Evidence of Extreme events from Multi-wavelength LIDAR measurements during the EARLI09 campaign

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Overview

Lidar systems are laser based instruments that can evidence local atmospheric phenomena due to their high dynamic range and real time response

The paper presents a case study of an atmospheric extreme event observed during an inter-comparison campaign in Leipzig – Germany on the 26th of May 2009

Introduction

EARLI09

    - organized at The Institute for Tropospheric Physics, Leipzig Germany

    - direct comparison of atmospheric measurements with different lidar systems

    - from May 4th to May 29th

Introduction

Systems in the EARLI09 campaign

- 16 lidar systems

- 90 channels

    - 58 elastic backscatter

    - 32 Raman channels

24 Days of measurements

Introduction

Weather related phenomena

- most of this phenomena – troposphere

- cannot be identified by ground weather instruments in real time

- occurs when two air masses- one warm and one cold – meet

- the masses develop a sharp boundary or interface (where the temperature difference becomes intensified)
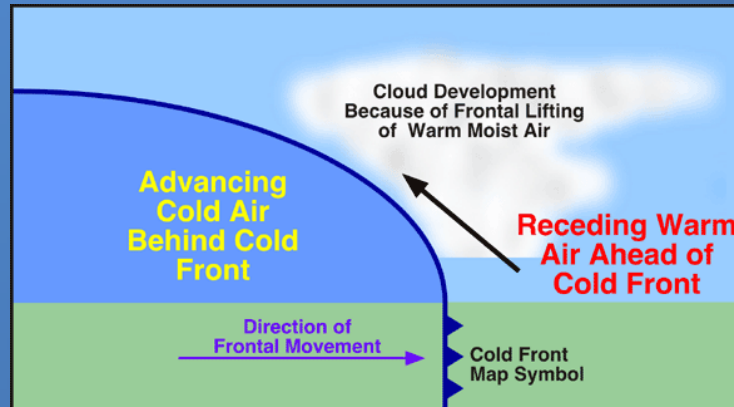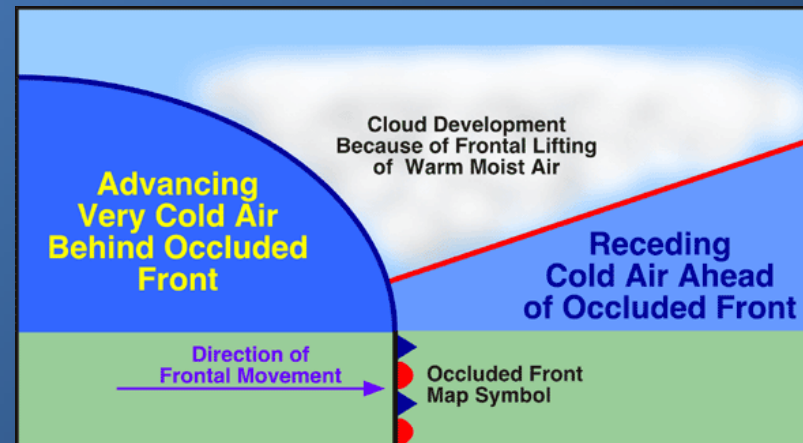
Introduction

http://www.physicalgeography.net/fundamentals/7r.html

Instrument

RALI – Multi-wavelength Raman Lidar

    - Total of 12 channels

       - 7 elastic channels

       - 5 inelastic channels

    - 400mm Cassegrain Telescope

    - FOV 1.73 mrad

    - 10 Hz laser

    - 90 mJ @ 1064 nm

    - 50 mJ @ 532 nm

    - 60 mJ @ 355 nm

Models

For this case-study:

DREAM - The Dust Regional Atmospheric Model

    Is an integrated modeling system to describe the dust cycle in the atmosphere

HYSPLIT - Hybrid Single Particle Lagrangian Integrated Trajectory Model

    Is a new system for computing simple air parcel trajectories to complex dispersion and deposition simulations
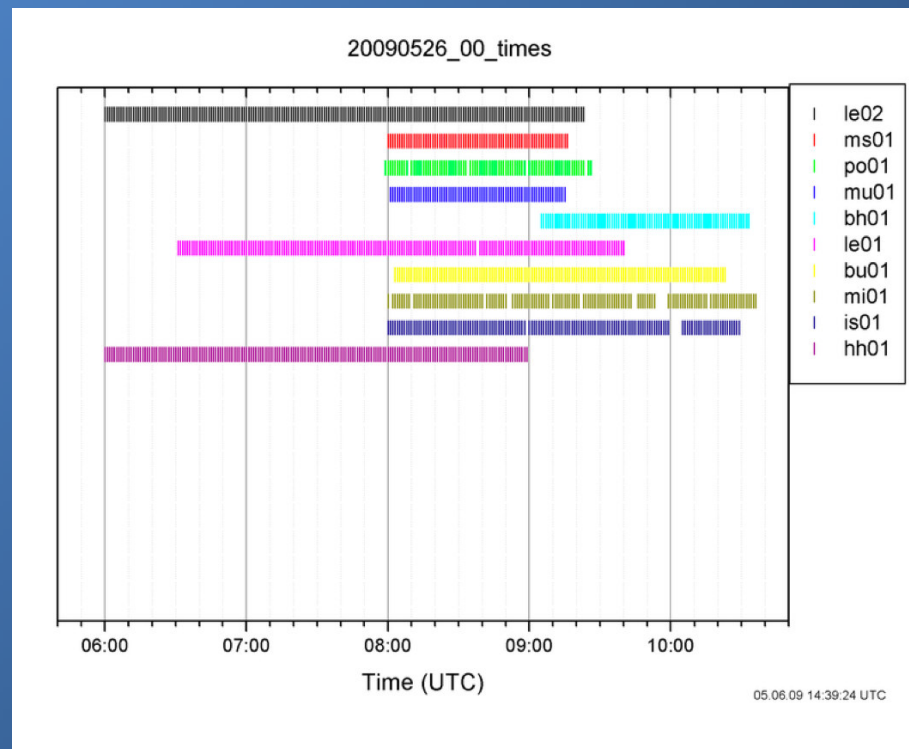
Case-Study

Case of an atmospheric phenomenon during measurements on May 26, 2009

The EARLI09 schedule for that day

Case-Study

May 26th 2009

- two phenomena: Saharan dust layer @ 4500m and a cloud formation reaching the Free Troposphere

Saharan Dust Event: DREAM, HYSPLIT and RALI ALGORITHM

Cloud formation: WEATHER MAPS - interpretation

Case-Study

May 26th 2009

Saharan Dust event

Saharan Dust concentration- DREAM
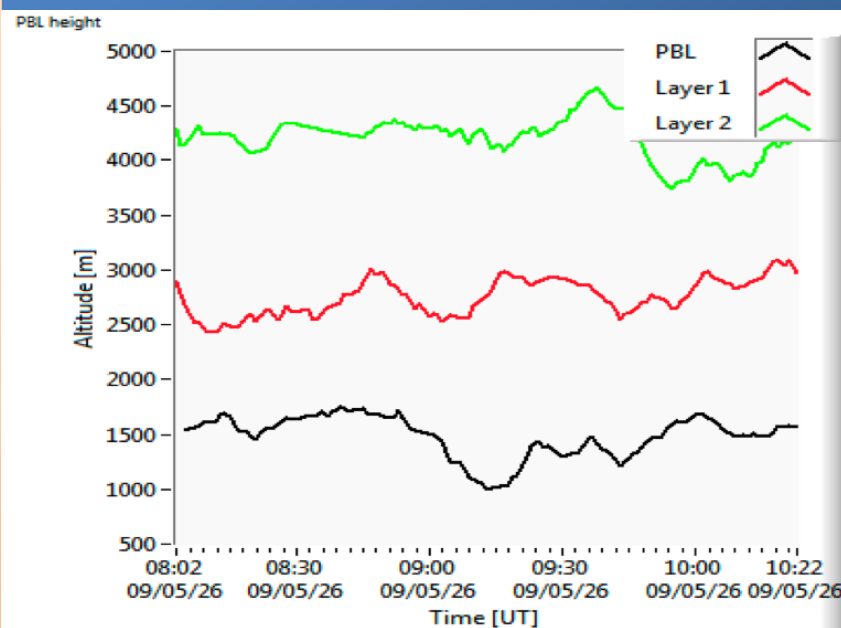
Back Trajectories Analysis

Case-Study

May 26th 2009

Saharan Dust event

Atmospheric layers obtained from RALI algorithm

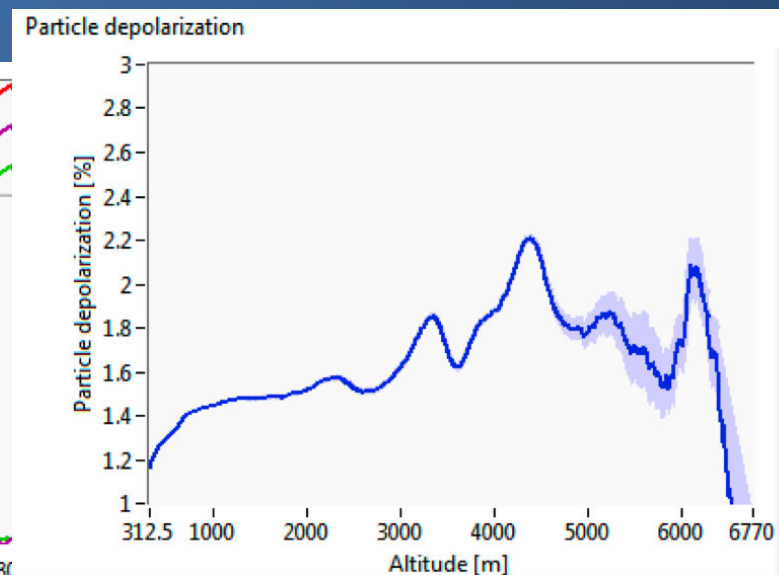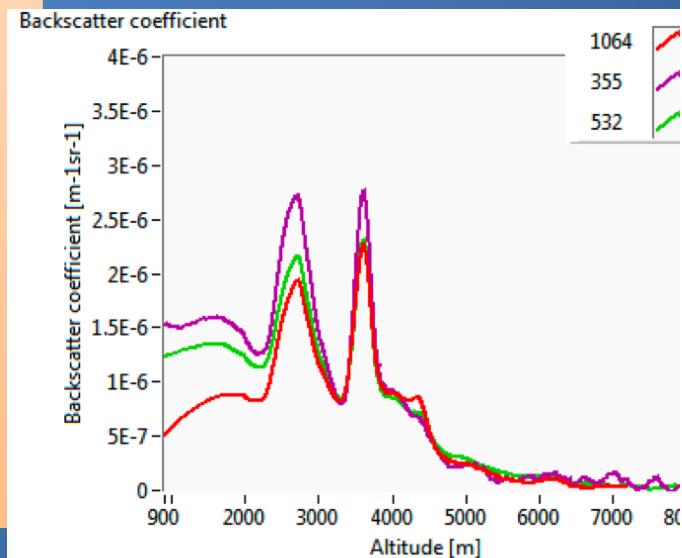Layers height were determined by applying the gradient method [2] to the RCS

Discussion

May 26th 2009

Case Study

- aerosols at 4500m – higher depolarization coefficient than the aerosol in PBL
- color ratio of 0.9 (b_{532}/b_{355}) & Angstrom exp. 0.1 (355/532)

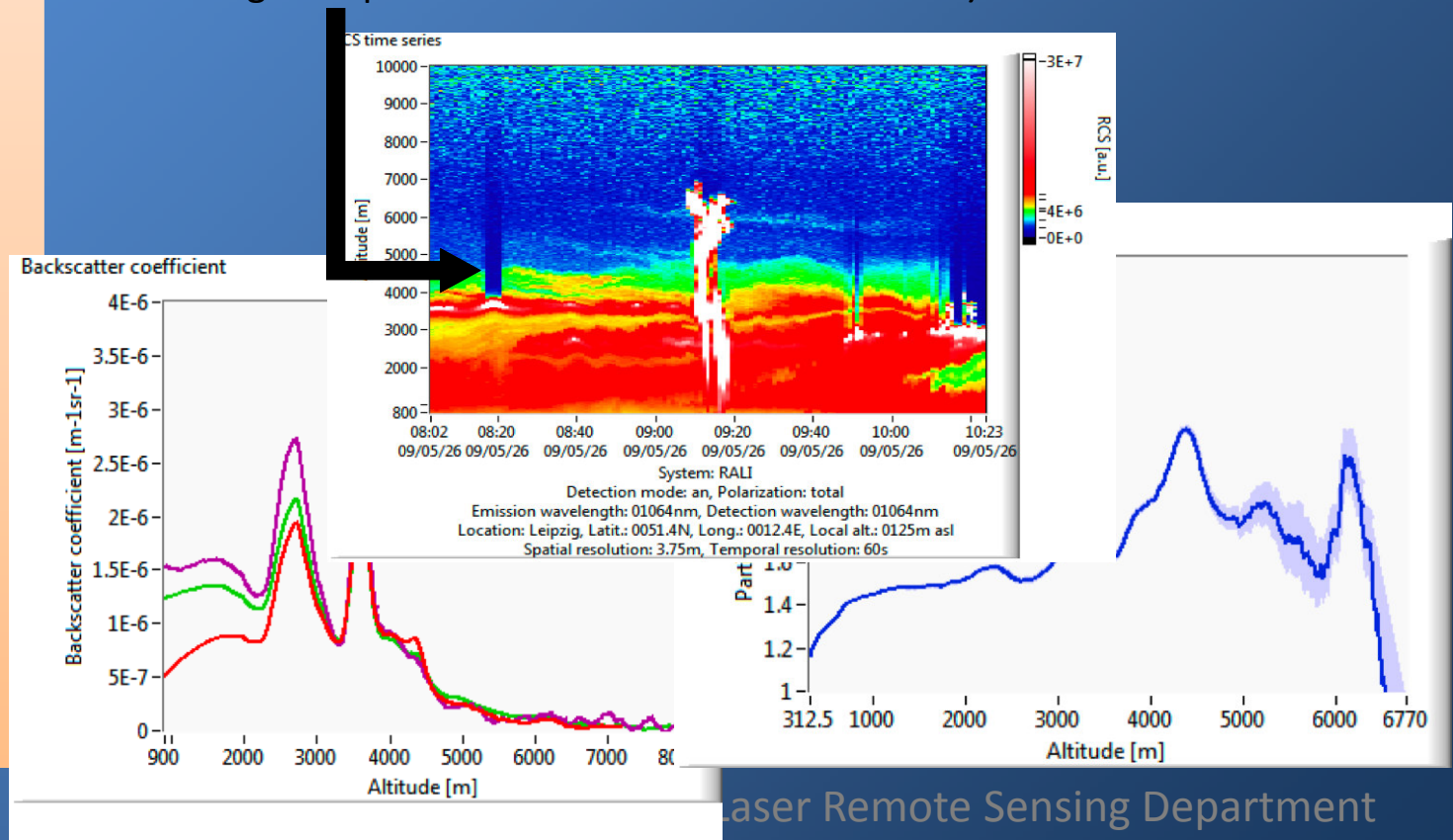=> particles with significant asphericity

Discussion

May 26th 2009

Case Study

• the formation of clouds at dust layer altitudes indicates that the mineral is somewhat hygroscopic (due to changes in composition during transport across the Mediterranean Sea)
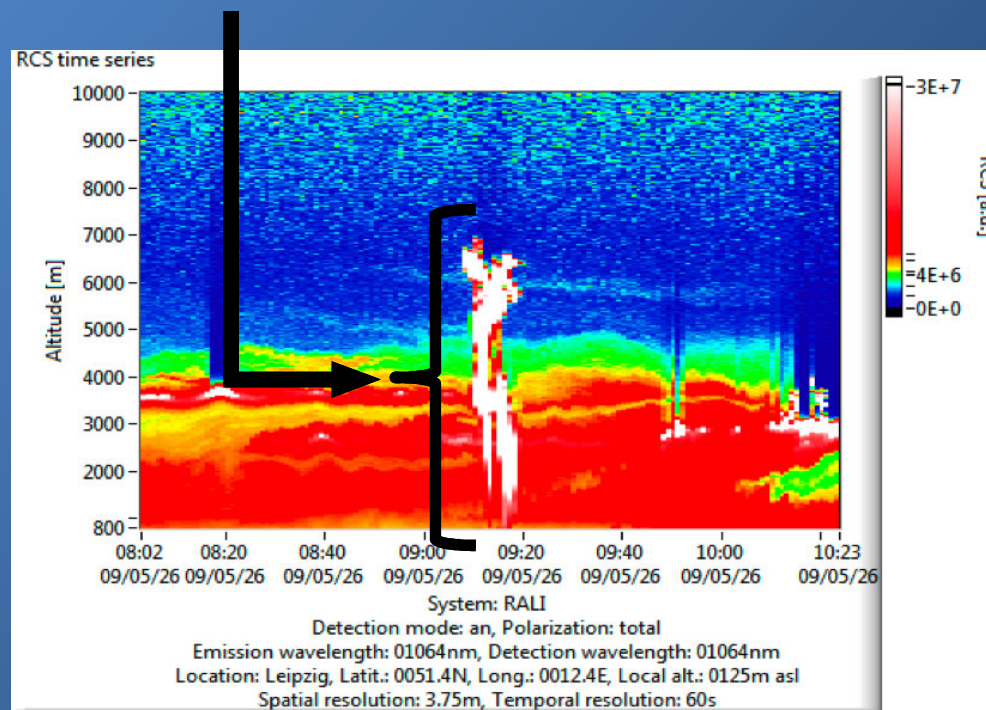
Case-Study

May 26th 2009

Cloud Formation – the second event of this case-study

- a short duration cloud formation developed in the PBL and reached the FT , overlapping on the dust intrusion event.
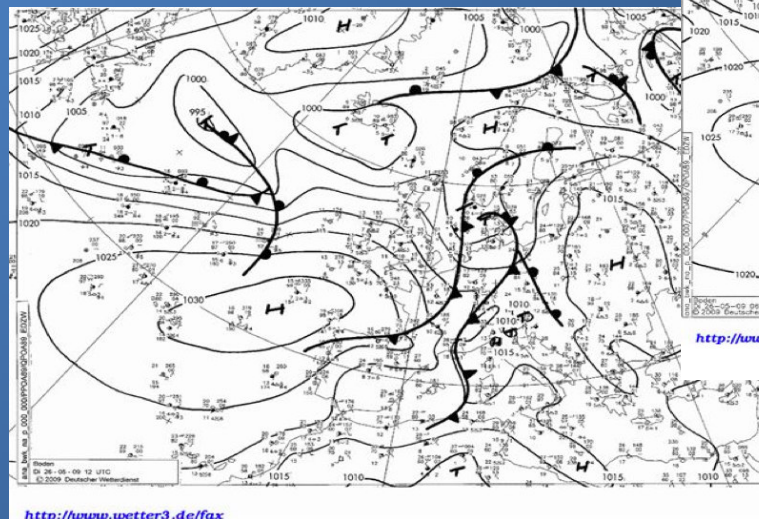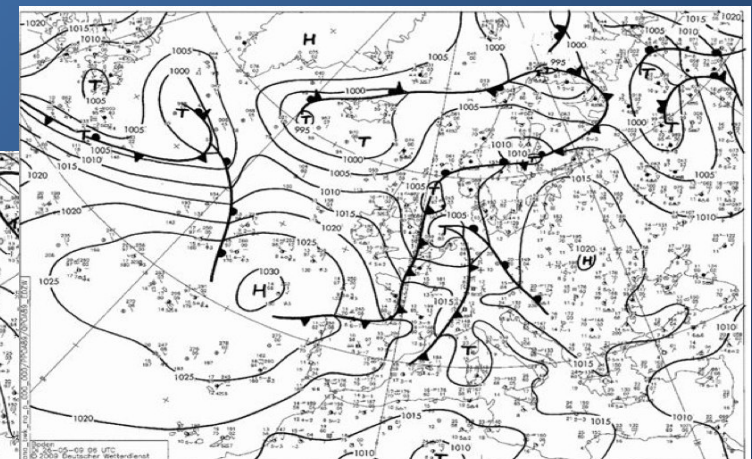
Case-Study

May 26th 2009

Cloud Formation

The weather map over Germany shows in area of Leipzig a large discontinuity in temperature, wind and air composition.

12 UTC

6 UTC

Discussion

May 26th 2009

Case Study

•The HYSPLIT GDAS Meteorological data for 26 May 2009
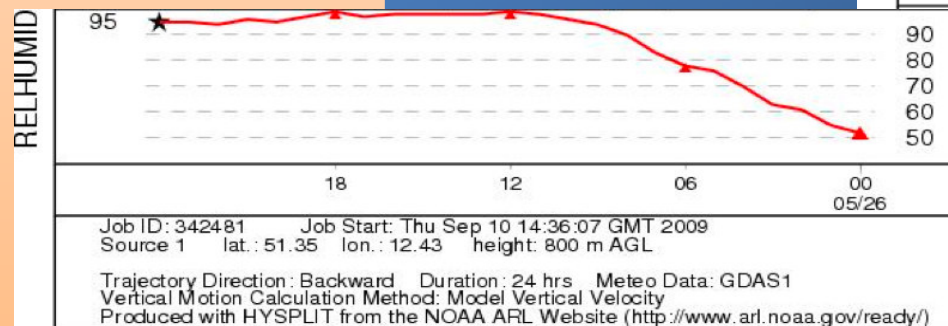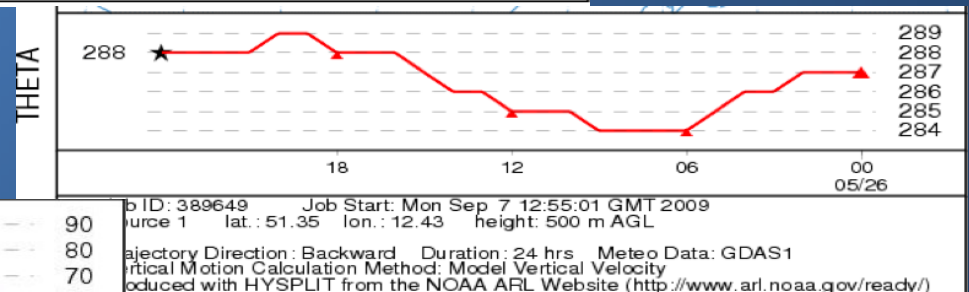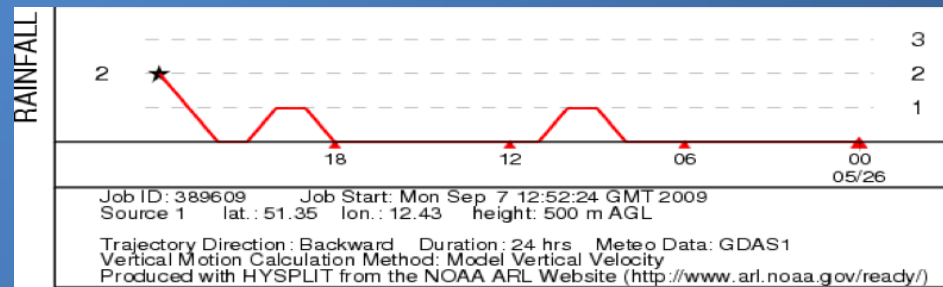
Conclusions

May 26th 2009

Lidars:

- vertical distribution of aerosols

- vertical structure of aerosol layers.

- highlight events such as atmospheric turbulence or vortices of air in the troposphere.

Models:

- for understanding phenomena – synergy between measurements and models

Cloud Formation

- a local extreme event occurred on May 26th during EARLI09 campaign

- the extent of this event is not signalized by any other measurement / model

Conclusions

May 26th 2009

Considering the complexity of information necessary for a complete understanding of processes in the atmosphere, no instrumentation proved to be capable so far to provide reasonable answers. Only *a synergy between ground-based, airborne and remote sensing instruments*, as well as regional and global atmospheric models could provide this.

References

May 26th 2009

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- http://www.bsc.es/projects/earthscience/DREAM/

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- [2]Sabina Stefan, Doina Nicolae and Mihaela Caian, Secretele aerosolului atmosferic in lumina laserilor, Ed. Ars Docendi, Bucuresti 2008, ISBN 978-973-558-357-6

- http://www.wetter3.de/Archiv/

- [3]Cooley J. R., and M. E. Soderberg, 1973: Cold air funnel clouds. NOAA Tech. Memo. NWS CR-52, Scientific Services Division, NWS Central Region, Kansas City, MO, 29 pp

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➡ Thank You!