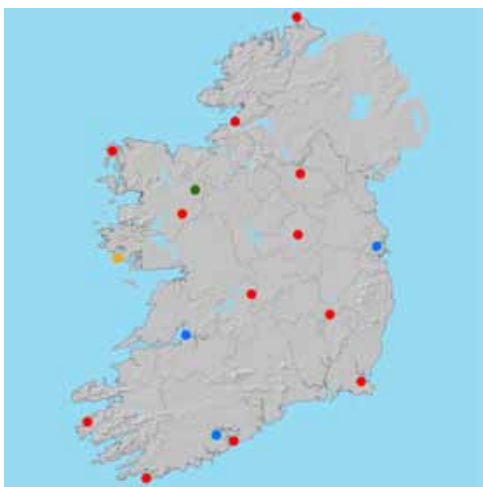


## 2.8 Cloud Properties

*Ned Dwyer, Colin O'Dowd and Séamus Walsh*

Clouds play an important role in maintaining the radiation balance and hydrological cycle of the Earth. They form when water vapour condenses as water droplets or ice crystals in the atmosphere. Aerosols in the atmosphere act as condensation nuclei around which clouds form. The combination of liquid water content, droplet size and number influences the amount of incoming solar radiation and outgoing infrared radiation reflected and absorbed. Significant uncertainties remain in the details of the relationship between aerosols, cloud properties and solar radiation.

Photo: © Marcus Austin



**Map 2.8.** Location of cloud-observation stations.

‘Significant uncertainties remain in the details of the relationship between aerosols, cloud properties and solar radiation.’

### Measurements

A range of cloud properties are observed at the Mace Head Atmospheric Research Station, Carna, Co. Galway (orange). These include vertical extent (cloud base and cloud top), cloud particle phase (liquid, ice), degree of adiabaticity,<sup>7</sup> liquid water path and liquid water content, microphysical

<sup>7</sup> An adiabatic process is one in which no heat is gained or lost by the system.

properties such as effective radius, cloud droplet number concentration and size distribution. Met Éireann takes hourly manual observations of cloud cover, cloud type and cloud height at staffed synoptic weather stations (blue and green). Observations of cloud height and estimated total cloud cover are made at a number of automated synoptic stations (red, orange and green).

Satellite sensors are used to collect information on cloud coverage, cloud top temperatures and a number of microphysical properties. These represent one of the longest and most robust time-series of satellite observations for any of the ECVs.

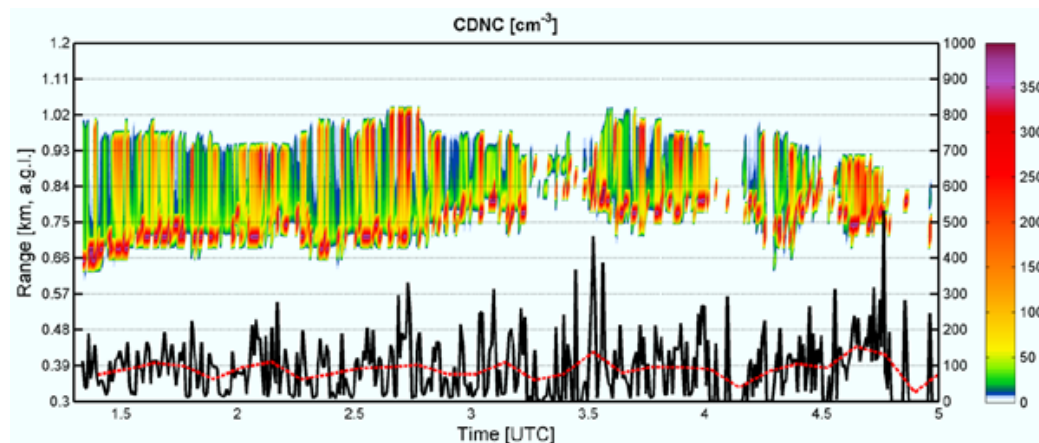
## Time-series and Trends

Figure 2.13 represents an example of the microphysical properties observed at Mace Head. The coloured lines show the varying number of cloud droplets in a

cubic centimetre of water (Cloud Droplet Number Concentration, right colour bar), in clean air. These measurements were made over a five-hour period and show that the clouds extended from approximately 0.6 km to 1.02 km above the ground (left axis). The solid black line is the height averaged concentration (right axis) while the red line is a 7.5-minute running mean of the height average.

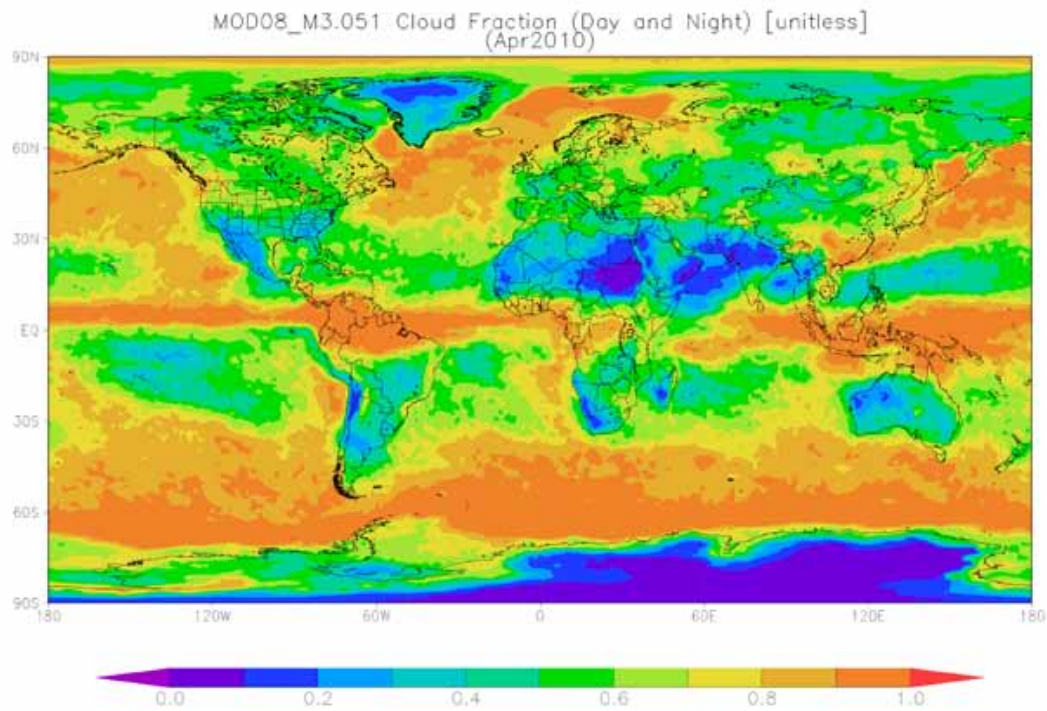
Figure 2.14 shows the mean global cloud fraction or cover for April 2010 determined using satellite data from the MODIS sensor on board the *Terra* satellite.<sup>8</sup> An analysis of such satellite-derived products for Ireland would be useful to determine if there is any trend or pattern in cloud cover.

*'The Mace Head cloud observation programmes lack long-term and sustainable operational support.'*



**Figure 2.13.** Example of one of the microphysical properties (Cloud Droplet Number Concentration) observed at Mace Head research station.

<sup>8</sup> Analyses and visualisations used in this section of the report were produced with the Giovanni online data system, developed and maintained by the NASA GES DISC.



**Figure 2.14.** Example of a satellite-derived global cloud cover product, April 2010.

## Maintaining the Observations

The network of synoptic stations operated by Met Éireann needs to be maintained and developed further to ensure the future of long-term cloud observations. Further resources are required to carry out analysis of cloud data. The Mace Head cloud observation programmes are funded on an ad hoc basis from a range of projects by the Centre for Climate and Air Pollution Studies [C-CAPS], School of Physics at the National University of Ireland Galway, but lack long-term and sustainable operational support. There is a need for ongoing research on the link between aerosols and cloud properties.

### Further Information and Data Sources

Norris, J.R. and Slingo, A. (2009) Trends in observed cloudiness and Earth's radiation budget in Strüngmann Forum Report, *Clouds in the Perturbed Climate System: Their Relationship to Energy Balance, Atmospheric Dynamics, and Precipitation*. Heintzenberg, J. and Charlson, R.J. (eds.) MIT Press.

Information on data availability from Met Éireann:  
<http://www.met.ie/climate/climate-data-information.asp>

Information on the Mace Head Facility:  
<http://www.macehead.org>

Information and data from ESA's Climate Change Initiative cloud project:  
<http://www.esa-cloud-cci.org/>

The World Climate Research Programme's International Satellite Cloud Climatology Project:  
<http://isccp.giss.nasa.gov>

Data via Giovanni from the Goddard Earth Sciences and Information Services Center: <http://disc.sci.gsfc.nasa.gov/giovanni/overview/index.html>