



OPERATIONAL GROUND BASED REMOTE SENSING at MET. SERV.

Ferenc Dombai PhD
Hungarian Meteorological Service

VERY SHORT OVERVIEW ON

- Weather radars - most widely used
- Wind profilers – mostly for NWP
- Lightning detection - thunderstorms
- Microwave radiometers - future
- Doppler Wind Lidars – airports and research

Essential variables: Pressure, Temperature, Relativ Humidity,
and hydrometeor distribution - rain, hail, snow

Identify meteorological phenomemas -

For issuing general information warnings and alarming

WEATHER RADAR (RAdio Detection ANd Ranging)

Short historical overview

1904 Hülsmeyer

Patent for WarShip observation by EMW

1921 Albert Wallace Hull

Creates the first MAGNETRON in UK

1935 - Home Chain

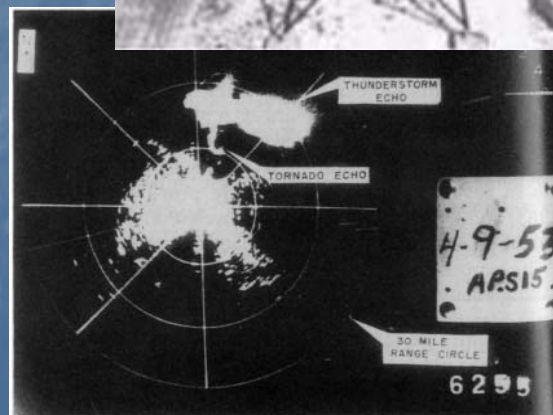
UK - AirForce set up defence radars

1940 - Home Chain detects
the first weather echoes

1947 First weather radar installed in USA
WASHINGTON

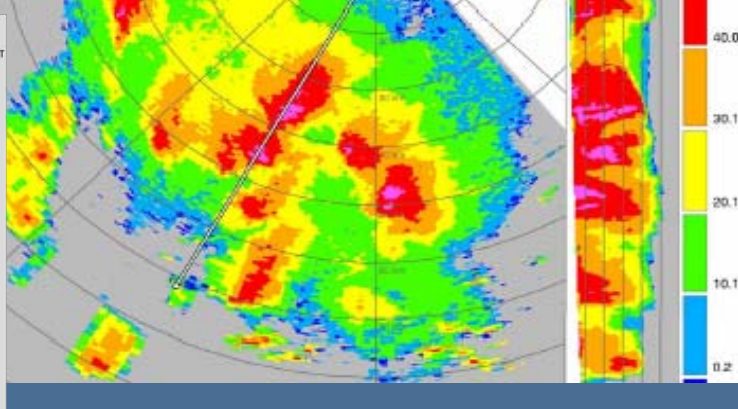
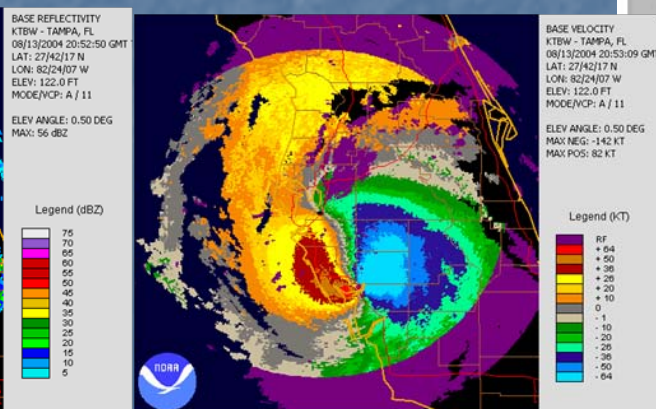
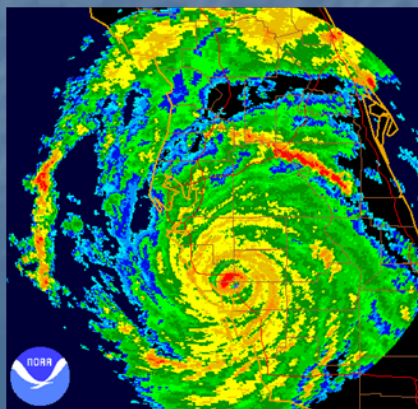
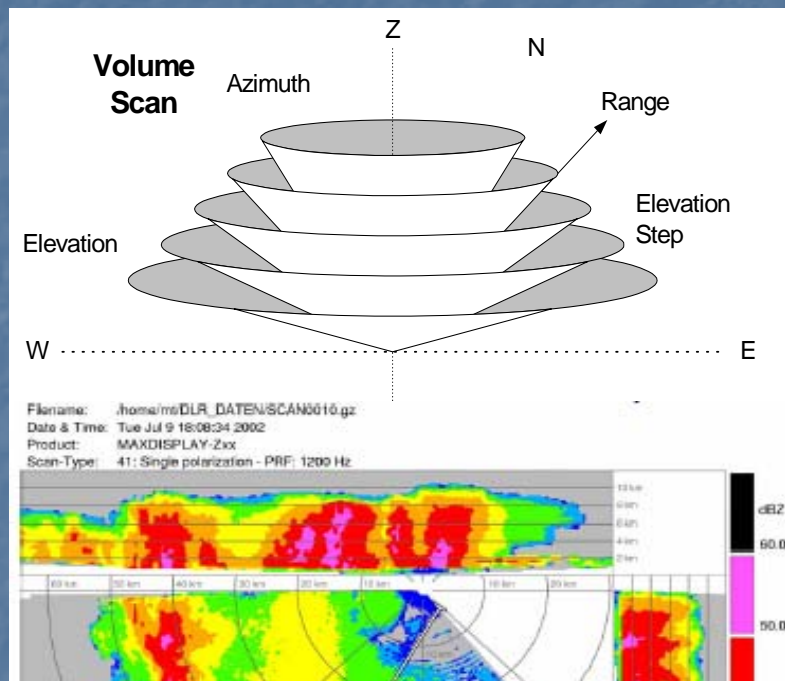
1985 – NEXRAD in USA

1999 – EUMETNET OPERA



TYPICAL WEATHER RADAR CHARACTERISTICS AND SCAN

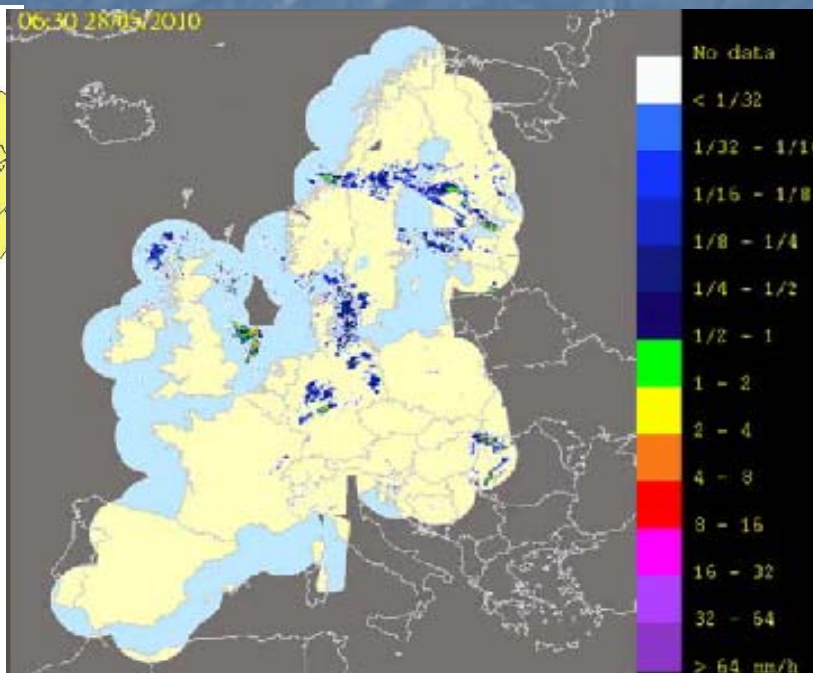
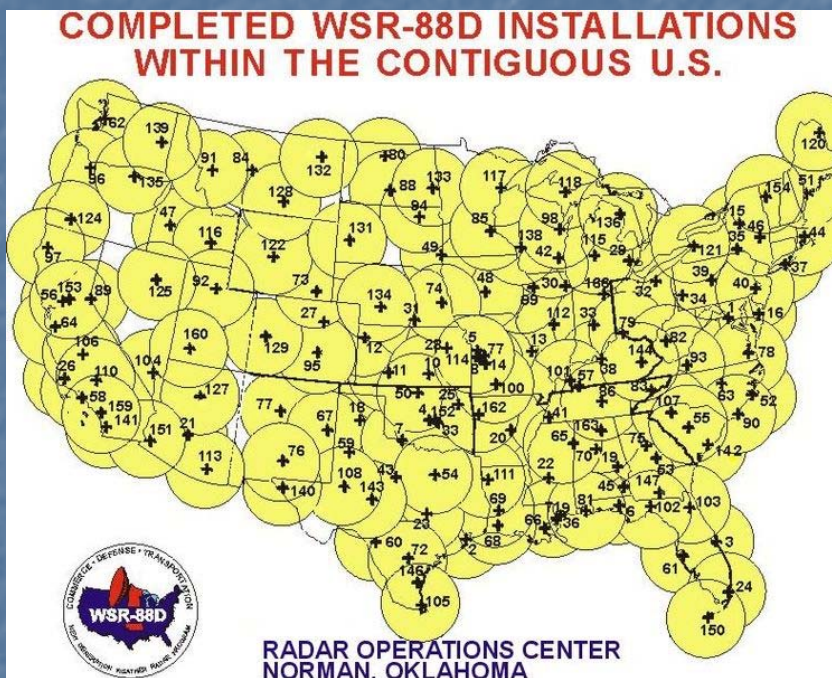
Parameter	Symbol	Typical values
Frequency	f_t	2900-5625-12500 MHz
Wavelength	λ	10, 5, 3 cm, S, C, X
Antenna diameter	D	1-9 m
Beam with	P_{avg}	0.5 - 1.5 ; 1.0 typical
Impulse power	P_t	0.01 - 1 MW
Impulse time	τ	0.1 - 1 μ sec
Impulse length	h	30-300 m (h=c τ)
Impulse repetition	PRF	1000 Hz
Received signal	P_r	10^{-6} mW , $10 \exp - 9 !$



MAIN WEATHER RADAR PRODUCTS

- Data in every 5 – 15 minutes up to 300 km
- Radar reflectivity – dBZ
- Radar precipitation intensity
- VIL/VILD- Vertically Integrated Liquid Water/Density
- Radial Doppler Wind
- Wind shears – horizontal/vertical/3D
- Vertical windprofile (in case of precipitation)
- Storm cells identification and tracking
- Other derived products – precipitation sums, severity indexes, hail probability, etc
- Dual Polarization products (DZR, LDR, kDP)- hydrometeor classification, attenuation correction,

NETWORKING OF WEATHER RADARS



NEXRAD – USA

Cooperation FAA, NOAA, DoD

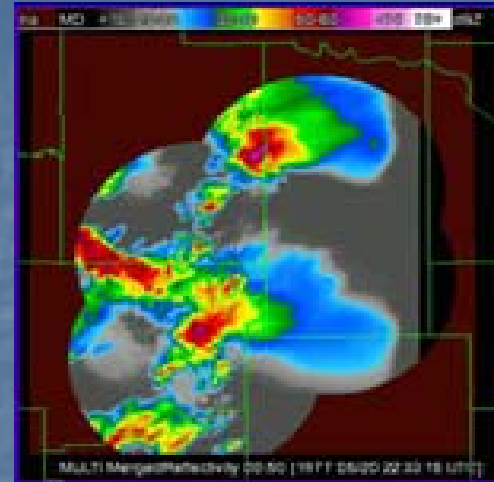
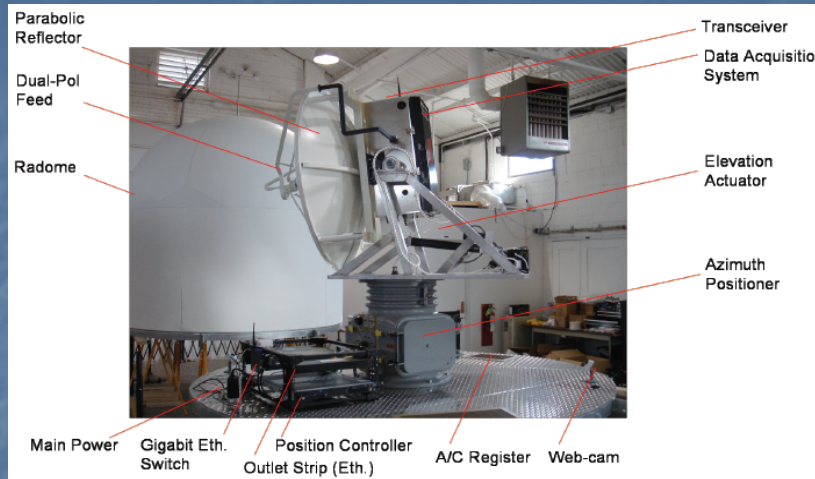
159 S band Doppler radars operated by NWS

OPERA

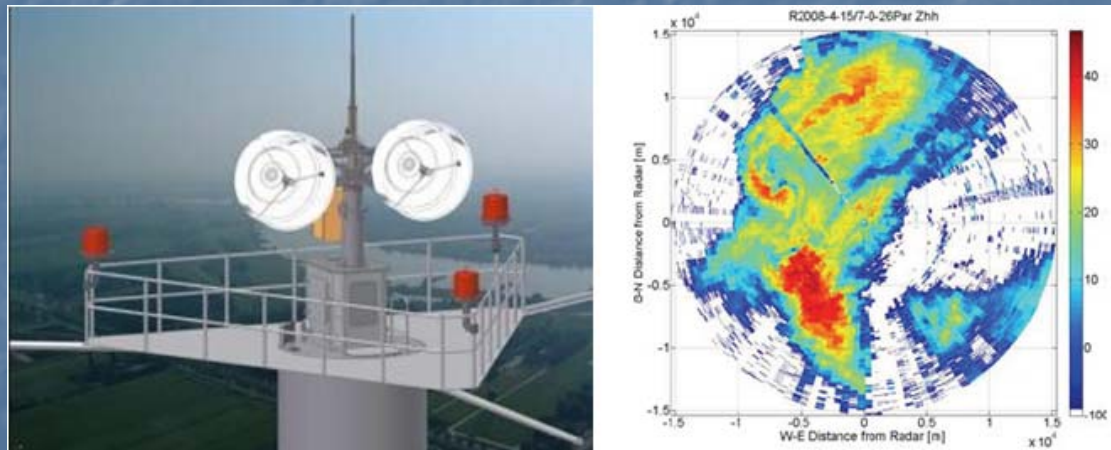
30 countries and 159 C and 33 S radar

Doppler 166, Dual Pol. 33

NEW TECH -X BAND RESEARCH WEATHER RADARS

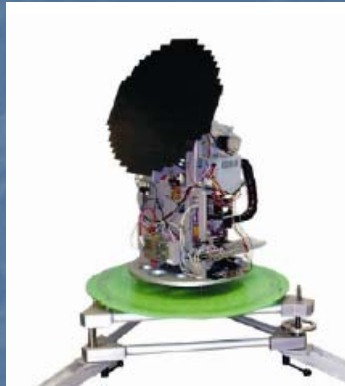


CASA X band Doppler dual polarization MINI Integrated composite of DCAS

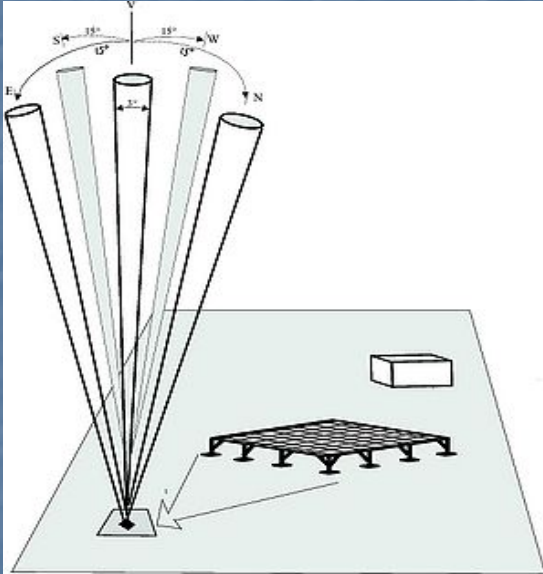


IDRA X band FMCW radar TU DELFT on the top of 213 m observation tower

MORE MINI X BAND WEATHER RADARS



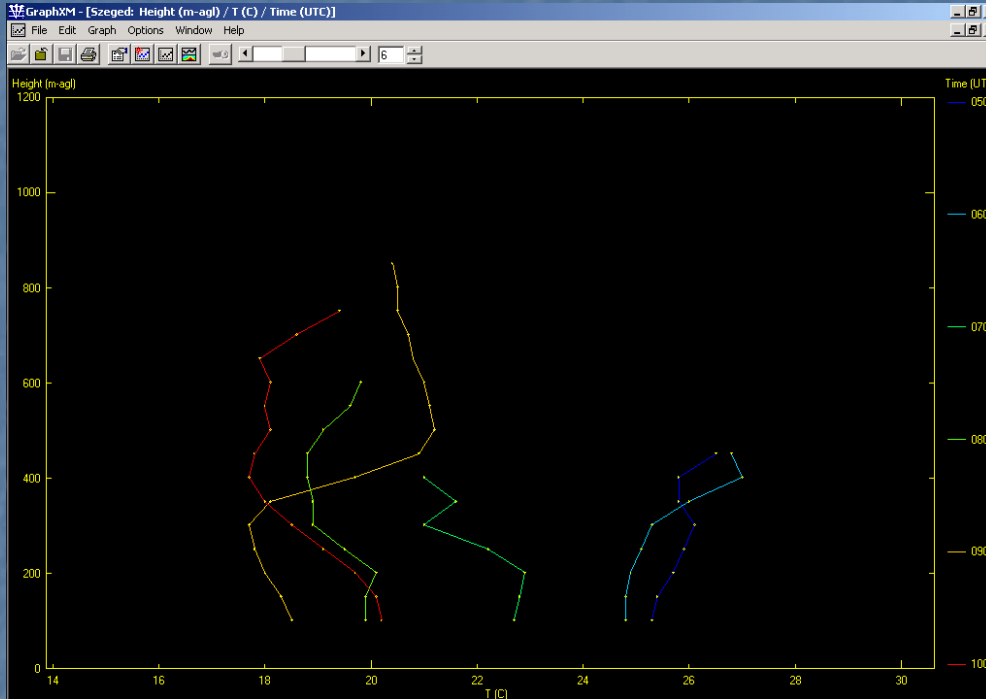
WIND PROFILERS



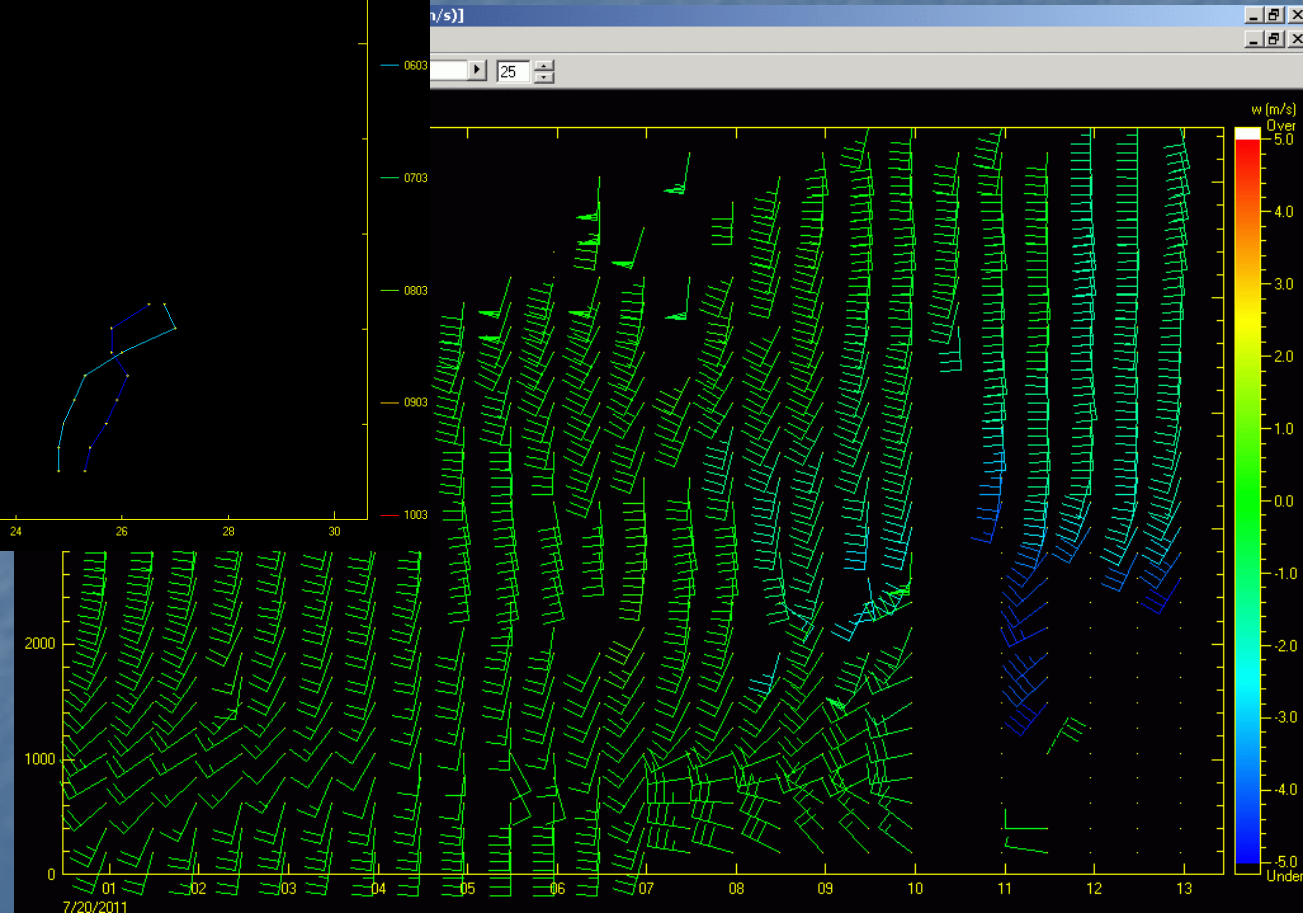
- targets are the atmospheric inhomogenities (turbolencies, etc)
- wavelength from 20~cm (L-Band) to about 6~m (VHF – XXL sizes).
- measurement heights depends on wavelength – from 2km to 20 km
- special radar with Doppler beam swinging (DBS) in vertical 75°
- typically phased array antennas,
- RASS – Radio Acoustic Sounding System
(sound impulses are the targets)

PRODUCTS

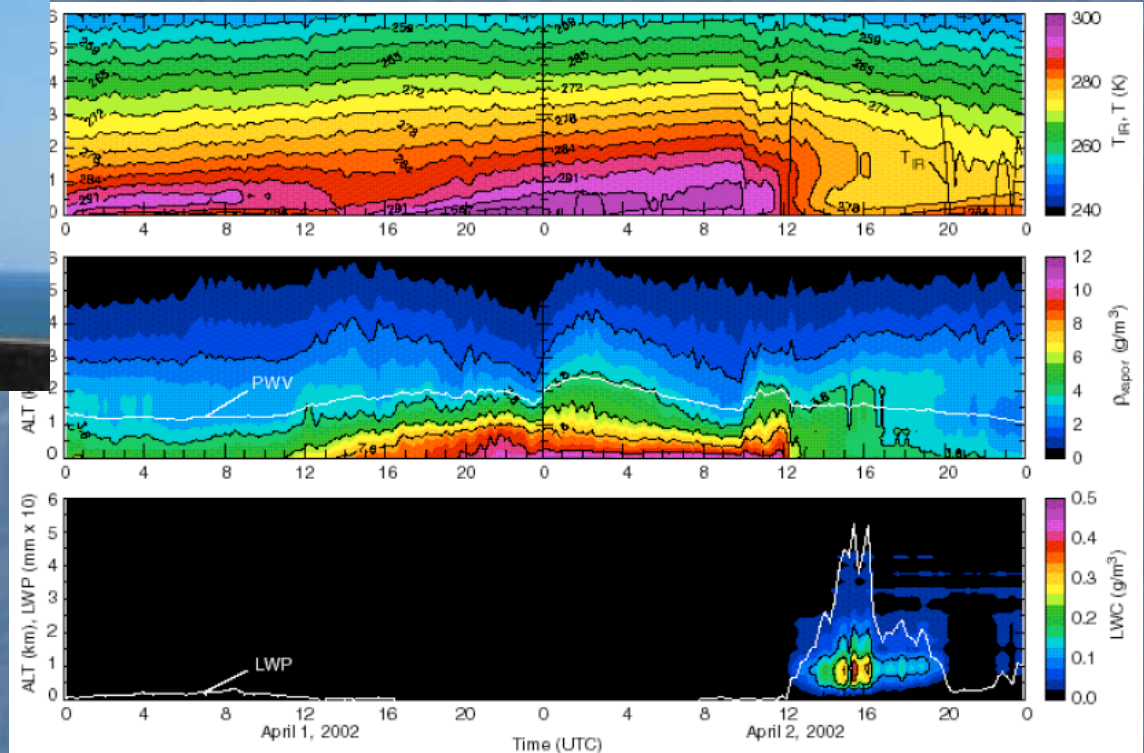
Typically used in Numerical Wether Forecast modelling



RASS profiles
above - T profile
on right - wind profile
Data in every 15-30
minutes



MICROWAVE PROFILING RADIOMETERS AT MET. SERV.



- measures the microwave brightness temperature, 7 channels at 22-30 GHz (water vapor) 7 channels at 51-59 GHz (oxygen)
- calculates profiles of temperature humidity and liquid water

Data – every 2-5 minutes
Some MWPR able to scan 3D

RADIOMETERS IN USE

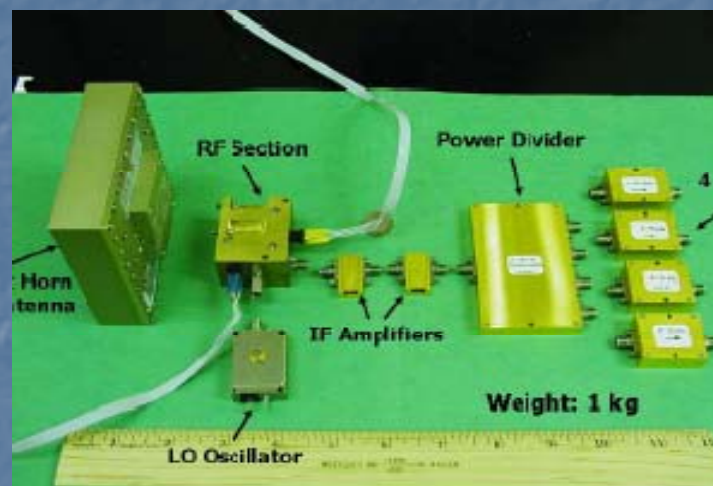
MWRNET - about 20 countries and 60 members



- only several met.serv. use radiometers but rapidly increases this number,
- used mainly for research but MWRP gives very good input into numerical weather models
- EG-CLIMET. COST ES0702 action
European Ground-Based Observations of Essential Variables for Climate and Operational Meteorology,
- MWRP will be the future standard profiling instruments of HMS – radisondes

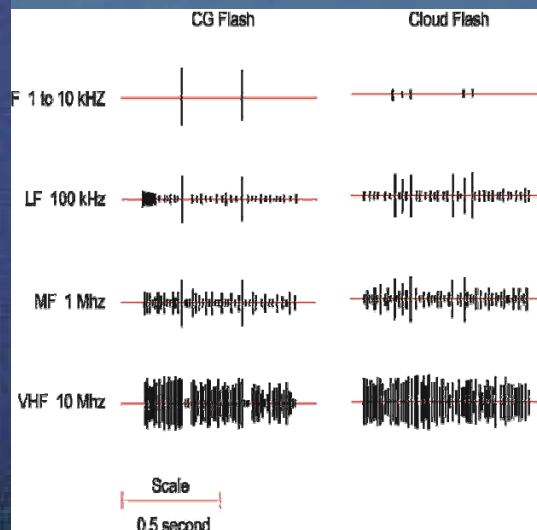
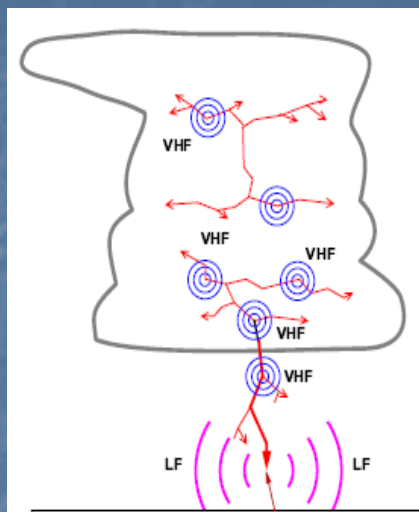
NEW TECHNOLOGIES - FUTURE OF MWPR USE

Miniaturized Water Vapor Profiling Radiometer for Network-based 3-D Measurements - 18 cm x 24 cm x 16 cm



Colorado State University and University of Massachusetts
 3D measurements of tropospheric water vapor (22.2, 22.7, 23.3 and 24.6 GHz)
 High temporal and spatial resolution
 Very dens network of MWVPR – as the automatic weather station networks !

LIGHTNING DETECTION



Detection on VLF – global scale CG, LF / VHF – regional and local scale for IC and CG flashes

Detection finding MDF -Magnetic Direction Finding on LF, or interferometric systems on VHF

SAFIR – VHF/LF - only operational system developed for detect IC and CG flashes

the IC activity is good indicator for thunderstorm development – meteorology !!

TOA -Time of Arrival differences – most precise localisation

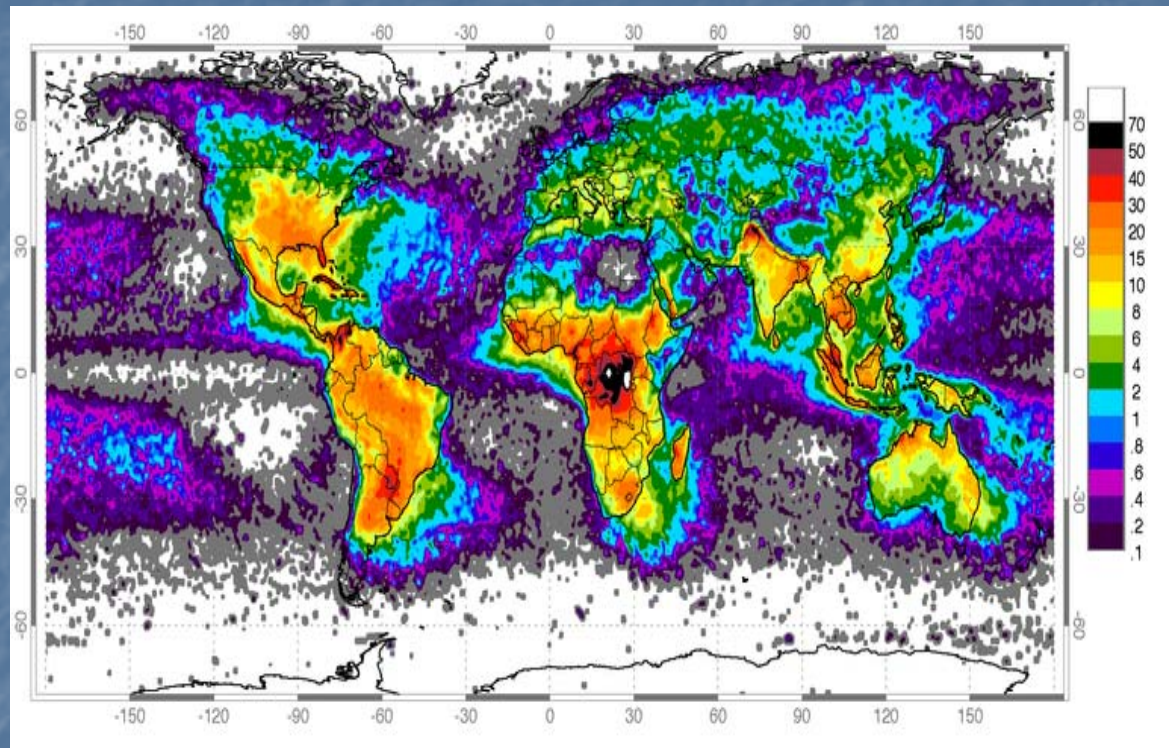
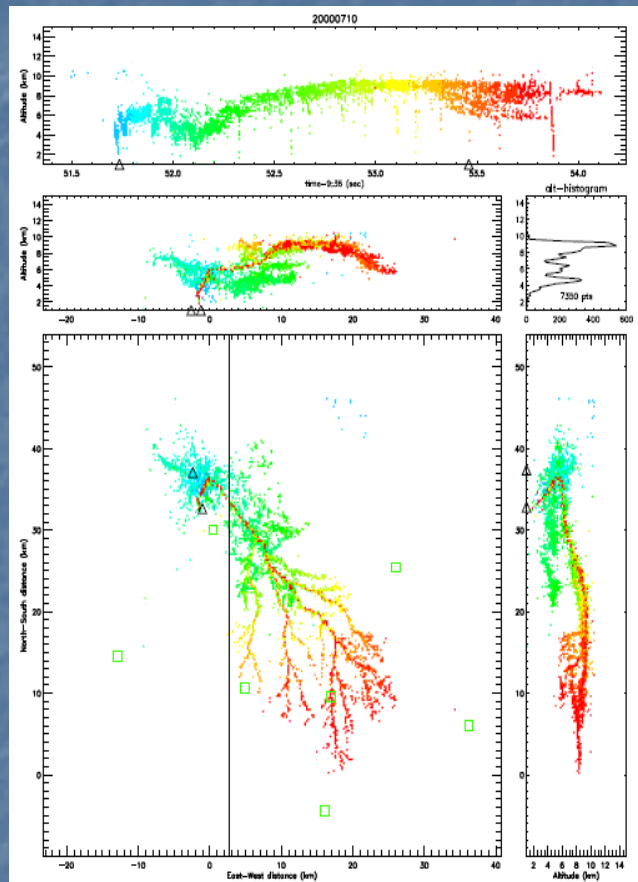
on LF – typical operational systems

on VHF – research systems LMA and LDAR

Data availability – continuously every flash events are detected

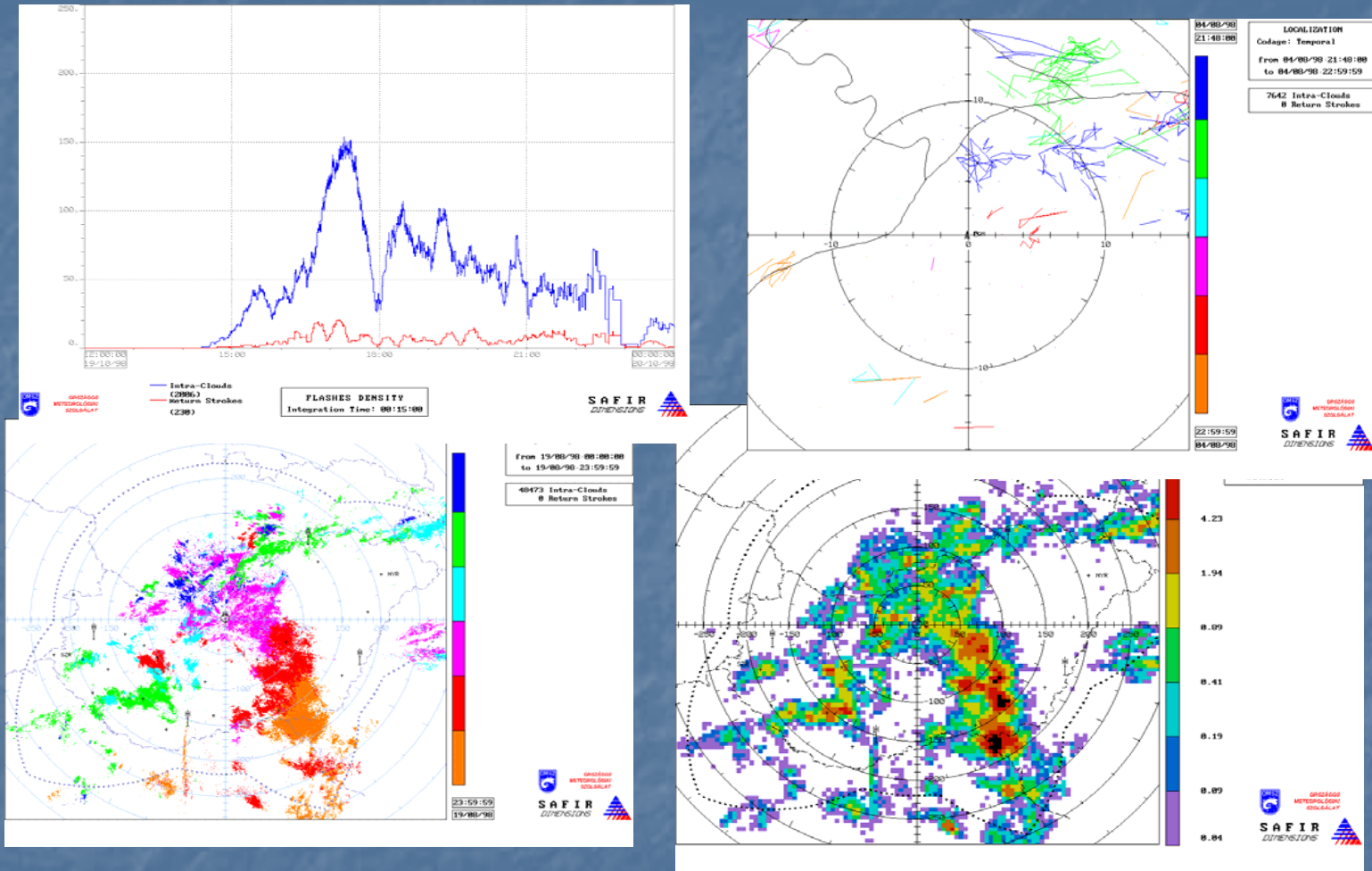
Special use – lightning produced NOX calculation !

LIGHTNING DETECTION – ONE FLASH AND GLOBAL SCALE



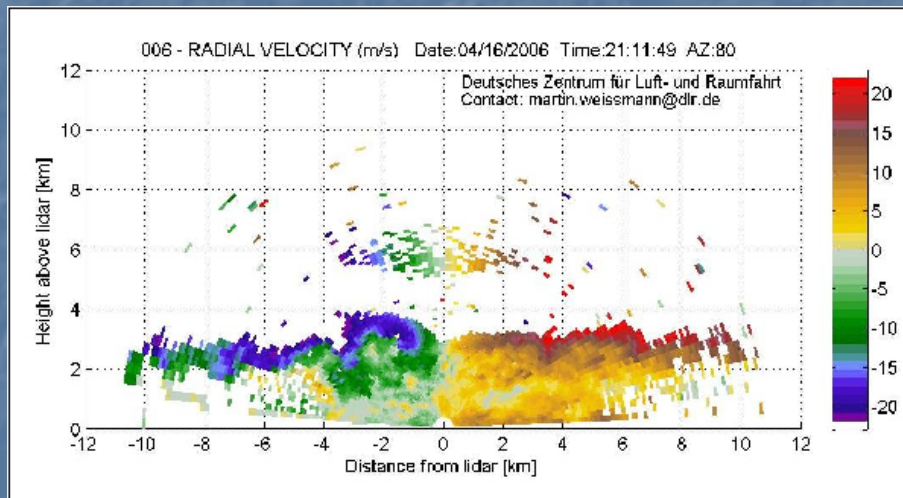
Above – satellite based measurements
Left – LMA research system

SAFIR INFORMATION FOR USERS



Information time, location, flash type, peak current, energy

DOPPLER WIND RADARS



Windtracer DWL Lockheed Martin and vertical cross section of Doppler lidar

Data availability as weather radars – some minutes needs 3D scanning
 Used mainly for researches but
 Simpler versions are used at airports for downburst and airplane vortex



THANK YOU !

Q & A