# KIRILL M. TEREKHOV

Curriculum Vitae

**BUSINESS ADDRESS:**
Marchuk Institute of Numerical Mathematics of the Russian Academy of Sciences
8 Gubkina street, Rm. 628, Moscow, Russia, 119333

**HOME ADDRESS:**
8 Pokryshkina street, Apt. 667,
Moscow, Russia, 119602

Phone: +7 901 755 43 79
E-mail: mailto:terekhov@inm.ras.ru
mailto:kirill.terehov@gmail.com
www: dodo.inm.ras.ru/terekhov
www.inmost.org

## PERSONAL DATA:

| | |
|---|---|
| Date and place of birth: | January 3, 1988, Leningrad, Russia |
| Citizenship | Russia |
| Marital Status: | Married |

## EDUCATION:

**PhD** **Institute of Numerical Mathematics of Russian Academy of Science**, Russia, 31 October 2013, GPA 5.0/5.0

**M.Sc.** **Moscow State University**, Russia, 2010, GPA 4.5/5.0
Faculty of Computational Mathematics and Cybernetics, Department of Computational Technologies and Modeling, 30 June 2010

## PROFESSIONAL EXPERIENCE:

| | |
|---|---|
| 10/2017-present: | Marchuk Institute of Numerical Mathematics of the Russian Academy of Sciences, Russia.<br>Senior Researcher. |
| 07/2022-present: | Sirius University of Science and Technology, Russia.<br>Associate Professor (Docent). |
| 01/2021-present: | Moscow Institute of Physics and Technolog, Russia.<br>Assistant Professor (Senior Lecturer). |
| 01/2014–10/2017: | Earth Resource Engineering, Stanford University, USA.<br>Postdoctoral Scholar. |

| | |
|---|---|
| 11/2013–01/2015: | Institute of Numerical Mathematics, Russian Academy of Sciences, Russia. Junior scientific researcher. |
| 06/2012–10/2013: | Institute of Nuclear Safety, Russian Academy of Sciences, Russia. Engineer. |
| 11/2010–09/2013: | Institute of Numerical Mathematics, Russian Academy of Sciences, Russia PhD Student. |
| 08/2012–09/2012: | Internship at Exxon Mobil Upstream Research Company. Topic: Application of nonlinear two-point flux approximation and dynamically adapted octree grids to fully implicit two-phase filtration problem. |

**RESEARCH INTERESTS:**

Discretization methods for PDEs, Nonlinear discretization methods, Computational Fluid Dynamics, Reservoir Simulation, Linear solvers, Nonlinear solvers, Mesh generation and adaptation, Parallel Computations.

**PROJECTS:**

- ExxonMobil Project "Conservative monotone second order discretizations of convection-diffusion equations", 2010 – 2013, 2018 – 2019.
- Rosatom Project "Breakthrough", 2012 – 2014
- Stanford University's Automatic Differentiation General Purpose Research Simulator, 2014 – 2017.
- Russian Science Foundation grant PI, 2018 – present `https://rscf.ru/en/project/21-71-20024/`.

**BOOKS:**

1. Yu.Vassilevski, **K. Terekhov**, K. Nikitin, I.Kapyrin, Parallel finite volume computation on general meshes, ISBN 978-3-030-47232-0, DOI `https://doi.org/10.1007/978-3-030-47232-0`, Springer Cham, 2020
2. Vassilevski Yu., Konshin I., Kopytov G., **Terekhov K.**, INMOST - Program platform and graphic environment for development of parallel numerical models on general meshes. (in Russian) Moscow university publishing, Moscow, 2012, P. 144. `https://ozon.ru/t/grELbyk`

**JOURNAL ARTICLES:**

1. Abushaikha, A., **Terekhov, K.** Adaptive Dynamic Grids and Mimetic Finite Difference Method for Miscible Displacement Problem. *Lobachevskii Journal of Mathematics*, 2024, DOI: `https://doi.org/10.1134/S1995080224010025`
2. Donskoi, A., Medvedev, A., Shchudro, T., **Terekhov, K.**, Vassilevski, Y. Production Well Placement and History Matching by Hyperparametric Optimization and Machine Learning. *Lobachevskii Journal of Mathematics*, 2024, DOI: `https://doi.org/10.1134/s1995080224010116`

3. Konshin, I., **Terekhov, K.**, Vassilevski, Y. Strategies with Algebraic Multigrid Method for Coupled Systems. *Lobachevskii Journal of Mathematics*, 2024, DOI: https://doi.org/10.1134/s199508022401027x

4. Li, L., Khait, M., Voskov, D., **Terekhov, K.M.**, Abushaikha, A. Applying Massively Parallel Interface for MPFA scheme with advanced linearization for fluid flow in porous media, *Journal of Petroleum Science and Engineering*, DOI: https://doi.org/10.1016/j.petrol.2022.111190

5. **Terekhov, K.M.**, Butakov, I.D., Danilov, A.A., Vassilevski, Y.V. Dynamic adaptive moving mesh finite-volume method for the blood flow and coagulation modeling, *International Journal for Numerical Methods in Biomedical Engineering*, 2023, DOI: https://doi.org/10.1002/cnm.3731

6. **Terekhov, K.M.** Pressure-correction projection method for modelling the incompressible fluid flow in porous media, *Russian Journal of Numerical Analysis and Mathematical Modelling*, 2023, https://doi.org/10.1515/rnam-2023-0019

7. Butakov, I.D., **Terekhov, K.M.** Two Methods for the Implicit Integration of Stiff Reaction Systems, *Computational Methods in Applied Mathematics*, 2023, DOI: https://doi.org/10.1515/cmam-2022-0083

8. **Terekhov, K.M.**, Vassilevski, Y.V. Finite volume method for coupled subsurface flow problems, II: Poroelasticity, *Journal of Computational Physics*, 2022, DOI: https://doi.org/10.1016/j.jcp.2022.111225

9. Vassilevski, Y.V., **Terekhov, K.M.** Nonlinear Finite Volume Method for the Interface Advection-Compression Problem on Unstructured Adaptive Meshes, *Computational Mathematics and Mathematical Physics*, 2022, DOI: https://doi.org/10.1134/s0965542522060148

10. **Terekhov, K.M.** Pressure Boundary Conditions in the Collocated Finite-Volume Method for the Steady Navier–Stokes Equations, *Computational Mathematics and Mathematical Physics*, 2022, DOI: https://doi.org/10.1134/s0965542522080139

11. **Terekhov, K.M.** Collocated finite-volume method for the incompressible Navier-Stokes problem, *Journal of Numerical Mathematics*, 2021, DOI: https://doi.org/10.1515/jnma-2020-0008

12. **Terekhov, K.M.** Fully-Implicit Collocated Finite-Volume Method for the Unsteady Incompressible Navier–Stokes Problem, *Lecture Notes in Computational Science and Engineering*, 2021, DOI: https://doi.org/10.1007/978-3-030-76798-3_23

13. **Terekhov K.** General finite-volume framework for saddle-point problems of various physics. *Russian Journal of Numerical Analysis and Mathematical Modelling*, 2021, DOI: https://doi.org/10.1515/rnam-2021-0029

14. **Terekhov K.** Collocated Finite-Volume Method for the Incompressible Navier-Stokes Problem. Journal of Numerical Mathematics, 2020, DOI: https://doi.org/10.1515/jnma-2020-0008

15. **Terekhov K.** Multi-physics flux coupling for hydraulic fracturing modelling within INMOST platform. *Russian Journal of Numerical Analysis and Mathematical Modelling*, 2020, DOI: https://doi.org/10.1515/rnam-2020-0019

16. Bouchnita A., **Terekhov K.**, Nony P., Vassilevski Yu., Volpert V. A mathematical model to quantify the effects of platelet count, shear rate, and injury size on the initiation of blood coagulation under venous flow conditions. *PloS one*, 2020, DOI: https://doi.org/10.1371/journal.pone.0235392

17. **Terekhov K.**, Tchelepi H. Cell-Centered Finite-Volume Method for Elastic Deformation of Heterogeneous Media with Full-Tensor Properties. *Journal of Computational and Applied Mathematics*, 2020, DOI: https://doi.org/10.1016/j.cam.2019.06.047

18. **Terekhov K.** Cell-Centered Finite-Volume Method for Heterogeneous Anisotropic Poromechanics Problem. *Journal of Computational and Applied Mathematics*, 2020, DOI: https://doi.org/10.1016/j.cam.2019.112357

19. Abushaikha A., **Terekhov K.** A fully implicit mimetic finite difference scheme for general purpose subsurface reservoir simulation with full tensor permeability. *Journal of Computational Physics*, 2020, DOI: https://doi.org/10.1016/j.jcp.2019.109194

20. **Terekhov K.**, Vassilevski Yu. Finite Volume Method for Coupled Subsurface Flow Problems, I: Darcy Problem. *Journal of Computational Physics*, 2019, DOI: https://doi.org/10.1016/j.jcp.2019.06.009

21. Nikitin K., **Terekhov K.**, Vassilevski Yu. Two methods of surface tension treatment in free surface flow simulations. *Applied Mathematics Letters*, 2018, DOI: https://doi.org/10.1016/j.aml.2018.07.005

22. Schneider M., Flemisch B., Helmig R., **Terekhov K.**, Tchelepi H. Monotone nonlinear finite-volume method for challenging grids. *Computational Geosciences*, 2018, DOI: https://doi.org/10.1007/s10596-017-9710-8

23. Nikitin K., Olshanskii M., **Terekhov K.**, Vassilevski Yu. A splitting method for free surface flows over partially submerged obstacles. *Russian Journal of Numerical Analysis and Mathematical Modelling*, 2018, DOI: https://doi.org/10.1515/rnam-2018-0009

24. **Terekhov K.**, Mallison B., Tchelepi H. Cell-Centered Nonlinear Finite-Volume Methods for the Heterogeneous Anisotropic Diffusion Problem. *Journal of Computational Physics*, 2017, DOI: https://doi.org/10.1016/j.jcp.2016.11.010

25. Nikitin K. Olshanskii M., **Terekhov K.** Vassilevski Yu., Yanbarisov R. An adaptive numerical method for free surface flows passing rigidly mounted obstacles. *Computers & Fluids*, 2017, DOI: https://doi.org/10.1016/j.compfluid.2017.02.007

26. Konshin I., Kapyrin I., Nikitin K., **Terekhov K.** Application of the Parallel INMOST Platform to Subsurface Flow and Transport Modelling. *Parallel Processing and Applied Mathematics, Lecutre Notes on Computer Sciences. Springer.*, 2016, DOI: https://doi.org/10.1007/978-3-319-32152-3_26

27. **Terekhov K.**, Nikitin K., Olshanskii M., Vassilevski Yu. A semi-Lagrangian method on dynamically adapted octree meshes. *Russian Journal of Numerical Analysis and Mathematical Modelling*, 2015, DOI: https://doi.org/10.1515/rnam-2016-0006

28. Nikitin K., Olshanskii M., **Terekhov K.**, Vassilevski Yu. A Splitting Method for Numerical Simulation of Free Surface Flows of Incompressible Fluids with Surface Tension. *Computational Methods in Applied Mathematics*, 2015, DOI: https://doi.org/10.1515/cmam-2014-0025

29. Danilov A., Nikitin K., Olshanskii M., **Terekhov K.**, Vassilevski Yu. A Unified Approach for Computing Tsunami, Waves, Floods, and Landslides. *Lecture Notes in Computational Science and Engineering*, 2014, DOI: https://doi.org/10.1007/978-3-319-10705-9_63

30. Nikitin K., **Terekhov K.**, Vassilevski Yu. A Monotone Nonlinear Finite Volume Method for Diffusion Equations and Multiphase Flows. *Computational Geosciences*, 2014, DOI: https://doi.org/10.1007/s10596-013-9387-6

31. **Terekhov K.**, Vassilevski Yu. Two-phase water flooding simulations on dynamic adaptive octree grids with two-point nonlinear fluxes. *Russian Journal of Numerical Analysis and Mathematical Modelling*, 2013, DOI: https://doi.org/10.1515/rnam-2013-0016

32. Olshanskii M., **Terekhov K.**, Vassilevski Yu. An octree-based solver for the incompressible Navier-Stokes equations with enchanced stability and low dissipation. *Computers & Fluids*, 2013, DOI: https://doi.org/10.1016/j.compfluid.2013.04.027

33. Nikitin K., Olshanskii M., **Terekhov K.**, Vassilevski Yu. CFD technology for 3D simulation of large-scale hydrodynamic events and disasters. *Russian Journal of Numerical Analysis and Mathematical Modelling*, 2012, DOI: https://doi.org/10.1515/rnam-2012-0022

34. Nikitin N., Olshanskii M., **Terekhov K.**, Vassilevski Yu. A numerical method for the simulation of free surface flows of viscoplastic fluid in 3D. *Journal of Computational Mathematics*, 2011, DOI: https://doi.org/10.4208/jcm.1109-m11si01

35. **Terekhov K.**, Volodin E., Gusev A. Methods and efficiency estimation of parallel implementation of the sigma-model of general ocean circulation. *Russian Journal of Numerical Analysis and Mathematical Modelling*, 2011, DOI: https://doi.org/10.1515/rjnamm.2011.011

**CONFERENCE ARTICLES:**

1. Konshin, I., **Terekhov, K.** Block Algebraic Multigrid Method for Saddle-Point Problems of Various Physics, *Lecture Notes in Computer Science*, 2023, DOI: https://doi.org/10.1007/978-3-031-49432-1_2

2. Konshin I., **Terekhov K.** Distributed Parallel Bootstrap Adaptive Algebraic Multigrid Method *Lecture Notes in Computer Science*, 2022, DOI: https://doi.org/10.1007/978-3-031-22941-1_7

3. **Terekhov, K.** Greedy Dissection Method for Shared Parallelism in Incomplete Factorization Within INMOST Platform. *In Russian Supercomputing Days. Springer.*, 2021, DOI: https://doi.org/10.1007/978-3-030-92864-3_7

4. Konshin I., **Terekhov K.** Solution of large-scale black oil recovery problem in parallel using INMOST platform. *In Russian Supercomputing Days. Springer.*, 2021, DOI: https://doi.org/10.1007/978-3-030-92864-3_19

5. Konshin I., **Terekhov K.** Sparse system solution methods for complex problems. *In International Conference on Parallel Computing Technologies. Springer.*, 2021, DOI: https://doi.org/10.1007/978-3-030-86359-3_5

6. **Terekhov K.**, Parallel Dynamic Mesh Adaptation Within INMOST Platform. *In: Voevodin V., Sobolev S. (eds) Supercomputing. RuSCDays 2019. Communications in Computer and Information Science*, 2019, DOI: https://doi.org/10.1007/978-3-030-36592-9_26

7. **Terekhov K.**, Vassilevski Yu. Mesh modification and adaptation within INMOST programming platform. *Numerical Geometry, Grid Generation and Scientific Computing, Lecture Notes in Computational Science and Engineering*, 2019, DOI: https://doi.org/10.1007/978-3-030-23436-2_18

8. **Terekhov K.**, Vassilevski Yu. INMOST Parallel Platform for Mathematical Modelling and Applications. *Communications in Computer and Information Science*, 2019, DOI: https://doi.org/10.1007/978-3-030-05807-4_20

9. Gries S., Metsch B., **Terekhov K.** Tomin P. System-AMG for Fully Coupled Reservoir Simulation with Geomechanics. *SPE Reservoir Simulation Conference*, 2019, DOI: https://doi.org/10.2118/193887-MS

10. Abushaikha A., **Terekhov K.** Hybrid Mixed Mimetic Discretization Scheme for Reservoir Simulation. *SPE Reservoir Simulation Conference*, 2019

11. Abushaikha A., **Terekhov K.** Hybrid-mixed mimetic method for reservoir simulation with full tensor permeability. *ECMOR XVI-16th European Conference on the Mathematics of Oil Recovery*, 2018

12. **Terekhov K.**, Vassilevski Yu. INMOST Parallel Platform for Mathematical Modelling and Applications. *Russian Supercomputing Days: Proc. of the Int. Conf. (September 24-25, 2018, Moscow, Russia)*, 2018,Moscow State University, Moscow, pp. 250–261.

13. Konshin I., Kramarenko V., Nikitin K., **Terekhov K.** Multiphase flow modelling using INMOST platform. *Russian Supercomputing Days: Proc. of the Int. Conf. (Sptember 26-27, 2016, Moscow, Russia)*, 2016, Moscow State University, Moscow, pp. 288–293.

14. Bagaev D., Burachkovsky A., Danilov A., Konshin I. **Terekhov K.** Development of INMOST platform: dynamic grids, linear solvers and automatic differentiation. *Russian Supercomputing Days: Proc. of the Int. Conf. (Sptember 26-27, 2016, Moscow, Russia)*, 2016, Moscow State University, Moscow, pp. 543–555.

15. Danilov A., **Terekhov K.**, Konshin I., Vassilevski Yu. The structure of INMOST program platform and its usage for numerical modeling problems. *Russian Supercomputing Days 2015*, URL: http://russianscdays.org/files/pdf/104.pdf

16. Danilov A., **Terekhov K.**, Konshin I., Vassilevski Yu. The structure of INMOST program platform and its usage for numerical modeling problems. *CEUR Workshop Proceedings*, 2015, pp. 104–109

17. Danilov A., **Terekhov K.**, Konshin I., Vassilevski Yu. INMOST parallel platform: Framework for numerical modeling. *Supercomputing Frontiers and Innovations*, 2015, 2(4), pp. 55-66

18. Kapyrin I., Nikitin K., **Terekhov K.**, Vassilevski Yu. Nonlinear Monotone FV Schemes for Radionuclide Geomigration and Multiphase Flow Models. *Finite Volumes for Complex Applications VII-Elliptic, Parabolic and Hyperbolic Problems*, 2014, V.78, pp. 655–663

19. Nikitin K., **Terekhov K.**, Vassilevski Yu. Multiphase Flows – Nonlinear Monotone FV Scheme and Dynamic Grids. In: *ECMOR XIV - 14th European Conference on the Mathematics of Oil Recovery*, 2014, Catania, Sicily, Italy

20. Nikitin K., Olshanskii M., **Terekhov K.**, Vassilevski Yu. Numerical modelling of viscoplastic free surface flows in complex 3D geometries. In: *Proceedings of European Congress on Computational Methods in Applied Sciences and Engineering, ECCOMAS*, 2012, Vienna, Austria

21. Nikitin K., Olshanskii M., **Terekhov K.**, Vassilevski Yu. Preserving distance property of level set function and simulation of free surface flows on adaptive grids. In: *Numerical geometry, grid generation and scientific computing, NUMGRID*, 2010, Moscow, Computing Center RAS, pp. 25–32

22. Nikitin K., Olshanskii M., Suleimanov A., **Terekhov K.**, Vassilevski Yu., Free surface flow modelling with dynamically refined octree meshes. In: *Abstracts of international conference, CMAM-4*, 2010, Bedlow, Poland

23. **Terekhov K.** Parallel realization of the general ocean circulation model. In: *Collection of theses of best graduate works*, 2010, MAKS Press CMC MSU, pp. 30–31, Moscow

24. Nikitin K., Suleimanov A., **Terekhov K.** Technology for freesurface flow modelling in realistic scene. In: *Works of N.I. Lobachevsky Mathematical Center*, 2009 , V.39, pp. 305–307

## REVIEWER:

Journals: Advances in Water Resources, Computer Methods in Applied Mechanics and Engineering, Journal of Computational Physics, Computational Geosciences, Numerical Methods for Partial Differential Equations, SPE Journal, PLoS one, Applied Mathematical Modelling, Communications in nonlinear science & numerical simulation, Journal of Computational and Applied Sciences, Neural Networks, Russian Journal of Numerical Analysis and Mathematical Modelling, Computational Methods in Applied Mathematics, Numerical heat transfer, Surface review and letters, Computers and Concrete,, Science China Mathematics

Conference PC member: ISPRASOPEN 2018, 2021

## SUPERVISED STUDENTS

Sergey Giniatulin (Moscow State University, MSc 2011)
Ruslan Ishakov (Stanford University, PhD 2017)
Andrey Burachkovskiy (Moscow State University, MSc 2018)
Nadezhda Suslova (Sechenov University, MSc 2020)
Timofey Lapin (Moscow Institute of Physics and Technology, BSc 2022)
Ivan Butakov (Moscow Institute of Physics and Technology, BSc 2022, MSc 2024, PhD present)
Andrei Donskoy (Sirius University, MSc 2023)
Maksim Pugachev (Sirius University, MSc present)
Valeria Gaeva (Moscow Institute of Physics and Technology, BSc 2023, MSc present)
Artem Medvedev (INM RAS, PhD present)

## TEACHING EXPERIENCE

Moscow State University, Supercomputing Academy, “Capabilities of open source packages for solution of solid mechanics problems”, Summer, 2018

Moscow Institute of Physics and Technology, "Practical methods for system solutions", Spring 2019, 2020, 2021, 2022, 2023

Sirius University of Science and Technology, "Practical methods for system solutions", 2023, 2024

Sirius University of Science and Technology, "Mathematical models of reservoir geomechanics", 2023, 2024

## SPECIALIZATION

| | |
|---|---|
| Programming languages: | C, C++, Fortran |
| Parallel programming: | MPI, OpenMP, OpenCL |
| Visualization: | OpenGL |
| Web programming: | HTML, XML, ML, CSS, Javascript, PHP |
| Languages: | Russian (native), English (fluent), French (basic), Spanish (basic) |

## SOFTWARE TOOLS DEVELOPED (C++):

1. Integrated Numerical Modelling and Object-oriented Supercomputing Technologies (INMOST). Website: `http://www.inmost.org`

2. Software for incompressible non-Newtonian fluid simulation with free surface on dynamically adapted octree grids (Floctree).
   Websites:
   `http://www.floctree.com`
   `http://dodo.inm.ras.ru/research/freesurface`
   `http://www.math.uh.edu/~molshan/viscoplastic.html`

3. Software for two-phase black oil simulation on dynamically adapted octree grids with cut-cells by fully implicit nonlinear finite-volume method.

4. Software for parallel three-phase black oil simulation on unstructured grids by fully implicit nonlinear finite-volume method.

5. Discretization toolkit for unstructured meshes with fractures for Stanford University's Automatic Differentiation based General Purpose Research Simulator.

## REFERENCES:

**Hamdi Tchelepi**, Energy Resource Engineering Department, Stanford University, Stanford, CA 94305, USA, E-mail: TCHELEPI@STANFORD.EDU

**Bradley Mallison**, Chevron Technology Company, San Ramon, CA 94583, USA, E-mail: BTMB@CHEVRON.COM

**Maxim Olshanskii**, Department of Mathematics, University of Houston, 651 PGH Building, Houston, TX 77204-3008, USA E-mail: MOLSHAN@MATH.UH.EDU