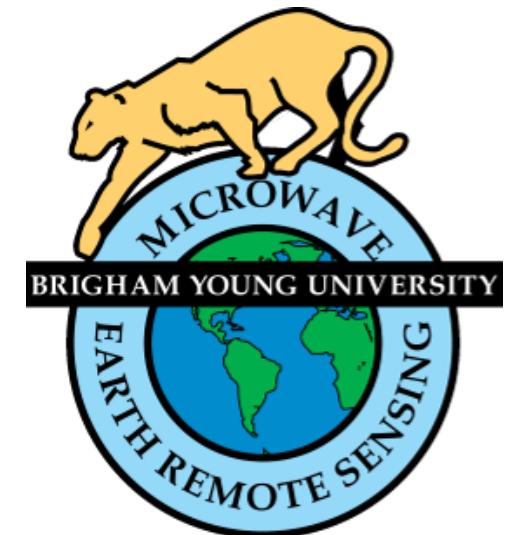


# Diurnal variations of $\sigma^0$ over land from RapidScat Observations



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David G. Long  
Nathan Madsen

Brigham Young University  
21 May 2015



Paget, A. C., D. G. Long, and N. Madsen (2015), RapidScat diurnal cycles over land,  
*IEEE Transactions on Geoscience and Remote Sensing*, in review.

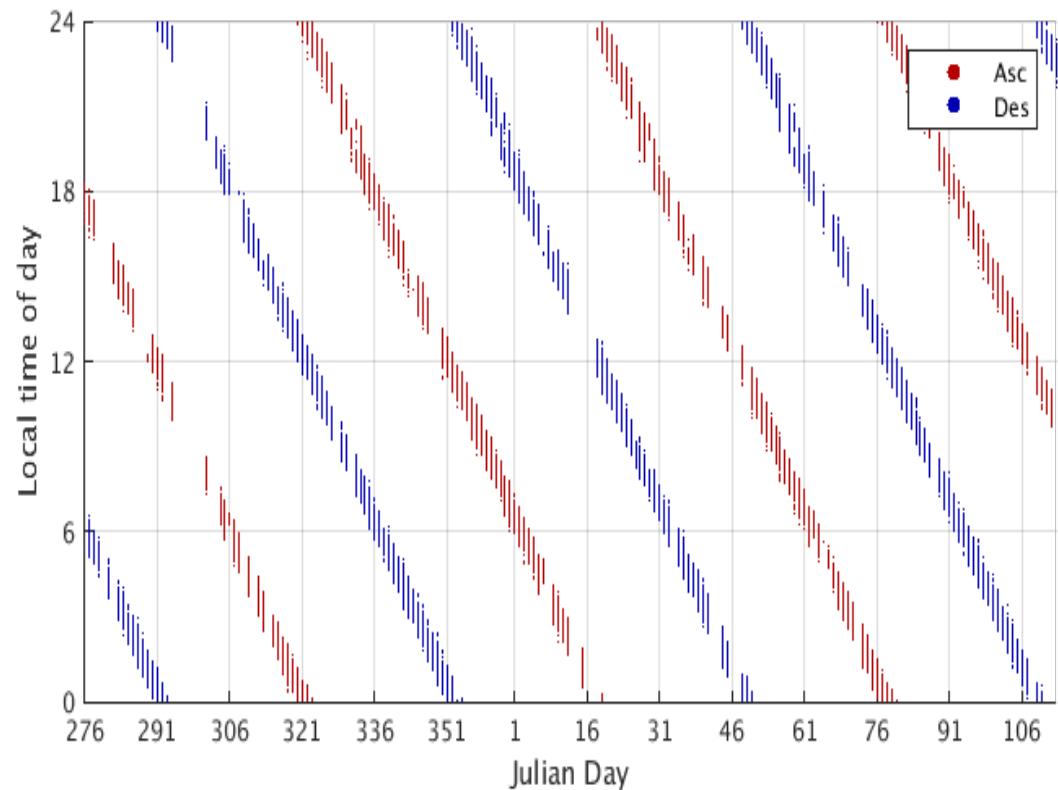
	SASS	NSCAT	SeaWinds	SeaWinds	OSCAT	HY-2A	RapidSCAT
Frequency (Ku-band)	14.6 GHz	13.995 GHz	13.6 GHz	13.6 GHz	13.6 GHz	13.256 GHz	13.6 GHz
Antenna azimuths							
Polarizations	VV and HH	VV and HH	VV-outer HH-inner	VV-outer HH-inner	VV-outer HH-inner	VV-outer HH-inner	VV-outer HH-inner
Beam resolution	Fixed Doppler	Variable Doppler	Pencil-beam	Pencil-beam	Pencil-beam	Pencil-beam	Pencil-beam
Resolution ( $\sigma^0$ )	Normally 50 km	25 km	Egg: 25x36 km Slice: 6x25 km	Egg: 25x36 km Slice: 6x25 km	Egg: 30x68 km Slice: 5x30 km	Outer beam 37 x 26 km Inner beam 33 x 23 km	Egg: 26x37 km Slice: 8x26 km
Swath (km)	 ~750    ~750	 600    600	 1400, 1800	 1400, 1800	 1400, 1836	 1350, 1700	 900, 1100
Incidence angles	0° - 70°	12° - 60°	46° & 54.4°	46° & 54.4°	49° & 57°	41.36° & 48.44°	49° & 56°
Daily coverage	Variable	78%	92%	92%	>90%	90%	65% between 58°N and 58°S
Mission & Dates	SeaSat 6/1978-10/1978	ADEOS-I 8/1996 - 6/1997	QuikSCAT 6/1999 - 11/2009	ADEOS II 1/2002 - 10/2002	OceanSat-2 10/2009 - 2/2015	8/2011 -	International Space Station 10/2014 -
Orbit type	Sun-synchronous	Sun-synchronous	Sun-synchronous	Sun-synchronous	Sun-synchronous	Sun-synchronous	Non sun-synchronous
Ascending equatorial crossing local time	6:00 AM & 12:00 PM	6:30 AM	6:00 AM	10:30 PM	12:00 AM	6:00 PM	Various
Orbit inclination	108°	98.616°	98.6°	98.62°	98.28°	99.3°	51.65°
Altitude (nominal)	805 km	803 km	800 km	802.9 km	720 km	970 km	375 – 435 km
Period	100.7 min	101 min	101 min	101 min	99.31 min	104.45 min	92.69 min





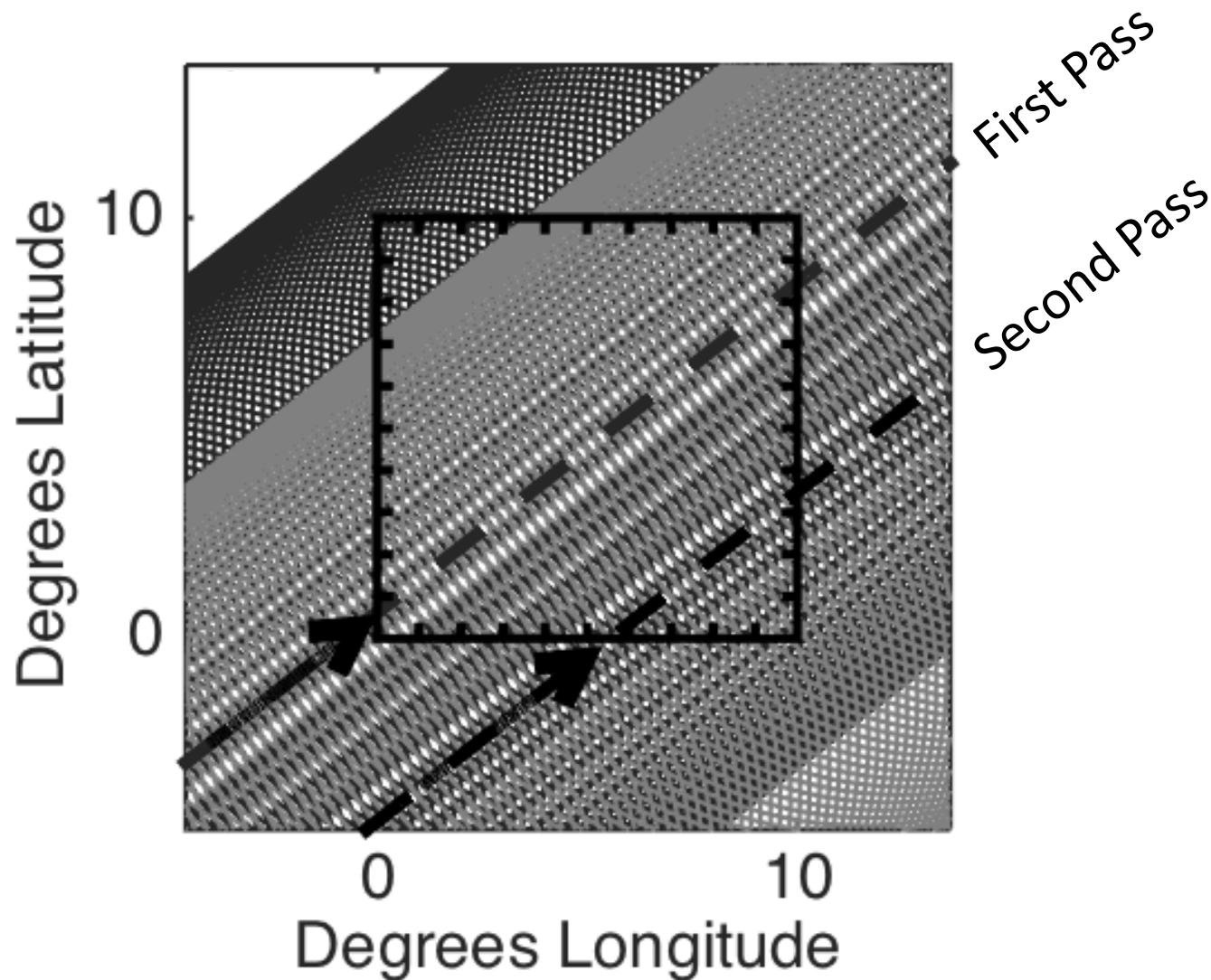
# RapidSCAT - Diurnal Capability

- First scatterometer not mounted on a sun-synchronous platform
- Can view a location at all local times of day every two months
- First chance to understand LTOD variation of sigma-0 over land calibration targets



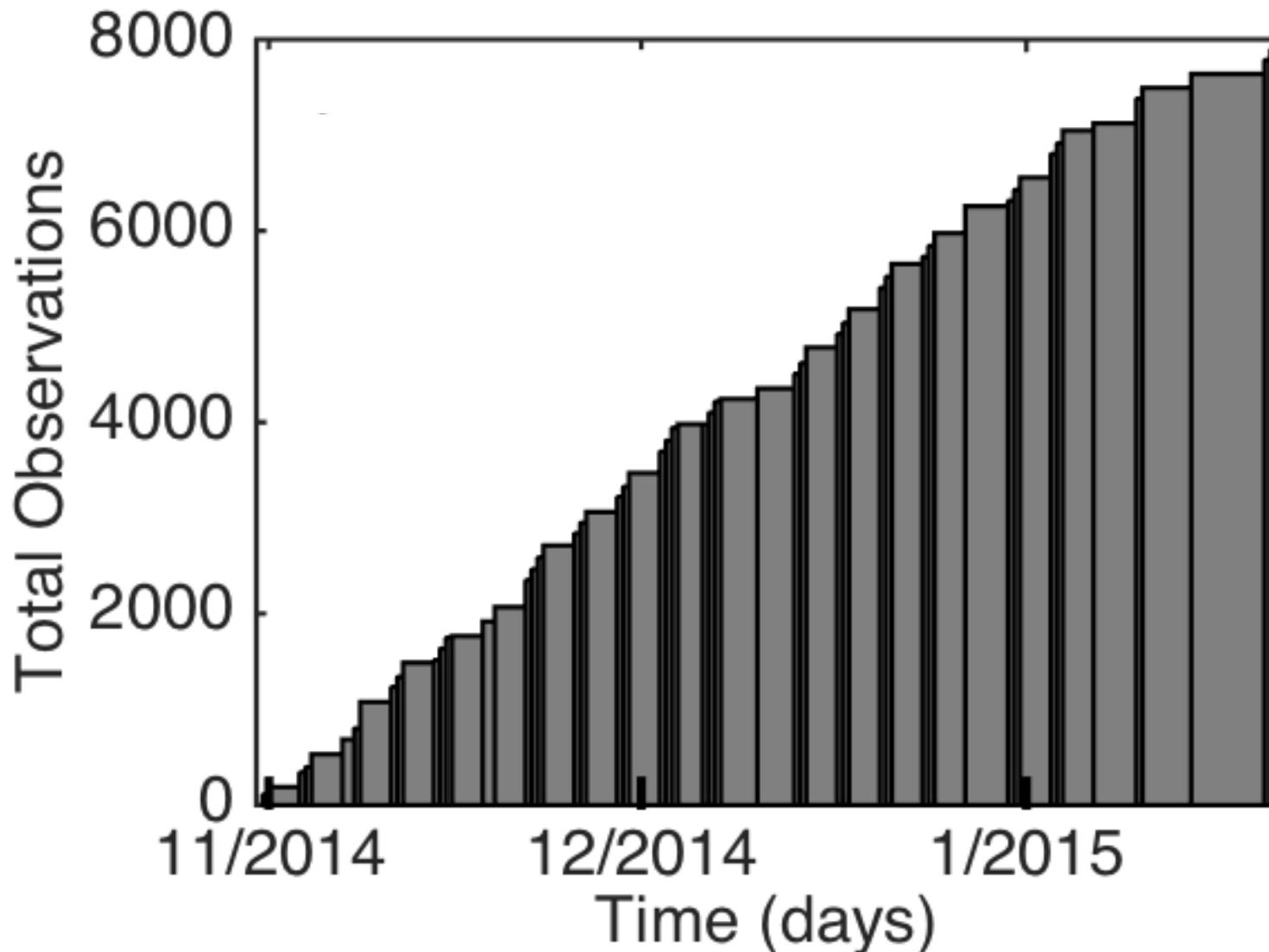


## RapidScat ascending track overlap after 15 revolutions (about 23 hours)



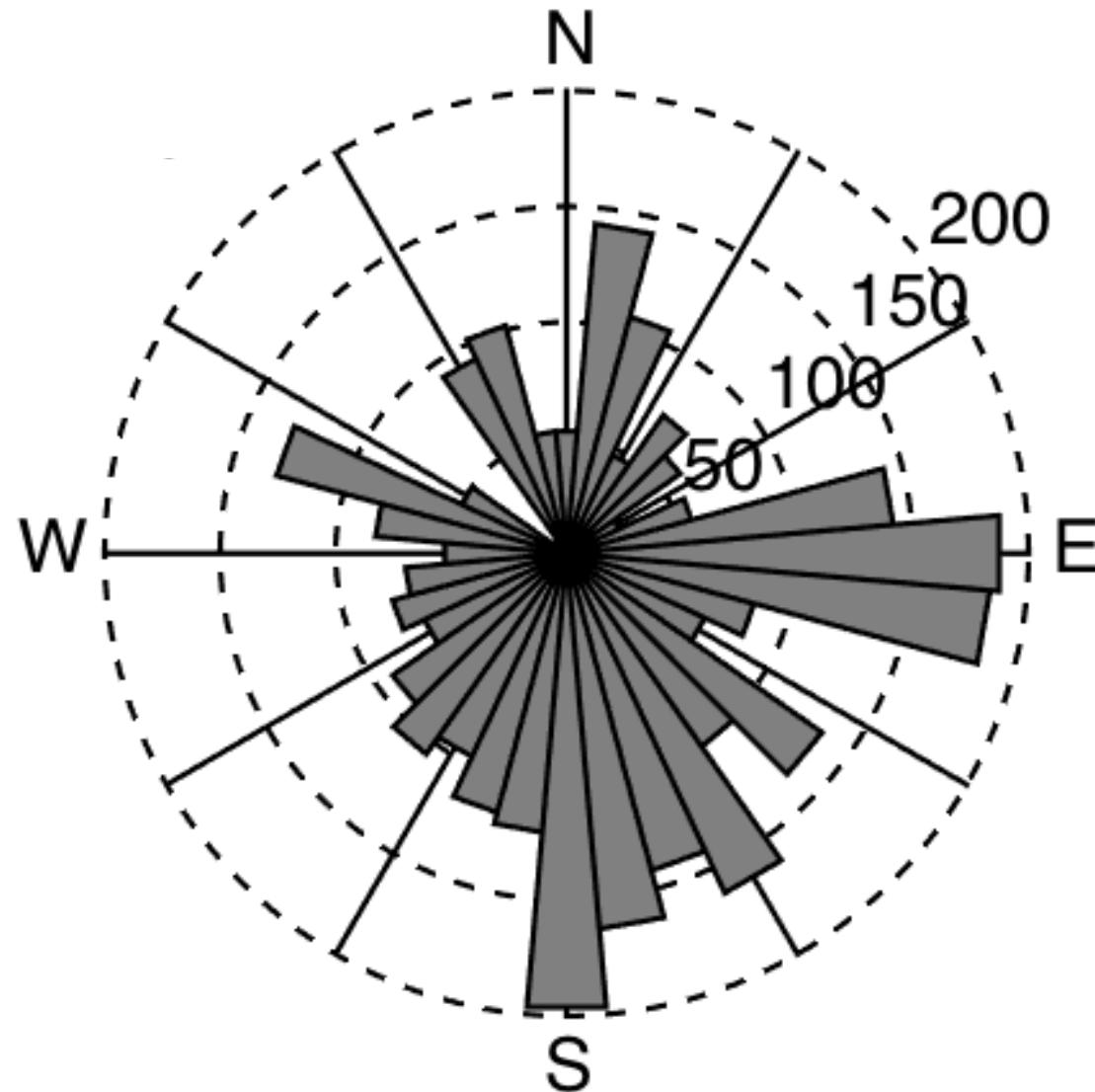


## Cumulative histogram by time of RapidScat $\sigma^0$ observations (sample region at 0°N and 100°E in Sumatra)



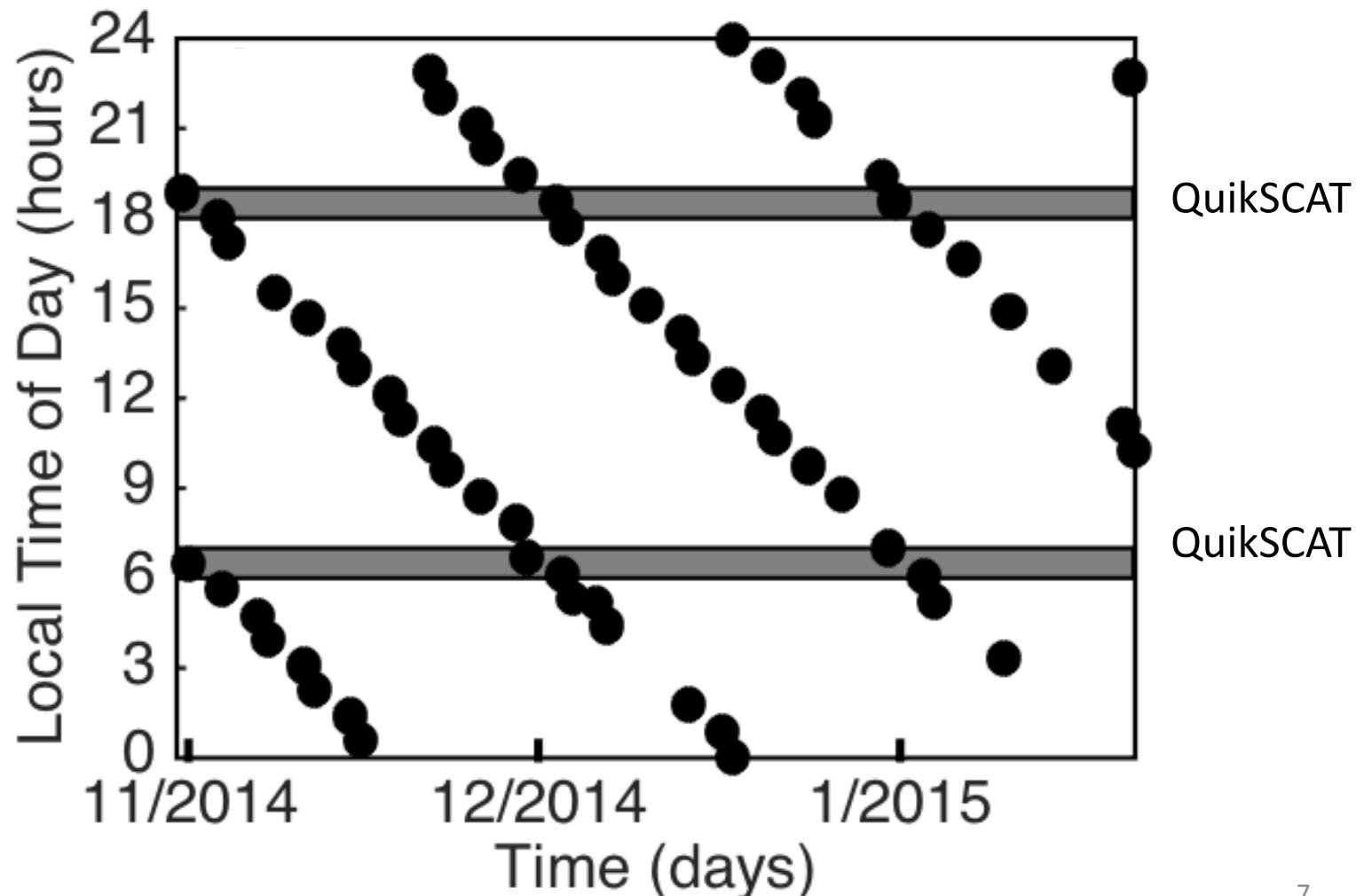


## Compass histogram of RapidScat ascending $\sigma^0$ observations (sample region at 0°N and 100°E in Sumatra)





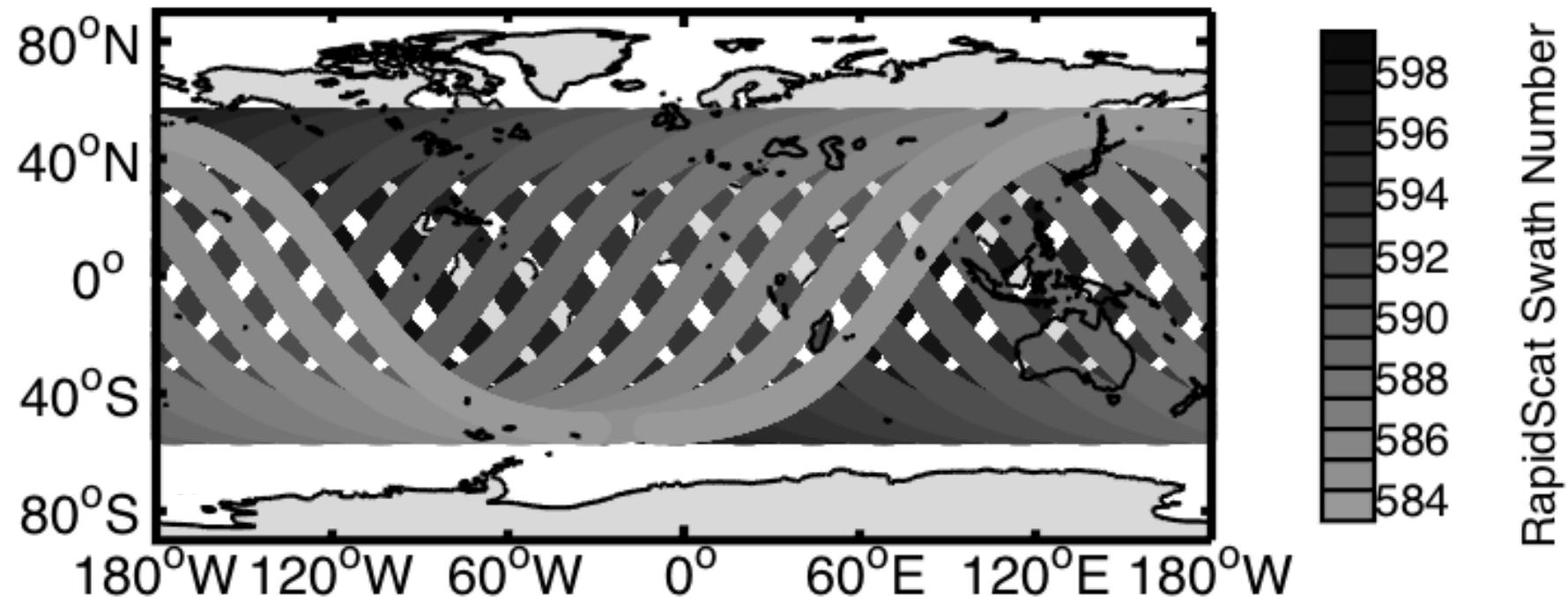
# RapidScat local time of day observations by date (sample region at 0°N and 100°E in Sumatra)





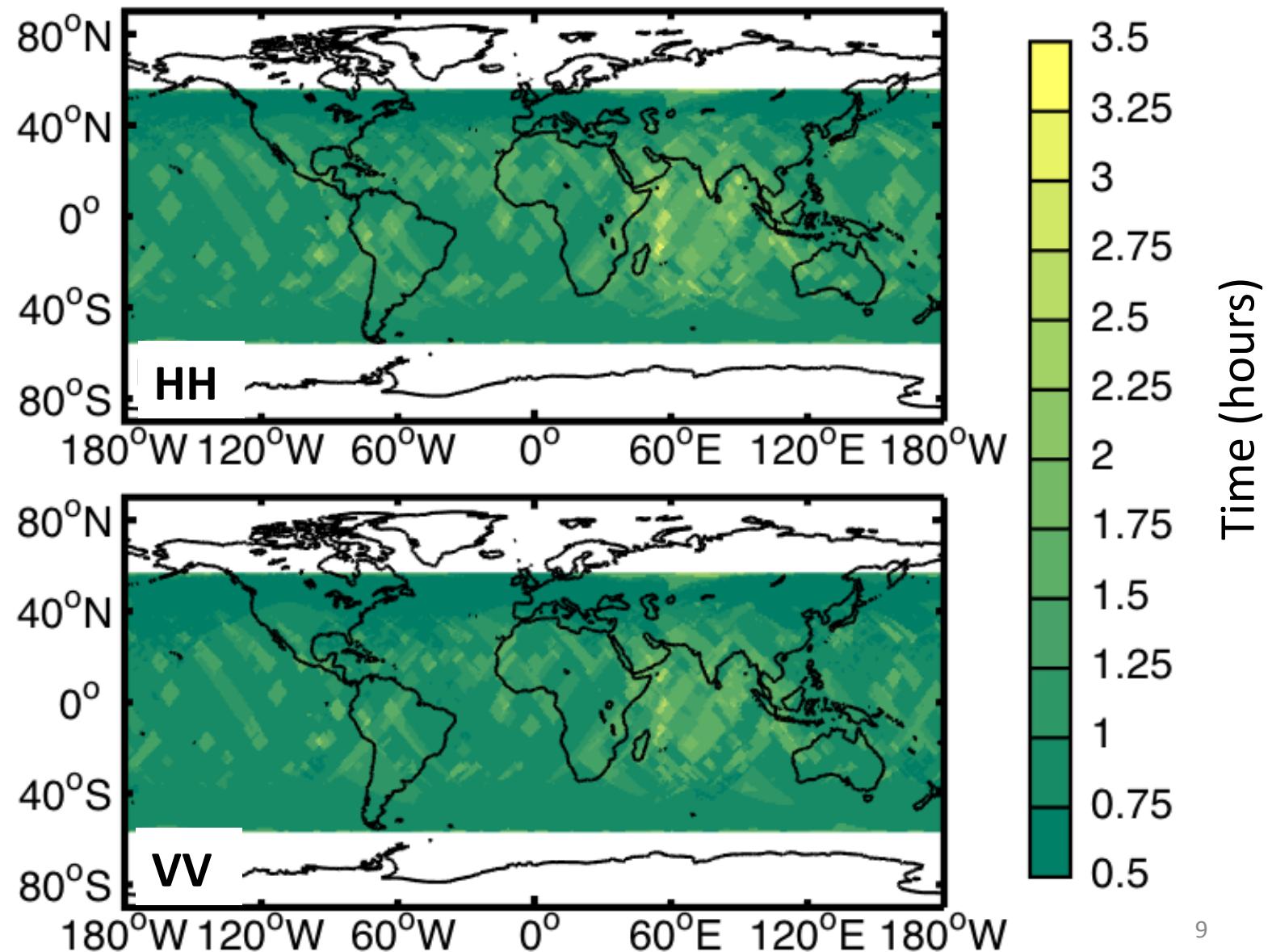
# Sample RapidScat surface observations

## 16 full orbits (approximately 1 day)





# Largest time gap in the composite local time of day (ascending and descending combined)





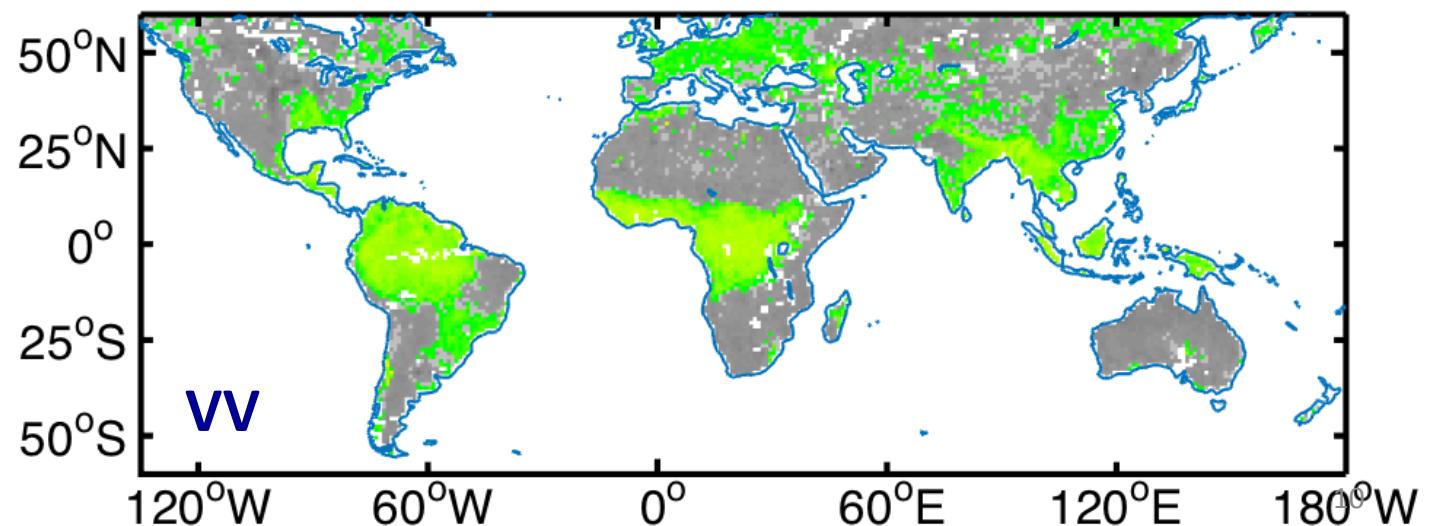
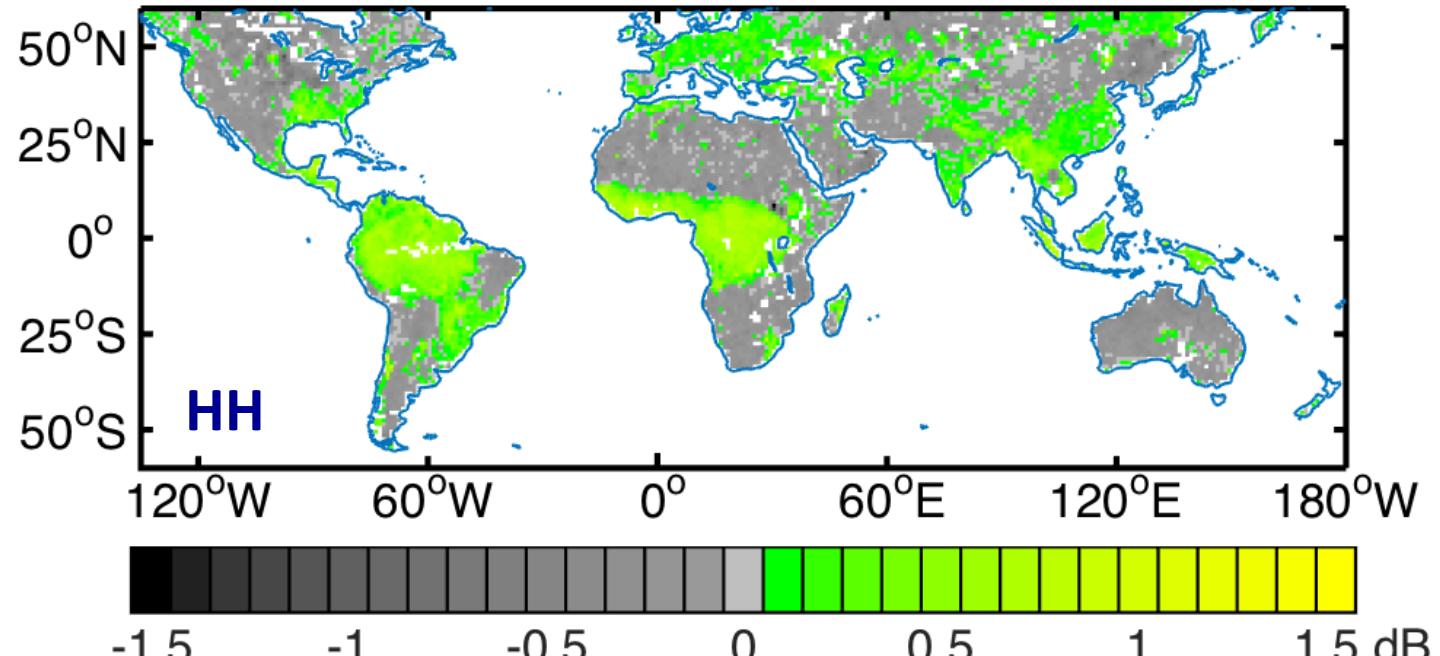
# QuikSCAT $\sigma^0$ diurnal differences (Morning – Evening)

1 October 2008 – 4 February 2009



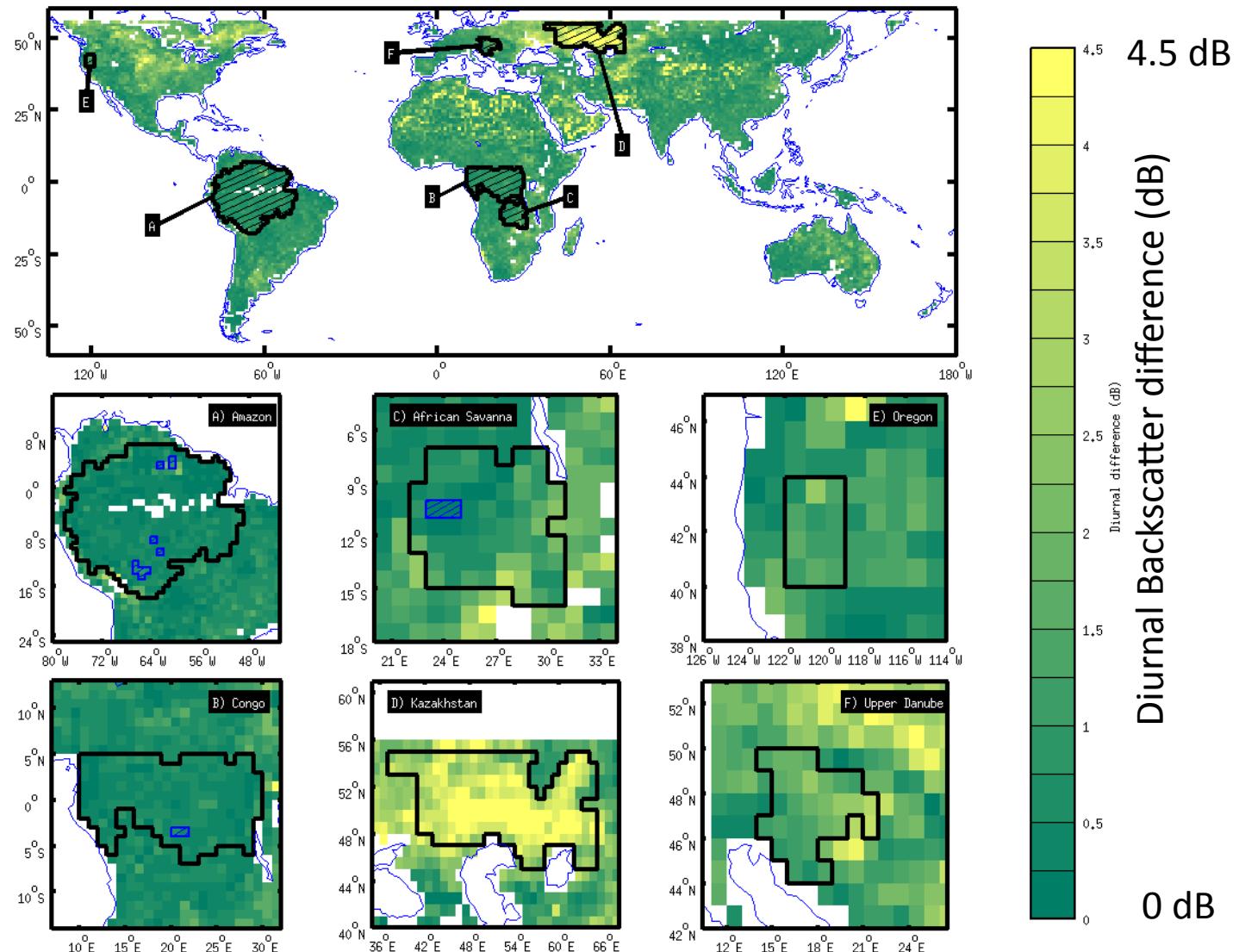
Polarizations  
similar

QuikSCAT  
morning/evening  
differences  
small compared  
to RapidSCAT  
results – would  
result in under  
reporting total  
variation



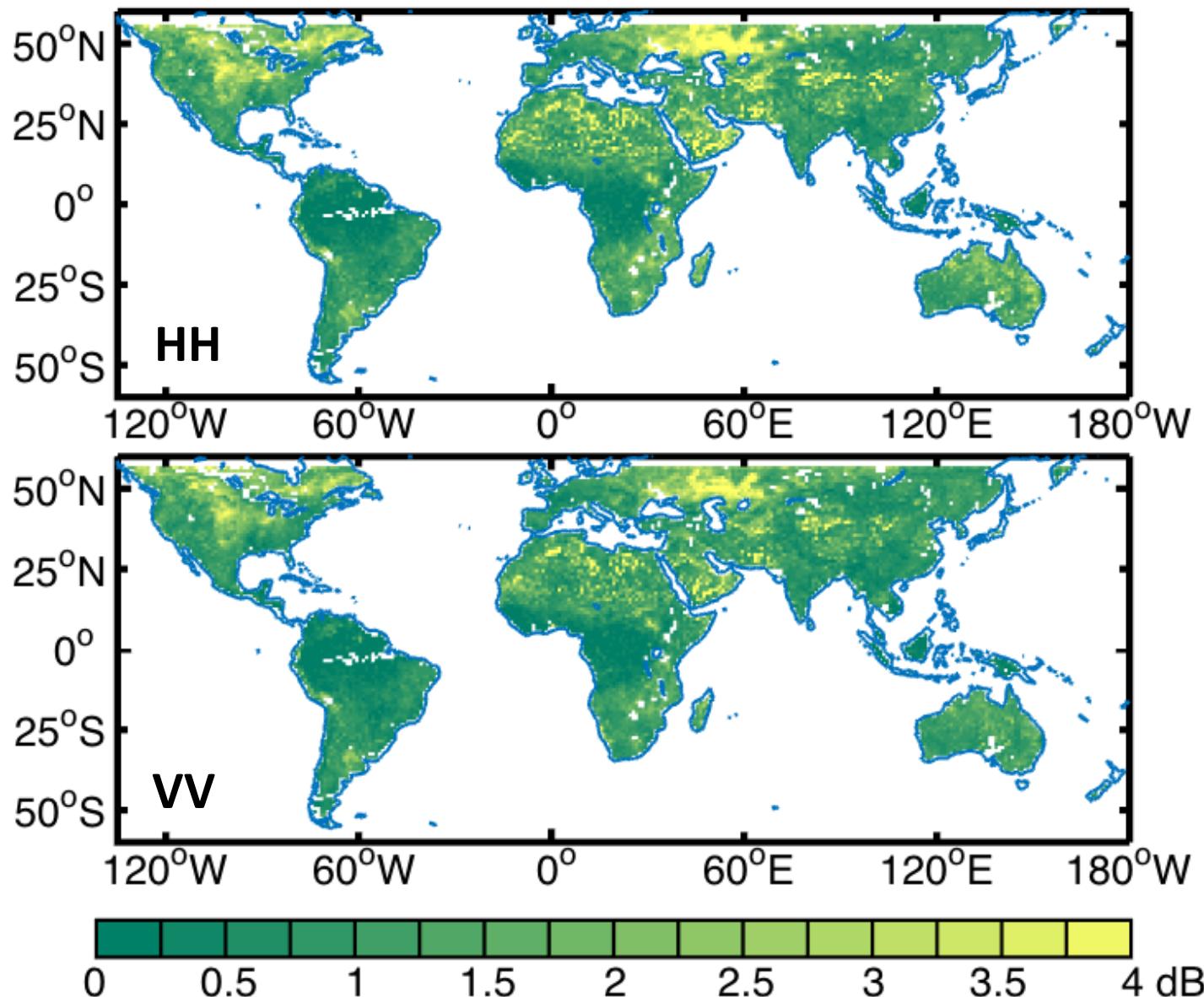


# RapidScat Diurnal Variation





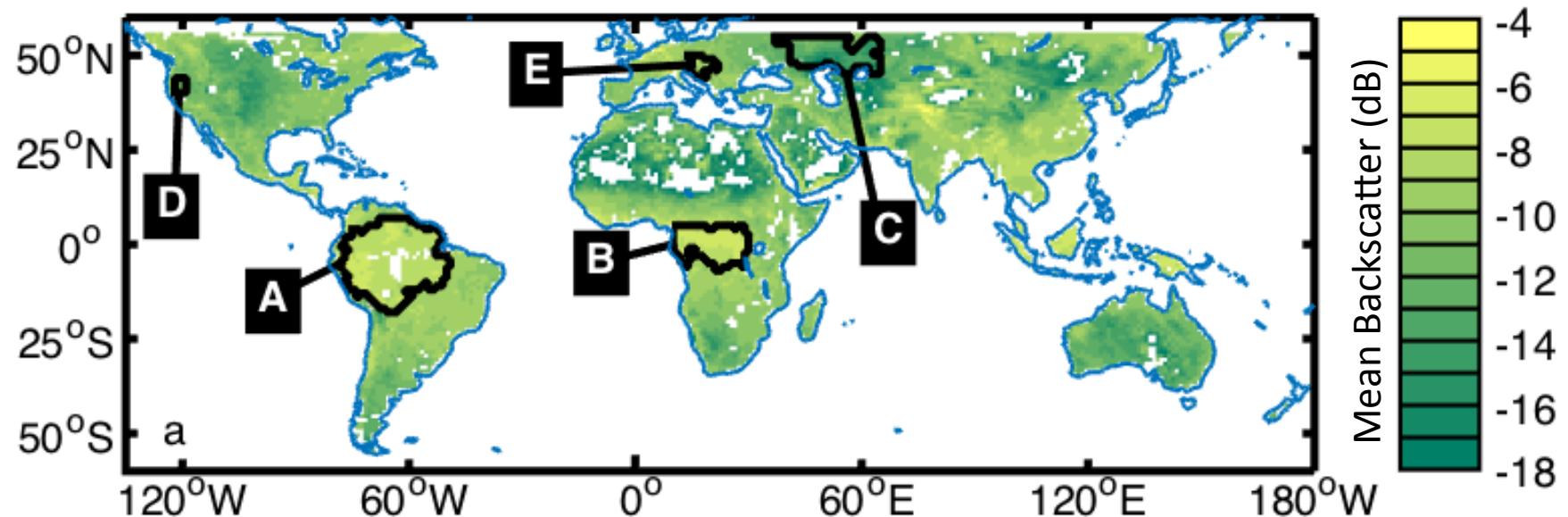
# Absolute difference in observed diurnal signal from RapidScat and QuikSCAT





# RapidScat Diurnal Variation

RapidScat mean  $\sigma^0$  for  $1^\circ \times 1^\circ$  regions globally (HH)



Specific Regions:

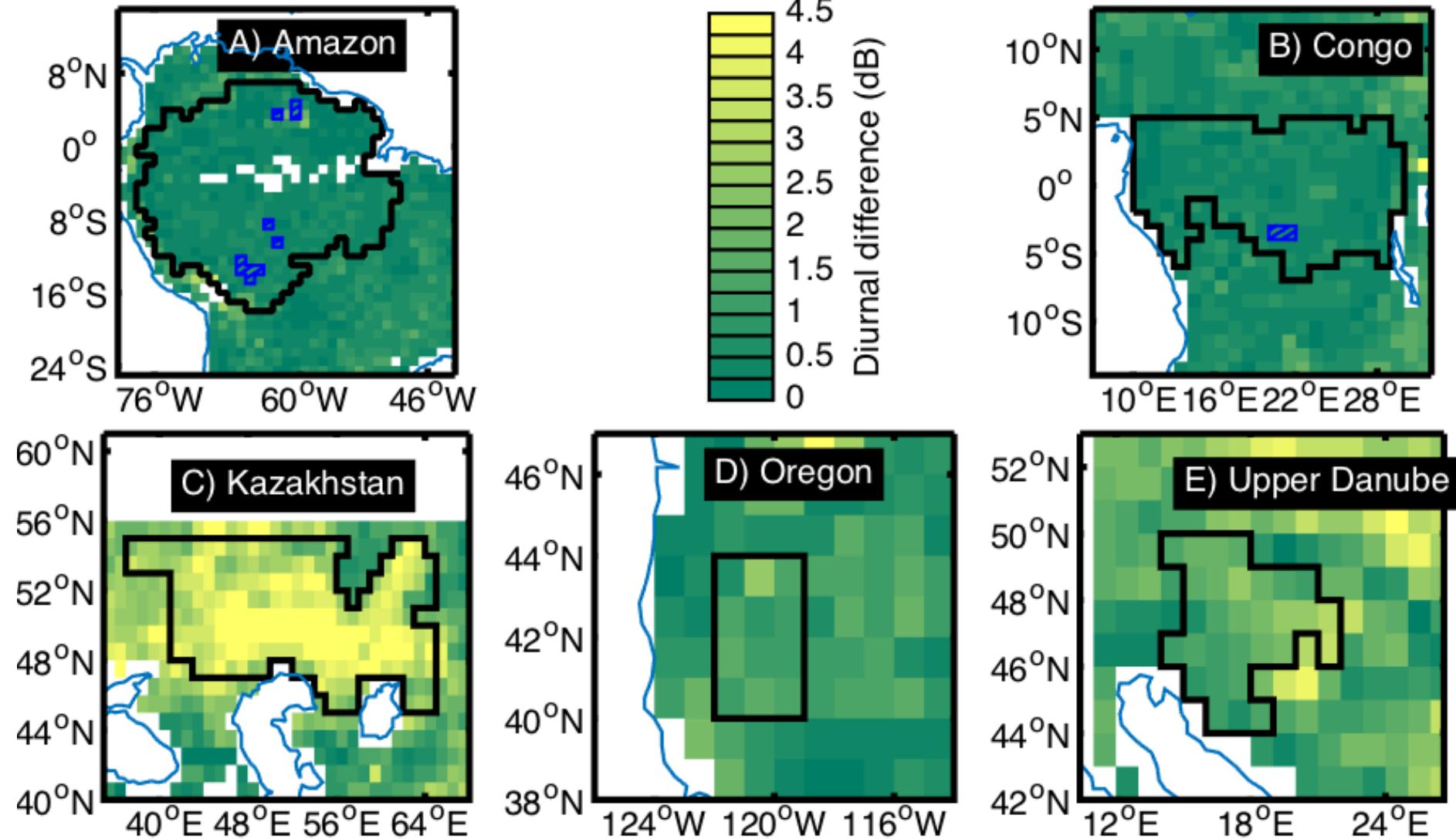
- A) Amazon
- B) Congo

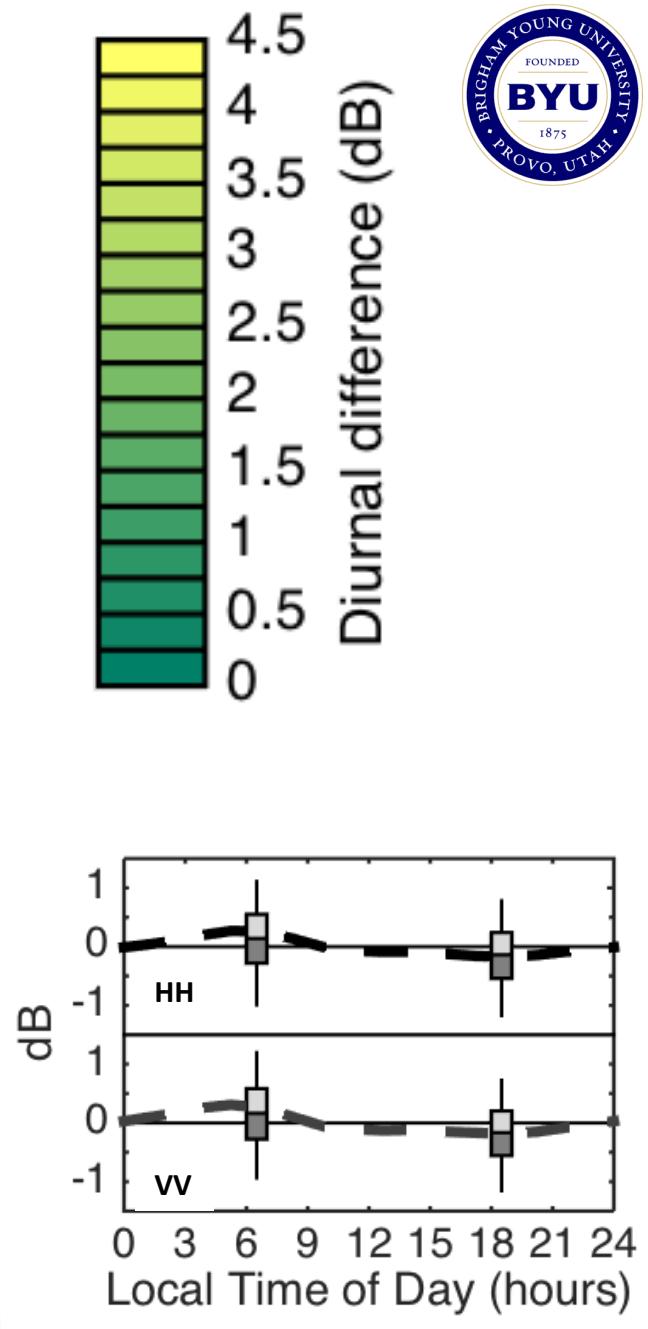
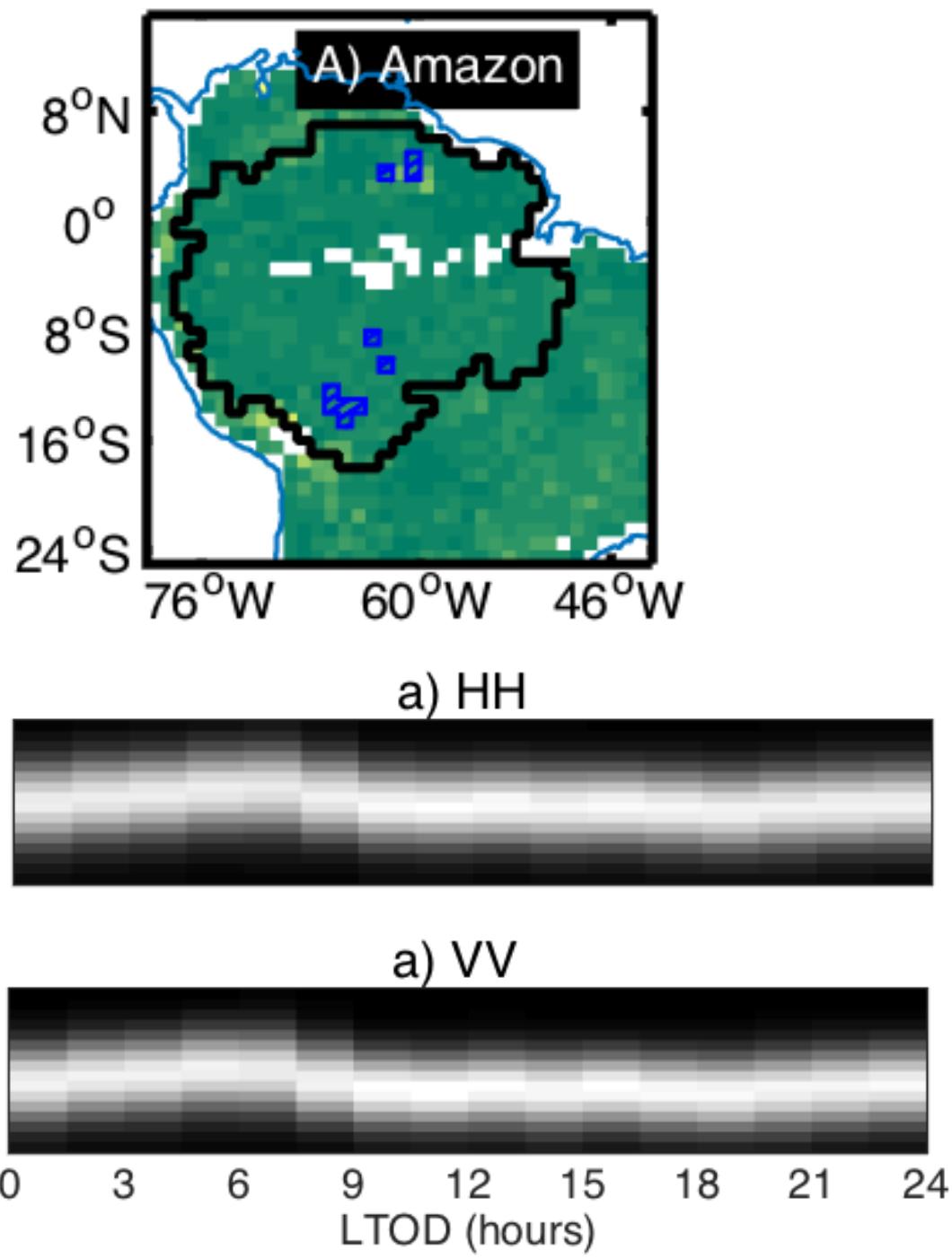
C) Kazakhstan

- D) Oregon
- E) Upper Danube



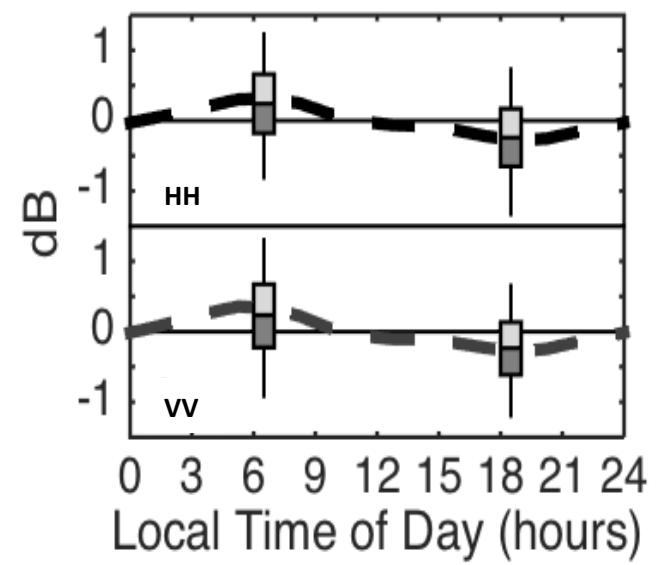
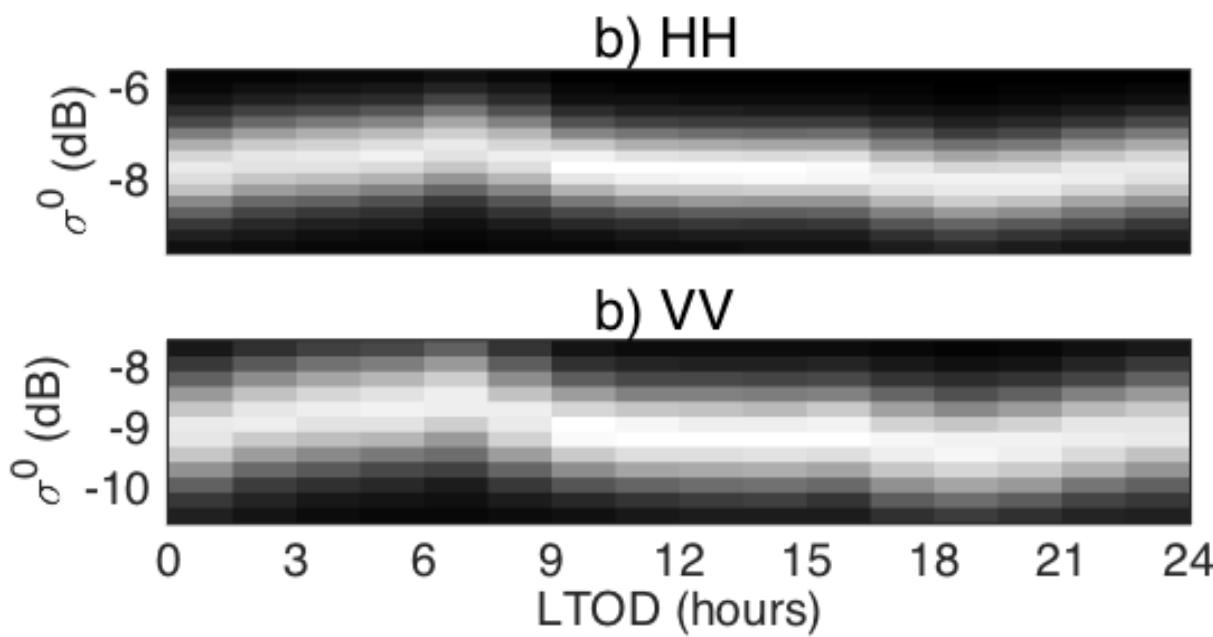
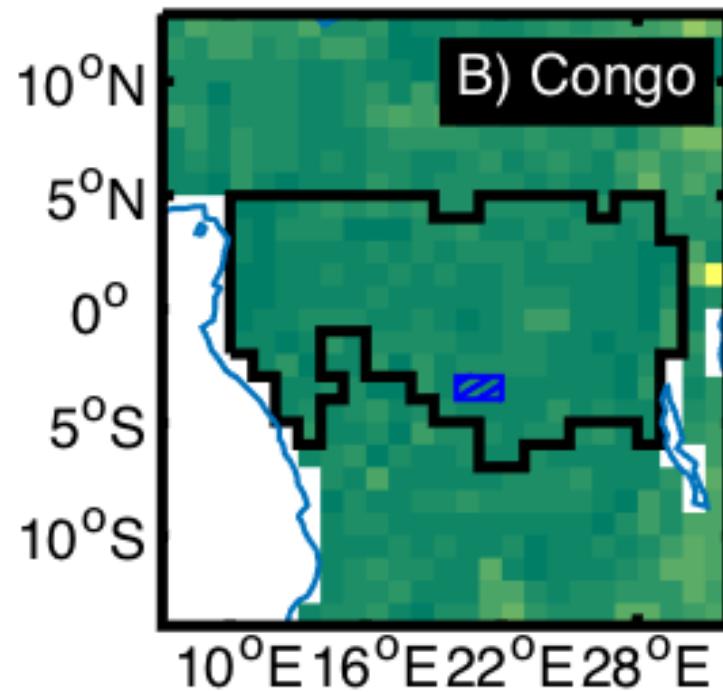
# RapidScat Diurnal Variation

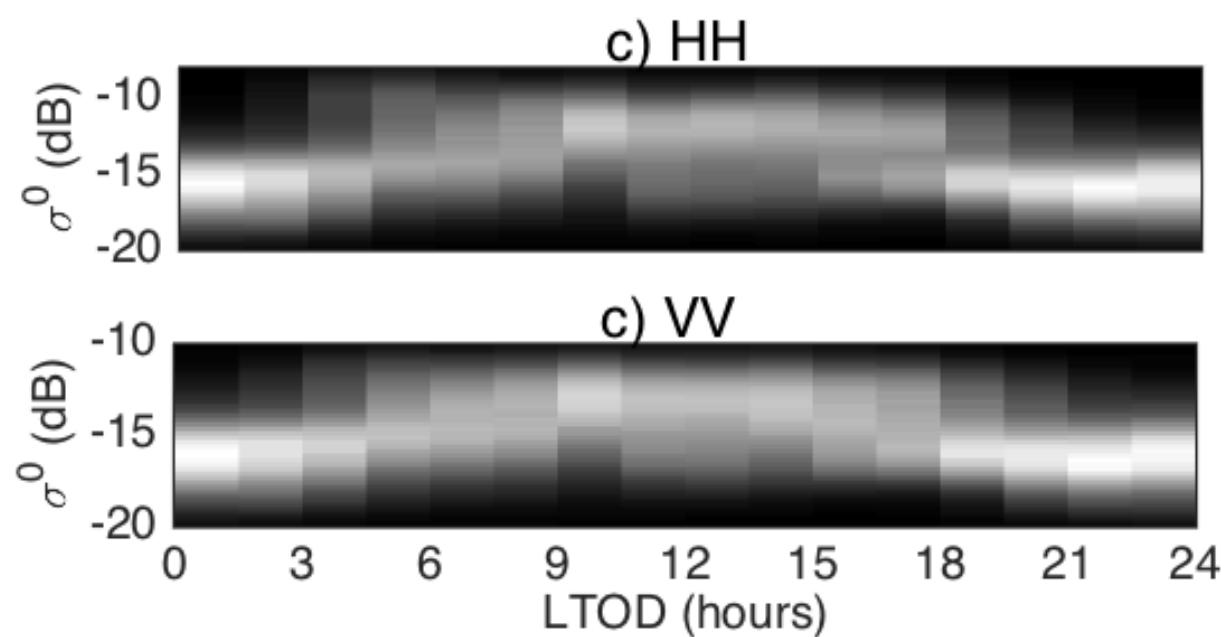
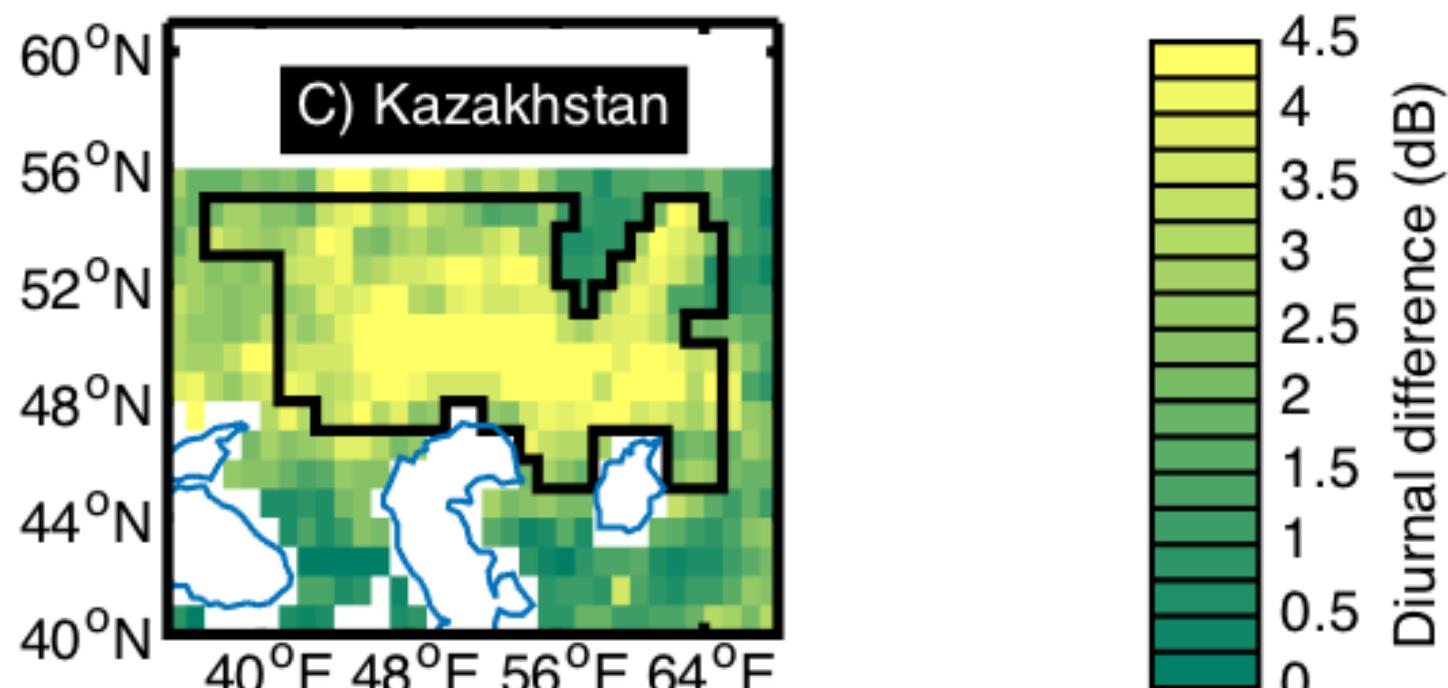


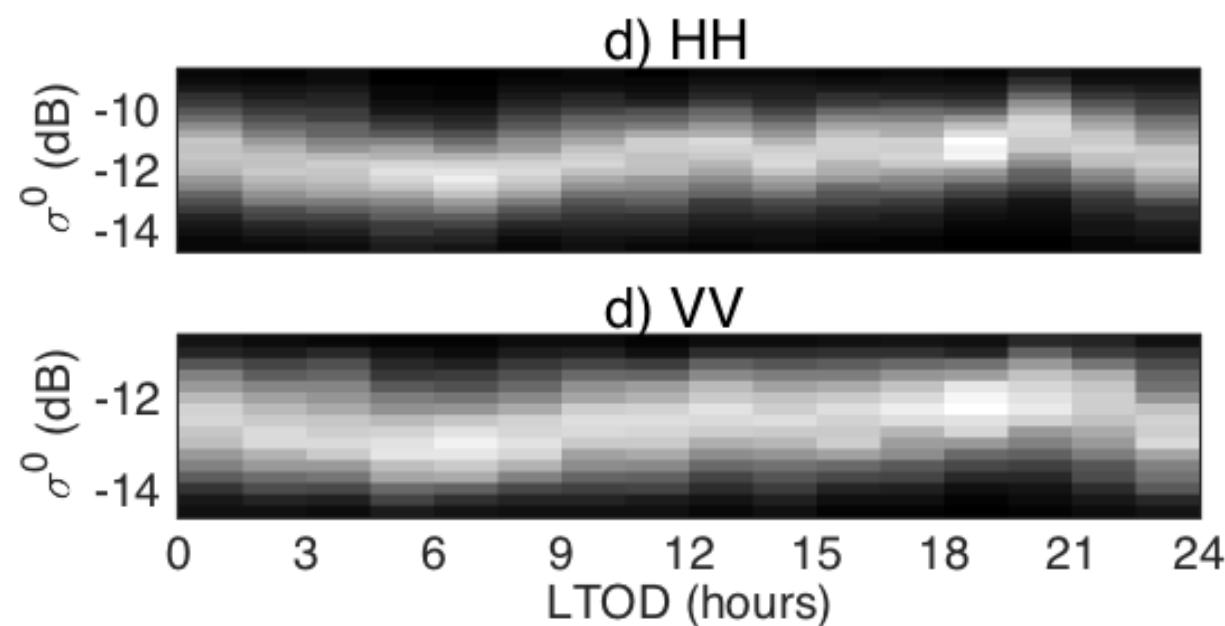
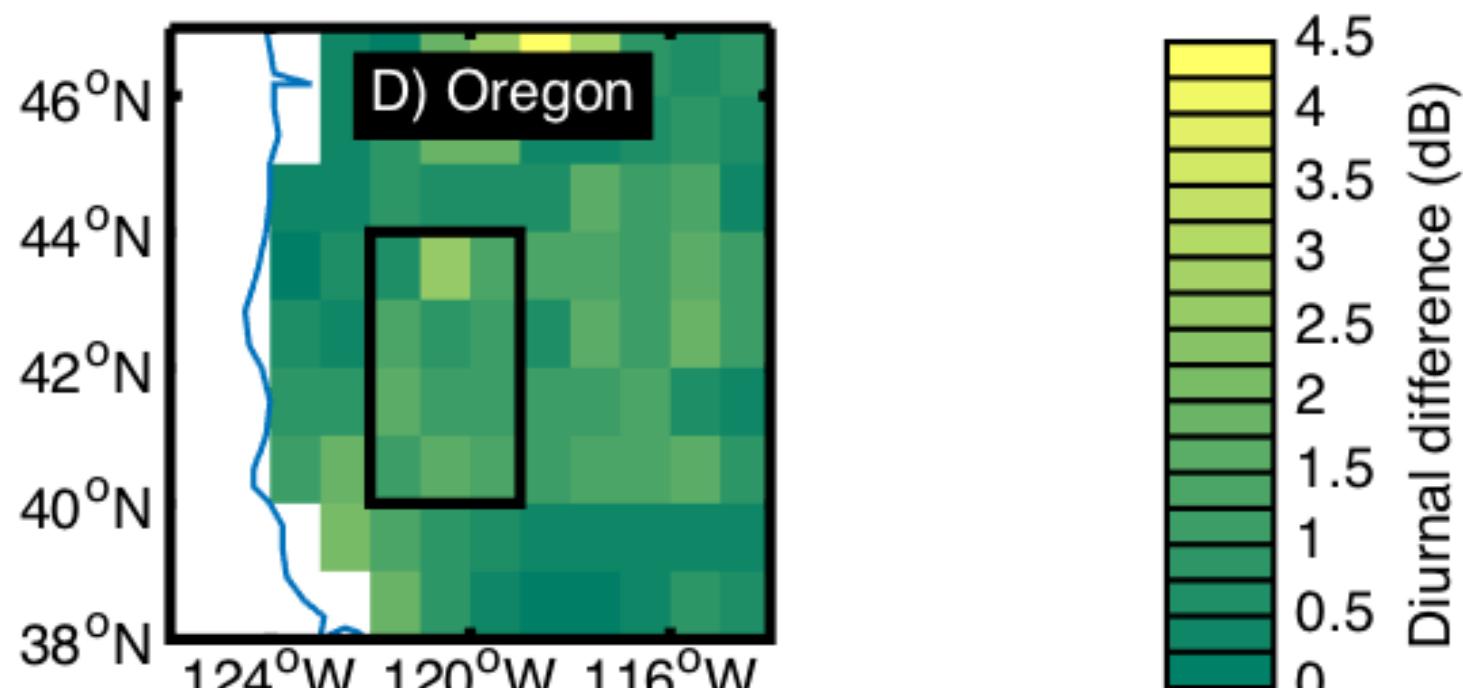


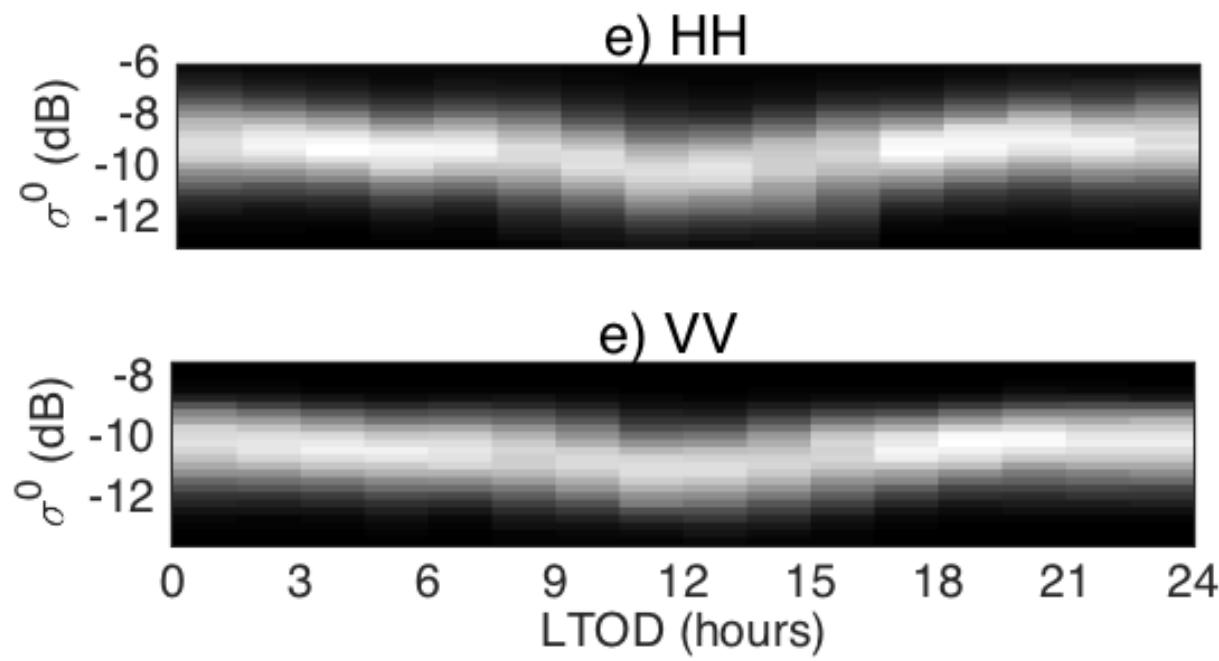
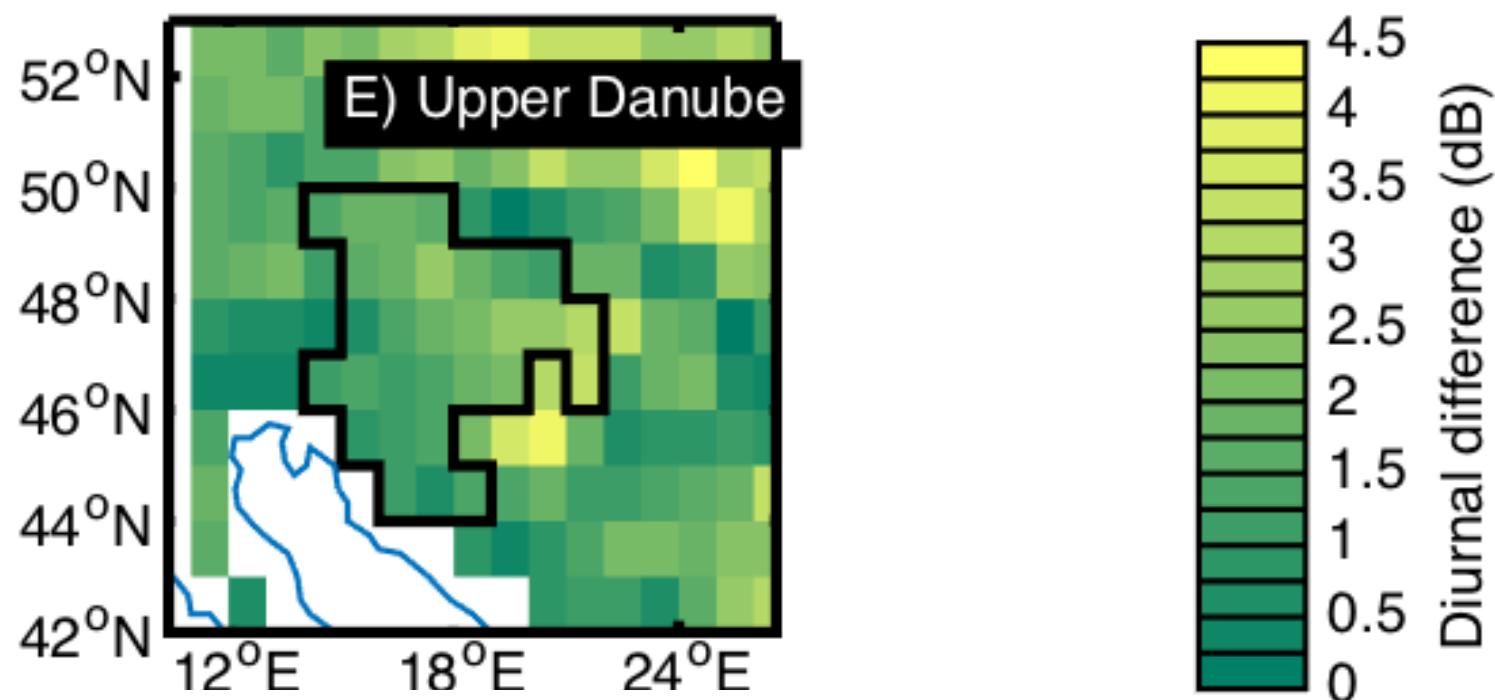
15





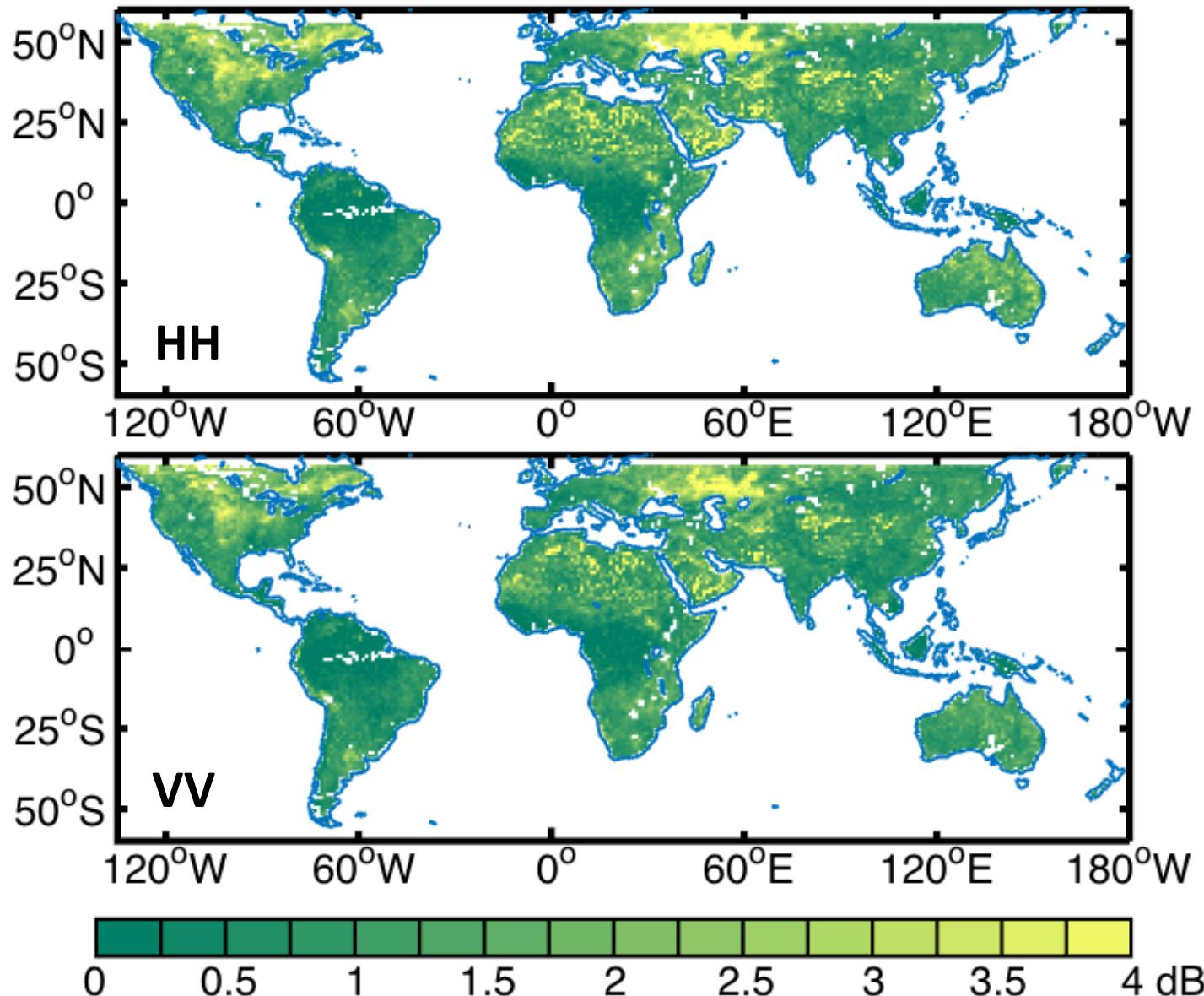








# Absolute difference in observed diurnal signal from RapidScat and QuikSCAT

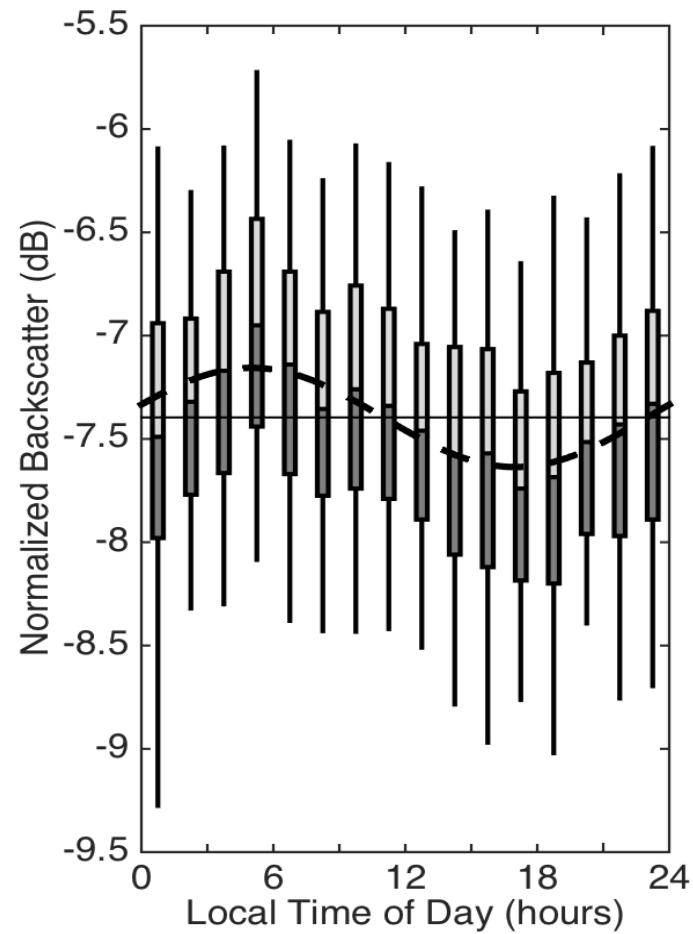




# Diurnal Backscatter Cycle

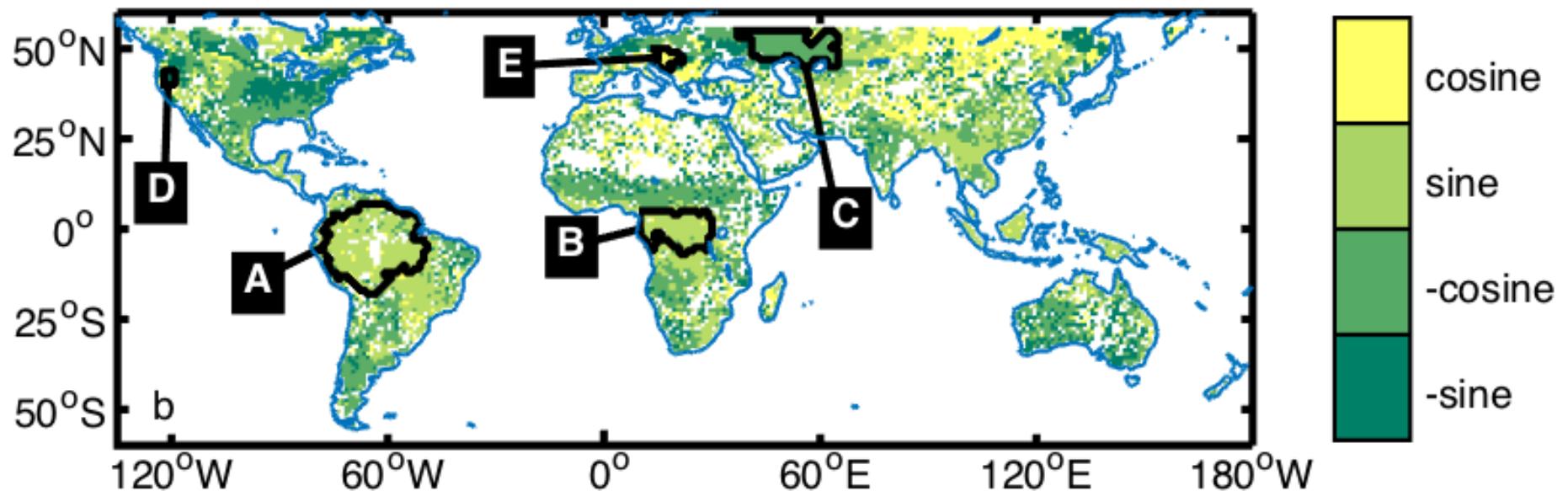
Diurnal changes in 90-minute local time of day bins  
1° x 1° region at 0°N and 100°E in Sumatra

- In most areas there is a nearly sinusoidal variation in backscatter with local tie of day
  - Magnitude and phase of cycle vary with location and vegetation type





# RapidScat sinusoidal phase match



Specific Regions:

- A) Amazon
- B) Congo

C) Kazakhstan

- D) Oregon
- E) Upper Danube



# RapidScat QuikScat Calibration

- Variations in response to season, local time of day, incidence angle, azimuth angle, and location are considered
- RapidSCAT sigma0-0 found to be generally stable over its mission life
- RapidSCAT sigma-0 estimated to be biased low by 0.2 to 0.3 dB compared to QuikScat

