
Subject: Re: Skewt plot
Posted by [afl](#) on Thu, 20 Jul 1995 07:00:00 GMT
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In article <3ukr5IINN5go@meteorology.ho.BOM.GOV.AU>, James Kelly
<jamesk@bom.gov.au> writes:
> Has anyone used IDL for specialised meteorological displays such as
> skewt? This plots a temperature profile (on a "skewed" x axis) versus
> height (log of pressure) through the atmosphere.

James,

Yes. I wrote it, but never really used it.
Please tell me if it works for you.

Andy Loughe

```
;=====
; SKEWT.PRO (IDL CODE)
;
; Draw a Skew-T, Log(P) diagram given a temperature range for your data.
;
; Originator: Andrew F. Loughe (afl@cdc.noaa.gov)
;           CIRES/NOAA
;           Boulder, CO USA
;           This code carries no warranty or claim
;           as to its usefulness or accuracy!
;
; A Number of the functions found in this file were converted from
; FORTRAN code that was received from NCAR in Boulder, CO USA.
; The original source of the equations is thought to be:
; "Algorithms for Generating a Skew-T, Log P Diagram
; and Computing Selected Meteorological Quantities"
; by G.S. Stipanuk, White Sands Missile Range, Report ECOM-5515.
;
;=====
; FUNCTION TO COMPUTE SATURATION VAPOR PRESSURE GIVEN TEMP IN KELVIN.
; ESAT(MILLIBARS), T(KELVIN)
; FUNCTION ESAT, T
;   TC = T - 273.16
;   ESAT = 6.1078 * EXP( (17.2693882 * TC) / (TC + 237.3) )
;   RETURN, ESAT
; END
;=====
; FUNCTION TO COMPUTE MIXING RATIO GIVEN TEMP. AND PRESS.
; W(GRAMS WATER VAPOR/KILOGRAM DRY AIR), P(MILLIBAR)
```

```

FUNCTION W, T, P
  IF (T GE 999.) THEN GOTO, JUMP10
  X = ESAT(T)
  W = 621.97 * X / (P - X)
  RETURN, W

JUMP10: W = 0.0
  RETURN, W
  END

;=====
; FUNCTION TO COMPUTE SATURATION ADIABATIC TEMP AT 1000 MB GIVEN T & P.
; OS AND T (KELVIN), P (MILLIBARS )
  FUNCTION OS, T, P
    IF (T LT 100.) THEN T1 = T + 273.16
    IF (T GE 100.) THEN T1 = T
    OS = T1 * ((1000./P)^.286) / (EXP( -2.6518986*W(T1,P) / T1) )
    RETURN, OS
  END

;=====
; FUNCTION TO COMPUTE THE TEMPERATURE (KELVIN) OF AIR AT A GIVEN
; PRESSURE AND WITH A GIVEN MIXING RATIO.
; TMR(KELVIN), W(GRAMS WATER VAPOR/KILOGRAM DRY AIR), P(MILLIBAR)
  FUNCTION TMR, W, P
    X = ALOG10 ( W * P / (622.+ W) )
    TMR = 10. ^ ( .0498646455 * X + 2.4082965 ) - 7.07475 + $
      38.9114 * ( (10.^ ( .0915 * X ) - 1.2035 )^2 )
    RETURN, TMR
  END

;=====
; FUNCTION TO COMPUTE TEMPERATUE (KELVIN) OF A MOIST ADIABAT GIVEN
; OS(KELVIN), P(MILLIBARS)
; SIGN(A,B) REPLACES THE ALGEBRAIC SIGN OF A WITH THE SIGN OF B
  FUNCTION TSA, OS, P
    A = OS
    TQ = 253.16
    D = 120
    FOR I = 1, 12 DO BEGIN
      D = D/2.
; IF THE TEMPERATURE DIFFERENCE, X, IS SMALL, EXIT THIS LOOP.
      X = A * EXP (-2.6518986*W(TQ,P)/TQ)-TQ*((1000./P)^.286)
      IF ( ABS(X) LT 0.01 ) THEN GOTO, JUMP2
;      TQ = TQ + SIGN(D,X)
      IF (X LT 0) THEN D = -ABS(D)
      IF (X GT 0) THEN D = ABS(D)
      TQ = TQ + D
    ENDFOR
  JUMP2: TSA=TQ
  RETURN, TSA

```

END

```
=====
; Function to determine position (temp, press) when the isotherms
; in the diagram are rotated (skewed) 45 degrees to the right.
; Used for finding the points needed to connect the dots when
; drawing ALL of the lines (except pressure).
; Originator: Andrew F. Loughe
  Function Tnew, T, P
    COMMON RANGES, trange, prange

    P0 = prange(0)
    xy1 = convert_coord( [T, P0], /data, /to_device)
    xy2 = convert_coord( [T, P], /data, /to_device)
    dy = xy2(1) - xy1(1)
    dx = dy ; dx = dy for this 45-45-90 triangle
    xy = convert_coord( [xy2(0)+dx, xy2(1)], /device, /to_data)
    Tnew = xy(0)
    return, Tnew
  end
=====
; Function to determine position (temp, press) in the unskewed
; coordinate system (Opposite of Tnew).
; Used only when placing the labels on various lines.
; Originator: Andrew F. Loughe
  Function Told, T, METHOD
    COMMON RANGES, trange, prange

    P0 = prange(0)
    P1 = prange(1)

    T0 = trange(0)
    T1 = trange(1)

    if (method eq 1) then begin
      xy1 = convert_coord( [T, P0], /data, /to_device )
      xy2 = convert_coord( [T0, P0], /data, /to_device )
      dx = xy2(0) - xy1(0)

      xy = convert_coord( [xy2(0), xy2(1)+dx], /device, /to_data )

      xy1 = convert_coord( [xy(0), xy(1)], /data, /to_device )
      xy2 = convert_coord( [xy(0), P1], /data, /to_device )
      dy = xy2(1) - xy1(1)

      xy = convert_coord([xy1(0)+(dy/2.), xy1(1)+(dy/2.)], $
        /device, /to_data)
    endif
```

```

if (method eq 2) then begin
  xy1 = convert_coord( [T, P0], /data, /to_device )
  xy2 = convert_coord( [T1, P0], /data, /to_device )
  dx = xy2(0) - xy1(0)

  xy = convert_coord( [xy1(0)+dx/2., xy1(1)+dx/2.], $
    /device, /to_data)
endif

return, xy
end
;=====
; Function to determine the necessary trange for plotting the sounding.
Function T_RANGE, p_range, t, td, p

COMMON RANGES, trange, prange

trange = [-40, 40] ; Default which can be changed
if (p_range eq 0) then $
  prange = [1050, 100] ; Default which can be changed

; Find number of data levels
szd = size(t)
nlevels = szd(1)

; Ensure that temperatures are in Celsius.
if ( (total(t)/nlevels) gt 100. ) then t = t - 273.16
if ( (total(td)/nlevels) gt 100. ) then td = td - 273.16

; Set up dummy plot space.
if (!d.name eq 'PS') then device, /inch, xsize=7, ysize=7
daspect = FLOAT(!D.Y_SIZE)/FLOAT(!D.X_SIZE) * $
  (trange(1)-trange(0))/80.
margin = 0.1
aspect = 1.0 ; A square
x0 = 0.50 - (0.5 - margin)*(daspect/aspect)
y0 = margin
x1 = 0.50 + (0.5 - margin)*(daspect/aspect)
y1 = 1.0 - margin

!P.position=[x0,y0,x1,y1]
plot_io, trange, prange, yrange=prange, /nodata, /xs, /ys, $
  color=!p.background, /noerase
!p.multi(0) = !p.multi(0) + 1

; Determine necessary temperature range for the diagram.

```

```

xx0 = fltarr(nlevels) & yy0=xx0 & xx1=xx0 & yy1=yy0
for i = 0, nlevels-1 do begin
    xx0(i) = tnew( t(i), p(i) )
    yy0(i) = p(i)
    xx1(i) = tnew( td(i), p(i) )
    yy1(i) = p(i)
endfor
xbegin = fix( (min(xx1)-10.) / 10. ) * 10.
xend   = fix( (max(xx0)+10.) / 10. ) * 10.

return, [xbegin, xend]
end

```

```

;=====
;
;
; PROCEDURE TO DRAW A SKEW-T, Log(P) DIAGRAM GIVEN A DESIRED
; TEMPERATURE RANGE FOR THE DATA.
;
;
; Originator: Andrew F. Loughe
;

```

```

PRO SKEWT, t_range, everyT=everyT, everyDA=everyDA, $
    everySA=everySA, everyW=everyW, title=title, notitle=notitle
on_error, 2

```

```

COMMON RANGES, trange, prange

```

```

if (n_elements(everyT) le 0) then everyT = 10 ; T = Temperature
if (n_elements(everyDA) le 0) then everyDA = 10 ; DA = Dry adiabat
if (n_elements(everySA) le 0) then everySA = 1 ; SA = Saturated adiabat
if (n_elements(everyW) le 0) then everyW = 1 ; W = Mixing ratio

```

```

if (not keyword_set(title)) then title='Skew-T, Log(P) Diagram'
if (keyword_set(notitle)) then title=' '
if (n_elements(prange)) eq 0 then prange = [1050., 100]

```

```

if (N_params() eq 0) then $
    message,$
    'EXAMPLE: skewt, [-20, 20], everyT=10, everyDA=10, everySA=2, everyW=2'
if (n_elements(t_range)) eq 1 then t_range=[-40., 40.]

```

```

; Set some defaults
trange = t_range
charsize = .8 ; Set default character size
!p.multi = [0,1,1]

```

```

; Set default color positions

```

```
RED = 44
GREEN = 22
BLUE = 33
BLACK = 0
WHITE = 1
```

```
; Make plot square for arbitrarily chosen range of 80 degrees.
; Code from Ken Bowman
```

```
if (!d.name eq 'PS') then device, /inch, xsize=7, ysize=7
```

```
daspect = FLOAT(!D.Y_SIZE)/FLOAT(!D.X_SIZE) * (trange(1)-trange(0))/80.
margin = 0.1
aspect = 1.0 ; A square
x0 = 0.50 - (0.5 - margin)*(daspect/aspect)
y0 = margin
x1 = 0.50 + (0.5 - margin)*(daspect/aspect)
y1 = 1.0 - margin
```

```
!P.POSITION = [x0, y0, x1, y1] ; Set value of system variable.
```

```
; Determine character height and width. Apply charsize.
char_ht = convert_coord([0, !d.y_ch_size], /device, /to_norm)
char_ht = char_ht(1) * 1.0
if (!d.name ne 'X' and charsize gt 1.) then $
    char_ht = char_ht * charsize
char_wd = convert_coord([0, !d.x_ch_size], /device, /to_norm)
char_wd = char_wd(1)
```

```
; Create the plot space.
```

```
plot_io, trange, prange, yrange=prange, /nodata, /xs, /ys, $
    xticklen=.01, ytickname=replicate(' ',30), charsize=charsize, $
    title=title
```

```
; Print PRESSURE title along the y-axis.
```

```
lnt=log(prange(1)) & ln0=log(prange(0)) & avg=exp(.5*(lnt+ln0))
xy = convert_coord([trange(0), avg],/data,/to_norm)
xyouts, xy(0)-(5.*char_wd), xy(1), 'PRESSURE (hPa)', orient=90, $
    /norm, align=.5
```

```
; Print TEMPERATURE title along the x-axis.
```

```
xy = convert_coord([.5*(trange(0)+trange(1)), prange(0)], /data, /to_norm)
xyouts, xy(0), xy(1)-(3.*char_ht), 'TEMPERATURE (!uo!nC)', align=.5, /norm
```

```
; Draw Pressure labels next to tick marks along the y-axis.
```

```

pressures = [1050,1000,900,800,700,600,500,400,300,200,100]
for i = 0, 10 do begin
  ytick = pressures(i)
  if (ytick ge prange(1)) then begin
    xy = convert_coord( [trange(0), ytick], /data, /to_norm )
    xyouts, xy(0)-(.2*char_wd), xy(1)-(.25*char_ht), $
      strcompress(string(ytick),/remove_all), align=1, $
      charsize=charsize, /norm

    plots, [trange(0), trange(1)], [ytick, ytick] ; Horizontal line.
  endif
endfor

clip=[trange(0),prange(0),trange(1),prange(1)] ; Define clipping space.

;=====
; Draw skewed isotherms every "everyT (10C)" (Lines are straight).
for temp = trange(0)-100, trange(1)+5, everyT do begin
  x0 = temp
  y0 = prange(0)
  x1 = temp
  y1 = prange(1)

; Draw the line.
  newx0 = tnew(x0, y0) ; Find rotated temperature position
  newx1 = tnew(x1, y1) ; Find rotated temperature position
  plots, [newx0, newx1], [y0, y1], color=BLUE, clip=clip, noclip=0

; Draw line labels
; Use method #1 in xy function to determine a place for the label.
  drew_label = 'no'
  xy = Told(temp, 1)
  if ( xy(0) gt trange(0) and xy(0) lt trange(1) and $
    xy(1) gt prange(1) and xy(1) lt prange(0) ) then begin
    drew_label = 'yes'
    xyouts, xy(0), xy(1), strcompress(string(fix(temp)), /rem),$
      color=BLUE, orient=45, align=.5, charsize=charsize
  endif

; Use method #2 in xy function to determine a place for the label.
  if (drew_label eq 'no') then xy = Told(temp, 2)
  if ( xy(0) gt trange(0) and xy(0) lt trange(1) and $
    xy(1) gt prange(1) and xy(1) lt prange(0) and $
    drew_label eq 'no') then begin
    xyouts, xy(0), xy(1), strcompress(string(fix(temp)), /rem),$
      color=BLUE, orient=45, align=.5, charsize=charsize
  endif
endif

```

endfor

```
=====
; Draw dry adiabats every "everyDA (10C)" (Lines are curved).
for temp = trange(0), trange(0)+220, everyDA do begin
  x1 = float(temp)
  y1 = 1050.
  inc = -2. ; Lines will be curved, so use a small press. increment.
  drew_label='no'
  icount = 0

; Dry adiabats from 1050mb up to prange(1).
; For a given temperature and pressure, compute theta and plot a line.
for press = y1, prange(1), inc do begin
  icount = icount + 1
  x0 = float(x1) ; Orig Temp
  y0 = float(press + inc) ; Orig Press
  y1 = float(y0 + inc) ; New Press
  x1 = (temp+273.16) * ( y1 / 1000. ) ^ (287./1004.) ; New Temp
  x1 = x1 - 273.16

  newx0 = tnew(x0, y0) ; Find rotated temperature position
  newx1 = tnew(x1, y1) ; Find rotated temperature position

; Draw the labels.
if (fix(x1) eq fix(trange(0)) and drew_label eq 'no') then begin
  drew_label='yes'
  if ( newx1 gt trange(0) and newx1 lt trange(1) and $
    y1 gt prange(1) and y1 lt prange(0) ) then $
    xyouts,newx1,y1,strcompress(string(fix(temp)),/remove),$
    align=.5, color=RED, charsize=charsize, orientation=-45
endif

; Draw the line.
if (icount gt 1) then $
  plots, [newx0, newx1], [y0, y1], color=RED, clip=clip, noclip=0
  if (newx1 lt trange(0)) then goto, jump2
endfor

jump2: dummy=0
endfor

=====
; Draw saturated adiabats. Begin at 40C and step backwards by 4C.
; These lines are curved.
TS = 40.
FOR TS = 40, -64, -everySA*4 DO BEGIN
```



```

P = 1060.
TK = TS + 273.16
AOS = OS(TK, 1000.)

```

```

ATSA = TSA(AOS, P) - 273.16
FOR J = 0, 85 DO BEGIN
  P0 = P
  T0 = ATSA

```

```

  P = P - 10.
  ATSA = TSA(AOS, P) - 273.16
  if (j gt 0) then begin
    newx0=tnew(T0,P0) ; Find rotated temperature position
    newx1=tnew(ATSA,P) ; Find rotated temperature position

```

```

; Leave a space for the labels and draw them.
  if (P gt 730 or P lt 700) then $
    plots, [newx0, newx1], [P0, P], $
    color=GREEN, clip=clip, noclip=0

  if ( P eq 730 ) then begin
    if (newx1 gt trange(0) and newx1 lt trange(1)) then $
      xyouts,newx1,P,strcompress(string(fix(TS)),/remove),align=.5,$
      color=GREEN, charsize=charsize
    endif
  endif
ENDFOR

```

```

ENDFOR

```

```

;=====
; Draw mixing ratio lines (Lines are straight).
; Find temperature for a given Ws (g/kg) and Press (mb).

```

```

Ws=[ .1,.2,.4,.6,.8,1.,1.5,2.,2.5,4,5,6,7,8,9,10,12, $
  14,16,18,20,24,28,32,36,40,44,48,52,56,60,68,76,84 ]

```

```

for i = 0, N_elements(Ws)-1, everyW do begin
  press1 = prange(0)
  tmr1 = tmr(Ws(i), press1) - 273.16

```

```

  press2 = 200.
  tmr2 = tmr(Ws(i), press2) - 273.16

```

```

  newx0=tnew(tmr1,press1) ; Find rotated temperature position
  newx1=tnew(tmr2,press2) ; Find rotated temperature position

```

```

; Draw the line.

```

```

plots, [newx0, newx1], [press1, press2], color=22, linestyle=2, $
    clip=clip, noclip=0

; Draw the line label.
drew_label='no'
if (newx0 gt trange(0) and newx0 lt trange(1)) then begin
    drew_label='yes'
    if (Ws(i) ge 1.0) then $
        xyouts, newx0, press1-2, strcompress(string(fix(Ws(i))),/remove),$
            align=.5,color=GREEN, charsize=charsize
    if (Ws(i) lt 1.0) then $
        xyouts, newx0, press1-2, string(Ws(i),format='(f3.1)'), align=.5,$
            color=GREEN, charsize=charsize
    endif
if (newx1 gt trange(0) and newx1 lt trange(1)) then begin
    if (Ws(i) ge 1.0) then $
        xyouts, newx1, press2-2, strcompress(string(fix(Ws(i))),/remove),$
            align=.5, color=GREEN, charsize=charsize
    if (Ws(i) lt 1.0) then $
        xyouts, newx1, press2-2, string(Ws(i),format='(f3.1)'), align=.5,$
            color=GREEN, charsize=charsize
    endif
endifor

;=====
; Redraw the plot boundary.
plots, [trange(0),trange(1),trange(1),trange(0),trange(0)], $
    [prange(0),prange(0),prange(1),prange(1),prange(0)], thick=2

!p.position = [.05, .05, .95, .95]    ; Reset position parameter

END

```

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--
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