Reply to Referee #2' comments regarding the article "A statistical approach to represent small-scale variability of permafrost temperatures due to snow cover".

We would like to thank Referee #2 for the constructive comments and suggestions that helped improving our manuscript.
We will address the comments point-by-point where **referee comments are in bold**, our answers are without formatting, and *changes to the initial manuscript are in Italics*.

MAIN COMMENTS

1. Section 3.1: is the subgrid distribution of snow depth conservative of the original coarse observation?

The sub-grid distribution is derived from the CV and the mean snow depth (which is the original coarse observation). The snow depth is therefore conserved. For clarification we include the following sentence at page 6669, line 6:

The average maximum snow depth corresponds to the coarse scale snow observation, and the original coarse scale snow depth is therefore conserved in the sub-grid snow distribution.

2. I think would be useful to have more information about the boreholes that were used. What depth are these boreholes? which depths are used in the analysis? Time periods? (related to point 6 below).

The output of the model is MAGT and MAGST (page 6667 line 15-18), and it is also validated for the same values (page 6670 l. 6-8). For clarification we revise the following sentences:
Page 6667 line 15-18: MAGT is defined as "Mean Annual Ground Temperature *at the top of the permafrost or at the bottom of the seasonal freezing layer*".
Page 6670, l-8): *For the evaluation runs the model* is forced with climatic data for the hydrological year corresponding to the observations.

Furthermore we have included full table of boreholes with depth and measurement periods in the supplementary material, and refer to it in the text as follows:

Page 6670, line 21: *Tables of ground surface temperature loggers (Table S1) and boreholes used for validation (Table S2), are included in the supplementary material.*

3. Section 3.2: Due to the great importance of nF/nT on your results, it would be nice to include a short section critical appraising the various pros/cons of such statistical approach in the context of permafrost modelling. A very first thought is how spatial and temporally consistent are these relationships likely to be? Where were they developed? Over what period of time? You of course mention the variability of snow depth as being a large driver in the variability you see in nF/nT (motivation for this paper) but what else is significant?

We have included the following section at page 6668, line 26:

The relationships between n-factors and snow cover in open areas are shown to be consistent within the two sites in southern Norway (Gisnås et al. 2013 and Gisnås et al. 2014). Due to lack of field observations including all required variables at one site in northern Norway, the relation is not tested for this area. However, it fits very well with a detailed study with 107 *loggers recording the variation in ground surface temperature at a lowland site in Svalbard (Gisnås et al. 2014). Other factors, such as solar radiation and soil moisture, have minor effects on the small-scale variation in ground surface temperatures in these areas. Gisnås et al (2014) demonstrated that most of the sub-grid variation in ground temperatures within 1x1 km areas in Norway and Svalbard was reproduced by including only the sub-grid variation of snow depths. In other areas other parameters than snow depth might have a larger effect on the ground surface temperatures, and should be accounted for in the derivation of n-factors.*

4. Section 3.2: Following on from the point above, you state that the relationship between n factors and snow depth is based on 13 stations in S.Norway and 80 loggers in Finse and Juvvasshoe. This seems to be quite geographically limited. Can you briefly state if/how you might expect these relationships to vary with space, i.e what might they look like in Lyngen or Finnmark?

Compared to the total model domain we agree that these observations are limited. However, compared to the amount of available datasets including systematic measurements of ground surface and air temperatures together with snow depths in the same point location, these datasets are quite unique on global basis. The relationships for *n*-factors in vegetated areas will vary within different species, and this is not discussed here. However, because permafrost is not present in vegetated areas in Norway, we have not focused on the variation within these surface classes. The variation in the relation between *n*-factors and snow depth is not examined in northern Norway because we lack detailed field observations in this area. However, the dataset from Ny-Ålesund, which includes 107 loggers in a 1x1 km area, shows very similar dependencies as the data from southern Norway, even though this site is a lowland site (20 – 40 m a.s.l.) with higher soil moisture and finer sediments.

We have included some comments on this in the section at page 6668, line 26, described in the previous point:

The relationships between n-factors and snow cover in open areas are shown to be consistent within the two sites in southern Norway (Gisnås et al. 2013 and Gisnås et al. 2014). Due to lack of field observations including all required variables at one site in northern Norway, the relation is not tested for this area. However, it fits very well with a detailed study with 107 loggers recording the variation in ground surface temperature at a lowland site in Svalbard (Gisnås et al. 2014). Other factors, such as solar radiation and soil moisture, have minor effects on the small-scale variation in ground surface temperatures in these areas. Gisnås et al (2014) demonstrated that most of the sub-grid variation in ground temperatures within 1x1 km areas in Norway and Svalbard was reproduced by including only the sub-grid variation of snow depths. In other areas other parameters than snow depth might have a larger effect on the ground surface temperatures, and should be accounted for in the derivation of n-factors.

5. P.6678, l.6-10: You mention the question of equilibrium with surface forcing on climatic scales, but how about seasonal lags ie. its quite typical to see max. Temperatures at 10m or so at around beginning of winter when summer forcing has been conducted to depth. Therefore to compare model and obs (even assuming you describe conductivities perfectly) you need to drive your model with at least 6months previous atmosphere to get the warming/cooling signal of that time slice. This could have an impact on your model performance, especially if there is an extreme season (dry, warm etc) missed in the simulation. Maybe I miss something here, but that brings me to the following point....

The reviewer makes a valid point. However, since we used field data distributed over larger areas and over longer time periods including all kinds of situations, the effect would mainly show in terms of a larger statistical spread, and not a systematic error. Using data from six

months before is not good either, since this will vary quite a bit depending on the ground thermal properties of each single site.
This is already partly commented on in the current manuscript p. 6678, line 15 – 20: “For the model evaluation with measured ground temperatures in boreholes (Sect. 5.4), the modelled temperatures are forced with data for the hydrological year corresponding to the observations. Because of the assumption of an equilibrium situation in the model approach, such a comparison can be problematic as many of the boreholes have undergone warming during the past decades. However, with the majority of the boreholes located in bedrock or coarse moraine material with relatively high conductivity, the lag in the climate signal is relatively small at the depth of the top of permafrost.“

We include the following sentence after this section (Page 6678, line 21) to make this point clearer:

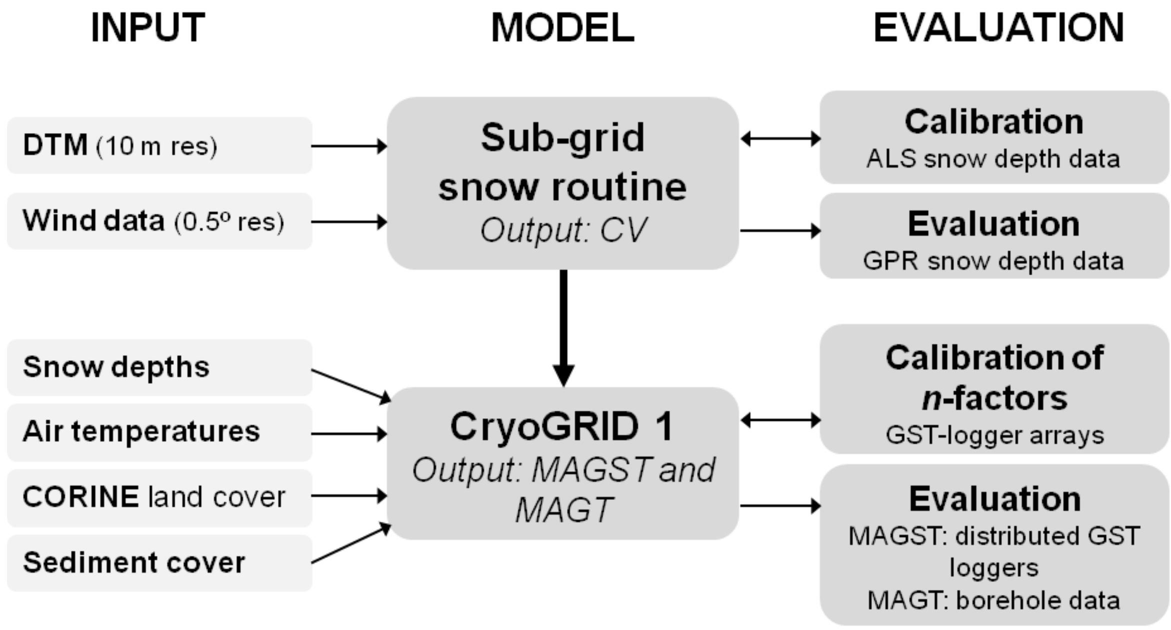
The lag will also vary from borehole to borehole, depending on the ground thermal properties. Since we use data distributed over larger areas and longer time periods, including a large range of situations, the effect mainly shows in terms of a larger statistical spread and not a systematic error.

6. In general you use a large amount of data and have a reasonable complex modell setup with multiple simulations and evaluations against various datasets. At times I felt a little lost on what was being computed, when and how. I think the paper would benefit tremendously from 3 additions: (1) a schematic of the model chain to give a very quick overview of the setup (forcing, permafrost model, wind model, subgrid distribution routine, calibrations and evaluations). (2) A table giving all data used together with details such as time period, depths of boreholes etc. (3) A table describing all your simulations with important information such as simulation period(s) - which I am really missing. To illustrate this I dont know what your MAGT and MAGST are based on? I see 2 date ranges 1961-2013 and 1981-2010 but presumably borehole data and surface loggers are a subset of this. Perhaps there is a better way to summarise but my main point is this paper really needs more synoptic figures/tables to guide the reader through the methods and evaluation.
The output of the model is MAGT and MAGST (page 6667 line 15-18), and it is also validated for the same values (page 6670 l. 6-8) (see comments above).

1) We have included the following schematic overview to clarify the modelling routines:

We refer to the figure on page 6669, Line 12: *A schematic of the model chain and the evaluation is shown in Figure 4.*

Figure 4: Schematic of the model chain, including input data and calibration and evaluation procedures.



2) This is partly answered in point 2 above. We have included the following for clarification:
Page 6667 line 15-18: MAGT is defined as "Mean Annual Ground Temperature *at the top of the permafrost or at the bottom of the seasonal freezing layer*".
Page 6670, l-8: *For the evaluation runs the model* is forced with climatic data for the hydrological year corresponding to the observations.

We have also included a full table of boreholes and ground surface temperature loggers in the supplementary material, giving the location, depth of boreholes, measurement periods, and vegetation type. We refer to this in the text as follows:

Page 6670, line 21: *Tables of ground surface temperature loggers (Table S1) and boreholes used for validation (Table S2), are included in the supplementary material.*

3) The model is forced with annual thawing and freezing degree days calculated over hydrological years. The main permafrost distribution results are given as an average over the 30-year period 1981 – 2010. For validation with ground surface temperature loggers and boreholes temperatures, the degree days forcing the model are calculated over the same hydrological year as the observation. This will therefore vary, but is not defined in the supplementary material (S1 and S2). There are no other periods used. The date range 1961 – 2013 is only the years with available climate forcing. We understand from the comments that this was confusing, but we think that some clarification in the text is better than another table. Instead we have included the tables of ground surface loggers and boreholes in the supplementary material (see point above), and made the following changes in the text:

Page 6670, line 8: *For the evaluation runs the model* is forced with climatic data for the hydrological year corresponding to the observations.

Page 6672, line 10-11: The climatic forcing of the permafrost model is daily gridded air temperature and snow depth data, called the seNorge dataset, provided by the Norwegian Meteorological Institute. (deleted: *for the period 1961 – 2013*)

Page 6672, line 13-14: The dataset, *available for the period 1961 - 2013,* is based on air temperature and precipitation data collected at the official meteorological stations in Norway, interpolated to 1 km x 1 km resolution.

P. 6674, line 18: Included the following sentence: *The main results are given as averages over the 30-year period 1981 - 2010.*

7. P.6672, l.16. What is this ’snow algorithm’ - is there a reference?

Yes, a detailed description was published in Saloranta et al. (2012), and it is also partly described in Engeset et al 2004. The following references are moved down from the previous sentence for clarification: *(Engeset et al. 2004; Saloranta, 2012)*

8. I think it is important to mention in the discussion that due to statistical nature inherent in core methods there maybe difficulties in inferring conclusions about future development of permafrost. That’s not to say this contribution isn’t valuable - just to include some discussion of possible limitations.

We have already discussed this on page 6678 l. 6-22: “CryoGRID1 is a simple modelling scheme delivering a mean annual ground temperature at the top of the permanently frozen ground based on near-surface meteorological variables, under the assumption that the ground thermal regime is in equilibrium with the applied surface forcing. This is a simplification, and the model cannot reproduce the transient evolution of ground temperatures. However, it has proven to capture the regional patterns of permafrost reasonably well (Gisnås et al., 2013; Westermann et al., 2013). Because of the simplicity it is computationally efficient, and suitable for doing test-studies like the one presented in this paper and in similar studies (Westermann et al., 2015).

For the model evaluation with measured ground temperatures in boreholes (Sect. 5.4), the modelled temperatures are forced with data for the hydrological year corresponding to the observations. Because of the assumption of an equilibrium situation in the model approach, such a comparison can be problematic as many of the boreholes have undergone warming during the past decades. However, with the majority of the boreholes located in bedrock or coarse moraine material with relatively high conductivity, the lag in the climate signal is relatively small at the depth of the top of permafrost.”

To comment it more explicit we have now added the following sentence on p. 6678, l. 10: “*, and is therefore not suitable for future climate predictions.”*

9. Topography isn’t mentioned anywhere in the methods - can air temperature and exposure to solar radiation be important predictors for subgrid variability of permafrost within 1km grids? Particularly in the south? Both variables are reasonably easy to distribute based on terrain parameters. Is there a reason not to do this? If so can you provide some references justifying the omission. I did find this reference (also cited by you in another context) which discuss some of these points (and possibly in the end favours ignoring topography) - but I think this deserves a short discussion:

Isaksen, K., Hauck, C., Gudevang, E., ØdegaÊ rd, R. S. & Sollid, J. L. 2002. Mountain permafrost distribution in Dovrefjell and Jotunheimen, southern Norway, based on BTS and DC resistivity tomography data. Norsk GeograÂO″ sk Tidsskrift–Norwegian Journal of Geography Vol. 56, 122–136. Oslo. ISSN 0029-1951.

Topography is absolutely discussed as the main driver for the snow distribution. But, correctly, this paper only accounts for the variation in snow depths as the driver for the variation of ground temperatures within 1x1 km. The relation between snow cover and surface offset in this study shows that more than 60 % of the variation in *nF* and almost 50 % of the variation in nT is explained by snow depths. The same logger sites were also analyzed with respect to aspect, slope, solar radiation, vegetation and sediment type. With the now four years of data we find that maximum snow depth is the main explaining variable for the spatial variation in both nF and nT at all three field sites. The timing of melt out, or length of summer season, has a significantly higher correlation to maximum snow depth than to solar radiation. Gisnås et al. (2014) show that the observed small-scale distribution in MAGST could to a large degree be explained including only the sub-grid variation in maximum snow depths. It was concluded in Gisnås et al. (2014) that maximum snow depth is the main explaining variable for the spatial variation of ground surface temperatures within 1 x 1 km areas at the three field sites in southern Norway and Svalbard. Based on the study by Gisnås et al. (2014) this paper aims to implement sub-grid snow distribution over larger areas.

This is a fundamental point for this study, and as we realize that this was not entirely clear, we include the following sentence in the introduction at page 6663, line 14:

Gisnås et al., (2014) show that the observed variability in ground surface temperatures within 1 x 1 km areas is large degree reproduced by only accounting for the variation in maximum snow depths.

We also found that the reference (Gisnås et al. 2013) in the previous sentence is wrong, and it is now corrected to (*Gisnås et al. 2014*).

TECHNICAL POINTS

1. **P.6666, l.25: "ALS" is mentioned for the first time without explanation of acronym.**

"the ALS" is changed into *"an Airborne Laser Scanning (ALS) of snow depths (see Sect. 4.1) "*

2. ***P.6669*, l.21: accent on "a" is not needed in English.**

"a" is deleted.

3. **P.6669, l.21: ">4000 grid cells in 70% of the areas" - I didn't understand this sentence, can you make it more clear what you mean? Why do the coarse grids of fixed area (0.5x1km) have varying numbers of 10x10m subgrids?**

The sentences have been changed into: Each 0.5 km x 1 km area includes 500 to 5000 grid cells a 10m x 10m, *depending on the area masked out due to lakes or measurement errors. There were* > 4000 grid cells in 70% of the areas.

4. **P.6670, l.21: I think "Figure 2" is the wrong reference here.**

That's correct. It should be Figure 1, and is now changed.

5. **P.6670, l.25: Can you specify "10 m above surface" for the wind variables you use - I think that is whats meant.**

Included *"above surface"*

6. **P.6671, l.7: Now use just acronym (see point 1).**

Airborne Laser Scanning (ALS) is changed into ALS.

7. **P.6671, l.9: ALS data instead of ALS scan? As 'S' already stands for 'scanning'.**

This is true. However, we find that "*survey*" is more precise than "*data*" in this sentence. "*Scan*" is therefore changed into "*survey*".

8. P.6671, l.13: 'ASL' –> 'ALS'

Changed as suggested

9. P.6671, l.16:'when' –> 'after'

Changed as suggested

10. P.6671, l.5-6: how was the wind speed scaled with elevation? Linearly?

The wind speeds are from a dataset dynamically downscaled from ERA-40 (see page 6670-6671). The bias-correction is simple, and all wind speeds (regardless of altitude) are increased with 60 % (p. 6671 line 5), which is derived from validation with weather stations in mountainous areas. We are aware that this is a rough approximation, and because of the poor quality, the wind speed data is only used to select the wind events accounted for when calculating the fraction of wind directions. For clarification we made the following change:

Page 6671, l. 5-6: For these areas the forcing dataset has been *linearly increased by 60 %.*

11. P.6671, 7-10: What is the resolution of the raw ALS data?

The survey was done with nominal 1.5 m x 1.5 m ground point spacing. The following is included in line 10, p. 6671:

The ALS survey is made along six transects, each covering a 0.5 km x 80 km area, *with nominal 1.5 m x 1.5 m ground point spacing.*

12. P.6671, l.22: These elevations seem very similar to me, 1300/1450m - is it really significant as a difference between sites?

"*elevation (1300/1450 m a.s.l.)"* has been removed.

13. P.6672, l.15: How was this interpolation done?

We have also revised the following sentence for clarification:

The dataset, *available for the period 1961 - 2013*, is based on air temperature and precipitation data collected at the official meteorological stations in Norway, interpolated to 1 km x 1 km resolution *applying Optical Interpolation, following the methods of Frei (2014).*

Frei, C.: Interpolation of temperature in a mountainous region using nonlinear profiles and non-Euclidean distances, International Journal of Climatology, 34, 1585-1605, 10.1002/joc.3786, 2014.

14. P.6679, l.1 'sensitivity of the model for' –> 'sensitivity of the model to'

Now changed into "*The sensitivity of the* CV_{sd}*-model to*"

15. P.6679, l.8 What was the conclusion of Luce and Tarboton?

They conclude in the paper that "Dimensionless depletion curves depend primarily on the CV and to a lesser extent on the shape of the snow distribution function, and are a generalization of previously presented methods for depletion curve estimation." We refer to this saying: "This result contradicts the conclusions by Luce and Tarboton (2004), suggesting that the parameterization of the distribution function is more important than the choice of distribution model.». For clarification we change «*suggesting*» into «*which suggest*».

16. Figure 6 caption: typo 'poability'

Changed into "probability"

16. Figure 8: over what time period is the data in this correlation from?

For the validation the model is run for the same periods as the years of observations in the boreholes and ground surface temperature loggers, respectively. See page 6678 l. 15-18. To clarify this point we have now provided an overview of the validation data, including the years of observation at each point as a supplementary table (see previous points).

Supplement S1

Table S1: Boreholes used for validation of the permafrost model. x marks years where data is available.

Borehole	Lat	Lon	Elevation (m)	Depth (m)	08/09	09/10	10/11	11/12	Reference
Abojavri BH1	69.642	22.194	761	6.6	x	X	x		Farbrot et al. 2013
Abojavri BH2	69.681	22.126	570	30.3	x	X			Farbrot et al. 2013
BH31/PACE31	61.676	8.368	1894	20	x	X	x	x	Isaksen et al. 2011
Guolosjavri BH1	69.354	21.211	786	32.3		X	x	x	Farbrot et al. 2013
Guolosjavri BH2	69.366	21.168	814	10.5	x				Farbrot et al. 2013
Guolosjavri BH3	69.356	21.061	780	10.5	x				Farbrot et al. 2013
Iskoras BH2	69.300	25.346	600	58.5		X	x	x	Farbrot et al. 2013
Jetta BH1	61.901	9.285	1560	19.5		X	x		Farbrot et al. 2011
Jetta BH2	61.902	9.234	1450	10		X	x		Farbrot et al. 2011
Jetta BH3	61.905	9.186	1218	10		X	x	x	Farbrot et al. 2011
Juvvass BH1	61.676	8.365	1861	10		X	x	x	Farbrot et al. 2011
Juvvass BH2	61.684	8.372	1771	10		X	x		Farbrot et al. 2011
Juvvass BH3	61.697	8.386	1561	10		X	x		Farbrot et al. 2011
Juvvass BH4	61.700	8.385	1559	10		X	x	x	Farbrot et al. 2011
Juvvass BH5	61.701	8.392	1468	10		X	x	x	Farbrot et al. 2011
Juvvass BH5	61.707	8.403	1314	10		X	x	x	Farbrot et al. 2011
Kistefjellet	69.291	18.130	990	24.8	x				Farbrot et al. 2013
Lavkavagge BH1	69.249	20.445	766	14	x	X	x	x	Farbrot et al. 2013
Lavkavagge BH2	69.239	20.493	600	30.5	x				Farbrot et al. 2013
Lavkavagge BH3	69.224	20.580	492	15.8	x				Farbrot et al. 2013
Tron BH1	62.174	10.702	1640	30		X	x	x	Farbrot et al. 2011
Tron BH2	62.170	10.703	1589	10		X	x	x	Farbrot et al. 2011
Tron BH3	62.151	10.715	1290	10		X	x	x	Farbrot et al. 2011

Supplement S2

Table S2: Location, vegetation type and period of measurements of ground surface temperature loggers used for validation.

Latitude	Longitude	Elevation (m)	Vegetation type	Start Year	End Year	No. Years
62.543	6.303	92	Forest	2005	2008	3
62.575	6.317	796	Non-vegetated	2005	2006	1
62.297	9.338	1505	Non-vegetated	2001	2007	6
62.296	9.354	1467	Non-vegetated	2001	2004	3
62.264	9.467	1094	Non-vegetated	2002	2007	5
62.247	9.499	1039	Non-vegetated	2002	2007	5
61.522	12.504	541	Forest	2005	2008	3
61.542	12.439	1022	Non-vegetated	2005	2008	3
60.593	7.526	1210	Non-vegetated	2006	2007	1
60.651	7.493	1559	Non-vegetated	2006	2007	1
60.632	7.496	1431	Non-vegetated	2006	2007	1
60.647	7.489	1508	Non-vegetated	2006	2007	1
60.948	8.152	1220	Non-vegetated	2005	2007	2
62.429	11.274	1538	Non-vegetated	2004	2007	3
62.480	11.293	676	Forest	2006	2008	2
62.447	11.261	1251	Non-vegetated	2006	2008	2
61.721	8.401	1065	Non-vegetated	2004	2007	3
61.707	8.403	1307	Non-vegetated	1999	2007	8
61.702	8.395	1391	Non-vegetated	1999	2002	3
61.702	8.394	1410	Non-vegetated	1999	2002	3
61.701	8.393	1430	Non-vegetated	1999	2002	3
61.701	8.393	1447	Non-vegetated	1999	2008	9
61.699	8.391	1480	Non-vegetated	1999	2001	2
61.699	8.390	1492	Non-vegetated	1999	2000	1
61.685	8.376	1767	Non-vegetated	2004	2007	3
61.678	8.369	1893	Non-vegetated	1999	2004	5
61.677	8.369	1893	Non-vegetated	1999	2007	8
61.678	8.369	1893	Non-vegetated	1999	2004	5
61.649	9.012	855	Forest	2005	2008	3
61.401	8.831	1525	Non-vegetated	2005	2007	2
61.555	8.193	1522	Non-vegetated	2005	2007	2
61.556	8.207	1389	Non-vegetated	2005	2007	2
61.552	8.182	1460	Non-vegetated	2006	2007	1
61.547	8.163	1354	Non-vegetated	2006	2007	1
61.532	8.230	1448	Non-vegetated	2006	2007	1
61.538	8.180	1696	Non-vegetated	2006	2007	1
62.099	8.931	607	Forest	2005	2008	3
62.027	8.925	1573	Non-vegetated	2004	2008	4
59.989	10.670	528	Forest	2003	2006	3
59.980	10.683	443	Forest	2004	2008	4
59.980	10.684	435	Forest	2004	2008	4

60.232	10.428	196	Forest	2006	2008	2
61.934	11.548	805	Non-vegetated	2002	2003	1
61.931	11.543	868	Non-vegetated	2002	2006	4
61.930	11.542	918	Non-vegetated	2002	2006	4
61.927	11.540	1010	Non-vegetated	2002	2006	4
61.925	11.538	1109	Non-vegetated	2002	2006	4
61.922	11.507	987	Non-vegetated	2002	2006	4
61.926	11.511	1051	Non-vegetated	2002	2006	4
61.919	11.536	1211	Non-vegetated	2002	2006	4
61.929	11.527	1043	Non-vegetated	2002	2003	1
61.929	11.527	1043	Non-vegetated	2002	2006	4
61.902	11.500	1069	Non-vegetated	2004	2005	1
61.892	11.504	1078	Non-vegetated	2004	2005	1
61.926	11.535	1071	Non-vegetated	2004	2005	1
61.926	11.535	1071	Non-vegetated	2004	2005	1
61.908	11.537	1418	Non-vegetated	2004	2005	1
61.908	11.537	1418	Non-vegetated	2004	2007	3
61.929	11.527	1043	Non-vegetated	2005	2007	2
62.134	12.020	906	Shrubs	2002	2006	4
62.135	12.055	1196	Non-vegetated	2002	2006	4
62.140	12.060	1316	Non-vegetated	2002	2003	1
62.137	12.053	1207	Non-vegetated	2002	2006	4
62.138	12.051	1192	Non-vegetated	2002	2006	4
62.137	12.030	1052	Non-vegetated	2002	2006	4
62.140	12.060	1316	Non-vegetated	2004	2007	3
62.141	12.061	1335	Non-vegetated	2005	2007	2
69.942	24.862	508	Non-vegetated	2003	2005	2
69.937	24.854	614	Non-vegetated	2003	2005	2
69.913	24.775	1002	Non-vegetated	2003	2005	2
69.910	24.770	1034	Non-vegetated	2003	2005	2
69.909	24.771	982	Non-vegetated	2003	2005	2
69.933	24.789	471	Non-vegetated	2004	2005	1
69.933	24.792	428	Non-vegetated	2004	2005	1
70.075	20.431	839	Non-vegetated	2003	2006	3
70.063	20.451	476	Non-vegetated	2003	2005	2
69.831	21.279	895	Non-vegetated	2002	2008	6
69.838	21.273	700	Non-vegetated	2002	2007	5
69.843	21.259	500	Non-vegetated	2002	2007	5
69.563	20.433	861	Non-vegetated	2002	2007	5
69.576	20.437	685	Non-vegetated	2002	2005	3
69.583	20.435	500	Non-vegetated	2002	2005	3
69.457	20.882	966	Non-vegetated	2006	2007	1
69.354	21.211	786	Non-vegetated	2004	2007	3
69.267	22.481	739	Non-vegetated	2003	2010	7
69.008	23.235	355	Forest	2003	2010	7
69.980	27.269	130	Forest	2003	2009	6

70.542	29.322	502	Non-vegetated	2002	2009	7
70.541	29.342	480	Non-vegetated	2002	2009	7
70.538	29.363	415	Non-vegetated	2002	2009	7
70.537	29.380	355	Non-vegetated	2002	2009	7
70.400	28.200	10	Shrubs	2008	2010	2
70.126	28.593	50	Mire	2008	2010	2
69.376	24.496	284	Non-vegetated	2008	2010	2
69.370	24.082	469	Non-vegetated	2008	2010	2
69.377	24.082	408	Non-vegetated	2008	2010	2
68.996	23.035	308	Shrubs	2008	2010	2
68.755	23.538	380	Shrubs	2008	2010	2
69.580	23.535	380	Shrubs	2008	2010	2
68.749	19.485	1713	Non-vegetated	2008	2010	2
69.292	18.133	1011	Non-vegetated	2007	2011	4
69.638	22.229	923	Non-vegetated	2007	2010	3
61.676	8.365	1861	Non-vegetated	2008	2010	2
61.684	8.372	1771	Non-vegetated	2008	2010	2
61.700	8.385	1559	Non-vegetated	2008	2010	2
61.698	8.401	1561	Non-vegetated	2008	2010	2
61.707	8.403	1314	Non-vegetated	2008	2010	2
61.701	8.393	1450	Non-vegetated	2008	2010	2
62.174	10.702	1630	Non-vegetated	2008	2009	1
62.170	10.703	1589	Non-vegetated	2008	2010	2
62.151	10.715	1290	Shrubs	2008	2010	2
61.903	9.275	1490	Non-vegetated	2008	2010	2
61.898	9.282	1664	Non-vegetated	2008	2010	2
69.291	18.130	990	Non-vegetated	2007	2009	2
69.249	20.445	766	Non-vegetated	2007	2009	2
69.642	22.194	761	Non-vegetated	2007	2010	3
69.681	22.126	570	Non-vegetated	2007	2010	3
62.149	9.378	1047	Non-vegetated	2005	2006	1
69.308	25.341	450	Shrubs	2008	2011	3
69.306	25.340	495	Shrubs	2008	2010	2
69.304	25.338	548	Shrubs	2008	2011	3
69.299	25.330	540	Shrubs	2008	2011	3
69.296	25.326	497	Shrubs	2008	2011	3
69.294	25.318	445	Shrubs	2008	2011	3
69.290	18.131	990	Non-vegetated	2007	2011	4
69.292	18.129	967	Non-vegetated	2007	2011	4
60.700	10.868	264	Forest	1994	2004	10
67.284	14.451	33	Non-vegetated	1994	2004	10