsgil	29	57	—	15.5[1]	—	—
4	Ytra-Strengsgil	23	45	90	14.6[1]	—	—
5	S-Fífladalir, upper part	53	26	53	14.3	13.5	14.3
6[3]	S-Fífladalir, lower part	43	22	43	15.5	14.7	15.5
7	Grindagil	—	17	34	—	12.7	13.4
8[3]	Below Fífladalir, central part	22	6	—	14.2	12.6	—
9	N-Fífladalir, upper part	130	130	260	15.7	15.7	16.3
10[3]	N-Fífladalir, lower part	130	65	130	15.6	14.4	15.6
11a/b	Hafnarhyrna ridge and Gimbraklettar	136	61	122	15.9	14.6	15.8
12	Below Hvanneyrarskál	59	30	59	15.4	14.6	15.4
13	S-Gróuskarðshnjúkur	58	29	58	14.5	13.1	14.5
14	N-Gróuskarðshnjúkur	81	40	81	15.5[2]	14.0	15.5[2]
15	Gully north of Gróuskarðshnjúkur	98	98	196	15.5[2]	15.5[2]	16.3[2]
16	Small depression west of Gróuskarðshnjúkur	7	7	14	—	—	—
Total		1019	765	1529	—	—	—

[1]Runout indices correspond to the runs without deflecting dams.
[2]Runout indices are extrapolated beyond the grid of the computations.
[3]Runout indices for avalanches starting in the lowest starting zones are computed with the same runout index distribution as for the uppermost starting zone in the same path in order to facilitate the comparison of the runout indices for the different avalanches. The runout index distributions for the different starting zones are very similar so that this does not lead to much difference in the computed runout indices.

It should be noted that the volumes given in the table are not completely consistent with the volumes given in the preceding table that summarises the mass and volume of snow in each run. This discrepancy, which is in all cases less than 1-2%, is caused by discretisation errors in the computational grid because the delineation of the starting zones does not run along grid cell boundaries.

Previous simulations for Bolungarvík and Neskaupstaður (Jóhannesson *et al.*, 2001) showed that the large bowl shaped class I starting zones in Neskaupstaður release avalanches that reach a runout index in the approximate range 15.5-16.5 for a snow depth of 1.25 m and runout index in the range 17-18 for a snow depth of 2.5 m. The much smaller class I starting zones in Bolungarvík produced shorter avalanches that reached runout index 13.5-14 and 15-15.5 for snow depths of 1.25 and 2.5 m, respectively. The class II and III starting zones in Neskaupstaður produced avalanches with a runout similar as in Bolungarvík in some cases, whereas other starting zones, for example in Urðarbotn, released avalanches with an intermediate runout index of about 15 for runs with a class I snow depth of 1.25 m.

The results for Siglufjörður show that Jörundarskál is the only starting zone in Siglufjörður with a runout comparable to the main starting areas in Neskaupstaður (a snow depth of 1.25 m leads to an avalanche with runout index of 16.7). Avalanches from the two Strengsgil gullies are shorter than this by 1-2 units in the runout index (for the runs without dams). This is due to the small size of the starting zones and lateral spreading of the avalanches after they enter the runout zone. Avalanches released in the upper N-Fífladalir starting zone are shorter than the Jörundarskál avalanches by about 1 runout index. This is in spite of a large starting zone that has an even larger area than Jörundarskál.

The avalanches from the upper part of N-Fífladalir flow in an open slope without lateral confinement and this may be expected to lead to comparatively short runout compared to Jörundarskál and the main gullies of Neskaupstaður. The Fífladalabrún shelf at about 320 m a.s.l. may also be expected to spread the avalanche in the longitudinal direction and lead to some additional shortening of the runout. The runout in the simulations with a weighted snow depth for avalanches from S-Fífladalir, the lower starting zone in N-Fífladalir, Hafnarhyrna, below Hvanneyrarskál and S- and N-Gróu-skarðshnjúkur is similar as for the gullies in Bolungarvík. The simulated avalanche from the S-Gróu-skarðshnjúkur starting zone terminates at a similar location as the observed deposit of the avalanche that destroyed two houses on 26.12.1963, confirming that avalanches released from this location of the slope can stop slightly to the north of the Hvanneyrará river as the avalanche in 1963 did. The simulated runout of avalanches from Hafnarhyrna (zones 11a and b) may be too long as mentioned above because avalanches extending over the whole starting area are considered unlikely.

The simulations of avalanches from Jörundarskál and Strengsgil that hit the recently constructed deflecting dams above the village show that the main part of the avalanches is deflected by the dams, but a thin layer overflows the dams and enters the village, particularly in the runs with the higher initial snow depth (runs 6 and 7). This is most easily analysed by viewing the time-dependent development of the avalanches (see the ppt-files on the attached CD). The overrun of the dams is sensitive to the simulated speed and to the physical and numerical treatment of the impact of the avalanche with the dams. The SAMOS model simulates relatively high speeds compared with other numerical avalanche models as previously mentioned. The speed of avalanches with the higher initial snow depth when they hit the dams is higher in the SAMOS simulations (60-65 m/s for Jörundarskál and 50 m/s for Ytra-Strengsgil) than the design speed of the dams (55 m/s for Jörundarskál and about 45 m/s for Ytra-Strengsgil). The SAMOS model does also not implement the expected momentum loss in the impact with the dam. These two effects increase the potential of the avalanches to overflow the dams in the simulations. The simulations do, on the other hand, not include a snow cover on the ground and this reduces the overflow potential in the simulations. Further analysis and simulations are required in order to increase our understanding of the level of safety provided by the dams. The simulations indicate that the dams are able to successfully deflect large avalanches that would otherwise have reached far into the current settlement.

The following conclusions may be drawn from the model results for Siglufjörður:

1. The Jörundarskál starting zone is by far the most dangerous starting zone in Siglufjörður in terms of avalanche runout. In spite of the high frequency of avalanches indicated by the avalanche history, the Ytra-Strengsgil path has a much smaller potential for very large avalanches than Jörundarskál.

2. The upper N-Fífladalir starting zone is most dangerous starting zone north of Strengsgil. The simulations indicate a rather broad tongue for large avalanches released from this starting zone, extending about 100 m further to the south than the south margin of the Þormóðseyri promontory.

3. Avalanches from the upper N-Fífladalir starting zone reach about 1 runout index shorter than avalanches with a similar initial snow depth from Jörundarskál as mentioned above. Hazard zoning in the N-Fífladalir area is not easy due to difficulties in estimating the frequency of avalanches. The avalanche history indicates a rather low frequency of avalanches with a runout higher than 11, but snow depth measurements in the mountain show high snow depths in this large starting zone. The SAMOS simulations indicate that using a comparatively low frequency of avalanches in a zoning based on runout indices may be appropriate in this area, because simulated avalanches reach a shorter runout than avalanches with the same starting conditions in Jörundarskál and other large avalanche paths.

4. Avalanches are deflected away from the area immediately north of Strengsgil (below Auðimelur). This is a consistent feature in all simulations where avalanches were released in the neighbourhood of this area indicating that hazard lines may be drawn comparatively close to the mountain at this location.

5. Tongues are formed in the simulated avalanche deposits in the S-Fífladalir area below gullies in the lower part of the slope that are called Skriðulækjargil. Drift snow may be expected to alter this landscape substantially during winter and therefore the size and locations of these tongues may be misleading. They should therefore not be reflected in a hazard zoning.

The persistent location of the main tongues in all the runs indicates that the simulated form of the tongues may be used to determine tongues in hazard lines in a hazard zoning of the village as was previously done for Bolungarvík and Neskaupstaður. Nevertheless, one should be careful not to overinterpret the tongue forms in the hazard zoning. Thus only an appropriate fraction of the runout differences between the central tongues and the intermediate areas indicated by the simulations should be used in the hazard zoning. The appropriate fraction to use is a matter of subjective judgement, but a value of about 1/2 could be used.

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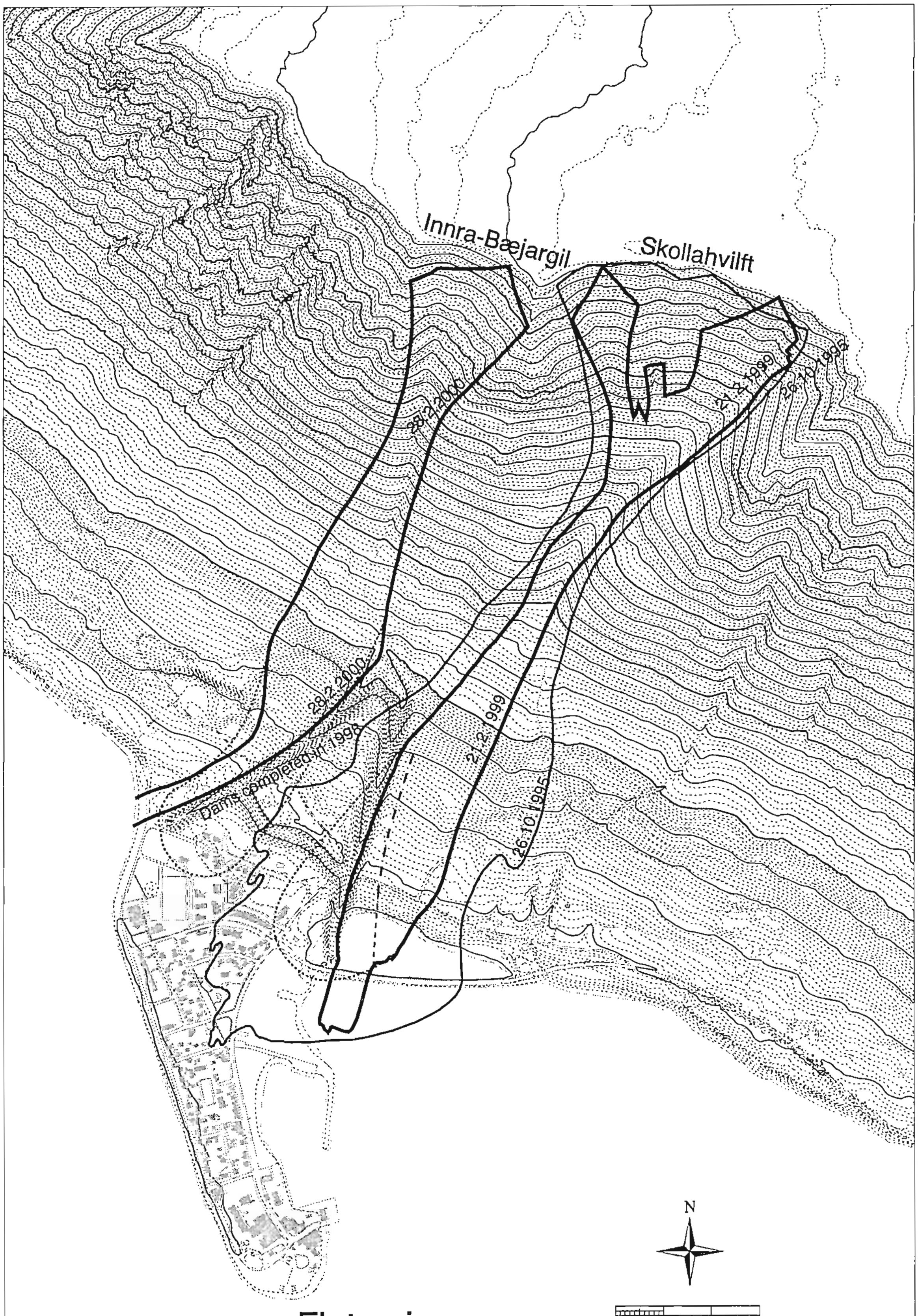
LIST OF FIGURES



Innra-Bæjargil
Skollahvilft
28.2.2000
21.2.1999
26.10.1995
Dams completed in 1998
N
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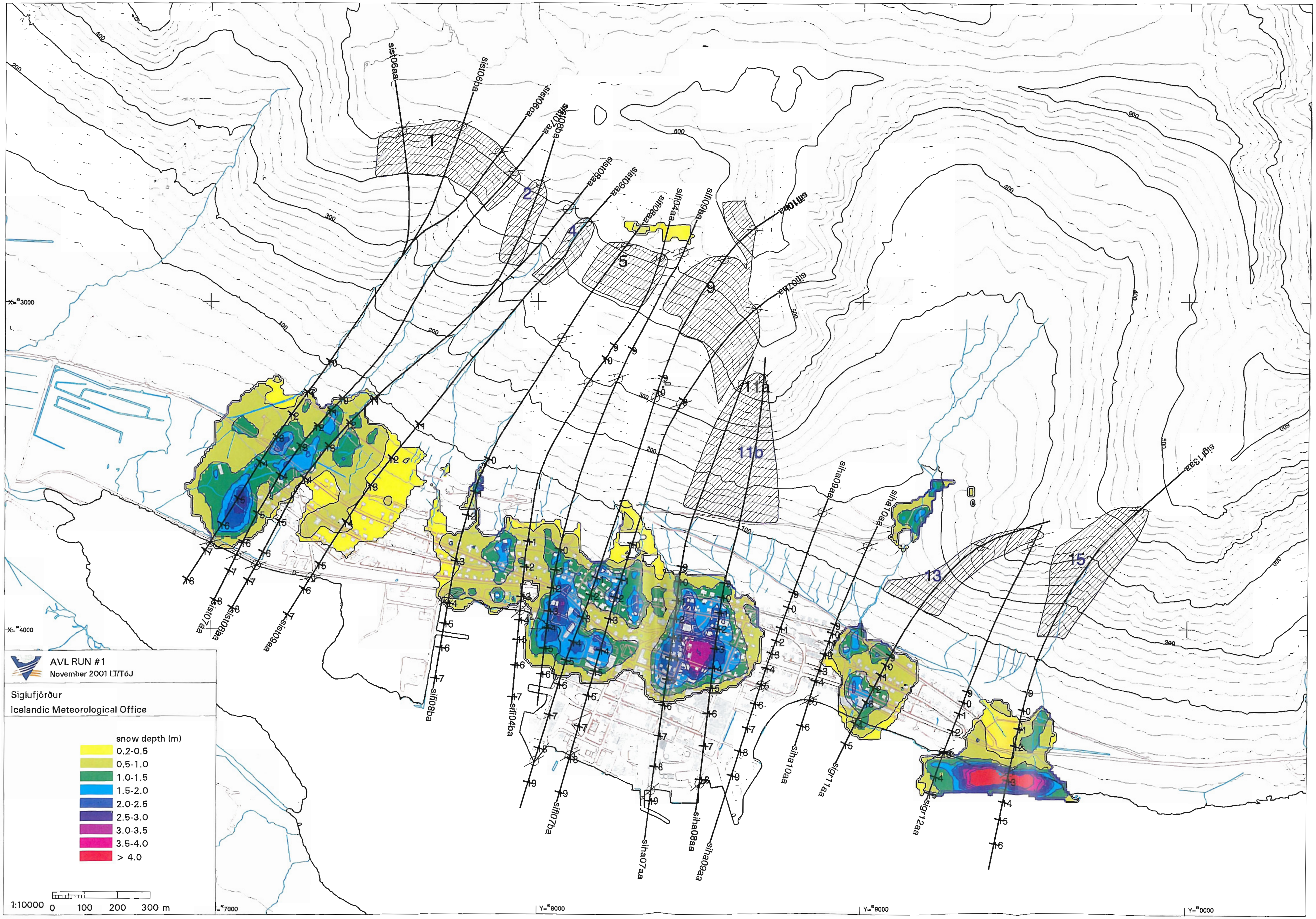
Flateyri



AVL RUN #1
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
snow depth (m)
0.2-0.5
0.5-1.0
1.0-1.5
1.5-2.0
2.0-2.5
2.5-3.0
3.0-3.5
3.5-4.0
> 4.0
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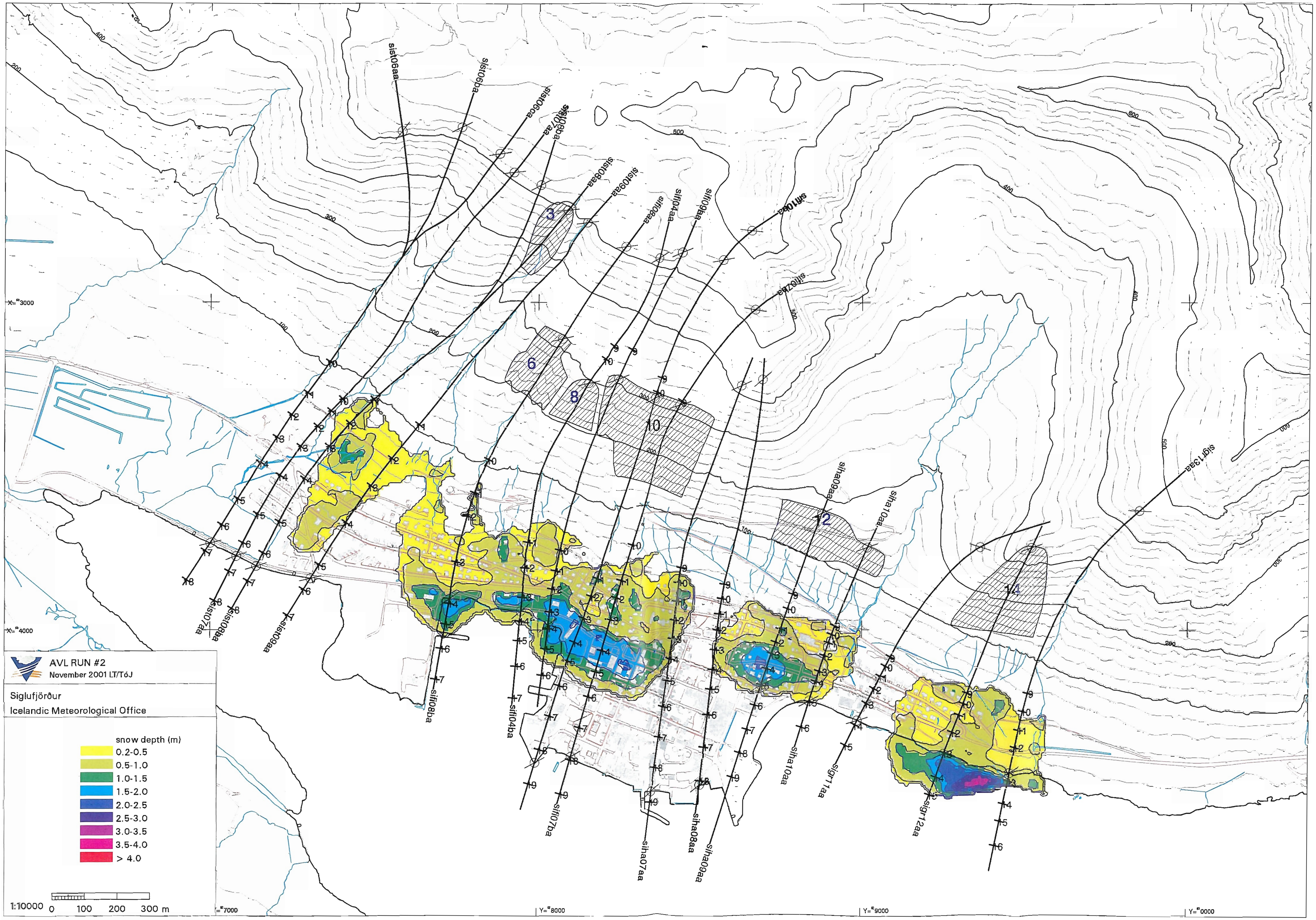
AVL RUN #2
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
snow depth (m)
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1.5-2.0
2.0-2.5
2.5-3.0
3.0-3.5
3.5-4.0
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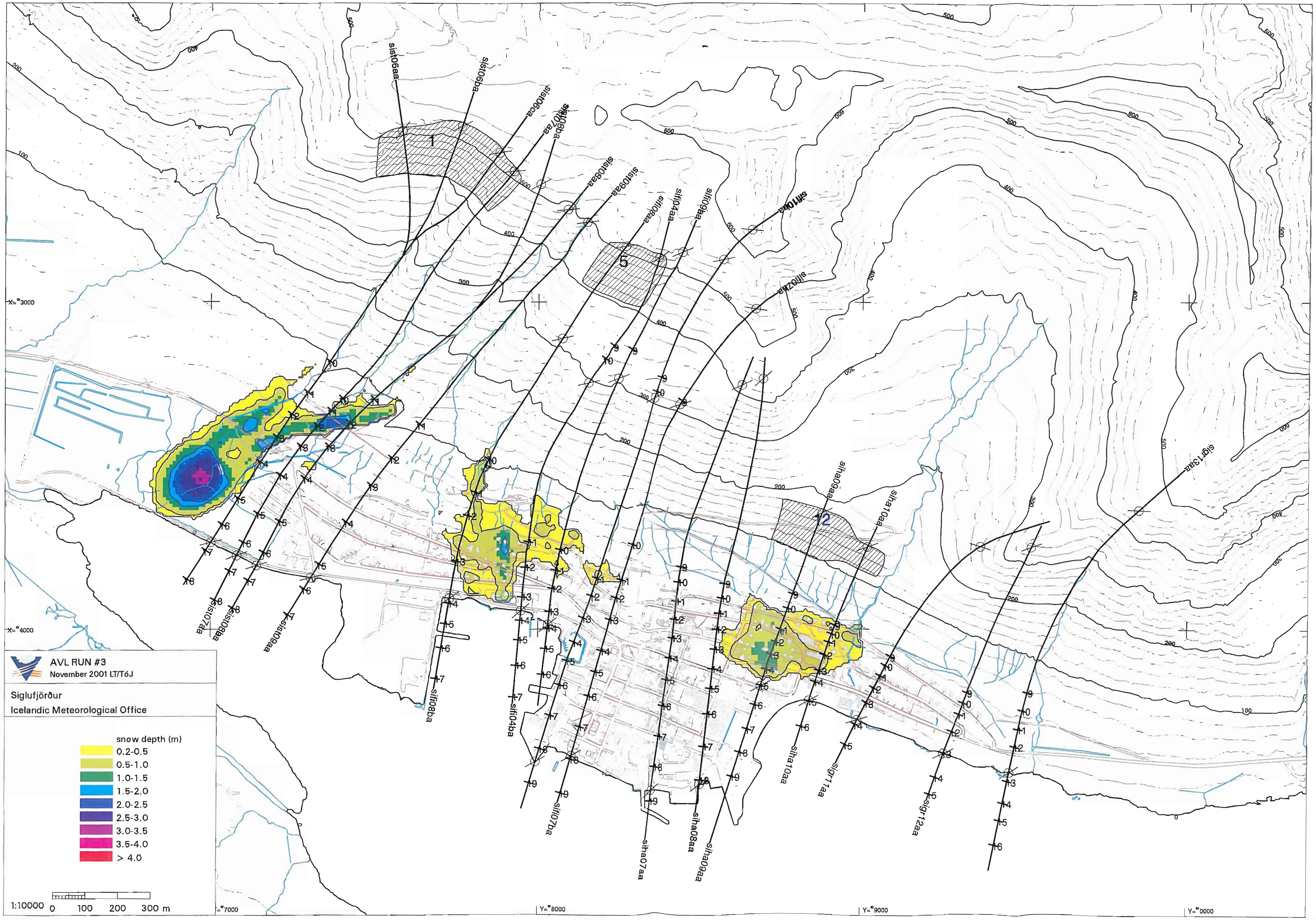
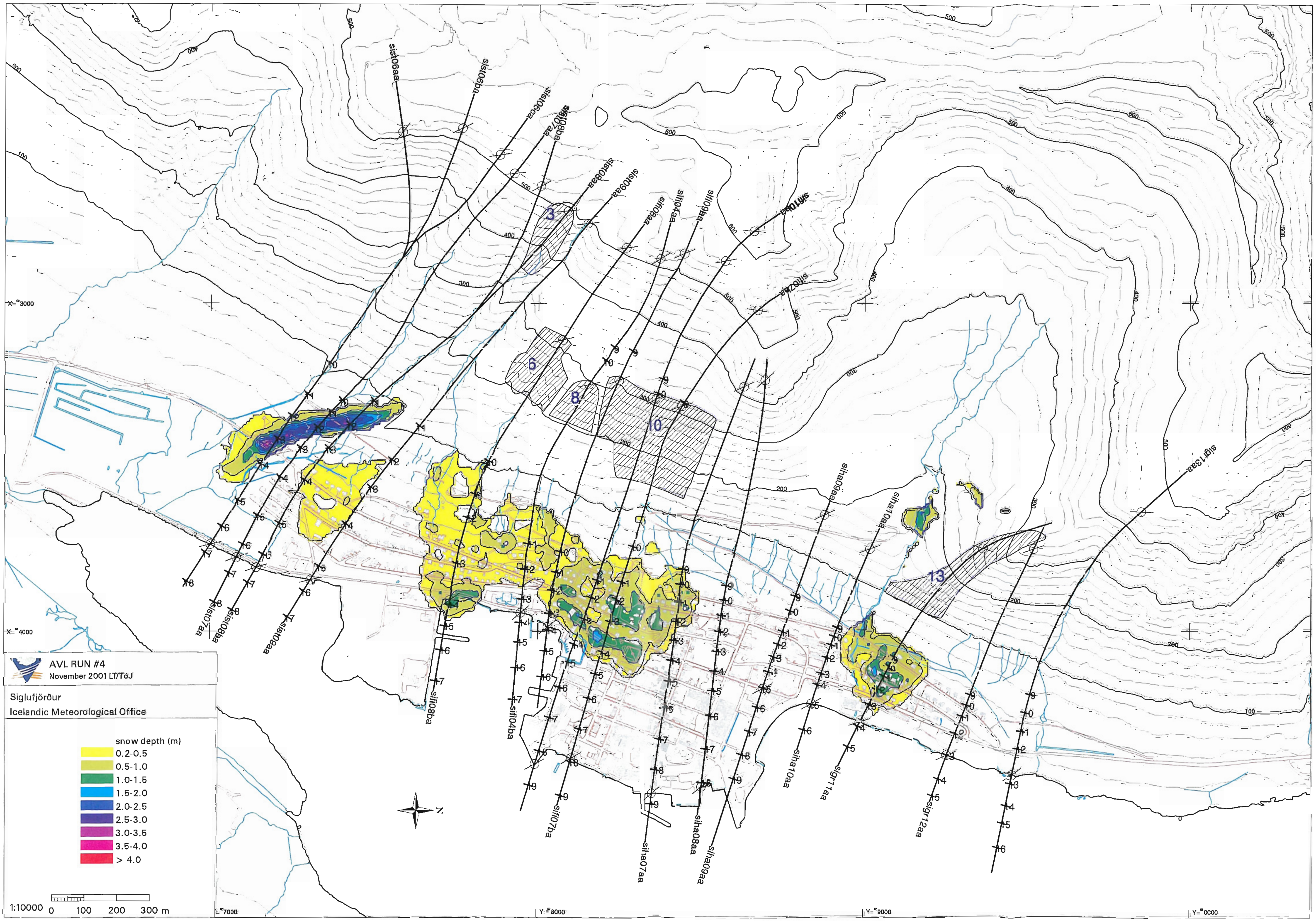
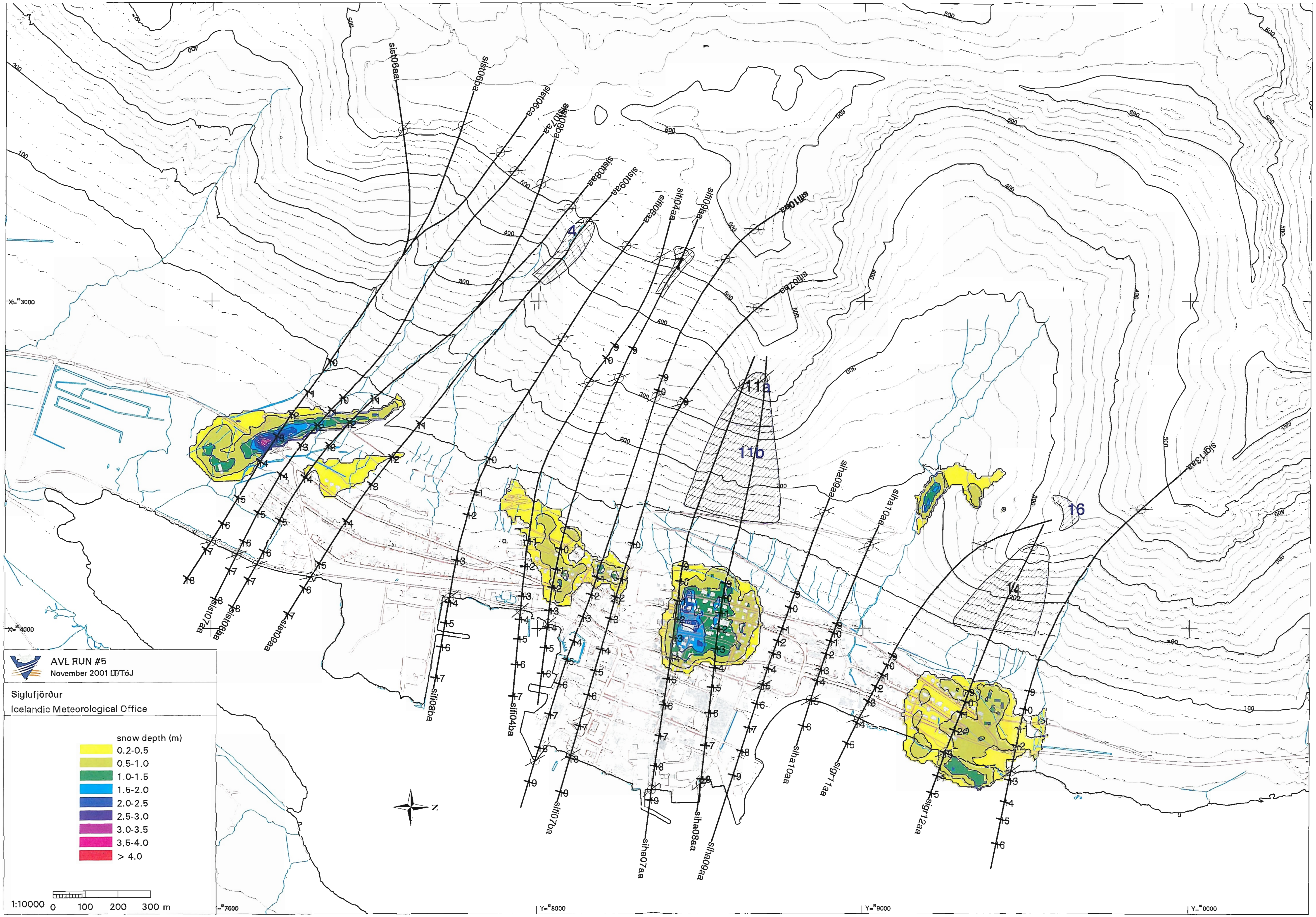
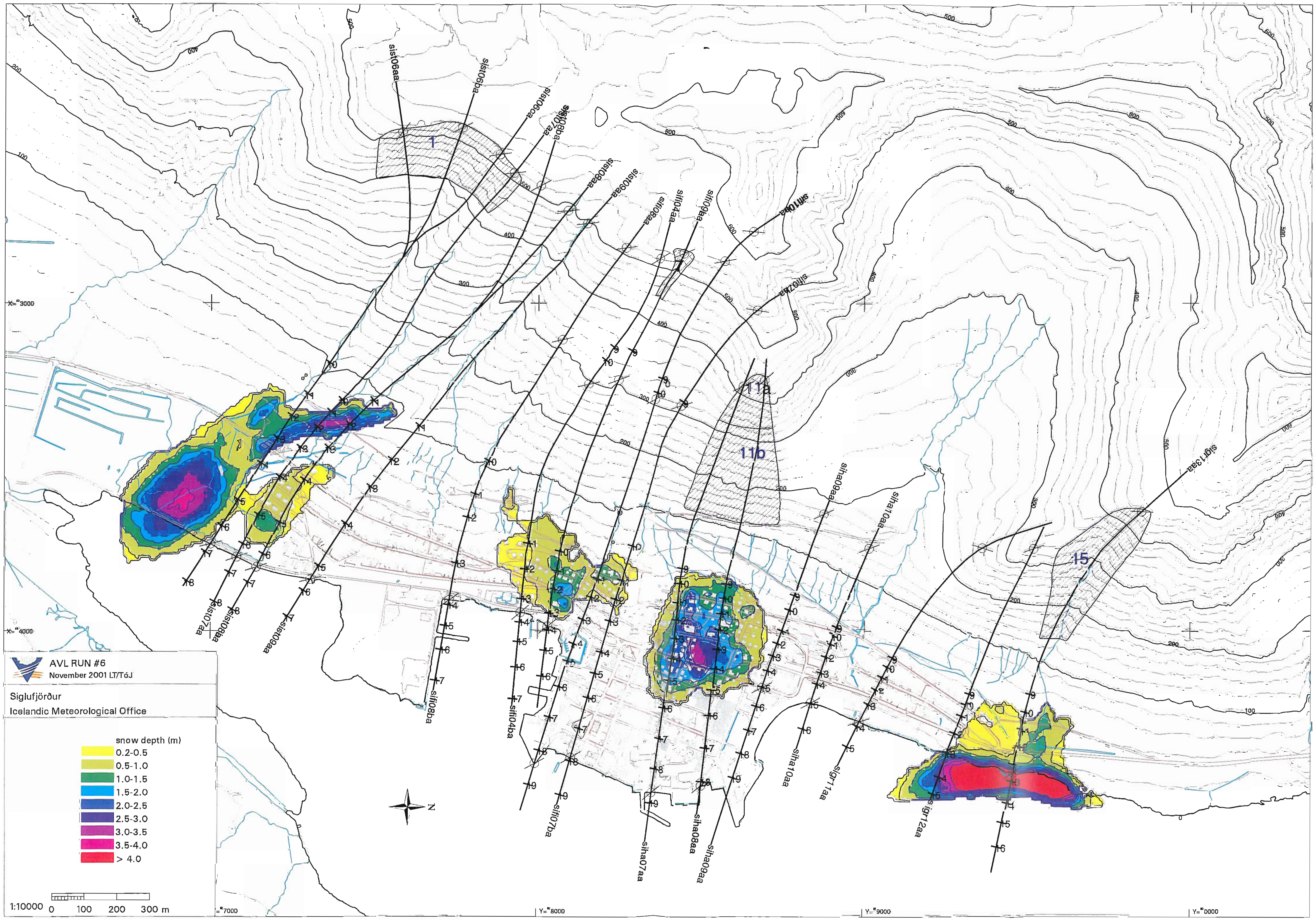
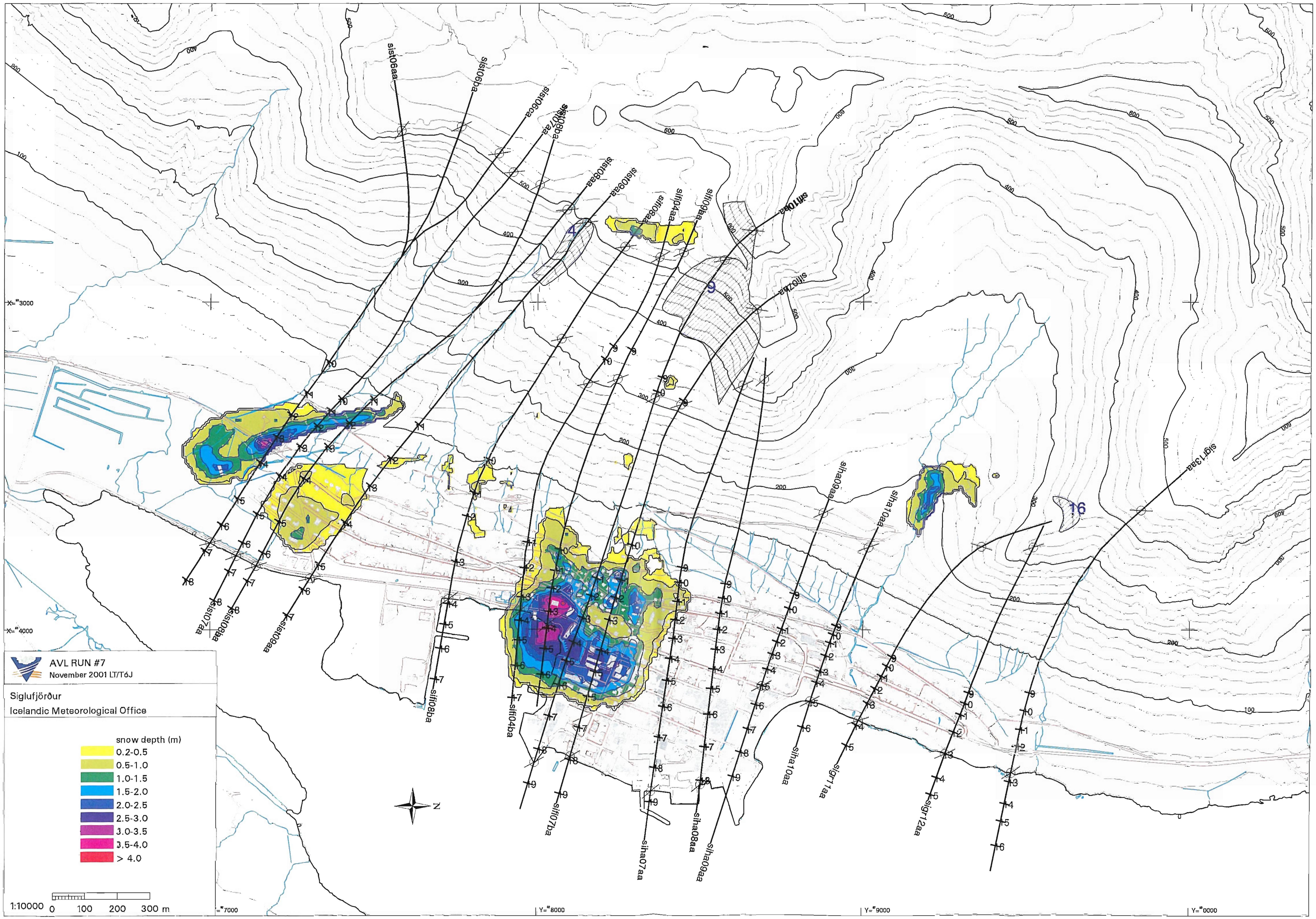

AVL RUN #3
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
snow depth (m)
0.2-0.5
0.5-1.0
1.0-1.5
1.5-2.0
2.0-2.5
2.5-3.0
3.0-3.5
3.5-4.0
> 4.0
1:10000 0 100 200 300 m
sist06aa
sist06ba
sist06ca
sist07aa
sist08aa
sist08ba
sist09aa
sifi08ba
sifi04ba
sifi07ba
sifi04aa
sifi06aa
sifi10aa
sifi02aa
siha07aa
siha08aa
siha09aa
siha10aa
sigr11aa
sigr12aa
sigr13aa

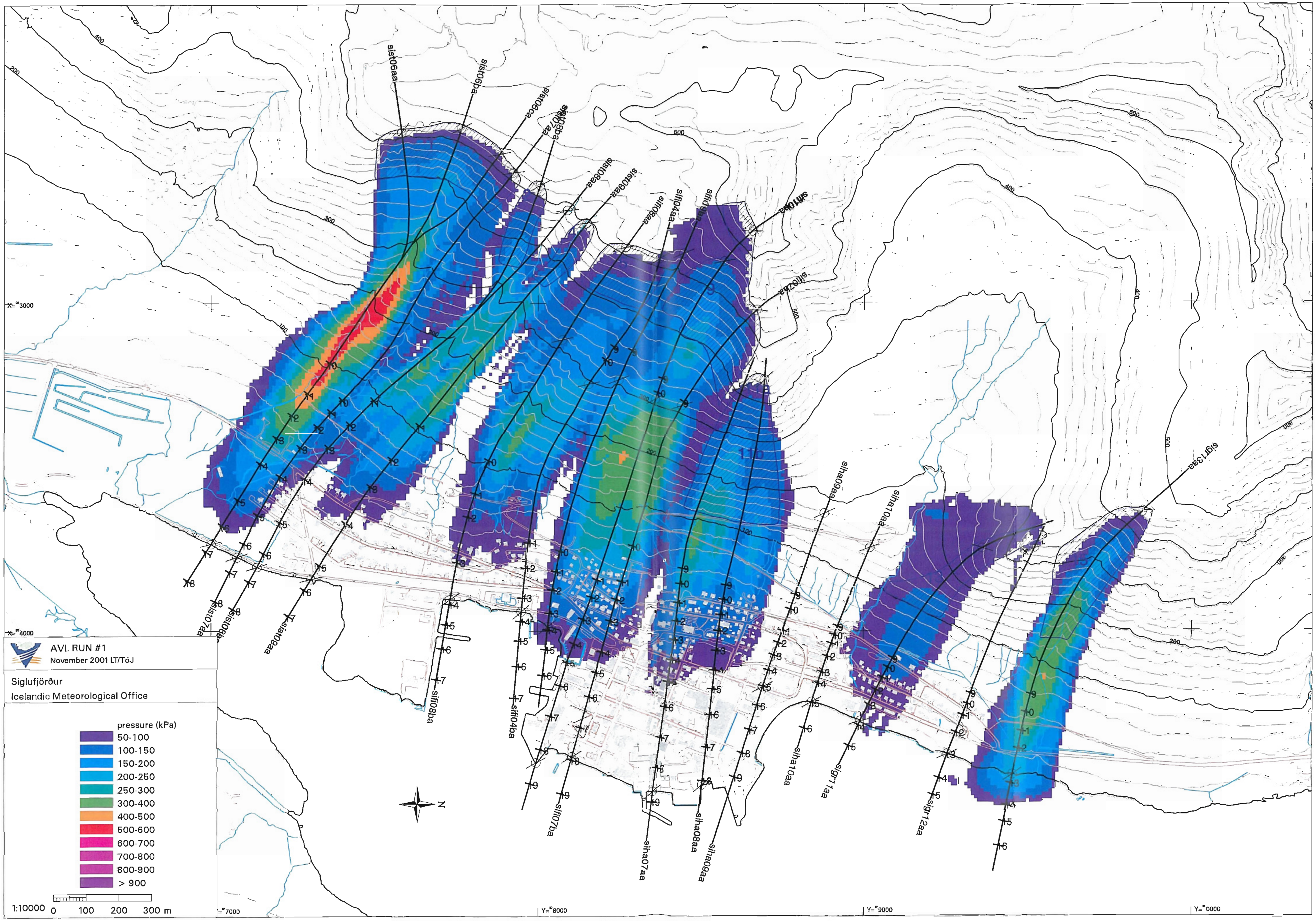

AVL RUN #4
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
snow depth (m)
0.2-0.5
0.5-1.0
1.0-1.5
1.5-2.0
2.0-2.5
2.5-3.0
3.0-3.5
3.5-4.0
> 4.0
1:10000
0
100
200
300 m
sist06aa
sist06ba
sist06ca
sist07aa
sist08ba
sist08aa
sist09aa
sifi08aa
sifi04aa
sifi09aa
sifi10aa
sifi12aa
siha09aa
siha10aa
sigr13aa
sifi08ba
sifi04ba
sifi07ba
siha07aa
siha08aa
siha09aa
siha10aa
sigr11aa
sigr12aa
3
6
8
10
13


AVL RUN #5
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
snow depth (m)
0.2-0.5
0.5-1.0
1.0-1.5
1.5-2.0
2.0-2.5
2.5-3.0
3.0-3.5
3.5-4.0
> 4.0
1:10000
0
100
200
300 m
sist06aa
sist06ba
sisi06ca
sisi07aa
sisi08ba
sisi08aa
sisi09aa
sifi08aa
sifi04aa
sifi09aa
sifi10aa
sifi07aa
siha09aa
siha10aa
sigr13aa
sisi07aa
sisi08aa
sisi09aa
sifi08ba
sifi04ba
sifi07ba
siha07aa
siha08aa
siha09aa
siha10aa
sigr11aa
sigr12aa
4
11a
11b
14
16
X=3000
X=4000
Y=7000
Y=8000
Y=9000
Y=0000

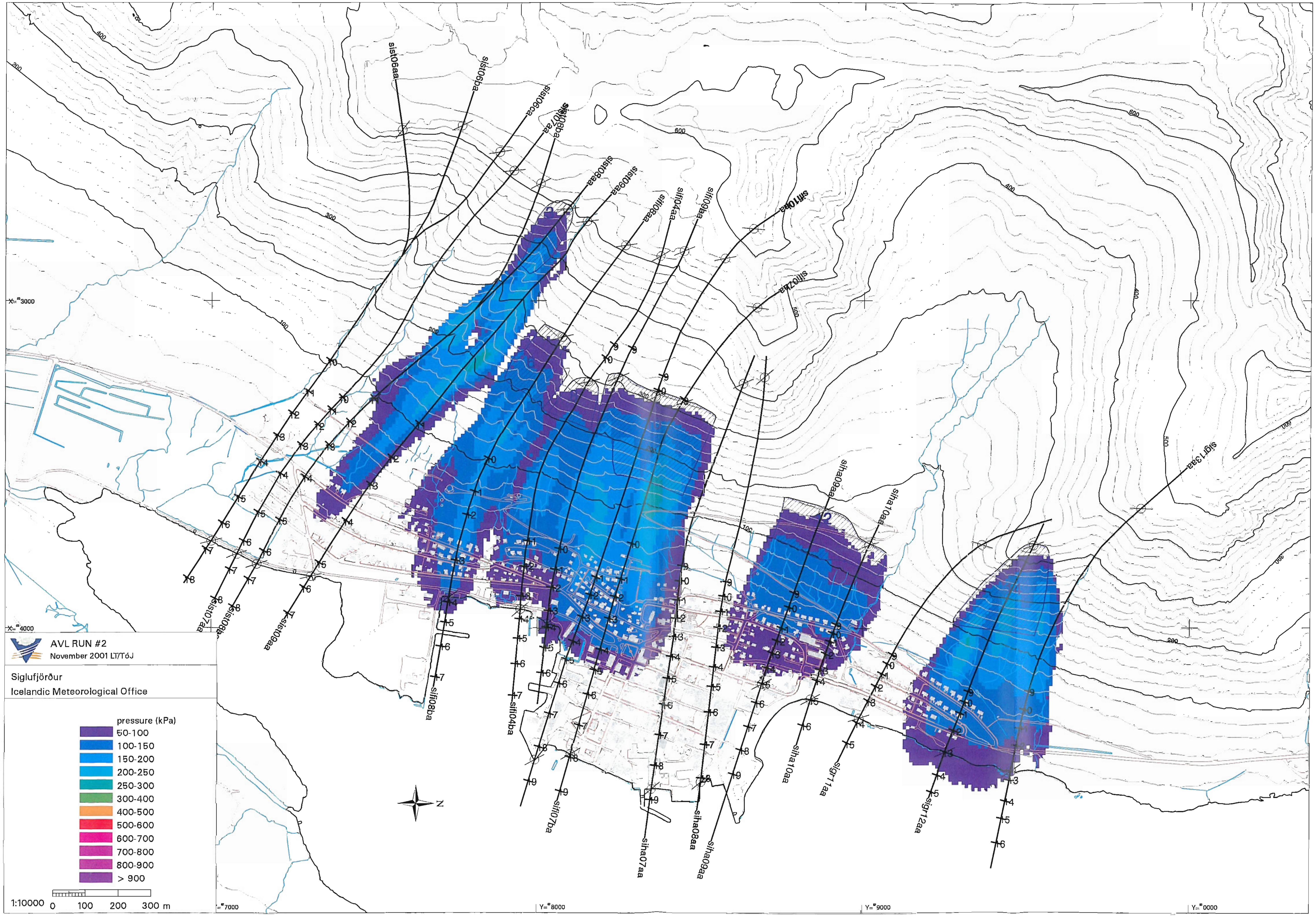

AVL RUN #6
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
snow depth (m)
0.2-0.5
0.5-1.0
1.0-1.5
1.5-2.0
2.0-2.5
2.5-3.0
3.0-3.5
3.5-4.0
> 4.0
1:10000
0 100 200 300 m
sist06aa
sist06ba
sist06ca
sist07aa
sist08ba
sist08aa
sist09aa
sifi08aa
sifi04aa
sifi09aa
sifi01aa
sifi02aa
sifi08ba
sifi04ba
sifi07ba
siha07aa
siha08aa
siha09aa
siha09aa
siha10aa
siha10aa
sigr11aa
sigr12aa
sigr13aa
1
11a
11b
15
X=3000
X=4000
Y=7000
Y=8000
Y=9000
Y=0000

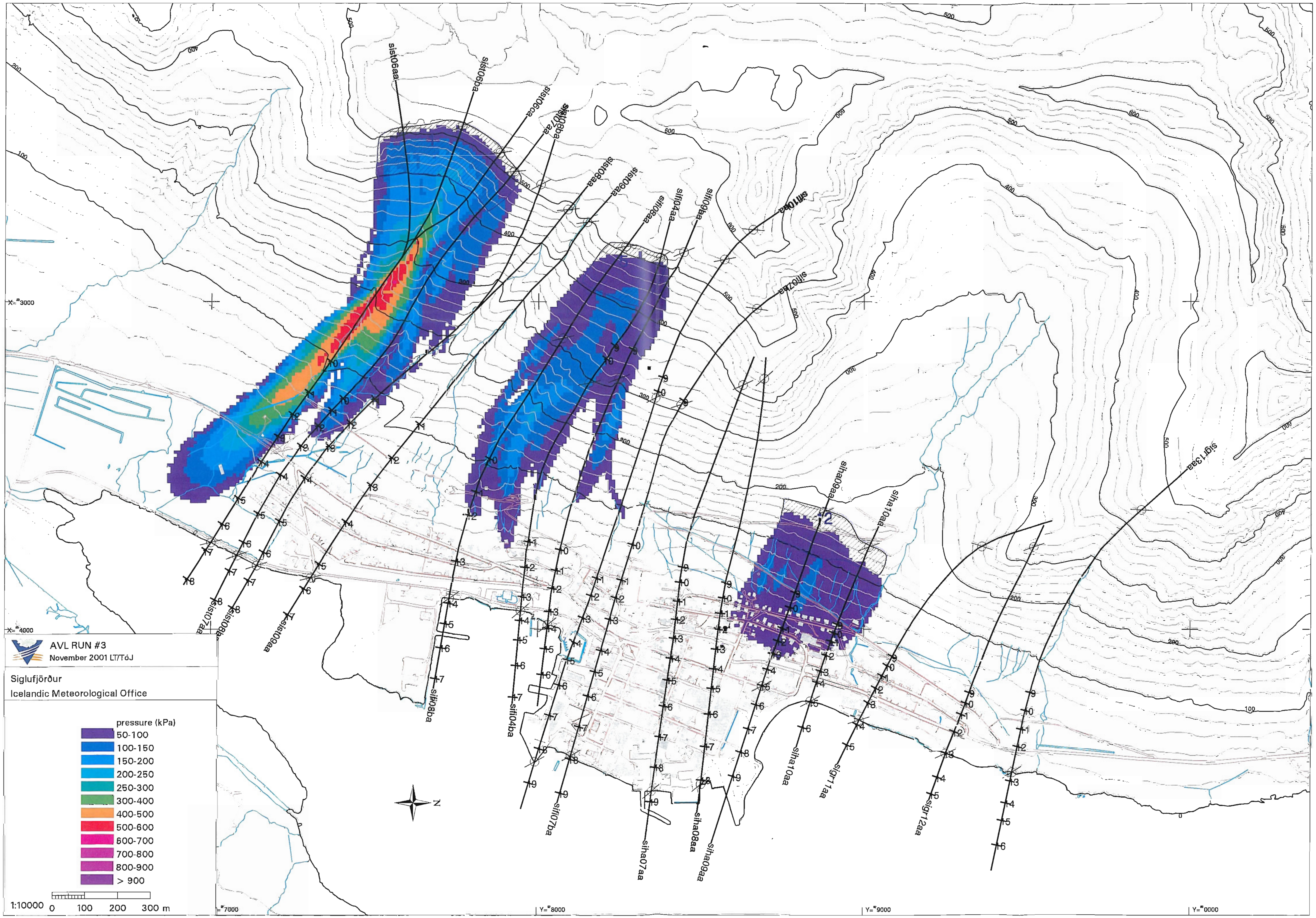


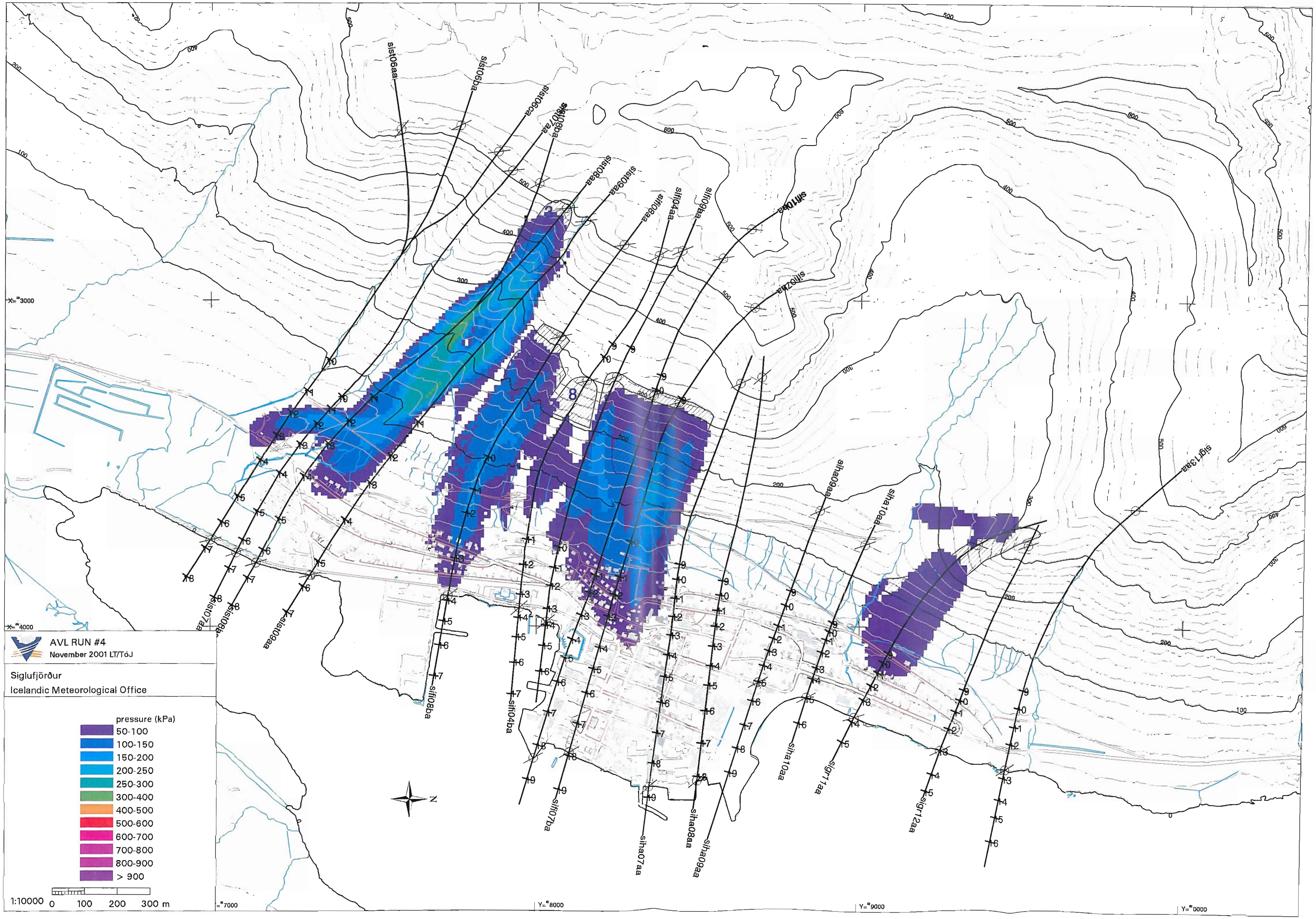
AVL RUN #7
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
snow depth (m)
0.2-0.5
0.5-1.0
1.0-1.5
1.5-2.0
2.0-2.5
2.5-3.0
3.0-3.5
3.5-4.0
> 4.0
1:10000 0 100 200 300 m

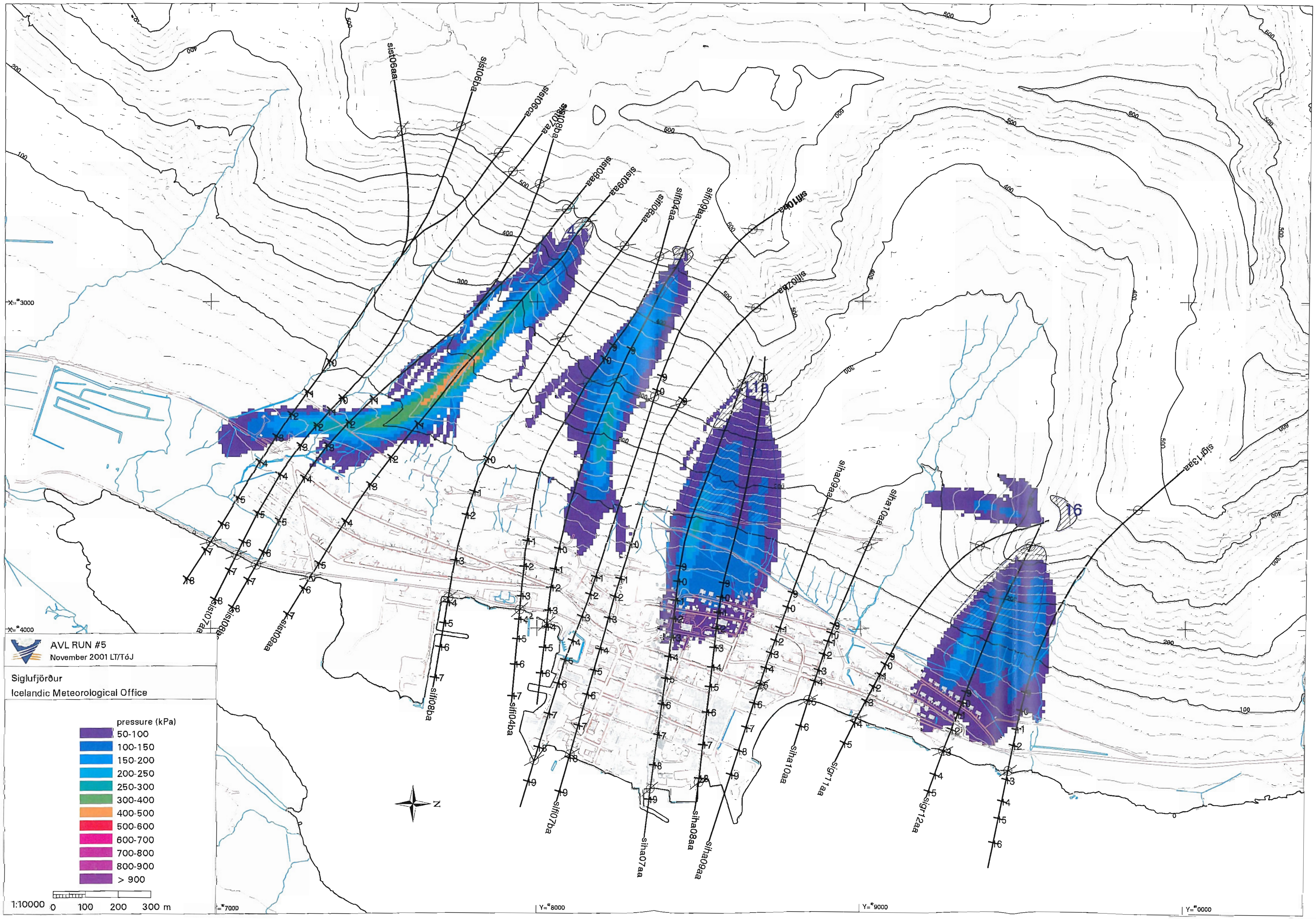


AVL RUN #1
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
pressure (kPa)
50-100
100-150
150-200
200-250
250-300
300-400
400-500
500-600
600-700
700-800
800-900
> 900
1:10000
0 100 200 300 m
N


AVL RUN #2
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
pressure (kPa)
50-100
100-150
150-200
200-250
250-300
300-400
400-500
500-600
600-700
700-800
800-900
> 900
1:10000
0 100 200 300 m


AVL RUN #3
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
pressure (kPa)
50-100
100-150
150-200
200-250
250-300
300-400
400-500
500-600
600-700
700-800
800-900
> 900
1:10000
0
100
200
300 m
N
sist06aa
sist06ba
sist06ca
sist07aa
sist08aa
sist08ba
sist09aa
sist09ba
sifl08aa
sifl04aa
sifl04ba
sifl09aa
sifl07ba
sifl08ba
sifl10aa
sifl12aa
siha07aa
siha08aa
siha09aa
siha10aa
sigr11aa
sigr12aa
sigr13aa


AVL RUN #4
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
pressure (kPa)
50-100
100-150
150-200
200-250
250-300
300-400
400-500
500-600
600-700
700-800
800-900
> 900
1:10000
0 100 200 300 m
N


AVL RUN #5
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
pressure (kPa)
50-100
100-150
150-200
200-250
250-300
300-400
400-500
500-600
600-700
700-800
800-900
> 900
1:10000
0
100
200
300 m
X=*3000
X=*4000
Y=*7000
Y=*8000
Y=*9000
Y=*0000
N
sist06aa
sist06ba
sisi06ca
sisi07aa
sisi08ba
sisi08aa
sisi09aa
sifi08aa
sifi04aa
sifi09ba
sifi08ba
sifi04ba
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siha09aa
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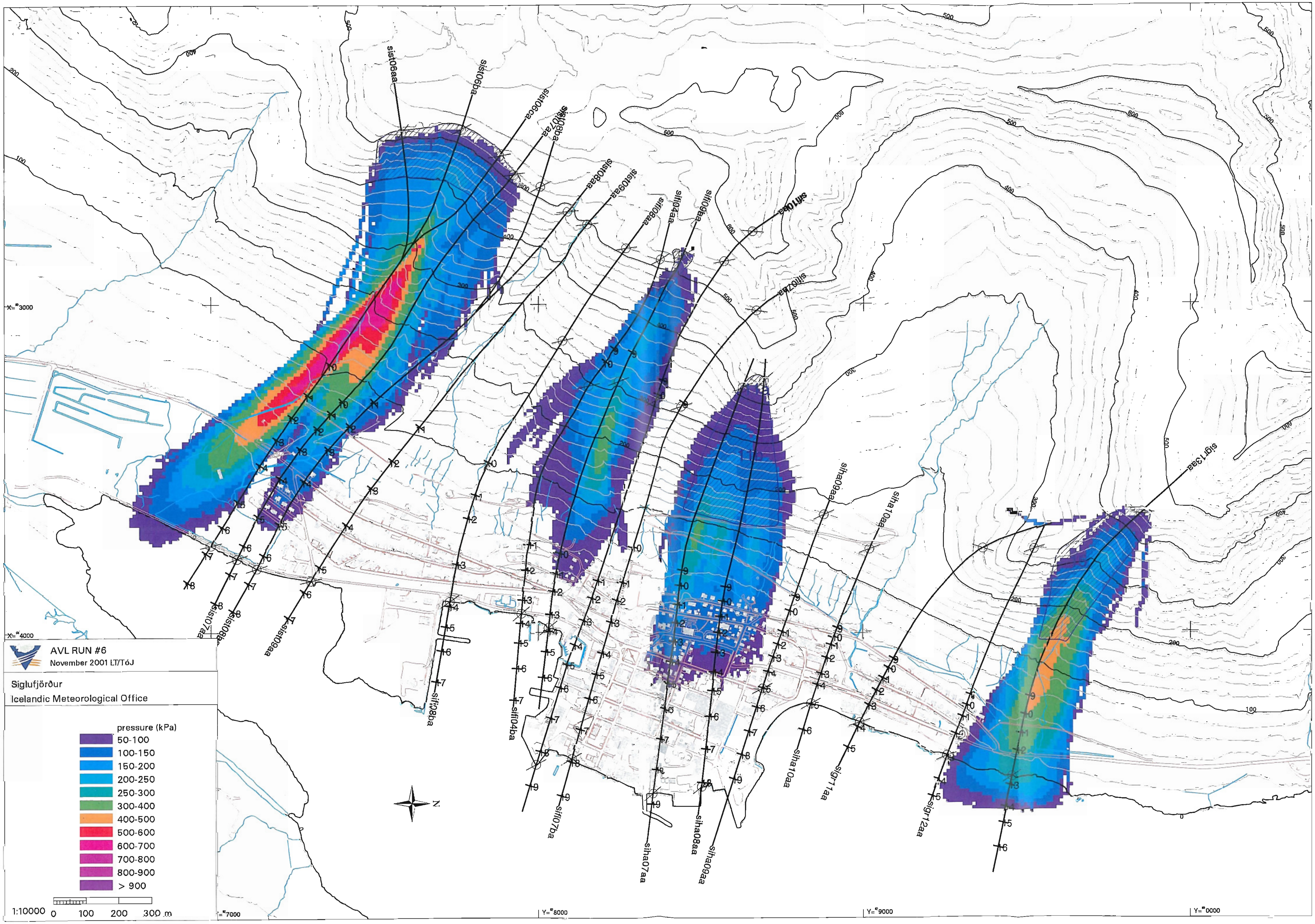
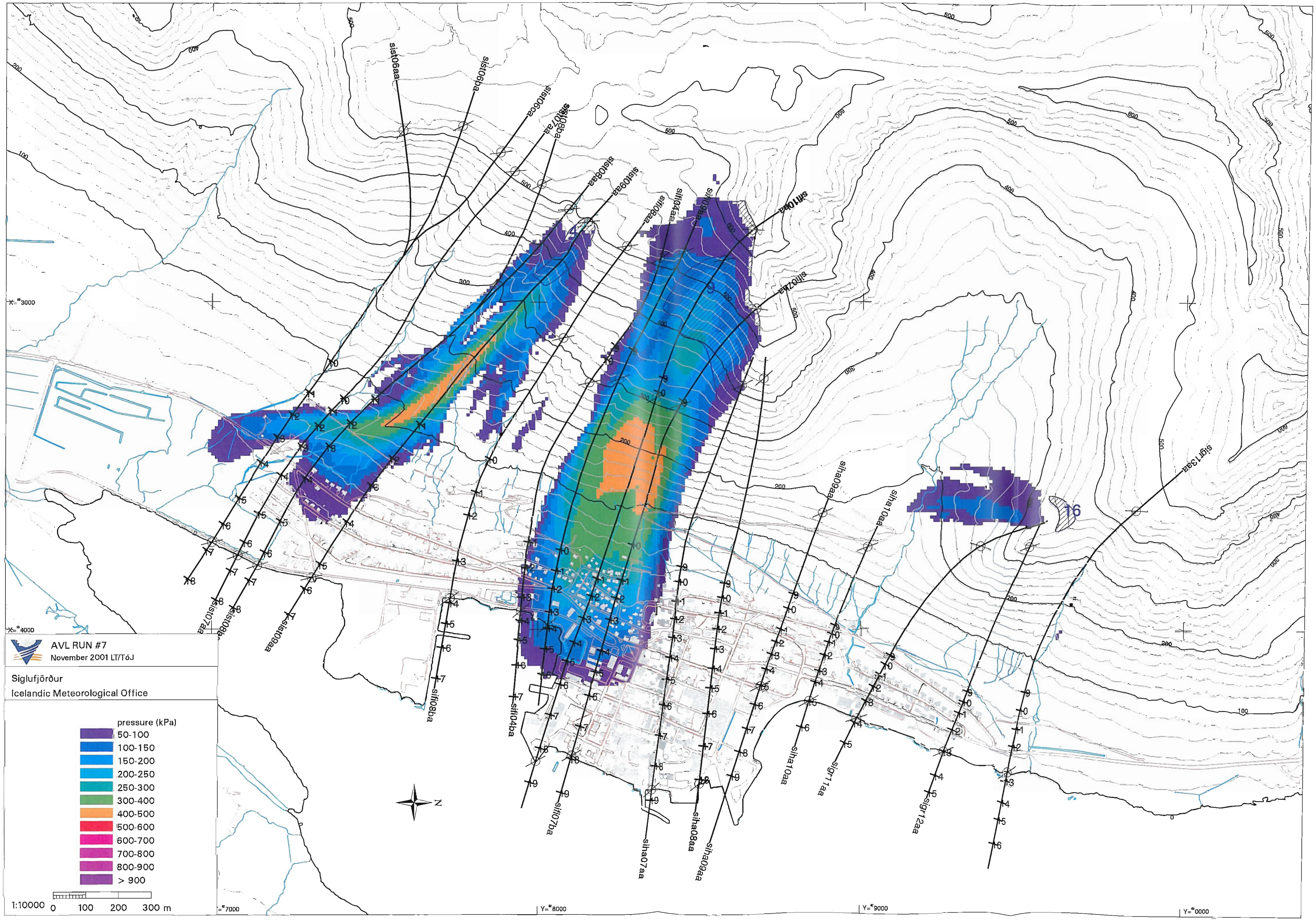
sigr11aa
sigr12aa
sigr13aa
16


AVL RUN #6
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
pressure (kPa)
50-100
100-150
150-200
200-250
250-300
300-400
400-500
500-600
600-700
700-800
800-900
> 900
1:10000
0
100
200
300 m
N
X=3000
X=4000
Y=7000
Y=8000
Y=9000
Y=0000
sist06aa
sist06ba
sist06ca
sist07aa
sist08aa
sist08ba
sist09aa
sifi04aa
sifi08aa
sifi09aa
sifi10aa
sifi07aa
sifi04ba
sifi07ba
sifi08ba
siha07aa
siha08aa
siha09aa
siha09aa
siha10aa
sigr11aa
sigr12aa
sigr13aa


AVL RUN #7
November 2001 LT/TóJ
Siglufjörður
Icelandic Meteorological Office
pressure (kPa)
50-100
100-150
150-200
200-250
250-300
300-400
400-500
500-600
600-700
700-800
800-900
> 900
1:10000
0 100 200 300 m