Status update on RS41 GRUAN Data Product (RS41-GDP.1)

Michael Sommer, Christoph von Rohden, Tzvetan Simeonov, Ruud Dirksen

GRUAN Lead Centre, DWD

13th GRUAN Implementation and Coordination Meeting (ICM-13)

Virtual, Session 1, 15 November 2021

Outline

- Long journey
- Characterisation
- Data processing & GDP
- Documentation
- Summary & outlook

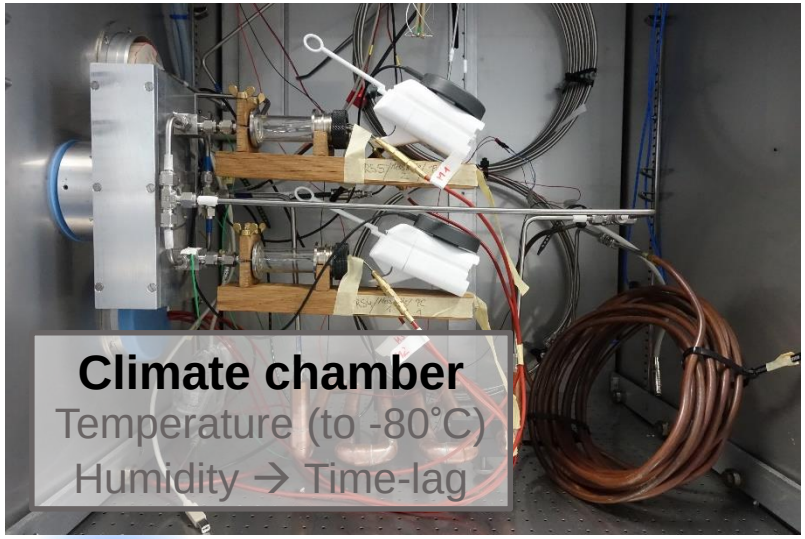
Long journey to final GDP

- 2014-07 → first calibration check of RS41 in lab (SHC)
- 2014-12 → first launches with RS41 at Lindenberg
- 2015-03 → first time-lag experiments in climate chamber
- 2016-03 → start of development of radiation wind tunnel (SISTER)
- 2016-06 → start restructuring of GDPS and optimising of modules
- 2017-07 → first radiation experiments inside SISTER
- 2019-02 → first official alpha version of GDP (ALPHA.1)
- 2020-03 → start writing technical document (TD)
- 2020-05 → start writing radiation paper
- 2020-06 → first official beta version of GDP (BETA.1)
- 2021-06 → last beta version of GDP (BETA.3) as RC
- 2021-06 → radiation paper submitted (amt-2021-187)
- 2021-11 → final version 1 of GDP (provisional certification)

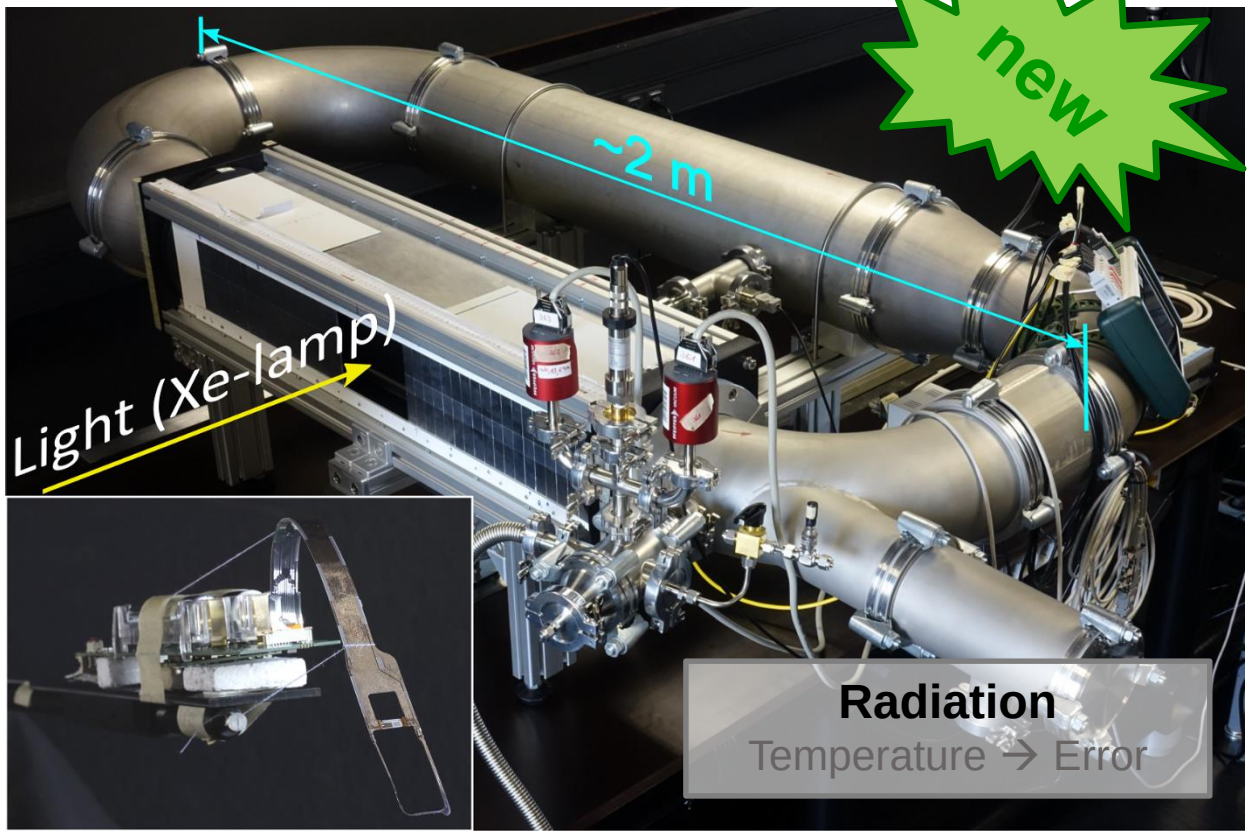
Characterisation of RS41

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Standard Humidity Chamber
Humidity → Calibration



Climate chamber
Temperature (to -80°C)
Humidity → Time-lag



Radiation
Temperature → Error

Development of and experiments with new radiation wind tunnel

Simulator for Investigation of Solar Temperature Error of Radiosondes (SISTER)

Radiation temperature error

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

https://doi.org/10.5194/amt-2021-187
Preprint. Discussion started: 20 July 2021

Atmospheric Measurement Techniques Discussions
Open Access
EGU

in review

https://doi.org/10.5194/amt-2021-187

Laboratory characterisation of the radiation temperature error of radiosondes and its application to the GRUAN data processing for the Vaisala RS41

Christoph von Rohden[1], Michael Sommer[1], Tatjana Naebert[1], Vasyl Motuz[2], and Ruud J. Dirksen[1]

[1]GRUAN Lead Centre, Deutscher Wetterdienst, Meteorologisches Observatorium Lindenberg, Am Observatorium 12, 15848 Tauche/Lindenberg, Germany

[2]Department of Aerodynamics and Fluid Mechanics, Brandenburg University of Technology, Cottbus-Senftenberg, Siemens-Halske-Ring 15a, 03046 Cottbus, Germany

Correspondence: Christoph von Rohden (Christoph.Rohden-von@dwd.de)

Abstract.

The paper presents the Simulator for Investigation of Solar Temperature Error of Radiosondes (SISTER), a setup that was developed to quantify the solar heating of the temperature sensor of radiosondes under laboratory conditions by recreating as closely as possible the atmospheric and illumination conditions that are encountered during a daytime radiosounding ascent. SISTER controls the pressure (3 hPa to 1020 hPa) and ventilation speed of the air inside the windtunnel-like setup to simulate the conditions between the surface and 35 km altitude, to determine the dependence of the radiation temperature error on the irradiance and the convective cooling. The radiosonde is mounted inside a quartz tube, while the complete sensor boom is illuminated by an external light source to include the conductive heat transfer between sensor and boom. A special feature of SISTER is that the radiosonde is rotated around its axis to imitate the spinning of the radiosonde in flight. The characterisation

GDPS – Processing of RS41-GDP.1

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

General & ground check	Pressure & altitude	Wind & ventilation	Temperature	Humidity
Make time axis steady	Calculate position (XYZ → LLA)	Pendulum analyse	Position of sun	Time-lag correction
Combine & grid data sources	Pressure calibration	Calculate ventilation	Estimate radiation (RTM simulations)	Smoothing (time-lag related)
Quality control of all input vars.	Recalculate alt. MSL, GPH	Calculate wind speed & direction	Radiation correction	Recalculation (internal T to air T)
Detect launch points	Calculate pressure using alt. (GNSS)	Smoothing (pendulum effects)	Smoothing (pendulum effects)	Estimate uncertainties
Detect and analyse SPIC / shell	Estimate uncertainties	Estimate uncertainties	Estimate uncertainties	Calculate further humidity variables
	Quality control of pressure & alt.	Quality control of wind	Quality control of temperature	Quality control of humidity

Completely new developed

Estimation of uncertainty

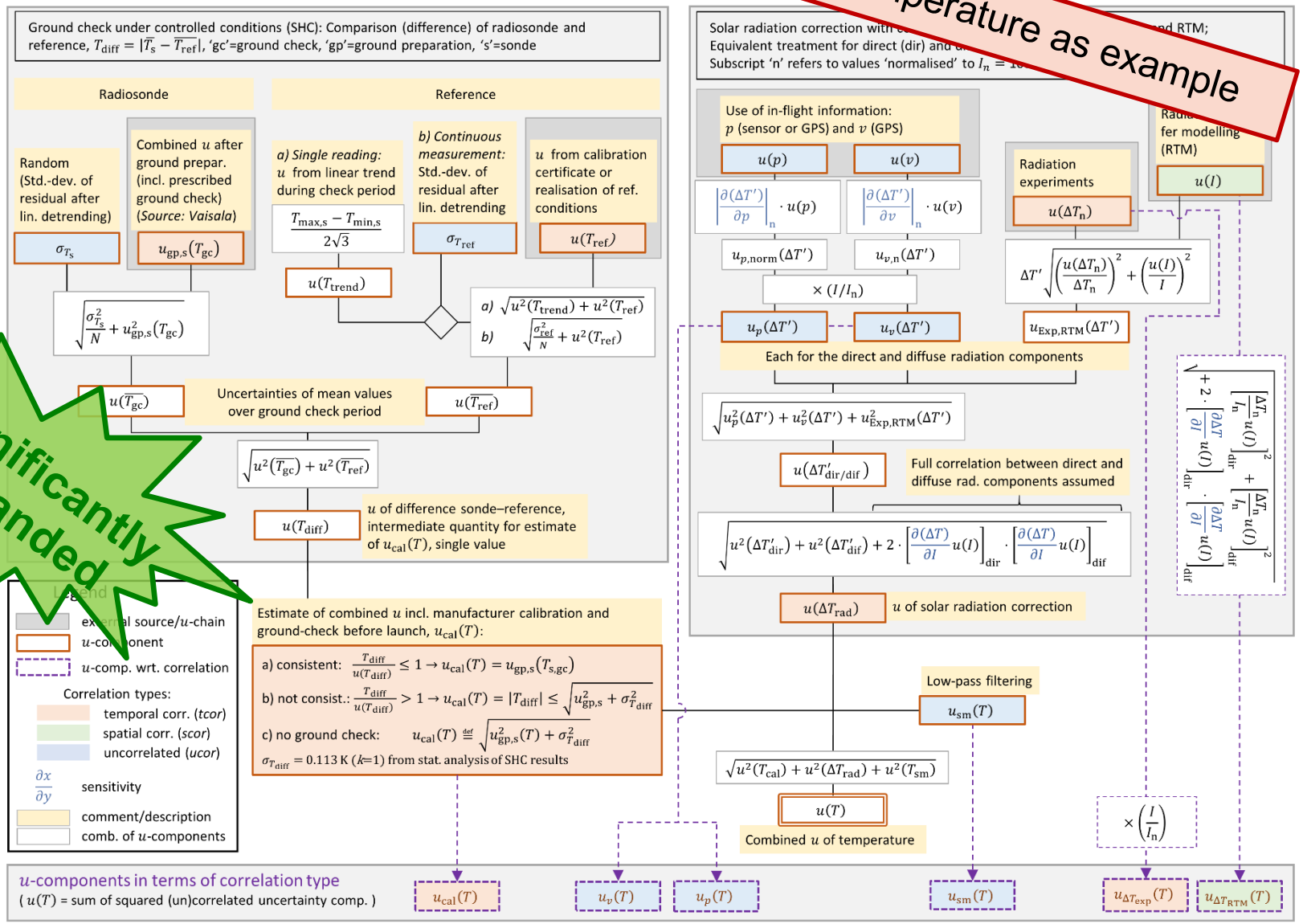
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Temperature
Relative humidity
Pressure (sensor)
Pressure (gnss)
Altitude (gph)
Altitude (amsl)
Altitude (wgs84)
Latitude
Longitude
Wind direction
Wind speed
Zonal wind comp.
Meridional wind c.
Dew point temp.
WVMR (mass)
WVMR (vol)
WV partial press.
WV sat. press.
Ventilation
Ascent speed

Significantly expanded

Temperature as example

Combination of uncertainty components for temperature in GDP for Vaisala RS41 radi



Content of RS41-GDP.1 files

- Meta-data

  significantly expanded

  - Product, file, site, measurement system, measurement setup, surface obs., measurement (times, equipment, day/night, position, pwc, tropopause, burst point), main/telemetry sonde, ground system, ground checks (ri41, shc, shelter), …

- Variables

  significantly expanded

  - Position (lat, lon), altitude (gph, wgs84, amsl), pressure (sensor, gnss), temperature, humidity (rh, dp, mr, …), wind variables (wdir, speed, wzon, wmeri), supplementary variables (sun angles, radiation, ventilation, pendulum, …)

- Corrections

  significantly expanded

  - Final data, total correction, correction components, raw data (+ flags)

- Uncertainties

  significantly expanded

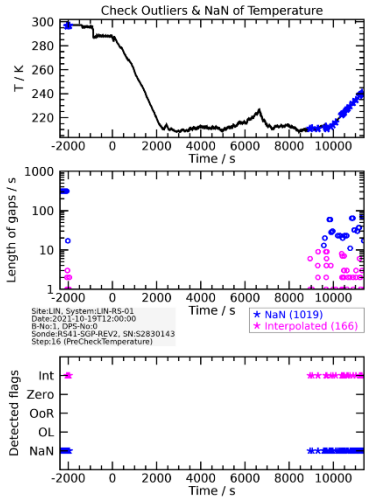
  - Combined, correlation parts, source components

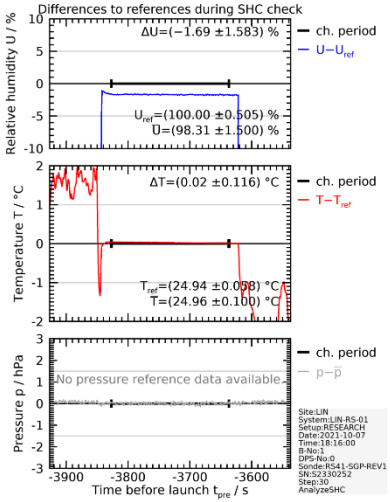
Compared to RS92-GDP.2

Analysis plots

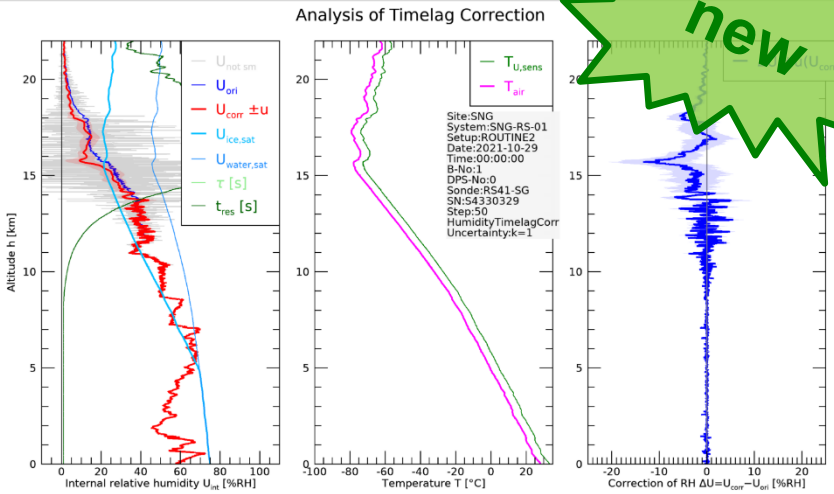
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Raw data analysis & ground check plots



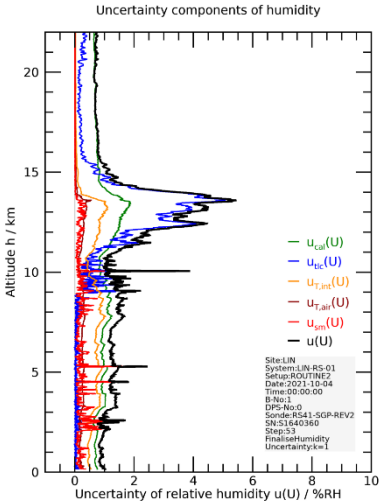


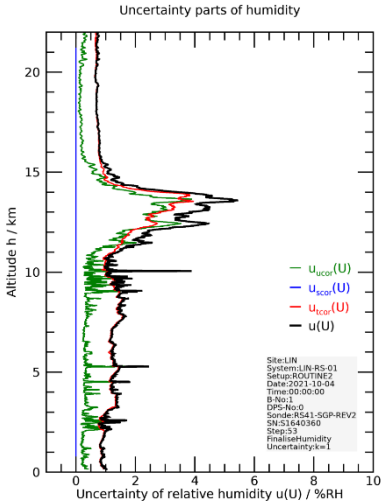
Internal analysis plots



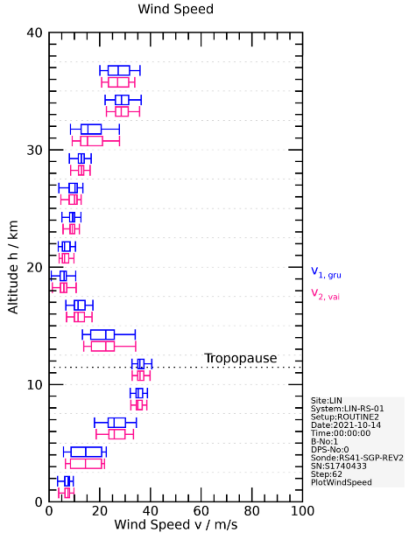
new

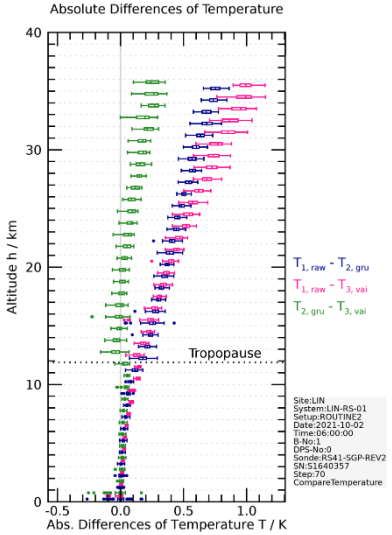
Plots of uncertainty components & parts





Comparison plots (GDP vs. Vaisala)





Final data product RS41-GDP.1

- Full characterisation → extensive & intensive experiments
- Comprehensive processing → correction & estimation of uncertainties
- GDP provided as very detailed NetCDF 4 files
- Analysis plots → Should they be available at website?
- **Processing of RS41-GDP.1 started (2021-11-02)**

RS41 Technical Document

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Title: "GRUAN characterisation and data processing of the Vaisala RS41 radiosonde"

Authors: Michael Sommer, Christoph von Rohden, Tzvetan Simeonov, Peter Oelsner, Tatjana Naebert, Ruud Dirksen, Hannu Jauhiainen, Petteri Survo, …

Aim: Full description of RS41 in GRUAN incl. instrumentation, measurement practice, characterisation, data processing, data flow

Status: on 2021-11-02, 176 pages, ~95% complete

Table of contents

Start of review end of 2021

RS41 User Guide

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Title: "User Guide of the RS41 GRUAN Data Product Version 1 (RS41-GDP.1)"

Authors: Michael Sommer, Christoph von Rohden, Tzvetan Simeonov, …

Aim: Describe content of GDP files of RS41 and help users to handle these files correctly

Status: on 2021-11-01, 57 pages, ~90% complete

Publishing January 2022

Table of contents

Comparison paper (RS92 vs. RS41)

Title: "GRUAN RS41/RS92 data product comparison: Characterization of temperature and relative humidity profiles"

Authors: Tzvetan Simeonov, Ruud Dirksen, Christoph von Rohden, Michael Sommer, …

Aim: Compare GRUAN processing and data product (GDP) of both RS92 and RS41

Status: on 2021-11-12, data analysis ongoing

Table of contents

Summary of current status

- **Radiation paper** in review process at AMT — in review
- RS41 **technical document** (TD) in finalisation — in finalisation
- RS41-GDP **user guide** (TN) in finalisation — in finalisation
- **Comparison paper** (RS92 vs. RS41) in preparation — in preparation
- Provisional **certification** — go ahead
  - Final certification after publication of TD and comparison paper — pending
- **Processing** of RS41-GDP.1 started — running

Outlook

- Future research & improvements of data product **in next years**
  - Update on climate chamber setup to investigate time-lag of humidity sensor at cold temperatures (→ see presentation by Christoph today)
  - Investigate detected small systematic humidity differences in troposphere → RS41 vs. CFH / GNSS-PW
  - Development of an experimental setup to investigate time-lag of temperature sensor → main issue is time resolution of 1 s
  - Extension of temperature radiation correction to include the dependency to air temperature (→ see presentation by Lee on Friday)
  - …

If you answer one question, you get three new ones.

- In between → Use first version of RS41 GDP (RS41-GDP.1)

Usage of GRUAN data products as working standard in WMO Upper-Air Instrument Intercomparison 2022 (UAII2022)

Acknowledgement
T. Naebert, S. Körner,
M. Fiedler-Krüger, R. Tietz,
H. Friedrich, P. Oelsner

Thank you for your attention.