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Education

- **B.Eng., Physics** (2000), East China Normal University, Shanghai, P.R. China
- **M.Sc., Geography** (2003), East China Normal University, Shanghai, P.R. China
- **Ph.D., Atmospheric Chemistry** (2007), University of Waterloo, Ontario, Canada

Professional Experience

- Research Scientist (2010-present), Jet Propulsion Laboratory
- Postdoctoral Scholar (2008-2010), JIFRESSE (UCLA and JPL)
- Postdoctoral Scholar (2007-2008), University of Waterloo

Specialty: Instrumentation and algorithm development for improving the vertical/horizontal resolution and the spatial coverage of the measurements of atmospheric trace gases and aerosols using remote sensing techniques such as high-resolution interferometry and polarimetry in the UV-Vis-NIR-TIR from orbital, suborbital, and ground-based platforms.

Principle Investigator Experience

Instrumentation/Technology

- PI: NASA Headquarter Directed R&TD (2019-2022) "*A broadband metasurface for high spectral resolution, imaging spectropolarimetry*"
- PI: JPL Strategic Initiative R&TD (2018-2021) "*Maturing HiMAP (High-resolution Imaging Multiple-species Atmospheric Profiler) System to TRL 6*"
- PI: JPL Topical R&TD (2017-2018) "*High-resolution Imaging Multiple-species Atmospheric Profiler*"

Retrieval algorithm development

- PI: NASA Headquarter Directed R&TD (2017-2018) "*MUSES algorithm development, characterization, and science application*"
- PI: JPL R&TD Spontaneous Concept Task (2015-2016) "*First direct measurements of global atmospheric isoprene from satellite observations*"
- PI: ROSES/AC-AST (2013-2017) "*Tropospheric ozone profiles using multispectral measurements from OMI, MLS, and AIRS*"
- JPL-led PI (2018-2022): ROSES/TASNPP "*Multi-decadal record of satellite carbon monoxide observations from Terra/MOPITT to SNPP/CrIS*" ,
- JPL-led PI: ROSES/AST-ACMAP (2017-2020) "*Isoprene Measurements from Space: New Global Constraints on Emissions and Photochemistry from Synthesis of CrIS and OMI Data*"

Experience in leading design and development of new scientific investigations

- Leading the development of HiMAP (High-resolution Multiple-species Atmospheric Profiler), an instrument concept crafted to fill the gaps of the vertical/horizontal resolution and the spatial coverage for the measurements of gaseous pollutants (O_3, NO_2) and aerosols, three air quality-related objectives ranked "MOST IMPORTANT" in the 2017 Earth Science Decadal Survey. Currently HiMAP is a payload in the "Ozone and Trace Gases" mission concept included in the FY'22-24 "Earth System Explorer Concept Maturation" Strategic Initiative portfolio in 8X.
- Led the development of a full-physics retrieval algorithm of CrIS instrument to quantify atmospheric isoprene – the most abundant non-methane volatile organic compound, fostering the understanding of atmospheric chemistry and climate. This investigation demonstrated that isoprene can be directly quantified from CrIS space measurements to advance our understanding of atmospheric chemistry and climate. Currently isoprene is included as one of the observables in the "Ozone and Trace Gases" mission concept in the FY'22-24 "Earth System Explorer Concept Maturation" Strategic Initiative portfolio in 8X.
- Led the development of the MUSES (MUlti-SpEctra, MUlti-SpEcies, MUlti-SEnsors) algorithmic code and produced unique profile data products of atmospheric composition through combining the space measurements from multiple satellites (Aura, Aqua, Suomi-NPP, and TROPOMI). MUSES is now known as an algorithmic tool that can provide atmospheric composition data with near-surface sensitivity and extend the multiple-decade continuity of NASA atmospheric ozone and carbon monoxide profile data, supporting new scientific studies of air quality, atmospheric chemistry, and climate.

Experience in successfully leading work groups and teams

- PI of a Strategic Initiative task of developing HiMAP (2018-2021): led an 11-membmer team including James McGuire (3830); Daniel Wilson, Richard Muller, William Johnson (389W); David Braun, Austin Nordman (383I); Yen-Hung Wu (383D); Nasrat Raouf (383C); Carol Bruegge, Deacon Nemchick (329H); Hui-Hsin Hsiao (National Taiwan Normal University); raised the TRL of both component and system level technologies to TRL 4; crafted operation concepts targeting at the Earth Venture and the Explore Class missions, in which HiMAP serves as a core payload in the new generation of NASA Earth System Observatory.
- PI of a Spontaneous R&TD task: led a 2-member team; conducted survey of the TIR space instruments (TES, CrIS, AIRS, and IASI) and provided theoretical and experimental evidence of the first direct space measurements of atmospheric isoprene; The results were used as inputs to a winning ROSES proposal and were published in a paper in Nature Communication together with the follow-up studies from the winning ROSES proposal.
- PI of a ROSES task for enabling the joint OMI, MLS, and AIRS ozone retrievals: led a 4-member team; developed the algorithmic code based on MUSES and produced decade ozone profile data that are being used by the scientific community of air quality and climate; MUSES received strong peer reviews/comments such as "It's laudable that the authors undertook this important task". Dejian has also been contacted by HQ management to present MUSES results in numerous workshops and conferences.

- Mentor to one postdoc; Co-mentor to 8 postdocs, 6 graduate students, 4 undergraduate students.

Experience in working with diverse researchers outside JPL

- 2018-present: Prof. Hui-Hsin Hsiao's group at National Taiwan Normal University for the development of metagrating technologies
- 2016-present: serve as technical monitor for 3 NASA SBIR projects
- 2016-2019: Prof. Russell Chipman's group at University of Arizona for the development of a division-of-amplitude photopolarimeter
- 2013-present: collaborate with over 20 colleagues in OMI, MOPITT, Suomi-NPP, TROPOMI teams and NCAR for the development of retrieval algorithmic code, level 2 data production, characterization and science applications
- 2010-2012: Prof. Qinbin Li's group at UCLA to combine the data from CLARS-FTS measurements and WRF-Chem model to advance the understanding of emission sources and sinks of greenhouse gases and pollutants over LA basin

Experience in developing and operating airborne and ground-based sensors for remote sensing of atmospheric composition

- Participated in development of CLARS-FTS instrument and algorithm, led the paper illustrating the design-integration-test-characterization of the CLARS-FTS system and retrieval algorithm.
- Participated in Airborne Tropical TRopopause Experiment (ATTREX) (Fall 2011): JPL's Laser Hygrometer instrument integration, tests, and deployment on NASA Global Hawk aircraft, retrieval algorithm development, characterization, and data production for the studies of the stratospheric water vapor enhancement over the summertime and the role of overshooting convection.
- Participated in field campaigns supporting the Canadian Atmospheric Chemistry Experiment (ACE) mission (2003-2010): integrated a Fourier transform spectrometer (named PARIS-IR) using the spare parts of ACE-FTS instrument and deployed PARIS-IR on a high-altitude balloon platform during the MANTRA 2004 field campaign at the prairie (Saskatchewan, Canada) and deployed PAIRS-IR instrument at the Polar Environment Atmospheric Research Laboratory (PEARL) – the high Arctic research station at the Canadian territory of Nunavut, in support of the ACE validation.

Postdoctoral Scholar mentored

- Dr. Myungje Choi 2018-2020

Postdoctoral Scholar co-mentored:

Dr. Dan Chen (former member of Prof. Qinbin Li group); 2010-2012

Dr. Chang-Hyoung Park (former member of Prof. Qinbin Li group); 2010-2012

Dr. Olga Pikelnaya (former member of Prof. Jochen Stutz group); 2010-2013

Dr. Min Huang (former member of Tropospheric composition group) 2012-2015

Dr. Yingdi Liu (former member of Dr. Stanley Sander's group); 2012-2014

Dr. Kam Weng Wong (member of Dr. Stanley Sander's group); 2012-2015

Dr. Kuai Le (JIFRESSE) 2016 – 2018

Graduate students co-mentored

Qiong Zhang (Caltech); 2012 to 2017
Ross Cheung (UCLA); 2010 to 2012
Catalina Tsai (UCLA); 2010 to 2012
Xiaoyi Zhao (University of Toronto); 2011 to 2013

Undergraduate students co-mentored

Alexandra Crawford: 2017
Zhaocheng Zeng; January 2016 to present
Yanbing Zhu: 2015
Cheuk Hei Lau: 2011

Honors and Awards

- William T. Pecora Award, the OMI Science Team, 2019
- JPL Group Achievement Award, OCO-3 mission, 2019
- NASA Group Achievement Award, the OCO-2 Science Algorithm Team, 2016
- JPL Voyager Award, 2016
- JPL Group Achievement Award, OCO-2 Algorithm Development 2015
- JPL Group Achievement Award, OCO-2 Algorithm Development 2014
- NASA Group Achievement Award, the Aura Project, 2014
- JPL Mariner Award, 2011
- Bruker BioSpin Graduate Scholarship, University of Waterloo, 2007
- Graduate Scholarship, University of Waterloo, September 2003–2007
- International Doctoral Student Award, University of Waterloo, 2003–2006

Peer-reviewed Publications

1. van Kempen T.A., Rotman, T. J., van Hees R.M., Bruegge C., **Fu D.**, Hoogeveen R., Pongetti T. J., Rosenberg R., and Aben I.: Vicarious Calibration of the TROPOMI-SWIR module over the Railroad Valley playa, *Atmos. Meas. Tech. Discuss*., https://doi.org/10.5194/egusphere-2023-89, in press (2023).
2. Taylor T.E., O'Dell C.W., Baker D., Bruegge C., Chang A., Chapsky L., Chatterjee A., Cheng C., Chevallier F., Crisp D., Dang L., Drouin B., Eldering A., Feng L., Fisher B., **Fu D.**, Gunson M., Haemmerle V., Keller G.R., Kiel M., Kuai L., Kurosu T., Lambert A., Laughner J., Lee R., Liu J., Mandrake L., Marchetti Y., McGarragh G., Merrelli A., Nelson R.R., Osterman G., Oyafuso F., Palmer P.I., Payne V.H., Rosenberg R., Somkuti P., Spiers G., To C., Wennberg P.O., Yu S., and Zong J.: Evaluating the consistency between OCO-2 and OCO-3 XCO2 estimates derived from the NASA ACOS version 10 retrieval algorithm, *Atmos. Meas. Tech. Discuss*., https://doi.org/10.5194/amt-2022-329, in press (2023).
3. Worden H.M., Francis G. L., Kulawik S.S., Bowman K.W., Cady-Pereira K., **Fu D.**, Hegarty J.D., Kantchev V., Luo M., Payne V.H., Worden J.R., Commane R., and McKain K.: TROPESS/CrIS carbon monoxide profile validation with NOAA GML and ATom in situ aircraft observations, *Atmos. Meas. Tech.*, 15, 5383–5398, https://doi.org/10.5194/amt-15-5383-2022, (2022).

4. Hsiao H.-H., Muller R.E., McGuire J.P., Nemchick D.J., Shen C.-H., van Harten G., Rud M., Johnson W.R., Nordman A.D., Wu Y.-H., Wilson D.W., Chiou Y.-P., Choi M., Hyon J.J., **Fu D.:** An Ultra-Broadband High Efficiency Polarization Beam Splitter for High Spectral Resolution Polarimetric Imaging in the Near Infrared. *Adv. Sci.* 2022, 9, 2201227. https://doi.org/10.1002/advs.202201227, (2022).

5. Choi M., Sander S.P., Spurr R.J.D., Pongetti T.J., van Harten G., Drouin B.J., Diner D.J., Crisp D., Eldering A., Kalashnikova O.V., Jiang J.H., Hyon J., **Fu D.**: Aerosol profiling using radiometric and polarimetric spectral measurements in the O_2 absorption bands: information content and measurement uncertainties estimation, *Remote Sens. Envir.*, 253, 112179, doi.org/10.1016/j.rse.2020.112179, (2021).

6. Kulawik S.S., Worden J.R., Payne V.H., **Fu D.**, Wofsy S.C., Sweeney C., Manning E., Lipton A., Polonsky I., He Y., Cady-Pereira K.E., Yin Y., Dlugokencky E.J.: Evaluation of AIRS CH_4 profile retrievals uncertainties using aircraft profile measurements, *Atmos. Meas. Tech.*, 14, 335–354, (2021).

7. Yu S., Rosenberg R., Bruegge C., Chapsky L., **Fu D.**, Lee R., Taylor T.E., Cronk H., O'Dell C., Angal A., Xiong X., Crisp D., Eldering A.: stability assessment of OCO-2 radiometric calibration using Aqua MODIS as a Reference, *Remote Sensing*, 12, 1269, doi.org/10.3390/rs12081269, (2020).

8. Herman R.L., Worden J., Noone D., Henze D., Bowman K., Cady-Pereira K., Payne V.H., Kulawik S., and **Fu D.**: Comparison of Optimal Estimation HDO/H_2O Retrievals from AIRS with ORACLES measurements, *Atmos. Meas. Tech.*, 13, 1825–1834, (2020).

9. **Fu D.**, Millet D.B., Wells K.C., Payne V.H., Yu S., Guenther A., and Eldering A.: Direct retrieval of isoprene from satellite-based infrared measurements, *Nature Communication*, 10, 3811, doi:10.1038/s41467-019-11835-0 (2019).

10. Shannon Kian Zareh, Miller C., Wong A., Sullivan P., Rud M., Beregovski Y., Wilson D., Wallace J.K., Sellar G., Keymeule D., Brooks C.B., Eldering A., **Fu D.**, Mainzer A.: The Carbon Balance Observatory (CARBO) instrument for remote sensing of greenhouse gases from space, Proceedings Volume 11152, Remote Sensing of Clouds and the Atmosphere XXIV; *SPIE Remote Sensing*, https://doi.org/ 10.1117/12.2539078, (2019).

11. Worden J.R., Kulawik S.S., **Fu D.**, Payne V.H., Lipton A.E., Polonsky I., He Y., Cady-Pereira K., Moncet J.-L., Herman R.L., Irion F.W., and Bowman K.W.: Characterization and Evaluation of AIRS-Based Estimates of the Deuterium Content of Water Vapor, *Atmos. Meas. Tech.*, 12, 2331–2339, (2019).

12. Richter J., Chipman R., Daugherty B., Diner D.J., Eldering A., Hyon J., Kupisnki M., Neu J.L., **Fu D.**: Specifying Polarimetric Tolerances of a High-resolution Imaging Multiple-species Atmospheric Profiler (HiMAP), *Proc. SPIE. 10925, Photonic Instrumentation Engineering VI*, (2019).

13. **Fu D.**, Kulawik S.S., Miyazaki K., Bowman K.W., Worden J.R., Eldering A., Livesey N.J., Teixeira J., Irion F.W., Herman R.L., Osterman G.B., Liu X., Levelt P.F., Thompson A.M., and Luo M.: Retrievals of Tropospheric Ozone Profiles from the Synergic Observation of AIRS and OMI: Methodology and Validation, *Atmos., Meas. Tech.*, 11, 5,587–5,605, (2018).

14. Miyazaki K., Sekiya T., **Fu D.**, Bowman K.W., Kulawik S.S., Sudo K., Walker T., Kanaya Y., Takigawa M., Ogochi K., Eskes H., Boersam F., Gaubert B., Barre J., and Emmons L.: Balance of emission and dynamical controls on ozone during KORUS-AQ from multi-constituent satellite data assimilation, *Journal of Geophysical Research: Atmospheres*, 124, 387–413, (2018).

15. Levelt P., Joiner J., Tamminen J., Veefkind P., Duncan B., Eskes H., Torres O., DeLand M., Marchenko S., Kleipool Q., Pickering K., Apituley A., Zweers D.S., Carn S., van der A R., Ialongo I., Arola A., Hassinen S., Hakkarainen J., McPeters R., Ziemke J., Boersma F., Krotkov N., **Fu D.**, Liu X., Abad G.G., Chance K., Suileman R., Li C., and Bhartia P.: The Ozone Monitoring Instrument: Overview of 14 years in space, *Atmos., Chem. Phys.*, 18, 5,699–5,745 (2018).

16. Irion F., Kahn B., Schreier M., Fetzer E., Fishbein E., **Fu D.**, Kalmus P., Wilson R.C., Wong S., and Yue Q.: Single-footprint retrievals of temperature, water vapor and cloud properties from AIRS, *Atmos., Meas. Tech.*, 11, 971–995, (2018).

17. Wallace J.K., Miller C., Shannon Kian Zareh, Mainzer A., Pagano T.S., Brooks C.B., Jaffe D.T., Wilson D., Eldering A., **Fu D.**, Bartos R., Beregovski Y., Rud M., McGuire J.P., Wong A., Keymeulen D., Sullivan P., Liggett E., Bernas M.: CARBO - The Carbon Observatory Instrument Suite – the next generation of Earth observing instruments for global monitoring of carbon gases, Proceedings Volume 10785, Sensors, Systems, and Next-Generation Satellites XXII; 107850U, *SPIE Remote Sensing*, https://doi.org/10.1117/12.2513286, (2018).

18. Herman R.L., Ray E.A., Rosenlof K.H., Bedka K.M., Schwartz M.J., Read W.G., Troy R.F., Chin K., Christensen L.E., **Fu D.**, Stachnik R.A., Bui T.P., and Dean-Day J. M.: Enhanced stratospheric water vapor over the summertime continental United States and the role of overshooting convection, *Atmos. Chem. Phys.*, 17, 6113–6124, (2017).

19. Crisp D., Pollock H.R., Rosenberg R., Chapsky L., Lee R.A.M., Oyafuso F.A., Frankenberg C., O'Dell C.W., Bruegge C.J., Doran G.B., Eldering A., Fisher B.M., **Fu D.**, Gunson M.R., Mandrake L., Osterman G.B., Schwandner F.M., Sun K., Taylor T.E., Wennberg P.O., and Wunch D.: The On-Orbit Performance of the Orbiting Carbon Observatory-2 (OCO-2) Instrument and its Radiometrically Calibrated Products, *Atmos. Meas. Tech.*, 10, 59–81, (2017).

20. Eldering A., O'Dell C. W., Wennberg P. O., Crisp D., Gunson M. R., Viatte C., Avis C., Braverman A., Castano R., Chang A., Chapsky L., Cheng C., Connor B., Dang L., Doran G., Fisher B., Frankenberg C., **Fu D.**, Granat R., Hobbs J., Lee R.A.M., Mandrake L., McDuffie J., Miller C.E., Myers V., Natraj V., O'Brien D., Osterman G. B., Oyafuso F., Payne V.H., Pollock H.R., Polonsky I., Roehl C.M., Rosenberg R., Schwandner F., Smyth M., Tang V., Taylor T.E., To C., Wunch D., and Yoshimizu J.: The Orbiting Carbon Observatory-2: First 18 months of Science Data Products, *Atmos. Meas. Tech.*, 10, 549–563, (2017).

21. Griffin D., Walker K.A., Conway S., Kolonjari F., Strong K., Batchelor R., Boone C.D., Dan L., Drummond J.R., **Fu D.**, Lindenmaier R., Manney G.L., Sung K., and Weaver D.: Multi-year comparisons of ground-based and space-borne Fourier Transform Spectrometers in the high Arctic between 2006 and 2013, *Atmos. Meas. Tech.*, 10, 3273–3294, (2017).

22. **Fu D.**, Bowman K.W., Worden H., Natraj V., Worden J.R., Yu S., Veefkind P., Aben I., Landgraf J., Strow L., Han Y.: High resolution tropospheric carbon monoxide profiles retrieved from CrIS and TROPOMI, *Atmos. Meas. Tech.*, 9, 2567–2579, (2016).

23. Zeng Z.-C., Zhang Q., Margolis J., Shia R.-L., Newman S., **Fu D.**, et al.: Aerosol scattering effects on water vapor retrievals over the Los Angeles Basin, *Atmos. Chem. Phys.*, 17, 2495–2508, (2017).

24. Connor B., Bösch H., McDuffie J., Taylor T., **Fu D.**, et al.: Quantification of Uncertainties in OCO-2 Measurements of XCO2: Simulations and Linear Error Analysis, *Atmos. Meas. Tech.*, 9, 5227–5238, (2016).

25. Zhang Q., Natraj V., Li K-F, Shia R-L, **Fu D.**, Pongetti T.J., et al.: Accounting for aerosol scattering in the CLARS retrieval of column averaged CO_2 mixing ratios, *J. Geophys. Rev.*, 120(14), 7205–7218, (2015).

26. Wong K.W., **Fu D.**, Pongetti T. J., Newman S., Kort E.A., Duren R., Y.-K. Hsu, Miller C. E., Yung Y.L., and Sander S.P.: Mapping CH_4: CO_2 ratios in Los Angeles with CLARS-FTS from Mount Wilson, California, *Atmos. Chem. Phys.*, 15, 241–252, (2015).

27. Bella D., Culpepper J., Khaimova J., Ahmed N., Belkalai A., Arroyo I., Andrews J., Gentle S., Emmanuel S., Lahmouh M., Ealy J., King Z., Jenkins O., **Fu D.**, Choi Y., Osterman G., Gruszczynski J., Skeete D., and Blaszczak-Boxe C.S.: Characterization of pollution transport into Texas using OMI and TES satellite, GIS and in situ data, and HYSPLIT back trajectory analyses: implications for TCEQ State Implementation Plans, *Air Quality, Atmosphere & Health*, 1–20, (2015).

28. **Fu D.**, Pongetti T.J., Blavier J-F L., Crawford T.J., Manatt K.S., Toon G.C., Wong C., and Sander S.P.: Near-infrared remote sensing of Los Angeles trace gas distributions from a mountaintop site, *Atmos. Meas. Tech.*, 7713–7729, (2014).

29. **Fu D.**, Worden J.R., Liu X., Kulawik S.S., Bowman K.W., and Natraj V.: Characterization of ozone profiles derived from Aura TES and OMI radiances, *Atmos. Chem. Phys.*, 13, 3445–3462, (2013).

30. Worden H.M., Edwards D.P., Deeter M.N., **Fu D.**, Kulawik S.S., Worden J.R., Arellano A., Averaging kernel prediction from atmospheric and surface state parameters based on multiple regression for nadir-viewing satellite measurements of carbon monoxide and ozone, *Atmos. Meas. Tech.*, 6, 1633–1646, (2013).

31. Bekker D.L., Blavier J.L., **Fu D.**, Key R.W., Manatt K.S., McKinney C., Rider D.M., Sander S.P., Werne T.A., Wu A.C., Wu Y.H., Command and data handling system for the panchromatic Fourier transform spectrometer, *Aerospace Conference IEEE*, 1–10, (2012).

32. **Fu D.**, Bernath P.F., Sung K., Walker K.A., Strong K., Mittermeier R. and Fast H., Simultaneous atmospheric remote sensing using Fourier transform infrared spectrometers at Polar Environment Atmospheric Research Laboratory (PEARL) during Spring 2006, *Atmos. Chem. Phys.,* 11, 5,383–5,405, (2011).

33. **Fu D.**, Boone C.D., Bernath P.F., Weisenstein D.K., Rinsland C.P., Manney G.L. and Walker K.A., First global observations of atmospheric COClF from the Atmospheric Chemistry Experiment mission, *J. Quant. Spectrosc. Rad. Trans.,* 110, 974–985, (2009).

34. Allen N.D.C., Bernath P.F., Boone C.D., Chipperfield M.P., **Fu D.**, Manney G.L., Oram D.E., Toon G.C., Weisenstein D.K., Global carbon tetrachloride distributions obtained from the Atmospheric Chemistry Experiment (ACE), *Atmos. Chem. Phys.*, 9(19), 7,449–7,459, (2009).

35. **Fu D.**, Sung K., Boone C.D., Walker K.A., and Bernath P.F., Ground-based solar absorption studies for the Carbon Cycle science by Fourier Transform Spectroscopy (CC-FTS), *J. Quant. Spectrosc. Rad. Trans.*, 109, 2,219–2,243, (2008).

36. **Fu D.**, Boone C.D., Bernath P.F., Walker K.A., Nassar R., Manney G.L. and McLeod S.D., Global phosgene observations from the Atmospheric Chemistry Experiment (ACE) mission, *Geophys. Res. Lett.,* 34, (2007).

37. **Fu D.**, Walker K.A., Sung K., Boone C.D., Soucy M.-A. and Bernath P.F.: The Portable Atmospheric Research Interferometric Spectrometer for the Infrared, PARIS-IR, *J. Quant. Spectrosc. Rad. Trans.,* 103, 362–370, (2007).

38. Fraser A., Bernath P.F., Blatherwick R.D., Drummond J.R., Fogal P.F., **Fu D.**: et al., Intercomparison of ground-based ozone and NO_2 measurements during the MANTRA 2004 campaign, *Atmos. Chem. Phys.,* 7, 5,489–5,499, (2007).

39. Sung K., Skelton R., Walker K.A, Boone C.D., **Fu D.**, Bernath P.F.: N_2O and O_3 Arctic Column Amounts from PARIS-IR Observations: Retrievals, Characterization and Error Analysis, *J. Quant. Spectrosc. Rad. Trans.*, 107, 385–406, (2007).

40. Wunch D., Taylor J., **Fu D.**, Bernath P.F., Drummond J.R., et al.: Simultaneous ground-based observations of O_3, HCl, N_2O and CH_4 over Toronto using three Fourier transform spectrometers with different resolutions, *Atmos. Chem. Phys.,* 7, 1,275–1,292, (2006).

41. Yu S., **Fu D.**, Shayesteh A., Gordon I.E., Appadoo D.R.T. and Bernath P.F.: Infrared and near infrared emission spectra of SbH and SbD, *J. Mol. Spectrosc.,* 229(2), 257–265, (2005).

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44. **Fu D.**, Zhu J., and Shen H.: The effects from the shapes of river mouth on the formation of the turbidity maximum zone, *J. East China Normal University*, 4, 72–78, (2004).

45. Zhu J., **Fu D.**, Wu H. and Qi D.: Dynamical model and numerical experiments on the formation cause of the turbidity maximum zone, *Ocean Engineering*, 22, 83–90, (2004).

46. Zhu J. and **Fu D.**: Open boundary condition considered residual current and tidal current simultaneously in ocean model, *Journal of East China Normal University*, 1, 81–85, (2003).