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Atmospheric Measurement Techniques Discussions
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Interactive comment on "High Spatial Resolution mapping of Precipitable Water Vapor using SAR interferograms, GPS observations and ERA-Interim reanalysis" *by* W. Tang et al.

Anonymous Referee #1

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The manuscript addresses the usage of InSAR to derive PWV maps over the Los Angeles region. They correct the total InSAR tropospheric delay for the hydrostatic component using the ERA-I weather model, prior to the estimation of the relative InSAR PWV maps. In their work the authors use GNSS PWV estimates to account for the arbitrary reference in the InSAR data. The work is of importance as PWV maps from InSAR can provide a high-spatial resolution constrained for weather models. While the manuscript has the necessary content, I suggest a major revision. In specific the manuscript needs to be elaborated on the applied processing strategies, the inclusion of references on the processing methods and other work in literature, and the consistency with the methodology used in literature.

Major Comments:

- The abstract discussion should also include the requirement of high temporal resolution of PWV maps for the application of weather modeling.

- The term dry delay is misnomer that is somewhat pervasive throughout the literature. The correct term is hydrostatic delay as this term also includes the contribution from the partial pressure of water vapor. Please change all instances of dry delay to hydrostatic e.g. p2: L18, L21, and many more. See Hansen (2001) p202 equation 6.1.8-6.1.9 for definition of the hydrostatic and wet delay, and also update k2-Rd/Rv*k1 to k2'.

- Throughout the text the term atmospheric noise or delay is used. This term groups tropospheric delay+ionospheric delay. Update equation (1) to include both terms and explain directly why the ionosphere can be neglected for most C-band studies.

- Most of the occurrences of atmospheric delay throughout the manuscript should be changed to tropospheric delay, e.g. P2: L17, P4: L25, P5: L9: L14, and many more.

- Section 3.1: L 25: Incorrect usage of atmospheric delay. This should be tropopsheric delay, and equation (2) should be tropospheric delay = hydrostatic + wet + liquid. Elaborate why liquid component can be neglected.

- The authors refer to PWV maps as water vapour mapping. The latter refers to a 3D mapping of water vapour in throughout the atmosphere, while they are actually referring to it as 2D mapping of Precipitable Water Vapor. Therefore occurrences of water vapour mapping should be updated to PWV maps. E.g. P2: L12, L24, and many more.

- p 5, L11-13: The hydrostatic component can be more than just a smooth gradient over the scene. It can introduce a spatially varying tropospheric signal. E.g. Bekaert et al., 2015 JGR. http://onlinelibrary.wiley.com/doi/10.1002/2014JB011557/abstract

- Literature defines the PI factor as being ~6.2, while in the manuscript a PI factor is defined as 1/Kappa. This is most confusing and needs to be updated throughout the text. E.g. Bevis, 1992 GPSM (equation 12); Bekaert et al, 2015 RSE; Walters et al., 2013 JGR http://radiometrics.com/data/uploads/2012/11/bevis_jgr92.pdf http://www.sciencedirect.com/science/article/pii/S0034425715301231 http://onlinelibrary.wiley.com/doi/10.1002/jgrb.50236/full

- The authors use the ERA-I model to compute their Kappa factor. A discussion should be included on the spatial accuracy of their estimates. Does the timing accuracy of the weather model introduce a larger error than assuming an average value? If once takes the average of the spatial map one would get close to the default value again assumed in literature.

- p7 L8-10: The formulation does not seem to correct, it states that it assumes water vapour to be concentrated for the lover 1.4 km. However this is not an assumption from the cut-off. Are not all GNSS satellites within the cone field of view used to estimate the zenith wet delay over a given time window, by using maping functions. If this is the case then it would not really be an average over the cone area.

- The processing description of the data needs to be expanded and more references provided. In specific the following items needs to be addressed:

1) The envisat oscilator drift correction is not included or mentioned (Marinkovic and Larsen). The authors should make a reference of this problem and elaborate the impact on their results. P. Marinkovic and Y. Larsen, On Resolving the Local Oscillator Drift Induced Phase Ramps in ASAR and ERS1/2 Interferometric Data âĂŤ The Final Solution

2) What is the coherence threshold that is used for the selection of the InSAR points. Has the data been processed with a time-series method? If so appropriate reference should be included.

3) Include the reference for SRTM (Farr et al, 2007): http://onlinelibrary.wiley.com/doi/10.1029/2005RG000183/abstract

4) P8: L27: Include a reference for the DORIS InSAR processor (Kampes, 2003): Kampes, B., R. Hanssen, and Z. Perski (2003), Radar Interferometry With Public Domain Tools, 6âĂĽpp., Proc. Fringe 2003 Workshop, Frascati, Italy.

5) Was the data processed from SLC level? If not a reference and explanation should be included how you did it. E.g. roipac?

6) Is there a citation for the GNSS network, or those who maintained the network?

7) How was the MODIS data processed, was the TRAIN package used in its calculation or processing? If so mention this and include reference to Bekaert et al, 2015, RSE. http://www.sciencedirect.com/science/article/pii/S0034425715301231

8) P3 L9: It is unclear if the average look angles is used to convert from zenith to pseudo-range. If an average is used, elaborate on the implication of your results.

9) How is the PI factor included. Is it averaged for the 2 SAR acquisition. Please include this in the text. Also this could related to why figure 10 shows Gaussian residuals. Is this because on of the SAR dates has an incorrect PI factor estimated? Please include a paragraph on this in the discussion.

10) P10: L12: A citation is needed for the 0.16 gmˆ-2.

Minor comments: - P2: L12, L19: The recent fleet of SAR satellites have swath up to 250 km. Mention this as this make it even more attractive for PWV application.

- P2: L32: L-band platforms such as ALOS will experience an ionospheric delays. Therefore less preferred for this type of PWV application.

- P2: L18: in time and space while => in time and space, while

- P3: L8 mages => images

- P4: L15: deccorrelation => decorrelation

-P4 L18: decribed in (Jolivet et al, 2011) => described in Jolivet et al (2011)

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Discussion paper

-P4 equation 3 and 4: Introduce lamba in the text as the radar wavelength.

-P5 L5: . . . and the factor 1/theta => . . . and the factor -4pi/lambda is a scale factor to convert from pseudo-range increase to phase delay.

- Equation (5), suggest to change ZWD_insar to Delta ZWD to be consistent with Delta PWV. i.e. it becomes more obvious when substituting equation (5) into (6)

- P6: L1: introduction of w in equation is unnecessary. Keep it as rw/rd.

- P7: L1: reword sentence: temporal diff. . .. . . are not directly comparable -> PWV estimated from GNSS is not directly comparable with Delta PWV estimated from InSAR.

- P7: L25: include a reference in support of high accuracy retrieval of water vapour. E.g. Li et al 2003.

-P10 L10: . . . water vapor measurements => water vapor pixels.

- P11 L8: radar => Synthetic Aperture Radar

- Table 1: mater => master

- Table 2: include reference for coefficients.

- Table 3: . . . obtained by InSAR => . . . obtained by InSAR after calibration of offset using GNSS.

- Figure 1,2: Indicate SAR LOS in figure and in caption

- Figure 2: replace: re-sampled to radar-coordinates => at interferogram pixels

- Figure 3: Indicate UTC time of satellite. taken at 18:00 => taken at 18:00 UTC (close to the SAR acquisition time of XXX UTC).

- Figure 6: include a legend for the stations

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