Flight report

Research Flight RF13
ATR-2024-0826a
SAFIRE flight as24035
Sal (SID-SID), 12:35 - 16:00 UTC

PI: **Sandrine Bony**

26 August 2024 a

1 Objectives

- Sampling of a transition from shallow to deep convection
- Sampling of the Northern edge of the ITCZ!
- First measurements in deep convective clouds

2 Cal/Val activity: No

3 Crew

SAFIRE	Name	Lab
Pilot (CDB)	Guillaume Seurat	SAFIRE
Pilot (OPL)	Dominique Duchanoy	SAFIRE
Mechanics	Thierry André	SAFIRE
Expé Principal	Hubert Bellec	SAFIRE
Expé	Claude Lainard	SAFIRE
SCIENTISTS		
PI seat	Sandrine Bony	LMD
LNG seat	Kevin Huet	LATMOS
aWALI seat	Frédéric Laly	LSCE
Microphys seat 1	Pierre Coutris	LAMP
Microphys seat 2	Alfons Schwarzenboeck	LAMP
RASTA seat	Julien Delanoë	LATMOS
BASTA seat	Emmeline François	LATMOS

4 Synoptic situation

- African Easterly Wave (AEW) was passing over Sal on Aug 26, and presumably because of this, the Northern edge of the ITCZ was very high in latitude.
- Presence of a dry layer and a temperature inversion at the top of the boundary layer.
- The flight followed a NW-SE transect associated with a strong gradient in precipitable water (crossing the 48 mm isoline) and heading towards a line of deep convection associated with the through of the AEW. The line was also associated with very weak winds (doldrums). AROME and IFS support the idea that this line of deep convection corresponds to the Northern edge of the ITCZ.
- The Northern part of the ATR transect was associated with shallow convection, including a spectrum of shallow clouds ranging from very shallow ones to deeper precipitating and turbulent clouds topping between 1.2 and 2 km.
- The extremity of the ATR transect was located in between two deep convective systems classified by MSG as 'rapidly developing storms' and topping (according to RASTA and MSG) at 14 km!
- The Saharian Aerosol Layer was present between 2 and 3.5 km.

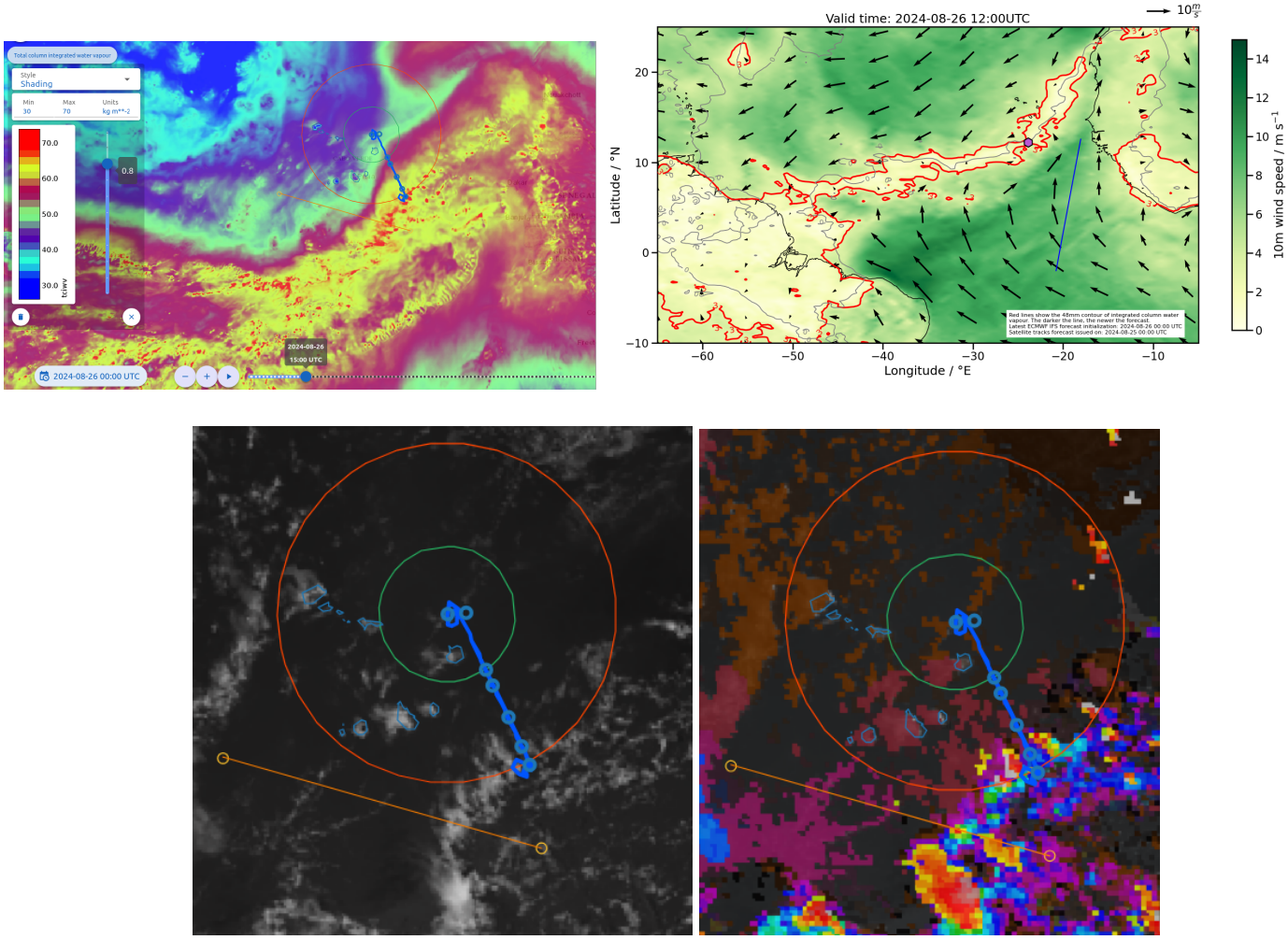

Figure 1: Top: Precipitable water predicted by AROME (the transect intersects the 48 mm isoligne) and Bottom: MSG imagery (left: Visible, right: cloud top height) on Aug 26 2024, 15:00 UTC.

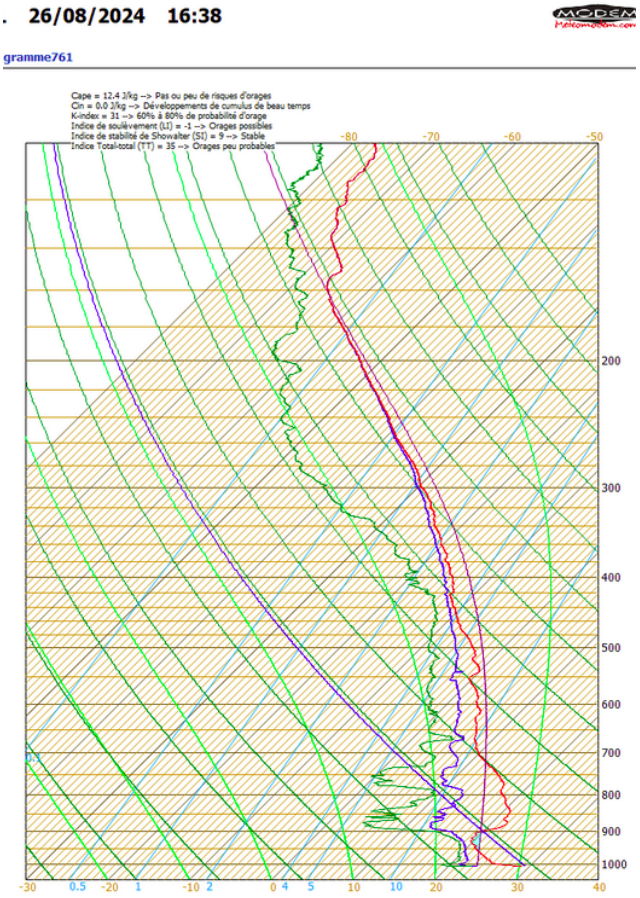

Figure 2: Sal radiosounding of 1600.

5 Flight elements

- MAESTRO flight pattern South-East of Sal
- WP1: 16°46'51"N 22°43'51"W ; WP2: 15°05'N 21°55'W
- The subcloud layer leg (500 ft) was extended Southward beyond WP2 (XX NM) in the hope to reach the area of deep convection (WP2bis). As a result, the legs at cloud-base were shorter than usual (?? NM) and covered only the Southern part of the transect. When being back at WP2bis, the ascent was made slightly off track within or as close as possible to a deep convective cloud. When it was not possible to fly within it, we flew around it (short straight segments with the system on the right hand side of the aircraft to be viewed by the horizontal remote sensing). Then the high-level leg (FL220) took place at a temperature of about -10^{o}C.
- The cloud base level was between 600 and 650 m. It was adjusted one or two times. Drizzle and rain were measured down to the surface.
- During the ascent in the (rapidly developing) deep convective system, up to 3 g/m^3 were measured by in-situ probes and ice columns were seen by the 2D-S. The 0^{o}C isotherm was around 550 hPa (4.8 km). Icing conditions around -2 ^{o}C. During the ascent, RASTA measured cloud tops at 14 km and BASTA detected hydrometeors up to 19 km! AWALI penetrated within ice clouds over 1 or 1.5 km.
- During the mid-tropospheric leg, significant anomalies of temperature ($\pm$ 0.5^{o}C) and water vapor were measured in clear-sky (gravity waves?). When AWALI detected clouds at this altitude, water vapor anomalies were noticed around them.

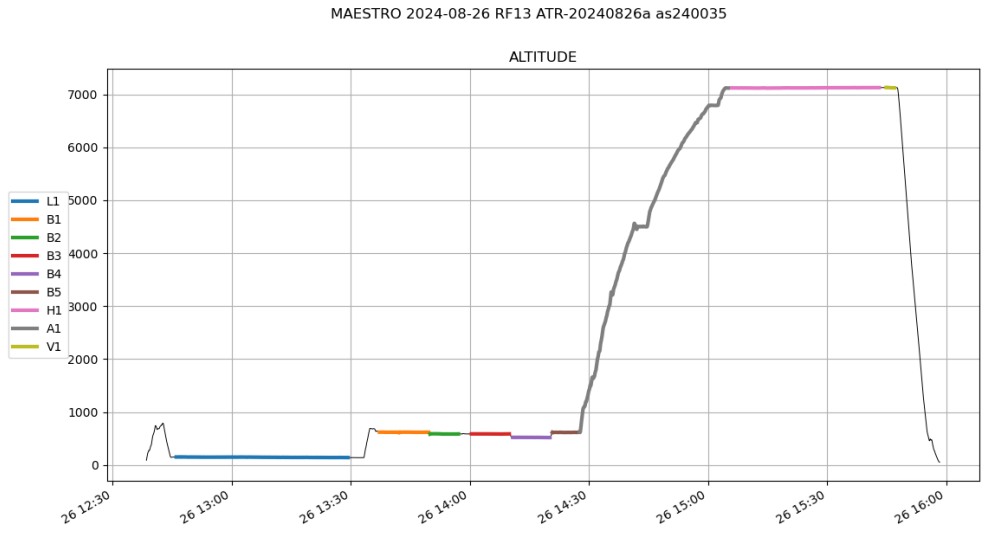

Figure 3: Flight segmentation of the ATR-20240826a flight (also named RF13 or as24035). Note that this segmentation corresponds to the yaml file but the segmengation presented in the table is simplified.

RF13 elements	Time (UTC)	Flight Level (FL)	Position	Notes
Takeoff	12:38		GVAC	
L1	12:46 – 13:29	500 ft	WP1 (N) → WP2bis (S)	Subcloud (145 m)
B1	13:37 – 13:56	618-585 m	WP2bis (S) → WP1bis	Cloud base
B2	13:57 – 14:27	520-614 m	WP1bis → WP2bis (S)	Cloud base
A1	14:27 – 15:05	ascent to FL220	WP2bis (S)	Within convective clouds
H1	15:05 – 15:43	FL220	WP2bis (S) → WP1 (N)	Mid-troposphere
V1	15:44 – 15:47	FL220 (7.2 km)	WP1 (N)	VAD (roll: 26 deg)
Landing	15:58		GVAC	

6 Quicklooks and Comments

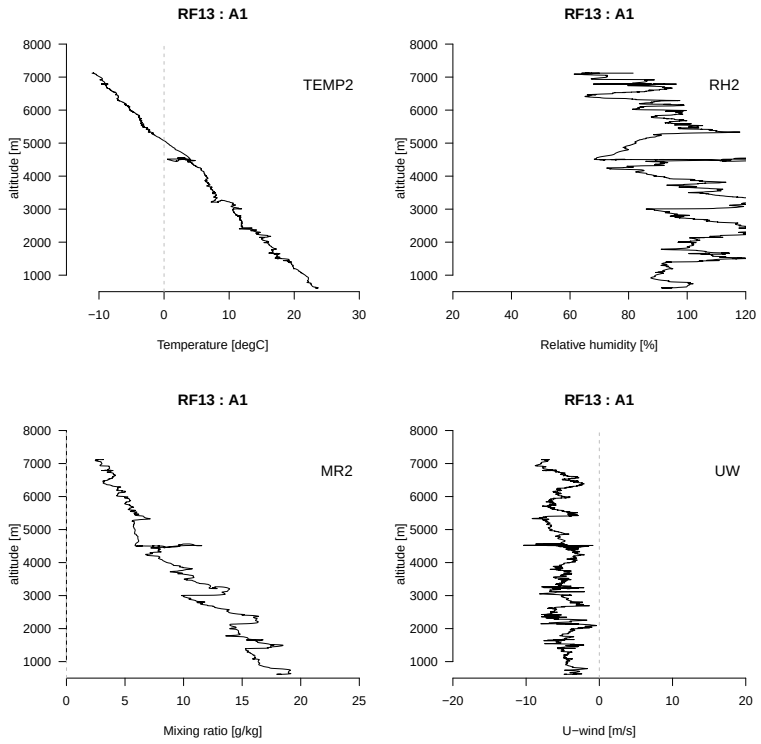

Figure 4: Vertical profiles of temperature, humidity mixing ratio, relative humidity and zonal wind measured by in-situ sensors during the ascent of the ATR from cloud base to FL220 (in the immediate vicinity of a convective system).

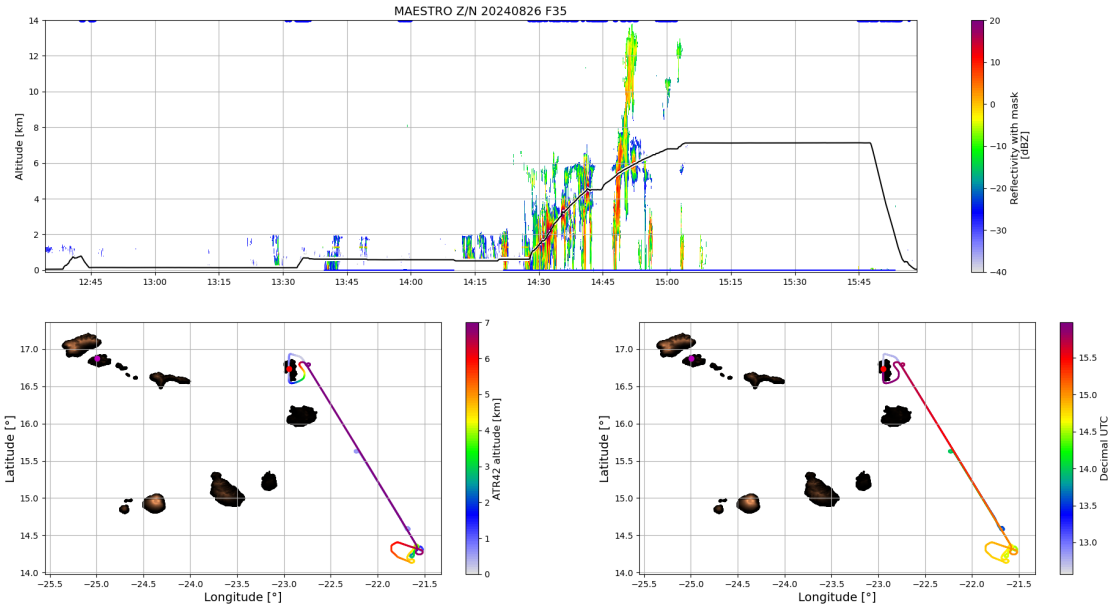

Figure 5: Radar reflectivity measured by the vertically-pointing RASTA Doppler cloud radar (courtesy Julien Delanoë).

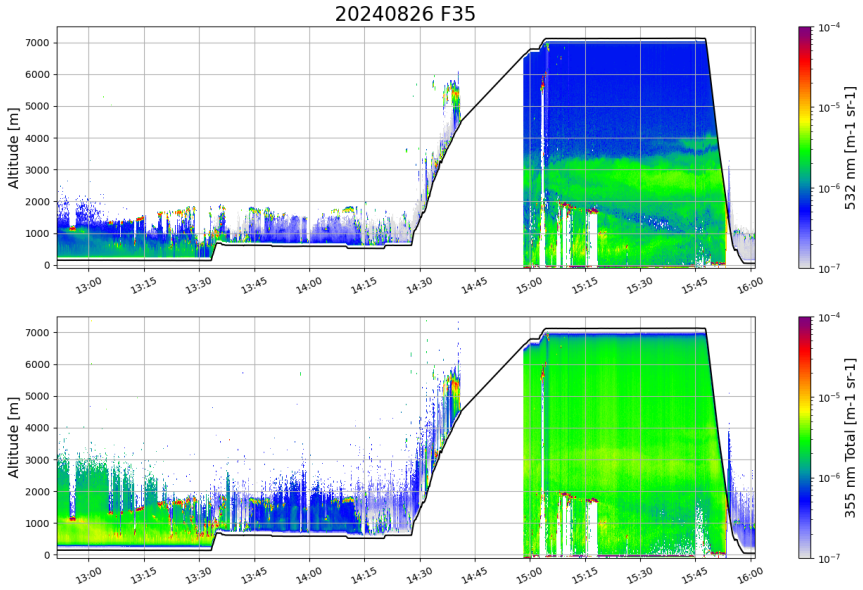

Figure 6: Backscatter signal measured at 355 nm and 532 nm by the vertically-pointing- HSRL Doppler lidar LNG (courtesy RALI team).

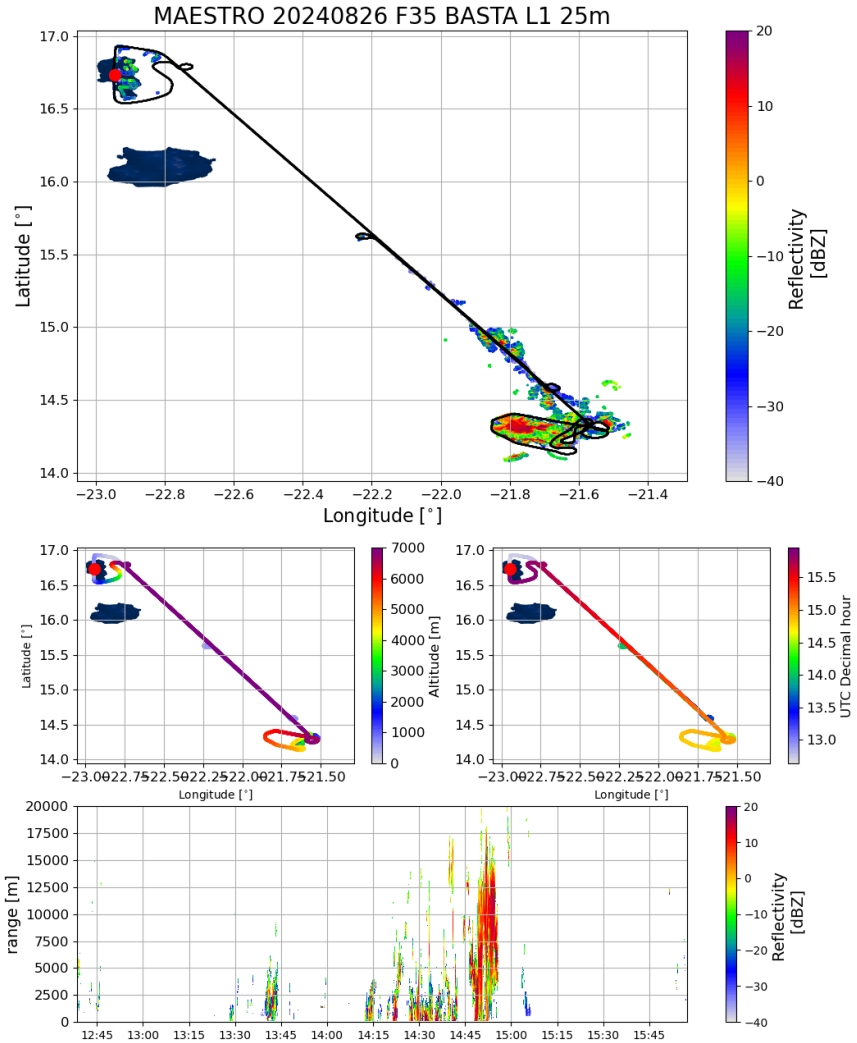

Figure 7: Radar reflectivity measured by the horizontally-pointing BASTA Doppler cloud radar (courtesy Julien Delanoë). Note that the radar used the 25m resolution mode on this flight.

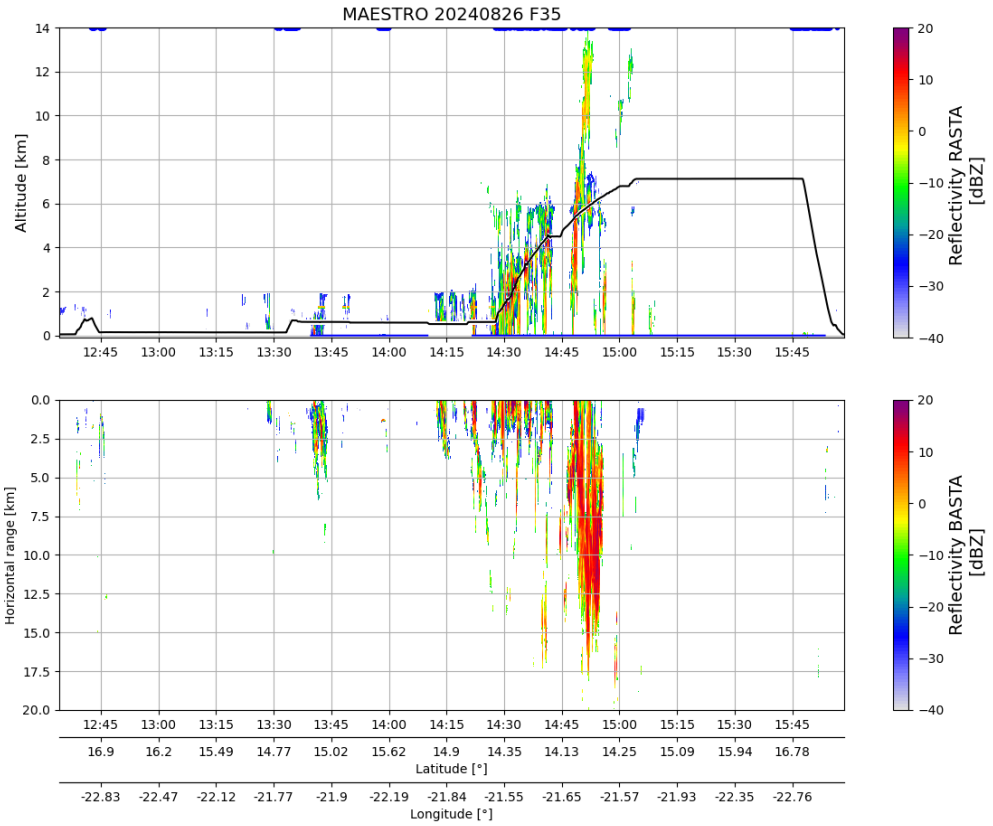

Figure 8: Radar reflectivity measured by the vertically-pointing radar RASTA and the horizontally-pointing radar BASTA (courtesy Julien Delanoë).

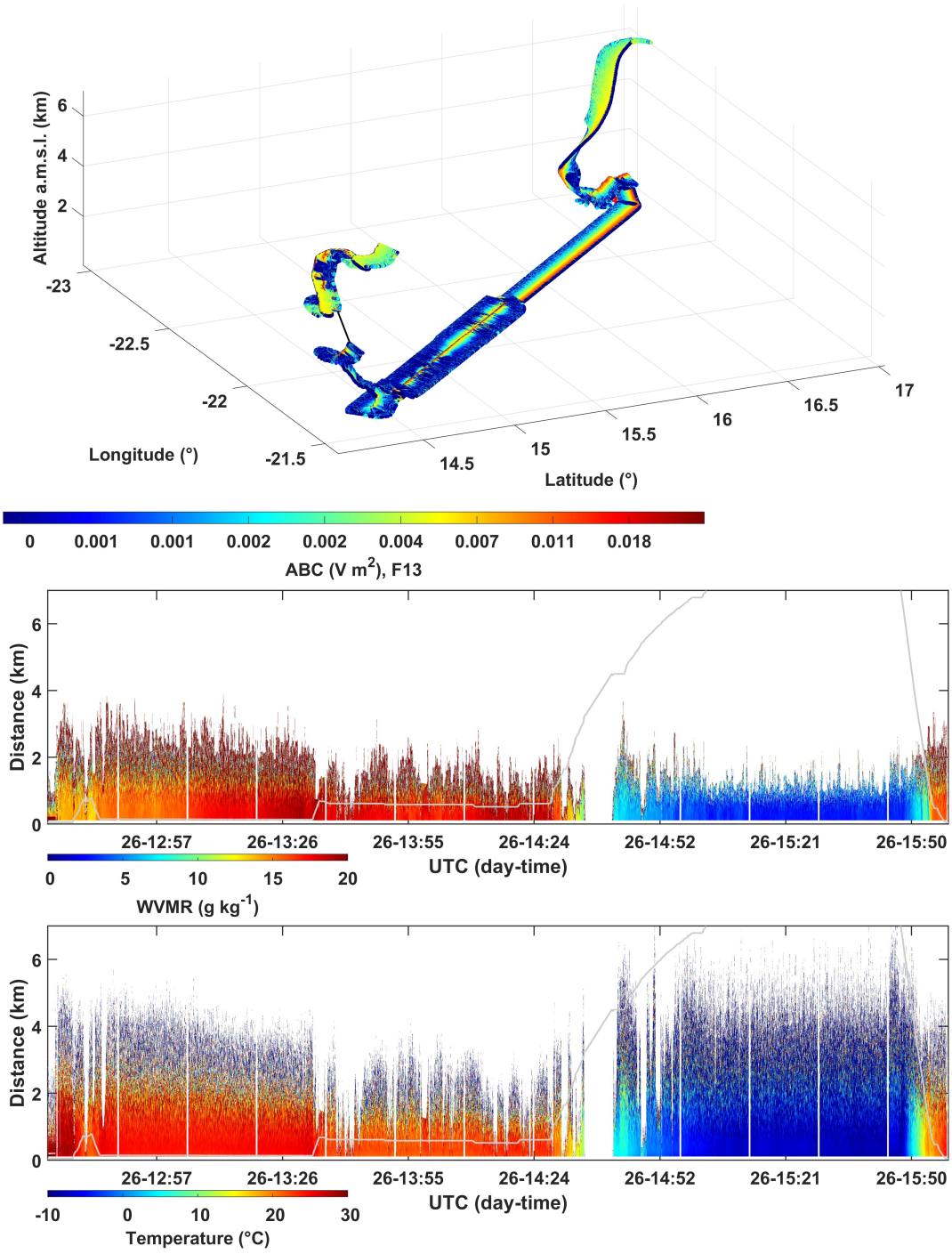

Figure 9: (Top left) Evolution of lidar backscatter ratio in the aerosol/cloud channel; (Top right) Vertical profile of the aerosol extinction, and (Bottom) 2D variation of the elastic backscatter signal, and the water vapor mixing ratio (stripes will be removed after processing) and temperature measured by the horizontally-pointing Raman lidar AWALI during RF11. (courtesy Frédéric Lally).

7 Instrument status

DATA	SAFIRE_name	DESCRIPTION	PARAMETER	STATUS	COMMENT
NAV	pos_lat_imu_1	Latitude from AIRINS	LATITUDE	OK	-
	pos_lon_imu_1	Longitude from AIRINS	LONGITUDE	OK	-
	alt_alt_imu_1	Altitude from AIRINS	ALTITUDE	OK	-
	nav_track_imu_1	Course	COURSE	OK	-
	att_thead_imu_1	True Heading	THEAD	OK	-
	att_roll_imu_1	Platform Roll angle	ROLL	OK	-
	att_pitch_imu_1	Platform Pitch angle	PITCH	OK	-
	vit_v_n_imu_1	Platform North speed	VN	OK	-
	vit_v_e_imu_1	Platform Eastward speed	VE	OK	-
	vit_v_w_imu_1	Vertical speed	VV	OK	-
	vit_v_gs_imu_1	Ground speed	GS	OK	-
RAD	ray_rg_down_1	Downwelling Shortwave radiation clear dome (no attitude correction)	SWD	OK	
	ray_rg_down_crsensor_1	Downwelling Shortwave radiation clear dome- Attitude correction for pitch/roll $<\pm 3°$	SWDC	OK	
	ray_pir_down_1	Downwelling Shortwave radiation red dome (no attitude correction)	SWD_RED	OK	
	ray_pir_down_crsensor_1	Downwelling shortwave radiation red dome-Attitude correction for pitch/roll $<\pm 3°$	SWDC_RED	OK	
	ray_rg_up_1	Upwelling Shortwave radiation clear dome (no attitude correction)	SWU	OK	
	ray_pir_up_1	Upwelling shortwave radiation red dome (no attitude correction)	SWU_RED	OK	
	ray_ir_down_1	Downwelling longwave radiation (no attitude correction)	LWD	OK	-
	ray_ir_up_1	Upwelling longwave radiation (no attitude correction)	LWU	OK	-
	ray_tb_ce332_c1_1	Brightness temperature channel1 (8.7μm) ce332 radiometer	TB_C1	OK	-
	ray_tb_ce332_c2_1	Brightness temperature channel2 (10.6μm) ce332 radiometer	TB_C2	OK	-
	ray_tb_ce332_c3_1	Brightness temperature channel3 (12μm) ce332 radiometer	TB_C3	OK	-
	ray_lum_ce332_c1_1	Radiance, channel1 (8.7μm) from ce332 radiometer	RAD_C1	OK	-
	ray_lum_ce332_c2_1	Radiance channel2 (10.6μm) from ce332 radiometer	RAD_C2	OK	-
	ray_lum_ce332_c3_1	Radiance channel3 (12μm) from ce332 radiometer	RAD_C3	OK	-
TDYN	pre_ps_av1_1	Static pressure corrected for flow distorsion	PRES	OK	-
	vit_v_dp2_crs_1	Dynamic pressure corrected for flow distorsion	DYNP	OK	-
	vit_v_p_av1_1	True Air Speed	TAS1	OK	reference
	vit_v_tas_adc_1	True Air Speed	TAS2	OK	-
	alt_ralt_15_m_1	Height	HEIGHT	OK	ok under 17900 ft
	att_aoa_radom_deg_1	Angle of Attack	AOA_RAD	OK	-
	att_aos_radom_deg_1	Angle of Sideslip	AOS_RAD	OK	-

DATA	SAFIRE_name	DESCRIPTION	PARAMETER	STATUS	COMMENT
	ven_wind_v_vp_imu_1	Upward Wind	WW	OK	maybe small offset (0,1 m/s)
	ven_wind_FF_vp_imu_1	Horizontal Wind Speed	WS	OK	reference
	ven_wind_DD_vp_imu_1	Horizontal Wind Direction	WD	OK	reference
	ven_wind_FF_simp_1	Horizontal Wind Speed WITHOUT Radome angles, with non-deiced Air Static Temperature	WS_RAW	OK	-
	ven_wind_DD_simp_1	Horizontal Wind Direction WITHOUT Radome angles, with non-deiced Air Static Temperature	WD_RAW	OK	-
	tpr_ts_rt_1	Air Static Temperature, non-deiced sensor	TEMP1	OK	reference
	tpr_ts_rtd_1	Air Static Temperature, deiced sensor	TEMP2	OK	-
	tpr_tt_rt_1	Total Temperature, non-deiced sensor	TTEMP1	OK	reference
	tpr_tt_rtd_1	Total Temperature, deiced sensor	TTEMP2	OK	-
	tpr_tp_rt_1	Potential Temperature	THETA	OK	-
	hum_hutd_1011_sync_1	Dew Point Temperature 1011C	DP1	OK	oscillations
	hum_hutd_wvs_rs_1	Dew Point Temperature from WVSSII	DP2	OK	reference
	hum_hutd_rtd_aero_1	Dew Point Temperature from humaero enviscope	DP3	OK	-
	hum_humr_1011_rs_1	Water Vapor Mixing ratio from 1011C	MR1	OK	
	hum_humr_wvs_rs_1	Water Vapor Mixing ratio WVSSII	MR2	OK	
	hum_humr_srtd_aero_1	Water Vapor Mixing ratio from humaero enviscope	MR3	OK	
	hum_huabs_rt_1011_1	Abolute Humidity from 1011C	HABS1	OK	
	hum_huabs_wvs_rs_1	Abolute Humidity from WVSSII	HABS2	OK	
	hum_huabs_srtd_aero_1	Abolute Humidity from enviscope	HABS3	OK	
	hum_hurel_rt_1011_rs_1	Relative Humidity from 1011C	RH1	OK	
	hum_hurel_wvs_rs_1	Relative Humidity from WVSSII	RH2	OK	
	hum_hurel_stat_rt_aero_1	Relative Humidity from enviscope	RH3	OK	
	ctl_CTL_P_CABINE_1	Cabin Pressure	P_CABIN	OK	
	ctl_CTL_T_CABINE_1	Cabin Temperature	T_CABIN	OK	
LWC	lwc_lwc300_rebase005_1	LWC calculation according to DMT PADS Hotwire LWC	LWC2	OK	-
FW	hum_humolfra_fw_crh_100	Mole fraction of water vapour in air measured by FastWave	FW_MOLFRA	OK	-
	hum_humr_fw_100	Water Vapor Mixing ratio from FastWave	MR6	OK	-
	pre_pb_fw_100	Air Pressure measured by FastWave	FW_P	OK	-
	tpr_tt_fw_100	Temperature measured by FastWave	FW_T	OK	-
OZONE	chm_cc_o3_2b_ppb_RS_cal_%10	O3 2493DB OzoneMonitor mixing ratio	O3_MONITOR2	OK	-
	chm_cc_o3_2b_ppb_anlg_%10	O3 2493DB OzoneMonitor concentration analogical	O3_MONITOR2_ANALOG	OK	-
	ctl_CTL_CELL_T_2B_RS_cal_%10	O3 2493DB OzoneMonitor cell temperature	TCELL_MONITOR2	OK	-
	ctl_CTL_CELL_P_2B_RS_cal_%10	O3 2493DB OzoneMonitor cell presure	PCELL_MONITOR2	OK	-

DATA	SAFIRE_name	DESCRIPTION	PARAMETER	STATUS	COMMENT
	ctl_CTL_VOLFR_2B_RS_cal_%10	O3 2493DB OzoneMonitor volumetric flow rate	VOLFLRATE_MONITOR2	OK	-
SPP300	mic_tabcount_SPP300_1	SPP300 particles count bin[1]...bin[30]	SPP300_COUNT	PB	no data above 4200 m
	mic_somcount_SPP300_1	SPP300 total particles count	SPP300_TCOUNT	PB	no data above 4200 m
	mic_tabconc_SPP300_1	SPP300 particles concentration bin[1]...bin[30]	SPP300_CONC	PB	no data above 4200 m
	mic_totalconc_SPP300_1	SPP300 Total particles concentration	SPP300_TCONC	PB	no data above 4200 m
UHSAS	mic_tabcount_uhsas_sync_1	UHSAS particles count	UHSAS_COUNT	OK	-
	mic_somcount_uhsas_sync_1	UHSAS total particles counts	UHSAS_TCOUNT	OK	-
	mic_tabconc_second_uhsas_sync_1	UHSAS Particles concentration	UHSAS_CONC	OK	-
	mic_totalconc_uhsas_sync_1	UHSAS total particles concentration	UHSAS_TCONC	OK	-
	ctl_sample_flow_uhsas_sync_1	UHSAS sample flow	UHSAS_FLOW	OK	-
	ctl_sheath_flow_uhsas_sync_1	UHSAS sheath flow	UHSAS_SHEATH	OK	-
REMOTE	RASTA	Cloud radar (Up and down)	Z, V, Doppler spectrum	OK	
	BASTA	Cloud radar (sidewards)	Z, V, Doppler spectrum	OK	
	LNG	Lidar (Up or Down)	Backscatter(355nm/532/1064) – HSRand Doppler 355nm	OK	15 min without data during H leg
	aWALI	Raman Lidar (sidewards)	Backscatter and inelastic(RH/Temp)	OK	Npenetration in ice clouds; only 2-3 min without data
MICRO	CVI		TWC	OK	
	HSI			PB	Did not work during ice clouds..
	2DS		Images and Spectrum	OK	
	HVPS	Hydrometeors imagery	Images	OK	
	FCDP	Droplets (2?m - 50?m)	Spectrum	OK	
	NP-2			OK	