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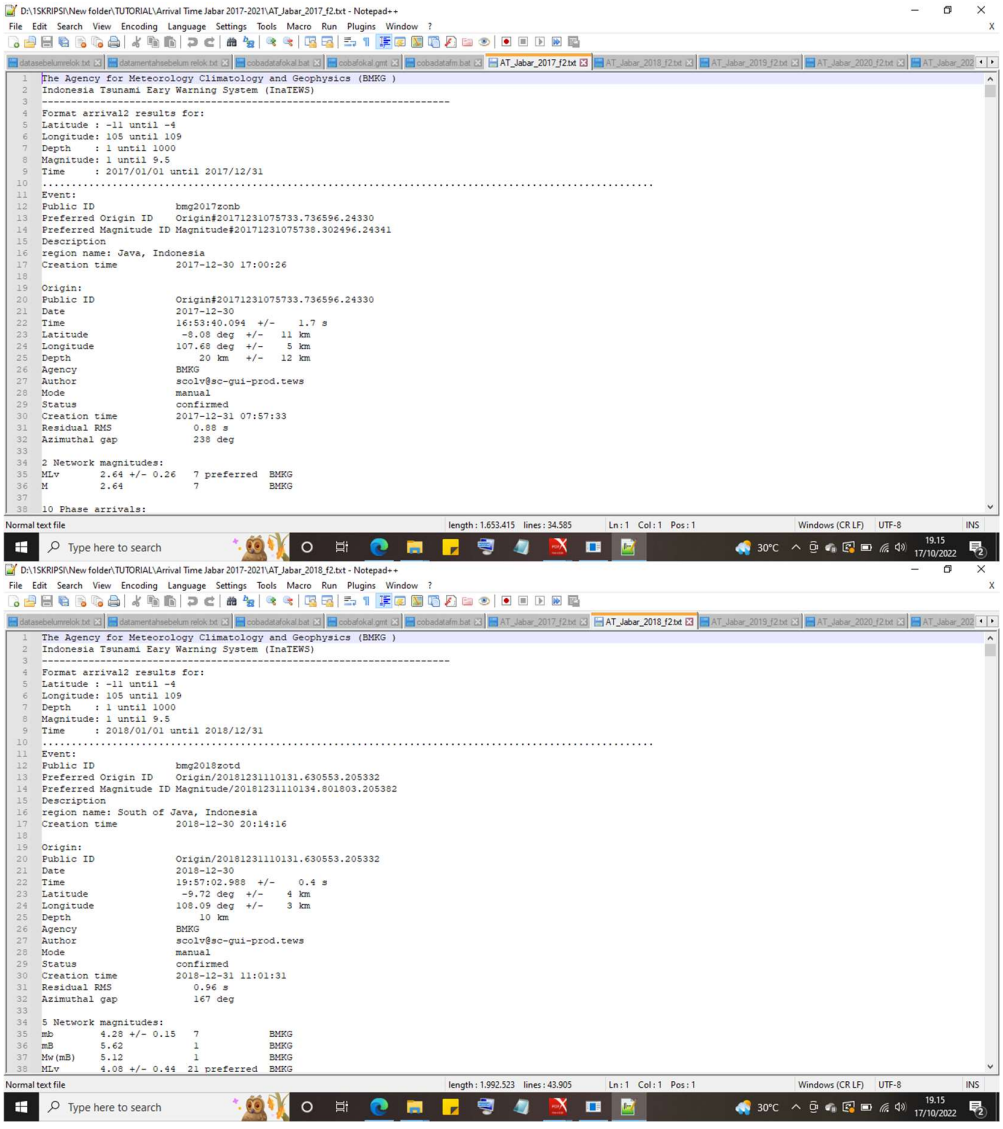
LAMPIRAN

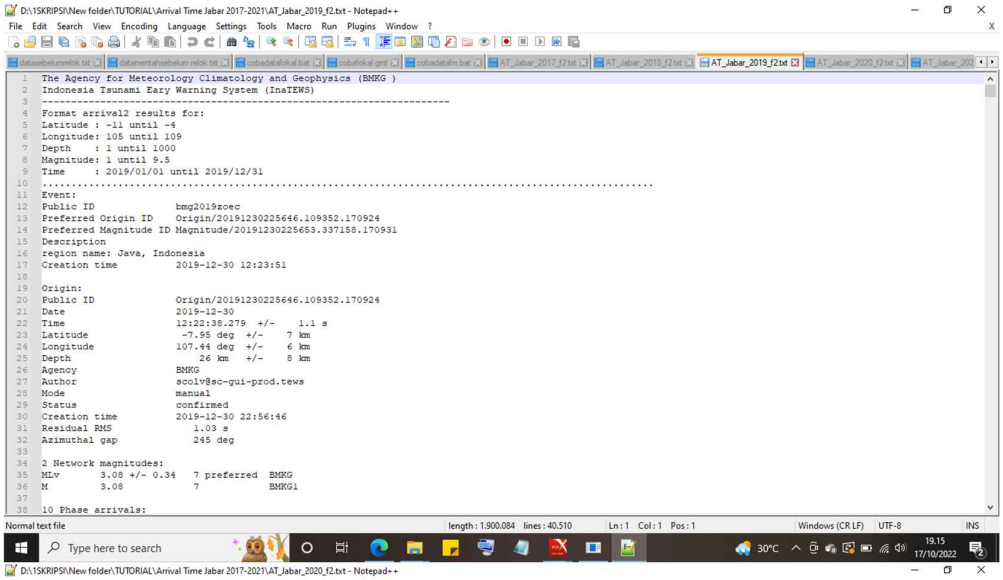
Lampiran Data Katalog BMKG

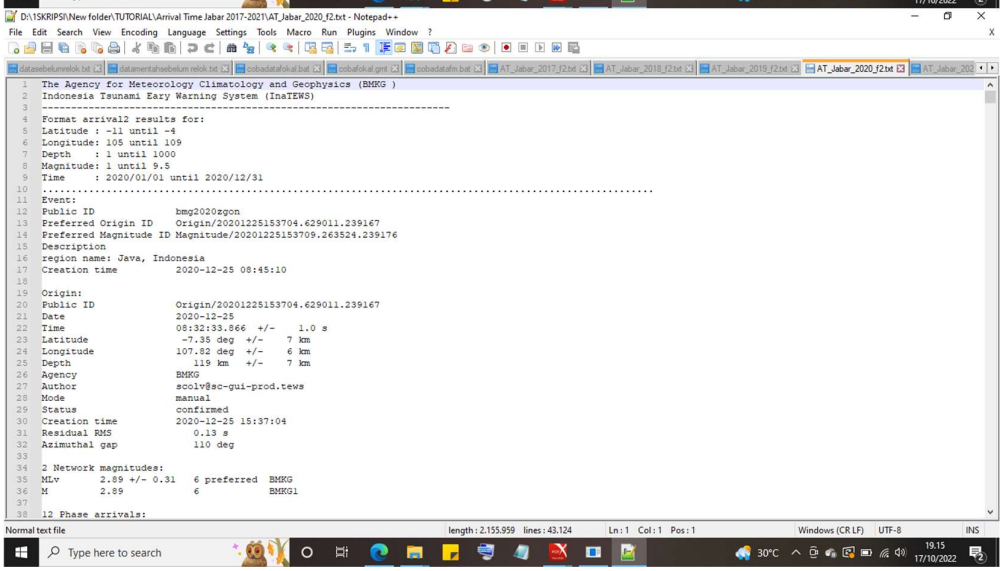


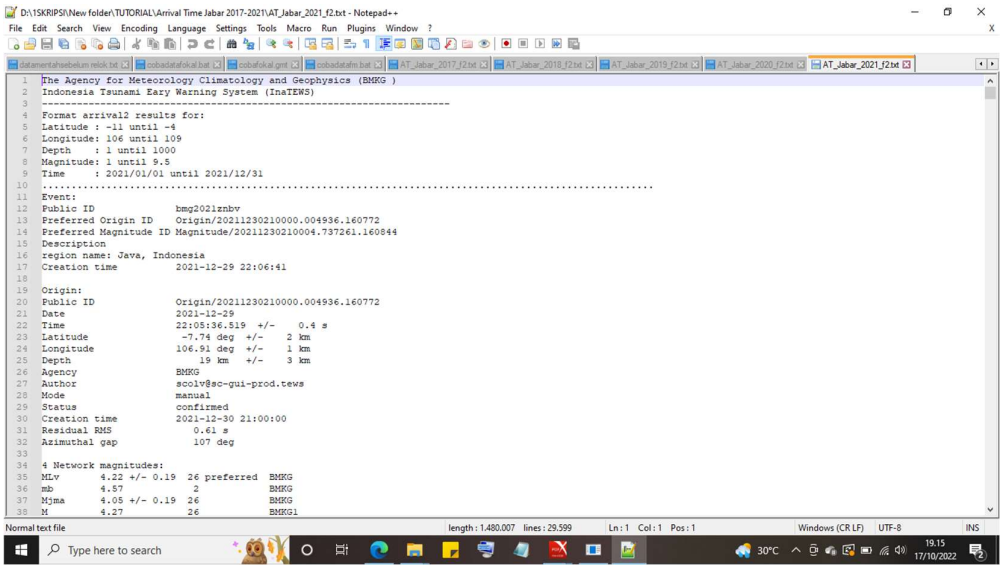
```
The Agency for Meteorology Climatology and Geophysics (BMKG )
Indonesia Tsunami Eary Warning System (InaTEWS)
--------------------------------------------------------------
Format arrival2 results for:
Latitude : -11 until -4
Longitude: 105 until 109
Depth    : 1 until 1000
Magnitude: 1 until 9.5
Time     : 2017/01/01 until 2017/12/31
.....................................................................................................
Event:
Public ID              bmg2017zonb
Preferred Origin ID    Origin#20171231075733.736596.24330
Preferred Magnitude ID Magnitude#20171231075738.302496.24341
Description
region name: Java, Indonesia
Creation time          2017-12-30 17:00:26

Origin:
Public ID              Origin#20171231075733.736596.24330
Date                   2017-12-30
Time                   16:53:40.094  +/-    1.7 s
Latitude               -8.08 deg  +/-   11 km
Longitude              107.68 deg  +/-    5 km
Depth                    20 km   +/-   12 km
Agency                 BMKG
Author                 scolv@sc-gui-prod.tews
Mode                   manual
Status                 confirmed
Creation time          2017-12-31 07:57:33
Residual RMS             0.88 s
Azimuthal gap            238 deg

2 Network magnitudes:
MLv       2.64 +/- 0.26   7 preferred  BMKG
M         2.64            7            BMKG

10 Phase arrivals:
```



```
The Agency for Meteorology Climatology and Geophysics (BMKG )
Indonesia Tsunami Eary Warning System (InaTEWS)
--------------------------------------------------------------
Format arrival2 results for:
Latitude : -11 until -4
Longitude: 105 until 109
Depth    : 1 until 1000
Magnitude: 1 until 9.5
Time     : 2018/01/01 until 2018/12/31
.....................................................................................................
Event:
Public ID              bmg2018zotd
Preferred Origin ID    Origin/20181231110131.630553.205332
Preferred Magnitude ID Magnitude/20181231110134.801803.205382
Description
region name: South of Java, Indonesia
Creation time          2018-12-30 20:14:16

Origin:
Public ID              Origin/20181231110131.630553.205332
Date                   2018-12-30
Time                   19:57:02.988  +/-    0.4 s
Latitude               -9.72 deg  +/-    4 km
Longitude              108.09 deg  +/-    3 km
Depth                    10 km
Agency                 BMKG
Author                 scolv@sc-gui-prod.tews
Mode                   manual
Status                 confirmed
Creation time          2018-12-31 11:01:31
Residual RMS             0.96 s
Azimuthal gap            167 deg

5 Network magnitudes:
mb        4.28 +/- 0.15   7            BMKG
mB        5.62            1            BMKG
Mw(mB)    5.12            1            BMKG
MLv       4.08 +/- 0.44   21 preferred  BMKG
```


D:\1SKRIPS\New folder\TUTORIAL\Arrival Time Jabar 2017-2021\AT_Jabar_2019_f2.txt - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
AT_Jabar_2019_f2.txt
The Agency for Meteorology Climatology and Geophysics (BMKG)
Indonesia Tsunami Eary Warning System (InaTEWS)
Format arrival2 results for:
Latitude : -11 until -6
Longitude: 105 until 109
Depth : 1 until 1000
Magnitude: 1 until 9.5
Time : 2019/01/01 until 2019/12/31
Event:
Public ID bmg2019zoec
Preferred Origin ID Origin/20191230225646.109352.170924
Preferred Magnitude ID Magnitude/20191230225653.337158.170931
Description
region name: Java, Indonesia
Creation time 2019-12-30 12:23:51
Origin:
Public ID Origin/20191230225646.109352.170924
Date 2019-12-30
Time 12:22:38.279 +/- 1.1 s
Latitude -7.95 deg +/- 7 km
Longitude 107.44 deg +/- 6 km
Depth 26 km +/- 8 km
Agency BMKG
Author scolv@sc-gui-prod.tews
Mode manual
Status confirmed
Creation time 2019-12-30 22:56:46
Residual RMS 1.03 s
Azimuthal gap 245 deg
2 Network magnitudes:
MLv 3.08 +/- 0.34 7 preferred BMKG
M 3.08 7 BMKG1
10 Phase arrivals:
Normal text file
length : 1.900.084 lines : 40.510
Ln : 1 Col : 1 Pos : 1
Windows (CR LF) UTF-8 INS
Type here to search
30°C
19.15
17/10/2022


D:\1SKRIPS\New folder\TUTORIAL\Arrival Time Jabar 2017-2021\AT_Jabar_2020_f2.txt - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
AT_Jabar_2020_f2.txt
The Agency for Meteorology Climatology and Geophysics (BMKG)
Indonesia Tsunami Eary Warning System (InaTEWS)
Format arrival2 results for:
Latitude : -11 until -6
Longitude: 105 until 109
Depth : 1 until 1000
Magnitude: 1 until 9.5
Time : 2020/01/01 until 2020/12/31
Event:
Public ID bmg2020zgon
Preferred Origin ID Origin/20201225153704.629011.239167
Preferred Magnitude ID Magnitude/20201225153709.263524.239176
Description
region name: Java, Indonesia
Creation time 2020-12-25 08:45:10
Origin:
Public ID Origin/20201225153704.629011.239167
Date 2020-12-25
Time 08:32:33.866 +/- 1.0 s
Latitude -7.35 deg +/- 7 km
Longitude 107.82 deg +/- 6 km
Depth 119 km +/- 7 km
Agency BMKG
Author scolv@sc-gui-prod.tews
Mode manual
Status confirmed
Creation time 2020-12-25 15:37:04
Residual RMS 0.13 s
Azimuthal gap 110 deg
2 Network magnitudes:
MLv 2.89 +/- 0.31 6 preferred BMKG
M 2.89 6 BMKG1
12 Phase arrivals:
Normal text file
length : 2.155.959 lines : 43.124
Ln : 1 Col : 1 Pos : 1
Windows (CR LF) UTF-8 INS
Type here to search
30°C
19.15
17/10/2022

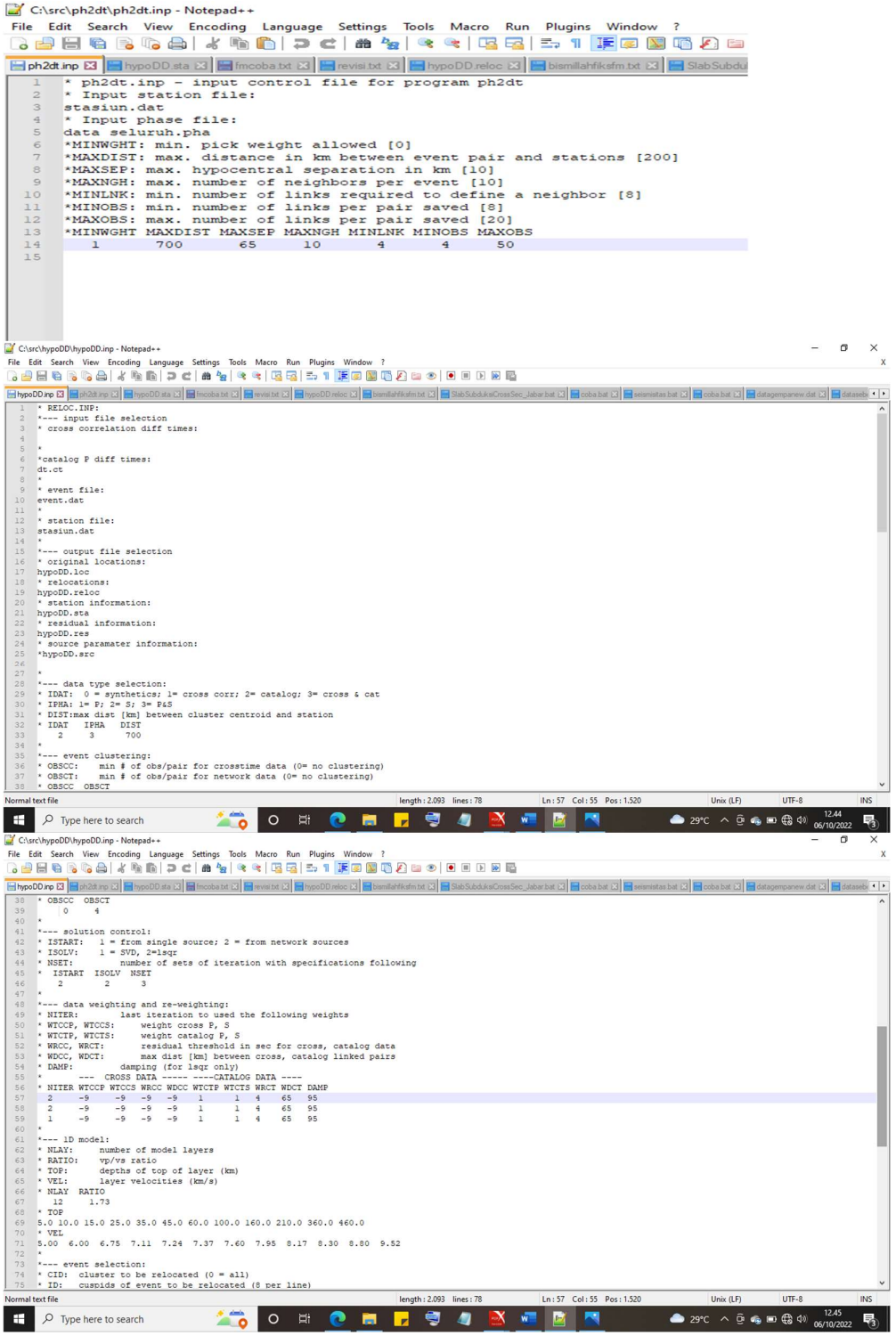


Script Peta Seismitas

```
set input=bismillahfiksfm.txt
set data=sum_slab1.0_clip.grd
set output=seismisitas_hypodd.ps
set clipfile=sum_slab1.0.clip
#Kedalaman Maksimum
set Dmax=450
#Interval kedalaman
set ID=60

#Membuat file warna
grd2cpt %data% -Cjet -Z> slab.cpt
makecpt -Cglobe -Z > elev.cpt
#%makecpt -Cno_green -I   -T0/350/50 -D > quake_depth.cpt
#%makecpt -Cred,yellow,blue -T0,60,300,600 -N > quake_depth.cpt
makecpt -Cseis -T0/%Dmax%/%ID% -D > quake_depth.cpt

#Menampilkan peta topografi dan batas pantai
#grdimage indo.nc -JM25.5 -Celev.cpt -K -R90/150/-15/15 -Y4> %output%
grdimage indo.nc -JM11 -Celev.cpt -K -R103/110.5/-11.2/-4.3 -Y4> %output%
pscoast -JM -R -B2f1WSNe -K -Dh -Wthin  -O >> %output%

#Menampilkan data slab dan melakukan "clip" agar hanya zona subduksi yang
        ditampilkan
#Serta membuat kontur dengan interval 20 km, perhatikan grdcontour bagian -
        C20
psclip %clipfile% -J -R -O -K >> %output%
grdimage %data% -Cslab.cpt -JM -R -K -O >> %output%
```

```
grdimage indo.nc -Celev.cpt -JM -R -K -O >> %output%
# grdcontour %data% -C20 -Ag -J -R -O -K -Wwhite >> %output%
psclip %clipfile% -J -R -O -K -C >> %output%
psxy %clipfile% -J -R -W1p -O -K >> %output%
pscoast -JM -R -B -K -O -Dh -Wthin  >> %output%

#Menampilkan batas subduksi
psxy -R -JM -W1.5,red -O -K trench.gmt>> %output%
psxy -R -JM -Wthin -m -O -K -W0.5,red, Java_fault.gmt >> %output%
psxy -R -JM -Wthin -m -O -K -W0.5,red, Sumatra_fault.gmt >> %output%
# psxy volcano.dat -R -J -St0.2 -Gred -W0 -O -K >> %output%

pscoast -JM -R -O -K -Dh -Wthinnest -P -Lf104.2/-9.4/12/200+l+jr --
        FONT_LABEL=10p >> %output%

gawk "{print $4, $3, $5, $6*0.016}" %input% | psxy -J -R -Sci -W0.2  -Gred -P -
        O -H -K -Cquake_depth.cpt>> %output%

#Menampilkan skala warna
psscale -D5.5/-1/10/0.4h -Cquake_depth.cpt -B%ID%:"Kedalaman (km)": -O >>
        %output%


ps2raster -A -P -Tj %output%
```

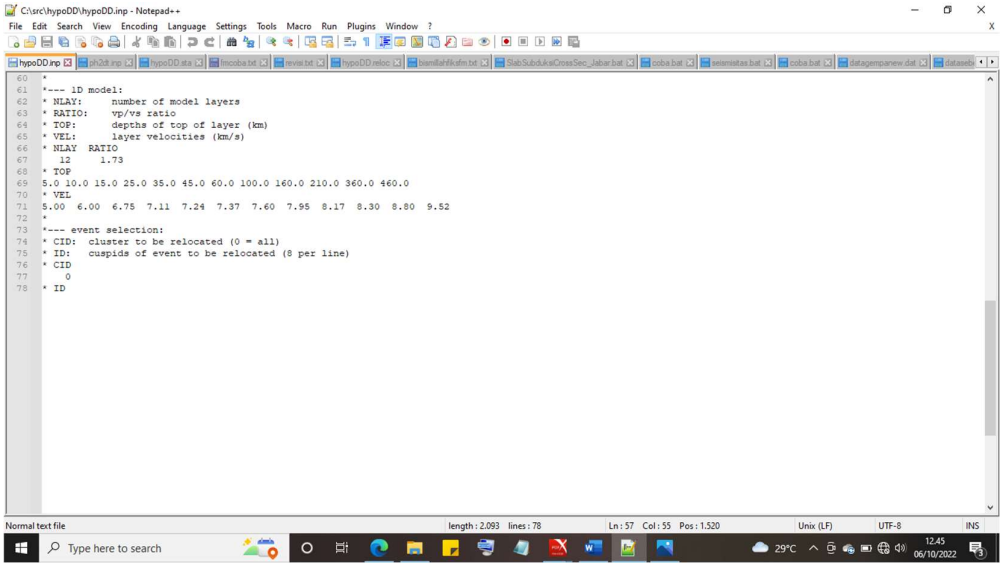
Lampiran Parameter *Input Ph2dt* dan *HypoDD*



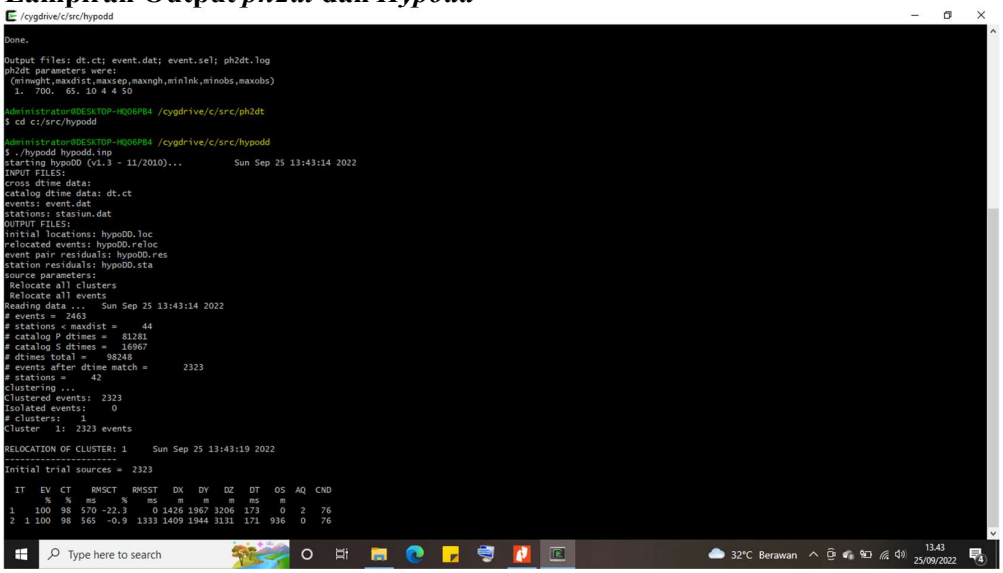
```
* ph2dt.inp - input control file for program ph2dt
* Input station file:
stasiun.dat
* Input phase file:
data seluruh.pha
*MINWGHT: min. pick weight allowed [0]
*MAXDIST: max. distance in km between event pair and stations [200]
*MAXSEP: max. hypocentral separation in km [10]
*MAXNGH: max. number of neighbors per event [10]
*MINLNK: min. number of links required to define a neighbor [8]
*MINOBS: min. number of links per pair saved [8]
*MAXOBS: max. number of links per pair saved [20]
*MINWGHT MAXDIST MAXSEP MAXNGH MINLNK MINOBS MAXOBS
   1       700       65       10       4       4       50
```

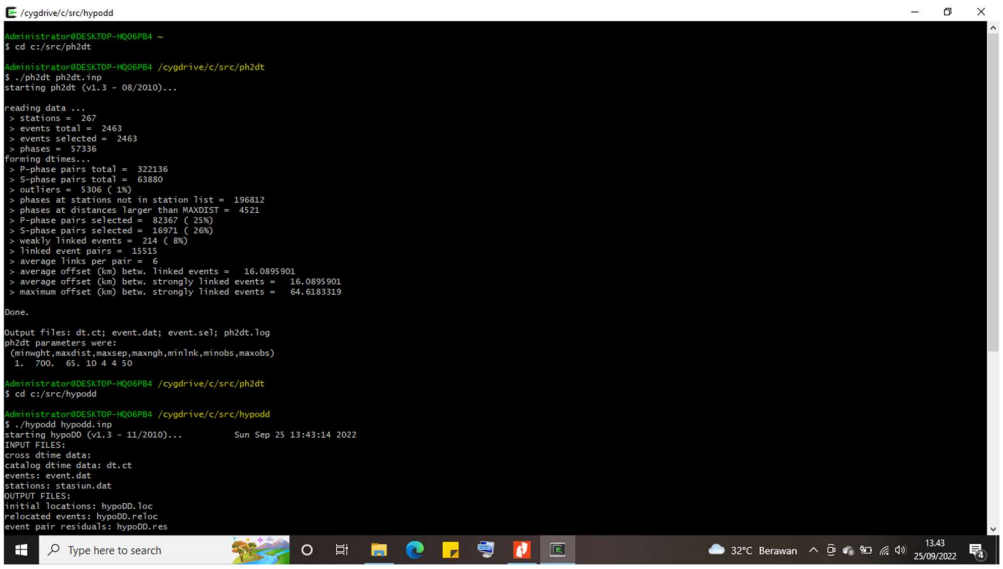
```
* RELOC.INP:
*--- input file selection
* cross correlation diff times:

*
*catalog P diff times:
dt.ct
*
* event file:
event.dat
*
* station file:
stasiun.dat
*
*--- output file selection
* original locations:
hypoDD.loc
* relocations:
hypoDD.reloc
* station information:
hypoDD.sta
* residual information:
hypoDD.res
* source paramater information:
*hypoDD.src

*
*--- data type selection:
* IDAT:  0 = synthetics; 1= cross corr; 2= catalog; 3= cross & cat
* IPHA: 1= P; 2= S; 3= P&S
* DIST:max dist [km] between cluster centroid and station
* IDAT   IPHA   DIST
    2      3      700
*
*--- event clustering:
* OBSCC:    min # of obs/pair for crosstime data (0= no clustering)
* OBSCT:    min # of obs/pair for network data (0= no clustering)
* OBSCC  OBSCT
```

```
* OBSCC  OBSCT
    0      4
*
*--- solution control:
* ISTART:   1 = from single source; 2 = from network sources
* ISOLV:    1 = SVD, 2=lsqr
* NSET:        number of sets of iteration with specifications following
*  ISTART  ISOLV  NSET
   2        2      3
*
*--- data weighting and re-weighting:
* NITER:        last iteration to used the following weights
* WTCCP, WTCCS:     weight cross P, S
* WTCTP, WTCTS:     weight catalog P, S
* WRCC, WRCT:       residual threshold in sec for cross, catalog data
* WDCC, WDCT:       max dist [km] between cross, catalog linked pairs
* DAMP:          damping (for lsqr only)
*        ---  CROSS DATA ----- ----CATALOG DATA ----
* NITER WTCCP WTCCS WRCC WDCC WTCTP WTCTS WRCT WDCT DAMP
  2     -9     -9   -9   -9    1      1    4    65   95
  2     -9     -9   -9   -9    1      1    4    65   95
  1     -9     -9   -9   -9    1      1    4    65   95
*
*--- 1D model:
* NLAY:     number of model layers
* RATIO:    vp/vs ratio
* TOP:      depths of top of layer (km)
* VEL:      layer velocities (km/s)
* NLAY  RATIO
   12     1.73
* TOP
5.0 10.0 15.0 25.0 35.0 45.0 60.0 100.0 160.0 210.0 360.0 460.0
* VEL
5.00  6.00  6.75  7.11  7.24  7.37  7.60  7.95  8.17  8.30  8.80  9.52
*
*--- event selection:
* CID:  cluster to be relocated (0 = all)
* ID:   cuspids of event to be relocated (8 per line)
```

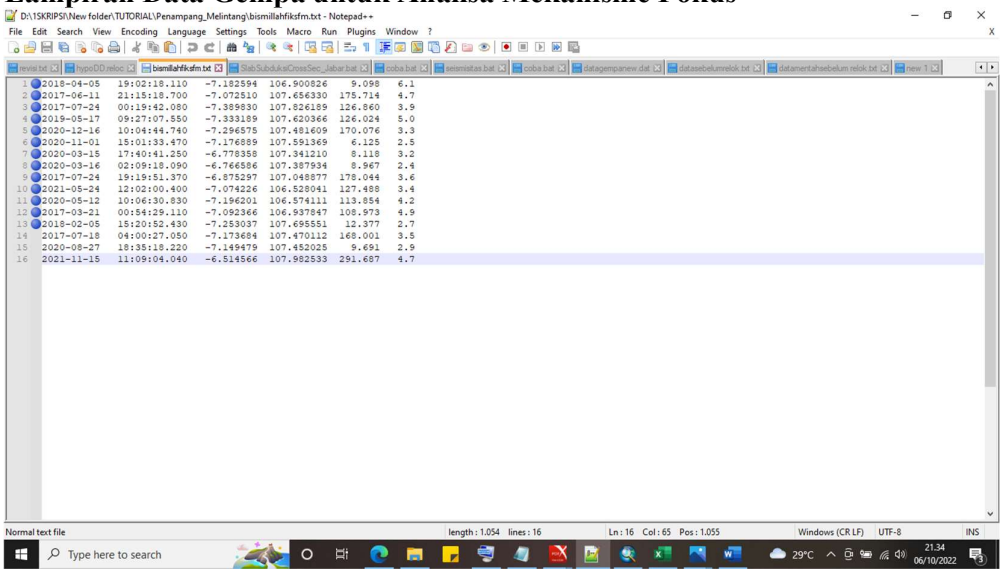


Lampiran Output *ph2dt* dan *Hypodd*

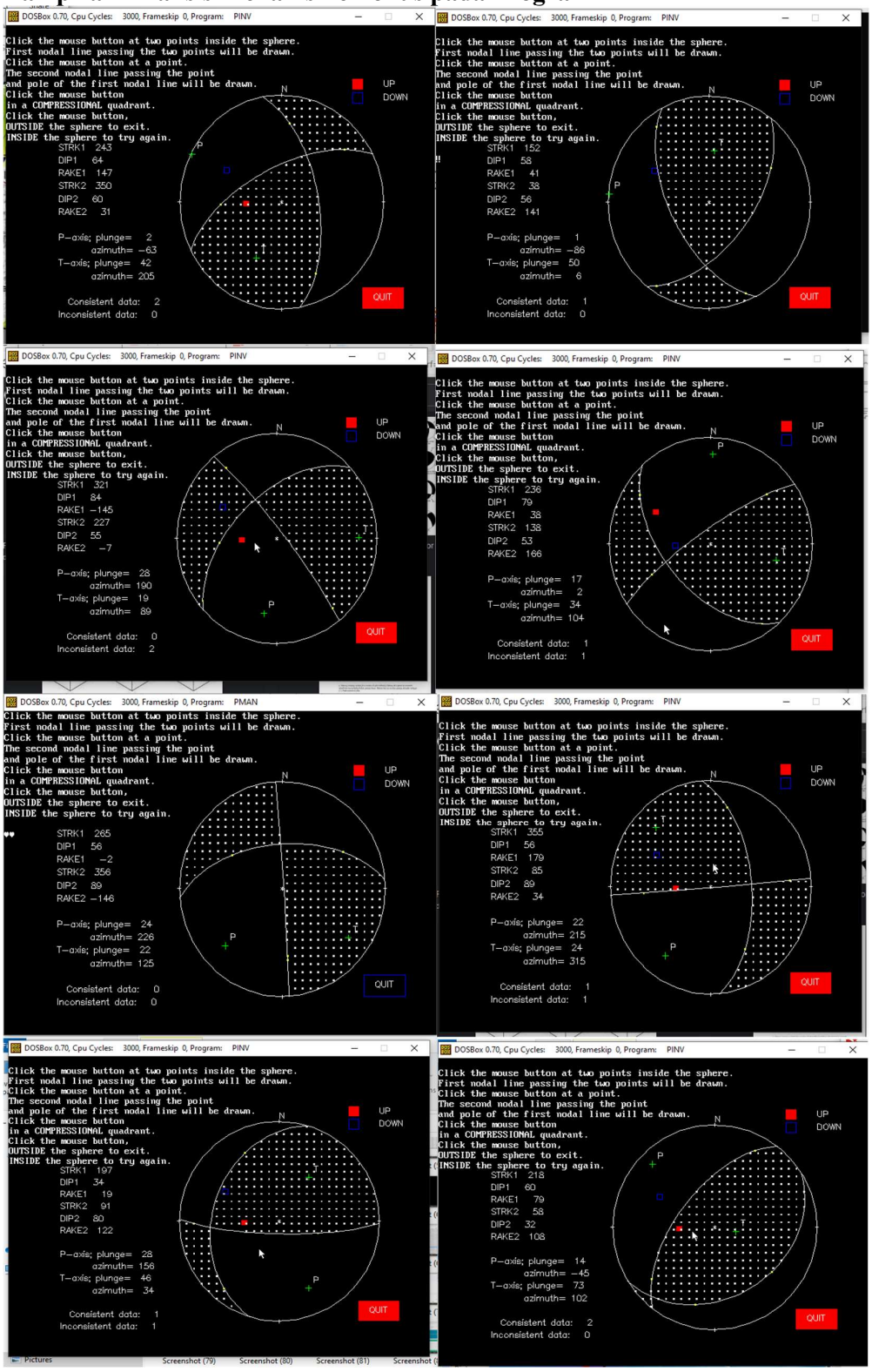




Lampiran Data Gempa untuk Analisa Mekanisme Fokus



Lampiran Analisis Mekanisme Fokus pada Program AZMTAK




DOSBox 0.70, Cpu Cycles: 3000, Frameskip 0, Program: PINV
Click the mouse button at two points inside the sphere.
First nodal line passing the two points will be drawn.
Click the mouse button at a point.
The second nodal line passing the point
and pole of the first nodal line will be drawn.
Click the mouse button
in a COMPRESSIONAL quadrant.
Click the mouse button,
OUTSIDE the sphere to exit.
INSIDE the sphere to try again.
STRK1 18
DIP1 73
RAKE1 136
STRK2 124
DIP2 48
RAKE2 23
P-axis; plunge= 15
azimuth= 76
T-axis; plunge= 43
azimuth= 332
Consistent data: 1
Inconsistent data: 1
N
P
T
UP
DOWN
QUIT
DOSBox 0.70, Cpu Cycles: 3000, Frameskip 0, Program: PINV
Click the mouse button at two points inside the sphere.
First nodal line passing the two points will be drawn.
Click the mouse button at a point.
The second nodal line passing the point
and pole of the first nodal line will be drawn.
Click the mouse button
in a COMPRESSIONAL quadrant.
Click the mouse button,
OUTSIDE the sphere to exit.
INSIDE the sphere to try again.
STRK1 243
DIP1 64
RAKE1 147
STRK2 350
DIP2 60
RAKE2 31
P-axis; plunge= 2
azimuth= -63
T-axis; plunge= 42
azimuth= 205
Consistent data: 2
Inconsistent data: 0
N
P
T
UP
DOWN
QUIT
DOSBox 0.70, Cpu Cycles: 3000, Frameskip 0, Program: PINV
Click the mouse button,
OUTSIDE the sphere to exit.
INSIDE the sphere to try again.
STRK1 27
DIP1 35
RAKE1 66
STRK2 236
DIP2 58
RAKE2 106
P-axis; plunge= 12
azimuth= 315
T-axis; plunge= 72
azimuth= 185
Consistent data: 2
Inconsistent data: 0
N
P
T
UP
DOWN
DOSBox 0.70, Cpu Cycles: 3000, Frameskip 0, Program: PINV
Click the mouse button at two points inside the sphere.
First nodal line passing the two points will be drawn.
Click the mouse button at a point.
The second nodal line passing the point
and pole of the first nodal line will be drawn.
Click the mouse button
in a COMPRESSIONAL quadrant.
Click the mouse button,
OUTSIDE the sphere to exit.
INSIDE the sphere to try again.
STRK1 218
DIP1 60
RAKE1 79
STRK2 58
DIP2 32
RAKE2 108
P-axis; plunge= 14
azimuth= -45
T-axis; plunge= 73
azimuth= 102
Consistent data: 2
Inconsistent data: 0
N
P
T
UP
DOWN
QUIT

Lampiran Deret Taylor

Waktu tiba gempa (*Arrival Time*) dalam gelombang berasal dari hiposenter (x_0, y_0, z_0, t_0) yang tiba pada stasiun ke-i adalah t_i, waktu tempuh berdasarkan model kecepatan yang digunakan adalah t_i^{cal} yang biasanya sedikit berbeda dari hasil observasinya $t_i^{obs} = t_i - t_0$. Selisih tersebut merupakan residual r_i, dihitung dengan persamaan:

$$r_i = t_i^{obs} - t_i^{cal} \quad (1)$$

t_i^{cal} merupakan *travel time* kalkulasi yang dapat ditulis dengan rumus:

$$t^{cal} = t_0 \frac{\sqrt{(x_p - x_s)^2 + (y_p - y_s)^2 + (z_p - z_s)^2}}{V_p} \quad (2)$$

Dimana x_p, y_p, z_p merupakan lokasi hiposenter dari model dan x_s, y_s, z_s adalah lokasi stasiun.

Persamaan tersebut (2) merupakan persamaan *nonlinier*. Untuk melinearkan sebuah persamaan dapat disumsikan bahwa model kecepatan sudah mendekati model sebenarnya dan pembacaan waktu tempuh (*travel time*) sudah benar, sehingga selisih waktu tempuh (*travel time*) sudah benar (Massinai, 2016). Selisih waktu tempuh adalah fungsi linier sederhana dari selisih parameter dugaan dan sebenarnya. Dengan fungsi inversi linear:

$$d = g(m) \quad (3)$$

dimana d merupakan data observasi ($t_1^{obs}, t_2^{obs} \ldots . t_n^{obs}$), g merupakan fungsi model ($t_1^{cal}, t_2^{cal} \ldots . t_n^{cal}$) dan m adalah parameter model (x, y, z, t0). Model pada persamaan (2) yaitu suku $(x_p - x_s)^2 + (y_p - y_s)^2 + (z_p - z_s)^2$ maka untuk melinearkannya menggunakan *Deret Taylor*.

$$g.m = g.m_0 + \frac{\partial g(m)}{\partial m}\Delta m + \frac{1}{2}\frac{\partial^2 g(m)}{\partial m^2}\Delta m^2 + \cdots \quad (4)$$

Karena sudah linear maka persamaan (4) yang diambil hanya orde 1. Kemudian,

$$g.m = g.m_0 + \frac{\partial g(m)}{\partial m}\Delta m$$

$$d = g.m_0 + \frac{\partial g(m)}{\partial m}\Delta m$$

$$d - g.m_0 = \frac{\partial g(m)}{\partial m}\Delta m$$

$$\Delta d = J.\Delta m \quad (5)$$

Travel Time Untuk Tiga Lapisan

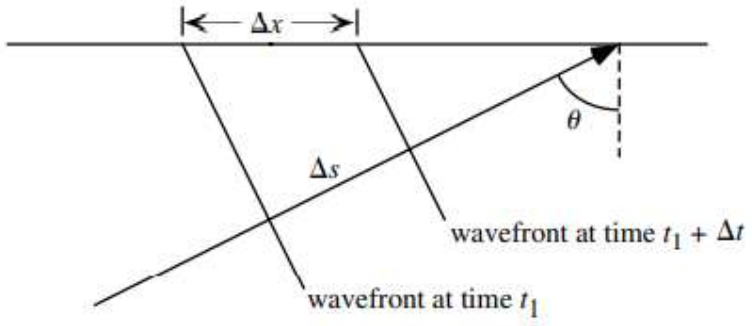
Gelombang yang merambat ke suatu medium dengan kecepatan v, yang memotong bidang horizontal, dengan gelombang permukaan saat t=t1 dan t=t1+Δt dipisahkan oleh Δs sebagai Panjang lintasannya. Sudut ini dari arah vertical disebut incident angel. Sudut ini berelasi dengan Δs terhadap jarak muka gelombang di permukaan, Δx, oleh:

$$\Delta s = \Delta x \sin \Theta$$

Karena Δs = v Δt, maka

$$v\,\Delta t = \Delta x \sin\theta$$

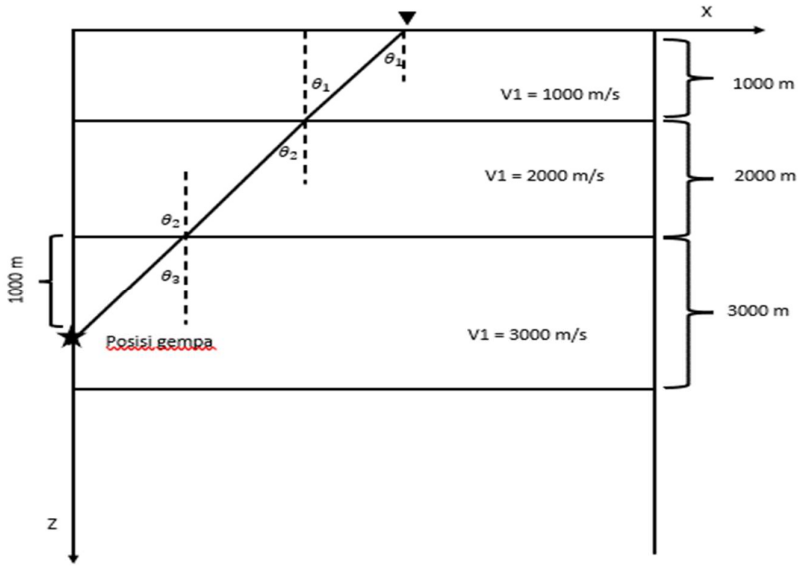
Atau $\frac{\Delta t}{\Delta x} = \frac{\sin\theta}{v} = u \sin\theta \equiv p$



Dimana **u adalah slowness (u=1/v) yang v adalah kecepatan)** dan **p merupakan ray parameter**. Dengan mengetahui waktu kedatangan gelombang di dua stasiun yang berbeda, maka p akan langsung bisa diukur, p merupakan parameter slowness gelombang yang pertama muncul dalam arah horizontal, jadi dapat ddikatakan **p biasanya disebut horizontal slowness**.

Jika gelombang bidang mengarah ke bawah menunjam ke permukaan horizontal antar dua lapisan homogen, dengan kecepatan berbeda. Maka lapisan atas mempunyai kecepatan yang lebihh rendah **(v1 < v2) dan (u1 > u2)** maka nilai p menjadi

$$p = u_1 \sin\theta 1 = u_2 \sin\theta 2$$



Pada contoh bidang permukaan di atas untuk penentuan travel time 3 lapis dimana pada lapisan 3 (X0) di atas merupakan titik hiposenter yang kemudian akan di tangkap oleh stasiun perekam pada lapisan 1. Dimana t merupakan nilai waktu tempuh kalkulasi yang akan dihitung pada setiap lapisan, h merupakan kedalaman ppada lapisan ke titik gempa, dan x merupakan jarak hiposenter pada batas lapisan. Untuk kemudian menghitung waktu tempuh kalkulasi dengan parameter hiposenter x,y,z,sebagai berikut:

$$tcal = \sqrt{\frac{((x1 - x0)^2 + (y1 - y0)^2 + (z1 - z0)^2}{v}}$$

Untuk perhitungan travel time juga menggunakan ray parameter (p) dengan $p = \frac{\sin}{v}$ dan u merupakan slowness atau perlambatan dengan $u = \frac{1}{v}$. dengan rumus sebagai berikut:

$t(p) = \sum_i^n \frac{u_i^2 \, \Delta z_i}{(u_i^2 - p^2)^{1/2}} 9$