Response to anonymous Referee #1

We would like to thank Referee 1 for helpful review comments. The scientific terms used in the revised manuscript have been better defined to improve clarity. We now provide answers to general comments and then report on detailed comments by quoting the revised text.

■ *It is mostly well written, the English is generally ok, but not free of small errors (tenses etc.) and slightly awkward formulations, on which I won't always comment in detail since I believe that this is not the job of a reviewer (while professional companies charge a lot of money for it). This should be checked.*

None of our coauthors is a native-born English speaker, and we apologize for our awkward formulations. Following your comment, we did our best to improve the readability of our revised manuscript.

■ *The description of previous work could be a bit more elaborate.*

We did improve the description of earlier work done at Dome C and Vostok, Antarctica:

L81: "The surface of the ice sheet around Kohnen is characterized by the presence of large sastrugi, created by wind redistribution and sublimation of snow, hence producing considerable variability in the snow surface age, origin and density. In particular, very hard dunes sticking up above the mean surface level may be half a year old (Birnbaum et al., 2010). A previous study performed at Vostok station (Antarctica) reported a large variability in the isotopic composition of the snow surface (10 cm depth) over an 1 km transect, with a maximum variation of 30‰ in δD over 100 m (Ekaykin et al., 2002)."

L597: "The parameter H_t is therefore the mixing-layer height. Sodar measurements performed at Dome C (Antarctica) showed magnitudes between 10 m and 300 m (Pietroni et al., 2012; Casasanta et al., 2014)."

Line by Line comments

Major comments

■ *32: what is a meteorological time scale? Better use "synoptic" if that is what you mean. (e.g. diurnal variations are also meteorological)*

L40: "only few studies have examined the drivers of Antarctic precipitation isotopic composition variability at timescales associated with synoptic or diurnal events"

■ *45: to avoid any confusion, please define humidity mixing ratio*

L56: “humidity mixing ratio (defined as the mass of water vapor divided by the mass of dry air)”

■ *91ff: How do you define a precipitation event? It is not correct that precipitation occurs only in summer, and at Kohnen station, only about 20% of snowfall events is directly related to synoptic systems. (additionally, there is diamond dust precipitation, which is not so rare). I personally don’t like reviewers, who always want their own papers quoted, but, of course, everybody knows their own papers best and, unfortunately, I do not know any other paper that investigates Kohnen precipitation but Schlosser et al. (2010), which gives some more information about the topic.*

Snowfall and light snowfall events are defined in section 3.1.
L115: “The katabatic regime can be interrupted by the influence of synoptic systems, responsible for 20 % of snowfall events at Kohnen station (Schlosser et al., 2010).”

■ *108: You might consider quoting Birnbaum et al. 2011 here (she is one of your coauthors anyway).*

The description of the snow surface texture has been moved to the end of the introduction.
L84: “In particular, very hard dunes sticking up above the mean surface level may be half a year old (Birnbaum et al., 2010).”

■ *111/112: is that your own definition of snowfall and light snowfall? Does “light snowfall” correspond to diamond dust? (Be careful with terms that are already defined)*

L138: *“*A snowfall event leaves a visible accumulation on flat surfaces (for example transport boxes) whereas during a light snowfall event or a diamond dust event no visible accumulation is observed*.”*

■ *243: what is the approximate height of the lowest model level? How is the model 2m temperature calculated? This would help to explain the differences between model and observations.*

L285: “The lowest model level (about 60 m above the surface) has been selected followed […]”
L309: “Furthermore, at Kohnen Station, the 2 m temperature in ECHAM5-wiso is calculated from the surface energy balance equation, assuming a constant surface albedo of 0.8”

■ *256: see above*

L305: “However, the reader should notice that simulated parameters such as humidity or water vapor isotopes are extracted from the first vertical model level (which represents a height of 60 m above ground) whereas the in-situ observations are measured close to the surface.”

■ *271: daily mean values of what?*

L326: *“*29 daily mean values of q, T, d-excess and δD have been calculated for the observations and the model outputs.*”*

■ *294: you compare only to the simulated data, how about the measured meteorological data?*

The highly depleted isotopic values simulated by ECHAM5-wiso arise from a computing issue that is certainly not related to a real meteorological event. The description of this issue has been improved to avoid misunderstanding:

L364: “These depletion events do not correspond to any parallel signal in the simulated meteorological data (cloud cover, wind speed, temperature or humidity mixing ratio) and further analyses will be necessary to understand these artifacts.”

■ *352: is that coincidence then or do you have an explanation for it? You mention this several times, and it is not clear if it is just by chance or if it hints at the ability of the model to calculate this correctly. {305: see comment 352}*

L381: *“*This might be explained by a stronger dependency of deuterium excess variability to climate conditions during evaporation processes in the vapor source regions, while the δD signal is understood to be more directly controlled by climate conditions near or at Kohnen station.*”*

■ *407: condensation: strictly spoken, condensation is the transition from vapor to liquid, whereas the transition from vapor to solid is called “deposition” according to the Glossary of Meteorology of the AMS (American Meteorological Society). Sometimes the term re-sublimation is used, too. You should explain this at the first point where “condensation” occurs in the paper and then stick to one expression, whichever you prefer.*

This is a very good point, not properly addressed in the original manuscript.

L91: “The term “condensation” (rather than “deposition”) is preferred in this paper to describe the water phase change from vapor to solid in order to avoid a possible confusion with “post-depositional processes”.”

■ *452: wind advection? There is advection of warm/cold air or moisture, but not of wind. The wind is rather the cause of the advection.*

L577: *"*In reality, there is advection of air masses with different moisture or temperature into and out of the box.*"*

■ *468: please give a reference for the height of the polar boundary layer*

L597: "The parameter H_t is therefore the mixing-layer height. Sodar measurements performed at Dome C (Antarctica) showed magnitudes between 10 m and 300 m (Pietroni et al., 2012; Casasanta et al., 2014)."

■ *472: Do you mean negative and positive trends rather than decreasing and increasing (thus changing) trends?*

L605: *"*In the first case, the mixing between the condensate and the snow surface will tend toward the equilibrium through a positive trend; in the second case, a negative trend is predicted.*"*

■ *486: Why do you assume liquid water? Is this only a model assumption or do you have physical evidence for it? Maybe rephrase a bit.*

The paragraph describing the different hypotheses of fractionation occurring during sublimation has been rephrased:

L617: *"*It is generally assumed that no fractionation occurs during sublimation. Using Greenland data, Steen-Larsen et al. (2011) and Landais et al. (2012) showed that on average the snow surface isotopes and the water vapor isotopes are in equilibrium, and estimated that the value of the equilibrium factor lies between the fractionation coefficient α_{ice} with respect to ice (Merlivat and Nief, 1967; Ellehoj et al., 2013) and the fractionation coefficient α_{water} with respect to water (Majoube, 1971). In this study, we test different hypotheses to obtain a range of prediction of the isotopic variation in the vapor and the snow surface.*"*

■ *551: I suggest deleting "striking". If the results confirmed earlier results by St.-L. they were not too surprising. This does not lower their value, of course.*

The word "striking" has been removed.

L705: *"*As these variations in the surface snow isotopic composition follow the diurnal trend in the air, this result confirms the observations of Steen-Larsen et al. (2013) at NEEM*"*

■ *570ff: the fractionation takes place no matter if the wind causes erosion or not. Please, rephrase.*

The fractionation does indeed take place with or without wind erosion, however the wind drift could bring ice crystals coming from another source.

L726: "We do observe an increase in δD_s during the sublimation process, which indicates that water isotopes undergo fractionation during sublimation. The only doubt we could emit on this result is related to the wind drift. Effectively, the isotopic variability observed on the diurnal scale in a snow patch could also be attributed to the renewal of the snow surface by the wind, which mixes the surface of the snow with ice crystals coming from other snow patches."

■ *576: you write "partly". Are there other possible reasons for the small day-to-day variability?*

No other reasons were possible, the word "partly" has been removed.

■ *Fig. 6 - Fig. 9: I suggest removing the figure titles (in the boxes) for clarity, since the legends already take quite a bit of space, and the caption describes the contents anyway. Also inserting grid lines seems to be always helpful. The legend of Fig. 6 would be easier to read if the explanations of the different lines were placed simply to the right of the lines.*

The figure titles have been removed. In order to allow readability of the figures which already have a lot of material, and because the key message is not in the exact values but on the magnitude of variations, we have decided not to insert additional grid lines in Fig. 6-9.

Minor comments, all corrected

101: Shortwave radiation, which includes direct radiation and diffuse radiation → L126

122: "ratio" rather than relative composition → L153

136: explain SLAP and GISP → L167

162: relationship between d18O¸ dD and q → L196

222/224: snow accumulation or erosion (not depletion) → L256

258: hourly values → this paragraph has been removed

268: which have data gaps larger than 8h → 325

292: strong (or high) depletion → L361

308: "and" rather than "versus" → L385

336: the mean wind speed is… (delete "concerning the wind speed") → L421

413: Fig. 5: surface height anomaly → done

489: with the relative humidity RH... and the kinetic fractionation factor k... → L630

536: which is of the same order of magnitude as the observations → L681

564: This is likely.... → L719