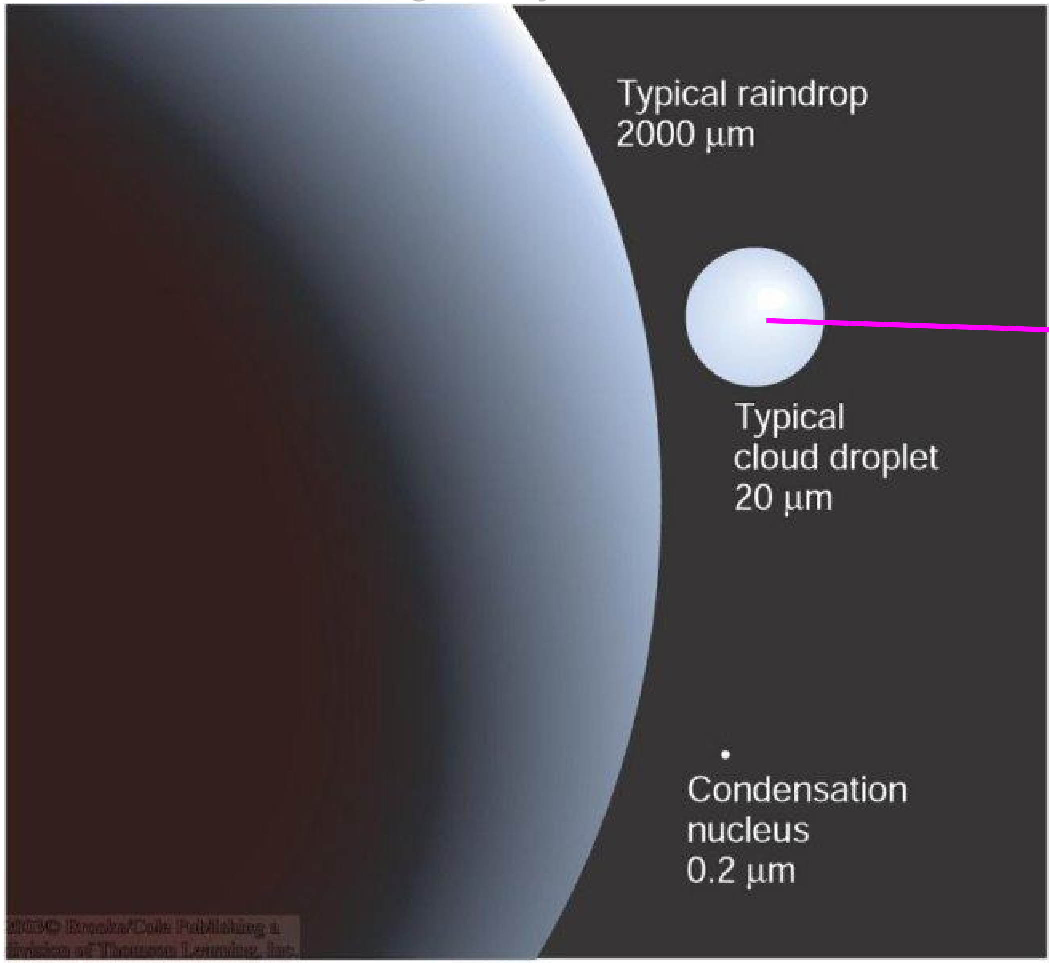
Universo de las gotas y sus tamaños



Tamaños relativos de gotas, gotas de nube y núcleos de condensación

gota de nube !!!!

- Gotitas de **nube** se forman….. el aire se sobresatura con respecto al agua/hielo.
- Generalmente ocurre debido al enfriamiento adiabático producido por el ascenso
- Puede también ocurrir por:
  - enfriamiento radiativo
  - enfriamiento
  - mezcla

La formación de una gota de nube es la nucleación

Si hablamos de nubes y queremos dar algunas características, entonces……

* $LWC = \int 4/3\ \pi\ r^3 \rho_l\ n(r)dr$ Contenido de Agua líquida de Nube

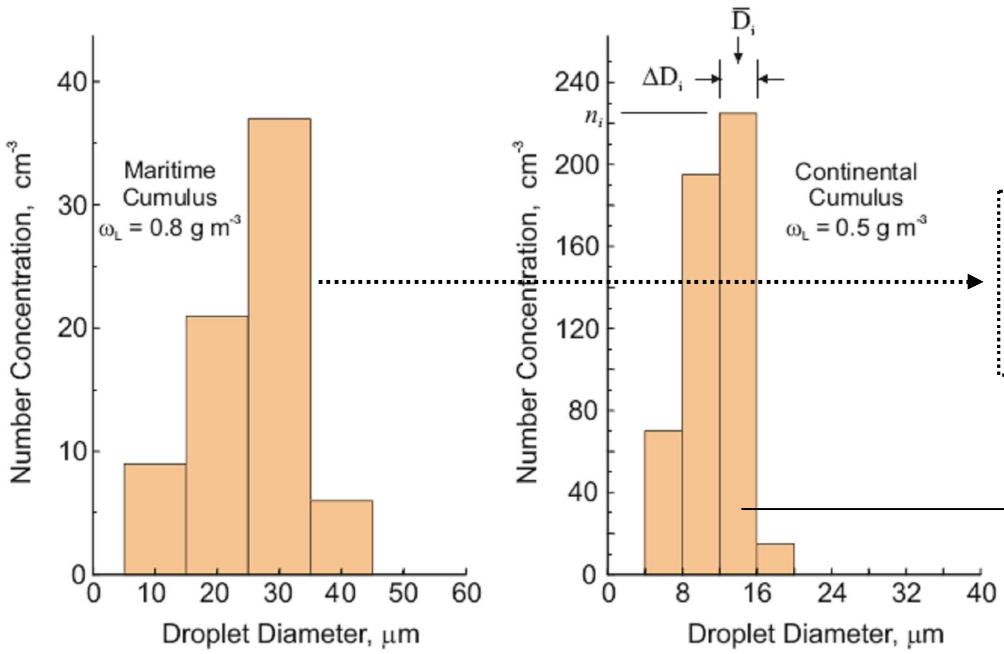
r, es el radio de la gotita de nube

n(r) → Numero de gotitas p/ unidad de volumen, f(r)
en definitiva f(r) es una función de distribución

↓

Puede ser diferente en distintos tipo de nube

CLOUD DROPLET SPECTRA



Adapted from Rogers and Yau (1989), Squires (1958)

Hay gotitas mas grande y es mas angosta la distribución

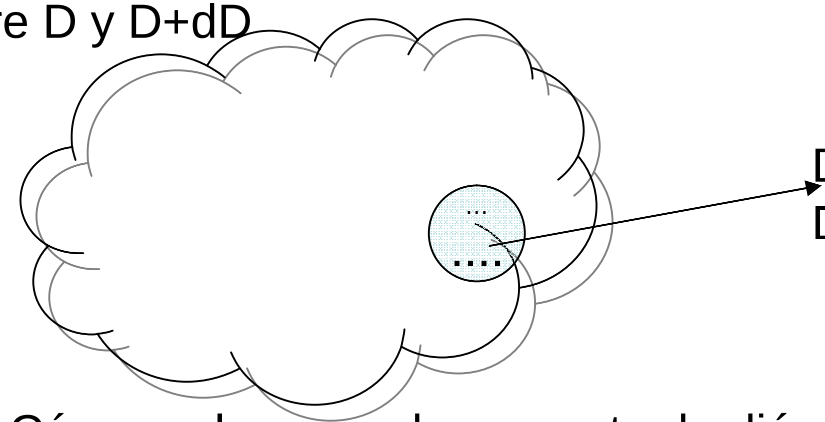
Hay gotitas mas pequeñas y es mas angosta la distribución

En una nube una función de distribución de tamaños de gotas es f(r), pero es mas usado el diámetro D, entonces tenemos N(D) y de acuerdo a todas las mediciones realizadas la mas usada es la FUNCION GAMMA

$N(D)=No.\ D^{\mu}\ e\text{-}^{\lambda D}$,

No es parámetro de intercepción y es constante, λ es la pendiente, μ es el parámetro de forma

Y N(D)dD es “Número de gotas por unidad de volumen cuyos diámetros están entre D y D+dD



Dentro de cada volumen existen gotitas
De distinto tamaño

¿Cómo es la masa de una gota de diámetroD?

$M_D = (4/3).\pi.(D/2)^3.\ \rho_{water}$ **masa de 1 gota**

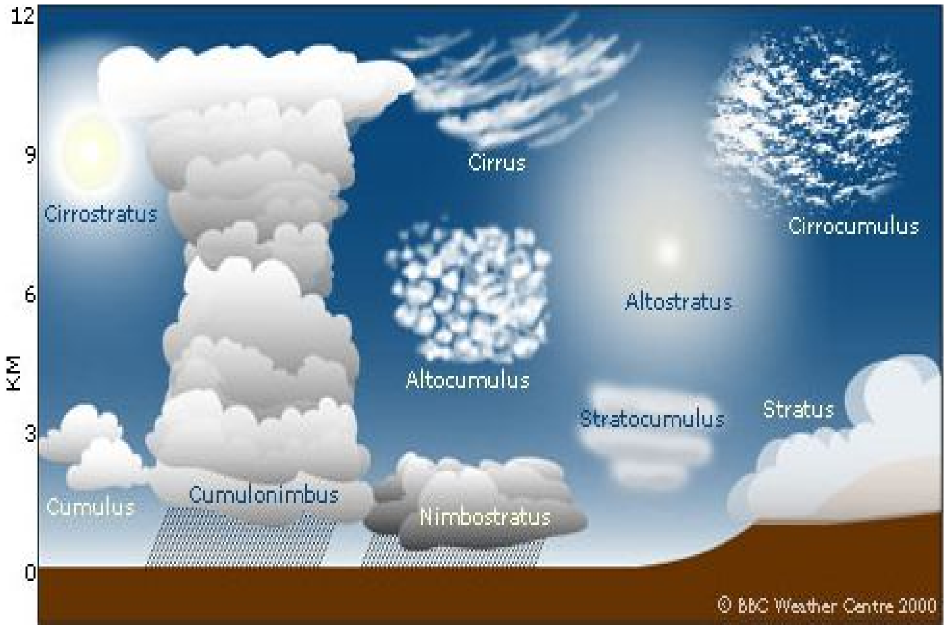
Entonces, ¿cómo es la distribución de masa asociada a gotas cuyo diámetro está entre D y D+dD?

$m(d) = N(D).\ (4/3).\pi.(D/2)3.\ \rho_{water}$ **distribución de masa**

Recordemos la Clasificación de la OMM (10 generos)

Existen básicamente 2 tipos de clasificaciones de nubes, las mismas pueden ser de acuerdo a sus *características físicas[1] y dinámicas[1]*, o de acuerdo a su aspecto o apariencia física, que es la que realiza la OMM y la que debe informar un observador.
Esta clasificación de acuerdo a su aspecto físico , se realiza en FAMILIAS principalmente con respecto a la altura de la base de nube, resultando 4 familias : Altas, Medias y Bajas y una 4ta que son las nubes de Desarrollo Vertical y esta clasificación conlleva a 10 principales géneros mostrados en la siguiente Tabla:

FAMILIA	**GENERO** (Forma)	**SIMBOLO**	**BASE** (Media en mts)
A (Altas)	Cirrus Cirrostratus Cirrocumulus	Ci Cs Cc	5000-6000
B (Medias)	Altostratus Altocumulus	As Ac	2500-3000
C (Bajas)	Stratus Stratocumulus Nimbostatus	St Sc Ns	150-600 600-1500 100-600
D(Desarrollo Vertica)	Cumulus Cumulonimbus	Cu Cb	300-2400 600-2400



Estas *características son*:(a) escalas temporales de las nubes (Tiempo de vida de la nube y Tiempo que le toma a una parcela entrar a la nube y salir por su tope)
(b) Velocidades verticales
(c) Contenidos de agua líquida
(d) Temperatura de la nube
(e) Turbulencia de la nube

Valores típicos de difrenetes propiedades de las Nubes

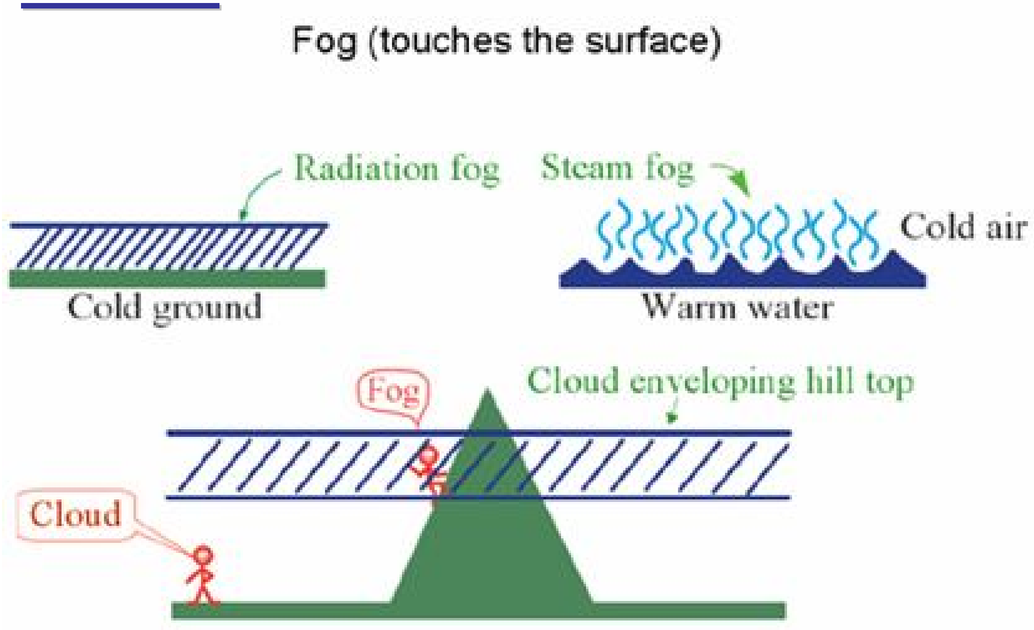
entorno	Tipo nube	|r| micrones		N (numero gotas por cm^3)	LWC (g/m^3)
continental	stratus	4.7		250	0.28
	cumulus (clean)	4.8		400	0.26
	cumulus (polluted)	3.5		1300	0.3
	cumulonimbus (growing)	6-8		~500	1-3
	cumulonimbus (disipandose)	7-8		~300	1.0-1.5
	fog	8.1		15	0.06
maritímo	stratus	6.7		80	0.30
	(strato)cumulus	10.4		65	0.44
continental o maritímo	cirrus (-25° C)	-		0.11	0.03
	cirrus (-50° C)	-		0.02	0.002

E. Linacre and B. Geerts

* based on in situ and satellite measurements over Indonesia, Thailand and Israel

Nubes (Houze´s Cloud atlas)

NIEBLA



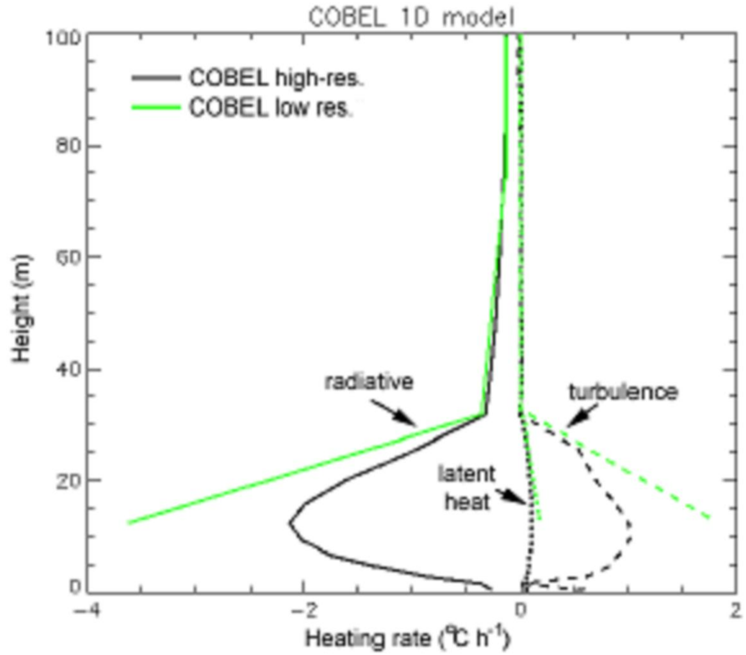
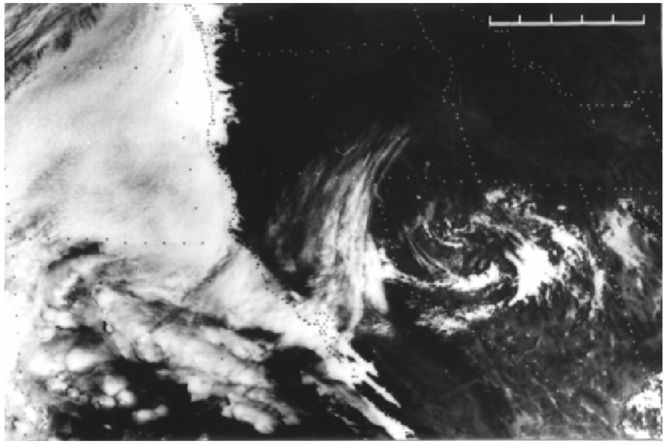


Figure 9. Profiles of contributions to the evolution of potential temperature, diagnosed in the COBEL high-resolution (black) and low-resolution (green) simulations, at 2224 UTC. Contributions are the divergence of net radiation (solid lines), divergence of turbulent heat fluxes (dashed lines) and latent heat (dotted lines).

- Tc: 2 a 6hs
- W =0.01 m/s
- Tp≈3hs
- LWC ≈0.05-0.2 g/m^3
- Crγ= 0.2°C/h
- Crrad=1-4°C/h
- U y W pequeños, dominada por la turbulencia

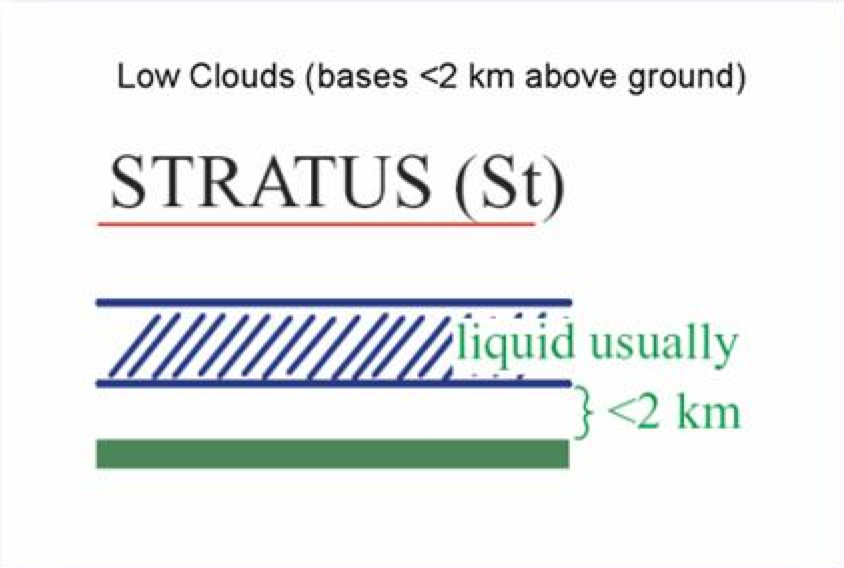
liquid composition, no precip,
process: *radiational* cooling.



Satellite view of *advection fog* along the west coast of the United States

Steam Fog

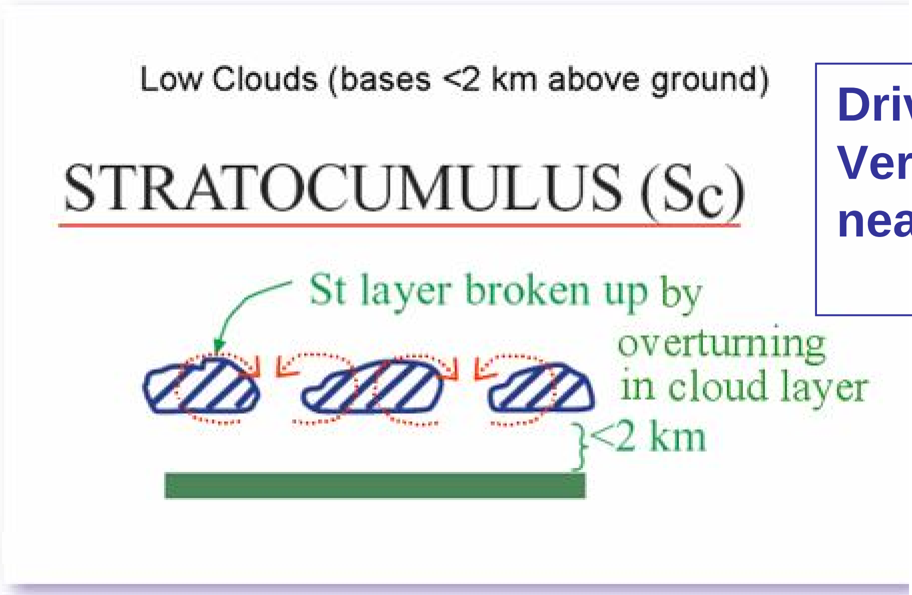
Stratus



- Tc: 6 a 12hs
- W =0.1 m/s
- Tp≈3hs
- LWC ≈0.05-0.25 g/m^3 con max de 0.6
- Crγ= 2°C/h ≈ Crrad
- La turbulencia es significativa comparada con w

→ Stratus y Scu

Stratocumulus



Driven by turbulence in the boundary layer
Very common, particularly over the oceans near the West coast of the major continents

a marine **stratocumulus** region. 01 UTC 2 September 1997, showing stratocumulus with some downward protruding scud.

Cloud streets" viewed from aircraft. Rows of **stratocumulus** as seen from a B-47 aircraft at 11 km on 10 April 1957. (Photo by Joachim P. Kuettner.)

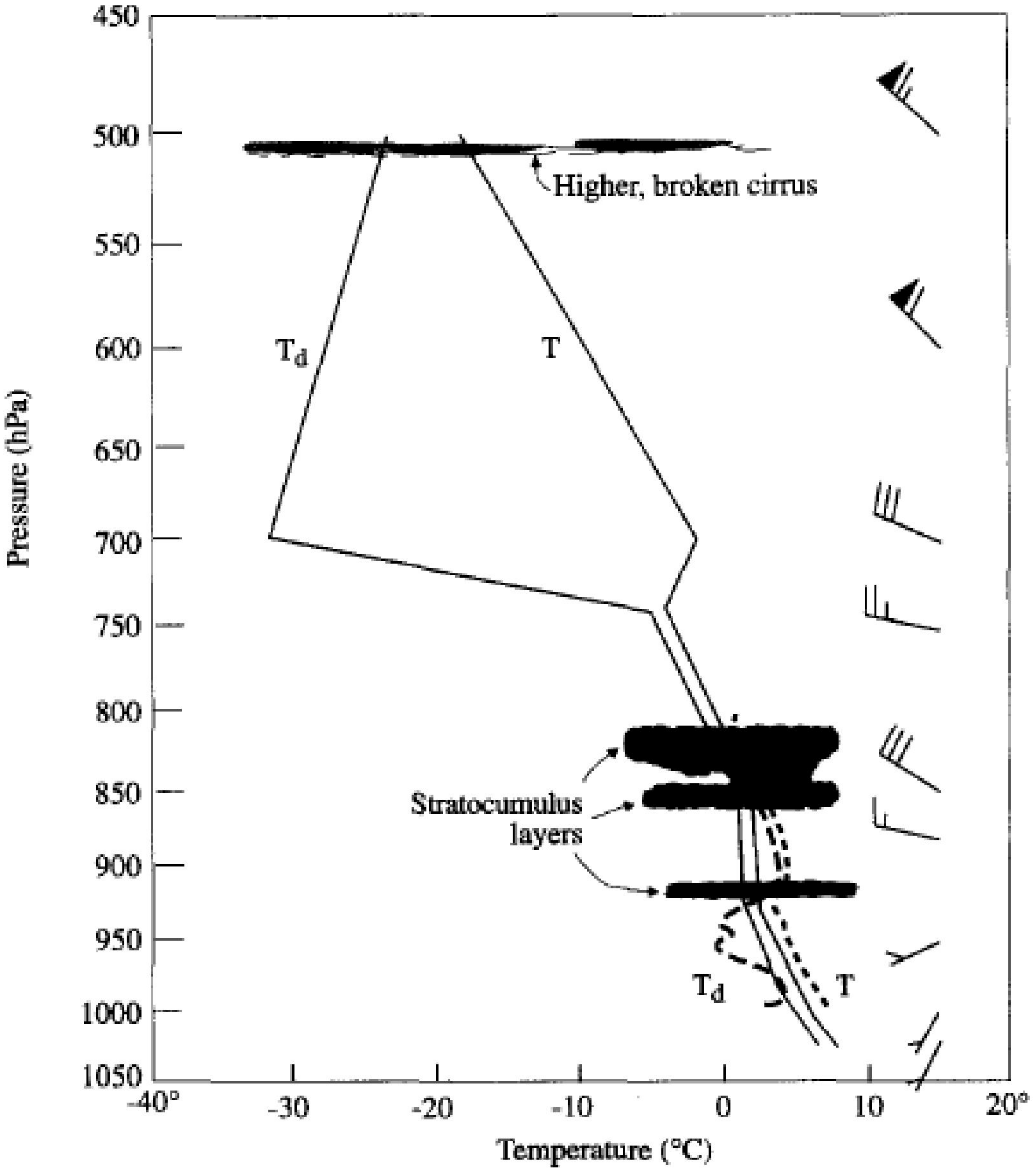


Fig. 2. Temperature and dewpoint soundings from the aircraft between 2025 and 2140 UTC 2 December 1991 (dashed lines), and from the National Weather Service sounding at Quillayute, Washington, at 0000 UTC 3 December 1991 (solid lines). The winds are from the Quillayute sounding. The scalloping shows the locations of the three cloud layers.

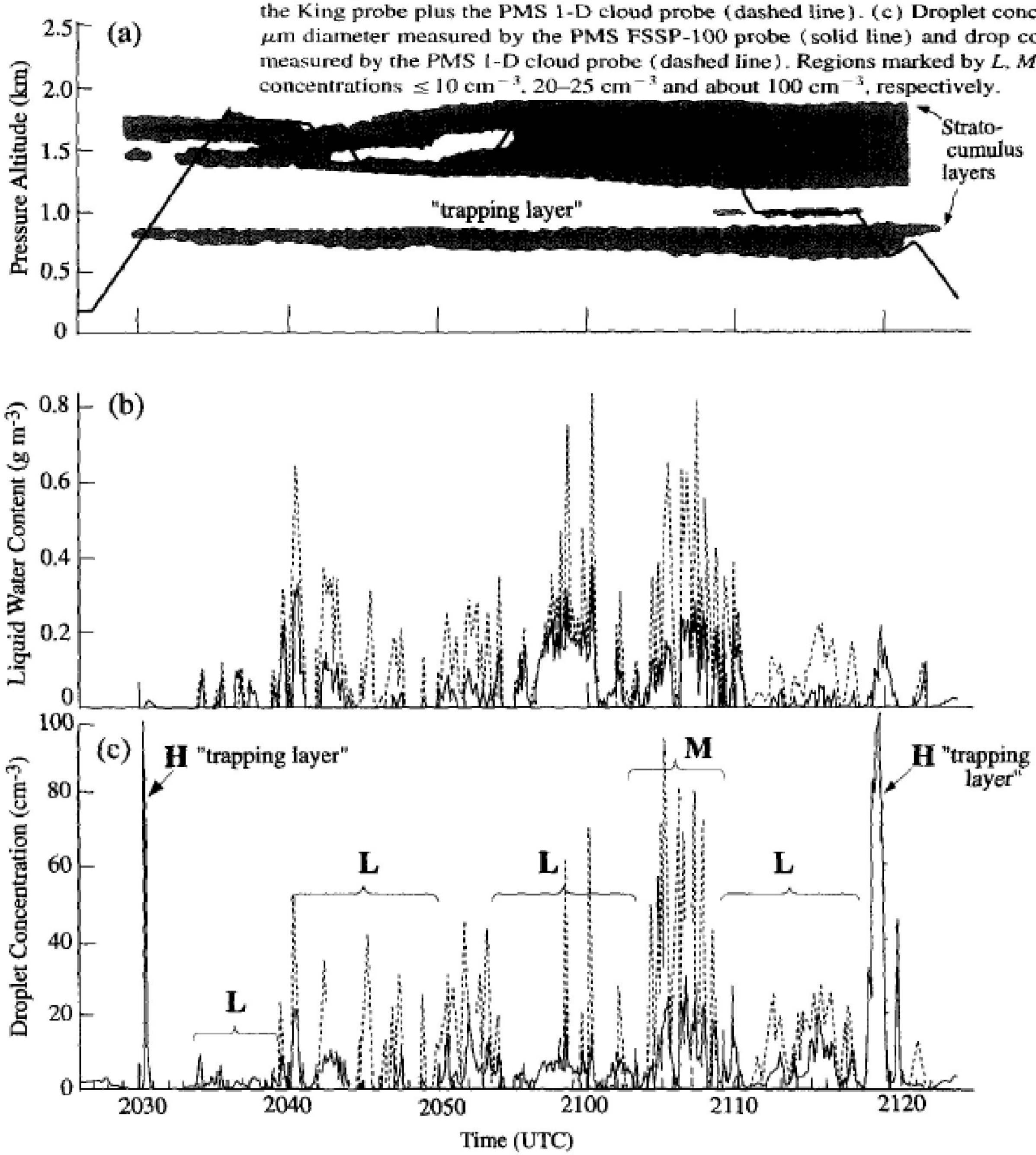
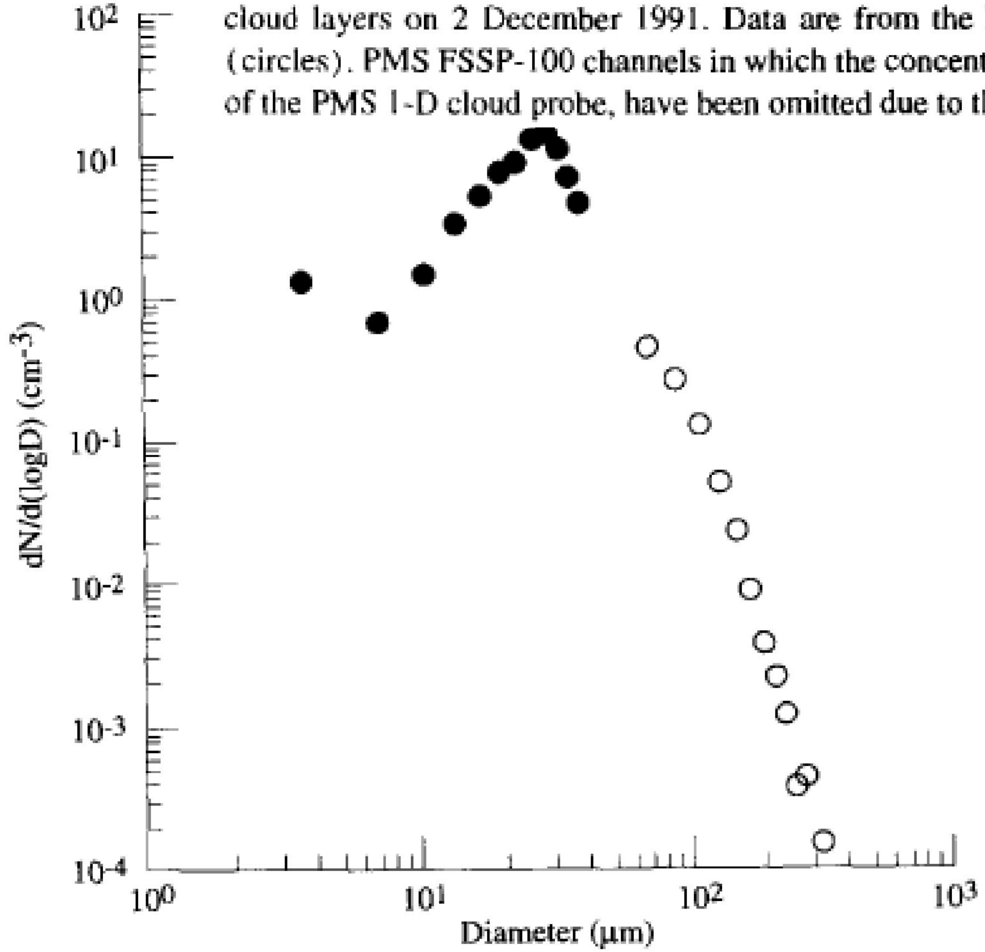


Fig. 3. Cloud microstructural measurements obtained on 2 December 1991 between 2025 and 2125 UTC. (a) Sketch of the three cloud layers intercepted by the aircraft or recorded by the forward video camera on the aircraft. The heavy line is the aircraft flight track. (b) Liquid water content measured by the King probe (solid line) and the King probe plus the PMS 1-D cloud probe (dashed line). (c) Droplet concentration in the size range 3 to 51 μm diameter measured by the PMS FSSP-100 probe (solid line) and drop concentrations ≥ 140 μm diameter measured by the PMS 1-D cloud probe (dashed line). Regions marked by *L*, *M* and *H* denote clouds with droplet concentrations ≤ 10 cm^{-3}, 20–25 cm^{-3} and about 100 cm^{-3}, respectively.

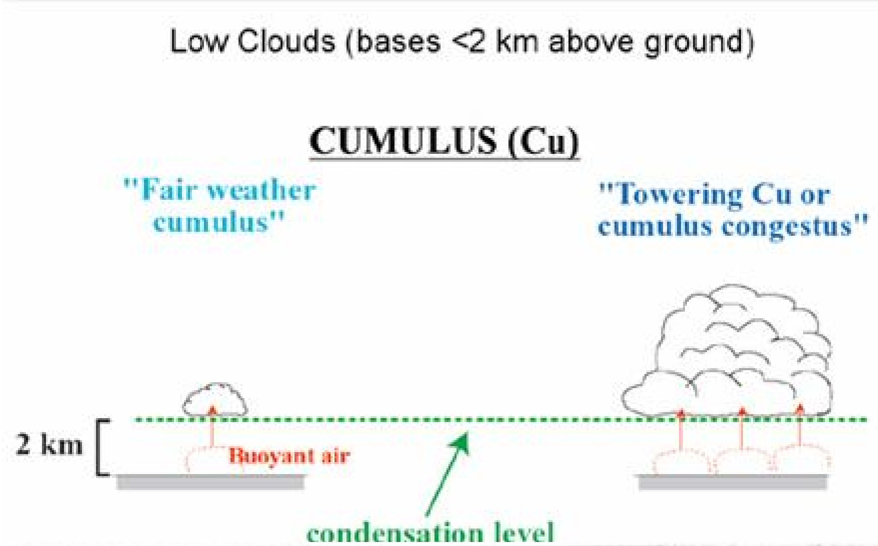
Precipitation from a maritime cloud layer with very low droplet concentrations

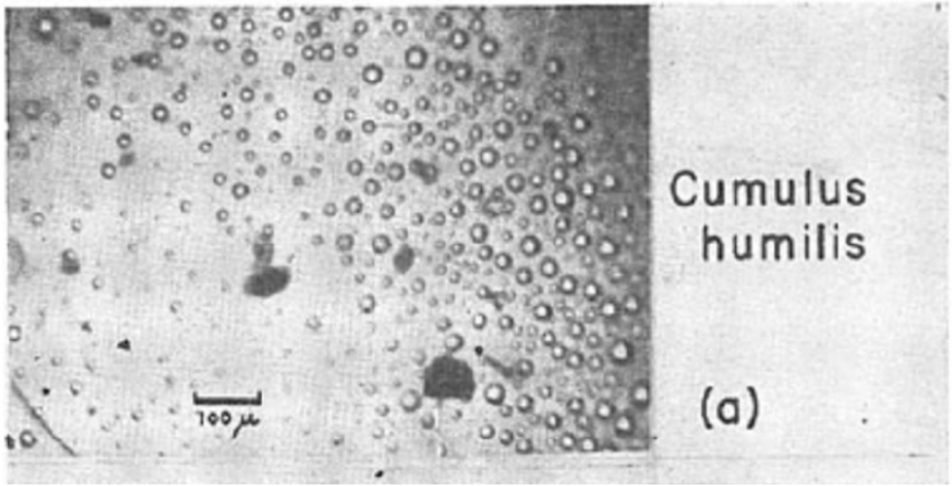
P.V. Hobbs *, A.L. Rangno
Department of Atmospheric Sciences, University of Washington, Seattle, WA 98195-1640, USA

Fig. 4. Cloud drop spectrum measured between 2055 to 2059 UTC near the top of the highest of the three stratiform cloud layers on 2 December 1991. Data are from the FSSP-100 (dots) and from the PMS 1-D cloud probe (circles). PMS FSSP-100 channels in which the concentration was less than 1 cm^{-3}, and the first three channels of the PMS 1-D cloud probe, have been omitted due to the undercounting of particles in these channels.



Cumulus





Cumulus Humilis

- Tc: 10 a 30 min
- W = 3 m/s
- Tp≈ 10 mim
- LWC ≈0.3-1 g/m^3
- Crγ= 50°C/h
- Crrad=4°C/h
- turbulencia moderada
- Pp poco probable

Cu humilis y mediocris

Domina el enfriamiento ad saturado

CUMULUS
HUMILIS

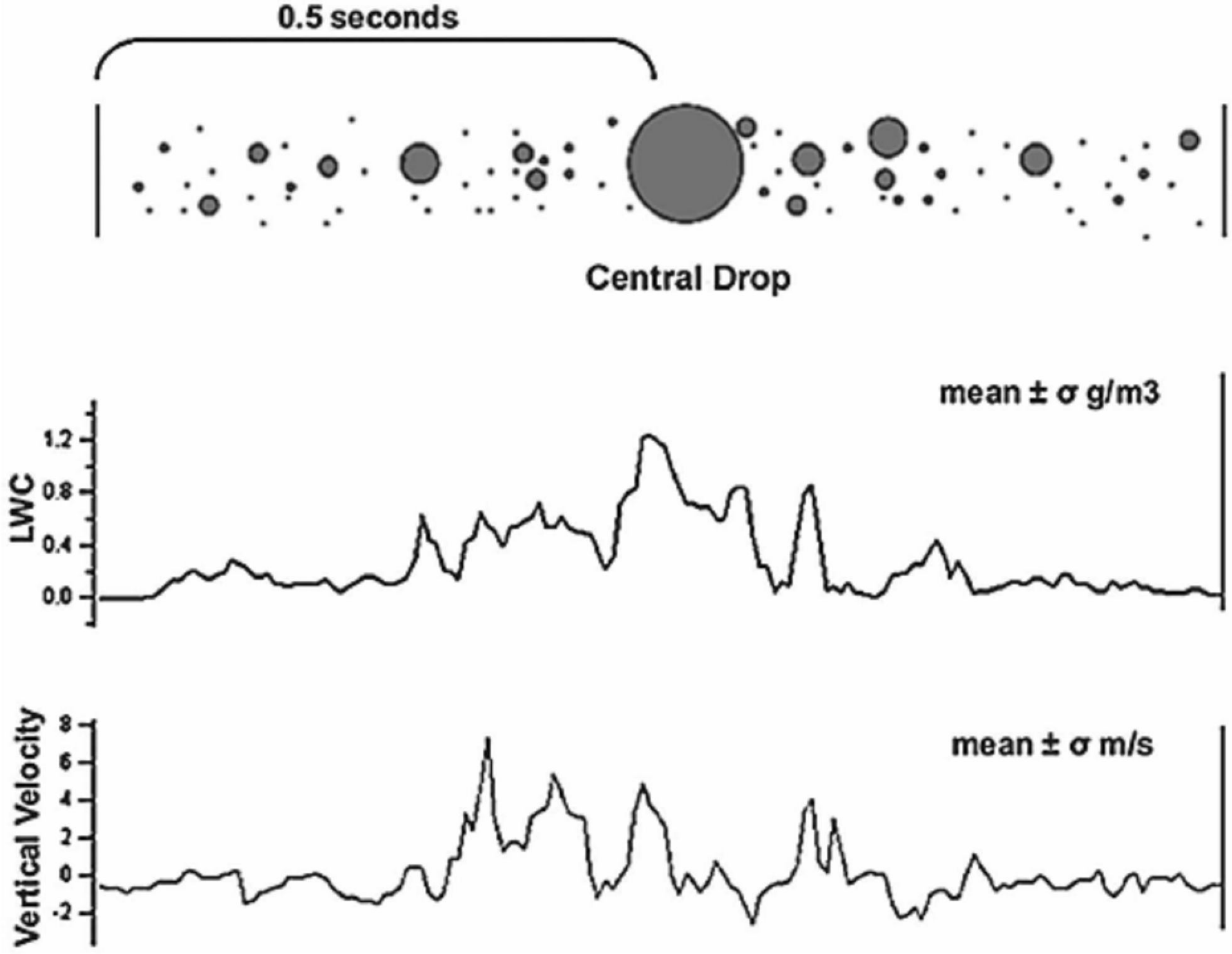


FIG. 4. Drop environment schematic. For every observed drop (i.e., the central drop), we select an environment beginning 0.5 s prior to the drop arrival and ending 0.5 s after, for a total time envelope of 1 s. The mean and standard deviation of a number of parameters (LWC and *w* shown here) within this envelope, all measured at 25 Hz, are calculated. In addition, the cloud drop size distribution is also determined from PDI measurements.

New Observations of Precipitation Initiation in Warm Cumulus Clouds

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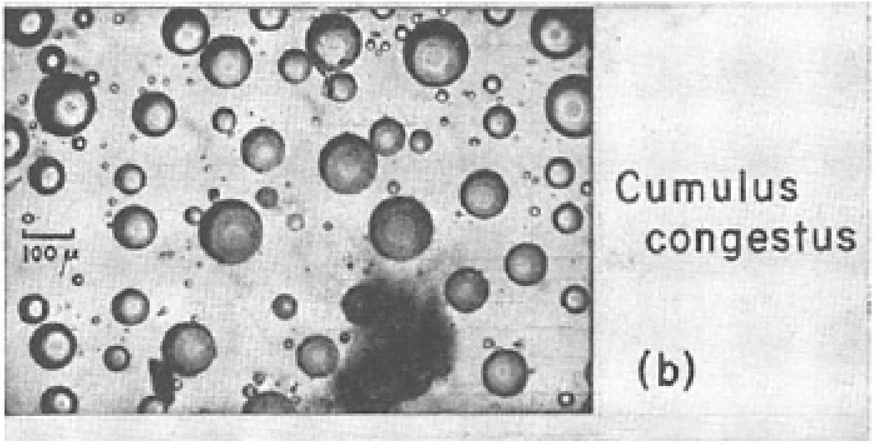

Cumulus congestus, developing into a cumulonimbus near Key Biscayne, Florida.

- Tc: 20 a 45 min
- W = 10 m/s
- Tp≈ 10 mim
- LWC ≈0.5-2.5 g/m^3
- Crγ= 50°C/h
- Crrad=4°C/h
- turbulencia importante
- Pp + probable

Domina el enfriamiento ad saturado

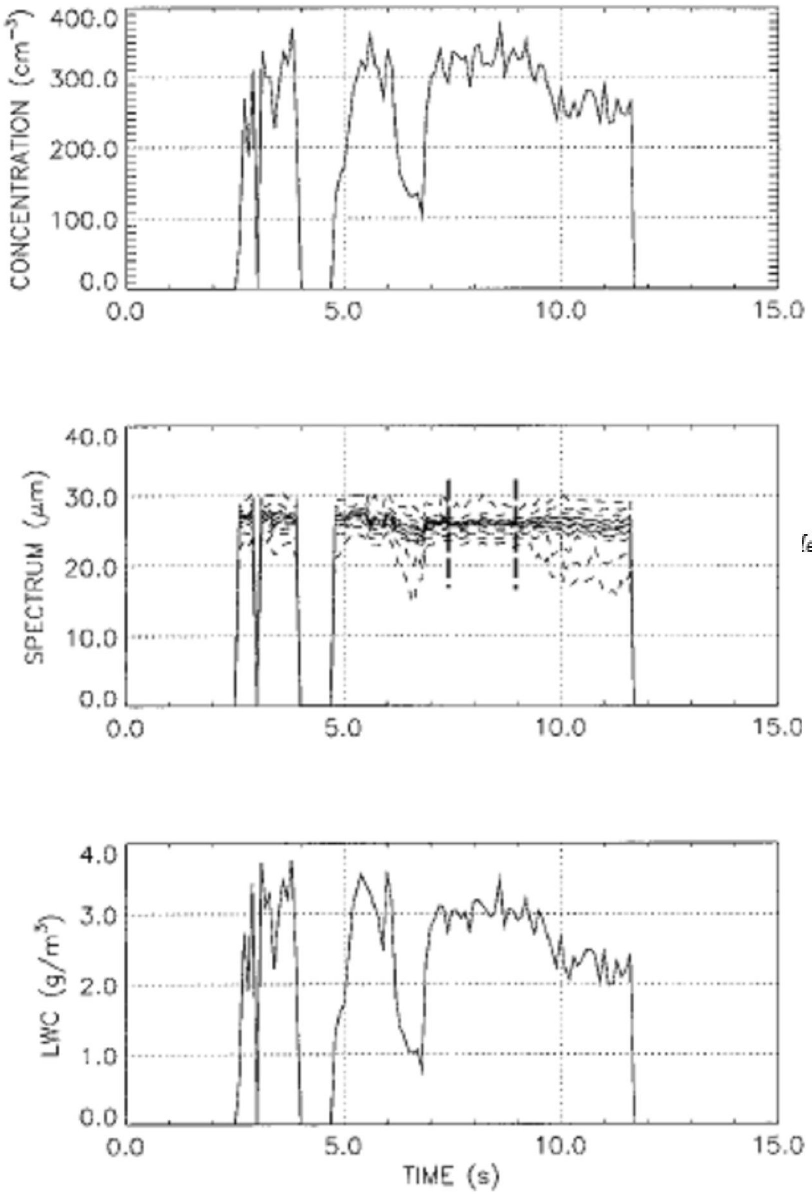

FIG. 2. Time series of total droplet number concentration, droplet spectrum represented by its 10% percentiles, and LWC, along a cumulus cloud traverse with the Merlin-IV. The two vertical bars indicate the selection of the adiabatic section. SCMS flight on 15:42:11.2 UTC 10 Aug 1995 at an altitude of 2188 m.

Droplet Spectra Broadening in Cumulus Clouds. Part I: Broadening in Adiabatic Cores

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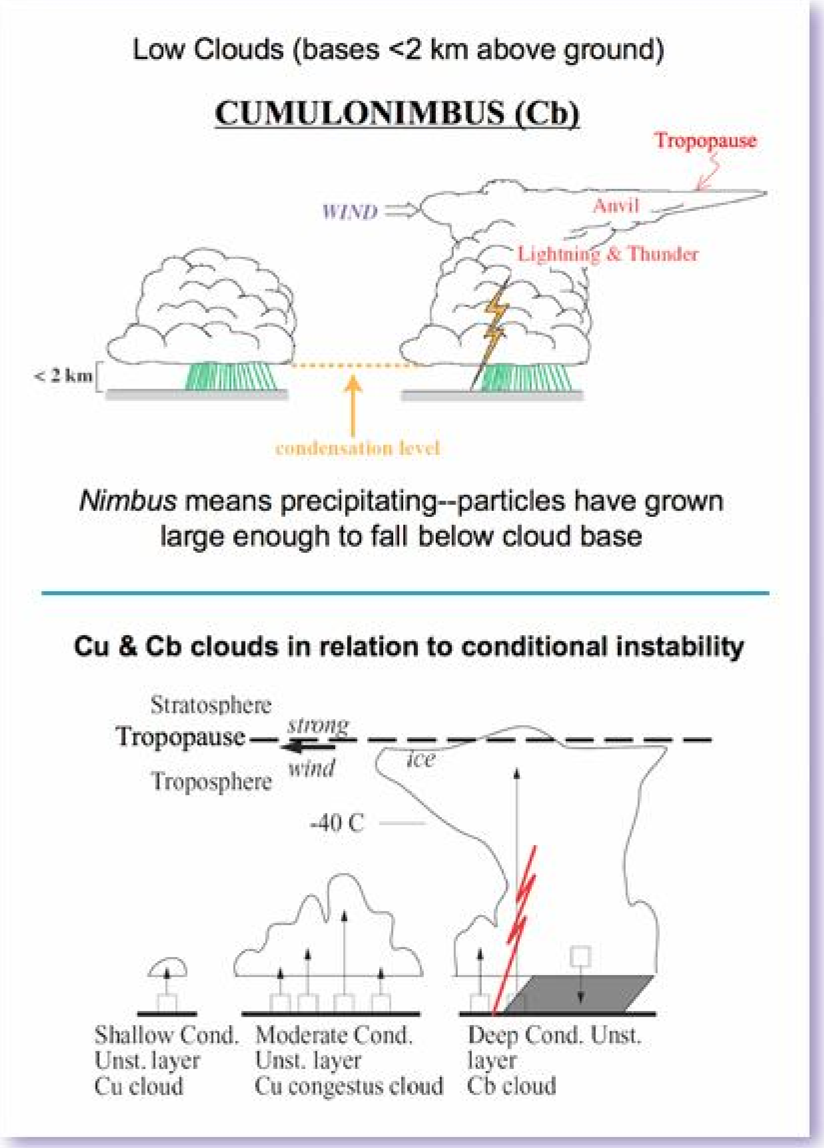
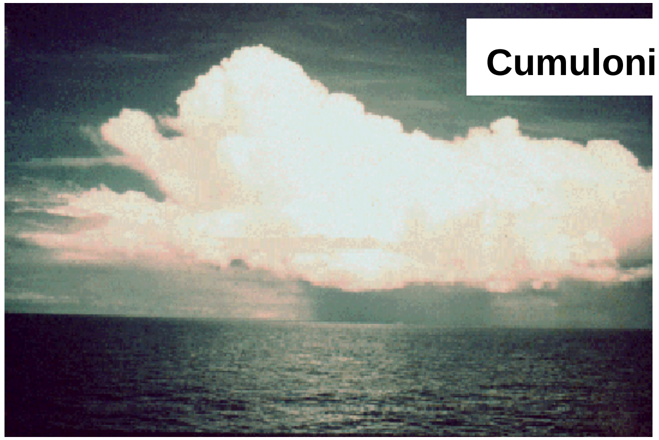
LAURE CHAUMAT

Météo-France, CNRM/GMEI, Toulouse, France

(Manuscript received 12 February 1999, in final form 5 July 2000)

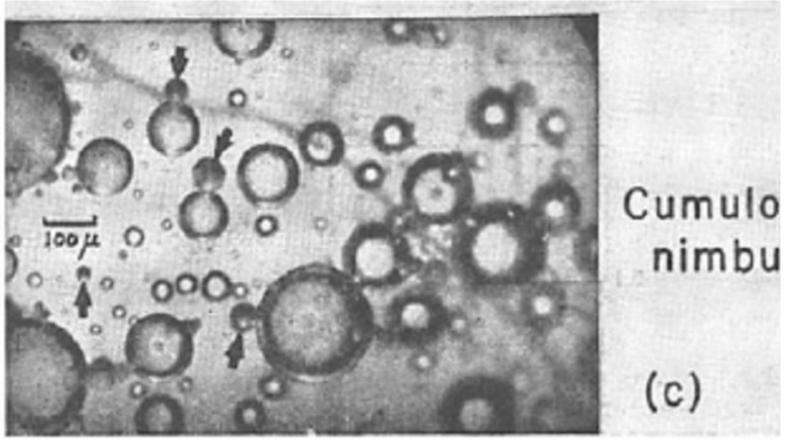
Cumulonimbus





Cumulonimbus without anvil.

- •Tc: 45 min a varias hs
- •W > 10 m/s
- •Tp≈ 400 s
- •LWC ≈ 1.5-4.5 g/m^3
- •Crγ= 500°C/h
- •Crrad= Importante sobre todo en el yunque, fav la inestabiliz.
- • turbulencia de gran magnitud
- •Puede no pp, pero es frecuente



Cloud Sampling Instruments for Icing Flight Tests: (3) Cloud Droplet Sizers

Richard Jeck August 2006

DOT/FAA/AR-TN06/31

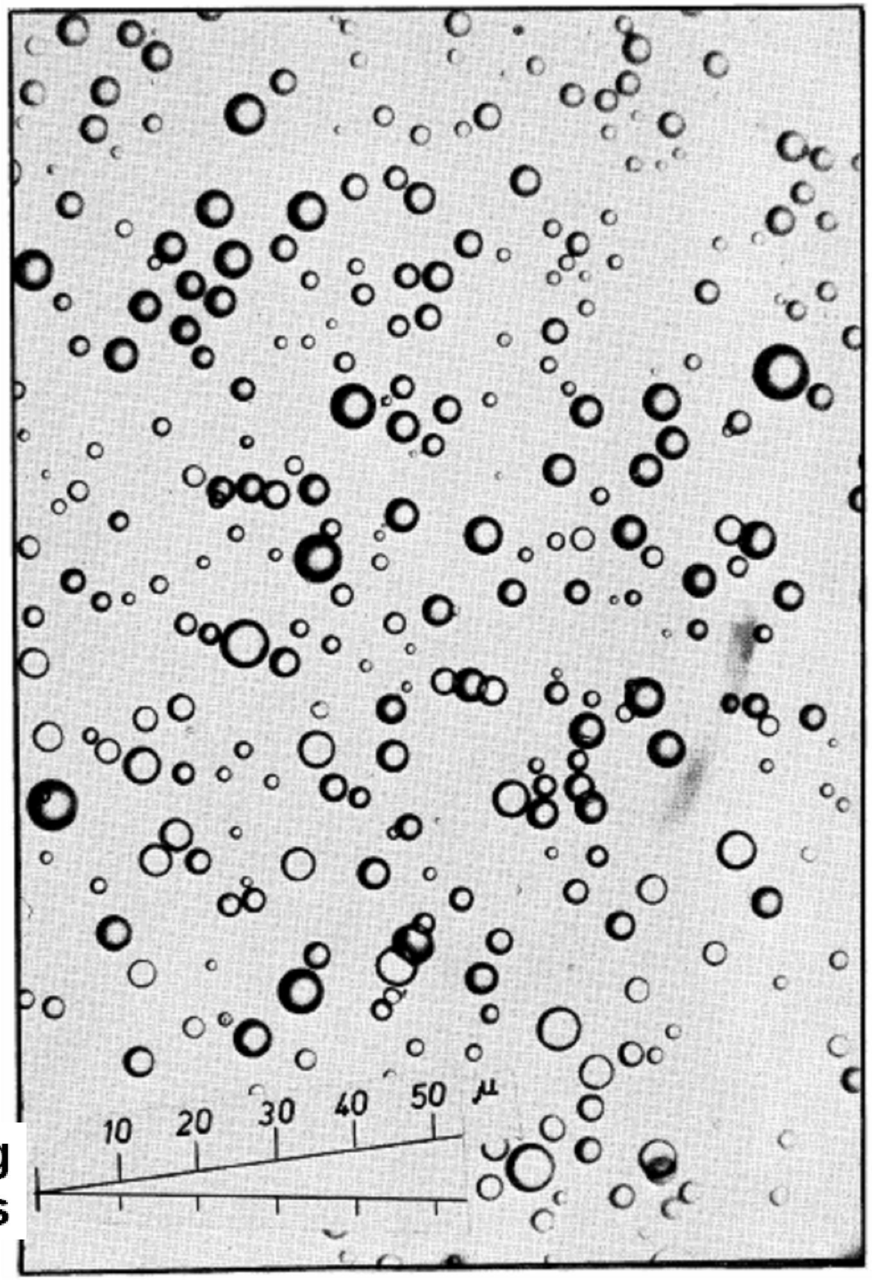
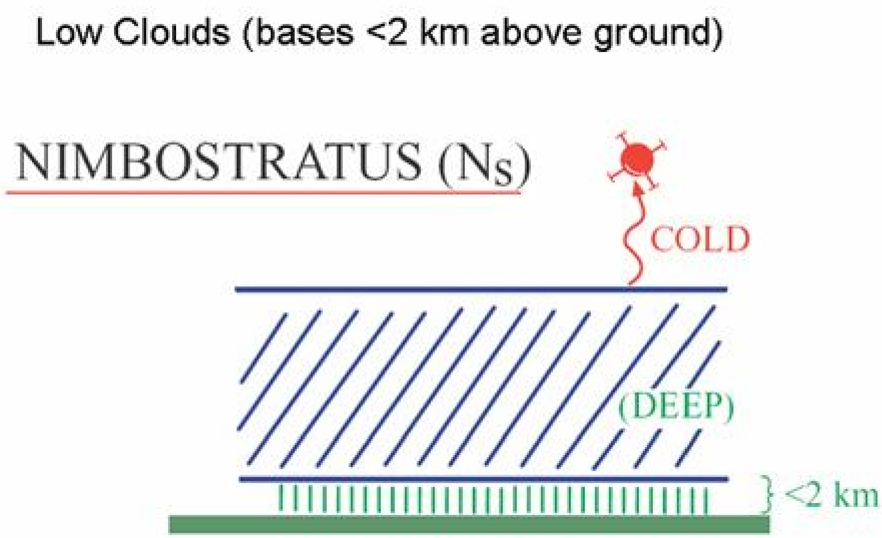
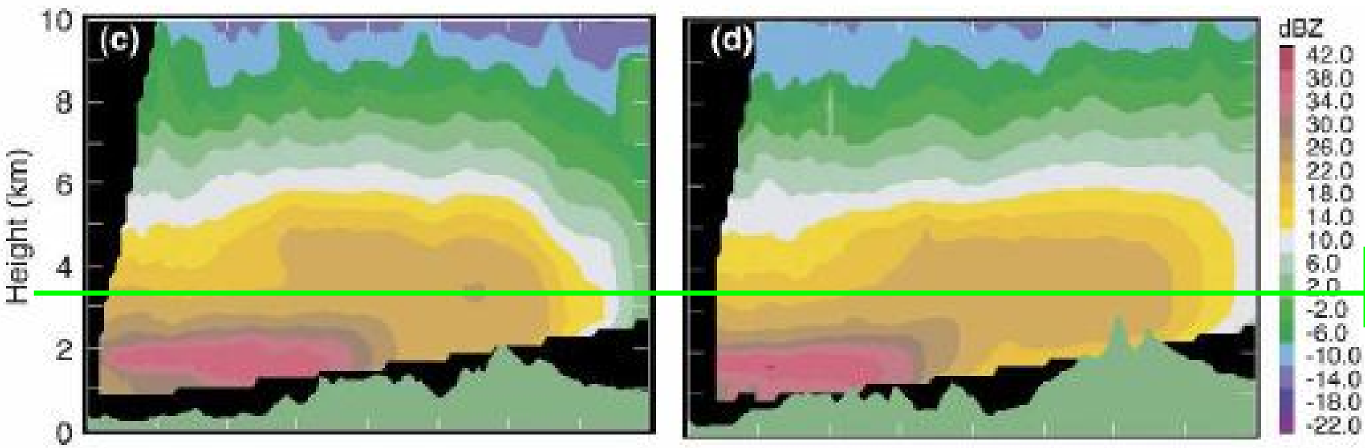


FIGURE 9. PHOTOGRAPH OF CLOUD DROPLETS CAPTURED ON AN OILED SLIDE [16]

$$Z_E = \frac{|K|^2 Z}{0.43}$$

Nimbostratus





$$Ze = \frac{|K|^2 Z}{0.43}$$

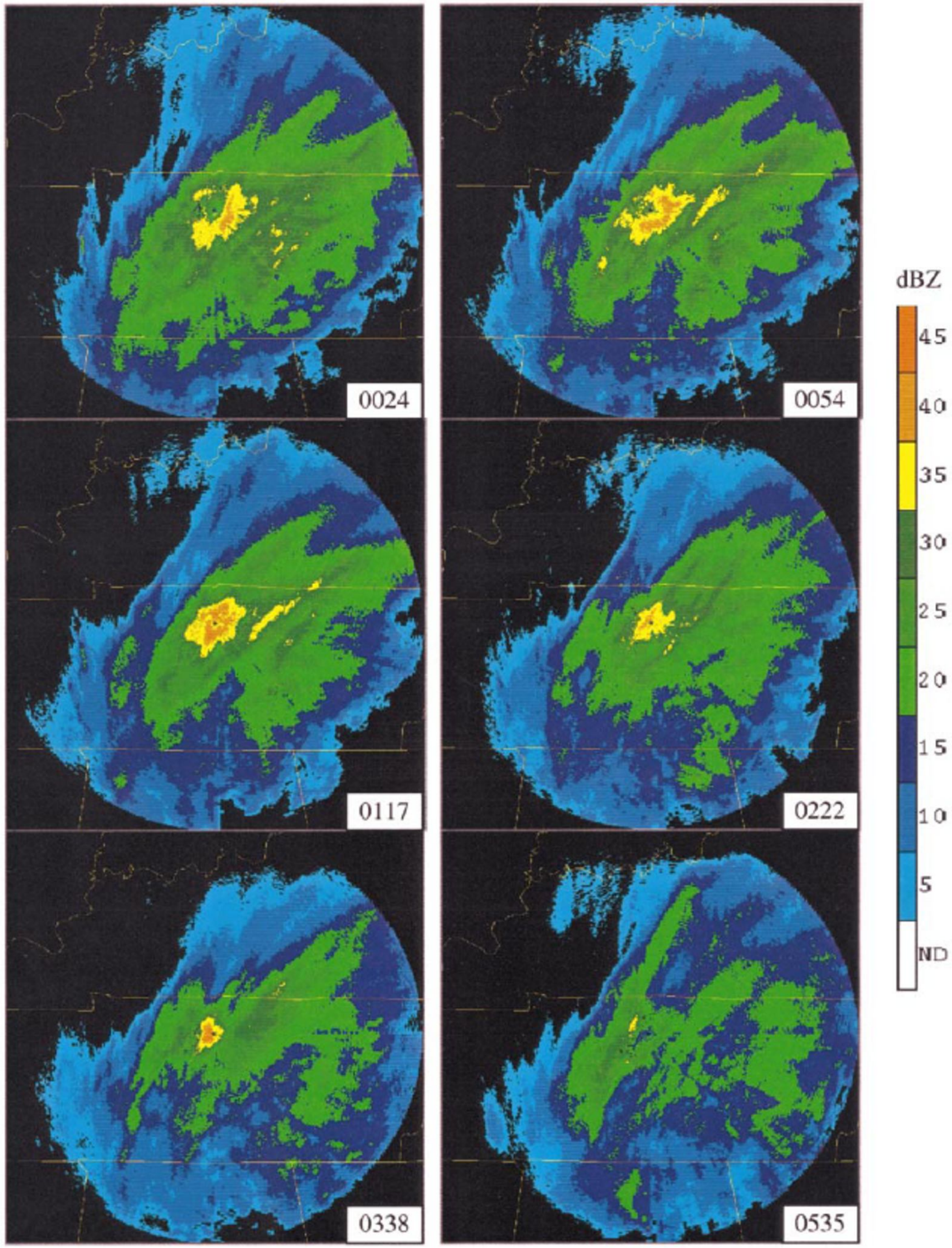
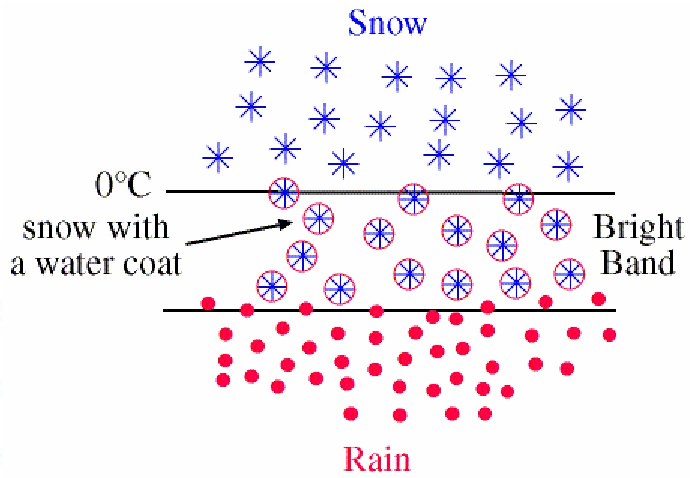
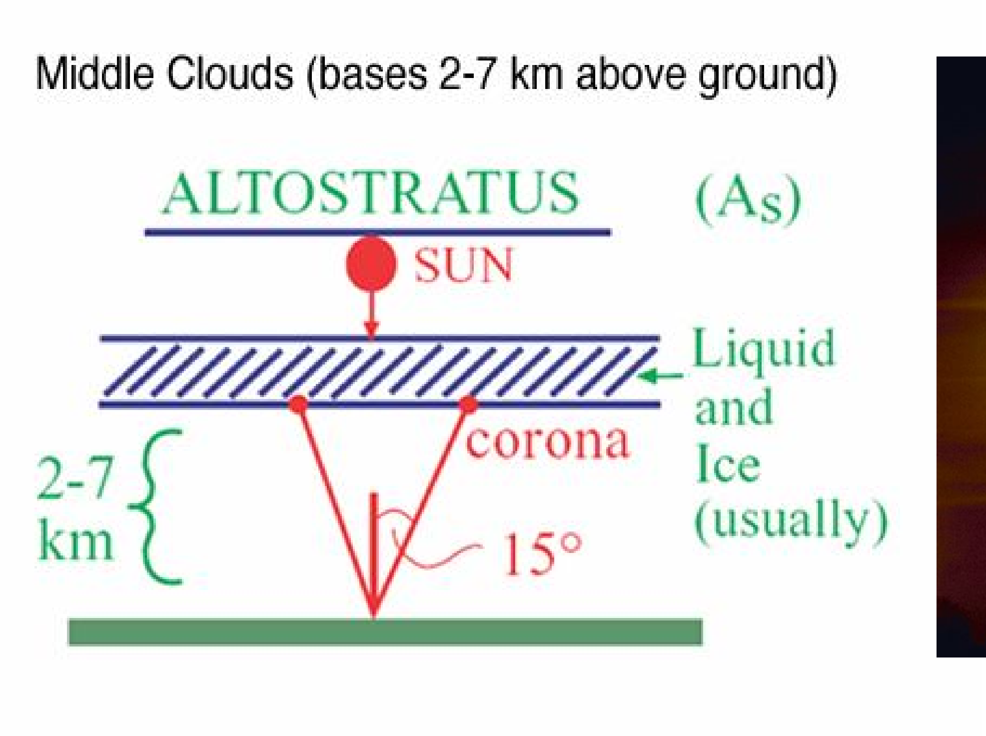


FIG. 6. Time series of base reflectivity images from KOHX (Nashville, TN) WSR-88D radar at 0.5° elevation angle. Note the shri with time of the "bright band," or higher reflectivity region roughly surrounding the radar site.

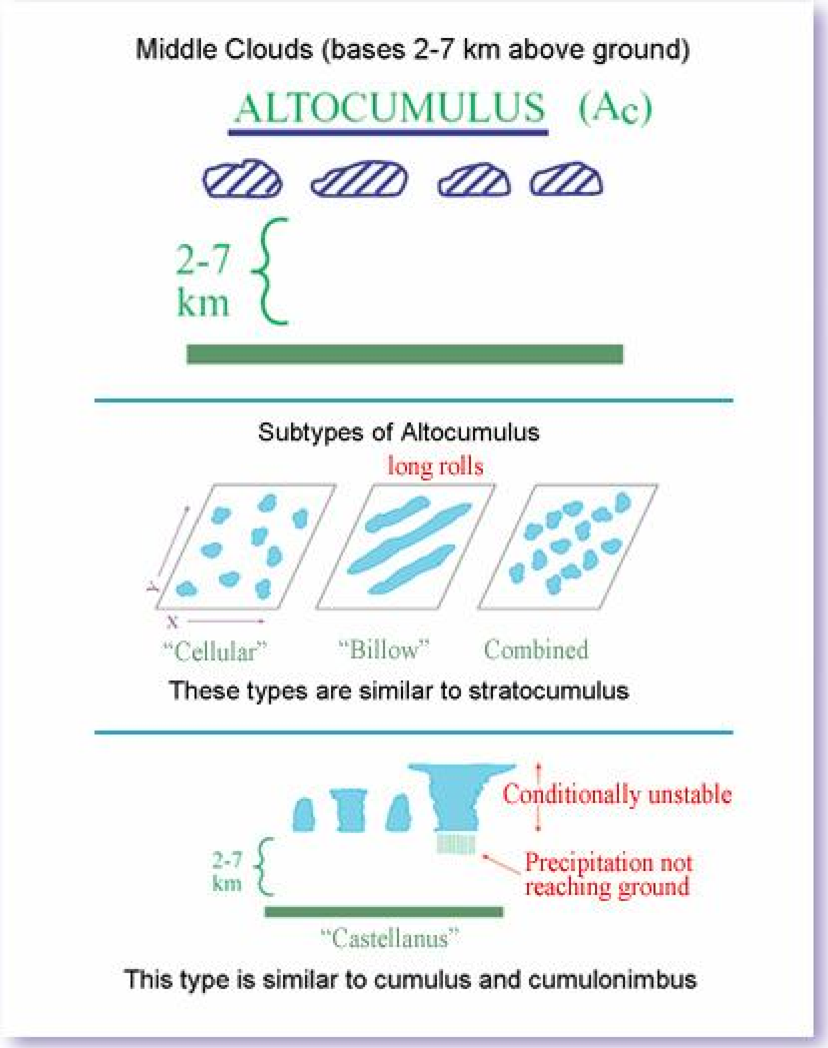


A radar bright band was observed (higher reflectivity resulting from frozen precipitation beginning to melt, presumably near the top of the melting layer). This bright band was observed to shrink toward the KBNA radar with time (Fig. 6), implying that the top of the melting layer was progressively moving to lower elevations with time. This observation was consistent with a process involving cooling of the lower layers of the atmosphere from above, as suggested by the 0000 UTC sounding (Fig. 5).

Altostratus

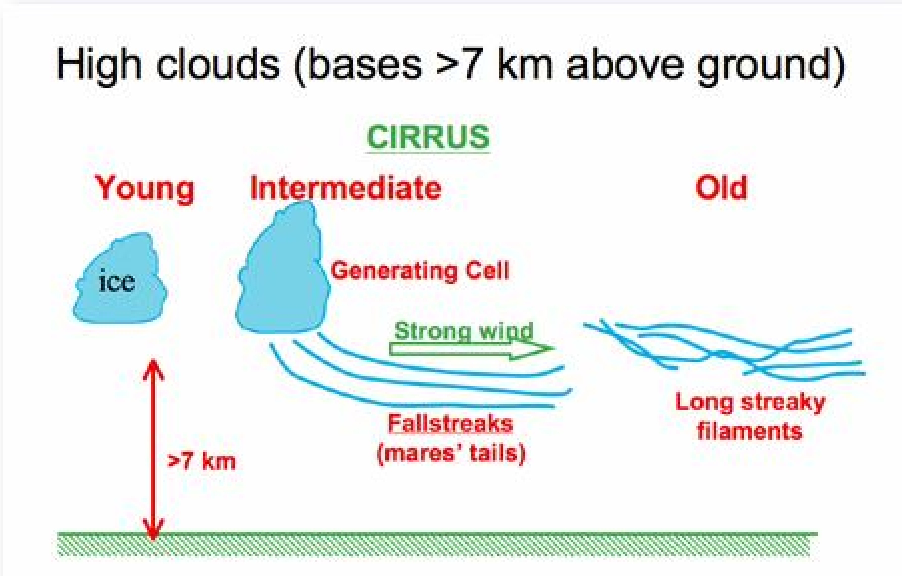


Altocumulus



In some cases altocumulus rolls are produced by shear instability, probably Kelvin Helmholtz type

Cirrus



R. K. Pilsbury, South Cambridgeshire (U.K.), 3 November 1978

- Ice cloud found in the upper toposphere (fronts, convective anvils)
- Important for the radiative impact

Cirrus

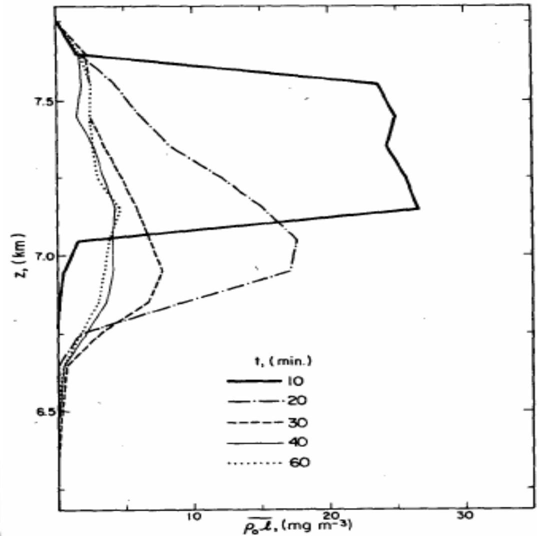


FIG. 9. Vertical profiles of horizontally averaged ice water content ($\overline{\rho_o l}$) at various times during a simulation of a thin cirrus cloud layer.

generation region after $t = 10$ minutes. It is interesting that diabatic stabilization of the immediate subcloud region is found while a lower region of diabatic destabilization occurs, i.e., below $z = 6.6$ km. Continuance of this pattern would eventually result in a second convectively active region evolving more than 0.5 km below the initial generator layer. Occurrence of multilayered thin cirrus is very common.

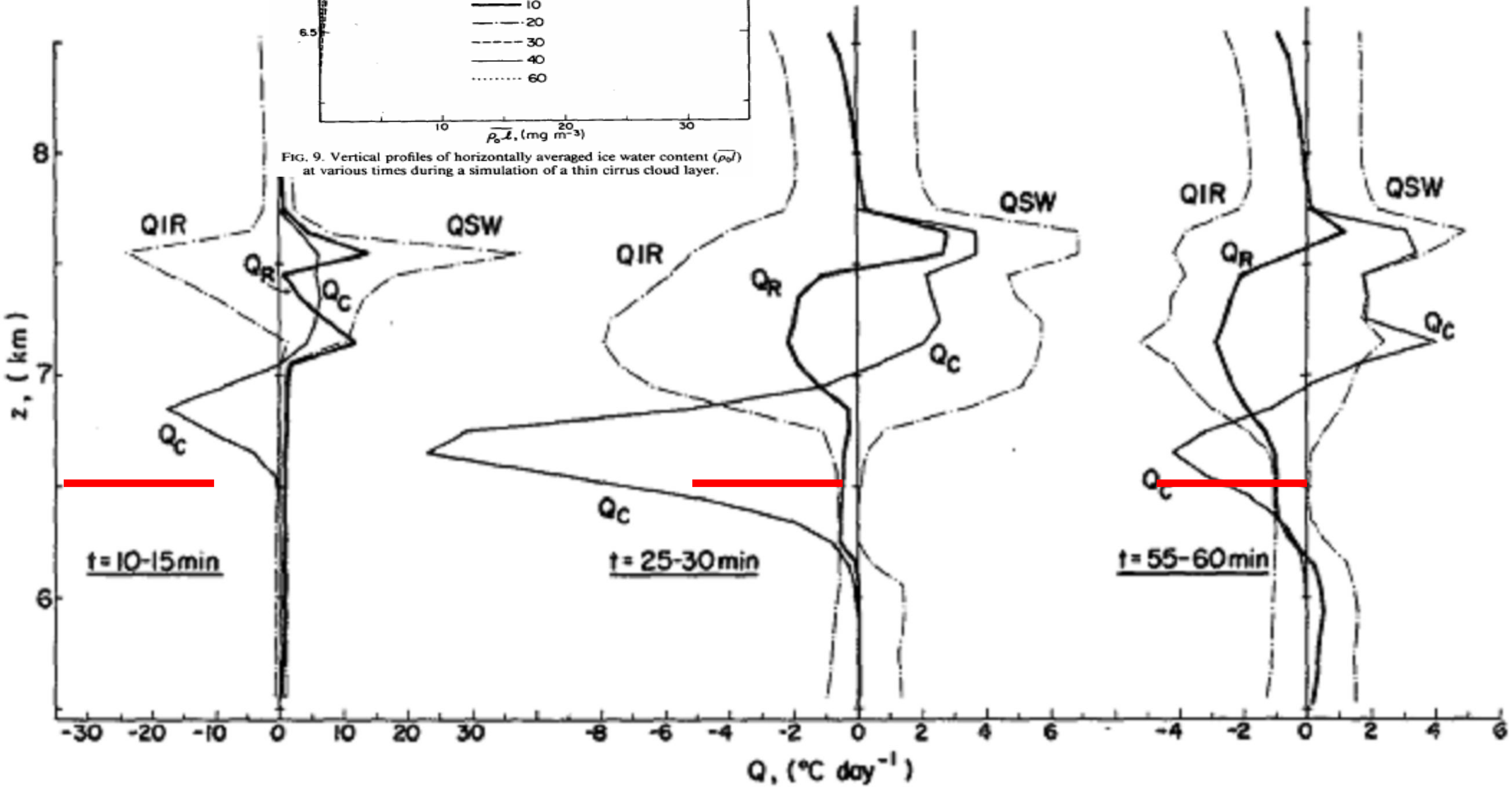
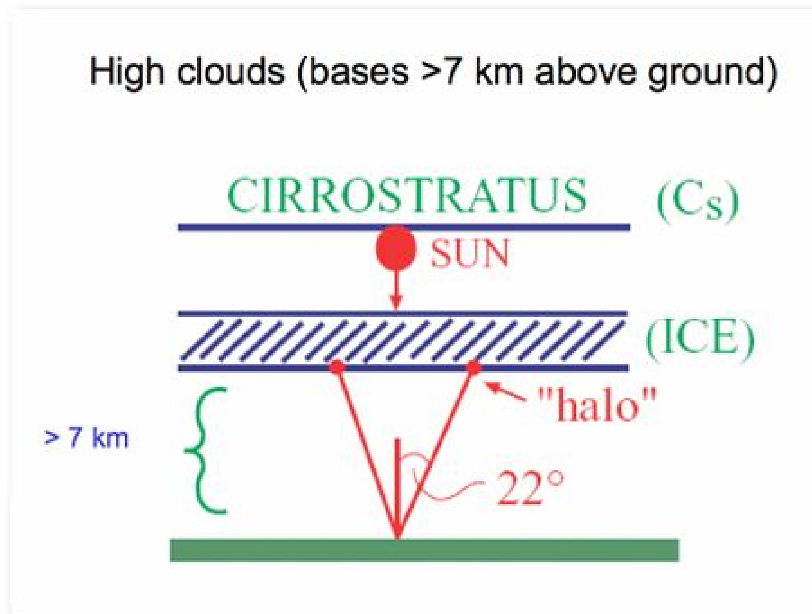


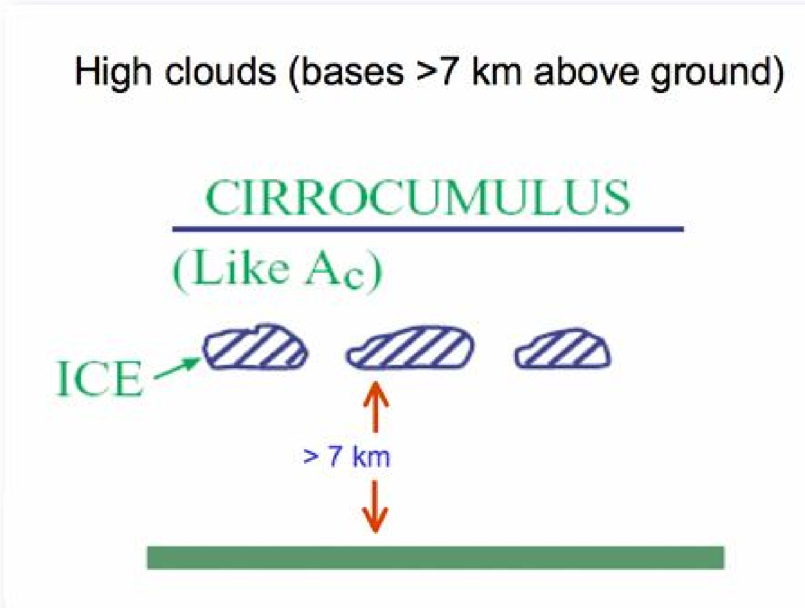
FIG. 10. Vertical profiles of horizontally averaged potential temperature tendencies due to phase changes of water ($\overline{Q_C}$), infrared radiative processes ($\overline{QIR}$), absorption of solar energy ($\overline{QSW}$) and net radiative processes ($\overline{Q_R}$) over various time periods during a simulation of thin cirrus cloud layer.

Cirrostratus

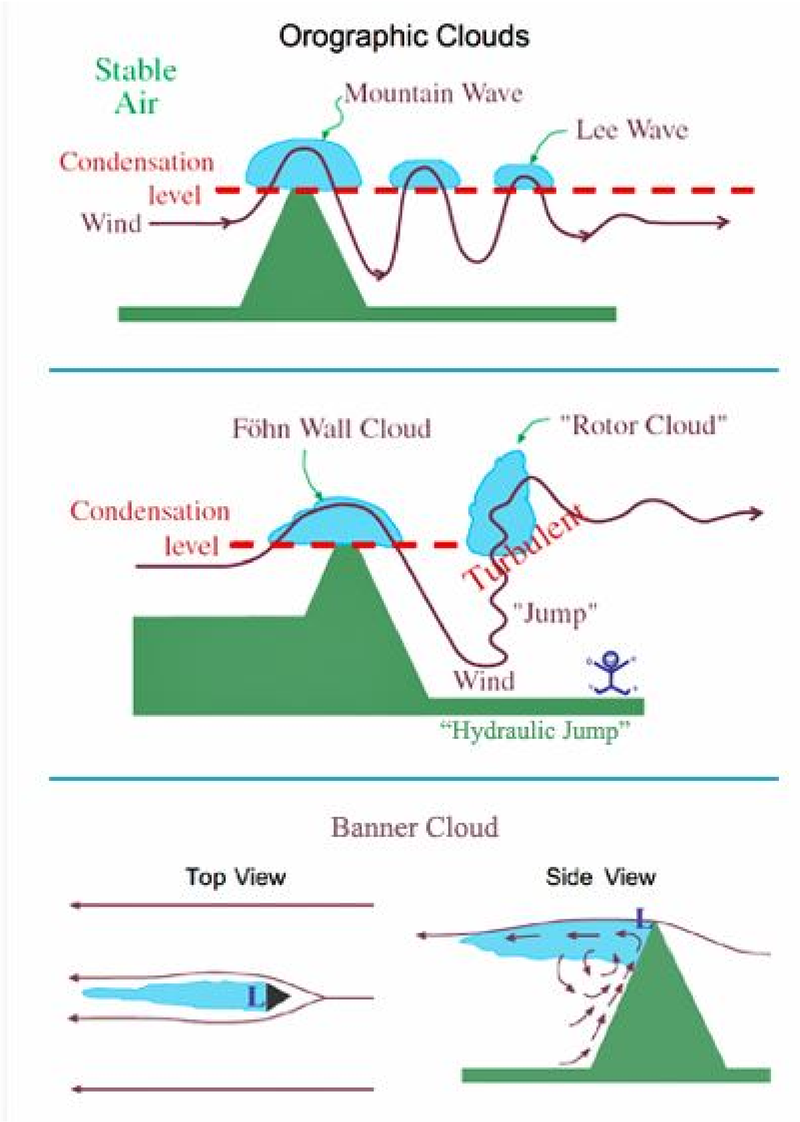


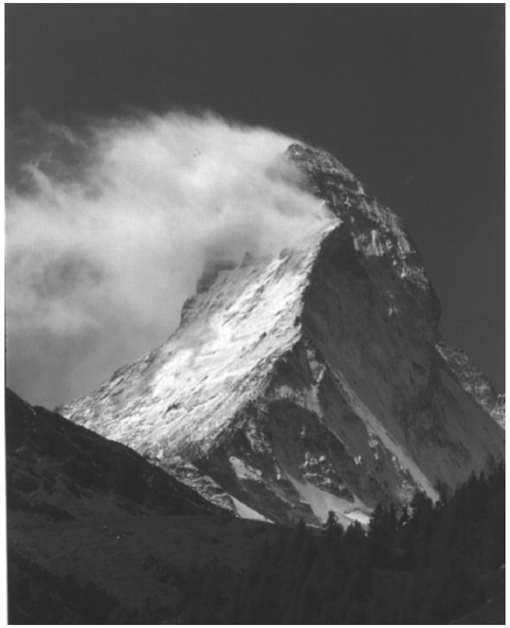
Cirrostratus with halo. Seattle, Washington**.**

Cirrocumulus



Nubes por ascenso forzado





Referencias:

Atlas de Nubes de Houze

P10.2

ON THE IMPACT OF VERTICAL RESOLUTION IN THE NUMERICAL FORECASTING OF FOG

Robert Tardif *
National Center for Atmospheric Research, Research Applications Program, Boulder, Colorado

11th Conference on Aviation, Range and Aerospace Meteorology,
Hyannis MA, October 2004

Cirrus Clouds. Part II: Numerical Experiments on the Formation and Maintenance of Cirrus

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