

Interactive comment on “Little ice age advance and retreat of Glaciar Jorge Montt, Chilean Patagonia, recorded in maps, air photographs and dendrochronology” by A. Rivera et al.

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Comments on the paper Little ice age advance and retreat of Glaciar Jorge Montt, Chilean Patagonia by A. Rivera et al

An interesting paper with much useful information. It is certainly acceptable with minor changes and a worthwhile contribution to the volume. However, there is some confused usage of the term Little Ice Age and discussion of how this glacier (GJM) fits into the regional picture. The date and maximum position of the GJM during the LIA is not known directly. The greatest extent given is the 1898 position which is likely not the LIA maximum. In several places the authors indicate the (regional) LIA maximum was

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between 1650 and 1750 but, based on the radiocarbon dates GJM was at least 19km upvalley of its 1898 position at that time. The authors should therefore clearly define what they consider to be the LIA and whether they have any direct information for the LIA position of GJM. The 14C dates they have recovered need to be assessed in more detail and I suggest reworking the lower part of Figure 9 to make it more informative. Some further discussion of the dendro dating is warranted and it would be useful to show the position of the 14C dates in the dendro chronology (if their position is known.). There is also little comment on the fact this glacier advances at least 19km into the sea during between ca 1700 and 1898. It would also be interesting to compare these results with recent work at Glaciar Upsala. Most of the comments are minor changes in English and require little additional work.

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Page Line Comment

3131 title Little Ice Age? (caps) 3132 7-8 The dendrochronology and maps indicate – what does this mean? Are there pre-LIA maps? And what are you calling the LIA 3132 10 based on 14C or dendro? 3132 19 Southern 3132 24 dated to between 1650 and 1750 AD (Glasser et al., 2010). Are these dates for the end or the duration of the LIA? 3133 3 retreat 3133 8 warming. However, Split sentence 3133 21 maximum in 1650- not what was said earlier what do Masiokas et al 2009 say? 3133 24 on board 3133 26 delete the at end of line 3134 10 areal thinning?? Do you mean the mean vertical thinning i.e. elevation loss averaged over the glacier? 3134 12 present details of the 20th 3134 17 before and after the Little Ice Age- rather too vague given problems of defining the LIA so far - perhaps- over the last 2-300 years would be better (depending on the dating) 3134 25 record includes no map 3135 12 a preliminary estimate 3135 23 the errors also depend on where the relevant image is within the photo- i.e. distortion increases away from the principal point 3136 6 the first LANDSAT was launched in 1972 3136 17-18 “where pixel size is multiplied by the perimeter of the changing portion and averaged by the time interval” this is not very clear- either

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expand or, probably, delete as those interested can presumably check the reference. Some idea of the likely magnitude of these errors might however be useful. 3137 17 photography not photographs 3137 20 what region? 3137 23 data were? 3138 9 mapped from a zodiac? 3138 17 salt not salty 3138 19 a private not the private 3138 28 fjord spaced approximately 500m apart 3139 2 terminal not terminus 3140 9-10 Thanks to this survey, the terminus position of Glaciér Jorge Montt was ascertained Rephrase. These images were used to map the terminus of GJM and ascertain that. . . . , 3140 12 morainic not moraine 3140 13 period after Ocean and new sentence thereafter. The lateral. . . 3140 21 reach not are reaching 3140 23 In the region where in 1945 the left lateral arm was overflowing into the lateral valley, change to In the region where the left lateral arm was overflowing into the lateral valley in 1945, the 1975 image showed that a small tongue has separated from 3140 26 the western valley, now ice-free, 3140 29-30 at some time since 1963 = some time after 1963 3141 6 retreat. However, 3141 8 north of what- the main calving front? 3141 11 this type of "dead ice" is melting in situ, almost 3141 13 icefield, is melting in situ, with becomes "icefield and has a small amount" 3141 21 had disappeared by 2003 3141 22 the disappearance of the stagnant ice exposed several trees that had been buried in-situ and were sampled in 2010 and 2011. 3141 27 delete "over the course of 9 days from" and replace with between 3142 1-2 throughout 2010. However, 3142 4 narrow 3142 7-9 revise The bathymetry at the 1898 ice front position (Figs 4 and 5) indicates this stable ice front position overlies a submarine moraine arc. 3142 12 The submerged section of the outer fjord. . . 3142 12 terminal not terminus 3142 15 the bathymetry between. . . shows a gently sloping valley floor with increasing water depth 3142 17-18 The position of this deep. . . 3142 21 close to the 2000-2003 ice front . 3142 25 invert sentence Rignot et al (2003) compared the . . . and showed 3143 5 LIDAR profiles in 2002 and 2008 showed a mean thinning rate . . . which increased to 22m/yr between 2008 and 2010 3143 20 40 14C yr BP 3143 21 cal AD. 3143 22 as above 3143 23 et seq. 14C dates in this time range have major problems because of the non- linear relationships between 14C years and calendar years. Also the writing here needs more precision.

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Where did these dates come from on the wood sampled- are they outer dates or inner dates? 3144 1-3 Rephrase- there is no evidence of multiple glacier advances 3144 4-5 how many trees rather than radii? 3144 10 how does the 14C date of 250 years fit with the older observations of the ice front? P 3132 line 24 gives a date of 1650-1750 for THE END OF the LIA. These 14C dates would suggest the glacier was 19 km upvalley of the 1898 position. So where is the LIA maximum position and how is it dated? The discussion of the earliest maps is quite vague but is the LIA maximum position of this glacier actually known and mapped? If one accepts the 250 BP 14C date then the glacier advances at least 19 km between 1650 and 1898. Need to give the range of 14C dates from Beta? 3144 11 the diagram does not give the impression of a mean age of 150 years (see comment on p 3162) 3144 18 when the water depth exceeded 350m 3144 20 depth 3144 24 As a first approximation? 3145 6 values indicate 3145 6 estimates 3145 9 The concerted modeling approach needed. . . is beyond 3145 15 outwash plain surrounded by its LIA moraine? = within the LIA moraine? 3145 21 1760? Based on what evidence? 3145 22 The moraine of the LIA maximum advance at Tempano? 3145 27 19.5 km from 1898 or the LIA maximum (where is the downvalley extent given?) 3146 1 is not are 3146 12 Bernardo would result in a smaller change in mass balance 3146 8-18 interesting discussion but surely the bathymetry of the fjord may be more significant but is not mentioned. 3146 20 the subaerial topography adjacent to. . . enough to strand (or anchor) some of 3146 27 it can preserve or it can lead to preservation of. However, surely the critical fact here is that the deglaciated surface is subaerial! 3146 29 is flowing much more slowly than the main glacier tongue 3147 2 could be not likely are 3147 5 the main calving tongue had retreated 3147 6 water depth at the 2010 glacier position has a maximum depth of >391m 3147 10 where 3147 15 delete and 3148 2 rate? 3148 6 are 3148 8 are 3148 11-12 invert order the retreat rates are correlated with depth, not the other way round. 3148 16 2010 based on the fact that 3148 20 morainic 3148 22 the not a 3148 23 delete comma 3148 24 had retracted to? Are you inferring here that the ice was more extensive prior to ca 250 years ago? Where do you document this? 3148 25 on what basis do you

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infer the start of the LIA. Elsewhere you indicate this age is the LIA maximum. 3148 26 in 2003 or 2010? 3149 3 at the maximum (i.e. LIA maximum) position? 3149 4 one of the 3149 6-7 you do not know this is the start of the LIA advance- you only know the glacier advanced after this date. The glacier may have been advancing for some time prior to the burial of the trees. You have presented a minimum age for the advance. 3149 8 you have never discussed the differences in the magnitude of these advances- you only discuss the extent of recession. 3149 10 advanced and retreated North? Surely this should be advanced and retreated at least ca 19 km between 250 yr BP and the present day. Do you know where the LIA maximum is? 3149 12 how do calving dynamics affect ice advance? 3149 15 glaciers. The present location of the ELA at ... is flatter than 3149 20-21 final comment ignores the possible role of water depth 3151 16 glacier? 3153 caption what is vertical spatial resolution? It is either spatial or vertical as they are unlikely to be the same. This looks like satellite pixel size. 3154 caption the units of columns 2-4 are misplaced 3155 caption should possibly indicate that the black line (e.g. on Jorge Montt) is the frontal position at a later date than the underlying image. 3156 Canal Baker not easily identified. Perhaps only a part of the map could be shown 3157 date of the underlying image? 3160 the numbers on the diagram could be more easily visible (larger) 3161 could the buried trees be identified (arrow or circles?) 3162 caption says 13 cores, inset upper diagram and text (3144 line 4) say 16 3162 It would be more useful to plot the sample numbers as individual radii (i.e. each stacked radius is a line showing the length of record with the vertical sequence ordered by the death date (oldest death date is the top bar, bottom one is the youngest death date. The distribution of outer dates is important. Are these death dates (i.e. outermost rings or only those partial records which crossdate). The fact that the end distribution of dates has a big gap between ca. 260 and 200 years suggests a range of death dates of over 60-100 years which, if correct has important implications. Some more information would be useful here. 3163 caption Fjord? 3184 key is too small. Explain the vertical dashed lines?

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