General comment:

This work is an effort to estimate ground temperature (usually below a snowpack) in arctic tundra regions from SMOS data, using for validation in-situ data in Alaska at fixed stations (latitude range from 68° to 71°N). Comparison is also made with ERA 5 data.
The retrieval model is simple, using only two fitting parameters H_r, one for the snow-ground interface and the other one for the ice-water interface. Unfortunately, the model test only relies on statistics, assuming constant behaviour for the investigated 8-year period.
A problem is the strong and variable influence of water bodies on the SMOS data. Furthermore, the large footprint of the satellite data limits the representativeness of local station data. Nevertheless, in areas with small water fraction, the results show promising results. Further work is needed because wetlands, rivers and lakes with variable snow and ice cover are abundant in this area. Their influence on microwave emission cannot be accounted for with the present assumptions, such as constant H_r values. Solutions may have to use further information, e.g. from polarisation, see references below.

Main comments:

1) Fitting parameters: The model used is very simple. Although the H_r values are thought to be related to interface roughness, other effects, such as impedance matching and local absorption/emission also play a role. Reduced reflectivity (Equation (3)) means increased absorption/emission. Therefore, such effects can be simulated using this model, too. An example is a sudden inflow of liquid water into the interface layers, e.g. by wind braking ice. But this means that the parameters are variable in space and time.

2) Potential model improvements: A more general model may have to consider additional effets such as:
- The reflection at the boundary between frozen and unfrozen soil may have a contribution to the observed signal.
- In permafrost areas, the soil layer may freeze completely.
- Shallow lakes may freeze down to the bottom.
- Bare rock areas with dielectric constant different from soil.
- Influence of vegetation may be noticeable.
- Rain-on-snow events followed by refreezing.

Some of these effects may be identified by temporal variations, giving valuable information, as can be seen in Figure 8.

3) Dielectric constant of frozen soil:
The value, 5.0, for the real part, needs a clarification, that may explain the discrepancy to the smaller values in Table A2: When soil freezes in late fall, the soil is often water saturated at and near the surface due to dew formation and water-vapour migration from warmer soil below. The value of 5 represents the dielectric constant of the frozen version of this kind of soil. This is also the reason for the large contrast of microwave signatures between frozen and unfrozen soil reported by many observers. In arctic regions, especially in high-porosity organic soil, the situation may be different. The imaginary part is sensitive to soil type, but values decrease with decreasing temperature.

4) Figures 5 to 7:
I do not fully understand the data in yellow, grey and blue. All three of them essentially show the same. The figures should be simplified. Some extra points are unexplained. Furthermore, in Figure 5, and in its caption, there appear to be errors with regard to H_r. The remark about the x axis is unclear and confusing. I have the same problem with Figure B1.

5) Figure 8:
For me this ist the most interesting figure of the study. It shows temporal variations that support support the applied retrieval model, e.g. in 2012 and 2013, but with significant differences in other years. To understand the behaviour, the data should be compared with additional in-situ information and with meteorological data. This may be helpful for the understanding, and consequently for the refinement of the retrieval model.

Some Details:

- Line 9: Please define: median correlation R
- Line 353: Need for clarification: snowpack conductivity: thermal or electrical?
- Same line: T_g transparency, what do you mean? Please define or explain.
- Lines 364 to 366: What do the temperature values in brackets () mean?
- Figure 9: Based on the variable behaviour from year to year, the figure should focus on single years, first.
- Table A2: Clarify SM in the caption. Frozen or unfrozen water content? Please give information on both.

References:

D. Hiltbrunner, C. Mätzler and A. Wiesmann: *Monitoring land surfaces with combined DMSP-SSM/I and ERS-1 Scatterometer data*, Proc. IGARSS'94, IEEE Cat. No. 94CH3378-7, pp. 1945-1947, JPL Pasadena CA, Aug. (1994).

D. Hiltbrunner: *Land Surface temperature and Microwave Emissivity from SSM/I Data*, doctoral Thesis, Faculty of Natural Sciences, University of Bern, Switzerland (1996).