

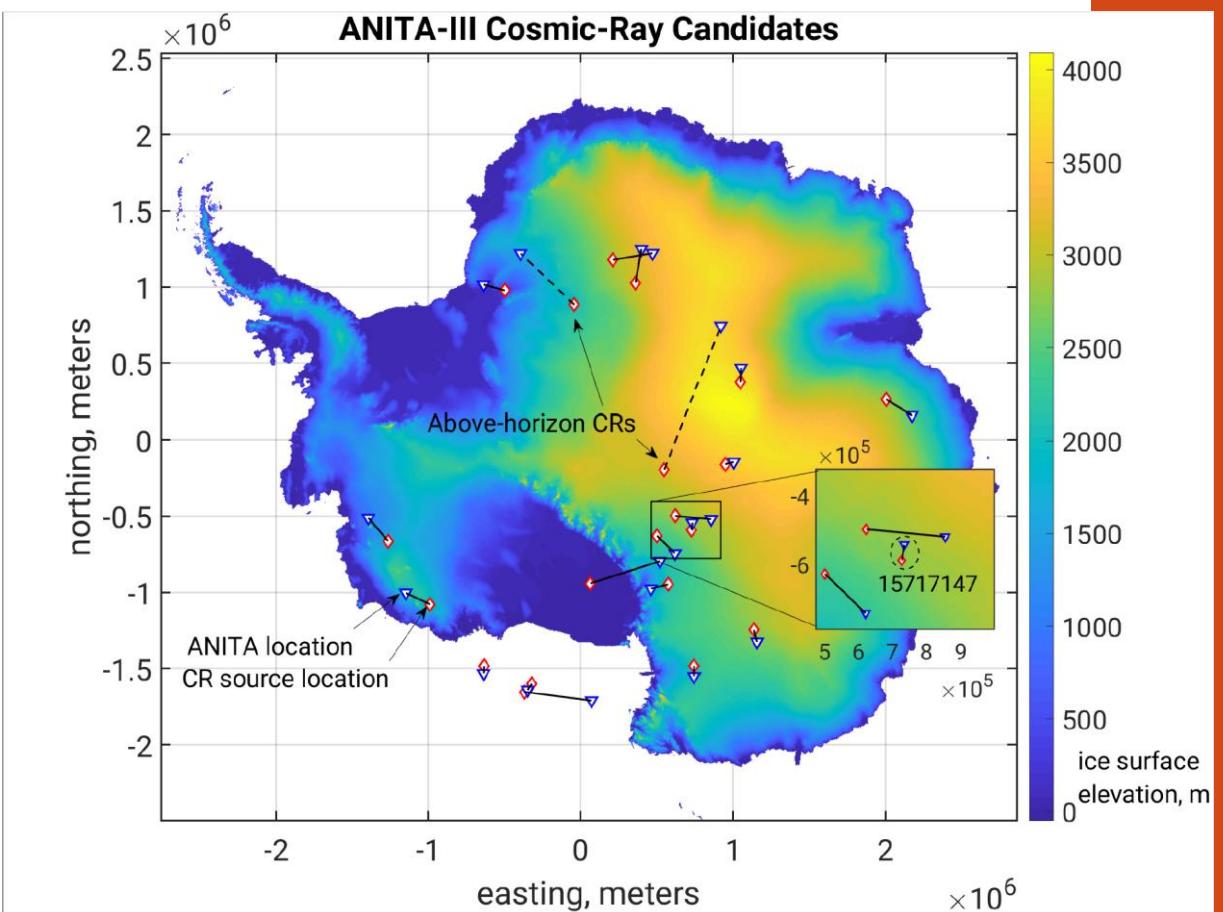
Upward CR-like Events from ANITA I, II, & III

Lauren Ennesser

April 5th, 2018 Group Meeting

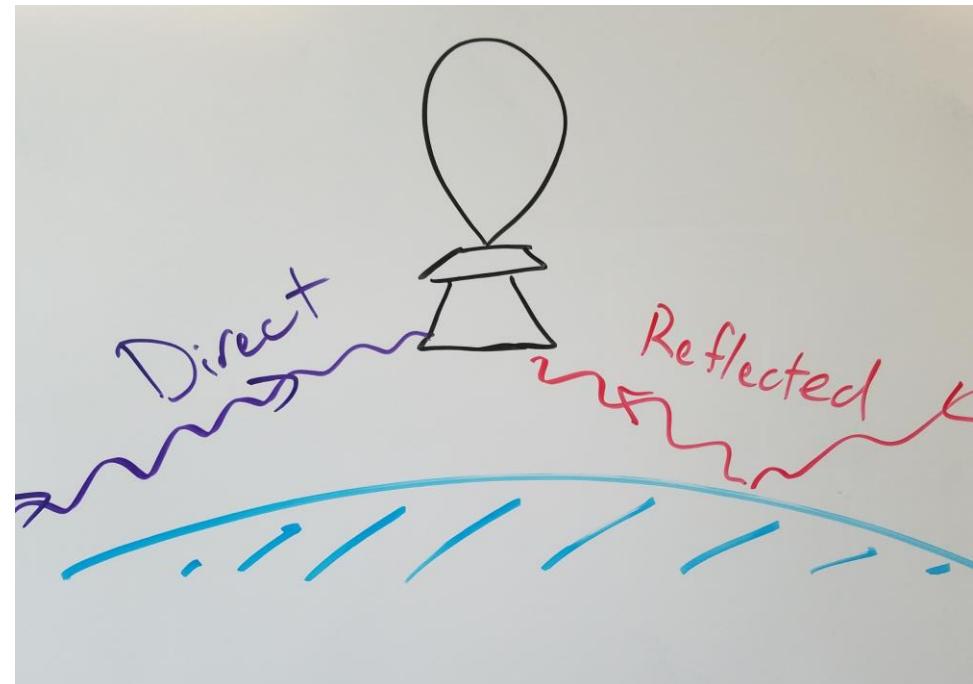
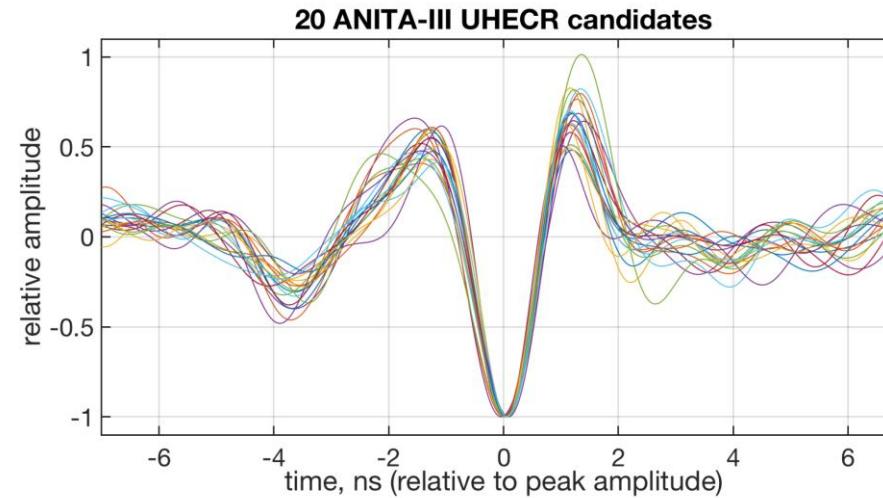
UHECRs

- ANITA designed to find UHE neutrinos via Askaryan effect in ice
- Will also pick up any radio signals within range
- UHECR events produce radio waves through air showers



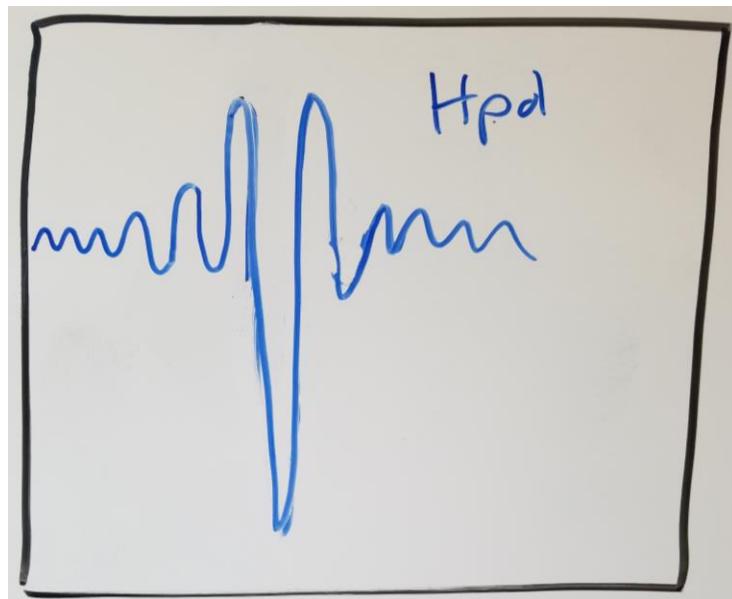
UHECRs

- Characteristic waveform
- Horizontally polarized
 - Not present in Vpol data
 - <10% of circular polarization in Stoke's parameters
- Can be detected either directly (“skimming the atmosphere”), or showers reflected off the ice
- Most are reflected



Characteristics

Direct: Low angles $< 10^\circ$

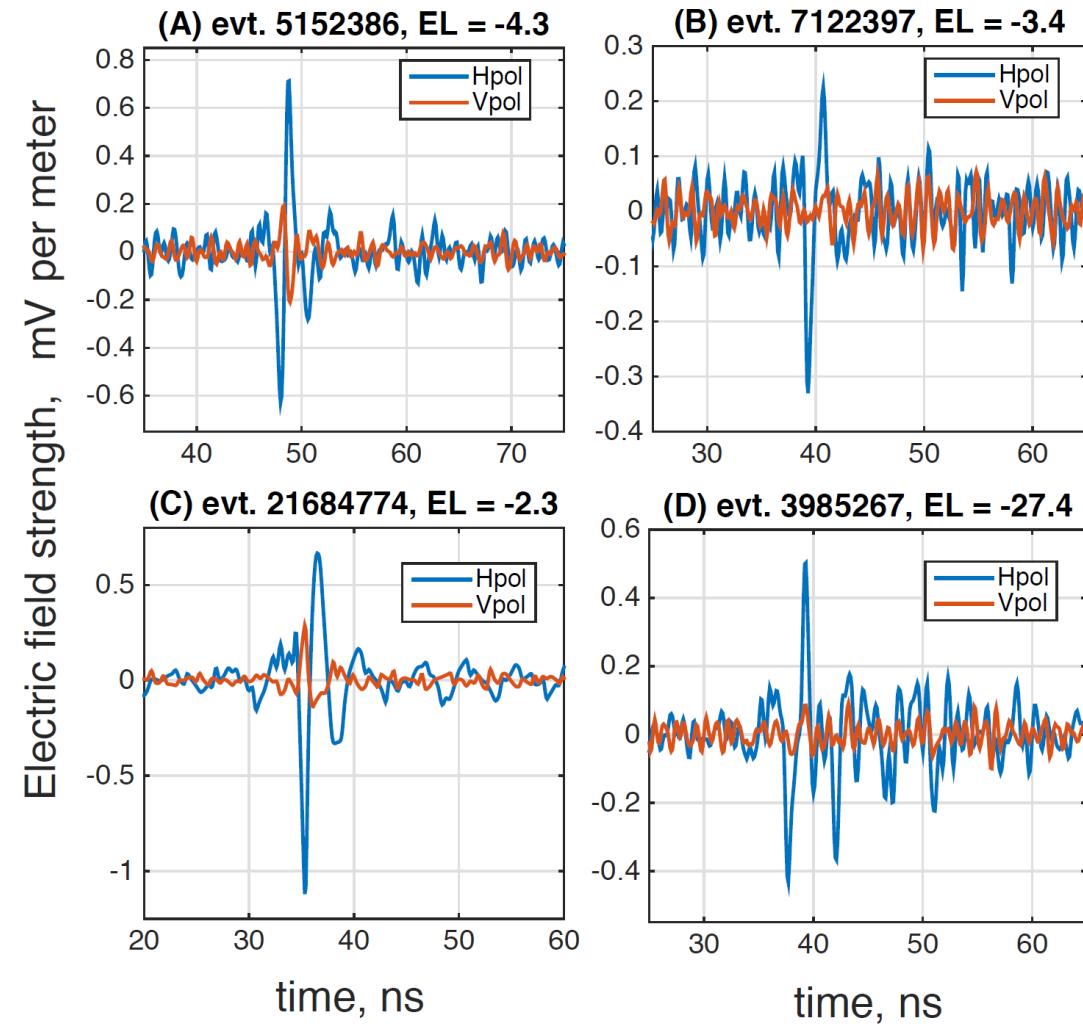


Reflected: Angles $> 20^\circ$



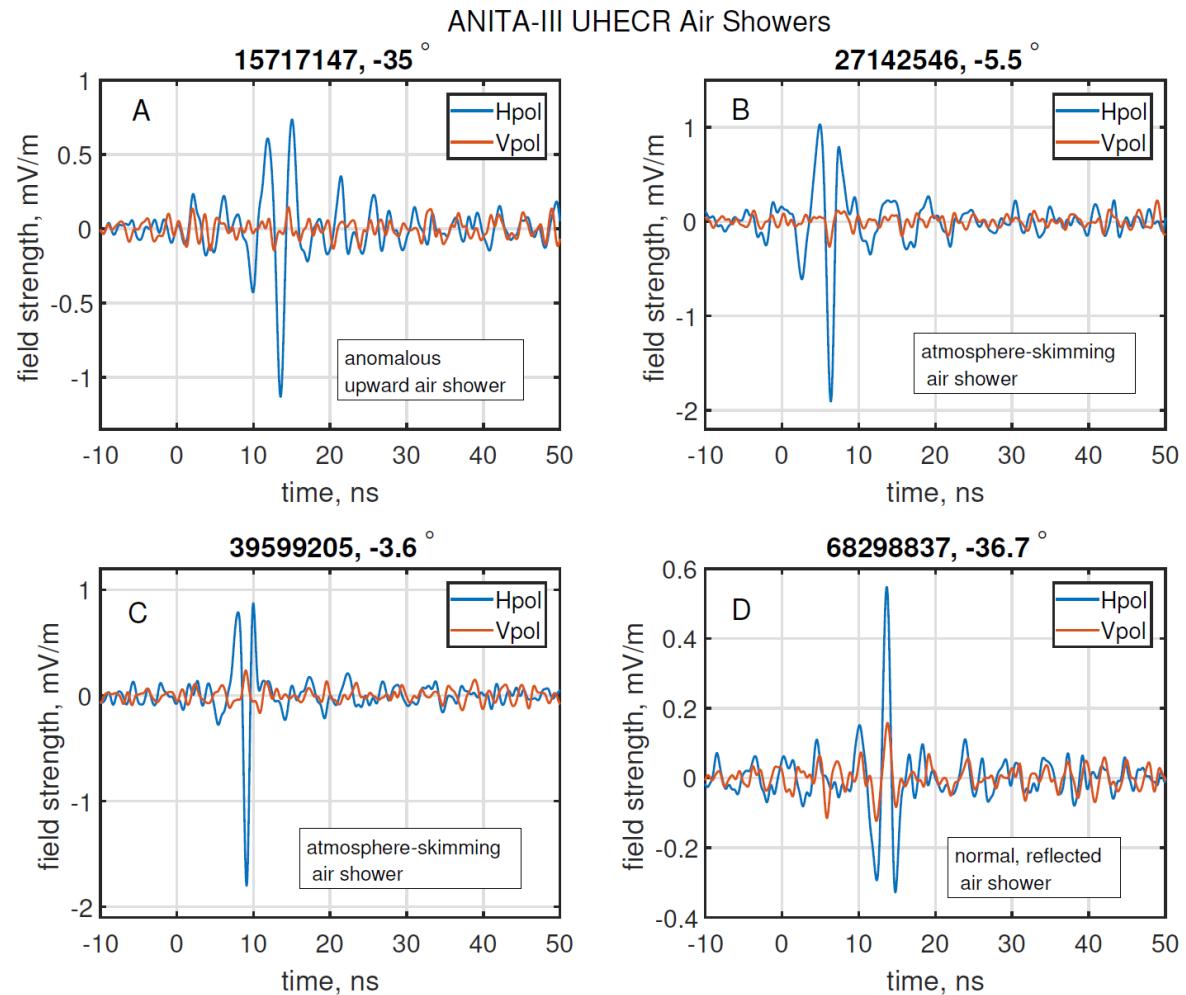
ANITA I & II

- ANITA I included CR trigger
 - 16 UHECR events total
 - 2 direct events (A, B)
 - 1 anomalous event (D)
- ANITA II: No dedicated CR trigger
 - 1 direct event (C)



ANITA III

- ALFA low frequency
 - Confirm CR events
- 20 UHECR events
- 3 Inverted events
 - 1 Upward shower (A)
 - 2 Direct (B,C)
 - 1 Reflected (D) for comparison



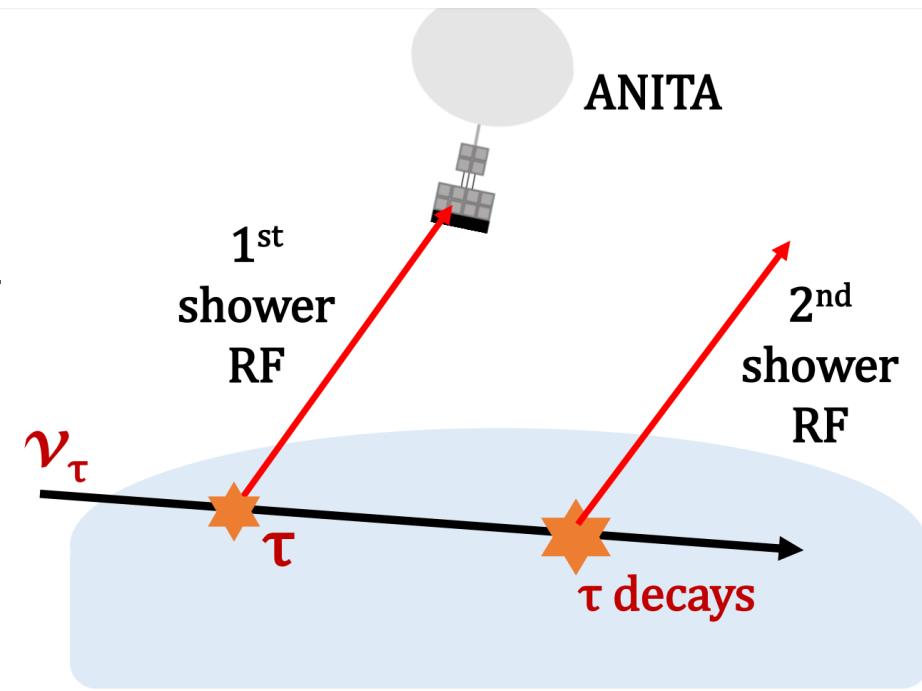
“Upward” showers

- Direct UHECR-like signal at reflected-like angle
- Does not match any known backgrounds
- Transition radiation from Earth-skimming event?
 - Unsure if waveform resembles UHECRs
- τ neutrino decaying into τ lepton?



Is it a tau???

- Charged-current $\nu_\tau \rightarrow \tau$
- Based on angular data, ANITA I event would have traveled $\sim 20,000$ km water-equivalent (5450 km crustal)
- SM tau neutrino interaction length is only 1600 km water-equivalent
- Would require suppressing SM cross section by factor of 2-4



Hadronic – 65% Leptonic – 35%
Leptonic τ decays:
 $\tau \rightarrow e^- + \bar{\nu}_e + \nu_\tau$
 $\tau \rightarrow \mu^- + \bar{\nu}_\mu + \nu_\tau$

So...is it a tau???

- Tau would also require a large flux (GRB or supernova)
 - ANITA III event has SN candidate, but no other τ - sensitive observatories can confirm
 - ANITA I event has no candidates
- Other τ sensitive experiments (IceCube, Auger) have not confirmed event during the time of ANITA III
 - IceCube's size and Auger's limited exposure at the time may have missed the event.

Conclusions

- Total of 2 “Upward” events from 3 flights of ANITA
- Proving tau events will still take some work
- ANITA IV analysis ongoing

References

- arXiv: 1603.05218v5
- arXiv: 1803.05088v1
- Jorge Torres, “Ultra-High Energy Neutrinos (UHE- ν s), part I: Origins and Importance”, ELOG
- Oindree Banerjee, “High Energy Neutrinos from Gamma Ray Bursts”, ELOG
- Oindree Banerjee, “Ultra-High Energy Neutrinos Producing EM Showers in ice”, ELOG