Yan Sun ✉(18/19) ⟳59:00

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| ## | Summary | Status | Action |
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| 1 | **3D Weather Data Visualization with IDV: Computational Thinking Contextualized in Atmospheric Science**, *Yan Sun; *Jamie Dyer; *Mahnas Jean Mohammadi-Aragh; *Jonathan Harris; *Mengni Bai; *Pat Ko<br>**In Full Session Type:** Innovate! Session<br>**Submission type:** Innovate! Session<br>**Keywords:** Technology Integration, Emerging technologies | **Accepted - In Session** | upload<br>unavailable<br>review summary |
| 2 | **Using IDV to Promote Computational Thinking in Atmospheric Science Learning**, *Yan Sun; *Jamie Dyer; *Mahnas Jean Mohammadi-Aragh; *Jonathan Harris; *Mengni Bai; *Pat Ko<br>**In Full Session Type:** Showcase Session<br>**Submission type:** Showcase<br>**Keywords:** Technology Integration, Emerging technologies | **Accepted - In Session** | add/edit poster boards<br>upload / remove<br>download<br>review summary<br>Edit Link to external URL |

## 3D Weather Data Visualization: Computational Thinking Contextualized in Atmospheric Science

This concurrent session introduces the innovative science learning experience designed and developed by the 3D Weather project funded by the NSF STEM+C project. Attendees of this session will be engaged in visualizing real world weather data to: (1) understand computational thinking skills contextualized in atmospheric science, and (2) experiencing the "engage, observe, and explain & communicate" learning process that promote computational thinking among middle and high school students by visualizing weather data with IDV (Integrated Data Viewer).

### Introduction

Computational thinking is essential to STEM fields (Henderson et al, 2007) and brining computational thinking into STEM classrooms gives students a realistic view of what these fields are and better prepare them for pursuing careers in these disciplines. However, computational thinking in K-12 STEM classrooms is still largely conceptualized from a computer science perspective and focus mostly on such skills as abstraction, algorithms, automation, decomposition, debugging etc. (Bar & Stephenson, 2011; Shelby & Woolaard,2013; Wing, 2006, 2008, 2011). Although these skills are inherent to thought processes useful in fields beyond computer science, they fail to capture the rapidly changing nature of the STEM disciplines as they are practiced in the professional world (Bailey & Borwein, 2011; Henderson et al, 2007). The 3D Weather project holds the view that the varied and applied use of computational thinking by STEM professionals provides a roadmap for what computational thinking instruction should include in the classroom. To help build the roadmap, the 3D Weather project identified computational thinking skills practiced by atmospheric scientists and embedded these skills into unique and exciting science learning experiences of using IDV to visualize real world weather data.

### Computational Thinking in 3D Weather Project

In the 3D weather project, four 3D weather learning modules were developed that integrate computational thinking into atmospheric science learning through 3D visualization of large-scale weather data using IDV. IDV is a free and open-source software developed by Unidata for analyzing and visualizing geoscience data that runs on Windows, macOS, and Linux platforms.

Using IDV, students are able to visualize various weather conditions or phenomena in 3D images and/or 3D animations. They can try different parameters or IDV features to "see" weather and weather changes along both space and time dimensions. They can also zoom in and out or rotate the 3D visualizations to better observe and understand weather conditions and changes in a dynamic way. In this process, a series of computational thinking skills focusing on spatial ability and associated with atmospheric science are embedded.

Spatial ability is defined as "the ability to generate, retain, retrieve, and transform well-structured visual images"(Lohman, 1996). Severn types of spatial abilities were identified as computational thinking related to atmospheric science and were embedded into the 3D Weather science learning modules: mental animation, disembedding, perspective taking, mental rotation, spatial reasoning, spatial reasoning, spatial visualization, and object location memory.

- Mental animation is the ability to determine the motion of one component of the system given information about the states of the other system components and the relations between the components. (Hegarty, 1992,1994)
- Dieembedding is the ability to hold a given visual percept or configuration in mind, so as to disembed it from other well-defined perceptual material (Ekstrom et al. 1976). It is the skill that allows people to find a simple object from a complex figure (Velez et al., 2005)
- Perspective taking is teh ability to infer other people's thoughts, feelings, or internal stage of knowledge. (Borke,1971; Chandler & Greenspan, 1972). In Piaget's mountain task (Borke, 1975), this ability focused on coordinating spatial relationships from different viewpoints.
- Mental rotation refers to the ability to determine two-dimensional pictures portray objects of the same three-dimensional shape in the situation that the objects are depicted in very different orientations(Shepard & Metzler, 1973)
- Spatial reasoning is the ability people reason about the spatial relations among objects (Gagnier et al., 2017). It involves a set of cognitive processes by which mental representations for spatial objects, relationships, and transformations are constructed and manipulated (Clements & Battista,1992).

- Object location memory is related to the ability to recall the location of objects correctly. (Silverman & Eals, 1992)

In addition to the above spatial abilities, the 3D Weather science learning modules also include other computational thinking skills such as recognizing weather patterns over space and time; making connections between weather conditions and knowledge of local or earth systems, and system thinking of the atmosphere as a complex system affected by various local factors or characteristics. These computational thinking skills were defined by contextualizing such general computational thinking skills as abstraction and pattern recognition in atmospheric science.

**A 3D Weather Learning Module Example**

The four 3D Weather science learning modules cover four themes: temperature, moisture, pressure and wind, and mid-latitude cyclone. The temperature module covers three topics: Global Temperature Cycle, Seasonal Temperature Cycle, and Diurnal Temperature Cycle. In the concurrent session, attendees will be able to visualize seasonal temperature cycle using weather data GFS files corresponding to the 1st day of each month for 2018 available from https://www.ncei.noaa.gov/data/global-forecast-system/access/historical/analysis/. Specifically, attendees will visualize the 0°C Isothermal Surface over the Course of a year and experience the "engage, observe, and explain & communicate" learning process to understanding how the 3D visualization and animation of the 0°C isothermal surface can help promote computational thinking that is practiced by atmospheric scientists.