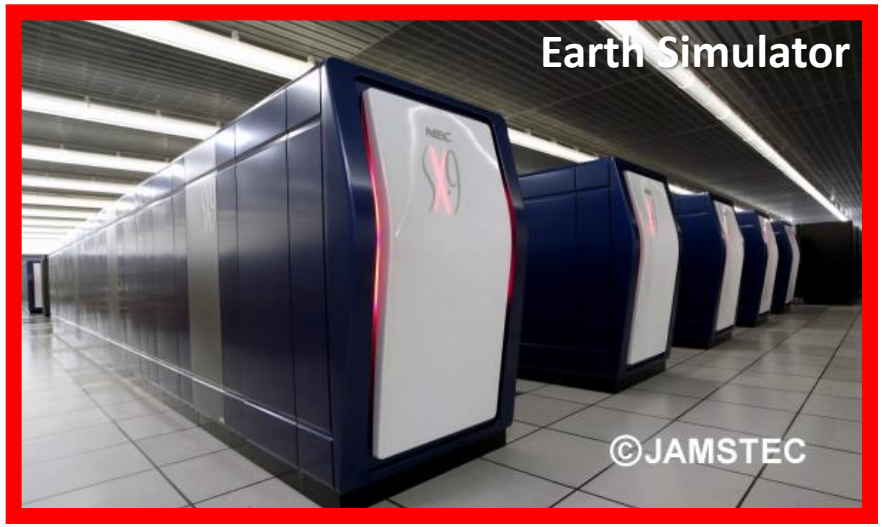
SCWS2017
Creative Informatics for the Earth

Visualization of Geoscientific Simulation Data in Academic Research

Daisuke Matsuoka, Ph.D.

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Research facilities/target in JAMSTEC



Facilities/instruments

- Drilling vessel
- AUV/ROV
- Manned submersible
- Super computer

etc.

Scientific target

- Ocean
- Atmosphere
- Earth’s interior
- Submarine creature

etc.

JAMSTEC 独立行政法人 海洋研究開発機構
JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY

» 日本語

Advanced Visualization and Computation Research Group, Center for Earth Information Science and Technology

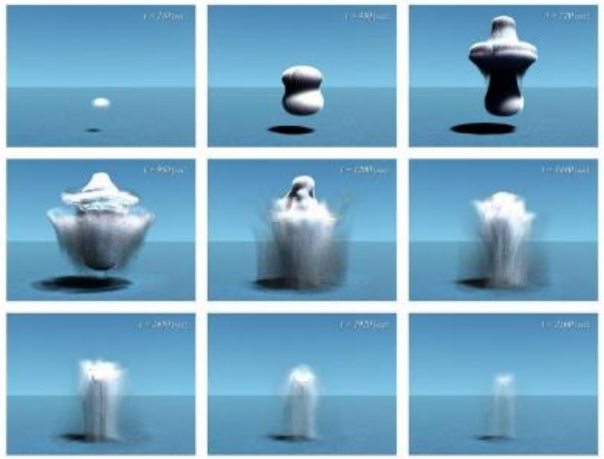
Research

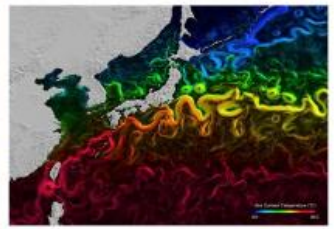
- EXTRAWING
- Volume Data Visualizer for Google Earth
- Data mining
- Large-scale Parallel Visualization
- VFIVE

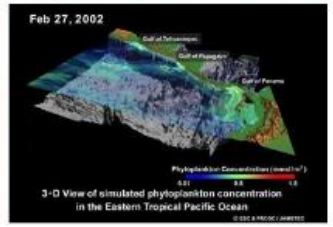
Advanced Visualization and Perception Research Group/Research

Last update : 2012.10.01

Data visualization is an indispensable step in the simulation researches. We can extract hidden information behind massive numerical data only through the visualization. When the output data to be visualized are small enough, simple graphs or charts are sufficient to understand what happened, or simulated, in the computer. However, when the data size becomes large, more sophisticated methods or tools than simple graphs are required for the data visualization.







One of the focused technologies in our research and development is the virtual reality (VR). Our VR system is described in other page. We investigate the application of advanced VR technology to

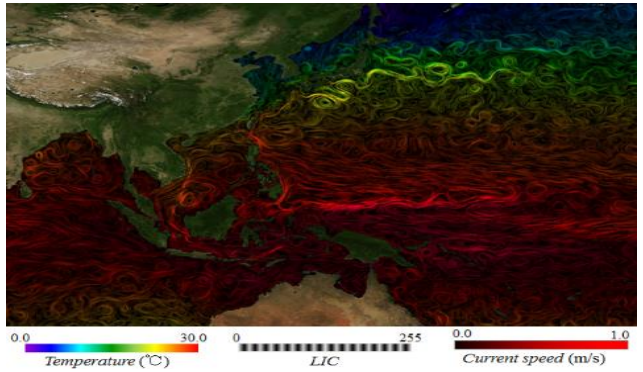
Study on scientific data visualization

- Visualization for analytics
- Visualization for machine learning
- Visualization for scientific arts and artistic science
- Visualization for virtual reality (VR) System
- Visualization for general public

Visualization for Analytics

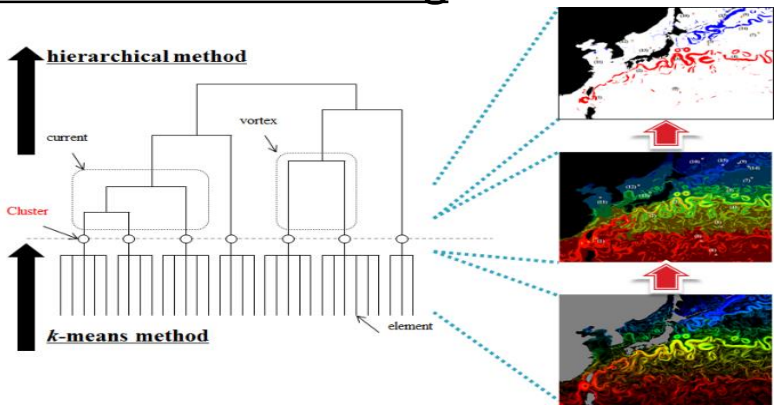
Visualization for analytics

1. Visual representation



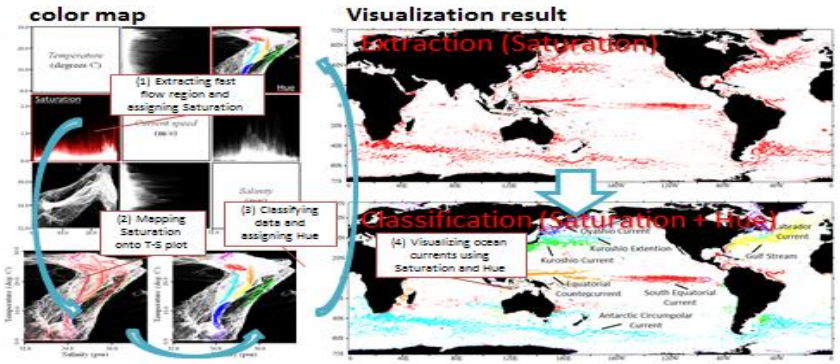
Matsuoka et al., 2012

2. Visual data mining



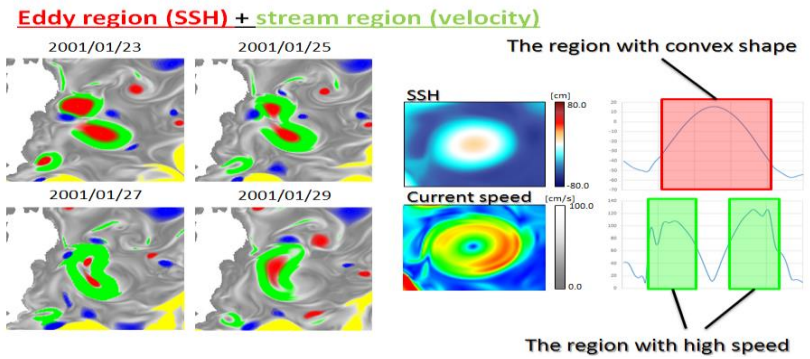
Matsuoka et al., 2012

3. Visual analytics



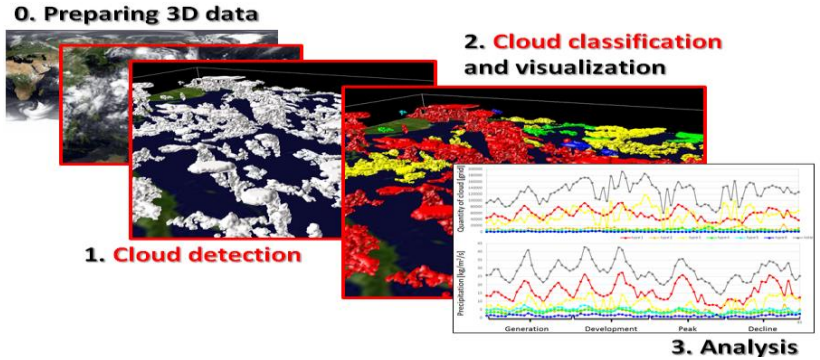
Matsuoka et al., 2015

4. Feature tracking



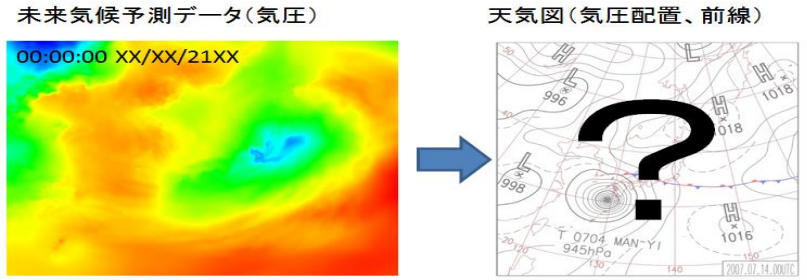
Matsuoka et al., 2016

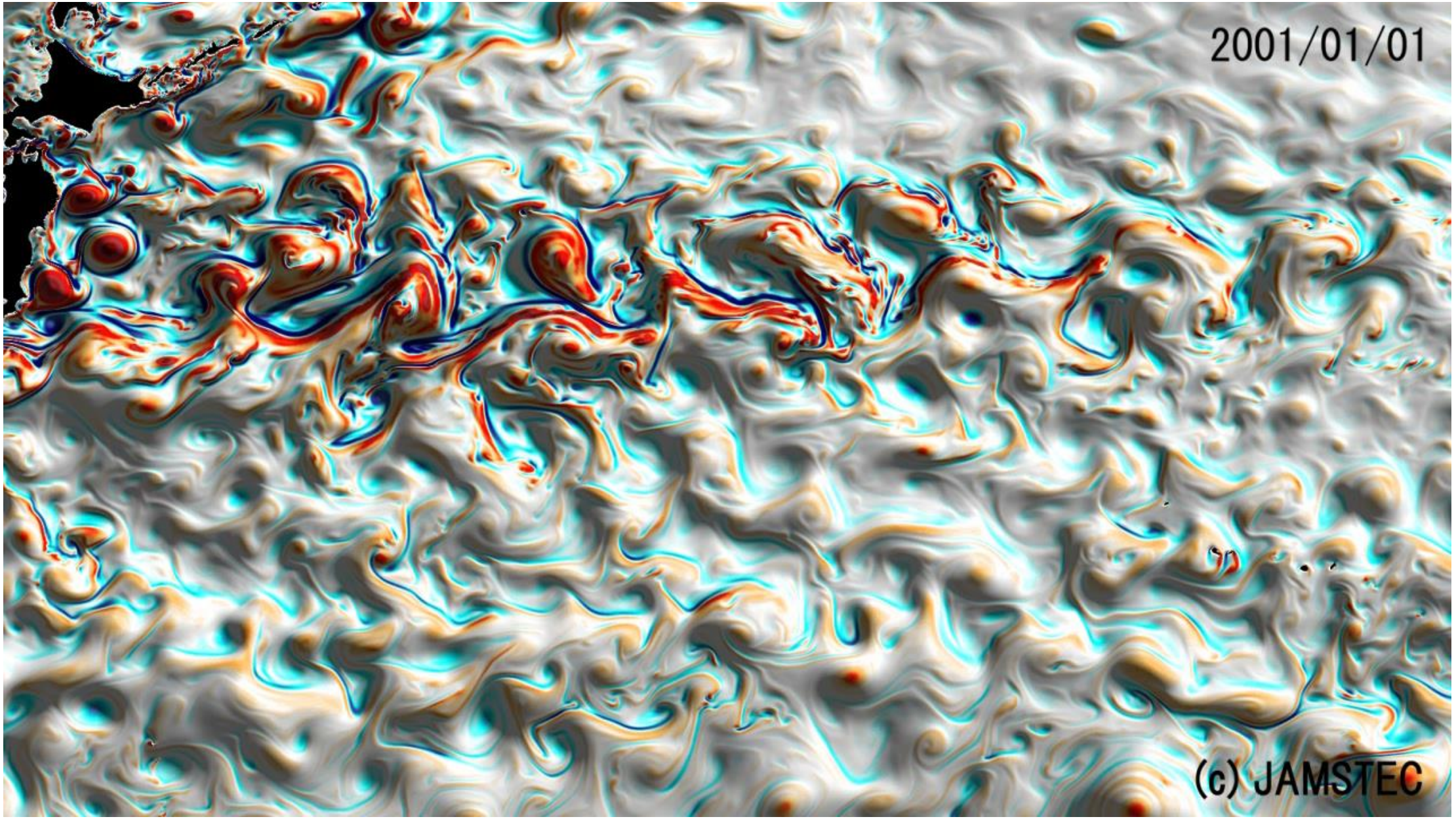
5. Feature classification



Matsuoka et al., 2016

6. Machine learning




2001/01/01
(c) JAMSTEC
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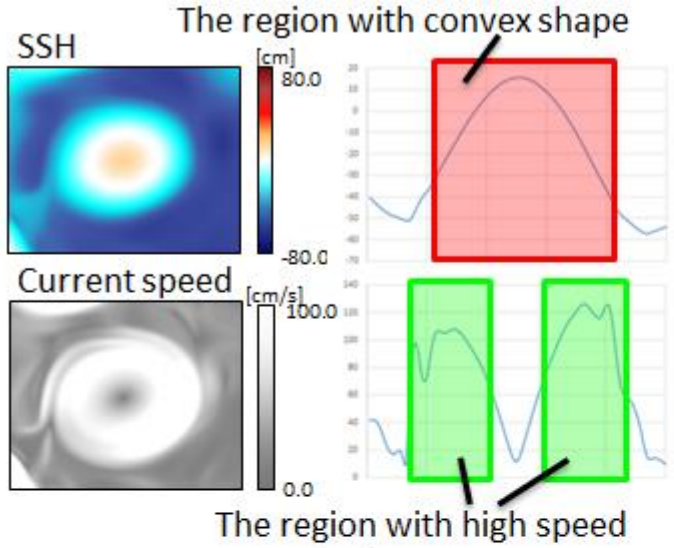
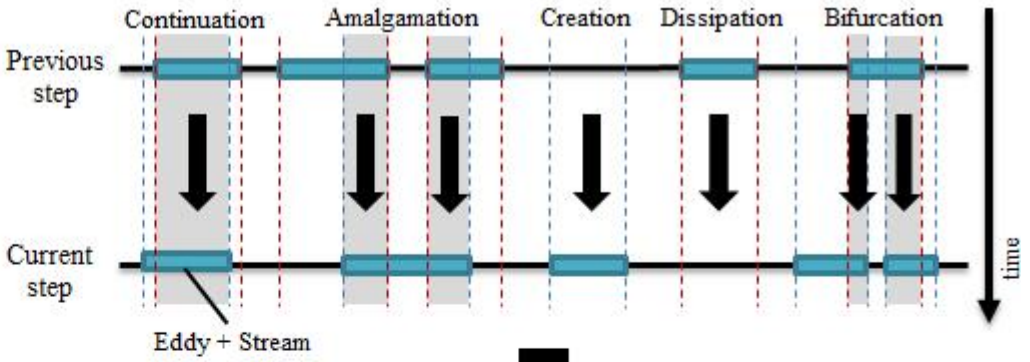
5.0
Relative vorticity (10^{-5} s^{-1})

Feature extraction and tracking

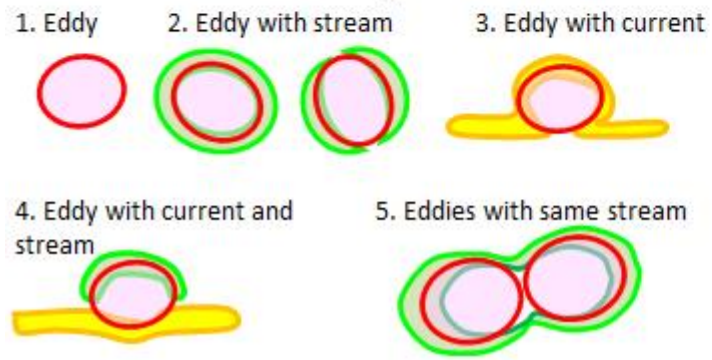
Eddy detection



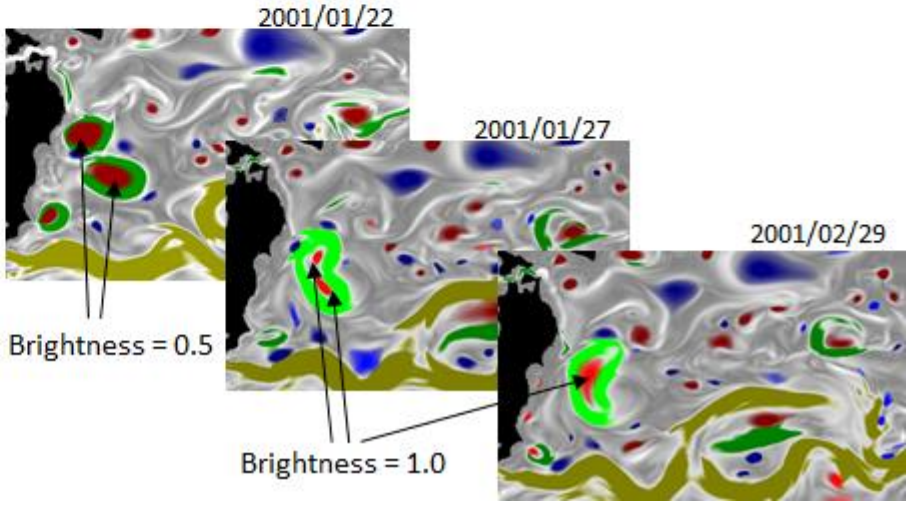
Eddy tracking

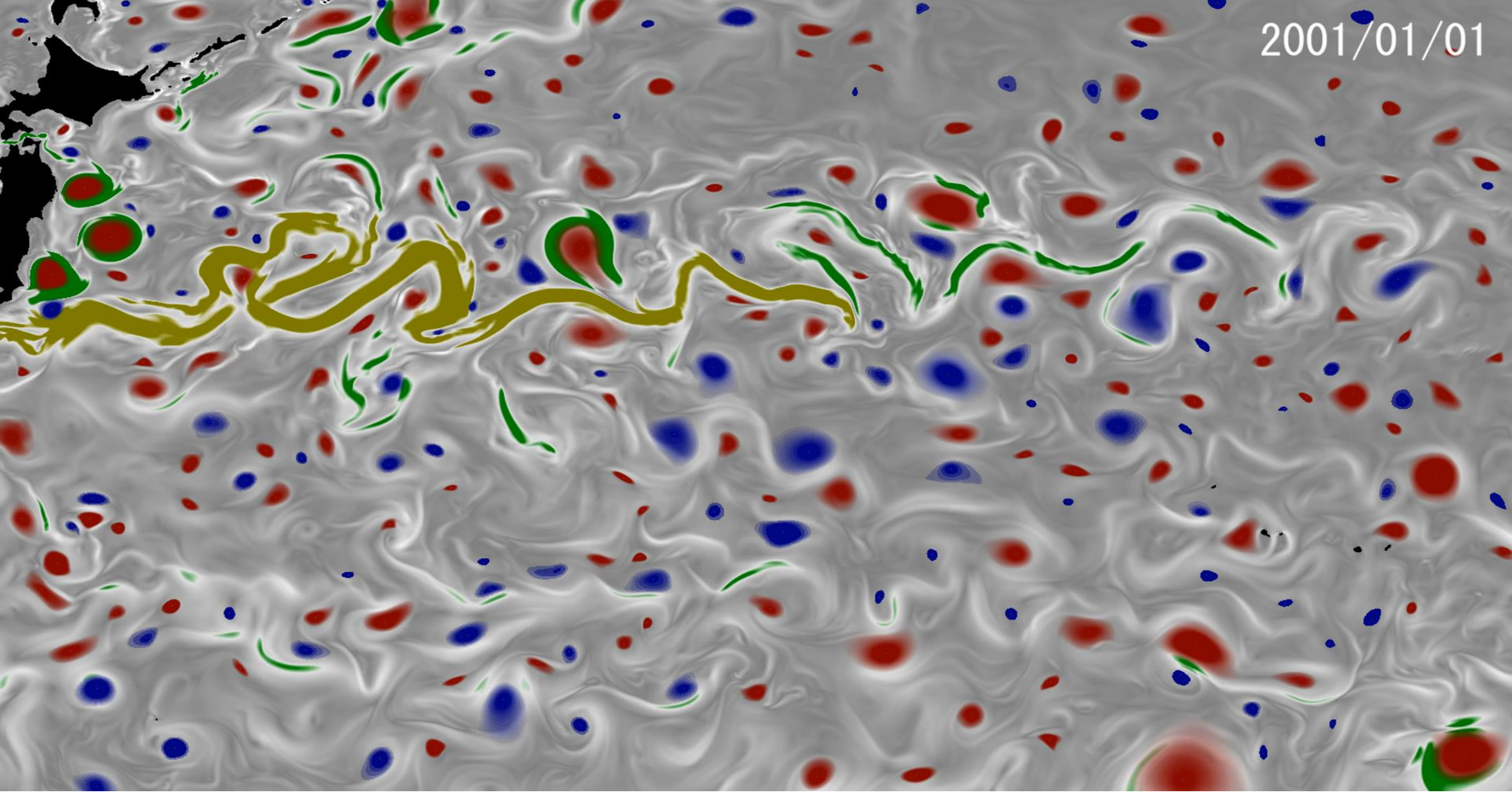


Classification



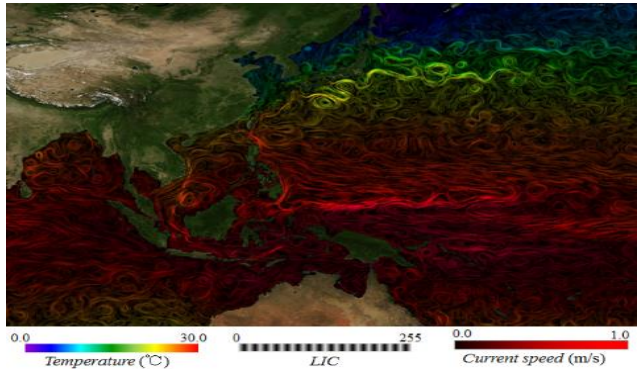
Event visualization




2001/01/01
Warm eddies
Cold eddies
Currents
Streams

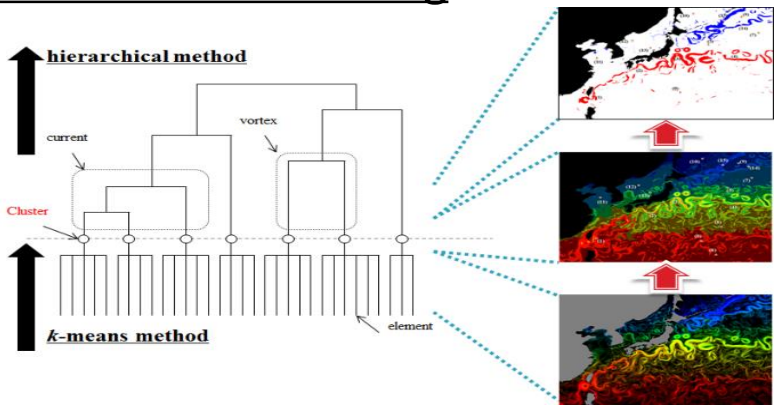
Visualization for analytics

1. Visual representation



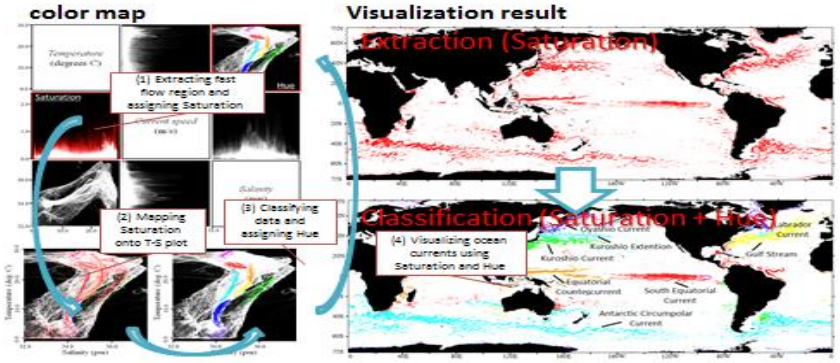
Matsuoka et al., 2012

2. Visual data mining



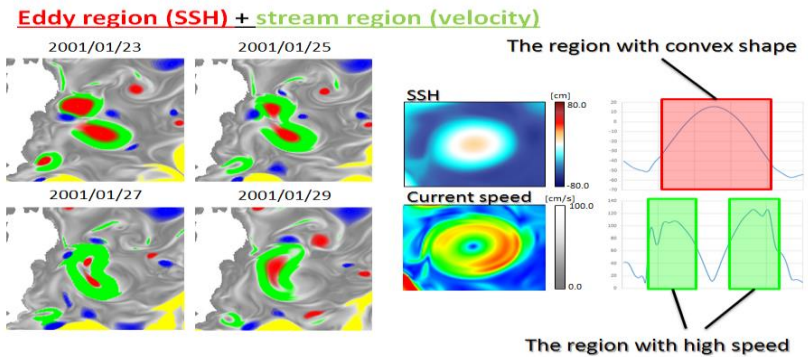
Matsuoka et al., 2012

3. Visual analytics



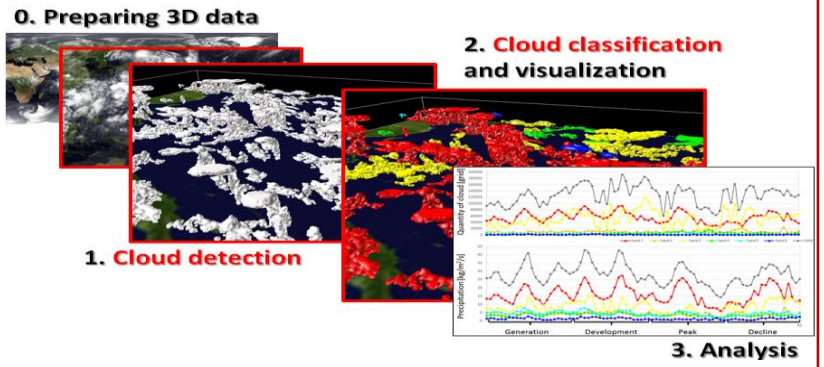
Matsuoka et al., 2015

4. Feature tracking



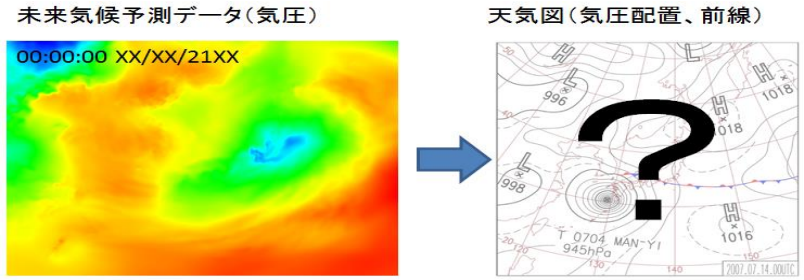
Matsuoka et al., 2016

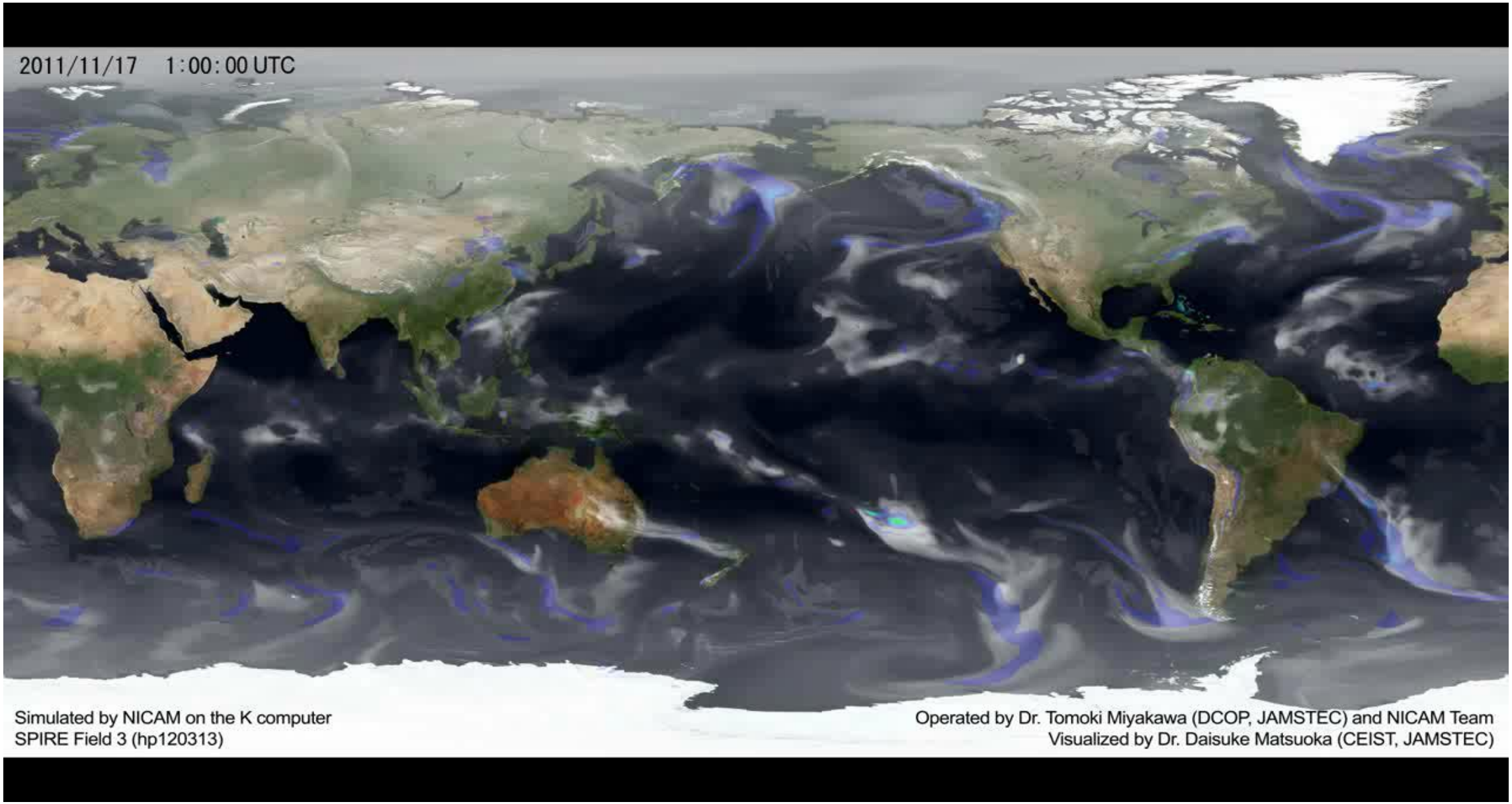
5. Feature classification



Matsuoka et al., 2016

6. Machine learning





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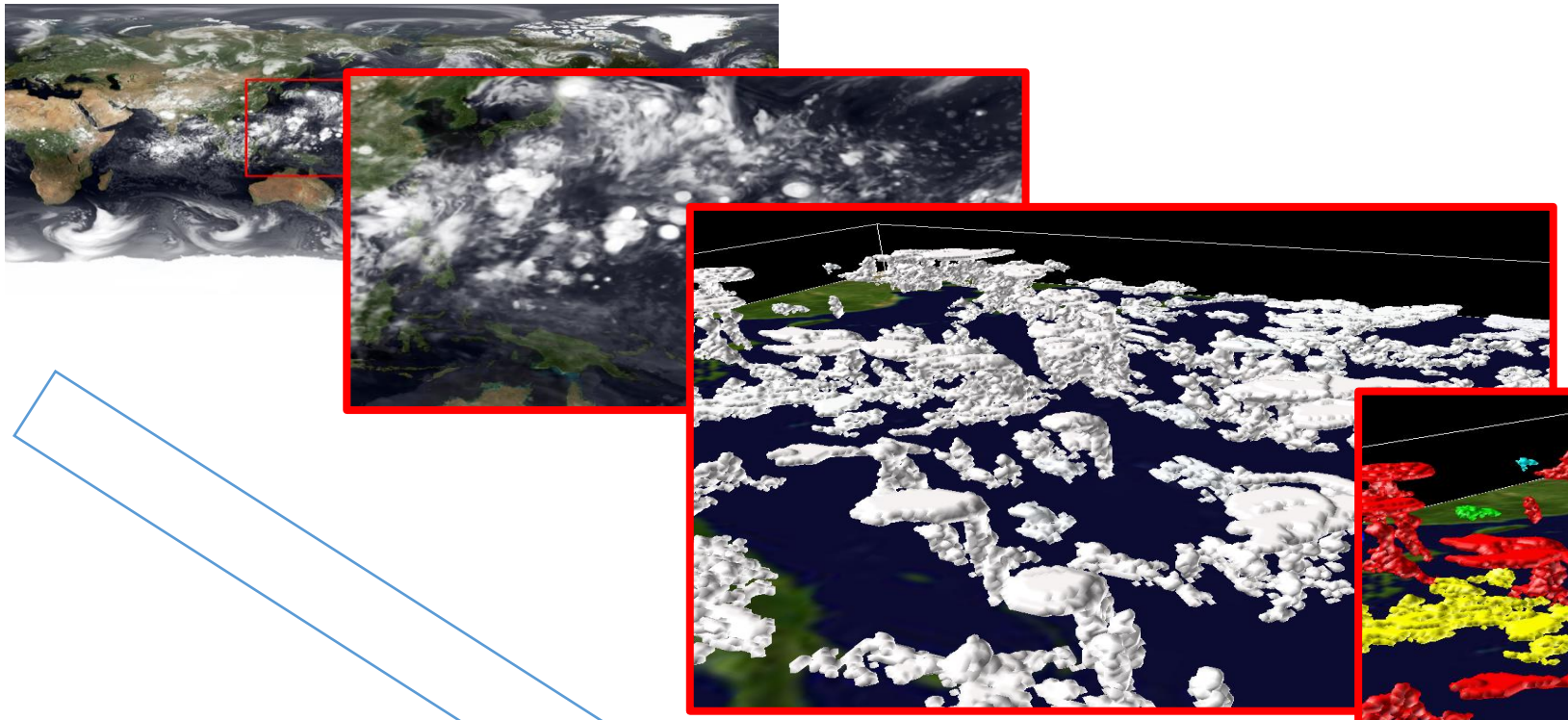
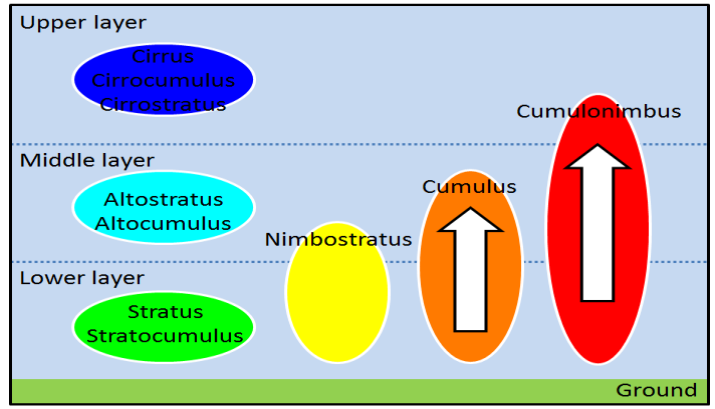
Precipitation ($Kg/m^2/s$)

3D cloud classification and visualization

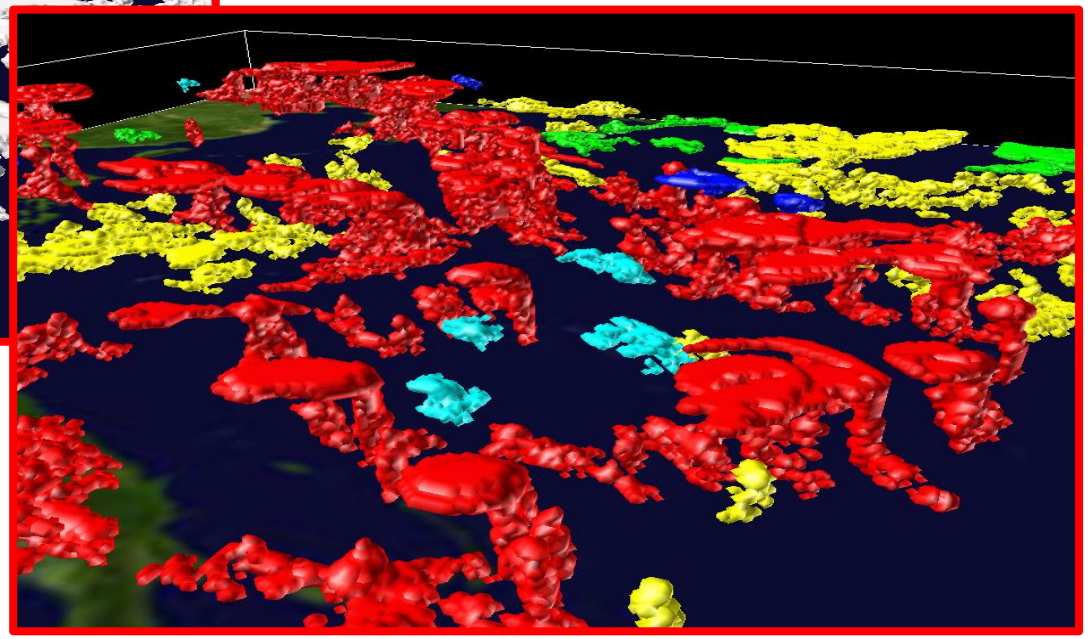
1. Preparing data

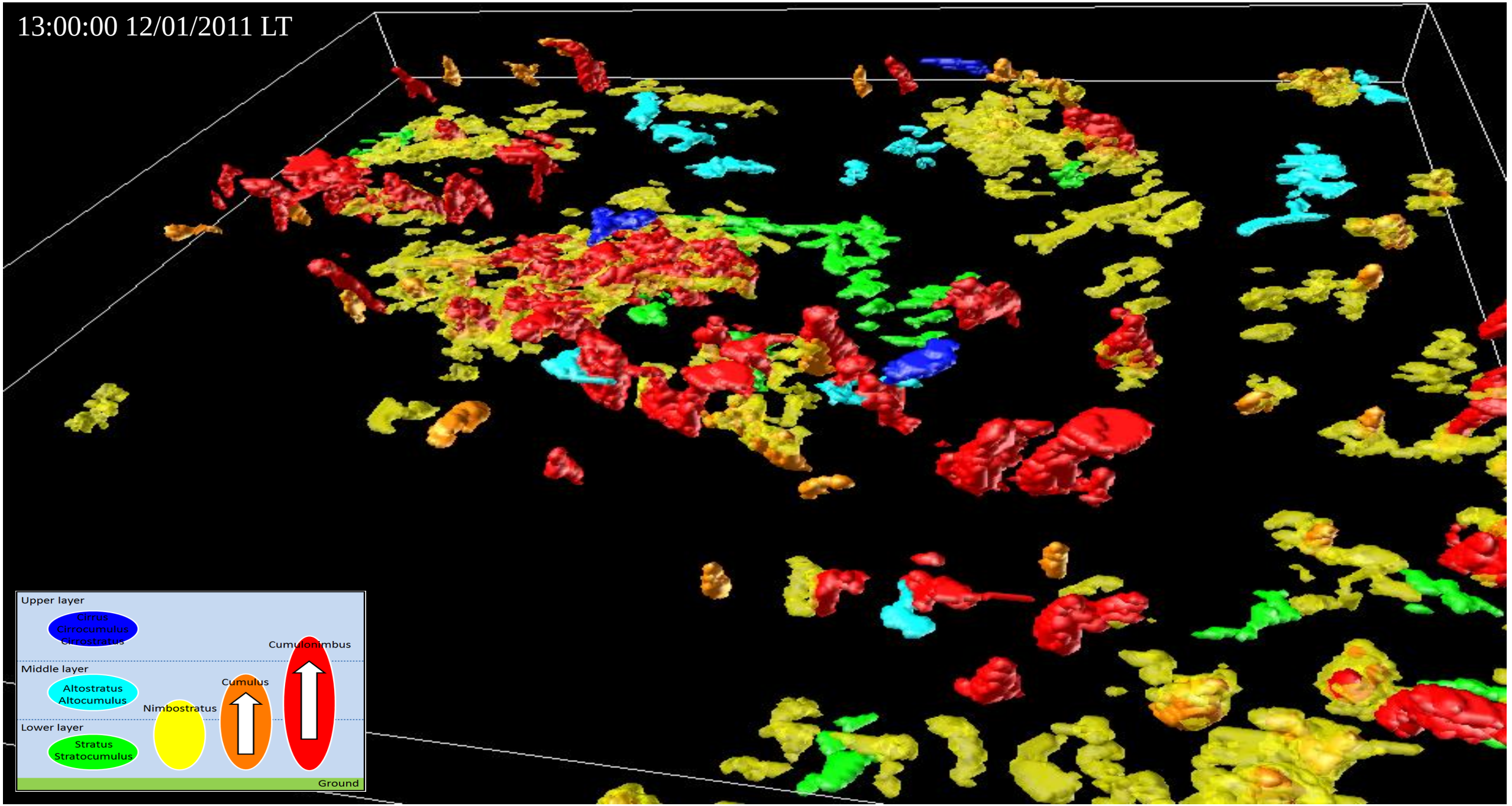


2. Cloud detection



3. Classification and visualization

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Upper layer
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Cirrocumulus
Cirrostratus
Cumulonimbus
Middle layer
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Altocumulus
Cumulus
Nimbostratus
Lower layer
Stratus
Stratocumulus
Ground

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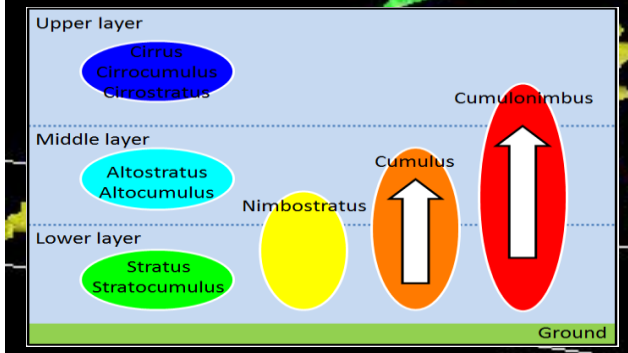

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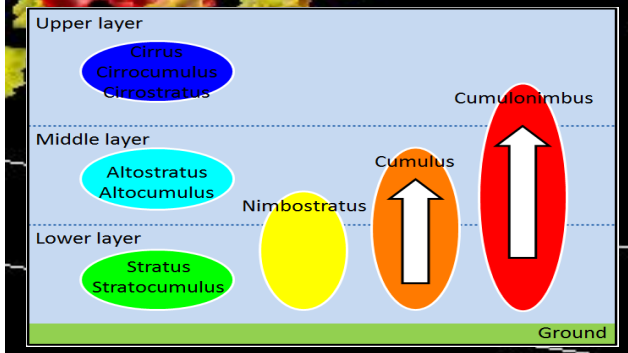

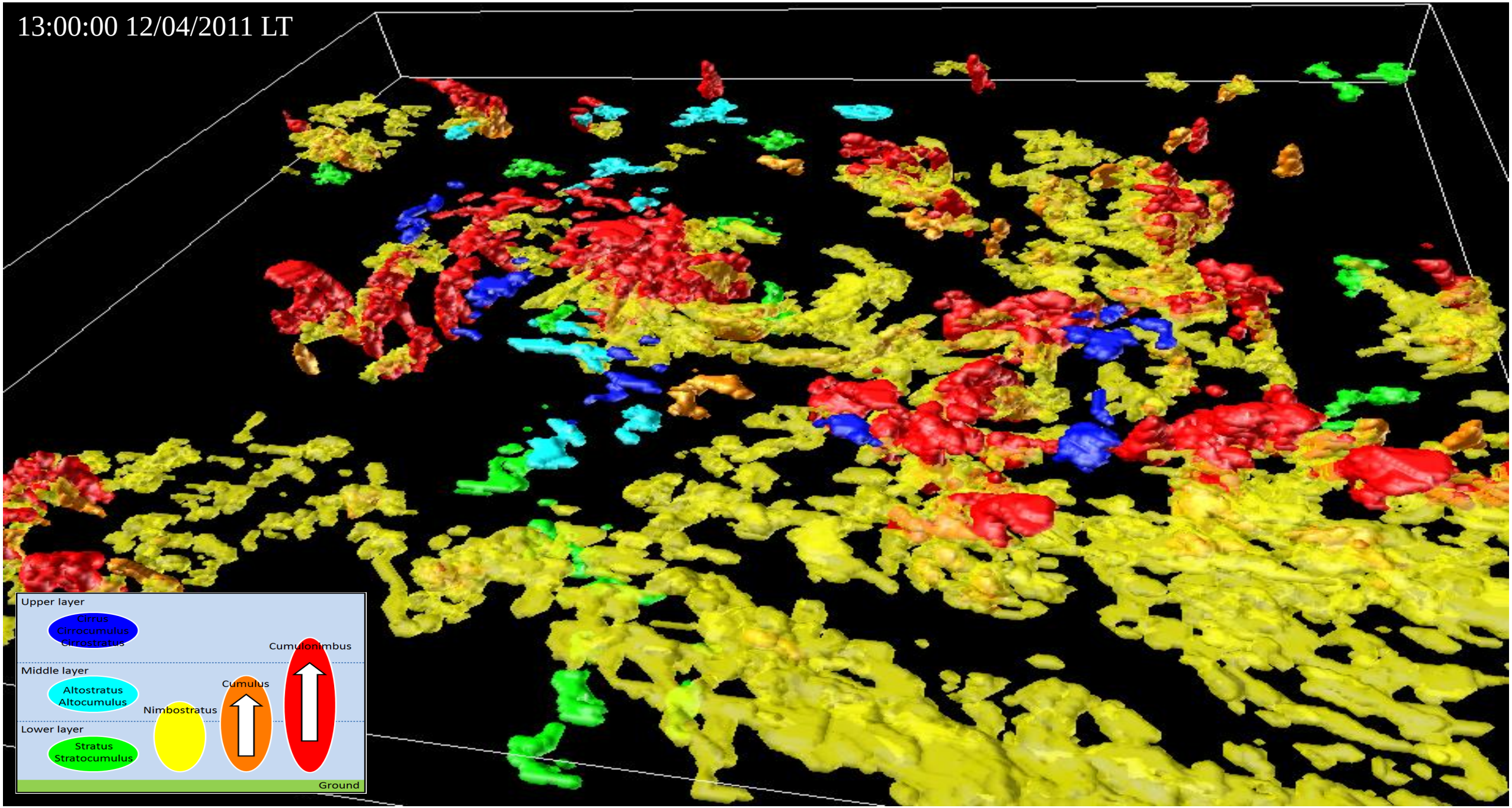
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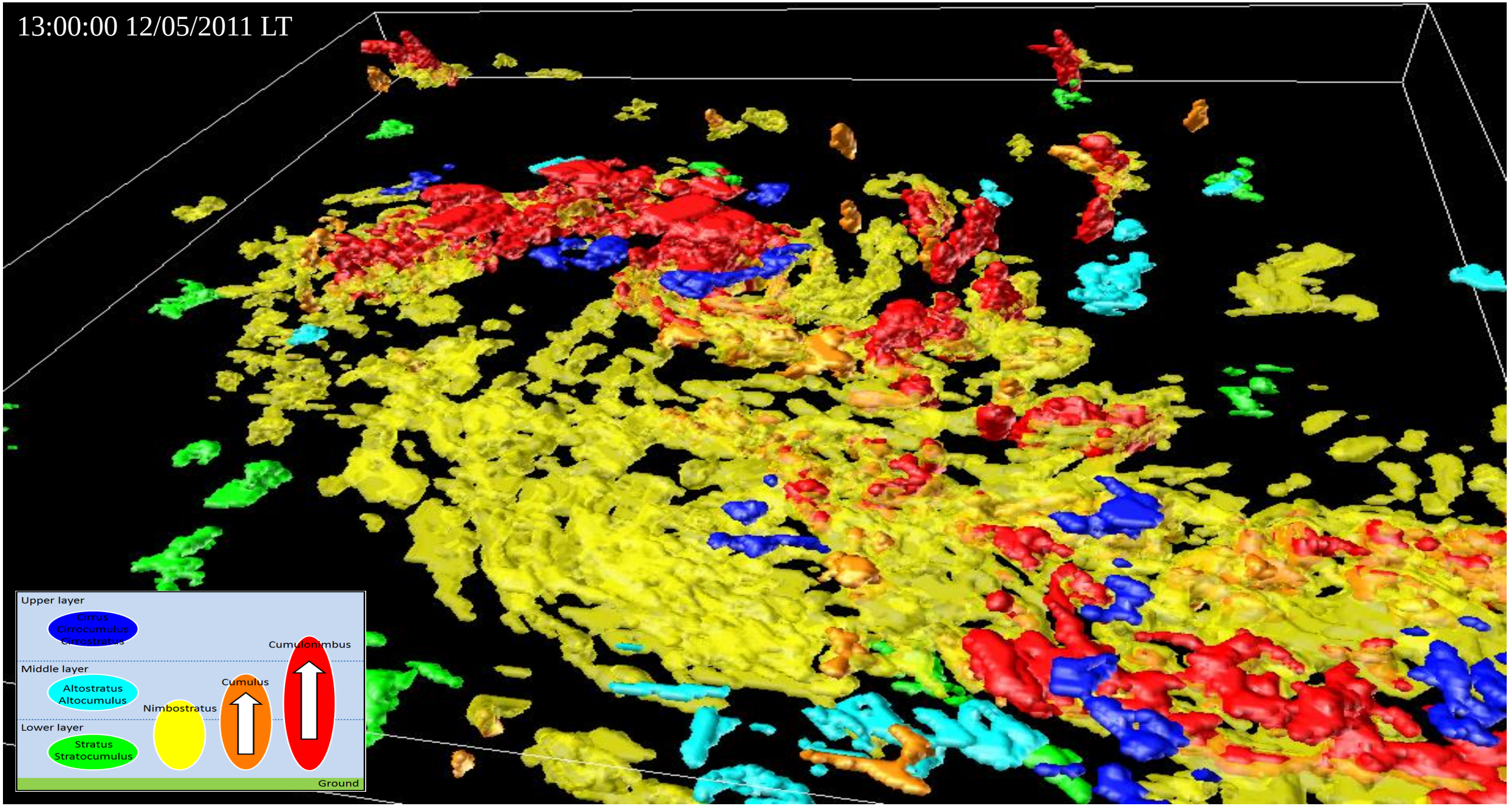
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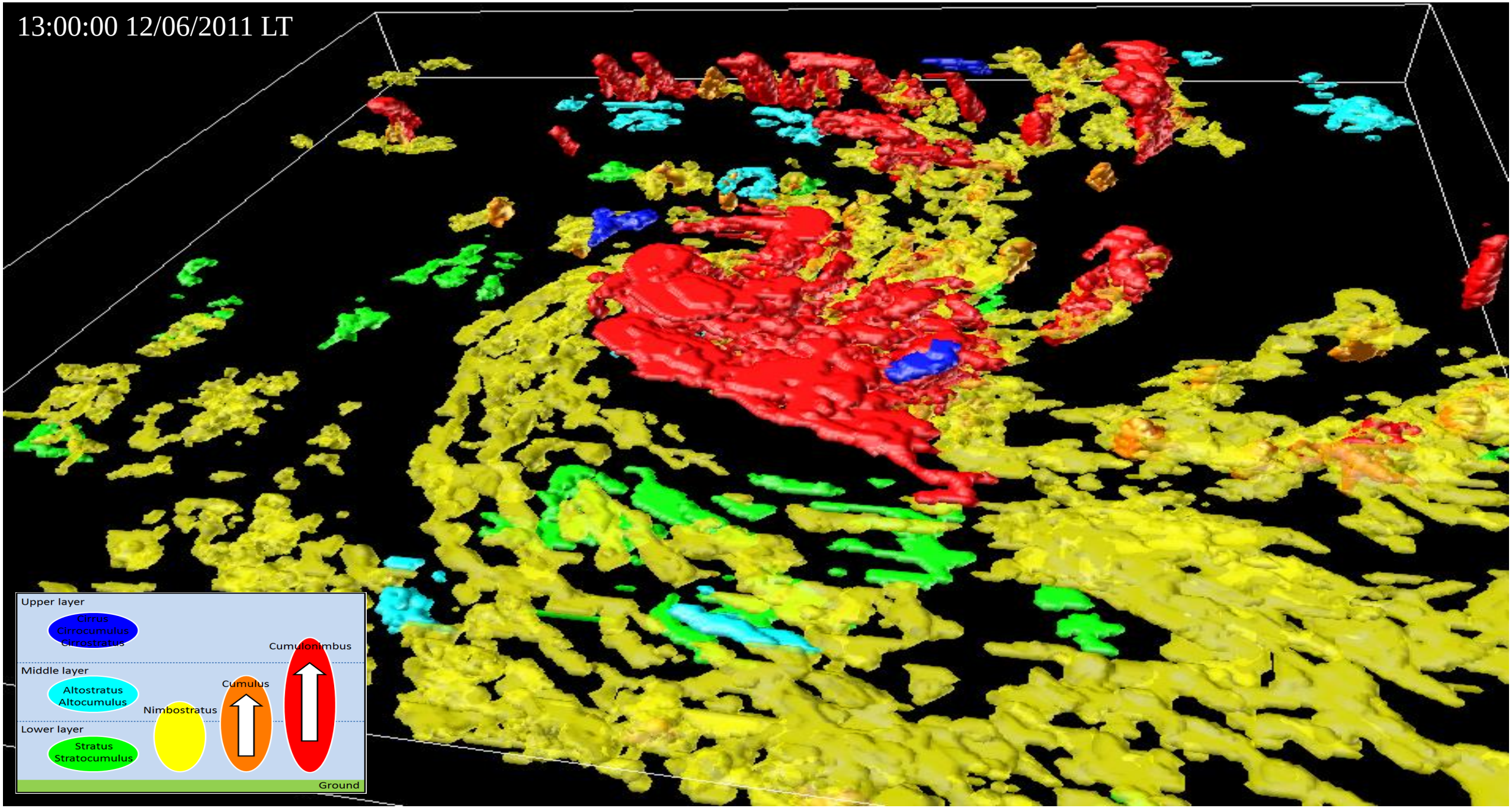
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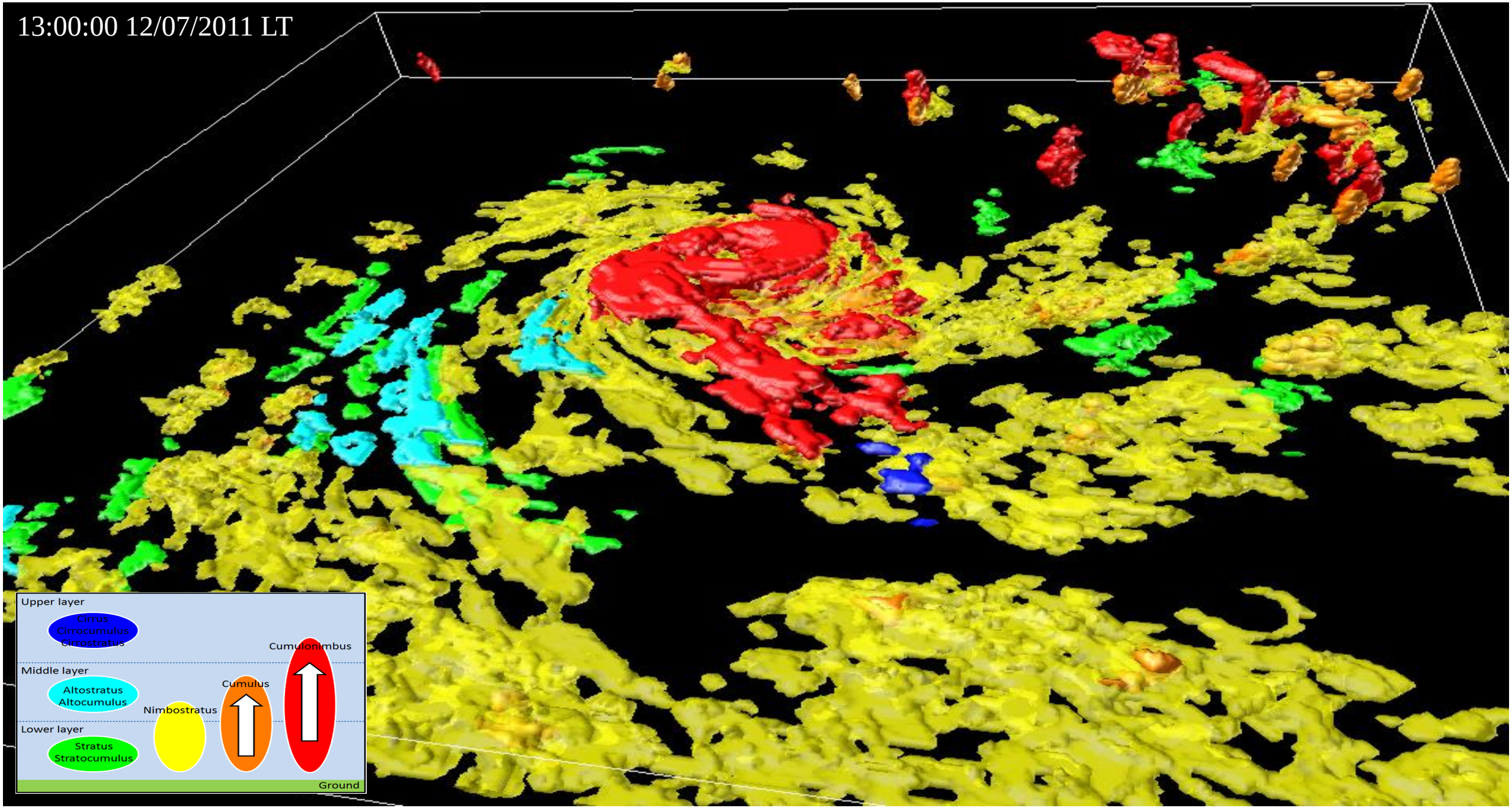
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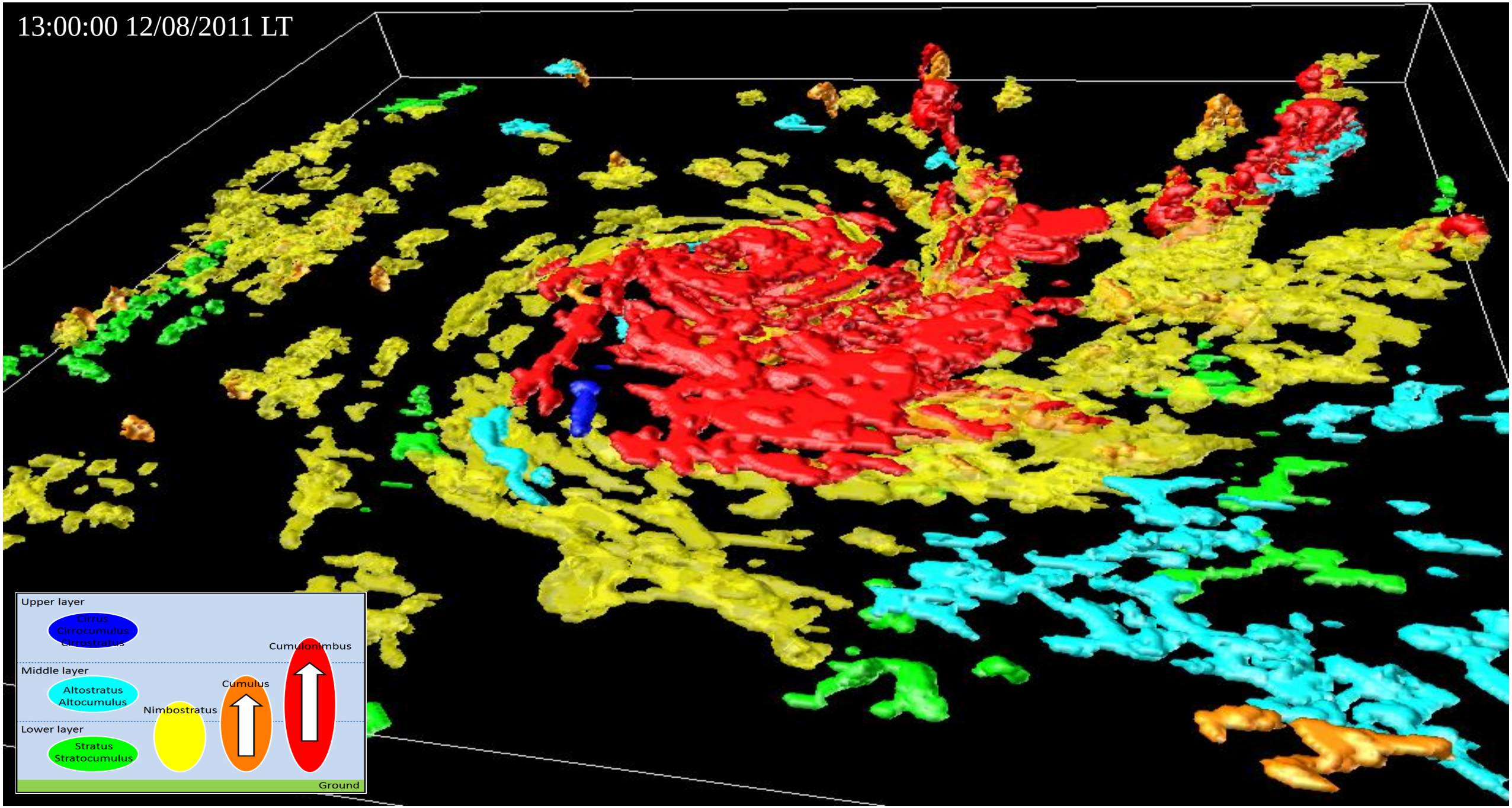
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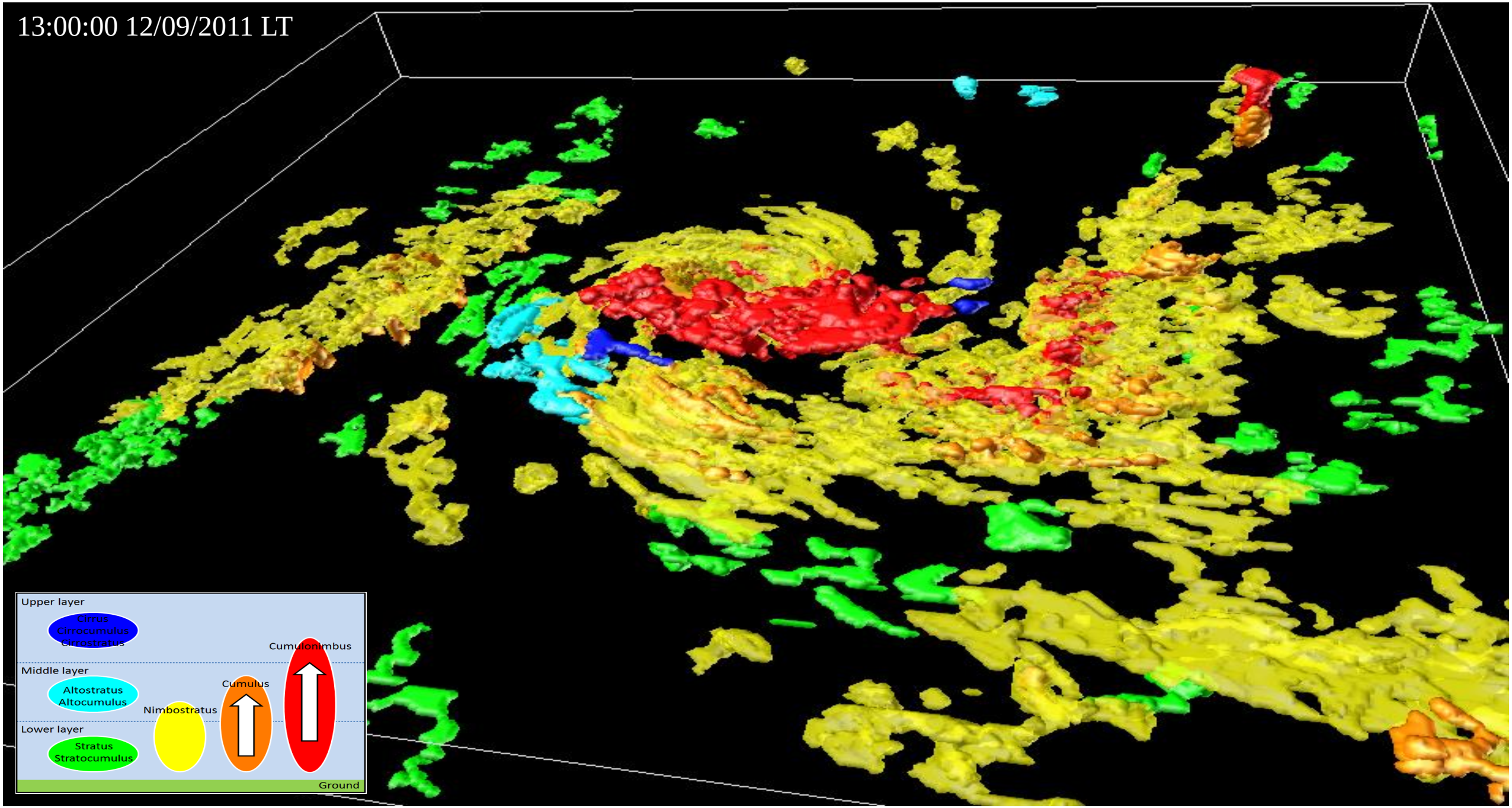
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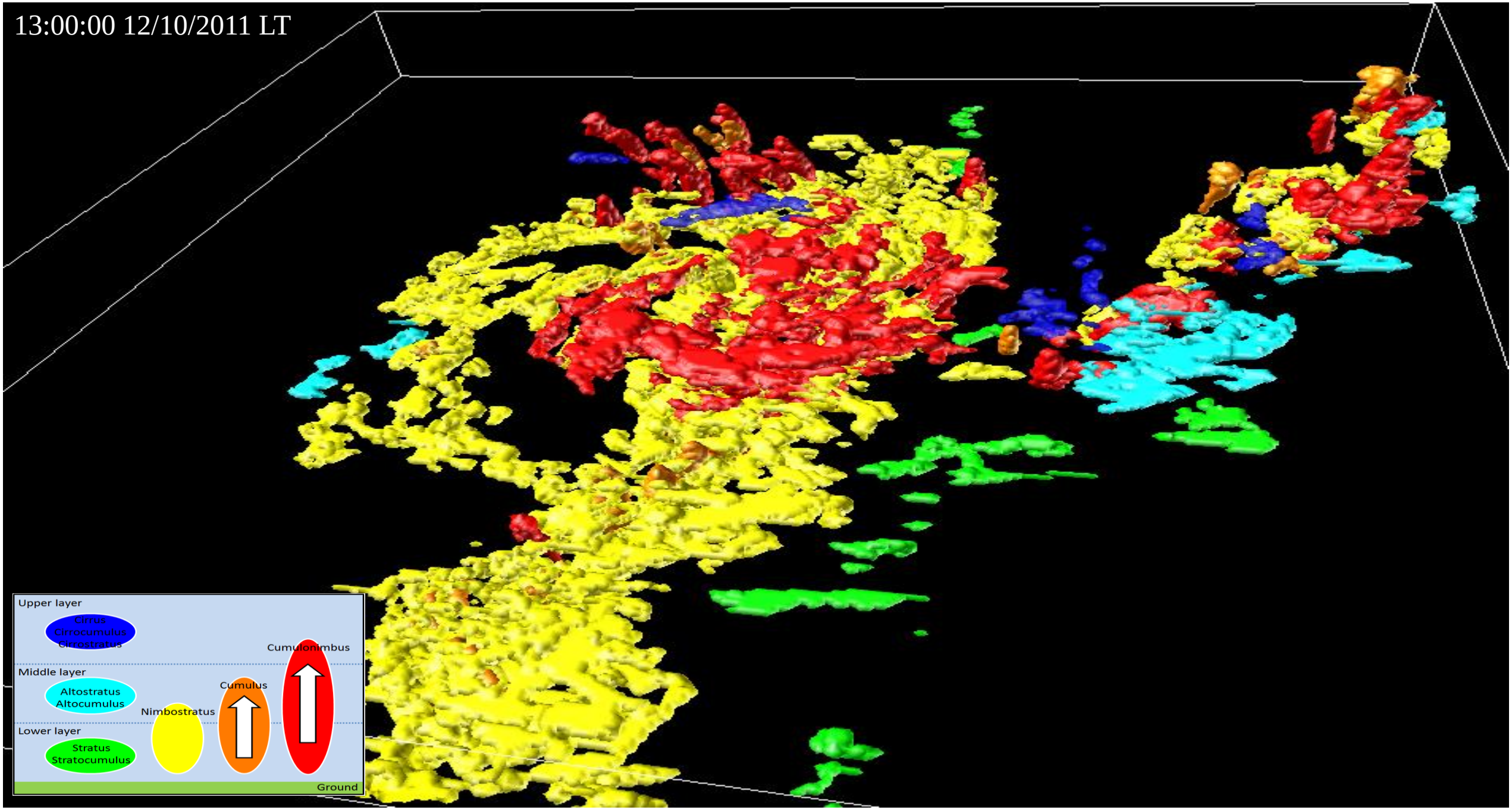
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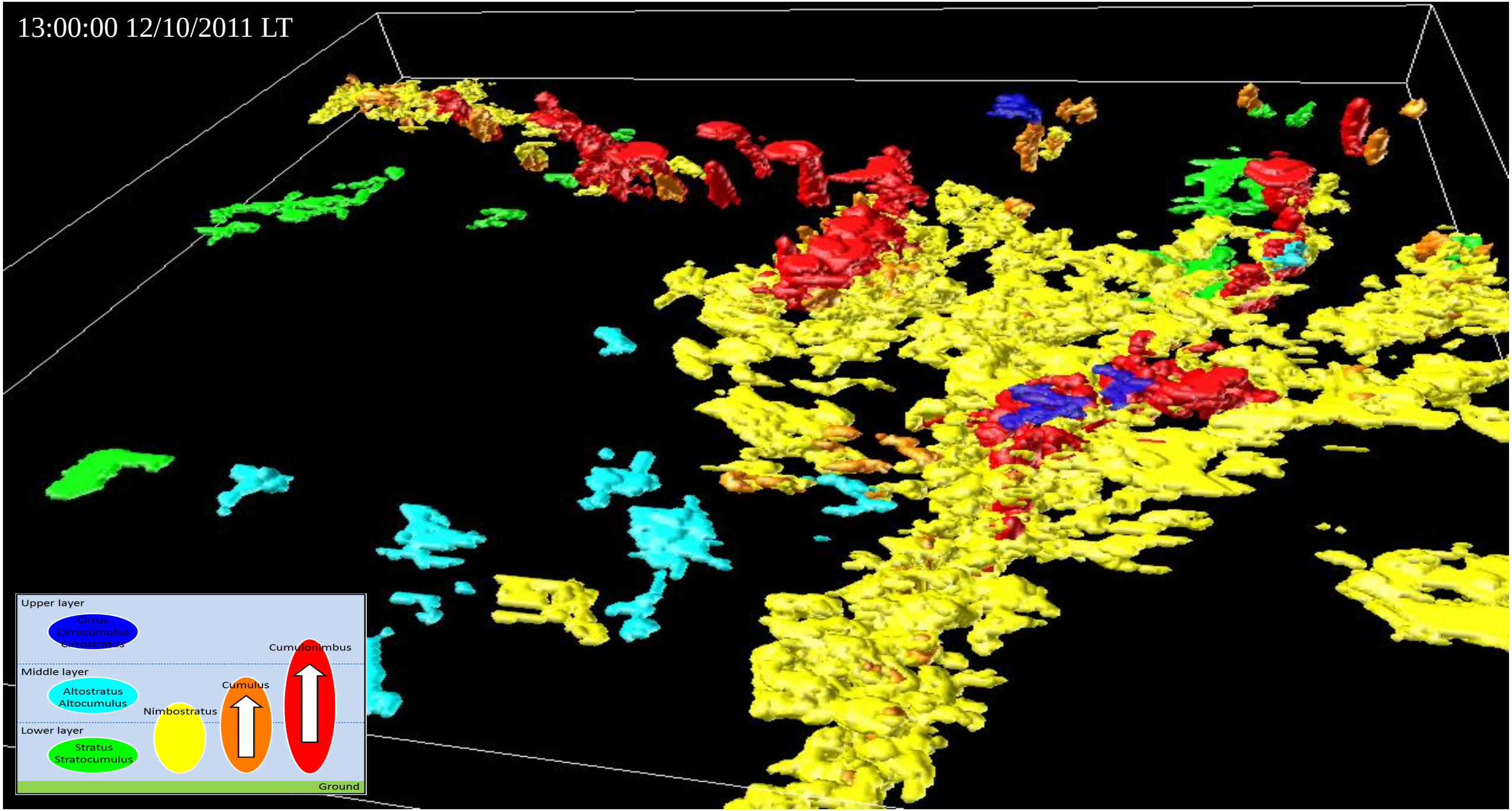
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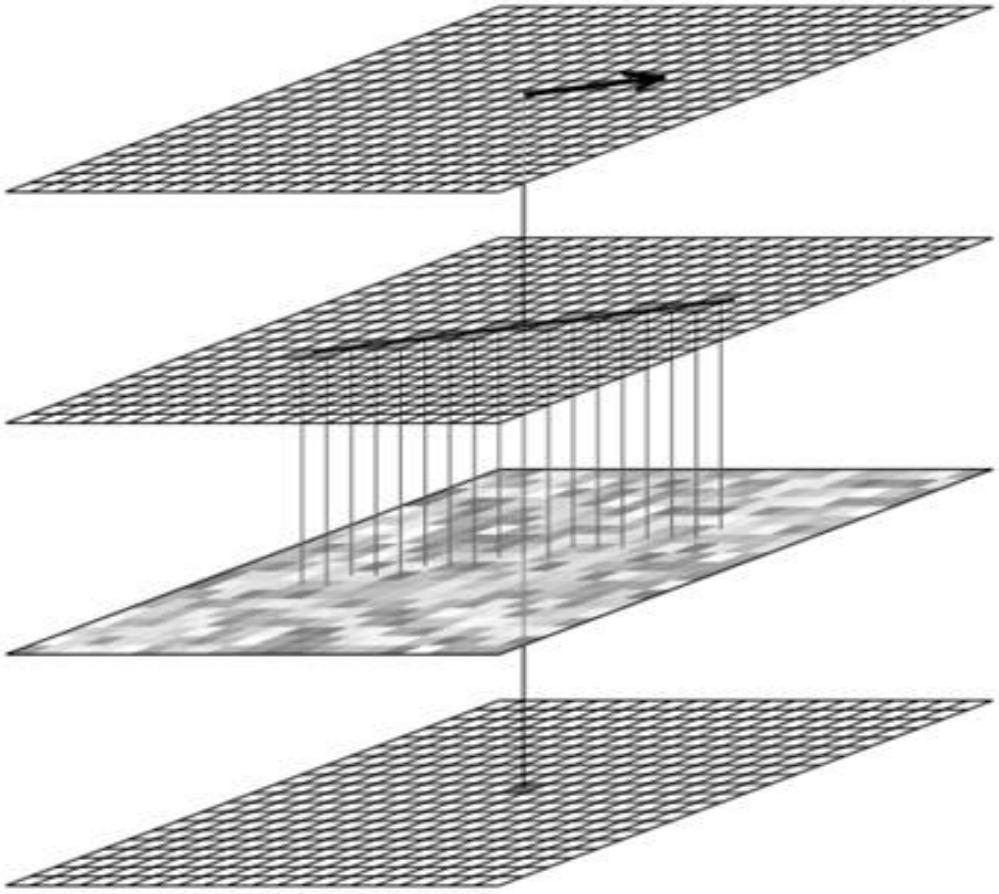
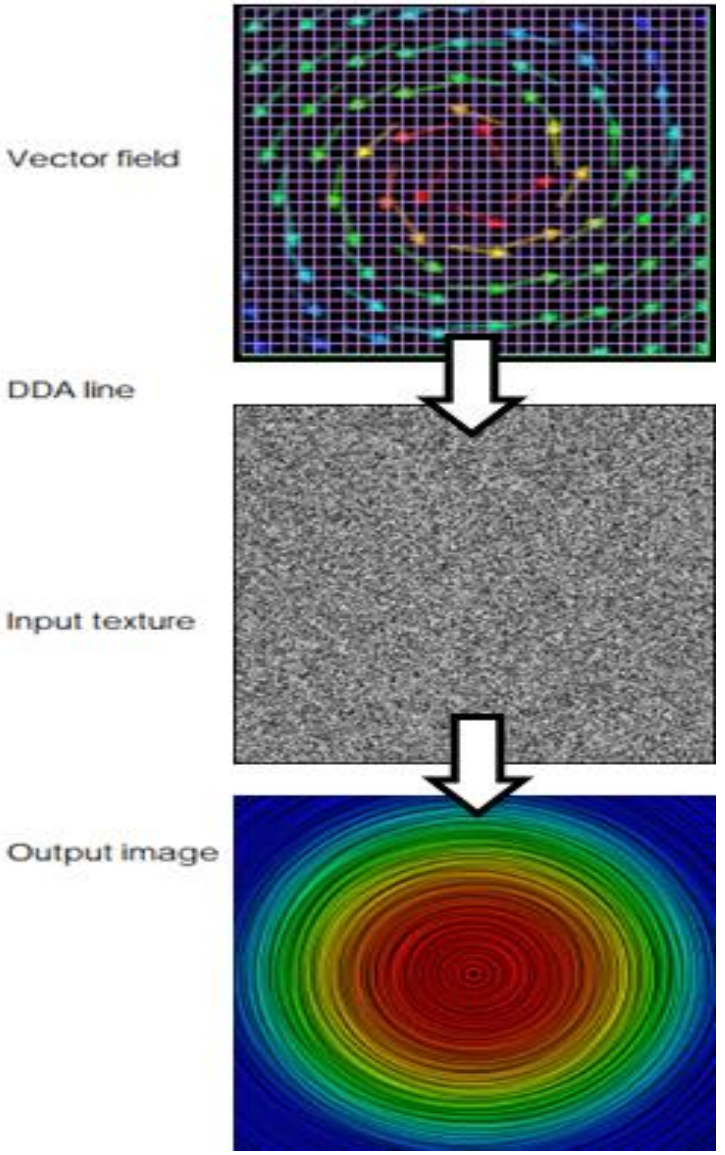
Ground

Visualization for Scientific arts and artistic science

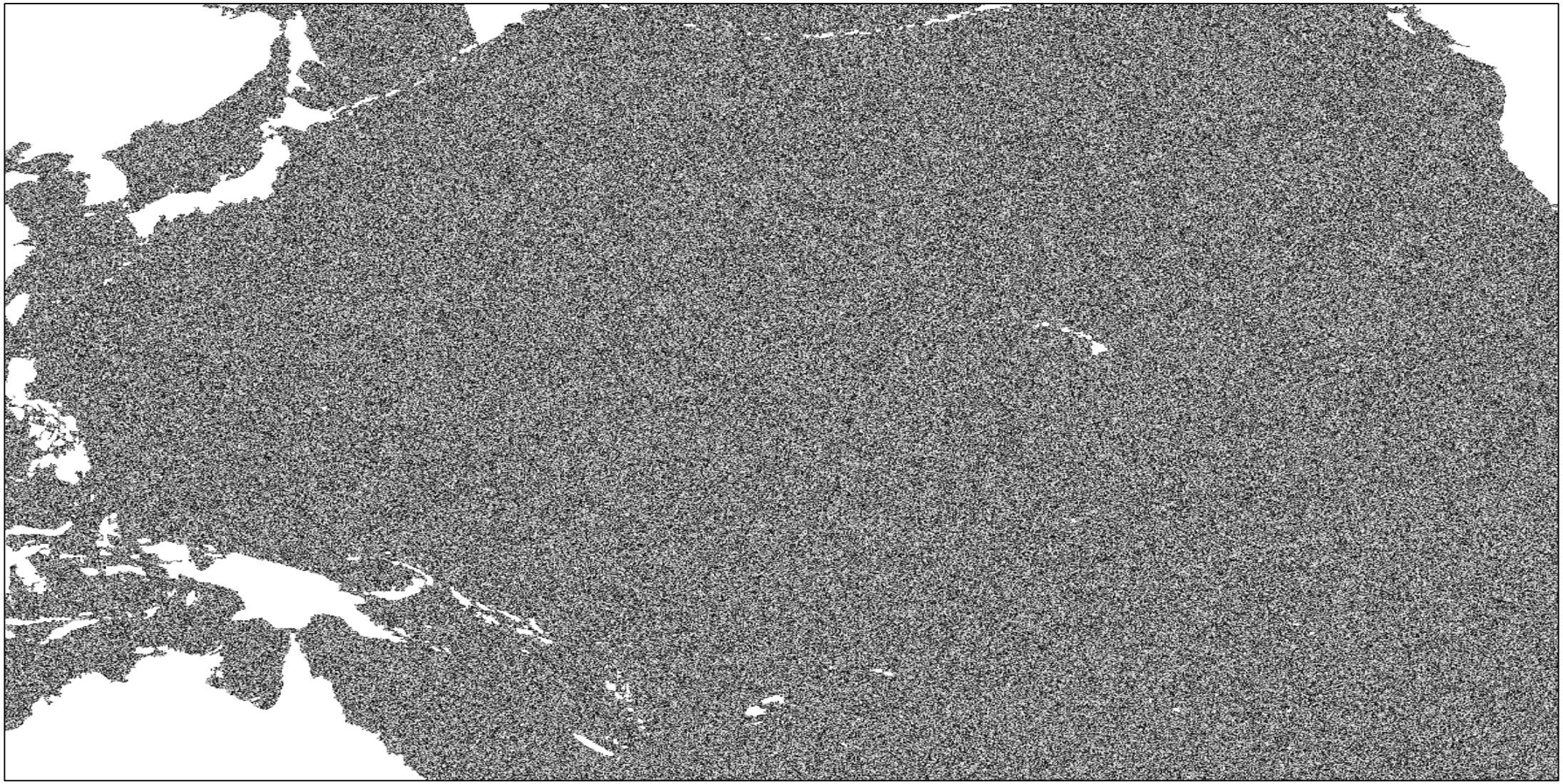
Application of LIC

Line Integral Convolution (Cabral, 1993)

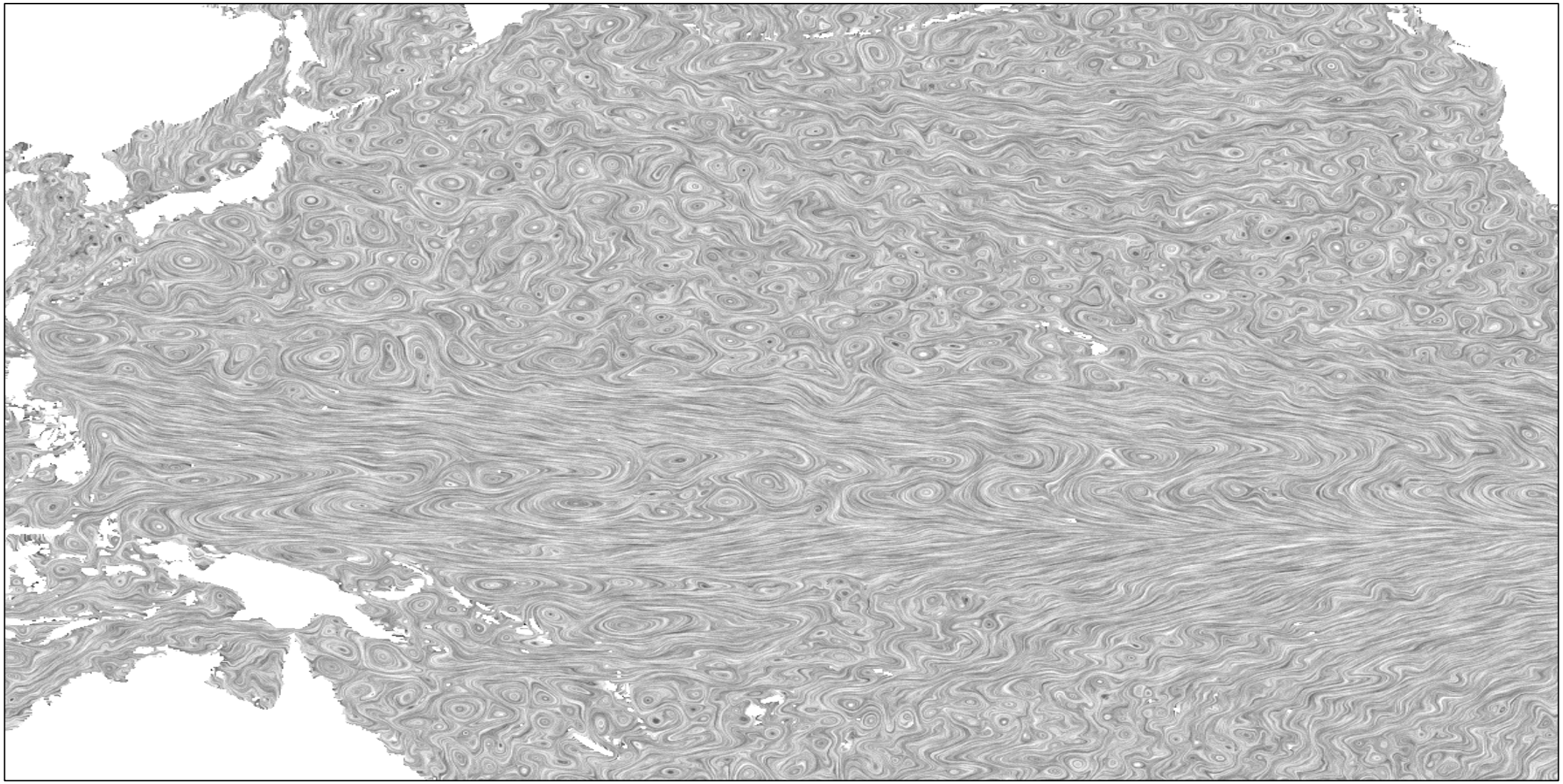




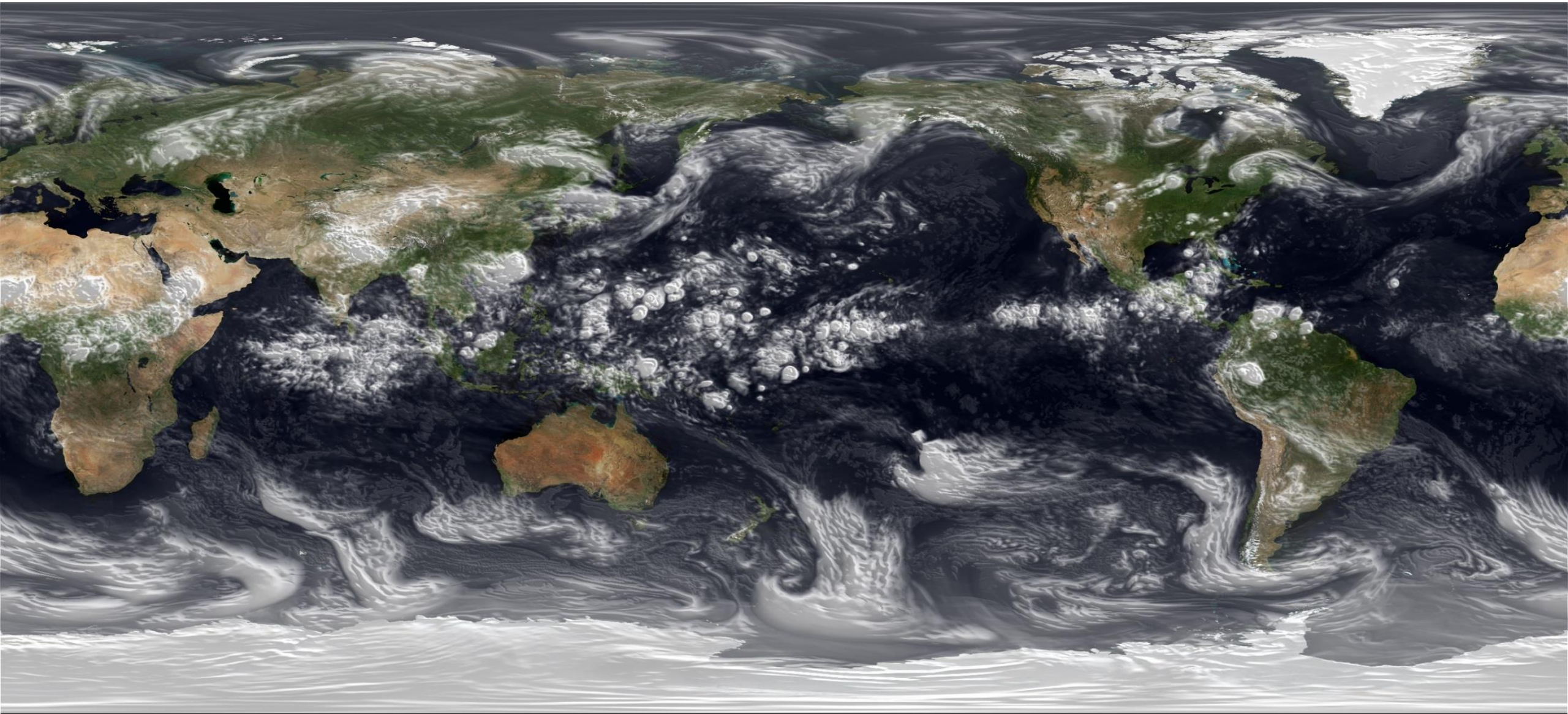
Application of LIC



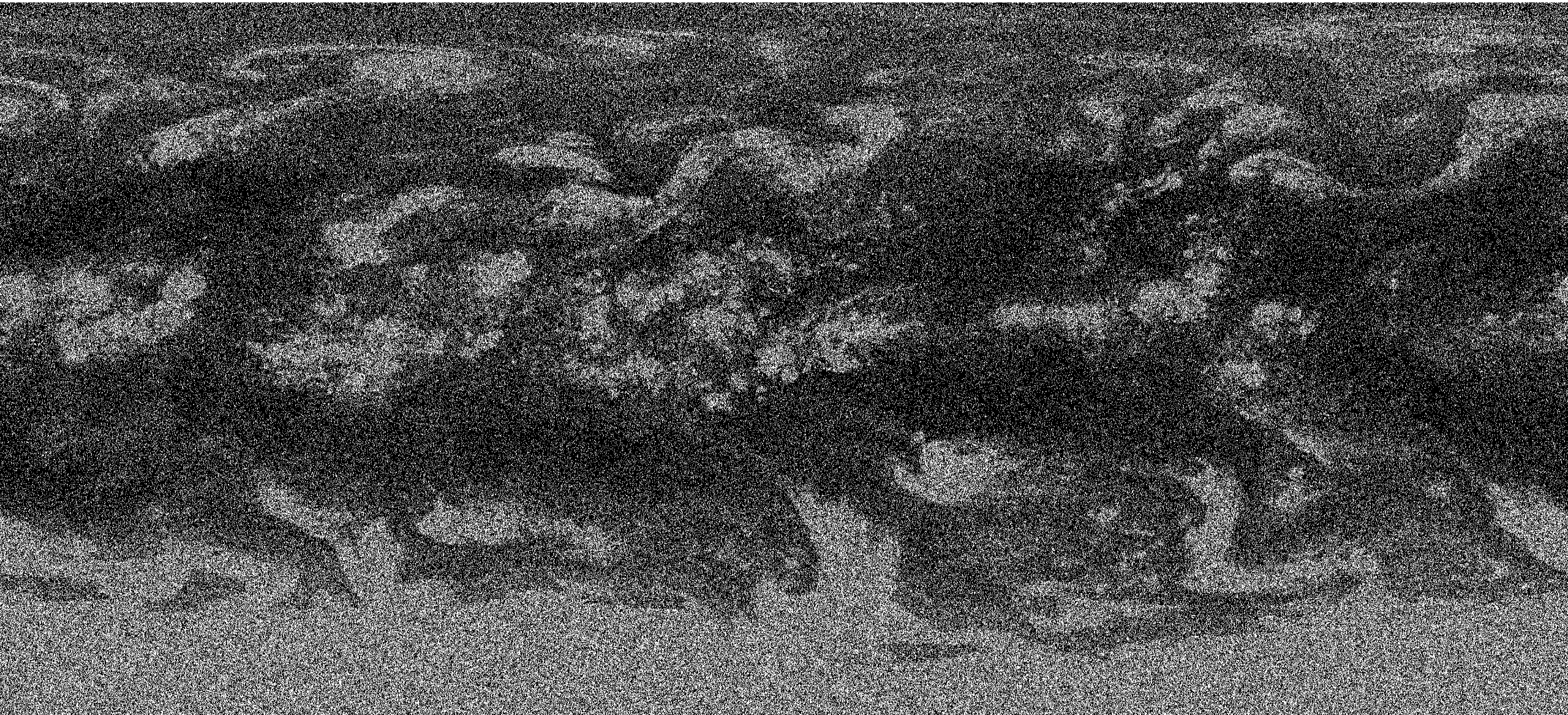
Application of LIC

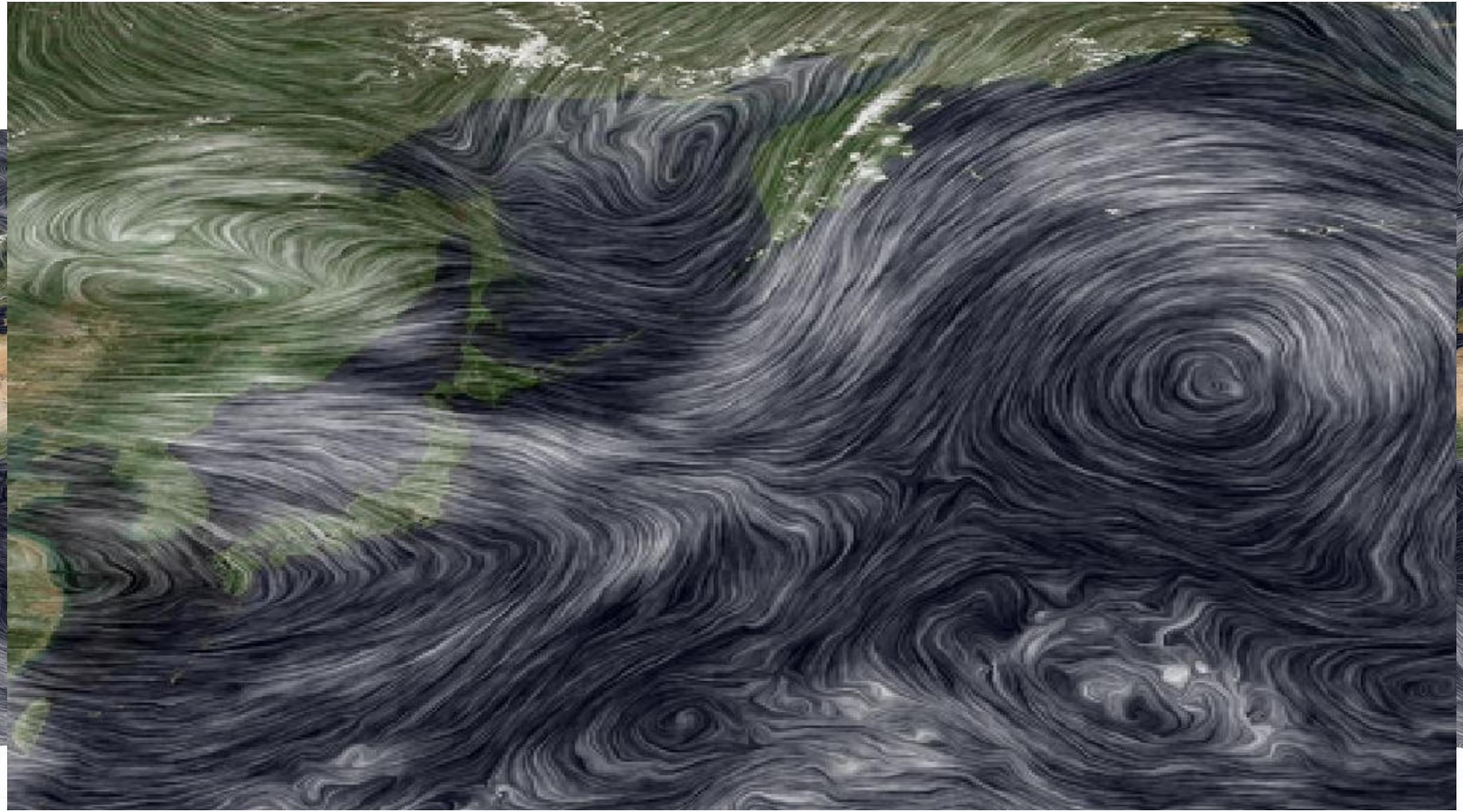


Multivariate LIC



Multivariate LIC



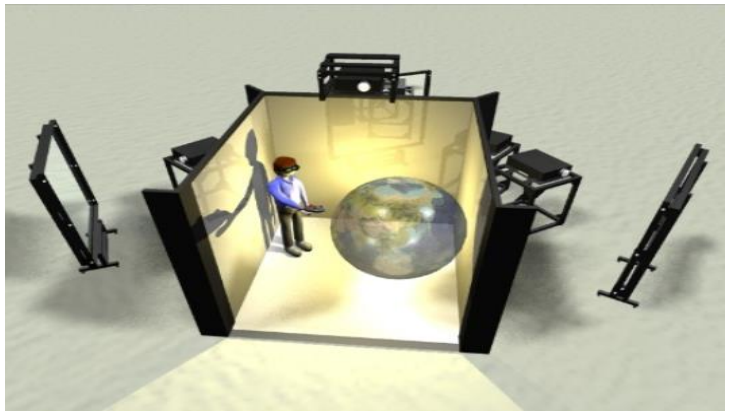



La nuit étoilée
(The starry night, 星月夜)
Vincent Willem van Gogh, 1889
PRODUCED BY BEVERLY

Visualization in Virtual Reality System

Visualization in CAVE

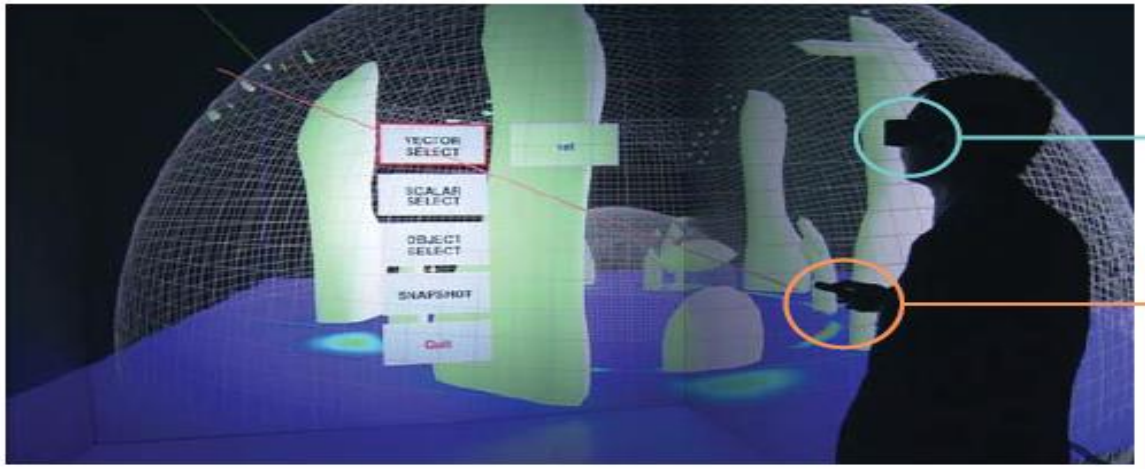
BRAVE: Booth for Research Virtual Environment



Overview

4 Screen (3x3m)

Asterism Ultra Model
CPU: AMD Opteron 8224SE x8
Memory 256GB, HDD: 8 TB
NVIDIA Quadro PLEX 1000x2



Controller

Shuttering glass

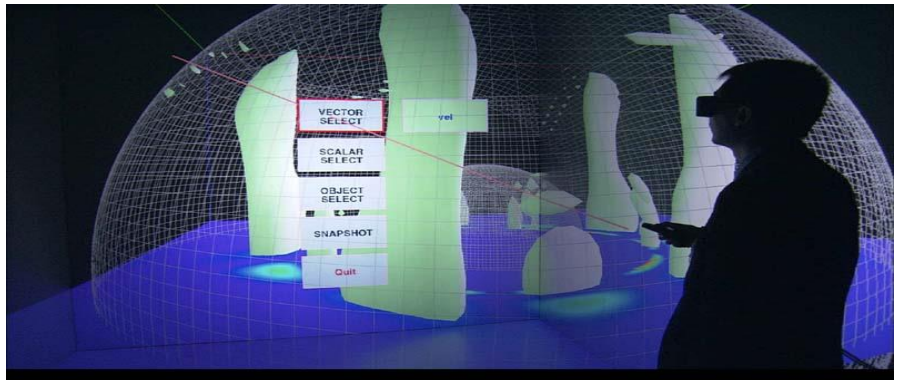
Visualization in CAVE

VFIVE: Virtual Reality Visualization Software for CAVE Systems

- Streamlines, particle tracer, arrow glyph, isorsurface, volume rendering, etc.
- OpelGL, VTK, CAVElib

Kageyama et al., 2000; Ohno et al., 2006

Application to geo-dynamo simulation data



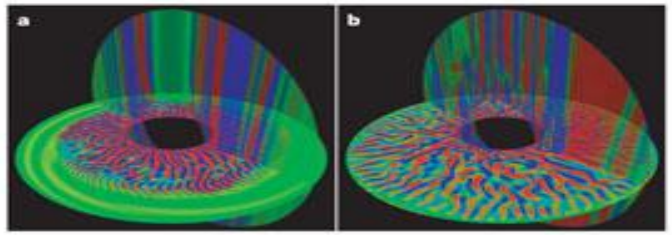
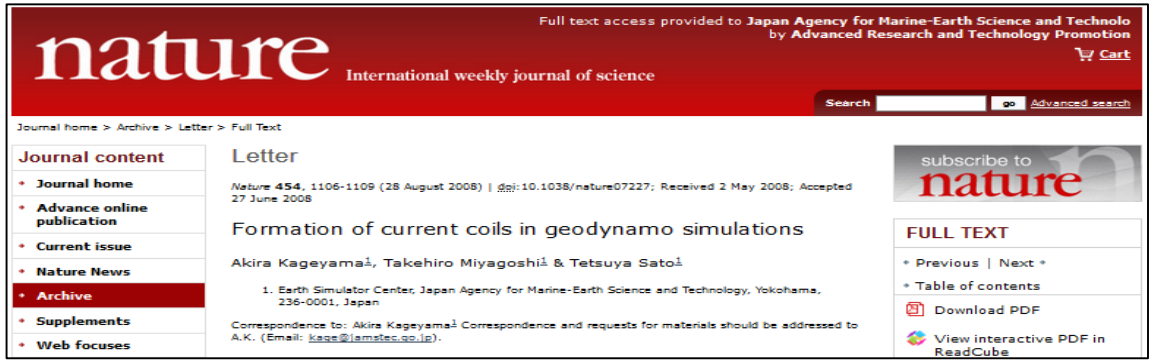
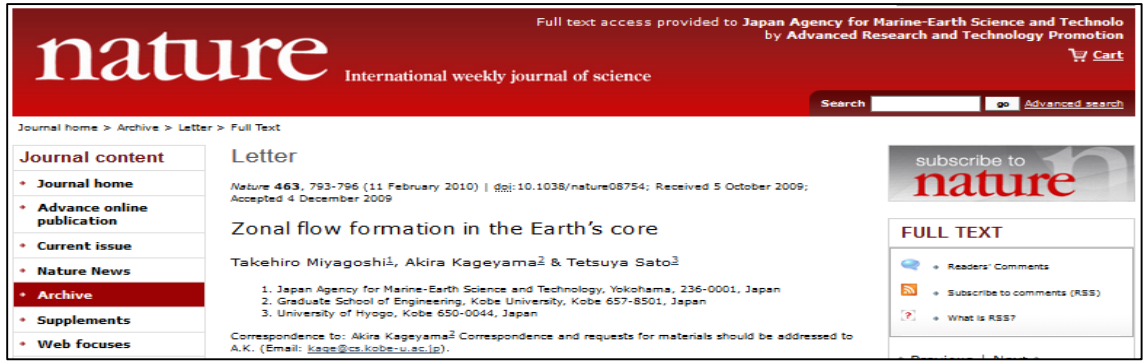


Figure 1 | Equatorial and meridional cross-sections of the axial component of the vorticity, ω_s. The Ekman number, E, is 2.3×10^{-7} in **a** and 2.6×10^{-6} in **b**. Convection plumes are evident in the equatorial cross-sections. The meridional cross-sections show that the flow is nearly two-dimensional. The convection in these low-Ekman-number regimes is organized as a set of thin plume sheets, rather than columnar cells. It can be seen that the larger Ekman number in **b** leads to thicker plume sheets.



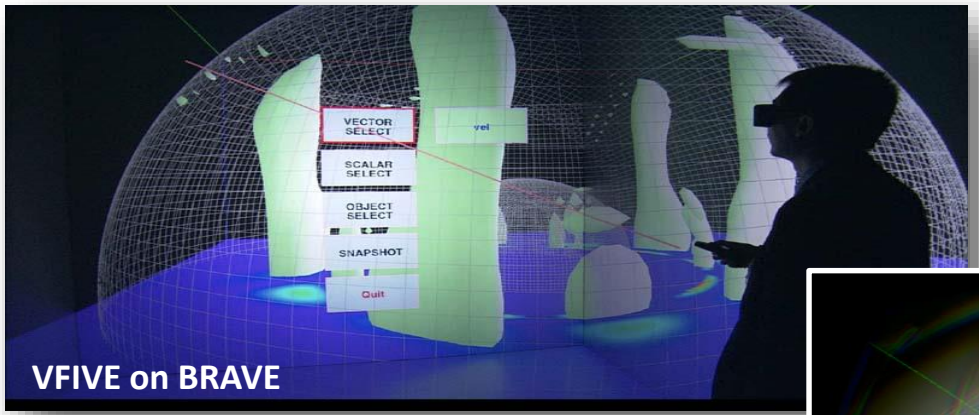
Kageyama et al., 2008



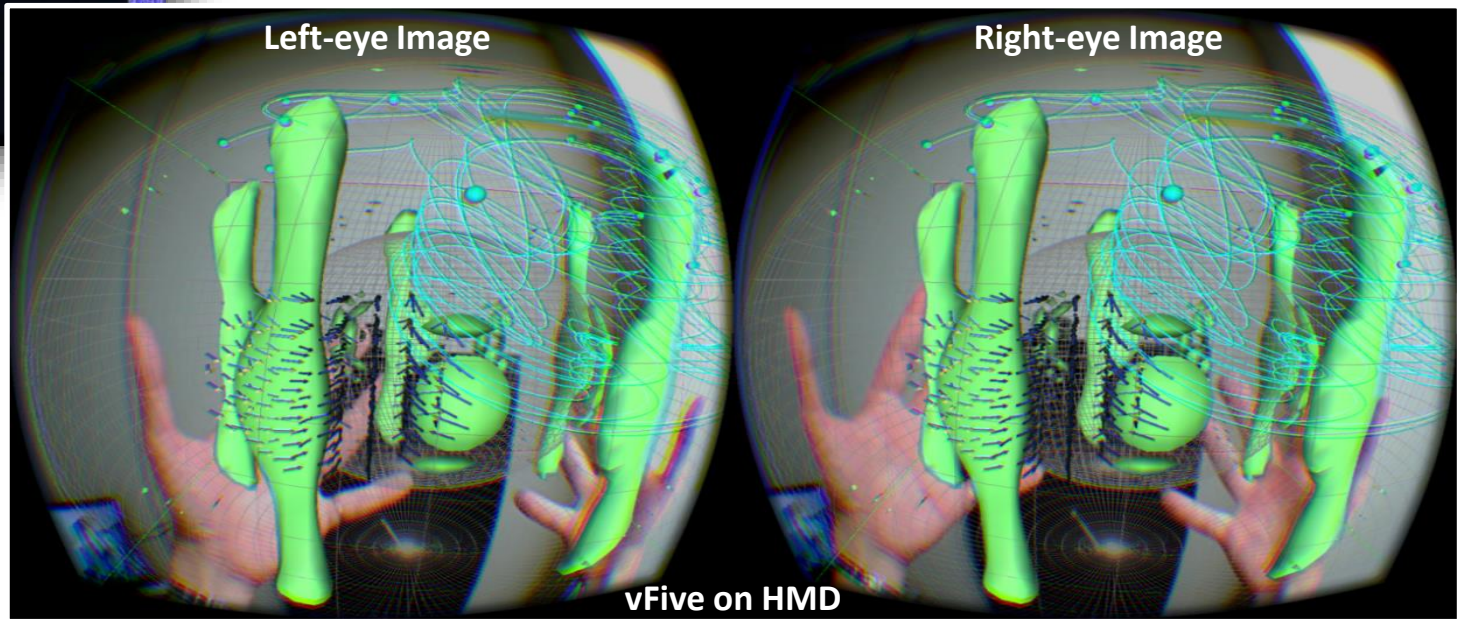
Miyagoshi et al., 2010

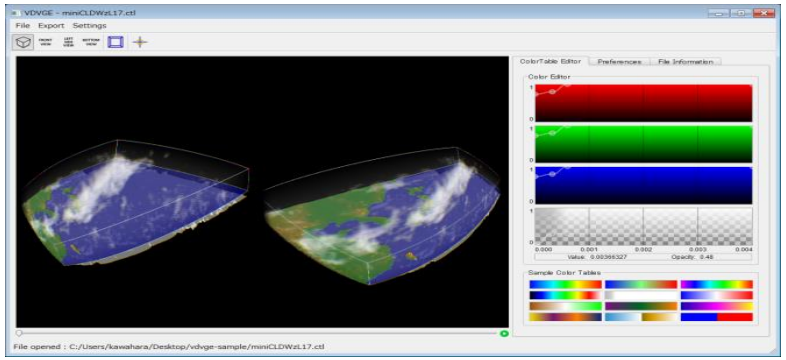
Visualization in HMD system

HMD: Head Mounted Display



Oculus Rift + OVRVision





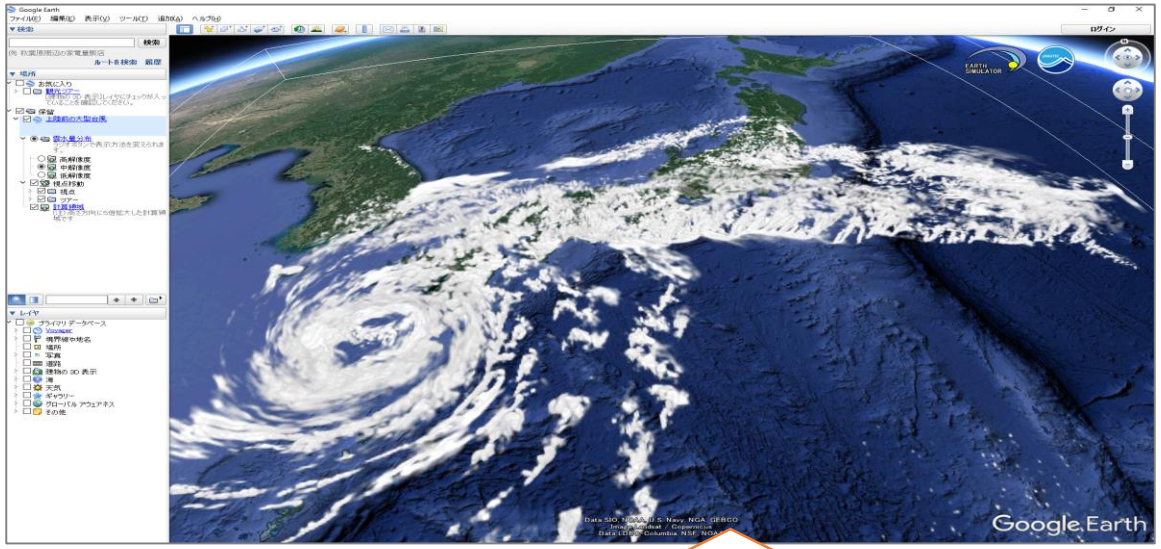
Visualization software for HMD

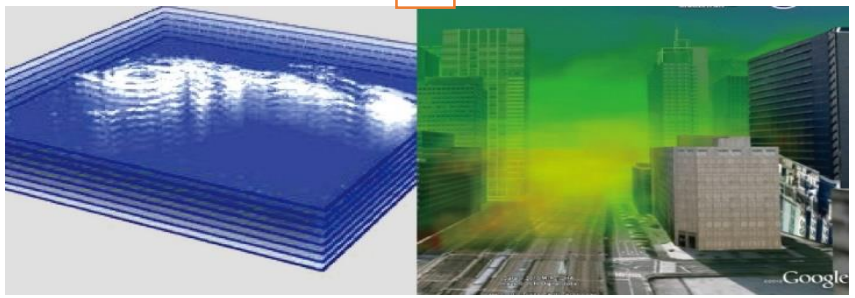
Kawahara et al., 2015

Visualization for General Public
(Children, stakeholder and other non-specialist)

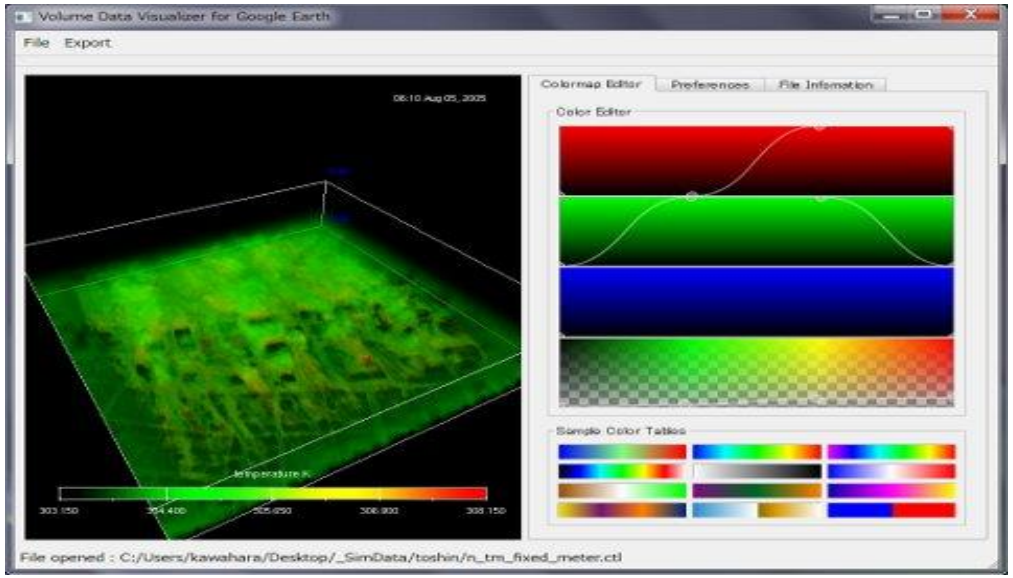
Visualization in Google Earth

EXTRAWING:
EXploring and TRAvelling the World INside Geoscientific data





VDVGE:
Volume Data Visualizer for Google Earth



Texture-based volume rendering using layered PNG image

Kawahara et al., 2014

https://www.jamstec.go.jp/esc/research/Perception/vdvge.en.html

独立行政法人 海洋研究開発機構

三菱地所設計　竹中工務店

高層ビルに囲まれたオアシス緑地の低温化現象と樹木の効果

Cooling Effect of Urban Green Oasis

丸の内パークビル周辺の熱環境

Thermal environment at Marunouchi Park Building

独立行政法人海洋研究開発機構 (JAMSTEC)

株式会社 三菱地所設計 (Mitsubishi Jisho Sekkei Inc.)

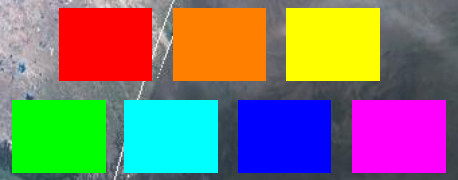
株式会社 竹中工務店 (Takenaka Corporation)

Visualization by Shintaro Kawahara and Fumiaki Araki (JAMSTEC)

JAMSTEC Open Day Events

Call for help by balloon with letter

1. Choose the color of the balloon!



2. Choose the start point!

Hint: wind velocity and cloud

JAMSTEC (4 locations) are goals.

3. Start!

Winner can get a present!

Desert island


Thank you for
your attention!
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Data © 2011 MIRC/JHA
Image © 2011 TerraMetrics
Google earth