Response to interactive comments on "Initial results from geophysical surveys and shallow coring of the Northeast Greenland Ice Stream (NEGIS)" by P. Vallelonga et al.

In the response below, the reviewers' comments are in standard text and our responses are in bold.

Both reviewers stressed that information in this paper is difficult to fully assess without reading the companion paper on surface geophysical surveys (Christianson et al., 2014). We believe these papers to be complementary because the presentation of all details of this large field effort in a single paper would create a long, convoluted manuscript that is difficult to read, as well as detracting from the topical focus of the current manuscript. We acknowledge that information about the geophysical dataset is not fully presented in this manuscript. Inclusion of such detailed information would result in a fundamental shift in the focus of this paper, which is to present the viability of future ice-core/climate studies in NEGIS.
Hence we opted on a publication strategy of three manuscripts focusing on three different topics: (1) direct examination of the basal interface with several geophysical techniques (Christianson et al., 2014), (2) tracing internal reflecting horizons in radar data from NGRIP to NEGIS and interpretation of radar internal stratigraphy (Keisling et al., 2014), and (3) a synthesis paper that presents the shallow core results with the necessary geophysical background to understand ice dynamics at the core site (this manuscript). Journals were selected by appropriateness of subject matter. The full details of the geophysical surveys are presented in Christianson et al. (2014) and Keisling et al. (2014). We have, however, attempted to clarify details and revise figures as much as possible following reviewer suggestions. Additionally, we now supply a paragraph at the start of section 2.2 where we outline the publication strategy so readers know where to find additional information. We supplied all three manuscripts to the editors of each respective journal as supplementary documents. Keisling et al. (2014) is now in press and Christianson et al. (2014) is in a very similar stage of review to this article. We anticipate that Christianson et al. (2014) will be published almost contemporaneously with this article.

Anonymous Referee #1
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General comments
The paper "Initial results from geophysical surveys and shallow coring of the North- east Greenland Ice Stream" by Vallelonga et al. presents an interesting overview of new results on the glaciological conditions in the headlands of the NEGIS ice stream, Northeast Greenland, and will be an important reference for any future geophysical or ice cores studies to be carried out in this area. Accordingly, I support publication of this paper in "The Cryosphere". In this context it should be considered, that a companion paper (Christianson et al., 2014) is currently under review in EPSL. As I have no access to this paper, I cannot judge in how far the two papers are redundant or complement each other. I suggest that the editor could check this before acceptance of the paper.

Overall the paper is well written and easy to follow. In some instances I would have hoped for a more detailed and more quantitative discussion of the results. Along this line the authors state in the abstract that "Tracing of RES layers from the NGRIP ice core site shows that the ice at NEGIS preserves a climatic record of at least the past 51 kyr", however, the internal layering is not really discussed in the text. Further on, they state that they "demonstrate that a deep ice core drilling in this location can provide a reliable Holocene and late-glacial climate record, as well as helping to constrain the past dynamics and ice-lithosphere interactions of the Greenland ice Sheet."

To fulfill these promises some more detailed discussion of the isochrone distribution in the study area and their use to pick a potential deep ice core drill site
Details on radar internal stratigraphy are fully presented in Keisling et al. (2014). We include a paragraph here discussing publication strategy and also reference Keisling et al. (2014) when discussing radar internal stratigraphy. We add that our layer continuity index analysis (Keisling et al., 2014) indicates that layers are easy to trace through the upper reaches of NEGIS except in the shear margins. However, as is clear in Figures 1-2 of Keisling et al. (2014), we can connect our survey to NGRIP via aerial surveys using lines with relatively high continuity. Therefore we believe our layer tracing is accurate. We believe that the explanation here is already quite thorough considering the reference to another published paper that discusses isochrone distribution and layer tracing methods (Keisling et al., 2014).

- the flow speed distribution upstream of the ice coring site and its potential impact on the age of the ice, the accumulation rate, and the chemical and isotopic parameters in the ice core would strengthen the paper. At the moment I feel that the reader is somewhat left alone with his/her own interpretation of the plots.

We have added additional discussion of the extent and relevance of upstream effects for the NEGIS firn core record described in the text. In section 4.1, we have calculated the upstream origin of the deepest strata of the NEGIS firn core and described this in context of the surface topography described in figure 4. We have made reference to the available literature, particularly the work of Reeh et al., (1985) and Fahnestock et al., (2001) which describe the influence of surface topography on accumulation variability and consequent effects on layer thickness. Few studies have investigated the effect of upstream flow on chemical and isotopic parameters in ice cores, so we are unable to comment in more detail on potential effects. Nonetheless we do note where upstream surface topographical variations may have contributed to variability in the water isotope composition, and propose a physical mechanism for such an effect. We note that the deepest strata sampled by this shallow firn core originated only 21 km upstream. We also identify a topographic depression >7 km upstream that corresponds to ice of age 1860 AD, assuming modern ice velocity. This local depression is correlated with an annual layer thickness maximum. This example is meant to be illustrative of upstream effects, but more sophisticated analyses are clearly required to interpret a longer record.

Specific comments:

p694, l14: unclear what is meant in the parentheses, please explain in more detail
We added that these assessments were made using kinematic constraints on glacier motion as discussed by Pfeffer et al. (2008).

p694, l22: there is something wrong with this sentence
This sentence was modified also in response to the other reviewer.

p695,l13: I think, there is some short paragraph missing to bridge between the intro-duction of fast ice streams and ice core drillings.

We now include a paragraph about why it may be of interest to drill in this location to investigate the deformation of the ice lower in the ice column in an area of streaming flow where significant ice deformation probably occurs and to study glacier basal hydrological process that facilitate ice-stream flow.

p697, l2: there is something wrong with this sentence
We attempted to clarify this sentence by separating it into two sentences and adjusting the wording.

section 2.3: there is very little detail given on the CFA analysis compared to all the other measurements. A high-resolution example plot showing the quality of the data, especially with respect to layer counting, would be helpful here.
We have provided additional detail regarding the CFA system and analytical components. Further we have added figure 5 which shows annual layer assignment and chemical parameters for a 2 m section of the firn core.

p698, l24: -427.5
Corrected

section 3.1: I assume the example plot suggested above would also help to illustrate the seasonal phasing discussed in the text
While the added figure does allow the relative phasing of the chemical parameters to be shown (for example, anti-phasing of NH_4^+ and Na), unfortunately the diffusion of water isotopes at the site does not allow us to show the season corresponding to each chemical parameter. Such phenomena are commonly observed in Greenland ice cores from higher-accumulation sites, and are described in detail by reviews such as that of Legrand and Mayewski (1997).

p700, l22-25: I assume the authors mean that in the 20th century there are less large NH4 peaks than in previous centuries? Please clarify the wording.
This has been clarified

p701, l9-13: one example, where a more in-depths discussion would be helpful. Please explain in detail how this effect on d18O through changes in layer thickness comes about.
We have provided additional description of these effects in section 4.1

section 3.3.1: based on the very small figures provided in TCD, this is really hard to see. A section profile across and one along the ice stream of surface topography, ice velocity, ice thickness and internal layering would be helpful.
We now include a section profile with surface and internal layer geometry as well as surface velocity along the flow line (Fig 3).

section 4.1: another example, where more discussion would strengthen the paper. While the hypothesis that the accumulation variations are due to upstream effects induced by changes in topography and ice velocity makes perfect sense, the paper would benefit from a more quantitative approach using the geophysical data at hand.
We have expanded this discussion as explained earlier. A more quantitative approach is now included with reference to appropriate figures and references. However, we again note that explanation is meant to be only an example and is not a comprehensive

algorithmic approach for incorporating upstream effects, which is beyond the scope of this paper.

p706, l15-29: this sounds a little bit already like “Conclusions” to me
This section has been moved to conclusions.