Analysis and Visualization of Madden-Julian Oscillation (MJO)

Application:

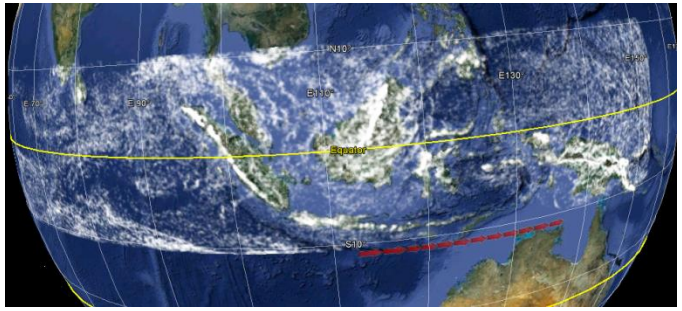
- Climate modeling by Dr. Ruby Leung and Dr. Samson Hagos at PNNL

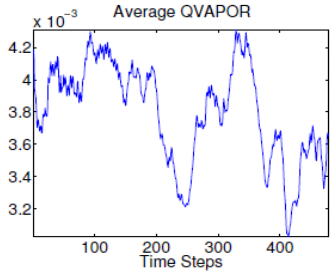
Simulation Goal: Understand MJO

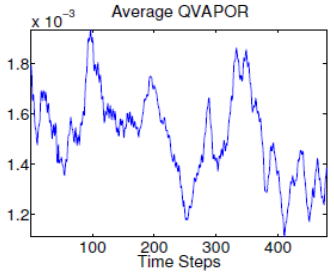
- A complex cloud system in multiple scales over the Indian and Pacific oceans
- An important weather phenomenon related to the tropical intra-seasonal change

Requirement: Time-varying Feature Tracking

- Visualizing the movement of MJO-related quantities (eg. cloud population and precipitation)
  - Understand how MJO is formed
  - Understand how MJO is related to different physical quantities
- Feature identification to filter the major cloud movement of MJO







Challenges

- Large data size generated by high resolution simulations
- Various temporal scales of MJO
  - make traditional techniques that perform per time step analysis and visualization ineffective
  - require global analysis over time other than local feature tracking

(Upper left): Cloud rendering on a virtual globe
(Lower left): The average water vapor mixing rate, indicating the existence of two MJO cycles

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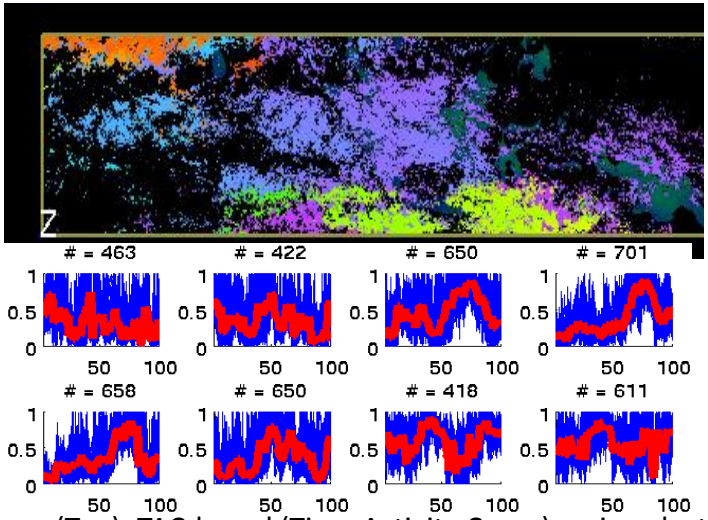
Time-Varying Data Analysis with Time Activity Curves

Technology

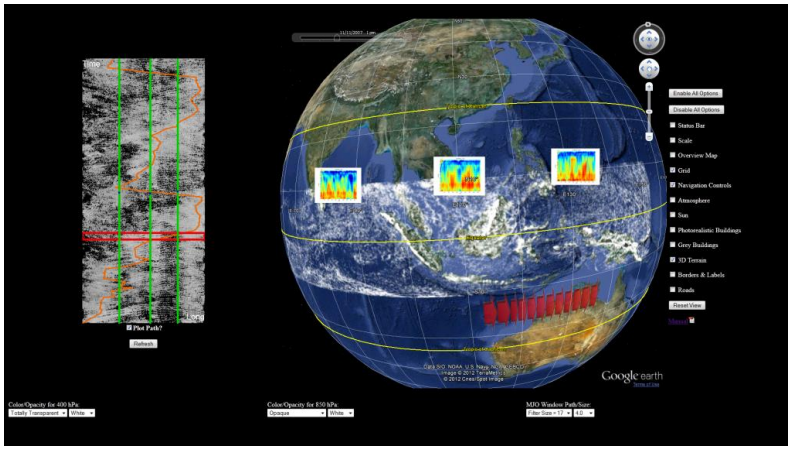
- Robust global time-varying feature descriptors
  - Model the time-varying feature based on the change of value over time at each location
- Visualize complex time-varying phenomena with detailed multivariate temporal trend analysis

Result/Impact

- Flexible interface to allow scientists to interact with data at their desktop
- Replace tedious viewing of animations with more efficient visualization of spatio-temporal features in still images
- Assist in summarizing and verifying major temporal trends such as MJO in extreme scale data sets



(Top): TAC-based (Time Activity Curve) region clustering
(Bottom): Clustering TACs from all 2D location.



Linked views between TAC-based overview and virtual globe.
(Top Left): TACs per longitude as Hovmoller diagram.
(Top Right) Cloud animation with Feature Tracking