The Cryosphere Discuss., 4, C627–C637, 2010
www.the-cryosphere-discuss.net/4/C627/2010/

The Cryosphere Discussions

Interactive comment on "Permafrost and surface energy balance of a polygonal tundra site in northern Siberia – Part 1: Spring to fall" *by* M. Langer et al.

Anonymous Referee #1

Received and published: 6 August 2010

Originally I was enthusiastic to learn more about the permafrost and surface energy balance of a polygonal tundra site in northern Siberia at Samoylov Island. Actually, the locality by itself seems to warrant a publication in the scientific literature. However what I had to read was more of an experience with the Department of the Seemingly Obvious – a nice Master's thesis approach but without the scientific rigor that I expected.

The present manuscript goes a couple steps behind what Ohmura already published (see Ohmura (1984), OHMURA (1982a), OHMURA (1982b), OHMURA (1982c), OHMURA (1982d)). Most of the statements are either textbook knowledge or qualitative statements that are so broad and all-inclusive that they cannot really be wrong.

This does not really add anything to our current understanding of Arctic energy budgets of polygonal tundra. And some of the rather bold statements are not really based on profound quantitative analyses of available data.

For example, page 923, lines 22-26: "As the contribution of the ground heat flux to the surface energy balance is significant even in the summer months, an adequate representation of the soil domain in global climate models seems mandatory, if the land-atmosphere exchange processes in permafrost regions are to be modeled correctly." – this is not supported by your data. Anyone who knows about global climate models also knows the costs associated with it; before you can show that any process that is not covered in the model must be included, it is important to show the level of significance. It is a misconception to assume that a more detailed model will automatically achieve a more correct representation of reality.

Other aspects on the experimental side of the manuscript seem similarly flawed. For example, page 924, lines 8–11: "With albedo differences between wet and dry areas on the order of 0.05, the net short-wave radiation can be on average by up to 7 W m^2 higher at wet compared to dry areas, while the diÃřerences can exceed 25 W m^2 for high radiative forcing during midday." – if you ever read the manual of such an instrument you will find the following specifications for the Kipp and Zonen CNR1:

Pyranometer: Zero offsets at 200 W m^{-2} thermal radiation: +15 W m^{-2} and for 5 K h^{-1} change in ambient temperature: ± 4 W m^{-2}. The directional error is specified at ± 25 W m^{-2} (at 1,000 W m^{-2}).

Pyrradiometer: The Kipp and Zonen manual sais "On a sunny windless day with a solar irradiance of 1000 W m^{-2}, an error of 25 Watts per square metre can be expected."

Your text on pages 906/907 seems to partially express this knowledge, but then you argue (on page 919): "This high closure term can be partly explained by an underestimation of the net radiation: a comparison of the NR-Lite and the four component sensor during fall 2008 reveals an offset of 6 W m^2, which is substantial considering the generally low radiation budget." – in my view this is a misconception: if something is not statistically significant (6 W m^2 is way below the accuracy of any of your radiation instruments!) then you cannot claim at the same time that it is substantial. In reality your measurements are unable to support the hypothesis that the null hypothesis (difference is zero) can be rejected.

Another serious conceptional error is found in Fig. 8 and text on page 921: "If only random measurement errors would be in- volved, the expected EBR distribution should be more similar to the normal distribution displayed in Fig. 8." – this is not correct. If you look at the uncertainty of a ratio where both the denominator and enumerator are sums or differences (your Eq. (8) for EBR), then it already becomes clear where the conceptual flaw is: already Wikipedia knows (http://en.wikipedia.org/wiki/Ratio_distribution) that ratios of normally distribute variables are **not** normally distributed:

"When X and Y are independent and have a Gaussian distribution with zero mean the form of their ratio distribution is fairly simple: It is a Cauchy distribution. However, when the two distributions have non-zero mean then the form for the distribution of the ratio is much more complicated."

Now, also the difference and sum between normally distributed variables are most likely not normally distributed (one finds plenty of hits by just googling for "probability distribution of sum of two variables" gives a good starting point to learn about unknown topics.

My view is that the scientific literature should be more rigorously founded than Wikipedia and other sources, and hence I would reject such an article that does not really comply with available knowledge and does not advance our understanding of the system under investigation. I hence strongly disagree with your statement on page 921, lines 3–8: "The normalized EBR distribution of the entire data set roughly resembles a normal distribution featuring a mean value of 0.86, a standard deviation of 0.34, and a slightly positive skewness of 0.47 (Fig. 8). If only random measurement errors

would be in- volved, the expected EBR distribution should be more similar to the normal distribution displayed in Fig. 8."

Another critical issue is the reference to Langer, M., Westermann, S., Muster, S., Piel, K., and Boike, J.: Permafrost and surface energy balance of a polygonal tundra site in northern Siberia – Part II: Winter, in preparation, 2010b. (pages 904, 922, 924, 925). I could not find this paper and it appears that a fair assessment of Part I would only be possible if the reviewer had access to Part II. In fact, normal journals tend to reject manuscripts that make such extensive references to unpublished material.

Your argumentation with respect to atmospheric stability in the arctic region is inconsistent. On page 909, lines 3–6 you write "... which is based on tests for stationarity of the turbulence and the integral turbulence characteristic (ITC). In this study, the latter is not applied, since the quality criterion of the integral turbulence characteristic is not well defined in arctic region, where stable atmospheric stratification and intermittent turbulence are common (Lüers and Bareiss, 2009)." but then on page 916, lines 25–28 you claim that "In both years, unstable stratifications (ζ <0) occur frequently during the day, but usually do not last longer than 12 h. The nights are dominated by neutral stratifications (ζ ≈0), while stable atmospheric conditions (ζ >0) are only observed occasionally under calm conditions and highly negative values of the net radiation." – this is a direct contradiction. Moreover the Lüers and Bareiss (2009) article cannot be found in the databases I have access to...

Minor issues

902/7: sounds like 1.5 years, not like "half year period"

904/3: here you say "This study presents the annual energy balance" but title and abstract only focus on spring to fall

Eq. (3): this is misleading – the emissivity (ε) is not necessarily the same for the local surface and the sky; you imply that the surface emissivity also applies to the sky, which is incorrect in most cases

907/14–17: a thermal infrared sensor as I know them measures radiation, and by specifying an emissivity of the local surface (some sensors use a fixed value of ε=0.95) one computes the surface temperature. Hence, if you want to backcalculate the radiation you have to use **the emissivity that the instrument has hard-coded**, not the emissivity of the surface (since this is irrelevant for the infrared radiometer)!

908/25: the wording "the internationally standardized QA/QC software package TK2" is misleading – TK2 was not internationally standardized, it was used as a reference for the Mauder et al. 2007 comparison without establishing that it conforms to some absolute standards. Moreover, the comparison was only done within the Carboeurope project. Hence a more cautious wording is highly recommended.

911/17: brackets around citation missing

915/23–24: "During the pre-melt period, the atmospheric stratification changes frequently between stable and unstable conditions (Fig. 2)." – first, this cannot be seen clearly in Fig. 2 with the scaling you use, and second it is quite normal that the diurnal cycle of stability goes from unstable during daytime to stable during the night. This is so ubiquitous a statement that it really does not advance our understanding of polygonal tundra.

Try to get rid of "essentially" – in most cases the word is used inappropriately. E.g. page 915, lines 21–22: "The atmospheric stratification is reflected in the stability parameter ζ, which is essentially zero during neutral conditions" – this is the definition of neutral conditions: ζ=0, and hence is not a finding of this study.

917/7: "dew fall" – although widely used in the trivial literature this expression is scientifically unsound; dew cannot fall, it can only form on surfaces (from which it can drip off)! Use "dew formation" instead.

917/10: Fig. 4 comes after Fig. 5, rearrange your figures chronologically

917/21: equally spaced intervals is always a good idea for time series, but why do you use a 20-day averaging? The natural intervals for times are seconds, minutes, hours, days, weeks, . . .

918/17–18: what should my imagination tell me about a zero-curtain? Please use dictionary words!

921/18–21: these are purely qualitative statements that are unrelated to your measurements. Dialectic argumentation without any quantitative measurements would have produced the same views.

922/15–21: why not just do it? I quickly browsed a literature data base I have access to to give you some potentially relevant literature citations that you might find useful to explore the surface energy budget of sites where snow plays a role. Also the above-mentioned Ohmura citations may be helpful. With respect to snow modeling there might be work by Glen Liston which might be of interest.

922/24–27: "During the spring period, our results indicate that the observed inter-annual differences in the ground temperatures are caused by different air temperatures, which are presumably related to the general synoptic conditions." – well, what other explanation would you have expected? In my view such a statement is so ubiquitous that it cannot be wrong, but does not relate to the specific conditions of polygonal tundra nor a Siberian site.

923/21: "Stefan equation" is confusing, please use "Stefan-Boltzmann equation" instead

926/2,5: I cannot confirm that I found this study "comprehensive" – my dictionary defines this term as "complete; including all or nearly all elements or aspects of something"

Figs. 2 and 4: dates are not in ISO format; odd tick spacing of 2.5 days; labels of dates must be at 00:00 hours of the respective day

Fig. 3: check uppercase/lowercase writing in the two y-axis labels

Fig. 5: dates not in ISO format

Fig. 6: in caption please explain what Qnet,p is; what is Qnet, and why not Qnet,t to be consistent in notation? Are date labels end of 20-day periods? These kinds of bar graph are problematic for the data that you want to show; a line graph with symbols would be correct (bar graphs are typically only used for categoric variables)

Fig. 7: I think the y-axis label should say ΔQ, not just Q (you seem to show a difference in Q, not Q itself); horizontal bars of whiskers are too wide (could be eliminated). Conceptionally I do not think that this display is correct: if QH goes up, then the footprint gets smaller, but it appears to me that you treat it as a pseudo-constant in this comparison.

Fig. 8: **NO!**

Final Remark

You see my frustration: I hoped to learn something that relates to polygonal tundra at an exciting remote site in northern Siberia, but what I had to read sounded like "the snow melts in spring and the sun shines brighter during summer". Sorry, but I do not see how this approach advances our understanding of the energy balance of tundra ecosystems.

References

Abnizova, A. and Young, K. L.: Sustainability of High Arctic Ponds in a Polar Desert Environment, Arctic, 63, 67–84, 2010.

Bewley, D., Pomeroy, J. W., and Essery, R. L. H.: Solar radiation transfer through a subarctic shrub canopy, Arctic Antarctic and Alpine Research, 39, 365–374, 2007.

Blok, D., Heijmans, M. M. P. D., Schaepman-Strub, G., Kononov, A. V., Maximov, T. C., and

Berendse, F.: Shrub expansion may reduce summer permafrost thaw in Siberian tundra, Global Change Biology, 16, 1296–1305, 2010.

Bowling, L. C. and Lettenmaier, D. P.: Modeling the Effects of Lakes and Wetlands on the Water Balance of Arctic Environments, Journal of Hydrometeorology, 11, 276–295, 2010.

DeBeer, C. M. and Pomeroy, J. W.: Modelling snow melt and snowcover depletion in a small alpine cirque, Canadian Rocky Mountains, Hydrological Processes, 23, 2584–2599, 2009.

Dornes, P. F., Pomeroy, J. W., Pietroniro, A., and Verseghy, D. L.: Effects of spatial aggregation of initial conditions and forcing data on modeling snowmelt using a land surface scheme, Journal of Hydrometeorology, 9, 789–803, 2008.

Elder, K., Cline, D., Goodbody, A., Houser, P., Liston, G. E., Mahrt, L., and Rutter, N.: NASA Cold Land Processes Experiment (CLPX 2002/03): Ground-Based and Near-Surface Meteorological Observations, Journal of Hydrometeorology, 10, 330–337, 2009.

Ellis, C. R. and Pomeroy, J. W.: Estimating sub-canopy shortwave irradiance to melting snow on forested slopes, Hydrological Processes, pp. 29–41, 2007a.

Ellis, C. R. and Pomeroy, J. W.: Estimating sub-canopy shortwave irradiance to melting snow on forested slopes, Hydrological Processes, 21, 2581–2593, 2007b.

Ellis, C. R., Pomeroy, J. W., Brown, T., and MacDonald, J.: Simulation of snow accumulation and melt in needleleaf forest environments, Hydrology and Earth System Sciences, 14, 925–940, 2010.

Essery, R. and Pomeroy, J.: Implications of spatial distributions of snow mass and melt rate for snow-cover depletion: theoretical considerations, Annals of Glaciology, Vol 38, 2004, 38, 261–265, 2004.

Essery, R., Pomeroy, J., Parviainen, J., and Storck, P.: Sublimation of snow from coniferous forests in a climate model, Journal of Climate, 16, 1855–1864, 2003.

Essery, R., Granger, R., and Pomeroy, J.: Boundary-layer growth and advection of heat over snow and soil patches: modelling and parameterization, Hydrological Processes, 20, 953–967, 2006.

Goetz, S. J., Mack, M. C., Gurney, K. R., Randerson, J. T., and Houghton, R. A.: Ecosystem responses to recent climate change and fire disturbance at northern high latitudes: observations and model results contrasting northern Eurasia and North America, Environmental Research Letters, 2, 2007.

Gorodetskaya, I. V., Tremblay, L. B., Liepert, B., Cane, M. A., and Cullather, R. I.: The influence of cloud and surface properties on the Arctic Ocean shortwave radiation budget in coupled

models, Journal of Climate, 21, 866–882, 2008.
Granger, R. J., Pomeroy, J. W., and Parviainen, J.: Boundary-layer integration approach to advection of sensible heat to a patchy snow cover, Hydrological Processes, 16, 3559–3569, 2002.
Granger, R. J., Essery, R., and Porneroy, J. W.: Boundary-layer growth over snow and soil patches: field observations, Hydrological Processes, 20, 943–951, 2006.
Groisman, P. and Soja, A. J.: Ongoing climatic change in Northern Eurasia: justification for expedient research, Environmental Research Letters, p. 045002 (7 pp.), 2009.
Gu, S., Tang, Y. H., Cui, X. Y., Du, M., Zhao, L., Li, Y., Xu, S. X., Zhou, H., Kato, T., Qi, P. T., and Zhao, X.: Characterizing evapotranspiration over a meadow ecosystem on the Qinghai-Tibetan Plateau, Journal of Geophysical Research-atmospheres, 113, 2008.
Ivey, M. D., Verlinde, J., Zak, B. D., and Zirzow, J.: The U.S. Department of Energy's Atmospheric Radiation Measurement Climate Research Facilities on the North Slope of Alaska, 2008 IEEE International Geoscience and Remote Sensing Symposium, IGARSS 2008, pp. 330–3, 2008.
Kato, S., Rose, F. G., Rutan, D. A., and Charlock, T. P.: Cloud effects on the meridional atmospheric energy budget estimated from Clouds and the Earth's Radiant Energy System (CERES) data, Journal of Climate, 21, 4223–4241, 2008.
Lafleur, P. M. and Humphreys, E. R.: Spring warming and carbon dioxide exchange over low Arctic tundra in central Canada, Global Change Biology, 14, 740–756, 2008.
Langlois, A., Fisico, T., Barber, D. G., and Papakyriakou, T. N.: Response of snow thermophysical processes to the passage of a polar low-pressure system and its impact on in situ passive microwave radiometry: A case study, Journal of Geophysical Research-oceans, 113, 2008a.
Langlois, A., Fisico, T., Barber, D. G., and Papakyriakou, T. N.: Response of snow thermophysical processes to the passage of a polar low-pressure system and its impact on in situ passive microwave radiometry: a case study, Journal of Geophysical Research - Part C - Oceans, p. C03S04 (17 pp.), 2008b.
Li, Q., Sun, S. F., and Dai, Q. D.: The Numerical Scheme Development of a Simplified Frozen Soil Model, Advances In Atmospheric Sciences, 26, 940–950, 2009.
Li, X., Wang, H., Zhang, Z. H., and Wu, H. D.: Simulation of arctic surface radiation and energy budget during the summertime using the single-column model, Acta Oceanologica Sinica, 27, 1–12, 2008.
Lu, J. H. and Cai, M.: Seasonality of polar surface warming amplification in climate simulations,

Geophysical Research Letters, 36, 2009.
Marks, D., Reba, M., Pomeroy, J., Link, T., Winstral, A., Flerchinger, G., and Elder, K.: Comparing Simulated and Measured Sensible and Latent Heat Fluxes over Snow under a Pine Canopy to Improve an Energy Balance Snowmelt Model, Journal of Hydrometeorology, 9, 1506–1522, 2008.
Marsh, P., Pomeroy, J. W., and Neumann, N.: Sensible heat flux and local advection over a heterogeneous landscape at an Arctic tundra site during snowmelt, Annals of Glaciology, Vol 25, 1997, 25, 132–136, 1997.
Marsh, P., Neumann, N. N., Essery, R. L. H., and Pomeroy, J. W.: Model estimates of local advection of sensible heat over a patchy snow cover, Interactions Between the Cryosphere, Climate and Greenhouse Gases, pp. 103–110, 1999.
Meyer, T. and Wania, F.: Organic contaminant amplification during snowmelt, Water Research, 42, 1847–1865, 2008.
Molders, N., Luijting, H., and Sassen, K.: Use of atmospheric radiation measurement program data from Barrow, Alaska, for evaluation and development of snow-albedo parameterizations, Meteorology and Atmospheric Physics, 99, 199–219, 2008.
OHMURA, A.: Climate and Energy-balance On the Arctic Tundra, Journal of Climatology, 2, 65–84, 1982a.
OHMURA, A.: A Historical Review of Studies On the Energy-balance of Arctic Tundra, Journal of Climatology, 2, 185–195, 1982b.
OHMURA, A.: Evaporation From the Surface of the Arctic Tundra On Axel-heiberg Island, Water Resources Research, 18, 291–300, 1982c.
OHMURA, A.: Regional Water-balance On the Arctic Tundra In Summer, Water Resources Research, 18, 301–305, 1982d.
Ohmura, A.: Comparative energy balance study for Arctic tundra, sea surface, glaciers and boreal forests, GeoJournal|GeoJournal, vol.8, no.3, 221–8, 1984.
Pomeroy, J., Essery, R., and Toth, B.: Implications of spatial distributions of snow mass and melt rate for snow-cover depletion: observations in a subarctic mountain catchment, Annals of Glaciology, Vol 38, 2004, 38, 195–201, 2004.
Pomeroy, J., Rowlands, A., Hardy, J., Link, T., Marks, D., Essery, R., Sicart, J. E., and Ellis, C.: Spatial Variability of Shortwave Irradiance for Snowmelt in Forests, Journal of Hydrometeorology, 9, 1482–1490, 2008.
Pomeroy, J. W. and Essery, R. L. H.: Turbulent fluxes during blowing snow: field tests of model

sublimation predictions, Hydrological Processes, 13, 2963–2975, 1999.

Pomeroy, J. W., Toth, B., Granger, R. J., Hedstrom, N. R., and Essery, R. L. H.: Variation in surface energetics during snowmelt in a subarctic mountain catchment, Journal of Hydrometeorology, 4, 702–719, 2003.

Pomeroy, J. W., Marks, D., Link, T., Ellis, C., Hardy, J., Rowlands, A., and Granger, R.: The impact of coniferous forest temperature on incoming longwave radiation to melting snow, Hydrological Processes, 23, 2513–2525, 2009.

Porter, D. F., Cassano, J. J., Serreze, M. C., and Kindig, D. N.: New estimates of the large-scale Arctic atmospheric energy budget, Journal of Geophysical Research-atmospheres, 115, 2010.

Quinton, W. L. and Carey, S. K.: Towards an energy-based runoff generation theory for tundra landscapes, Hydrological Processes, 22, 4649–4653, 2008.

Quinton, W. L., Shirazi, T., Carey, S. K., and Pomeroy, J. W.: Soil water storage and active-layer development in a sub-alpine tundra hillslope, southern YukonTerritory, Canada, Permafrost and Periglacial Processes, 16, 369–382, 2005.

Reba, M. L., Link, T. E., Marks, D., and Pomeroy, J.: An assessment of corrections for eddy covariance measured turbulent fluxes over snow in mountain environments, Water Resources Research, 45, 2009.

Shaw, W. J., Stanton, T. P., McPhee, M. G., Morison, J. H., and Martinson, D. G.: Role of the upper ocean in the energy budget of Arctic sea ice during SHEBA, Journal of Geophysical Research-oceans, 114, 2009.

Shirazi, T., Allen, D. M., Quinton, W. L., and Pomeroy, J. W.: Estimating soil thaw energy in sub-Alpine tundra at the hillslope scale, Wolf Creek, Yukon Territory, Canada, Hydrology Research, 40, 1–18, 2009.

Sicart, J. E., Pomeroy, J. W., Essery, R. L. H., Hardy, J., Link, T., and Marks, D.: A sensitivity study of daytime net radiation during snowmelt to forest canopy and atmospheric conditions, Journal of Hydrometeorology, 5, 774–784, 2004.

Walsh, J. E., Chapman, W. L., and Portis, D. H.: Arctic Cloud Fraction and Radiative Fluxes in Atmospheric Reanalyses, Journal of Climate, 22, 2316–2334, 2009.

Zhang, Y. S., Carey, S. K., and Quinton, W. L.: Evaluation of the algorithms and parameterizations for ground thawing and freezing simulation in permafrost regions, Journal of Geophysical Research-atmospheres, 113, 2008.