Commission G Report

March 30, 2017

1. Meeting announcement/report

(Meetings in future)

- The 18th EISCAT symposium which will be held from 26th to 30th May 2017 at National Institute of Polar Research (NIPR), Tokyo, Japan, in connection with the 15th MST (Mesosphere/Stratosphere/Troposphere) radar workshop. Two meetings will share the venue and part of sessions are conducted together. About 250 abstracts were collected, and in the programming process.

  http://eiscat.nipr.ac.jp/about/18th_eiscat_symposium.html
  http://www2.rish.kyoto-u.ac.jp/mst15/index.html

- Joint IAPSO-IAMAS-IAGA Assembly will be held in Cape Town, South Africa. The Joint Assembly, endorsed by the University of Cape Town and the South African Department of Science and Technology, will take place from 27 August to 1 September 2017 at the Cape Town International Convention Centre (CTICC).

  http://iapso-iamas-iaga2017.com/index.php

- MU radar /Equatorial Atmosphere Radar Symposium will be held at RISH, Kyoto University in September 2016. This is the annual meeting for the cooperative use of the facilities. Commission G of Japanese URSI co-sponsors this symposium.

2. Topics

2.1. Masterplan 2017

Research Institute for Sustainable Humanosphere (RISH), Kyoto University, National Institute of Polar Research (NIPR), Institute for Space-Earth Environmental Research (ISEE), Nagoya University, and International Center for Space Weather Science and Education (ICSWSE), Kyushu University proposed the research project “Coupling process in the solar-terrestrial system” (PI: Prof. Toshitaka Tsuda at RISH, Tsuda et al. [2016]) to Masterplan 2017 of Science Council of Japan (SCJ). This is a project to study the solar energy inputs into the Earth, and the response of Geospace (magnetosphere, ionosphere and atmosphere) to the energy input. We plan to install large atmospheric radars with active phased array antenna at the equator and the Arctic regions. One is Equatorial MU (EMU) radar by RISH in Sumatera Island, Indonesia, and the other is EISCAT_3D by NIPR in northern Scandinavia under international collaborations. We develop the global observation network is planned (ISEE, ICSWSE with other institutions). SCJ announced the Masterplan 2017 on February 8, 2017 (see web page). Our proposal was selected as one of the important large research projects (in total 28 projects were selected), which is the same status as in Masterplan 2014. Selection of the Roadmap 2017 of the Ministry of Education, Culture, Sports, Science and Technology will soon start following this result of Masterplan 2017.

Tsuda, T., M. Yamamoto, H. Hashiguchi, K. Shiokawa, Y. Ogawa, S. Nozawa, H. Miyaoka, and A. Yoshikawa (2016), A proposal on the study of solar-terrestrial coupling processes with atmospheric radars and ground-based observation network, Radio Sci., 51, 1587-1599, doi:10.1002/2016RS006035.

Announcement SCJ Masterplan 2017 by SCJ http://www.scj.go.jp/ja/info/kohyo/kohyo-23-t241-1.html

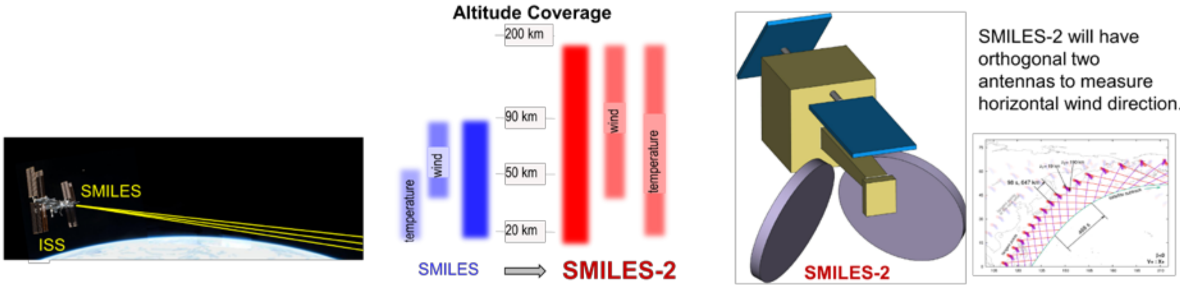
2.2. THz/sub-millimeter-wave radiometer in space for the measurement of the middle/upper atmosphere

(From International Symposium on the Whole Atmosphere (ISWA), Univ. of Tokyo, 14-16 Sep. 2016) A plan of submillimeter limb sounder for measurement of the middle atmosphere

Satoshi OCHIAI[1], Philippe BARON[1], Yoshihisa IRIMAJIRI[1], Yoshinori UZAWA[1], Toshiyuki NISHIBORI[2], Takeshi MANABE[3], Akira MIZUNO[4], Makoto SUZUKI[2], and Masato SHIOTANI[5]

1: National Institute of Information and Communications Technology, 2: Japan Aerospace Exploration Agency, 3: Osaka Prefecture University, 4: Nagoya University, 5: Kyoto University

Effectiveness of highly sensitive submillimeter-wave limb sounder in vertical-distribution measurements of atmospheric chemical compositions, temperature, and wind over a wide altitude range has been demonstrated by the Superconducting Submillimeter-wave Limb-Emission Sounder (SMILES), which was operated in 2009-2010 winter on the International Space Station [Kikuchi et al., 2010]. Our proposed new submillimeter-wave limb sounder boarded on a small satellite will inherit excellent highly-sensitive superconducting sensor technology of SMILES and will provide precise measurement of vertical distribution of compositions, temperature, and wind, but extremely extend the altitude coverage and variety of observing targets by implementing multi-frequency band receiver including THz channel. The proposed sounder will be outstanding at measurement precision and altitude coverage in comparison with other currently planned satellite missions.



K. Kikuchi, T. Nishibori, S. Ochiai, H. Ozeki, Y. Irimajiri, Y. Kasai, M. Koike, T. Manabe, K. Mizukoshi, Y. Murayama, T. Nagahama, T. Sano, R. Sato, M. Seta, C. Takahashi, M. Takayanagi, H. Masuko, J. Inatani, M. Suzuki, and M. Shiotani, Overview and early results of the Superconducting Submillimeter - Wave Limb - Emission Sounder (SMILES), J. Geophys. Res. 115, D23306, doi:10.1029/2010JD014379, 2010.

3. Research Report

3.1. Report from National Institute for Polar Research (NIPR)

(Yasunobu Ogawa, NIPR)

=== Recent research activity related to PANSY ===

A 1-year continuous full system observation of the PANSY radar has been successfully conducted from late September 2015 through September 2016. This is the first MST radar data in the world covering a whole year continuously. It will enable us to capture various temporal- and spatial-scale phenomena in the Antarctic troposphere, stratosphere and mesosphere with high temporal and vertical resolution throughout the year and to contribute to improving global climate models for better understanding of future climate change.

In addition, the second Interhemispheric Coupling Study by Observations and Modeling (ICSOM: see details at http://pansy.eps.s.u-tokyo.ac.jp/icsom/) campaign was successfully conducted from January 22 to February 28, 2017. International collaborative studies based on the first and second ICSOM campaigns are ongoing. It is expected that these international collaborations including the PANSY radar will promote a more accurate understanding of the Antarctic atmosphere and interhemispheric coupling processes.

=== Recent papers related to PANSY ===

Sato, K., M. Kohma, M. Tsutsumi, and T. Sato, Frequency spectra and vertical profiles of wind fluctuations in the summer Antarctic mesosphere revealed by MST radar observations, J. Geophys. Res., 122, 3-19, doi:10.1002/2016JD025834, 2017.

=== Recent papers related to EISCAT ===

Takahashi, T., K. Hosokawa, S. Nozawa, T. T. Tsuda, Y. Hiraki, J. Sakai, Y. Ogawa, M. Tsutsumi, H. Fujiwara, T. D. Kawahara, N. Saito, S. Wada, T. Kawabata, and C. Hall, Depletion of mesospheric sodium during extended period of pulsating aurora, J. Geophys. Res., DOI: 10.1002/2016JA023472, January 2017.

Taguchi, S., Y. Chiba, K. Hosokawa, and Y. Ogawa, Horizontal profile of a moving red line cusp aurora, J. Geophys. Res., DOI: 10.1002/2016JA023115, 2017.

Bjoland, L.M., Y. Ogawa, C. Hall, M. Rietveld, U.P. Lovhaug, C. La Hoz, and H. Miyaoka, Long-term variations and trends in the polar E-region, Journal of Atmospheric and Solar-Terrestrial Physics, 2017.

Y. Yamazaki, M.J. Kosch, Y. Ogawa, abnd D. R. Themens, High-latitude Ion Temperature Climatology during the International Polar Year 2007-2008, J. Space Weather Space Clim., 6, A35, doi: 10.1051/swsc/2016029, October 2016.

3.2. Report from Institute for Space-Earth Environmental Research (ISEE), Nagoya University
(Satonori Nozawa, Nagoya University)

=== Research topics ===

A new scenario is presented for the cause of magnetospheric relativistic electron decreases (REDs) and potential effects in the atmosphere and on climate. High-density solar wind heliospheric plasmasheet (HPS) events impinge onto the magnetosphere, compressing it along with remnant noon-sector outer-zone magnetospheric ~10-100 keV protons. The betatron accelerated protons generate coherent electromagnetic ion cyclotron (EMIC) waves, which interact with relativistic electrons and cause the rapid loss of these particles to a small region of the atmosphere. A peak total energy deposition of ~3 × 10^20 ergs is derived for the precipitating electrons with a maximum energy deposition and creation of electron-ion pairs at 30-50 km and at<30 km altitude. We focus the readers' attention on the relevance of this present work to climate change mechanisms.

== Recent papers ===

Tsurutani, B. T., R. Hajra, T. Tanimori, A. Takada, B. Remya, A. J. Mannucci, G. S. Lakhina, J. U. Kozyra, K. Shiokawa, L. C. Lee, E. Echer, R. V. Reddy, and W. D. Gonzalez, Heliospheric Plasma Sheet (HPS) Impingement onto the Magnetosphere as a Cause of Relativistic Electron Dropouts (REDs) via Coherent EMIC Wave Scattering with Possible Consequences for Climate Change Mechanisms, J. Geophys. Res., 121, doi: 10.1002/2016JA022499, 2016.

3.3. Report from National Institute for Information and Communications Technology (NICT)
(Minoru Kubota, NICT)

=== Recent papers===

Jiang, C., G. Yang, J. Liu, T. Yokoyama, T. Komolmis, H. Song, T. Lan, C. Zhou, Y. Zhang, Z. Zhao, Ionosonde observations of daytime spread F at low latitudes, J. Geophys. Res. Space Physics, 121, 12,093-12,103, doi:10.1002/2016JA023123, 2016.

Kalita, B. R, R. Hazarika, G. Kakoti, P. K. Bhuyan, D. Chakrabarty, G. K. Seemala, K. Wang, S. Sharma, T. Yokoyama, P. Supnithi, T. Komolmis, C. Y. Yatini, M. L. Huy, and P. Roy, Conjugate hemisphere ionospheric response to the St. Patrick's Day storms of 2013 and 2015 in the 100E longitude sector, J. Geophys. Res. Space Physics, 121, 11,364-11,390, doi:10.1002/2016JA023119, 2016.

Tsunoda, R. T., T. Maruyama, T. Tsugawa, T. Yokoyama, M. Ishii, T. T. Nguyen, T. Ogawa, and M. Nishioka, Off-great-circle paths in transequatorial propagation: 1. Discrete and diffuse types, J. Geophys. Res. Space Physics, 121, 11,157-11,175, doi:10.1002/2015JA021695, 2016.

Tsunoda, R. T., T. Maruyama, T. Tsugawa, T. Yokoyama, M. Ishii, T. T. Nguyen, T. Ogawa, and M. Nishioka, Off-great-circle paths in transequatorial propagation: 2. Non-magnetic-field-aligned reflections, J. Geophys. Res. Space Physics, 121, 11,176-11,190, doi:10.1002/2016JA022404, 2016.

Jamjareegulgarn, P., P. Supnithi, K. Watthanasangmechai, T. Yokoyama, T. Tsugawa and M. Ishii, A new expression for computing the bottomside thickness parameter and comparisons with the NeQuick and IRI-2012 models during declining phase of solar cycle 23 at equatorial latitude station, Chumphon, Thailand, Advances in Space Research, ISSN 0273-1177, http://dx.doi.org/10.1016/j.asr.2016.11.003., 2016.

Maruyama, T., H. Shinagawa, K. Yusupov, and A. Akchurin, Sensitivity of ionosonde detection of atmospheric disturbances induced by seismic Rayleigh waves at different latitudes, Earth, Planets Space, 69(20), doi:10.1186/s40623-017-0600-z, 2017.

3.4. Report from Kyushu Universith
(Huixin Liu, Kyushu University)

=== Recent papers===

Y. Yamazaki, Huixin Liu, Y. Sun, Y. Miyoshi, M. Kosch, M. G. Mlynczak Quasi-biennial oscillation of the ionospheric wind dynamo, J. Geophys. Res., 122, 1-17, doi: 10.1002/2016JA023684, 2017.

L. Liu, Huixin Liu, H. Le, Y. Chen, Y. Sun, B. Ning, L. Hu, W. Wan, N. Li, J. Xiong Mesospheric temperatures estimated from the meteor radar observations at Mohe, China, J. Geophys. Res., 122, 2249-2259, doi: 10.1002/2016JA023776, 2017.

L. Liu, Huixin Liu, Y. Chen, H. Le, Y.-Y. Sun, B. Ning, L. Hu, and W. Wang, Variations of the meteor echo heights at Beijing and Mohe, China, J. Geophys. Res., 122, 1117-1127, doi: 10.1002/2016JA023448, 2017.

Hamid, N. S. A., Huixin Liu, T. Uozumi, A. Yoshikawa, N. M. N., Peak time of equatorial electrojet from different longitude sectors during fall solar minimum, IEEE Proc. of the 2017 IconSpace, 2017.

3.5. Report from Research Institute for Sustainable Humanosphere (RISH), Kyoto University
(Mamoru Yamamoto, RISH)

=== Recent papers===

M. Yamamoto, K. Shiokawa, T. Nakamura and N. Gopalswamy, Special issue "International CAWSES-II Symposium", Earth, Planets and Space, 68:26, DOI: 10.1186/s40623-016-0392-6, 2016

Tsuda, T., M. Yamamoto, H. Hashiguchi, K. Shiokawa, Y. Ogawa, S. Nozawa, H. Miyaoka, and A. Yoshikawa (2016), A proposal on the study of solar-terrestrial coupling processes with atmospheric radars and ground-based observation network, Radio Sci., 51, 1587-1599, doi:10.1002/2016RS006035.

Ajith, K. K., S. Tulasi Ram, M. Yamamoto, Y. Otsuka, and K. Niranjan (2016), On the fresh development of equatorial plasma bubbles around the midnight hours of June solstice, J. Geophys. Res. Space Physics, 121, 9051?9062, doi:10.1002/2016JA023024.

J. Kawahara, T. Iwahori, H. Yamakawa, T. Sato, M. Yamamoto, and H. Hashiguchi, Study on space debris observation technique by using the Kyoto University MU radar, Aeronautical and Space Sciences Japan, Vol.64, No.3, p.189-199, DOI:10.2322/jjsass.64.189, 2016. (in Japanese)

S. Saito, S. Suzuki, M. Yamamoto, C.-H. Chen, A. Saito, Real-time Ionosphere Monitoring by Three-dimensional Tomography Over Japan, Proceedings of the 29th International Technical Meeting of The Satellite Division of the Institute of Navigation (ION GNSS+ 2016), Portland, Oregon, September 2016, pp. 706-713, 2016.

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Rao, N.V., M.V. Ratnam, C. Vedavathi, T. Tsuda, B.V.K. Murthy, S. Sathishkumar, S. Gurubaran, K.K. Kumar, K.V. Subrahmanyam, S.V.B. Rao, Seasonal, inter-annual and solar cycle variability of the quasi two day wave in the low-latitude mesosphere and lower thermosphere, J. Atmos. Solar-Terr. Phys., 152-153, pp. 20-29, 2016.

Yabuki, M., M. Matsuda, T. Nakamura, T. Hayashi, and T. Tsuda, A scanning Raman lidar for observing the spatio-temporal distribution of water vapor, J. Atmos. Solar-Terr. Phys., 150, pp. 21-30, 2016.

Shoji, Y., K. Sato, M. Yabuki, and T. Tsuda, PWV Retrieval over the Ocean Using Shipborne GNSS Receivers with MADOCA Real-Time Orbits, SOLA, 12, pp. 265-271, 2016.

3.6. Report from Tohoku University

(Takeshi Sakanoi, Tohoku University)

=== Symposium===

The 18th symposium on planetary science 2017 was held in Sendai on February 20-22, 2017. The symposium concerned the following topics: atmospheres and magnetospheres on terrestrial and Jovian planets and their satellites studied by observations and numerical analyses, and development of new observational and computational approaches. Invited talks and discussions were held relating to planetary explorations by Akatsuki, Juno and Hisaki etc. and to future planetary and satellite missions.

=== Summary of the research ===

< Gravity wave in the mesopause region>

Perwitasari et al. (2016) reported a statistical study on concentric gravity waves (CGWs) in the mesopause (~95 km) using 3 years nightglow data obtained by Ionosphere, Mesosphere, upper Atmosphere and Plasmasphere/Visible and near-Infrared Spectral Imager. The 235 CGWs events were found with horizontal wavelength ranging from 40 to 250 km and maximum radius of 200 to 3000 km. The latitudinal distribution of the CGWs centers had peaks in mid latitude (40°N and 40°S) and minimum at low latitudes (10°S). More events were found in the summer hemisphere midlatitudes, with a rapid transition between northern and Southern Hemisphere around the equinoxes.

<Small-scale auroral dynamics>

Nishiyama et al. (2016) observed mesoscale pulsating aurora aurora (100 km × 100 km) with patchy structure and equatorward propagation. Fast Fourier transform (FFT) analysis revealed that this pulsating patch clearly exhibited temporal variations that can be categorized into two types: on-off pulsation (7.8–10 s) with large amplitudes and luminosity modulations excited during on phase with a frequency of about 3.0 Hz. In addition, they applied principal component analysis (PCA) to time series image data of the pulsating aurora for the first time. Time coefficients were estimated by PCA for the whole patch and the substructures were consistent with those obtained from the FFT analysis, and therefore, they concluded that PCA is capable of decomposing several structures that have different coherent spatiotemporal characteristics.

<Radiation belt>

Kato et al. (2016) carried out a self-consistent simulation of the generation process of whistler-mode chorus by a spatially one-dimensional electron hybrid code, by assuming the magnetic field inhomogeneity corresponding to L = 4 of the dipole field. Chorus emissions with rising tones are reproduced in the simulation result, while the frequency range, sweep rate, and the amplitude profiles in the spectra of the reproduced elements are consistently explained by the nonlinear wave growth theory. Kitahara and Kato (2017) report the application for the Wave-Particle Interaction Analyzer (WPIA) on the Arase (ERG) satellite which was launched successfully in December 2016, which measures the relative phase angle between the wave magnetic field vector and the velocity vector of each particle and calculates the energy exchange from waves to particles. They expand its applicability by proposing a method of using the WPIA to directly detect pitch angle scattering of resonant particles by plasma waves by calculating the g values.

< Planetary sciences>

IPRT (Iitate Planetary Radio Telescope) is a ground-based VHF-UHF radio telescope developed by Tohoku University, which has been developed at the Iitate observatory in Fukushima prefecture Japan since 2000 and dedicated for the observations of solar and planetary radio emissions. IPRT has two distinctive radio receivers; one is a low noise and quite stable receiver tuned at 325MHz and 785MHz, and another one is a 100-500MHz spectro-polarimeter, named AMATERAS (the Assembly of Metricband Aperture TElescope and Real-time Analysis System). The former is mainly used for observing Jupiter's synchrotron emission with the sensitivity of 0.1Jy, and enables us to investigate dynamical variations of Jupiter's deep inner magnetosphere. The latter is used for observing solar radio bursts with 10ms accumulation time and 61 KHz bandwidth, and enables us to clarify various micro structure of wave-particle or wave-wave interactions generated in the solar corona region.

The Jovian and solar radio wave receiver system in HF range (15-40MHz) was continuously operated at Iitate Observatory of Tohoku University. Spectrograms of Jovian and solar radio wave with a time resolution of 0.5 sec were automatically archived and provided to the researchers through the internet. The discussion on combining this data archive with that of Nancay observatory has started between the researches of Paris Astronomical Observatory and Tohoku University. In addition, the operation of RF waveform recording receiver system for the observation of Jovian decametric S-bursts was started at Iitate Observatory since October 2013. The data will be useful for the analysis of the repetition of S-bursts, which is caused by Jovian Ionospheric Alfven Resonator (IAR).

Sakanoi et al. (2017) reported specifically designed instruments on 40 and 60cm telescopes on Mount Haleakala, Hawaii, to study phenomena such as volcanic activity on Io and exoplanetary polarization. For continuous monitoring of planetary atmospheres by the telescope at Haleakala, Nakagawa et al. (2016) developed a new Mid-Infrared Laser Heterodyne Instrument (MILAHI) with >106 resolving power at 7–12 μm. Room-temperature-type quantum cascade lasers (QCLs) that cover wavelength ranges of 7.69–7.73, 9.54–9.59, and 10.28–10.33 μm have been newly installed as local oscillators to allow observation of CO2, CH4, H2O2, H2O, and HDO. They also showed scientific capabilities and measurement sensitivities of the MILAHI using a model with radiative transfer code.

For Matian atomosphere, Terada et al. (2017) revealed gravity wave-like perturbations in the Martian upper thermosphere observed by the Neutral Gas Ion Mass Spectrometer (NGIMS) onboard the Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft. The amplitudes of small-scale perturbations with apparent wavelengths between ~100 and ~500 km in the Ar density around the exobase show a clear dependence on temperature (T0) of the upper thermosphere. The average amplitude of the perturbations is ~10% on the dayside and ~20% on the nightside, which is about 2 and 10 times larger than those observed in the Venusian upper thermosphere and in the low-latitude region of Earth's upper thermosphere, respectively. Kuroda et al. (2016) carried out simulations with a new high-resolution Martian general circulation model (MGCM) (T106 spectral resolution, or ~67-km horizontal grid size) to reveal global distributions of gravity waves (GWs) during the solstice and equinox periods. They showed that shorter-scale harmonics progressively dominate with height, and the body force per unit mass (drag) they impose on the larger-scale flow increases. GW energy in the troposphere due to the shortest-scale harmonics is concentrated in the low latitudes for both seasons and is in a good agreement with observations. Terada et al. (2016) develop a one-dimensional full-particle model of the Martian upper thermosphere-exosphere, where the Direct Simulation Monte Carlo (DSMC) method is applied to both thermal and non-thermal components. Their full-particle model can self-consistently solve the transition from collisional to collisionless domains in the upper thermosphere, so that the energy deposition from non-thermal energetic components to thermal components in the transition region is properly described.

Masunaga et al., (2017) examined Venusian EUV dayglow using the Hisaki data. They showed that ~ 4-day periodic variations are detected and are dominant on the dawnside of Venus. The ~4 day periodic dayglow variations may reflect atmospheric dynamics of Venus. For Jupiter aurora, Kita et al. (2016) reported the statistical relationship between the total power of the Jovian ultraviolet aurora and the solar wind properties found from long-term monitoring by the spectrometer EXCEED on board the Hisaki satellite. Superposed epoch analysis indicates that auroral total power increases when an enhanced solar wind dynamic pressure hits the magnetosphere.

=== Recent papers===

Terada, N., F. Leblanc, H. Nakagawa, A. S. Medvedev, E. Yigit, T. Kuroda, T. Hara, S. L. England, H. Fujiwara, K. Terada, K. Seki, P. R. Mahaffy, M. Elrod, M. Benna, J. Grebowsky, and B. M. Jakosky (2017), Global distribution and parameter dependences of gravity wave activity in the Martian upper thermosphere derived from MAVEN/NGIMS observations, J. Geophys. Res., 122, doi:10.1002/2016JA023476.

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W. Bader, B. Bovy, S. Conway, K. Strong, D. Smale, A. J. Turner, T. Blumenstock, C. Boone, M. C. Coen, A. Coulon, O. Garcia, D. W. T. Griffith, F. Hase, P. Hausmann, N. Jones, P. Krummel, I. Murata, I. Morino, H. Nakajima, S. O'Doherty, C. Paton-Walsh, J. Robinson, R. Sandrin, M. Schneider, C. Servais, R. Sussmann and E. Mahieu (2017), The recent increase of atmospheric methane from 10 years of ground-based NDACC FTIR observations since 2005, Atmos. Chem. Phys., 17, 2255-2277, doi:10.5194/acp-17-2255-2017.

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