Visualization of 5D Assimilation Data for Meteorological Forecasting and Its Related Disaster Mitigations Utilizing Vis5D of Software Tool

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***Abstract*—Method for visualization of 5D assimilation data for meteorological forecasting and its related disaster mitigations utilizing Vis5D of software tool is proposed. In order to mitigate severe weather related disaster, meteorological forecasting and prediction is needed. There are some numerical weather forecasting data, in particular, assimilation data. Time series of three dimensional geophysical parameters have to be represented visually onto computer display in a comprehensive manner. On the other hand, there are some visualization software tools. In particular, Vis5D of software tool for animation of three dimensional imagery data can be displayed. Through experiments with NCEP/GDAS assimilation data, it is found that the proposed method is appropriate for representation of 5D assimilation data in a comprehensive manner.**

Keywords—animation; assimilation data; weather related disaster; Vis5D; NCEP/GDAS

I. Introduction

In order to mitigate severe weather related disaster, meteorological forecasting and prediction is needed. There are some numerical weather forecasting data, in particular, assimilation data. Time series of three dimensional geophysical parameters have to be represented visually onto computer display in a comprehensive manner. On the other hand, there are some visualization software tools. In particular, Vis5D of software tool for animation of three dimensional imagery data can be displayed.

Method for visualization of 5D assimilation data for meteorological forecasting and its related disaster mitigations utilizing Vis5D of software tool is proposed. Through experiments with NCEP/GDAS assimilation data, it is found that the proposed method is appropriate for representation of 5D assimilation data in a comprehensive manner.

The following section, the proposed method is described followed by the experiments. Then conclusion is described together with some discussions.

II. Proposed Method

A. Vis5D Outline

Vis5D software tool allows display five dimensional imagery data, three dimensional location data (x, y, z), time, and geophysical parameters.

The number of lattice points, the name of geographical map, the name of variables (geophysical parameters), the acquisition time, etc. are attributes of the five dimensional data. Vis5D supports two types of data format, v5d and comp5d formats. Comp5d format is old format so that v5d format is popular and default format at this time.

Figure 1 shows control panel of Vis5D while Figure 2 shows manipulating images.

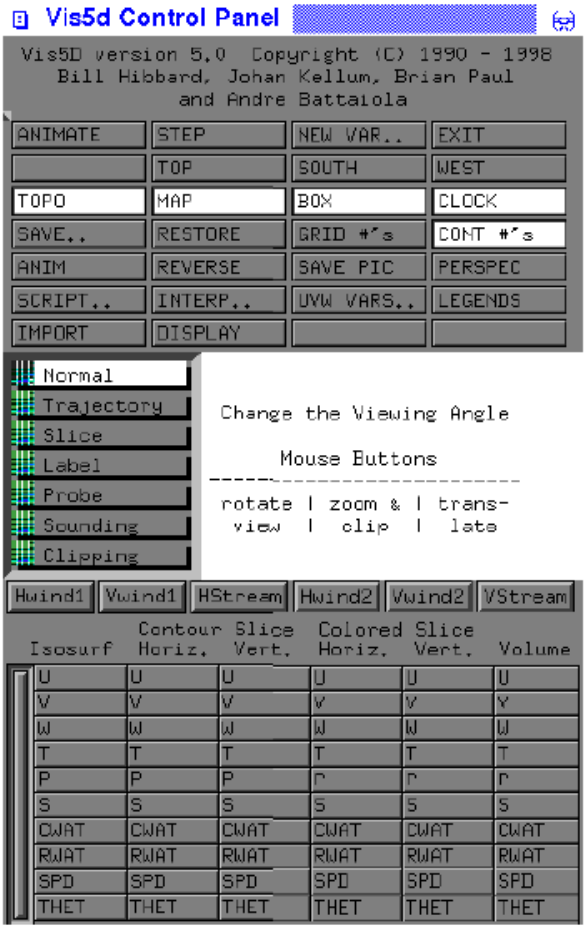


Fig. 1. Control panel for Vis5D

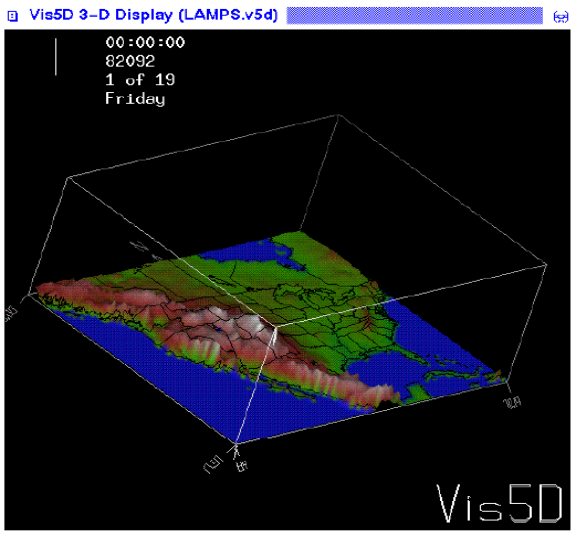


Fig. 2. Displayed image

B. Vis5D Functions

Process menus and parameters can be selected from the control panel. Input images as well as manipulating and resultant images are displayed on the right hand of control parameter. Therefore, image manipulation can be done interactively with the menu as shown in Table 1. Animation can be done by ANIMATION function with mouse operations together with STEP function. 3D display is available with Vis5D as shown in Figure 3.

TABLE I. MENU OF VIS5D

Nomal
Trajectory
Slice
Label
Probe
Souding
Clipping

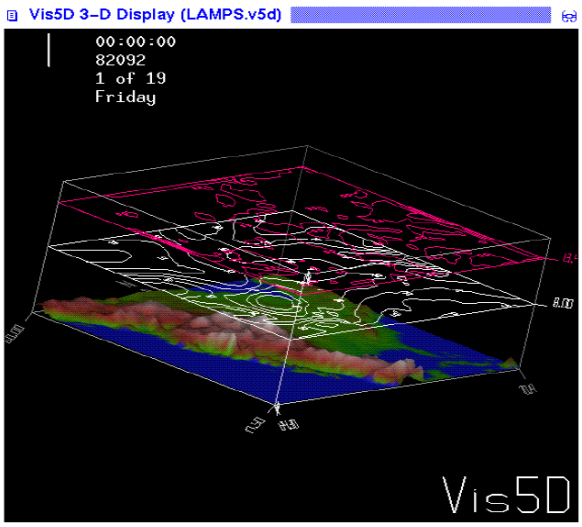


Fig. 3. Example of 3D display with Vis5D

The menu "Normal" has geometric conversion of the displayed manipulation images such as magnification rotation, translation, etc. By using the menu "Trajectory", object tracking result of trajectory can be displayed. "Slice" allows horizontal and vertical line features location identification. 3D displayed image label can be process with "Label" while meshed grid data can be checked with "Probe". Using "Sound", vertical profile can be retrieved while "Clip" allows clipping 3D objects.

C. Geographical Map Format Conversion

Input data format of geographical data provided by Japanese Survey Geography is shown in Figure 4. It is quite simple format, starting from header record followed by line by line data. This type of map data can be treated by Vis5D.

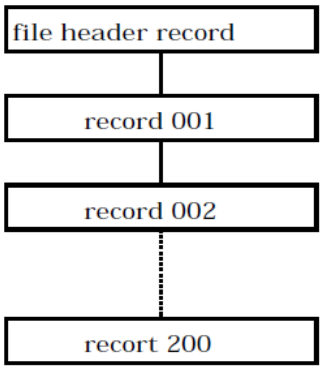


Fig. 4. Data format treated by Vis5D

Geographic map of meshed data such as geographical data can be treated with Vis5D as well. Data format for meshed data is shown in Table 2. There are sets of combined data of mesh code, record number and elevation data. Figure 5 shows the example of Shimonoseki, Japan. It can be transformed to ASCII code by using geographical map data conversion software tool developed as shown in Figure 6.

TABLE II. GEOGRAPHICAL MAP OF MESHED DATA

Mesh Code	Record No.	Elevation Data
??????	001	1 2 3 4 ••• 199 200
??????	002	1 2 3 4 ••• 199 200
??????	003	1 2 3 4 ••• 199 200
•	•	•
•	•	•
•	•	•
??????	199	1 2 3 4 ••• 199 200
??????	200	1 2 3 4 ••• 199 200

D. Vis5D Examples

Figure 7 shows examples of the GIF formatted meteorological assimilation data of Dew point (a), Air temperature (b), and Atmospheric pressure (c) downloaded from Illinois University site. Format conversion can be done with xv of software tool, from GIF to pgm format, in this case.

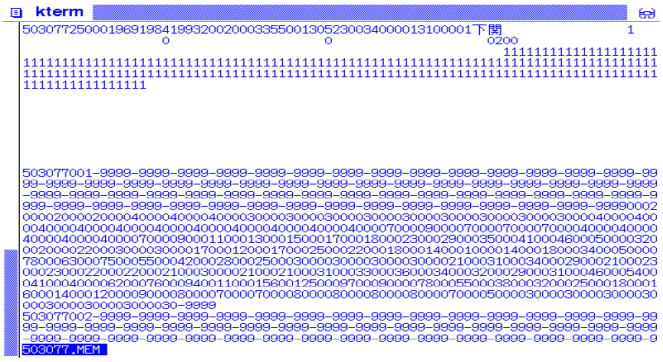


Fig. 5. Example of geographical data

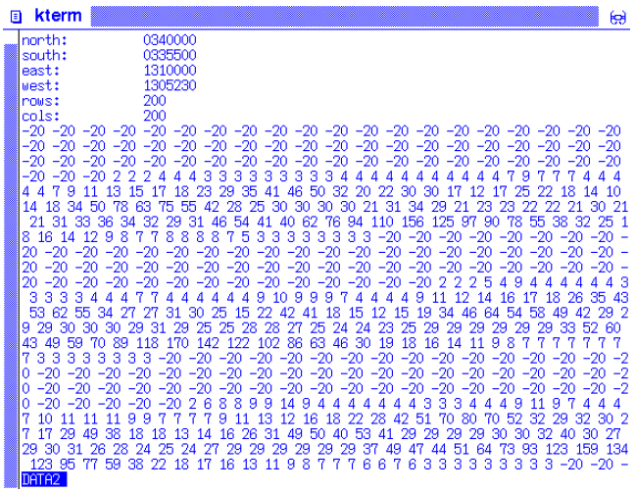
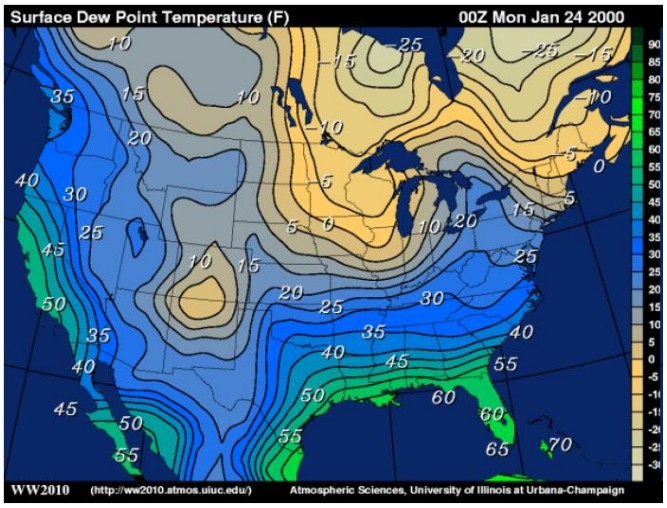
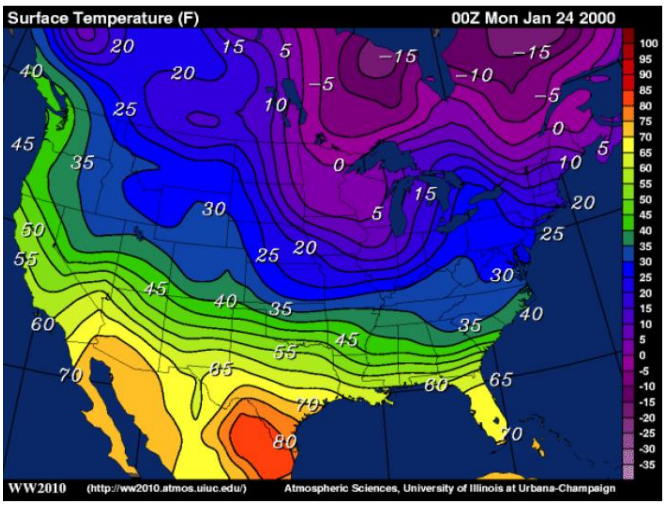


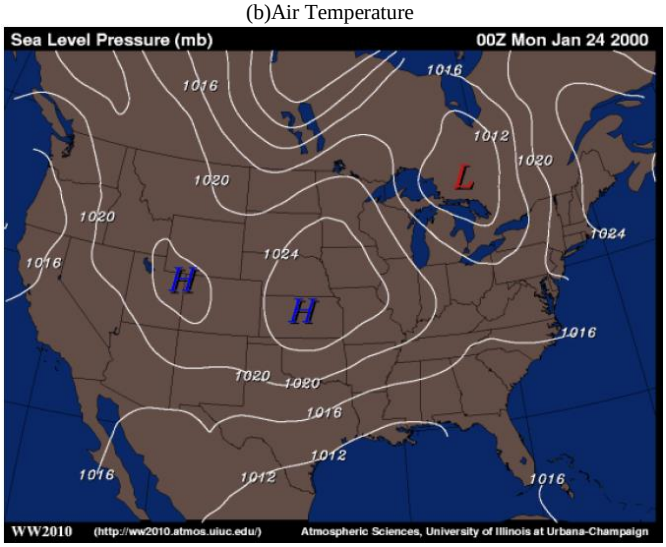
Fig. 6. Example of ASCII data of geographical data



(a)Dew point



(b)Air Temperature



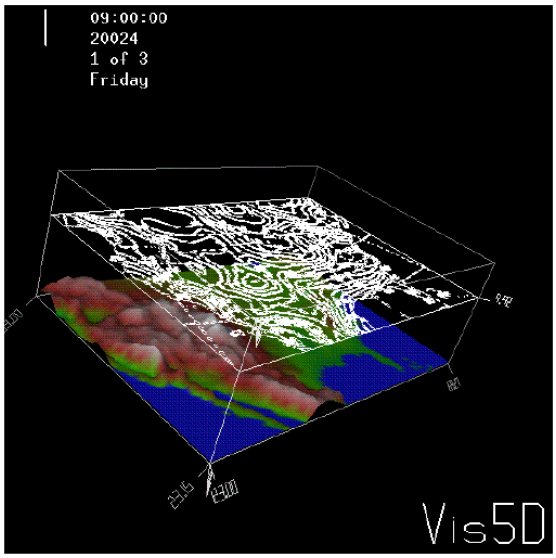
(c)Atmospheric pressure

Fig. 7. Examples of the GIF formatted meteorological assimilation data

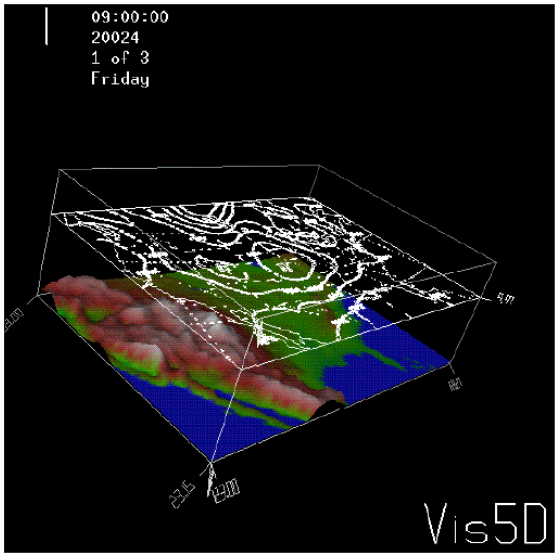
Four types of format conversion software tools are available to use for Vis5D. Although Vis5D can display v5d formatted data, these conversion software tools allows format conversion to match to v5d format.

E. Comparative Study on 5D Assimilation Data Display

There are three major methods for representation of 5D assimilation data display. One is to display the time series of geophysical parameter of image at time by time. Figure 8 shows the geophysical parameter, relative humidity (Figure 8 (a), (b), (c)), air temperature (Figure (d), (e), (f)), and atmospheric pressure (Figure 8 (g), (h), (i)). These geophysical parameter data can be obtained from NCEP/GDAS site.


09:00:00
20024
1 of 3
Friday
Vis5D

(a)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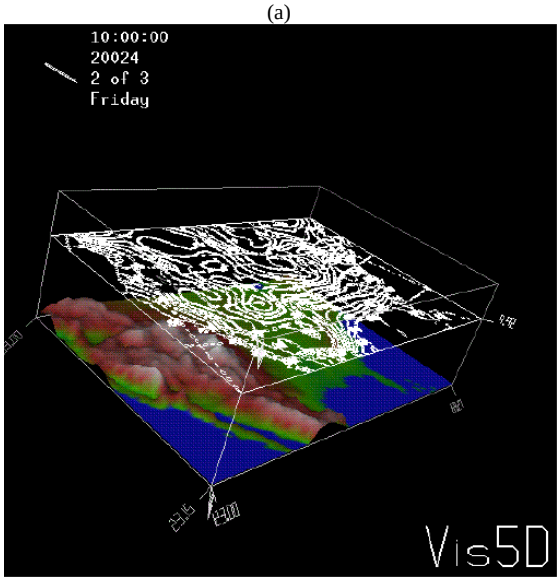
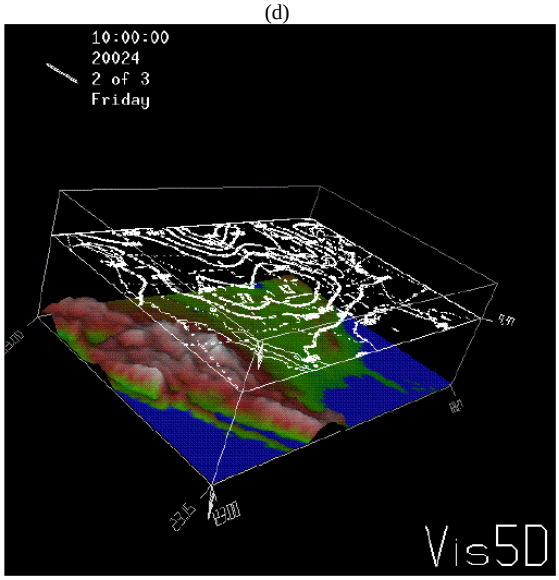
20024
1 of 3
Friday
Vis5D

(d)


10:00:00
20024
2 of 3
Friday
Vis5D

(b)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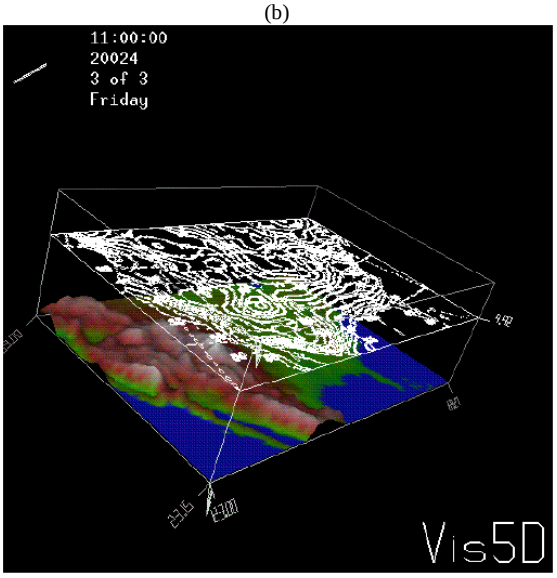
20024
2 of 3
Friday
Vis5D

(e)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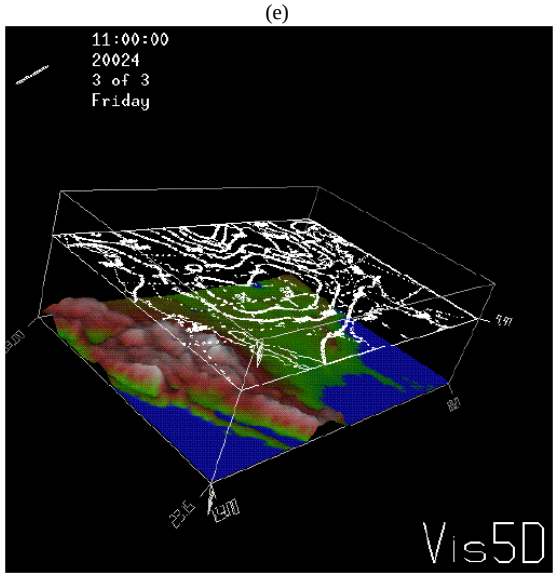
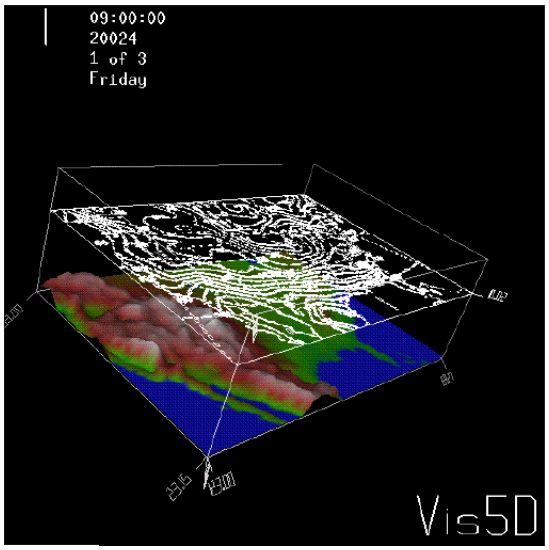
20024
3 of 3
Friday
Vis5D

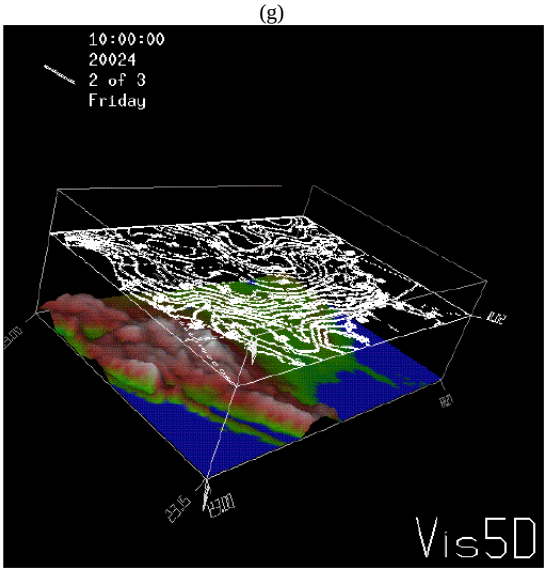
(c)


11:00:00
20024
3 of 3
Friday
Vis5D

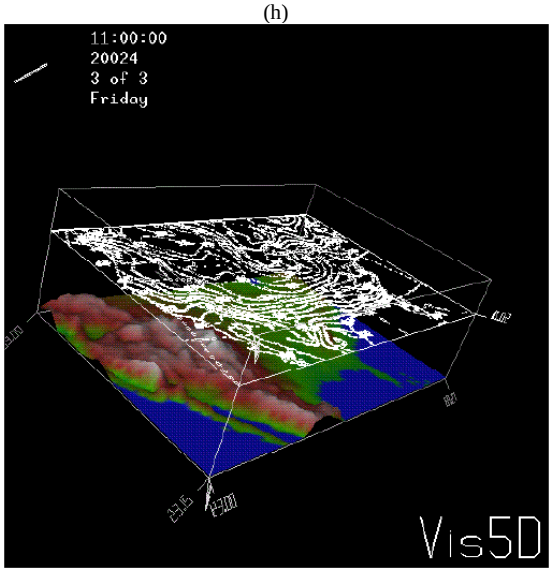
(f)



(g)



(h)



(i)

Fig. 8. Example of time series data display by time by time

The second representation method is to display the time series of data by using different colors. Namely, different color is assigned to the specific geophysical parameter. Then these colored geophysical parameters are superimposed and displayed onto screen as shown in Figure 9. Time series of geophysical parameters can be displayed with animations. It, however, is hard to see. In particular for layered geophysical parameters, it cannot be displayed.

The third representation method is to display the time series of three layered geophysical parameters with different color assignment as shown in Figure 10. It can be displayed with animation as shown in Figure 11. Figure 11 (a), (b), and (c) shows time series of three layered geophysical parameters of relative humidity, air temperature, and atmospheric pressure at the three altitudes. These can be animated with Vis5D.

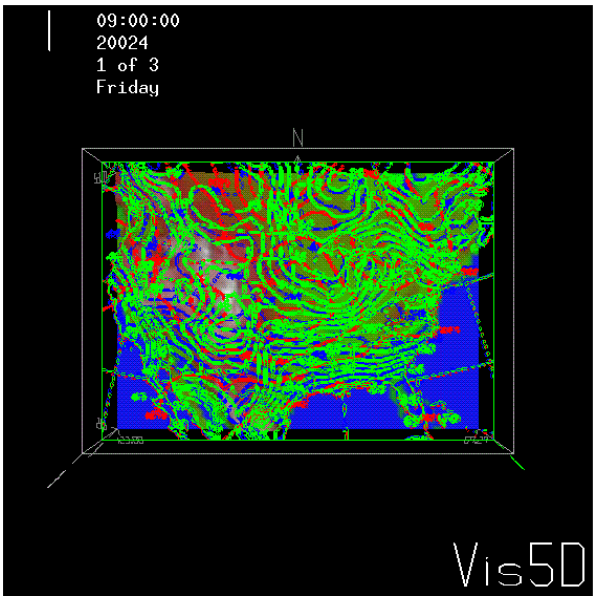


Fig. 9. Example of geophysical parameter display with the different colors

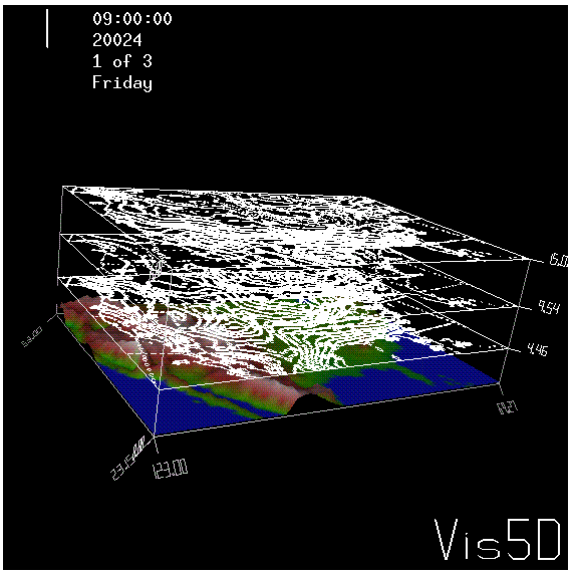
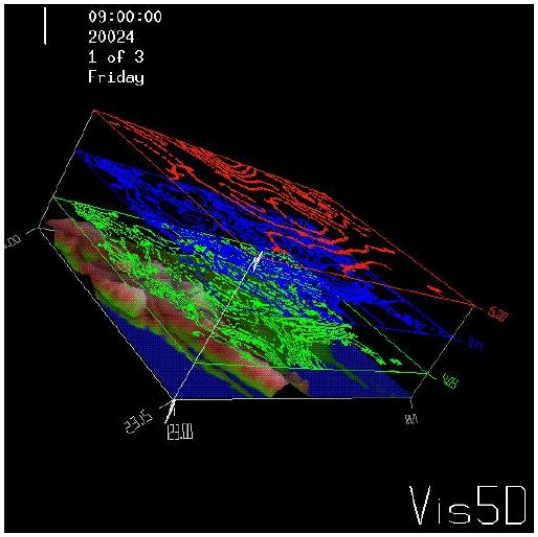
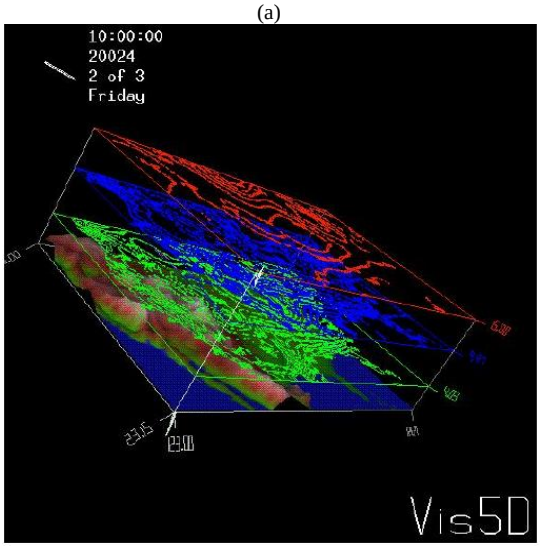


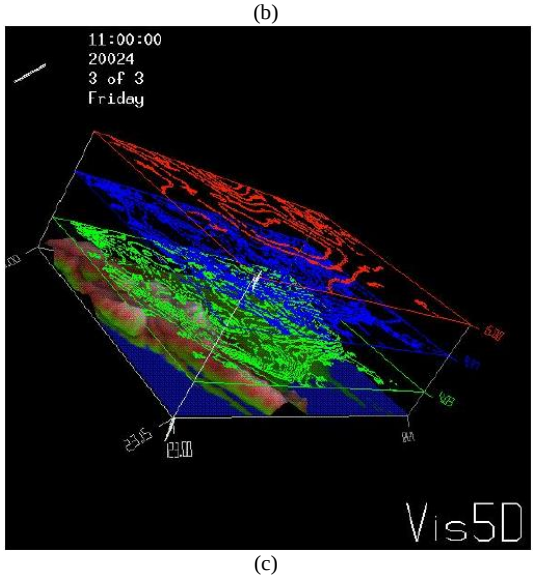
Fig. 10. Example of three layered geophysical parameter display



(a)



(b)



(c)

Fig. 11. Example of display the time series of three layered geophysical parameters with different color assignments

III. Conclusion

Method for visualization of 5D assimilation data for meteorological forecasting and its related disaster mitigations utilizing Vis5D of software tool is proposed. In order to mitigate severe weather related disaster, meteorological forecasting and prediction is needed. There are some numerical weather forecasting data, in particular, assimilation data.

Time series of three dimensional geophysical parameters have to be represented visually onto computer display in a comprehensive manner. On the other hand, there are some visualization software tools. In particular, Vis5D of software tool for animation of three dimensional imagery data can be displayed.

Through experiments with NCEP/GDAS assimilation data, it is found that the proposed method is appropriate for representation of 5D assimilation data in a comprehensive manner.

It is found that the most appropriate method for displaying time series of three layered geophysical parameter data is to use Vis5D with animation with different colors. It can be used for meteorological forecasting and prediction as well as disaster mitigations.

Acknowledgment

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References

[1] Masao Matsumoto, Hiroki Fujiku, Kiyoshi Tsuchiya, Kohei Arai, Category decomposition in the maximum likelihood classification, Journal of Japan Society of Phtogrammetro and Remote Sensing, 30, 2, 25-34, 1991.

Authors Profile

Kohei Arai, He received BS, MS and PhD degrees in 1972, 1974 and 1982, respectively. He was with The Institute for Industrial Science and Technology of the University of Tokyo from April 1974 to December 1978 also was with National Space Development Agency of Japan from January, 1979 to March, 1990. During from 1985 to 1987, he was with Canada Centre for Remote Sensing as a Post Doctoral Fellow of National Science and Engineering Research Council of Canada. He moved to Saga University as a Professor in Department of Information Science on April 1990. He was a councilor for the Aeronautics and Space related to the Technology Committee of the Ministry of Science and Technology during from 1998 to 2000. He was a councilor of Saga University for 2002 and 2003. He also was an executive councilor for the Remote Sensing Society of Japan for 2003 to 2005. He is an Adjunct Professor of University of Arizona, USA since 1998. He also is Vice Chairman of the Commission "A" of ICSU/COSPAR since 2008. He wrote 30 books and published 322 journal papers.