

GravityModel

5.0

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| jeod::GravityManager | 42 |
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Chapter 4

Data Structure Index

4.1 Data Structures

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| jeod::GravityIntegFrame | 32 |
| Class that aids in determining whether gravity should be applied as a direct effect or a third body effect | |
| jeod::GravityInteraction | 35 |
| Specifies interactions between a vehicle and a set of gravitational bodies | |
| jeod::GravityManager | 42 |
| The master gravitational model for a simulation | |
| jeod::GravityMessages | 48 |
| Specifies the message IDs used in the gravity model | |
| jeod::GravitySource | 52 |
| Models the gravity for a specific planet; pure virtual | |
| jeod::SphericalHarmonicsDeltaCoeffs | 56 |
| Base class for tidal and temporal gravity models | |
| jeod::SphericalHarmonicsDeltaCoeffsInit | 61 |
| Initialization data for a SphericalHarmonicsDeltaCoeffs instance | |
| jeod::SphericalHarmonicsDeltaControls | 64 |
| Provides controls for how a variational model affects a vehicle | |
| jeod::SphericalHarmonicsGravityControls | 67 |
| Specifies whether and how a SphericalHarmonicsGravitySource affects a vehicle | |
| jeod::SphericalHarmonicsGravitySource | 82 |
| Models the gravity for a specific planet using spherical harmonics | |
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| jeod::SphericalHarmonicsSolidBodyTides | |
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| Models tidal effects as a delta on top of a gravity model | 109 |
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File Index

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| Define member functions for the GravityControls class | 124 |
| gravity_controls.hh | |
| Define the gravity controls | 125 |
| gravity_integ_frame.cc | |
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| gravity_integ_frame.hh | |
| Define the gravity integration frame class | 126 |
| gravity_interaction.cc | |
| Define methods for the GravityInteraction class | 126 |
| gravity_interaction.hh | |
| Define the GravityInteraction class, used to represent the gravitational interaction between a DynBody and a set of planetary bodies | 127 |
| gravity_manager.cc | |
| Define member functions for the GravityManager class | 128 |
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| Define the Gravity Manager | 128 |
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| Implement the class GravityMessages | 129 |
| gravity_messages.hh | |
| Define the class GravityMessages, the class that specifies the message IDs used in the gravity model | 129 |
| gravity_source.cc | |
| Define member functions for the GravitySource class | 130 |

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| gravity_source.hh | |
| Define the gravity body base (pure virtual) class | 130 |
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| Define member functions for the SphericalHarmonicsDeltaCoeffs class | 137 |
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| Define the class SphericalHarmonicsDeltaCoeffs, the base class for tidal effects and temporal gravity sub-models | 138 |
| spherical_harmonics_delta_coeffs_init.cc | |
| Define member functions for the SphericalHarmonicsDeltaCoeffsInit class | 138 |
| spherical_harmonics_delta_coeffs_init.hh | |
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| spherical_harmonics_delta_controls.cc | |
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| spherical_harmonics_gravity_source_default_data.hh | 142 |
| spherical_harmonics_solid_body_tides.cc | |
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| spherical_harmonics_solid_body_tides.hh | |
| Define the SphericalHarmonicsSolidBodyTides class, which models solid-body tidal effects | 143 |
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| spherical_harmonics_tidal_effects.cc | |
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| Define the class SphericalHarmonicsTidalEffects, which is the base class for solid-body and ocean tidal effects | 145 |
| spherical_harmonics_tidal_effects_init.cc | |
| Define member functions for the SphericalHarmonicsTidalEffectsInit class | 145 |

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Chapter 6

Module Documentation

6.1 Models

Modules

- [Environment](#)

6.1.1 Detailed Description

6.2 Environment

Modules

- [Gravity](#)

6.2.1 Detailed Description

6.3 Gravity

Files

- file [class_declarations.hh](#)
Forward declarations of classes defined for the gravity model.
- file [gravity_controls.hh](#)
Define the gravity controls.
- 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 between a DynBody and a set of planetary bodies.
- file [gravity_manager.hh](#)
Define the Gravity Manager.
- file [gravity_messages.hh](#)
Define the class GravityMessages, the class that specifies the message IDs used in the gravity model.
- file [gravity_source.hh](#)
Define the gravity body base (pure virtual) class.
- file [spherical_harmonics_delta_coeffs.hh](#)
Define the class SphericalHarmonicsDeltaCoeffs, the base class for tidal effects and temporal gravity sub-models.
- file [spherical_harmonics_delta_coeffs_init.hh](#)
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](#)
Define the SphericalHarmonicsTidalEffectsInit class, the initialization class for tidal effects models.
- file [gravity_controls.cc](#)
Define member functions for the GravityControls class.
- file [gravity_integ_frame.cc](#)
Define member functions for the GravityIntegFrame class.
- 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.
- file [spherical_harmonics_calc_nonspherical.cc](#)

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

- file [spherical_harmonics_delta_coeffs.cc](#)
Define member functions for the `SphericalHarmonicsDeltaCoeffs` class.
- file [spherical_harmonics_delta_coeffs_init.cc](#)
Define member functions for the `SphericalHarmonicsDeltaCoeffsInit` class.
- file [spherical_harmonics_delta_controls.cc](#)
Define member functions for the `SphericalHarmonicsDeltaControls` class.
- file [spherical_harmonics_gravity_controls.cc](#)
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](#)
Define member functions for the `SphericalHarmonicsSolidBodyTides` class.
- file [spherical_harmonics_solid_body_tides_init.cc](#)
Define member functions for the `SphericalHarmonicsSolidBodyTidesInit` class.
- file [spherical_harmonics_tidal_effects.cc](#)
Define member functions for the `SphericalHarmonicsTidalEffects` class.
- file [spherical_harmonics_tidal_effects_init.cc](#)
Define member functions for the `SphericalHarmonicsTidalEffectsInit` class.

Namespaces

- [jeod](#)
Namespace `jeod`.

Macros

- `#define` [PATH](#) "environment/gravity/"

6.3.1 Detailed Description

6.3.2 Macro Definition Documentation

6.3.2.1 PATH

```
#define PATH "environment/gravity/"
```

Definition at line 37 of file `gravity_messages.cc`.

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; pure virtual.
- 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](#)
Specifies whether and how a [SphericalHarmonicsGravitySource](#) affects a vehicle.
- class [SphericalHarmonicsGravitySource](#)
Models the gravity for a specific planet using spherical harmonics.
- class [SphericalHarmonicsGravitySource_default_data](#)
- class [SphericalHarmonicsGravitySource_earth_GEMT1_default_data](#)
- class [SphericalHarmonicsGravitySource_earth_GGM02C_default_data](#)
- class [SphericalHarmonicsGravitySource_earth_GGM05C_default_data](#)
- class [SphericalHarmonicsGravitySource_earth_spherical_default_data](#)
- class [SphericalHarmonicsGravitySource_jupiter_spherical_default_data](#)

- class [SphericalHarmonicsGravitySource_mars_MRO110B2_default_data](#)
- class [SphericalHarmonicsGravitySource_mars_spherical_default_data](#)
- class [SphericalHarmonicsGravitySource_moon_GRAIL150_default_data](#)
- class [SphericalHarmonicsGravitySource_moon_LP150Q_default_data](#)
- class [SphericalHarmonicsGravitySource_moon_spherical_default_data](#)
- class [SphericalHarmonicsGravitySource_sun_spherical_default_data](#)
- 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

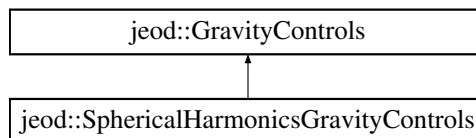
Data Structure Documentation

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](#) ()
GravityControls constructor.
- virtual [~GravityControls](#) ()
GravityControls destructor.
- virtual void [initialize_control](#) ([GravityManager](#) &grav_man)
Initialize this GravityControl.
- virtual void [reset_control](#) ([BaseDynManager](#) &dyn_manager)
Reset subscriptions for this GravityControl.
- void [gravitation](#) (const double integ_pos[3], unsigned int integ_frame_idx, double body_grav_accel[3], double dgdxd[3][3], double Pot[1])
Compute the gravitation at a given position toward a gravity body.
- void [gravitation](#) (const [RefFrame](#) &point_of_interest, unsigned int integ_frame_idx, double body_grav_accel[3], double dgdxd[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 posn[3], double body_grav_accel[3], double dgdx[3][3], double Pot[1])=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.

Private Member Functions

- [GravityControls](#) (const [GravityControls](#) &)
Not implemented.
- [GravityControls](#) & [operator=](#) (const [GravityControls](#) &)
Not implemented.

Friends

- class [InputProcessor](#)
- void [init_attrjeod__GravityControls](#) ()

8.1.1 Detailed Description

Specifies whether and how a [GravitySource](#) affects a vehicle.

Definition at line 91 of file gravity_controls.hh.

8.1.2 Constructor & Destructor Documentation

8.1.2.1 GravityControls() [1/2]

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

Not implemented.

8.1.2.2 GravityControls() [2/2]

```
jeod::GravityControls::GravityControls ( )
```

[GravityControls](#) constructor.

Definition at line 65 of file gravity_controls.cc.

References [grav_accel](#), [grav_accel_magsq](#), [grav_grad](#), and [grav_pot](#).

8.1.2.3 ~GravityControls()

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

[GravityControls](#) destructor.

Definition at line 90 of file gravity_controls.cc.

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

| | |
|----------|--------------------------------|
| <i>a</i> | First control to be compared. |
| <i>b</i> | Second control to be compared. |

Definition at line 256 of file `gravity_controls.hh`.

References `grav_accel_magsq`.

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

8.1.3.2 calc_nonspherical()

```
virtual void jeod::GravityControls::calc_nonspherical (
    const double posn[3],
    double body_grav_accel[3],
    double dgdx[3][3],
    double Pot[1] ) [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 | <i>posn</i> | Inertial position of the point of interest relative to the gravitational body. |
| out | <i>body_grav_accel</i> | Acceleration at the point of interest due to the gravitational body. |
| out | <i>dgdx</i> | Gravity gradient at the point of interest. |
| out | <i>Pot</i> | 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

| | |
|--------------------------|---|
| <i>point_of_interest</i> | The point of interest, as a reference frame. |
| <i>rel_pos</i> | Displacement vector from the grav body to the POI. |
| <i>rel_vel</i> | Time derivative of <i>rel_pos</i> . |
| <i>perturbing_accel</i> | 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

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

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

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

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

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

Note that the common factor $\frac{1}{c} \frac{GM_B}{r_{AB}}$ 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 494 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

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

Definition at line 331 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] )
```

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

Parameters

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

Definition at line 216 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 )
```

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

Parameters

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

Definition at line 266 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 | <i>grav_man</i> | Ref to Gravity Manager |
|----|-----------------|------------------------|

Reimplemented in `jeod::SphericalHarmonicsGravityControls`.

Definition at line 104 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 & ) [private]
```

Not implemented.

8.1.3.9 reset_control()

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

Reset subscriptions for this GravityControl.

Parameters

| | | |
|----|--------------------|-------------------------|
| in | <i>dyn_manager</i> | Ptr to dynamics manager |
|----|--------------------|-------------------------|

Definition at line 151 of file gravity_controls.cc.

References `active`, `body`, `jeod::GravitySource::inertial`, `jeod::GravityMessages::null_pointer`, `jeod::GravitySource::pfx`, `source_name`, `spherical`, `subscribed_to_inertial`, and `subscribed_to_pfx`.

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 93 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 105 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 126 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 139 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 115 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 145 of file gravity_controls.hh.

Referenced by `jeod::GravityManager::gravitation()`, `GravityControls()`, 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 160 of file gravity_controls.hh.

Referenced by accel_mag_less_ptr(), GravityControls(), and 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 150 of file gravity_controls.hh.

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

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 169 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 155 of file gravity_controls.hh.

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

8.1.5.10 `perturbing_only`

```
bool jeod::GravityControls::perturbing_only
```

Compute only the perturbing gravity?

`trick_units(-)`

Definition at line 120 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 133 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 191 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 100 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 110 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 176 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 183 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 \(\)](#)
GravityIntegFrame constructor.
- [~GravityIntegFrame \(\)](#)
GravityIntegFrame destructor.

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](#)
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 89 of file gravity_integ_frame.hh.

8.2.2 Constructor & Destructor Documentation

8.2.2.1 GravityIntegFrame()

```
jeod::GravityIntegFrame::GravityIntegFrame (  
    void )
```

[GravityIntegFrame](#) constructor.

Definition at line 44 of file gravity_integ_frame.cc.

References [accel](#), [is_third_body](#), [pos](#), [ref_frame](#), and [time](#).

8.2.2.2 ~GravityIntegFrame()

```
jeod::GravityIntegFrame::~~GravityIntegFrame (  
    void )
```

[GravityIntegFrame](#) destructor.

Definition at line 58 of file gravity_integ_frame.cc.

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 91 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 112 of file gravity_integ_frame.hh.

Referenced by GravityIntegFrame().

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 102 of file gravity_integ_frame.hh.

Referenced by jeod::GravityControls::calc_spherical(), GravityIntegFrame(), 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 107 of file gravity_integ_frame.hh.

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

8.2.4.4 ref_frame

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

Reference frame.

trick_units(—)

Definition at line 97 of file gravity_integ_frame.hh.

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

8.2.4.5 time

```
double jeod::GravityIntegFrame::time
```

Timestamp of last update to this class.

trick_units(s)

Definition at line 117 of file gravity_integ_frame.hh.

Referenced by GravityIntegFrame(), and jeod::GravitySource::initialize_state().

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

- [gravity_integ_frame.hh](#)
- [gravity_integ_frame.cc](#)

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.
- 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](#)
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.

Private Member Functions

- [GravityInteraction](#) (const [GravityInteraction](#) &frame)
Not implemented.
- [GravityInteraction](#) & [operator=](#) (const [GravityInteraction](#) &frame)
Not implemented.

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 97 of file `gravity_interaction.hh`.

8.3.2 Constructor & Destructor Documentation

8.3.2.1 GravityInteraction() [1/2]

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

Not implemented.

8.3.2.2 GravityInteraction() [2/2]

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

Construct a [GravityInteraction](#) instance.

Definition at line 60 of file gravity_interaction.cc.

References [grav_accel](#), [grav_controls](#), and [grav_grad](#).

8.3.2.3 ~GravityInteraction()

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

Destruct a [GravityInteraction](#) instance.

Definition at line 78 of file gravity_interaction.cc.

References [grav_controls](#).

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 | <i>control</i> | Control to be added |
|----|----------------|---------------------|

Definition at line 108 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 | <i>dyn_manager</i> | Ref to Dyn Manager |
| in | <i>grav_manager</i> | Ref to Gravity Manager |

Definition at line 158 of file gravity_interaction.cc.

References [grav_controls](#), and [reset_controls\(\)](#).

8.3.3.3 operator=()

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

Not implemented.

8.3.3.4 remove_control()

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

Remove a [GravityControls](#) from the [grav_controls](#) list.

Parameters

| | | |
|----|----------------|--|
| in | <i>control</i> | GravityControls to be removed. |
|----|----------------|--|

Definition at line 134 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 178 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 | <i>ref_frame</i> | Integration frame |
| in | <i>dyn_manager</i> | Dynamics manager |

Definition at line 95 of file gravity_interaction.cc.

References integ_frame_index.

8.3.3.7 sort_controls()

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

Sort the [GravityControls](#) in the grav_controls list in increasing acceleration magnitude order.

Definition at line 195 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 99 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 123 of file gravity_interaction.hh.

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

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 143 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 129 of file gravity_interaction.hh.

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

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 136 of file gravity_interaction.hh.

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

8.3.5.5 integ_frame_index

```
unsigned int jeod::GravityInteraction::integ_frame_index
```

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 110 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.
- [GravitySource](#) * [find_grav_source](#) (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](#) (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 Member Functions

- [GravityManager](#) (const [GravityManager](#) &)
- [GravityManager](#) & operator= (const [GravityManager](#) &)

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 91 of file gravity_manager.hh.

8.4.2 Constructor & Destructor Documentation

8.4.2.1 GravityManager() [1/2]

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

8.4.2.2 GravityManager() [2/2]

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

[GravityManager](#) constructor.

Definition at line 59 of file gravity_manager.cc.

8.4.2.3 ~GravityManager()

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

[GravityManager](#) destructor.

Definition at line 71 of file gravity_manager.cc.

References [sources](#).

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 | <i>source</i> | Gravity source to be added |
|----|---------------|----------------------------|

Definition at line 118 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 (
    std::string source_name ) const
```

Find the gravitational body with the given name.

Returns

Pointer to found body

Parameters

| | | |
|----|--------------------|------------------------------------|
| in | <i>source_name</i> | Name of gravity source to be found |
|----|--------------------|------------------------------------|

Definition at line 85 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 163 of file gravity_manager.hh.

References sources.

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 | <i>integ_pos</i> | Dyn body location (integ frm) Units: M |
| in, out | <i>grav</i> | Gravity interaction |

Definition at line 193 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 | <i>point</i> | Point of interest, as a reference frame. |
| in, out | <i>grav</i> | Gravity interaction |

Definition at line 240 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 | <i>manager</i> | Dynamics manager |
|---------|----------------|------------------|

Definition at line 154 of file gravity_manager.cc.

8.4.3.7 initialize_state()

```
void jeod::GravityManager::initialize_state (
    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 | <i>manager</i> | Dynamics manager |
|---------|----------------|------------------|

Definition at line 178 of file gravity_manager.cc.

References [sources](#).

8.4.3.8 operator=()

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

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 93 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 105 of file gravity_manager.hh.

Referenced by add_grav_source(), find_grav_source(), get_bodies(), 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>
```

Static Public Attributes

- static char const * [duplicate_entry](#) = "environment/gravity/" "duplicate_entry"
Issued when a duplicate entry is detected.
- static char const * [missing_entry](#) = "environment/gravity/" "missing_entry"
Issued when a missing entry is detected.
- static char const * [invalid_name](#) = "environment/gravity/" "invalid_name"
Error issued when a name is invalid (null or empty).
- static char const * [invalid_object](#) = "environment/gravity/" "invalid_object"
Error issued when an object is invalid (wrong type).
- static char const * [invalid_limit](#) = "environment/gravity/" "invalid_limit"
Issued when a limit is out of range.
- static char const * [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 char const * [null_pointer](#) = "environment/gravity/" "null_pointer"
Error issued when a pointer is invalid (null or empty).

Private Member Functions

- [GravityMessages](#) (void)
- [GravityMessages](#) (const [GravityMessages](#) &)
- [GravityMessages](#) & [operator=](#) (const [GravityMessages](#) &)

Friends

- class [InputProcessor](#)
- void [init_attrjeod__GravityMessages](#) ()

8.5.1 Detailed Description

Specifies the message IDs used in the gravity model.

Definition at line 84 of file gravity_messages.hh.

8.5.2 Constructor & Destructor Documentation

8.5.2.1 GravityMessages() [1/2]

```
jeod::GravityMessages::GravityMessages (  
    void ) [private]
```

8.5.2.2 GravityMessages() [2/2]

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

8.5.3 Member Function Documentation

8.5.3.1 operator=()

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

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 87 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 122 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 96 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 116 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 106 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 111 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 101 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 127 of file gravity_messages.hh.

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

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

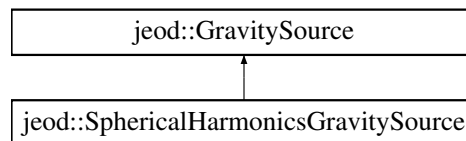
- [gravity_messages.hh](#)
- [gravity_messages.cc](#)

8.6 jeod::GravitySource Class Reference

Models the gravity for a specific planet; pure virtual.

```
#include <gravity_source.hh>
```

Inheritance diagram for jeod::GravitySource:



Public Member Functions

- [GravitySource](#) ()
GravitySource constructor.
- virtual [~GravitySource](#) ()
GravitySource destructor.
- 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.

Private Member Functions

- [GravitySource](#) (const [GravitySource](#) &)
Not implemented.
- [GravitySource](#) & [operator=](#) (const [GravitySource](#) &)
Not implemented.

Friends

- class [InputProcessor](#)
- void [init_attrjeod__GravitySource](#) ()

8.6.1 Detailed Description

Models the gravity for a specific planet; pure virtual.

Definition at line 91 of file gravity_source.hh.

8.6.2 Constructor & Destructor Documentation

8.6.2.1 GravitySource() [1/2]

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

Not implemented.

8.6.2.2 GravitySource() [2/2]

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

[GravitySource](#) constructor.

Definition at line 54 of file gravity_source.cc.

8.6.2.3 ~GravitySource()

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

[GravitySource](#) destructor.

Definition at line 70 of file gravity_source.cc.

References frames.

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 | <i>integ_frames</i> | All possible integration frames |
| in | <i>gravity_manager</i> | Gravity Manager |

Definition at line 85 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 & ) [private]
```

Not implemented.

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 93 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 127 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 this trick_units(—)

Definition at line 110 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 122 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_earth_GEMT1_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_sun_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 103 of file gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravitySource::add_deltacoeff(), jeod::GravityManager::add_grav←_source(), jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravity←Controls::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::SphericalHarmonicsGravity←Source_mars_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_spherical_←default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize(), jeod←::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonics←GravitySource_earth_GEMT1_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GG←M05C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_sun_spherical_default_data::initialize(), jeod::SphericalHarmonics←GravitySource_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 117 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:

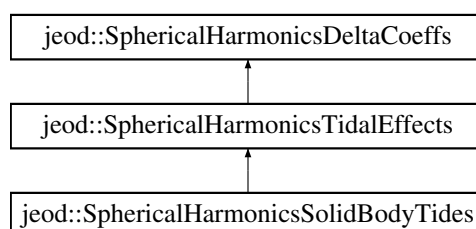
- [gravity_source.hh](#)
- [gravity_source.cc](#)

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](#) ()
SphericalHarmonicsDeltaCoeffs constructor.
- 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 90 of file `spherical_harmonics_delta_coeffs.hh`.

8.7.2 Constructor & Destructor Documentation

8.7.2.1 SphericalHarmonicsDeltaCoeffs()

```
jeod::SphericalHarmonicsDeltaCoeffs::SphericalHarmonicsDeltaCoeffs (
    void )
```

[SphericalHarmonicsDeltaCoeffs](#) constructor.

Definition at line 55 of file `spherical_harmonics_delta_coeffs.cc`.

8.7.2.2 `~SphericalHarmonicsDeltaCoeffs()`

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

[SphericalHarmonicsDeltaCoeffs](#) destructor.

Definition at line 72 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

| | | |
|----------------------|------------------------------------|------------------|
| <code>in</code> | <i>var_init</i> | Init structure |
| <code>in, out</code> | <i>dyn_manager</i> | Dynamics manager |

Reimplemented in [jeod::SphericalHarmonicsTidalEffects](#), and [jeod::SphericalHarmonicsSolidBodyTides](#).

Definition at line 92 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 | <i>controls</i> | Ignored |
|----|-----------------|---------|

Reimplemented in [jeod::SphericalHarmonicsTidalEffects](#), and [jeod::SphericalHarmonicsSolidBodyTides](#).

Definition at line 127 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 92 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 126 of file spherical_harmonics_delta_coeffs.hh.

Referenced by [jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs\(\)](#), and [jeod::SphericalHarmonicsSolidBodyTides::update\(\)](#).

8.7.5.2 degree

```
unsigned int jeod::SphericalHarmonicsDeltaCoeffs::degree
```

Coefficient degree to be used for this [SphericalHarmonicsDeltaCoeffs](#).

trick_units(-)

Definition at line 116 of file spherical_harmonics_delta_coeffs.hh.

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

8.7.5.3 delta_Cnm

```
double** jeod::SphericalHarmonicsDeltaCoeffs::delta_Cnm
```

Normalized real (cosine) variational spherical harmonic coefficients.

trick_units(-)

Definition at line 106 of file spherical_harmonics_delta_coeffs.hh.

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

8.7.5.4 delta_Snm

```
double** jeod::SphericalHarmonicsDeltaCoeffs::delta_Snm
```

Normalized imaginary (sine) variational spherical harmonic coeffs.

trick_units(-)

Definition at line 111 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 101 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 121 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:

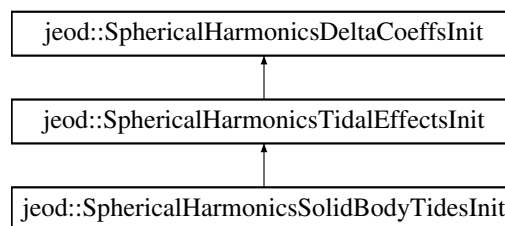
- [spherical_harmonics_delta_coeffs.hh](#)
- [spherical_harmonics_delta_coeffs.cc](#)

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\(\)](#)
SphericalHarmonicsDeltaCoeffsInit constructor.
- virtual [~SphericalHarmonicsDeltaCoeffsInit\(\)](#)
SphericalHarmonicsDeltaCoeffsInit destructor.

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 85 of file `spherical_harmonics_delta_coeffs_init.hh`.

8.8.2 Constructor & Destructor Documentation

8.8.2.1 SphericalHarmonicsDeltaCoeffsInit()

```
jeod::SphericalHarmonicsDeltaCoeffsInit::SphericalHarmonicsDeltaCoeffsInit (
    void )
```

[SphericalHarmonicsDeltaCoeffsInit](#) constructor.

Definition at line 45 of file `spherical_harmonics_delta_coeffs_init.cc`.

References `degree`, `delta_Cnm`, `delta_Snm`, and `order`.

8.8.2.2 ~SphericalHarmonicsDeltaCoeffsInit()

```
jeod::SphericalHarmonicsDeltaCoeffsInit::~~SphericalHarmonicsDeltaCoeffsInit (
    void ) [virtual]
```

[SphericalHarmonicsDeltaCoeffsInit](#) destructor.

Definition at line 58 of file `spherical_harmonics_delta_coeffs_init.cc`.

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 87 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 106 of file spherical_harmonics_delta_coeffs_init.hh.

Referenced by jeod::SphericalHarmonicsDeltaCoeffs::initialize(), and SphericalHarmonicsDeltaCoeffsInit().

8.8.4.2 delta_Cnm

```
double** jeod::SphericalHarmonicsDeltaCoeffsInit::delta_Cnm
```

Normalized real (cosine) variational spherical harmonic coefficients.

trick_units(—)

Definition at line 96 of file spherical_harmonics_delta_coeffs_init.hh.

Referenced by jeod::SphericalHarmonicsDeltaCoeffs::initialize(), and SphericalHarmonicsDeltaCoeffsInit().

8.8.4.3 delta_Snm

```
double** jeod::SphericalHarmonicsDeltaCoeffsInit::delta_Snm
```

Normalized imaginary (sine) variational spherical harmonic coeffs.

trick_units(—)

Definition at line 101 of file spherical_harmonics_delta_coeffs_init.hh.

Referenced by jeod::SphericalHarmonicsDeltaCoeffs::initialize(), and SphericalHarmonicsDeltaCoeffsInit().

8.8.4.4 order

```
unsigned int jeod::SphericalHarmonicsDeltaCoeffsInit::order
```

Coefficient order to be used for this [SphericalHarmonicsDeltaCoeffs](#).

trick_units(-)

Definition at line 111 of file `spherical_harmonics_delta_coeffs_init.hh`.

Referenced by `jeod::SphericalHarmonicsDeltaCoeffs::initialize()`, and `SphericalHarmonicsDeltaCoeffsInit()`.

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

- [spherical_harmonics_delta_coeffs_init.hh](#)
- [spherical_harmonics_delta_coeffs_init.cc](#)

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](#) ()
SphericalHarmonicsDeltaControls constructor.
- [~SphericalHarmonicsDeltaControls](#) ()
SphericalHarmonicsDeltaControls destructor.

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](#)
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 89 of file spherical_harmonics_delta_controls.hh.

8.9.2 Constructor & Destructor Documentation

8.9.2.1 SphericalHarmonicsDeltaControls()

```
jeod::SphericalHarmonicsDeltaControls::SphericalHarmonicsDeltaControls (  
    void )
```

[SphericalHarmonicsDeltaControls](#) constructor.

Definition at line 49 of file spherical_harmonics_delta_controls.cc.

8.9.2.2 ~SphericalHarmonicsDeltaControls()

```
jeod::SphericalHarmonicsDeltaControls::~~SphericalHarmonicsDeltaControls (  
    void )
```

[SphericalHarmonicsDeltaControls](#) destructor.

Definition at line 66 of file spherical_harmonics_delta_controls.cc.

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 91 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 110 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 120 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
```

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

trick_units(-)

Definition at line 115 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 100 of file spherical_harmonics_delta_controls.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::add_deltacontrol(), and jeod::SphericalHarmonicsGravityControls::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 105 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 125 of file spherical_harmonics_delta_controls.hh.

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

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

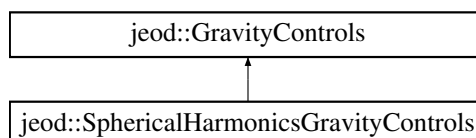
- [spherical_harmonics_delta_controls.hh](#)
- [spherical_harmonics_delta_controls.cc](#)

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.
- virtual [~SphericalHarmonicsGravityControls](#) ()
SphericalHarmonicsGravityControls destructor.
- virtual void [initialize_control](#) (GravityManager &grav_manager)
Initialize this GravityControl.
- virtual void [add_deltacontrol](#) (SphericalHarmonicsDeltaControls *delta_control)
Add a new GravityDeltaControls to the var_effects list.
- unsigned int [get_degree](#) (void)
Output the current functional degree.
- unsigned int [get_order](#) (void)
Output the current functional order.
- void [get_degree_order](#) (unsigned int ¤t_degree, unsigned int ¤t_order)
Output the current functional degree and order.
- unsigned int [get_grad_degree](#) (void)
Output the current functional gradient degree.
- unsigned int [get_grad_order](#) (void)
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

- virtual void [calc_nonspherical](#) (const double posn[3], double body_grav_accel[3], double dgdx[3][3], double Pot[1])
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](#) (void)
Check the validity of the gravity controls.
- virtual void [update_deltacoeffs](#) (void)
Command all of the gravitational variation effects to update themselves.
- virtual void [sum_deltacoeffs](#) (void)
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.

Private Member Functions

- [SphericalHarmonicsGravityControls](#) (const [SphericalHarmonicsGravityControls](#) &)
Not implemented.
- [SphericalHarmonicsGravityControls](#) & operator= (const [SphericalHarmonicsGravityControls](#) &)
Not implemented.

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 89 of file spherical_harmonics_gravity_controls.hh.

8.10.2 Constructor & Destructor Documentation

8.10.2.1 SphericalHarmonicsGravityControls() [1/2]

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

Not implemented.

8.10.2.2 SphericalHarmonicsGravityControls() [2/2]

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

[SphericalHarmonicsGravityControls](#) constructor.

Definition at line 56 of file spherical_harmonics_gravity_controls.cc.

References `var_effects`.

8.10.2.3 ~SphericalHarmonicsGravityControls()

```
jeod::SphericalHarmonicsGravityControls::~SphericalHarmonicsGravityControls (
    void ) [virtual]
```

[SphericalHarmonicsGravityControls](#) destructor.

Definition at line 83 of file spherical_harmonics_gravity_controls.cc.

References `jeod::SphericalHarmonicsGravitySource::degree`, `delta_Cnm`, `delta_degree`, `delta_Snm`, `harmonics_↔source`, `Pnm`, and `var_effects`.

8.10.3 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 | <i>delta_control</i> | Control to be added |
|----|----------------------|---------------------|

Definition at line 186 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 posn[3],
    double body_grav_accel[3],
    double dgdx[3][3],
    double Pot[1] ) [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 | <i>posn</i> | Point of interest, inrtl coords Units: M |
| out | <i>body_grav_accel</i> | Accel for given grav body Units: M/s2 |
| out | <i>dgdx</i> | Gradient for given grav body Units: 1/s2 |
| out | <i>Pot</i> | Potential |

Implements [jeod::GravityControls](#).

Definition at line 56 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 (
    void ) [protected], [virtual]
```

Check the validity of the gravity controls.

Definition at line 427 of file spherical_harmonics_gravity_controls.cc.

References jeod::SphericalHarmonicsGravitySource::degree, degree, jeod::GravityControls::gradient, gradient_order, 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 265 of file spherical_harmonics_gravity_controls.hh.

References min_radius_warn.

8.10.3.5 get_degree()

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

Output the current functional degree.

Returns

Current degree

Definition at line 238 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 | <i>current_degree</i> | Current degree |
| out | <i>current_order</i> | Current order |

Definition at line 263 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 (
    void )
```

Output the current functional gradient degree.

Returns

Current gradient degree

Definition at line 279 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 | <i>curr_grad_degree</i> | Current gradient degree |
| out | <i>curr_grad_order</i> | Current gradient order |

Definition at line 304 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 (
    void )
```

Output the current functional gradient order.

Returns

Current gradient order

Definition at line 291 of file spherical_harmonics_gravity_controls.cc.

References `gradient_order`.

8.10.3.10 get_order()

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

Output the current functional order.

Returns

Current order

Definition at line 250 of file spherical_harmonics_gravity_controls.cc.

References `order`.

8.10.3.11 initialize_control()

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

Initialize this GravityControl.

Parameters

| | | |
|----|---------------------|------------------------|
| in | <i>grav_manager</i> | Ref to Gravity Manager |
|----|---------------------|------------------------|

Reimplemented from [jeod::GravityControls](#).

Definition at line 121 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 & ) [private]
```

Not implemented.

8.10.3.13 set_degree()

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

Update the functional degree.

Parameters

| | | |
|----|-------------------|--------------------|
| in | <i>new_degree</i> | New desired degree |
|----|-------------------|--------------------|

Definition at line 320 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 | <i>new_degree</i> | New desired degree |
| in | <i>new_order</i> | New desired order |

Definition at line 355 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 | <i>new_grad_degree</i> | New desired degree |
|----|------------------------|--------------------|

Definition at line 374 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 | <i>new_grad_degree</i> | New desired degree |
| in | <i>new_grad_order</i> | New desired order |

Definition at line 409 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 | <i>new_grad_order</i> | New desired order |
|----|-----------------------|-------------------|

Definition at line 391 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 | <i>new_order</i> | New desired order |
|----|------------------|-------------------|

Definition at line 337 of file spherical_harmonics_gravity_controls.cc.

References `check_validity()`, and `order`.

8.10.3.19 sum_deltacoeffs()

```
void jeod::SphericalHarmonicsGravityControls::sum_deltacoeffs (
    void ) [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 556 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_coefs`, `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 (
    void ) [protected], [virtual]
```

Command all of the gravitational variation effects to update themselves.

Definition at line 534 of file spherical_harmonics_gravity_controls.cc.

References `jeod::GravityControls::active`, `jeod::SphericalHarmonicsGravitySource::delta_coefs`, `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 91 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 152 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 132 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 121 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 126 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 138 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 166 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 173 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 110 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 103 of file `spherical_harmonics_gravity_controls.hh`.

Referenced by `calc_nonspherical()`, and `disable_min_radius_warnings()`.

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 159 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 115 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_coefs`.

`trick_units(-)`

Definition at line 144 of file `spherical_harmonics_gravity_controls.hh`.

Referenced by `calc_nonspherical()`, and `sum_deltacoeffs()`.

8.10.5.13 var_effects

```
JeodPointerVector<SphericalHarmonicsDeltaControls>::type jeod::SphericalHarmonicsGravityControls::var_effects
```

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

`trick_io(**)`

Definition at line 178 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:

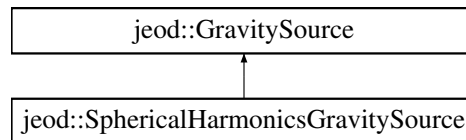
- [spherical_harmonics_gravity_controls.hh](#)
- [spherical_harmonics_calc_nonspherical.cc](#)
- [spherical_harmonics_gravity_controls.cc](#)

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.
- virtual [~SphericalHarmonicsGravitySource \(\)](#)
SphericalHarmonicsGravitySource destructor.
- virtual void [initialize_body](#) (void)
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.

Private Member Functions

- [SphericalHarmonicsGravitySource](#) (const [SphericalHarmonicsGravitySource](#) &)
Not implemented.
- [SphericalHarmonicsGravitySource](#) & operator= (const [SphericalHarmonicsGravitySource](#) &)
Not implemented.

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 92 of file `spherical_harmonics_gravity_source.hh`.

8.11.2 Constructor & Destructor Documentation

8.11.2.1 SphericalHarmonicsGravitySource() [1/2]

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

Not implemented.

8.11.2.2 SphericalHarmonicsGravitySource() [2/2]

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

[SphericalHarmonicsGravitySource](#) constructor.

Definition at line 59 of file spherical_harmonics_gravity_source.cc.

References [delta_coeffs](#).

8.11.2.3 ~SphericalHarmonicsGravitySource()

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

[SphericalHarmonicsGravitySource](#) destructor.

Definition at line 90 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](#).

8.11.3 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 | <i>var_init</i> | Effect init structure |
| in | <i>dyn_manager</i> | Dynamics manager |
| in | <i>var_effect</i> | Delta coeff to be added |

Definition at line 297 of file spherical_harmonics_gravity_source.cc.

References [delta_coeffs](#), [jeod::GravityMessages::duplicate_entry](#), [find_deltacoeff\(\)](#), [jeod::SphericalHarmonicsDeltaCoeffs::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 | <i>delta_coeff</i> | delta-coeff to be found |
|----|--------------------|-------------------------|

Definition at line 266 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 (
    void ) [virtual]
```

Initialize Gottlieb gravity coefficients.

Definition at line 130 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 & ) [private]
```

Not implemented.

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 94 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 137 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 141 of file `spherical_harmonics_gravity_source.hh`.

Referenced by `jeod::SphericalHarmonicsGravityControls::calc_nonspherical()`, `initialize_body()`, and `~SphericalHarmonicsGravitySource()`.

8.11.5.3 beta

```
double* jeod::SphericalHarmonicsGravitySource::beta
```

Gottlieb coefficient beta.

trick_units(-)

Definition at line 145 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ~SphericalHarmonicsGravitySource().

8.11.5.4 Cnm

```
double** jeod::SphericalHarmonicsGravitySource::Cnm
```

Normalized real (cosine) spherical harmonic coefficients.

trick_units(-)

Definition at line 117 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravitySource_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::SphericalHarmonicsGravitySource_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 107 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::check_validity(), jeod::SphericalHarmonicsGravitySource_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::SphericalHarmonicsGravitySource_earth_GEMT1_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data::initialize(), initialize_body(), jeod::SphericalHarmonicsGravityControls::initialize_control(), jeod::SphericalHarmonicsGravityControls::~~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 175 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 169 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 165 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), initialize_body(), and ~SphericalHarmonicsGravitySource().

8.11.5.10 order

```
unsigned int jeod::SphericalHarmonicsGravitySource::order
```

The order of the spherical harmonics gravity coefficients.

trick_units(—)

Definition at line 112 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::check_validity(), jeod::SphericalHarmonicsGravitySource_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::SphericalHarmonicsGravitySource_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 102 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravitySource_earth_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM02C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_LP150Q_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_mars_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_mars_MRO110B2_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_jupiter_spherical_default_data::initialize(), jeod::SphericalHarmonicsGravitySource_sun_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 122 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravitySource_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::SphericalHarmonicsGravitySource_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 127 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), 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_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 132 of file spherical_harmonics_gravity_source.hh.

Referenced by jeod::SphericalHarmonicsGravityControls::calc_nonspherical(), jeod::SphericalHarmonicsGravitySource_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::SphericalHarmonicsGravitySource_earth_GEMT1_default_data::initialize().

8.11.5.15 `upsilon`

```
double** jeod::SphericalHarmonicsGravitySource::upsilon
```

Gottlieb coefficient `upsilon`.

`trick_units(-)`

Definition at line 161 of file `spherical_harmonics_gravity_source.hh`.

Referenced by `jeod::SphericalHarmonicsGravityControls::calc_nonspherical()`, `initialize_body()`, and `~SphericalHarmonicsGravitySource()`.

8.11.5.16 `xi`

```
double** jeod::SphericalHarmonicsGravitySource::xi
```

Gottlieb coefficient `xi`.

`trick_units(-)`

Definition at line 149 of file `spherical_harmonics_gravity_source.hh`.

Referenced by `jeod::SphericalHarmonicsGravityControls::calc_nonspherical()`, `initialize_body()`, and `~SphericalHarmonicsGravitySource()`.

8.11.5.17 `zeta`

```
double** jeod::SphericalHarmonicsGravitySource::zeta
```

Gottlieb coefficient `zeta`.

`trick_units(-)`

Definition at line 157 of file `spherical_harmonics_gravity_source.hh`.

Referenced by `jeod::SphericalHarmonicsGravityControls::calc_nonspherical()`, `initialize_body()`, and `~SphericalHarmonicsGravitySource()`.

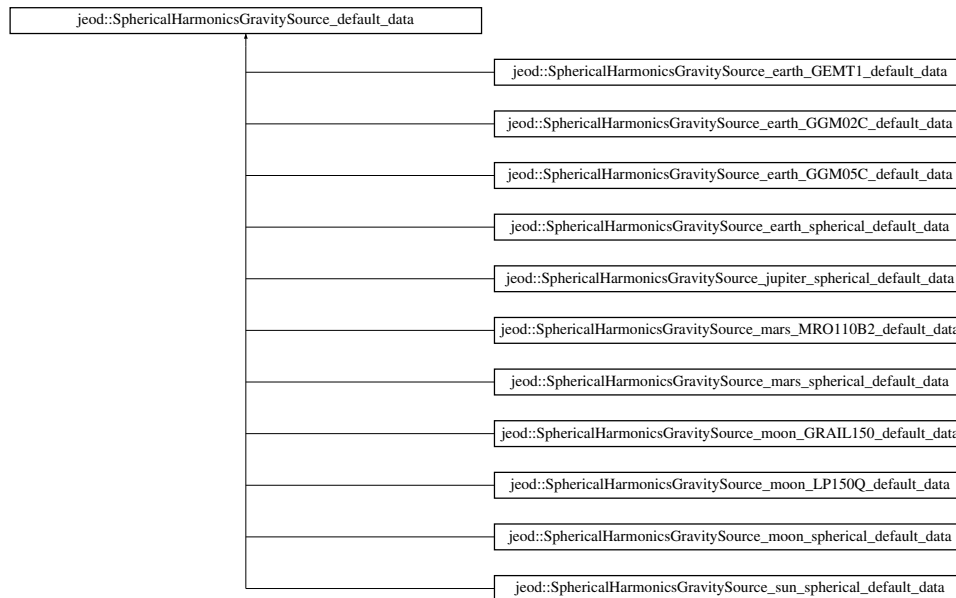
The documentation for this class was generated from the following files:

- [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](#) ()

8.12.1 Detailed Description

Definition at line 50 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 ( ) [inline], [virtual]
```

Definition at line 53 of file `spherical_harmonics_gravity_source_default_data.hh`.

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_su](#), [jeod::SphericalHarmonicsGravitySource_earth_GEMT1_default_data](#), [jeod::SphericalHarmonicsGravitySource_earth_GGM02C_def](#), [jeod::SphericalHarmonicsGravitySource_earth_GGM05C_default_data](#), [jeod::SphericalHarmonicsGravitySource_mars_MRO110B2](#), [jeod::SphericalHarmonicsGravitySource_mars_spherical_default_data](#), [jeod::SphericalHarmonicsGravitySource_moon_LP150Q_def](#), [jeod::SphericalHarmonicsGravitySource_moon_spherical_default_data](#), [jeod::SphericalHarmonicsGravitySource_earth_spherical_de](#) and [jeod::SphericalHarmonicsGravitySource_moon_GRAIL150_default_data](#).

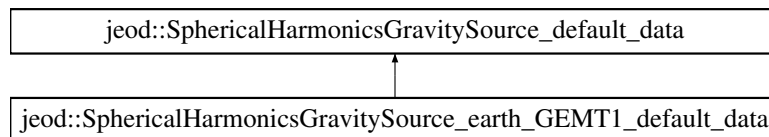
The documentation for this class was generated from the following file:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource *](#))

8.13.1 Detailed Description

Definition at line 54 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 ) [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](#).

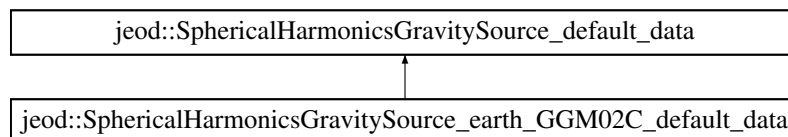
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource](#) *)

8.14.1 Detailed Description

Definition at line 54 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 ) [virtual]
```

Implements [jeod::SphericalHarmonicsGravitySource_default_data](#).

Definition at line 55 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](#).

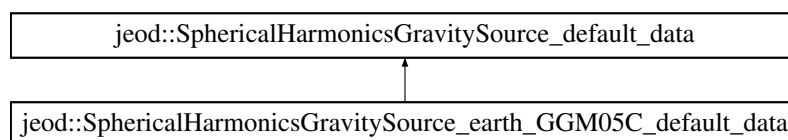
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource](#) *)

8.15.1 Detailed Description

Definition at line 54 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 ) [virtual]
```

Implements [jeod::SphericalHarmonicsGravitySource_default_data](#).

Definition at line 33 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](#).

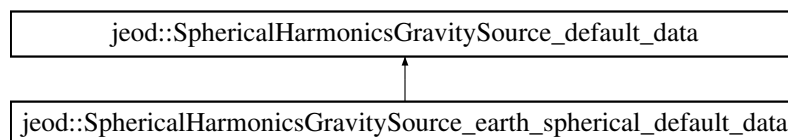
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource](#) *)

8.16.1 Detailed Description

Definition at line 53 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 ) [virtual]
```

Implements [jeod::SphericalHarmonicsGravitySource_default_data](#).

Definition at line 38 of file `earth_spherical.cc`.

References [jeod::SphericalHarmonicsGravitySource::degree](#), [jeod::GravitySource::mu](#), [jeod::GravitySource::name](#), [jeod::SphericalHarmonicsGravitySource::order](#), and [jeod::SphericalHarmonicsGravitySource::radius](#).

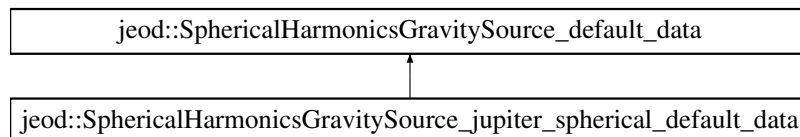
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource](#) *)

8.17.1 Detailed Description

Definition at line 54 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 ) [virtual]
```

Implements [jeod::SphericalHarmonicsGravitySource_default_data](#).

Definition at line 37 of file jupiter_spherical.cc.

References [jeod::GravitySource::mu](#), [jeod::GravitySource::name](#), and [jeod::SphericalHarmonicsGravitySource↵
::radius](#).

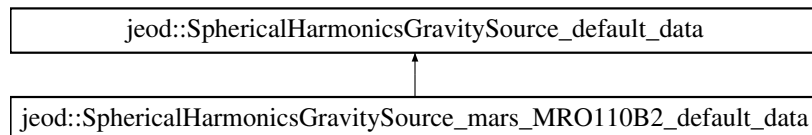
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource *](#))

8.18.1 Detailed Description

Definition at line 54 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 ) [virtual]
```

Implements [jeod::SphericalHarmonicsGravitySource_default_data](#).

Definition at line 49 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](#).

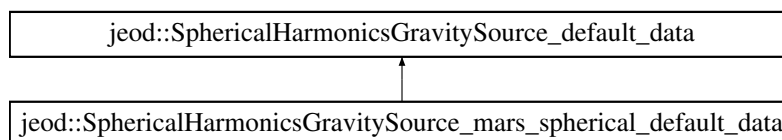
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource](#) *)

8.19.1 Detailed Description

Definition at line 54 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 ) [virtual]
```

Implements [jeod::SphericalHarmonicsGravitySource_default_data](#).

Definition at line 38 of file mars_spherical.cc.

References [jeod::GravitySource::mu](#), [jeod::GravitySource::name](#), and [jeod::SphericalHarmonicsGravitySource↵::radius](#).

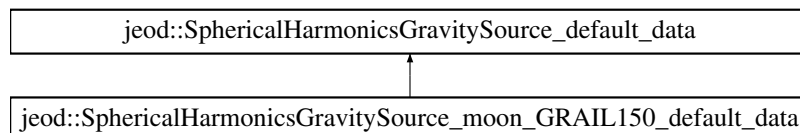
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource](#) *)

8.20.1 Detailed Description

Definition at line 53 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 ) [virtual]
```

Implements [jeod::SphericalHarmonicsGravitySource_default_data](#).

Definition at line 52 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](#).

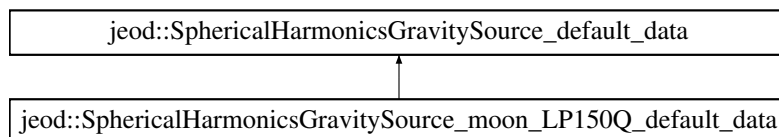
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource](#) *)

8.21.1 Detailed Description

Definition at line 54 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 ) [virtual]
```

Implements [jeod::SphericalHarmonicsGravitySource_default_data](#).

Definition at line 54 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](#).

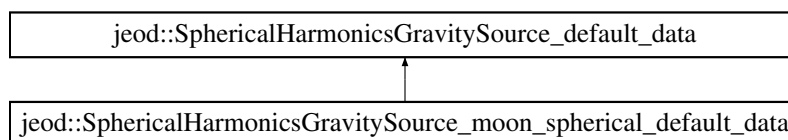
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource](#) *)

8.22.1 Detailed Description

Definition at line 54 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 ) [virtual]
```

Implements [jeod::SphericalHarmonicsGravitySource_default_data](#).

Definition at line 40 of file moon_spherical.cc.

References [jeod::GravitySource::mu](#), [jeod::GravitySource::name](#), and [jeod::SphericalHarmonicsGravitySource<T>::radius](#).

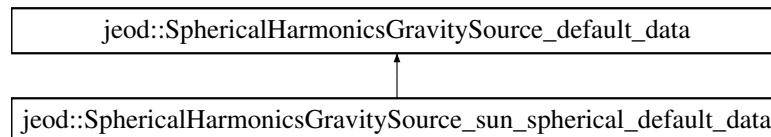
The documentation for this class was generated from the following files:

- [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

- virtual void [initialize](#) ([SphericalHarmonicsGravitySource](#) *)

8.23.1 Detailed Description

Definition at line 54 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 ) [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:

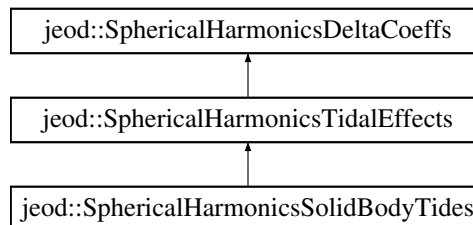
- [sun_spherical.hh](#)
- [sun_spherical.cc](#)

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](#) ()
SphericalHarmonicsSolidBodyTides constructor.
- virtual [~SphericalHarmonicsSolidBodyTides](#) ()
SphericalHarmonicsSolidBodyTides destructor.
- virtual void [initialize](#) ([SphericalHarmonicsDeltaCoeffsInit](#) &var_init, BaseDynManager &dyn_manager)
Initialize the solid body tidal model.
- virtual void [update](#) ([SphericalHarmonicsGravityControls](#) &controls)
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 92 of file spherical_harmonics_solid_body_tides.hh.

8.24.2 Constructor & Destructor Documentation

8.24.2.1 SphericalHarmonicsSolidBodyTides()

```
jeod::SphericalHarmonicsSolidBodyTides::SphericalHarmonicsSolidBodyTides (
    void )
```

[SphericalHarmonicsSolidBodyTides](#) constructor.

Definition at line 58 of file spherical_harmonics_solid_body_tides.cc.

8.24.2.2 ~SphericalHarmonicsSolidBodyTides()

```
jeod::SphericalHarmonicsSolidBodyTides::~~SphericalHarmonicsSolidBodyTides (
    void ) [virtual]
```

[SphericalHarmonicsSolidBodyTides](#) destructor.

Definition at line 68 of file spherical_harmonics_solid_body_tides.cc.

8.24.3 Member Function Documentation

8.24.3.1 initialize()

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

Initialize the solid body tidal model.

Parameters

| | | |
|----|--------------------|-----------------------|
| in | <i>var_init</i> | Effect init structure |
| in | <i>dyn_manager</i> | Dynamics manager |

Reimplemented from [jeod::SphericalHarmonicsTidalEffects](#).

Definition at line 82 of file spherical_harmonics_solid_body_tides.cc.

References [jeod::SphericalHarmonicsTidalEffects::initialize\(\)](#).

8.24.3.2 update()

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

Update the solid-body tidal delta-coefficients.

Parameters

| | | |
|----|-----------------|-----------------------------|
| in | <i>controls</i> | Gravity controls for planet |
|----|-----------------|-----------------------------|

Reimplemented from [jeod::SphericalHarmonicsTidalEffects](#).

Definition at line 98 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 94 of file spherical_harmonics_solid_body_tides.hh.

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

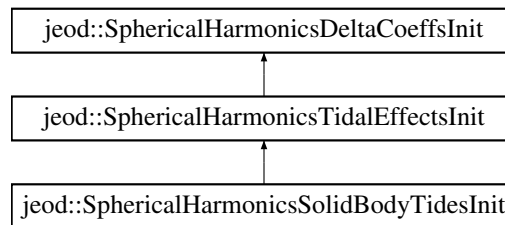
- [spherical_harmonics_solid_body_tides.hh](#)
- [spherical_harmonics_solid_body_tides.cc](#)

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 \(\)](#)
SphericalHarmonicsSolidBodyTidesInit constructor.
- virtual [~SphericalHarmonicsSolidBodyTidesInit \(\)](#)
SphericalHarmonicsSolidBodyTidesInit destructor.

Friends

- class [InputProcessor](#)
- void [init_attrjeod__SphericalHarmonicsSolidBodyTidesInit \(\)](#)

Additional Inherited Members

8.25.1 Detailed Description

Initializes a solid body tides model.

Definition at line 87 of file spherical_harmonics_solid_body_tides_init.hh.

8.25.2 Constructor & Destructor Documentation

8.25.2.1 SphericalHarmonicsSolidBodyTidesInit()

```
jeod::SphericalHarmonicsSolidBodyTidesInit::SphericalHarmonicsSolidBodyTidesInit (
    void )
```

[SphericalHarmonicsSolidBodyTidesInit](#) constructor.

Definition at line 47 of file spherical_harmonics_solid_body_tides_init.cc.

8.25.2.2 ~SphericalHarmonicsSolidBodyTidesInit()

```
jeod::SphericalHarmonicsSolidBodyTidesInit::~~SphericalHarmonicsSolidBodyTidesInit (
    void ) [virtual]
```

[SphericalHarmonicsSolidBodyTidesInit](#) destructor.

Definition at line 57 of file spherical_harmonics_solid_body_tides_init.cc.

References [jeod::SphericalHarmonicsTidalEffectsInit::num_tidal_bodies](#), and [jeod::SphericalHarmonicsTidalEffectsInit::tidal_body_names](#).

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 90 of file spherical_harmonics_solid_body_tides_init.hh.

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

- [spherical_harmonics_solid_body_tides_init.hh](#)
- [spherical_harmonics_solid_body_tides_init.cc](#)

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 54 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 40 of file earth_solid_tides.cc.

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

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

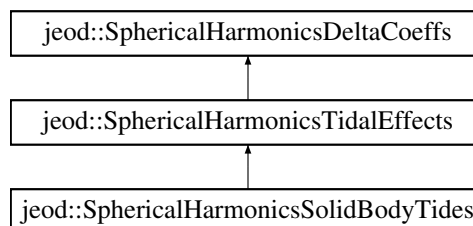
- [earth_solid_tides.hh](#)
- [earth_solid_tides.cc](#)

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 \(\)](#)
SphericalHarmonicsTidalEffects constructor.
- virtual [~SphericalHarmonicsTidalEffects \(\)](#)
SphericalHarmonicsTidalEffects destructor.
- virtual void [initialize](#) ([SphericalHarmonicsDeltaCoeffsInit](#) &var_init, BaseDynManager &dyn_manager)
Initialize a SphericalHarmonicsTidalEffects object.
- virtual void [update](#) ([SphericalHarmonicsGravityControls](#) &controls)
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 94 of file spherical_harmonics_tidal_effects.hh.

8.27.2 Constructor & Destructor Documentation

8.27.2.1 SphericalHarmonicsTidalEffects()

```
jeod::SphericalHarmonicsTidalEffects::SphericalHarmonicsTidalEffects (
    void )
```

[SphericalHarmonicsTidalEffects](#) constructor.

Definition at line 69 of file spherical_harmonics_tidal_effects.cc.

8.27.2.2 ~SphericalHarmonicsTidalEffects()

```
jeod::SphericalHarmonicsTidalEffects::~~SphericalHarmonicsTidalEffects (
    void ) [virtual]
```

[SphericalHarmonicsTidalEffects](#) destructor.

Definition at line 86 of file `spherical_harmonics_tidal_effects.cc`.

References `jeod::SphericalHarmonicsDeltaCoeffs::degree`, `Knm`, `tidal_bodies`, and `tidal_bodies_inertial`.

8.27.3 Member Function Documentation

8.27.3.1 initialize()

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

Initialize a [SphericalHarmonicsTidalEffects](#) object.

This method overrides and calls the base class initialize method.

Parameters

| | | |
|----|---------------------|-----------------------|
| in | <i>gen_var_init</i> | Effect init structure |
| in | <i>dyn_manager</i> | Dynamics manager |

Reimplemented from [jeod::SphericalHarmonicsDeltaCoeffs](#).

Reimplemented in [jeod::SphericalHarmonicsSolidBodyTides](#).

Definition at line 117 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`, `jeod::SphericalHarmonicsTidalEffectsInit::num_tidal_bodies`, `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 ) [virtual]
```

Pure virtual update method.

Parameters

| | | |
|----|-----------------|-----------------------------|
| in | <i>controls</i> | Gravity controls for planet |
|----|-----------------|-----------------------------|

Reimplemented from [jeod::SphericalHarmonicsDeltaCoeffs](#).

Reimplemented in [jeod::SphericalHarmonicsSolidBodyTides](#).

Definition at line 224 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 96 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 115 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 121 of file `spherical_harmonics_tidal_effects.hh`.

Referenced by `initialize()`, and `~SphericalHarmonicsTidalEffects()`.

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 126 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 144 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 134 of file `spherical_harmonics_tidal_effects.hh`.

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

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 139 of file spherical_harmonics_tidal_effects.hh.

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

8.27.5.7 xp

```
double jeod::SphericalHarmonicsTidalEffects::xp
```

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

trick_units(-)

Definition at line 105 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 110 of file spherical_harmonics_tidal_effects.hh.

Referenced by initialize().

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

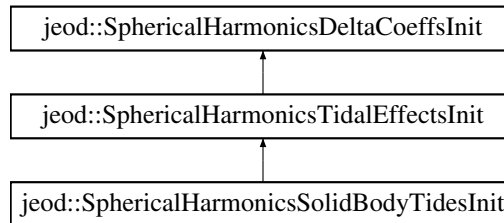
- [spherical_harmonics_tidal_effects.hh](#)
- [spherical_harmonics_tidal_effects.cc](#)

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 \(\)](#)
SphericalHarmonicsTidalEffectsInit constructor.
- virtual [~SphericalHarmonicsTidalEffectsInit \(\)](#)
SphericalHarmonicsTidalEffectsInit destructor.

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.
- char ** [tidal_body_names](#)
A named list of gravitational bodies contributing to this tidal effect.
- unsigned int [num_tidal_bodies](#)
The number of tidal bodies named in tidal_body_names.

Friends

- class [InputProcessor](#)
- void [init_attrjeod__SphericalHarmonicsTidalEffectsInit \(\)](#)

8.28.1 Detailed Description

Initializes a tidal gravity model.

Definition at line 87 of file spherical_harmonics_tidal_effects_init.hh.

8.28.2 Constructor & Destructor Documentation

8.28.2.1 SphericalHarmonicsTidalEffectsInit()

```
jeod::SphericalHarmonicsTidalEffectsInit::SphericalHarmonicsTidalEffectsInit (
    void )
```

[SphericalHarmonicsTidalEffectsInit](#) constructor.

Definition at line 45 of file spherical_harmonics_tidal_effects_init.cc.

References `k2`, `KnM`, `num_tidal_bodies`, `tidal_body_names`, `xp`, and `yp`.

8.28.2.2 ~SphericalHarmonicsTidalEffectsInit()

```
jeod::SphericalHarmonicsTidalEffectsInit::~SphericalHarmonicsTidalEffectsInit (
    void ) [virtual]
```

[SphericalHarmonicsTidalEffectsInit](#) destructor.

Definition at line 60 of file spherical_harmonics_tidal_effects_init.cc.

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 90 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 model `trick_units(-)`

Definition at line 109 of file `spherical_harmonics_tidal_effects_init.hh`.

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

8.28.4.2 Knm

```
double** jeod::SphericalHarmonicsTidalEffectsInit::Knm
```

A matrix of love numbers.

Used for higher order (not first) tidal effect `trick_units(-)`

Definition at line 114 of file `spherical_harmonics_tidal_effects_init.hh`.

Referenced by `jeod::SphericalHarmonicsTidalEffects::initialize()`, and `SphericalHarmonicsTidalEffectsInit()`.

8.28.4.3 num_tidal_bodies

```
unsigned int jeod::SphericalHarmonicsTidalEffectsInit::num_tidal_bodies
```

The number of tidal bodies named in `tidal_body_names`.

`trick_units(count)`

Definition at line 124 of file `spherical_harmonics_tidal_effects_init.hh`.

Referenced by `jeod::SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data::initialize()`, `jeod::SphericalHarmonicsTidalEffects::initialize()`, `SphericalHarmonicsTidalEffectsInit()`, and `jeod::SphericalHarmonicsSolidBodyTidesInit::~SphericalHarmonicsSolidBodyTidesInit()`.

8.28.4.4 tidal_body_names

```
char** jeod::SphericalHarmonicsTidalEffectsInit::tidal_body_names
```

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

`trick_units(-)`

Definition at line 119 of file `spherical_harmonics_tidal_effects_init.hh`.

Referenced by `jeod::SphericalHarmonicsSolidBodyTidesInit_earth_solid_tides_default_data::initialize()`, `jeod::SphericalHarmonicsTidalEffects::initialize()`, `SphericalHarmonicsTidalEffectsInit()`, and `jeod::SphericalHarmonicsSolidBodyTidesInit::~SphericalHarmonicsSolidBodyTidesInit()`.

8.28.4.5 xp

```
double jeod::SphericalHarmonicsTidalEffectsInit::xp
```

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

trick_units(-)

Definition at line 99 of file spherical_harmonics_tidal_effects_init.hh.

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

8.28.4.6 yp

```
double jeod::SphericalHarmonicsTidalEffectsInit::yp
```

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

trick_units(-)

Definition at line 104 of file spherical_harmonics_tidal_effects_init.hh.

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

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

- [spherical_harmonics_tidal_effects_init.hh](#)
- [spherical_harmonics_tidal_effects_init.cc](#)

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 41 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 38 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 16 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 22 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 22 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 <cstdint>
#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_source.hh"
#include "../include/gravity_integ_frame.hh"
#include "../include/gravity_interaction.hh"
#include "../include/gravity_manager.hh"
#include "../include/gravity_messages.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 "gravity_source.hh"
#include "dynamics/dyn_manager/include/base_dyn_manager.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.cc File Reference

Define member functions for the GravityIntegFrame class.

```
#include <cstdlib>
#include "environment/ephemerides/ephem_interface/include/ephem_ref_frame.hh"
#include "utils/math/include/vector3.hh"
#include "../include/gravity_integ_frame.hh"
```

Namespaces

- [jeod](#)

Namespace jeod.

9.14.1 Detailed Description

Define member functions for the GravityIntegFrame class.

9.15 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.

9.15.1 Detailed Description

Define the gravity integration frame class.

9.16 gravity_interaction.cc File Reference

Define methods for the GravityInteraction class.

```
#include <cstdlib>
#include <algorithm>
#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_interaction.hh"
#include "../include/gravity_source.hh"
#include "../include/gravity_controls.hh"
#include "../include/gravity_manager.hh"
#include "../include/gravity_messages.hh"
```

Namespaces

- [jeod](#)

Namespace jeod.

9.16.1 Detailed Description

Define methods for the GravityInteraction class.

9.17 gravity_interaction.hh File Reference

Define the GravityInteraction class, used to represent the gravitational interaction between 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.

9.17.1 Detailed Description

Define the GravityInteraction class, used to represent the gravitational interaction between 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.

9.18 gravity_manager.cc File Reference

Define member functions for the GravityManager class.

```
#include <string>
#include <cstring>
#include <cstdlib>
#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_manager.hh"
#include "../include/gravity_controls.hh"
#include "../include/gravity_interaction.hh"
#include "../include/gravity_messages.hh"
#include "../include/gravity_source.hh"
```

Namespaces

- [jeod](#)
Namespace jeod.

9.18.1 Detailed Description

Define member functions for the GravityManager class.

9.19 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.

9.19.1 Detailed Description

Define the Gravity Manager.

9.20 gravity_messages.cc File Reference

Implement the class GravityMessages.

```
#include "../include/gravity_messages.hh"
```

Namespaces

- [jeod](#)
Namespace jeod.

Macros

- #define [PATH](#) "environment/gravity/"

9.20.1 Detailed Description

Implement the class GravityMessages.

9.21 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.

9.21.1 Detailed Description

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

9.22 gravity_source.cc File Reference

Define member functions for the GravitySource class.

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

Namespaces

- [jeod](#)

Namespace jeod.

9.22.1 Detailed Description

Define member functions for the GravitySource class.

9.23 gravity_source.hh File Reference

Define the gravity body base (pure virtual) class.

```
#include <vector>
#include <string>
#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; pure virtual.

Namespaces

- [jeod](#)

Namespace jeod.

9.23.1 Detailed Description

Define the gravity body base (pure virtual) class.

9.24 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

9.24.1 Macro Definition Documentation

9.24.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_jupiter_spherical_default_data
```

Definition at line 22 of file jupiter_spherical.cc.

9.25 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.

9.26 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

9.26.1 Macro Definition Documentation

9.26.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_mars_MRO110B2_default_data
```

Definition at line 32 of file mars_MRO110B2.cc.

9.27 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.

9.28 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

9.28.1 Macro Definition Documentation

9.28.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_mars_spherical_default_data
```

Definition at line 22 of file mars_spherical.cc.

9.29 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.

9.30 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

9.30.1 Macro Definition Documentation

9.30.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_moon_GRAIL150_default_data
```

Definition at line 35 of file moon_GRAIL150.cc.

9.31 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.

9.32 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

9.32.1 Macro Definition Documentation

9.32.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_moon_LP150Q_default_data
```

Definition at line 37 of file moon_LP150Q.cc.

9.33 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.

9.34 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

9.34.1 Macro Definition Documentation

9.34.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_moon_spherical_default_data
```

Definition at line 24 of file moon_spherical.cc.

9.35 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.

9.36 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/vector3.hh"
#include "utils/math/include/matrix3x3.hh"
#include "../include/gravity_messages.hh"
#include "../include/spherical_harmonics_gravity_controls.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 SphericalHarmonicsGravityControl calc_nonspherical method, which computes non-spherical gravitational acceleration of a gravitational body on a given position.

9.37 spherical_harmonics_delta_coeffs.cc File Reference

Define member functions for the SphericalHarmonicsDeltaCoeffs class.

```
#include <cstdint>
#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.

9.37.1 Detailed Description

Define member functions for the SphericalHarmonicsDeltaCoeffs class.

9.38 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.

9.38.1 Detailed Description

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

9.39 spherical_harmonics_delta_coeffs_init.cc File Reference

Define member functions for the SphericalHarmonicsDeltaCoeffsInit class.

```
#include <cstdint>
#include "../include/spherical_harmonics_delta_coeffs_init.hh"
```

Namespaces

- [jeod](#)
Namespace jeod.

9.39.1 Detailed Description

Define member functions for the SphericalHarmonicsDeltaCoeffsInit class.

9.40 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.

9.40.1 Detailed Description

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

9.41 spherical_harmonics_delta_controls.cc File Reference

Define member functions for the SphericalHarmonicsDeltaControls class.

```
#include <cstdlib>
#include "../include/spherical_harmonics_delta_controls.hh"
#include "../include/spherical_harmonics_delta_coeffs.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
```

Namespaces

- [jeod](#)
Namespace jeod.

9.41.1 Detailed Description

Define member functions for the SphericalHarmonicsDeltaControls class.

9.42 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.

9.42.1 Detailed Description

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

9.43 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/spherical_harmonics_gravity_controls.hh"
#include "../include/spherical_harmonics_delta_coeffs.hh"
#include "../include/spherical_harmonics_delta_controls.hh"
#include "../include/gravity_manager.hh"
#include "../include/gravity_messages.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
```

Namespaces

- [jeod](#)
Namespace jeod.

9.43.1 Detailed Description

Define member functions for the SphericalHarmonicsGravityControls class.

9.44 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 "gravity_controls.hh"
#include "class_declarations.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.

9.44.1 Detailed Description

Define the gravity controls.

9.45 spherical_harmonics_gravity_source.cc File Reference

Define member functions for the SphericalHarmonicsGravitySource class.

```
#include <cmath>
#include <cstdlib>
#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/spherical_harmonics_delta_coeffs.hh"
#include "../include/spherical_harmonics_delta_coeffs_init.hh"
#include "../include/gravity_manager.hh"
#include "../include/gravity_messages.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
```

Namespaces

- [jeod](#)

Namespace jeod.

9.45.1 Detailed Description

Define member functions for the SphericalHarmonicsGravitySource class.

9.46 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.

9.46.1 Detailed Description

Define the spherical harmonics implementation of a gravity body.

9.47 spherical_harmonics_gravity_source_default_data.hh File Reference

Data Structures

- class [jeod::SphericalHarmonicsGravitySource_default_data](#)

Namespaces

- [jeod](#)
Namespace jeod.

9.48 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_solid_body_tides.hh"
#include "../include/spherical_harmonics_delta_coeffs_init.hh"
#include "../include/spherical_harmonics_gravity_controls.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
```

Namespaces

- [jeod](#)

Namespace jeod.

9.48.1 Detailed Description

Define member functions for the SphericalHarmonicsSolidBodyTides class.

9.49 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 "spherical_harmonics_tidal_effects.hh"
#include "class_declarations.hh"
```

Data Structures

- class [jeod::SphericalHarmonicsSolidBodyTides](#)

Models solid body tidal effects.

Namespaces

- [jeod](#)

Namespace jeod.

9.49.1 Detailed Description

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

SphericalHarmonicsSolidBodyTides inherits directly from the SphericalHarmonicsTidalEffects class.

9.50 spherical_harmonics_solid_body_tides_init.cc File Reference

Define member functions for the SphericalHarmonicsSolidBodyTidesInit class.

```
#include "utils/memory/include/jeod_alloc.hh"
#include "../include/spherical_harmonics_solid_body_tides_init.hh"
```

Namespaces

- [jeod](#)
Namespace jeod.

9.50.1 Detailed Description

Define member functions for the SphericalHarmonicsSolidBodyTidesInit class.

9.51 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.

9.51.1 Detailed Description

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

9.52 spherical_harmonics_tidal_effects.cc File Reference

Define member functions for the SphericalHarmonicsTidalEffects class.

```
#include <cstdlib>
#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/spherical_harmonics_tidal_effects.hh"
#include "../include/spherical_harmonics_delta_coeffs_init.hh"
#include "../include/spherical_harmonics_tidal_effects_init.hh"
#include "../include/gravity_messages.hh"
#include "../include/spherical_harmonics_gravity_source.hh"
```

Namespaces

- [jeod](#)

Namespace jeod.

9.52.1 Detailed Description

Define member functions for the SphericalHarmonicsTidalEffects class.

9.53 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 "spherical_harmonics_delta_coeffs.hh"
#include "class_declarations.hh"
```

Data Structures

- class [jeod::SphericalHarmonicsTidalEffects](#)

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

Namespaces

- [jeod](#)

Namespace jeod.

9.53.1 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.

9.54 spherical_harmonics_tidal_effects_init.cc File Reference

Define member functions for the SphericalHarmonicsTidalEffectsInit class.

```
#include <cstddef>
#include "../include/spherical_harmonics_tidal_effects_init.hh"
```

Namespaces

- [jeod](#)

Namespace jeod.

9.54.1 Detailed Description

Define member functions for the SphericalHarmonicsTidalEffectsInit class.

9.55 spherical_harmonics_tidal_effects_init.hh File Reference

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

```
#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.

9.55.1 Detailed Description

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

9.56 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`

9.56.1 Macro Definition Documentation

9.56.1.1 JEOD_FRIEND_CLASS

```
#define JEOD_FRIEND_CLASS SphericalHarmonicsGravitySource_sun_spherical_default_data
```

Definition at line 24 of file sun_spherical.cc.

9.57 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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