```
1   C**AGEQN
2   C  Continuum Dynamics, Inc.
3   C  AGDISP Version 8.29 11/16/16
4   C
5         SUBROUTINE AGEQN(XOV)
6   C
7   C  AGEQN integrates the equations of motion
8   C
9   C  XOV    - Array of locations, velocities, etc.
10  C
11        DIMENSION XOV(9,60),XNV(9,60),DV(6,60)
12        DIMENSION YNR(2),ZNR(2),YNL(2),ZNL(2),YNP(4),ZNP(4)
13  C
14        INCLUDE 'AGCOMMON.INC'
15        COMMON /DVFV/ IYDV(60,51),IYFV(60,51)  !,IYHV(60,51)
16  C
17  C  Save initial positions
18  C
19        ISWC=NVAR
20        SFAC=SDISP+0.5*(1+IBOOM)
21  C     IF (ISDTYP.NE.1) SFAC=SFAC+SDISP
22        NSWTM=NSWTH
23        IF (IBOOM.EQ.1) NSWTM=NSWTH+1
24        DO I=1,NVAR
25          DO J=1,NSWTM
26            IYDV(I,J)=0
27            IYFV(I,J)=0
28  C         [redacted]
29          ENDDO
30        ENDDO
31        NSTEP=0
32        LCPEND=0
33        LSPEND=0
34        IVTT=NVAR
35        CALL AGSAV(XOV,0.0)
36  C
37  C  Initialize integration
38  C
39        DT=0.0
40        T=0.0
41        DMIN=DIAM
42        ISTT=0
43        IF (NPRP.NE.0) THEN
44          DO N=1,NPRP
45            CPXI(N)=CPXI(N)+XO-XPRP(N)
46          ENDDO
47        ENDIF
48        IF (LMVEL.EQ.2.AND.XO.GT.0.0) THEN
49          FN=EXP(-AMIN1(CHF*XO,25.0))
50          G2PI(1)=CHG*(1.0-FN)
51          ZBAR(1)=HHEL
52          ZBAL(1)=HHEL
53          WHEL=CHW*SQRT(FN)
54        ENDIF
55  C
56  C  Integrate to TMAX
57  C
58  10    NSTEP=NSTEP+1
59        UTERM=9.58*(1.0-EXP(-(DMIN/1770.0)**1.147))
60        DT=0.0002*DMIN/UTERM
61        CALL AGBKG(XOV,DV,T)
62  C
63  C  Solve the equations of motion for the DT time step
64  C    X  Y  Z  U  V  W  XX  XU  UU
65  C
66        DO I=1,NVAR
67          IF (ISW(I).NE.0) THEN
68            EXPT=0.0
69            IF (DV(1,I).GT.0.0) EXPT=EXP(-AMIN1(DT/DV(1,I),25.0))
70            TEM1=DV(2,I)+9.8*STU*DV(1,I)
71            TEM2=XOV(4,I)-TEM1
72            XNV(1,I)=XOV(1,I)+TEM1*DT+TEM2*DV(1,I)*(1.0-EXPT)
73            XNV(4,I)=TEM1+TEM2*EXPT
74            TEM1=DV(3,I)-9.8*CTU*STS*DV(1,I)
75            TEM2=XOV(5,I)-TEM1
76            XNV(2,I)=XOV(2,I)+TEM1*DT+TEM2*DV(1,I)*(1.0-EXPT)
77            XNV(5,I)=TEM1+TEM2*EXPT
78            TEM1=DV(4,I)-9.8*CTU*CTS*DV(1,I)
79            TEM2=XOV(6,I)-TEM1
80            XNV(3,I)=XOV(3,I)+TEM1*DT+TEM2*DV(1,I)*(1.0-EXPT)
81            XNV(6,I)=TEM1+TEM2*EXPT
82            TEM1=DV(5,I)+DV(1,I)*DV(6,I)
83            TEM2=XOV(8,I)-DV(5,I)+DV(1,I)*(XOV(9,I)-2.0*DV(6,I))
84            TEM3=XOV(9,I)-DV(6,I)
85            XNV(9,I)=DV(6,I)+TEM3*EXPT*EXPT
86            XNV(8,I)=TEM1+TEM2*EXPT-TEM3*DV(1,I)*EXPT*EXPT
87            XNV(7,I)=XOV(7,I)+2.0*TEM1*DT+2.0*TEM2*DV(1,I)*(1.0-EXPT)
88       $          -TEM3*DV(1,I)*DV(1,I)*(1.0-EXPT*EXPT)
89            XNV(7,I)=AMAX1(0.0,XNV(7,I))
90            XNV(9,I)=AMAX1(0.0,XNV(9,I))
91  C
92            IF (XNV(3,I).LE.ZREF) THEN
93              RATE=(XOV(3,I)-ZREF)/(XOV(3,I)-XNV(3,I))
94              DO J=1,9
95                XNV(J,I)=XOV(J,I)+RATE*(XNV(J,I)-XOV(J,I))
96              ENDDO
97              XNV(3,I)=ZREF
98              ISW(I)=-1
99            ENDIF
100 C
101 C  Canopy deposition and total accountancy in height
102 C
103           CNEW=CMASS(I)
104           IF (LCANF.GT.0) THEN
105             CALL AGCAN(XOV(1,I),XNV(1,I),EDOV(I),EDNV(I),CNEW)
106           ENDIF
107           ETEM=YMASS*CMASS(I)*((EDOV(I)/DIAM)**3-(EDNV(I)/DIAM)**3)
108           CTEM=YMASS*(CMASS(I)-CNEW)*(EDNV(I)/DIAM)**3
109           ATEM=YMASS*(CMASS(I)-CNEW)
110           DH=XNV(3,I)-XOV(3,I)
111           NH=MAX0(IFIX(ABS(DH)/0.1)+1,2)
112           DH=DH/(NH-1)
113           IF (CTEM.GT.0.0) THEN
114             NC=0
115             DO N=2,NH
116               HTEM=XOV(3,I)-ZREF+(N-1)*DH
117               IF (HTEM.GT.0.0.AND.HTEM.LT.HCAN-ZREF) NC=NC+1
118             ENDDO
119             IF (NC.GT.0) THEN
120               TEMNC=1.0/NC
121             ELSE
122               TEMNC=0.0
123             ENDIF
124           ENDIF
125           DO N=2,NH
126             HTEM=XOV(3,I)-ZREF+(N-1)*DH
127             IH=MAX0(MIN0(IFIX(HTEM/DAHH)+1,NAHH),1)
128             TAHFV(1,IH)=TAHFV(1,IH)+ETEM/(NH-1)
129             IF (CTEM.GT.0.0) THEN
130               IF (HTEM.GT.0.0.AND.HTEM.LT.HCAN-ZREF) THEN
131                 TAHFV(2,IH)=TAHFV(2,IH)+TEMNC*CTEM
132 C               [redacted]
133               ENDIF
134             ENDIF
135             IF (ISW(I).LT.0) TAHFV(3,IH)=TAHFV(3,IH)
136      $          +YMASS*CNEW*(EDNV(I)/DIAM)**3
137           ENDDO
138 C
139 C  Total accountancy in distance
140 C
141           ND=1
142 20        IF (XNV(2,I).GT.TADDV(ND)) THEN
143             IF (ND.LT.NADD) THEN
144               ND=ND+1
145               GOTO 20
146             ENDIF
147           ENDIF
148           TADFV(1,ND)=TADFV(1,ND)+ETEM
149           TADFV(2,ND)=TADFV(2,ND)+CTEM
150           IF (ISW(I).LT.0) TADFV(3,ND)=TADFV(3,ND)
151      $          +YMASS*CNEW*(EDNV(I)/DIAM)**3
152 C
153 C  Total accountancy in time
154 C
155           NT=1
156 30        IF (T.GT.TATTV(NT)) THEN
157             IF (NT.LT.NATT) THEN
158               NT=NT+1
159               GOTO 30
160             ENDIF
161           ENDIF
162           IF (XNV(2,I).LT.YGRID2) INMAX=MAX0(INMAX,NT)
163           DO N=NT,NATT
164             TATFV(1,N)=TATFV(1,N)+ETEM
165             TATFV(2,N)=TATFV(2,N)+CTEM
166             IF (ISW(I).LT.0) TATFV(3,N)=TATFV(3,N)
167      $          +YMASS*CNEW*(EDNV(I)/DIAM)**3
168           ENDDO
169           EFRAC=EFRAC+ETEM
170           CALL AGDSD(YMASS*(CMASS(I)-CNEW),EDNV(I),DSCP)  !canopy DSD
171           CMASS(I)=CNEW
172 C
173           IF (ISW(I).LT.0) XDTOT=XDTOT+YMASS*CMASS(I)
174 C
175           DO J=1,NSWTM
176             YTEM=0.0
177             IF (J.EQ.1.AND.IBOOM.EQ.1) THEN
178               IF (IHALF(I).EQ.1) YTEM=1.0
179             ELSEIF (J.EQ.NSWTM.AND.IBOOM.EQ.1) THEN
180               IF (IHALF(I).EQ.0) YTEM=1.0
181             ELSE
182               YTEM=1.0
183             ENDIF
184             TEM=YEDGE2+(J-1)*SWATH
185             IF (XNV(2,I).GT.TEM.AND.IYDV(I,J).EQ.0) THEN
186               YDRFT=YDRFT+YTEM*YMASS*CMASS(I)
187               IYDV(I,J)=1
188             ENDIF
189             TEM=YFLXV+(J-1)*SWATH
190             IF (XNV(2,I).GT.TEM.AND.IYFV(I,J).EQ.0) THEN
191               FDTOT=FDTOT+YTEM*YMASS*CMASS(I)
192               IYFV(I,J)=1
193               CALL AGDSD(YTEM*YMASS*CMASS(I),EDNV(I),DSVP)  !transport DSD
194             ENDIF
195 C
196             IF (ISW(I).LT.0) THEN
197               TEF=(J-SFAC)*SWATH
198               IF (XNV(2,I).LT.TEF) THEN
199                 CALL AGDSD(YTEM*YMASS*CMASS(I),EDNV(I),DSSB)  !spray block DSD
200               ELSE  IF (XNV(2,I).LT.TEM) THEN
201                 CALL AGDSD(YTEM*YMASS*CMASS(I),EDNV(I),DSDW)  !downwind DSD
202               ENDIF
203 C
204               TEM=YFLXV+(J-1)*SWATH
205               TEMY=0.5*(XNV(2,I)-TEM)**2/XNV(7,I)
206               TEMM=YTEM*YMASS*CMASS(I)*EXP(-AMIN1(TEMY,25.0))
207      $            /SQRT(XNV(7,I))
208               CALL AGDSD(TEMM,EDNV(I),DSDP)  !point DSD
209             ENDIF
210           ENDDO
211         ENDIF
212       ENDDO
213 C
214 C  Determine new positions of vortices
215 C
216       IF (LMVEL.NE.0) THEN
217         IF (LMVEL.EQ.2) JHEL=1
218         DO N=1,NVOR
219           CALL AGVEL(XO,YBAR(N),ZBAR(N),TEM,VBAR,WBAR)
220           YNR(N)=YBAR(N)+DT*VBAR
221           ZNR(N)=ZBAR(N)+DT*WBAR
222           CALL AGVEL(XO,YBAL(N),ZBAL(N),TEM,VBAL,WBAL)
223           YNL(N)=YBAL(N)+DT*VBAL
224           ZNL(N)=ZBAL(N)+DT*WBAL
225         ENDDO
226         IF (NPRP.NE.0) THEN
227           DO N=1,NPRP
228             CALL AGVEL(XO-XPRP(N),YPRP(N),ZPRP(N),TEM,VBAR,WBAR)
229             YNP(N)=YPRP(N)+DT*VBAR
230             ZNP(N)=ZPRP(N)+DT*WBAR
231           ENDDO
232         ENDIF
233         IF (LMVEL.EQ.2) THEN
234           NVOR=0
235           CALL AGVEL(XO,YHEL,ZHEL,TEM,VBAR,WBAR)
236           YHEL=YHEL+DT*VBAR
237           ZHEL=ZHEL+DT*WBAR
238           NVOR=1
239           JHEL=0
240         ENDIF
241         DO N=1,NVOR
242           YBAR(N)=YNR(N)
243           ZBAR(N)=ZNR(N)
244           YBAL(N)=YNL(N)
245           ZBAL(N)=ZNL(N)
246         ENDDO
247         IF (NPRP.NE.0) THEN
248           DO N=1,NPRP
249             YPRP(N)=YNP(N)
250             ZPRP(N)=ZNP(N)
251           ENDDO
252         ENDIF
253 C
254 C  Correct circulation decay
255 C
256         IF (XO.GT.0.0) THEN
257           DO N=1,NVOR
258             IF (ABS(GDKV(N)).GT.1.0E-10) THEN
259               TEM=AMAX1(1.0,YBAR(N)-YBAL(N))
260               HTEM=2.0*ZBAR(N)/TEM
261               IF (HTEM.GT.2.0) THEN
262                 GDKT=GDKO+(GDK-GDKO)/0.102167/HTEM**3.291
263               ELSE
264                 GDKT=GDK
265               ENDIF
266               GDKV(N)=GDKV(N)*EXP(-AMIN1(ABS(GDKT*BSTAB*DT/TEM),25.0))
267             ENDIF
268             IF (GDKV(N).GT.0.001) THEN
269               DO I=1,NVAR
270                 IF (ISW(I).NE.0) YGAUS1=AMAX1(YGAUS1,XNV(2,I))
271               ENDDO
272             ENDIF
273           ENDDO
274         ENDIF
275       ENDIF
276 C
277 C  Correct model parameters
278 C
279       XO=XO+UO*DT
280       IF (NPRP.NE.0) THEN
281         DO N=1,NPRP
282           CPXI(N)=CPXI(N)+UO*DT
283           RN=CPXI(N)/11.785
284           VPRP(N)=VPRP(N)*(RPRP(N)/RN)**2
285           RPRP(N)=RN
286         ENDDO
287       ENDIF
288       IF (LMVEL.EQ.2.AND.XO.GT.0.0) THEN
289         IF (XO.LT.40.0*S) THEN
290           FN=EXP(-AMIN1(0.01*CHF*XO,25.0))
291           G2PI(1)=CHG*(1.0-FN)
292           ZBAR(1)=ZHEL
293           ZBAL(1)=ZHEL
294           WHEL=CHW*SQRT(FN)
295         ELSE
296           WHEL=0.0
297         ENDIF
298       ENDIF
299 C
300 C  Check solution and continue
301 C
302       T=T+DT
303       ISWC=0
304       MSWC=0
305       IVTT=0
306       DO I=1,NVAR
307         IF (ISW(I).NE.0) THEN
308           ISWC=ISWC+1
309           DO J=1,9
310             XOV(J,I)=XNV(J,I)
311           ENDDO
312           IF (LEVAP.NE.0) THEN
313             EDOV(I)=AMAX1(EDNV(I),DCUT)
314             DMIN=AMIN1(DMIN,EDOV(I))
315             IF (IVT(I).EQ.1.AND.
316      $          (EDOV(I).EQ.DCUT.OR.XOV(2,I).GT.YGRID2)) THEN
317               IVT(I)=0  !turn off save for vapor tracking
318               TVTMAX=AMAX1(TVTMAX,T)
319             ENDIF
320           ENDIF
321           IF (ABS(XNV(2,I)).GT.GRDMX) ISW(I)=-2
322           IF (ISW(I).LT.0) MSWC=1
323           IF (EDOV(I).LT.2.0) ISW(I)=0  !stop small droplets < 2 um
324           IVTT=IVTT+IVT(I)
325         ENDIF
326       ENDDO
327       IF (T.GE.TMAX) THEN
328         ISWC=0
329         MSWC=1
330       ENDIF
331 C
332 C  Check CALPUFF data collection for later export
333 C
334       IF (LCPFLG.EQ.1.AND.LCPEND.EQ.0) THEN
335         IF (LMVEL.EQ.1.OR.(LMVEL.EQ.2.AND.WHEL/CHW.LT.0.1)) THEN
336           IF ((ABS(G2PI(1)*GDKV(1)).LE.G2PIMN).AND.(T.GE.ETAU)) THEN
337             ISWC=0 !was commented out
338             MSWC=1
339             LCPEND=1
340           ENDIF
341         ENDIF
342       ENDIF
343 C
344 C  Check SCIPUFF end of calculation for this droplet size
345 C
346       IF (LSPFLG.EQ.1) THEN
347         IF (LMVEL.EQ.1.OR.(LMVEL.EQ.2.AND.WHEL/CHW.LT.0.1)) THEN
348           IF (ABS(G2PI(1)*GDKV(1)).LE.G2PIMN) THEN
349             ISWC=0
350             MSWC=1
351             LSPEND=1
352           ENDIF
353         ENDIF
354       ENDIF
355 C
356       I=MAX0(1,IFIX(200.0/DMIN))
357       IF (MOD(NSTEP,I).EQ.0) MSWC=1
358       IF (MSWC.EQ.1) CALL AGSAV(XNV,T)
359       IF (ISWC.NE.0) GOTO 10
360       CALL AGSAV(XNV,-T)
361       RETURN
362       END
```

- Initial XV = XOV sent in from Agdrop. Saved line 35
- (line 19) ?
- (line 20) this was done in Aglims? is it needed here again
- IBOOM 0 = no, 1 = yes
- Legend: Single Line If Statements; If … Endif: Closed Multi line If/Then Endif; Do … ENDDO; Call Subroutine; (#) Goto #; Goto Call
- (line 34) IVTT does not look to do anything
- (line 35) Agsav does not look to change or itirate current results
- (line 61) XOV, T From above go in, DV determined + returned
- XOV is xv from agdrop
- STU default 0, set 57 Agint; set to value if SMOKEY; 0 = regulatory, 1 = forest service
- (line 105) For canopy
- (line 111) IFIX real → integer
- DAHH and NAHH set in Aglims
- NADD from Aglims, used as part of initializing arrays
- (line 159) Why this reference instead of Maxdwnd?
- TATTV, NATT, TATFV Set in AGLIMS
- (line 162) INMAX Set by Aglims
- YEDGE2 → Set by AGLIMS
- (line 200) Commented out
- YFLXV = Input Flux Plane AGINIT
- (line 219) 2nd
- (line 222) 3rd
- (line 228) 4th
- LMVEL 0 = ground, 1 = aerial, fixed, 2 = heli
- (lines 288–298) Heli
- I think this is related to Calpuff + Scipuff?
- (line 307) ISW 1,0,-1 droplet status
- (line 310) Next position/vel array set
- (lines 312–320) Evaporation
- (line 321) If the y location > grid max
- (line 324) 2 Not used anywhere
- (lines 332–354) Skipped for now
- MOD modulo
- (line 359) Back to NSTEP = NSTEP + 1
- Agequ runs until ISWC=0 lines 303, 328, 337, 349