

Assimilation of polarimetric radar data to improve high resolution rainfall in models

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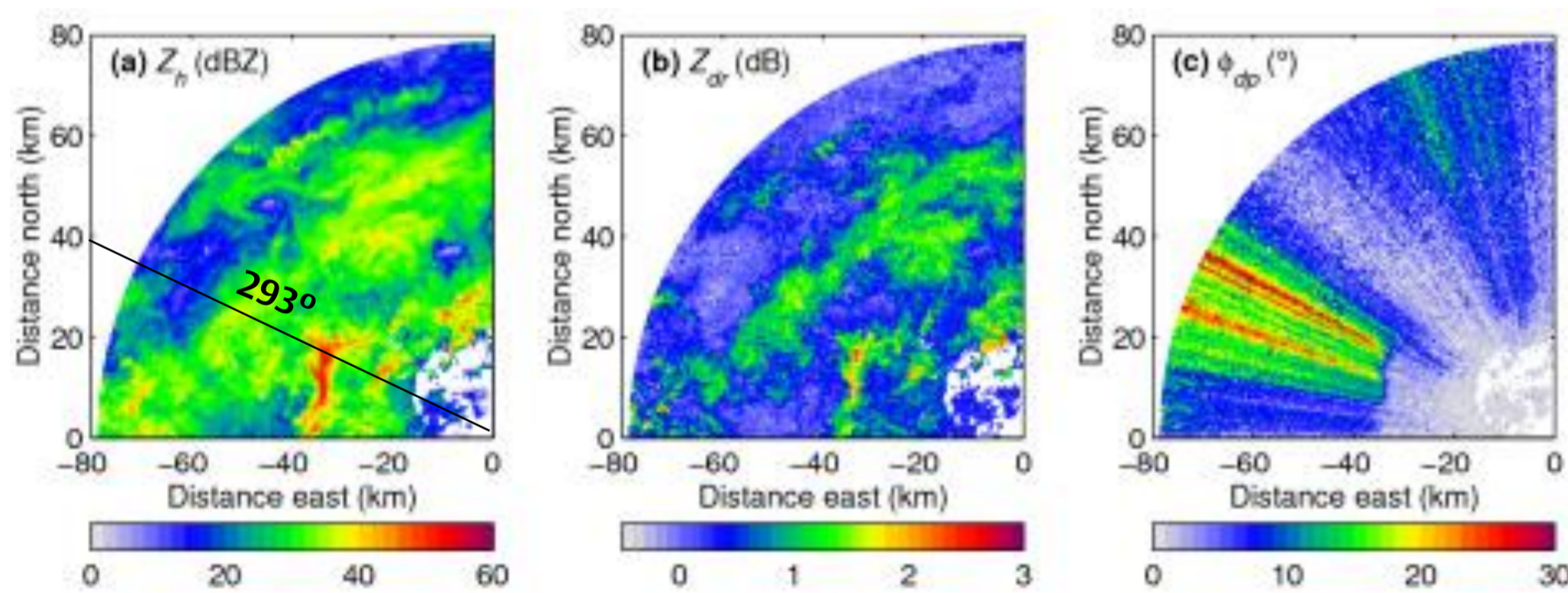
What is the problem?

High resolution information on storm events is vital for flood prediction and risk management. However, assimilation of conventional radar reflectivity data (i.e. observations of rainfall rate) into high resolution models has met with limited success so far. **Model forecasts of thunderstorms may be qualitatively correct but have the wrong location or timing, thus the model air motions are inconsistent with the observed data** and either the data are rejected or spurious rain events are created.

Novel polarimetric radar observations have the potential to overcome some of these problems by providing path-integrated measurements that may enable the assimilation algorithm to **shift a convective system along a ray-path.**

How can polarimetric radar help?

Most weather radars transmit and receive at a single polarization. **Polarimetric radar make measurements using both horizontal and vertical polarizations** so are sensitive to both the horizontal and vertical dimensions of the raindrops.



The **differential reflectivity**

$$Z_{dr} = 10 \log Z_H / Z_V$$

is a measure of mean particle shape, and hence **mean drop size**, since raindrops generally have an oblate shape with an axial ratio which depends on their size.

The **differential phase**

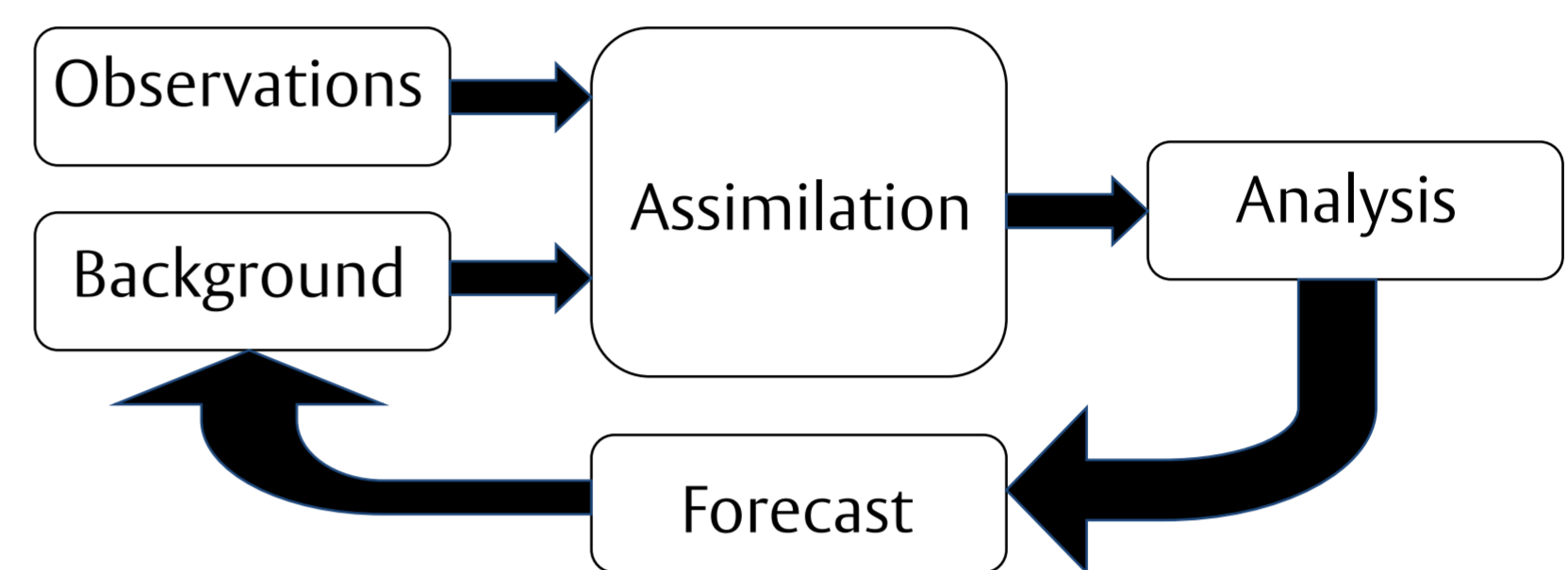
$$\phi_{dp} = \phi_v - \phi_h$$

measures the lag between the phase of the two polarizations. This provides information on the **rain rate along the ray path.**

The figures show examples of Z_H , Z_{dr} and ϕ_{dp} for a scan and for one extracted ray for a real rain case¹. High differential reflectivity generally occurs where conventional reflectivity (Z_H) is high: 30dBZ or higher.

What about data assimilation?

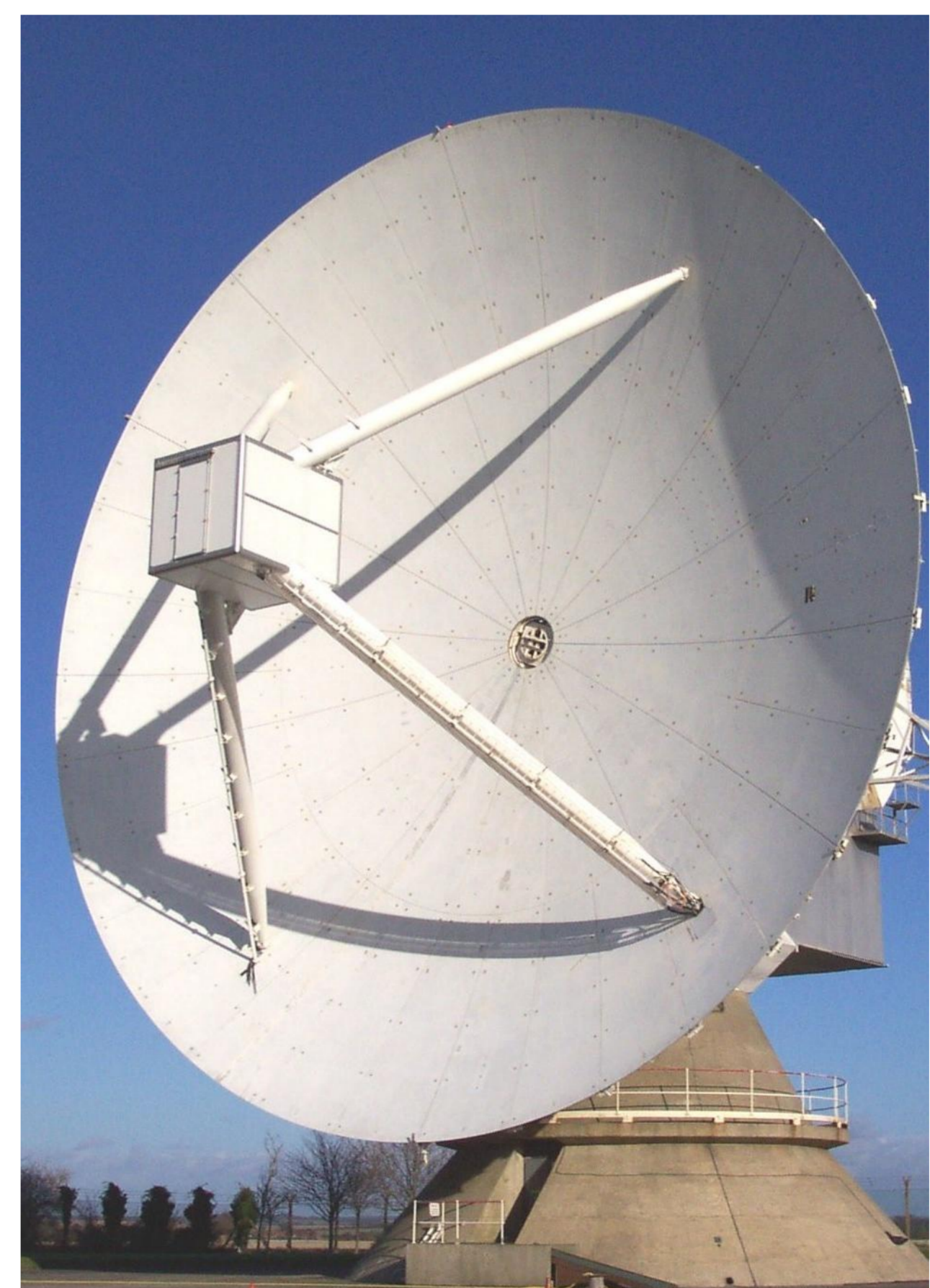
The crucial test for new observations is whether they lead to an improved analysis and hence a better forecast. Introducing high resolution moisture data into models has met with significant challenges in the past².



The benefit of polarimetric radar data will be assessed by implementing a simplified physical model and performing **Observing System Simulation Experiments (OSSEs)**. 3D- and 4D-var assimilation algorithms will be designed to assimilate pseudo-observations and assess their impact. Later, the scheme will also be tested with real observations.

Where will the real data come from?

A new C-band polarimetric radar was opened in Thurnham in 2005, having been jointly funded by the Met Office and Environment Agency following the flooding events in 2000³.



The picture above is of the Chilbolton 3GHz dual-polarization radar, which provided the data shown in the figures on the left.

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References

1. **Hogan, 2007:** A variational scheme for retrieving rainfall rate and hail reflectivity fraction from polarization radar, *J. Appl. Meteorol. Climatology*.
2. **Dance, 2004:** Issues in high resolution limited area data assimilation for quantitative precipitation forecasting, *Physica D*
3. RMetS Meteorological Observing Systems Special Interest Group, Newsletter issue 22, 2006.