GRUAN Lidar Data Stream

ICM-10 Progress Status (2018)

Thierry Leblanc

Jet Propulsion Laboratory, California Institute of Technology
Wrightwood, CA USA

What is Lidar?
Why Lidar in GRUAN?

Lidar (LIght Detection And Ranging) is an active remote sensing technique

1. One or more laser beam(s) sent in the atmosphere
2. Laser light backscattered by atmospheric molecules and particles, collected by telescope
3. Amount of light (raw lidar signal) analyzed as a function of time, i.e., altitude (high temporal and vertical resolution)

What species? what time and vertical resolutions?

1. Vertical profiles of ozone, water vapor, temperature, wind, cloud and aerosol properties (also, CO_2, CH_4, NO_2, and more)
2. Temporal resolution from seconds to days (e.g., Payerne WV)
3. Vertical resolution from meters to a few kilometers

Why including Lidars in GRUAN?

1. Good complement to the core GRUAN products (e.g., for water vapor, ozone, temperature)
2. Redundancy, validation purposes, as well as dedicated studies (e.g., 2D variability)
3. Synergy with other networks, measurements already available in some GRUAN sites

Lidar Product for GRUAN

GRUAN Requirements:

1. **Uncertainty** fully characterized
2. **Traceable standards** for data processing
3. **Transparent** processing methodology (no black box)
4. **Careful management of change** with time

GRUAN Solutions:

1. LidarRunClient interface at each GRUAN Lidar site
2. Centralized, yet instrument-dependent and time-dependent data processing software

➔ **GLASS (Global Lidar Analysis Software Suite)**

LidarRunClient Status

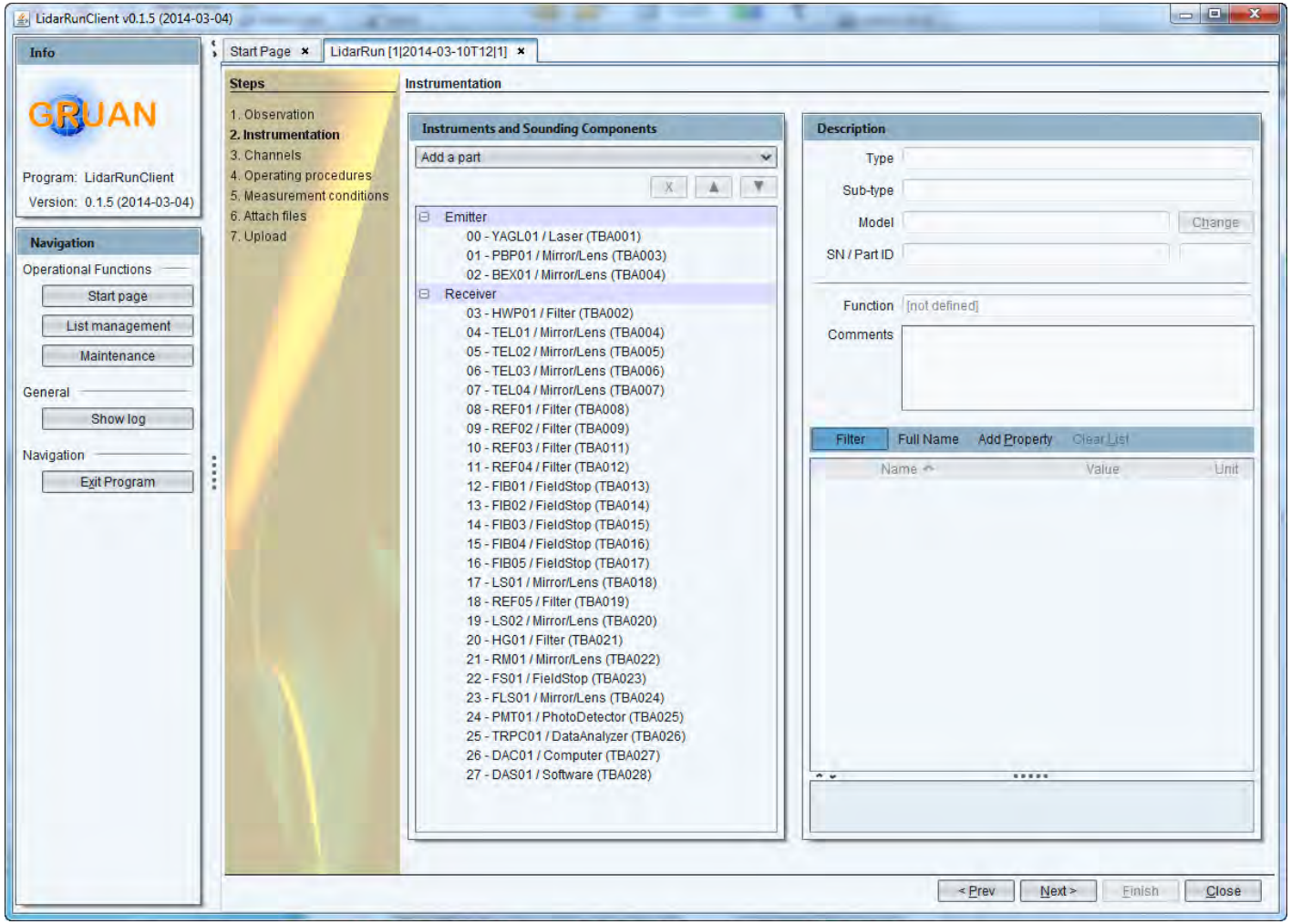
Initiated in 2015

Refined in 2016

Revamped and Extended in 2017

with feedback from Cabauw and Payerne Lidars' investigators

Yet to be Finalized in 2018



GLASS version 1
Comprehensive meta data ingestion

Meta data ingested to GLASS using 3 meta data files:

1. **Instrumentation** hardware and software configuration
2. **Signals analysis options ("pre-processing")**
3. **Product options** (species-specific retrieval)

Imported meta data are instrument-dependent AND time-dependent

Instrument meta data file is unique for a given lidar instrument
It includes history of the instrument's hardware and raw data acquisition configuration

Signal analysis configurations meta data file does not have to be unique
Can depend on time and/or science application

Species retrieval configurations meta data file does not have to be unique
Can depend on time and/or science application

Each meta data read in the meta data files can be overridden at GLASS execution time, by using IDL keywords

Advantages of meta data ingestion approach

Main advantage: Mass processing and re-processing are made easy!

- Suitable for networks
- Suitable for large (long-term) data sets
- Suitable for transparency and traceability (all meta data used are recorded)
- Suitable for multi-applications (process study? climatology? Pick your pref.)

Data processing uses a single call line (IDL), building batch files is easy:

- **Example 1:**

```
GLASS,'TMTOL','2018/03/01',anlmode='NDACC'
```

The above IDL command line will launch GLASS for the analysis of the TMF tropospheric ozone lidar (TMTOL) data taken on March 1, 2018, with the option of producing a profile tailored for the NDACC archive center

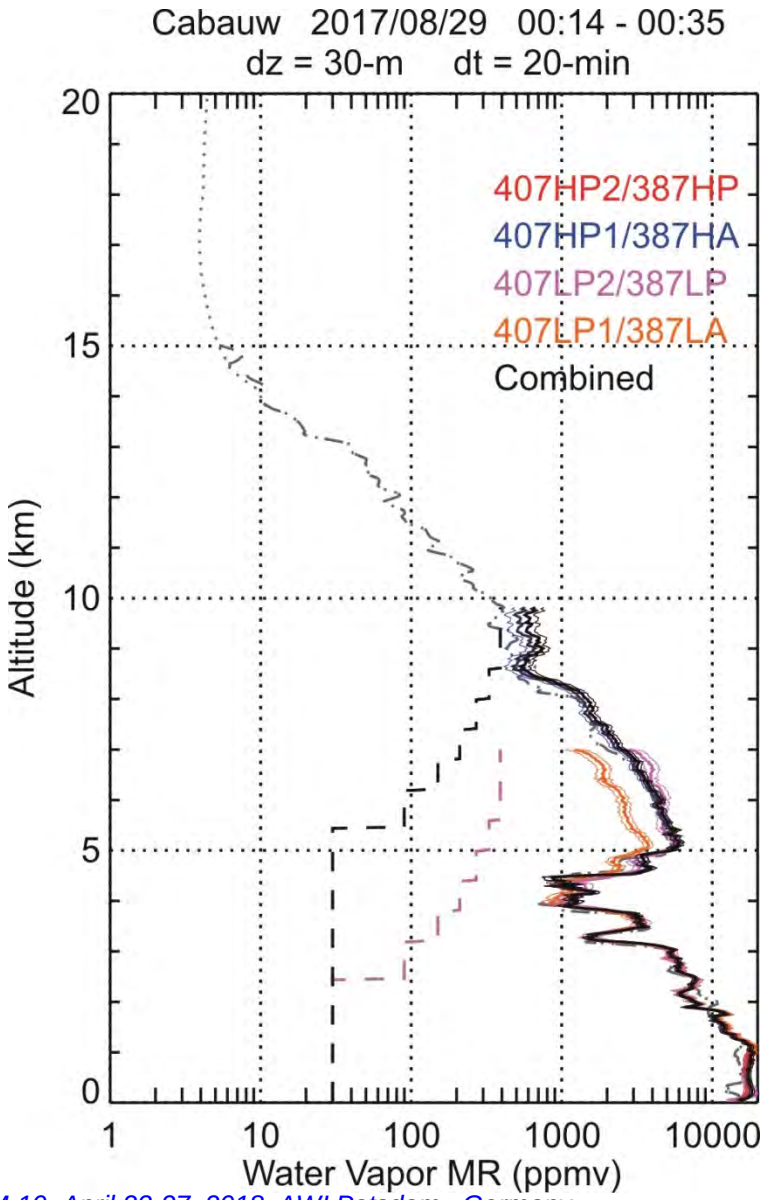
- **Example 2:**

```
GLASS,'TMTOL','2018/03/01',anlmode='TROPOMI',o3filtnam='SGBlackman'
```

The above IDL command line will do the same thing, but will use specific parameters adapted for the validaiton of the TROPOMI satellite instrument, and also will override the default filter used to vertically smooth the profile
(next slide shows which meta data file 3 keyword is replaced)

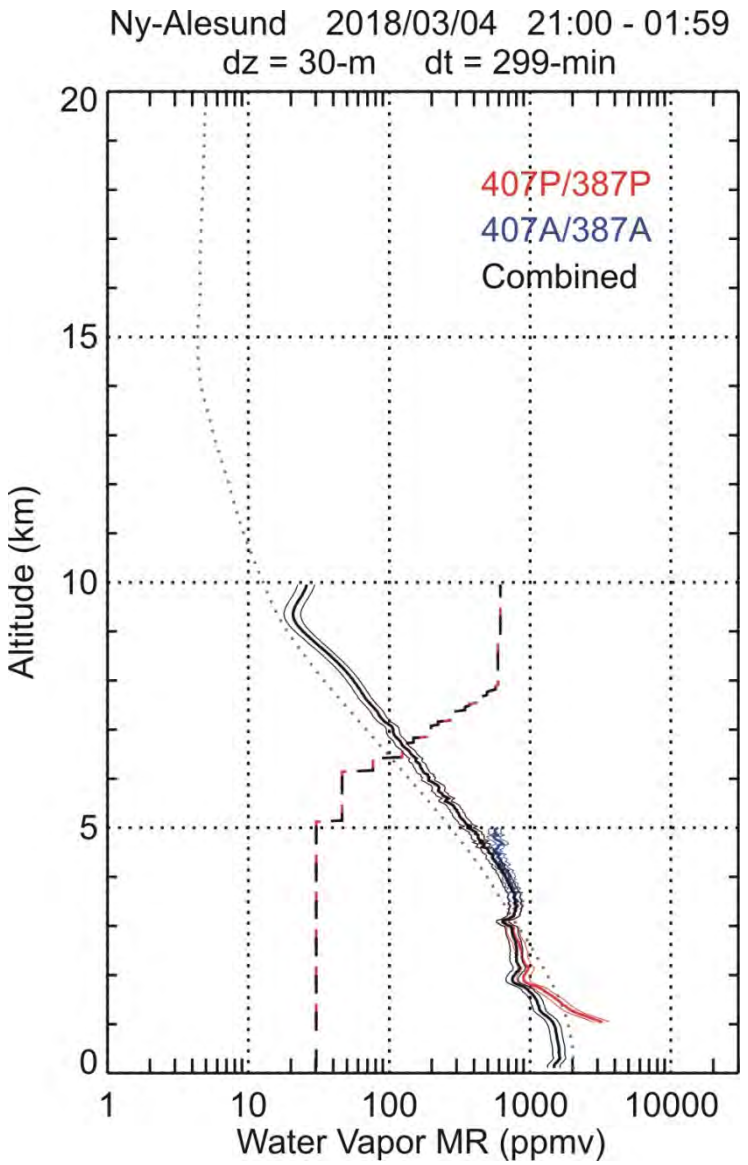
Examples of results: Cabauw

20 minutes integration for process studies or satellite validation



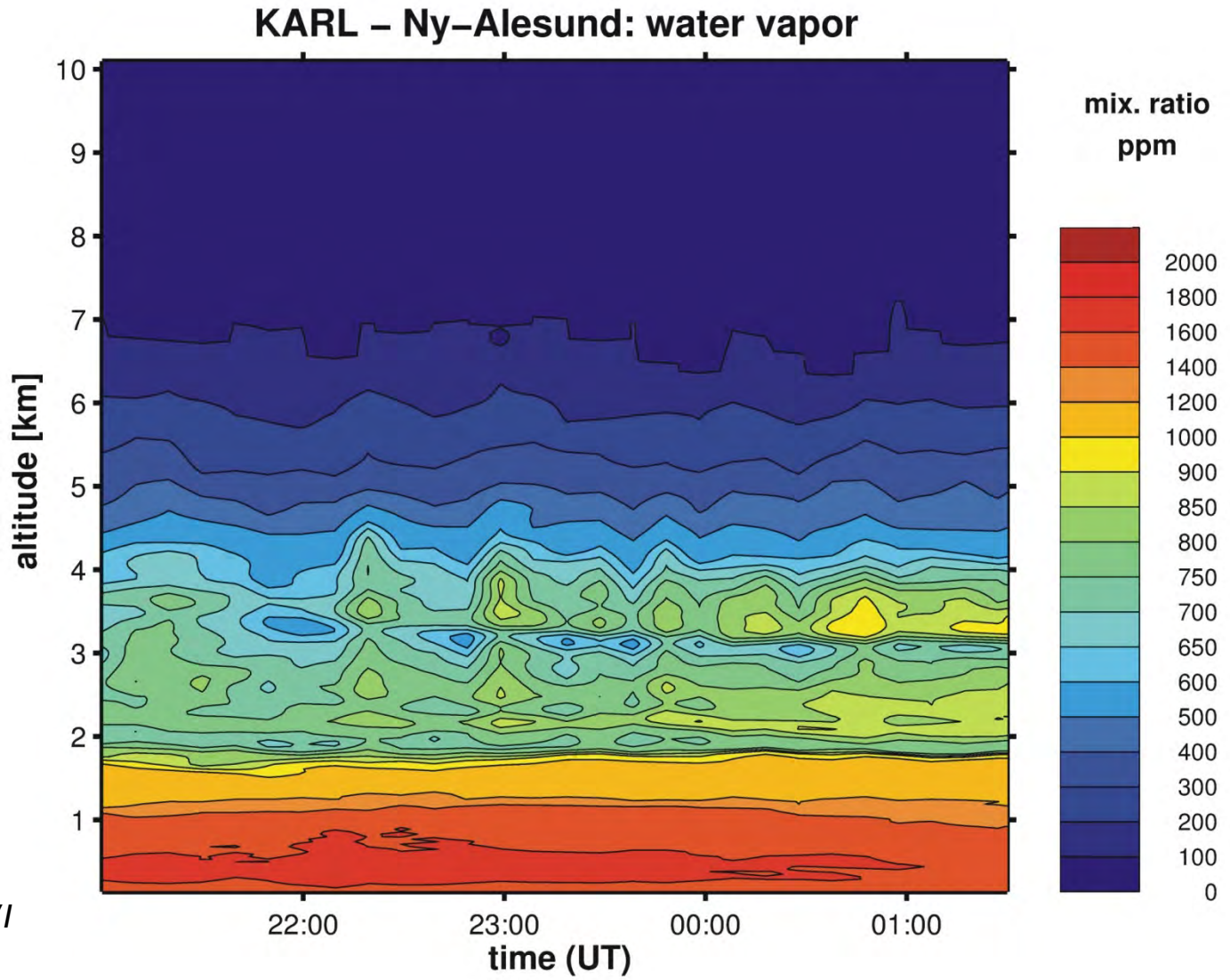
Examples of results: Ny-Ålesund

5 hours integration
for climatology and trends



Examples of results: Ny-Ålesund

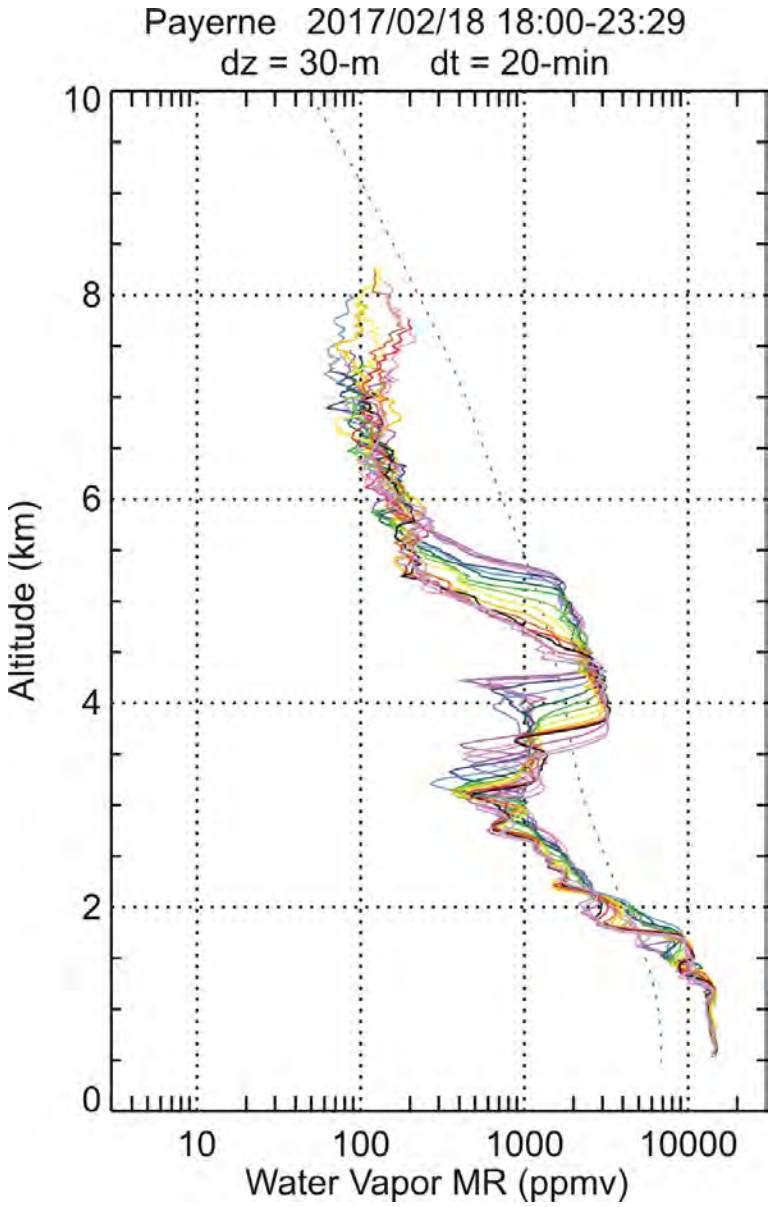
Same 5 hours integration but sliced by 10 minutes



From C. Ritter, AWI

Examples of results: Payerne

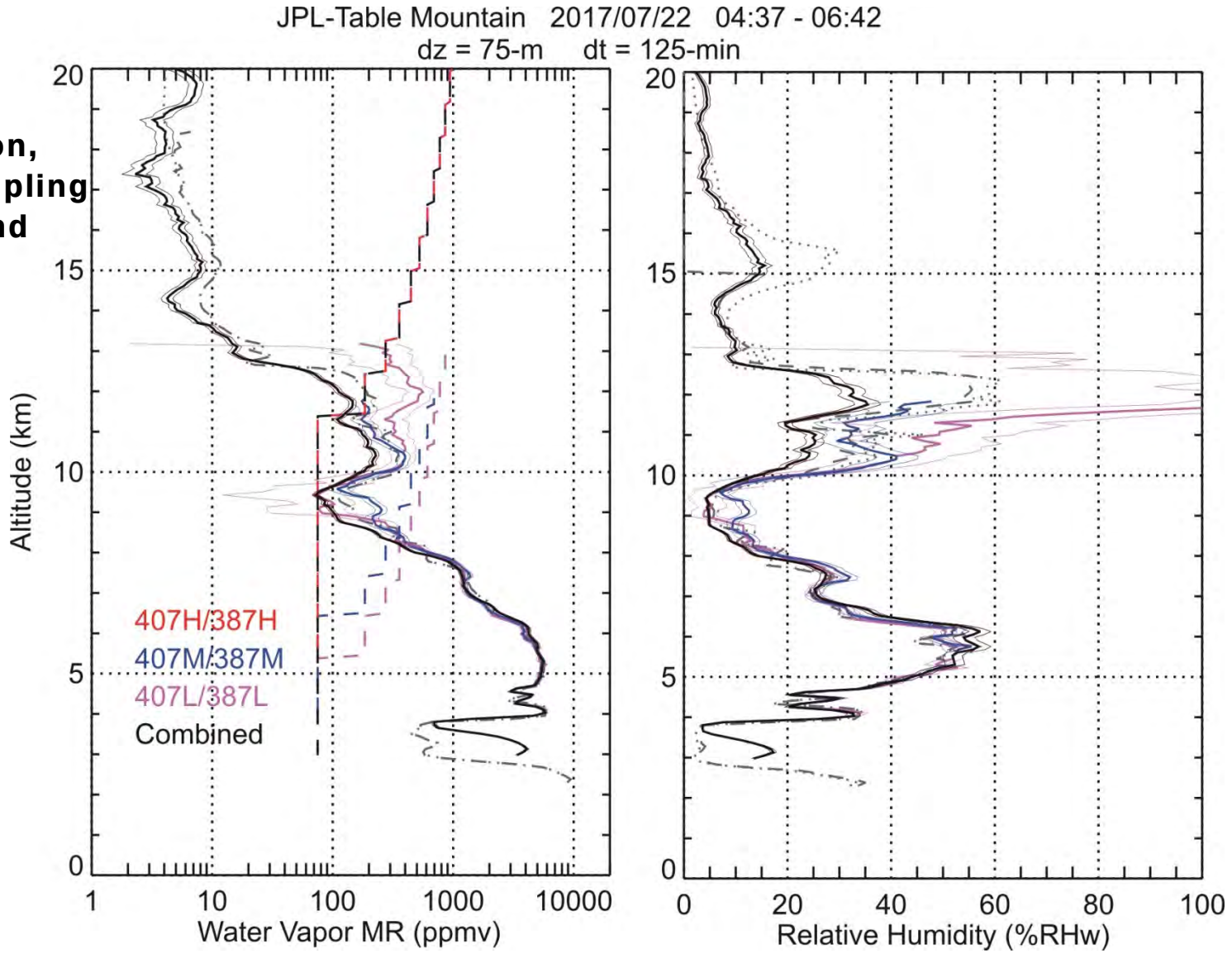
5 hours time span,
20 minutes integration
for process studies or
satellite validation



Examples of results: Table Mountain

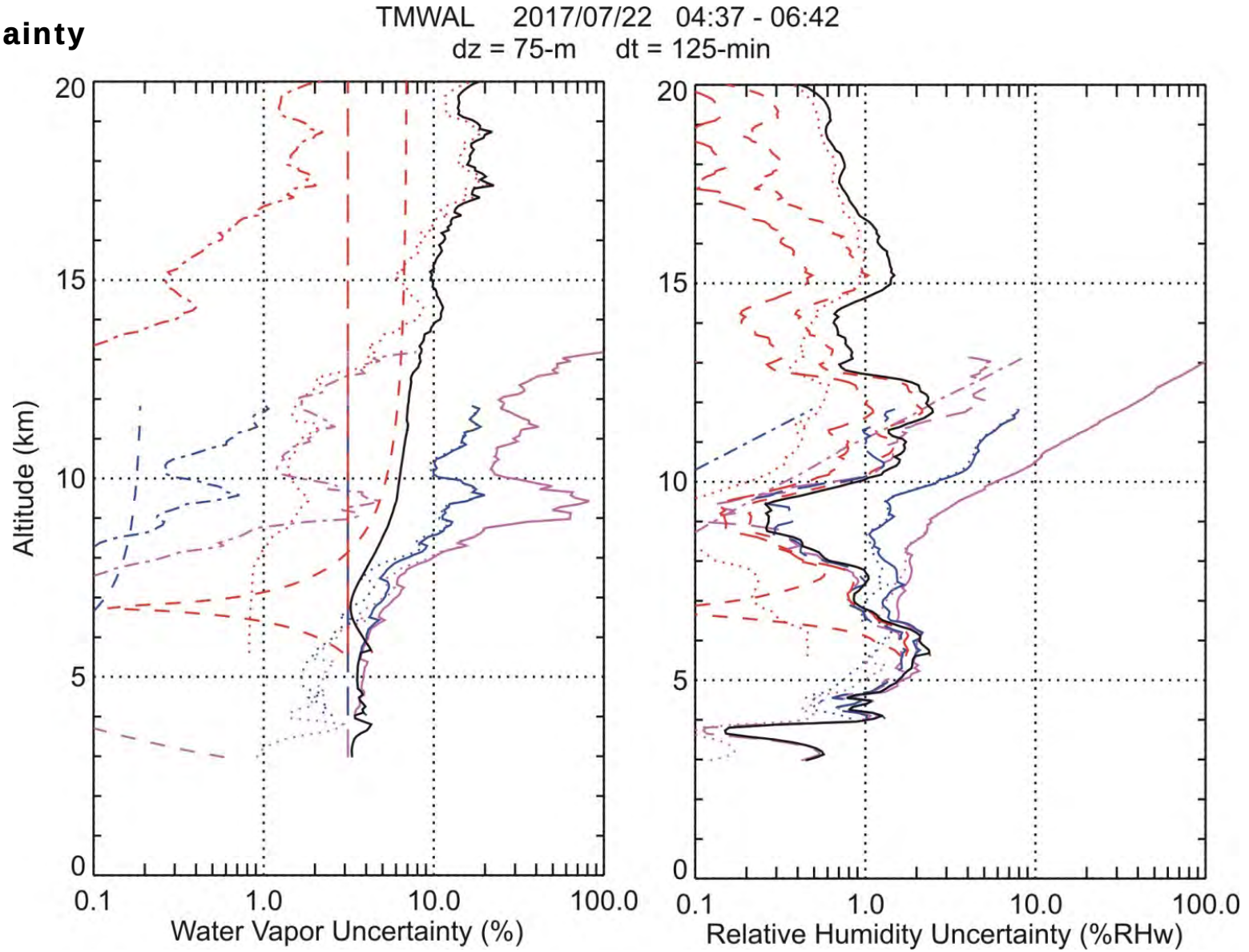
2 hours integration, 75 m vertical sampling for climatology and trends

UTLS included

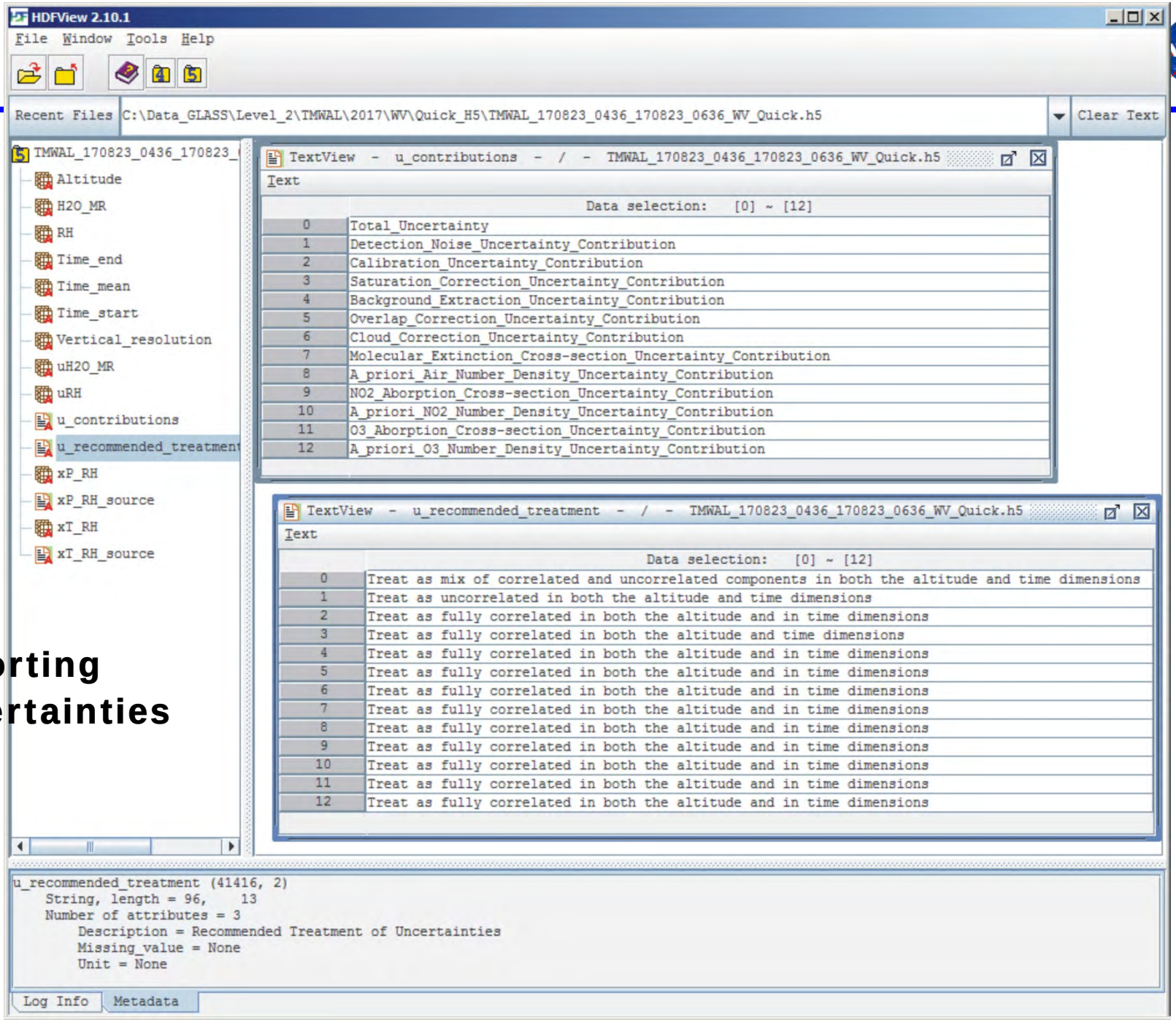


Uncertainties: Full budget reported with product

Up to 12 uncertainty components included



Reporting Uncertainties



Summary of GLASS products ready to be validated

GRUAN GRUAN+NDACC NDACC NDACC+TOLNET TOLNET

CAELI (Cabauw):
- ➔ Species: WV, T
- ➔ Network: GRUAN
- ➔ Time span: 2012-present

KARL(Ny-Alesund):
- ➔ Species: WV
- ➔ Network: GRUAN, NDACC
- ➔ Time span: 2010-present

RALMO (Payerne):
- ➔ Species: WV, T
- ➔ Network: GRUAN, NDACC
- ➔ Time span: 2003-present

TMWAL (Table Mountain):
- ➔ Species: WV, T
- ➔ Network: NDACC
- ➔ Time span: 2006-present

LAUSOL (Lauder):
- ➔ Species: O3, T
- ➔ Network: GRUAN, NDACC
- ➔ Time span: 1995-present

TMSOL (Table Mountain):
- ➔ Species: O3, T, Aer
- ➔ Network: NDACC
- ➔ Time span: 1988-present

EURL (Eureka):
- ➔ Species: O3, T
- ➔ Network: NDACC
- ➔ Time span: 2016-present

MLSOL(Mauna Loa):
- ➔ Species: O3, T, Aer
- ➔ Network: NDACC
- ➔ Time span: 1994-present

TROPOZ (Beltsville):
- ➔ Species: O3
- ➔ Network: NDACC, TOLNet
- ➔ Time span: 2016-present

TMTOL (Table Mountain):
- ➔ Species: O3
- ➔ Network: NDACC, TOLNet
- ➔ Time span: 1999-present

LMOL(LaRC):
- ➔ Species: O3
- ➔ Network: TOLNet
- ➔ Time span: 2016-present

AMOLITE (Env. Canada):
- ➔ Species: O3
- ➔ Network: TOLNet
- ➔ Time span: 2016-present

Where do we go from here?

1. GRUAN Lidar Data Product version 1 Validation

Feedback needed by GRUAN WG and Community

"GRUAN Science coordinator" team offered to step in

Fabio Madonna, Xavier Calbet, Tom Gardiner to lead/coordinate efforts with T. Leblanc

Comparisons with sondes, dedicated process studies, etc.

Independent (blind) investigations strongly advised

2. Need to set up systematic / automated raw lidar data and GRUAN data products flow from / to processing center, LC, and NCDC

3. Need to set up final version of LidarRunClient for Cabauw, Payerne, Ny-Alesund, etc.

4. Last but not least: Write out TD with all aspects of GRUAN Lidar Data Stream included

THANK YOU