REPORT ON THE PRELIMINARY RESULTS OF THE PROJECT "GOVERNING PARAMETERS FOR THE EQUATION OF TURBULENT DIFFUSION IN THE PBL OF A ROTATING FLOW"

(02lo)

1) - *OBJECTIVE OF THE PROJECT*

THE SCIENTIFIC OBJECTIVE OF THE PROJECT WAS TO TRY TO UNDERSTAND THE DIRECT INFLUENCE OF THE EARTH ROTATION (CORIOLIS PARAMETER) ON THE TURBULENT DIFFUSION MECHANISMS IN THE WHOLE PBL.

ITS IMPLEMENTATION, WHICH DREW INSPIRATION FROM A THEORETICAL APPROACH WORKED OUT BY WIPPERMANN AND YORDANOV (1972), HEREAFTER [**WY72**], HAS BEEN THE VERIFICATION, THROUGH LABORATORY EXPERIMENTS IN A LARGE HYDRAULIC ROTATING TANK IN DYNAMICAL SIMILITUDE, OF THE UNIVERSAL FUNCTIONS PREDICTED BY THEIR THEORY OF TURBULENT DISPERSION COEFFICIENTS UNDER THE INFLUENCE OF THE CORIOLIS PARAMETER.

2) - *RATIONALE*

THE SPACE AND TIME DISTRIBUTIONS OF AIRBORNE POLLUTANTS RELEASED INTO THE ATMOSPHERE OF THE ROTATING EARTH, EITHER AS HOT PLUMES FROM ELEVATED STACKS OF LARGE INDUSTRIAL AND POWER PLANTS, OR AS EXTENDED SURFACE EMISSIONS FROM URBAN REGIONS MARKED BY HEAT AND MOISTURE ISLANDS, DEPEND ON THE WHOLE DEPTH, OR A SUBSTANTIAL FRACTION, OF THE PLANETARY BOUNDARY LAYER (PBL) OF THE ATMOSPHERE.

IN THESE SITUATIONS, THE SPREAD OF POLLUTANT PLUMES OR CLOUDS WILL NOT BE DETERMINED ANY MORE ENTIRELY BY ATMOSPHERIC TURBULENCE CONDITIONS NEAR THE SURFACE, BUT NEW TURBULENCE SCALES SHOULD BE SOUGHT, BASED ON LOCAL AND NON-LOCAL PROPERTIES OF THE TURBULENT FLOW IN THE WHOLE PBL (NIEUWSTADT, 1974; SORBJAN, 1978 AND 1995).

NOTWITHSTANDING THIS, THE INPUT DATA OF MOST NUMERICAL AND ANALYTICAL MODELS, APPLIED FOR ASSESSING SPACE AND TIME PATTERNS OF POLLUTANT CONCENTRATIONS, STILL MAKE USE OF PARAMETERS RELEVANT TO SURFACE CONDITIONS.

THEN, IT FOLLOWS THAT SEEKING FOR RELIABLE RELATIONSHIPS, CONNECTING EASY OF ACCESS SURFACE TURBULENT SCALES WITH THE EARTH-ROTATION-GOVERNED DYNAMICS OF THE WHOLE PBL, STILL APPEARS TO BE A TOPICAL SUBJECT, BECAUSE IT COULD HELP REVEAL SOME REASONS OF MANY DISCREPANCIES, STILL UNSOLVED, AMONG FIELD OBSERVATIONS AND MODEL PREDICTIONS.

THIS EFFECT OF THE ROTATION ON THE DIFFUSION PARAMETERS, WHICH OPERATES INDEPENDENTLY OF THE DISTORTIONS OF THE MEAN FLOW (EVEN IF CAN BE RELATED TO THEM), IS NOT EASILY FIT FOR BEING ORGANIZABLE IN THE FRAME OF A THEORY BASED ON THE PRIMITIVE EQUATIONS GOVERNING THE TURBULENT DISPERSION INTO THE BPL.

[**WY72**] DEMONSTRATED THAT THE TURBULENT STRESSES, AS WELL AS THE DIFFUSION COEFFICIENTS AND MIXING LENGHTS, WHEN MADE NON-DIMENSIONAL WITH INTERNAL SCALES OF THE PBL (ESSENTIALLY THE FRICTION VELOCITY) IN A REFERENCE FRAME WHOSE X-AXIS IS PARALLEL TO THE SURFACE STRESS, DO NOT DEPEND ON EXTERNAL SCALES (GEOSTROPHIC WIND AND ROUGHNESS LENGTH Z_O) FOR $Z >> Z_O$, WHERE SURFACE-ROSSBY-NUMBER SIMILARITY EXISTS.

SO DO THEIR VERTICAL PROFILES AS A FUNCTION OF THE NON-DIMENSIONAL HEIGHT OF THE PBL.

WITH SIMILAR ARGUMENTS, [**WY72**] DEMONSTRATED THAT WHEN THE TURBULENT DIFFUSION EQUATION OF PASSIVE TRACERS IS MADE NON-DIMENSIONAL WITH INTERNAL SCALES, IT EXISTS SURFACE-ROSSBY-NUMBER SIMILARITY FOR $Z >> Z_O$, WHICH MEANS THAT THE DEFECT LAWS OF VELOCITY AND THE VERTICAL PROFILE OF THE TURBULENT DIFFUSION ARE UNIVERSAL FUNCTIONS OF Z ONLY.

IN THIS SITUATION, THE NON- DIMENSIONAL TRACER CONCENTRATION:

$$S = \hat{s}\kappa u_*^3 / \left(bf^2\right)$$

WHERE B IS THE STRENGTH [G SEC^{-1}] OF THE SOURCE SUBJECT TO THE EQUATION OF CONTINUITY IN THE STATIONARY CASE:

$$\iint \hat{u}\,\hat{s}\,dy\,dz = b$$

BECOMES INDEPENDENT OF EXTERNAL PARAMETERS FOR $Z >> Z_O$.

OUR PROJECT ADDRESSED, IN PARTICULAR WAY, THE VERIFICATION OF THE [WY72] UNIVERSAL FUNCTION OF THE NON-DIMENSIONAL DISPERSION COEFFICIENT:

$$K_{x,y,z} = \frac{k_{x,y,z}}{\kappa^2 u_*^2 / f}$$

WHERE $K_{X,Y,Z}$ IS THE DIMENSIONAL COEFFICIENT OF TURBULENT DIFFUSION ALONG THE X,Y,Z DIRECTIONS RESPECTIVELY.

UP TO NOW, THIS THEORETICAL ASSUMPTION HAS BEEN CHECKED WITH SCARSE AND POOR EXPERIMENTAL OBSERVATIONS.

ON THE CONTRARY, IN LABORATORY EXPERIMENTS IN ROTATING TANK, ALL THE ABOVE SCALES AND PARAMETERS CAN BE REPRODUCED IN A VERY ACCURATE WAY.

IN PARTICULAR, A WIDE RANGE OF LOW ROSSBY NUMBERS CAN BE INVESTIGATED IN SUCH A FACILITY, BY CONVENIENTLY CHANGING ITS ROTATION SPEED.

3) - *THE LABORATORY EXPERIMENT*

THE RESEARCH CONSISTED IN A SERIES OF LABORATORY SIMULATIONS OF THE DYNAMICS OF ROTATING TURBULENT PLANETARY BOUNDARY LAYERS (PBL) AND THEIR INFLUENCE ON THE DIFFUSIVE CONDITIONS OF THE ATMOSPHERE

THE EXPERIMENTS WERE CARRIED OUT IN CONDITIONS OF NEUTRAL STRATIFICATION AND TOOK PLACE ON THE HYDRODYNAMIC ROTATING TANK OF “CORIOLIS/LEGI” LABORATORY (GRENOBLE). THE ROTATING SPEED OF THE TANK CAN BE CONTINUOUSLY CHANGED UP TO 5 REVOLUTIONS PER MINUTE, ALLOWING TO ACHIEVE ROSSBY NUMBERS TYPICAL OF MESOSCALE CIRCULATIONS (10^{-1}<RO<1).

THE LARGE PLATFORM OF “CORIOLIS/LEGI” LABORATORY IS ESSENTIAL FOR GETTING THE ABOVE MENTIONED RESULTS NOT ONLY ON ACCOUNT OF THE HORIZONTAL SPATIAL SCALE, BUT MAINLY BECAUSE IT ALLOWS THE NECESSARY RESOLUTION FOR REPRODUCING THE SURFACE ROUGHNESS ELEMENTS AND FOR DETERMINING THE VELOCITY FIELD INSIDE THE TOPOGRAPHICAL FEATURES OF THE SIMULATED COMPLEX TERRAIN.

THE LASER-PIV (PARTICLE IMAGE VELOCIMETRY) SYSTEM, ANNEXED TO THIS HYDRODYNAMIC SIMULATION LABORATORY, ALLOWS THE QUANTITATIVE DETECTION OF EULERIAN FLOW CHARACTERISTICS, LIKE VELOCITY,VORTICITY AND DIVERGENCE FIELDS.
THIS CAN BE ACCOMPLISHED BY SPREADING INTO THE WATER A MICROSCOPIC SEEDING AND LIGHTENING IT BY A LIGHT SHEET PRODUCED BY A CONTINUOUS ARGON LASER AND A BEAM EXPANDING OPTICAL DEVICE.

A HIGH RESOLUTION NUMERICAL SMD TV CAMERA RECORDS SEQUENCES OF IMAGES SHOT AT ADJUSTABLE TIME RATE AND, THROUGH CROSS-CORRELATION TECHNIQUES, IDENTIFY THE DISPLACEMENTS OF CLUSTERS OF ELEMENTS OF SEEDING, AND THEN THE VELOCITY OF FLOW AT ANY POINT AND TIME OF THE MONITORED REGION
A WIDE ILLUMINATION SYSTEM (LIGHT SHEET) HAS BEEN ALSO USED TO LIGHTEN A FLUORESCENT PASSIVE TRACER IN ORDER TO OBTAIN THE CONCENTRATION MEAN AND FLUCTUATION FIELDS BY MEANS OF THE LIF (LASER INDUCED FLUORESCENCE) TECHNIQUE, SO AS TO CORRELATE LOCAL TURBULENT PROPERTIES OF THE FLOW WITH TRACER DISPERSION AND TURBULENCE PATTERNS.

UNFORTUNATELY, IT WAS NOT POSSIBLE TO MEASURE CONCENTRATION FIELDS AND PERFORM PIV SIMULTANEOUSLY; NEVERTHELESS, IN A SUBSEQUENT PHASE OF THE ANALYSIS OF RESULTS, AN ATTEMPT TO CORRELATE VELOCITY AND CONCENTRATION FLUCTUATIONS AT DIFFERENT TIMES WILL BE MADE, AFTER CHECKING THAT STATIONARY CONDITION WERE ATTAINED.

A SCHEMATIC PICTURE OF THE EXPERIMENTS SET-UP IS SHOWN IN FIGURE 1. TWO DIFFERENT POSITION OF THE CAMERA WERE CONSIDERED IN ORDER TO GET TWO HORIZONTAL COMPONENT OF THE FLOW.

THE EXPERIMENTS WERE CARRIED OUT WITH DIFFERENT VALUES OF THE ROUGHNESS LENGTH. IN THE FIRST CASE NO ROUGHNESS ELEMENTS WERE PUT IN THE FLOOR OF THE TANK, WHILE IN THE SECOND SERIES OF EXPERIMENTS CUBIC-SHAPED ROUGHNESS ELEMENTS WERE GLUED OVER IT.

4) - *PRELIMINARY RESULTS*

IN ORDER TO ACHIEVE THE PROPER CONDITIONS ALLOWING TO INVESTIGATE THE TURBULENT PBL OVER A SURFACE WITH AND WITHOUT ROUGHNESS, A FLOW WAS CREATED IN THE TANK BY VARYING, IN A VERY SHORT TIME, THE ROTATION PERIOD T OF THE PLATFORM FROM T_0 TO T_1.
THIS VARIATION PRODUCED A SOLID BODY ROTATIONS OF THE FLUID IN THE TANK WITH A VELOCITY $U=2\pi(1/T_1-1/T_0)R$, PROPORTIONAL TO THE DISTANCE R FROM THE ROTATION AXIS (IN OUR CASE R=5.1 m).

FIRSTLY, A SERIES OF VELOCITY MEASUREMENTS BY USING SOUND DOPPLER PROBES WERE CARRIED OUT.

THEY WERE AIMED TO OBTAIN THE FRICTION AS A FUNCTION OF THE REYNOLDS NUMBER AND TO ESTABLISH THE RANGE OF CONDITIONS ASSURING A TURBULENT FLOW.

THE FIRST CONDITION TO BE SATISFIED IS TO CREATE A TURBULENT PBL.

THE EKMAN LAYER INSTABILITY IS ATTAINED FOR REYNOLDS NUMBERS $Re = U\delta/\nu$ [where $\delta=(\nu T_1/2\pi)^{1/2}$ IS THE LAMINAR LAYER DEPTH] OF THE ORDER OF 55.

TURBULENCE IS FULLY DEVELOPED FOR REYNOLDS NUMBERS HIGHER THAN THIS VALUE.

IN ORDER TO ASSESS THE PRESENCE OF WELL DEVELOPED TURBULENCE IN THE FLOW, WE PERFORMED A SERIES OF EXPERIMENTS WITH DIFFERENT INITIAL VELOCITY (GENERATED BY CHOOSING DIFFERENT VALUES FOR T_0 AND T_1), BOTH ACCELERATING (SPIN-UP) AND DECELERATING (SPIN-DOWN) THE TANK ROTATION. THE RESULTS ARE SHOWN IN FIGURE 2.

TWO TYPICAL BEHAVIORS CAN BE OBSERVED FOR ALL CURVES.

THE FIRST ONE CORRESPONDS TO A TURBULENCE REGIME, FOR $\frac{U}{U_0} > 0.8$ AND NORMALIZED TIMES $\frac{tU_0}{H} < 10^2$ (WHERE H=30CM IS THE TOTAL FLUID DEPTH).

THE SECOND ONE CORRESPONDS TO A LAMINAR REGIME FOR LOWER VELOCITY AND LONGER TIMES.

IN THE CASE OF A FULLY DEVELOPED TURBULENCE THE FRICTION LAW CAN BE WRITTEN AS:

$$H\frac{dU}{dt} = -u_*^2$$

WHERE THE FRICTION VELOCITY u_* IS PROPORTIONAL TO THE GEOSTROPHIC VELOCITY U_g ABOVE THE BOUNDARY LAYER, $u_* = \alpha U_g$.

WE HAVE:

$$\frac{1}{U} = -\alpha^2 \frac{t}{H} + \frac{1}{U_0}$$

IN FIGURE 3 THIS LINEAR LAW FOR 1/U IS VERIFIED FOR THE SAME CASES OF FIGURE 2 AND for $\alpha=0.07$.

IT CAN BE SEEN THAT THE MEASURED CURVES AGREE WITH THE LINEAR LAW FOR SMALL TIME AND LARGE VELOCITIES. MOREOVER DIFFERENT TRENDS WERE FOUND FOR SPIN-UP (THE FIRST THREE CURVES IN THE LEGEND) AND SPIN-DOWN (SECOND THREE CASES).

ANALYSING THE CORRESPONDING EXPERIMENTS FOR THE CASES WITH AND WITHOUT ROUGHNESS, NO SENSIBLE DIFFERENCES WERE FOUND.
THIS FACT IS NOT SURPRISING, BECAUSE THE PROBES WERE POSITIONED ABOVE THE BOUNDARY LAYER AND HENCE THE MEASUREMENTS WERE NOT INFLUENCED BY THE TURBULENCE DEVELOPED INSIDE OF IT.
THE TURBULENT BOUNDARY LAYER DEPTH CAN BE EVALUATED TO BE OF THE ORDER OF:

$$\delta_t=0.4\, u_* /f, \qquad (1)$$

WHERE $f=4\pi/T_1$. where $f=4\pi/T_1$. and $u_*=\alpha\, U$

.

CONSIDERING THAT $U= 2\pi(1/T_1-1/T_0)R$, WE HAVE:

$$\delta_t =0.2\, \alpha\, (1-T_1/T_0)\, r \qquad (2)$$

WHICH DOES NOT DEPEND ON THE ROTATION PERIOD.

IN OUR EXPERIMENTS WE HAD: $T_1/T_0=1/2$, $A = 0.07$ AND $R=5.1$ m, AND THUS:

$$\delta_t = 3.6 \text{ cm}$$

THE REYNOLDS NUMBER BASED ON THE LAMINAR DEPTH WAS:

$$U\delta/\nu= (1- T_1/T_0)R(2\pi)^{1/2} \ (\nu T_1)^{-1/2} = 6390T_1^{-1/2}$$

IN THE EXPERIMENTS WITH VALUES OF T_1 RANGING FROM 30 s TO 240 s WE OBTAINED REYNOLDS NUMBERS RANGING FROM 412 TO 1166. THESE VALUES REFER TO THE INITIAL VELOCITY.

THEN THE VELOCITY DECREASED AND HENCE THE REYNOLDS NUMBERS BECAME LOWER. THE FLOW, INITIALLY TURBULENT, AFTER ABOUT 10^2 NORMALISED TIMES BECSAME LAMINAR (SEE Figure 2**)**.

THESE RESULTS ARE CONFIRMED BY THE ANALYSIS OF THE EXPERIMENTS MEASURED THROUGH THE PIV TECHNIQUE. THE EXPERIMENTS REFER TO THE CASE WITHOUT ROUGHNESS, WITH A FREE STREAM VELOCITY OF ABOUT 5.5 cm/s.
THIS VELOCITY WAS OBTAINED BY VARYING THE ROTATION PERIOD OF THE TANKFROM T_0=120s TO T_1=60s (SPIN-UP). WITH THESE VALUES OF THE PARAMETERS, THE REYNOLDS NUMBER WAS: Re = 171.

FIGURE 4 AND 5 SHOW THE VERTICAL PROFILES OF THE HORIZONTAL MEAN VELOCITY COMPONENTS <u> AND <v> (RESPECTIVELY ALONG AND ACROSS THE FLOW DIRECTION IN THE TANK), FOR TWO ASYMPTOTIC VELOCITIES AND TWO DIFFERENT ROUGHNESS. IT CAN BE CLEARLY OBSERVED THE EKMAN LAYER GENERATED BY THE ROTATION.

FIGURE 6 DEPICTS THE VERTICAL PROFILES OF THE SECOND ORDER MOMENTUM $\langle W'^2 \rangle$ ($cm^2 s^{-2}$) OF THE VERTICAL VELOCITY FOR THE SAME TWO ASYPTOTIC VELOCITIES AND ROUGHNESS OF FIGS. 4 AND 5.

THEY DEMONSTRATE THE PRESENCE OF A TURBULENT LAYER WHOSE HEIGHT δ_t IS OF THE ORDER OF 3.6 cm, ACCORDING WITH THE VALUE PRESCRIBED BY EQUATION (1).

FIGURES 7 AND 8 PRESENT THE RESULTS RELEVANT TO THE MOMENTUM FLUX <U'W'> IN TERMS OF VERTICAL PROFILE. ALSO IN THIS CASE A TURBULENT LAYER IS FOUND IN THE LAYER BELOW 4 CM. THE PLOTS ALSO SHOW THAT IN LOWER LAYER (BELOW ABOUT 2 CM) THE RESULTS CANNOT BE CONSIDERED SATISFACTORY. THIS EFFECT WAS PROBABLY DUE TO THE REFLECTION OF THE LASER LIGHT SHEET ON THE TANK WALL, WHICH PRODUCED A NOISE IN THE IMAGES AND DID NOT ALLOW TO DETECT THE VELOCITY FIELD CLOSE TO THE WALL.

AT LAST, THE VERTICAL PROFILES OF THE TURBULENT DIFFUSIVITY $\mathbf{K_m}$ MADE NON-DIMENSIONAL WITH THE INTERNAL SCALES OF THE PBL AS A FUNCTION OF THE NON-DIMENSIONAL HEIGHT OF THE PBL IS PRESENTED IN FIG. 8 FOR THE SAME TWO ASYMPTOTIC VELOCITIES AND ROUGHNESS CONDITIONS OF FIGS. 4 AND 5.

IT APPEARS THAT THEIR SHAPES QUALITATIVELY COMPLY WITH THE UNIVERSAL LAW OF [**WY72**] AND WITH THE LEIPZIG DIFFUSIVITY PROFILE OBTAINED IN NEAR NEUTRAL, BAROTROPIC, CONDITIONS.

THERE ARE HOWEVER SOME PECULIARITIES WHICH LIMIT, FOR THE MOMENT, THEIR FULL AGREEMENT WITH BOTH THEORY AND OBSERVATIONS.

FIRST OF ALL, THEY DO NOT SHOW CLEARLY THE SURFACE ROSSBY-NUMBER SIMILARITY FOR $\mathbf{Z \gg Z_o}$ **.**

SECOND, THEIR MAXIMA ARE FOUND AT ABOUT 0.5 – 0.7 OF THE NON - DIMENSIONAL HEIGHT OF THE PBL. THIS LOOKS IN DISAGREEMENT WITH THE LEIPZIG OBSERVATION (WHICH SHOWS THE MAXIMA OF $\mathbf{K_m}$ AT ABOUT 0.2 – 0.3 OF THE NON-DIMENSIONAL HEIGHT OF THE PBL), WHILE CAN BE CONSIDERED IN FAIRLY GOOD AGREEMENT WITH THE THEORETICAL EXPECTATIONS OF [**WY72**] , WHICH ALLOW $\mathbf{K_m}$ MAXIMA IN THE RANGE 0.2 –0.7, ACCORDING TO THE VALUE OF Z_o.

THE REASONS FOR WHICH THE SURFACE-ROSSBY NUMBER SIMILARITY DID NOT APPEAR CLEARLY CAN BE TRACED BACK TO THE VERY POOR STATISTICS (ONLY FOUR CASES EXAMINED, WITH THE SAME CORIOLIS PARAMETER) AND TO THE LOW QUALITY OF PIV IMAGES. ON THE CONTRARY, THE NON-DIMENSIONALIZATION OF $\mathbf{z}$ AND $\mathbf{K_m}$ WITH THE INTERNAL SCALES OF THE PBL IMPROVED A LOT THE REPRESENTATION OF THE VERTICAL PROFILES OF TURBULENT DIFFUSIVITY PROFILES. THIS IS SHOWN BY THE COMPARISON OF FIGURE 8 WITH FIG. 9.

THIS LAST, IN FACT, SHOWS THE VERTICAL PROFILES OF THE DIMENSIONAL DIFFUSIVITY AS A FUNCTION OF THE DIMENSIONAL ALTITUDE **z**, WHICH APPEARS TO BE FARTHER FROM ANY UNIVERSAL LAW THAN THE DIMENSIONLESS ONE.

5) - *CONCLUSIONS*

THIS WORK FOCUSED ON THE LABORATORY SIMULATION OF SIMPLE CONDITIONS OF BAROTROPIC BOUNDARY LAYERS OVER REGULAR AND FLAT TERRAIN.

THE MOST IMPORTANT RESULT IS THE ABILITY OF THE PIV METHODOLOGY TO RECONSTRUCT THE AVERAGE KINEMATIC FIELDS OF FLOW AND SOME STATISTICAL MOMENTS OF TURBULENT QUANTITIES.

SPECIFIC ALGORITHMS, DEVOTED TO TURN THE INFORMATION PROVIDED BY THE PIV METHODOLOGY INTO EULERIAN FIELDS OF FLOW VELOCITY AT DIFFERENT LEVELS OF THE TURBULENT ROTATING ABL, WERE USED.

THE EULERIAN VELOCITY FIELDS WERE USED TO CALCULATE TURBULENT QUANTITIES AS TURBULENT KINETIC ENERGY AND REYNOLDS STRESS.

THE EULERIAN KINEMATIC FLOW FIELDS PROVIDED BY THE PIV ANALYSIS AND THE RECONSTRUCTION OF THE CONCENTRATION FIELDS OF RELEASED DYE TRACERS CAN ALSO ALLOW TO ESTIMATE THE COEFFICIENTS OF TURBULENT DIFFUSION.

THE ENSEMBLE OF ALL THE ABOVE MENTIONED EXPERIMENTAL INFORMATION OF MEAN AND TURBULENT FLOW PATTERNS AND OF TRACER DISPERSION OBTAINED UNDER STRICTLY CONTROLLED LABORATORY CONDITIONS MIGHT LET ONE FORESEE, IN PERSPECTIVE, A PROMISING UP-GRADE OF NUMERICAL DISPERSION MODELS OF AIRBORNE POLLUTANTS, BEFORE THEY ARE APPLIED TO SIMULATE NATURAL DISPERSION PROCESSES IN ACTUAL CONDITIONS OF THE NATURAL PROTOTYPE AT MESO-SCALE.

THIS COULD BE ACHIEVED THROUGH: I) - ADIMENSIONALIZATION WITH THE PROPER SCALES; II) - CALIBRATION OF THEIR PARAMETERS; AND, III) - VALIDATION OF THEIR PREDICTIONS, OBTAINED WITH THE SAME BOUNDARY CONDITIONS ADOPTED IN THE ROTATING TANK, AGAINST THE RELEVANT RESULTS OF THE LABORATORY EXPERIMENTS.

AS A FUTURE WORK, THE EXPERIMENTS COULD BE EXTENDED TO BAROTROPIC ABL OVER A FEW TYPOLOGIES OF COMPLEX TERRAIN (SCHEMATIC TWO-AND THREE-DIMENSIONAL OBSTACLES, TERRAIN SUBSIDENCES, AND SO ON). ADDITIONAL POSSIBILITIES, COULD INCLUDE A REPETITION OF THE EXPERIMENTS, FOR A WEAKLY BAROCLINIC PBL.

6) – *ACKNOWLEDGMENTS*

THIS WORK HAS BEEN CARRIED OUT AT THE LEGI CORIOLIS LABORATORYIN THE FRAME OF THE EU PROGRAMME “TRANSNATIONAL ACCESS TO MAJOR RESEARCH INFRASTRUCTURES

FIGURES

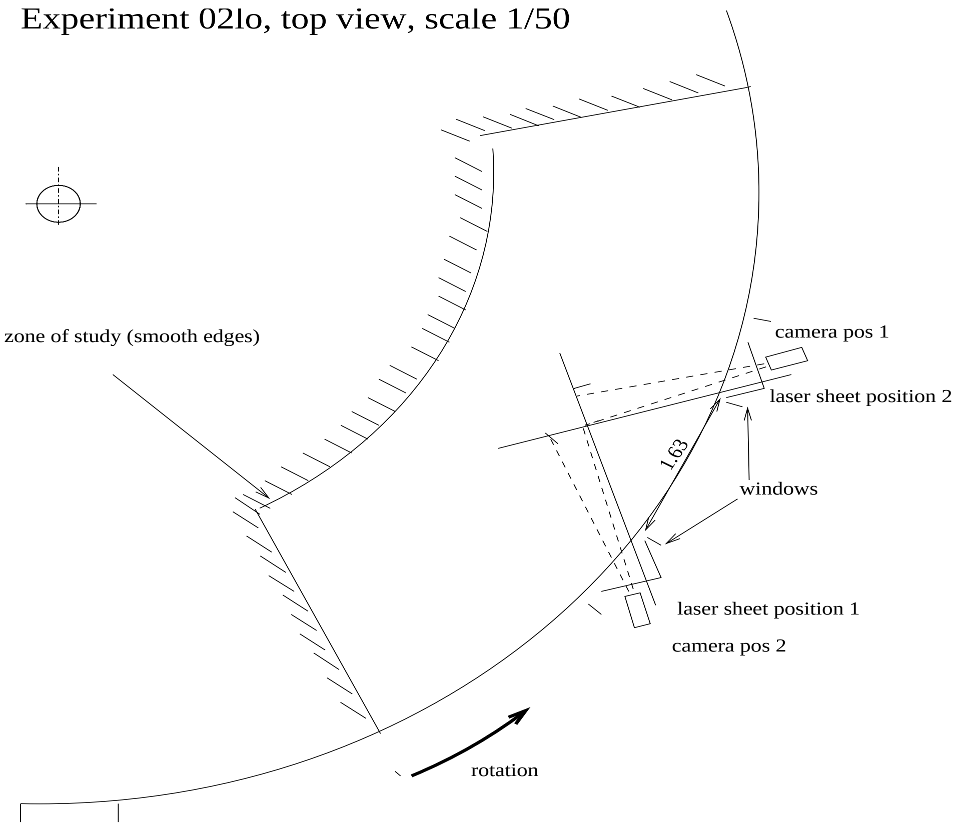

Experiment 02lo, top view, scale 1/50
zone of study (smooth edges)
camera pos 1
laser sheet position 2
1.63
windows
laser sheet position 1
camera pos 2
rotation

Figure 1

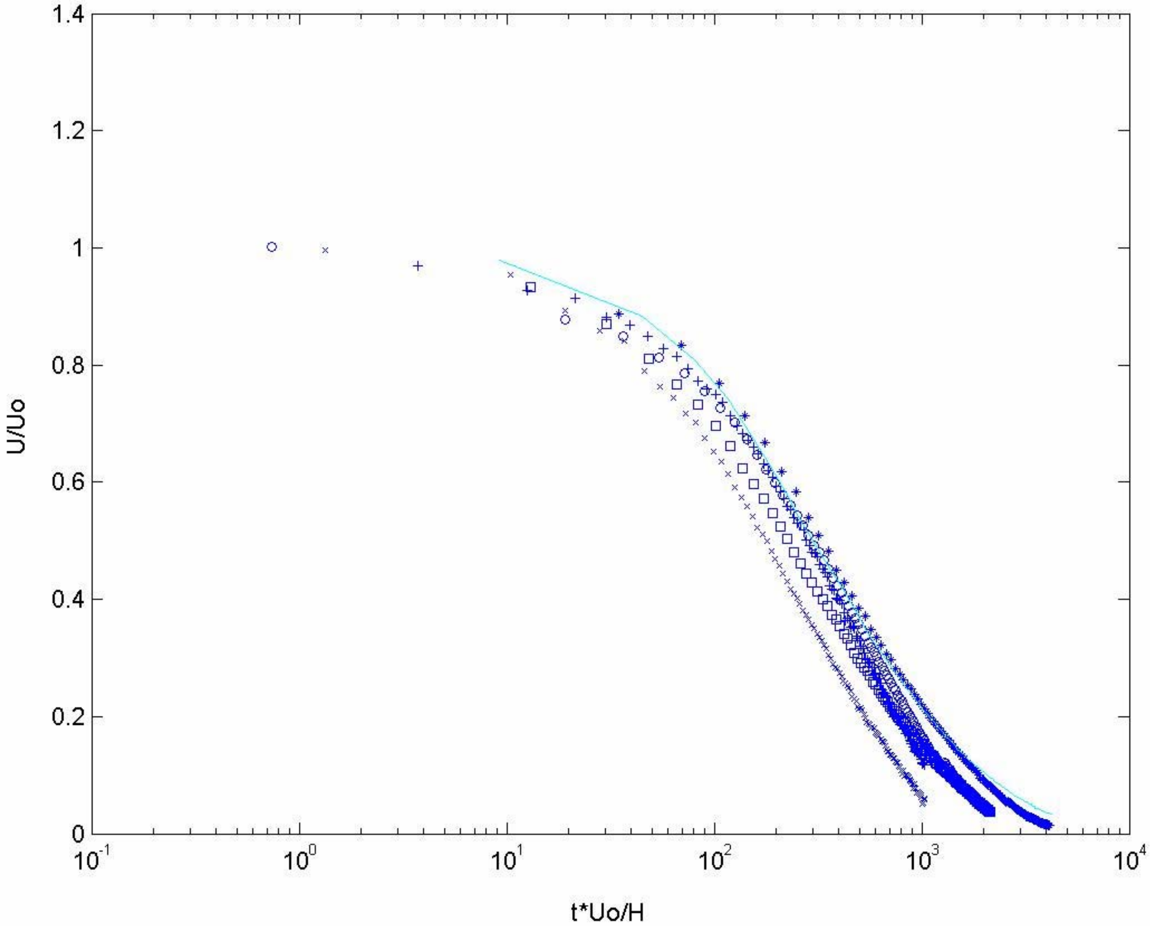
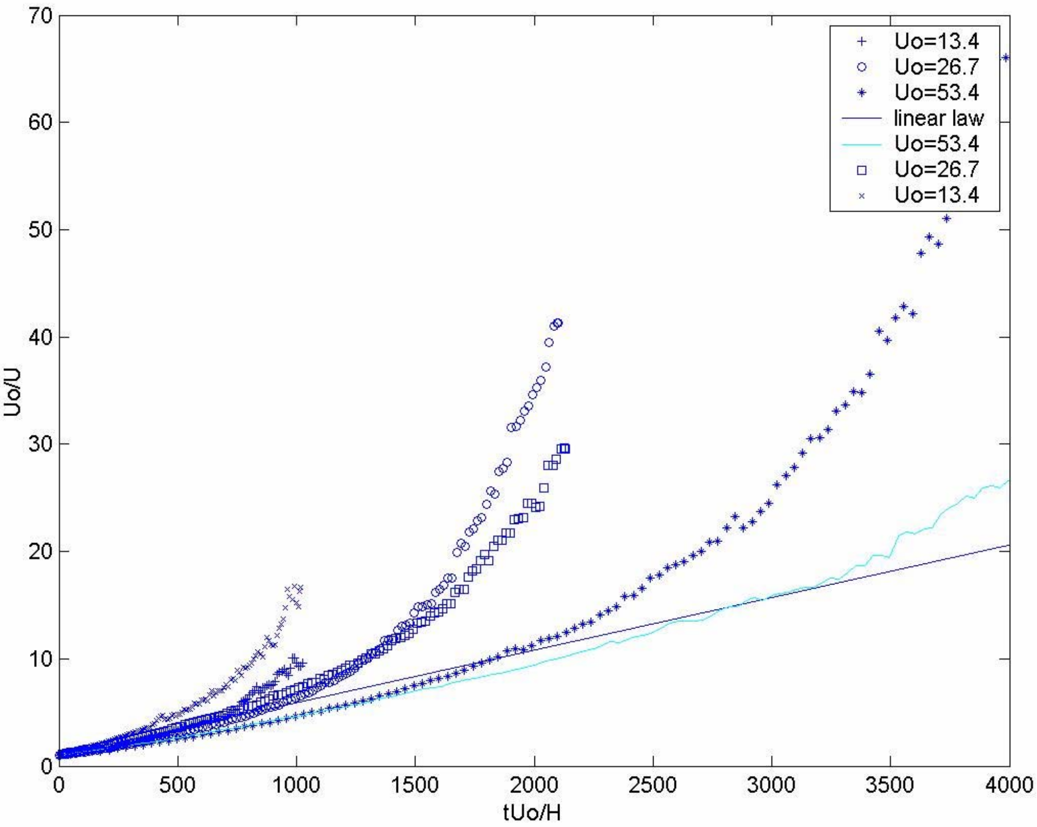


Figure 2



Uo=13.4
Uo=26.7
Uo=53.4
linear law
Uo=53.4
Uo=26.7
Uo=13.4
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Figure 3

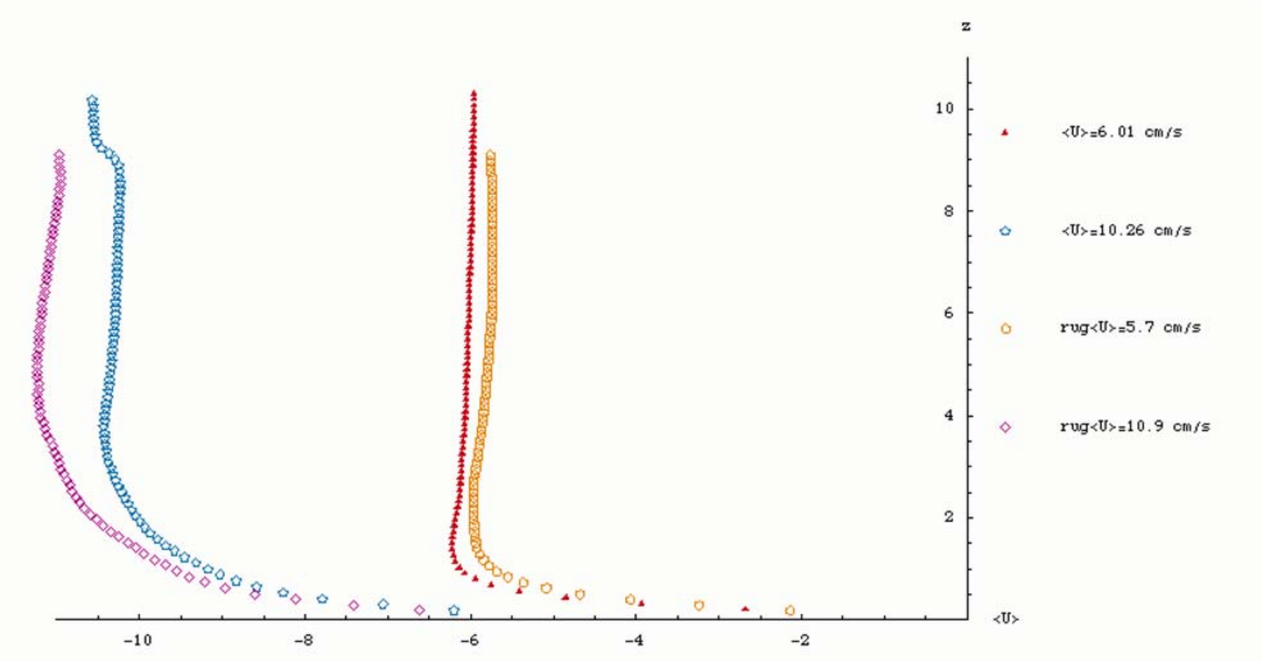

Figure 4: Vertical profiles of the horizontal mean velocity component <u> (cm s^{-1}) along the flow in the tank as a function of the height z (cm).

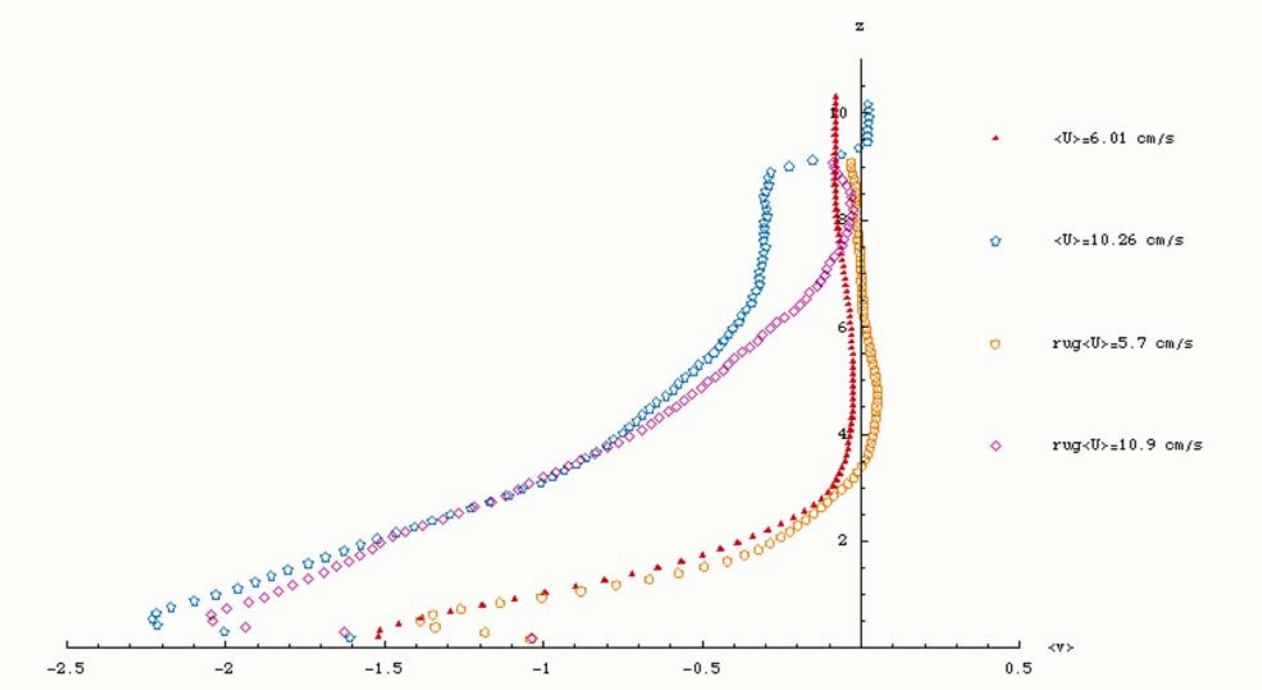

Figure 5: Vertical profiles of the horizontal mean velocity component <u> (cm s^{-1}) across the flow in the tank as a function of the height z (cm).

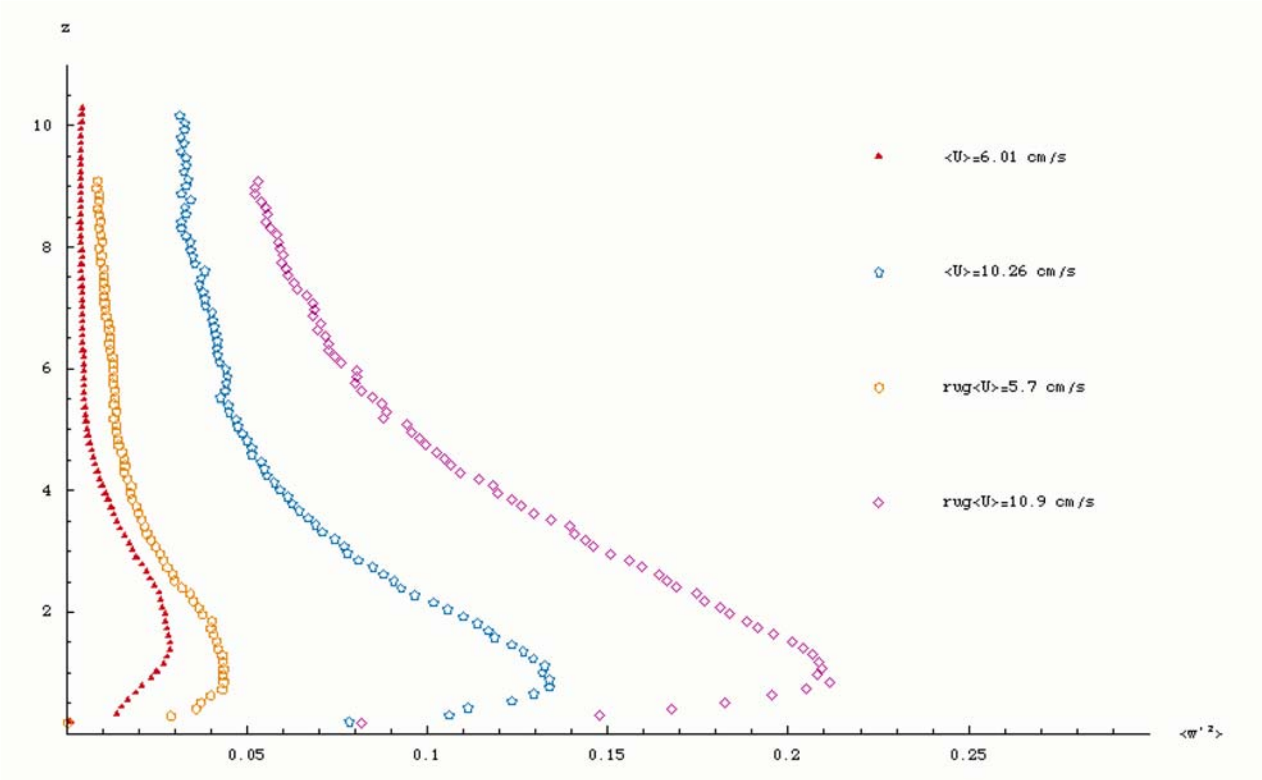

Figure 6:Vertical profile of the second order momentum of the vertical turbulent velocity

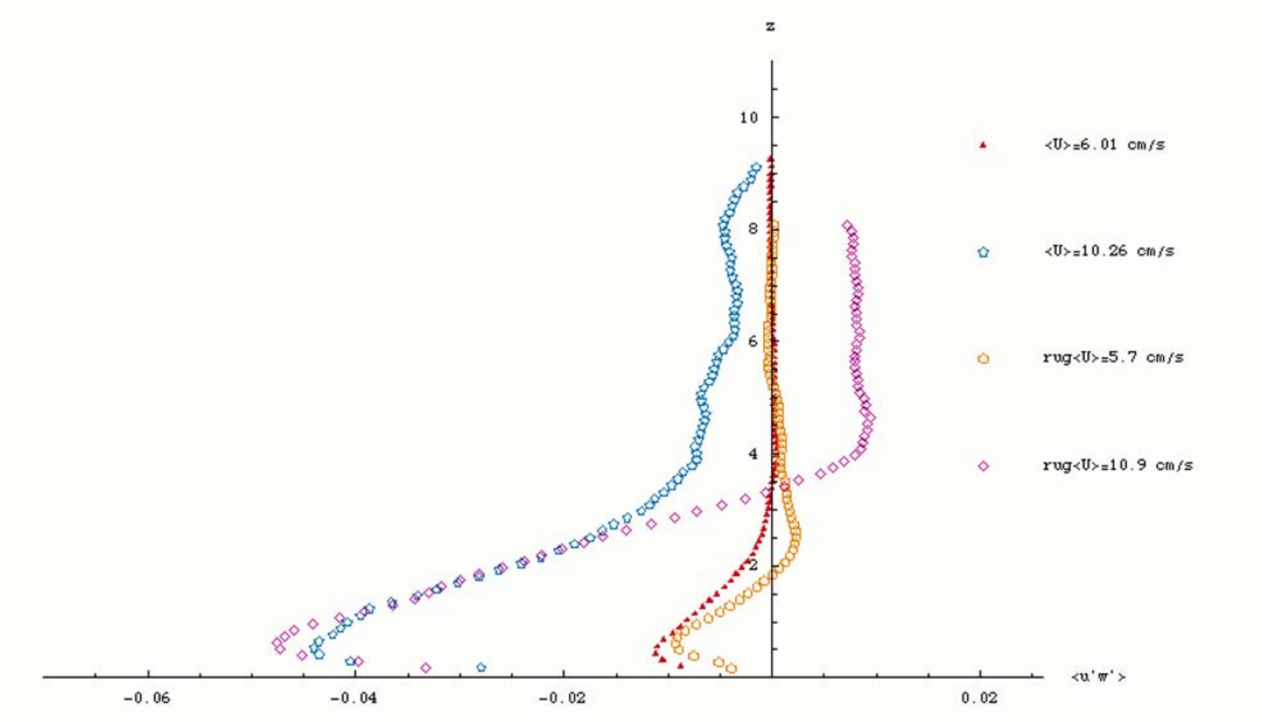

Figure 7:Vertical profiles of kinematic turbulent momentum fluxes

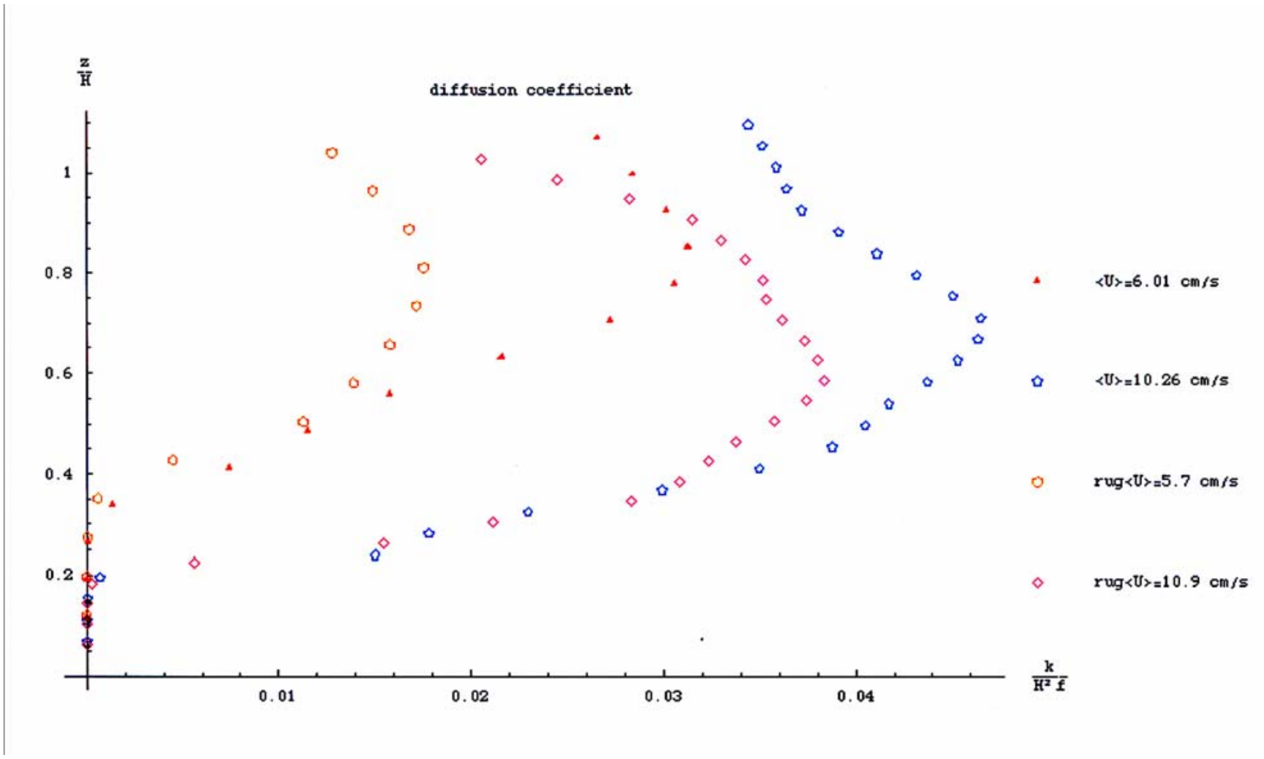

Figure 8: Vertical profile of turbulent diffusivity $\mathbf{K_m}$ made non-dimensional with internal scales of the PBL as a function of the non-dimensional altitude Z.

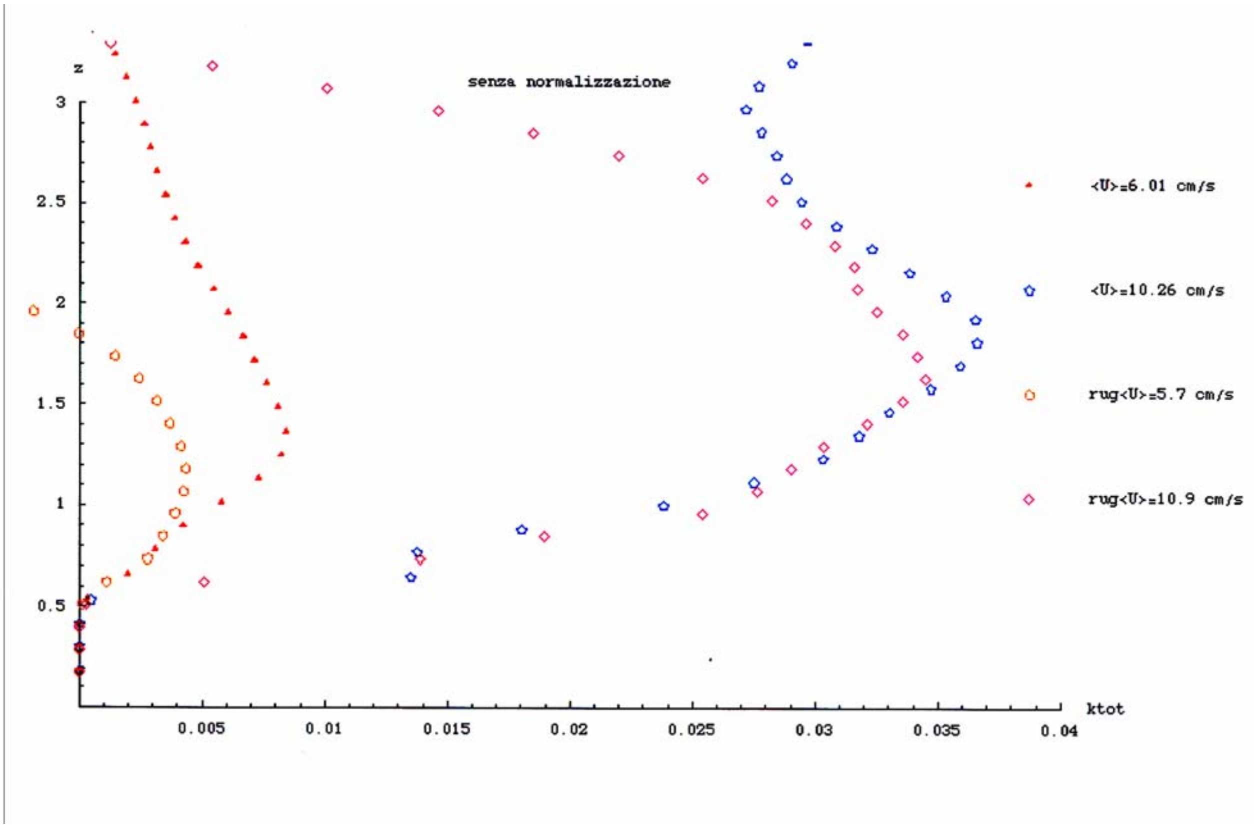

Figure 9: Vertical profile of dimensional turbulent diffusivity $\mathbf{K_m}$ as a function of the non-dimensional altitude Z.