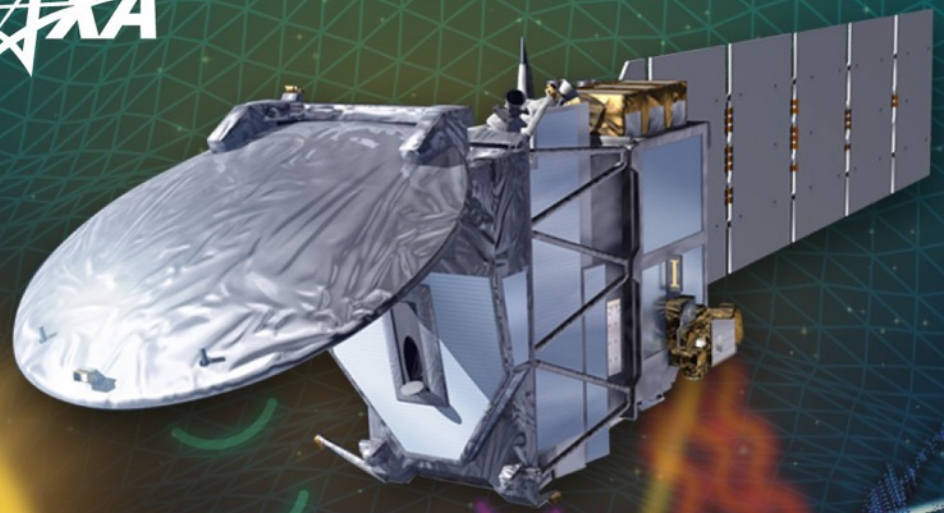


ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

13 – 17 November 2023 | ESA-ESRIN, Frascati (Rome), Italy

BOWTIE – The shipborne Trans-ITCZ Experiment

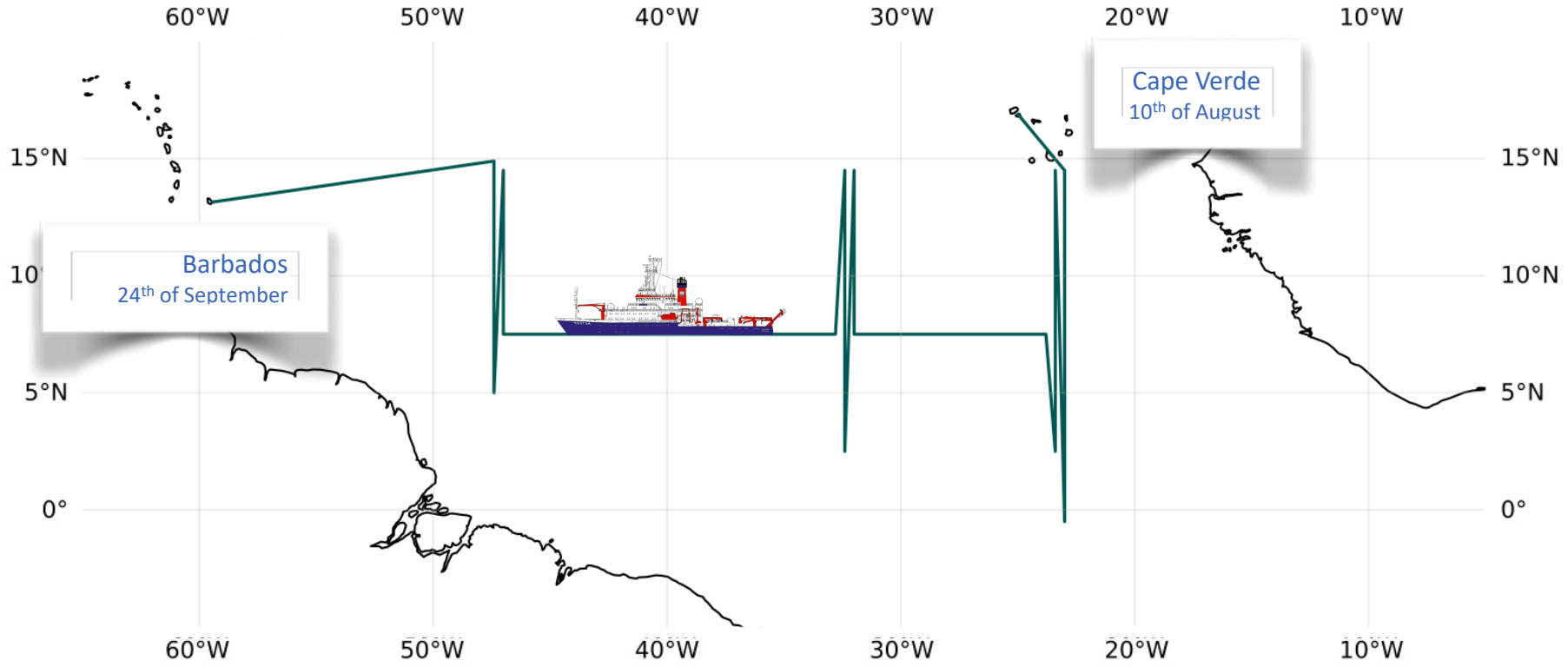
*Heike Kalesse-Los[1], **Julia Windmiller[2]**, Daniel Klocke[2], Lutz Hirsch[2], Ilya Serikov[2]*

[1] Leipzig Institute of Meteorology (LIM), Leipzig University (presenting author)

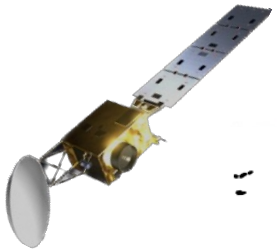
[2] MPI-Meteorology, Hamburg

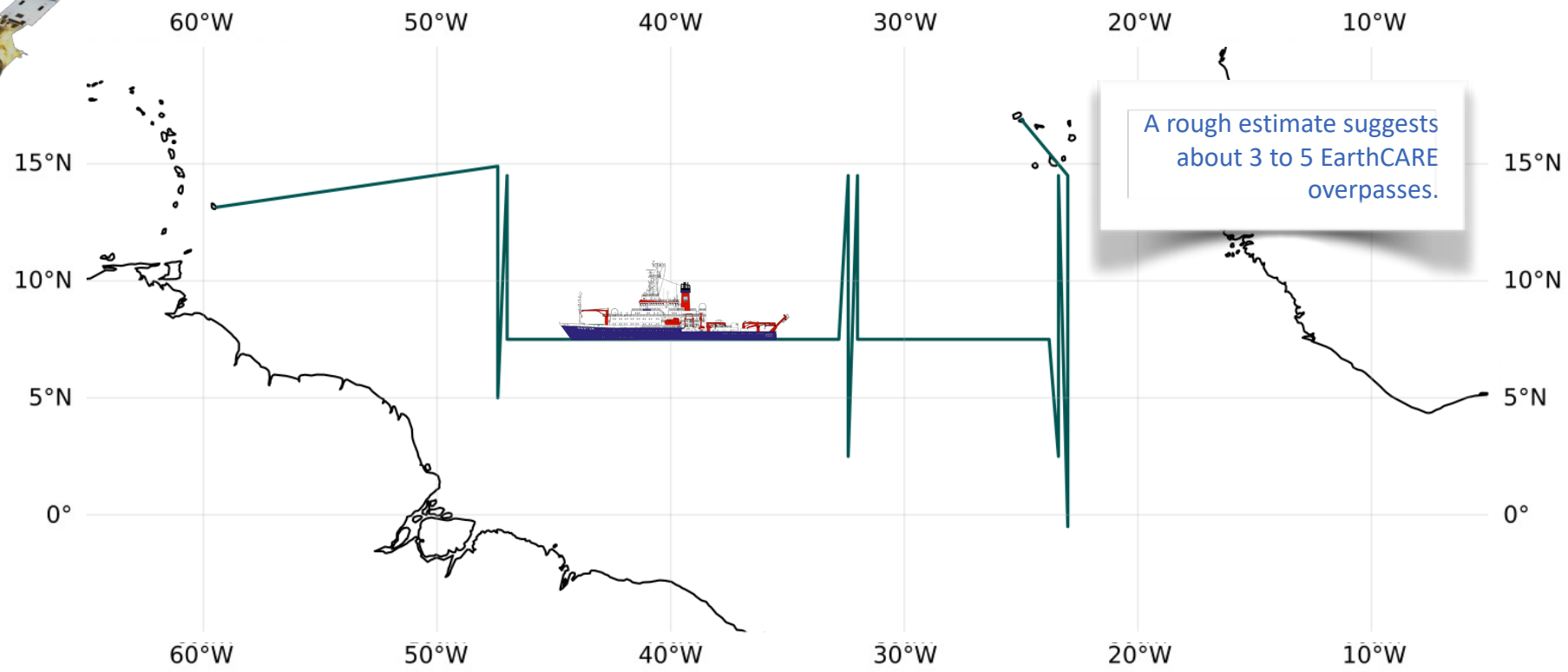
BOW-TIE — August and September 2024

Ship based measurement campaign on-board the German RV METEOR.



BOW-TIE — August and September 2024

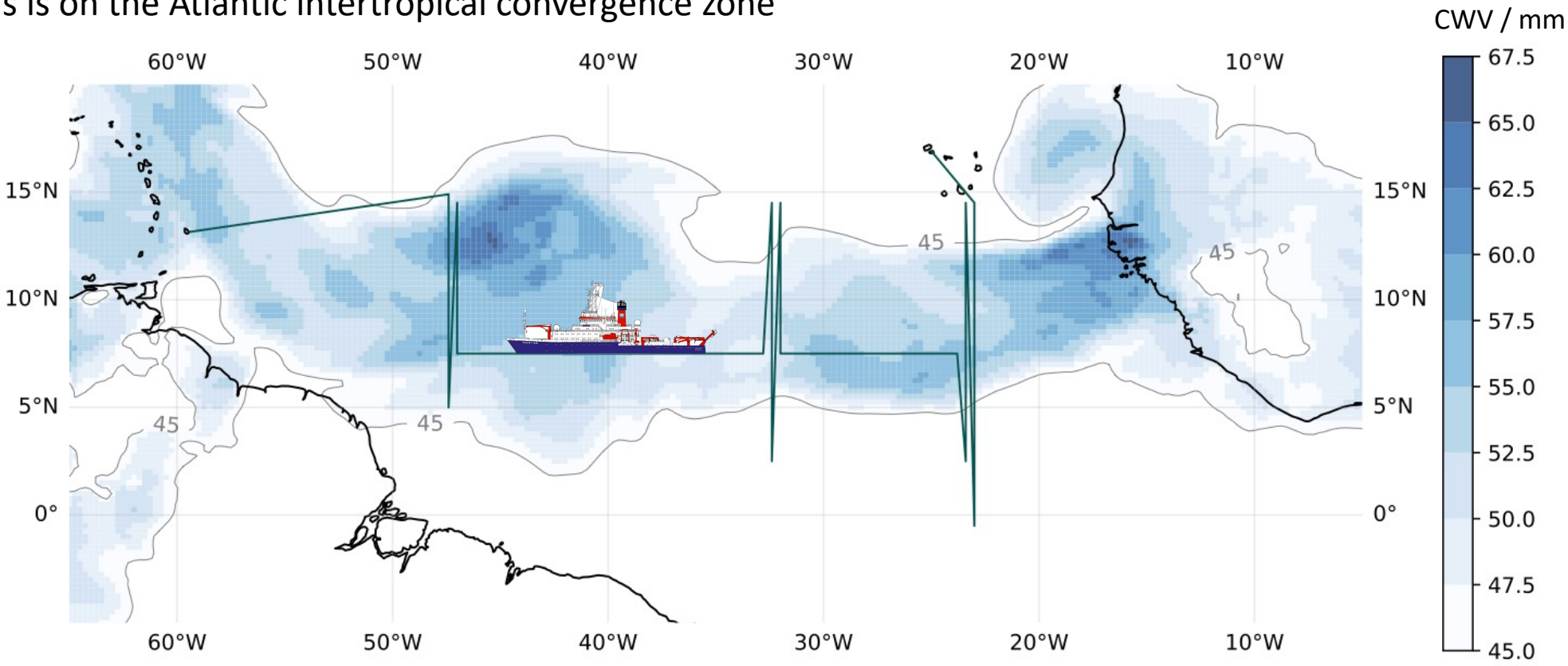




A rough estimate suggests about 3 to 5 EarthCARE overpasses.

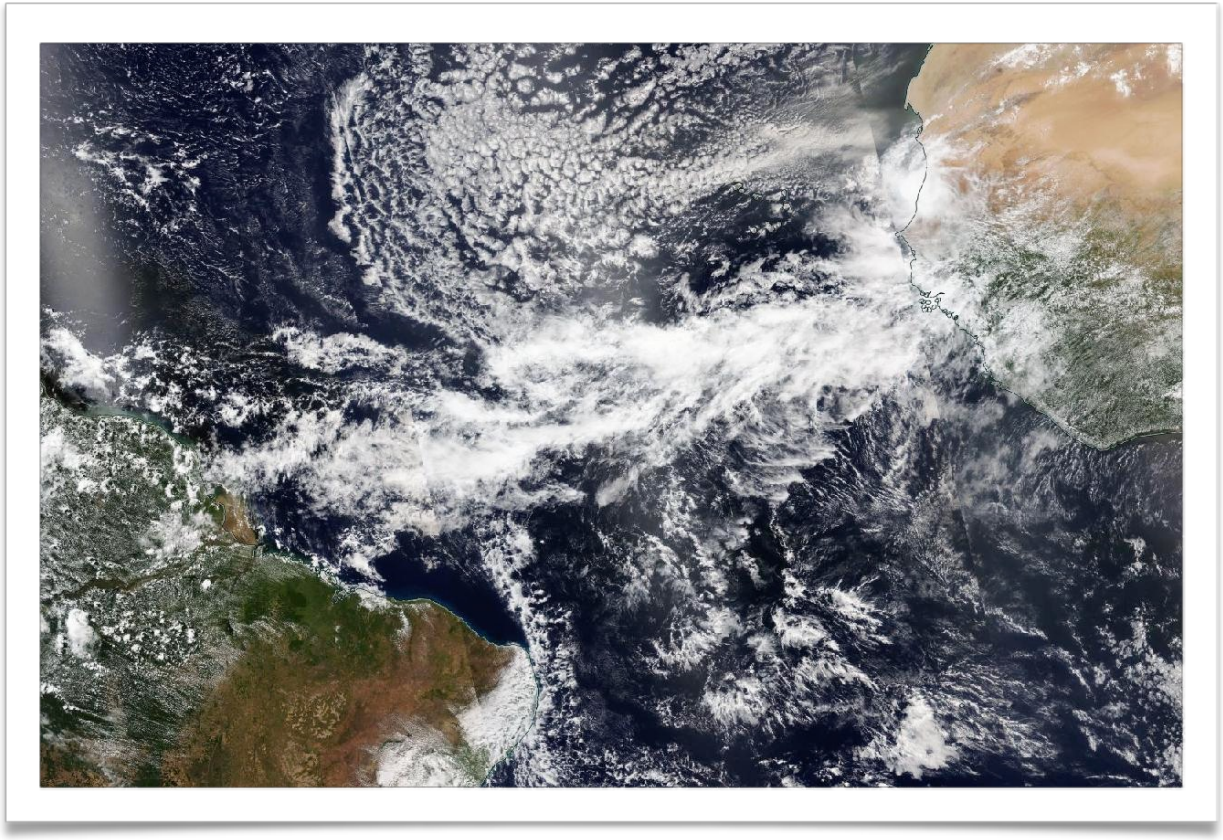
BOW-TIE — August and September 2024

Focus is on the Atlantic intertropical convergence zone



Location of the ITCZ on the 15th of August 2001 as indicated by the column water vapour field (ERA5).

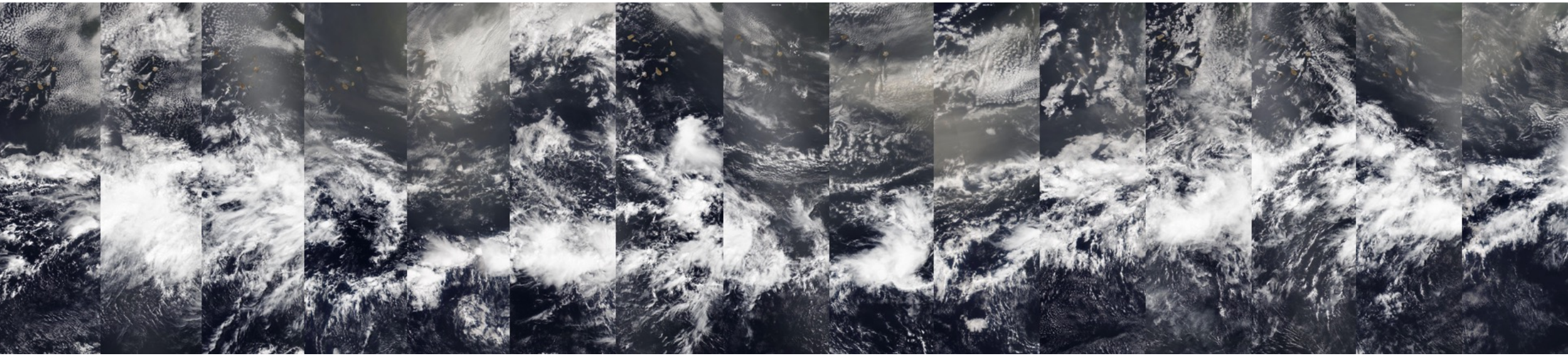
Why the intertropical convergence zone?



- As the rising branch of the Hadley circulation it structures the global circulation system
- ⅓ of the global precipitation falls within the associated latitudinal band
- Associated with a longstanding bias in climate models
- Classic picture: A line of surface convergence with clouds and precipitation centered around it

Scientific motivation

BOW-TIE seeks to understand how air-mass properties and meso-scale processes, influence the structure and dynamics of the inter-tropical convergence zone.

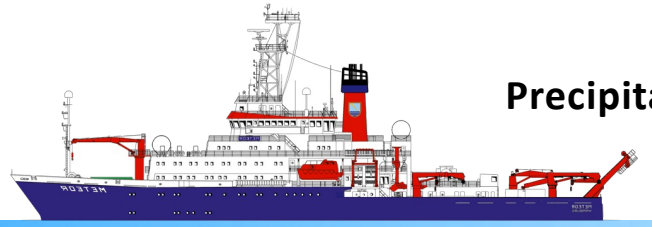


Snapshots from VIIRS (NOAA-20) from the 1st of July 2021 until the 15th of July 2021 in the East Atlantic (26°W to 20°W)

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

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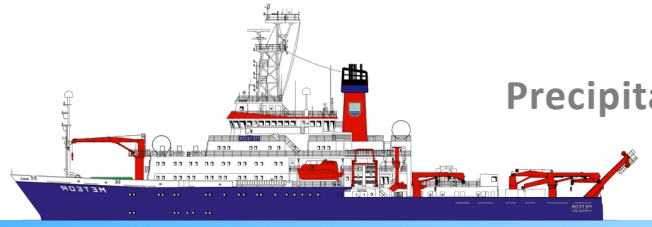

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SHIP-STABILIZED 94 GHZ RADAR, MICROWAVE RADIOMETER

Set-up from EUREC^{4}A also planned for BOW-TIE on the RV METEOR – Navigation Deck

MPI-Met HH Ceilometer

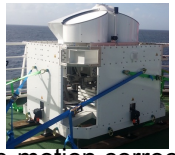
LU stabilized Cloud Radar

LU MWR

Sketch: RV Meteor Handbook

Application of Cloudnet retrieval algorithms

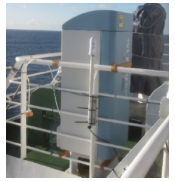
LIMRAD94
stabilized cloud radar



ship-motion corrected

LIMHAT-MWR

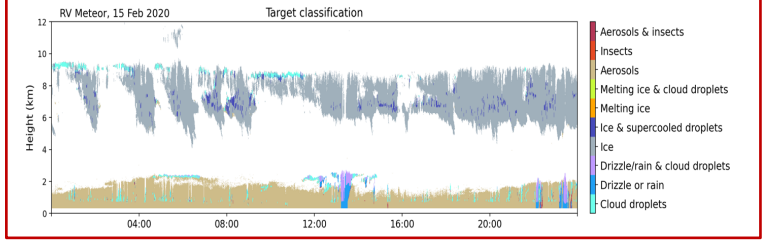
MPI-HH
Ceilometer



Cloudnet

Illingworth et al., 2007
Tukkianen et al., 2020

Hydrometeor target classification



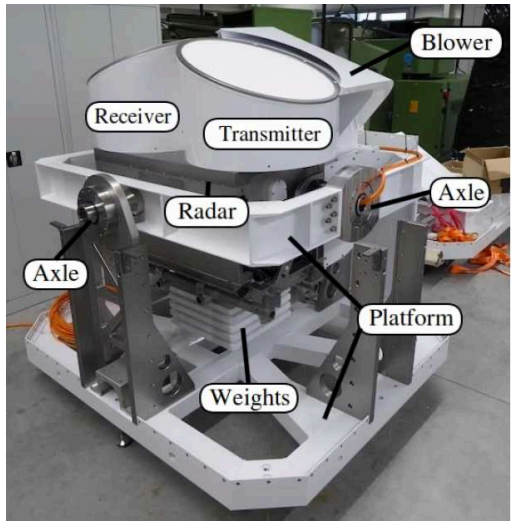
Higher level Cloudnet products

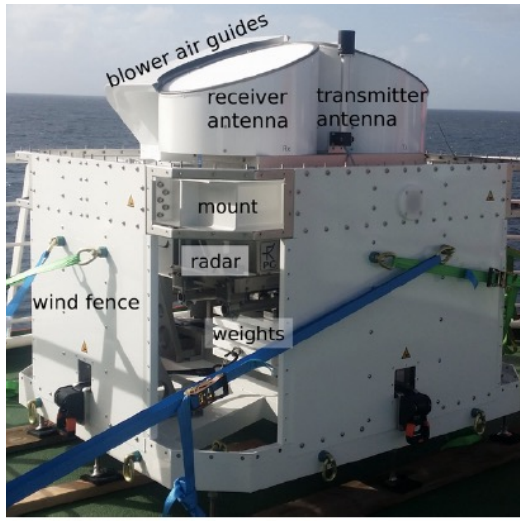
Liquid water content (LWC)
Ice water content (IWC)
Droplet effective radius
Ice crystal effective radius
Droplet number concentration

https://cloudnet.fmi.fi

94 GHz FMCW Doppler cloud radar (RPG) in ship stabilization platform

- Passive stabilization mount
- two axis cardanic mount: allows for free-swinging of radar
- max. tilt angle of radar: +- 20 deg
- 150 kg stabilization weights
- wind fence to limit wind drag on radar
- motion sensors: radar in-built, Arduino, RV Meteor Seapath in center of ship
- First voyage: eurec4a





94 GHz FMCW Doppler cloud radar (RPG) in ship stabilization platform

- Passive stabilization mount
- two axis cardanic mount: allows for free-swinging of radar
- max. tilt angle of radar: +- 20 deg
- 150 kg stabilization weights
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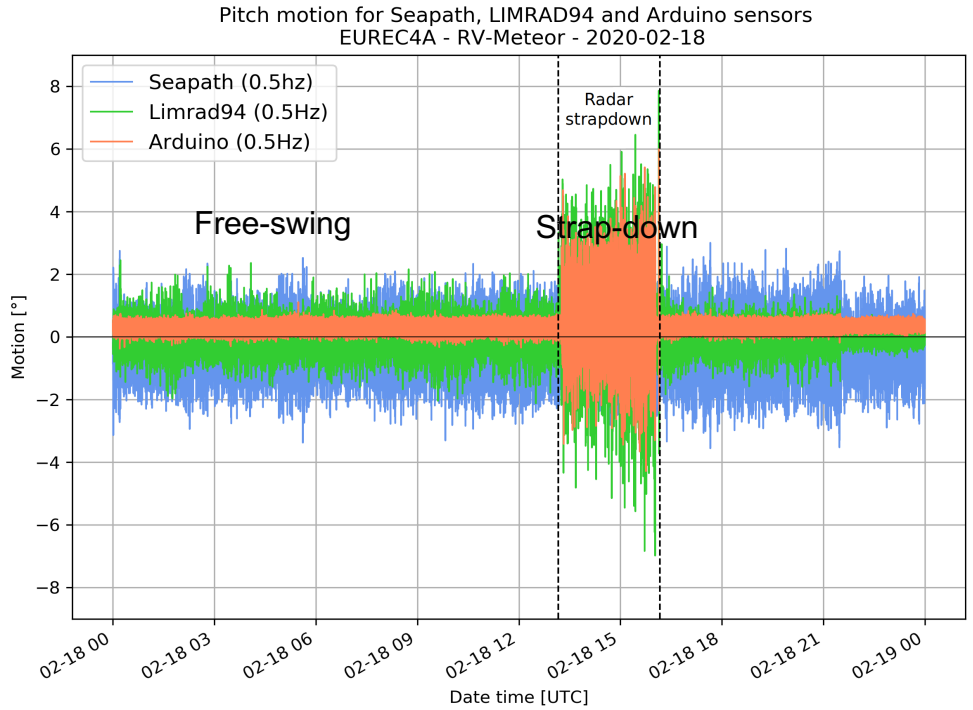
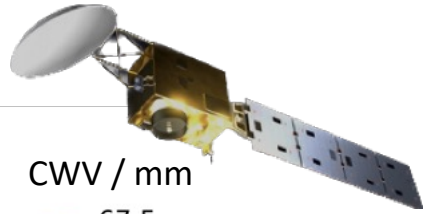
- motion sensors: radar in-built, Arduino, RV Meteor Seapath in center of ship
- First voyage: eurec4a



→ Conclusion: Stabilization platform performed satisfactory during eurec4a
→ Experienced roll+pitch angles generally < 0.4 +-0.31° (mean +- std dev)*

BOW-TIE is part of ORCESTRA



HALO

CWV / mm

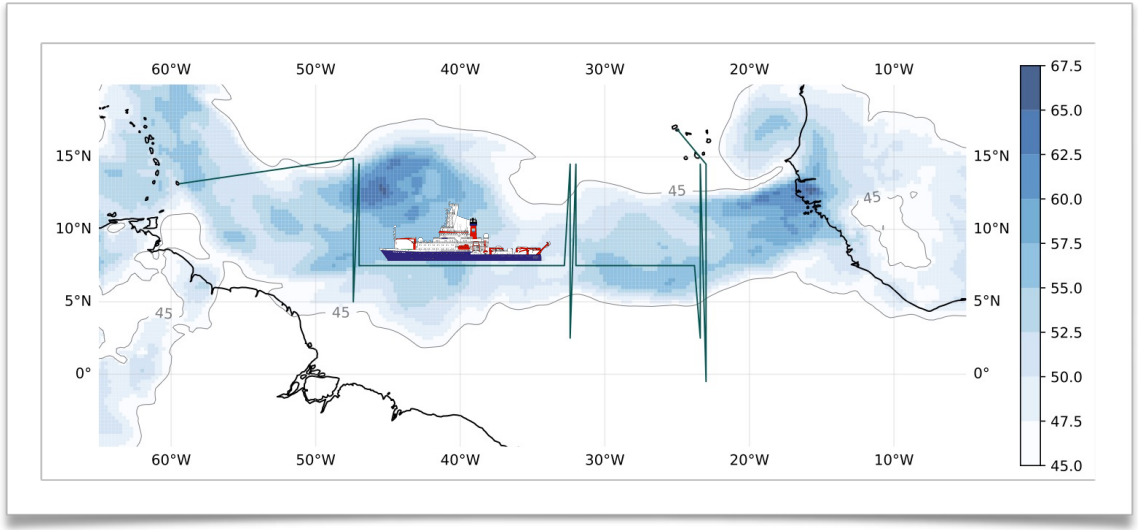
ATR42 - SAFIRE

Barbados Cloud Observatory

RV METEOR

Conclusion

- BOW-TIE is a ship based measurement campaign in the tropical Atlantic in August and September 2024
- The scientific focus is on the dynamic and thermodynamic structure of the Intertropical Convergence Zone
- About 3 to 5 EarthCARE overpasses are expected
- Different on-board atmospheric measurements may be useful for satellite validation (e.g. radiosondes)
- Core instrument for validation is the W-Band Radar from the University of Leipzig (Heike Kalesse-Los)



INSTRUMENT NAME	INSITUT	CONTACT PERSON
Microwave radiometer (HATPRO)	Uni Leipzig	Heike Kalesse-Los (heike.kalesse@uni-leipzig.de)
GPS met.	MPI-M	Pierre Bosser (pierre.bosser@ensta-bretagne.fr)
Disdrometer (x2)	MPI-M	Friedhelm Jansen (friedhelm.jansen@mpimet.mpg.de)
LIDAR	MPI-M	Ilya Serikov (ilya.serikov@mpimet.mpg.de)
Ceilometer	MPI-M	Friedhelm Jansen (friedhelm.jansen@mpimet.mpg.de)
Infrared Thermometer (skin temp.)	University of Southampton	Werenfried Wimmer (w.wimmer@soton.ac.uk)
Sea snakes (SST)	NOAA	Elizabeth Thompson (elizabeth.thompson@noaa.gov)
Radiosondes	MPI-M	Björn Brügmann (bjoern.bruegmann@mpimet.mpg.de)
Flux measurements	Uni. Hamburg	Felix Ament (felix.ament@uni-hamburg.de)
Aerosol measurements	TROPOS	Mira Pöhlker (mira.poehlker@tropos.de)
Sea-Pol	FSU	Allison Wing (awing@fsu.edu)
Drones	IGF PAN	Dariusz Baranowski (d.baranowski@igf.edu.pl)
Drones	TU Delft	Geet George (g.george@tudelft.nl)
Sunphotometer	NASA	Alexander Smirnov (alexander.smirnov-1@nasa.gov)
Wind LIDAR* (stabelized)	MPI-M	Ilya Serikov (ilya.serikov@mpimet.mpg.de)
Wind LIDAR* (stabelized?)	TU Delft	Louise Nuijens (Louise.Nuijens@tudelft.nl)
Wind LIDAR* (stabelized?)	U Leipzig	Matthias Tesche (matthias.tesche@uni-leipzig.de)
W-Band Radar (stabelized with cardanic mount)	U Leipzig	Heike Kalesse-Los (heike.kalesse@uni-leipzig.de)
Micro Rain Radar	U Leipzig	Heike Kalesse-Los (heike.kalesse@uni-leipzig.de)

CPICS (on Rosette)	HEREON	Klas Möller (Klas.Moeller@hereon.de)
UVP-6 HF (on Rosette)	HEREON	Klas Möller
WireWalker (Drifting)	HEREON	Klas Möller
UVP-6 LP (on Glider)	HEREON	Klas Möller
VPR (towed Camera)	HEREON	Klas Möller
Plankton Net	HEREON	Klas Möller
FlowCam	HEREON	Klas Möller

Ocean Gliders	GEOMAR	Marcus Dengler (mdengler@geomar.de)
Microstructure system	GEOMAR	Marcus Dengler
Drifting buoy	GEOMAR	Marcus Dengler
CTD/Rosette system	GEOMAR	Marcus Dengler
underway CTD system	GEOMAR	Marcus Dengler
Mooring equipment	GEOMAR	Marcus Dengler
Biogeochemical analysis	MPI für Marine Mikrobiologie	Wiebke Mohr (wmohr@mpi-bremen.de)

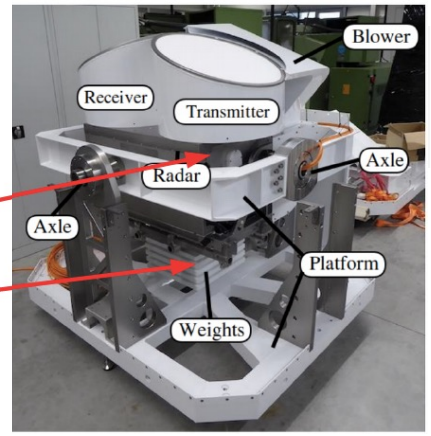
94 GHZ FMCW DOPPLER CLOUD RADAR (RPG) IN SHIP STABILIZATION PLATFORM

@eurec4a:

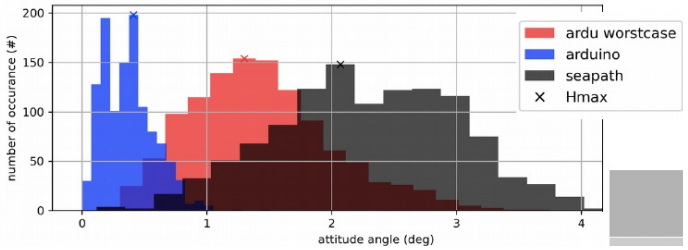
	LIMRAD94	Arduino	Ship
Res.	0.5 Hz	4Hz	10Hz
Acc.	0.02°	0.1°	0.02°

LIMRAD94 internal sensor

ARDUINO



Attitude angle PDF



New @BOWTIE:

Sensor combination

Accelerometer + (Magnetometer)
- Absolute Measurements
- Corruption by external sources
  (Ship movement, Magnetic fields)

Initialize & compensate if accelation > 1g

Gyroscope
- Undisturbed relative measurements
- Requires inital orientation
- Drifts over time