# Flight report

Research Flight RF04
ATR-2024-0813b
SAFIRE flight as240026
Sal (SID-SID), 19:15 - 22:30 UTC

PI: **Sandrine Bony**

13 August 2024

## 1 Objectives

- Typical MAESTRO/ORCESTRA flight sampling shallow convection
- Coordination with HALO (ATR circle) and SAR on Sentinel 1 (19:42 UTC)
- Nighttime conditions during most of the flight

## 2 Cal/Val activity: No

## 3 Crew

| SAFIRE | Sandrine Bony | LMD |
|---|---|---|
| Pilot (CDB) | Guillaume Seurat | SAFIRE |
| Pilot (OPL) | Jean-François Bourdinot | SAFIRE |
| Mechanics | Thierry André | SAFIRE |
| Expé Principal | Clément Bezier | SAFIRE |
| Expé | Gilles Vergez | SAFIRE |
| SCIENTISTS | | |
| PI seat | Sandrine Bony | LMD |
| LNG seat | Kevin Huet | LATMOS |
| aWALI seat | Patrick Chazette | LSCE |
| Microphys seat 1 | Pierre Coutris | LAMP |
| Microphys seat 2 | Thierry Latchimy | LAMP |
| RASTA seat | Sophie Bounissou | LATMOS |
| BASTA seat | Jérémie Lagarrigue | LSCE |

# 4 Synoptic situation

- Behind the through of an African Easterly Wave.
- Northern edge of the ITCZ around position
- Strong Saharian Aerosol Layer (SAL) between 2 and 4 km.
- Moisture and stability conditions consistent with climatological values at this date.
- PRW: 45 mm (GNSS); LTS: 17.7 K (AROME)

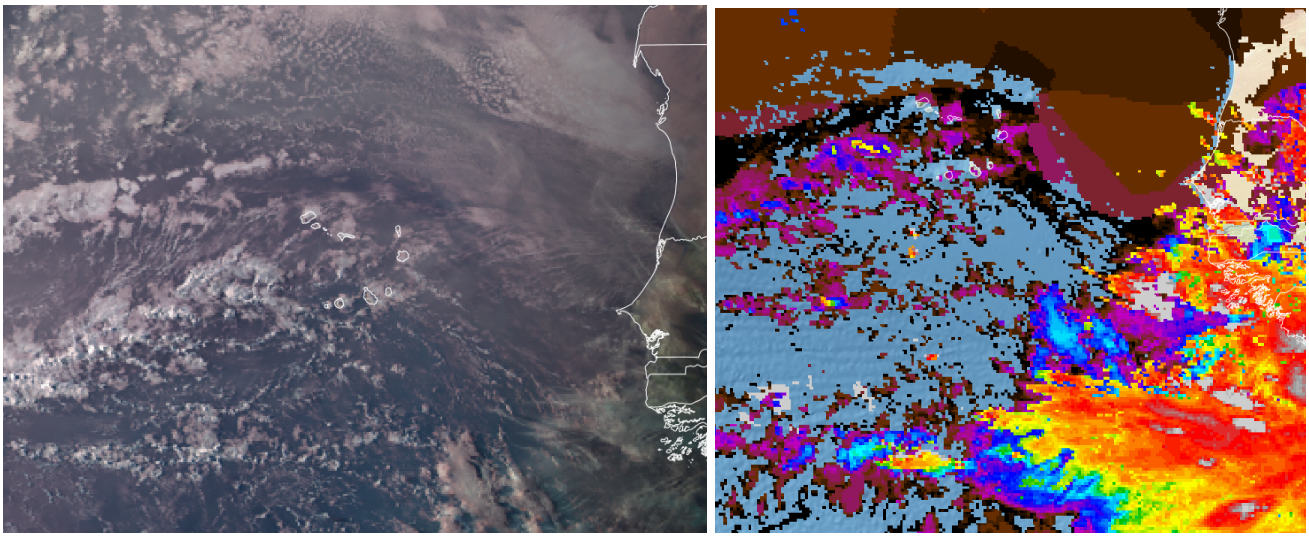


Figure 1: MSG imagery (left: RGB, right: cloud top height) on 2024-0813 at 19:00 UTC.

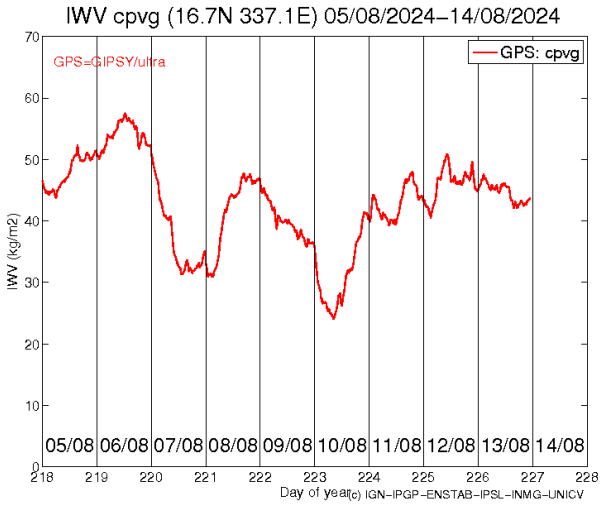



Figure 2: Evolution of the vertically-integrated water vapor measured at Sal by GNSS over the last 10 days (Courtesy Olivier Bock).

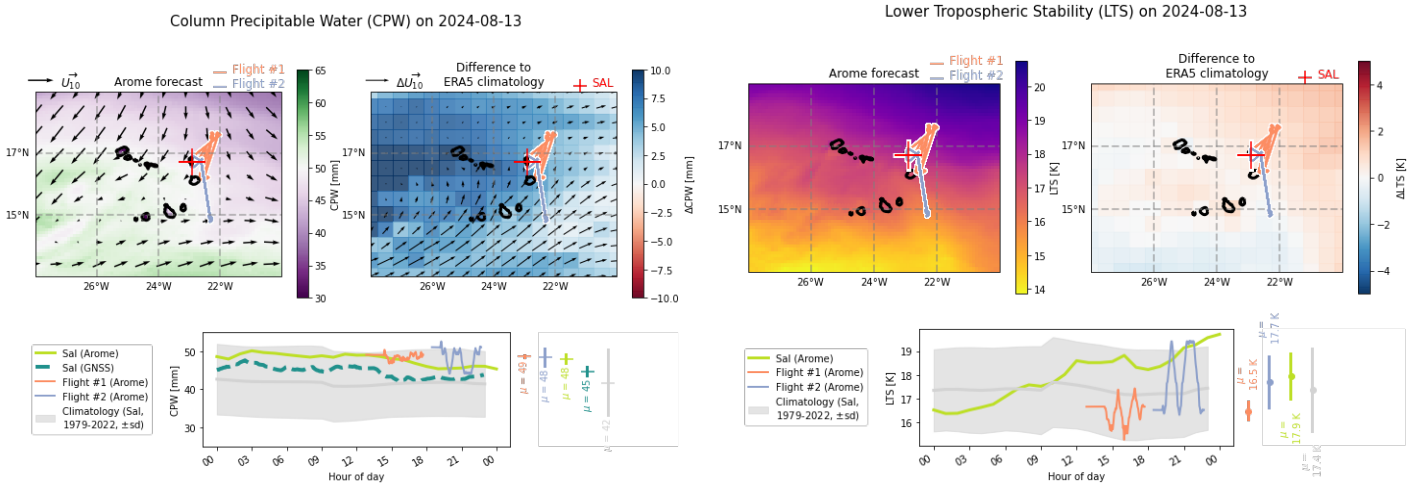
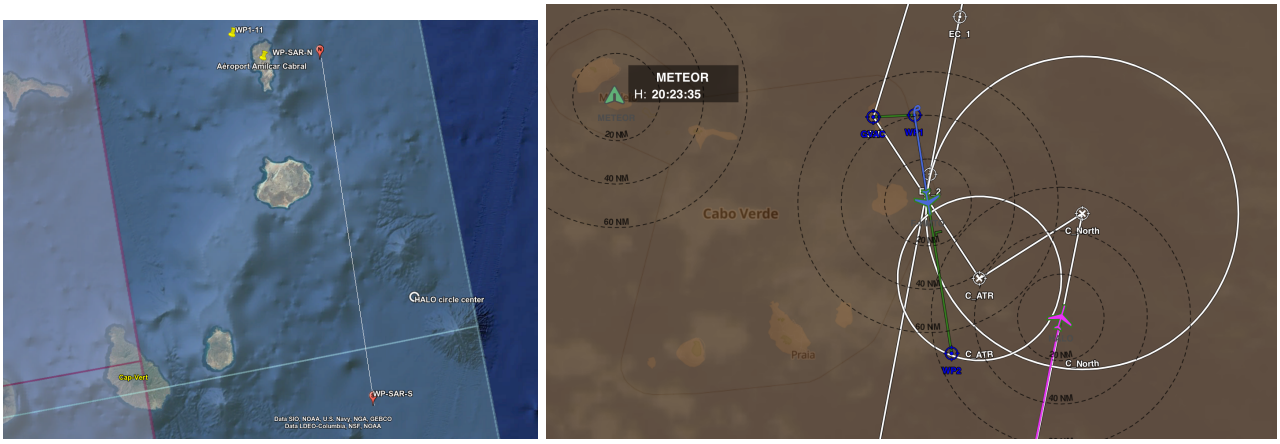



Figure 3: Comparison of the precipitable water (PRW or IWV) and lower-tropospheric stability (LTS) predicted by AROME or measured (GNSS) with the climatology. (Courtesy Emilie Fons).

# 5 Flight elements

- Typical MAESTRO flight pattern South-East of Sal
- WP1: N 16$^o$ 45' 12"; W 22$^o$ 37' 19"; WP2: N 14$^o$ 55' 44"; W 22$^o$ 19' 35"
- The flight pattern started with the subcloud-layer leg to be close to the ocean surface during the passage of SAR (at 19:42 UTC), and ended with the free-tropospheric leg.
- The cloud base level as initially around 800 m (as in Mindelo) but then adjusted visually from the cockpit to 565 m (where AWALI also detected many small clouds).
- The sunset occurred at 19:57 UTC, so that starting at cloud base, the flight occurred during nighttime.

| RF04 elements | Time (UTC) | Flight Level (FL) | Position | Notes |
|---|---|---|---|---|
| Takeoff | 19:11 | | GVAC | |
| L1 | 19:22 – 19:56 | 500 ft | WP1 (N) → WP2 (S) | Subcloud layer (150 m) |
| B1 | 20:00 – 20:35 | 1900 ft | WP2 (S) → WP1 (N) | Cloud base (560 m) |
| B2 | 20:39 – 21:15 | 1900 ft | WP1 (N) → WP2 (S) | Cloud base (560 m) |
| A1 | 21:15 – 21:46 | to FL210 | WP2 | Ascent |
| V1 | 21:47 – 21:50 | FL210 | WP2 | VAD (roll: 26 deg) |
| H1 | 21:50 – 22:24 | FL210 | WP2 (S) → WP1 (N) | Free-tropospheric leg (6.8 km) |
| Landing | 22:35 | | GVAC | |
| ATR circle | 22:20 – 23:00 | FL350 (11.5 km) | (15.5N, 22.1W), 70km radius | HALO: 12 dropsondes |



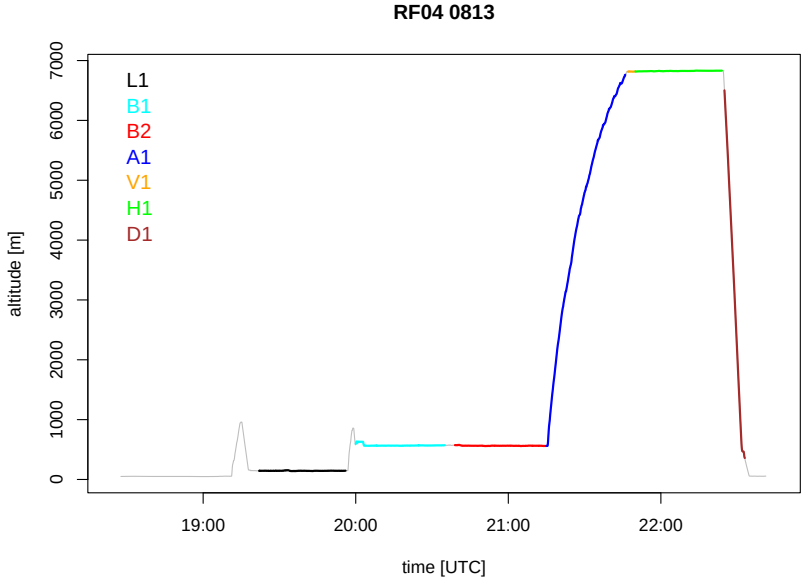




Figure 4: (Top left) ATR trajectory on top of the SAR/Sentinel-1 swath and screenshot of Planet showing the position of the ATR trajectory relative to the HALO/ATR circles. (Bottom) flight segmentation of the ATR-20240813b flight (also named RF04 or as240026) as described in the table.

# 6 Quicklooks and Comments

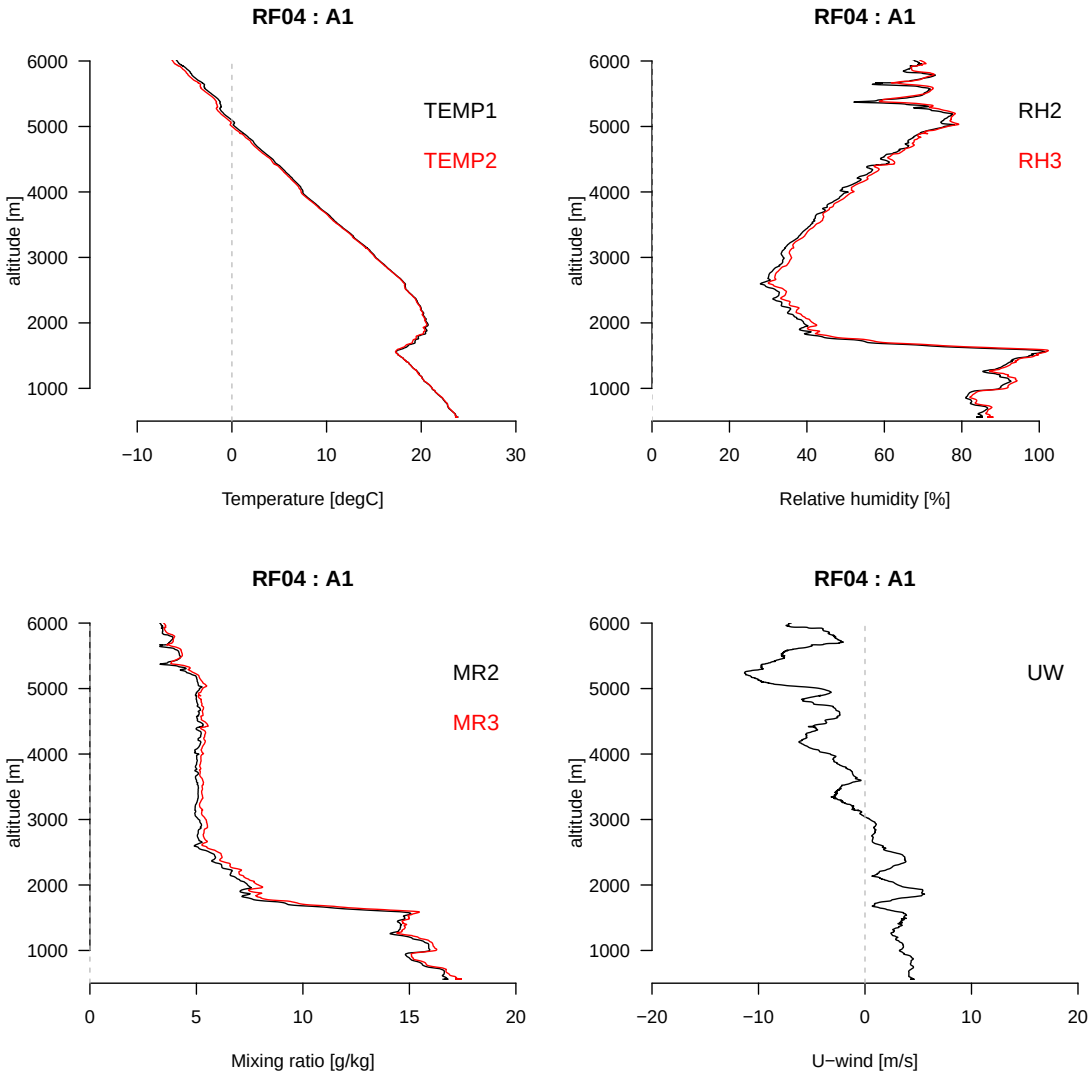



Figure 5: Vertical profiles of temperature, humidity mixing ratio, relative humidity and zonal wind measured by several in-situ sensors during the ascent of the ATR from cloud base and FL210. Note the strong inversion and hydrolapse around 1600 m.

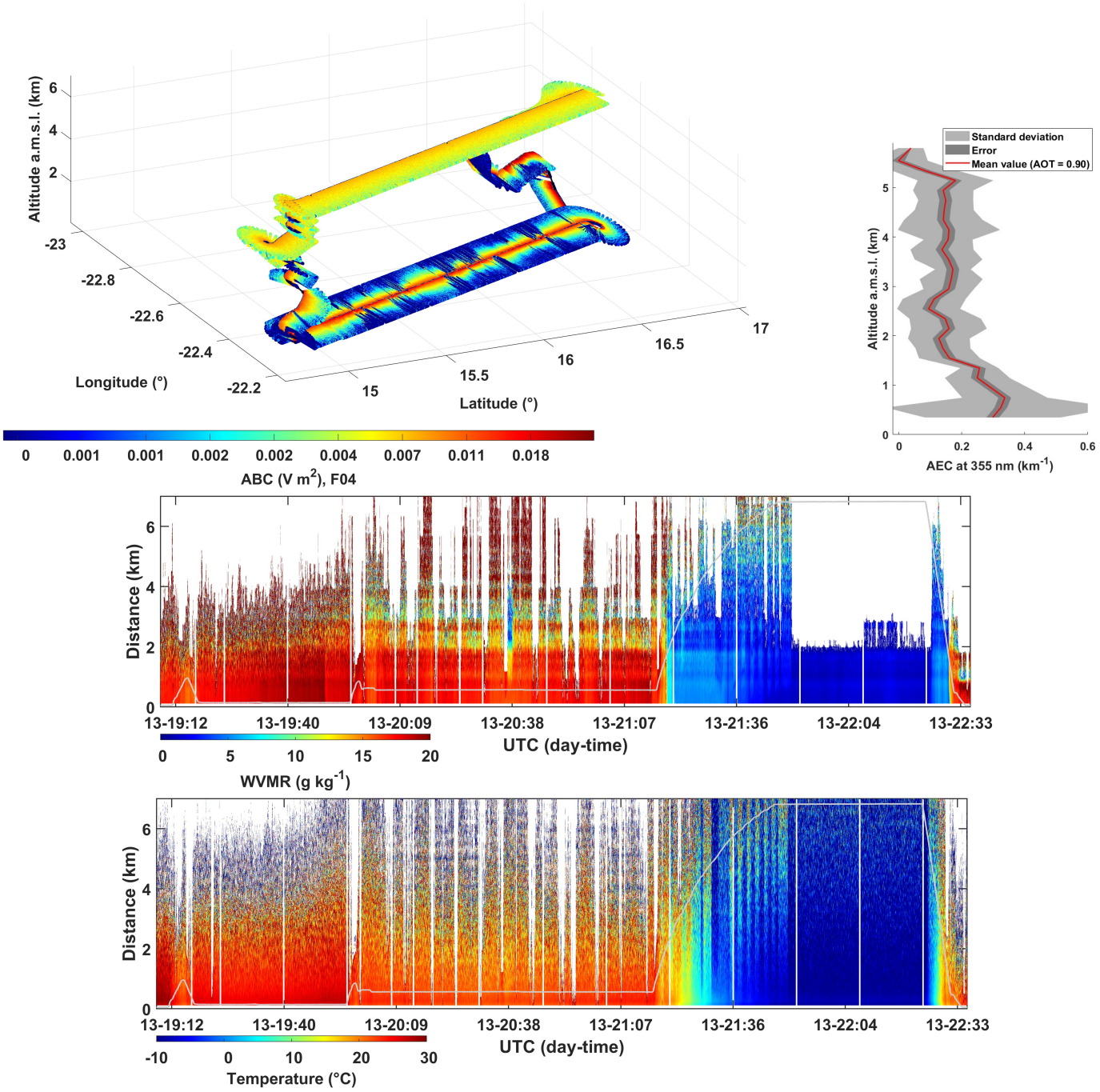



Figure 6: (Top left) Evolution of lidar backscatter ratio in the aerosol/cloud channel; (Top right) Vertical profile of the aerosol extinction, and (Bottom) 2D variation of the water vapor mixing ratio and temperature measured by the horizontally-pointing Raman lidar AWALI during RF04 (courtesy Patrick Chazette).

Figure 7: [TO BE ADDED SOON] Backscatter signal measured at 532 nm by the vertically-pointing LNG HSRL lidar. Note the Saharan Aerosol Layer between 3-5 km, the presence of very shallow clouds and of slightly deeper clouds topping around the inversion level (1500 m) (courtesy Emmeline François).

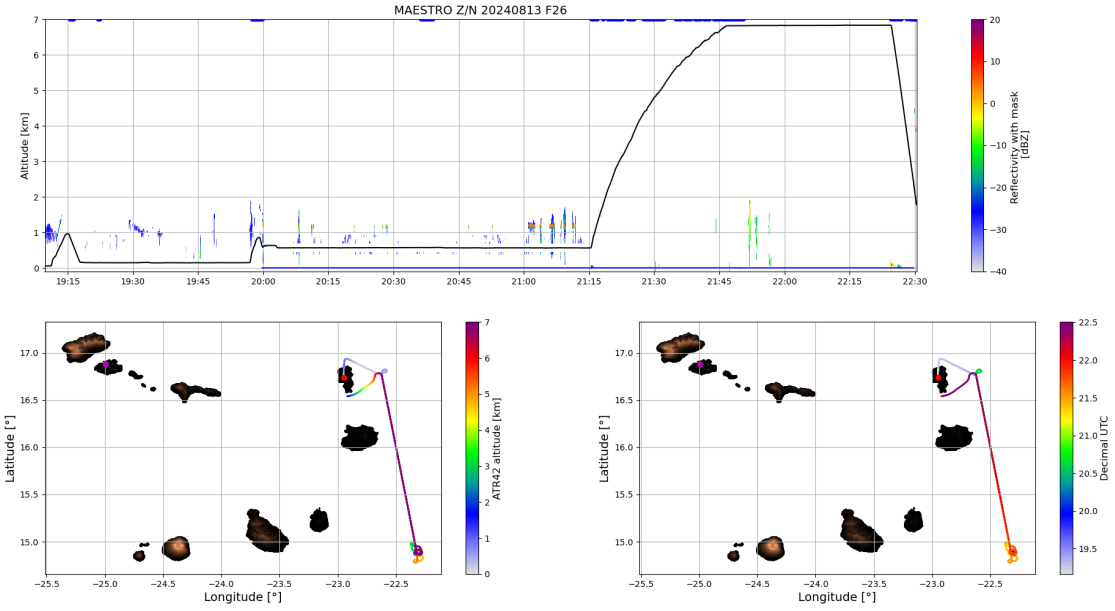



Figure 8: Radar reflectivity measured by the RASTA Doppler cloud radar (courtesy Julien Delanoë).

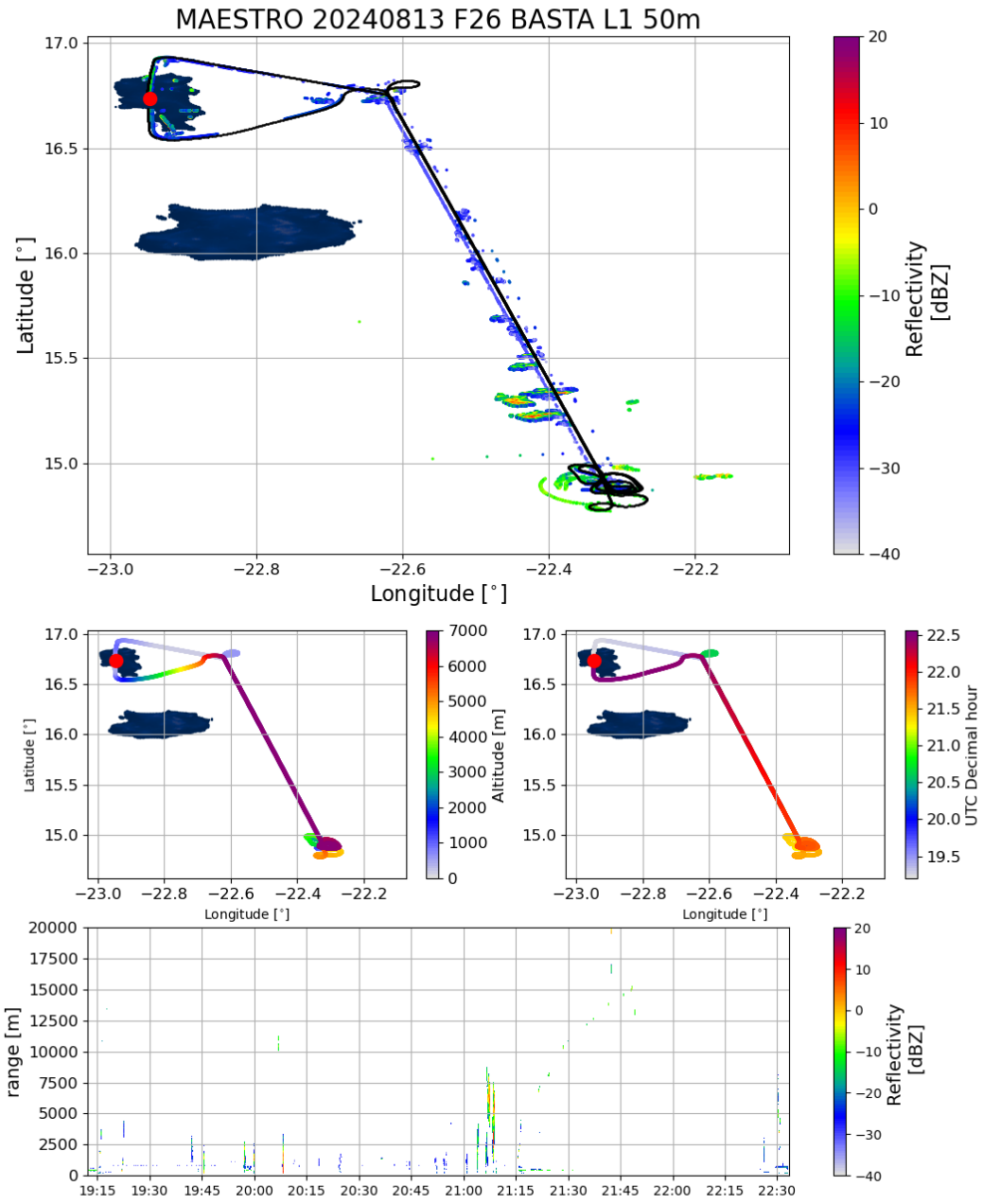



Figure 9: Radar reflectivity measured by the BASTA Doppler cloud radar (courtesy Julien Delanoë).

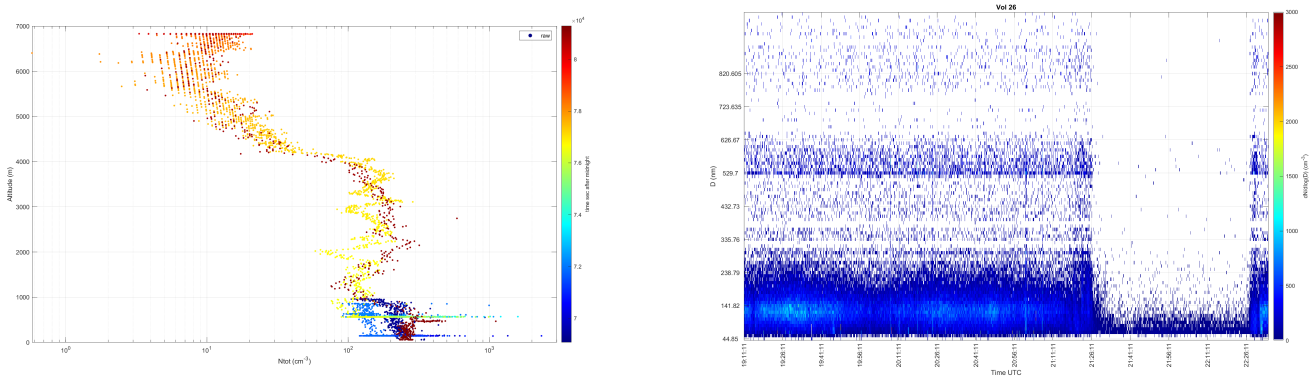



Figure 10: Left: Time-height evolution of the total concentration in aerosols measured by UHSAS during the flight and Right: the associated size distribution. Note the marked SAL. (courtesy Pierre Coutris).

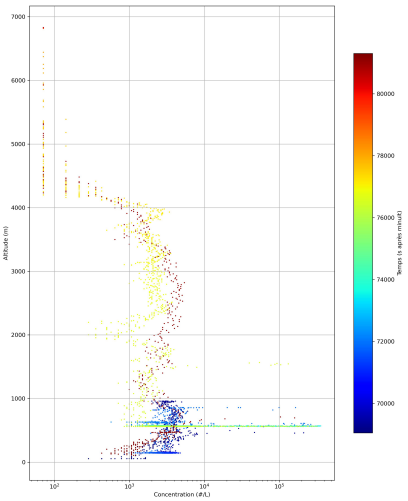



Figure 11: Vertical distribution of particles measured by the FCDP during RF04. (courtesy Antoine Baudoux).

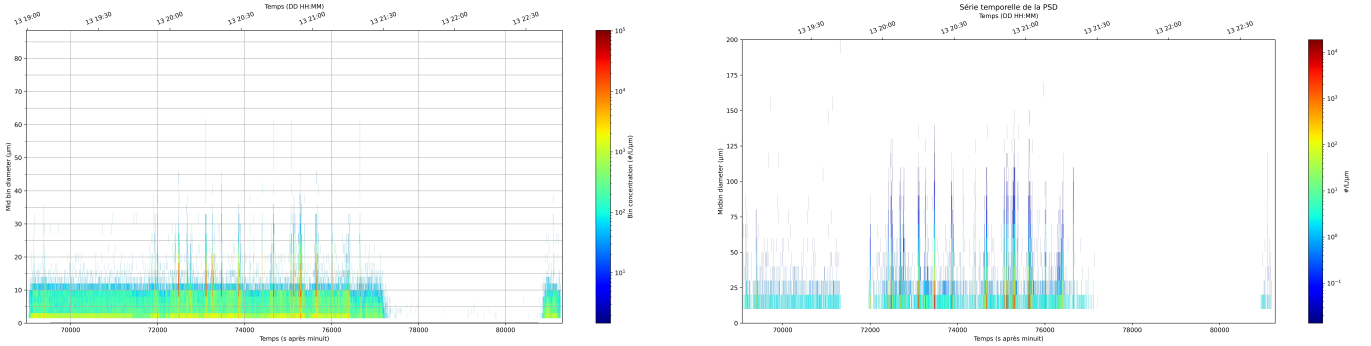



Figure 12: Concentration in particles measured by (left) the FCDP and (right) 2D-S during RF04. (courtesy Antoine Baudoux).

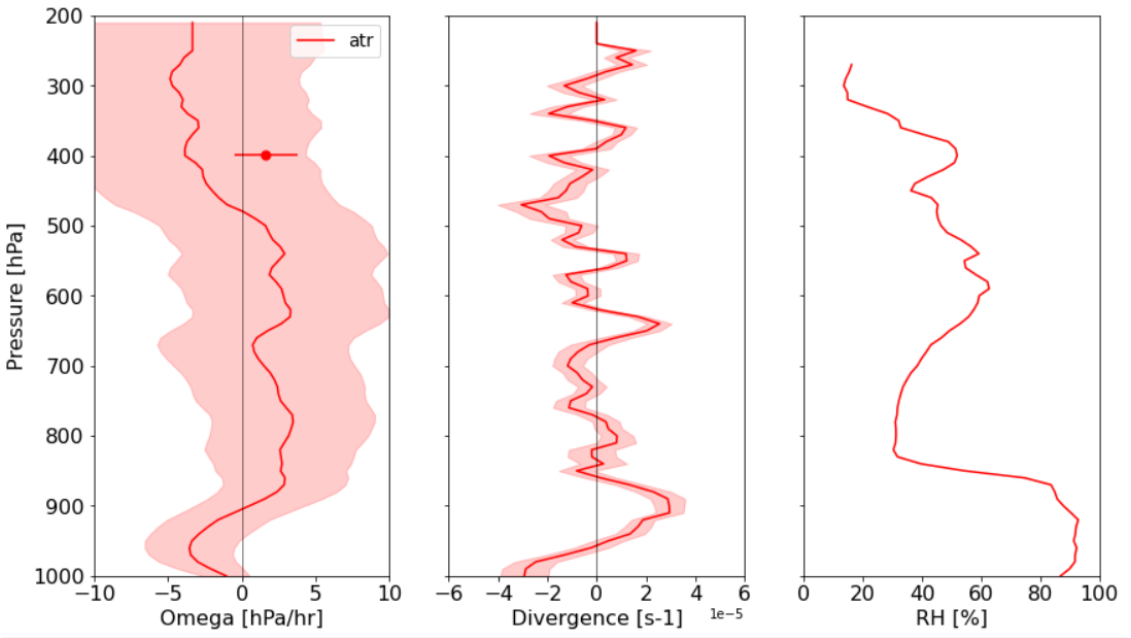



Figure 13: Vertical profiles of mesoscale vertical velocity (with uncertainty), mass divergence and relative humidity derived from the 12 HALO dropsondes dropped by HALO during its 'ATR circle' at the end of the ATR flight. Note the mass convergence and mesoscale ascent in the subcloud layer and the subsidence in the free troposphere. The value of the clear-sky vertical velocity retrieved from MSG during the ATR circle is reported on the omega profile (courtesy Basile Poujol).

# 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 | reference, ignore arctefact at 19:55, night flight |
| | 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 | reference, ignore arctefact at 19:55, night flight |
| | ray_rg_up_1 | Upwelling Shortwave radiation clear dome (no attitude correction) | SWU | OK | peak at 19:15 due to strong roll (sunset ?) |
| | ray_pir_up_1 | Upwelling shortwave radiation red dome (no attitude correction) | SWU_RED | OK | peak at 19:15 due to strong roll |
| | 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 (8.7$\mu$m) ce332 radiometer | TB_C1 | OK | - |
| | ray_tb_ce332_c2_1 | Brightness temperature channel2 (10.6$\mu$m) ce332 radiometer | TB_C2 | OK | - |
| | ray_tb_ce332_c3_1 | Brightness temperature channel3 (12$\mu$m) ce332 radiometer | TB_C3 | OK | - |
| | ray_lum_ce332_c1_1 | Radiance, channel1 (8.7$\mu$m) from ce332 radiometer | RAD_C1 | OK | - |
| | ray_lum_ce332_c2_1 | Radiance channel2 (10.6$\mu$m) from ce332 radiometer | RAD_C2 | OK | - |
| | ray_lum_ce332_c3_1 | Radiance channel3 (12$\mu$m) 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, ignore arctefact at 19:55, night flight |
| | vit_v_tas_adc_1 | True Air Speed | TAS2 | OK | - |

| DATA | SAFIRE_name | DESCRIPTION | PARAMETER | STATUS | COMMENT |
|---|---|---|---|---|---|
| | alt_ralt_15_m_1 | Height | HEIGHT | OK | limited at 15000ft (5800 m) |
| | att_aoa_radom_deg_1 | Angle of Attack | AOA_RAD | OK | - |
| | att_aos_radom_deg_1 | Angle of Sideslip | AOS_RAD | OK | - |
| | ven_wind_v_vp_imu_1 | Upward Wind | WW | OK | ok, but 0,2 m/s offset |
| | 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 | better in low level, oscillations on hight level |
| | 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 | a bit slow |
| | hum_humr_1011_rs_1 | Water Vapor Mixing ratio from 1011C | MR1 | OK | oscillations on hight level |
| | hum_humr_wvs_rs_1 | Water Vapor Mixing ratio WVSSII | MR2 | OK | reference, but a little bit slow on low level |
| | hum_humr_srtd_aero_1 | Water Vapor Mixing ratio from humaero enviscope | MR3 | OK | a bit slow |
| | hum_huabs_rt_1011_1 | Abolute Humidity from 1011C | HABS1 | OK | oscillations on hight level, better in low level |
| | hum_huabs_wvs_rs_1 | Abolute Humidity from WVSSII | HABS2 | OK | slower in low level |
| | hum_huabs_srtd_aero_1 | Abolute Humidity from enviscope | HABS3 | OK | a bit slow |
| | hum_hurel_rt_1011_rs_1 | Relative Humidity from 1011C | RH1 | OK | oscillations on hight level, better in low level |
| | hum_hurel_wvs_rs_1 | Relative Humidity from WVSSII | RH2 | OK | slower in low level |
| | hum_hurel_stat_rt_aero_1 | Relative Humidity from enviscope | RH3 | OK | a bit slow |
| | 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 | - |

| DATA | SAFIRE_name | DESCRIPTION | PARAMETER | STATUS | COMMENT |
|---|---|---|---|---|---|
| FW | hum_humolfra_fw_crh_100 | Mole fraction of water vapour in air measured by FastWave | FW_MOLFRA | NOK | investigating |
| | hum_humr_fw_100 | Water Vapor Mixing ratio from FastWave | MR6 | NOK | investigating |
| | pre_pb_fw_100 | Air Pressure measured by FastWave | FW_P | NOK | investigating |
| | tpr_tt_fw_100 | Temperature measured by FastWave | FW_T | NOK | investigating |
| 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 | - |
| | 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 | OK | miss value on high level |
| | mic_somcount_SPP300_1 | SPP300 total particles count | SPP300_TCOUNT | OK | miss value on high level |
| | mic_tabconc_SPP300_1 | SPP300 particles concentration bin[1]...bin[30] | SPP300_CONC | OK | miss value on high level |
| | mic_totalconc_SPP300_1 | SPP300 Total particles concentration | SPP300_TCONC | OK | miss value on high level |
| 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 | RAS |
| | BASTA | Cloud radar (sidewards) | Z, V, Doppler spectrum | OK | RAS |
| | LNG | Lidar (Up or Down) | Backscatter(355nm/532/1064) – HSRand Doppler 355nm | NOK | RAS. Some stability issues of the IHM sometimes but acquisition ok |
| | aWALI | Raman Lidar (sidewards) | Backscatter and inelastic(RH/Temp) | PB | RAS. Only a few hickups at cloud base sometimes |
| MICRO | CVI | | TWC | OK | |
| | HSI | | | OK | |
| | 2DS | | Images and Spectrum | OK | |
| | HVPS | Hydrometeors imagery | Images | OK | |
| | FCDP | Droplets (2?m - 50?m) | Spectrum | OK | |
| | NP-2 | | | OK | |