

Visualization of cloud-resolving atmospheric simulation data

Niklas Röber
Deutsches Klimarechenzentrum
Hamburg

Mahendra Roopa
NVIDIA IndeX
Berlin

HLRE3 – Mistral



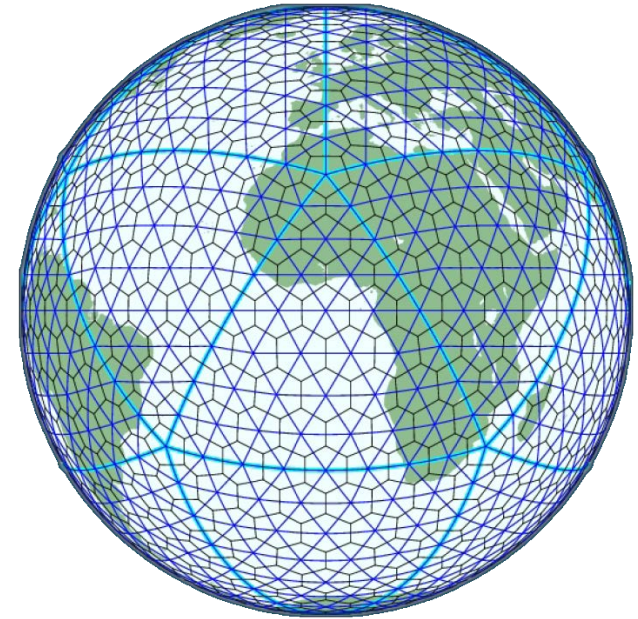
- > 3000 Bullx DLC 720 (> 100.000 cores, 240 TB memory, 54 PB disk)
- 3.6 PetaFLOPS, Infiniband FDR (Top500: 33)



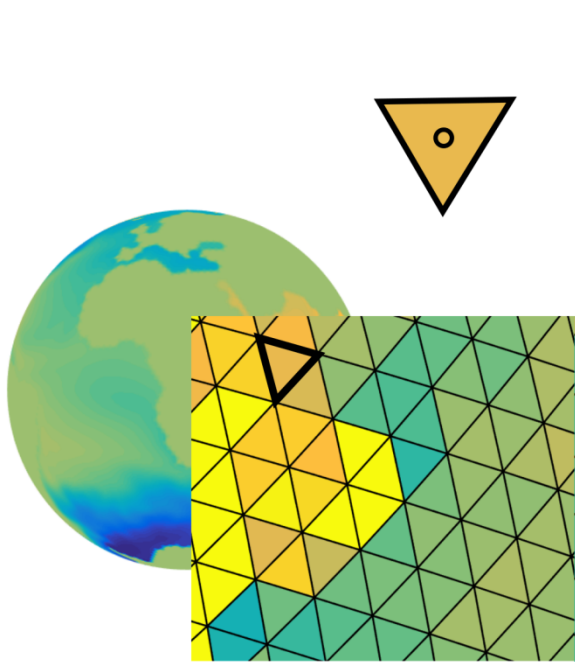
- 21 GPU nodes (2 Haswell/Boadwell, 256/512/1024 GB memory)
- 4 GPUs per node (2 dual Kepler/Maxwell)
- Software: NCL, ParaView, AvizoGreen, VAPOR

ICON

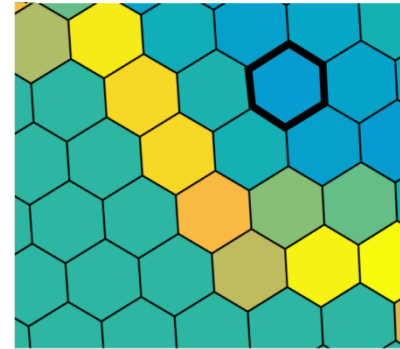
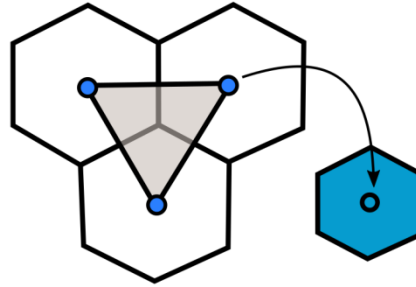
- **ICO**sahedral **N**on-hydrostatic grid
- Atmosphere and Ocean
- Ocean – 10km resolution
(3.8 million cells / 64 levels)
- $\text{HD}(\text{CP})^2$ – 120m resolution
(22.5 million cells / 150 levels)



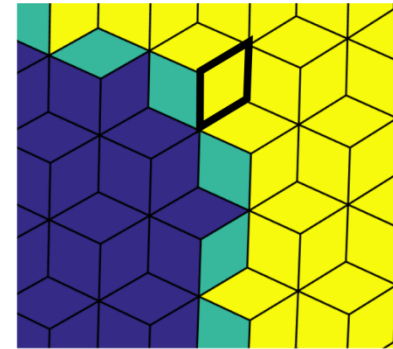
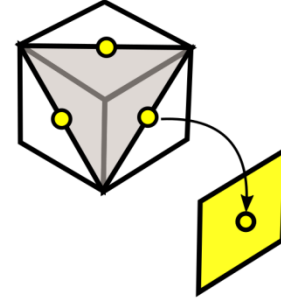
Grid Layout



Cells



Points



Edges

HD(CP)² Phase II: Hurricane “Gaston”

SPIEGEL ONLINE DER SPIEGEL SPIEGEL TV Suche Anmelden

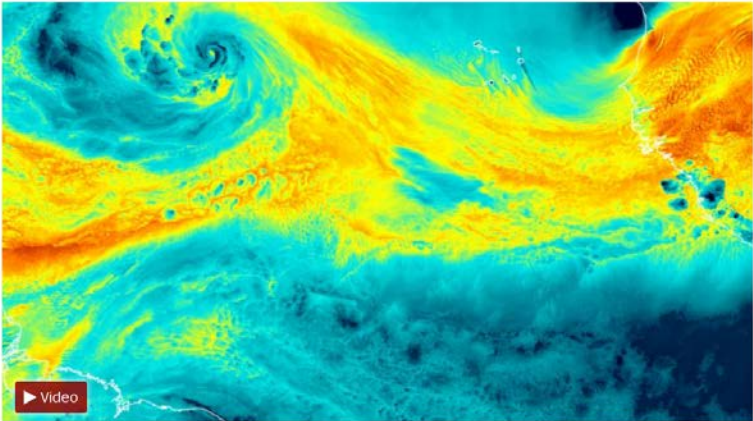
WISSENSCHAFT Schlagzeilen Wetter DAX 10.421,67 TV-Programm Abo

Nachrichten > Wissenschaft > Natur > Klimawandel > Meteorologie: Wolkenzählung soll größtes Klimarätsel lösen

Meteorologie
Wolkenzählung soll größtes Klimarätsel lösen

Wolken entscheiden darüber, wie stark die Klimaerwärmung ausfällt - doch niemand weiß, ob sie mehr werden oder weniger. Jetzt wird gezählt.

Von Axel Bojanowski

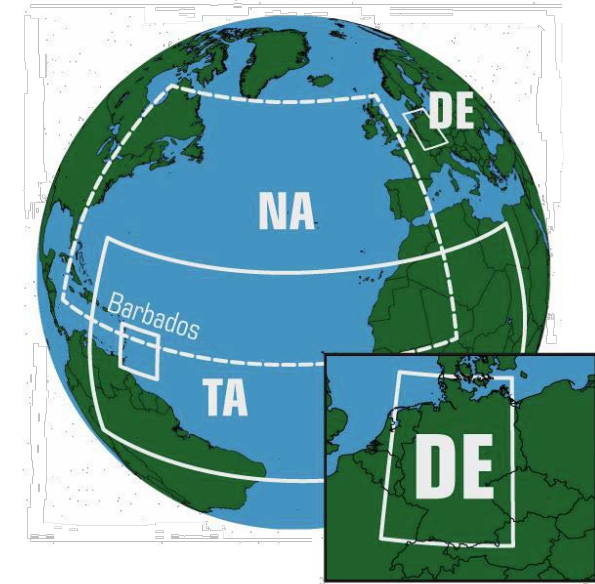


Video

Donnerstag, 08.09.2016 16:07 Uhr Drucken Nutzungsrechte Feedback

Vor ein paar Tagen gewitterte es im Westen Afrikas - das gewöhnliche Wetterphänomen geriet zur großen Show für Wissenschaftler: Genauer als je zuvor verfolgten sie an ihren Computerbildschirmen, wie die Gewitter zu einem riesigen Sturmwirbel verschmolzen, zum Hurrikan "Gaston".

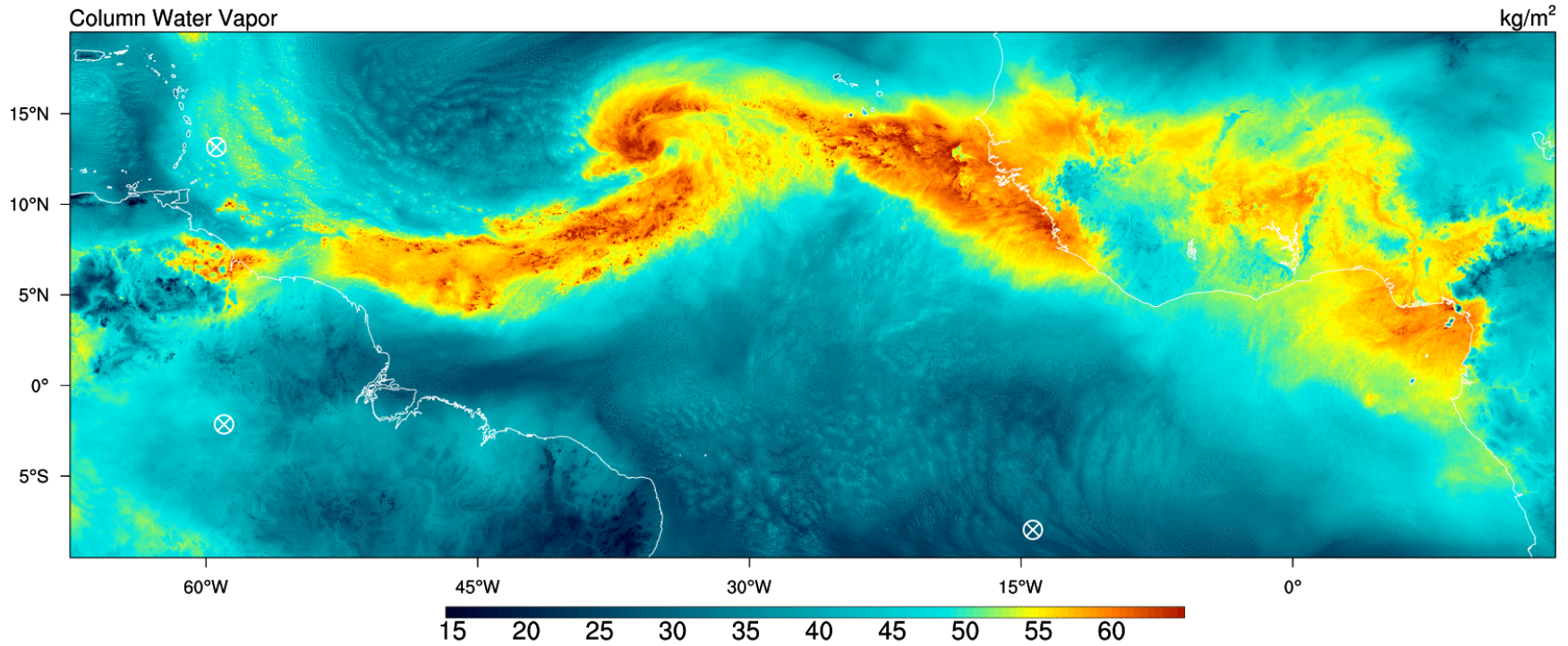
Das Besondere: Auf den neuen Wettersimulationen der Forscher sind selbst



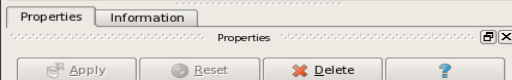
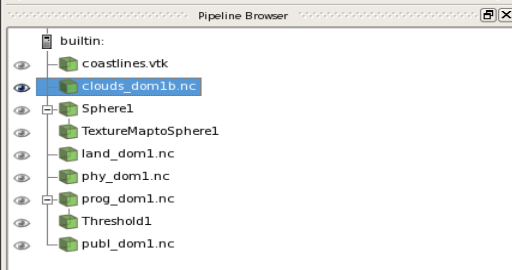
HD(CP)² Domains

Hurricane "Gaston"

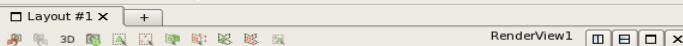
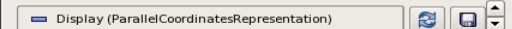
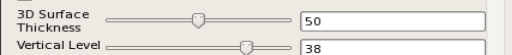
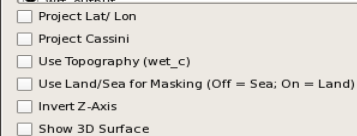
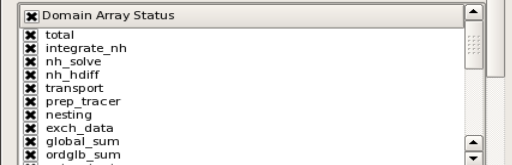
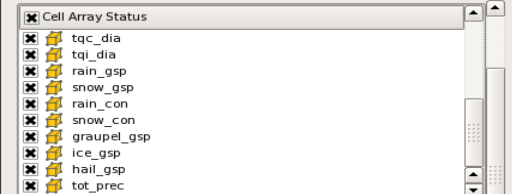
ICON HERZ - NARVAL-II - HD(CP)² Simulations: 20160817 +10.0h



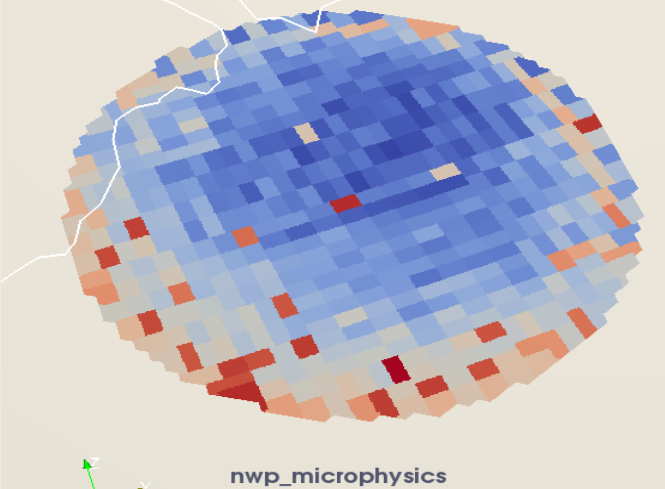
Simulation by Daniel Klocke (DWD) and visualization by Matthias Brueck (MPI-M)



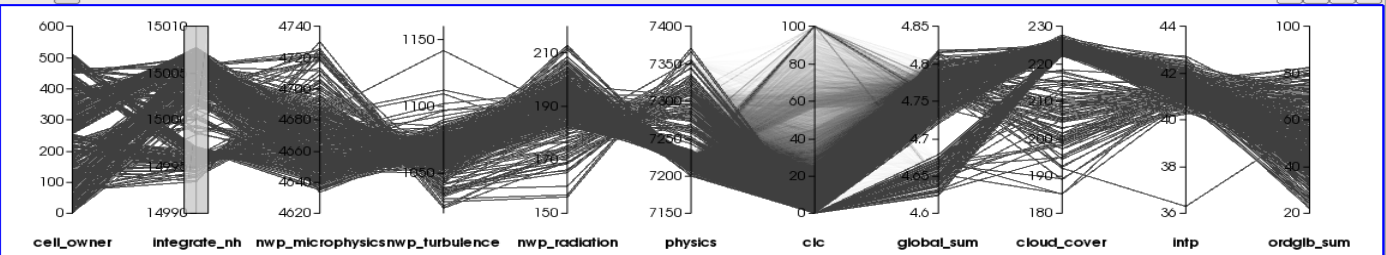
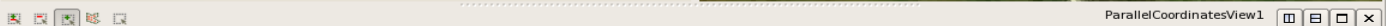
Search ... (use Esc to clear text)

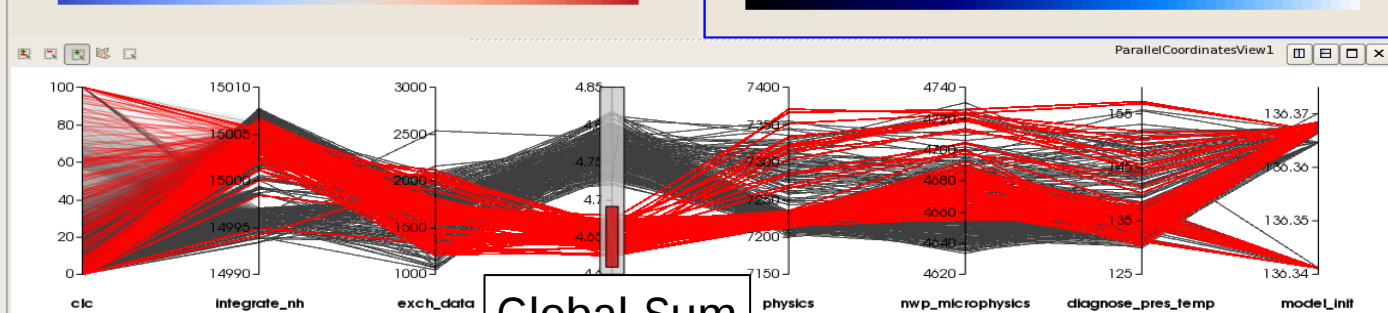
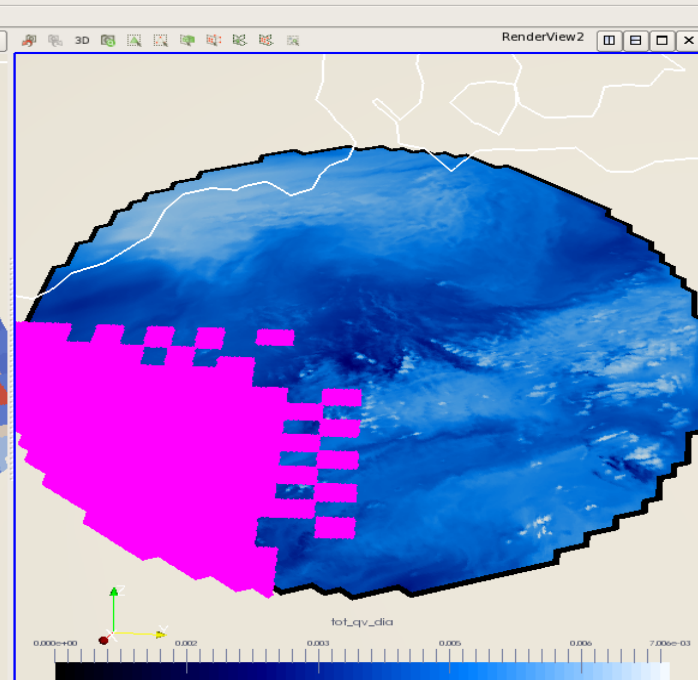
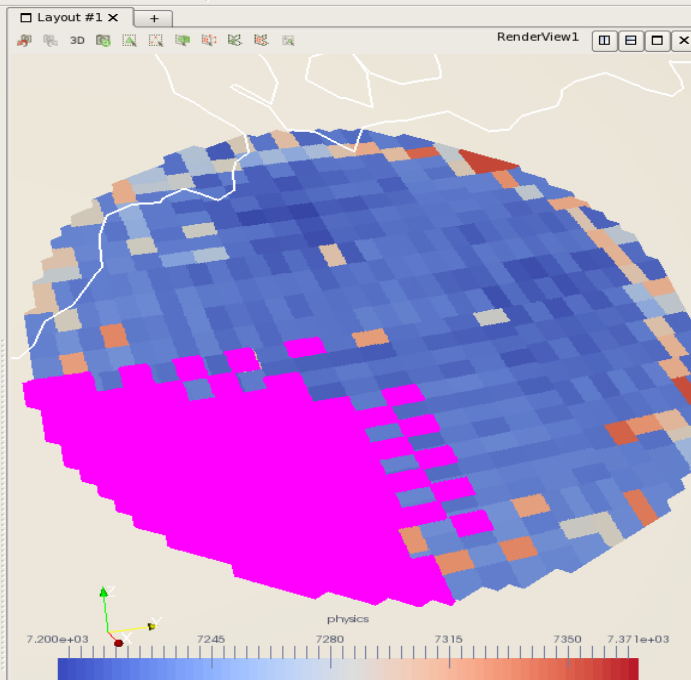
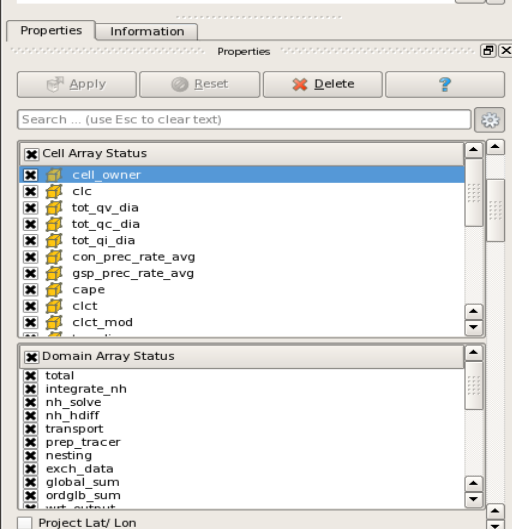
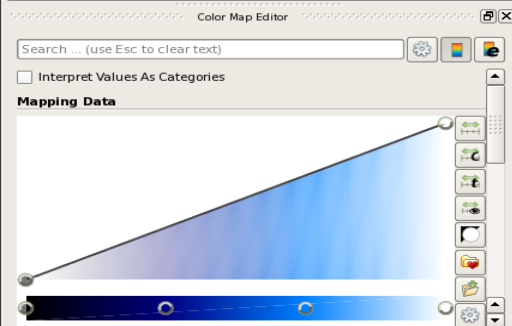
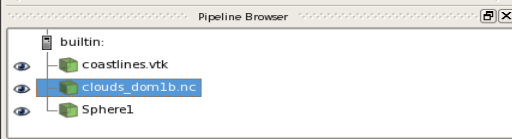


Performance Data

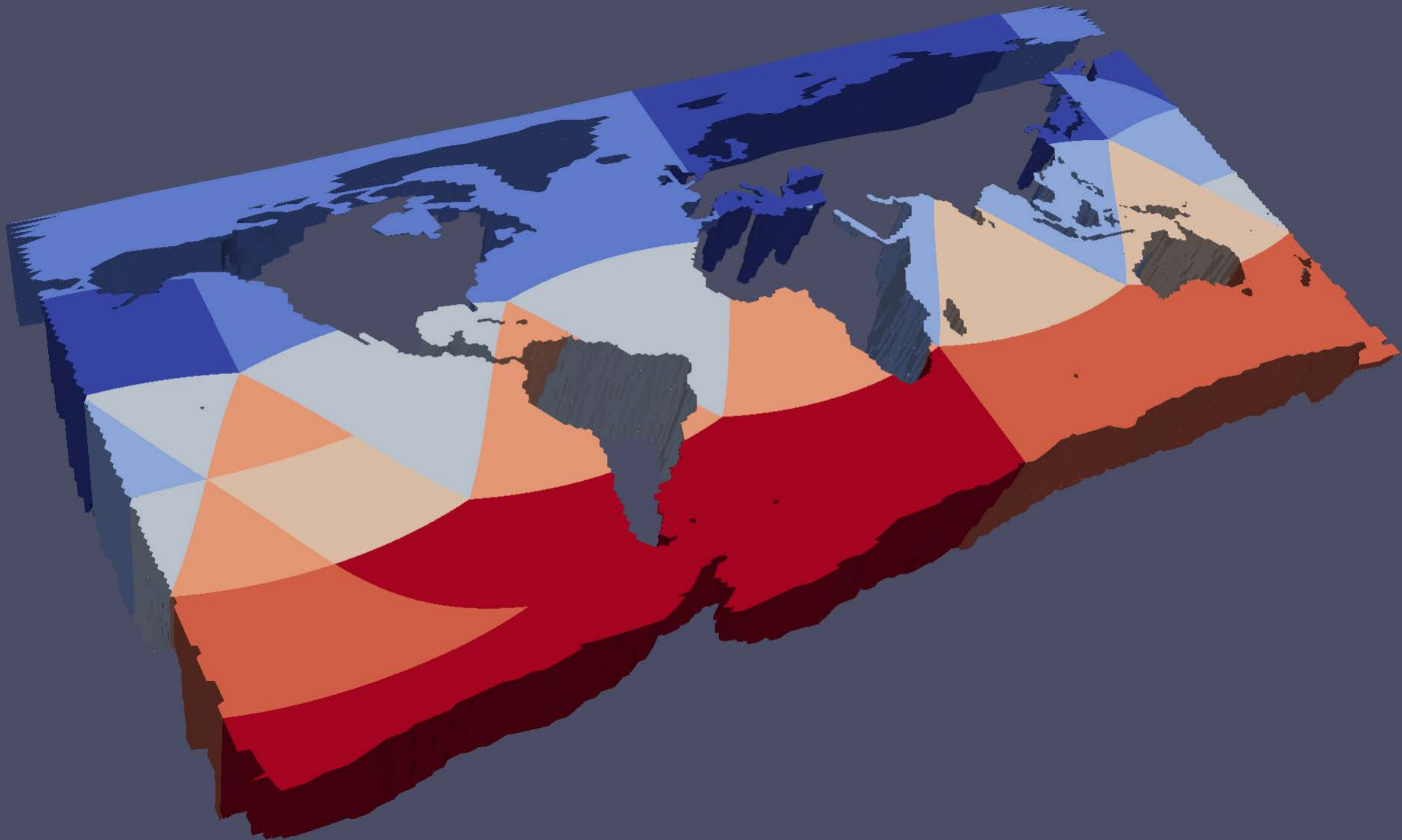


Simulation Data



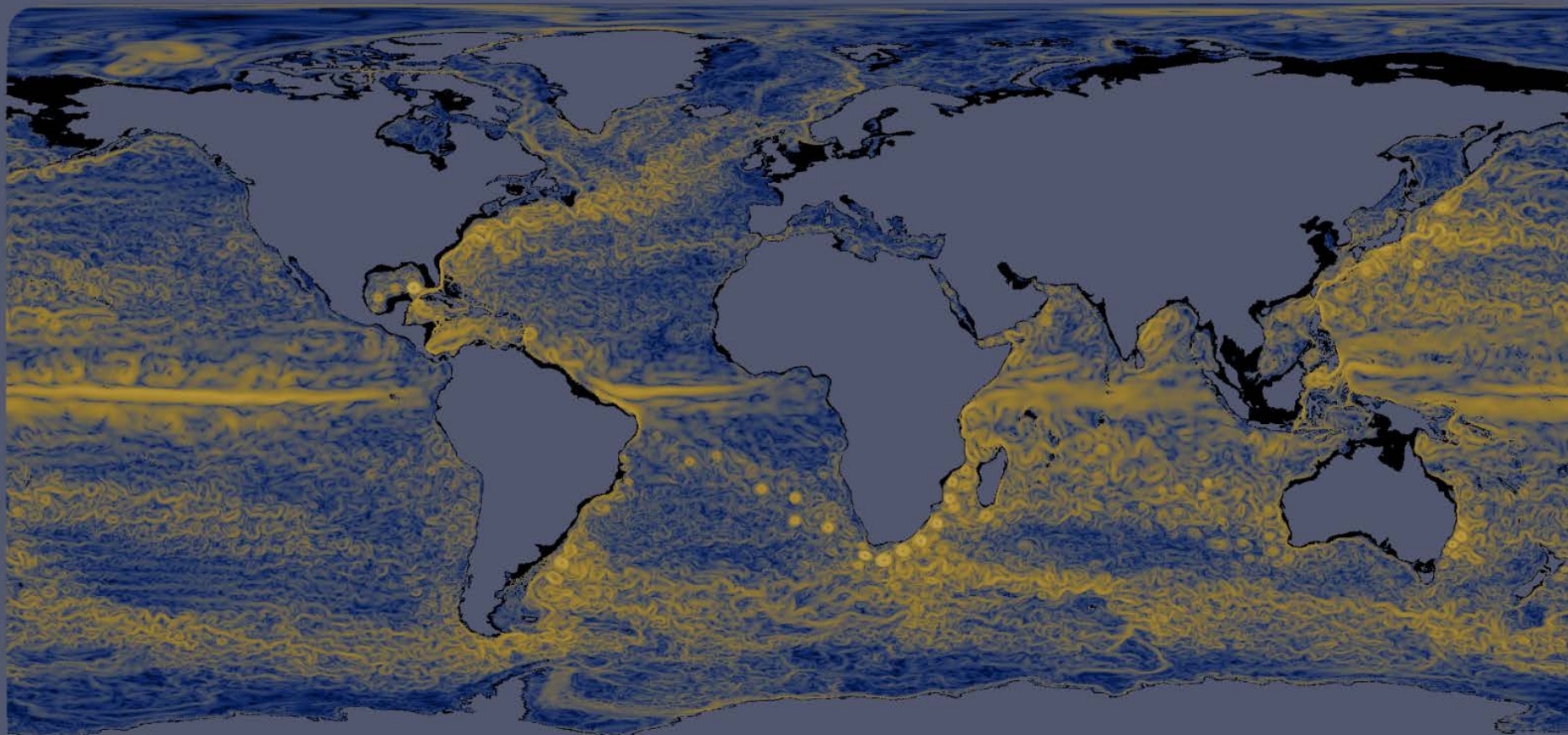


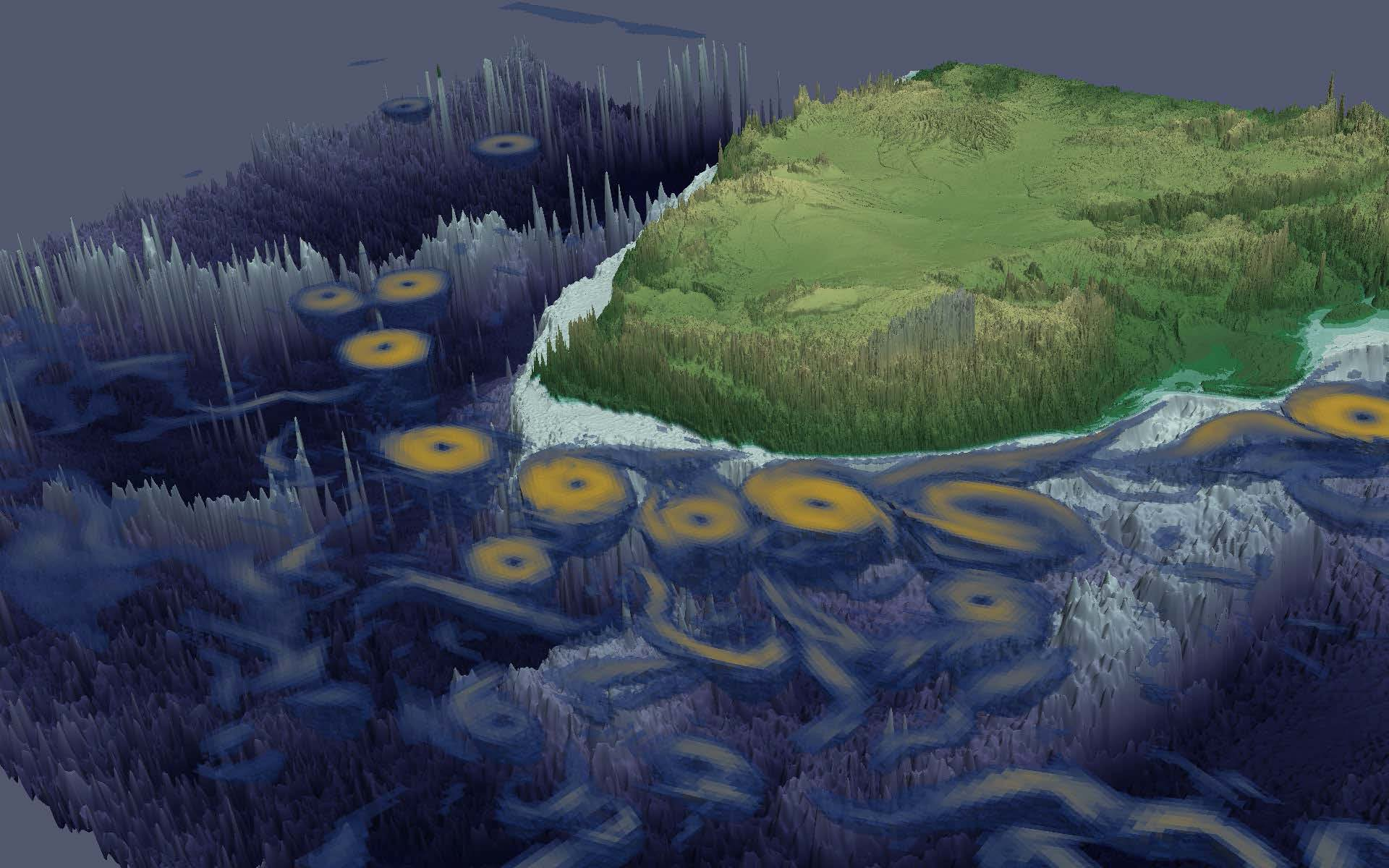
Global Sum



mag

1.000e-03 0.002 0.005 0.01 0.02 0.05 0.1 0.2 0.5 1 2 5 1.000e+01

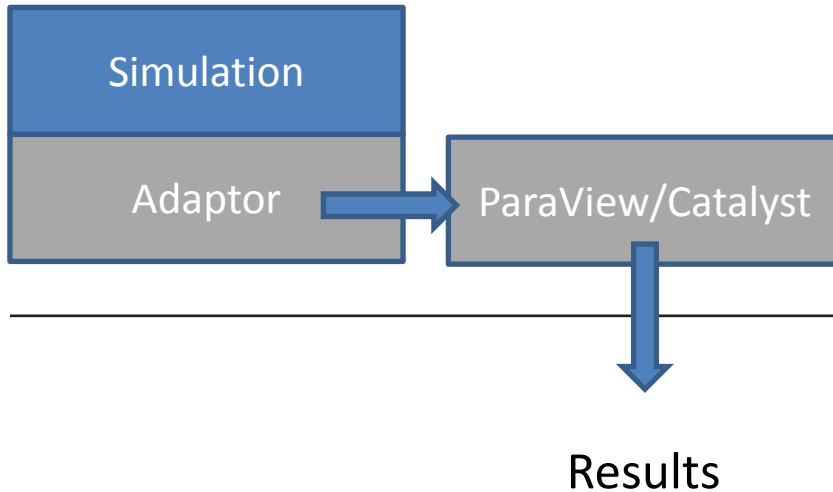




Visualization of really large data

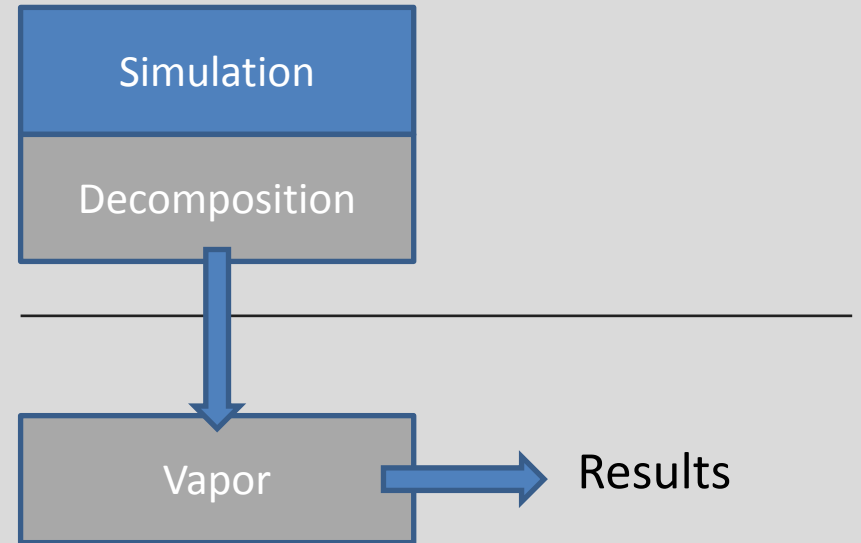
in-situ Visualization

(ParaView/Catalyst)

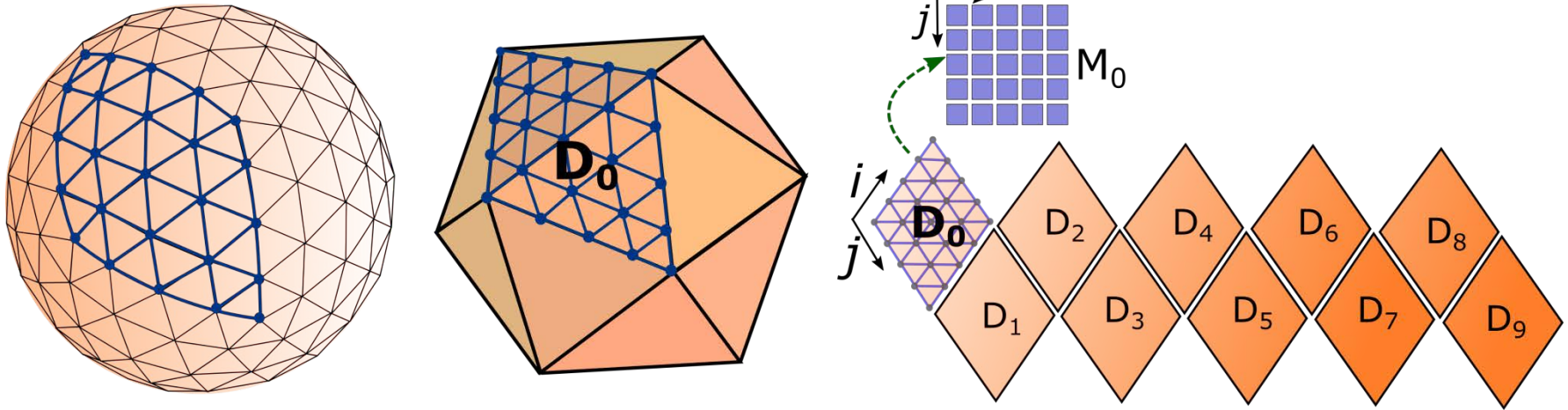


in-situ Compression

(Vapor)

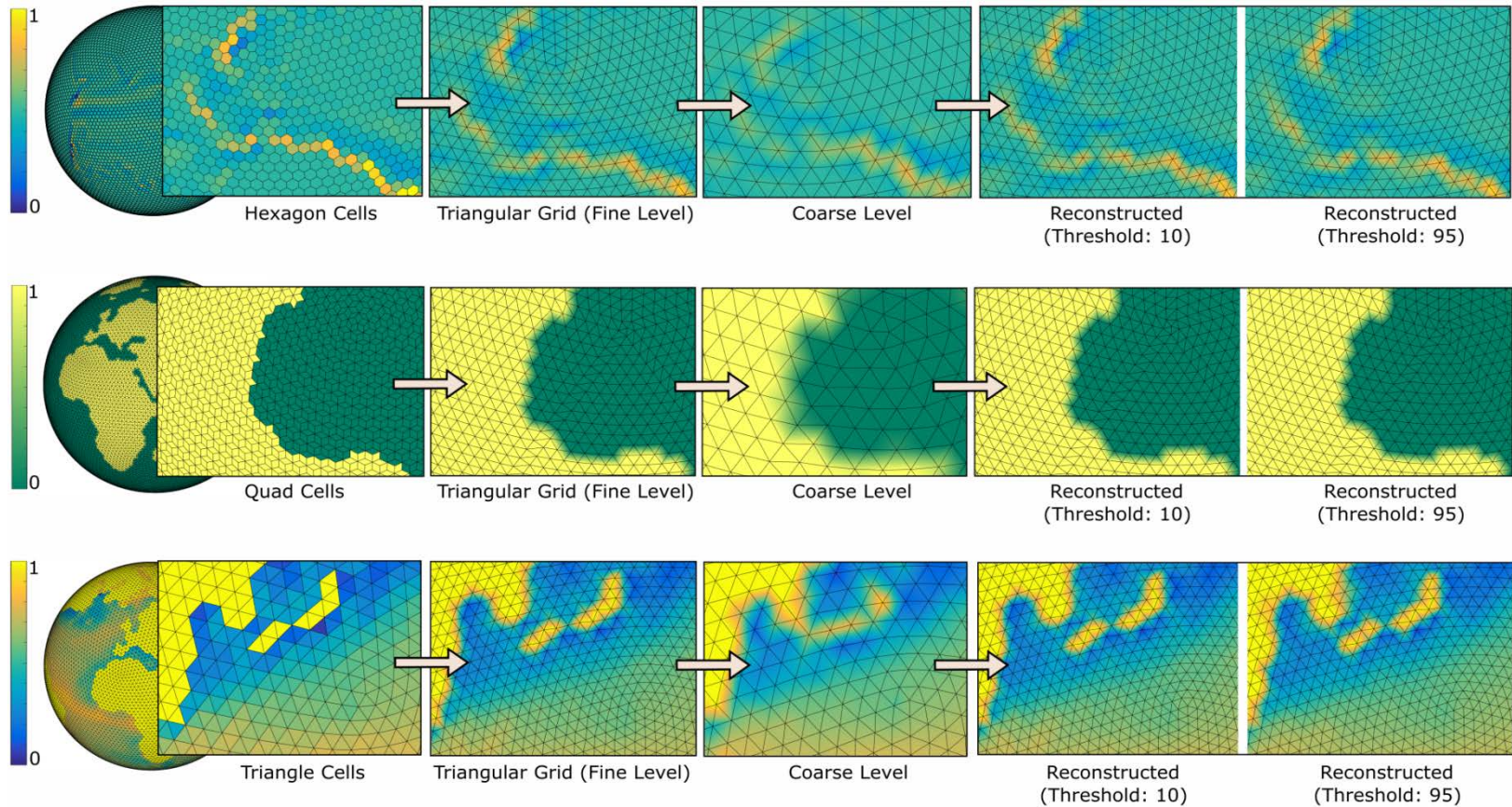


Multiresolution with icosahedral maps



[1] Jubair et.al. "Icosahedral Maps for a Multiresolution Representation of Earth Data", VMV 2016

Multiresolution with icosahedral maps



[1] Jubair et.al. *"Icosahedral Maps for a Multiresolution Representation of Earth Data"*, VMV 2016

NVIDIA IndeX and beyond ...

- **Interactive** visualization of large data (high spatial and/or temporal resolution)
 - For exploration, learning and understanding
 - For presentation and demonstration
- Visualization on the native grid
- I/O issues: in-situ visualization/compression
- Automated feature detection
- **Visualization driven simulation**

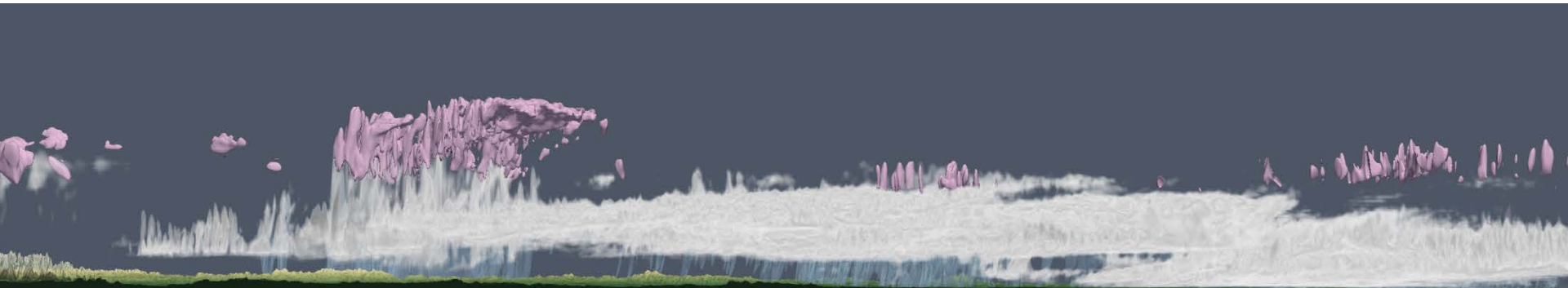
DEMO

Simulated Day	April, 26 th 2013
Resolution	312m – 1429 x 1556 x 202 (regular rectilinear grid)
Height	0m – 12km (60m spacing)
Timesteps	1440 (1 minute resolution)

Variables

- Liquid cloud water (kg/kg)
- Cloud ice (kg/kg)
- Rain mixing ratio (kg/kg)
- Wind / magnitude (m/s)
 - Vorticity
 - Divergence

[1] Heinze et.al. *“Large-eddy simulations over Germany using ICON: A comprehensive evaluation”*, QJRM 2016



Cloud-resolving simulation over Germany through ICON HighRes

Simulation and Visualization produced by the HD(CP)² project
of the German Ministry of Education and Research (BMBF).



Bundesministerium
für Bildung
und Forschung



HD(CP)²

High definition clouds and precipitation
for advancing climate prediction