Anonymous Referee #1 Received and published: 20 April 2018

Thomas et al. present new high-resolution pollen data on a radiocarbon dated peat record from the Falkland Islands for the last about 5000 years. They relate major changes in the vegetation dynamics on the island and in the far-distant Patagonia pollen transport to major reorganizations of the high latitude Antarctic atmospheric circulation pattern in the Southeastern Pacific sector, namely the intensity and position of the Amundsen Sea Low (ASL).

Main observation of this study is a significant change in the vegetation and enhanced charcoal input around 2.5 kyrs indicating a shift to warmer/drier conditions over the island likely associated with a strengthening and northward expansion of the ASL. Simple Dome ice core data and a marine carbonate record from the Chilean fjord region are used for comparison and in support of their interpretation. This peat record is one of the few very valuable paleoenvironmental data available from this part of the world. However, this cannot be the only reason to assume, that it is representative for the whole South Atlantic ("across the South Atlantic"), as it is stated several time in the manuscript. Rather it responds to SE Pacific/Southern Ocean climate variability, which is restricted more or less to the southeastern South Atlantic (as it is shown also in the correlation maps, Fig. 2). Altogether, the manuscript is well organized and concise, referencing is adequate, and the layout and total number of figures are very reasonable.

We thank the reviewer for their kind remarks and constructive suggestions, which have been extremely helpful to for improving our manuscript. We have addressed all the comments in the revised manuscript and detail these below. (Our responses in blue, reviewer comments in black).

General remarks:

1. Please provide evidence for the representativeness of this location for the South Atlantic, if not please correct the respective statements in the whole manuscript

We understand the reviewers concern here and stated more explicitly the importance of the location and our interpretation of the results. Crucially, the Falkland Islands lie at a strategic location sensitive to changes in the Amundsen Sea Low, through the influence of the latter on atmospheric circulation over the southeastern South Atlantic region (e.g. Fogt et al. 2012, Russell and McGregor 2010, Hosking et al. 2013 and Turner et al. 2013).

2. The indicated wind pattern in figure 1 is too simplistic and this map would benefit from adding major surface current patterns and the frontal zones in this region.

This is a good suggestion. We have added the 925 hPa winds (vectors) trends since 1979 from ERA-Interim (Dee et al., 2011). This shows both the location and increase in westerly winds over the satellite era. We have also added the mean locations of the southern limb of the Antarctic Circumpolar Current (purple), the polar front (red) and the subantarctic front (green), following Orsi et al. (1995). (See the revised Figure 1 below).

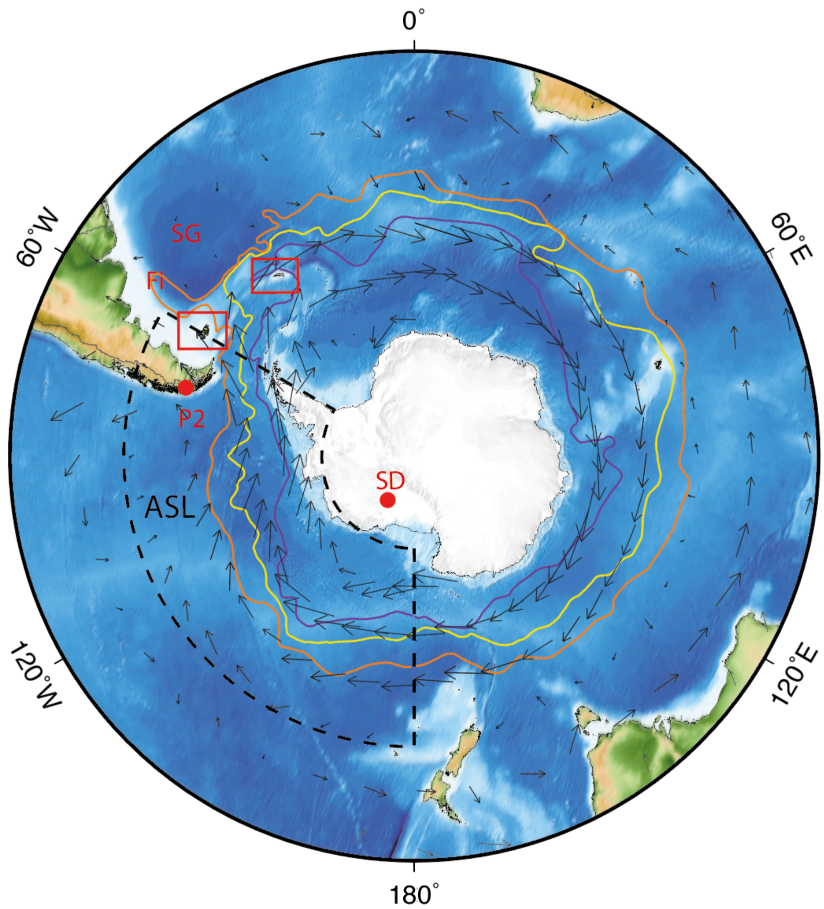

Figure 1. *Location of the Falkland Islands (FI), South Georgia [SG], Siple Dome [SD] and Palm2 [P2]. Dashed line denotes contemporary defined limits of the ASL domain (Fogt et al., 2012). Mean locations of the southern limb of the Antarctic Circumpolar Current (purple), the polar front (red) and the subantarctic front (green) are shown, following Orsi et al. (1995). The grey arrows denote the 925 hPa winds (vectors) trends since 1979 from ERA-Interim (Dee et al., 2011), depicting the location and increase in westerly winds over the satellite era. Map made using Generic Mapping Tools (GMT) (Wessel et al., 2013).*

3. The interpretation of the own data is very much restricted to the atmospheric part. Changes in ACC strength, Drake Passage through flow, and the surface current dynamics in the southwestern South Atlantic (Malvinas confluence dynamics e.g. Voigt et al. 2015) are important as well and not discussed.

We appreciate the reviewers concern. Our analysis demonstrates the dominant control on temperature and precipitation at Canopus Hill is via atmospheric processes. Spatial correlation maps suggest limited ocean influence on these climate variables on the Falkland Islands; something we have now stated explicitly. As part of this we have added a discussion of ocean currents, and have also added the mean locations of the southern limb of the Antarctic Circumpolar Current (purple), the polar front (red) and the subantarctic front (green), following Orsi et al. (1995), to Figure 1. We feel a figure showing this does not add to the narrative but if the editor would like us to include we are happy to do so.

4. Regarding the age model I have two comments/remarks. One is regarding the 137Cs record. It is mentioned in the text as age marker for the earlie sixties nuclear weapon testing fallout. Normally, the manuscript should contain the graphic display of the whole measured activity profile, just the mentioning in the text is not enough. Second, if fruits and leaves werde 14C dated (as indicated in the table), there is not much reason to exclude two dated at the base but include only the one date above (this could have been a outlier as well). Sedimentation rates would make sense with the two basal xsages as well. So I suggest to include them into the bayesian age modelling.

We thank the reviewer for their suggestions to improve the description of the age modelling. As commented in Hancock et al. (2011), the anthropogenic radionuclide, ^{137}Cs (with a half time of 30 years) is derived from atmospheric nuclear weapons testing and can provide an important "first appearance" horizon of known age (1954–1955) i.e. an independent marker horizon to assist with age model validation. Specifically, we analysed contiguous peat samples for the first presence of ^{137}CS and in the age model used the prior U(1952, 2011) to capture the possible range of calendar years (CE) for the onset of ^{137}Cs deposition in the sequence (Hancock et al 2011). We have however, included more detail on the measurement and application of ^{137}Cs for constructing our age model.

We agree that we should have explained in more details why the two basal ages were removed. The sedimentation rate is internally more consistent when excluding these two basal ages; without them the sedimentation rate from the entire metre of sediment above does not change significantly (with a sedimentation rate for 141.5-156 cm of 38 yrs/cm compared to an average of 27 yrs/cm for the preceding metre of sediment), whereas including them increases the sedimentation rate over this depth range abruptly to 11.6 yrs/cm. We suspect these basal ages may comprise some intruded younger root material; a scenario not unusual in relatively slowly accumulating sedimentary sequences e.g. Brock et al. (2011, *Quaternary Geochronology*). However, we have run the age model again to include these basal ages, and have added a column in Table 1 include the mean calibrated 2 sigma age range. The calibrated age ranges are almost identical for both age models until 142 cm, from where it diverges. Importantly, our conclusions based on the changes observed in the Canopus Hill Record at ~2.5 ka BP are not at all affected by the choice of age model. The modified Table 1 is pasted below:

Depth, cm	Wk lab number	Material	% Modern /^{14}C BP ± 1 σ	2σ cal. age range (years BP)	2σ cal. age range (years BP)	Mean cal. age (years BP)
				With 2 basal ages	Excluding 2 basal ages	
8-9	34598	Fruits and leaves	117.0±0.4%M	-4 to -43	-4 to -44	-21
9		^{137}Cs		-6 to -42	-6 to -42	-19
11-12	32994	Fruits and leaves	107.8±0.4%M	-2 to -14	-1 to -14	-8
18-19	37007	Fruits and leaves	107.3±0.3%M	0 to -13	26 to -15	-3
25-26	35146	Fruits and leaves	95±25	250 to -1	249 to -1	86
35-36	37008	Fruits and leaves	647±25	652 to 547	652 to 547	603
39-40	33445	Fruits and leaves	761±25	719 to 570	719-570	661
57-58	32996	Fruits and leaves	1818±25	1804 to 1595	1801 to 1597	1682
70-71	32350	Fruits and leaves	2235±25	2315 to 2102	2314 to 2104	2215
97-98	32997	Fruits and leaves	2749±25	2866 to 2755	2865 to 2755	2810
107-108	32998	Fruits and leaves	2914±26	3140 to 2877	3139 to 2878	2997
120-121	41767	Fruits and leaves	3238±20	3476 to 3361	3471 to 3362	3416
141-142	32351	Fruits and leaves	3955±32	4430 to 4184	4511 to 4236	4352
148-149	41768	Fruits and leaves	4390±20	4515 to 4300	5027 to 4845	4908
153.5-154.5	42144	Fruits and leaves	4039±21	4521 to 4421		
156.5-157.5	42145	Fruits and leaves	4075±22	4567 to 4429		

Table 1. *Radiocarbon and modelled calibrated age ranges for the Canopus Hill peat sequences using the P_sequence and Outlier analysis option in OxCal 4.2 (Bronk Ramsey, 2008; Bronk Ramsey and Lee, 2013). The SHCal13 (Hogg et al., 2013) and Bomb04SH (Hua and Barbetti, 2004) calibration curves were used. Note: calibrated ages are relative to Before Present (BP) i.e. CE 1950.*

5. In the "contemporary climate" chapter the author use deseasonalised/detrended seasonal data? As a paleoclimatologist, I's difficult for me to understand this preprocessing step and perhaps some additional explanation could make things clearer here.

This is a fair point. Using deseasonalised and detrended data means that the correlations between two records are not based on them having similar seasonal differences, or similar trends, which would bias the correlation. We have included a more detailed explanation in the main manuscript to explain this. Thank you for the suggestion to make this clearer.

6. In the data comparison chapter the Siple Dome and PALM2 data are assumed to be consistent with the Falkland data. There are, however, rather large offsets in the timing of the proposed "regime shift". Majewski et al. e.g. suggest the Siple Dome ssNa+ shift to start aroud 1000-1500 years BP - that is more than 1000 years later that the quite abrupt shift described in the in the Canopus Hill record. There is also a 500 year offset to the carbonate accumulation record from the Chilean Fjords, which, by the way, is not an accumulation of carbonate in the surficial fjord waters, neither a carbonate preservation issue. If I understood these authors well, it represents marine carbonate production in the surficial fjord waters and its subsequent accumulation on the sea bed in response to salinity changes in the upper water column of the fjord. Of course all these records have theirs own stratigraphic issues, but one perhaps should discuss the potential meaning of these offsets more thoroughly.

We acknowledge are there are differences in the timing within the records that we compare. These may be an artefact of the uncertainties in the individual age models, or represent real dynamic changes operating on multi-decadal to centennial timescales. Importantly, we now make clear we are not specifically suggesting that there is a 'regime shift' that affects the entire region concurrently. Indeed, the Siple Dome ssNA+ record shows a more long-term trend to a deepening of the ASL that may suggest an early expression in this part of the Antarctic (as shown in Figure 4). Identifying a particularly time for a shift may be misleading, and we have removed any reference to a specific age.

In terms of the PALM2 record (and other records that we have since added from the Peruvian margin), there changes do appear to be more abrupt, and several centuries after the observed shift in the Canopus Hill record. We have included a significantly more detailed discussion on the timing of these changes. We have also reworded the description of the PALM2 record to be clearer, thank you.

7. The Late Holocene changes described in Lamy et al. address the latitudinal northward displacement of the westerly wind strength from its southern core (Early Holocene) towards its northern margin (Late Holocene). Conceptually, they suggest a weakening of the core westerlies in the Magellan Strait region, which is somehow in contradiction to what the authors assume in this manuscript.

In terms of comparisons to other reconstructions of westerly airflow, there is a substantial incongruity between different proxy records over the Holocene. It must also be pointed out that while the Lamy et al. reconstruction covers the full Holocene, the new extended record from Canopus Hill only covers the last 5000 years; thus comparisons between the early and late Holocene are not possible. The Lamy et al. (2010) paper does seem to indicate stronger westerly airflow from ~2 ka BP, which may have been influenced by the ASL, however, the last age control point for this record is the start of the inflection, which is dated to 2570 ^{14}C BP, calibrated to 2410 cal yr BP (note however that no uncertainty or calibrated age range is given, nor is there a reported uncertainty for the marine reservoir correction of 200 years). This indicates that the age uncertainties between the changes observed in the Canopus Hill record and the PALM2 record may possibly overlap.

8. Beside the millenial-scale trend there is much more centennial-scale fluctuation in the pollen/charcoal data from Falkland Island that unfortunately are not discussed.

While there is discussion in Turney et al. (2016) with regards to the centennial-scale variability identified in Canopus Hill, we agree that this should be briefly discussed. In addition, similar cyclical variations in West Antarctic Peninsula glacier discharge in Pike et al. (2013, *Nature Geoscience*) have also been reported; something not discussed in the previous draft of the manuscript but is now included.

Minor comments:
Line 30: please explain why ASL is of global significance.

A fair point, we did not explain this well. We have reworded the beginning of the abstract to introduce the ASL better.

Line 98: More precisely it is a vegetation record. “record of airflow” is for my feeling to imprecise here

We do understand the reviewers point here, however, we strongly believe it is more appropriate to call it a record of airflow. In particular, the *Nothofagus* and charcoal is emphatically not a record of vegetation change on the Falkland Islands (being wind-blown from South America), and it would be incorrect to discuss it in this way. It is true however that the local pollen does represent vegetation on the Falkland Islands. We will be more explicit about the interpretation of the proxies depending on whether they represent local or ‘exotic’ sources.

Line 133: If mentioned, please provide the exact information for the two periods

We are unsure what the reviewer means here, though we infer that it is the period defining the contemporary limits of the ASL and oceanic fronts. Assuming this is correct, we have added this information: The contemporary limits of the ASL (45-75°S, 180-60°W) are defined across the 1979–2001 average (Fogt et al., 2012), while the Orsi et al. (1995) oceanic front data is based on analyses of hydrographic station data available up to 1990 (see Table 1 of Orsi et al. 1995 for more details). We hope this satisfactory.

Line 125: “contiguously” should be “continuously”

In fact we do mean ‘contiguously’ here (differing from ‘continuously’ to mean having discrete boundaries between each sample, i.e. every cm).

Line 283-283: This cannot be, except the authors assume an full inversion of the westerly winds? Across the South Atlantic would mean easterly winds?

We think there may be some confusion here. From a climate/meteorological context, west to east airflow is described as ‘westerly winds’, i.e. from the west.

Line 291: “compliment” should be “complement”

We have changed this, thank you.