# Inverse processing of Gschwend's advection test

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# Setup overview

- Basic transport equation $u_t + \boldsymbol{a} \cdot \nabla u = 0$ with $\boldsymbol{a} = (1, 0, 0)^T$ or [linearized] Euler equations with entropy perturbation only
- Initial conditions: Gaussian pulse for entropy
- Uniform Cartesian meshes

# Setup details

Gaussian: $u_0(\boldsymbol{r}) = A\exp(-\alpha|\boldsymbol{r}|^2)$.
What is specified in Gschwend's report:

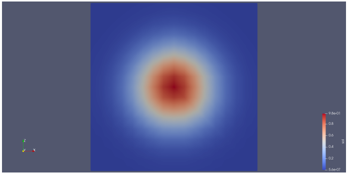
- $A = 1$;
- advection velocity $\boldsymbol{a} = (1, 0, 0)^T$;
- meshes: $8 \times 8 \times 8$, $16 \times 16 \times 16$, ..., $128 \times 128 \times 128$.

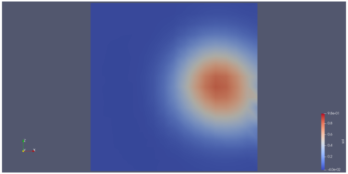
What is not specified:

- $\alpha$;
- maximal integration time;
- domain size (only affect scaling other parameters and time, I assume it to be the unit cube).

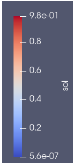
# A look on the Gschwend's results

Initial and final plots:





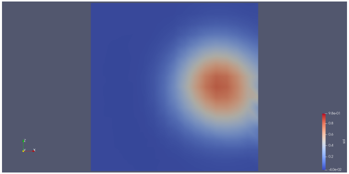
In the first figure, one can see the contour legend.




Mininal value $5.6 \cdot 10^{-7}$ looks to be the value of the pulse at the domain corners. Then $\alpha \approx 28.8$, which yields half-width $\approx 6.44$. From the second figure one can get the maximal integration time.

# Misgiving – 1

One the final plot the pulse clearly reached the output boundary. This should affect the accuracy unless a special care is taken during the reconstruction (that is not too hard since Gschwend ran this case on a special code indended for the transport equation only).



However, in the report the following is stated: *The numerical error is measured before the solution interacts with the boundary.*

# Misgiving – 2

Even on rather coarse meshes where the “interior” error dominates the “boundary” error, the numerical results for the EBR5 scheme (here it is just the 5th order finite-difference scheme) shows greater numerical error than it is stated in the Gschwend’s report.

| Mesh | Error (C), Gschwend | Error (C), my results |
|---|---|---|
| $8 \times 8 \times 8$ | 0.00954 | 0.08854 |
| $16 \times 16 \times 16$ | 0.00237 | 0.01286 |
| $32 \times 32 \times 32$ | 0.00039 | 0.00217 |
| $64 \times 64 \times 64$ | 0.00006 | 0.00051 |
| $128 \times 128 \times 128$ | 0.000007 | 0.00052 |

# Conclusion

- Something is wrong with the setup.
- I can run the calculations as soon the problem will be specified.
- Probably I will need to take larger computational domain or to impose periodical conditions.

- To add my results to the report, I need the style file **RR** (INRIA research report?). Otherwise I will not be able to compile that LaTeX file.