This presentation originally intended to be an oral presentation has suffered from Corona-related restrictions, both

- *at the preparation phase, and*
- *for the presentation.*

The authors wish to thank all partners and EGU2020 participants for their understanding

Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
National Metrology Institute

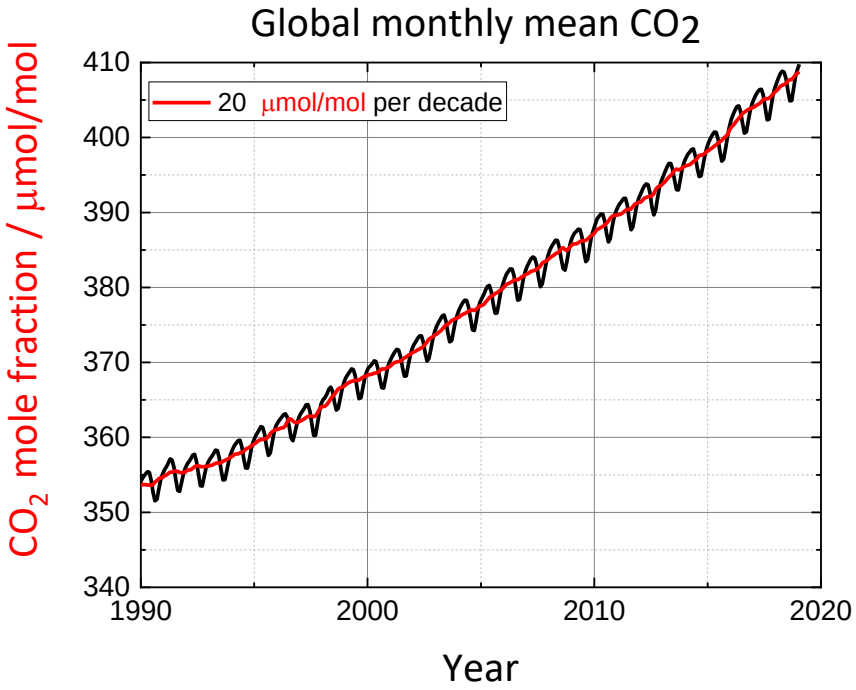
CLIMATE AND
OCEAN OBSERVATION

PTB for Climate Sciences: Combined efforts supporting the European Metrology Network for Climate and Ocean Observation

EGU GA 2020, web presentation – originally intended to be presented as oral presentation D3587 May 5th, session CL5.7.

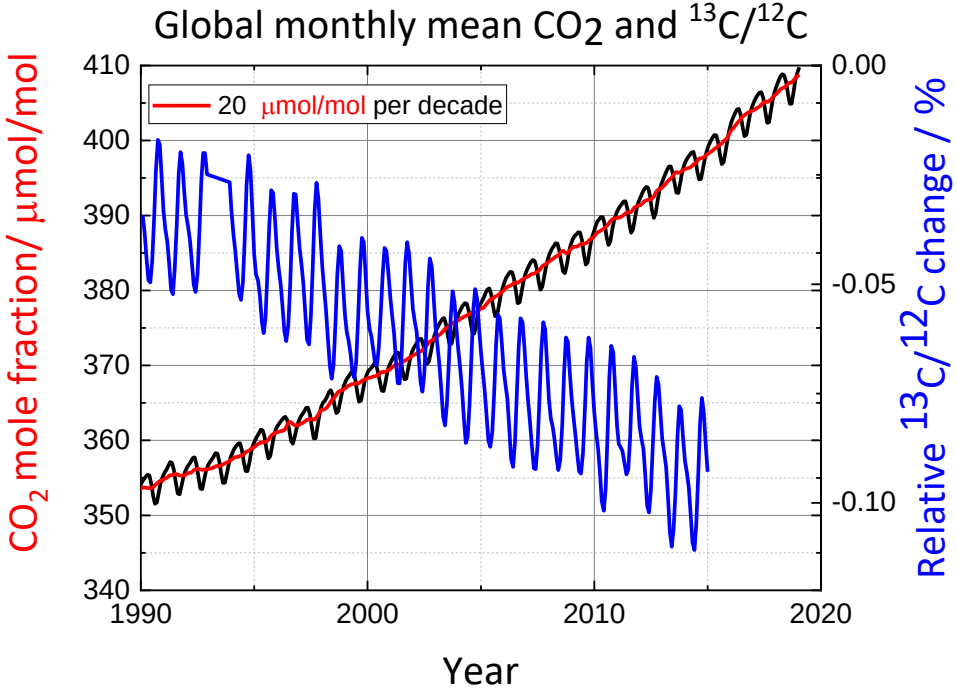
- Olav Werhahn,
Christian Monte, Steffen Seitz

CO_2 is an important greenhouse gas



How to discriminate man-made from natural contribution in the atmosphere?

CO_2 is an important greenhouse gas



How to discriminate man-made from natural contribution in the atmosphere?

About 1.1% of CO_2 contains ^{13}C isotope

Plants "prefer" ^{12}C over ^{13}C

- Fossil fuel is depleted in ^{13}C
- Combustion produces CO_2 with less ^{13}C

Isotopes are the key to understand sinks and sources of CO_2

Isotopic composition of CO_2

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Isotopes - nuclides having the same atomic number but different mass numbers.

natural abundance:

^{12}C (98.9%)	^{13}C (1.1%)	$^{14}C_{(radioactive)}$
^{16}O (99.8%)	^{18}O (0. 2%)	^{17}O (0.04%)

delta-value (sub-‰ variations):

$$\delta^{13}C = \frac{(^{13}C/^{12}C)_{sample}}{(^{13}C/^{12}C)_{reference}} - 1$$

Metrological traceability to the SI?

IAEA International Atomic Energy Agency

IAEA reference materials:
NBS 18 *(exhausted)*
IAEA 603 *(replacement)*

} *solids*

National Metrology Institutes' Input

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As for example by:

- Calibration & measurement service capabilities,
  e.g. listed under the KCDB database at the BIPM (https://www.bipm.org/en/about-us/)
- Joint Research & Joint Network Projects under the
  European Metrology Programme for Innovation and Research (EMPIR)
  - the Metrology for Stable Isotope Reference Standards (SIRS) project
    (cf. EGU 2020 presentation I. Prokhorov et al., EGU2020-221, session AS5.11)
- European Metrology Networks, as e.g.
  - the EMN for Climate and Ocean Observation

Example: SIRS

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„*Metrology for Stable Isotope Reference Standards*“
(2 M€, 3 years research project within EMPIR, HORIZON2020)

WP1:

- Static and dynamic pure CO_2 and air-CO_2 isotope reference materials
- Remeasure isotope ratios in international standards to provide data for SI traceability

WP3:

- **Advance spectroscopic CO_2 isotope ratio measurements**
- **Spectral line data measurements**

PTB @ EMN COO

CLIMATE AND OCEAN OBSERVATION

PTB is committed to all three sections of the EMN COO:

- Land and Earth observation by remote sensing, as represented by
  - the working group for Infrared Radiation Thermometry (led by Christian Monte)
- Atmosphere related metrology, as represented by the activities of
  - the working group for Spectrometric Gas Analysis (led by Olav Werhahn)
- Ocean related metrology, as represented by activities of the
  - the working group for Electrochemistry (led by Steffen Seitz)

PTB @ EMN COO Land/Earth section

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Reduced Background Calibration Facility - RBCF

Source chamber with vacuum blackbodies

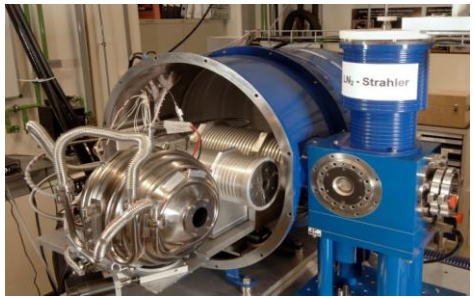
VLTBB: - 170 °C to 170 °C

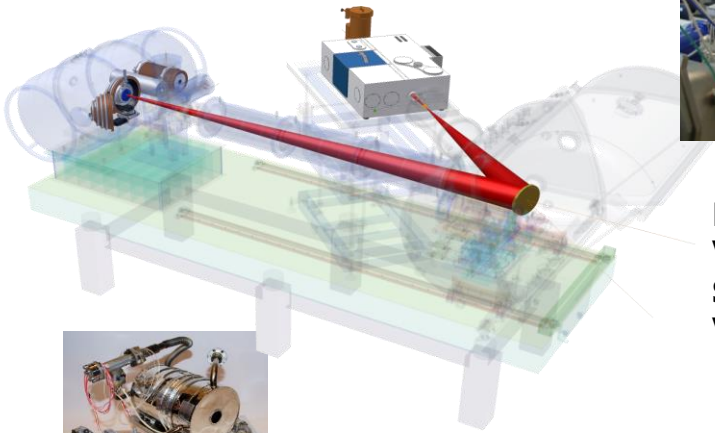
VMTBB: 80 °C to 450 °C

Sampleholder for emissivity measurements

and

LOBB: - 60 °C to 80 °C

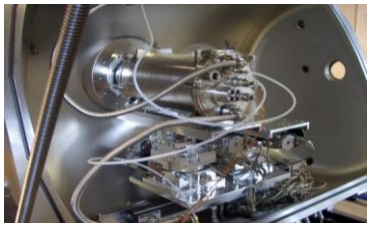




LOBB

Vacuum-Fouriertransformspectrometer

Detector chamber with Vacuum Infrared Radiation Standard Thermometer VIRST



C. Monte et. al., The Reduced Background Calibration Facility for Detectors and Radiators at the Physikalisch-Technische Bundesanstalt, SPIE Remote Sensing, *Sensors, Systems, and Next-Generation Satellites XIII*, **2009**, *7474*

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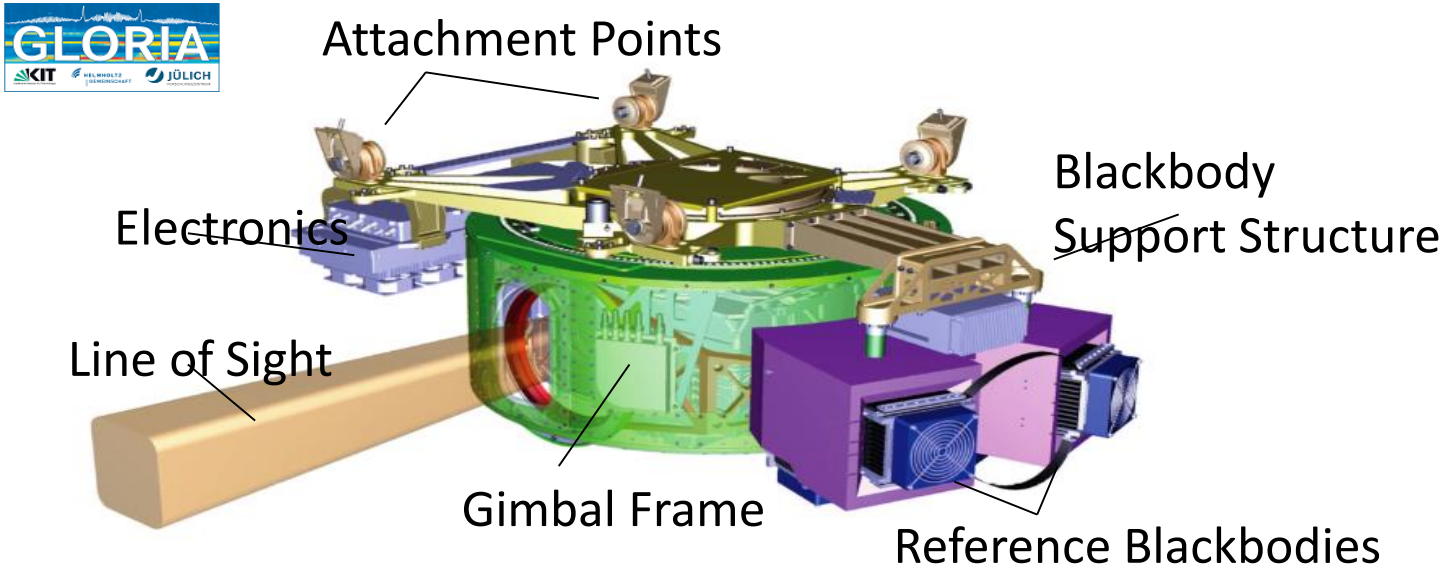
GLORIA Gimballed Limb Observer for Imaging of the Atmosphere

http://gloria.helmholtz.de



F. Friedl-Vallon et al., Instrument concept of the imaging Fourier transform spectrometer
GLORIA, *Atmos. Meas. Tech. Disc.*, **2014**, *7*, 2301-2337

PTB @ EMN COO Atmosphere section

CLIMATE AND OCEAN OBSERVATION

Metrological traceability of spectroscopy-based measurements of gaseous substances

- quantities: Amount-of-Substance-Fractions / µmol/mol
- direct traceable results by means of the TILSAM method
  - applying tunable diode laser absorption spectrocopy (dTDLAS), cavity ring down spectroscopy, Fourier-transform spectroscopy
    J. Nwaboh et al., EGU2020-19259
- optical isotope ratio spectroscopy (OIRS) measuring
  - $^{13}C/^{12}C$, $^{18}O/^{16}O$ isotope ratios in CO_2 and CH_4 referring to the δ-notation, cf. the presentation, I. Prokhorov et al., EGU2020-221
  - developing strategies for absolute and traceable isotope ratios

PTB @ EMN COO Atmosphere section

CLIMATE AND OCEAN OBSERVATION

Metrological traceability of spectroscopy-based measurements of gaseous substances

- quantities: spectral molecular line data / line intensities, broadening coefficients to be provided to, e.g., to HITRAN, GEISA, etc.
- traceable line data on atmospheric relevant species: CO, CO_2, CH_4, N_2O, NH_3, H_2O
  - operating two high-resolution FT spectrometers (Bruker IFS-125) complying to TCCON standards
  - contributing to EURAMET research projects: EUMETRISPEC, HIGHGAS, MetNH3, METEOMET, MetNO2, SIRS
    cf. G. Li et al., EGU2020-21718

PTB @ EMN COO Ocean section

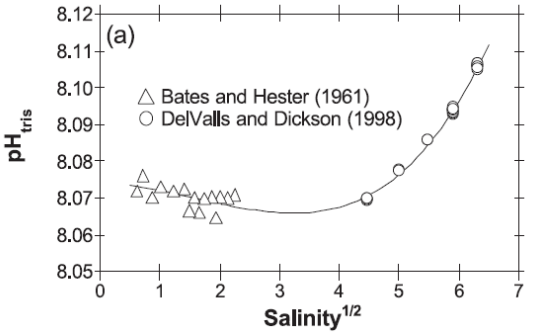
CLIMATE AND OCEAN OBSERVATION

Research on the metrology of seawater salinity and pH (EMRP “Ocean”)

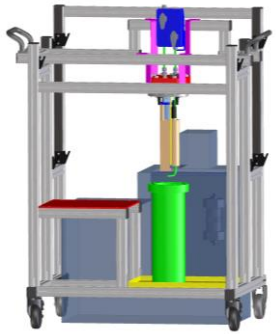
Development of a calibration setup for high pressure salinity sensors

Coordination of international comparisons for oceanographic institutes

Consultation for oceanographic institutions on metrological issues (ISO standard for marine sensors, IOOS QA manual, IOW accreditation)



ISO/DIS 22013
Marine environment sensor performance -- Specifications, testing and reporting - General requirements



PTB @ EMN COO Ocean section

CLIMATE AND OCEAN OBSERVATION

Calibration of CTDs

Conductance of seawater is a function of salinity, temperature, pressure: $G(S, t, p)$

Current procedure:
CTD calibration/adjustment in seawater bath

- Measurement of salinity (salinometer) and conductance signals at various temperatures
- Inversion of PSS-78 to adjust conductance signal to salinity
- Correction of pressure effects on cell constant using correction function from manufacturer

Is the effect of electrode polarization on the conductance signal the same for salinity variation as for temperature variation ?

PTB @ EMN COO

Conclusions

- PTB is committed to the mission and goals of the European Metrology Network for Climate and Ocean Observation
- PTB is serving all three sections by means of three different working groups , i.e. Infrared Radiation Thermometry, Spectrometric Gas Analysis, and Electrochemistry
- Together with the EMN partners, PTB is supporting the integration of measurement science with climate and ocean observation research in three environmental themes: atmosphere, ocean, and land and earth
- For details on the EMN COO as a whole, cf. the presentation, E. Woolliams et al.," Metrology for Climate Sciences: The European Metrology Network for Climate and Ocean Observation, EGU2020-21628

Acknowledgements

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PTB is member of the European Metrology Network for Climate and Ocean Observation.

EMPIR EURAMET

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

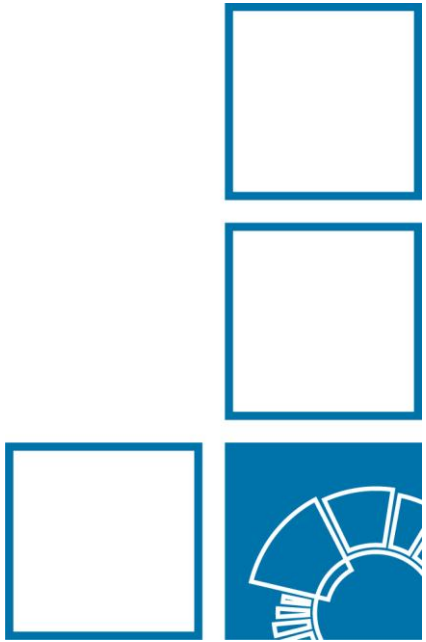
CLIMATE AND OCEAN OBSERVATION

https://msu.euramet.org/

https://www.euramet.org/european-metrology-networks/climate-and-ocean-observation/

PTB acknowledges the collaboration with all partners in the EMN for Climate and Ocean Observation.

Have a nice time for everybody



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