

# Varunyantra to tap Skywater: A Bhagirath effort

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By

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# What is Skywater ?

- Atmospheric evaporation and precipitation
  - Oceans                                      87%                                      80 %
  - Land areas.                                      13%                                      20 %
- This difference between the imports and exports of moisture by land amounting to 44,800 km<sup>3</sup> per year is by means of the transfer of atmospheric moisture from the oceans to the land.
- This unique natural process increases the availability of water on land.
- As 44,800 Km<sup>3</sup> of water circulates annually round the hydrological cycle, it can provide almost hundred times our present rate of supply.
- Skywater is the water in form of water vapor and droplets floating in the atmosphere in form of clouds
- Although there is enough water in the world, it is rarely in the right place at the right time in the right quantity and quality.

# Skywater tapping - A need of the hour

- Water Scarcity – A National Crisis
- India – Monsoon Based Economy
- Vagaries of Monsoon – Annual Feature
- Severe droughts in large but different parts of India a Recurring Annual Feature
- Conventional thinking about water resources
  - Ground water – Dams, bunds etc
  - Underground water – Wells, tubewells etc
- Enlightened scientists, bureaucrats, industrialists and statesmen in about 50 countries are frequently using cloud seeding operations for over 40 years

# Tapping skywater

## A personal experience

- Partnership Farming Project in village Sujlegaon, Nanded
- No rains until 10<sup>th</sup> August 2009
- Discovered artificial rain-making solution through Internet and Prof Shivaji Rao and his book “Cloud seeding for India”.
- Necessity is the Mother of Invention
- Inspiration from James P. Espy’ suggestion in 1839 to burn large blocks of wood
- In desperation, made a bonfire on 19<sup>th</sup> August 2009 in Sujlegaon and vaporized salt by sprinkled salt on flames.
- And it rained for 2 hours and saved the crops

# Some more experimental results !

- Succession of results on 19<sup>th</sup>, 20<sup>th</sup>, 21<sup>st</sup> August 2009 in Sujlegaon, Navandi and Rudrur (Nizamabad) on firewood
- First Lavan Vajra on burning tire in Sujlegaon on August 24, 2009 in morning, noon, evening
- Excellent weather conditions
- Overcast sky
- Dark low-lying clouds
- Very little wind
- High humidity
- Gave 5~10 mm of heavy rain

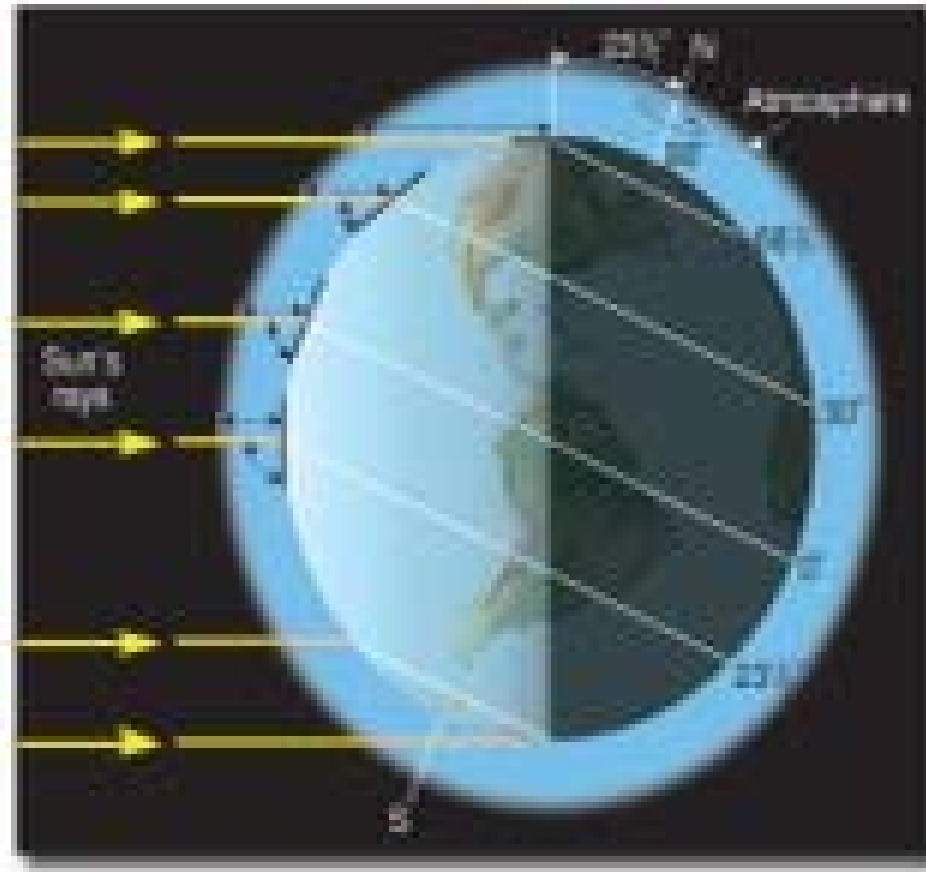


# Birth of Varun Yantra

- Yantra in Sanskrit means machine, Varun was the name of Rig-vedic god of rain
- Varun Yantra is the process of the vaporization of common salt on any kind of fire



# The Earth's Heating



# Warm and Cold Clouds

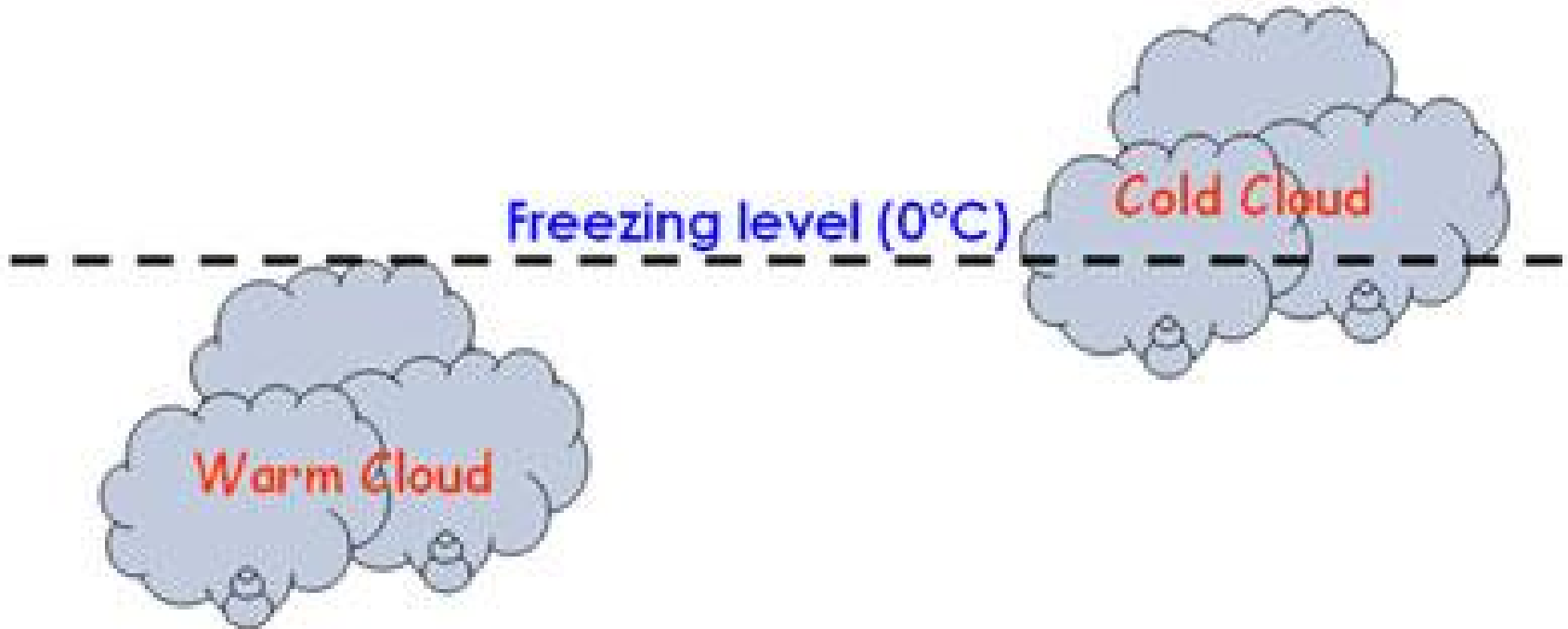


Fig. Schematic diagram of warm and cold clouds


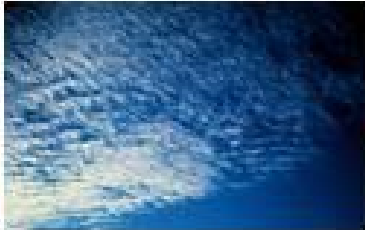
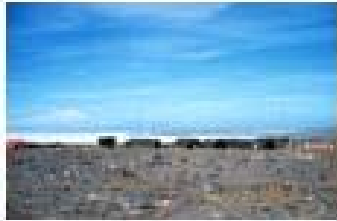


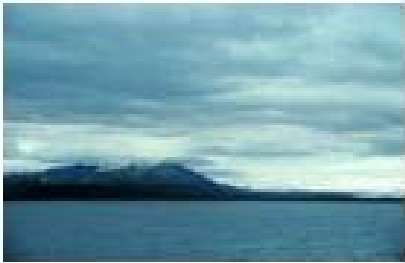





# Rainfall Process

- Water vapor + Dust Particle ( < 1 micron )
- Cloud Droplets ( ~ 10 microns )
- Water Drop (1 to 2 mm) / Ice Crystal ( few cm in diameter )
- Rain / Hail

# Coalescence and Collision

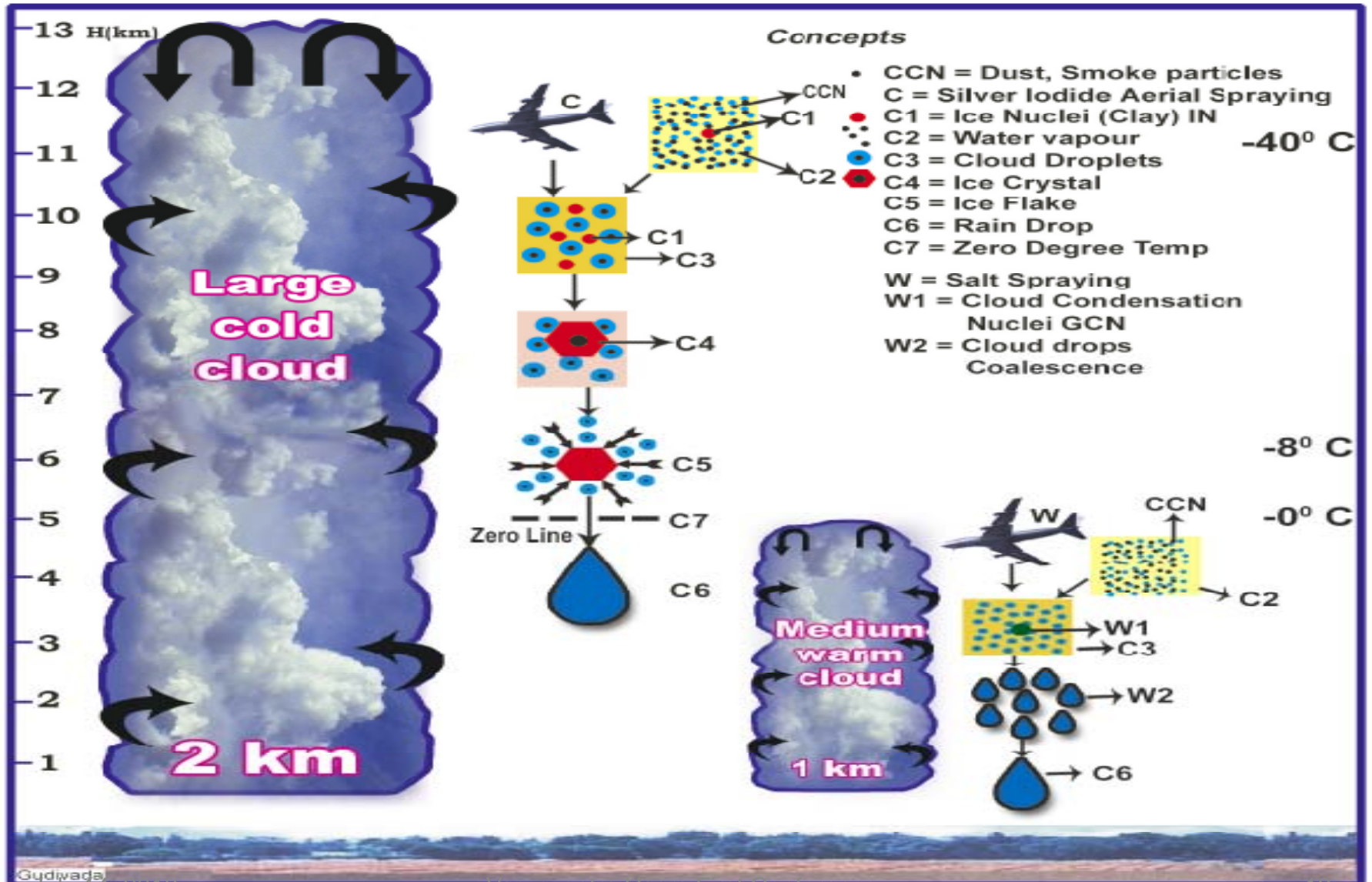
1. Some liquid cloud drops are bigger than others, hence, they will fall at a faster rate.
2. This differential rate of descent results in collisions between liquid cloud drops .
3. If conditions are favorable (electrical factors), the two drops will stick together ("coalesce") and a new, bigger drop results.
4. Collisions continue. If the drop becomes big enough, it falls out of the cloud as rain.

	<b>cirrus</b>	<b>cirrocumulus</b>	<b>cirrostratus</b>	<b>Cumulonimbus</b>
<b>HIGH</b>				
<b>Above 20000 ft</b>	<b>altocumulus</b>	<b>altostratus</b>		
<b>MIDDLE</b>				
<b>6500 – 20000 ft</b>	<b>Cumulus (fair weather)</b>	<b>Cumulus (with development)</b>	<b>Stratus</b>	
<b>LOW</b>				
<b>0 – 6000ft</b>				

# Cloud Seeding –A way to tap Skywater

- Cloud seeding aids natural processes of rain-formation and acts as a catalyst
- By adding cloud condensation nuclei to clouds
- Hygroscopic salts such as Mg / Ca /Na Chloride work for warm clouds and AgI for cold clouds
- Conventionally done with delivery by means of specially equipped aircraft

# Warm Cloud and Cold Cloud Seeding Processes



# Why is cloud seeding required at all?

## One: Extensive Deforestation

- Nature provide Cloud Condensation Nuclei by vaporized Salt (from the sea), Particles from dead matter from trees, or agricultural waste, dead insects that have salt
- Extensive deforestation in rural areas.
- Sujlegaon has 410 households, each needing about 8 quintals of firewood, equivalent of 2 trees per year i.e. about 810 trees a year, in the past 10 years 8,000 trees felled + say 2000 for consumption makes it 10,000 trees in one village in 10 years
- Naigaon tahsil of 500 sq km has 100 villages making it 10 lak trees in 10 years
- Resulting in low humidity, less supply of CCN

# Why is cloud seeding required at all?

## Two: Pollution

- 10 years back Sujlegaon had no vehicles except 2 tractors.
- Now there are 8 jeeps, 9 three-wheelers, 7 tractors + harvestors and bull-dozers are frequently used
- Fragmentation of water-droplets
- Increase in ground temperature thus pushing clouds up

# Cost of NOT timely tapping skywater

## Agriculture Loss Analysis

- ▶ Village Sujlegaon has 1000 acres of Soyabean cultivation in 2009 kharif seas, let us take a low yield of 6 quintals per acre and a price of Rs 2500 per quintal. This implies  $1,000 \times 6 \times 2,500 = 15,000,000$  i.e. a potential loss of Rs 1.5 crores
- ▶ Taluka Naigaon has 100 villages. Thus Naigaon Taluka has a potential loss of 150 crores of Soyabean production in this season
- ▶ Nanded has 16 tahsils so we are talking about a loss of Rs 1500 crores in Soyabean.



# Activities in China In 2005

- 1,952 counties of 31 provinces carrying out precipitation enhancement and hail suppression by using *artilleries and rocket launchers on Ground*
- 21 provinces carrying out precipitation enhancement by using *37 airplanes equipped with AgI, dry ice or liquid nitrogen generators and PMS probes*
- Over 37,210 full-time and part-time people
- New-generation Doppler weather radar 158 radars
- 996,720 artillery shells, 84,416 rockets
- 676 Kg AgI (silver iodide), 9,760 litres liquid nitrogen, 11,820 Kg liquid CO<sub>2</sub> (carbon dioxide)

# Chinese technologies for cloud-seeding



# Varunyantra Gevelopment

## An individual effort

- Using bio-briquettes (carbon-neutral, non-polluting)
- Varunyantra heat production – 2800 kwh ~ 10,000 KJ ,
- Vaporising Potential 10 Kg of salt,
- Generates local thermals

# Varunyantra Models

## Air Supply Unit and Mobile design

- **Air Supply Unit** : 10 assorted pieces of 1” GI threaded pipes.(4-way etc). The GI pieces are drilled to have holes that supply turbulent air to the bio-masses. This will be connected to a blower. This is common to all models.
- **Mobile**: A mobile Varunyantra can be built by means of a discarded 200 L drum (2 ‘ dia, 3’ height), about 40 feet each of 6 mm and 10 mm gajali for a grill and support. The total cost of this will be under Rs 3,000

# Varunyantra Models

## Fixed, Portable

- **Fixed:** A fixed Varunyantra can be built by building a 4' x 4' x 4' brick structure with a wall thickness of 4 inches. The brick structure has ventilation holes, a grill kept at 9" above the base. This will require about 400 bricks, 1 bag of cement and couple of bags of sand.
- **Portable:** A portable hexagonal structure in a kit form can be built using two 1 mm x 8' x 4' MS sheets that can be cut into 8 pieces of 2' x 4'. The pieces will be drilled, bent and can be nut bolted to slotted angles on location.

# Varunyantra

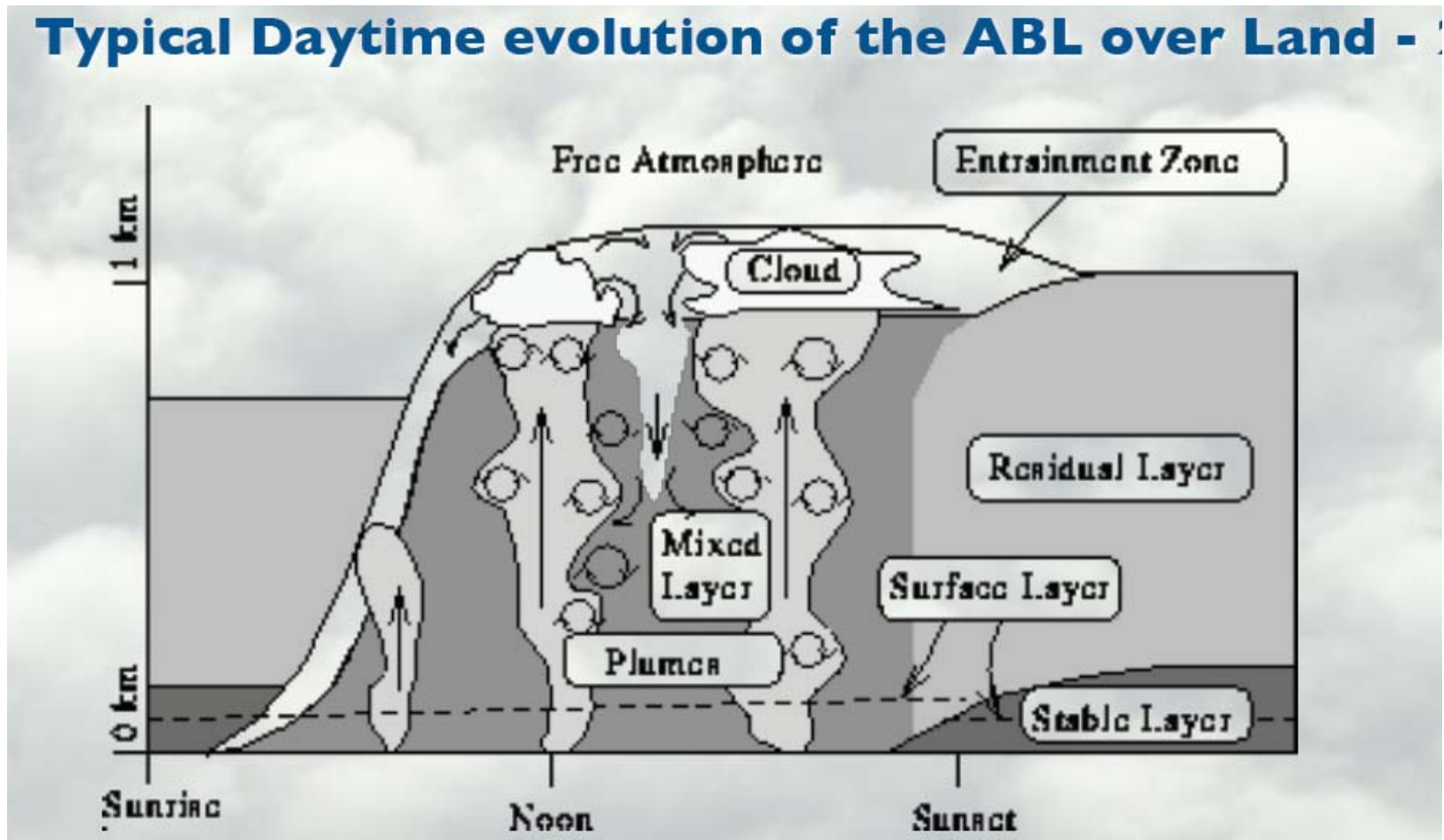


# Varunyantra Physical Chemistry

- Biomass burning byproducts are  $\text{CO}_2$  and  $\text{H}_2\text{O}$
- Internal temperatures achieved – 1200 centigrade, Instantaneous temperature much higher
- Salt melting point – 804 centigrade, Salt boiling point – 1413 centigrade
- Four possible processes
  - Vaporisation of salt
  - Evaporation of Saline Water ( $\text{Na}^+$ ,  $\text{Cl}^-$  ions)
  - Nano scale, pico-duration plasma
  - Cavitation like bursting of bubbles and salt particle spluttering

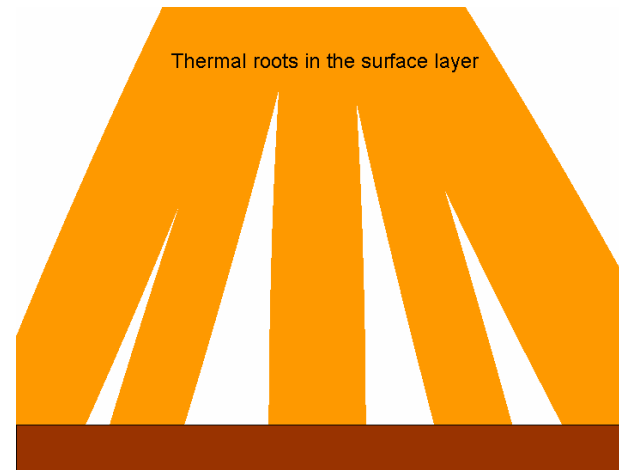
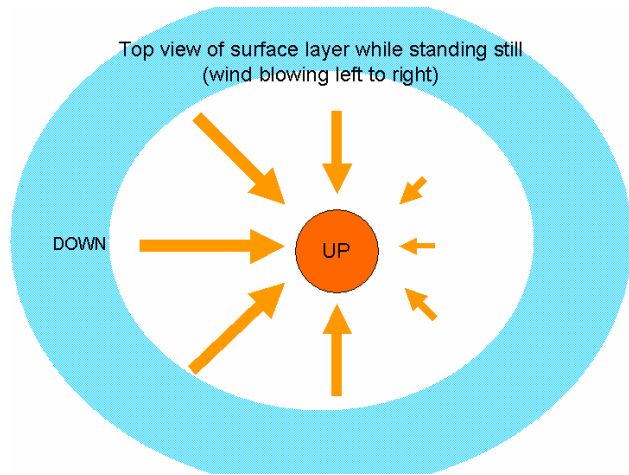
# Boundary Layer as a Carrier

## Typical Daytime evolution of the ABL over Land -

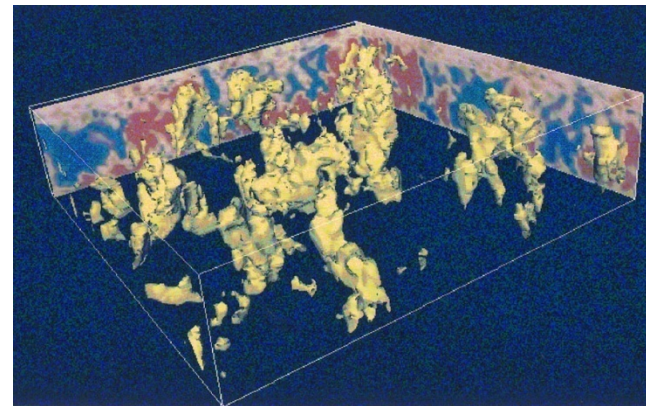
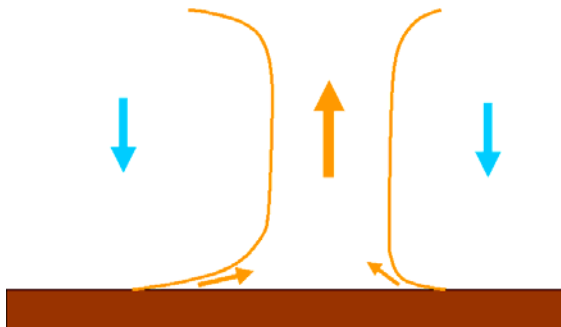




# Creating thermals and riding on them



A thermal as seen while traveling with the background wind



# Using Varunyantra

## When and where ?

### When

- There should be Good dark cloud cover (6~8 octa). Relative humidity > 50 %. Very little wind, Good time one and half hour after sunrise, one and half hour before sunset, one hour after noon sun. At night only if the cloud cover is good and low-lying and if there is no wind.

### Where

- Pick a spot where there is not much wind. It should not be set up on hill-tops (with the mistaken belief that it will near the clouds!) but at the base of hills where up currents can carry salt vapours upwards and not sideways. Good choices could be near water bodies, wells. It should be located where the smoke and heat will not hurt people or discolor walls with

# Using Varunyantra

## How and results ?

### How

- Start with 10 kg of biomass (wood, coal, bio-briquettes). Put ½ litre of kerosene or diesel. Set fire. When flames are good, start Blower. Add 90 kg of biomass slowly . Start sprinkling (ordinary or powder) salt or spray saline water. Total salt weight about 10 kg of salt per quintal of biomass. The process should take about one to two hours. The typical cost per application would be Rs 500.

### Results?

- Rains accompanied by thundershowers expected between 2 to 72 hours. Guess Probability between 50 % to 75 %.

# A Thank You Note

- Prof. T Shivaji Rao, Foremost Environmentalist and Director, Environmental Studies, Gitam University, Vishakhapatnam
- Prof Mukunda, CGPL, Indian Institute of Science, Bangalore
- Ms Rohini Nilekani, Chairman, Arghyam
- Dr. Shrikar Pardeshi, Collector, Nanded
- Many IITB alumni friends, Pune
- Several well-wisher friends and telephonic advisers
- Sujlegaon Partnership Farmers and countless volunteers

*“Satya sankalpancha vali ishwar asato”*

“Refusal of cloud seeding operations means promoting water and food scarcity, diseases, poverty, unemployment and blocking economic prosperity of a nation.”

*an environmentalist view of*

*Prof T Shivaji Rao*

*From his book*

*Cloud seeding for India*

*(an effective weapon to fight the draughts)*