Cyclogenesis in the tropical Atlantic: First scientific highlights from the Clouds-Atmospheric Dynamics-Dust Interactions in West Africa (CADDIWA) field campaign

Supplement

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A Joint venture across the North Atlantic: the Joint Aeolus Tropical Atlantic Campaign JATAC

The CADDIWA aircraft campaign was part of a larger experimental consortium that operated under the umbrella of the “Joint Aeolus Tropical Atlantic Campaign” (JATAC) supported by the European Space Agency (ESA) and the National Administration of Space and Aeronautics (NASA). The SAFIRE F20 operations were coordinated with the deployment of three other aircraft (see Table ES1), as well as with the ground-based supersite implemented specifically in Mindelo in the framework of the ASKOS initiative under the auspices of the Ocean Science Center in Mindelo, on São Vicente Island. The Karlsruher Institut für Technologie (KIT) also contributed to JATAC by sending PhD student Maurus Borne in charge of launching meteorological balloons from the Sal airport at the time of the Aeolus overpasses as well as during aircraft operations. The Deutsches Zentrum für Luft- und Raumfahrt (DLR) and SAFIRE Falcons operated from the Island of Sal, while the Aerovizija Advantic WT-10 operated from Mindelo and the NASA DC-8 from St Croix in the US Virgin Island.

The SAFIRE F20 has a typical range of 1400 NM, an autonomy of 3.5 h and a ceiling of 12 km amsl when loaded with scientific equipment, as was the case for CADDIWA. While cruising between 8 and 12 km amsl, the typical so-called science speed (ensuring optimal measurements quality) is
~200 m s⁻¹ (minimum speed is 82 m s⁻¹ and maximum speed is max 254 m s⁻¹, depending on flight level).

<table>
<thead>
<tr>
<th>Component</th>
<th>Aircraft</th>
<th>Detachment period</th>
<th>Detachment site</th>
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<tbody>
<tr>
<td>CADDIWA</td>
<td>Safire Falcon 20</td>
<td>6-23 September 2021</td>
<td>Sal (Cape Verde)</td>
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<tr>
<td>AVATART</td>
<td>DLR Falcon 20</td>
<td>6-28 September 2021</td>
<td>Sal (Cape Verde)</td>
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<td>CEPEX-AW</td>
<td>NASA DC-8</td>
<td>19 August-10 September 2021</td>
<td>St Croix (US Virgin Islands)</td>
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<tr>
<td>CAVA-AW</td>
<td>Aerovizija Advantic WT-10</td>
<td>6-19 September 2021</td>
<td>Sao Vincente (Cape Verde)</td>
</tr>
</tbody>
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Table ES1. JATAC components and aircraft involved, detachment periods and detachment sites.

Daily JATAC coordination meetings with DLR (physically) and other JATAC participants (remotely) were conducted under the guidance of ESA. A JATAC quicklooks meeting was held on 19 September at Hotel Morabeza together with DLR and KIT teams and remotely with the ASKOS and CAVA-AW teams. A 2-day CADDIWA quicklooks hackathon was held on 23 and 24 September, after the cessation of the aircraft operations during which all the measurements acquired during the campaign were presented in depth and discussed to define paths towards publication.

The CADDIWA team

The CADDIWA science team in Cape Verde had 3 components:

- a three-person-team dedicated to the set-up and maintenance of a dedicated GNSS station. The GNSS station was used to monitor TCWV in Sal and incoming weather events. It was installed at the Instituto Nacional de Meteorologia e Geofisica close to the Amilcar Cabral International Airport on Sal: Thomas Donal (Institut national de l’information géographique et forestière, IGN), Mateus Andrade and Nicolau Araujo (University of Cape Verde),

- a two-person-team dedicated to boat-borne operations around the island of Sao Vincente to study of the capability of the LNG lidar onboard the SAFIRE F20 to retrieve sea water optical properties in the upper-ocean and to validate of the Aeolus-derived oceanic
products. It was based in the Ocean Science Center in Mindelo: Cédric Jamet and Eric Lecuyer (LOG),

- a large 23-member team dedicated to airborne operations from the Amilcar Cabral International Airport. The near-complete aircraft team is presented in Figure ES1 in front of the SAFIRE F20 in a hangar and on the tarmac of the airport. The 23 scientists and engineers were from the Centre National de la Recherche Scientifique (CNRS) mixed research units (LATMOS in Paris and Guyancourt, LAERO in Toulouse, IGE in Grenoble, LaMP in Clermont), Météo-France, as well as from the Scuola Universitaria Superiore IUSS of Pavia and the University of Cape Verde in Praia:
  - The Science Director: Cyrille Flamant (LATMOS)
  - The instruments scientists:
    - LNG lidar: Hélène Collomb and Sophie Bounissou (LATMOS) – supported by Quitterie Cazenave (LATMOS) as well,
    - RASTA radar: Quitterie Cazenave, Christophe Caudoux (LATMOS), and Clémantyne Aubry (LATMOS/DLR),
    - Microphysics: Pierre Coutris and Guy Febvre (LaMP);
  - The forecasts supporting cast for the aircraft operations: Marco Gaetani (Scuola Universitaria Superiore IUSS), Jean-Pierre Chaboureau and Azusa Takeishi (LAERO), Christophe Lavaysse (IRD), Tanguy Jonville and Cédric Gacial Ngoungué Langué (LATMOS), Mateus Andrade and Nicolau Araujo (University of Cape Verde);
  - The aircraft operator SAFIRE, with the Ops manager Aurélien Bourdon, 2 pilots Jean-Francois Bourdinot (SAFIRE) and Dominique Duchanoy (SAFIRE) and 1 mechanic Thierry André (SAFIRE). The SAFIRE was completed with 3 flight engineers and instrument specialists: Hubert Bellec (SAFIRE), Tetyana Jiang (SAFIRE) and Gilles Vergez (SAFIRE).
Figure ES1: The near-complete CADDIWA team photographed at the Amilcar Cabral International Airport on 18 September 2021 before SAFIRE F20 flight F12. Top from left to right: Aurélien Bourdon, Jean-François Bourdinot, Pierre Coutris, Dominique Duchanoy, Sophie Bounissou, Gilles Vergez, Nicolau Gomes Araujo, Cyrille Flamant, Mateus Neves Andrade, Hubert Bellec, Cédric Gacial Ngoungué Langué, Hélène Collomb, Quitterie Cazenave, Tanguy Jonville, Clémantyne Aubry, Jean-Pierre Chaboureau, Guy Febvre, Christophe Caudoux and Marco Gaetani. Bottom from left to right: Aurélien Bourdon, Nicolau Gomes Araujo, Guy Febvre, Marco Gaetani, Dominique Duchanoy, Pierre Coutris, Gilles Vergez, Cyrille Flamant, Jean-Pierre Chaboureau, Thierry André, Tanguy Jonville, Hélène Collomb, Cédric Gacial Ngoungué Langué, Quitterie Cazenave, Sophie Bounissou, Tetyana Jiang, Mateus Neves Andrade, Clémantyne Aubry, Hubert Bellec, Christophe Caudoux, Maurus Borne. Missing from the photos: Christophe Lavaysse, Azusa Takeishi.

Dedicated daily CADDIWA forecasting support

The regional aerosol simulations paramount to the project were carried out using two state-of-the-art French national “codes communautaires”, namely WRF-CHIMERE (Menut et al., 2021) and Meso-NH (Lac et al., 2018). CHIMERE is a chemistry-transport model forced by meteorological fields of WRF.
Pre-selected plots for the meteorology and aerosol/chemistry forecasts made with the Meso-NH and CHIMERE were made available through bulletins produced automatically at the end of each simulations on dedicated pages:

- [https://www.lmd.polytechnique.fr/~menut/cad3fcst/](https://www.lmd.polytechnique.fr/~menut/cad3fcst/)

Plots from the Meso-NH simulations can also be accessed directly from [http://mesonh.aero.obs-mip.fr/cgi-bin/chaboureau/selec.pl](http://mesonh.aero.obs-mip.fr/cgi-bin/chaboureau/selec.pl).

These web sites are still active and bulletins and plots can be downloaded for genuine research purposes. They include (Figure ES2):

- Time series of hourly AOD, planetary boundary layer height, surface dust concentration, precipitation, 2-m temperature and 10-m winds in Bodélé (Chad), Niamey (Niger), Dakar and St Louis (Senegal), Nouakchott (Mauritania), Sal and Mindelo (Cap Verde),
- Maps of dust AOD with overlain winds at 4 km amsl and IR brightness temperature at 10 µm, surface dust concentrations with 10-m winds overlain, Dust RGB mimicking SEVIRI products, TCWV, and precipitation on the large simulation domains,
- Same maps as above, but on a domain zoomed around Cape Verde,
- Vertical cross-sections of dust concentrations with overlain winds in the cross-sections, liquid water content (LWC) and rain along 3 longitudes (18°W, 23°W and 28°W) and 3 latitudes (12°, 17° and 22°N),
- And for the inner domain of Meso-NH, vertical cross-sections of dust concentrations with overlain winds in the cross-sections, liquid water content (LWC) and rain along morning and afternoon Aeolus tracks (0800 and 1900 UTC, when orbits were in the domain) and along the MetOp-C orbit (1100 UTC).
Figure ES2: (a) Meso-NH forecast on the 16-km domain of dust AOD (warm colors) with overlain winds at 4 km amsl (arrows) and IR brightness temperature at 10 µm (cold colors) at 1900 UTC on 10 September 2021 (D+1 forecast from run initiated on 9 September and available at 1000 UTC on 10 September, D corresponding to the first day of the forecast). (b) Same as (a) but for SEVIRI-like dust RGB product. (c) Same as (a) but for the 4-km domain. The outer circle materializes the maximum range of the SAFIRE F20. The black line represents the afternoon Aeolus track. (d) Vertical cross-sections of dust extinction with overlain winds in the cross-sections, liquid water content (cold colors) and isentropes along the afternoon Aeolus track. (e) CHIMERE forecast on the 60-km domain of dust AOD (warm colors) with overlain winds at 4 km amsl (arrows) at 1900 UTC on 10 September D+1 forecast from run initiated on 9 September and available at 0500 UTC on 10 September). (f) Same as (e) but on the 4-km domain.