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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characteristic nature of vertical motions observed in Arctic mixed-phase stratocumulus" *by* J. Sedlar and M. D. Shupe

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We appreciate Reviewer 2's positive response to the paper and insightful comments regarding the need for uncertainties in the methods used in this study. We have made changes to the text to account for retrieval uncertainty and how they may or may not affect the general results of the paper.

Response to the comments of Reviewer 2:

Regarding figure details: We appreciate the difficulties in interpreting the figures as they were, considering the amount of detail described in Figs. 7, 9, 10, 11 (see also similar concerns of Reviewer 1). We have increased the readability of the wavelet figures by focussing on the relevant timescales 2-240 min, as suggested, as well as

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increasing the font sizes of the labels in each of these figures.

Page 7 line 14: The reviewer raises a valid point in potential complications of using cloud droplets as tracers of vertical air motions. We have discussed in the text that the absolute magnitudes of w derived from this method are uncertain due to the uncertainties, and general small absolute magnitudes of w, of retrieving vertical velocity from radar. As Shupe et al. (2008b) note, the uncertainties in w-retrievals as a function of radar-volume turbulence and horizontal wind speed are second order relative to the mean (positive) bias observed within these estimates. We argue that since we focus on the statistical and spectral characteristics of the vertical motions using FFT transforms in the form of wavelets and power-spectra, the correction for such uncertainties does not impact the timescales of variances or the vertical distribution of w-skewness. Section 2.2 discusses that analyzing the variance, skewness and spectral timescales of w-variance using both a corrected (for mean bias) and uncorrected w-estimate did not affect the results of this study.

Page 11 line 25: We have accounted for this overstatement by toning down the text to read that the median Sw profile shape generally changes from negative to positive with an interface near zn = 0.6-0.7, despite substantial spread in the distributions of Sw.

Page 12 line 1: We have revised the text to emphasize that it is the median Sw profiles that are shown to change sign with height in the cloud layer.

Page 12 line 1: We have removed the notches and discussion around them. We now include the that the non-parametric Wilcoxon Rank sum significance test shows a rejection of the null hypothesis of distributions with equal medians at different heights within the cloud layer.

Page 12 line 21: Delta theta profiles are estimated by taking the difference in theta between adjacent levels both the scanning radiometer and radiosounding native vertical profile resolutions. To combine the full week period statistics we need to normalize the depth of the sub cloud and cloud layers by the boundaries between near surface (first

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profile height above surface) with cloud base and cloud top. We then combine all delta theta estimates by combining normalized heights into ten bins; the number of observations in each bin will vary depending upon the depth of each layer at the respective scanning radiometer time (10 min) and for 5 min following each radiosonde release. We have included this information on the method in Section 3.3.

Performing the analysis with inclusion of the lower temporal frequency radiosonde delta thetas further supports the general stability changes observed with the higher frequency scanning radiometer. We do note now in the text the uncertainties in temperature retrieval from the scanning radiometer, which are stated to have a bias less than -0.2 degrees C. Thus the median distributions of delta theta observed are within the uncertainty and we can no longer state there are significant differences in the median values when comparing different heights in the layers. However, the generally changing stability profile with height in both the sub-cloud and cloud layers in both the radiosonde and scanning radiometer profiles suggests these transitions in stability are robust - confirmed by tests of the null hypothesis of equal medians at two heights where changing stabilities are observed (zn = 0.2 and zn = 0.8) using the Wilcoxon Rank Sum significance test.

Page 13 line 7: We have removed artificial adjectives such as “drastically” from the text as suggested by the reviewer.

Page 13 line 17: This text is no longer included in the revised manuscript.

Page 20 line 4: We thank the reviewer for pointing out this shortcoming. The text has been revised with reference to earlier work addressing the phenomenon of radiative shielding.

Technical corrections: These have been revised following the reviewer’s suggestions.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 31079, 2013.