COMBINED SHEAR

ALGORITHM DESCRIPTION

NX-DR-03-033/04

1.0 PROLOGUE

1.1 FUNCTIONAL DESCRIPTION

This algorithm computes combined shear of the radial velocities at a single elevation within a volume scan. This combined shear is related but not equivalent to the total shear of the horizontal wind field. Since most wind phenomena related to aircraft mishaps involve shears (gradients of the wind), maps of the combined shear of the radial velocities as measured by Doppler weather radar will prove useful in the detection of such hazards.

On an azimuth-by-azimuth basis the algorithm performs the following calculations:

1) Running averages of Doppler velocity over a specified number of sample volumes. Only those data values with corresponding received power levels greater than a specified threshold power are included in the averages.

2) Running differences of the radially-averaged Doppler velocities. These differences are taken over a radial distance equal to the averaging distance. For final processing, the differences are assigned to Cartesian grid points.

3) Azimuthal differences of the radially-averaged Doppler velocities. These differences are taken between adjacent azimuths at constant range. For final processing, the differences are divided by the distance between the effective sample volume centers, with the quotients then assigned to Cartesian grid points.

Once all azimuths have been processed, the following are computed within the rectangular Cartesian grid:

1) Average radial and azimuthal differences at each grid point.

2) Filtered difference fields using a centered, two-dimensional filter.

3) Combined shear of the radial velocities at each grid point by squaring the radial and azimuthal shears, adding, and taking the square root.

4) Thresholded total shears, where only those values above a defined threshold are retained.

This process yields a field of shear values that are easily displayed and are available as input to higher level algorithms, such as a GUST FRONT DETECTION algorithm.

1.2 SOURCE

The algorithm was developed at the Air Force Geophysics Laboratory (LYR) by F. Ian Harris (SASC Technologies, Inc.), Kenneth M. Glover (AFGL/LYR) and Glenn R. Smythe (SASC Technologies, Inc.).

REFERENCE

Harris, F.I., K.M. Glover and G.R. Smythe, 1985: Gust Front Detection and Prediction. Preprints 14th Conference on Severe Local Storms, Amer. Meteor. Soc., Boston, MA.

1.3 PROCESSING ENVIRONMENT

This algorithm uses reflective power and dealiased radial velocity data collected by a Doppler weather radar. Ground clutter effects are assumed to have been removed. The data are treated on a plane basis only, i.e., no vertical correlations are performed.

2.0 INPUTS

2.1 IDENTIFICATION

AZIMUTH = Azimuthal position, in radians.

DOMAIN (Resolution) = Grid point spacing for the Cartesian grid, in km (0.5 - 4.0).

DOMAIN (X Minimum) = The lower left X (W - E) coordinate relative to the radar for the rectangular Cartesian grid for the interpolated shears, in km.

DOMAIN (Y Minimum) = The lower left Y (S - N) coordinate relative to the radar for the rectangular Cartesian grid for the interpolated shears, in km.

DOMAIN (X Size) = Length of the (W - E) side of the Cartesian grid box, in km (230).
Note: The box is centered on the radar.

DOMAIN (Y Size) = Length of the (S - N) side of the Cartesian grid box, in km (230). Note: The box is centered on the radar.

ELEVATION = Elevation angle, in radians.

FLAG VALUE = Default value for filtered SHEAR (Radial-RSA), filtered SHEAR (Azimuthal) and COMBINED SHEAR.

MAXIMUM SAMPLES (Radial) = The maximum number of SAMPLE VOLUMEs in one radial.

NUMBER (Filter) = Number of data points used in the uniform filter applied to the mean SHEAR (Azimuthal) and mean SHEAR (Radial) fields (9).

NUMBER (Sample Volumes) = Number of contiguous SAMPLE VOLUMEs to be averaged to produce each estimate of average RADIAL VELOCITY (Range)(3). Also used in determining the difference distance for the radial shear computations.

POWER	= Received power for each SAMPLE VOLUME, in dBm.
RANGE (Slant)	= The slant range to the center of a SAMPLE VOLUME, in kilometers.
Azimuth RANGE SAMPLE SPACING	= Differences in range between two adjacent SAMPLE VOLUMEs along an azimuth.
THRESHOLD (Number)	= The minimum fraction of NUMBER (Radial Difference) to NUMBER (Potential Difference Radial) and of NUMBER (Azimuthal Difference) to NUMBER (Potential Difference Azimuthal) for the calculations of the respective shears (.75).
THRESHOLD (Combined Shear)	= The minimum combined shear value allowed for acceptance in the final shear field, in 1/hr (8-16).
THRESHOLD (Velocity Power)	= The received power above which velocities will be processed, in dB (5-10).
VELOCITY (Doppler)	= Doppler velocities in a SAMPLE VOLUME, in km/hr.

2.2 ACQUISITION

AZIMUTH, ELEVATION, RANGE (Slant) and RANGE SAMPLE SPACING are obtained by direct measurement.

VELOCITY (Doppler) and POWER are obtained directly from the basic data acquisition process of the Doppler radar system.

DOMAIN (Resolution), DOMAIN (X Minimum), DOMAIN (Y Minimum), DOMAIN (X Size), DOMAIN (Y Size), FLAG VALUE, NUMBER (Filter), MAXIMUM SAMPLES (Radial), NUMBER (Sample Volumes), THRESHOLD (Number), THRESHOLD (Velocity Power), and THRESHOLD (Combined Shear) are all input parameters and are all site-adaptable.

3.0 PROCEDURE

3.1 ALGORITHM

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BEGIN ALGORITHM (COMBINED SHEAR)
1.0 COMPUTE (AZIMUTH LIMITS)
2.0 COMPUTE (RANGE LIMITS)
3.0 COMPUTE (X-DIMENSION)
4.0 COMPUTE (Y-DIMENSION)
5.0 DO FOR ALL (AZIMUTHs FROM minimum AZIMUTH TO maximum
    AZIMUTH)
    5.1 DO FOR ALL (RANGEs (Slant) FROM minimum RANGE (Slant)
        TO maximum RANGE (Slant))
        5.1.1 COMPUTE (average VELOCITYs (Doppler))
        END DO
    5.2 DO FOR ALL (RANGEs (Slant) FROM minimum RANGE (Slant)
        TO maximum RANGE (Slant))
        5.2.1 COMPUTE (DIFFERENCE (Radial))
        5.2.2 COMPUTE (radial X-INDEX)
        5.2.3 COMPUTE (radial Y-INDEX)
        5.2.4 IF ((radial X-INDEX) is not less than zero AND
                  (radial X-INDEX) is not greater than (X-DIMEN-
                  SION)
                  AND (radial Y-INDEX) is not less than zero AND
                  (radial Y-INDEX) is not greater than (Y-
                  DIMENSION))
              THEN
                  COMPUTE (NUMBER (Potential Difference
                          Radial))
                  COMPUTE (SUM (Radial Difference))
                  COMPUTE (NUMBER (Radial Difference))
              END IF
        5.2.5 IF (Current AZIMUTH is not first processed
                  azimuth)
              THEN
                  COMPUTE (DIFFERENCE (Azimuthal))
                  COMPUTE (azimuthal X-INDEX)
                  COMPUTE (azimuthal Y-INDEX)
                  IF ((azimuthal X-INDEX) is not less than zero
                     AND (azimuthal X-INDEX) is not greater than
                     (X-DIMENSION) AND (azimuthal Y-INDEX) is
                     not less than zero AND (azimuthal Y-INDEX)
                     is not greater than (Y-DIMENSION))
                  THEN
                     COMPUTE (NUMBER (Potential Difference
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                                Azimuthal))
                        COMPUTE (SUM (Azimuthal Difference))
                        COMPUTE (NUMBER (Azimuthal Difference))
                    END IF
                END IF
            END DO
        END DO

6.0 DO FOR ALL (SUM (Radial Difference) and SUM (Azimuthal
                Difference))
        6.1 IF (NUMBER (Radial Difference) is greater than (THRESHOLD
            (Number) x Number (Potential Difference Radial)) AND
            NUMBER (Azimuthal Difference) is greater than
            (THRESHOLD (Number) x NUMBER (Potential Difference
            Azimuthal)))
            THEN
            6.1.1 COMPUTE (mean SHEAR (Radial-RSA))
            6.1.2 COMPUTE (mean SHEAR (Azimuthal))
            ELSE
            SET (mean SHEAR (Radial-RSA)) to FLAG VALUE
            SET (mean SHEAR (Azimuthal)) to FLAG VALUE
            END IF
        END DO

NOTE: The FLAG VALUE should be some value not in the range of
      possible shear values, i.e., the flag value should NOT be
      equal to zero.


7.0 DO FOR ALL (mean SHEAR (Radial-RSA) and mean SHEAR
                (Azimuthal))
        7.1 COMPUTE (filtered SHEAR (Radial-RSA))
        7.2 COMPUTE (filtered SHEAR (Azimuthal))
        7.3 COMPUTE (COMBINED SHEAR)
            7.3.1 IF (COMBINED SHEAR is less than THRESHOLD
                     (Combined Shear))
                  THEN
                  (Set COMBINED SHEAR to 0)
                  END IF
        END DO

8.0 WRITE (COMBINED SHEAR)

END ALGORITHM (COMBINED SHEAR)
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3.2 COMPUTATION

3.2.1 NOTATION

AZ = AZIMUTH, azimuthal position, in radians. Precise to 10^{-2} radians.

AZmin = minimum AZIMUTH, minimum azimuth angle to be processed. Value determined by the Cartesian grid specification, in radians. Precise to 10^{-2} radians.

AZmax = maximum AZIMUTH, maximum azimuth angle to be processed. Value determined by the Cartesian grid specification, in radians. Precise to 10^{-2} radians.

AZAl,AZA2, AZA3,AZA4 = AZIMUTH LIMITS, azimuth angles to the vertices of the Cartesian grid, with the radar as the origin.

CFLA = COUNT FILTER (Azimuthal), count of the number of (mean SHEAR (Azimuthal)) values used in filter for current point being filtered. This value will always be less than or equal to NUMBER (Filter).

CFLR = COUNT FILTER (Radial), count of the number of (mean SHEAR (Radial)) values used in filter for current point being filtered. This value will always be less than or equal to NUMBER (Filter).

DA = DIFFERENCE (Azimuthal), differences in average VELOCITY (Doppler) computed between adjacent azimuths and at constant range.

DOR = DOMAIN (Resolution), grid point spacing for the Cartesian grid, in km (0.5 - 4.0).

DR = DIFFERENCE (Radial), radial differences in average VELOCITY (Doppler) computed between sample volumes spaced NUMBER (Sample Volumes) apart and at constant azimuth.

DXM = DOMAIN (X Minimum), the lower left X (W - E) coordinate relative to the radar for the rectangular Cartesian grid for the interpolated shears, in km.

DXS = DOMAIN (X Size), length of the (W - E) side of the Cartesian grid box, in km (230). Note: The box is centered on the radar.

DYM = DOMAIN (Y Minimum), the lower left Y (S - N) coordinate relative to the radar for the rectangular Cartesian grid for the interpolated shears, in km.

DYS = DOMAIN (Y Size), length of the (S - N) side of the Cartesian grid box, in km (230). Note: The box is centered on the radar.

FLV = FLAG VALUE, default value for filtered SHEAR (Radial-RSA), filtered SHEAR (Azimuthal) and COMBINED SHEAR.

MSR = MAXIMUM SAMPLES (Radial), the maximum number of SAMPLE VOLUMEs in one radial.

NAD = NUMBER (Azimuthal Difference), number of azimuthal shear values accumulated at each grid point.

NFL = NUMBER (Filter), number of data points used in the uniform filter applied to the mean SHEAR (Azimuthal) and mean SHEAR (Radial) fields (9).

NGR = NUMBER (Good Radial Velocities), number of good radial velocity values which have gone into the corresponding average VELOCITY (Doppler) computation.

NPDR = NUMBER (Potential Difference Radial), total number of DIFFERENCE (Radial) values that could potentially contribute to the COMBINED SHEAR at each grid point if all acceptance criteria are met.

NPDA = NUMBER (Potential Difference Azimuthal), total number of DIFFERENCE (Azimuthal) values that could potentially contribute to the COMBINED SHEAR at each grid point if all acceptance criteria are met.

NRD = NUMBER (Radial Difference), number of radial shear values accumulated at each grid point.

NSV = NUMBER (Sample Volumes), number of contiguous SAMPLE VOLUMEs to be averaged to produce each estimate of average VELOCITY (Doppler)(3). Also used in determining the difference distance for the radial shear computations.

NTH = THRESHOLD (Number), the minimum fraction of NUMBER (Radial Difference) to NUMBER (Potential Difference Radial) and of NUMBER (Azimuthal Difference) to NUMBER (Potential Difference Azimuthal) for the calculations of the respective shears (.75).

PHI# = ELEVATION, elevation angle, in radians. Precise to 10^{-2} radians.

POW = POWER, received power for each SAMPLE VOLUME, in dBm.

RSmax = maximum RANGE (Slant), maximum range for which the data are to be processed. Value determined by the Cartesian grid specification, in kilometers. Precise to 10^{-2} kilometers.

RSmin = minimum RANGE (Slant), minimum range for which the data are to be processed. Value determined by the Cartesian grid specification, in kilometers. Precise to 10^{-2} kilometers.

RS = RANGE (Slant), the slant range to the center of a SAMPLE VOLUME, in kilometers. Precise to 10^{-2} kilometers.

RSSazi = Azimuth RANGE SAMPLE SPACING, differences in range between two adjacent SAMPLE VOLUMEs along an azimuth, in kilometers. Precise to 10^{-2} kilometers.

VD = VELOCITY (Doppler), Doppler velocities in a SAMPLE VOLUME, in km/hr.

VDavg = average VELOCITY (Doppler), running average in range of radial velocity, in km/hr.

R1,R2, R3,R4 = RANGE LIMITS, ranges from the radar to the vertices of the Cartesian grid.

SAD = SUM (Azimuthal Difference), sum of the azimuthal differences at each Cartesian grid point.

SAfilter = filtered SHEAR (Azimuthal), shear values derived by imposing a uniform filter to the field of mean SHEAR (Azimuthal) values.

SAmean = mean SHEAR (Azimuthal), normalized SUM (Azimuthal Difference) values at each grid point.

SRD = SUM (Radial Difference), sum of the radial differences at each Cartesian grid point.

SRfilter = filtered SHEAR (Radial-RSA), shear values derived by imposing a uniform filter to the field of mean SHEAR (Radial) values.

SRmean = mean SHEAR (Radial-RSA), normalized SUM (Radial Difference) values at each grid point.

COSH = COMBINED SHEAR, combined shear as computed from the mean radial shear and the mean azimuthal shear, in 1/hr.

TPOW = THRESHOLD (Velocity Power), the received power above which velocities will be processed, in dB (5-10).

THCS = THRESHOLD (Combined Shear), the minimum combined shear value allowed for acceptance in the final shear field, in 1/hr (8-16).

XDIM = X-DIMENSION, the integral number of grid locations in the x-direction of the grid as determined by DOMAIN (X Size) and DOMAIN (Resolution).

XINazi = azimuthal X-INDEX, X-index corresponding to the transformation of the DIFFERENCE (Azimuthal) values in polar coordinates to the rectangular Cartesian coordinate system used for the shear fields.

YDIM = Y-DIMENSION, the integral number of grid locations in the y-direction of the grid as determined by DOMAIN (Y Size) and DOMAIN (Resolution).

YINDazi = azimuthal Y-INDEX, Y-index corresponding to the transformation of the DIFFERENCE (Azimuthal) values in polar coordinates to the rectangular Cartesian coordinate system used for the shear fields.

XINrad = radial X-INDEX, X-index corresponding to the transformation of the DIFFERENCE (Radial) values in polar coordinates to the rectangular Cartesian coordinate system used for the shear fields.

YINDrad = radial Y-INDEX, Y-index corresponding to the transformation of the DIFFERENCE (Radial) values in polar coordinates to the rectangular Cartesian coordinate system used for the shear fields.

Note: Precision is equivalent to the units unless otherwise stated.

3.2.2 SYMBOLIC FORMULAS

COMPUTE (AZIMUTH LIMITS)
IF (|DXM+DXS| is less than DXS and |DYM+DYS| is less than DYS)
THEN
AZmin = 0 radians
AZmax = 2 radians
ELSE
AZmin = MINIMUM(AZAl,AZA2,AZA3,AZA4)
AZmax = MAXIMUM(AZAl,AZA2,AZA3,AZA4)
END IF
where AZAl = $\tan^{-1}$(DXM/DYM)
AZA2 = $\tan^{-1}$(DXM/(DYM+DYS))
AZA3 = $\tan^{-1}$((DXM+DXS)/DYM)
AZA4 = $\tan^{-1}$((DXM+DXS)/(DYM + DYS))

Note that these tangent function computations are to be made such that the resultant angles are placed in the quadrants consistent with the signs of the numerator and denominator.

COMPUTE (RANGE LIMITS)
RSmax = MAXIMUM(Rl,R2,R3,R4) + FLOAT (NSV/2)(RSSazi)
IF (RSmax is greater than (MSR)(RSSazi))
RSmax = (MSR)(RSSazi)
END IF
IF (|DXM+DXS| is less than DXS or |DYM+DYS| is less than DYS)
THEN
RSmin = 0
ELSE
RSmin = MINIMUM(Rl,R2,R3,R4) - FLOAT (NSV/2)(RSSazi)
IF (RSmin is less than 0)
RSmin = 0
END IF
END IF
where $Rl = SQRT(DXM^2 + DYM^2)$
$R2 = SQRT(DXM^2 + (DYM + DYS)^2)$
$R3 = SQRT((DXM + DXS)^2 + DYM^2)$
$R4 = SQRT((DXM + DXS)^2 + (DYM + DYS)^2)$

COMPUTE (X-DIMENSION)
XDIM = nearest integer (DOMAIN(X Size)/DOR) + 1

COMPUTE (Y-DIMENSION)
YDIM = nearest integer (DOMAIN(Y Size)/DOR) + 1

COMPUTE (average VELOCITY (Doppler))

$$j = \min (i + INT(NSV/2), RSmax/RSSazi)$$

$$VDavg_i = \text{median} (VD_j)$$

$$j = \max (i - INT(NSV/2), RSmin/RSSazi)$$

where i is the sample volume number, $(RSmin/RSSazi) \leq i \leq (RSmax/RSSazi$ and POW_j is greater than THRESHOLD (Velocity Power). NGR is equal to the number of data values contributing to VDavg and is computed by incrementing NGR for each good VD value that contributes to VDavg. NGR must be greater than INT(NSV/2) for VDavg to be acceptable. Otherwise set VDavg to a default value. (NOTE: "INT" is the integer portion of a rational number.)

COMPUTE (DIFFERENCE (Radial))

$DR_{i,k} = VDavg_{((i+INT(NSV/2)),k)} - VDavg_{((i-INT(NSV/2)),k)}$

where i is the sample volume number, k the azimuth number, and where ((RSmin/RSSazi) + INT(NSV/2)) $\leq$ i $\leq$ ((RSmax/RSSazi)-INT(NSV/2)). For DR to be valid both VDavg values must be valid, i.e., not equal to a default value.

COMPUTE (DIFFERENCE (Azimuthal))

$DA_{i,k-.5} = (VDavg_{i,k} - VDavg_{i,k-1})/(RS_i \times (AZ_k - AZ_{k-1}))$

where i is the sample volume number and k, the azimuth number. For DA to be valid, both VDavg values must be valid, i.e., not equal to a default value. Watch for problems at the beginning and ending rays as well as around 0 radians.

COMPUTE (radial X-INDEX)

$XINrad = (RS_i \times \sin(AZ_k) \times \cos(N) - DXM)/DOR$

where i is the sample volume number and k, the azimuth number. This computation needs to be rounded to nearest whole number. Lower left corner of grid is assumed to have (0,0) indices.

COMPUTE (radial Y-INDEX)

$YINDrad = (RS_i \times \cos(AZ_k) \times \cos(N) - DYM)/DOR$

where i is the sample volume number and k, the azimuth number. This computation needs to be rounded to nearest whole number. Lower left corner of grid is assumed to have (0,0) indices.

COMPUTE (NUMBER (Potential Difference Radial))

$^{NPDR}XINrad,YINDrad = NPDR_{XINrad,YINDrad} + 1$

where incrementing is performed for computation of each (XINrad, YINDrad) pair.

COMPUTE (azimuthal X-INDEX)

$XINazi = (RS_i \times \sin((AZ_k + AZ_{k-1})/2) \times \cos(N) - DXM)/DOR$

where i is the sample volume number and k, the azimuth number. This computation needs to be rounded to nearest whole number. Lower left corner of grid is assumed to have (0,0) indices.

COMPUTE (azimuthal Y-INDEX)

$YINDazi = (RS_i \times \cos((AZ_k + AZ_{k-1})/2) \times \cos(N) - DYM)/DOR$

where i is the sample volume number and k, the azimuth number. This computation needs to be rounded to nearest whole number. Lower left corner of grid is assumed to have (0,0) indices.

COMPUTE (NUMBER (Potential Difference Azimuthal))

$NPDA_{XINazi,YINDazi} = NPDA_{XINazi,YINDazi} + 1$

where incrementing is performed for computation of each (XINazi, YINDazi) pair.

COMPUTE (SUM (Radial Difference))

$SRD_{XINrad,YINDrad} = SRD_{XINrad,YINDrad} + DR_{i,k}$

where i and k are the sample volume and azimuth numbers, respectively and DR is not equal to the default value.

COMPUTE (NUMBER (Radial Difference))

$NRD_{XINrad,YINDrad} = NRD_{XINrad,YINDrad} + 1$

where incrementing is performed only when a SRD is computed.

COMPUTE (SUM (Azimuthal Difference))

$SAD_{XINazi,YINDazi} = SAD_{XINazi,YINDazi} + DA_{i,k}$

where i and k are the sample volume and radial numbers, respectively and DA is not equal to the default value.

COMPUTE (NUMBER (Azimuthal Difference))

$NAD_{XINazi,YINDazi} = NAD_{XINazi,YINDazi} + 1$

where incrementing is performed only when a SAD is computed.

COMPUTE (mean SHEAR (Radial-RSA))

$SRmean_{l,m} = SRD_{l,m} / (NRD_{l,m} \times RSSazi \times (NSV-1))$

where 1 and m are the indices in x and y, respectively.

COMPUTE (mean SHEAR (Azimuthal))

$SAmean_{l,m} = SAD_{l,m} / NAD_{l,m}$

where 1 and m are the indices in x and y, respectively. If NAD equals 0 then SAmean is set to 0.

COMPUTE (filtered SHEAR (Radial-RSA))

$$SRfilter_{l,m} = \sum_{i=-p}^{i=p} \sum_{j=-p}^{j=p} SRmean_{l+i,m+j} / CFLR$$

where 1 and m are the indices in x and y, respectively and p = (SQRT(NFL) - 1)/2, and where $SRmean_{l+i,m+j}$ is not equal to FLAG VALUE, and where CFLR is incremented for each $SRmean_{l+i,m+j}$ that is not equal to FLAG VALUE.

IF CFLR equals zero then set SRfilter (l,m) to FLAG VALUE.

COMPUTE (filtered SHEAR (Azimuthal))

$$SAfilter_{l,m} = \sum_{i=p}^{i=p} \sum_{j=p}^{j=p} SAmean_{l+i,m+j} / CFLA$$

where 1 and m are the indices in x and y, respectively and p = (SQRT(NFL) - 1)/2, and where $SAmean_{l+i,m+j}$ is not equal to FLAG VALUE, and where CFLA is incremented for each $SAmean_{l+i,m+j}$ that is not equal to FLAG VALUE.

IF CFLA equals zero then set SAfilter (l,m) to FLAG VALUE.

COMPUTE (COMBINED SHEAR)

```
IF (SRfilter(l,m) = FLV or SAfilter(l,m) = FLV)
   THEN
       COSH(l,m) = FLV
   ELSE
       COSH(l,m) = SQRT(SRfilter(l,m)**2 + SAfilter(l,m)**2)
END IF
```

l and m are indices in x and y.

The indices which correspond to the input window dimensions are as follows:

$$p \leq l \leq XDIM - 1 - p$$
$$p \leq m \leq YDIM - 1 - p$$

and p = (SQRT(NFL) - 1)/2

4.0 OUTPUT

4.1 IDENTIFICATION

The field COMBINED SHEAR contains values of the combined shear of the radial velocities as measured by the Doppler radar. This shear field is organized onto a rectangular Cartesian grid with origin (lower left corner) at (DXM,DYM) where these coordinates are relative to the radar.

4.2 DISTRIBUTION

The values of COMBINED SHEAR may be easily mapped for display or may be used as input for higher level routines.

5.0 INFERENCES

5.1 LIMITATIONS

No major limitations are noted at this time.

5.2 FUTURE DEVELOPMENTS

No further development is anticipated on this particular algorithm. However, the output from this algorithm will be exploited in terms of developing hazard products. In addition, the site-adaptable parameters should be explored further with respect to determination of optimum values.