Southern Hemisphere MSTID response to a Sudden Stratospheric Warming Observed by the Falkland Islands SuperDARN Radar

James P. Fox[1], Nicholas Guerra[1], Thomas Pisano[1], Michael Molzen[1], Nathaniel A. Frissell[1], V. Lynn Harvey[2], Joseph Klobusicky[1], Mark Fenner[1], Joseph B. H. Baker[3], J. Michael Ruohoniemi[3]

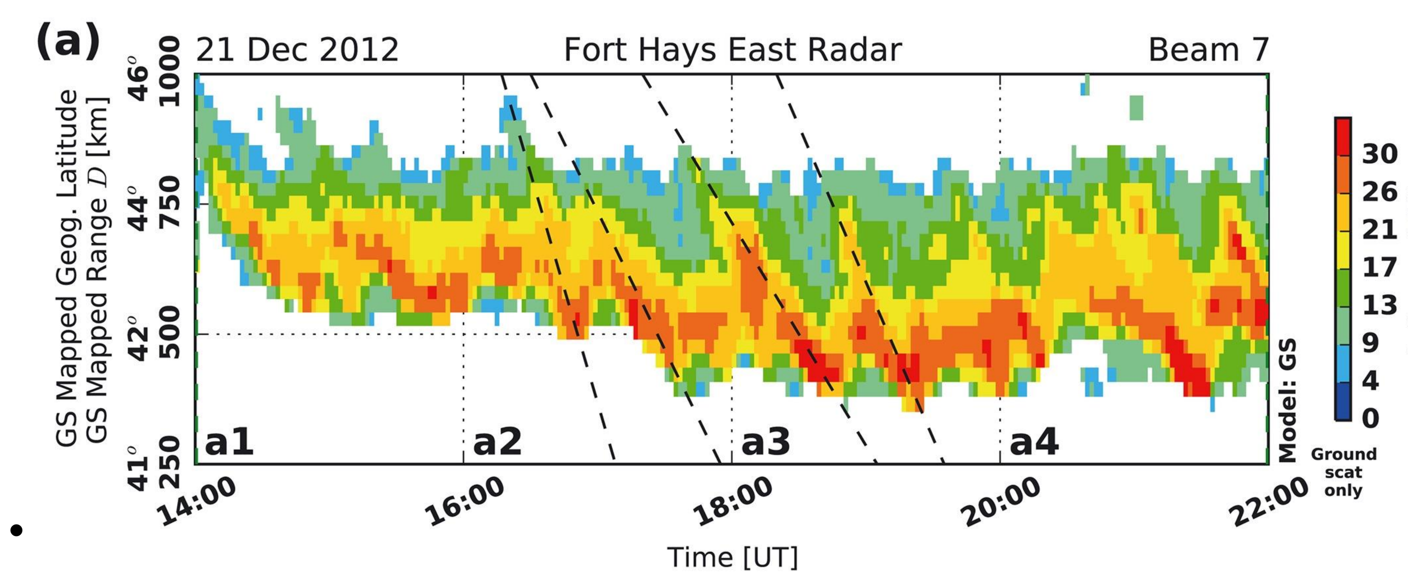
[1]The University of Scranton, Scranton, PA [2]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, [3]Virginia Tech, Blacksburg, VA

The Ionosphere

- The ionosphere is a region of Earth's upper atmosphere that contains a high concentration of positive ions and free electrons
- Depending on various phenomena can impact radio wave propagation
- main layers of the ionosphere are the D, E, F regions

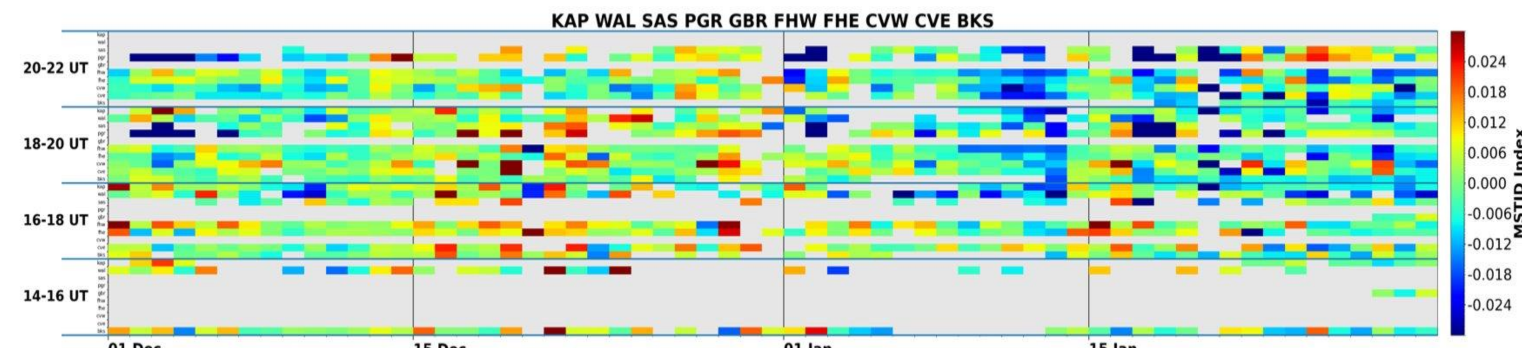
TIDs & MSTIDs

- Traveling Ionospheric Disturbances (TIDs) are quasi-periodic variations in the plasma that exists in the upper atmosphere
- TIDs have various properties like propagation speed, direction of travel and period
- Medium Scale Traveling Ionospheric Disturbances (MSTIDs) are defined as TIDs which travel at 100-250 m/s and have periods of less than an hour



SuperDARN Radars & TIDs

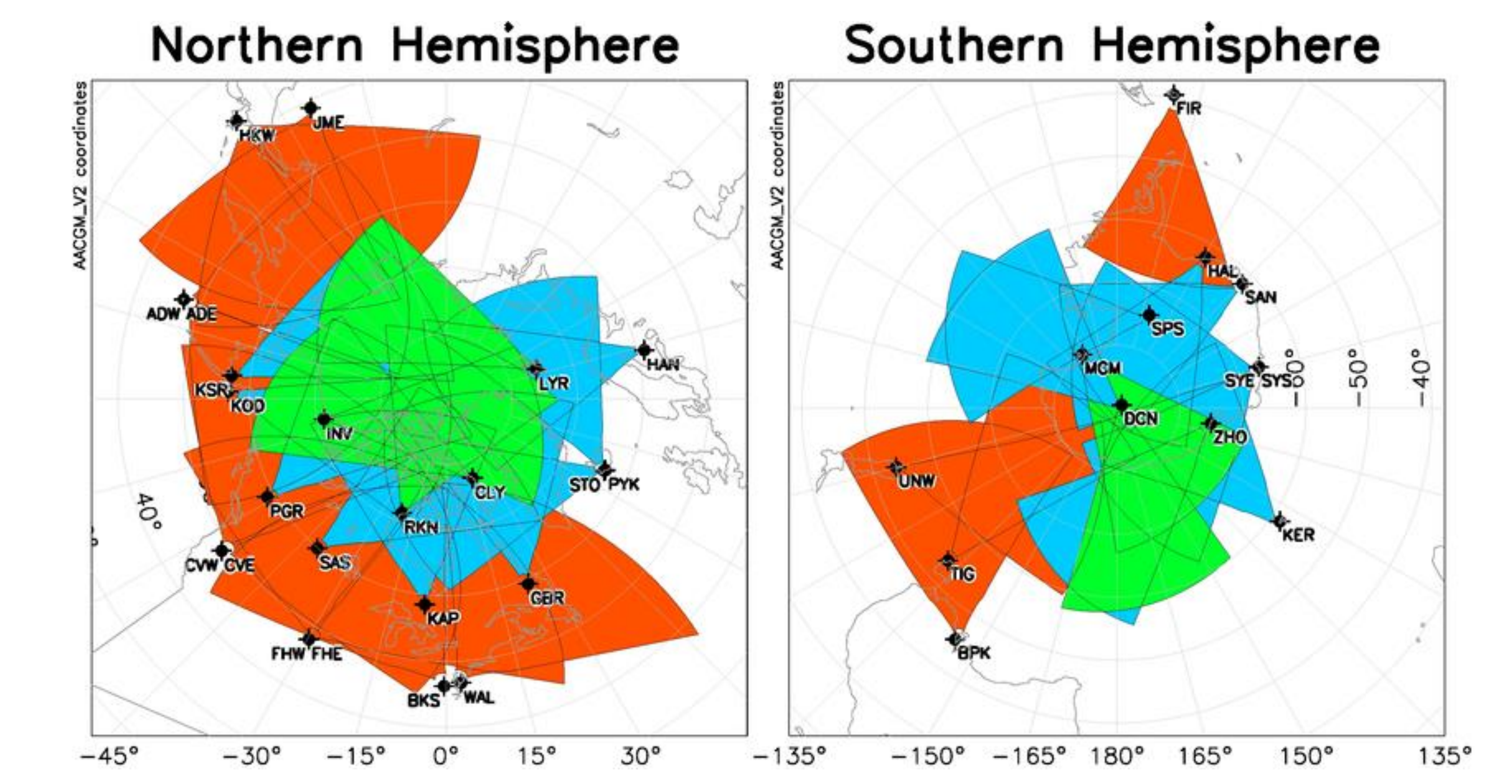
- SuperDARN is a global network of high frequency radars directed towards the poles of the Earth
- TIDs impact the ionospheres' ability to reflect radio waves and thus conclusions can be made about MSTID activity from SuperDARN radar data
- Frissell 2014 and Frissell 2016 designed and developed a frequency analysis technique for identifying MSTIDs using ground scatter from SuperDARN radars
- Frissell applied this technique to the Northern hemisphere over a portion of a year and only during specific hours
- This technique created an MSTID index for each 2hr window which indicates high or low MSTID activity over a given year
- This worked great as there is more viable radars and data in the Northern Hemisphere



- Climatology Plot showing MSTID index for each 2hr window

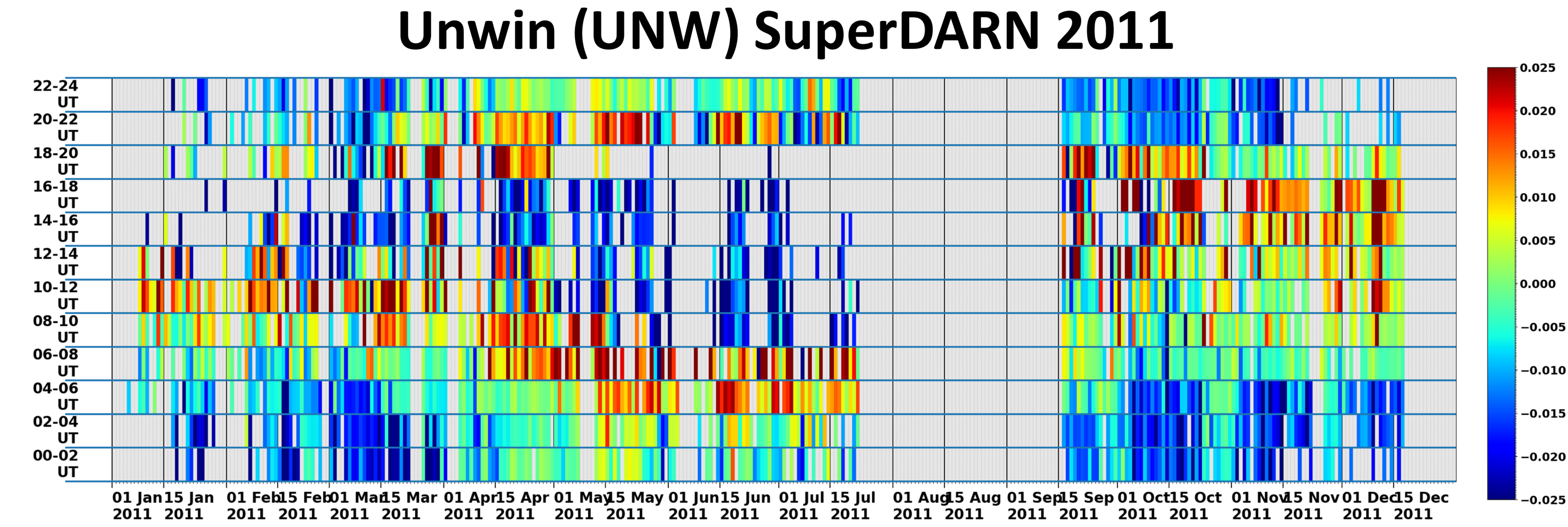
Searching for MSTIDs in the Southern Hemisphere

- There are few studies identifying MSTIDs in the Southern Hemisphere due to lack of quality data
- Not only is there more Northern Hemisphere radars but most Southern Hemisphere radars are over ice making ground scatter observations difficult



- To better understand this Southern Hemisphere MSTID activity Frissells existing code was adopted to work on Southern Hemisphere data and ran for all 14 SH radars over the 12-year period on all 2hr windows

Unwin (UNW) SuperDARN 2011



- The above is a climatology plot for the TIG radar with the extended time and date range
- The large gap is likely due to operational issues

Sudden Stratospheric Warming (SSW) Events

- SSWs are rapid increases in temperature in the stratosphere typically in the polar regions which significantly disrupt circulation patterns
- SSWs have been shown to impact MSTID activity
- This means that these events should be visible in our climatology plots

References

Grocott, Adrian, et al. "Characteristics of medium-scale traveling ionospheric disturbances observed near the Antarctic Peninsula by HF radar." *Journal of Geophysical Research: Space Physics* 118.9 (2013): 5830-5841.

Frissell, N. A., et al. "Climatology of medium-scale traveling ionospheric disturbances observed by the midlatitude Blackstone SuperDARN radar." *Journal of Geophysical Research: Space Physics* 119.9 (2014): 7679-7697.

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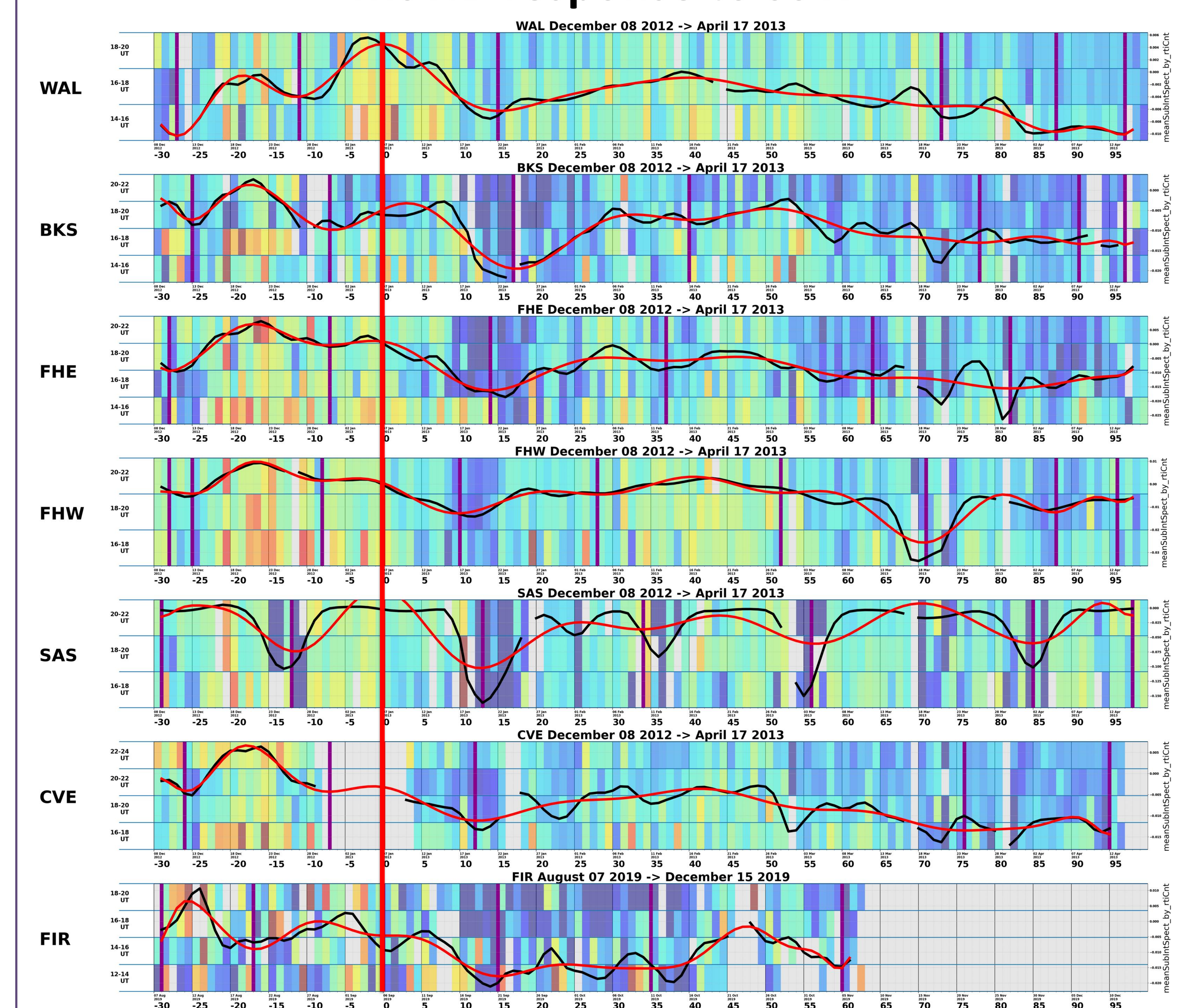
Comparing Northern & Southern Hemisphere MSTID response to SSW



- Above are climatology plots from 6 Northern and 1 Southern Hemisphere radars. Time ranges were selected specifically to show that radars best.
- They are aligned such that the major SSWs on January 7th 2013 and January 2nd 2019 occur on the red vertical line. The graphs are numbered by days before and after the SSW event
- The black line indicates the smoothed MSTID index. This is done by applying a gaussian average with a sigma value of 3
- The purple line indicates what the algorithm considers to be a low point in MSTID activity. The vertical purple line is picked by finding the relative minimums in the degree 20 polynomial which is represented by the red curve.
- The first minimum following the SSW is the most interesting because it shows the delay between the SSW and the low point in MSTID activity
- The Northern Hemisphere radars observe their MSTID low point between 10-17 days after the SSW event in 2013
- The singular Southern Hemisphere radar which observed a 15 day delay between the SSW and the MSTID low point

Acknowledgements

This work is supported by NASA Grant 80NSSC23K0848 and NSF Grant AGS-2045755. We acknowledge the use of SuperDARN data. SuperDARN is a network of radars funded by national scientific funding agencies of Australia, Canada, China, France, Italy, Japan, Norway, South Africa, the United Kingdom, and the United States of America. The Falklands Islands Radar (FIR) is run by the British Antarctic Survey (BAS), funded by the UK Natural Environment Research Council as part of the BAS Polar Science for a Sustainable Planet program. The data are provided courtesy of the BAS SuperDARN PI Gareth Chisham.

james.fox@scranton.edu

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