The vertical density profile in ice shelves is required by all the studies that need, for example, estimates of the ice thickness from hydrostatic equilibrium. However the densification of snow to ice depends on many factors that can be temporally and spatially variable. Accurate and efficient field data are then required to improve our understanding of this variability.

This paper presents a new algorithm to invert the vertical density profile from wide angle radar measurements. There is an application at 6 locations on the Roi Baudoin Ice shelf.
The presentation of the method is clear and its performance validated against a model twin experiment. The method is further validated using 2 density profiles obtained by optical televiewing in 2 boreholes located in the area.

This study is an important and timely study and I have mainly minor comments.

Specific comments:

- the paper conclude that the firn in the channel is "anomalously" *(title)* dense or "denser" *(abstract, discussion, conclusion)* . By this, we understand that the measurements in the channel are outside the spatial variability. However there is only 7 measurements (5 radar + 2 boreholes) and the derived air content at site 3 (in channel) is higher that site 2 (outside channel) and within the error bar of site 6 (outside channel). I think this is difficult to conclude from this that the measurements in the channel present an anomaly. It's maybe only that the spatial variability is underestimated? At least the authors should try to discuss processes that would make the firn denser in the channel than outside to support the idea that there is something special in the channel.
- In the inversion, they suppose that the density at the surface is uniform in the study area (the parameter A in the model is constant). However from the OPTV measurements (Figure 7) we have the filling that the surface density could be higher in the channel. Maybe a sensitivity study to the value of A should be added.
- It could be interesting to check if, with the derived density and thickness, there is hydrostatic equilibrium at each field site?

Technical comments:

- Symbols: "c" is used 3 times: c for speed of light introduced in Eq. 3; Capital C introduced in Eq. 4, and covariance matrices Ct and C_m in Eq. 11. It could bebetter to use different letters.
- Sec. 2.3 forward model: I find a bit strange to give approximations of the forward model (Eqs. 5 to 10) before the forward model itself. I think it could be more clear to put equations 5 to 10 in the section 2.4 (Inversion) and explain that computing the gradient of the first term of J (Eq. 11) requires to compute the adjoint of the forward model which is not possible. The partial derivatives of J, required to update efficiently the model parameters, are then estimated from simple approximations (Eqs. 5 to 10).
- Eq. 11 : change "C_M" to "C_m" , in agreement to what is given below.
- Eq. 11 : " C_t" and " C_m" should be " C_t^{-1}" and " C_m^{-1}"
- page 5657 line 22: "fin-ice" => "firn-ice"