



P-24

東北大における惑星大気研究: 将来地上・探査機観測に向けて

Y. Kasaba, H. Okano, I. Murata, T. Sakanoi ,
H. Fujiwara, N. Terada, M. Kagitani,
H. Nakagawa, Kaori Terada, Chihiro Tao
(Tohoku Univ.)



[Major Topics and Core Members] Two regular meetings

(A) Numerical modeling for Atmospheric studies

Coupling processes in atmospheres, Escape of Atmospheres, Future systems

Staff H. Fujiwara, N. Terada, Y. Kato, Y. Kasaba

PD C. Tao (2008FY:D3), K. Terada

DC N. Hoshino (2009FY:D1)

[with Master students]

Simulation team meeting

(B) Observations of Atmospheric Structures and Dynamics

Cloud structures of Jupiter (and Venus), Dynamics of Upper Atmosphere of Jupiter

Staff Y. Kasaba, T. Sakanoi

DC T. Kobuna (D1), T. Sato (D1)

[with Master students]

(C) Observations of Atmospheric Minor Components

Atmospheric minor components of Earth and Mars

Staff Y. Kasaba, I. Murata, T. Sakanoi, S. Okano

PD H. Nakagawa (GCOE)

DC

[with Master students]

Opt-IR team meeting

(D) Future instrumentations for Atmospheric (& Plasma) studies

Ground-based & Flight instruments, Data archives

Staff Y. Kasaba, I. Murata, S. Okano, T. Sakanoi,

Y. Kato, A. Kumamoto, H. Misawa, T. Ono, F. Tsuchiya

PD M. Kagitani, H. Nakagawa (GCOE)

DC many

[with Master students]

Long-range investment
for future



A. Numerical modeling for Atmospheric studies

A.1 Coupling processes in Planetary atmospheres

Staffs Hitoshi Fujiwara, Yasumasa Kasaba

PD Chihiro Tao (D3 [JSPS] in 2008FY, PD [JST] in 2009FY)

DC Naoya Hoshino (D1 [IARE] in 2009FY)

with Univ. Colorado (USA), CNDS (France)

A.2 Escape and Long-term Evolution of Atmospheres

Staffs N. Terada, Y. Kasaba, F. Tsuchiya

PD K. Terada (D3 [JSPS] in 2008FY, PD [JST] in 2009FY)

M. Kagitani (PD in 2008-2009FY)

DC N. Kitamura (D1 [SDC] in 2009FY)

with SRI (Austria), PGI (Russia), UMCS (Poland)

**** This field has long heritage & is much competitive. ****

Simulation team meeting



B. Observations of Atmospheric Structures and Dynamics

B.1 Cloud Structure of Jupiter (& Venus)

Staffs Yasumasa Kasaba (, Takehiko Satoh [JAXA])

DC Takao Sato (D1 [JSPS] in 2009FY)

MC Tomoko Teraguchi (M1 in 2009FY)

with NASA/JPL (USA), MPI (Germany)

B.2 Dynamics of Upper Atmosphere of Jupiter

Staffs T. Sakanoi, Y. Kasaba

DC T. Kobuna (D1 [RA] in 2009FY)

MC T. Uno (M2 in 2009FY)

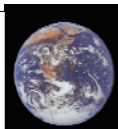
**** We try to enter new fields, with
own ground-based observations,
international collaborations for orbiter data sets, and
links to our simulation / instrumentation works, ****

Opt-IR team meeting

C. Observations of Atmospheric Minor Components

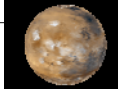
C.1 Minor Components in Terrestrial atmosphere

Staffs Isao Murata (Dep. Env. Studies)
MC H. Goto (M2 in 2009FY)
with NDACC IRWG (USA)



C.2 Minor Components in Martian atmosphere

Staffs Y. Kasaba, I. Murata
PD H. Nakagawa (PD in 2008FY, PD/ Assist.Prof. [GCOE] in 2009FY)
MC A. Hashimoto (M2 in 2008FY), A. Aoki (M1 in 2009FY)
with INAF (Italy)



**** Based on the long heritage of terrestrial minor component studies, we try to enter new fields, with
own ground-based observations,
international collaborations for orbiter data sets, and
links to our simulation / instrumentation works. ****

Opt-IR team meeting

D. Future instrumentations for Atmospheric & Plasma studies

D.1 Ground-based Facilities and Instruments

Staffs S. Okano, T. Sakanoi, H. Misawa, A. Kumamoto, F. Tsuchiya, Y. Kasaba, I. Murata, N. Terada, T. Ono
PD M. Kagitani, H. Nakagawa
DC many
with Univ. Hawaii, UCLA, Univ. Colorado (USA) ...

* Expansion plan of our unique PPARC Optical/IR facilities

S. Okano, Y. Kasaba, M. Kagitani et al. with Univ. Hawaii, ...

* New high-spectral resolution IR spectrometers

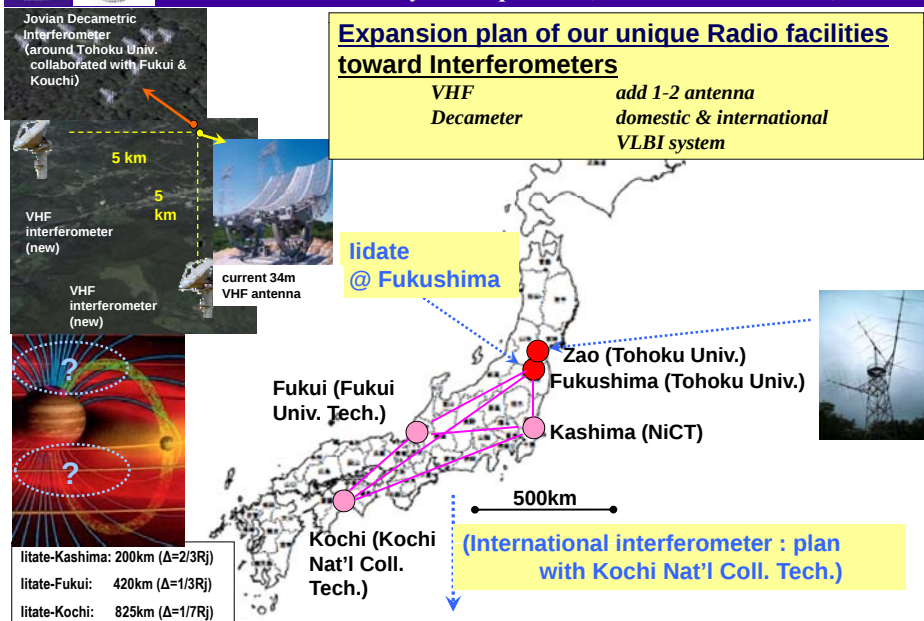
[NIR] T. Sakanoi, Y. Kasaba, T. Kobuna, et al. with Dep. Astronomy
[MIR] Y. Kasaba, I. Murata, S. Okano, H. Nakagawa, et al.
with Univ. Cologne, NASA/GSFC, Oxford Univ.

* Interoperable planetary database including our facilities' data

M. Kagitani, H. Misawa, T. Sakanoi, A. Kumamoto, F. Tsuchiya
T. Ono, S. Okano, Y. Kasaba with JAXA, Nagoya Univ, UCLA, et al.

* Development of simulation infrastructure

H. Fujiwara, N. Terada, Y. Kato, C. Tao, K. Kaneda, ...



Expansion plan of our unique Optical/IR facilities

The new telescope project with Univ. Hawaii et al.

[Discussion was born from 2007, by the proposal of our lidade 60cm telescope moving to Haleakala. The MOU between Tohoku Univ. & Univ. Hawaii was established in Nov. 2009. Development of the main mirror will start soon. Core meeting will be in Feb. 2010.]

<http://www.ifa.hawaii.edu/haleakalanew/planets/>
<http://kopiko.ifa.hawaii.edu/planets/>

40cm Schmidt-Cassegrain (Haleakala, Maui)



60cm Vis/IR telescope (lidade, for instrument tests)

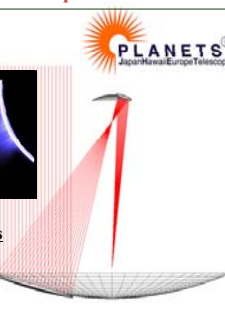
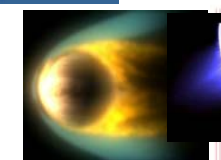


Disk around a young star in polarized light (~300AU). A ring at 150AU might be a proto-planet clearing.

Weak light close to Planets scattered by the escaping atmosphere from Mars / Venus / Io / Enchelas

~2mφ(tbc) at Haleakala

- Wide dynamic range
- Off-axis with 1/100λ smoothness
- Coronagraph: Gregorian-type
- Polarization: Equatorial mount



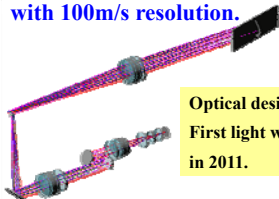
*** New high-spectral resolution IR spectrometers**

[NIR] T. Sakanoi, Y. Kasaba, T. Kobuna, T. Uno, et al. with Dep. Astronomy

Echelle Spectrometer in NIR

[Prof. Ichikawa, including Antarctic Telescope project.]

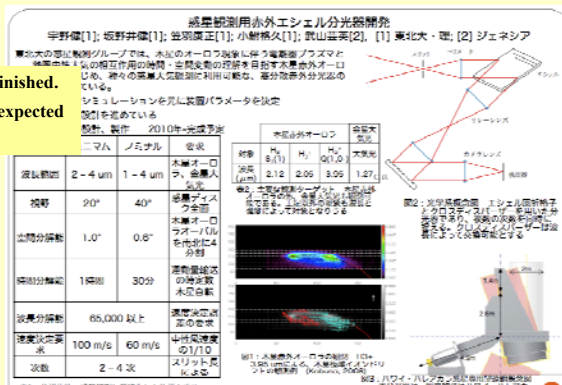
Main issue will be Jovian atmospheric coupling observed by H_2 & H_3^+ simultaneously, with 100m/s resolution.



Optical design is finished.
First light will be expected in 2011.



One of the target facility
Hokkaido Univ. Nayoro



T. Uno: MS thesis (2010)

*** New high-spectral resolution IR spectrometers**

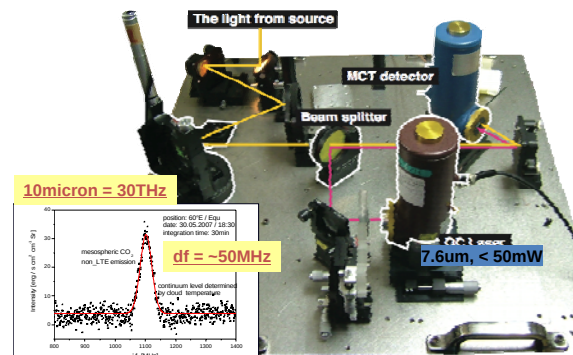
[MIR] Y. Kasaba, I. Murata, S. Okano, H. Nakagawa, et al. with Univ. Cologne, NASA/GSFC, Oxford Univ.

Laser Heterodyne Spectrometer in MIR

Restart the development with Quantum Cascade Laser from the end of 2007.

- Heterodyne signal by a test bench system was established in the fall of 2008.
- The first generation spectrometer is now in development.

[Efficiency problem is solving.]



Highest spectral resolution in Medium IR range with simple system

- $\lambda/\Delta\lambda > 10^6$
- several 10s-100s m/s
- ~ similar scale to planetary atmospheric motions ~

- Bandwidth: 200MHz in ours
[New detector with >1GHz will come in April 2010.]

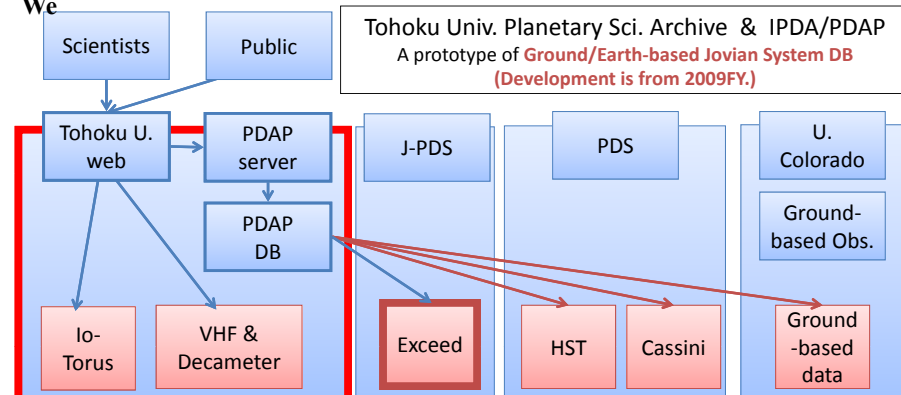
A. Hashimoto: MS thesis (2009)

*** Interoperable planetary database including our facilities' data**

M. Kagitani, H. Misawa, T. Sakanoi, A. Kumamoto, F. Tsuchiya
T. Ono, S. Okano, Y. Kasaba [Chair of IPDA] with JAXA, Nagoya Univ, UCLA, et al.

IPDA (International Planetary Data Alliance) tries to establish the interoperable database access with a protocol 'Planetary Data Access Protocol' (PDAP).

We



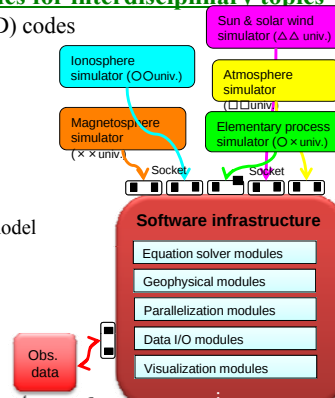
*** Development of simulation infrastructure**

H. Fujiwara, N. Terada, Y. Kato, C. Tao, K. Kaneda, ...

To Improve the development environment for students
To enhance the experiences of collaborative works during MC/DC
<< Simulation sciences will be more systematic. >>

An infrastructure based on our state-of-the-art codes for interdisciplinary topics

- Magnetohydrodynamic (MHD) and hydrodynamic (HD) codes
 - Earth and planetary thermosphere model
 - Planetary exosphere model
 - Planetary ionosphere model
 - Planetary magnetosphere model
 - Protoplanetary disk model
 - Molecular cloud model
- Some coupled codes:
 - Earth extended atmosphere-thermosphere-ionosphere model
 - Jupiter thermosphere-ionosphere-magnetosphere model
 - Mars exosphere-ionosphere-magnetosphere model
- Particle (PIC) codes:
 - Electron hybrid code
 - Ion/electron hybrid code



[Collaborators: Kyushu univ., NICT, NAOJ, Nagoya univ., etc.]

D. Future instrumentations for Atmospheric & Plasma studies

D.2 Flight Projects and Instruments

Staffs Y. Kasaba, I. Murata, S. Okano, T. Sakanoi, H. Misawa, A. Kumamoto, F. Tsuchiya, N. Terada, T. Ono
PD M. Kagitani, H. Nakagawa
DC many
with Obs. Paris, ... (France), IRF-Uppsala, ... (Sweden), IKI (Russia), JAXA, ESA, NASA, ...

*** Balloon-born optical sensor:** for profiles of ozone and some trace species
 I. Murata, S. Okano with JAXA, Tokyo Univ, NIPR, and AWI

*** Electric Field & Radio instruments:** for Magnetospheric & Radio
 Y. Kasaba, A. Kumamoto, T. Ono, Y. Kato, H. Misawa, F. Tsuchiya
 with Kyoto Univ., ..., Obs. Paris, ... (France), IRF, ... (Sweden) ...

*** Optical/Infrared instruments:** for Air glows & Planetary missions
 T. Sakanoi, Y. Kasaba, H. Nakagawa ...
 with JAXA, IKI (Russia), CNRS (France), BIRA/IASB (Belgium)

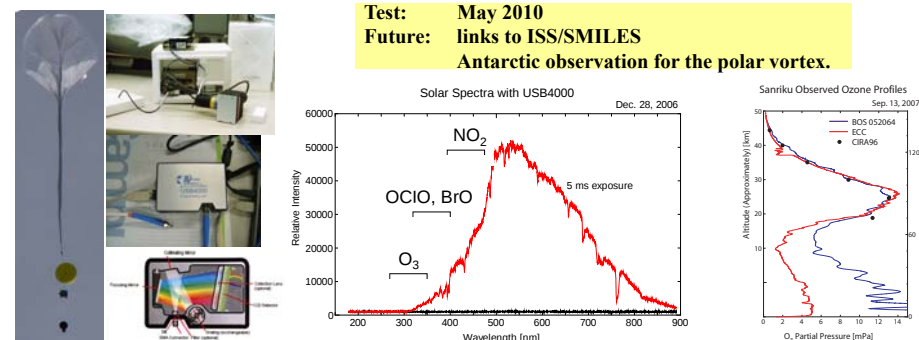
*** Support to Japanese Future missions as one of core institutions**

*** Balloon-born optical sensor:** for profiles of ozone and some trace species
 I. Murata, S. Okano with JAXA, Tokyo Univ, NIPR, and AWI

A balloon-borne optical ozone sensor (BOS) for the vertical distribution of upper stratospheric ozone up to 50 km by high-altitude balloon at Sanriku since 1994. **Unique** for upper stratospheric ozone & gravity waves

Old: Optical filter for UV absorption in ozone band (~300nm)

New: **Small spectrometer for O₃ with NO₂, OCIO, and BrO simultaneously with similar weight, without moving parts**



*** Optical: Airglow measurement on ISS**

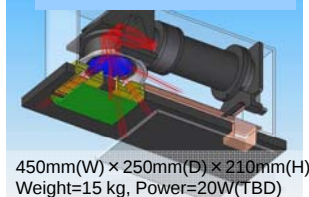
VISI: airglow emissions

730nm (OH, Alt. 85km), 762nm (O₂, Alt. 95km),
 630nm(O, Alt. 250km)
 ±45 deg. forward and backward FOV

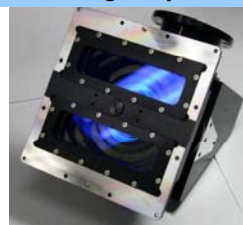
Observation is scheduled to start in 2011FY.

Based on the heritages of Reimei MAC

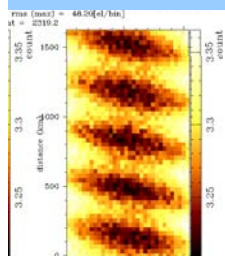
Structure model



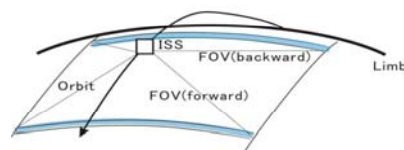
Proto-Flight optics



Scientific Simulation



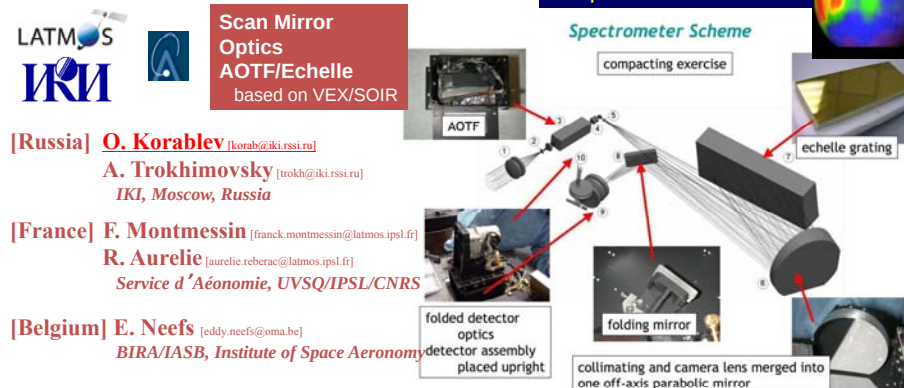
VISI field-of-view
 ISS orbit 400km alt.



VISI instrument on the international space station.

*** Infrared: Echelle Spectrometer for Mars**

First high-resolution IR spectrometer for Mars



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 IKI, Moscow, Russia

[France] **F. Montmessin** [franc.montmessin@latmos.ipsl.fr]

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BIRA/IASB, Institute of Space Aeronomy

[Japan] **Y. Kasaba** [kasaba@pat.gp.tohoku.ac.jp], **H. Nakagawa** [rom@pat.gp.tohoku.ac.jp]

Department of Geophysics, Tohoku University, Japan

S. Okano [okano@pparc.gp.tohoku.ac.jp], **T. Sakanoi** [tsakanoi@pparc.gp.tohoku.ac.jp]

Planetary Plasma and Atmospheric Research Center (PPARC), Tohoku Univ

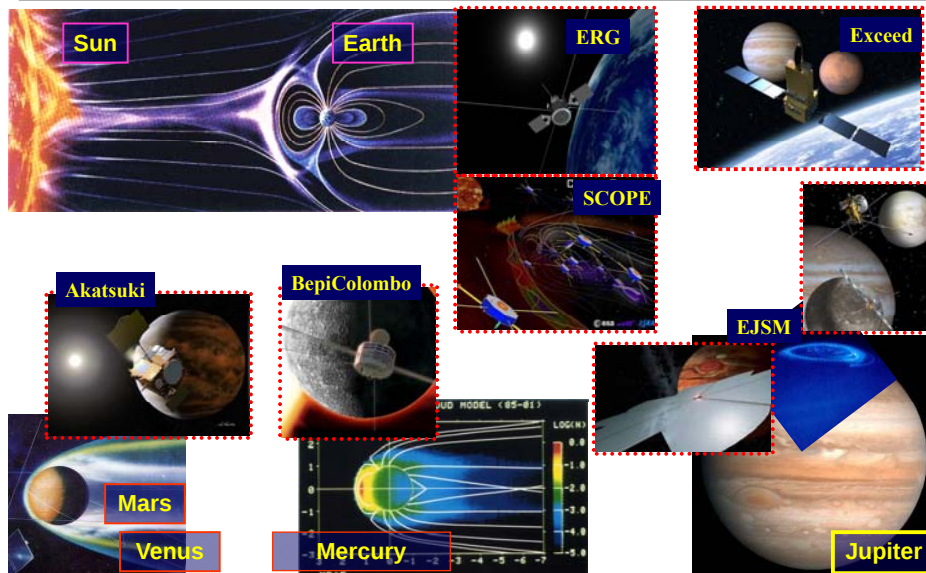
M. Ueno [ueno@stp.isas.jaxa.jp], **T. Sato** [satoh@stp.isas.jaxa.jp]

Institute of Space and Astronautical Science (ISAS), JAXA

Detector
 Cooler
 DPU
 based on P-C/IR2



* Create & Support Japanese Future missions as one of core institutions



[SUMMARY]

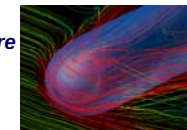
The simulations & instrumentations are the most cores for us.
We have set that Students & Young Scientists can be skilled either (A) and/or (B).
Using these skills, we create the path to the atmospheric sciences.

(A) Numerical modeling for Atmospheric studies

Coupling processes in atmospheres, Escape of Atmospheres, Future

A.1 Coupling processes in Planetary atmospheres

A.2 Escape and Long-term Evolution of Atmospheres

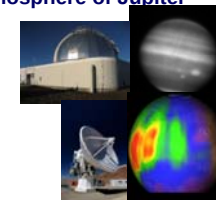


(B) Observations of Atmospheric Structures and Dynamics

Cloud structures of Jupiter (and Venus), Dynamics of Upper Atmosphere of Jupiter

B.1 Cloud Structure of Jupiter (& Venus)

B.2 Dynamics of Upper Atmosphere of Jupiter



(C) Observations of Atmospheric Minor Components

Atmospheric minor components of Earth and Mars

C.1 Minor Components in Terrestrial atmosphere

C.2 Minor Components in Martian atmosphere



(D) Future instrumentations for Atmospheric (& Plasma) studies

Ground-based & Flight instruments, Data archives

D.1 Ground-based Facility and Instruments

D.2 Flight Projects and Instruments