MINUTES OF THIRD CLOUDNET WORKSHOP

(Version b produced 27 October 2004)

18-19 October 2004, TUD, Delft, NL.
Present: D Bouniol, A Armstrong, A Protat, J Pelon, J Delanoe (IPSL); Martial Haeffelin (LMD); David Donovan, Henk Klein-Baltnink (19th only), Gerd-Jan van Zadelhoff (KNMI); John Goddard, Charles Wrench (RCRU); Oleg Krasnov, Herman Russchenberg (TUD); Robin Hogan, Ewan O'Connor, A Illingworth (co-ordinator.), Nicolas Gaussiat (Administrator) (UR); M Brooks (Met Office); Ulrika Willen (SMHI).

1. GENERAL REMARKS and PROGRESS ON DELIVERABLES.
1.0 Apologies for absence. A Tomkins (ECMWF), P Ravila (Vaisala); J Mehl, G Kadner, (Gematronik); J-M Piriou (MeteoFrance), P Claeyman (Degreane). D.Wilson (Met Office), A Mathieu (LMD).

1.1 Actions arising from the minutes not completed and not dealt under other headings.
Action 1.1. from earlier meeting: Collaboration with DWD has started (see 1.3.1 later).
Actions from third progress meeting, Exeter UK, 5-6 April 2004.
7.2 - EJO – the sonde ascents deemed not urgent; put on web site when time permits..
2.5 – Automatic Gain Control of the CT75 ceilometer at Cabauw has been fixed.
3.3. The LNA lidar at SIRTA is pointing a few degrees off vertical.
6.1 – PR provide software for CT75 to record aerosols at high sensitivity – email from PR will complete by the end of the month.
6.2 JM to report on feasibility of X-band cloud radar – outstanding.
6.3 – Specification for LMD 'mini-lidar' - action transferred to Jacques Pelon. – see 7.1.
8.2, 8.3, 8.4 – availability of MODIS, MSG, GERB satellite data above sites – see 7.4.

1.2 GEWEX Working Group on Clouds and Aerosol Profiling. 28-29 Sep 04 in Reading. The minutes have just been released. The following items from the minutes were noted.
1.2.1 There has been considerable science activity at the sites. A highlighted activity here was the CloudNET project involving Cabauw, Chilbolton, and Palaiseau and an assortment of weather forecast models.
1.2.2 Stable base funding for continued site operations is a concern for all the sites, but particularly for some of the European sites.
1.2.3. A common data policy based on the CloudNET document was agreed.
1.2.4. The WG agreed to work on several joint projects

1. Incorporate the ARM sites into the CloudNET project by running the CloudNET retrievals on the ARM data; similarly, investigate the feasibility of incorporating the Lindenberg data into the same project (see project web page at http://www.met.rdg.ac.uk/radar/cloudnet/index.html)
2. Test the ARM Broad Band Heating Rate Project code on CloudNET retrievals.

1.3 Overview of timetables, deliverables, publications, conferences and data policy.
1.3.1 CloudNET is in good shape as recognised at the recent GEWEX meeting (see 1.2). In view of the recent and planned activity involving the incorporation of more sites (Lindenberg, Potenza, and the five ARM sites) and models (DWD, SMHI, Environment Canada) into CloudNET and the work involved a request has been made to Brussels for a six month no-cost extension so that CloudNET would finish on 30 September 2005.

1.3.2 An invitation has been received from Franz Berger (Lindenberg, D) for CloudNET to hold their final meeting at Lindenberg 10-11 October 2005 ahead of the next GEWEX-CAP meeting scheduled from 12-13 October. This the week of the Lindenberg 100th year centenary celebrations and an excellent opportunity to publicise CloudNET achievements.
ACTION 1.1 AJI to write to F Berger and accept the invitation.

1.3.3 The two deliverables for October 04, D8 year 2 of observations, and D9 year 2 of models) are on schedule. Deliverables D10 Optimised algorithms and D11 Comparison of algorithms with models are schedules for Jan 05. This data would slip to April 05 if the no-cost extension is granted.

1.3.4 Publications.
Several additional submitted, in press or recently appeared papers were identified.
1.2 ACTION AP and DD to supply titles and pages of recent submitted articles.
1.3 ACTION All – update on other papers.
1.4 ACTION NG, AJI Ensure list of publications with links to the papers is displayed on the web site as well as in the annual reports.

1.3.5 Upcoming Conferences.
The following conferences were identified:
HISE conference in Jan 05 – USA. Dave Donovan will submit a cloudnet paper. Details: http://www.osa.org/meetings/topicals/FTS%5FHISE/ and http://www.osa.org
EGS – Vienna – Easter 05 - not clear if there is an appropriate session.
IAMAS – Beijing Aug 05 – Martial Haeffelin will submit CloudNET paper.

1.3.6 Publicity
The merits and demerits of a glossy A5 colour Cloudnet booklet based on the final report and a BAMS article were discussed. It was felt that a BAMS article would have more impact and noted that the Cliwanet project had a BAMS article in press, but that BAMS now insist on a pre-submission proposal rather than an unsolicited submission.
ACTION 1.5 AJI to contact S Crewell of Cliwanet for advice on proposal to AMS.

1.3.7. Data Policy
The new data policy written by RJH has been approved and is now on the web. Several requests from data have been received (Xiquan Dong, U of N Dakota; Graham Feingold, NOAA, BBC/cliwanet). The data will be available to them when Version 1 is released.

1.4 Review of Data Base.
RJH reported that the categorisation code has been improved and now deals with the SIRTA data and the LD40 ceilometer and also performs well with the tests using the ARM data. EJO described the expanding suite of level 2 parameters with more IWC products and the first LWC estimates to arrive shortly. It was agreed that CloudNET had a duty to produce a best IWC estimate for users. EJO also showed the new RCA (SMHI) model data on the web and the two months of test ARM data from the SGP and NSA sites. RJH described the monthly statistics for cloud fraction using Equitable Threat Score (ETS) and PDFs score now on the web and will be extended to the iwc products.
ACTION 1.6 DB IWC product from IPSL radar/lidar algorithm to be added when multiple scattering is accounted for.

ACTION 1.7 OK Liquid water products from TARA to be added when they are ready.

2. DATA GATHERING AND PROCESSING.

2.1 Chilbolton – CLW reported that the 94GHz had been switched off.
ACTION 2.1 NG/DB provide earlier plot of the decay of the three 94GHz tubes.
The 35GHz radar has operated for 7 months and no decay of transmitted power had been detected. A 78GHz – 10mW transmit power FM/CW radar has been operating in parallel with the 35GHz radar for the past two months. This could be a low cost alternative. The range side lobes seem low so cloud fraction may be estimated.
ACTION 2.2 CLW to report on comparisons of profiles with the 78 and 35GHz radars to define the side-lobe limitations precisely and if they can be screened out for good Z.
The 35GHz radar now has pulse coding which leads to a gain of 12dB and has a minimum range of 700m. Range side lobes seem to be negligible apart from falling rain with a high Doppler shift, but the data are not useful anyway in such conditions. The coded and non-coded operation can be alternated very rapidly thus aiding comparisons.
ACTION 2.3 CLW (E Pavelin) – Further characterise coded pulse performance.

2.2 Cabauw - HKB via DD reported the CT75 had been repaired. Other instruments OK. HR reported plans for an 8m dish for TARA, with a half deg beam rather than the present 1.5deg, and be better for better for ice clouds. TARA is unaffected by rain. .
ACTION 2.4 OK/HB Derive IWC from the TARA Z data for comparison with the other (rain-affected) IWC products.

2.3 Palaiseau
MH reported that as of 1 October radar observations had ceased at SIRTA. An application had been made for a new tube for the ground based system. During the next month LNA was being upgraded so that it had an automatic rain shield, but night time operations would still not be possible as it needs an on site operator. A more substantial shelter is planned for installation in 2006. The observations from the radiative flux instrumentation have now been accepted by BSRN. A permanent sonic anemometer is also projected.

The VAPIC water vapour campaign was carried out during May 2004. A fine month with lots of clear skies. Data from the LNA as a stand alone instrument was presented with targets categorised as molecules, aerosol or clouds. Optical depth of clouds was derived using a) molecular reference b) assuming a backscatter ratio of 18sr. No correction for multiple scattering has been applied. There is also two years (approx 360 days) of data with typically 8hrs per day. Statistics were presented from vertical profiles of cloud fraction as a function of height and the occurrence of multiple layers. Analysis using the depolarisation to infer mixed phase clouds is in progress. The data were divided into clear sky and cloudy occasions and the radiative observations used to estimate the cloud forcing. These daytime observations revealed high clouds up to 10-12km altitude, and that a one month round-the-clock data set would be invaluable for identifying biases in the ‘continuous cloudnet’ data-set.

ACTION 2.5 – MH – Compare the LNA data with the model data sampled temporally in the same way as the LNA observations. Does this explain the low levels of ice cloud observed from the continuous cloudnet data set when compared with the model?

ACTION 2.6 EOC. Produce LNA categorisation products as appropriate.

3. RETRIEVAL ALGORITHMS
LIQUID WATER.
3.1 N Gaussiat reported on a different approach to LWP retrieval from dual channel radiometers at 22 and 28GHz. Periods of finite LWP were identified from the ceilometer. When LWP is zero from the ceilometer, elimination of WVP from the two equations for the observed brightness temperatures and minimisation of a cost function yields the 'calibration term' C22 and C28 (which includes model and instrument imperfections) and which can be tracked during periods of no liquid water clouds. Linear interpolation of the C22 and C28 is used to yield LWP when water clouds are present. This ensures LWP is always zero in cloud free periods, eliminates negative values, and yields more sensible LWP values. Error analysis is currently in progress.

3.2 Anne Armstrong reported on a parallel approach using the 23.8 and 36.5GHz channels of DRAKAR. Initial calibration fixed an offset of 6-7 degs in the 23.8 channel, then the calibration of the 36.5GHz channel was changed so lwp was zero when liquid clouds were absent; this resulted in typical changes of –1.8deg Jan and - 4.4deg in July.

ACTION 3.1 NG/AA Continue this work and reach a convergent algorithm.

3.3 EOC reported work using the LWP retrievals of NG to derive LWC for model comparison. A simple algorithm used the lidar to detect cloud base, and then distributed the water with a linear increase with height up to radar cloud top. For thin clouds with no radar the cloud generally was thinner than a model grid box vertical dimension.   A more advanced algorithm will use used the lidar extinction profile and Z to estimate N and D.

ACTION 3.2 EOC   Implement this LWP/LWC product when available.

3.4 OK reported further work using the ratio of Z(radar) to alpha(lidar) against Z as a classification of drizzle versus no drizzle. On occasions this did not agree with the CloudNET classification. This may be due to drizzle with low terminal velocity.
ACTION 3.3 OK to continue the work with cross checking sing Doppler velocity.

ICE WATER CONTENT
3.5   RJH summarised work on deriving Z-IWC-T relationship from aircraft flights comparing observed 3GHZ Z with Z calculated from particle images in the range Z –25dBZ to +15dBz. This is the basis of the currnt cloudnet 'Z-IWC-T' product.
RJH reported that for pdfs of IWP as observed from Z profiles and from the model data with and without precipitation >0.5mm/hr, only larger values of model IWP were affected by precipitation. For lower values of IWP the pdfs of all the model values (including the new RCA model) were consistently about twice that observed.   It was suggested that the IWP and model data be split up into mid-level and upper-level to see if there was a radar sensitivity issue.
ACTION 3.4 RJH to continue this work.

3.6 AP described work on IWC-Z and IWC-Z-T for a large range of tropical and mid-latitude flights. A large difference in such relationships and in the bias and error of individual data points was reported depending on whether a linear or a log fit was

employed. For a linear fit the standard deviation was reduced by a factor of two for the smaller values of IWC. A vigorous discussion ensued.
ACTION 3.5 RJH and AP to continue dialogue.

3.7 JD described IWC retrievals using V information. Z , V and alpha (extinction) were computed from in-situ images and V-Z formulae derived assuming Brown and Francis density function. For an assumed universal normalised ice spectra V is related to Dm. The maximum diameter was used to compute alpha and velocity rather than the diameter with the same area as the image. The RADON technique for better IWC involves computing hourly V-Z relations over three height ranges from the observations and thus deriving a density function. Using this density function an optimum IWC-Z was derived and used for the individual Z observations. Future work will be to explore the use of the ratio of Doppler width to the mean Doppler.
ACTION 3.6 JD to examine the use of the equivalent area diameter.
ACTION 3.7 JD to implement RADON technique for CloudNET data set.

3.8 Dual 3 and 35GHz retrieval of IWC and LWC.
HR reported comparisons of Z at the two wavelengths revealed a mean standard deviation of 4dB at individual gates. Two MSc students were tackling the IWC and LWC retrieval.
ACTION 3.8 HR to compare Z profiles at the two wavelengths to characterise the consistency of Z, and then to report on the work of the two MSc students.

3.9 The IPSL radar/lidar retrieval technique for IWC .
DB reported that implementation of the multiple scattering technique should soon start.
ACTION 3.9 DB to pursue this and expedite the production of IWC for cloudnet data set.

3.10 RAMAN and elastic lidar retrieval comparisons.
DD reported a detailed analysis from the MPL (ARM) lidars. ARM scientists have reported that the radar/lidar KNMI technique has difficulties for alpha <0.5. Several techniques were explored for inferring optical depth of these thin clouds: a) Elastic Rayleigh molecular above and below the cloud b) Raman direct to get density and optical depth c) ratio of Raman to Raman plus elastic. It was concluded that the multiple scattering correction was OK and the Rayleigh technique performed well. For these thin clouds the boundary condition of constant concentration (a la IPSL) may be better than the constant size KNMI approach.
ACTION 3.10 DD to pursue this further and then consider extension to the SIRTA LNA data and devleop a scheme which blends Rayleigh and non-Rayleigh approaches.

4. COMPARISON WITH MODELS.

4.1 MB presented further comparisons using regimes depending upon whether there was up, down, or no updraft at 300 and 750mbars. The pdfs of model vertical velocities were now split into thirds to obtain the three regimes as was the pdf of the vertical profile of the gradient of potential temperature in the lowest 100mb. Statistics based on these divisions were presented.
A vertical profile of observed vertical profile of mean iwc with and without rain had only a small reduction for the raining case. It was commented that a) one would expect a much larger change because of the 10dB radome attenuation, and b) the pdf shown of

iwc high in the cloud had a big difference between observed rain and no-rain cases and c) Damian W had found (may 04) that only 30% of model iwc remained when times with ppn was >0.1mm/hr were removed.
ACTION 4.1 MB to resolve these apparent contradictions, then continue the work. RJH suggested that deriving IWC from mean V may be less sensitive to attenuation than Z.
ACTION 4.2 AP/JD to examine the values of Z, IWC and V computed from the data set of aircraft images and quantify the accuracy of deriving IWC from V rather than Z.

4.2 MH reported upon AM's work on boundary layer clouds during April – Aug 03 over the stations compared with the model representation. The cloud base in the model was frequently 300m lower than the observed level. This could be because the model has a bias to warmth and humidity at the surface. Ceilometer artefacts were discussed.
ACTION 4.3 AM to check that the cloud base is derived from the ceilometer mode height, rather from the sides of clouds and occasional higher cloud levels.

4.3 Ulrika Willen discussed the cloud parameterisation in the SMHI RCA model which use a diagnostic humidity based scheme. Changes in cloud fraction depending upon the overlap scheme and whether cloud fraction by area of volume impacted upon the radiation. For more accurate fluxes, profiles of humidity, temperature, ice and liquid water content are needed.

5. SATELLITE COMPARISONS.
5.1 G-J Z reported comparisons of retrieved optical depth and liquid water path from MSG visible and infra red channels. These will now be compared with cloudnet data over the three sites.
5.2 DD reported first comparisons of work on cloud top temperatures inferred during April –May 03 and cloud tops from cloudnet.

6. MODEL DEVELOMENTS.
A list of the salient changes in the models over the past three years has been put together. and will shortly be on the web. The next stage is to highlight key dates when changes occurred so these can be used to define the various comparison periods.
ACTION AJI to contact AT and J-M P to confirm key model change dates.

7. WRAP UP SESSION

7.1 The recommended cloud observing station.
There was a vigorous discussion on the elements needed for such a station. It was agreed that the basic specification of such a station was to detect, to a height accuracy of 60m, t clouds and aerosols with a tau above 0.05/km, and an LWP above 10g/m^3 (such targets are sufficient to cause a flux change of 10W/m^2 if the cloud/aerosol changed height by 500m). More specification of available instruments were needed.
ACTION 7.1 JP/MH Provide specifications (incl costs) of the LMD mini-lidar and the ten other lidars commercially available. A specification of Beta of 2.5 10 $^{-6}$ /m/sr with a 30second dwell time at 10km range for aerosols and clouds is desirable.
ACTION 7.2 AJI, CLW and HKB to acquire specifications for the sensitivity of the Cabauw and Chilbolton 35GHz pulse coded radars, the Lindenberg cloud radar and the 78Ghz 100mw FM/CW rad at Chilbolton. A detection of –37dBZ at 10km is desirable.

ACTION 7.3 UoR to look at categorisation products to quantify the frequency with which low level clouds obscure upper level ice clouds.
ACTION 7.4 AJI to contact S Crewell re cliwanet recommended specifications for radiometers and then with (CLW, NG, AA) consider what frequencies and what bias/stability, drift is tolerable to derive LWP.
ABOVE ACTIONS TO BE COMPLETED BY 20 JAN 2005.

7.2 IWC products.
Several IWC products will shortly be available on the cloudnet web site. We need to consider carefully the strengths and weaknesses of each technique and how they can be combined to produce a single optimised IWC estimate. Current products are:

a) Z-IWC-T (except when rain at ground)
b) Z-V-IWC Matrosov. (except when rain at ground)
c) Radar-lidar – r constraint KNMI (need lidar penetration, and no rain at ground)

And coming very soon:

d) Radar-lidar N constraint – IPSL (need lidar penetration, and no rain at ground)
e) Z-V-IWC - IPSL (except when rain at ground)
f) LNA Lidar only – (Day time sampling only, no low cloud)
g) TARA Z-IWC - 3GHz no attenuation. – all weather.

ACTION 7.5 - BY 20 JAN 05 - All involved to consider how to correct for sampling biases and derive best product.

7.3 Radiation.
The following sequence of comparisons was agreed.
ACTION 7.6 UW – From cloud properties inferred from 30 second profiles (+ aeronet aerosols profiles when available) – compute fluxes using model profiles as needed and compare with ground observations. Compare with fluxes obtained by averaging cloud/aerosol properties for one hour, to quantify sub-grid scale effects.
ACTION 7.7 AP/UW. Ring the changes on the retrievals to find sensitivity due to ice density, and iwc retrieval, cloud overlap, and cloud fraction definition.
ACTION 7.8 MH (+UW,EOC,G-JvZ) Start case studies at SIRTA using categorised LNA data (action 2.5) to compare clear sky with clouds and quantify cloud forcing.
ACTION 7.9 If time permits, UW compare derived fluxes from observations with values in operational models, and find how long an averaging period is needed to improve agreement.

7.4 Satellite data.
ACTION 7.10 MH. Further explore the use of NASA/Langley web site for MODIS, MSG and GERB data above the three CloudNET sites. MH to discuss with DD/J-G Z KNMI satellite data stored at KNMI above the sites and recommend optimum system.

8. Date of next meeting. Monday 4 - Tuesday 5 April 2005 in Paris.