Review of "Stochastic analysis of cone penetration tests in snow" by Lin et al

Main comments

The paper analyzes snow micro-penetrometer (SMP) signals in terms of stochastic jump-diffusion dynamics. The analysis is very interesting and adds novel aspects to the interpreation of SMP data. The paper is well written, the topic is suitable for TC and the results warrant publication.

I have mainly two questions I would like to ask an answer for in the present work:

- **Independence**. Naively one is tempted to assume that the signal must be the result of one (and only one) underlying stochastic process, which is the disordered microstructure of snow. The present model rather assumes that the penetration leads to a situation with contributions from different stochastic processes which are assumed to be independent. While I can imagine how such a situation may originate from the physics, it would be helpful if this assumption of independence (between the jump characteristics and the diffusion) could be further assessed.

  Along these lines we have previously seen that interpreting the signal as a shot noise process with three parameters (λ, δ and f_0) we always end up with correlations between estimates of λ, and δ, which obviously cannot be convincingly separated by such a model. Since δ roughly translates to $1/D^{(1)}$ of the present model, I wonder if these parameters still show correlations. In addition, for large λ and small σ_ξ a jump process with drift could "tend" to diffusion. Therefore potential correlations of the latter parameters with $D^{(2)}$ are relevant too. In the simplest case it would be sufficient to provide mutual scatter-plots of estimated parameters λ, $D^{(1)}$, σ_ξ and $D^{(2)}$ for the profile in Sec 3, but maybe there are even rigorous ways to answer this question.

- **Kernel width**. It might be good to check if a fixed kernel width of 0.6mm (l168) is a robust choice in view of the statements in the discussion about grain size dependencies: Converting the SSA values given in Tab 1 into a "grain size" (the optical diameter) reveals that diameters range from 0.12mm for PP to 0.70 mm for RGlr. Now the diffusive contribution is assumed to be a result of steric (grain-grain) interactions in front of the cone, and this process will need a few grain diameters to develop. A fixed kernel of this particular size might thus induce a bias here. *A priori* grain size information is clearly commonly not available (like for the analysis of hardness profile in Sec 3.2). But it seems relevant to compare, at least for the data from SEc 3.1, how the parameter estimates for the 4 samples compare with those generated from a *constant* ratio of kernel width and optical diameter. Results could be simply added to existing figures.

Kind regards,
Henning Löwe

Minor comments

(l117): I don't entirely understand why an R dependence of the coefficients is introduced here. Isn't the analysis later only based on constant coefficients, i.e. additive noise? Would everything work also for multiplicative noise?

(l135): Here it might be illustrative to explicitly mention the "triply-stochastic" nature of Eq 11 and that all (ξ, J_t, W_t) are independent.

(Tab 2): Here uncertainties/errors should be included that reflect inter-sample variations of the same snow type.

(l174): What is the final size of the sub-samples? Is this choice also consistent with grain size $\ll$ sample size in all cases?

(l189): It would be nice to include the correlation lengths estimated from the ACF also in Tab 2 to support this statement. (DH and RGlr appear to be very similar in Fig 8 while the L_c differ by a factor of two)

(Fig 9): What is taken as Δz?

(Fig 10): Top left, this looks like R and not R'?

(Fig 10): Maybe a semilogy scale for K^4 better reveals the differences?

(Fig 10): It would be good to include also $\lambda \Delta z$ and $D^{(2)}/\lambda\sigma_\xi^2$ in this figure. The subfigures can be safely reduced a bit in height.

(l234): This is such a statement which might be affected by the choice of the kernel width...