GravityModel

5.3

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- file gravity_integ_frame.hh

  Define the gravity integration frame class.
- file gravity_interaction.hh

  Define the GravityInteraction class, used to represent the gravitational interaction betweens a DynBody and a set of planetary bodies.
- file gravity_manager.hh

  Define the Gravity Manager.
- file gravity_messages.hh

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  Define the gravity body base (pure virtual) class.
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  Define the class SphericalHarmonicsDeltaCoeffs, the base class for tidal effects and temporal gravity sub-models.
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  Define the class SphericalHarmonicsDeltaCoeffsInit, the base initialization class for tidal effects and temporal gravity sub-models.
- file spherical_harmonics_delta_controls.hh

  Define the gravity controls for the variational gravity models such as solid-body tides.
- file spherical_harmonics_gravity_controls.hh

  Define the gravity controls.
- file spherical_harmonics_gravity_source.hh

  Define the spherical harmonics implementation of a gravity body.
- file spherical_harmonics_solid_body_tides.hh

  Define the SphericalHarmonicsSolidBodyTides class, which models solid-body tidal effects.
- file spherical_harmonics_solid_body_tides_init.hh

  Define the SphericalHarmonicsSolidBodyTidesInit class, which is the initialization class for the solid body tides model.
- file spherical_harmonics_tidal_effects.hh

  Define the class SphericalHarmonicsTidalEffects, which is the base class for solid-body and ocean tidal effects.
- file spherical_harmonics_tidal_effects_init.hh

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- file gravity_interaction.cc

  Define methods for the GravityInteraction class.
- file gravity_manager.cc

  Define member functions for the GravityManager class.
- file gravity_messages.cc

  Implement the class GravityMessages.
- file gravity_source.cc

  Define member functions for the GravitySource class.
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  Define member functions for the SphericalHarmonicsGravityControls class.
- file spherical_harmonics_gravity_source.cc

  Define member functions for the SphericalHarmonicsGravitySource class.
- file spherical_harmonics_solid_body_tides.cc

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Namespaces

- jeod

  Namespace jeod.

6.3.1 Detailed Description

Chapter 7

Namespace Documentation

7.1 jeod Namespace Reference

Namespace jeod.

Data Structures

- class GravityControls

  Specifies whether and how a GravitySource affects a vehicle.
- class GravityIntegFrame

  Class that aids in determining whether gravity should be applied as a direct effect or a third body effect.
- class GravityInteraction

  Specifies interactions between a vehicle and a set of gravitational bodies.
- class GravityManager

  The master gravitational model for a simulation.
- class GravityMessages

  Specifies the message IDs used in the gravity model.
- class GravitySource

  Models the gravity for a specific planet;.
- class SphericalHarmonicsDeltaCoeffs

  Base class for tidal and temporal gravity models.
- class SphericalHarmonicsDeltaCoeffsInit

  Initialization data for a SphericalHarmonicsDeltaCoeffs instance.
- class SphericalHarmonicsDeltaControls

  Provides controls for how a variational model affects a vehicle.
- class SphericalHarmonicsGravityControls

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- class SphericalHarmonicsGravitySource_jupiter_spherical_default_data

- class SphericalHarmonicsGravitySource_mars_MRO110B2_default_data
- class SphericalHarmonicsGravitySource_mars_spherical_default_data
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- class SphericalHarmonicsGravitySource_moon_spherical_default_data
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- class SphericalHarmonicsSolidBodyTides

  Models solid body tidal effects.
- class SphericalHarmonicsSolidBodyTidesInit

  Initializes a solid body tides model.
- class SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data
- class SphericalHarmonicsTidalEffects

  Models tidal effects as a delta on top of a gravity model.
- class SphericalHarmonicsTidalEffectsInit

  Initializes a tidal gravity model.

Variables

- static constexpr double speed_of_light_sq = 89875517873681764.0

  The speed of light squared, in m^2/s^2.

7.1.1 Detailed Description

Namespace jeod.

7.1.2 Variable Documentation

7.1.2.1 speed_of_light_sq

```
constexpr double jeod::speed_of_light_sq = 89875517873681764.0  [static]
```

The speed of light squared, in m^2/s^2.

Definition at line 58 of file gravity_controls.cc.

Referenced by jeod::GravityControls::calc_relativistic().

Chapter 8

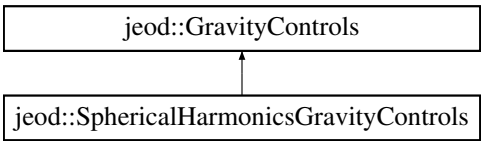
Data Structure Documentation

8.1 jeod::GravityControls Class Reference

Specifies whether and how a GravitySource affects a vehicle.

`#include <gravity_controls.hh>`

Inheritance diagram for jeod::GravityControls:



Public Member Functions

- GravityControls ()=default
- virtual ~GravityControls ()=default
- GravityControls (const GravityControls &)=delete
- GravityControls & operator= (const GravityControls &)=delete
- virtual void initialize_control (GravityManager &grav_man)

  Initialize this GravityControl.
- virtual void reset_control (BaseDynManager &dyn_manager)

  Reset subscriptions for this GravityControl.
- virtual void gravitation (const double integ_pos[3], unsigned int integ_frame_idx, double body_grav_accel[3], double dgdx[3][3], double Pot[1])

  Compute the gravitation at a given position toward a gravity body.
- virtual void gravitation (const RefFrame &point_of_interest, unsigned int integ_frame_idx, double body_↩ grav_accel[3], double dgdx[3][3], double &pot)

  Compute the gravitation at a given position toward a gravity body.

Static Public Member Functions

- static bool accel_mag_less_ptr (const GravityControls *a, const GravityControls *b)

  Compares the magnitude of the two input gravity controls, returning true if a->grav_accel_magsq is less than b->grav_accel_magsq, false otherwise.

Data Fields

- std::string source_name

  Planet name.
- bool active {}

  Gravity for this body active?
- bool spherical {}

  Ignore non-spherical effects?
- bool gradient {}

  Compute gravity gradient matrix?
- bool perturbing_only {}

  Compute only the perturbing gravity?
- bool battin_method {}

  Compute third body gravity using Battin's method (Battin, Mathematics and Methods of Astrodynamics)?
- bool relativistic {}

  Indicates that the relativistic correction to Newtonian gravitation is to be computed.
- GravitySource * body {}

  Pointer to the GravitySource object named by planet_name.
- double grav_accel [3] {}

  Gravitational acceleration toward the GravitySource at the location of the DynBody, including third body effects.
- double grav_grad [3][3] {}

  Gradient of the gravitational acceleration.
- double grav_pot {}

  Gravitational potential.
- double grav_accel_magsq {}

  Square of the magnitude of grav_accel.

Protected Member Functions

- virtual void calc_nonspherical (const double integ_pos[3], const double posn[3], const GravityIntegFrame &grav_source_frame, double body_grav_accel[3], double dgdx[3][3], double &pot)=0

  Nominally, compute the non-spherical contribution to gravity at a given position.
- void calc_relativistic (const RefFrame &point_of_interest, const double rel_pos[3], const double rel_vel[3], double perturbing_accel[3])

  Calculates the relativistic correction to gravitational acceleration.
- void calc_spherical (const double integ_pos[3], const double posn[3], const GravityIntegFrame &grav_↩ source_frame, double body_grav_accel[3], double dgdx[3][3], double &pot)

  Calculate the spherical gravitational acceleration, either directly or as a third body acceleration.

Protected Attributes

- GravityManager * grav_manager {}

  Pointer to the simulation-wide GravityManager object.
- bool subscribed_to_inertial {}

  Indicates that a subscription to the planet-centered inertial frame of the planet associated with the gravity_source been issued.
- bool subscribed_to_pfix {}

  Indicates that a subscription to the planet-centered, planet-fixed frame of the planet associated with the gravity_source been issued.
- bool skip_spherical {}

  Some derived classes' calc_nonspherical method computes all contributions to gravitation, including spherical.

Friends

- class InputProcessor
- void init_attrjeod__GravityControls ()

8.1.1 Detailed Description

Specifies whether and how a GravitySource affects a vehicle.

Definition at line 89 of file gravity_controls.hh.

8.1.2 Constructor & Destructor Documentation

8.1.2.1 GravityControls() [1/2]

```
jeod::GravityControls::GravityControls ( )  [default]
```

8.1.2.2 ~GravityControls()

```
virtual jeod::GravityControls::~GravityControls ( )  [virtual], [default]
```

8.1.2.3 GravityControls() [2/2]

```
jeod::GravityControls::GravityControls (
            const GravityControls &  )  [delete]
```

8.1.3 Member Function Documentation

8.1.3.1 accel_mag_less_ptr()

```
static bool jeod::GravityControls::accel_mag_less_ptr (
            const GravityControls * a,
            const GravityControls * b )  [inline], [static]
```

Compares the magnitude of the two input gravity controls, returning true if a->grav_accel_magsq is less than b->grav_accel_magsq, false otherwise.

Returns

Result of comparison

Parameters

a	First control to be compared.
b	Second control to be compared.

Definition at line 228 of file gravity_controls.hh.

Referenced by jeod::GravityInteraction::sort_controls().

8.1.3.2 calc_nonspherical()

```
virtual void jeod::GravityControls::calc_nonspherical (
             const double integ_pos[3],
             const double posn[3],
             const GravityIntegFrame & grav_source_frame,
             double body_grav_accel[3],
             double dgdx[3][3],
             double & pot )  [protected], [pure virtual]
```

Nominally, compute the non-spherical contribution to gravity at a given position.

Derived classes whose override of this function computes the full gravitation model, including the spherical contribution, should set the skip_spherical flag.

Parameters

in	*posn*	Inertial position of the point of interest relative to the gravitional body.
out	*body_grav_accel*	Acceleration at the point of interest due to the gravitional body.
out	*dgdx*	Gravity gradient at the point of interest.
out	*Pot*	Specific gravitational potential energy.

Implemented in jeod::SphericalHarmonicsGravityControls.

Referenced by gravitation().

8.1.3.3 calc_relativistic()

```
void jeod::GravityControls::calc_relativistic (
             const RefFrame & point_of_interest,
             const double rel_pos[3],
             const double rel_vel[3],
             double perturbing_accel[3] )  [protected]
```

Calculates the relativistic correction to gravitational acceleration.

Parameters

point_of_interest	The point of interest, as a reference frame.
rel_pos	Displacement vector from the grav body to the POI.
rel_vel	Time derivative of rel_pos.
perturbing_accel	Output relativistic accel, sans the Newtonian term.

Implements equation 27 (Folkner) / equation 4 (Genova) to compute a parameteric post-Newtonian correction to gravitation. The referenced equation is of the form

$$\begin{aligned}\boldsymbol{a}_{\text{A,pm-pm}} = & \sum_{B\neq A}\frac{GM_B}{r_{AB}^3}(\boldsymbol{r}_B-\boldsymbol{r}_A)\left(1+\frac{s_1}{c^2}\right)\\ & +\frac{1}{c^2}\sum_{B\neq A}\frac{GM_B}{r_{AB}^3}(\boldsymbol{v}_A-\boldsymbol{v}_B)\Big((\boldsymbol{r}_A-\boldsymbol{r}_B)\cdot\big((2+2\gamma)\boldsymbol{v}_A-(1+2\gamma)\boldsymbol{v}_B\big)\Big)\\ & +\frac{3+4\gamma}{2c^2}\sum_{B\neq A}\frac{GM_B}{r_{AB}}\boldsymbol{a}_B\end{aligned}$$

where $\boldsymbol{a}_B$ is the net acceleration of gravitating body *B* toward the other gravitating bodies (typically taken to be the Newtonian gravitational acceleration) and

$$\begin{aligned}s_1 = & -2(\beta+\gamma)\sum_{C\neq A}\frac{GM_C}{r_{AC}}-(2\beta-1)\sum_{C\neq A}\frac{GM_C}{r_{BC}}\\ & +\gamma v_a^2+(1+\gamma)v_b^2-2(1+\gamma)\boldsymbol{v}_A\cdot\boldsymbol{v}_B\\ & -\frac{3}{2}\left(\frac{(\boldsymbol{r}_A-\boldsymbol{r}_B)\cdot\boldsymbol{v}_B}{r_B}\right)^2\\ & +\frac{1}{2}(\boldsymbol{r}_B-\boldsymbol{r}_A)\cdot\boldsymbol{a}_B\end{aligned}$$

In terms of the referenced equation, the intent of this function is to compute the relativistic portion of the acceleration of body *A* toward body *B*. With this, the expression this function computes is

$$\begin{aligned}\boldsymbol{\Delta}a_{\text{A,B}} = \frac{1}{c}^2\frac{GM_B}{r_{AB}}\Bigg\{ & \frac{\boldsymbol{r}_B-\boldsymbol{r}_A}{r_{AB}^2}s_1\\ & +\frac{\boldsymbol{v}_A-\boldsymbol{v}_B}{r_{AB}^2}\Big((\boldsymbol{r}_A-\boldsymbol{r}_B)\cdot\big((2+2\gamma)\boldsymbol{v}_A-(1+2\gamma)\boldsymbol{v}_B\big)\Big)\\ & +\frac{3+4\gamma}{2}\boldsymbol{a}_B\Bigg\}\end{aligned}$$

Note that the common factor $\frac{1}{c}^2\frac{GM_B}{r_{AB}}$ is unitless and thus each of the three terms in the braced expression has units of acceleration.

The referenced equations explicitly involve the parameterized post-Newtonian (PPN) factors β and γ. This function hardcodes both of those factors as one, consistent with general relativity. For example, the factor $(3+4\gamma)/2$ becomes 3.5 in the code. Magic numbers that involve β or γ, including a factor of one (e.g., $2\beta-1$), are noted in comments.

References:

- William M. Folkner, et al., *Planetary and Lunar Ephemerides DE430 and DE431*, IPN Progress Report 42-196, 15 February 2014. ftp://naif.jpl.nasa.gov/pub/naif/generic_kernels/spk/planets/de430_↩and_de431.pdf

- Antonio Genova, et al., *Solar system expansion and strong equivalence principle as seen by the NASA MESSENGER mission*, Nature Communications 9:289, 18 January 2018, DOI: 10.1038/s41467-017-02558-1.
https://www.nature.com/articles/s41467-017-02558-1

Definition at line 456 of file gravity_controls.cc.

References body, jeod::GravityManager::get_bodies(), grav_manager, jeod::GravitySource::inertial, jeod::GravitySource::mu, and jeod::speed_of_light_sq.

Referenced by gravitation().

8.1.3.4 calc_spherical()

```
void jeod::GravityControls::calc_spherical (
             const double integ_pos[3],
             const double posn[3],
             const GravityIntegFrame & grav_source_frame,
             double body_grav_accel[3],
             double dgdx[3][3],
             double & pot ) [protected]
```

Calculate the spherical gravitational acceleration, either directly or as a third body acceleration.

Parameters

integ_pos	Point of interest location, integ frame coordinates
posn	Vector from gravitational body to point of interest
grav_source_frame	Frame corresponding to the gravitational body
body_grav_accel	Acceleration at integ_pos due to the grav body
dgdx	Gravity gradient at integ_pos due to the grav body
pot	Gravitational potential at integ_pos due to the grav body.

Definition at line 291 of file gravity_controls.cc.

References battin_method, body, gradient, jeod::GravityIntegFrame::is_third_body, jeod::GravitySource::mu, and jeod::GravityIntegFrame::pos.

Referenced by gravitation().

8.1.3.5 gravitation() [1/2]

```
void jeod::GravityControls::gravitation (
             const double integ_pos[3],
             unsigned int integ_frame_idx,
             double body_grav_accel[3],
             double dgdx[3][3],
             double Pot[1] ) [virtual]
```

Compute the gravitation at a given position toward a gravity body.

Parameters

in	*integ_pos*	Point of interest, integ coords Units: M
in	*integ_frame_idx*	Integ frame index
out	*body_grav_accel*	Accel for given grav body Units: M/s2
out	*dgdx*	Gradient for given grav body Units: 1/s2
out	*Pot*	Potential

Definition at line 187 of file gravity_controls.cc.

References body, calc_nonspherical(), calc_spherical(), jeod::GravitySource::frames, jeod::GravitySource::inertial, perturbing_only, jeod::GravityIntegFrame::pos, jeod::GravityIntegFrame::ref_frame, skip_spherical, and spherical.

Referenced by jeod::GravityManager::gravitation().

8.1.3.6 gravitation() [2/2]

```
void jeod::GravityControls::gravitation (
             const RefFrame & point_of_interest,
             unsigned int integ_frame_idx,
             double body_grav_accel[3],
             double dgdx[3][3],
             double & pot ) [virtual]
```

Compute the gravitation at a given position toward a gravity body.

Parameters

in	*point_of_interest*	Point of interest, as a reference frame.
in	*integ_frame_idx*	Integ frame index.
out	*body_grav_accel*	Accel for given grav body.
out	*dgdx*	Gradient for given grav body.
out	*pot*	Specific gravitational potential for given grev body.

Definition at line 232 of file gravity_controls.cc.

References body, calc_nonspherical(), calc_relativistic(), calc_spherical(), jeod::GravitySource::frames, jeod::GravitySource::inertial, perturbing_only, jeod::GravityIntegFrame::pos, jeod::GravityIntegFrame::ref_frame, relativistic, skip_spherical, and spherical.

8.1.3.7 initialize_control()

```
void jeod::GravityControls::initialize_control (
             GravityManager & grav_man ) [virtual]
```

Initialize this GravityControl.

Parameters

in	*grav_man*	Ref to Gravity Manager

Reimplemented in jeod::SphericalHarmonicsGravityControls.

Definition at line 71 of file gravity_controls.cc.

References body, jeod::GravityManager::find_grav_source(), grav_manager, jeod::GravitySource::inertial, jeod::GravityMessages::invalid_object, jeod::GravityMessages::missing_entry, jeod::GravitySource::name, and source_name.

Referenced by jeod::SphericalHarmonicsGravityControls::initialize_control().

8.1.3.8 operator=()

```
GravityControls& jeod::GravityControls::operator= (
            const GravityControls &  )  [delete]
```

8.1.3.9 reset_control()

```
void jeod::GravityControls::reset_control (
            BaseDynManager & dyn_manager )  [virtual]
```

Reset subscriptions for this GravityControl.

Parameters

in	*dyn_manager*	Ptr to dynamics manager

Definition at line 119 of file gravity_controls.cc.

References active, body, jeod::GravitySource::inertial, jeod::GravityMessages::null_pointer, jeod::GravitySource::pfix, source_name, spherical, subscribed_to_inertial, and subscribed_to_pfix.

8.1.4 Friends And Related Function Documentation

8.1.4.1 init_attrjeod__GravityControls

```
void init_attrjeod__GravityControls ( )  [friend]
```

8.1.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 91 of file gravity_controls.hh.

8.1.5 Field Documentation

8.1.5.1 active

```
bool jeod::GravityControls::active {}
```

Gravity for this body active?

trick_units(–)

Definition at line 101 of file gravity_controls.hh.

Referenced by jeod::GravityManager::gravitation(), reset_control(), jeod::GravityInteraction::sort_controls(), and jeod::SphericalHarmonicsGravityControls::update_deltacoeffs().

8.1.5.2 battin_method

```
bool jeod::GravityControls::battin_method {}
```

Compute third body gravity using Battin's method (Battin, Mathematics and Methods of Astrodynamics)?

trick_units(–)

Definition at line 122 of file gravity_controls.hh.

Referenced by calc_spherical().

8.1.5.3 body

```
GravitySource* jeod::GravityControls::body {}
```

Pointer to the GravitySource object named by planet_name.

Note

Users should not set this data member in the input file.trick_units(–)

Definition at line 135 of file gravity_controls.hh.

Referenced by calc_relativistic(), calc_spherical(), gravitation(), jeod::SphericalHarmonicsGravityControls::initialize_control(), initialize_control(), and reset_control().

8.1.5.4 gradient

```
bool jeod::GravityControls::gradient {}
```

Compute gravity gradient matrix?

trick_units(–)

Definition at line 111 of file gravity_controls.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), calc_spherical(), and jeod::SphericalHarmonicsGravityControls::check_validity().

8.1.5.5 grav_accel

```
double jeod::GravityControls::grav_accel[3] {}
```

Gravitational acceleration toward the GravitySource at the location of the DynBody, including third body effects.

trick_units(m/s2)

Definition at line 141 of file gravity_controls.hh.

Referenced by jeod::GravityManager::gravitation(), and jeod::GravityInteraction::sort_controls().

8.1.5.6 grav_accel_magsq

```
double jeod::GravityControls::grav_accel_magsq {}
```

Square of the magnitude of grav_accel.

trick_units(m2/s4)

Definition at line 156 of file gravity_controls.hh.

Referenced by jeod::GravityInteraction::sort_controls().

8.1.5.7 grav_grad

```
double jeod::GravityControls::grav_grad[3][3] {}
```

Gradient of the gravitational acceleration.

trick_units(1/s2)

Definition at line 146 of file gravity_controls.hh.

Referenced by jeod::GravityManager::gravitation().

8.1.5.8 grav_manager

```
GravityManager* jeod::GravityControls::grav_manager {}  [protected]
```

Pointer to the simulation-wide GravityManager object.

Note

Users should not set this data member in the input file.trick_units(–)

Definition at line 163 of file gravity_controls.hh.

Referenced by calc_relativistic(), jeod::SphericalHarmonicsGravityControls::initialize_control(), and initialize_control().

8.1.5.9 grav_pot

```
double jeod::GravityControls::grav_pot {}
```

Gravitational potential.

trick_units(m2/s2)

Definition at line 151 of file gravity_controls.hh.

Referenced by jeod::GravityManager::gravitation().

8.1.5.10 perturbing_only

```
bool jeod::GravityControls::perturbing_only {}
```

Compute only the perturbing gravity?

trick_units(–)

Definition at line 116 of file gravity_controls.hh.

Referenced by gravitation().

8.1.5.11 relativistic

```
bool jeod::GravityControls::relativistic {}
```

Indicates that the relativistic correction to Newtonian gravitation is to be computed.

The public methods enable_relativistic_correction and disable_relativistic_correction set / clear this flag.trick_units(–)

Definition at line 129 of file gravity_controls.hh.

Referenced by gravitation().

8.1.5.12 skip_spherical

```
bool jeod::GravityControls::skip_spherical {}  [protected]
```

Some derived classes' calc_nonspherical method computes all contributions to gravitation, including spherical.

Those classes need to set this flag. The flag is clear in the base class and in the SphericalHarmonicsGravityControls derived class.trick_units(–)

Definition at line 185 of file gravity_controls.hh.

Referenced by gravitation().

8.1.5.13 source_name

```
std::string jeod::GravityControls::source_name
```

Planet name.

trick_units(–)

Definition at line 96 of file gravity_controls.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::check_validity(), initialize_control(), and reset_control().

8.1.5.14 spherical

```
bool jeod::GravityControls::spherical {}
```

Ignore non-spherical effects?

trick_units(–)

Definition at line 106 of file gravity_controls.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::check_validity(), gravitation(), and reset_control().

8.1.5.15 subscribed_to_inertial

```
bool jeod::GravityControls::subscribed_to_inertial {}  [protected]
```

Indicates that a subscription to the planet-centered inertial frame of the planet associated with the gravity_source been issued.

Note

Users should not set this data member in the input file.trick_units(–)

Definition at line 170 of file gravity_controls.hh.

Referenced by reset_control().

8.1.5.16 subscribed_to_pfix

```
bool jeod::GravityControls::subscribed_to_pfix {}  [protected]
```

Indicates that a subscription to the planet-centered, planet-fixed frame of the planet associated with the gravity_↩ source been issued.

Note

Users should not set this data member in the input file.trick_units(–)

Definition at line 177 of file gravity_controls.hh.

Referenced by reset_control().

The documentation for this class was generated from the following files:

- gravity_controls.hh
- gravity_controls.cc

8.2 jeod::GravityIntegFrame Class Reference

Class that aids in determining whether gravity should be applied as a direct effect or a third body effect.

```
#include <gravity_integ_frame.hh>
```

Public Member Functions

- GravityIntegFrame ()=default
- ~GravityIntegFrame ()=default

Data Fields

- const EphemerisRefFrame * ref_frame {}

  Reference frame.
- bool is_third_body {}

  Is it a third body effect in this frame?
- double pos [3] {}

  Position of the integration frame origin with respect to a body.
- double accel [3] {}

  Acceleration of the frame origin with respect to the body.
- double time {9e99}

  Timestamp of last update to this class.

Friends

- class InputProcessor
- void init_attrjeod__GravityIntegFrame ()

8.2.1 Detailed Description

Class that aids in determining whether gravity should be applied as a direct effect or a third body effect.

Definition at line 83 of file gravity_integ_frame.hh.

8.2.2 Constructor & Destructor Documentation

8.2.2.1 GravityIntegFrame()

```
jeod::GravityIntegFrame::GravityIntegFrame ( )  [default]
```

8.2.2.2 ~GravityIntegFrame()

```
jeod::GravityIntegFrame::~GravityIntegFrame ( )  [default]
```

8.2.3 Friends And Related Function Documentation

8.2.3.1 init_attrjeod__GravityIntegFrame

```
void init_attrjeod__GravityIntegFrame ( )  [friend]
```

8.2.3.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 85 of file gravity_integ_frame.hh.

8.2.4 Field Documentation

8.2.4.1 accel

```
double jeod::GravityIntegFrame::accel[3] {}
```

Acceleration of the frame origin with respect to the body.

trick_units(m/s2)

Definition at line 104 of file gravity_integ_frame.hh.

8.2.4.2 is_third_body

```
bool jeod::GravityIntegFrame::is_third_body {}
```

Is it a third body effect in this frame?

trick_units(–)

Definition at line 94 of file gravity_integ_frame.hh.

Referenced by jeod::GravityControls::calc_spherical(), and jeod::GravitySource::initialize_state().

8.2.4.3 pos

```
double jeod::GravityIntegFrame::pos[3] {}
```

Position of the integration frame origin with respect to a body.

trick_units(m)

Definition at line 99 of file gravity_integ_frame.hh.

Referenced by jeod::GravityControls::calc_spherical(), and jeod::GravityControls::gravitation().

8.2.4.4 ref_frame

```
const EphemerisRefFrame* jeod::GravityIntegFrame::ref_frame {}
```

Reference frame.

trick_units(–)

Definition at line 89 of file gravity_integ_frame.hh.

Referenced by jeod::GravityControls::gravitation(), and jeod::GravitySource::initialize_state().

8.2.4.5 time

```
double jeod::GravityIntegFrame::time {9e99}
```

Timestamp of last update to this class.

trick_units(s)

Definition at line 109 of file gravity_integ_frame.hh.

Referenced by jeod::GravitySource::initialize_state().

The documentation for this class was generated from the following file:

- gravity_integ_frame.hh

8.3 jeod::GravityInteraction Class Reference

Specifies interactions between a vehicle and a set of gravitational bodies.

```
#include <gravity_interaction.hh>
```

Public Member Functions

- GravityInteraction ()

  Construct a GravityInteraction instance.
- virtual ~GravityInteraction ()

  Destruct a GravityInteraction instance.
- GravityInteraction (const GravityInteraction &frame)=delete
- GravityInteraction & operator= (const GravityInteraction &frame)=delete
- virtual void set_integ_frame (const EphemerisRefFrame &ref_frame_in, const BaseDynManager &dyn_↩ manager)

  Set the integration frame and associated integration frame index.
- virtual void add_control (GravityControls *control)

  Add a new GravityControls to the grav_controls list.
- virtual void remove_control (GravityControls *control)

  Remove a GravityControls from the grav_controls list.
- virtual void initialize_controls (BaseDynManager &dyn_manager, GravityManager &grav_manager)

  Initialize all GravityControls in the grav_controls list.
- virtual void reset_controls (BaseDynManager &dyn_manager)

  Reset all GravityControls in the grav_controls list.
- virtual void sort_controls ()

  Sort the GravityControls in the grav_controls list in increasing acceleration magnitude order.

Data Fields

- unsigned int integ_frame_index {9999}

  The integration frame index number of the DynBody's integration frame.
- double grav_accel [3] {}

  The total gravitational acceleration of the DynBody toward all planetary with which the vehicle interacts gravitationally.
- double grav_grad [3][3] {}

  The gradient of the gravitational acceleration vector evaluated at the DynBody's position, expressed in the vehicle's integration frame.
- double grav_pot {}

  The total gravitational potential at the location of the DynBody due to the gravity fields of all "active" gravitational bodies (i.e., planets).
- JeodPointerVector< GravityControls >::type grav_controls

  The gravity controls list for a DynBody specifies the planetary bodies with which the DynBody interacts and specifies the nature of those interactions.

Friends

- class InputProcessor
- void init_attrjeod__GravityInteraction ()

8.3.1 Detailed Description

Specifies interactions between a vehicle and a set of gravitational bodies.

Definition at line 96 of file gravity_interaction.hh.

8.3.2 Constructor & Destructor Documentation

8.3.2.1 GravityInteraction() [1/2]

```
jeod::GravityInteraction::GravityInteraction ( )
```

Construct a GravityInteraction instance.

Definition at line 58 of file gravity_interaction.cc.

References grav_controls.

8.3.2.2 ~GravityInteraction()

```
jeod::GravityInteraction::~GravityInteraction ( )  [virtual]
```

Destruct a GravityInteraction instance.

Definition at line 68 of file gravity_interaction.cc.

References grav_controls.

8.3.2.3 GravityInteraction() [2/2]

```
jeod::GravityInteraction::GravityInteraction (
            const GravityInteraction & frame )  [delete]
```

8.3.3 Member Function Documentation

8.3.3.1 add_control()

```
void jeod::GravityInteraction::add_control (
            GravityControls * control )  [virtual]
```

Add a new GravityControls to the grav_controls list.

Parameters

in	*control*	Control to be added

Definition at line 91 of file gravity_interaction.cc.

References jeod::GravityMessages::duplicate_entry, and grav_controls.

8.3.3.2 initialize_controls()

```
void jeod::GravityInteraction::initialize_controls (
            BaseDynManager & dyn_manager,
            GravityManager & grav_manager )  [virtual]
```

Initialize all GravityControls in the grav_controls list.

Parameters

in	*dyn_manager*	Ref to Dyn Manager
in	*grav_manager*	Ref to Gravity Manager

Definition at line 135 of file gravity_interaction.cc.

References grav_controls, and reset_controls().

8.3.3.3 operator=()

```
GravityInteraction& jeod::GravityInteraction::operator= (
            const GravityInteraction & frame )  [delete]
```

8.3.3.4 remove_control()

```
void jeod::GravityInteraction::remove_control (
            GravityControls * control )  [virtual]
```

Remove a GravityControls from the grav_controls list.

Parameters

in	*control*	GravityControls to be removed.

Definition at line 113 of file gravity_interaction.cc.

References grav_controls, and jeod::GravityMessages::missing_entry.

8.3.3.5 reset_controls()

```
void jeod::GravityInteraction::reset_controls (
            BaseDynManager & dyn_manager )  [virtual]
```

Reset all GravityControls in the grav_controls list.

Definition at line 150 of file gravity_interaction.cc.

References grav_controls.

Referenced by initialize_controls().

8.3.3.6 set_integ_frame()

```
void jeod::GravityInteraction::set_integ_frame (
            const EphemerisRefFrame & ref_frame,
            const BaseDynManager & dyn_manager )  [virtual]
```

Set the integration frame and associated integration frame index.

Assumptions and Limitations

- Provided frame is a valid integration frame.

Parameters

in	*ref_frame*	Integration frame
in	*dyn_manager*	Dynamics manager

Definition at line 82 of file gravity_interaction.cc.

References integ_frame_index.

8.3.3.7 sort_controls()

```
void jeod::GravityInteraction::sort_controls ( )  [virtual]
```

Sort the GravityControls in the grav_controls list in increasing acceleration magnitude order.

Definition at line 163 of file gravity_interaction.cc.

References jeod::GravityControls::accel_mag_less_ptr(), jeod::GravityControls::active, jeod::GravityControls::grav_accel, jeod::GravityControls::grav_accel_magsq, and grav_controls.

8.3.4 Friends And Related Function Documentation

8.3.4.1 init_attrjeod__GravityInteraction

```
void init_attrjeod__GravityInteraction ( )  [friend]
```

8.3.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 98 of file gravity_interaction.hh.

8.3.5 Field Documentation

8.3.5.1 grav_accel

```
double jeod::GravityInteraction::grav_accel[3] {}
```

The total gravitational acceleration of the DynBody toward all planetary with which the vehicle interacts gravitationally.

The acceleration is expressed in the DynBody's integration frame. The gravitational acceleration of the integration frame itself toward the planetary bodies is excluded from this total acceleration. For example, for a vehicle integrated in Earth-centered inertial, the Sun component of the total gravitational acceleration is the Newtonian gravitation acceleration of the vehicle toward the Sun less the Newtonian gravitational acceleration of the Earth toward the Sun.trick_units(m/s2)

Definition at line 118 of file gravity_interaction.hh.

Referenced by jeod::GravityManager::gravitation().

8.3.5.2 grav_controls

```
JeodPointerVector<GravityControls>::type jeod::GravityInteraction::grav_controls
```

The gravity controls list for a DynBody specifies the planetary bodies with which the DynBody interacts and specifies the nature of those interactions.

trick_io(**)

Definition at line 138 of file gravity_interaction.hh.

Referenced by add_control(), jeod::GravityManager::gravitation(), GravityInteraction(), initialize_controls(), remove_control(), reset_controls(), sort_controls(), and ~GravityInteraction().

8.3.5.3 grav_grad

```
double jeod::GravityInteraction::grav_grad[3][3] {}
```

The gradient of the gravitational acceleration vector evaluated at the DynBody's position, expressed in the vehicle's integration frame.

trick_units(1/s2)

Definition at line 124 of file gravity_interaction.hh.

Referenced by jeod::GravityManager::gravitation().

8.3.5.4 grav_pot

```
double jeod::GravityInteraction::grav_pot {}
```

The total gravitational potential at the location of the DynBody due to the gravity fields of all "active" gravitational bodies (i.e., planets).

trick_units(m2/s2)

Definition at line 131 of file gravity_interaction.hh.

Referenced by jeod::GravityManager::gravitation().

8.3.5.5 integ_frame_index

```
unsigned int jeod::GravityInteraction::integ_frame_index {9999}
```

The integration frame index number of the DynBody's integration frame.

This data member must be kept in strict synchronization with the DynBody's integration frame.trick_units(–)

Definition at line 105 of file gravity_interaction.hh.

Referenced by jeod::GravityManager::gravitation(), and set_integ_frame().

The documentation for this class was generated from the following files:

- gravity_interaction.hh
- gravity_interaction.cc

8.4 jeod::GravityManager Class Reference

The master gravitational model for a simulation.

```
#include <gravity_manager.hh>
```

Public Member Functions

- GravityManager ()
  GravityManager constructor.
- ~GravityManager ()
  GravityManager destructor.
- GravityManager (const GravityManager &)=delete
- GravityManager & operator= (const GravityManager &)=delete
- GravitySource * find_grav_source (const std::string &source_name) const
  Find the gravitational body with the given name.
- void add_grav_source (GravitySource &source)
  Create a gravitational body, initialize it with the supplied gravity coefficients, and add it to the vector of bodies.
- void initialize_model (BaseDynManager &manager)
  Perform base initialization.
- void initialize_state (const BaseDynManager &manager)
  Pass the initialize_state method to each GravitySource object registered with the gravity manager.
- void gravitation (const double integ_pos[3], GravityInteraction &grav)
  Compute the gravitational attraction of gravitational bodies on the provided dynamic body.
- void gravitation (const RefFrame &point, GravityInteraction &grav)
  Compute the gravitational attraction of gravitational bodies on the provided dynamic body.
- const std::vector< GravitySource * > & get_bodies () const
  Get the vector of gravitational bodies.

Private Attributes

- JeodPointerVector< GravitySource >::type sources
  The gravitational bodies.

Friends

- class InputProcessor
- void init_attrjeod__GravityManager ()

8.4.1 Detailed Description

The master gravitational model for a simulation.

Definition at line 88 of file gravity_manager.hh.

8.4.2 Constructor & Destructor Documentation

8.4.2.1 GravityManager() [1/2]

```
jeod::GravityManager::GravityManager ( )
```

GravityManager constructor.

Definition at line 57 of file gravity_manager.cc.

8.4.2.2 ~GravityManager()

```
jeod::GravityManager::~GravityManager ( )
```

GravityManager destructor.

Definition at line 67 of file gravity_manager.cc.

References sources.

8.4.2.3 GravityManager() [2/2]

```
jeod::GravityManager::GravityManager (
            const GravityManager &  )  [delete]
```

8.4.3 Member Function Documentation

8.4.3.1 add_grav_source()

```
void jeod::GravityManager::add_grav_source (
            GravitySource & source )
```

Create a gravitational body, initialize it with the supplied gravity coefficients, and add it to the vector of bodies.

Parameters

in	*source*	Gravity source to be added

Definition at line 109 of file gravity_manager.cc.

References jeod::GravityMessages::duplicate_entry, find_grav_source(), jeod::GravityMessages::invalid_name, jeod::GravitySource::name, and sources.

8.4.3.2 find_grav_source()

```
GravitySource * jeod::GravityManager::find_grav_source (
            const std::string & source_name ) const
```

Find the gravitational body with the given name.

Returns

Pointer to found body

Parameters

in	*source_name*	Name of gravity source to be found

Definition at line 78 of file gravity_manager.cc.

References jeod::GravityMessages::invalid_name, jeod::GravitySource::name, and sources.

Referenced by add_grav_source(), and jeod::GravityControls::initialize_control().

8.4.3.3 get_bodies()

```
const std::vector<GravitySource *>& jeod::GravityManager::get_bodies ( ) const  [inline]
```

Get the vector of gravitational bodies.

Warning

Do not modify the vector, or elements of it.

Definition at line 148 of file gravity_manager.hh.

Referenced by jeod::GravityControls::calc_relativistic().

8.4.3.4 gravitation() [1/2]

```
void jeod::GravityManager::gravitation (
            const double integ_pos[3],
            GravityInteraction & grav )
```

Compute the gravitational attraction of gravitational bodies on the provided dynamic body.

Assumptions and Limitations

- Only the gravitational bodies specified in the dynamic body's gravity controls have a bearing on the dynamic body's state.

Warning

This overload is deprecated.

Parameters

in	*integ_pos*	Dyn body location (integ frm) Units: M
in,out	*grav*	Gravity interaction

Definition at line 177 of file gravity_manager.cc.

References jeod::GravityControls::active, jeod::GravityInteraction::grav_accel, jeod::GravityControls::grav_accel, jeod::GravityInteraction::grav_controls, jeod::GravityInteraction::grav_grad, jeod::GravityControls::grav_grad, jeod::GravityInteraction::grav_pot, jeod::GravityControls::grav_pot, jeod::GravityControls::gravitation(), and jeod::GravityInteraction::integ_frame_index.

8.4.3.5 gravitation() [2/2]

```
void jeod::GravityManager::gravitation (
            const RefFrame & point,
            GravityInteraction & grav )
```

Compute the gravitational attraction of gravitational bodies on the provided dynamic body.

Assumptions and Limitations

- Only the gravitational bodies specified in the dynamic body's gravity controls have a bearing on the dynamic body's state.
- The supplied reference frame is assumed to be a direct child of the dynamic body's integration frame.

Parameters

in	*point*	Point of interest, as a reference frame.
in,out	*grav*	Gravity interaction

Definition at line 222 of file gravity_manager.cc.

References jeod::GravityControls::active, jeod::GravityInteraction::grav_accel, jeod::GravityControls::grav_↩ accel, jeod::GravityInteraction::grav_controls, jeod::GravityInteraction::grav_grad, jeod::GravityControls::grav_↩ grad, jeod::GravityInteraction::grav_pot, jeod::GravityControls::grav_pot, jeod::GravityControls::gravitation(), and jeod::GravityInteraction::integ_frame_index.

8.4.3.6 initialize_model()

```
void jeod::GravityManager::initialize_model (
             BaseDynManager & manager )
```

Perform base initialization.

Note

This method differs from the other initialize_models methods in that this method takes no coefficients as arguments. The S_define must call add_grav_source explicitly when this signature is used.

Parameters

in,out	*manager*	Dynamics manager

Definition at line 144 of file gravity_manager.cc.

8.4.3.7 initialize_state()

```
void jeod::GravityManager::initialize_state (
             const BaseDynManager & manager )
```

Pass the initialize_state method to each GravitySource object registered with the gravity manager.

Assumptions and Limitations

- Initialization phasing: The following must have been called prior to calling this method:
  - GravityManager::initialize_model to register the GravityManager object with the dynamics manager
  - GravityManager::add_grav_source to register all GravitySource objects in the simulation with the gravity manager.
  - Planet::register_model to associate the planet with a GravitySource.
  - DynamicsManager::activate_ephemerides to identify which reference frames can serve as integration frames.

Parameters

in,out	*manager*	Dynamics manager

Definition at line 165 of file gravity_manager.cc.

References sources.

8.4.3.8 operator=()

```
GravityManager& jeod::GravityManager::operator= (
             const GravityManager &  )  [delete]
```

8.4.4 Friends And Related Function Documentation

8.4.4.1 init_attrjeod__GravityManager

```
void init_attrjeod__GravityManager ( )  [friend]
```

8.4.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 90 of file gravity_manager.hh.

8.4.5 Field Documentation

8.4.5.1 sources

```
JeodPointerVector<GravitySource>::type jeod::GravityManager::sources  [private]
```

The gravitational bodies.

trick_io(**)

Definition at line 97 of file gravity_manager.hh.

Referenced by add_grav_source(), find_grav_source(), initialize_state(), and ~GravityManager().

The documentation for this class was generated from the following files:

- gravity_manager.hh
- gravity_manager.cc

8.5 jeod::GravityMessages Class Reference

Specifies the message IDs used in the gravity model.

`#include <gravity_messages.hh>`

Public Member Functions

- GravityMessages ()=delete
- GravityMessages (const GravityMessages &)=delete
- GravityMessages & operator= (const GravityMessages &)=delete

Static Public Attributes

- static const char * duplicate_entry = "environment/gravity/" "duplicate_entry"

  Issued when a duplicate entry is detected.
- static const char * missing_entry = "environment/gravity/" "missing_entry"

  Issued when a missing entry is detected.
- static const char * invalid_name = "environment/gravity/" "invalid_name"

  Error issued when a name is invalid (null or empty).
- static const char * invalid_object = "environment/gravity/" "invalid_object"

  Error issued when an object is invalid (wrong type).
- static const char * invalid_limit = "environment/gravity/" "invalid_limit"

  Issued when a limit is out of range.
- static const char * domain_error = "environment/gravity/" "domain_error"

  Issued when a value is outside the known-to-be-valid range, e.g., a radial distance less than the planet's equatorial radius.
- static const char * null_pointer = "environment/gravity/" "null_pointer"

  Error issued when a pointer is invalid (null or empty).

Friends

- class InputProcessor
- void init_attrjeod__GravityMessages ()

8.5.1 Detailed Description

Specifies the message IDs used in the gravity model.

Definition at line 82 of file gravity_messages.hh.

8.5.2 Constructor & Destructor Documentation

8.5.2.1 GravityMessages() [1/2]

```
jeod::GravityMessages::GravityMessages ( )  [delete]
```

8.5.2.2 GravityMessages() [2/2]

```
jeod::GravityMessages::GravityMessages (
            const GravityMessages &  )  [delete]
```

8.5.3 Member Function Documentation

8.5.3.1 operator=()

```
GravityMessages& jeod::GravityMessages::operator= (
            const GravityMessages &  )  [delete]
```

8.5.4 Friends And Related Function Documentation

8.5.4.1 init_attrjeod__GravityMessages

```
void init_attrjeod__GravityMessages ( )  [friend]
```

8.5.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 84 of file gravity_messages.hh.

8.5.5 Field Documentation

8.5.5.1 domain_error

```
char const * jeod::GravityMessages::domain_error = "environment/gravity/" "domain_error"  [static]
```

Issued when a value is outside the known-to-be-valid range, e.g., a radial distance less than the planet's equatorial radius.

trick_units(–)

Definition at line 115 of file gravity_messages.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical().

8.5.5.2 duplicate_entry

```
char const * jeod::GravityMessages::duplicate_entry = "environment/gravity/" "duplicate_entry"
[static]
```

Issued when a duplicate entry is detected.

trick_units(–)

Definition at line 89 of file gravity_messages.hh.

Referenced by jeod::GravityInteraction::add_control(), jeod::SphericalHarmonicsGravitySource::add_deltacoeff(), and jeod::GravityManager::add_grav_source().

8.5.5.3 invalid_limit

```
char const * jeod::GravityMessages::invalid_limit = "environment/gravity/" "invalid_limit"
[static]
```

Issued when a limit is out of range.

trick_units(–)

Definition at line 109 of file gravity_messages.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::check_validity().

8.5.5.4 invalid_name

```
char const * jeod::GravityMessages::invalid_name = "environment/gravity/" "invalid_name"  [static]
```

Error issued when a name is invalid (null or empty).

trick_units(–)

Definition at line 99 of file gravity_messages.hh.

Referenced by jeod::GravityManager::add_grav_source(), jeod::GravityManager::find_grav_source(), and jeod::↩ SphericalHarmonicsTidalEffects::initialize().

8.5.5.5 invalid_object

```
char const * jeod::GravityMessages::invalid_object = "environment/gravity/" "invalid_object"
[static]
```

Error issued when an object is invalid (wrong type).

trick_units(–)

Definition at line 104 of file gravity_messages.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::check_validity(), jeod::SphericalHarmonicsTidalEffects↩
::initialize(), and jeod::GravityControls::initialize_control().

8.5.5.6 missing_entry

```
char const * jeod::GravityMessages::missing_entry = "environment/gravity/" "missing_entry"
[static]
```

Issued when a missing entry is detected.

trick_units(–)

Definition at line 94 of file gravity_messages.hh.

Referenced by jeod::GravityControls::initialize_control(), and jeod::GravityInteraction::remove_control().

8.5.5.7 null_pointer

```
char const * jeod::GravityMessages::null_pointer = "environment/gravity/" "null_pointer"  [static]
```

Error issued when a pointer is invalid (null or empty).

trick_units(–)

Definition at line 120 of file gravity_messages.hh.

Referenced by jeod::GravityControls::reset_control().

The documentation for this class was generated from the following files:

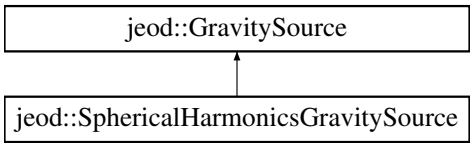
- gravity_messages.hh
- gravity_messages.cc

8.6 jeod::GravitySource Class Reference

Models the gravity for a specific planet;.

`#include <gravity_source.hh>`

Inheritance diagram for jeod::GravitySource:



Public Member Functions

- GravitySource ()

  GravitySource constructor.
- virtual ~GravitySource ()

  GravitySource destructor.
- GravitySource (const GravitySource &)=delete
- GravitySource & operator= (const GravitySource &)=delete
- virtual void initialize_state (const std::vector< EphemerisRefFrame *> &integ_frames, const GravityManager &gravity_manager)

  Initialize frame states for the gravity body.

Data Fields

- std::string name {""}

  The name of the source (i.e.
- EphemerisRefFrame * inertial {}

  The pseudo-inertial frame associated with this gravity source.
- EphemerisRefFrame * pfix {}

  Planetoid fixed frame.
- double mu {}

  The planet's standard gravitational parameter, G times planet mass.
- GravityIntegFrame * frames {}

  Relative states with respect to this body, for each integration frame.

Friends

- class InputProcessor
- void init_attrjeod__GravitySource ()

8.6.1 Detailed Description

Models the gravity for a specific planet;.

Definition at line 89 of file gravity_source.hh.

8.6.2 Constructor & Destructor Documentation

8.6.2.1 GravitySource() [1/2]

```
jeod::GravitySource::GravitySource ( )
```

GravitySource constructor.

Definition at line 51 of file gravity_source.cc.

8.6.2.2 ~GravitySource()

```
jeod::GravitySource::~GravitySource ( )  [virtual]
```

GravitySource destructor.

Definition at line 59 of file gravity_source.cc.

References frames.

8.6.2.3 GravitySource() [2/2]

```
jeod::GravitySource::GravitySource (
            const GravitySource &  )  [delete]
```

8.6.3 Member Function Documentation

8.6.3.1 initialize_state()

```
void jeod::GravitySource::initialize_state (
            const std::vector< EphemerisRefFrame *> & integ_frames,
            const GravityManager & gravity_manager )  [virtual]
```

Initialize frame states for the gravity body.

Parameters

in	*integ_frames*	All possible integration frames
in	*gravity_manager*	Gravity Manager

Definition at line 69 of file gravity_source.cc.

References frames, inertial, jeod::GravityIntegFrame::is_third_body, jeod::GravityIntegFrame::ref_frame, and jeod::GravityIntegFrame::time.

8.6.3.2 operator=()

```
GravitySource& jeod::GravitySource::operator= (
            const GravitySource &  )  [delete]
```

8.6.4 Friends And Related Function Documentation

8.6.4.1 init_attrjeod__GravitySource

```
void init_attrjeod__GravitySource ( )  [friend]
```

8.6.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 91 of file gravity_source.hh.

8.6.5 Field Documentation

8.6.5.1 frames

```
GravityIntegFrame* jeod::GravitySource::frames {}
```

Relative states with respect to this body, for each integration frame.

trick_units(–)

Definition at line 123 of file gravity_source.hh.

Referenced by jeod::GravityControls::gravitation(), initialize_state(), and ~GravitySource().

8.6.5.2 inertial

```
EphemerisRefFrame* jeod::GravitySource::inertial {}
```

The pseudo-inertial frame associated with this gravity source.

Used for most basic gravity calculations planet represented by thistrick_units(–)

Definition at line 106 of file gravity_source.hh.

Referenced by jeod::GravityControls::calc_relativistic(), jeod::GravityControls::gravitation(), jeod::GravityControls::initialize_control(), initialize_state(), and jeod::GravityControls::reset_control().

8.6.5.3 mu

```
double jeod::GravitySource::mu {}
```

The planet's standard gravitational parameter, G times planet mass.

trick_units(m3/s2)

Definition at line 118 of file gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::GravityControls::calc_relativistic(), jeod::GravityControls::calc_spherical(), jeod::SphericalHarmonicsGravitySource_earth_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_mars_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_sun_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_jupiter_spherical_default_data::initialize(), and jeod::SphericalHarmonicsSolidBodyTides::update().

8.6.5.4 name

```
std::string jeod::GravitySource::name {""}
```

The name of the source (i.e.

associated planet or planetoid) The GravitySource object, the BasePlanet derived object that points to the GravitySource object, and the EphemerisPlanet that enables populating the planetoid's inertial RefFrame object must all have the exact same name.trick_units(–)

Definition at line 99 of file gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravitySource::add_deltacoeff(), jeod::GravityManager::add_grav_source(), jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravityControls::check_validity(), jeod::SphericalHarmonicsGravitySource::find_deltacoeff(), jeod::GravityManager::find_grav_source(), jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_mars_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_sun_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_jupiter_spherical_default_data::initialize(), and jeod::GravityControls::initialize_control().

8.6.5.5 pfix

```
EphemerisRefFrame* jeod::GravitySource::pfix {}
```

Planetoid fixed frame.

The Cartesian reference frame centered and fixed on the associated gravity source. Used for advanced (e.g. nonspherical gravity effects.trick_units(–)

Definition at line 113 of file gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsTidal↩ Effects::initialize(), and jeod::GravityControls::reset_control().

The documentation for this class was generated from the following files:

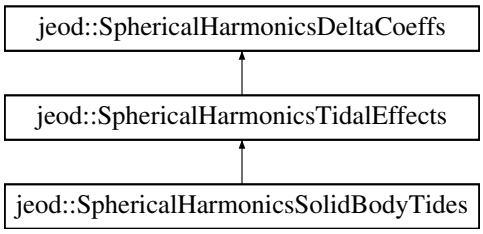
- gravity_source.hh
- gravity_source.cc

8.7 jeod::SphericalHarmonicsDeltaCoeffs Class Reference

Base class for tidal and temporal gravity models.

```
#include <spherical_harmonics_delta_coeffs.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsDeltaCoeffs:



Public Member Functions

- SphericalHarmonicsDeltaCoeffs ()=default
- virtual ~SphericalHarmonicsDeltaCoeffs ()

  SphericalHarmonicsDeltaCoeffs destructor.
- virtual void initialize (SphericalHarmonicsDeltaCoeffsInit &var_init, BaseDynManager &dyn_manager)

  Initialize the class.
- virtual void update (SphericalHarmonicsGravityControls &controls)

  Pure virtual update method.

Data Fields

- SphericalHarmonicsGravitySource * grav_source {}

  Pointer to the gravity body associated with this effect.
- double ** delta_Cnm {}

  Normalized real (cosine) variational spherical harmonic coefficients.
- double ** delta_Snm {}

  Normalized imaginary (sine) variational spherical harmonic coeffs.
- unsigned int degree {}

  Coefficient degree to be used for this SphericalHarmonicsDeltaCoeffs.
- unsigned int order {}

  Coefficient order to be used for this SphericalHarmonicsDeltaCoeffs.
- double dC20 {}

  delta C20 coefficient for first order effect

Friends

- class InputProcessor
- void init_attrjeod__SphericalHarmonicsDeltaCoeffs ()

8.7.1 Detailed Description

Base class for tidal and temporal gravity models.

Definition at line 88 of file spherical_harmonics_delta_coeffs.hh.

8.7.2 Constructor & Destructor Documentation

8.7.2.1 SphericalHarmonicsDeltaCoeffs()

```
jeod::SphericalHarmonicsDeltaCoeffs::SphericalHarmonicsDeltaCoeffs ( )  [default]
```

8.7.2.2 ~SphericalHarmonicsDeltaCoeffs()

```
jeod::SphericalHarmonicsDeltaCoeffs::~SphericalHarmonicsDeltaCoeffs ( )  [virtual]
```

SphericalHarmonicsDeltaCoeffs destructor.

Definition at line 51 of file spherical_harmonics_delta_coeffs.cc.

References degree, delta_Cnm, and delta_Snm.

8.7.3 Member Function Documentation

8.7.3.1 initialize()

```
void jeod::SphericalHarmonicsDeltaCoeffs::initialize (
            SphericalHarmonicsDeltaCoeffsInit & var_init,
            BaseDynManager & dyn_manager )  [virtual]
```

Initialize the class.

Parameters

in	*var_init*	Init structure
in,out	*dyn_manager*	Dynamics manager

Reimplemented in jeod::SphericalHarmonicsTidalEffects, and jeod::SphericalHarmonicsSolidBodyTides.

Definition at line 62 of file spherical_harmonics_delta_coeffs.cc.

References jeod::SphericalHarmonicsDeltaCoeffsInit::degree, degree, jeod::SphericalHarmonicsDeltaCoeffsInit::delta_Cnm, delta_Cnm, jeod::SphericalHarmonicsDeltaCoeffsInit::delta_Snm, delta_Snm, jeod::SphericalHarmonicsDeltaCoeffsInit::order, and order.

Referenced by jeod::SphericalHarmonicsGravitySource::add_deltacoeff(), and jeod::SphericalHarmonicsTidalEffects::initialize().

8.7.3.2 update()

```
void jeod::SphericalHarmonicsDeltaCoeffs::update (
            SphericalHarmonicsGravityControls & controls )  [virtual]
```

Pure virtual update method.

Parameters

in	*controls*	Ignored

Reimplemented in jeod::SphericalHarmonicsTidalEffects, and jeod::SphericalHarmonicsSolidBodyTides.

Definition at line 96 of file spherical_harmonics_delta_coeffs.cc.

8.7.4 Friends And Related Function Documentation

8.7.4.1 init_attrjeod__SphericalHarmonicsDeltaCoeffs

```
void init_attrjeod__SphericalHarmonicsDeltaCoeffs ( )  [friend]
```

8.7.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 90 of file spherical_harmonics_delta_coeffs.hh.

8.7.5 Field Documentation

8.7.5.1 dC20

```
double jeod::SphericalHarmonicsDeltaCoeffs::dC20 {}
```

delta C20 coefficient for first order effect

trick_units(–)

Definition at line 120 of file spherical_harmonics_delta_coeffs.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs(), and jeod::SphericalHarmonicsSolid↩ BodyTides::update().

8.7.5.2 degree

```
unsigned int jeod::SphericalHarmonicsDeltaCoeffs::degree {}
```

Coefficient degree to be used for this SphericalHarmonicsDeltaCoeffs.

trick_units(–)

Definition at line 110 of file spherical_harmonics_delta_coeffs.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::add_deltacontrol(), initialize(), jeod::Spherical↩ HarmonicsTidalEffects::initialize(), and ∼SphericalHarmonicsDeltaCoeffs().

8.7.5.3 delta_Cnm

```
double** jeod::SphericalHarmonicsDeltaCoeffs::delta_Cnm {}
```

Normalized real (cosine) variational spherical harmonic coefficients.

trick_units(–)

Definition at line 100 of file spherical_harmonics_delta_coeffs.hh.

Referenced by initialize(), jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs(), and ∼Spherical↩ HarmonicsDeltaCoeffs().

8.7.5.4 delta_Snm

```
double** jeod::SphericalHarmonicsDeltaCoeffs::delta_Snm {}
```

Normalized imaginary (sine) variational spherical harmonic coeffs.

trick_units(–)

Definition at line 105 of file spherical_harmonics_delta_coeffs.hh.

Referenced by initialize(), jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs(), and ~SphericalHarmonicsDeltaCoeffs().

8.7.5.5 grav_source

```
SphericalHarmonicsGravitySource* jeod::SphericalHarmonicsDeltaCoeffs::grav_source {}
```

Pointer to the gravity body associated with this effect.

trick_units(–)

Definition at line 95 of file spherical_harmonics_delta_coeffs.hh.

Referenced by jeod::SphericalHarmonicsGravitySource::add_deltacoeff(), jeod::SphericalHarmonicsTidalEffects::initialize(), and jeod::SphericalHarmonicsSolidBodyTides::update().

8.7.5.6 order

```
unsigned int jeod::SphericalHarmonicsDeltaCoeffs::order {}
```

Coefficient order to be used for this SphericalHarmonicsDeltaCoeffs.

trick_units(–)

Definition at line 115 of file spherical_harmonics_delta_coeffs.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::add_deltacontrol(), initialize(), and jeod::SphericalHarmonicsTidalEffects::initialize().

The documentation for this class was generated from the following files:

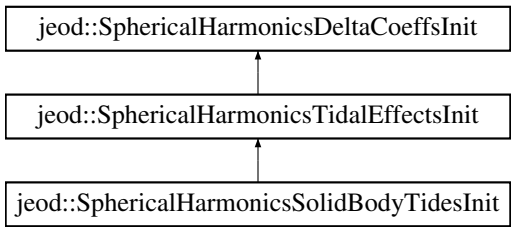
- spherical_harmonics_delta_coeffs.hh
- spherical_harmonics_delta_coeffs.cc

8.8 jeod::SphericalHarmonicsDeltaCoeffsInit Class Reference

Initialization data for a SphericalHarmonicsDeltaCoeffs instance.

`#include <spherical_harmonics_delta_coeffs_init.hh>`

Inheritance diagram for jeod::SphericalHarmonicsDeltaCoeffsInit:



Public Member Functions

- SphericalHarmonicsDeltaCoeffsInit ()=default
- virtual ~SphericalHarmonicsDeltaCoeffsInit ()=default

Data Fields

- double ** delta_Cnm {}

  Normalized real (cosine) variational spherical harmonic coefficients.
- double ** delta_Snm {}

  Normalized imaginary (sine) variational spherical harmonic coeffs.
- unsigned int degree {}

  Coefficient degree to be used for this SphericalHarmonicsDeltaCoeffs.
- unsigned int order {}

  Coefficient order to be used for this SphericalHarmonicsDeltaCoeffs.

Friends

- class InputProcessor
- void init_attrjeod__SphericalHarmonicsDeltaCoeffsInit ()

8.8.1 Detailed Description

Initialization data for a SphericalHarmonicsDeltaCoeffs instance.

Definition at line 78 of file spherical_harmonics_delta_coeffs_init.hh.

8.8.2 Constructor & Destructor Documentation

8.8.2.1 SphericalHarmonicsDeltaCoeffsInit()

```
jeod::SphericalHarmonicsDeltaCoeffsInit::SphericalHarmonicsDeltaCoeffsInit ( )  [default]
```

8.8.2.2 ~SphericalHarmonicsDeltaCoeffsInit()

```
virtual jeod::SphericalHarmonicsDeltaCoeffsInit::~SphericalHarmonicsDeltaCoeffsInit ( )  [virtual],
[default]
```

8.8.3 Friends And Related Function Documentation

8.8.3.1 init_attrjeod__SphericalHarmonicsDeltaCoeffsInit

```
void init_attrjeod__SphericalHarmonicsDeltaCoeffsInit ( )  [friend]
```

8.8.3.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 80 of file spherical_harmonics_delta_coeffs_init.hh.

8.8.4 Field Documentation

8.8.4.1 degree

```
unsigned int jeod::SphericalHarmonicsDeltaCoeffsInit::degree {}
```

Coefficient degree to be used for this SphericalHarmonicsDeltaCoeffs.

trick_units(–)

Definition at line 95 of file spherical_harmonics_delta_coeffs_init.hh.

Referenced by jeod::SphericalHarmonicsDeltaCoeffs::initialize().

8.8.4.2 delta_Cnm

```
double** jeod::SphericalHarmonicsDeltaCoeffsInit::delta_Cnm {}
```

Normalized real (cosine) variational spherical harmonic coefficients.

trick_units(–)

Definition at line 85 of file spherical_harmonics_delta_coeffs_init.hh.

Referenced by jeod::SphericalHarmonicsDeltaCoeffs::initialize().

8.8.4.3 delta_Snm

```
double** jeod::SphericalHarmonicsDeltaCoeffsInit::delta_Snm {}
```

Normalized imaginary (sine) variational spherical harmonic coeffs.

trick_units(–)

Definition at line 90 of file spherical_harmonics_delta_coeffs_init.hh.

Referenced by jeod::SphericalHarmonicsDeltaCoeffs::initialize().

8.8.4.4 order

```
unsigned int jeod::SphericalHarmonicsDeltaCoeffsInit::order {}
```

Coefficient order to be used for this SphericalHarmonicsDeltaCoeffs.

trick_units(–)

Definition at line 100 of file spherical_harmonics_delta_coeffs_init.hh.

Referenced by jeod::SphericalHarmonicsDeltaCoeffs::initialize().

The documentation for this class was generated from the following file:

- spherical_harmonics_delta_coeffs_init.hh

8.9 jeod::SphericalHarmonicsDeltaControls Class Reference

Provides controls for how a variational model affects a vehicle.

```
#include <spherical_harmonics_delta_controls.hh>
```

Public Member Functions

- SphericalHarmonicsDeltaControls ()=default
- ~SphericalHarmonicsDeltaControls ()=default

Data Fields

- SphericalHarmonicsDeltaCoeffs * grav_effect {}

  Pointer to associated coefficient-altering gravitational effect.
- SphericalHarmonicsGravitySource * grav_source {}

  Pointer to the gravity body associated with this effect.
- bool active {}

  Is this variational gravity effect active for this body?
- bool first_order_only {true}

  Calculate first-order term of this effect only; default to true for 2.0.
- unsigned int degree {}

  Coefficient degree to be used for this gravity effect.
- unsigned int order {}

  Coefficient order to be used for this gravity effect.

Friends

- class InputProcessor
- void init_attrjeod__SphericalHarmonicsDeltaControls ()

8.9.1 Detailed Description

Provides controls for how a variational model affects a vehicle.

Definition at line 81 of file spherical_harmonics_delta_controls.hh.

8.9.2 Constructor & Destructor Documentation

8.9.2.1 SphericalHarmonicsDeltaControls()

```
jeod::SphericalHarmonicsDeltaControls::SphericalHarmonicsDeltaControls ( )  [default]
```

8.9.2.2 ~SphericalHarmonicsDeltaControls()

```
jeod::SphericalHarmonicsDeltaControls::~SphericalHarmonicsDeltaControls ( )  [default]
```

8.9.3 Friends And Related Function Documentation

8.9.3.1 init_attrjeod__SphericalHarmonicsDeltaControls

```
void init_attrjeod__SphericalHarmonicsDeltaControls ( )  [friend]
```

8.9.3.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 83 of file spherical_harmonics_delta_controls.hh.

8.9.4 Field Documentation

8.9.4.1 active

```
bool jeod::SphericalHarmonicsDeltaControls::active {}
```

Is this variational gravity effect active for this body?

trick_units(–)

Definition at line 98 of file spherical_harmonics_delta_controls.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs().

8.9.4.2 degree

```
unsigned int jeod::SphericalHarmonicsDeltaControls::degree {}
```

Coefficient degree to be used for this gravity effect.

trick_units(–)

Definition at line 108 of file spherical_harmonics_delta_controls.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs().

8.9.4.3 first_order_only

```
bool jeod::SphericalHarmonicsDeltaControls::first_order_only {true}
```

Calculate first-order term of this effect only; default to true for 2.0.

trick_units(–)

Definition at line 103 of file spherical_harmonics_delta_controls.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs().

8.9.4.4 grav_effect

```
SphericalHarmonicsDeltaCoeffs* jeod::SphericalHarmonicsDeltaControls::grav_effect {}
```

Pointer to associated coefficient-altering gravitational effect.

trick_units(–)

Definition at line 88 of file spherical_harmonics_delta_controls.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::add_deltacontrol(), and jeod::SphericalHarmonics↩ GravityControls::sum_deltacoeffs().

8.9.4.5 grav_source

```
SphericalHarmonicsGravitySource* jeod::SphericalHarmonicsDeltaControls::grav_source {}
```

Pointer to the gravity body associated with this effect.

trick_units(–)

Definition at line 93 of file spherical_harmonics_delta_controls.hh.

8.9.4.6 order

```
unsigned int jeod::SphericalHarmonicsDeltaControls::order {}
```

Coefficient order to be used for this gravity effect.

trick_units(–)

Definition at line 113 of file spherical_harmonics_delta_controls.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs().

The documentation for this class was generated from the following file:

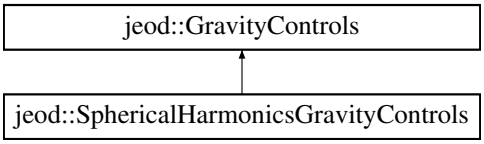
- spherical_harmonics_delta_controls.hh

8.10 jeod::SphericalHarmonicsGravityControls Class Reference

Specifies whether and how a SphericalHarmonicsGravitySource affects a vehicle.

`#include <spherical_harmonics_gravity_controls.hh>`

Inheritance diagram for jeod::SphericalHarmonicsGravityControls:



Public Member Functions

- SphericalHarmonicsGravityControls ()
  SphericalHarmonicsGravityControls constructor.
- ~SphericalHarmonicsGravityControls () override
  SphericalHarmonicsGravityControls destructor.
- SphericalHarmonicsGravityControls (const SphericalHarmonicsGravityControls &)=delete
- SphericalHarmonicsGravityControls & operator= (const SphericalHarmonicsGravityControls &)=delete
- void initialize_control (GravityManager &grav_manager) override
  Initialize this GravityControl.
- virtual void add_deltacontrol (SphericalHarmonicsDeltaControls *delta_control)
  Add a new GravityDeltaControls to the var_effects list.
- unsigned int get_degree ()
  Output the current functional degree.
- unsigned int get_order ()
  Output the current functional order.
- void get_degree_order (unsigned int &current_degree, unsigned int &current_order)
  Output the current functional degree and order.
- unsigned int get_grad_degree ()
  Output the current functional gradient degree.
- unsigned int get_grad_order ()
  Output the current functional gradient order.
- void get_grad_degree_order (unsigned int &curr_grad_degree, unsigned int &curr_grad_order)
  Output the current functional gradient degree and order.
- void set_degree (unsigned int new_degree)
  Update the functional degree.
- void set_order (unsigned int new_order)
  Update the functional order.
- void set_degree_order (unsigned int new_degree, unsigned int new_order)
  Update the functional degree and order.
- void set_grad_degree (unsigned int new_grad_degree)
  Update the functional gradient degree.
- void set_grad_order (unsigned int new_grad_order)
  Update the functional gradient order.
- void set_grad_degree_order (unsigned int new_grad_degree, unsigned int new_grad_order)
  Update the functional gradient degree and order.
- void disable_min_radius_warnings ()
  Disable minimum radius warnings for this spherical harmonics gravity control.

Data Fields

- SphericalHarmonicsGravitySource * harmonics_source {}

  The GravitySource pointer from the base class, recast.
- double ** Pnm {}

  LeGendre polynomials used to calculate non-spherical attraction.
- unsigned int delta_degree {}

  Coefficient degree to be used for totaling up all active delta_coeffs.
- unsigned int delta_order {}

  Coefficient order to be used for totaling up all active delta_coeffs.
- double ** delta_Cnm {}

  Array for collecting all active normalized real (cosine) variational spherical harmonic coefficients.
- double ** delta_Snm {}

  Array for collecting all active normalized real (sine) variational spherical harmonic coefficients.
- double total_dC20 {}

  delta C20 coefficient for collecting first order effects of all active delta_coeffs.
- unsigned int degree {}

  Non-spherical degree to be used.
- unsigned int order {}

  Non-spherical order to be used.
- unsigned int gradient_degree {}

  Non-spherical degree to be used for computing gradient.
- unsigned int gradient_order {}

  Non-spherical order to be used for computing gradient.
- JeodPointerVector< SphericalHarmonicsDeltaControls >::type var_effects

  List of controls for variational gravity effects like solid-body tides.

Protected Member Functions

- void calc_nonspherical (const double integ_pos[3], const double posn[3], const GravityIntegFrame &grav_source_frame, double body_grav_accel[3], double dgdx[3][3], double &pot) override

  Compute the gravitational acceleration at a given position toward a gravitational body assuming the body has a non-spherical mass distribution.
- virtual void check_validity ()

  Check the validity of the gravity controls.
- virtual void update_deltacoeffs ()

  Command all of the gravitational variation effects to update themselves.
- virtual void sum_deltacoeffs ()

  Loop over all of the active gravitational variation effects models and aggregate their changes to the gravity coefficients into the top-level delta-coeffs "bin" for this gravity body.

Protected Attributes

- bool min_radius_warn {}

  Indicates that the minimum radius threshold has been crossed and that a warning has been issued for such.

Friends

- class InputProcessor
- void init_attrjeod__SphericalHarmonicsGravityControls ()

Additional Inherited Members

8.10.1 Detailed Description

Specifies whether and how a SphericalHarmonicsGravitySource affects a vehicle.

Definition at line 87 of file spherical_harmonics_gravity_controls.hh.

8.10.2 Constructor & Destructor Documentation

8.10.2.1 SphericalHarmonicsGravityControls() [1/2]

```
jeod::SphericalHarmonicsGravityControls::SphericalHarmonicsGravityControls ( )
```

SphericalHarmonicsGravityControls constructor.

Definition at line 55 of file spherical_harmonics_gravity_controls.cc.

References var_effects.

8.10.2.2 ~SphericalHarmonicsGravityControls()

```
jeod::SphericalHarmonicsGravityControls::~SphericalHarmonicsGravityControls ( )  [override]
```

SphericalHarmonicsGravityControls destructor.

Definition at line 65 of file spherical_harmonics_gravity_controls.cc.

References jeod::SphericalHarmonicsGravitySource::degree, delta_Cnm, delta_degree, delta_Snm, harmonics_source, Pnm, and var_effects.

8.10.2.3 SphericalHarmonicsGravityControls() [2/2]

```
jeod::SphericalHarmonicsGravityControls::SphericalHarmonicsGravityControls (
            const SphericalHarmonicsGravityControls &  )  [delete]
```

8.10.3 Member Function Documentation

8.10.3.1 add_deltacontrol()

```
void jeod::SphericalHarmonicsGravityControls::add_deltacontrol (
            SphericalHarmonicsDeltaControls * delta_control )  [virtual]
```

Add a new GravityDeltaControls to the var_effects list.

Parameters

in	*delta_control*	Control to be added

Definition at line 145 of file spherical_harmonics_gravity_controls.cc.

References jeod::SphericalHarmonicsDeltaCoeffs::degree, delta_Cnm, delta_degree, delta_order, delta_Snm, jeod::SphericalHarmonicsDeltaControls::grav_effect, jeod::SphericalHarmonicsDeltaCoeffs::order, and var_effects.

8.10.3.2 calc_nonspherical()

```
void jeod::SphericalHarmonicsGravityControls::calc_nonspherical (
            const double integ_pos [3],
            const double posn[3],
            const GravityIntegFrame & grav_source_frame,
            double body_grav_accel[3],
            double dgdx[3][3],
            double & pot ) [override], [protected], [virtual]
```

Compute the gravitational acceleration at a given position toward a gravitational body assuming the body has a non-spherical mass distribution.

Parameters

in	*posn*	Point of interest, inrtl coords Units: M
out	*body_grav_accel*	Accel for given grav body Units: M/s2
out	*dgdx*	Gradient for given grav body Units: 1/s2
out	*Pot*	Potential

Implements jeod::GravityControls.

Definition at line 54 of file spherical_harmonics_calc_nonspherical.cc.

References jeod::SphericalHarmonicsGravitySource::alpha, jeod::SphericalHarmonicsGravitySource::beta, jeod::SphericalHarmonicsGravitySource::Cnm, degree, jeod::GravityMessages::domain_error, jeod::SphericalHarmonicsGravitySource::eta, jeod::GravityControls::gradient, gradient_degree, gradient_order, harmonics_source, jeod::SphericalHarmonicsGravitySource::int_to_double, min_radius_warn, jeod::GravitySource::mu, jeod::GravitySource::name, jeod::SphericalHarmonicsGravitySource::nrdiag, order, jeod::GravitySource::pfix, Pnm, jeod::SphericalHarmonicsGravitySource::radius, jeod::SphericalHarmonicsGravitySource::Snm, sum_deltacoeffs(), jeod::SphericalHarmonicsGravitySource::tide_free, jeod::SphericalHarmonicsGravitySource::tide_free_delta, total_dC20, update_deltacoeffs(), jeod::SphericalHarmonicsGravitySource::upsilon, var_effects, jeod::SphericalHarmonicsGravitySource::xi, and jeod::SphericalHarmonicsGravitySource::zeta.

8.10.3.3 check_validity()

```
void jeod::SphericalHarmonicsGravityControls::check_validity ( )  [protected], [virtual]
```

Check the validity of the gravity controls.

Definition at line 322 of file spherical_harmonics_gravity_controls.cc.

References jeod::SphericalHarmonicsGravitySource::degree, degree, jeod::GravityControls::gradient, gradient_degree, gradient_order, harmonics_source, jeod::GravityMessages::invalid_limit, jeod::GravityMessages::invalid_object, jeod::GravitySource::name, jeod::SphericalHarmonicsGravitySource::order, order, jeod::GravityControls::source_name, and jeod::GravityControls::spherical.

Referenced by initialize_control(), set_degree(), set_degree_order(), set_grad_degree(), set_grad_degree_order(), set_grad_order(), and set_order().

8.10.3.4 disable_min_radius_warnings()

```
void jeod::SphericalHarmonicsGravityControls::disable_min_radius_warnings ( )  [inline]
```

Disable minimum radius warnings for this spherical harmonics gravity control.

Definition at line 227 of file spherical_harmonics_gravity_controls.hh.

8.10.3.5 get_degree()

```
unsigned int jeod::SphericalHarmonicsGravityControls::get_degree ( )
```

Output the current functional degree.

Returns

Current degree

Definition at line 188 of file spherical_harmonics_gravity_controls.cc.

References degree.

8.10.3.6 get_degree_order()

```
void jeod::SphericalHarmonicsGravityControls::get_degree_order (
            unsigned int & current_degree,
            unsigned int & current_order )
```

Output the current functional degree and order.

Parameters

out	*current_degree*	Current degree
out	*current_order*	Current order

Definition at line 207 of file spherical_harmonics_gravity_controls.cc.

References degree, and order.

8.10.3.7 get_grad_degree()

```
unsigned int jeod::SphericalHarmonicsGravityControls::get_grad_degree ( )
```

Output the current functional gradient degree.

Returns

Current gradient degree

Definition at line 217 of file spherical_harmonics_gravity_controls.cc.

References gradient_degree.

8.10.3.8 get_grad_degree_order()

```
void jeod::SphericalHarmonicsGravityControls::get_grad_degree_order (
             unsigned int & curr_grad_degree,
             unsigned int & curr_grad_order )
```

Output the current functional gradient degree and order.

Parameters

out	*curr_grad_degree*	Current gradient degree
out	*curr_grad_order*	Current gradient order

Definition at line 236 of file spherical_harmonics_gravity_controls.cc.

References gradient_degree, and gradient_order.

8.10.3.9 get_grad_order()

```
unsigned int jeod::SphericalHarmonicsGravityControls::get_grad_order ( )
```

Output the current functional gradient order.

Returns

Current gradient order

Definition at line 226 of file spherical_harmonics_gravity_controls.cc.

References gradient_order.

8.10.3.10 get_order()

```
unsigned int jeod::SphericalHarmonicsGravityControls::get_order ( )
```

Output the current functional order.

Returns

Current order

Definition at line 197 of file spherical_harmonics_gravity_controls.cc.

References order.

8.10.3.11 initialize_control()

```
void jeod::SphericalHarmonicsGravityControls::initialize_control (
            GravityManager & grav_manager ) [override], [virtual]
```

Initialize this GravityControl.

Parameters

in	*grav_manager*	Ref to Gravity Manager

Reimplemented from jeod::GravityControls.

Definition at line 86 of file spherical_harmonics_gravity_controls.cc.

References jeod::GravityControls::body, check_validity(), jeod::SphericalHarmonicsGravitySource::degree, jeod::GravityControls::grav_manager, harmonics_source, jeod::GravityControls::initialize_control(), and Pnm.

8.10.3.12 operator=()

```
SphericalHarmonicsGravityControls& jeod::SphericalHarmonicsGravityControls::operator= (
            const SphericalHarmonicsGravityControls & ) [delete]
```

8.10.3.13 set_degree()

```
void jeod::SphericalHarmonicsGravityControls::set_degree (
             unsigned int new_degree )
```

Update the functional degree.

Parameters

in	*new_degree*	New desired degree

Definition at line 247 of file spherical_harmonics_gravity_controls.cc.

References check_validity(), and degree.

8.10.3.14 set_degree_order()

```
void jeod::SphericalHarmonicsGravityControls::set_degree_order (
             unsigned int new_degree,
             unsigned int new_order )
```

Update the functional degree and order.

Parameters

in	*new_degree*	New desired degree
in	*new_order*	New desired order

Definition at line 272 of file spherical_harmonics_gravity_controls.cc.

References check_validity(), degree, and order.

8.10.3.15 set_grad_degree()

```
void jeod::SphericalHarmonicsGravityControls::set_grad_degree (
             unsigned int new_grad_degree )
```

Update the functional gradient degree.

Parameters

in	*new_grad_degree*	New desired degree

Definition at line 285 of file spherical_harmonics_gravity_controls.cc.

References check_validity(), and gradient_degree.

8.10.3.16 set_grad_degree_order()

```
void jeod::SphericalHarmonicsGravityControls::set_grad_degree_order (
            unsigned int new_grad_degree,
            unsigned int new_grad_order )
```

Update the functional gradient degree and order.

Parameters

in	*new_grad_degree*	New desired degree
in	*new_grad_order*	New desired order

Definition at line 310 of file spherical_harmonics_gravity_controls.cc.

References check_validity(), gradient_degree, and gradient_order.

8.10.3.17 set_grad_order()

```
void jeod::SphericalHarmonicsGravityControls::set_grad_order (
            unsigned int new_grad_order )
```

Update the functional gradient order.

Parameters

in	*new_grad_order*	New desired order

Definition at line 297 of file spherical_harmonics_gravity_controls.cc.

References check_validity(), and gradient_order.

8.10.3.18 set_order()

```
void jeod::SphericalHarmonicsGravityControls::set_order (
            unsigned int new_order )
```

Update the functional order.

Parameters

in	*new_order*	New desired order

Definition at line 259 of file spherical_harmonics_gravity_controls.cc.

References check_validity(), and order.

8.10.3.19 sum_deltacoeffs()

```
void jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs ( )  [protected], [virtual]
```

Loop over all of the active gravitational variation effects models and aggregate their changes to the gravity coefficients into the top-level delta-coeffs "bin" for this gravity body.

Definition at line 469 of file spherical_harmonics_gravity_controls.cc.

References jeod::SphericalHarmonicsDeltaControls::active, jeod::SphericalHarmonicsDeltaCoeffs::dC20, jeod::SphericalHarmonicsDeltaControls::degree, jeod::SphericalHarmonicsDeltaCoeffs::delta_Cnm, delta_Cnm, jeod::SphericalHarmonicsGravitySource::delta_coeffs, delta_degree, delta_order, jeod::SphericalHarmonicsDeltaCoeffs::delta_Snm, delta_Snm, jeod::SphericalHarmonicsDeltaControls::first_order_only, jeod::SphericalHarmonicsDeltaControls::grav_effect, harmonics_source, jeod::SphericalHarmonicsDeltaControls::order, total_dC20, and var_effects.

Referenced by calc_nonspherical().

8.10.3.20 update_deltacoeffs()

```
void jeod::SphericalHarmonicsGravityControls::update_deltacoeffs ( )  [protected], [virtual]
```

Command all of the gravitational variation effects to update themselves.

Definition at line 450 of file spherical_harmonics_gravity_controls.cc.

References jeod::GravityControls::active, jeod::SphericalHarmonicsGravitySource::delta_coeffs, harmonics_source, and var_effects.

Referenced by calc_nonspherical().

8.10.4 Friends And Related Function Documentation

8.10.4.1 init_attrjeod__SphericalHarmonicsGravityControls

```
void init_attrjeod__SphericalHarmonicsGravityControls ( )  [friend]
```

8.10.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 89 of file spherical_harmonics_gravity_controls.hh.

8.10.5 Field Documentation

8.10.5.1 degree

```
unsigned int jeod::SphericalHarmonicsGravityControls::degree {}
```

Non-spherical degree to be used.

NOTE: this data being public is deprecated and should not be relied upon in future releases. Use the provided accessor methods instead.trick_units(–)

Definition at line 146 of file spherical_harmonics_gravity_controls.hh.

Referenced by calc_nonspherical(), check_validity(), get_degree(), get_degree_order(), set_degree(), and set_↩ degree_order().

8.10.5.2 delta_Cnm

```
double** jeod::SphericalHarmonicsGravityControls::delta_Cnm {}
```

Array for collecting all active normalized real (cosine) variational spherical harmonic coefficients.

trick_units(–)

Definition at line 127 of file spherical_harmonics_gravity_controls.hh.

Referenced by add_deltacontrol(), sum_deltacoeffs(), and ∼SphericalHarmonicsGravityControls().

8.10.5.3 delta_degree

```
unsigned int jeod::SphericalHarmonicsGravityControls::delta_degree {}
```

Coefficient degree to be used for totaling up all active delta_coeffs.

trick_units(–)

Definition at line 116 of file spherical_harmonics_gravity_controls.hh.

Referenced by add_deltacontrol(), sum_deltacoeffs(), and ∼SphericalHarmonicsGravityControls().

8.10.5.4 delta_order

```
unsigned int jeod::SphericalHarmonicsGravityControls::delta_order {}
```

Coefficient order to be used for totaling up all active delta_coeffs.

trick_units(–)

Definition at line 121 of file spherical_harmonics_gravity_controls.hh.

Referenced by add_deltacontrol(), and sum_deltacoeffs().

8.10.5.5 delta_Snm

```
double** jeod::SphericalHarmonicsGravityControls::delta_Snm {}
```

Array for collecting all active normalized real (sine) variational spherical harmonic coefficients.

trick_units(–)

Definition at line 133 of file spherical_harmonics_gravity_controls.hh.

Referenced by add_deltacontrol(), sum_deltacoeffs(), and ∼SphericalHarmonicsGravityControls().

8.10.5.6 gradient_degree

```
unsigned int jeod::SphericalHarmonicsGravityControls::gradient_degree {}
```

Non-spherical degree to be used for computing gradient.

NOTE: this data being public is deprecated and should not be relied upon in future releases. Use the provided accessor methods instead.trick_units(–)

Definition at line 160 of file spherical_harmonics_gravity_controls.hh.

Referenced by calc_nonspherical(), check_validity(), get_grad_degree(), get_grad_degree_order(), set_grad_↩ degree(), and set_grad_degree_order().

8.10.5.7 gradient_order

```
unsigned int jeod::SphericalHarmonicsGravityControls::gradient_order {}
```

Non-spherical order to be used for computing gradient.

NOTE: this data being public is deprecated and should not be relied upon in future releases. Use the provided accessor methods instead.trick_units(–)

Definition at line 167 of file spherical_harmonics_gravity_controls.hh.

Referenced by calc_nonspherical(), check_validity(), get_grad_degree_order(), get_grad_order(), set_grad_↩ degree_order(), and set_grad_order().

8.10.5.8 harmonics_source

```
SphericalHarmonicsGravitySource* jeod::SphericalHarmonicsGravityControls::harmonics_source {}
```

The GravitySource pointer from the base class, recast.

Note

Users should not set this data member in the input file.trick_units(–)

Definition at line 106 of file spherical_harmonics_gravity_controls.hh.

Referenced by calc_nonspherical(), check_validity(), initialize_control(), sum_deltacoeffs(), update_deltacoeffs(), and ∼SphericalHarmonicsGravityControls().

8.10.5.9 min_radius_warn

```
bool jeod::SphericalHarmonicsGravityControls::min_radius_warn {}  [protected]
```

Indicates that the minimum radius threshold has been crossed and that a warning has been issued for such.

This prevents a spew of messages regarding such under-threshold conditions.

Note

Users should not set this data member in the input file unless you wish to disable all such messages.trick_↩ units(–)

Definition at line 99 of file spherical_harmonics_gravity_controls.hh.

Referenced by calc_nonspherical().

8.10.5.10 order

```
unsigned int jeod::SphericalHarmonicsGravityControls::order {}
```

Non-spherical order to be used.

NOTE: this data being public is deprecated and should not be relied upon in future releases. Use the provided accessor methods instead.trick_units(–)

Definition at line 153 of file spherical_harmonics_gravity_controls.hh.

Referenced by calc_nonspherical(), check_validity(), get_degree_order(), get_order(), set_degree_order(), and set_order().

8.10.5.11 Pnm

```
double** jeod::SphericalHarmonicsGravityControls::Pnm {}
```

LeGendre polynomials used to calculate non-spherical attraction.

trick_units(–)

Definition at line 111 of file spherical_harmonics_gravity_controls.hh.

Referenced by calc_nonspherical(), initialize_control(), and ~SphericalHarmonicsGravityControls().

8.10.5.12 total_dC20

```
double jeod::SphericalHarmonicsGravityControls::total_dC20 {}
```

delta C20 coefficient for collecting first order effects of all active delta_coeffs.

trick_units(–)

Definition at line 139 of file spherical_harmonics_gravity_controls.hh.

Referenced by calc_nonspherical(), and sum_deltacoeffs().

8.10.5.13 var_effects

```
JeodPointerVector<SphericalHarmonicsDeltaControls>::type jeod::SphericalHarmonicsGravity↩
Controls::var_effects
```

List of controls for variational gravity effects like solid-body tides.

trick_io(**)

Definition at line 172 of file spherical_harmonics_gravity_controls.hh.

Referenced by add_deltacontrol(), calc_nonspherical(), SphericalHarmonicsGravityControls(), sum_deltacoeffs(), update_deltacoeffs(), and ~SphericalHarmonicsGravityControls().

The documentation for this class was generated from the following files:

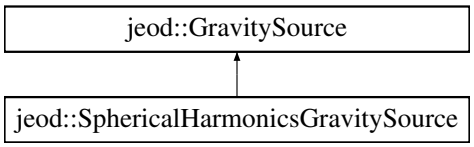
- spherical_harmonics_gravity_controls.hh
- spherical_harmonics_calc_nonspherical.cc
- spherical_harmonics_gravity_controls.cc

8.11 jeod::SphericalHarmonicsGravitySource Class Reference

Models the gravity for a specific planet using spherical harmonics.

`#include <spherical_harmonics_gravity_source.hh>`

Inheritance diagram for jeod::SphericalHarmonicsGravitySource:



Public Member Functions

- SphericalHarmonicsGravitySource ()

  SphericalHarmonicsGravitySource constructor.
- ~SphericalHarmonicsGravitySource () override

  SphericalHarmonicsGravitySource destructor.
- SphericalHarmonicsGravitySource (const SphericalHarmonicsGravitySource &)=delete
- SphericalHarmonicsGravitySource & operator= (const SphericalHarmonicsGravitySource &)=delete
- virtual void initialize_body ()

  Initialize Gottlieb gravity coefficients.
- int find_deltacoeff (const SphericalHarmonicsDeltaCoeffs &delta_coeff) const

  Find the given variational gravity effect if already exists.
- void add_deltacoeff (SphericalHarmonicsDeltaCoeffsInit &var_init, BaseDynManager &dyn_manager, SphericalHarmonicsDeltaCoeffs &var_effect)

  Add a gravitational variation effect (i.e., a delta coeffs) to the vector of effects.

Data Fields

- double radius {}

  Spherical harmonics distance scale, typically the planet's mean equatorial radius.
- unsigned int degree {}

  The degree of the spherical harmonics gravity coefficients.
- unsigned int order {}

  The order of the spherical harmonics gravity coefficients.
- double ** Cnm {}

  Normalized real (cosine) spherical harmonic coefficients.
- double ** Snm {}

  Normalized imaginary (sine) spherical harmonic coefficients.
- bool tide_free {}

  Is C20 coefficient free of the permanent tide effect?
- double tide_free_delta {}

  Number to be added to C20 to remove the permanent tide.
- double * a_by_rad {}

  (Planet radius/vehicle distance)^ n
- double * alpha {}

  Gottlieb coefficient alpha.

- double * beta {}

  Gottlieb coefficient beta.
- double ** xi {}

  Gottlieb coefficient xi.
- double ** eta {}

  Gottlieb coefficient eta.
- double ** zeta {}

  Gottlieb coefficient zeta.
- double ** upsilon {}

  Gottlieb coefficient upsilon.
- double * nrdiag {}

  Gottlieb coefficient nrdiag.
- double * int_to_double {}

  0 to degree+1 cast as doubles
- JeodPointerVector< SphericalHarmonicsDeltaCoeffs >::type delta_coeffs

  List of all gravity coefficient altering effects such as solid-body tides.

Friends

- class InputProcessor
- void init_attrjeod__SphericalHarmonicsGravitySource ()

8.11.1 Detailed Description

Models the gravity for a specific planet using spherical harmonics.

Definition at line 90 of file spherical_harmonics_gravity_source.hh.

8.11.2 Constructor & Destructor Documentation

8.11.2.1 SphericalHarmonicsGravitySource() [1/2]

```
jeod::SphericalHarmonicsGravitySource::SphericalHarmonicsGravitySource ( )
```

SphericalHarmonicsGravitySource constructor.

Definition at line 57 of file spherical_harmonics_gravity_source.cc.

References delta_coeffs.

8.11.2.2 ~SphericalHarmonicsGravitySource()

```
jeod::SphericalHarmonicsGravitySource::~SphericalHarmonicsGravitySource ( )  [override]
```

SphericalHarmonicsGravitySource destructor.

Definition at line 67 of file spherical_harmonics_gravity_source.cc.

References a_by_rad, alpha, beta, Cnm, degree, delta_coeffs, eta, int_to_double, nrdiag, Snm, upsilon, xi, and zeta.

8.11.2.3 SphericalHarmonicsGravitySource() [2/2]

```
jeod::SphericalHarmonicsGravitySource::SphericalHarmonicsGravitySource (
            const SphericalHarmonicsGravitySource &  )  [delete]
```

8.11.3 Member Function Documentation

8.11.3.1 add_deltacoeff()

```
void jeod::SphericalHarmonicsGravitySource::add_deltacoeff (
            SphericalHarmonicsDeltaCoeffsInit & var_init,
            BaseDynManager & dyn_manager,
            SphericalHarmonicsDeltaCoeffs & var_effect )
```

Add a gravitational variation effect (i.e., a delta coeffs) to the vector of effects.

Parameters

in	*var_init*	Effect init structure
in	*dyn_manager*	Dynamics manager
in	*var_effect*	Delta coeff to be added

Definition at line 240 of file spherical_harmonics_gravity_source.cc.

References delta_coeffs, jeod::GravityMessages::duplicate_entry, find_deltacoeff(), jeod::SphericalHarmonics↩DeltaCoeffs::grav_source, jeod::SphericalHarmonicsDeltaCoeffs::initialize(), and jeod::GravitySource::name.

8.11.3.2 find_deltacoeff()

```
int jeod::SphericalHarmonicsGravitySource::find_deltacoeff (
            const SphericalHarmonicsDeltaCoeffs & delta_coeff ) const
```

Find the given variational gravity effect if already exists.

Returns

Index number of delta-coeff; -1 if not found

Parameters

in	*delta_coeff*	delta-coeff to be found

Definition at line 211 of file spherical_harmonics_gravity_source.cc.

References delta_coeffs, and jeod::GravitySource::name.

Referenced by add_deltacoeff().

8.11.3.3 initialize_body()

```
void jeod::SphericalHarmonicsGravitySource::initialize_body ( )  [virtual]
```

Initialize Gottlieb gravity coefficients.

Definition at line 86 of file spherical_harmonics_gravity_source.cc.

References a_by_rad, alpha, beta, degree, eta, int_to_double, nrdiag, upsilon, xi, and zeta.

8.11.3.4 operator=()

```
SphericalHarmonicsGravitySource& jeod::SphericalHarmonicsGravitySource::operator= (
            const SphericalHarmonicsGravitySource &  )  [delete]
```

8.11.4 Friends And Related Function Documentation

8.11.4.1 init_attrjeod__SphericalHarmonicsGravitySource

```
void init_attrjeod__SphericalHarmonicsGravitySource ( )  [friend]
```

8.11.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 92 of file spherical_harmonics_gravity_source.hh.

8.11.5 Field Documentation

8.11.5.1 a_by_rad

```
double* jeod::SphericalHarmonicsGravitySource::a_by_rad {}
```

(Planet radius/vehicle distance)^n

trick_units(–)

Definition at line 133 of file spherical_harmonics_gravity_source.hh.

Referenced by initialize_body(), and ~SphericalHarmonicsGravitySource().

8.11.5.2 alpha

```
double* jeod::SphericalHarmonicsGravitySource::alpha {}
```

Gottlieb coefficient alpha.

trick_units(–)

Definition at line 138 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ~Spherical↩HarmonicsGravitySource().

8.11.5.3 beta

```
double* jeod::SphericalHarmonicsGravitySource::beta {}
```

Gottlieb coefficient beta.

trick_units(–)

Definition at line 143 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ~Spherical↩HarmonicsGravitySource().

8.11.5.4 Cnm

```
double** jeod::SphericalHarmonicsGravitySource::Cnm {}
```

Normalized real (cosine) spherical harmonic coefficients.

trick_units(–)

Definition at line 113 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravity↩Source_moon_GRAIL150_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05C_↩default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data::initialize(), jeod::↩SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize(), jeod::SphericalHarmonicsGravity↩Source_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_↩default_data::initialize(), and ∼SphericalHarmonicsGravitySource().

8.11.5.5 degree

```
unsigned int jeod::SphericalHarmonicsGravitySource::degree {}
```

The degree of the spherical harmonics gravity coefficients.

trick_units(–)

Definition at line 103 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::check_validity(), jeod::SphericalHarmonicsGravity↩Source_earth_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_GRAIL150↩_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize(), jeod::SphericalHarmonics↩GravitySource_earth_GEMT1_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150↩Q_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data::initialize(), initialize_body(), jeod::SphericalHarmonicsGravityControls::initialize_control(), jeod::SphericalHarmonicsGravity↩Controls::∼SphericalHarmonicsGravityControls(), and ∼SphericalHarmonicsGravitySource().

8.11.5.6 delta_coeffs

```
JeodPointerVector<SphericalHarmonicsDeltaCoeffs>::type jeod::SphericalHarmonicsGravitySource↩
::delta_coeffs
```

List of all gravity coefficient altering effects such as solid-body tides.

trick_io(**)

Definition at line 179 of file spherical_harmonics_gravity_source.hh.

Referenced by add_deltacoeff(), find_deltacoeff(), SphericalHarmonicsGravitySource(), jeod::Spherical↩HarmonicsGravityControls::sum_deltacoeffs(), jeod::SphericalHarmonicsGravityControls::update_deltacoeffs(), and ∼SphericalHarmonicsGravitySource().

8.11.5.7 eta

```
double** jeod::SphericalHarmonicsGravitySource::eta {}
```

Gottlieb coefficient eta.

trick_units(–)

Definition at line 153 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ~Spherical↩ HarmonicsGravitySource().

8.11.5.8 int_to_double

```
double* jeod::SphericalHarmonicsGravitySource::int_to_double {}
```

0 to degree+1 cast as doubles

trick_units(–)

Definition at line 173 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ~Spherical↩ HarmonicsGravitySource().

8.11.5.9 nrdiag

```
double* jeod::SphericalHarmonicsGravitySource::nrdiag {}
```

Gottlieb coefficient nrdiag.

trick_units(–)

Definition at line 168 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ~Spherical↩ HarmonicsGravitySource().

8.11.5.10 order

```
unsigned int jeod::SphericalHarmonicsGravitySource::order {}
```

The order of the spherical harmonics gravity coefficients.

trick_units(–)

Definition at line 108 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::check_validity(), jeod::SphericalHarmonicsGravity↩Source_earth_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_↩default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data::initialize(), jeod↩::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonics↩GravitySource_earth_GEMT1_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q↩_default_data::initialize(), and jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize().

8.11.5.11 radius

```
double jeod::SphericalHarmonicsGravitySource::radius {}
```

Spherical harmonics distance scale, typically the planet's mean equatorial radius.

trick_units(m)

Definition at line 98 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravity↩Source_earth_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_↩default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data::initialize(), jeod↩::SphericalHarmonicsGravitySource_earth_GEMT1_default_data::initialize(), jeod::SphericalHarmonicsGravity↩Source_earth_GGM02C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_↩default_data::initialize(), jeod::SphericalHarmonicsGravitySource_mars_spherical_default_data::initialize(), jeod↩::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonics↩GravitySource_sun_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05↩C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_jupiter_spherical_default_data::initialize(), and jeod::SphericalHarmonicsSolidBodyTides::update().

8.11.5.12 Snm

```
double** jeod::SphericalHarmonicsGravitySource::Snm {}
```

Normalized imaginary (sine) spherical harmonic coefficients.

trick_units(–)

Definition at line 118 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravity↩Source_moon_GRAIL150_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05C_↩default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data::initialize(), jeod::↩SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize(), jeod::SphericalHarmonicsGravity↩Source_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_↩default_data::initialize(), and ∼SphericalHarmonicsGravitySource().

8.11.5.13 tide_free

```
bool jeod::SphericalHarmonicsGravitySource::tide_free {}
```

Is C20 coefficient free of the permanent tide effect?

trick_units(–)

Definition at line 123 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravity↩Source_moon_GRAIL150_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_↩default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize(), jeod↩::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonics↩GravitySource_earth_GGM05C_default_data::initialize(), and jeod::SphericalHarmonicsGravitySource_earth_↩GEMT1_default_data::initialize().

8.11.5.14 tide_free_delta

```
double jeod::SphericalHarmonicsGravitySource::tide_free_delta {}
```

Number to be added to C20 to remove the permanent tide.

trick_units(–)

Definition at line 128 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravity↩Source_moon_GRAIL150_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_↩default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize(), jeod↩::SphericalHarmonicsGravitySource_earth_GGM05C_default_data::initialize(), and jeod::SphericalHarmonics↩GravitySource_earth_GEMT1_default_data::initialize().

8.11.5.15 upsilon

```
double** jeod::SphericalHarmonicsGravitySource::upsilon {}
```

Gottlieb coefficient upsilon.

trick_units(–)

Definition at line 163 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ∼Spherical↩HarmonicsGravitySource().

8.11.5.16 xi

```
double** jeod::SphericalHarmonicsGravitySource::xi {}
```

Gottlieb coefficient xi.

trick_units(–)

Definition at line 148 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ~Spherical↩ HarmonicsGravitySource().

8.11.5.17 zeta

```
double** jeod::SphericalHarmonicsGravitySource::zeta {}
```

Gottlieb coefficient zeta.

trick_units(–)

Definition at line 158 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ~Spherical↩ HarmonicsGravitySource().

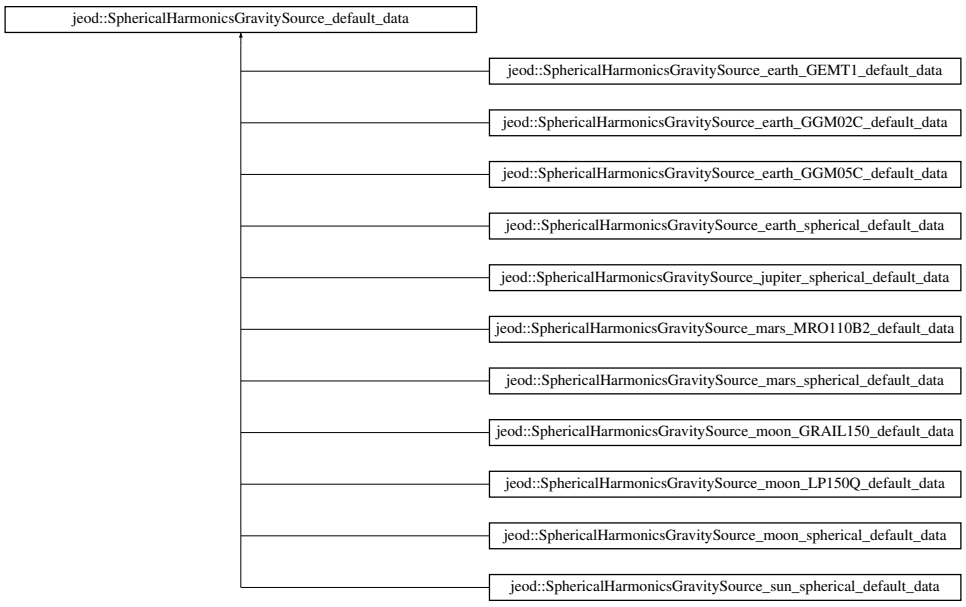
The documentation for this class was generated from the following files:

- spherical_harmonics_gravity_source.hh
- spherical_harmonics_gravity_source.cc

8.12 jeod::SphericalHarmonicsGravitySource_default_data Class Reference

```
#include <spherical_harmonics_gravity_source_default_data.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_default_data:



Public Member Functions

- virtual void initialize (SphericalHarmonicsGravitySource *)=0
- virtual ~SphericalHarmonicsGravitySource_default_data ()=default

8.12.1 Detailed Description

Definition at line 51 of file spherical_harmonics_gravity_source_default_data.hh.

8.12.2 Constructor & Destructor Documentation

8.12.2.1 ~SphericalHarmonicsGravitySource_default_data()

```
virtual jeod::SphericalHarmonicsGravitySource_default_data::~SphericalHarmonicsGravitySource↩
_default_data ( )  [virtual], [default]
```

8.12.3 Member Function Documentation

8.12.3.1 initialize()

```
virtual void jeod::SphericalHarmonicsGravitySource_default_data::initialize (
            SphericalHarmonicsGravitySource *  )  [pure virtual]
```

Implemented in jeod::SphericalHarmonicsGravitySource_jupiter_spherical_default_data, jeod::SphericalHarmonicsGravitySource_ea
jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data, jeod::SphericalHarmonicsGravitySource_earth_GGM05C_d
jeod::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data, jeod::SphericalHarmonicsGravitySource_mars_spherical_
jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data, jeod::SphericalHarmonicsGravitySource_moon_spherical_de
jeod::SphericalHarmonicsGravitySource_sun_spherical_default_data, jeod::SphericalHarmonicsGravitySource_earth_spherical_defa
and jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_default_data.

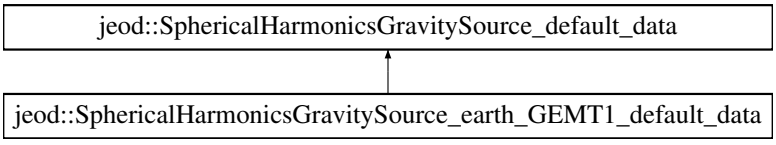
The documentation for this class was generated from the following file:

- spherical_harmonics_gravity_source_default_data.hh

8.13 jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data Class Reference

```
#include <earth_GEMT1.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.13.1 Detailed Description

Definition at line 55 of file earth_GEMT1.hh.

8.13.2 Member Function Documentation

8.13.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 58 of file earth_GEMT1.cc.

References jeod::SphericalHarmonicsGravitySource::Cnm, jeod::SphericalHarmonicsGravitySource::degree, jeod::GravitySource::mu, jeod::GravitySource::name, jeod::SphericalHarmonicsGravitySource::order, jeod::SphericalHarmonicsGravitySource::radius, jeod::SphericalHarmonicsGravitySource::Snm, jeod::SphericalHarmonicsGravitySource::tide_free, and jeod::SphericalHarmonicsGravitySource::tide_free_delta.

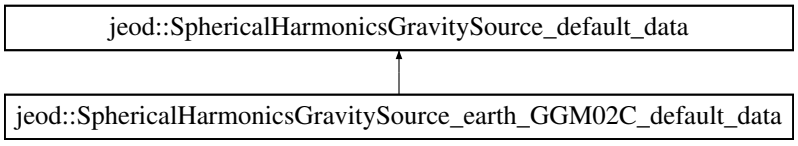
The documentation for this class was generated from the following files:

- earth_GEMT1.hh
- earth_GEMT1.cc

8.14 jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data Class Reference

```
#include <earth_GGM02C.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.14.1 Detailed Description

Definition at line 55 of file earth_GGM02C.hh.

8.14.2 Member Function Documentation

8.14.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 54 of file earth_GGM02C.cc.

References jeod::SphericalHarmonicsGravitySource::Cnm, jeod::SphericalHarmonicsGravitySource::degree, jeod::GravitySource::mu, jeod::GravitySource::name, jeod::SphericalHarmonicsGravitySource::order, jeod::SphericalHarmonicsGravitySource::radius, jeod::SphericalHarmonicsGravitySource::Snm, jeod::SphericalHarmonicsGravitySource::tide_free, and jeod::SphericalHarmonicsGravitySource::tide_free_delta.

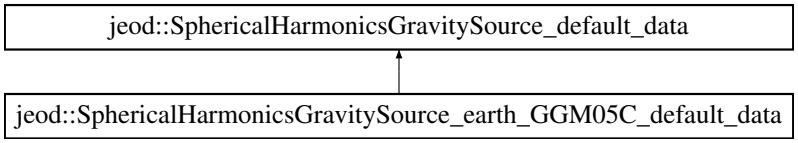
The documentation for this class was generated from the following files:

- earth_GGM02C.hh
- earth_GGM02C.cc

8.15 jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data Class Reference

```
#include <earth_GGM05C.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.15.1 Detailed Description

Definition at line 55 of file earth_GGM05C.hh.

8.15.2 Member Function Documentation

8.15.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 32 of file earth_GGM05C.cc.

References jeod::SphericalHarmonicsGravitySource::Cnm, jeod::SphericalHarmonicsGravitySource::degree, jeod::GravitySource::mu, jeod::GravitySource::name, jeod::SphericalHarmonicsGravitySource::order, jeod::SphericalHarmonicsGravitySource::radius, jeod::SphericalHarmonicsGravitySource::Snm, jeod::SphericalHarmonicsGravitySource::tide_free, and jeod::SphericalHarmonicsGravitySource::tide_free_delta.

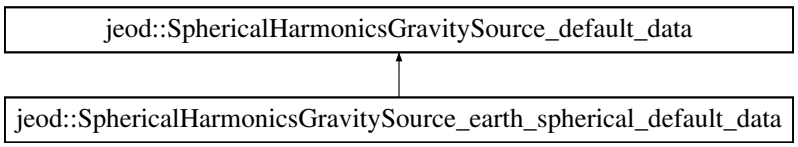
The documentation for this class was generated from the following files:

- earth_GGM05C.hh
- earth_GGM05C.cc

8.16 jeod::SphericalHarmonicsGravitySource_earth_spherical_default_data Class Reference

```
#include <earth_spherical.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_earth_spherical_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.16.1 Detailed Description

Definition at line 54 of file earth_spherical.hh.

8.16.2 Member Function Documentation

8.16.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_earth_spherical_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 37 of file earth_spherical.cc.

References jeod::SphericalHarmonicsGravitySource::degree, jeod::GravitySource::mu, jeod::GravitySource::name, jeod::SphericalHarmonicsGravitySource::order, and jeod::SphericalHarmonicsGravitySource::radius.

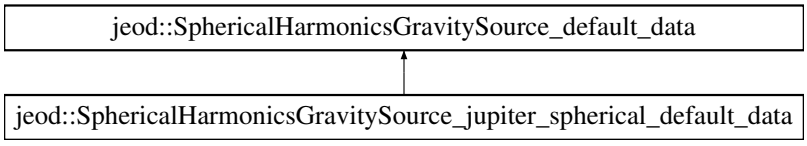
The documentation for this class was generated from the following files:

- earth_spherical.hh
- earth_spherical.cc

8.17 jeod::SphericalHarmonicsGravitySource_jupiter_spherical_default_data Class Reference

```
#include <jupiter_spherical.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_jupiter_spherical_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.17.1 Detailed Description

Definition at line 55 of file jupiter_spherical.hh.

8.17.2 Member Function Documentation

8.17.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_jupiter_spherical_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 36 of file jupiter_spherical.cc.

References jeod::GravitySource::mu, jeod::GravitySource::name, and jeod::SphericalHarmonicsGravitySource::radius.

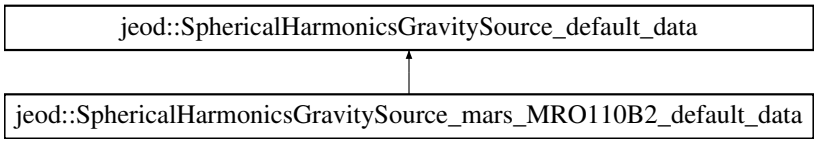
The documentation for this class was generated from the following files:

- jupiter_spherical.hh
- jupiter_spherical.cc

8.18 jeod::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data Class Reference

```
#include <mars_MRO110B2.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.18.1 Detailed Description

Definition at line 55 of file mars_MRO110B2.hh.

8.18.2 Member Function Documentation

8.18.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 48 of file mars_MRO110B2.cc.

References jeod::SphericalHarmonicsGravitySource::Cnm, jeod::SphericalHarmonicsGravitySource::degree, jeod::GravitySource::mu, jeod::GravitySource::name, jeod::SphericalHarmonicsGravitySource::order, jeod::SphericalHarmonicsGravitySource::radius, jeod::SphericalHarmonicsGravitySource::Snm, and jeod::SphericalHarmonicsGravitySource::tide_free.

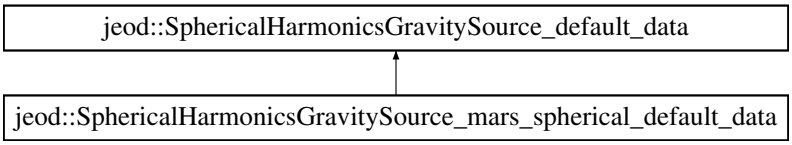
The documentation for this class was generated from the following files:

- mars_MRO110B2.hh
- mars_MRO110B2.cc

8.19 jeod::SphericalHarmonicsGravitySource_mars_spherical_default_data Class Reference

```
#include <mars_spherical.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_mars_spherical_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.19.1 Detailed Description

Definition at line 55 of file mars_spherical.hh.

8.19.2 Member Function Documentation

8.19.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_mars_spherical_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 37 of file mars_spherical.cc.

References jeod::GravitySource::mu, jeod::GravitySource::name, and jeod::SphericalHarmonicsGravitySource::radius.

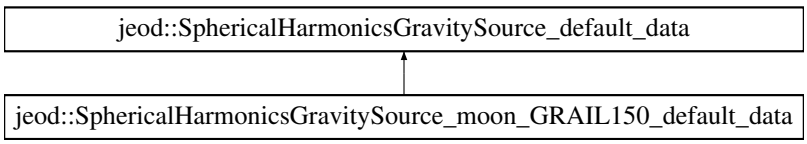
The documentation for this class was generated from the following files:

- mars_spherical.hh
- mars_spherical.cc

8.20 jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_default_data Class Reference

```
#include <moon_GRAIL150.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.20.1 Detailed Description

Definition at line 54 of file moon_GRAIL150.hh.

8.20.2 Member Function Documentation

8.20.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 51 of file moon_GRAIL150.cc.

References jeod::SphericalHarmonicsGravitySource::Cnm, jeod::SphericalHarmonicsGravitySource::degree, jeod::GravitySource::mu, jeod::GravitySource::name, jeod::SphericalHarmonicsGravitySource::order, jeod::SphericalHarmonicsGravitySource::radius, jeod::SphericalHarmonicsGravitySource::Snm, jeod::SphericalHarmonicsGravitySource::tide_free, and jeod::SphericalHarmonicsGravitySource::tide_free_delta.

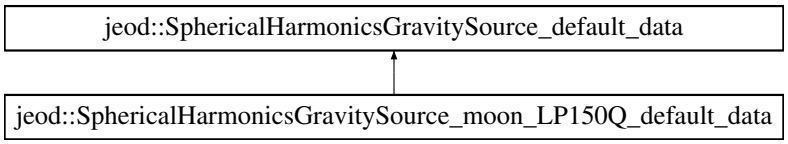
The documentation for this class was generated from the following files:

- moon_GRAIL150.hh
- moon_GRAIL150.cc

8.21 jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data Class Reference

```
#include <moon_LP150Q.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.21.1 Detailed Description

Definition at line 55 of file moon_LP150Q.hh.

8.21.2 Member Function Documentation

8.21.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr ) [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 53 of file moon_LP150Q.cc.

References jeod::SphericalHarmonicsGravitySource::Cnm, jeod::SphericalHarmonicsGravitySource::degree, jeod::GravitySource::mu, jeod::GravitySource::name, jeod::SphericalHarmonicsGravitySource::order, jeod::SphericalHarmonicsGravitySource::radius, jeod::SphericalHarmonicsGravitySource::Snm, jeod::SphericalHarmonicsGravitySource::tide_free, and jeod::SphericalHarmonicsGravitySource::tide_free_delta.

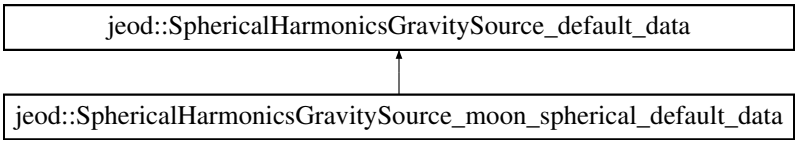
The documentation for this class was generated from the following files:

- moon_LP150Q.hh
- moon_LP150Q.cc

8.22 jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data Class Reference

```
#include <moon_spherical.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.22.1 Detailed Description

Definition at line 55 of file moon_spherical.hh.

8.22.2 Member Function Documentation

8.22.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 39 of file moon_spherical.cc.

References jeod::GravitySource::mu, jeod::GravitySource::name, and jeod::SphericalHarmonicsGravitySource::radius.

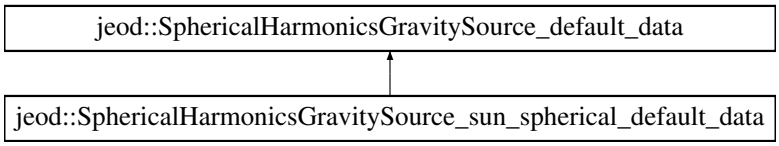
The documentation for this class was generated from the following files:

- moon_spherical.hh
- moon_spherical.cc

8.23 jeod::SphericalHarmonicsGravitySource_sun_spherical_default_data Class Reference

```
#include <sun_spherical.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsGravitySource_sun_spherical_default_data:



Public Member Functions

- void initialize (SphericalHarmonicsGravitySource *) override

8.23.1 Detailed Description

Definition at line 55 of file sun_spherical.hh.

8.23.2 Member Function Documentation

8.23.2.1 initialize()

```
void jeod::SphericalHarmonicsGravitySource_sun_spherical_default_data::initialize (
            SphericalHarmonicsGravitySource * SphericalHarmonicsGravitySource_ptr )  [override],
[virtual]
```

Implements jeod::SphericalHarmonicsGravitySource_default_data.

Definition at line 40 of file sun_spherical.cc.

References jeod::GravitySource::mu, jeod::GravitySource::name, and jeod::SphericalHarmonicsGravitySource::radius.

The documentation for this class was generated from the following files:

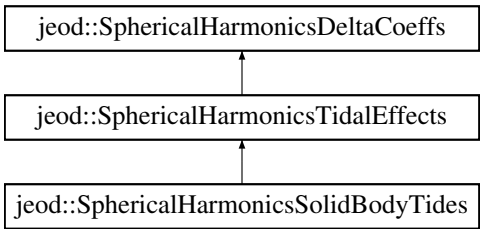
- sun_spherical.hh
- sun_spherical.cc

8.24 jeod::SphericalHarmonicsSolidBodyTides Class Reference

Models solid body tidal effects.

```
#include <spherical_harmonics_solid_body_tides.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsSolidBodyTides:



Public Member Functions

- SphericalHarmonicsSolidBodyTides ()=default
- ~SphericalHarmonicsSolidBodyTides () override=default
- void initialize (SphericalHarmonicsDeltaCoeffsInit &var_init, BaseDynManager &dyn_manager) override

  Initialize the solid body tidal model.
- void update (SphericalHarmonicsGravityControls &controls) override

  Update the solid-body tidal delta-coefficients.

Friends

- class InputProcessor
- void init_attrjeod__SphericalHarmonicsSolidBodyTides ()

Additional Inherited Members

8.24.1 Detailed Description

Models solid body tidal effects.

Definition at line 89 of file spherical_harmonics_solid_body_tides.hh.

8.24.2 Constructor & Destructor Documentation

8.24.2.1 SphericalHarmonicsSolidBodyTides()

```
jeod::SphericalHarmonicsSolidBodyTides::SphericalHarmonicsSolidBodyTides ( )  [default]
```

8.24.2.2 ~SphericalHarmonicsSolidBodyTides()

```
jeod::SphericalHarmonicsSolidBodyTides::~SphericalHarmonicsSolidBodyTides ( )  [override],
[default]
```

8.24.3 Member Function Documentation

8.24.3.1 initialize()

```
void jeod::SphericalHarmonicsSolidBodyTides::initialize (
            SphericalHarmonicsDeltaCoeffsInit & var_init,
            BaseDynManager & dyn_manager )  [override], [virtual]
```

Initialize the solid body tidal model.

Parameters

in	*var_init*	Effect init structure
in	*dyn_manager*	Dynamics manager

Reimplemented from jeod::SphericalHarmonicsDeltaCoeffs.

Definition at line 58 of file spherical_harmonics_solid_body_tides.cc.

References jeod::SphericalHarmonicsTidalEffects::initialize().

8.24.3.2 update()

```
void jeod::SphericalHarmonicsSolidBodyTides::update (
            SphericalHarmonicsGravityControls & controls )  [override], [virtual]
```

Update the solid-body tidal delta-coefficients.

Parameters

in	*controls*	Gravity controls for planet

Reimplemented from jeod::SphericalHarmonicsDeltaCoeffs.

Definition at line 69 of file spherical_harmonics_solid_body_tides.cc.

References jeod::SphericalHarmonicsDeltaCoeffs::dC20, jeod::SphericalHarmonicsDeltaCoeffs::grav_source, jeod::SphericalHarmonicsTidalEffects::k2, jeod::GravitySource::mu, jeod::SphericalHarmonicsTidalEffects::num↩_tidal_bodies, jeod::SphericalHarmonicsTidalEffects::pfix, jeod::SphericalHarmonicsGravitySource::radius, jeod↩::SphericalHarmonicsTidalEffects::tidal_bodies, and jeod::SphericalHarmonicsTidalEffects::tidal_bodies_inertial.

8.24.4 Friends And Related Function Documentation

8.24.4.1 init_attrjeod__SphericalHarmonicsSolidBodyTides

```
void init_attrjeod__SphericalHarmonicsSolidBodyTides ( )  [friend]
```

8.24.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 91 of file spherical_harmonics_solid_body_tides.hh.

The documentation for this class was generated from the following files:

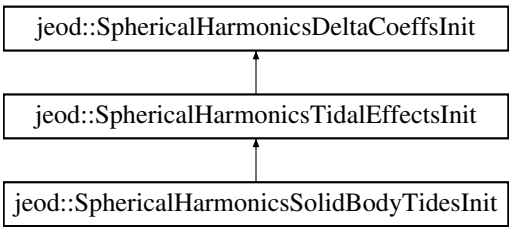
- spherical_harmonics_solid_body_tides.hh
- spherical_harmonics_solid_body_tides.cc

8.25 jeod::SphericalHarmonicsSolidBodyTidesInit Class Reference

Initializes a solid body tides model.

`#include <spherical_harmonics_solid_body_tides_init.hh>`

Inheritance diagram for jeod::SphericalHarmonicsSolidBodyTidesInit:



Public Member Functions

- SphericalHarmonicsSolidBodyTidesInit ()=default
- ~SphericalHarmonicsSolidBodyTidesInit () override=default

Friends

- class InputProcessor
- void init_attrjeod__SphericalHarmonicsSolidBodyTidesInit ()

Additional Inherited Members

8.25.1 Detailed Description

Initializes a solid body tides model.

Definition at line 81 of file spherical_harmonics_solid_body_tides_init.hh.

8.25.2 Constructor & Destructor Documentation

8.25.2.1 SphericalHarmonicsSolidBodyTidesInit()

`jeod::SphericalHarmonicsSolidBodyTidesInit::SphericalHarmonicsSolidBodyTidesInit ( ) [default]`

8.25.2.2 ~SphericalHarmonicsSolidBodyTidesInit()

```
jeod::SphericalHarmonicsSolidBodyTidesInit::~SphericalHarmonicsSolidBodyTidesInit ( )  [override],
[default]
```

8.25.3 Friends And Related Function Documentation

8.25.3.1 init_attrjeod__SphericalHarmonicsSolidBodyTidesInit

```
void init_attrjeod__SphericalHarmonicsSolidBodyTidesInit ( )  [friend]
```

8.25.3.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 83 of file spherical_harmonics_solid_body_tides_init.hh.

The documentation for this class was generated from the following file:

- spherical_harmonics_solid_body_tides_init.hh

8.26 jeod::SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data Class Reference

```
#include <earth_solid_tides.hh>
```

Public Member Functions

- void initialize (SphericalHarmonicsSolidBodyTidesInit *)

8.26.1 Detailed Description

Definition at line 55 of file earth_solid_tides.hh.

8.26.2 Member Function Documentation

8.26.2.1 initialize()

```
void jeod::SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data::initialize (
            SphericalHarmonicsSolidBodyTidesInit * SphericalHarmonicsSolidBodyTidesInit_ptr )
```

Definition at line 39 of file earth_solid_tides.cc.

References jeod::SphericalHarmonicsTidalEffectsInit::k2, and jeod::SphericalHarmonicsTidalEffectsInit::tidal_body_names.

The documentation for this class was generated from the following files:

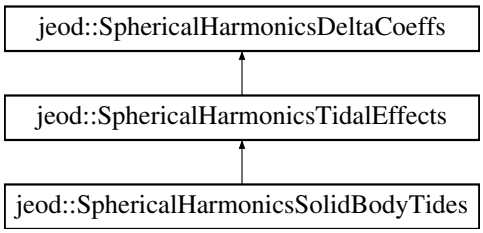
- earth_solid_tides.hh
- earth_solid_tides.cc

8.27 jeod::SphericalHarmonicsTidalEffects Class Reference

Models tidal effects as a delta on top of a gravity model.

```
#include <spherical_harmonics_tidal_effects.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsTidalEffects:



Public Member Functions

- SphericalHarmonicsTidalEffects ()=default
- ~SphericalHarmonicsTidalEffects () override

  SphericalHarmonicsTidalEffects destructor.
- void initialize (SphericalHarmonicsDeltaCoeffsInit &var_init, BaseDynManager &dyn_manager) override

  Initialize a SphericalHarmonicsTidalEffects object.
- void update (SphericalHarmonicsGravityControls &controls) override

  Pure virtual update method.

Data Fields

- double xp {}

  Copy of polar motion coefficient xp (from polar motion class).
- double yp {}

  Copy of polar motion coefficient yp (from polar motion class).
- double k2 {}

  The love number.
- double ** Knm {}

  A matrix of love numbers.
- unsigned int num_tidal_bodies {}

  The number of tidal bodies named in tidal_bodies.

Protected Attributes

- Planet ** tidal_bodies {}

  The tidal bodies.
- RefFrame ** tidal_bodies_inertial {}

  Pointers to the tidal_bodies inertial reference frames.
- RefFrame * pfix {}

  The planet fixed reference frame of the subject body.

Friends

- class InputProcessor
- void init_attrjeod__SphericalHarmonicsTidalEffects ()

8.27.1 Detailed Description

Models tidal effects as a delta on top of a gravity model.

Definition at line 91 of file spherical_harmonics_tidal_effects.hh.

8.27.2 Constructor & Destructor Documentation

8.27.2.1 SphericalHarmonicsTidalEffects()

```
jeod::SphericalHarmonicsTidalEffects::SphericalHarmonicsTidalEffects ( )  [default]
```

8.27.2.2 ~SphericalHarmonicsTidalEffects()

```
jeod::SphericalHarmonicsTidalEffects::~SphericalHarmonicsTidalEffects ( )  [override]
```

SphericalHarmonicsTidalEffects destructor.

Definition at line 65 of file spherical_harmonics_tidal_effects.cc.

8.27.3 Member Function Documentation

8.27.3.1 initialize()

```
void jeod::SphericalHarmonicsTidalEffects::initialize (
            SphericalHarmonicsDeltaCoeffsInit & gen_var_init,
            BaseDynManager & dyn_manager )  [override], [virtual]
```

Initialize a SphericalHarmonicsTidalEffects object.

This method overrides and calls the base class initialize method.

Parameters

in	*gen_var_init*	Effect init structure
in	*dyn_manager*	Dynamics manager

Reimplemented from jeod::SphericalHarmonicsDeltaCoeffs.

Definition at line 78 of file spherical_harmonics_tidal_effects.cc.

References jeod::SphericalHarmonicsDeltaCoeffs::degree, jeod::SphericalHarmonicsDeltaCoeffs::grav_source, jeod::SphericalHarmonicsDeltaCoeffs::initialize(), jeod::GravityMessages::invalid_name, jeod::GravityMessages::invalid_object, jeod::SphericalHarmonicsTidalEffectsInit::k2, k2, jeod::SphericalHarmonicsTidalEffectsInit::Knm, Knm, num_tidal_bodies, jeod::SphericalHarmonicsDeltaCoeffs::order, jeod::GravitySource::pfix, pfix, tidal_bodies, tidal_bodies_inertial, jeod::SphericalHarmonicsTidalEffectsInit::tidal_body_names, jeod::SphericalHarmonicsTidalEffectsInit::xp, xp, jeod::SphericalHarmonicsTidalEffectsInit::yp, and yp.

Referenced by jeod::SphericalHarmonicsSolidBodyTides::initialize().

8.27.3.2 update()

```
void jeod::SphericalHarmonicsTidalEffects::update (
            SphericalHarmonicsGravityControls & controls )  [override], [virtual]
```

Pure virtual update method.

Parameters

in	*controls*	Gravity controls for planet

Reimplemented from jeod::SphericalHarmonicsDeltaCoeffs.

Definition at line 174 of file spherical_harmonics_tidal_effects.cc.

8.27.4 Friends And Related Function Documentation

8.27.4.1 init_attrjeod__SphericalHarmonicsTidalEffects

```
void init_attrjeod__SphericalHarmonicsTidalEffects ( )  [friend]
```

8.27.4.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 93 of file spherical_harmonics_tidal_effects.hh.

8.27.5 Field Documentation

8.27.5.1 k2

```
double jeod::SphericalHarmonicsTidalEffects::k2 {}
```

The love number.

Only used for a first order tidal effect model.trick_units(–)

Definition at line 108 of file spherical_harmonics_tidal_effects.hh.

Referenced by initialize(), and jeod::SphericalHarmonicsSolidBodyTides::update().

8.27.5.2 Knm

```
double** jeod::SphericalHarmonicsTidalEffects::Knm {}
```

A matrix of love numbers.

Used for higher order (not first-order) tidal effects.trick_units(–)

Definition at line 114 of file spherical_harmonics_tidal_effects.hh.

Referenced by initialize().

8.27.5.3 num_tidal_bodies

```
unsigned int jeod::SphericalHarmonicsTidalEffects::num_tidal_bodies {}
```

The number of tidal bodies named in tidal_bodies.

trick_units(count)

Definition at line 119 of file spherical_harmonics_tidal_effects.hh.

Referenced by initialize(), and jeod::SphericalHarmonicsSolidBodyTides::update().

8.27.5.4 pfix

```
RefFrame* jeod::SphericalHarmonicsTidalEffects::pfix {}  [protected]
```

The planet fixed reference frame of the subject body.

trick_units(–)

Definition at line 136 of file spherical_harmonics_tidal_effects.hh.

Referenced by initialize(), and jeod::SphericalHarmonicsSolidBodyTides::update().

8.27.5.5 tidal_bodies

```
Planet** jeod::SphericalHarmonicsTidalEffects::tidal_bodies {}  [protected]
```

The tidal bodies.

Filled out at initialization. Length after init is num_tidal_bodies.trick_units(–)

Definition at line 126 of file spherical_harmonics_tidal_effects.hh.

Referenced by initialize(), and jeod::SphericalHarmonicsSolidBodyTides::update().

8.27.5.6 tidal_bodies_inertial

```
RefFrame** jeod::SphericalHarmonicsTidalEffects::tidal_bodies_inertial {}  [protected]
```

Pointers to the tidal_bodies inertial reference frames.

trick_units(–)

Definition at line 131 of file spherical_harmonics_tidal_effects.hh.

Referenced by initialize(), and jeod::SphericalHarmonicsSolidBodyTides::update().

8.27.5.7 xp

```
double jeod::SphericalHarmonicsTidalEffects::xp {}
```

Copy of polar motion coefficient xp (from polar motion class).

trick_units(–)

Definition at line 98 of file spherical_harmonics_tidal_effects.hh.

Referenced by initialize().

8.27.5.8 yp

```
double jeod::SphericalHarmonicsTidalEffects::yp {}
```

Copy of polar motion coefficient yp (from polar motion class).

trick_units(–)

Definition at line 103 of file spherical_harmonics_tidal_effects.hh.

Referenced by initialize().

The documentation for this class was generated from the following files:

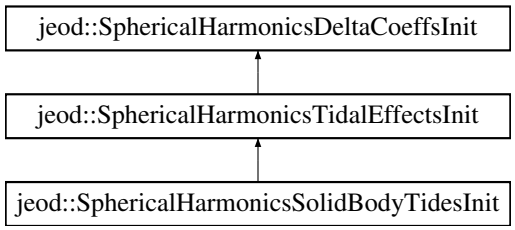
- spherical_harmonics_tidal_effects.hh
- spherical_harmonics_tidal_effects.cc

8.28 jeod::SphericalHarmonicsTidalEffectsInit Class Reference

Initializes a tidal gravity model.

```
#include <spherical_harmonics_tidal_effects_init.hh>
```

Inheritance diagram for jeod::SphericalHarmonicsTidalEffectsInit:



Public Member Functions

- SphericalHarmonicsTidalEffectsInit ()=default
- ~SphericalHarmonicsTidalEffectsInit () override=default

Data Fields

- double xp {}

  Copy of polar motion coefficient xp (from polar motion class).
- double yp {}

  Copy of polar motion coefficient yp (from polar motion class).
- double k2 {}

  The love number.
- double ** Knm {}

  A matrix of love numbers.
- std::vector< std::string > tidal_body_names

  A named list of gravitational bodies contributing to this tidal efffect.

Friends

- class InputProcessor
- void init_attrjeod__SphericalHarmonicsTidalEffectsInit ()

8.28.1 Detailed Description

Initializes a tidal gravity model.

Definition at line 83 of file spherical_harmonics_tidal_effects_init.hh.

8.28.2 Constructor & Destructor Documentation

8.28.2.1 SphericalHarmonicsTidalEffectsInit()

```
jeod::SphericalHarmonicsTidalEffectsInit::SphericalHarmonicsTidalEffectsInit ( )  [default]
```

8.28.2.2 ~SphericalHarmonicsTidalEffectsInit()

```
jeod::SphericalHarmonicsTidalEffectsInit::~SphericalHarmonicsTidalEffectsInit ( )  [override],
[default]
```

8.28.3 Friends And Related Function Documentation

8.28.3.1 init_attrjeod__SphericalHarmonicsTidalEffectsInit

```
void init_attrjeod__SphericalHarmonicsTidalEffectsInit ( )  [friend]
```

8.28.3.2 InputProcessor

```
friend class InputProcessor  [friend]
```

Definition at line 85 of file spherical_harmonics_tidal_effects_init.hh.

8.28.4 Field Documentation

8.28.4.1 k2

```
double jeod::SphericalHarmonicsTidalEffectsInit::k2 {}
```

The love number.

Only used for a first order tidal effect modeltrick_units(–)

Definition at line 100 of file spherical_harmonics_tidal_effects_init.hh.

Referenced by jeod::SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data::initialize(), and jeod::SphericalHarmonicsTidalEffects::initialize().

8.28.4.2 Knm

```
double** jeod::SphericalHarmonicsTidalEffectsInit::Knm {}
```

A matrix of love numbers.

Used for higher order (not first) tidal effectstrick_units(–)

Definition at line 105 of file spherical_harmonics_tidal_effects_init.hh.

Referenced by jeod::SphericalHarmonicsTidalEffects::initialize().

8.28.4.3 tidal_body_names

```
std::vector<std::string> jeod::SphericalHarmonicsTidalEffectsInit::tidal_body_names
```

A named list of gravitational bodies contributing to this tidal efffect.

trick_units(–)

Definition at line 110 of file spherical_harmonics_tidal_effects_init.hh.

Referenced by jeod::SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data::initialize(), and jeod::SphericalHarmonicsTidalEffects::initialize().

8.28.4.4 xp

```
double jeod::SphericalHarmonicsTidalEffectsInit::xp {}
```

Copy of polar motion coefficient xp (from polar motion class).

trick_units(–)

Definition at line 90 of file spherical_harmonics_tidal_effects_init.hh.

Referenced by jeod::SphericalHarmonicsTidalEffects::initialize().

8.28.4.5 yp

```
double jeod::SphericalHarmonicsTidalEffectsInit::yp {}
```

Copy of polar motion coefficient yp (from polar motion class).

trick_units(–)

Definition at line 95 of file spherical_harmonics_tidal_effects_init.hh.

Referenced by jeod::SphericalHarmonicsTidalEffects::initialize().

The documentation for this class was generated from the following file:

- spherical_harmonics_tidal_effects_init.hh

Chapter 9

File Documentation

9.1 class_declarations.hh File Reference

Forward declarations of classes defined for the gravity model.

Namespaces

- jeod

  Namespace jeod.

9.1.1 Detailed Description

Forward declarations of classes defined for the gravity model.

9.2 earth_GEMT1.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/earth_GEMT1.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_earth_GEMT1_default_data

9.2.1 Macro Definition Documentation

9.2.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_earth_GEMT1_default_data
```

Definition at line 43 of file earth_GEMT1.cc.

9.3 earth_GEMT1.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data

Namespaces

- jeod

  Namespace jeod.

9.4 earth_GGM02C.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/earth_GGM02C.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_earth_GGM02C_default_data

9.4.1 Macro Definition Documentation

9.4.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_earth_GGM02C_default_data
```

Definition at line 39 of file earth_GGM02C.cc.

9.5 earth_GGM02C.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data

Namespaces

- jeod

  Namespace jeod.

9.6 earth_GGM05C.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/earth_GGM05C.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_earth_GGM05C_default_data

9.6.1 Macro Definition Documentation

9.6.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_earth_GGM05C_default_data
```

Definition at line 17 of file earth_GGM05C.cc.

9.7 earth_GGM05C.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data

Namespaces

- jeod

  Namespace jeod.

9.8 earth_solid_tides.cc File Reference

```
#include "environment/gravity/include/spherical_harmonics_delta_coeffs_↩
init.hh"
#include "environment/gravity/include/spherical_harmonics_solid_body_tides↩
_init.hh"
#include "environment/gravity/include/spherical_harmonics_tidal_effects_↩
init.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/earth_solid_tides.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data

9.8.1 Macro Definition Documentation

9.8.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data
```

Definition at line 23 of file earth_solid_tides.cc.

9.9 earth_solid_tides.hh File Reference

Data Structures

- class jeod::SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data

Namespaces

- jeod

  Namespace jeod.

9.10 earth_spherical.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/earth_spherical.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_earth_spherical_default_data

9.10.1 Macro Definition Documentation

9.10.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_earth_spherical_default_data
```

Definition at line 23 of file earth_spherical.cc.

9.11 earth_spherical.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_earth_spherical_default_data

Namespaces

- jeod

  Namespace jeod.

9.12 gravity_controls.cc File Reference

Define member functions for the GravityControls class.

```
#include <algorithm>
#include <cmath>
#include <cstddef>
#include "dynamics/dyn_manager/include/base_dyn_manager.hh"
#include "environment/ephemerides/ephem_interface/include/ephem_ref_frame.↩
hh"
#include "environment/planet/include/planet.hh"
#include "utils/math/include/matrix3x3.hh"
#include "utils/math/include/vector3.hh"
#include "utils/message/include/message_handler.hh"
#include "utils/ref_frames/include/ref_frame.hh"
#include "../include/gravity_controls.hh"
#include "../include/gravity_integ_frame.hh"
#include "../include/gravity_interaction.hh"
#include "../include/gravity_manager.hh"
#include "../include/gravity_messages.hh"
#include "../include/gravity_source.hh"
```

Namespaces

- jeod

  Namespace jeod.

Variables

- static constexpr double jeod::speed_of_light_sq = 89875517873681764.0

  The speed of light squared, in m^2/s^2.

9.12.1 Detailed Description

Define member functions for the GravityControls class.

9.13 gravity_controls.hh File Reference

Define the gravity controls.

```
#include <string>
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
#include "dynamics/dyn_manager/include/base_dyn_manager.hh"
#include "gravity_source.hh"
```

Data Structures

- class jeod::GravityControls

  Specifies whether and how a GravitySource affects a vehicle.

Namespaces

- jeod

  Namespace jeod.

9.13.1 Detailed Description

Define the gravity controls.

9.14 gravity_integ_frame.hh File Reference

Define the gravity integration frame class.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
```

Data Structures

- class jeod::GravityIntegFrame

  Class that aids in determining whether gravity should be applied as a direct effect or a third body effect.

Namespaces

- jeod

  Namespace jeod.

9.14.1 Detailed Description

Define the gravity integration frame class.

9.15 gravity_interaction.cc File Reference

Define methods for the GravityInteraction class.

```
#include <algorithm>
#include <cstddef>
#include "dynamics/dyn_body/include/dyn_body.hh"
#include "dynamics/dyn_manager/include/base_dyn_manager.hh"
#include "environment/ephemerides/ephem_interface/include/ephem_ref_frame.↩
hh"
#include "environment/planet/include/planet.hh"
#include "utils/math/include/matrix3x3.hh"
#include "utils/math/include/vector3.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "../include/gravity_controls.hh"
#include "../include/gravity_interaction.hh"
#include "../include/gravity_manager.hh"
#include "../include/gravity_messages.hh"
#include "../include/gravity_source.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.15.1 Detailed Description

Define methods for the GravityInteraction class.

9.16 gravity_interaction.hh File Reference

Define the GravityInteraction class, used to represent the gravitational interaction betweens a DynBody and a set of planetary bodies.

```
#include "utils/container/include/pointer_vector.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
```

Data Structures

- class jeod::GravityInteraction

  Specifies interactions between a vehicle and a set of gravitational bodies.

Namespaces

- jeod

  Namespace jeod.

9.16.1 Detailed Description

Define the GravityInteraction class, used to represent the gravitational interaction betweens a DynBody and a set of planetary bodies.

Note that while each DynBody instance has a GravityInteraction data member, this class is defined as a part of the gravity model rather than the dyn_body model. This is because the coupling between this class and the other parts of the gravity model is much stronger than the coupling between this class and the dyn_body model.

9.17 gravity_manager.cc File Reference

Define member functions for the GravityManager class.

```
#include <cstddef>
#include <cstring>
#include <string>
#include "dynamics/dyn_manager/include/base_dyn_manager.hh"
#include "utils/math/include/matrix3x3.hh"
#include "utils/math/include/vector3.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/message/include/message_handler.hh"
#include "../include/gravity_controls.hh"
#include "../include/gravity_interaction.hh"
#include "../include/gravity_manager.hh"
#include "../include/gravity_messages.hh"
#include "../include/gravity_source.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.17.1 Detailed Description

Define member functions for the GravityManager class.

9.18 gravity_manager.hh File Reference

Define the Gravity Manager.

```
#include "utils/container/include/pointer_vector.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
```

Data Structures

- class jeod::GravityManager

  The master gravitational model for a simulation.

Namespaces

- jeod

  Namespace jeod.

9.18.1 Detailed Description

Define the Gravity Manager.

9.19 gravity_messages.cc File Reference

Implement the class GravityMessages.

```
#include "utils/message/include/make_message_code.hh"
#include "../include/gravity_messages.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define MAKE_GRAVITY_MESSAGE_CODE(id) JEOD_MAKE_MESSAGE_CODE(GravityMessages, "environment/gravity/", id)

9.19.1 Detailed Description

Implement the class GravityMessages.

9.19.2 Macro Definition Documentation

9.19.2.1 MAKE_GRAVITY_MESSAGE_CODE

```
#define MAKE_GRAVITY_MESSAGE_CODE(
              id ) JEOD_MAKE_MESSAGE_CODE(GravityMessages, "environment/gravity/", id)
```

Definition at line 43 of file gravity_messages.cc.

9.20 gravity_messages.hh File Reference

Define the class GravityMessages, the class that specifies the message IDs used in the gravity model.

```
#include "utils/sim_interface/include/jeod_class.hh"
```

Data Structures

- class jeod::GravityMessages

  Specifies the message IDs used in the gravity model.

Namespaces

- jeod

  Namespace jeod.

9.20.1 Detailed Description

Define the class GravityMessages, the class that specifies the message IDs used in the gravity model.

9.21 gravity_source.cc File Reference

Define member functions for the GravitySource class.

```
#include <cstddef>
#include "environment/ephemerides/ephem_interface/include/ephem_ref_frame.↩
hh"
#include "environment/planet/include/planet.hh"
#include "utils/math/include/vector3.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "../include/gravity_integ_frame.hh"
#include "../include/gravity_source.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.21.1 Detailed Description

Define member functions for the GravitySource class.

9.22 gravity_source.hh File Reference

Define the gravity body base (pure virtual) class.

```
#include <string>
#include <vector>
#include "environment/ephemerides/ephem_interface/include/class_declarations.↩
hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
#include "gravity_integ_frame.hh"
```

Data Structures

- class jeod::GravitySource

  Models the gravity for a specific planet;.

Namespaces

- jeod

  Namespace jeod.

9.22.1 Detailed Description

Define the gravity body base (pure virtual) class.

9.23 jupiter_spherical.cc File Reference

```
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/jupiter_spherical.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_jupiter_spherical_default_data

9.23.1 Macro Definition Documentation

9.23.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_jupiter_spherical_default_data
```

Definition at line 23 of file jupiter_spherical.cc.

9.24 jupiter_spherical.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_jupiter_spherical_default_data

Namespaces

- jeod

  Namespace jeod.

9.25 mars_MRO110B2.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/mars_MRO110B2.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_mars_MRO110B2_default_data

9.25.1 Macro Definition Documentation

9.25.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_mars_MRO110B2_default_data
```

Definition at line 33 of file mars_MRO110B2.cc.

9.26 mars_MRO110B2.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data

Namespaces

- jeod

  Namespace jeod.

9.27 mars_spherical.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/mars_spherical.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_mars_spherical_default_data

9.27.1 Macro Definition Documentation

9.27.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_mars_spherical_default_data
```

Definition at line 23 of file mars_spherical.cc.

9.28 mars_spherical.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_mars_spherical_default_data

Namespaces

- jeod

  Namespace jeod.

9.29 moon_GRAIL150.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/moon_GRAIL150.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_moon_GRAIL150_default_data

9.29.1 Macro Definition Documentation

9.29.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_moon_GRAIL150_default_data
```

Definition at line 36 of file moon_GRAIL150.cc.

9.30 moon_GRAIL150.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_default_data

Namespaces

- jeod

  Namespace jeod.

9.31 moon_LP150Q.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/moon_LP150Q.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_moon_LP150Q_default_data

9.31.1 Macro Definition Documentation

9.31.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_moon_LP150Q_default_data
```

Definition at line 38 of file moon_LP150Q.cc.

9.32 moon_LP150Q.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data

Namespaces

- jeod

  Namespace jeod.

9.33 moon_spherical.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/moon_spherical.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_moon_spherical_default_data

9.33.1 Macro Definition Documentation

9.33.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_moon_spherical_default_data
```

Definition at line 25 of file moon_spherical.cc.

9.34 moon_spherical.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data

Namespaces

- jeod

  Namespace jeod.

9.35 spherical_harmonics_calc_nonspherical.cc File Reference

Define SphericalHarmonicsGravityControl calc_nonspherical method, which computes non-spherical gravitational acceleration of a gravitational body on a given position.

```
#include <cmath>
#include "environment/planet/include/planet.hh"
#include "utils/math/include/matrix3x3.hh"
#include "utils/math/include/vector3.hh"
#include "../include/gravity_messages.hh"
#include "../include/spherical_harmonics_delta_controls.hh"
#include "../include/spherical_harmonics_gravity_controls.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.35.1 Detailed Description

Define SphericalHarmonicsGravityControl calc_nonspherical method, which computes non-spherical gravitational acceleration of a gravitational body on a given position.

9.36 spherical_harmonics_delta_coeffs.cc File Reference

Define member functions for the SphericalHarmonicsDeltaCoeffs class.

```
#include <cstddef>
#include "dynamics/dyn_manager/include/base_dyn_manager.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "../include/spherical_harmonics_delta_coeffs.hh"
#include "../include/spherical_harmonics_delta_coeffs_init.hh"
#include "../include/spherical_harmonics_delta_controls.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.36.1 Detailed Description

Define member functions for the SphericalHarmonicsDeltaCoeffs class.

9.37 spherical_harmonics_delta_coeffs.hh File Reference

Define the class SphericalHarmonicsDeltaCoeffs, the base class for tidal effects and temporal gravity sub-models.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
```

Data Structures

- class jeod::SphericalHarmonicsDeltaCoeffs

  Base class for tidal and temporal gravity models.

Namespaces

- jeod

  Namespace jeod.

9.37.1 Detailed Description

Define the class SphericalHarmonicsDeltaCoeffs, the base class for tidal effects and temporal gravity sub-models.

9.38 spherical_harmonics_delta_coeffs_init.hh File Reference

Define the class SphericalHarmonicsDeltaCoeffsInit, the base initialization class for tidal effects and temporal gravity sub-models.

```
#include "utils/sim_interface/include/jeod_class.hh"
```

Data Structures

- class jeod::SphericalHarmonicsDeltaCoeffsInit

  Initialization data for a SphericalHarmonicsDeltaCoeffs instance.

Namespaces

- jeod

  Namespace jeod.

9.38.1 Detailed Description

Define the class SphericalHarmonicsDeltaCoeffsInit, the base initialization class for tidal effects and temporal gravity sub-models.

9.39 spherical_harmonics_delta_controls.hh File Reference

Define the gravity controls for the variational gravity models such as solid-body tides.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
```

Data Structures

- class jeod::SphericalHarmonicsDeltaControls

  Provides controls for how a variational model affects a vehicle.

Namespaces

- jeod

  Namespace jeod.

9.39.1 Detailed Description

Define the gravity controls for the variational gravity models such as solid-body tides.

9.40 spherical_harmonics_gravity_controls.cc File Reference

Define member functions for the SphericalHarmonicsGravityControls class.

```
#include <cmath>
#include <cstddef>
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/message/include/message_handler.hh"
#include "../include/gravity_manager.hh"
#include "../include/gravity_messages.hh"
#include "../include/spherical_harmonics_delta_coeffs.hh"
#include "../include/spherical_harmonics_delta_controls.hh"
#include "../include/spherical_harmonics_gravity_controls.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.40.1 Detailed Description

Define member functions for the SphericalHarmonicsGravityControls class.

9.41 spherical_harmonics_gravity_controls.hh File Reference

Define the gravity controls.

```
#include "utils/container/include/pointer_vector.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
#include "gravity_controls.hh"
#include "spherical_harmonics_gravity_source.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravityControls

  Specifies whether and how a SphericalHarmonicsGravitySource affects a vehicle.

Namespaces

- jeod

  Namespace jeod.

9.41.1 Detailed Description

Define the gravity controls.

9.42 spherical_harmonics_gravity_source.cc File Reference

Define member functions for the SphericalHarmonicsGravitySource class.

```
#include <cmath>
#include <cstddef>
#include <cstring>
#include <typeinfo>
#include "dynamics/dyn_manager/include/base_dyn_manager.hh"
#include "environment/ephemerides/ephem_interface/include/ephem_ref_frame.↩
hh"
#include "utils/math/include/numerical.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/message/include/message_handler.hh"
#include "../include/gravity_manager.hh"
#include "../include/gravity_messages.hh"
#include "../include/spherical_harmonics_delta_coeffs.hh"
#include "../include/spherical_harmonics_delta_coeffs_init.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.42.1 Detailed Description

Define member functions for the SphericalHarmonicsGravitySource class.

9.43 spherical_harmonics_gravity_source.hh File Reference

Define the spherical harmonics implementation of a gravity body.

```
#include <vector>
#include "utils/container/include/pointer_vector.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
#include "gravity_source.hh"
#include "spherical_harmonics_delta_coeffs.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource

  Models the gravity for a specific planet using spherical harmonics.

Namespaces

- jeod

  Namespace jeod.

9.43.1 Detailed Description

Define the spherical harmonics implementation of a gravity body.

9.44 spherical_harmonics_gravity_source_default_data.hh File Reference

Data Structures

- class jeod::SphericalHarmonicsGravitySource_default_data

Namespaces

- jeod

  Namespace jeod.

9.45 spherical_harmonics_solid_body_tides.cc File Reference

Define member functions for the SphericalHarmonicsSolidBodyTides class.

```
#include <cmath>
#include "dynamics/dyn_manager/include/base_dyn_manager.hh"
#include "environment/planet/include/planet.hh"
#include "utils/math/include/vector3.hh"
#include "utils/ref_frames/include/ref_frame.hh"
#include "../include/spherical_harmonics_delta_coeffs_init.hh"
#include "../include/spherical_harmonics_gravity_controls.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
#include "../include/spherical_harmonics_solid_body_tides.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.45.1 Detailed Description

Define member functions for the SphericalHarmonicsSolidBodyTides class.

9.46 spherical_harmonics_solid_body_tides.hh File Reference

Define the SphericalHarmonicsSolidBodyTides class, which models solid-body tidal effects.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
#include "spherical_harmonics_tidal_effects.hh"
```

Data Structures

- class jeod::SphericalHarmonicsSolidBodyTides

  Models solid body tidal effects.

Namespaces

- jeod

  Namespace jeod.

9.46.1 Detailed Description

Define the SphericalHarmonicsSolidBodyTides class, which models solid-body tidal effects.

SphericalHarmonicsSolidBodyTides inherits directly from the SphericalHarmonicsTidalEffects class.

9.47 spherical_harmonics_solid_body_tides_init.hh File Reference

Define the SphericalHarmonicsSolidBodyTidesInit class, which is the initialization class for the solid body tides model.

```
#include "utils/sim_interface/include/jeod_class.hh"
#include "spherical_harmonics_tidal_effects_init.hh"
```

Data Structures

- class jeod::SphericalHarmonicsSolidBodyTidesInit

  Initializes a solid body tides model.

Namespaces

- jeod

  Namespace jeod.

9.47.1 Detailed Description

Define the SphericalHarmonicsSolidBodyTidesInit class, which is the initialization class for the solid body tides model.

9.48 spherical_harmonics_tidal_effects.cc File Reference

Define member functions for the SphericalHarmonicsTidalEffects class.

```
#include <cstddef>
#include "dynamics/dyn_manager/include/base_dyn_manager.hh"
#include "environment/planet/include/planet.hh"
#include "utils/memory/include/jeod_alloc.hh"
#include "utils/message/include/message_handler.hh"
#include "utils/ref_frames/include/ref_frame.hh"
#include "../include/gravity_messages.hh"
#include "../include/spherical_harmonics_delta_coeffs_init.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
#include "../include/spherical_harmonics_tidal_effects.hh"
#include "../include/spherical_harmonics_tidal_effects_init.hh"
```

Namespaces

- jeod

  Namespace jeod.

9.48.1 Detailed Description

Define member functions for the SphericalHarmonicsTidalEffects class.

9.49 spherical_harmonics_tidal_effects.hh File Reference

Define the class SphericalHarmonicsTidalEffects, which is the base class for solid-body and ocean tidal effects.

```
#include "environment/planet/include/class_declarations.hh"
#include "utils/ref_frames/include/class_declarations.hh"
#include "utils/sim_interface/include/jeod_class.hh"
#include "class_declarations.hh"
#include "spherical_harmonics_delta_coeffs.hh"
```

Data Structures

- class jeod::SphericalHarmonicsTidalEffects

  Models tidal effects as a delta on top of a gravity model.

Namespaces

- jeod

  Namespace jeod.

9.49.1 Detailed Description

Define the class SphericalHarmonicsTidalEffects, which is the base class for solid-body and ocean tidal effects.

SphericalHarmonicsTidalEffects inherits directly from the SphericalHarmonicsDeltaCoeffs class.

9.50 spherical_harmonics_tidal_effects_init.hh File Reference

Define the SphericalHarmonicsTidalEffectsInit class, the initialization class for tidal effects models.

```
#include <string>
#include <vector>
#include "utils/sim_interface/include/jeod_class.hh"
#include "spherical_harmonics_delta_coeffs_init.hh"
```

Data Structures

- class jeod::SphericalHarmonicsTidalEffectsInit

  Initializes a tidal gravity model.

Namespaces

- jeod

  Namespace jeod.

9.50.1 Detailed Description

Define the SphericalHarmonicsTidalEffectsInit class, the initialization class for tidal effects models.

9.51 sun_spherical.cc File Reference

```
#include "environment/gravity/include/gravity_source.hh"
#include "environment/gravity/include/spherical_harmonics_gravity_source.↩
hh"
#include "utils/named_item/include/named_item.hh"
#include "../include/sun_spherical.hh"
```

Namespaces

- jeod

  Namespace jeod.

Macros

- #define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_sun_spherical_default_data

9.51.1 Macro Definition Documentation

9.51.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_sun_spherical_default_data
```

Definition at line 26 of file sun_spherical.cc.

9.52 sun_spherical.hh File Reference

```
#include "spherical_harmonics_gravity_source_default_data.hh"
```

Data Structures

- class jeod::SphericalHarmonicsGravitySource_sun_spherical_default_data

Namespaces

- jeod

  Namespace jeod.

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