3D Visualization of Hirlam data and use of Virtual Reality interfaces

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3D-VIS LAB

KNMI

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3DVIS-LE Project: Work in Progress

- **3DVIS – LE project:**
  3D Visualization
  of high resolution atmospheric data
  in a Learning Environment
- Starting with Hirlam ("low res")
- Preparing for HARMONIE ("high res")
- Invitation for Virtual Reality demonstration: Hirlam 3D Explorer

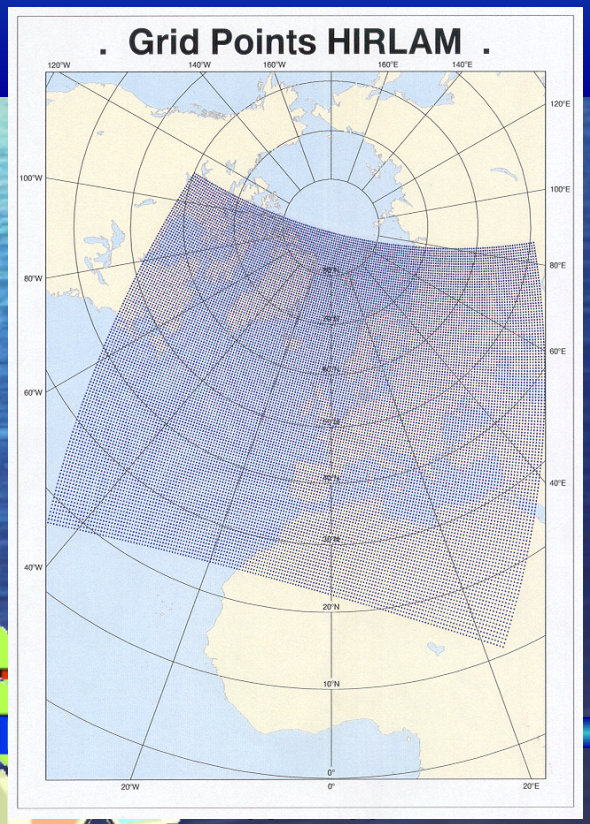
HIRLAM Data on the Input

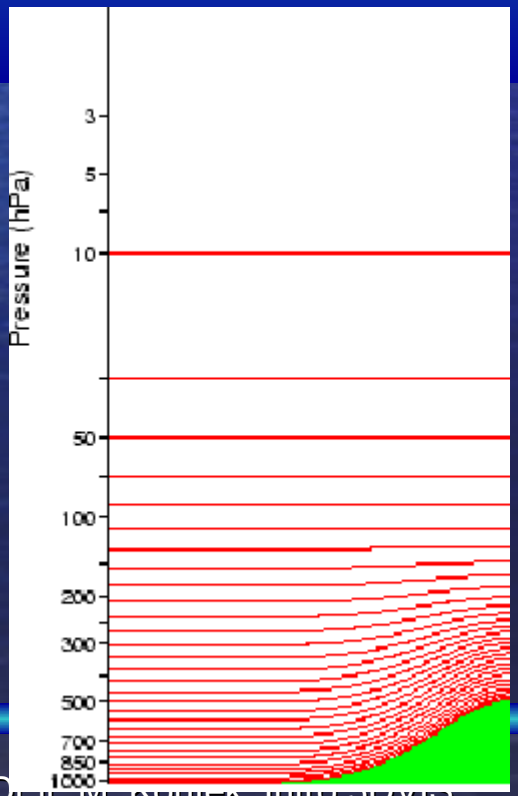
Resolution computation space

- Lat-lon grid: 0.1 x 0.1 Deg. over the domain, 40(/60 .. 80) isobaric levels

Resolution for visualization space

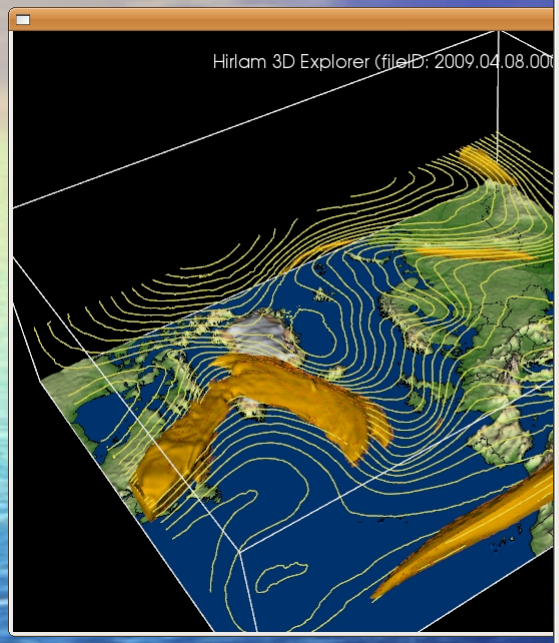
- Lat-lon grid: 0.2 x 0.2 Deg. over the domain, 40 isobaric levels,
- 406x324 GRID cells (… Data from Hirlam APL ..)

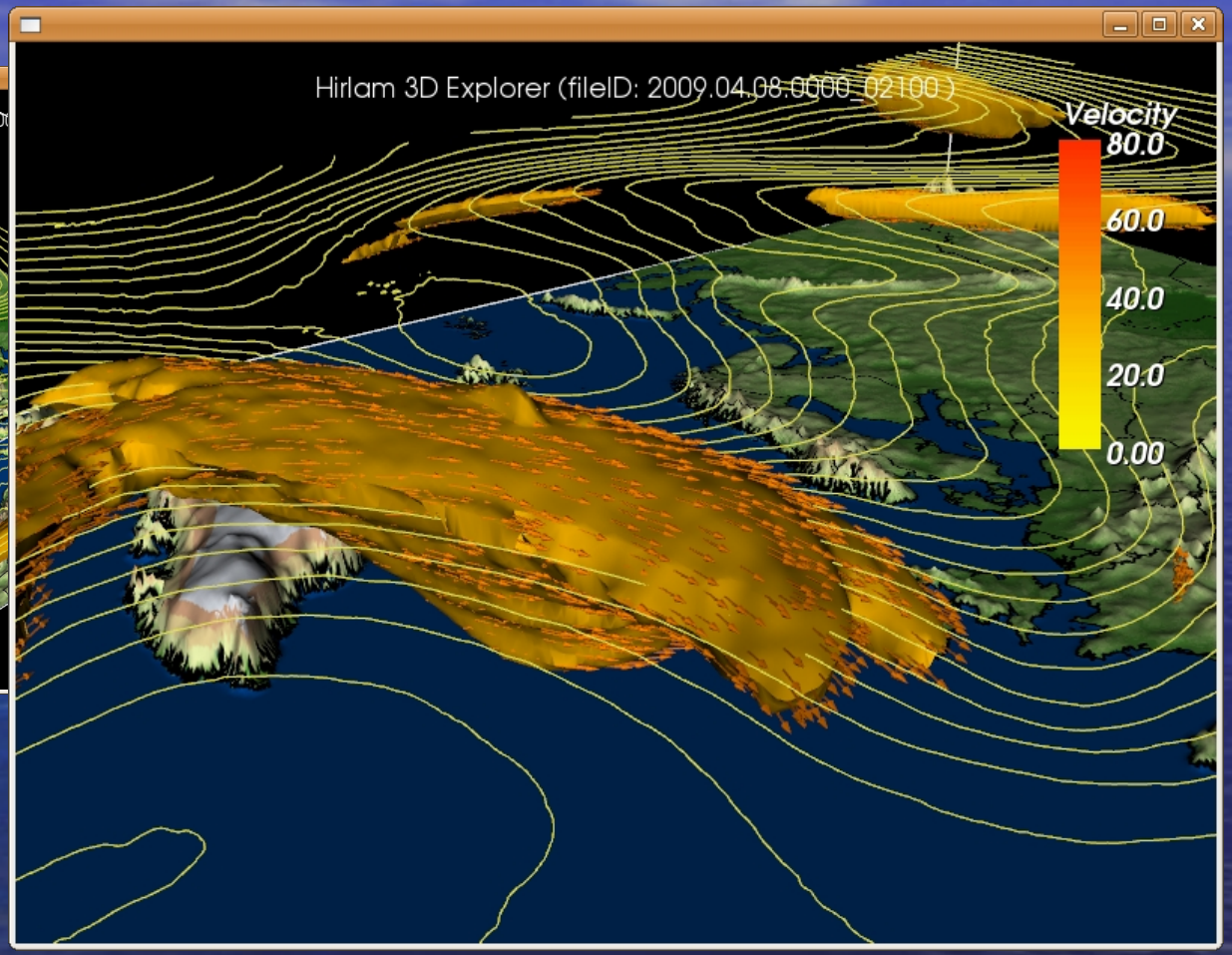




$$P(n) = A(n) + B(n)*Ps$$

Interactive 3D Visualization on the Output





3D Visualization in Atmospheric Sciences

- **Visualization** helps us to gain new insights into the phenomena inside our data and numerical models…
- It remains still to be a great challenge to use it in a daily practice…
- How can make 3D visualization a more succesful tool?
- => Provide a more effective and more intuitive working environment …
- Virtual Reality holds a great promise to be THE environment to do interactive exploration in a revolutionary way ..

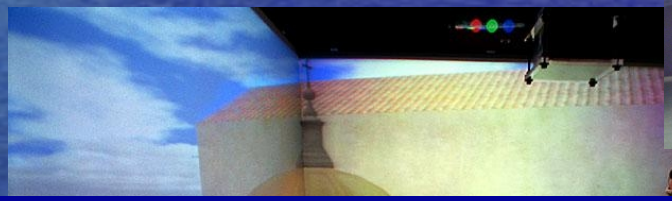
VR Applications …. Everywhere …




- **VR:**

  "Think of display as a window into a virtual world.."

  [Sutherland 1968]


- **Virtual Reality and Virtual Environments**
  - **Virtual Reality** (VR) is the use of computer technology to create an effect of **<u>interactive 3D world (virtual environment)</u>**, …..



Visualization of Atmospheric Data using Virtual Reality

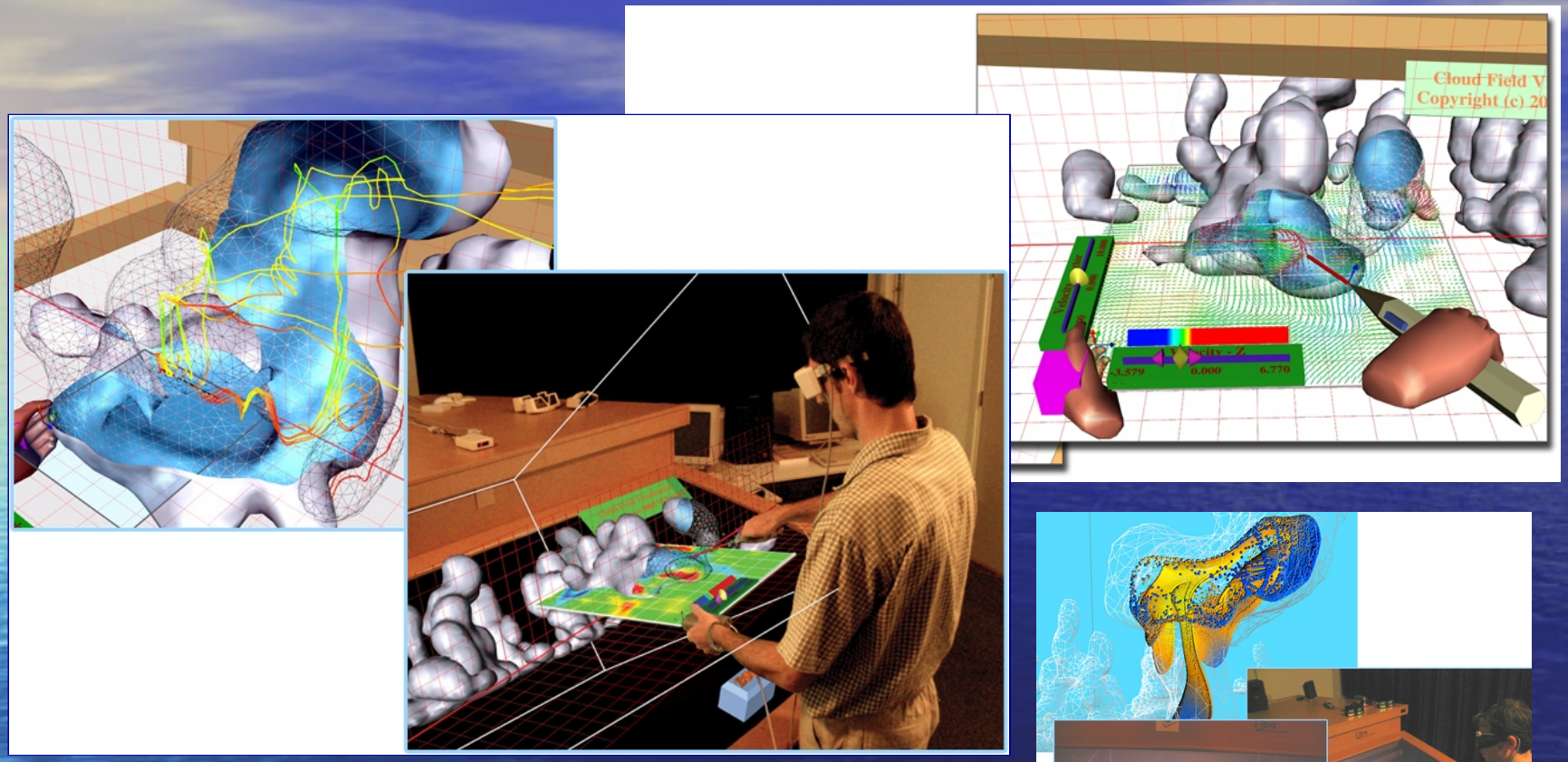
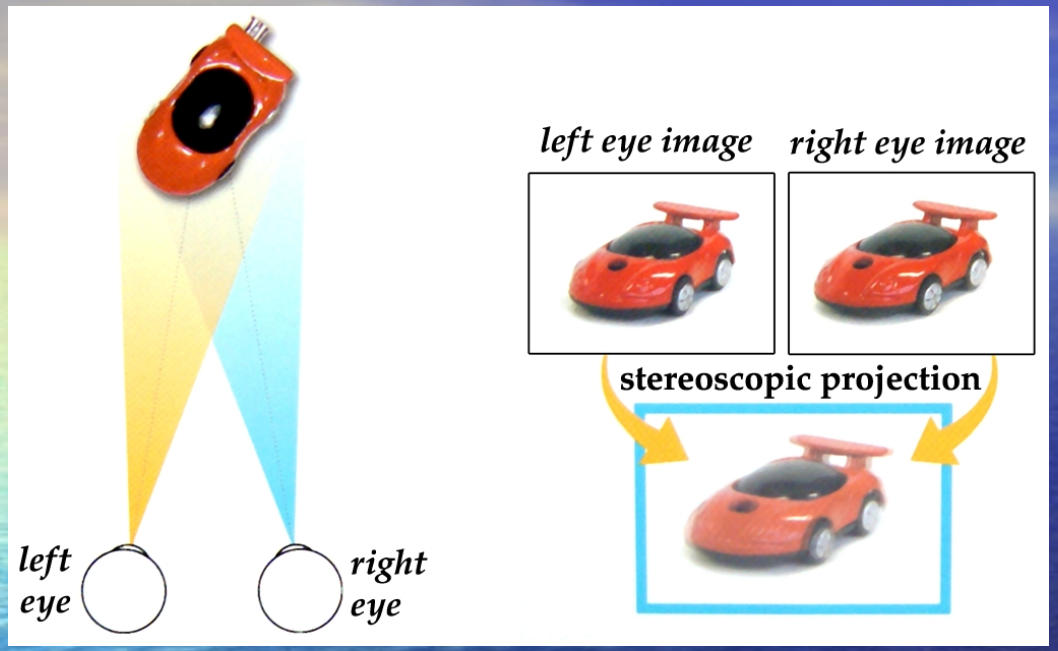


Figure: Atmospheric visualization of Cumulus clouds using Virtual Reality at the VR lab of the TU Delft; Virtual Reality Explorer (VRX) with LES data from in year 2002 (left), Cloud Explorer with feature tracking, particle advection, streamlines, pathlines in year 2007 (right).

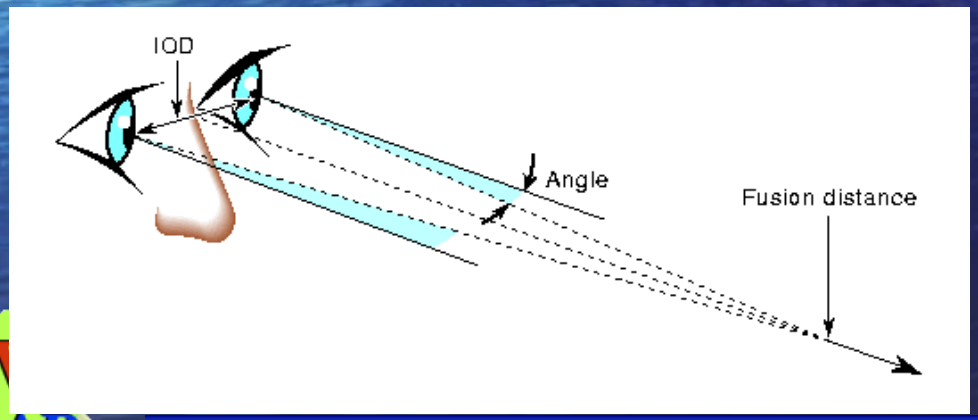
First Thing you needed for VR is … Stereo Vision



Stereoscopic vision & projection;

3D fusion of left & right images

Binocular parallax *(stereopsis, stereo vision) is achieved by displaying a separate image for each eye.*



Basic stereo parameters:

- inter-ocular-distance (IOD)
- fusion distance

KNMI: Setting up the 3D Lab

- Idea:
  - Largest screen possible
  - High resolution images
  - Support up to 3 interacting users (headtracking and 3D interaction devices)

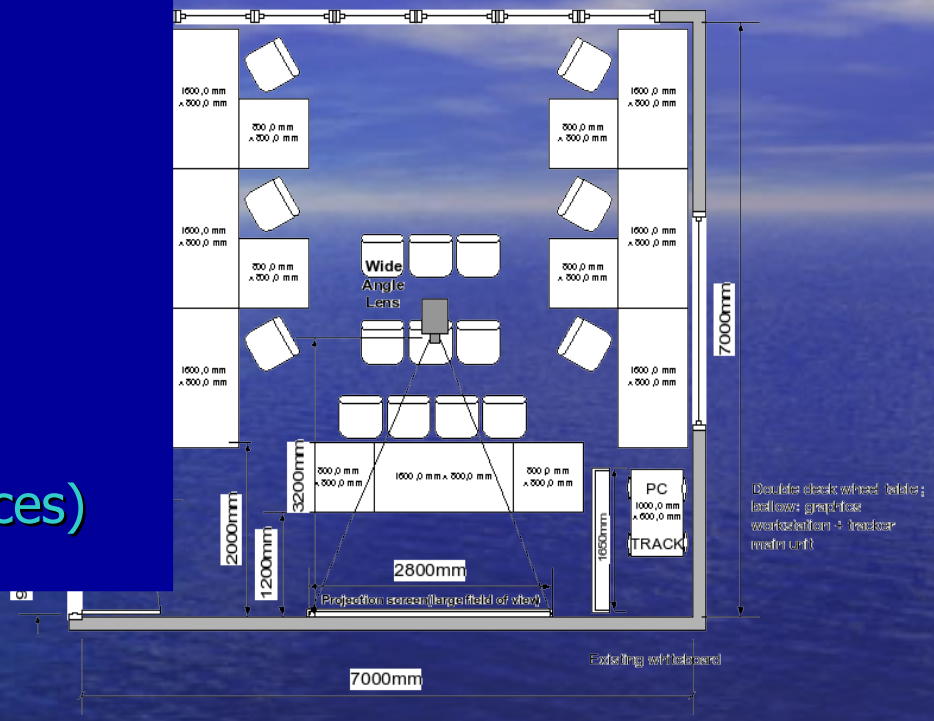


Figure 3: Top view A3.02: 3D-Visualization Lab for Mesoscale Meteorologic Experiments

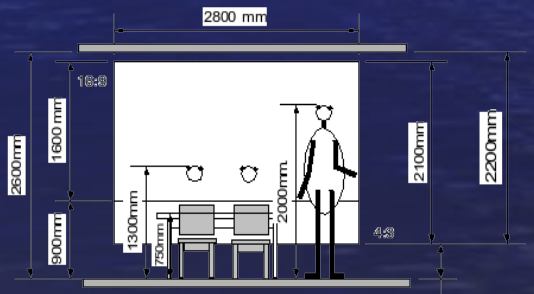
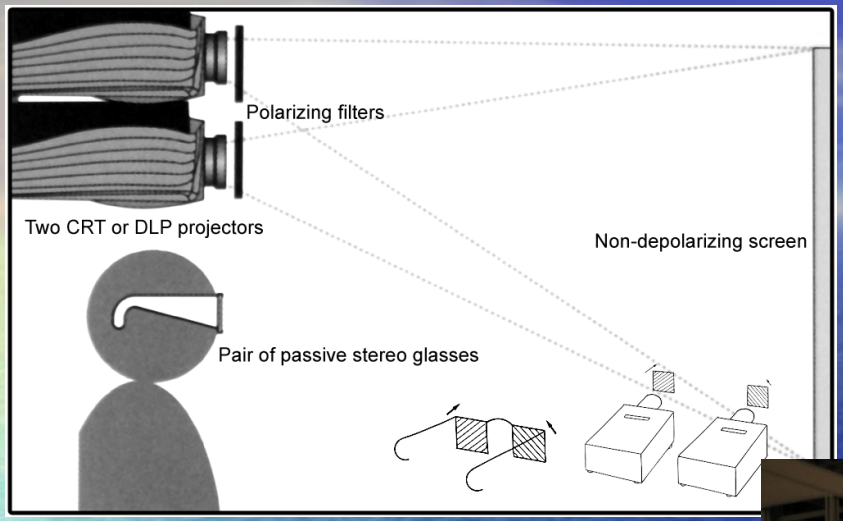
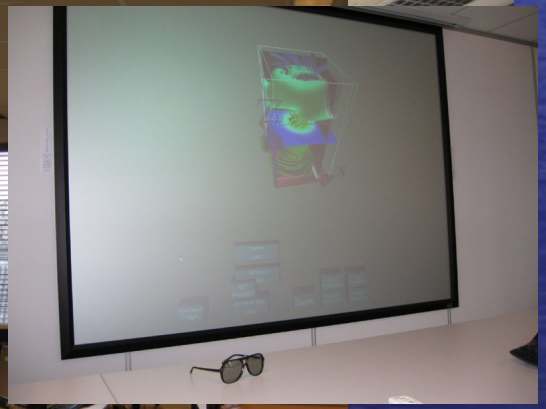


Figure 5: Front view 3D screen – size 280x210cm and aspect ratios (4:3 and 16:9)

Stereo (VR) Wall at KNMI (Temporarily installed here on site)



Linear polarization of light



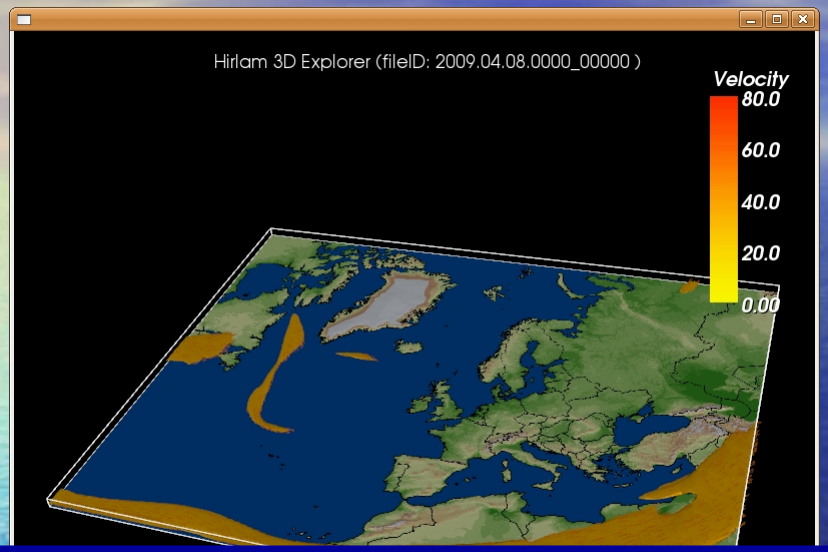
Passive stereo:

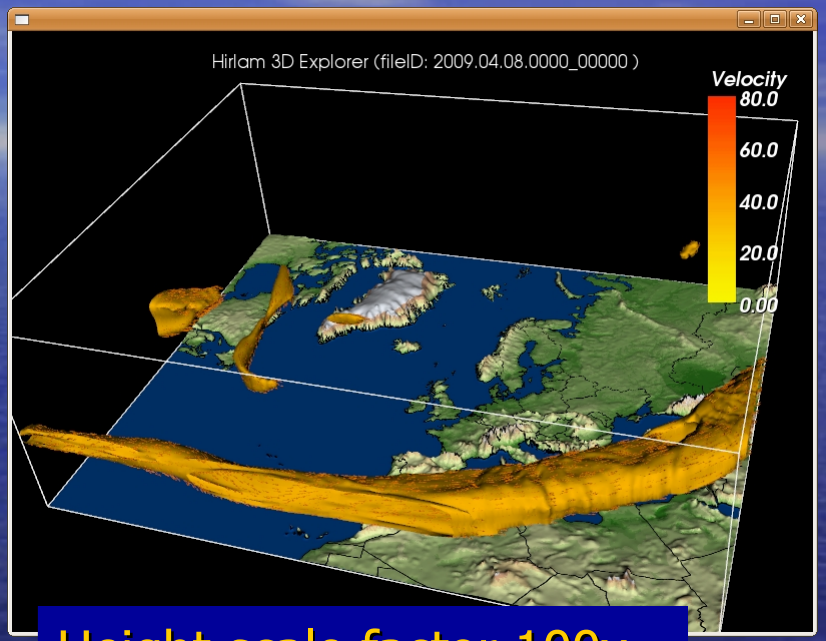
- two projectors + polarizing filters
- passive depolarizing glasses

3DVIS-LE: Vision for the Coming Years…

3D Visualization Learning Environment for High Resolution Atmospheric Data

"FLAT" 3D into "deep" 3D





Height scale factor 100x

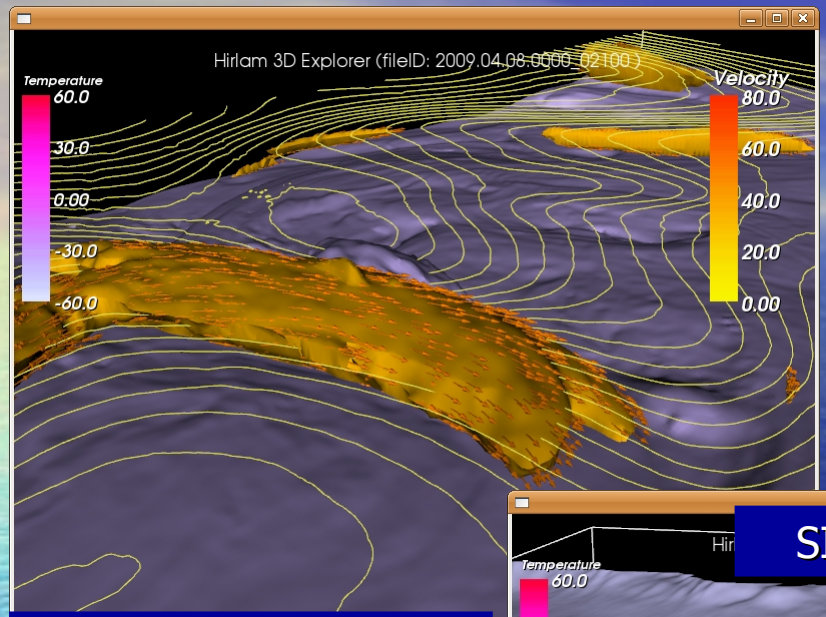
Approx. 9.000km x 8.000km x 30km (height)

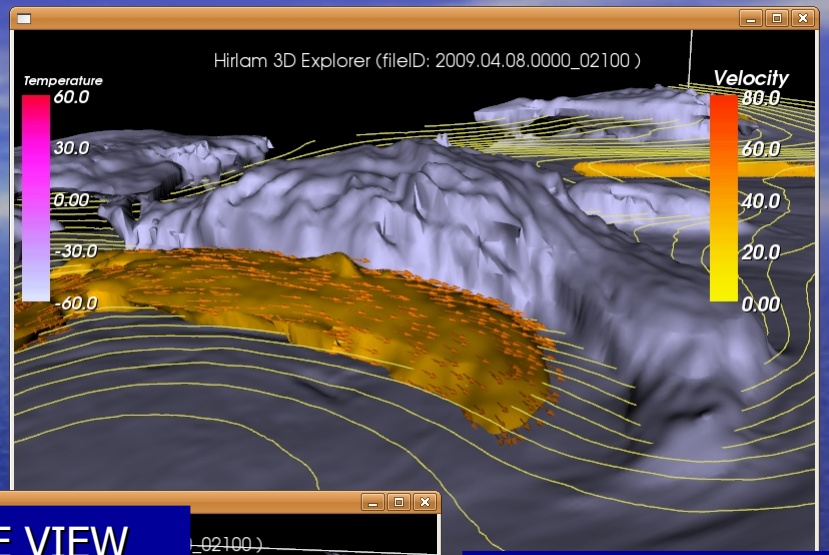
… essentially very flat,

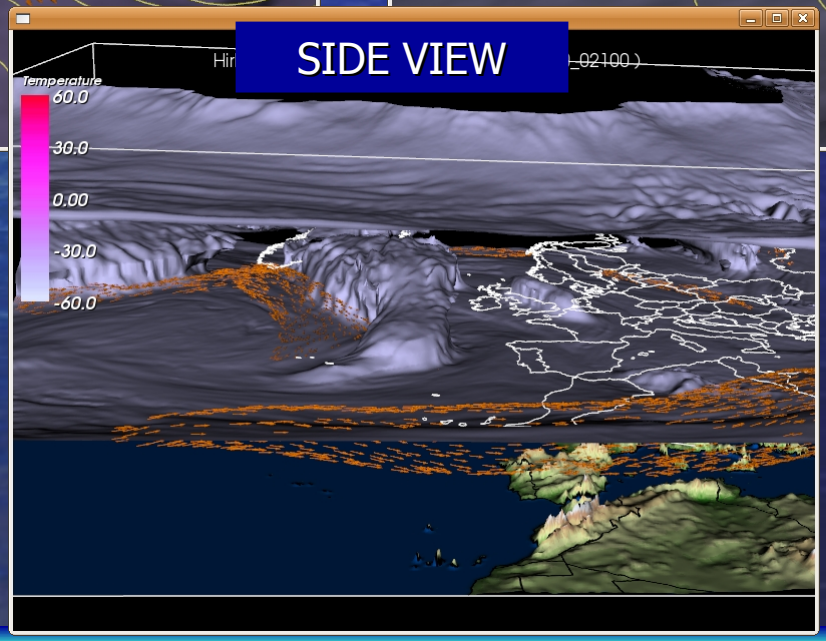
but **TRULY 3D** !!!!

Let's make it visible. =>

Warm and Cold Side of a Jet-Stream



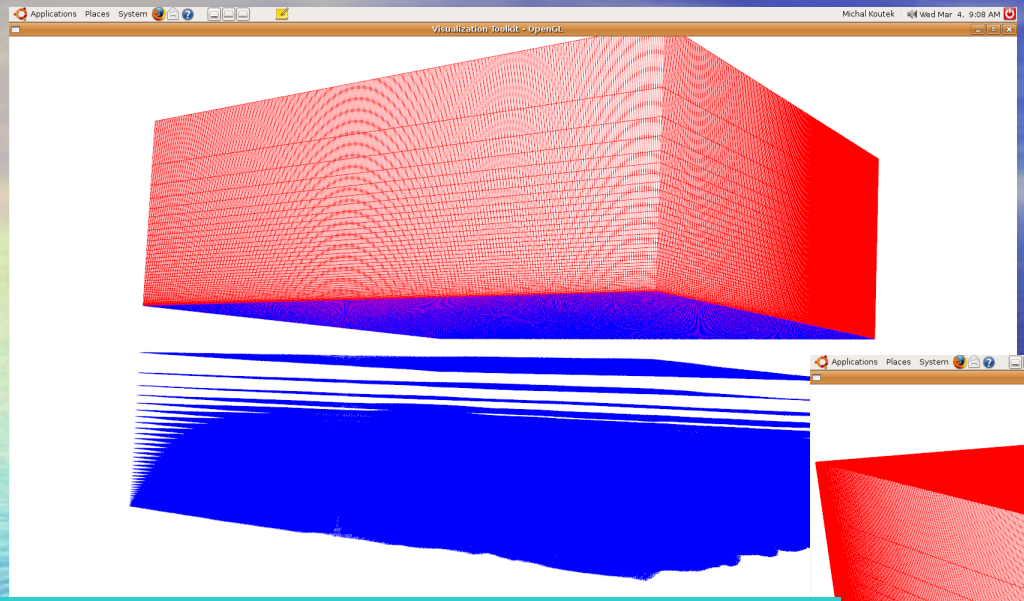


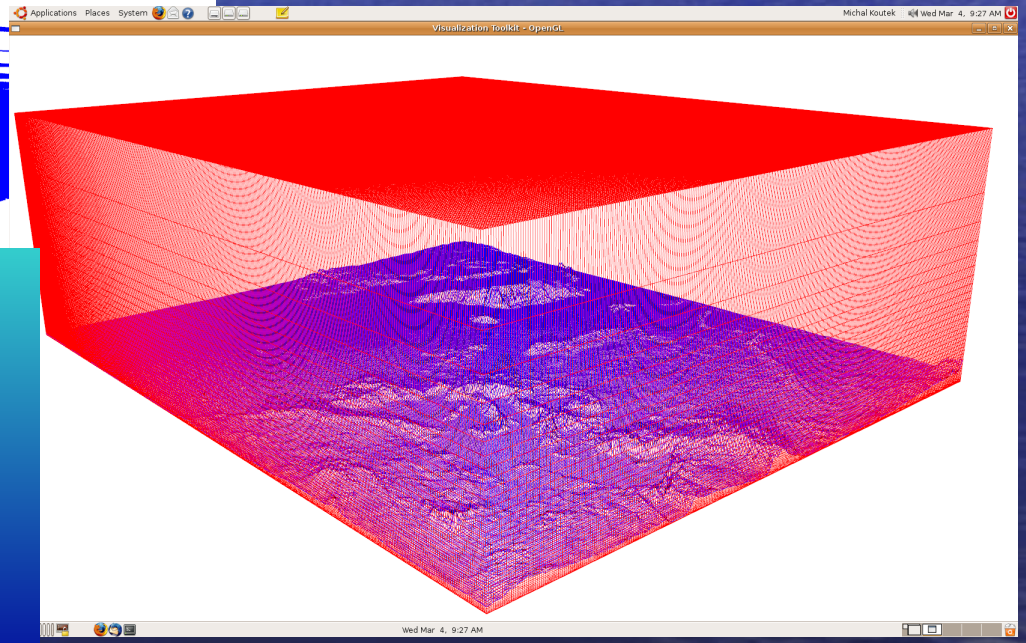


- IsoTemp: **-40 deg. C**
- IsoJetStream: 50m/s
- HeightContours – IsoPressure: every 4 decameters

- IsoTemp: **-50 deg. C**
- IsoJetStream: 50m/s
- HeightContours – IsoPressure: every 4 decameters

Grid Convections and Grid Conversion





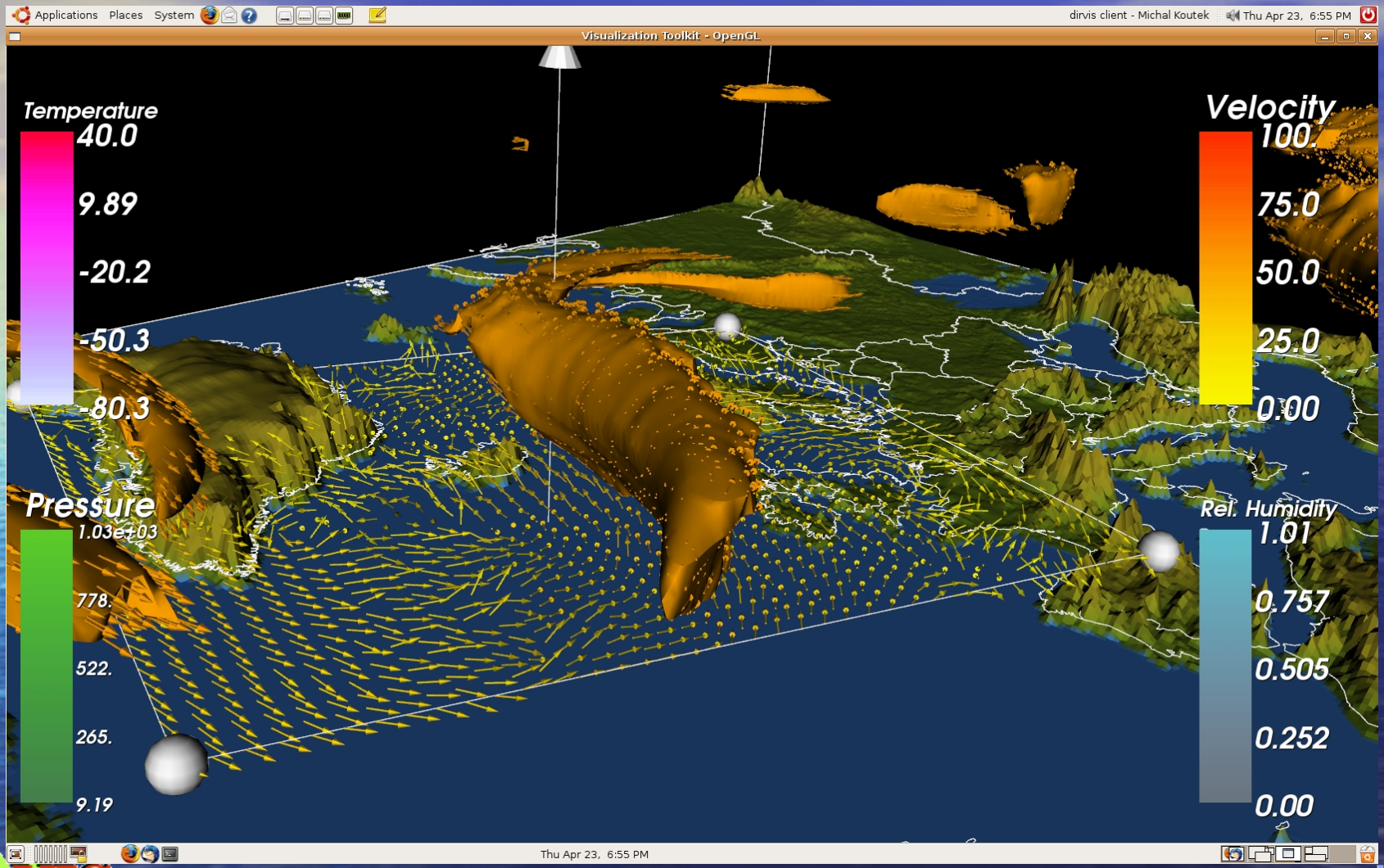
Hybrid (structured) Hirlam GRID

⇒ (vertically) rectilinear grid

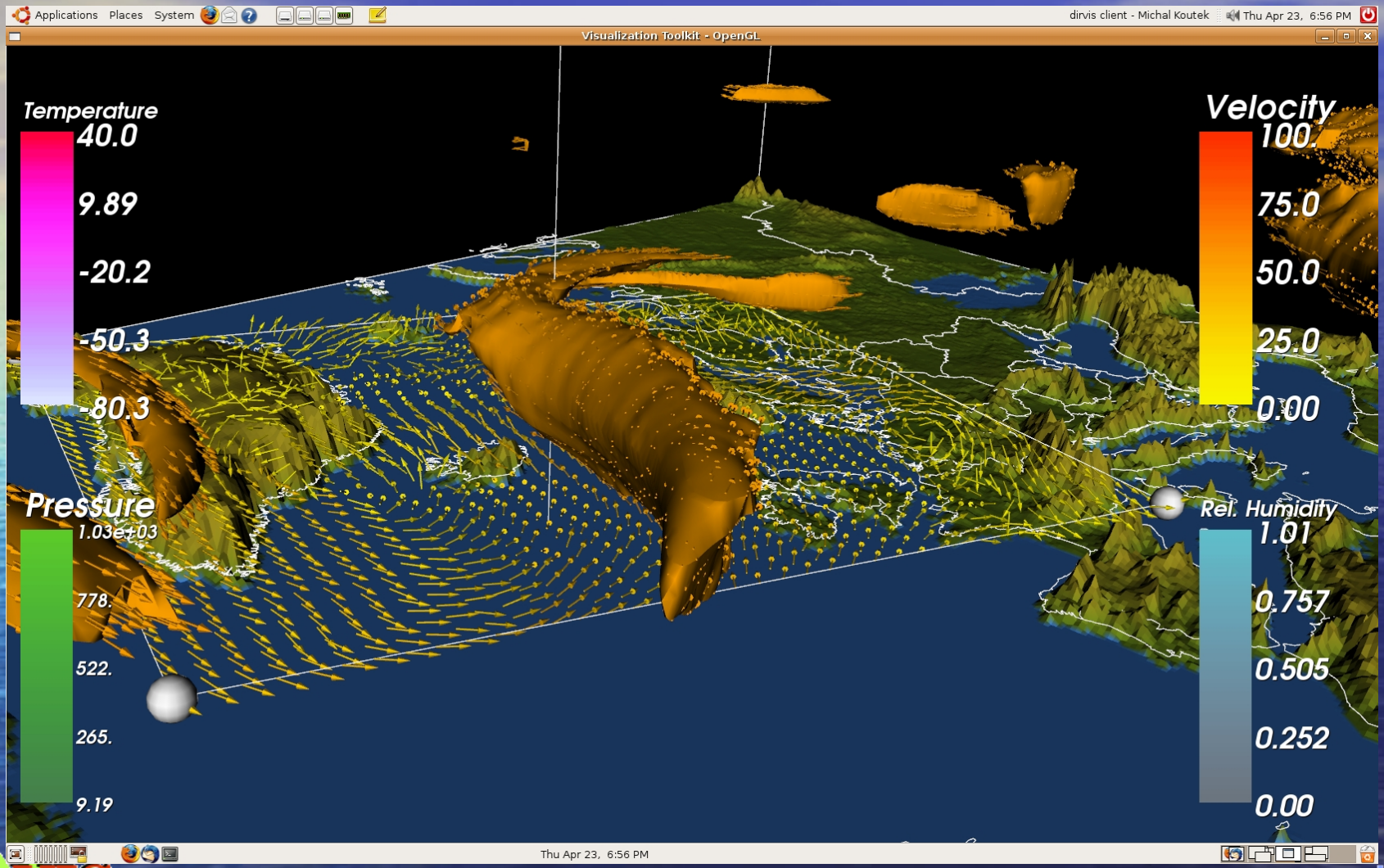
⇒ Vertical into meters !

= interpolation of the data

Airflow Exploration Around a Jet-Stream



Airflow Exploration Around a Jet-Stream



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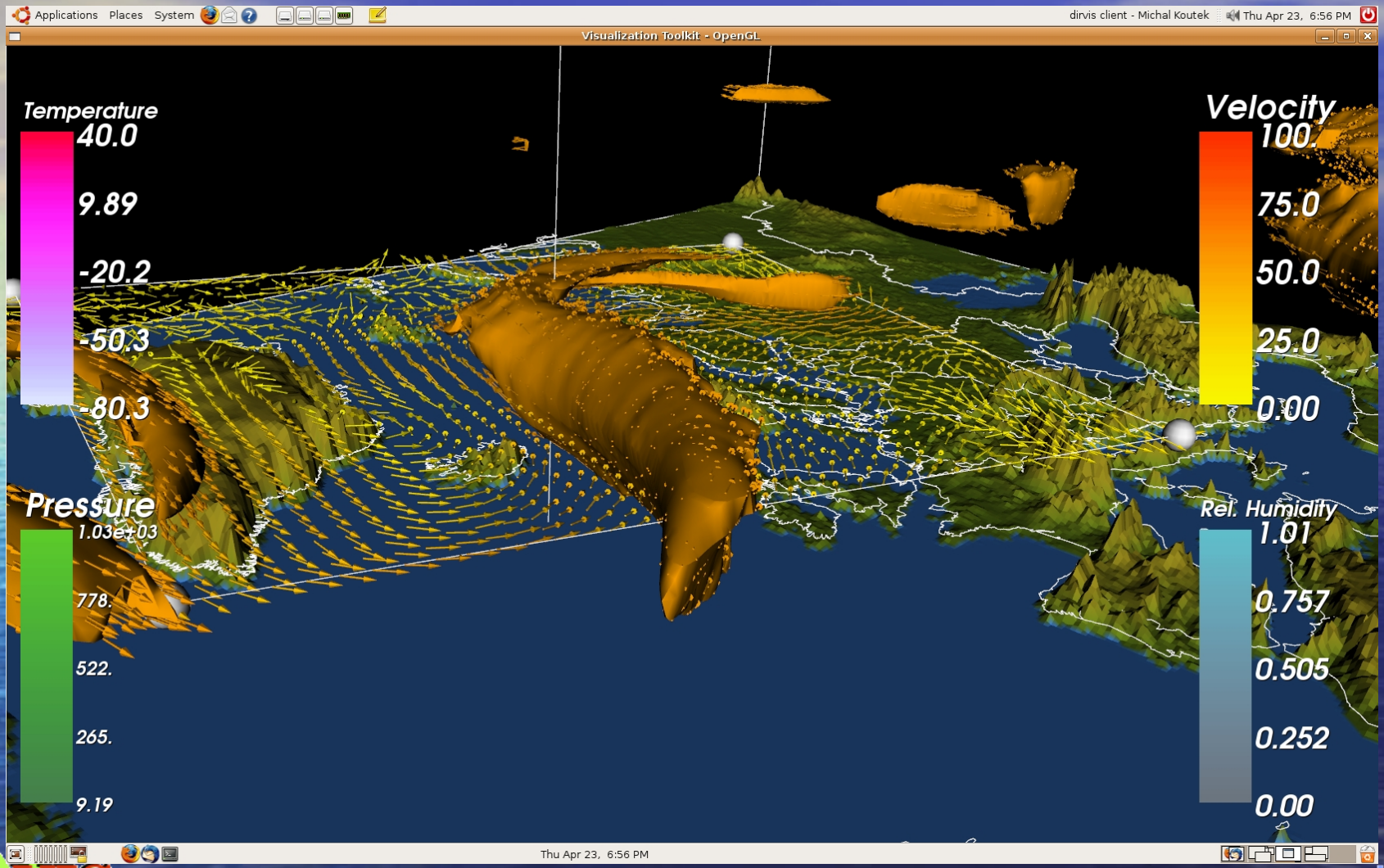
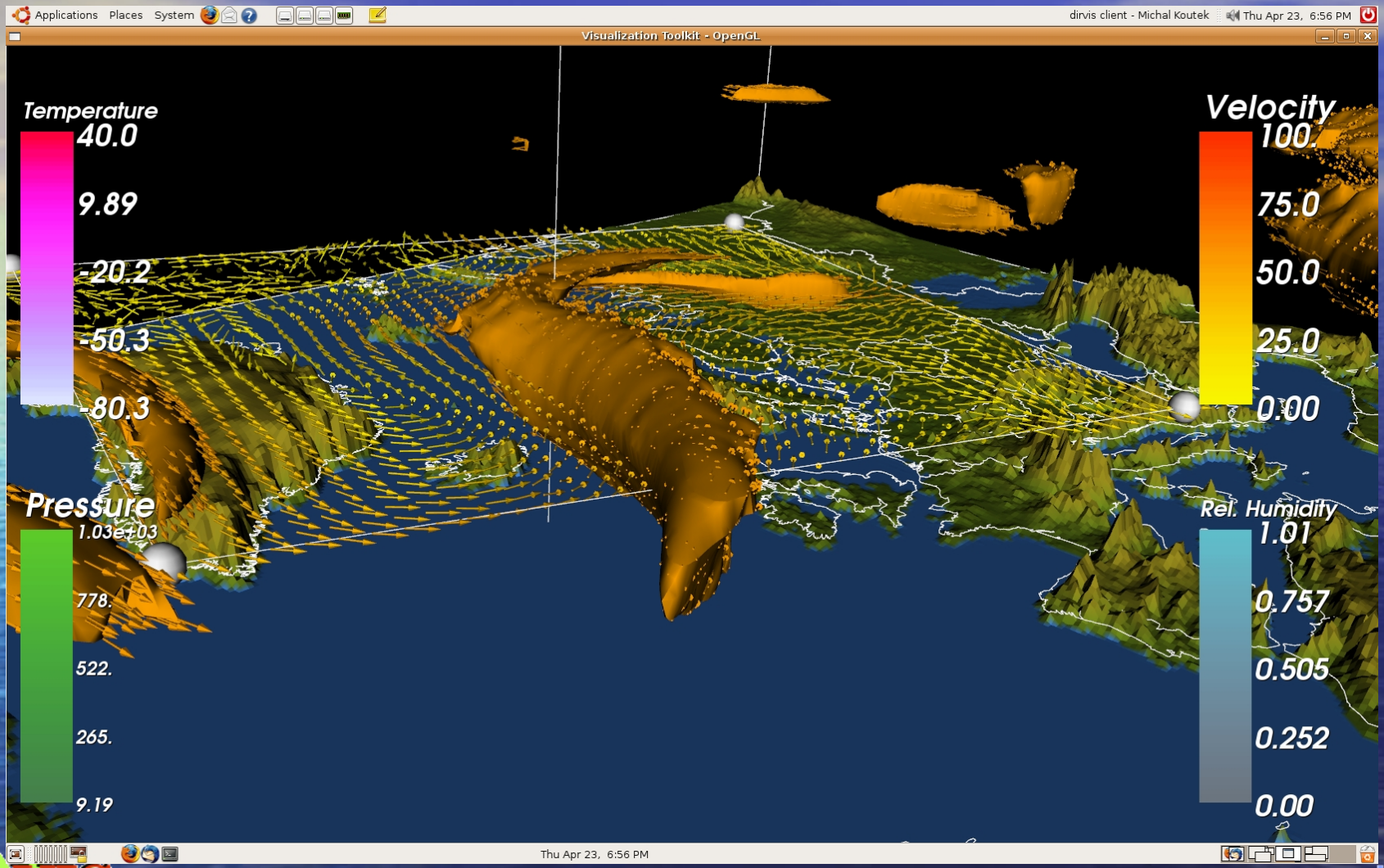
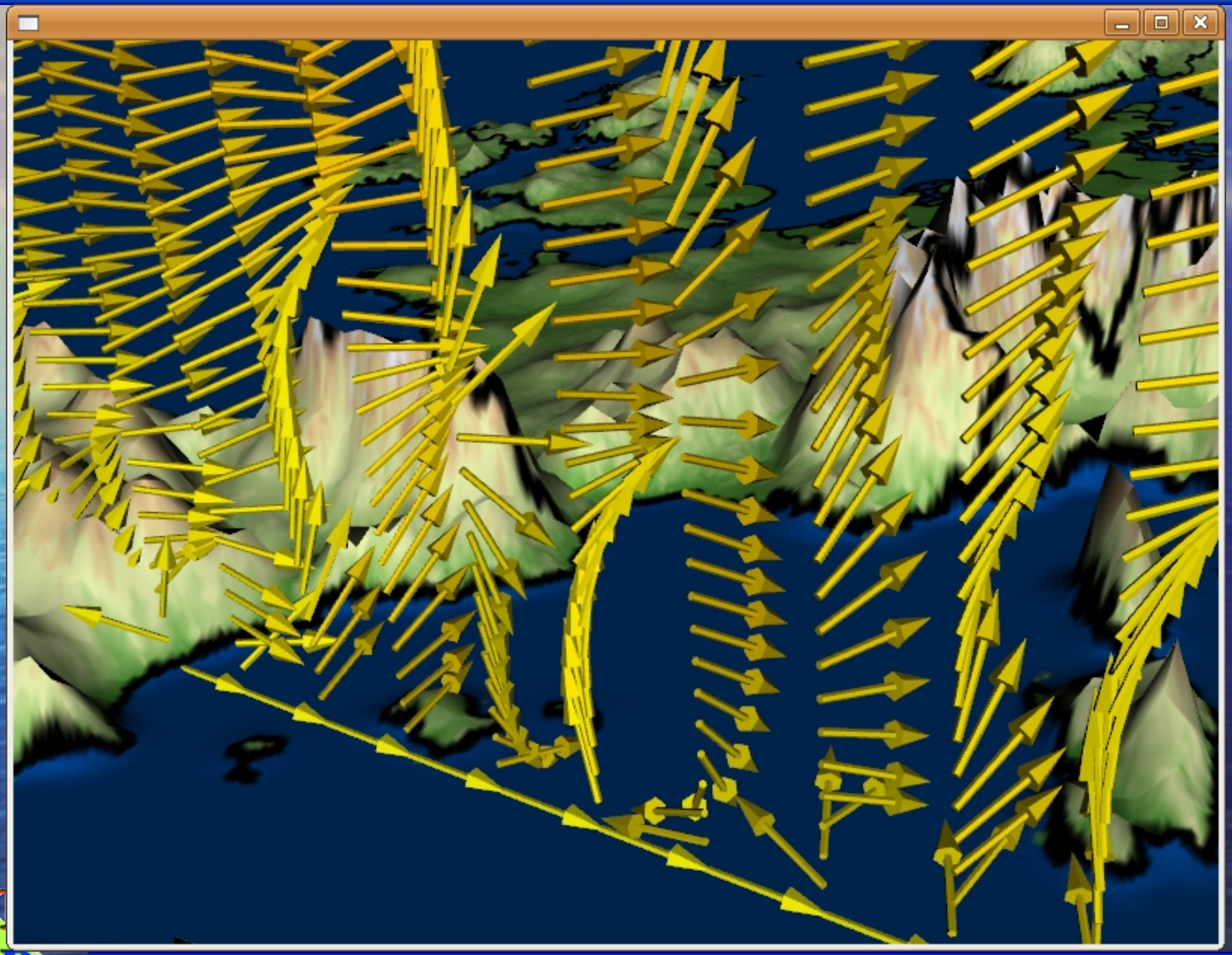


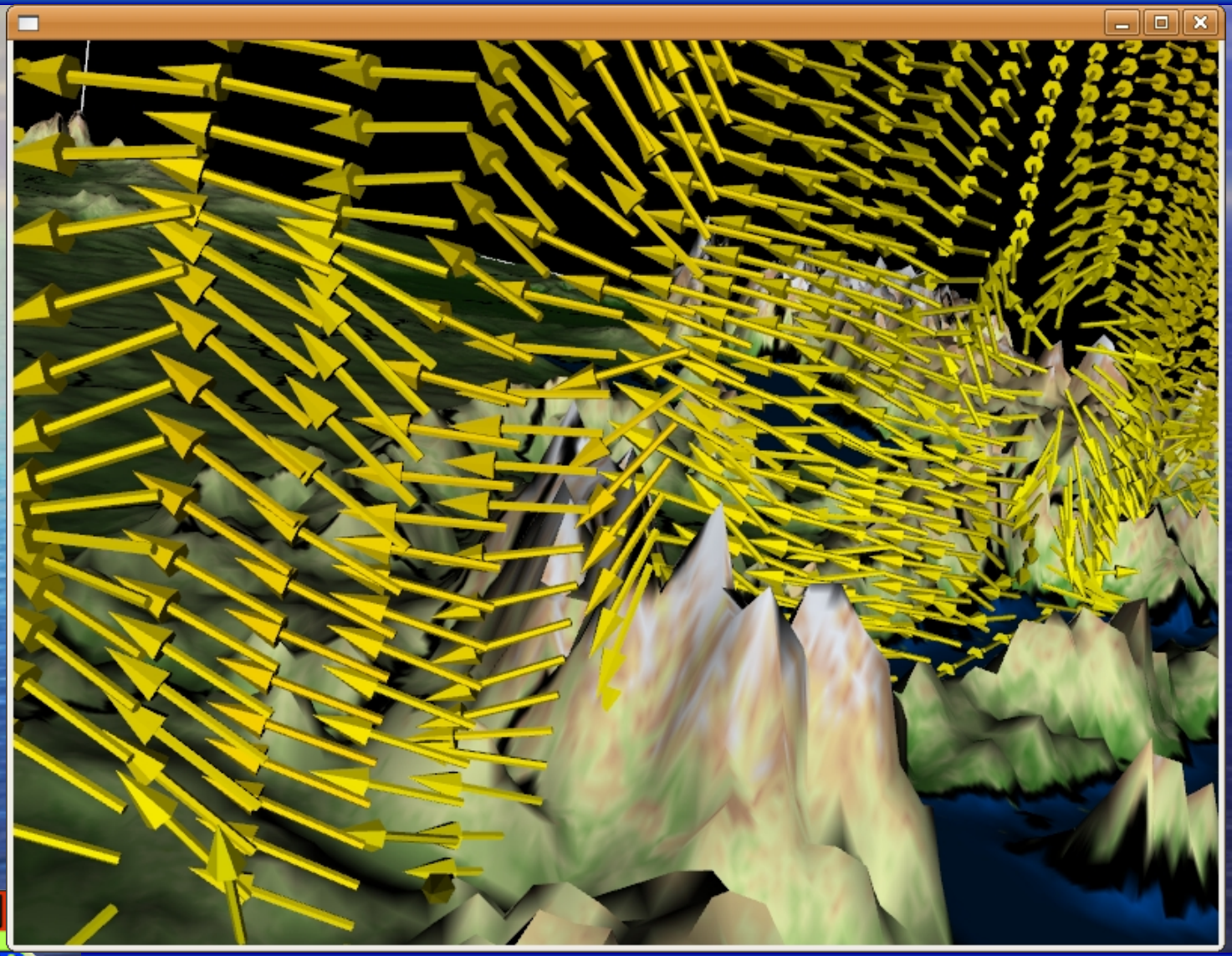
Airflow Exploration Around a Jet-Stream



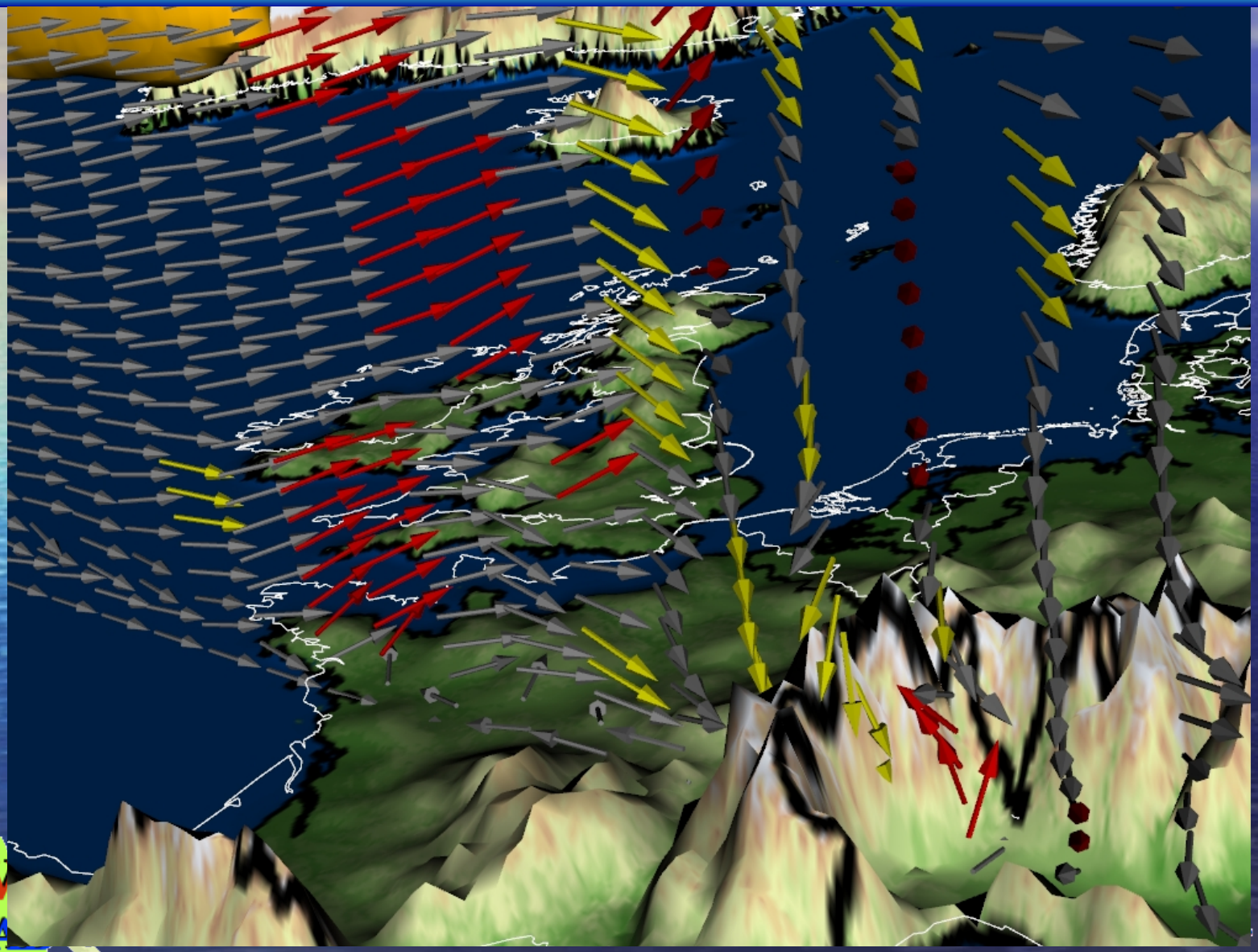
Convective Cells Resolved by Hirlam?



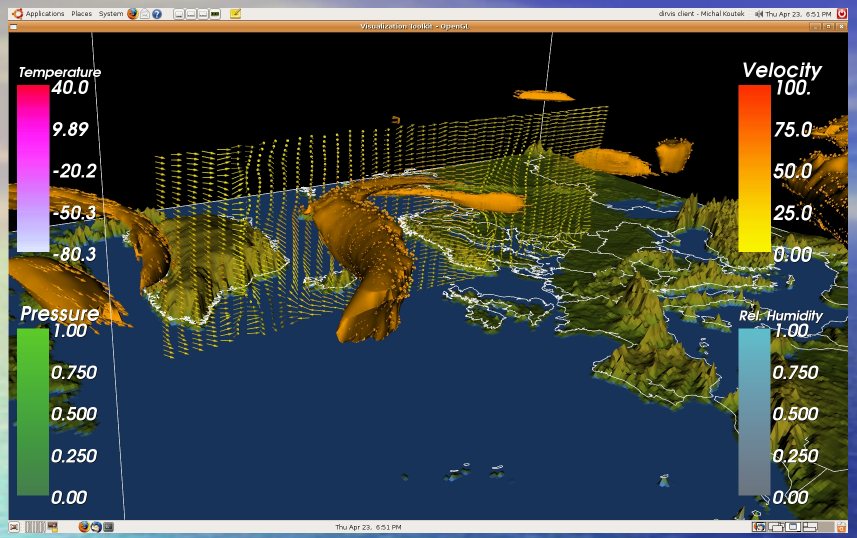
Airflow Above Orography

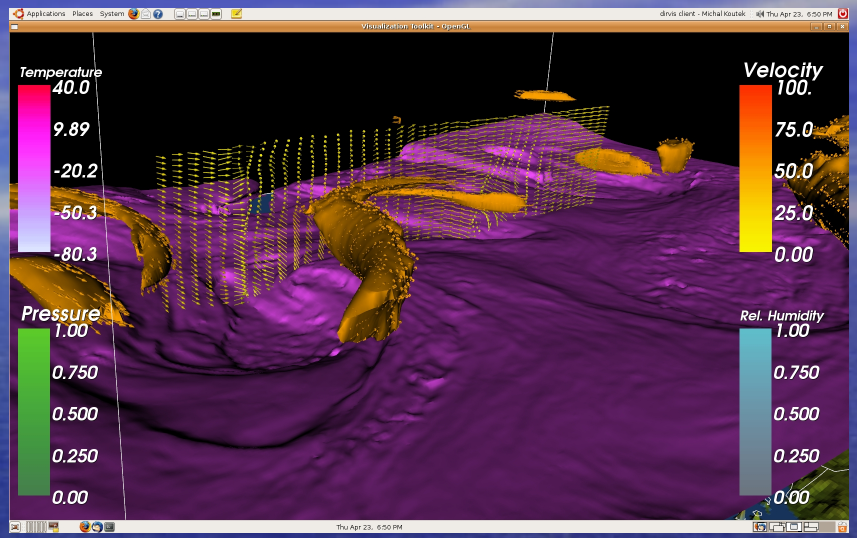


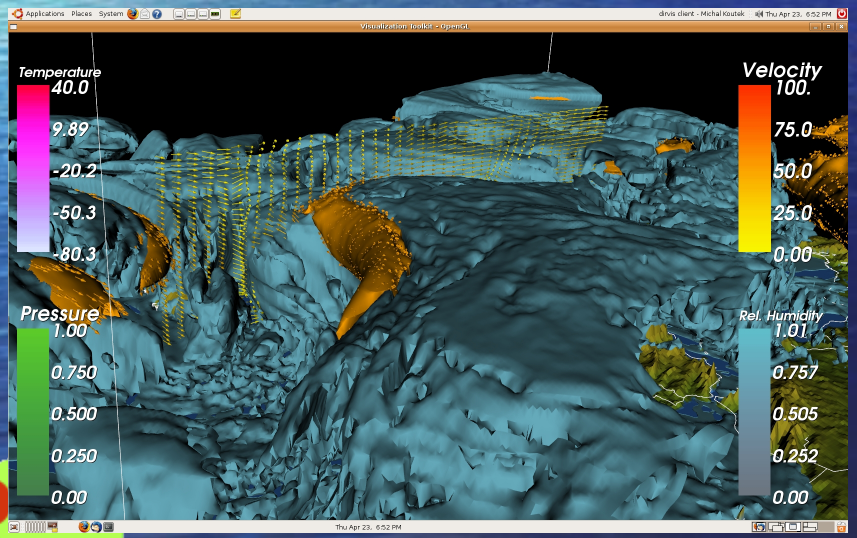
Updrafts and downdrafts…

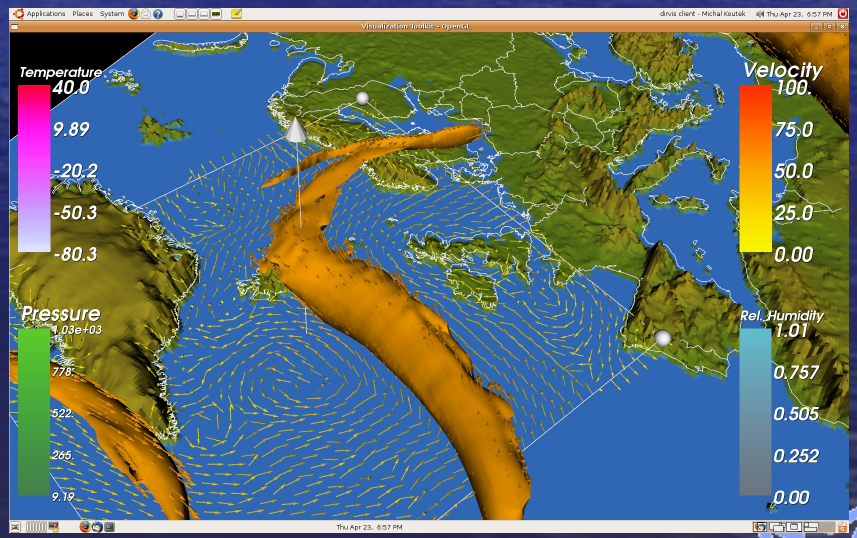


Exploring Frontal Systems

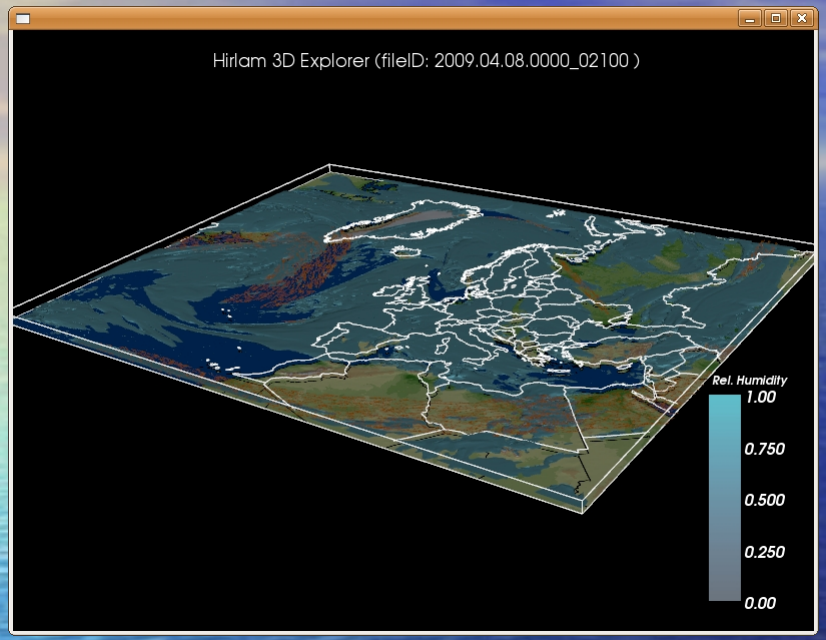


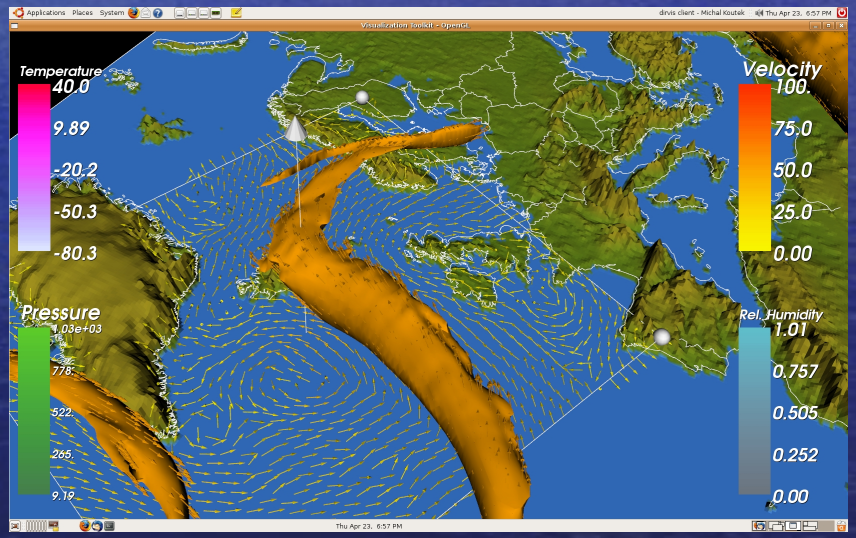






But DON'T forget the domain is flat ..





BUT truly 3D and a lot of 3D effects happen in there ....

Demonstration Schedule Central Museum Utrecht

- Tuesday 12 May: 16:45 - 18:00
- Wednesday 13 May: 10:00 – 17:00 during breaks in the programme
- Thursday 14 May: 10:00 – 11:30

Where: AULA (~ black theater),

go along the "Ship", follow AULA signs