

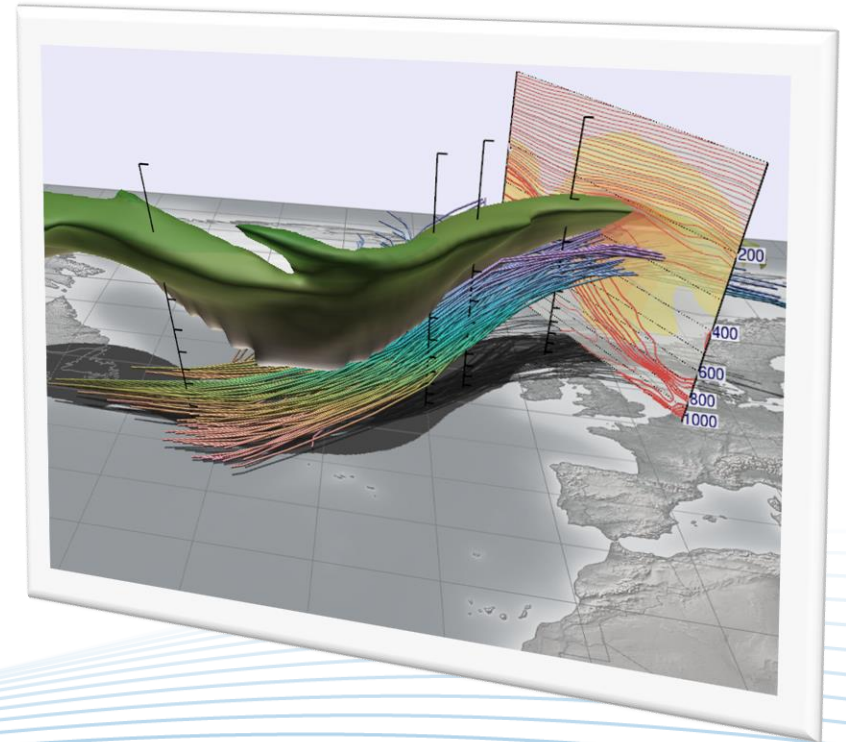
Met.3D introductory tutorial

Marc Rautenhaus

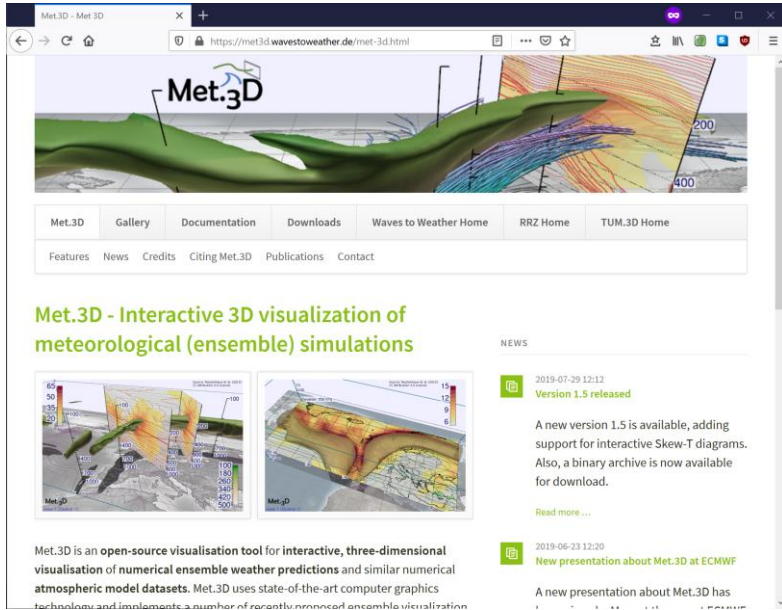
Universität Hamburg, Regional Computing Center Visual Data Analysis Group,
Centre for Earth System Research and Sustainability (CEN)



Version 2021.03.20

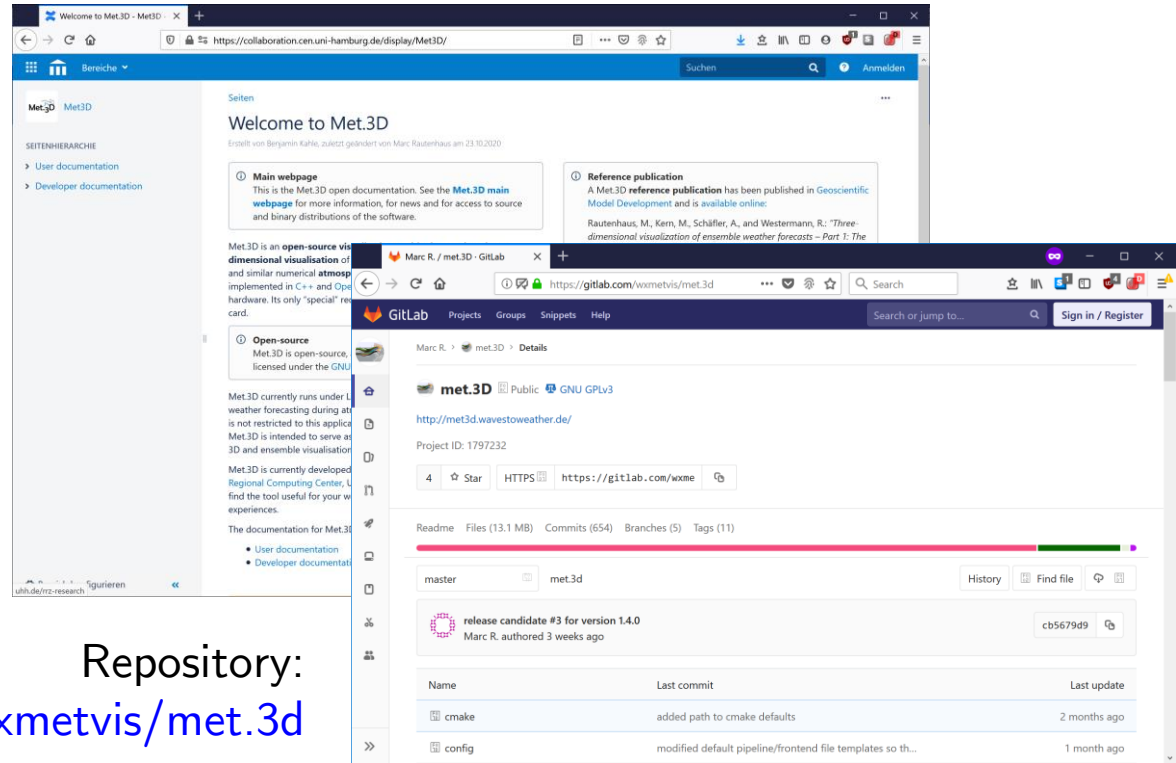


Before you start: Met.3D online resources



Website:
met3d.wavestoweather.de

Documentation:
<https://collaboration.cen.uni-hamburg.de/display/Met3D/>

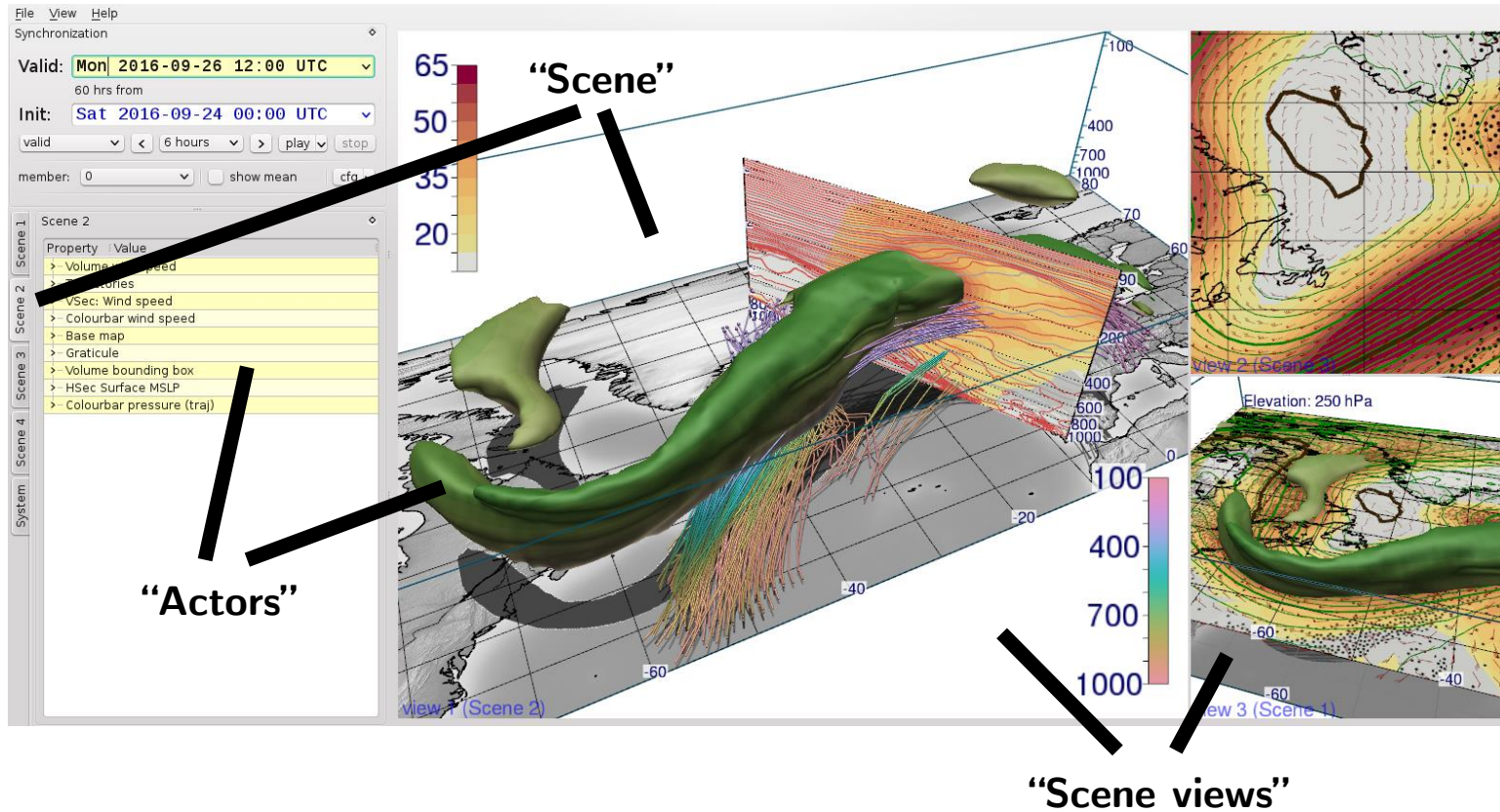


Repository:
gitlab.com/wxmetvis/met.3d

Basics: Met.3D frontend elements

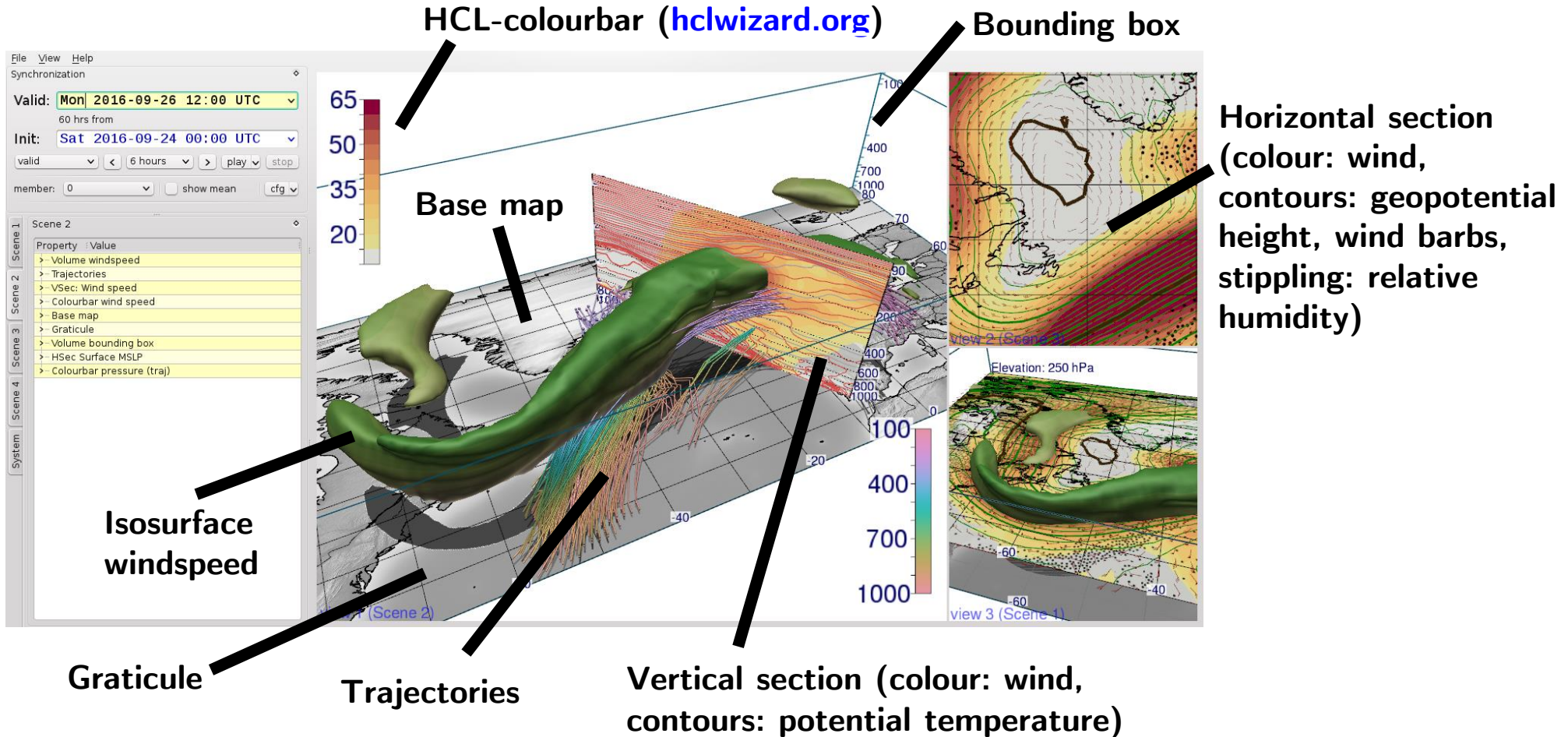
Time and ensemble navigation

Parameters for actors and views



Different 3D projection options

Basics: Met.3D frontend elements



Tutorial content: you will learn...

1. Actors 1: create graticule, basemap etc.
2. Saving individual actors, session management
3. Loading datasets
4. Actors 2: horizontal section with data
5. Basic time and ensemble navigation, adjusting the colour bar
6. Actors 3: vertical section
7. System settings: multiple views, vertical scaling, camera interaction, annotations
8. Actors 4: 3D isosurface and vertical poles
9. Transfer functions
10. Basic ensemble statistics
11. Saving images and creating animations
12. Direct volume rendering
13. Data format: typical NetCDF layout
14. Working with Met.3D...

Create actors

File View Help

Synchronization

Valid: Mon 2018-10-01 00:00 UTC

0 hrs from

Init: Mon 2018-10-01 00:00 UTC

valid < 6 hours > play stop

member: show mean cfg

Scene 1

| Property | Value |
|----------|-------|
|----------|-------|

properties

Scene 2

Scene 3

Scene 4

System

scene view

view 1 (Scene 1)

to create actors and to manage scenes:
“Scene management” (F4)

create actor

Scene settings:

Scenes:

- Scene 1
- Scene 2
- Scene 3
- Scene 4

Render order in selected scene:

up down

create delete

Assignment of scenes to scene controls:

Scene view 1: Scene 1

Scene view 2: Scene 2

Scene view 3: Scene 3

Scene view 4: Scene 4

Actor settings:

Actors:

Labels

create create from file delete

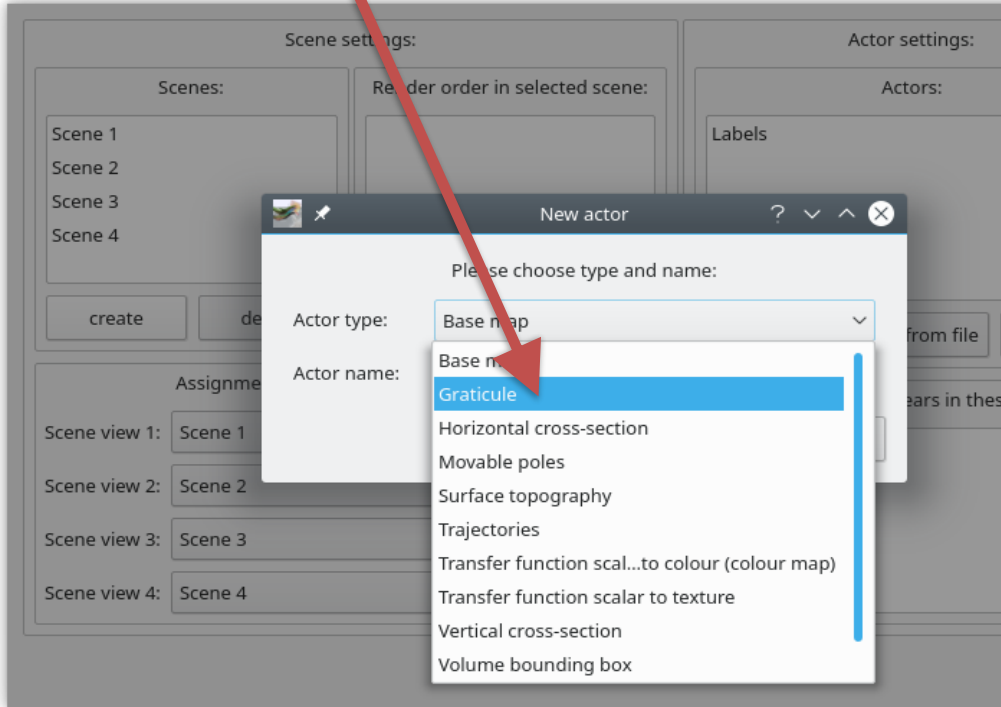
Selected actor appears in these scenes:

- Scene 1
- Scene 2
- Scene 3
- Scene 4

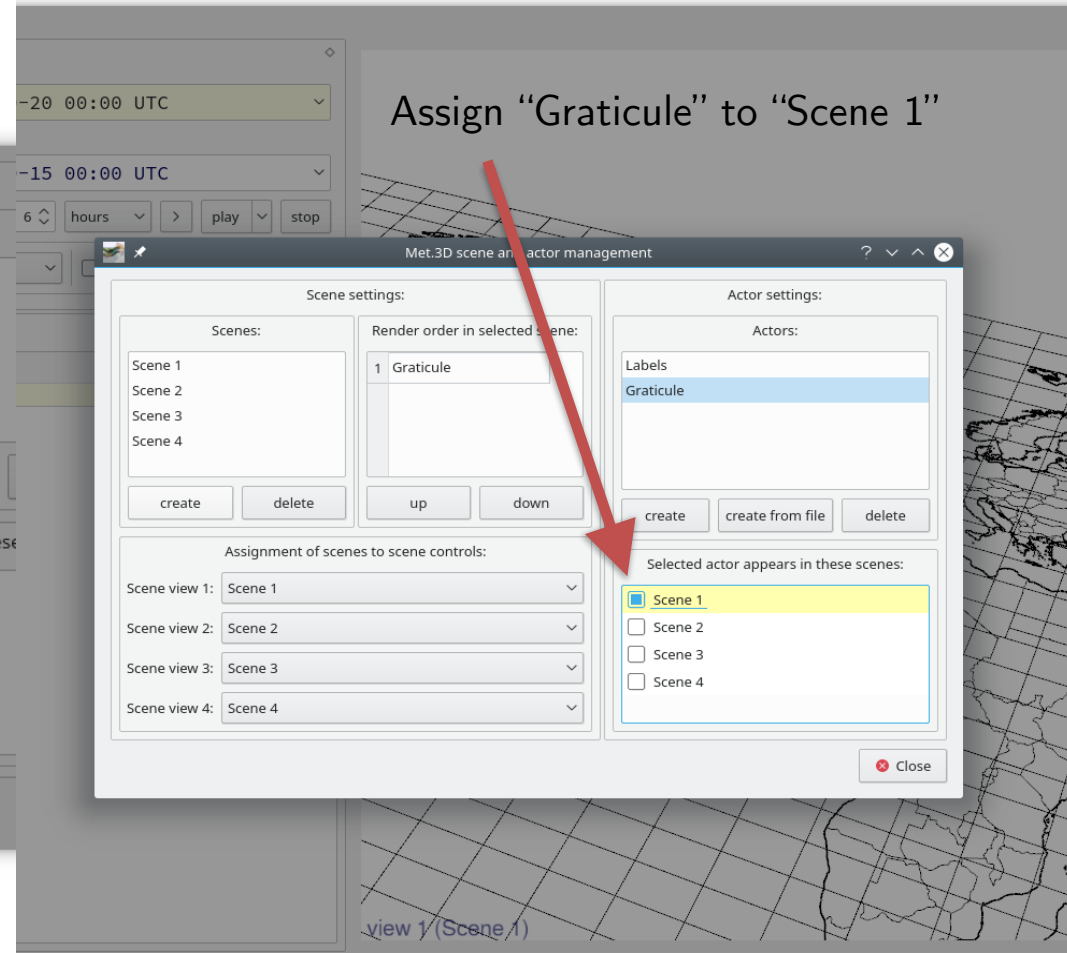
Close

Create an actor: Graticule

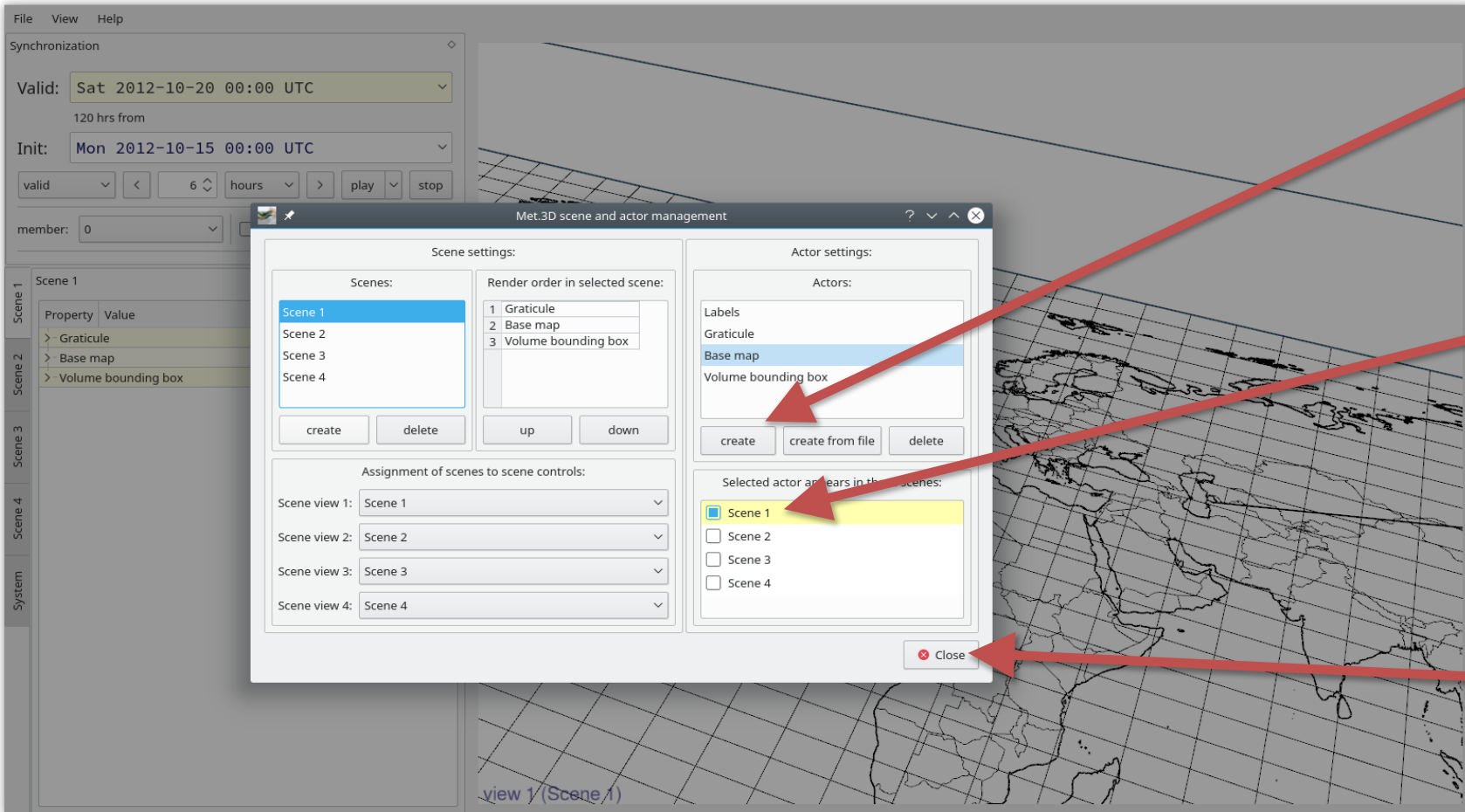
Choose “Graticule”, confirm with “ok”



Assign “Graticule” to “Scene 1”



Create actors: add “basemap” and “volume bounding box”



create new actors

assign actors to scene

close dialog

Adjusting the visible region (bounding box)

The screenshot shows a software interface with the following components:

- Synchronization Panel:** Includes fields for 'Valid' (Sat 2012-10-20 00:00 UTC), 'Init' (Mon 2012-10-15 00:00 UTC), and a '120 hrs from' duration. It also has 'play' and 'stop' buttons.
- Scene 1 Property Panel:** A tree view showing properties for 'Graticule' (enabled: True), 'configuration', 'actor properties', 'labels', 'spacing', 'colour', 'draw graticule', 'draw coast lines', 'draw border lines', 'rotated grid support', and 'Base map'. The 'bounding box' property is expanded, showing a dropdown menu with options: Global, North America, North Atlantic and Europe (selected), North Atlantic and Europe NAWDEX, and Northern Hemisphere.
- Bounding Boxes Table:** A table with columns: name, western longitude, southern latitude, east-west extend, north-south extend, bottom pressure (hPa), and top pressure (hPa). The table contains 5 rows of data.

| | name | western longitude | southern latitude | east-west extend | north-south extend | bottom pressure (hPa) | top pressure (hPa) |
|---|----------------------------------|-------------------|-------------------|------------------|--------------------|-----------------------|--------------------|
| 1 | Global | -180 | -90 | 360 | 180 | 1045 | 20 |
| 2 | North America | -170 | 10 | 125 | 70 | 1045 | 20 |
| 3 | North Atlantic and Europe | -60 | 30 | 100 | 40 | 1045 | 20 |
| 4 | North Atlantic and Europe NAWDEX | -90 | 30 | 120 | 55 | 1045 | 20 |
| 5 | Northern Hemisphere | -180 | 0 | 360 | 90 | 1045 | 20 |

1) View -> Show Bounding Boxes (or F3) shows list of bounding boxes, parameters can be adjusted

2) For each actor, the bounding box that should be used can be chosen

Here: Select “North Atlantic and Europe”

3) Parameters could be set here; F3 closes the view

Basemap: load map file

File View Help

Synchronization

Valid: Sat 2012-10-20 00:00 UTC

120 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 0 show mean cfg

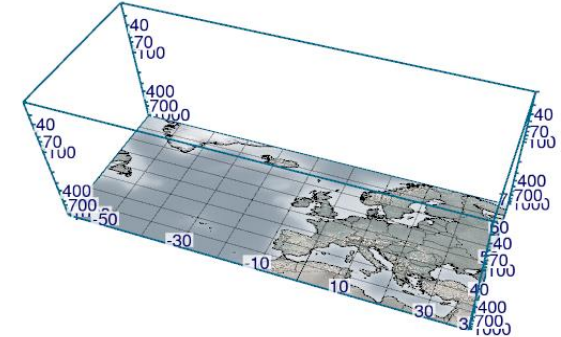
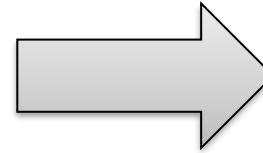
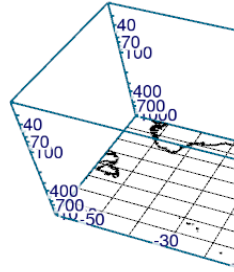
Scene 1

| Property | Value |
|------------------------|--|
| > Graticule | |
| > Base map | |
| enabled | <input checked="" type="checkbox"/> True |
| > configuration | |
| > actor properties | |
| > labels | |
| load map | execute |
| map file | |
| bounding box | North Atlantic and Europe |
| colour saturation | 0.30 (0..1) |
| > rotated grid support | |
| > Volume bounding box | |

view 1 (Scene 1)

Bounding Boxes

| | name | western longitude | southern latitude | east-west extend | north-south extend | bottom pressure (hPa) | top pressure (hPa) |
|---|----------------------------------|-------------------|-------------------|------------------|--------------------|-----------------------|--------------------|
| 1 | Global | -180 | -90 | 360 | 180 | 1045 | 20 |
| 2 | North America | -170 | 10 | 125 | 70 | 1045 | 20 |
| 3 | North Atlantic and Europe | -60 | 30 | 100 | 40 | 1045 | 20 |
| 4 | North Atlantic and Europe NAWDEX | -90 | 30 | 120 | 55 | 1045 | 20 |
| 5 | Northern Hemisphere | -180 | 0 | 360 | 90 | 1045 | 20 |



In "Basemap" properties, select "load map" and open a GeoTIFF file

view 1 (Scene 1)

| bottom pressure (hPa) | top pressure (hPa) |
|-----------------------|--------------------|
| 1045 | 20 |
| 1045 | 20 |
| 1045 | 20 |
| 1045 | 20 |
| 1045 | 20 |
| 1045 | 20 |

Get accustomed to 3D navigation

File View Help

Synchronization

Valid: Fri 2012-10-19 06:00 UTC
102 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 9 show mean cfg

Scene 1 System

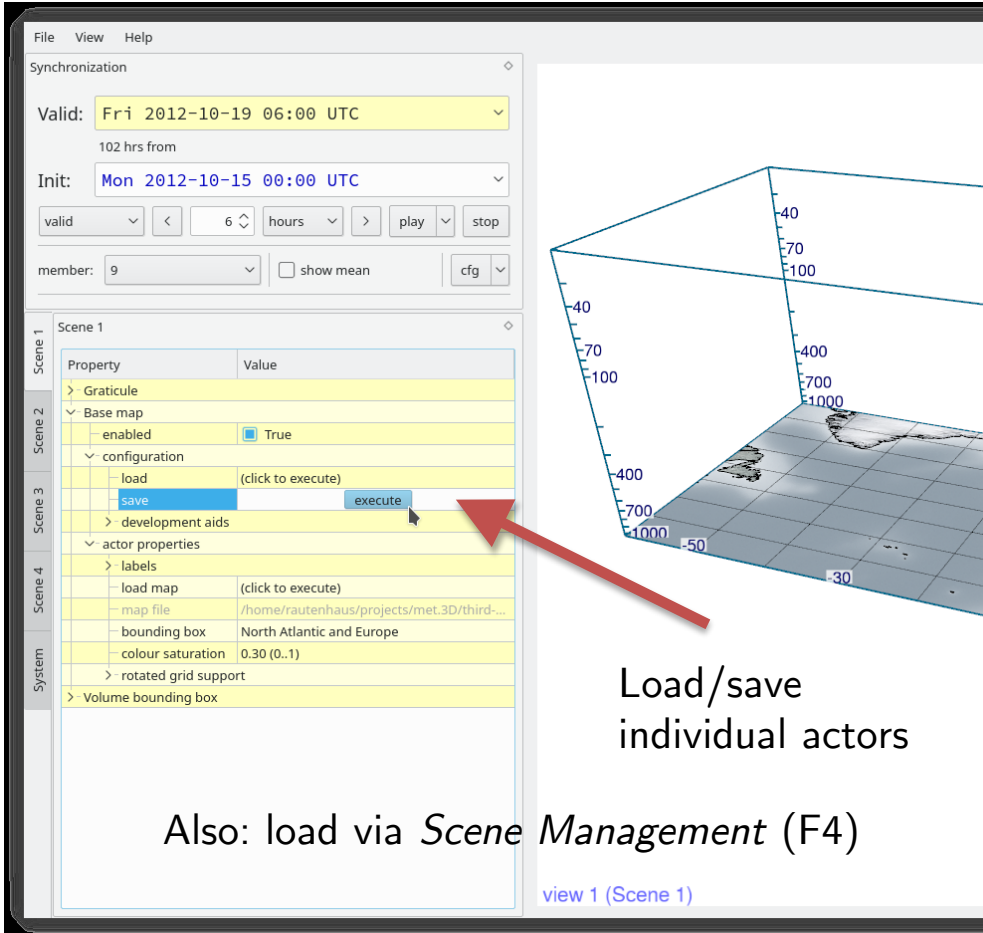
Render time per frame: 3546.6 ms (0.3 fps)

| Property | Value |
|--|--|
| > OpenGL resources (4.6.0 NVIDIA 390.87) | |
| > Application configuration | |
| > All scene views | |
| > Scene view #1 | |
| > configuration | |
| camera position | 2.4/-31.9/36.0 |
| > modify camera | |
| > interaction | |
| rotate | (click to execute) |
| save to image file | (click to execute) |
| scene navigation | move camera |
| > scene rotation centre | move camera |
| full-screen actor | rotate scene |
| navigation sensitivity | 2D top view |
| auto-rotate camera | single full-screen actor |
| sync camera with view | none |
| actor interaction mode | <input type="checkbox"/> False |
| analysis mode | <input type="checkbox"/> False |
| draw position labels | <input checked="" type="checkbox"/> True |
| > rendering | |
| > annotations | |
| > Scene view #2 | |
| > Scene view #3 | |

view 1 (Scene 1)

- 1) Navigate using left/right mouse button and scroll wheel
- 2) Select the "System" properties tab
- 3) For "Scene view #1", find out if the "scene navigation" setting "move camera" or "rotate scene" works better for you

Saving individual actors and entire visualization sessions



The screenshot shows the software interface with a 3D visualization of a map. The left sidebar contains a tree view with 'Scene 1' selected. The 'actor properties' section is expanded, and the 'save' button is highlighted with a red arrow. The 'execute' button is also visible.

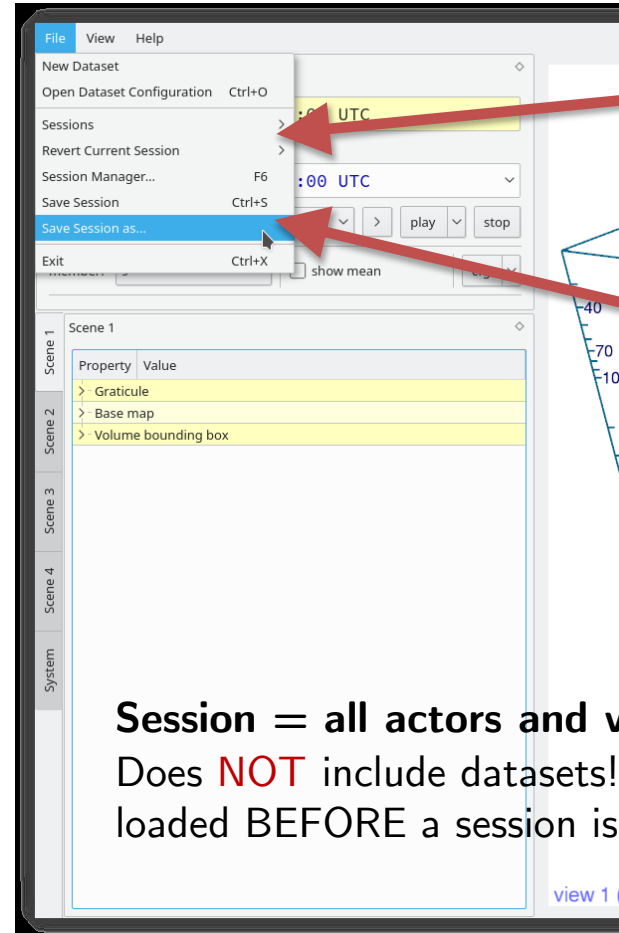
Valid: Fri 2012-10-19 06:00 UTC
102 hrs from
Init: Mon 2012-10-15 00:00 UTC
valid < 6 hours > play stop
member: 9 show mean cfg

| Property | Value |
|-----------------------|--|
| > Graticule | |
| > Base map | |
| enabled | True |
| configuration | |
| load | (click to execute) |
| save | (click to execute) |
| development aids | |
| actor properties | |
| labels | |
| load map | (click to execute) |
| map file | /home/rautenhaus/projects/met.3D/third-... |
| bounding box | North Atlantic and Europe |
| colour saturation | 0.30 (0..1) |
| rotated grid support | |
| > Volume bounding box | |

view 1 (Scene 1)

Load/save individual actors

Also: load via *Scene Management* (F4)



The screenshot shows the software interface with the 'File' menu open. The 'Save Session as...' option is highlighted with a red arrow. The 'Revert Current Session' option is also highlighted with a red arrow.

File View Help
New Dataset
Open Dataset Configuration Ctrl+O
Sessions
Revert Current Session
Session Manager... F6
Save Session Ctrl+S
Save Session as...
Exit Ctrl+X

Valid: Fri 2012-10-19 06:00 UTC
102 hrs from
Init: Mon 2012-10-15 00:00 UTC
valid < 6 hours > play stop
member: 9 show mean cfg

| Property | Value |
|-----------------------|-------|
| > Graticule | |
| > Base map | |
| > Volume bounding box | |

view 1 (S

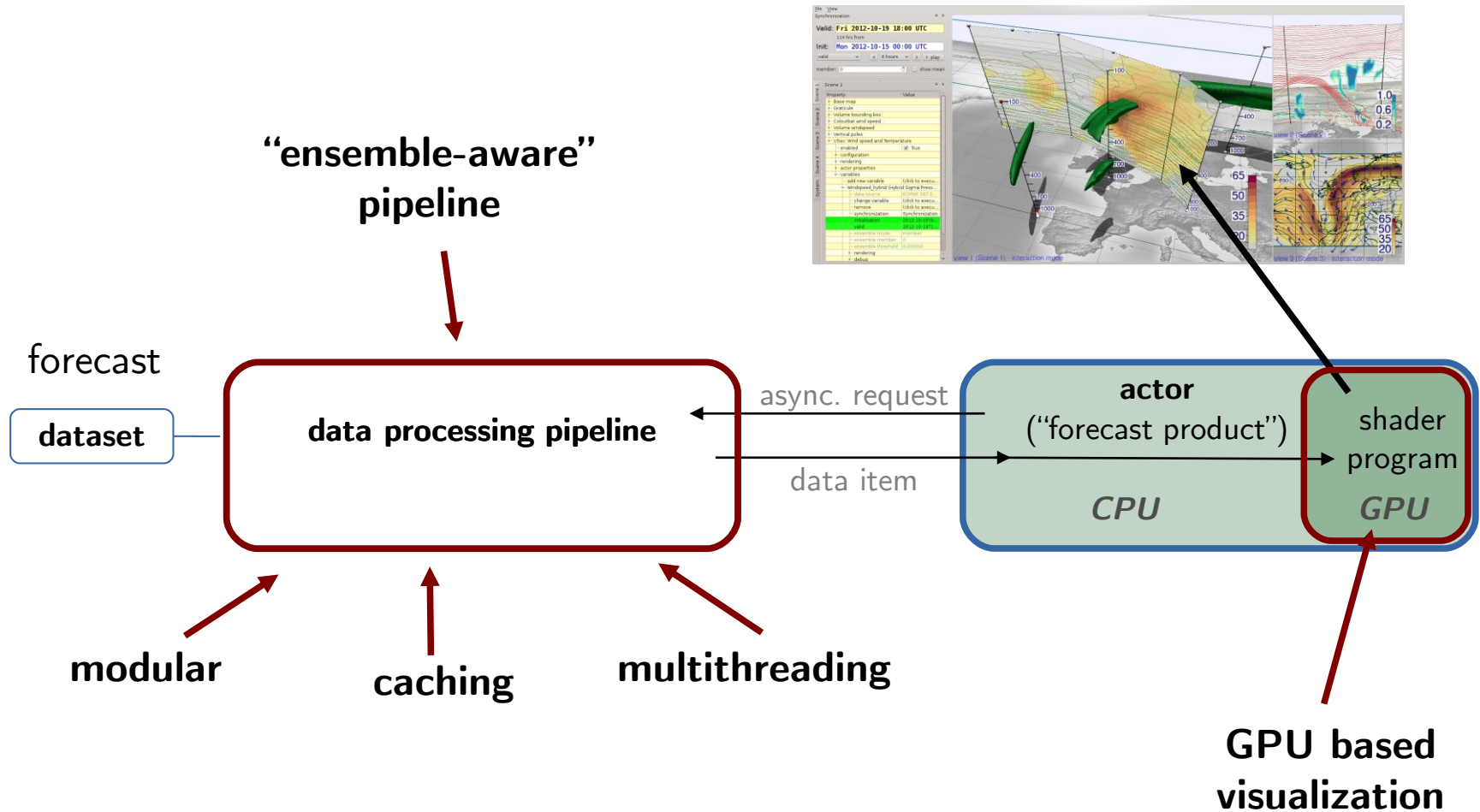
Load/revert/
switch session

Save current session

“**Ctrl-S**”
(see terminal output)

Session = all actors and viewport settings.
Does **NOT** include datasets! These need to be loaded BEFORE a session is loaded.

How to get data into Met.3D: basic architecture



Load a dataset

Name of dataset: ECMWF ENS

NWP Trajectories

Basic configuration

Directory in which data files are stored: ...

Use only files that match this filter (wildcards allowed): *

File format: CF_NETCDF

Advanced settings

enable vertical regridding

enable probability region detection filter

treat rotated grid as regular grid

convert geometric height to pressure using the ICAO standard atmosphere

surface pressure field type: auto

Auxiliary 3D pressure field name:

disable grid consistency check

Input variables for derived variables:

Memory manager for the dataset pipeline: NWP

Scheduler ID: MultiThread

save Configuration

OK Cancel

A “*dataset*” describes a single simulation or an ensemble of simulations. All variables and timesteps within a dataset need to be defined on the same grid. Data can be in a single file or distributed over multiple files.

- 1) File -> New Dataset
- 2) Specify name of dataset
- 3) Choose directory in which file(s) are stored
- 4) Specify a “filter” name that matches all the files that belong to the dataset
- 5) Select data format
- 6) Additional parameters
- 7) Save configuration to reload later

!! Check terminal output for messages!

Create a horizontal section (map) with wind speed data

2) Select bounding box

1) Scene management (F4) ->
Create actor -> select "Horizontal
cross section" -> add to "Scene 1"

The image displays a screenshot of the Met.3D software interface. On the left, a 'Scene management' panel shows a list of scenes (Scene 1 to Scene 4) and system components. A 'New actor' dialog box is open, with 'Horizontal cross-section' selected. A red arrow points from the text '1) Scene management...' to this dialog. In the center, a 'Synchronization' panel shows the valid time (Sat 2012-10-20 00:00 UTC) and initial time (Mon 2012-10-15 00:00 UTC). Below it, a 'Scene 1' configuration panel lists various actors and their properties. A red arrow points from the text '2) Select bounding box' to the 'bounding box' property, which is set to 'North Atlantic and Europe'. On the right, a 3D visualization shows a horizontal cross-section of the atmosphere at 250 hPa, with a bounding box overlaid on the map. A red arrow points from the text '2) Select bounding box' to this 3D view.

Create a horizontal section (map) with wind speed data

A horizontal section can display multiple “variables” from a dataset

- 3) Select “add new variable”
- 4) Choose “wind speed”

Available data sources

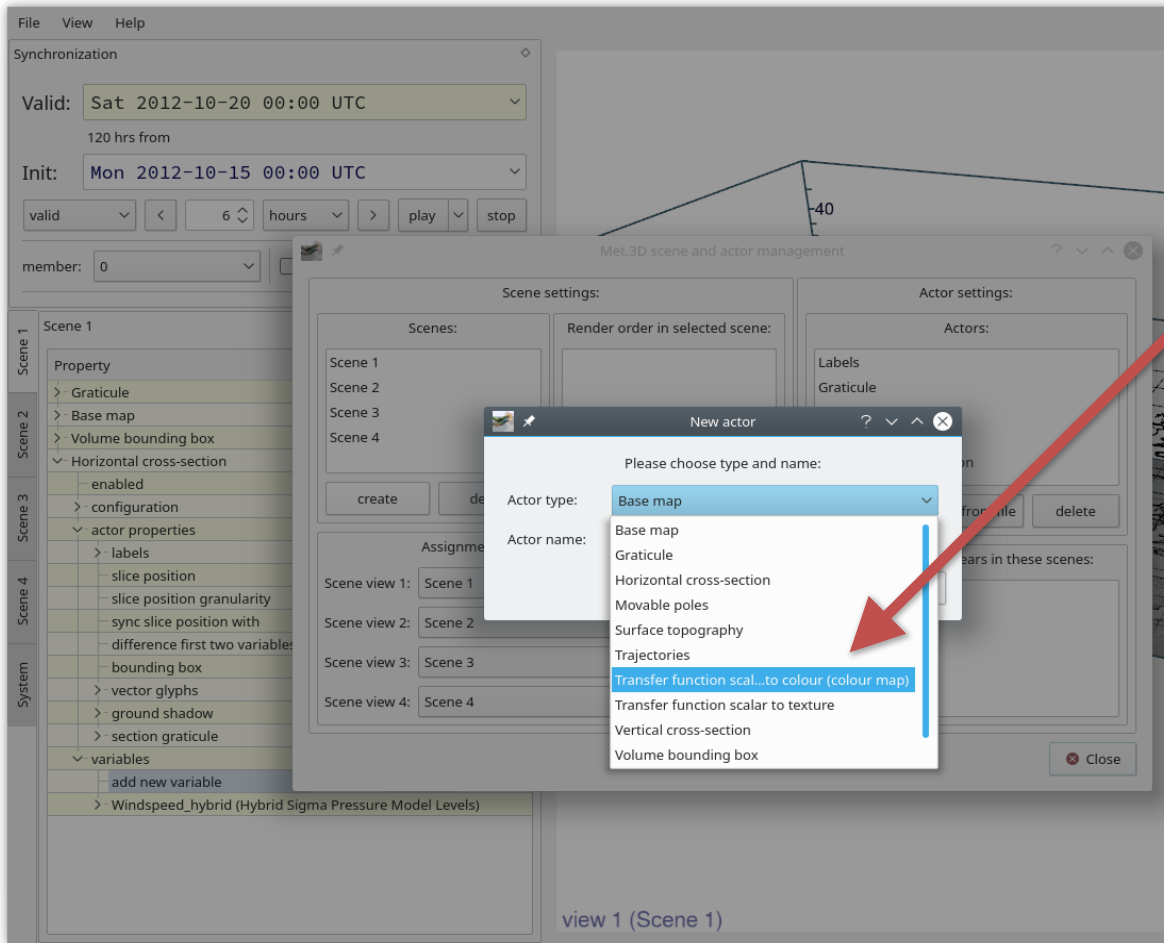
Please select a variable and confirm with "OK":

| Dataset | Vertical Dimension | Variable Name |
|---------------------|--------------------|--------------------------------------|
| ECMWF ENS ENSFilter | Surface | 10_metre_U_wind_component_surface |
| ECMWF ENS ENSFilter | Surface | 10_metre_V_wind_component_surface |
| ECMWF ENS ENSFilter | Surface | 2_metre_dewpoint_temperature_surface |
| ECMWF ENS ENSFilter | Surface | 2_metre_temperature_surface |
| ECMWF ENS ENSFilter | Surface | Albedo_surface |
| ECMWF ENS ENSFilter | Surface | Boundary_layer_height_surface |
| ECMWF ENS ENSFilter | Surface | Convective_available_potential_en |
| ECMWF ENS ENSFilter | Surface | Convective_precipitation_surface |
| ECMWF ENS ENSFilter | Surface | Evaporation_surface |
| ECMWF ENS ENSFilter | Surface | Geopotential_surface |
| ECMWF ENS ENSFilter | Surface | High_cloud_cover_surface |
| ECMWF ENS ENSFilter | Surface | Land-sea_mask_surface |
| ECMWF ENS ENSFilter | Surface | Low_cloud_cover_surface |
| ECMWF ENS ENSFilter | Surface | Mean_sea_level_pressure_surface |
| ECMWF ENS ENSFilter | Surface | Medium_cloud_cover_surface |
| ECMWF ENS ENSFilter | Surface | Sea-ice_cover_surface |
| ECMWF ENS ENSFilter | Surface | Sea_surface_temperature_surface |
| ECMWF ENS ENSFilter | Surface | Skin_temperature_surface |
| ECMWF ENS ENSFilter | Surface | Snow_albedo_surface |
| ECMWF ENS ENSFilter | Surface | Snow_depth_surface |

Please select a variable and confirm with "OK":

| Dataset | Vertical Dimension | Variable Name |
|---------------------|------------------------------------|--|
| ECMWF ENS ENSFilter | Surface | Surface_pressure_surface |
| ECMWF ENS ENSFilter | Surface | Total_cloud_cover_surface |
| ECMWF ENS ENSFilter | Surface | Total_column_water_surface |
| ECMWF ENS ENSFilter | Surface | Total_column_water_vapour_surface |
| ECMWF ENS ENSFilter | Surface | Total_precipitation_surface |
| ECMWF ENS ENSFilter | Surface | Ice_thickness_of_ |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Equivalent_potential_temperature_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Fraction_of_cloud_cover_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Geopotential_height_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Potential_temperature_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Potential_vorticity_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Pressure |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Relative_humidity_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Specific_cloud_ice_water_content_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Specific_cloud_liquid_water_content_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Specific_humidity_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Temperature_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Vertical_velocity_pressure_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | Windspeed_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | u-component_of_wind_hybrid |
| ECMWF ENS ENSFilter | Hybrid Sigma Pressure Model Levels | v-component_of_wind_hybrid |

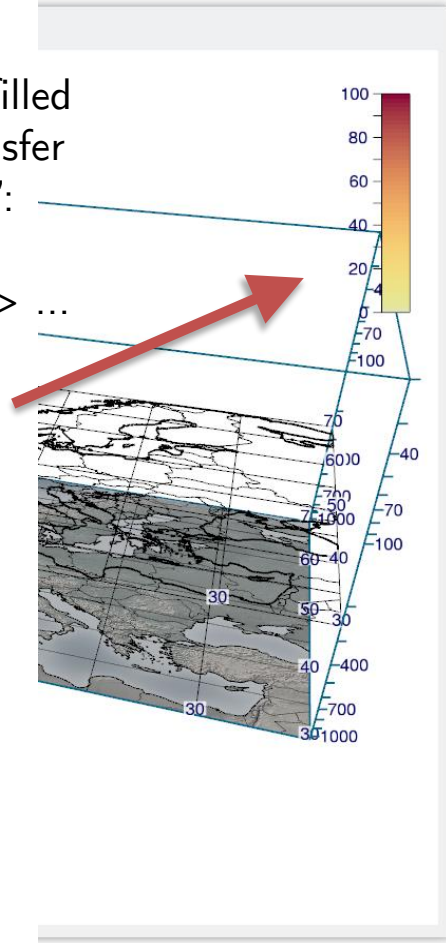
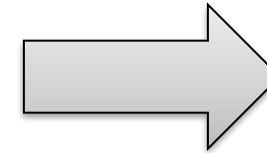
Create a horizontal section (map) with wind speed data



5) To show data as filled contours, add a “transfer function/colour map”:

F4 -> create actor -> ...

This is also an actor.



Create a horizontal section (map) with wind speed data

File View Help

Synchronization

Valid: Sat 2012-10-20 00:00 UTC

120 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 0 show mean cfg

Scene 1

| Property | Value |
|---|-----------------------------|
| > section graticule | |
| variables | |
| add new variable | (click to execute) |
| Windspeed_hybrid (Hybrid Sigma Pressure Model Levels) | |
| data source | ECMWF ENS ENSFilter |
| long name | Horizontal wind speed ... |
| > change/remove | |
| > data statistics (entire grid) | |
| > synchronization | |
| initialisation | 2012-10-15T00:00:00Z |
| valid | 2012-10-20T00:00:00Z |
| select members | (click to execute) |
| utilized members | 0/1/2/3/4/5/6/7/8/9/10/1... |
| ensemble mode | member |
| ensemble member | 0 |
| ensemble threshold | 0.000000 |
| rendering | |
| render mode | filled contours |
| transfer function | Transfer function scalar |
| textured transfer function | None |
| > contour sets | Transfer function scalar |
| contour label suffix | |
| > debug | |
| > Transfer function scalar to colour (colour map) | |

view 1 (Scene 1)

Elevation: 250 hPa

100 80 60 40 20 0 -20 -40 -60 -80 -100

40 70 100

400 300 200 100 0 100 200 300 400

1000 500 300 100 50 30 10 0 10 30 50 100

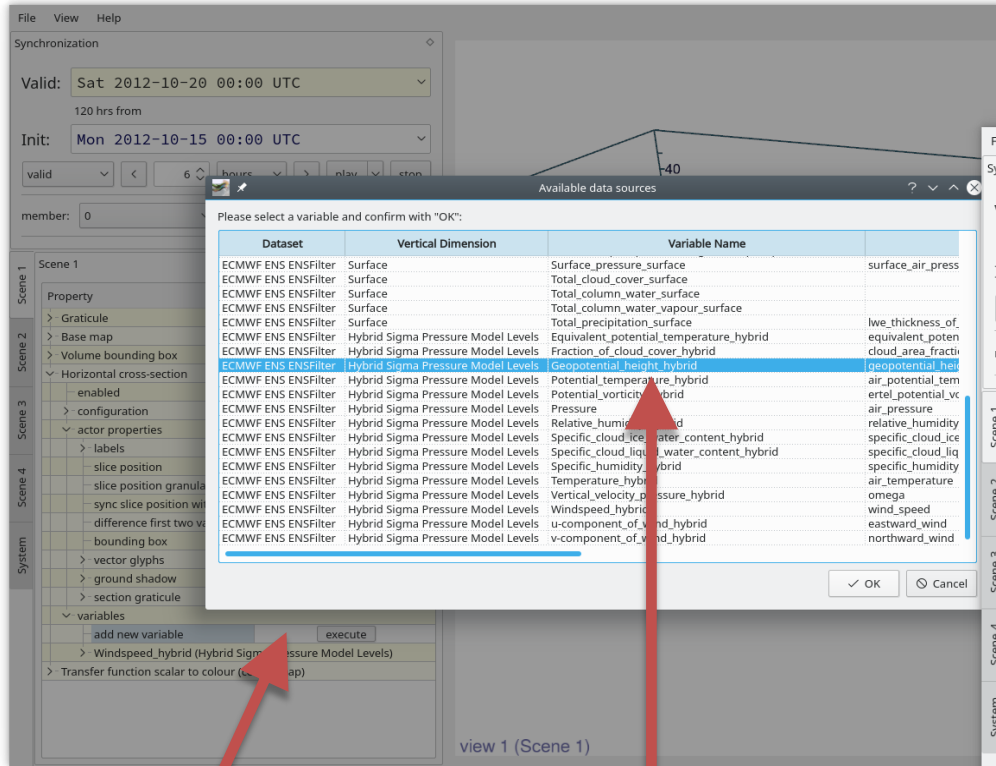
6000 5000 4000 3000 2000 1000 0 1000 2000 3000 4000 5000 6000

Settings to display (render) a variable are located in the “variables/rendering” section

6) Set “render mode” to “filled contours”

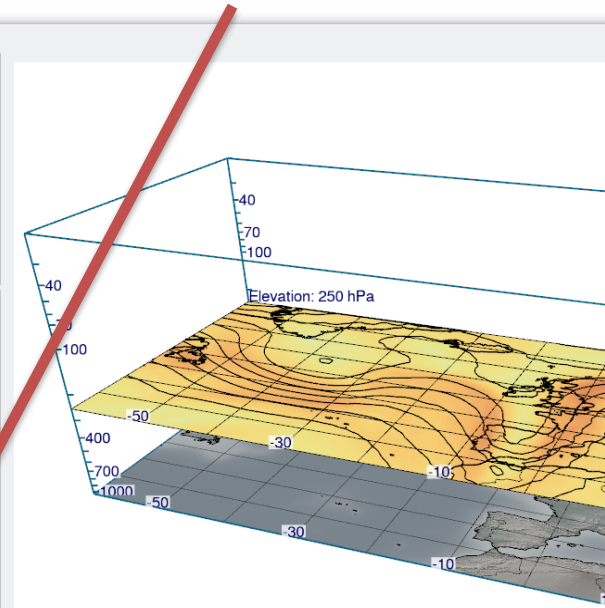
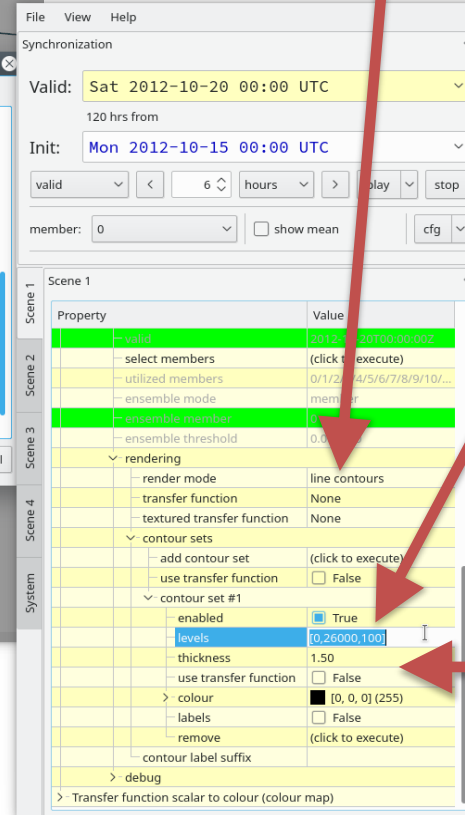
7) Select transfer function that has been added

Add a second variable: Geopotential height



1) Add new variable -> select "Geopotential height" on model levels

2) Now choose "render mode" = "line contours", then specify contour levels as "[from, to, step]"



3) Contour colour, thickness etc. can be specified here. Multiple "contour sets" are possible.

view 1 (Scene 1)

“Actor interaction mode”: move horizontal section

File View Help

Synchronization

Valid: Sat 2012-10-20 00:00 UTC

120 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 0 show mean cfg

Scene 1

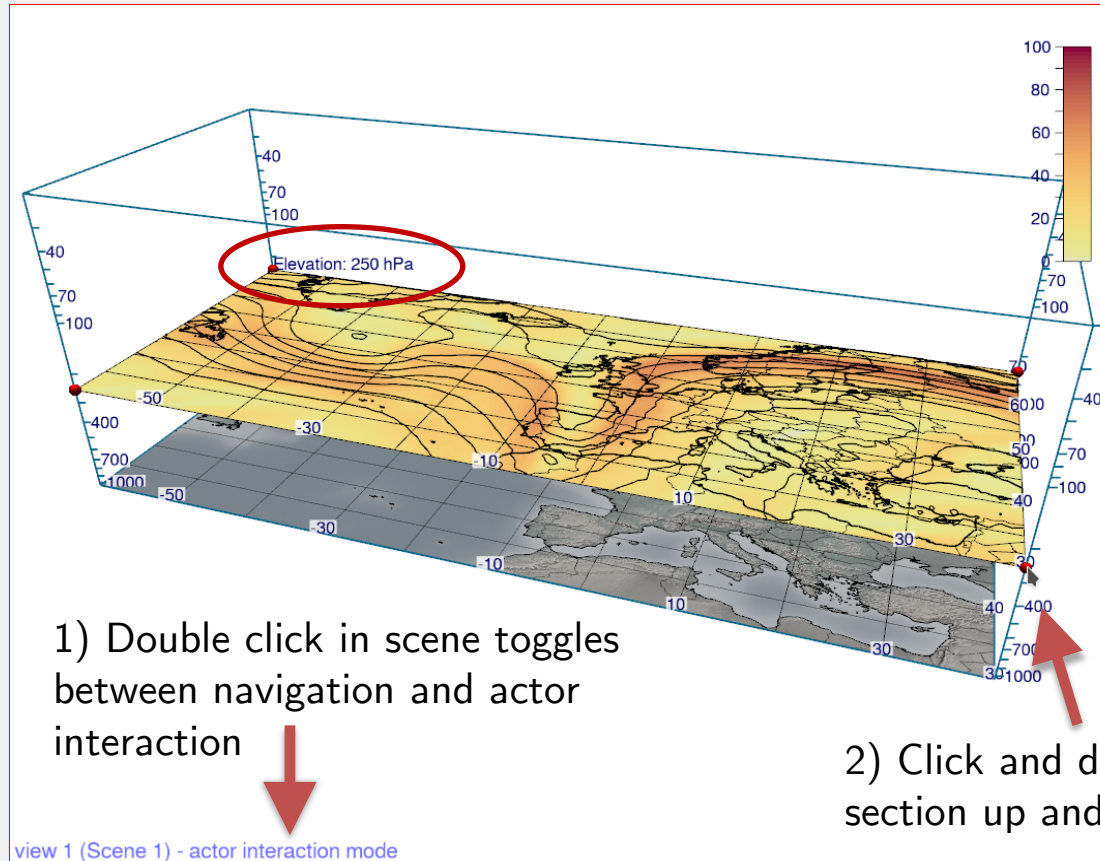
| Property | Value |
|---|-------|
| > Graticule | |
| > Base map | |
| > Volume bounding box | |
| > Horizontal cross-section | |
| > Transfer function scalar to colour (colour map) | |

Scene 2

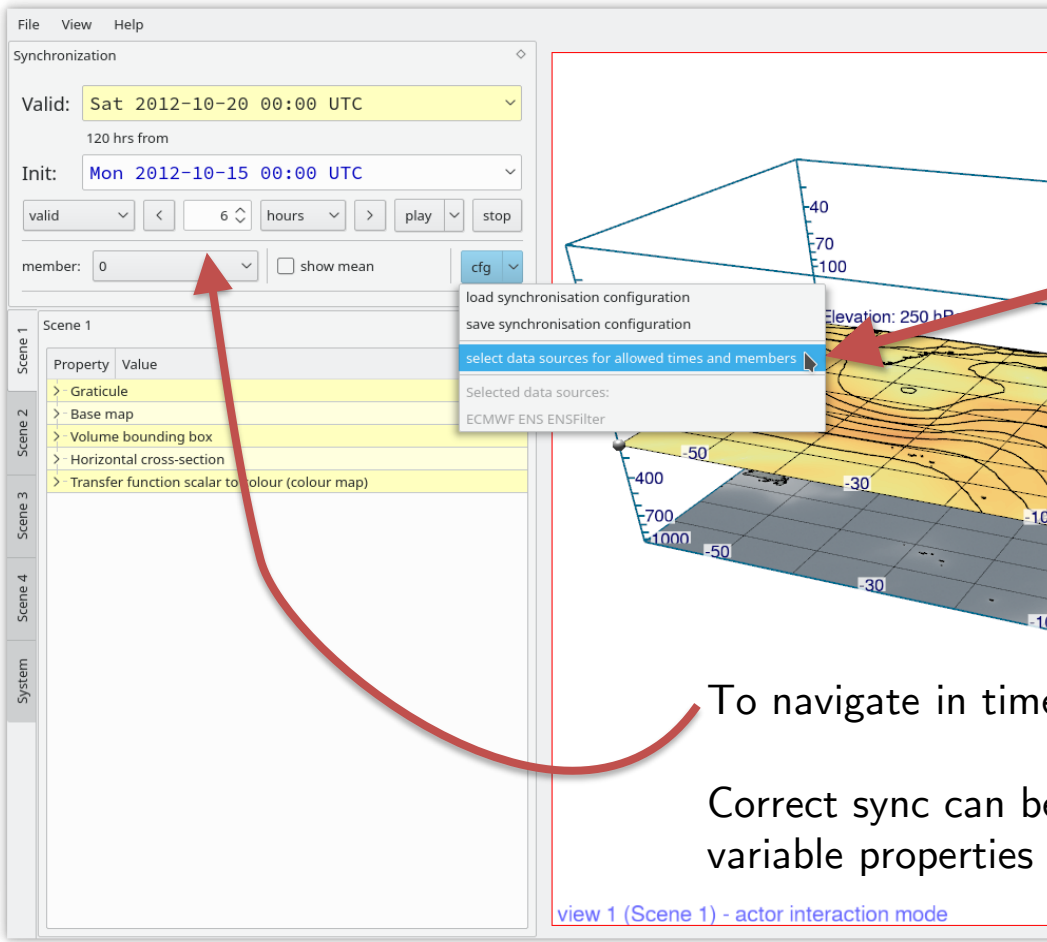
Scene 3

Scene 4

System



Time navigation



File View Help

Synchronization

Valid: Sat 2012-10-20 00:00 UTC

120 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 0 show mean

cfg

- load synchronisation configuration
- save synchronisation configuration
- select data sources for allowed times and members

Selected data sources:
ECMWF ENS ENSFilter

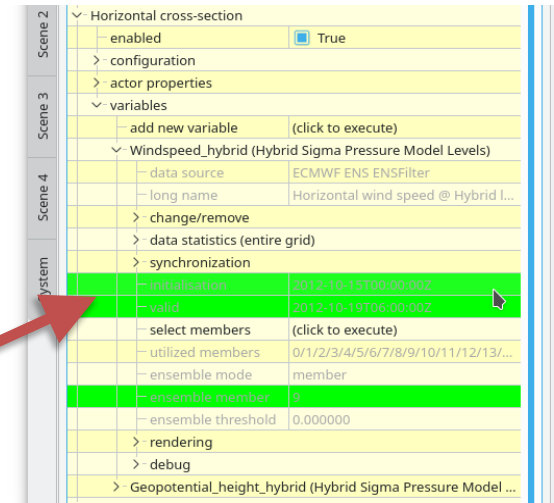
view 1 (Scene 1) - actor interaction mode

By default all variables are synchronized (can be disabled in actor properties).

To restrict possible dates and times to values in dataset, “connect” dataset with sync control.

To navigate in time, use GUI elements.

Correct sync can be checked in actor variable properties (green = ok):



Horizontal cross-section

- enabled True
- configuration
- actor properties
- variables
 - add new variable (click to execute)
 - Windspeed_hybrid (Hybrid Sigma Pressure Model Levels)
 - data source ECMWF ENS ENSFilter
 - long name Horizontal wind speed @ Hybrid L...
 - change/remove
 - data statistics (entire grid)
 - synchronization
 - initialisation 2012-10-15T00:00:00Z
 - valid 2012-10-19T06:00:00Z
 - select members (click to execute)
 - utilized members 0/1/2/3/4/5/6/7/8/9/10/11/12/13/...
 - ensemble mode member
 - ensemble member 9
 - ensemble threshold 0.000000
 - rendering
 - debug
 - Geopotential_height_hybrid (Hybrid Sigma Pressure Model ...

Ensemble navigation

The screenshot displays a 3D visualization of a meteorological ensemble forecast. The main view shows a horizontal cross-section of a Hybrid Sigma Pressure Model at 250 hPa elevation, with a color scale ranging from -100 to 100. The interface includes a left sidebar with a 'Synchronization' panel and a 'Scene' list. The 'Synchronization' panel shows 'Valid: Fri 2012-10-19 06:00 UTC' and 'Init: Mon 2012-10-15 00:00 UTC'. The 'Scene' list includes 'Scene 1' through 'Scene 4' and 'System'. A red arrow points from the 'Scene 1' dropdown menu to the 'Synchronization' panel. Another red arrow points from the 'Synchronization' panel to the 'Scene 1' dropdown menu. A third red arrow points from the 'Scene 1' dropdown menu to the 'Scene 1' dropdown menu. A fourth red arrow points from the 'Scene 1' dropdown menu to the 'Scene 1' dropdown menu. A fifth red arrow points from the 'Scene 1' dropdown menu to the 'Scene 1' dropdown menu. A sixth red arrow points from the 'Scene 1' dropdown menu to the 'Scene 1' dropdown menu. A seventh red arrow points from the 'Scene 1' dropdown menu to the 'Scene 1' dropdown menu. An eighth red arrow points from the 'Scene 1' dropdown menu to the 'Scene 1' dropdown menu. A ninth red arrow points from the 'Scene 1' dropdown menu to the 'Scene 1' dropdown menu. A tenth red arrow points from the 'Scene 1' dropdown menu to the 'Scene 1' dropdown menu.

Similar to time, navigate between ensemble members or toggle ensemble mean.
Check console output!

view 1 (Scene 1)

Horizontal cross-section

- enabled True
- > configuration
- > actor properties
- > variables
 - add new variable (click to execute)
 - > Windspeed_hybrid (Hybrid Sigma Pressure Model Levels)
 - data source ECMWF ENS ENSFilter
 - long name Horizontal wind speed @ Hybrid ...
 - > change/remove
 - > data statistics (entire grid)
 - > synchronization
 - initialisation 2012-10-15T00:00:00Z
 - valid 2012-10-19T06:00:00Z
 - select members (click to execute)
 - utilized members 0/1/2/3/4/5/6/7/8/9/10/11/12/13/...
 - ensemble mode member
 - ensemble member 9
 - ensemble threshold 0.000000
 - > rendering
 - > debug
 - > Geopotential_height_hybrid (Hybrid Sigma Pressure Model ...

Adjusting colour bar range

File View Help

Synchronization

Valid: Fri 2012-10-19 06:00 UTC

102 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 9 show mean cfg

Scene 1

| Property | Value |
|---|--|
| > Graticule | |
| > Base map | |
| > Volume bounding box | |
| > Horizontal cross-section | |
| > Transfer function scalar to colour (colour map) | |
| - enabled | <input checked="" type="checkbox"/> True |
| > configuration | |
| > actor properties | |
| > labels | |
| > range | |
| - minimum value | 15 |
| - maximum value | 65 |
| - steps | 50 |
| > min/max options | |
| > position | [[0.90, 0.90], 0.05 x 0.50] |
| - display opacity | <input checked="" type="checkbox"/> True |
| - reverse range | <input type="checkbox"/> False |
| - colourmap type | HCL |
| > HCL | |
| > Editor | |
| > predefined | |
| > HSV | |

view 1 (Scene 1)

The range of the colour bar can be adjusted in the colour bar properties.

Similar: vertical sections

File View Help

Synchronization

Valid: Fri 2012-10-19 06:00 UTC
102 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 9 show mean cfg

Scene 1

| Property | Value |
|---|--|
| Vertical cross-section | |
| enabled | <input checked="" type="checkbox"/> True |
| configuration | |
| actor properties | |
| variables | |
| add new variable | (click to execute) |
| Windspeed_hybrid (Hybrid Sigma Pressure Model Levels) | |
| data source | ECMWF ENS ENSE |
| long name | Horizontal wind speed (Hybrid L... |
| change/remove | |
| data statistics (entire grid) | |
| synchronization | |
| initialisation | 2012-10-15T00:00:00Z |
| valid | 2012-10-19T06:00:00Z |
| select members | (click to execute) |
| utilized members | 0/1/2/3/4/5/6/7/8/9/10/11/12/13 |
| ensemble mode | member |
| ensemble member | 9 |
| ensemble threshold | 0.000000 |
| rendering | |
| render mode | filled contours |
| transfer function | Transfer function scalar to colour |
| contour sets | |
| debug | |

View 1 (Scene 1)

1) F4 -> create actor -> vertical section -> assign to scene

2) Add variable (here: wind speed) -> render mode = "filled contours" -> select transfer function

3) Toggle actor interaction with double click -> click and drag handles

stop cfg

view 1 (Scene 1) - actor interaction mode

System settings: multiple views, vertical scaling etc.

Multiple view layouts can be selected from the “View” menu.

Scene Management (F4) menu options:

- 1 Single View (Alt+1)
- 2 Dual View (Alt+2)
- 3 Dual View, Vertical (Alt+3)
- 4 One Large, Two Small Views (Alt+4)
- 5 One Large, Three Small Views (Alt+5)
- 6 Quad View (Alt+6)

Scene Management Dialog (Scene 1):

| Property | Value |
|-----------|-------|
| Graticule | |

Actor settings Dialog (Actors):

Actors:

- Base map
- Volume bounding box
- Transfer function scalar to colour (colour m)
- Horizontal cross-section

Selected actor appears in these scenes:

- Scene 1
- Scene 2
- Scene 3
- Scene 4

Scene Management Dialog (Assignment of scenes to scene controls):

| Scene view | Scene |
|---------------|---------|
| Scene view 1: | Scene 1 |
| Scene view 2: | Scene 2 |
| Scene view 3: | Scene 3 |
| Scene view 4: | Scene 4 |

Main View Labels:

- view 1 (Scene 1)
- view 2 (Scene 2)
- view 3 (Scene 3)

In the scene management dialog (F4), select which actor appears in which scene and which scene appears in which view.

System settings: multiple views, vertical scaling etc.

In the “System” tab, properties for each of the scene views can be set.

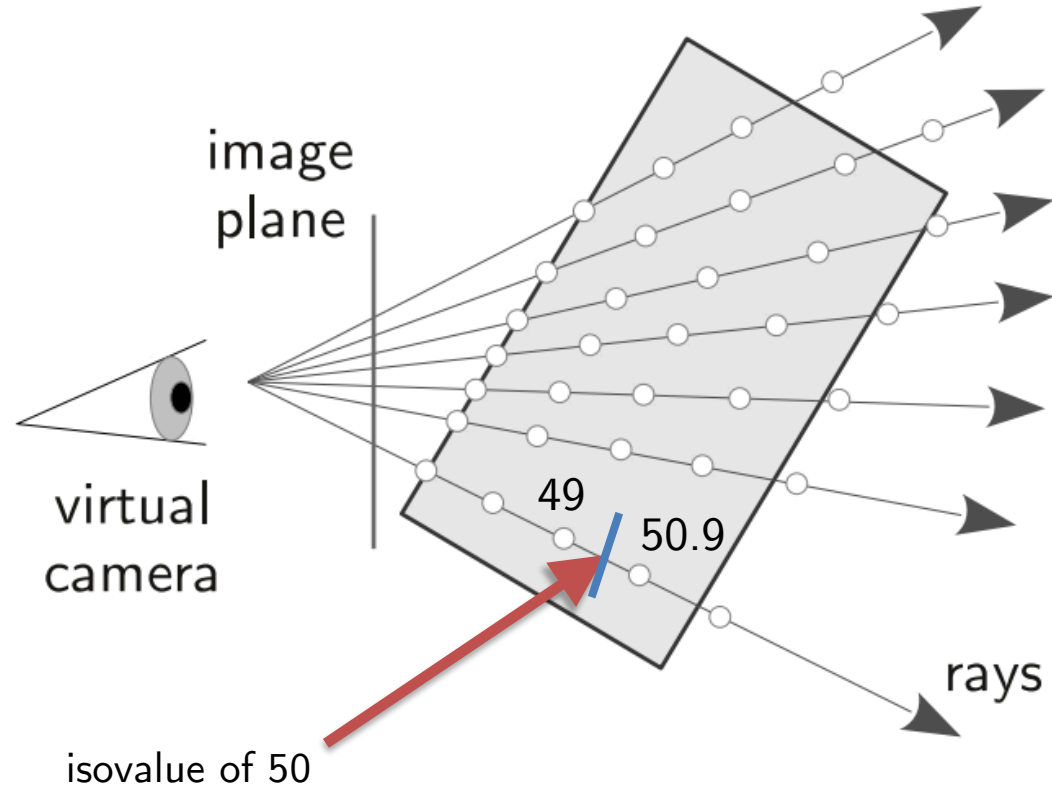
Examples: type of scene navigation, vertical scaling of the 3D view, some annotations, synchronizing the camera viewpoint between two views.

The screenshot displays a software interface with a 'System' tab on the left and three views on the right. The 'System' tab contains a 'Synchronization' section with 'Valid: Fri 2012-10-19 06:00 UTC' and 'Init: Mon 2012-10-15 00:00 UTC'. Below this is a 'Property' table for 'Scene view #2' with various settings like 'scene navigation' set to '2D top view' and 'vertical scaling' set to '36.00'. The three views on the right are: 'view 1 (Scene 1)' showing a 3D perspective of a 250 hPa elevation map; 'view 2 (Scene 2)' showing a 2D top-down map of the same data; and 'view 3 (Scene 3)' showing a 3D perspective of a 250 hPa pressure map. Red arrows point from the 'System' tab settings to the corresponding views.

| Property | Value |
|------------------------|--|
| configuration | |
| camera position | -9.7/49.0/86.0 |
| modify camera | |
| interaction | |
| resize | (click to execute) |
| save to image file | (click to execute) |
| scene navigation | 2D top view |
| scene rotation centre | |
| full-screen actor | None |
| navigation sensitivity | 1.00 |
| auto-rotate camera | <input type="checkbox"/> False |
| sync camera with view | None |
| actor interaction mode | <input type="checkbox"/> False |
| analysis mode | <input type="checkbox"/> False |
| draw position labels | <input checked="" type="checkbox"/> True |
| rendering | |
| background colour | [255, 255, 255] (255) |
| far plane | 500.00 |
| multisampling | <input checked="" type="checkbox"/> True |
| antialiasing | <input type="checkbox"/> False |
| depth test for labels | <input checked="" type="checkbox"/> True |
| lighting | Top |
| vertical scaling | 36.00 |
| 30s FPS measurement | (click to execute) |
| annotations | |
| time | |
| synchronise with | Synchronization |
| font size | 16.00 |
| font colour | [16, 0, 0] (255) |

Met.3D: Isosurfaces

3D isosurfaces and direct volume rendering (DVR) are implemented using “raycasting”, i.e. a ray is “shot” from the camera through each image pixel and through the data volume to obtain the required visualization information.



Met.3D: Isosurfaces

3D isosurfaces and direct volume rendering (DVR) are implemented using “raycasting”, i.e. a ray is “shot” from the camera through each image pixel and through the data volume to obtain the required visualization information.

The screenshot displays the Met.3D software interface. On the left, the 'Synchronization' panel shows a valid time of 'Fri 2012-10-19 06:00 UTC' and an initial time of 'Mon 2012-10-15 00:00 UTC'. Below this, the 'Scene 1' properties are listed, including 'Volume raycaster' (enabled), 'render mode' (isosurface), 'observed variable' (Windspeed_hybrid), and 'shading variable' (Windspeed_hybrid). The 'Volume raycaster' section is expanded, showing 'bounding box' (North Atlantic and Europe) and 'draw bounding box' (checked). The 'Variables' section is also expanded, showing 'Windspeed_hybrid (Hybrid Sigma Pressure Model Levels)'. On the right, the 'New actor' dialog box is open, showing a list of actor types with 'Volume raycaster' selected. The background shows a 3D visualization of a volume with a bounding box and a vertical scale from -40 to -1000.

- 1) Create a “Volume raycaster” actor
- 2) Select bounding box and add data variable (here: wind speed)

Met.3D: Isosurfaces

File View Help

Synchronization

Valid: Fri 2012-10-19 06:00 UTC

102 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 0 show mean cfg

Scene 1

| Property | Value |
|-----------------------------|--|
| Volume raycaster | |
| enabled | <input checked="" type="checkbox"/> True |
| configuration | |
| actor properties | |
| labels | |
| render mode | isosurface |
| observed variable | Windspeed_hybrid |
| shading variable | Windspeed_hybrid |
| isosurface raycaster | |
| isovalues | |
| add isovalue | (click to execute) |
| isovalue #1 | |
| enabled | <input checked="" type="checkbox"/> True |
| isovalue | 50 |
| isovalue significant digits | 1 |
| isovalue step | 0.1 |
| colour mode | constant colour |
| constant colour | [255, 255, 255] (255) |
| remove | (click to execute) |
| sampling step size | |
| shadow | |
| bounding box | North Atlantic and Eur... |
| draw bounding box | <input checked="" type="checkbox"/> True |
| lighting | |

view 1 (Scene 1)

Specify the isovalue to be displayed in "actor properties/isosurface raycaster" (set "significant digits" if you need floats).

Multiple isovalues can be specified and displayed, e.g., using transparent colours.

Improve spatial perception: add poles

The screenshot displays a software interface with several panels. On the left, a 'Synchronization' panel shows date and time settings. Below it, a 'Scene 1' panel contains a table of properties for a 'Movable poles' actor. A 'New actor' dialog box is centered, showing a list of actor types with 'Movable poles' highlighted. A red arrow points from the 'add pole' button in the actor properties panel to the 'Movable poles' option in the dialog box.

| Property | Value |
|-------------------------|--|
| > Graticule | |
| > Base map | |
| > Volume bounding box | |
| > Volume raycaster | |
| > Movable poles | |
| enabled | <input checked="" type="checkbox"/> True |
| > configuration | |
| actor properties | |
| > labels | |
| > colour | <input type="checkbox"/> [0, 104, 139] (255) |
| render mode | Tubes |
| tube radius | 0.06 |
| specify height per pole | <input type="checkbox"/> False |
| bottom pressure | 1,050.00 hPa |
| top pressure | 100.00 hPa |
| tick marks | |
| add pole | <input type="button" value="execute"/> |

view 1 (Scene 1)

- 1) Add a “Movable poles” actor to the scene.
- 2) Each “poles” actor can display multiple poles. Add poles via actor properties.

Improve spatial perception: add poles

File View Help

Synchronization

Valid: **Fri 2012-10-19 06:00 UTC**

102 hrs from

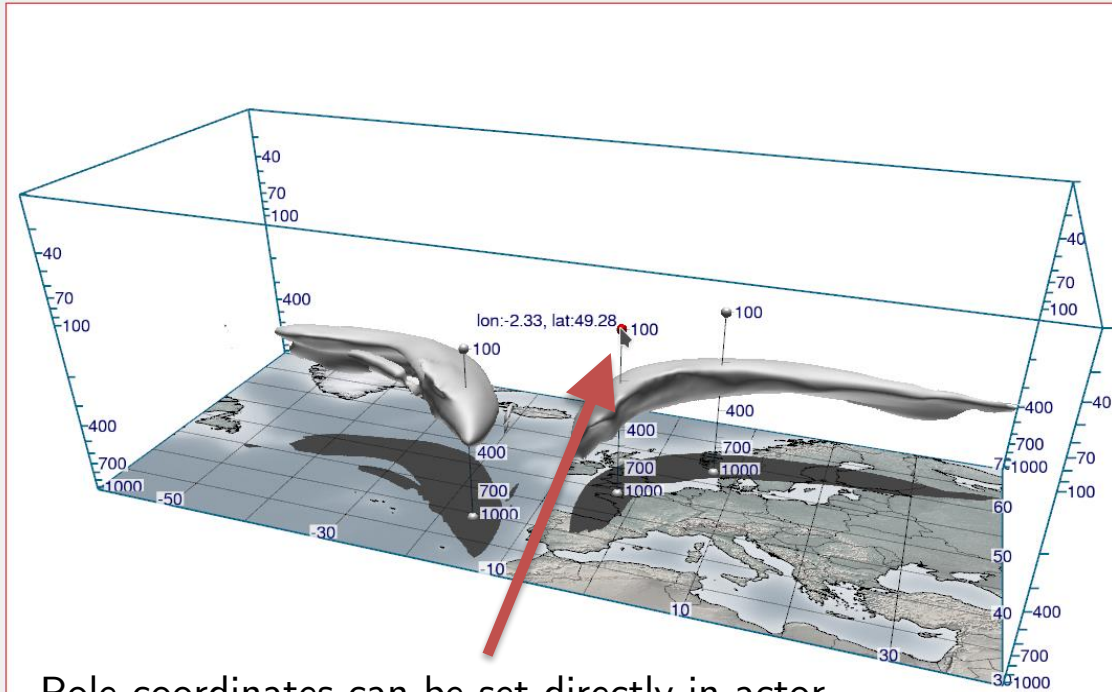
Init: **Mon 2012-10-15 00:00 UTC**

valid < 6 hours > play stop

member: 0 show mean cfg

Scene 1

| Property | Value |
|-------------------------|--|
| > Graticule | |
| > Base map | |
| > Volume bounding box | |
| > Volume raycaster | |
| > Movable poles | |
| enabled | <input checked="" type="checkbox"/> True |
| > configuration | |
| > actor properties | |
| > labels | |
| > colour | [0, 104, 139] (255) |
| render mode | Tubes |
| tube radius | 0.06 |
| specify height per pole | <input type="checkbox"/> False |
| bottom pressure | 1,050.00 hPa |
| top pressure | 100.00 hPa |
| > tick marks | |
| add pole | <input type="button" value="execute"/> |
| > pole | |
| > pole | |
| > pole | |
| position | (-2.33, 49.28) |
| lon | -2.33 |
| lat | 49.28 |
| bottom pressure | 1,050.00 hPa |



Pole coordinates can be set directly in actor properties. Poles can also be moved interactively in actor interaction mode (double click on view).

view 1 (Scene 1) - actor interaction mode

Transfer functions (colour bars): HCL

Hue-Chroma-Luminance (HCL) is a perceptually linear colour space → no misleading colour gradients

1) Choose/create HCL colour scale with “HCL Wizard” online

2) Copy parameters to Met.3D transfer function actor

The screenshot shows the Met.3D software interface. On the left, the 'Scene 1' property panel is visible, with the 'HCL' section expanded. The 'type' is set to 'diverging'. The 'hue 1' is 340.0, 'hue 2' is 128.0, 'chroma 1' is 45.0, 'chroma 2' is 30.0, 'luminance 1' is 35.0, 'luminance 2' is 95.0, 'power 1/C' is 0.70, 'power 2/L' is 2.00, 'alpha 1' is 1.000, 'alpha 2' is 1.000, and 'power alpha' is 1.000. A red arrow points from these settings to the 'HCL Wizard' website. The website interface shows 'Base Options' (Nature of your data: Diverging, Base color scheme: PiYg, Example: Map), 'Color Settings' (HUE 1: 340, HUE 2: 128, CHROM: 45, LUMIN: 35, LUMIN: 95, POWER: 0.7, NUM: 2), and 'Control Options' (Reverse: unchecked, Correct colors: checked, Desaturated: unchecked, Vision: Normal selected). A red arrow points from the website to a 3D visualization of a map of the United States, which is colored according to the HCL transfer function. The map shows a color gradient from green to purple, with a vertical color bar on the right side of the 3D view. The 3D view is labeled 'view 1 (Scene 1) - actor interaction mode'.

Colour an isosurface using a second variable

2) To colour (“shade”) the isosurface, select the new variable as “shading variable”.

3) For the isovalue of interest, set “colour mode” to “transfer function”.

1) Add a new data variable (here: vertical velocity). In the variable’s properties, in the “render mode” group, select a transfer function.

The screenshot displays a software interface with two main panels. The top panel, titled 'Synchronization', contains the following settings: 'Valid: Fri 2012-10-19 06:00 UTC', '102 hrs from', 'Init: Mon 2012-10-15 00:00 UTC', and a 'valid' range of 6 hours. The bottom panel, titled 'Scene 1', shows a tree view of properties for 'Volume raycaster' and 'isosurface raycaster'. The 'Volume raycaster' properties include 'enabled' (True), 'render mode' (isosurface), 'observed variable' (Windspeed_hybrid), and 'shading variable' (Vertical_velocity_pressure_hybrid). The 'isosurface raycaster' properties include 'isovalues' (50), 'isovalue significant digits' (1), 'isovalue step' (0.1), 'colour mode' (transfer function (shading variable)), and 'constant colour' ([255, 255, 255]).

The 3D visualization on the right shows a map of the North Atlantic and Europe with a 3D isosurface. The isosurface is colored according to a vertical velocity scale, ranging from -0.5 (green) to 0.5 (red). The isosurface is labeled with values 100, 400, 700, and 1000. A color bar on the right indicates the scale from -0.5 to 0.5.

Ensemble statistics: Wind speed mean+std.dev

File View Help

Synchronization

Valid: **Fr i 2012-10-19 06:00 UTC**
102 hrs from

Init: **Mon 2012-10-15 00:00 UTC**

valid < 6 hours > play stop

member: 0 show mean cfg

Scene 1

| Property | Value |
|------------------------------|--|
| - valid | 2012-10-19 06:00 UTC |
| - valid | 2012-10-19 06:00 UTC |
| - select members | (click to execute) |
| - utilized members | 0/1/2/3/4/5/6/7/8/9/10/... |
| - ensemble mode | member |
| - ensemble member | 0 |
| - ensemble threshold | 0.000000 |
| rendering | |
| - render mode | line contours |
| - transfer function | None |
| - textured transfer function | None |
| contour sets | |
| - add contour set | (click to execute) |
| - use transfer function | <input type="checkbox"/> False |
| contour set #1 | |
| - enabled | <input checked="" type="checkbox"/> True |
| - levels | [40, 80, 5] |
| - thickness | 2.00 |
| - use transfer function | <input type="checkbox"/> False |
| - colour | <input type="checkbox"/> [0, 0, 0] (255) |
| - labels | <input type="checkbox"/> False |
| - remove | (click to execute) |
| - contour label suffix | |
| - debug | |

view 1 (Scene 1)

1) Create a horizontal section, add wind speed, display as line contours in the range 40m/s .. 80 ms/s. These contours will later show the ensemble mean wind speed.

Ensemble statistics: Wind speed mean+std.dev

File View Help

Synchronization

Valid: Fri 2012-10-19 06:00 UTC
102 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 0 show mean cfg

Scene 1

| Property | Value |
|---|--|
| > Graticule | |
| > Base map | |
| > Volume bounding box | |
| > Horizontal cross-section | |
| enabled | <input checked="" type="checkbox"/> True |
| > configuration | |
| > actor properties | |
| > variables | |
| add new variable | (click to execute) |
| > Windspeed_hybrid (Hybrid Sigma Pressure Model Levels) | |
| > Windspeed_hybrid (Hybrid Sigma Pressure Model Levels) | |
| > Colour map STD wind | |
| enabled | <input checked="" type="checkbox"/> True |
| > configuration | |
| > actor properties | |

view 1 (Scene 1)

3) Add a colour bar to colour code the standard deviation, set the range to 10..20.

2) Add a second variable, also containing wind speed. This will be used to display the wind speed standard deviation.

Ensemble statistics: Wind speed mean+std.dev

The screenshot displays a software interface with a synchronization panel on the left and a 3D map of Europe on the right. The synchronization panel includes fields for 'Valid' (Fri 2012-10-19 06:00 UTC) and 'Init' (Mon 2012-10-15 00:00 UTC), along with buttons for 'play' and 'stop'. Below these are controls for 'member' (0) and 'show mean' (checkbox). The 'Scene 1' settings table is shown below:

| Property | Value |
|---|--|
| Windspeed_hybrid (Hybrid Sigma Pressure Model Levels) | |
| data source | ECMWF ENS ENSFilter |
| long name | Horizontal wind speed ... |
| change/remove | |
| data statistics (entire grid) | |
| synchronization | |
| synchronize with | Synchronization |
| sync init time | <input checked="" type="checkbox"/> True |
| sync valid time | <input checked="" type="checkbox"/> True |
| sync ensemble | <input type="checkbox"/> False |
| initialisation | 2012-10-15T00:00:00Z |
| valid | 2012-10-19T06:00:00Z |
| select members | (click to execute) |
| utilized members | 0/1/2/3/4/5/6/7/8/9/10 |
| ensemble mode | mean |
| ensemble member | 0 |
| ensemble threshold | 0.000000 |
| rendering | |
| render mode | line contours |
| transfer function | None |
| textured transfer function | None |
| contour sets | |
| add contour set | (click to execute) |
| use transfer function | <input type="checkbox"/> False |

The 3D map shows wind speed contours over Europe, with a vertical axis labeled 'Elevation: 250 hPa'. Contour values range from -70 to 100. Two red arrows point from the text on the right to the 'sync ensemble' checkbox and the 'ensemble mode' dropdown in the settings panel.

view 1 (Scene 1)

4) For the first wind speed variable (contours), disable ensemble synchronization to allow local setting of ensemble mode, then set its ensemble mode to "mean".

Ensemble statistics: Wind speed mean+std.dev

The screenshot shows a software interface with the following components:

- Synchronization Panel:** Valid: Fri 2012-10-19 06:00 UTC, 102 hrs from, Init: Mon 2012-10-15 00:00 UTC. Includes buttons for valid, play, stop, and a member count of 0.
- Scene 1 Configuration Table:**

| Property | Value |
|---|--|
| Windspeed_hybrid (Hybrid Sigma Pressure Model Levels) | |
| Windspeed_hybrid (Hybrid Sigma Pressure Model Levels) | |
| data source | ECMWF ENS ENSFilter |
| long name | Horizontal wind speed ... |
| change/remove | |
| data statistics (entire grid) | |
| synchronization | |
| initialisation | 2012-10-15T00:00:00Z |
| valid | 2012-10-19T06:00:00Z |
| select members | (click to execute) |
| utilized members | 0/1/2/3/4/5/6/7/8/9/10/11 |
| ensemble mode | standard deviation |
| ensemble member | 0 |
| ensemble threshold | 0.000000 |
| rendering | |
| render mode | filled contours |
| transfer function | Colour map STD wind |
| textured transfer function | None |
| contour sets | |
| contour label suffix | |
| debug | |
| Colour map STD wind | |
| enabled | <input checked="" type="checkbox"/> True |
| configuration | |
- 3D Map:** A 3D map of Europe showing wind speed contours and a color map. The map is labeled "Elevation: 250 hPa".

Red arrows point from the text on the right to the following settings in the scene configuration table:

- From "5) For the second wind speed variable (std.dev.), also disable ensemble synchronization." to the "synchronization" property.
- From "Then set its ensemble mode to 'standard deviation'"; for rendering select 'filled contours'" to the "ensemble mode" property.
- From "and connect to the colour map." to the "render mode" property.

view 1 (Scene 1)

5) For the second wind speed variable (std.dev.), also disable ensemble synchronization. Then set its ensemble mode to “standard deviation”; for rendering select “filled contours” and connect to the colour map.

Investigate vertical structure and temporal development of std.dev.

Ensemble statistics: probabilities

All actors that display simulation data can also display these basic ensemble statistics.

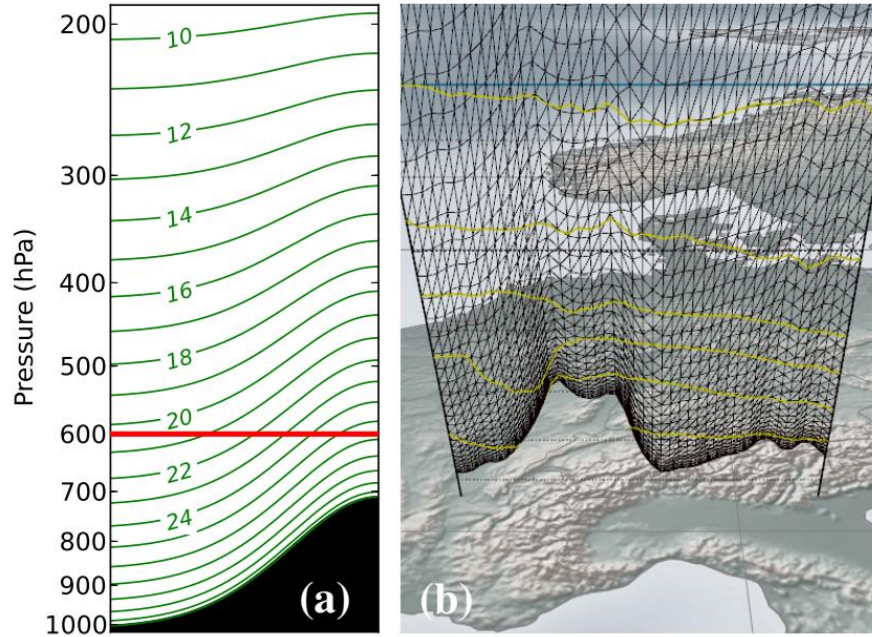
Another example: Create a volume raycaster, add wind speed, disconnect ensemble synchronization, set the ensemble mode to “p > threshold” (= probability that threshold is exceeded), set the threshold to 50m/s, set the isovalue to 0.5.

3D regions are shown in which the probability that the wind speed exceeds 50m/s is larger than 50%.

The screenshot shows a software interface with a left-hand menu and a main 3D visualization area. The left-hand menu is organized into sections: Synchronization, Scene 1, Scene 2, Scene 3, Scene 4, and System. The Synchronization section includes fields for 'Valid' (Fri 2012-10-19 06:00 UTC) and 'Init' (Mon 2012-10-15 00:00 UTC), along with buttons for 'valid', '6', 'hours', 'play', and 'stop'. The Scene 1 section contains a table of properties and values, with the 'ensemble threshold' property highlighted in blue and set to 50.000000. The 3D visualization area shows a map of the North Atlantic region with a grid overlay. A volume raycaster is visible, showing a white, semi-transparent volume that represents the probability of wind speed exceeding 50m/s. The volume is shaped like a large, irregular cloud over the ocean. The map shows the outlines of North America, South America, and Europe. The 3D visualization is labeled 'view 1 (Scene 1)' at the bottom.

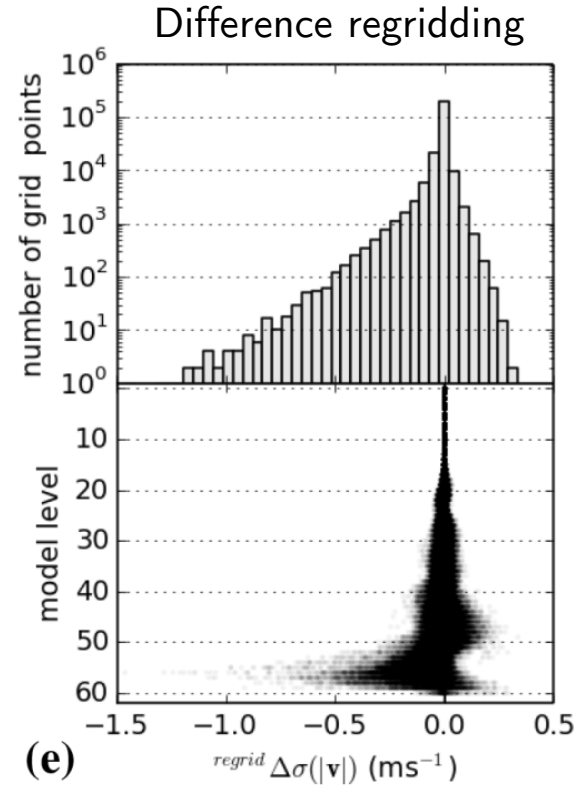
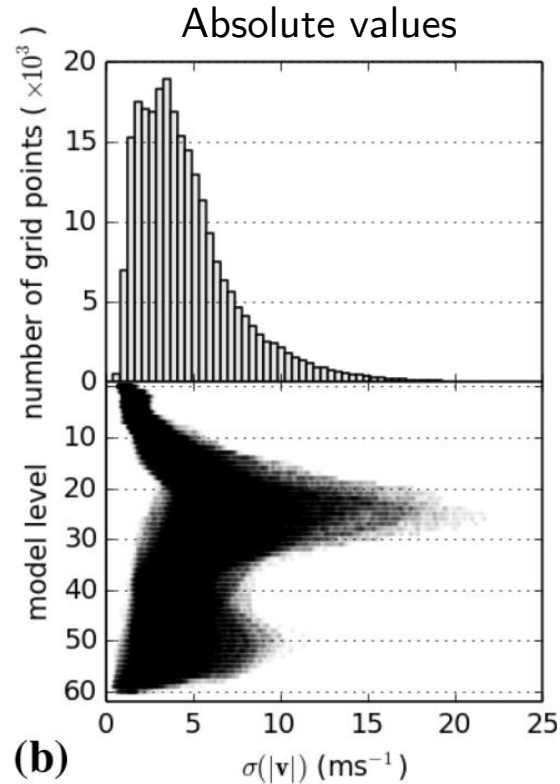
| Property | Value |
|---|--|
| draw bounding box | <input checked="" type="checkbox"/> True |
| lighting | |
| normal curves | |
| variables | |
| add new variable | (click to execute) |
| Windspeed_hybrid (Hybrid Sigma Pressure Model Levels) | |
| data source | ECMWF ENS ENSFilter |
| long name | Horizontal wind speed... |
| change/remove | |
| data statistics (entire grid) | |
| synchronization | |
| synchronize with | Synchronization |
| sync init time | <input checked="" type="checkbox"/> True |
| sync valid time | <input checked="" type="checkbox"/> True |
| sync ensemble | <input type="checkbox"/> False |
| initialization | 2012-10-15T00:00:00Z |
| valid | 2012-10-19T06:00:00Z |
| select members | (click to execute) |
| utilized members | 0/1/2/3/4/5/6/7/8/9/1 |
| ensemble mode | p(> threshold) |
| ensemble member | 0 |
| ensemble threshold | 50.000000 |
| rendering | |
| debug | |

Ensemble statistics: Caution with hybrid grids



Vertical position of grid points is slightly offset in each member.

Standard deviation of wind speed:



Saving images

File View Help

Synchronization

Valid: Fri 2012-10-19 06:00 UTC

102 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 0 show mean

animation time step: 1000 ms

from: Thu 2012-10-18 00:00 UTC IT VT

to: Fri 2012-10-19 06:00 UTC IT VT

Single pass

Loop

Back and forth

Reverse time direction

Automatically save screenshots

directory: /home/rautenhaus/met3d/...

file name: met3d-image.%it.%vt.%m

[%vt:valid time, %it:init time, %m: member]

Save image series of scene view: view #1

view 1 (Scene 1)

To save individual images: Click on the scene view and press “s”. A “save-file-dialog” will appear.

Entire time series can be saved from the animation control. Set animation parameters (from which time to which time) and enable “automatically save screenshots”.

Select a directory for the images and a file name template (init and valid time and ensemble member can be automatically replaced).

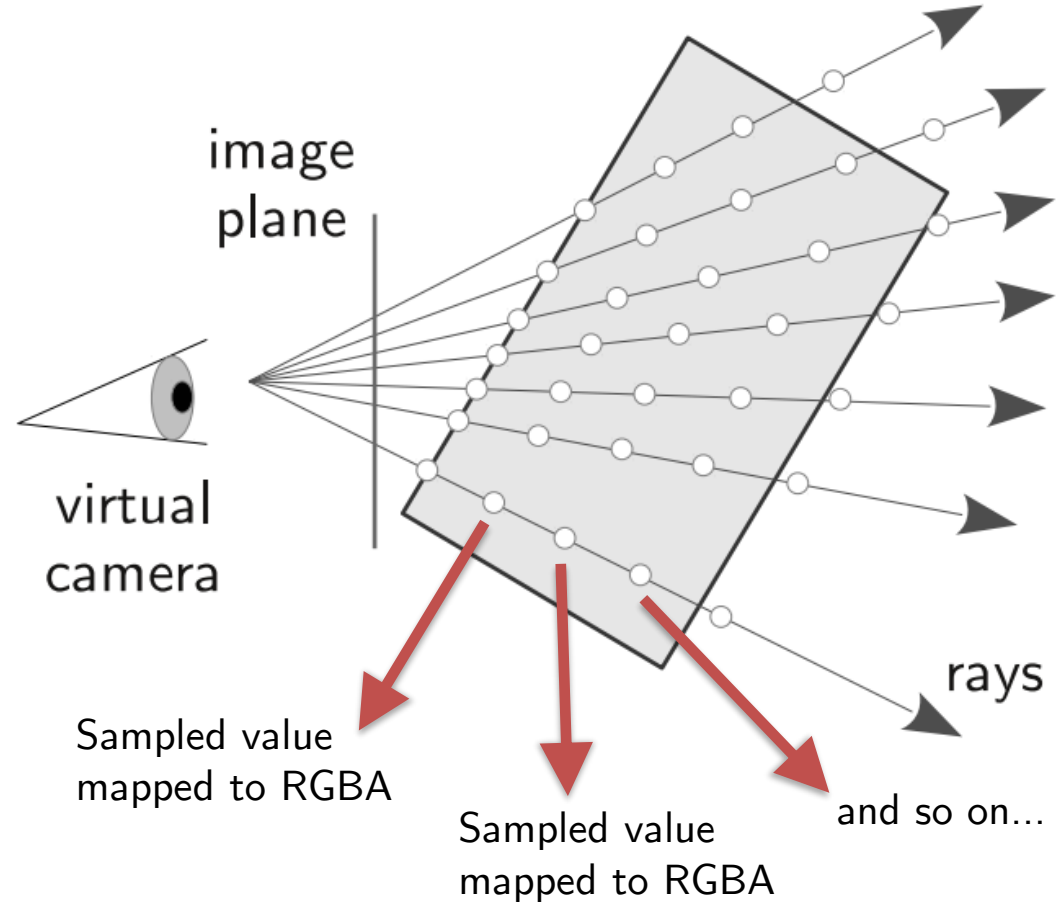
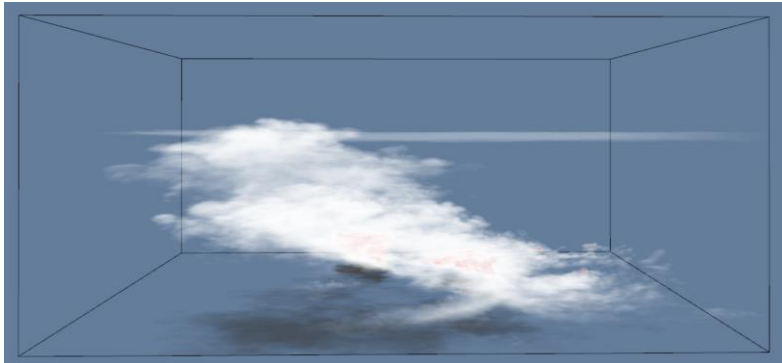
When running the animation, all images will be saved.

Direct volume rendering

Direct volume rendering implements a simple “emission-absorption model”:

Rays are casted through the data volume; at each sample location the encountered scalar value is mapped to colour (emission) and opacity (absorption).

The sample values are “merged” (“alpha blending”) to obtain the pixel colour.



Direct volume rendering

The screenshot shows a software interface for direct volume rendering. The interface is divided into several panels:

- Synchronization Panel:** Contains fields for 'Valid' (Fri 2012-10-19 06:00 UTC), 'Init' (Mon 2012-10-15 00:00 UTC), and 'member' (0). It also has buttons for 'play' and 'stop'.
- Scene 1 Panel:** A table with columns 'Property' and 'Value'. It lists various properties for a volume raycaster, including 'enabled' (True), 'render mode' (isosurface), 'observed variable' (Fraction of cloud cover hybrid), 'shading variable' (Fraction of cloud cover hybrid), 'bounding box' (North Atlantic and Europe), and 'Transfer function scalar to colour (colour map)'. A red arrow points from this property to the color scale in the 3D view.
- 3D View:** A 3D visualization of a city with a volume bounding box. A color scale on the right indicates the 'fraction of cloud cover' from 0 to 100. A red arrow points from the 'fraction of cloud cover' text in the first step to this scale.

1) Create a new “volume raycaster” actor, select a bounding box and add a variable. Here, we use “fraction of cloud cover”.

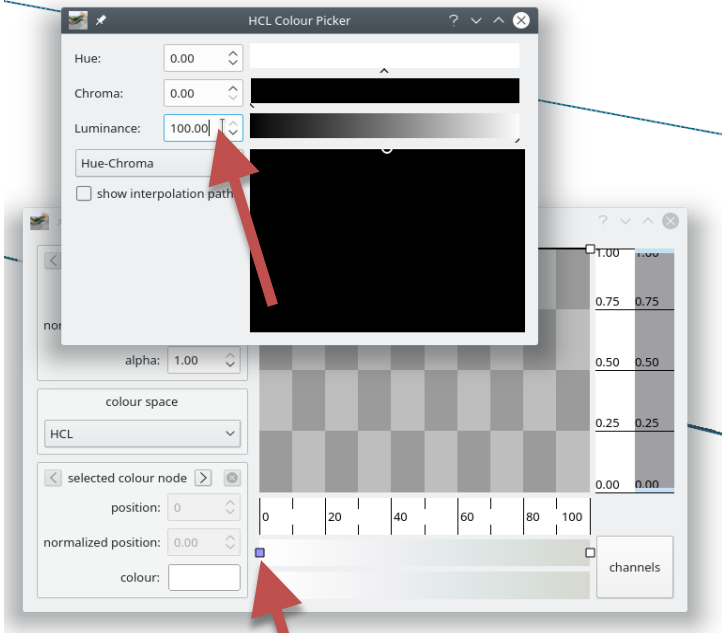
2) Add a new transfer function, connect it to the cloud cover variable (in the variables properties in “rendering”).

Direct volume rendering

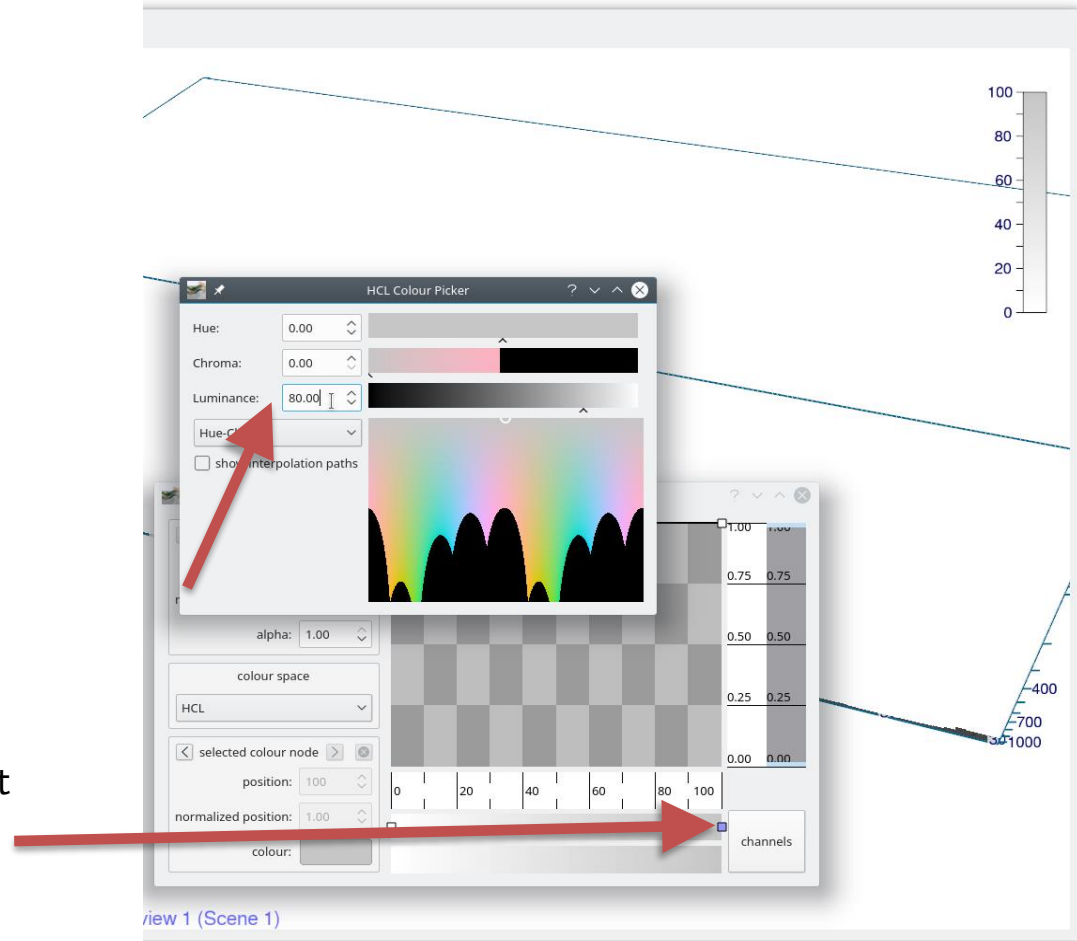
3) Set the raycaster's render mode to "DVR".

4) For the transfer function, change its type to "Editor" and open the editor.

Direct volume rendering



5) Change the default colour map to a “white-to-grey” scale: Double click on the left colour node, set HCL values for “white” (0-0-100). Repeat for the right colour node, set a grey value (0-0-80).



Direct volume rendering

The screenshot displays a software interface for direct volume rendering. On the left, a scene tree shows the hierarchy of objects, with the 'range' property of the 'Transfer function scalar to colour (colour map)' node highlighted. A red arrow points from this property to the 'Transferfunction Editor' window. The 'Transferfunction Editor' window shows a 2D color map with a red arrow pointing to the left opacity node, which is set to 0. The 3D view shows a volume rendering of a scene with a color map and a vertical axis labeled with values -40, -70, and -100. A red arrow also points from the 3D view to the 'Transferfunction Editor' window.

view 1 (Scene 1)

6) Change the colour map's range to 0..1 (this is the range of cloud cover values).

7) Drag the left opacity node to 0.

Direct volume rendering

File View Help

Synchronization

Valid: Fri 2012-10-19 06:00 UTC

102 hrs from

Init: Mon 2012-10-15 00:00 UTC

valid < 6 hours > play stop

member: 0 show mean cfg

Scene 1

Property Value

- > Graticule
- > Base map
- > Volume bounding box
- > Volume raycaster
- > Transfer function scalar to colour (colour map)
 - enabled True
 - > configuration
 - > actor properties

Transferfunction Editor

selected alpha node

position: 0.585

normalized position: 0.59

alpha: 0.15

colour space: HCL

selected colour node

position: 1

normalized position: 1.00

colour: [grey]

channels

view 1 (Scene 1)

8) Adjust the opacity scale to adjust the “absorption model” and to change the display.

How to get data into Met.3D

Met.3D can read data in NetCDF that comply with the CF-conventions and that

- are defined on a regular or rotated lon-lat grid, or a regular projected grid in the horizontal
- are defined on levels of constant pressure or hybrid sigma-pressure model levels, or that provide 3D pressure fields

GRIB files from ECMWF can be read.

Trajectory data needs to be in NetCDF.

More information:

<https://collaboration.cen.uni-hamburg.de/display/Met3D/Data+Handling>

```
1 netcdf somegriddedata.pl {
2   dimensions:
3     lon = 101 ;
4     lat = 41 ;
5     isobaric = 12 ;
6     time = 1 ;
7     ens0 = 51 ;
8   variables:
9     float lat(lat) ;
10      lat:units = "degrees_north" ;
11     float lon(lon) ;
12      lon:units = "degrees_east" ;
13     float isobaric(isobaric) ;
14      isobaric:units = "hPa" ;
15      isobaric:long_name = "Isobaric surface" ;
16      isobaric:positive = "down" ;
17     int time(time) ;
18      time:units = "Hour since 2012-10-15T00:00:00.000Z" ;
19      time:standard_name = "time" ;
20     int ens0(ens0) ;
21      ens0:standard_name = "ensemble_member_id" ;
22
23     float Geopotential_isobaric(time, ens0, isobaric, lat, lon) ;
24      Geopotential_isobaric:long_name = "Geopotential @ Isobaric surface" ;
25      Geopotential_isobaric:units = "m2.s-2" ;
26     float Temperature_isobaric(time, ens0, isobaric, lat, lon) ;
27      Temperature_isobaric:long_name = "Temperature @ Isobaric surface" ;
28      Temperature_isobaric:units = "K" ;
29
30     ...
31 }
```

Thanks for your interest in using Met.3D!

Met.3D is a project with limited resources, hence bugs and issues become known but often cannot be fixed immediately. Look at the online issue tracker: <https://gitlab.com/wxmetvis/met.3d/issues>

We are working on improving the software! Please help us do so:

- Talk to us when you use Met.3D.
- Talk to us when you run into any kind of problems with the software.
- Talk to us when you have any special ideas/requests/...
- Let us know when you would like to use a Met.3D image for any presentation or publication. In particular in the beginning we may be able to help improve it! Also, please acknowledge Met.3D as the image source – acknowledgements will help us acquire further funding.
- Report bugs that you discover.
- If you want to contribute, that would be great, too!

If you are interested in using some of the “prototype-level-code” (jets, fronts, clustering, ..) talk to us as well!