Dear reviewer,

thank you very much for your comments and suggestions on the manuscript. Below we have pasted your comments in blue, our point-by-point response is given in black.

Kind regards,
Henning Löwe

This paper presents micro-CT measurements of specific surface area and density of fresh snow under conditions of different isothermal temperatures and stress. The study focuses on the period of rapid evolution during the first day or so following snowfall, which is critical for a variety of snow applications. The authors also derive parameterizations for rates of change of SSA and density (ice volume fraction) using functional forms of equations that have been applied widely in previous studies. Overall, I find this to be a valuable study worthy of publication, after the following issues are addressed.

Major issues:
My only major critique is that the paper is inconsistent in describing the extent to which stress influences the rate of SSA change. On one hand, Figure 7, text in section 3.3.2, and text in section 4.4 all indicate or acknowledge that the rate of SSA evolution depends on stress, at least in some circumstances. On the other hand, the SSA parameterization includes no dependency on stress, and this is justified on p.1806, line 18 with the statement that "... no influence on the applied stress has been observed". Similarly, p.1810, line 20-21 states that "We have previously observed that the SSA evolution is in fact independent of the ... applied stress". The authors need to amend the manuscript for consistency and describe more clearly the conditions under which stress may influence SSA evolution. The omission of stress from the parameterization of SSA (Eq 5) also needs to be acknowledged in section 3 as a potential source of bias, even if it is only relevant in a limited number of cases.
We agree, this is confusing. For clarification: In general there are two different processes which may influence the SSA evolution, namely coarsening and formation of new contacts during densification. These processes have been discerned in (Schleef etal 2014b). If the structure is stable enough, only coarsening is relevant and the SSA evolution is not influenced by stress. This is the case here for the vast majority of time steps. Only initially during the first 6 hours, some samples show signatures of the formation of new contacts (signalled by the Euler characteristic). For these cases an influence of stress becomes visible. This has been explained now more explicitly in the discussion. The mentioned text passages have been reformulated accordingly.

The abstract refers to a linear relationship that is found between density and SSA. It needs to be clarified that the slope of this relationship differs substantially from one set of snow conditions to another, as is clearly seen in Figure 5 and also described in section 3.2. In fact, the slope must differ with different values of stress in order for the proposed parameterizations to be physically realistic, since stress enters into the parameterization of density, but not SSA. The value of the linear relationships seems to be that they are amenable to parameterization, whereas the current wording in the abstract (and perhaps elsewhere in the text) may inadvertently give some readers the impression that a universal linear relationship was found between SSA and density.

We agree, abstract reworded and details on the variation of the slope added.

Minor comments:

Abstract: I suggest adding a couple of sentences with more detail on the key findings, e.g., the ranking of factors influencing SSA and density evolution under different circumstances.

The main influence on both, the SSA rate and the densification rate are now mentioned explicitly in the abstract.

Abstract, line 7-8: Wording is unclear.

Reworded.

1796,19: remove "shortly"

Removed.

1796,23: "densification density" ?

“density” deleted

1798,19: although the "Euler characteristic" is described later, I suggest that the authors very briefly describe its meaning at its first mention.

We agree and added an explanation already at this point.

1800,3: Is there any energy dissipation in the ice, or more precisely a sufficient amount to alter its metamorphic state and thereby influence the measurement?

A change of the metamorphic state would require a change of temperature via X-ray absorption. From the dose, the temperature rise of the ice during a scan can be expected to be in the order of tens of mK. This is negligible compared to the small, but measurable temperature rise (<1°C, cf. Schleef and Löwe 2013) which is caused by the heat from the X-ray tube.

1800,20: typical -> typically

Corrected.

1801,13: "bare evolution" - There may be a better way to word this.

Changed: “bare” → “temporal”

1802,7: "expected" -> "is expected"

Corrected.

1806,18: "influence of the SSA decrease on the temperature" - Here, I think you mean to communicate "influence of temperature on SSA" rather than vice versa.

Yes. Corrected.

1810,12: "resulted to" -> "resulted in"

Corrected.

Figures: It is a bit difficult to distinguish the magenta curves in the figures, partially because of the density of overlying red curves. A different color may improve the clarity of figures 1,2,5,9, and 10.

We agree, the color contrast has been improved.

Figure 6: Why is 1/T (and not T) used for the abscissa?
This is common for Arrhenius plots: An Arrhenius law for a quantity *f* has the functional form *f* ~ exp(*Q/T*) which is equivalent to a linear relation when plotting log(*f*) vs *1/T.*

Figure 9: Over what time period does the "Delta SSA" represent? This should either be described in the caption or Delta SSA should be expressed as a rate as in Figure 7.
This is also a rate as in Figure 7. Corrected.