Description of the POSS post processed "PR" file

Updated Feb. 11 2013.

Introduction

The Precipitation Occurrence Sensor System (POSS) is a small X-band, continuous wave, Doppler radar originally developed by the Meteorological Service of Canada for reporting the occurrence, type and intensity of precipitation from automated weather observing stations. The radar is mounted on a post about 3 m above the surface. It measures the Doppler velocity spectrum of hydrometeors traversing a small volume within a distance of about 3 m of the sensor. Post processing of the raw Doppler velocity power spectrum data produces a file with the prefix "PR". This file contains derived precipitation and radar parameter estimates, for both liquid and solid precipitation, with 1 minute temporal resolution.

Precipitation Rate Estimation

The minutely POSS precipitation rates are estimated using two different methods in liquid precipitation, and one method in solid precipitation. The first method is referred to as the "mass flux (MF) method". The raindrop size distribution (DSD) is estimated from the measured Doppler velocity spectrum. The product of the number concentration of drops, their volume, and fall velocity is summed over 34 diameter channels to give the mass flux (rate). This method cannot be used for solid precipitation. If meteorological observer reports of precipitation type are available, they are used to determine which algorithms to apply. If not available, the POSS precipitation type estimate is used. Fields contain #N/A when the algorithm is not applied.

The second method is analogous to the so-called "Z-R" method used by large scale precipitation radars where a regression between radar reflectivity, Z, and rate, R, (or their logarithms) is performed. This method is used for both liquid and solid precipitation with different regression coefficients and is referred to here as the "regression method".

File format

ASCII fixed width, comma separated fields (CSV)

Field descriptions:

Header:

Date,Obs_Wx,POSS_Wx,Obs_Temp(c),POSS_Temp(c),Obs_wind_speed(kts),
1min_wind_speed(kts),Diagnostic,0th_moment,Mode_vel(m/s),Mean_vel(m/s),
SD_vel(m/s),LWC_or_IWC(g/m^3),RATE_dsd(mm/h)[T/F],log_RATE_dsd(mm/h),
RATE_regression(mm/h),log_RATE_regression(mm/h),Z_Rayleigh(dBZ),Zh_C(dBZ),
Zv_C(dBZ),Zdr_C(dB),Kdp_C(deg/km), Ah_C(dB/km), Av_C(dB/km), Ad_C(dB/km),
D0(mm),N0_Waldvogel(m^-3 mm^-1),N0_mod_gamma(m^-3 mm^-(1+mu),
SD_N0_mod_gamma,Mu_gamma,SD_Mu_gamma,
Lambda_gamma(mm^-1),SD_Lambda_gamma,chi2,NVALID,NTOTAL,
log N(D)(m^-3 mm^-1), .34, .38, .44, .49, .54, .60, .66, .72, .78, .84, .91, .97, 1.05, 1.12, 1.20, 1.28, 1.37, 1.46, 1.55, 1.65, 1.76, 1.87, 2.00, 2.12, 2.26, 2.40, 2.56, 2.73, 2.92, 3.14, 3.40, 3.70, 4.15, 5.34,

1. Col A - **“Date”**: MM/DD/YY hh:mm:ss
2. Col B - **“Obs_Wx”**: Meteorological Observer Weather in standard “SA” format (not given here)
3. Col C - “**POSS_Wx**”: POSS Weather in standard “SA” format
4. Col D - “**Obs_Temp(c)**”: Meteorological observer temperature (C) (integer)
5. Col E - “**POSS_Temp(c)**”: POSS temperature (C) (integer)
6. Col F - “**Obs_wind_speed(kts)**”: Meteorological observer wind speed (knots) (integer)
7. Col G - “**1min_wind_speed(kts)**”: when available 1 min wind speed in knots
8. Col H - “**Diagnostic**”: POSS diagnostic code not defined here (4 hex digits)
9. Col I - “**0th_moment**”: 0th moment of POSS Doppler velocity spectrum
10. Col J - “**Mode_vel(m/s)**”: velocity at the mode of the POSS Doppler velocity spectrum
11. Col K - “**Mean_vel(m/s)**”: 1st moment of POSS Doppler velocity spectrum
12. Col L - “**SD_vel(m/s)**”: 2nd moment of POSS Doppler velocity spectrum
13. Col M - “**LWC_or_IWC(g/m^3)**”: POSS estimate of liquid precip water content from 3^{rd} moment of DSD or ice precip water content from first order log-log regression on 0^{th} moment. (4 decimals)
14. Col N - “**RATE_dsd(mm/h)**”: POSS mass flux rate (mm/h) (3 decimals) for liquid precip and N/A for solid. Note if a “T” is last character then the DSD is wind corrected otherwise “F” indicates uncorrected.
15. Col O - “**log_RATE_dsd(mm/h)**”: log base 10 of POSS mass flux rate (mm/h) (3 decimals)
16. Col P - “**RATE_regression(mm/h)**”: POSS rate (mm/h) from second order log-log regression on 0^{th} moment (3 decimals). Eq. different for liquid and solid.
17. Col Q - “**log_RATE_regression(mm/h)**”: log base 10 of POSS regression rate (mm/h) (3 decimals)
18. Col R - “**RATE_regression_for_P(mm/h)_assuming_liquid**”: If POSS reports “P” then rate (mm/h) assuming liquid second order log-log regression on 0^{th} moment (3 decimals). If POSS reports “R” “L” or “S” then #N/A is reported.
19. Col S - “**log_RATE_regression(mm/h)**”: log base 10 of POSS regression rate (mm/h) (3 decimals) in column 18.

20. Col T - “**RATE_regression_for_P(mm/h)_assuming_solid**”: If POSS reports “P” then rate (mm/h) assuming solid second order log-log regression on 0^{th} moment (3 decimals). If POSS reports “R” “L” or “S” then #N/A is reported.
21. Col U - “**log_RATE_regression(mm/h)**”: log base 10 of POSS regression rate (mm/h) (3 decimals) in column 20.
22. Col V - “**Z_Rayleigh(dBZ)**”: radar reflectivity factor calculated assuming Rayleigh scattering by spherical water drops, i.e. 6^{th} moment of DSD (1 decimal). For snow, this is #N/A.
23. Col W - “**Zh_C(dBZ)=Ze**”: equivalent radar reflectivity factor for horizontal polarization for C-band wavelengths (1 decimal). If POSS reports liquid or “P” then it is calculated from the DSD using the refractive index factor for liquid $|K_w|^2$. If POSS reports solid it is calculated from a second order log-log regression on the 0^{th} moment using refractive index factor for liquid $|K_w|^2$.
24. Col X - “**Zh_C(dBZ)=Ze_for_P_assuming_solid**”: equivalent radar reflectivity factor of solid precipitation for horizontal polarization for C-band wavelengths (1 decimal) reported only if POSS reports “P”. The calculation is identical to column 23 for solid precipitation. If POSS reports “R” “L” or “S” then #N/A is reported.
25. Col Y - “**Zv_C(dBZ)**”: radar reflectivity factor for vertical polarization for C-band wavelengths (1 decimal) for liquid and N/A for solid
26. Col Z – “**Zdr_C(dBZ)**”: differential radar reflectivity factor for C-band wavelengths for liquid precip only (2 decimal)
27. Col AA - “**Kdp_C(deg/km)**”: specific differential phase for C-band wavelengths for liquid precip only (2 decimal)
28. Col AB - “**Ah_C(dB/km)**”: specific horizontal attenuation (dB/km) for liquid precip only (scientific notation)
29. Col AC - “**Ah_C(dB/km)**”: specific vertical attenuation (dB/km) for liquid precip only (scientific notation)
30. Col AD - “**Ad_C(dB/km)**”: specific differential attenuation (dB/km) for liquid precip only (scientific notation)
31. Col AE - “**D0(mm)**”: median volume diameter (2 decimal)
32. Col AF - “**N0_Waldvogel(m^-3 mm^-1)**”: intercept of DSD calculated using Waldvogel 1974) JAS vol.31 p.1072 (2 decimal)
33. Col AG - “**N0_mod_gamma(m^-3 mm^-(1+mu)**“: N0 modified gamma function fit to DSD (2 decimal)
34. Col AH - “**SD_N0_mod_gamma**“: uncertainty in estimate of N0 modified gamma function fit to DSD (2 decimal)
35. Col AI - “**Mu_gamma**“: mu modified gamma function fit to DSD (2 decimal)
36. Col AJ - “**SD_Mu_gamma**“: uncertainty in estimate of mu modified gamma function fit to DSD (2 decimal)
37. Col AK - “**Lambda_gamma(mm^-1)**“:lambda modified gamma function fit to DSD (2 decimal)
38. Col AL - “**SD_Lambda_gamma**“: uncertainty in estimate of lambda modified gamma function fit to DSD (2 decimal)
39. Col AM - “**chi2**“: chi squared for modified gamma function fit to DSD (2 decimal)

40. Col AN - “**NVALID**“: # of DSD points in modified gamma function fit to DSD (integer)
41. Col AO - “**NTOTAL(m^-3)**”: total number of raindrops per m^3 rounded to nearest integer.
42. Col AP - “**log N(D)(m^-3 mm^-1)**”: start of raindrop size distribution (DSD)
43. Col AQ - **34 channel** of DSD at diameter (mm) given in header. (4 decimal)

to

76. Col CA

Notes:

1. Fields with “#N/A” indicate that either the data was not available (e.g. from a meteorological observer) or the field was not calculated from the raw data (e.g. usually because of the precipitation type is solid.)
2. The Date field in UTC, comes from the clock of the computer used to acquire the raw data files with prefix “P0”. Beware of a potential drift in typical PC clocks if not synchronized with reference sources.
3. The observer precipitation type, if available, will take precedent over the POSS precipitation type for the purposes of selecting algorithms for the calculation of precipitation parameters. However if the observer reports clear “C” then the POSS precipitation type is used.
4. A “P” in the POSS_WX field indicates that the POSS detected precipitation but could not identify the type. If the POSS detects very light precipitation “P- -“, with the 0^{th} moment field = 0, then no precipitation or radar parameters are calculated. In this case the velocity parameters are based on extremely weak signal levels and should not be given too much credence.
5. In mixed precipitation POSS only reports the “dominant” type.
6. The mass flux (RATE_dsd in field 14) method for estimating rate in liquid precipitation is the most accurate at wind speeds < =12 knots. At higher wind speeds it will overestimate the rate and the regression method is generally better. The MF can be corrected for the wind but this requires 1 minute wind speeds in a specific file format.
7. As for large scale precipitation radars, POSS sees a “bright band” effect in wet snow conditions near 0 C. This can cause large overestimation of the rate in snow. In mixed precipitation if the POSS reports rain, this effect can also cause overestimation of all parameters derived from the DSD.
8. The LWC is calculated from integration of the raindrop size distribution for liquid precipitation and the IWC by a regression equation for solid precipitation. Note that for liquid precipitation the wind can cause overestimation of the LWC (see note 6 above).

9. All of the radar parameters with polarization dependency are calculated for liquid precipitation only, using a raindrop axial ratio given by Brandes et al., 2002: Experiments in rainfall estimation with a polarimetric radar in a subtropical environment. *J. Appl. Meteor.*, 41, 674-685.

Changes made to post analysis program DSD21.exe on Jan 29, 2013

The changes were in part introduced to give the analyst the option of assuming POSS reports of "P" were either liquid or solid and compare the differences.

If POSS reports "P" then the columns 16 and 17 report #N/A and new columns 18 and 19 report the rate and log rate using the rate regression equation for liquid. New columns 20 and 21 report the rate and log rate using the rate regression equation for solids.

Column 23 is now Ze for both liquid and solid precipitation. Otherwise the calculation is as before: for "R L or P" the radar reflectivity is calculated from the DSD, and for "S", by second order log-log regression on the POSS 0^{th} moment assuming a solid precipitation "forward" model. The refractive index factor for liquid $|K_w|^2$ is then used to calculate Ze for both liquid and solid models (definition of Ze).

If POSS reports "P", a new column 24 contains Ze calculated from a second order log-log regression on the POSS 0^{th} moment assuming a solid precipitation forward model. As in column 23, the refractive index factor for liquid $|K_w|^2$ is then used to calculate Ze. **This means that for "P" there are 2 values for Ze: one derived from a liquid precipitation "forward" model (column 23) and one assuming a solid precipitation "forward" model (column 24).**