

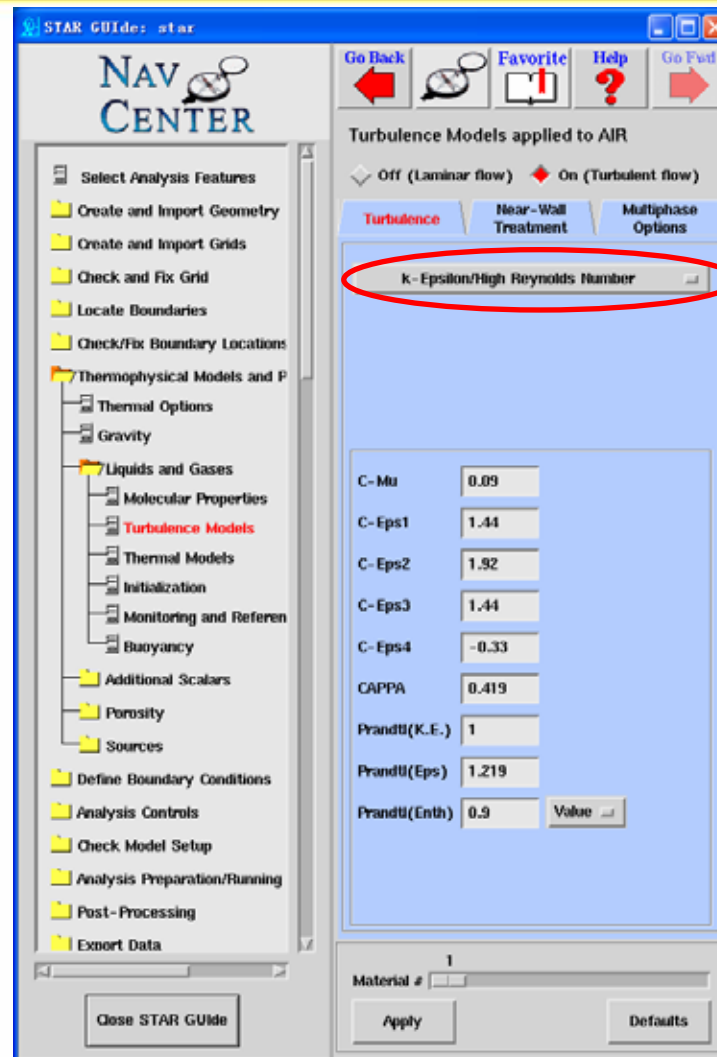
基于K- ϵ 湍流模型添加用户自定义子模型

西迪阿特信息科技有限公司

CDAJ-China Beijing



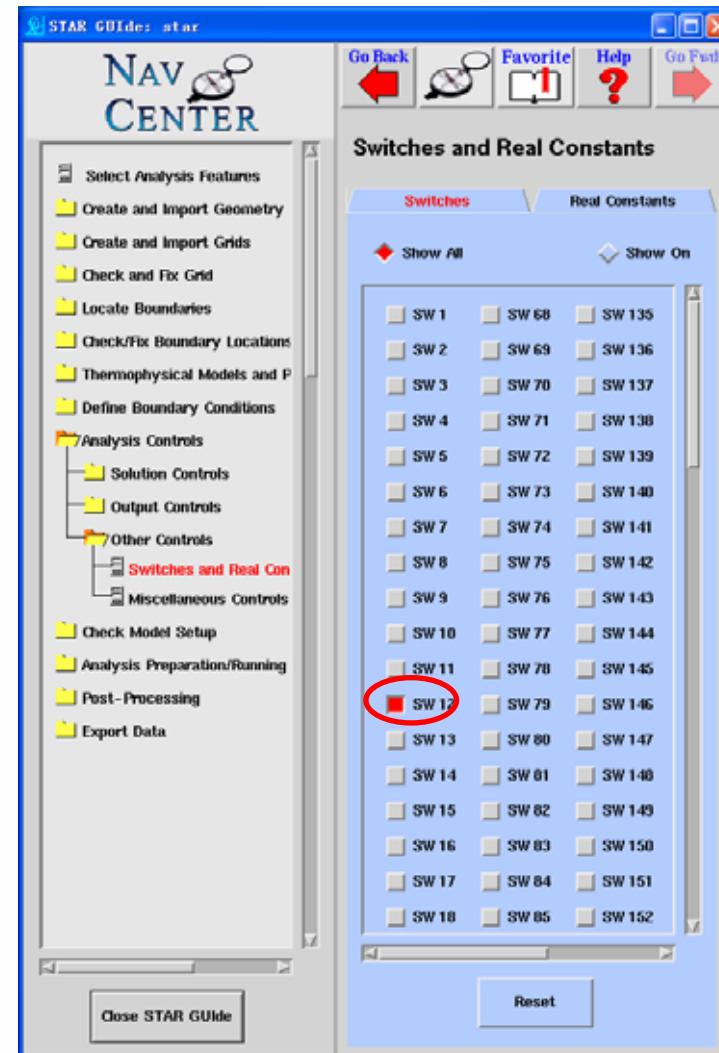
1. 设置High Re $k-\epsilon$ 湍流模型



2. 设置Switch 12

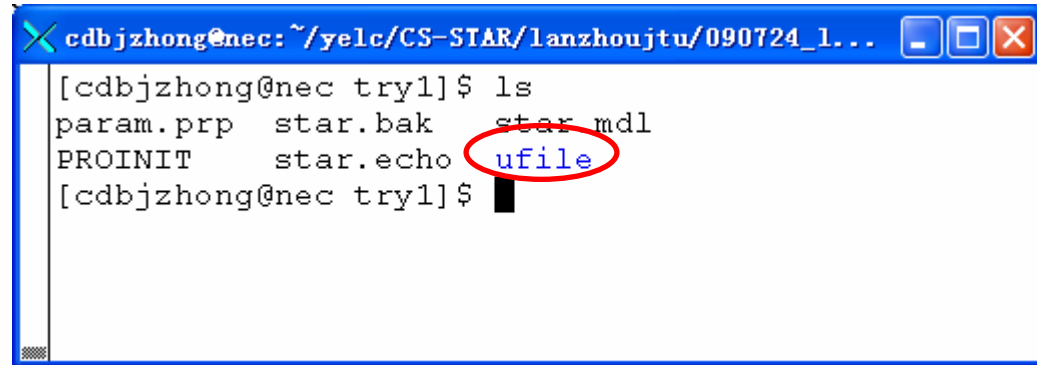
SWITCH 12 Y: User routine for turbulent viscosity is used for k-eps model and its variants.

基于标准 $k-\varepsilon$ 模型的MMK模型和DURBIN模型, ν_t 的表达式有变化, 打开Switch 12来设定 ν_t 新的表达式



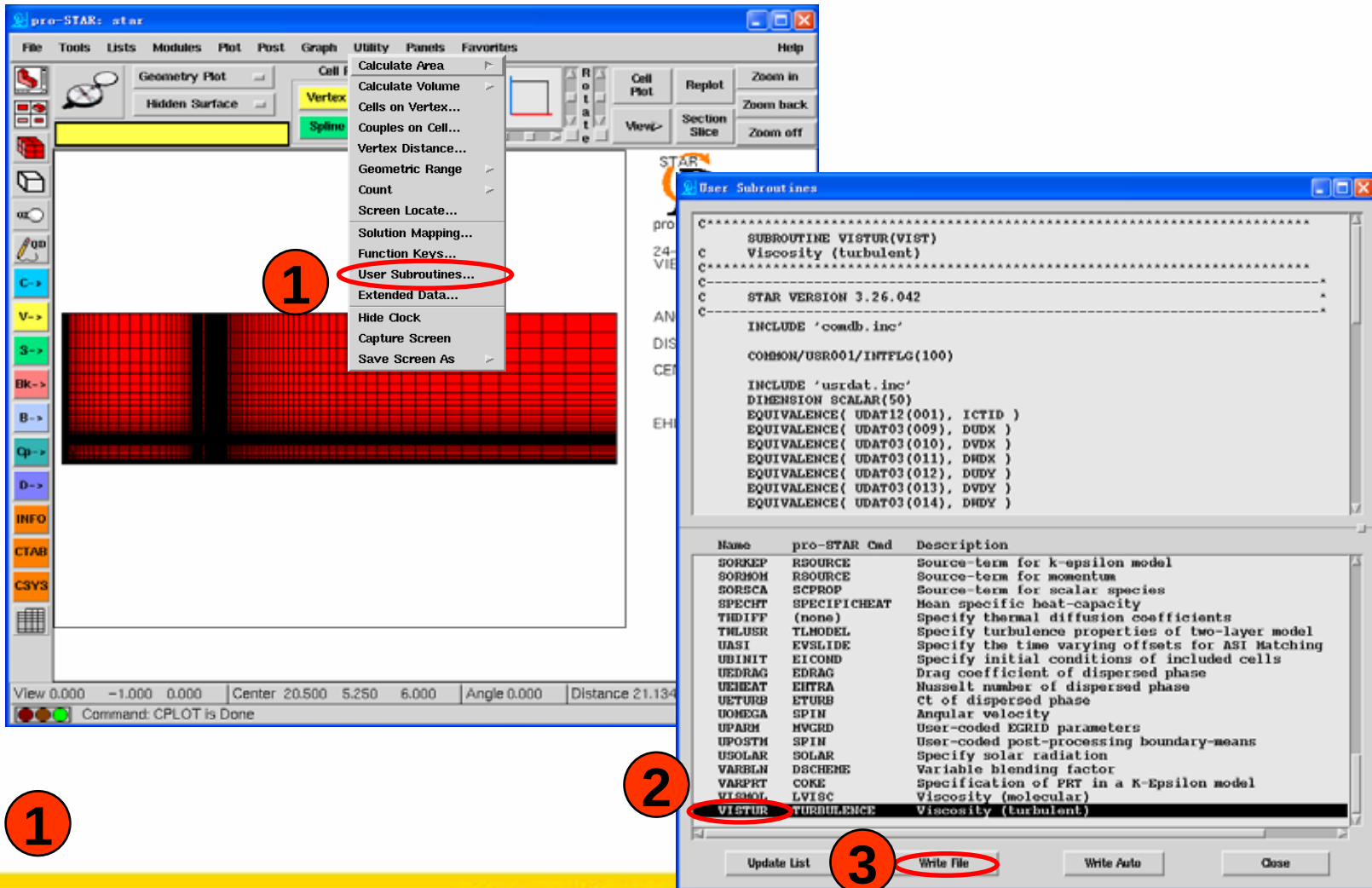
3. 生成ufile文件夹

- Star-CD计算时如果要用到用户子程序，应将所有的子程序放在计算目录下的ufile文件夹中。
- 可在Prostar命令窗口中执行如下命令流生成ufile文件夹，同时会自动将子程序定义时用到的参数文件写入该文件夹：
 - syst
 - ufiles



```
cdbjzhong@nec: ~/yelc/CS-STAR/lanzhoujtu/090724_1...  
[cdbjzhong@nec try1]$ ls  
param.prp  star.bak  star.mdl  
PROINIT    star.echo  ufile  
[cdbjzhong@nec try1]$
```

4. 将vistur.f子程序模板写入ufile文件夹



The screenshot shows the pro-STAR software interface. The main window displays a 3D grid of a rectangular domain. A red circle with the number 1 highlights the 'User Subroutines...' option in the 'Utility' menu. A second window, titled 'User Subroutines', is open, showing a list of subroutines. A red circle with the number 2 highlights the 'VISTUR' subroutine. A third red circle with the number 3 highlights the 'Write File' button at the bottom of the 'User Subroutines' window.

1 User Subroutines...

2 VISTUR

3 Write File

The 'User Subroutines' window displays the following code for the VISTUR subroutine:

```

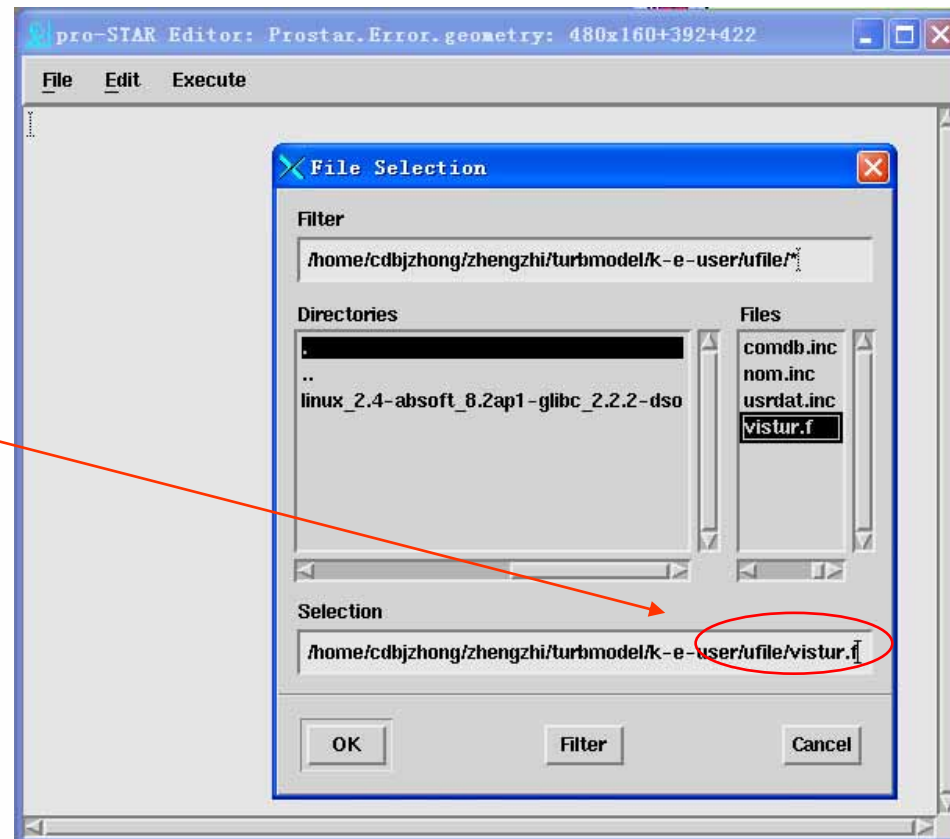
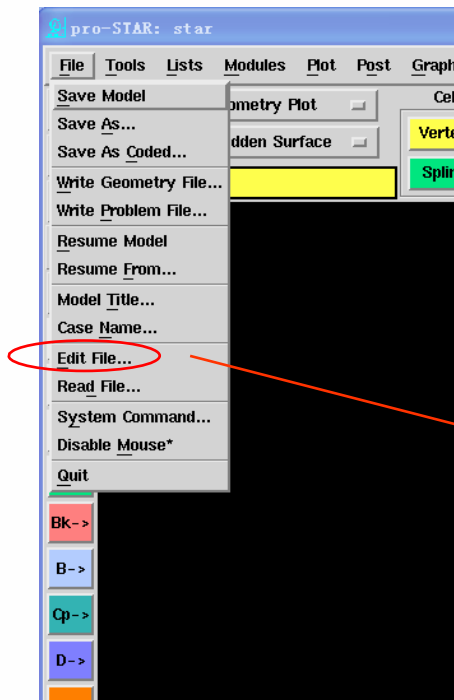
SUBROUTINE VISTUR(VIST)
C *****
C      Viscosity (turbulent)
C *****
C-----*-----*
C      STAR VERSION 3.26.042
C-----*-----*
C
C      INCLUDE 'comdb.inc'
C
C      COMMON/USR001/INTFLG(100)
C
C      INCLUDE 'usrdat.inc'
C      DIMENSION SCALAR(50)
C      EQUIVALENCE( UDAT12(001), ICTID )
C      EQUIVALENCE( UDAT03(009), DUDX )
C      EQUIVALENCE( UDAT03(010), DVDX )
C      EQUIVALENCE( UDAT03(011), DWDX )
C      EQUIVALENCE( UDAT03(012), DUDY )
C      EQUIVALENCE( UDAT03(013), DVDY )
C      EQUIVALENCE( UDAT03(014), DWDY )

```

The table below lists the subroutines and their descriptions:

Name	pro-STAR Cad	Description
SORKEP	RSOURCE	Source-term for k-epsilon model
SORHOM	RSOURCE	Source-term for momentum
SORSCA	SCPROP	Source-term for scalar species
SPECHEAT	SPECIFICHEAT	Mean specific heat-capacity
THERDIFF	(none)	Specify thermal diffusion coefficients
TLUSER	TLMODEL	Specify turbulence properties of two-layer model
UASI	EVSLIDE	Specify the time varying offsets for ASI Matching
UBINIT	EICOND	Specify initial conditions of included cells
UEDRAG	EDRAG	Drag coefficient of dispersed phase
UEHEAT	ENTRA	Nusselt number of dispersed phase
UETURB	ETURB	Ct of dispersed phase
UOMEGA	SPIN	Angular velocity
UPARM	MVGRD	User-coded EGRID parameters
UPOSTM	SPIN	User-coded post-processing boundary-means
USOLAR	SOLAR	Specify solar radiation
VARIABLEN	DSCHENE	Variable blending factor
VARPET	COKE	Specification of PRT in a K-Epsilon model
VISMOL	LVISC	Viscosity (molecular)
VISTUR	TURBULENCE	Viscosity (turbulent)

5. 修改vistur.f子程序，添加用户模型



打开vistur.f
文件，加入
用户自定义
程序代码段

5. 修改vistur.f子程序，添加用户模型

```

pro-STAR Editor: Prostar.Error.geometry: 480x160+392+422
File Edit Execute
C*****
C      SUBROUTINE VISTUR(VIST)
C      Viscosity (turbulent)
C*****
C      STAR VERSION 3.26.000
C*****
C      INCLUDE 'comdb.inc'
C
C      COMMON/USR001/INTFLG(100)
C
C      INCLUDE 'usrdat.inc'
C      DIMENSION SCALAR(50)
C      EQUIVALENCE( UDAT12(001), ICTID )
C      EQUIVALENCE( UDAT03(009), DUDX )
C      EQUIVALENCE( UDAT03(010), DVDX )
C      EQUIVALENCE( UDAT03(011), DWDX )
C      EQUIVALENCE( UDAT03(012), DUDY )
C      EQUIVALENCE( UDAT03(013), DVDY )
C      EQUIVALENCE( UDAT03(014), DWDY )
C      EQUIVALENCE( UDAT03(015), DUDZ )
C      EQUIVALENCE( UDAT03(016), DVDZ )
C      EQUIVALENCE( UDAT03(017), DWDZ )
C      EQUIVALENCE( UDAT03(018), SECINV )
C      EQUIVALENCE( UDAT04(001), CP )
C      EQUIVALENCE( UDAT04(002), DEN )
C      EQUIVALENCE( UDAT04(003), ED )
C      EQUIVALENCE( UDAT04(006), P )
C      EQUIVALENCE( UDAT04(008), TE )
C      EQUIVALENCE( UDAT04(009), SCALAR(01) )
C      EQUIVALENCE( UDAT04(059), U )
C      EQUIVALENCE( UDAT04(060), V )
C      EQUIVALENCE( UDAT04(061), W )
C      EQUIVALENCE( UDAT04(062), VISM )
C      EQUIVALENCE( UDAT04(007), T )
C      EQUIVALENCE( UDAT04(067), X )
C      EQUIVALENCE( UDAT04(068), Y )
C      EQUIVALENCE( UDAT04(069), Z )
C
C-----
C      This subroutine enables the user to specify the turbulent viscosity
C      (VIST) in an arbitrary manner.
C
C      ** Parameter to be returned to STAR:  VIST
C
C-----
C
C      Sample coding: To specify the turbulent viscosity for a group of
C      cells with cell table number 2
C

```

vistur.f子程序提供的变量，
变量含义可查阅 ufile/nom.inc 文件

```

C      (VIST) in an arbitrary manner.
C
C      ** Parameter to be returned to STAR:  VIST
C
C-----
C
C      Sample coding: To specify the turbulent viscosity for a group of
C      cells with cell table number 2
C
C      IF(ICTID.EQ.2) VIST=0.01
C-----
C
C      Cmyu =0.09
C
C-- durbin
C      alpha=1.0
C
C      If(ED.eq.0) then
C        ZED=1.0e-15
C      else
C        ZED=ED
C      endif
C
C      ZA=TE/ZED
C
C
C      ZS=(SECINV ** 2.0 * 0.5)**0.5
C
C      ZS0 = (DUDX**2.0 + DVDY**2.0 + DWDZ**2.0)
C      ZS1 = (DUDY+DVDX)**2.0
C      ZS2 = (DUDZ+DWDX)**2.0
C      ZS3 = (DVDZ+DWDY)**2.0
C
C      ZS=( 2.0*ZS0 + ZS1 + ZS2 + ZS3 )**0.5
C
C      ZB=Cmyu * 3.0**0.5 * ZS
C
C      If(ZB.eq.0) then
C        ZB=1.0e-15
C      endif
C
C      ZB=alpha / ZB
C
C      ZT=min(ZA,ZB)
C
C      VIST=DEN * Cmyu * TE * ZT
C
C      RETURN
C      END
C

```

添加用户自定义程序代码段，保存

范 例

算例2 湍流模型加入

添加MMK湍流模型和DURBIN1湍流模型，方程如下：

[模型介绍]

基于标准k-ε模型的改进两方程模型MMK模型与DURBIN模型。各模型不同之处见下表：

$$S = \sqrt{\frac{1}{2}(U_{ij} + U_{ji})^2}$$

$$\Omega = \sqrt{\frac{1}{2}(U_{ij} - U_{ji})^2}$$

$$T = \min\left(\frac{k}{\varepsilon}, \frac{\alpha}{C_\mu S \sqrt{3}}\right)$$

	P_k	ν_t
标准k-ε	$\nu_t S^2$	$C_\mu k^2 / \varepsilon$
MMK	$\nu_t S^2$	$\frac{C_\mu k^2 / \varepsilon}{C_\mu k^2 / \varepsilon * (\Omega / S)}$ $\begin{matrix} [\Omega \geq S] \\ [\Omega < S] \end{matrix}$
DURBIN1	$\nu_t S^2$	$C_\mu k * T$

DURBIN1中 $\alpha = 1.0$ 。

符号说明：

P_k 湍流脉动动能K的产生项 (单位： $m^2 * s^{-3}$)

ν_t 湍流动力粘性系数 (单位： $m^2 * s^{-1}$)

S 变形速度尺度 (单位： s^{-1})

Ω 旋转速度尺度 (单位： s^{-1})

K 湍流脉动动能 (单位： $m^2 * s^{-2}$)

ε 湍流动能耗散率 (单位： $m^2 * s^{-3}$)

C_μ 常系数 $C_\mu = 0.09$

T 最小时间尺度 (单位： s)

范 例

Table 1 Modeling of P_k and ν_t

	P_k	ν_t
標準k- ϵ	$\nu_t S^2$ (1)	$C_\mu k^2 / \epsilon$ (7)
LK	$\nu_t S \Omega$ (2)	
改良LK	$\nu_t S^2$ [$\Omega / S \geq 1$] (3) $\nu_t S \Omega$ [$\Omega / S < 1$] (4)	
MMK	$\nu_t S^2$ (5)	$C_\mu k^2 / \epsilon$ [$\Omega / S \geq 1$] (8) $C_\mu k^2 / \epsilon \cdot \Omega / S$ [$\Omega / S < 1$] (9)
Durbin	$\nu_t S^2$ (6)	$C_\mu k T$ (10) (13) 式の $\alpha=1.0$
Durbin2	$\nu_t S^2$ (6)	$C_\mu k T$ (10) (13) 式の $\alpha=0.5$
$S = \sqrt{\frac{1}{2} \left(\frac{\partial U_i}{\partial x_j} + \frac{\partial U_j}{\partial x_i} \right)^2}$ (11), $\Omega = \sqrt{\frac{1}{2} \left(\frac{\partial U_i}{\partial x_j} - \frac{\partial U_j}{\partial x_i} \right)^2}$ (12), $T = \min \left(\frac{k}{\epsilon}, \frac{\alpha}{C_\mu \sqrt{3S}} \right)$ (13)		

← durbin1

Vistur.f + switch 12

```

C*****
C*****
C      SUBROUTINE VISTUR(VIST)
C      Viscosity (turbulent)
C*****
C*****
C-----*
C  STAR VERSION 3.26.000      *
C-----*
C      INCLUDE 'comdb.inc'
C
C      COMMON/USR001/INTFLG(100)
C
C      INCLUDE 'usrdat.inc'
C      DIMENSION SCALAR(50)
C      EQUIVALENCE( UDAT12(001), ICTID )
C      EQUIVALENCE( UDAT03(009), DUDX )
C      EQUIVALENCE( UDAT03(010), DVDX )
C      EQUIVALENCE( UDAT03(011), DWDX )
C      EQUIVALENCE( UDAT03(012), DUDY )
C      EQUIVALENCE( UDAT03(013), DVDY )
C      EQUIVALENCE( UDAT03(014), DWDY )
C      EQUIVALENCE( UDAT03(015), DUDZ )
C      EQUIVALENCE( UDAT03(016), DVDZ )
C      EQUIVALENCE( UDAT03(017), DWDZ )
C      EQUIVALENCE( UDAT03(018), SECINV )
C      EQUIVALENCE( UDAT04(001), CP )
C      EQUIVALENCE( UDAT04(002), DEN )
C      EQUIVALENCE( UDAT04(003), ED )
C      EQUIVALENCE( UDAT04(006), P )
C      EQUIVALENCE( UDAT04(008), TE )
C      EQUIVALENCE( UDAT04(009), SCALAR(01) )
C      EQUIVALENCE( UDAT04(059), U )
C      EQUIVALENCE( UDAT04(060), V )
C      EQUIVALENCE( UDAT04(061), W )
C      EQUIVALENCE( UDAT04(062), VISM )
C      EQUIVALENCE( UDAT04(007), T )
C      EQUIVALENCE( UDAT04(067), X )
C      EQUIVALENCE( UDAT04(068), Y )
C      EQUIVALENCE( UDAT04(069), Z )
C-----

```

```

C
C  This subroutine enables the user to specify the turbulent viscosity
C  (VIST) in an arbitrary manner.
C
C  ** Parameter to be returned to STAR: VIST
C
C-----
C
C  Sample coding: To specify the turbulent viscosity for a group of
C  cells with cell table number 2
C
C  IF(ICTID.EQ.2) VIST=0.01
C-----
C
C      Cmyu =0.09
C
C-- durbin
C      alpha=1.0
C
C      If(ED.eq.0) then
C          ZED=1.0e-15
C      else
C          ZED=ED
C      endif
C
C      ZA=TE/ZED
C
C
C      ZS=(SECINV ** 2.0 * 0.5)**0.5
C
C      ZB=Cmyu * 3.0**0.5 * ZS
C
C      If(ZB.eq.0) then
C          ZB=1.0e-15
C      endif
C
C      ZB=alpha / ZB
C
C      ZT=min(ZA,ZB)
C
C      VIST=DEN * Cmyu * TE * ZT
C
C      RETURN
C      END
C

```

范例

Tutorial8 Air Flow Over An Obstacle

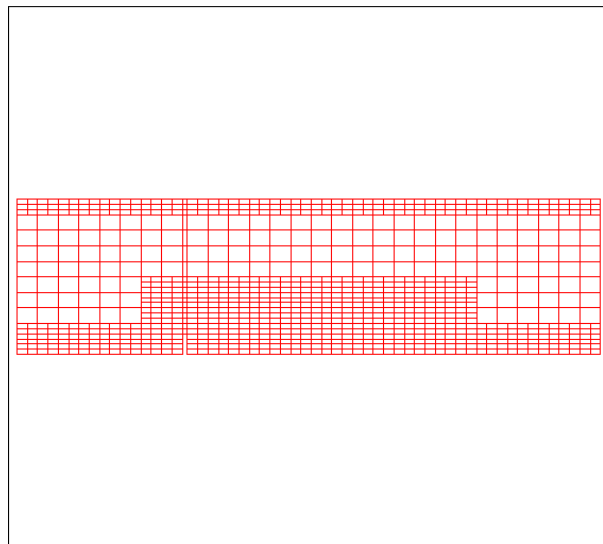
Inlet

$$U = 1.17 \text{ m/s}$$

$$k = 0.024 \text{ m}^2/\text{s}^2$$

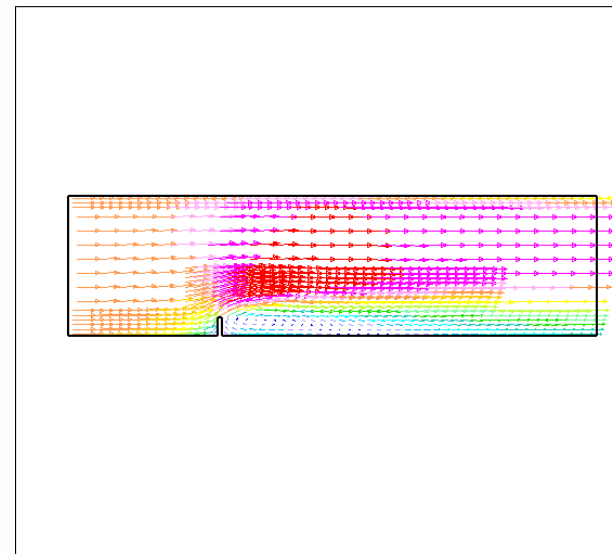
$$e = 0.07 \text{ m}^2/\text{s}^3$$

k-e model



STAR
pro-STAR 3.2
2-FEB-07
VIEW
0.000
0.000
1.000
ANGLE
0.000
DISTANCE
582.474
CENTER
565.000
150.000
5.000
NORMAL PLOT

Y
X

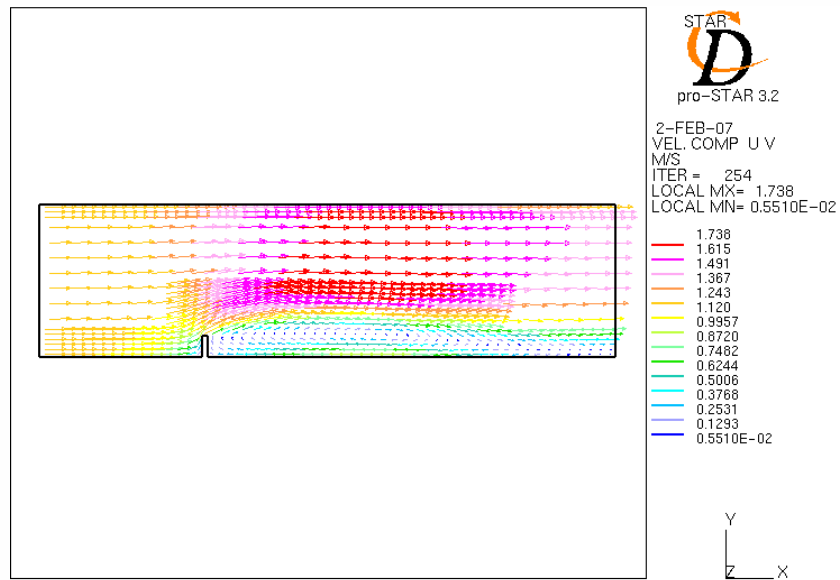


STAR
pro-STAR 3.2
2-FEB-07
VEL. COMP U V
M/S
ITER = 60
LOCAL MX= 1.576
LOCAL MN= 0.2250E-01
1.576
1.465
1.354
1.243
1.132
1.021
0.9101
0.7992
0.6882
0.5773
0.4663
0.3554
0.2444
0.1335
0.2250E-01

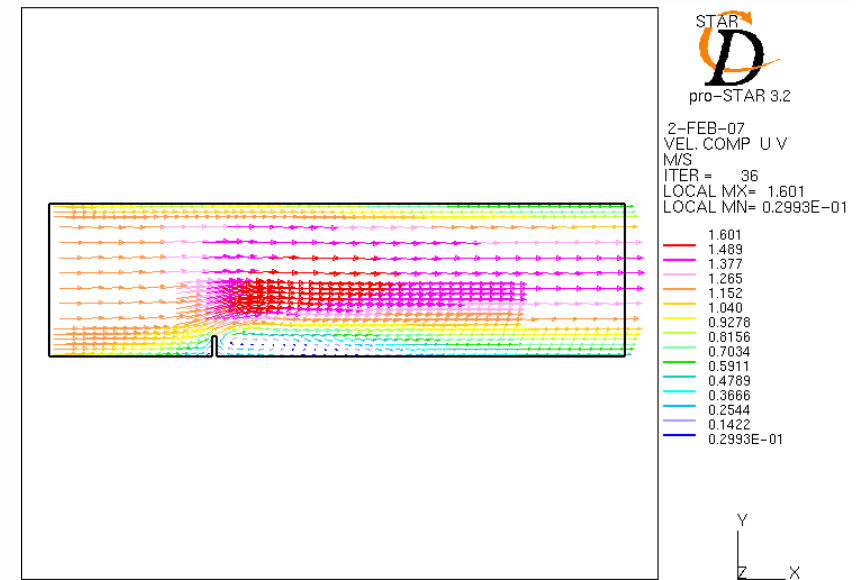
Y
X

范例

DURBIN1 model



MMK model



Thanks !

