Controlled weather balloon ascents and descents for atmospheric research and climate monitoring

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Andreas Kräuchi and Rigel Kivi

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Radiation Measurements through the Atmosphere

SRS-C34 Radiosondes
CNR 4 Net Radiometer

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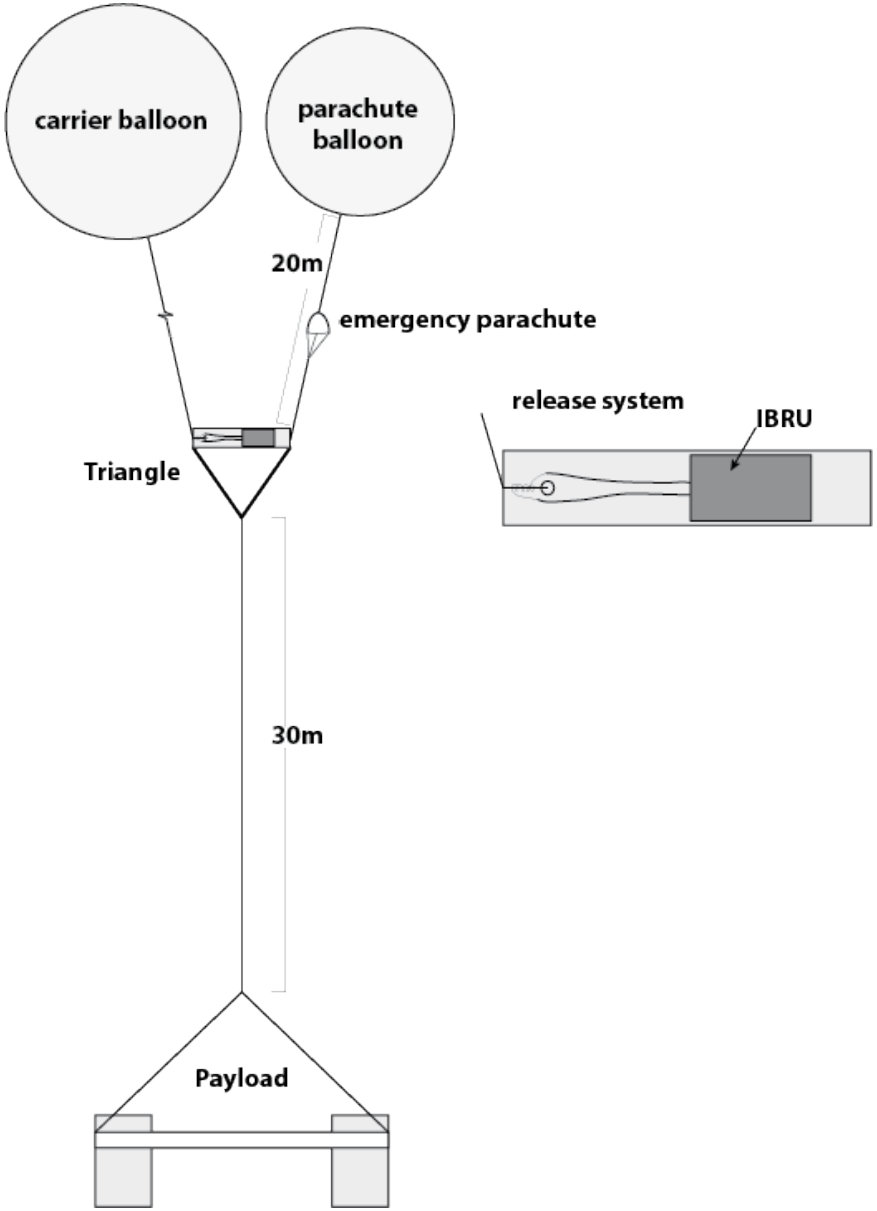
Double Balloon Technique



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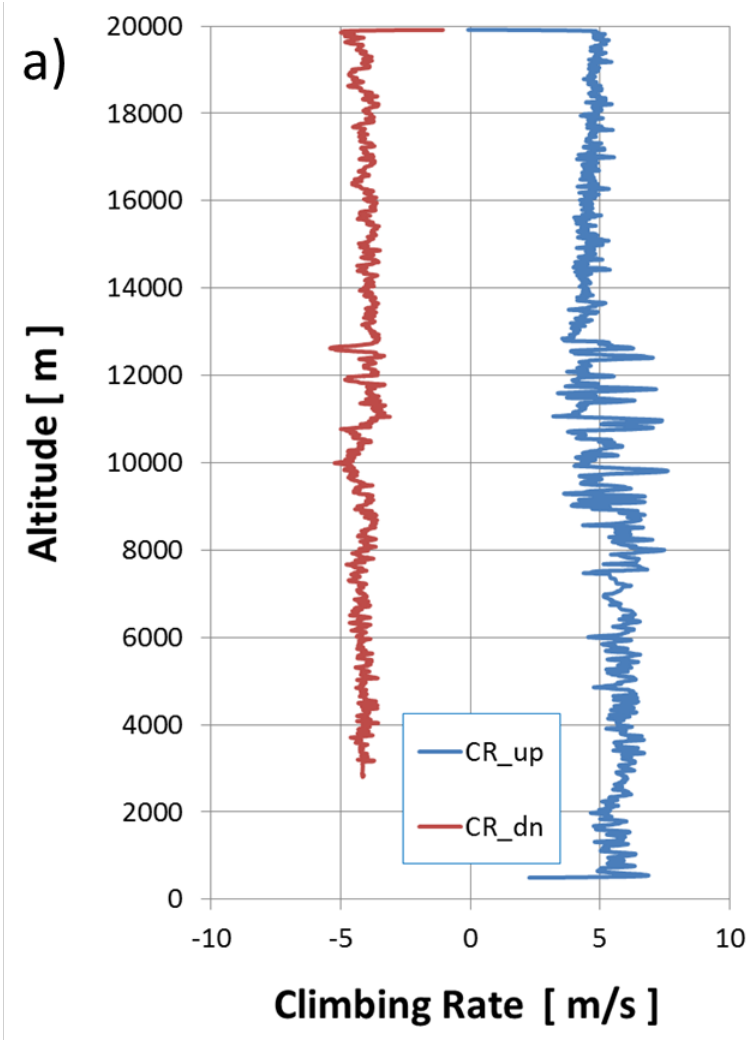
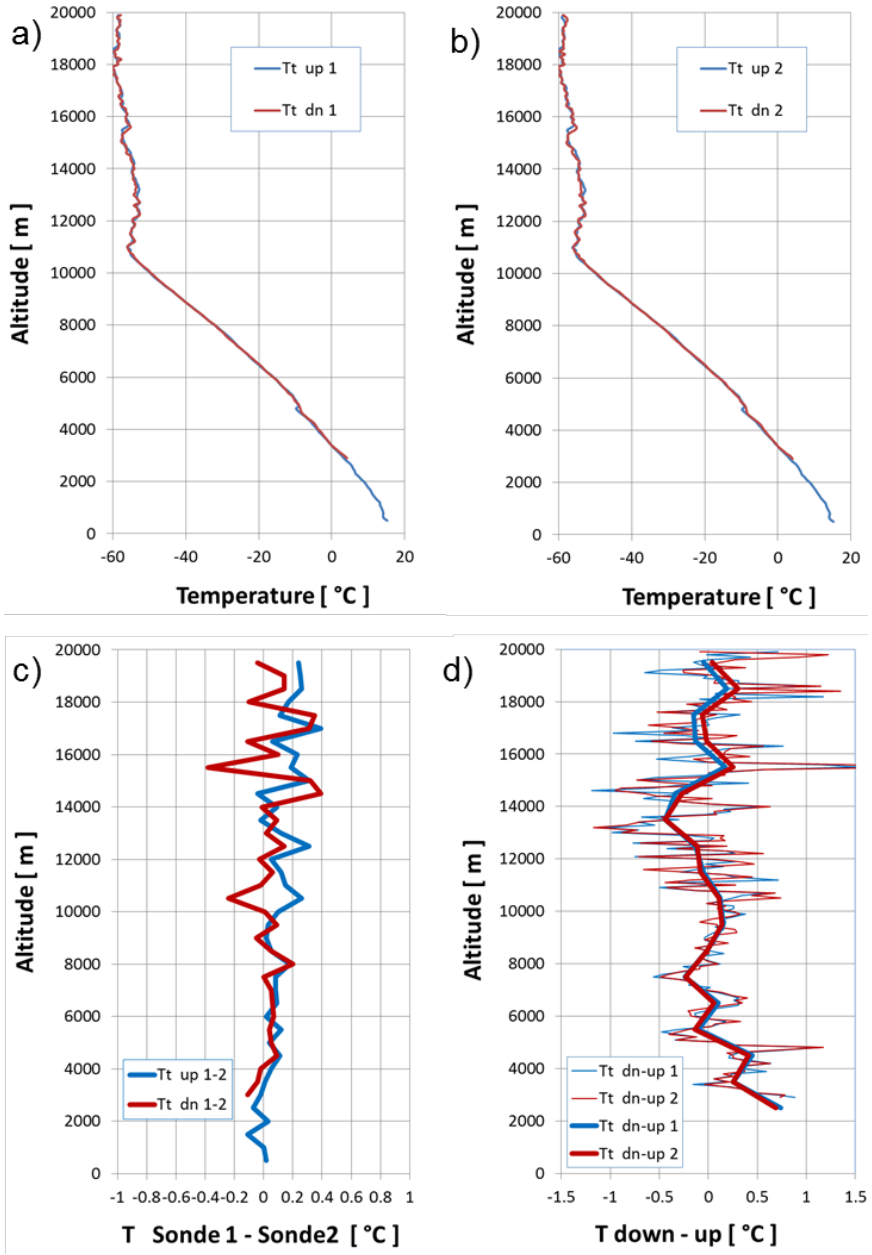
Flight to 20 km and back with 2 SRS-C34





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Atmos. Meas. Tech., 9, 929–938, 2016
www.atmos-meas-tech.net/9/929/2016/
doi:10.5194/amt-9-929-2016
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Atmospheric Measurement Techniques
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Controlled weather balloon ascents and descents for atmospheric research and climate monitoring

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Received: 9 September 2015 – Published in Atmos. Meas. Tech. Discuss.: 3 December 2015
Revised: 17 February 2016 – Accepted: 18 February 2016 – Published: 7 March 2016

Abstract. In situ upper-air measurements are often made with instruments attached to weather balloons launched at the surface and lifted into the stratosphere. Present-day balloon-borne sensors allow near-continuous measurements from the Earth's surface to about 35 km (3–5 hPa), where the balloons

1 Introduction

Weather balloons have been used for climate and meteorological research for more than 100 years. The first instru-

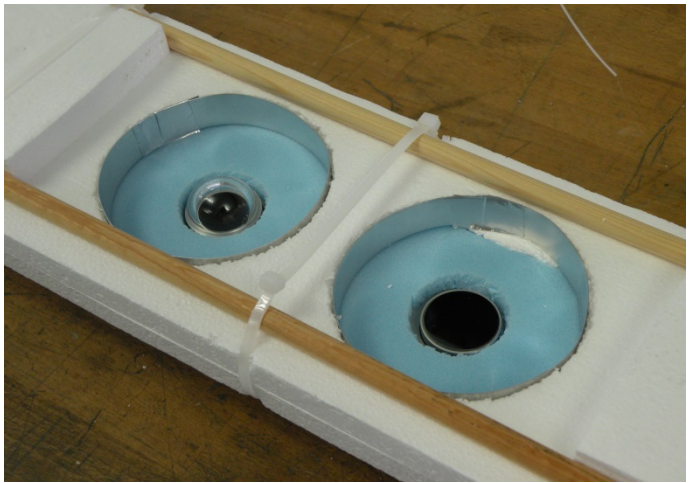
Upper-Air Radiation Measurements

- Commercial CNR 4 net radiometer
  - Upward and downward pyranometers
  - Upward and downward pyrgeometers

Pyranometer and Pyrgeometer measuring downward fluxes

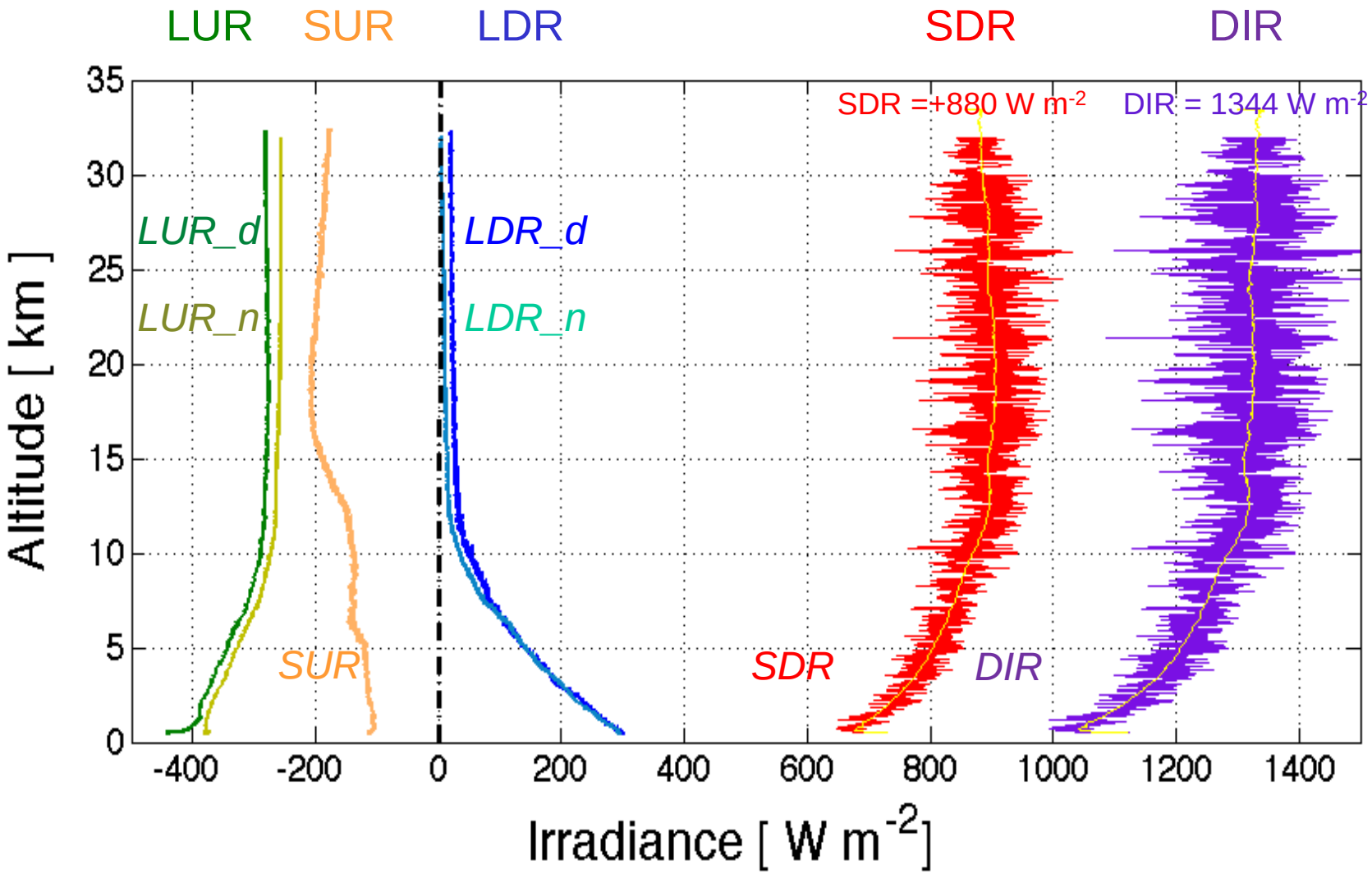
CNR 4

Pyranometer and Pyrgeometer measuring upward fluxes



Shortwave and longwave Radiation Profiles

Day flight: 23 Sep 2011, UT10:13 and **Night flight: 23 Sep 2011, UT21:20**



Philipona, Kräuchi, Brocard, GRL, 2012

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Problems with Upper-Air Ballooning

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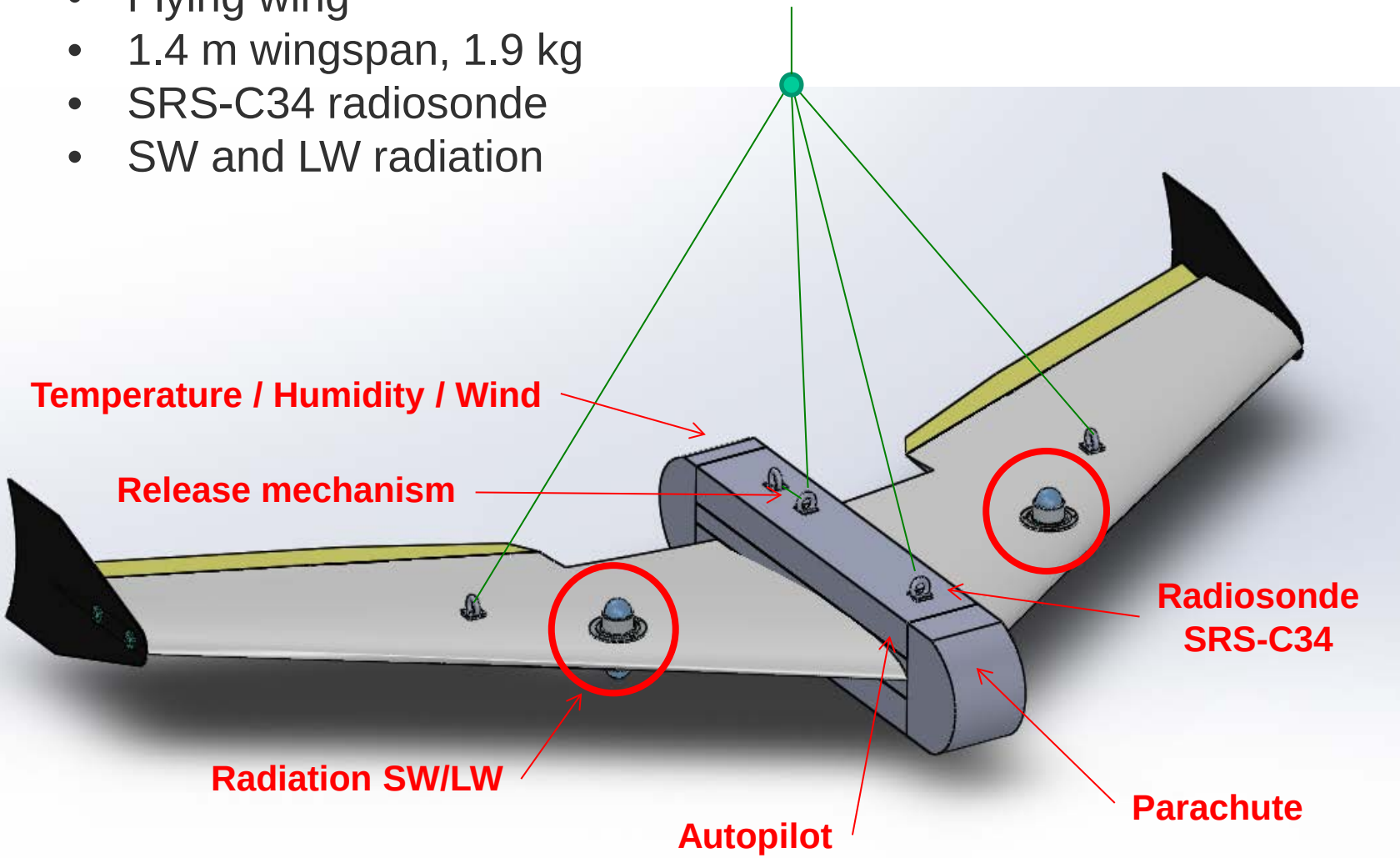
Return Glider - Radiosonde

- **Return Glider Radiosonde (RG-R)**
  - Flying wing
  - 1.4 m wingspan, 1.9 kg
  - SRS-C34 radiosonde
  - SW and LW radiation



New Radiation Instruments

- Same dome and thermopile as CNR 4 used in 2011
- Body mass reduced by half for flight security reasons
- Body and dome temperature thermocouples inside

Return Glider - Radiosonde Operation

- Rises with 5 m/s like operational radiosondes
- Releases from the balloon at desired altitude (24-30 km)

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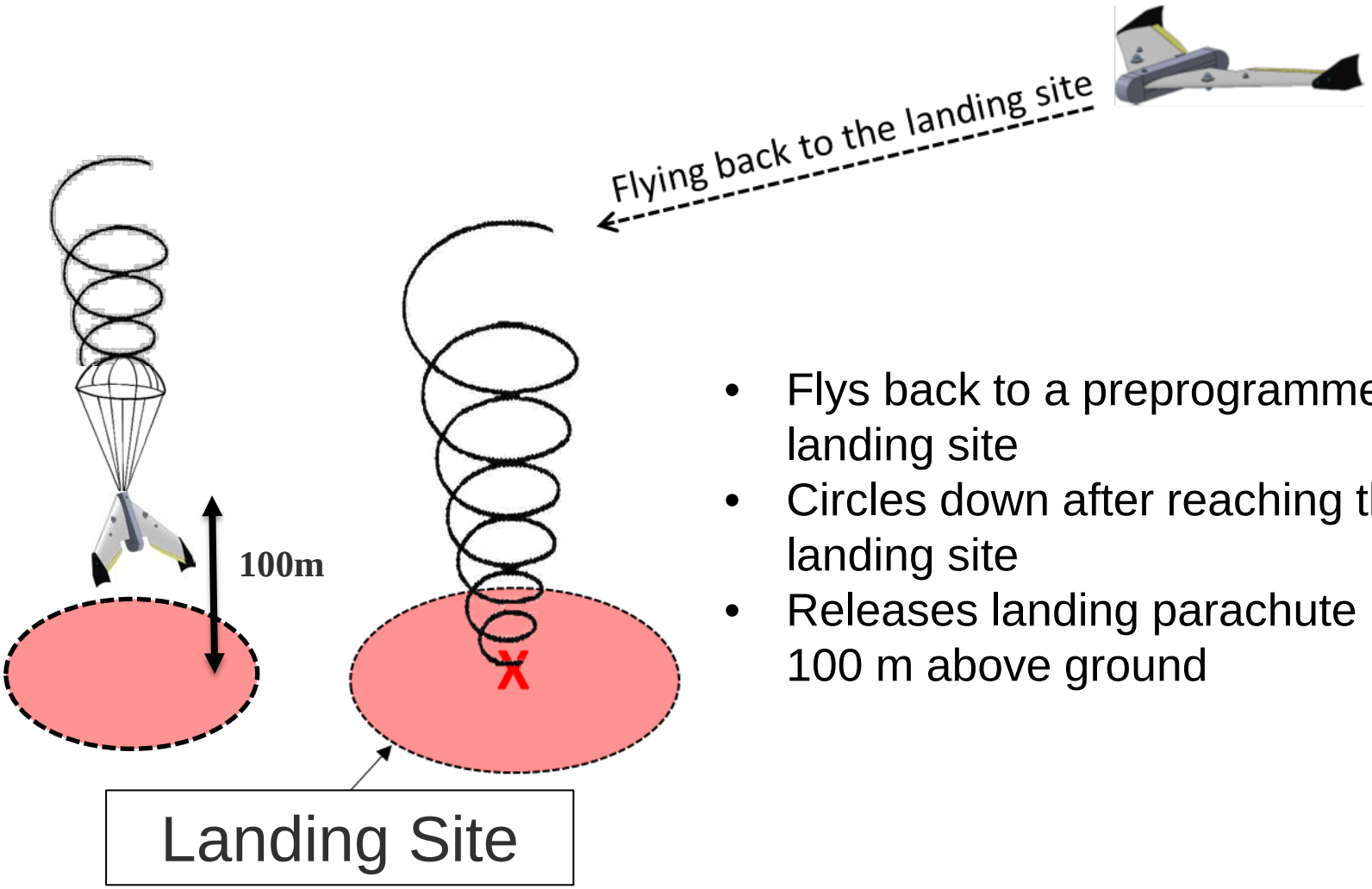
Return Glider - Radiosonde Operation



- Flys back to a preprogrammed landing site
- Circles down after reaching the landing site
- Releases landing parachute 100 m above ground

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Return Glider - Radiosonde Operation

Kräuchi and Philipona, AMTD, 2016

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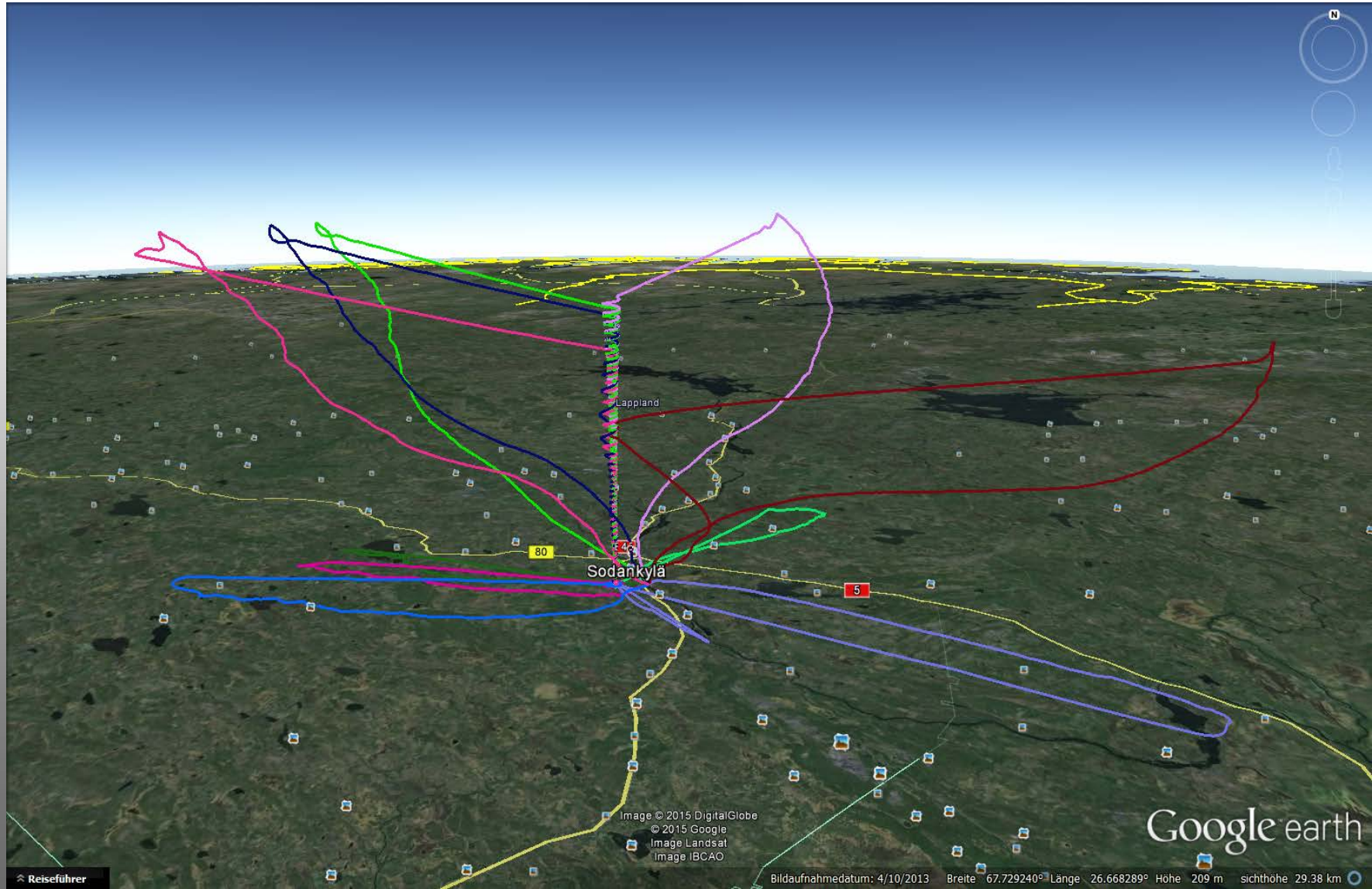
RG-R Test Flights in Sodankylä, Finland

Flights Trajectories of several Flights



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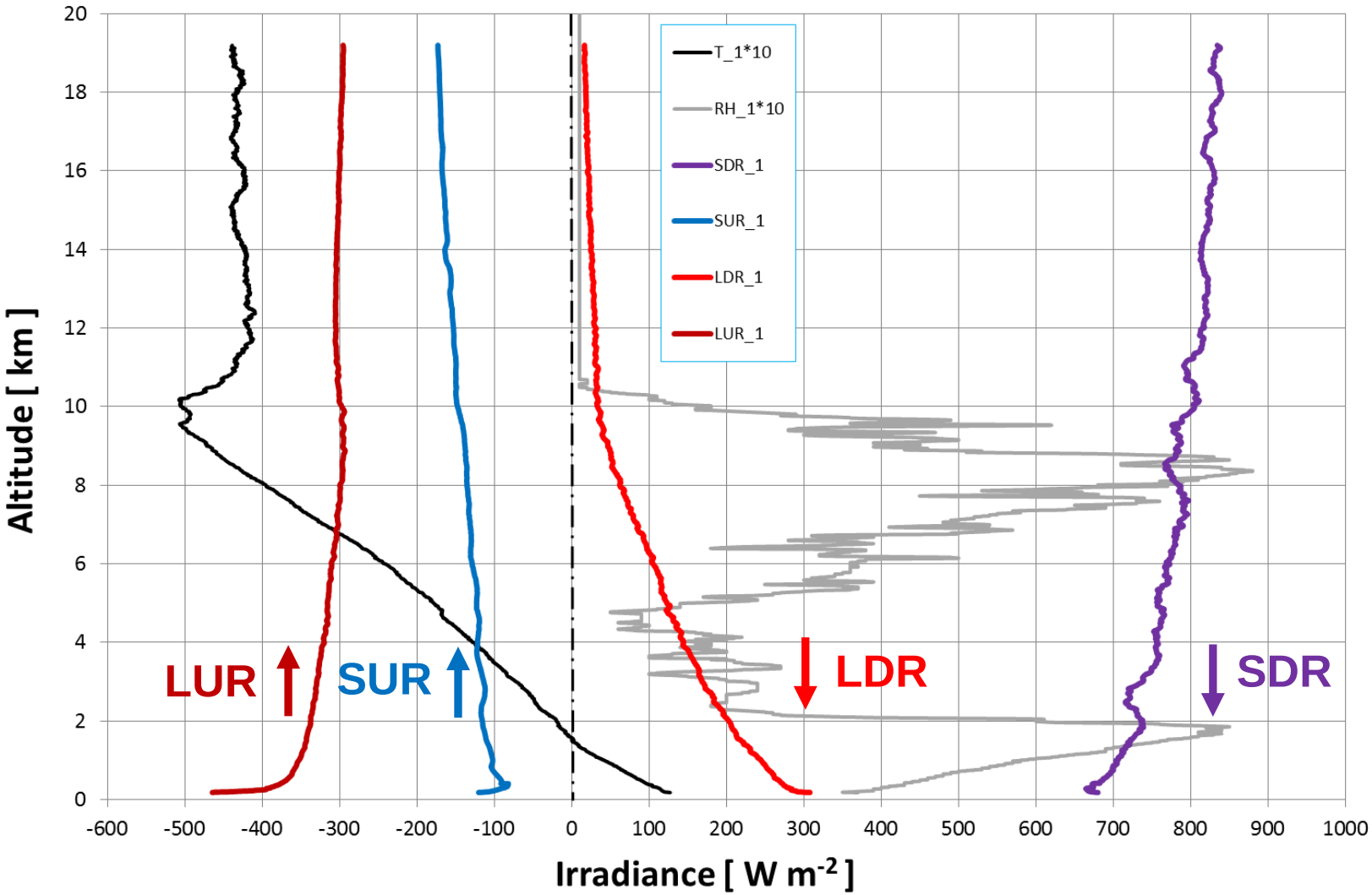
Flight 1 Cloud Free 30. June 2015

Time Top: LT 12:54

Solar Height: 45.5°



Time Start: LT 11:50

Solar Height: 45.6°

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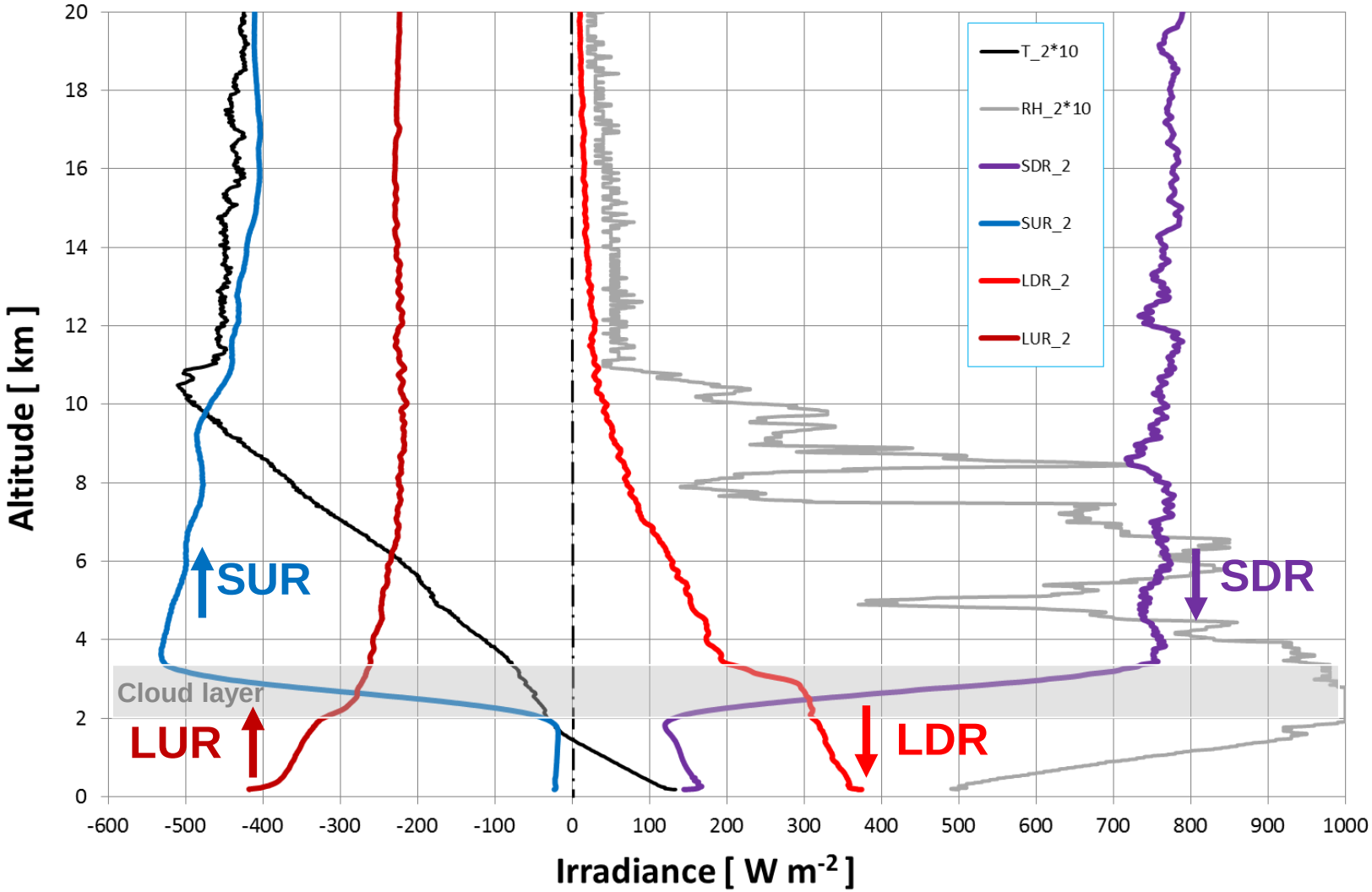
Flight 2 Cloud Layer 6. July 2015

Time Top: LT 16:21

Solar Height: 32.1°



Time Start: LT 15:30

Solar Height: 36.5°

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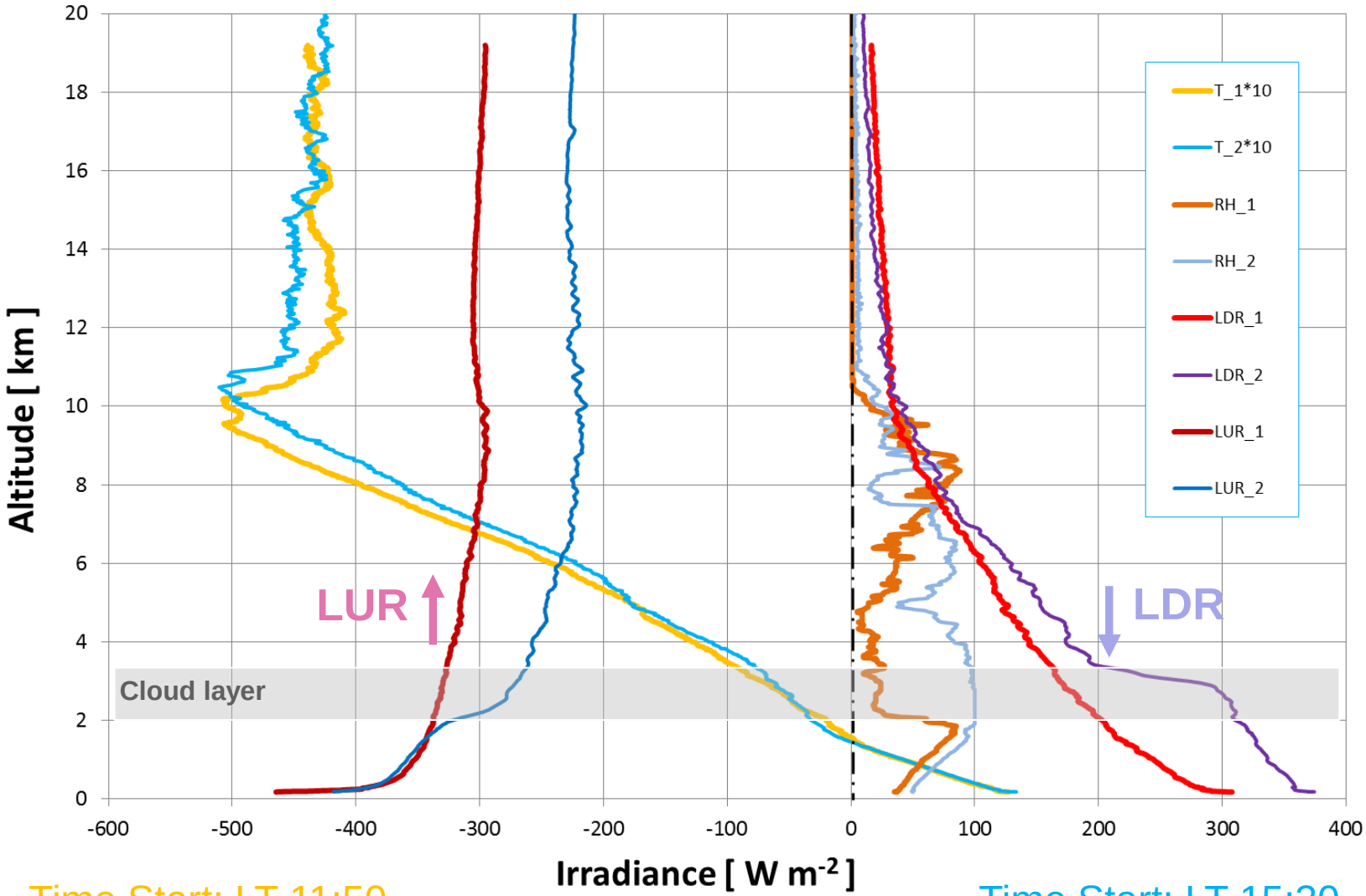
Flight 1 Cloud Free and Flight 2 Cloud Layer

Time Top: LT 12:54

Time Top: LT 16:21



Time Start: LT 11:50

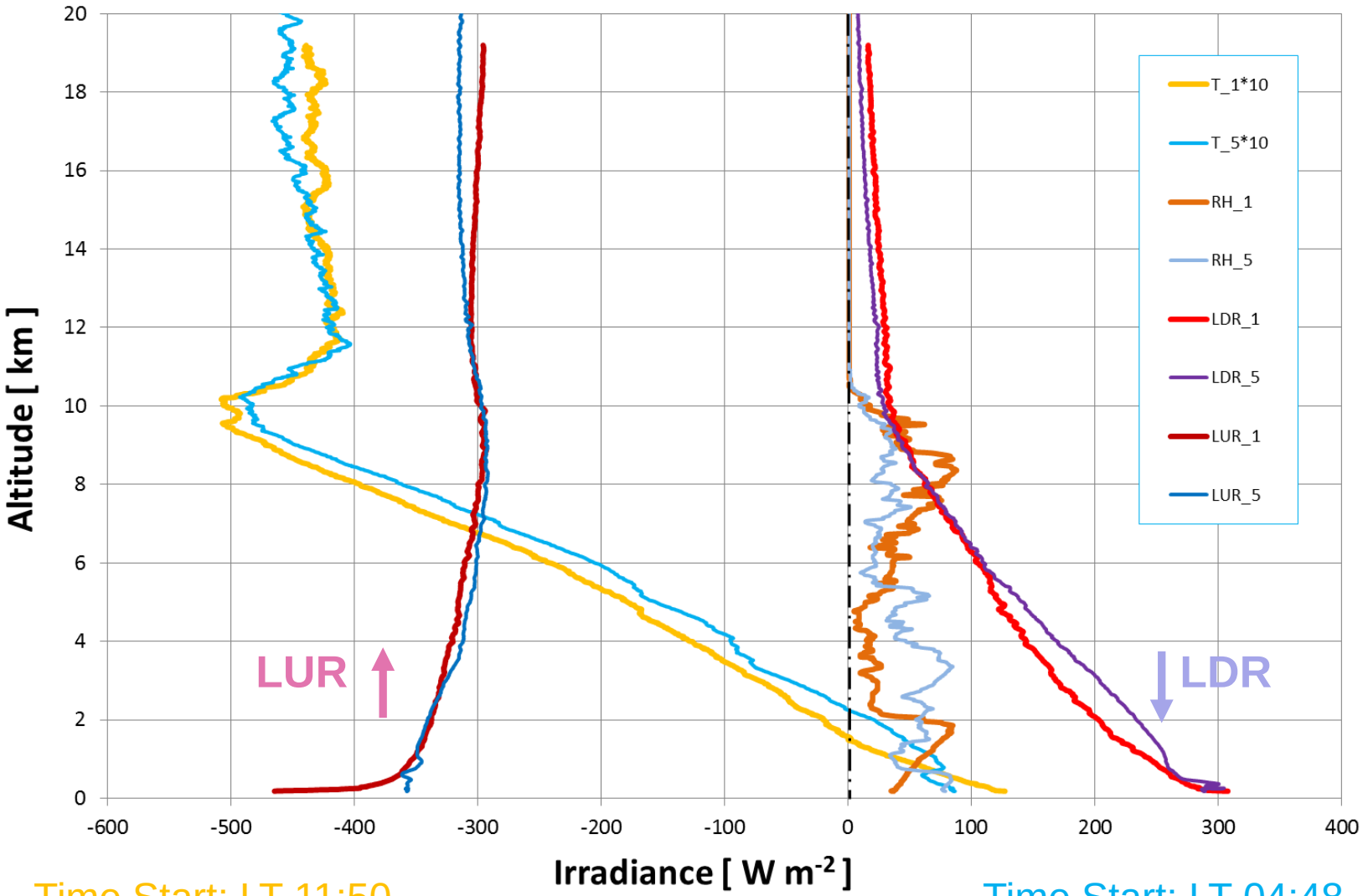
Time Start: LT 15:30

MeteoSwiss

Flight 1 Cloud Free and Flight 5 Cloud Free

Time Top: LT 12:54

Time Top: LT 06:18



Time Start: LT 11:50

Time Start: LT 04:48

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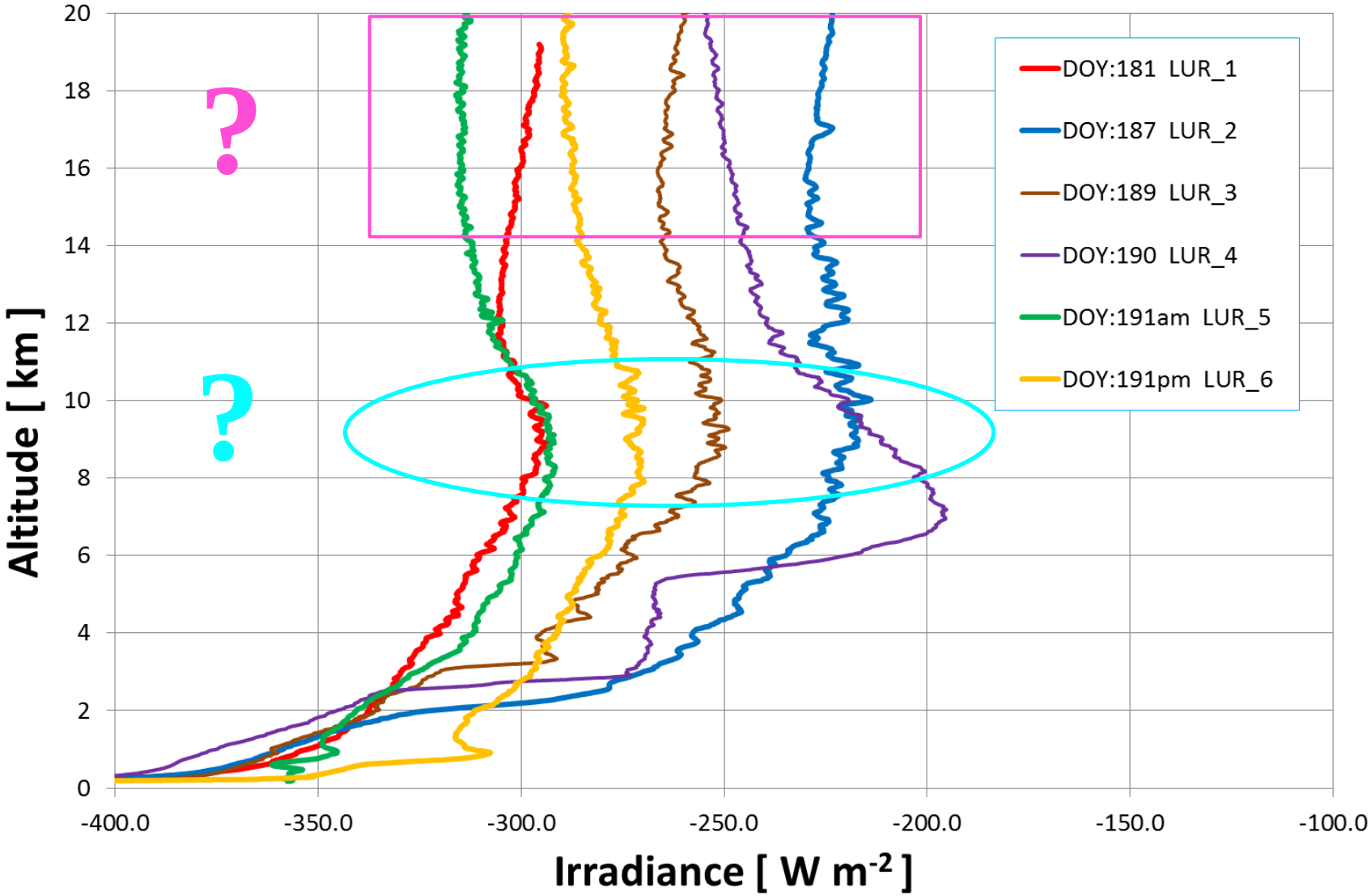
LUR of six flights in Sodankylä



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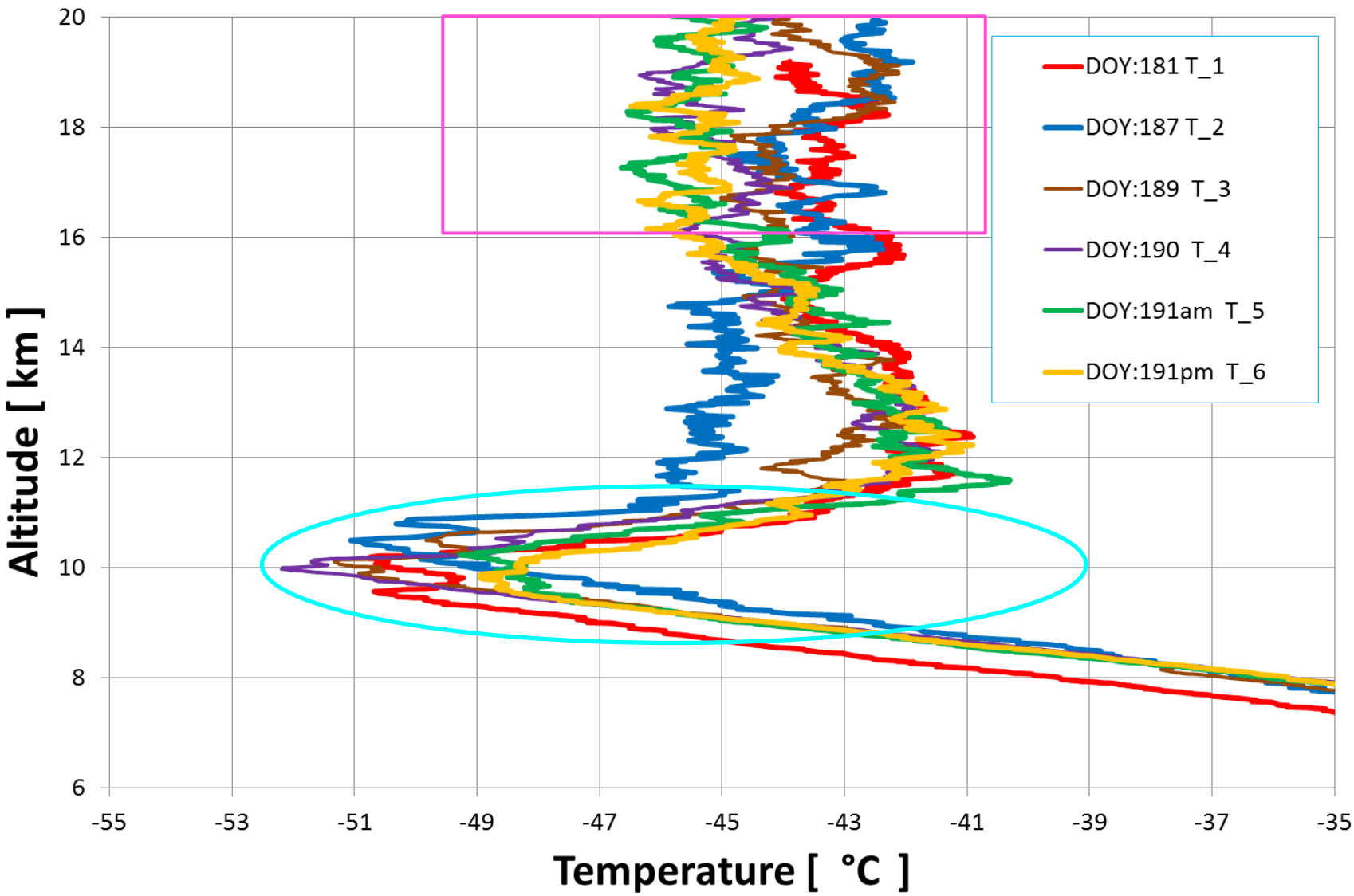
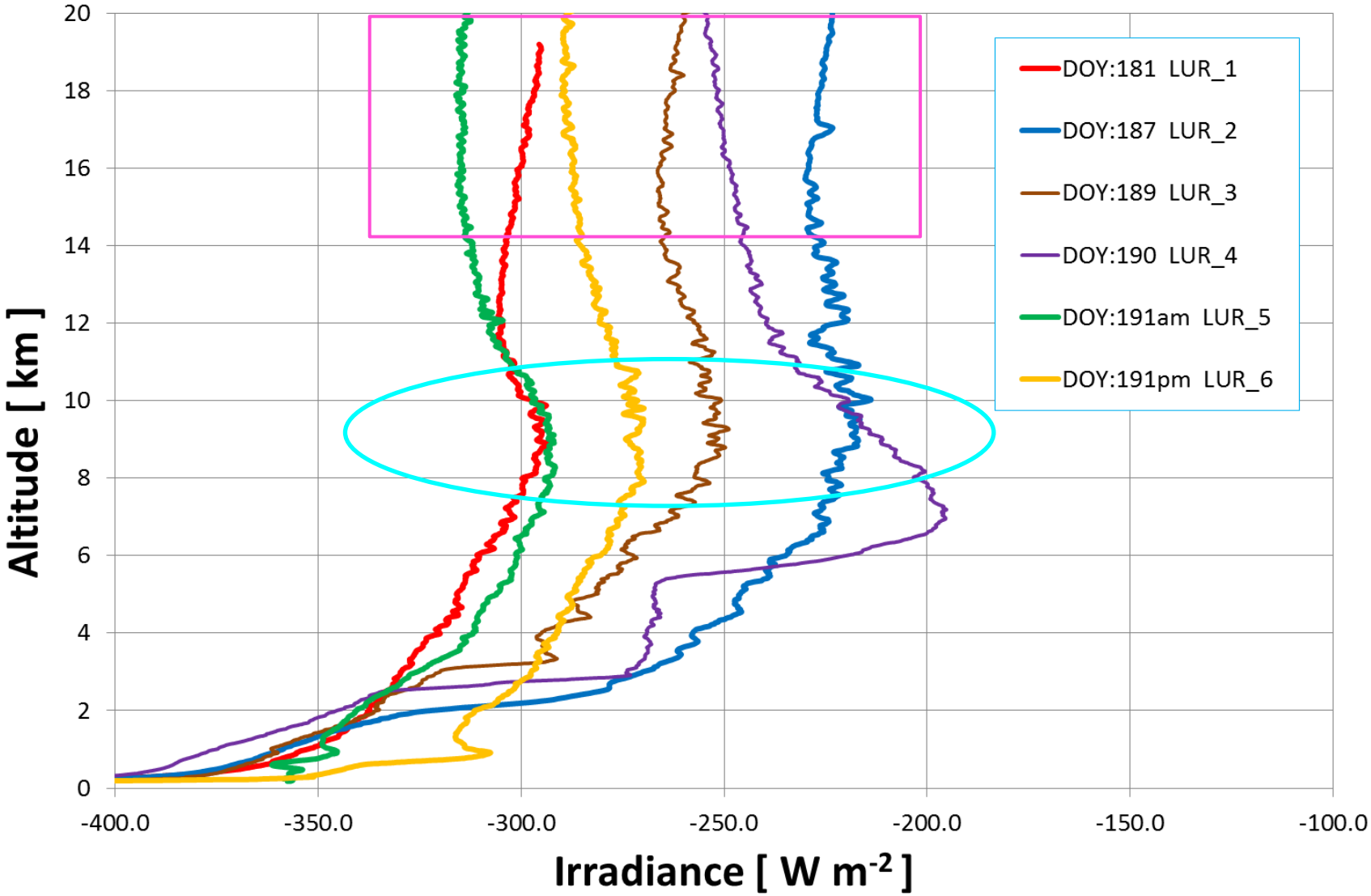
Temperature of six flights in Sodankylä



MeteoSwiss

LUR of six flights in Sodankylä



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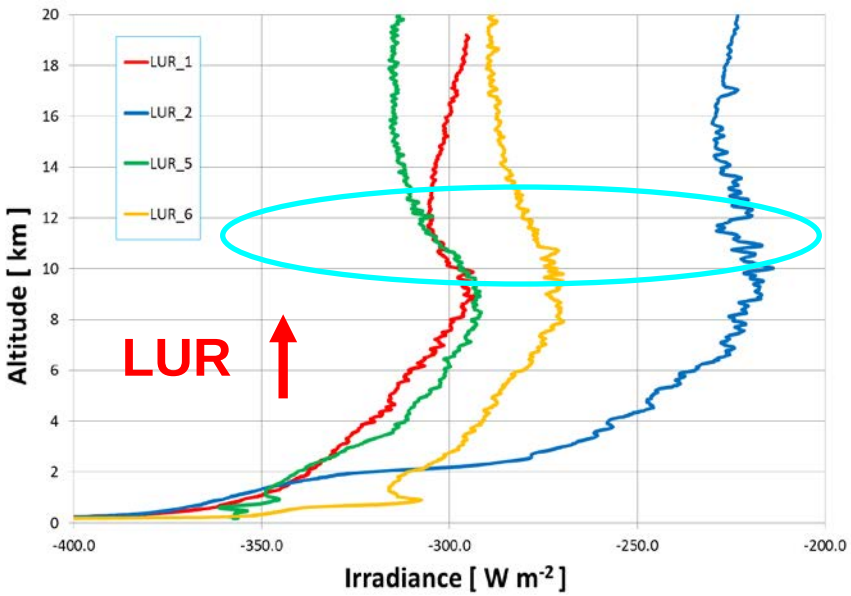
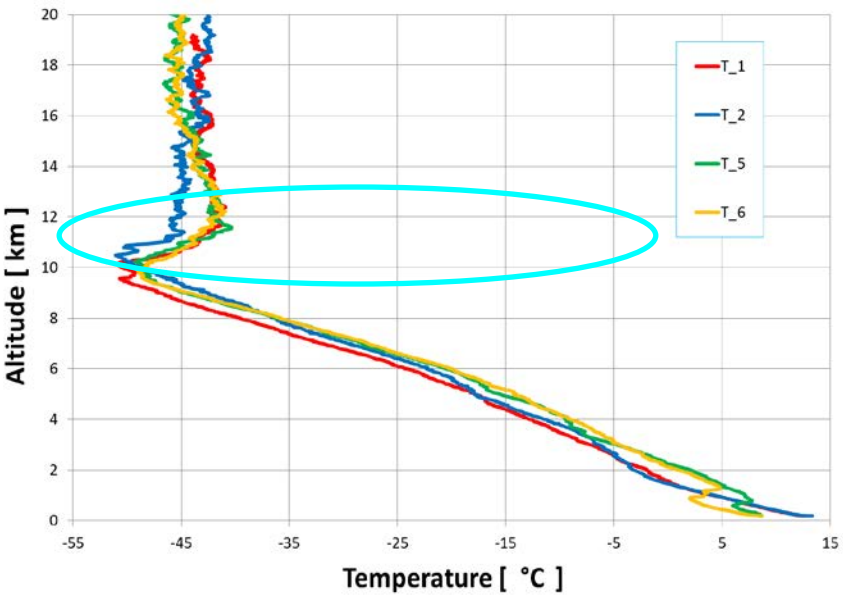
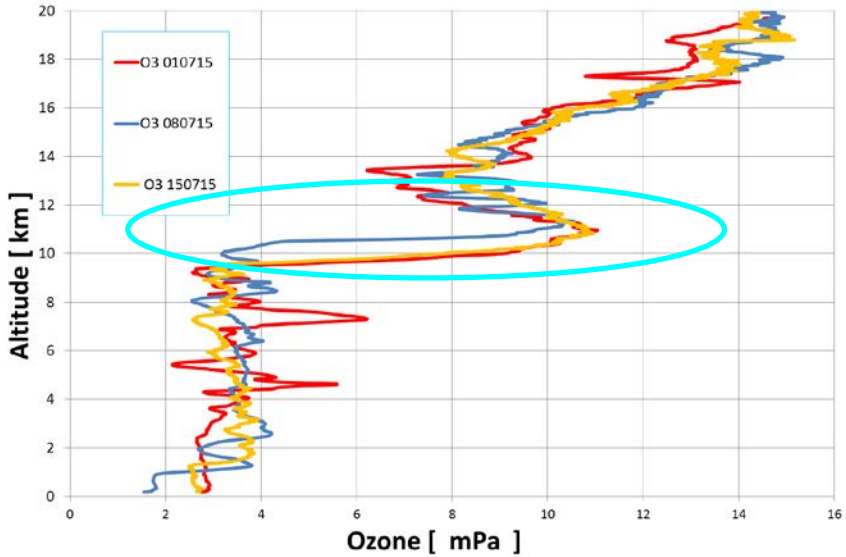
LUR increase at Tropopause







Increase of Temperature
and of LUR
above the Tropopause

Due to Ozone layer ?

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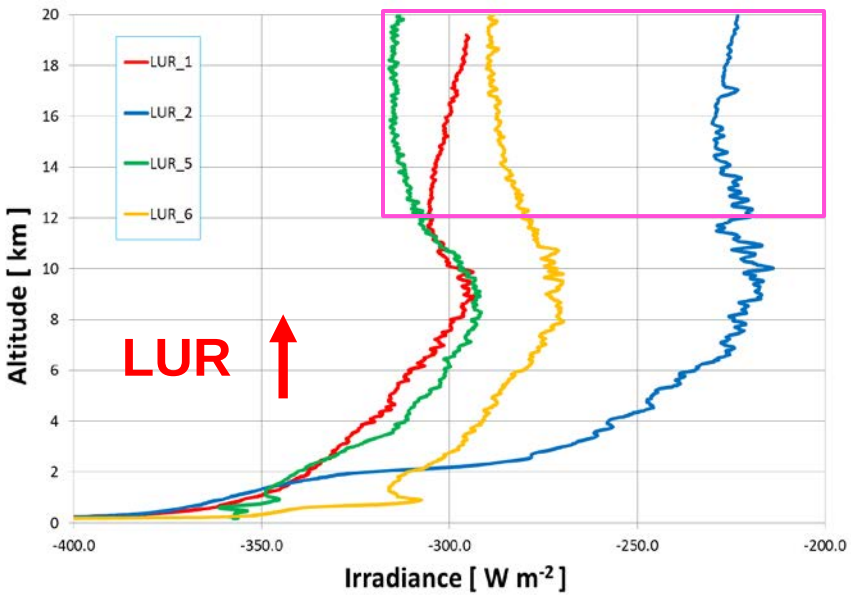
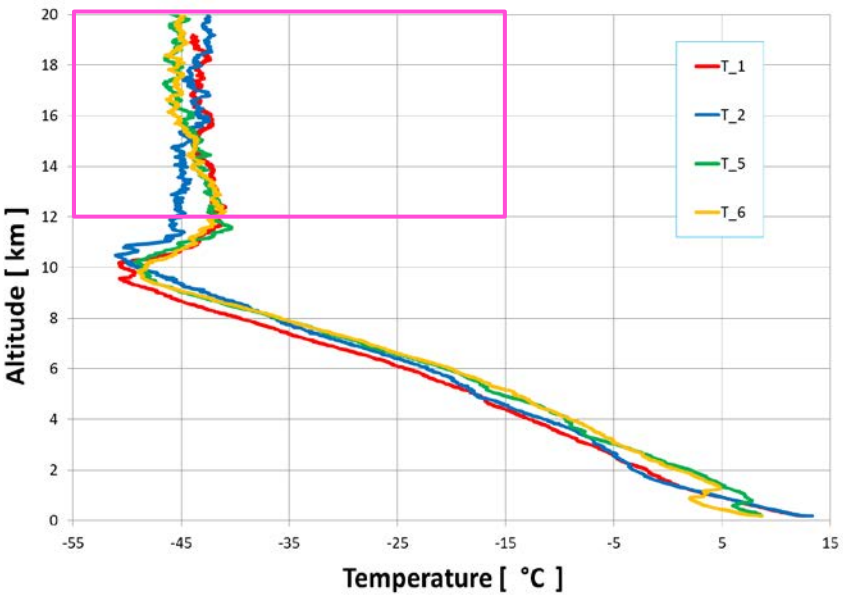
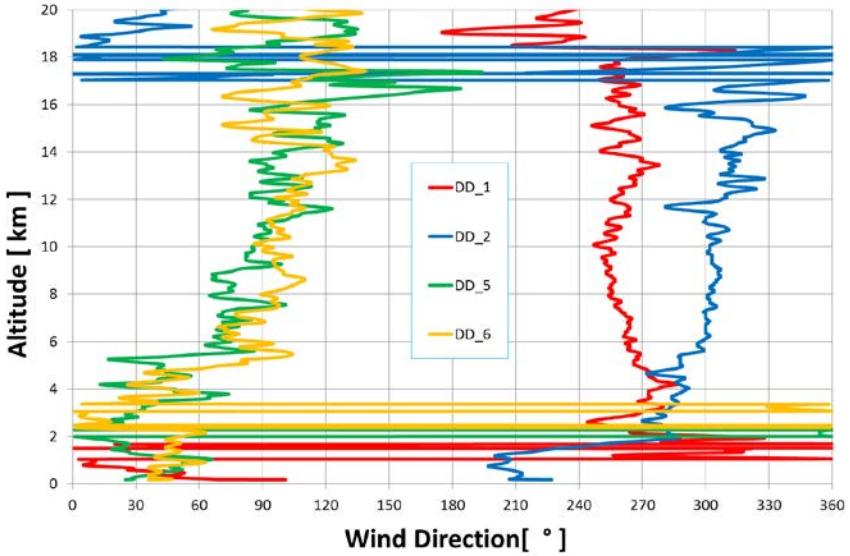
LUR decrease in Stratosphere







Absorption of LUR in the Stratosphere rises Temperature under westerly Winds

What is absorbing ?

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Summary

Cloudy compared to **cloud free** Atmospheres :

- Absorb more LUR in the Troposphere
- Emit less LUR to Space

Increase of Temperature and of LUR observed at the Tropopause

- Due to Ozone layer ?

Absorption of LUR in the Stratosphere rises the Temperature

- What is absorbing LUR in the Stratosphere ?

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Conclusions

Shortwave radiation profiles allow investigating effects of clouds and the albedo through the atmosphere

Longwave radiation profiles allow investigating absorption and emission in the troposphere and the stratosphere

Shortwave and longwave radiation profiles help to understand the greenhouse effect

Thank you for your attention