THE DYNAMICS–AEROSOL–CHEMISTRY–CLOUD INTERACTIONS IN WEST AFRICA FIELD CAMPAIGN
Overview and Research Highlights

C. Flamant, P. Knippertz, A. H. Fink, A. Akpo, B. Brooks, C. J. Chiu, H. Coe, S. Danuor, M. Evans, O. Jegede, N. Kalthoff, A. Konaré, C. Lioussè, F. Lohou, C. Mari, H. Schlager, A. Schwarzenboeck, B. Adler, L. Amekudzi, J. Aryee, M. Ayoola, A. M. Batenburg, G. Bessardon, S. Borrmann, J. Brito, K. Bower, F. Burnet, V. Catoire, A. Colomb, C. Denjean, K. Fosu-Amankwah, P. G. Hill, J. Lee, M. Lothon, M. Maranan, J. Marsham, R. Meynadier, J.-B. Ngamini, P. Rosenberg, D. Sauer, V. Smith, G. Stratmann, J. W. Taylor, C. Voigt, and V. Yoboué

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PARTICIPANTS IN THE DACCIWA FIELD CAMPAIGNS. Many colleagues from European and African institutions participated in the Dynamics–Aerosol–Chemistry–Cloud Interactions in West Africa (DACCIWA) field campaigns. As not all of them could be included as coauthors to the BAMS paper describing the field campaign, we have decided to list them in a dedicated table (Table ES1), thereby acknowledging their precious contributions to the overall conduct of operations during the field phase of the project.

The Service des Avions Français Instrumentés pour la Recherche en Environnement [SAFIRE, a joint entity of Centre National de la Recherche Scientifique (CNRS), Météo-France, and Centre National d’Etudes Spatiales (CNES) and operator of the ATR 42] is thanked for its support with the logistics of the aircraft campaign and for liaising with air traffic control of French-speaking countries on behalf of all aircraft operators. The British Antarctic Survey (BAS, operator of the Twin Otter) is thanked for liaising with air traffic control of English-speaking countries on behalf of all aircraft operators.

Other institutions involved and listed in the tables below are Centre National de la Recherche Scientifique, Laboratoire d’Aérologie (LA), Laboratoire de Météorologie Physique (LaMP), Laboratoire des Sciences du Climat et de l’Environnement (LSCE), University of Leeds (UNIVLEEDS), and Université Félix Houphouët-Boigny (UFHB).
| Affiliation/company | Name |
|--------------------|------|
| Université Félix-Houphouët-Boigny and Lamto Geophysical Observatory | Prof. A. Diawara, M. P. Zouzoua, M. L. Yap, Assamo, S. Keita, J. Adon, J. Bahinp, G. Ossohou, É. Touré, I. Tidiane, and M. Coulibali |
| Institut Pasteur, Ivory Coast | K. Kouamé |
| Université d’Abomey-Calavi, Cotonou | B. Fayomi, J. Djossou, M. Bodjrenou, and M. Abbey |
| Institut Régional de Santé Publique, Ouidah, Benin | M. Kedote |
| Ghana Met Services | C. York, S. Y. Komla, M. Baidu, and M. Addi |
| AeroEquipe and station heads at Abidjan, Cotonou, and Parakou | A. Solete, P. Sossa Minou, G. N’Zi, and J. Bente |
| Deutscher Wetterdienst | B. Richter |
| Direction Météo National du Togo | L. Issaou and A. Affo-Dogo |
| Kwame Nkrumah University of Science and Technology | W. A. Atiah, F. Caule-Aelhelhard, and S. Francis |
| Obafemi Awolowo University and Nigerian Met Services | O. Abiye, A. Ajao, D. Akpootu, D. Babatunde, I. Boboye, S. Francis, O. Imansogie, D. Obisesan, A. Ogunwale, O. Omokungbe, F. Soneye, and L. Sunmonu |
| Karlsruhe Institute of Technology | A. Kniffka, G. Pante, P. Vogel, A. Schlüter, L. Leufen, Th. Kociok, K. Leydecker, M. Buchholz, A. Wieser, M. Kohler, B. Deny, S. Kraut, J. Seringer, N. Kunka, M. Haid, S. Scheer, J. Handwerker, T. Gamer, S. Haas, and N. Tan |
| Universität Paul Sabatier (UPS) | C. Dione, C. Jambert, F. Tocquier, F. Brosse, Y. Bezombes, C. Chiron, C. Delon, S. Derrien, P. Durand, O. Gabella de la Fuente, C. Galy-Lacaux, E. Gardrat, J. Leclercq, J.-F. Léon, P. Medina, F. Pacifico, I. Reinares Martinez, C. Chiron, H.M. Xu, É. Touré, L. Roblou, G. Bret, P.-E. Brilouet, and B. Diallo |
| Pole AERIS/SEDOO | N. Belmahfoud, G. Brissebrat, H. Ferre, L. Fleury, and A. Fontaine |
| Université Blaise Pascal (UBP) | R. Dupuy, K. Sellegri, J. Duplessi, and P. Dominutti |
| Université Pierre et Marie Curie (UPMC) | A. Deroubaix, M. Gaetani, C. Lavaysse, R. Guebsi, and I. Annesi-Maesano |
| Université Paris Diderot | A. Baeza and M. L. Tran |
| Max Planck Institute for Chemistry (MPI-C) | C. Schulz and J. Schneider |
| Centre National de la Recherches Météorologiques (CNRM) | T. Bourrianne and E. Bourgeois |
| Laboratoire de Physique et Chime de l’Environnement et de l’Espace (LPC2E) | S. Chevrier, V. Brocchi, and G. Krysztofiak |
| Commissariat à L’Energie Atomique et aux Énergies Alternatives | P. Chazette and J. Totems |
| Deutsches Zentrum für Luft- und Raumfahrt (DLR) | Y. Ren, S. Kaufmann, M. Moser, M. Zaki, J. Kleine, V. Hahn, N. Hannemann, S. Hempe, F. Gebhardt, V. Dreiling, P. Weber, R. Welser, and D. Woudsma |
| Service des Avions Français Instrumentés pour la Recherche en Environnement | T. Perrin, C. Lamorthe, L. Guiraud, F. Plouvesle, M. Laurens, G. Vergez, J.-P. Desbios, C. Lainard, L. Cluzeau, H. Bellec, F. Loiseaux, G. Seurat, D. Duchanoy, J.-F. Bourdinot, P. Vitupier, K. Salaun, T. Charoy, and A. Bourdon |
| British Antarctic Survey | M. Beasley, O. Smith, V. Auld, J. Slatcher, J. Johnson, and R. Ladkin |
| University of York (UoY) | J. Hopkins, A. Vaughan, S. Garroway, E. Morris, and S. Young |
| University of Manchester (UNIMAN) | S. Haslett, M. Flynn, J. Dorsey, and I. Crawford |
| Wageningen University and Research | X. Pedruzo-Bagazgoitia |
| Technische Universität Braunschweig | K. Bärfuss, L. Bretschneider, and K. Endres |
| Royal Holloway, University of London | R. Fisher |
Fig. ESI. SAFIRE ATR42 flight tracks.
| Instrument | Parameter | Responsible institution/ DACCIWA partner |
|------------|-----------|------------------------------------------|
| Rosemount $T$ | Temperature $T$ | SAFIRE/CNRS |
| Rosemount 120 and 1221 | Pressure $P$ (static and dynamic) | SAFIRE/CNRS |
| Five-port turbulence probe | Momentum fluxes, heat fluxes | SAFIRE/CNRS |
| GE krypton hygrometer (dewpoint) (KH20) | Humidity: dewpoint; ultraviolet (UV) absorption | LA/UPS |
| Inertial navigation system and global positioning system | Wind component, position | SAFIRE/CNRS |
| Adjustable (flow, orientation) aerosol community inlet | Particle aerosol sampling | CNRM/CNRS |
| Aircraft dual condensation particle counter (CPC) MARIE | Particle number concentrations for diameters $D > 4$ and $D > 15$ nm (variable) | LaMP/UBP |
| CPC3788 | Total counter (water CPC) (>3 nm) | CNRM/CNRS |
| CPCboot | Turbulent mixing CPC (>3 nm) | LaMP/UBP |
| Scanning mobility particle sizer (SMPS) and V-SMPS | Ambient and desorbed ($T$ selectable) particle size distribution 0.02–0.5 µm; 90-s time resolution | LaMP/UBP |
| Optical particle counter (OPC) 1.129, V-OPC 1.129 | Ambient and desorbed particle size distribution 0.25–2 µm; 1-s time resolution | LaMP/UBP |
| Grimm 1.109 | Ambient particle size distribution 0.25–2 µm; 1-s time resolution | CNRM/CNRS |
| Ultrahigh sensitivity aerosol spectrometer (UHSAS-A) | Aerosol size distribution 0.06–1 µm; 1-s time resolution | LaMP/UBP and SAFIRE/CNRS |
| Passive cavity aerosol spectrometer probes (PCASP) | Aerosol (and cloud) particle size distribution 0.1–3 µm; 1-s time resolution | SAFIRE/CNRS |
| Particle and soot absorption photometer (PSAP) (3λ) | Absorption coefficient, black carbon content Blue: 470 nm; green: 522 nm; red: 660 nm | LaMP/UBP |
| Aurora 3000 | Lightsscatter coefficient (sigma), backscatter coefficient 450, 525, and 635 nm; 0–20,000 Mm$^{-1}$, 5 L min$^{-1}$ | LaMP/UBP |
| Cavity attenuate phase shift (CAPS) extinction monitor | Extinction Mm$^{-1}$ 630 nm | CNRM/CNRS |
| Atmospheric pressure interface time of flight (API-TOF) mass spectrometer | Ion clusters | LaMP/UBP and University of Helsinki |
| Compact time of flight aerosol mass spectrometer (cToF-AMS) | Size-resolved condensation nucleus (CN) chemical composition (volatile and semivolatile components) 0.05–0.6 µm | LaMP/UBP |
| Dual-stage impactor | Sub- and supermicronic elementary particle analysis: transmission electron microscope/scanning electron microscope equipped with an energy dispersive X-ray (TEM/SEM-EDX) Two stages: sub- and supermicron particles | LaMP/UBP |
| Single particle soot photometer (SP2) | Measurement of black carbon (soot) mass in individual aerosol particles and particle optical size using light scattering Black carbon mixing state at the single-particle level | CNRM/CNRS |
| Instrument | Parameter | Responsible institution/ DACCIWA partner |
|------------|-----------|----------------------------------------|
| Cloud condensation nucleus counter [CCNC (mini CCNC)] | CCN concentration | CNRM/CNRS |
| | Supersaturation to be chosen | |
| Proton transfer reaction mass spectrometry (PTR-MS) | Primary and secondary volatile organic compounds (VOCs) | SAFIRE/CNRS |
| | Real-time monitoring of VOCs (mass) like acetone, acetaldehyde, methanol, ethanol, benzene, toluene, xylene, and others | |
| Mozart | CO, O$_3$ measured every second, then averaged over 30 s | SAFIRE/CNRS |
| | O$_3$: 1 ppbv; CO: 5 ppbv | |
| Thermo Environmental Instruments, Inc. model 42C trace level (TEI 42C TL) NO$_x$ analyzer | NO$_x$: measured every 1 s, then averaged over $n \times 10$ s; 50-ppt integration over 120 s | SAFIRE/CNRS |
| SO$_2$ analyzer | SO$_2$ | LaMP/UPB |
| Aerolaser HCHO | HCHO (formaldehyde) (ppbv) | LaMP/UPB |
| Picarro sensors | CO$_2$, CH$_4$, CO cavity ring down spectroscopy | SAFIRE/CNRS |
| | Carbon dioxide (CO$_2$) every 5 s with precision to 150 ppb, methane (CH$_4$) to 1 ppb, and CO to 30 ppb | |
| Meteo Consult photoelectric detectors | Upwelling and downwelling photolysis frequency J(NO$_2$) | SAFIRE/CNRS |
| | 300–380 nm | |
| Ultraviolet Lidar for Canopy Experiment (ULICE) aerosol/cloud lidar | Aerosol backscatter at 355 nm | LSCE/UPMC |
| | | |
| Conveyable low-noise infrared (IR) radiometer for measurements of atmosphere and ground surface targets (CLIMAT) | Brightness temperature in the IR (8.7, 10.8, and 12 $\mu$m) | SAFIRE/CNRS |
| Kipp and Zonen CMP22 (two) | Upwelling and downwelling visible radiances and fluxes 0.2–3.6 $\mu$m; 5-s response time | SAFIRE/CNRS |
| Kipp and Zonen CGR4 (two) | Upwelling and downwelling IR radiances and fluxes 4.2–42 $\mu$m 0–700 W m$^{-2}$ | SAFIRE/CNRS |
| Fast forward-scattering spectrometer probe (Fast-FSSP) and backscatter cloud probe with polarization detection (BCPD) | Droplet spectrum (2–50 $\mu$m) | CNRM/CNRS |
| Particle volume monitor (PVM) | Cloud liquid water content (LWC), effective diameter Deff | SAFIRE/CNRS |
| Cloud droplet probe (CDP-2) | Cloud droplet spectrum (2–50 $\mu$m), LWC, Deff | LaMP/UPB |
| CDP-1 | Cloud droplet spectrum (2–50 $\mu$m), LWC, Deff | CNRM/CNRS |
| Signal processing package (SPP-100) extended range (ER) | Extended-range cloud droplet spectrum (3–95 $\mu$m) | LaMP/UPB |
| Two-dimensional stereo (2D-S) probe | Imaging probe for large drizzle droplets 10–1,280 $\mu$m | LaMP/UPB |
Fig. ES2. DLR Falcon 20 flight tracks.
| Instrument | Parameter | Responsible institution/ DACCIWA partner |
|------------|-----------|------------------------------------------|
| UV absorption (TE49c) | O$_3$ | DLR |
| Quantum cascade laser (QCL) on board Spectromètre Infrarouge In Situ Toute Altitude (SPIRIT)] | CO, NO$_2$, CH$_4$ | LPC2E/CNRS |
| Fluorescence (TE43 TL) | SO$_2$ | DLR |
| Tube sampler + thermal desorption gas chromatography mass spectrometry (TD-GC-MS) | VOCs, perfluorocarbons (PFC) | DLR |
| Tedlar bag sampler | CH$_4$ isotopes | DLR |
| CPC (TSI 3010) | CN (>14 nm) | DLR |
| OPC (Grimm) × 2 | Particle size and number (0.2–2 μm) | DLR and MPI-C |
| C-ToF-AMS | Aerosol chemical composition | MPI-C |
| UHSAS-A | Particle size and concentration (60 nm–1 μm) | DLR |
| Cloud and aerosol spectrometer with depolarization (CAS-DPOL) | Particle size and number concentration, depolarization (0.5–50 μm), LWC | DLR |
| 2D-S | Particle size and number concentration (10–1,280 μm), imaging probe for large drizzle droplets | DLR |
| P, T probes | Pressure, temperature | DLR |
| Five-hole probe | Horizontal and vertical wind | DLR |
| Ly alpha | Relative humidity | DLR |
| Tunable diode laser hygrometer (TDL) (WARRAN-TDL, Spectra Sensors), dewpoint meter (DPM) hygrometer (Buck CR-2) | Total H$_2$O, Gas-phase H$_2$O, dewpoint | DLR |
Fig. ES3. BAS Twin Otter flight tracks.
| Instrument | Parameter | Responsible institution/ DACCIWA partner |
|------------|-----------|------------------------------------------|
| Rosemount 102 | Temperature | BAS/UNIVMAN |
| Vaisala humicap | Temperature, pressure, humidity | BAS/UNIVMAN |
| Buck 1011C cooled-mirror hygrometer | Dewpoint | BAS/UNIVMAN |
| National Oceanic and Atmospheric Administration/Airborne Research Australia (NOAA/ARA) nine-hole turbulence probe and thermocouple temperature sensors | Momentum and sensible fluxes Operating at 50 Hz coupled with Oxford Technical Solutions (OxTS) Inertial and Inertial Measurement Unit (IMU) coupled with Trimble GPS | BAS/UNIVMAN |
| NOAA/ARA nine-hole turbulence probe and Licor LI-7000 IR gas sensor | Latent heat and CO₂ fluxes Operating at 50 Hz | BAS/UNIVMAN |
| GPS, inertial central | Wind component, position | BAS |
| Radar altimeter | Altitude, range ~900 m above ground level (AGL) | BAS/UNIVMAN |
| Brechtel model 1200 isokinetic inlet | Particle aerosol sampling D95 = 6 µm; D65 = 10 µm Inlet temperature – instruments below | BAS/UNIVMAN, UNIVLEEDS |
| Brechtel mixing CPC | Turbulent mixing CPC (>3 nm) | UNIVMAN |
| SMPS | Ambient and desorbed (T selectable) particle size distribution 20–350 nm; 60-s time resolution Using TSI 3772 CPC | UNIVMAN and BAS |
| Grimm 1.109 OPC | Ambient and desorbed particle size distribution 0.25–2 µm; 1-s time resolution | BAS/UNIVMAN, UNIVLEEDS |
| UHSAS-A | Aerosol size distribution 0.06–1 µm; 1-s time resolution | UNIVMAN & |
| Droplet Measurement Technologies (DMT) PCASP or Stratton Park Engineering Company (SPEC) 2D-S cloud probe (one or the other at any one time) | Aerosol (and cloud) particle size distribution 0.5–40 µm; 1-s time resolution Imaging probe for large drizzle droplets 10–1,280 µm | UNIMAN |
| Filters | Collection of particles for offline environmental scanning electron microscope (ESEM) analysis | UNIVMAN |
| Aerodyne CAPS particulate matter single-scattering albedo (PMssa) monitor | Scattering and extinction 630 nm | UNIVMAN |
| Brechtel PSAP (λl) | Aerosol optical absorption | UNIVMAN |
| Aerodyne AMS | Size-resolved CN chemical composition (volatile and semivolatile components) 0.05–0.6 µm | UNIMAN |
| DMT SP2 photometer | Black carbon mass and mixing state 0.15–0.6 µm | UNIVMAN |
| CCNC (mini CCNC) | CCN concentration Supersaturation to be chosen | CNRM/CNRS |
| Whole air samples | Primary and secondary VOCs | UoY |
| Gas chromatography with flame ionization detector (GC-FID) | 30 samples per flight | UoY |
| 2B Technologies model 205, TEI49i | O₃ | UoY |
| Air-quality design | NO, NO₂ | UoY |
| TEI 43i | SO₂ | UoY |
Table ES4. Continued.

| Instrument                                                                 | Parameter          | Responsible institution/ DACCIWA partner                  |
|----------------------------------------------------------------------------|--------------------|------------------------------------------------------------|
| Aerolaser AL5002                                                           | CO                 | UoY                                                       |
| Los Gatos Research microportable greenhouse gas analyzer (Micro-GGA), CO$_2$, CH$_4$ | UoY and BAS/ UNIVMAN, UNIVLEEDS, UoY |
| Video cameras                                                              | 720p, forward and downward looking | BAS                                                       |
| Eppley Laboratories precession spectral pyranometer (PSP) (two)            | Upwelling and downwelling visible radiances and fluxes 0.285–2.8 µm | BAS                                                       |
| Eppley Laboratories precision infrared pyrgeometer (PIR)                   | Upwelling and downwelling IR radiances and fluxes 3.5–50 µm 0–700 W m$^{-2}$ | BAS                                                       |
| DMT CDP                                                                    | Cloud droplet spectrum (2–50 µm), LWC, Deff | UNIVMAN                                                   |
| DMT CAPS cloud probe                                                       | Combined cloud probe | BAS/UNIVMAN, UNIVLEEDS                                    |

Fig. ES4. DACCIWA radiosonde network and deployed radiosonde types during Jun and Jul 2016. Blue: operational or reactivated AMMA stations with four-times-daily sounding frequencies; black: DACCIWA supersites performing 0600 UTC plus additional 1200, 1800, and 0000 UTC launches on IOP days; red: DACCIWA stations operated by KIT, GMet, UFHB, and the LAMTO Geophysical Observatory with up to five soundings per day; and yellow: operational upper-air station in Nigeria with 1200 UTC soundings. The shape of the marker indicates radiosonde type.
| Date       | Flight No.   | Time (UTC) | From/to         | Locations       | Objectives                                                                 |
|------------|--------------|------------|-----------------|-----------------|-----------------------------------------------------------------------------|
| 29 Jun 2016 | F20_20160629a | 1311–1520  | Lomé/Lomé       | Togo, Benin     | Cloud–aerosol interactions; city emissions: Lomé                            |
|            | ATR_as17     | 1359–1649  | Lomé/Lomé       | Togo, Benin     | Cloud–aerosol interactions; city emissions: Lomé, Cotonou; biogenic emissions |
| 30 Jun 2016 | F20_20160630a | 1118–1453  | Lomé/Lomé       | Ghana           | Cloud–aerosol interactions; city emissions: Accra, Kumasi, Takoradi        |
|            | ATR_as18     | 1236–1609  | Lomé/Lomé       | Togo            | Cloud–aerosol interactions; city emissions: Lomé; biogenic emissions        |
| 1 Jul 2016  | F20_20160701a | 1111–1431  | Lomé/Lomé       | Ghana           | Cloud–aerosol interactions; city emissions: Accra, Kumasi; biogenic emissions |
|            | ATR_as20     | 0940–1304  | Lomé/Lomé       | Benin           | Radiation calibration; dust aerosols                                       |
|            | ATR_as21     | 1445–1807  | Lomé/Lomé       | Ocean           | Air–sea interactions [European Facility for Airborne Research (EUFAR) Observing the Low-Level...][OLACTA]); biomass burning plume |
| 3 Jul 2016  | ATR_as22     | 0942–1313  | Lomé/Lomé       | Togo, Benin     | Cloud–aerosol interactions; city emissions: Lomé; land–sea breeze          |
|            | TO02         | 1101–1400  | Lomé/Lomé       | Togo, Benin     | Cloud–aerosol interactions                                                 |
| 4 Jul 2016  | TO03         | 1155–1515  | Lomé/Lomé       | Ghana           | City emissions: Accra                                                      |
| 5 Jul 2016  | F20_20160705a | 1124–1458  | Lomé/Lomé       | Togo, Benin     | Cloud–aerosol interactions; city emissions: Lomé                          |
|            | ATR_as23     | 0802–1056  | Lomé/Lomé       | Togo, Benin     | Cloud–aerosol interactions; city emissions: Lomé                          |
|            | TO04         | 1124–1245  | Lomé/Lomé       | Togo, Benin     | Cloud–aerosol interactions; radiation closure                             |
|            | TO05         | 1600–1750  | Lomé/Lomé       | Togo, Benin     | Cloud–aerosol interactions                                                 |
| 6 Jul 2016  | F20_20160706a | 0941–1313  | Lomé/Lomé       | Ghana, Ivory Coast | Cloud–aerosol interactions; city emissions: Abidjan linking with urban campaign; biomass burning plume |
|            | ATR_as24     | 0709–1049  | Lomé/Abidjan     | Ghana, Ivory Coast | Cloud–aerosol interactions; city emissions: Accra, Abidjan linking with urban campaign; biogenic emissions; biomass burning plume |
|            | ATR_as25     | 1247–1502  | Abidjan/Lomé     | Ghana, Ivory Coast | City emissions: Accra, Abidjan linking with urban campaign; biogenic emissions; biomass burning plume |
|            | TO06         | 0942–1140  | Lomé/Lomé       | Togo, Benin     | Radiation closure                                                          |
|            | TO07         | 1355–1637  | Lomé/Lomé       | Ghana           | City emissions: Accra                                                      |
| 7 Jul 2016  | F20_20160707a | 1101–1335  | Lomé/Lomé       | Ocean           | Flaring and shipping [EUFAR Air Pollution from Shipping and Oil Platforms of West Africa (APSOWA)] |
|            | ATR_as26     | 1317–1650  | Lomé/Lomé       | Ocean           | Air–sea interactions (EUFAR OLACTA)                                       |
|            | TO08         | 0946–1241  | Lomé/Lomé       | Togo            | Cloud–aerosol interactions                                                 |
| Date       | Flight No. | Time (UTC) | From/to Locations          | Objectives                                                                 |
|------------|------------|------------|----------------------------|-----------------------------------------------------------------------------|
| 8 Jul 2016 | F20_20160708a | 0833–1206 | Lomé/Lomé Togo, Benin      | Cloud–aerosol interactions; city emissions: Lomé; tracer experiment          |
|            | ATR_as27   | 0544–0917  | Lomé/Lomé Ghana            | Cloud–aerosol interactions; city emissions: Accra; biogenic emissions       |
|            | ATR_as28   | 1040–1604  | Lomé/Lomé Benin            | Midlevel clouds [EUFAR Mid-Level Clouds over West Africa (MICWA)]; dust aerosols; radiation closure dust |
|            | TO09       | 0836–1127  | Lomé/Lomé Togo             | Cloud–aerosol interactions; radiation closure                               |
|            | TO10       | 1330–1635  | Lomé/Lomé Togo, Benin      | City emissions: Cotonou                                                    |
| 10 Jul 2016| F20_20160710a | 1106–1438 | Lomé/Lomé Ocean, Ghana     | Flaring and shipping (EUFAR APSOWA); biomass burning                      |
|            | ATR_as29   | 1019–1356  | Lomé/Lomé Benin            | Midlevel clouds (EUFAR MICWA); dust aerosols                              |
|            | TO11       | 0854–1133  | Lomé/Lomé Togo, Benin      | Cloud–aerosol interactions                                                 |
|            | TO12       | 1418–1615  | Lomé/Lomé Benin            | Radiation closure                                                          |
| 11 Jul 2016| F20_20160711a | 1030–1426 | Lomé/Lomé Ocean, Ivory Coast | Flaring and shipping (EUFAR APSOWA); city emissions: Abidjan; biomass burning aerosols |
|            | ATR_as30   | 0710–1048  | Lomé/Abidjan Ghana, Ivory Coast | Cloud–aerosol interactions; city emissions: Abidjan; biogenic emissions; biomass burning plume from central Africa |
|            | ATR_as31   | 1331–1622  | Abidjan/Lomé Ghana, Ivory Coast | City emissions: Abidjan                                                   |
|            | TO13       | 0817–1024  | Lomé/Lomé Togo, Benin      | Cloud–aerosol interactions; city emissions: Accra, Lomé                   |
|            | TO14       | 1215–1445  | Lomé/Lomé Togo             | City emissions: Lomé                                                       |
| 12 Jul 2016| F20_20160712a | 0831–1218 | Lomé/Lomé Togo             | Cloud–aerosol interactions; city emissions: Lomé; biomass burning aerosols; tracer experiment |
|            | ATR_as32   | 1339–1658  | Lomé/Lomé Ghana            | Cloud–aerosol interactions; city emissions: Accra; biomass burning aerosols |
| 13 Jul 2016| F20_20160713a | 0918–1242 | Lomé/Lomé Togo             | Cloud–aerosol interactions; city emissions: Lomé; biomass burning aerosols; tracer experiment |
|            | ATR_as33   | 1225–1551  | Lomé/Lomé Benin            | Midlevel clouds (EUFAR MICWA); biomass burning aerosols                   |
|            | TO15       | 0859–1205  | Lomé/Lomé Ghana            | City emissions: Accra                                                     |
| 14 Jul 2016| F20_20160714a | 0855–1233 | Lomé/Lomé Ocean; Ghana, Ivory Coast | Flaring and shipping (EUFAR APSOWA); city emissions: Accra |
|            | ATR_as34   | 1138–1446  | Lomé/Lomé Ocean            | Air–sea interactions (EUFAR OLACTA); biomass burning aerosols             |
|            | TO16       | 0655–0925  | Lomé/Lomé Togo             | Cloud–aerosol interactions; city emissions: Lomé                          |
| 15 Jul 2016| ATR_as35   | 0921–1244  | Lomé/Lomé Togo, Benin      | Cloud–aerosol interactions; city emissions: Lomé; radiation closure clouds |
|            | TO17       | 0930–1205  | Lomé/Lomé Togo, Benin      | Radiation calibration                                                     |
|            | TO18       | 1340–1645  | Lomé/Lomé Ghana            | City emissions: Accra                                                     |
| 16 Jul 2016| ATR_as36   | 1134–1453  | Lomé/Lomé Ghana            | City emissions: Accra                                                     |
| Flights       | Abidjan       | Accra         | Kumasi        | Takoradi      | Lomé           | Cotonou        | Benin      | Ghana      | Togo      |
|--------------|---------------|---------------|---------------|---------------|----------------|----------------|------------|------------|-----------|
| F20_20160706a | F20_20160630a | F20_20160630a | F20_20160630a | F20_20160629a | ATR_as17       | TO10           | ATR_as17   | ATR_as19   | ATR_as18  |
| ATR_as24     | F20_20160701a | F20_20160701a | F20_20160701a | ATR_as17     | ATR_as17       | TO10           | ATR_as17   | ATR_as24   | ATR_as27  |
| ATR_as25     | ATR_as19     | ATR_as19     | ATR_as19     | ATR_as18     |                | TO01           | ATR_as25   | ATR_as27   | ATR_as30  |
| F20_20160711a | TO03          |               |              |              |                |                |            |            |           |
| ATR_as30     | F20_20160706a |               |              |              |                |                |            |            |           |
| ATR_as31     | TO07          |               |              |              |                |                |            |            |           |
|              | ATR_as27     |               |              |              |                |                |            |            |           |
|              | TO13          |               |              |              |                |                |            |            |           |
|              | ATR_as32     |               |              |              |                |                |            |            |           |
|              | TO15          |               |              |              |                |                |            |            |           |
|              | F20_20160714a |               |              |              |                |                |            |            |           |
|              | TO18          |               |              |              |                |                |            |            |           |
|              | ATR_as36     |               |              |              |                |                |            |            |           |

|   |   |   |   |   |   |   |   |   |   |
| Total | 6 | 13 | 3 | 3 | 15 | 2 | 1 | 5 | 1 |

**Table ES6. Aircraft flight objectives for city and biogenic emission flights.**
### Table ES7. Aircraft flight objectives for dust and biomass burning aerosol flights.

| Flights       | Biomass burning aerosols | Dust aerosols |
|---------------|--------------------------|---------------|
| ATR_as21      | ATR_as20                 |               |
| F20_20160706a | ATR_as28                 |               |
| ATR_as24      | ATR_as29                 |               |
| ATR_as25      |                          |               |
| F20_20160709a |                          |               |
| F20_20160711a |                          |               |
| ATR_as30      |                          |               |
| F20_20160712a |                          |               |
| ATR_as32      |                          |               |
| F20_20160713a |                          |               |
| ATR_as33      |                          |               |
| ATR_as34      |                          |               |
| **Total**     | **12**                   | **3**         |

### Table ES8. Aircraft flight objectives for cloud–aerosol interaction flights.

| Flights       | Lomé–Savè | Accra–Kumasi | Lomé–Abidjan | Others |
|---------------|-----------|--------------|--------------|--------|
| F20_20160629a | ATR_as17  | F20_20160630a| ATR_as24     | F20_20160708a |
| ATR_as20      | ATR_as19  | ATR_as27     | ATR_as30     | F20_20160712a |
| ATR_as22      | TO02      |              |              | F20_20160713a |
| F20_20160705a | ATR_as23  |              |              | TO16   |
| TO05          | TO08      |              |              |        |
| **Total**     | **10**    | **3**        | **3**        | **6**  |

### Table ES9. Aircraft flight objectives for radiation flights.

| Flights       | Calibration | Closure |
|---------------|-------------|---------|
| ATR_as20      | TO04        |         |
| TO17          | TO06        |         |
|               | TO09        |         |
|               | ATR_as28    |         |
|               | TO12        |         |
| **Total**     | **2**       | **5**   |
Table ES10. Instruments, sites, and parameters measured: Q: net radiation; H: sensible heat flux; E: latent heat flux; B: soil heat flux; SW: shortwave radiation components; LW: longwave radiation components; SM: soil moisture; ST: soil temperature; T: air temperature; RH: relative humidity; P: pressure; WS: wind speed; WD: wind direction; precip: precipitation; BF: biogenic fluxes (isoprene turbulent fluxes); SF: soil flux by chamber method (NO, NO<sub>2</sub>, NH<sub>3</sub>); CCC: chemical compound concentration of O<sub>3</sub>, NO, NO<sub>2</sub>, CO, and isoprene; AH: absolute humidity; IWV: integrated water vapor; and LWP: liquid water path. Maximum measurement ranges are given in parentheses.

| Instrument | Site       | Measured parameters                                      |
|------------|------------|----------------------------------------------------------|
| Energy balance station | Ile-Ife, Kumasi, Savè | Q, H, E, B, SW, LW, SM, ST, T, P, WS, WD, precip |
| Chemistry measurements | Savè | BF, SF, CCC |

**Near-surface measurements (ground based)**

| Instrument | Site       | Measured parameters                                      |
|------------|------------|----------------------------------------------------------|
| Sodar      | Ile-Ife, Kumasi, Savè | Horizontal wind profiles (0–600 m AGL) |
| UHF wind profiler | Savè | Horizontal wind profiles (200–4,000 m AGL) |
| Wind lidars | Savè | Lidar 1: radial velocity profiles, scanning or vertical stare (400–10,000 m AGL) | Lidar 2: vertical velocity profiles (40–600 m AGL) |
| Microwave radiometer | Kumasi, Savè | T and AH profiles (0–10,000 m AGL), IWV, LWP |
| Radiosondes | Kumasi, Savè | T, RH, P, WS, and WD profiles (0–20,000 m AGL) |
| Tethered radiosonde | Ile-Ife, Savè | T and RH profiles (every 3 h) (0–600 m AGL) |
| Frequent radiosonde | Kumasi, Savè | T, RH, P, WS, and WD profiles (0–1,600 m AGL) |

**Measurements of dynamics and thermodynamics in the boundary layer and above**

| Instrument | Site       | Measured parameters                                      |
|------------|------------|----------------------------------------------------------|
| Cloud radar | Savè | Radial velocity and reflectivity profiles (150–15,000 m AGL) |
| Ceilometer | Kumasi, Savè | Aerosol backscatter profiles (15–15,000 m AGL) |
| X-band radar | Savè | Precip distribution (horizontal range: 100 km) |
| MRR, distrometer | Kumasi, Savè | Precip, drop size distribution |
| Infrared radiometer | Kumasi, Savè | Cloud-base T |
| Hand-held infrared radiometer | Ile-Ife, Savè | Cloud-base T |
| Cloud camera | Kumasi, Savè | Visible and infrared sky image |
| Sun photometer | Kumasi, Savè | Aerosol optical depth |
| Hand-held sun photometer | Ile-Ife, Savè | Aerosol optical depth |

**RPASs at Savè site**

| RPAS | Site       | Measured parameters                                      |
|------|------------|----------------------------------------------------------|
| Aladina | Savè airfield | T, RH, P, WS, WD |
| Ovli   | Savè site  | T, RH, P, WS, WD |
Fig. ESS. Launching frequencies at the seven DACCIWA radiosonde stations in Jun 2016. Green dots: operational data; blue dots: DACCIWA radiosondes, with red markers indicating that the radiosonde was lost before reaching 500 hPa. Data are available at high vertical resolutions of 5–10 m.
### July

|                | DACCIWA | Operational | NIMET Hi-Res | NIMET Non-Hi-Res | Did not reach 500 hPa |
|----------------|---------|-------------|---------------|------------------|-----------------------|
| Abidjan        |         |             |               |                  |                       |
| Accra          |         |             |               |                  |                       |
| Cotonou        |         |             |               |                  |                       |
| Kumasi         |         |             |               |                  |                       |
| Lamto          |         |             |               |                  |                       |
| Parakou        |         |             |               |                  |                       |
| Save           |         |             |               |                  |                       |
| Lagos          |         |             |               |                  |                       |
| Abuja          |         |             |               |                  |                       |
| Calabar        |         |             |               |                  |                       |
| Enugu          |         |             |               |                  |                       |
| Kano           |         |             |               |                  |                       |

**Fig. ES6.** As in Fig. ES5, but for Jul 2016.
| Table ES. II. Instruments in Jul 2016 at the four sites for urban campaigns. |
|---------------------------------------------------------------|
| Passive samplers ($\text{NO}_x$, $\text{NH}_3$, $\text{HNO}_3$, $\text{SO}_2$, $\text{O}_3$): bimonthly sampling |
| PM2.5 aerosol (mass, black carbon, organic carbon, ions, etc.): weekly sampling |
| Aerosol optical depth measurements (UFHB Abidjan, Cotonou University) |
| Epidemiological survey |
| Three impactors in parallel during 3 h: ultrafine, fine, and coarse particles |
| Carbonaceous aerosols, water soluble organic carbon, redox capacity |
| Aerosol mass, ions |
| In vitro biological analysis: cytotoxicity assays, oxidative stress, proinflammatory response |
| Personal exposure: PM2.5 and aerosol chemistry measurements on the following: |
| Two kids living near the waste burning site at Abidjan |
| Two women living near the domestic fire site at Abidjan |
| Two zem drivers at Cotonou |
| Emission factor measurements from Jul 2015 to Jul 2016: wood and charcoal burning, charcoal making, waste burning, different specific vehicles (old and new, two wheels, buses, taxis, personal vehicles, etc.) |