Observation strategies for severe rain in The Netherlands

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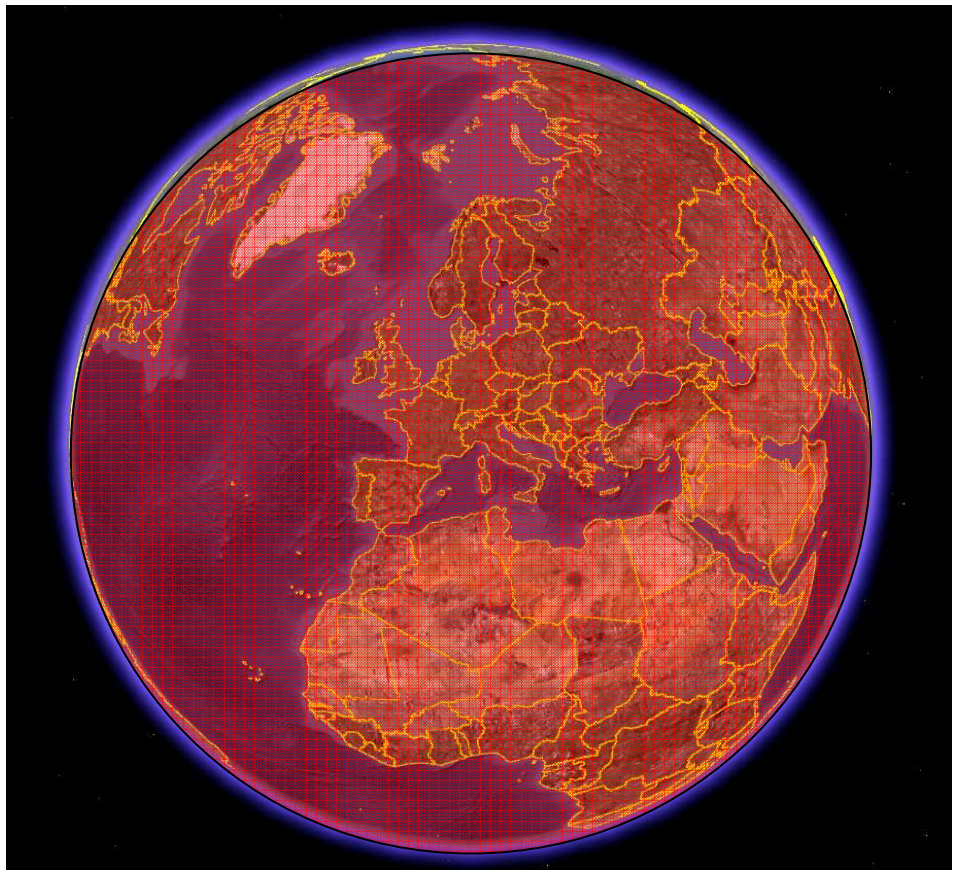
Our Earth

is slowly warming



The world population

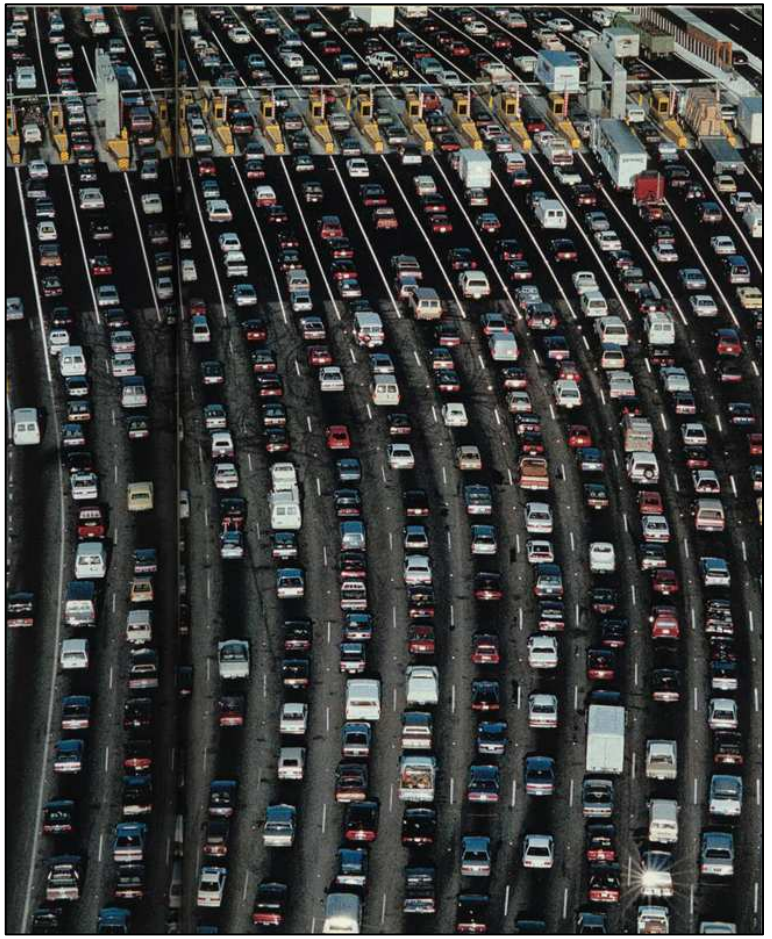
is moving into the cities

and gets prone to

… severe weather

and gets prone to

… infrastructure infarcts



and gets prone to

… heat

and gets prone to

… air pollution

‘Gets prone’

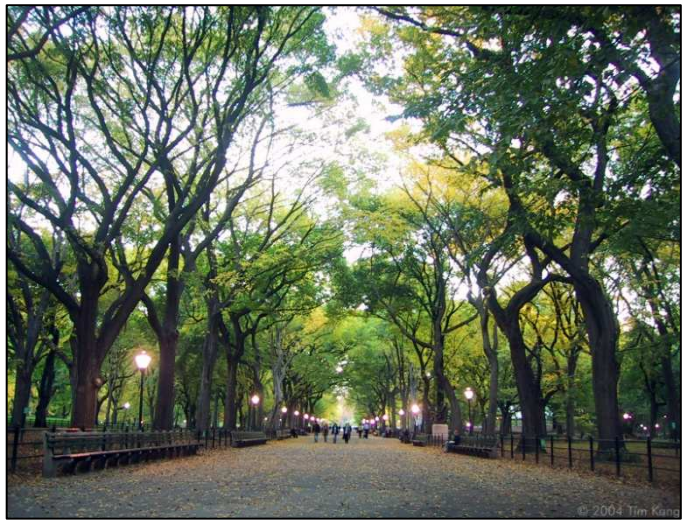
… does not have to mean ‘will experience’

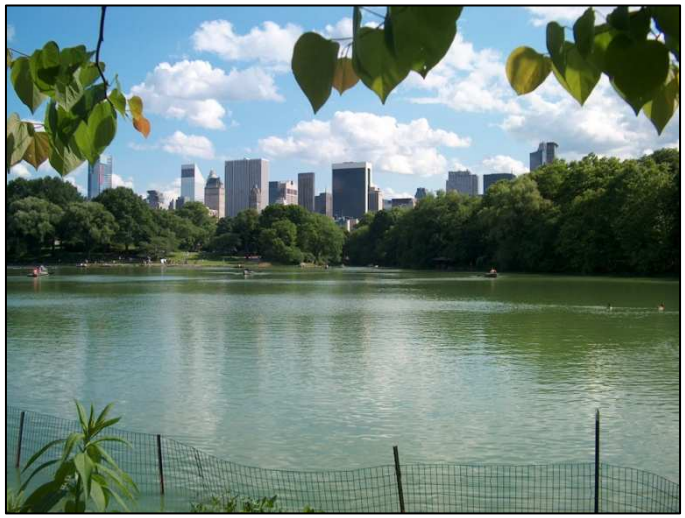
The challenge is

… to make cities a nice place to live

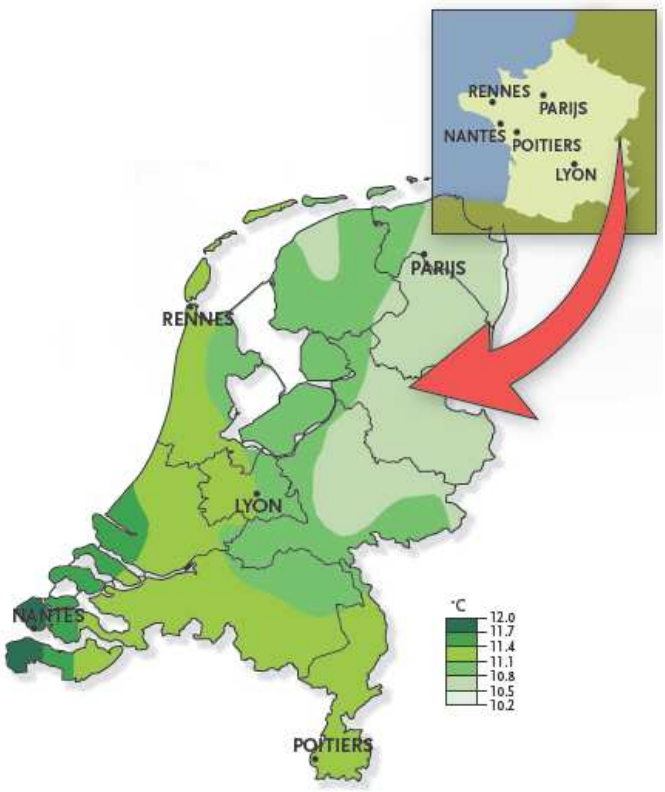
… for 50 % of the world population

… summer, spring, autumn and winter



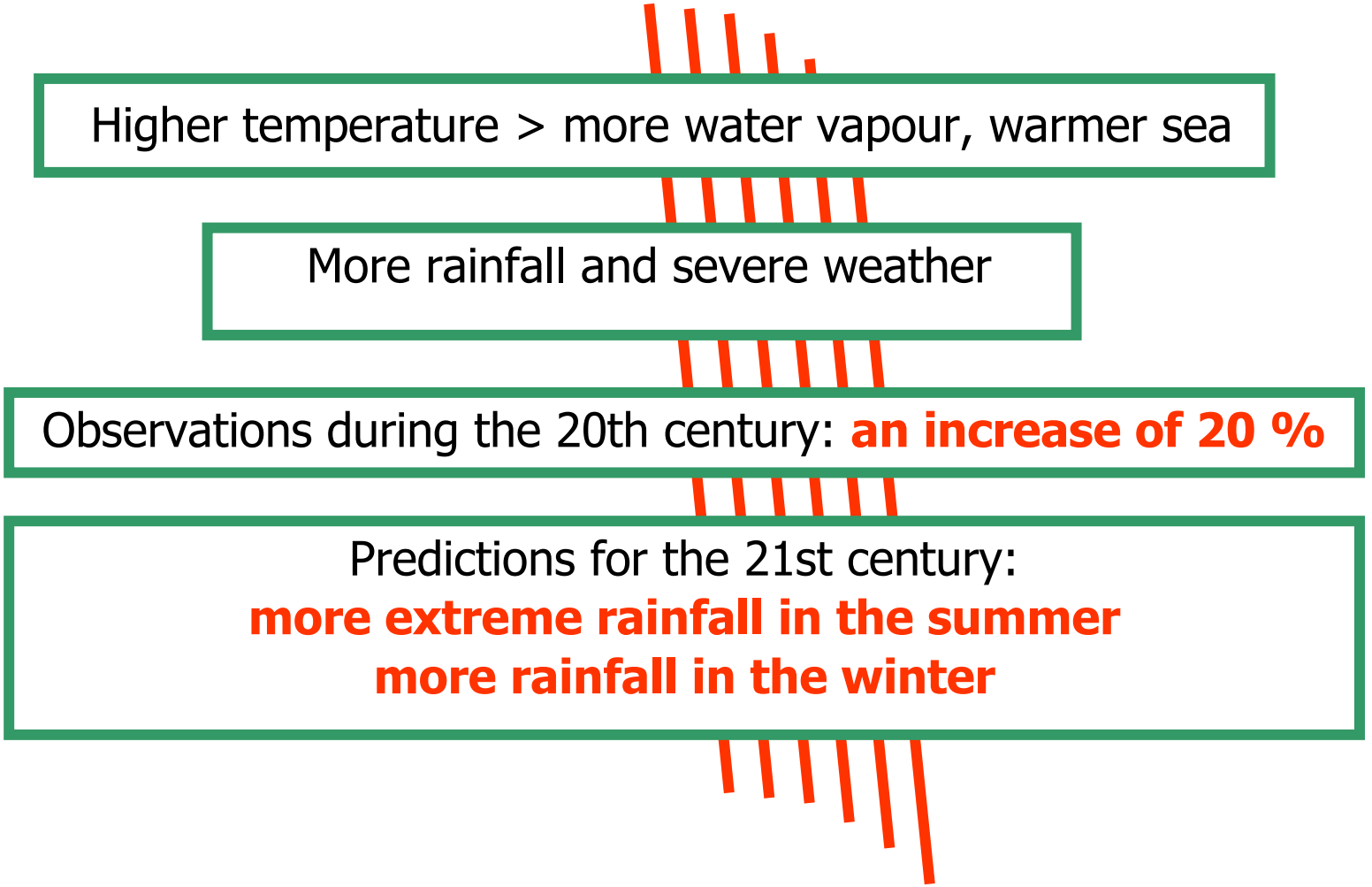


Climate change:
What to expect in The Netherlands?



Source: KNMI

Rainfall in a changing climate

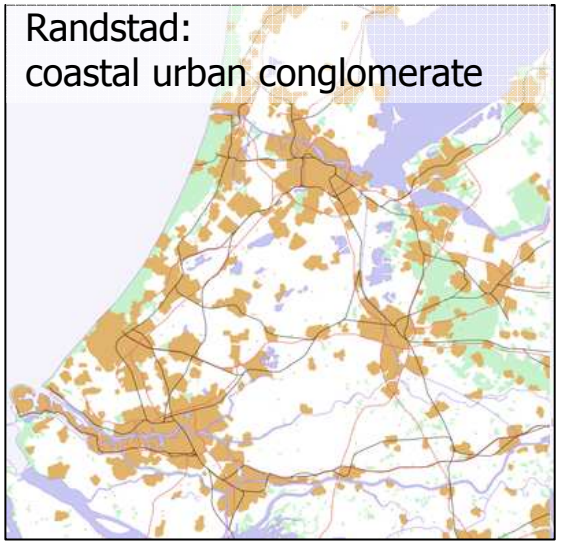


Extreme rainfall in a metropolis

Larger vulnerability modern society
(flooding, transport, communication)

Accurate information needed

Integrated model-observation warning systems
Better understanding rainfall formation
Detailed observations of microphysics needed



Population: 7 million
Economy: 4th region of Europe
Dense infrastructure

Philosophy:

composite sat-lo-hi-res model

to improve forecasts:

street level

hourly basis

The field laboratory: CESAR

IDRA – TU Delft IRCTR Drizzle radar

CESAR – Cabauw Experimental Site for Atmospheric Research

IDRA is mounted on top of the 213 m high meteorological tower.

Specifications

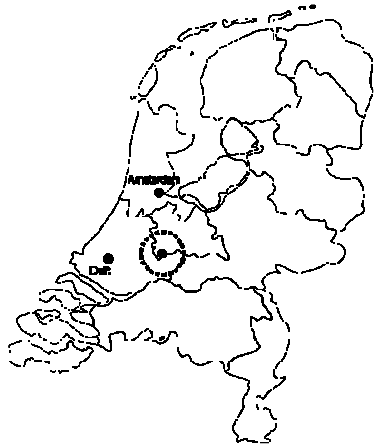
- 9.475 GHz central frequency
- FMCW with sawtooth modulation
- transmitting alternately horizontal and vertical polarisation, receiving simultaneously the co- and the cross-polarised component
- 20 W transmission power
- 102.4 μs – 3276.8 μs sweep time
- 2.5 MHz – 50 MHz Tx bandwidth
- 60 m – 3 m range resolution
- 1.8° antenna half-power beamwidth

Reference

J. Figueras i Ventura: "Design of a High Resolution X-band Doppler Polarimetric Weather Radar", *PhD Thesis*, TU Delft, 2009. (online available at http://repository.tudelft.nl)

Near real-time display:
http://ftp.tudelft.nl/TUDelft/irctr-rse/idra

Processed and raw data available at:
http://data.3tu.nl/repository/collection:cabauw

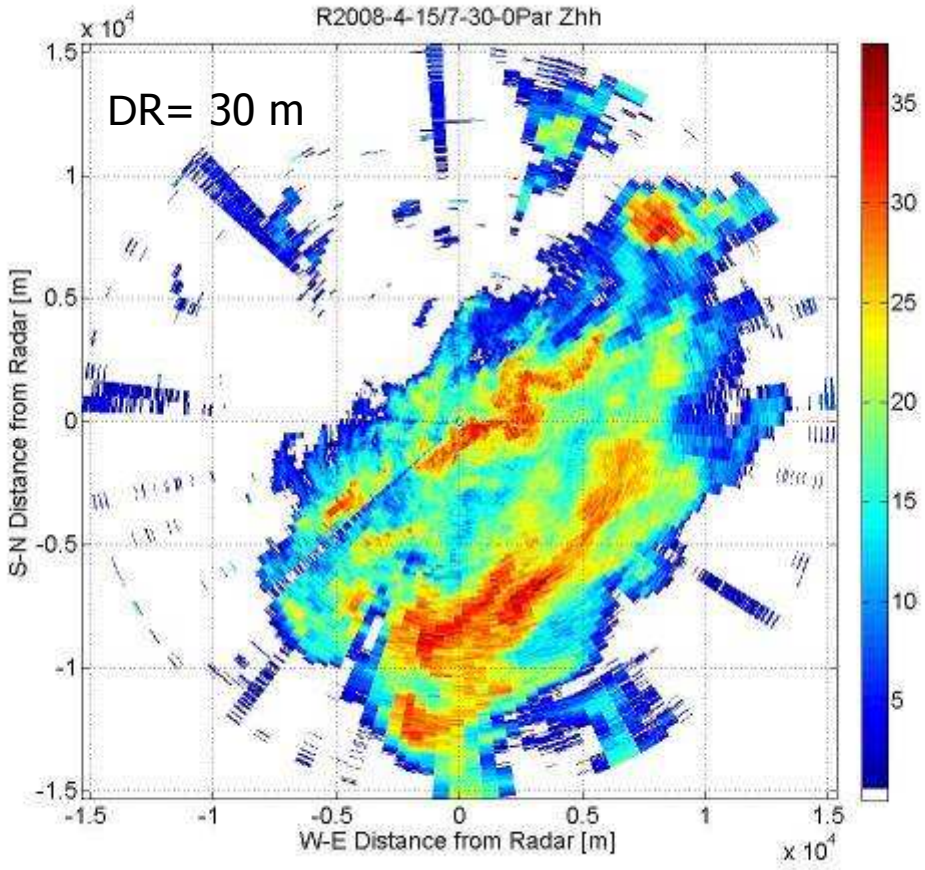


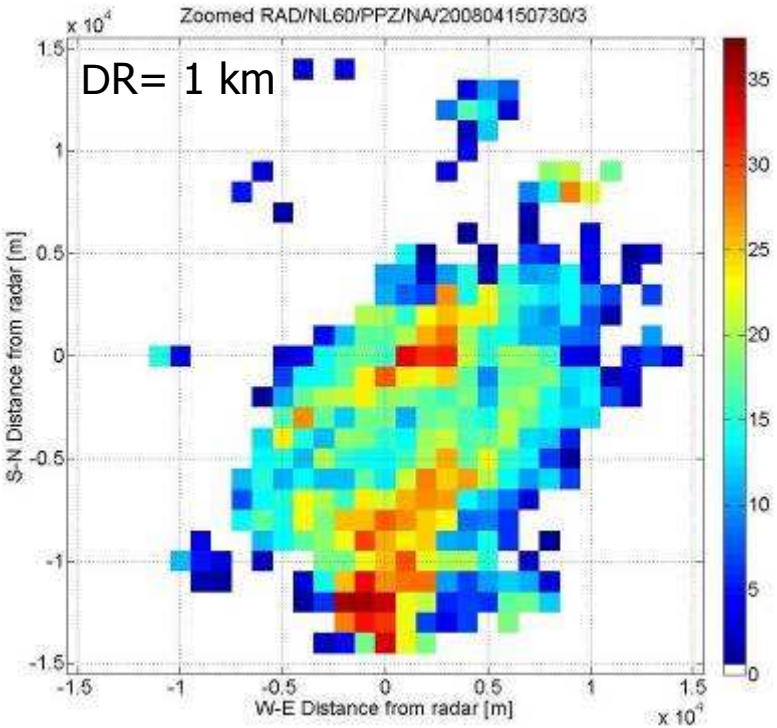
Why FM-CW?

- Low transmit power
- Flexibility
- High resolution possible
- Solid state

But: two antennas needed and more complex processing

High resolution rain observations

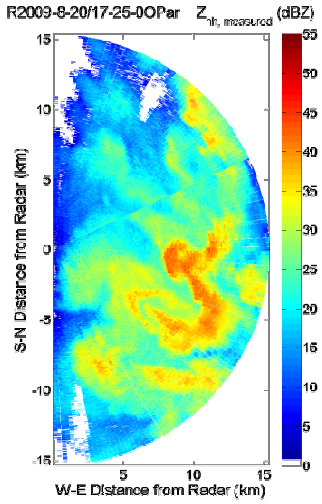




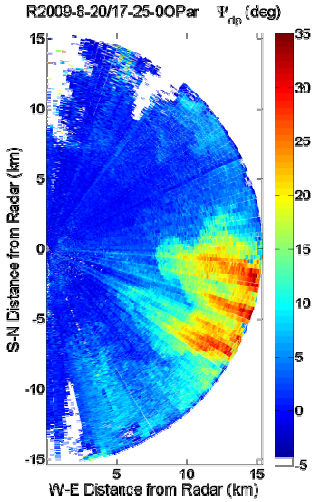
Courtesy: KNMI

Examples of polarimetric X-band radar

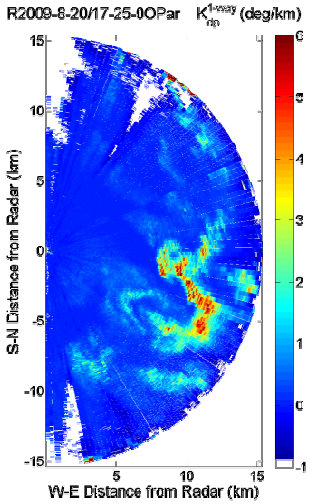
reflectivity (dBZ)



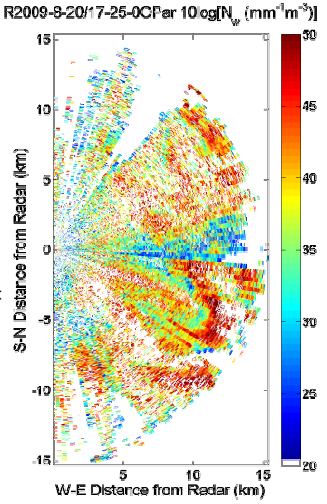
differential phase (°)



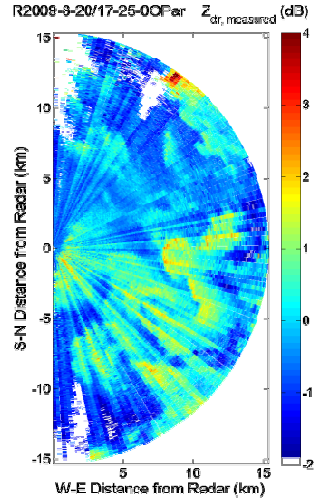
specific diff. phase (°/km)



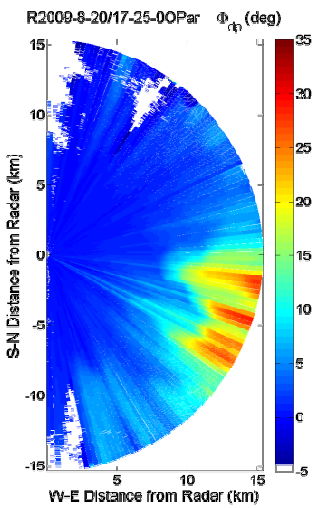
RDSD N_w (mm^{-1} m^{-3})



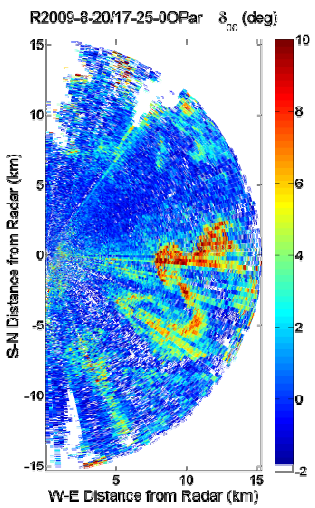
differential reflectivity (dB)



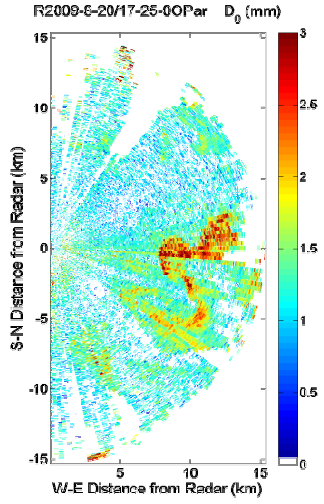
diff. propagation phase (°)



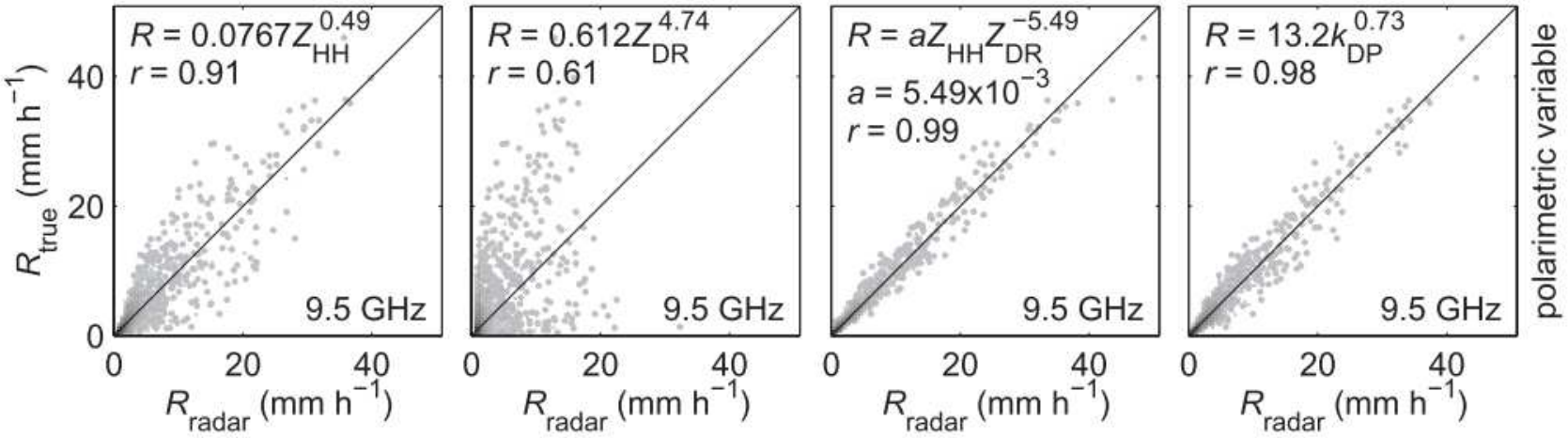
diff. backscatter phase (°)



RDSD D_0 (mm)



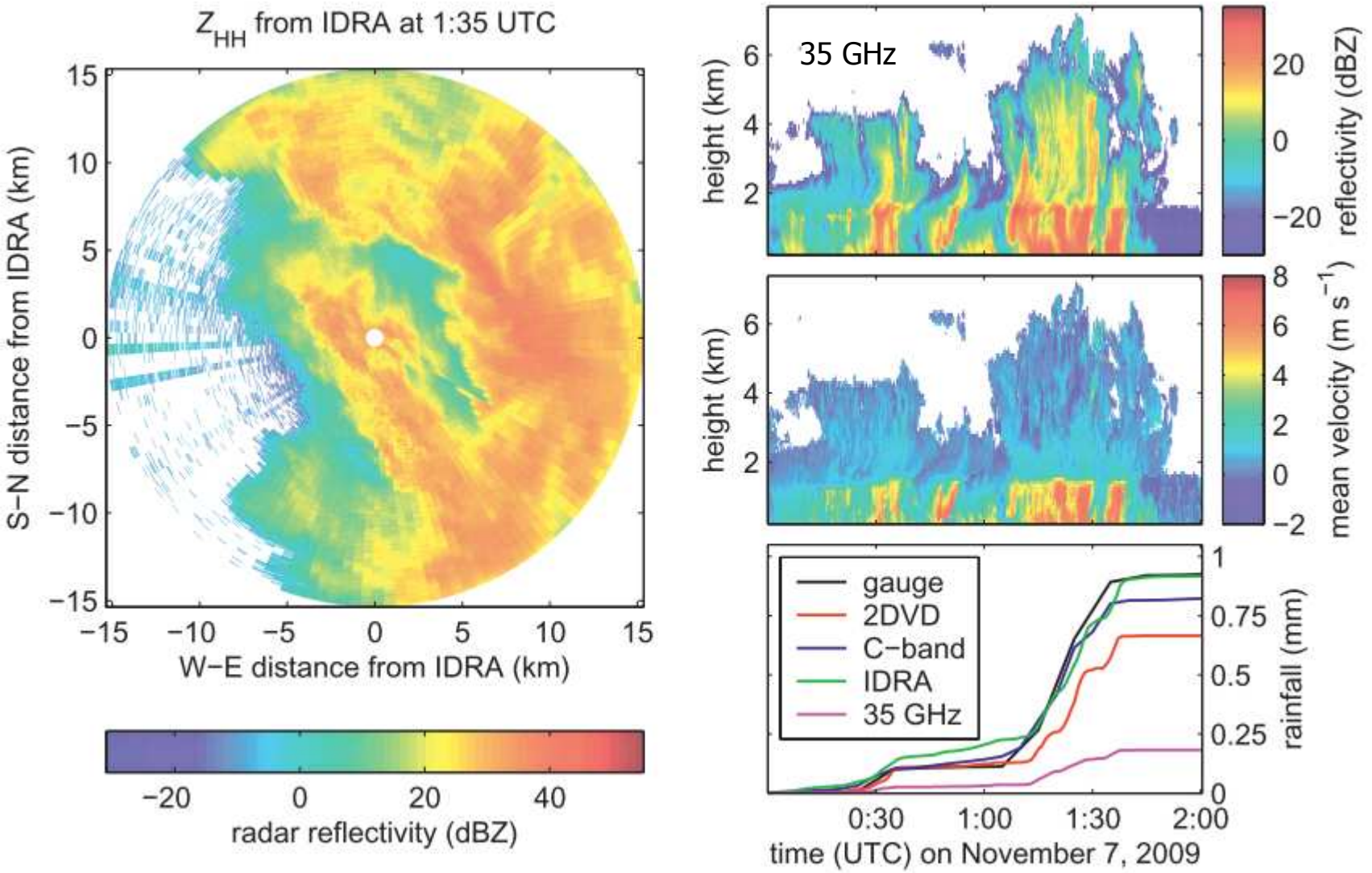
Impact of polarimetry on estimation of rainfall rates



No polarimetry

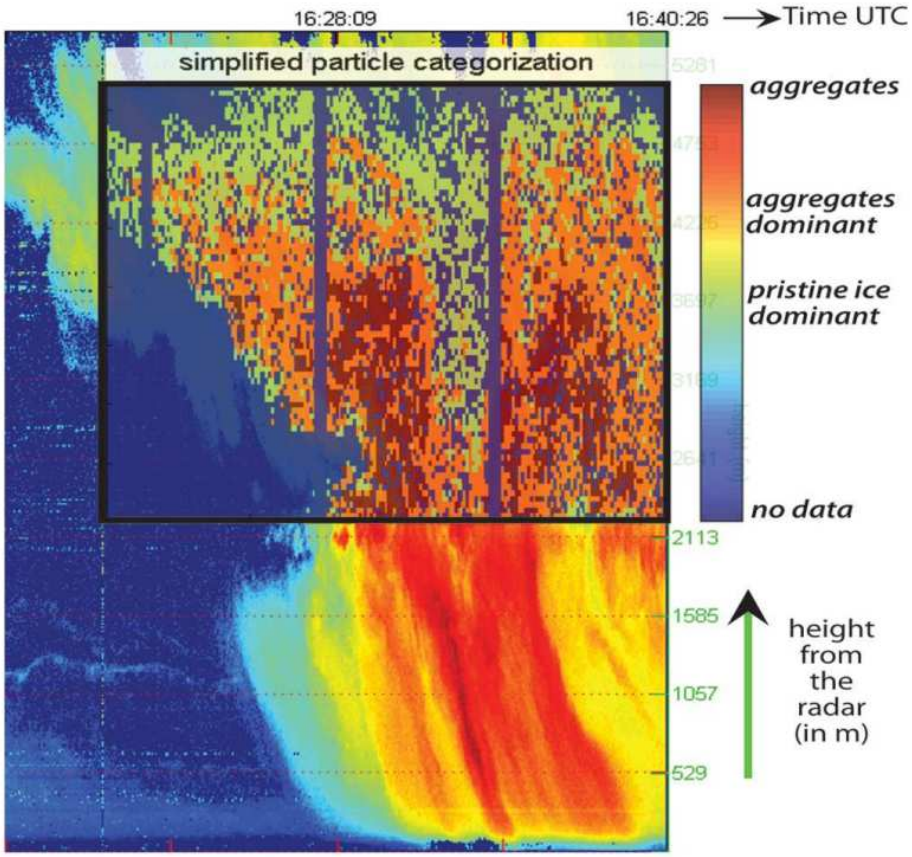
Optimum use of polarimetry

Courtesy Leijnse



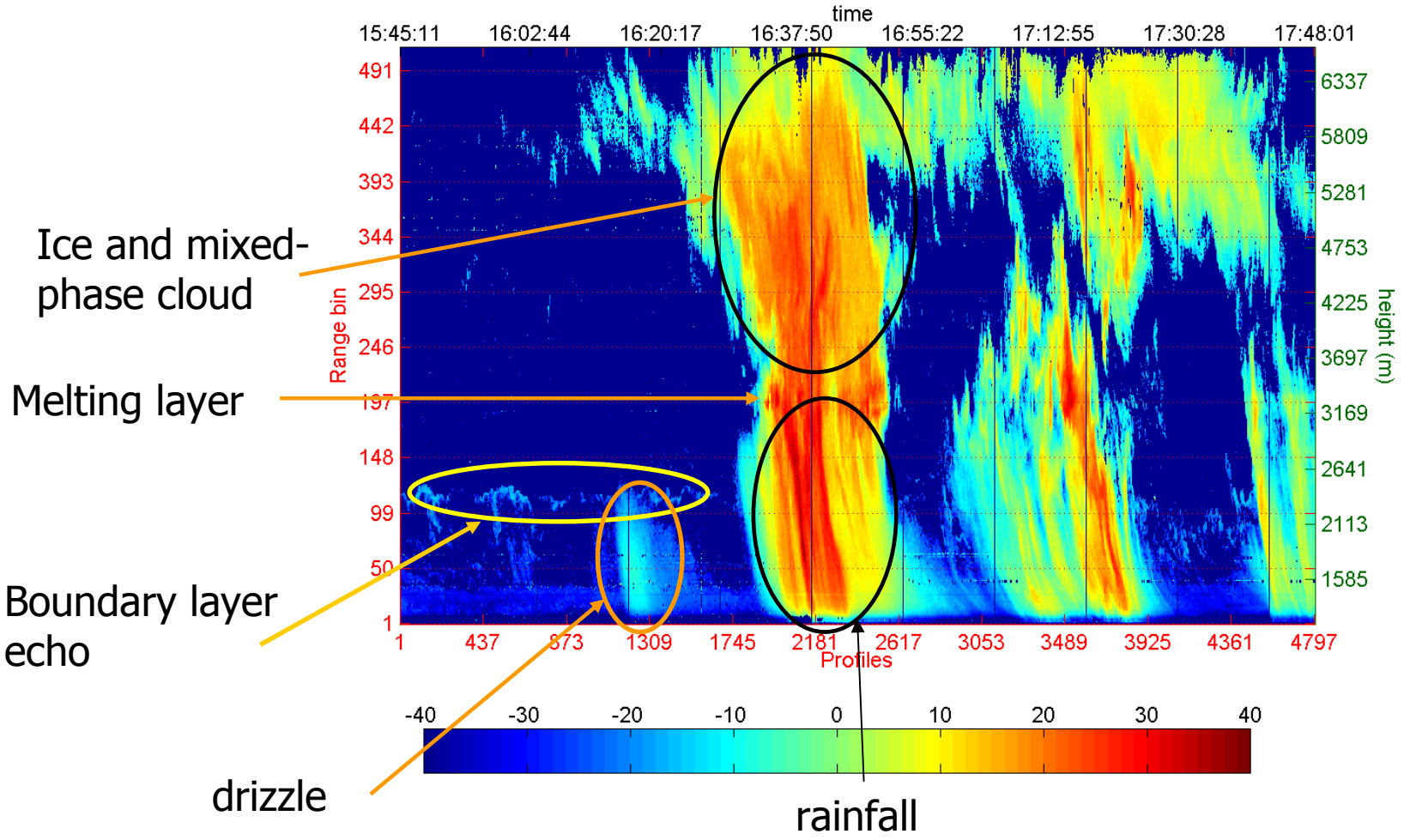
Courtesy Leijnse

Spectral-polarimetric classification



Courtesy Durfournet

Development of rain: system plus meteorological model



Courtesy Durfournet

Concluding remarks

- Climate change leads to more severe weather
- Better forecasts of rainfall needed
- Explore feasibility of high-frequency, short range radars in cities
- Doppler-polarimetry gives details of microphysics and processes
- Combine with small scale, cloud resolving models
- Radar should be able to do without ground observations (truth?)