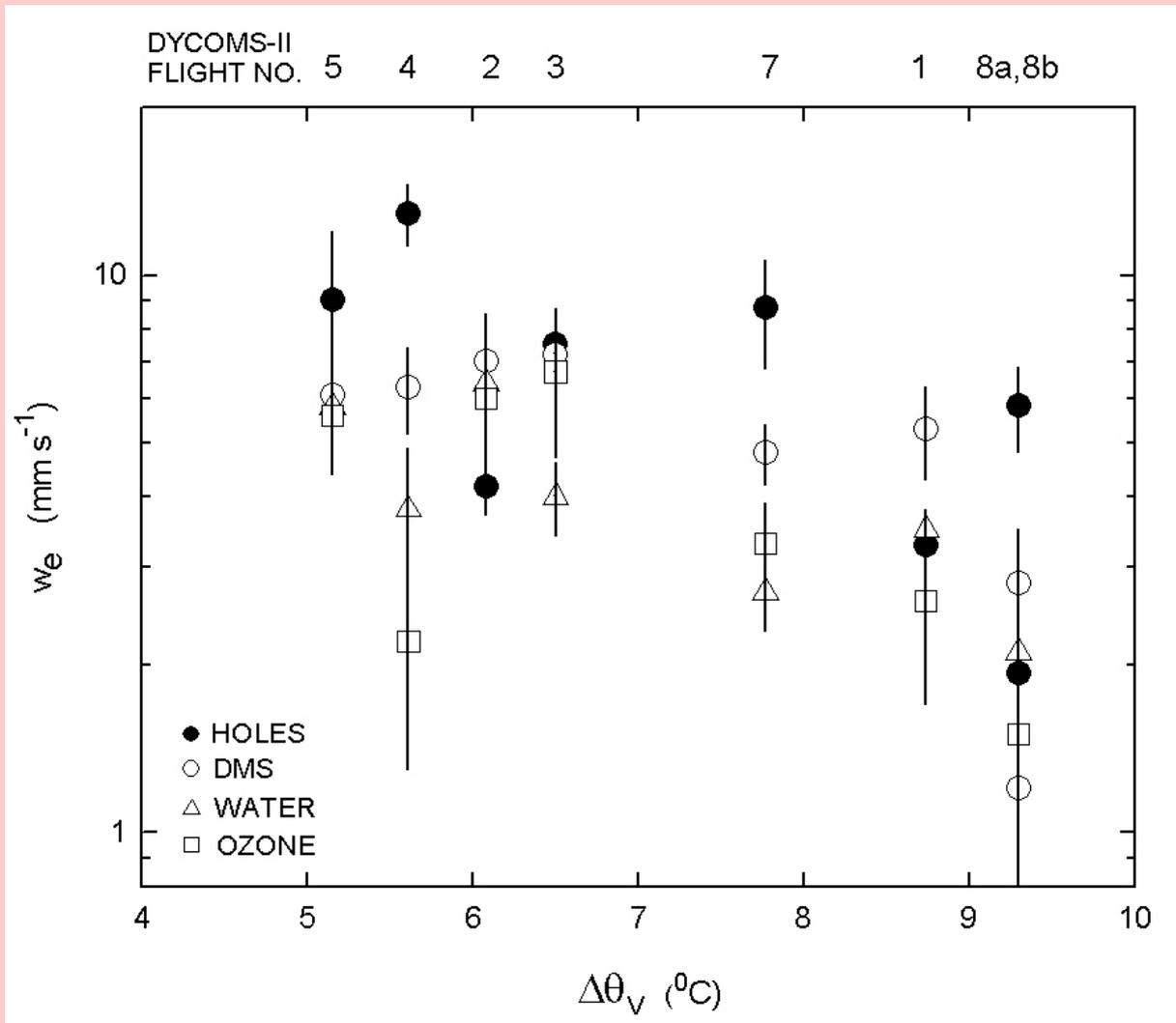


# ENTRAINMENT VELOCITY vs BUOYANCY JUMP



# ENTRAINMENT VELOCITY, $w_e$

## Method

## Eqn.

## Definitions

Difference

$$w_e = \frac{dz_i}{dt} - W$$

$dz_i/dt$  = change of cloud top height  
 $W$  = mean subsidence velocity

Flux-Jump

$$w_e = \frac{\overline{w'\phi'}}{\Delta\phi}$$

$w'\phi'$  = flux of scalar at inversion base  
 $\Delta\phi$  = jump of scalar across inversion

Conditional-Sampling

$$w_e = \frac{A_h}{A_t} \frac{\overline{w' \times (\phi_f - \phi_h)}}{\Delta\phi}$$

$A_h$  = cloud top area with holes  
 $A_t$  = total cloud top area  
 $\phi_f$  = scalar in unaffected cloud  
 $\phi_h$  = scalar in cloud hole

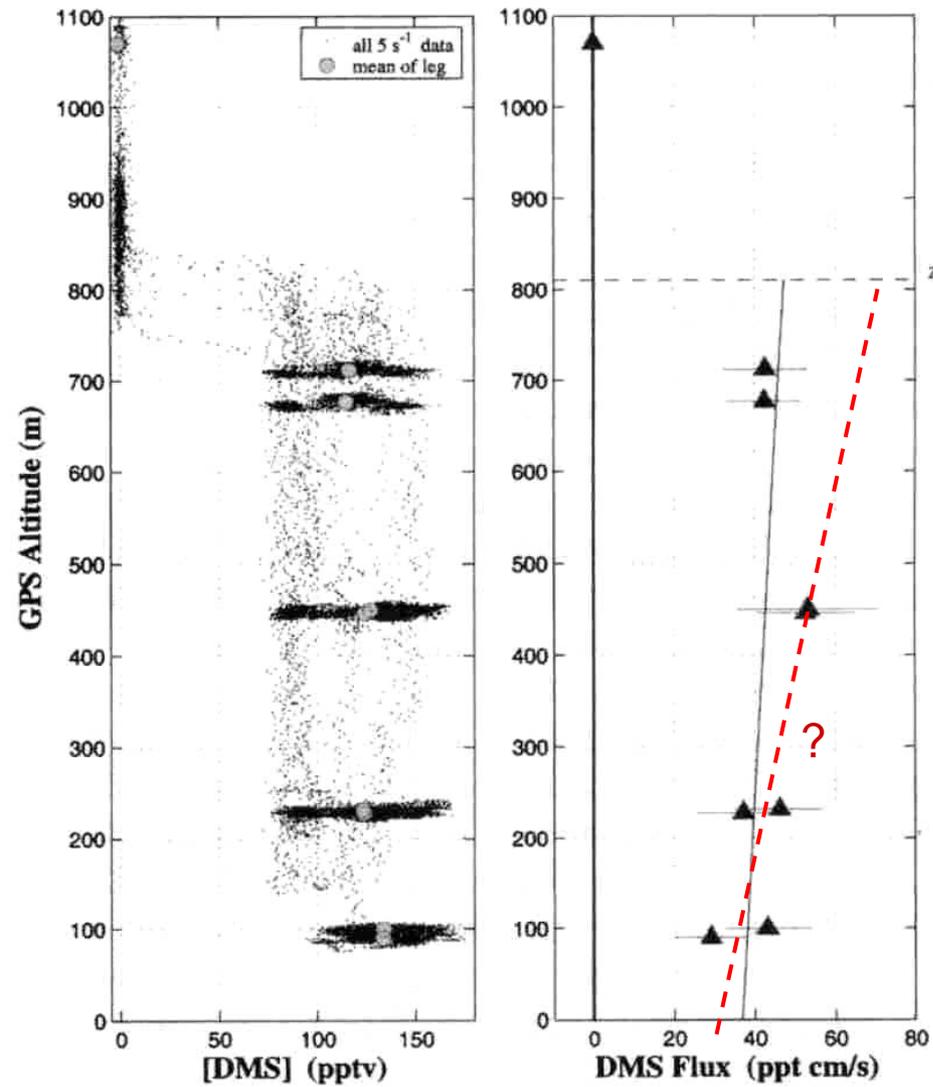


FIG. 2. As in Fig. 1 but for DMS.

(Faloona, et al., 2005: J. Atmos. Sci., 62, 3268-3285)



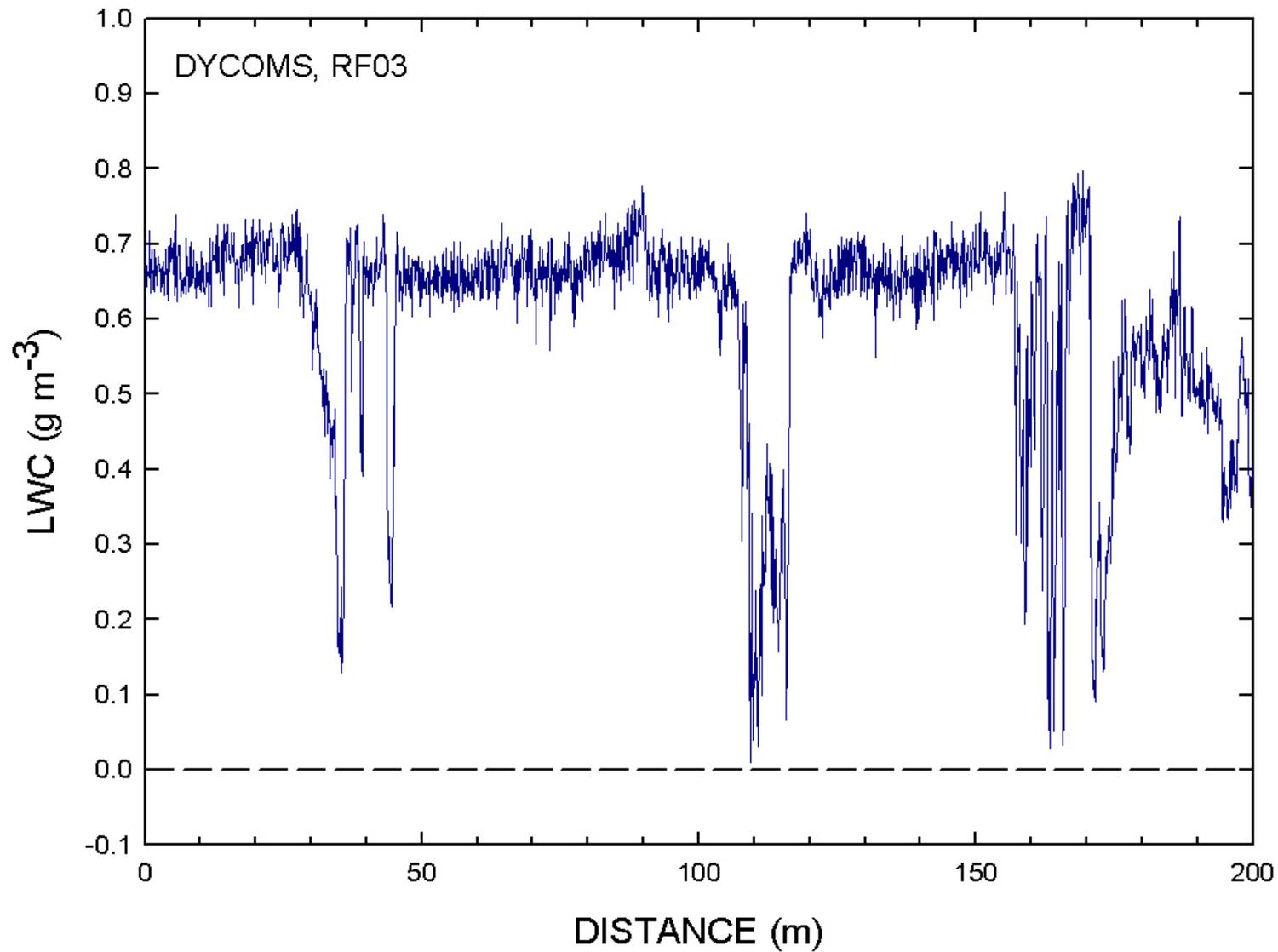
TABLE 3. Concentration  $N$  of holes, percentage  $p$  of cloud-free air, and fractional cloud area  $A_r$  containing holes for the flight legs at  $z_a$ . The entrainment velocity  $w_e^*$  at  $z_a$  depends on the listed hole fluxes and total water jump at cloud top.

Flight	$N$ ( $\text{km}^{-1}$ )	$p$ (%)	$A_r$	$\Delta q_r \times \rho$ ( $\text{g m}^{-3}$ )	$\langle w' \rangle$ ( $\text{m s}^{-1}$ )	$\langle w' \times \text{LWC}' \rangle$ ( $\text{g m}^{-2} \text{s}^{-1}$ )	$\langle w' \times q'_v \times \rho \rangle$ ( $\text{g m}^{-2} \text{s}^{-1}$ )	$w_e^*$ ( $\text{mm s}^{-1}$ )
RF01	10.0	0.43	0.208	-8.86	-0.102	0.0351	0.0375	-1.93
RF02	11.3	4.78	0.284	-8.94	-0.287	0.0395	0.0327	-2.58
RF03	7.3	0.30	0.167	-8.04	-0.344	0.0662	0.0333	-2.46
RF04	5.7	$\approx 0$	0.101	-4.44	-0.544	0.0659	0.0304	-2.41
RF05	12.8	4.15	0.337	-8.09	-0.230	0.0315	0.0373	-3.24
RF06		$\approx 0$	0.135	-4.38	-0.345	0.0590	0.0162	-2.62
RF07	6.2	$\approx 0$	0.118	-6.31	-0.575	0.0803	0.0482	-2.72
RF08*	11.7	0.55	0.218	-7.06	-0.130	0.0137	0.0107	-0.87
RF08**	7.2	0.87	0.151	-7.06	-0.321	0.0421	0.0271	-1.70
RF09*	9.5	3.16	0.177	-10.6	-0.100	0.0110	0.0006	-0.17
RF09**	11.6	0.29	0.219	-10.6	-0.237	0.0387	0.0040	-1.02

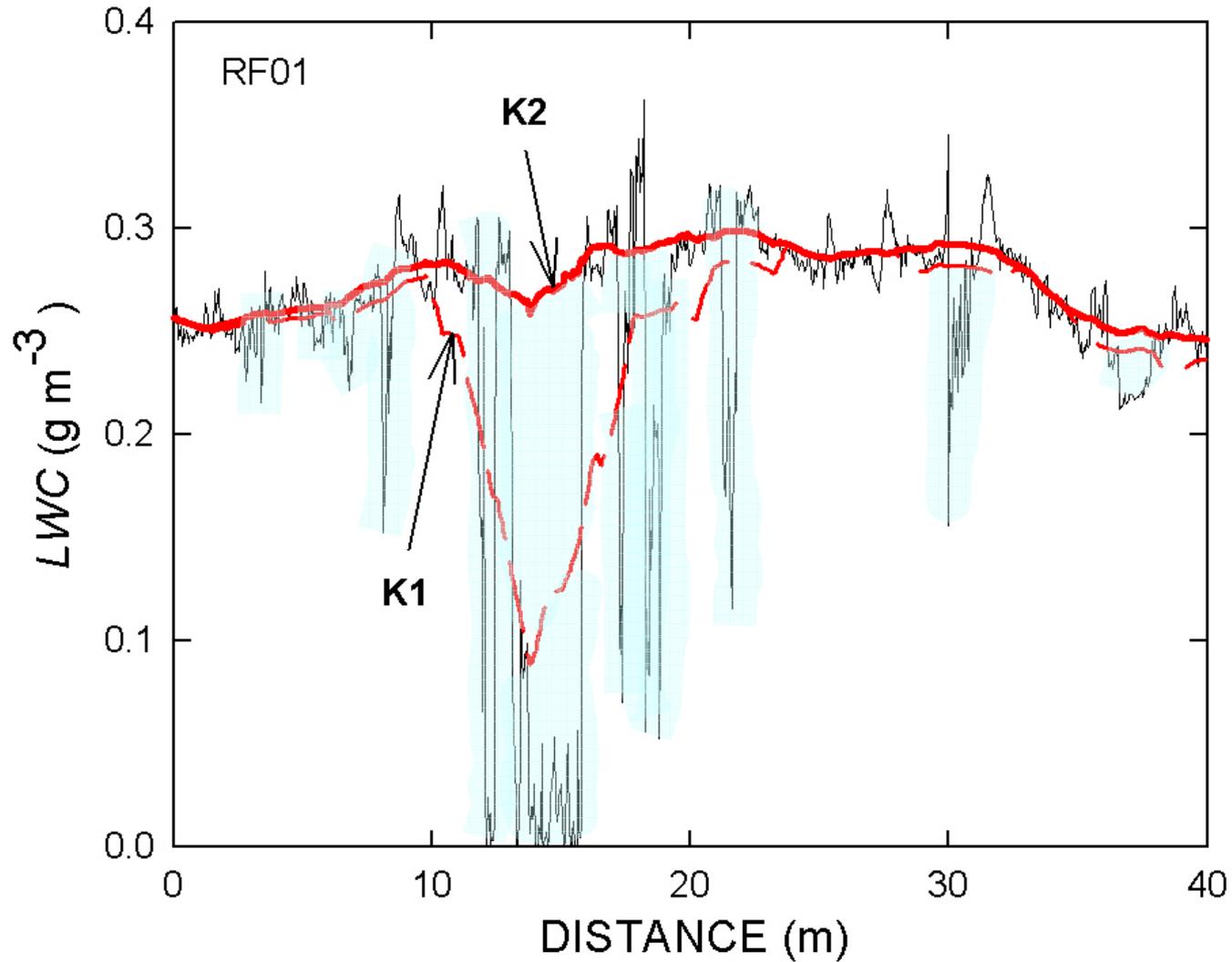
\* Afternoon flight segment.

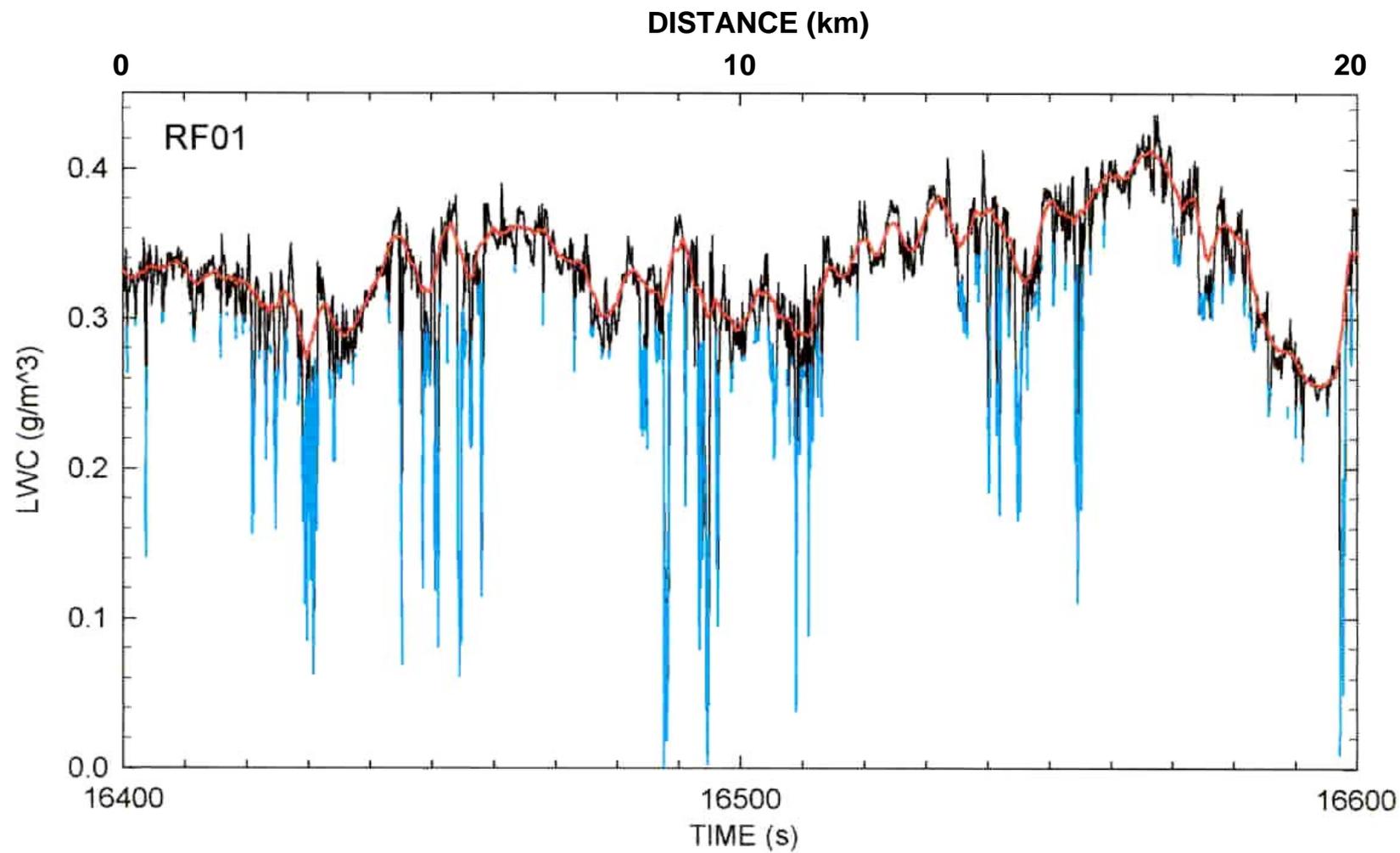
\*\* Evening flight segment.

# CLOUD HOLES

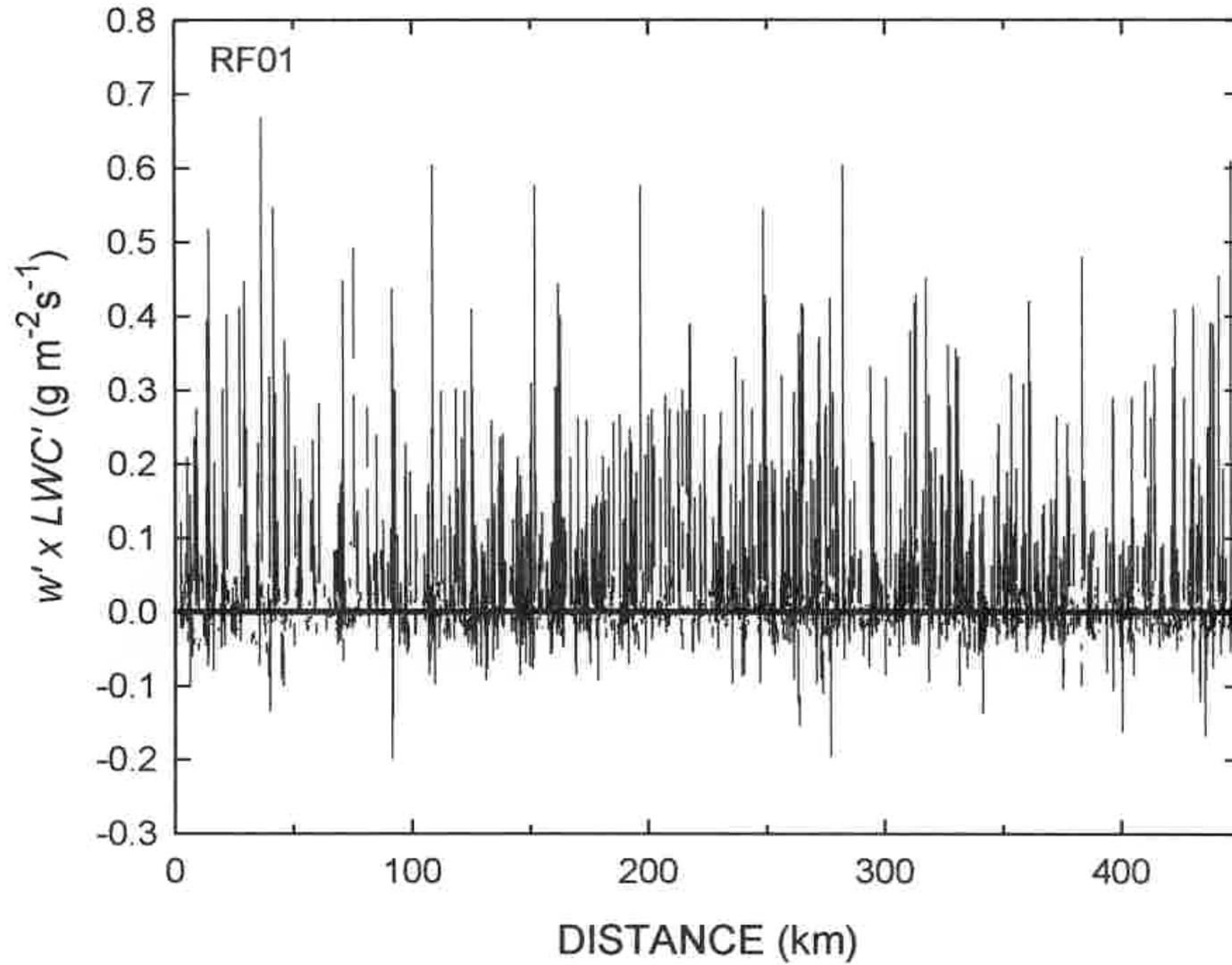


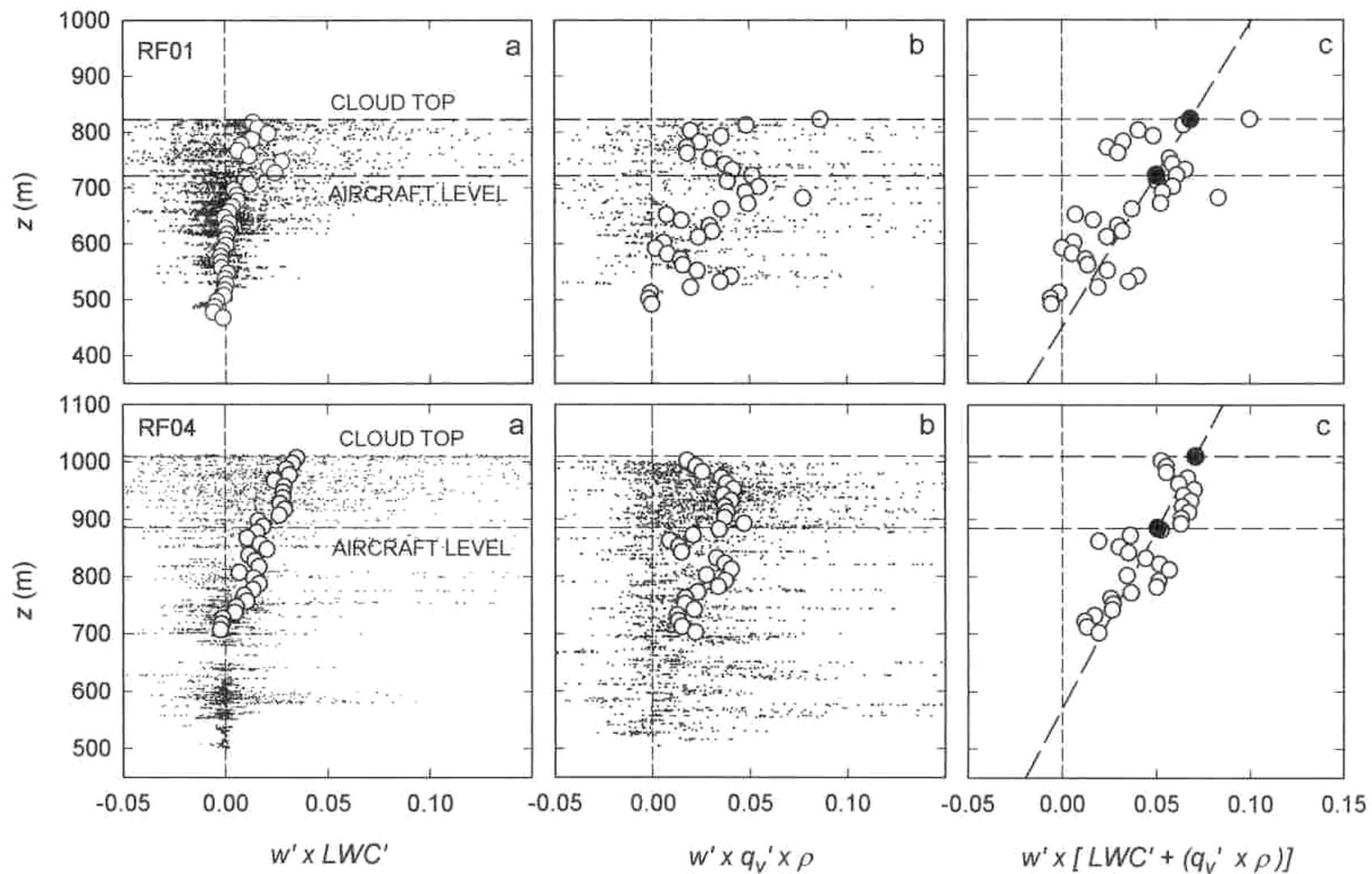
## CONDITIONAL SAMPLING OF CLOUD HOLES

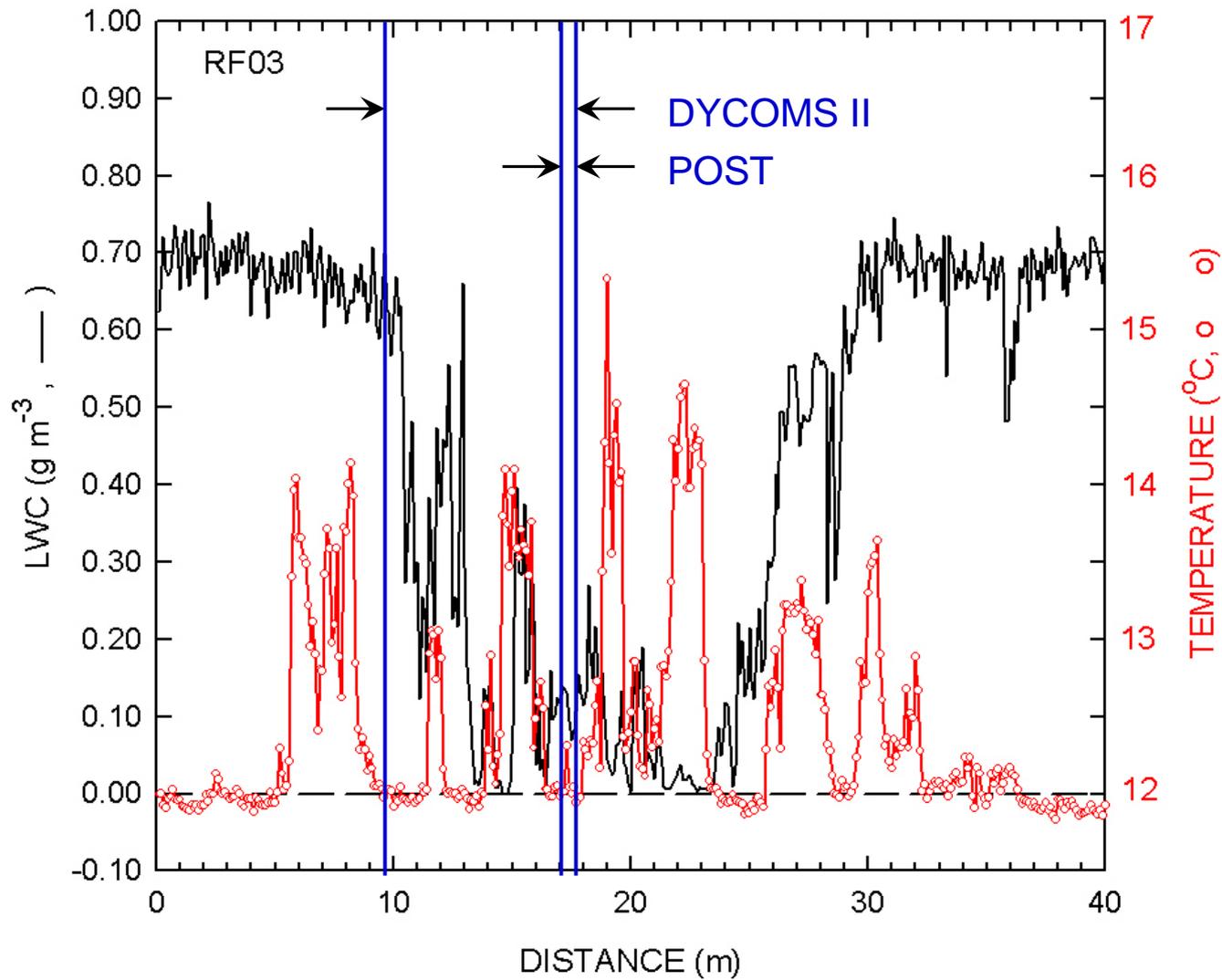


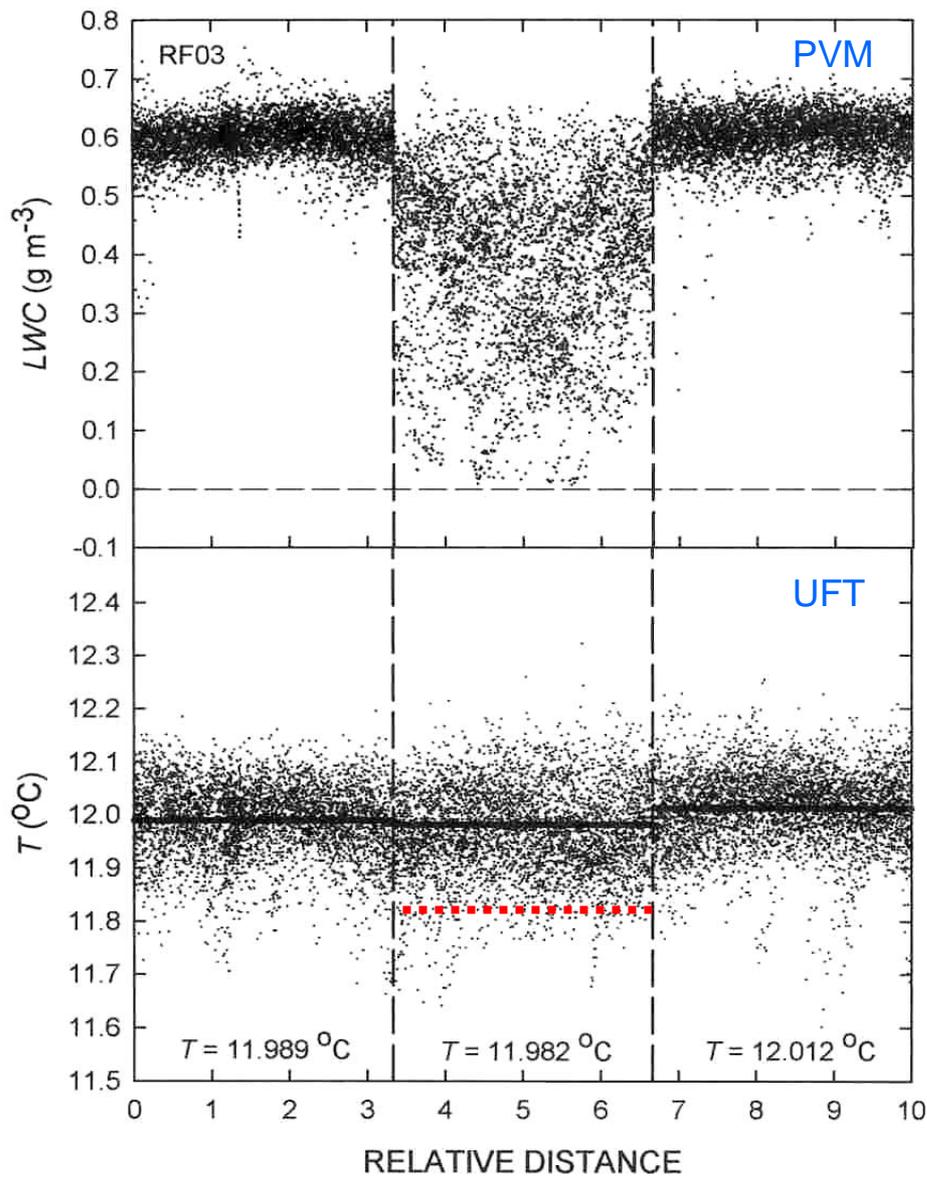


# DEPLETED $LWC'$ FLUX









CONDITIONALLY  
SAMPLED CLOUD  
HOLES WITH  
*LWC' AND T'*

$$T' = -0.018 \text{ } ^\circ\text{C}$$

Fig. 17 - Composite of 1000-hz conditionally-sampled *LWC* and temperature data in cloud holes from the aircraft porpoising section at cloud top for RF03. The hole lengths are normalized to the same relative distance bordered by the vertical dashed lines.

