NEAR REAL TIME TEMPERATURE AND SPECIFIC HUMIDITY PROFILES BASED ON GPS RADIO OCCULTATIONS FROM METOP-A AND METOP-B.

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ROM SAF DMI

Geneva Sept. 2014

Outline

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Application
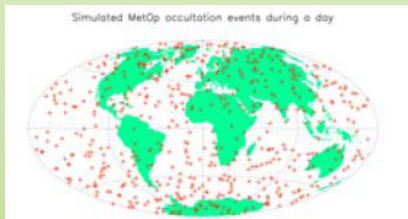Facilities

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Introduction to RO
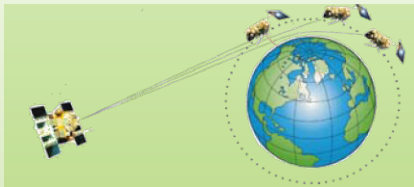
$$N = k_1 \frac{P_{\text{dry air}}}{T} + k_3 \frac{P_{\text{water}}}{T^2}$$

- ▶ Global coverage
- ▶ Vertical resolution < 250 m
- ▶ Horizontal resolution < 300 km
- ▶ Calibration free
- ▶ Proven useful in NWP

Simulated MetOp occultation events during a day

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ROM SAF Level2b activities
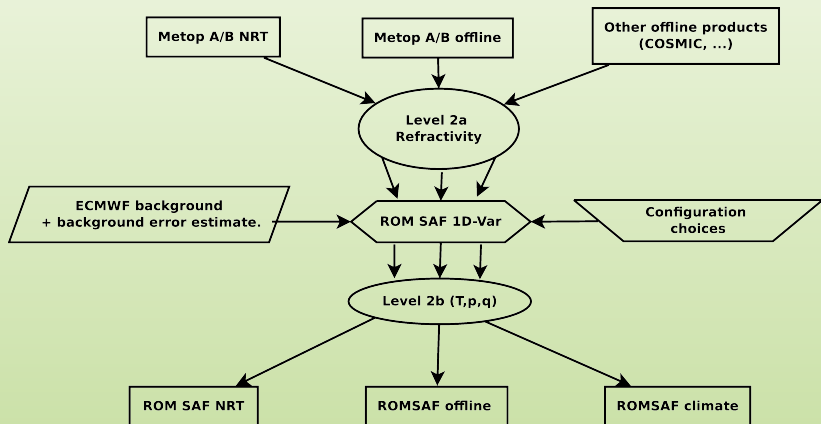
ROM SAF Level 2b current status

NRT

- ▶ 1D-Var version 2.6.2 operational from August 2014. GTS, EUMETCAST and www.romsaf.org. Delay $\approx$ 1 hour.
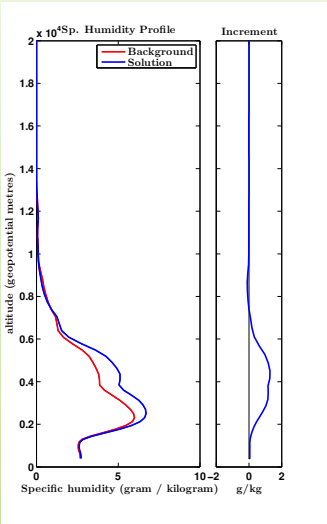 - More about RO 1D-Var in a few minutes!

Offline
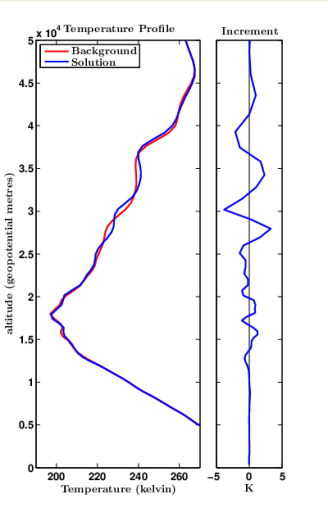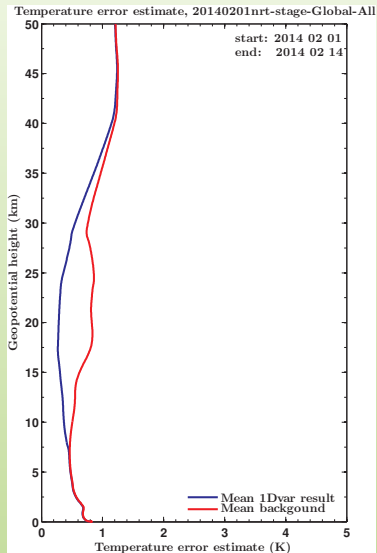
- ▶ Under development.

Climate

- ▶ COSMIC data are currently processed operationally and disseminated through gridded (Level 3) climate products. For more details about the ROM SAF and its climate products please attend poster #2.11 by Kent Lauritsen.

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Example of retrieved T/q profiles (1D-Var)

Error estimates of retrieved T/q profiles (1D-Var)

All products come with individual error estimates.

Temperature error estimate, 20140201nrt-stage-Global-All

start: 2014 02 01
end: 2014 02 14

Mean 1Dvar result
Mean backgound

Geopotential height (km)

Temperature error estimate (K)

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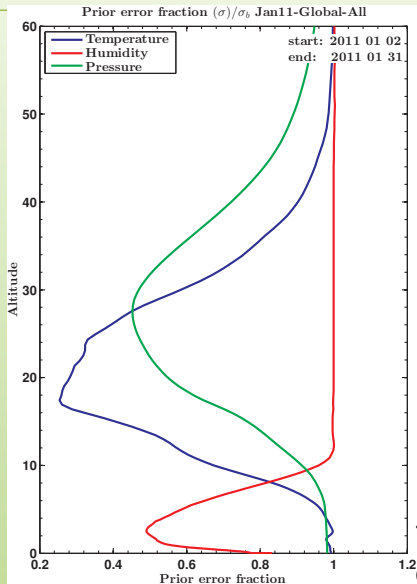**ROM SAF**
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1D-Var configuration

$$J(\mathbf{x}) = \tfrac{1}{2}(\mathbf{x} - \mathbf{x}^b)^T \mathbf{B}^{-1}(\mathbf{x} - \mathbf{x}^b) + \tfrac{1}{2}(\mathbf{y}^o - \mathbf{H}(\mathbf{x}))^T \mathbf{O}^{-1}(\mathbf{y}^o - \mathbf{H}(\mathbf{x}))$$

where $x = (\mathbf{T}; \mathbf{q}; p)$

- ▶ Observation covariance **O**. Stdv. 2% enhanced below background tropopause. Correlation $1/e$-length 3 km.
- ▶ Background covariance provided by ECMWF. Fixed temperature uncertainty and fixed relative humidity uncertainty.
- ▶ Currently 137 state vector levels.
- ▶ Logarithmic representation of q, p (also prevents $q \leq 0$)
- ▶ For current NRT: 8 km geo-potential height cut off, due to closed loop sampling and geometric optics. -To be upgraded in 2015.

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Uncertainty reduction

Prior error fraction $(\sigma)/\sigma_b$ Jan11-Global-All

start: 2011 01 02
end: 2011 01 31

Legend:
- Temperature
- Humidity
- Pressure

Axes: Altitude (vertical), Prior error fraction (horizontal)

This example is from COSMIC data. 1D-Var version 2.5

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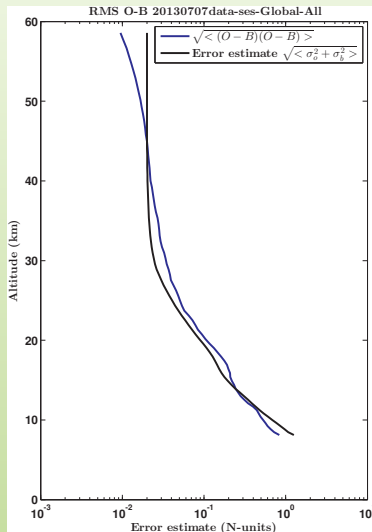
Desroziers relations

RMS O-B 20130707data-ses-Global-All

In refractivity space:

$$\langle (o-b)(o-b)^T \rangle = \mathbf{HBH}^T + \mathbf{O}$$

Desroziers et al. (2005)

Confirming error model.

Characterization of 1D-var temperatures

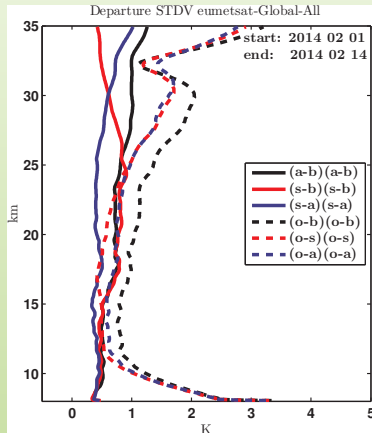**Dashed red line:**
1D-Var solution - observation.
Dashed blue line:
ECMWF analysis - observation.

o: Observation,
(Dry Temperature)
a: ECMWF analysis
b: ECMWF forecast
c: 1D-Var solution

Departure STDV eumetsat-Global-All

start: 2014 02 01
end: 2014 02 14

- (a-b)(a-b)
- (s-b)(s-b)
- (s-a)(s-a)
- (o-b)(o-b)
- (o-s)(o-s)
- (o-a)(o-a)

Outline

Usage of RO Data

Originally the intention was to provide $T/q/p$ profiles for NWP, but nowadays NWP's assimilate bending angles directly.

Applications;

- Interest from meteorologists (DMI) *"another radio sonde"*.
- LAM assimilation (refractivity).
- On line calibration of vertically retrieved products.
- Climate.
- Ideas?

Additional value:

- equivalent to globally distributed radio sondes
- available before ECMWF analysis
- different information content than ECMWF
- good for RO QC and monitoring

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Summary

- NRT 1D-Var has been operational since August 1st 2014. EUMETSAT upgrade to cover most of troposphere in 2015.
- COSMIC data processed and validated for ROM SAF on-line climate products.
- ROM SAF NRT 1D-Var is closer to RO obervations than ECMWF analysis is.
- Virtually a high accuracy globally distributed "radiosonde product".
- Interested? Feel free to contact us here at the conference. (jkn@dmi.dk)

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