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> Sinv:=Matrix(<<1,0,0>|<0,cos(phi)/(sin(theta)*sin(phi)+(cos(phi))^2),-sin(phi)/(sin(theta)*sin(phi)+(cos(phi))^2>|<-sin(theta),sin(theta)*cos(theta)/(sin(theta)*sin(phi)+(cos(phi))^2),cos(theta)*cos(phi)/(sin(theta)*sin(phi)+(cos(phi))^2>>);
>

$$Sinv := \begin{bmatrix} 1 & 0 & -\sin(\theta) \\ 0 & \frac{\cos(\phi)}{\sin(\theta)\sin(\phi)+\cos(\phi)^2} & \frac{\sin(\theta)\cos(\theta)}{\sin(\theta)\sin(\phi)+\cos(\phi)^2} \\ 0 & -\frac{\sin(\phi)}{\sin(\theta)\sin(\phi)+\cos(\phi)^2} & \frac{\cos(\theta)\cos(\phi)}{\sin(\theta)\sin(\phi)+\cos(\phi)^2} \end{bmatrix}$$

> J:=Matrix(<<Jxx,Jyx,Jzx>|<Jxy,Jyy,Jzy>|<Jxz,Jyz,Jzz>>);

$$J := \begin{bmatrix} J_{xx} & J_{xy} & J_{xz} \\ J_{yx} & J_{yy} & J_{yz} \\ J_{zx} & J_{zy} & J_{zz} \end{bmatrix}$$

> SinvT:=Matrix(<<1,0,-sin(theta)>|<0,cos(phi)/(sin(theta)*sin(phi)+(cos(phi))^2),sin(theta)*cos(theta)/(sin(theta)*sin(phi)+(cos(phi))^2>|<0,-sin(phi)/(sin(theta)*sin(phi)+(cos(phi))^2),cos(theta)*cos(phi)/(sin(theta)*sin(phi)+(cos(phi))^2>>);

$$SinvT := \begin{bmatrix} 1 & 0 & 0 \\ 0 & \frac{\cos(\phi)}{\sin(\theta)\sin(\phi)+\cos(\phi)^2} & \frac{\sin(\phi)}{\sin(\theta)\sin(\phi)+\cos(\phi)^2} \\ -\sin(\theta) & \frac{\sin(\theta)\cos(\theta)}{\sin(\theta)\sin(\phi)+\cos(\phi)^2} & \frac{\cos(\theta)\cos(\phi)}{\sin(\theta)\sin(\phi)+\cos(\phi)^2} \end{bmatrix}$$

> Sdot:=(<<0,0,0>|<cos(phi)*phidot*tan(theta)+sin(phi)*sec(theta)^2*thetadot,-sin(phi)*phidot,(cos(theta)*cos(phi)*phidot+sin(phi)*sin(theta)*thetadot)/(cos(theta)^2>|<-sin(phi)*phidot*tan(theta)+cos(phi)*sec(theta)^2,-cos(theta)*thetadot,(-cos(theta)*sin(phi)*phidot+cos(phi)*sin(theta)*thetadot)/(cos(theta)^2>>);
Sdot :=

$$\begin{bmatrix} [0, \cos(\phi) \text{phidot} \tan(\theta) + \sin(\phi) \sec(\theta)^2 \text{thetadot}, -\sin(\phi) \text{phidot} \tan(\theta) + \cos(\phi) \sec(\theta)^2] \\ [0, -\sin(\phi) \text{phidot}, -\cos(\theta) \text{thetadot}] \\ \left[ 0, \frac{\cos(\theta) \cos(\phi) \text{phidot} + \sin(\phi) \sin(\theta) \text{thetadot}}{\cos(\theta)^2}, \right. \\ \left. \frac{-\cos(\theta) \sin(\phi) \text{phidot} + \cos(\phi) \sin(\theta) \text{thetadot}}{\cos(\theta)^2} \right] \end{bmatrix}$$

> xddot:=Matrix(<<phiddot,thetaddot,psiddot>>);

$$xddot := \begin{bmatrix} \text{phiddot} \\ \text{thetaddot} \\ \text{psiddot} \end{bmatrix}$$

> xdot:=Matrix(<<phidot,thetadot,psidot>>);

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$$x_{dot} := \begin{bmatrix} phidot \\ thetadot \\ psidot \end{bmatrix}$$

> **H:=Matrix([[0,-Hz,Hy],[Hz,0,-Hx],[-Hy,Hx,0]]);**

$$H := \begin{bmatrix} 0 & -Hz & Hy \\ Hz & 0 & -Hx \\ -Hy & Hx & 0 \end{bmatrix}$$

> **JstarXddot:=SinvT.J.Sinv.xddot;**

JstarXddot :=

$$\left[J_{xx} phiddot + \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) thetaddot + \left(-\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) psiddot \right]$$

$$\left[\left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) phiddot + \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right.$$

$$\left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \right) thetaddot + \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta)$$

$$+ \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)$$

$$\left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi) \right) psiddot \right]$$

$$\left[\left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) phiddot + \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right]$$

$$\begin{aligned}
& \frac{\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& - \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \theta\dot{\text{addot}} + \Bigg(\\
& - \left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \\
& + \frac{\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \psi\dot{\text{iddot}}
\end{aligned}$$

> **CstarXdot := (-SinvT.J.Sinv.Sdot.Sinv-SinvT.H.Sinv).xdot;**
>

CstarXdot :=

$$\begin{aligned}
& \left[\left(- \left(\left(J_{xx} (\cos(\phi) \phi\dot{\text{idot}} \tan(\theta) + \sin(\phi) \sec(\theta)^2 \theta\dot{\text{addot}}) \right. \right. \right. \right. \\
& - \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \phi\dot{\text{idot}} + \left(\\
& \left(-\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \\
& \left. \left. \left. \left. (\cos(\theta) \cos(\phi) \phi\dot{\text{idot}} + \sin(\phi) \sin(\theta) \theta\dot{\text{addot}}) \right) / \cos(\theta)^2 \right) \cos(\phi) \right) / (\\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2) + \left(\left(J_{xx} (-\sin(\phi) \phi\dot{\text{idot}} \tan(\theta) + \cos(\phi) \sec(\theta)^2) \right. \right. \\
& - \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \theta\dot{\text{addot}} + \left(\\
& \left(-\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \\
& \left. \left. (-\cos(\theta) \sin(\phi) \phi\dot{\text{idot}} + \cos(\phi) \sin(\theta) \theta\dot{\text{addot}}) \right) / \cos(\theta)^2 \right) \sin(\phi) \right) / (\\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2) + \frac{\cos(\phi) H_z}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\sin(\phi) H_y}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \theta\dot{\text{addot}} + \Bigg(\left(\left(\right. \right. \right. \right.
\end{aligned}$$

$$\begin{aligned}
& J_{xx} (\cos(\phi) \dot{\phi} + \sin(\phi) \sec(\theta)^2 \dot{\theta}) \\
& - \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \dot{\phi} + \left(\right. \\
& \left. \left(-\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. (\cos(\theta) \cos(\phi) \dot{\phi} + \sin(\phi) \sin(\theta) \dot{\theta}) \right) / \cos(\theta)^2 \sin(\theta) \cos(\theta) \Bigg) / \left(\right. \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 - \left(\left(J_{xx} (-\sin(\phi) \dot{\phi} \tan(\theta) + \cos(\phi) \sec(\theta)^2) \right. \right. \\
& \left. \left. - \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \dot{\theta} \right) + \left(\right. \\
& \left. \left(-\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. \left. (-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta}) \right) \right) / \cos(\theta)^2 \cos(\theta) \cos(\phi) \Bigg) / \left(\right. \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 + \frac{\sin(\theta) \cos(\theta) Hz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\cos(\theta) \cos(\phi) Hy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \dot{p}_s \\
& \left[\left(-\frac{\cos(\phi) Hz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Hy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \dot{\phi} + \left(\left(\right. \right. \right. \\
& \left. \left. \left. \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \right. \\
& \left. \left. (\cos(\phi) \dot{\phi} \tan(\theta) + \sin(\phi) \sec(\theta)^2 \dot{\theta}) - \left(\right. \right. \right. \\
& \left. \left. \left. \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \right. \\
& \left. \left. \left. \sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) \right. \right. \\
& \left. \left. \left(-\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \right) \sin(\phi) \dot{\phi} + \left(\left(\right. \right. \right. \\
& \left. \left. \left. \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right) \right. \right.
\end{aligned}$$

$$\begin{aligned}
& + \frac{\left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \\
& (\cos(\theta) \cos(\phi) \dot{\phi} + \sin(\phi) \sin(\theta) \dot{\theta}) \Bigg) / \cos(\theta)^2 \Bigg) \cos(\phi) \Bigg) / \Bigg(\\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 \Bigg) + \Bigg(\\
& \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) (-\sin(\phi) \dot{\phi} \tan(\theta) + \cos(\phi) \sec(\theta)^2) \\
& - \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \\
& - \left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \Bigg) \cos(\theta) \dot{\theta} + \Bigg(\\
& \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \\
& + \frac{\left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \\
& (-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta}) \Bigg) / \cos(\theta)^2 \Bigg) \sin(\phi) \Bigg) / \Bigg(\\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 \Bigg) \dot{\theta} + \Bigg(- \left(\left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right.
\end{aligned}$$

$$\begin{aligned}
& (\cos(\phi) \dot{\phi} + \sin(\phi) \sec(\theta)^2 \dot{\theta}) - \left(\right. \\
& \left. \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \\
& \left. \left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \right) \sin(\phi) \dot{\phi} + \left(\right. \\
& \left. \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \\
& \left. \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta) \right. \\
& \left. \left. + \frac{\left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. \left(\cos(\theta) \cos(\phi) \dot{\phi} + \sin(\phi) \sin(\theta) \dot{\theta} \right) \right/ \cos(\theta)^2 \right) \sin(\theta) \cos(\theta) \Bigg) / \\
& \left(\sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) - \left(\right. \\
& \left. \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) (-\sin(\phi) \dot{\phi} \tan(\theta) + \cos(\phi) \sec(\theta)^2) \right. \\
& \left. \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \\
& \left. \left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \right) \cos(\theta) \dot{\theta} + \left(\right. \\
& \left. \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right)
\end{aligned}$$

$$\begin{aligned}
& + \frac{\left(\frac{\cos(\phi) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(\frac{\cos(\phi) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \\
& (-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta}) \Bigg) / \cos(\theta)^2 \Bigg) \cos(\theta) \cos(\phi) \Bigg) / \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 + \left(\frac{\cos(\phi) Hz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\sin(\phi) Hy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \\
& + \frac{\sin(\phi) Hx \sin(\theta) \cos(\theta)}{(\sin(\theta) \sin(\phi) + \cos(\phi)^2)^2} + \frac{\cos(\phi)^2 Hx \cos(\theta)}{(\sin(\theta) \sin(\phi) + \cos(\phi)^2)^2} \Bigg) \dot{\psi} \\
& \Bigg[\left(-\frac{\sin(\theta) \cos(\theta) Hz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Hy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \dot{\phi} + \left(-\left(\frac{\sin(\theta) \cos(\theta) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. (\cos(\phi) \dot{\phi} \tan(\theta) + \sin(\phi) \sec(\theta)^2 \dot{\theta}) - \right. \\
& \left. \left(-\sin(\theta) Jxy + \frac{\sin(\theta) \cos(\theta) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \\
& \left. \left(-\sin(\theta) Jxz + \frac{\sin(\theta) \cos(\theta) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \right) \sin(\phi) \dot{\phi} + \Bigg] \\
& \left(-\left(-\sin(\theta) Jxx + \frac{\sin(\theta) \cos(\theta) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \\
& \left. + \frac{\left(-\sin(\theta) Jxy + \frac{\sin(\theta) \cos(\theta) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right)
\end{aligned}$$

$$\begin{aligned}
& + \frac{\left(-\sin(\theta) Jxz + \frac{\sin(\theta) \cos(\theta) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& \left. \left(\cos(\theta) \cos(\phi) \dot{\phi} + \sin(\phi) \sin(\theta) \dot{\theta} \right) \right/ \cos(\theta)^2 \left. \cos(\phi) \right/ \left(\right. \\
& \left. \left. \sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) + \left(\right. \\
& \left. \left. \left(-\sin(\theta) Jxx + \frac{\sin(\theta) \cos(\theta) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. \left. \left(-\sin(\phi) \dot{\phi} + \cos(\phi) \sec(\theta)^2 \right) - \left(\right. \right. \\
& \left. \left. \left. \left(-\sin(\theta) Jxy + \frac{\sin(\theta) \cos(\theta) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \right. \\
& \left. \left. \left. \sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) \right. \right. \\
& \left. \left. \left. - \left(\left(-\sin(\theta) Jxz + \frac{\sin(\theta) \cos(\theta) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \right. \right. \right. \\
& \left. \left. \left. \sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) \cos(\theta) \dot{\theta} \right) \right. \right. \\
& + \left(\left(-\sin(\theta) Jxx + \frac{\sin(\theta) \cos(\theta) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \\
& + \left. \left. \left(-\sin(\theta) Jxy + \frac{\sin(\theta) \cos(\theta) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta) \right. \right. \\
& \left. \left. \sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) \right. \right. \\
& + \left(\left(-\sin(\theta) Jxz + \frac{\sin(\theta) \cos(\theta) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi) \right. \right. \\
& \left. \left. \sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) \right. \right. \\
& \left. \left. \left(-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta} \right) \right. \right. \left. \sin(\phi) \right) \right/ \cos(\theta)^2 \left. \sin(\phi) \right) \right/ \left(\right.
\end{aligned}$$

$$\begin{aligned}
& \frac{\left(\sin(\theta) Hz + \frac{\cos(\theta) \cos(\phi) Hx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(-\sin(\theta) Hy - \frac{\sin(\theta) \cos(\theta) Hx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \theta\dot{\text{adot}} + \left(\left(\right. \right. \\
& \left. \left. \left(-\sin(\theta) Jxx + \frac{\sin(\theta) \cos(\theta) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. \left. (\cos(\phi) \phi\dot{\text{idot}} \tan(\theta) + \sin(\phi) \sec(\theta)^2 \theta\dot{\text{adot}}) - \right. \right. \\
& \left. \left. \left(-\sin(\theta) Jxy + \frac{\sin(\theta) \cos(\theta) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \\
& \left. \left. \left. - \frac{\left(-\sin(\theta) Jxz + \frac{\sin(\theta) \cos(\theta) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \phi\dot{\text{idot}} + \right. \right. \\
& \left. \left. \left(\left(-\sin(\theta) Jxx + \frac{\sin(\theta) \cos(\theta) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \right. \\
& \left. \left. + \frac{\left(-\sin(\theta) Jxy + \frac{\sin(\theta) \cos(\theta) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right. \right. \\
& \left. \left. + \frac{\left(-\sin(\theta) Jxz + \frac{\sin(\theta) \cos(\theta) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \right. \\
& \left. \left. (\cos(\theta) \cos(\phi) \phi\dot{\text{idot}} + \sin(\phi) \sin(\theta) \theta\dot{\text{adot}}) \right) / \cos(\theta)^2 \right) \sin(\theta) \cos(\theta) \Bigg) / \left(\right. \\
& \left. \left. \left(\sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) - \left(\left(\right. \right. \right. \\
& \left. \left. \left. \left(-\sin(\theta) Jxx + \frac{\sin(\theta) \cos(\theta) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \right. \right. \\
\end{aligned}$$

$$\begin{aligned}
& (-\sin(\phi) \dot{\phi} + \cos(\phi) \sec(\theta)^2) - \left(\frac{\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right. \\
& \left. - \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \dot{\theta} \\
& + \left(\left(\left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \right. \\
& + \frac{\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& \left. \left. + \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. \left(-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta} \right) \right) / \cos(\theta)^2 \right) \cos(\theta) \cos(\phi) \Bigg) / \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 + \left(\frac{\sin(\theta) \cos(\theta) H_z}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\cos(\theta) \cos(\phi) H_y}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \\
& - \frac{\left(\sin(\theta) H_z + \frac{\cos(\theta) \cos(\phi) H_x}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& - \frac{\left(-\sin(\theta) H_y - \frac{\sin(\theta) \cos(\theta) H_x}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg] \dot{\psi}
\end{aligned}$$

> **RHS :=**JstarXddot+CstarXdot;

>

RHS :=

$$\left[J_{xx} \dot{\phi} + \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \dot{\theta} \right]$$

$$\begin{aligned}
& + \left(-\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) p\dot{s} + \left(- \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \dot{\phi} + \left(\right. \right. \\
& \left. \left. -\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. (\cos(\theta) \cos(\phi) \dot{\phi} + \sin(\phi) \sin(\theta) \dot{\theta}) \right) / \cos(\theta)^2 \right) \cos(\phi) \Big) / \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 + \left(\left(J_{xx} (-\sin(\phi) \dot{\phi} \tan(\theta) + \cos(\phi) \sec(\theta)^2) \right. \right. \\
& \left. \left. - \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \dot{\theta} + \left(\right. \right. \\
& \left. \left. -\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. \left. (-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta}) \right) \right) / \cos(\theta)^2 \right) \sin(\phi) \Big) / \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 + \frac{\cos(\phi) H_z}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\sin(\phi) H_y}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Big) \dot{\theta} + \left(- \left(\right. \right. \\
& \left. \left. J_{xx} (\cos(\phi) \dot{\phi} \tan(\theta) + \sin(\phi) \sec(\theta)^2 \dot{\theta}) \right. \right. \\
& \left. \left. - \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \dot{\phi} + \left(\right. \right. \\
& \left. \left. -\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. \left. (\cos(\theta) \cos(\phi) \dot{\phi} + \sin(\phi) \sin(\theta) \dot{\theta}) \right) \right) / \cos(\theta)^2 \right) \sin(\theta) \cos(\theta) \Big) / \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 - \left(\left(J_{xx} (-\sin(\phi) \dot{\phi} \tan(\theta) + \cos(\phi) \sec(\theta)^2) \right. \right. \\
& \left. \left. - \left(\frac{J_{xy} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{J_{xz} \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \dot{\theta} + \left(\right. \right. \\
& \left. \left. -\sin(\theta) J_{xx} + \frac{J_{xy} \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{J_{xz} \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. \left. (-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta}) \right) \right) / \cos(\theta)^2 \right) \cos(\theta) \cos(\phi) \Big) /
\end{aligned}$$

$$\begin{aligned}
& \left. \left[\sin(\theta) \sin(\phi) + \cos(\phi)^2 \right] + \frac{\sin(\theta) \cos(\theta) Hz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\cos(\theta) \cos(\phi) Hy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right] psidot \\
& \left[\left(\frac{\cos(\phi) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) phiddot + \right. \\
& \left. \left(\frac{\cos(\phi) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \\
& \left. \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right. \right. \\
& \left. \left(\frac{\cos(\phi) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \right] thetaddot + \right. \\
& \left. \left. \left. \left. \left(\frac{\cos(\phi) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \right. \right. \\
& \left. \left. \left. \left. \left(\frac{\cos(\phi) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta) \right. \right. \right. \\
& \left. \left. \left. \left. \left. + \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right. \right. \right. \right. \\
& \left. \left. \left. \left. \left(\frac{\cos(\phi) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi) \right. \right. \right. \right. \\
& \left. \left. \left. \left. \left. + \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) psiddot \right. \right. \right. \right. \\
& \left. \left. \left. \left. \left(- \frac{\cos(\phi) Hz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Hy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) phidot + \right. \right. \right. \right. \\
& \left. \left. \left. \left. \left(\frac{\cos(\phi) Jyx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzx}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \right. \right. \right. \\
& \left. \left. \left. \left. \left((\cos(\phi) phidot \tan(\theta) + \sin(\phi) \sec(\theta)^2 thetadot) - \right. \right. \right. \right. \\
& \left. \left. \left. \left. \left(\frac{\cos(\phi) Jyy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzy}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \right. \right. \right. \\
& \left. \left. \left. \left. \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right. \right. \right. \right. \\
& \left. \left. \left. \left. \left(\frac{\cos(\phi) Jyz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) Jzz}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \right. \right. \right. \right. \\
& \left. \left. \left. \left. \left. + \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) phidot + \right. \right. \right. \right.
\end{aligned}$$

$$\begin{aligned}
& \left(- \frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \\
& + \frac{\left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \\
& (\cos(\theta) \cos(\phi) \dot{\phi} + \sin(\phi) \sin(\theta) \dot{\theta}) \Bigg) / \cos(\theta)^2 \Bigg) \cos(\phi) \Bigg) / \\
& \left(\sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) + \left(\left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) (-\sin(\phi) \dot{\phi} \tan(\theta) + \cos(\phi) \sec(\theta)^2) \right. \\
& - \left(\frac{\left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right. \\
& - \left. \left. \frac{\left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \dot{\theta} \right) + \left(\left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \\
& + \left(\frac{\left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right. \\
& + \left. \left. \frac{\left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& (-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta}) \Bigg) / \cos(\theta)^2 \Bigg) \sin(\phi) \Bigg) /
\end{aligned}$$

$$\begin{aligned}
& \left. \sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) \theta \cdot \dot{\theta} + \left(- \left(\left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \right. \\
& (\cos(\phi) \phi \cdot \dot{\phi} \tan(\theta) + \sin(\phi) \sec(\theta)^2 \theta \cdot \dot{\theta}) - \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \\
& \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \phi \cdot \dot{\phi} + \left(\left(\right. \right. \\
& - \left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \\
& \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \theta \cdot \dot{\theta} + \left(\left(\right. \right. \\
& - \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \\
& \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta) \\
& + \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta) \\
& \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \\
& + \left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi) \\
& \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \\
& (\cos(\theta) \cos(\phi) \phi \cdot \dot{\phi} + \sin(\phi) \sin(\theta) \theta \cdot \dot{\theta}) \Big/ \cos(\theta)^2 \Big) \sin(\theta) \cos(\theta) \Big) \Big/ \\
& \left(\left(\right. \right. \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 \Big) - \left(\left(\right. \right. \\
& \left(\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) (-\sin(\phi) \phi \cdot \dot{\phi} \tan(\theta) + \cos(\phi) \sec(\theta)^2) \\
& - \left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \\
& \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \\
& - \left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \\
& \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \theta \cdot \dot{\theta} + \left(\left(\right. \right.
\end{aligned}$$

$$\begin{aligned}
& \left[\frac{\cos(\phi) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right] \sin(\theta) \\
& + \frac{\left(\frac{\cos(\phi) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(\frac{\cos(\phi) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\sin(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg] \\
& (-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta}) \Bigg] / \cos(\theta)^2 \Bigg] \cos(\theta) \cos(\phi) \Bigg] / \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 + \left(\frac{\cos(\phi) H_z}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\sin(\phi) H_y}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \\
& + \frac{\sin(\phi) H_x \sin(\theta) \cos(\theta)}{(\sin(\theta) \sin(\phi) + \cos(\phi)^2)^2} + \frac{\cos(\phi)^2 H_x \cos(\theta)}{(\sin(\theta) \sin(\phi) + \cos(\phi)^2)^2} \Bigg] \dot{\psi} \\
& \left[\left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \dot{\phi} \right. \\
& \left. + \left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \\
& \left. - \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right] \dot{\theta} \\
& - \left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \\
& + \frac{\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg] \dot{\psi}
\end{aligned}$$

$$\begin{aligned}
& + \left(-\frac{\sin(\theta) \cos(\theta) H_z}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) H_y}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \dot{\phi} + \left(- \left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \quad \left. (\cos(\phi) \dot{\phi} \tan(\theta) + \sin(\phi) \sec(\theta)^2 \dot{\theta}) - \left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \\
& \quad \left. - \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \dot{\phi} + \left(\right. \\
& \quad \left. \left(-\left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \right. \\
& \quad \left. \left. + \frac{\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right. \right. \\
& \quad \left. \left. + \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \quad \left. (\cos(\theta) \cos(\phi) \dot{\phi} + \sin(\phi) \sin(\theta) \dot{\theta}) \right) / \cos(\theta)^2 \right) \cos(\phi) \Bigg) / \\
& \quad \left(\sin(\theta) \sin(\phi) + \cos(\phi)^2 \right) + \left(\right. \\
& \quad \left. \left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \quad \left. \left(-\sin(\phi) \dot{\phi} \tan(\theta) + \cos(\phi) \sec(\theta)^2 \right) - \left(\right. \right.
\end{aligned}$$

$$\begin{aligned}
& \left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \\
& - \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \cos(\theta) \text{thetadot} \\
& + \left(\left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \\
& + \frac{\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \Bigg) \\
& (-\cos(\theta) \sin(\phi) \text{phidot} + \cos(\phi) \sin(\theta) \text{thetadot}) \Bigg/ \cos(\theta)^2 \Bigg) \sin(\phi) \Bigg/ \left(\frac{\sin(\theta) H_z + \frac{\cos(\theta) \cos(\phi) H_x}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right. \\
& \left. + \frac{\left(-\sin(\theta) H_y - \frac{\sin(\theta) \cos(\theta) H_x}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \text{thetadot} + \left(\left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& (\cos(\phi) \text{phidot} \tan(\theta) + \sin(\phi) \sec(\theta)^2 \text{thetadot}) - \left. \left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \\
& \left. \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right)
\end{aligned}$$

$$\begin{aligned}
& - \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \sin(\phi) \dot{\phi} + \\
& \left(-\left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right. \\
& + \frac{\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \\
& (\cos(\theta) \cos(\phi) \dot{\phi} + \sin(\phi) \sin(\theta) \dot{\theta}) \Bigg/ \cos(\theta)^2 \Bigg| \sin(\theta) \cos(\theta) \Bigg/ (\\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2) - \left(\left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& (-\sin(\phi) \dot{\phi} \tan(\theta) + \cos(\phi) \sec(\theta)^2) - \left(-\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\phi) \right. \\
& \left. \left. \frac{\sin(\theta) \sin(\phi) + \cos(\phi)^2}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \right. \\
& \left. \left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\phi) \right) \cos(\theta) \dot{\theta} \\
& + \left(\left(-\left(-\sin(\theta) J_{xx} + \frac{\sin(\theta) \cos(\theta) J_{yx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zx}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \right)
\end{aligned}$$

$$\begin{aligned}
& + \frac{\left(-\sin(\theta) J_{xy} + \frac{\sin(\theta) \cos(\theta) J_{yy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zy}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& + \frac{\left(-\sin(\theta) J_{xz} + \frac{\sin(\theta) \cos(\theta) J_{yz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} + \frac{\cos(\theta) \cos(\phi) J_{zz}}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& \left. \left(-\cos(\theta) \sin(\phi) \dot{\phi} + \cos(\phi) \sin(\theta) \dot{\theta} \right) \right/ \cos(\theta)^2 \left. \cos(\theta) \cos(\phi) \right/ \\
& \sin(\theta) \sin(\phi) + \cos(\phi)^2 + \left(\frac{\sin(\theta) \cos(\theta) H_z}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} - \frac{\cos(\theta) \cos(\phi) H_y}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \\
& - \frac{\left(\sin(\theta) H_z + \frac{\cos(\theta) \cos(\phi) H_x}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \sin(\theta) \cos(\theta)}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \\
& - \left. \left. \left. \left(-\sin(\theta) H_y - \frac{\sin(\theta) \cos(\theta) H_x}{\sin(\theta) \sin(\phi) + \cos(\phi)^2} \right) \cos(\theta) \cos(\phi) \right) \right. \right. \right] \dot{\psi}
\end{aligned}$$