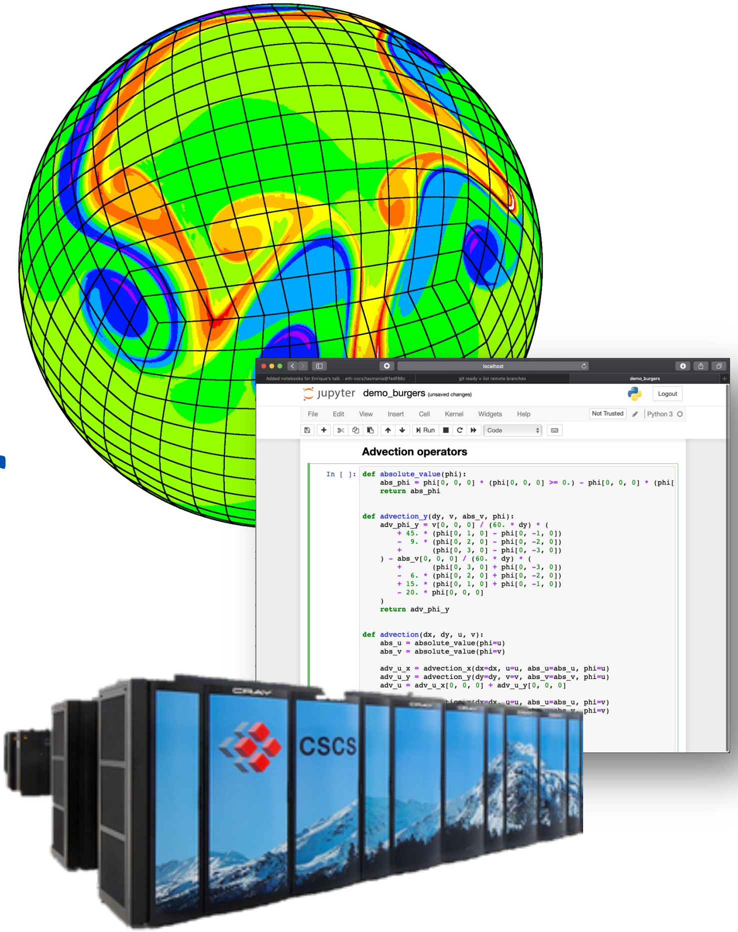
High Performance Computing for Weather and Climate (HPC4WC)



Content: Administrative

Lecturers: Oliver Fuhrer, Tobias Wicky, Stefano Ubbiali

Block course 701-1270-00L

Summer 2021

Nice to meet you!

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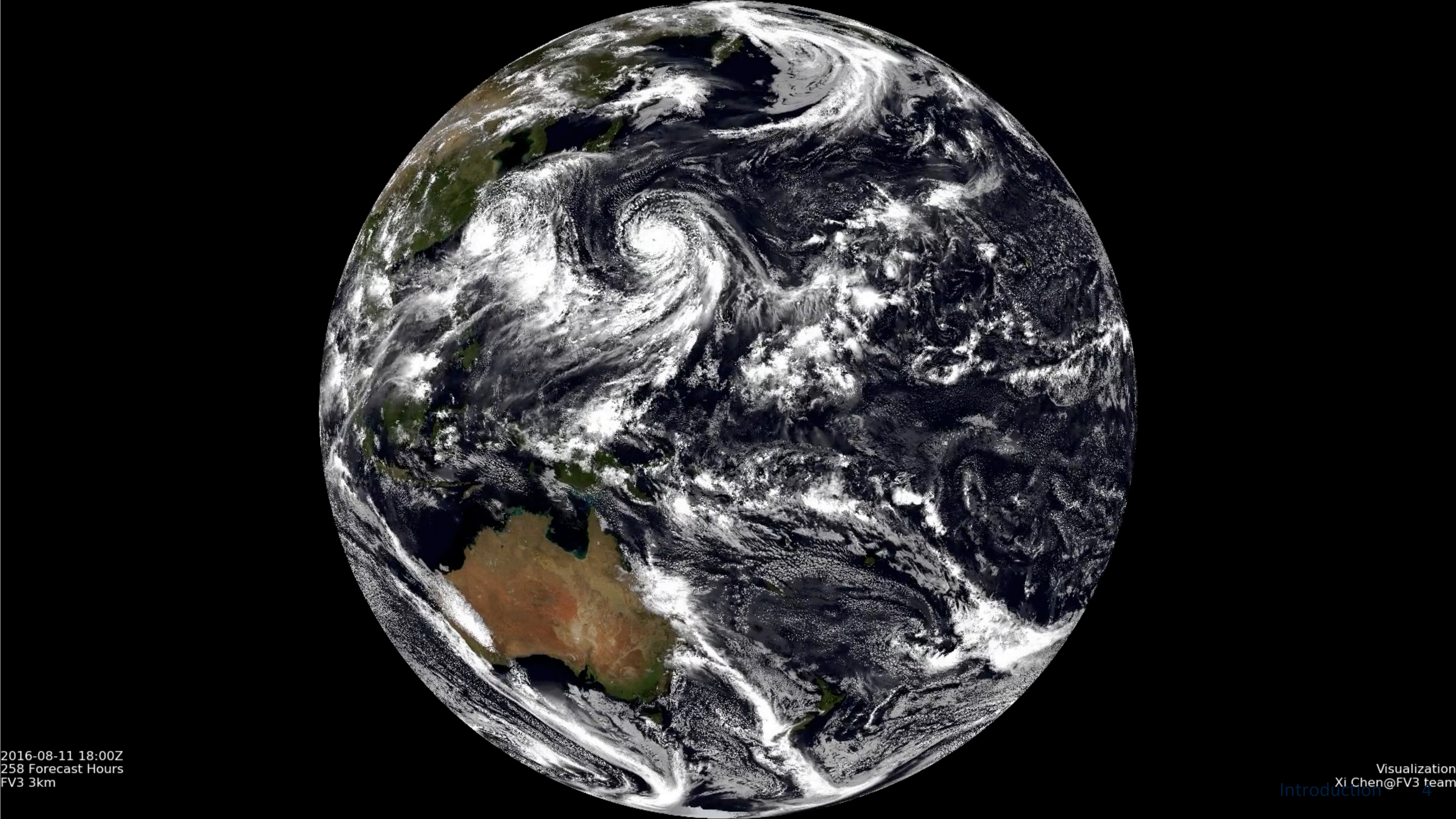
Goals of course

- Understand high performance computing concepts relevant for weather and climate simulations
- Able to work with weather and climate simulation codes that run on large supercomputers


2016-08-11 18:00Z
258 Forecast Hours
FV3 3km
Visualization
Xi Chen@FV3 team

Approach

“ I **Hear** and I Forget,
I **See** and I Remember,
I **Do** and I Understand ”

(chinese proverb)

- Lectures that explain concepts and give context (*hear*).
- Demonstrations of the concepts being applied (*see*).
- Practical exercises and a work project (*do*).

Questions, please!

Schedule

Monday	Motivation, stencil computations, memory hierarchy, lab environment
Tuesday	Shared memory parallelism, OpenMP, performance metrics
Wednesday	Distributed memory parallelism, domain-decomposition and halo-updates
Thursday	Hardware trends in supercomputing, GPU computing
Friday	High-level programming, domain-specific languages, wrapup

08:15 – 12:00	Morning session
08:15	Check-in (Zoom)
12:00 – 13:30	***Lunch break***
13:30 – 17:30	Afternoon session
13:30	Check-in (Zoom)
17:00	Check-in (Zoom)

Zoom lectures will be recorded and made available!

Currently registered students

MS/BS Computational Sciences and Engineering (MAVT)	11
MS/BS Environmental Science (USYS)	5
PhD students (USYS, MAVT)	5
MS Atmosphere and Climate Science (USYS)	2
MS/BS Physics (PHYS)	1
MS/BS Computer Science (INFK)	1
MS Mechanical Engineering (MAVT)	1
Total	**26**

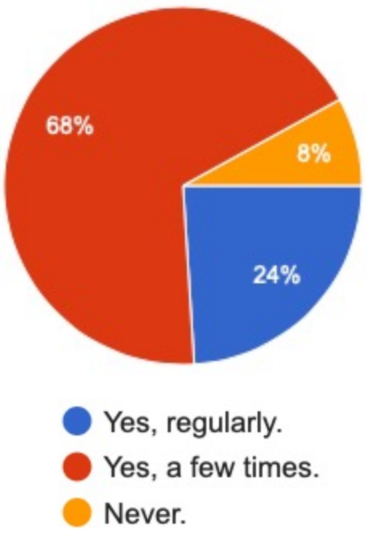
Prerequisites

- **Fundamentals of numerical analysis and atmospheric modeling**
  - Basic partial differential calculus and finite difference methods.
  - e.g. ETH course "Numerical methods in environmental physics" or "Numerical modeling of weather and climate"
- **Experience in a programming language (C/C++, Fortran, Python, …)**
  - We will read and write Fortran, C++ and Python in this course.
- **Experience using command line interfaces in *nix environments (e.g., Unix, Linux)**
  - Familiar with work in the command line shell and the most commonly used shell commands.
  - Can logon to linux system via ssh and can work remotely on that system.
  - We will work on the Piz Daint supercomputer at the Swiss National Supercomputing Center (CSCS) in Lugano in this course.

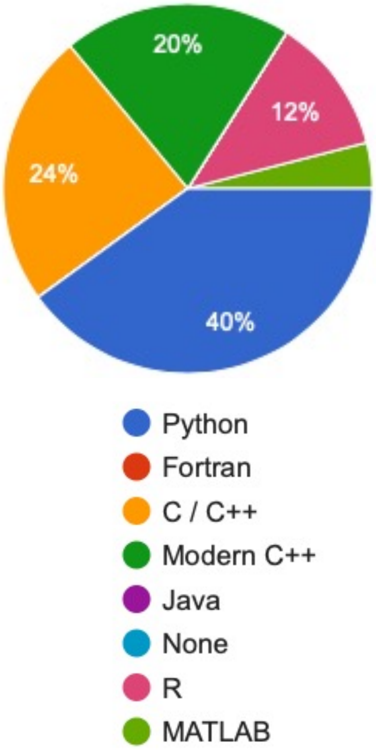
If you think this course might not be suitable for you, contact us!

Questionnaire (based on 30 replies received by 6/6/20)

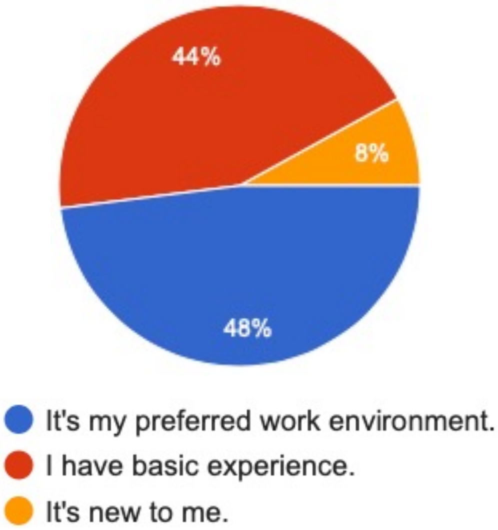
PDEs on computer



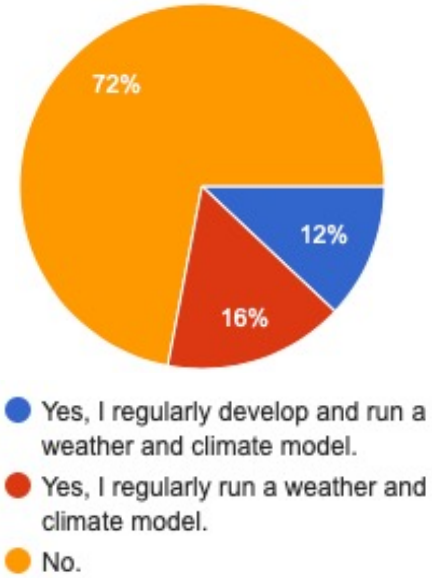
Programming language



Linux / unix



Weather/climate model



Practicalities

- **All course material on GitHub repository** (slides, notebooks, codes, …)
  https://github.com/ofuhrer/HPC4WC/
- **Questions related to course in dedicated Slack workspace**
  https://join.slack.com/t/hpc4wc/shared_invite/zt-rdlkb3y8-6P~gjYpNLzGs9qC7ZbH8IQ
  - Possible to use video and screen sharing.
  - Generally, try to use public channels for questions since others probably have the same questions.
- **Lectures and check-ins are via Zoom**
  (Link shared before lecture via Slack)

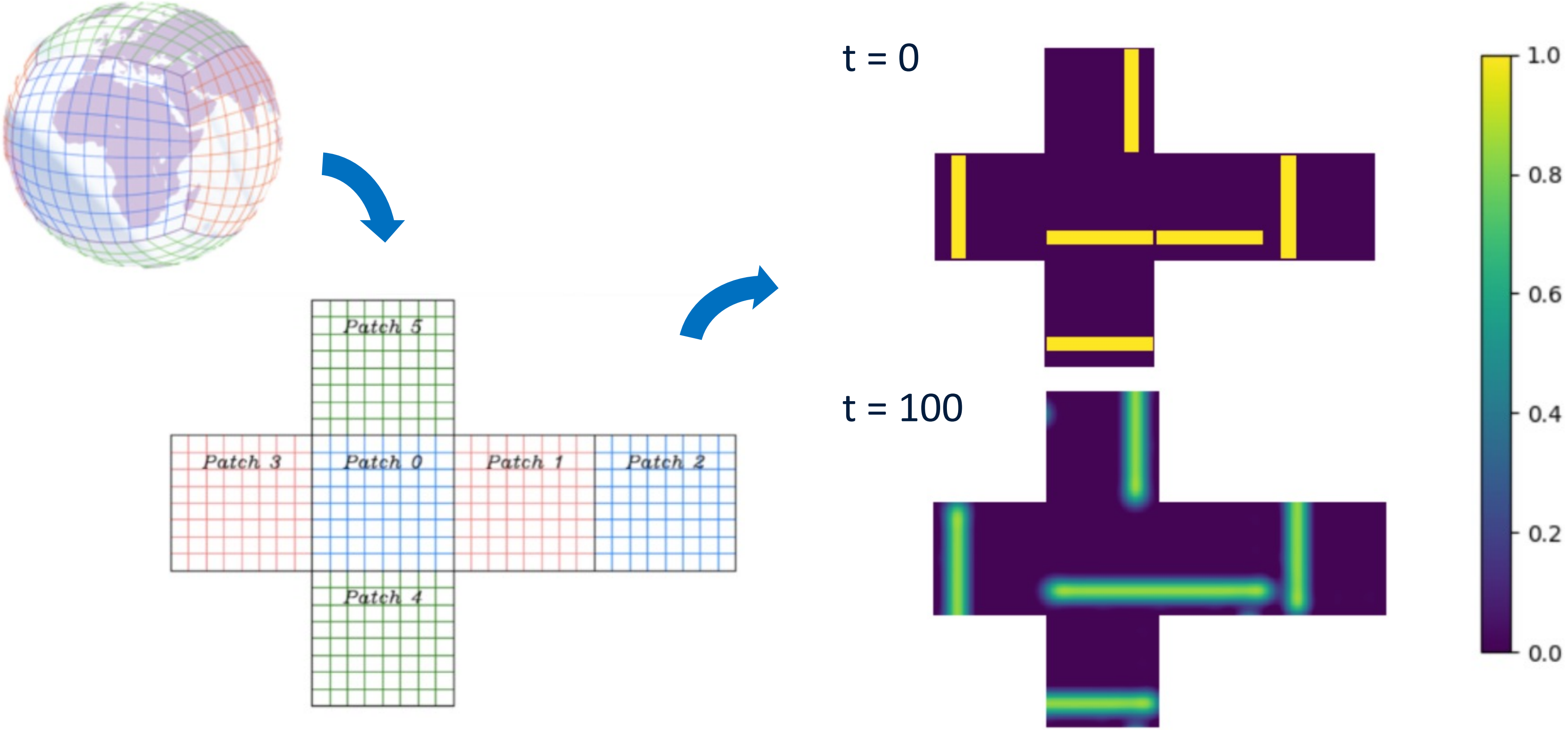
How to earn credits (3 ECTS)

- **Attend the block course** (and participate actively!)
- **Work project**
  - Choose group and topic
  - Hand in working source code and report (max. 10 pages)
  - Projects will be graded
  - **Deadline: 31. August 2020**
- Credits are awarded if course attended and grade of work project ≥ 4.0
- Same rules apply for BS, MS, and PhD students

Work project

- **Work in groups of 2-3** (individual projects are strongly discouraged)
  - Programming is not a solitary art!
- **Topics will be presented on Friday**
  - If you prefer to choose your own, you are required to discuss with us beforehand
  - Each project must have a software development and performance evaluation part and has to be related to course material
- **Grading**
  - 25% correctness (compiles & runs, results correct, no bugs)
  - 25% quality (structure, clean code, comments, naming, tests, error handling)
  - 25% performance (depending on work project)
  - 25% report (maximum 10 pages)
- **See last year's projects for examples**

Example: Diffusion on a cubed-sphere grid



Lab exercises

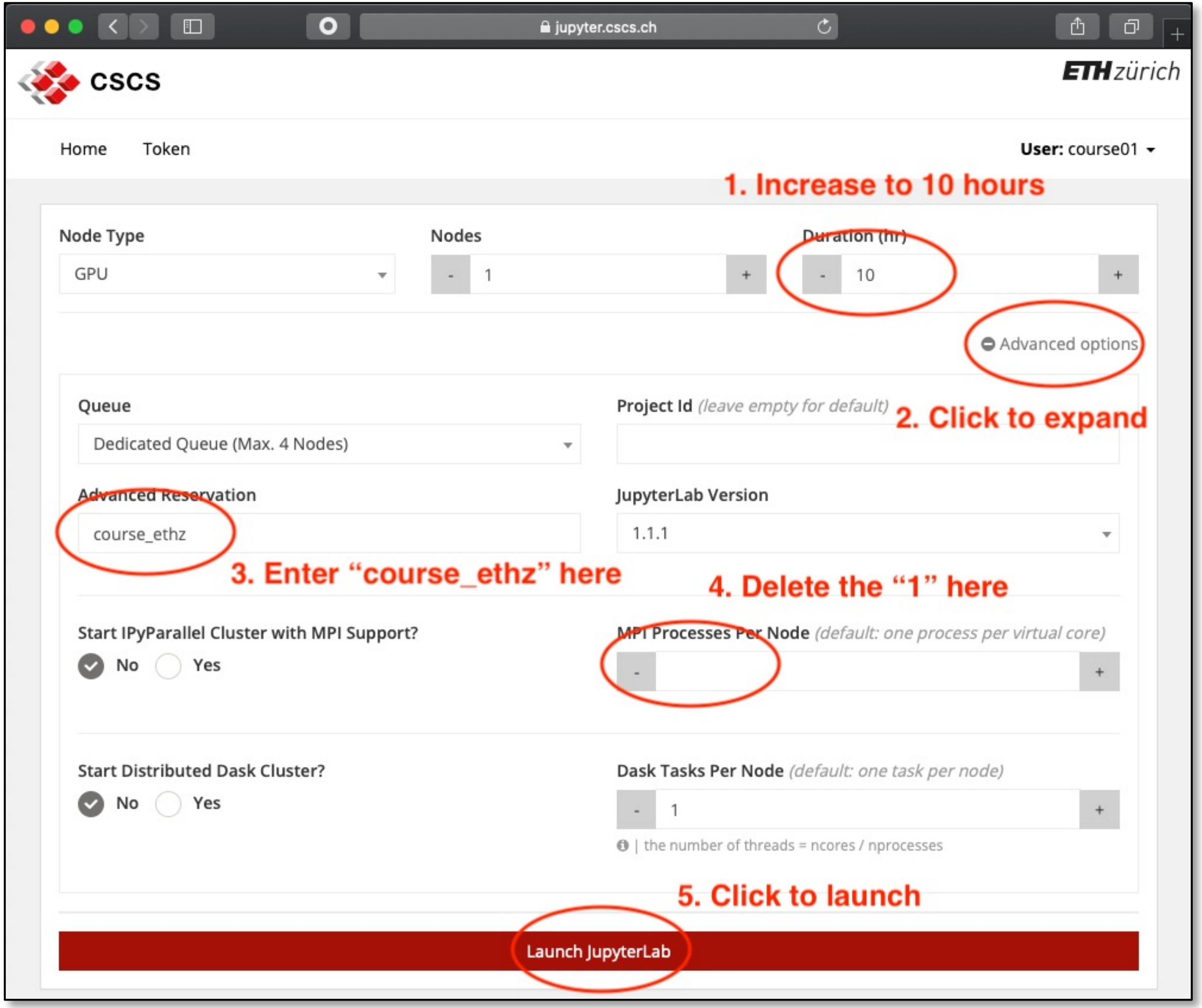
- Swiss National Supercomputing Centre https://www.cscs.ch/
- Piz Daint supercomputer (Europe's largest supercomputer)

CSCS Accounts

- Send us a direct message on Slack to get your user name and password.
- **Do not share you login / pwd with anybody else.** Accounts with suspicious activities will be close down by CSCS immediately.
- **Change your password** immediately upon your first login to CSCS using the kpasswd command in a Terminal (see instructions).
- We have a shared quota of 3000 node hours for using the CSCS supercomputers for this block course.
  - Do not launch jobs with more than 1 node without checking with us first.
  - Do not leave your JupyterHub Server running if you don’t need it.
- **Do not contact CSCS** if you have trouble. Use the Slack workspace to get your issues resolved.
- Take a look at the **CSCS Code of Conduct**

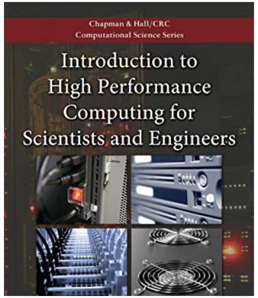
JupyterHub

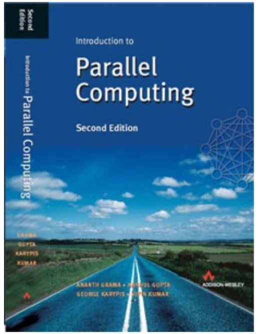
- Lab exercises will all be conducted on https://jupyter.cscs.ch/, the JupyterHub portal of CSCS.
- Interactive development and computing environment.
- If things get stuck or go wrong, it's always possible to "Stop Server" and "Lauch Server" again.
- Jupyter notebooks auto-save and almost certainly no work will be lost.



Literature & Links

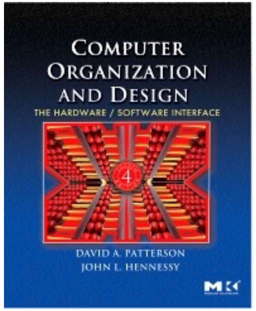
Introduction to High Performance Computing for Scientists and Engineers, G. Hager and G. Wellein, CRC Press, 2011 (available online at ETH)





Parallel Computing, A. Grama, A. Gupta, G. Karypis, V. Kumar (available free online)

Parallel Programming in MPI and OpenMP, V. Eijkhout (Link to course)



Computer Organization and Design, D.H. Patterson and J.L. Hennessy (available online at ETH)