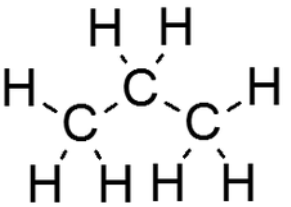
Dispersal of Cloud Seeding Agents

Release of Cooling Agents: Dry Ice

- Dry ice is almost exclusively an airborne release substance.
  - Put in hoppers on the aircraft and dispensed in pellet form.
  - Pellets fall from the aircraft through the cloud, so the aircraft must get to altitudes higher than the desired point of nucleation.
  - There are some problems with keeping the dry ice in small pellet form.

Cooling Agents: Liquid Propane



- Main use is in ground releases for fog abatement.
- Obvious drawback is that it is flammable.
- Technically feasible to release from the air.

$$C_3H_8 + 5\,O_2 \longrightarrow 3\,CO_2 + 4\,H_2O + \text{heat}$$

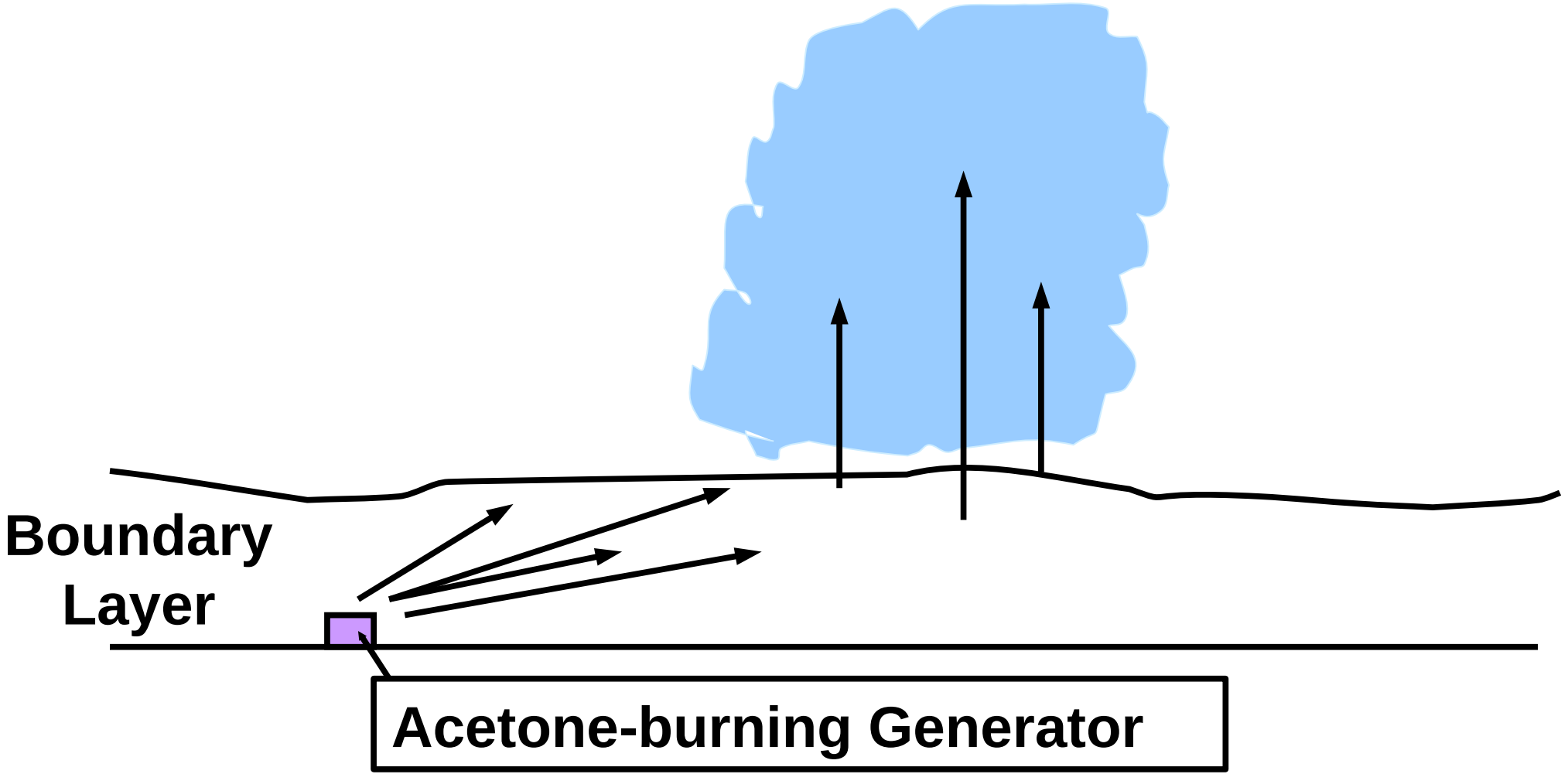
Release of Ice Nuclei into the Atmosphere

- Released from ground or air since ice nuclei is normally produced as smoke.
- Primary advantage of ground release is considerably less expensive.
- Primary advantage of airborne release is the certainty of targeting.

Ground Release of Silver Iodine (AgI)

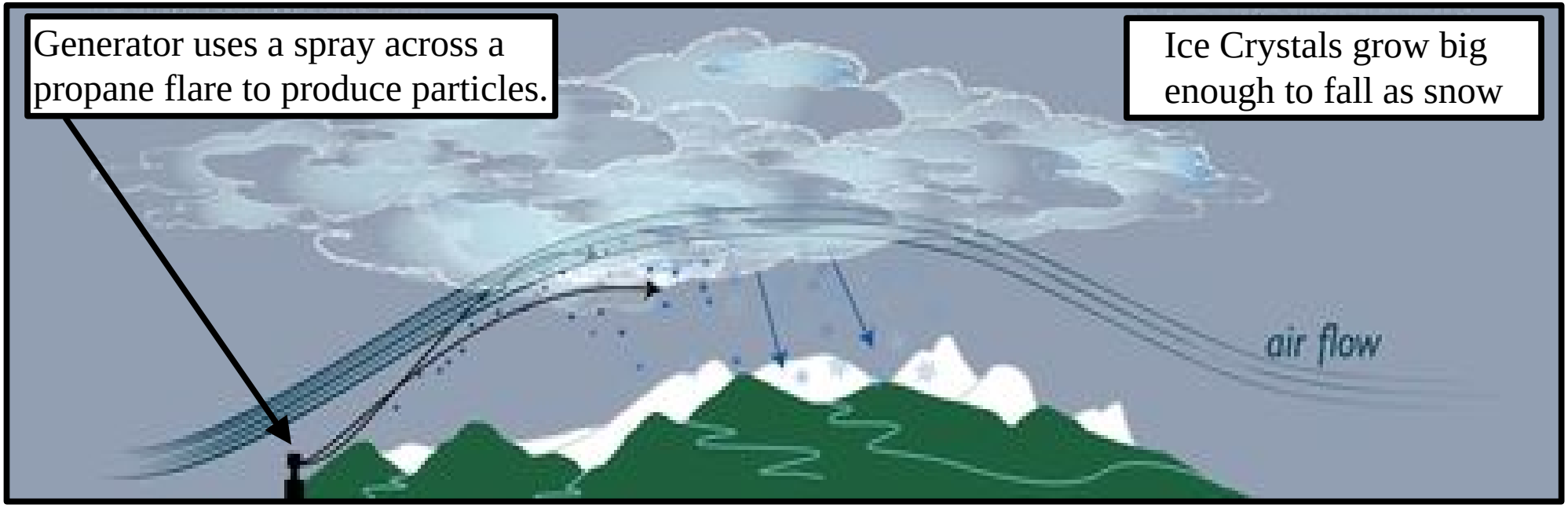
- Can be released from ground or from air, since it is normally put out as a smoke.
- Primary advantage of ground release is that it is considerably less expensive.
- Primary advantage of airborne release is that the targeting is much more certain.

Overview of Ground Release of AgI



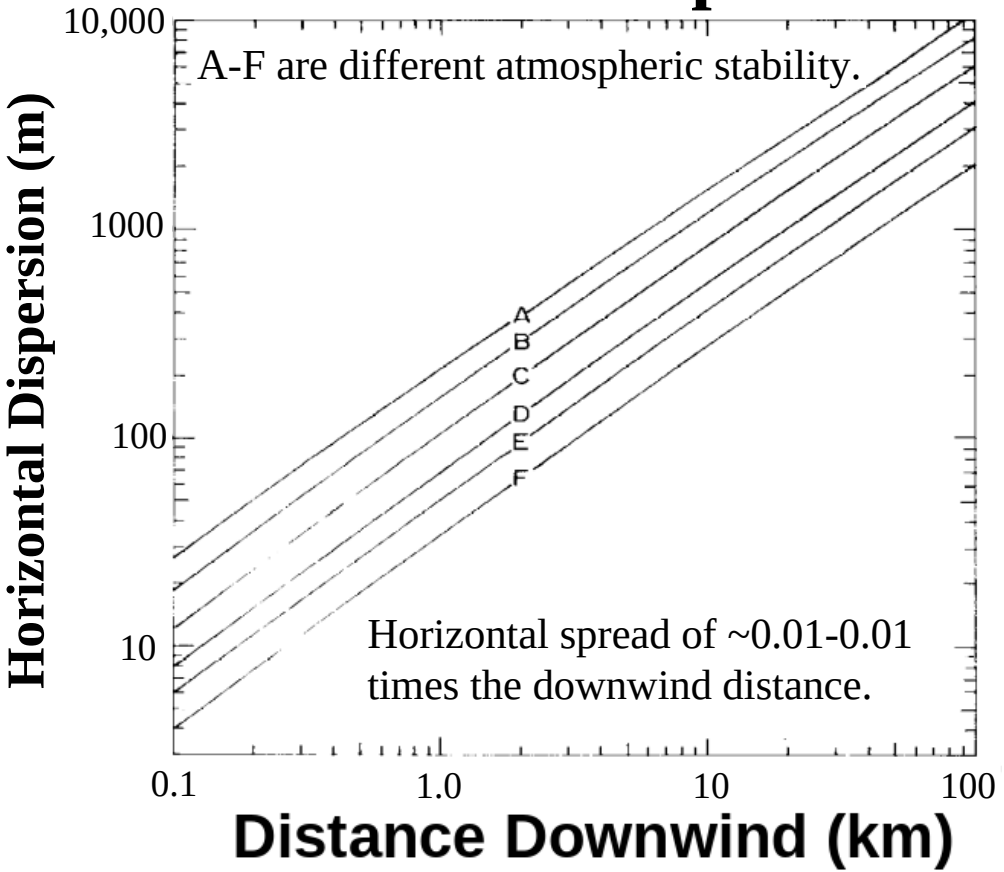
Ground Release of Silver Iodine (AgI)

- Ground releases of Silver Iodine is very common in winter, orographic cloud seeding.
- Delivery is done by wind carry Silver Iodine particles up the mountain slopes into the orographically induced cloud.

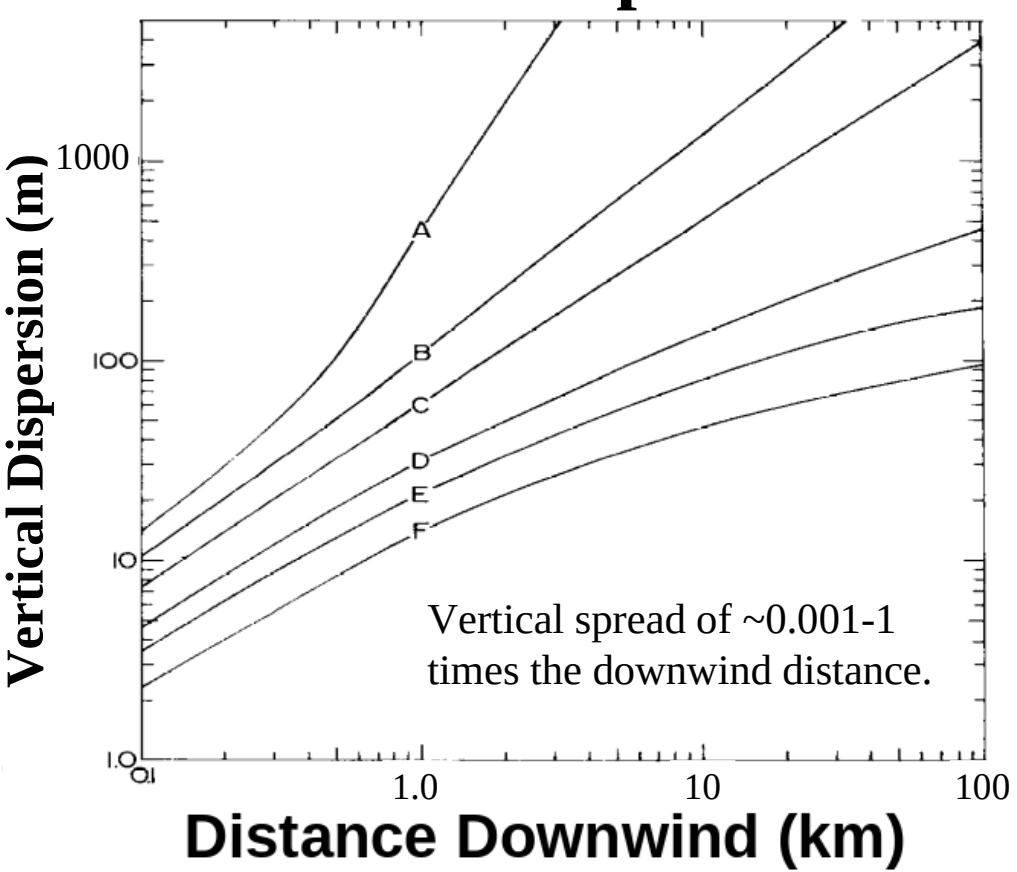


Spread of Cloud Seeding Plume

Horizontal Spread



Vertical Spread

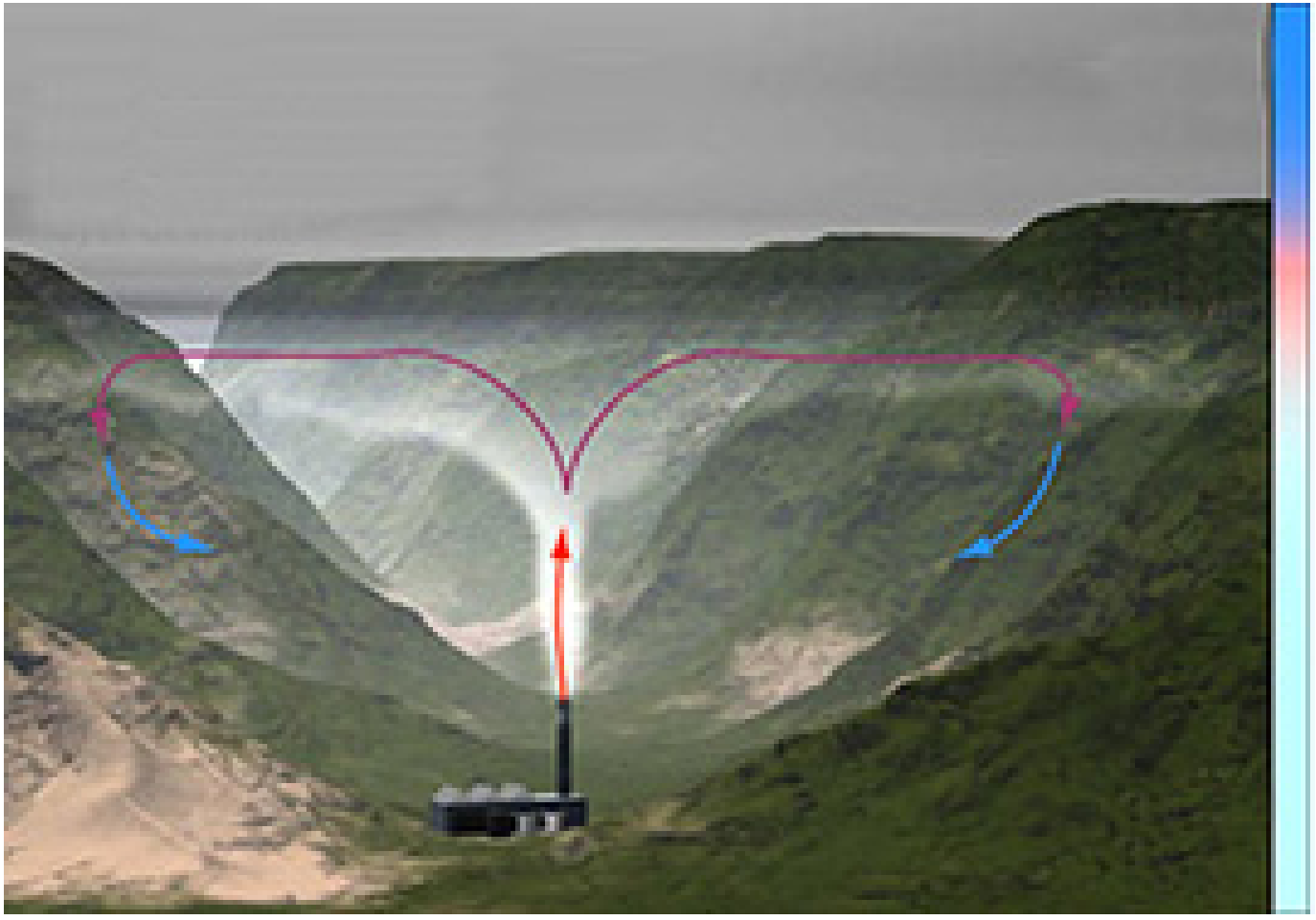


D. B. Turner (1969) Workbook of Atmospheric Dispersion Estimates, Report 78-22, 84 pp. National Air Pollution Control Administration, Cincinnati

Problems with Ground Releases

- Photodeactivation
- Uncertainty in trajectory of AgI with respect to the desired target area.
- In mountains, the generators are often placed below the typical inversion levels.

Temperature Inversion Level



Cold Air

Warm Air

Cool Air

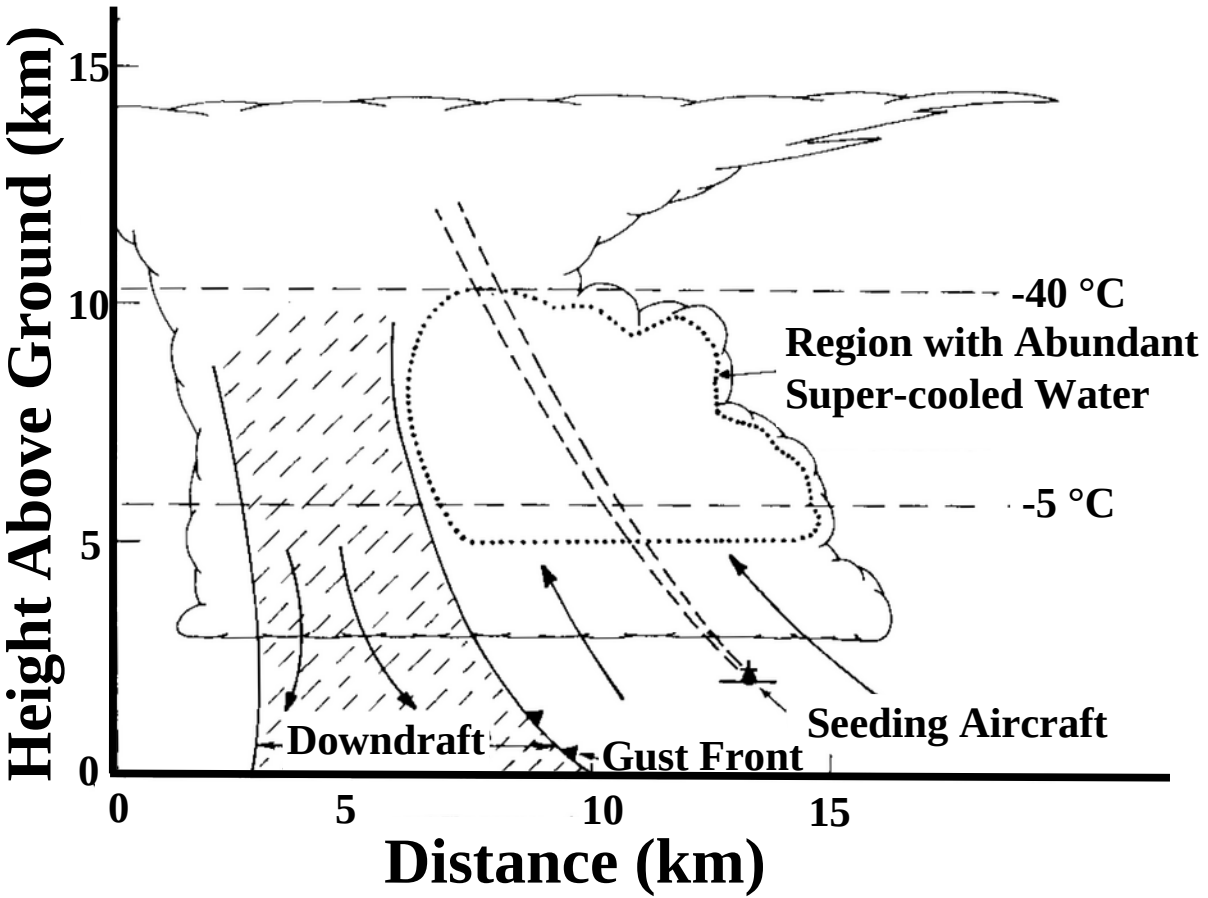
Airborne Research of Sliver Iodine (AgI)

- Wing tip or under wing acetone-burning generators.
- Burn-in-place flares.
- Ejectable pyrotechnics.

Cloud Base Releases of Silver Iodine (AgI)

- Using acetone-burning generators or burn-in-place flares, aircraft is below the level where AgI is desired.
- Updrafts carry the material up further in the cloud.
- The aircraft will often circle at cloud base with either of these generating systems.

Clouds Base affect ~1-2 % of the Updraft Passing upward through the -5 °C level



Ejectable Pyrotechnics

- When using ejectable pyrotechnics, the aircraft flies above the desired level and lets the burning flare fall through the cloud.
- Produces a curtain of seeding material not a line.
- Dropping dry ice has the same effect.