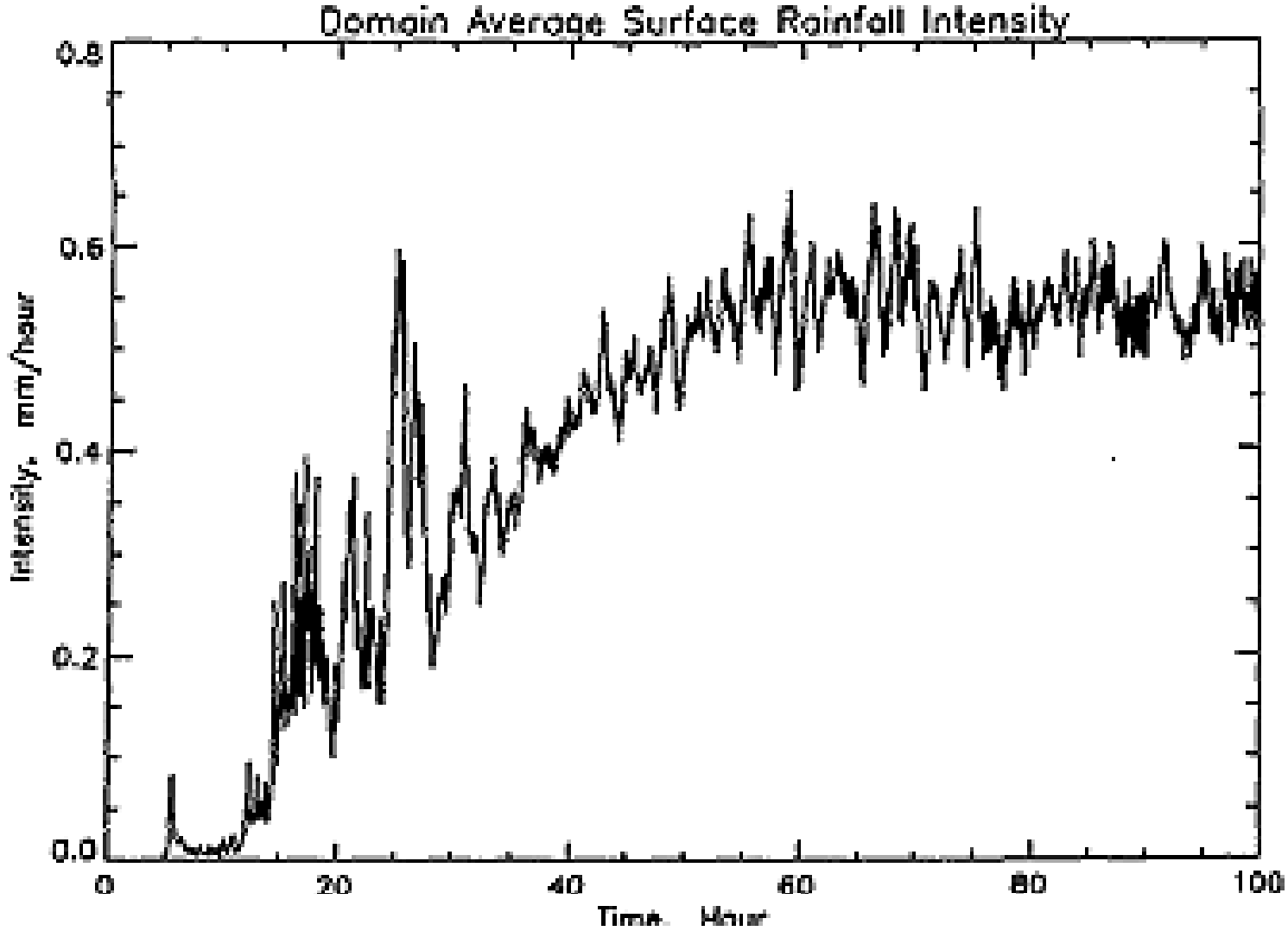
Note:
Radiative-Convective Code

Three-Dimensional Cloud-Permitting Nonhydrostatic models run into statistical equilibrium with calculated or prescribed radiative cooling over a fixed, constant sea surface temperature (Doubly-periodic domains)


Domain Average Surface Rainfall Intensity
Intensity, mm/hour
0.0
0.2
0.4
0.6
0.8
0
20
40
60
80
100
Time, Hour

Robe and Emanuel, J. Atmos. Sci., 1996

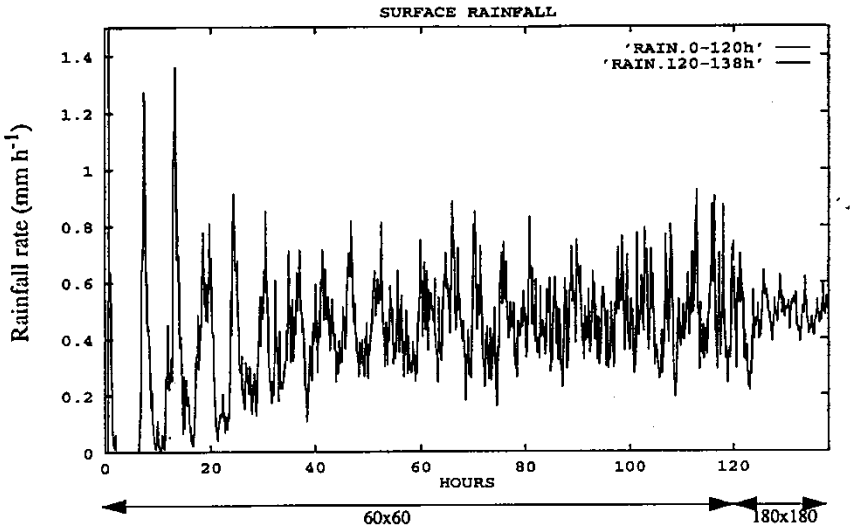
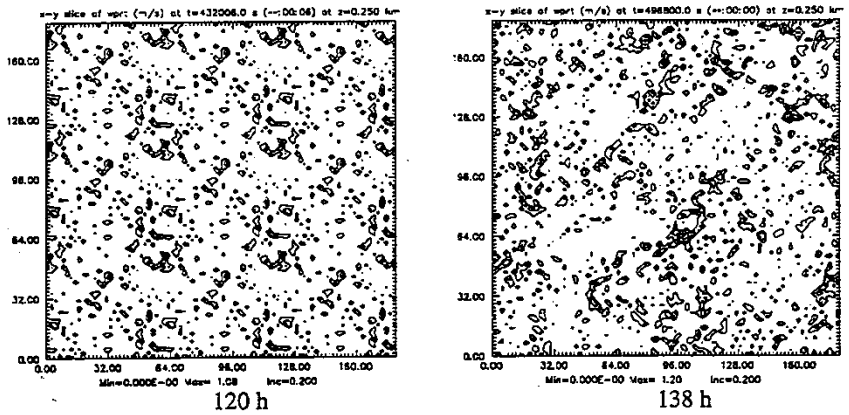
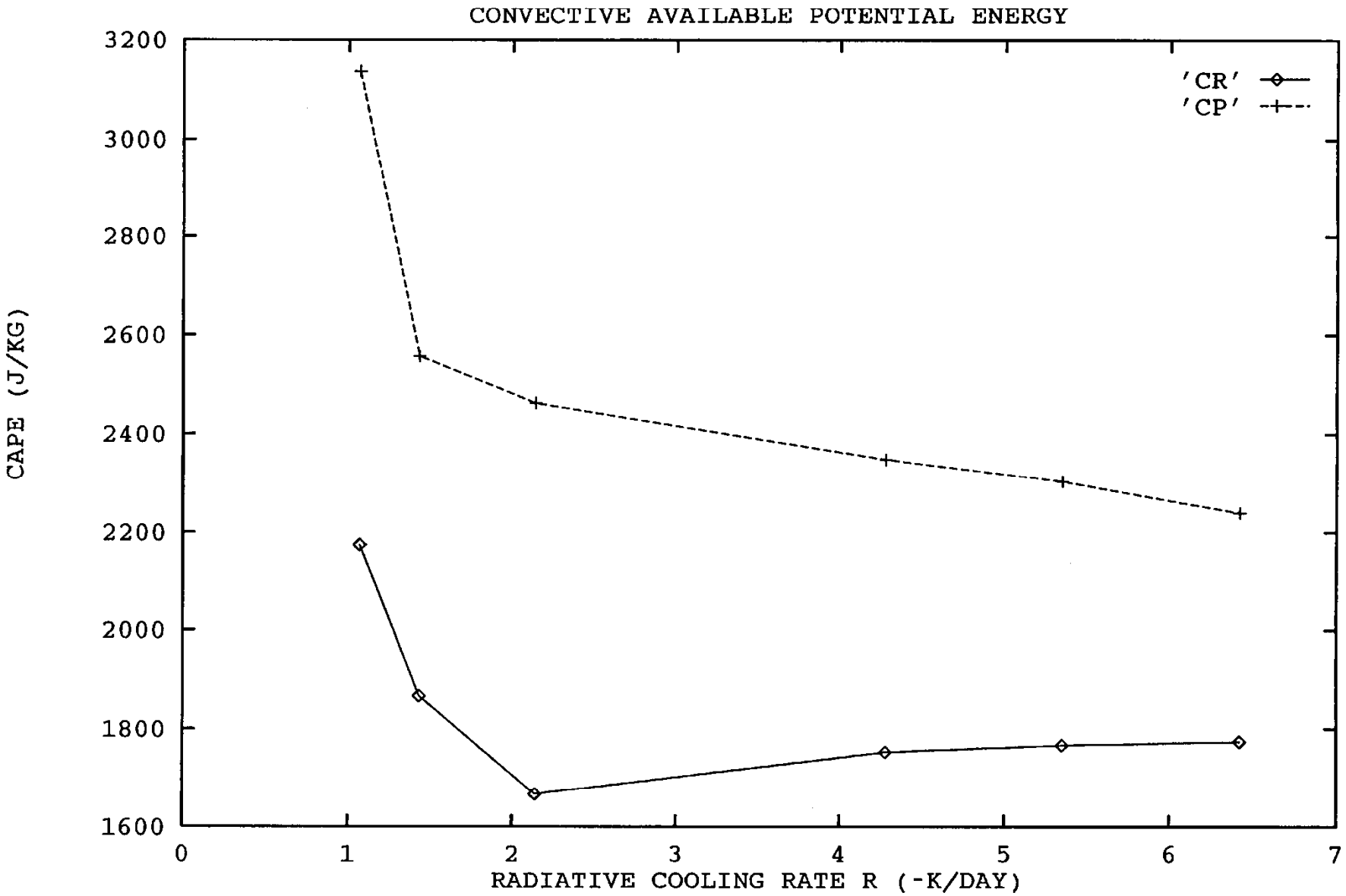
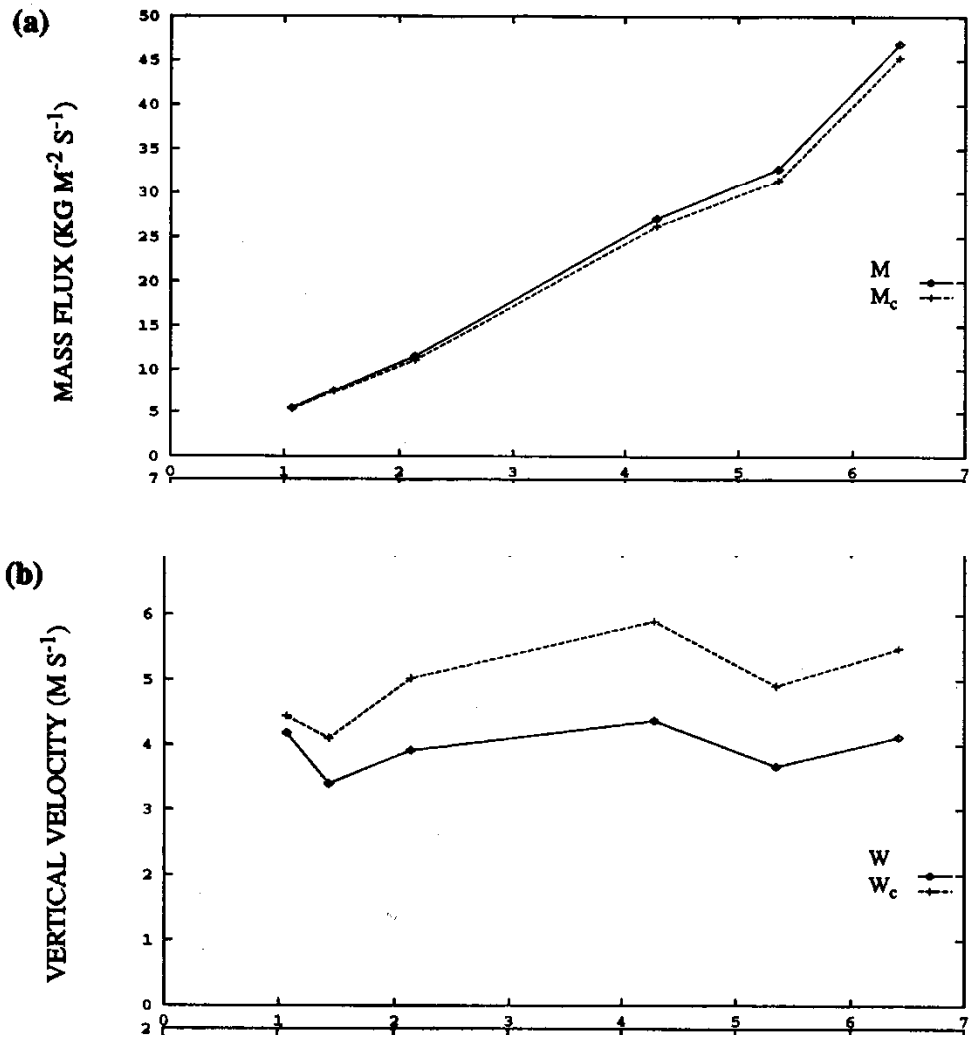


Figure 4.5: time-series of the horizontally averaged rainfall at the ground for R= -5.4 K/day. The domain extends over 60 x 60 km^2 for the first 120 hours, and over 180 x 180 km^2 for the last 18 hours.



120 h 138 h


CONVECTIVE AVAILABLE POTENTIAL ENERGY
CAPE (J/KG)
RADIATIVE COOLING RATE R (-K/DAY)
'CR'
'CP'
3200
3000
2800
2600
2400
2200
2000
1800
1600
0
1
2
3
4
5
6
7


(a)
MASS FLUX (KG M^{-2} S^{-1})
M
M_c
(b)
VERTICAL VELOCITY (M S^{-1})
W
W_c
(c)
AREAL COVERAGE (%)
σ
σ_c
RADIATIVE COOLING RATE (K DAY^{-1})I

Rainfall Intensity vs. Terminal Fall Speed

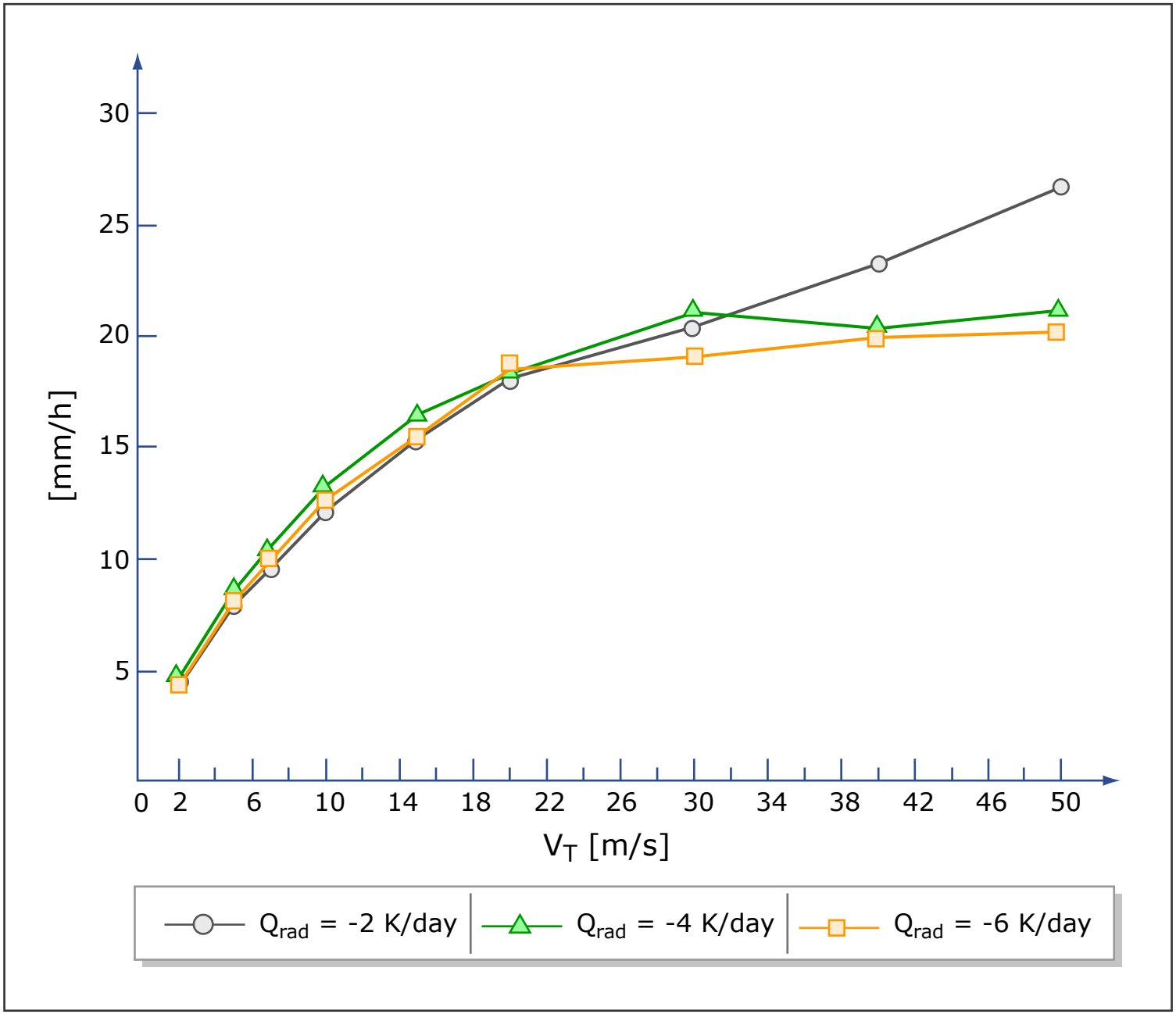
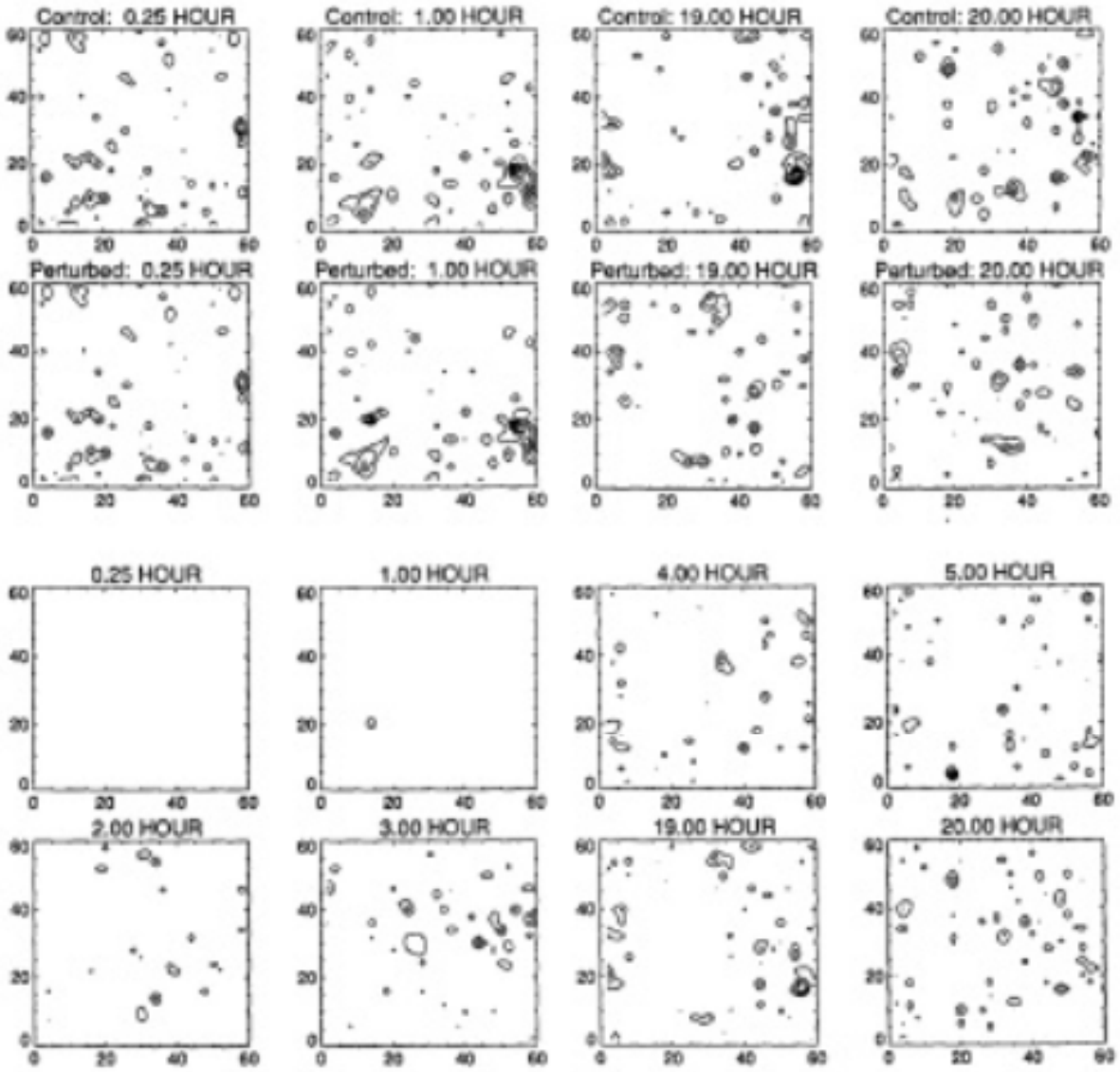


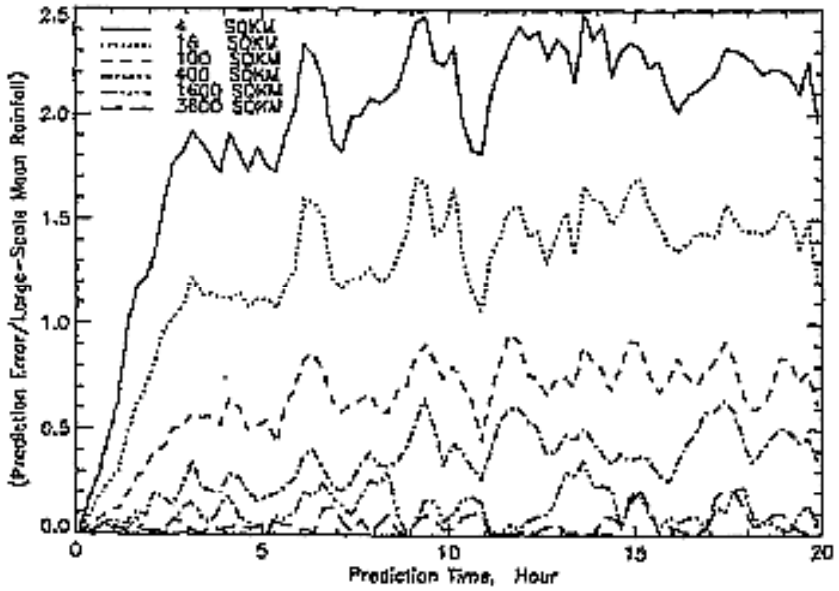
Image by MIT OpenCourseWare.

Parodi and Emanuel, 2009

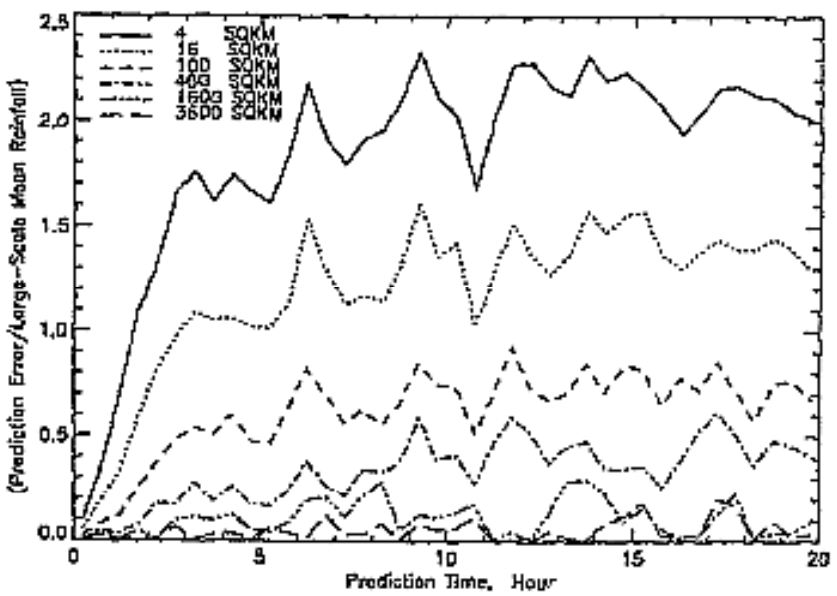
Islam et al. Predictability Experiments

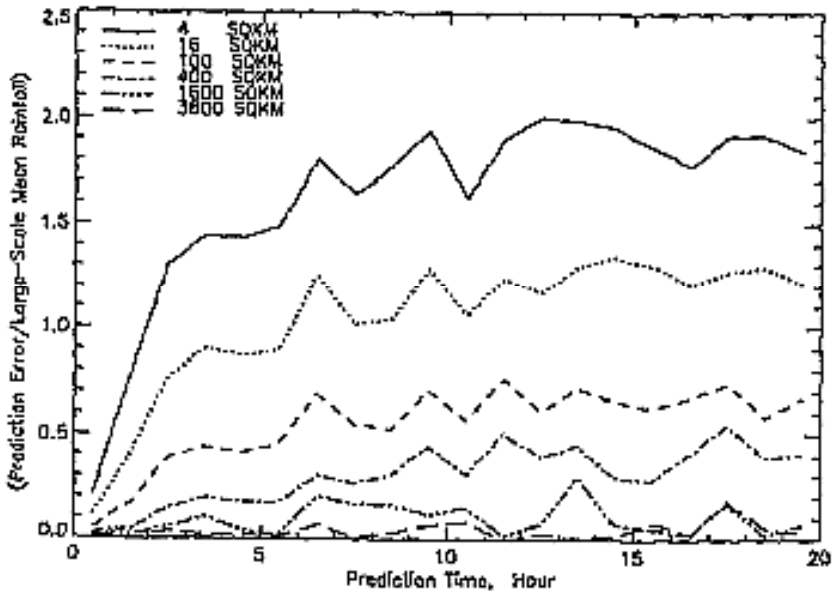


15 min

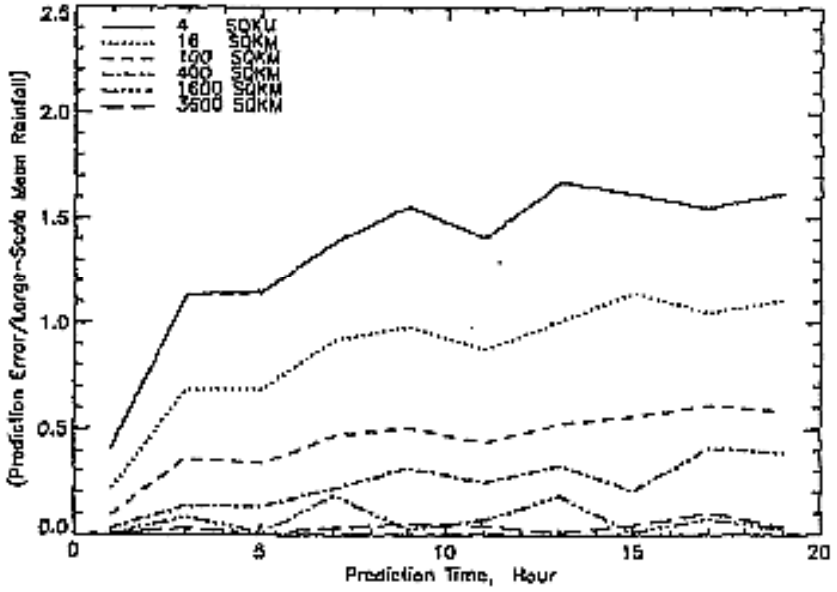


30 min



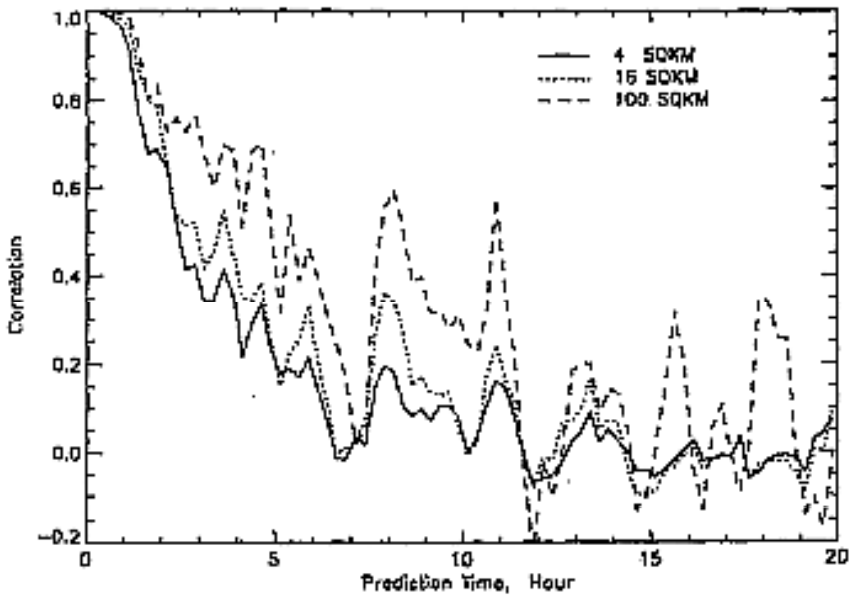


60 min

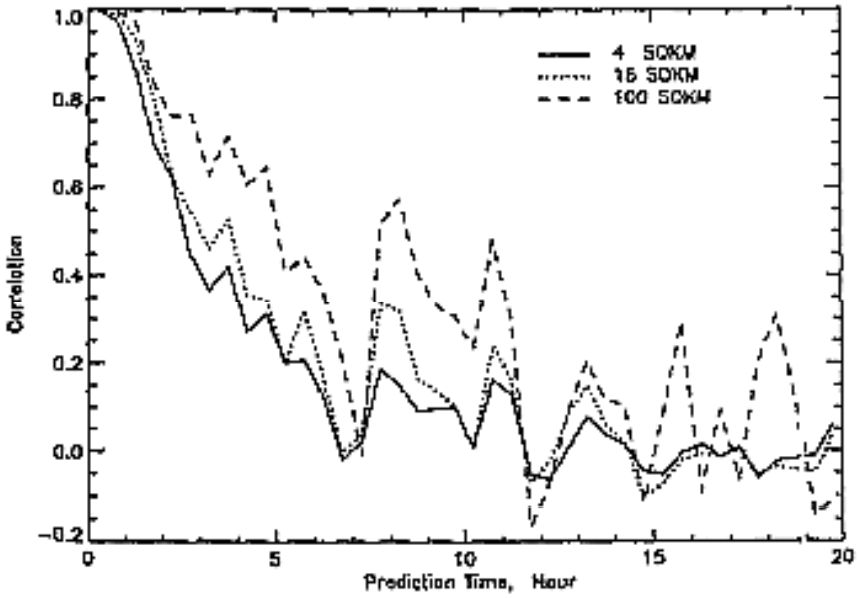


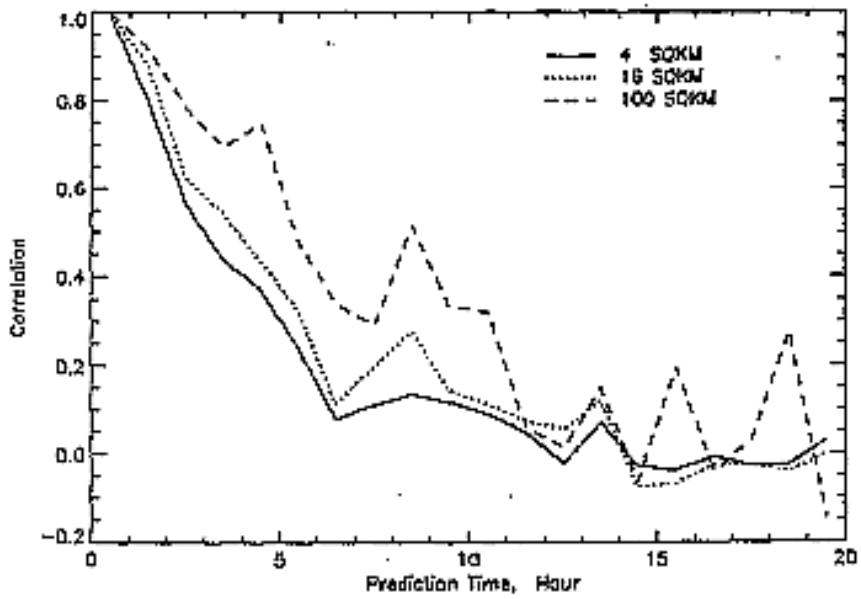
120 min

15 min

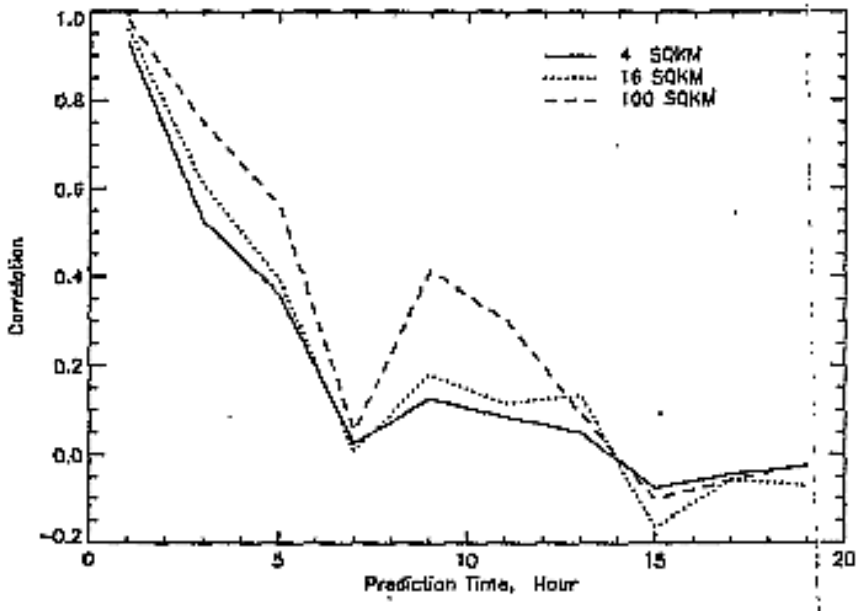


30 min

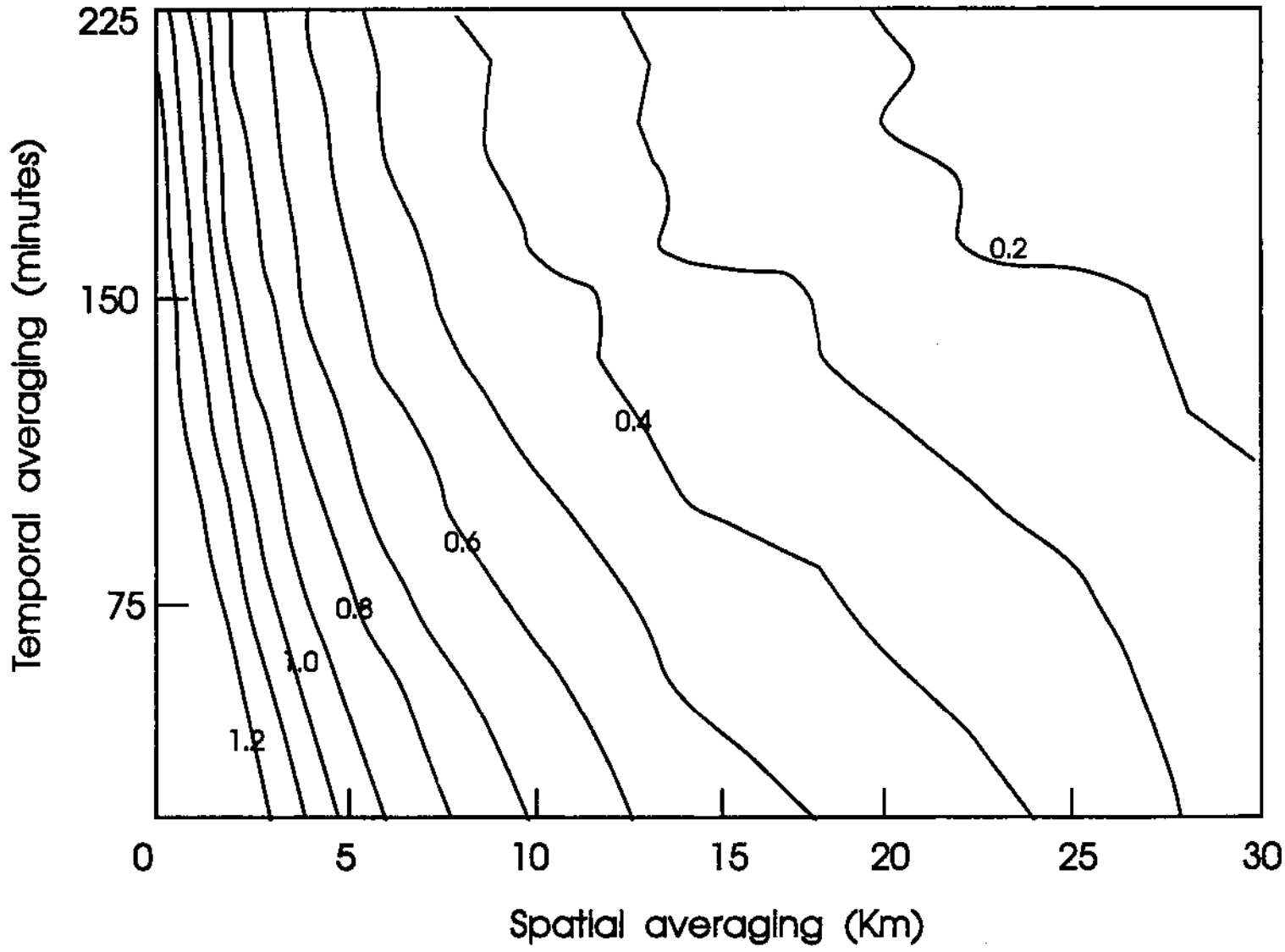




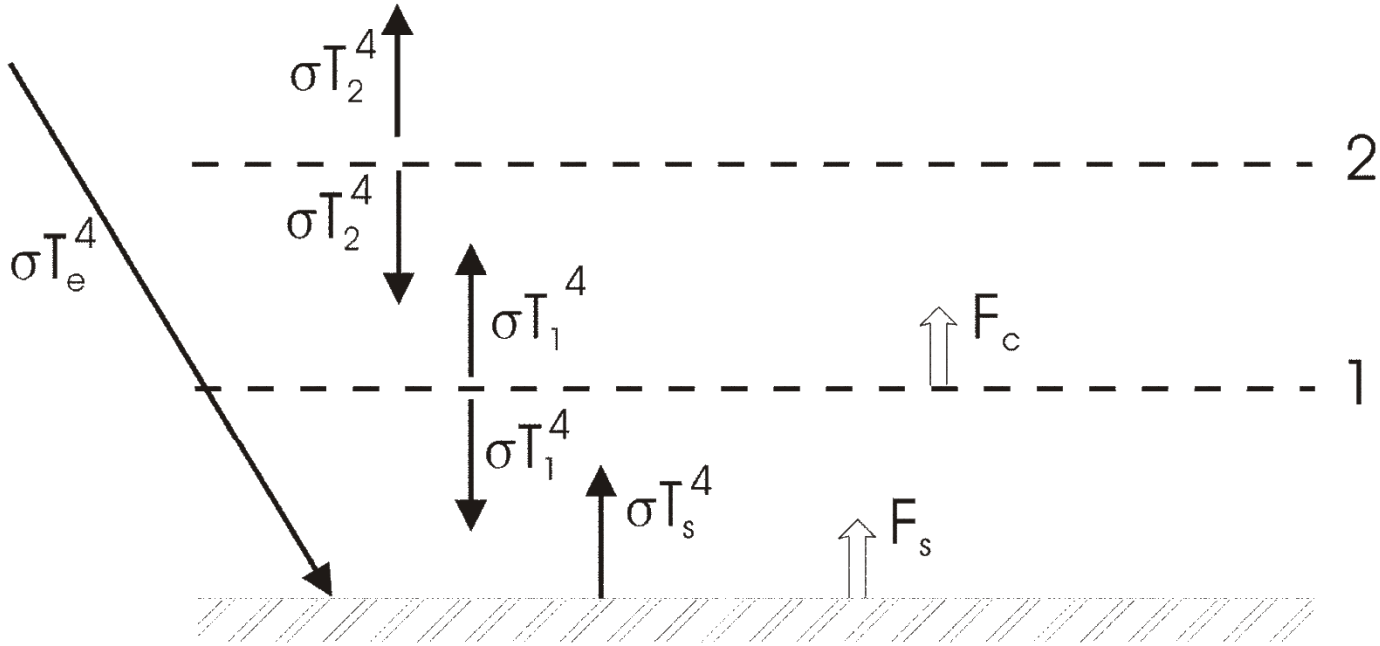
60 min



120 min


225
150
75
Temporal averaging (minutes)
0.2
0.4
0.6
0.8
1.0
1.2
0
5
10
15
20
25
30
Spatial averaging (Km)

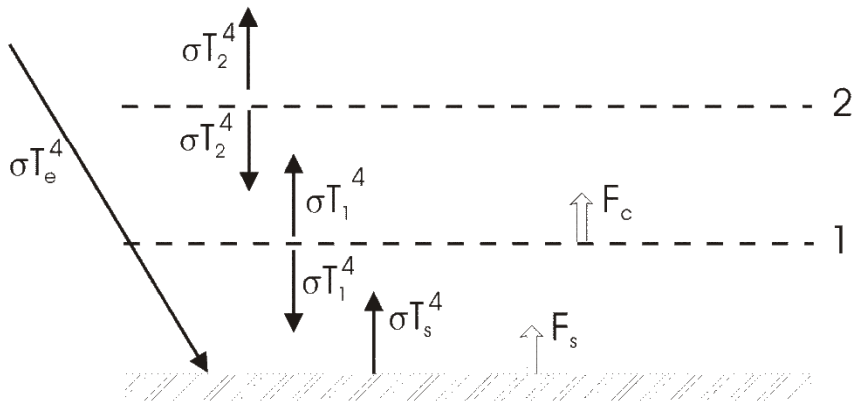
Simple Radiative-Convective Model



Enforce convective neutrality:

$$T_1 = T_2 + \Delta T,$$

$$T_s = T_2 + 2\Delta T$$



$$TOA: \quad T_2 = T_e \rightarrow T_1 = T_e + \Delta T, \quad T_s = T_e + 2\Delta T$$

$$Surface: \quad F_s + \sigma T_s^{\,4} = \sigma T_e^{\,4} + \sigma T_1^{\,4}$$

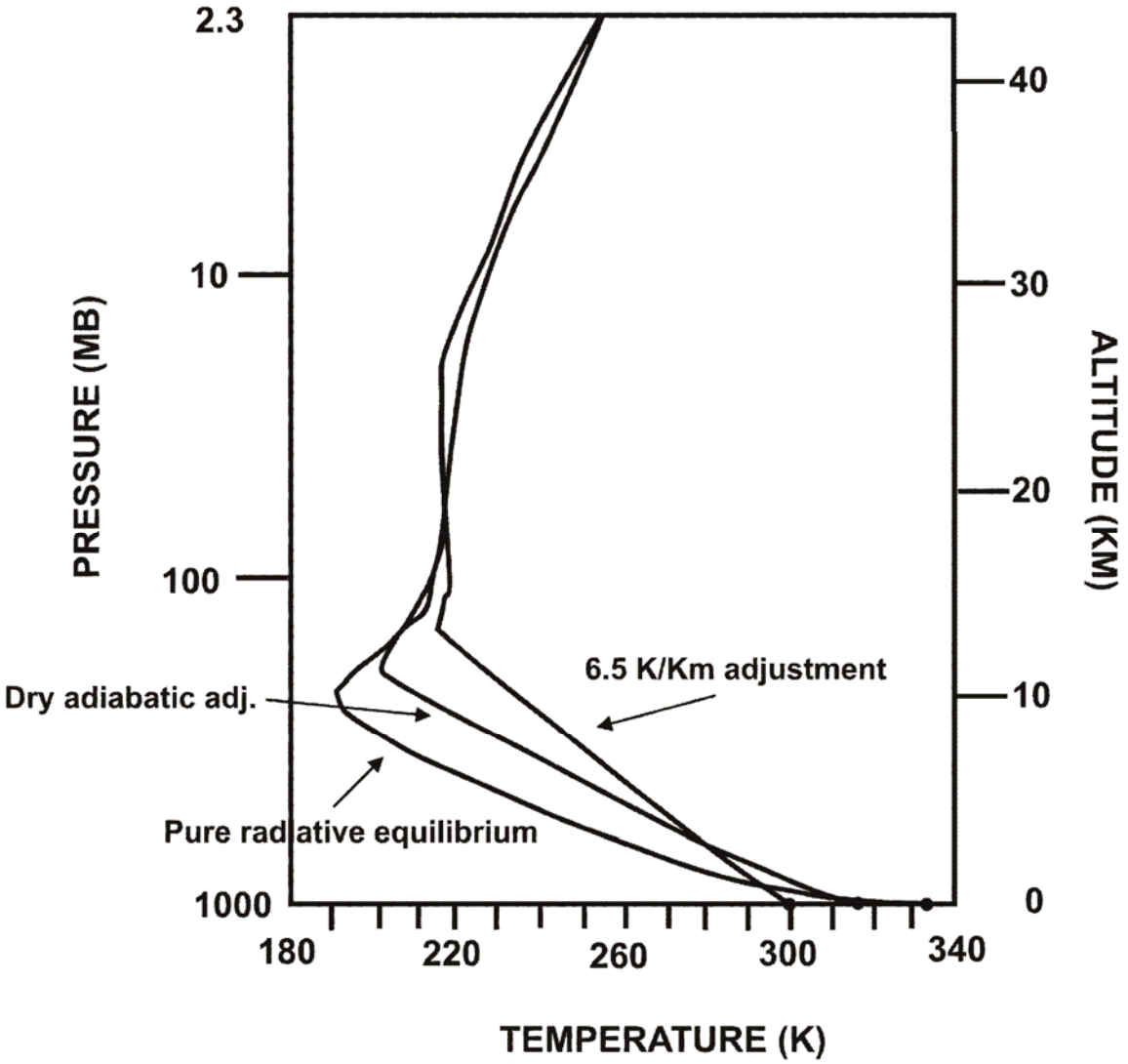
$$Layer\ 2: \quad 2\sigma T_e^{\,4} = \sigma T_1^{\,4} + F_c$$

$$Define \quad x \equiv \Delta T \Big/ T_e ,$$

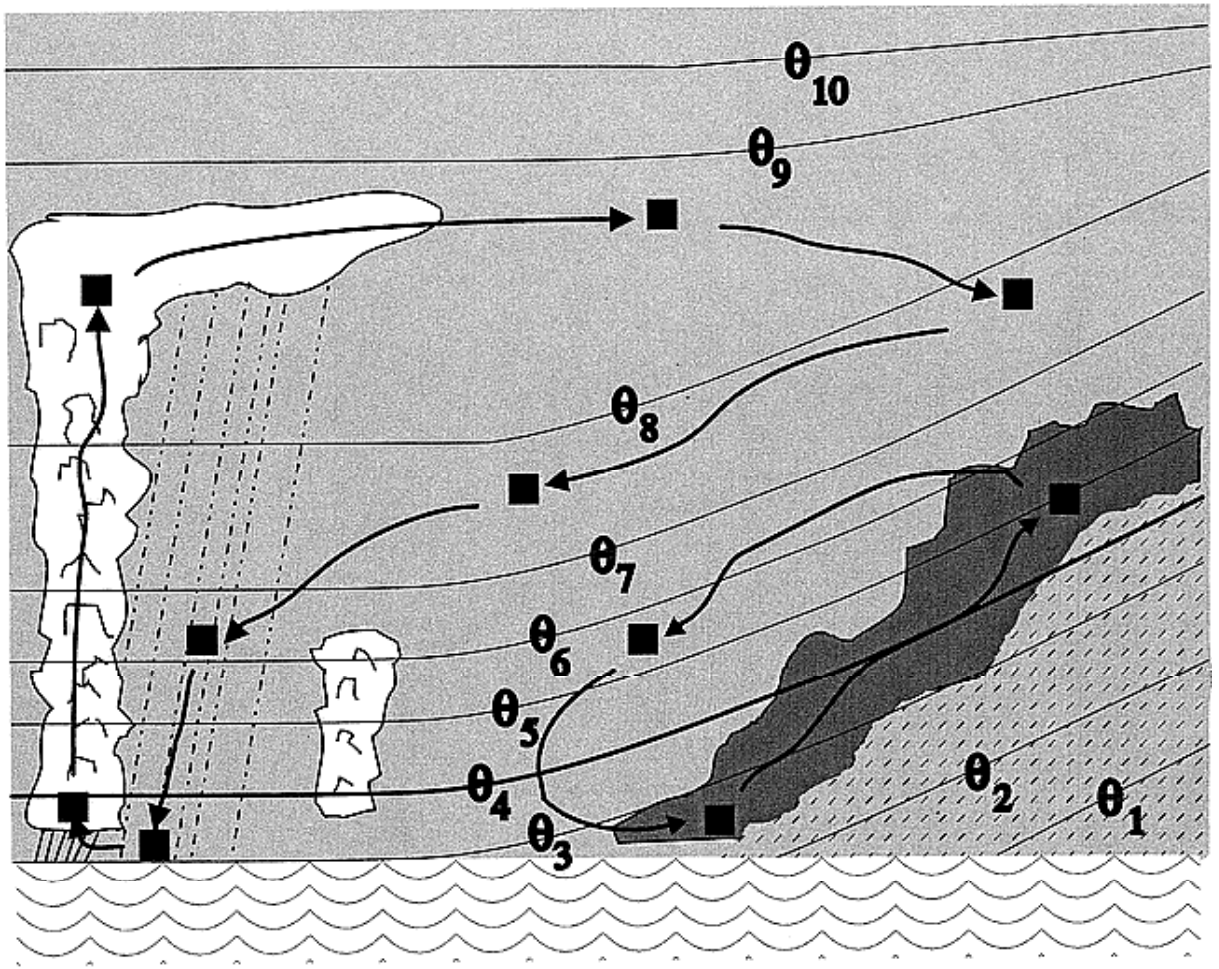
$$F_s = \sigma T_e^{\,4}\left[1+\left(1+x\right)^4 - \left(1+2x\right)^4\right],$$

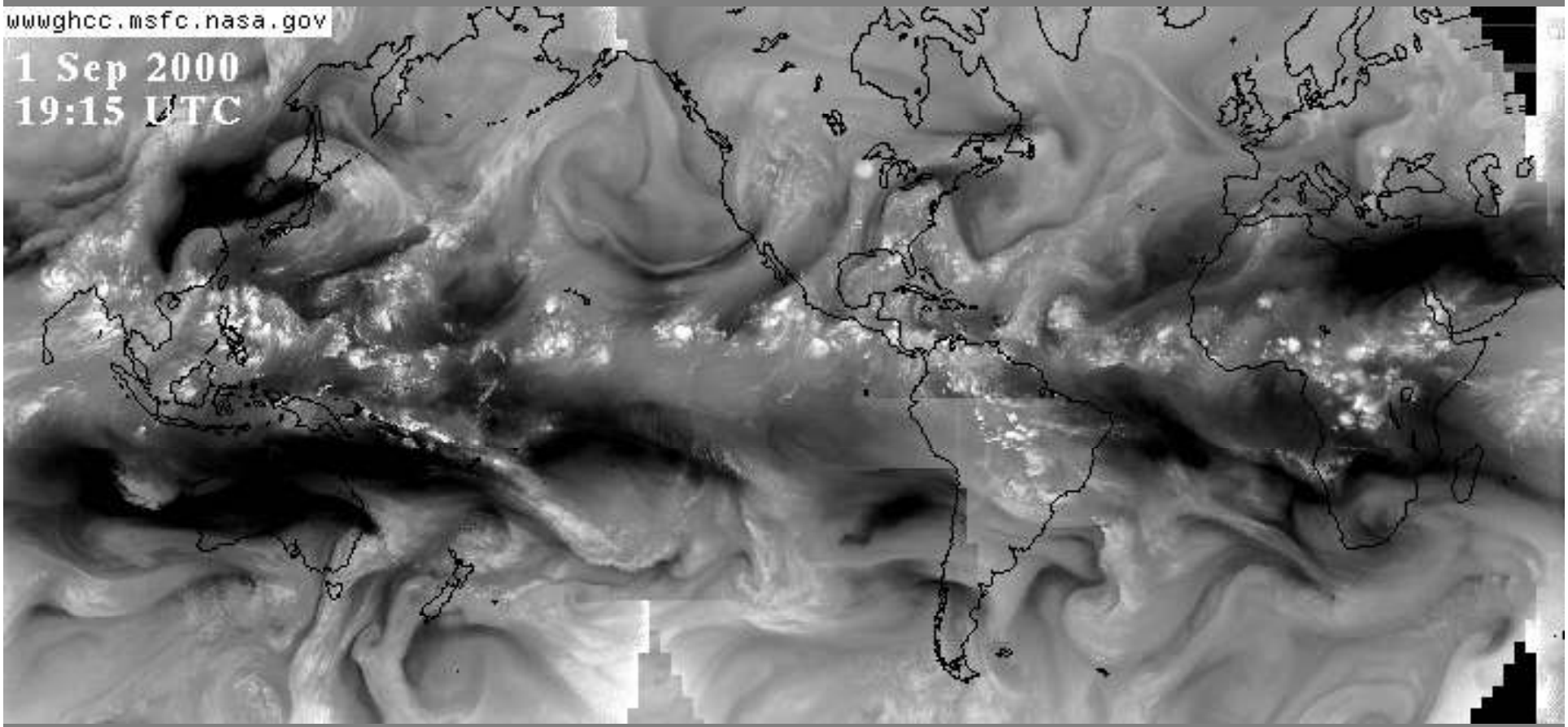
$$F_c = \sigma T_e^{\,4}\left[2-\left(1+x\right)^4\right]$$

Manabe and Strickler 1964 calculation:



Flux of water by convection makes real problem complex




wwwghcc.msfc.nasa.gov
1 Sep 2000
19:15 UTC

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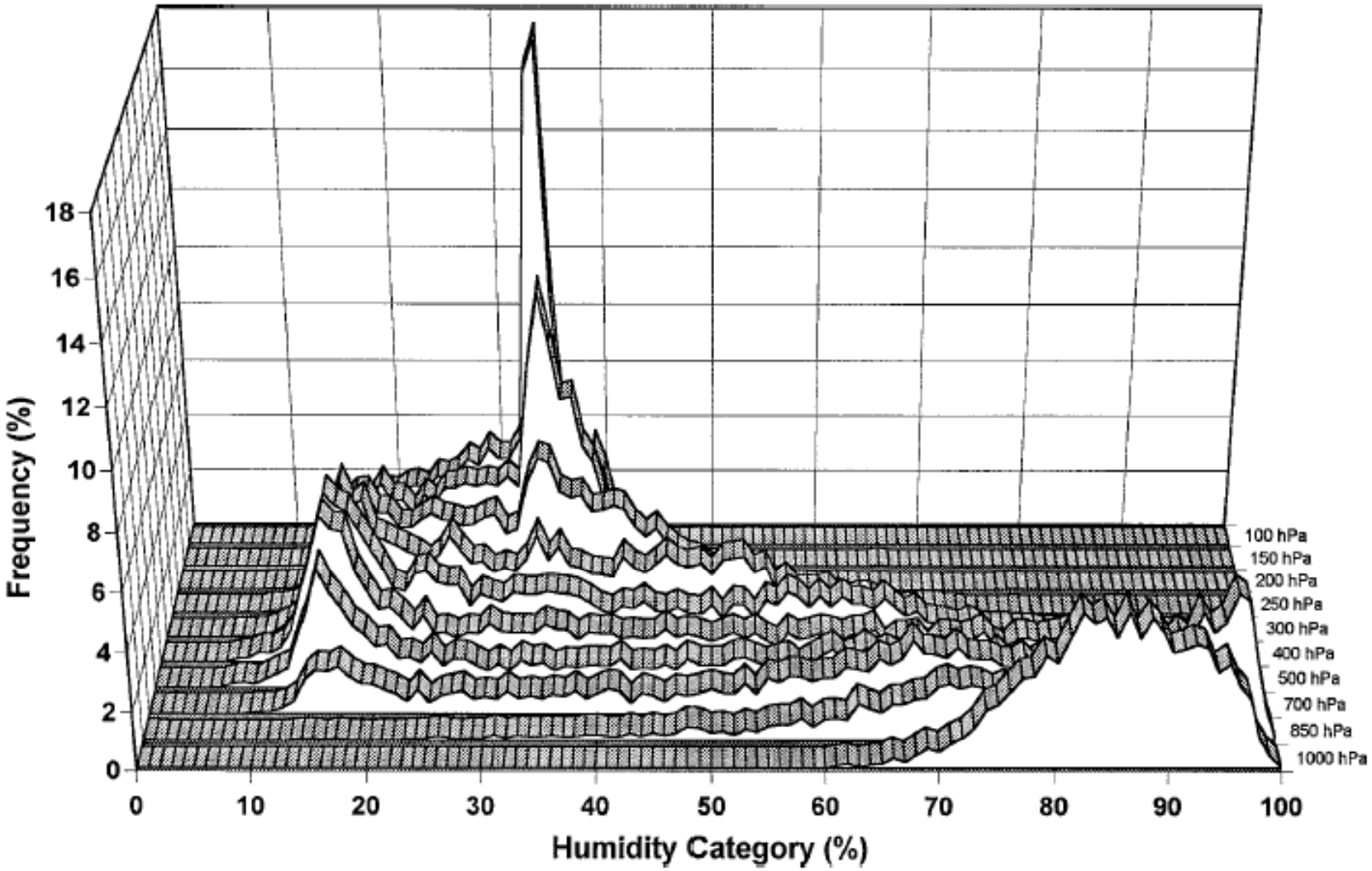
Frequency histogram of rawindsonde relative humidities from 1600 ascents at the tropical Pacific islands of Yap, Koror, Ponape and Majuro, January-May, 1994-95. Spencer and Braswell, *Bull. Amer. Meteor. Soc.*, 1997.



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