Sondes VS Hyperspectral

For SONDES?:
- Meteorological community
- NWP community

For RETRIEVALS?:
- Remote Sensing community
- RTM community
Sondes MEET Hyperspectral

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

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EUMETSAT
1. **Direct Comparison**: ConcordIASI cases

2. **Sonde/Hyper Match**: Sodankylä cases

3. **Assessment method**: clear Sodankylä case
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2. Sonde/Hyper Match: Sodankylä cases
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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
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
Temperature Statistics

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

- ECMWF Forecast
- NLR Retrieval
- OE Retrieval

WARNING: Small sample!
Humidity Statistics

Concordiasi vs ECMWF +12/+19h Forecast or OE/NLR Retrieval

![Graph showing humidity statistics with different lines representing ECMWF Forecast, NLR Retrieval, and OE Retrieval.]

WARNING: Small sample!
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.
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

Calbet et al. AMT 2011
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.

Calbet et al. AMT 2011
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Is there a way to check reference measurement?

EXAMPLE

Sodankyla 2007/07/17 08:18

Interpolated
ECMWF
PTU -5 min
PTU -5 min Vomel
OE IASI

$p\ (\text{hPa})$

$T_{\text{dew}}\ ,\ T\ (\text{°C})$

Calbet ITSC18, 2012
Is there a way to check reference measurement?

EXAMPLE
Is there a way to check reference measurement?

**EXAMPLE**

\[ \Delta x = \left( K^T S_\varepsilon^{-1} K + S_a^{-1} \right)^{-1} (K^T S_\varepsilon^{-1} \Delta y) , \]

where \( \Delta y = y_O - y_C \)

\( y_O \) = observed radiances

\( y_C \) = calculated radiances
Is there a way to check reference measurement?

EXAMPLE

Calbet ITSC18, 2012
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.
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
Temperature OK!

RS92 Moisture above tropopause NOT GOOD

CFH Moisture above 40 hPa NOT GOOD

Moisture profiles can vary a lot in 1 hour!
Sodankylä Sondes (2/2)

ECMWF AND RS-92 not accurate here

ECMWF not very accurate in UT/LS