OSKAR Settings

1 Introduction

This document describes the settings files used by OSKAR applications, which use the INI plain-text file format.

Note that if you are using the OSKAR GUI, the settings descriptions are available as tool-tips, and you should not need to refer to this document.

Settings are defined simply using key-value pairs, for example:

```
simulator/double_precision=true
observation/start_time_utc=01-01-2000 12:01:02.000
observation/length=06:00:00.000
```

Settings can also be grouped into sections. For example, the above can also be written as:

```
[simulator]
double_precision=true

[observation]
start_time_utc=01-01-2000 12:01:02.000
length=06:00:00.000
```

Settings files can be written or modified using any text editor, or by using the `-set` command line flag when running the application, or (the recommended method) by using the OSKAR GUI.

The following section describes the currently available settings.

2 Settings used by OSKAR applications

The following section describes the possible options that can be currently used in OSKAR settings files. The settings file is arranged into a number of groups, which are described in the subsections below.

Required parameters are marked with a dagger symbol (†).

2.1 Simulator settings

These parameters affect the operation of the software.

All settings keys in this group are prefixed with `simulator/`.

Key	Description	Allowed values	Default
double_precision	Determines whether double precision arithmetic is used.	Bool	true
use_gpus	Use GPU devices if available.	Bool	true
cuda_device_ids	A comma-separated string containing device (GPU) IDs to use on a multi-GPU system, or 'all' to use all devices.	CSV integer list or 'all'	all
num_devices	Number of compute devices to use for the simulation. A compute device is either a local CPU core, or a GPU. Don't set this to more than the number of CPU cores in your system.	Integer ≥ 0, or 'auto'	auto
max_sources_per_chunk	Maximum number of sources or pixels processed concurrently on a single compute device. Reduce if simulations run out of GPU memory.	Integer > 0	16384
keep_log_file	Determines whether a log file of the run will remain on disk. Note that even if this option is set to false, logs will be stored in any visibility data files produced by the simulator.	Bool	false
write_status_to_log_file	If set, write status (progress) messages to the log file.	Bool	false

2.2 Sky model settings

These parameters are used to specify the content of the sky model.

All settings keys in this group are prefixed with `sky/`.

Key	Description	Allowed values	Default
oskar_sky_model/file	Paths to one or more OSKAR sky model text or binary files. See the accompanying documentation for a description of an OSKAR sky model file.	CSV list of path names	
oskar_sky_model/filter/flux_min	Minimum flux density allowed by the filter, in Jy. This is an exclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	min
oskar_sky_model/filter/flux_max	Maximum flux density allowed by the filter, in Jy. This is an inclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	max
oskar_sky_model/filter/radius_inner_deg	Minimum angular distance from phase centre allowed by the filter, in degrees. This is an inclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	0.0
oskar_sky_model/filter/radius_outer_deg	Maximum angular distance from phase centre allowed by the filter, in degrees. This is an exclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	180.0
oskar_sky_model/extended_sources/FWHM_major	Major axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
oskar_sky_model/extended_sources/FWHM_minor	Minor axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
oskar_sky_model/extended_sources/position_angle	Position angle override of all extended sources in this group (from North to East), in degrees.	Double	0.0
gsm/file	Path to a Global Sky Model file, pixellated using the HEALPix RING scheme. This option can be used to load a GSM data file produced from software written by Angelica de Oliveira-Costa, available at http://space.mit.edu/angelica/gsm/	Path name	
gsm/freq_hz	Frequency at which to apply the conversion from brightness temperature to Jy/pixel.	Unsigned double	408e6
gsm/spectral_index	The spectral index to give to each pixel.	Double	-0.7
gsm/filter/flux_min	Minimum flux density allowed by the filter, in Jy. This is an exclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	min
gsm/filter/flux_max	Maximum flux density allowed by the filter, in Jy. This is an inclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	max
gsm/filter/radius_inner_deg	Minimum angular distance from phase centre allowed by the filter, in degrees. This is an inclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	0.0

Continued on next page...

Key	Description	Allowed values	Default
gsm/filter/radius_outer_deg	Maximum angular distance from phase centre allowed by the filter, in degrees. This is an exclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	180.0
gsm/extended_sources/FWHM_major	Major axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
gsm/extended_sources/FWHM_minor	Minor axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
gsm/extended_sources/position_angle	Position angle override of all extended sources in this group (from North to East), in degrees.	Double	0.0
fits_image/file	FITS file(s) to use as a sky model.	CSV list of path names	
fits_image/min_peak_fraction	The minimum allowed pixel value, as a fraction of the peak value in the image.	Unsigned double	0.02
fits_image/min_abs_val	The minimum pixel value accepted, in units of the original image.	Unsigned double	0.0
fits_image/default_map_units	The physical units of pixels in the input map, if not specified in the file.	One of the following: • Jy/beam • Jy/pixel • K • mK	Jy/beam
fits_image/override_map_units	If true, override any units found in the file header with the default.	Bool	false
fits_image/spectral_index	The spectral index of each pixel.	Double	0.0
fits_image/filter/flux_min	Minimum flux density allowed by the filter, in Jy. This is an exclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	min
fits_image/filter/flux_max	Maximum flux density allowed by the filter, in Jy. This is an inclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	max
fits_image/filter/radius_inner_deg	Minimum angular distance from phase centre allowed by the filter, in degrees. This is an inclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	0.0
fits_image/filter/radius_outer_deg	Maximum angular distance from phase centre allowed by the filter, in degrees. This is an exclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	180.0
healpix_fits/file	Paths to one or more HEALPix FITS files, ordered using the HEALPix RING scheme (NEST schemes are not supported).	CSV list of path names	
healpix_fits/min_peak_fraction	The minimum allowed pixel value, as a fraction of the peak value in the image.	Unsigned double	0.0
healpix_fits/min_abs_val	The minimum pixel value accepted, in units of the original image.	Unsigned double	0.0

Continued on next page. . .

Key	Description	Allowed values	Default
healpix_fits/coord_sys	The spherical coordinate system used for the HEALPix representation.	One of the following: • Galactic • Equatorial	Galactic
healpix_fits/default_map_units	The physical units of pixels in the input map, if not specified in the file.	One of the following: • Jy/pixel • K • mK	K
healpix_fits/override_map_units	If true, override any units found in the file header with the default.	Bool	false
healpix_fits/freq_hz	Frequency at which to apply the conversion from brightness temperature to Jy/pixel.	Unsigned double	408e6
healpix_fits/spectral_index	The spectral index to give to each pixel.	Double	-0.7
healpix_fits/filter/flux_min	Minimum flux density allowed by the filter, in Jy. This is an exclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	min
healpix_fits/filter/flux_max	Maximum flux density allowed by the filter, in Jy. This is an inclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	max
healpix_fits/filter/radius_inner_deg	Minimum angular distance from phase centre allowed by the filter, in degrees. This is an inclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	0.0
healpix_fits/filter/radius_outer_deg	Maximum angular distance from phase centre allowed by the filter, in degrees. This is an exclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	180.0
healpix_fits/extended_sources/FWHM_major	Major axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
healpix_fits/extended_sources/FWHM_minor	Minor axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
healpix_fits/extended_sources/position_angle	Position angle override of all extended sources in this group (from North to East), in degrees.	Double	0.0
generator/random_power_law/num_sources	Number of sources scattered approximately uniformly over the sphere (before filtering). A value greater than 0 will activate the random power-law generator.	Unsigned integer	0
generator/random_power_law/flux_min	Minimum flux density in the random distribution, in Jy (before filtering).	Unsigned double	0.0
generator/random_power_law/flux_max	Maximum flux density in the random distribution, in Jy (before filtering).	Unsigned double	0.0
generator/random_power_law/power	Power law exponent describing number per unit flux density.	Double	0.0
generator/random_power_law/seed	Random number generator seed used for random distributions.	Integer $\geq$ 1, or 'time'	1

Continued on next page. . .

Key	Description	Allowed values	Default
generator/random_power_law/filter/flux_min	Minimum flux density allowed by the filter, in Jy. This is an exclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	min
generator/random_power_law/filter/flux_max	Maximum flux density allowed by the filter, in Jy. This is an inclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	max
generator/random_power_law/filter/radius_inner_deg	Minimum angular distance from phase centre allowed by the filter, in degrees. This is an inclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	0.0
generator/random_power_law/filter/radius_outer_deg	Maximum angular distance from phase centre allowed by the filter, in degrees. This is an exclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	180.0
generator/random_power_law/extended_sources/FWHM_major	Major axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
generator/random_power_law/extended_sources/FWHM_minor	Minor axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
generator/random_power_law/extended_sources/position_angle	Position angle override of all extended sources in this group (from North to East), in degrees.	Double	0.0
generator/random_broken_power_law/num_sources	Number of sources scattered approximately uniformly over the sphere (before filtering). A value greater than 0 will activate the random broken-power-law generator.	Unsigned integer	0
generator/random_broken_power_law/flux_min	Minimum flux density in the random distribution, in Jy (before filtering).	Unsigned double	0.0
generator/random_broken_power_law/flux_max	Maximum flux density in the random distribution, in Jy (before filtering).	Unsigned double	0.0
generator/random_broken_power_law/power1	Power law exponent describing number per unit flux density in region 1.	Double	0.0
generator/random_broken_power_law/power2	Power law exponent describing number per unit flux density in region 2.	Double	0.0
generator/random_broken_power_law/threshold	Threshold flux density for the intersection of region 1 and 2, in Jy. Region 1 is less than the threshold; Region 2 is greater than the threshold.	Double	0.0
generator/random_broken_power_law/seed	Random number generator seed used for random distributions.	Integer $\geq$ 1, or 'time'	1
generator/random_broken_power_law/filter/flux_min	Minimum flux density allowed by the filter, in Jy. This is an exclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	min
generator/random_broken_power_law/filter/flux_max	Maximum flux density allowed by the filter, in Jy. This is an inclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	max
generator/random_broken_power_law/filter/radius_inner_deg	Minimum angular distance from phase centre allowed by the filter, in degrees. This is an inclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	0.0
generator/random_broken_power_law/filter/radius_outer_deg	Maximum angular distance from phase centre allowed by the filter, in degrees. This is an exclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	180.0

Continued on next page...

Key	Description	Allowed values	Default
generator/random_broken_power_law/extended_sources/FWHM_major	Major axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
generator/random_broken_power_law/extended_sources/FWHM_minor	Minor axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
generator/random_broken_power_law/extended_sources/position_angle	Position angle override of all extended sources in this group (from North to East), in degrees.	Double	0.0
generator/grid/side_length	Side length of the generated grid. A value greater than 0 will activate the grid generator.	Unsigned integer	0
generator/grid/fov_deg	Field-of-view spanned by the grid centre, in degrees.	Double in range $0 \leq x \leq 180.0$	0.0
generator/grid/mean_flux_jy	The mean of generated Stokes I fluxes, in Jy.	Unsigned double	0.0
generator/grid/std_flux_jy	The standard deviation of generated Stokes I fluxes, in Jy.	Unsigned double	0.0
generator/grid/seed	Random number generator seed used for random distributions.	Integer ≥ 1, or 'time'	1
generator/grid/pol/mean_pol_fraction	The mean polarisation fraction of generated source fluxes (range 0 to 1).	Double in range $0 \leq x \leq 1$	0.0
generator/grid/pol/std_pol_fraction	The standard deviation of polarisation fraction of generated source fluxes (range 0 to 1).	Double in range $0 \leq x \leq 1$	0.0
generator/grid/pol/mean_pol_angle_deg	The mean polarisation angle of generated source fluxes, in degrees.	Double	0.0
generator/grid/pol/std_pol_angle_deg	The standard deviation of polarisation angle of generated source fluxes, in degrees.	Unsigned double	0.0
generator/grid/pol/seed	Random number generator seed used for random distributions.	Integer ≥ 1, or 'time'	1
generator/grid/extended_sources/FWHM_major	Major axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
generator/grid/extended_sources/FWHM_minor	Minor axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
generator/grid/extended_sources/position_angle	Position angle override of all extended sources in this group (from North to East), in degrees.	Double	0.0
generator/healpix/nside	HEALPix Nside parameter. A value greater than 0 will activate the HEALPix generator, which will produce points evenly spaced over the whole sky. The total number of points is 12 * Nside * Nside.	Unsigned integer	0
generator/healpix/amplitude	Amplitude assigned to generated HEALPix points, in Jy.	Double	1.0
generator/healpix/filter/flux_min	Minimum flux density allowed by the filter, in Jy. This is an exclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	min
generator/healpix/filter/flux_max	Maximum flux density allowed by the filter, in Jy. This is an inclusive interval bound; i.e. min $<$ flux $\leq$ max.	Double $\geq$ -MAX, 'min' or 'max'	max
generator/healpix/filter/radius_inner_deg	Minimum angular distance from phase centre allowed by the filter, in degrees. This is an inclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	0.0

Continued on next page...

Key	Description	Allowed values	Default
generator/healpix/filter/radius_outer_deg	Maximum angular distance from phase centre allowed by the filter, in degrees. This is an exclusive interval bound; i.e. inner $\leq$ r $<$ outer.	Double in range $0 \leq x \leq 180$	180.0
generator/healpix/extended_sources/FWHM_major	Major axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
generator/healpix/extended_sources/FWHM_minor	Minor axis FWHM override of all sources in this group, in arc seconds.	Unsigned double	0.0
generator/healpix/extended_sources/position_angle	Position angle override of all extended sources in this group (from North to East), in degrees.	Double	0.0
spectral_index/override	If **true**, override all source spectral index values using the parameters below.	Bool	false
spectral_index/ref_frequency_hz	Reference frequency of all sources in the final sky model.	Unsigned double	0.0
spectral_index/mean	Mean spectral index of all sources in the final sky model.	Double	0.0
spectral_index/std_dev	Standard deviation of spectral index values for all sources in the final sky model.	Double	0.0
spectral_index/seed	Random number generator seed used for random distributions.	Integer $\geq$ 1, or 'time'	1
common_flux_filter/flux_min	Minimum flux density allowed by the filter, in Jy. **Note that this filter is applied on a per-channel basis after scaling all source fluxes by the spectral index.**	Double $\geq$ -MAX, 'min' or 'max'	min
common_flux_filter/flux_max	Maximum flux density allowed by the filter, in Jy. **Note that this filter is applied on a per-channel basis after scaling all source fluxes by the spectral index.**	Double $\geq$ -MAX, 'min' or 'max'	max
advanced/zero_failed_gaussians	If **true**, remove (set to zero) sources for which Gaussian width parameter solutions have failed. This can occur for sources very far from the phase centre. If **false** (the default), sources with failed Gaussian parameter solutions are modelled as point sources.	Bool	false
advanced/apply_horizon_clip	If **true**, clip sources below the horizon of every station at each time step. This is a benefit for all-sky models, where removing a large number of sources below the horizon can save a significant amount of time. However, to avoid a wasted check, set this to **false** if the sky model covers a small area which is known to be always above every station's horizon for the whole observation.	Bool	true
output_binary_file	Path used to save the final sky model structure as an OSKAR binary file. Leave blank if not required.	Path name	
output_text_file	Path used to save the final sky model structure as a text file (useful for debugging). Leave blank if not required.	Path name	

2.3 Observation settings

These parameters are used to specify the observation.

All settings keys in this group are prefixed with `observation/`.

Key	Description	Allowed values	Default
phase_centre_ra_deg	Right Ascension of the observation pointing (phase centre), in degrees.	Double, or CSV list of doubles.	0
phase_centre_dec_deg	Declination of the observation pointing (phase centre), in degrees.	Double, or CSV list of doubles.	0
pointing_file	Pathname to optional station pointing file, which can be used to override the beam direction for any or all stations in the telescope model. See the accompanying documentation for a description of a station pointing file.	Path name	
start_frequency_hz†	The frequency at the midpoint of the first channel, in Hz.	Unsigned double	
num_channels	Number of frequency channels / bands to use.	Integer > 0	1
frequency_inc_hz	The frequency increment between successive channels, in Hz.	Unsigned double	0
start_time_utc†	The start time and date for the observation. This can be either a MJD value or a string with one of the following formats: • **`d-M-yyyy h:m:s.z`** • **`yyyy/M/d/h:m:s.z`** • **`yyyy-M-d h:m:s.z`** • **`yyyy-M-dTh:m:s.z`** where: • **d** is the day number (1 to 31) • **M** is the month (1 to 12) • **yyyy** is the year (4 digits) • **h** is the hour (0 to 23) • **m** is minutes (0 to 59) • **s** is seconds (0 to 59) • **z** is milliseconds (0 to 999)	Double (if MJD), or formatted date-time string.	

Continued on next page. . .

Key	Description	Allowed values	Default
length†	The observation length either in seconds, or in hours, minutes and seconds as a formatted string with the syntax `h:m:s.z`, where: • **h** is the hour (0 to 23) • **m** is minutes (0 to 59) • **s** is seconds (0 to 59) • **z** is milliseconds (0 to 999) Note that values support optional leading zeros in the format string.	Double (if length in seconds), or formatted time string.	
num_time_steps	Number of time steps in the output data during the observation length. This corresponds to the number of correlator dumps for interferometer simulations, and the number of beam pattern snapshots for beam pattern simulations.	Integer > 0	1

2.4 Telescope model settings

These parameters are used to specify the contents of the telescope model.

All settings keys in this group are prefixed with `telescope/`.

Key	Description	Allowed values	Default
input_directory†	Path to a directory containing the telescope configuration data. See the accompanying documentation for a description of an OSKAR telescope model directory.	Path name	
station_type	The type of each station in the interferometer. A simple, time-invariant Gaussian station beam can be used instead of an aperture array beam if required for testing. All station beam effects can be disabled by selecting 'Isotropic beam'.	One of the following: • Aperture array • Isotropic beam • Gaussian beam • VLA (PBCOR)	Aperture
normalise_beams_at_phase_centre	If **true**, then scale the amplitude of every station beam at the interferometer phase centre to precisely 1.0 for each time snapshot. This effectively performs an amplitude calibration for a source at the phase centre.	Bool	true
pol_mode	The polarisation mode of simulations which use the telescope model. If this is **Scalar**, then only Stokes I visibility data will be simulated, and scalar element responses will be used when evaluating station beams. If this is **Full** (the default) then correlation products from both polarisations will be simulated. **Note that scalar mode can be significantly faster.**	One of the following: • Full • Scalar	Full
allow_station_beam_duplication	If enabled, and if all stations are identical, all station beam responses will be copied from the first. This can reduce the simulation time, but **when using a telescope model with long baselines, source positions will not shift with respect to each station's horizon if this option is enabled.** This setting has no effect if all stations are not identical.	Bool	false
aperture_array/array_pattern/enable	If true, then the contribution to the station beam from the array pattern (given by beamforming the antennas in the station) is evaluated. If false, then the array pattern is ignored.	Bool	true
aperture_array/array_pattern/normalise	If true, the amplitude of each station beam will be divided by the number of antennas in the station; if false, then this normalisation is not performed. Note, however, that global beam normalisation is still possible by enabling the option labeled *'Normalise beams at phase centre'*.	Bool	false

Continued on next page. . .

Key	Description	Allowed values	Default
aperture_array/array_pattern/element/gain	Mean element amplitude gain factor. If set (and > 0.0), this will override the contents of the station files.	Double	0.0
aperture_array/array_pattern/element/gain_error_fixed	Systematic element amplitude gain standard deviation. If set, this will override the contents of the station files.	Double	0.0
aperture_array/array_pattern/element/gain_error_time	Time-variable element amplitude gain standard deviation. If set, this will override the contents of the station files.	Double	0.0
aperture_array/array_pattern/element/phase_error_fixed_deg	Systematic element phase standard deviation. If set, this will override the contents of the station files.	Double	0.0
aperture_array/array_pattern/element/phase_error_time_deg	Time-variable element phase standard deviation. If set, this will override the contents of the station files.	Double	0.0
aperture_array/array_pattern/element/position_error_xy_m	The standard deviation of the antenna xy-position uncertainties. If set, this will override the contents of the station files.	Double	0.0
aperture_array/array_pattern/element/x_orientation_error_deg	The standard deviation of the antenna X-dipole orientation error. If set, this will override the contents of the station files.	Double	0.0
aperture_array/array_pattern/element/y_orientation_error_deg	The standard deviation of the antenna Y-dipole orientation error. If set, this will override the contents of the station files.	Double	0.0
aperture_array/array_pattern/element/seed_gain_errors	Random number generator seed used for systematic gain error distribution.	Integer ≥ 1, or 'time'	1
aperture_array/array_pattern/element/seed_phase_errors	Random number generator seed used for systematic phase error distribution.	Integer ≥ 1, or 'time'	1
aperture_array/array_pattern/element/seed_time_variable_errors	Random number generator seed used for time variable error distributions.	Integer ≥ 1, or 'time'	1
aperture_array/array_pattern/element/seed_position_xy_errors	Random number generator seed used for antenna xy-position error distribution.	Integer ≥ 1, or 'time'	1
aperture_array/array_pattern/element/seed_x_orientation_error	Random number generator seed used for antenna X dipole orientation error distribution.	Integer ≥ 1, or 'time'	1
aperture_array/array_pattern/element/seed_y_orientation_error	Random number generator seed used for antenna Y dipole orientation error distribution.	Integer ≥ 1, or 'time'	1
aperture_array/element_pattern/enable_numerical	If **true**, make use of any available numerical element pattern files. If numerical pattern data are missing, the functional type will be used instead.	Bool	true
aperture_array/element_pattern/functional_type	The type of functional pattern to apply to the elements, if not using a numerically-defined pattern.	One of the following: • Dipole • Geometric dipole • Isotropic (unpolarised)	Dipole

Continued on next page...

Key	Description	Allowed values	Default
aperture_array/element_pattern/dipole_length	The length of the dipole, if using dipole elements.	Double	0.5
aperture_array/element_pattern/dipole_length_units	The units used to specify the dipole length (metres or wavelengths), if using dipole elements.	One of the following: • Wavelengths • Metres	Wavelengths
aperture_array/element_pattern/taper/type	The type of tapering function to apply to the element pattern.	One of the following: • None • Cosine • Gaussian	None
aperture_array/element_pattern/taper/cosine_power	If a cosine element taper is selected, this setting gives the power of the cosine(theta) function.	Double	1.0
aperture_array/element_pattern/taper/gaussian_fwhm_deg	If a Gaussian element taper is selected, this setting gives the full-width half maximum value of the Gaussian, in degrees.	Double	45.0
gaussian_beam/fwhm_deg	For stations using a simple Gaussian beam, this setting gives the full-width half maximum value of the Gaussian station beam at the reference frequency, in degrees.	Double	0.0
gaussian_beam/ref_freq_hz	The reference frequency of the specified FWHM, in Hz.	Double	0.0

2.5 Element pattern fitting settings

These settings are used when running the 'oskar_fit_element_data' application binary to fit splines to numerically-defined element pattern data.

All settings keys in this group are prefixed with `element_fit/`.

Key	Description	Allowed values	Default
input_cst_file	Pathname to a file containing an ASCII data table of the directional element pattern response, as exported by the CST software package in (theta, phi) coordinates. See the Telescope Model documentation for a description of the required columns.	Path name	
input_scalar_file	Pathname to a file containing an ASCII data table of the scalar directional element pattern response. See the Telescope Model documentation for a description of the required columns.	Path name	
frequency_hz	Observing frequency at which numerical element pattern data is applicable, in Hz.	Unsigned double	0.0
pol_type	Specify whether the input data is to be used for the X or Y dipole, or both. (This is ignored for scalar data.)	One of the following: • XY • X • Y	XY
element_type_index	The type index of the element. Leave this at zero if there is only one type of element per station.	Unsigned integer	0
ignore_data_at_pole	If **true**, then numerical element pattern data points at theta = 0 and theta = 180 degrees are ignored.	Bool	false
ignore_data_below_horizon	If **true,** then numerical element pattern data points at theta $>$ 90 degrees are ignored.	Bool	true
average_fractional_error	The target average fractional error between the fitted surface and the numerical element pattern input data. Choose this value carefully. A value that is too small may introduce fitting artifacts, or may cause the fitting procedure to fail. A value that is too large will cause detail to be lost in the fitted surface.	Unsigned double	0.005
average_fractional_error_factor_increase	If the fitting procedure fails, this value gives the factor by which to increase the allowed average fractional error between the fitted surface and the numerical element pattern input data, before trying again. Must be $>$ 1.0.	Unsigned double	1.1
output_directory	Path to the telescope or station directory in which to save the fitted coefficients.	Path name	

2.6 Interferometer settings

These settings are used only when running the interferometer simulation.

All settings keys in this group are prefixed with `interferometer/`.

Key	Description	Allowed values	Default
channel_bandwidth_hz	The channel width, in Hz, used to simulate bandwidth smearing. (Note that this can be different to the frequency increment if channels do not cover a contiguous frequency range.)	Unsigned double	0
time_average_sec	The correlator time-average duration, in seconds, used to simulate time averaging smearing.	Unsigned double	0
max_time_samples_per_block	The maximum number of time samples held in memory before being written to disk.	Unsigned integer	10
correlation_type	The type of correlations to produce: either cross-correlations, auto-correlations, or both.	One of the following: • Cross-correlations • Auto-correlations • Both	Cross-correlations
uv_filter_min	The minimum value of the baseline UV length allowed by the filter. **Note that visibilities on baseline UV lengths outside this range will not be evaluated!**	Double ≥ 0, 'min' or 'max'	min
uv_filter_max	The maximum value of the baseline UV length allowed by the filter. **Note that visibilities on baseline UV lengths outside this range will not be evaluated!**	Double ≥ 0, 'min' or 'max'	max
uv_filter_units	The units of the baseline UV length filter values.	One of the following: • Wavelengths • Metres	Wavelengths
noise/enable	If **true**, noise addition is enabled.	Bool	false
noise/seed	Random number generator seed.	Integer ≥ 1, or 'time'	1

Continued on next page. . .

Key	Description	Allowed values	Default
noise/freq	Selection of the list of frequencies for which noise values are defined: • **Telescope model**: frequencies are loaded from a data file in the telescope model directory. • **Observation settings**: frequencies are defined by the observation settings. • **Data file**: frequencies are loaded from the specified data file. • **Range**: frequencies are specified by the range parameters.	One of the following: • Telescope model • Observation settings • Data file • Range	Telescope
noise/freq/file	Data file consisting of an ASCII list of frequencies, in Hz.	Path name	
noise/freq/number	Number of frequencies.	Unsigned integer	0
noise/freq/start	Start frequency, in Hz.	Unsigned double	0
noise/freq/inc	Frequency increment, in Hz.	Unsigned double	0
noise/rms	RMS noise value specification: • **Telescope model**: values are loaded from files in the telescope model directory. • **Data file**: values are loaded from the specified file. • **Range**: values are evaluated according to the specified range parameters. Noise values are specified in Jy and represent the RMS noise in terms of the flux of an unpolarised source measured in a single polarisation of the detector. *Note that unless using the telescope model, the noise RMS will be the same for each station in the interferometer.*	One of the following: • Telescope model • Data file • Range	Telescope
noise/rms/file	Station RMS flux density data file. This is an ASCII file consisting of a list of noise RMS values as a function of frequency in Jy.	Path name	None
noise/rms/start	Station RMS flux density range start value, in Jy. The range is expanded linearly over the number of frequencies for which noise is defined.	Double	0.0
noise/rms/end	Station RMS flux density range end value, in Jy. The range is expanded linearly over the number of frequencies for which noise is defined.	Double	0.0
oskar_vis_filename	Path of the OSKAR visibility output file containing the results of the simulation. Leave blank if not required.	Path name	

Continued on next page. . .

Key	Description	Allowed values	Default
ms_filename	Path of the Measurement Set containing the results of the simulation. Leave blank if not required.	Path name	
force_polarised_ms	If **True**, always write the Measurment Set in polarised format even if the simulation was run in the single polarisation 'Scalar' (or Stokes-I) mode. If **False**, the size of the polarisation dimension in the the Measurement Set will be determined by the simulation mode.	Bool	false

2.7 Beam pattern settings

These settings are used only when running beam pattern simulations.

All settings keys in this group are prefixed with `beam_pattern/`.

Key	Description	Allowed values	Default
all_stations	If set, produce beams for all stations in the telescope model; otherwise, for selected stations.	Bool	false
station_ids	The zero-based station ID number(s) to select from the telescope model when generating beam pattern(s). More than one station ID is specified using a CSV list.	CSV integer list	0
coordinate_frame	Specification of the coordinate frame in which to evaluate the beam pattern. Horizon-based beam patterns will cover the entire sky.	One of the following: • Equatorial • Horizon	Equatorial
coordinate_type	Specification of coordinates at which to evaluate the beam pattern. • **Beam image:** Tangent plane image, centred on the phase centre direction. • **Sky model:** Evaluate beam only at the supplied coordinates.	One of the following: • Beam image • Sky model	Beam
beam_image/size	Image dimensions. If a single value is specified, the image is assumed to have the same number of pixels along each dimension. Example: • A value of '256' results in a square image of size 256 by 256 pixels. • A value of '256,128' results in an image of 256 by 128 pixels, with 256 pixels along the Right Ascension direction.	CSV integer list	256

Continued on next page. . .

Key	Description	Allowed values	Default
beam_image/fov_deg	Field-of-view (FOV) in degrees (max 180.0). If a single value is specified, the image is assumed to have the same FOV along each dimension. Example: • A value of '2.0' results in an image with a FOV of 2.0 degrees in each dimension. • A value of '2.0,1.0' results in an image with a FOV of 2.0 degrees in Right Ascension, and 1.0 degrees in Declination.	Double, or CSV list of doubles.	2.0
sky_model/file	Path to an input sky model file.	Path name	None
root_path	Root path name of the generated data file. Appropriate suffixes and extensions will be added to this, based on the settings below.	Path name	None
output/separate_time_and_channel	Output files without performing any averaging over the time or channel dimensions.	Bool	true
output/average_time_and_channel	Output files after averaging over both the time and channel dimensions.	Bool	false
output/average_single_axis	Output files after averaging over the selected dimension.	One of the following: • None • Time • Channel	None
station_outputs/text_file/raw_complex	If true, save the raw complex pattern in text files.	Bool	false
station_outputs/text_file/amp	If true, save each amplitude (voltage) pattern in text files. This is given by the square root of the sum of the squares of the real and imaginary values.	Bool	false
station_outputs/text_file/phase	If true, save each phase pattern in text files.	Bool	false
station_outputs/text_file/auto_power	If true, save each total intensity (auto-correlation) beam in text files.	Bool	false
station_outputs/fits_image/amp	If true, save each amplitude (voltage) pattern in FITS image files. This is given by the square root of the sum of the squares of the real and imaginary values.	Bool	false
station_outputs/fits_image/phase	If true, save each phase pattern in FITS image files.	Bool	false
station_outputs/fits_image/auto_power	If true, save each total intensity (auto-correlation) beam in FITS image files.	Bool	false

Continued on next page. . .

Key	Description	Allowed values	Default
telescope_outputs/text_file/cross_power_raw_complex	If true, save the average cross-power beam raw response from all specified stations as a text file.	Bool	false
telescope_outputs/text_file/cross_power_amp	If true, save the average cross-power beam amplitude response from all specified stations as text files.	Bool	false
telescope_outputs/text_file/cross_power_phase	If true, save the average cross-power beam phase response from all specified stations as text files.	Bool	false
telescope_outputs/fits_image/cross_power_amp	If true, save the average cross-power beam amplitude response from all specified stations in FITS image files.	Bool	false
telescope_outputs/fits_image/cross_power_phase	If true, save the average cross-power beam phase response from all specified stations in FITS image files.	Bool	false

2.8 Image settings

These settings are used when running the OSKAR imager.

All settings keys in this group are prefixed with `image/`.

Key	Description	Allowed values	Default
double_precision	Determines whether double precision arithmetic is used.	Bool	true
use_gpus	Use GPU devices if available.	Bool	true
cuda_device_ids	A comma-separated string containing device (GPU) IDs to use on a multi-GPU system, or 'all' to use all devices.	CSV integer list or 'all'	all
num_devices	Number of compute devices to use. A compute device is either a local CPU core, or a GPU. Don't set this to more than the number of CPU cores in your system.	Integer ≥ 0, or 'auto'	auto
specify_cellsize	If set, specify cellsize; otherwise, specify field of view.	Bool	false
fov_deg	Total field of view in degrees.	Unsigned double	2.0
cellsize_arcsec	The cell (pixel) size in arcseconds.	Unsigned double	1.0
size	Image width in one dimension (e.g. a value of 256 would give a 256 by 256 image). This must be even.	Integer > 0	256
image_type	The type of image to generate. Note that the Stokes parameter images (if selected) are uncalibrated, and are formed simply using the standard combinations of the linear polarisations: • I = 0.5 (XX + YY) • Q = 0.5 (XX - YY) • U = 0.5 (XY + YX) • V = -0.5i (XY - YX) The point spread function of the observation can be generated using the PSF option.	One of the following: • Linear (XX,XY,YX,YY) • XX • XY • YX • YY • Stokes (I,Q,U,V) • I • Q • U • V • PSF	I
channel_snapshots	If true, then produce an image cube containing snapshots for each frequency channel. If false, then use frequency-synthesis to stack the channels in the final image.	Bool	false
freq_min_hz	The minimum visibility channel centre frequency to include in the image or image cube, in Hz.	Unsigned double	0.0

Continued on next page. . .

Key	Description	Allowed values	Default
freq_max_hz	The maximum visibility channel centre frequency to include in the image or image cube, in Hz.	Double ≥ 0, 'min' or 'max'	max
time_min_utc	The minimum visibility time centroid to include in the image. This can be either a MJD value or a string with one of the following formats: • **`d-M-yyyy h:m:s.z`** • **`yyyy/M/d/h:m:s.z`** • **`yyyy-M-d h:m:s.z`** • **`yyyy-M-dTh:m:s.z`** where: • **d** is the day number (1 to 31) • **M** is the month (1 to 12) • **yyyy** is the year (4 digits) • **h** is the hour (0 to 23) • **m** is minutes (0 to 59) • **s** is seconds (0 to 59) • **z** is milliseconds (0 to 999)	Double (if MJD), or formatted date-time string.	0.0

Continued on next page. . .

Key	Description	Allowed values	Default
time_max_utc	The maximum visibility time centroid to include in the image. This can be either a MJD value or a string with one of the following formats: • **`d-M-yyyy h:m:s.z`** • **`yyyy/M/d/h:m:s.z`** • **`yyyy-M-d h:m:s.z`** • **`yyyy-M-dTh:m:s.z`** where: • **d** is the day number (1 to 31) • **M** is the month (1 to 12) • **yyyy** is the year (4 digits) • **h** is the hour (0 to 23) • **m** is minutes (0 to 59) • **s** is seconds (0 to 59) • **z** is milliseconds (0 to 999)	Double (if MJD), or formatted date-time string.	0.0
uv_filter_min	The minimum UV baseline length to image, in wavelengths.	Unsigned double	0.0
uv_filter_max	The maximum UV baseline length to image, in wavelengths.	Double ≥ 0, 'min' or 'max'	max
algorithm	The type of transform used to generate the image.	One of the following: • FFT • DFT 2D • DFT 3D • W-projection	FFT
weighting	The type of visibility weighting scheme to use.	One of the following: • Natural • Radial • Uniform	Natural
fft/use_gpu	If true, use the GPU to perform the FFT.	Bool	false

Continued on next page. . .

Key	Description	Allowed values	Default
fft/kernel_type	The type of gridding kernel to use.	One of the following: • Spheroidal • Pillbox	Spheroidal
fft/support	The support size used for the gridding kernel.	Int	3
fft/oversample	The oversample factor used for the gridding kernel.	Int	100
wproj/generate_w_kernels_on_gpu	If true, use the GPU to generate the W-kernels.	Bool	true
wproj/num_w_planes	The number of W-planes to use. Values less than 1 mean "auto".	Int	0
direction	Specifies the direction of the image phase centre. • If **Observation direction** is selected, the image is centred on the pointing direction of the primary beam. • If **RA, Dec.** is selected, the image is centred on the values of RA and Dec. found below.	One of the following: • Observation direction • RA, Dec.	Observation
direction/ra_deg	The Right Ascension of the image phase centre. This value is used if the image centre direction is set to 'RA, Dec.'.	Double	0.0
direction/dec_deg	The Declination of the image phase centre. This value is used if the image centre direction is set to 'RA, Dec.'.	Double	0.0
input_vis_data	Path to the input OSKAR visibility data file(s) or Measurement Set(s).	CSV list of path names	None
scale_norm_with_num_input_files	Sets the option to scale image normalisation with number of input files. • Set this to **true** if the different files represent multiple sky model components observed with the same telescope configuration and observation parameters. • Set this to **false** if the different files represent multiple observations of the same sky observed with different telescope configurations or observation parameters.	Bool	false
ms_column	The name of the column in the Measurement Set to use, if applicable.	One of the following: • DATA • MODEL_DATA • CORRECTED_DATA	DATA

Continued on next page. . .

Key	Description	Allowed values	Default
root_path	The root filename used to save the output image. The full filename will be constructed as <**root**>_<**image_type**>**.fits** If left blank when running the application, the output file name will be based on the name of the first input file.	Path name	None

Revision History

Revision	Date	Modification
1	2012-04-23	Creation.
2	2012-05-08	Added default value column to settings tables.
3	2012-06-13	Updated settings for version 2.0.2-beta.
4	2012-07-27	Updated settings for version 2.0.4-beta.
5	2012-10-22	Updated for revised settings in version 2.1.0-beta.
6	2012-11-20	Updated for version 2.1.1-beta.
7	2013-03-01	Updated settings for version 2.2.0. This includes changes to most settings in the sky model group, and changes to the settings that define the files saved from beam pattern simulations.
8	2013-11-13	Updated settings for version 2.3.0. This consists of an update to the specification of beam pattern simulation settings.
9	2014-07-17	Updated settings for version 2.5.0. Moved element pattern fitting parameters out of the telescope model group to the top-level 'element_fit' group. Added global beam normalization option. Added isotropic beam station type. Added Gaussian station beam reference frequency. Added dipole length options. Added UV range filtering parameters. Added scalar mode option. Removed option to make image after interferometer simulation.
10	2014-09-08	Updated descriptions in system noise settings to clarify that the noise is specified for a single polarisation. Changed all random number seed integer ranges to start at 1 (rather than 0). Changed beam normalization to be enabled by default.
11	2015-04-28	Moved option to select polarisation mode into telescope model settings group, so that scalar mode can also be used for beam pattern simulations. Moved and renamed option to allow station beam duplication into telescope model group. Added option to disable horizon clip in advanced sky model settings. Re-wrote most of the beam pattern options to support the new output modes. Added the ability to use seconds (as well as hours, minutes and seconds) to specify observation length. Removed options to write OSKAR image files. Removed ability to load a GSM file directly or use HEALPix temperature maps, as the frequency scaling was not treated correctly.
12	2017-01-05	Added new imager settings. Removed telescope position settings (these are now specified in the telescope model folder). Updated beam pattern output settings. Reinstated GSM and HEALPix sky model settings.