

Importance of weather Radars in cloud seeding operations



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Indian History of cloud seeding

- 1951- Tata firm over western Ghats using ground based silver iodide generators
- 1957-1966 National Physical Laboratory (NPL) conducted experiments using ground based generators, in North India.
- 1973-1974, 1976, and 1979-86 IITM, experiments with cloud seeding shows 24% increase in the rain fall
- 1983, 1984-87, 1993-94 Tamil Nadu Govt carried out cloud seeding
- 1990-2000 witnessed many advances in the airborne instrumentation, radars, flares and softwares. They got imported to India in new millennium.
- 2003 Karnataka Govt has initiated cloud seeding with modern gradztes like radars and aircrafts Maharashtra Govt followed a month later.
- 2003-2009 Andhrapradesh Govt has conducted cloud seeding operations perhaps the longest & biggest programme in south east Asia.

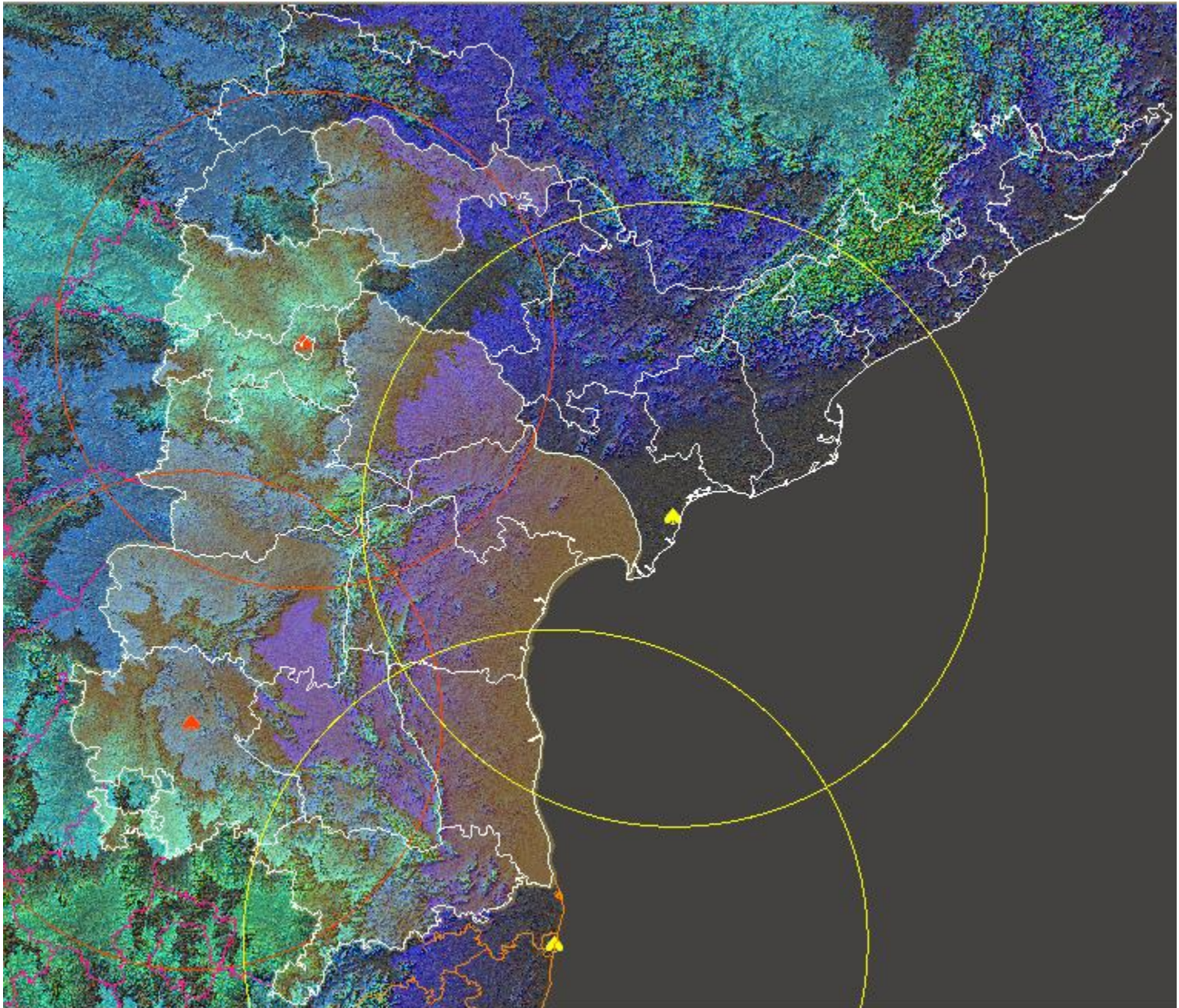
Rain Shadow Area Development Department

- o Government of Andhra Pradesh has declared 555 mandals out of 1125 mandals as Rain Shadow Areas through their Memo. No. 180/RS.V/2004-I; 22nd July 2005. This comprises an area of 1,35,680 Sq.km out of total area of 2,75,045 Sq. km .
- o The classification of Rain Shadow (RS) Mandals was done based on the mandal receiving less than 600mm rainfall during Southwest monsoon period in 9 years out of last 18 years.
- o Most of the RS Mandals are lying in the districts of Ranga Reddy, Nalgonda, Mahabubnagar, Guntur, Prakasam, Nellore, Kurnool, Anantapur, Cuddapah and Chittore districts.
- o Districts like Chittore, Nellore, Prakasam, and Guntur receive rainfall during northeast monsoon also.
- o In order to enhance rainfall, dynamic seeding of clouds was taken-up in the above RS districts during both Southwest and Northeast monsoons, with the instructions of Hon'ble Chief Minister of Andhra Pradesh Dr Y.S.Rajasekhara Reddy, under the Project, called INDIRA MEGHAMADHANAMU, which was started in the year 2004.
- o These programmes are regularly being monitored by Hon'ble Minister for Agriculture, Sri N.Raghuveera Reddy and Principle Secretary of Rain Shadow Area Development (RSAD) Department. In addition to the state level committee and technical committee comprises several experts in the field

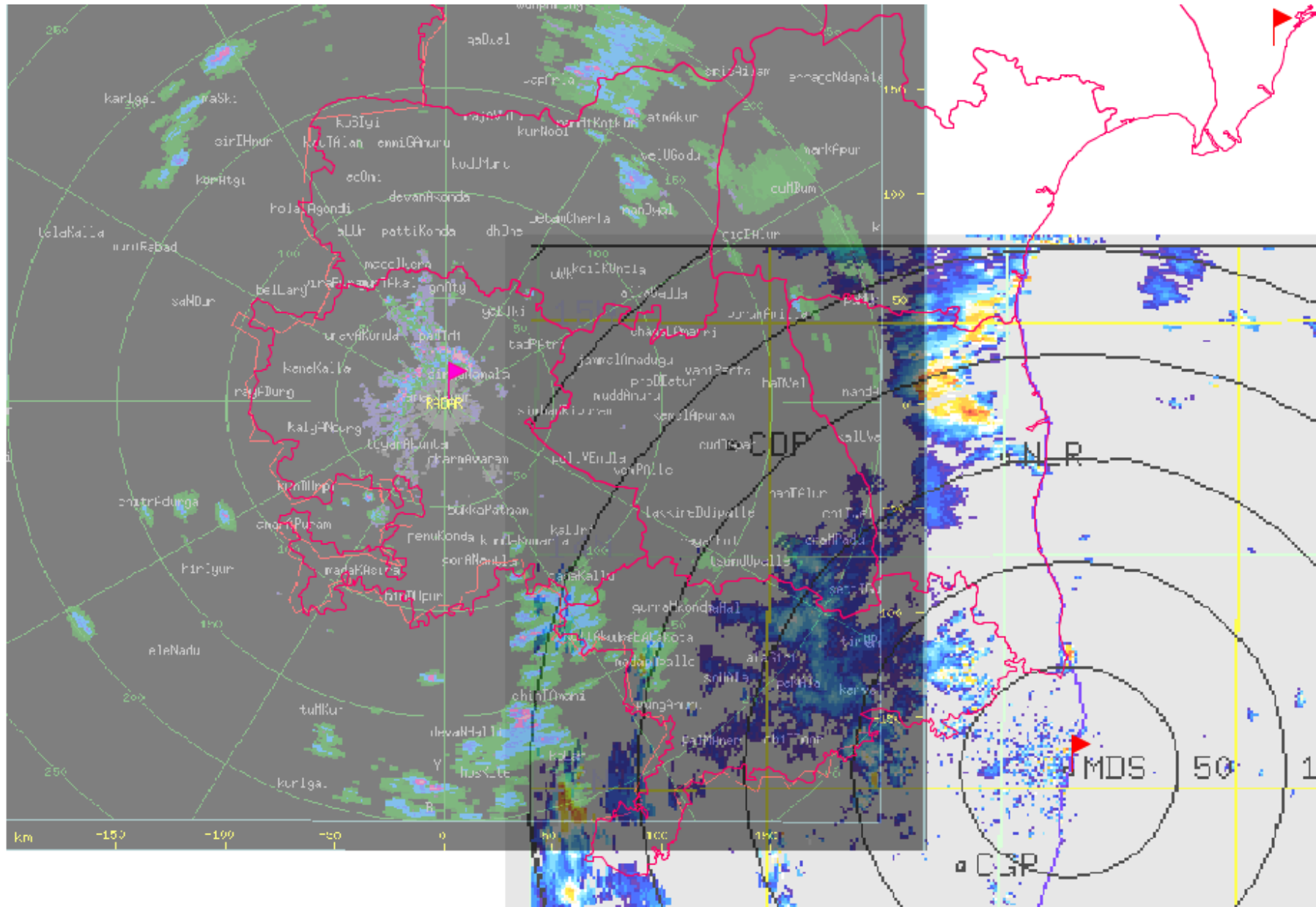
History of cloud seeding operations in Andhra Pradesh

Year	Operating Agency	Monitoring Agency	No. of Flares			% of Success	No of Mandals Covered in 656 Mandals	No. of C-Band Radars
			Hygros	BIP	Eject ables			
2003	Weather Modification Incorporation (WMI) of Fargo, USA in association with AGNI Aviation, Bangalore.	WALAMTARI, Government of Andhra Pradesh.	121	69	582		63	WEATHER RADAR, at Jekkur Aerodrome near Bangalore.
2004	Weather Modification Incorporation (WMI) of Fargo, USA in association with M/s AGNI Aviation, Bangalore.	PanchayathRaj Department; Government of AP.	963	161	1436	59.6	510	Weather Radars were installed at Karimnagar and Nandyal. At the time of withdrawal of Southwest monsoon, Karimnagar Radar was shifted to Tirupathi to study Northeast monsoon clouds.
2005	M/s Agni Aviation, Bangalore.	Jawaharlal Nehru Technological University (JNTU), Hyderabad.	457	52	185	71.7	476	C-band Radars at Ibrahimpatnam and Anathapur.
2006	M/s Agni Aviation, Bangalore.	Jawaharlal Nehru Technological University (JNTU), Hyderabad.	200	27	15	54.4	552	Ibrahimpatnam Radar was shifted to JNTU, Kukatpally and with the other Radar at Anathapur.
2007	M/s Agni Aviation, Bangalore.	Jawaharlal Nehru Technological University (JNTU), Hyderabad.	547	82	--	82	566	JNTU, Kukatpally, Hyderabad and other Radar at Anathapur.
2008	M/s Agni Aviation, Bangalore.	Jawaharlal Nehru Technological University (JNTU), Hyderabad.	563 *	--	--	78.2	651	JNTU, Kukatpally, Hyderabad and other Radar at Anathapur
2009	M/s Agni Aviation, Bangalore.	Jawaharlal Nehru Technological University (JNTU), Hyderabad	541	--	--	75.7	558	JNTU, Hyderabad, Anathapur and Tirupati

RADAR coverage's



Ananthapur & Chennai RADAR coverage



Testing of flare Particles producing Cloud condensation nuclei (CCN), its size distribution over ground

Sample **Not Recording** Read a File

Current Data File: 20090815060537

Manua Slow Mediu Fast 06:06:11 06:15:00 06:20:00 06:25:35 00 d 06:14:54 (22495sec) **Hardware Key Not Detected**

(0) CIP (1) CDP (2) Hotwire_LWC (3) CCP Summary (4) NI_A2D (5) AIMMS20 (6) SPP_200 (7) CCN (8) Dewpoint Telemetry Setup

Pump Relay Control **ON** OFF

Relay On This light indicates that PADS thinks it has turned the relay on. There is no direct feedback from the probe.

SPP_200 Data

Number Conc (# / cm ³)	Sample Flow (vol cm ³ /s)
27978.3	1.03
Volume Conc (um ³ / cm ³)	Sheath Flow (vol cm ³ /s)
21124.54	14.4
MVD (um)	Laser Ref (V)
1.45	4.46
ED (um)	Electronics Temp (C)
1.31	38.1
Aux Analog 1	Avg Transit
0	399
Hi Gain Baseline (V)	ADC Overflow
2.87	7
Mid Gain Baseline (V)	Pump Flow OK
3.29	
Lo Gain Baseline (V)	
0.76	

#Conc/Vol Conc Selectable Charts

Enable **Enabled** COM Port 6 **No Fault** v2.7.2

SPP_200 # Conc (#/cm³)

SPP_200 Volume Conc (um³/cm³)

X-Axis Auto-Scale

Particle Count

Particle Size Bins

Bin	Particle Count
1	0
2	0
3	0
4	0
5	0
6	500
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	200
16	300
17	500
18	1500
19	8000
20	6000
21	4000
22	3000
23	1500
24	1200
25	800
26	500
27	300
28	200
29	100
30	50
31	0

PARTICLE SIZE NATURAL vs FLARE

S.No	HYDERABAD		ANANTHAPUR		FLARE	
	Particles Size (Microns)	% of Total	Particles Size (Microns)	% of Total	Particles Size (Microns)	% of Total
1	0.2	41.60%	0.1	41.60%	0.8	28.50%
2	0.4	33.30%	0.3	33.30%	1	12.50%
3	0.6	16.60%	0.5	16.60%	0.2	14.60%
4	0.8	8.30%	0.7	8.30%	0.4	10.20%

Operations

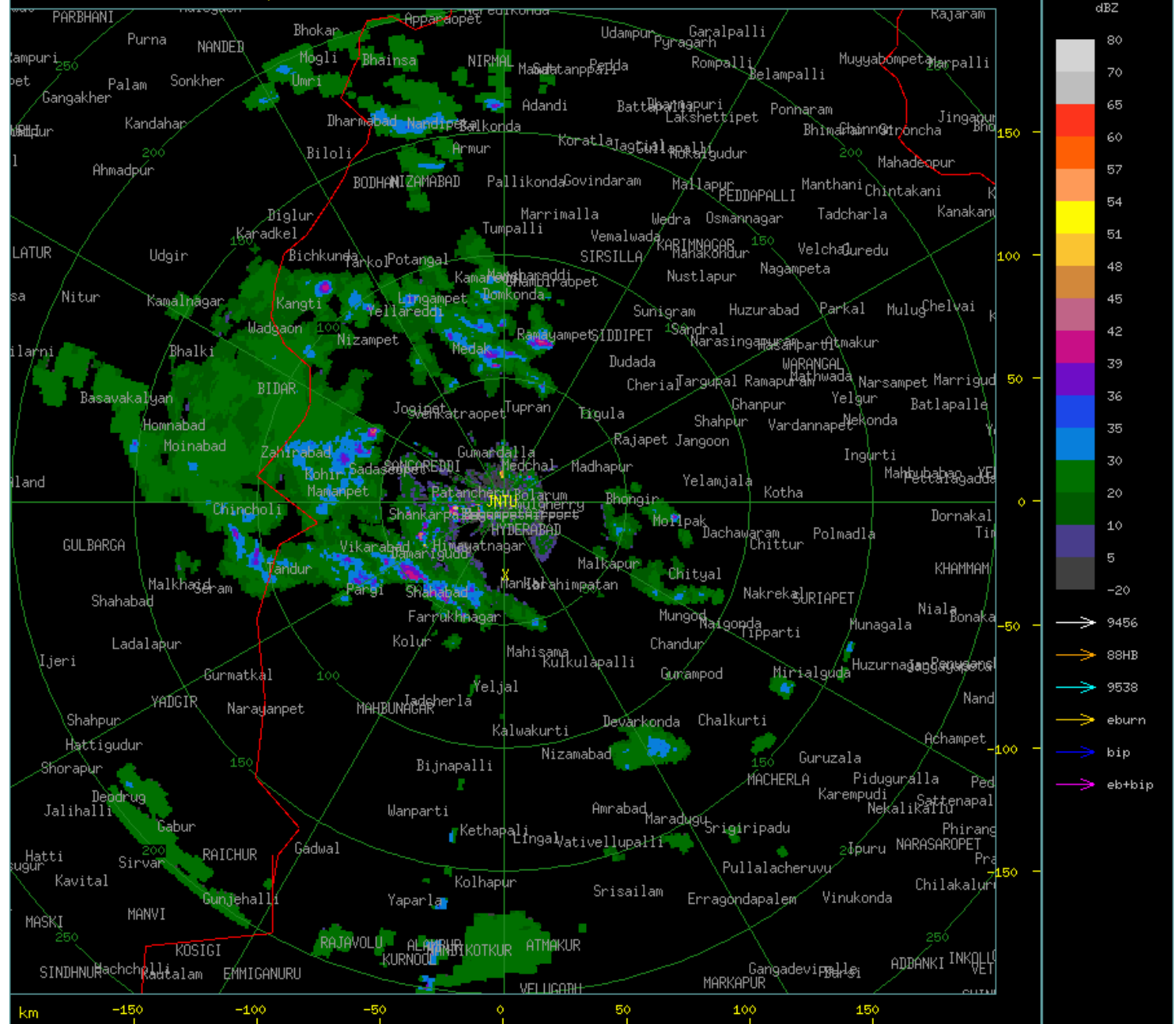


dBZ

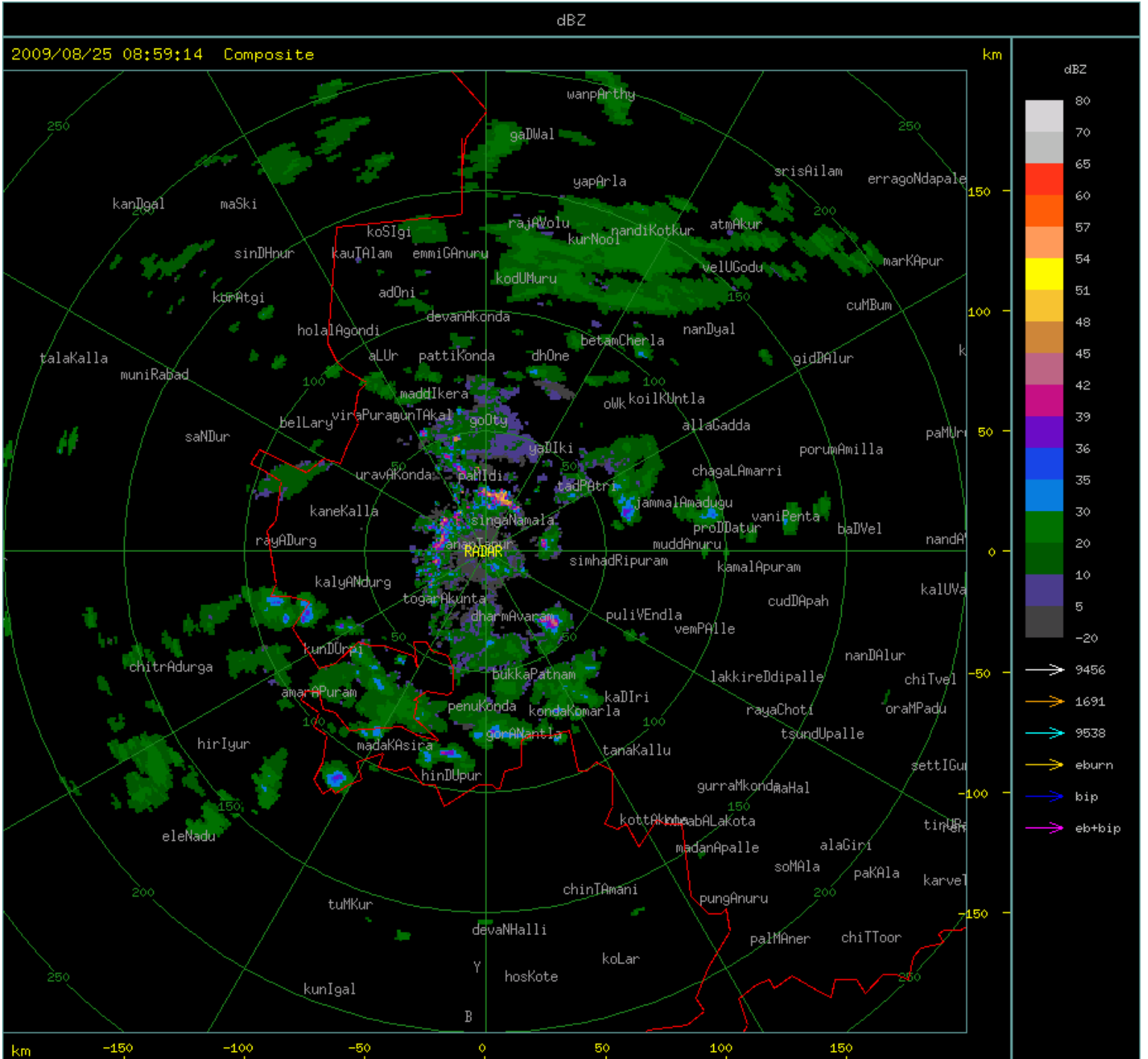
2009/09/02 07:01:42 Composite

km

Seeding operation

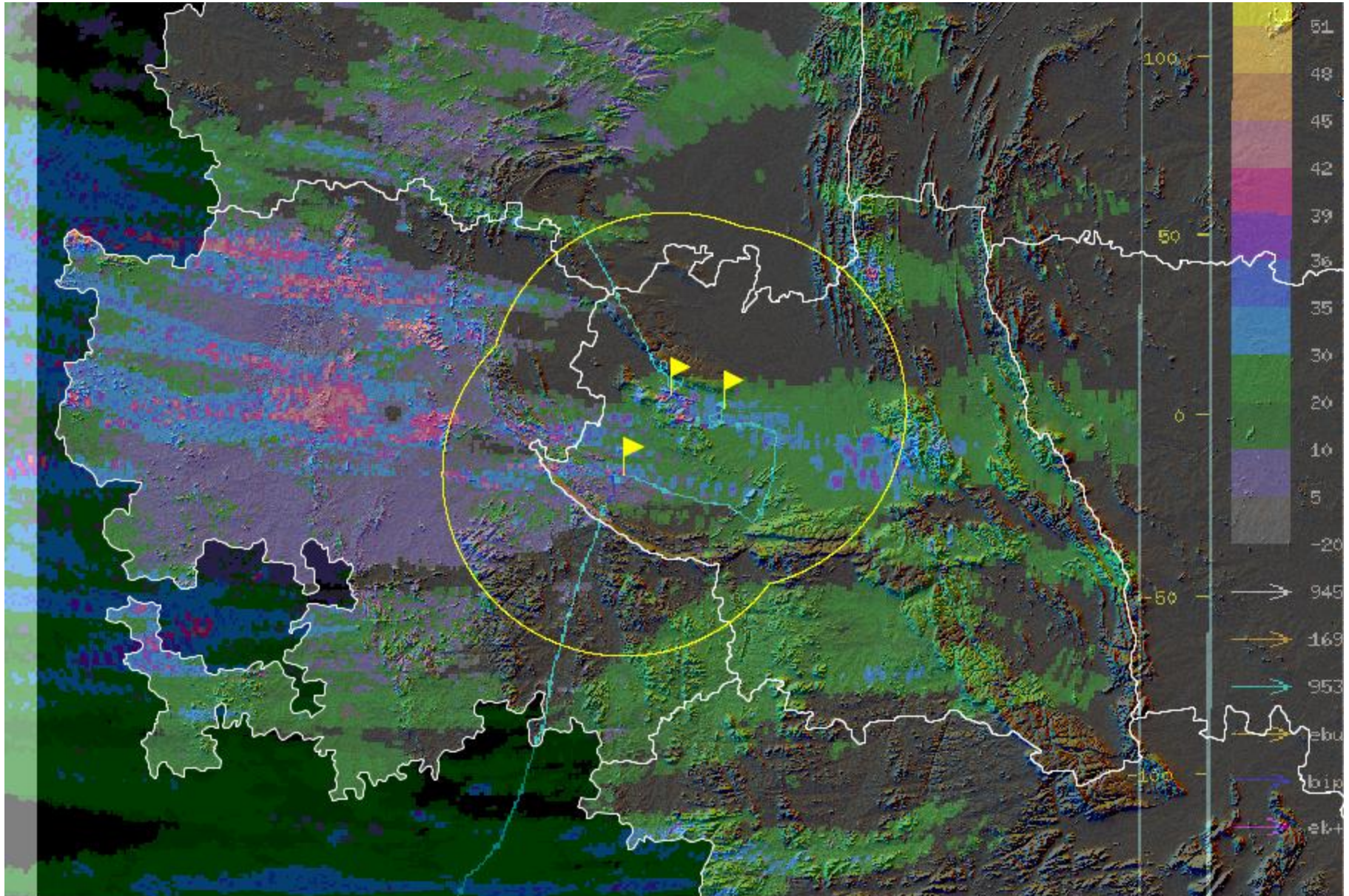


Seeding operation

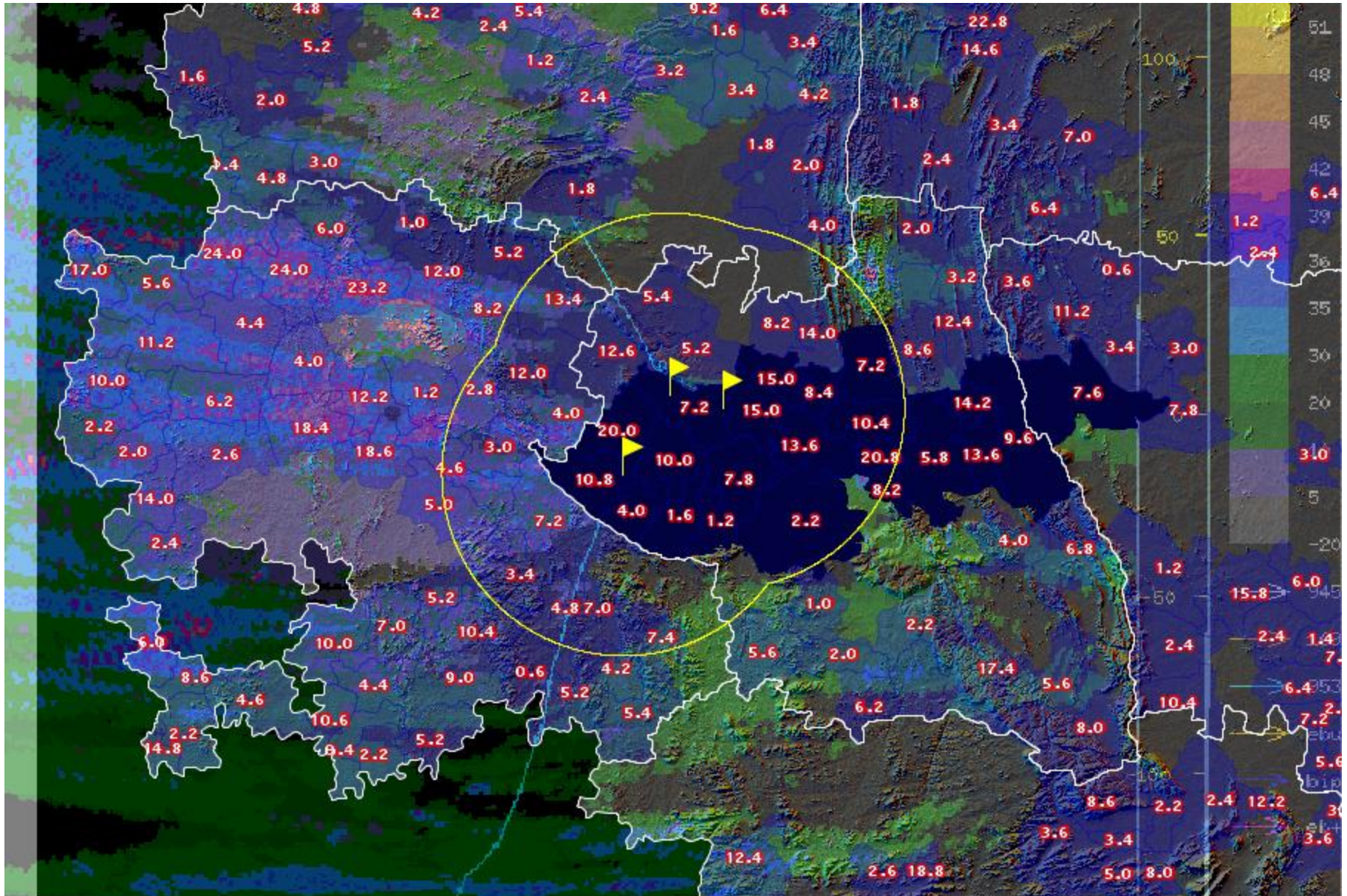


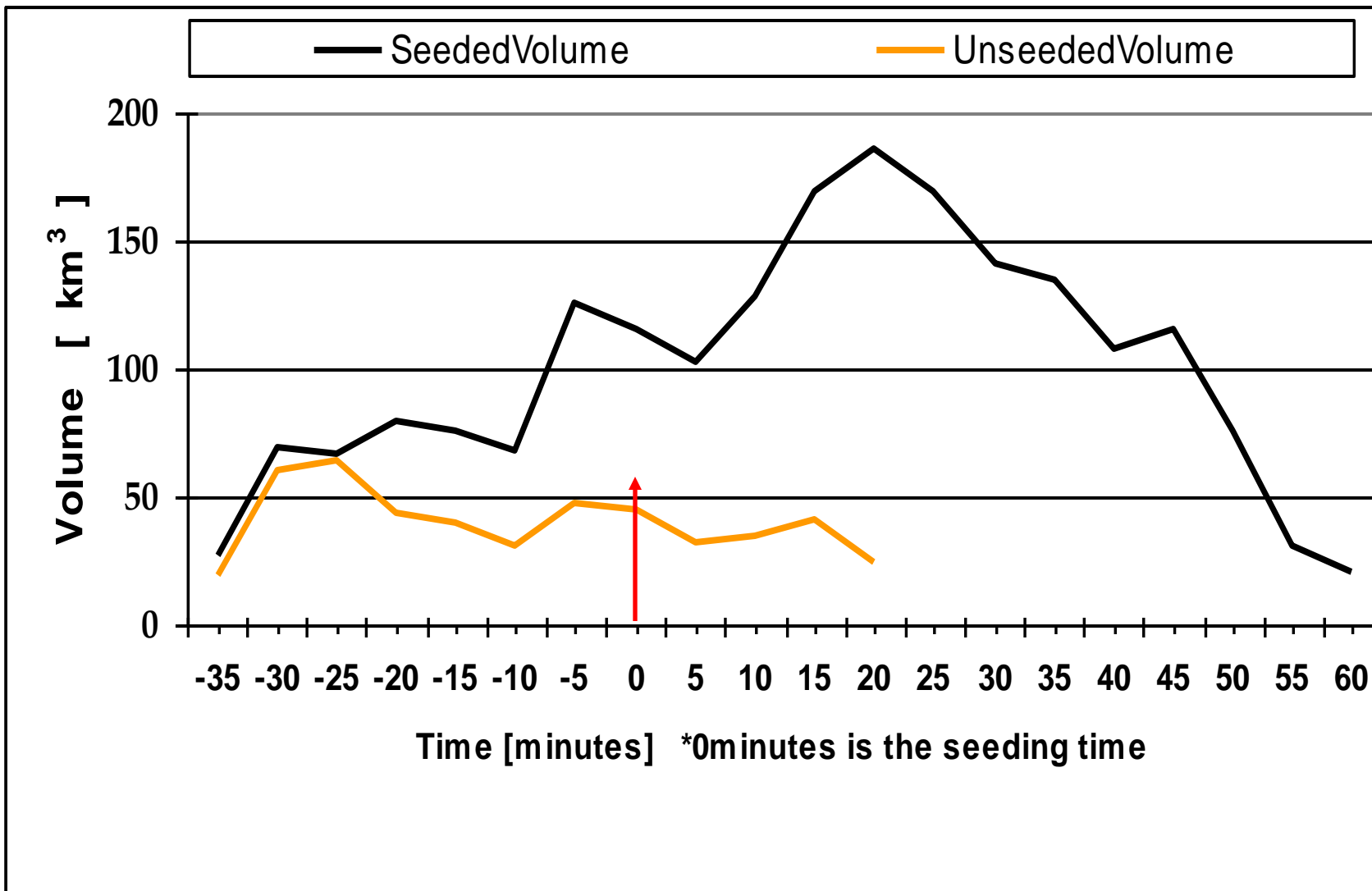
First time seeding influence is evaluated by considering zone of influence only under the seeded cloud.

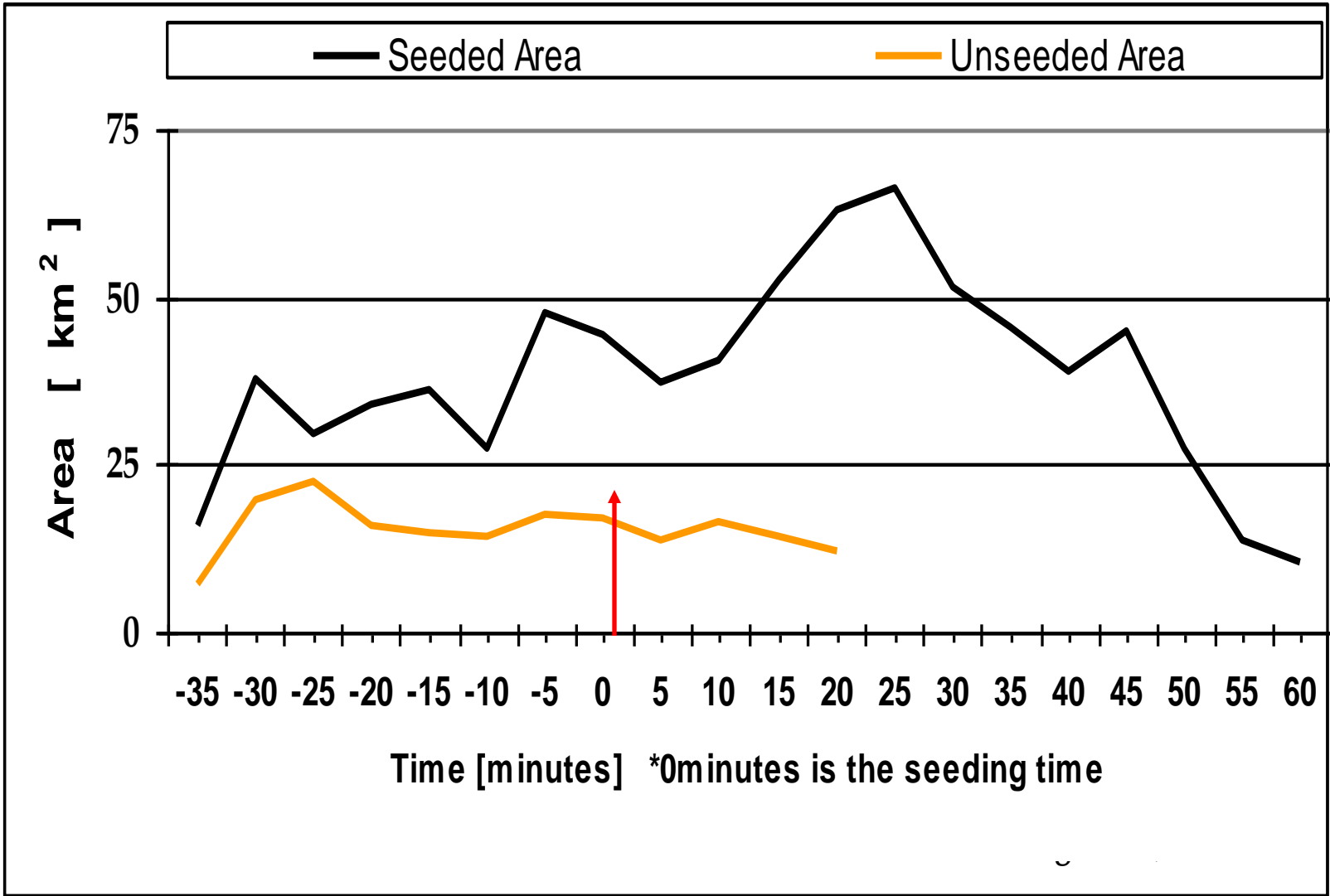
25 Aug 09 seeding locations and Post seeding cloud track

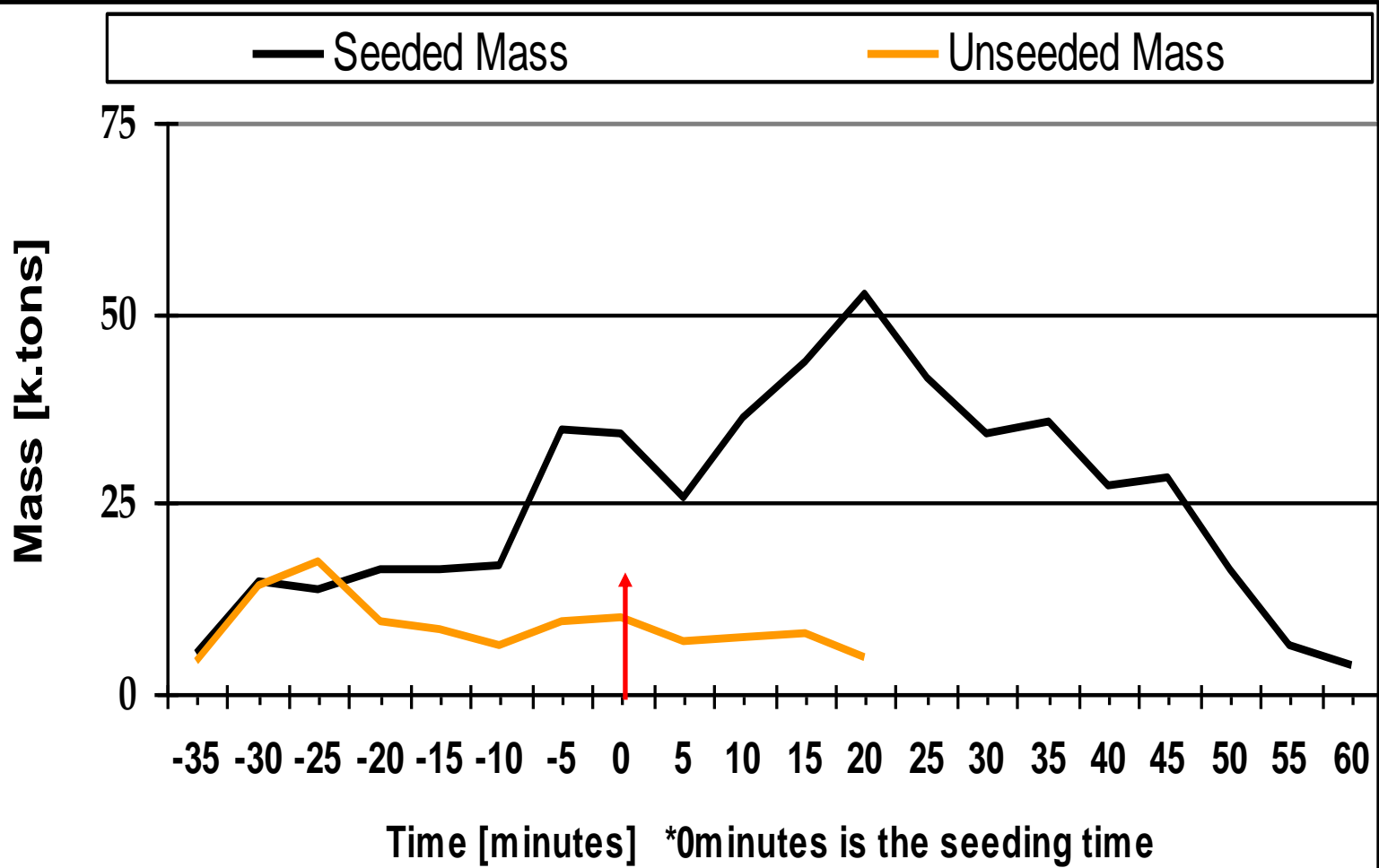


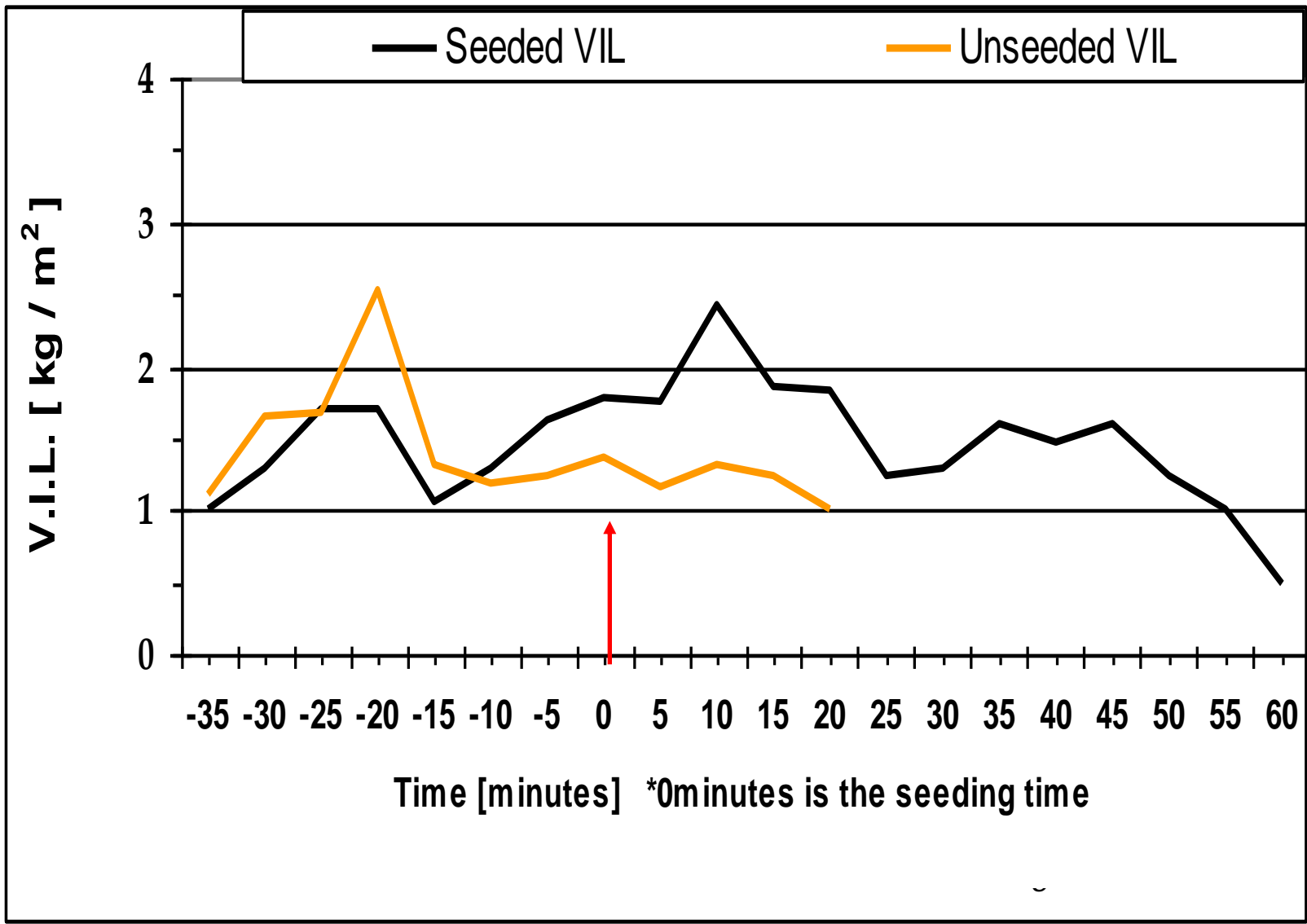
25 Aug 09 seeding locations and Spatial distribution of rain gauge recorded rainfalls (mm) & Rainfalls below the seeded cloud track.











Summary of cloud seeding operations over Andhra Pradesh (2004 - 2009)

S.No	Year	No of Aircrafts used	No of RADARs Used	Total districts covered	No of Mandals seeded	% of Rainfall attributed to cloud seeding operations
1	2003	1	0	1	63	--
2	2004	3	2	16	510	--
3	2005	3	2	10	476	12.85
4	2006	2	2	10	552	17.25
5	2007	2	2	12	566	19.17
6	2008	2	2	12	651	18.25
7	2009	3	2	12	558	17.01

Conclusions:

- Warm cloud seeding is found to be more effective.
- Cloud Seeding is effective on Continental clouds over Anathapur, Cuddapah, Kurnool, Mahbubnagar, Nalgonda and Ranga Reddy districts where seeding particle size suits for the enhancement of Clouds after seeding.
- Cloud Seeding is ineffective on maritime clouds over coastal districts of Guntur, Prakasam, Nellore and eastern half of Chittore. This is because the Salt particles found in the maritime clouds are bigger than released CCN BY SEEDING.
- During weak monsoon conditions also seeding for isolated convective clouds has yielded encouraging results

Thank You.....

