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ANALYSIS OF TETHERED BALLOON, CEILOMETER AND CLASS SOUNDING DATA TAKEN ON SAN NICOLAS ISLAND DURING THE FIRE PROJECT

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During the FIRE Marine Stratocumulus Program on San Nicolas Island, Colorado State University (CSU) and the British Meteorological Office (BMO) operated separate instrument packages on the NASA tethered balloon. The CSU package contained instrumentation for the measurement of temperature, pressure, humidity, cloud droplet concentration, and long and short wave radiation. Eight research flights, performed between July 7 and July 14, are summarized in the attached table. We have assigned an analysis priority to the July 7, 8, and 11 flights for the purposes of comparing the CSU and BMO data. Results will be presented at the conference.

In addition, CSU operated a laser ceilometer for the determination of cloud base, and a CLASS radiosonde site which launched 69 sondes. We are in the process of analyzing data from all of the above systems. Reports have so far been prepared on the ceilometer and on the CLASS sounding data (see attached references). According to the ceilometer record, 55 of the 69 CLASS soundings were released with stratocumulus overhead. For each of these 55 soundings we have determined the cloud top total water jump Δr as follows. We first compute the vertically averaged water vapor mixing ratio in the layer which extends from 60 m to 240 m above cloud top. We then subtract from this the average water vapor mixing ratio in the layer which extends from 65 m to 165 m above sea level (the island sounding site being 38 m above sea level). This water vapor mixing ratio difference should be equivalent to the cloud top jump in total water if the boundary layer is well-mixed. The procedure for determining $\Delta\theta_e$ is identical. In this way each of the fifty-five soundings was characterized by a point in the $(\Delta r, \Delta\theta_e)$ plane as shown in Fig. 1. As can be seen, 40 of the 55 points lie on the stable side of the Randall (1980) stability line (the line labeled $\Delta\theta_e = kL\Delta r/c_p$), and 15 lie on the unstable side. According to the ceilometer record, 7 of the unstable cases show cloud break-up within 12 hours while 4 of the stable cases show break-up within 12 hours. The cases exhibiting break-up are indicated in Fig. 1 by the partially blackened symbols, with the fraction of blackening indicating the fraction of 12 hours before cloud disappearance. The occurrence of partially blackened symbols on the stable side of the critical stability line indicates that cloud top evaporative instability is not the only mechanism for break-up. For further discussion the reader is referred to Kuo and Schubert (1988), who report on model experiments designed to understand the existence of persistent cloud decks with soundings which are unstable according to theory.

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DATE:	REMARKS:
July 7 1987	9.8 hours – daytime; launch at 07:45 PDT. BMO attach 6 packages as balloon is taken to about 2400 ft. BMO does four 68 minute runs while CSU package is above cloud. At 13:25 PDT CSU begins two soundings with 5 minute legs at each 300 ft level.
July 8 1987	6.5 hours – daytime; launch at 07:30 PDT. Four BMO packages deployed at 100 ft intervals just below CSU package. Four 20 minute constant level runs with packages near cloud top (which was about 935 mb). Balloon brought down in 200 ft steps with 20 minutes at each level.
July 9 1987	4.0 hours – daytime; launch at 08:31 PDT. Very deep cloud with top near 950 meters. Some drizzle. Flight shortened because BMO could not get highest package above cloud top. No turbulence data but good sounding data.
July 10 1987	10.0 hours – daytime; launch at 08:34 PDT. Very deep boundary layer (1000 meters) so BMO stands down in light of previous day. CSU package steps upward in 300 ft intervals with 20 minutes at each level. Many 15 minute legs at 50 ft intervals near cloud top on descent.
July 11 1987	9.5 hours – evening; launch at 13:35 PDT. Some difficulty in getting the balloon above cloud top. BMO deploys 6 packages but takes the lowest one off. BMO does two 64 minute runs. CSU then steps down with eleven 20 minute legs.
July 12 1987	1 hour – night time; launch at 03:40 PDT. BMO put on four packages. At about 930 mb slack suddenly developed in the cable and everything was brought down in a hurry.
July 13 1987	11.5 hours – daytime; launch at 09:20 PDT. Only CSU is operating today. Cloud top near 960 mb. Ran about 16 twenty minute legs in the cloud layer and 9 in the subcloud layer.
July 13–14 1987	6.5 hours – night time; launch at 21:45 PDT without BMO. Low cloud top still. Performed 20 constant level legs in the boundary layer.

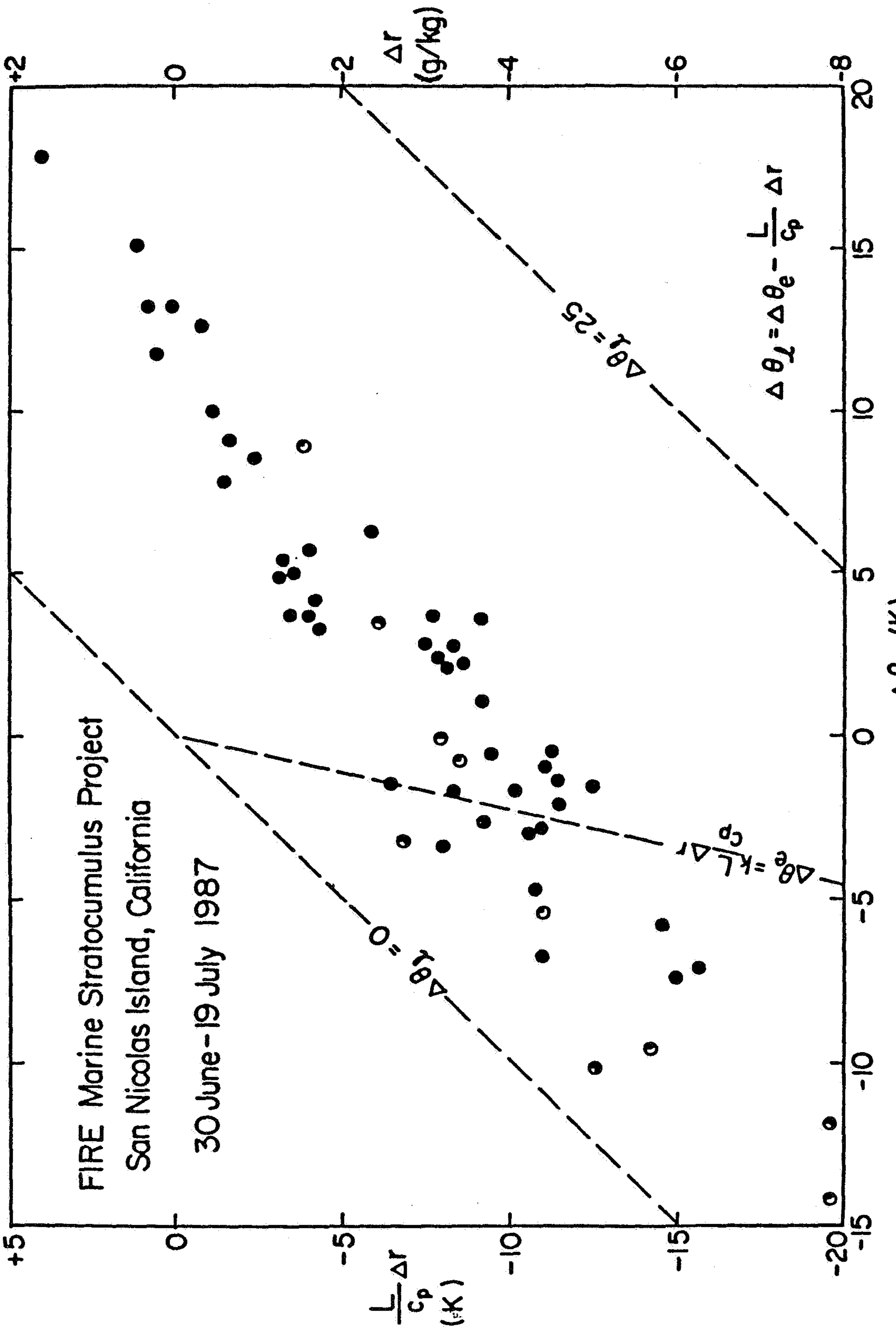
FIRE Marine Stratocumulus Project
San Nicolas Island, California
30 June-19 July 1987
$\Delta\theta_l = 25$
$\Delta\theta_l = 0$
$\Delta\theta_e = k\frac{L}{c_p}\Delta r$
$\Delta\theta_l = \Delta\theta_e - \frac{L}{c_p}\Delta r$
$\Delta\theta_e$ (K)
$\frac{L}{c_p}\Delta r$ (K)
Δr (g/kg)
-15
-10
-5
0
5
10
15
20
+5
-20
+2
-2
-4
-6
-8

Figure 1