

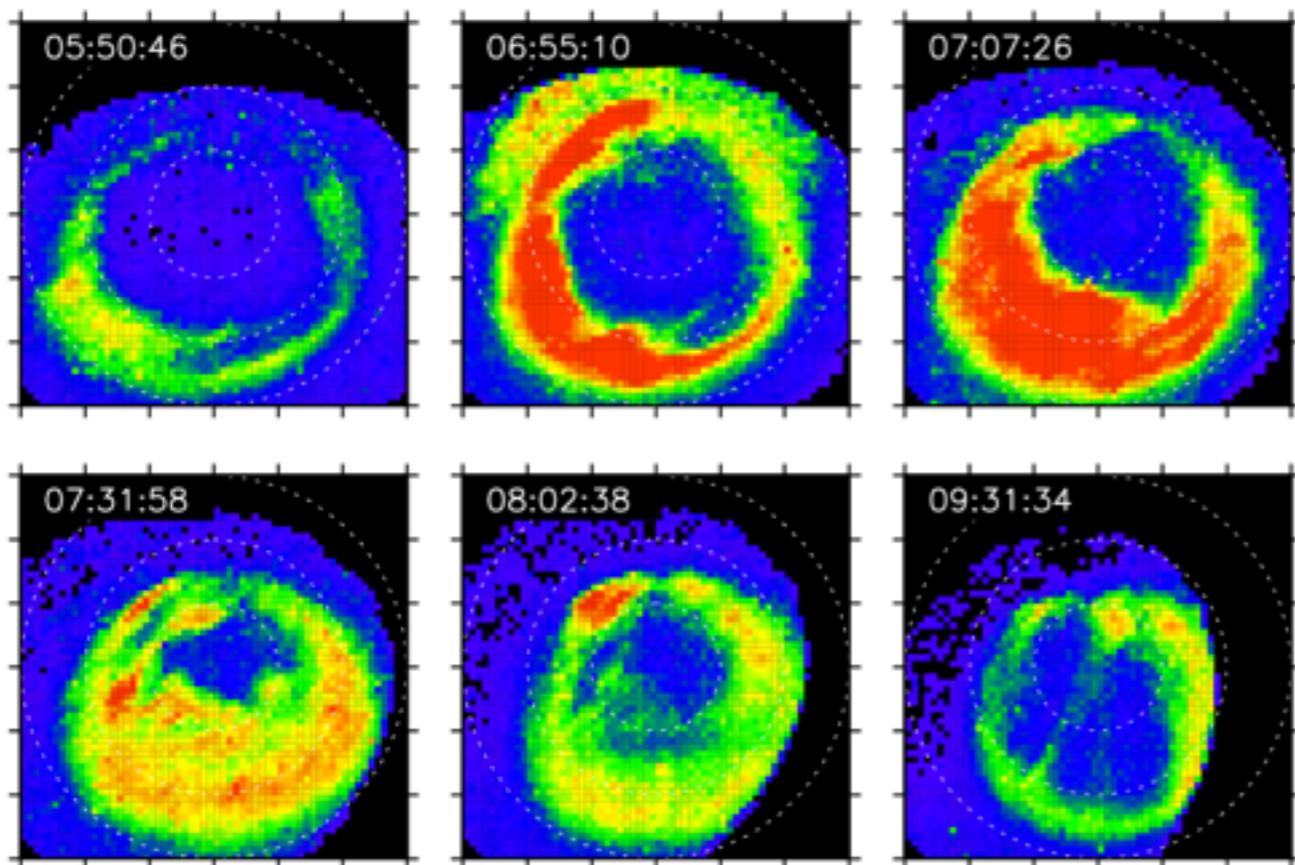
BARREL-RBSP

Agenda

- First Part - Resources for measuring precipitation
 - Intro
 - BARREL
 - POES
 - REPTile
 - CINEMA
 - FIREBIRD
- Second Part - Combining data from different resources
 - Defining conjunctions: ky-ky committee white paper
 - Tools
 - Coordination: campaigns, data access
 - Other?

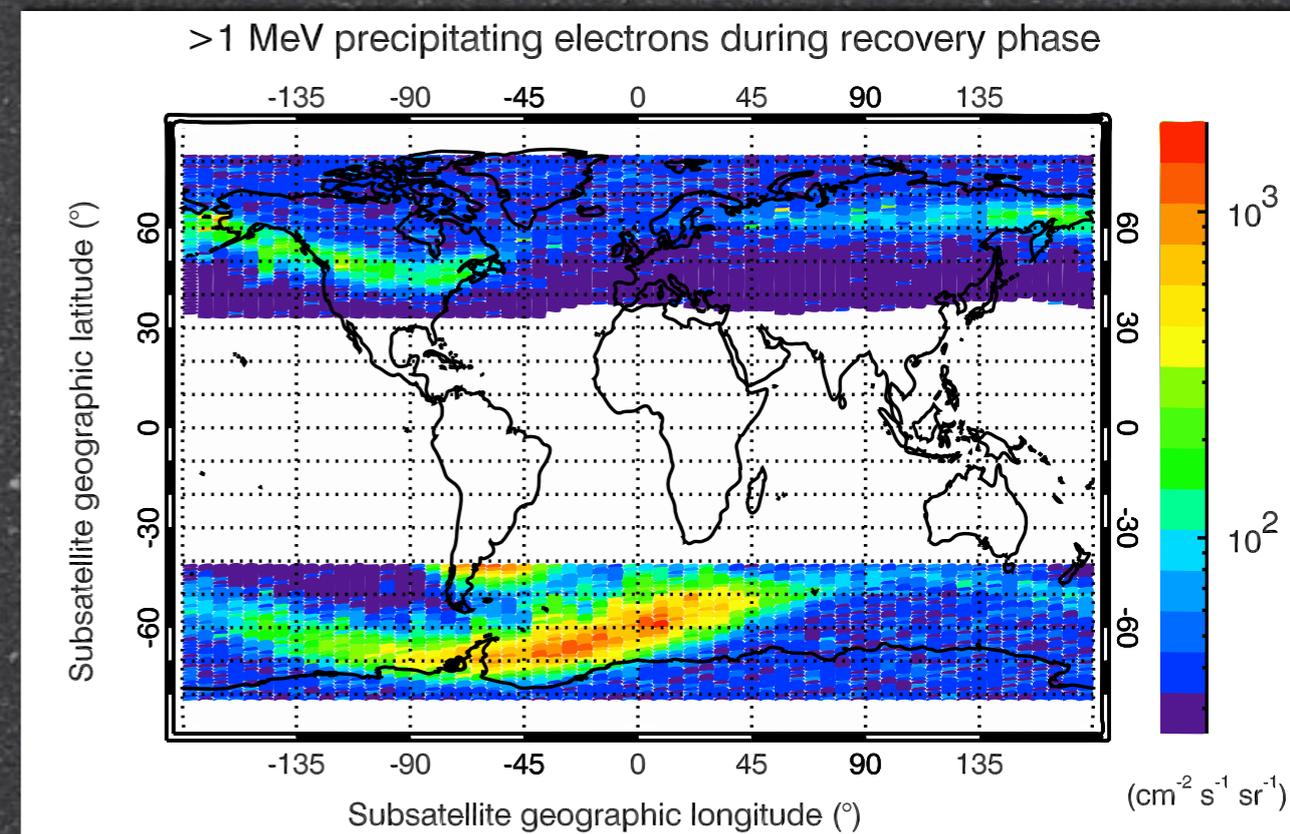
Precipitation: spatial-temporal evolution

auroral precipitation



spatial-temporal evolution
during a substorm

energetic precipitation



Horne et al., 2009

statistical map from POES
during recovery phase

models use empirical lifetime:
i.e. $\tau \sim K_p/3$

Energetic Precipitation

Duskside (DREP)

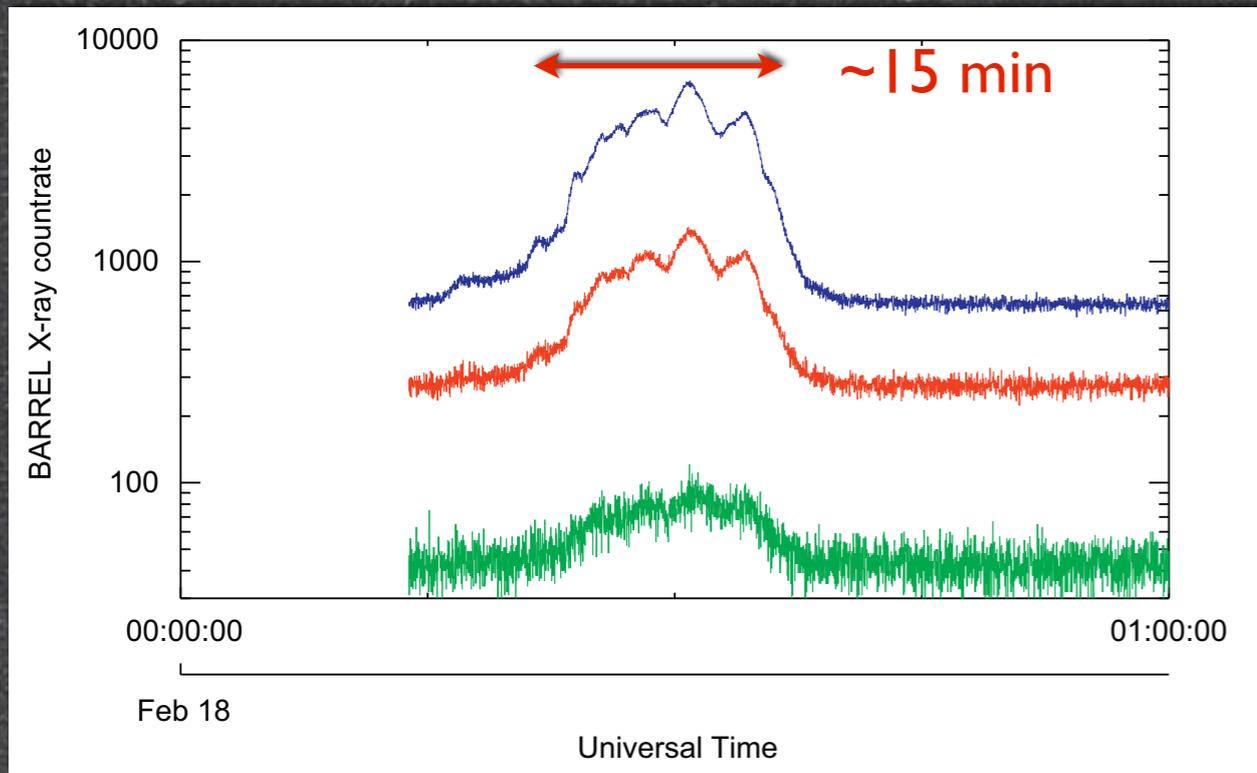
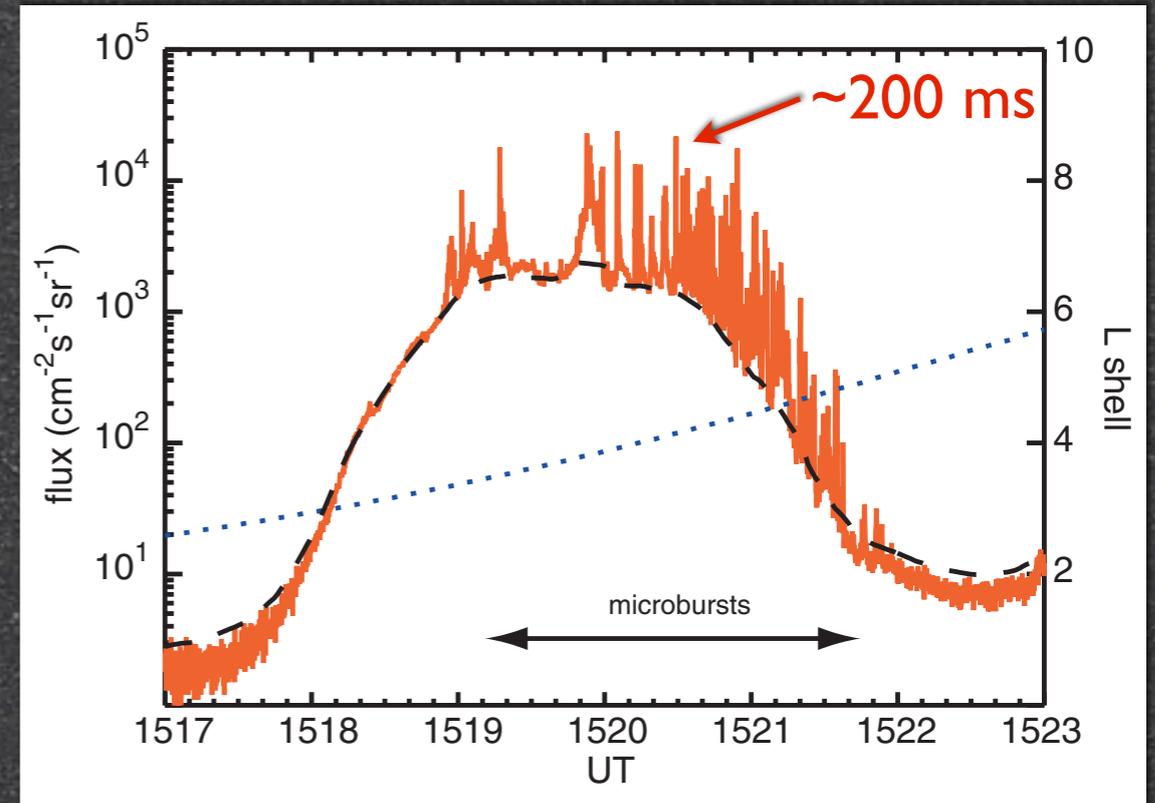
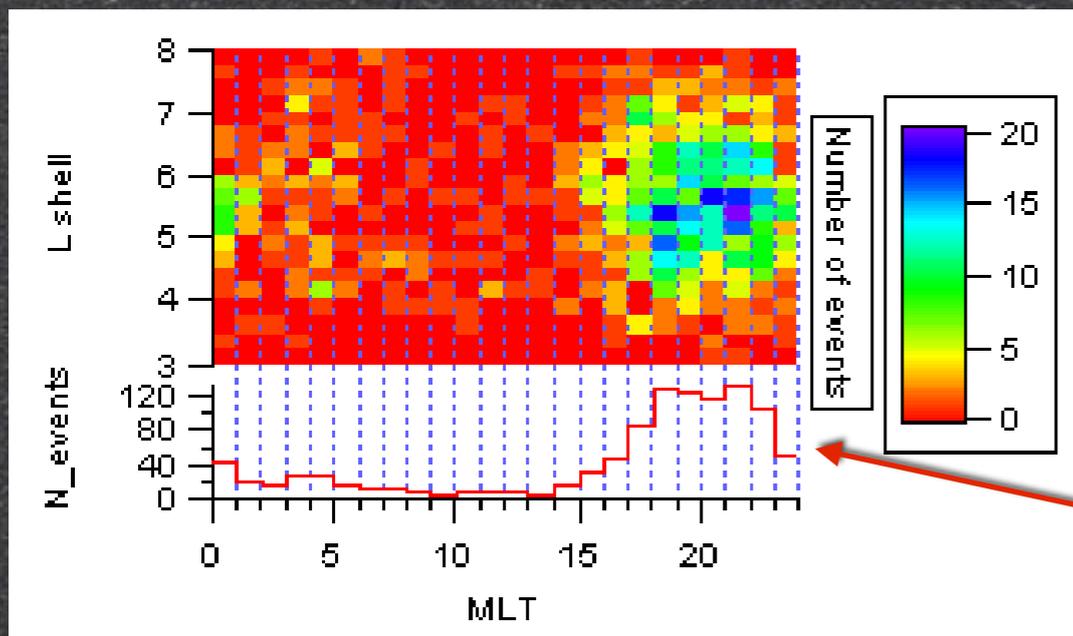


Figure from Millan, 2011 (in press)

Microbursts

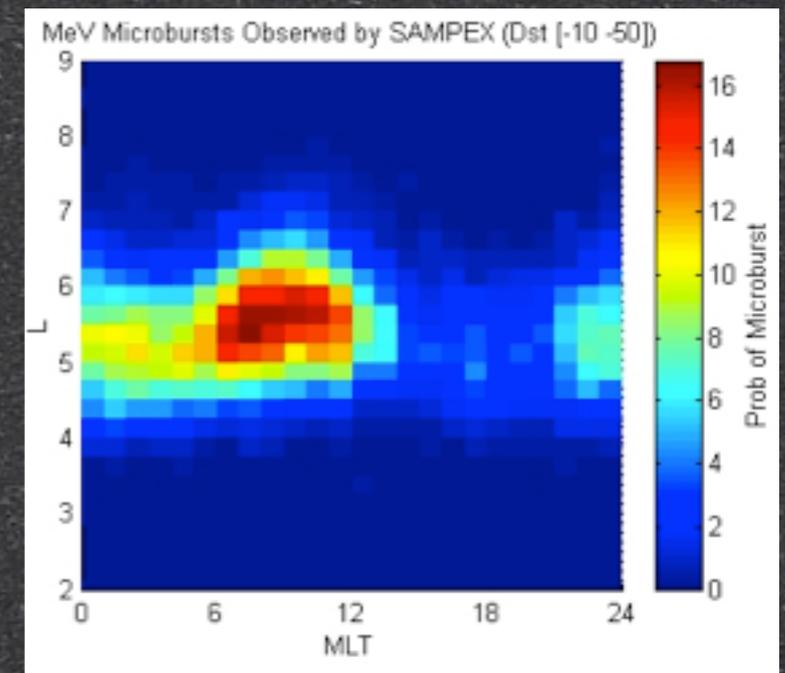


[Lorentzen et al., 2001]



80% of events with >500 keV e-folding at dusk

Comess et al., submitted to JGR



Courtesy T. P. O'Brien

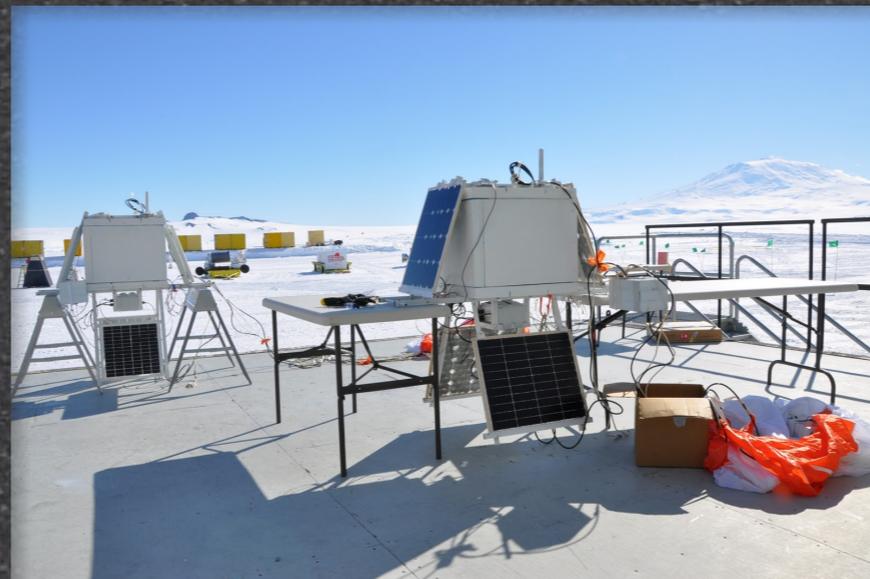
BARREL

- BARREL is a multiple-balloon experiment for studying losses from Earth's radiation belts.



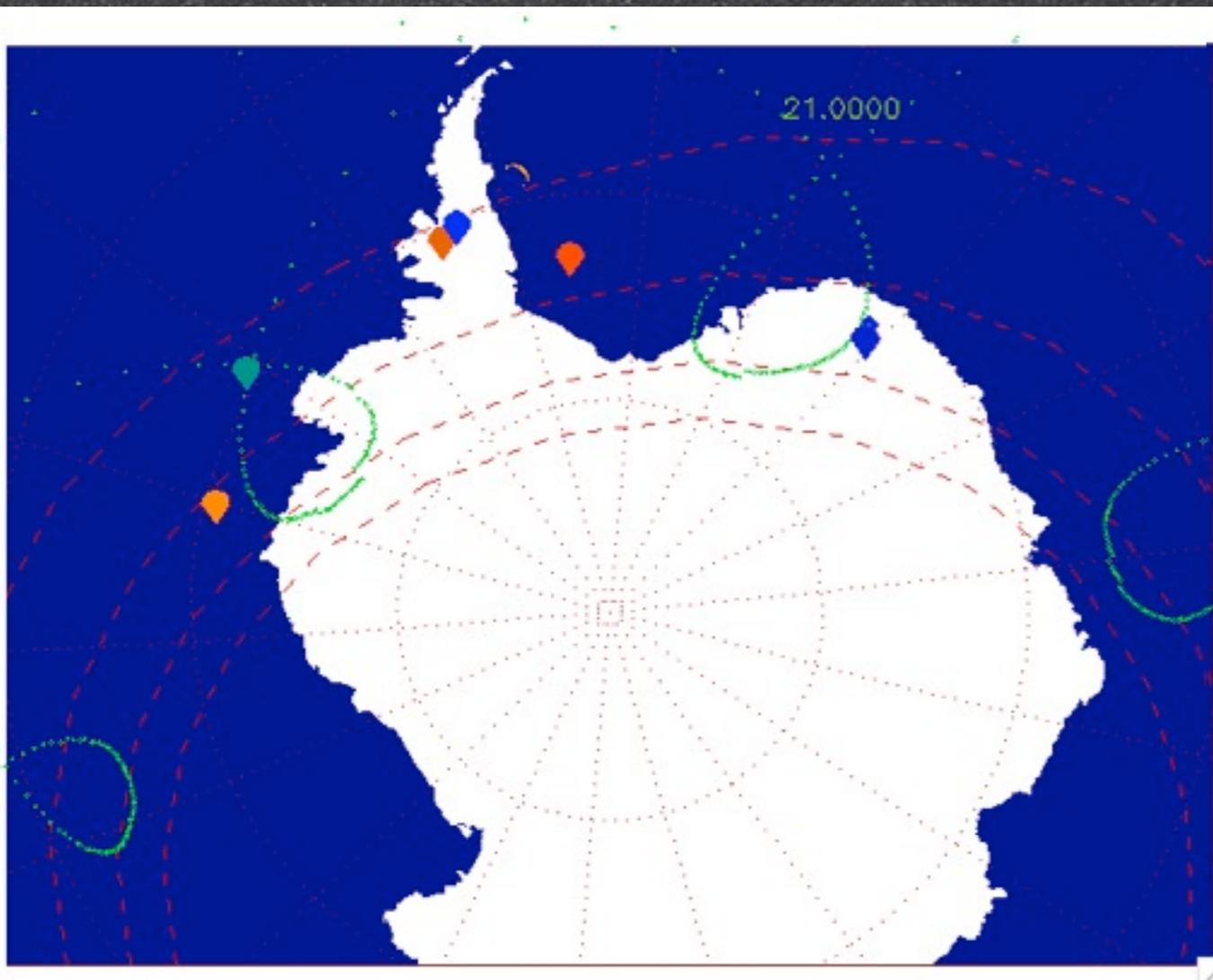
- **Two Antarctic Science Campaigns during RBSP Mission**

- Current plan: 20 balloons in each campaign in 2013 and 2014
- Launched successively to set up slowly drifting array
- Long duration balloon flights => 30 day campaign
- >3000 hours of data in radiation belt region ($L < 7$)
- Launch sites planned: Halley Bay and South African Antarctic station (SANAE)

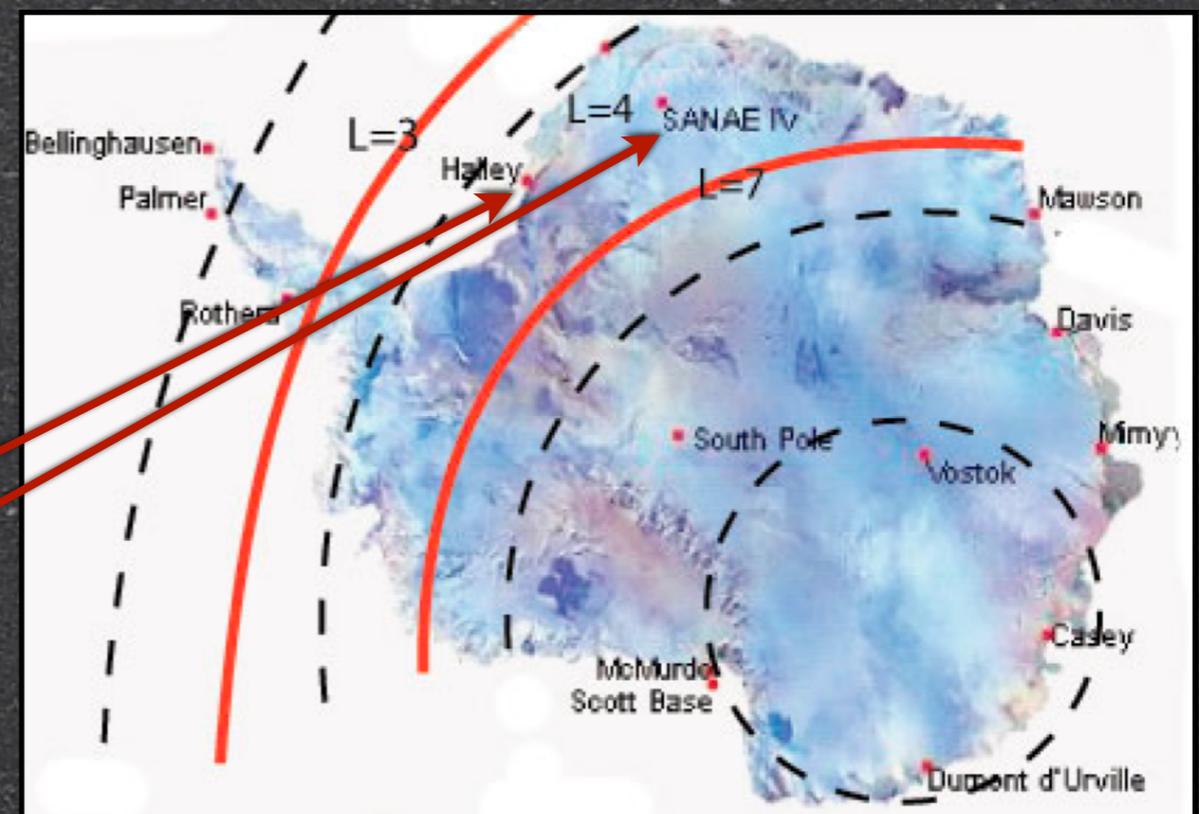


BARREL Locations

- BARREL uses an array of balloons to achieve its science
 - 4-5 balloons aloft simultaneously
 - separation 1-2 hours of MLT
 - flight durations ~7 days
 - 20 balloons per campaign



- Two launch sites:
 - Halley Bay
 - SANAE



Question #1

What fraction of radiation belt losses are due to precipitation (vs. magnetopause losses or de-energization)?

- *Method:*

- Measure the spatial extent and precipitating flux of >500 keV using BARREL and LEO spacecraft to quantify total loss rate.
- Measure the change in trapped flux, remove adiabatic effects to quantify the number of trapped electrons using RBSP, THEMIS, GOES
- Quantify magnetopause losses???

- *Comment:*

- Need to identify times of interest. Quiet times, main phase, recovery phase, long term, etc....

Question #2

What fraction of precipitation losses are due to microbursts vs. duskside precipitation vs. something else?

- *Method:*

- Measure the instantaneous spatial extent of the precipitation.
- Measure average precipitating flux across region or use typical rates observed by SAMPEX.

Question #3

What causes relativistic electron microbursts?

- *Hypothesis #1:* Pitch angle diffusion due to small amplitude whistlers causes the majority of bursts.
- *Hypothesis #2:* Non-linear interaction with large amplitude whistlers causes the majority of bursts.
- *Method:*
 - Identify conjunctions between RBSP and BARREL (or SAMPEX, etc) during observed microburst events.
 - Event studies:
 - Measure VLF wave properties, B, particle distribution at RBSP
 - Compute expected scattering rates as function of energy and compare with microburst observations
 - Statistical study of wave properties during observed microburst events
- *Comment:*
 - What if most large amplitude waves are not at equator?

Question #4

What causes observed duskside precipitation bursts?

- *Hypothesis:* Pitch angle scattering by EMIC waves is the cause.
- *Method:*
 - Identify conjunctions between RBSP and BARREL (or SAMPEX, etc) during observed duskside events.
 - Event studies:
 - Measure wave properties, B, particle distribution at RBSP
 - Compute expected scattering rates as function of energy and compare with observations of precipitation
 - Statistical study of wave properties during observed events

Question #5

What causes observed ULF timescale modulation of precipitation?

- *Hypothesis:* Modulation of plasma wave growth by ULF waves which leads to modulation of scattering rate.
- *Hypothesis:* Modulation of some other parameter like cold plasma density or background magnetic field
- *Hypothesis:* Direct modulation of the precipitation rate by some unknown process.
- *Method:*
 - Identify conjunctions
 - Measure wave amplitude vs. time at RBSP (or THEMIS)
 - Measure cold plasma density, B , as function of time