Jansen *et al.* present linescan data from the NEEM ice core. The internal layers visible with this technique show signs of small scale folding and flow disturbances. They show that, where folds are present, the ice crystal orientations present a strong single maximum with inclined bands of grains where the c-axis orientation deviates from the single maximum. They use the ELLE model to discuss their data.

As noted by the first reviewer, the data are well presented and convincing. However the discussion to generalise their interpretation of the folds makes many assumptions on the stress/strain state in the ice cores (especially the role of vertical compression) which are not supported by the model results where only simple shear is applied. I think the discussion part should be revised. Below are my specific comments.

Specific comments:

- *Page 5819, lines 15-19 :".... (e.g. Paterson, 1991) and may lead to deformation heterogeneities such as non-uniform thinning"*. Paterson (1991) discuss the feedback between initial viscosity contrast and fabric development, which makes initially softer ice even softer in simple shear. This process has been modelled by Durand et al., Clim. Past., 2007. This has been discussed for large scale flow, and the results show that it is not because ice is softer that it will thin faster, as this will requires, because of mass conservation, some kind of extrusion flow.
- *Page 5819, lines 24-25: "Azuma and Goto-Azuma (1996) concluded from model studies with an anisotropic flow law".* Azuma and Goto-Azuma (1996) did not used a flow model, they proposed an anisotropic flow law where stress and strain-rate are not co-linear (i.e. the viscosity is a tensor). With this flow law they show that simple shear stresses can produce vertical strain-rates because of the no-co-linearity. They propose a simple sketch where, because of this effect, a layer submitted to simple shear but with different fabrics could exhibit thinning and thickening leading to boudinage. However there is not flow-model (i.e. solving for momentum and mass conservation) in their application.
- *Page 5823, lines 12-16: "Starting with the same initial microstructure, models with two different ratios between dynamic recrystallisation (grain boundary migration and recovery) and viscoplastic deformation were performed: 1 and 10 DRX steps per deformation (FFT) step ...".* The difference between the two ratios is not discussed in the results section and we don't know for which set-up the results are given.
- *Section 3.1:* It would be interesting to give an idea of the thickness of the annual layers for the different depths. Are the visible layers annual layers?
- *Section 3.1:* When the authors discuss features in the Figures (especially Figure 2), they should put some symbols on the Figure to avoid any ambiguity on which feature is discussed (e.g. *line 24 "central greyish layer"*).
- *Page 5825, Line 2: "...been flattened out by shear deformation."*. If it is simple shear it should not produce any thinning of thickening?
- *Figure 4.* Red lines should be thicker to make them more visible.
- *Page 5827, lines 9- 10 : "This approach is reasonable, since there is a non-coaxial flow component in the region (NEEM Community Members, 2013)."* I don't understand the term co-axial here?
- *Page 5828, lines 10-13: "The development of the kink bands is represented in the model run, but the flattening of the structures probably takes place faster under real conditions due to the additional vertical flattening caused by the overlying ice column."* This is not clear. Do the authors assume that there is differential thinning? Or that the bands rotate faster because of compression. Is it not possible to test this with the model and apply both simple shear and compression?
- *Page 5829, line 14: "the evolution of an anisotropic fabric (red line) for several ice cores".* Not clear how the position of the red line has been chosen. In many cores the development of the fabrics is continuous, so that is it very difficult to give a threshold to define a *"single*

maximum fabric" (caption Fig.10).

- *Page 5829, line 17: "Greenland reveal that the onset of visible folding is dependent on the relation between vertical strain rates and shear strain rates (Fig. 10)."* Not clear as no indication has been given on this ratio for the different cores. Maybe the depth at witch vertical strain-rates and shear strain-rates becomes equivalent could be evaluated following Montagnat et al., 2014b?
- *Page 5829, lines 21-23: "The later onset of folding in the deeper ice cores shows that higher shear strain is required to produce visible folding due to the higher overburden pressure."* I don't see the role of the overburden pressure here. I understand that the authors suggest that the amount of shear should be higher if the vertical strain-rates are higher? However the overburden pressure do not produce strain-rates, only the deviatoric stresses do. A good proxy for the surface vertical strain-rate is the ratio between ice accumulation and thickness, while the shear stress increase with depth and surface slope (at first order). So that ice thickness only is not sufficient to evaluate the ratio between vertical strain and shear strain.
- *Section 4.2 kink-bands...:* I have difficulties to follow the discussion here as the citation by Cobbold et al. 1971 speaks of compression to explain the formation of the kink bands while only simple shear is applied here with the model. I think the first paragraph should be reformulated and maybe illustrated by a cartoon to explain the formation of the bands and their orientation.
- *Page 5831, lines 21-25:* "Azuma and Goto-Azuma (1996) suggested that horizontal variation in the single maximum direction could explain heterogeneous layer thinning or thickening of initially horizontal layers, eventually leading to folding." The authors already show that they are able to produce some small scale folds with their model in simple shear. Because the flow law proposed by Azuma and Goto-Azuma (1996) applies to fabrics and thus polycristals, I think the mechanism was more suggested for larger scale folds (at least the layers should be larger than a polycristal). So I think this do not apply here.
- *Page 5833, line 15, "but the results are in line with findings from ice flow models on the larger scale (Azuma and Goto-Azuma, 1996)".* See previous comments.