**Supplementary information**

**Video captions**

**Video 1**

Time lapse video of traditional Schlieren imaging of ice growth from a 35ppt NaCl solution. The forcing temperature at the top of cell is ‑20°C, the starting temperature of the water is ‑1°C, the time shown in the video corresponds to the time after cooling began. Brine fingers are visible emerging from the top of the field of view, as thin regions which show up as brighter and darker areas on the grey background. After a short time, the fingers are joined by longer streamers. The growth of ice can be seen as the dark region which advances from the top of the field of view. The number of streamers decreases as the ice layer grows. The fingers and streamers appear earlier at the left hand side of the image, and do not sink uniformly, but seem to drift sideways. We suggest that the uneven appearance and the drift of these features may be due to temperature driven convection, caused by an uneven distribution of temperature in the cooling lid. Some crystal structure can be seen at the ice-water interface, demonstrating that the interface is not flat. However, internal structure in the ice is not visible.

**Video 2**

Time lapse video of adapted traditional Schlieren imaging of ice growth from a 35ppt NaCl solution. The forcing temperature at the top of cell is ‑20°C, the starting temperature of the water is ‑1°C, the time shown in the video corresponds to the time after cooling began. Extra lighting allows brine channel structures to be seen in the overlying ice layer, as well as streamers in the water layer. Strongly defined streamers emerge from channel structures into the water layer, these streamers can be seen to change over time, some stopping and restarting occurs. Movement can be seen to happen within the ice layer, channels meander within the ice, and also migrate laterally through the ice layer on a slower timescale. Channels are mostly vertical, but there is a period of time where the central right channel is oriented at an angle of ~45° from the vertical. Less well defined fingers are also entering the water layer from the ice between the drainage channels. We identify these smaller fingers as interfacial convection driven by salt segregation, and they are present throughout the ice growth (see discussion in main text). This experiment is a continuation of the experiment as in Video 1; first image taken approximately 1 hour after the end of Video 1. A horizontal line can be seen in the ice layer, due to a pause in ice growth as the ambient temperature in the environmental chamber increased during refocussing of the optical system between Video 1 and 2.

Some images were lost at time = 5h50min (black images) and the secondary light source weakened during the course of the experiment, causing a gradual darkening of the ice layer, eventually failing after ~16 hours of cooling, so no further information on the position of channels within the ice can be determined. Condensation can be seen on the exterior of the cell at the beginning of the video, and also at time = 14h51min, due to increases in ambient temperature.

**Video 3**

Evolution of the shape and position of one brine channel imaged by direct imaging. The forcing temperature at the top of cell is ‑20°C, the starting temperature of the water is ‑1°C, the time shown in the video corresponds to the time after cooling began. The mobile behaviour of the channel can be seen as it moves around a fairly fixed position. The exit point for brine migrates over time, but on a slower timescale than the meandering movement. Parallel ice lamellae visible at the right hand side of the field of view are replaced by irregular recrystallization when the brine channel passes through them. Merging of two channels can be seen in the left hand side of the field of view, and the movement ceases as the channel freezes after time = 16h.