# Relating Electrified Cloud Properties to Wilson Currents: An Oceanic and Continental Case Study

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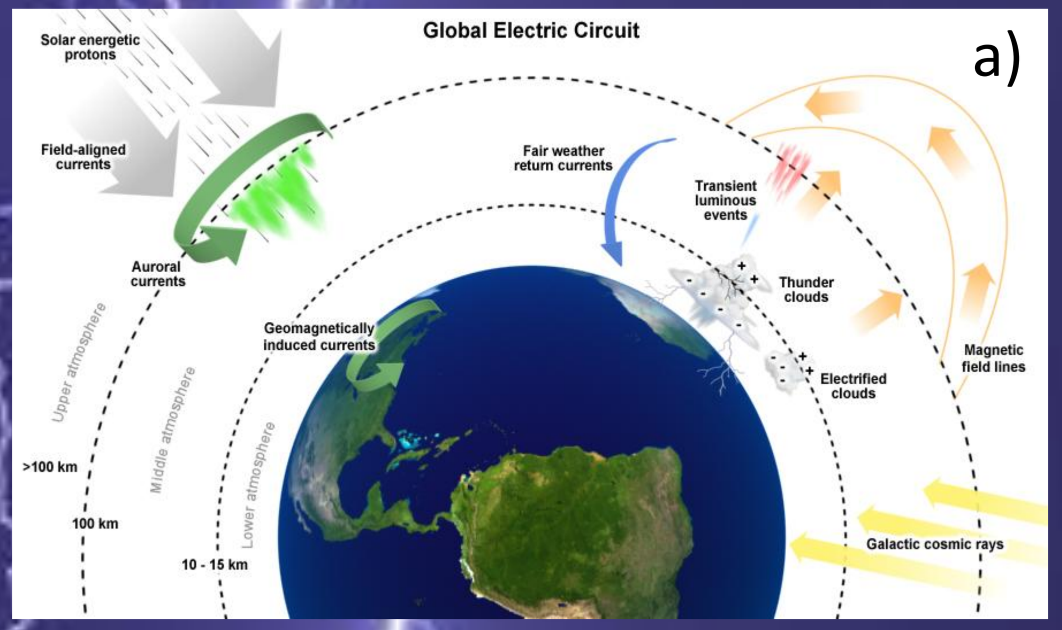
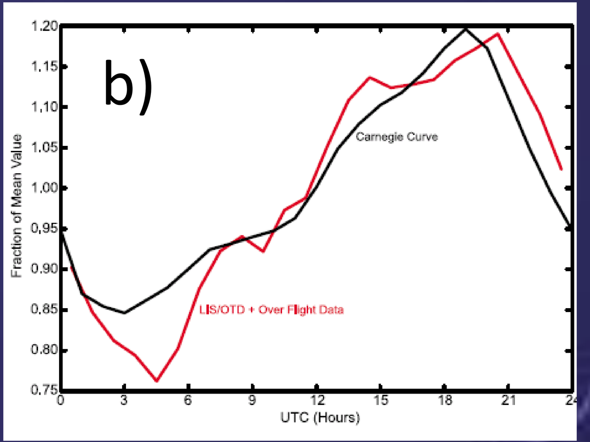
## Background

- The Global Electric Circuit (GEC) is driven by a potential difference between Earth's surface and electrosphere
- Wilson currents help maintain potential difference, fair weather currents weaken it
- Diurnal variation of fair weather current, depicted in the Carnegie Curve, shown to relate Wilson currents and lightning data
- Clouds believed to electrify from non-inductive charging: updrafts support development of ice crystals and graupel which collide in the presence of supercooled water to create charge
- Mach et al. (2009-2011) computed Wilson current estimates for oceanic and continental storms from data collected by the NASA ER-2 aircraft
- Found oceanic storms had stronger Wilson currents than continental




a) The GEC and all of its contributing processes; Wilson currents in orange, fair weather currents in blue (FESD:ECCWES)




b) Carnegie Curve overlaid with lightning sensor data and Wilson current measurements from various storm types (Mach et al. 2011)

## Objectives

- Utilize the Mach et al. (2009-2011) data set to compare Wilson currents to dynamical and microphysical properties of electrified clouds and storm evolution
- Investigated cloud properties have already been shown to be related to the electrification state of the storm
- Robust relationships may then be used as a Wilson current parameterization for modeling the GEC

## Acknowledgements

Thanks to Carol Park, NCAR and Logan Dawson, Purdue University for all of their advice and support.

- FESD: ECCWES, cited 2011: Global Electric Circuit. [Available online at http://sisko.colorado.edu/FESD/Team.htm.]
- Mach, D. M., R. J. Blakeslee, M. G. Bateman, and J. C. Bailey, 2009: Electric Fields, Conductivity, and Estimated Currents from Aircraft Overflights of Electrified Clouds, *J. Geophys. Res.*, **114**, D10204. doi:10.1029/2008JD011495.
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- Mach, D. M., R. J. Blakeslee, and M. G. Bateman, 2011: Global Electric Circuit Implications of Combined Aircraft Storm Electric Current Measurements and Satellite-Based Diurnal Lightning Statistics, *J. Geophys. Res.*, **116**, D05201. doi:10.1029/2010JD014462.
- Background image from: http://www.pxleyes.com

- This work was performed under the auspices of the Significant Opportunities in Atmospheric Research and Science Program. SOARS is managed by the University Corporation for Atmospheric Research and is funded by the National Science Foundation, the National Oceanic and Atmospheric Administration, the Cooperative Institute for Research in Environmental Science, and by the Center for Multiscale Modeling of Atmospheric Processes.

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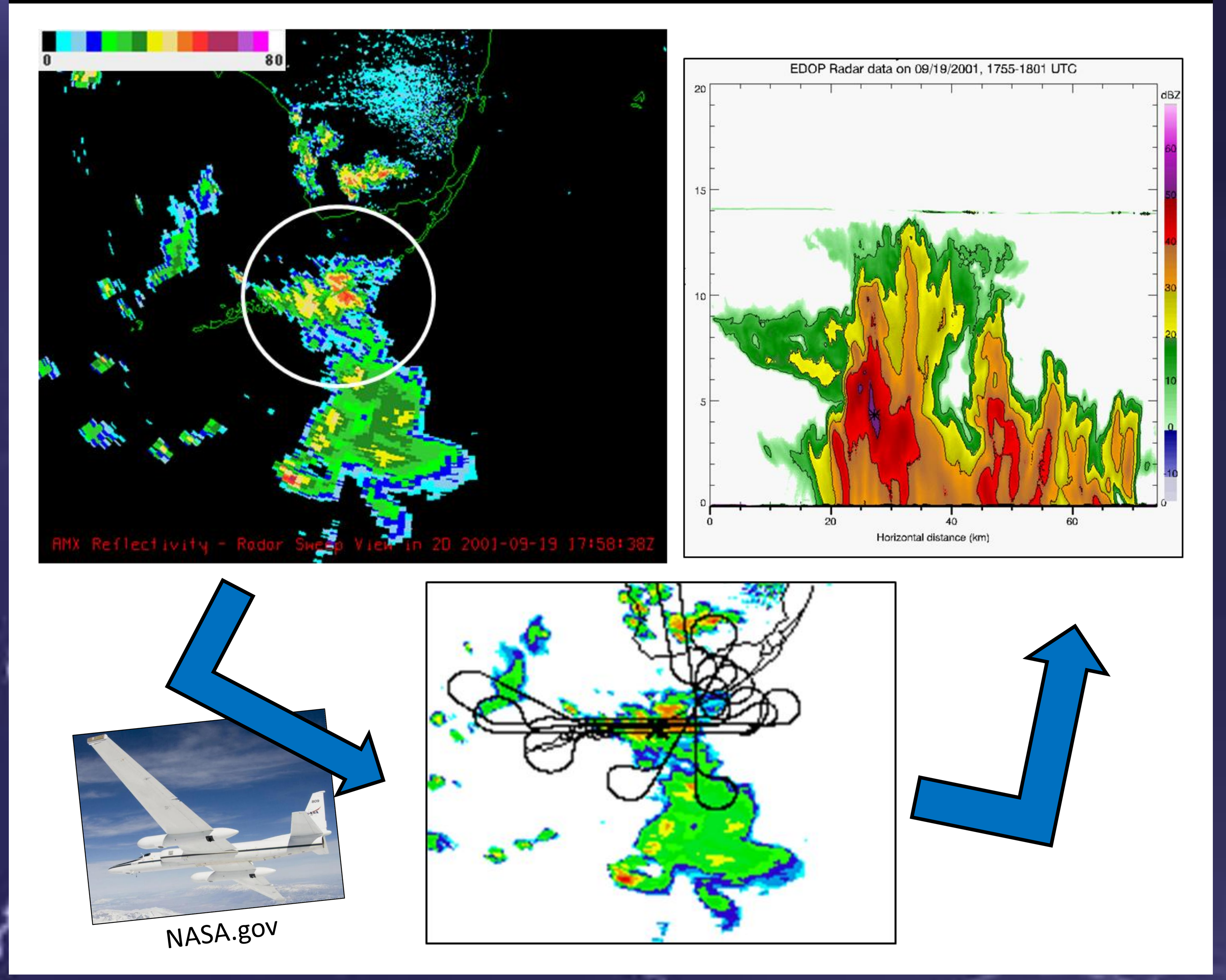
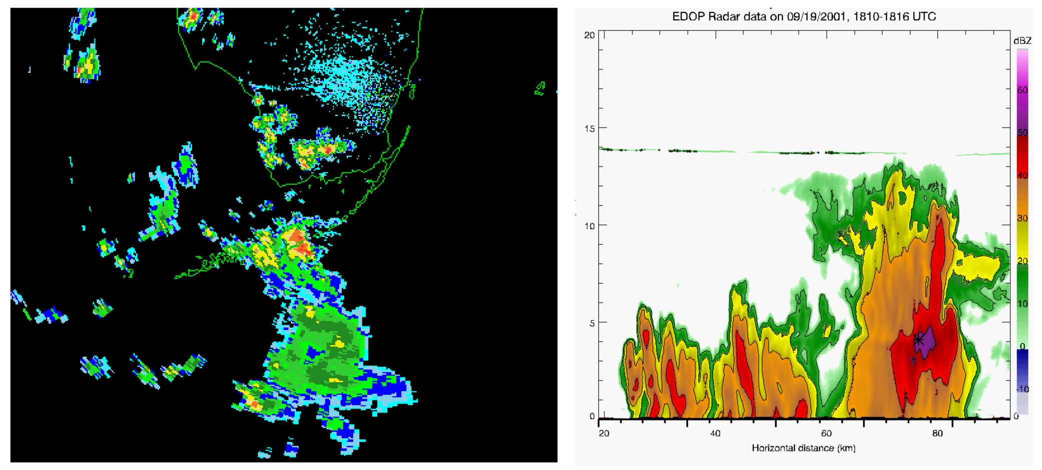
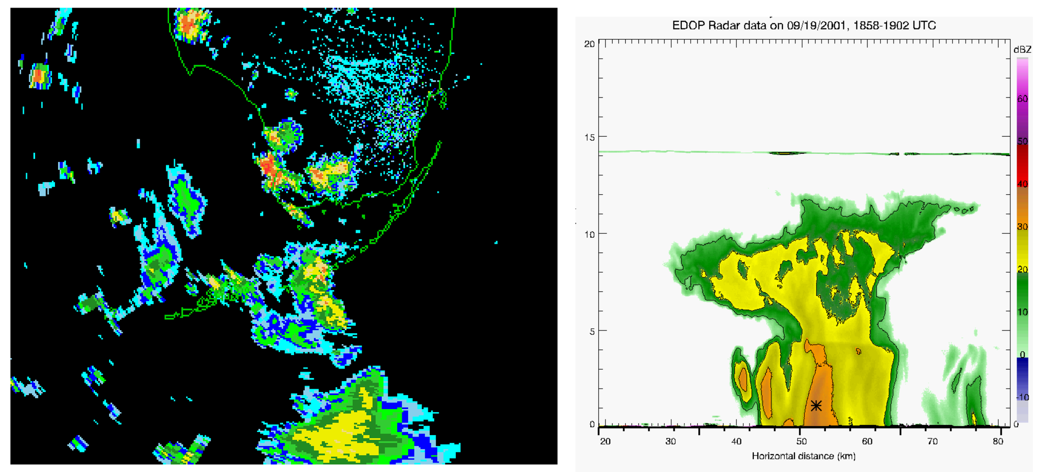
## Data Collection and Analysis



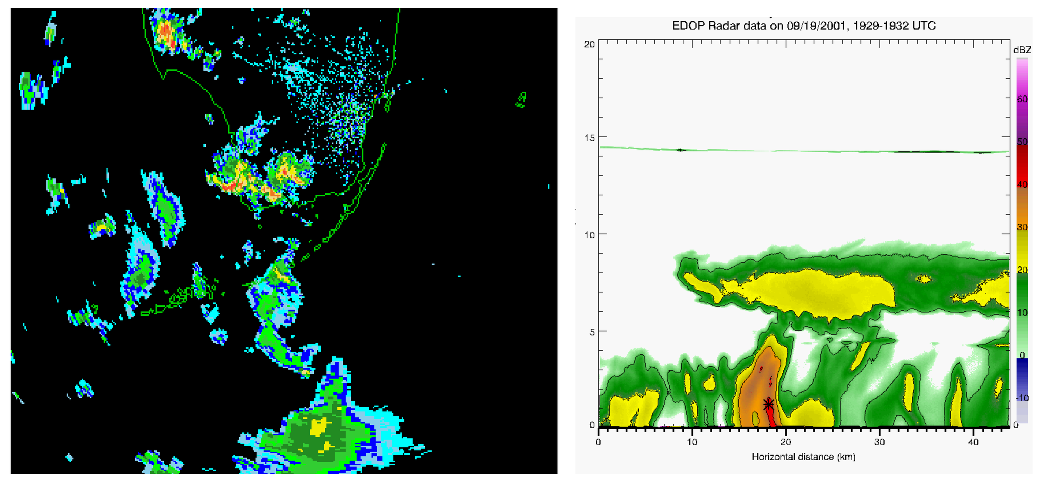

## Oceanic Multicell Storm Evolution 9/19/01



- Mature Stage
- Direct overflight
- 1810 UTC

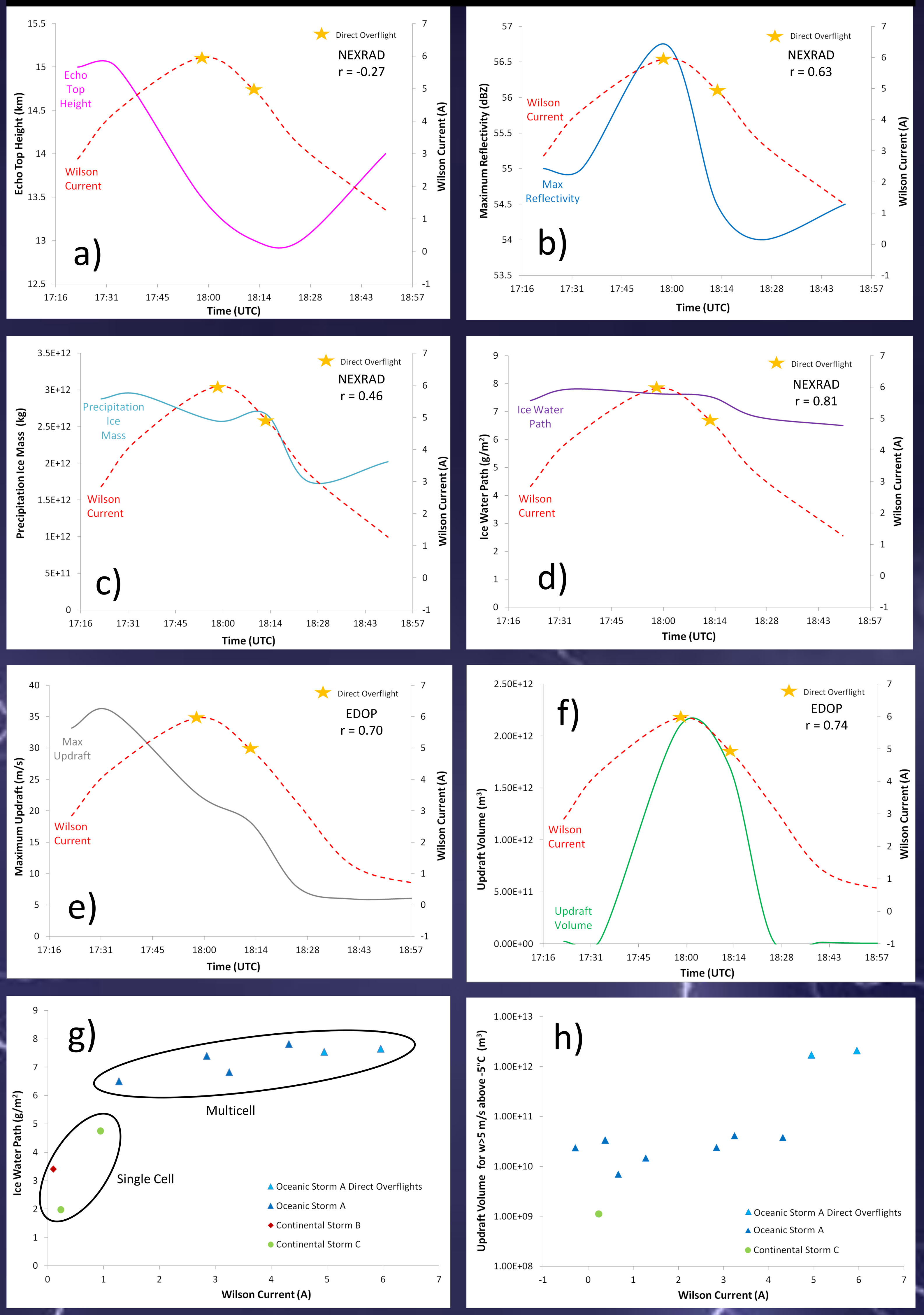


- Dissipation Stage
- Not a direct overflight
- 1856 UTC



- Dissipation Stage
- Direct overflight
- 1931 UTC

## Results




## Conclusions

- Peak in Wilson currents corresponds to peak in mature stage of storm; weakens once storm begins weakening
- All variables correlate well with Wilson currents except echo top height and precip ice mass
- g) illustrates strong difference between multicell and single cell storms rather than oceanic and continental
- MUCH more data is needed to draw any robust conclusions
- **Future work:** Look for differences in storm type and regime