METEO-Visualization in VR: From a Lab into a Weather Room

BY: MICHAL KOUTEK, Frans Debie, Ian van der Neut
KNMI, The Royal Netherlands Meteorological Institute
The question is: How about getting beyond nice demos ... ?
How to get the forecasters to use it?
Roadmap for Meteo-(VR)-3D-Visualization

Technology domain:

1. Interactive 3D visualization
2. Virtual Reality; Immersive 3D displays + 3D interaction

Application domain:

- METEOROLOGICAL content

Technology PUSH
Brief project history

2009: Installation VR-VISUALIZATION LAB
  - First prototype interactive visualization: Hirlam 3d Explorer

2010 - 2012:
  - Software development of the W3DX framework (Weather 3D Explorer)
  - Support for the latest HARMONIE (numerical weather prediction) model.
  - Many studies into severe weather situations
  - Supporting meteo-education

2012-2013:
  - Installation of 3D-Weather Visualization systems in the Weather Room:
    - Weather-briefing room
    - Guidance / chief meteorologist
Multi-dimensional Weather Data

- Atmospheric (weather-related) processes are very complex.
- Often interactive 3D visualization can help in understanding.
- Weather data:
  - observations, (satellite, radar)
  - measurements (ground-based, radiosondes, air-born)
  - NWP models
- GEO-SPATIAL time-dependent: 0D, 1D, 2D, 3D (+ time)

Everything naturally GEO-referenced..
Bringing the data into one 3D SPACE

- NWP Model onto globe
- Vertical scaling applied
Bringing the data into one 3D SPACE

- **North-pole stereographic projection** preferred by our meteorologists;

  ![Example of geographic projection of NWP model coordinates (HARMONIE).](image)

- Example of geographic projection of NWP model coordinates (HARMONIE).
Bringing the data into one 3D SPACE

For geo-reference: model orgography textured with WMS images
Bringing the data into one 3D SPACE

3D overlay of satellite images (CLOUDS)
Bringing the data into one 3D SPACE

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Bringing the data into one 3D SPACE

- 3D overlay of satellite images (CLOUDS)
- 3D overlay of radar images (EU composite pseudo-CAPPI)
- 3D overlay of model clouds - 3D iso-contours (HARMONIE model)
- Satellite images semi-transparent
Bringing the data into one 3D SPACE

- Basically any 2D image/ GIS/ WMS layer can be placed as a layer geographically collocated into 3D space.
Bringing the data into one 3D SPACE

- **Weathermap** referencing NWP model data
Bringing the data into one 3D SPACE

- **Ground-based measurements** compared and referenced to NWP model data
Bringing the data into one 3D SPACE

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2D and 3D co-exist
Bringing the data into one 3D SPACE

- **3D Air-borne (aircraft) measurements** visualized together with the NWP model data;
- Example shows JET-STREAM (Hirlam model) and flight-paths (mode-s data) colored with measured windspeed.
Bringing the data into one 3D SPACE

- 3D atmospheric profiles from satellite infra-red sounders; proxy data for MTG-IRS; [Pilot projects in cooperation with EUMETSAT]
Weather 3D Explorer in action:

Time for a short MOVIE ..
Meteorological visualization in the weather room
Operational meteorologists

- work under tight time-schedules;
- require accurate, well-known and established products.
- Introduction of new methods and tools takes TIME.
Automated visualization systems provide (animated) static views/visualizations of data typically via web.

Interactive visualization systems provide user with visualization tools to interactively explore the data.

In the daily routine there is not much time to interactively explore the datasets.

If a tool / method needs more than 2 ~ 3 clicks it will not be used much.

Forecasters expect from the visualization systems EXTREMELY fast responsiveness.
Traditional visualization products

- Big diversity of WEB-portals in the weather room
Traditional visualization products

- Often specialized WEB-portals for different products with pre-generated images (for high responsiveness).
Traditional visualization products

- Even dedicated screens and displays for certain products
New generation of visualization products

- WEB-based visualization services
  ADAGUC WEB-portals
  - rendering on-demand
How to FIT
3D visualization into the weather room for operational use?
3D visualization for operational use

- Talk to the users over their needs; study the operational process and the daily routine.
- Gives extensive user trainings and support.
- Involve forecasters into (off-line) analysis of extreme weather event with the 3D tooling.
- Make the system robust and fast (3D data handling, visualization processing, rendering).

- Will this be enough?
  - MOST PROBABLY NOT.
3D visualization for operational use

- It requires a certain level of skills and familiarity with 3D visualization by users to understand the full potential of using it with meteo-data.
- Make it therefore **easily accessible** to the user.
- **REMOVE virtually all obstacles.** It turns out that **USER INTERFACE** needs a special care!
- Forecaster-friendly navigation in time (= instant random visualization image access).
- Forecaster-proof 3D camera navigation in the scene.
- Forecasters like the **interactive 3D cross-sections**; make sure direct-interaction works intuitively and **apply 3D manipulation constrains** (slice remains perpendicular or horizontal).
Source of our inspiration

- One of the frequently used WEB-portals during the briefings in our weather room

Developed by a forecaster for other forecasters.
W3DX WEB-portal
Proof-of-Concept Implementation

NOTE: This an experimental development version of the 3D WebPortal. It might happen that due to software-development parts of this web-portal will not work properly.
Visualization catalog in the WEB-portal
Visualization catalog in the WEB-portal

Zoom in/out

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Visualization catalog in the WEB-portal

Explore product in 3D
Data 3D post-processing
VR / 3D Experience over WEB?

- Watch animated 3D visualizations on 3D TV
- Client-side:
  - 2D monitor for WEB-portal
  - 3D HD TV or 3D HD projector
  - No advanced graphics (GPU) required
VR / 3D Experience over WEB?

- 3D HD stereographics format: TOP-BOTTOM
- Turn 3D TV (client-side) into 3D mode, put on 3D glasses .. ;-)
CONCLUSIONS

Without W3DX-WebPortal:

- Limited access: Interactive 3D exploration (W3DX) of the operational weather data only possible at “dedicated” graphics / visualization workstations.
- Sub-optimal user interface.
- Freedom to modify visualization settings.

With W3DX-WebPortal: < although still in development .. >

- Wide and significantly simplified access;
- Larger group of forecasters can playback the pre-rendered 3D previews in the browser.
- Guidance / chief forecaster is provided easy way to open interactive 3D sessions on the visualization server; he/she can also modify the visualization products and share with others.
Thank you for your attention!

Questions?

More information: http://projects.knmi.nl/W3DX

Contact: koutek@knmi.nl