WP5 – NA5: Clouds and aerosol quality controlled-observations
Deliverable D5.1: Minutes of workshop for new stations

Clouds and aerosol quality controlled-observations Workshop

Time : 12-13 Sep 2011
Place : Snijderszaal, Dept. of Elec. Eng., Math. and Computer Science, Delft University of Technology, Delft, The Netherlands.
Chair : Anthony Illingworth
minutes : Anthony Illingworth and Ewan O'Connor
APPENDIX-1 Participant list
APPENDIX-2 Agenda

Aim of the workshop was to discuss a strategy for extending the scope of the existing Cloudnet programme by incorporating new stations within Europe and extending the geographic and climatological coverage of the Cloudnet network. More specifically to consider the harmonisation of lidar and cloud radar formats, calibration and retrieval algorithms.

1.1. Capability of the 14 existing and candidate Cloudnet stations.

Presentations of the capability of the 14 stations are summarised in the Table below. Further details

Site	Radar	Lidar	Raman lidar	Water vapour lidar	Doppler lidar	Ceilometer	Microwave radiometer	GPS	Raingauge	Radiation	Sunphotometer	Radiosonde	Standard met	Surface aerosol	Sonic	Wind profiler
Cabauw	35 GHz, IDRA	3b+2a	Y	Y	Y	Y	Y	Y	Y	BSRN	Y	Y	Y MAST		Y	
Chilbolton	Copernicus, Galileo	Y			Y	Y	Y		Y	~BSRN	Y	Y	Y		Y	Y
Juelich	MIRA, MRR				Y	Y	Y		Y	~BSRN + AERI	Y	Y	Y MAST	MAX-DOAS		Y
Leipzig	MIRA	3b+2a	Y	Y	Y	Y	Y			~BSRN	Y	Y		Y		
Lindenberg	MIRA	Y	Y	Y		Y	Y	Y	Y	BSRN	Y	Y	Y MAST		Y	Y
Mace Head	MIRA					Y	Y	Y						Y		
Marburg	FMCW					Y			Y				Y	Y		
Munich	MIRA	3b+2a	Y			Y			Y	UV	Y	Y	Y MAST			
Palaiseau	FMCW, RASTA	Y			Y	Y	Y	Y	Y	BSRN	Y	Y	Y MAST	Y	Y	Y
Potenza	MIRA	3b+2a	Y	Y		Y	Y	Y	Y	BSRN	Y	Y	Y			
Sodankylä	MIRA				Y	Y	Y	Y	Y	~BSRN	Y	Y	Y MAST	Y		
Zugspitze	MIRA, MRR					Y	Y	Y	Y	AERI			Y			
Warsaw		3b+2a	Y			Y		Y	Y	~BSRN	Y	Y	Y	Y	Y	

Key:
24, 35, 94 GHz

on the web site.

Table 1: Outline of the instruments at each site.
Radar: MIRA cloud radar high sensitivity, -44dBZ at 5km range.
Lidar: '3b+2a', backscatter at 355, 532, 1064, extinction from nitrogen Raman at two wavelengths. Usually depolarisation at one or more frequencies. b+a single Raman channel
Doppler lidar – operates in range 1-5 – 2um Doppler from aerosol returns**.**
Microwave radiometer – two or more channels (close to 22 and 31 GHz) give liquid water path (LWP) and integrated water vapour.
Ceilometer – backscatter profile sensitive enough for identifying water clouds.
Sunphotometer – derive columnar aerosol optical depth and its spectral variation (Aeronet).

1.2. Issues arising:

Cloudnet ideal instrument fit. Consists of a cloud radar, a backscatter lidar/ceilometer and a microwave radiometer to derive liquid water path (LWP), all running continuously 24/7 every day of the year. If year round observations are not possible then periods of length one month are acceptable.

Cloud Radars: MIRA radar sensitivity is sufficient for virtually all water and ice clouds. Absolute calibration of 35GHz radar is an issue. Some MIRA instruments have a scanning capability. For Cloudnet, vertical dwell is best but scanning may be useful for calibration. Water on the radome leads to a large unknown attenuation at 94GHz, and is still a significant problem at 35GHz.
For FM/CW radars, saturation of the receiver (occurs at short ranges and/or large vertical reflectivity gradients) is an issue.
ACTION: Pietras. A technique for reliably recognising and flagging the spurious FM/CW signals is needed.

Lidar/ceilometers. If one is not available then it is difficult to identify water clouds, so liquid water content cannot be derived and cloud ice content is likely to be affected by unknown attenuation. Cloud fraction can still be derived.

Microwave radiometers. Stations without microwave radiometers will not be able to derive liquid water content or correct ice water content for attenuation, but cloud fraction can still be derived.

2. Review of calibration, data formats, target classification and retrieval algorithms.

2.1. Calibration of 35 and 94GHz cloud radar.

Three methods were proposed and their applicability discussed

a) Statistical comparison with overflying cloud radar. Protat et al. (2011) suggest calibration to 1-2dB is possible, but the CloudSat satellite has failed and EarthCARE will not be launched for several years.

ACTION: O'Connor to consider retrospective calibration using the historical CloudSat for sites that were operating previously to Cloudsat failure. This is not possible for new stations.

b) Quasi-constant radar reflectivity with varying rain rate at 500m range (Hogan et al, 2003) Method only applicable for 94GHz radars – difficulty to adapt for 35GHz radars.

c) Corner reflector on a post which is scanned by radar as used by ARM.

ACTION: Illingworth to enquire of Kollias at AMS radar conference late Sept. (remembering that min elevation of MIRA is 15 degs)

d) Portable calibrated radar to visit each site. This was done in Cloudnet in 2003, where at Chilbolton the S-band radar was calibrated to 0.5dB by redundancy of polarization parameters in rain, and then simultaneous scans in Rayleigh scattering ice cloud allowed calibration of 35 and 94GHz radars.

ACTION: Wandinger to consider the feasibility of using the Leipzig portable MIRA-35 radar.

e) Rely on the MIRA radars all having the same calibration factor.

ACTION: Compare the offset of the factory supplied calibration factor of MIRA radars with that computed using an absolute method (such as spaceborne comparison).

2.2. Radome wetting

At 94 GHz, radome wetting leads to unquantifiable losses of up to 7-8dB, so Cloudnet processing currently requires profiles where it is raining or has rained to be flagged and removed from comparisons. This creates problems because it is not clear how to remove similar rain periods from the model data to provide a fair comparision. The mirror arrangement used by the MIRA appears to be less prone to wetting problems.

ACTION: Goersdorf. Examine statistics of hours lost per month due to mirror wetting by MIRA as a function of rainfall rate at the site.

ACTION: U of Reading. Consider methods of estimating radome attenuation at 35 and 94GHz from the increased emission noise.

2.3. Target classification issues.

a) Metek provides a pre-classification of certain targets from radar alone within their mmclx files for MIRA. This can then be ingested into the Cloudnet routines which uses both radar, lidar and radiometer for target classification. (Discussions are ongoing with Matthias Bauer-Pfundstein from Metek).

b) Extension of Cloudnet algorithms – if LDR is available from certain radars then better insect/cloud discrimination is possible. Similarly for lidar, if depolarisation available, better discrimination between aerosol, ice and liquid is possible.

c) Philosophy is to have different errors when only a sub-set of instruments is available.

2.4. Model parameters to be evaluated.

a) Cloud fraction, ice and liquid water content have been evaluated so far. Extend this to pdf of iwc and lwc within the model grid box to give subgrid scale variability. How should we consider cloud overlap?

ACTION: To be discussed at the workshop D5.3 with NWP users in spring 2012.

b) Skill scores for these parameters have also been derived.

ACTION: Skill scores to be discussed at workshop D5.4

c) Cloudnet code design is modular so that new algorithms developed to derive additional parameters can be plugged in directly on top of categorization/classification product; once written for one location can in principle be applied to all sites.

d) Drizzle parameters (O'Connor et al., 2005) are currently being prepared for evaluation.

e) Extension to turbulence, through estimation of the dissipation rate of TKE, for clear and cloudy air. In-cloud values can be derived from cloud radar Doppler properties, clear air values in the boundary layer from Doppler lidar returns from aerosol particles (some in-cloud values can also be estimated).

f) Algorithms for microphysical parameters such as size distribution, number concentration are in development. These could then be used to aid the design of, and evaluate, double moment schemes for particle size distributions that are currently being tested in NWP models.

2.5. Cloud algorithm issues

a) Liquid water clouds. Current method is to derive liquid water content by diagnosing cloud top and cloud base and scaling the quasi-linear adiabatic lwc profile to match the value of lwp from microwave radiometer. Other approaches will be tested during the blind test meeting 7-9Feb 2012, including the possibility to derive microphysical parameters (DSD) using approaches such as SYRSOC which yields number concentration and effective radius. Also consider neural network approaches.

ACTION: Loehnert to invite Madonna to test his neural network approach.

b) Ice water clouds. Extend Cloudnet to use more Doppler information to obtain microphysical information (DSD and density), as per Delanoë et al. (2007).

ACTION: Illingworth/O'Connor to discuss implementation with Delanoë.

c) Extend Cloudnet to use more Doppler information to obtain microphysical information (DSD and density) using a statistical approach (Protat et al., 2010). Also use variational approach for ice clouds, developed for CloudSat/Calipso from space, to provide an estimate of ice water content, ice effective radius, and optical extinction with error statistics (Delanoë and Hogan, 2008). They use radar-lidar synergy as from space to give an optimally smooth retrieval on a column by column base by utilising information from lidar only, radar only, and radar-lidar returns. This has algorithm has been briefly tested from the ground**.**

ACTION: O'Connor. Further tests and implementation at ground stations.

d) Mixed-phase clouds. Can be recognized from lidar signal as long as signal penetrates to cloud top (where the liquid water is usually situated). When lidar fully attenuated, detection from radar alone is difficult as reflectivity normally dominated by ice.

ACTION: O'Connor and others. Investigate use of Doppler spectra.

3 Cloudnet deliverables to end users – consultation workshop D 5.3.

It was decided to hold this meeting in the time frame 19th march to 27 April 2012. The first day with the NWP users to define their requirements for new parameters and skill scores, the second day for instrument scientists to consider the implications of their requests.

ACTION: Illingworth to contact NWP users and agree a date for the meeting.

4 Status of Cloudnet stations and future plans.

All 14 stations wish to participate.

ACTION: O'Connor to liaise with the stations to arrange installation of cloudnet software. .

Future meetings will discuss in more detail the errors of the instrument observables (D5.6) and those of the retrieved variables (D5.7).

References

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APPENDIX-1 Participant list

1. Henk Klein Baltink, Cabauw, KNMI, Netherlands,
2. Adolfo Cameron, UPC, Barcelona, Spain.
3. Kerstin Ebell, U of Cologne, Germany.
4. Ulrich Goersdorf, DWD, Met Obs Lindenberg, Germany.
5. Martin Hagen, DLR Oerpfaffenhofen, Germany
6. Anne Hirsikko, FMI, Finland.
7. Anthony Illingworth, University of Reading
8. Holger Linne MPI, Hamburg, Germany .
9. Ulrich Loehnert, U of Cologne, Germany
10. Ewan O'Connor, U Reading UK and FMI, Finland.
11. Christophe Pietras, IPSL, LMD, Palaiseau, France
12. Fabio Madonna, CNR-IMAA, Potenza, Italy.
13. Giovanni Martucci, NUIG, Galway, Ireland.
14. Kersten Schmidt, DLR, Oberpfaffenhofen, Germany.
15. Boris Thies, University of Marburg, Germany
16. Herman Russchenberg, TU-Delft
17. Ulla Wandinger, Leibniz Institute for Tropospheric Research
18. Matthias Wiegner, LMU-MIM, Munich, Germany.

APPENDIX-2 AGENDA

Monday 11.9.11

11-00 Welcome and opening of the meeting.

11.10 Description of the 12 existing and candidate cloudnet stations.

12.30 Lunch

13 :30 Continuation of description of the stations.

14 :15 Overview of the cloudnet observations and processing scheme (Illingworth)

15.00 Coffee

15.30 Calibration, data format, target classifications, retrieval algorithms (O'Connor)

16.30 Incorporation of aerosol observations (Wandinger)

17.30 Close

19.30 Dinner

Tuesday 12.9.11

09.00 General discussion and conclusions.

12.00 Close the meeting.