Exploring GEOS-5 Nature Run Deep Convection Events via a Statistically Driven Case Finding System

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MOTIVATION

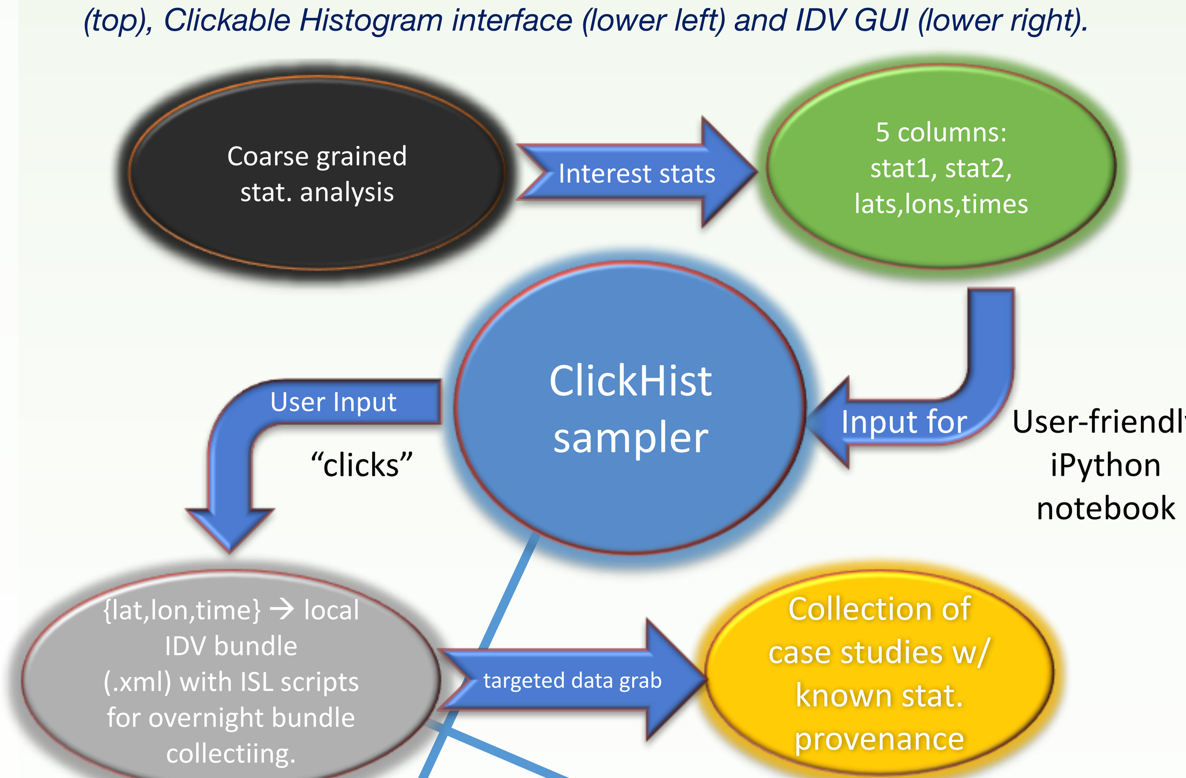
- The Goddard Earth Observing System Model, Version 5 (GEOS-5) hosts hourly data for the entire duration of the project (i.e. May 2005 to May 2007).
- In addition, GEOS-5 boasts resolution down to 7 km, which is excellent for resolving convective features, especially in episodes of deep moist convection.
- The main objective is to then *characterize or evaluate* these convective features on model levels for raw numerical clarity.

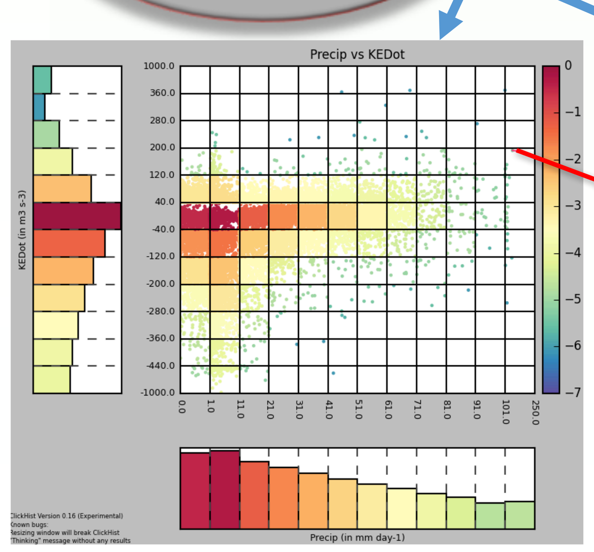
DEFINING *INTERESTING* CASES

- GEOS-5 0.5 degree data can be rebinned and regridded to a coarsened 2 or 4 degree resolution for statistical purposes.
- Classify cases based on the following statistics:
  - Precipitation
  - Vertical Velocity
  - Eddy Momentum Flux $[u'w'] = [uw]-[u][w]$
    - Mapes and Wu (2001)
  - Zonal Shear Kinetic Energy $< \mathbf{V} \cdot -d/dp(w'\mathbf{V}') >$
    - LeMone (1983)
  - Horizontal Mesoscale Variability
- Move to cumulus parameterization to understand convective processes
  - Any vertical modes? Kelvin wave enhanced convection?

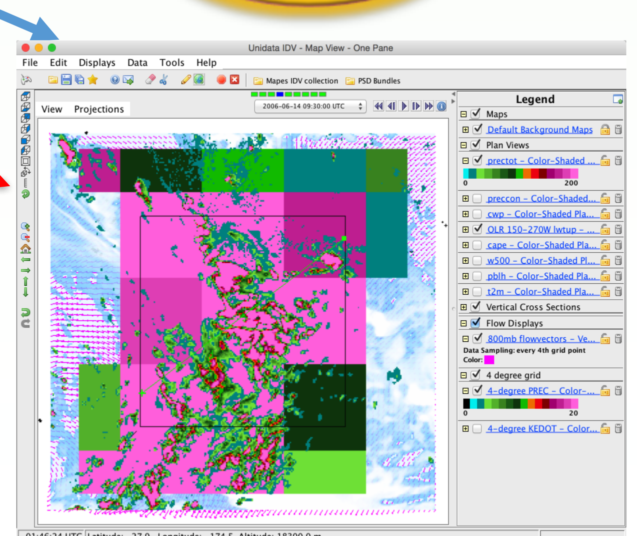
METHODOLOGY

Fig. 1 (below): General overview of the workflow with start-to-finish process (top), Clickable Histogram interface (lower left) and IDV GUI (lower right).





Clickable Histogram (ClickHist) of Atmospheric Data (CHAD)



Interactive Data Viewer (IDV)

IMPLEMENTING CLICKHIST

- An example of a model case in this study was selecting one that combined two statistical parameters in very high quantiles (>99.9%).
- Once a point is clicked, an IDV bundle full of displays is generated including cross sections and plan views of many atmospheric parameters.
- Two cases were selected and are displayed below as an excerpt.

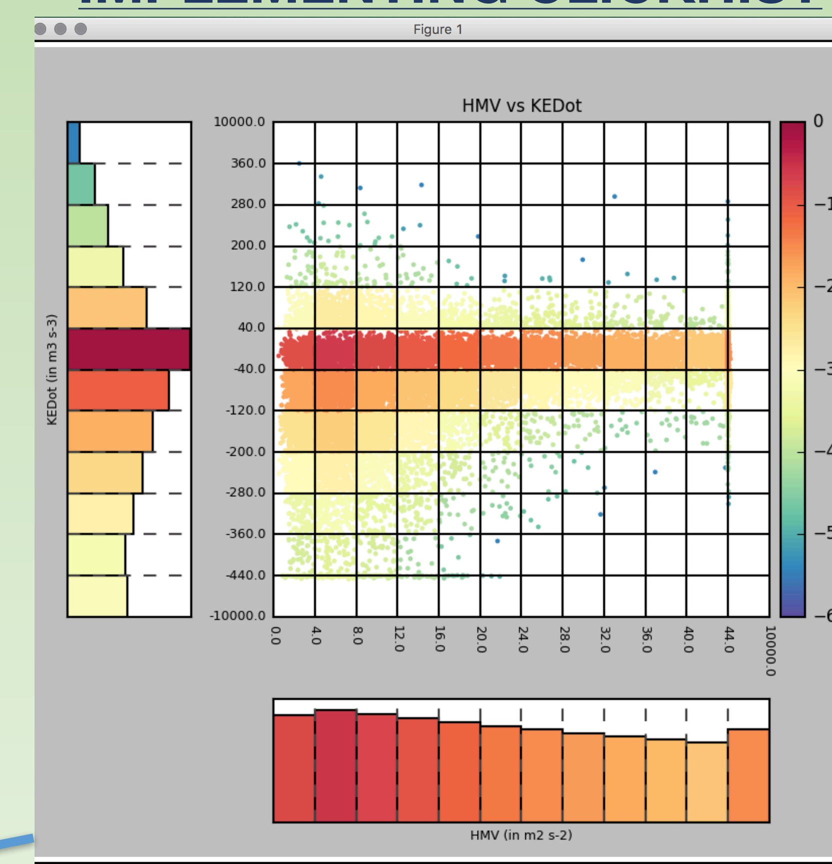


Fig. 2: ClickHist instance showing the available cases in comparison of HMV vs. ZSKEDot.

OBSERVATIONS WITH IDV

Case below: 2006-06-14; ~ -28 S, 175 W

- Not surprisingly, cumulus moisture fluxes and higher values of observed total precipitation coincide.
- Planetary boundary layer heights were found to be displaced higher in areas of deep convection (not shown).

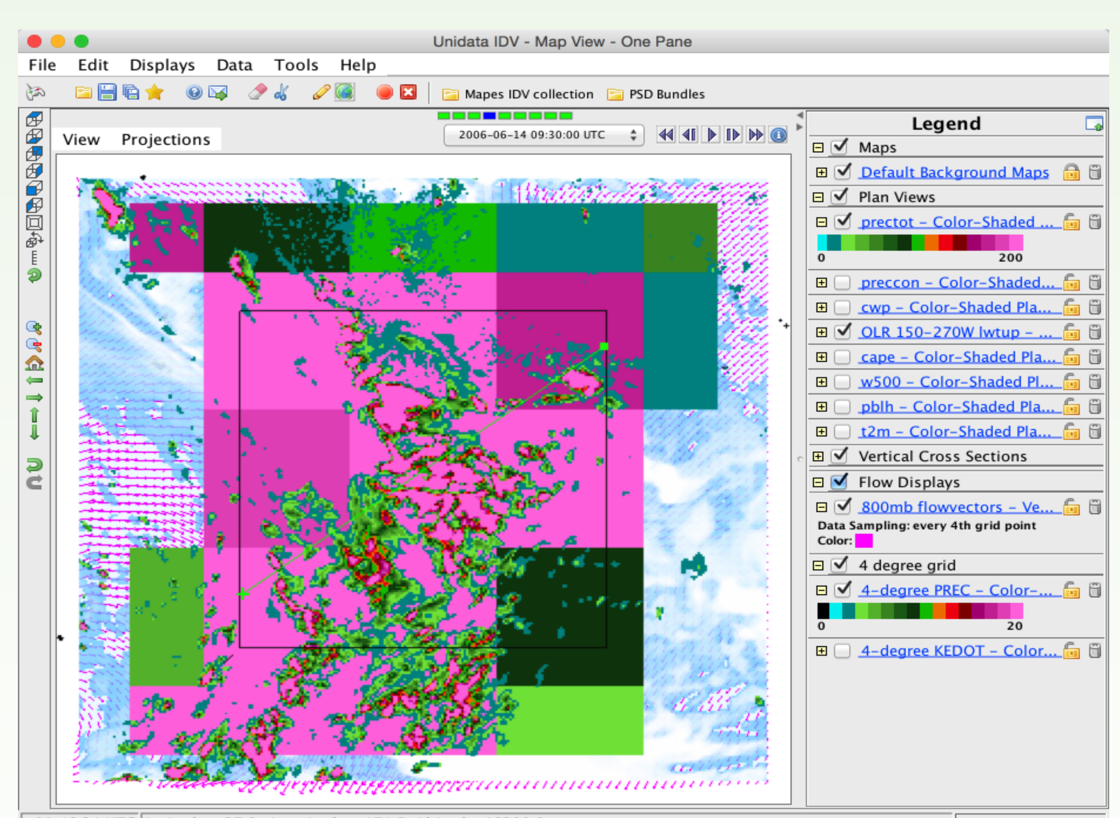


Fig. 3: Case from 2006-06-14 showing a plan view of total precipitation, outgoing longwave radiation, 800 hPa flow vectors, and precipitation at a coarsened 4-degree resolution.

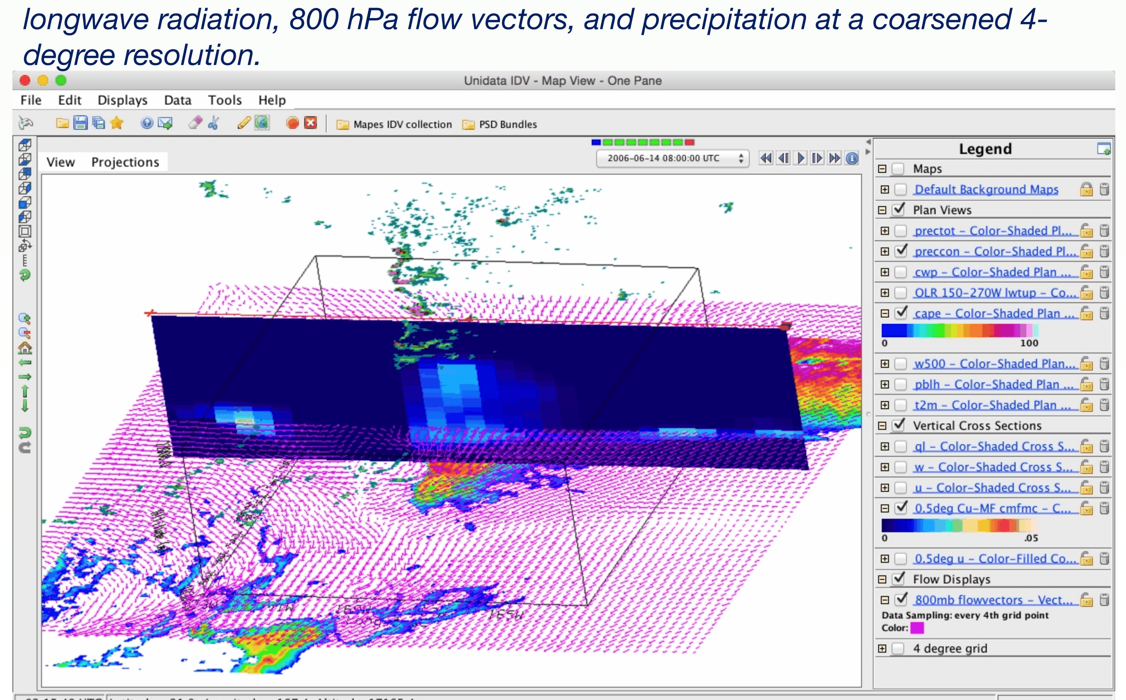


Fig. 4: A 3-D cross-sectional analysis of convective precipitation, 800 hPa flow vectors, convective available potential energy, and cumulus moisture fluxes (dark slab area).

Case below: 2006-07-03; ~ -3 S, 145 W

- Depiction of surface gravity waves oriented south to north along cross section (black line) as well as trade wind advection from northeast to southwest.
- Vertical mode (Fig. 6) prominent in deep convection bands along the equator.

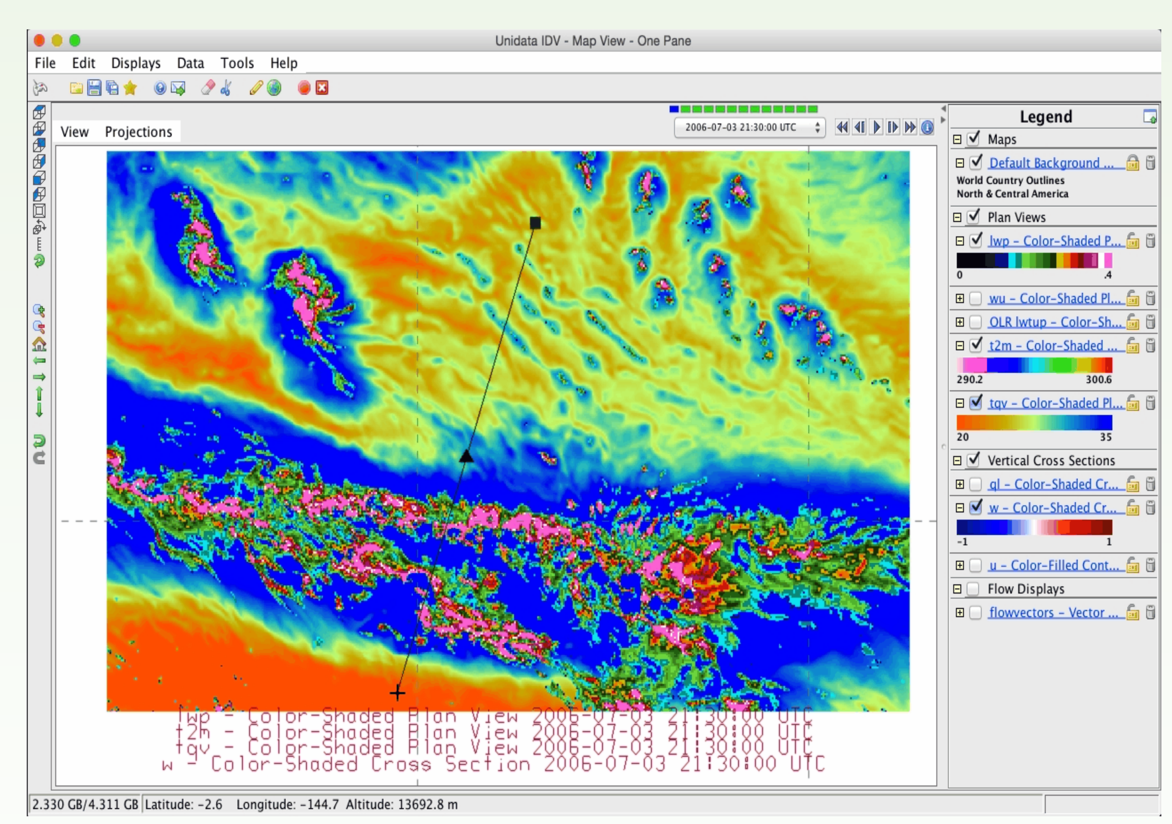


Fig. 5: Case from 2006-07-03 showing plan views of liquid water precipitation (LWP), 2-metre temperature; total precipitable water (tqv). The vertical velocity cross-section is not shown here.

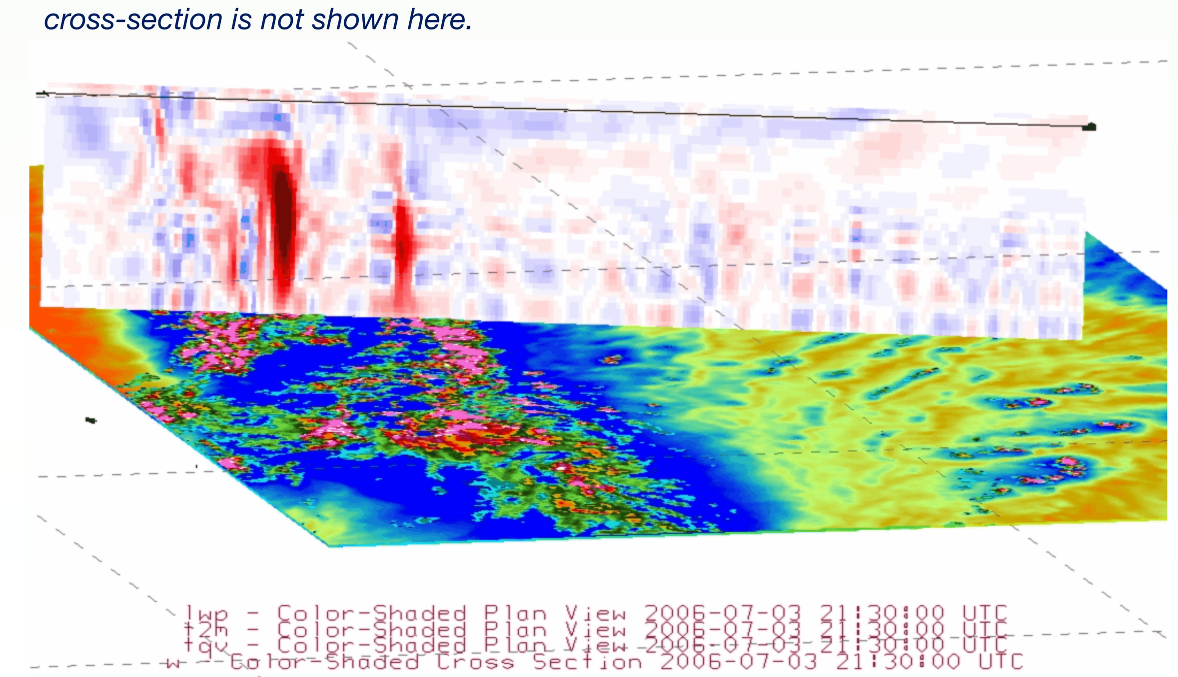


Fig. 6: Same as fig. 4, except with plan views of fig. 5 and now a vertical velocity cross-sectional analysis is introduced.

FINDINGS

- **Model Aspect:**
  - Peculiar standing vertical mode in the vertical cross section in the lower troposphere.
  - Liquid Water Content was observed to have dropouts in some of the updraft cores.
  - Cumulus parameterization can be seen to be somewhat active. However, this may not be the full explanation.
- **Science Aspect:**
  - Eddy momentum fluxes are contributed largely in part by updraft mechanisms in preferential zones of horizontal eddies.
  - Cumulus parameterization can be seen to be somewhat active. However, this may not be the full explanation.
    - Squall conceptualization remains poorly understood (ongoing and future work).

CONCLUDING REMARKS/FUTURE WORK

- The combination of the Ipython Notebooks, CHAD, and the IDV embody an interactive sampling experience in 2-D space.
- The enhanced functionalities of the IDV GUI provide an excellent analysis platform for exploring case studies and their mechanisms.
  - Capabilities of bundles go further than the preloaded displays; bundles can be extended!
- Big data hyperslabs can be collected overnight via ISL scripts for efficient case study collection.
- Ongoing and future work implements all of the tools for use with MERRA and TRMM datasets for reanalysis case studies; *extreme precipitation classification & analysis.*

REFERENCES

LeMone, M. A. (1983). Momentum Transport by a Line of Cumulonimbus. *J. Atmos. Sci.*, **40**, 1815-1834.

Mapes, B. E., and X. Wu (2001). Convective Eddy Momentum Tendencies in Long 2D and 3D Cloud-Resolving Model Simulation. *J. Atmos. Sci.*, **58**, 517-526.

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