Anonymous Referee #2:

The biological fixation of nitrogen (or BNF) is a very important soil process yet is plagued by large spatial and temporal variability, arising from the large numbers of variables (environmental, biogeochemical and microbial) which can influence the magnitude of the process. It is particularly important in soil systems that have a limited alternative source of nitrogen or those that have been affected by pollution. One such system is peatlands, which are supplied primarily by precipitation, resulting in generally ombrotrophic conditions, and which have also been affected by atmospheric deposition of pollutants such as N and S compounds.

This manuscript is a useful addition to the literature on being able to bring together possible explanations for the variations in the rates of BNF and the manuscript contains an extensive review of the literature which addresses this topic. The primary contribution is to show that three central European peatlands at a high elevation receiving substantial atmospheric deposition of N and containing Sphagnum moss have very different rates of BNF and the study seeks to find why, using two main approaches. One is incubation of Sphagnum moss samples with labeled 15N2 and the second is to use natural abundance variations in the 15N isotope composition of the plant material, water and precipitation. The 'usual suspects' controlling BNF are examined with the measurements available, or deduced from alternative sources.

The main conclusion is that one site appears to be affected by a paucity of P and one by a high concentration of SO4, resulting in essentially no BNF, with the third site showing the largest rate of BNF, but without any clear indicator of why, though the weaker knowledge of hydrology at the site may be a factor. The occurrence of methanotrophic bacteria as a component of BNF requires evidence that methane is available in the location where oxidation will occur and incubation of samples with ambient methane concentration is unlikely to identify that source. The laboratory conditions for the BNF assessment were somewhat unusual and 'one-time', whereas there are likely substantial variations in field conditions. There is a suggestion that at the BNF-active site, microbes may have adapted to the high atmospheric N loading (from another paper), though it was the same at the other sites.

The natural abundance assessment is complicated because of all the changes in 15N that may be brought about by N transformations, and the presence of N uptake by Sphagnum from N in peat water produced by the mineralization of the peat and litter, and these uncertainties are recognized. On top of this, the 15N sampling at the site with substantial BNF showed a large spatial variability which suggested small-scale variations in BNF, or 'hot spots' and possibly 'hot moments'. <u>One question occurred to me: Sphagnum N concentration was larger at the active-BNF site than the other two (Fig. 5) but the underlying peat (0-10 cm) had a smaller N concentration (Fig. 7). Any reason for that change?</u>

<u>Our response:</u> Please note the small letters in the superscript in Fig. 5. BRU and MMJ are marked with "b". That means that these two sites are statistically indistinguishable in terms of N concentrations in Sphagnum. We cannot say that N concentration was larger at the BNF-active site than at the other two. We are reluctant to conclude that the underlying peat had a smaller N concentration at MMJ than at the other two sites at the wetland scale because we had only one vertical profile in Fig. 7 and as many as 21 Sphagnum analyses in Fig. 5. For such a comparison, we would need a number of vertical peat profiles at each site. Please note that the topmost peat sample in Fig. 7 is essentially living Sphagnum. The one sample at MMJ had low [N] in Fig. 7 while Fig. 5 shows a surprisingly large [N] variability at MMJ,

compared to the other sites. In our view, the top low-[N] sample in the MMJ peat core only confirms the large [N] variability in Fig. 5 bottom.

I found the manuscript to be well structured, written and illustrated with a substantial linking to previous studies. It is 'interdisciplinary' (as much as 'disciplines' still exist), drawing upon atmospheric, biogeochemical and biological controls on the BNF process in an edaphic context. On the whole, though, some of the results are inconclusive because of a lack of measurements to assess all the variables that may affect BNF, but that is the nature of the topic undertaken. I found a few typographical errors, which should be readily correctible.