

SMILES L2 v2.4 updates

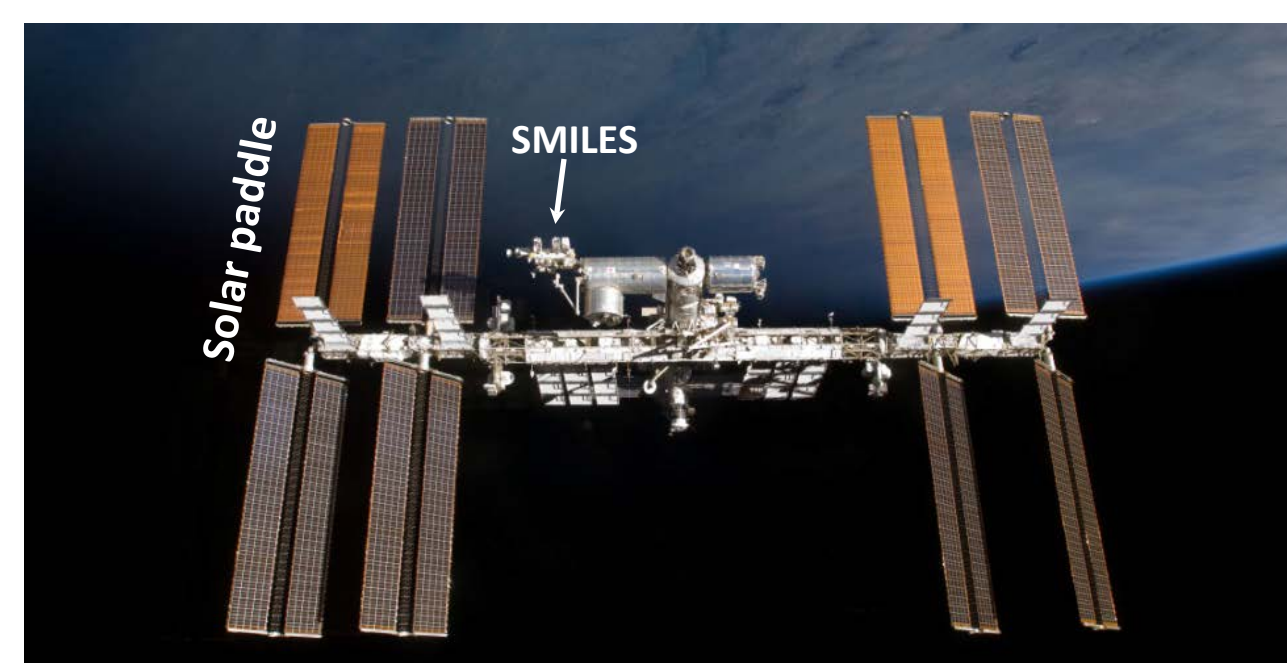
Chihiro MITSUDA¹, Takuki SANO², Makoto SUZUKI², Naohiro MANAGO³,
Eriko NISHIMOTO^{2,5}, Yoko NAITO⁴, Chikako TAKAHASHI¹, Koji IMAI², Masato SHIOTANI⁵
(1: Fujitsu FIP Corporation, 2: ISAS/JAXA, 3: CERes, Chiba-Univ., 4: RISH, Kyoto-U., 5: Dep. of Geophysics, Kyoto-U.)

Abstract

JEM/SMILES L2 product has been updated 3 times since v2.1 was opened to the public in March of 2012. One of the major targets in the updates after v2.1 is improvement of the profiles at mesosphere / lower thermosphere. In the latest v2.4, thermospheric peak of ozone can be retrieved with SMILES data, similar to the result from other spaceborne measurements, and these ozone profiles are now under validation. HO₂ profiles in v2.4 have also similar peaks at the 80km altitude during nighttime. Another target is reevaluation of the status flag. In the v2.1, status flag were strictly configured due to the revision of the inversion model, so that only 30% of band C data are marked as "useful." Due to the reevaluation of criteria of flagging, up to 80-90% of data are usable in the v2.4. In the future, recheck of bias in some species and consistency between data from two spectrometer inside SMILES will be done, resulting with v3.0 which will be released in the summer of 2013.

1. Introduction: JEM/SMILES

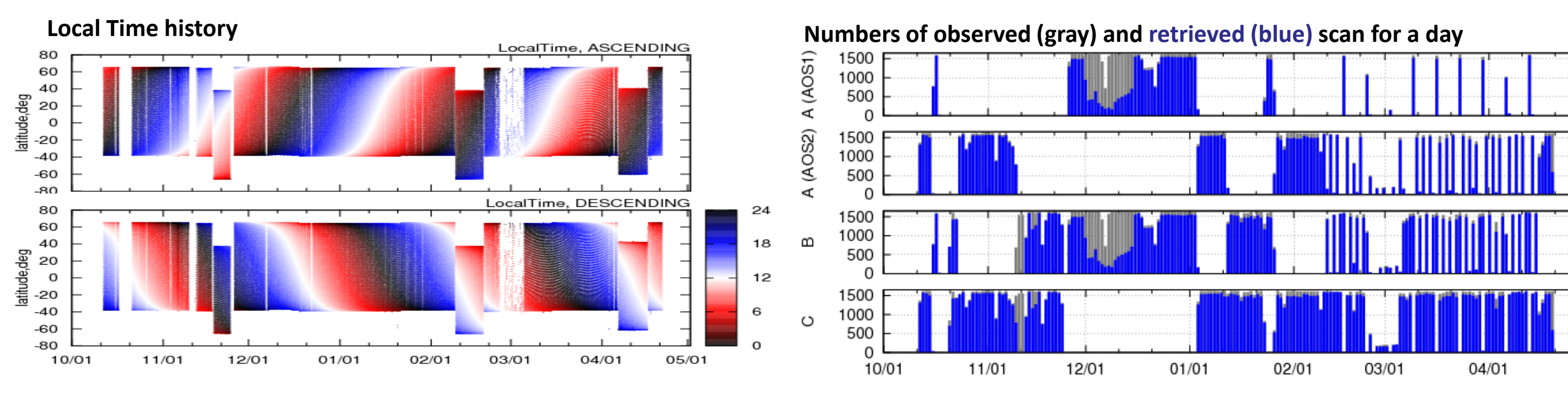
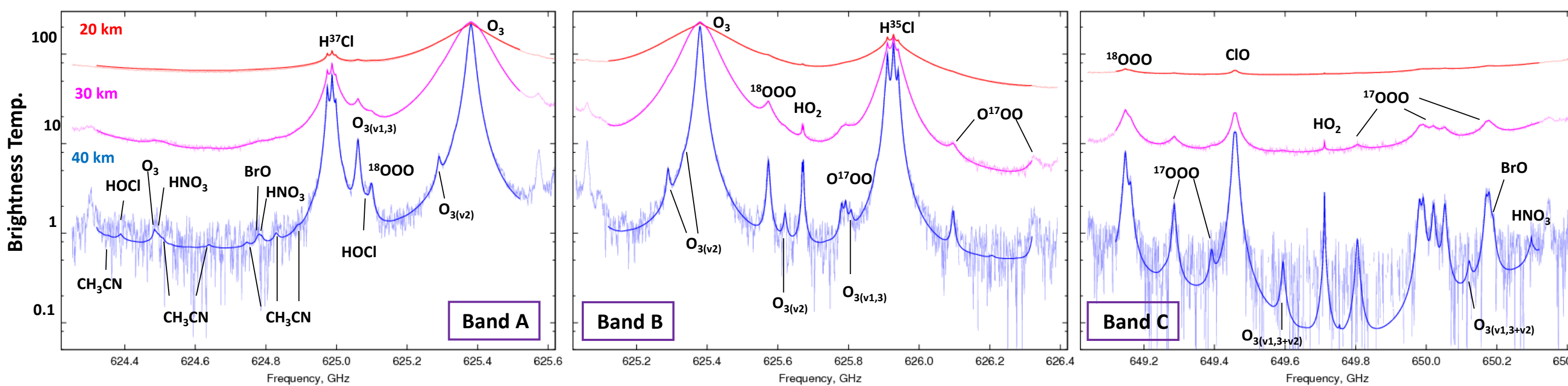
- The Superconducting Sub-millimeter Limb-emission Sounder (SMILES) was developed under the cooperation with JAXA and NICT, in order to operate onboard Japan Experiment Module (JEM) of the International Space Station (ISS). SMILES has observed submillimeter-wave radiations from Earth's atmosphere from 12 October 2009 to 21 April 2010. Thanks to the non-sun-synchronous orbit of SMILES (ISS), it can also capture the feature of diurnal variation of atmospheric constituents. (Lower left: Local Time History)
- SMILES has three measurement band (A/B/C) within 624-650 GHz frequency region. But only two of the three bands can be measured simultaneously. Especially, band A is measured with different receiver depend on band combination. That results in different accuracy of retrieved profile among band A data.
- SMILES can observe 1630 scan per day, but a small percent of the data are unavailable because of FOV intercept with solar paddle. Some data are not valid in case of incoming solar light.
- In average, 1200 scans per day are available. (see Lower Right) (Except for 2009/12/01-15: solar paddle halt in SMILES FOV, 2010/02/25-03/05: ISS/JEM communication system trouble)



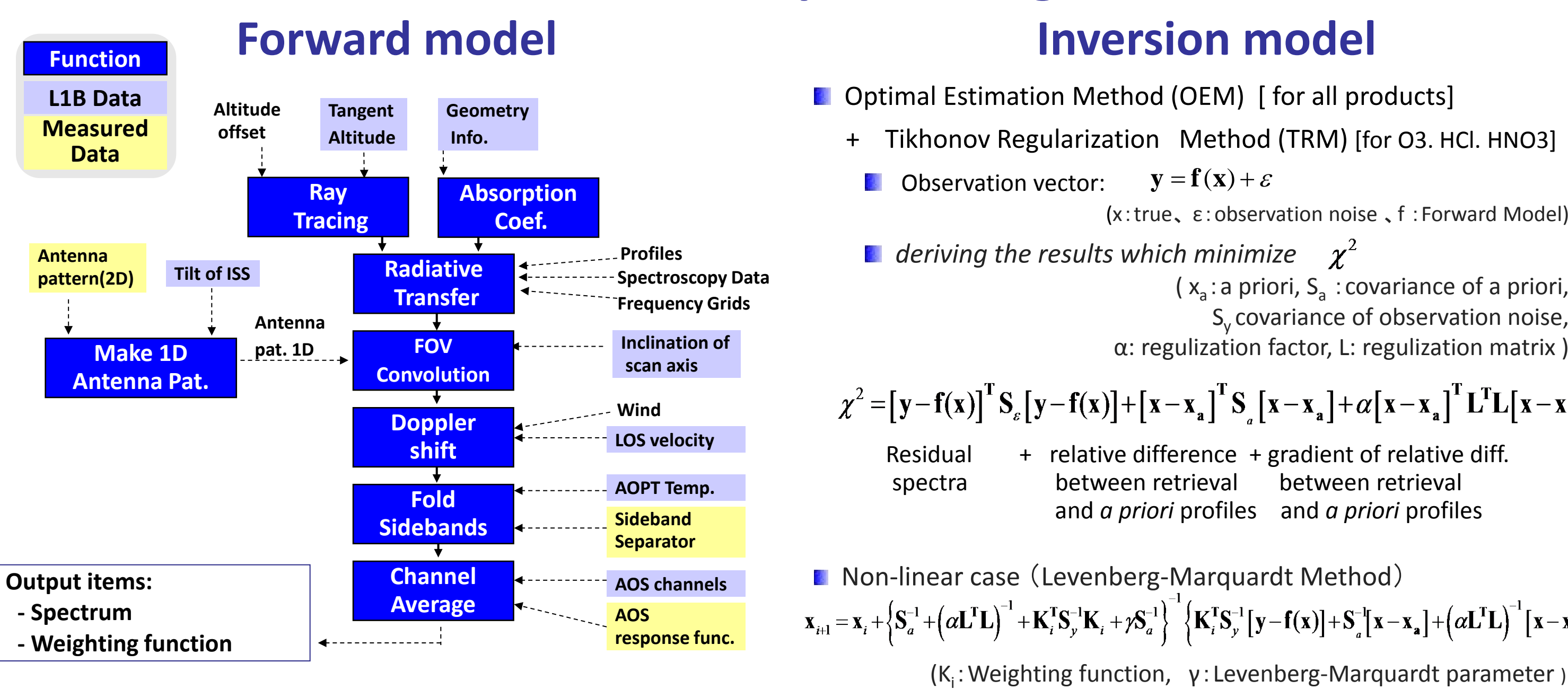
Type	Parameters
Frequency bands	A : 624.32-625.52 GHz B : 625.12-626.32 GHz C : 649.12-650.32 GHz
System noise Temperature	< 500 K
Instrumental height resolution	3.5 - 4.1 km (nominal)
Frequency resolution	1.8 MHz (FWHM)
Channel Separation	0.8 MHz / channel
Integration time	0.5 s for each tangent height
Retrieved Altitude range	8 - 85 km
Global coverage	38S - 65 N (nominal)
Observation interval	53 s / scan

Standard Products:
O₃, HCl, ClO, HNO₃, CH₃CN, HO₂,
HOCl, BrO, O₃ isotopes

Typical sample of the spectrum: daytime, Observed (thin lines) and fitted (thick lines)



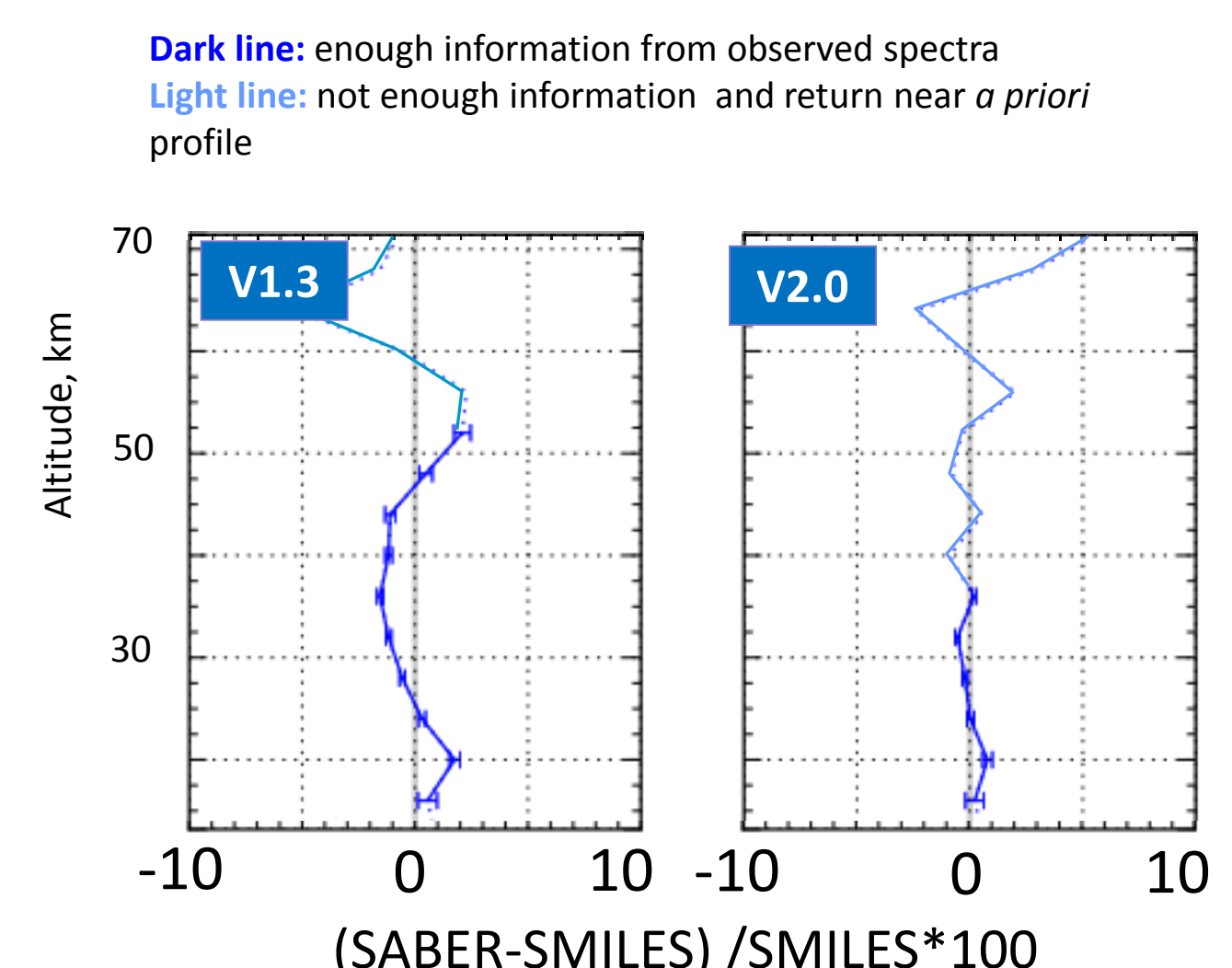
2. L2 data processing



3. Product release calendar

- 2010/01/23 v1.0 (005-06-0024): for retrieval test
 - Test processing with using pre-launch algorithm
- 2010/04/19 v1.1 (005-06-0032): for mapping test
 - Increase of "useful data" according to interpolation of ISS attitude data STT
- 2010/09/15 v1.2 (005-06-0150): algorithm update (I)
 - Decrease of inconsistency between different bands according to experimental correction of instrumental function (response function of the receiver)
- 2011/03/02 v1.3 (006-06-0200): algorithm update (II)
 - Improvement of quality of the screening flag
 - Removal of abnormal data around the FOV-intercepted scan, etc.
- 2011/10/04 v2.0 (007-08-0300): algorithm update (III)
 - Improvement of temperature profiles (see Right)
- 2012/01/16 v2.1 (007-08-0310): algorithm update (IV)
 - Improvement of HOCl profiles
- 2012/03/05: Public release of v2.1

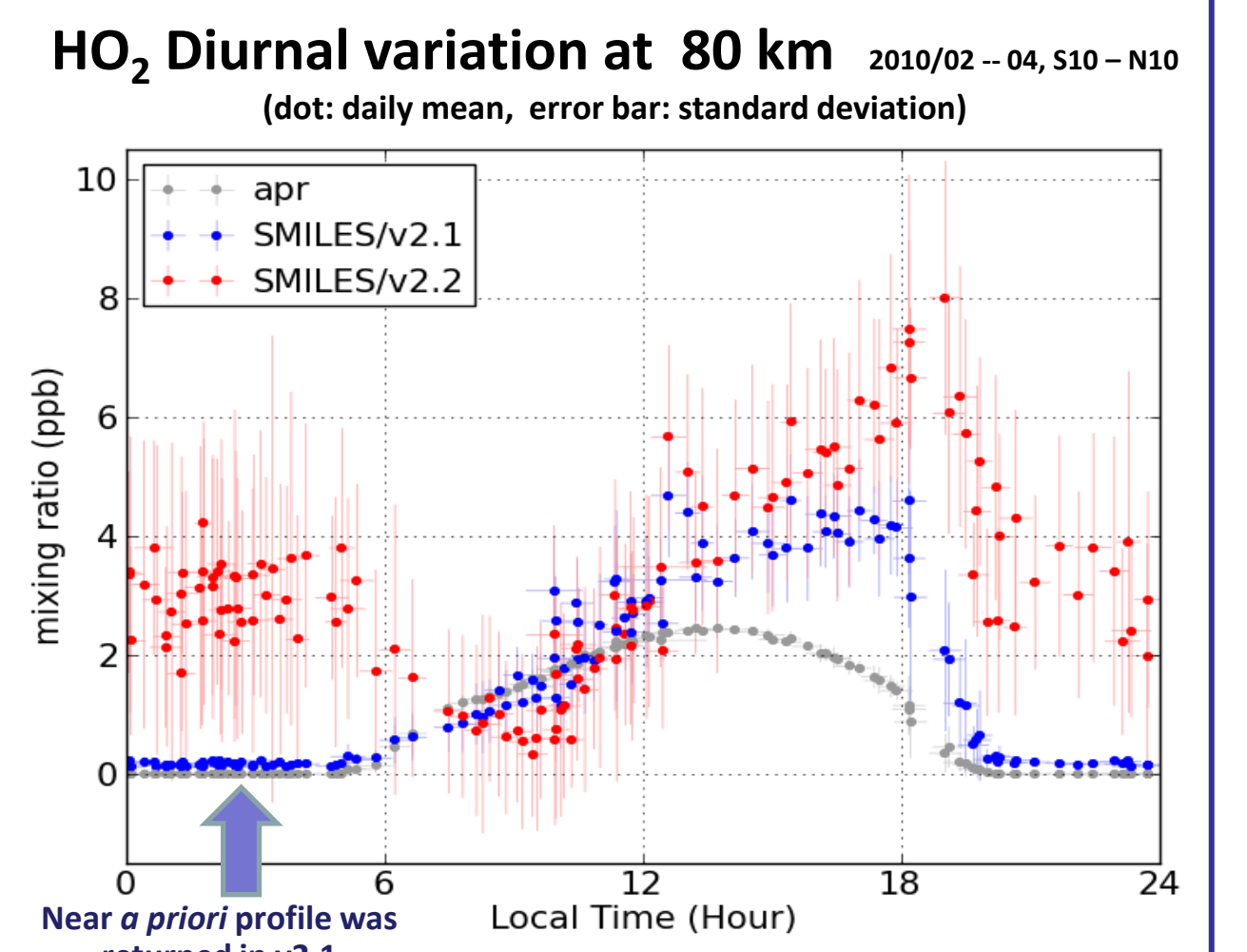
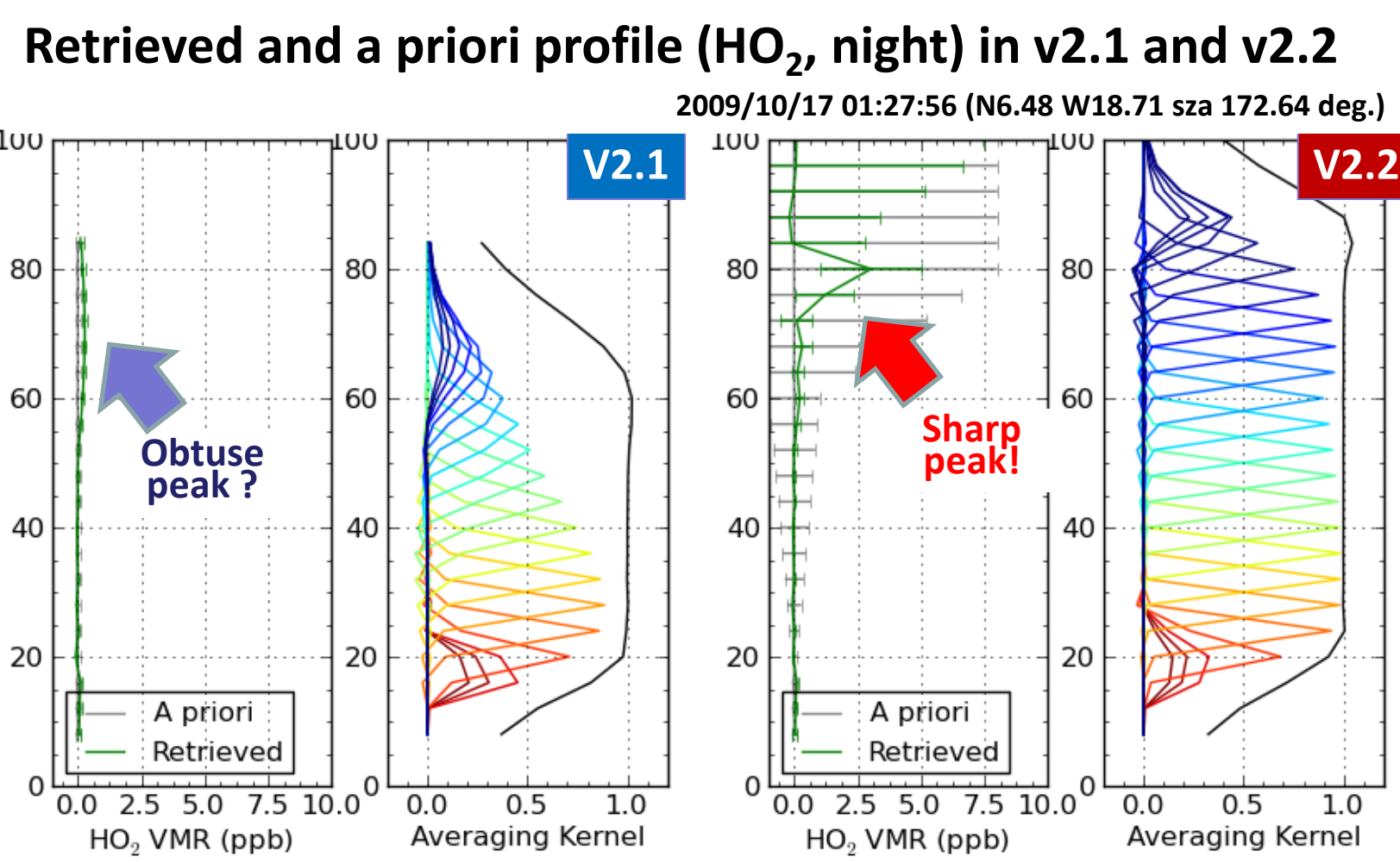
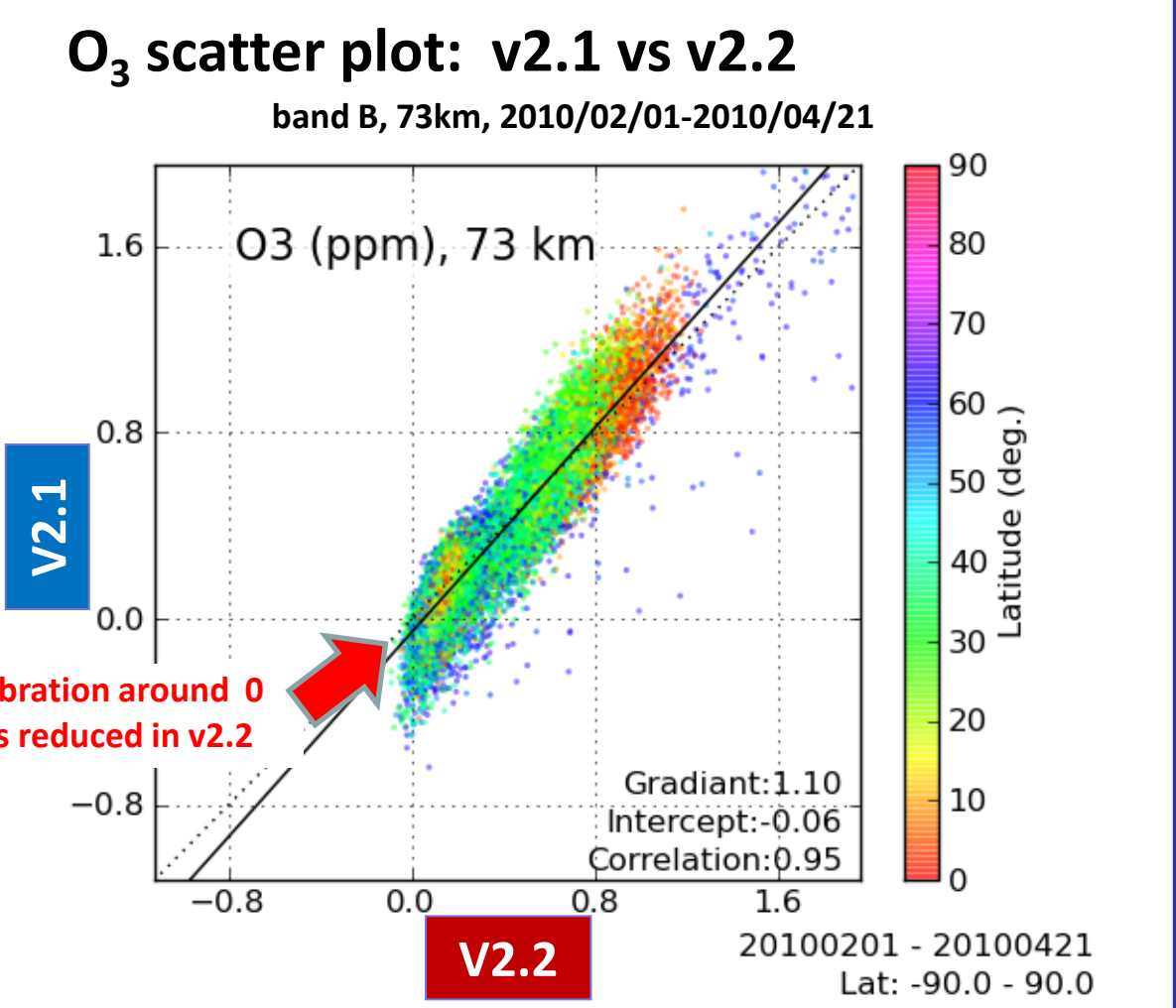
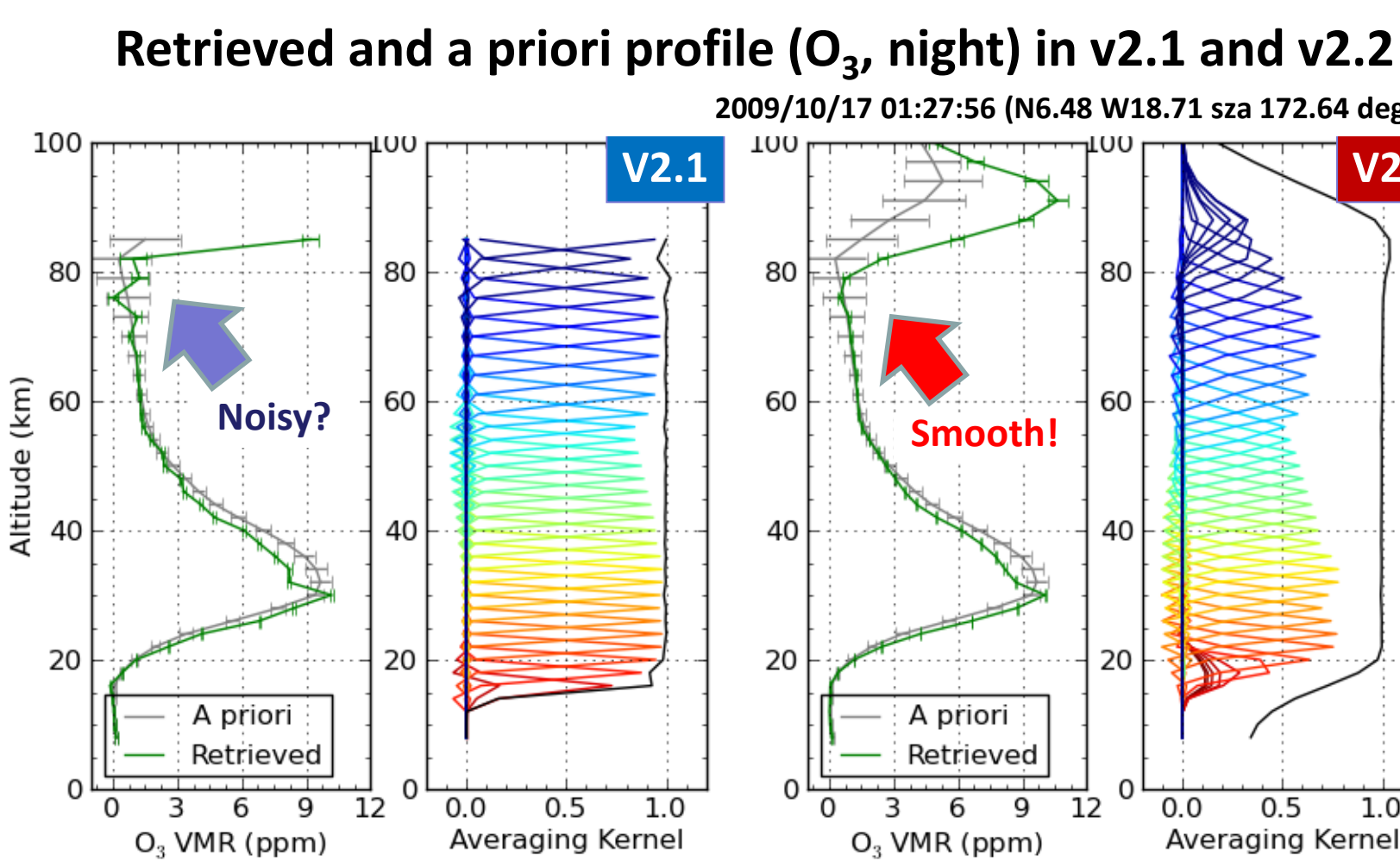
Coincidence sample: SABER vs. SMILES (2009/10/17 08:45, S37.I2 E165.2, band B, same scan)



4. Product updates in v2.2 - v2.4

Objectives of v2.2:

- Suppression of vibration found in the profile of (mesospheric O₃, HCl, and stratospheric HNO₃)
 - Extension of altitude range of retrieval of O₃, HCl, HO₂ (maximum: 85km -> 100km)
- Approach for suppression of vibration in the profiles:
 - Suppression of error in the forward model
 - Update of response function of AOS (Acousto-Optical Spectrometer)
 - Decrease of impact from a priori error, by considering SMILES' sensitivity up to 100km in the forward model calculations.
 - Smoothing effect in the retrieval process
 - Introduce of hybrid OEM + TRM method in the retrieval algorithm of O₃, HCl, and HNO₃.
 - Retrieval altitude ranges of O₃, HCl, HO₂ have been extended up to 100km, as well as altitude grid of calculation and a priori error have been tuned.
- Suppression of vibration in retrieved profiles (See below for the sample of O₃) and improvement of retrieved profiles at higher altitude (See below for the sample of HO₂) have been ascertained.



Objectives of v2.3:

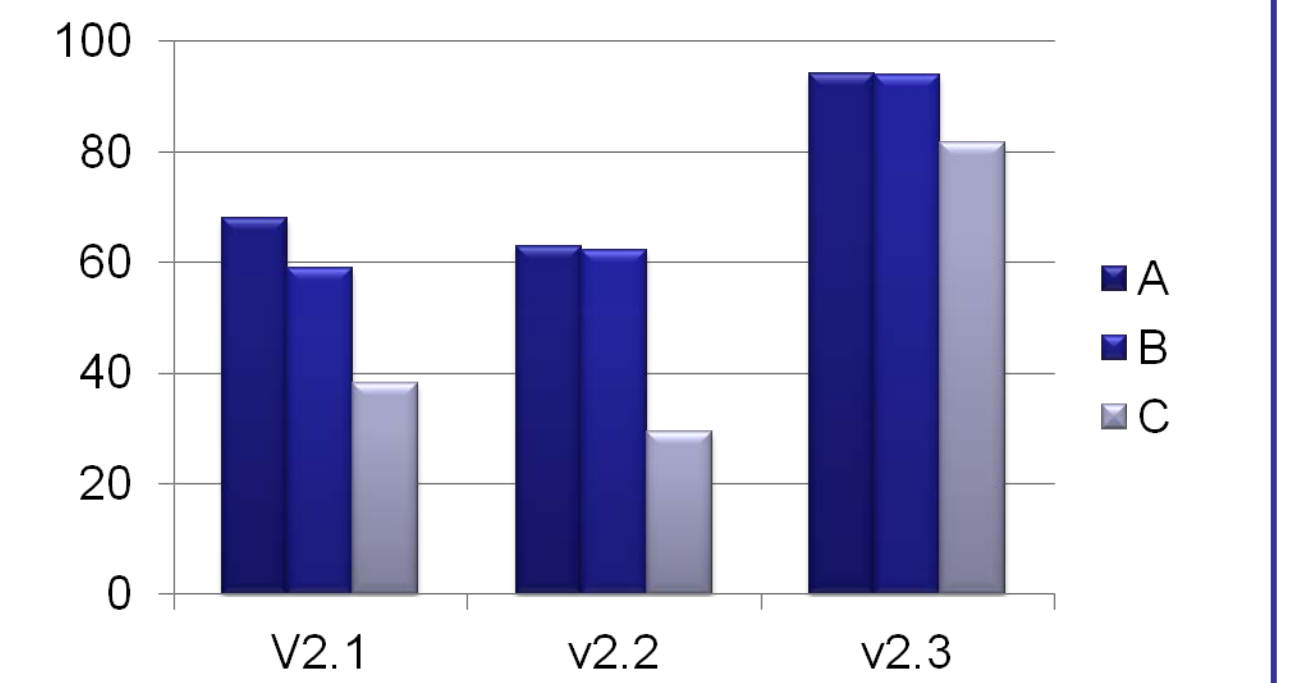
- Appropriate setting of the screening flags and increase of "useful" data
- Existing "screening flag" has contained quality flag in L1B data and convergence factor in L2 retrieval.
 - Valid profile of band C (in low sensitivity) are flagged only ~30%.
 - Up to 20% of FOV interference flag (one of L1B quality flags) are missing, which resulted in difficulty of appropriate screening.
 - Screening conditions are modified in v2.3 (See the table below)
 - Valid profile in each band have been increased 30 - 50%, and most of abnormal profile of O₃ have been removed.

Major screening conditions in v2.2 and v2.3

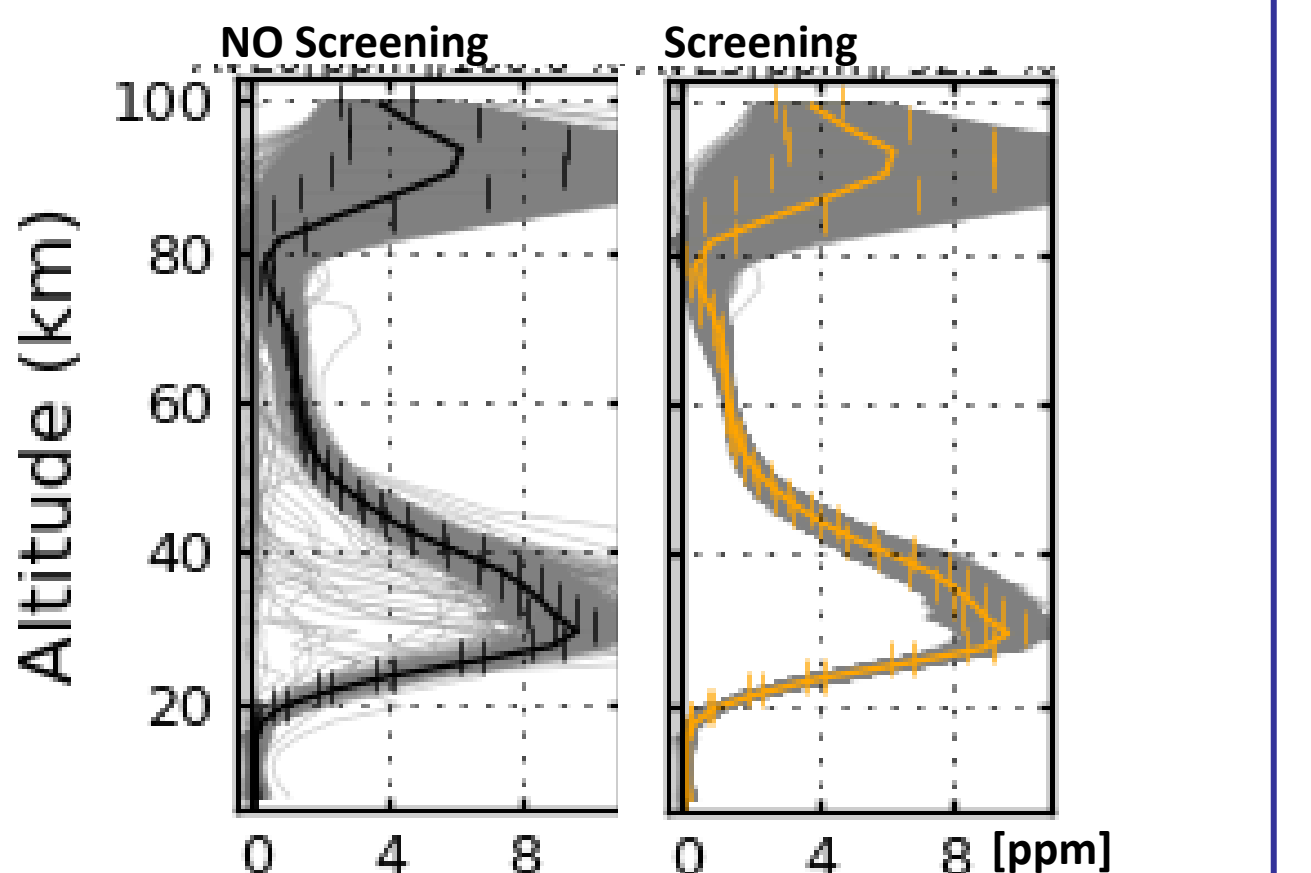
Objectives	v2.2	v2.3
FOV interference	• FOV interference flag in L1B data • Abnormal data in calibration phase in each scan	• Adequacy of HCl profiles* • Abnormal data in calibration phase in each scan
Adequacy of retrieval algorithm	• Convergence of retrieval results	• Residual of spectrum < standard noise (0.5K) • Adequacy of HCl profiles

- HCl can be retrieved from all observation data of SMILES. It has small diurnal and seasonal variation, so it is used as index of quality of retrieved profiles.
- Criteria: a profile of 25-80km fitted within 5-sigma of zonal mean profile

Ratios of useful data [%] (status flag = 0)



Screening example (O3, band A, S10-N10)

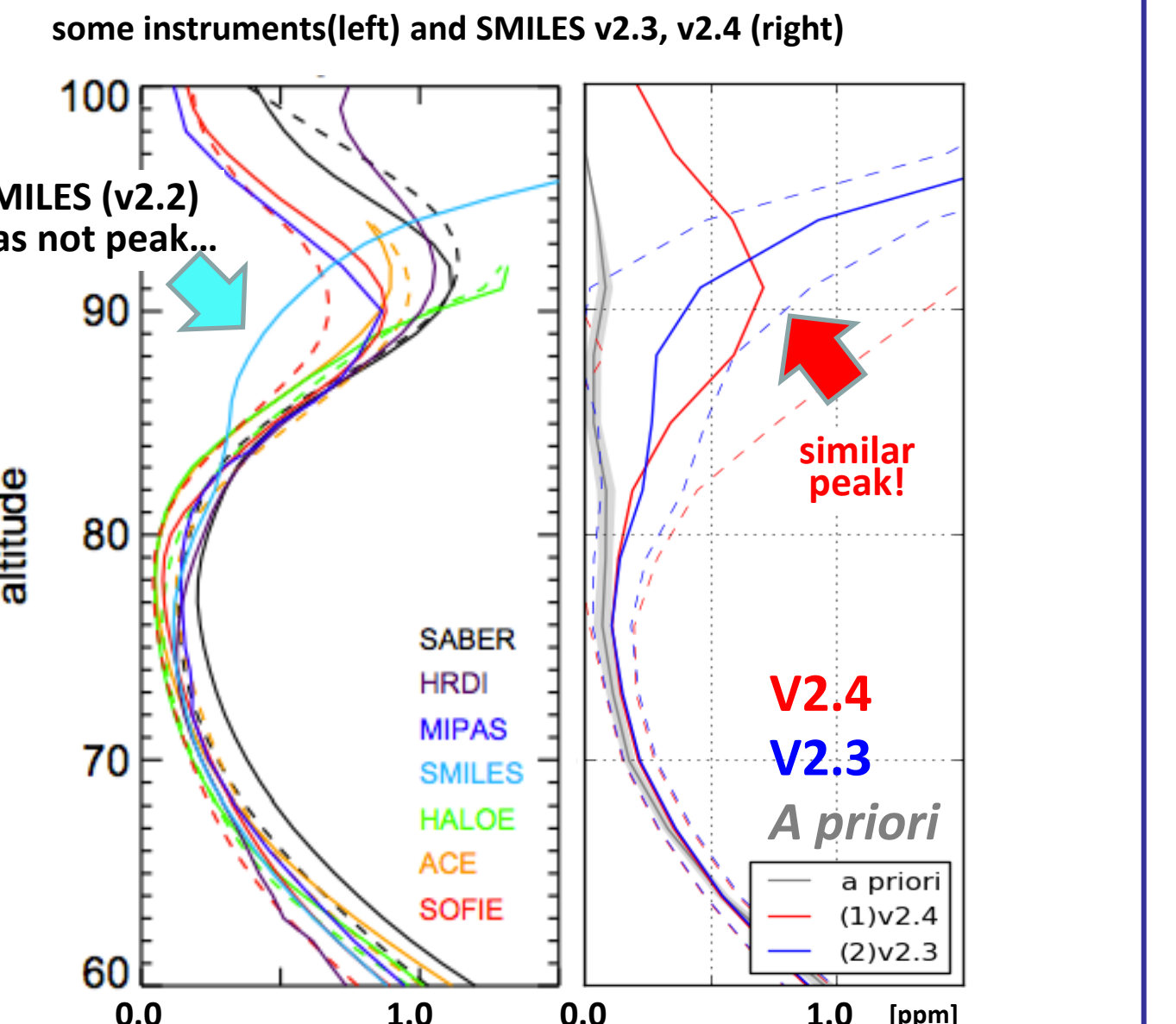


Objectives of v2.4:

Improvement of O3 profile at lower thermosphere

- O₃ profile of SMILES v2.3 didn't have small peak at lower thermosphere, due to some wrong setting in retrieval algorithm.
- A priori profiles of ozone are come from averaged MLS v2.2 data, which have low reliability over 75km (useful range of MLS data). At over 100km in SMILES retrieval, a priori data are directly introduced, but the a priori error caused additional retrieval error at the lower layers.
- In v2.4, retrieval altitude range is extended up to 120 km, as well as a priori profiles and a priori error have been tuned. As a result, small peak at lower thermosphere can be retrieved from SMILES data.

Average of all daytime profiles (SZA < 85°)



5. Future plans

- Next version (v3.0) are planned to release in the summer of 2013:
 - Suppression of inconsistency between different AOSs
 - Experimental correction of parameter in "temperature control OFF" term
 - Application of TRM to other products and reevaluation of error function
 - Recheck of bias in BrO, HOCl, and HO₂
- Some ideas of further improvements:
 - Correction of baseline error with Spline function
 - Renewal of the line shape (consideration of galatry function or SD-voigt function)

BrO: SMILES - bias vs. JPL Balloon

