Cloud microphysical process in single-layer arctic stratus during MPACE

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1 Arctic boundary single-layer stratus

FIG 1 Backscatter intensity and depolarization ratio measured by Wisconsin HSRL Lidar in Barrow, AK. During MPACE, single-layer arctic stratus was observed from Oct 09 2004 to Oct 12 2004.

2 Vertical cloud structure

FIG 2 Example of selected HVPS (left), 2DC (middle) and CPI (right) images acquired for spiral flown between 2140 and 2147 on 10 October 2004 through a single-layer stratus. Smaller spherical images near cloud top (CPI) are small drizzle or supercooled drops. Larger ice crystal images show dominance of irregular and rimed crystal shapes throughout cloud and precipitating beneath cloud base.

3 Cloud microphysical process

3a Condensational growth of water droplets

FIG 5 Vertical variation of r_w (effective radius of water droplets) and r_i (effective radius of ice crystals). Increase of r_w with height in cloud is seen whereas r_i is less correlated with z_c.

3b Ice enhancement

FIG 6 Vertical variation of N_w (number concentration of water droplets) and N_i (number concentration of ice crystals with D>53 μm). On average, N_i changed by only 8% between z_c of 0.1 and 0.8.

The increase of r_w with z_c and relatively constant N_w with z_c suggest condensational growth of water droplets and additional nucleation did not take place inside the cloud.

3c Ice particle growth

FIG 7 Vertical variation of IN (number concentration of ice nucleus) and N_i. N_i is 10 times bigger than IN, suggesting secondary ice crystal production processes are occurring.

FIG 8 number concentration of large ice crystals (D>1mm) versus N_i. N_i tends to increase with number concentration of large ice crystals and small ice crystals are positively correlated.

4 Conclusions

- Effective radius of water drops (r_w) increases with z_c while total number of water drops (N_w) is not strongly correlated with z_c. This indicates condensational growth of water droplets.
- N_i concentrations too large to be explained by primary nucleation mechanisms. N_i tends to increase with number concentration of ice crystals with D>1mm while it doesn’t show strong dependence on N_i.
- Ice crystals tends to be bigger with decreasing height while having the same area ratio.

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