



# MET.O.14

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METEOROLOGICAL OFFICE  
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TURBULENCE & DIFFUSION NOTE

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Note on Running the Linear Flow over Topography Model

by

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Please note: Permission to quote from this unpublished note should be obtained from the Head of Met.O.14, Bracknell, Berks, U.K.

FH13

### The linear topography model

The model is described in TDN 111 and the notes below are details required to use the program.

The model is coded to use the lower boundary condition

$$W = u_x - \frac{D}{2} (v_x - u_y) \quad D = \frac{2}{\Omega L^2}$$

(Mason & Sykes 1978) which incorporates the Ekman pumping velocity induced by the Ekman boundary layer, ( $2\Omega = f$ ).

The continuous fourier transforms of the solution variables have singularities when  $D = 0$  but not otherwise and for this reason a warning is output to the line printer in this case. However in the periodic problem these singularities are only of concern if they occur very close to a particular wavenumber component present. Should this happen a warning is sent every time this occurs - an arbitrary value is assigned to this component (zero) in the solution and processing continues. For the continuous transform the contribution at such singularities vanishes and they are not important, but this is probably not true for the discrete case. The singularities correspond to particular wavelengths of topography that do not have solutions exhibiting the same periodicity - the nature of these singular solutions has not been found.

The model is a FORTRAN module GTEMPLHP and uses WTPLLOT, a FORTRAN subroutine. Both programs are held on DEADSOURCE tapes. A subroutine TOPOG must be supplied to give the ground profile.

CARD INPUT      FT05F001.

Card 1      F3.0      Run number

Card 2      613      Wave number truncation and space resolution

M1    M2    N1    N2    M    N

The truncation is  $(-M1, M2)$  and  $(-N1, N2)$  and space resolution  $M \times N$ .

Card 3      5E12.5     $F_i$     $R_i$     $D$     $L_{ix}$     $h_o$

These quantities are dimensionless and defined in the TDN;  $L_{ix}$  is a length scale of the topography in the x direction and  $h_o$  the height.

Card 4 5E12.5  $L_y$   $L_{iy}$

The model integrates on a periodic domain  $[0,1] \times [0,L_y]$  after scaling with  $L_y$ .  $L_{iy}$  is a hill scale in the y direction.

Card 5 20L1, I1, I2, E12.5 INDIC(20) ISUP NHTS DISP

INDIC see later

ISUP = 1 (YES) Digital printout of fields.

= 0 (NO) No " " " " .

NHTS ( $\leq 19$ ) number of heights at which solution fields will be calculated minus one

DISP ( $0 \leq \text{DISP} < 1$ ) relative displacement of zero contour in plot routine (a contour will be drawn for the value  $\text{DISP} * \Delta$  where  $\Delta$  is the contour interval, instead of at the value zero).

Cards 6 6E12.5 Z0A(I) I = 1, NHTS+1

Heights at which calculations to be made - on as many cards as necessary.

Cards 7 20A4

Two cards, each a FORMAT statement for output of

(i) FORM MxN fields

(ii) FORM1 (M1+M2+1) x (N1+N2+1) fields.

INDIC(I)

I	Action if TRUE	I	Action if TRUE
1	Writes out $\tilde{h}_{ke}$	11	Writes out $\tilde{v}$
2	" " $m_{ke}$	12	" " $v$
3	" " $\tilde{w}_{ke}$	13	" " $\tilde{p}$
4	" " $w(x,y)$	14	" " $p$
5	" " $\tilde{\delta}$	15	" " $k\tilde{p}$
6	" " $\tilde{b}$	16	" " $k\tilde{p}_{ke} \tilde{h}_{-ke}$
7	" " $\tilde{w}$ modified (quantity used later in calculation)	17	Calculate $D_p$ (drag)
8	Writes out $\tilde{u}$	18	Reconstruct topography and print
9	" " $u$	19	Write out $\tilde{h}$ after magnitude truncation (CHOP)
10	" " $u+1$	20	Dump $\tilde{h}_{ke}$ to disc and STOP (the dump is always made if calculation continues).

In the coding there are variables ERR and ERR2 which are currently set to zero, (line numbers 7000-7100). If the maximum value of  $|\tilde{h}_{ke}|$  is  $\tilde{H}$ , then subroutine CHOP puts to zero all the  $\tilde{h}_{ke}$  such that  $|\tilde{h}_{ke}| < \text{ERR2} * \tilde{H}$  to minimise accumulation of round off errors. ERR is used for the critical separation between one singularity in the fourier transform and a nearby wavenumber below which a warning is printed, for  $R^2 - k^2 < \text{ERR}$ .

#### JCL

Programs GTEMPLHP, WTPLOT and TOPOG must be concatenated and compiled.

Then at the LKED step, the following must be included:-

M14.OBJ (GRF03) - produces line printer contour plot  
 M02.OBJLIB (KFFT) - FFT routines  
 M21.OBJLIB (JCNTS) - Calcomp contour plotting routine  
 MET.CALCOMP (OPENON35)

During the GO step, the files needed are

FT05F001 (cards) and FT06F001

FT08F001 - for CALCOMP

FT14F001 - device for unformatted output of  $\tilde{h}_{ke}$  coefficients

#### TOPOG

This routine puts the ground height at each "grid" point into A(M,N) and can use the COMMONS in the main program, in particular those below

```
SUBROUTINE TOPOG (A,HH)
COMMON    HLX, HLY
COMMON    /DIM/LY
COMMON    /DD/M1,M2,MX,M,N1,N2,NX,N
```

where HH is the height scale; HLX,HLY are respective length scales in two horizontal directions; and LY is the lateral dimension of the domain in units of L.

COMMON /DD/ holds dimensioning data.