**Bloom modeling part**

Produce coccolithophore cross-section and bloom state equations.

(\* get coccolithophore cross section and get bloom state equations. Need to note actual equations and to add gapshape parameters \*)

(\* note that the core radius rc is given by rc=2 Sqrt[ao^2/b] to follow Zhai proportions \*)

Produce ft2 exclusion factor which is the ratio of the coccolith core center area to the total area of the coccolith. It is required to obtain the cross-section of the coccolithophores.

(47)

Expressing the exclusion factor in terms of the geometry of the coccolith we have:

(48)

For liths with the morphology measured by (Young et al., 2014) we have

(\* core exclusion factor for Young morphology \*)

ftsqryoung=0.3635

Produce the geometric cross-section of the coccolithophore.

(\* geometric cross section of coccolithophore \*)

crosslithbloomgeo[ovl\_,ftsqr\_,tln\_,aob\_,ao\_]:=ovl 2 Pi(4 ao^2/aob)(1-ftsqr)(1+tln (1+aob)/(2aob))

Produce the backscattering cross-section of the coccolithophore.

crosslithbloomgen[ovl\_,ftsqr\_,tln\_,index\_,gapshape\_,ngap\_,gapratio\_,wwn\_,wrn\_,aob\_,ao\_,wave\_]:=

qbblithgen[index,gapshape,ngap,gapratio,wwn,wrn,aob,ao,wave]crossgeo[tln,ao,ao/aob]

crosslithbloomgeo[ovl,ftsqr,tln,aob,ao]

(\* need qabs for coccolithophore cross-section wavelenght in microns\*)

del[wave\_]:=4 kabscc[wave] 2 Pi/wave

qabs[rc\_,wave\_]:=2((1/2)+

(Exp[-del[wave]rc]/(del[wave]rc))+((Exp[-del[wave]rc]-1)/(del[wave]rc)^2))

(\* proportionality factors for coccolithophore layers \*)

For the Hoffman interlocked model

delrsrchoffman=1/5

ftdzhai=1/4

(\* ratio of the semi-major axis of the lith to the semi-minoraxis \*)

ratioaxis=1.2

Produce the ratio of the coccolithophore cross-section to the coccoltih cross section including the effect of absorption and layers.

crossratio[ovl\_,drsrc\_,ftsqr\_,ratio\_,rc\_,wave\_]:=

2(1+((1+ratio)/(2ratio))ftsqr)/(2-qabs[2 rc,wave 1.3333]/(1+ovl drsrc)^2)

Produce the coccolithophore cross-section

crosscoccobloomgen[ovl\_,drsrc\_,ftsqr\_,tln\_,index\_,gapshape\_,ngap\_,gapratio\_,wwn\_,wrn\_,

aob\_,ao\_,wave\_]:=

crosslithbloomgen[ovl,ftsqr,tln,index,gapshape,ngap,gapratio,wwn,wrn,aob,ao,wave]/

crossratio[ovl,drsrc,ftsqr,aob,2 Sqrt[ao^2/aob],wave]

Produce the mean cococcolithophore cross-section for a mu=2, vu=2 gamma size distribution

crosscoccobloom22meangen[sig\_,mu\_,ovl\_,drsrc\_,ftsqr\_,tln\_,index\_,gapshape\_,ngap\_,

gapratio\_,wwn\_,wrn\_,aob\_,wave\_]:=

NIntegrate[crosscoccobloomgen[ovl,drsrc,ftsqr,tln,index,gapshape,ngap,gapratio,wwn,wrn,aob,ao,wave]psize22norm[betamusig22[sig],rminmusig22[mu,sig],ao],{ao,0,Infinity}]

Produce the mean cococcolith cross-section for a mu=2, vu=2 gamma size distribution

crosslithbloom22meangen[sig\_,mu\_,ovl\_,ftsqr\_,tln\_,index\_,gapshape\_,ngap\_,gapratio\_,wwn\_,wrn\_,aob\_,wave\_]:=

NIntegrate[crosslithbloomgen[ovl,ftsqr,tln,index,gapshape,ngap,gapratio,wwn,wrn,aob,ao,

wave]psize22norm[betamusig22[sig],rminmusig22[mu,sig],ao],{ao,0,Infinity}]

Produce the mean backscatter cross-section for a given bloom state

bloomstategen[flith\_,sig\_,mu\_,ovl\_,drsrc\_,ftsqr\_,tln\_,index\_,gapshape\_,ngap\_,gapratio\_,wwn\_,wrn\_,aob\_,wave]:=(1.-flith)

crosscoccobloom22meangen[sig,mu,ovl,drsrc,ftsqr,tln,index,gapshape,ngap,gapratio,wwn,wrn,aob,wave]+flith

crosslithbloom22meangen[sig,mu,ovl,ftsqr,tln,index,gapshape,ngap, gapratio,wwn,wrn,aob,

wave]

Produce test cases for comparison

(\* test case \*)

Plot[{bloomstategen[0.0,0.15,1.6,4,delrsrchoffman,ftsqryoung,ftzhai,1.2,0.01,34,0.666,wwao,wrao,aobo,wave/1.333],

bloomstategen[0.2,0.15,1.6,4,delrsrchoffman,ftsqryoung,ftzhai,1.2,0.01,34,0.666,wwao,wrao,

aobo,wave/1.333],

bloomstategen[0.4,0.15,1.6,4,delrsrchoffman,ftsqryoung,ftzhai,1.2,0.01,34,0.666,wwao,wrao,

aobo,wave/1.333],

bloomstategen[0.6,0.15,1.6,4,delrsrchoffman,ftsqryoung,ftzhai,1.2,0.01,34,0.666,wwao,wrao,

aobo,wave/1.333],

bloomstategen[0.8,0.15,1.6,4,delrsrchoffman,ftsqryoung,ftzhai,1.2,0.01,34,0.666,wwao,wrao,

aobo,wave/1.333],

bloomstategen[1.0,0.15,1.6,4,delrsrchoffman,ftsqryoung,ftzhai,1.2,0.01,34,0.666,wwao,wrao,

aobo,wave/1.333]}

,{wave,.3,1.}]