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Interactive comment on "Tracking the Choco jet since the 19th Century by using historical wind direction measurements" *by* David Gallego et al.

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General Comment I commend the authors for their interest in this relevant and singular feature (westerlies!) within the low-level atmospheric circulation over the tropical far eastern Pacific. In particular, I find it very relevant their objective of tracking the Choco jet since the 19th Century using historical wind observations, by introducing and computing the so-called CHOCO-D index. That said, I think that the manuscript is far from being ready for publication in Earth Syst. Dynam., and that major and minor comments need to be dealt with in detail in the revised version.

RESPONSE: We thank Dr. Poveda for his constructive approach to this review. Please see below our detailed response to major and minor comments.

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Discussion paper

Major Comments: 1. The Choco low-level jet (LJJ) was introduced in the literature as one of the mechanisms that contribute to explain the existence of one of the rainiest regions on Earth over the Pacific coast of Colombia (Poveda et al., 1998; Poveda & Mesa, 1999a, 1999b,2000). In particular, the locality of Lloró witnesses mean annual rainfall rates on the order or 13,000 mm, with years such as 1974 with 26,000 mm. Such world-record breaking rainfall intensity would not be possible were if not for the large amounts of moisture transported by the Choco jet into the Colombian Pacific coast. The original Choco Jet was defined at the region between 2N-8N and 80W [77W-82W], either using the averaged horizontal zonal wind velocities or the transport of moisture by the zonal winds (Poveda et al., 2006, Rueda and Poveda, 2006) at 925 hPa, the vertical location of its core, as it is constrained between 1000 and 850 hPa. As referred to by the authors, more recent studies have shown that the Chocó Jet is an important mechanism of the Central American isthmus weather and climate. Within that geographical region, the Choco Jet satisfies all the criteria mentioned by Stensrud (1996) to identify a low-level jet.

RESPONSE: We agree. The relevance of this jet for the moisture transport to Central America and northern South America is unquestionable. Remarkably, some of the characteristics mentioned by Stensrud as typical of Low Level jets and found in the Choco Jet (maximum wind velocities between 900 and 1000 hPa, shallow baroclinicity, significant horizontal shear, etc.) make it quite challenging to envision a method intended to quantify the Choco Jet intensity by relying solely on the distribution of the wind direction taken at the surface level. We must admit that at the beginning of the work, we were also quite skeptical about this possibility but as our work progressed we realized that it was possible and that the signal we found in the spatial distribution of the wind direction was significantly related to the intensity of the wind at the core of the Choco Jet. Later we will clarify the basis of this relationship.

2. Also, the geographical region associated with the original Choco Jet allowed to differentiate it from the activity of the Caribbean LLJ, at the time referred to as the San

Andres LLJ (Poveda and Mesa, 1999a, 2000) given that it crosses over the San Andres archipelago in the Colombian Caribbean. Figures 1 and 2 show, respectively, the distribution of the zonal and meridional components of the horizontal winds at 925 hPa over the far eastern Pacific, northwestern South America and the southwestern Caribbean Sea. It can be seen that that the region is crossed by the westerly and easterly winds of both jets (Figure 1), but also by meridional winds associated with both jets (Figure2). Furthermore, the original Choco Jet was also constrained vertically, given that the westerly wind flow was evident from 1000 to 850 hPa, but also to differentiate its dynamics from the mid-tropospheric jet (700-600 hPa) (Hastenrath,1991, 1999; Poveda and Mesa, 1999a, 1999b, 2000) which is also seen in Figures 3 to 6.

RESPONSE: In fact, it is the existence of the San Andres LLJ what allowed to develop an index for the Choco Jet by using solely wind direction observations. This is precisely the reason why we need data along a large range of latitudes (4N to 15N) to obtain a meaningful signal. Please, see our reply to question #4 for details.

3. This previous introduction was deem necessary to point out one of the major concerns with the manuscript, regarding the region defined for the newly introduced CHOCO-D index: the area [4 N-15 N; 120W-84 W] plus the area [4N-9 N; 84W-77.5W]. Such region mixes up regions influenced by the opposite seasonal dynamics of both the Choco and the Caribbean LLJs. In particular, during December-January-February (DJF), the easterly Caribbean LLJ crosses the Mesoamerican isthmus, and three distinct wind jets form across the major gaps of the Central American mountain range in the Gulfs of Tehuantepec, Papagayo, and Panama (Chelton et al.,2000; Xie et al., 2005; Serra et al., 2010; Poveda et al., 2014).

RESPONSE: When using an index only relying in wind direction (directional index) to characterize a jet, it is critical to define it in an area larger than that where the core of the jet is located. Otherwise it would be impossible to obtain a climatic signal related to the jet's variability. In other words, if a directional index is defined for a region where the jet is permanently located as suggested (in this case the vicinity of 5°N and 80°W at 925 hPa), we would find no changes in the wind direction associated to the jet's variability, simply because the wind direction is scarcely variable there. In this area, the variability of the jet is optimally captured by changes in the wind force, but this is not our approach. Instead, we want to build a series based solely on wind direction and longer than those currently available. This viewpoint has been extensively applied with success (see Garcia Herrera et al 2018, WIRES Clim. Change. DOI: 10.1002/wcc.544, and references therein) because the use of indices based on wind direction has several advantages when looking at long term variability (temporal homogeneity, instrumental character even for the oldest records. . .). As can be seen in the examples shown in García-Herrera et al (2018), the area selected is always wider than the core of the phenomenon that we want to characterize. This is an extremely relevant issue and a number of concerns of Dr. Poveda are related to it. This will be clarified in the new version of the manuscript. In our reply to the following question (#4) we develop a complete discussion on this topic.

4. Therefore, I think it is a mistake to state that the Choco Jet constitutes a monsoonal circulation. What is really going on is a "tug of war" between two different LLJs acting over the proposed region through the seasonal cycle. As defined originally, the Choco Jet does not reverse once a year as evidenced in Figures 1 and 2. Furthermore, Figures3 to 6 show the vertical distribution of the zonal winds at 80W between 5S and15N, using data from four different reanalysis: NCEP/NCAR, ERA-Interim, MERRA2,and 20th Century V2c Reanalysis. All of them confirm that the original Choco Jet maintains its westerly direction and a very well-defined seasonal variability. Therefore, we are not in the presence of a monsoonal circulation but of two different LLJs acting over the region simultaneously. The situation is even more complex, given that during the DJF season the Caribbean jet, after crossing over the Panama Gulf gets merged with the Choco Jet and then inland over western Colombia (Poveda and Mesa, 1999a;2000; Sakamoto et al., 2011; Poveda et al., 2001, 2006, 2014).

RESPONSE: We concur with Dr. Poveda in this point. The Choco jet is not a monsoonal circulation and in this sense we think that our original introduction section, developed in terms of monsoons can led to this misinterpretation. The reason why we approached the development of the CHOCO-D index in this way was that our methodology was originally conceived to quantify monsoons (see Gallego et al. 2015. Q. J. R. Meteorol. Soc. DOI:10.1002/qj.2601 or García-Herrera et al. 2018 for example). During the course of our work on monsoonal systems, we performed a general feasibility analysis intended to locate the areas best suited to develop directional indices with ICOADS data. The one affected by the Choco Jet immediately arose as a promising area of study (see figure 1 of our original manuscript). We focused our introduction on this general feasibility analysis. We agree that this introduction can be misleading. Consequently, the new version of the introduction will be focused on the climatology of the region and more specifically in the description of the two LLJ mentioned by Dr. Poveda. This will also allow us to justify the necessity of using the large area [4N-15N; 120W-84W] plus the area [4N-9N;84W-77.5W] where the influence of both jets is mixed, as Dr. Poveda points out (see comment #3). In essence, in order to find out which jet is winning the "tug of war" mentioned by the reviewer by using solely the changes in the wind direction, it is necessary to observe the entire "arena" where the jets are "fighting". To illustrate this, we have chosen the years 1997 and 2010 where the average u-wind at 925hPa at 5N and 80W is low and high respectively (weak/strong Choco jet according to its original definition, see also Figure 3 of the original manuscript). During years of weak Choco jet (Figure 1.a in this document) the CLLJ is clearly "winning" and easterlies dominate the selected area from 4N to 15N, while the weak westerlies associated with the Choco Jet are restricted to the 5N 80W vicinity. In the zonal wind height-latitude cross sections at 80N (Figure 1.b) the Choco jet is apparent at 925 hPa (although still noticeable and precisely centered at 5°N as Dr. Poveda indicates). At 90W the easterlies are clearly dominant (Figure 1.c). On the contrary, during strong Choco Jet years, such as 2010, the jet shows its canonical structure in the 80W cross section (Figure 2.b), with its core still centered at 925hPa and 5N. However, during these episodes, the westerlies are still clearly seen well westward 80W (Figure 2.c). At the surface level these westerlies can reach the 15N latitude (the northern limit of our study area). The wind structure over our study region (Figure 2.a) shows the extension of the area with predominant westerly component in relation with our study area.

From figures 1 and 2, it is evident that the core of the Choco jet is always centered at 5°N and its latitude is scarcely dependent on the jet strength (as pointed out by the referee). In this sense, any index for the Choco Jet based on the wind speed should be centered at 5N and 80W as Dr. Poveda indicates, but this would not be effective for an index based on wind direction such as ours, as the wind direction scarcely varies at this location. What we have found is that by using an extended area, the changes in the relation of westward/eastward winds are a good "proxy" of the strength of the Choco jet at its core (something not evident that will be stressed in our revised version). As any climate proxy, the CHOCO-D index has pros and cons, being the main "pro" the possibility of computing the index for long periods (wind direction was measured with great precision since the pre-instrumental era) and the main "con" (as for any proxy) that it is not perfectly correlated with the wind speed at the core of the Choco Jet (as our correlations of Figure 4 ranging between +0.36 to +0.69 reveal). This discussion will be explicitly included in our revised paper.

5. Besides the mentioned shortcomings of the chosen region, the definition of the CHOCO-D index is based upon criteria defined by the NCEP/NCAR reanalysis. Figures3 to 6 show that the different reanalysis capture the seasonal cycle of the Choco Jet, albeit with different core velocities, range of extent of peak velocities, and zonal wind velocities at 850 hPa (top of the Choco LLJ), also shown in Table 1.

RESPONSE: In the definition of our CHOCO-D index, the NCEP/NCAR reanalysis is only used as a "calibrator" i.e. we select the optimal percentage of observations necessary to consider a day as one "with prevalent wind blowing from the south west" as that maximizing the correlation of our directional index (CHOCO-D) and the "classical" index based on wind velocity (from NCEP/NCAR). In this sense, we only make use of the year-to-year variability and the precise value of the wind speed at the jet-core is not quite relevant for this correlation. We preferred performing the calibration with NCEP/NCAR in order to do it for a period as large as possible (1948-2014). ERA interim or MERRA-2 limit the calibration period to 1979-2014 or 1980-2014 respectively. This will be explicitly stated in the revised manuscript.

6. Also, I find it confusing to discuss the dynamics involved from a summer-winter perspective, given its very equatorial setting. The area proposed for the new CHOCO-D index also mixes up regions whose annual rainfall regime is bi-modal (as per the passage of the Intertropical Convergence Zone), and unimodal as per their location on the northern hemisphere.

RESPONSE: In our study area bi-modal and unimodal precipitation regimes can be found, but this is not relevant for the index definition. Our original introduction based on monsoons can lead to think that we make use of the changes in the seasonal (summer/winter) precipitation to define our area and/or to calibrate the index. However, this is not the case. The area is chosen as that allowing to capture the changes in the Choco Jet through the westerlies/easterlies relationship (see our reply to question #4). So our study area is only dependent on the winds climatology. This is also valid for the calibration, which exclusively relies on the correlation with the zonal wind speed between 5N and 7.5N. We expect that our new introduction will clarify these issues.

7. Lines 18-19. “In the case of precipitation, monsoonal areas are usually demarcated as those where the local summer minus winter precipitation rate exceeds 2 mm day-1.” Comment: Again, the consideration of summer and winter precipitation is misleading here, since this area contains regions exhibiting a bi-modal annual cycle of rain allowing to the meridional oscillation of the ITCZ, passing twice per year over this region, but also regions with uni-modal annual cycle of rainfall.

RESPONSE: We concur. However this does not interfere with our index definition nor with our interpretation of the results (see reply to question #6). This will be addressed by rewriting the introduction and abandoning the unnecessary summer/winter perspective given there.

8. Lines 28-29: "...it is necessary to identify regions where the monsoonal wind reversal found at the 850 hPa level is also found at the surface." Comment: This is not the case of the Choco Jet as shown in the mentioned reanalysis.

RESPONSE: Again this is just the result of focusing our introduction in terms of monsoons. Most monsoonal indices are defined at the 850 hPa level and that was the level we used in our initial feasibility study (Figure 1 of our original manuscript). However after our introduction section, we do not use the 850 hPa wind anymore and we do not use any variable at this level for subsequent results. In fact we only use the zonal wind at 925 hPa, -at the core of the Choco jet- to calibrate the CHOCO-D index (see Figure 3 in our original manuscript). This issue will be addressed by rewriting the introduction, avoiding any reference to monsoons. Any reference to the wind at 850 hPa is then unnecessary and it will be removed from the text.

9. Line 32: "...in a 2.5_ x 2.5 grid where the last release of the ICOADS database currently has two or more wind direction observations per month for the summer months for at least 90 years in the 1900-2014 period. "Comment: Such spatial resolution seems too gross to perform detailed analyses of this LLJ.

RESPONSE: This paragraph also belongs to our feasibility analysis originally included in the introduction (see reply to question #4). In order to compute a directional index with reasonable uncertainty, it is necessary to have a minimum of 50 to100 raw observations per month (see Figure 4 of our original manuscript representing the uncertainty of a directional index in our study area as a function of the number of data). For our entire study area, this roughly corresponds to the specified data density. However, although the output of this feasibility analysis inspired our study, it is not necessary in the manuscript because the finally chosen region is not based on this analysis (see our reply to question #4). In consequence, the referred phrase, as part of the original introduction, will be eliminated from the revised text.

10. Lines 13-14, p. 3. “CHorro del Occidente COlombiano” (Western Colombian Jet) and as the place name “Chocó”, one of the Colombia’s regions most affected by this wind reversal. ”Comment: There is no wind reversal in the Choco Jet as shown by the different reanalyses.

RESPONSE: Again, this phrase is related with our original approach in terms of monsoons. Our feasibility algorithm detected that in a large area of the equatorial Pacific, the winds typically reverses between January and July, which is one of the classical criteria to define monsoonal areas (see Figure 3 below). However, as Dr. Poveda points out, this does not imply that the Choco jet reverses (at its core 80°W 5°N, 925 hPa). As with the rest of our original approach in terms of monsoons, this phrase will be eliminated. In our revised text it will be clearly stated that while the Choco Jet core does not reverse the change in the relation of the westerlies/easterlies winds in our extended area can be considered a “proxy” of the jet core strength.

11. Lines 14-16. Between May and November, the winter wind regime characterized by predominant north-easterly winds in this part of the world is replaced by south westerlies at low levels”. Comment: Again, it does not seem appropriate to talk about winter wind regime over this tropical region, since the winds are quite different during MAM, when the ITCZ is heading in a northward direction, while in SON the ITCZ is heading in a southward direction.

RESPONSE: This is a relevant precision. In the revised text, the references to winter/summer regime will be substituted by a discussion in terms of the seasonal migration of the ITCZ.

12. Lines 17-18. “... and it has a profound impact on the western coast, from Costa Rica to northern Colombia, which, as a result, are among the rainiest places on earth(Poveda et al., 2014).”Comment: This is quite true. Perhaps the community needs to be aware that this world record breaking rainy region has been recognized

in the literature since long: Murphy(1939), Schmidt (1952), Trojer (1958), Arnett and Steadman (1970), Snow (1976, p.371), Meisner and Arkin (1987), Eslava (1993, 1994), Janowiak et al. (1994), Poveda and Mesa (1999a, 2000), Jaramillo et al. (2017), King et al. (2017), among others.

RESPONSE: We concur. Unfortunately, the climate community is still not fully aware of the singular precipitation regime of this part of the world. We will emphasize this fact in our revised version adding the provided references.

13. Lines 27-29, p. 4: "This percentage was set as the one maximizing the average correlation between June and October for the 1948-2014 period with the NCEP/NCAR monthly zonal wind at 925 hPa averaged over the area [5N-7.5N; 90W-80W],which is considered a good representation of strength of the Choco jet core (Poveda and Mesa, 2000)".Comment: Again, restricting analysis to June-October is misleading since the Choco Jet is permanent (although seasonally-variable) throughout the year.

RESPONSE: Our directional index is not capable of characterizing the Choco Jet in some months. The CHOCO-D index is statistically related with the Choco jet strength (wind velocity at its core) only between May and November with a maximum correlation in August. During the rest of the year, the winds in the selected area at the surface level blow mainly from the east (see for example Figure 3 in our response to comment #10 for the case of January). For these months our index is close to zero. In the revised version, we will include a specific paragraph explaining this limitation.

14. Figure 3 caption. "Numbers over the CHOCO-D values indicates the monthly correlation between both series for the 1948-2014 period. "Comment: The mean annual cycle of the new proposed index shows easterly (negative) winds from January to April, which is not the case for the original definition. No wonder why the lack of correlation between the newly proposed index and the original one.

RESPONSE: As stated in the original figure caption, in this figure we compare the CHOCO-D with the NCEP/NCAR 925 hPa u winds averaged over the region [5N-7.5N;

90W-80W]. In this region, the area-averaged zonal wind is slightly negative from January to April as our original figure 3 shows. As Dr. Poveda points out, this is not the case for the area where the Choco jet was originally defined [2N-8N and 80W] (see comment #1). In Figure 4 (below) we show a figure equivalent to our original Figure 3.a but for [2N-8N; 80W]. In this case, limiting the longitude to 80W, the easterly winds are noticeable smaller and they only appear for February and March. When the area is restricted to the grid point 80W 5N at 925 hPa there are not easterly winds along the entire year (not shown). Notwithstanding, we prefer to maintain our original figure, this does not affect the interpretation nor the significance of our results (correlations in Figure 4 shown here are comparable to those on Figure 3 of the original paper) but the original figure makes easier to discuss the changes in wind direction in terms of the migration of the ITCZ. Notwithstanding, we will explicitly indicate in the paper that the core of the Choco Jet shows westerlies along the entire year and that the negative values found in Figure 3 are consequence of the extended area. In relation with the absence of correlation between the CHOCO-D and the averaged zonal velocity from December to April, it can be easily explained by the characteristics of our index. As the CHOCO-D is defined as the % of westerly winds in the selected area, our index is essentially zero from December to April. (see for example the wind distribution for January in Figure 3.a in this document) so by correlating the CHOCO-D with any other series, we are correlating the latter with a series mostly composed by “zeroes”. As stated in our reply to question #13 the impossibility of characterizing the wind variability these months is a limitation of our index and it will be explicitly discussed in our revised version.

15. Also Fig 3 caption: “... b) Standardized temporal series (June to October average) of the CHOCO-D index and the NCEP-NCAR zonal wind at 925 hPa averaged over the [5N-7.5N; 90W-80W] (blue dashed line).”Comment: Again, June-October is not completely appropriate to judge the newly proposed index.

RESPONSE: As explained in our reply to question #13, the CHOCO-D is only related with the jet’s strength from May to November. For computing annual averages we also discarded the months in the limits (May and November). So although it is true that June-October is not ideal to analyze the dynamic of the Choco- jet, it is the best that can be achieved with a directional index. Of course, the benefit of our approach is that we can compute an index based on actual observations since the late 19th century. We think that this characteristic fully justifies the interest of the new index, even considering its limitations. We will add a discussion on this issue in the new version of the manuscript.

16. Lines 12-13, p.5: “These values indicate that the CHOCO-D captures a significant part of the variability of the zonal winds at the core of the Choco jet. ”Comment: Please quantify correlation among these two series and p value.

RESPONSE: This correlation is r=+0.59 ($p<0.01$). We will add this information to the revised figure 3.b.

17. Line 23, p.5: “...as a function of N between May and November is shown in Fig. 4 for the period 1971-2010.”Comment: Again. May-November is not an appropriate period for this Equatorial region, since it contains winds from two different LLJs exhibiting opposite directions depending on the month of the year.

RESPONSE: As detailed in our reply to question #4, we need these two different LLJs over the region to construct an index based on wind direction. What we found is that between May and November, the relationship between the westerlies (Choco) and the easterlies (CLLJ) in our study area is significantly correlated with the strength of the Choco Jet, as measured by the zonal wind at the jet core. This correlation is only significant between May and November. Between December and April, the predominance of the easterlies in our extended area is too large (see for example Figure 3.a in our reply to comment #10) to capture any variability related with the Choco Jet. As commented in our reply to comment #13, this is a limitation of our approach that will be explicitly discussed in the revised version.

18. Lines 14-15, p. 6: “The connection of these rainfall anomalies with the moisture

advection has been assessed by computing the vertically integrated moisture transport through the 1000-700 hPa levels and the corresponding moisture convergence (Fig.6)."Comment: The original westerly Choco jet is confined between 1000 and 850 hPa as shown in Figures 3 to 6. Above 850 hPa the winds are clearly easterlies, and therefore the 1000-700 hPa layer contains winds from opposite directions.

RESPONSE: Thank you for noting this; limiting the integration to the 1000-850 hPa layer allows a more precise estimation of the specific contribution of the Choco Jet to the moisture advection. We have redone the figure with these new limits (see Figure 5 below).This figure will substitute our original Figure 6. These new results are quite similar to the original ones, but the anomalies in the moisture convergence (shading) are now more clearly centered at 5N latitude. This is especially evident in August, the month in which the CHOCO-D is best correlated to the wind anomalies between 2.5N-7.5N and 80W (see our response to question #14). We think this reinforces the usefulness of our index.

19. Lines 24 and 25, p. 7: "Ultimately the Choco jet originates in the southerly trade winds, making it strongly dependent on the meridional SST gradient along the Eastern Equatorial Pacific (Martinez et al., 2003)."Comment: Please acknowledge that this explanation was originally introduced by Poveda and Mesa (1999a, 2000), and has been further discussed by Poveda et al.(2001, 2006 and 2014).

RESPONSE: This is again a relevant issue, as this scheme is quite related to the possibility of characterizing the Choco Jet by measuring changes in a large area of the eastern Equatorial Pacific. We will emphasize this explanation and will acknowledge the suggested references in the revised paper.

20. Last line, p. 7 and first line p. 8: "Figure 9 shows the correlation of the CHOCO-D index between July and September and the following El Niño3.4 index (December to February of the following year) for variable timescales. "Comment: I find it difficult to understand why the authors estimate seasonal lagged correlations between the newly

proposed CHOCO-D index and the following El Niño3.4index. It would make much more physical sense to estimate the simultaneous and lagged (El Niño index leading, instead of lagging) seasonal correlations among ElNiño3.4 index and the CHOCO-D index. Another point worth commenting is the selection of the seasons. I suggest estimating the simultaneous and lagged correlations for the following cases: El Niño index (JJA) vs. CHOCO-D (JJA), El Niño index (JJA) vs. CHOCO-D (SON), El Niño index (SON) vs. CHOCO-D (SON), El Niño index (SON) vs. CHOCO-D (DJF, year +1), and El Niño index (DJF, year +1) vs. CHOCO-D (DJF, year+1).

RESPONSE: There are three different issues about this question: First, with regard to the election of the seasons, we concur with Dr. Poveda, using the standard season definition (DJF, MAM, JJA and SON) eases comparison with existent literature, so we have changed our season's definition as suggested. Second, due to the limitations of our index, the CHOCO-D does not produces reliable estimations of the jet strength between December and April (see our reply to question #13), so unfortunately we cannot perform useful correlations for the suggested cases involving CHOCO-D(DJF). Third, in our original manuscript, we decided to present the lagged correlation (CHOCO-D leading ElNiño3.4) because we were interested in the relation between a weakening of the jet during a developing phase of El Niño. We found that there is a strong correlation between a weak Choco Jet during summer and the existence of El Niño conditions the following winter. However, as recommended, being both the ENSO cycle and the Choco-jet long lived climatic features, it is also quite interesting to test the suggested correlations (El Niño index (JJA) vs. CHOCO-D (JJA), El Niño index (SON) vs. CHOCO-D (SON)) and the lagged El Niño index (JJA) vs. CHOCO-D (SON). We have computed these cases (see Figure 6 below). Figure 6.a (blue line) corresponds to our original analysis, where a weak jet in JJA tends to be followed by SST increases (El Niño conditions) the following winter. Additionally, Figure 6.a (red line) also shows that these negative correlations are also found for the in-phase JJA series. The relevant result here is that these relations have been remarkably stable along the 20th century. On the other hand, Figure 6.b shows that, according to our series, a weak jet during SON is also typically concurrent to with in-phase warmer SSTs (Figure 6.b, red line), while warm SSTs during JJA tend to be followed by a weaker jet (Figure 6.b blue line). Interestingly, the intensity of these relations involving the SON averaged CHOCO-D has changed along the 20th century, being clearly weaker prior to the 1930s. We have not currently an explanation for this finding, but it is probably related to the shift from negative to positive anomalies around the 1920s-1930s discussed for the September and October CHOCO-D series (see Figure 7 of our original manuscript). Notwithstanding, we consider these results quite relevant for stimulating future research in the area, so we will include this discussion in the revised paper. Former figure 9 of the manuscript will be replaced by Figure 6 of this document.

21. Lines 18-19, p.8: "This is because the exceptionally large latitude range where the monsoon-like changes in the wind direction can be related to the Choco jet. "Comment: This is one of the problems of the manuscript. Changes in the wind direction are not solely related to the Choco Jet, but to the dynamics of the Caribbean LLJ over such a wide region.

RESPONSE: As commented in previous replies, this is probably the central issue raised by Dr. Poveda. We expect that by changing the introduction (eliminating our feasibility analysis in terms of monsoons), it should be clear the necessity of considering an area where both the Choco Jet and the Caribbean LLJ are included in order to compute a directional index. This new approach will clarify at the same time the questions relative to the study area and the presence of two different LLJs and the questions relative to the inadequacy of discussing in summer/winter terms.

22. Lines 7-8, p.9: "This structure explains the excellent response of the CHOCO-D to the seasonal march of the Choco jet." Comment: This seems to be an overstatement as per results shown in Figure 3a.

RESPONSE: Maybe we were a little bit enthusiastic. In the revised version we will substitute "excellent response" by "significant relationship" and we will explicitly indicate that this relation is restricted to the May-November period as: “This structure explains the significant relationship of the CHOCO-D to the seasonal march of the Choco jet between May and November.”

Minor Comments: 1. Line 23, p.6: Change pacific for Pacific.2. Line 28, p. 7: “In this way, a year with weak (strong) jet tends to be followed by ElNiño (La Niña) conditions.”Comment: For the sake of clarity, I suggest rephrasing this sentence as: In fact, the transport of moisture by the jet is weakened during El Niño events, and enhanced during La Niña events (e.g. Figure 9 of Poveda et al., 2006).

RESPONSE: We concur and we will include this rephrasing in our revised text.

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2018-54, 2018.

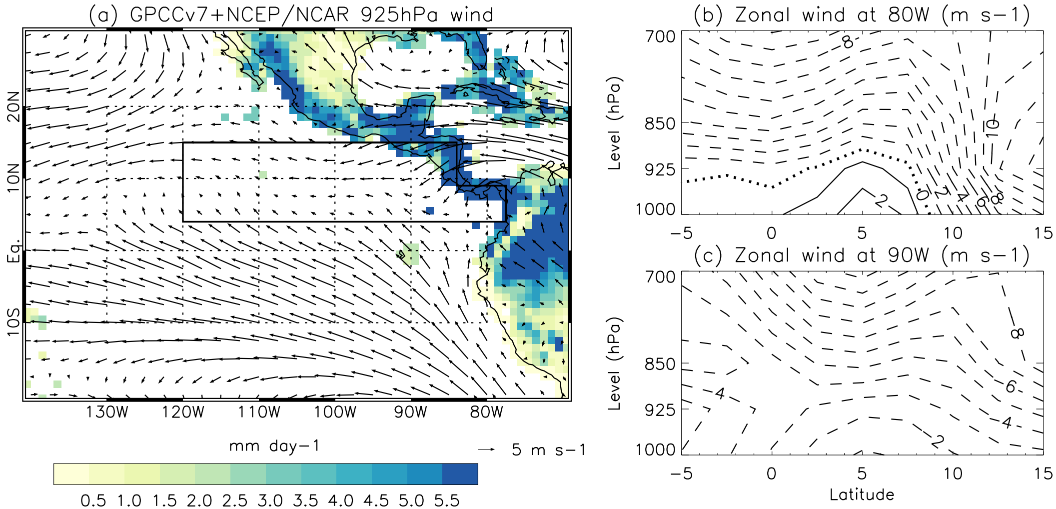

Fig. 1. (a) NCEP/NCAR wind vector at 925 hPa for August 1997. (b) Cross section of the zonal wind from 5S to 15N at 80W. (c) Cross section of the zonal wind from 5S to 15N at 90W.

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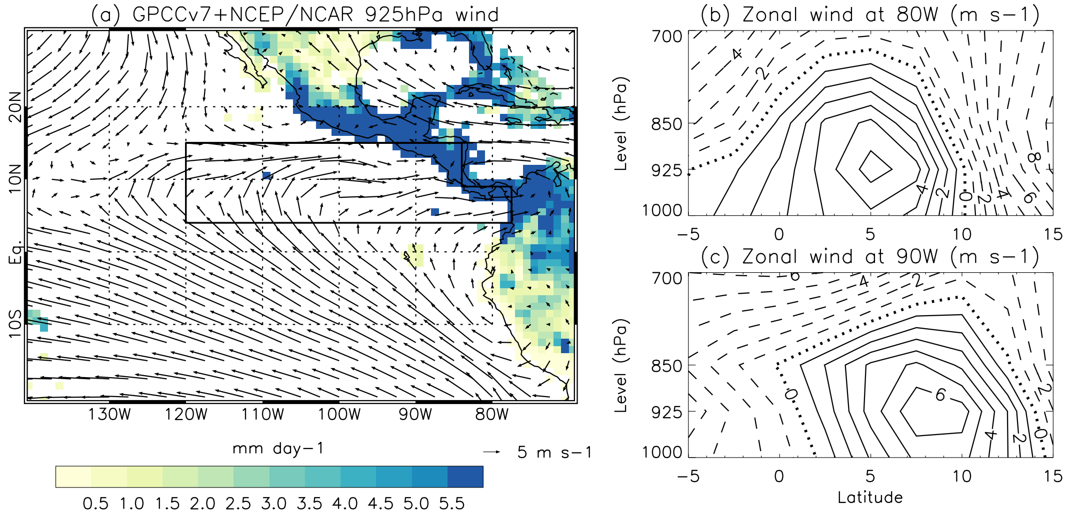

Fig. 2. (a) NCEP/NCAR wind vector at 925 hPa for August 2010. (b) Cross section of the zonal wind from 5S to 15N at 80W. (c) Cross section of the zonal wind from 5S to 15N at 90W.

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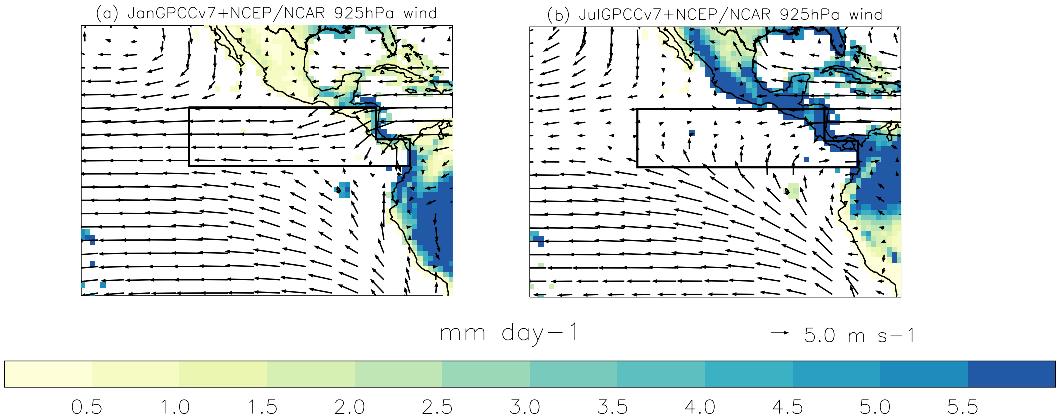

Fig. 3. 1981-2010 averaged NCEP/NCAR wind vector at 925 hPa for (a) January and (b) July. Shading shows the corresponding GPCCv7 precipitation.

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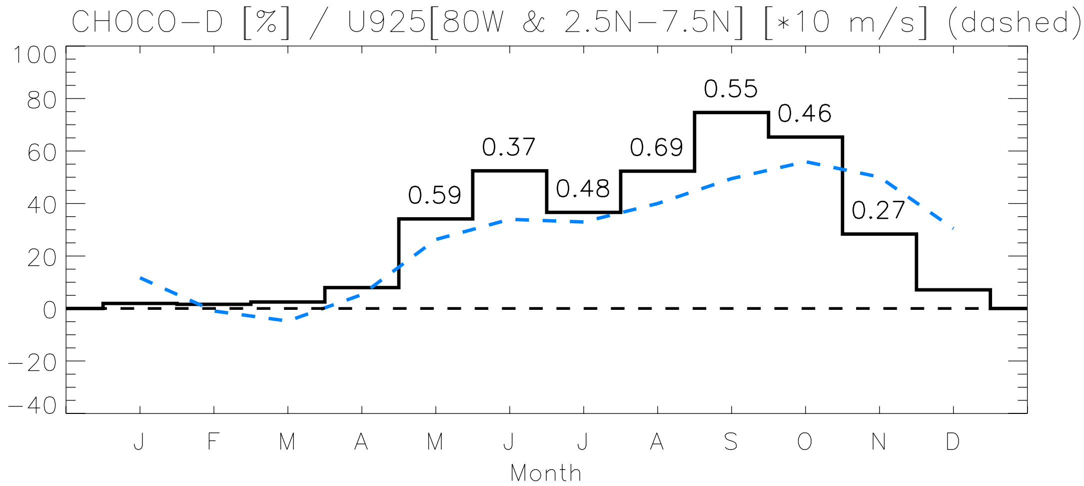

Fig. 4. . Monthly averages (1948-2014) of the NCEP-NCAR zonal wind at 925 hPa averaged over [5N-7.5N; 80W] (blue dashed line) and monthly averages of the CHOCO-D index for the same period in %.

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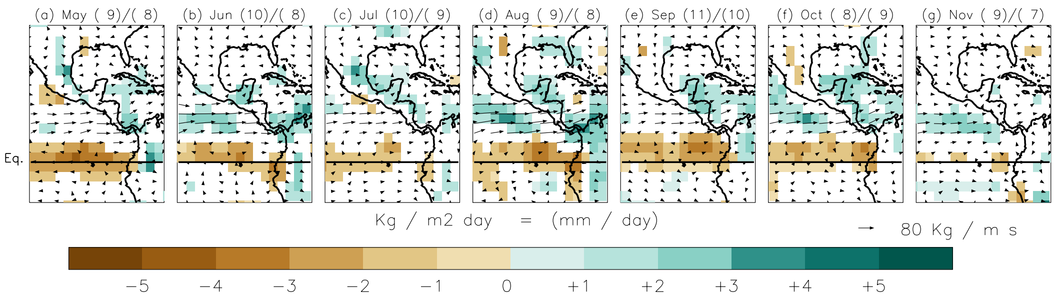

Fig. 5. 1000-850 hPa vertically integrated moisture transport (arrows) and moisture convergence (shaded areas) differences between CHOCO-D +/- 0.75 standard deviations.

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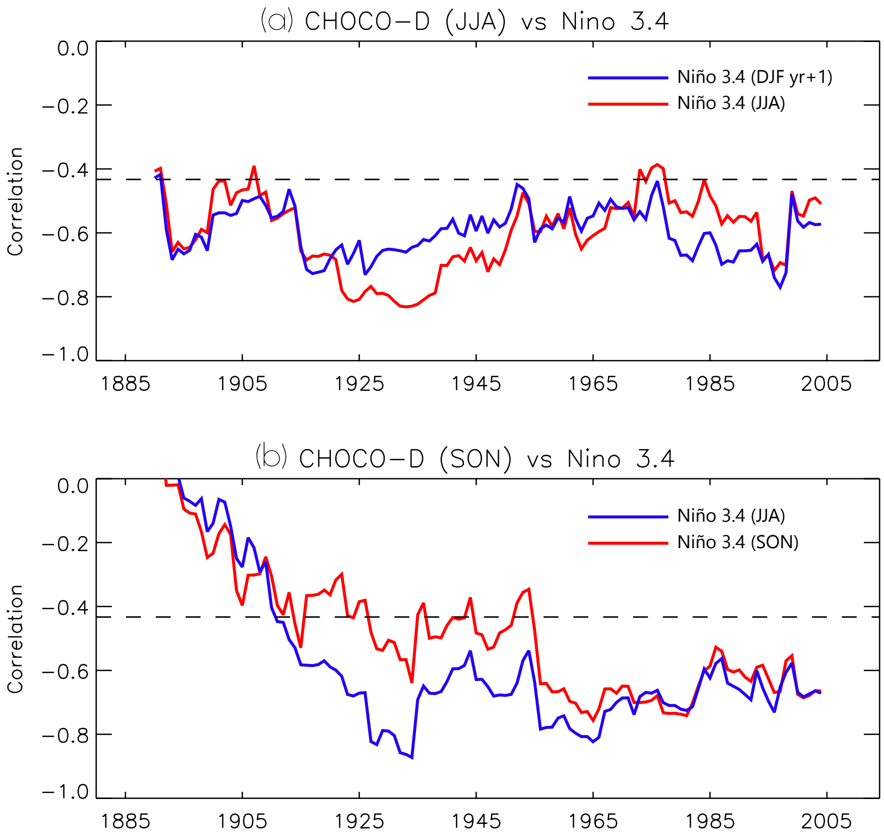

Fig. 6. 21-yr running Pearson's correlation coefficient between CHOCO-D and El Niño3-4 for in-phase and lagged cases.

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