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UNIVERSITÄT BERN

SITE ATMOSPHERIC STATE BEST ESTIMATE (SASBE) OF OZONE PROFILE ABOVE PAYERNE, SWITZERLAND:

a method for the combination of simultaneous microwave radiometer and radiosonde ozone profiles.

Eliane Maillard Barras

Microwave Radiometer SOMORA

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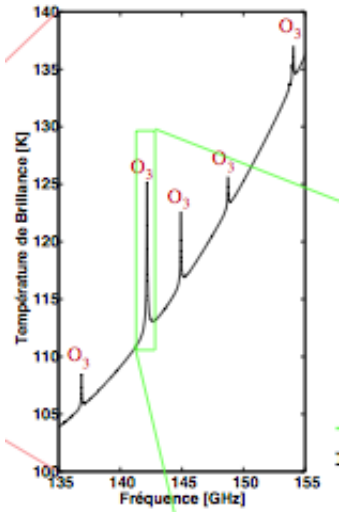
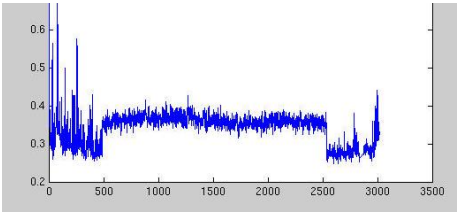


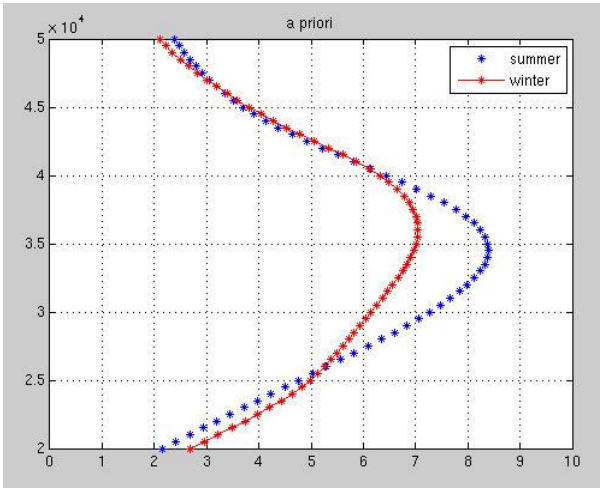
- O3 line at 142.17 GHz
- 1 cycle : 20 sec
- Resolution FFT spectrometer: 61 kHz/ch (16384 ch for 1GHz)
- Correction for window, for tropospheric opacity, linear baseline

continuously operated since 2000	time resolution: 30 min
ozone profiles from 20 to 65 km	vertical resolution: 8-15 km
2 major instrumental modifications	2005: front-end change 2009: spectrometer change from AOS to FFT

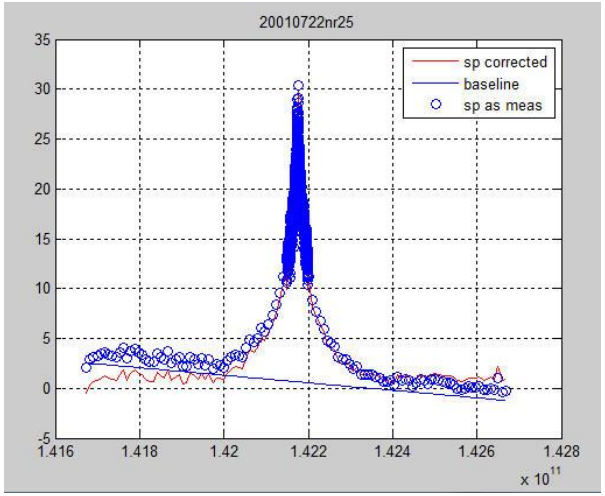
➢Retrieval of ozone profiles: ARTS/Qpack based on OEM by Rodgers
described in ERIKSSON, P., et al, 2005, *Journal of Quantitative Spectroscopy & Radiative Transfer,* 91, 47–64

Microwave Radiometer SOMORA



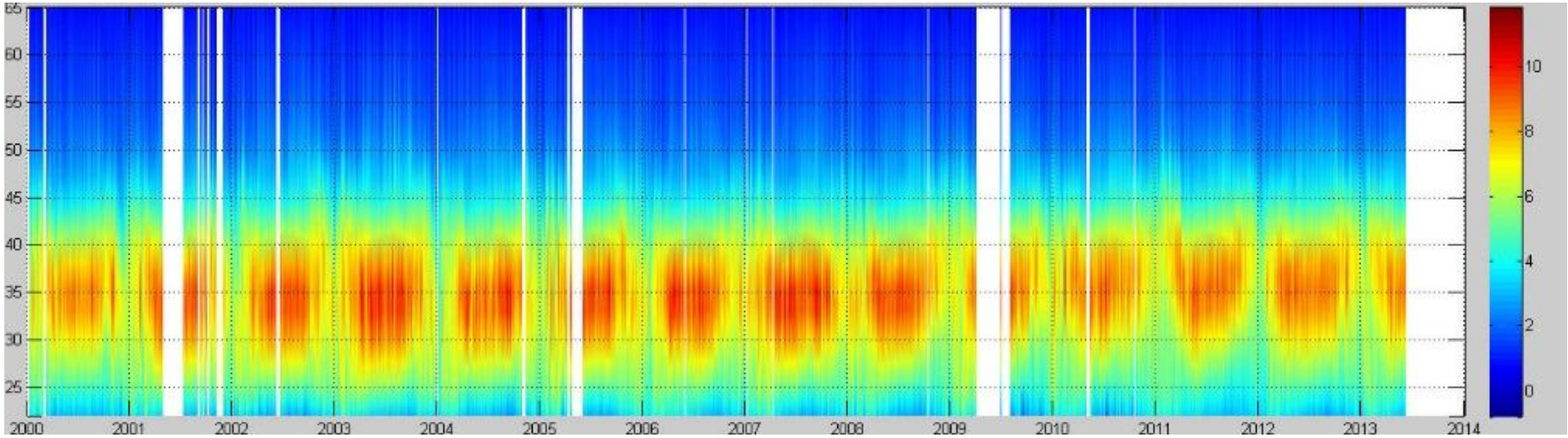


binning	1000 channels : center of the line: 800 ch (resolution of 61kHz) Wings: 200 ch
Correction for troposphere	Ingold method [Ingold et al., Radio Sci. Vol. 33, pp. 905-918, 1998]
Noise cov matrix	Varies with spectrum noise for each spectrum
A priori cov matrix	determined from a statistical analysis of ozonesonde between Nov 1994 and Oct 1998 completed by stdev of GROMOS profiles for upper stratosphere and mesosphere.
A priori	2 standard profiles (W & S) [Keating,1990]:
baseline	Linear
Nb output levels	30 pressure levels



Microwave Radiometer SOMORA time series

SOMORA 2000-2013 ozone content [ppm]



Time [year]

SOMORA
Alt range: 20 km – 70 km
Time resolution: 30 min
Vertical resolution: 8-15 km
Error: 10-15%

Microwave Radiometer SOMORA : retrieval

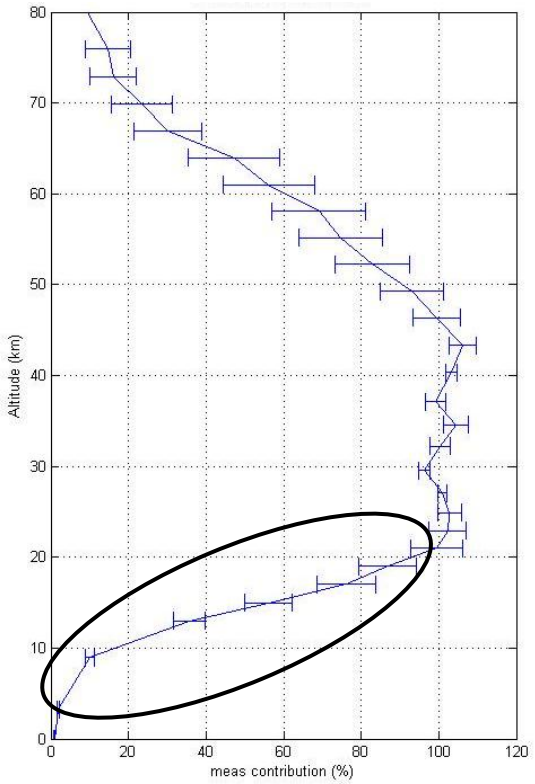
The OEM solution $\hat{x}$ to the inverse problem minimizes the cost function derived from the Bayesian theory:

$$\hat{x} = x_a + S_a^{-1} + (K^T S_y^{-1} K)^{-1} K^T S_y^{-1} \left(y - F(x_a)\right)$$

with
x_a the a priori ozone profile
S_a the error covariance matrix of the a priori
K the derivative of F(x) with respect to x
S_y the error covariance matrix of the measured spectrum
$F(x_a)$ the calculated spectrum corresponding to the a priori profile

Site Atmospheric State Best Estimate: SASBE

Measurement response



- Consider the **simultaneous ozone radiosonde profile as the a priori**
- Retrieve SOMORA ozone profile with strong weight on this a priori below 25 km
- Weight on a priori based on the high precision of the RS between 0 and 25 km

Radiosonding

Ozone sondes are launched from Payerne 3 times /week since 1968.
The ozone sonde consists of an electrochemical cell where the reaction of ozone with potassium iodide in aqueous solution is used to measure continuously the ozone concentration.
ECC (0.5% KI concentration)

Ozone is measured in the altitude range of 0 km to 30 km with a time resolution of 3 profiles per week.
The vertical resolution is 150 m and the estimated error 5%.

Radiosonde
Alt range: 0 km – 30 km
Time resolution: 3x/week
Vertical resolution: 150 m
Error: 5%

ECMWF ERA-Interim model

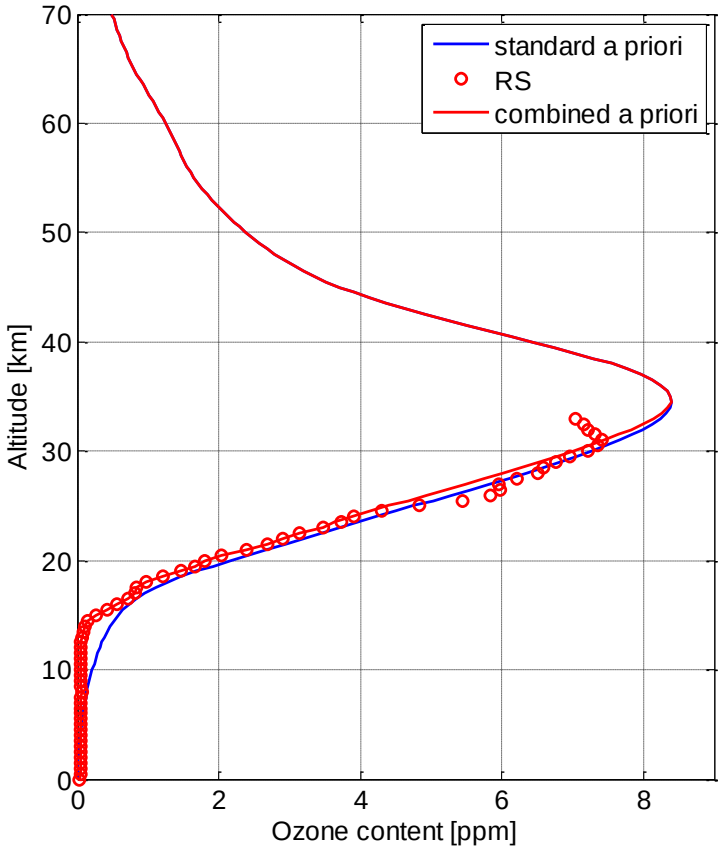
Data assimilation of reactive gases in the stratosphere

MIPAS, SCIAMACHY, TOMS, GOME, MLS, OMI

- 4D-VAR data assimilation
- Horizontal resolution : 1.125° lat x 1.125° lon
- 37 pressure levels as vertical coordinates (1-1000hPa)
- Model time step : 6 hours

ECMWF ERA-Interim model
Alt range: 0 km – 50 km
Time resolution: 6 hours
Vertical resolution: 2 km
Error: 10%

SASBE: a priori



The a priori is then composed by the standard model ozone profile of Keating and by the radiosonde ozone profiles.

A weighted correction factor is applied to the RS ozone profile between 18 and 23 km in order to get a smoothed transition between the RS profile and the standard ozone profile as shown in red.

The same procedure is applied to the a priori ozone profile when the ECMWF-ERA interim model is used in the combination.

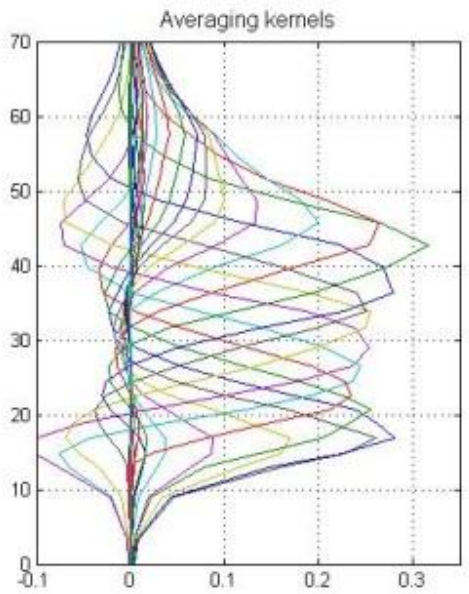
combination of the summer standard a priori ozone profile and one RS ozone profile

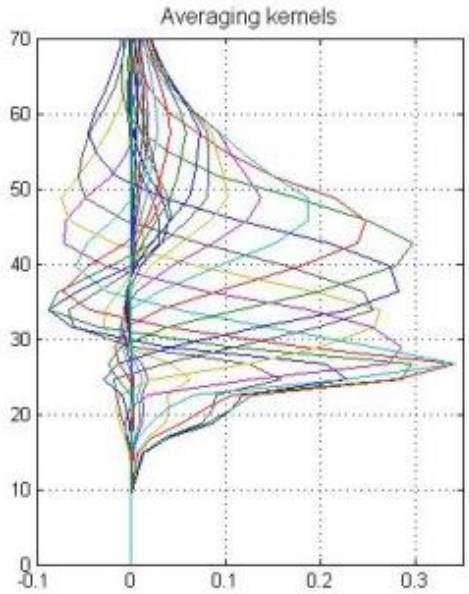
SASBE: a priori covariance matrix

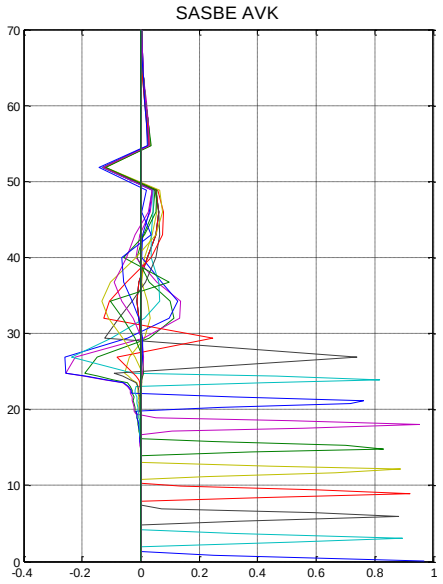
The square roots of the **diagonal elements** of the a priori covariance matrix S_a are set to the standard deviation of a **climatology** of Payerne **radiosonde**s below 25 km and of a climatology of **MWR** ozone profiles above 25 km.

The **off-diagonal elements** of the a priori covariance matrix S_a are calculated assuming an exponentially decreasing correlation function with a correlation length of **150 m** below 25 km and **3 km** above

SASBE: Averaging Kernels

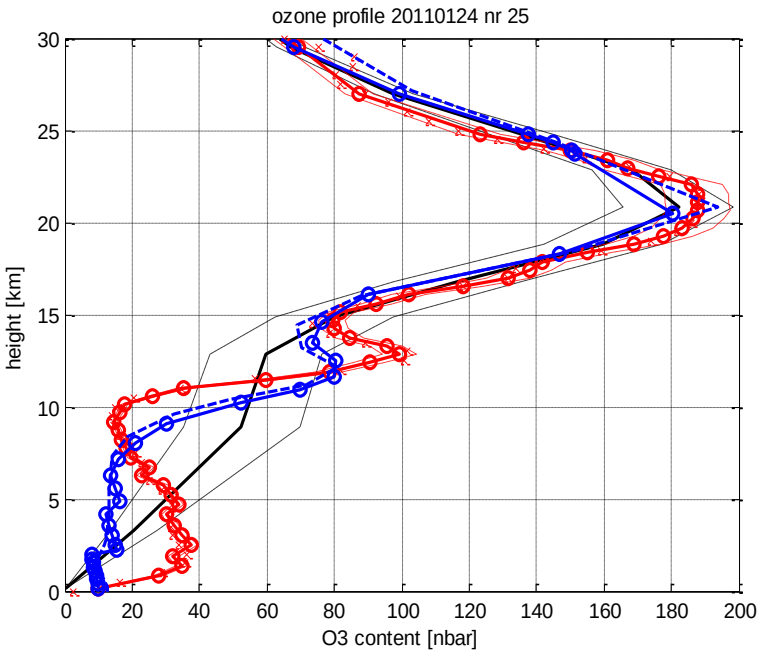






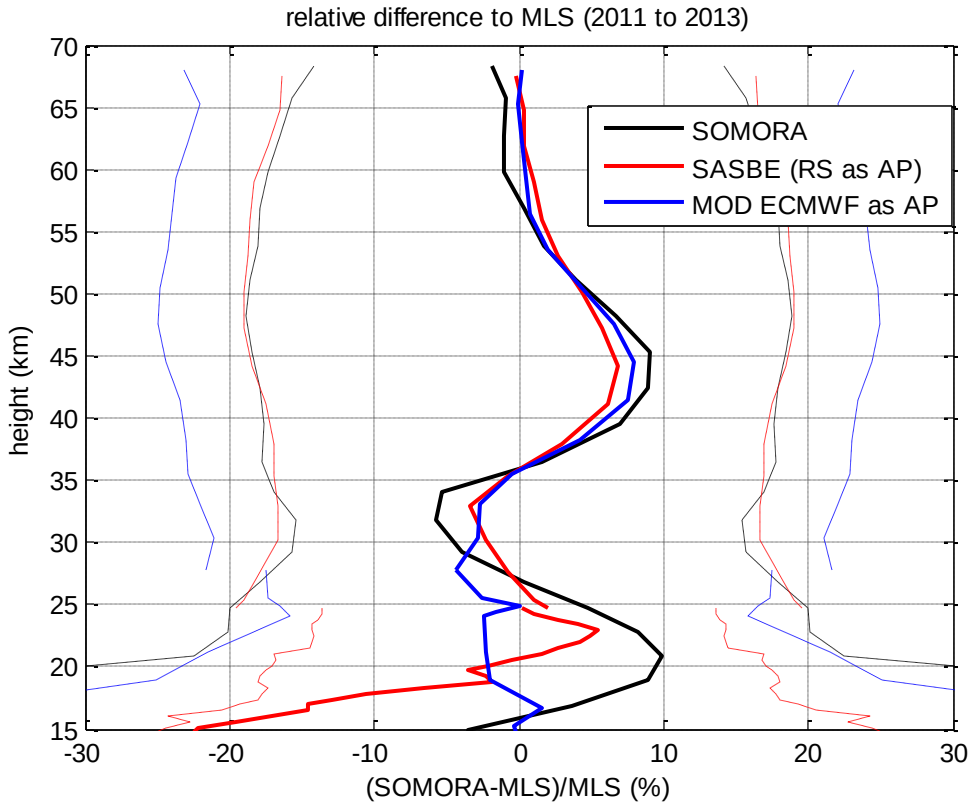
AVK in fraction of profile for one (ie 20110107 at 12h UTC) SOMORA ozone profile (a) and the corresponding SASBE ozone profile (b). (c) SASBE AVK by simulation of perturbations of the true state (RS profile) below 25 km.

SASBE: ozone profile

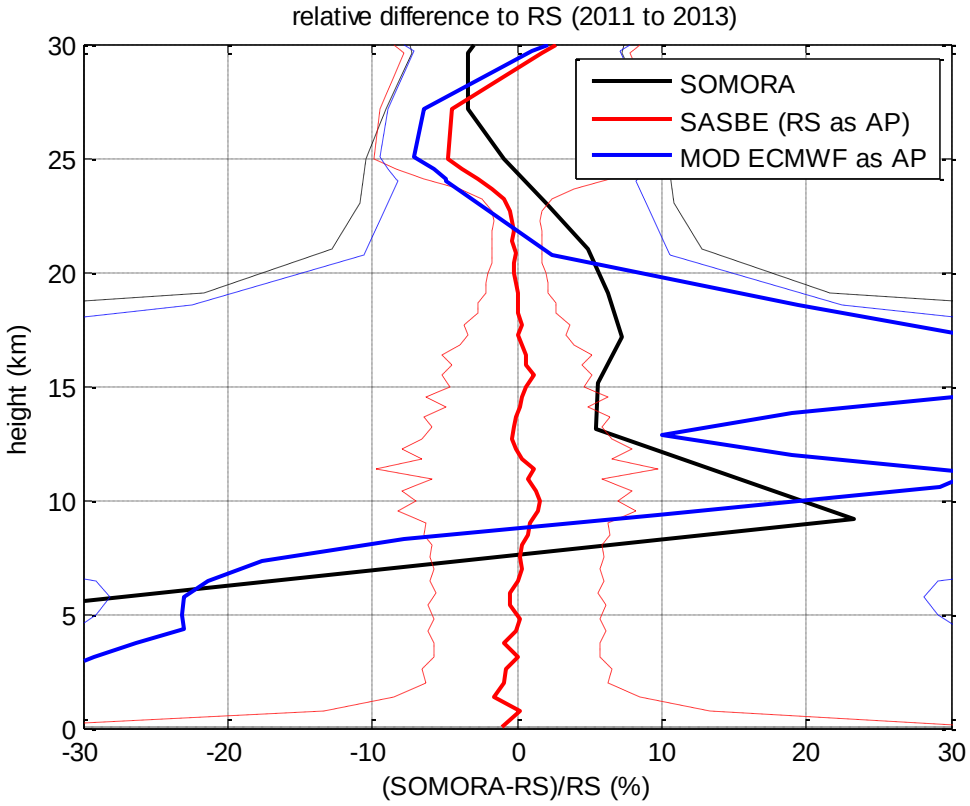


*one **SOMORA ozone profile** in black, the corresponding **SASBE ozone profile** combining RS and SOMORA in red, and **combining ECMWF model and SOMORA** in blue.*
RS is plotted in dashed red and ECMWF simulated profile in dashed blue.

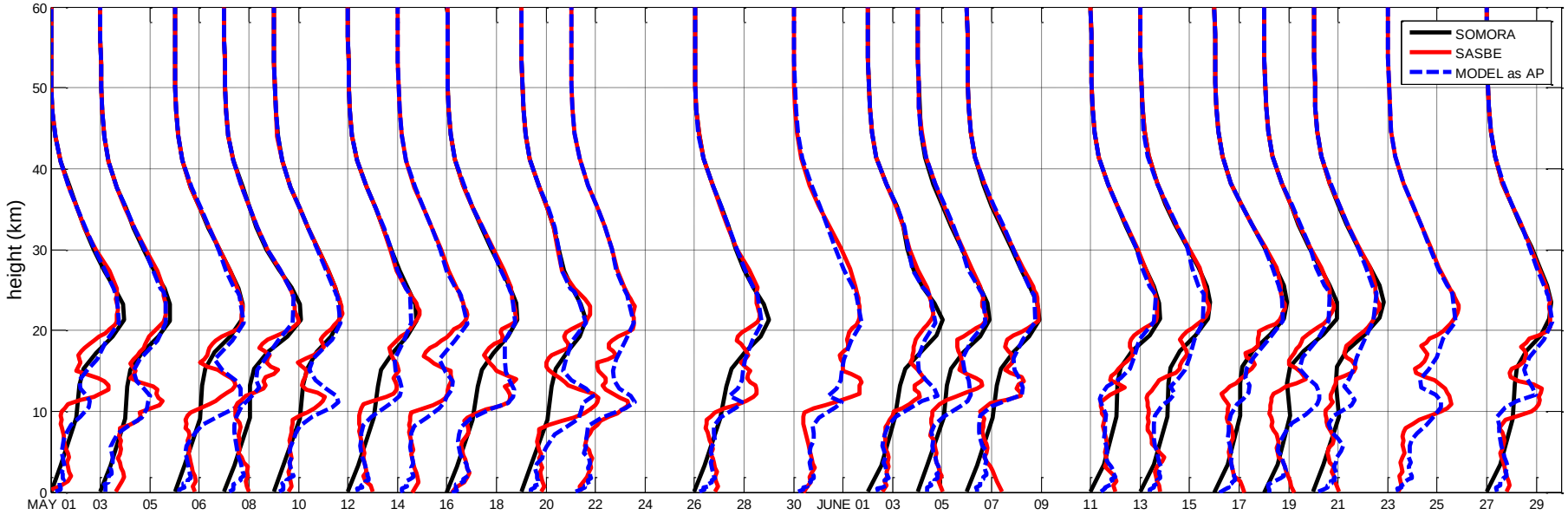
COMPARISON to AURA/MLS



COMPARISON to Payerne Radiosonde



SASBE : ozone profile time series in nbar



By the combination (**SASBE**) of Radiosonde and **SOMORA** ozone profiles, the integrated ozone profile timeseries show profiles with reliable values from ground up at the time resolution of RS.