



دومین نشست دستاوردهای اساتید و دانش آموختگان عمران شریف  
پنجشنبه ۲۱ بهمن ماه ۱۳۹۵



# 25 Years of Research in Water and Environmental Engineering Division

Mirmosadegh Jamali, Ph.D.

Department of Civil Engineering  
Sharif University of Technology

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# Research topics

- Water Resources Management
- Environmental Engineering (water Quality, air quality, wastewater treatment)
- Hydraulics
- Environmental Fluid Mechanics
- Numerical and Experimental Works

# What is EFM?

- The study of flow and transport in surface water, groundwater, and atmosphere.
  - Environmental significance
  - Heat and mass transfer
  - Turbulence and mixing
  - Stratification

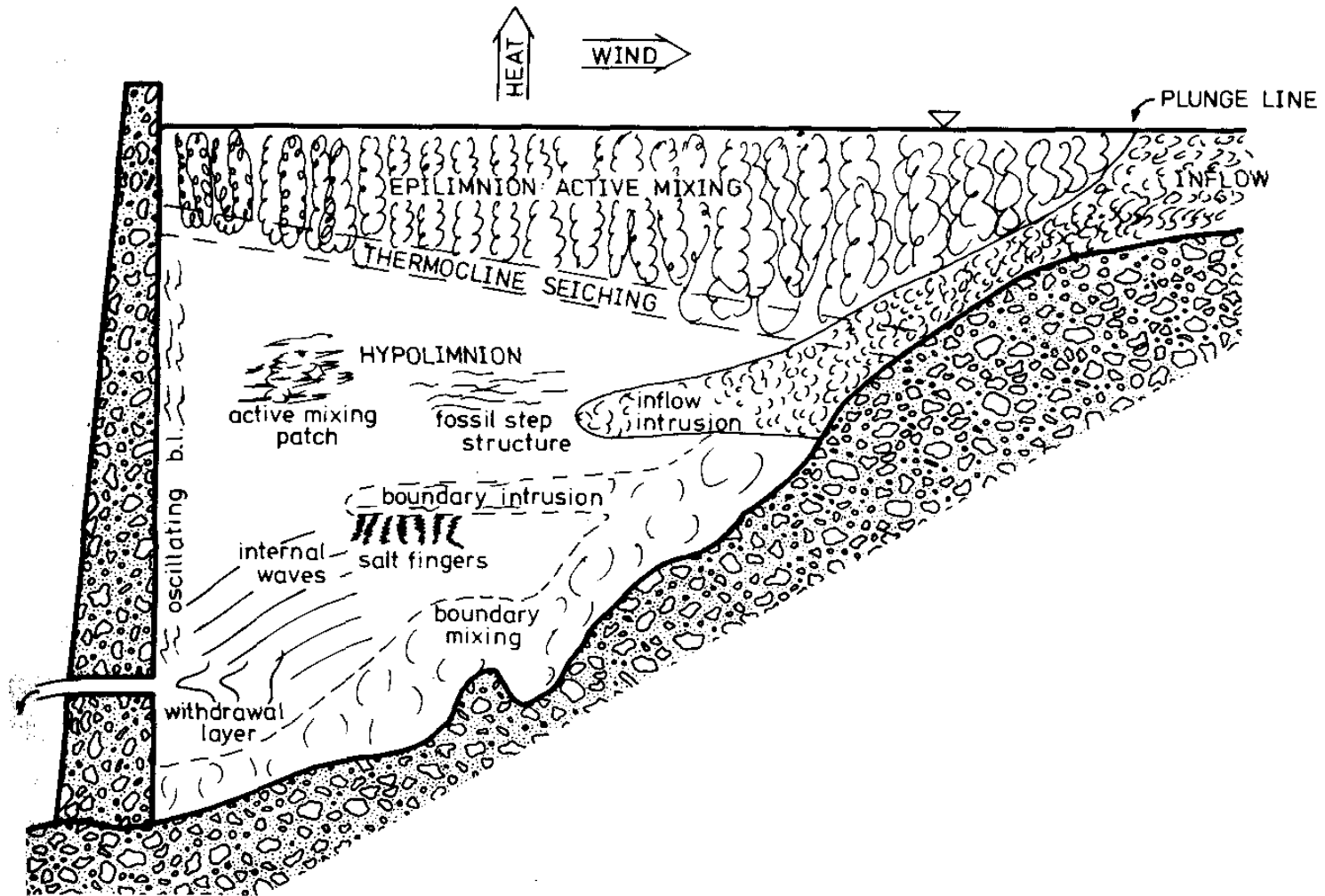
# Stratification

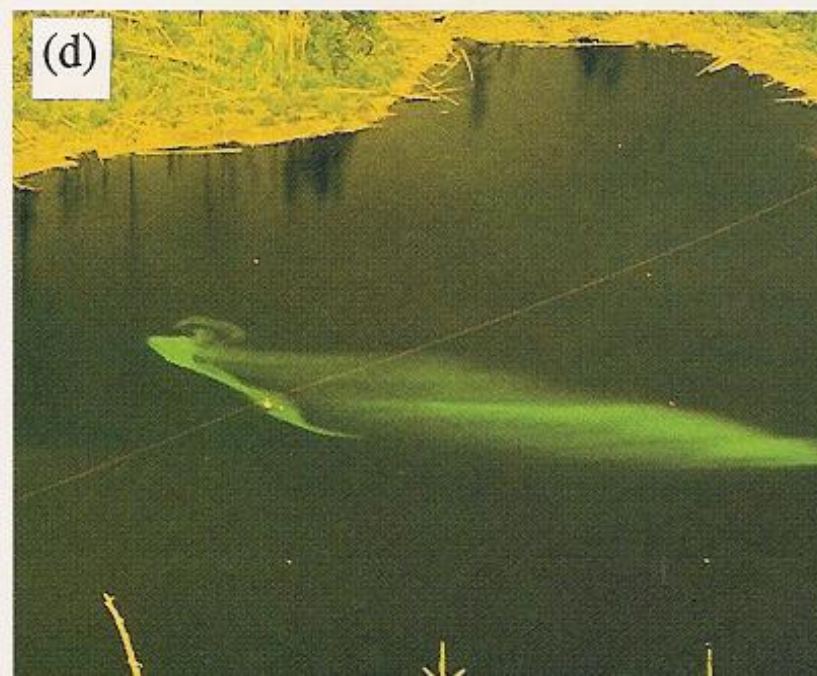
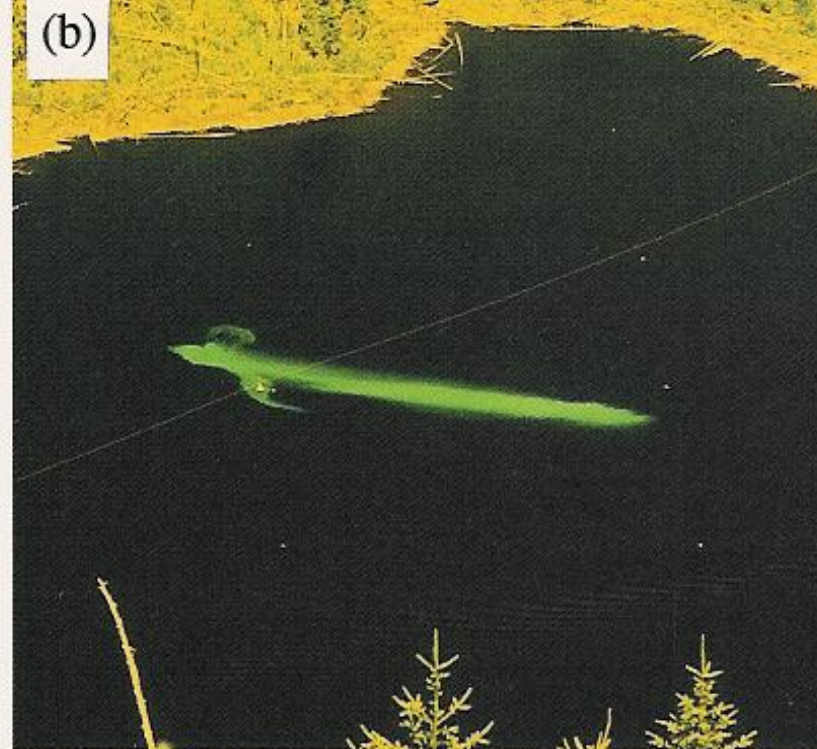
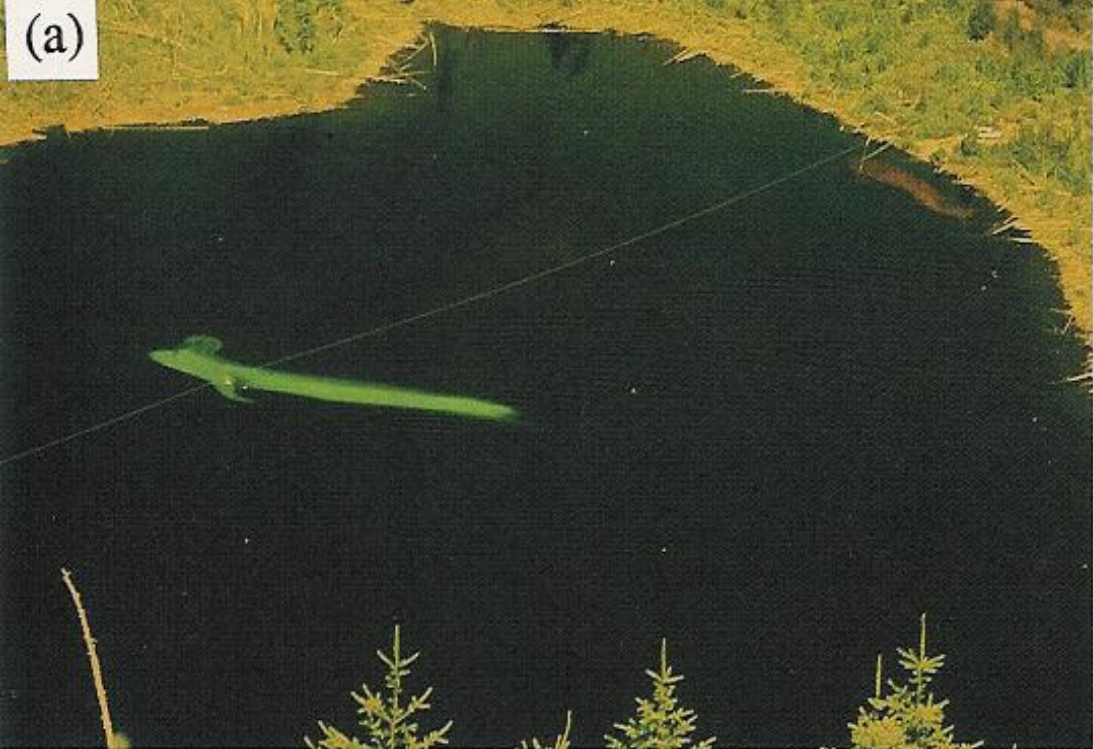
- Most fluids are density stratified
  - Variations in temperature, salinity, etc.
- Very small density differences
  - Enhance horizontal motions
  - Inhibit vertical mixing
  - Have important environmental consequences

# Examples of topics in EFM

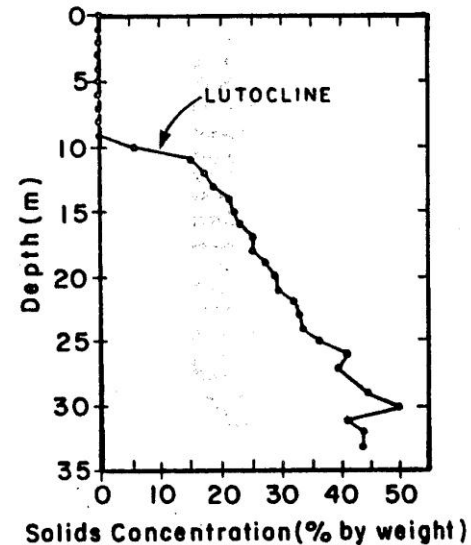
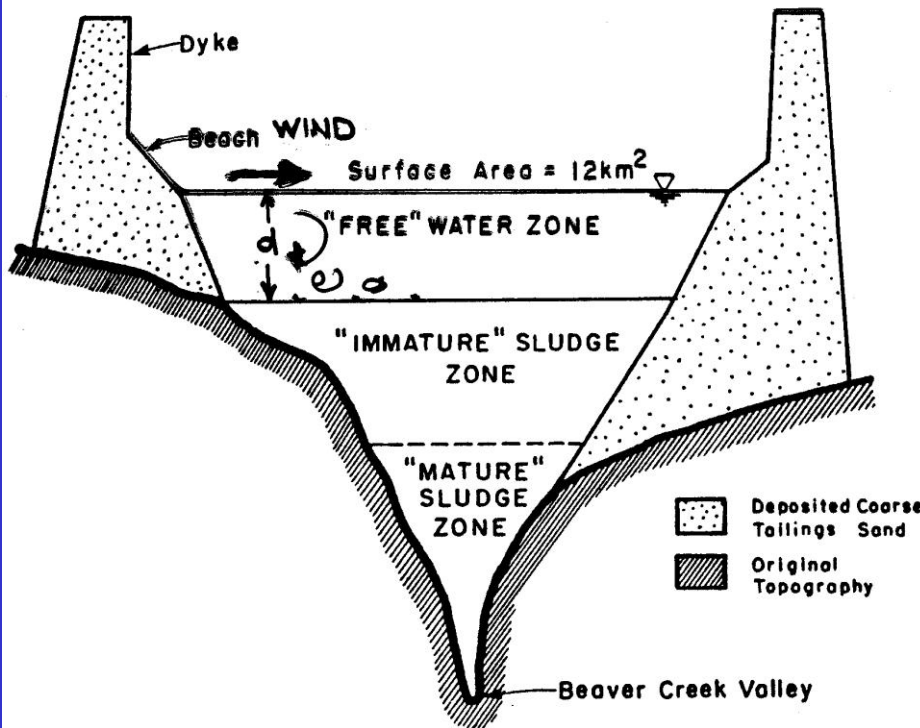
- Dispersion of contaminants in rivers, lakes, seas, groundwater, and atmosphere
- Dynamics of lakes and reservoirs
- Internal waves
- Selective withdrawal
- Two-layer hydraulics
- Wave interaction
- Hydrodynamic Stability
- Numerical, analytical, or laboratory modeling

# Mixing in reservoirs





# Mixing in tailings ponds



$$d = 0.00187 \left( \frac{U^2 F^2}{g} \right)^{\frac{1}{3}} \ln \left[ 0.037 \frac{R (g F U^4)^{\frac{1}{6}}}{U_t} \right]$$

- d - Required depth
- U - Wind speed
- F - Fetch
- $U_t$  - Threshold velocity?



# Island Copper Empty



April 9, 1996

# Island Copper Full



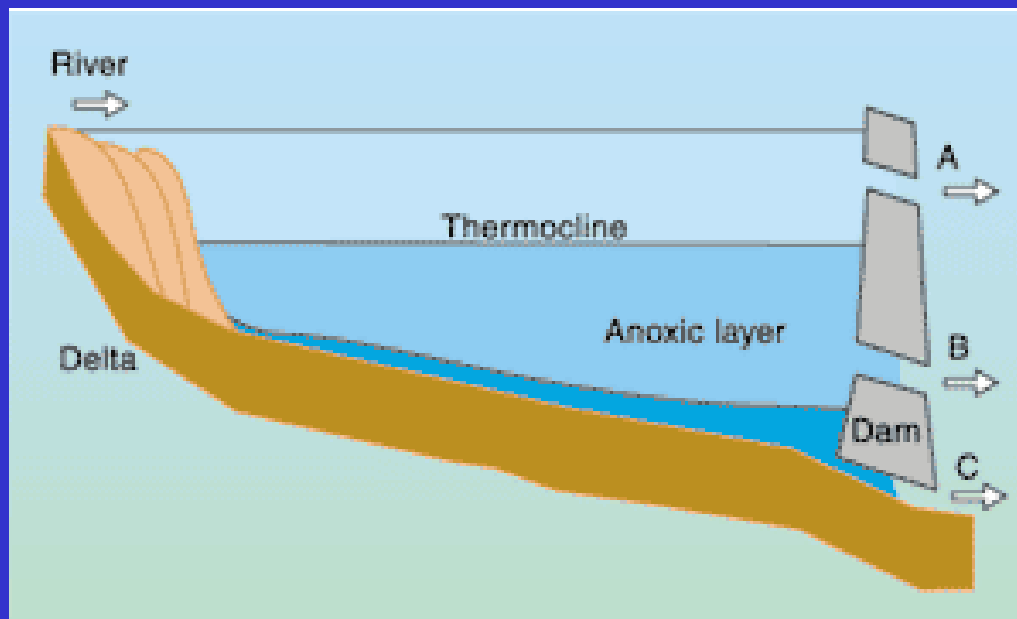
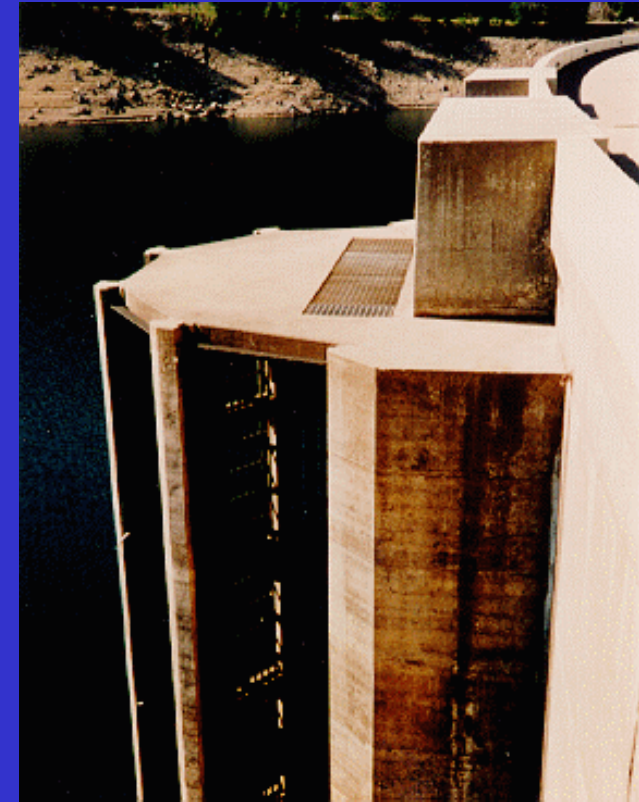


Fig. 5: different levels of possible water discharge from a dam

# Selective-withdrawal system

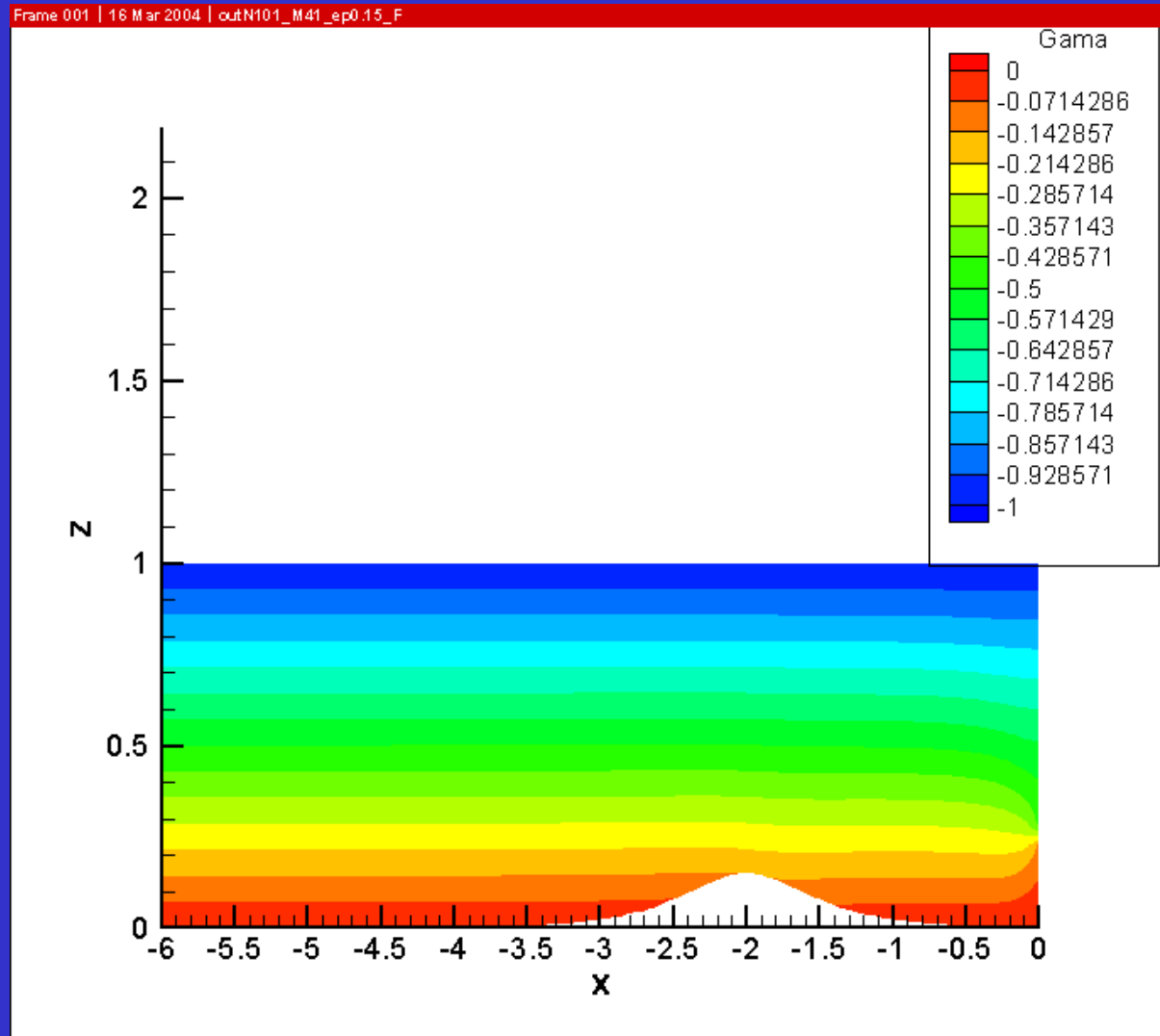


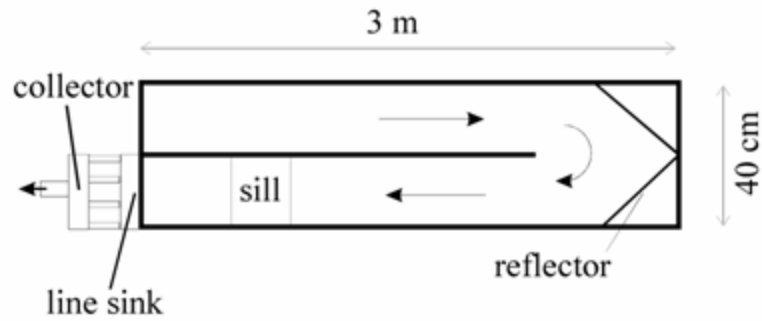
Hungry Horse dam,  
built in 1952



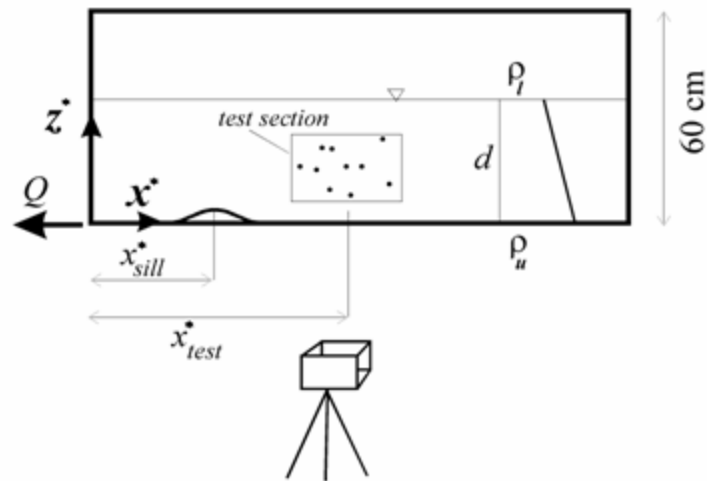
Selective  
withdrawal  
system installed  
in 1995

# Selective Withdrawal over a sill

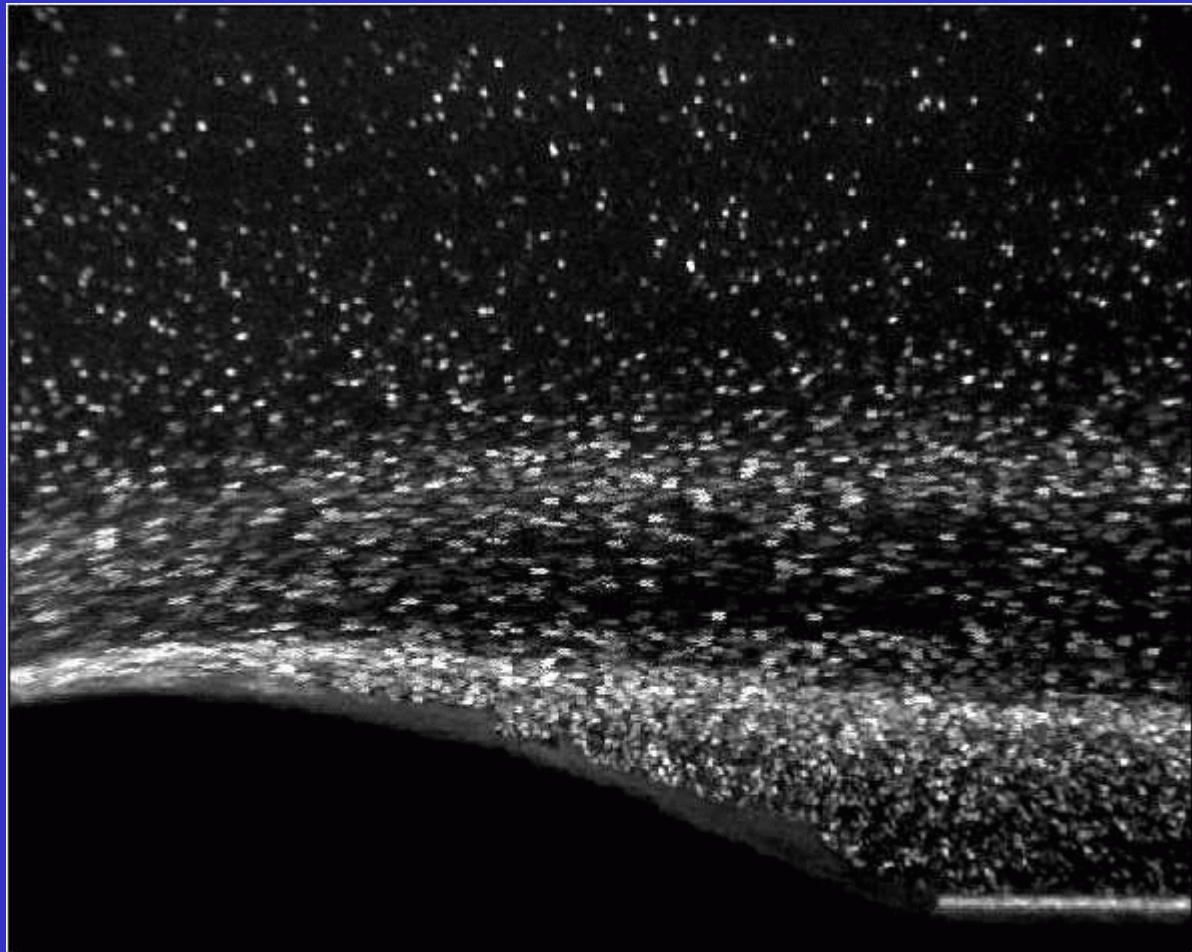




PLAN VIEW

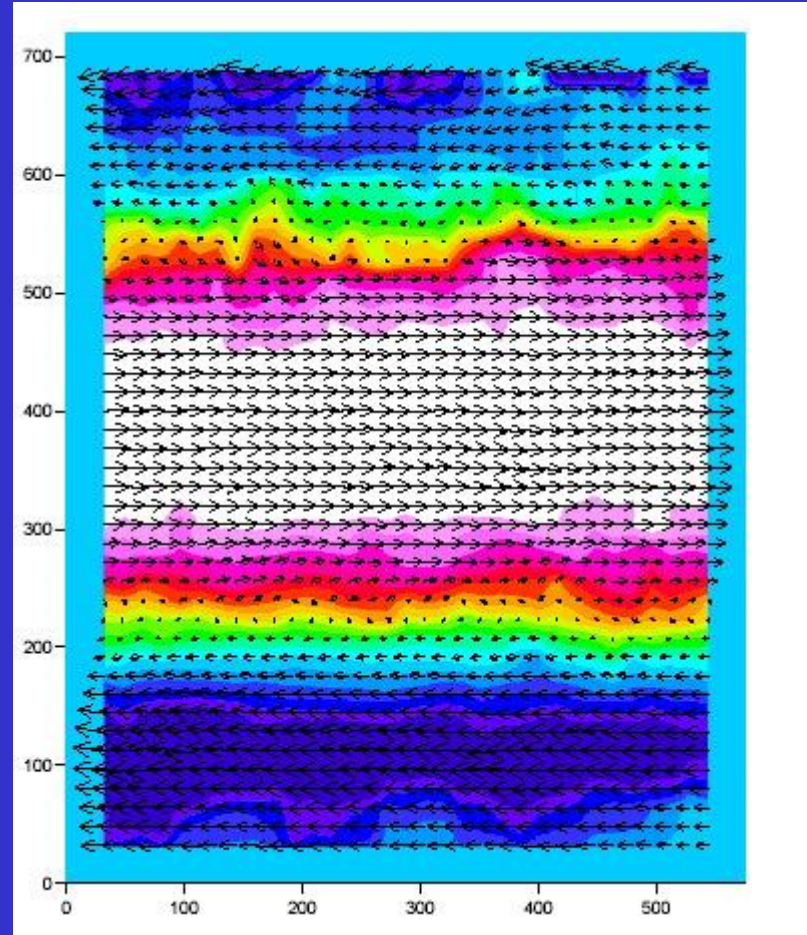
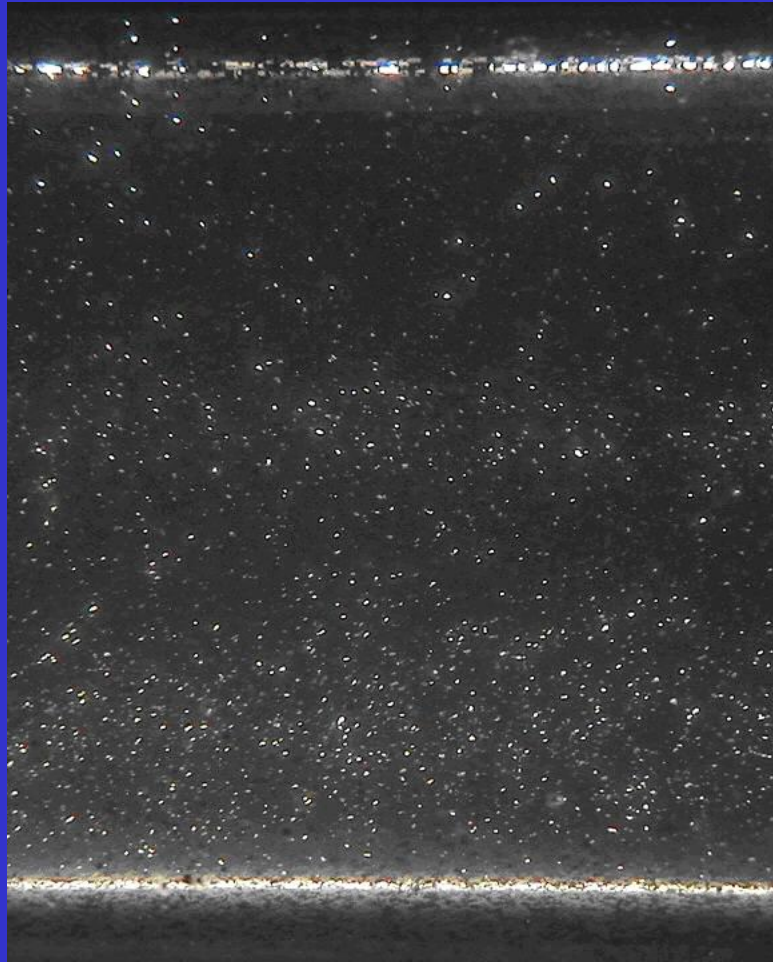


SIDE VIEW







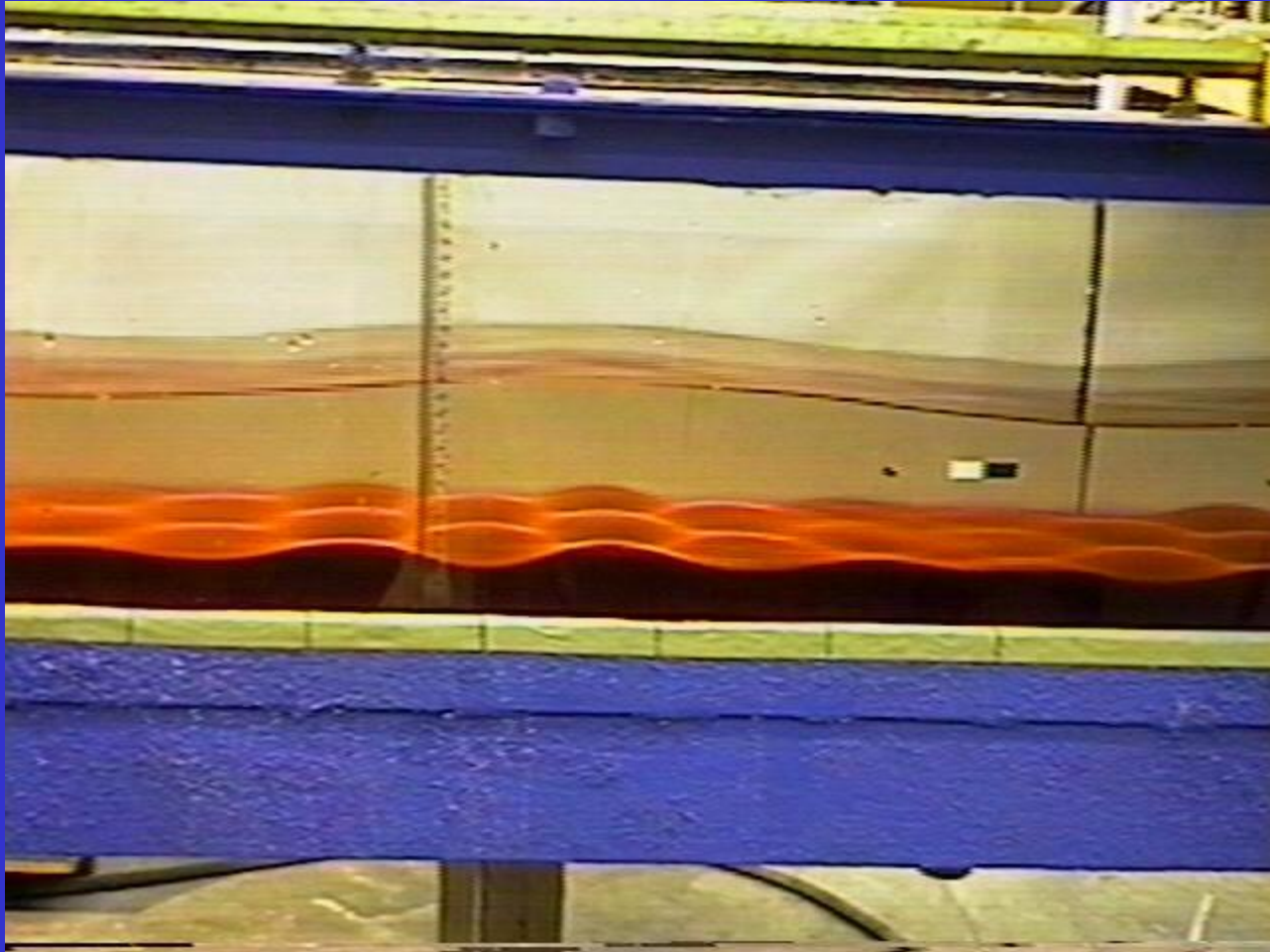


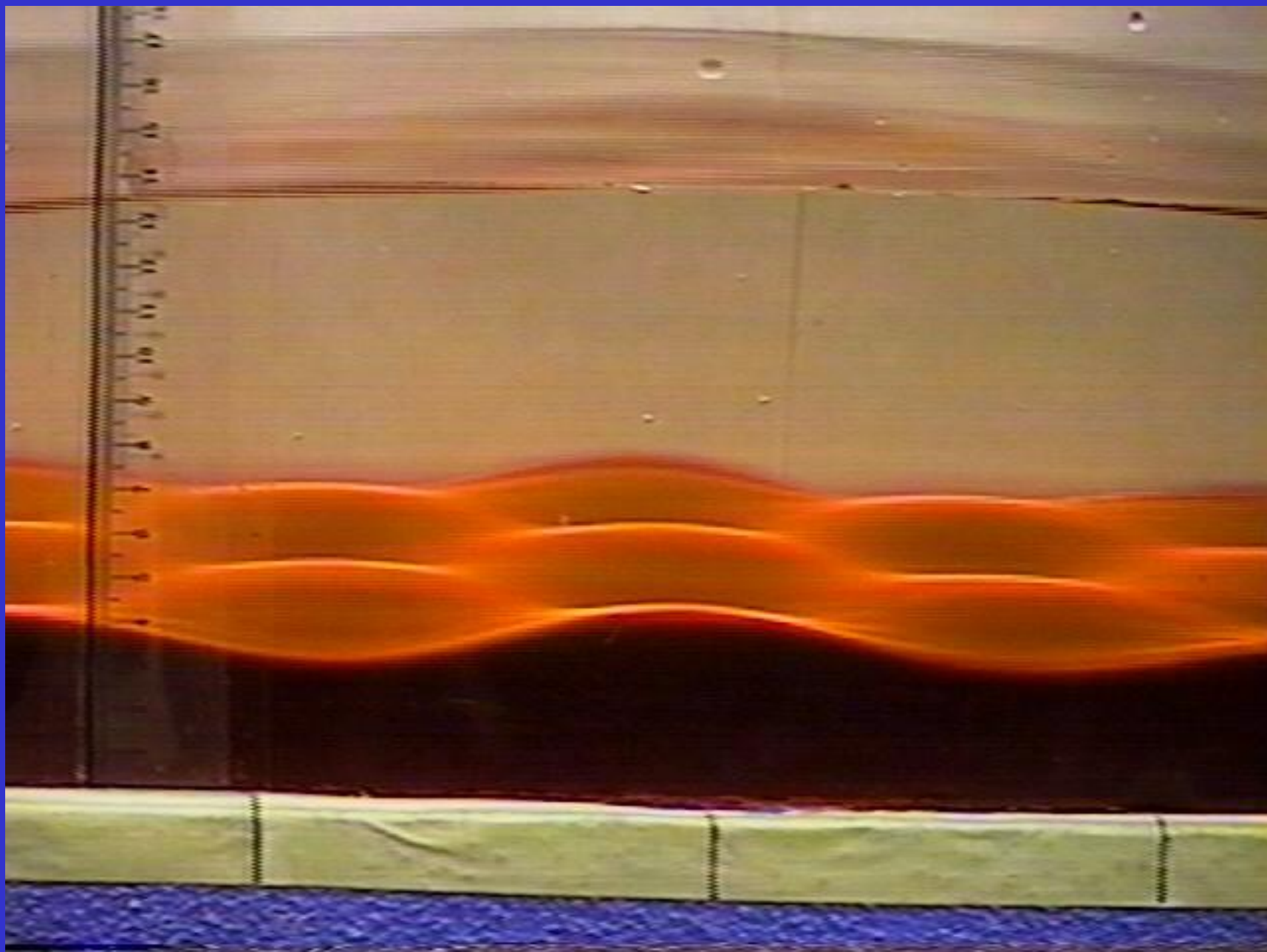


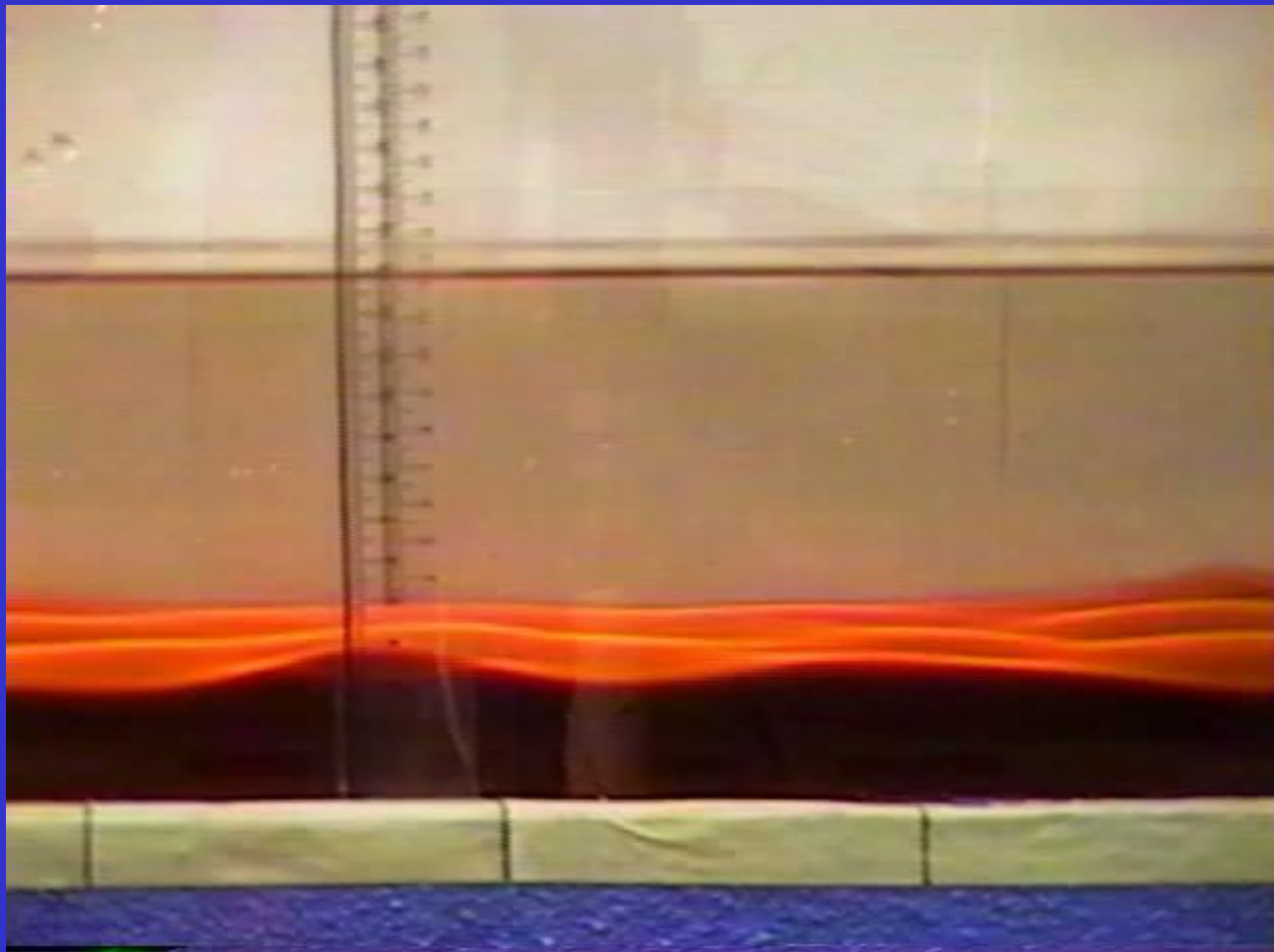
# Internal Waves

- A major type of motion within a stratified body
- Play an important role in mixing and transport in reservoir
- Long characteristic time-scale

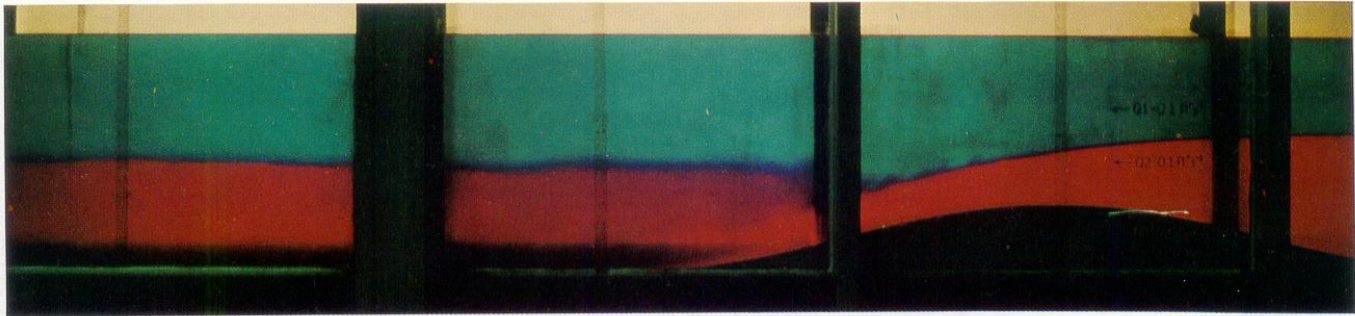
# Interaction of Waves



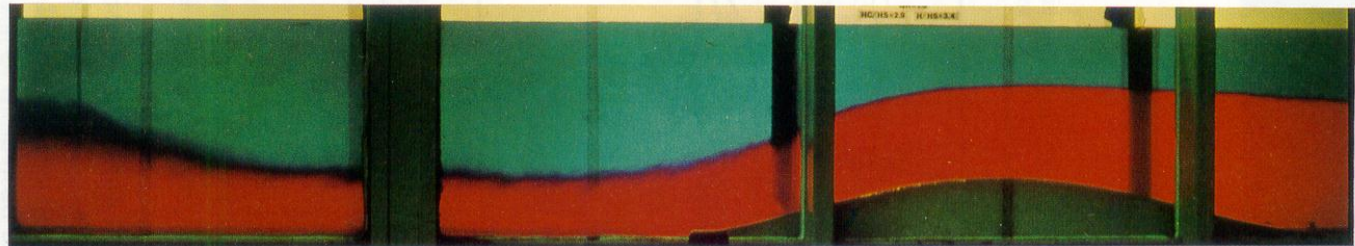




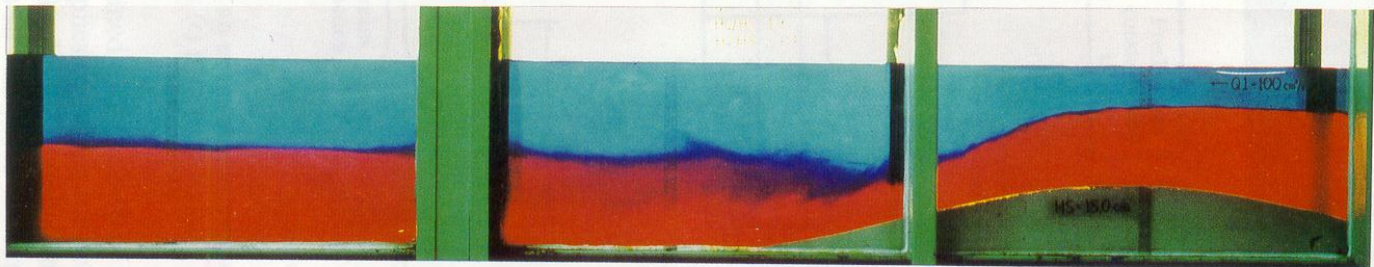
# Two-layer Hydraulics



(b)

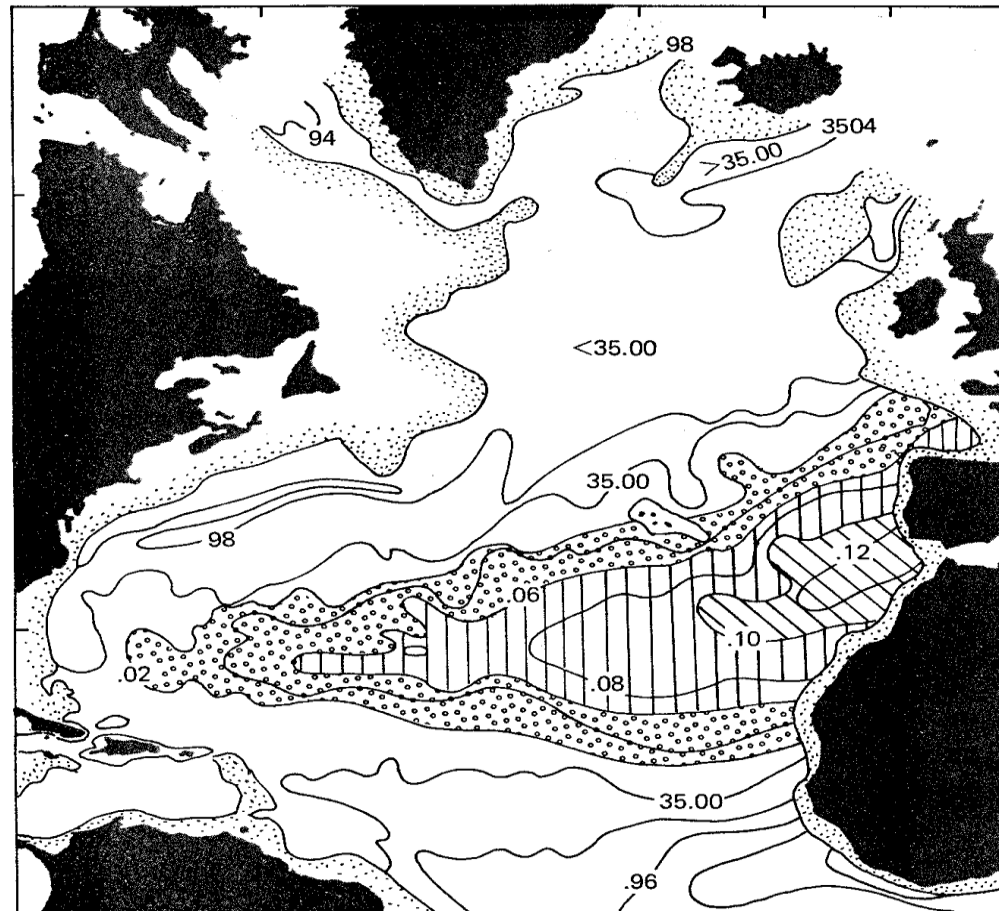
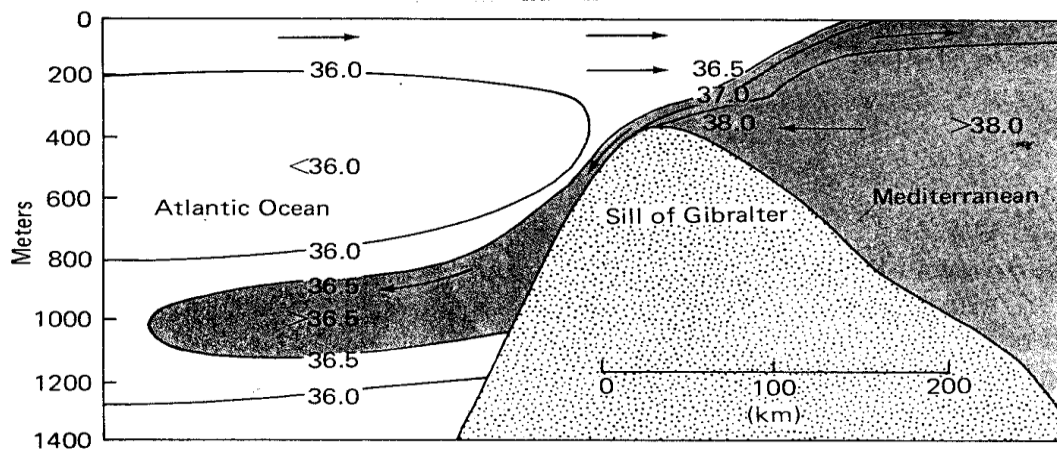


(c)









# Hamilton Harbour Side

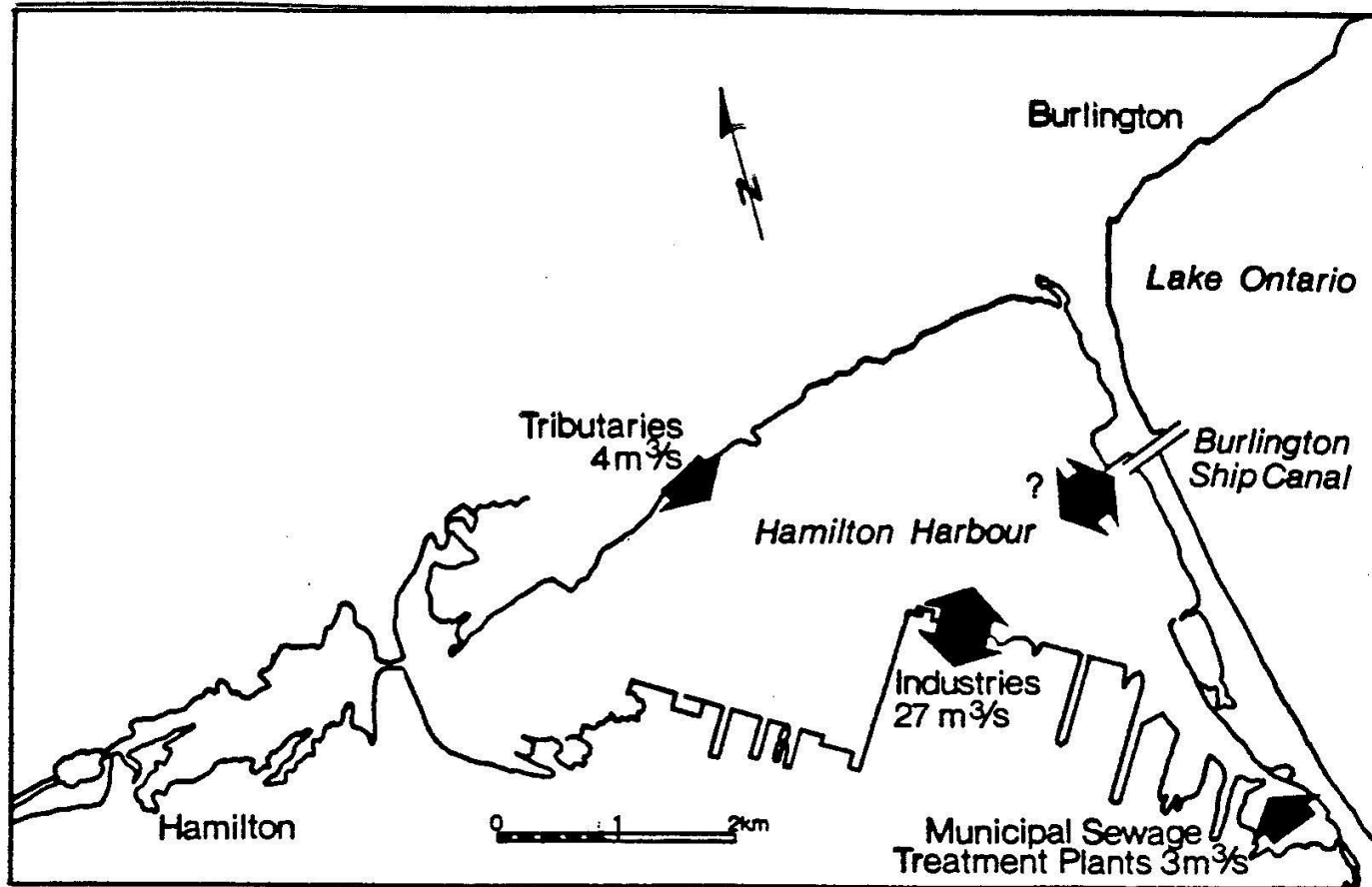


Figure 1. Map of Hamilton Harbour showing major inflows and exchanges.

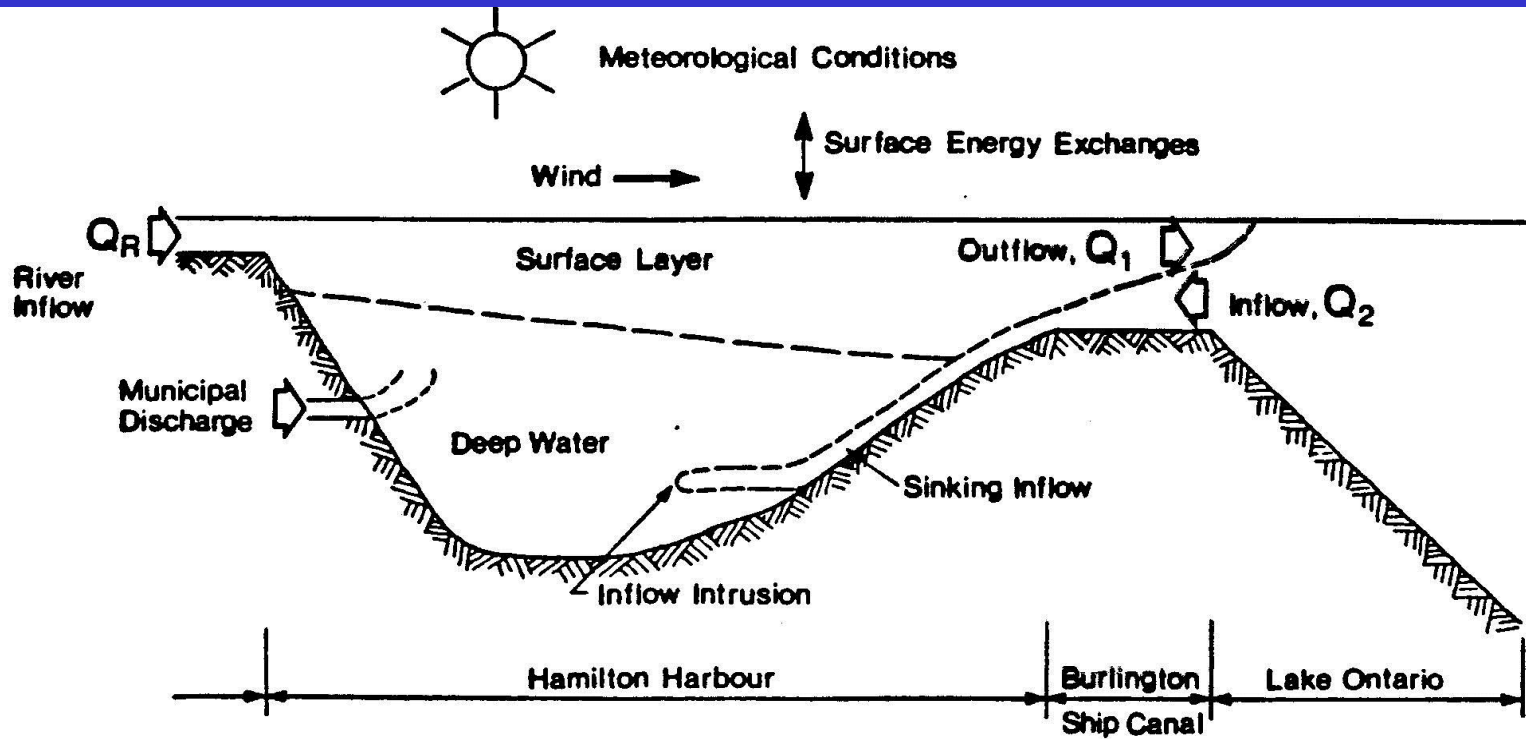
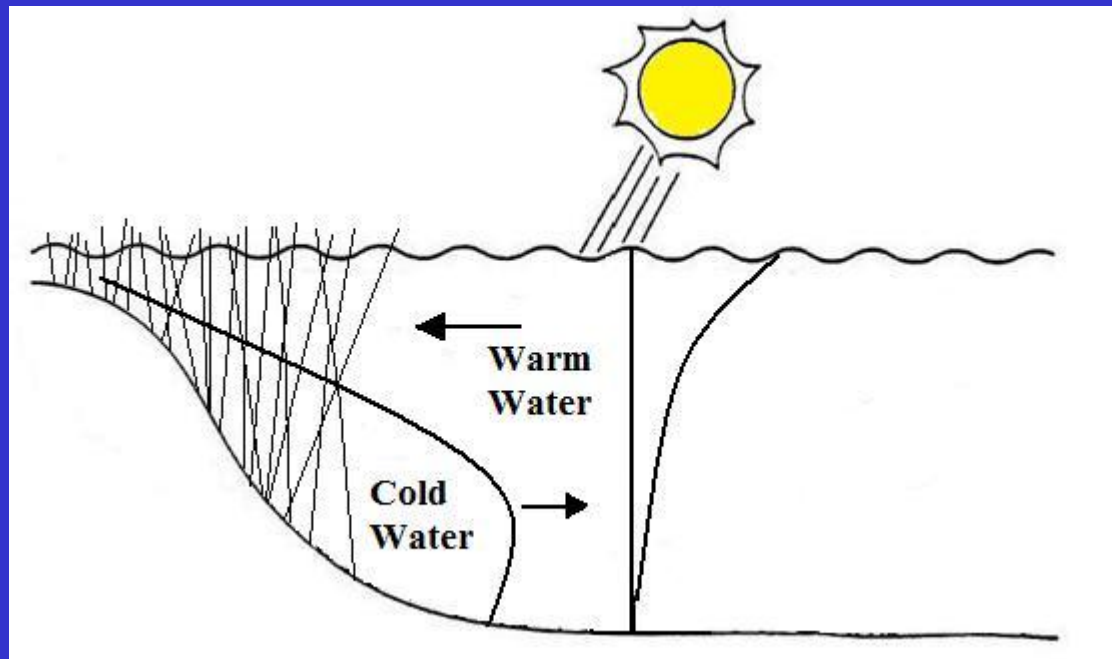


Figure 2. Schematic of the two layer exchange flow between Hamilton Harbour and Lake Ontario, applicable from May to October.

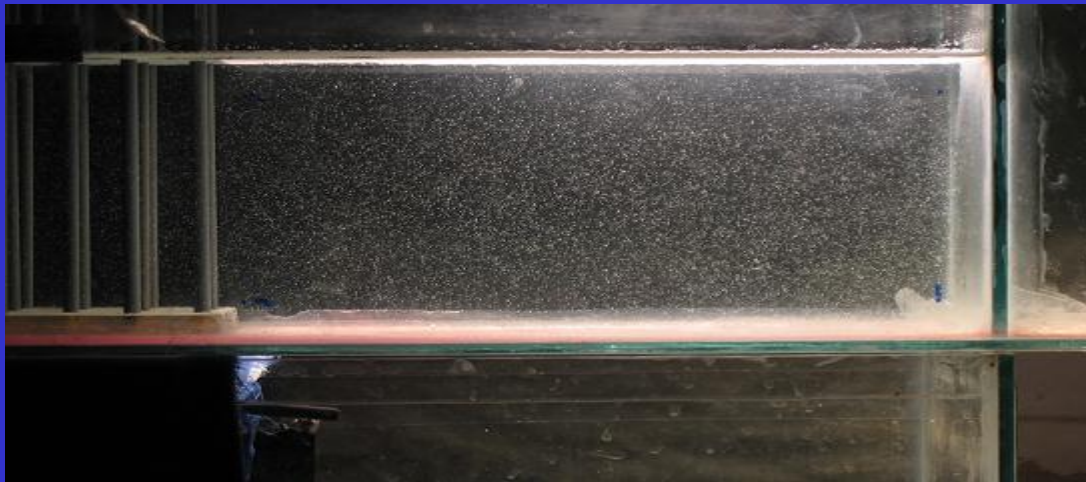


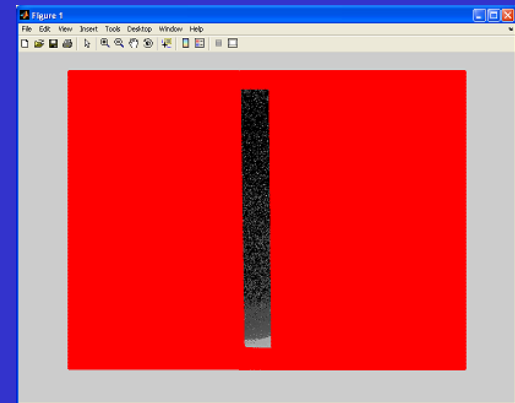
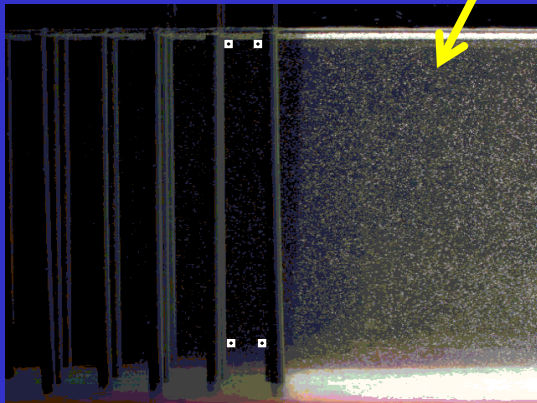
# Exchange flow in canopies



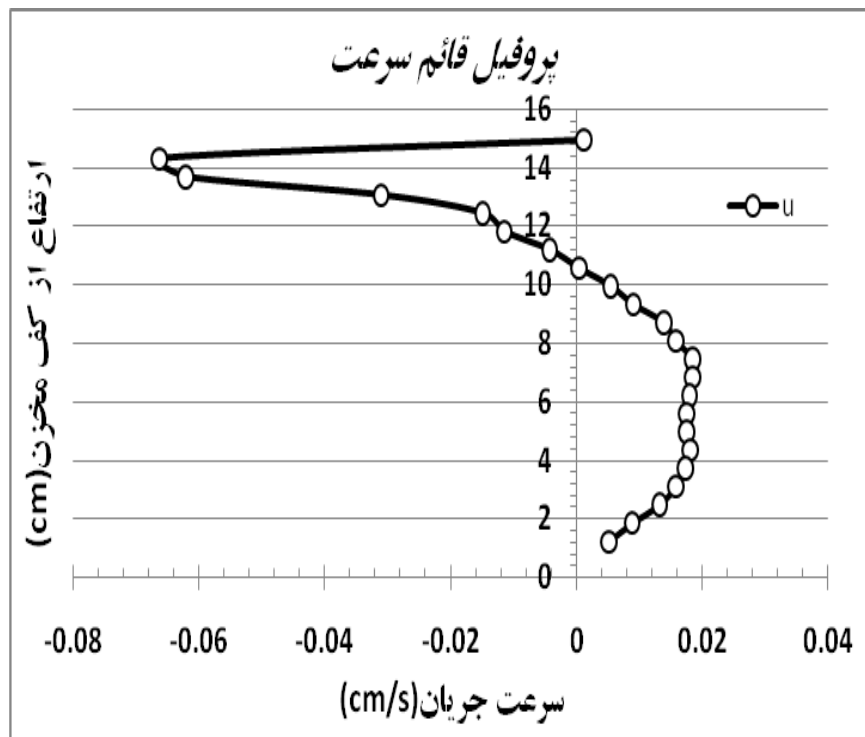
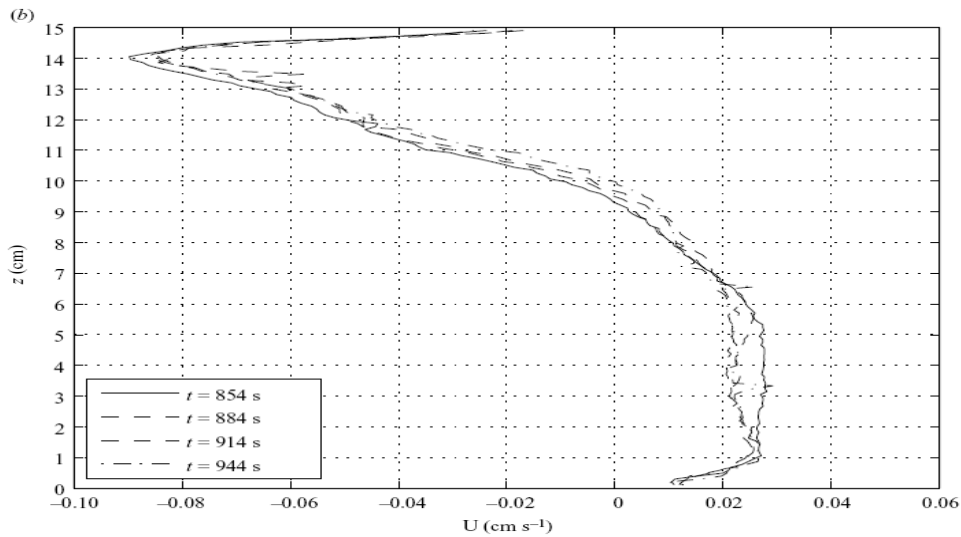


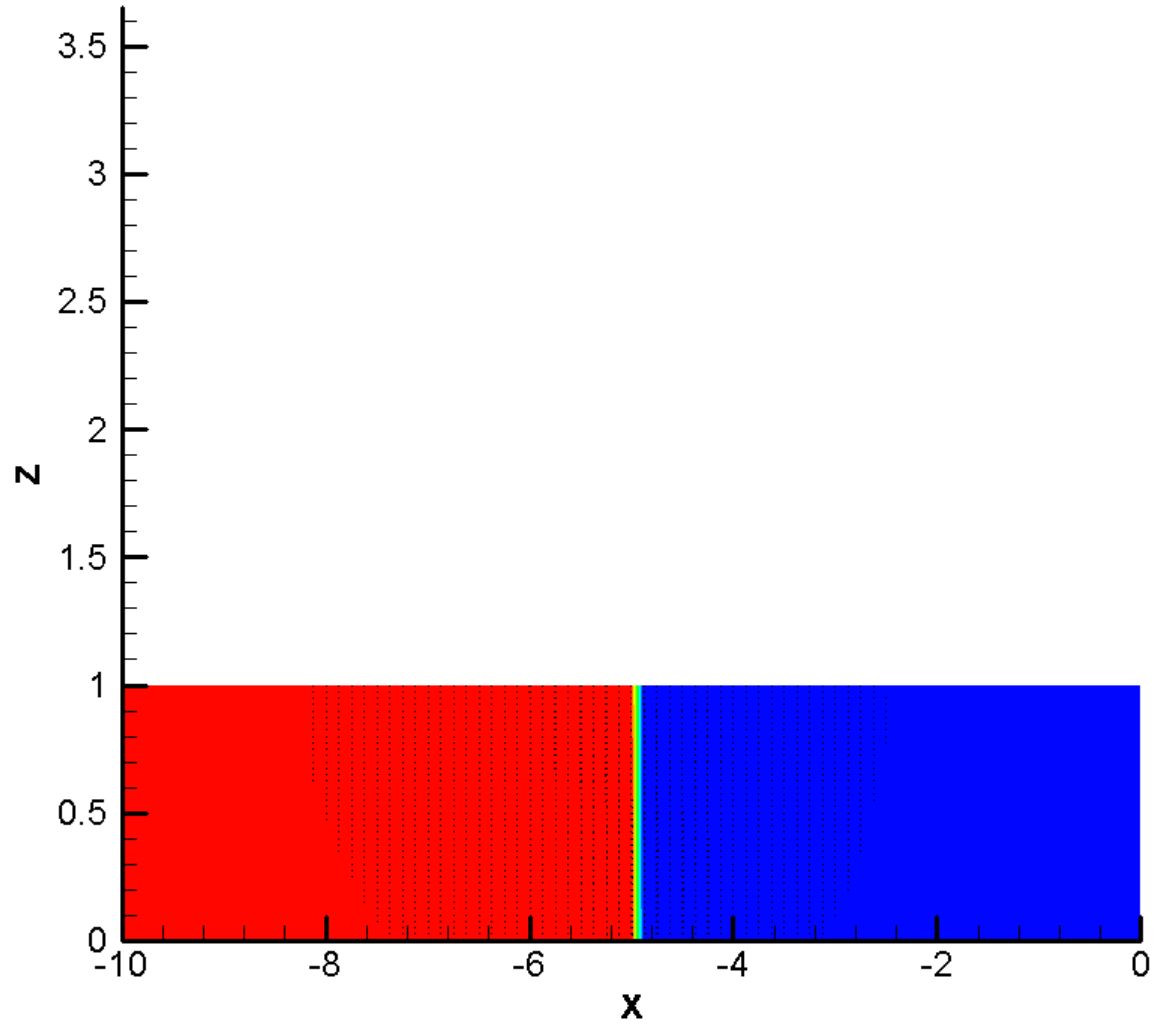
# Time-dependent exchange flow











# Conclusions

- Many environmental problems are fluid mechanics problems
- EFM is a fast-growing multidisciplinary field in fluid mechanics
- Many unexplored problems in EFM