JEM/SMILES limb sounder:
the Level 2 research products

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Outline

- Brief introduction about SMILES observations
- Description of the L2 research products
- Description of the processing chain for the L2-research
- Conclusions and future works

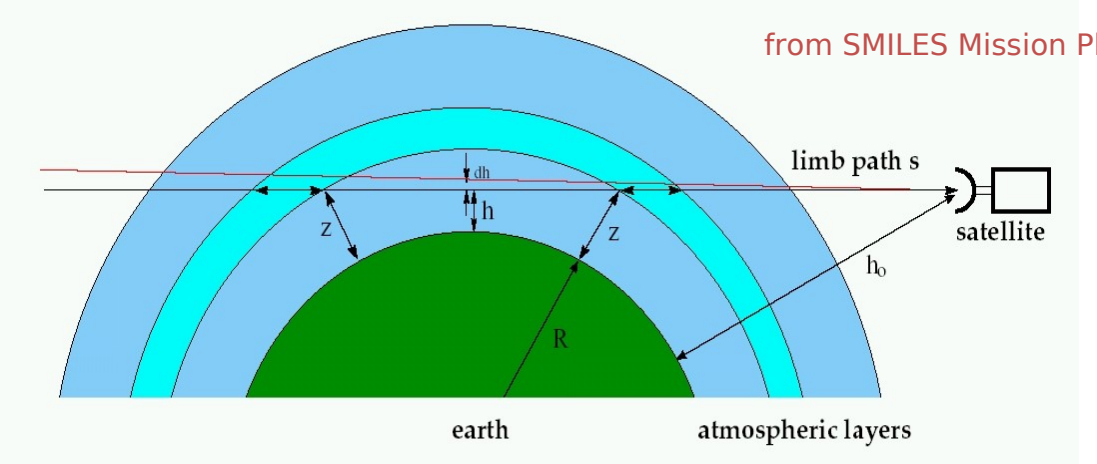
Superconducting submillimeter-Wave Limb Emission Sounder (SMILES) overview

- Limb-sounder to study the middle atmosphere chemistry and dynamics (~10-~80 km)
- High sensitive sub-millimeter receiver (first use for atmospheric observation of a 4K cooled SIS mixer in space)
- Operate from the Japanese Experiment Module (JEM) on the International Space Station (ISS).

- To be launched in Sept. 2009

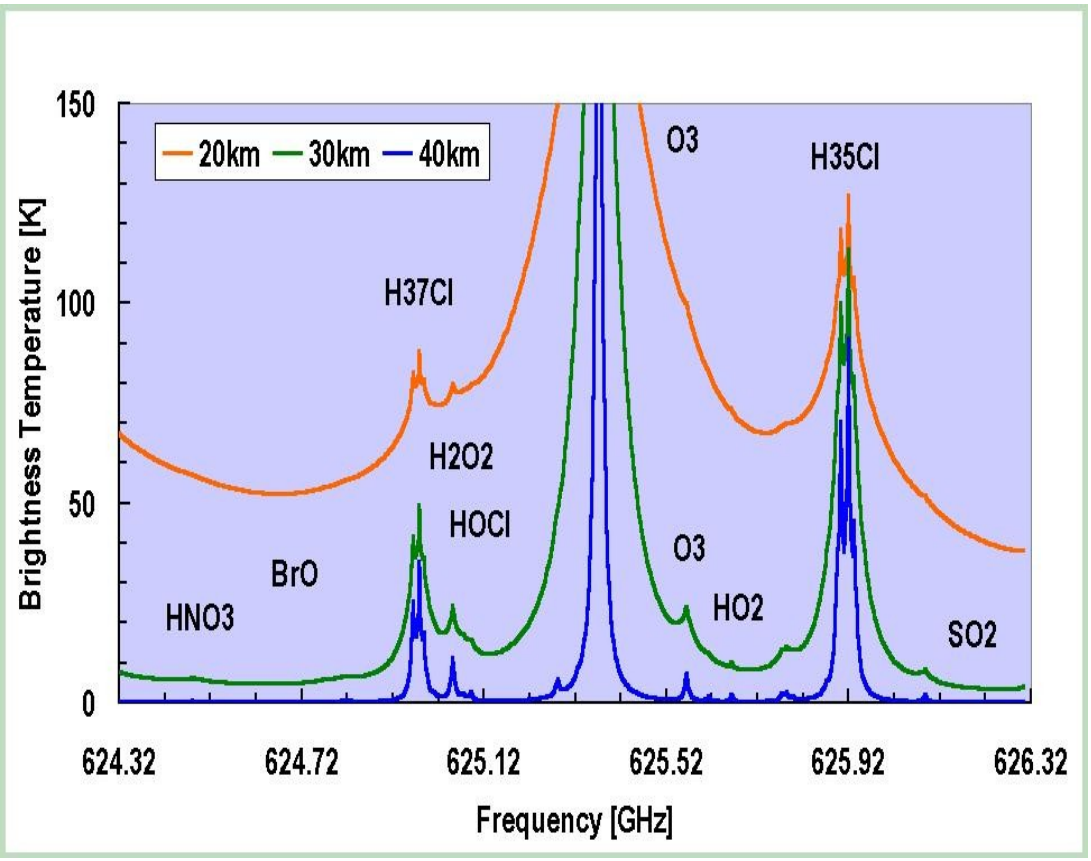
Observation characteristics

Limb scanning observation

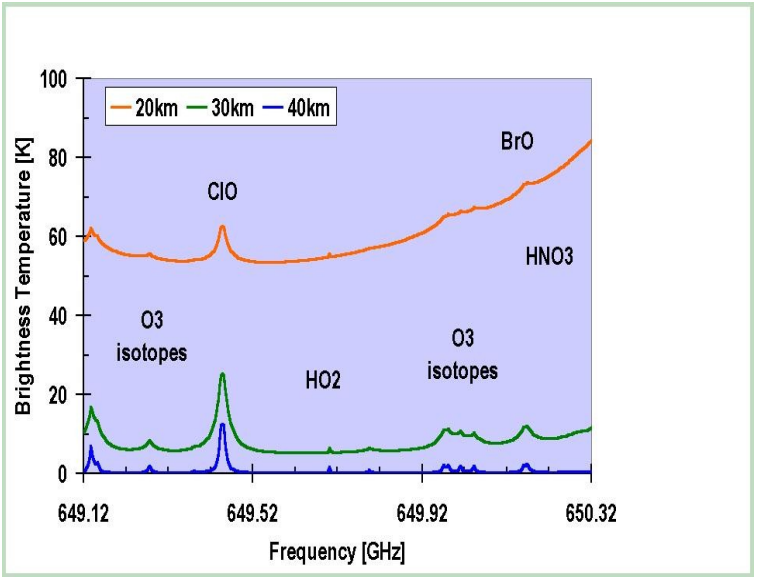


- Atmosphere is repeatedly scanned from the below surface to ~100 km height (1600 scans/day).
- 3 spectral bands (λ=0.1 mm) have been defined but **only 2** are simultaneously observed during one scan.
- Vertical distribution of molecular abundances and temperature/pressure (Level 2 data) are derived from each scan.

Frequency bands



from SMILES Mission Plan

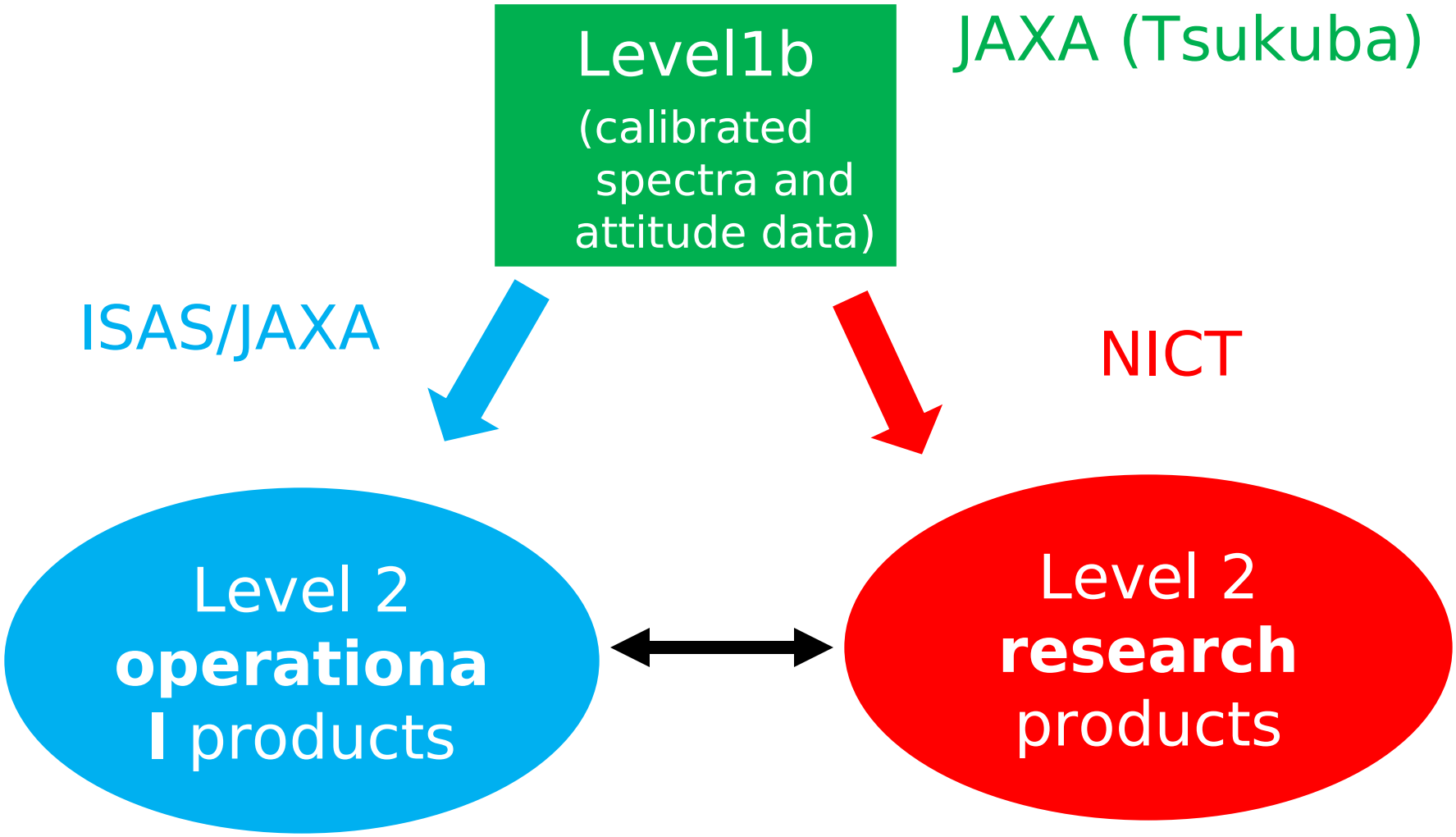


band A

band B

band C

SMILES geophysical (Level 2) data



Why a L2 research product ?

- Support the operational chain:
  - cross-comparison of the products (retrieval algorithms validation)
  - investigate improvement for retrieval algorithms
  - correct instrument problems observed after launch
- Produce data that are not in the operational data
  - UT/LS H2O, ice water content …
  - mesospheric data
  - molecules with extremely low SNR
- Research on atmospheric remote sensing

The Level 2 research products

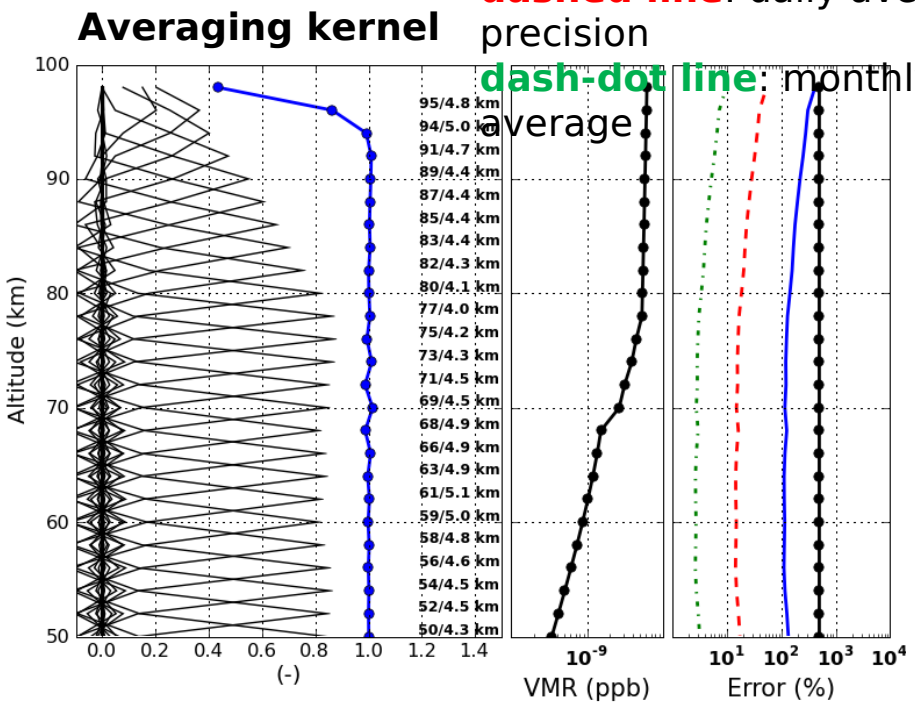
Processing modes	Band A	Band B	Band C
Stratospheric high SNR 10-60 km	O_3, $H^{37}Cl$, H_2O, Temp, Pointing offset, wind	O_3, $H^{35}Cl$, H_2O, Temp, Pointing offset, wind	H_2O, ClO, O_3
Stratospheric medium/low SNR 10-60 km	HOCl, CH_3CN, ^{18}OOO, HNO_3, BrO, H_2O_2, SO_2	N_2O, ^{18}OOO, HO_2, HNO_3, SO_2, $O^{17}OO$	^{18}OOO, ^{17}OOO, HO_2, HNO_3, BrO, $O^{17}OO$
Mesospheric medium/low SNR	O_3, $H^{37}Cl$, wind, ^{18}OOO, H_2O_2	O_3, $H^{35}Cl$, wind, ^{18}OOO, HO_2, SO_2	HO_2, ^{18}OOO, ^{17}OOO, ClO
UT/LS	H_2O, Ice water content, O_3		
Extremely Low SNR	H_2CO, HOBr, $ClONO_2$, OClO, ClOOCl, H_2SO_4	CH_3Cl, H_2CO, HOBr, $ClONO_2$, OClO, ClOOCl	COF_2, $ClONO_2$, NO_2, OClO, ClOOCl

blue: single scan, red: daily average, green: monthly average,
black: very challenging

Example of mesospheric products:

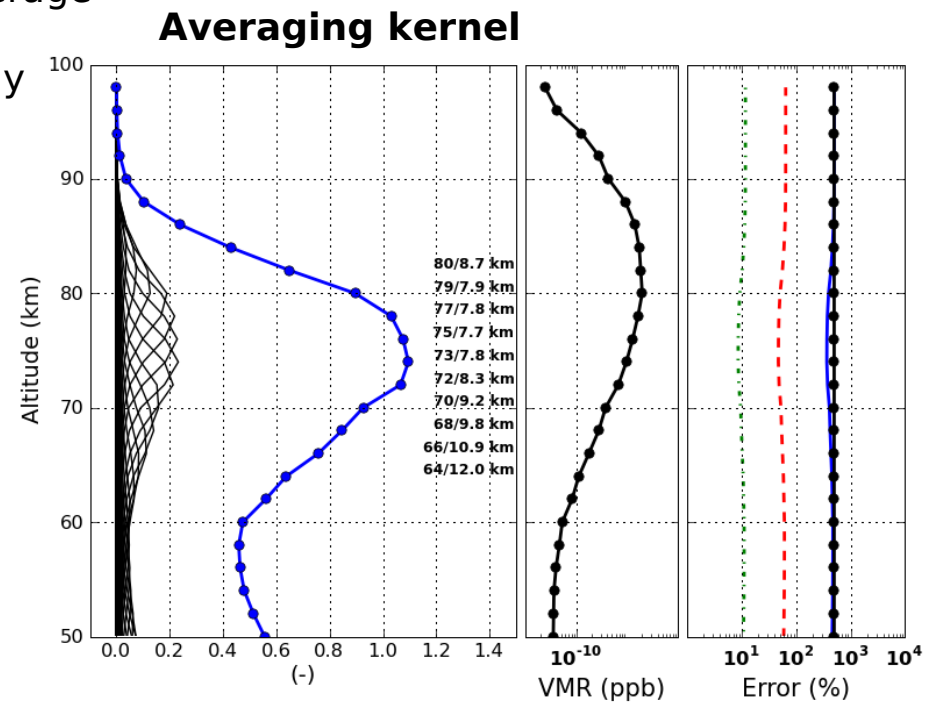
HO2 (band B)

black-dots: a priori error
full line: single scan precision
dashed line: daily average precision
dash-dot line: monthly average



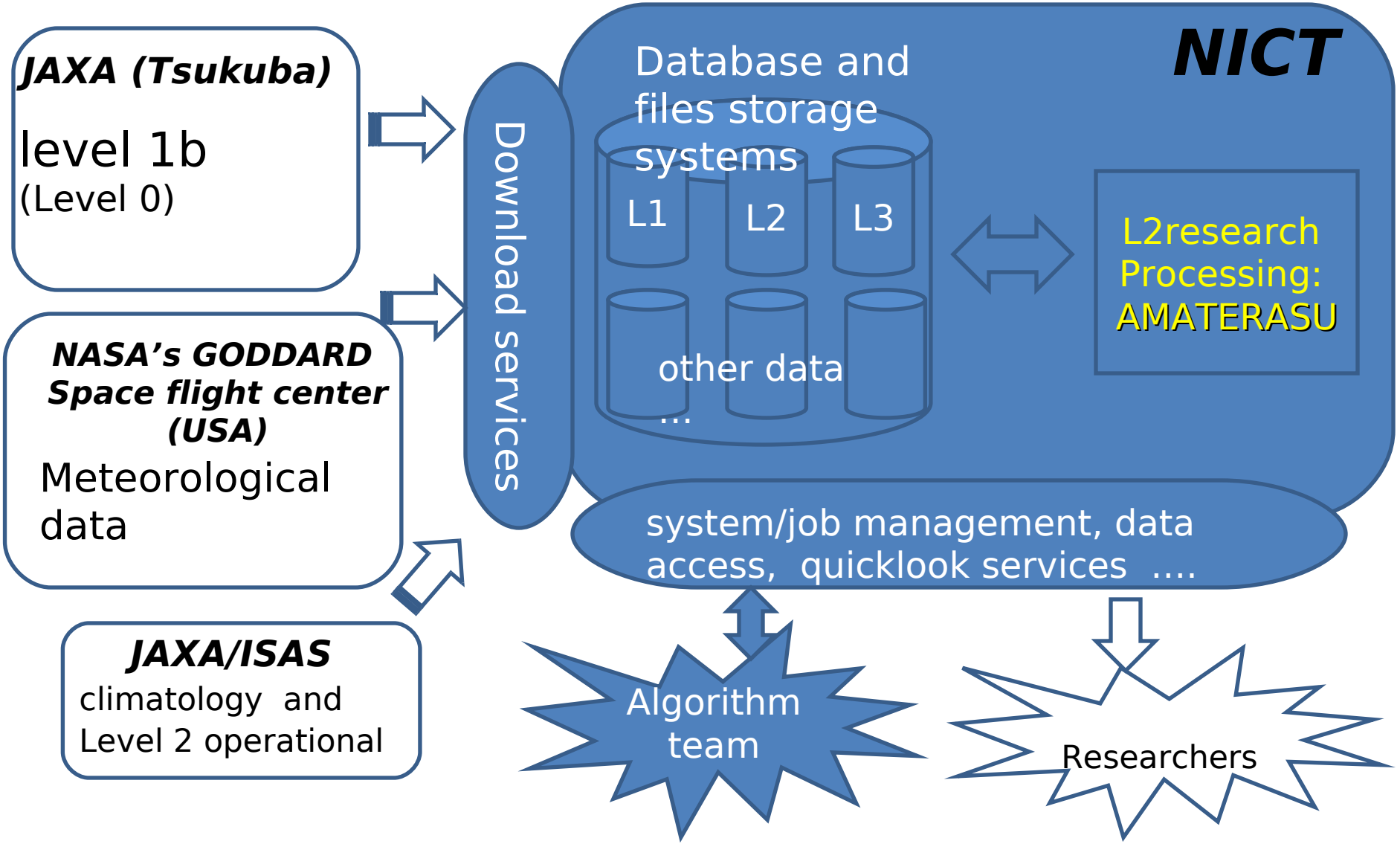
Altitude coverage: 50 - 96 km
Vertical resolution: 4.5 km
Single scan precision: 100 %
Daily average: 10-20%

H2O2 (band C)



Altitude coverage: 64 - 80 km
Vertical resolution: 8 - 12 km
Single scan precision: 500 %
Monthly average: 10%

The L2 research processing chain

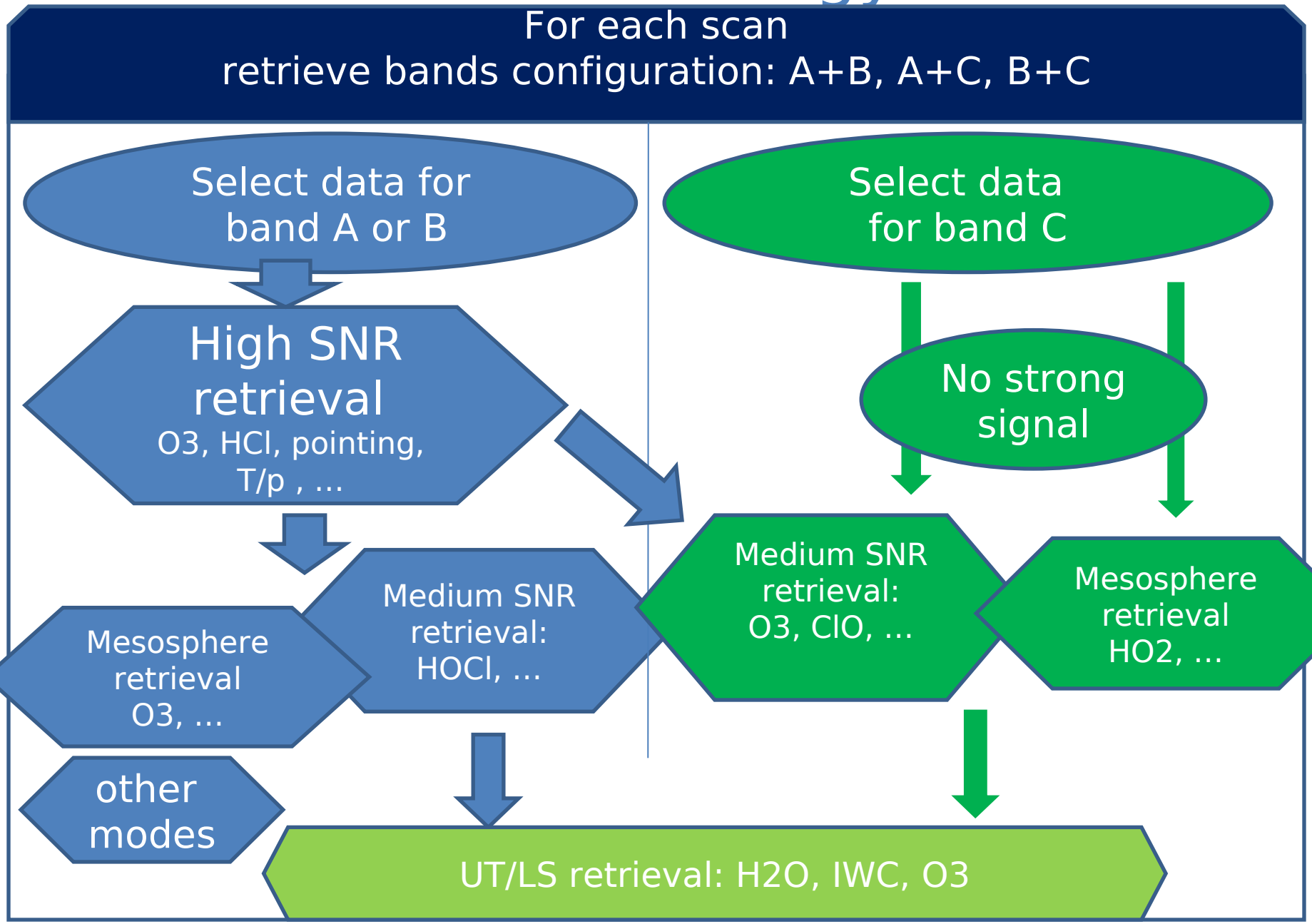


AMATERASU:

Advanced Model for Atmospheric TeraHertz Radiation Analysis and Simulation

- Model that is being developed in NICT for simulating SMILES radiances and retrieve atmospheric parameters (level 2)
- General model (not only used for SMILES):
  - Applicable from micro-wave to IR spectral domains
  - Applicable for different observation geometries and atmospheres
  - Able to take into account clouds on the line of sight
  - Horizontal inhomogeneities along the line of sight

Retrieval strategy:



Some details about the chain

- 4 computers:
  - 1 management computer
  - 1 file server with high storage capability (Raid 5 system)
  - 2 processing computers with high CPU capabilities
  -
- Un-interruptible power supply (battery pack)

- Software:
  - Ubuntu Linux
  - Torques/MAUI for batch processing
  - MySQL database
  - Python + additional libraries (calculation/visualization/database connection)
  - AMATERASU code for L2 retrieval calculations

Conclusions

- A **L2 research** chain for JEM/SMILES is under development at NICT:
  - Same molecules as the operational chain will be produced, plus extra-products (UT/LS, mesosphere, extremely low SNR)
  - A first version of the retrieval strategy has been defined and a data processing chain is being installed in NICT
- A full error analysis will be carried out to estimate the accuracy and the precision of the research products before launch.
- Improvements of the retrieval strategy are already being investigated: joint AOS bands and pointing jitter retrievals, …

Collaborations

- SMILES L2 team (JAXA/ISAS)
- SMILES instrument team (JAXA, NICT + Osaka prefecture university + Toho university)
- Chalmers University of Technology
- Luleå Technical University (Sweden)
- Jet Propulsion Laboratory (US)

- *System Engineering Consultants (SEC), Tokyo*

To use the SMILES data, please write a research announcement proposal (soon at http://smiles.tksc.jaxa.jp)