

Open Science Beyond Data Sharing

2022 ARM/ASR Open Science Workshop

May 10, 2022

Markus Petters

Open Science

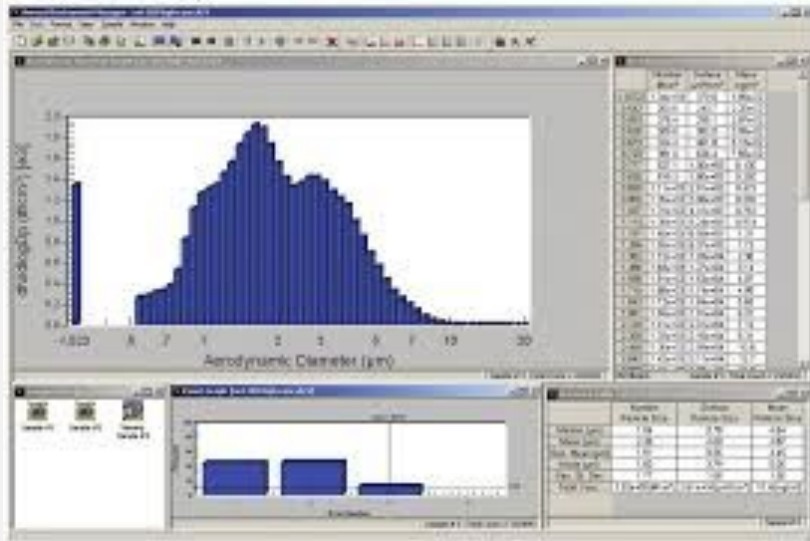
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<https://www.fosteropenscience.eu/taxonomy/term/100>

- I. Open access (Manuscript publication available free of charge to reader, manuscript content has a free license)
- II. Open data (Data available in publicly accessible repositories without download restrictions)
- III. Open software (Data acquisition and processing scripts available under free license. 100% free software tool chain)
- IV. Open hardware (Instrument designs and specifications available and free of licensing restrictions)

Most state of the science commercial and home-built instruments are not compatible with open science, yet.

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Open Software Examples/Challenges

Atmos. Meas. Tech., 14, 7909–7928, 2021
https://doi.org/10.5194/amt-14-7909-2021
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Atmospheric
Measurement
Techniques
Open Access
EGU

Revisiting matrix-based inversion of scanning mobility particle sizer (SMPS) and humidified tandem differential mobility analyzer (HTDMA) data

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RegularizationTools.jl

Public



A Julia package to perform Tikhonov regularization for small to moderate size problems.



DifferentialMobilityAnalyzers.jl

Public



A Julia package for working differential mobility analyzers.

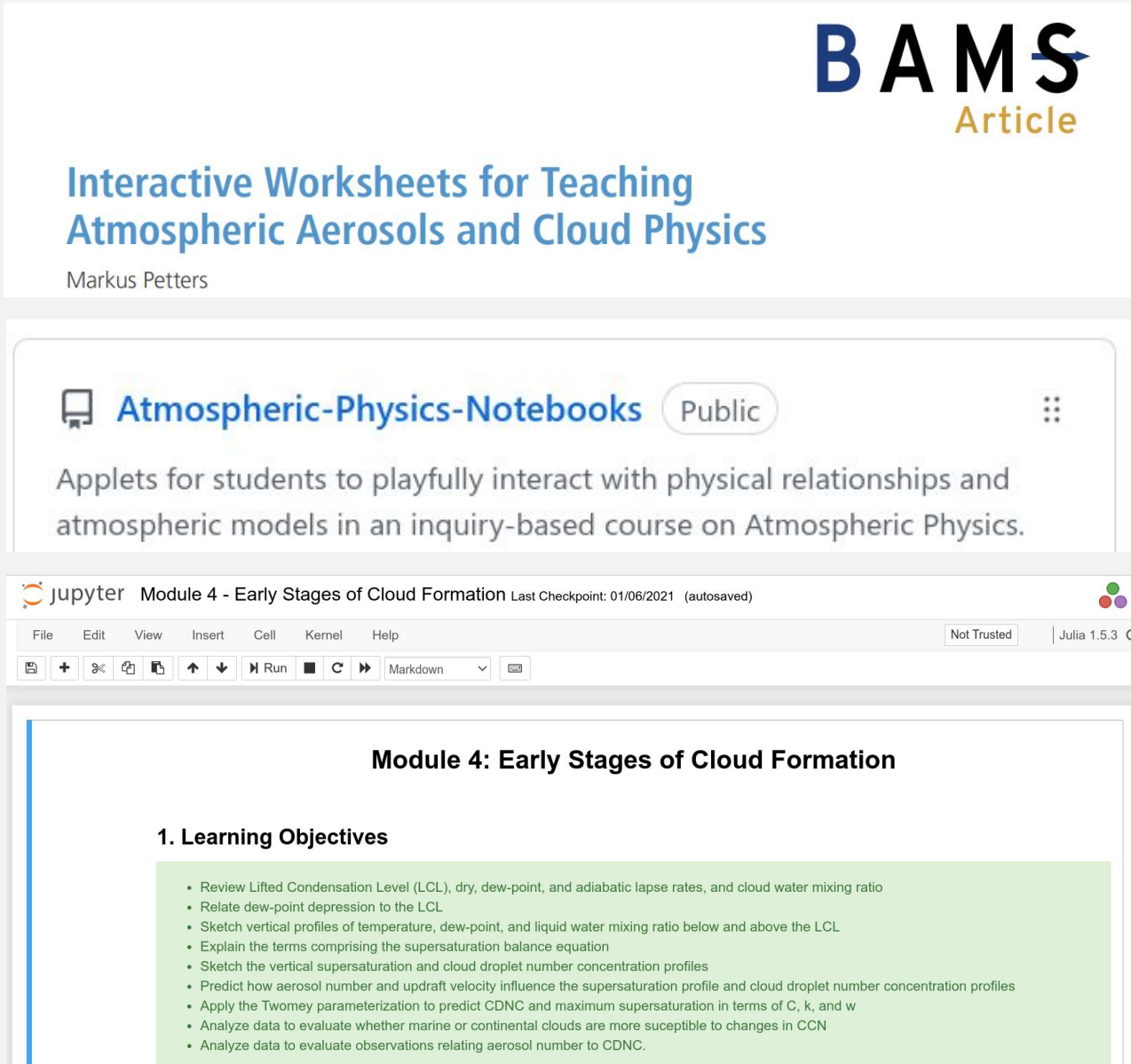
Specialized Domain-Specific Software

- Software tool to help with inversion
- Specialized language
- Targeted to “developer”

Challenges

- Documentation
- Software evolves but paper is static
- Must be maintained with moving open source ecosystem
- Not easy to install/learn/use
 - Needs front end for users (static software, web interface)
 - Tutorials
 - Containerization
- **Time commitment**

Open Software Examples/Challenges



BAMS
Article

Interactive Worksheets for Teaching Atmospheric Aerosols and Cloud Physics

Markus Petters

Atmospheric-Physics-Notebooks Public

Applets for students to playfully interact with physical relationships and atmospheric models in an inquiry-based course on Atmospheric Physics.

jupyter Module 4 - Early Stages of Cloud Formation Last Checkpoint: 01/06/2021 (autosaved)

File Edit View Insert Cell Kernel Help Not Trusted Julia 1.5.3

Module 4: Early Stages of Cloud Formation

1. Learning Objectives

- Review Lifted Condensation Level (LCL), dry, dew-point, and adiabatic lapse rates, and cloud water mixing ratio
- Relate dew-point depression to the LCL
- Sketch vertical profiles of temperature, dew-point, and liquid water mixing ratio below and above the LCL
- Explain the terms comprising the supersaturation balance equation
- Sketch the vertical supersaturation and cloud droplet number concentration profiles
- Predict how aerosol number and updraft velocity influence the supersaturation profile and cloud droplet number concentration profiles
- Apply the Twomey parameterization to predict CDNC and maximum supersaturation in terms of C , k , and w
- Analyze data to evaluate whether marine or continental clouds are more susceptible to changes in CCN
- Analyze data to evaluate observations relating aerosol number to CDNC.

Designed to be

- Teaching material for instructors
- Learning material for students
- Adaptable for place-based learning
- Engagement and participation

Challenges

- Software installation
- Requires maintenance (software packages evolve).
- Scalable delivery to students
- Performance optimization

Open Hardware Examples/Challenges

HardwareX 11 (2022) e00266



Contents lists available at ScienceDirect

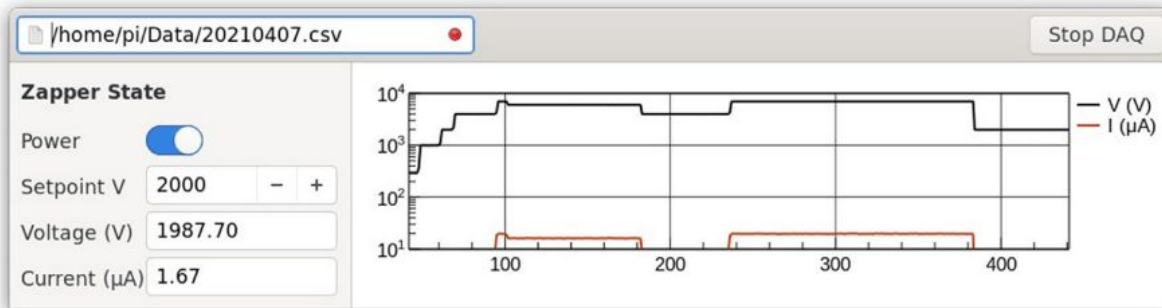
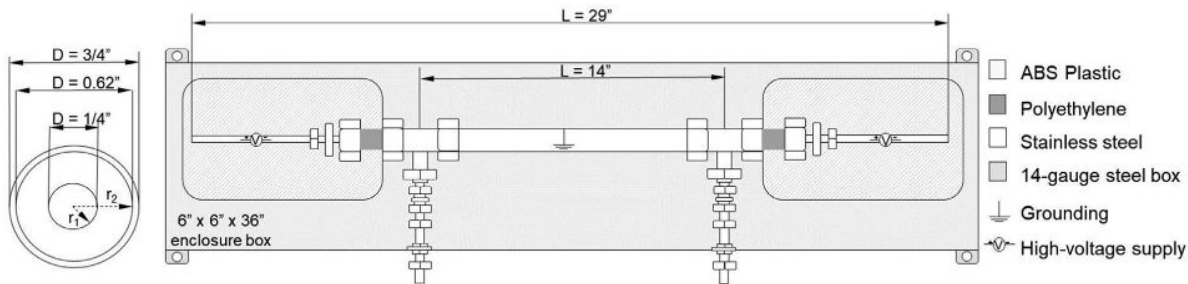
HardwareX

journal homepage: www.elsevier.com/locate/ohx



Open-hardware design and characterization of an electrostatic aerosol precipitator

Sabin Kasparoglu, Timothy P. Wright, Markus D. Petters*



Designed to be

- Low cost
- Self manufacture for grad. student
- Enable participation
- Simple parts
- Accelerate innovation

Challenges

- Documentation
- Multiple repositories
- Software/hardware platform aging
- Time requirement to publication
- Means to share back improvements and getting credit (GitHub vs. Zenodo; “paper” vs. “project”)

Open Hardware Examples/Challenges



NC STATE
UNIVERSITY

Ice Nucleation Cold Stage

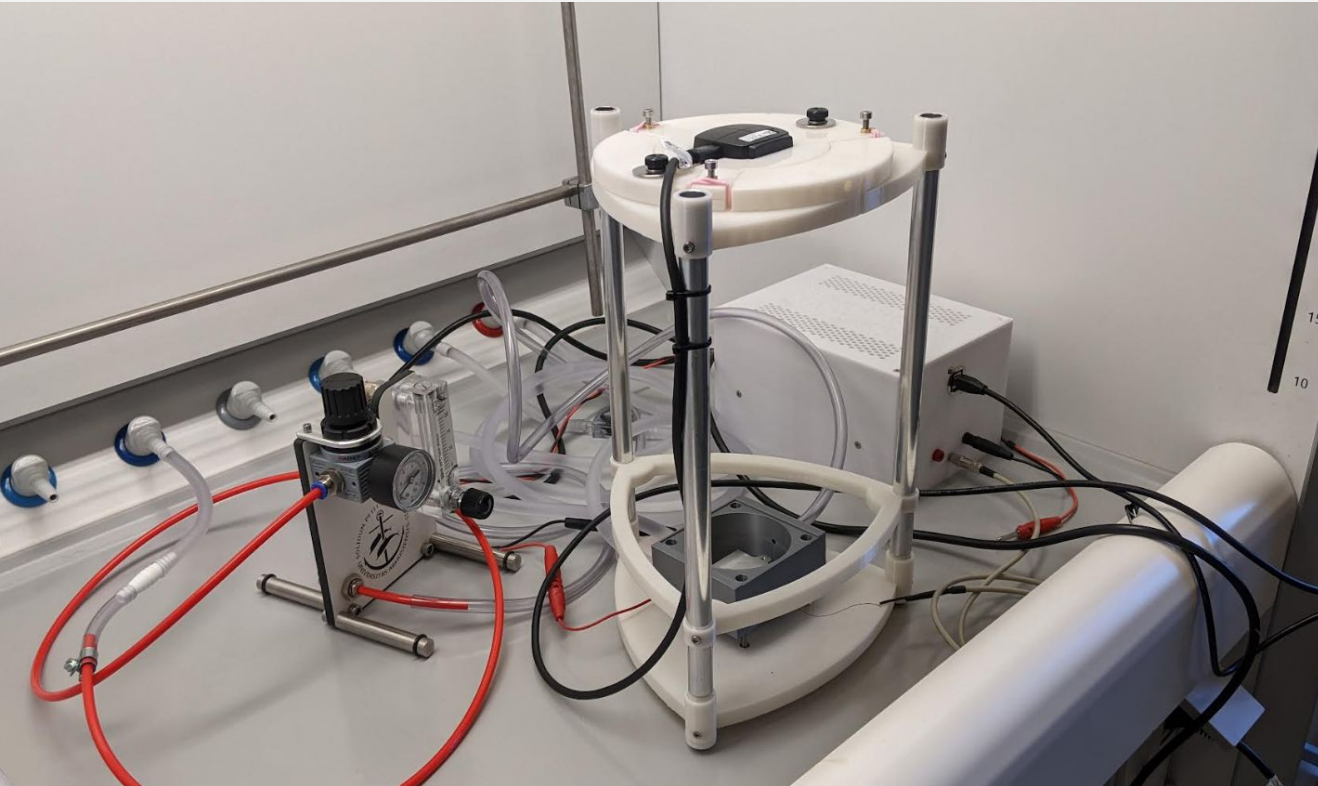
<https://cif-cold-stage.github.io/>

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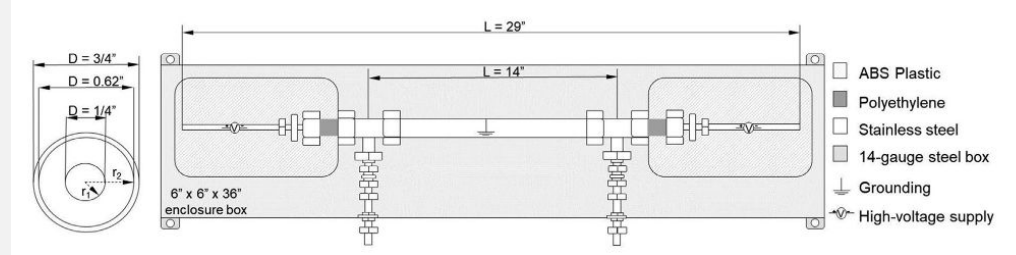
Challenges

- Documentation
- Multiple repositories
- Software/hardware platform aging
- Time requirement to publication
- Means to share back improvements and getting credit (GitHub vs. Zenodo; “paper” vs. “project”)
- **“Skill” of customers (designs, manufacturing, tools)**



The Virtuous Cycle Promise of Open Science

build tool at moderate cost



- answers science question
- gained hands on skills



Student/research group
has a science question

share design improvements



Better Graduates – Faster Science – Cheaper Science – Improved Instrumentation

DOE Office of Science Definition from FOA

SC is dedicated to promoting the values of openness in Federally supported scientific research, including, but not limited to, ensuring that **research may be reproduced** and that the results of Federally supported research are **made available to other researchers**. These objectives may be met through any number of mechanisms including, but not limited to, data access plans, data sharing agreements, the use of archives and repositories, and the use of various licensing schemes.

Themes for Discussion

Incentives

- Time
- Funding
- “Recognition”

Philosophical Questions

- What should we consider as archivable data?
- What types and how should we archive software?
- How do we balance “publication” vs. “maintained project?”
- For whom do we generate these products?

Technology

- Complex tooling landscape
- No 100% satisfactory solutions yet