Presentation at the
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EVALUATING THE K-ε TURBULENCE MODEL WITHIN SUSPENDED SEDIMENT TRANSPORT SIMULATIONS

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Overview

Concept

Implementation

Test-cases

- Free shear-layer
- Stably stratified boundary layer
  Erosion
- Deposition of suspended sediments

Summary

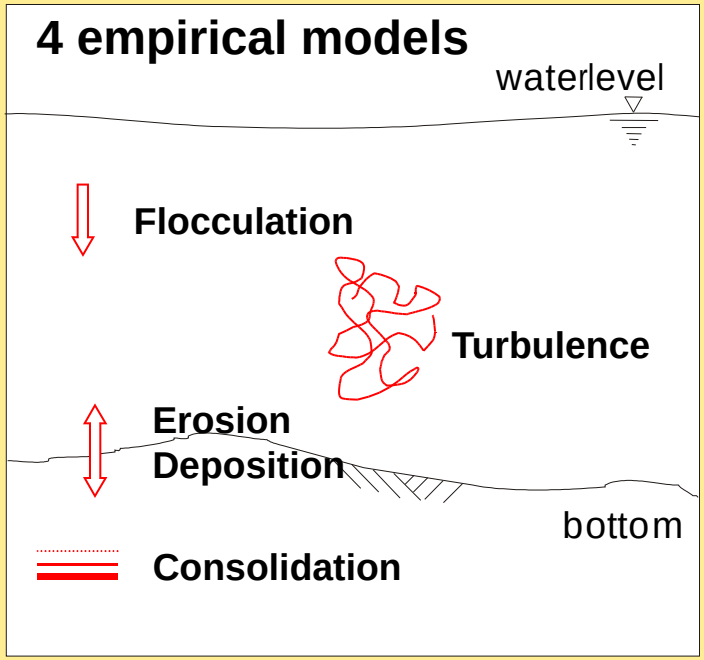
Concept

Accuracy of transport simulations
is unknown and probably low.

Focus on:

- k-ε turbulence-model
- stable density stratification

Transport Simulation for
fine, cohesive, suspended sediment



Transport rate as a measure

Implementation

Software „casu“

Basis

- 3D REYNOLDS-averaged NAVIER-STOKES-equations
- Hydrostatic pressure assumption (shallow free surface flows)
- Numerical algorithm based on the ideas of CASULLI et al.

Extension

- settling sediment
- k-ε turbulence-model

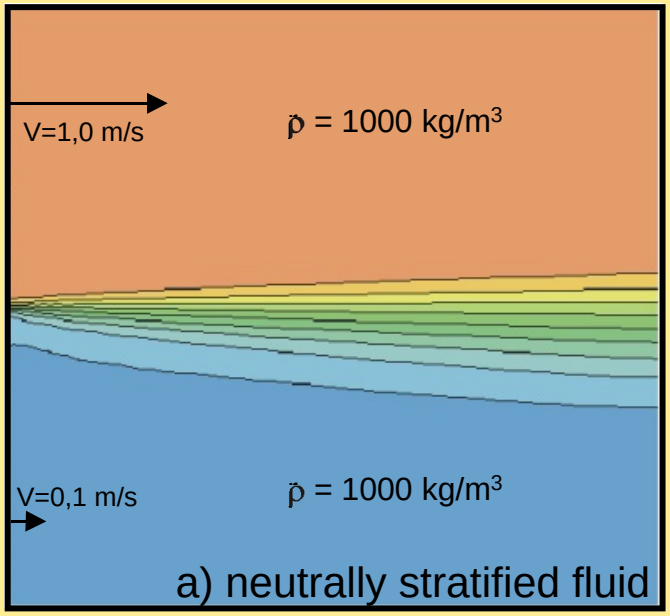
Verification

- Implementation turbulence-model chain of analytical solutions
  (allows to check all terms a 2-eqn. turbulence-model consists of)

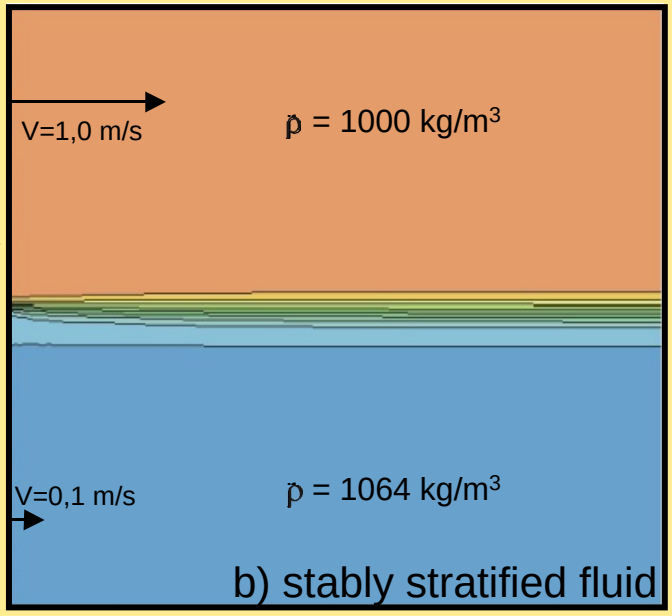
Open source

- http://www.wyrwa.de

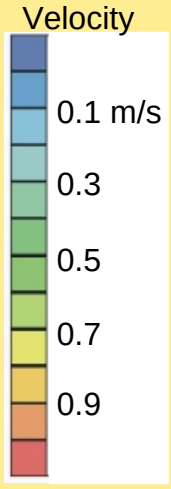
Free (plain) shear-layer



Inflow
Ri_g=0.2

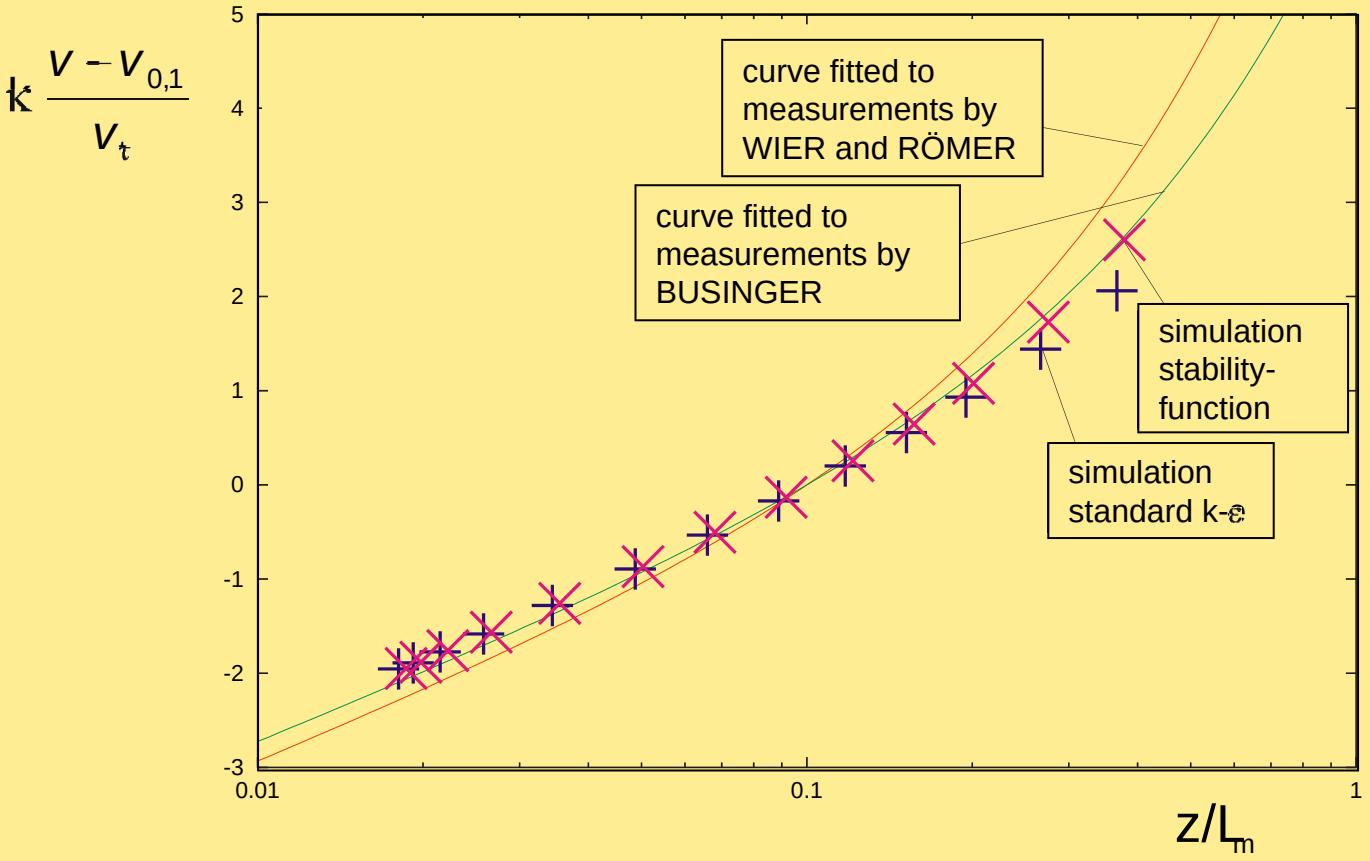


Outflow
Ri_g=0.45



Experiments by
CHU et al.:
Rig = 0,30 ... 0,47

Stably stratified boundary layer

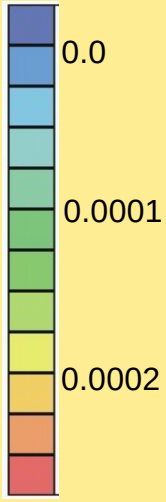


Extension of the k-ε-model with GALPERIN stability function

L_m - MONIN-OBUKHOV length scale

Erosion

Conc. volume fraction



Longitudinal section, concentration
length 2000 m, water depth 10 m

standard k-ε

$\tau_b = 1.35 \, N/m^2$

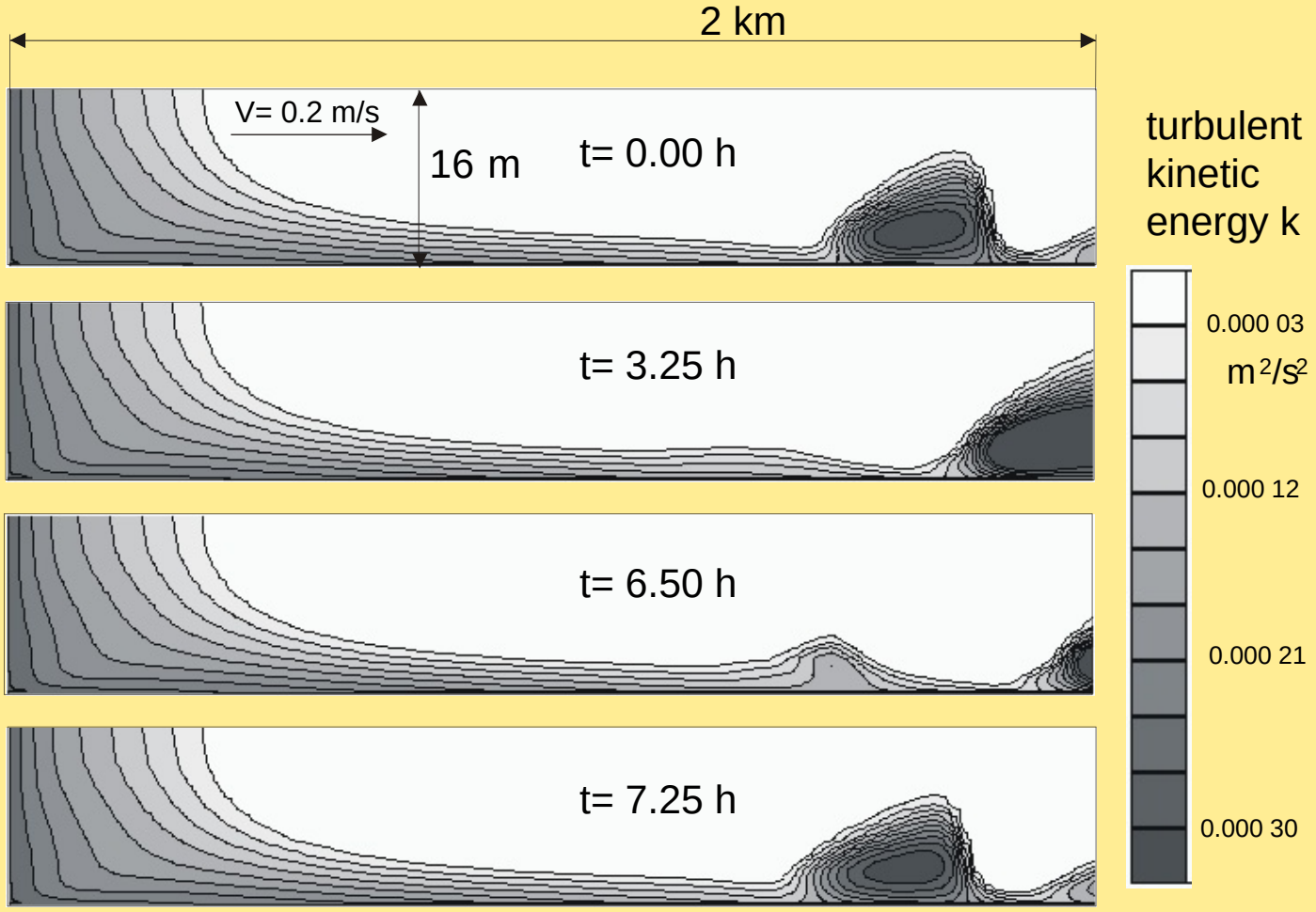
standard k-ε with
GALPERIN stability function

$\tau_b = 1.17 \, N/m^2$

bottom friction
end of the channel

Erosional Mass Flux
42% higher
(KRONE erosion model)

Deposition


2 km
V= 0.2 m/s
16 m
t= 0.00 h
t= 3.25 h
t= 6.50 h
t= 7.25 h
turbulent kinetic energy k
0.000 03
m²/s²
0.000 12
0.000 21
0.000 30

Summary

- Open source software “casu” coded and verified

  - stably stratified free shear-layer:
    qualitative agreement
    specific demand for more relevant experiments

  - 42% error in the erosional mass flux

  - Deposition
    non stationary process.

- **increased experimental evidence + improved models = quantifiable error margin**