

# HERCORE: Highly Efficient and quasi-Realistic CORonal and coronal mass Ejection modeling



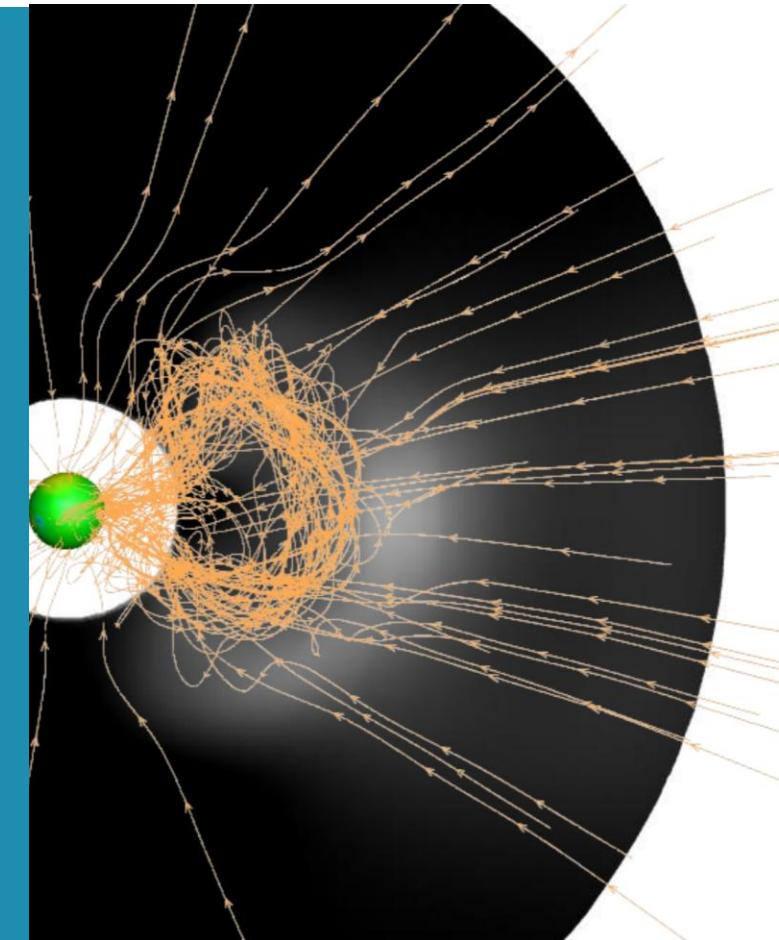
Dr. Haopeng Wang

*KU Leuven, 02/10/2025*

Postdoctoral Researcher, KU Leuven (Supervisor: Stefaan Poedts)

Ph.D., National Space Science Center, UCAS (Supervisor: Xueshang Feng)

E-mail: [haopeng.wang1@kuleuven.be](mailto:haopeng.wang1@kuleuven.be)



# Installation of COCONUT

## From master version shared on GitHub

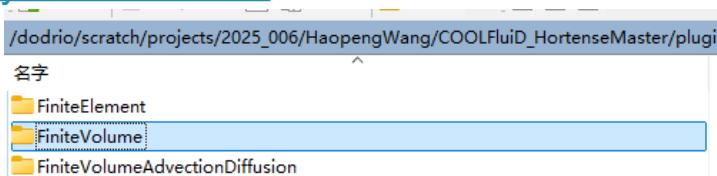
- All source code files, job submission scripts, and installation and recompilation scripts are shared via GitHub or OneDrive. You can directly upload the files from the ***first four folders*** into the corresponding directories in the ***plugins*** folder of the Master version of COCONUT you just installed.
- Before recompile, you need to open the already replaced files, add a space in any blank area, and then save them. This will ensure the replaced files are recognized as modified and will be recompiled.
- ***ScriptDecE*** and ***scriptMaster*** contain job submission scripts corresponds to COCONUT adopting decomposed and full energy equations. The .Cfcases can be used in both Tier1 and Tier2.

- **Shared via GitHub:** <https://github.com/wanghaopengcn/Start-from-COCONUT-HW>

[wanghaopengcn/Start-from-COCONUT-HW](https://github.com/wanghaopengcn/Start-from-COCONUT-HW): This repository shares several modifications made to the coronal model COCONUT.

- **Shared via OneDrive: no longer maintained!**

[Start\\_from\\_Master\\_Version\\_COCONUT](#)



wanghaopengcn	Delete NewtonMethod/CMakeLists.txt
FiniteVolume	Initial public release
FiniteVolumeMHD	Initial public release
MHD	Initial public release
NewtonMethod	Delete NewtonMethod/CMakeLists.txt
ScriptDecE	Update map_steady.CFcase
TestCaseAround2024MayEvent	Add new files and folders
scriptMaster	Initial public release
zDocuments	Add files via upload
ReadMe.txt	Update ReadMe.txt
compile_Tier1.sh	Initial public release
compilescript_Tier2.sh	Add files via upload
install_COOLFluiD_mod_Tier1.sh	Rename install_COOLFluiD_mod.sh to inst
install_COOLFluiD_mod_Tier2.sh	Add files via upload
map_steady.CFcase	Initial public release
map_steady_fullIMHD.CFcase	Initial public release
map_unsteadyeclipse_fullIMHD.CFcase	Initial public release

# Installation of COCONUT

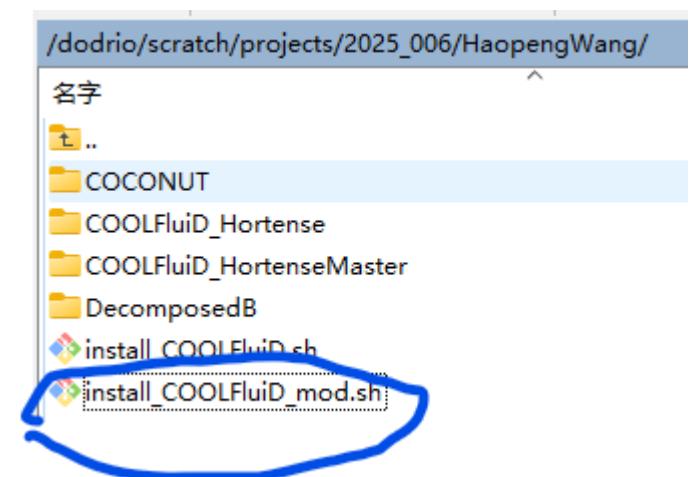
## From master version shared on GitHub

### *Installation of master version COCONUT on Tier1*

1. Modify the path definition of “TOP\_DIR” and “COOLFLUID\_TOP\_DIR” in the script “install\_COOLFluiD\_mod\_Tier1.sh” according to your case.
2. Via permission of visiting the installation script and execute installation:  
chmod a+x ./install\_COOLFluiD\_mod.sh  
./install\_COOLFluiD\_mod.sh DEBUG NOCUDA –download=2

```
install_COOLFluiD_mod.sh x
29 module load CMake/3.26.3-GCCcore-12.3.0
30 module load PETSc/3.20.3-foss-2023a
31
32 export TOP_DIR="${VSC_SCRATCH_PROJECTS_BASE}/2025_006/HaopengWang/"
33 export COOLFLUID_TOP_DIR="${TOP_DIR}/COOLFluid_HortenseMaster/"
```

```
vsc35794@login58:dodrio/scratch/projects/2025_006/HaopengWang
81 |     throw (Common::NoSuchValueException)
|     ^
ccplus: note: unrecognized command-line option '-Wno-dev' may have been intended to silence earlier diagnostics
[ 7%] Building CXX object src/Framework/CMakeFiles/Framework.dir/DetermineCFL.cxx.o
```



# Installation of COCONUT

## From master version shared on GitHub

*Revision of the master version shared on GitHub*

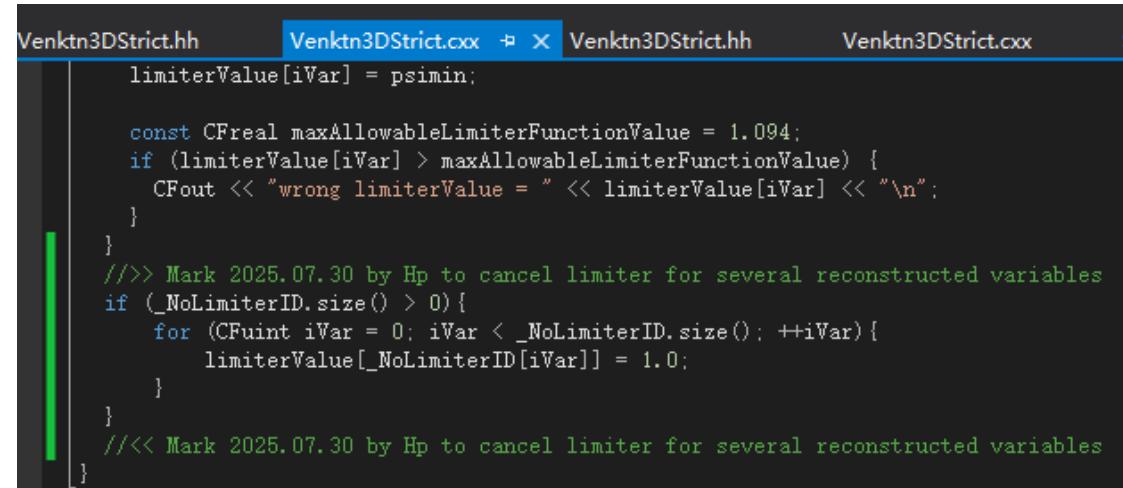
### Venktn3DStrict.hh

- Add `std::vector<CFuint> _NoLimiterID;` (Variables which don't implement limiter)

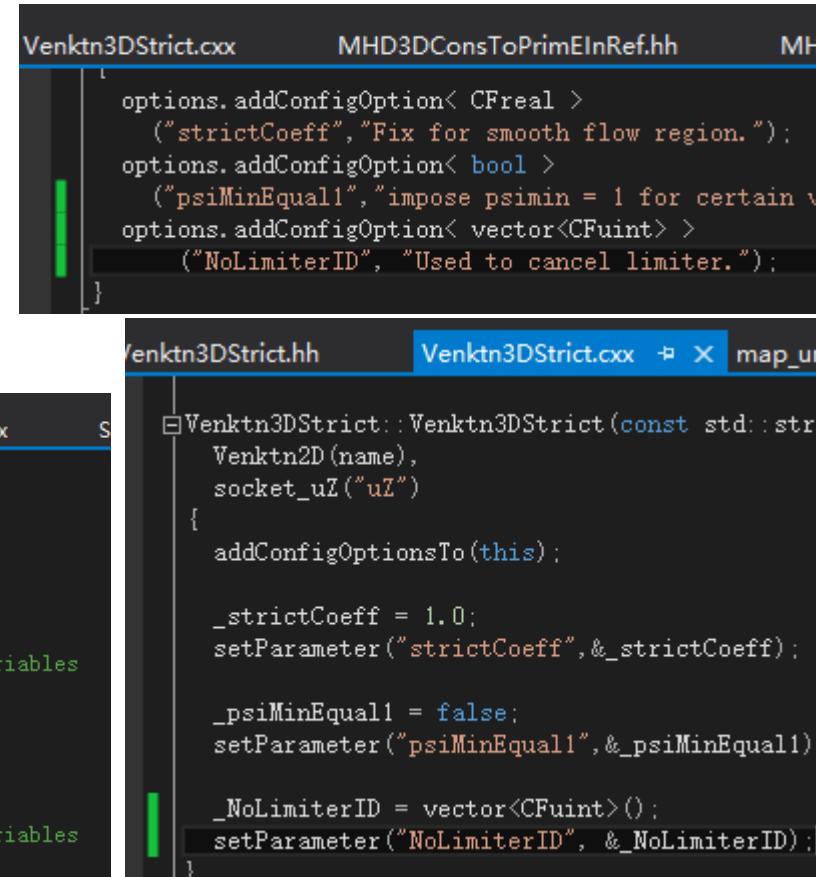
### Venktn3DStrict.cxx

- Add the following snippet to abandon limiter for the selected variables.

```
if (_NoLimiterID.size() > 0){  
    for (CFuint iVar = 0; iVar < _NoLimiterID.size(); ++iVar){  
        limiterValue[_NoLimiterID[iVar]] = 1.0;  
    }  
}
```



```
Venktn3DStrict.hh      Venktn3DStrict.cxx  Venktn3DStrict.hh      Venktn3DStrict.cxx  s  
protected:  
    CFreal _strictCoeff;  
  
    bool _psiMinEqual1;  
  
    /// corresponding to variables which do  
    std::vector<CFuint> _NoLimiterID;  
  
    limiterValue[iVar] = psimin;  
  
    const CFreal maxAllowableLimiterFunctionValue = 1.094;  
    if (limiterValue[iVar] > maxAllowableLimiterFunctionValue) {  
        CFout << "wrong limiterValue = " << limiterValue[iVar] << "\n";  
    }  
}  
//>> Mark 2025.07.30 by Hp to cancel limiter for several reconstructed variables  
if (_NoLimiterID.size() > 0){  
    for (CFuint iVar = 0; iVar < _NoLimiterID.size(); ++iVar){  
        limiterValue[_NoLimiterID[iVar]] = 1.0;  
    }  
}  
//<< Mark 2025.07.30 by Hp to cancel limiter for several reconstructed variables
```



```
Venktn3DStrict.cxx      MHD3DConsToPrimEInRef.hh      MH  
options.addConfigOption< CFreal >  
    ("strictCoeff", "Fix for smooth flow region.");  
options.addConfigOption< bool >  
    ("psiMinEqual1", "impose psimin = 1 for certain v");  
options.addConfigOption< vector<CFuint> >  
    ("NoLimiterID", "Used to cancel limiter.");  
  
Venktn3DStrict.hh      Venktn3DStrict.cxx  map_u  
Venktn3DStrict::Venktn3DStrict(const std::str  
    Venktn2D(name),  
    socket_uZ("uZ")  
{  
    addConfigOptionsTo(this);  
  
    _strictCoeff = 1.0;  
    setParameter("strictCoeff",&_strictCoeff);  
  
    _psiMinEqual1 = false;  
    setParameter("psiMinEqual1",&_psiMinEqual1);  
  
    _NoLimiterID = vector<CFuint>();  
    setParameter("NoLimiterID", &_NoLimiterID);  
}
```

# Installation of COCONUT

## From master version shared on GitHub

*Revision of the master version shared on GitHub*

### StdUpdateSolPP.hh

- Add CFreal \_pBC; & CFreal \_rhoBC; (It corresponds to boundary density and pressure)

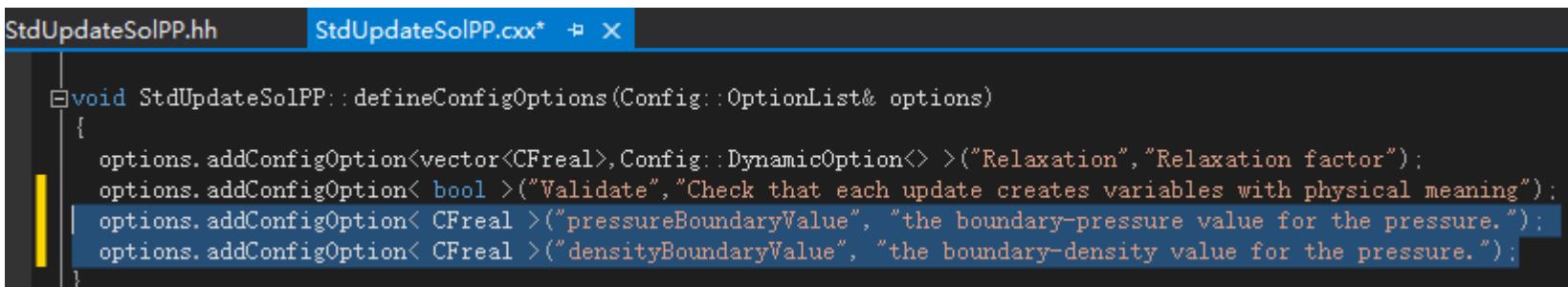
### StdUpdateSolPP.cxx

- Add the following snippet to define boundary pressure and density via .Cfcase file.

```
options.addConfigOption< CFreal >("pressureBoundaryValue", "the boundary-pressure value for the pressure.");
```

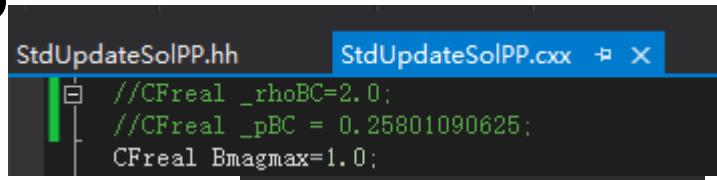
```
options.addConfigOption< CFreal >("densityBoundaryValue", "the boundary-density value for the pressure.");
```

- Comment out CFreal \_rhoBC=2.0; & CFreal \_pBC = 0.25801090625;



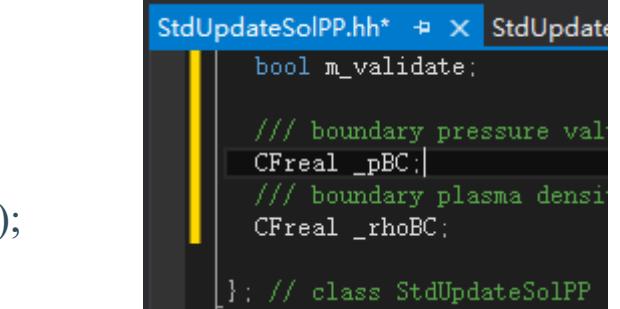
```
StdUpdateSolPP.hh StdUpdateSolPP.cxx* + X

void StdUpdateSolPP::defineConfigOptions(Config::OptionList& options)
{
    options.addConfigOption<vector<CFreal>, Config::DynamicOption<>>("Relaxation", "Relaxation factor");
    options.addConfigOption< bool >("Validate", "Check that each update creates variables with physical meaning");
    options.addConfigOption< CFreal >("pressureBoundaryValue", "the boundary-pressure value for the pressure.");
    options.addConfigOption< CFreal >("densityBoundaryValue", "the boundary-density value for the pressure.");
}
```



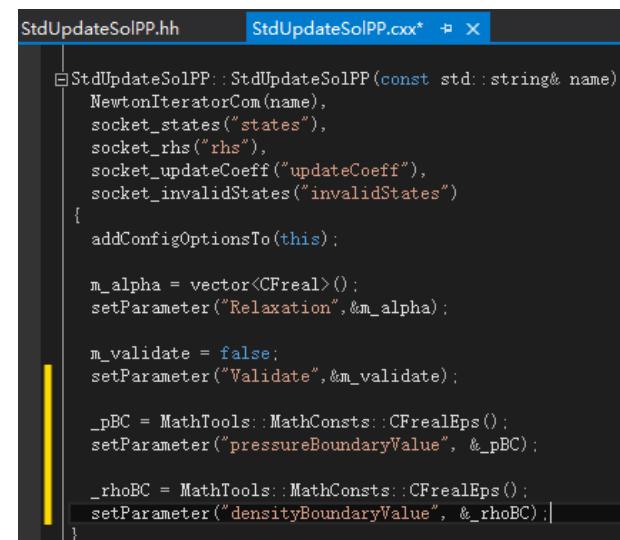
```
StdUpdateSolPP.hh StdUpdateSolPP.cxx* + X

//CFreal _rhoBC=2.0;
//CFreal _pBC = 0.25801090625;
CFreal Bmagmax=1.0;
```



```
StdUpdateSolPP.hh StdUpdateSolPP.cxx* + X StdUpdate

bool m_validate;
/// boundary pressure val
CFreal _pBC;
/// boundary plasma densi
CFreal _rhoBC;
} // class StdUpdateSolPP
```



```
StdUpdateSolPP::StdUpdateSolPP(const std::string& name)
    NewtonIteratorCom(name),
    socket_states("states"),
    socket_rhs("rhs"),
    socket_updateCoeff("updateCoeff"),
    socket_invalidStates("invalidStates")
{
    addConfigOptionsTo(this);

    m_alpha = vector<CFreal>();
    setParameter("Relaxation", &m_alpha);

    m_validate = false;
    setParameter("Validate", &m_validate);

    _pBC = MathTools::MathConsts::CFrealEps();
    setParameter("pressureBoundaryValue", &_pBC);

    _rhoBC = MathTools::MathConsts::CFrealEps();
    setParameter("densityBoundaryValue", &_rhoBC);
}
```

# Installation of COCONUT

## From master version shared on GitHub

*Recompile the master version COCONUT on Tier1*

1. Modify the path definition of “TOP\_DIR” and “COOLFLUID\_TOP\_DIR” in the script “compile\_Tier1.sh” according to your case.
2. Go to the OPENMPI directory where you upload the recompile script “compile\_Tier1.sh” and execute recompile via:
  - sh compile\_Tier1.sh

```
compile_Tier1.sh x
1 module load CMake/3.26.3-GCCcore-12.3.0
2 module load PETSc/3.20.3-foss-2023a
3 export TOP_DIR="/readonly${VSC_SCRATCH_PROJECTS_BASE}/2025_006/HaopengWang/"
4 export COOLFLUID_TOP_DIR="${TOP_DIR}/COOLFluid_HortenseMaster"
5
6 export BUILD_MODE=optim
7 export CONF_FILE="COOLFluid_Hortense_nocuda.conf"
8
9
10 export COOLFLUID_BASEBUILD_DIR="${COOLFLUID_TOP_DIR}/OPENMPI"
11 export COOLFLUID_CONF_FILE="${COOLFLUID_TOP_DIR}/${CONF_FILE}"
12 export COOLFLUID_INSTALL_DIR="${COOLFLUID_BASEBUILD_DIR}/${BUILD_MODE}/INSTALL"
13 export ALL_ACTIVE=1
14
15 cd ${COOLFLUID_TOP_DIR}
16 ./prepare.pl --config-file=${COOLFLUID_CONF_FILE} --build=${BUILD_MODE}
17
18 cd ${COOLFLUID_BASEBUILD_DIR}/${BUILD_MODE}
19 make -j 4
20 #make install
```

```
[vsc35794@login58 ~]$ cd /dodrio/scratch/projects/2025_006/HaopengWang/COOLFluid_HortenseMaster/OPENMPI/
[vsc35794@login58 OPENMPI]$ sh compile_Tier1.sh
```

# Installation of COCONUT

## From master version shared on GitHub

*1<sup>st</sup> step: Polytropic quasi-steady-state simulation on Tier1*

**Revise the following configuration in map\_steady.Cfcase**

- Simulator.Paths.ResultsDir = ./results-map-res/30Rs\_lvl6/steady/polytropic/ADAPT2008/lmax25
- Simulator.SubSystem.EM.Data.DistanceBased.FileNameTw= ./MapData/ADAPT2008Lmax25/map\_adapt\_lmax25\_20080803140000.dat
- Simulator.SubSystem.Flow.Data.DistanceBased.FileNameTw = ./MapData/ADAPT2008Lmax25/map\_adapt\_lmax25\_20080803140000.dat
- Simulator.SubSystem.Flow.Data.Venktn3DStrict.NoLimiterID = 1 2 3 4 5 6
- Simulator.SubSystem.CFmesh1.FileName = corona\_NoLim\_PPDecEBC1\_20080803ADAPT.Cfmesh
- Simulator.SubSystem.Tecplot1.FileName = corona\_NoLim\_PPDecEBC1\_20080803ADAPT.plt
- Simulator.SubSystem.FlowIterator.StdUpdateSolPP.pressureBoundaryValue =0.108 #0.25801090625  
Simulator.SubSystem.FlowIterator.StdUpdateSolPP.densityBoundaryValue =1.0 #2.0
- The following boundary conditions should be revised according to your cases.  
  
Simulator.SubSystem.Flow.Jet1.rhoBC = 1.0 #1.0  
Simulator.SubSystem.Flow.Jet1.pBC = 0.108 #0.00284615174 #0.08592156224 #0.108  
Simulator.SubSystem.Flow.InField.Def = \

**Create a symbolic link to the path of the working folder**

- ln -sf /dodrio/scratch/projects/2025\_006/CompleteCopyTest/COOLFluiD\_Hortense/OPENMPI/optim/apps/Solver/coolfluid-solver\* ./

**Submit a job**

- qsub run\_Quali\_steady\_Tier1.pbs

# Installation of COCONUT

## From master version shared on GitHub

*2<sup>nd</sup> step: Restart full MHD quasi-steady-state simulation from the polytropic quasi-steady-state simulation results on Tier1*

### Revise the following configuration in map\_steady\_fullMHD.Cfcase

- Simulator.Paths.ResultsDir = ./results-map-res/30Rs\_lvl6/steady/fullMHD/ADAPT2008/lmax25
- Simulator.SubSystem.CFmeshFileReader0.Data.FileName = ./results-map-res/30Rs\_lvl6/steady/polytropic/ADAPT2008/lmax25/corona\_NoLim\_PPDecEBC1\_20080803ADAPT.Cfmesh
- Simulator.SubSystem.CFmeshFileReader1.Data.FileName = ./results-map-res/30Rs\_lvl6/steady/polytropic/ADAPT2008/lmax25/corona\_NoLim\_PPDecEBC1\_20080803ADAPT.Cfmesh
- Simulator.SubSystem.Flow.Restart = true
- The other revisions are like those modifications in map\_steady.Cfcase

### Submit a job

- qsub run\_Quasi\_steadyfullMHD\_Tier1.pbs

```
cd /dodrio/scratch/projects/2025_006/HaopengWang/COCONUT/
##module swap cluster/dodrio/cpu_rome_512
module load CMake/3.26.3-GCCcore-12.3.0
module load PETSc/3.20.3-foss-2023a
module load vsc-mympirun
mympirun --universe 360 ./coolfluid-solver --scase /dodrio/
```

# Installation of COCONUT

## From master version shared on GitHub

*3<sup>rd</sup> step: Restart time-evolving coronal simulation from full MHD quasi-steady-state simulation results on Tier1*

### Pay attention to the following modification in **map\_steady\_fullMHD.Cfcase**

- Simulator.SubSystem.FlowSubSystemStatus.TimeStep = 0.207297 # Corresponds to 5 minutes
- Simulator.SubSystem.InitialTime = 0.0 # In code hour unite, the restart physical time \*3600.0/1447.2
- Simulator.SubSystem.MaxTime.maxTime = 1641.79 # End of the physical time \*3600.0/1447.2
- Simulator.SubSystem.Flow.Data.DistanceBased.FileNameTwADF = ./MapData/zqsCR2296Lmax25/map\_gong\_lmax25\_2025 0400.dat 663 1  
2025 32919 32918 # Require to be revised according to your cases.
- Simulator.SubSystem.Flow.Data.Venktn3DStrict.NoLimiterID = 1 2 3 4 5 6 # variables which don't implement limiter
- Simulator.SubSystem.Flow.Data.HLL.AddLax = true # true for decomposed energy equation
- The other revisions are like those modifications in map\_steady.Cfcase
- Comment out *Simulator.SubSystem.Flow.Jet1.VarIDs = 0* will turn the time-evolving regime to quasi-steady-state regime.
- Pay attention to comments starting with # Decomposed energy
- Also refer to the papers and manuals contained in the **eDocuments** folder for further reference.

### Submit a job

- qsub run\_TimeevolvingfullMHD\_Tier1.pbs

# Installation of COCONUT

## From master version shared on GitHub

Calculate source terms as Haopeng Wang did and considering decomposed energy equation.

### MHDConsACAHWSourceTerm.hxx

- Add the following snippet for decomposed energy equation
- Switching to “Simulator.SubSystem.Flow.Data.SourceTerm = MHDConsACAHWST” to calculate source terms as Haopeng Wang did.
- Adding “Simulator.SubSystem.Flow.Data.MHDConsACAHWST.deCompEorNot = 0” means doesn’t calculate the source term caused by decomposed energy equation.

```
options.addConfigOption< CFint >("RadiativeLossTerm", "Switch on optically thin approximation for radiation loss")
options.addConfigOption< CFint >("deCompEorNot", "Calculate source term caused by decomposed energy equation.")
```

```
setParameter("RadiativeLossTerm", &_RadiativeLossTerm);
_deCompE = 0;
setParameter("deCompEorNot", &_deCompE);
```

```
CFint _wave_pressure;
CFint _deCompE
```

```
onsACAHWSourceTerm.hh      MHDConsACAHWSourceTerm.hxx  map_steady.CFcase
}

//>> energy Source terms caused by decomposed energy equation
//CFuint deCompE = 1;
CFreal Q_deCompE = 0.0;
//if (deCompE == 1 && r_dimless>1.05) {
if (_deCompE == 1) {
    const CFuint BXID = 4;
    const CFuint BYID = 5;
    const CFuint BZID = 6;
    const CFuint gradBXID = elementID*nbEqs + BXID;
    const CFuint gradBYID = elementID*nbEqs + BYID;
    const CFuint gradBZID = elementID*nbEqs + BZID;
    _gradEx[XX] = this->m_ux[gradBXID];
    _gradEx[YY] = this->m_uy[gradBXID];
    _gradEx[ZZ] = this->m_uz[gradBXID];
    _gradBy[XX] = this->m_ux[gradBYID];
    _gradBy[YY] = this->m_uy[gradBYID];
    _gradBy[ZZ] = this->m_uz[gradBYID];
    _gradBz[XX] = this->m_ux[gradBZID];
    _gradBz[YY] = this->m_uy[gradBZID];
    _gradBz[ZZ] = this->m_uz[gradBZID];
    std::vector<CFreal> BdotLamdaB(3, 0.0);
    std::vector<CFreal> VdotLamdaB(3, 0.0);
    VdotLamdaB[0] = Vx*_gradEx[XX] + Vy*_gradEx[YY] + Vz*_gradEx[ZZ];
    VdotLamdaB[1] = Vx*_gradBy[XX] + Vy*_gradBy[YY] + Vz*_gradBy[ZZ];
    VdotLamdaB[2] = Vx*_gradBz[XX] + Vy*_gradBz[YY] + Vz*_gradBz[ZZ];
    BdotLamdaB[0] = (Bx*_gradEx[XX] + By*_gradEx[YY] + Bz*_gradEx[ZZ]) / BO;
    BdotLamdaB[1] = (Bx*_gradBy[XX] + By*_gradBy[YY] + Bz*_gradBy[ZZ]) / BO;
    BdotLamdaB[2] = (Bx*_gradBz[XX] + By*_gradBz[YY] + Bz*_gradBz[ZZ]) / BO;
    Q_deCompE = Vx*BdotLamdaB[0] + Vy*BdotLamdaB[1] + Vz*BdotLamdaB[2] -
               (Bx*VdotLamdaB[0] + By*VdotLamdaB[1] + Bz*VdotLamdaB[2]) / BO;
    source[7] += Q_deCompE*volumes[elementID];
}
//<< energy Source terms caused by decomposed energy equation
```

# Installation of COCONUT

## From master version shared on GitHub

Considering extra dissipation term for decomposed energy equation.

### HLLFlux.hxx & HLLFlux.hh

- Add the following snippet to add extra diffusion term to HLL solver for decomposed energy equation
- Adding “Simulator.SubSystem.Flow.Data.HLL.AddLax = false” to .Cfcase means doesn’t consider the extra dissipation term.
- Always keep “Simulator.SubSystem.Flow.Data.HLL.UseAlpha = true”.

```
LFlux.hh  HLLFlux.hxx  map_steady
setParameter("UseAlpha", &_useAlpha);
_addLax = false;
setParameter("AddLax", &_addLax);

void HLLFlux::defineConfigOptions(Config::OptionList& options)
{
    options.addConfigOption< bool >("UseAlpha", "Use diffusion reduction coefficient");
    options.addConfigOption< bool >("AddLax", "Add extra diffusion term to HLL solver");
}

HLLFlux.hxx  HLLFlux.hxx
result = 0.5*(_leftFlux
    (amax + amin)/(amax
        amax * amin/(amax
    )
else {
    CFreal alpha=max(abs(am
        if (_addLax){
            alpha = 1.0;
        }
    result = 0.5*(_leftFlux
        (amax + amin)/(amax
            alpha*2.0*amax * a
    )
```

```
Flux.hh  HLLFlux.hxx  map_steady.Cfcase
//>> mark 2025.08 by HP
if (_addLax){
    GeometricEntity& face = *data.getCurrentFace();
    State& left = *face.getState(0);
    State& right = *face.getState(1);

    CFreal P0 = 0.03851; // N/m**2
    CFreal mu0 = 1.2566e-6;
    CFreal p_tempL = left[7];
    CFreal p_tempR = right[7];
    CFreal pthL = p_tempL*P0;
    CFreal pthR = p_tempR*P0;
    CFreal BxL = left[4];
    CFreal ByL = left[5];
    CFreal BzL = left[6];
    CFreal BxR = right[4];
    CFreal ByR = right[5];
    CFreal BzR = right[6];
    CFreal Bsq2L = BxL*BxL + ByL*ByL + BzL*BzL;
    CFreal Bsq2R = BxR*BxR + ByR*ByR + BzR*BzR;
    CFreal pmagL = max(Bsq2L / 2. / mu0, 1.e-16);
    CFreal pmagR = max(Bsq2R / 2. / mu0, 1.e-16);
    CFreal plasmaBetaL = pthL / pmagL;
    CFreal plasmaBetaR = pthR / pmagR;
    CFreal fac = 1.0;
    CFreal Q_BetafactorL = std::tanh(fac / plasmaBetaL / 100.0);
    CFreal Q_BetafactorR = std::tanh(fac / plasmaBetaR / 100.0);
    CFreal Q_Betafactor = max(Q_BetafactorL, Q_BetafactorR);
    result[7] -= 0.125*Q_Betafactor*max(amax, std::abs(amin)) * (rightState[7] - leftState[7]);
}
//<< mark 2025.08 by HP
```

# Installation of COCONUT

## From master version shared on GitHub

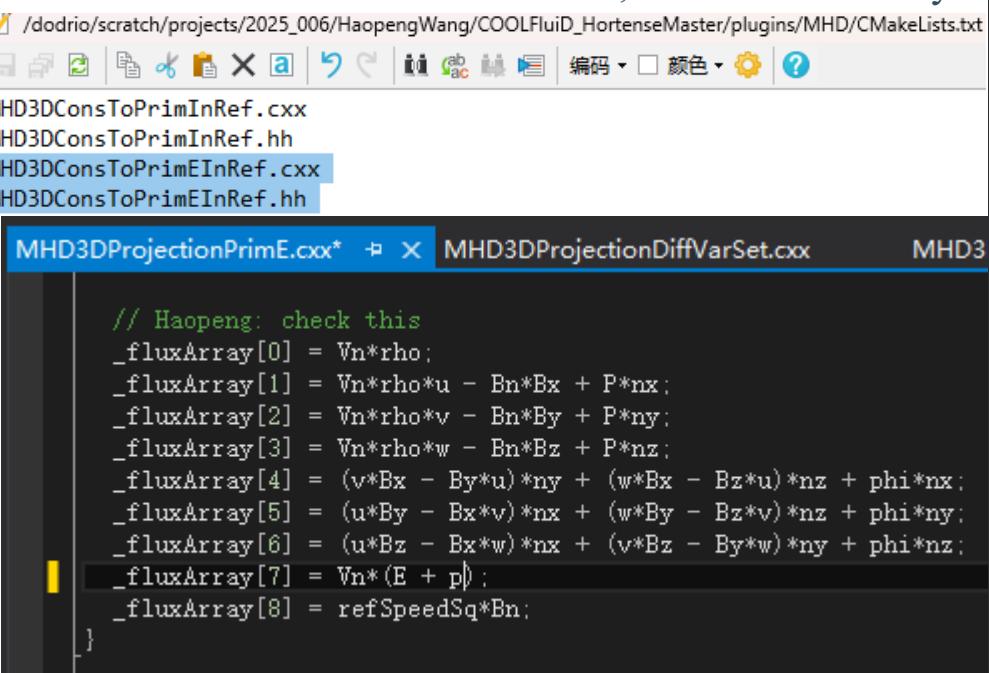
Considering decomposed energy equation.

### MHD3DProjectionPrimE.cxx

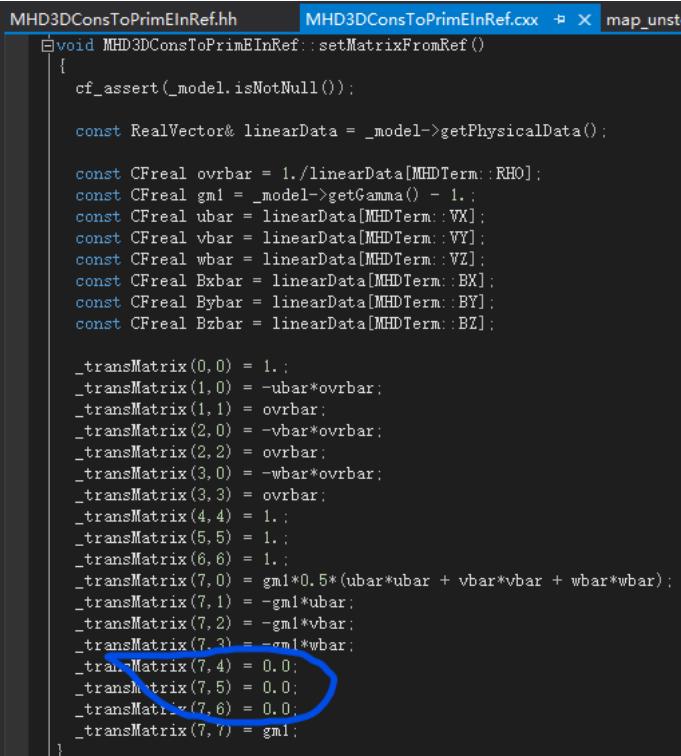
- Correct “`_fluxArray[7] = Vn*(E + P);`” to “`_fluxArray[7] = Vn*(E + p);`” for decomposed energy equation

### MHD3DConsToPrimEInRef.xx

- Create “`MHD3DConsToPrimEInRef.xx`” based on “`MHD3DConsToPrimInRef.xx`”, and add the newly created files to `CMakeLists.txt`



```
// Haopeng: check this
_fluxArray[0] = Vn*rho;
_fluxArray[1] = Vn*rho*u - Bn*Bx + P*nx;
_fluxArray[2] = Vn*rho*v - Bn*By + P*ny;
_fluxArray[3] = Vn*rho*w - Bn*Bz + P*nz;
_fluxArray[4] = (v*Bx - By*u)*ny + (w*Bx - Bz*u)*nz + phi*nx;
_fluxArray[5] = (u*By - Bx*v)*nx + (w*By - Bz*v)*nz + phi*ny;
_fluxArray[6] = (u*Bz - Bx*w)*nx + (v*Bz - By*w)*ny + phi*nz;
_fluxArray[7] = Vn*(E + p);
_fluxArray[8] = refSpeedSq*Bn;
```



```
void MHD3DConsToPrimEInRef::setMatrixFromRef()
{
    cf_assert(_model.IsNotNull());
    const RealVector& linearData = _model->getPhysicalData();

    const CFreal ovrbar = 1./linearData[MHDTerm::RHO];
    const CFreal gm1 = _model->getGamma() - 1.;
    const CFreal ubar = linearData[MHDTerm::WX];
    const CFreal vbar = linearData[MHDTerm::VY];
    const CFreal wbar = linearData[MHDTerm::WZ];
    const CFreal Bxbar = linearData[MHDTerm::BX];
    const CFreal Bybar = linearData[MHDTerm::BY];
    const CFreal Bzbar = linearData[MHDTerm::BZ];

    _transMatrix(0, 0) = 1.;

    _transMatrix(1, 0) = -ubar*ovrbar;
    _transMatrix(1, 1) = ovrbar;
    _transMatrix(2, 0) = -vbar*ovrbar;
    _transMatrix(2, 2) = ovrbar;
    _transMatrix(3, 0) = -wbar*ovrbar;
    _transMatrix(3, 3) = ovrbar;
    _transMatrix(4, 4) = 1.;

    _transMatrix(5, 0) = 1.;

    _transMatrix(6, 0) = 1.;

    _transMatrix(7, 0) = gm1*0.5*(ubar*ubar + vbar*vbar + wbar*wbar);
    _transMatrix(7, 1) = -gm1*ubar;
    _transMatrix(7, 2) = -gm1*vbar;
    _transMatrix(7, 3) = -gm1*wbar;
    _transMatrix(7, 4) = 0.0;
    _transMatrix(7, 5) = 0.0;
    _transMatrix(7, 6) = 0.0;
    _transMatrix(7, 7) = gm1;
}
```

# Installation of COCONUT

## From master version shared on GitHub

*Considering decomposed energy equation.*

### .Cfcase

- Simulator.SubSystem.Flow.Data.HLL.UseAlpha = true # Use self-adjustable dissipation term for HLL flux solver.
- Simulator.SubSystem.Flow.Data.HLL.AddLax = true # true for decomposed energy equation with addition dissipation term to HLL flux solver
- Simulator.SubSystem.Flow.Data.SourceTerm = MHDConsACAHWST # calculate source terms as Haopeng did.
  
- Simulator.SubSystem.Tecplot1.Data.outputVar = PrimE # adopt decomposed energy equation
- Simulator.SubSystem.ParaView1.Data.updateVar = PrimE # adopt decomposed energy equation
- Simulator.SubSystem.Flow.Data.UpdateVar = PrimE # adopt decomposed energy equation
- Simulator.SubSystem.Flow.Data.MHDConsACAHWST.deCompEorNot = 1 # 1 for decomposed energy equation with source term caused by decomposed energy equation

- Since the source code is modified for decomposed energy equation, remember to execute recompile before job submission.

# Installation of COCONUT

## From master version shared on GitHub

*Considering full energy equation.*

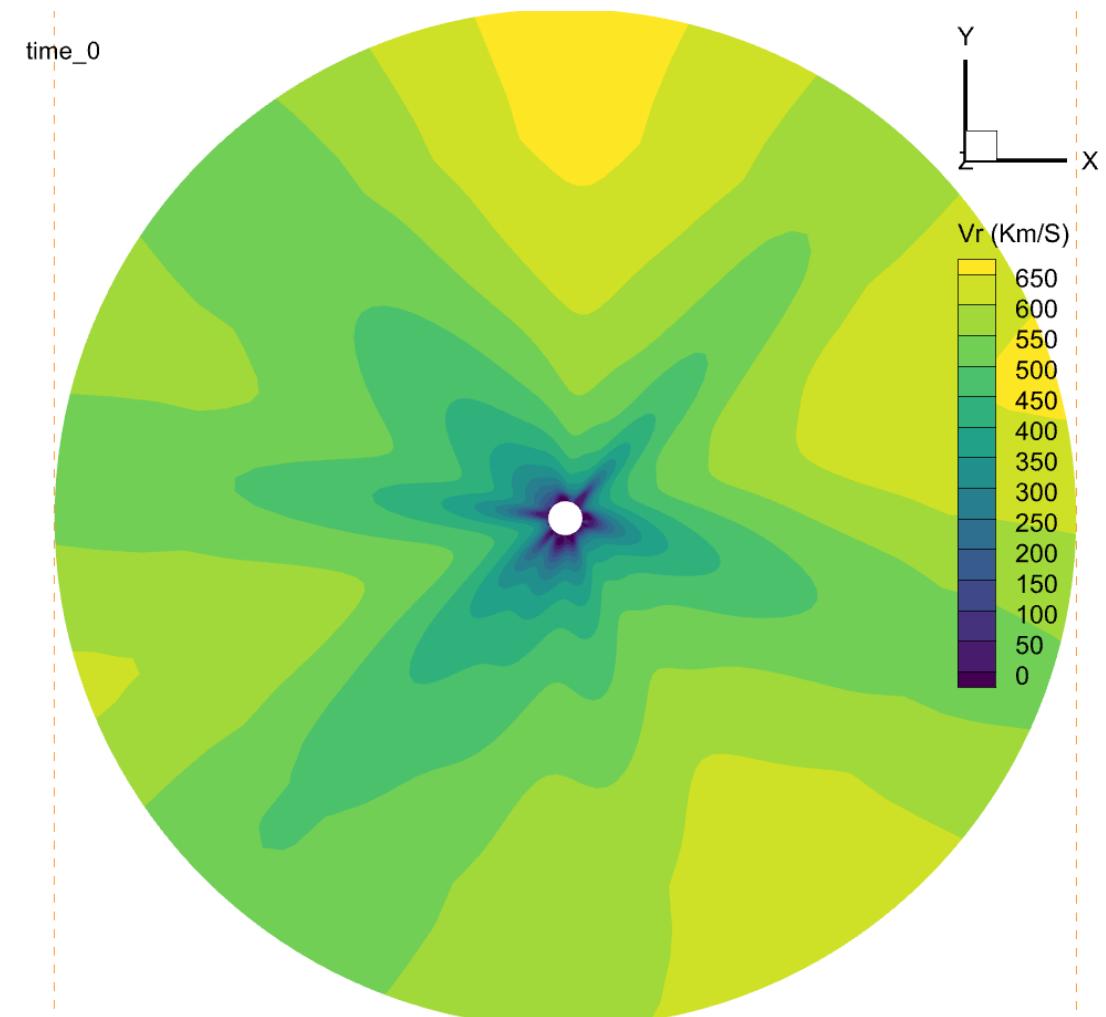
### .Cfcase

- Simulator.SubSystem.Flow.Data.HLL.UseAlpha = true
- Simulator.SubSystem.Flow.Data.HLL.AddLax = false # false for full energy equation without addition dissipation term to HLL flux solver
- Simulator.SubSystem.Flow.Data.HLL.AddLax = true # true for full energy equation with addition dissipation term to HLL flux solver
- Simulator.SubSystem.Flow.Data.SourceTerm = MHDConsACAHWST # calculate source terms as Haopeng did.
  
- Simulator.SubSystem.Tecplot1.Data.outputVar = Prim # adopt full energy equation
- Simulator.SubSystem.ParaView1.Data.updateVar = Prim # adopt full energy equation
- Simulator.SubSystem.Flow.Data.UpdateVar = Prim # adopt full energy equation
- Simulator.SubSystem.Flow.Data.MHDConsACAHWST.deCompEorNot = 0 # 0 for full energy equation without source term caused by decomposed energy equation

# Installation of COCONUT

## From master version shared on GitHub

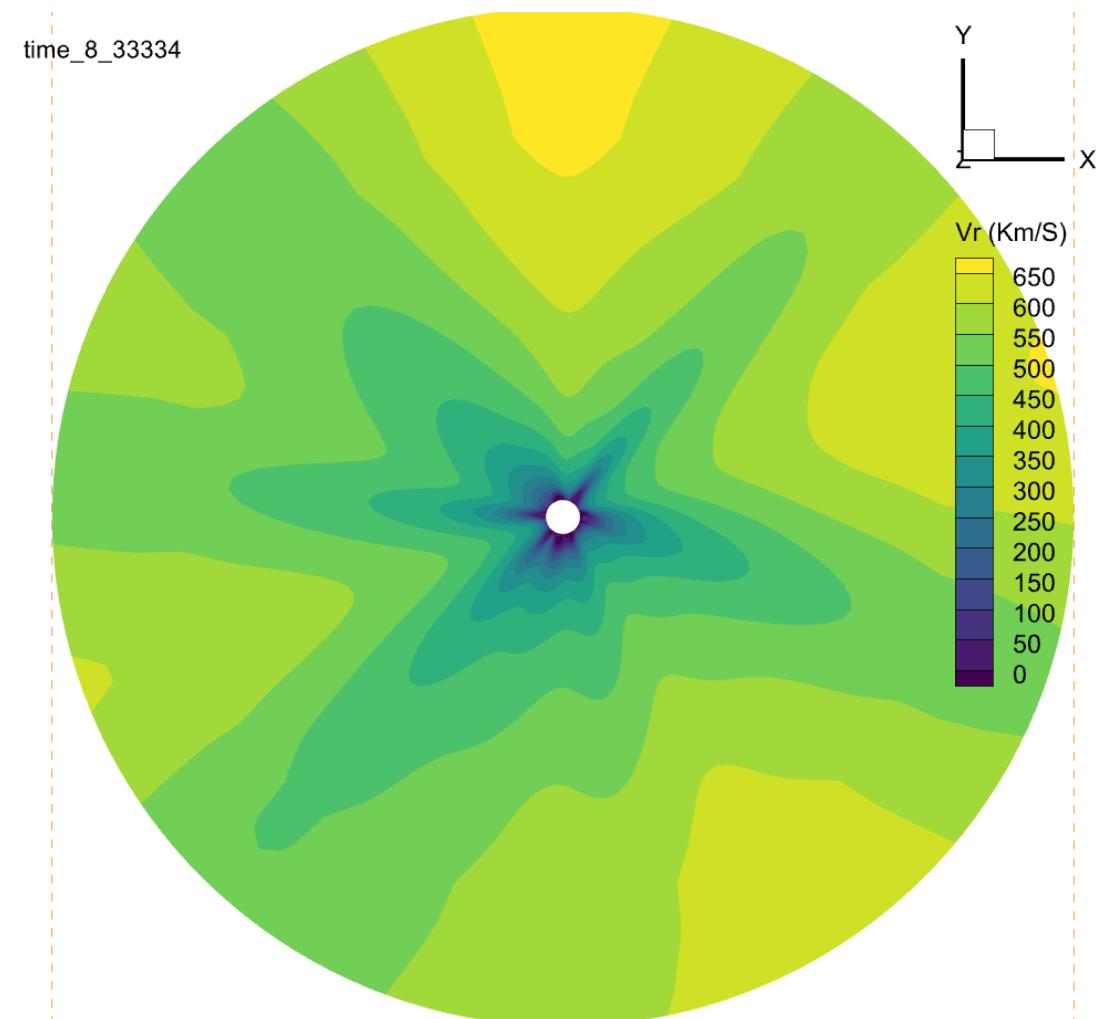
*Calculated by full energy equation for CR2296 (GONGzqs Lmax=25).*



# Installation of COCONUT

## From master version shared on GitHub

*Calculated by full energy equation for CR2296 (GONGzqs Lmax=25).*



## Call for more collaborations

1. The implicit time-evolving coronal models **COCONUT** and **SIP-IFVM** show great promise for **practical space weather forecasting** due to their efficiency and stability. (Providing inner-boundary conditions for inner-heliosphere models, improve efficiency of CME simulations with required accuracy, ...)
2. The extended magnetic field decomposition strategy and energy decomposition strategies improve the numerical stability of the MHD coronal and CME models in addressing **time-evolving low- $\beta$  issues**.
3. We are **extending** the coronal model to 1 AU or **coupling** the coronal model with an inner heliosphere model to conduct some **faster-than-real-time** and more **realistic** CME simulations from the solar surface to 1 AU.
4. We plan to integrate active region models into global coronal model COCONUT.

Looking forward to more good ideas and  
comments

*Thanks*

E-mail: [haopeng.wang1@kuleuven.be](mailto:haopeng.wang1@kuleuven.be)

