TECHNOLOGICAL IMPLEMENTATION PLAN

A Framework for the further development, dissemination and use of
the results of EC RTD Projects (including also thematic networks and concerted actions)

DATA SHEETS

X☐ Preliminary version at mid-term (optional, programme per programme)

☐ Final version before final term (contractual obligation)

Part 1: Overview and description of your project and its results
One form per project **Publishable**

1.1: Executive summary (to be used for an accurate update of the programme synopsis of projects)
1.2: Overview of all results
1.3: Quantified data on the project
1.4.: Assessment of the European interests : This section enables the co-ordinator to explain the interest for the European Union (the competitiveness of its industries, the usefulness for (part of) its population,…) of the achieved results and of their foreseen impacts.
1.5.: Expected project impact

Part 2: Description of each Result - Search for collaboration through Commission services
One form per Result **Publishable**

This section will be used to document your result(s) in CORDIS and to inform any appropriate audience

2.1 : Description of the result(s)
2.2 : Quantified data about the result
2.3 : Further collaboration, dissemination and use of the result : This section enables each partner – individually or as a consortium – to describe its needs in further collaboration in view of the dissemination an use of its results(s).

Part 3: Description of the intentions by each partner
One form per partner **Confidential**

This section enables each partner – individually or as a consortium – to describe its use and dissemination intentions (including a timetable of its future activities).
3.1 : Description of the use and the dissemination of result(s), partner per partner
3.2 : Quantified data for each partner's main result

- The Technological Implementation Plan data sheets are available as a predefined form in Microsoft Word format. The file may be downloaded from the European Commission's CORDIS web site at: http://www.cordis.lu/fp5/tip.htm or may be obtained by e-mail from your EC programme help desk or your Project Officer.
- The form should be completed electronically and returned preferably by e-mail to your project officer (Firstname.Lastname@cec.eu.int). Alternatively it can be sent on a diskette to the address provided by your Project Officer :
  - ✓ Part 1, 2 by the project co-ordinator;
  - ✓ Part 3 by the project co-ordinator or by each partner individually, as preferred.

Part 1 Overview and description of your project and its results

EC PROGRAMME :	**ENERGY, ENVIRONMENT AND SUSTAINABLE DEVELOPMENT**
PROJECT TITLE & ACRONYM:	**CLOUDNET: DEVELOPMENT OF A EUROPEAN NETWORK OF STATONS FOR OBSERVING CLOUD PROFILES.**
CONTRACT NUMBER :	**CLOUDNET EVK2 – 2000 – 00065**
PROJECT WEB SITE (if any) :	http://www.met.reading.ac.uk
PARTNERS NAMES :	**1. University of Reading, UK (UR)** **2. Council for the Central Laboratory for the Research Councils, UK (RAL – CCLRC)** **3. Centre National de la Research Scientifique, Delegation Ile-de-France Ouest et Nord (CNRS-IPSL)** **4. Royal Netherlands Meteorological Institute (KNMI)** **5. Technical University of Delft (TUD)** **6. The Meteorological office (The Met Office)** **7. Vaisala Oyj (Vaisala)**

1.1 Executive summary

Please, synthesise (in 1 or 2 pages) your project original objectives and final outcome.

a) Original research objectives

The overall objectives of CLOUDNET are :

To optimise the use of existing data sets to develop and validate cloud remote sensing synergy algorithms.

To demonstrate the importance of an operational network of Cloud Remote Sensing stations (CRS-stations) to provide data for the improvement of the representation of clouds in climate and weather forecast models and for the use of GCOS.

The objectives of the five work packages are:

WP1 – Exploit Existing Cloud Data Sets.
To organise the existing data in to a format accessible by other partners.
To test first versions of algorithms to derive cloud characteristics from the data set.
To analyse the in-situ cloud aircraft data to validate the retrievals.

WP2 – Operate three cloud remote sensing stations.
To operate the stations for a minimum of one week per month for two years.
To quality control and archive the data.
To archive the model forecast data over each of the sites.

WP3 – Development of retrieval algorithms.
To develop algorithms for retrieving macroscopic cloud properties, and liquid ice and mixed phase cloud properties from radar and lidar observations and consider the technological implications of implementing such algorithms.

WP4 – Compare retrieved cloud profiles with operational models.
To compare the macroscopic cloud properties, and liquid ice and mixed phase cloud properties inferred from radar and lidar observations with the values held in four European operational forecasting models.

The final work package is scheduled to start later in the action.
WP5 - Definition of instruments and algorithms for GCOS.
To define the optimal combinations of instruments, algorithms and data formats for a practical GCOS stations.

b) Expected deliverables

The action has the following deliverables:

D0	Project Publicity Brochure	by jul 01	delivered.
D1	Kick-off workshop report	by Jul 01	delivered
D2	Existing data sets and initial analysis.	By Oct 02	delivered, see WP1.
D3	Initial algorithm recommendation	by Oct 02	delivered, see WP3
D4	User Requirement Document	by Oct 02	delivered
D5	CloudNET web side	by Oct 01	delivered
D6	Year one data gathered	by Oct 03	ongoing, see WP2
D7	Model data year one	by Oct 03	ongoing, see WP2
D8	Year two of data gathered	by Oct 04	start 1 Oct 03
D9	Model data year two	by Oct 04	start 1 Oct 03
D10	Optimised algorithms and performance	by Jan 05	see WP3
D11	Comparison of algorithms with model.	By Jan 05	see WP4
D12	Recommendation for industry	by Apr 05	see WP5, starts Apr 03.
D13	Report of final workshop	by Apr 05	all WPs
D14	Description of recommended GCOS station.	By Apr 05	WP5.

The completed deliverables are available on the web site:
http;//www.met.reading.ac.uk/radar/cloudnet/

c) Project's actual outcome ***(in terms of technical achievements or if appropriate task per task)***

Summary of the deliverables and original findings within each work package:

WP1 – Exploit Existing Cloud Data Sets. (D2)

- Independent evaluation of a new radar/lidar retrieval of ice particle size and water content using blind tests.
- One year's climatology of ice particle size as a function of ice water content and temperature.
- New algorithms for deriving liquid water content, drizzle size spectra and attenuation within stratocumulus liquid water cloud .
- Use of combined reflectivity and Doppler velocity to classify ice particles.

WP2 – Operate three cloud remote sensing stations. (D6)

- Operation of the three stations has started.
- Development of a calibration technique for 94GHz cloud radar.
- Characterise the lifetime and decay of a 94GHz cloud radar EIKA.
- Demonstration of the ability to make unattended long time series of radar and lidar data.
- Development of a lidar self calibration technique.

WP3 – Development of retrieval algorithms. (D10)

- Theoretical demonstration of the retrieval of liquid water droplet size from a lidar with a double field of view.
- Identification of specular reflection from ice particles.
- Retrieval of particle size spectra from Doppler spectral width.

WP4 – Compare retrieved cloud profiles with operational models. (D11)

- Comparison of fractional cloud cover, observed ice water content and missed phase clouds with their representation in operational models.
- Derivation of probability density functions of water content and cloud inhomogeneities.
- The definition of cloud fraction by area or volume.
- A two year climatology of the radar reflectivity of stratocumulus.

d) Broad dissemination and use intentions for the expected outputs *(such as industrial development, standards, regulations and norms, improvement of environment, health, working conditions, employment, net economic benefits, etc)*

Advice to industrial partners on the optimum instruments and algorithms for an operational cloud Remote Sensing Station.

Comparison of the observations of cloud properties over three cloud remote sensing stations in UK, NL and F with the properties held in four operational forecast models for the grid box over these stations. Identification of systematic errors in the forecast models.

These outputs should enable modellers to improve the parameterisation of clouds within their models. Such improved parameterisations would lead to better weather forecasts of flooding and improved climate forecast of global warming.

1.2 Overview of all your main project results

No.	Self-descriptive title of the result	Category A, B or C*	Partner(s) owning the result(s) (referring in particular to specific patents, copyrights, etc.) & involved in their further use
1	Evaluation of new radar/lidar retrieval of ice particle size and water content and errors using blind tests.	A	UR, IPSL, KNMI
2	One year’s climatology of ice particle size as a function of IWC and T over Oklahoma.	A	KNMI
3	New algorithms for deriving liquid water content, drizzle size spectra, and attenuation within stratocumulus liquid water cloud	A	UR, TUD
4	Use of combined reflectivity and Doppler velocity to classify ice particles	A	IPSL
5	Development of a calibration technique for 94GHz cloud radar.	A	UR, RAL, IPSL
6	Characterise lifetime and decay of 94 GHz cloud radar amplifier EIKA, and install new design EIKA for further lifetime performance tests	A	RAL, UR
7	Demonstration of the ability to make unattended long time series of radar and lidar data	A	KNMI, RAL
8	Lidar self calibration technique.	A	UR, RAL
9	Theoretical demonstration of the retrieval of liquid water droplet size from a lidar with a double field of view.	A	KNMI, NL
10	Identification of Specular reflection.	A	UR

* A: results usable outside the consortium / B: results usable within the consortium / C: non usable results

No.	Self-descriptive title of the result	Category A, B or C*	Partner(s) owning the result(s) (referring in particular to specific patents, copyrights, etc.) & involved in their further use
11	Retrieval of particle size spectra from Doppler spectral width.	A	UR, IPSL
12	Comparison of fractional cloud cover, observed ice water content, and mixed phase clouds with their representation in operational models.	A	UR
13	Probability density functions of water content and cloud inhomogeneities.	A	UR
14	Definition of cloud fraction by area or volume.	A	UR
15	A two-year climatology of the radar reflectivity of stratocumulus.	A	UR
16			
17			
18			
19			
20			

* A: results usable outside the consortium / B: results usable within the consortium / C: non usable results

1.3 Quantified Data on the dissemination and use of the project results

Items about the dissemination and use of the project results (consolidated numbers)	**Currently achieved quantity**	**Estimated future* quantity**
# of product innovations (commercial)	4	3
# of process innovations (commercial)		
# of new services (commercial)		
# of new services (public)		
# of new methods (academic)		
# of scientific breakthrough	11	12
# of technical standards to which this project has contributed		
# of EU regulations/directives to which this project has contributed		
# of international regulations to which this project has contributed		
# of PhDs generated by the project		4
# of grantees/trainees including transnational exchange of personnel		

*# = number of ... / * "Future" means expectations within the next 3 years following the end of the project*

1.4. Comment on European Interest

All projects are expected to meet European interests. This section should provide an appraisal of your project in terms of European added value and support to the implementation of European Union policies.

1.4.1. Community added value and contribution to EU policies

a. European dimension of the problem
(The extent to which the project has contributed to solve problems at European level)

Three pilot cloud remote sensing stations have been set up and are operating in the UK, France and The Netherlands. We have one European industrial partner who has attended all our workshops and meetings and two other companies who wish to join the project.

b. Contribution to developing S&T co-operation at international level. European added value
(Development of critical mass in human and financial terms; combination of complementary expertise and resources available Europe-wide)

Groups from three countries of the EU are working together to develop common instruments, commons algorithms and a common means of comparing cloud properties to European forecast models.

c. Contribution to policy design or implementation
(Contribution to one or more EU policies; RTD connected with standardisation and regulation at Community and/or national levels)

1.4.2. Contribution to Community social objectives

a. Improving the quality of life in the Community :

The project involves comparing cloud observations with their representation in forecast models with the aim of identifying errors in their representation and then improving their forecasting. The impacts of this are twofold:

- **i) Improved flood forecasting through improved representation of clouds in forecast models.**
- **ii) Improved forecasts of future global warming – the current unacceptable range of uncertainty over predicted global warming over the next century stems largely from uncertainties over the representation of clouds in such models.**

b. Provision of appropriate incentives for monitoring and creating jobs in the Community (including use and development of skills) :

c) Supporting sustainable development, preserving and/or enhancing the environment (including use/conservation of resources) :

Improved forecasts of rainfall and flooding will lead to a reduction in the damage to the environment caused by recent severe flooding events.

1.5. Expected project impact (to be filled in by the project coordinator)

Remark: by replying to the following questions, the coordinator is asked to express his best estimation regarding the impact of the project.

Overall Policy Impact[1]

EU Policy Goals	I SCALE OF EXPECTED IMPACT OVER THE NEXT 10 YEARS[2] -1 0 1 2 3	II other: Not applicable to project	II other: Project Impact too difficult to estimate
1. Improved sustainable economic development and growth, competitiveness Θ			
2. Improved employment Θ			
3. Improved quality of life and health and safety Θ			
4. Improved education Θ			
5. Improved preservation and enhancement of the environment Θ			
6. Improved scientific and technological quality Θ			
7. Regulatory and legislative environment Θ			
8. Other ______________ Θ			

[1] Coordinator should respond to section I or, if appropriate, to section II. If the project has had no impact, a "0" should be entered in section I. Scores other than zero in section I will prompt a more detailed subquestion on a separate screen. However, you may access in any case the subquestions by clicking on the symbol" Θ "following each main question.

[2] Indication for scale as follows: -1 represents negative impact, 0 no impact, 1 small positive impact, 2 medium positive impact , 3 is a strong positive impact

Indicate your replies below by putting in each box the number corresponding to the score you chose:

1. Economic development and growth, competitiveness	**Scale of Expected Impacts over the next 10 years (**2)	
	By Project End -1 0 1 2 3	**After Project End** -1 0 1 2 3
a) Increased Turnover for project participants - national markets		
- international markets		
b) Increased Productivity for project participants		
c) Reduced costs for project participants		
d) Improved output quality/high technology d)		

2. Employment	**Scale of Expected Impacts over the next 10 years (**2)	
	By Project End -1 0 1 2 3	**After Project End** -1 0 1 2 3
a) Safeguarding of jobs		
b) Net employment growth in projects participants staff		
c) Net employment growth in customer and supply chains		
d) Net employment growth in the European economy at large		

3. Quality of Life and health and safety	**Scale of Expected Impacts over the next 10 years (2)**	
	By Project End -1 0 1 2 3	**After Project End** -1 0 1 2 3
a) Improved health care		
b) Improved food, nutrition		
c) Improved safety (incl. consumers and workers safety)		
d) Improved quality of life for the elderly and disabled		
e) Improved life expectancy		
f) Improved working conditions		
g) Improved child care		
h) Improved mobility of persons		

4. Improved education	**Scale of Expected Impacts over the next 10 years** (2)	
	By Project End -1 0 1 2 3	**After Project End** -1 0 1 2 3
a) Improved learning processes including lifelong learning		
b) Development of new university curricula		

5. Preservation and enhancement of the environment	**Scale of Expected Impacts over the next 10 years** (2)	
	By Project End -1 0 1 2 3	**After Project End** -1 0 1 2 3
a) Improved prevention of emissions		
b) Improved treatment of emissions		
c) Improved preservation of natural resources and cultural heritage		
d) Reduced energy consumption		

6. S&T quality	Scale of Expected Impacts over the next 10 years (2) By Project End -1 0 1 2 3	After Project End -1 0 1 2 3
a) Production of new knowledge		
b) Safeguarding or development of expertise in a research area		
c) Acceleration of RTD, transfer or uptake		
d) Enhance skills of RTD staff		
e) Transfer expertise/know-how/technology		
f) Improved access to knowledge-based networks		
g) Identifying appropriate partners and expertise		
h) Develop international S&T co-operation		
i) Increased gender equality		

7. Regulatory and legislative environment	Scale of Expected Impacts over the next 10 years (2) By Project End -1 0 1 2 3	After Project End -1 0 1 2 3
a) Contribution to EU policy formulation		
b) Contribution to EU policy implementation		

8. Other (please specify)	Scale of Expected Impacts over the next 10 years (2) By Project End -1 0 1 2 3	After Project End -1 0 1 2 3

I, **project co-ordinator**, confirm the published information contained in this part 1 of the TIP.

Signature: **Name:**

Date: **Organisation:**

Part 2 Description of each result

A separate part 2 must be completed for each result. This may be done by the partner responsible for the result or by the project co-ordinator.

The part 2 must be consolidated at the consortium level and transmitted to the Commission by the co-ordinator.

PARTS 2 WILL BE DISSEMINATED BY THE COMMISSION

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
1	Evaluation of new radar/lidar retrieval of ice particle size and water content and errors using blind tests.

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

Simultaneous radar and lidar backscatter return signals from ice clouds have the potential to provide, for the first time, accurate ice particle size and ice water content. Current retrievals are unreliable because it is difficult to correct for the severe attenuation of the lidar signal. Two new methods to correct for attenuation by using the radar return at the back of the clouds have been compared and evaluated in a series of blind tests. Theoretically, the radar return (Z) (= ND^6) and the corrected lidar return (B) (=o ND^2) where N is ice particle concentration and D is their size, so D can be estimated from Z/B. The first method (KNMI) is to iteratively adjust the lidar attenuation of the cloud so that D on the far side of the cloud is well behaved and constant over the last few detectable gates, whereas the second method (IPSL) is to adjust the attenuation so that N is constant over the last few gates.

Aircraft observations of ice particle size spectra were used to calculate profiles of ice water content, ice particle size, and radar and attenuated. The lidar backscatter is attenuated and only penetrates the top few km of the cloud. The two teams then fed the radar and attenuated lidar backscatter into their algorithms and reported back their inferred profiles of extinction coefficient and particle size; the retrievals are very close to the original data. The extinction coefficient is the most important, as this controls the radiative fluxes, and is very accurately retrieved, with an accuracy sufficient to constrain the long wave fluxes to 10W m^{-2}.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	Details (Title, ref. number, general description, language)	Status: *PU*=Public *CO*=Confidential
Refereed Article	Protat A, C.Tinel and J Testud. Dynamic properties of clouds and dynamic/microphysical interactions from 94GHz radar and lidar. In revision. Phys and Chem of the Earth. B. 2002	PU
Refereed Article	C.Tinel, J Testud, A. Protat, and J.Pelon. Microphysical and radiative properties ice clouds using a cloud radar-lidar algorithm. In revision. Phys and Chem of the Earth. B. 2002	PU
Non referred Article	D.P. Donovan, Effective particle sizes in Cirrus derived from combined lidar, radar reflectivity and Doppler velocity measurements. 2nd European Radar Conference, Delft, The Netherlands, November 2002.	PU
Non referred Article	P. Donovan, Effective ice cloud Size distribution parameterization using combined lidar, radar reflectivity and Doppler velocity measurements. EGS-AGU-EUG Joint assembly, Nice, France, 06-11 April 2003.	PU

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
2	One year's climatology of ice particle size as a function of IWC and T over Oklahoma.

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

Radiative properties of ice clouds are controlled by their optical depth which is affected by the size of the ice particles. The KNMI retrieval method has been applied to 7 months data from the US Government Atmospheric Radiation Measurement's (ARM) Southern Great Planes (SGP) site situated Oklahoma has been compared with previously suggested effective particle radius parameterisations derived from in-situ aircraft data. In general, our results confirm previous parameterisations, but there are some large differences probably due to differences in IWC.

The results of this work have been used to formulate parameterisations of cirrus cloud effective particle radii and other relevant quantities that are suitable for inclusion in atmospheric models. This work strongly argues that in formulating ice-crystal size parameterisation that both IWC and temperature should be taken independently into account.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Referred Article	D.P.Donovan, First ice cloud effective particle size parameterization based on combined lidar and radar data, GRL, 29, No. 1, 10.1029/2001GL013731, 2002	PU
Referred Article	D.P.Donovan Ice-Cloud effective particle size parameterization based on combined lidar,radar reflectivity, and mean Doppler velocity measurements, GRL, In press.	PU

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
3	New algorithms for deriving liquid water content, drizzle size spectra, and attenuation within stratocumulus liquid water cloud

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

A new algorithm for characterising the drizzle falling below stratocumulus exploits the four radar and lidar observables. The ratio of the radar reflectivity (Z) and the lidar backscatter provides an estimate of mean drizzle droplet size, once the size is known then the value of Z fixes the concentration, the Doppler spectral width then fixes the width of the drizzle drop spectrum defined by μ. These three observables have now defined the three parameters in a normalised gamma function, which describe the drizzle drop size spectrum.

Once these parameters are known then the liquid water content and liquid water flux can be computed from the size spectrum. The value of the Doppler terminal velocity of the drops can also be computed, and subtracted from the observed Doppler velocity (which has not been used until now) to derive the up and down drafts in the stratocumulus.

A second technique to retrieve the liquid water content of water clouds containing drizzle has been developed which combines radar, lidar and microwave radiometers together with a cloud classification technique. The method assumes a quasi-adiabatic water content with a corresponding height dependence of drop size distribution.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Referred Article	E J O'Connor, A J Illingworth and R J Hogan: Retrieving stratocumulus drizzle parameters using Doppler radar and lidar. Submitted to J Atmos Oceanic Technol, July 2003.	PU
Referred Article	Baedi, R.; Boers,R.; Russchenberg, H.W.J.: Detection of Boundary Layer Water Clouds by Spaceborne Cloud Radar. Journal of Atmospheric and Oceanic Technology Vol.19	PU
Non referred Article	Krasnov O and Russchenberg H: An enhanced algorithm for the retrieval of liquid water cloud properties from simultaneous radar and lidar measurements. Part 1: The basic analysis of in-situ drop spectra. European Conference on Radar Meteorology (ERAD) 2002 Proceedings, 18 - 22 November 2002, Delft, The Netherlands, ERAD Publication Series Vol. 1 - pp. 173 – 178	PU
Non referred Article	Krasnov O and Russchenberg H: An enhanced algorithm for the retrieval of liquid water cloud properties from simultaneous radar and lidar measurements. Part II Validation using ground based radar. lidar and microwave radiometer data European Conference on Radar Meteorology (ERAD) 2002 Proceedings, 18 - 22 November 2002, Delft, The Netherlands, ERAD Publication Series Vol. 1 - pp. 173 – 178	PU
Non referred Article	Heijnen S H, H. Klein-Baltnink, H W J Russchenberg, W.F. Van der Zwan; Polarimetric cloud studies at 3.3.GHz. European Conference on Radar Meteorology (ERAD) 2002 Proceedings, 18 - 22 November 2002, Delft, The Netherlands, ERAD Publication Series Vol. 1 - pp. 173 – 178	PU

Non referred Article	Krasnov, O. A., and H.W.J. Russchenberg. The Comparative Study of the Relation Between Cloud Microphysics and Radar-to-Lidar Ratio for the Different Geographical Regions and Field Campaigns, Open Symposium on Propagation and Remote Sensing URSI Commission-F, 12-15 February 2002, Garmisch-Partenkirchen, Germany 10 pp.	PU
Non referred Article	Krasnov, O. A., and H.W.J. Russchenberg. The relation between the radar to lidar ratio and the effective radius of droplets in water clouds: An analysis of statistical models and observed drop size distributions. 11th Conference on Cloud Physics, 3-7 June 2002, Ogden, Utah, AMS. (Proc. on CD-ROM)- 9 pp.	PU
Non referred Article	Krasnov, O. A., and H.W.J. Russchenberg. Use of simultaneous radar and lidar data for the retrieval of microphysical parameters in low-level water clouds. 15th Symposium on Boundary Layer and Turbulence, 15-19 July 2002, Wageningen, The Netherlands, AMS, pp. 88-91.	PU
	A.D. Hassiotis, H. Klein-Baltink, N.C. Skaropoulos, M. Quante, and H. Russchenberg, 'Comparison of multiple-wavelength cloud radar observations in the BBC campaign,' Conference CD of URSI, 27th General Assembly of the International Union of Radio Science, Maastrich, The Netherlands (2002).	PU

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
4	Use of combined reflectivity and Doppler velocity to classify ice particles

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

The terminal velocity of ice particles is important in defining the lifetime of cirrus clouds. Current models assume a simple dependence of mean terminal velocity on ice water content, but in fact this velocity depends on ice particle shape, size and density, all of which are variable. Ice particle concentrations are very variable, so a given ice water content (IWC) could have a high concentration of small ice particles which would fall slowly, or a low concentration of larger ice particles which would fall more rapidly. To remove this dependence the ice water content is divided by the normalised ice particle concentration, which effectively gives the mean mass of particles in the spectra. Once the concentration has been removed from the IWC expression then the mean mass of the ice particles is much better correlated with the terminal velocity of the spectrum. Observations show slower velocities for a given mean mass at higher altitudes, one assumes this is because at colder temperatures the density of the ice particles is lower.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
5	Development of a calibration technique for 94GHz cloud radar

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

Accurate calibration of a radar so that the reflectivity, Z, is correct is an essential step but one which is often given insufficient attenuation. Our experience is that traditional engineering calculation of the link budget, can easily be out by more than a factor of two. Traditionally, for precipitation radars an improved calibration is carried out by comparing the radar signal with the rainfall rate measured by a ground based gauge a few km from the radar, but this direct approach is not possible for a cloud radar because the 94GHz signal is enormously attenuated by the rain. The new method we have developed relies on the theoretical 94GHz radar reflectivity of rainfall above 2mm/hr being reduced by Mie scattering so that it is constant and close to 19dBZ with little dependence on the raindrop concentration (N_L) or the shape of the spectra (μ).

The calibration method is to adjust the value of Z measured in rain to be 19dBZ when observed with vertically pointing radar at a range of only 250m to minimise attenuation. In practice, a difficulty arises, because water on the radome gives another 9-14dB of attenuation, so that the constant value in the figure is closer to 8dBZ. Operating the radar at a lower elevations angle and employing a shelter to keep it dry can avoid the attenuation due to the wet radome. When this is done averaging over several rainfall events during a month is sufficient to calibrate the radar to within 1dB (25%).

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	21	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Referred Article	R J Hogan, D H Bouniol, D N Ladd, E J O'Connor and A J Illingworth: Absolute Calibration of 94-GHz radars using rain. J Atmos and Ocean Technol, 20, 572-580, 2003.	PU

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
6	Characterise lifetime and decay of 94 GHz cloud radar amplifier EIKA, and install new design EIKA for further lifetime performance tests

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

The 94 GHz (Galileo) cloud radar currently operational at Chilbolton uses an Extended Interaction Klystron Amplifier (EIKA) for which little information on lifetime and decay characteristics is available. The radar has been operated for a total period of over 3 years, and a steady drop in sensitivity has been observed over the last 15 months, before complete failure.

The Extended Interaction Klystron Amplifier (EIKA) designed and manufactured by Communications and Power Industries (CPI) is a high power amplifier of relatively recent design and it has not been extensively tested to determine its operational lifetime. Cloud radars are often used for short campaigns, either ground-based or aircraft based, and little information has been available from other radar users on the decay characteristics of these amplifiers. The Galileo radar at Chilbolton has been operated on a continuous basis, but with significant interruptions, since September 1996.

A new EIKA was delivered in March 2003. The EIKA is of a new design using a Triple Alloy coated cathode, which is expected to have a longer operational lifetime than the earlier design.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐
Guidelines, methodologies, technical drawings	☐ X
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
7	Demonstration of the ability to make unattended long time series of radar and lidar data.

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

The ability to make unattended long time series of cloud radar and lidar data is a crucial aspect of this project. Below we summarise how this achievement has been demonstrated at the Cabauw and Chilbolton field sites.

Cabauw: Data from the 35GHz cloud radar and CT75 ceilometer at Cabauw in the the Netherlands have been collected in the framework of CloudNET since October 2001 has been continuous without any significant breaks since this date and uploaded regularly to the CloudNET database maintained on a ftp-server at the KNMI. The only concern is the gradual decrease of the transmit power of the 35 GHz cloudradar. Since the start of the measurements the output power of the TWT (travelling wave tube), i.e. the 35 GHz power amplifier, has dropped from 100 W to near 50 W early 2003 after operating for almost 17000 hrs.

Chilbolton.

During the first year of the Cloudnet project the lidar ceilometer has been operated continuously at Chilbolton. As described in the previous sections the cloud radar was operated continuously for the 15 months from Jan 01 to march 02 before failure of the tube. The tube is now repaired and continuous observations resumed.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐
Guidelines, methodologies, technical drawings	☐ X
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
8	.Lidar self calibration technique

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

Traditionally calibration of visible lidars is achieved by comparison with Rayleigh scatter from the molecules in the air, but this is not possible for the common lidars operating near one micron. A method of automatically self-calibrating lidars has been developed which can be used every time low-level thick stratocumulus clouds are present. The method is to add up the lidar backscatter (in /m/sr) at each gate until the signal is extinguished to give the 'integrated backscatter'. The lidar calibration is then adjusted until the integrated backscatter is about 15sr. Typical calibration over a period of seven hours of low level cloud, after calibration, gives a constant value of integrated backscatter, apart from occasional short periods where the cloud is thinner. The method provides a calibration accurate to about 10%.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Referred Article	E J O'Connor, A J Illingworth and R J Hogan: A technique for auto-calibration of cloud lidar: Submitted to J Atmos Oceanic Technol, 2003.	PU

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
9	Theoretical demonstration of the retrieval of liquid water droplet size from a lidar with a double field of view.

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

The possibility of using multiple field-of-view lidar data in order to estimate effective particle sizes of stratocumulus clouds has been investigated using theoretical calculations. The results were used to formulate a prototype inversion approach. The results indicate that a practical approach may be possible using a relatively simple two field-of-view lidar (or two paired lidars with different fields-of-view).

Multiple scattering complicates the analysis of even simple elastic backscatter data. However, since the degree of multiple-scatter largely depends on the physical `size' of the cloud particles and the field-of-view of the lidar, the use of multiple-field-of-view lidar information may help determine microphysical properties of low level water clouds which cannot be detected by even the most sensitive radar. Due to multiple scattering, in an optically dense medium the lidar pulse will tend to broaden to an extent which depends on the particles size. Example calculations made using an approximate analytical model with the effective particle size within the cloud at 10 microns. The multiple-scattering contribution to the total signal becomes larger for the larger FOV. This effect will tend to increase with increasing particle size

It seems that a minimal system operating at 908 nm should have one field-of-view around 0.1-0.3 mrads and another in the range of 2.0-3.0 microns. Such an arrangement would allow the discrimination of effective particle sizes from 5.0-25 microns. True multiple-field-of-view lidar systems tend to be complex and expensive (even for only two field-of-views). Thus, a dual receiver system or paired lidar (ceilometers) configuration would likely be more practical within CloudNet. .

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐
Guidelines, methodologies, technical drawings	☐ X
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
10	Identification of Specular reflection

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

It has long been known that specular reflection from horizontally aligned crystals acting as mirrors can cause anomalously high backscatter when observed by a zenith pointing lidar. It is not clear whether this phenomenon is a curse of a blessing. It can be a curse because the enhanced return is not accompanied by any increase in extinction and so it makes interpretation of lidar backscatter in terms of it cloud optical properties problematic. It could be a blessing as a way of identifying pristine crystals in a cloud. Integration of the backscatter over each gate in the vertical can be used to identify specular reflection. For water droplets the ratio of the extinction to backscatter is 18 sr^{-1}, so the maximum value of the integrated backscatter is about 0.38 if the cloud has infinite optical depth. These values are exceeded by supercooled cloud.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
11	Retrieval of particle size spectra from Doppler spectral width

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

Values of spectral width observed by the vertically pointing 35GHz cloud radars have been used to infer the breadth of the drop size spectrum in light rainfall. Hydrometeor size spectra are well characterised by a normalised gamma function with the breadth of the spectrum defined by the factor μ. If μ is zero, then we have the well-known inverse exponential fall off of concentration with size..

The Doppler width observation at vertical incidence provides a direct measure of the spread of terminal velocities in the spectrum, which for a given mean size of droplets is related to μ. Analysis of observed Doppler widths at vertical incidence shows that they are appreciably smaller than expected for an exponential size spectrum.. There is a small range of uncertainty because for a given rain rate, the mean drop size is also a function of the concentration, but this is a small effect. We conclude that the spectra are far from the exponential value often assumed in the past and that a value of μ closer to 5 or 10 is more appropriate.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
12	Comparison of fractional cloud cover, observed ice water content, and mixed phase clouds with their representation in operational models

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

One year of cloud radar observed over Chilbolton has been compared with the representation of clouds at that time in the ECMWF and Met Office operational models. The models represent ice clouds using these two variable and these data are the first evaluation of model performance. The representation of mixed phase clouds is much cruder, so we do not expect the models to capture their behaviour so well, even though we know that such clouds are common and have a large radiative effect. The radar and lidar observe the cloud every thirty seconds with a vertical resolution of 60m, so for a typical model grid box of depth 500m produced every hour, there are several hundred observed pixels observed, and the fraction of the box filled with cloud can be estimated to a few %. The average value of radar reflectivity is converted to ice water content using an empirical relationship accurate to about 50%. The supercooled clouds are detected by their high lidar and low radar signal.

There has been much concern because the ice water contents in climate models are varying by an order of magnitude, but are producing the same top of the atmosphere flux. These results show that the value of ice water content for the ECMWF and Met Office the performance is better than this, with model values of ice water content about 50% of those observed for heights between 3 and 7km, and agreeing above 7km.

The models tend to underestimate the mid-level cloud and overestimate the amount of cloud above 7km. This means that when mid level cloud is present the amount of ice water content is about right, but the amount of mid-level cloud is too low. Finally, the fraction of cloud, which contain supercooled layers within them has been derived. The fraction observed is about 25% just below freezing, but does fall to 0% at –40C as expected, but generally the representation of supercooled water in models is very poor.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	Details (Title, ref. number, general description, language)	Status: *PU*=Public *CO*=Confidential
Referred Article	R J Hogan, H Flentje, P N Francis, A J Illingworth, M Quante and J Pelon: Characteristics of mixed phase clouds. Part1: Lidar, radar and aircraft observations from CLARE ‘98. Q J R Meteorol Soc, 129, 2089-2116, 2003.	PU
Referred Article	R J Hogan, A J Illingworth, J P V Poiares Baptista and E J O’Connor: Characteristics of supercooled clouds: Part II A climatology from ground-based lidar. Q J R Meteorol Soc 129, 2117-2134, 2003.	PU
Article in preparation	N.Gaussiat, R.J.Hogan and A J Illingworth. Stratocumulus liquid water content from dual wavelength radar. To be submitted to J Ocean Atmos Technol.	CO
Article in preparation	M E Brooks, R J Hogan and A J Illingworth. Comparisons of radar derived values of IWC and their representation in operational models of ECMWF and Met Office. To be submitted	CO

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
13	Probability density functions of water content and cloud inhomogeneities.

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

Cloud variability on scales smaller than the gridbox size of numerical forecast and climate models is believed to be important in determining the radiative effects of clouds. An 18 month series of vertical profiles of cloud properties over Chilbolton has been examined to derive expressions for the probability distribution function of ice water content within grid boxes.

The effect of shear is to make the iwc more uniform. This is demonstrated by different values for the pdf of ice water content for different values of shears. The pdfs can be reasonably well fitted to a gamma or log normal function. 18 months of data has been analysed and expressions have been derived for how the pdfs vary as a function grid box size and wind shear. This data is needed by modellers wishing to express cloud variability within the grid box.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Referred Article	R J Hogan and A J Illingworth: Parameterizing ice cloud inhomogeneity and the overlap of inhomogeneities using cloud radar data. J Atmos Sci, 60, 756-767, 2003	PU

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
14	Definition of cloud fraction by area or volume

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

Cloud fraction is an essential variable needed by models when grid boxes are partially filled with clouds. It is always assumed that the fraction of the volume of the grid box (Cv) which is saturated is also the fraction of the grid box area (Ca) which is cloud covered and controlling the radiative fluxes. Fig 1 shows that this is only true if the clouds have vertical edges, any sloping clouds will lead to a value of Ca>Cv. A one year Chilbolton data set has been analysed to quantify the size of this effect as a function of grid box dimensions. Clearly, there is no difference in Ca and Cv for totally clear or totally cloud grid box, but for a box with the volume half filled with cloud (Cv=0.5) the horizontally projected area of cloud is nearly 80%. Analytical expressions to correct for the underestimate of Ca by Cv as a function of grid box size and wind shear have been derived from one year's data and the values of these expressions are shown to capture the behaviour quite well. The assumption that the value of Cv can be used for calculating radiative effects has the potential to lead to large errors.

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	**Details (Title, ref. number, general description, language)**	**Status: *PU*=Public *CO*=Confidential**
Referred Article	M E Brooks, R J Hogan and A J Illingworth: The definition of cloud fraction in GCMs by area and by volume. Submitted J Atmos Sci, 2003.	PU

2.1 : Description of the result(s), one form per result

No. & TITLE OF RESULT (same as in table 1.2)

No.	Self-descriptive title of the result
15	A two-year climatology of the radar reflectivity of stratocumulus

SUMMARY *(200 words maximum)*

Provide an overview of the result which gives the reader an immediate impression of the nature of the result, its relevance and its potential; Briefly describe the current status/applications of the result (if appropriate) with non confidential information on entities potentially involved.

Stratocumulus clouds are important radiatively and easily detectable by lidar, but their radar reflectivity (Z) is often very low because they contain such small droplets. However, because the radar reflectivity is proportional to the sixth power of the drop size, the presence of just a few large drizzle droplets is sufficient to raise their value of Z 10 or 20dB so that the radar can easily detect them. The sensitivity of the radar is such that it only detects a small fraction of the clouds seen by the lidar. Most of those detected by the radar have echoes extending below the lidar cloud base indicating the presence of drizzle From examining over 9200 hours of coincident radar and lidar data covering a period of 18 months it is found that the lidar sees cloud 23% of the time. The maximum sensitivity of a ground based radar is about –50dBZ and the cumulative probability plot shows immediately that it will detect only 56% of all stratocumulus clouds; a radar with a sensitivity of –37dBZ would miss 47% of the clouds, and one with –27dBZ would miss 66%. Rather higher percentages are detected in the winter, and analysis shows that this is because there is more drizzle in the winter clouds

Please categorise the result using codes from Annex 1

Subject descriptors	536	213	211	271	269

CURRENT STAGE OF DEVELOPMENT

Please tick one category only ✔

Scientific and/or Technical knowledge (Basic research)	☐ X
Guidelines, methodologies, technical drawings	☐
Software code	☐
Experimental development stage (laboratory prototype)	☐
Prototype/demonstrator available for testing	☐
Results of demonstration trials available	☐
Other (please specify.):	☐

DOCUMENTATION AND INFORMATION ON THE RESULT

List main information and documentation, stating whether public or confidential.

Documentation type	Details (Title, ref. number, general description, language)	Status: *PU*=Public *CO*=Confidential
Article in preparation	E J O'Connor, R J Hogan and A J Illingworth. Radar detection and climatology of stratocumulus clouds. To be submitted. J Appl Met.	CO

INTELLECTUAL PROPERTY RIGHTS

Type of IPR	**KNOWLEDGE:** Tick a box and give the corresponding details (reference numbers, etc) if appropriate					**Pre-existi** Tick a box details(ref appropria
	Current				**Foreseen**	**Tick**
	Tick	**NoP 1)**	**NoI 2)**	**Details**	**Tick**	
Patent applied for	☐				☐	☐
Patent granted	☐				☐	☐
Patent search carried out	☐				☐	☐
Registered design	☐				☐	☐
Trademark applications	☐				☐	☐
Copyrights	☐				☐	☐
Secret know-how	☐				☐	☐
Other - please specify :	☐				☐	☐

1) Number of **P**riority (national) applications/patents
2) Number of **I**nternationally extended applications/patents