Weather radars

basic principles and application in nowcasting in Romania

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WeADL 2021 Workshop

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WeaMyL

METEO ROMANIA

Norwegian Meteorological Institute

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- Operational and research activities
- Coordination of the national weather radar network
- Reasearch on severe storms and climatology

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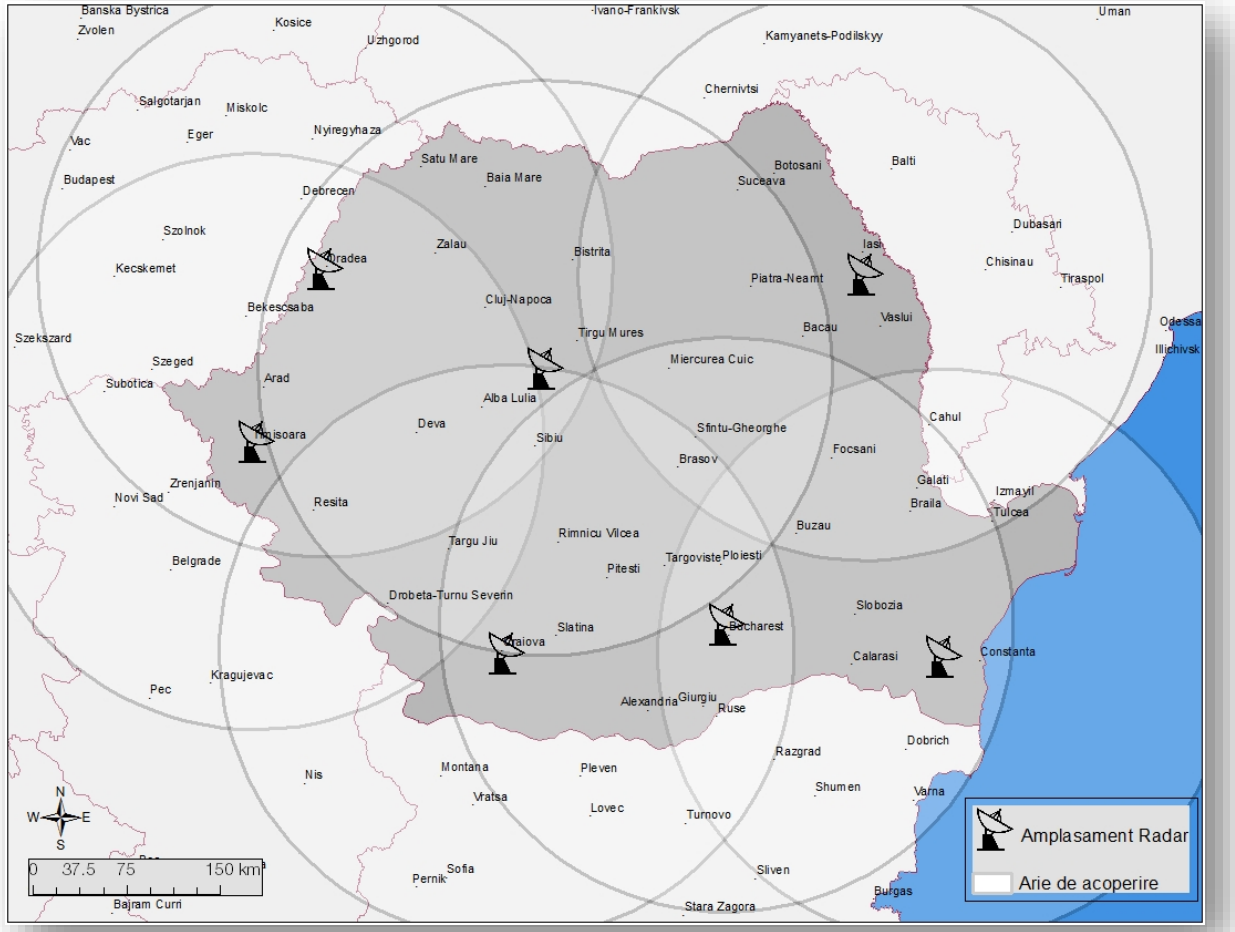
Outline:

- Introduction
- Weather radar systems
- Basic principles
- Basics of data interpretation

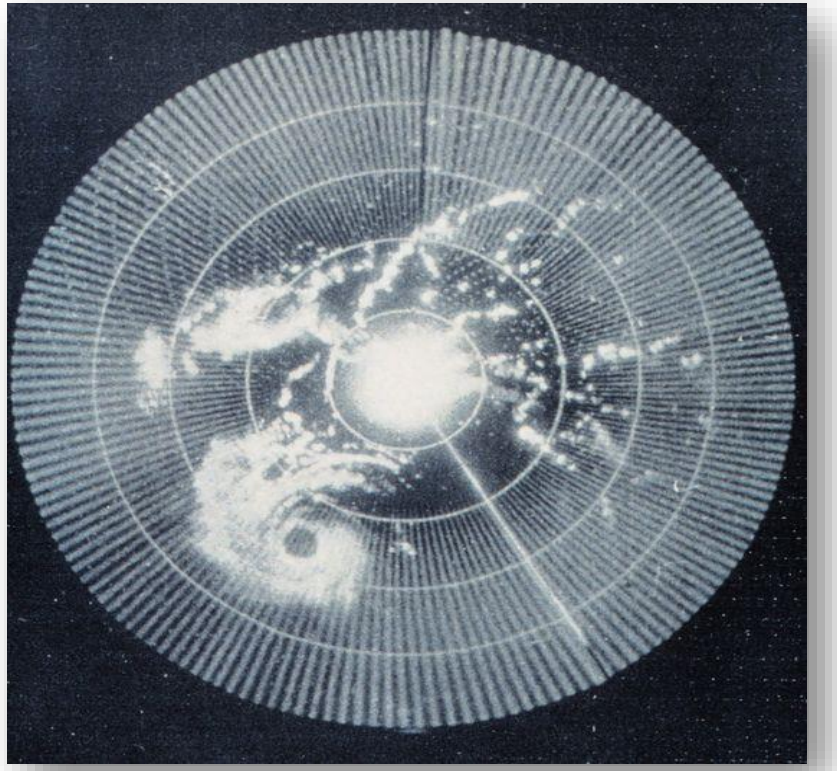


Romania NMAs Weather Radars Network

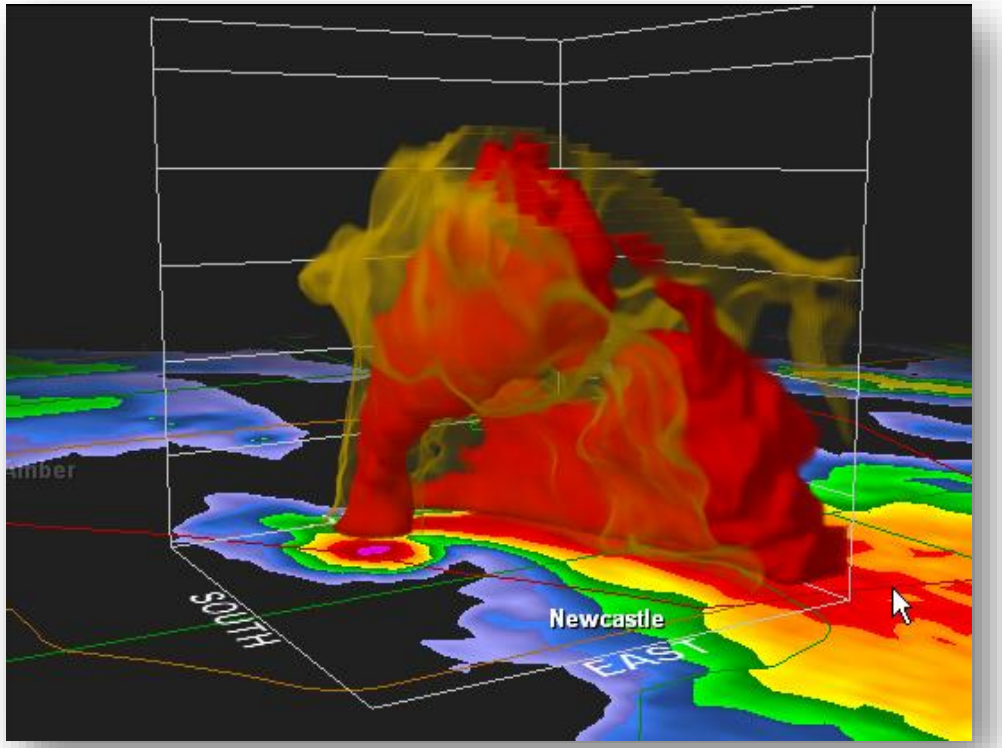
What RADAR means?

- Radar history
  - RADAR – Radio Detection And Ranging
  - Who invented radar?
  - Significant development of radar techniques during WWII
- Importance
  - Nowcasting (warnings)
  - Hydrometeorological warnings
  - Severe weather detection (ex. aviation)

Evolution



Simple Radar Display – 1960



Volumetric Radar Display - Today

Why use radar for forecasting:

- Vital tool for short-term forecasting
  - High spatial and temporal resolution
  - Shows you where the rain is and how intense areas of precipitation are
  - Shows where weather systems are in near-real time

- Detection of severe thunderstorms
- Movement of thunderstorms and fronts
- Crucial part of Nowcasting system

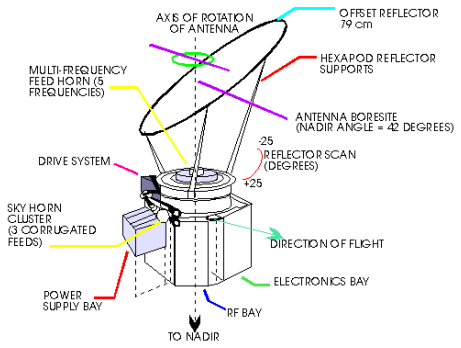
Severe convective storms

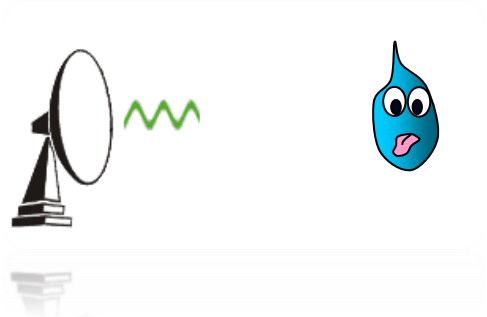
Large hail	Strong winds	Heavy rainfall	Lightnings

Radar systems

REMOTE SENSING

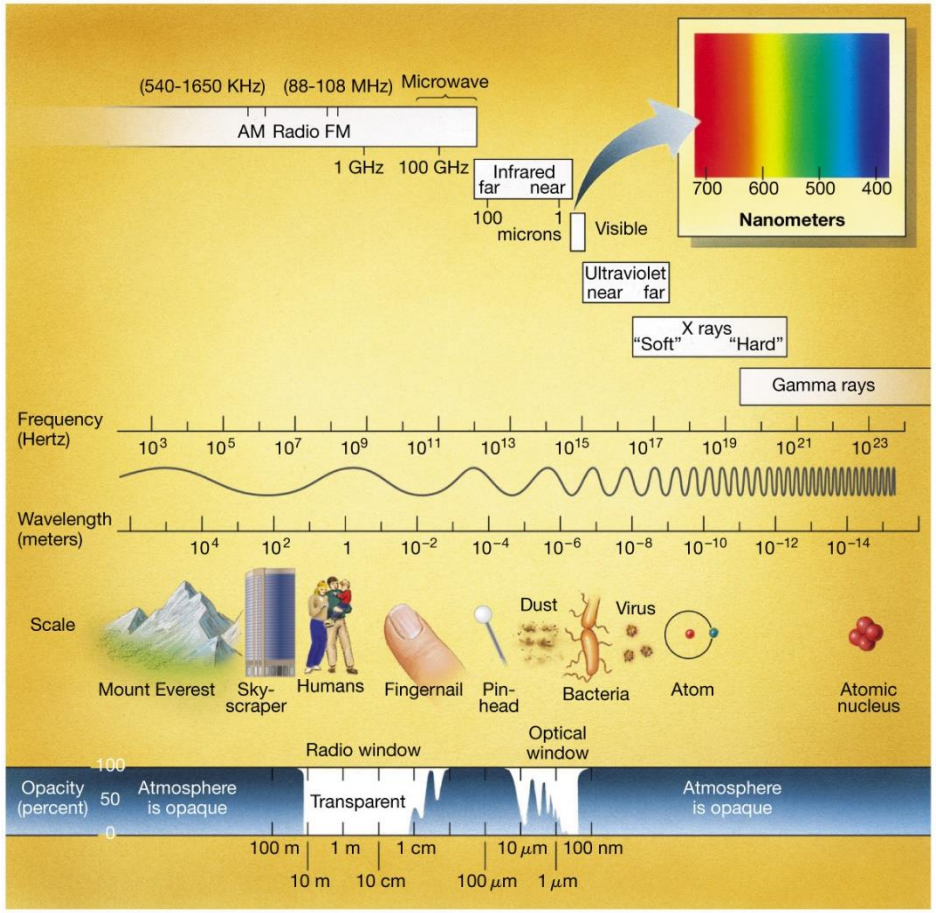
- PASSIVE
  - RADIOMETERS
- **ACTIVE**
  - **RADARS**





Scanning Multi-channel Microwave Radiometer (SMMR)

EM Spectrum



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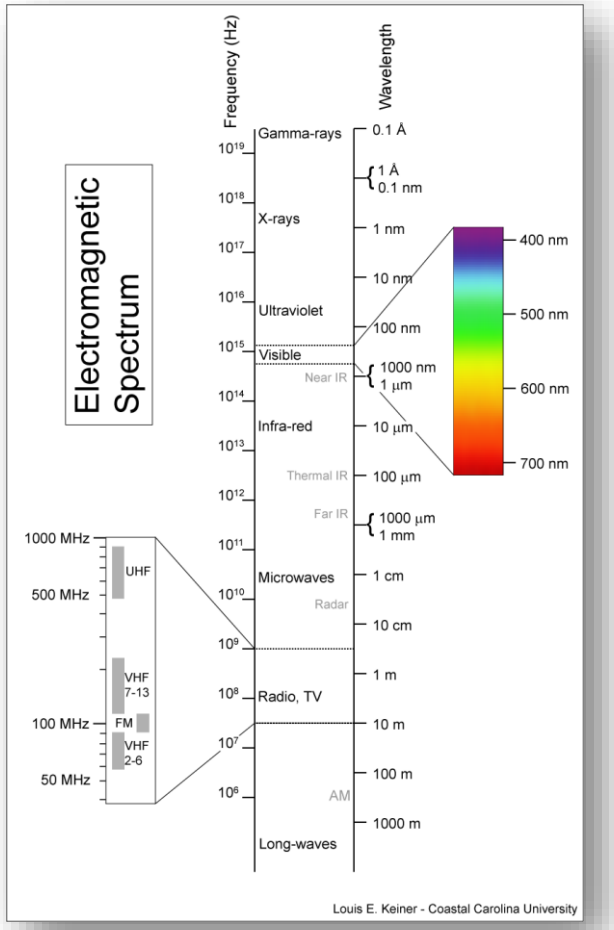
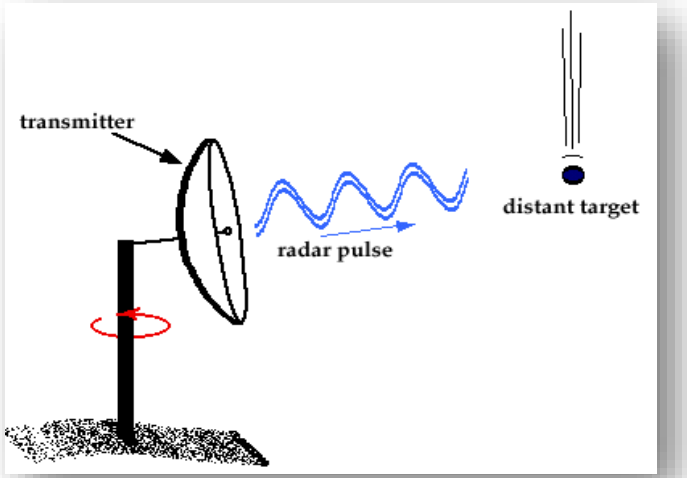
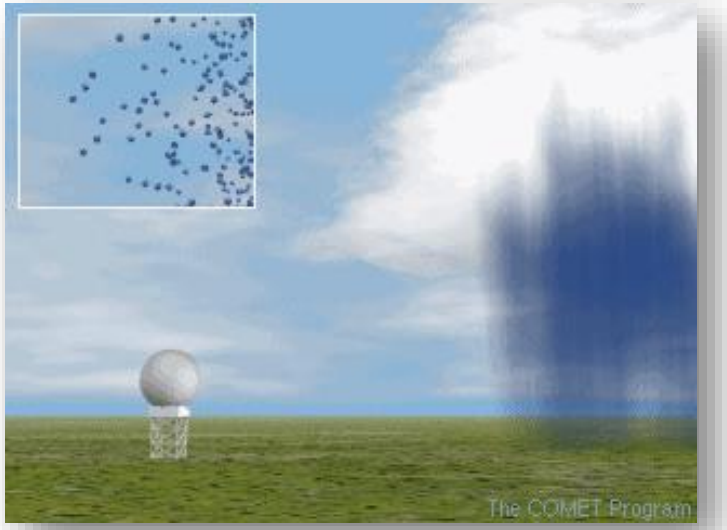
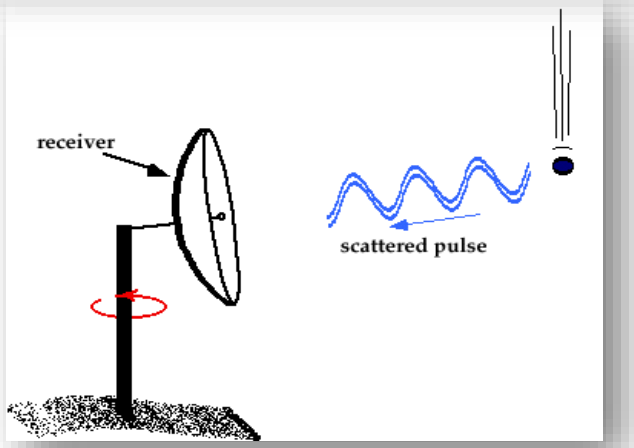


Basic principle



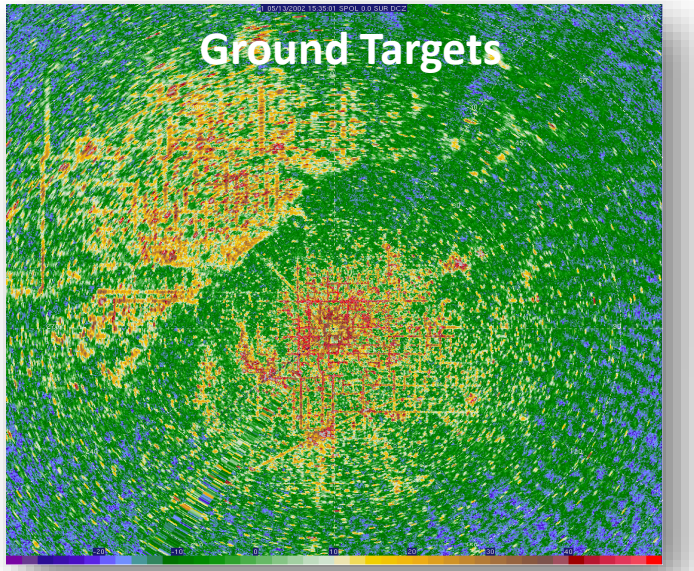




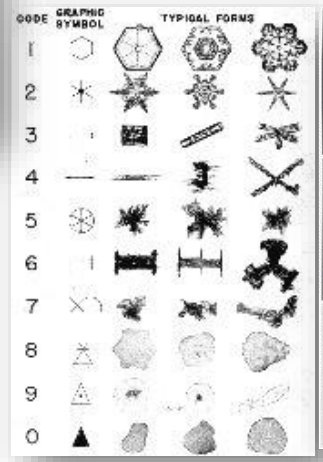
- Radio wave energy is transmitted ...

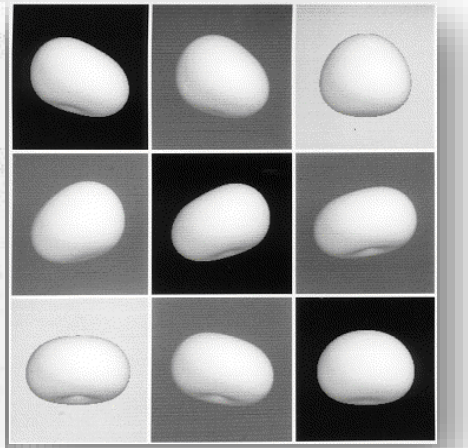
...and scattered back

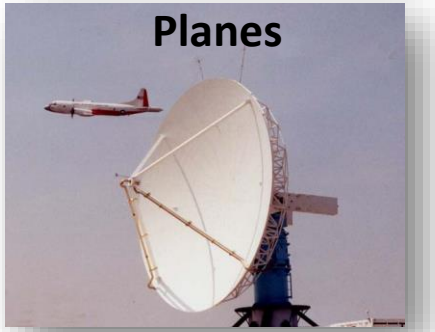
Targets



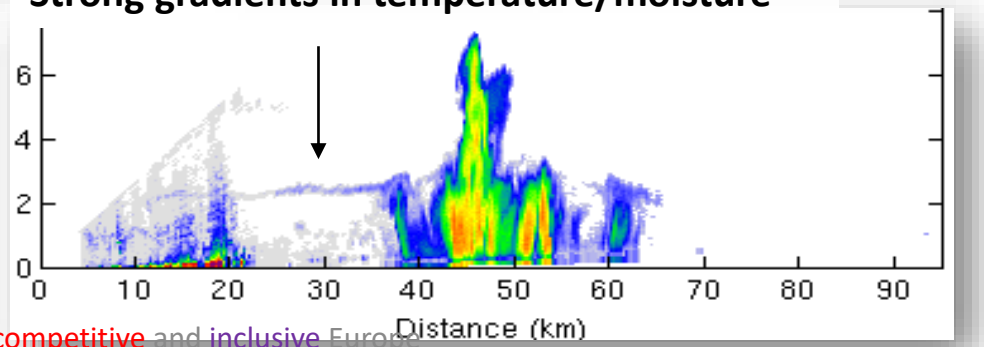
Precipitation particles





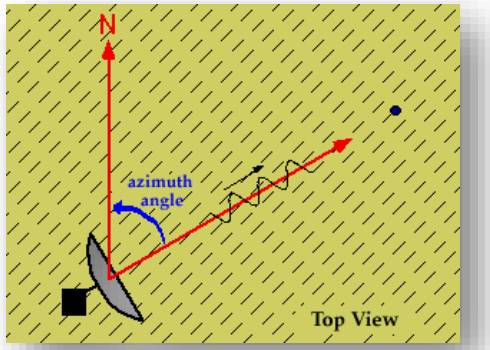


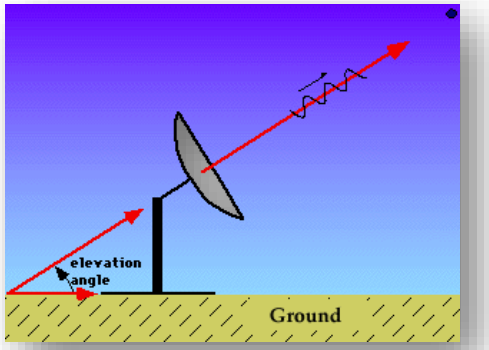
Strong gradients in temperature/moisture



Target location

- Three pieces of information
  - Azimuth angle
  - Elevation angle
  - Distance to target (range)

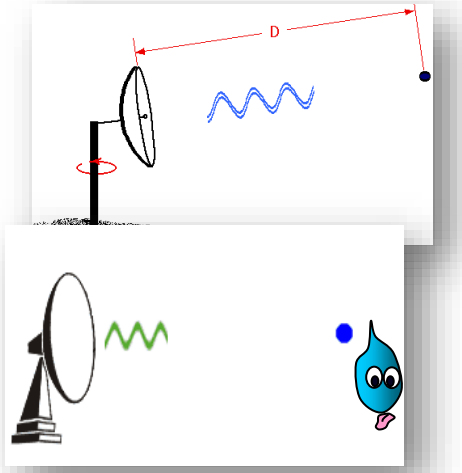




- From these data the radar can determine exact target location

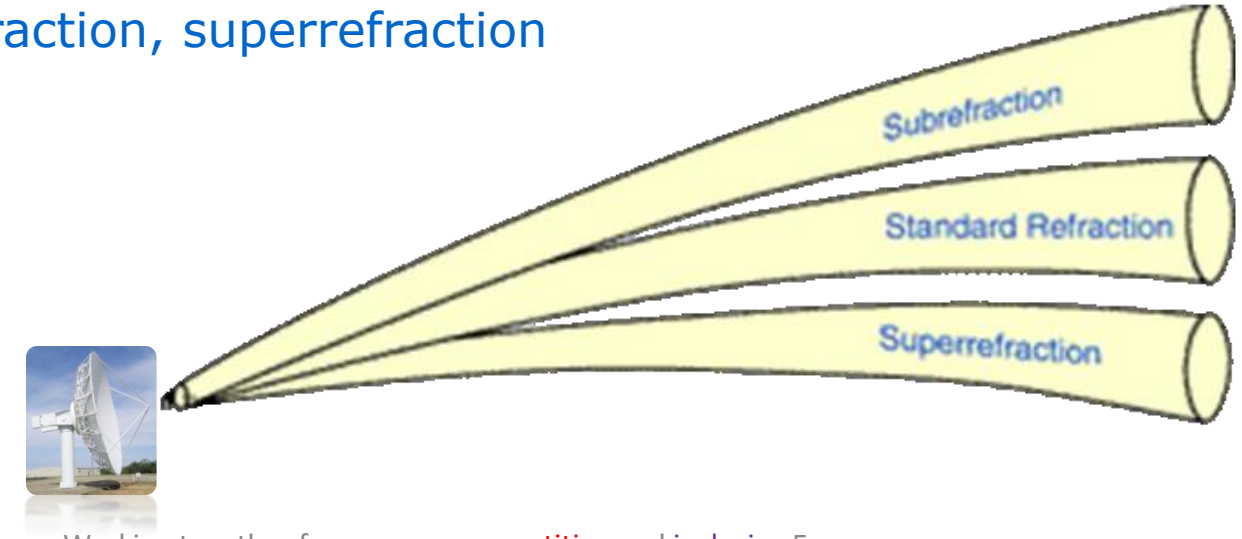
D = cT/2

T ≡ pulse's round trip time



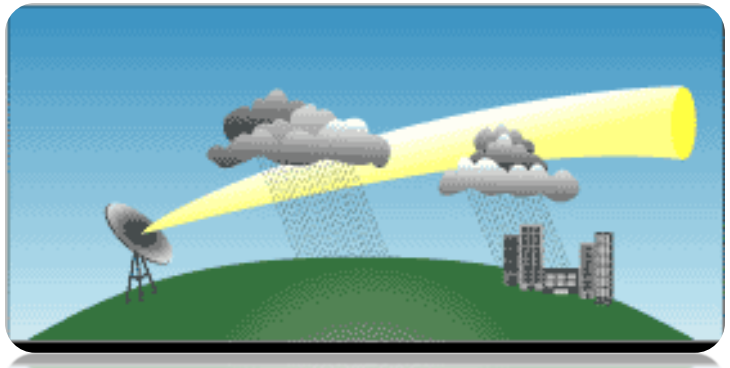
Beam propagation

- Propagation in **standard** atmosphere;
- Changing in atmospheric conditions – the beam propagation is different from the **normal** one;
- Rezults: subrefraction, superrefraction



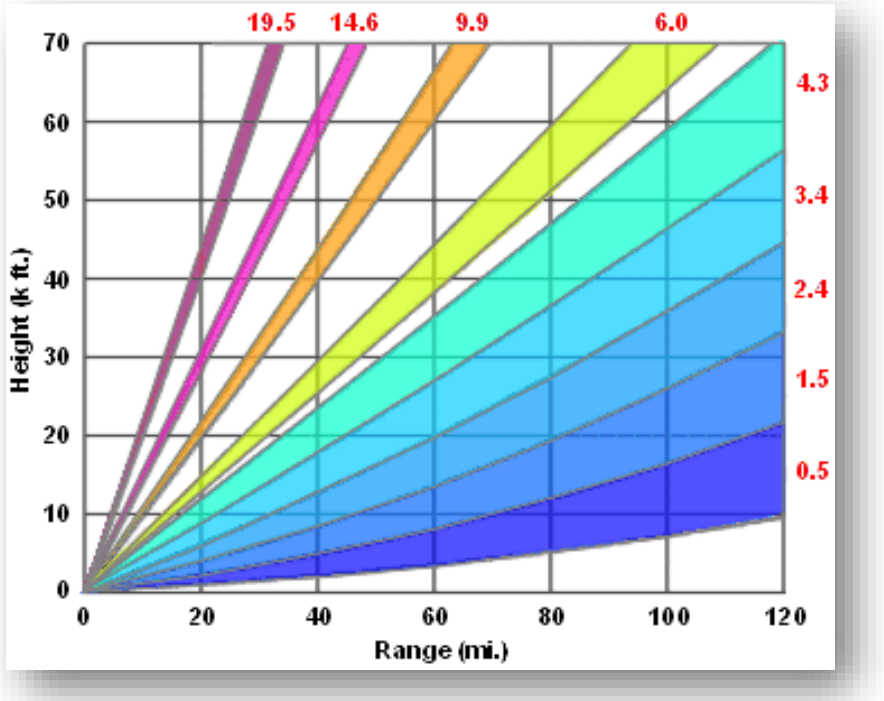
Limitations of measurements

- Ground clutter
- Anomalous propagation (AP)
- Partial beam filling
- Wet radome
- Incorrect hardware calibration



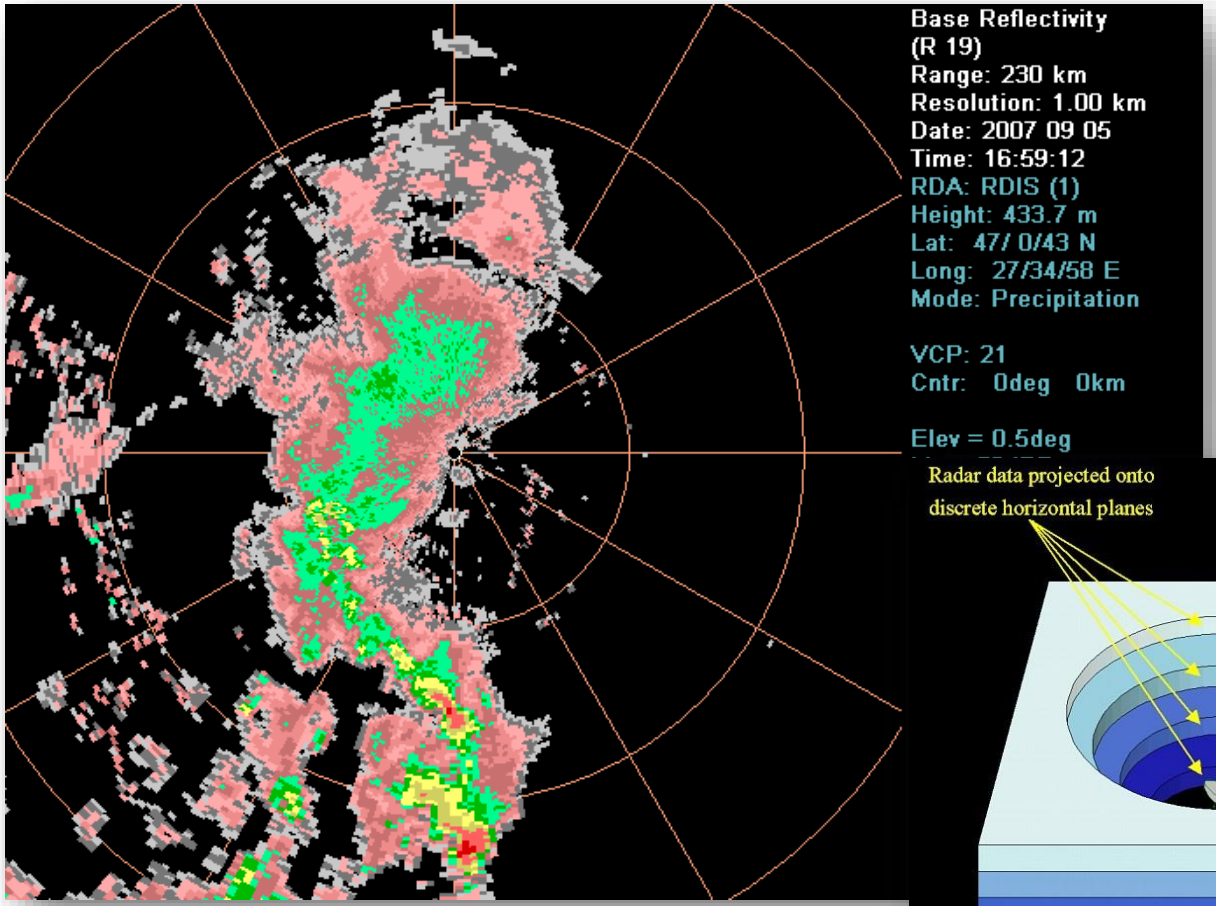
Volume scan

- VCP – rotating the antenna 360° in azimuth at different elevation angles in a certain time interval
- VCP21 – 9 elevations in 6 minutes

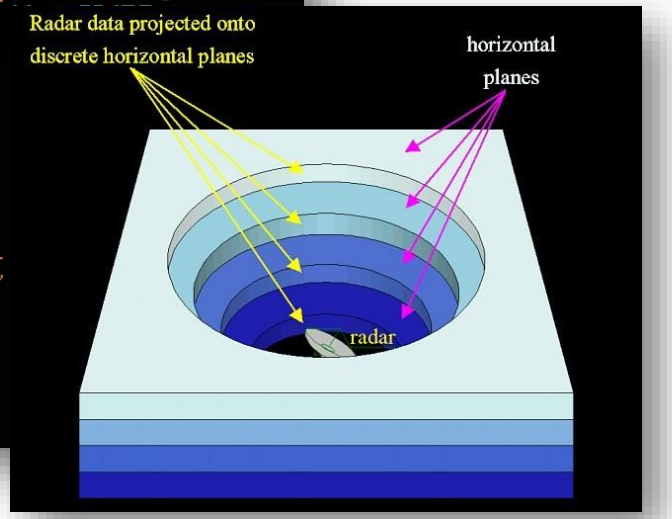


VOLUME COVERAGE PATTERN

Plan Position Indicator (PPI)

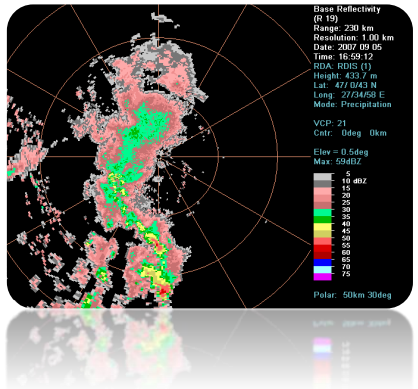


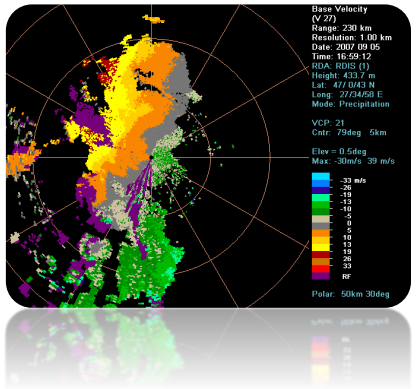
Afișare a datelor în modul PPI - un singur unghi de elevație (suprafața conului)

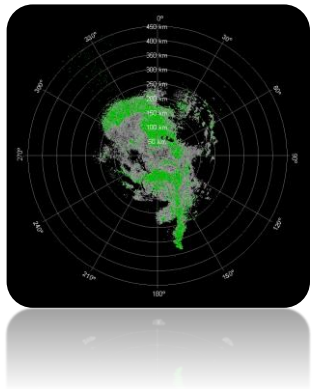


Base data:

- Three types of information
  - Reflectivity
  - Radial velocity
  - Spectrum width







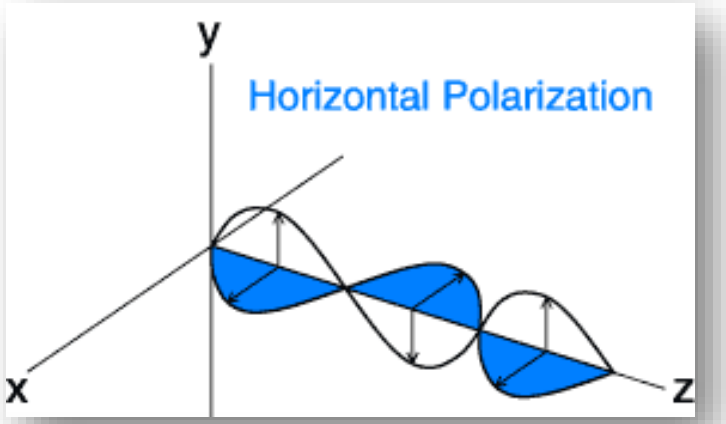
Doppler radar

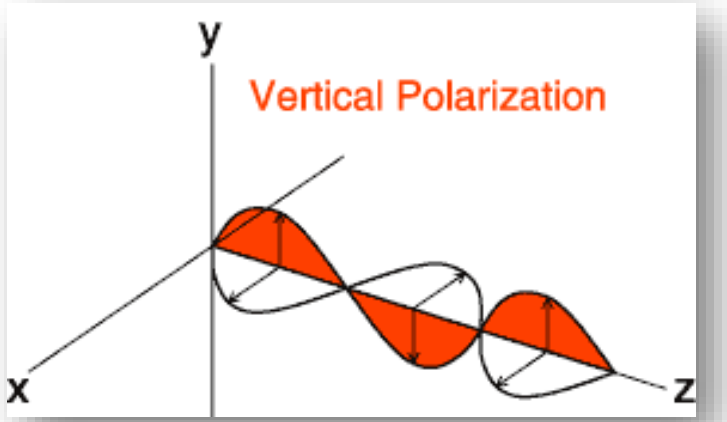
- Doppler radar – returned power and phase shift
- Doppler radar :
  - Radial velocity
  - Spectrum width

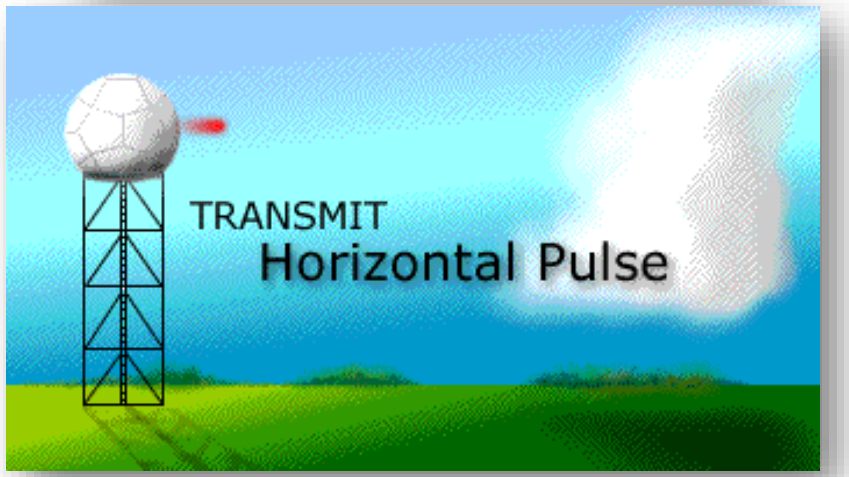
Benefits

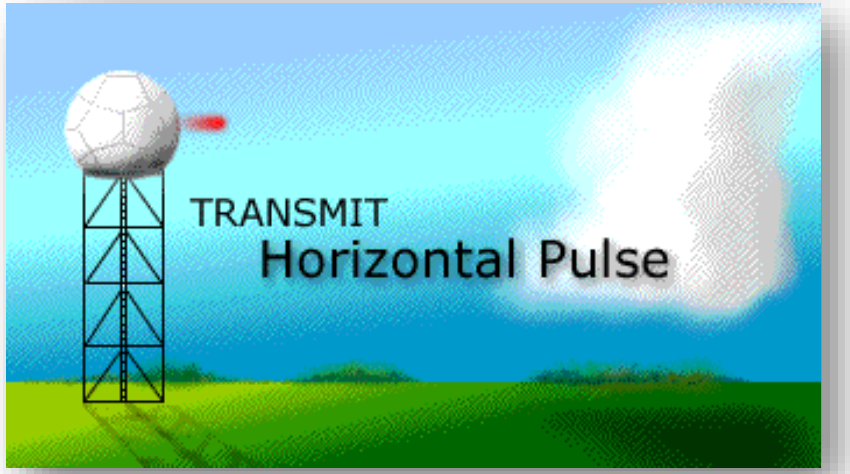
- Increasing the capacity of detecting severe convective storms and improving the forecast at mesoscale.

Dual-polarization radars:









Dual-polarization radars:

- Better weather prediction

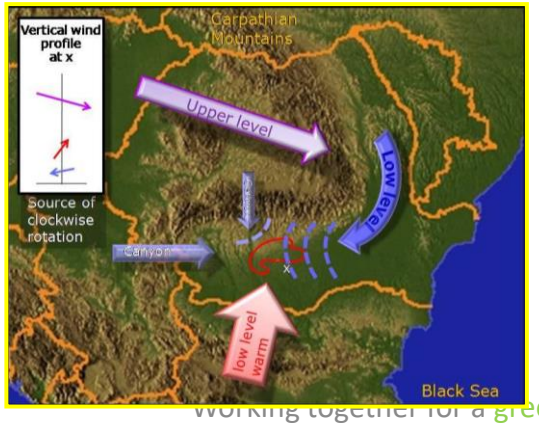
  - Improved estimation of rain and snow rates.
  - Discrimination of hail from rain and possibly gauging hail size.
  - Identification of precipitation type in winter storms.
  - Identification of non-meteorological targets.
  - Etc.

Much damage

Hard to forecast

The solution

Conceptual models



Based on radar and ***additional*** data

Radar analysis of storms

Radar signatures (detection) - you have indeed identified a certain signature on your radar display.

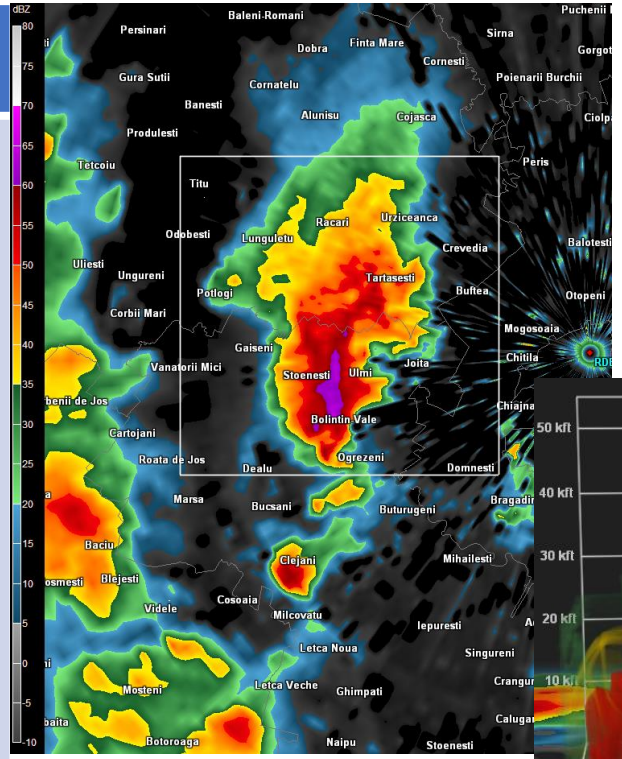
Conceptual models - knowledge on how the signature might have formed.

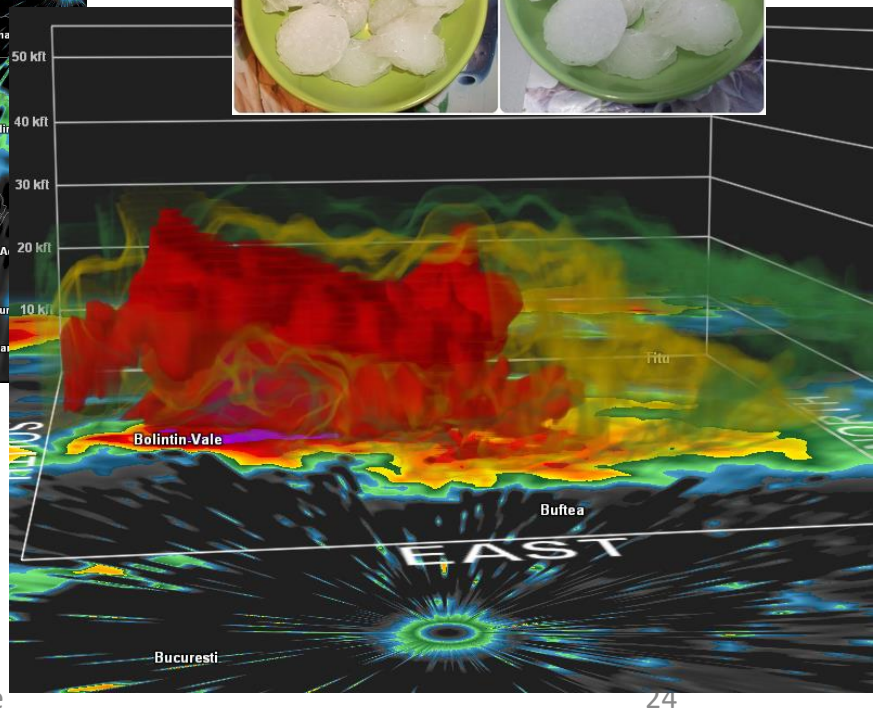
Diagnosis – how severe your specific signature might be within the range of all possible signatures of its kind.

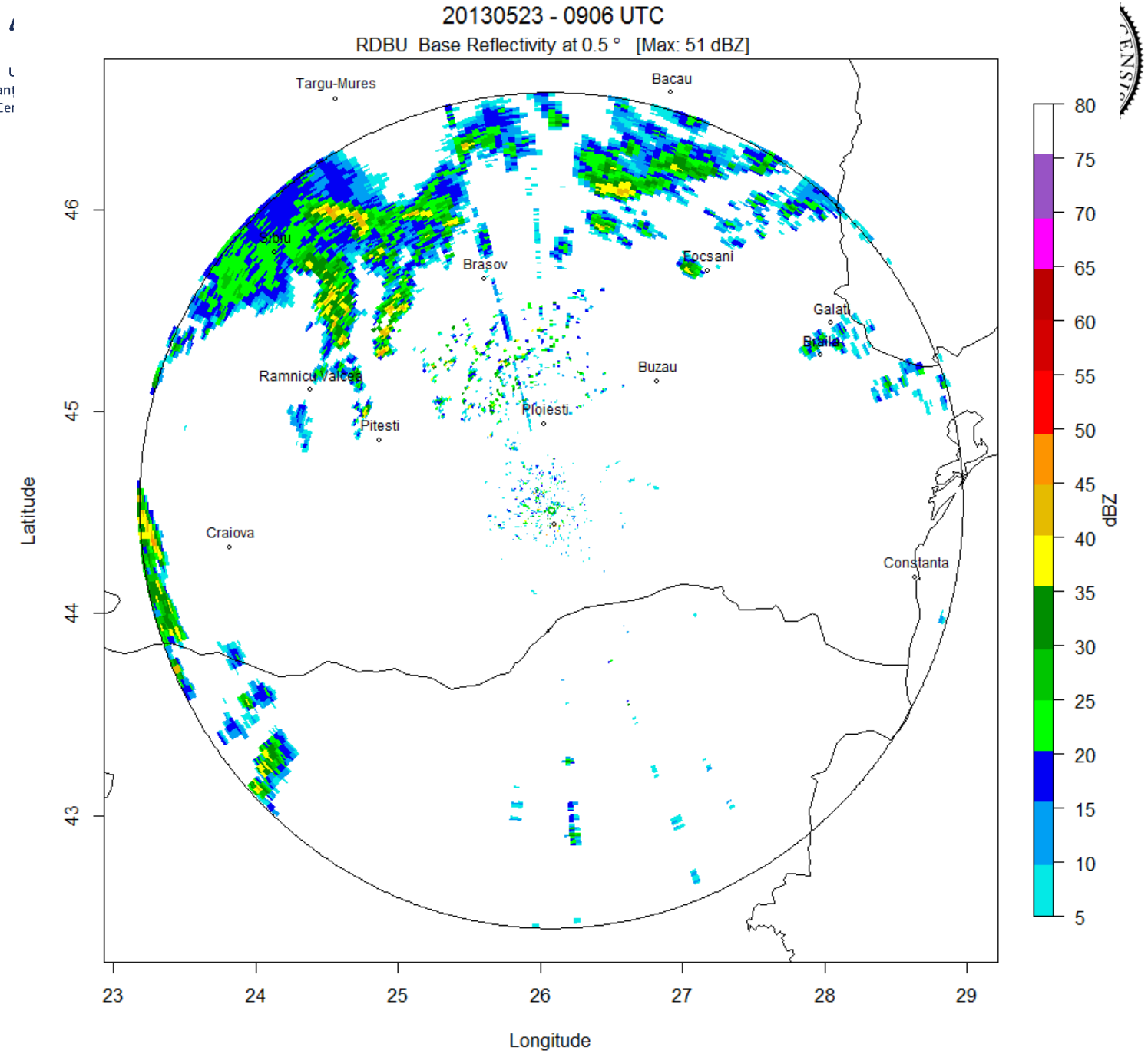
Radar Signatures for hail

Reflectivity:
- Strong low-level reflectivity gradient
- Storm-top displacement
- WER, BWER
- Hook echo / Pendant
- TBSS (radar artifact)
- 50dBZ echo through hail growth layer

Velocity:
- Mid-level rotation
- Strong storm-top divergence






20130523 - 0906 UTC
RDBU Base Reflectivity at 0.5 ° [Max: 51 dBZ]
Targu-Mures
Bacau
Brasov
Focsani
Galati
Braila
Buzau
Ramnicu Valcea
Ploiesti
Pitesti
Craiova
Constanta
Latitude
Longitude
dBZ
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45
44
43
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Thank you for your attention!