

# ***Management of Change for GRUAN:*** ***Lessons learn from Lindenberg radiosonde data***

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**NCAR**

# What is the problem?

To identify break points:

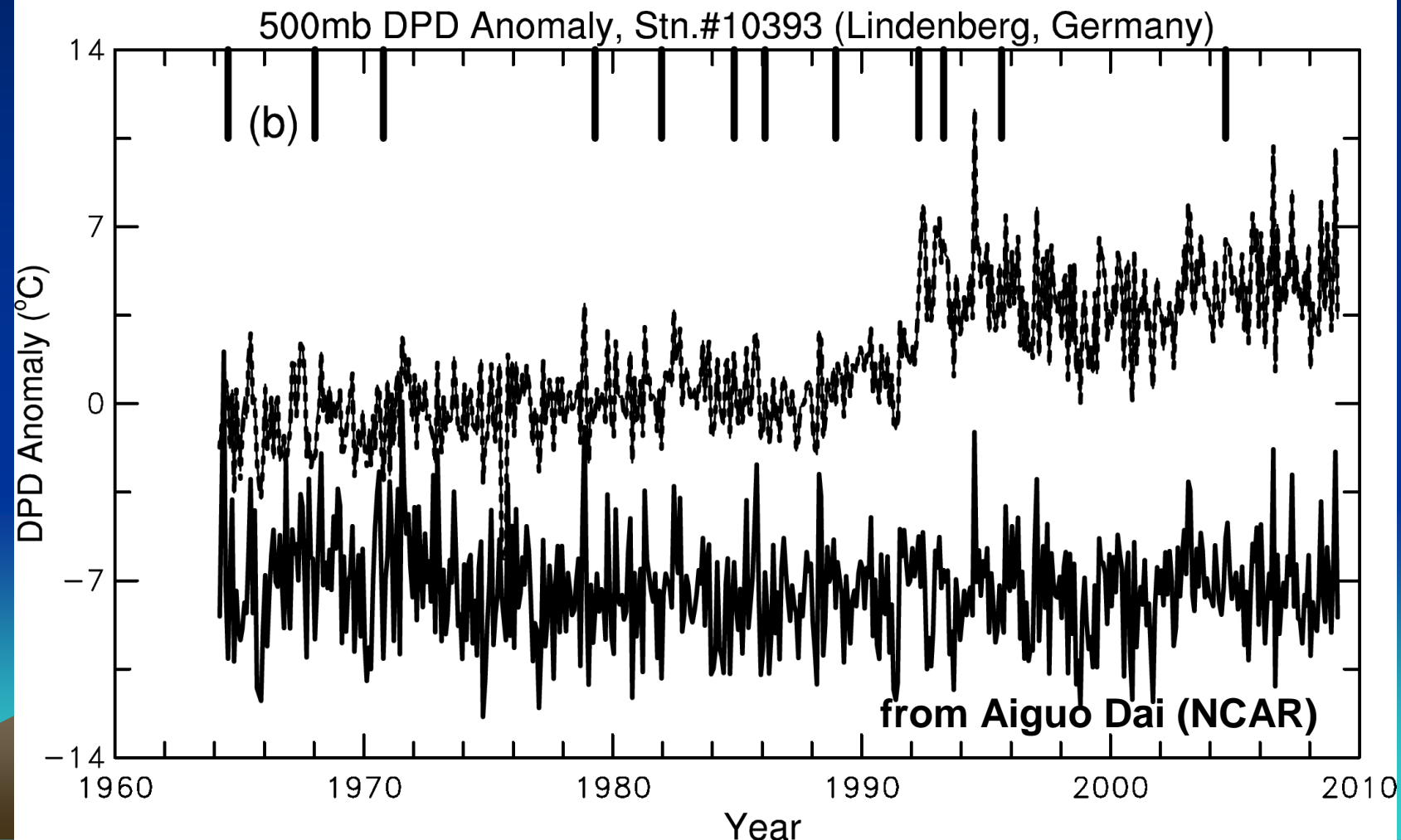
- Reference time series & methods

- Metadata and other info for validation

To make adjustments:

- Adjustment methods

- Last or one segment as reference



**Fact:** Changes are inevitable for any observation network.

**Goal:** How can we do better in GRUAN in the following areas?

1. To document detailed changes
2. To assess impacts of changes
3. To minimize impacts

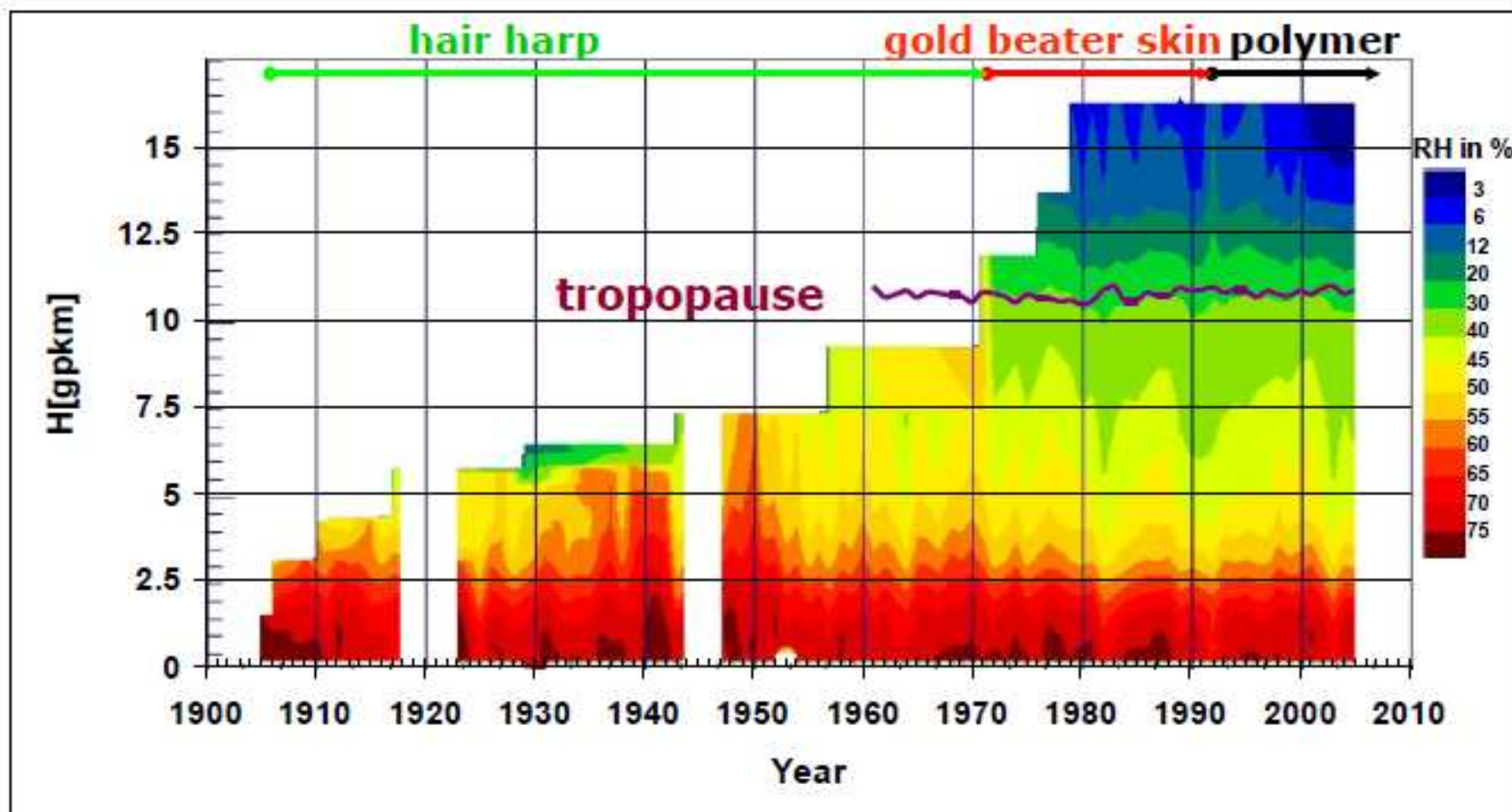
**Questions to be answered:** What co-incident, independent (i.e. redundant) measurements, how much and what kind of associated metadata, and how much overlap between old and new instruments are needed?



## **Approach:**

- 1. To select the long-term data collected from GRUAN stations with reliable metadata and redundant measurements;**
- 2. To analyze the data to assess what practices are essential to document the changes;**
- 3. To analyze the overlap and redundant measurements to quantify the impacts of the changes;**
- 4. To make recommendations on best practices for GRUAN.**

## Humidity Profile Lindenberg / corrected:



from Horst Dier (MOL-RAO)

# Lindenberg dual-sonde data

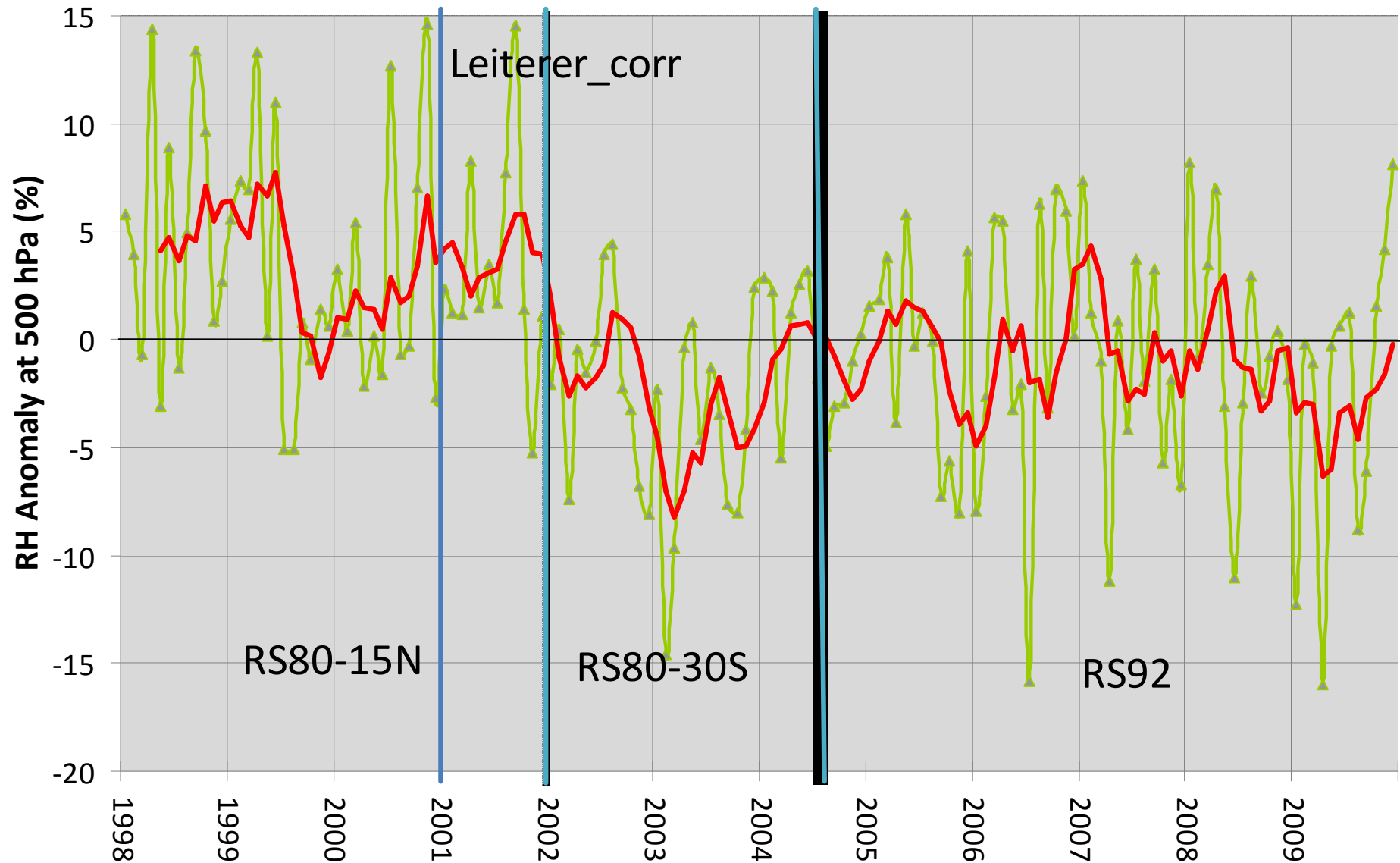
## (high resolution (5s) with detailed metadata)

	<u>Routine</u>	<u>Sonde Types</u>	<u>RS90fn</u>	<u>Sonde Types</u>	<u>RS92fn</u>	<u>Sonde Types</u>
1998	1449	RS80-30, RS80-15S, RS80-15NS, RS80-15N				
1999	1410	RS80-15N	24	FN90NC		
2000	1430	RS80-15N	56	FN90NC, FN9052		
2001	1457	RS80-15N	57	FN90NC, FN9052		
2002	1449	RS80-30S	54	FN90NC, FN9052, FN9040		
2003	1452	RS80-30S	63	FN90NC, FN9052, FN9040		
2004	1447	RS80-30S, RS92-AGP	83	FN90NC, FN9052, FN9040		
2005	1460	RS92-AGP	59	FN90NC, FN9052, FN9040		
2006	1468	RS92-AGP, RS92-SGP	58	FN90NC, FN9052		
2007	1748	RS92-SGP	107	FN90NC, FN9052, FN9040		
2008	1540	RS92-SGP, RS92-SGP(V)	60	FN90NC, FN9052	35	RS92-SGP
2009	781	RS92-SGP(V)	15	FN90NC, FN9052	13	RS92-SGP
TOTAL	17091					

# Information for change point identification

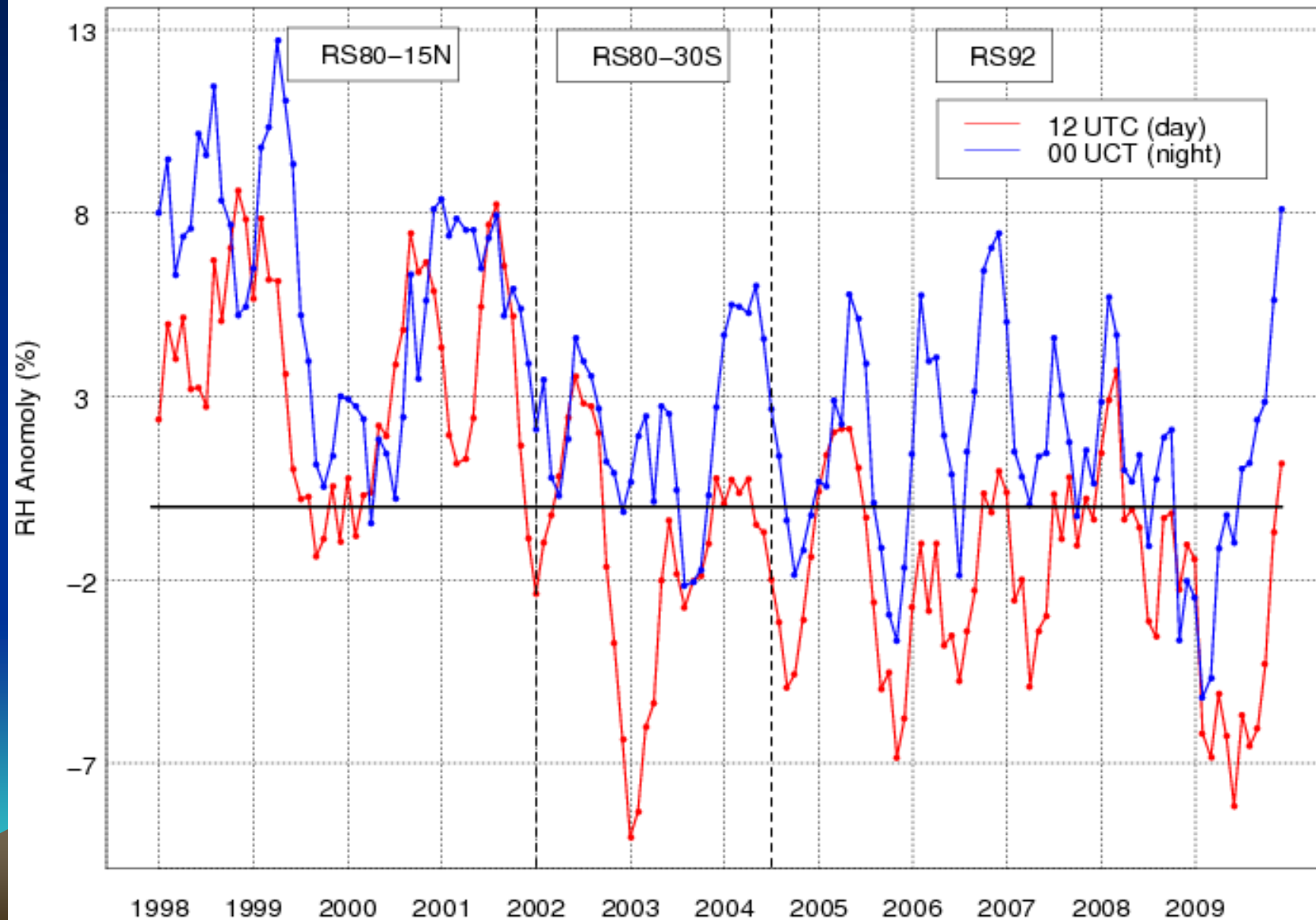
- ❖ Metadata: hardware and software changes
- ❖ Solar zenith angle
- ❖ Co-incident RS90/92-FN comparisons
- ❖ GPS-PW comparisons
- ❖ MW RP comparisons

# Metadata for change point identification

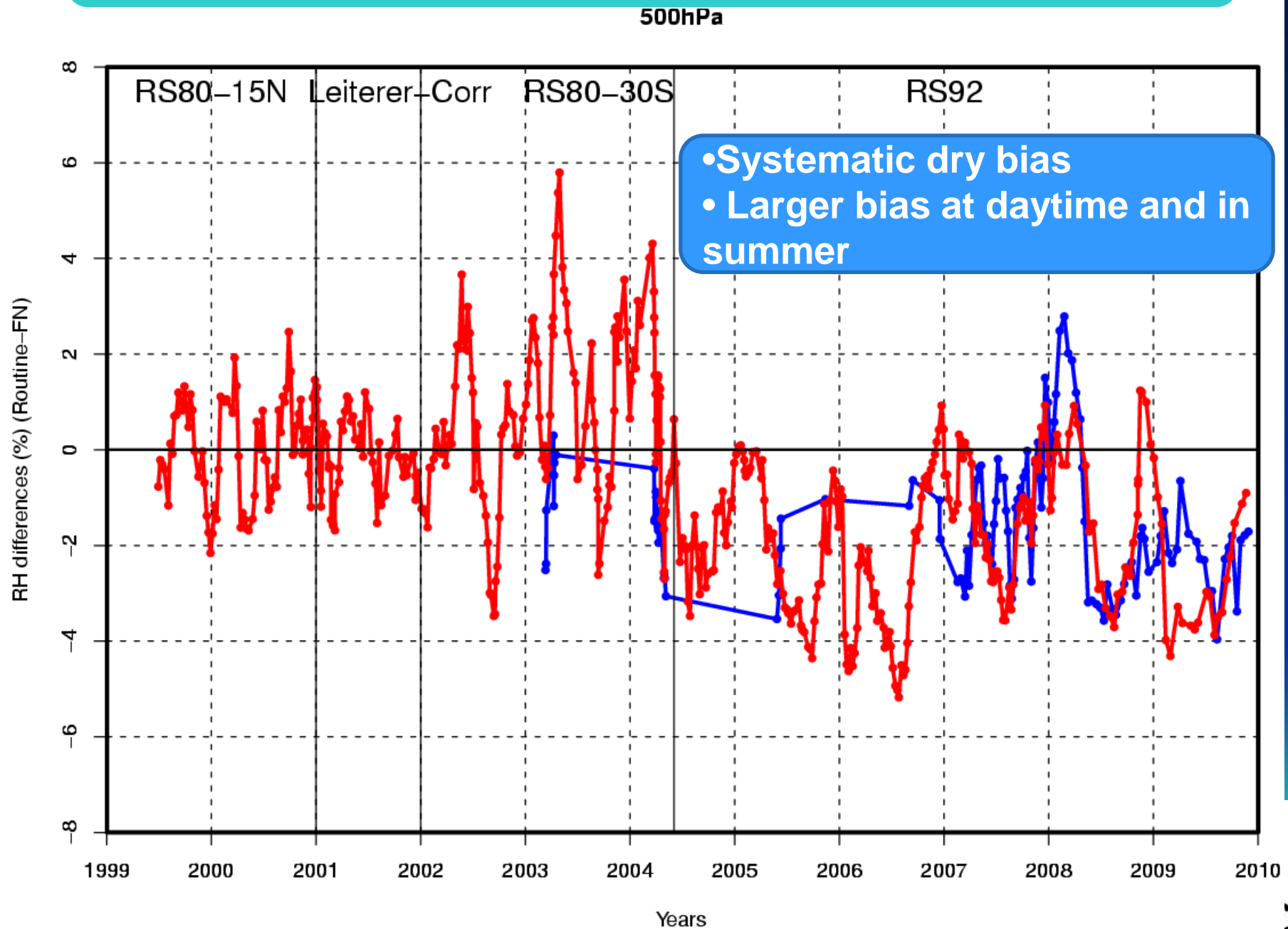




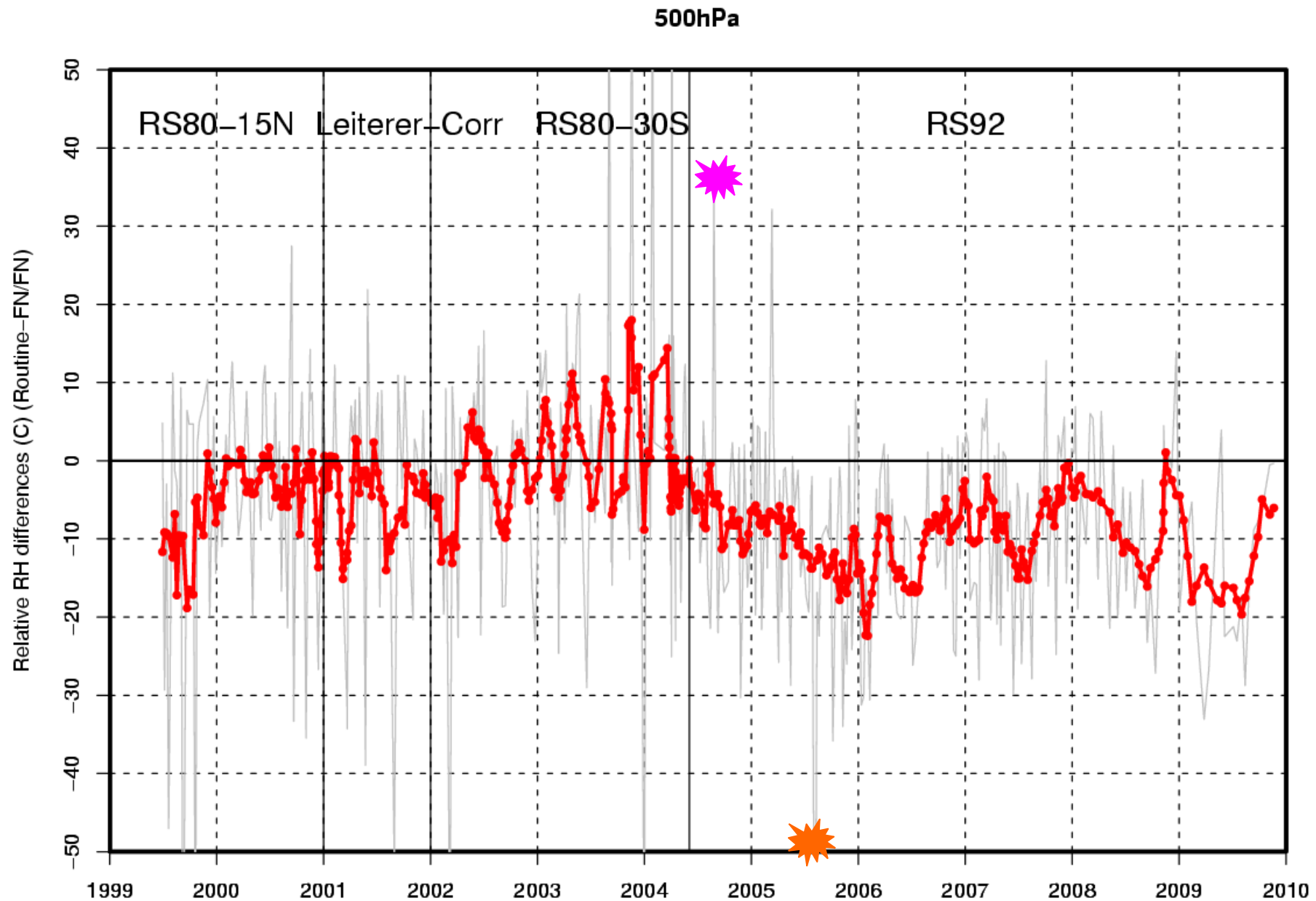
# SZA for change point identification



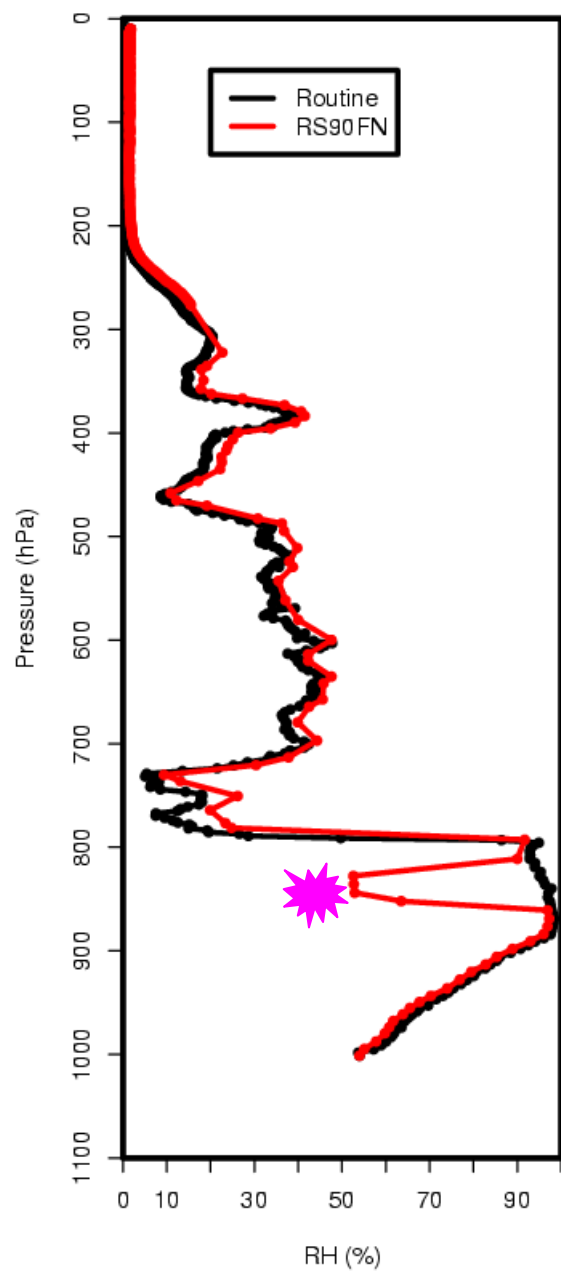
# Dual sonde data for change point identification



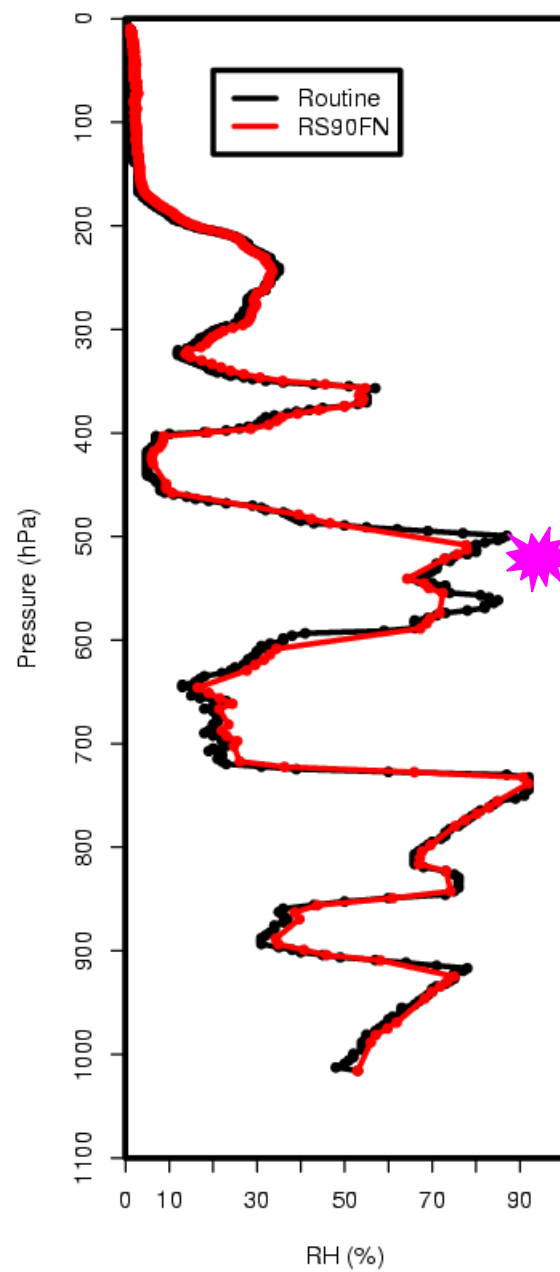
# Concerns on dual-sonde data



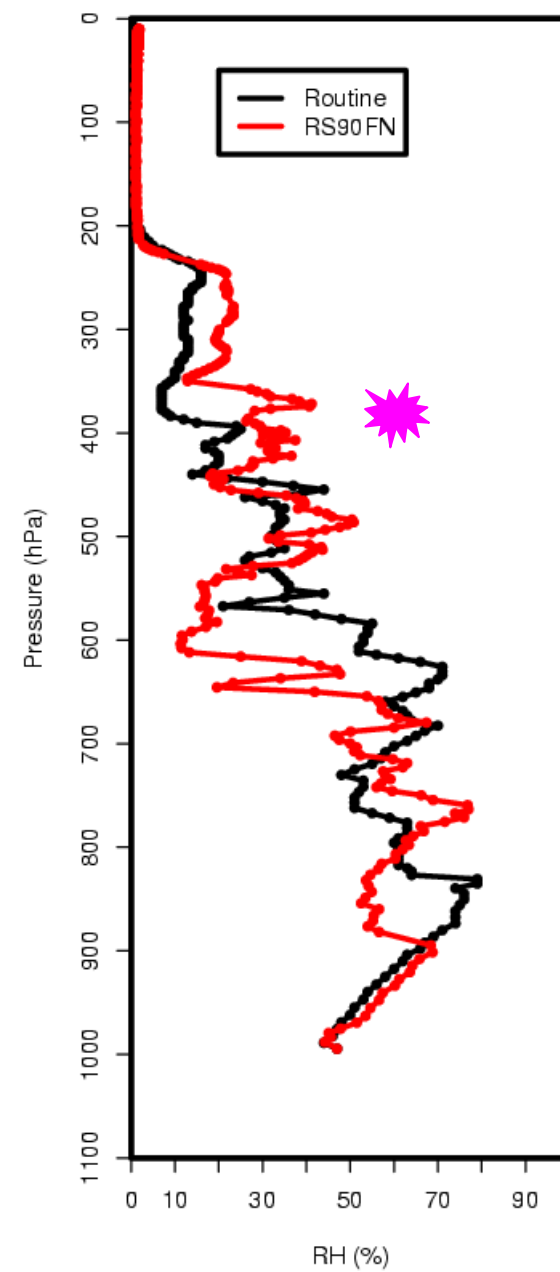
1\_20060406\_1200



1\_20050310\_1200

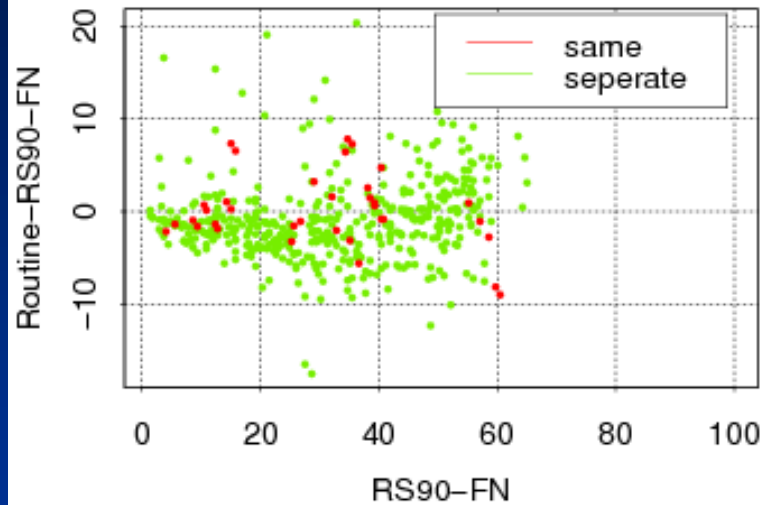


1\_19990818\_1200

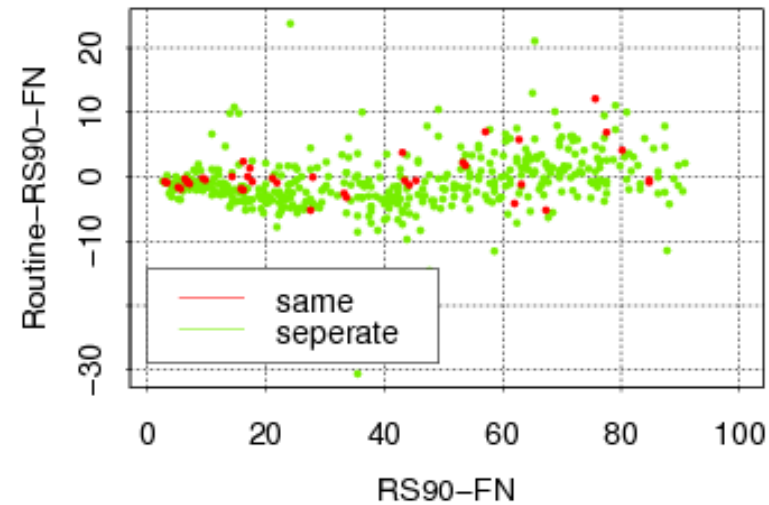


# Side-by-side or on the same balloon?

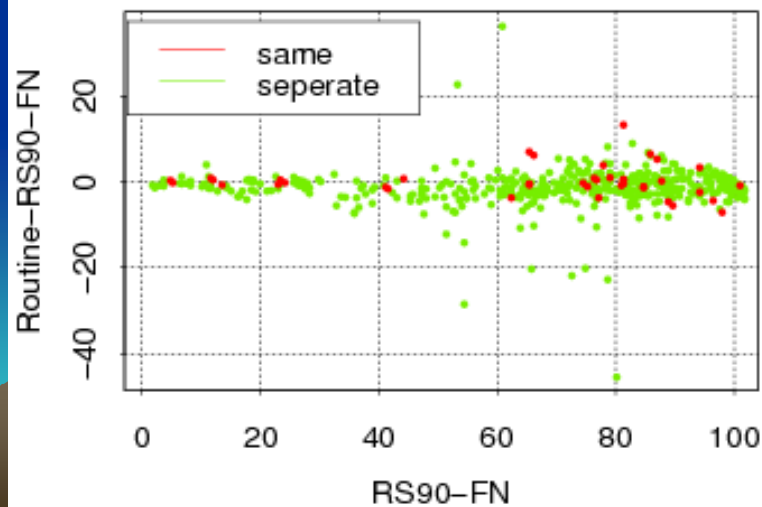
RH 300 mb (12 UTC ) N=480



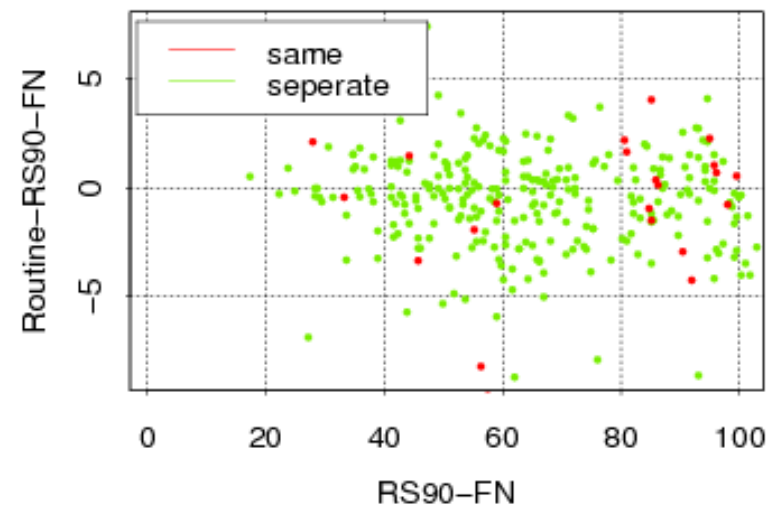
RH 500 mb (12 UTC ) N=495



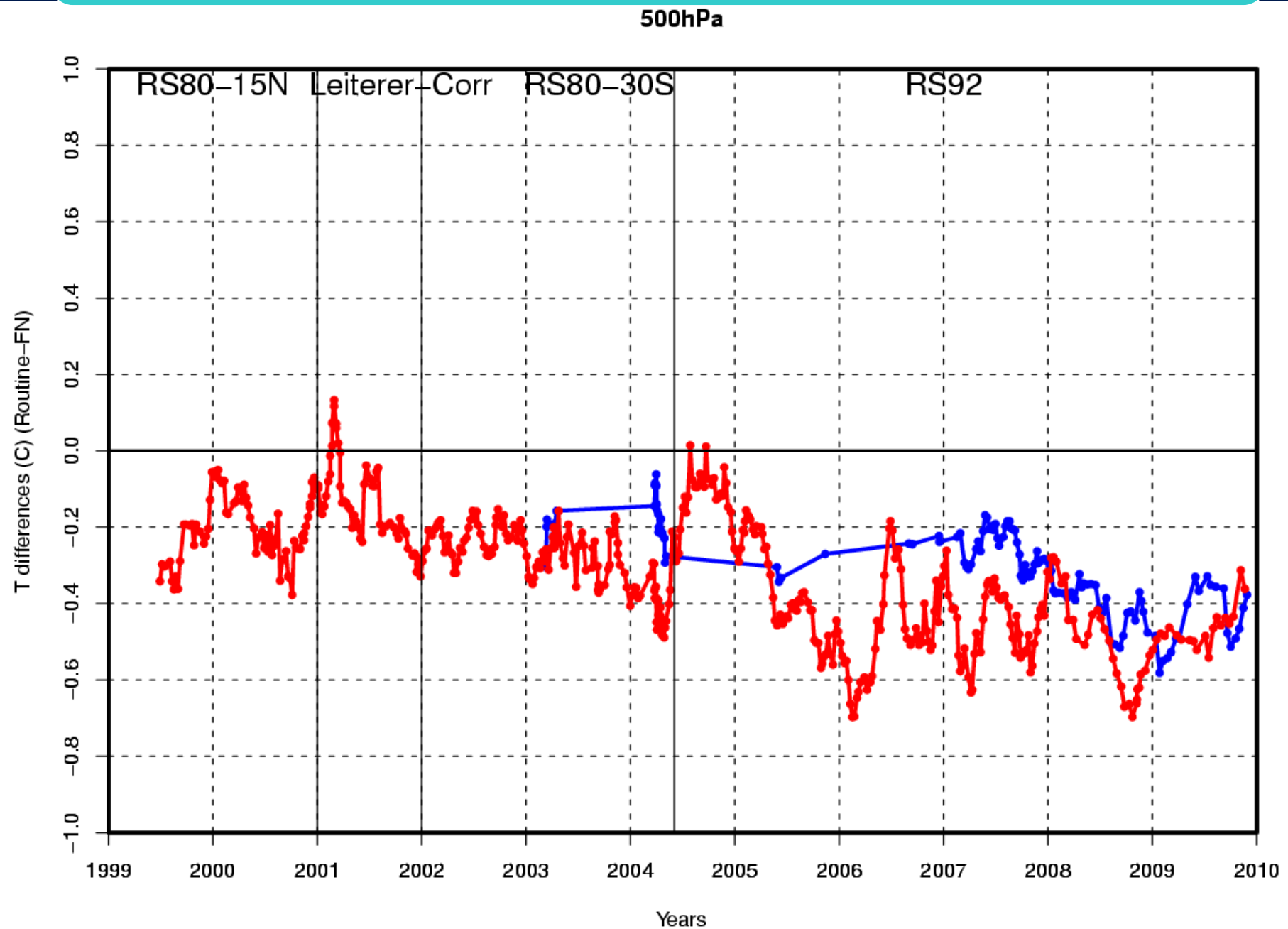
RH 850 mb (12 UTC ) N=510



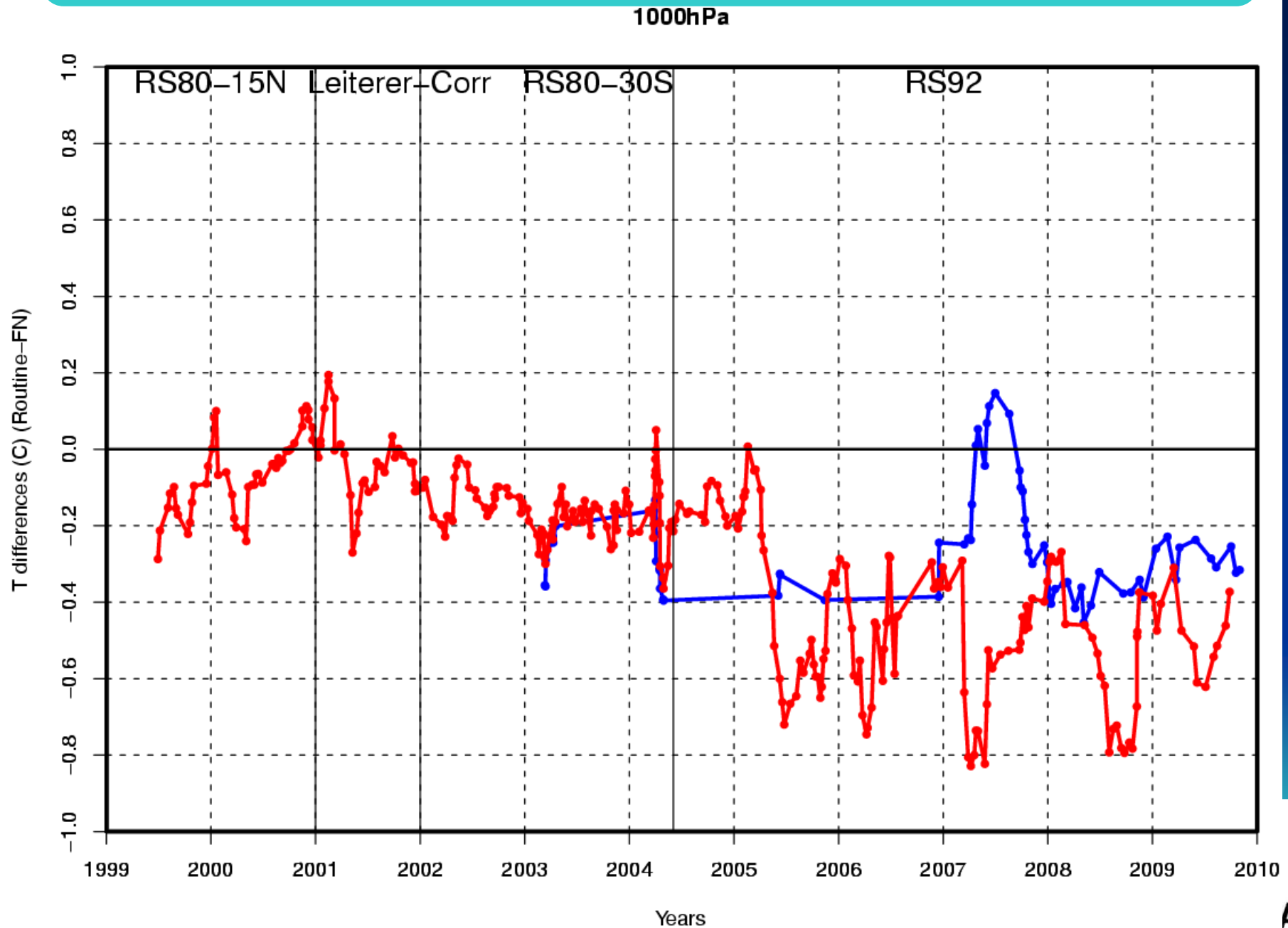
RH 1000 mb (12 UTC ) N=297



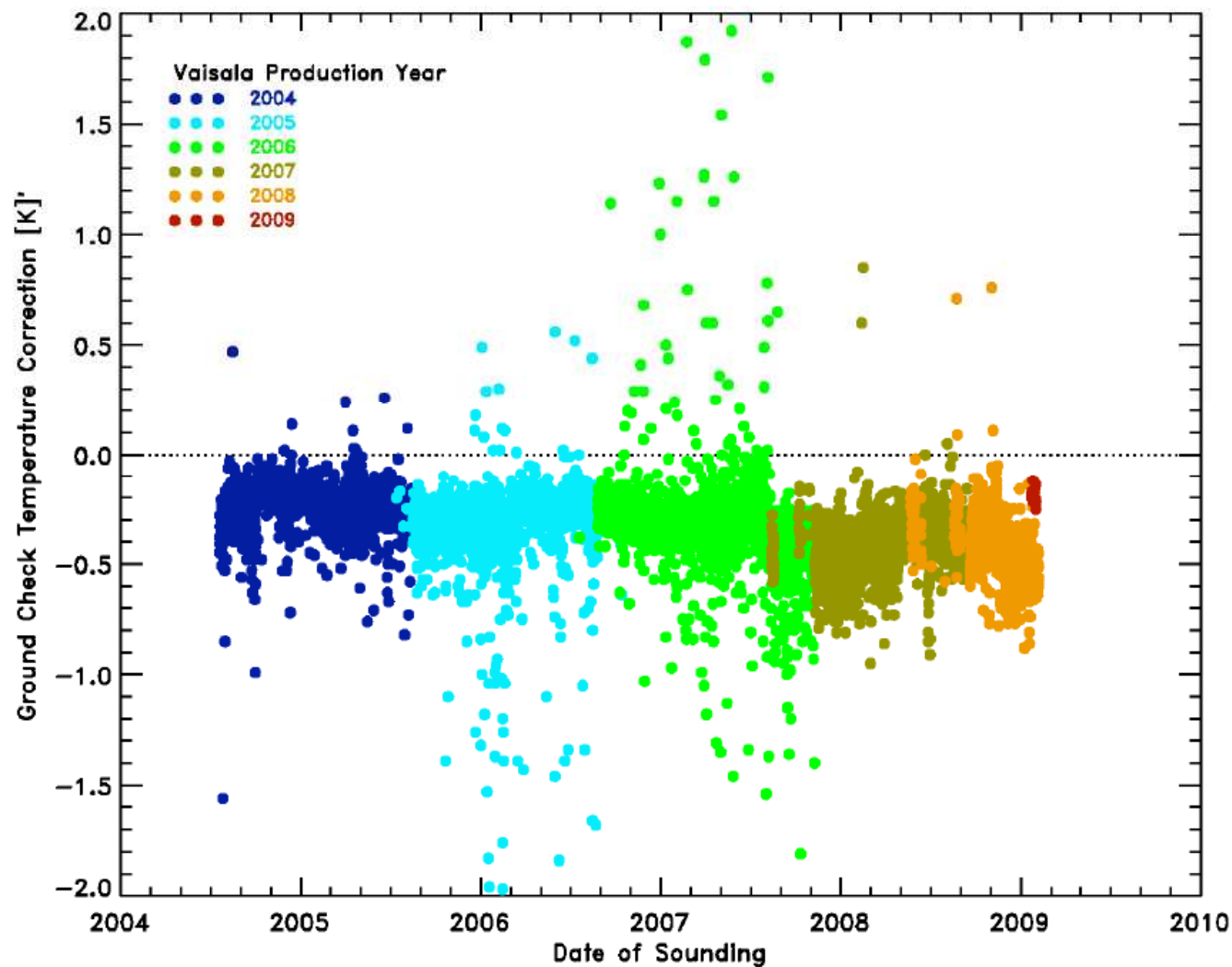
# Temperature difference (Routine-FN) at 500 hPa



# Temperature difference (Routine-FN) at 1000 hPa



# Temperature: Ground check





## Conclusion and future work

1. Detailed metadata are proved very useful; 4-times daily soundings provide good diurnal sampling.
  2. Regular dual-sonde data provide independent information to evaluate the performance of routine soundings, especially at change points.
  3. Scatters in comparisons of dual sonde humidity data raise concerns.
- 
1. To investigate other factors (batch numbers, separation distance, ...) in order to understand the differences in routine and FN data.
  2. To develop correction methods for routine data using FN data.
  3. To study the amount of overlap dual sonde data required;
  4. GPS and MWRP data will be analyzed to evaluate the value of redundant data in managing the sonde changes.

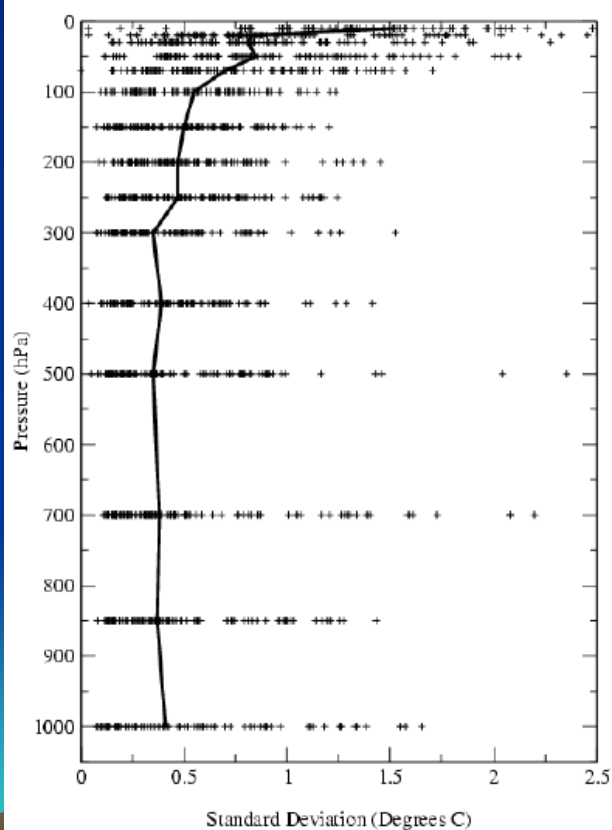


# A CLIMATE CONTINUITY STRATEGY FOR THE RADIOSONDE REPLACEMENT SYSTEM TRANSITION

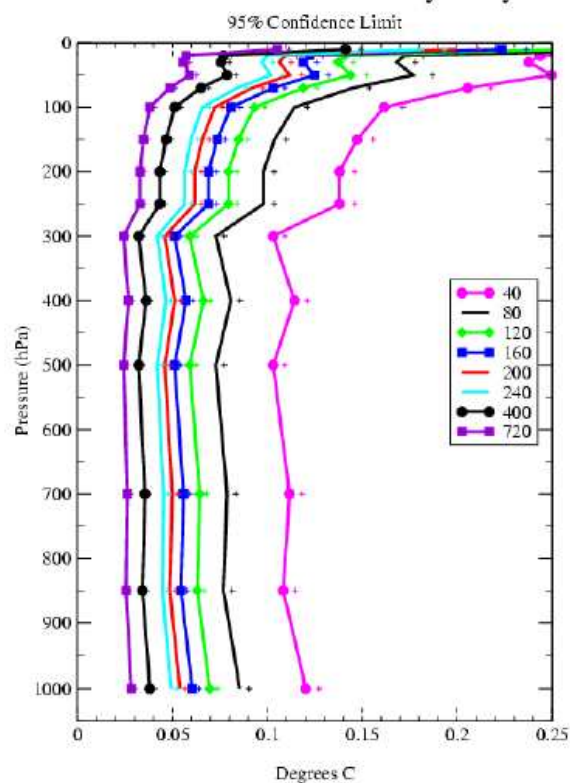
Thomas C. Peterson \* and Imke Durre

- Only for temperature and only over contiguous U.S.
- 200 flights spread out over all four seasons required to achieve  $<0.05^{\circ}\text{C}$  discontinuity

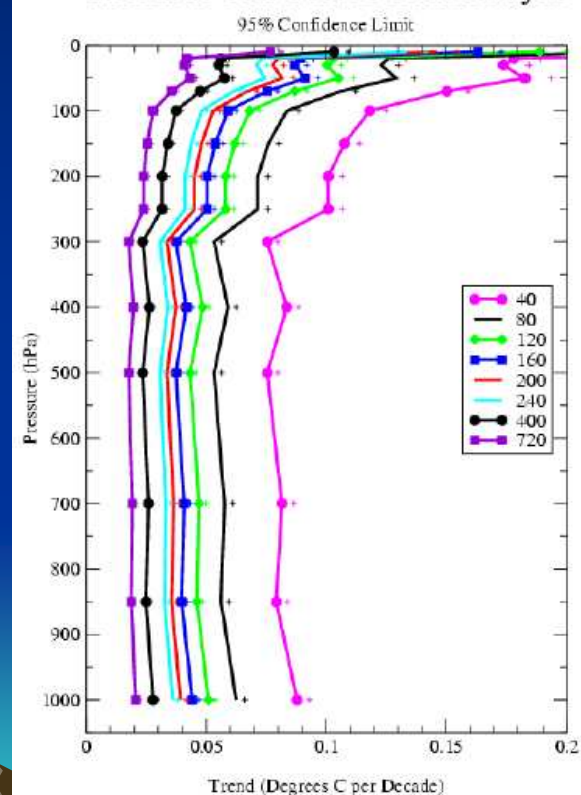
Radiosonde Intercomparisons



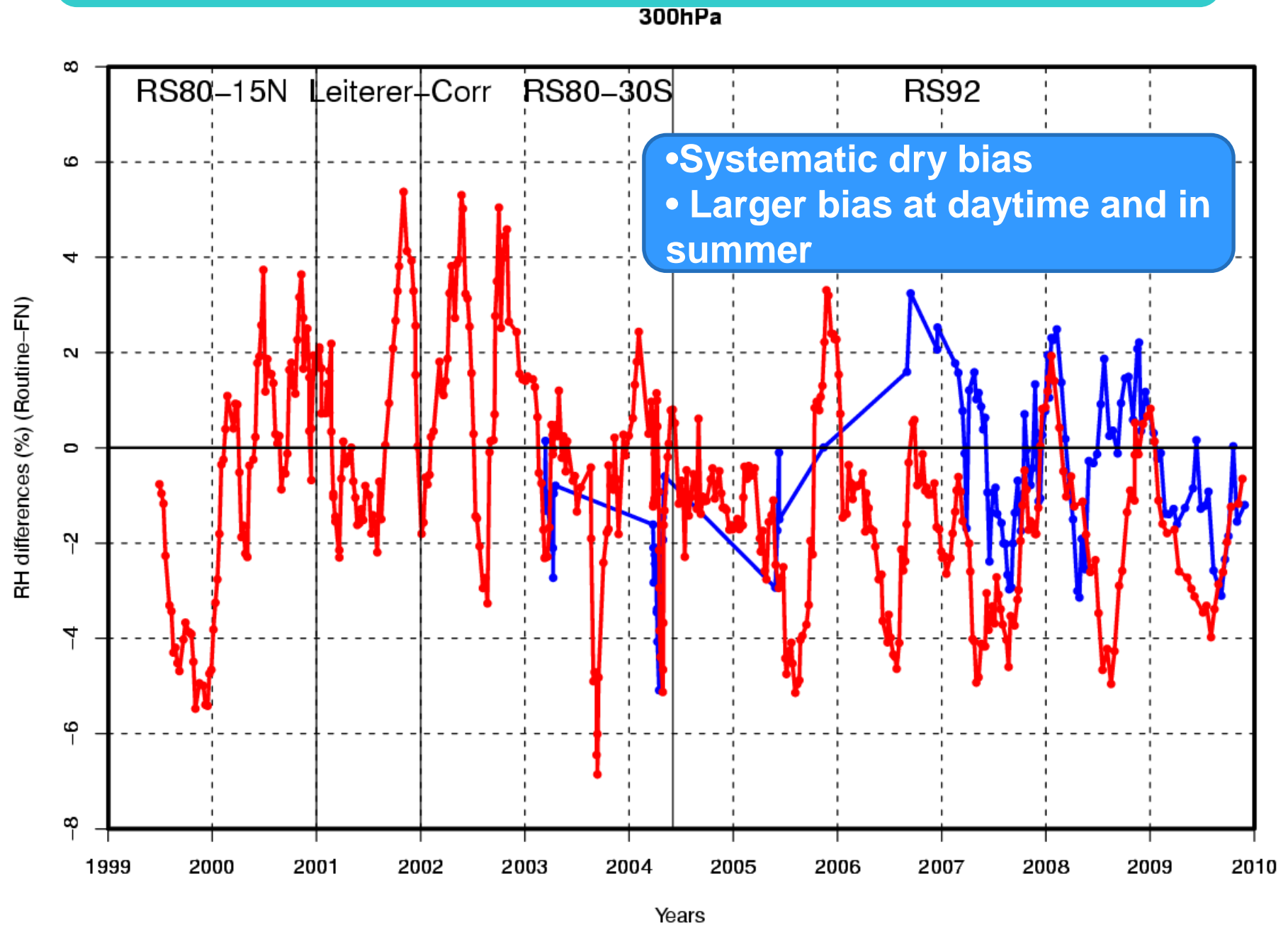
Error in CONUS Discontinuity Analysis



Error in 20 Year CONUS Trend Analysis



# Dual sonde data for change point identification



# Management of Change

## 1. Lindenberg 12-year routine and RS90/92-FN radiosonde data:

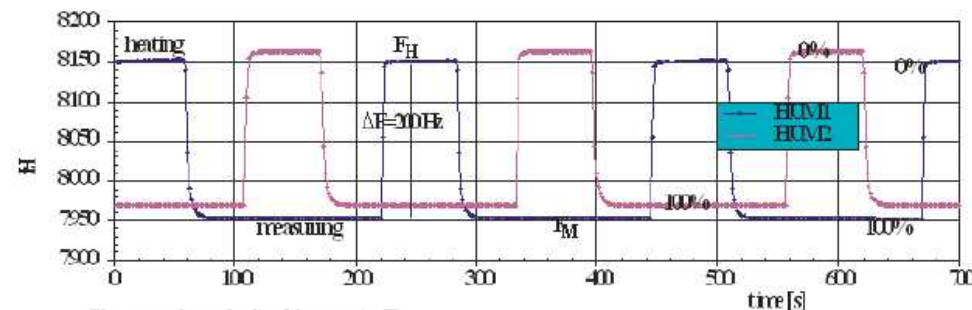
- Identify changes and quantify the impacts of changes:
  - 1) Metadata: hardware and software changes
  - 2) Solar zenith angle
  - 3) Co-incident RS90/92-FN comparisons: change points, impacts and number of dual soundings (this can also be used to study scheduling protocols: is 4/month sampling (00/12) enough to calculate monthly mean comparing with 4/daily?)
  - 4) GPS-PW comparisons
  - 5) MWRP comparisons: change points and impacts



## FN-Method



Leiterer, U. et al.; 2004: A Correction Method for RS80-A Humicap Profiles and their Validation by Lidar Backscattering Profiles in Tropical Cirrus Clouds. JAOT, Vol. 22, No. 1, 18-29.



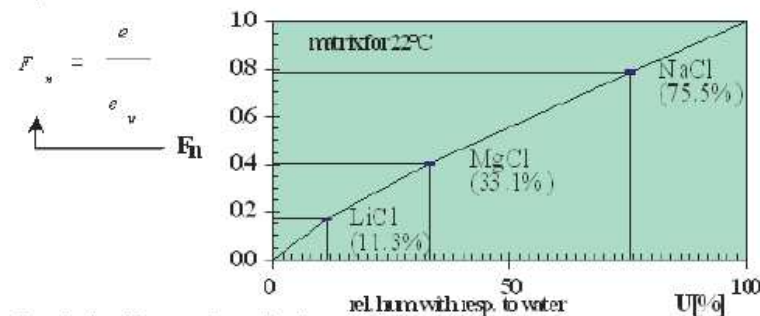
Idea: used of standardized frequencies  $F_H$

during flight, in situ "calibration"

$$F_n = \frac{F_H(U\%) - F_M(U\%)}{F_H(100\%) - F_M(100\%)} = 0.000...1.000 = \frac{e}{e_w}$$

$\Delta F$ : individual difference at  $e_w$  about 200 Hz

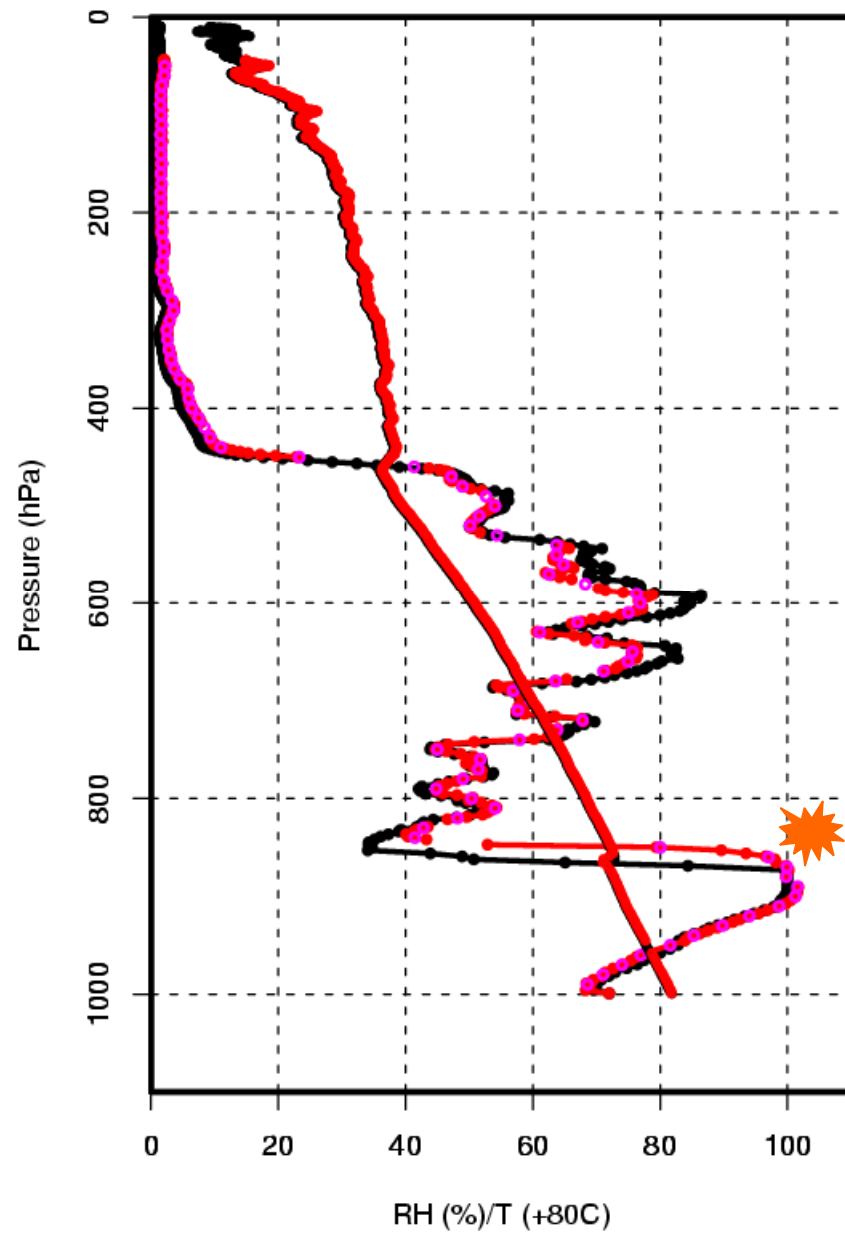
↑ foreground check, before flight at room temperature (18...25°C)  
with  $F_H(0\%) \approx F_H(100\%) \approx F(0\%)$



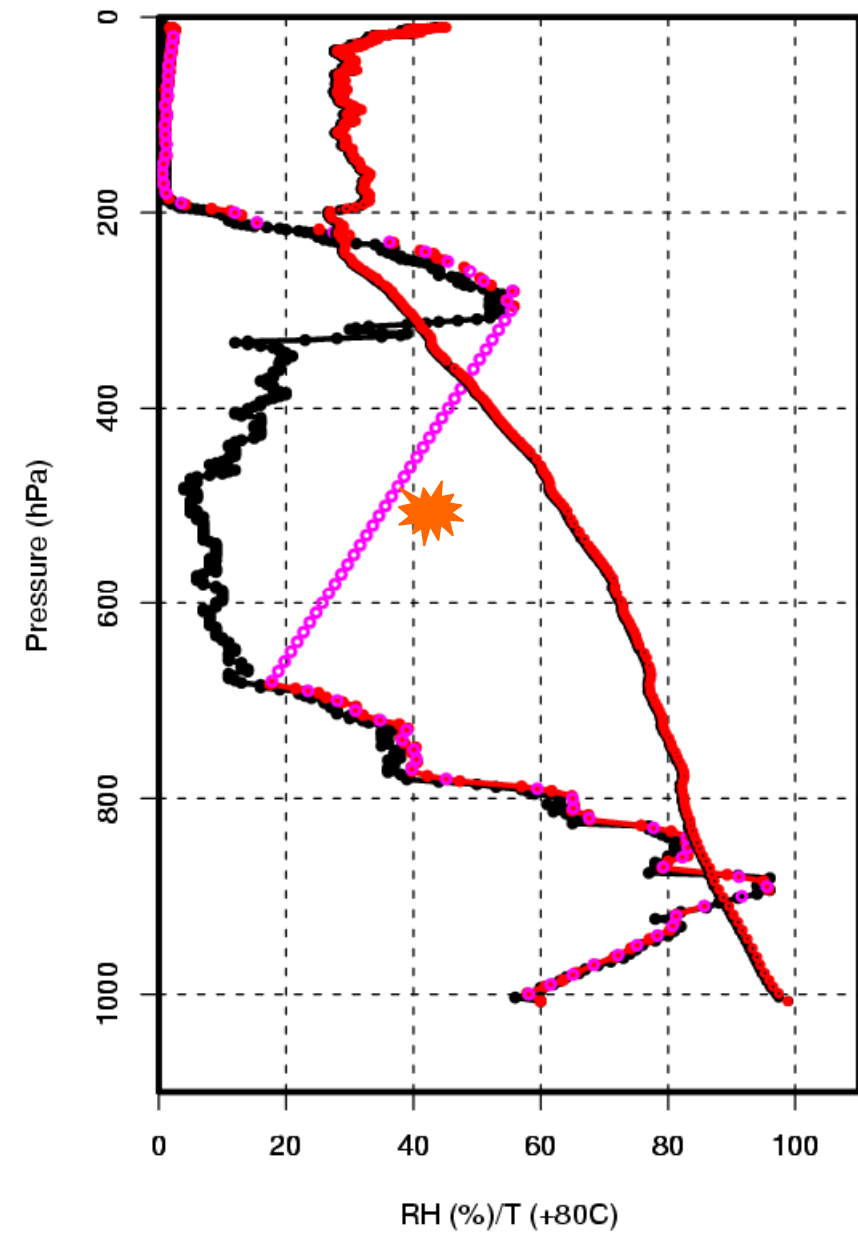
Standardized frequencies method

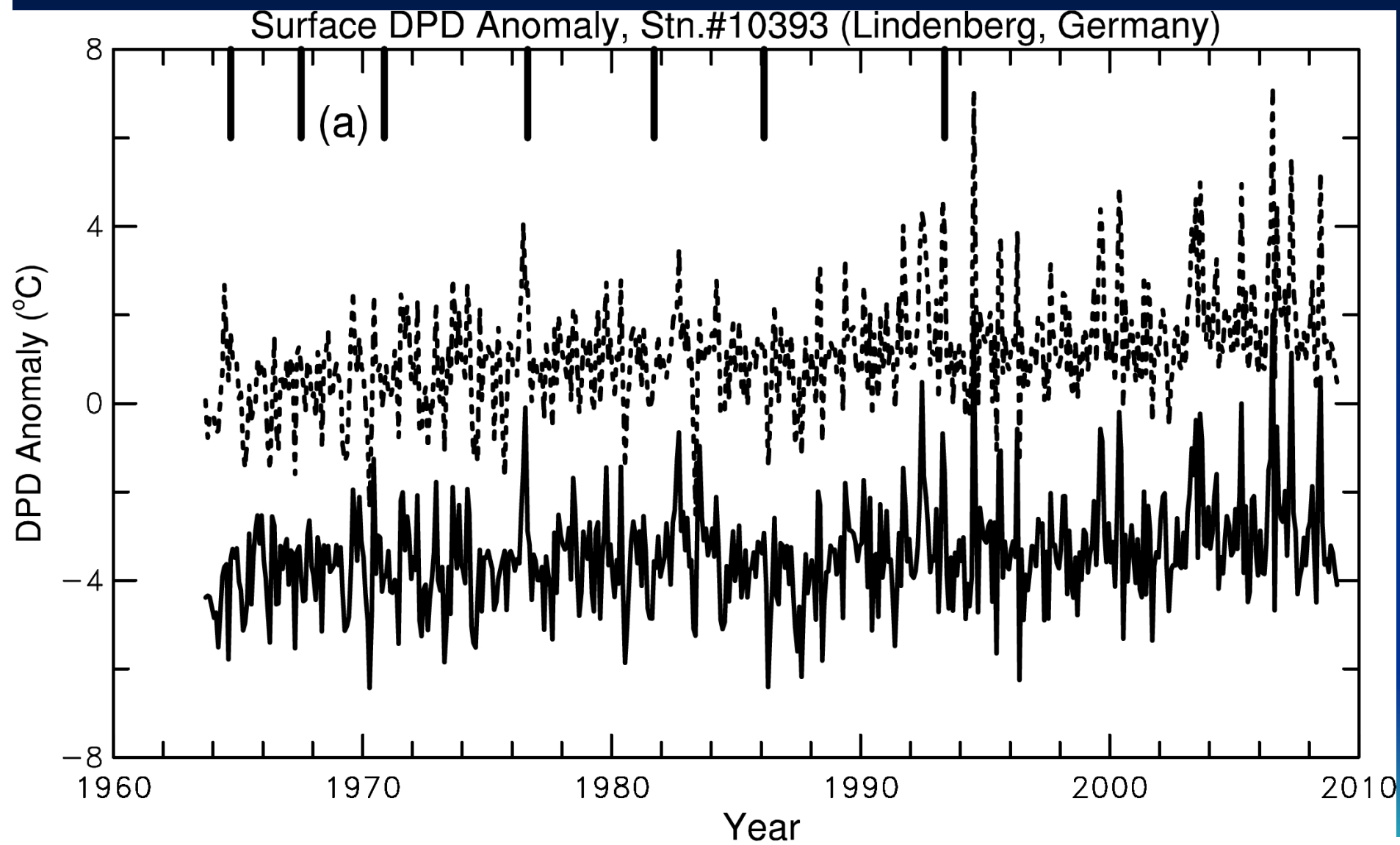


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1\_20050804\_1200

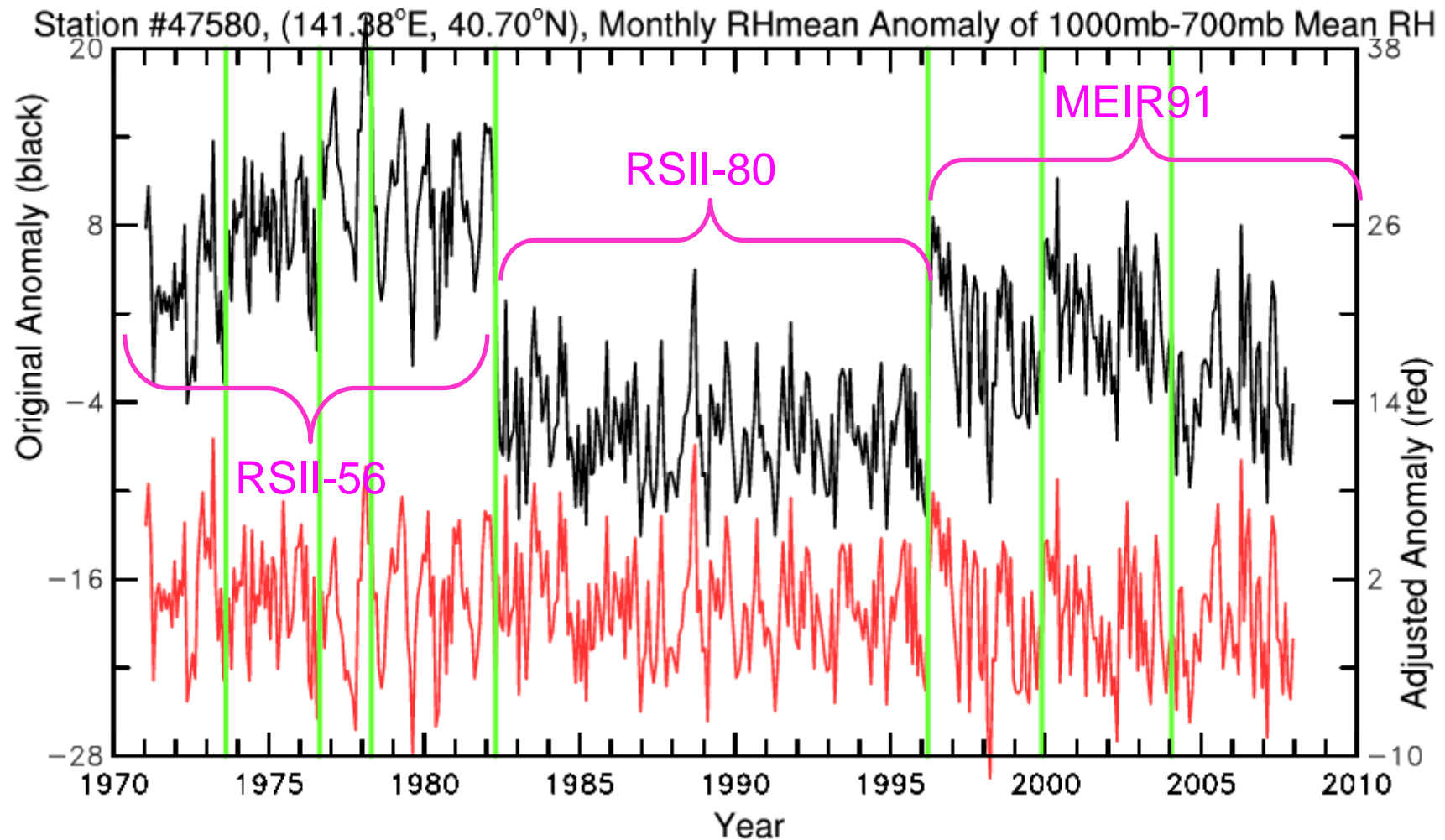




NCAR

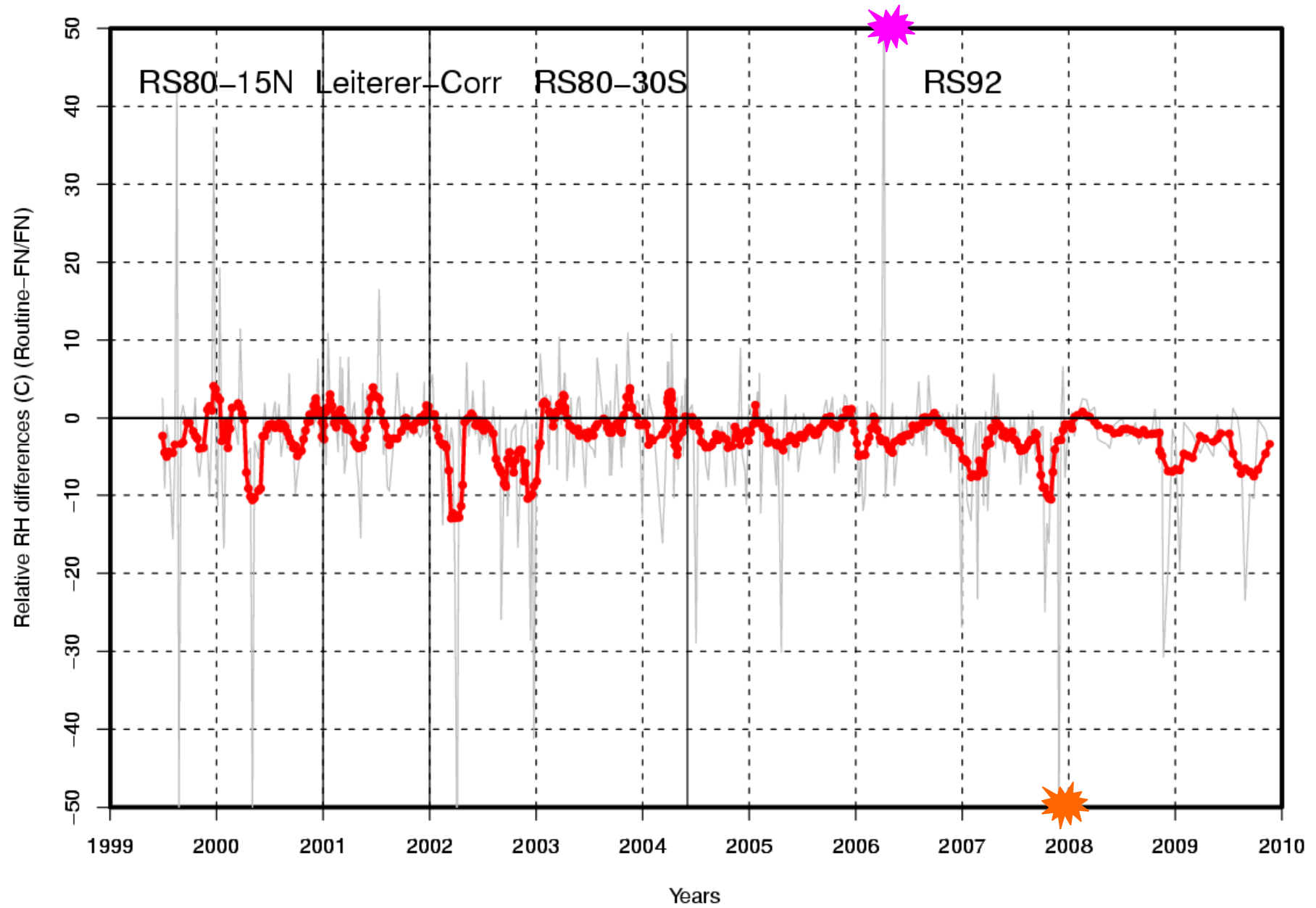
# Managing Change

1. To document changes
2. To assess impacts of changes
3. To minimize impacts

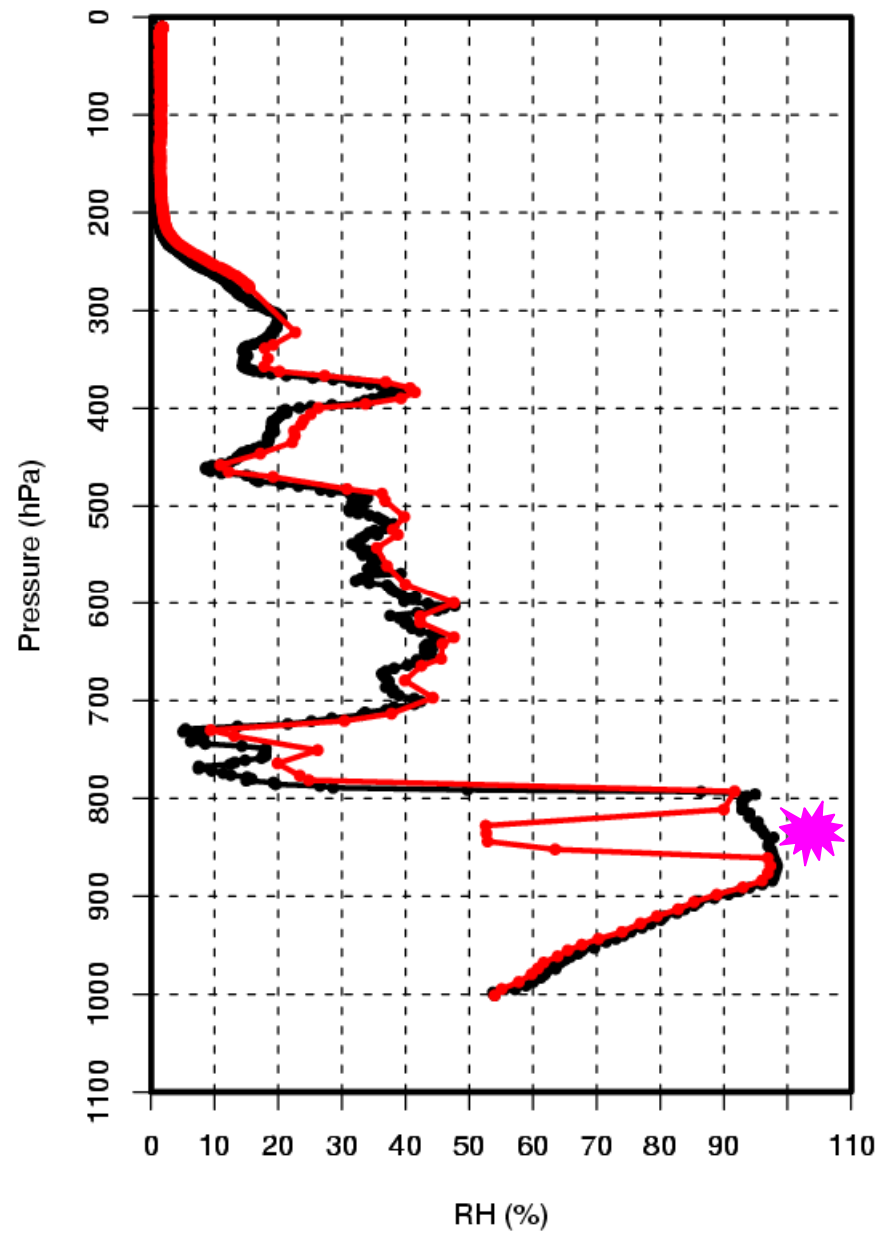




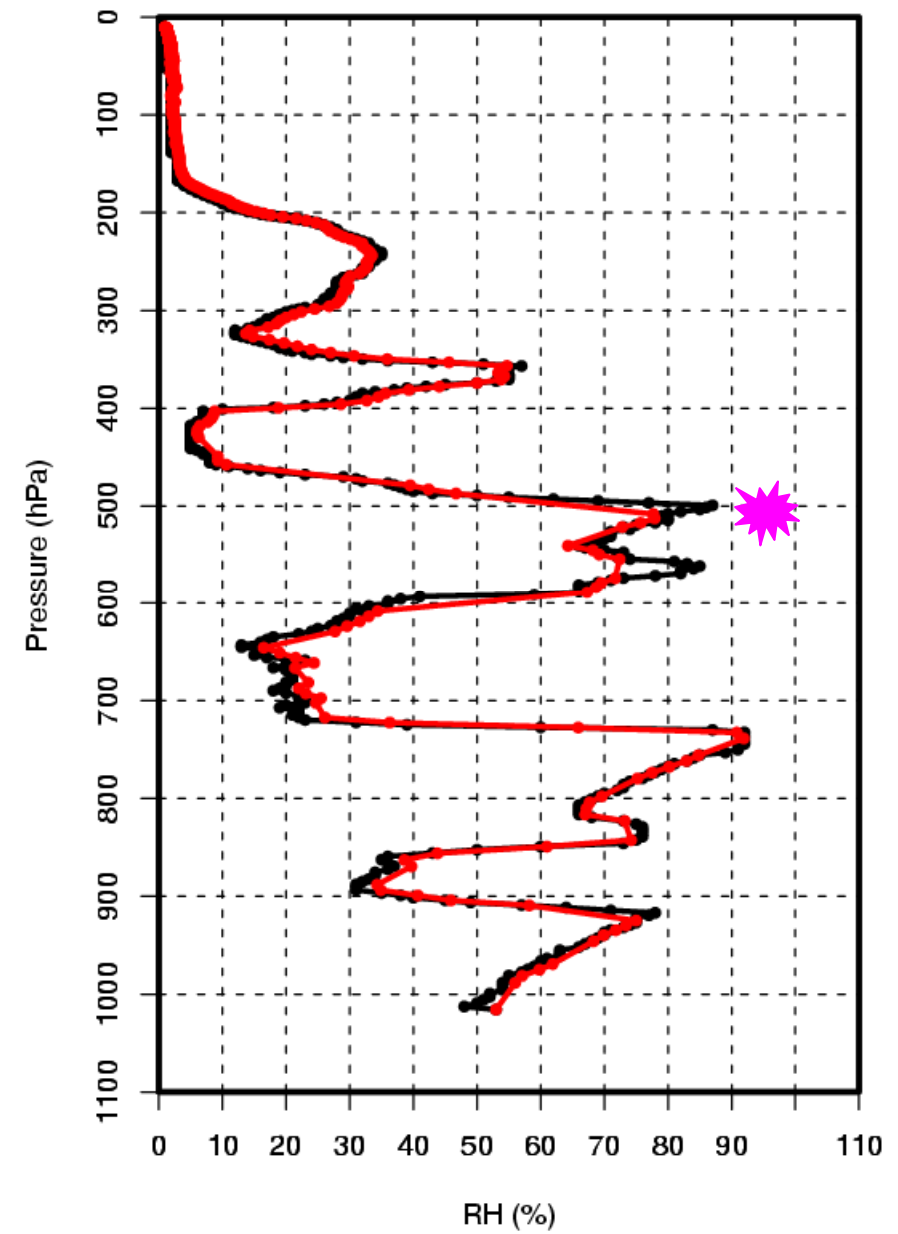
850hPa



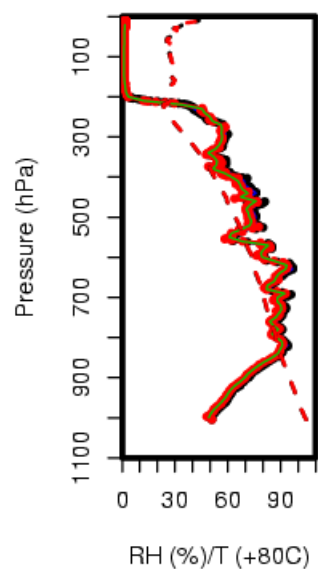
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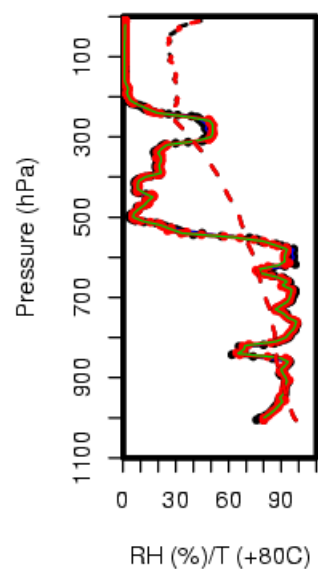
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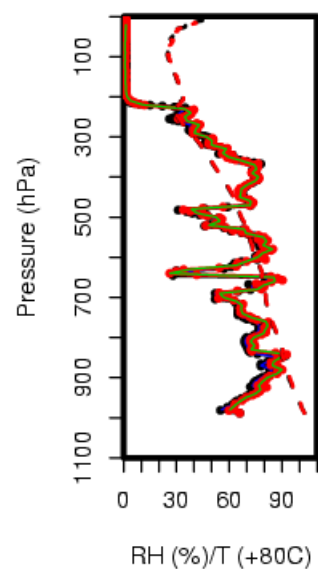
1\_19990630\_1200



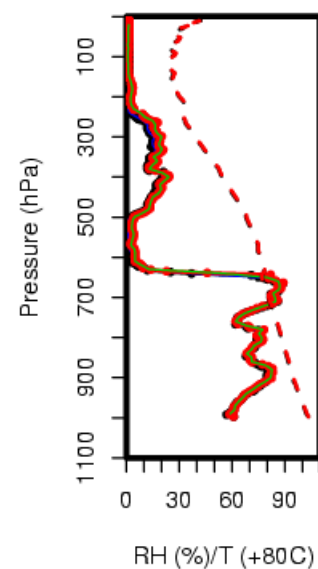
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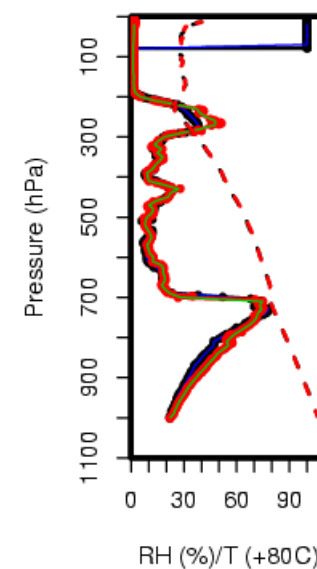
**1\_19990714\_1200**



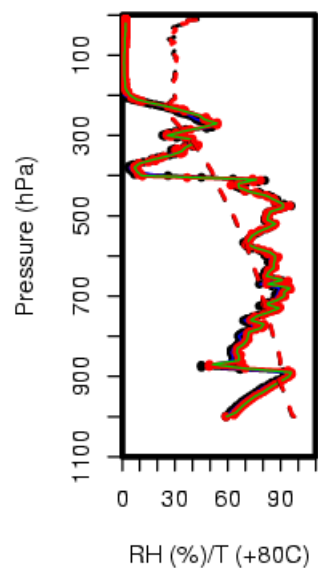
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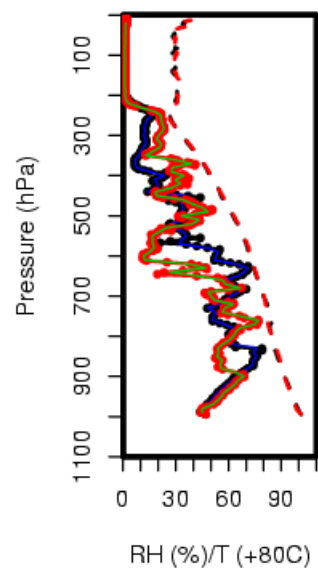
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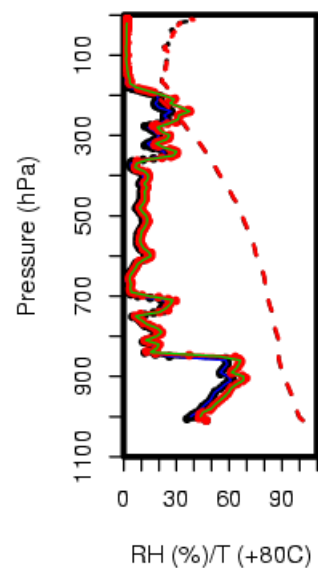
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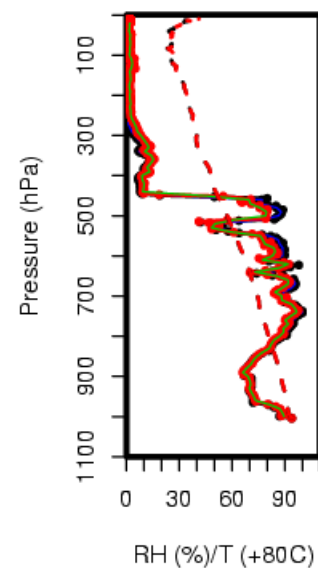
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1\_19990825\_1200



1\_19990901\_1200



1\_19990908\_1200

