We would like to thank reviewer 2 for the positive comments and good suggestions. We respond in detail to the reviewer's comments below (our responses are given immediately below the reviewer's comments).

General comments

Although Yang et al. have claimed that results of this study provide the initial estimates of the available soil P for plant uptake in global biogeochemistry models, they have not considered the impact of fertilizer application that play a significant role for plant uptake and growth. The authors have mentioned in the manuscript that they are aware of this, but without considering the effect and impact of fertilizer application within a reasonable time scale, the distribution of different forms and accessibility of soil P for plant (Page 16378, Figure 3) might be less useful.

Response: We agree with the reviewer that fertilizer application has a significant impact on plant P uptake and growth in agricultural land. We decided not to consider fertilizer input in this study for three reasons (1) the main objective of this study is to estimate the global distribution of different forms of P in soils for the initialization of global biogeochemical models that incorporate P cycling without human alteration. From this the timing, amount, and fate of applied fertilizer can be additionally considered but is beyond the scope of this manuscript. (2) We attempt to derive the global P distribution using a data-based approach from pedogenic perspective. In order to estimate the impact of fertilizer application on soil P, a modeling approach would be needed to determine the fate of the fertilizer P input in soils. (3) The Hedley P database used in this study is restricted to natural ecosystems (Yang and Post, 2011). We acknowledge that we underestimate soil available P in agricultural land. We believe the estimates for agricultural soil P will be improved if the maps derived here were used in conjunction with process-based models and fertilizer P data. We have cited recent papers on global maps of P in agricultural land (Bouwman et al., 2009; MacDonald et al., 2011) in the discussion section of the revised manuscript.

Between different forms of P, inorganic labile P is the most available P for plants. The map of distribution of labile P given in Figure 3 does not give enough information since the level of labile P is changing between 0-125 g P m-2 only in three steps for the entire world. Coupling this map with the global map of agronomic P and agricultural soil P budget (Bouwman et al., 2009; MacDonald et al., 2011) could be a great achievement to show the total availability of P for plants.

Response: We re-plotted the P maps and the distribution of labile P is described in more detail now. As we discussed above, the main objective of this study is to provide global distribution of different forms of P in soils for the initialization of global biogeochemical models. It is important to couple the maps derived in this study with a processes based model and the global map of agronomic P input to improve total available P estimate in agricultural soils, but that is beyond the scope of this study. Although we are not considering fertilizer application in this study we acknowledge the importance of

fertilizer P input to agricultural soil available P and both papers have been cited in the discussion of the revised manuscript.

While, many processes govern soil P transformations and they interact across a huge range of spatial and temporal scales. Pedogenic Phosphorus Depletion Index has been calculated or providned from different references (Table S1) at different times over more than 20 years (from 1988 till 2011). The form of P may change in time and transfer of P to the different soil P pools is a dynamic process (Sattari et al., 2012). When the data have been presented in the same map, it is assumed (implicitly) that the data have been taken at the same time, which is not valid. It is useful to discuss about the kinetics of soil P pools and how important is the un-synchronized data gathering in making the final maps.

Response: We agree that the various biological and geochemical processes controlling soil P transformations occur across a wide range of temporal time scales. This study attempts to tackle soil P estimate on the global scale based on our understanding of P transformations during pedogenesis combining with data on lithology, chronosequence studies and soil P measurement. Considering the geological time scale of PPDI we would not expect the change of soil P in decadal time scale would change our estimates significantly.

There are also uncertainties in estimation of Hedley fractions and soil strains (page 16374 Table 3; high uncertainty in strain value specially in Intermediate range of soil type) that cause a large uncertainty –up to 70%- in estimating of the total P. Although the uncertainties in estimations have been discussed in the manuscript, authors should provide sensitivity to this analysis in the conclusion.

Response: Thanks for the suggestion. The uncertainty estimate is now added in the conclusion.

Minor Comments:

- It would be useful to define PgP in the first use as Petagrams P - Page 16351 line 11 &12; Batjes 2010 is not in the reference list

Response: it is now defined.

- It seems to me that the dimension of both sides of Eq.2 does not match. Please make clarification.

Response: Thanks for pointing this out. We modified the equation in the revised manuscript as

$$TP_s = 0.01D\frac{\rho_P C_P(1 - PPDI)}{\varepsilon + 1}$$

where TP_S (g P m^{-2}) is total P in the top 50cm soil, D is the soil depth(50cm), ρ_P (g cm^{-3}) is the bulk density of parent material (see Table 1), C_P (ppm) is parent material P concentration, ε is the volumetric soil strain.

- Page 16359 line 10; Smil (2000) is correct Not Smil et al.

Response: We have corrected it.

- Page 16360 line 13; "soil P is" should be "soil P in"

Response: It is corrected now.

- Page 16363 line 28 and 16364 line 3; PPPI should be PPDI

Response: We have corrected them now.

- Page 16372 Table 1, make it clear which type of P?

Response: We have added (apatite P) in the table caption now.

- Page 16379, Figure 4, you may add (a) reference(s) for field measurement in the legend of Figure 4.

Response: the reference for the measurement has been added in the legend of Figure 4.

- Table S1:

a. In Temperature column sometimes there is a "C" and sometimes is not, keep it in consistent way.

Response: It is revised now.

b. Precipitation is referring to which year? Or period of time?

Response: Here it is annual mean precipitation given in the referenced paper.

c. Is "Waitutu" referring to a chronosequence study? If so, please mention it in the Table.

Response: Yes, it is mentioned in the table now.

d. I couldn't find "Sheldon,2012" in the references list of Supplementary material. e. Selmants and Hart, 2010 is correct. - You may add the reference to the table S2

Response: It should be "Sheldon, 2003" and it has been corrected. We have also added the reference for Table S2.

- Table S3 is not well structured. ”Slightly weathered soil” should be removed from the heading and only a general term “e.g weathering category” should be allocated in the heading of the table. Then “Slightly weathered soils” can be moved under the heading line as the same position as “Intermediately” and “Highly Weathered soils”.

Response: Thanks for the suggestions. Table S3 has been revised.

- Table S3, The reference “Yousefifard et al, 2012” is correct. Not 2015,2016,2017 and 2018!

Response: The reference has been corrected.

Reference:

Bouwman A., Beusen A., Billen G. (2009) Human alteration of the global nitrogen and phosphorus soil balances for the period 1970–2050. Global Biogeochemical Cycles 23. DOI: doi:10.1029/2009GB003576.

MacDonald G.K., Bennett E.M., Potter P.A., Ramankutty N. (2011) Agronomic phosphorus imbalances across the world’s croplands. Proceedings of the National Academy of Sciences 108:3086-3091. DOI: 10.1073/pnas.1010808108.

Yang, X. and Post, W. M.: Phosphorus transformations as a function of pedogenesis: A synthesis of soil phosphorus data using Hedley fractionation method, Biogeosciences, 8, 2907-2916, doi:10.5194/bg-8-2907-2011, 2011