Supplemental material to paper “Impacts of the phase shift between incident radar waves on the polarization variables from ice cloud particles” by V. Melnikov

Fig. S1. (a, b, c): $Z_{DR}$ as a function of the angles $\theta$ and $\varphi$ at (a) $\psi_i = 0^\circ$, (b) $\psi_i = 45^\circ$, and (c) $\psi_i = 90^\circ$ for thin ice plates. (d, e, f): As in (a, b, and c), but for ice needles. The parameters at the tops show the maximal values of $Z_{DR}$ and $\delta$ and angles at which these maximums are attained.
Fig. S2. Vertical cross sections of $Z_{\text{DR}}$ and $\Phi_{\text{DP}}$ collected with X-band radar at Norman, OK on 15 July 2017 at 2355 UTC at an azimuth of 64.6°. Note positive $Z_{\text{DR}}$ area at the cloud top at distances around 60 km and a drop in $\Phi_{\text{DP}}$ in that area.

Fig. S3. As in Fig. S2, but for reflectivity and correlation coefficient.
Radar data below have been collected with S-band WSR-88D KOUN located at Norman, OK, USA.

Fig. S4. Vertical cross section of $Z$, $Z_{DR}$, $\Phi_{DP}$, and $\rho_{hv}$ collected with KOUN on 1 August 2007 at 2112 UTC at an azimuth of 249°. High $Z_{DR}$ values at heights up to 2 km and distances up to 50 km are due to scattering from insects.
Fig. S5. Same layout as in Fig. S4, but collected on 6 Feb. 2006 at 0228 UTC at an azimuth of 241°.

Fig. S6. Same layout as in Fig S4, but collected on 17 June 2015 at 2236 UTC at an azimuth of 40°.
Fig. S7. Same layout as in Fig S4, but collected on 13 March 2015 at 1618 UTC at an azimuth of 180°.
Low $Z_{DR}$ and $\rho_{HV}$ close to the ground are caused by leftovers of ground clutter contaminations.
Fig. S9. Same layout as in Fig S4, but collected on March 26, 2014 at 1556 UTC at an azimuth of 230°.
Fig. S10. Same layout as in Fig. S4, but observed on June 17, 2015 at 2219 UTC at an azimuth of 180°.
Fig. S11. Vertical cross section collected on Oct. 24, 2019 at 2234 UTC at an azimuth of 60°. V_h and W_h are the Doppler velocity and spectrum width at horizontal polarization.
Fig. S12. The $\rho_{hv}$ and $\delta$ values from ice spheroids with the axis ratio of 0.6 as functions of the incident differential phase at the indicated flutter intensity. The legend in the left panel is applicable for the right panel. $Z_{DR}$ does not depend on $\psi_i$, but depends on $\sigma_0$. The corresponding $Z_{DR}$ values are shown in the right panel.

Fig. S13. Ice particle (yellow) with a water drop (blue) at its bottom. In two right panels, half of the outer surface of water drop is shown for better viewing of the relative sizes of particle’s ice and water parts.
Fig. S14. A sketch of an aggregate as a collection of ice needles (yellow) with a water droplet (blue) inside the collection. The diameter of the water droplet is 1 mm, the size of the whole model particle is 2.5 mm.

Fig. S15. A sketch of a dendrite (yellow) with a droplet (blue) on one of its branch. The plane OXY is horizontal. OZ is vertical. The wet particle is not symmetrical and its equilibrium canting angle is not zero.