Purpose of each paragraph in the submit-sample[‡]

Introduction

1. Present methods that use isotopic content to estimate crystal formation temperatures may be inaccurate.
2. Surface processes on ice may influence temperature reconstructions of ice in currently unknown ways.
3. This paper shows that the effect of surface fractionation may be large.

2.1

4. Surface processes affect ice crystal growth and thus may affect fractionation.

2.2

5. Quantify and describe the net flux of water species into vapor-grown ice.
6. Quantify and describe how growth impedance reduces the supersaturation and hinders growth.
7. Describe physically the two bulk impedances.
8. Describe physically the surface impedance.

3

9. Define the fractionation coefficient and derive its dependence on the impedances.
10. The coefficient agrees with previous results and shows the importance of gas speeds and deposition coefficients.
11. Physically link the various processes that cause fractionation. Emphasize *x*.

[‡] See the sample manuscript at http://www.redmondphysicalsciences.com/submitsample.pdf

12. Absolute values of the deposition coefficients also affect fractionation, but these must be calculated numerically.
13. Fractionation depends on the impedance ratios *z* and *x*.
14. When *z* exceeds unity and *x* differs by 5% from the diffusion constant ratio (*d'*), the fractionation significantly differs from previous theory (Fig. 2).
15. When *x* differs from *d'* by more than 5%, the same result occurs even when *z* doesn't exceed unity.

4.1

16. A cylindrical crystal better fits real crystals and adds two features.
17. Each face has its own fractionation coefficient and impedances, with formulas given elsewhere.
18. To calculate the surface impedance, we use the value at the corner because it controls the rate of growth.
19. The net fractionation is a weighted average of the fractionation to each face.
20. Crystal shape can lower or raise fractionation at high *z*.
21. As with the sphere case, when *z* is large, small changes to *x* greatly affect fractionation.

4.2

22. Non-facet regions also contribute to fractionation (show equation).
23. On stellar-type crystals, about 80% of the mass uptake is through non-facet regions.
24. For hollow crystals, up to about 60% of the mass uptake is through the non-facet (hollow) regions.

Discussion

25. In many regions, the crystals are largely non-facetted, but polar regions have largely facetted crystals.
26. The inferred temperature from isotopic records could be up to about 15 ºC off.
27. New experiments are needed to evaluate the surface fractionation effect.
28. With knowledge of the fractionation relations for both HDO and $H_2{}^{18}O$, one could infer the deposition temperature and supersaturation of an ice sample.

Conclusions

29. Surface kinetic fractionation may significantly affect isotope fractionation, but new experiments are needed.

Appendix A

30. Describe the vapor impedance.

Appendix B

31. The deposition coefficient ratio may reasonably range between 0.8 and 1.2.

Appendix C

32. Describe an empirical relation for the deposition coefficient for a spherical crystal as a function of crystal size and external conditions.