Review of Paper ACPD **15** (2015), 34439-34496

Fast descent routes from within or near the stratosphere to Earth´s surface,

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General Remarks

The paper describes a thorough and thoughtful study of pathways of stratospheric air reaching the low-lying surface site Fukuoka in Japan that deserves publication. The application of ^{7}Be as a tracer of UTLS air is a reasonable approach that could gain from a combination with low water vapour. The combination with trajectory analyses looks convincing, although the station is located at 30 m a.s.l. where mixing could play a role. However, the paper lacks from important deficiencies that must be overcome before publication in ACP can be recommended. In particular, the literature included is sparse and does not indicate the enormous amount of work done in this field. There seems to be a strong bias towards theoretical studies (that are adequately selected). There is also no explanation how the ^{7}Be-loaded air parcels enter the boundary layer. This is a difficult topic, and there have been hints that there is low penetration at least during daytime. Also the validity of trajectory calculations in the boundary layer must be discussed.

Details

(1) Abstract, Lines 20-23: This statement about mixing is courageous. Is there observational evidence that ^{7}Be is higher at higher altitudes? I would expect mixing to be most pronounced in the boundary layer.

(2) P. 34441, Line 3: Tropopause folding has been reported to have a low seasonal dependence elsewhere (Beekmann et al., J. Atmos. Chem. **28** (1997), 29-44) and deep stratospheric intrusions maximize in winter (Stohl et al., Atmos.Environ. **34** (2000), 1323-1354; Trickl et al., ACP **10** (2010), 499-524). Is this different for East Asia?

(3) P. 34441, Lines 8-10: Investigations of STT start in the 1950s. Please, explain why you start with Kida (1997), or include some of the pioneering work.

(4) P. 34441, Line 17: “Only recently” is not true. Deep STT has been studied for several decades. In recent years strong interest in the potential impact of STT on near-surface has started, in particular in the U.S. Recent papers are (e.g.)
Ambrose et al., Atmos. Environ. **45** (2011),5302-5315; Langford et al., JGR **117** (2012) D00V06; Lin et al., JGR **117** (2012), D00V22; Lefohn et al., Atmos. Environ. **62** (2012), 646-656; Yates et al., ACP **13** (2013), 12481-12484; Dempsey, Atmos. Env. **98** (2014), 111-122; Langford et al. (2014, already cited, please, control the year); Lin et al., Nature Communications ?? (2015), 6:7105, DOI: 10.1038.
A penetration of stratospheric air into the PBL is not trivial. Intrusions tend to slide along the top of the PBL without much vertical exchange. A recent study in the eastern U.S. (not yet published) addresses the issue of daytime in the entrainment of STT air in the PBL. Eisele et al., JAS **56** (1999), 319-330 show a case of deep STT reaching low altitudes in the early morning followed by downward mixing in the developing PBL. They also discuss previous literature on this subject.

(5) P. 34442, Line 6: There is also a growing number of publications on measurements in or in the vicinity of Tibet, e.g., Zhang et al., Adv. Atmos. Sci. 27 (2010), 1344-1360; Chen et al., ACP **11** (2011), 5113-5122; Cristofanelli et al., ACP 10 (2010), 6537-6549; Bracci et al., J. Appl.

Meterol. Clim. **51** (2012), 1489-1507; Sarangi et al., JGR **119** (2014), 1592-1611; Ma et al., ACP **14** (2014), 5311-5325; Ohja et al., Atmos. Environ. **88** (2014), 201-211.

(6) P. 34442, lines 8-9: The first part of this sentence is trivial! You should rephrase the following part like "which is our direct environment". However, I would rewrite the first two sentences in this paragraph entirely. You could also refer to the recent interest in the impact of STT to air quality and cite the papers listed under (4).

(7) P. 34442, Line 19: (Langford, 2014)

(8) P. 34443, Line 7: "mainly": Please, more precisely! (about 2/3 according to Lal and Peters: Cosmic ray produced radioactivity on the earth, Handb. Phys. **46** (1967), 551-612)

(9) P. 34443, Line 17: Add citations of such STT studies! You could add those on the following page and and some more. From the past 20 years I remember a number of climatological studies, e.g., Elbern et al., Atmos. Environ. **31** (1997), 3207-3226; Stohl et al., 2000, see (2); Zanis et al., ACP **3** (2003), 763-777; Cristofanelli et al., JGR **111** (2006), D03306; Trickl et al., 2010, see (2)). In addition, I found a recent one on low altitude surface observations: Tan et al., J. Radioanal. Nucl. Chem. **298** (2013), 883-891. This one could be cited in connection with your low-altitude study.

(10) P. 34443, Lines 25-26: "several" is not enough. One possibility could be "a limited number". The sentence "In other words, ..." is unnecessary and should be deleted. You do not explain where the problems are!

(11) P. 34443, Lines 1-3: The references listed under (8) are also related to mountain sites. Ozone is frequently elevated in the presence of elevated ^{7}Be. If you want to present Tsutsumi et al. as a special example, you could introduce that sentence by "In East Asia, Tsutsumi et al. ....".

(12) P. 34444, Line 14: Add (Stohl et al., 2003)

(13) P. 34445, Line 5: I am missing a summary of the existing knowledge on STT air reaching low altitudes (see (4)), as a transition to the current study.

(14) P. 34446, Line 5: Why do you mention two companies (Ortec, Canberra) for one detection system?

(15) P. 34447, Lines 7-11: "concentration" is not fully precise. However, "specific activity" is related to mass (Bq kg^{-1}) and is, thus, not a better solution. Maybe you should use quotation marks around concentration in Line 7 (first case). What is the accumulation time?

(16) P. 34448: There is no information on the calculation of PV!

(17) P. 34452, Line 3: What is the "eastern hemisphere"?

(18) P. 34452, Line 7: "higher latitudes"? "high" could be around the North Pole! 45º is normally named "mid-latitude". Please, carefully examine the paper elsewhere!

(19) P. 34457, Line 1: "that the potential temperature is not conserved along the trajectories"?

(20) P. 34457, Line 12: Why do values mix? Air parcel can mix. Is this a numerical effect? Free-tropospheric mixing is a rather slow process (see Trickl et al., ACP **14** (2014), 9941-9961, for some discussion).

(21) P. 34457, Line 18: "high altitudes" or "high latitudes"? Please, make sure. If "altitudes": Please, specify!

(22) P. 34457, Line 19: “diffluent area” looks strange. Do you mean “area with predominantly diffluent air masses”?

(23) P. 34457, Lines 21-23: “this southward flow”: there is also a northward flow! Please, describe clearer. The sentence “That is, descending parcels .... but parts of them.” is also difficult to understand.

(24) P. 34458, Lines 15-17: First you write “rapid descent”, here “considerably long (longer?) time”. I suggest writing “somewhat longer time”. “low altitudes” is confusing. The intrusions start at high altitudes!

(25) P. 34459, Line 18: “it is rare”: Do not generalize! Better “First, we conclude from our analysis ...”.

(26) P. 34460, Line 12: “reference altitudes of 8000 and 10000 m.”?

(27) P. 34461, Lines 1-3: According to Beekmann et al. (1997) (see (2)) the frequency of tropopause folding is rather constant over the year. Please, explain or rephrase! Do you refer to deep intrusions which would make sense?

(28) P. 34461, Lines 5-6: I think you do not exclude the difference! The impact is what matters.

(29) P. 34461, Line 13: Is 3 PVU correct or a misprint? (2 PVU?)

(30) P. 34661, Line 234: The variances of what? Please, more precisely!

(31) P. 34463, Line 2: “folds are frequent”: See (27)!

(32) P. 344564, Lines 4-5: “mixing”: See (20). See also Line 9.

(33) P. 34465, Line 9: What means “high”? Lower-tropospheric ozone peaks rarely exceed 80 ppb. Maybe “elevated” is more adequate.

(34) Table 1, Line 1: What is the accumulation time?

(35) Fig. 3: Specify units (altitude, potential temperature), also in other similar captions

(36) Fig. 5: “the last two days of travel”; “Horizontal component of the trajectories” (please, examine also elsewhere, e.g., Fig. 6)

(37) Fig,. 16, Line 2: “on 16 December” (see also following captions)

Figures:

(1) Fig. 1

Style

(1) P. 34441, Line 15: Change to “and, therefore, they”

(2) P. 34442, Line 3: “33 years of”?

(3) P. 34442, Line 5: Better “hot spots”.

(4) P. 34442, Line 23: “This study aims at answering”

(5) P. 34443, lines 1-2: “backward destination”?

(6) P. 34443, Line 7: Replace “substance” by “isotope”.

(7) P. 34443, Line 24: “is sufficient”

(8) P. 34446, Line 3 (and throughout paper, there a quite a few occurrences): Is is strange style to use the tilde for abbreviating “about”! There is no need for abbreviating. In addition, the tilde is the mathematical symbol for “proportional to” which would not make any sense here.

(9) P. 3447, Line 2: “aimed at understanding”

(10) P. 34447, Line 15: “00:00 on the following day”

(11) P. 34447, Line 21: I would use a comma ahead of “but” for more clearness, although this prescribed only if there is a second verb.

(12) P. 34447, Line 26: I suggest “considered to exhibit fast descent from ...”

(13) P. 34449, Line 17: Replace “areas” by “altitude ranges”.

(14) P. 34451, Line 20: “vary among”: Do you mean “range within”?

(15) P. 34452, Line 12: “descent by 6892 m within two days”. You should specify which days (e.g., “within the first two days”).

(16) P. 34453, Line 6: “to finally arrive” is a split infinitive, prohibited by the English grammar. Better “to arrive finally”. See also Line 22, P. 34460 (Line 19),

(17) P. 34453: Why not just “reach the surface”?

(18) P. 34454, Line 1: “Case studies”

(19) P. 34455, Line 9: ”afterwards”, “located on the rear side”

(20) P. 34455, Line 10: “18:00 UTC on 11 March”

(21) P. 34455, Line 25: “southern”

(22) P. 34457, Lines 23 and 25: Does “push” mean “hit”?

(23) P. 34458, Line 14: “12:00 UTC on 16 May 2011”

(24) P. 34459, Line 8: “pushes”: “hits”?

(25) P. 34459, Line 10: “By repeating this process”

(26) P. 34459, Line 12: “strong-subsidence”

(27) P. 34459, Line 26: “transport”

(28) P. 34460, Line 2: “northerly flow”?

(29) P. 34460, Line 20: Better “diminish” instead of “reduce”

(30) P. 34461, Line 22: “northerly wind”? I just know “the northerlies” or the “westerlies”.

(31) P. 3363, Line 14: “northerly flow”

(32) P. 34464, Line 1: “a diffluent wind field”?

(33) P. 34464: Line 4: Replace “push” by “hit”?