

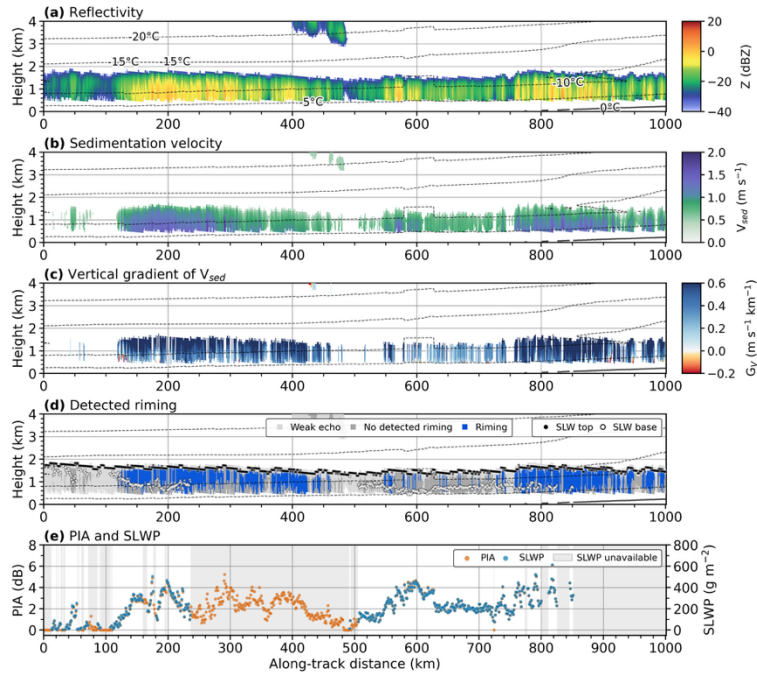


Figure S1: Additional example of a low-level mixed-phase cloud (LLMPC) observed by EarthCARE over the Southern Ocean on 19 January 2025 (Orbit/Frame ID: 03666G, H). Panels (a)–(d) show reflectivity (Z), sedimentation velocity (V_{SED}), the vertical gradient of sedimentation velocity (G_V), and the detected riming (blue areas), respectively. Filled and open circles in panel (d) indicate the ATLID-detected SLW top and the estimated SLW base. Panel (e) shows path-integrated attenuation (PIA; orange dots) and the corresponding supercooled liquid water path (SLWP; teal dots) where available. Gray shading in panel (e) marks regions where an SLWP estimate is unavailable.

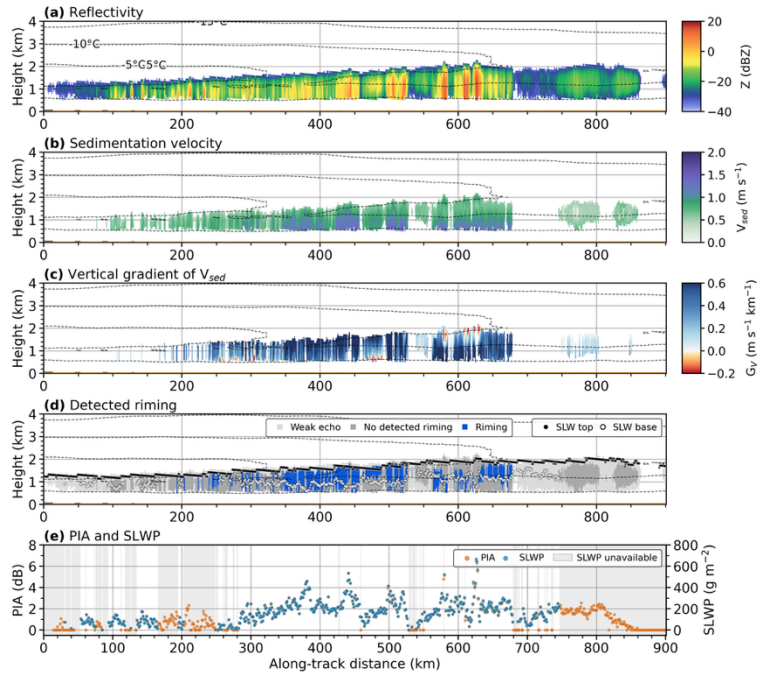


Figure S2: Same as Fig. S1, but over the Southern Ocean on 10 February 2025 (Orbit/Frame ID: 04001H).

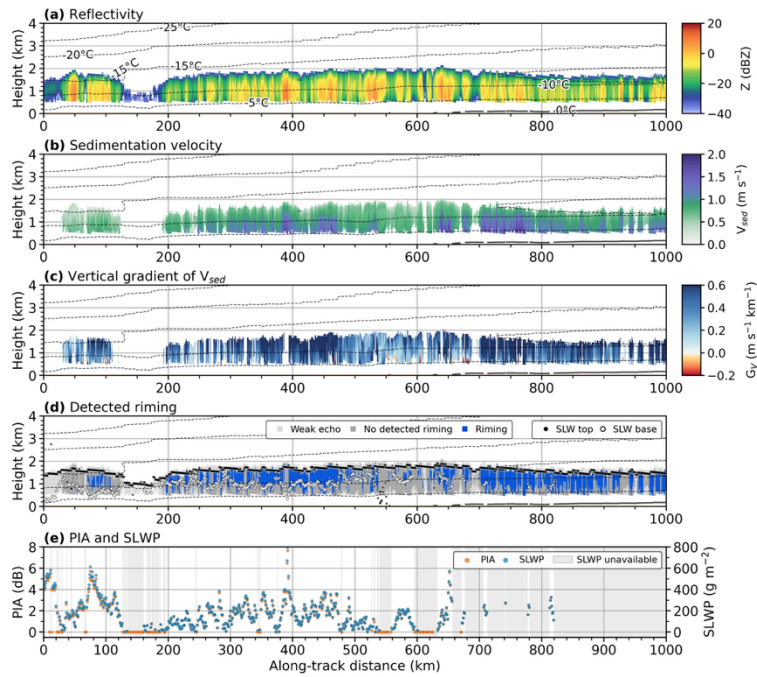


Figure S3: Same as Fig. S1, but over the Southern Ocean on 9 March 2025 (Orbit/Frame ID: 04425G, H).

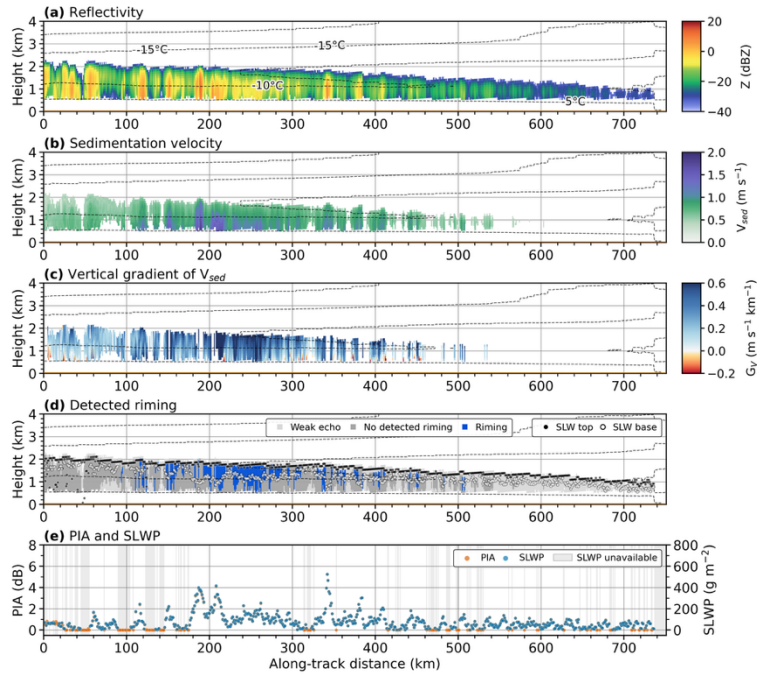


Figure S4: Same as Fig. S1, but over the Southern Ocean on 19 March 2025 (Orbit/Frame ID: 04583F).

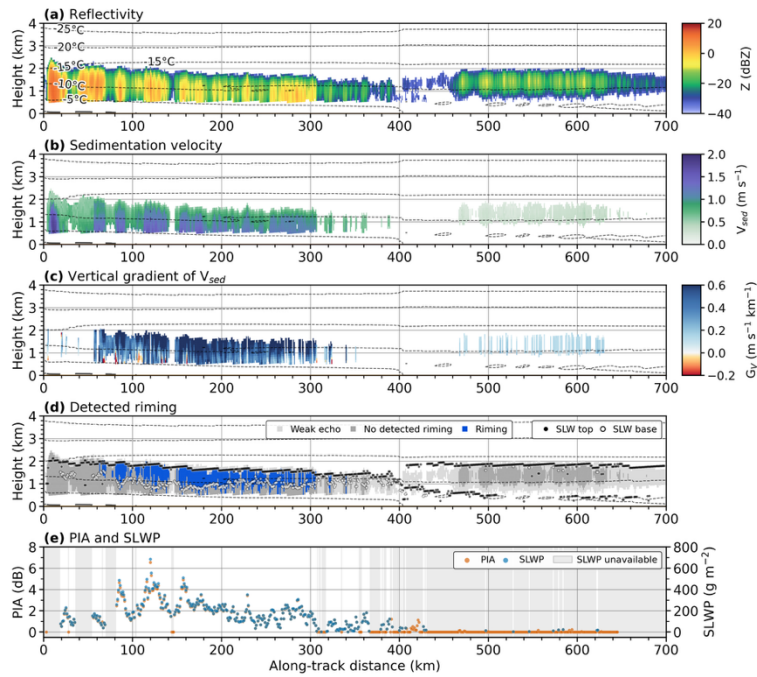


Figure S5: Same as Fig. S1, but over the Southern Ocean on 15 May 2025 (Orbit/Frame ID: 05474F, G).

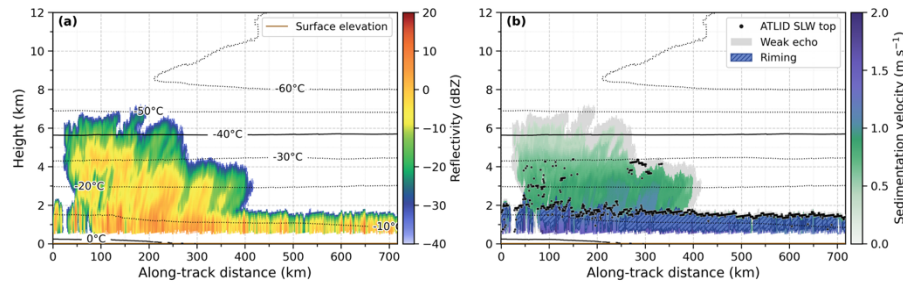


Figure S6: Example of a cloud scene observed by EarthCARE over the Southern Ocean on 16 July 2025 (Orbit/Frame ID: 06435F). Reflectivity is shown in panel (a), and sedimentation velocity in panel (b), with detected riming (blue hatched areas). Black dots indicate the ATLID-detected supercooled liquid water (SLW) top.

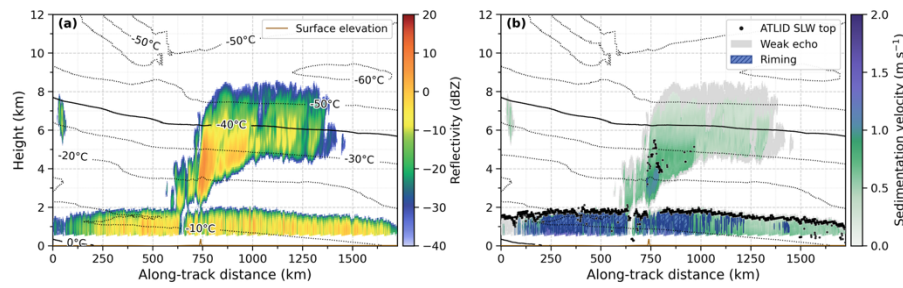


Figure S7: Same as Fig. S6, but over the northwest Pacific on 15 March 2025 (Orbit/Frame ID: 04523B).

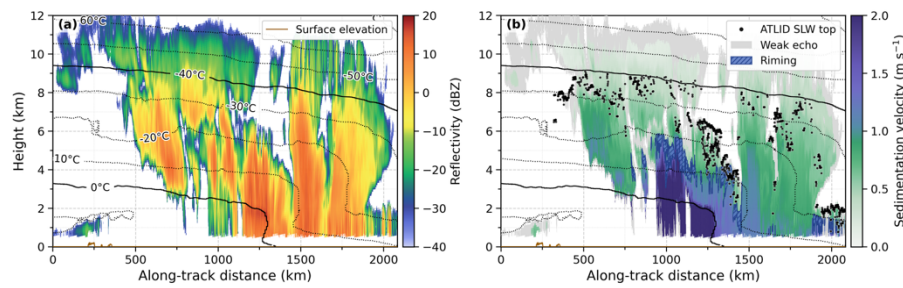


Figure S8: Same as Fig. S6, but over the northwest Atlantic on 20 December 2025 (Orbit/Frame ID: 08873B).

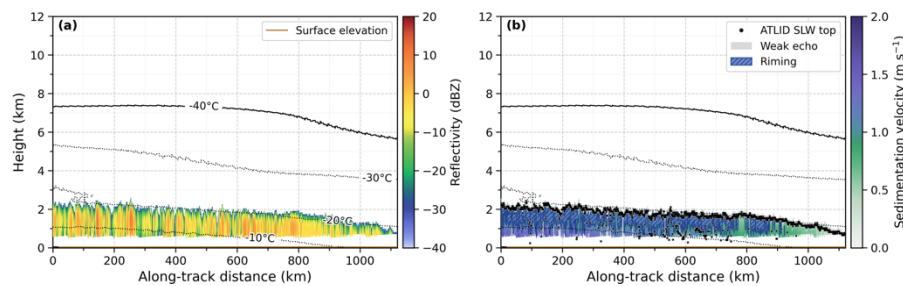


Figure S9: Same as Fig. S6, but over the Norwegian Sea on 9 April 2025 (Orbit/Frame ID: 04902C).

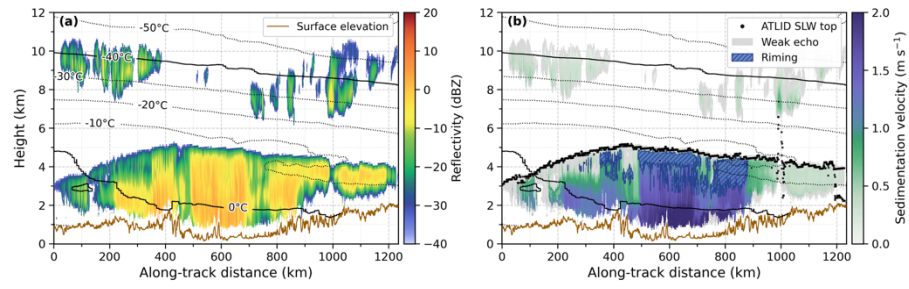


Figure S10: Same as Fig. S6, but over the Sichuan Basin and its surrounding area in China on 6 January 2025 (Orbit/Frame ID: 03467B).