Date: September 11, 2017

Manuscript #:   acp-2017-525
Manuscript title: ***Comparison of Global Observations and Trends of Total Precipitable Water Derived from Microwave Radiometers and COSMIC Radio Occultation from 2006 to 2013***

Brief Summary of the Manuscript
This manuscript compares TPW estimates from the COSMIC radio occultation mission against estimates from SSM/I, SSMIS, radiometers, and WindSat over clear sky and cloudy conditions. The authors report a very good agreement between COSMIC and all other TWP data sets and trends. They also claim that the estimated differences between MW radiometers and COSMIC are mainly due to biases in the MW retrieval uncertainty under cloudy and precipitating conditions. This analysis is in my opinion a novel approach to establishing radio occultations as a new remote sensing climate instrument by cross-comparing the COSMIC results with independent data sets. The manuscript is very well written, coherent, and the results are presented nicely within the context of the investigation. My recommendation for this manuscript is publication after minor revisions, as described below.

Major Comments:
1) **Page 7; Line 147:** What is the cut-off value of the liquid water column? Given that this value establishes an upper limit in the estimation of the TPW in the RSS products, could this introduce a bias in the COSMIC vs RSS comparisons at high TPW values? I think this must be explicitly discussed in the manuscript.
2) **Page 11; Line 236:** The authors assume an 80% relative humidity below 0.1 km. What is the sensitivity of the COSMIC TPW estimation the relative humidity assumption? How does that affect the conclusions of this investigation?
3) **Lines 289–291, Lines 309–310, Lines 414-423:** The authors conclude that the primary source of the estimated biases between COSMIC and the rest of the data sets is the MW retrieval uncertainty. Because the largest biases are found under cloudy precipitating conditions, I think that the authors should also acknowledge that errors due to: a) cut-off liquid water and b) the 80% RH assumption below 0.1 km, could also contribute to the reported differences. Could there be a combined effect as well?
4) **Page 16; Line 357:** It should read: "...with F15, F16, F17, and WindSat under..."

Minor Comments:
a) **Line 57:** Grammatically the sentence is fine, but the noun "increases" reads rather awkward. Perhaps, consider replacing it with the word "enhancements"?
b) **Line 69:** It should read: "reanalyses".
c) **Line 92:** Place a comma after the word "Recently".
d) **Line 116:** Delete the word "and"
e) **Line 161:** It should read: "... (RR, in mm/hr), respectively, in 2007."
f) **Line 161:** It should read: "temperature variations over the Intertropical Convergence Zone (ITCZ) (Fig. 1b), which..."
g) **Lines 181-182:** It should read: "where P is the pressure in hPa, T is the temperature in K, P_w is the water vapor pressure in hPa, W_{water} is the liquid water content in grams per cubic meter (g m^{-3})... "
h) **Line 208:** Place a comma after the word "troposphere".
i) **Lines 216-218:** I think that this statement is a bit bold. Perhaps, mention that the "...retrieved water vapor profiles are weekly dependent on the first guess" and provide a more appropriate reference that demonstrates that?
j) **Line 244:** Check "Wick2008". Is it written properly?
k) **Line 264:** Spell out December.
l) **Lines 264-266:** Delete this sentence. It appears twice in Lines 259-260.
m) **Line 268:** It should read: "Figures 2a-d..."
n) **Line 275:** Explain briefly how the "rad-cal" beacon biases the F15 data.

o) **Line 300:** It should read: "Figures 4a-d depict the..."
p) **Line 318:** It should read: "Figure 5b indicates that..."
q) **Line 321:** Delete "Fig. 5d"
r) **Line 323:** It should read: "Figure 5e shows that..."
s) **Lines 338, 342:** Spell out December.
t) **Line 353:** It should read: "Figure 8 depicts the..."
u) **Line 366:** It should read: "Figure 9 shows the..."
v) **Line 382:** It should read: "Figure 10 shows..."
w) **Line 383:** What about the F15 data?
x) **Line 385:** It should read: "...and west of Australia, south..."
y) **Lines 399–400:** It should read: "Because RO data have low sensitivity to clouds..."