

Interactive comment on “Observation of an optical anisotropy in the deep glacial ice at the geographic South Pole using a laser dust logger” by Martin Rongen et al.

Martin Rongen et al.

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Dear Referee,

Thank you for your timely review. Please find the responses to the issues raised in-line with your review comments below:

General:

C1

The authors present observation on anisotropic light scattering in the ice sheet near South Pole. The results are derived from measurements with an optical dust logger deployed in a 1750-m borehole. The authors attribute the anisotropy to a preferential light diffusion by the birefringent property of ice, which could be the basis for a new technique for in situ logging of ice fabric properties. The paper is a clear description and analysis of the novel observations.

Specific comments:

p. 2, l. 16: "For crystal realizations where the deflection outweighs the additional diffusion, the photon flux along the flow axis will continuously increase with distance". I suggest expanding the introduction here: What is additional diffusion? What means photon flux increases with distance? Probably it (finally) decreases by absorption and scattering.

True. The absolute photon flux does decrease with distance. But it increases with respect to the intensity on the orthogonal axis. The additional diffusion was also meant with this comparison in mind, comparing the larger diffusion along the flow axis with the smaller diffusion along the orthogonal axis.

The paragraph has been expanded to read as follows:
The deflection per distance increases for stronger girdle fabrics, a larger average crystal elongation or a smaller average crystal size. For crystal realizations where the deflection outweighs the additional diffusion along the flow axis compared to the diffusion along the orthogonal direction, the photon flux along the flow axis

C2

will increase with distance compared to the photon flux along the orthogonal axis.

p. 4, l. 7: "anti-freeze": general definition of an anti-freeze is an additive that lowers the freezing point of a water-based liquid. Here, Estisol-140 is a non-freezing drilling fluid.

Thank you for the clarification. This has been adopted.

p. 4, l. 9+13: Voigt (2017) is not in references.

That reference had an error and was cited by the first name, not the family name. This has been corrected.

p. 4, l. 11: The accumulation site varies with the depth below the surface. Titan Dome is the accumulation site only for the deepest ice.

That's a good point. The sentence has been changed to:
The associated accumulation site for the deepest ice is believed by ? to be Titan Dome, meaning that the ice has been transported as far as 200 km.

p. 6, l. 10: "craigite" was suggested as mineral name in the 1980's but to my

C3

knowledge never approved. Use clathrate hydrate.

Done.

p. 6, l. 15 "global offsets". As the logs are from the same hole, the "global" offsets do not have an external origin. They are rather caused by the logging instrument(?) If so, the term "global" seems inadequate to me.

We have expanded on the explanation. The sentence now reads as:
These systematic offsets, caused for example by the changing clarity of the drilling fluid or grime accumulation on the logger, are corrected using a second-degree polynomial fitted to the ratio.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-34>, 2020.