Visual analytics to explore iceberg movement

Ulanbek Turdukulov, Connie Blok
ITC - International Institute for Geo-Information Science and Earth Observation,
PO Box 6, 7500 AA, Enschede, the Netherlands

Remote sensing image repositories are the fastest growing archives of spatio-temporal information. This leads to large time-series that geoscientists need to explore and understand. Effective exploratory tools are urgently needed to handle the large data sets efficiently. Common application areas that require such tools are, amongst others: climate change and environmental monitoring studies, hazard analysis, and the management of agriculture, forest and water resources.

Large time-series of remote sensing data are often explored by animating image sequences with user controlled interactions (play, stop, change display speed etc.). However, evidences from evaluation studies show a rather mixed trend - despite being interactive, animated time series still lead to information overload, often limiting their exploratory usage.

In our previous work we have shown how computational feature tracking can reduce information overload, since feature tracking essentially simulates the human tracking process. However compared to human tracking, the computational tracking process also generates *quantitative information* about each tracked feature, such as its spatio-temporal position, spatial extent, lifetime, and attribute information about each feature's evolution. All these can be used to generate new representations and interactions, as well as to modify existing ones for the purpose of exploration. Examples given in our previous work include multiple representations together with querying object behaviour such as lifetime and presence of specific trends in attributes of the tracked features (Figure 1).

The above mentioned possibilities are by no means exhaustive. In this paper we would like to further develop the idea of exploiting the tracked information for exploratory purposes. We use a subset of freely available large Antarctic Iceberg Tracking Database collected from 2000 to 2008 (http://www.scp.byu.edu/data/iceberg/database1.html) in which icebergs were identified and tracked using five different satellite scatterometer and radiometer instruments, resulting in records containing iceberg positions every 1-5 days with over 9000 records (Figure 2 shows iceberg tracks for one day).

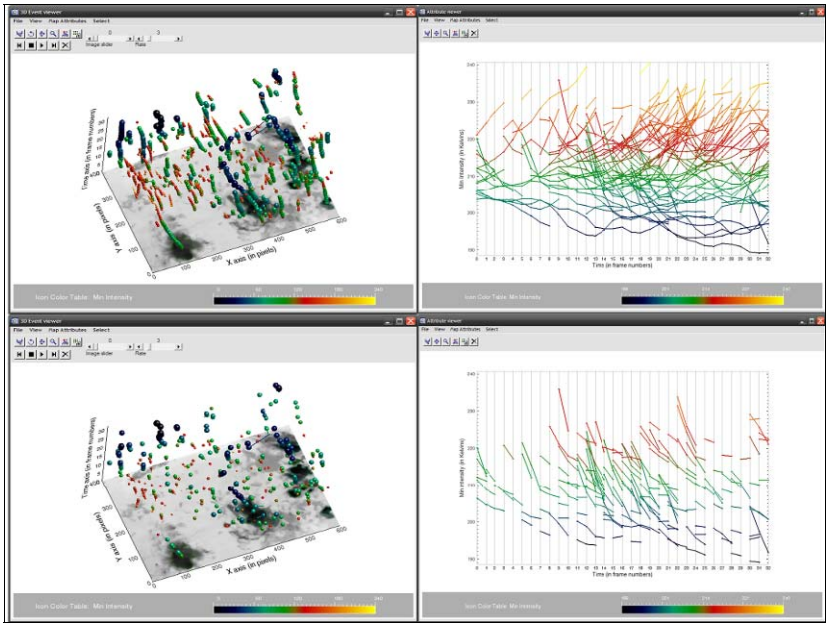

Figure 1 Overview of clouds (upper windows) and visual query (lower windows) for clouds with negative temperature gradients in the Space Time Cube (left) and in the time-series graph (right). Negative gradients point to convective clouds that indicate severe weather conditions.

Clearly, visualizing such long time series in an animated sequence would be a difficult way of gaining insights for experts involved in monitoring and tracking the behaviour of icebergs and the changes in patterns. The information derived from monitoring and tracking activities serves different applications, ranging from studies on climate changes, processes in the atmosphere and the hydrosphere (e.g. patterns of ocean currents), to providing timely information about iceberg positions to mariners.

Question is how to provide the visual means (visualization and interaction) to explore the iceberg movements given that we have tracking information available. The resulting exploration environment should be intuitive to use, enable domain experts to find answers to their questions, hence be effective, and efficient, in the sense that it requires little time and efforts to understand the iceberg movement patterns.

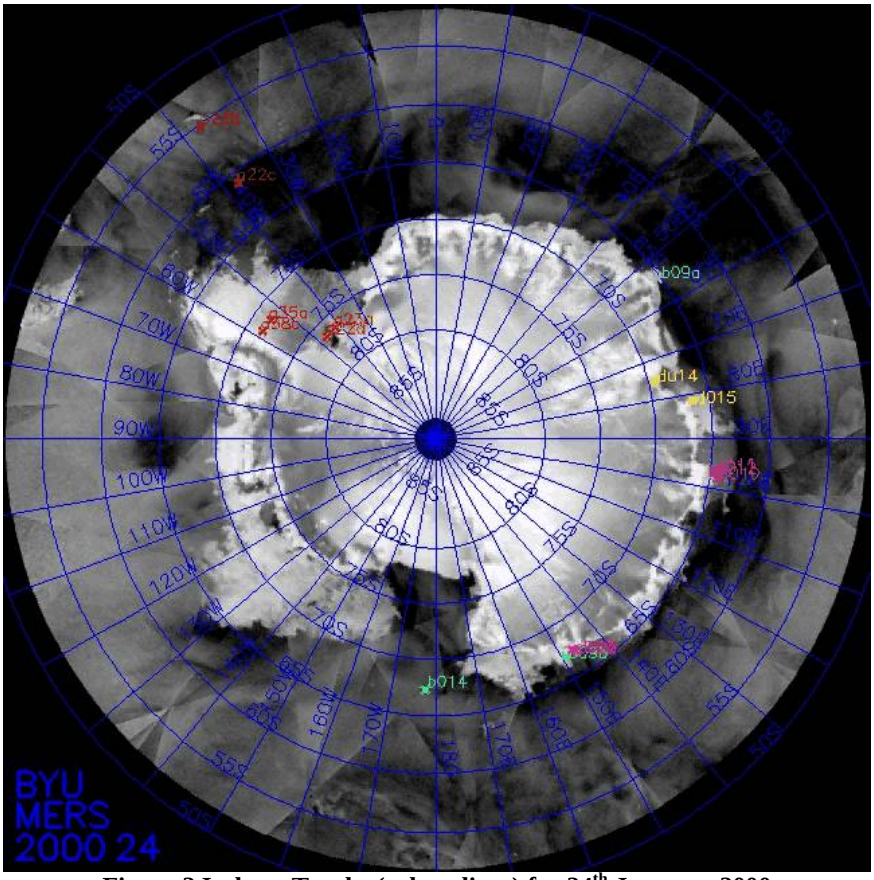

Figure 2 Iceberg Tracks (colour lines) for 24th January, 2000

We approach the problem by deriving descriptive measures of iceberg movement characteristics. These are:

- Path of each iceberg during its lifetime
- Average speed of icebergs during their lifetime
- Lifetime
- Average size
- Locations and time of iceberg's appearances and disappearances.
- Frequency of occurrences

Using these descriptors we propose visualizations and interaction that can support users in categorizing the iceberg movements.
Figure 3 shows essential elements of the categorization process:

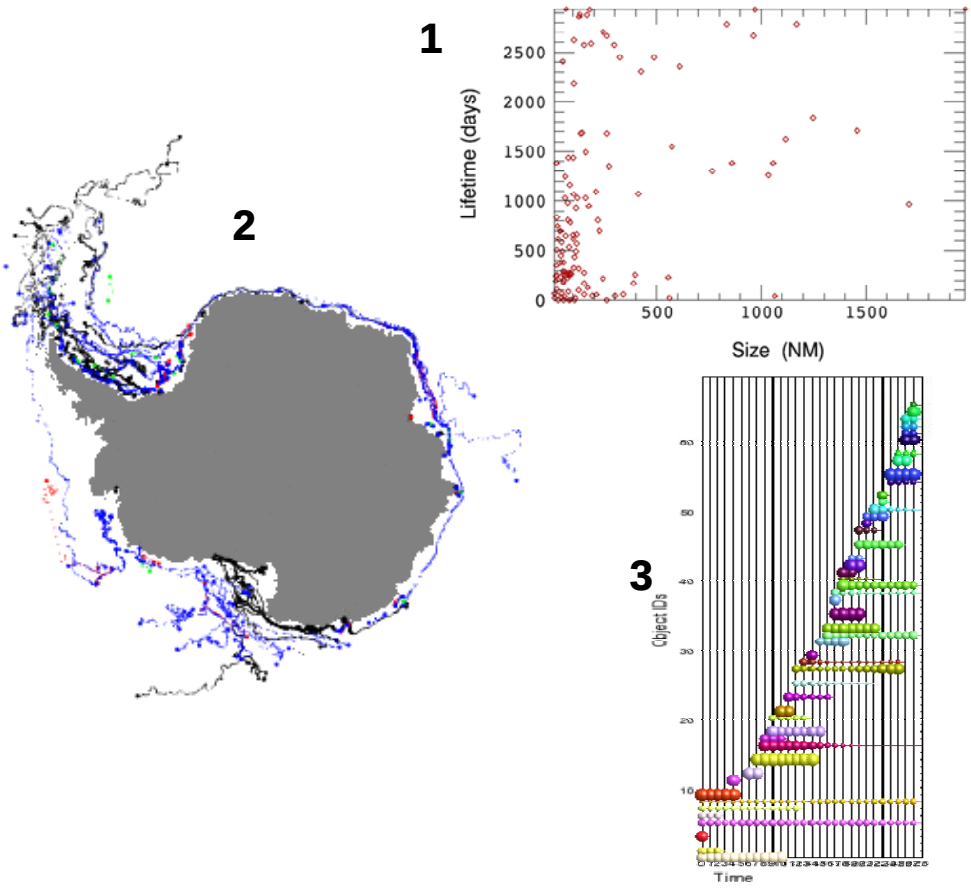

Figure 3 Proposed multiple view environment for visual exploration of iceberg tracks: View 1 is a main categorization tool linked to other representations; here it displays relation between average size and lifetime of the icebergs that enables categorization of, for instance, larger icebergs that existed longer. In the final exploratory environment, different attributes can be selected and plotted against each other. 2- Spatial View; 3 – Lifetime View. All views will be linked, and the final environment will also contain a time view to explore (multi-) temporal patterns.

We have presented an ongoing work that relies on linking analytical and visualization techniques to gain insights into a movement database. We have done this by using descriptive measures of iceberg movements and are constructing visualizations and interactions that supports categorization and classification of movement data. By doing so, the aim is to demonstrate that with tracking information available, the visualizations and interactions can be user-tailored, providing solutions for particular tasks, like search for patterns and trends in appearances and paths, sieve features of interest to further reduce the complexity, and help users to focus attention on the selected objects. Ultimately, the environment should, as mentioned above, be intuitive, effective and efficient.