Republic Hydrometeorological Service of Serbia

167 years

since the beginning of the first systematic meteorological measurements in Serbia

127 years

since the establishment of the national meteorological services and unified network of meteorological stations in Serbia

7 years

Since the establishment of Southeast European Climate Changes Center "Milutin Milankovitch" within the Republic Hydrometeorological Service

93 years

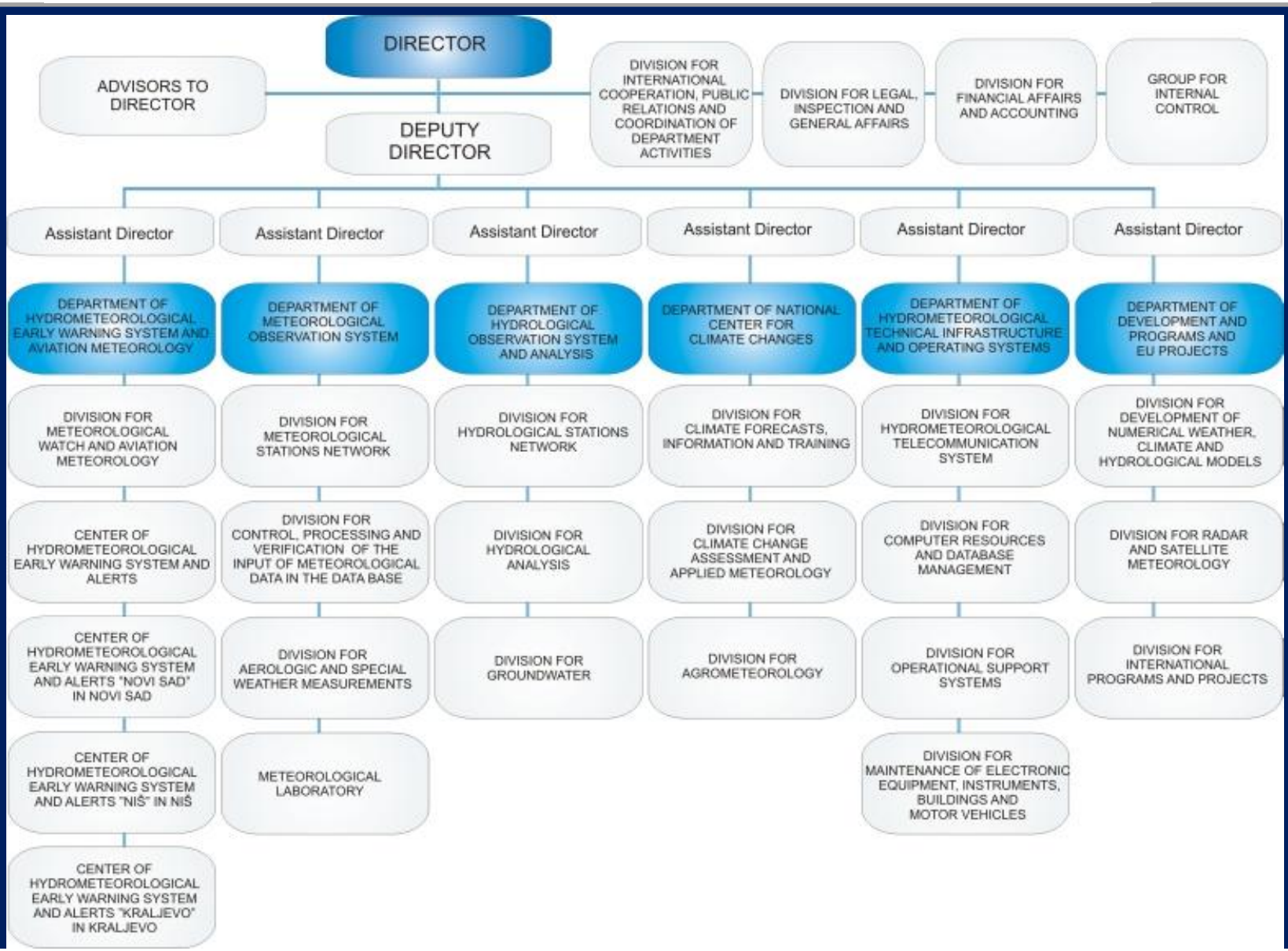
since the founding of the state hydrological service and the unique network of hydrological stations in Serbia

Republic Hydrometeorological Service of Serbia

Republic Hydrometeorological Service (RHMS) is the state administration of the Republic of Serbia with the status of special organization, performing meteorological and hydrological activities of interest for the Republic of Serbia.

Republic Hydrometeorological Service of Serbia

ORGANIZATIONAL STRUCTURE



AFTER 4 YEARS

THE HAIL SUPPRESSION SYSTEM

is again a part of
Hydrometeorological Service of Serbia
according to the law adopted in the
National Assembly of Serbia
On 19th of June 2015.

ACCORDING TO THIS LAW THE HAIL SUPPRESION IS BASED ON THE PRINCIPLES OF PREVENTIVE CARE, THE SCIENTIFIC BASIS AND ECONOMIC JUSTIFICATION, THE PRINCIPLE OF UNITY AND THE PRINCIPLE OF TRANSPARENCY.

THE LAW IS BASED ON

- Constitution of the Republic of Serbia
- The Law on ministries
- The Law on emergency situations
- The Law on Agricultural Land
- International conventions

THE LOW DEFINES JURISDICTION OF

- The Government of the Republic
- The Hydrometeorological Institute
- The autonomous province
- The local government

GOVERNMENT OF THE REPUBLIC

Based on the proposal of the competent ministry adopts:

1. Long-term program for the development and operation of the hail suppression system;
2. Medium-term program for the development and operation of the hail suppression system;
3. Regular and special reports on the functioning of an integrated hail suppression system.

IMPORTANT NOTE:

All projects of weather modification relating to the hail suppression and carried out on the territory of the Republic of Serbia must be approved and controlled by the government.

THE HYDROMETEOROLOGICAL SERVICE

1. Provides fully functioning of the unified hail suppression system,
2. Proposes development programs, regular and special reports to the Government,
3. Prepares regular and special reporst about of the hail suppression system for the bodies of the local authority.

THE LOCAL GOVERNMENT

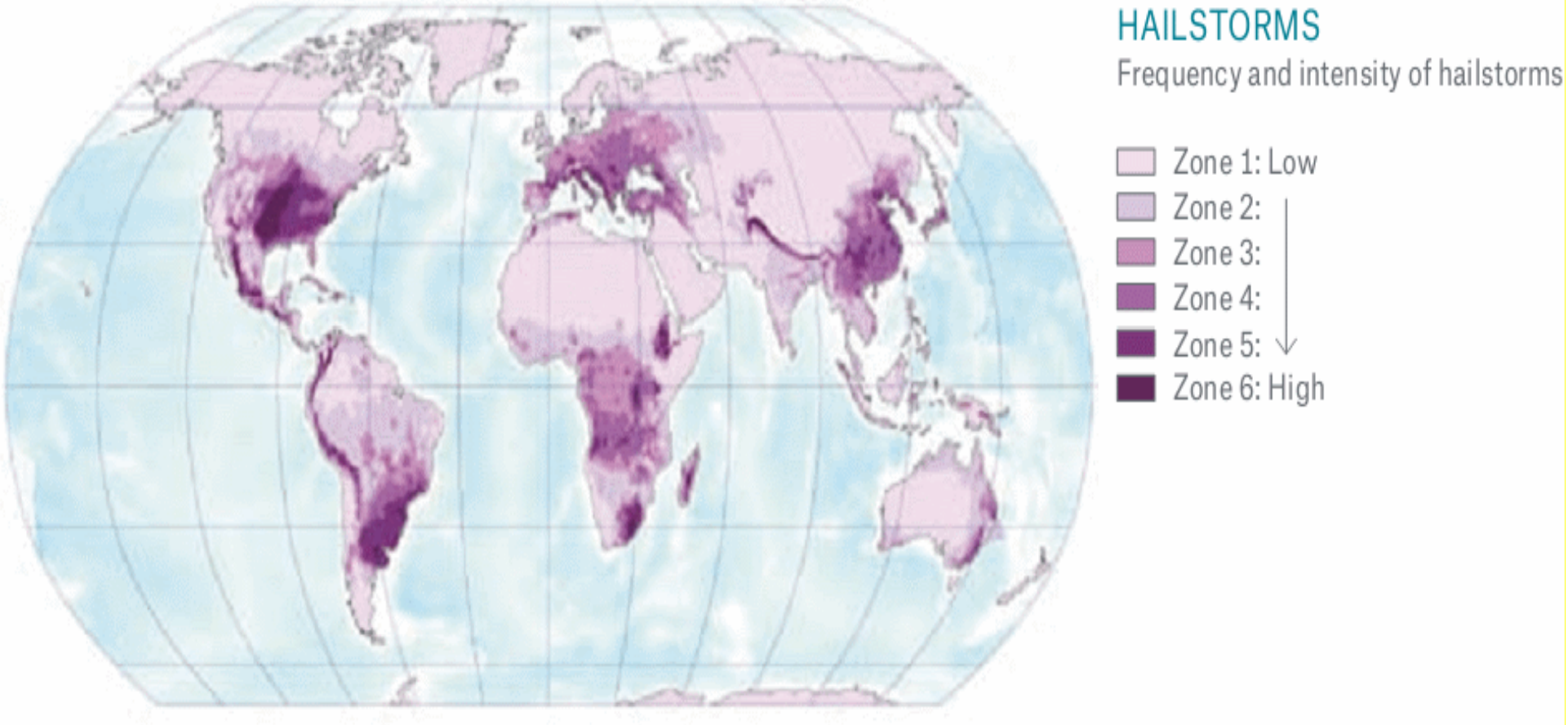
1. Provides support in the hail suppression on its territory in particular about hiring staff on launching stations;
2. Carry out a preliminary assessment of hail damage of agricultural crops within seven days from the date when the damage occurred, and the final assessment issued within 45 days from the date when the damage occurred;
3. Consider reports on the hail suppression to its territory.

FINANCING

Funds for financing the hail suppression system is provided by:

1. the budget of the Republic of Serbia,
2. budgets of local governments - conditionally
3. part of the subsidized crop insurance premium ,
4. other sources in accordance with the law

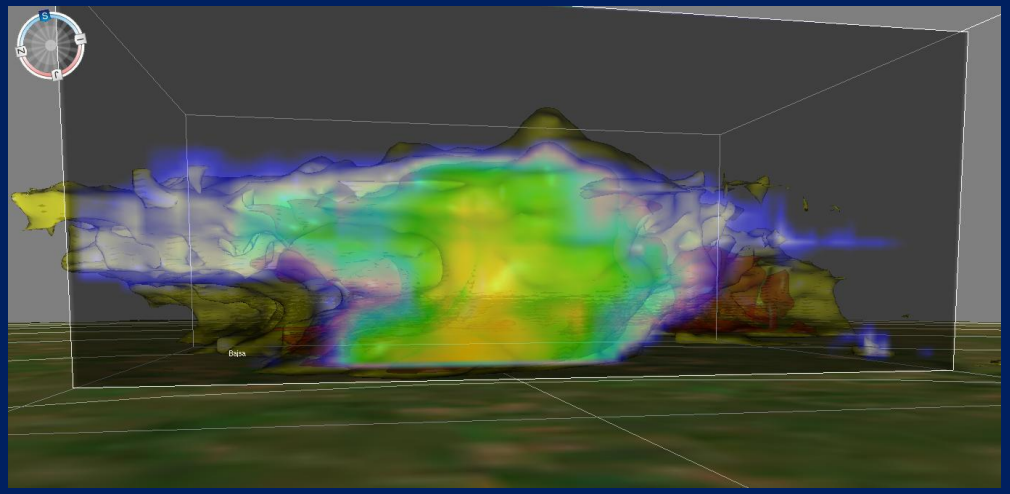
FREQUENCY AND INTENSITY OF HAILSTORMS

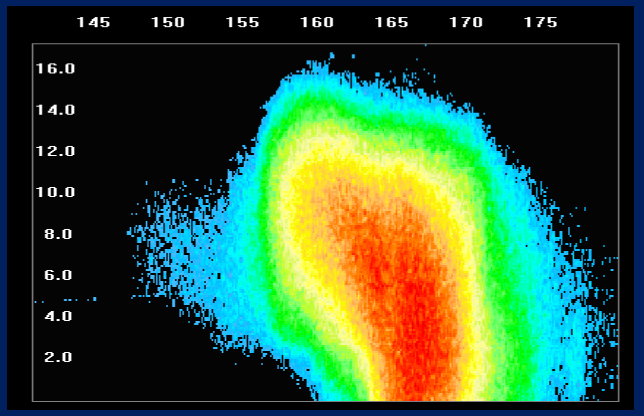


NATHAN - World map of natural hazards (2011 version)

SERBIAN
HAIL SUPPRESSION SYSTEM

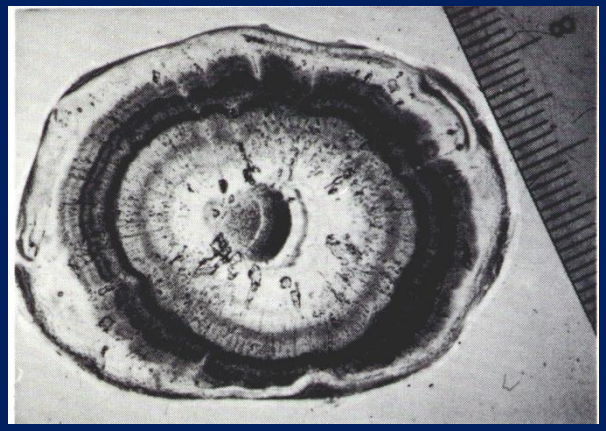
- DIVISION FOR OPERATIONAL ACTIVITIES
- DIVISION FOR METHODOLOGY OF WEATHER MODIFICATION

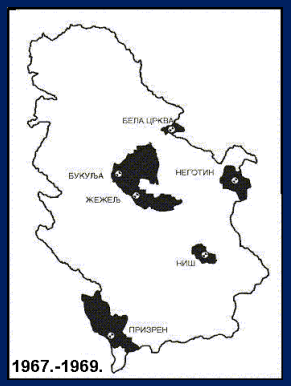




48 YEARS OF HAIL SUPPRESSION

Hail is a frequent meteorological event in Serbia
50 to 60 days per year.
Highest intensity in period May –July.
Diameter of hailstones in most cases is up to 15 mm.





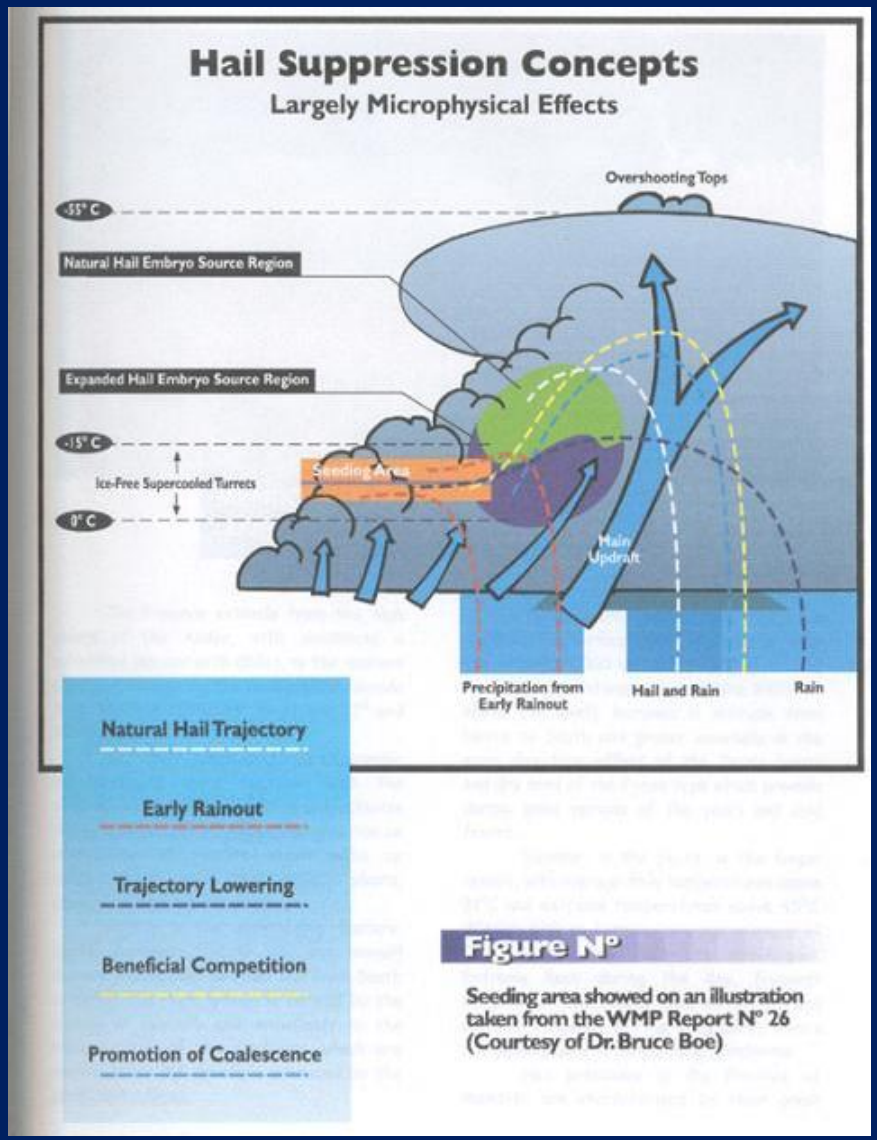
TERRITORIAL EXPANSION OF THE HAIL SUPPRESSION SYSTEM FROM (1967-2008)

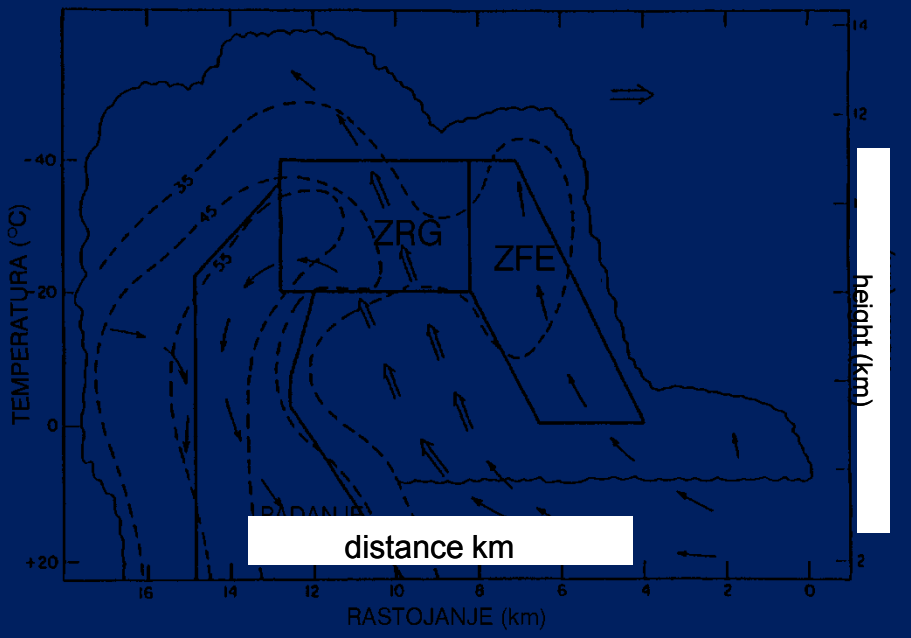
RADAR CENTERS

HAIL SUPPRESSION in SERBIA

* 77,498 km^2 total area
* 51,069 km^2 agricultural area
* 13 radar centers
* 1,800 hail suppression stations
* center in Belgrade
* 222 workers
* 3600 workers on launching sites
* Season duration: 15th of April to 15th of October
* Average annual number of days with seeding: 55

METHODOLOGY
Concept of beneficial competition





Schematic diagram of cumulonimbus with Zone of hail embryo formation ZFE and Zone of Hailstone growth ZHG

(K.C.Young Microphysical Processes in Cloud, Oxford University Press 1993)

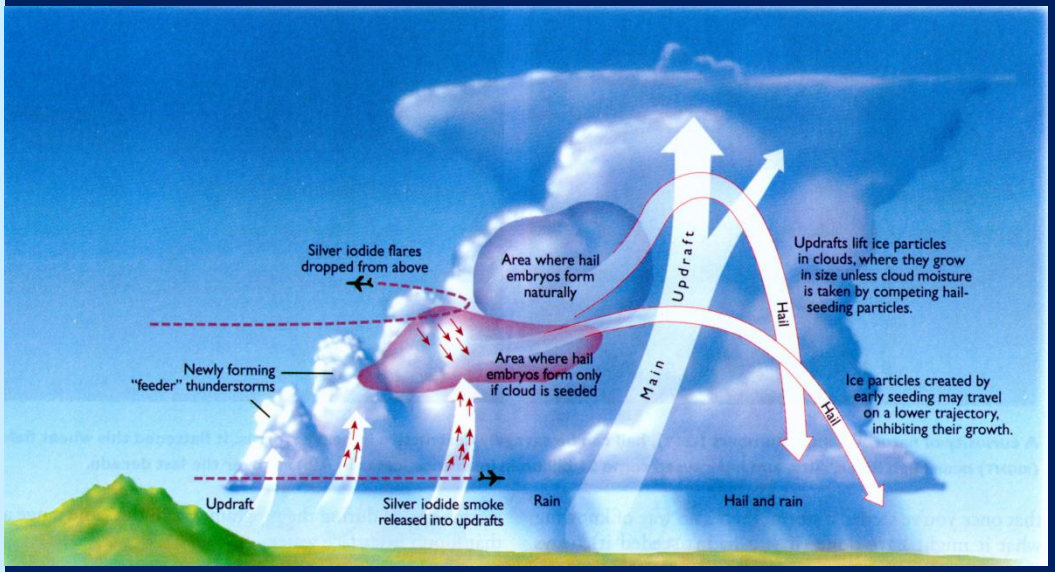
GENERAL PRINCIPLES OF METODOLOGY

* HAIL FORMATION

  - I - conditions for hail embryos
  - II - hail embryos formation
  - III - hail embryos growth
  - IV - hailstone falling

* HYPOTHESIS

  - M.T. Abshaev - process acceleration in cloud or in part of it
  - 25 dBZ <Z<45 dBZ
  - between -4°C and -12°C

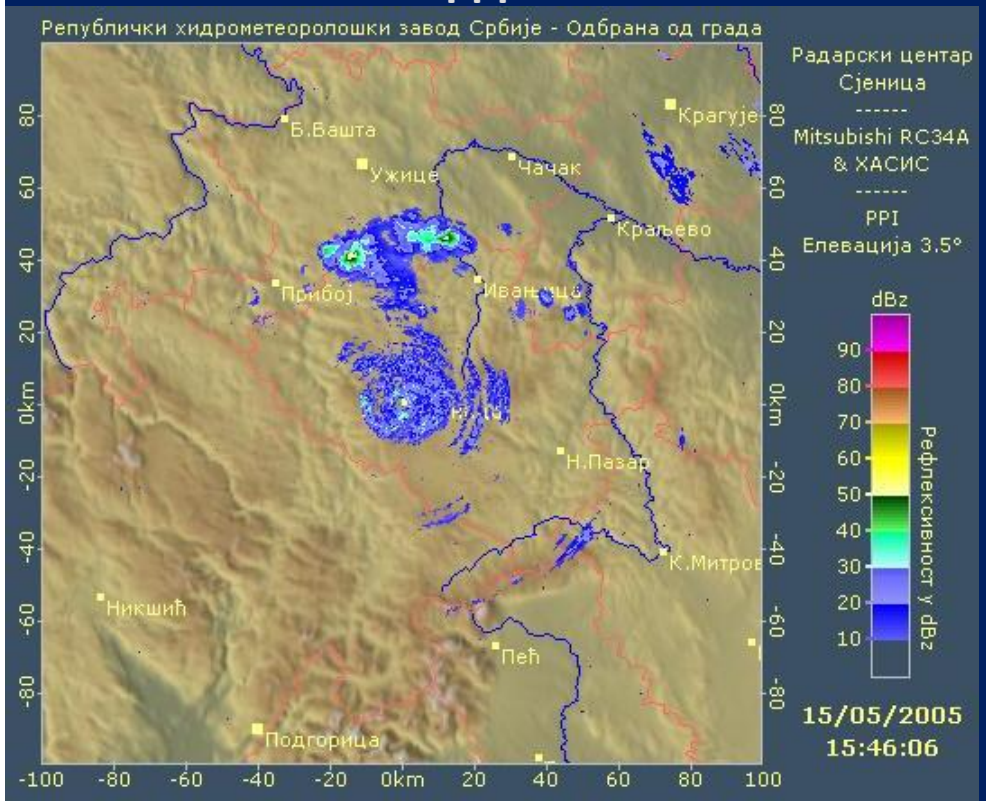



RADAR NETWORK
10 radars Mitsubishi RC 34-A made in period 1978 to 1984. Radars are automated possessing DSP cards and HAil Suppression Information System (HASIS).
3 Doppler radars Gematronik made in period 2000 to 2002 year. One of them is with dual-polarisation.

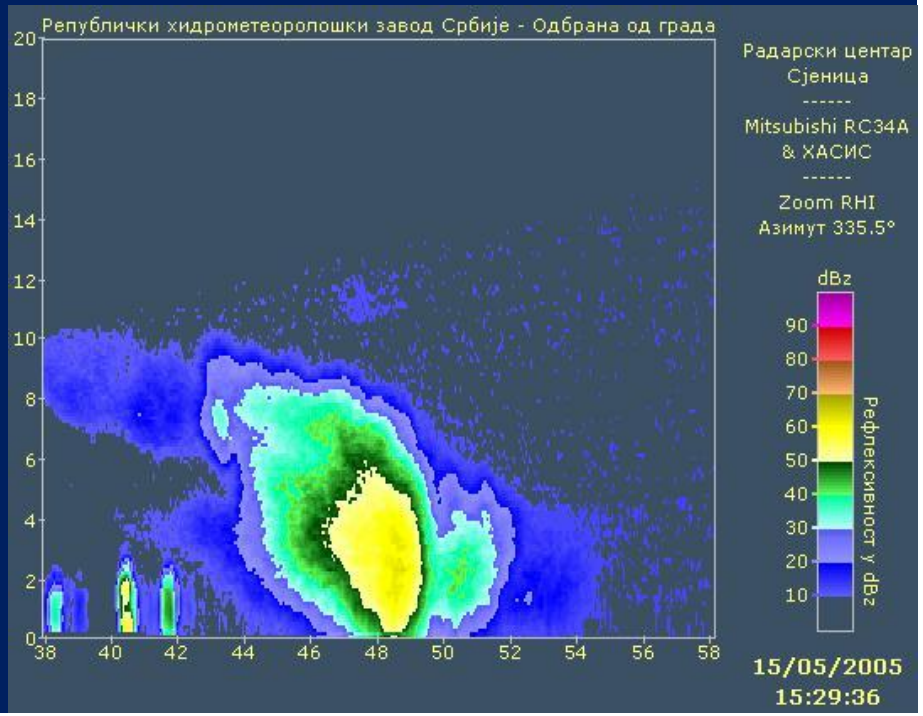
TECHNICAL CHARACTERISTIC OF RADAR MITSUBISHI RC 34-A

* TRANSMITTING POWER 400 KW
* PULSE LENGTH 2 μs
* WAVE LENGTH 10.7 cm
* BEAM WIDTH OF ANTENNA 2°
* ANTENNA GAIN 37 dB
* ANTENNA REFLECTOR 4 m
* POLARIZATION HORIZONTAL
* MDS -107 dBm

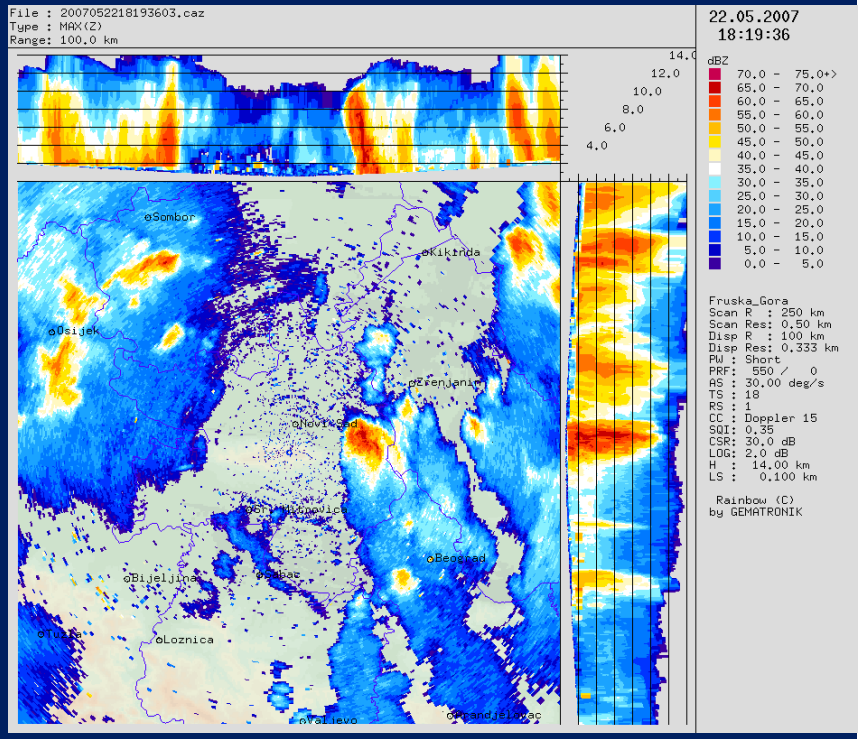
PPI



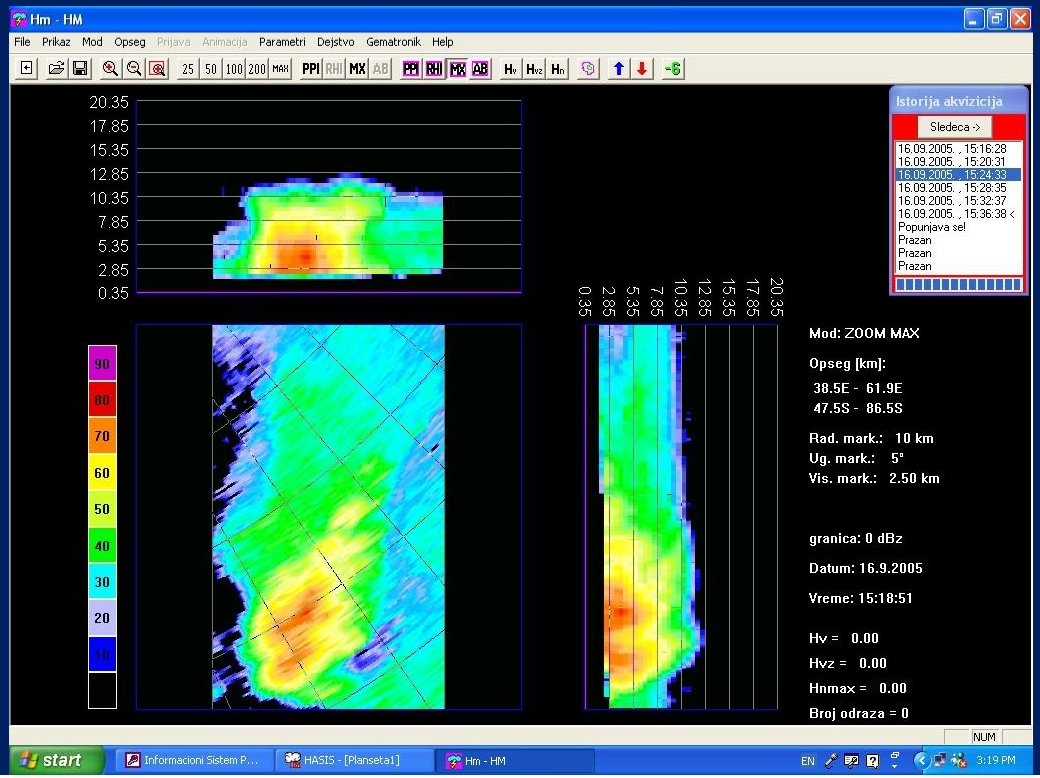
RHI



RADAR GEMATRONIK METEOR 400



* TRANSMITTING POWER 600 KW
* PULSE LENGTH 1/ 2s
* WAVE LENGTH 10 cm
* BEAM WIDTH 1.1°
* ANTENNA GAIN 42.3 dB
* ANTENNA REFLECTOR 6.1 m
* MDS long pulse -110 dBm
  short pusle -105 dBm


Hm - HM
File Prikaz Mod Opseg Prijava Animacija Parametri Dejstvo Gematronik Help
25 50 100 200 MAX PPI RHI MX AB
20.35
17.85
15.35
12.85
10.35
7.85
5.35
2.85
0.35
90
80
70
60
50
40
30
20
10
Istorija akvizicija
Sledeca ->
16.09.2005. , 15:16:28
16.09.2005. , 15:20:31
16.09.2005. , 15:24:33
16.09.2005. , 15:28:35
16.09.2005. , 15:32:37
16.09.2005. , 15:36:38 <
Popunjava se!
Prazan
Prazan
Prazan
Mod: ZOOM MAX
Opseg [km]:
38.5E - 61.9E
47.5S - 86.5S
Rad. mark.: 10 km
Ug. mark.: 5°
Vis. mark.: 2.50 km
granica: 0 dBz
Datum: 16.9.2005
Vreme: 15:18:51
Hv = 0.00
Hvz = 0.00
Hnmax = 0.00
Broj odraza = 0
NUM
start
Informacioni Sistem P...
HASIS - [Planseta1]
Hm - HM
EN
3:19 PM

CHARACTERISTICS OF SOFTWARE HASIS

- Hardware:

Mitsubishi RC 34-A radar

Main workstation with additional DSP card

2 additional workstations

Intelligent mikrowave link

- Real-time software

Radar signal processing and radar data visualisation (PPI, RHI, sector PPI and RHI, CAPPI, sector CAPPI, zooming, arhiving).

Tracking and position prediction of a cloud radar echo.

Selection of seeding areas and optimal selection of launching sites for firing.

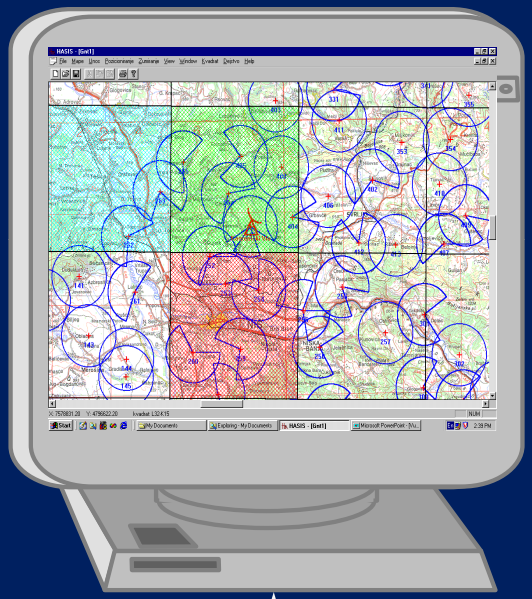
Launching rockets elements and timing calculations.

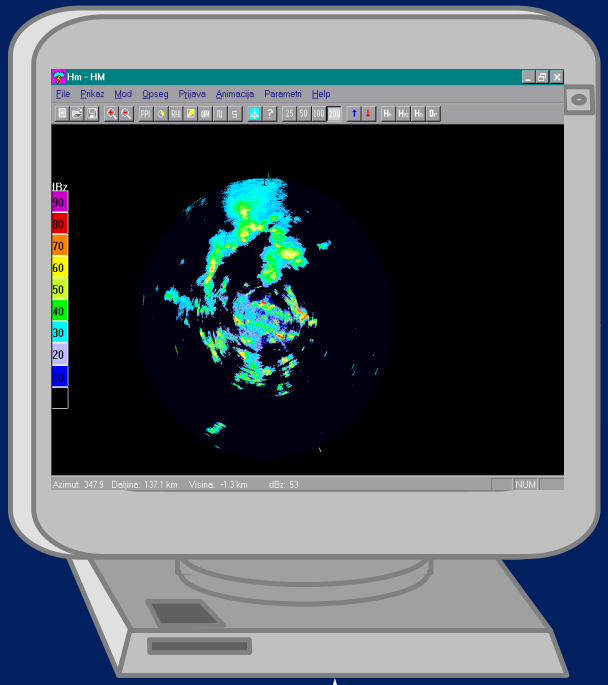
- Software for administration of radar center

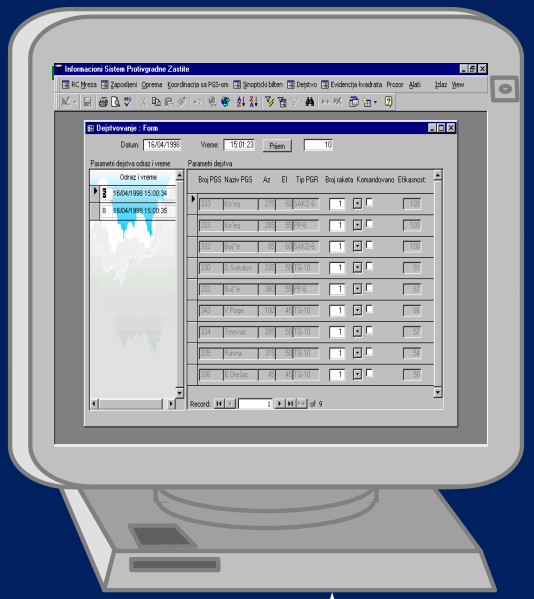
Additional workstation
PLANSETA

Main workstation
RADAR

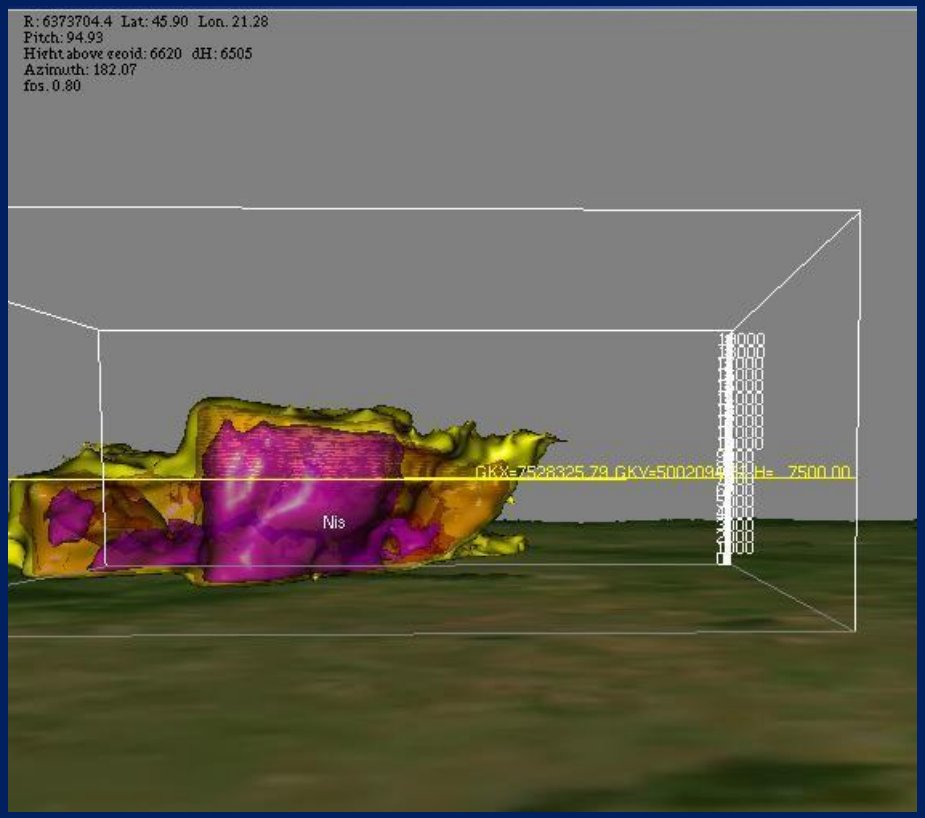
Additional workstation
STRELAC

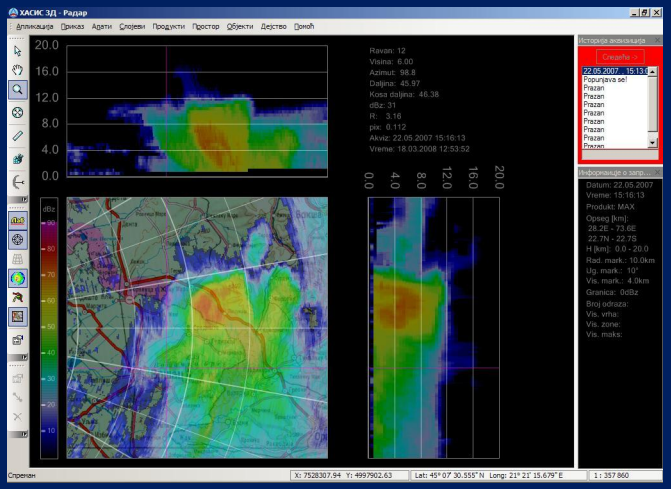


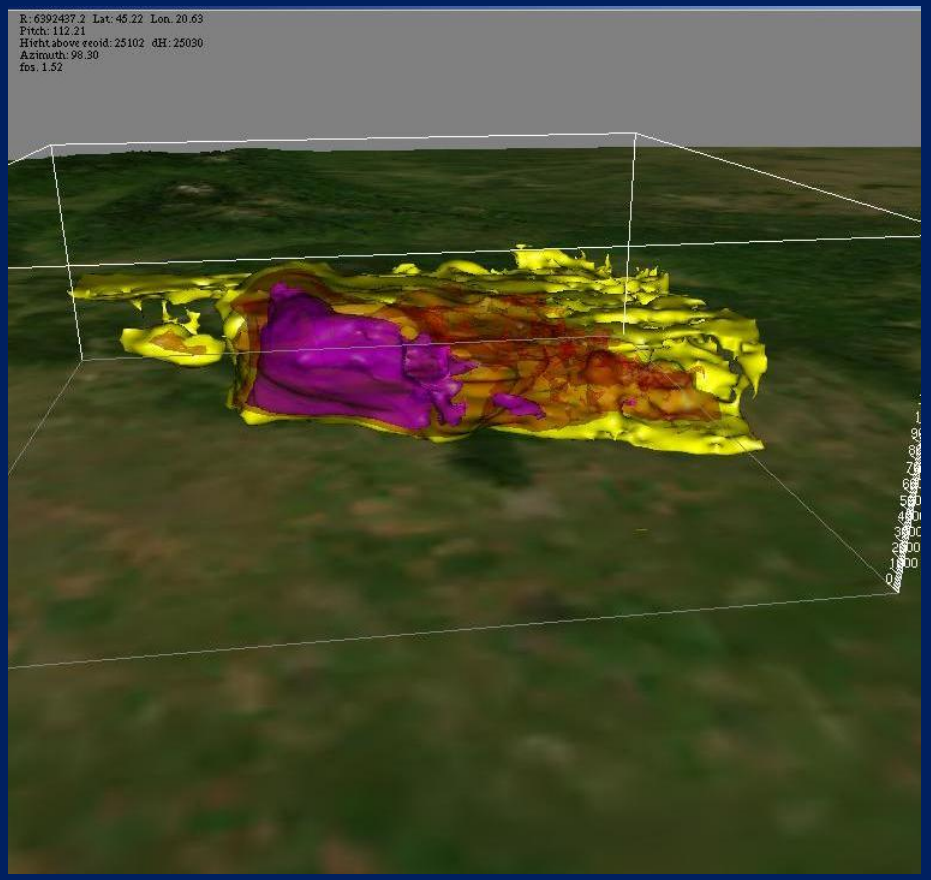


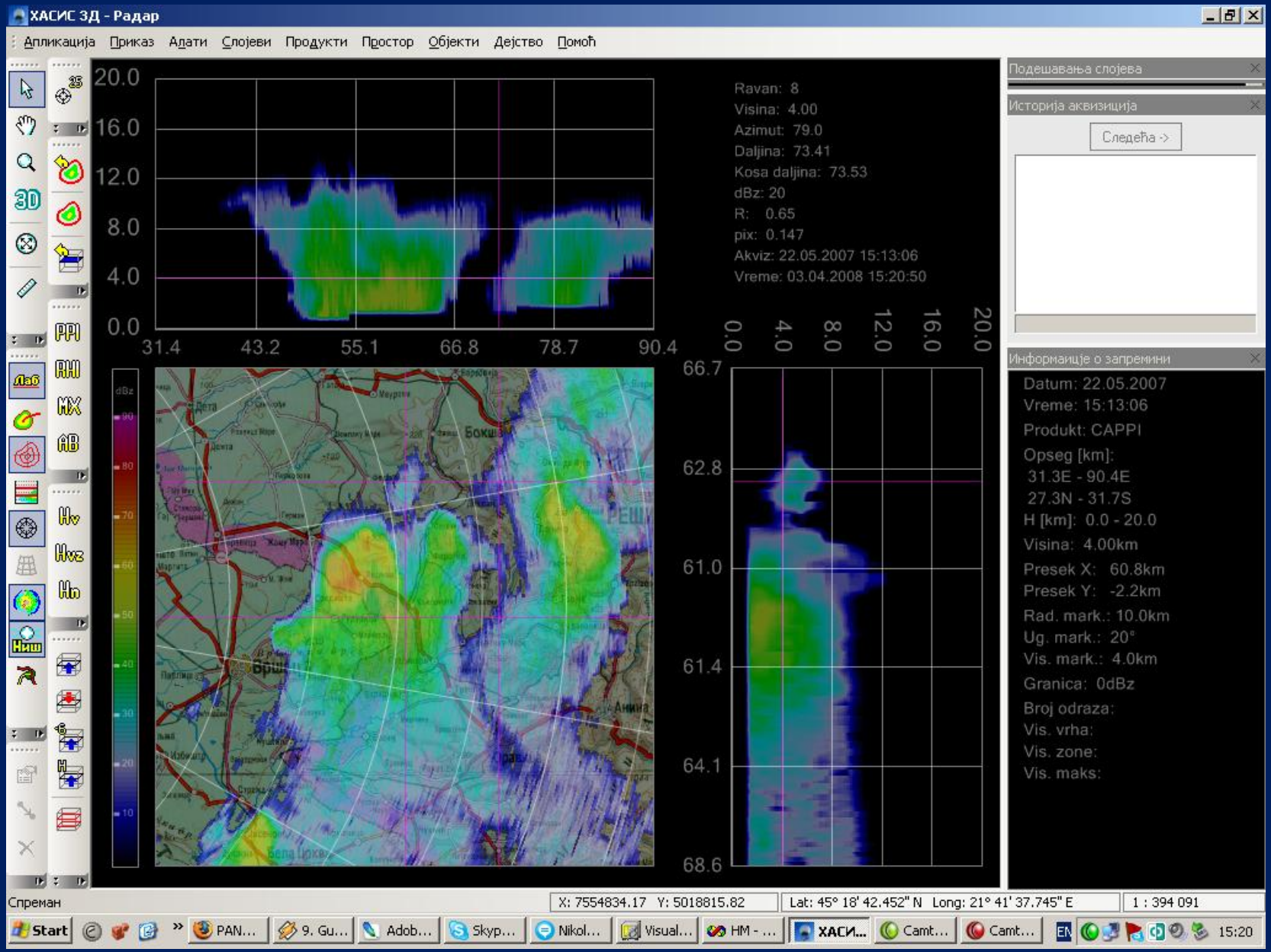


3D View in HASIS-3D

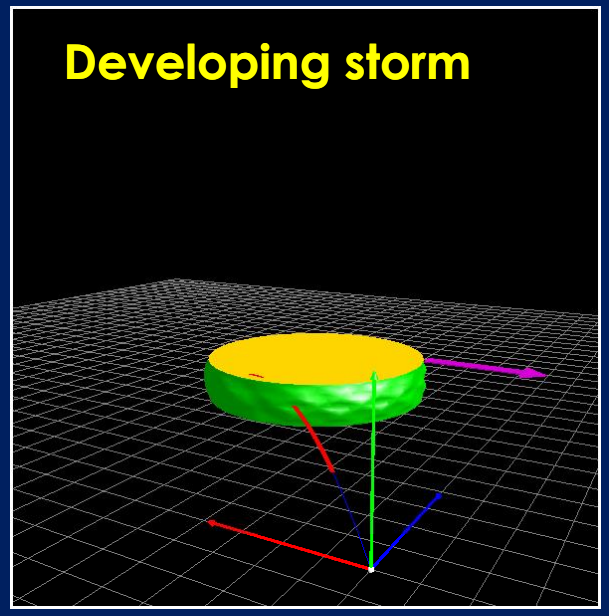


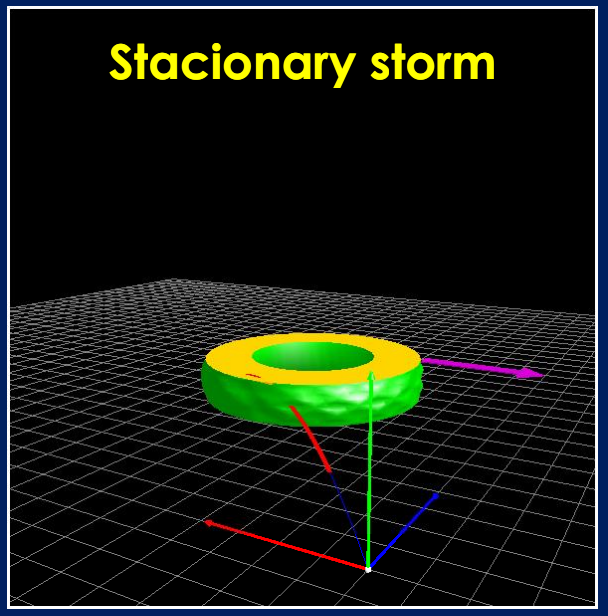


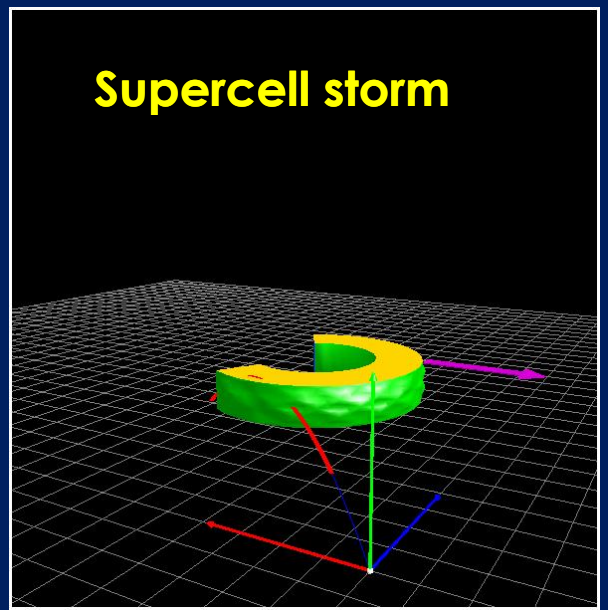


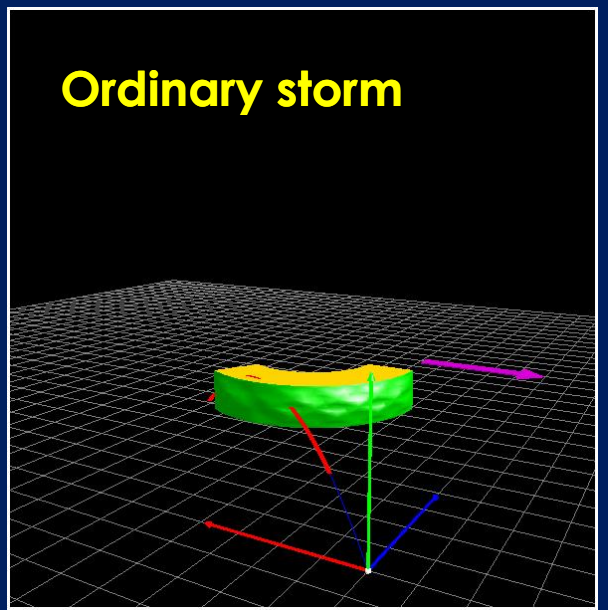

ХАСИС 3Д - Радар
Апликација Приказ Алати Слојеви Продукти Простор Објекти Дејство Помоћ
Ravan: 8
Visina: 4.00
Azimut: 79.0
Daljina: 73.41
Kosa daljina: 73.53
dBz: 20
R: 0.65
pix: 0.147
Akviz: 22.05.2007 15:13:06
Vreme: 03.04.2008 15:20:50
Подешавања слојева
Историја аквизиција
Следећа ->
Информације о запремини
Datum: 22.05.2007
Vreme: 15:13:06
Produkt: CAPPI
Opseg [km]:
31.3E - 90.4E
27.3N - 31.7S
H [km]: 0.0 - 20.0
Visina: 4.00km
Presek X: 60.8km
Presek Y: -2.2km
Rad. mark.: 10.0km
Ug. mark.: 20°
Vis. mark.: 4.0km
Granica: 0dBz
Broj odraza:
Vis. vrha:
Vis. zone:
Vis. maks:
Спреман
X: 7554834.17 Y: 5018815.82
Lat: 45° 18' 42.452" N Long: 21° 41' 37.745" E
1 : 394 091
Start
15:20

ZONES FOR SEEDING

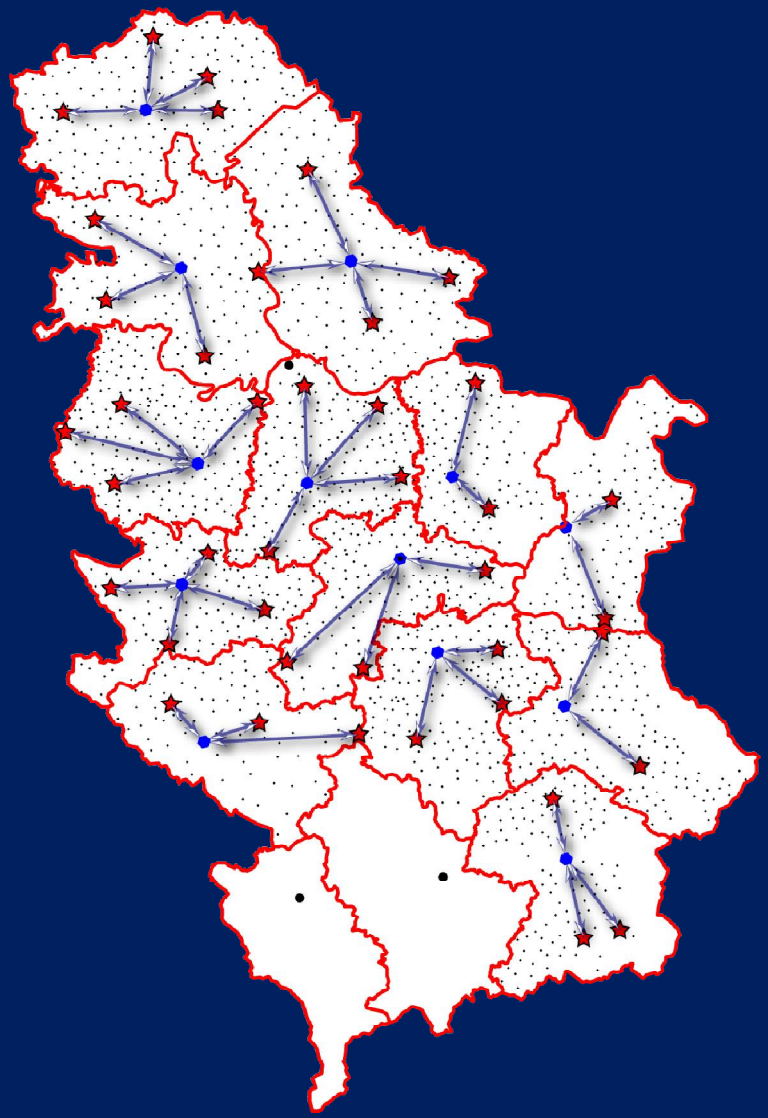


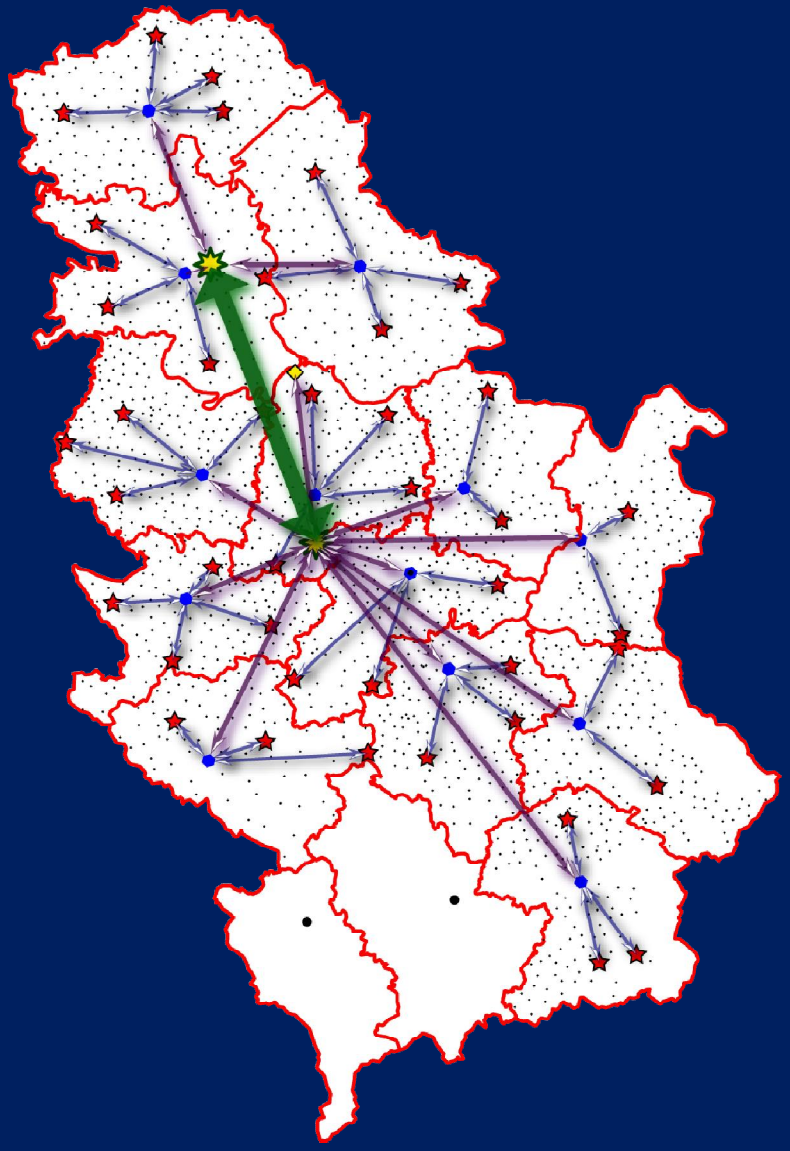






SYSTEM FOR TELECOMMUNICATION





LAUNCHING SITE

UNIVERSAL ROCKET LAUNCHERS

safe firing of all types of anti-hail rockets

Operational characteristics:

- quick and easy to manual handling
- enables stable and precise firing of the rocket
- calibration of slides enabled
- the rocket can be easily connected to the power supply (24V)
- long life span and easy maintenance
- rocket launching per minutes: 10 or 12

Dimensional characteristics

- Caliber 75±10 mm
- No. of launching tracks: 1-6
- No. of conic supports: 1-4 or 1-6
- Effect zone-azimuth 0°-360° with 5° lap
- Effect zone-elevation 45°-85° with 5° lap
- Mass 85 kg
- Dimensions: 1705 x 840 x 600 mm

ANTIHAIL ROCKETS
Manufactured in Serbia

КПГР-6

Kwsic
VALJEVO

ПП-6
ПП-6Т
ПП-6 КС

KORPORACIJA Polihester a.d. PRIBOJ

ТД-6

TRAYAL KORPORACIJA

ТД-6Б

TRAYAL KORPORACIJA

ТГ-10

AD 19.decembar

ПП-8

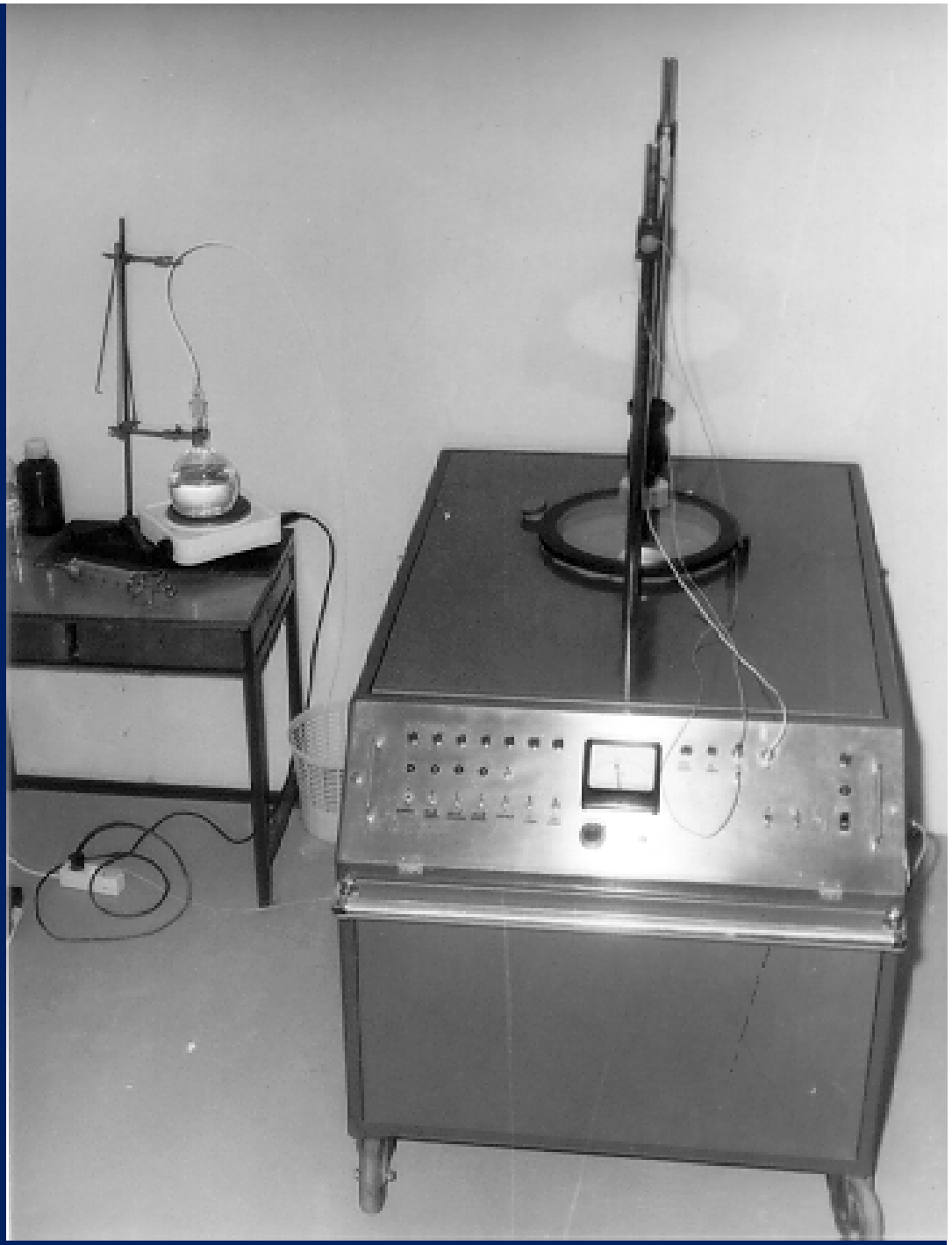
KORPORACIJA Polihester a.d. PRIBOJ

ANTIHAIL ROCKETS

- 1-9.5 km seeding radius: TG-10, PP-8
- 0.5-6 km seeding radius: PP-6, TD-6, KPGR-6
- Mass of reagent: 400-500 g AgI
- Active nuclei per gram of reagent at -10°C: $10^{12\text{-}13}$
- Smoking time: 28 ± 2 s
- Time to self-destruction: 5s after end of smoking
- Launching from launching tubes or launching tracks.
- Average price: 250 Euros.

ANALYSIS OF ROCKET FUNCTION IN STATIC CONDITION

CONTROL MEASUREMENTS OF SEEDING MATERIAL EFFICIENCY FROM MANUFACTURED ROCKETS IN ISOTHERMAL CHAMBER HMSS



EXPERIMENT IN ISOTHERMAL CLOUD CHAMBER VINCA

- Temperature range: from –1°C to –20°C
- Adjustment of the liquid water content (LWC, g/m^3)
- Performance of the experiment:
  - Burning out of the reagent – formation of aerosol
  - Aerosol homogenization
  - Introduction of aerosol in the chamber
  - Recording of time after the sample introduction
  - Extraction of the microscopic platelets from the chamber; observation under microscope after 1st, 3rd, 6th…15th minute
  - Counting of crystals – total number of crystals N; calculation of A; formula

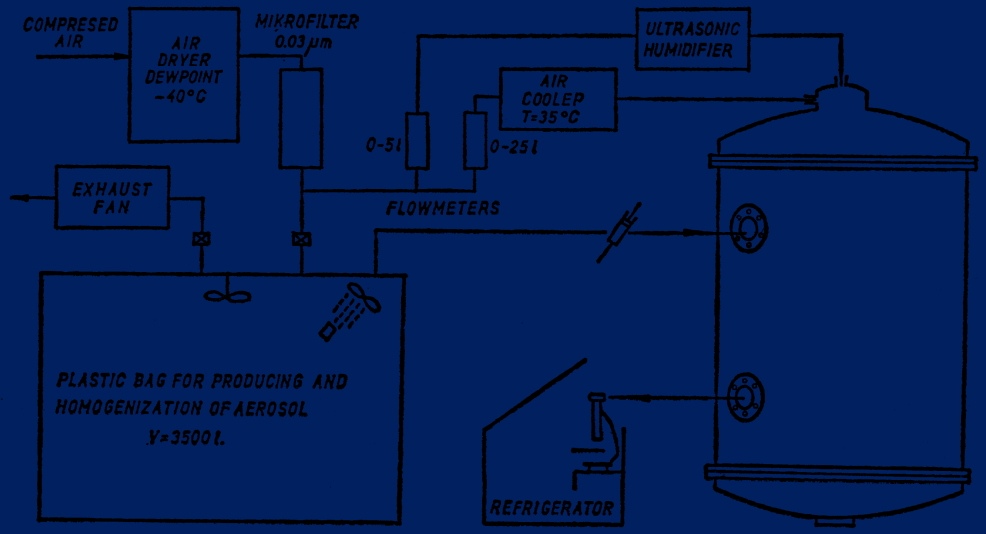


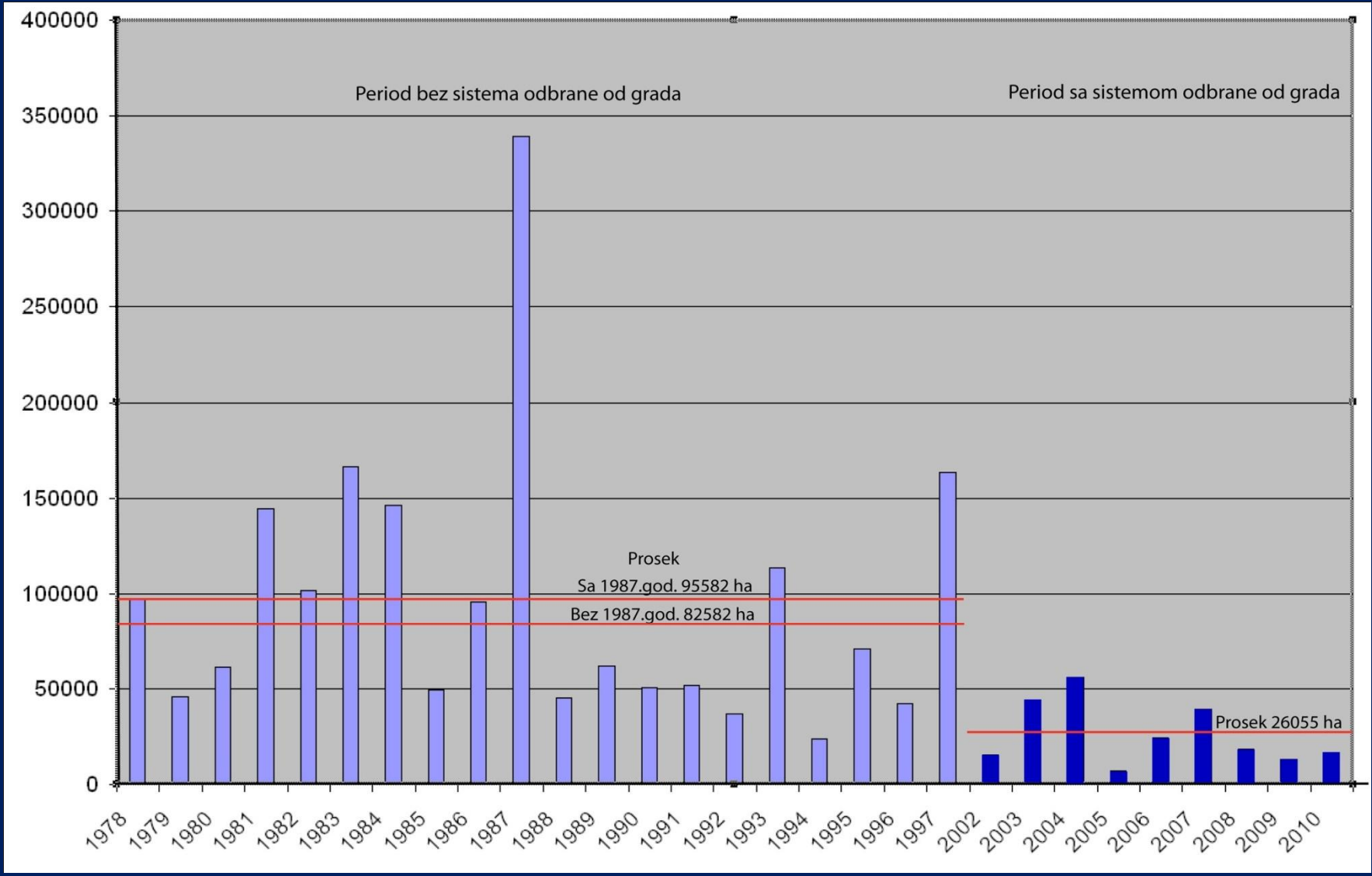
Fig. 3. Schematic of the experiment with the corresponding equipment.

$$A = \frac{N}{m} \cdot \frac{VS}{vs}$$

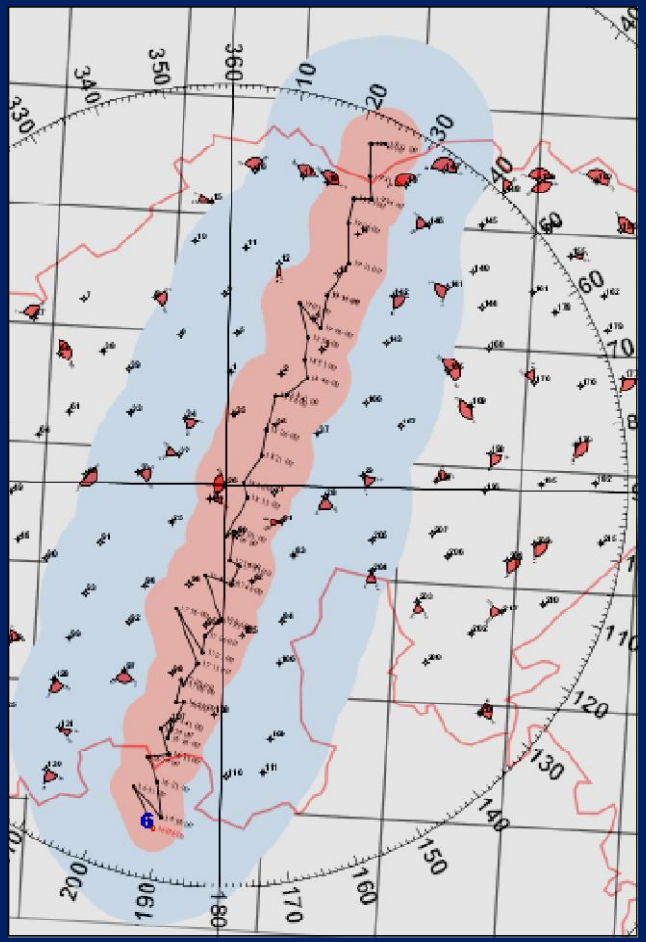
M.A.Huter, M. Čurić,

Fizika 19 (1987.) 4, 433-440

HAIL DAMAGES IN VOJVODINA



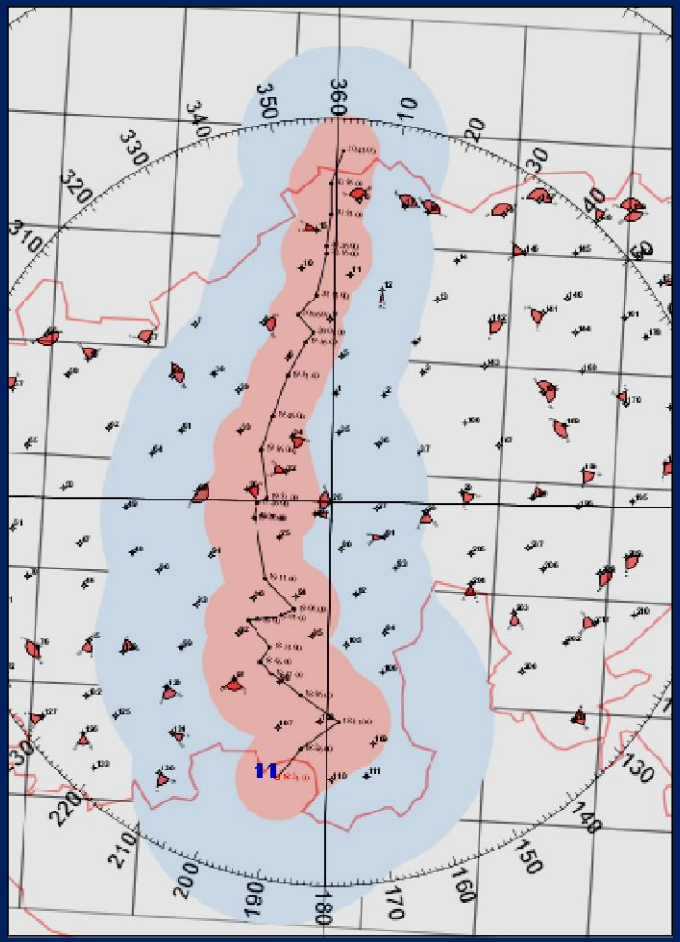
2 SUPERCELLS ON 11TH OF MAY 2013.

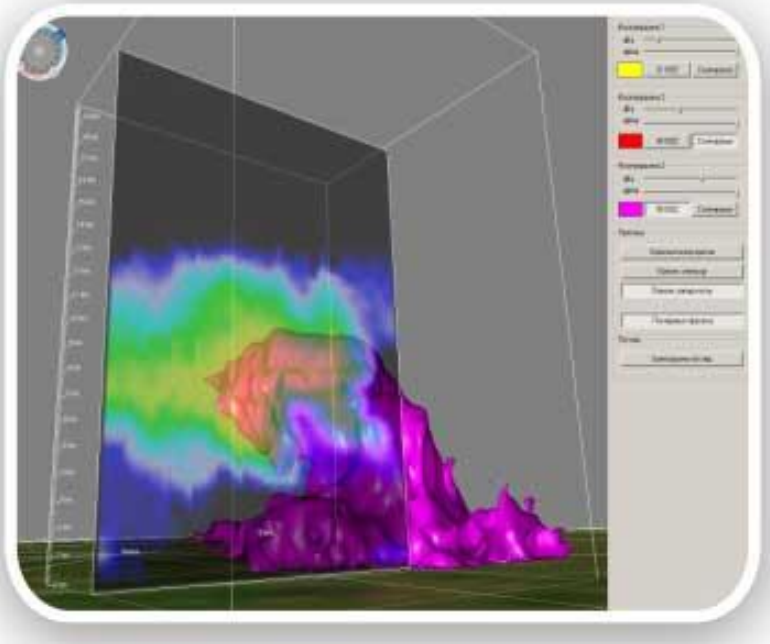


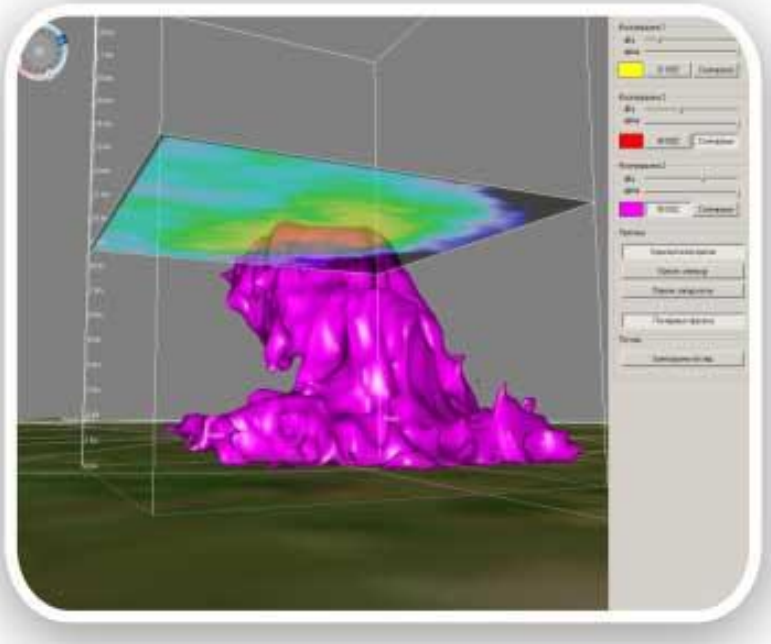
The cell on the left side was on territory of the radar center Bajsa from16:06 to 19:51,

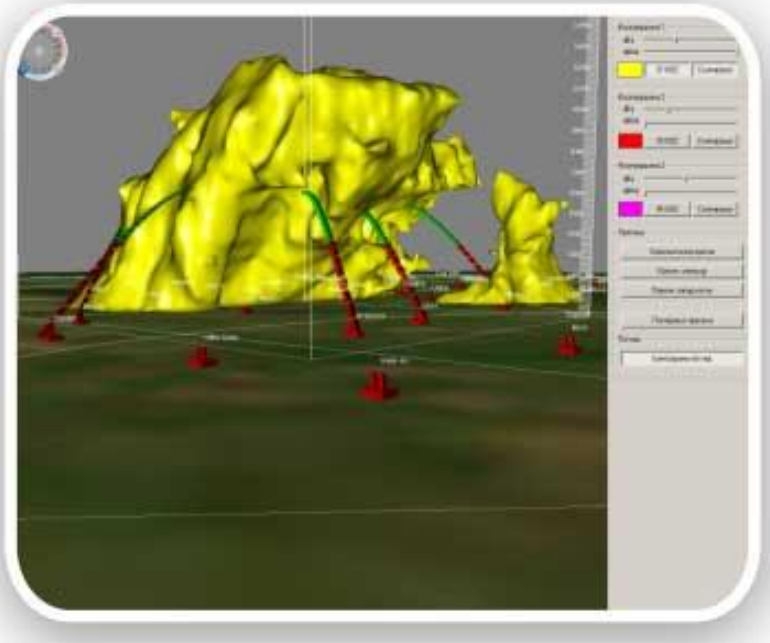
The cell of the right from 18:21 to 20:41 percig

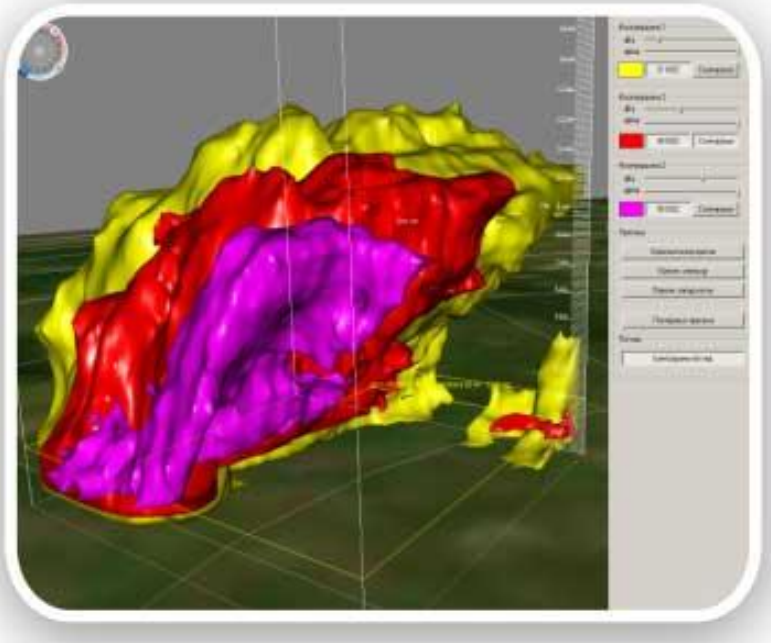
The second cell caused a big hail with big damage on crops, becouse we did not have rockets.



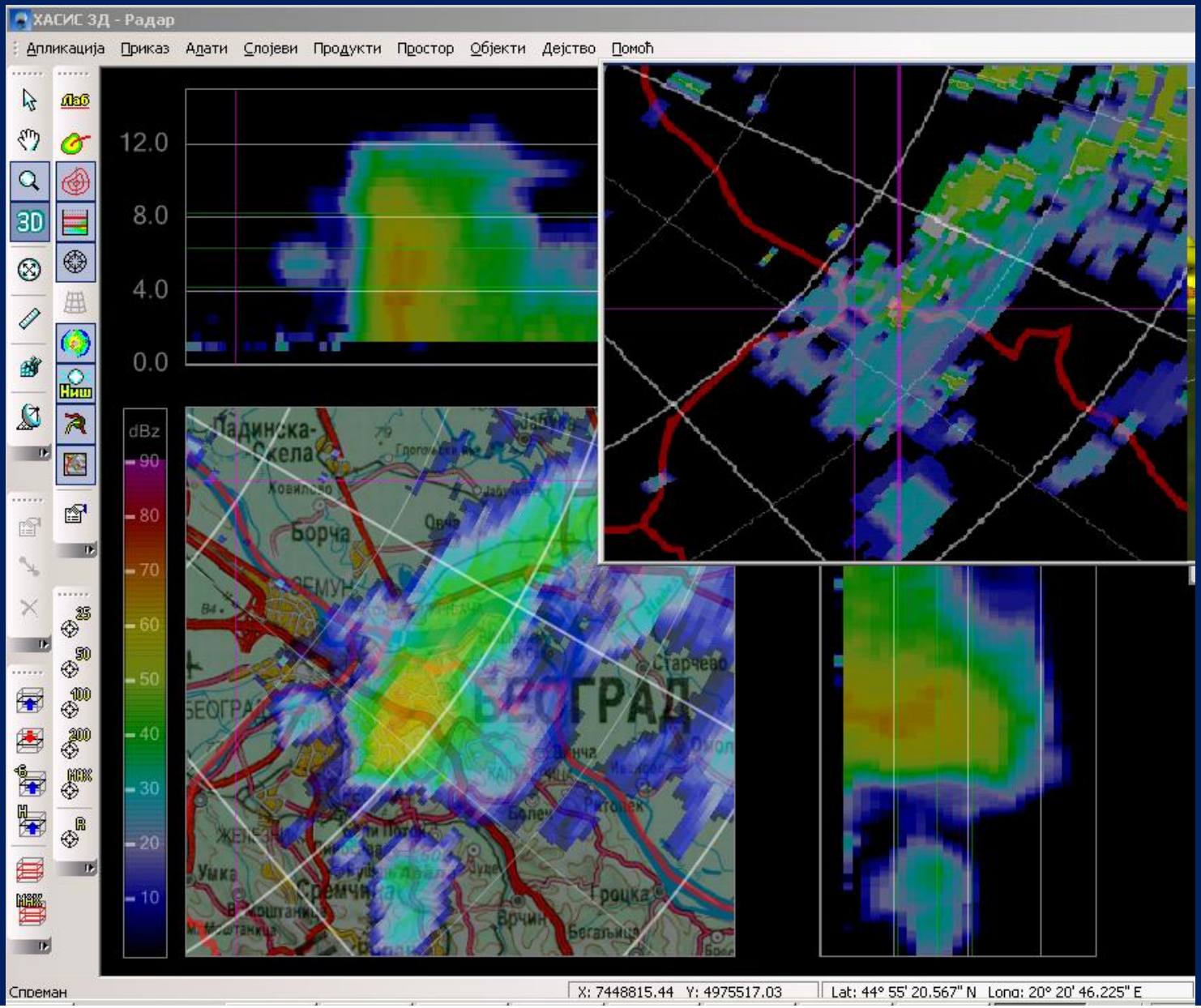








Comparative view of radar reflectivity and radial velocity of the same convective cloud



Comparative view of reflectivity and differential reflectivity