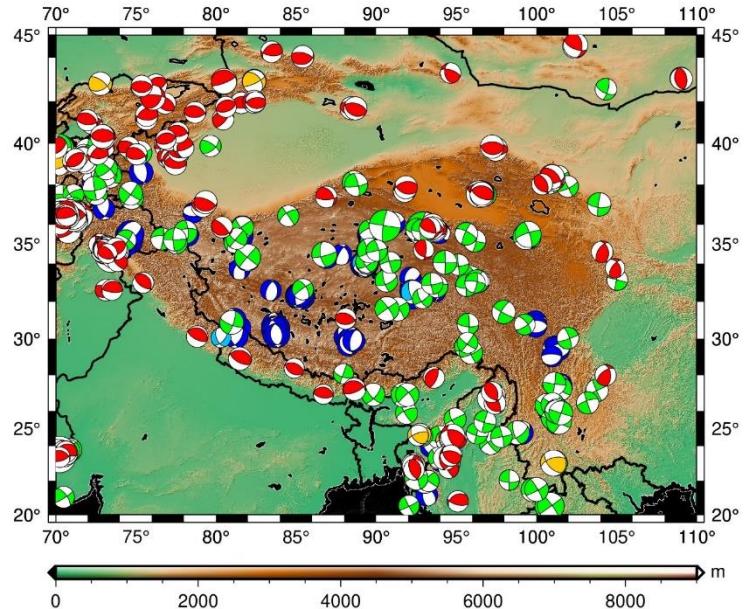
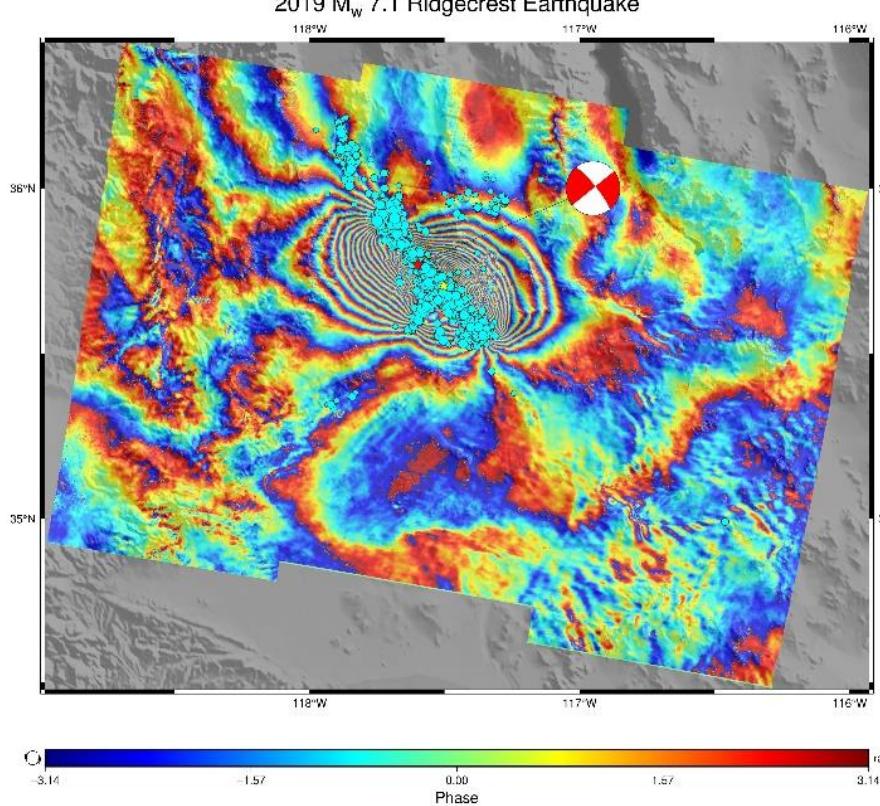


# *GMT Lecto7 : Legend & Interferogram*

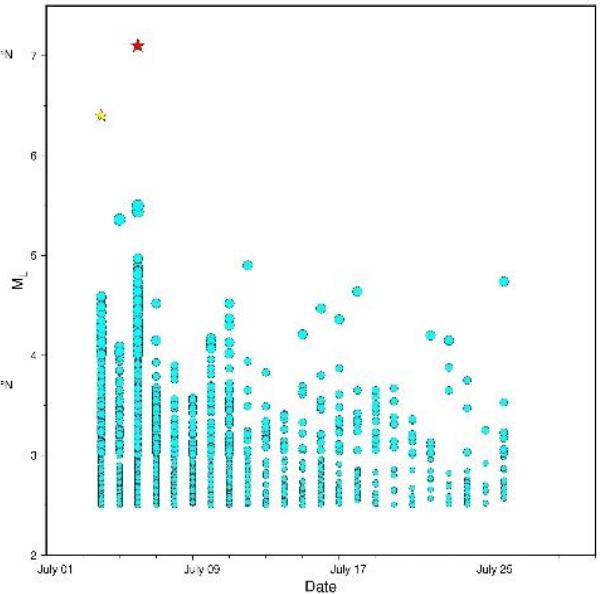
Tibetan Plateau



2019  $M_w$  7.1 Ridgecrest Earthquake



●  $M_w > 2.0$   
 ●  $M_w > 3.0$   
 ●  $M_w > 4.0$   
 ●  $M_w > 5.0$   
 ★  $M_w > 6.0$   
 ★  $M_w$  7.1 Ridgecrest earthquake



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 Jyr-Ching HU, Dept. of Geosciences, NTU

# *GMT commands*

**Legend** - To plot a map legend (繪製圖例說明)

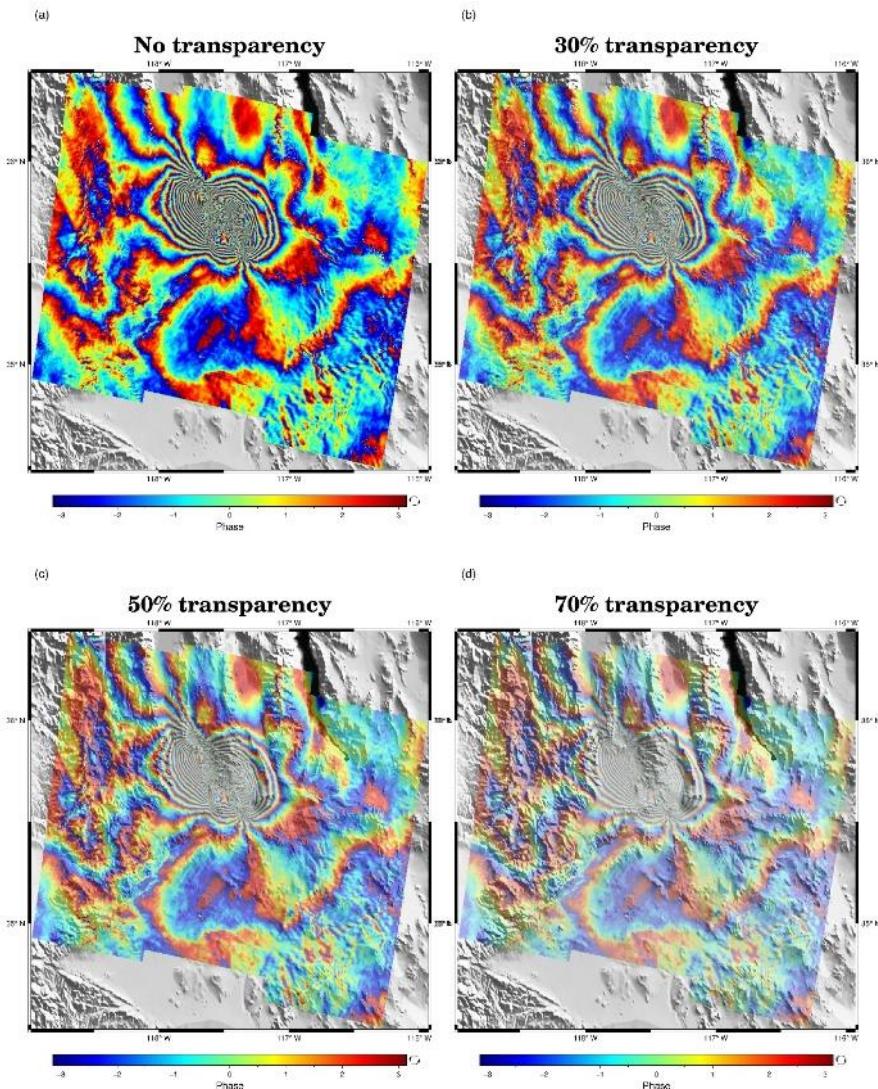
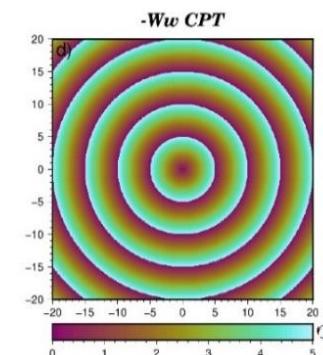
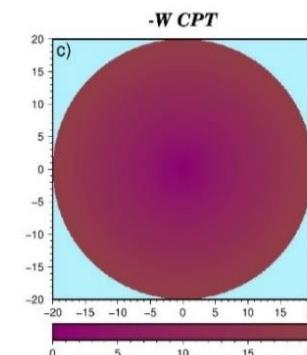
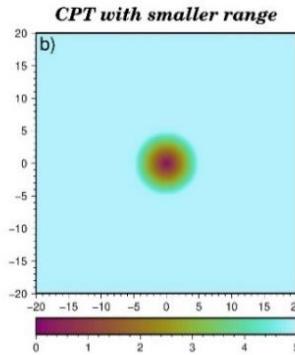
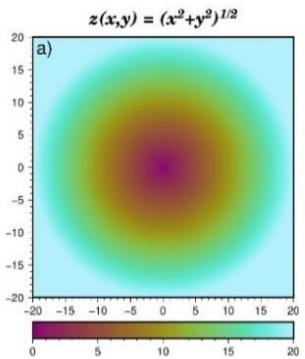
**gmtlogo** - Plot the GMT logo (在圖上繪製GMT圖形logo)

**grdmath** - Reverse Polish Notation (RPN) calculator for grids (element by element) (用逆波蘭表示法對網格檔做數學計算操作)

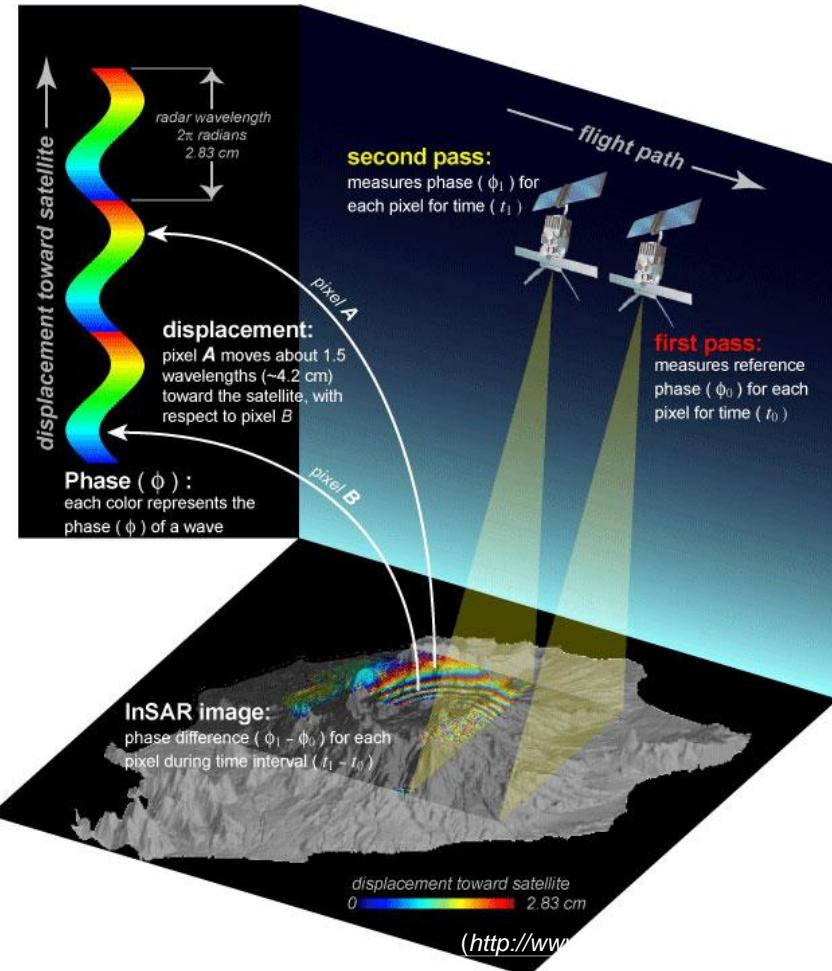
**makecpt -Ww** - Wrapped (Cyclic) CPT (循環式的色階檔)

**subplot** - Manage modern mode figure subplot configuration and selection (管理和設置子圖模式)

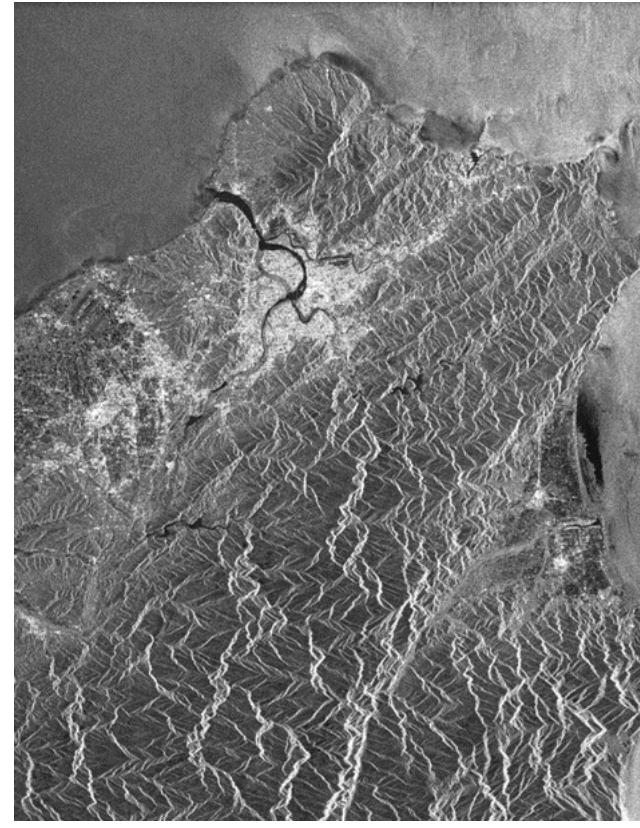
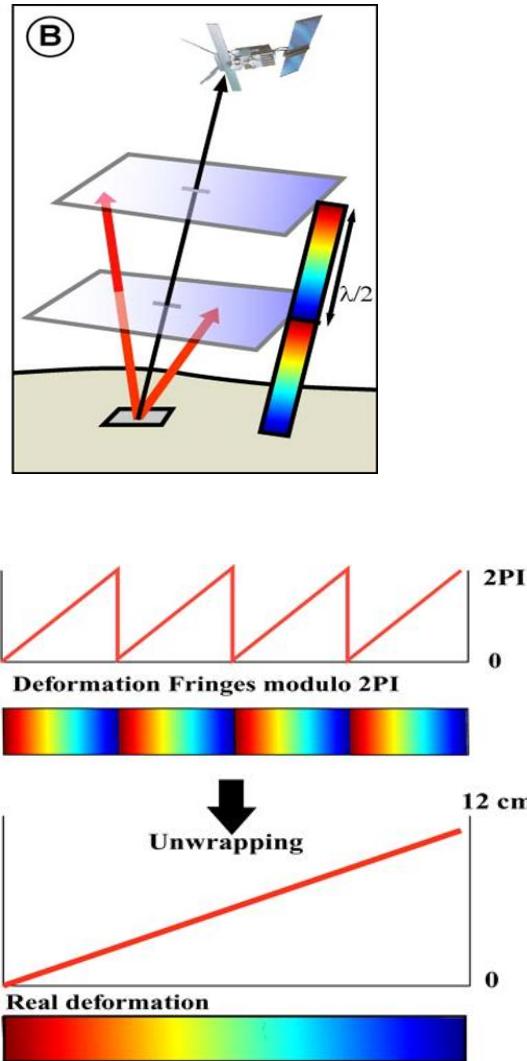
**grdimage -t** - Transparency in grdimage (調整透明度)



# *D-InSAR: Differential Interferometric SAR* (差分合成孔徑 雷達干涉觀測)

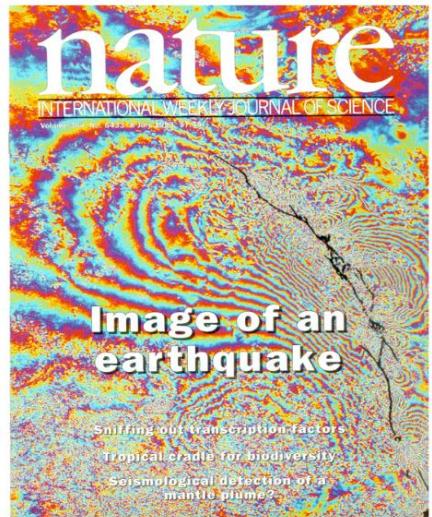


Repeat pass interferometry

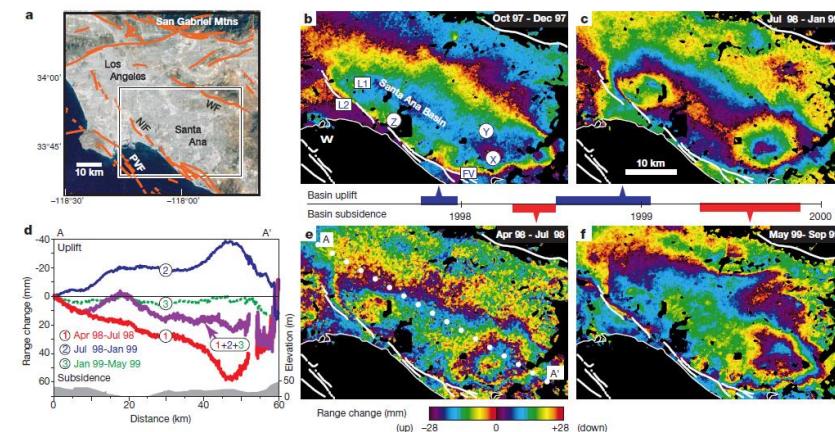
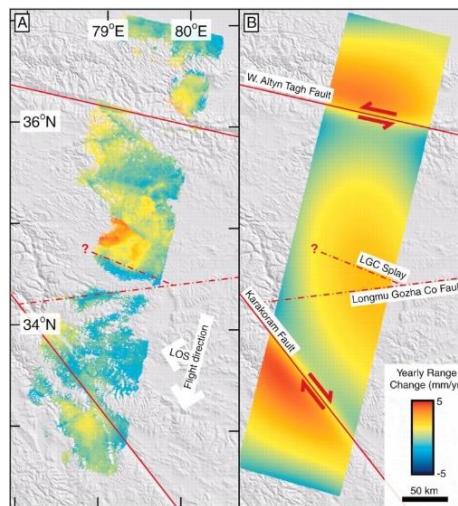


# D-InSAR: Differential Interferometric SAR (差分合成孔徑雷達干涉觀測)

Earthquake:  
Massonnet et al., 1993,  
Nature

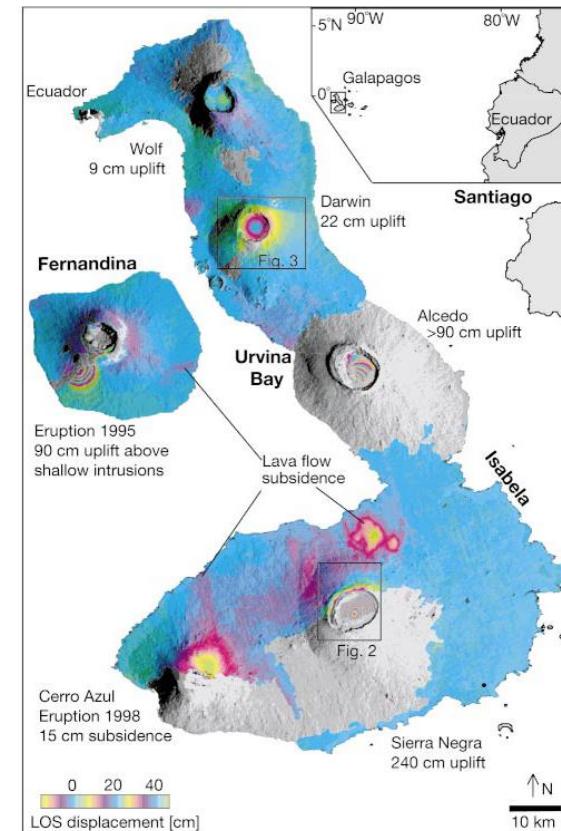


Tectonic activity:  
Wright et al., Science, 2004



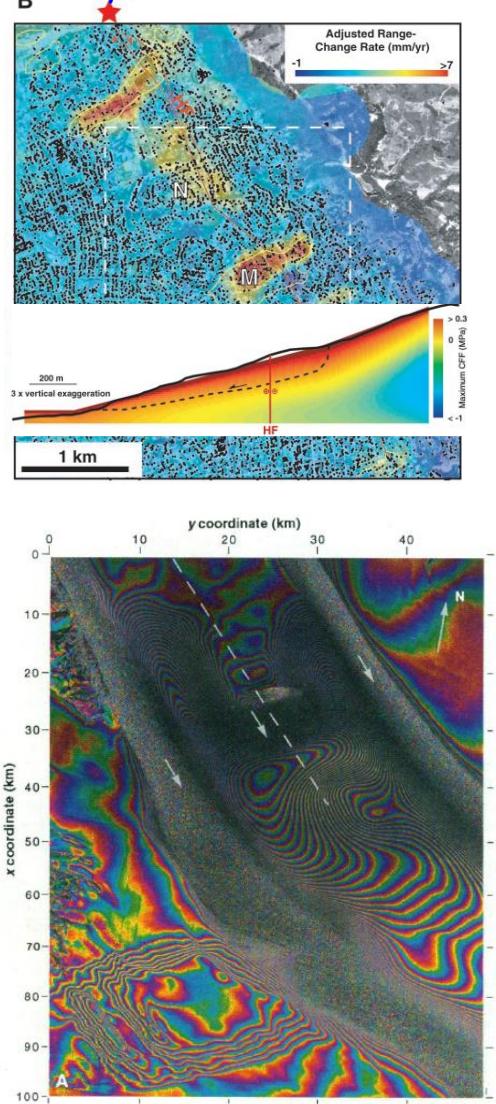
Land subsidence Bawden et al., Nature, 2001

Volcano activity  
Amelung et al., Nature, 2000



Ice sheet motion:  
Goldstein et al., Science, 1993

Landslide  
Hilley et al., Science, 2004

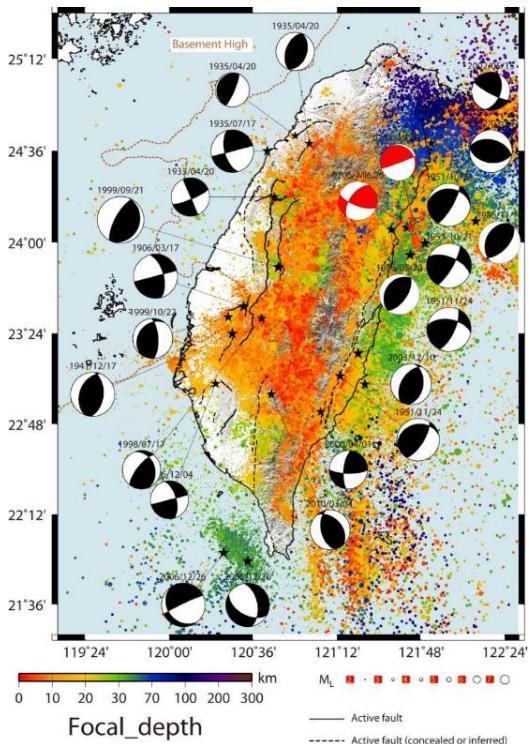
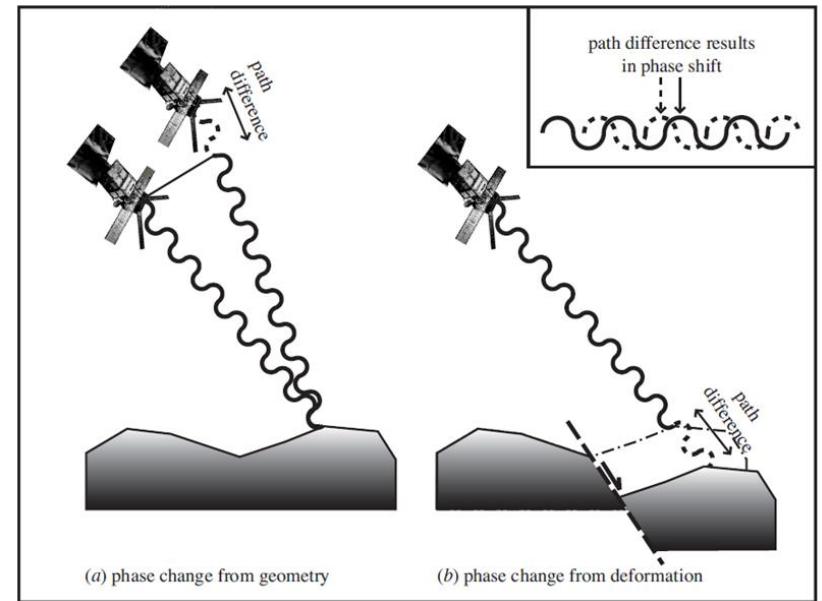


# Schematic of radar interferometry

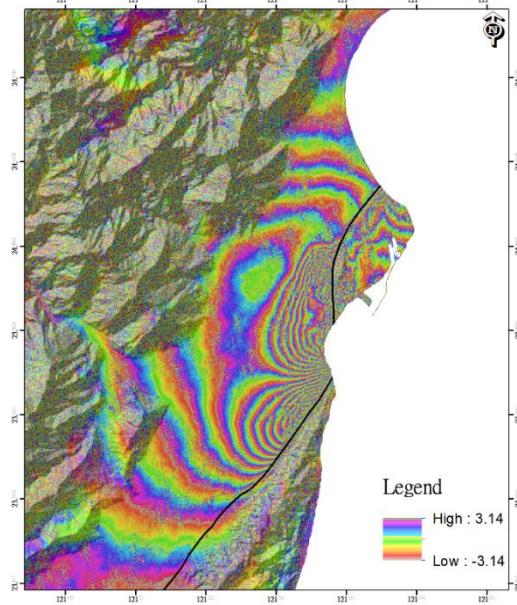
$$\delta\phi_{diff} = \delta\phi_{\varepsilon} + \delta\phi_{mov} + \delta\phi_{atm} + \delta\phi_{noise}$$

觀測的相位變化=地表高程+變形+大氣+噪訊的相位變化

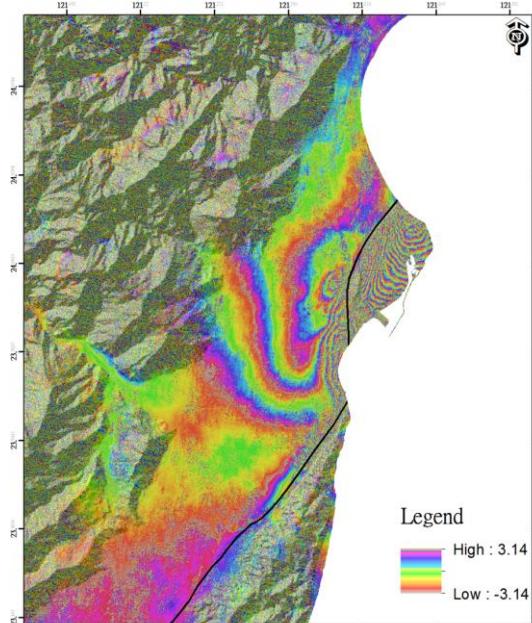
Coseismic deformations (同震變形) of  
2018 Hualien Mw 6.4 and 2024 ML 7.2 earthquakes



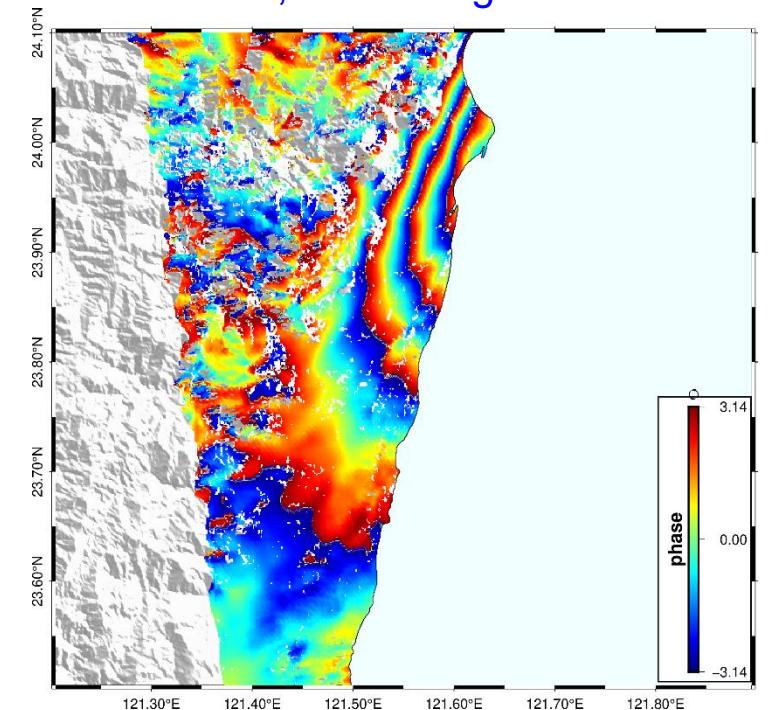
Sentinel-1, ascending:



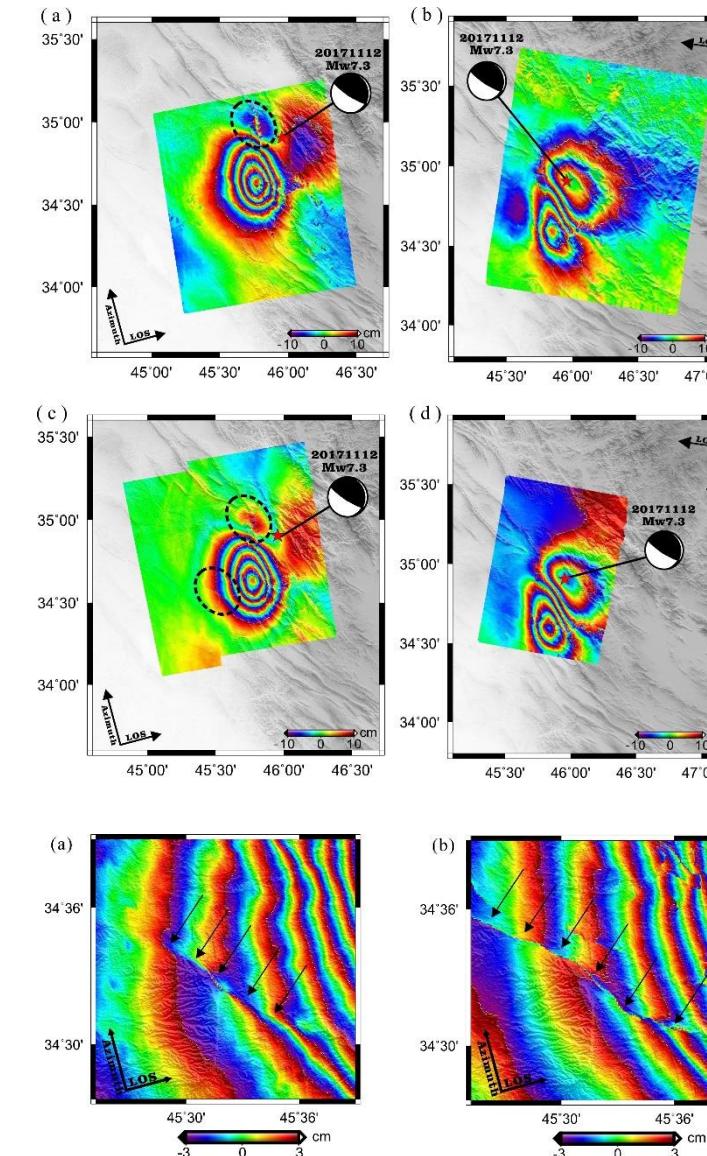
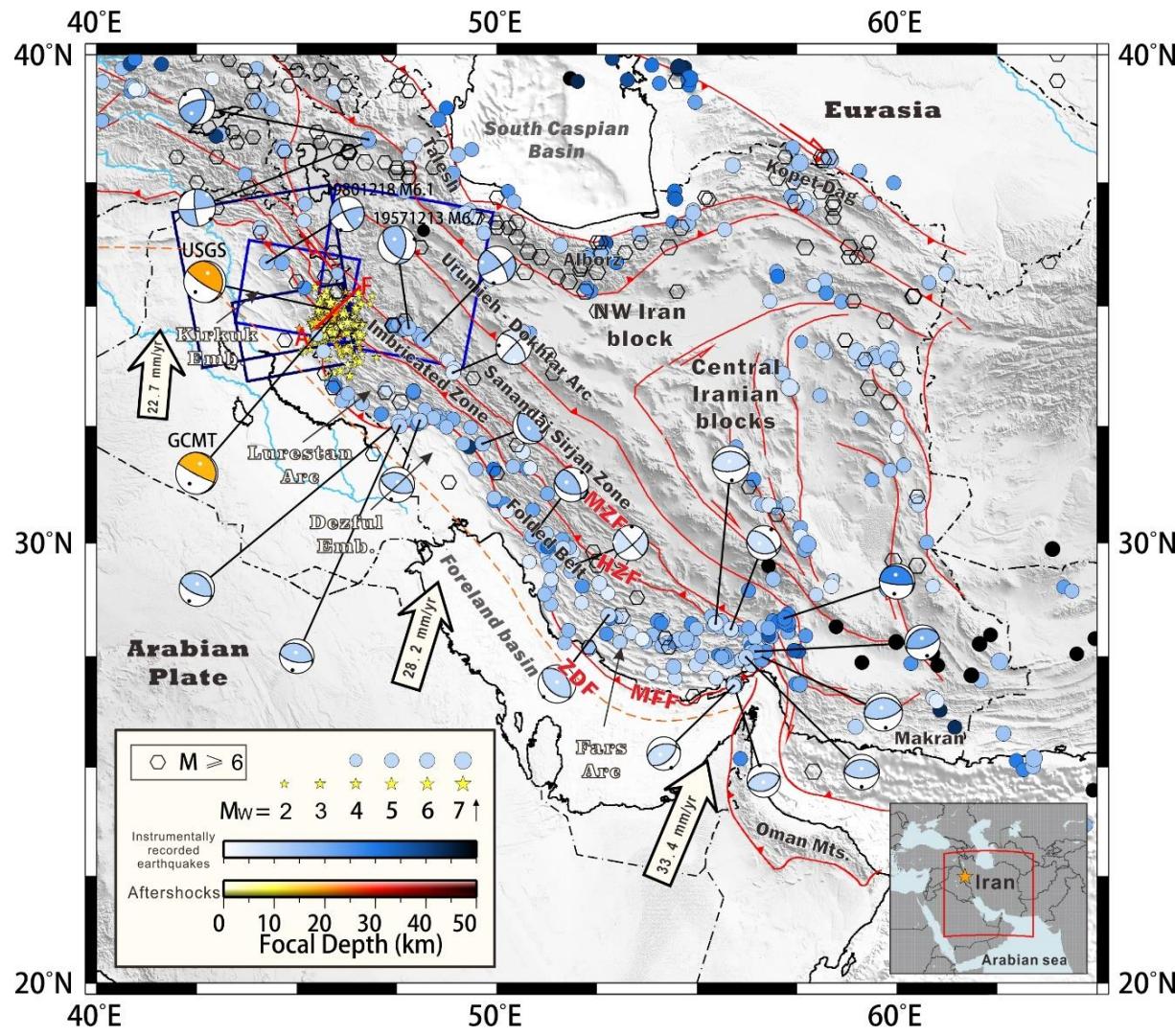
Sentinel-1, descending:



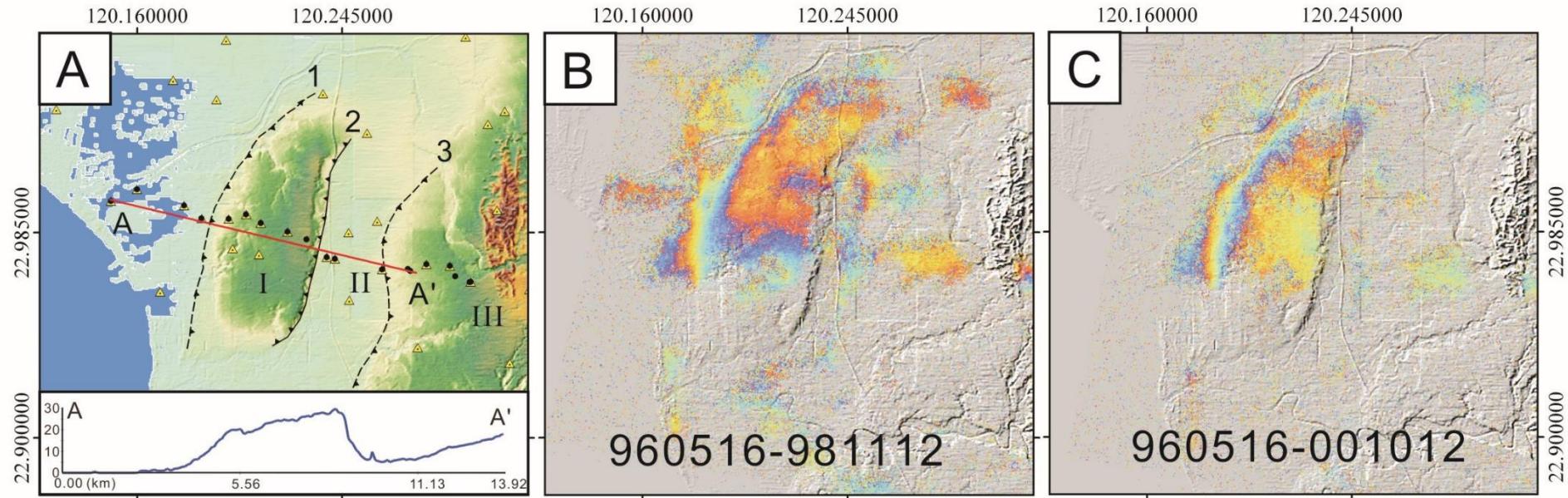
ALOS-2, ascending:



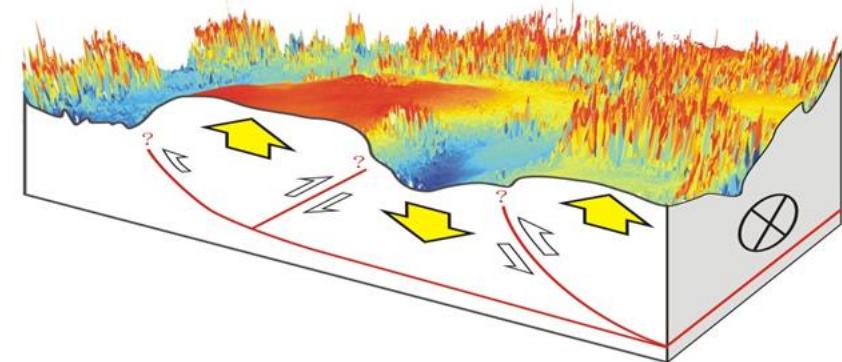
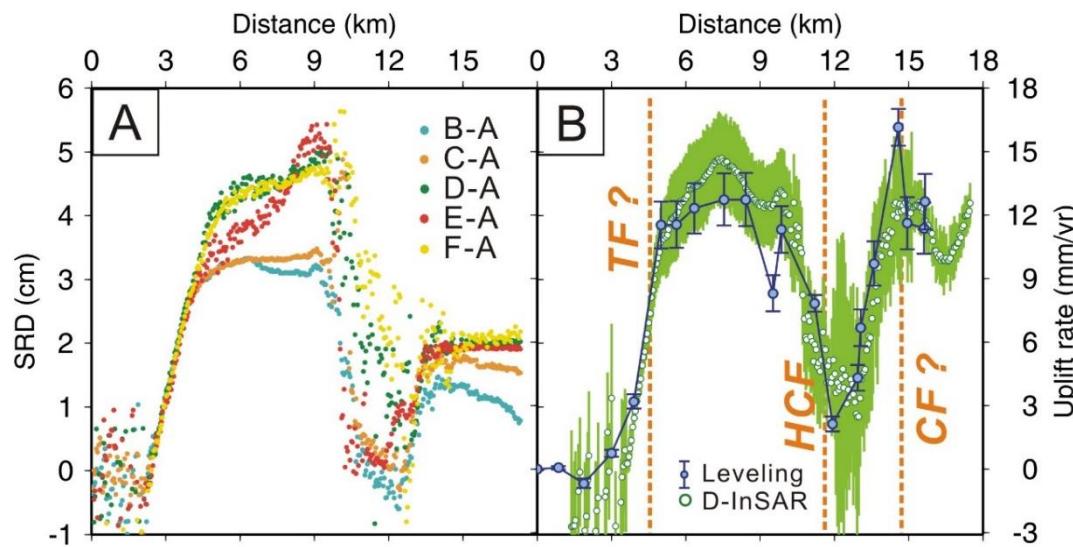
# Coseismic interferograms of 2017 Mw 7.3 Sarpol Zahab Earthquake in Zagros Mountain belt, Iran



# Interseismic interferograms of active folding in Tainan Tableland

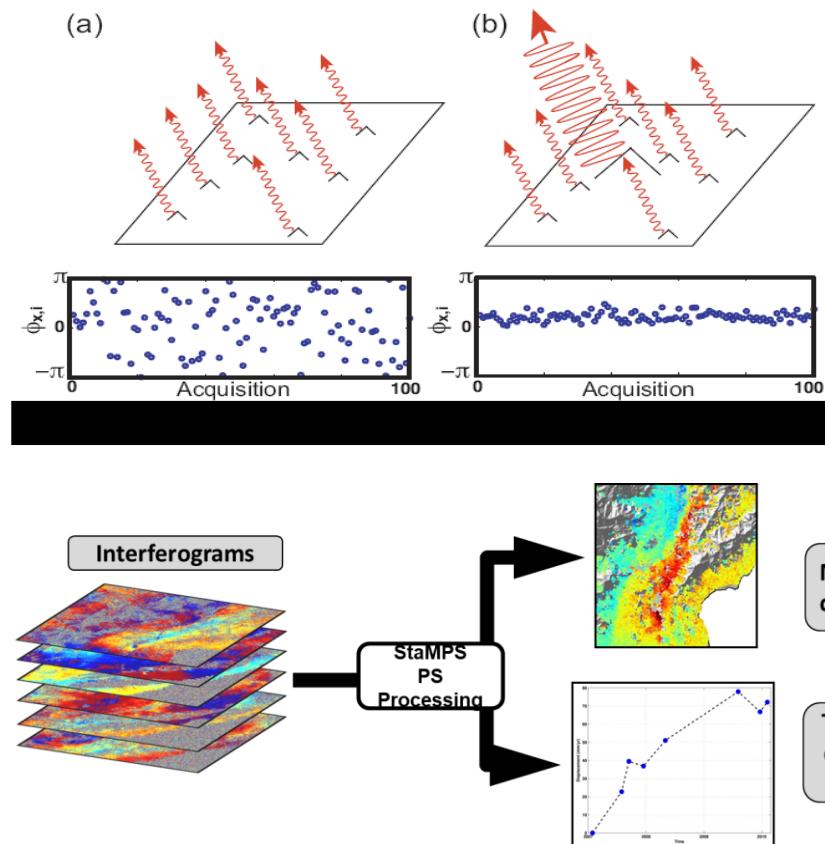


B-A: 960516-981112 (910 days); C-A: 960516-990121 (980 days)  
 D-A: 960516-990506 (1085 days); E-A: 960516-991028 (1260 days)  
 F-A: 960516-001012 (1610 days)



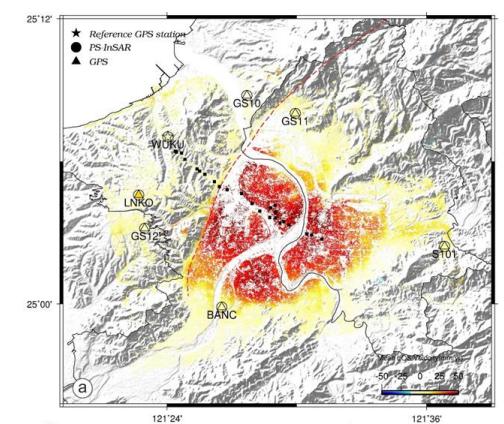
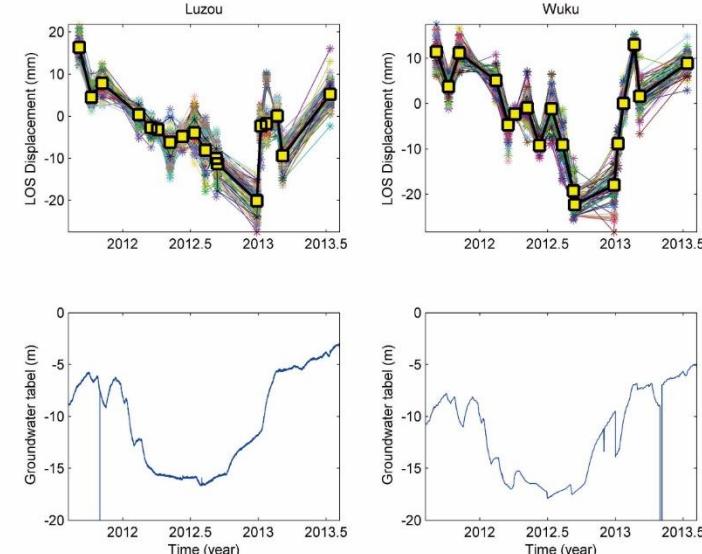
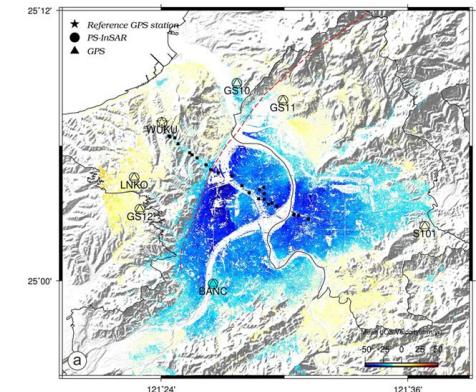
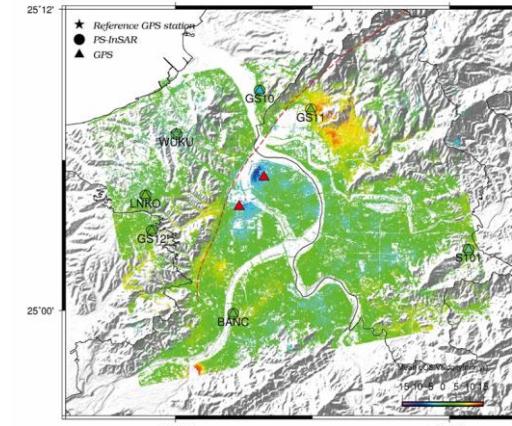
Huang et al., Geophys. Res. Lett., 2006

# What is Persistent Scatterers InSAR (PSInSAR: 持久性散射體合成孔徑雷達干涉)?



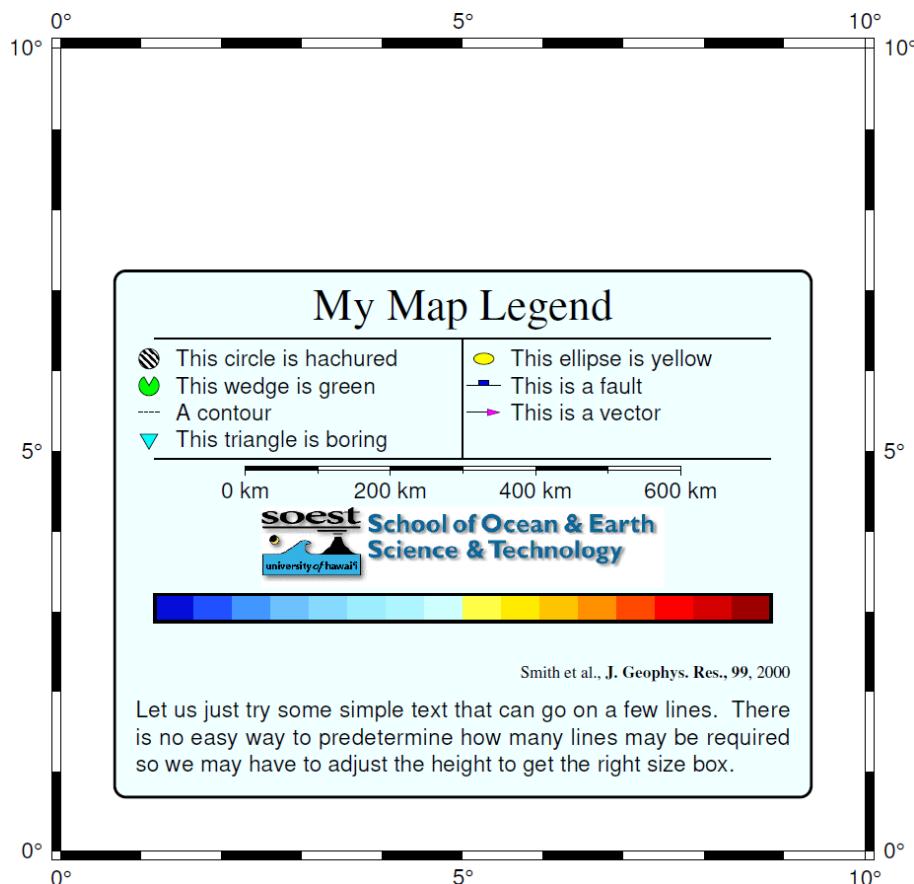
18 x-band COSMO-SkyMed radar images (3m x 3m)

09/2011~07/2013



# Lecto7A: To plot a map legend (繪製圖例說明)

```
gmt legend [ specfile ] -Drefpoint [ -B[p|s]parameters ][ -Cdx/dy ][ -Fbox ] [ -Jparameters ]  
[ -M[h|e] ][ -Rregion ][ -Sscale ][ -Tfile ][ -U[stamp] ][ -V[level] ][ -X[a|c|f|r][xshift[]] ][ -  
Y[a|c|f|r][yshift] ][ -pflags ][ -qiflags ][ -ttransp ][ --PAR=value ]
```



```
gmt makecpt -Cpanoply -T-8/8 -H > legend.cpt  
gmt set FONT_ANNOT_PRIMARY 12p  
echo G -0.1i > legend.txt  
echo H 24p,Times-Roman My Map Legend >> legend.txt  
.....  
gmt legend legend.txt -R0/10/0/10 -JM6i -  
Dx0.5i/0.5i+w5i+jBL+l1.2 -C0.1i/0.1i -F+p+gazure1+r+c0.1i -B5f1
```

**-D[g|j|J|n|x]refpoint+wwidth[/height][+justify][+lspacing]**  
**[+odx[/dy]]:** Defines the reference point on the map for the legend (設定圖例框的位置及大小)  
**+lspacing:** change the line-spacing factor in units of the current font size [1.1] (設置圖例裡的行間距預設值1.1，即當前字體大小的1.1倍)

```
gmt makecpt -Cpanoply -T-8/8 -H > legend.cpt
```

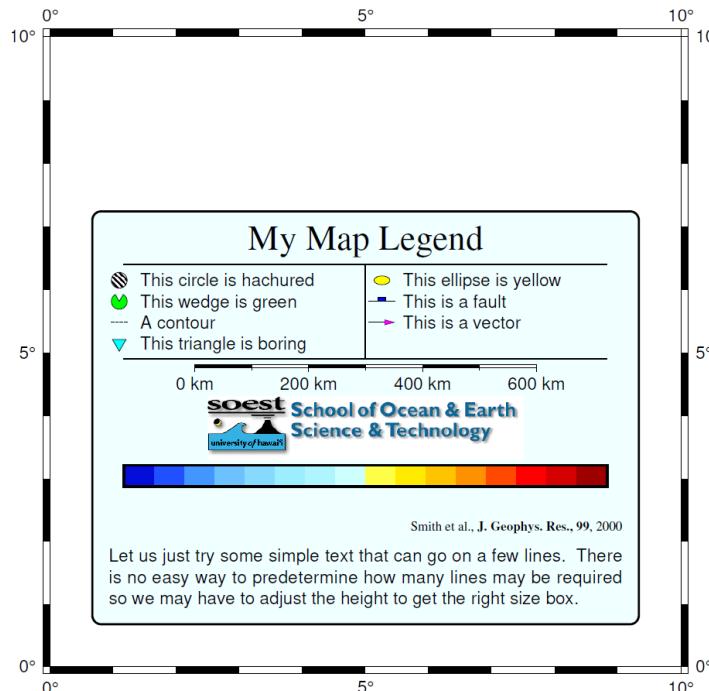
```
gmt set FONT_ANNOT_PRIMARY 12p
```

```
echo G -0.1i > legend.txt
```

```
echo H 24p,Times-Roman My Map Legend >> legend.txt
```

.....

```
gmt legend legend.txt -R0/10/0/10 -JM6i -Dx0.5i/0.5i+w5i+jBL+l1.2 -C0.1i/0.1i -F+p+gazure1+r+c0.1i -B5f1
```



**-Cdx/dy:** Sets the clearance between the legend frame and the internal items [4p/4p]. (設定圖例邊框與內部圖例之間的空白，預設(默認)是4p/4p)

**-F[+cclearances][+gfill][+i[[gap/]pen]][+p[pen]][+r[radius]][+s[[dx/dy]/[shade]]]:** Without further options, draws a rectangular border around the legend using MAP\_FRAME\_PEN (設定圖例框的背景屬性，畫筆屬性由 MAP\_FRAME\_PEN 定義)

**+cclearance:** clearance is either **gap**, **xgap/ygap**, or **lgap/rgap/bgap/tgap** where these items are uniform, separate in x- & y-direction, or individual side spacings between logo and border (設定修飾物與圖框之間的空白距離。gap 為四個方向增加相同的空白距離；xgap/ygap分別指定X向及Y向不同的空白距離；lgap/rgap/bgap/tgap指定四個方向不同的空白距離)

**+gfill:** fill the logo box [no fill] (圖例框填色，預設不填色)

```
gmt makecpt -Cpanoply -T-8/8 -H > legend.cpt
```

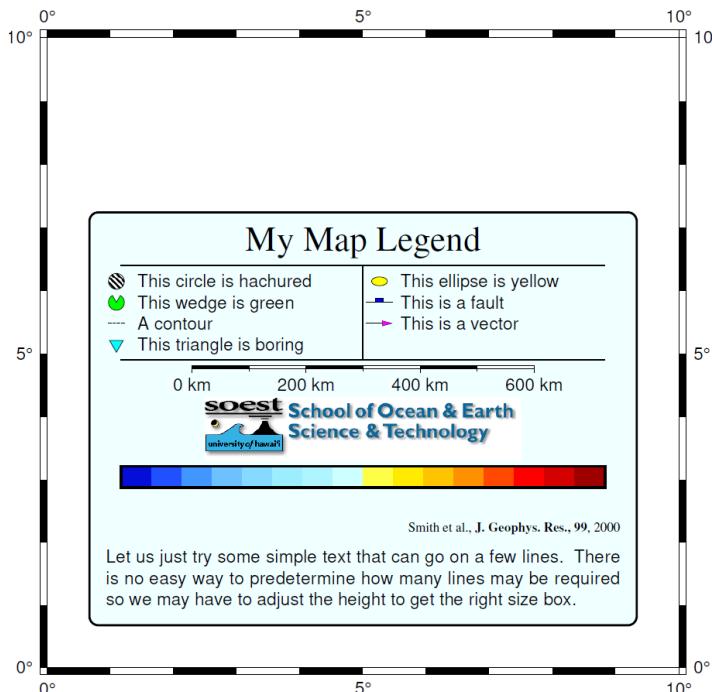
```
gmt set FONT_ANNOT_PRIMARY 12p
```

```
echo G -0.1i > legend.txt
```

```
echo H 24p,Times-Roman My Map Legend >> legend.txt
```

.....

```
gmt legend legend.txt -R0/10/0/10 -JM6i -Dx0.5i/0.5i+w5i+jBL+l1.2 -C0.1i/0.1i -F+p+gazure1+r +c0.1i -B5f1
```



**+i [[gap/]pen]**: draw a secondary, inner border as well, use a uniform gap between borders of **2p** and the **MAP\_DEFAULTS\_PEN** unless other values are specified (繪製圖例框內邊框，由gap設定兩框空白距離，預設值為2p。畫筆屬性由**MAP\_DEFAULTS\_PEN**定義)

**+p[pen]**: specify a different pen (繪製插圖邊框。pen為邊框的畫筆屬性)

**+r[radius]**: draw **rounded rectangular borders** instead, with a **6p** corner radius (繪製圓角邊框，radius為圓角的半徑，預設值6p)

**+s[dx/dy/][shade]**: Draw an **offset background shaded region**. **dx/dy** indicates the shift relative to the foreground frame [4p/-4p] and **shade** sets the fill style to use for shading **[gray50]** (繪製陰影區。dx/dy是陰影區相對於邊框的偏移量，shade是陰影區的顏色，預設值為4p/-4p/gray50)

Please try **-F+glightyellow+p+i+r** and **-F+glightyellow+p1p,red,-+i1p/1p,blue+r10p**

## My Map Legend

This circle is hachured  
This wedge is green  
--- A contour  
▼ This triangle is boring

This ellipse is yellow  
— This is a fault  
→ This is a vector

0 km 200 km 400 km 600 km



A horizontal color bar showing a gradient from dark blue on the left to dark red on the right, with intermediate colors in cyan, green, yellow, and orange.

Smith et al., J. Geophys. Res., 99, 2000

Let us just try some simple text that can go on a few lines. There is no easy way to predetermine how many lines may be required so we may have to adjust the height to get the right size box.

G -0.1i

H 24p,Times-Roman My Map Legend

D 0.2i 1p

N 2

V 0 1p

S 0.1i c 0.15i p300/12 0.25p 0.3i This circle is hachured

S 0.1i e 0.15i yellow 0.25p 0.3i This ellipse is yellow

S 0.1i w 0.15i green 0.25p 0.3i This wedge is green

S 0.1i f 0.25i blue 0.25p 0.3i This is a fault

S 0.1i - 0.15i - 0.25p,- 0.3i A contour

S 0.1i v 0.25i magenta 0.5p 0.3i This is a vector

S 0.1i i 0.15i cyan 0.25p 0.3i This triangle is boring

D 0.2i 1p

V 0 1p

N 1

M 5 5 600+u+f

G 0.05i

I @SOEST\_block4.png 3i CT

G 0.05i

B tt.cpt 0.2i 0.2i -B0

G 0.05i

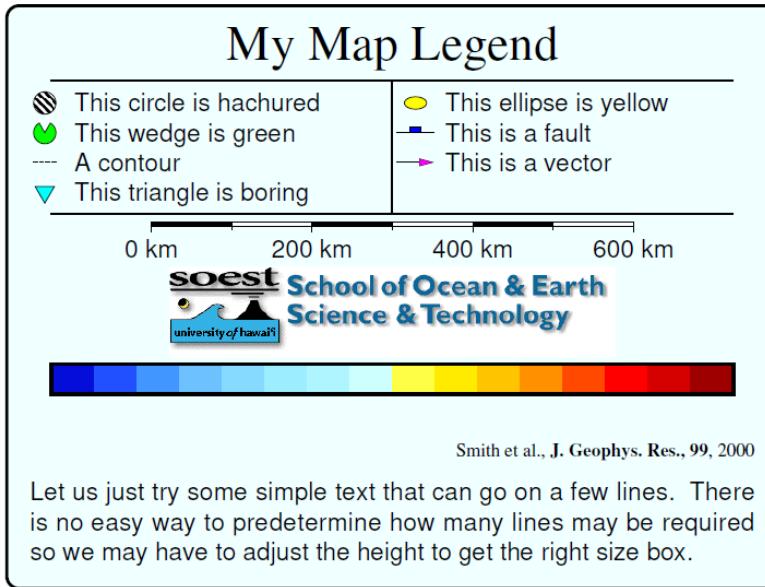
L 9p,Times-Roman R Smith et al., @%%5%%J. Geophys. Res., 99@%%%, 2000

G 0.1i

T Let us just try some simple text that can go on a few lines.

T There is no easy way to predetermine how many lines may be required

T so we may have to adjust the height to get the right size box.



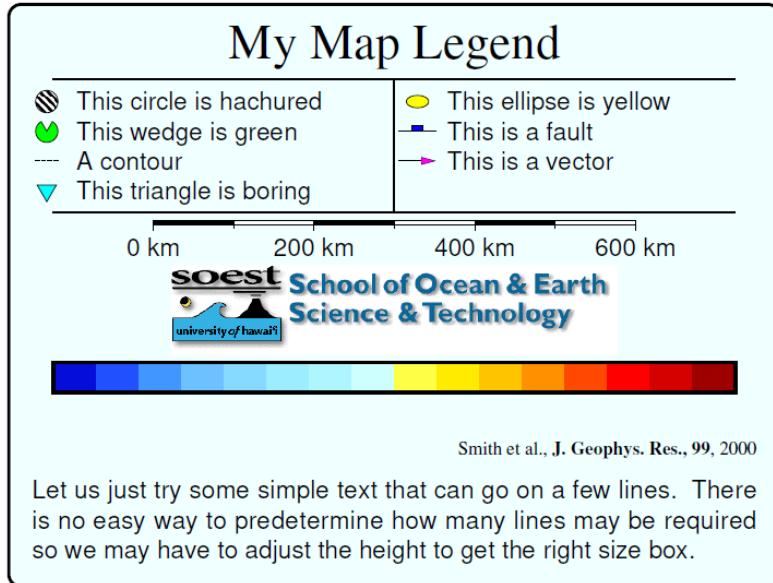
```

echo G -0.1i
echo H 24p,Times-Roman My Map Legend
echo D 0.2i 1p
echo N 2
echo V 0 1p

```

- **Legend Codes:** ASCII file (*specfile*) contains instructions for the layout of items in the legend. Each legend item is described by a unique record. The order of the legend items is implied by the order of the records. Fourteen different record types are recognized

- 圖例檔用於控制圖例中的佈局。圖例檔中的每個記錄對應圖例中的一項，圖例中每項的順序由記錄的先後順序決定。每個記錄的第一個字元決定目前記錄的圖例類型，共有14種圖例類型
- **G gap:** specifies a vertical gap of the given length. In addition to the standard units (i, c, p) you may use l for lines. A negative gap will move the current line upwards (thus closing a gap) (給定一個垂直空白。空白的高度由gap決定，gap 可以用i|c|p單位，也可用l作為單位表示幾倍行距的空白，gap 也可取負值，表示將當前行上移)
- **H font|- header:** Plots a centered text string using the specified font parameters. Use - to default to size and fonttype of FONT\_TITLE. (為圖例指定一個居中的標題。header為標題，font為文字屬性。若字體為-則使用預設字體FONT\_TITLE)



```

echo G -0.1i
echo H 24p,Times-Roman My Map Legend
echo D 0.2i 1p
echo N 2
echo V 0 1p

```

- **D [offset] pen [-|+|=]**: Results in a horizontal line with specified pen across the legend with one quarter of the line-spacing left blank above and below the line
- **Two gaps of offset units are left blank** between the horizontal line and the left and right frame sides [0]. If pen is set to - then **no visible line** is drawn. To not add the quarter line-spacing before the line, add -. To not add the spacing after the line, add +. For no spacing at all, add = (繪製一條水平線，預設情況下，線條上下各留出四分之一的行間距。offset為線條左右頂端與圖例邊框的空白距離[預設為0]。若pen 設置為-，則繪製一條不可見的線，供V記錄使用。-|+= 分別表示線條上方無空白、線條下方無空白和線條上下均無空白)
- **V [offset] pen**: Draws a vertical line between columns (if more than one) using the selected pen. offset is analogous to the offset for the D records but in the vertical direction [0] (在兩列之間繪製垂直的線條。offset為線條上下兩端與圖例邊框的空白距離[預設為0])

● This circle is hachured  
◀ This wedge is green  
--- A contour  
▼ This triangle is boring

○ This ellipse is yellow  
— This is a fault  
→ This is a vector

```
S 0.1i c 0.15i p300/12 0.25p 0.3i This circle is hachured
S 0.1i e 0.15i yellow 0.25p 0.3i This ellipse is yellow
S 0.1i w 0.15i green 0.25p 0.3i This wedge is green
S 0.1i f 0.25i blue 0.25p 0.3i This is a fault
S 0.1i - 0.15i - 0.25p,- 0.3i A contour
S 0.1i v 0.25i magenta 0.5p 0.3i This is a vector
S 0.1i i 0.15i cyan 0.25p 0.3i This triangle is boring
```

Q: What is p300/12?

Try filling in symbol with different hachured pattern.

➤ **S [dx1 symbol size fill pen [ dx2 text ]]**:  
Plots the selected symbol with specified diameter, fill, and outline (see **plot -S**) (在圖例中繪製符號，參考 **plot -S**)

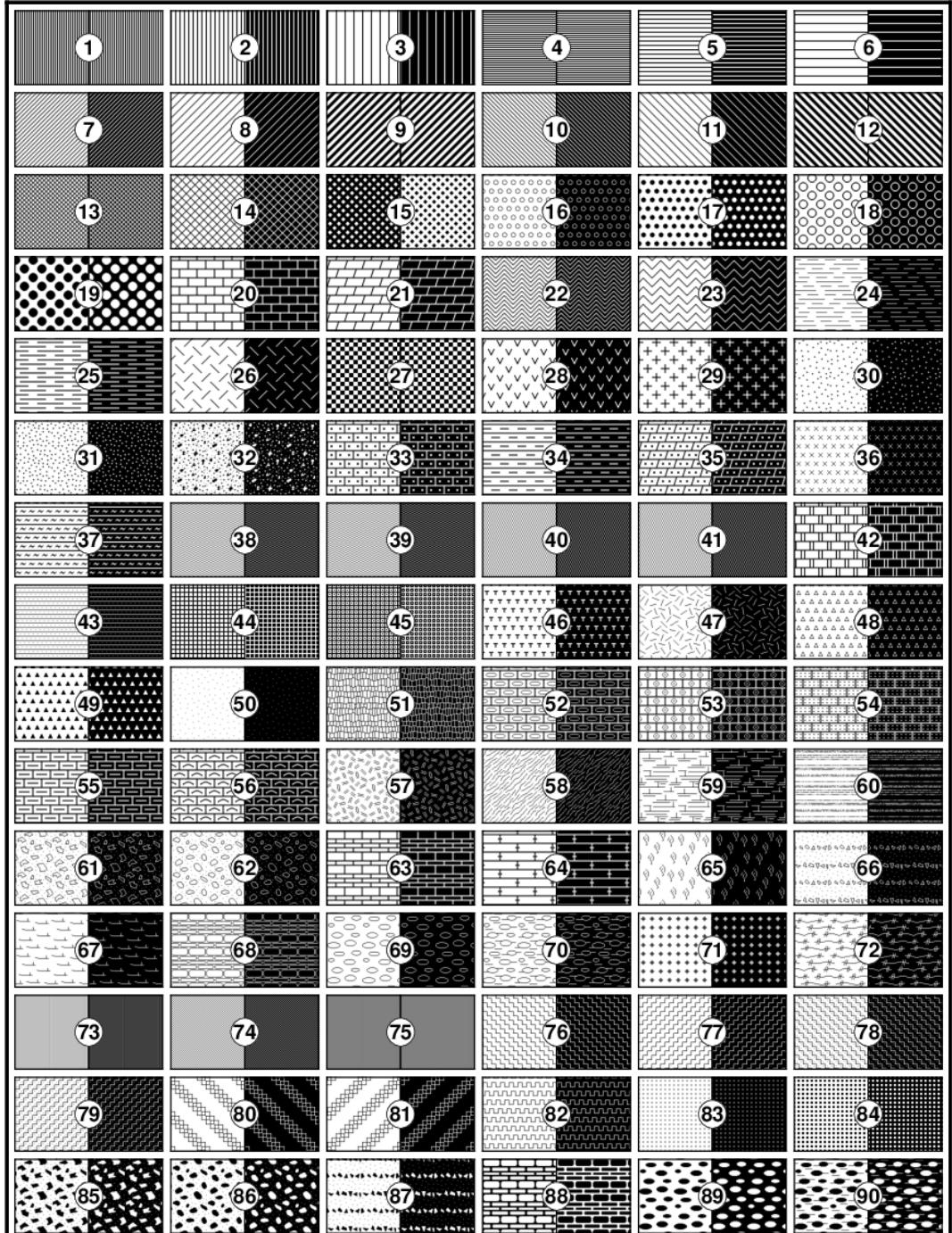
**dx1**: Symbol is centered at dx1 from the left margin of the column, If dx1 is given as **-** then it is automatically computed from half the largest symbol size

(符號中心與左邊框的距離。若為**-**則自動設置為最大的符號大小的一半。dx1 除可指定距離，還可使用**L|C|R** 表示符號在當前列的對齊方式)

**symbol**: 指定要繪製的符號類型，見 **plot** 命令的 **-S** 選項。

**size**: 符號大小

**fill**: 符號的填充色。使用**-**表示不填充。fill也可用 **z=value** 的形式從 CPT 檔中根據 Z 值查找顏色



## *Predefined bit & hachure patterns in GMT: -Gp & -GP*



This circle is hatched

S 0.1i c 0.15i p300/12 0.25p  
0.3i This circle is hatched

- GMT provides 90 different bit and hachure (暈滃線) patterns: selected with the **-Gp** or **-GP** option in most plotting programs.
- Left side of each image was created using **-Gp**, the right side shows the inverted version using **-GP**.
- Patterns are reproduced below at 300 dpi.

- This circle is hachured
- This wedge is green
- A contour
- This triangle is boring

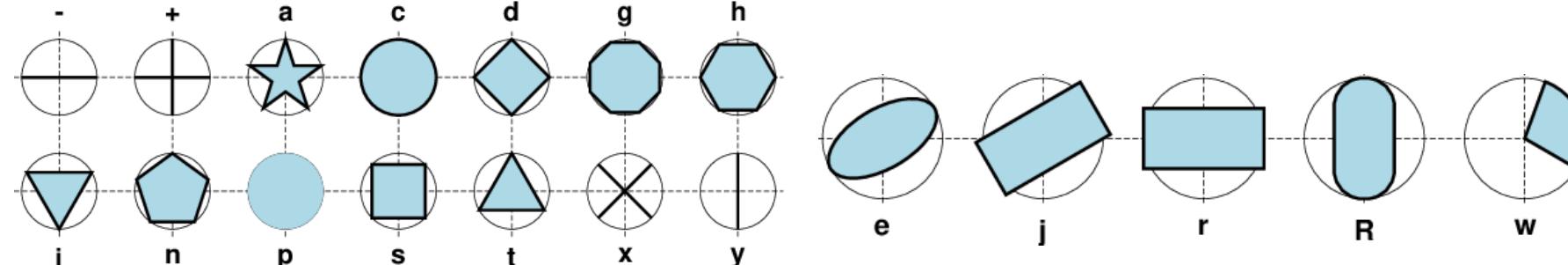
- This ellipse is yellow
- This is a fault
- This is a vector

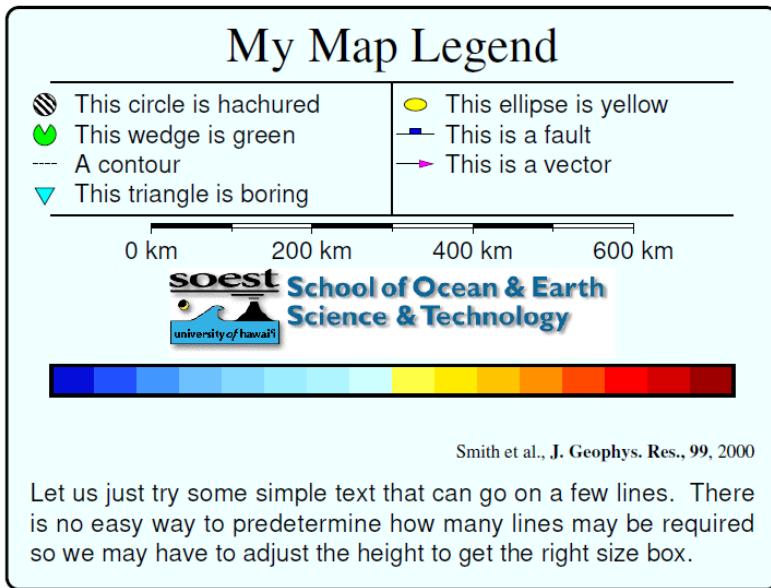
S 0.1i c 0.15i p300/12 0.25p 0.3i This circle is hachured  
 S 0.1i e 0.15i yellow 0.25p 0.3i This ellipse is yellow  
 S 0.1i w 0.15i green 0.25p 0.3i This wedge is green  
 S 0.1i f 0.25i blue 0.25p 0.3i This is a fault  
 S 0.1i - 0.15i - 0.25p,- 0.3i A contour  
 S 0.1i v 0.25i magenta 0.5p 0.3i This is a vector  
 S 0.1i i 0.15i cyan 0.25p 0.3i This triangle is boring

**pen**: Use - if no fill or outline (pen) is required (符號的外框筆屬性。使用-表示不繪製符號外框)

**dx2**: The optional explanatory text starting dx2 from the margin, printed with FONT\_ANNOT\_PRIMARY. If dx2 is given as - then it is automatically computed as 1.5 times the largest symbol size (text與左邊框的距離。使用-則自動設置為最大符號大小的1.5倍。text為符號的文字說明，字體屬性由 FONT\_ANNOT\_PRIMARY 控制)

For detail symbol code, please see [plot.html](#) and **-S** arguments





```
echo V 0 1p
echo N 1
echo M 5 5 600+u+f
echo G 0.05i
```

➤ **M slon/-slat length [+f][+l[label]][+u] [-Fparam] [ -Rw/e/s/n -Jparam ]:** Place a map scale in the legend (在圖例中繪製比例尺)

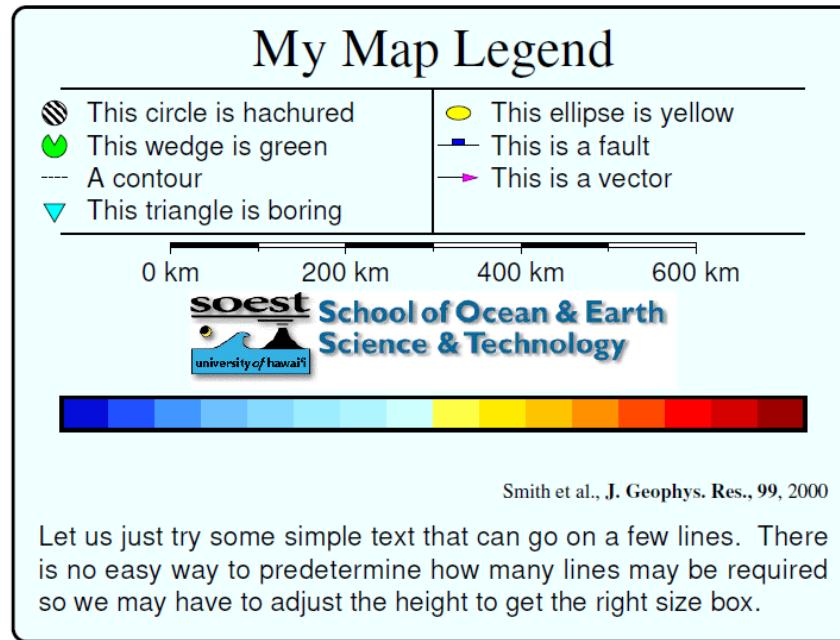
Slon - Slat: Point on the map where the scale applies (slon is only meaningful for certain oblique projections. If not needed, you must specify - instead) (用於指定繪製哪一點的比例尺。slon 僅對特定的傾斜投影有效。對於一般投影，應設置為-)。

**+f:** for a fancy map scale [Default is plain]

**+l:** to the length to select the default label which equals the distance unit (meter, feet, km, miles, nautical miles, survey feet) and is justified on top of the scale

**+u:** append the unit to all distance annotations along the scale

**-F[d||t][+cclearances][+gfill][+i[[gap/]pen]][+p[pen]][+r[radius]][+s[[dx/dy/][shade]]]:** panel option (see basemap for details on panels as well as map scale modifiers). (若想要為比例尺加上背景面板，則可使用 basemap 的-F選項)



```
echo I @SOEST_block4.png 2i CT
```

```
echo G 0.05i
```

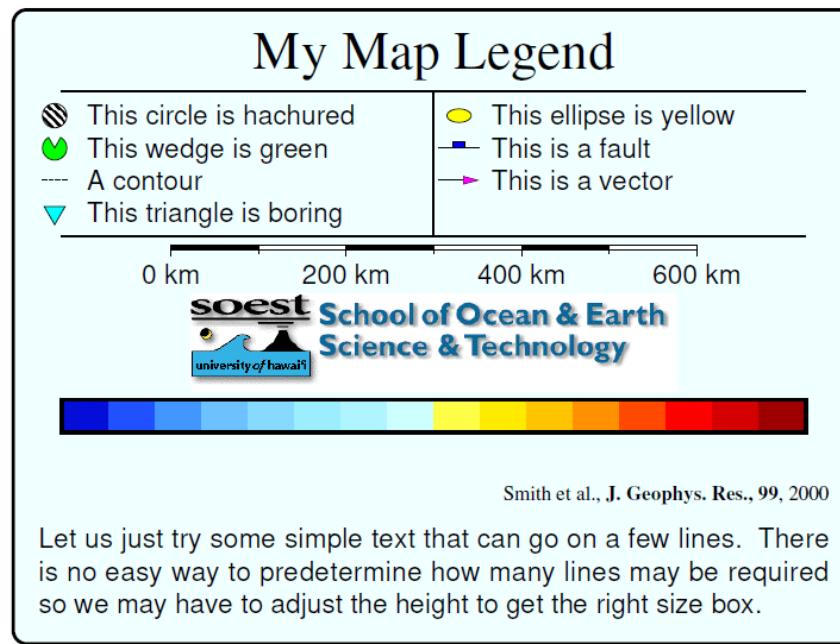
```
echo B legend.cpt 0.2i 0.2i -B0
```

```
echo G 0.05i
```

```
echo L 9p,Times-Roman R Smith et al., @%%5%%J.
```

```
Geophys. Res., 99@%%%, 2000
```

- **I imagefile width justification:** Place an EPS (Encapsulated PostScript) or raster image in the legend justified relative to the current point. The image width determines the size of the image on the page (將EPS或光柵檔放在圖例中。width 為圖片寬度；justification 為圖片的對齊方式)
- **B cptname offset height [optional arguments]:** Plot a horizontal color bar, colorbar-style in the middle, starting at offset from the left edge, and of the given height. You may add any additional colorbar options as well (繪製水平色彩條。offset是色彩條相對於圖例框左邊界的距離；height是色彩條高度)
- **L font|- justification label:** The L record plots a (L)eft, (C)entered, or (R)ight-justified text string within a column using the specified font parameters. Use - to default to the size and font type of FONT\_LABEL. (在某一列增加指定的文字。label為顯示的文本，font 為字體。若font 為-則使用預設字體FONT\_LABEL。justification 為對齊方式，可以取L|C|R，分別表示左對齊、居中對齊和右對齊)



Open DOS prompt or terminal to run `pstext -L`

`echo L 9p,Times-Roman R Smith et al., @%%5%%J. Geophys.`

`Res., 99@%%%%, 2000`

`echo G 0.1i`

`echo T Let us just try some simple text that can go on a few lines.`

`echo T There is no easy way to predetermine how many lines may be required`

`echo T so we may have to adjust the height to get the right size box.`

Q: What is `@%%5%%J. Geophys. Res., 99@%%%%`

Nota bene : shell script for Times-bold is as the following: `@%5%J. Geophys. Res., 99@%%`

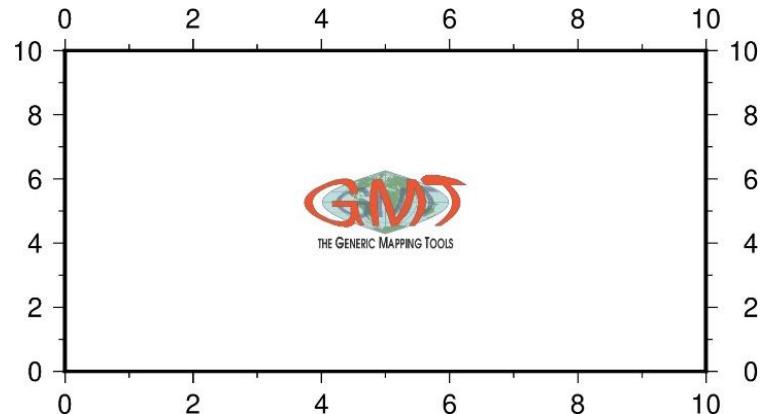
`@%font%` (pstext, escape sequence)

Switches to `font` where font can either be a font number or name (see `-L`) (`@%%` resets it)

- **T paragraph-text:** One or more of these T records with `paragraph-text` printed with `FONT_ANNOT_PRIMARY`. To specify special positioning and typesetting arrangements, or to enter a paragraph break, use the `optional P record` (列印一段文本，字體由`FONT_ANNOT_PRIMARY`控制)
- **P paragraph-mode-header-for-pstext:** Start a `new text paragraph` by specifying all the parameters needed (see `text -M` record description). (在在圖例中添加文本段落，參考`text`命令中的-M段落模式)

# *gmt logo: Plot the GMT logo*

```
gmt logo [ -D[g|j|J|n|x]refpoint+width[+justify][+odx[/dy]] ] [ -  
F[+cclearances][+gfill][+i[[gap/]pen]][+p[pen]][+r[radius]][+s[[dx/dy]/[shade]]] ]  
[ -Jparameters ] [ -Jz|Zparameters ] [ -  
Rwest/east/south/north[/zmin/zmax][+r][+uunit] ] [ -S[l|n|u] ] [ -U[stamp] ] [ -  
V[level] ] [ -X[a|c|f|r][xshift[u]] ] [ -Y[a|c|f|r][yshift[u]] ] [ -ttransp ] [ --PAR=value ]
```

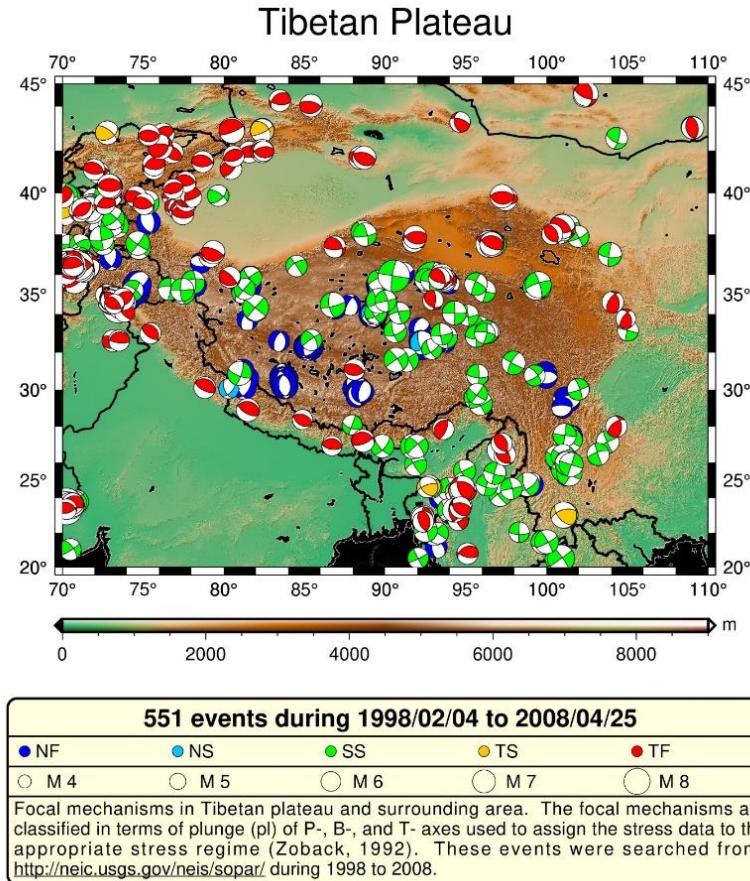


```
gmt begin logo01 jpg  
gmt basemap -R0/10/0/10 -JX10c/5c -Baf  
gmt logo -DjCM+w1i  
gmt end
```

**-D[g|j|J|n|x]refpoint+width[/height][+justify][+spacing][+odx[/dy]]:**

Defines the reference point on the map for the legend (設定圖例框的位置及大小)

# Lecto7B: Stress Regime Characterization



```

set range=65/115/20/50
set cpt=topo_dem3.cpt
set grid1=d:\gridfiles\GEBCO_2019.nc
set grid2=Tibet.grd
gmt grdcut %grid1% -G%grid2% -R%range% -V
gmt grd2cpt %grid2% -Cdem3 -L0/8000 -Z > %cpt% -V
.....
gawk "{if ($16 >= 52 && $10 <= 35) print $3, $2, $5, $18, $19, $20,
$6, $3, $2 }" hiclimb.txt | meca -Sa0.5c -G0/0/255 -h4 -C -L -V

```

Open **hiclimb.txt** and see what are **\$16, \$10, \$3, \$2, \$5, \$18-20, \$6**.

EPICENTER			MOMENT			PRINCIPAL AXES						NODAL PLANES														
DATE	LAT	LONG	SRC	DEPTH	VAL	EX	T	N (B?)	P	1	2	% SRC	PL	AZM	PL	AZM	VAL	PL	AZM	STK	DP	SLIP	STK	DP	SLIP	DC
YR	MO	DA	deg	deg	km	Mw	Nm	VAL	PL	AZM	VAL	PL	AZM	VAL	PL	AZM	VAL	PL	AZM	STK	DP	SLIP	STK	DP	SLIP	DC
1998/02/04	37.075	70.089	PDE	17.0	5.9	8.7	17	8.25	8	84	0.84	78	215	-9.	10	9	353	128	78	-179	38	89	-12	82	GS	
1998/02/04	37.130	69.920	HRV	33.8	5.9	8.4	17	7.82	8	75	1.08	76	308	-8.	90	11	167	211	76	-2	301	88	-166	76	HRV	

# Stress regime characterization: Plunge ( $p\ell$ ) of $P$ , $B$ , & $T$ axes or $\sigma_1$ , $\sigma_2$ & $\sigma_3$

## Plunge of Axes (according to Zoback, 1992)

$P/\sigma_1$	$B/\sigma_2$	$T/\sigma_3$	Regime	$S_{Hmax}$ Azimuth
$p\ell \geq 52^\circ$		$p\ell \leq 35^\circ$	NF	Azi. of B axis
$40^\circ \leq p\ell < 52^\circ$		$p\ell \leq 20^\circ$	NS	Azi. of T axis+90°
$p\ell < 40^\circ$	$p\ell \geq 45^\circ$	$p\ell \leq 20^\circ$	SS	Azi. of T axis+90°
$p\ell \leq 20^\circ$	$p\ell \geq 45^\circ$	$p\ell < 40^\circ$	SS	Azi. of P axis
$p\ell \leq 20^\circ$		$40^\circ \leq p\ell < 52^\circ$	TS	Azi. of P axis
$p\ell \leq 35^\circ$		$p\ell \geq 52^\circ$	T	Azi. of P axis

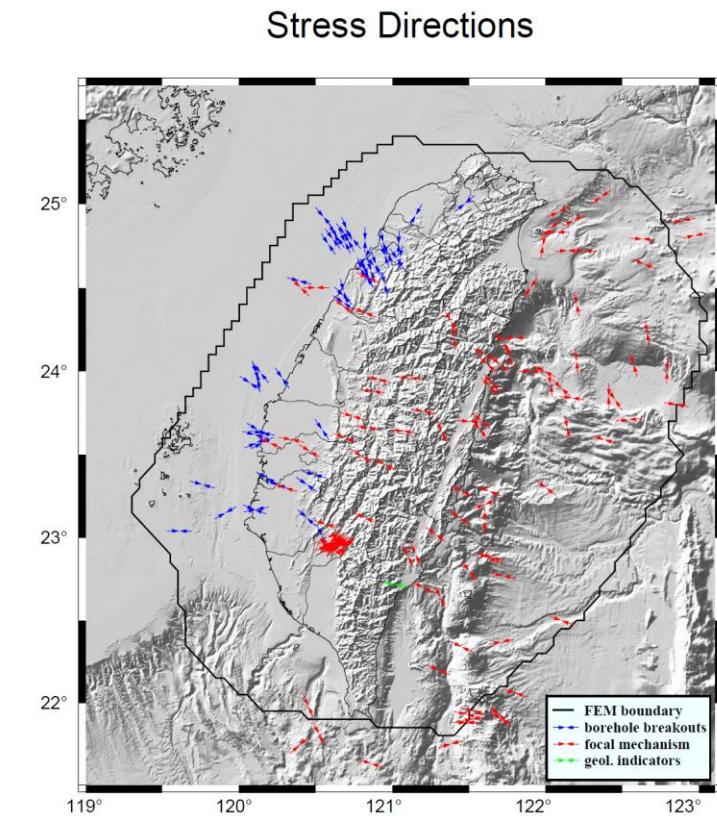
$S_{Hmax}$ : Orientation given for thrust or strike-slip faulting stress regimes

$S_{hmin}$ : given for normal faulting stress regime

**NF**: Normal faulting, **NS**: predominately normal with strike-slip component

**SS**: Strike-Slip faulting (includes minor normal and thrust component)

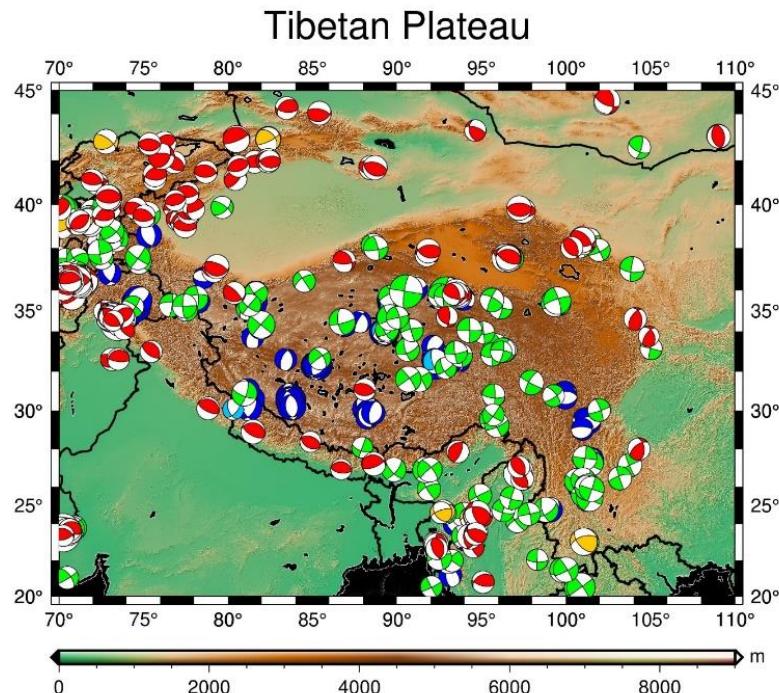
**TF**: Thrust faulting; **TS**: predominately thrust with strike-slip component



For detail see [Tectonic Stress Regime Assignment @ WSM \(World Stress Map\)](#)  
<http://www.world-stress-map.org/data/>

# legend: To plot a map legend (繪製圖例說明)

```
gmt legend [ specfile ] -Drefpoint [ -B[p|s]parameters ][ -Cdx/dy ][ -Fbox ][ -Jparameters ]
[ -M[h|e] [ -Rregion ][ -Sscale ][ -Tfile ][ -U[stamp] ][ -V[level] ][ -X[a|c|f|r][xshift[]] ][ -
Y[a|c|f|r][yshift] ][ -pflags ][ -qiflags ][ -ttransp ][ --PAR=value ]
```



Focal mechanisms in Tibetan plateau and surrounding area. The focal mechanisms are classified in terms of plunge (pl) of P-, B-, and T- axes used to assign the stress data to the appropriate stress regime (Zoback, 1992). These events were searched from: <http://neic.usgs.gov/neis/sopar/> during 1998 to 2008.

```
legend neis.legend -Dx3i/-1.2i+w7i/1.7i+jTC -Jx1i -
R0/8/0/8 -F+glightyellow+p+r -V
```

- **D[g|j|J|n|x]refpoint+wwidth[/height][+justify][+lspacing][+odx/dy]**: Defines the reference point on the map for the legend (設定圖例框的位置及大小)
- **F[+cclearances][+gfill][+i[[gap/]pen]][+p[pen]][+r[radius]][+s[[dx/dy]/[shade]]]**: Without further options, draws a rectangular border around the legend using MAP\_FRAME\_PEN (設定圖例框的背景屬性，畫筆屬性由 **MAP\_FRAME\_PEN** 定義設定圖例框的屬性)

551 events during 1998/02/04 to 2008/04/25

● NF	● NS	● SS	● TS	● TF
○ M 4	○ M 5	○ M 6	○ M 7	○ M 8

Focal mechanisms in Tibetan plateau and surrounding area. The focal mechanisms are classified in terms of plunge (pl) of P-, B-, and T- axes used to assign the stress data to the appropriate stress regime (Zoback, 1992). These events were searched from: <http://neic.usgs.gov/neis/sopar/> during 1998 to 2008.

legend neis.legend -Dx3i/-1.2i+w7i/1.7i+jTC  
-Jx1i -R0/8/0/8 -F+glightyellow+p+r -V

**-F[+cclearances][+gfill][+i[[gap/]pen]][+p[pen]][+r[radius]][+s[[dx/dy/][shade]]]**: Without further options, draws a rectangular border around the legend using MAP\_FRAME\_PEN (設定圖例框的背景屬性，畫筆屬性由MAP\_FRAME\_PEN定義)

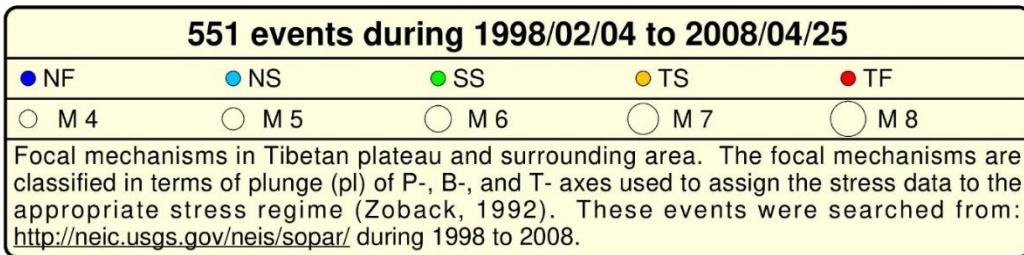
**+cclearance**: clearance is either **gap**, **xgap/ygap**, or **lgap/rgap/bgap/tgap** where these items are uniform, separate in x- & y-direction, or individual side spacings between logo and border (設置修飾物與圖框之間的空白距離。gap為四個方向增加相同的空白距離；xgap/ygap分別指定X向及Y向不同的空白距離；lgap/rgap/bgap/tgap指定四個方向不同的空白距離)

**+gfill**: fill the logo box [no fill] (圖例框填色，預設不填色)

**+p[pen]**: specify a different pen (繪製插圖邊框。pen為邊框的畫筆屬性)

**+r[radius]**: draw rounded rectangular borders instead, with a 6p corner radius (繪製圓角邊框，radius為圓角的半徑，預設值6p)

# legend Codes

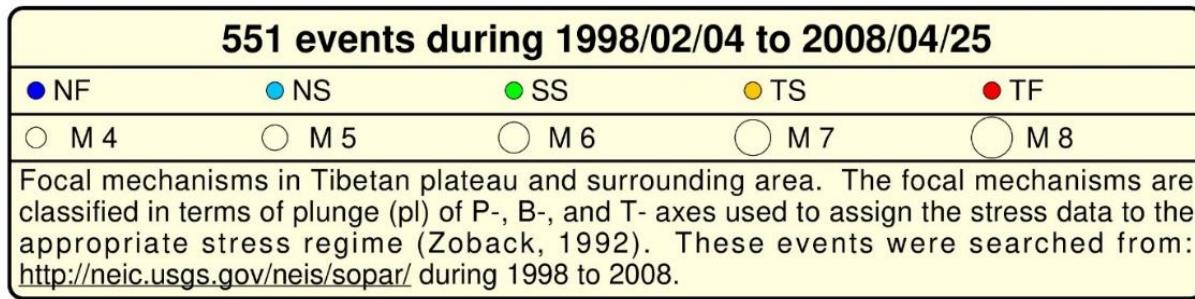


- **Legend Codes:** ASCII file (*specfile*) contains instructions for the **layout of items** in the legend. Each legend item is described by a **unique record**. The order of the legend items is implied by the order of the records. (圖例檔用於控制圖例中的佈局。圖例檔中的每個記錄對應圖例中的一項，圖例中每項的順序由記錄的先後順序決定。每個記錄的第一個字元決定目前記錄的圖例類型)

Please open **neis.legend**

**H** 16 Times-Roman 551 events  
during 1998/02/04 to 2008/04/25  
**D** 0.1i 1p  
**N** 5  
**V** 0 1p  
**S** 0.1i c 0.1i 0/0/255 0.25p 0.2i NF

- **H [font]- header:** Plots a centered **text string** using the specified **font parameters**. Use - to default to size and fonttype of **FONT\_TITLE**. (為圖例指定一個居中的標題。header為標題，font為文字屬性。若字體為-則使用預設字體**FONT\_TITLE**)
- **D [offset] pen [-/+/=]:** Results in a **horizontal line** with specified pen across the legend with **one quarter of the line-spacing left blank** above and below the line (繪製一條水平線，預設情況下，線條上下各留出四分之一的行間距。offset為線條左右頂端與圖例邊框的空白距離[預設為0] )



**H 16 Times-Roman 551 events during 1998/02/04 to 2008/04/25**

**D 0.1i 1p**  
**N 5**  
**V 0.1i 1p**  
**S 0.1i c 0.1i 0/0/255 0.25p 0.2i NF**

- **N [ncolumns or relwidth1 relwidth2 ... relwidthn]**: Change the **number of columns** in the legend [1]. This only affects the printing of **symbols (S)** and **labels (L)**. The number of columns stay in effect until N is used again (修改圖例中的欄數，給予數量(等寬)或是數量 [ 欄寬1 、 欄寬2 ...])
- **V [offset] pen** : The V record draws a **vertical line** between columns (if more than one) using the selected **pen offset** is analogous to the offset for the **D records** but in the vertical direction (在兩欄間繪製垂直線， offset為線條上下兩端與圖例邊框的空白距離[預設為0]，間距用法同 D選項)
- **S [dx1 symbol size fill pen [ dx2 text ]]**: Plots the selected symbol with specified diameter, fill, and outline. The symbol is centered at dx1 from the left margin of the column, with the optional explanatory text starting dx2 from the margin, printed with **FONT\_ANNOT\_PRIMARY** (繪製圖例符號，格式依序為：符號左邊界距離、**符號代碼**、符號大小、符號顏色、符號筆觸、文字左邊界距離和文字內容)

## 551 events during 1998/02/04 to 2008/04/25

● NF	● NS	● SS	● TS	● TF
○ M 4	○ M 5	○ M 6	○ M 7	○ M 8

Focal mechanisms in Tibetan plateau and surrounding area. The focal mechanisms are classified in terms of plunge (pl) of P-, B-, and T- axes used to assign the stress data to the appropriate stress regime (Zoback, 1992). These events were searched from: <http://neic.usgs.gov/neis/sopar/> during 1998 to 2008.

### ➤ **P paragraph-mode-header-for-pstext:**

Start a **new text paragraph** by specifying all the parameters needed (see **text -M record description**). (開啟段落模式，在在圖例中添加文本段落，參考**text**命令中的-**M**段落模式)

- **T paragraph-text:** One or more of these T records with **paragraph-text** printed with **FONT\_ANNOT\_PRIMARY**. To specify special positioning and typesetting arrangements, or to enter a paragraph break, use the **optional P record** (列印一段文本，字體由 **FONT\_ANNOT\_PRIMARY** 控制)
- @\_<http://neic.usgs.gov/neis/sopar/> @\_ : @\_ turn underline on or off, 開啟或關閉在文字下面畫線，請看Lecture 04，**Text Escape Sequences** (轉義序列)

.....

**N** 1

**P**

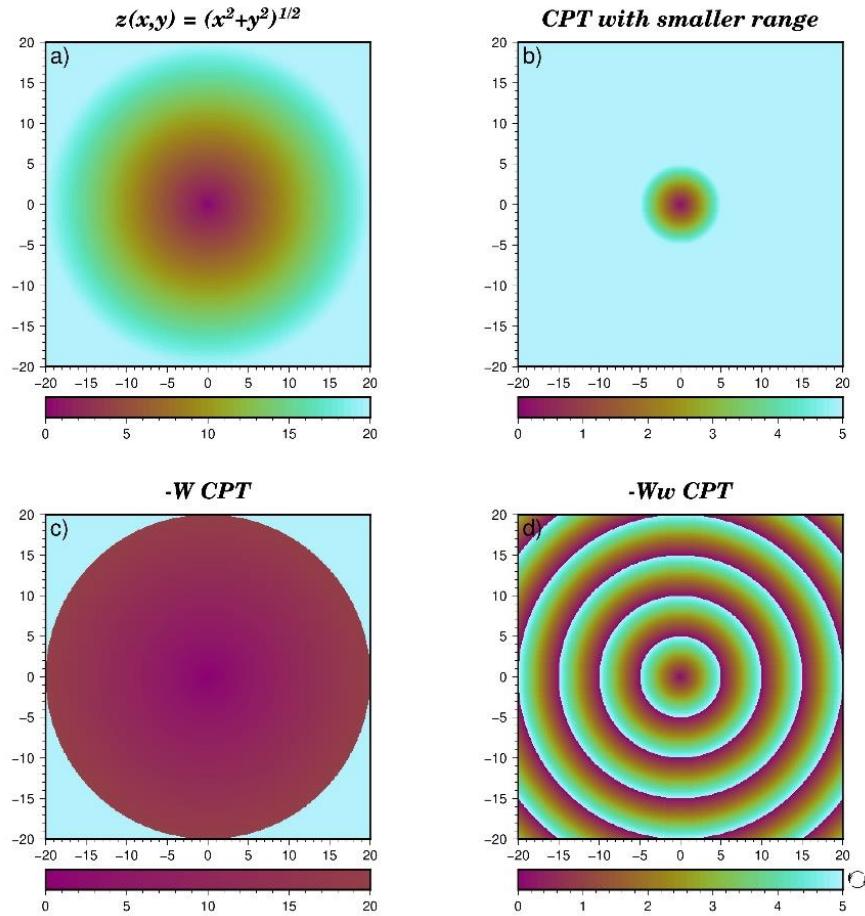
**T** Focal mechanisms in Tibetan plateau and surrounding area. The focal mechanisms are classified

**T** in terms of plunge (pl) of P, B, and T axes.

**T** These events were searched from:

@\_<http://neic.usgs.gov/neis/sopar/> @\_ during 1998 to 2008.

## Lecto7C: cyclic cpt



```
gmt grdimage % grd% -R%range% -JX? -C04.cpt -Ba5f1.0 -BWStr+t"-Ww CPT" -V -c
gmt colorbar -DjMB+jCM+o0.0i/-0.5i+w4.0i/0.25i+h -C04.cpt -Bxa5f1 -V
```

```
set range=-20/20/-20/20
set grd=hypotenuse.nc
set prefix=Lect07C
gmt grdmath -R%range% -I0.1 X Y HYPOT = %grd% -V
gmt grdinfo %grd% -V
gmt makecpt -Chawaii -T0/20/0.4 -V > 01.cpt
gmt makecpt -Chawaii -T0/5/0.1 -V > 02.cpt
gmt makecpt -Chawaii -T0/20/0.4 -W -V > 03.cpt
gmt makecpt -Chawaii -T0/5/0.1 -Ww -V > 04.cpt
gmt begin %prefix% jpg A+m0.5c
gmt subplot begin 2x2 -Fs4.0i/4.0i -A -M0.65i
gmt grdimage %grd% -R%range% -JX? -C01.cpt -Ba5f1.0 -BWStr+t"z(x,y) = (x@+2@+\053y@+2@+)@+1/2@+-" -V -c
gmt colorbar -DjMB+jCM+o0.0i/-0.5i+w4.0i/0.25i+h -C01.cpt -Bxa5f1 -V
```

# *grdmath* (對網格檔做數學計算操作)

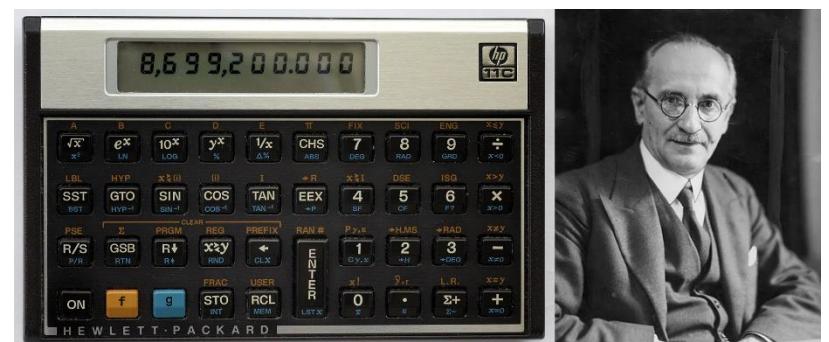
```
gmt grdmath [-Amin_area[/min_level/max_level]] [+a[g|i][s|S]][+r/] [+percent] ] [-C[cpt]] [-Dresolution[+f]] [-Iincrement] [-M] [-N] [-Rregion] [-S] [-V[level]] [-aflags] [-bibinary] [-dinodata[+ccol]] [-eregexp] [-fflags] [-ggaps] [-hheaders] [-iflags] [-nflags] [-rreg] [-x[-]n] [-PAR=value] operand [operand] OPERATOR [operand] OPERATOR ... = outgrdfile
```

gmt grdmath -R%range% -I0.1 X Y HYPOT = %grd% -V

- **grdmath**: Perform operations like add, subtract, multiply, and divide on one or more grid files or constants using **Reverse Polish Notation (RPN, 逆波蘭表示法) syntax** (e.g., **Hewlett-Packard calculator-style**).
- **Operand (運算數)**: If operand can be opened as a file it will be read as a grid file. If not a file, it is interpreted as a numerical constant or a special symbol.
- 209 operators: “args” are the number of **input** and **output** arguments

Operator	args	Returns
HYPOT	2 1	hypot (A, B) = sqrt (A*A + B*B)

- Hypot (hypotenuse): 直角三角形的斜邊
- Reverse Polish Notation (RPN, 逆波蘭表示法): 3 4 + =7



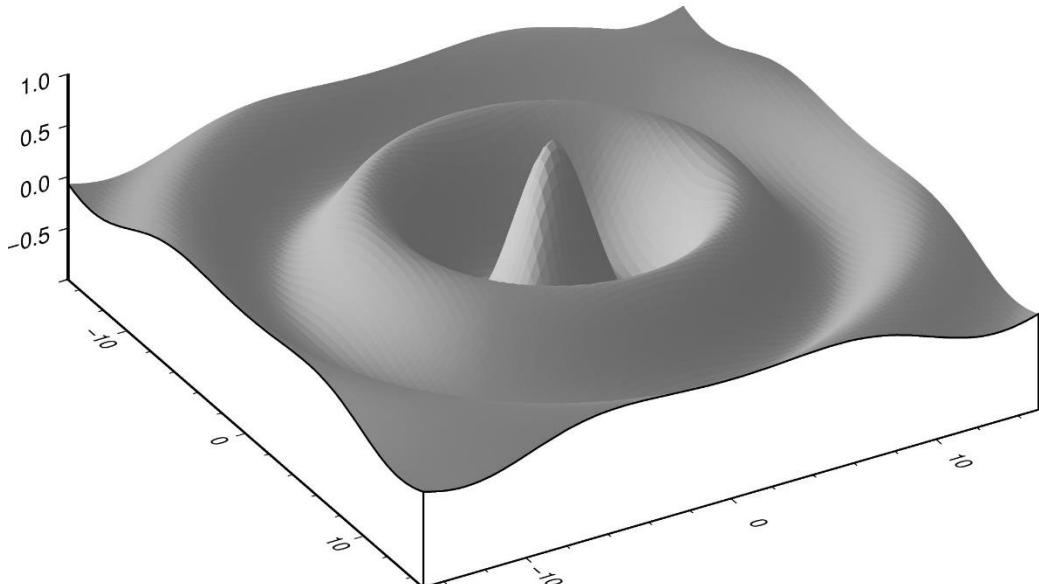
Hewlett-Packard made lots of calculators (left) using Reverse Polish Notation, developed by **Jan Łukasiewicz** (right).

# *grdmath* (對網格檔做數學計算操作)

```
gmt grdmath [ -Amin_area[/min_level/max_level][+a[g|i][s|S]][+r||][+ppercent] ] [ -C[cpt] ] [ -Dresolution[+f] ] [ -Iincrement ] [ -M ] [ -N ] [ -Rregion ] [ -S ] [ -V[level] ] [ -aflags ] [ -bibinary ] [ -dinodata[+ccol] ] [ -eregexp ] [ -fflags ] [ -ggaps ] [ -hheaders ] [ -iflags ] [ -nflags ] [ -rreg ] [ -x[[-]n] ] [ --PAR=value ] operand [ operand ] OPERATOR [ operand ] OPERATOR ... = outgrdfile
```

Open and run C:\programs\gmt6\share\doc\examples\ex05\ex05.bat or ex05.sh

$$z(r) = \cos(2\pi r/8) \cdot e^{-r/10}$$



```
gmt begin ex05 jpg
gmt grdmath -R-15/15/-15/15 -I0.3 X Y HYPOT DUP 2
MUL PI MUL 8 DIV COS EXCH NEG 10 DIV EXP MUL =
sombrero.nc
gmt makecpt -C128 -T-5/5 -N
gmt grdview sombrero.nc -JX12c -JZ4c -B -Bz0.5 -
BSEwnZ+t"z(r) = cos (2@~p@~r/8) @~\327@~e@+-
r/10@+" -N-1+gwhite -Qs -l+a225+nt0.75 -C -R-15/15/-
15/15/-1/1 -p120/30 --FONT_TITLE=50p,ZapfChancery-
MediumItalic --MAP_TITLE_OFFSET=-1c
del sombrero.nc
gmt end show
```

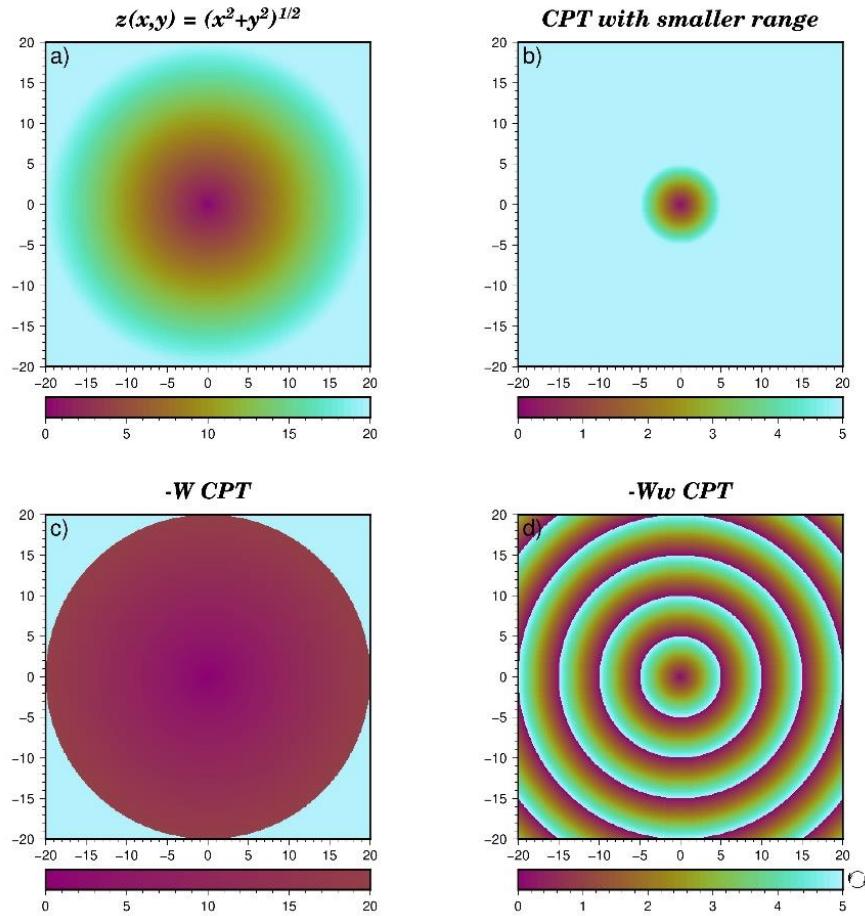
# *Wrapped (Cyclic) CPT* (循環式的色階檔)

```
gmt makecpt [ -Atransparency[+a] ] [ -Ccpt ] [ -D[i|o] ] [ -E[nlevels] ] [ -F[R|r|h|c][+c[label]] [+kkeys] ] [ -Gzlo/zhi ] [ -H ] [ -I[c][z] ] [ -M ] [ -N ] [ -Q ] [ -Smode ] [ -T[min/max/inc[+[+b|i||n]|file||list] ] [ -V[level] ] [ -W[w] ] [ -Z ] [ -bibinary ] [ -dinodata[+ccol] ] ] [ -hheaders ] [ -iflags ] [ --PAR=value ]
```

```
gmt makecpt -Chawaii -T0/5/0.1 -Ww -V > 04.cpt
```

- **-W[w]**: Do not interpolate the input color table but pick the output colors starting at the beginning of the color table, until colors for all intervals are assigned.
- This is particularly useful in combination with a categorical color table, like “[categorical](#)”. Cannot be used in combination with -Z (給予每個間隔特定顏色，呈現明顯而非漸變的邊界，適合用在呈現分類而非漸變的情形)
- **-Ww**: Produce a [wrapped \(cyclic\) color](#) table that endlessly repeats its range (當繪製值超過色盤檔的極值時，會以色階檔範圍為周期持續繪製。GMT在根據Z值查找對應的顏色時，會首先從Z值中減去色階檔中Z值範圍的整數倍，使得Z值永遠落在色階檔所指定的範圍內)
- 例如一個循環式或週期性色階檔，其Z值範圍在 $-\pi$  到 $\pi$  之間的顏色表。若Z值等於 $3/2\pi$ ，則會取 $-\pi/2$  處的值作為其顏色)

## Lecto7C: cyclic cpt



```
gmt grdimage % grd% -R%range% -JX? -C04.cpt -Ba5f1.0 -BWStr+t"-Ww CPT" -V -c
gmt colorbar -DjMB+jCM+o0.0i/-0.5i+w4.0i/0.25i+h -C04.cpt -Bxa5f1 -V
```

```
set range=-20/20/-20/20
set grd=hypotenuse.nc
set prefix=Lect07C
gmt grdmath -R%range% -I0.1 X Y HYPOT = %grd% -V
gmt grdinfo %grd% -V
gmt makecpt -Chawaii -T0/20/0.4 -V > 01.cpt
gmt makecpt -Chawaii -T0/5/0.1 -V > 02.cpt
gmt makecpt -Chawaii -T0/20/0.4 -W -V > 03.cpt
gmt makecpt -Chawaii -T0/5/0.1 -Ww -V > 04.cpt
gmt begin %prefix% jpg A+m0.5c
gmt subplot begin 2x2 -Fs4.0i/4.0i -A -M0.65i
gmt grdimage %grd% -R%range% -JX? -C01.cpt -Ba5f1.0 -BWStr+t"z(x,y) = (x@+2@+\053y@+2@+)@+1/2@+-" -V -c
gmt colorbar -DjMB+jCM+o0.0i/-0.5i+w4.0i/0.25i+h -C01.cpt -Bxa5f1 -V
```

# *subplot* (管理和設置子圖模式)

Manage modern mode figure subplot configuration and selection

```
gmt subplot begin nrowsxncols -F[f|s]width/height[+fwfracs/hfracs] [+af|s] [+cdx/dy][+gfill][+ppen][+wpen]
[ -Aautolabel ] [ -C[side]/clearance ] [ -B[p|s]parameters ] [ -Jparameters ] [ -Mmargins ] [ -Rregion ] [ -
Sc|r[layout][mods] ] [ -Ttitle ] [ -V[level] ] [ -X[a|c|f|r][xshift] ] [ -Y[a|c|f|r][yshift] ] [ --PAR=value ]
```

- **-c[row,col|index]**: Advance plot focus to selected (or next) subplot panel (選擇特定的子圖:該選項用於控制繪圖命令在哪一個子圖中進行繪製，該選項僅可在子圖模式下才能使用。所有繪圖模組均可使用該選項。該選項使得當前及之後的一系列繪圖命令均在指定的子圖中繪製，直到某個繪圖命令再次使用該選項為止)

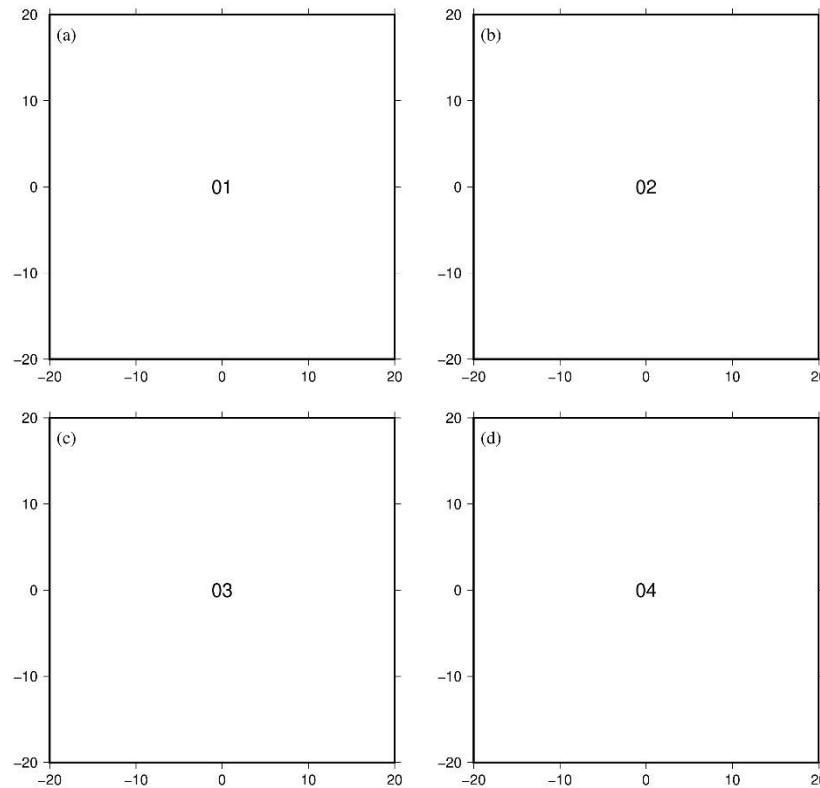
1. 使用-c 則GMT會自動啟動“下一個”子圖面板
2. **-crow,col**: 表示當前及接下來的繪圖命令在第 *row* 行、第 *col* 列子圖中繪製
3. **-cindex**: 當前及接下來的繪圖命名在第 *index* 個子圖內進行

Nota bene 1: *row*、*col*、*index* 均從 0 開始起算

Nota bene 2: -c選項等效於在繪圖指令前使用 gmt subplot set 命令。

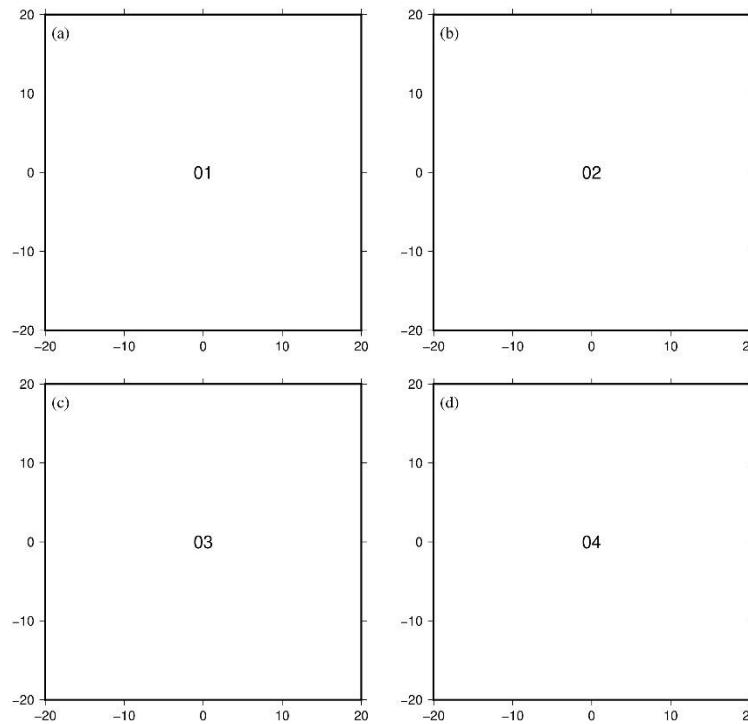
- **-F**: Specify the dimensions of the figure (指定圖片的尺寸)

Open and run ~/07c/subplot03.bat  
or subplot03.sh



```
gmt begin subplot03_modify jpg A+m0.5c
gmt get FONT_TAG
gmt text -L
gmt set FONT_TAG 15p,Times-Roman
gmt subplot begin 2x2 -Fs4.0i/4.0i -A(a)+JTL+o0.2c/0.4c -
M0.5c/0.2c -R-20/20/-20/20
gmt basemap -Ba -BWSen -c
echo 0 0 01 | gmt text -F+f18p,0,black
gmt basemap -Ba -BWSen -c
echo 0 0 02 | gmt text -F+f18p,0,black
gmt basemap -Ba -BWSen -c
echo 0 0 03 | gmt text -F+f18p,0,black
gmt basemap -Ba -BWSen -c
echo 0 0 04 | gmt text -F+f18p,0,black
gmt subplot end
```

- **-Fs**: Specify the dimensions of each subplot directly (指定單個子圖的尺寸)
- **-M margins**: Margin space added between neighboring subplots (i.e., the interior margins) in addition to the automatic space added for tick marks, annotations, and labels (相鄰子圖之間的額外空白)
- **-A autolabel**: Specify **automatic tagging** of each subplot. Append either a **number** or **letter** [a] (為子圖自動添加編號，可以是單個數位或字母)



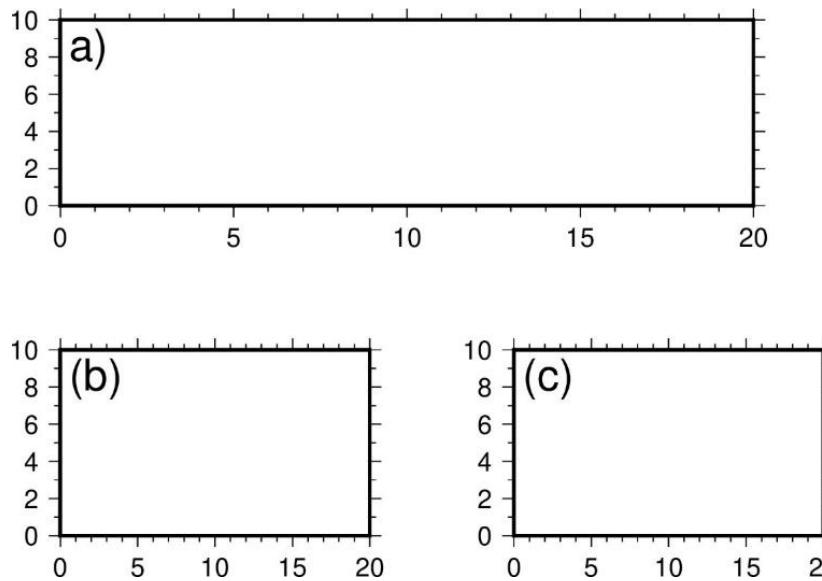
```

gmt subplot begin 2x2 -Fs4.0i/4.0i -A(a)+JTL+o0.2c/0.4c -
M0.5c/0.2c -R-20/20/-20/20
gmt basemap -Ba -BWSen -c
echo 0 0 01 | gmt text -F+f18p,0,black
gmt basemap -Ba -BWSen -c
echo 0 0 02 | gmt text -F+f18p,0,black
gmt basemap -Ba -BWSen -c
echo 0 0 03 | gmt text -F+f18p,0,black
gmt basemap -Ba -BWSen -c
echo 0 0 04 | gmt text -F+f18p,0,black
gmt subplot end

```

- **-Fs**: Specify the dimensions of each subplot directly (指定單個子圖的尺寸)
- **-Mmargins**: Margin space added between neighboring subplots (i.e., the interior margins) in addition to the automatic space added for tick marks, annotations, and labels (相鄰子圖之間的額外空白)
- **-Aautolabel**: Specify **automatic tagging** of each subplot. Append either a **number** or **letter** [a] (為子圖自動添加編號，可以是單個數位或字母)
- **-Slayout**: Set **subplot layout** for **shared axes**. May be set separately for **rows (-SR)** and **columns (-SC)** (設置一列中的所有子圖共用X軸或一行中的所有子圖共用Y軸。**-SCb**表示一列中，只有最下一列子圖的X軸有標注；**-SRI**表示一行中，只有最左一行子圖的Y軸有標注)

## See Lecture 04 ~subplot/subplot02.bat or subplot02.sh

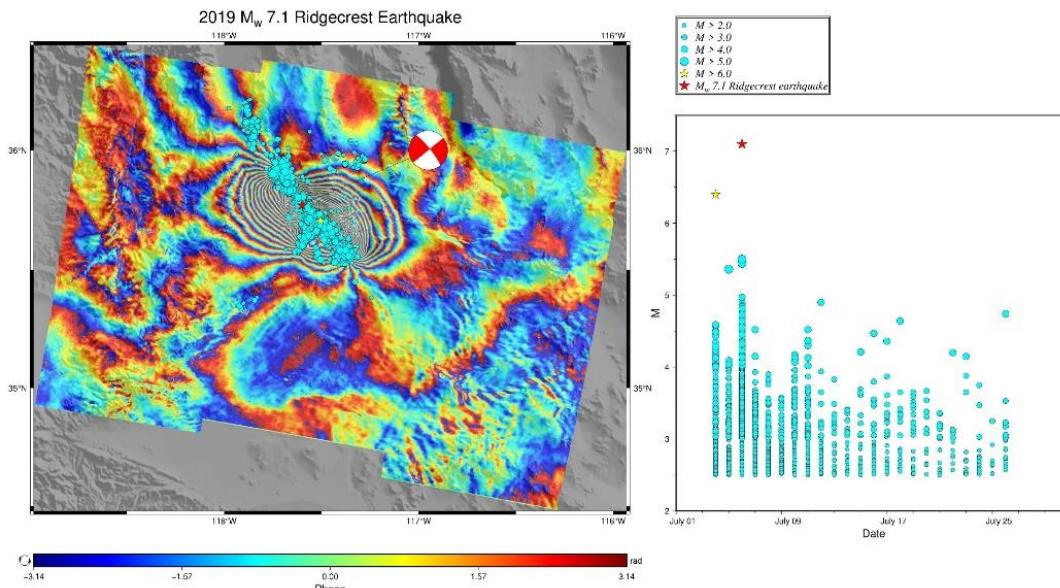


```
gmt begin subplot02 jpg A+m0.5c  
gmt subplot begin 2x2 -Fs5c/3c -A -M0.5c  
gmt subplot set 0  
gmt basemap -R0/20/0/10 -JX11.2c/3c -Baf -  
BWSen  
gmt subplot set 2 -A(b)  
gmt basemap -R0/20/0/10 -JX? -Baf -BWSen  
gmt subplot set 3 -A(c)  
gmt basemap -R0/20/0/10 -JX? -Baf -BWSen  
gmt subplot end  
gmt end
```

gmt subplot set [ row,col/**index** ] [ -Afixedlabel ] [ -Cside/clearance[u] ] [ -V[level] ]

- **index**: 此範例展示如何繪製一個不完全規則排列的子圖。在此例中利用 subplot set，為子圖編碼0、2和3。因第一張圖同時佔據子圖編碼0和1的空間。在情況下，subplot begin的自動編號功能無法正確編號，因此需要用 subplot set 中-A選項為每個子圖單獨指定編號。
- **-JX?**: If any -J option is passed with ? as scale or width when plotting subplots, then the dimensions of the map are automatically determined by the subplot size and your region.

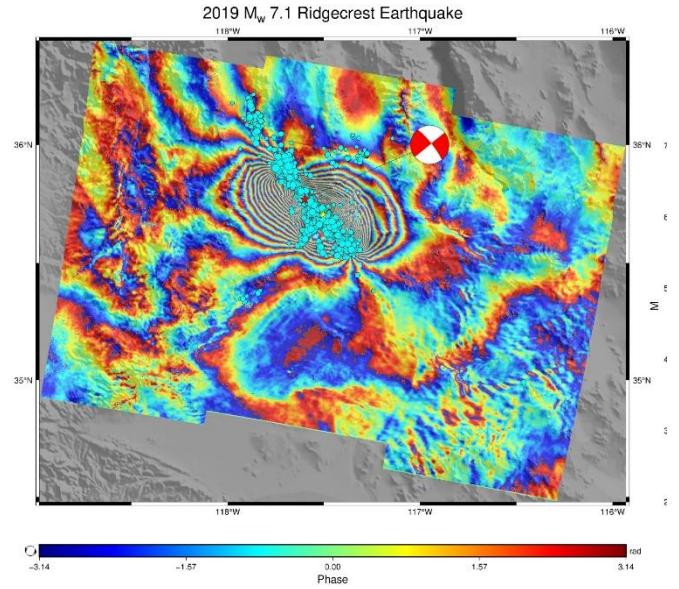
# Coseismic interferogram & aftershock sequences



```
set C:\gridfiles\GEBCO_2023_sub_ice_topo.nc
set InSAR=phasefilt_ll.nc
set topo=temp.grd
set seis=2019RQ_seq.csv
set cmt=2019RQ_CMT.txt
set cpt1=topo_gray.cpt
set cpt2=phase.cpt
gmt set FORMAT_DATE_IN yyyy/mm/dd
```

```
gmt grdcut %grd% -R%InSAR% -G%topo% -V
REM create cpt for DEM & InSAR
gmt makecpt -Cgray -T0/4000/500 -I -N > %cpt1% -V
gmt makecpt -Cjet -T-3.14/3.14 -Ww > %cpt2% -V
```

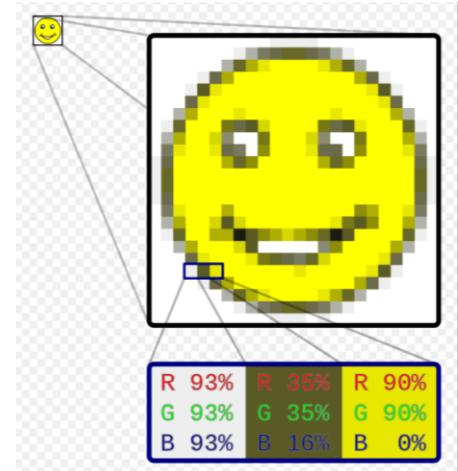
**-Rgridfile:** This will copy the **domain settings** found for the grid in specified file. Note that depending on the nature of the calling program, this mechanism will also set **grid spacing** and possibly the **grid registration** (從2D網格檔gridfile中提取資料範圍資訊。對於某些命令，此方式不僅會從網格中讀取範圍資訊，也會讀入網格間隔和網格配準信息)

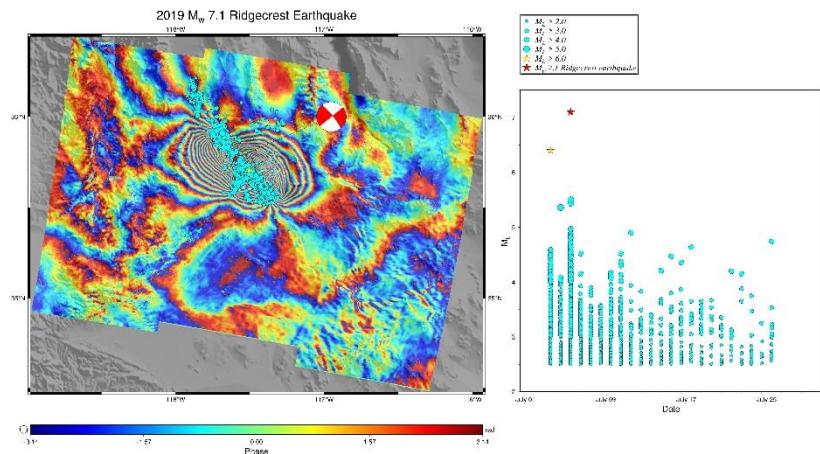


```
gmt basemap -R%InSAR% -JM242.0/12.0i -
Bxa1f0.5 -Bya1f0.5 -BWESN+t"2019 M@-w@-
7.1 Ridgecrest Earthquake" --
FORMAT_GEO_MAP=ddd:mm:ssF -V
gmt grdimage %topo% -C%cpt1% -
|+a45+ne1.0 -V
REM draping interferogram with transparency
gmt grdimage %InSAR% -C%cpt2% -t30 -V
```

```
gmt colorbar -C%cpt2% -Dx6.0i/-1.0i+jCM+w12.0i/0.25i+h -Bx1.57f1.57+lPhase -By+lrad -V
```

- **-t[transp]: Set transparency level for an overlay, in (0-100) percent range.** [Default is 0, i.e., opaque]. Only visible when PDF or raster format output is selected (以百分比調整當前圖層的透明度。預設值為0，表示不透明；100則為完全透明。透明度僅能在PDF與柵格影像格式(例如jpeg, png)中呈現。無法在PS與EPS格式下呈現透明效果)
- Raster graphics or **bitmap image (點陣圖)**: a dot matrix data structure (see [https://en.wikipedia.org/wiki/Raster\\_graphics](https://en.wikipedia.org/wiki/Raster_graphics)).





```

gawk "{if ($5 > 2.0 && $5 < 3.0) print $3, $2 }" FS="," %seis% | gmt plot -Sc6p -W0.25p,black -G0/255/255 -I" M > 2.0"+s6p -V
.....
gawk "{if ($5 > 7.0) print $3, $2 }" FS="," %seis% | gmt plot -Sa16p -W0.25p,black -G255/0/0 -I" M@-w@- 7.1
Ridgecrest earthquake"+s16p -V

```

Open: [2019RQ\\_CMT.txt](#),  
[2019RQ\\_seq.csv](#)

```

gmt meca %cmt% -Sa40p -W0.25p,black -Gred -C -V
gmt legend -Dx13.0i/10.0i+jTL -F+pthick+i thinner+gwhite --
FONT_ANNOT_PRIMARY=16p,Times-Italic -V

```

```

>> LON LAT DEPTH STRIKE DIP RAKE MAG X Y NAME
-117.58 35.78 12.0 321 81 180 7.1 -116.95 36.00

```

```

>>time,latitude,longitude,depth,mag,magType,nst,gap,dmin,rms,net,id,updated,place,type,h
orizonalError,depthError,magError,magNst,status,locationSource,magSource
2019/7/26,35.6346664,-117.5029984,9.01,2.62,ml,41,63,0.05844,0.17,ci,ci38651039,2019-
07-26T23:49:09.884Z,"16km E of Ridgecrest,
CA",earthquake,0.22,0.61,0.277,23,automatic,ci,ci

```

FS: Field separator ([default=whitespace](#)), 文字中空白的處理方法 (white-space)

# *Field separator & record separator*

	Field 1 (Longitude)	Field 2 (Latitude)	Field 3 (Focal depth)	Field 4 (Magnitude)
Record 2	122.03880	23.85300	12.41	3.32
	121.45750	23.80067	3.21	3.30
	121.50280	23.76733	3.67	3.08
	121.33650	23.86133	6.31	3.64
	121.30170	23.83933	5.30	3.27
	122.35650	24.05917	9.41	3.36
	121.59870	23.94517	5.41	3.48
	121.25370	23.65517	0.16	4.29
	122.64430	23.69833	3.13	4.32
Record 10	121.72970	23.78267	5.98	3.64

A file with 10 records, each with four fields

FS: Field separator (default=whitespace)

RS: Record separator (default=\n)

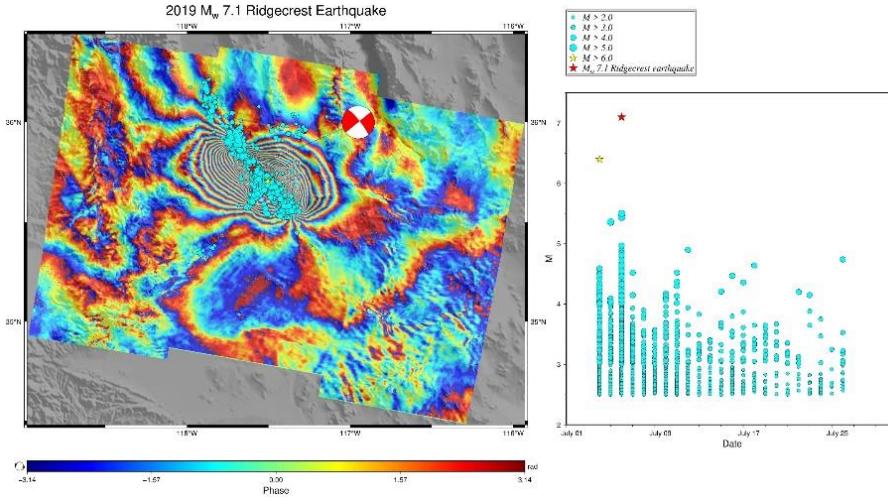
OFS: Output field separator (default=space)

ORS: Output record separator (default=\n)

NF: Number of fields in current record

NR: Number of the current record

- 文字中空白的處理方法 (white-space)：空白字包括，換行(line feed, new line character, \n)，回車 (TAB, carriage return character, \r)，跳行字(form feed)
- Unix與Mac系統裡，每行結尾只有 “<換行 (line feed), >” ，即 “\n” ；Windows系統裡面，每行結尾是 “<換行><回車>” ，即 “\n\r” ；  
舊Mac系統(至Mac OS 9)裡，每行結尾是 “<回車(carriage return)>” 。
- Unix/Mac系統下的文件在Windows裡打開的話，所有文字會變成一行；而Windows裡的文件在Unix/Mac下打開的話，在每行的結尾可能會多出一個^M符號。

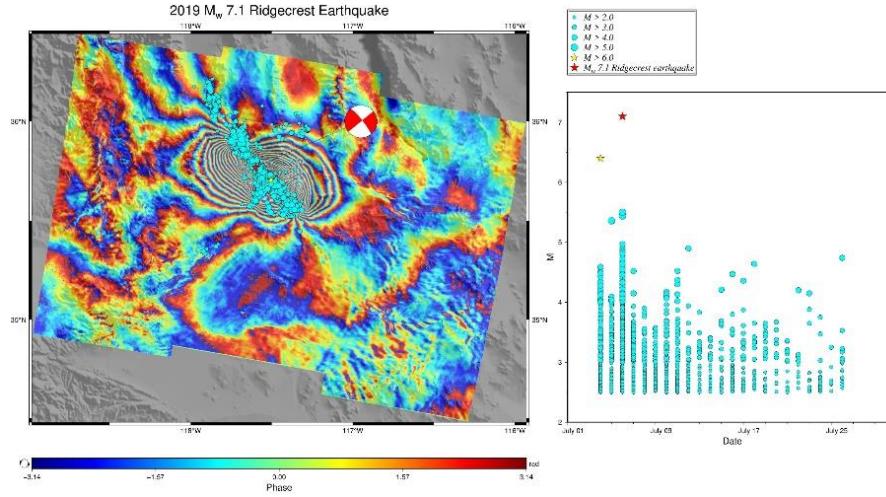


```

gawk "{if ($5 > 7.0) print $3, $2 }" FS=," %seis% |
gmt plot -Sa16p -W0.25p,black -G255/0/0 -I"M@-
w@- 7.1 Ridgecrest earthquake"+s16p -V
gmt legend -Dx13.0i/10.0i+jTL -
F+pthick+ithinner+gwhite --
FONT_ANNOT_PRIMARY=16p,Times-Italic

```

- **-I[*label*][*modifiers*]**: Add an item to the **automatic plot legend** (繪製的符號或線條添加圖例記錄)
- ***Modifiers*:[*dpen*][**+f*font***][**+g*gap***][**+h*header***][**+j*just***][**+l*code/*txt**][**+n*cols***][**+s*size***][**+v*pen***][**+w*width***][**+x*scale***]: [beta version] Add a **map legend entry** to the **session legend information file** for the current plot.**
- +d**: Draw a **horizontal line** before the legend entry is placed [**no line**]
- +f**: Set the **font** used for the legend header [**FONT\_TITLE**]
- +g**: Add some **vertical space** [**0**]; **+h**: Add a legend header [**no header**]
- +j**: Placement of the legend [**TR**]
- +l**: Set a line text; prepend a horizontal **justification code** L, C, or R [**C**]
- +n**: Change the **number of columns** used to set the following legend items [**1**]
- +s**: Override the **size of the current symbol** for the legend or set a length if plotting a line or contour [**same as plotted**]



```

gawk "{if ($5 > 7.0) print $3, $2 }" FS=, %seis%
gmt plot -Sa16p -W0.25p,black -G255/0/0 -I" M@-
w@- 7.1 Ridgecrest earthquake" +s16p -V
gmt legend -Dx13.0i/10.0i+jTL -
F+pthick+i thinner+gwhite --
FONT_ANNOT_PRIMARY=16p,Times-Italic

```

➤ **Modifiers:** [dpen][+ffont][+ggap][+hheader][+jjust][+[code/]txt][+ncols][+ssize][+v[pen]][+width][+xscale]: [beta version] Add a **map legend entry** to the **session legend information file** for the current plot.

**+v:** Start and +vopen to stop drawing vertical line from previous to current horizontal line [**no vertical line**]

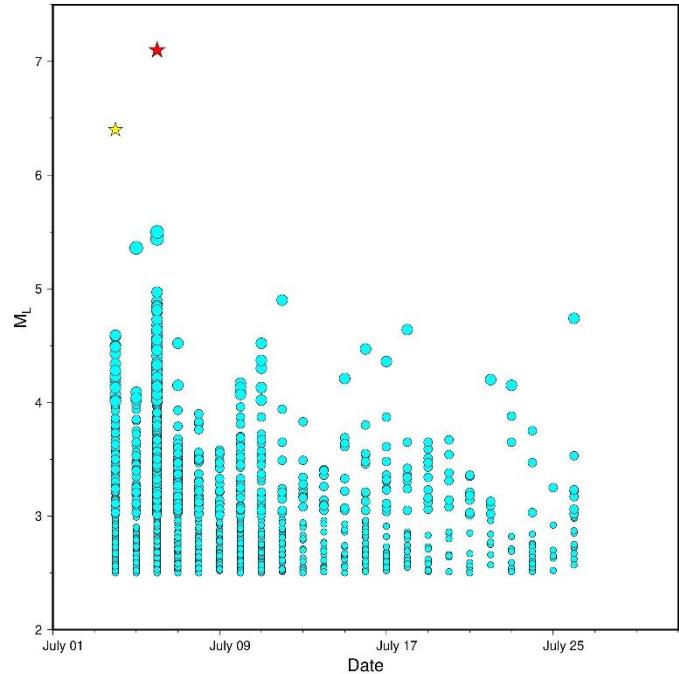
**+w:** Set legend width [**auto**],

**+x:** Resize all symbol and length sizes in the legend

➤ **Default pen** is given by **MAP\_DEFAULT\_PEN**

➤ Note that **+h**, **+j**, **+w**, and **+x** will only **take effect** if given on the **very first -I** option for a plot

➤ **-F[+cclearances][+gfill][+i[[gap/]pen]][+p[pen]][+r[radius]][+s[[dx/dy/][shade]]]:** Without further options, draws a rectangular border around the legend (設定圖例框的背景屬性)



```

gmt set FORMAT_DATE_IN yyyy/mm/dd
gmt basemap -JX8.0i/8.0i -R2019-07-01/2019-07-
31/2.0/7.5 -Bxa8Df2D+IDate -Bya1.0f0.5+l" M@-L@- " -
BWStr -X13.0i -V --FORMAT_DATE_MAP="o dd"
REM plot time-mag. plot of earthquake sequence
gawk "{if ($5 > 2.0 && $5 < 3.0) print $1, $5}" FS=,
%seis% | gmt plot -Sc6p -G0/255/255 -W0.25p,black -V

```

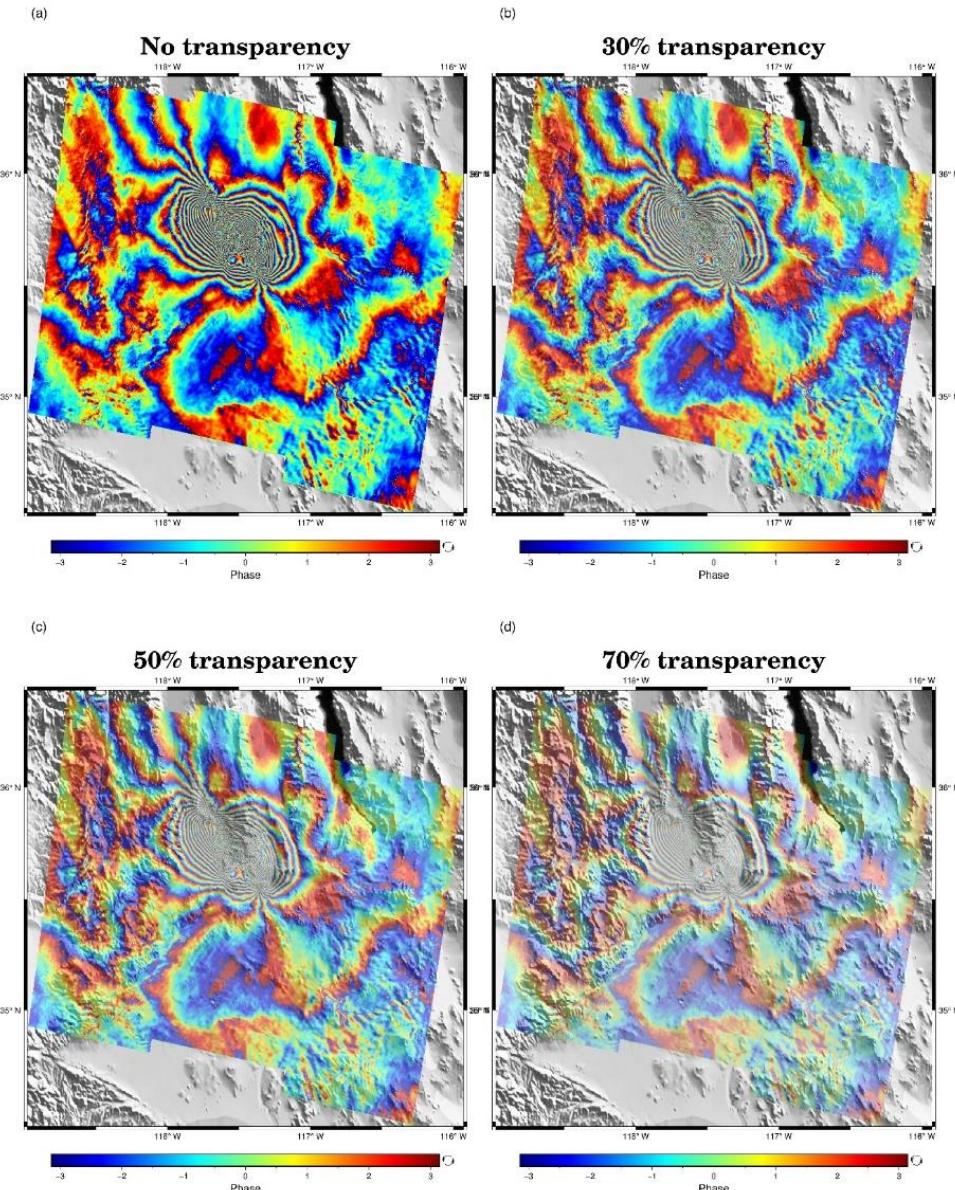
```

>>time,latitude,longitude,depth,mag,magType,nst,gap,dmin,rms,net,id,updated,place,type,h
orizontalError,depthError,magError,magNst,status,locationSource,magSource
2019/7/26,35.6346664,-117.5029984,9.01,2.62,ml,41,63,0.05844,0.17,ci,ci38651039,2019-
07-26T23:49:09.884Z,"16km E of Ridgecrest,
CA",earthquake,0.22,0.61,0.277,23,automatic,ci,ci

```

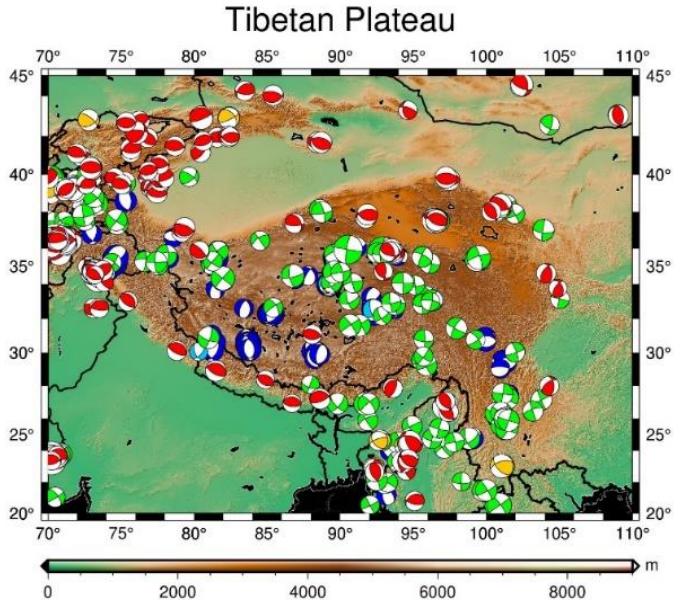
- **FORMAT\_DATE\_IN** 輸入資料中日期字串的格式範本 [yyyy-mm-dd]: 日期字串可以用西曆表示，也可以用ISO周曆(ISO week date)表示。yyyy: 四位年份；yy：兩位年份；mm：兩位月份；o：月份的名稱簡寫；dd：兩位日期；jjj：一年中的第幾天

# *Transparency in grdimage* (調整透明度)



```
gmt subplot begin 2x2 -Fs9.0i/12.0i -A(a)+jTL+o0.2c/0.2c  
-M5p  
.....  
gmt subplot set 4  
gmt basemap -JX? -R%InSAR% -Bxa1f0.5 -Bya1f0.5 -  
B+t"70%% transparency" -V  
gmt grdimage %topo% -C%cpt1% -I+a45+ne1.0 -V  
gmt grdimage %InSAR% -C%cpt2% -t70 -Q -V  
gmt colorbar -DjMB+jCM+o0.0i/-0.7i+w8.0i/0.25i+h -  
C%cpt2% -Bxa1f0.5+l"Phase" -V  
gmt subplot end
```

**-Q:** Make grid nodes with  $z = \text{NaN}$  transparent, using the color-masking feature in PostScript Level 3 (將值為  $\text{NaN}$  的節點處設置為透明色)



## Exercise 07

- Using [Lect07B.bat](#) or [Lect07B.sh](#) as a template
- Draw focal mechanisms in mapview of  $Mw \geq 6.0$  in and around Taiwan according to [20200426102440\\_csv.txt](#) acquired from **AutoBATs search**. (*nota bene: FS=","*)
- Using Stress regime characterization: [Plunge \(pl\)](#) of P, B, & T axes to separate different focal mechanisms
- Using [gmt legend](#) to draw a legend

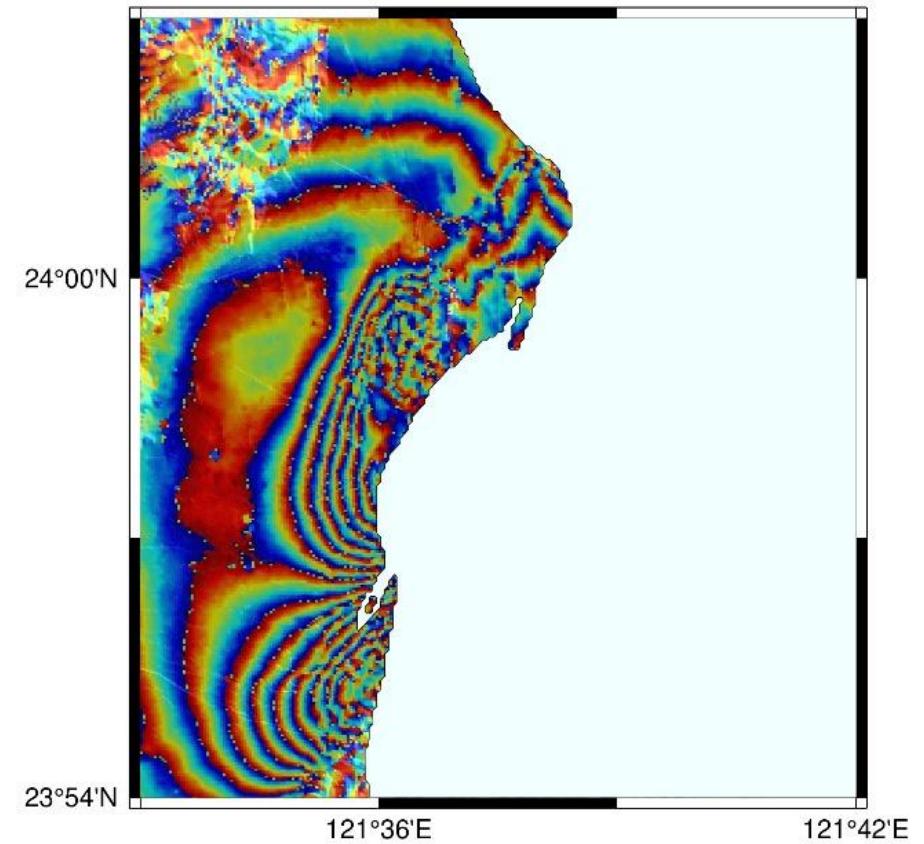
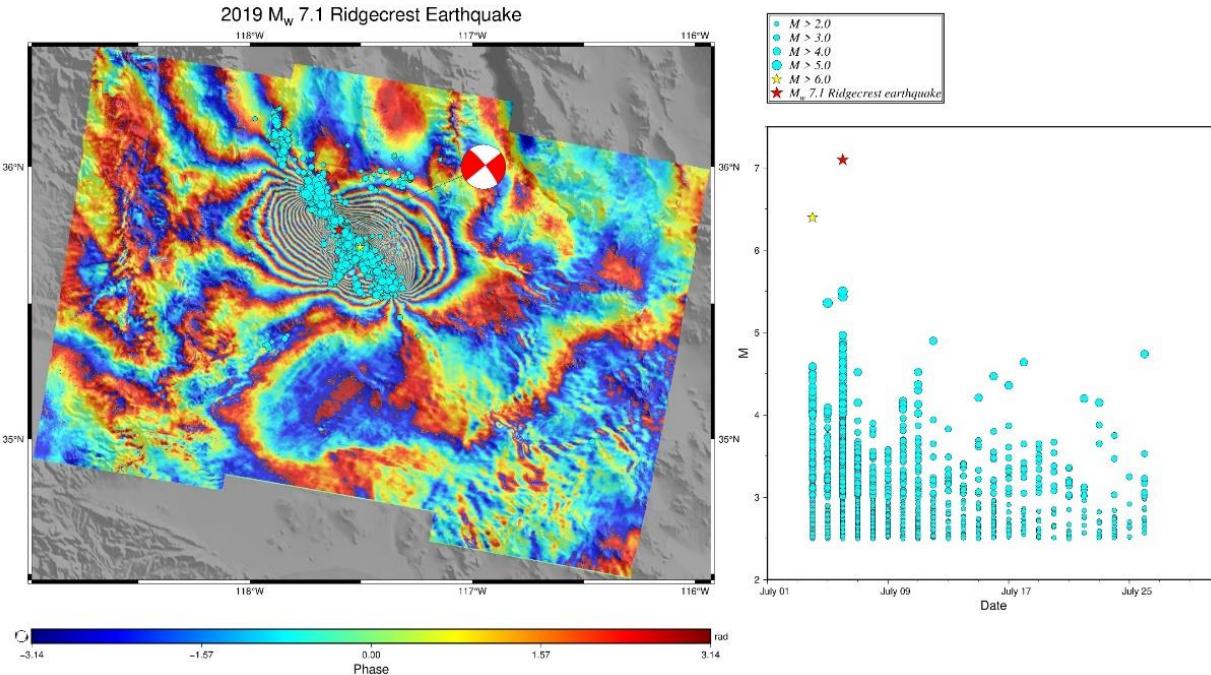
Date, Time, [Latitude](#), [Longitude](#), [CWB Depth](#), [ML](#), strike1, dip1, slip1, strike2, dip2, slip2, m11, m22, m33, m12, m13, m23, Mrr, Mtt, Mff, Mrt, Mrf, Mtf, exponentexponent, [M0](#), [Mw](#), [Centroid\\_depth](#), CLVD, ISO, misfit, gap, nsta, [Paz](#), [Ppl](#), [Baz](#), [Bpl](#), [Taz](#), [Tpl](#), QC

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1996-07-29,20:20:53.53,[24.4888](#),[122.3470](#),**65.68**, **6.14**,[189.79](#), [44.11](#), [51.60](#), 57.62, 56.94, 121.05,-0.386010,-1.366326,1.751916,1.158373,1.012454,0.138034,1.751916,-0.386010,-1.366326,1.012454,-0.138034,-1.158370, **24**, **2.22002e+24**, **5.50**, **59**, 5.5, 0.0, 0.272,323.800,5,**126.055**,**7.007**,**-140.567**,[25.616](#),[21.906](#),[63.306](#),A1

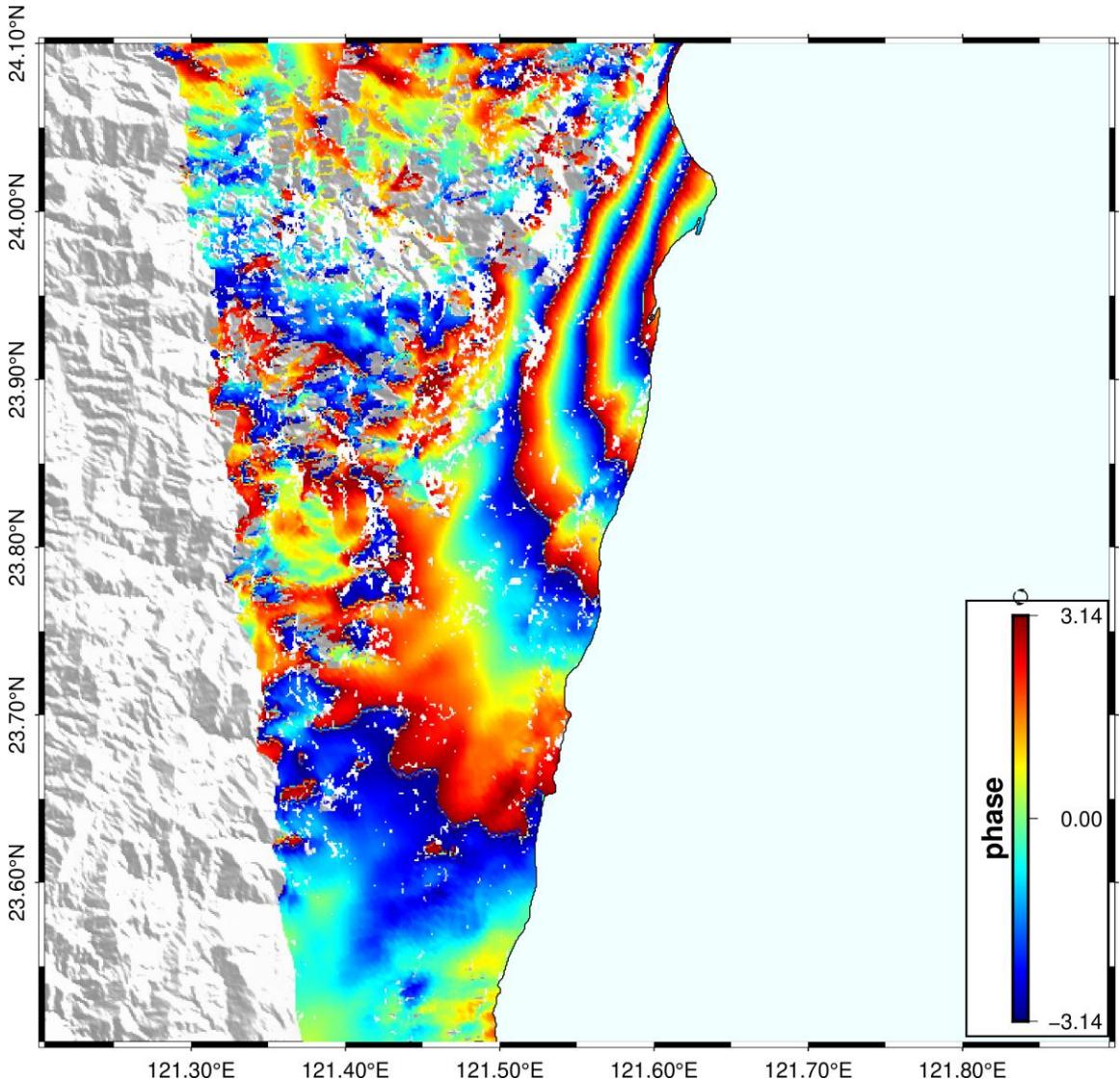
# Homework 07a

## Ascending Interferogram



- Using [Lect07D1.bat](#) or [Lect07D1.sh](#) as a template
- Draw coseismic interferograms of 0206 Hualien earthquake (data: `asc_phasefilt_ll.grd`) superimposed on 40 m DEM
- Draw earthquake sequences (data: `201802P_HualienEQ.txt`)
- Draw focal mechanism of main shock (searching it on BATS)

# *Homework 07b*



- Using [Lect07D1.bat](#) or [Lect07D1.sh](#) as a template
- Draw coseismic interferograms of 0403 Hualien earthquake from **ALOS-2 L-band SAR images** (data: [A2\\_ASC-Lon-Lat-def-wrap-coh.txt](#)) superimposed on Taiwan 20 m DEM on land and 200m DEM offshore)
- Adjust the transparency of interferogram on DEM
- Draw focal mechanism of main shock (searching it on BATS)