



Sondes meet Hyperspectral



14.06.2012

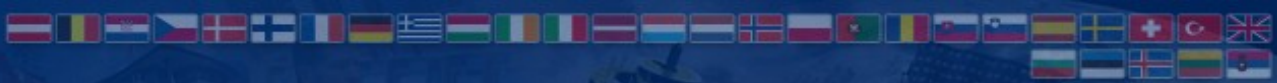
**Xavier Calbet and Thomas August
EUMETSAT**

EUM/MET/VWG/12/0567

v1

05.11.2012





Sondes **VS** Hyperspectral

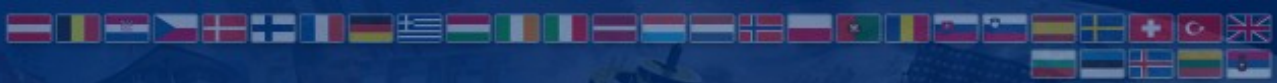
For **SONDES?**:

- Meteorological community
- NWP community

For **RETRIEVALS?**:

- Remote Sensing community
- RTM community





Sondes **MEET** Hyperspectral

For **SONDES??:**

- Meteorological community
- NWP community

ATMOSPHERE



For **RETRIEVALS??:**

- Remote Sensing community
- RTM community





Why current sonde technology can become a reference measurement for hyperspectral retrievals



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1. **Direct Comparison**: ConcordIASI cases
2. **Sonde/Hyper Match**: Sodankylä cases
3. **Assessment method**: clear Sodankylä case





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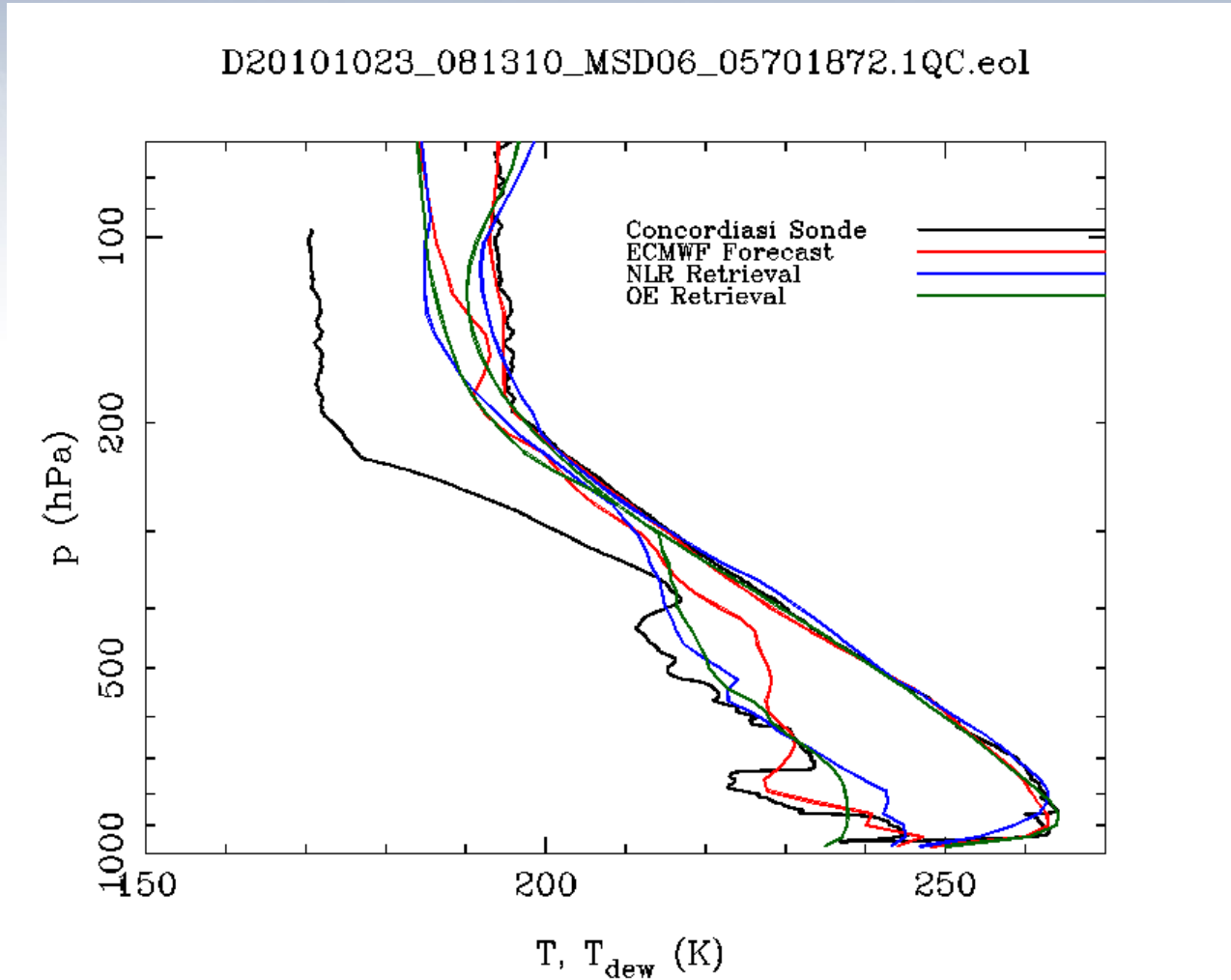
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How to compare Retrievals with Sondes?

**Straight forward approach:
Direct Comparison!!**





Retrievals

We **obtain** atmospheric profiles from:

- IASI Retrievals from **Non-Linear-Regression (NLR)**: Linear Regression+Artificial Neural Networks+Kernel Ridge Regression
- IASI Retrievals from **Optimal Estimation** with NLR as first guess + **Climatological Background**
- **ECMWF** +12 and +18 hr **forecasts**





Sondes

We **validate** atmospheric profiles with:

- **Concordiasi dropsondes**, taken as is, with no bias corrections in humidity, etc.
 - Dropsondes are **co-located** to IASI FOV by choosing the closest IASI FOV (10-50 km) within 1hr
 - Only **16 Sondes** used from 600 of Concordiasi!

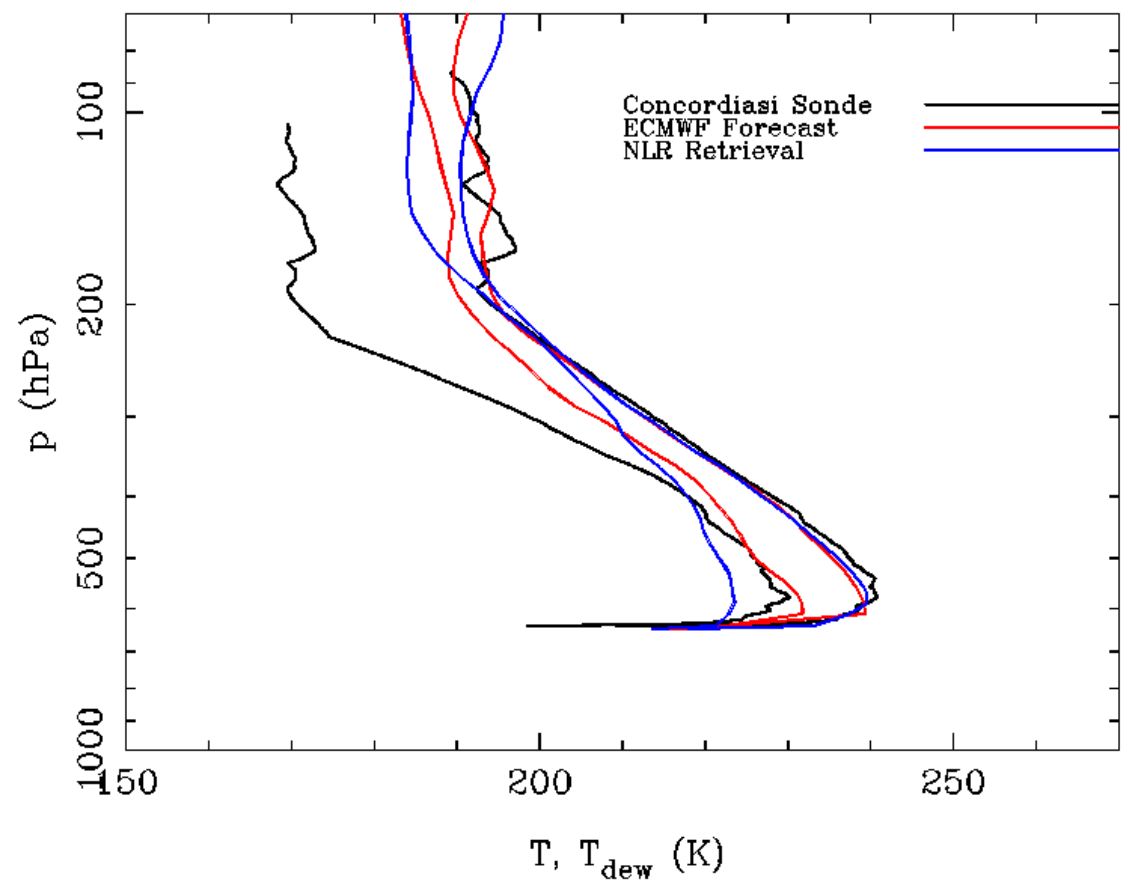
Courtesy of **Rabier, F.** et al, 2010: “The Concordiasi project in Antarctica”. BAMS, January 2010, 69-86. The driftsonde data have been obtained through a cooperation between UCAR and CNES, under the sponsorship of the NSF and CNES.





Example 1/2

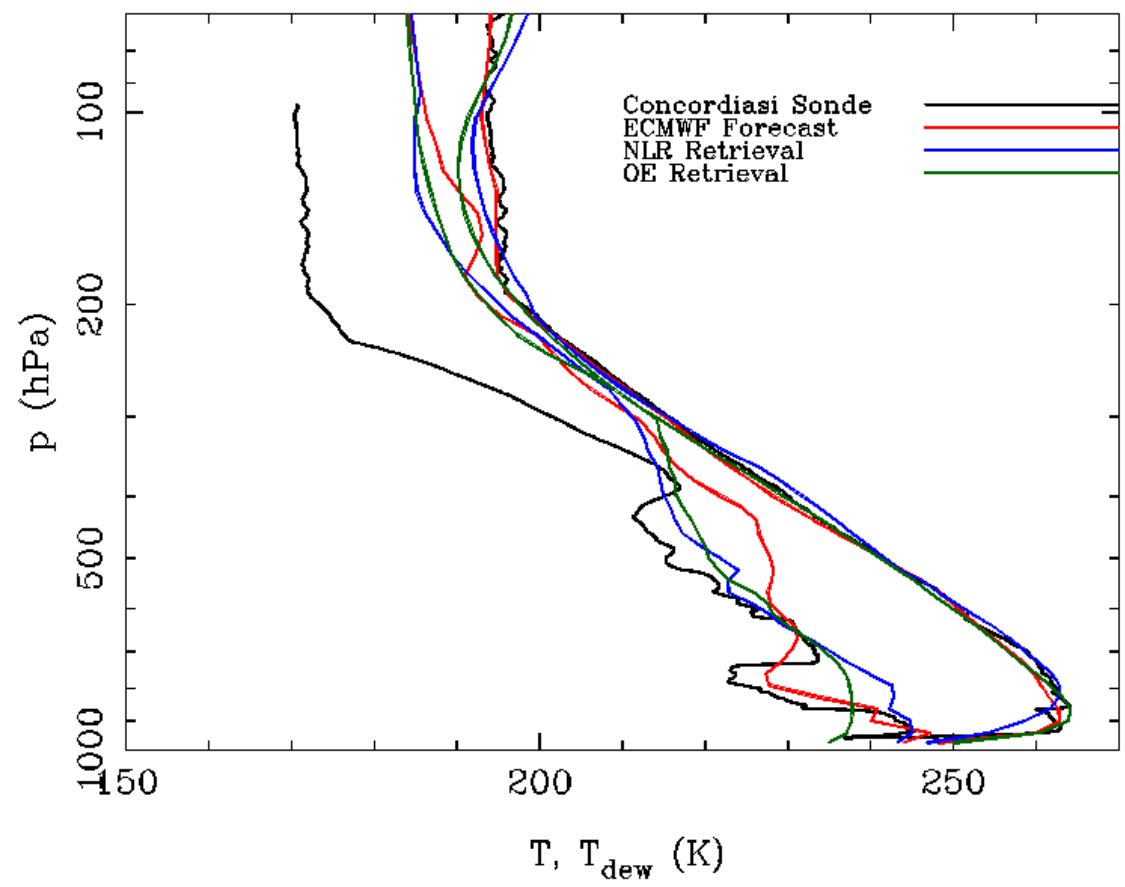
D20100930_182707_MSD04_05703A89.1QC.eol





Example 2/2

D20101023_081310_MSD06_05701872.1QC.eol

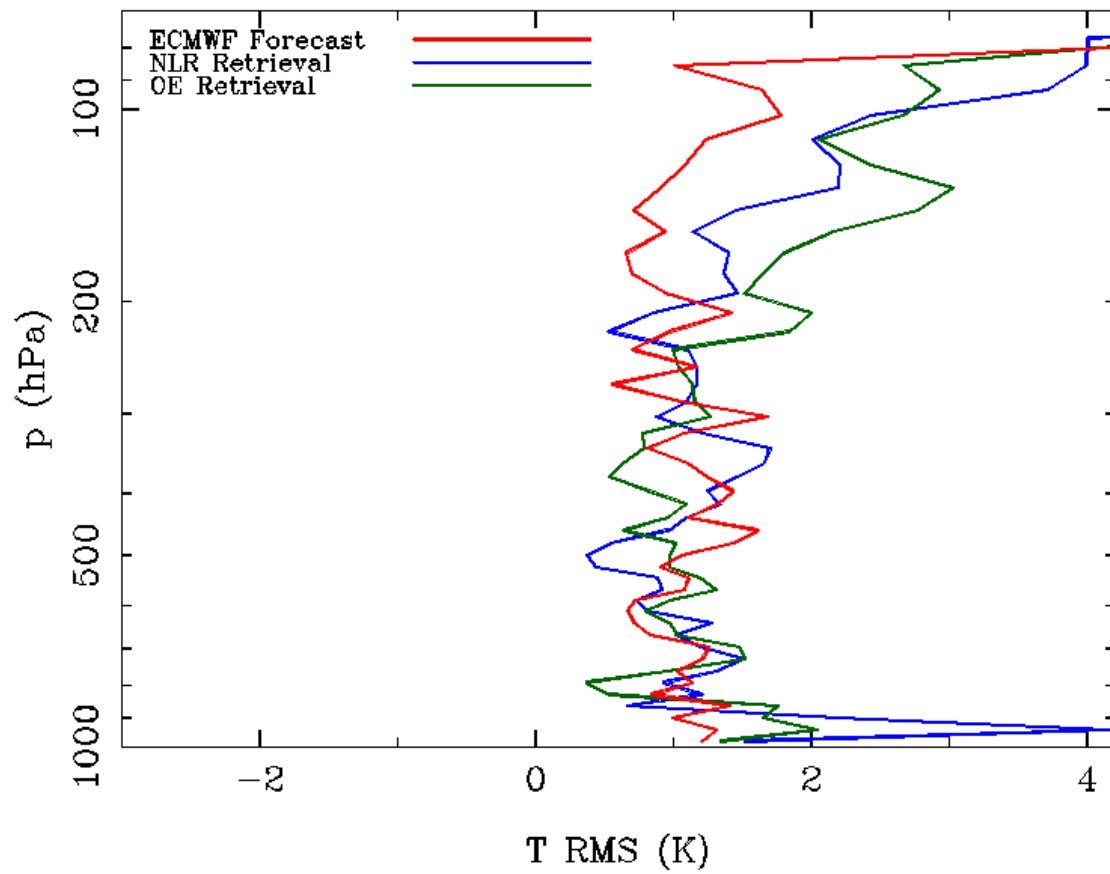




Temperature Statistics

WARNING: Small sample!

Concordiasi vs ECMWF +12/+18h Forecast or OE/NLR Retrieval

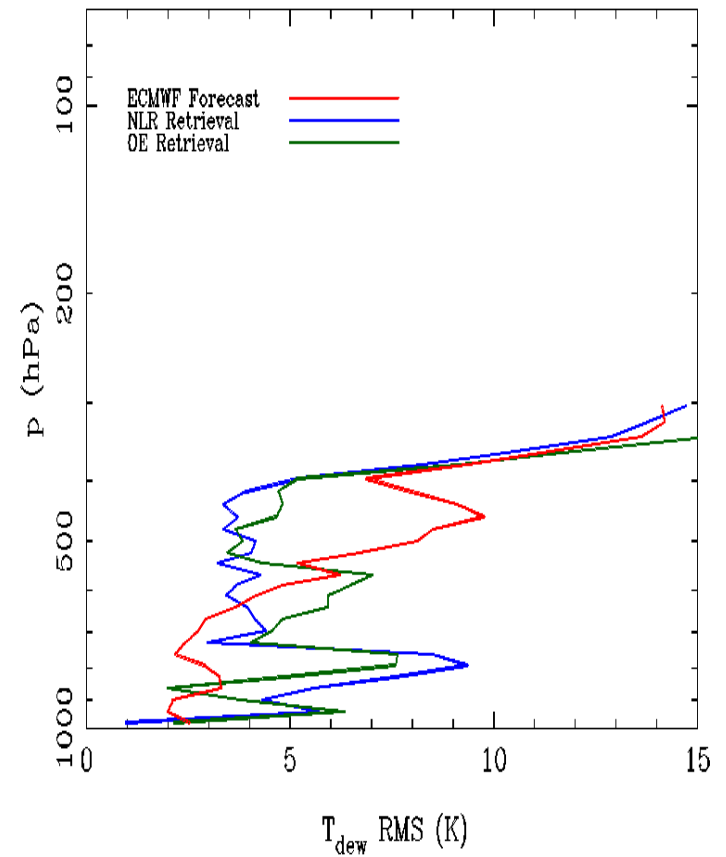
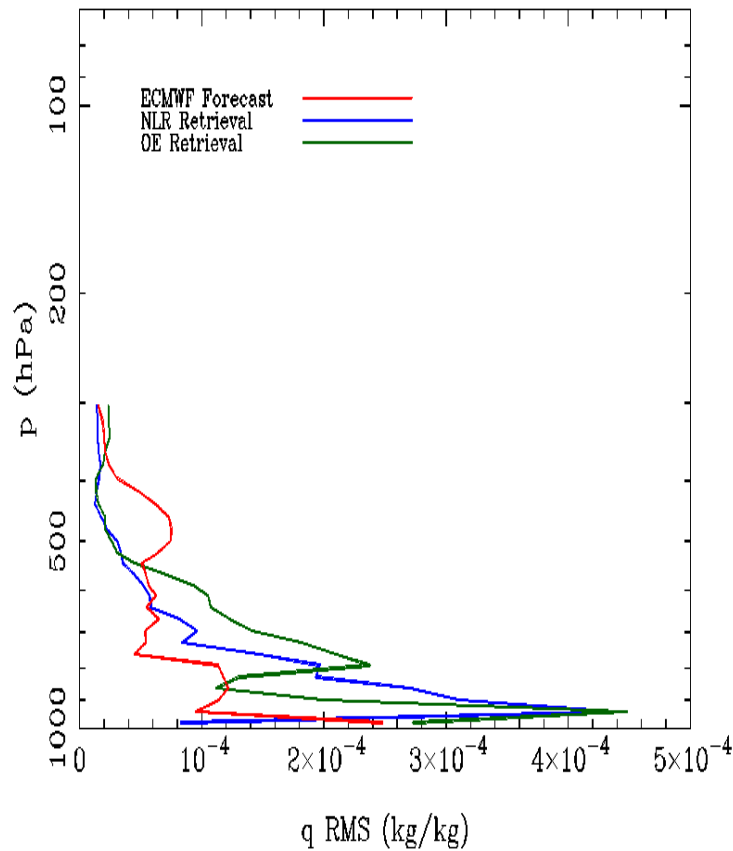


Humidity Statistics

WARNING: Small sample!

Concordiasi vs ECMWF +12/+18h Forecast or OE/NLR Retrieval

Concordiasi vs ECMWF +12/+18h Forecast or OE/NLR Retrieval





Conclusions ...

- **Temperature errors:**
 - **Retrievals:** Around 1 K, except at the lowest levels (> 800 hPa) and upper levels (< 200 hPa)
 - **Forecasts:** Around 1.2 K from surface to 100 hPa
- **Humidity errors:** Forecasts better below 600 hPa, retrievals better above 600 hPa up to 350 hPa where sonde seems off.





... but...

Are we sure about errors in comparisons?

- Co-location errors
- Sonde humidity measurement errors
- Other ...

These errors make us unsure about the conclusions up to the point that we may not trust them!!





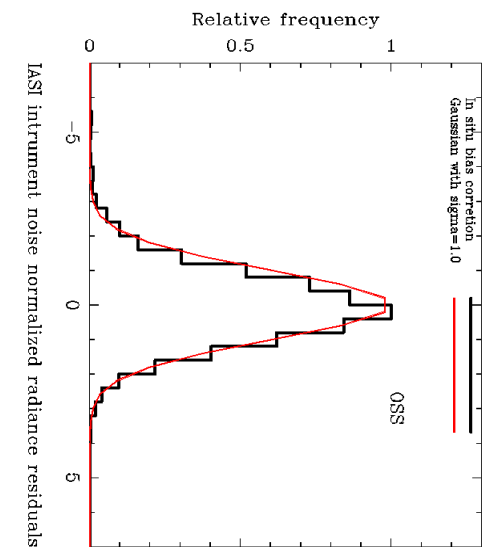
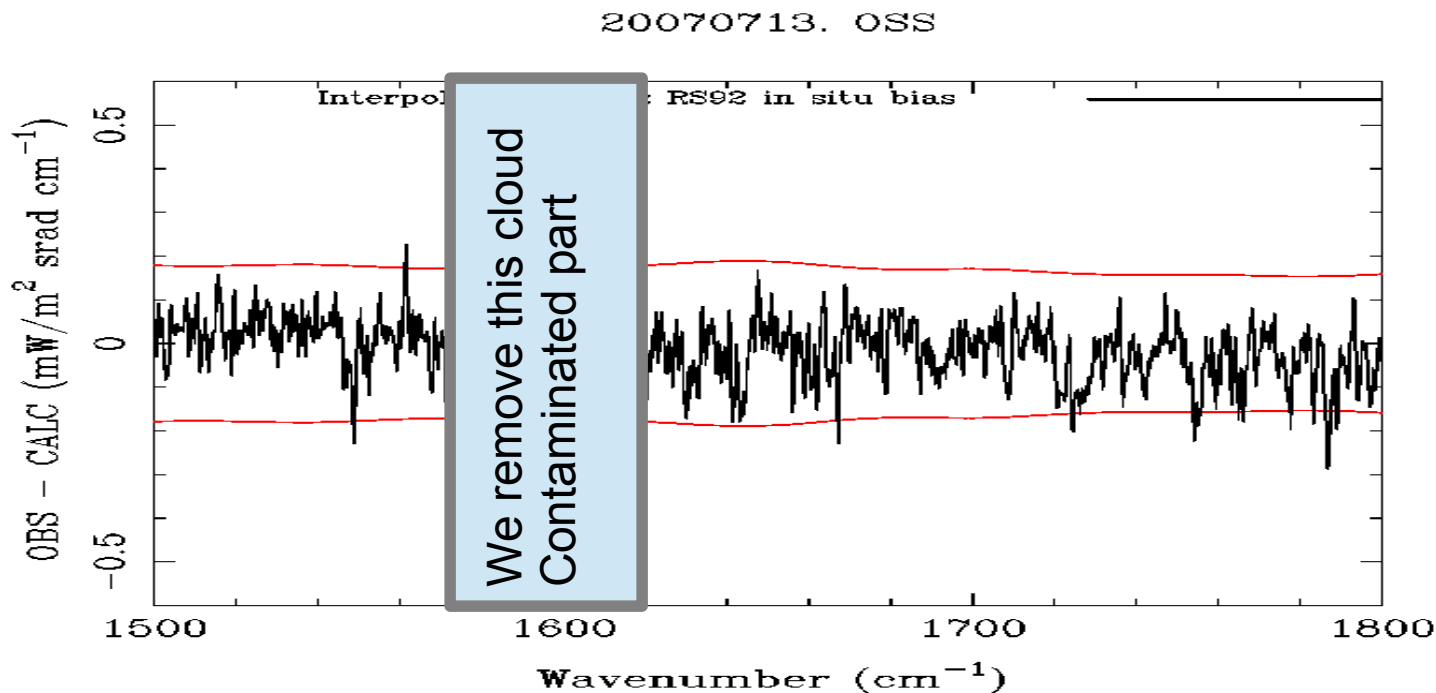
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Is there a way to check good co-location and high quality of reference measurement?

- **Yes!**, by using Observed - Calculated spectra (reference profile + radiative transfer model) within 1-sigma IASI instrument noise



Chans: 1500 < nu < 1570 or 1615 < nu < 1800 cm^{-1} . All days



Is there a way to check good co-location and high quality of reference measurement?

Key Aspects from Sodankylä campaign:

- Cryogenic Frost Point Hygrometers or well corrected RS92 sondes.
- Good time co-location by launching subsequent sondes and Tobin interpolation.





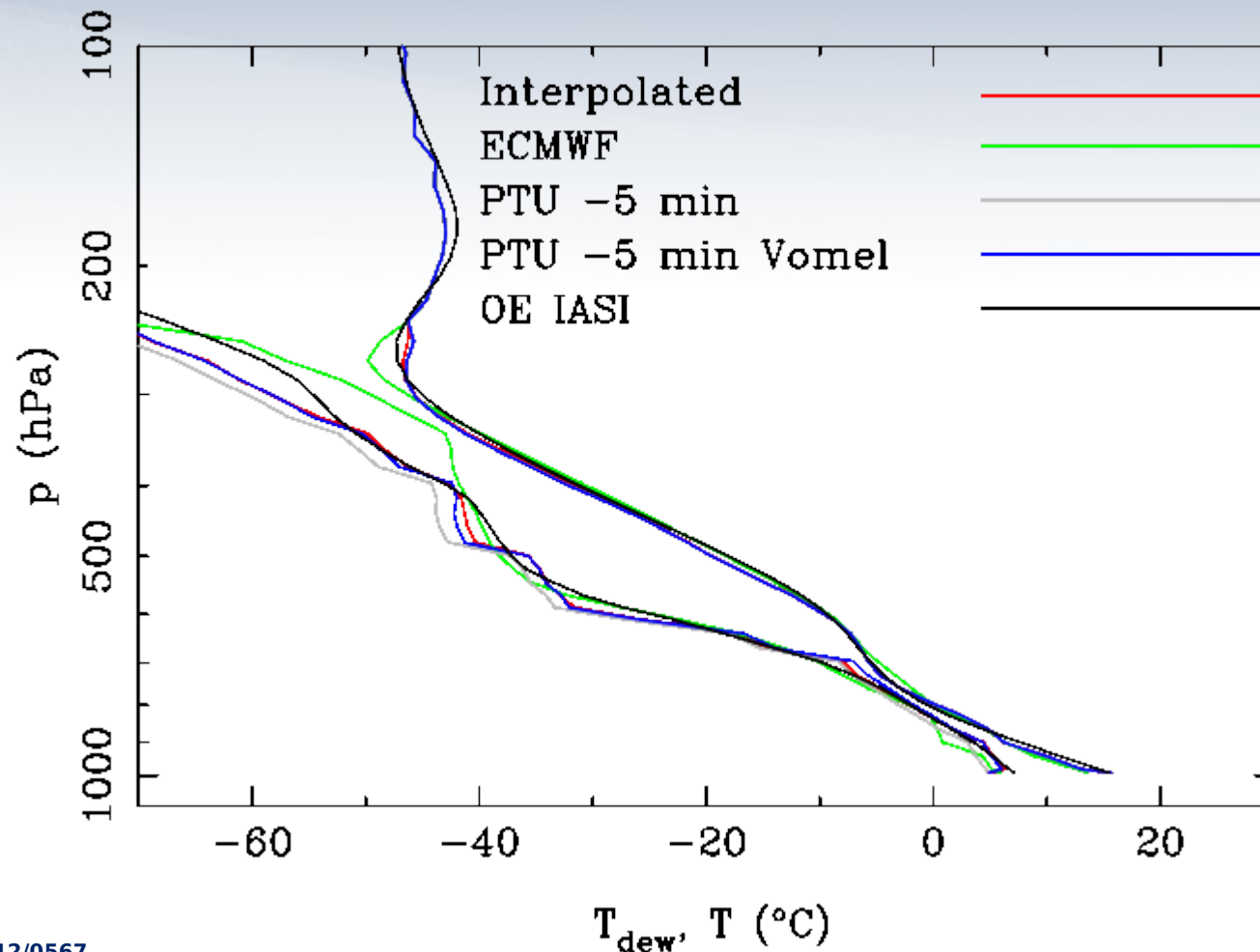
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Is there a way to check reference measurement? EXAMPLE

Sodankyla 2007/07/17 08:18



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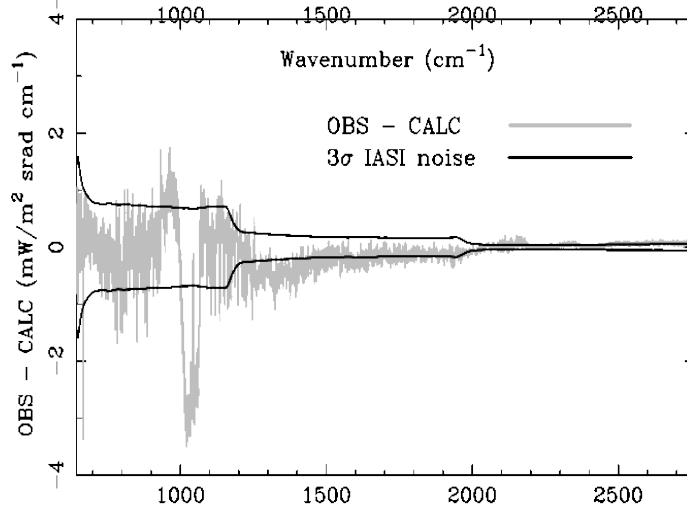
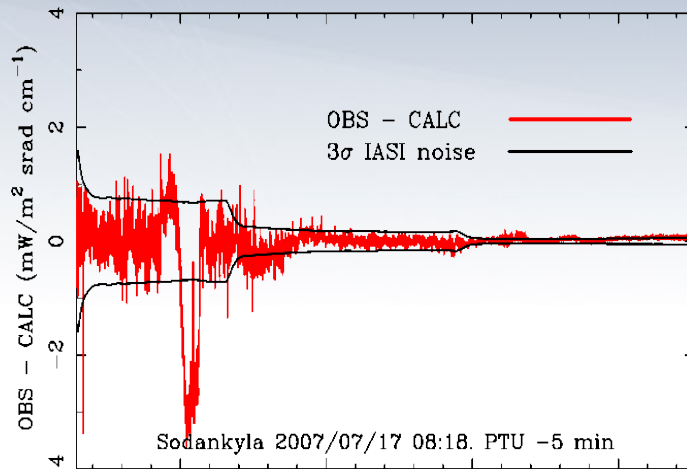
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Calbet ITSC18, 2012

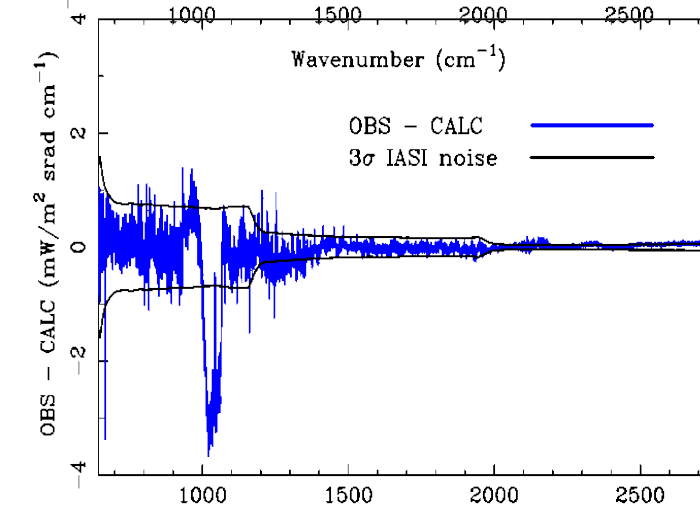
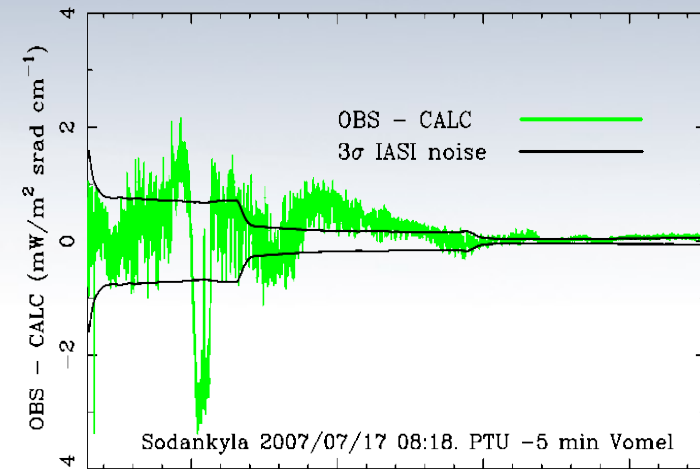


Is there a way to check reference measurement? EXAMPLE

Sodankyla 2007/07/17 08:18. Interpolated



Sodankyla 2007/07/17 08:18. ECMWF



Is there a way to check reference measurement? EXAMPLE

$$\Delta x = (K^T S_{\varepsilon}^{-1} K + S_a^{-1})^{-1} (K^T S_{\varepsilon}^{-1} \Delta y),$$

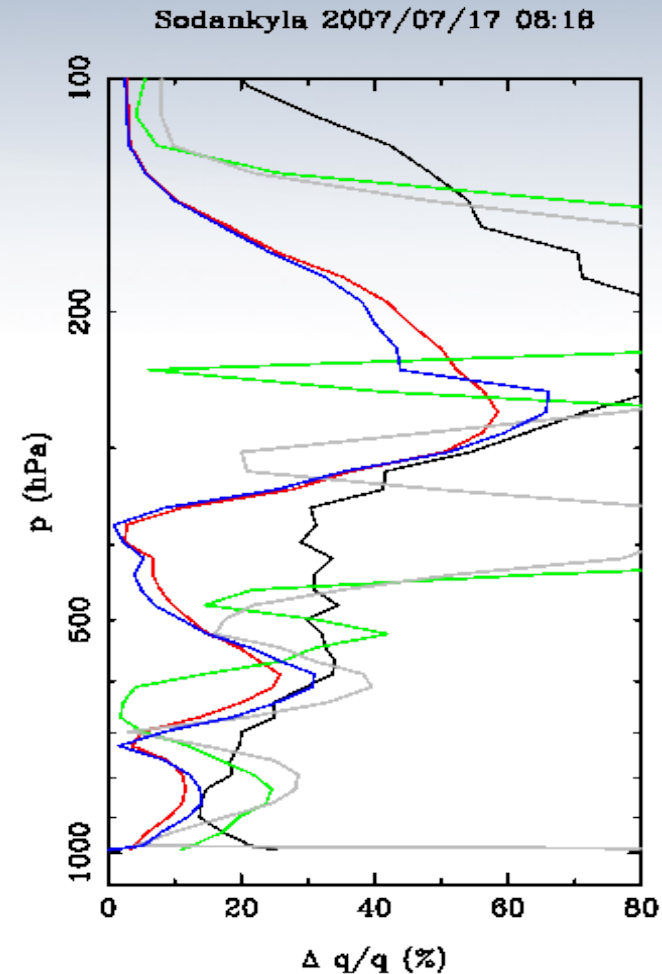
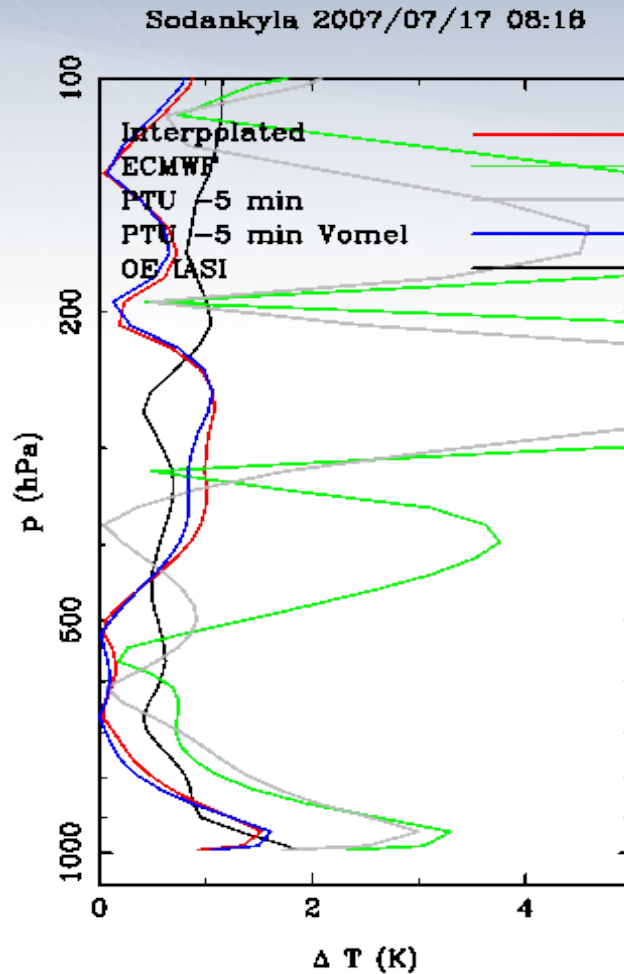
where $\Delta y = y_o - y_c$

y_o = observed radiances

y_c = calculated radiances



Is there a way to check reference measurement? EXAMPLE





Conclusion

1. It is possible to have a “perfect match” of **Sondes** and **IR Hyperspectral** sounders
2. There is a way to **assess** whether a given reference measurement + RTM assumptions are **adequate** and **well co-located** with satellite measurement. This would be a **necessary condition** before **validating** with a profile.





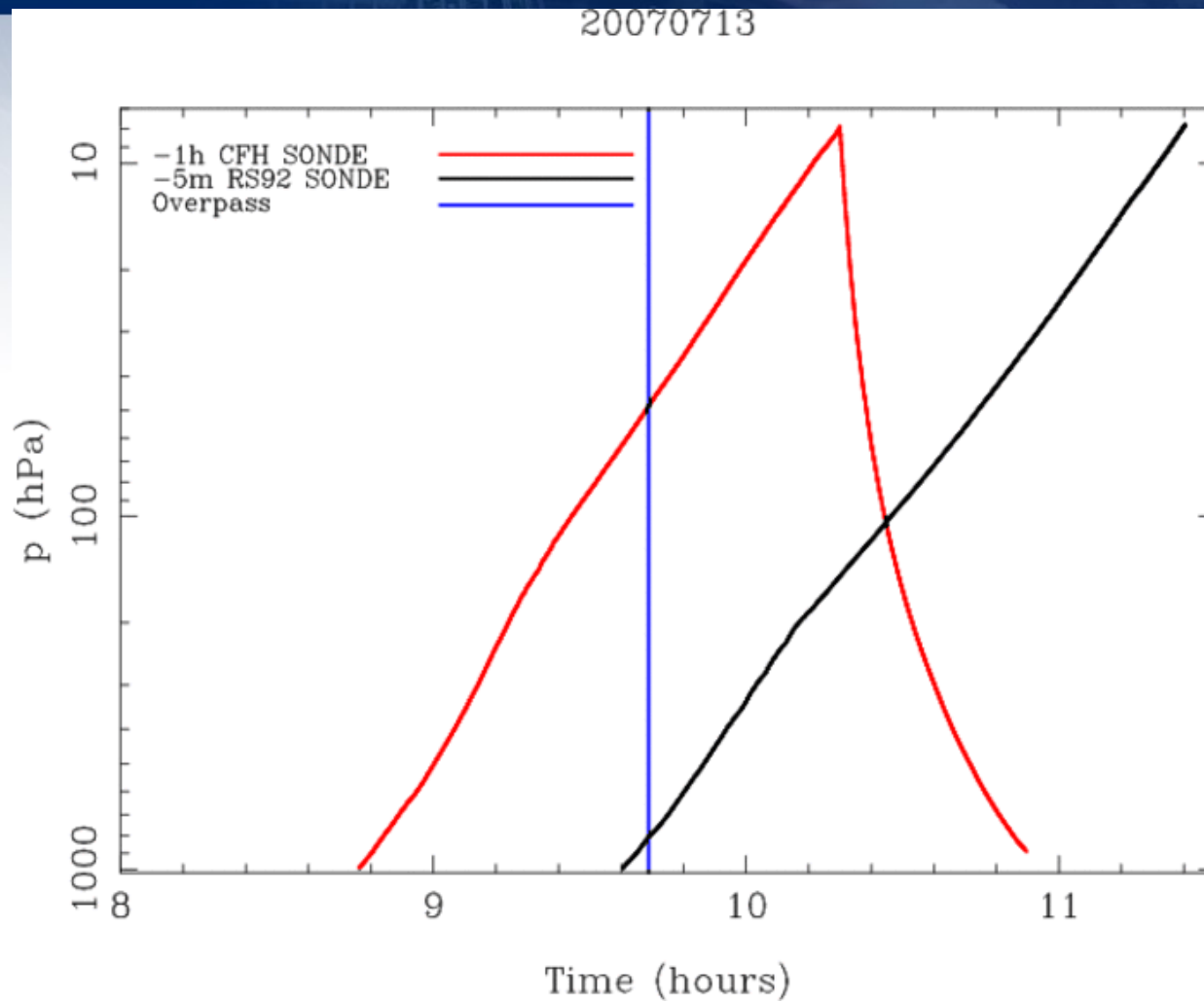
Conclusion

3. **Pro:** Having **consistency** of the radiosonde with a highly accurate instrument like a hyperspectral infrared sounder gives us a **huge confidence** that the radiosonde is indeed a **reference and representative measurement** within a few tens of km.

4. **Con:** Given a set of atmospheric profiles (GRUAN, NPROVS, ConcordIASI), and selecting them using the assessment criteria shown before, how many **reference measurements** would be **left**?



Tobin interpolation



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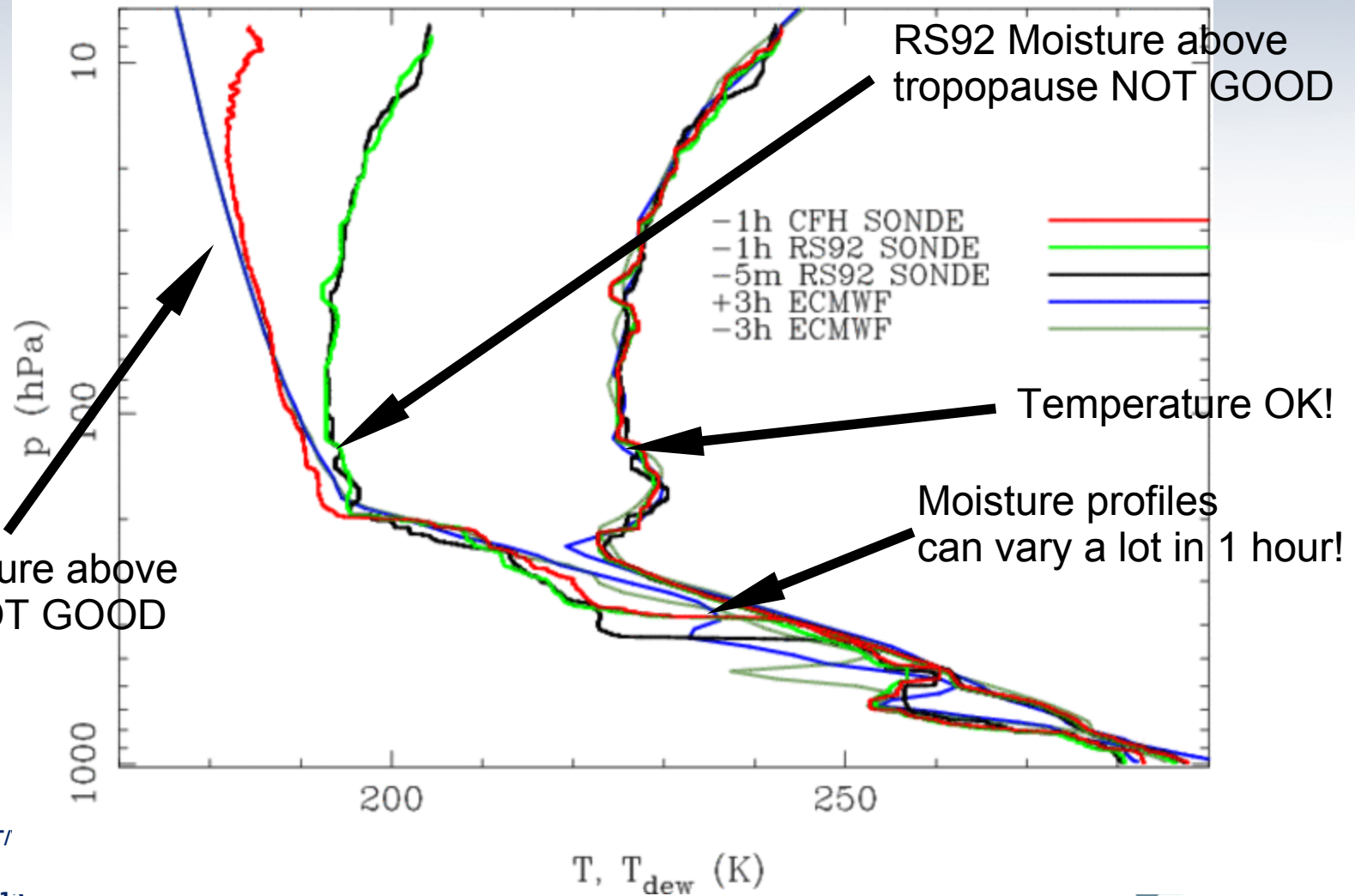
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Sodankylä Sondes (1/2)

20070713





Sodankylä Sondes (2/2)

20070717

