**ORCESTRA: ORganized Convection and EarthCare Studies over the TRopical Atlantic**

**Overarching objective:**
Better understand physical mechanisms that organize tropical convection at the mesoscale, and the impact of convective organization on climate and Earth’s radiation budget

Members of ORCESTRA:
- MAESTRO
- PERCUSION
- BOW-TIE
- PICCOLO
- SCORE
- CELLO

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ORCESTRA-PICCOLO
Process Investigation of Clouds and Convective Organization over the Atlantic Ocean

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ORCESTRA-PICCOLO

• Deploy the SEA-POL radar on the RV Meteor, to characterize the properties of precipitation and its mesoscale organization.

• SEA-POL is the Colorado State University (CSU) Sea-Going Polarimetric Radar, a National Science Foundation (NSF) community facility.

• Goals:
  • Investigate the nature, governing mechanisms, and impact of mesoscale organization of precipitating deep convection in the context of the Atlantic ITCZ.
  • Characterize the importance of localized internal feedbacks in relation to large-scale external forcing in the control of convective upscale growth and mesoscale organization.

PICCOLO is funded by the National Science Foundation.
About SEA-POL

- Wavelength/Frequency: C-band (5 cm, 5.65 GHz)
- Antenna diameter: 4.3 m (5.4 m fiber glass radome)
- Measures Dual-polarization
- Built for harsh environments:
  - An inertial navigation unit (INU) measures ship motion and sends compensation commands to the antenna positioner.
  - Doppler velocity data is also corrected for ship velocity. This permits high quality data to be collected at sea, correcting for ship roll and pitch up to 7 degrees.
SEA-POL data

Dual-polarized data:

- Specific Differential Phase (Kdp)
- Differential Reflectivity (Zdr)
- Hydrometeor type (Level-3 product, using CSU-radar package algorithm)
- Sensitivity: -7 dBZ at 100 km
- PPI range ~150 km,
- RHI range ~100 km

(a) Radar reflectivity and (b) polarimetric hydrometeor identification of an MCS observed by a SEA-POL radar RHI scan during PRECIP on 29 July 2022. (image: NOAA)
1. **Real-time imagery** will be uploaded to the SEA-POL website (almost real-time) if bandwidth allows.

2. **Level 1 data**: all the measurements as is (reflectivity, Doppler velocity, dual-pol data)

3. **Level 2 data**: format converted and QC’ed. will be delivered *no later than 3 months after the end of the deployment.*

4. **Level 3 data**: additional QC & scientific processing including
   - Removal of non-meteorological echoes
   - Cartesian gridding
   - Hydrometeor Identification
SEA-POL on R/V Meteor

Sea-Pol radome being installed on R/V Roger Revelle (2017 Spurs)

Possible arrangement of SEA-POL
(courtesy of Karsten Heikens)

- Portion of radar coverage area blocked for bridge operation
- Exact blocking angle range is TBD
SEA-POL operation & scan strategy

- 24-hour continuous operation
- PPI volumes and RHI slices at pre-defined angles for unbiased statistics
- Some user-selected scans to boost RHI sampling of convective targets and coordinate retrievals with other platforms

Radar shelter container: operation center & radar workstation (1 or 2 engineers on board)
- Transmitter, Signal processor
- Power conversion and distribution
- Data storage
- Tools and hardware

Elevation angles used in the PISTON 2019 rain mapping PPI volumes.
PICCOLO Objectives

*Investigate the nature, governing mechanisms, and impact of mesoscale organization of precipitating deep convection in the context of the Atlantic ITCZ*

**Objective 1:**
Evaluate observed process relationships between precipitation, humidity, and convective organization in comparison to numerical simulations.

**Objective 2:**
Use advanced polarimetric radar retrievals to investigate the microphysical, dynamical, and radiative characteristics of convection in relation to mesoscale organization.

**Objective 3:**
Investigate the importance of radiative processes in relation to large-scale forcing in driving mesoscale convective organization using field observations.

**Objective 4:**
Use novel observational approaches to compute the entropy budget to advance our understanding of organized convection and its impacts on the climate system.
PICCOLO Science Overview

**Objective 1:** Precipitation, Humidity & Organization
- H1: Increasing stratiform area fraction and column moisture lead to greater volumetric rainfall in association with convective upscale development.

**Objective 2:** Microphysical Characteristics
- H2: Cloud-radiative feedbacks are essential to driving mesoscale organization under conditions of weak vertical wind shear.

**Objective 3:** Importance of Radiative Processes
- H3: The time scale of cloud-circulation coupling increases with convective upscale growth, resonating with the diurnal cycle of radiative heating in highly organized states.

**Objective 4:** Entropy Budget
- H4: Mesoscale organization reduces the rate of work performed by moist convection, in spite of reduced production of entropy by hydrometeor sedimentation.

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**Table:**

<table>
<thead>
<tr>
<th>Tier</th>
<th>Type</th>
<th>Model(s)</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>Idealized (H1)</td>
<td>30-member RCEMIP ensemble [159, 160]</td>
<td>GCMs (100 km grid), CRMs (6000 x 4000 km² domain, 3 km grid)</td>
</tr>
<tr>
<td>Tier 2</td>
<td>Semi-Realistic (H1–H4)</td>
<td>CM1 [19], SAM [61], WRF-ARW [128]</td>
<td>~300 x 300 km² domain, 300 m grid.</td>
</tr>
<tr>
<td>Tier 3</td>
<td>Semi-Realistic (H1–H4)</td>
<td>WRF-ARW [128]</td>
<td>~4000 x 3000 km² domain, 3 km grid.</td>
</tr>
<tr>
<td>Tier 4</td>
<td>Realistic (H1–H4)</td>
<td>ICON [48, 62]</td>
<td>Global coupled (1 km grid), Atlantic basin atmos-only (300 m grid).</td>
</tr>
</tbody>
</table>

Provided by: SEA-POL, Other instruments on Meteor, Models, Dropsondes.
Other Instruments
BOW-TIE instrumentation — Atmosphere

Atmospheric profiles of Humidity, Wind, Temperature, Clouds, and Aerosol
(RAMAN LiDAR - 1064, 532, 355 nm, Radiosondes, Wind LiDAR, W-band cloud radar, Drones*)

3D Precipitation field *(PICCOLO: CSU Sea-Pol C-band scanning Rain Radar)*

Cloud base height, Cloud Water and Water Content
(Ceilometer, Microwave radiometer, GPS Met.)

Precipitation, Surface Wind Speed and Direction, Sea-Surface Temperature, Surface fluxes, Aerosols
(Disdrometer, Infrared Thermometer, Sea snakes, Onboard Weather Station, Ultra-Sonic Anemometer/Thermometer, Open-path gas analyser, Aerosol Spectrometer)

+ Upper ocean measurements

*Funding decision still pending
A HIGH-ALTITUDE LONG-RANGE AIRCRAFT CONFIGURED AS A CLOUD OBSERVATORY
The NARVAL Expeditions


Using dropsondes and advanced remote sensing instrumentation, the German High-Altitude Long-Range Research Aircraft (HALO) is configured for use as an airborne cloud observatory.