

Balloon-borne GLORIA hyperspectral Limb and Nadir imager in the LWIR

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GLORIA-AB (Gimballed Limb Observer for Radiance Imaging of the Atmosphere – Airborne) is an imaging IR spectrometer for atmospheric sounding, designed to observe the emitted radiance of the atmosphere. The main geometry is the Limb, but it can also be used in Nadir configuration.

- High spatial, temporal and spectral resolution instrument
- Ideal for the observation of mesoscale structures
- Highly adaptable for atmosphere dynamics missions or atmospheric chemistry missions
- High power, weight and maintenance requirements
- Endurance limited by data capacity and cryogenic cooling, but also by operational margins of the carrier to circa 10 hours
- A decade (2011-2021) of successful missions (ESSENCE, TACTS/ESMVal, POLSTRACC/PGS, STRATOCCLIM, WISE, SOUTHTRAC)
- Over 700 flight hours with observations contributing to many peer-reviewed papers, including in Nature Geoscience



GLORIA-AB on M55 Geophysica, Kathmandu



GLORIA-AB instrument under HALO

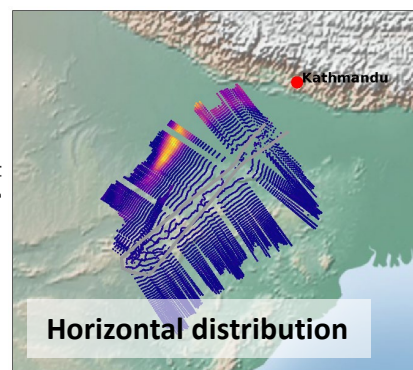
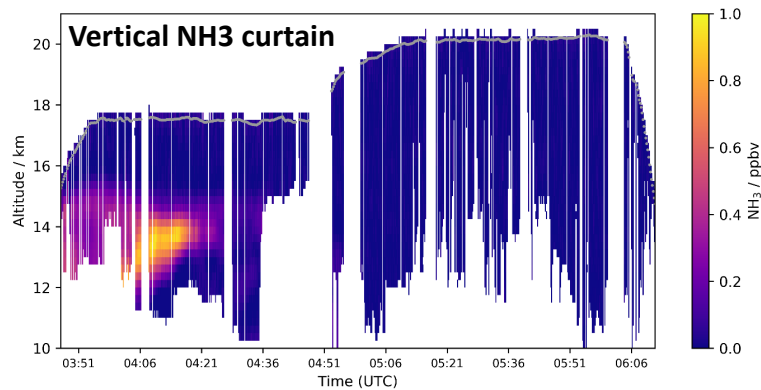
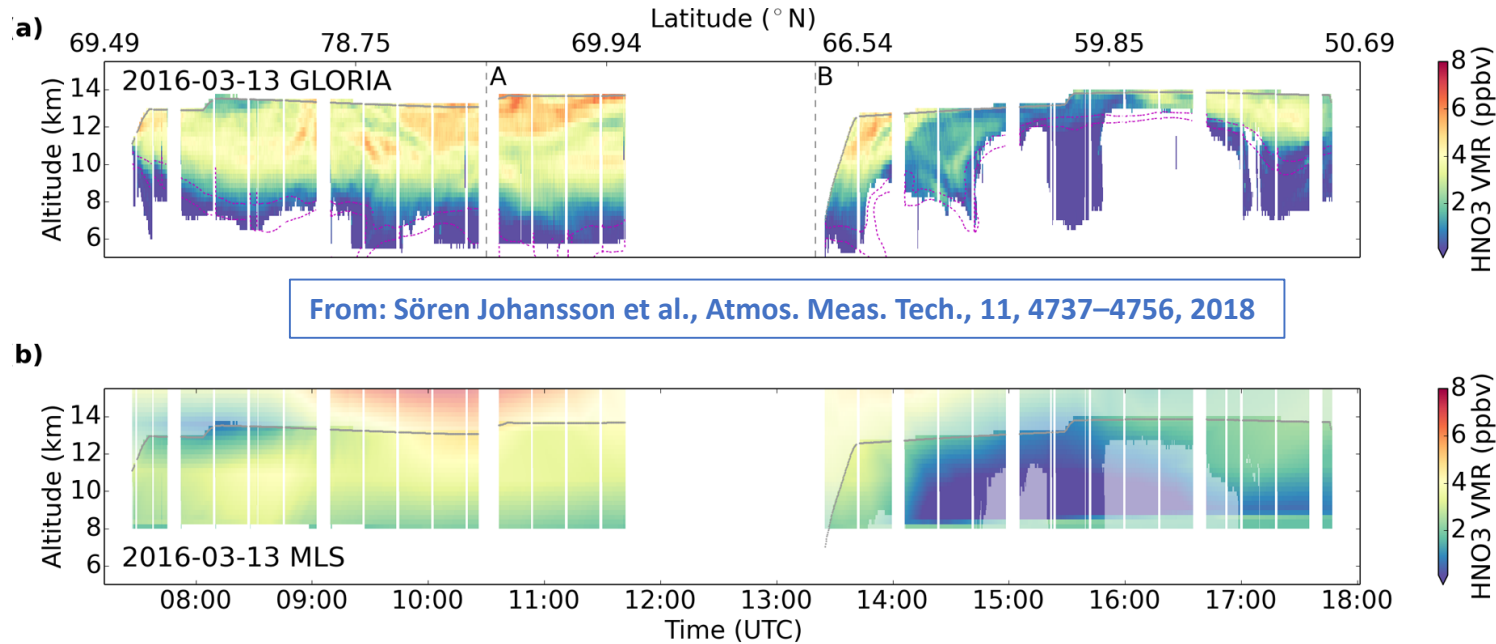


GLORIA-AB on HALO, Kiruna

Felix Friedl-Vallon et al., *Atmos. Meas. Tech.*, **7**, 3565–3577, 2014
Martin Riese et al., *Atmos. Meas. Tech.*, **7**, 1915–1928, 2014
Michael Höpfner et al., *Nat. Geosci.*, **12**, 608-612, 2019

More on GLORIA : Visit the AMT special issue
Atmospheric limb imaging with GLORIA
https://amt.copernicus.org/articles/special_issue59.html

Retrieval of HNO_3 and comparison with MLS fly-by (POLSTRACC, 2016)



NH_3 plume observation at 13 km over India (STRATOCLIM, 2017)

See: Michael Höpfner et al., Nat. Geosci., 12, 608-612, 2019

Main retrieved species and typical performances

Parameter	Spectral range (cm ⁻¹)	Estimated retrieval error ¹	Altitude resol. (km)
Temp.	810.5 – 812.9 956.0 – 958.2	0.1 – 0.2 K	0.4 – 0.9
C ₂ H ₂	759.6 – 780.9	6 – 10 pptv	0.5 – 1.5
C ₂ H ₆	819.0 – 833.1	30 – 90 pptv	0.8 – 1.5
HCOOH	1103.5 – 1116.9	10 – 15 pptv	0.3 – 0.8
PAN	780.0 – 805.0	10 – 20 pptv	0.3 – 0.8
CCl ₄	780.0 – 805.0	20 – 40 pptv	0.3 – 1.0
ClONO ₂	780.0 – 780.4	15 – 25 pptv	0.5 – 1.0
O ₃	780.6 – 787.6	10 – 20 ppbv	0.4 – 1.0
H ₂ O	795.7 – 796.1	0.5 – 3 ppmv	0.4 – 0.8
CFC-11	842.5 – 849.0	1 – 3 pptv	0.4 – 0.8
CFC-12	918.9 – 921.3	3 – 6 pptv	0.5 – 1.0
HCFC-22	828.0 – 829.9	5 – 8 pptv	0.4 – 1.3
HNO ₃	862.0 – 901.8	0.02 – 0.04 ppbv	0.4 – 0.8
NH ₃	965.0 – 968.0	3 – 5 pptv	0.5 – 1.5

¹ Error related only to the radiometric precision (NESR)

GLORIA-B (B for Balloon) is based on the spectrometer of GLORIA-AB, replacing the 3-axis gimballed frame with a single axis (elevation) stabilization. Azimuthal agility to be provided by the gondola.

The system is adapted for passive radiative thermal management, with exception of the spectrometer remaining cryogenically cooled.

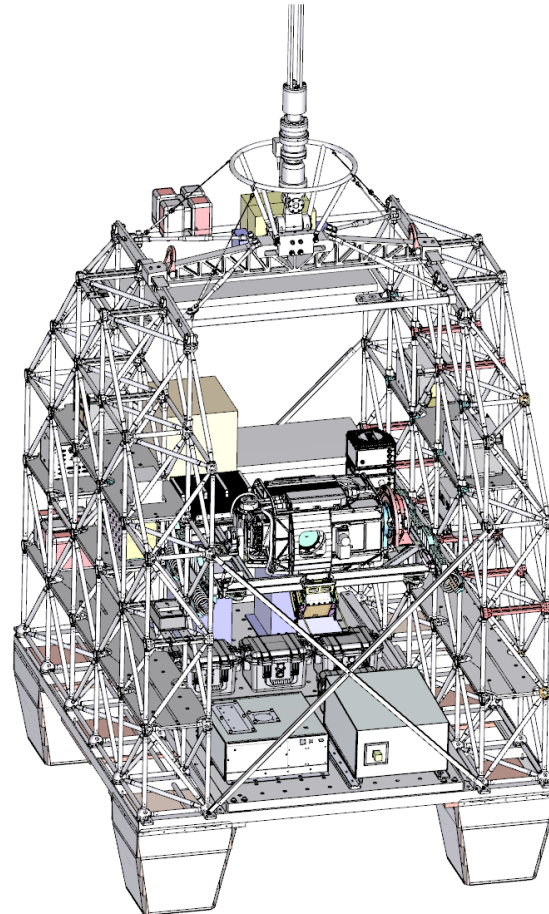


Main goals of the adaptation

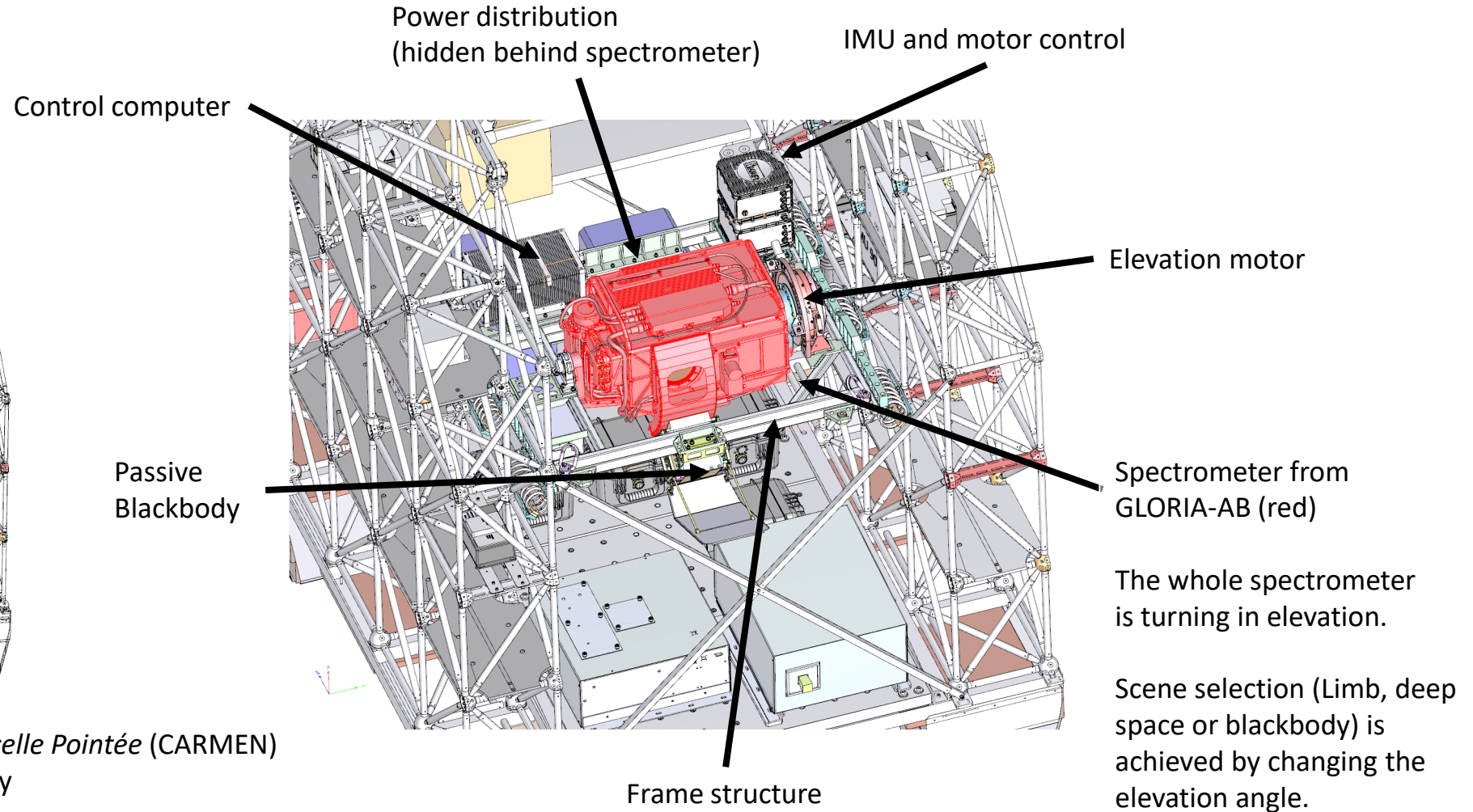
- Weight and power consumption reduction
- Thermal management for near-vacuum conditions (radiative cooling / insulation)
- Mitigation of CO₂ outgassing from cryogenic cooling
- System simplification and additional automation (no operator on board)
- Adaptation of measurement and calibration scenario for ZPB balloon flights
- Maximum reuse of existing modules to minimize development costs

Overview of the changes

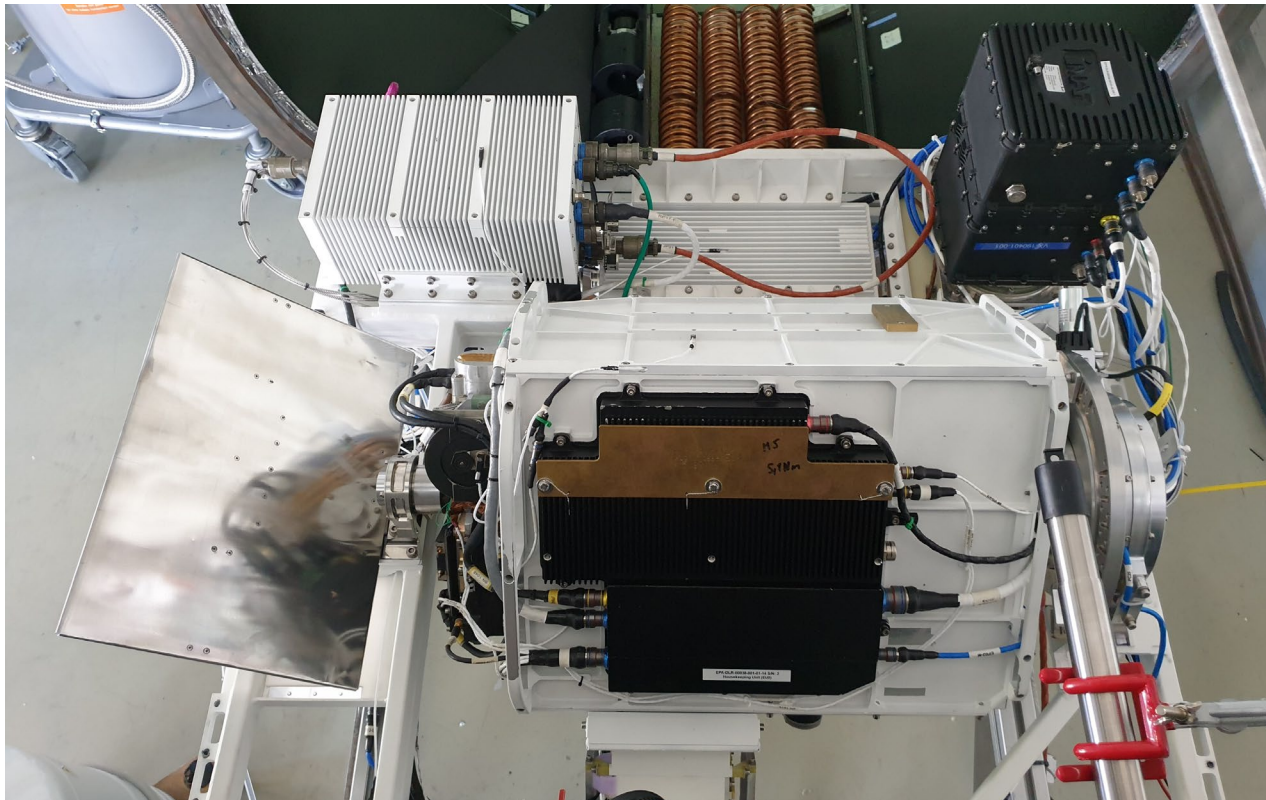
- New carrier frame designed for the CNES gondola with elevation agility only
- Dual actively cooled calibration blackbody replaced with single passively cooled blackbody
- Single Focal Plane Array (FPA) detector upgraded to dual-band-on-single-FPA detector to improve long wave sensitivity
- New optimized power and housekeeping system
- Control computer adaptation (see Neubert et al. EGU21-7447)



GLORIA-B integrated in the CNES *Nacelle Pointée* (CARMEN)
The gondola provides azimuthal agility



All components ready and tested for thermal-vacuum conditions. GLORIA-B is fully integrated on its frame with all components and being prepared for system-level thermal-vacuum testing, system functional tests, performance tests and control software finalization.



Next major milestones

- System thermal-vacuum testing for functional tests and validation of thermal management concept (May 2021)
- Integration testing with CNES (mechanical, electrical and logical) (June 2021)
- Balloon flight in Kiruna/ESRANGE in the frame of the HEMERA infrastructure project (August 2021)

GLORIA-B in preparation for thermal-vacuum testing
The spectrometer is looking into the reference blackbody
(far bottom of the image)