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Supplement of

A prognostic pollen emissions model for climate models (PECM1.0)

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Figure S1. Linear regressions of the phenological relationship between start day-of-year (sDOY) and previous year annual average temperature (PYAAT) for all taxa. Each point signifies one station per year for pollen count data from 2003-2010 (total denoted as N). (j) *ulmus_2* denotes a second (later) pollen peak in *Ulmus* and (o) *poac_2* denotes a second (later) pollen peak in *Poaceae*.

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923 **Figure S2.** Same as Figure S1, but for end day-of-year (eDOY) versus PYAAT.

No.	City, State	Latitude	Longitude	Years	Acknowledgements
Northeast (38)					
1	Albany, NY	42.67	-73.80	2003-2010	David Shulan, M.D. Certified Allergy Consultants Albany, NY Certified Allergy Consultants
2	Armonk, NY	41.13	-73.71	2003-2010	Guy Robinson, PhD The Louis Calder Center Armonk, NY
3	Baltimore, MD	39.30	-76.61	2003-2010	Jonathon Matz, MD FAAAAI & David Golden, MD FAAAAI Dr. Golden and Dr. Matz, LLC Baltimore, MD
4	Boston, MA	42.35	-71.06	2010	Immunology Research Institute of New England Lawrence M. DuBuske, MD FAAAAI Boston, MA

5	Brooklyn, NY	40.65	-73.95	2004-2010	Clifford W. Bassett, MD & Mehdi Vesaghi, MD Long Island College Hospital Brooklyn, NY
6	Chelmsford, MA	42.60	-71.37	2003-2005	Julian Melamed, M.D. Chelmsford, MA
7	Cherry Hill, NJ	39.90	-75.00	2003-2010	Larchmont Medical Center II Donald J. Dvorin, MD FAAAAI Cherry Hill, NJ
8	Chicago, IL	41.84	-87.68	2003-2010	John Shane, PhD McCrone Research Institute Chicago, IL
9	Dayton, OH	39.78	-84.20	2003-2010	Mr. Andy Roth RAPCA Dayton, OH
10*	Erie, Pennsylvania	42.13	-80.09	2003-2007, 2009-2010	Philip E. Gallagher, MD FAAAAI Allergy & Asthma Associates of Northeastern PA Erie, PA

11	Hamilton, Ontario	43.25	-79.1	2003-2005	Jason A. Ohayan, MD Hamilton, ON
12	Indianapolis, IN	39.78	-86.15	2003-2009	L.Y. Frank Wu, M.D. St. Vincent Professor Building Indianapolis, IN
13	Kansas City, MO	39.12	-94.55	2003-2007, 2009-2010	Jay Portnoy, MD FAAAAI Children's Mercy Hospital Kansas City, MO
14	La Crosse, WI	43.83	-91.23	2003-2010	N/A
15	Lexington, KY	38.043	-84.46	2003-2006, 2008-2010	Beth Miller, M.D. University of Kentucky Asthma Allergy & Immunology Lexington, KY
16	Lincoln, NE	40.82	-96.69	2004-2009	Fred Keichel, MD Allergy, Asthma & Immunology Associates Lincoln, NE

17	London, ON	42.98	-81.25	2003-2005	James Anderson, MLT OSHTECH London, ON
18	Louisville, KY	38.22	-85.74	2003-2010	James L. Sublett, MD FAAAAI Family Allergy & Asthma Louisville, KY
19	Madison, WI	43.08	-89.39	2003-2010	Robert Bush, MD FAAAAI UW Medical School Madison, WI
20	Melrose Park, IL	41.90	-87.86	2003-2010	Joseph G. Leija, MD FAAAAI Dr. Joseph Leija Melrose Park, IL
21	Minneapolis, MN	44.96	-93.27	2010	Harold B. Kaiser, MD FAAAAI Clinical Research Institute Minneapolis, MN
22	Newark, NJ	40.72	-74.17	2003-2009	Alan Wolff, M.D. UMDNJ Newark, NJ

23*	New Castle, DE	39.62	-75.56	2005-2010	Michael McDowell Division of Air Quality, DNREC, State of Delaware New Castle, DE
24	New York, NY	40.08	-78.43	2003-2010	Guy Robinson, PhD Fordham College at Lincoln Center New York, NY
25	Niagara Falls, ON	43.09	-79.09	2003-2005	Dr. Michael Alexander, MD Niagara Falls, ON
26	Olean, NY	42.08	-78.43	2003-2010	Fred Lewis, MD FAAAAI Olean, NY
27	Philadelphia, PA	40.01	-75.13	2003-2007, 2010	Donald J. Dvorin, MD FAAAAI Allergic Disease Associates, P.C. Philadelphia, PA
28	Pittsburgh, PA (2)	40.44	-79.98	2003-2010	David Skoner, MD FAAAAI Allegheny General Hospital Pittsburgh, PA

29	Rochester, NY	43.17	-77.62	2003-2010	Donald W. Pulver, MD FAAAAI Allergy, Asthma & Immunology of Rochester Rochester, NY
30	Salem, MA	42.53	-70.87	2007-2010	Paul Hannaway, M.D. Salem, MA
31	St. Claire Shores, MI	42.49	-82.89	2003-2005, 2009-2010	Andrew I. Dzul, MD Lakeshore Ear Nose & Throat Center St. Clair Shores, MI
32	St. Louis, MO	38.64	-90.24	2003,2006-2010	Mr. Wayne Wilhelm St. Louis County Health Department Berkeley, MO (St. Louis)
33	Washington, DC	38.91	-77.02	2003-2010	Susan E. Kosisky MA Walter Reed Army Medical Ctr. Washington, DC
34	Waturbury, CT	41.56	-73.04	2003-2010	Christopher Randolph, MD FAAAAI Waterbury, CT

35	Waukesha, WI	43.01	-88.24	2007-2009	Walter Brummund, MD, PhD, FAAAAI Allergy & Asthma Centers, S.C. Waukesha, WI
36	Wauwatosa, WI	43.06	-88.03	2003-2006	Walter Brummund, MD, PhD, FAAAAI Allergy & Asthma Centers, S.C. Waukesha, WI
37	York, PA	39.96	-76.73	2003-2010	Michael S. Nickels, MD PhD Allergy and Asthma Consultants, Inc. York, PA
Southeast (33)					
1	Atlanta, GA	33.76	-84.42	2003-2010	Santley M. Fineman, MD MBA FAAAAI Atlanta Allergy and Asthma Marietta, GA (Atlanta)
2	Austin, TX	30.31	-97.95	2003-2005	Kim T. Hovanky, MD FAAAAI & Sheila M. Amar, MD FAAAAI, FACAAI Allergy & Asthma Center of Georgetown Austin, TX (Georgetown)

3	Baton Rouge, Louisiana	30.45	-91.13	2003-2005	James M. Kidd III Kidd Allergy Clinic Baton Rouge, LA
4	Birmingham, AL	33.53	-86.80	2010	Weilly Soong, MD FAAAAI Birmingham-Southern College/Alabama Allergy & Asthma Center Birmingham, AL
5	Charlotte, NC	35.20	-80.83	2003-2007	John T. Klimas, MD FAAAAI Carolina Asthma and Allergy Center Charlotte, NC
6	College Station, TX	30.60	-96.31	2003-2010	David R. Weldon, MD FAAAAI, FACAAI Scott & White Clinic College Station, TX
7	Corpus Christi, TX	27.69	-97.29	2003-2005	Gary L. Smith, M.D. Corpus Christi, TX
8	Dallas, TX	32.79	-96.77	2003-2010	Jeffrey Adelglass, M.D. Dr. Jeffrey Adelglass Dallas, TX

9	Fargo, ND	46.88	-96.82	2003-2010	Dan Dalan, MD FAAAAI Allergy & Asthma Care Center Fargo, ND
10	Flower Mound, TX	33.03	-97.09	2006-2010	Marie H Fitzgerald, MD North Texas Pollen Station Flower Mound, TX
11	Fort Smith, AK	35.37	-94.38	2003-2006	N/A
12	Georgetown, TX	30.65	-97.69	2006-2010	Kim T. Hovanky, MD FAAAAI & Sheila M. Amar, MD FAAAAI, FACAAI Allergy & Asthma Center of Georgetown Austin, TX (Georgetown)
13	Greenville, SC	34.84	-82.37	2003-2010	Neil L Kao MD FAAAAI Allergic Disease and Asthma Center Greenville, SC
14	Houston, TX	29.77	-95.39	2005-2010	Mr. Tony Huynh City of Houston Houston, TX

15	Huntsville, AL	34.71	-86.63	2003-2010	Ms. Debra Hopson Natural Resources & Environmental Management Huntsville, AL
16	Knoxville, TN	35.97	-83.95	2003-2010	Michael Miller, MD FAAAAI Allergy, Asthma and Immunology Knoxville, TN
17	Little Rock, AK	34.72	-92.35	2004-2010	Karl V Sitz, MD Little Rock Allergy & Asthma Clinic Little Rock, AR
18	Miami, FL	25.78	-80.21	2003-2005	Elene Ubals, MD & Richard Schiff, MD, PhD Miami, FL
19	New Orleans, LA	30.07	-89.93	2008-1010	W Edward Davis MD MS MBA MMM Ochsner Clinic Foundation New Orleans, LA
20	Ocala, FL	29.19	-82.13	2003-2005	Dr. Karl M Altenburger Allergy and Asthma Care of Florida Ocala, FL

21	Oklahoma City, OK (2)	35.47	-97.51	2003-2010	Warren V. Filley, MD FAAAAI OK Allergy Asthma Clinic, Inc. Oklahoma City, OK
22	Omaha, NE	41.26	-96.01	2003-2010	N/A
23	Orlando, FL	28.51	-81.37	2006-2007	Bruce A. Hornberger, MD FAAAAI Allergy & Asthma Center of East Orlando Orlando, FL
24	Oxford, AL	33.61	-85.84	2010	Robert Grubbe, MD Allergy & Asthma Center, LLC Oxford, AL
25	Rogers, AK	36.33	-94.13	2006-2010	Curtis L. Hedberg, MD FAAAAI Hedberg Allergy & Asthma Center Rogers, AR (Fort Smith)
26*	Sarasota, FL	27.34	-82.53	2003-2010	Mary Jelks, MD FAAAAI Sarasota, FL

27	Savannah, GA	32.02	-81.13	2008-2010	Brad H. Goodman, M.D. & Bruce D. Finkel, M.D. Coastal Allergy & Asthma, P.C. Savannah, GA
28	Tallahassee, FL	30.46	-84.28	2003-2005	Ronald Saff, M.D. Tallahassee, FL
29	Tampa, FL	27.96	-82.48	2003-2010	Richard Lockey, MD FAAAAI University of South Florida Tampa, FL
30	Tulsa, OK	36.13	-95.92	2003-2010	Estelle Levetin, PhD FAAAAI University of Tulsa Tulsa, OK
31	Waco, TX (2)	31.57	-97.18	2003-2010	N.J. Amar, MD FAAAAI Allergy and Asthma Center Waco, TX

Mountain (8)

1	Bismarck, ND	46.81	-100.77	2003-2005, 2010	Dan Dalan, M.D. North Dakota DOH East Lab Bismarck, ND
2	Colorado Springs (2)	38.86	-104.76	2003-2010	William Storms, MD FAAAAI The William Storms Allergy Clinic Colorado Springs, CO
3	Draper, UT	40.52	-111.86	2009-2010	Duane J. Harris, MD FAAAAI Intermountain Allergy & Asthma Clinic Draper, UT
4*	Missoula, MT	46.87	-114.01	2006-2007, 2009-2010	Emily Weiler U of Montana, Ctr for Environmental Health Sciences Missoula, MT
5	Salt Lake City, UT	40.78	-111.93	2003-2004, 2008	N/A
6	Scottsdale, AZ	33.69	-111.87	2006-2007	Michael E. Manning, M.D. Scottsdale, AZ

7*	Twin Falls, ID	42.56	-114.46	2003-2010	N/A
California (13)					
1	La Jolla, CA	32.84	-117.26	2003-2010	Robert Reid, Jr, MD Scripps Memorial Hospital LaJolla, CA
2	Orange, CA	33.81	-117.82	2003-2010	Sherwin A. Gillman, M.D. Children's Hospital of Orange County-Pediatric Subspecialty Faculty Orange, CA
3	Pasadena, CA	34.16	-118.14	2004-2005, 2010	Philip Taylor, PhD The Pollen Group Pasadena, CA
4	Pleasanton, CA	37.67	-121.89	2003-2010	N/A

5	Reno, NV	39.54	-119.82	2003-2006, 2009-2010	Leonard Shapiro, MD FAAAAI Allergy & Asthma Associates Sparks, NV
6	Roseville, CA	38.76	-121.29	2006-2010	Sunil P. Perera, MD FAAAAI Allergy Medical Group of the North Area Roseville, CA (Sacramento)
7	Sacramento, CA	38.57	-121.47	2003-2006	Sunil P. Perera, MD FAAAAI Allergy Medical Group of the North Area Roseville, CA (Sacramento)
8	Salinas, CA	36.68	-121.64	2003	Steven S. Prager, M.D. Salinas Allergy Clinic Salinas, CA
9	San Diego, CA	32.82	-117.14	2006, 2008-2010	Robert T. Reid, MD Erik and Ese Banck Clinical Research Center San Diego, CA
10	San Jose, CA (2)	37.30	-121.85	2003-2010	Theodore Chu, MD FAAAAI San Jose, CA

11	Santa Barbara, CA	34.43	-119.72	2003-2010	Myron Liebhaber, M.D. Sansum - Santa Barbara Medical Foundation Clinic Santa Barbara, CA
12	Stockton, CA	37.97	-121.31	2009-2010	Gregory W. Bensch, MD FAAAAI & George W Bensch, MD FAAAAI Allergy, Immunology and Asthma Medical Group Stockton, CA

Pacific NW (4)

1	Crescent City, CA	41.76	-124.20	2009-2010	N/A
2*	Eugene, OR	44.05	-123.11	2003-2010	Kraig W. Jacobson, MD, FAAAAI Allergy & Asthma Research Group Eugene, OR
3	Seattle, WA	47.62	-122.35	2003-2010	N/A

4*	Vancouver, WA	45.63	-122.64	2003-2010	Raymond Brady, M.D. and Joseph Hassett, M.D. Vancouver, WA
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924 **Table S1.** AAAAI pollen counting stations included in development and evaluation of model. Categorized by U.S. subregions Northeast, Southeast, Mountain,
925 California, and Pacific Northwest. Sites equipped with two samplers are denoted in parentheses (ex. Pittsburgh, PA (2)). Station numbers with asterisk (*) are
926 collocated with DayMet temperature for phenological regressions.

Taxon	Maximum P_{avgmax} (grains m^{-3})	Average P_{avgmax} (grains m^{-3})
<i>Acer</i>	535	212
<i>Alnus</i>	176	73
<i>Ambrosia</i>	379	193
Arecaceae	27	13
<i>Artemisia</i>	76	36
Asteraceae	64	28
<i>Betula</i>	564	232
<i>Carpinus/Ostrya</i>	71	29
<i>Carya</i>	126	54
<i>Celtis</i>	155	65
Chenopodiaceae/Amaranthaceae	80	29
<i>Corylus</i>	13	5
Cupressaceae	1949	960
Cyperaceae	37	12
<i>Eupatorium</i>	27	13
<i>Fagus</i>	66	17
<i>Fraxinus</i>	462	227
Graminae / Poaceae	197	98
<i>Juglans</i>	71	34
<i>Ligustrum</i>	13	6
<i>Liquidambar</i>	109	44
<i>Morus</i>	940	398
<i>Myrica</i>	50	25
<i>Olea</i>	197	43
Other Grass Pollen	85	42
Other Tree Pollen	863	332
Other Weed Pollen	160	51
Pinaceae	645	328
<i>Plantago</i>	33	13
<i>Platanus</i>	191	103
<i>Populus</i>	367	158
<i>Prosopis</i>	34	16
<i>Pseudotsuga</i>	7	3

<i>Quercus</i>	2106	1081
<i>Rumex</i>	59	23
<i>Salix</i>	123	58
<i>Tilia</i>	19	6
<i>Tsuga</i>	12	5
<i>Typha</i>	19	10
<i>Ulmus</i>	556	249
Unidentified Pollen	198	57
Urticaceae	86	36

Table S2. Maximum and average P_{avgmax} used for selecting pollen taxa for this study. Shaded taxa are selected taxa based on minimum of 1) 100 grains m^{-3} for the maximum P_{avgmax} and 2) 70 grains m^{-3} for the average P_{avgmax} .

```
program fluxcode
```

```
! MODEL VERSION: PECM1.0
```

```
! Final Code Update: Matthew Wozniak, 09/05/17
```

```
! Authors: Matthew C. Wozniak, Allison L. Steiner
```

```
! Department of Climate and Space Sciences and Engineering, College of  
Engineering, University of Michigan
```

```
! *****  
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! *****
```

```
use netcdf
```

```
implicit none
```

```
logical :: plac_flag
```

```
integer ::
```

```
nx,ny,nyr,ndy,ndy_nextyr,nspec,nbeld,nclm,cnt,cnt_yrs,cnt_mnths,nlev,yrst,  
yrend,ndytot,ngra,nrag ! mcwoz added nlev, yrst, yrend, ndytot, nclm,  
ngra, nrag
```

```
integer :: idbeld,idLat,idLong,idyear,idday,idclm,idpft,idurb,idc3,idc4,  
idurblev ! mcwoz added idc3, idc4, idurblev
```

```
integer :: idcru,idTmp,status,dimval,nlats
```

```
integer :: len, wid
```

```
integer :: phen_dimids(4),phen_count(4)
```

```
integer :: i,ii,iii,iv, iv2,jj,id_2d(2),start(4),count(4),start1(4),count1(4),  
rcode,pcoutid,ncidout ! mcwoz added jj
```

```
integer :: dimid1,dimid2,dimid3,dimid4,dimid5,dimids(4),dimid6,dimid7,lonoutid,  
latoutid,dayoutid,yroutid,specoutid,timeoutid,levoutid,lcoutid,sdoyoutid,  
edoyoutid,duroutid,dbloutid,enloutid,graoutid,ragoutid ! mcwoz added  
dbl-,enl-,gra-,ragoutid
```

```
real,allocatable :: sDOY_m(:),sDOY_b(:),eDOY_m(:),eDOY_b(:),ef(:)
```

```
double precision,allocatable :: tval(:,:,:),pft(:,:,:),urban(:,:,:) :
```

```
real,allocatable :: xlat(:,:),xlon(:,:),grass(:,:)
```

```
integer,allocatable :: ispec(:),idspec(:),ttest(:,:,:),latteest(:,:)
```

```
integer,allocatable :: iyr(:),idy(:),idcrop(:) ! mcwoz added idcrop
```

```
real, allocatable :: pyaat_sum(:,:,:),pyaat(:,:,:),pyaat_sum_adj(:,:,:),  
pyaat_adj(:,:,:) ! pyaat = prior year annual average temperature
```

```
real, allocatable :: frac_area(:,:,:),beld(:,:,:),sDOY(:,:,:),eDOY(:,:,:),  
dur(:,:,:),pc(:,:,:),dbl_poll(:,:,:),enl_poll(:,:,:),gra_poll(:,:,:),  
rag_poll(:,:,:) :
```

```
real, dimension(103,2) :: stat_llind
```

```
real :: sigma, mu, gphen,sigma1,sigma2,mu1,mu2,tot_flg,ef_d ! mcwoz added  
tot_flg, ef_d
```

```

real :: vf = 0.10 ! for application of flowering probability (vitality) to
    emission factor
character(len=256) :: longname(8), units(8), lc_option(1)
character(4),allocatable :: name(:), year(:)
yrst = 1 ! start year of emissions
yrend = 11 ! end year of emissions
nyr = yrend-yrst + 1
units(4) = 'days since 2000-12-31 00:00:00'

! Indicate below which land cover specification to use ("PFT" = PFT-level from
    CLM, "TAX" taxon-level from BELD)
lc_option = "TAX"

if (lc_option(1:3) .eq. "TAX") then
! Read input file scalars
    open(unit=20,file='emission_params_beld.in',status='unknown')
    read(20,*) nx ! Number of grid points in x direction
        (longitude)
    read(20,*) ny ! Number of grid points in y direction
        (latitude)
    read(20,*) ndy ! number of days per year (calendar
        definition)
    read(20,*) nbeld ! number of tree taxa in the BELD species
        database (currently 11)
    read(20,*) ngra ! number of grass taxa (currently 2: C3 and
        C4)
    read(20,*) nrag ! number of ragweed taxa (currently 1)
    read(20,*) idc3 ! index of c3 non-arctic grasses pft in CLM
        species data
    read(20,*) idc4 ! index of c4 grasses pft in CLM species data
    read(20,*) idurblev ! index of the urban level used for ragweed
        parameterization
    read(20,*) nspec ! number of pollen genus/type to include in
        model
    read(20,*) nlev ! number of vertical levels in emissions model

allocate(year(nyr))
year =
    ('2001','2002','2003','2004','2005','2006','2007','2008','2009','2010','201
    1'/)

! count the total number of days in the emissions calculation accounting for
    leap days
ndytot = 0
do iv = yrst,yrend
    if (year(iv) .eq. '2004' .or. year(iv) .eq. '2008') then
        ndytot = ndytot + 366
    else
        ndytot = ndytot + 365
    end if
end do

!--- Allocate memory for arrays
allocate(xlon(nx,ny)) ! note CRU dims are different
allocate(xlat(nx,ny))
allocate(iyr(nyr))

```



```

allocate(idy(ndytot))
allocate(idspec(nspec))
allocate(frac_area(nx,ny,nspec))
allocate(beld(nx,ny,nbeld))
allocate(tval(nx,ny,144)) ! note revised format for CRU data and that CRU dims
    are different
allocate(pyaat(nx,ny,nyr))
allocate(pyaat_sum(nx,ny,nyr))
allocate(pyaat_adj(nx,ny,nyr))
allocate(pyaat_sum_adj(nx,ny,nyr))
allocate(sDOY_m(nspec))
allocate(sDOY_b(nspec))
allocate(eDOY_m(nspec))
allocate(eDOY_b(nspec))
allocate(ef(nspec))
allocate(sDOY(nx,ny,nyr,nspec))
allocate(dur(nx,ny,nyr,nspec))
allocate(eDOY(nx,ny,nyr,nspec))
allocate(dbl_poll(nx,ny,nlev,ndytot))
allocate(enl_poll(nx,ny,nlev,ndytot))
allocate(gra_poll(nx,ny,nlev,ndytot))
allocate(rag_poll(nx,ny,nlev,ndytot))
allocate(name(nspec))
allocate(ttest(nx,ny,144))
allocate(lattest(ny,nx))
allocate(urban(nx,ny,3))
allocate(grass(ny,nx))
allocate(pft(nx,ny,25))
allocate(idcrop(4)) ! currently just corn and soybean crops

! set idy to integer counting array counting from 1 to the number of days of
    emissions
idy = (/ (i, i = 1,ndytot) /)
iyr = (/ (i, i = 1,nyr) /)

! read in rest of input file
    read(20,*) (idcrop(i),i=1,4) ! read in crop pft indices (2
        corn, 2 soybean)
    read(20,*) (name(i),i=1,nspec) ! read the names of the
        emitting taxa
    read(20,*) (ef(i),i=1,nspec) ! read in emission factors
        (grains/m2; RW is grains/plant)
    read(20,*) (sDOY_m(i),i=1,nspec) ! read in sDOY regression
        slope
    read(20,*) (sDOY_b(i),i=1,nspec) ! read in sDOY regression
        intercept
    read(20,*) (eDOY_m(i),i=1,nspec) ! read in eDOY regression
        slope
    read(20,*) (eDOY_b(i),i=1,nspec) ! read in eDOY intercept

! print the phenological parameters to screen
do i=1,nspec
write(*,*) name(i),ef(i),sDOY_m(i),sDOY_b(i),eDOY_m(i),eDOY_b(i)
end do

!---Read in BELD3 25km res lat/lon file-----

```

```

status = nf90_open(path = "/good_share/alsteine/pollendata/
    merged_beld_25km.nc", mode = nf90_nowrite, ncid = idbeld)

do i=1,nbeld
    status = nf90_inq_varid(idbeld, name(i), idspec(i))
    status = nf90_get_var(idbeld, idspec(i), beld(:,:,i))
end do

frac_area(:,:,1:nbeld) = beld(:,:,1)

status = nf90_close(idbeld)

! read in CLM land cover data (PFTS for grasses and crops, urban landcover)
status = nf90_open(path = "/home/mcwoz/CLM45_surface_emisvars.nc", mode = nf90
    _nowrite, ncid = idclm)
status = nf90_inq_varid(idclm, 'pft_2d', idpft)
status = nf90_get_var(idclm, idpft, pft)
status = nf90_inq_varid(idclm, 'urb_2d', idurb)
status = nf90_get_var(idclm, idurb, urban)

! Duplicate the elm landcover
frac_area(:,:,12) = frac_area(:,:,11)

! convert land cover percent to fraction...
frac_area(:,:,1) = 0.01*frac_area(:,:,1) ! convert from percent to fraction (m2
    veg/m2 total)
pft(:,:,1) = 0.01*pft(:,:,1)
urban(:,:,1) = 0.01*urban(:,:,1)

! grass landcover
nclm = ngra
frac_area(:,:,13) = real(pft(:,:,idc3),4)
frac_area(:,:,14) = real(pft(:,:,idc4),4)

! Ragweed landcover; NOTE: in plants/m2, NOT fractional area
frac_area(:,:,15) = real(0.01*(2.*0.75 + 10.*0.25)*(pft(:,:,idcrop(1)) +
    pft(:,:,idcrop(2))) + 0.01*(2.*0.55 + 10.*0.45)*(pft(:,:,idcrop(3)) +
    pft(:,:,idcrop(4))) + 0.1*0.5*urban(:,:,idurblev),4)
! (t_density*till + nt_density*no-till)*(corn) + (t_density*till +
    nt_density*no-till)*(soybean) + urb_density*urban
! now with crop density reduced by factor of 100, urban reduced by factor of 10

do i = 1,nx
    do ii = 1,ny
        do iii = 13,15
            if (frac_area(i,ii,iii).lt.0) then
                frac_area(i,ii,iii) = 0.
            end if
        end do
    end do
end do

end if ! ends "if ('TAX')" block

if (lc_option(1:3) .eq. "PFT") then

```

```

! Read input file scalars
open(unit=20,file='emission_params_pft.in',status='unknown')
read(20,*) nx                ! Number of grid points in x direction
    (longitude)
read(20,*) ny                ! Number of grid points in y direction
    (latitude)
read(20,*) ndy               ! number of days per year (calendar
    definition)
read(20,*) ntree             ! number of tree plant functional types
    (currently 2: DBL, ENL)
read(20,*) ngra              ! number of grass taxa
read(20,*) nrag              ! number of ragweed taxa (currently 1)
read(20,*) idc3              ! index of c3 non-arctic grasses pft in CLM
    species data
read(20,*) idc4              ! index of c4 grasses pft in CLM species data
read(20,*) idurblev          ! index of the urban level used for ragweed
    parameterization
read(20,*) nspec             ! number of pollen genus/type to include in
    model
read(20,*) nlev              ! number of vertical levels in emissions model

allocate(year(nyr))
year =
    (/'2001','2002','2003','2004','2005','2006','2007','2008','2009','2010','20
    11'/)

! count the total number of days in the emissions calculation accounting for
    leap days
ndytot = 0
do iv = yrst,yrend
    if (year(iv) .eq. '2004' .or. year(iv) .eq. '2008') then
        ndytot = ndytot + 366
    else
        ndytot = ndytot + 365
    end if
end do

!--- Allocate memory for arrays
allocate(xlon(nx,ny))        ! note CRU dims are different
allocate(xlat(nx,ny))
allocate(iyr(nyr))
allocate(idy(ndytot))
allocate(idspec(nspec))
allocate(frac_area(nx,ny,nspec))
allocate(tval(nx,ny,144))    ! note revised format for CRU data and that CRU dims
    are different
allocate(pyaat(nx,ny,nyr))
allocate(pyaat_sum(nx,ny,nyr))
allocate(pyaat_adj(nx,ny,nyr))
allocate(pyaat_sum_adj(nx,ny,nyr))
allocate(sDOY_m(nspec))
allocate(sDOY_b(nspec))
allocate(eDOY_m(nspec))
allocate(eDOY_b(nspec))
allocate(ef(nspec))

```

```

allocate(sDOY(nx,ny,nyr,nspec))
allocate(dur(nx,ny,nyr,nspec))
allocate(eDOY(nx,ny,nyr,nspec))
allocate(dbl_poll(nx,ny,nlev,ndytot))
allocate(enl_poll(nx,ny,nlev,ndytot))
allocate(gra_poll(nx,ny,nlev,ndytot))
allocate(rag_poll(nx,ny,nlev,ndytot))
allocate(name(nspec))
allocate(ttest(nx,ny,144))
allocate(lattest(ny,nx))
allocate(urban(nx,ny,3))
allocate(grass(ny,nx))
allocate(pft(nx,ny,25))
allocate(idcrop(4)) ! currently just corn and soybean crops
allocate(iddbl(3))
allocate(idenl(2))

! set idy to integer counting array counting from 1 to the number of days of
emissions
idy = (/ (i, i = 1,ndytot) /)
iyr = (/ (i, i = 1,nyr) /)

! read in rest of input file
read(20,*) (idcrop(i),i=1,4) ! read in crop pft indices
read(20,*) (iddbl(i),i=1,3)
read(20,*) (idenl(i),i=1,2) ! recently updated to include
boreal ENF
read(20,*) (name(i),i=1,nspec) ! read the names of the
emitting taxa
read(20,*) (ef(i),i=1,nspec) ! read in emission factors
(grains/m2; RW is grains/plant)
read(20,*) (sDOY_m(i),i=1,nspec) ! read in sDOY regression
slope
read(20,*) (sDOY_b(i),i=1,nspec) ! read in sDOY regression
intercept
read(20,*) (eDOY_m(i),i=1,nspec) ! read in eDOY regression
slope
read(20,*) (eDOY_b(i),i=1,nspec) ! read in eDOY intercept

! print the phenological parameters to screen
do i=1,nspec
write(*,*) name(i),ef(i),sDOY_m(i),sDOY_b(i),eDOY_m(i),eDOY_b(i)
end do

! read in CLM land cover data (PFTS for grasses and crops, urban landcover)
status = nf90_open(path = "/home/mcwoz/CLM45_surface_emisvars.nc", mode = nf90
_nowrite, ncid = idclm)
status = nf90_inq_varid(idclm, 'pft_2d', idpft)
status = nf90_get_var(idclm, idpft, pft)
status = nf90_inq_varid(idclm, 'urb_2d', idurb)
status = nf90_get_var(idclm, idurb, urban)

pft(:,:,:) = 0.01*pft(:,:,:)
urban(:,:,:) = 0.01*urban(:,:,:)

! tree landcover

```

```

frac_area(:, :, 1) = pft(:, :, iddbl(1)) + pft(:, :, iddbl(2)) + pft(:, :, iddbl(3))
frac_area(:, :, 2) = pft(:, :, idenl(1)) + pft(:, :, idenl(2))

! grass landcover
nclm = ngra
frac_area(:, :, 3) = real(pft(:, :, idc3), 4)
frac_area(:, :, 4) = real(pft(:, :, idc4), 4)

! Ragweed landcover; NOTE: in plants/m2, NOT fractional area
frac_area(:, :, 5) = real(0.01*(2.*0.75 + 10.*0.25)*(pft(:, :, idcrop(1)) +
    pft(:, :, idcrop(2))) + 0.01*(2.*0.55 + 10.*0.45)*(pft(:, :, idcrop(3)) +
    pft(:, :, idcrop(4))) + 0.1*0.5*urban(:, :, idurblev), 4)
! (t_density*till + nt_density*no-till)*(corn) + (t_density*till +
    nt_density*no-till)*(soybean) + urb_density*urban
! now with crop density reduced by factor of 100

do i = 1, nx
    do ii = 1, ny
        do iii = 1, 5
            if (frac_area(i, ii, iii).lt.0) then
                frac_area(i, ii, iii) = 0.
            end if
        end do
    end do
end do

end if ! ends "if ('PFT')" block

! officially close landcover files
status = nf90_close(idclm)

! officially close landcover files
status = nf90_close(idclm)

!---Read in CRU daily temperature (Tmax) file-----
if (.false.) then
    status = nf90_open(path = "/home/mcwoz/cru2rcm_tavg_aat_1999-2010.nc", mode =
        nf90_nowrite, ncid = idcru)
    status = nf90_inq_varid(idcru, "tavg", idTmp)

    status = nf90_get_var(idcru, idTmp, pyaat, start=(/1,1,2/), count=(/nx,ny,nyr/))

    if(status /= nf90_noerr) write(*,*)"netcdf error =
        ", trim(nf90_strerror(status))

!---Read in latitude values -----

status = nf90_inq_varid(idcru, "xlat", idLat)
status = nf90_get_var(idcru, idLat, xlat, start=(/1,1/), count=(/nx,ny/))

!---Read in longitude values -----

status = nf90_inq_varid(idcru, "xlon", idLong)
status = nf90_get_var(idcru, idLong, xlon, start=(/1,1/), count=(/nx,ny/))

! Close the file, freeing all resources.

```

```

status = nf90_close(idcru)
status = nf90_open(path = "/home/mcwoz/cru2rcm_tavg_aatj_1999-2010.nc", mode =
    nf90_nowrite, ncid = idcru)
status = nf90_inq_varid(idcru, "tavg", idTmp)
status = nf90_get_var(idcru, idTmp, pyaat_adj, start=(/1,1,1/),count=(/nx,ny,
    nyr/))

if(status /= nf90_noerr) write(*,*)"netcdf error =
    ",trim(nf90_strerror(status))
status = nf90_close(idcru)
end if

status = nf90_open(path = "/home/mcwoz/cru2rcm_aat_aajt_2002-2015.nc", mode =
    nf90_nowrite, ncid = idcru)
status = nf90_inq_varid(idcru, "aat", idTmp)
status = nf90_get_var(idcru, idTmp, pyaat, start=(/1,1,1/),count=(/nx,ny,nyr/))
status = nf90_inq_varid(idcru, "aajt", idTmp)
status = nf90_get_var(idcru, idTmp, pyaat_adj, start=(/1,1,1/),count=(/nx,ny,
    nyr/))

if(status /= nf90_noerr) write(*,*)"netcdf error =
    ",trim(nf90_strerror(status))
status = nf90_close(idcru)

if (.false.) then ! on/off - calculate pyaat from monthly temperature data

!---Calculate prior year annual average temperature (spring taxa; start in
    January)
pyaat_sum = -9999.
pyaat = -9999.
do i = 1,nx          !Loop over all longitudes
do ii = 1,ny         !Loop over all latitudes
    cnt_yrs = 1 ! reset count years
    cnt_mnth = 1 ! count of good months (months without missing data)
    do iv = 13,132 ! year loop, starting on July 1 1999 and ending early
        (2009)
        if (pyaat_sum(i,ii,cnt_yrs) .eq. -9999. .and. tval(i,ii,iv).lt.100) then
            pyaat_sum(i,ii,cnt_yrs) = 0
            pyaat_sum(i,ii,cnt_yrs) = pyaat_sum(i,ii,cnt_yrs) + tval(i,ii,iv)
            cnt_mnth = cnt_mnth + 1 ! update count of good months
        else if (pyaat_sum(i,ii,cnt_yrs) .ne. -9999. .and. tval(i,ii,iv).lt.100)
            then
            pyaat_sum(i,ii,cnt_yrs) = pyaat_sum(i,ii,cnt_yrs) + tval(i,ii,iv)
            cnt_mnth = cnt_mnth + 1 ! update count of good months
        else
            ! do nothing
        end if
        if(mod(iv,12).eq.0) then
            if (pyaat_sum(i,ii,cnt_yrs).ne.-9999) then
                pyaat(i,ii,cnt_yrs) = pyaat_sum(i,ii,cnt_yrs)/cnt_mnth ! to get
                    annual averages
            end if
            cnt_yrs = cnt_yrs + 1 ! update count years
            cnt_mnth = 1 ! reset count months
        end if
    end do ! end time loop
end do ! end do

```

```

end do
end do

!---Calculate prior year annual average temperature (winter taxa; start in
      July)
pyaat_sum_adj = -9999.
pyaat_adj = -9999.
do i = 1,nx      !Loop over all longitudes
do ii = 1,ny     !Loop over all latitudes
  cnt_yrs = 1 ! reset count years
  cnt_mnths = 1 ! count of good months (months without missing data)
  do iv = 7,126 ! year loop, starting on July 1 1999 and ending early (2009)
    if (pyaat_sum_adj(i,ii,cnt_yrs) .eq. -9999. .and. tval(i,ii,iv).lt.100)
      then
        pyaat_sum_adj(i,ii,cnt_yrs) = 0
        pyaat_sum_adj(i,ii,cnt_yrs) = pyaat_sum_adj(i,ii,cnt_yrs) + tval(i,ii,
          iv)
        cnt_mnths = cnt_mnths + 1 ! update count of good months
      end if
      if (pyaat_sum_adj(i,ii,cnt_yrs) .ne. -9999. .and. tval(i,ii,iv).lt.100)
        then
          pyaat_sum_adj(i,ii,cnt_yrs) = pyaat_sum_adj(i,ii,cnt_yrs) + tval(i,ii,
            iv)
          cnt_mnths = cnt_mnths + 1
        end if
        if(mod(iv,6).eq.0.and.mod(iv,12).ne.0) then ! add in extra conditional
          if (pyaat_sum_adj(i,ii,cnt_yrs).ne.-9999.) then
            pyaat_adj(i,ii,cnt_yrs) = pyaat_sum_adj(i,ii,cnt_yrs)/cnt_mnths !
              to get annual averages
          end if
          cnt_yrs = cnt_yrs + 1 ! update count years
          cnt_mnths = 1 ! reset count months
        end if
      end do ! end time loop
    end do
  end do

end if ! on/off - calculate pyaat from monthly temperature data

!---Calculate Pollen Emissions Start Day of Year, end day of year and
      Duration-----

if (.true.) then
do i=1,nspec
  if(i.eq.2 .or. i.eq.4 .or. i.eq.7) then !Alnus, Cupressaceae, Pinus
    sDOY(:, :, :, i) = NINT((sDOY_m(i)*pyaat_adj(:, :, :))+sDOY_b(i))
    eDOY(:, :, :, i) = NINT((eDOY_m(i)*pyaat_adj(:, :, :))+eDOY_b(i))
  else
    sDOY(:, :, :, i) = NINT((sDOY_m(i)*pyaat(:, :, :))+sDOY_b(i))
    eDOY(:, :, :, i) = NINT((eDOY_m(i)*pyaat(:, :, :))+eDOY_b(i))
  end if
  dur(:, :, :, i) = eDOY(:, :, :, i) - sDOY(:, :, :, i) !calculate duration from
    phenological dates
  do ii = 1,nx
    do iii = 1,ny
      do iv = 1,nyr

```

```

        if(i.eq.2 .or. i.eq.4 .or. i.eq.7) then
            if (pyaat_adj(ii,iii,iv) .lt. -9998) then
                sDOY(ii,iii,iv,i) = -9999.
                dur(ii,iii,iv,i) = -9999.
                eDOY(ii,iii,iv,i) = -9999.
            end if
        else
            if (pyaat(ii,iii,iv) .lt. -9998) then
                sDOY(ii,iii,iv,i) = -9999.
                dur(ii,iii,iv,i) = -9999.
                eDOY(ii,iii,iv,i) = -9999.
            end if
        end if
        if (dur(ii,iii,iv,i).le.0) then
            dur(ii,iii,iv,i) = -9999.
        end if
    end do
end do
end do
end if

!---Output new netcdf file containing pollen count data for each grid cell for
    each day ---

! netcdf-output write parameters
start = (/1,1,1,1/)
count = (/nx,ny,nlev,ndytot/)

! dimension and variable attributes for netcdf-output
longname(1) = 'longitude'
longname(2) = 'latitude'
longname(3) = 'level index'
longname(4) = 'time'
longname(5) = 'pollen emission potential (flux)'

units(1) = 'degrees_east'
units(2) = 'degrees_north'
units(3) = 'level'
!units(4) = 'days since 2000-12-31 00:00:00' ! set at beginning of code for
    convenience!
units(5) = 'grains m-2 day-1'

! Output NetCDF file create
rcode = nf90_create(path = "/good_share/mcwoz/emis_out/
    pollen_emissions_2001-2011_25km_speciated-calc_FINAL.nc",cmode = nf90_64
    bit_offset,initialsize = 0,ncid = ncidout)

! NetCDF file variable definition
rcode = nf90_redef(ncidout)

rcode = nf90_def_dim(ncidout,'jx', count(1),dimid1)
rcode = nf90_def_dim(ncidout,'iy', count(2),dimid2)
rcode = nf90_def_dim(ncidout,'lev', count(3),dimid3)
rcode = nf90_def_dim(ncidout,'time', count(4),dimid4)
rcode = nf90_def_dim(ncidout,'spec', nspec,dimid5)

```



```

rcode = nf90_def_dim(ncidout,'year',nyr,dimid6)
if(rcode /= nf90_noerr) write(*,*)"netcdf error =
    ",trim(nf90_strerror(rcode))

id_2d(1) = dimid1
id_2d(2) = dimid2

dimids = (/ dimid1,dimid2,dimid3,dimid4/)
phen_dimids = (/ dimid1,dimid2,dimid6,dimid5/)
phen_count = (/ nx,ny,nyr,nspec /)

! mcwoz edits: changed output variables to those of RegCM chemical emissions
  format
rcode = nf90_def_var(ncidout,'lon'      ,nf90_real,id_2d,lonoutid)
rcode = nf90_def_var(ncidout,'lat'      ,nf90_real,id_2d,latoutid)
rcode = nf90_def_var(ncidout,'lev'      ,nf90_real,dimid3,levoutid)
rcode = nf90_def_var(ncidout,'time'     ,nf90_real,dimid4,timeoutid)
rcode = nf90_def_var(ncidout,'spec'     ,nf90_real,dimid5,specoutid)
rcode = nf90_def_var(ncidout,'year'     ,nf90_real,dimid6,yroutid)
rcode = nf90_def_var(ncidout,'clm_lc'   ,nf90_double,(/dimid1,dimid2/),lcoutid)
rcode = nf90_def_var(ncidout,'sDOY'    ,nf90_real,phen_dimids,sdoyoutid)
rcode = nf90_def_var(ncidout,'eDOY'    ,nf90_real,phen_dimids,edoyoutid)
rcode = nf90_def_var(ncidout,'dur'     ,nf90_real,phen_dimids,duroutid)
rcode = nf90_def_var(ncidout,'DBL_POLL',nf90_real,dimids,dbloutid)
rcode = nf90_def_var(ncidout,'ENL_POLL',nf90_real,dimids,enloutid)
rcode = nf90_def_var(ncidout,'GRA_POLL',nf90_real,dimids,graoutid)
rcode = nf90_def_var(ncidout,'RAG_POLL',nf90_real,dimids,ragoutid)
if(rcode /= nf90_noerr) write(*,*)"netcdf error =
    ",trim(nf90_strerror(rcode))

rcode = nf90_put_att(ncidout,lonoutid, 'long_name',trim(longname(1)))
rcode = nf90_put_att(ncidout,latoutid, 'long_name',trim(longname(2)))
rcode = nf90_put_att(ncidout,timeoutid, 'long_name',trim(longname(4)))
rcode = nf90_put_att(ncidout,levoutid, 'long_name',trim(longname(3)))
rcode = nf90_put_att(ncidout,dbloutid, 'long_name',trim(longname(5)))
rcode = nf90_put_att(ncidout,enloutid, 'long_name',trim(longname(5)))
rcode = nf90_put_att(ncidout,graoutid, 'long_name',trim(longname(5)))
rcode = nf90_put_att(ncidout,ragoutid, 'long_name',trim(longname(5)))
if(rcode /= nf90_noerr) write(*,*)"netcdf error =
    ",trim(nf90_strerror(rcode))

rcode = nf90_put_att(ncidout,lonoutid,'units',trim(units(1)))
rcode = nf90_put_att(ncidout,latoutid,'units',trim(units(2)))
rcode = nf90_put_att(ncidout,timeoutid,'units',trim(units(4)))
rcode = nf90_put_att(ncidout,levoutid,'units',trim(units(3)))
rcode = nf90_put_att(ncidout,dbloutid,'units',trim(units(5)))
rcode = nf90_put_att(ncidout,enloutid,'units',trim(units(5)))
rcode = nf90_put_att(ncidout,graoutid,'units',trim(units(5)))
rcode = nf90_put_att(ncidout,ragoutid,'units',trim(units(5)))
if(rcode /= nf90_noerr) write(*,*)"netcdf error =
    ",trim(nf90_strerror(rcode))

rcode = nf90_enddef(ncidout) !end definition mode

! NetCDF file data addition, basic dimension information
rcode = nf90_put_var(ncidout,lonoutid,xlon, start(1:2),count(1:2))

```

```

rcode = nf90_put_var(ncidout,latoutid,xlat, start(1:2),count(1:2))
rcode = nf90_put_var(ncidout,timeoutid,idy, start(4:4),count(4:4))
rcode = nf90_put_var(ncidout,levoutid,(/1/),start(3:3),count(3:3))
rcode = nf90_put_var(ncidout,specoutid,(/ (i,i=1,nspec) /),start(4:4),
    phen_count(4:4))
rcode = nf90_put_var(ncidout,yroutid,iyr,start(3:3),phen_count(3:3))
rcode = nf90_put_var(ncidout,lcoutid,frac_area(:, :, 13) + frac_area(:, :, 14),
    start(1:2),count(1:2))
rcode = nf90_put_var(ncidout,sdoyoutid,sDOY,(/1,1,1,1/),phen_count)
rcode = nf90_put_var(ncidout,sdoyoutid,sDOY,(/1,1,1,1/),phen_count)
rcode = nf90_put_var(ncidout,edoyoutid,eDOY,(/1,1,1,1/),phen_count)
rcode = nf90_put_var(ncidout,duroutid,dur,(/1,1,1,1/),phen_count)
if(rcode /= nf90_noerr) write(*,*)"netcdf error =
    ",trim(nf90_strerror(rcode))

!---Calculate pollen count-----

wid = 3 ! mcwoz edit: gaussian width (makes control of the model's width
    easier)
dbl_poll = 0.
enl_poll = 0.
gra_poll = 0.
rag_poll = 0.
write(*,*) 'starting emissions calculation loop...'
do iv2 = 1,nspec ! -2 cuts off the grasses
    plac_flag = .true. ! write out which PFT this taxon's emissions will be
        added to
    cnt = 1 ! now counting days for total period of emissions
    write(*,*) 'Calculating taxon...',iv2,name(iv2)
    do i = 1,nx
        do ii = 1,ny
            cnt = 1
            do iv = yrst,yrend
                if (year(iv) .eq. '2004' .or. year(iv) .eq. '2008') then
                    ndy = 366
                else
                    ndy = 365
                end if
                tot_flx = 0
                if (dur(i,ii,iv,iv2).gt.0) then
                    if(iv.lt.nyr) then
                        mu1 = sDOY(i,ii,iv,iv2) + dur(i,ii,iv,iv2)/2.
                        mu2 = (ndy+sDOY(i,ii,iv+1,iv2)) + dur(i,ii,iv
                            +1,iv2)/2.
                        sigma1 = dur(i,ii,iv,iv2)/wid
                        sigma2 = dur(i,ii,iv+1,iv2)/wid
                        do jj = 1,ndy
                            tot_flx = tot_flx + exp(-(real(jj)-mu1)**2./(2.*
                                sigma1**2))+exp(-(real(jj)-mu2)**2./(2.*
                                    sigma2**2))
                        end do
                        ef_d = ef(iv2)/tot_flx ! daily emissions flux is
                            division of annual emission factor over total
                            yearly flux
                    else
                        mu = sDOY(i,ii,iv,iv2) + dur(i,ii,iv,iv2)/2.

```

```

        sigma = dur(i,ii,iv,iv2)/wid
        do jj = 1,ndy
            tot_flx = tot_flx + exp(-(real(jj)-mu)**2./
                (2.*sigma**2))
        end do
        ef_d = ef(iv2)/tot_flx
    end if
do iii = 1,ndy
    ! switch for doing season overlap (cannot calculate
    ! overlap for final season because no future start/
    ! end dates)
    if(iv.lt.nyr) then
        gphen = exp(-(real(iii)-mu1)**2./(2.*sigma1**2))+
            exp(-(real(iii)-mu2)**2./(2.*sigma2**2))
    else
        gphen = exp(-(real(iii)-mu)**2./(2.*sigma**2))
    end if
    if (iv2.eq.4 .or. iv2.eq.7) then ! ENL taxa
        if(plac_flag) write(*,*) 'adding to ENL PFT'
        if(plac_flag) write(*,*) 'Year ', iv
        enl_poll(i,ii,1,cnt) = enl_poll(i,ii,1,cnt) + ef_d*
            frac_area(i,ii,iv2)*gphen
    end if
    if (iv2.eq.13 .or. iv2.eq.14) then ! grass taxa
        if(plac_flag) write(*,*) 'adding to grass PFT'
        if(plac_flag) write(*,*) 'Year ', iv
        gra_poll(i,ii,1,cnt) = gra_poll(i,ii,1,cnt) + ef_d*
            frac_area(i,ii,iv2)*gphen
    end if
    if (iv2.eq.15) then ! ragweed
        if(plac_flag) write(*,*) 'adding to ragweed PFT'
        if(plac_flag) write(*,*) 'Year ', iv
        rag_poll(i,ii,1,cnt) = rag_poll(i,ii,1,cnt) + ef_d*
            frac_area(i,ii,iv2)*gphen
    end if
    if (iv2.eq.1 .or. iv2.eq.2 .or. iv2.eq.3 .or. iv2.eq.
        5 .or. iv2.eq.6 .or. iv2.eq.8 .or. iv2.eq.9 .or. iv
        2.eq.10 .or. iv2.eq.11 .or. iv2.eq.12) then ! DBL
        taxa
        if(plac_flag) write(*,*) 'adding to DBL PFT'
        if(plac_flag) write(*,*) 'Year ', iv
        dbl_poll(i,ii,1,cnt) = dbl_poll(i,ii,1,cnt) + ef_d*
            frac_area(i,ii,iv2)*gphen
    end if
    plac_flag = .false.
    cnt = cnt + 1 ! update the day for pc
end do !day loop
end if ! if duration not equal to zero
end do ! year loop
end do ! latitude loop
end do ! longitude loop
end do ! end iv2 species loop

```

```

rcode = nf90_put_var(ncidout,dbloutid,dbl_poll,start=start,count=count)
rcode = nf90_put_var(ncidout,enloutid,enl_poll,start=start,count=count)
rcode = nf90_put_var(ncidout,graoutid,gra_poll,start=start,count=count)

```

```
rcode = nf90_put_var(ncidout,ragoutid,rag_poll,start=start,count=count)

if(rcode /= nf90_noerr) write(*,*)"netcdf error =
    ",trim(nf90_strerror(rcode))

rcode = nf90_close(ncidout)

end program fluxcode
```