The earthquake source is represented by the point force ***f***, which may be written in terms of a moment tensor ***M*** as (omitting the source time function)

, (1)

The point force ***f*** in 2D:

, (2)

Multiplying equations (2) by the time-independent test functions, we can obtain:

, (3)

where  and  are the test functions, respectively.

Applying the identity of the Dirac delta function:

, (4)

If we can find the dimensionless parameters  satisfying:

, (5)

Applying (5) and considering the unit test function, equations (4) can be expressed:

, (6)

Therefore, the source force at each GLL node can be written:

 (7)

**In your code:**

do m=1,NGLLZ

do k=1,NGLLX

xixd = xix(k,m,ispec\_selected\_source)

xizd = xiz(k,m,ispec\_selected\_source)

gammaxd = gammax(k,m,ispec\_selected\_source)

gammazd = gammaz(k,m,ispec\_selected\_source)

G11(k,m) = Mxx\*xixd+Mxz\*xizd

G13(k,m) = Mxx\*gammaxd+Mxz\*gammazd

G31(k,m) = Mxz\*xixd+Mzz\*xizd

G33(k,m) = Mxz\*gammaxd+Mzz\*gammazd

end do

end do

! compute Lagrange polynomials at the source location

call lagrange\_any(xi\_source,NGLLX,xigll,hxis,hpxis)

call lagrange\_any(gamma\_source,NGLLZ,zigll,hgammas,hpgammas)

! calculate source array

do m=1,NGLLZ

do k=1,NGLLX

sourcearray(:,k,m) = ZERO

do iv=1,NGLLZ

do ir=1,NGLLX

sourcearray(1,k,m) = sourcearray(1,k,m) + hxis(ir)\*hgammas(iv) &

\*(G11**(ir,iv)**\*hpxis(k)\*hgammas(m) &

+G13**(ir,iv)**\*hxis(k)\*hpgammas(m))

sourcearray(2,k,m) = sourcearray(2,k,m) + hxis(ir)\*hgammas(iv) &

\*(G31**(ir,iv)**\*hpxis(k)\*hgammas(m) &

+G33**(ir,iv)**\*hxis(k)\*hpgammas(m))

end do

end do

end do

end do

According to the expression (7), the subscripts associated with G11, G13, G31 and G33 may be not correct. I think that their subscripts should be (k, m).

**The corrected version:**

do m=1,NGLLZ

do k=1,NGLLX

xixd = xix(k,m,ispec\_selected\_source)

xizd = xiz(k,m,ispec\_selected\_source)

gammaxd = gammax(k,m,ispec\_selected\_source)

gammazd = gammaz(k,m,ispec\_selected\_source)

G11(k,m) = Mxx\*xixd+Mxz\*xizd

G13(k,m) = Mxx\*gammaxd+Mxz\*gammazd

G31(k,m) = Mxz\*xixd+Mzz\*xizd

G33(k,m) = Mxz\*gammaxd+Mzz\*gammazd

end do

end do

! compute Lagrange polynomials at the source location

call lagrange\_any(xi\_source,NGLLX,xigll,hxis,hpxis)

call lagrange\_any(gamma\_source,NGLLZ,zigll,hgammas,hpgammas)

! calculate source array

do m=1,NGLLZ

do k=1,NGLLX

sourcearray(:,k,m) = ZERO

do iv=1,NGLLZ

do ir=1,NGLLX

sourcearray(1,k,m) = sourcearray(1,k,m) + hxis(ir)\*hgammas(iv) &

\*(G11**(k,m)**\*hpxis(k)\*hgammas(m) &

+G13**(k,m)**\*hxis(k)\*hpgammas(m))

sourcearray(2,k,m) = sourcearray(2,k,m) + hxis(ir)\*hgammas(iv) &

\*(G31**(k,m)**\*hpxis(k)\*hgammas(m) &

+G33**(k,m)**\*hxis(k)\*hpgammas(m))

end do

end do

end do

end do

**However, the second loop can be simplified.**

do m=1,NGLLZ

do k=1,NGLLX

sourcearray(:,k,m) = ZERO

dsrc\_dx = (G11**(k,m)**\*hpxis(k)\*hgammas(m) &

+G13**(k,m)**\*hxis(k)\*hpgammas(m))

dsrc\_dz = (G31**(k,m)**\*hpxis(k)\*hgammas(m) &

+G33**(k,m)**\*hxis(k)\*hpgammas(m))

do iv=1,NGLLZ

do ir=1,NGLLX

sourcearray(1,k,m) = sourcearray(1,k,m) + hxis(ir)\*hgammas(iv) &

\*dsrc\_dx

sourcearray(2,k,m) = sourcearray(2,k,m) + hxis(ir)\*hgammas(iv) &

\*dsrc\_dz

end do

end do

end do

end do

**If we apply the identity of the Lagrange function, i.e. sum(hxis(1:NGLLX)) = 1, and**

**Sum(hgammas(1:NGLLZ)) = 1, the two loops can be merged:**

call lagrange\_any(xi\_source,NGLLX,xigll,hxis,hpxis)

call lagrange\_any(gamma\_source,NGLLZ,zigll,hgammas,hpgammas)

sourcearray(:,:,:) = ZERO

do m=1,NGLLZ

do k=1,NGLLX

xixd = xix(k,m,ispec\_selected\_source)

xizd = xiz(k,m,ispec\_selected\_source)

gammaxd = gammax(k,m,ispec\_selected\_source)

gammazd = gammaz(k,m,ispec\_selected\_source)

G11(k,m) = Mxx\*xixd+Mxz\*xizd

G13(k,m) = Mxx\*gammaxd+Mxz\*gammazd

G31(k,m) = Mxz\*xixd+Mzz\*xizd

G33(k,m) = Mxz\*gammaxd+Mzz\*gammazd

dsrc\_dx = (G11**(k,m)**\*hpxis(k)\*hgammas(m) &

+G13**(k,m)**\*hxis(k)\*hpgammas(m))

dsrc\_dz = (G31**(k,m)**\*hpxis(k)\*hgammas(m) &

+G33**(k,m)**\*hxis(k)\*hpgammas(m))

sourcearray(1,k,m) = sourcearray(1,k,m) + dsrc\_dx

sourcearray(2,k,m) = sourcearray(2,k,m) + dsrc\_dz

end do

end do

**Certainly, your code is correct for linear mapping element because G(ir,iv) = G(k,m) in that case. However, it is not correct for nonlinear mapping element!**

**Now, the code is consistent with equations (7).**