The **BIG** dish

The Chilbolton Observatory, home to the world's largest fully steerable meteorological radar, celebrated its 40th anniversary this year. **Charles Wrench** explains why it is still at the cutting-edge of research.

For most people who know the Chilbolton Observatory, they immediately think of the 25-metre diameter dish which has dominated the Test Valley in Hampshire since 1967. Built at a cost of £428,000 to study how the atmosphere can modify radiowaves, scientists originally needed the observatory to resolve problems associated with early satellite communications. But, a near-perfect surface and excellent pointing precision made it ideal for radio astronomy. Throughout the 1970s this was its primary role, making major contributions to studies of radio sources beyond our own galaxy, fluctuations in the cosmic microwave background and star formation regions.

Forty years after its construction, the antenna still participates in cutting-edge research – these days it is used mainly by atmospheric scientists researching how rain develops. A key instrument in this research is the Chilbolton Advanced Meteorological Radar (CAMRa), a high-power 3GHz radar added in the late 1970s. The instrument can detect anything from aircraft to insects, and, more pertinently, researchers can study the dynamic nature of clouds and rainfall at high resolution, as well as determine the shape and size of raindrops out to a range of 90 kilometres. It works by transmitting and receiving pulses of energy that are alternately polarised – the electric field oscillates in either the horizontal or the vertical plane. The difference in reflected power at the two polarisations gives us the shape of the raindrops in the beam; this is important because larger raindrops deform into oblate spheroids (stretched spheres) due to aerodynamic forces, and the degree of that deformation is directly proportional to drop size. Measurements also allow researchers to distinguish between targets composed primarily of rain, solid ice or snow. Meteorologists use such information to improve estimates of rainfall from radar data. It was technological developments first implemented on the Chilbolton radar that led to new insights into the structure of rain and snow, and to the Met Office's subsequent introduction of polarisation radars into its operational UK rainfall radar network.

In 2003, engineers added another radar capable of detecting dynamic changes in the atmosphere's refractive index – radar signals are backscattered from these regions. This enables us to detect the onset of convection that can lead to storms. For three months during the summer of 2005, the Convective Storm Initiation Project used Chilbolton radars to observe how and where convective clouds form and develop into rain clouds. During the campaign the team observed a number of notable events including the Glastonbury floods, flash floods in Oxford, and the birth of a storm that produced a tornado in Birmingham.

One of the most pressing uncertainties in climate prediction is how to represent clouds in climate models. This has led to an expansion in the remote-sensing capability at Chilbolton and eventually to the establishment of the Chilbolton Facility for Atmospheric and Radio Research (CFARR) in 2004, where the focus is now on improving weather forecasting and climate research. Scientists working at CFARR are reducing uncertainties by measuring cloud, water vapour and aerosols (small particles necessary for cloud formation) using multiple mm-wavelength radars, lidars, and multifrequency radiometers. Recent measurements are supporting experiments designed to: quantify the formation and growth of ice particles in cumulus clouds; investigate the effects of ice particle shape and orientation on the Earth's energy balance; and investigate the significant impact on shortwave radiation of supercooled water and associated pristine ice crystals that are found in mixed phase clouds. These are clouds in which water exists in both solid and liquid forms. Additional measurements are improving understanding of how stratocumulus clouds form and develop. Towards the end of 2007 we will be making radar and lidar observations to support a major NERC project to improve understanding of how aerosol particles control the microphysics of mixed phase clouds. ■

The activities described in this article are the work of many researchers, in particular scientists from the universities of Leeds, Manchester and Reading, and from the Radio Communications Research Unit at the Rutherford Appleton Laboratory.

Charles Wrench is head of the NERC Chilbolton Facility for Atmospheric and Radio Research.
Email: C.L.Wrench@rl.ac.uk

Chilbolton in brief

1967	Chilbolton Observatory opens for business.
1970s	Radio astronomy, and the development of meteorological radar.
1980s	New radar techniques lead to improved understanding of radio propagation, particularly in rain.
1990s	Further development of radar techniques and use of lidars for atmospheric science, in particular to improve description of rain and cloud.
2000s	Development of new radars to improve knowledge of convection and clouds leading to improved forecasting of severe storms, and better climate change prediction. 25-metre dish used to perform in-orbit testing of new ESA satellites.