

ESiWACE HPDA / Vis Training 2021

Data Visualization using ParaView

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Deutsches Klimarechenzentrum (DKRZ)

- September 13th/14th: ParaView
DKRZ – Niklas Röber, Florian Ziemen
- September 15th/16th: Ophidia
CMCC – Donatello Elia

Visualization Workshops at DKRZ


- Hands-on tutorials for ParaView, NCL, VaPOR from 2 and 5 days
- Some online tutorials available at www.dkrz.de/up/services/analysis
- Still working on online video tutorials
- Teaching (workshops, tutorials)
- Public relations (guided tours, conferences, venues)



Documentation

[How to get a user account](#)[Mistral](#)[HPSS tape archive](#)[Data Processing](#)[Visualization](#)[Software](#)[Avizo Green](#)[Avizo Earth](#)[Paraview](#)[Simvis](#)[Vapor](#)[NCL](#)[PyNGL / PyNIO](#)[Python matplotlib](#)[GrADS](#)[CUDA](#)[Visualization on](#)[Mistral](#)[Remote3D](#)[Filesystems](#)[Cloud Storage](#)[Training](#)[FAQs & known issues](#)[Seminar Rooms](#)[IMDI](#)[Terms of use](#)

News

 **New supercomputer „Mistral“ at DKRZ delivers particularly detailed regional climate simulations for Germany**


Oct 05, 2015

 **Preview: DKRZ at SC¹⁵**

Sep 30, 2015

 **Kick-off for ESIWACE and ESCAPE**

Sep 29, 2015

 **Allocations 2016 - request resources**

[Home](#) → [User Portal](#) → [Documentation](#) → [Visualization](#) → [Software](#) → [Paraview](#)

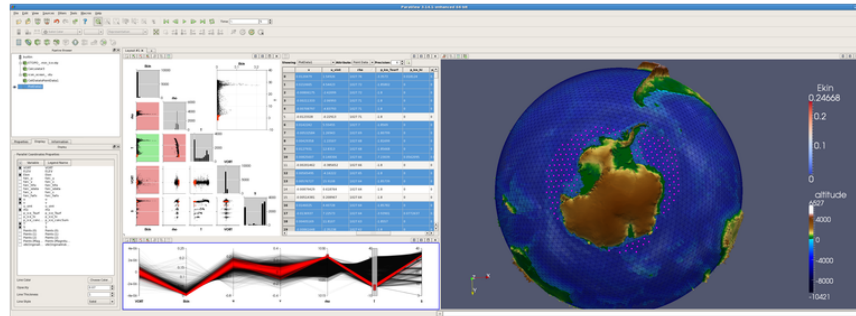
ParaView

Paraview is an open source visualization package that reads a variety of different data formats and lattices and implements the most common visualization techniques. More specifically, Paraview also reads netCDF files and supports different grids, so that it can be used to visualize climate and earth science data sets.

Paraview 4.1 is installed on all visualization nodes of Halo and can be started from the command line via 'paraview'. Older versions of Paraview can be started by appending the version number, such as 'paraview3.98'.

Paraview has come a long way and is used and developed by a very large community from a variety of different sciences. It is installed on DKRZ's Halo nodes since the end of 2012, and we have now prepared a little tutorial that will teach you how to use Paraview for the visualization of your own climate research data.

More general information on Paraview, along with some tutorial data can also be found online on the [Paraview website](#).



The above example shows a complex visualization of an ICON ocean data set using Paraview. The viewport on the right displays the data, the selection made, as well as the Earth's topography. The three viewports on the left hand side are used to specify the selection, based on a scatterplot matrix and parallel coordinates. These techniques are especially well suited for an in-depth data analysis and exploration.

Paraview Tutorial

The final tutorial document will comprise 8 chapters and will be released at the end of the summer in 2014. Alongside, we will provide courses to teach Paraview in a hands-on setting. The first course will already start in December 2013.

Here is a glimpse of the content from the tutorial:

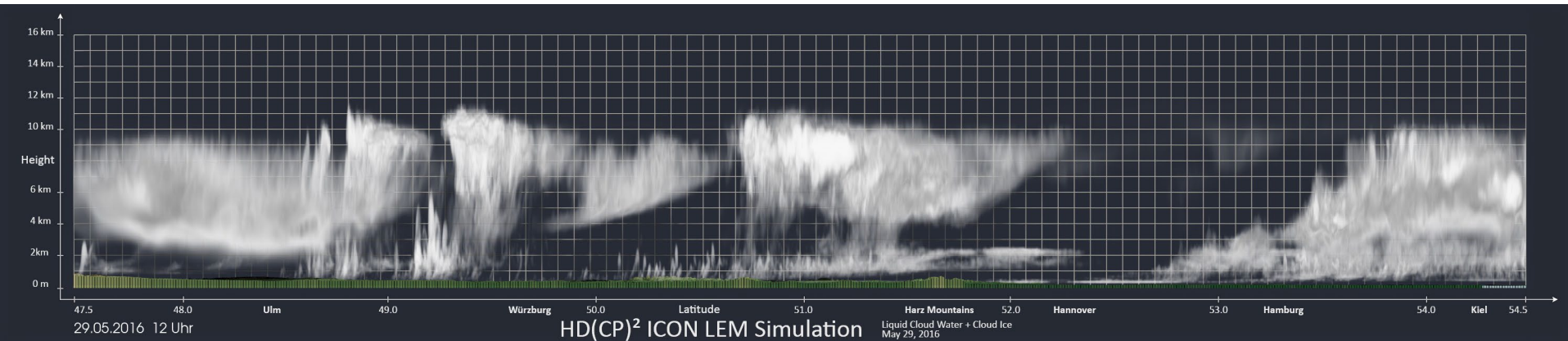
- Chapter 1 "Introduction and Overview" --- The first Chapter starts with an overview of Paraview and briefly explains the underlying visualization toolkit pipeline. The second part of this chapter concentrates on an introduction of the user interface, some data preparation steps, and creates a first simple visualization, supported using an ECHAM

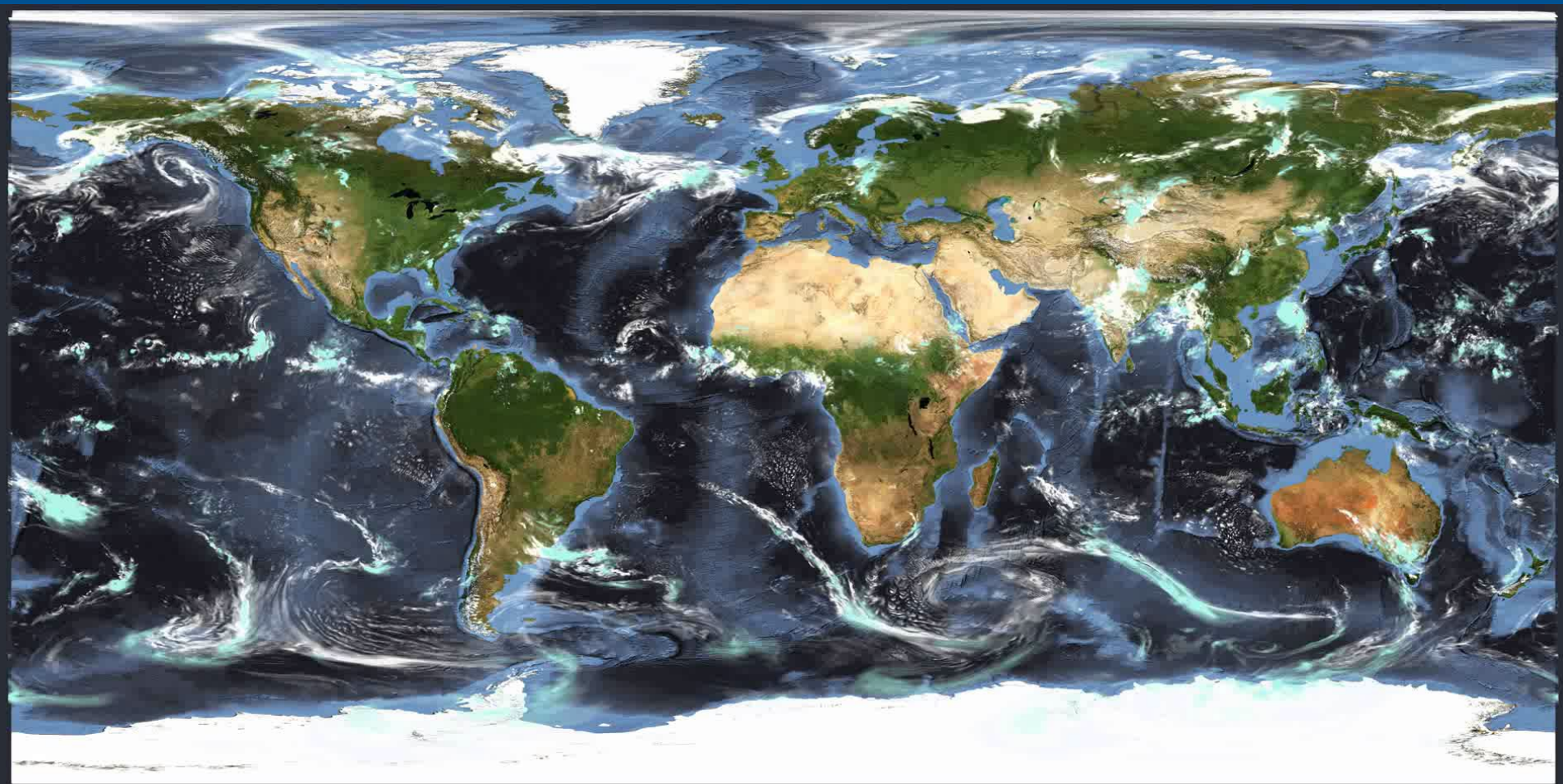
Visualization Work at DKRZ

- Looking at ways to work and interact with LARGE data
 - In-situ visualization with ParaView/Catalyst
 - Compression and progressive data visualization using wavelets and Vapor
 - Batch visualization on MISTRAL using ParaView and NCL
- Compression, especially *lossy*, as it has always been done (precision, variables, temporal/spatial resolution, model error, GRIB)
- Visualization of uncertainty
- Multivariate data visualization
- Machine learning & online feature tracking

See, understand, learn, communicate ...

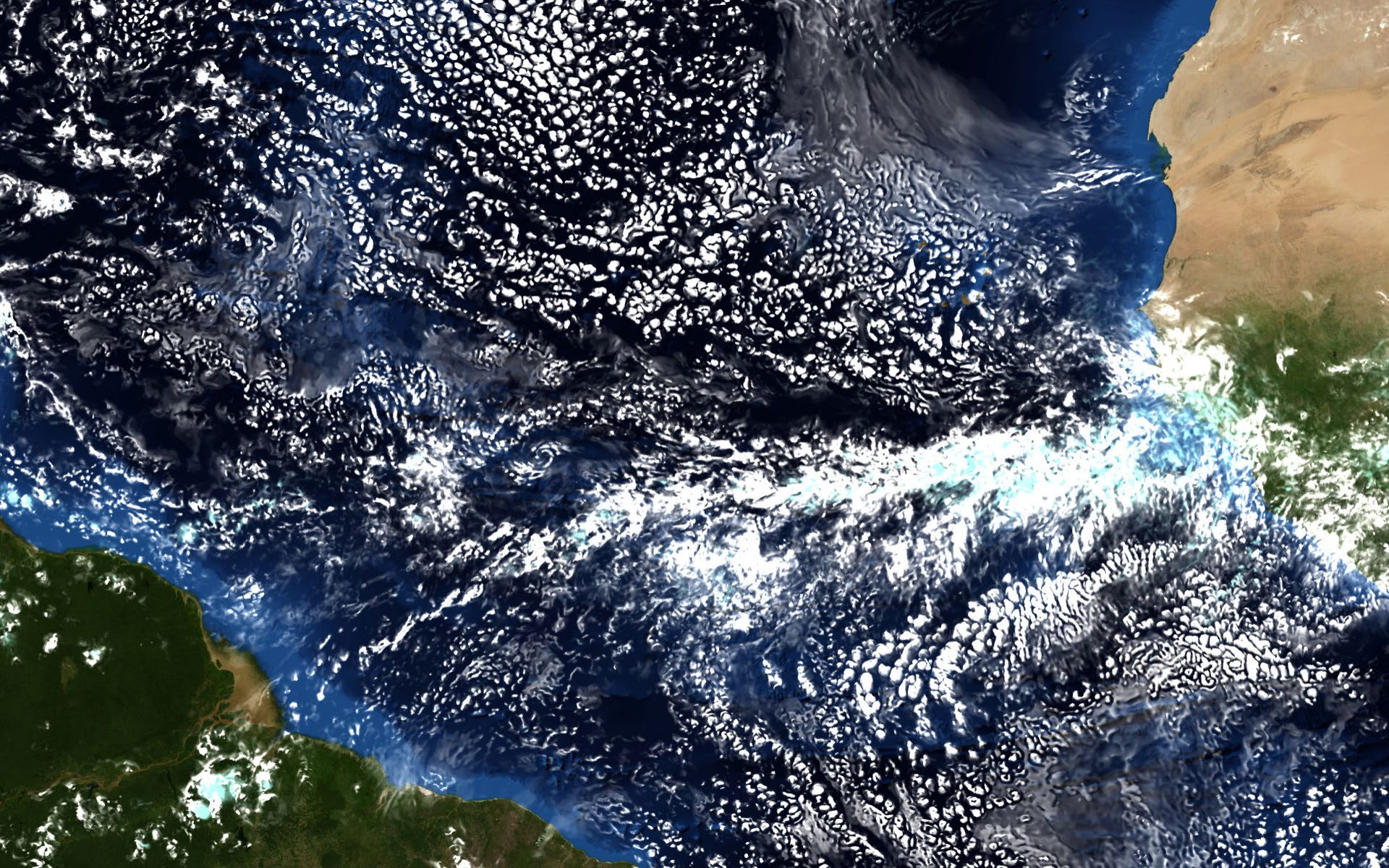
- **Confirmatory** visualization
- **Exploratory** visualization
- Creating animations & stills for **communication**

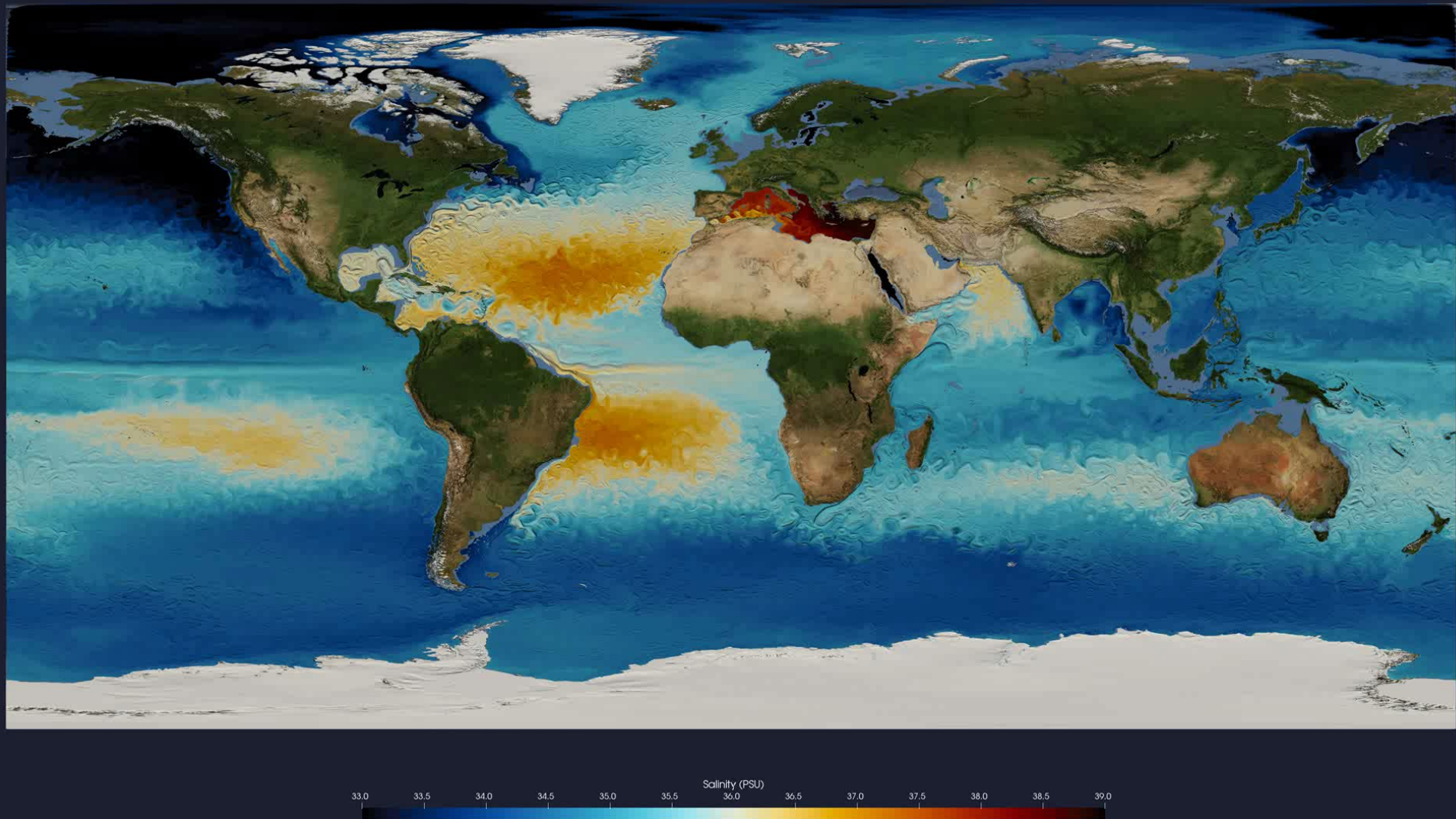




ICON DYAMOND R2B10 2.5km Resolution
01.08.2016 at 00:00







Velocity Magnitude (m/s)

Salinity (PSU)



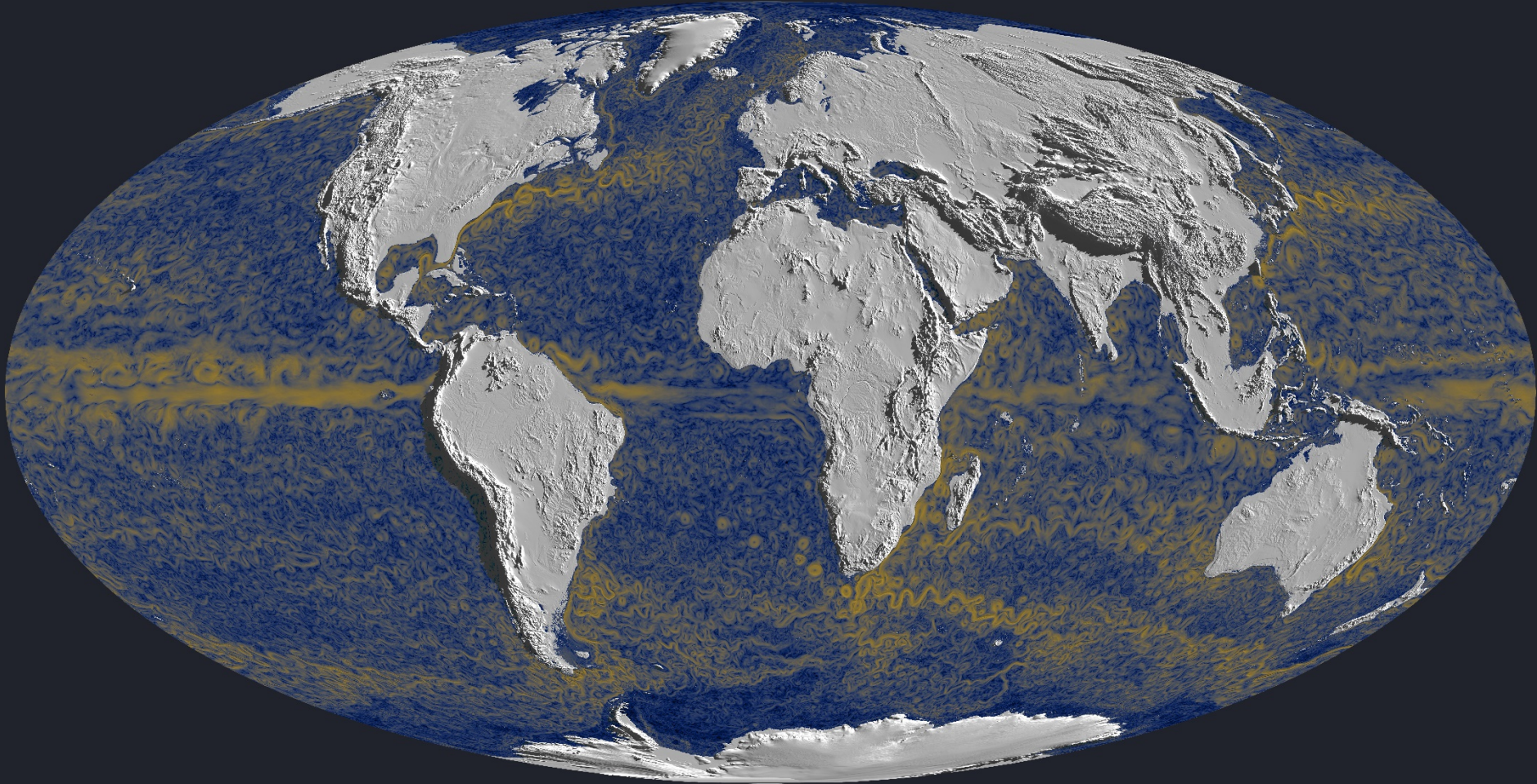
20.01.2020 01:00

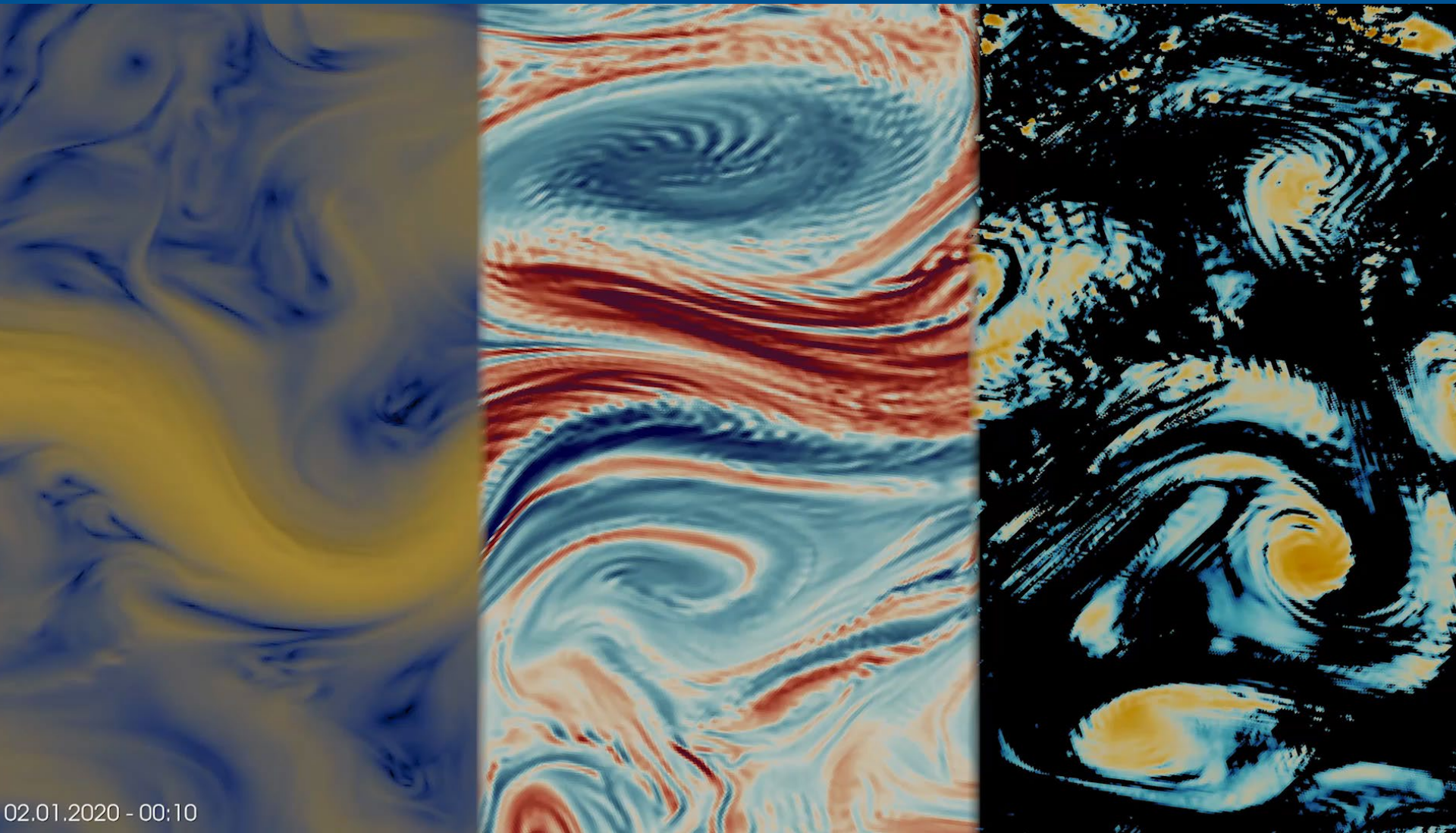
Niklas Röber (DKRZ)

13.09.2021

10

ICON Ocean 1.25km



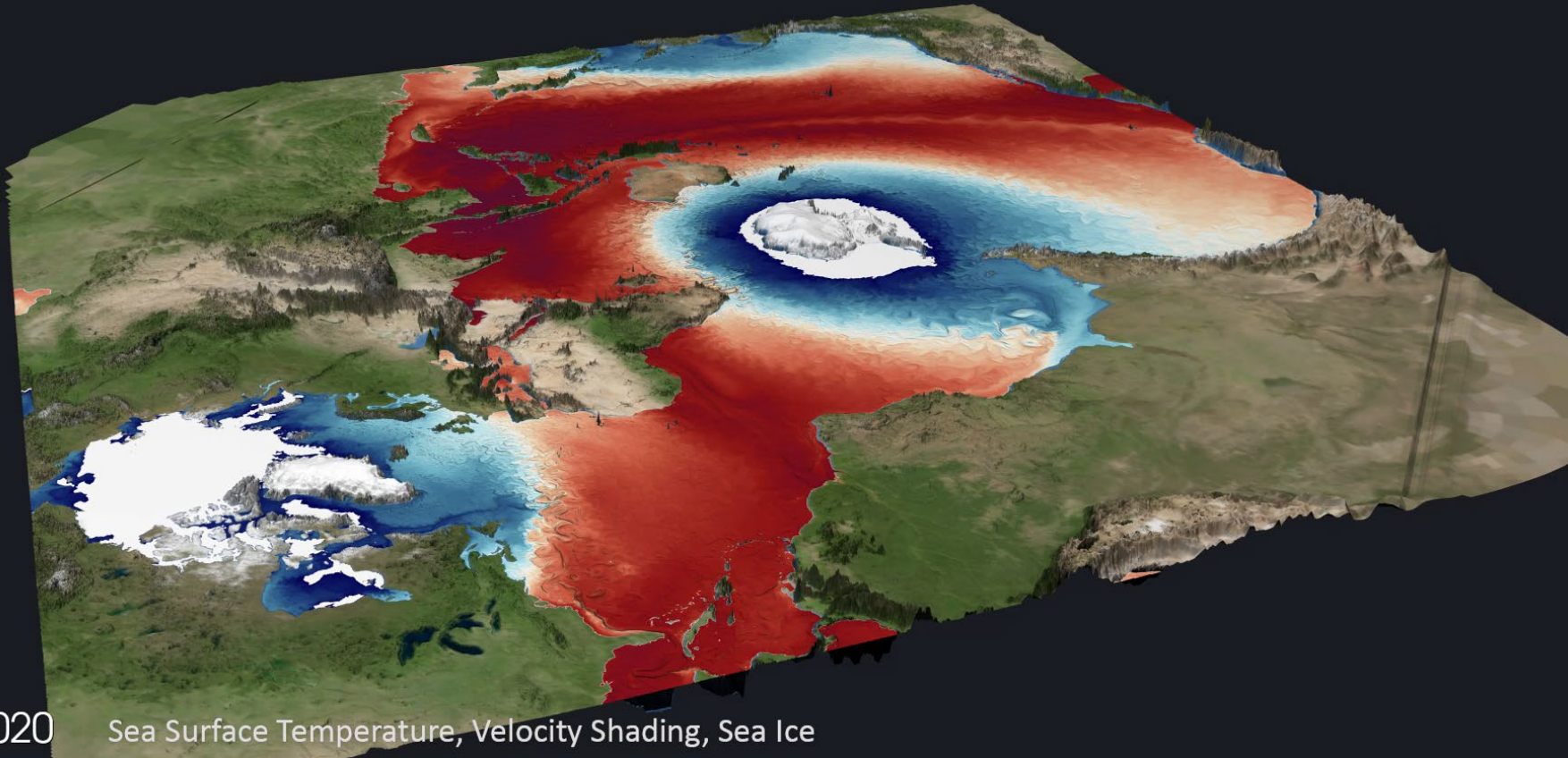


02.01.2020 - 00:10

Niklas Röber (DKRZ)

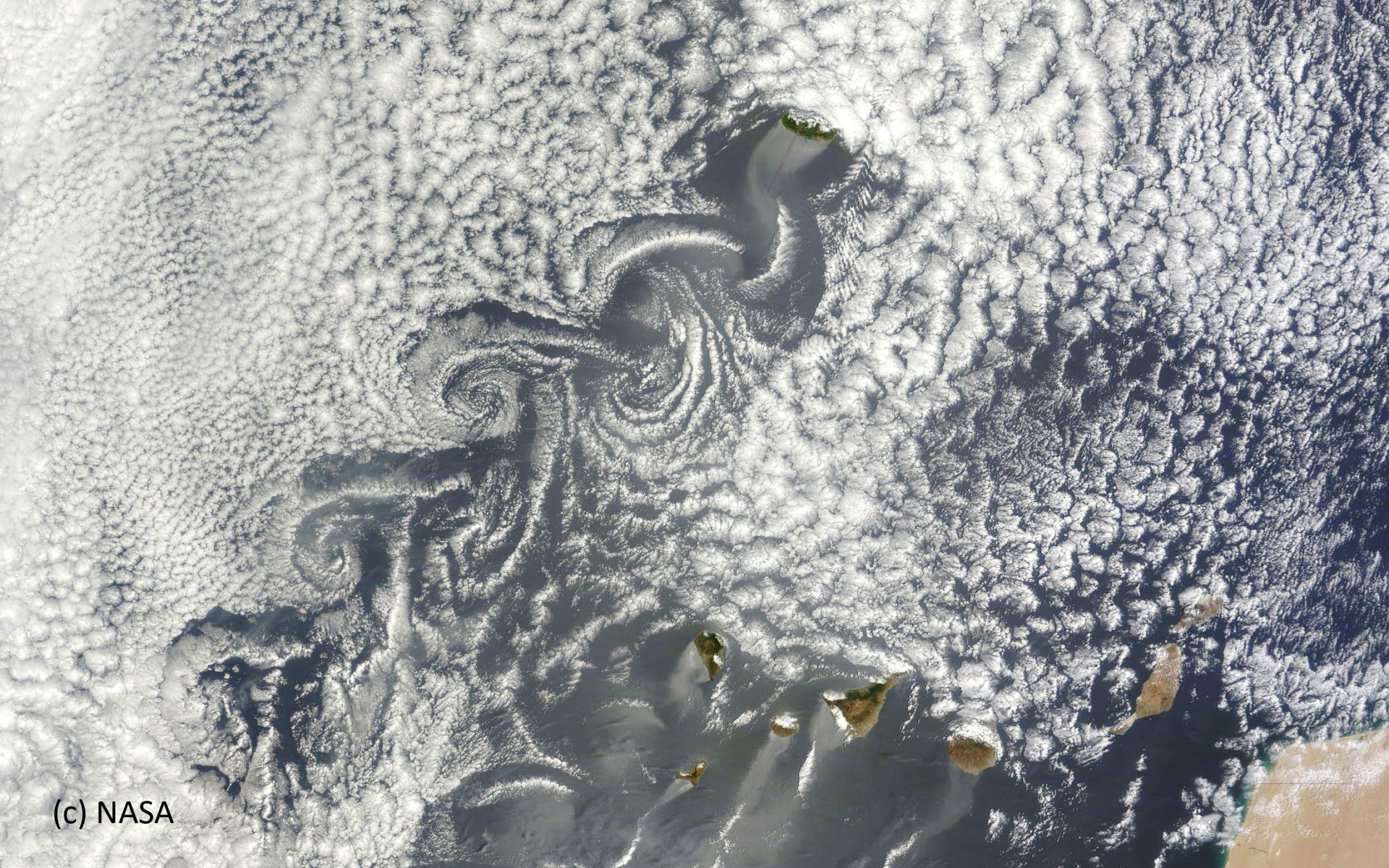
13.09.2021

12



02.07.2020

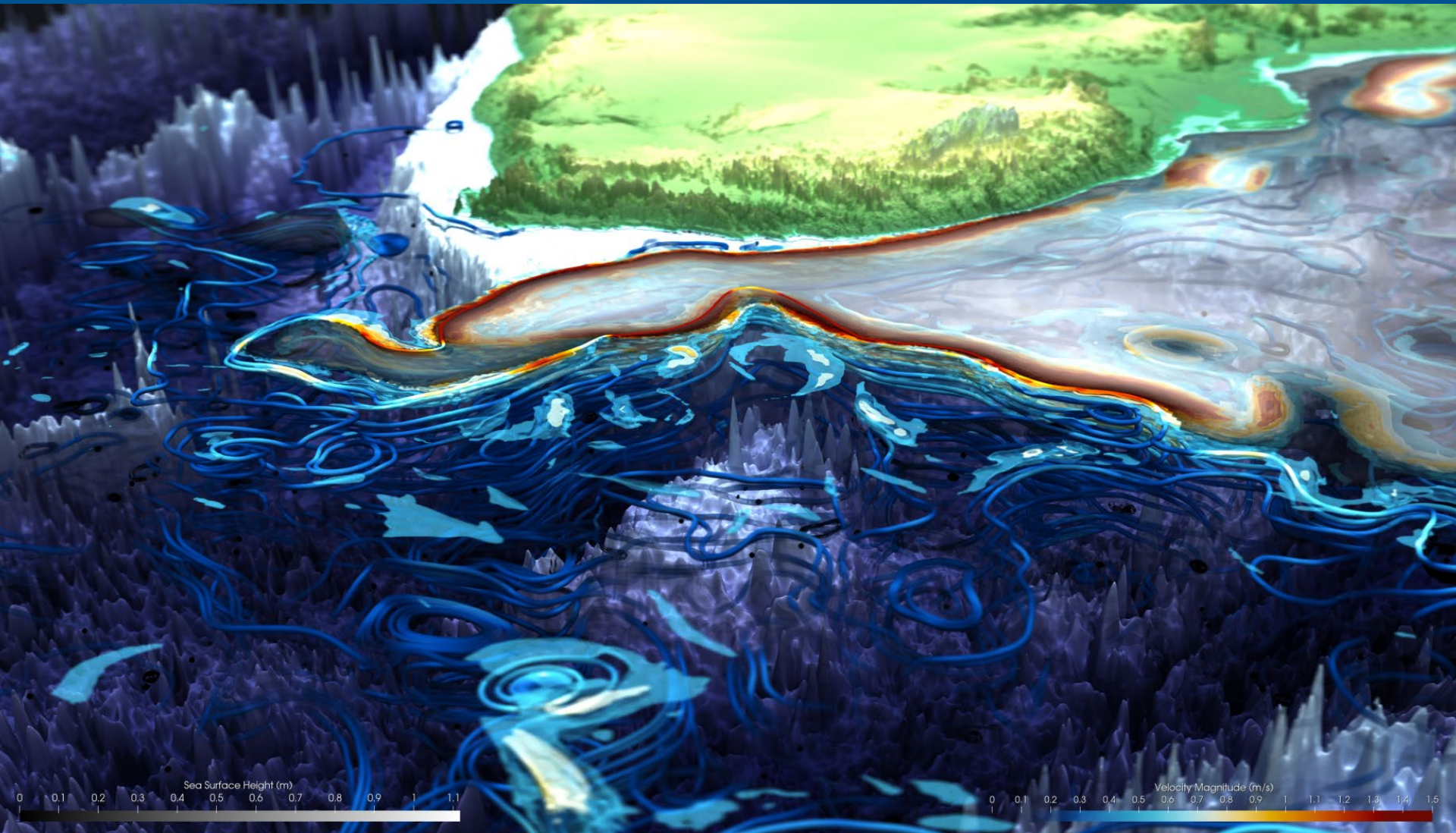
Sea Surface Temperature, Velocity Shading, Sea Ice

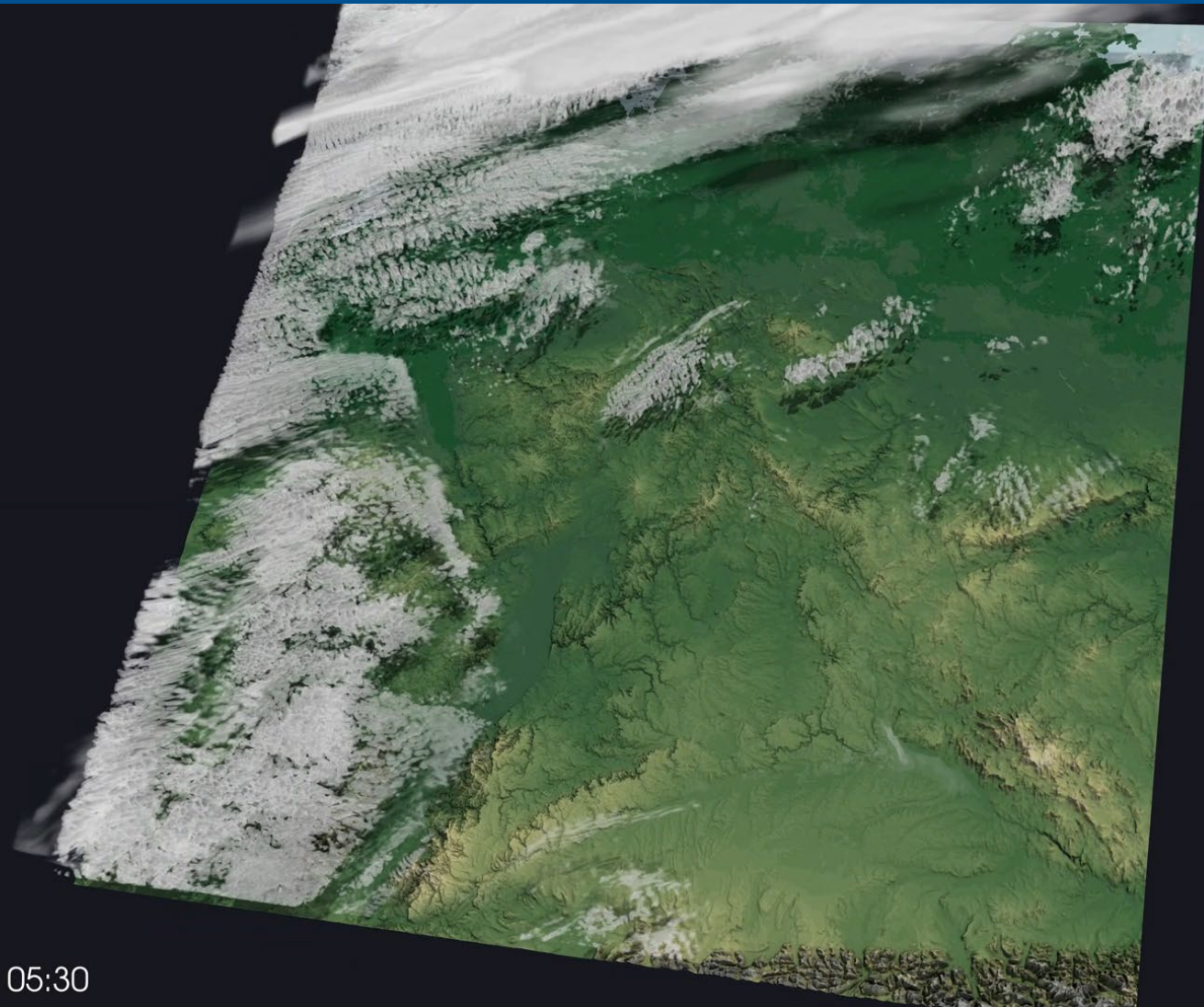


(c) NASA

Canary Islands

DYAMOND R2B10 - 2D Wind Visualization
(3 Minute Output - 10m Height)



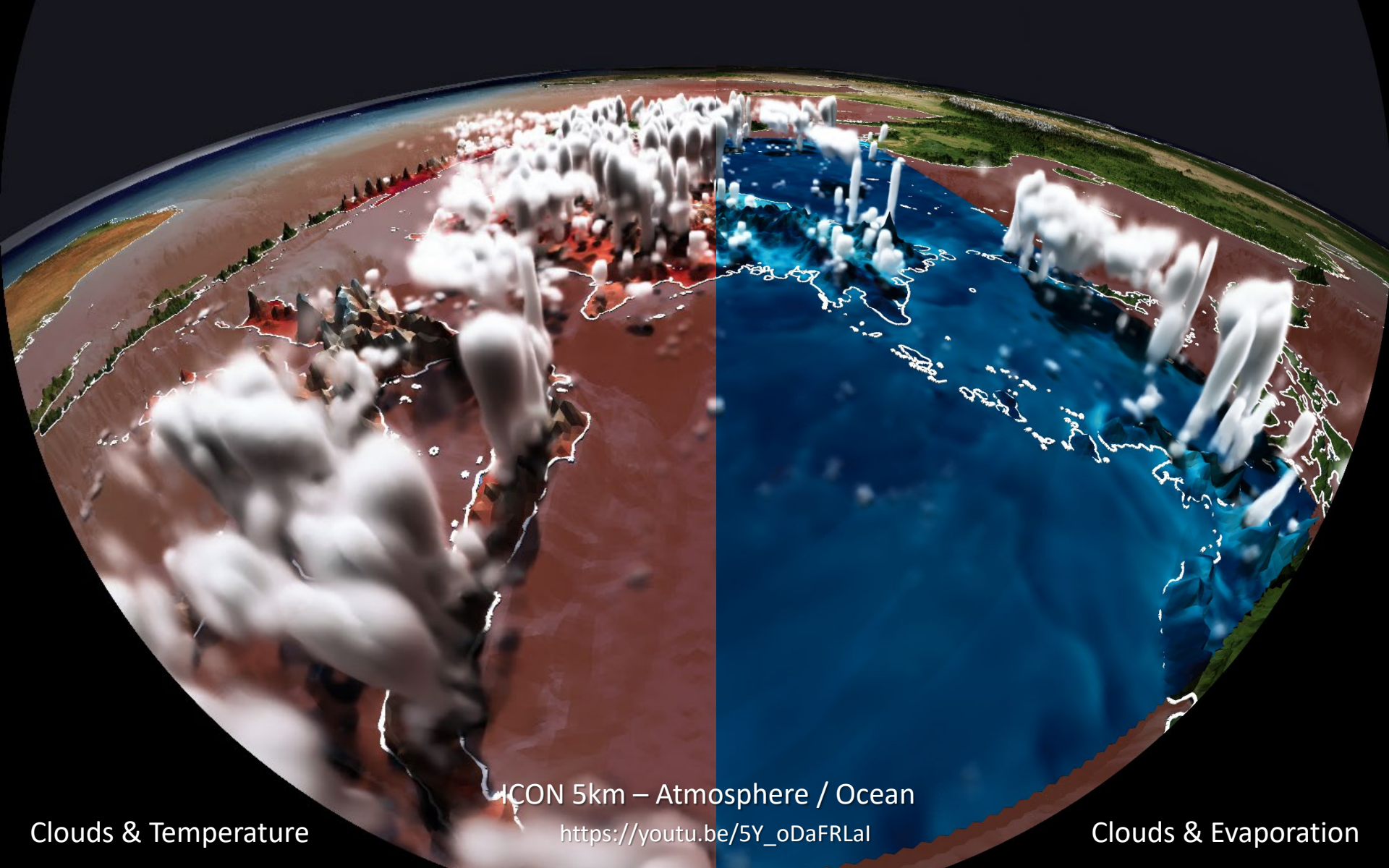


26.04.2013 05:30

Niklas Röber (DKRZ)

13.09.2021

17

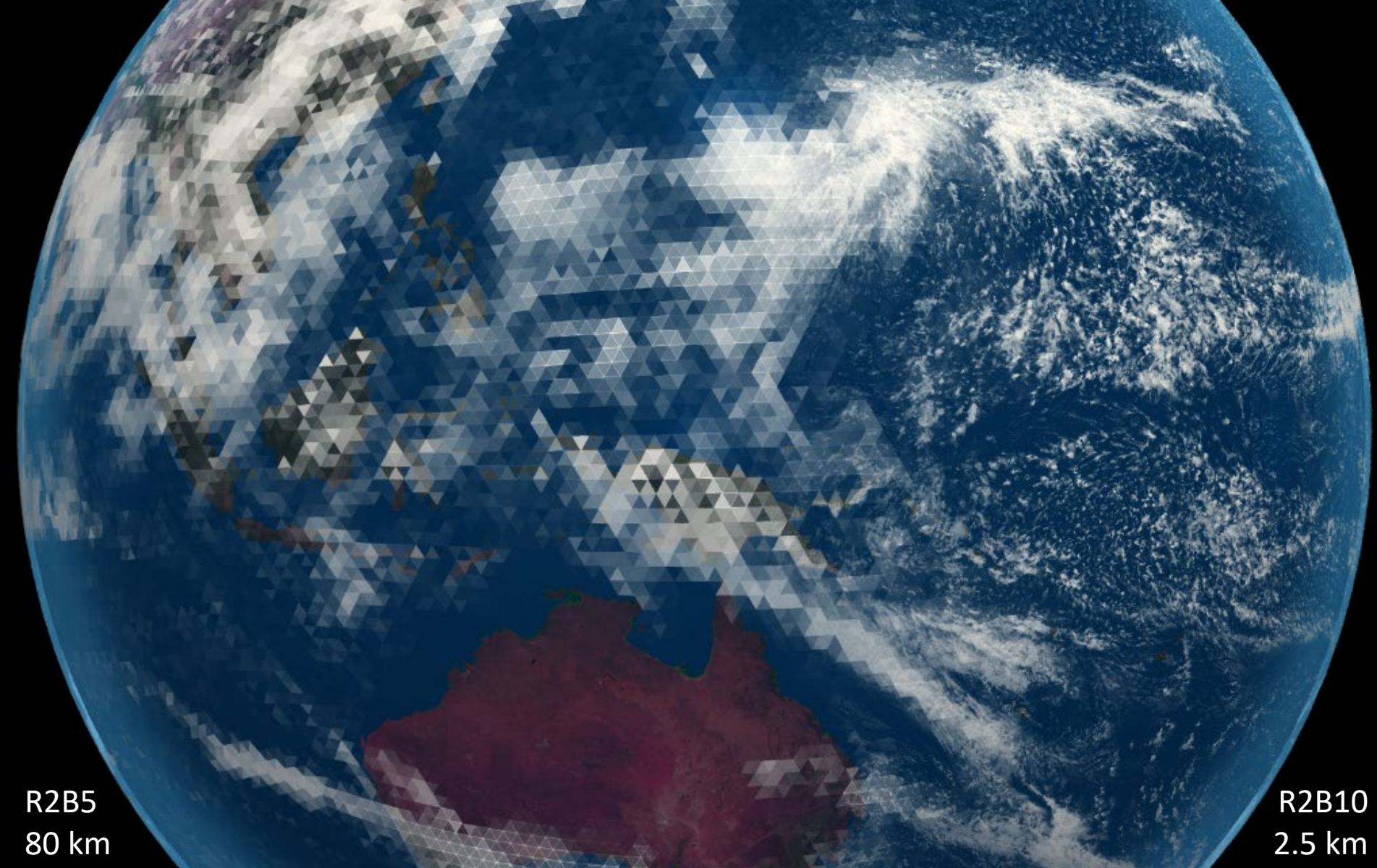


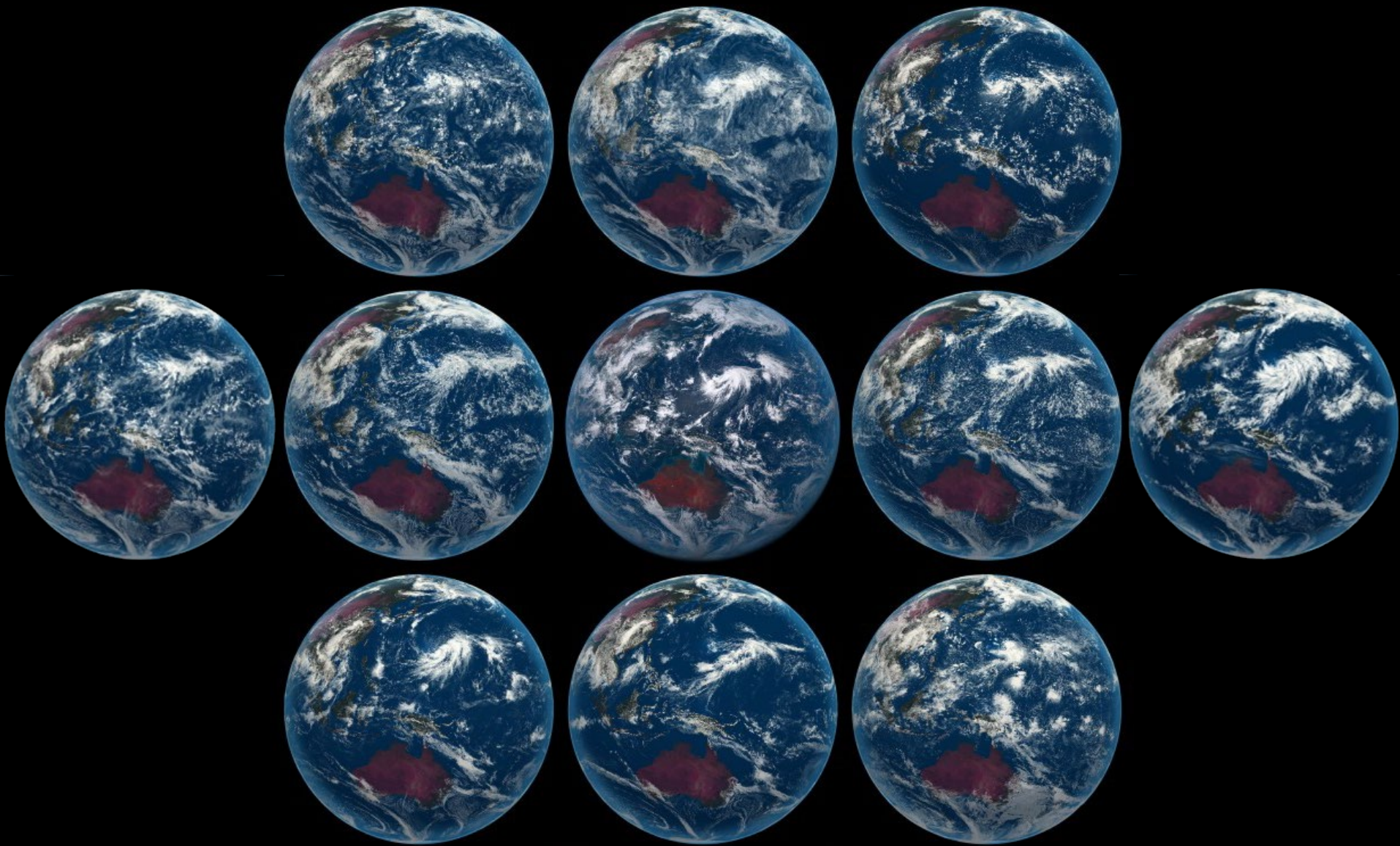
ICON 5km – Atmosphere / Ocean

Clouds & Temperature

https://youtu.be/5Y_oDaFRLal

Clouds & Evaporation









- 21 GPU nodes (two Haswell/Boadwell, 256/512/1024 GB memory)
- 4 GPUs per node (two dual Kepler/Maxwell)
- Software: NCL, ParaView, VaPOR, IDL, Python

Visualization Software on Mistral

Type	Name	URL	Properties	
Domain-specific	NCL	http://www.ncl.ucar.edu/	2D script-based	free
	IDV	http://www.unidata.ucar.edu/software/idv/	2D/3D interactive GUI	free
	Vapor	https://www.vapor.ucar.edu/	3D interactive GUI	free
	UV-CDAT	http://uvcdat.llnl.gov/	Collection: 2D /3D tools	free
	GrADS	http://cola.gmu.edu/grads/	2D script-based	free
	GMT	http://gmt.soest.hawaii.edu/	2D script-based	free
	PyNGL / PyNIO	https://www.pyngl.ucar.edu/Download/	2D script-based	free
General-purpose	ParaView	http://www.paraview.org/	3D interactive GUI	free
	Visit	https://visit.llnl.gov/	3D interactive GUI	free
	Avizo	https://www.fei.com/software/avizo3d/	3D interactive GUI	\$\$
	IDL	http://www.harrisgeospatial.com/	2D script-based	\$\$
	Python / matplotlib	http://matplotlib.org/	2D script-based	free

Linked Views in ParaView

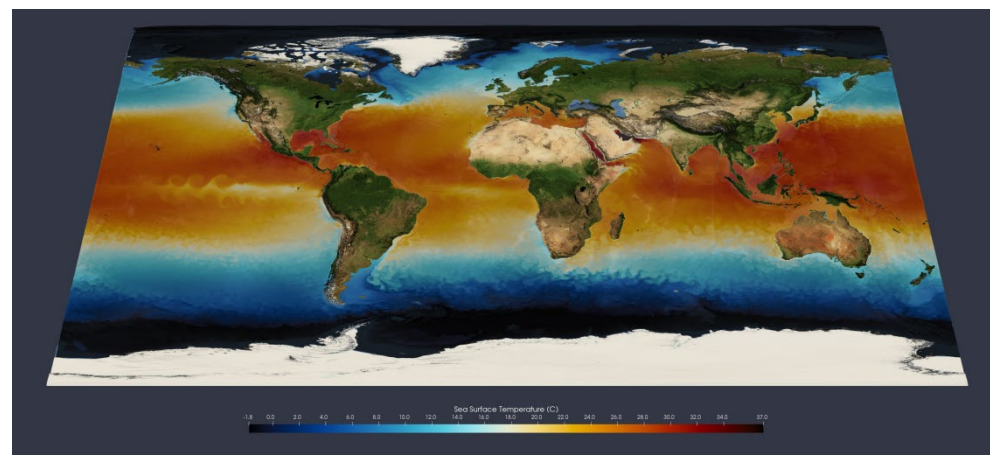
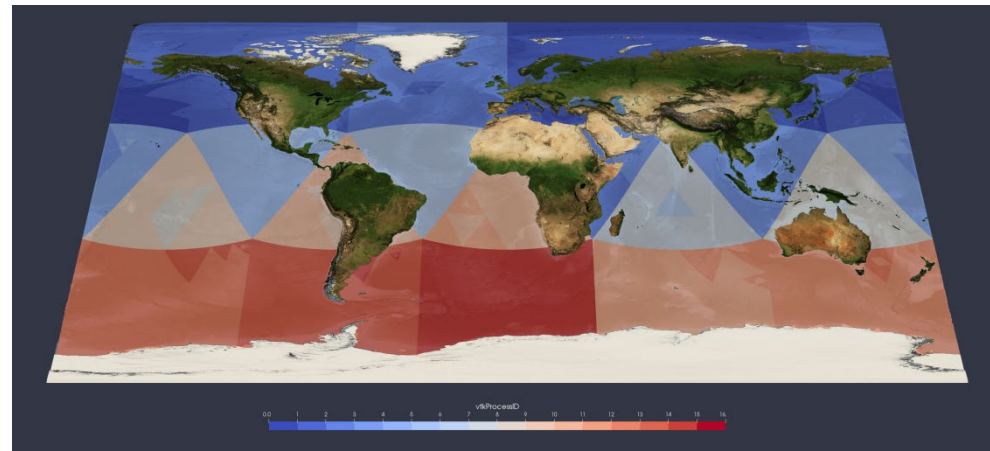
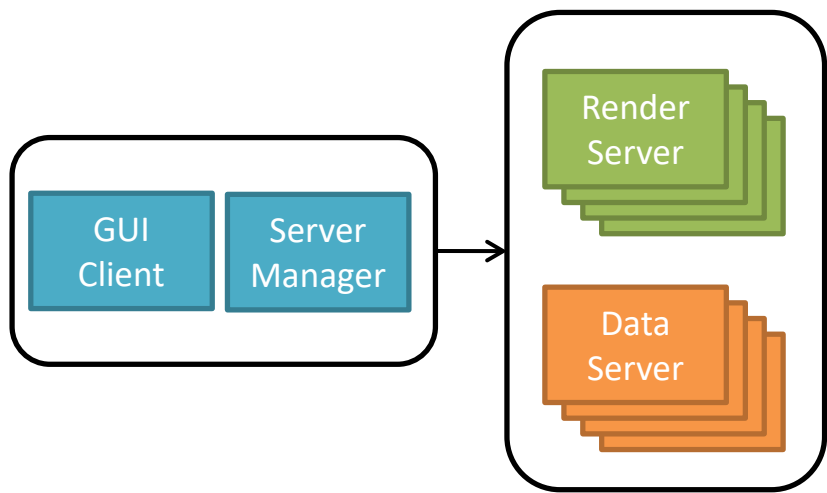
The screenshot displays the ParaView interface with three main views:

- RenderView1:** A 3D globe showing a yellow grid overlaying the Earth's surface. The title bar indicates 'Sea Surface Height' with a color scale from -1.89 to 0.942.
- PlotMatrixView1:** A 2D plot matrix showing histograms and scatter plots for variables: ELEV, Ekin, mo, and S. The axes are labeled with values like 0, 10, 20, 30, 40.
- SpreadSheetView1:** A data table with columns: Cell ID, Cell Type, ELEV, Ekin, Sea Mask (S), and T. The table contains 20 rows of data.

On the left, the Pipeline Browser shows the data source 'icon_ocean_time.nc' and the Color Map Editor for 'Sea Surface Height'.

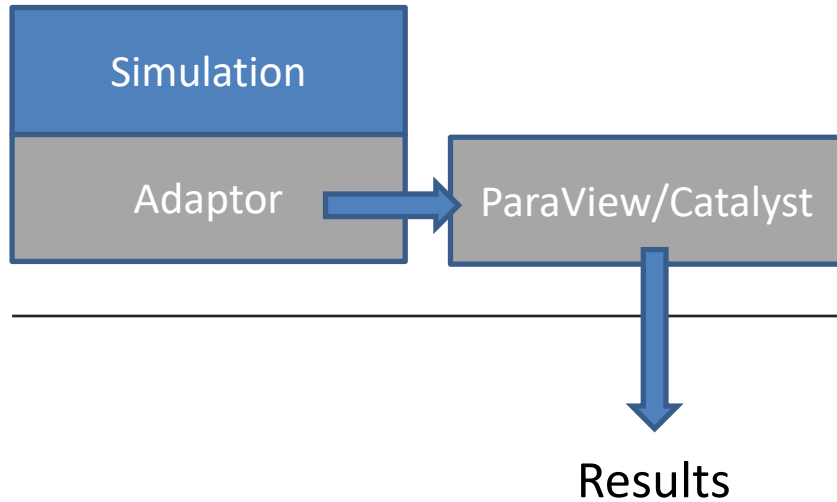
Showing	Cell ID	Cell Type	Attribute: ELEV	Cell Data: Ekin	Sea Mask (S)	T
635	18021	Triangle	-1.52816	0.00342...	1	34.1431
636	16995	Triangle	-1.52755	0.00245...	1	34.1427
637	19028	Triangle	-1.52699	0.00727...	1	33.9291
638	19012	Triangle	-1.52676	0.00754...	1	33.8666
639	18661	Triangle	-1.52671	0.00118...	1	34.1518
640	17994	Triangle	-1.52355	0.00691...	1	34.1434
641	18174	Triangle	-1.52337	0.00089...	1	34.0001
642	18519	Triangle	-1.523	0.01145...	1	34.1585
643	15569	Triangle	-1.52279	0.00264...	1	34.0922
644	15562	Triangle	-1.52096	0.00375...	1	34.089
645	16992	Triangle	-1.52064	0.00338...	1	34.1378
646	19670	Triangle	-1.52019	0.00758...	1	34.2011
647	16986	Triangle	-1.51984	0.00323...	1	34.1786
648	18017	Triangle	-1.51977	0.00803...	1	34.1475
649	15544	Triangle	-1.51848	0.00203...	1	34.0578
650	15542	Triangle	-1.51841	0.00453...	1	34.1029
651	20202	Triangle	-1.51836	0.00079...	1	34.1006
652	19304	Triangle	-1.51818	0.00375...	1	34.1393
653	15590	Triangle	-1.51556	0.00319...	1	34.0837
654	17943	Triangle	-1.51444	0.00253...	1	34.0315
655	16990	Triangle	-1.51421	0.00486...	1	34.1377
656	19595	Triangle	-1.51407	0.00525...	1	34.1379
657	17144	Triangle	-1.51365	0.00320...	1	34.1531
658	15978	Triangle	-1.51279	0.00336...	1	34.0979
659	17124	Triangle	-1.50995	0.04927...	1	34.1565
660	18119	Triangle	-1.50918	0.00076...	1	34.0252
661	18014	Triangle	-1.50917	0.00419...	1	34.153
662	18659	Triangle	-1.5091	0.00107...	1	34.1412
663	17938	Triangle	-1.50859	0.00250...	1	34.0542
664	15538	Triangle	-1.50841	0.00371...	1	34.073
665	18003	Triangle	-1.50777	0.00059...	1	34.1533

Parallel Processing and Visualization

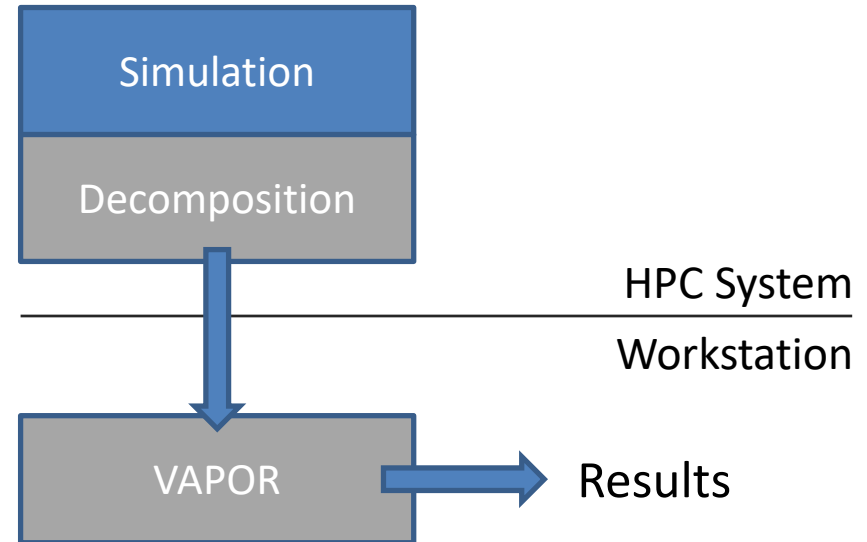


Large Data Visualization

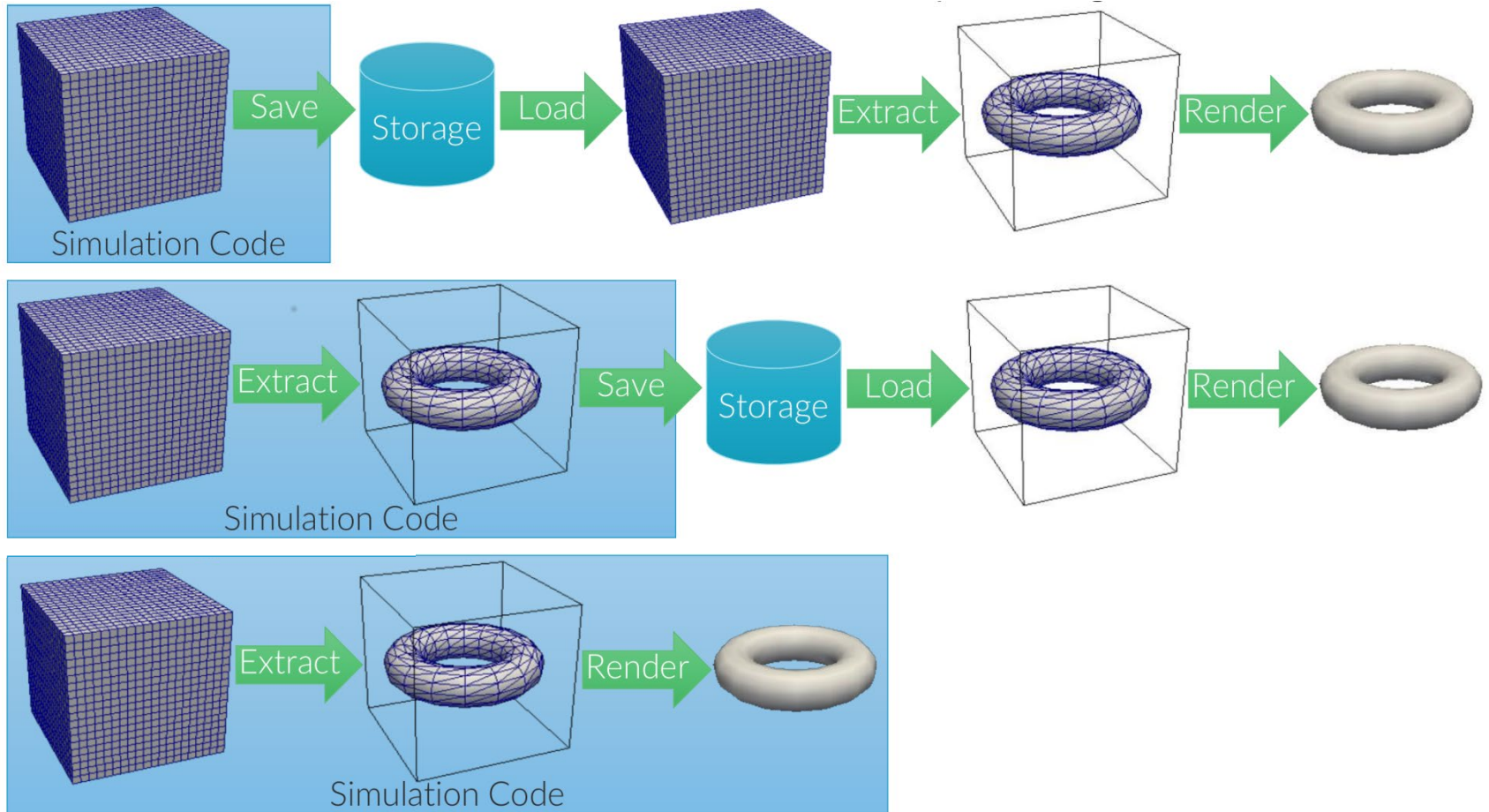
In Situ Visualization (ParaView/Catalyst)



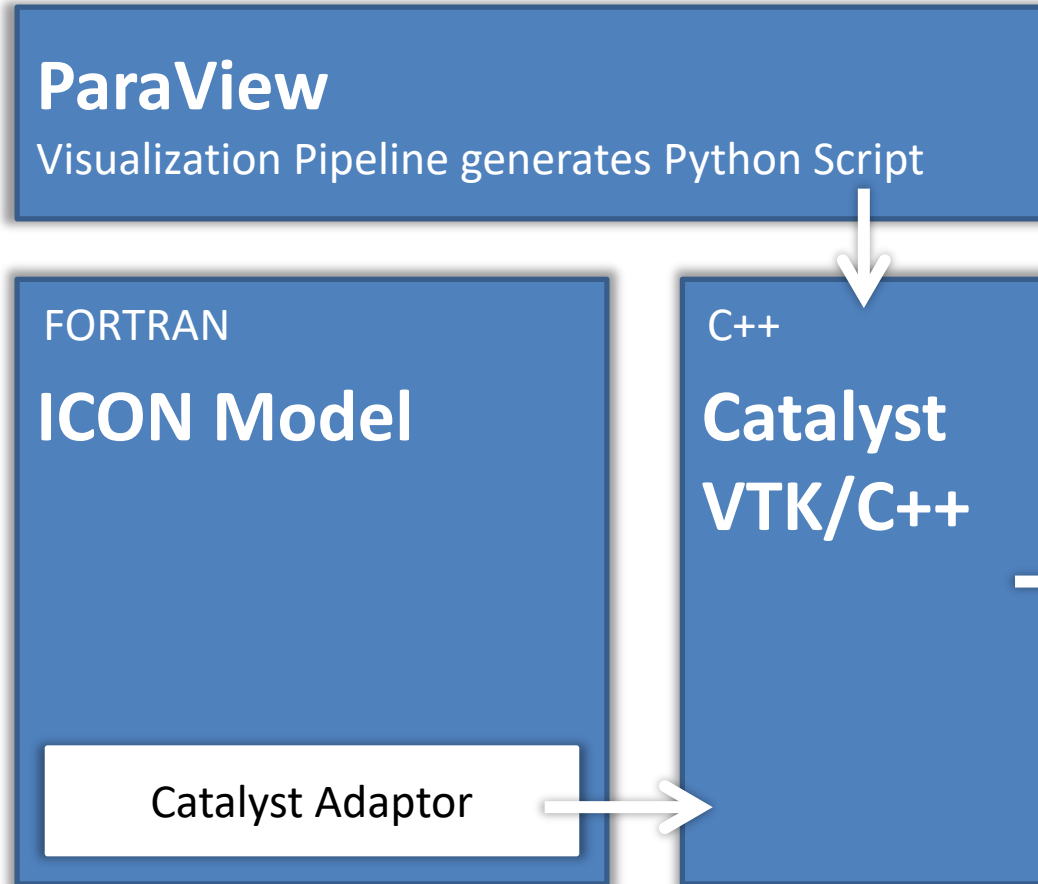
Progressive Visualization (VAPOR)



From Post Visualization to In-Situ



ICON and Catalyst Adaptor



- Rendered images
- Cinema database
- Data reduction (par. I/O)
- Feature det./tracking (e.g. cloud classification)
- Live visualization
- Data decomp./comp.

Advantages

- Much less I/O
-> Simulation faster / less disk
- Preview of data
- In situ feature tracking
- Analyze extremely large simulation “output”
- Time to knowledge shorter

Drawbacks

- Additional resources required
- A priori knowledge needed
- Need to run sim/vis again for new analysis/visualization
- Workflow complexity increases
- Statistical analysis more complex

Generating a Catalyst Script

The screenshot shows the ParaView 5.6.0-RC2 64-bit interface. The main window displays a 3D visualization of a catalyst structure, with a pinkish-purple surface and a blue base. The Catalyst Export Inspector dialog box is open, showing the following settings:

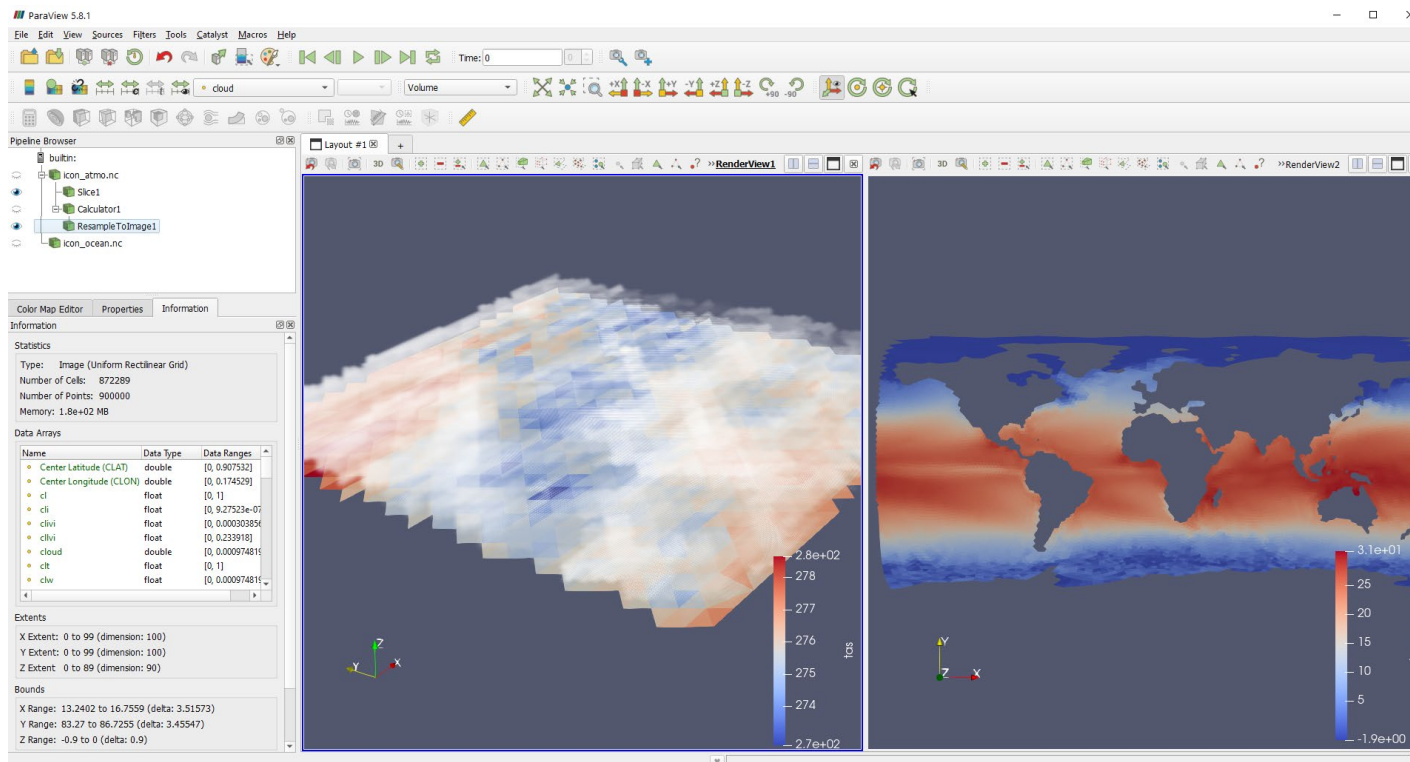
- Data Extracts:** Threshold1, XMLPUnstructuredGridWri (checked)
- Image Extracts:** RenderView1, PNG image (*.png)
- Global Settings:**
 - Enable Live Connections
 - Live Frequency: 1
 - Root Directory: bn/experiments/atm_icoles_giraffe/
 - File Padding: 0
 - Request Specific Arrays
 - Write Start: 0
 - Force First Output
 - Rescale to Data Range
 - Save Cinema D Table

Timings R2B10 – 2.5km global / 540 nodes

name	# calls	t_min	min r	t_avg	t_max	max r	total min (s)	total min r	total max (s)	total max rank
total	4305	06m48s	[6]	06m48s	48s	[3919]	408.010	[6]	408.027	[3919]
L wrt_output	8610	0.00778s	[17]		90s	[3239]	23.707	[14]		[2838]
L integrate_nh	344400	3.9458s	[34]		784s	[256]	347.016	[34]		[0]
L nh_solve	1722000	0.29028s			31s	[216]	156.504	[20]		[47]
L nh_hdiff	344400	0.09548s	[13]		944s	[420]	8.426	[21]		[1852]
L physics	344400	0.53099s	[4]	0.02430s	728s	[2598]	57.132	[4]	2.037	[2831]
....										
L insitu_set_var	344400	0.01999s		0.06853s	760s	[221]	1.663		10.067	[126]
L insitu_do_work	340095	0.00014s	[10]	1.6174s	341s	[0]	5.312	[23]	2.033	[0]
L insitu_do_work1st	4305	1.5387s	[22]		325s	[0]	1.539	[22]		[0]
....										
model_init	12915	1.5042s	[17]	01m11s	01s	[1672]	214.388	[19]	215.458	[885]
L insitu_init	4305	4.9177s	[19]	6.1077s	381s	[4164]	4.918	[19]	6.388	[4164]

- www.paraview.org
- discourse.paraview.org
- www.paraview.org/Wiki/The_ParaView_Tutorial
- www.dkrz.de/up/services/analysis/visualization/sw/paraview

Hands-on Examples with ParaView



<https://nextcloud.dkrz.de/s/eEg9Xz8FTbGJDR6>

My favorite Pancake Recipe (4 pcs.)

- 50g Butter
- 200g Flower
- 50g Powder Sugar
- 2tsp. Baking Powder
- 1/4tsp. Salt
- 250ml Milk
- 2 Eggs
- 4tbsp. Oil
- Mix flower, backing powder, sugar and salt together.
- Put mix into bowl and make a dent in the middle.
- Put milk and eggs in and stir together using an egg beater. Stir for a few minutes.
- Melt the butter and stir into the mix using egg beater.
- Let it all sit for 20 – 30 minutes.
- Use the oil and heat up frying pan on middle/high heat. (Not too high!!!)
- Bake 2 minutes on first side and about 1 on the second.
- Stack together with more butter and maple syrup!
- Enjoy!



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CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER
AND CLIMATE IN EUROPE



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