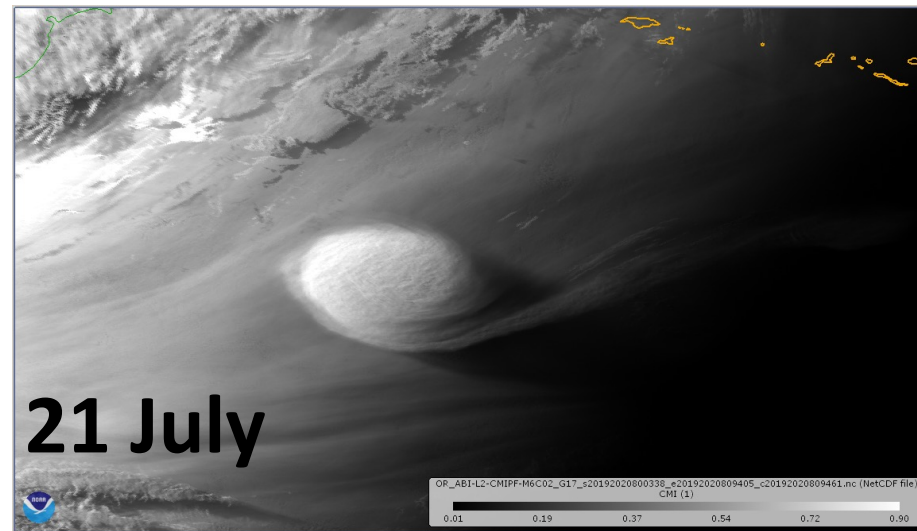
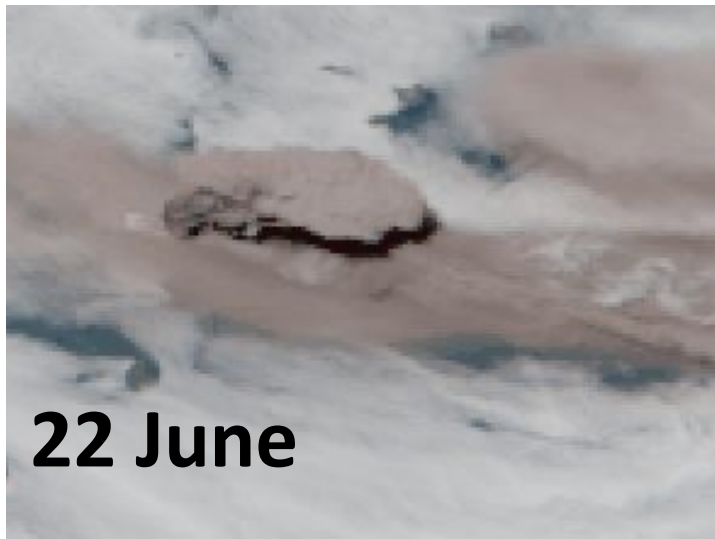


# High-Vertical-Resolution Radiosonde measurements of Stratospheric Volcanic Clouds

Mike Fromm, NRL

Case Study: Raikoke eruption, June 2019



**SSACC:**  
**S**O<sub>2</sub>  
**S**ulfate  
**A**nticyclonic  
**C**ontained  
**C**irculation

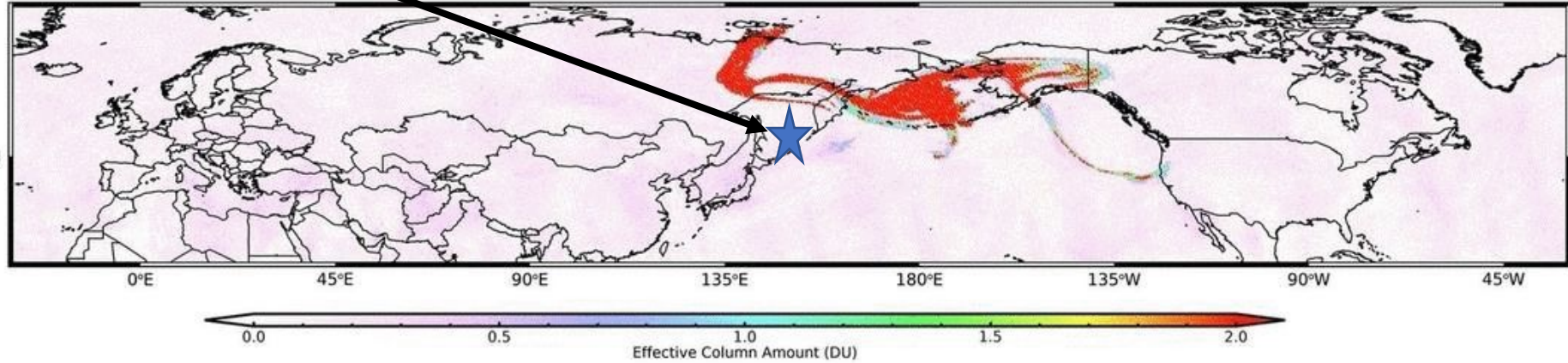
Thanks: Pat Kablick, Colin Seftor, Isabelle Taylor, Don Grainger, Judd Welton, Javier Fochesatto

# The Big Picture: IASI SO<sub>2</sub>

25 June

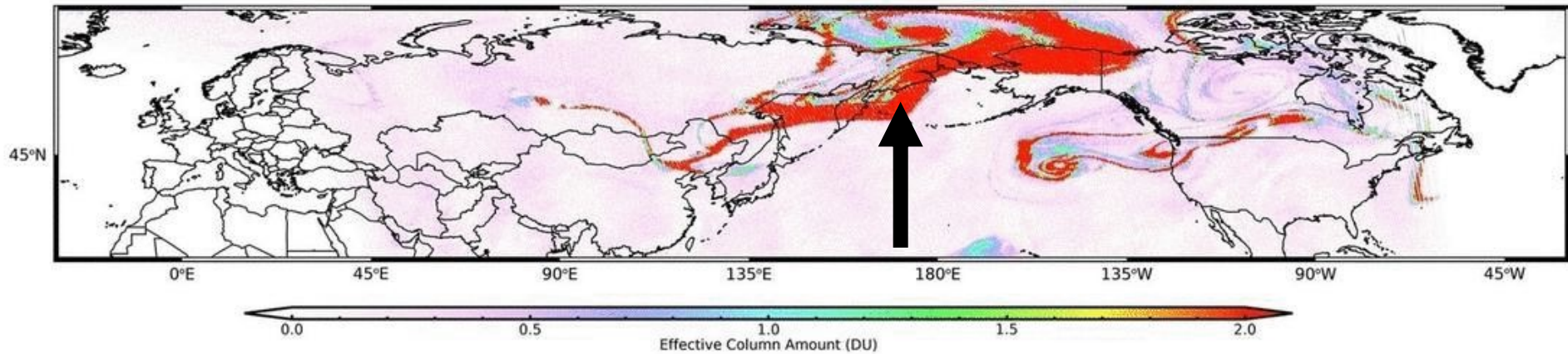
Raikoke

20190625 - AM



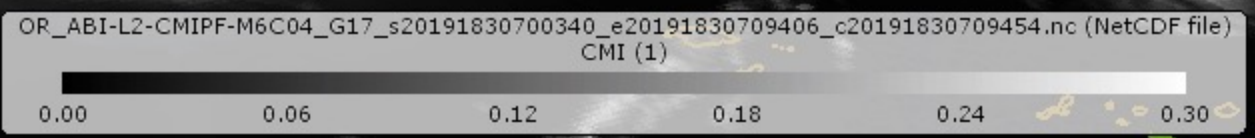
2 July

20190702 - AM



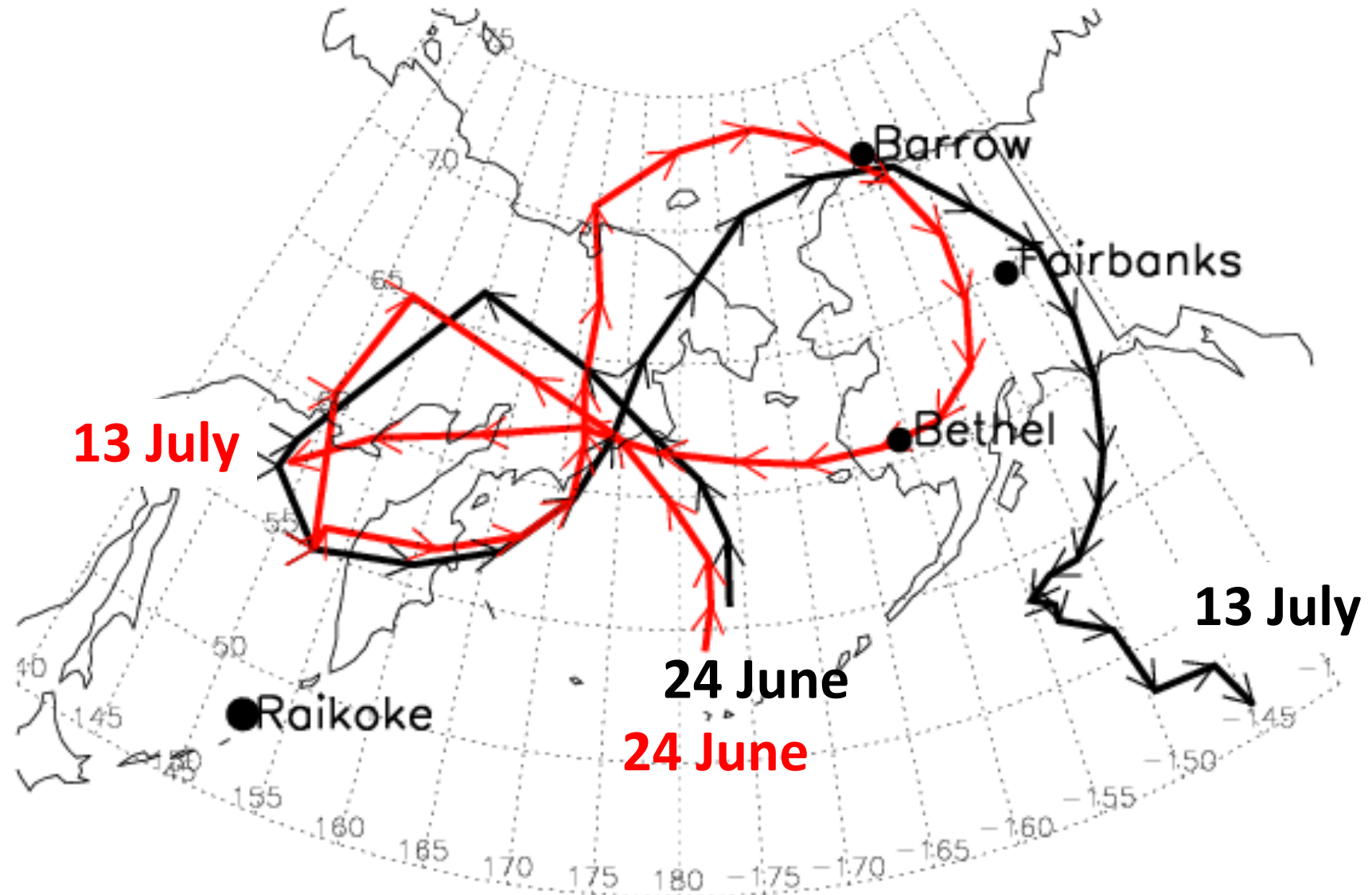
# GOES West, Cirrus channel, 2-4 July

**Kamchatka**



# Tracking SSACC Movement 19 Days

**SSACC1**  
**SSACC2**

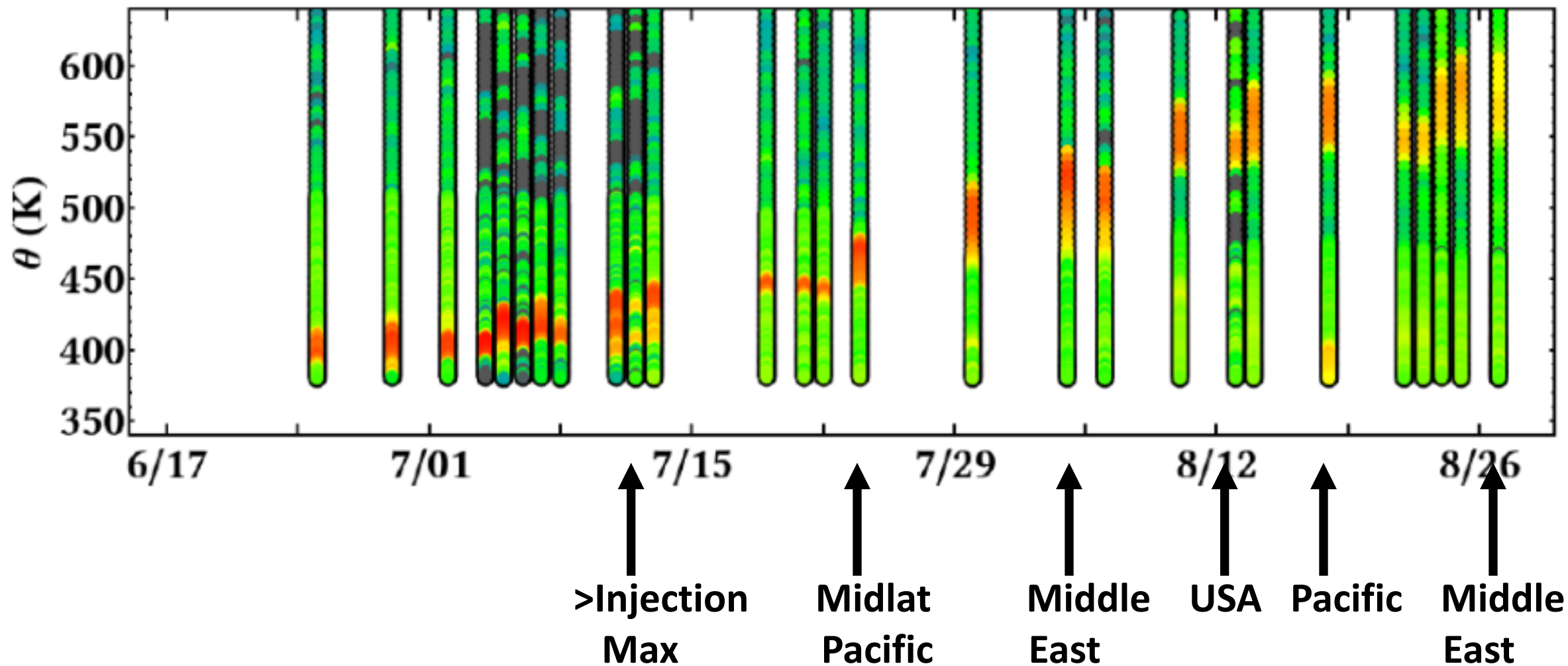


SSACC1 tracked out to ~10 August

**SSACC2** tracked out to September at subtropical latitudes (Gorkavyi et al., 2021; Chouza et al., 2020; Khaykin et al., 2022)

# SSACC 2

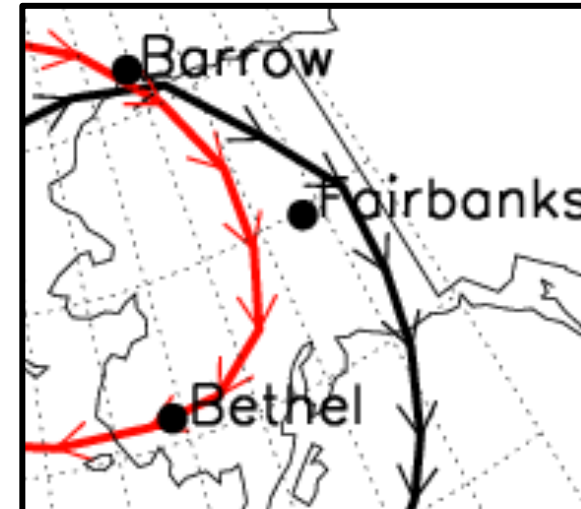
Progression of CALIOP extinction profiles w.r.t to potential temperature following the plume.



# SSACC 1: Detailed lidar and radiosonde encounter

## Nutshell:

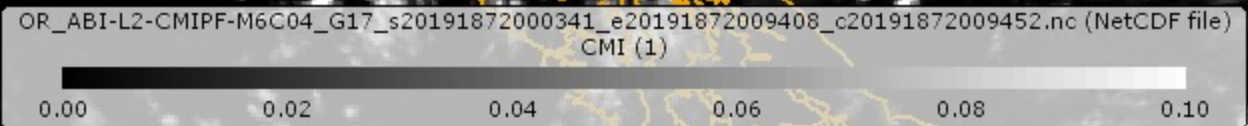
- > On 7 July 2019, Fairbanks MicroPulse lidar saw the SSACC.
  - several hours surrounding 00z 7 July.
- > Fairbanks RAOB (PAFA) encounter, 00z 7 July.
- > Lidar and GOES confirm balloon ascended through SACC's western fringe.



**Question: Does the balloon indicate any peculiar SSACC winds?**

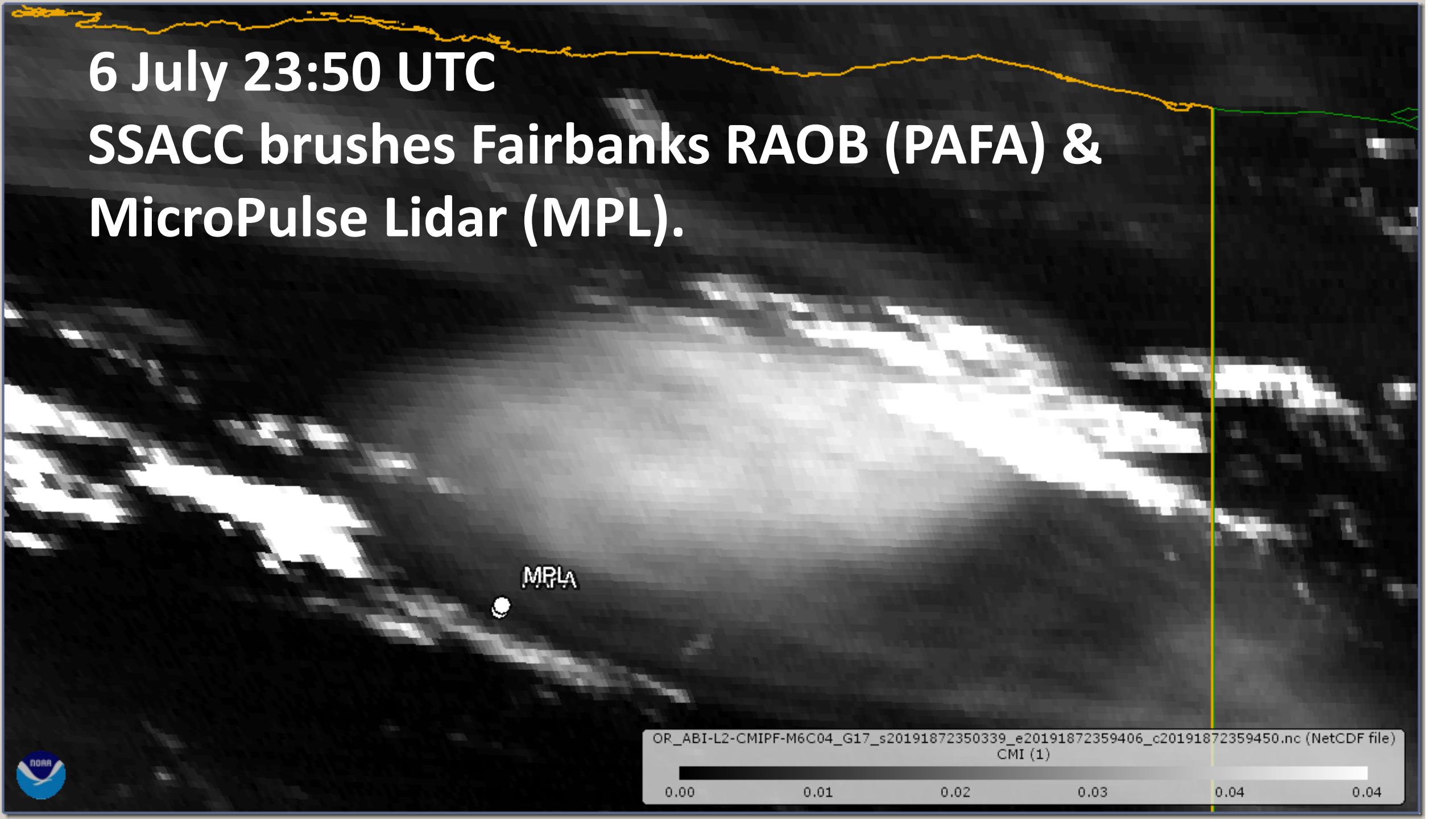
**GOES West Cirrus channel reflectance**  
**20 UTC 6 July – 07 UTC 7 July**

PAFA



6 July 23:50 UTC

SSACC brushes Fairbanks RAOB (PAFA) &  
MicroPulse Lidar (MPL).



OR\_ABI-L2-CMIPF-M6C04\_G17\_s20191872350339\_e20191872359406\_c20191872359450.nc (NetCDF file)

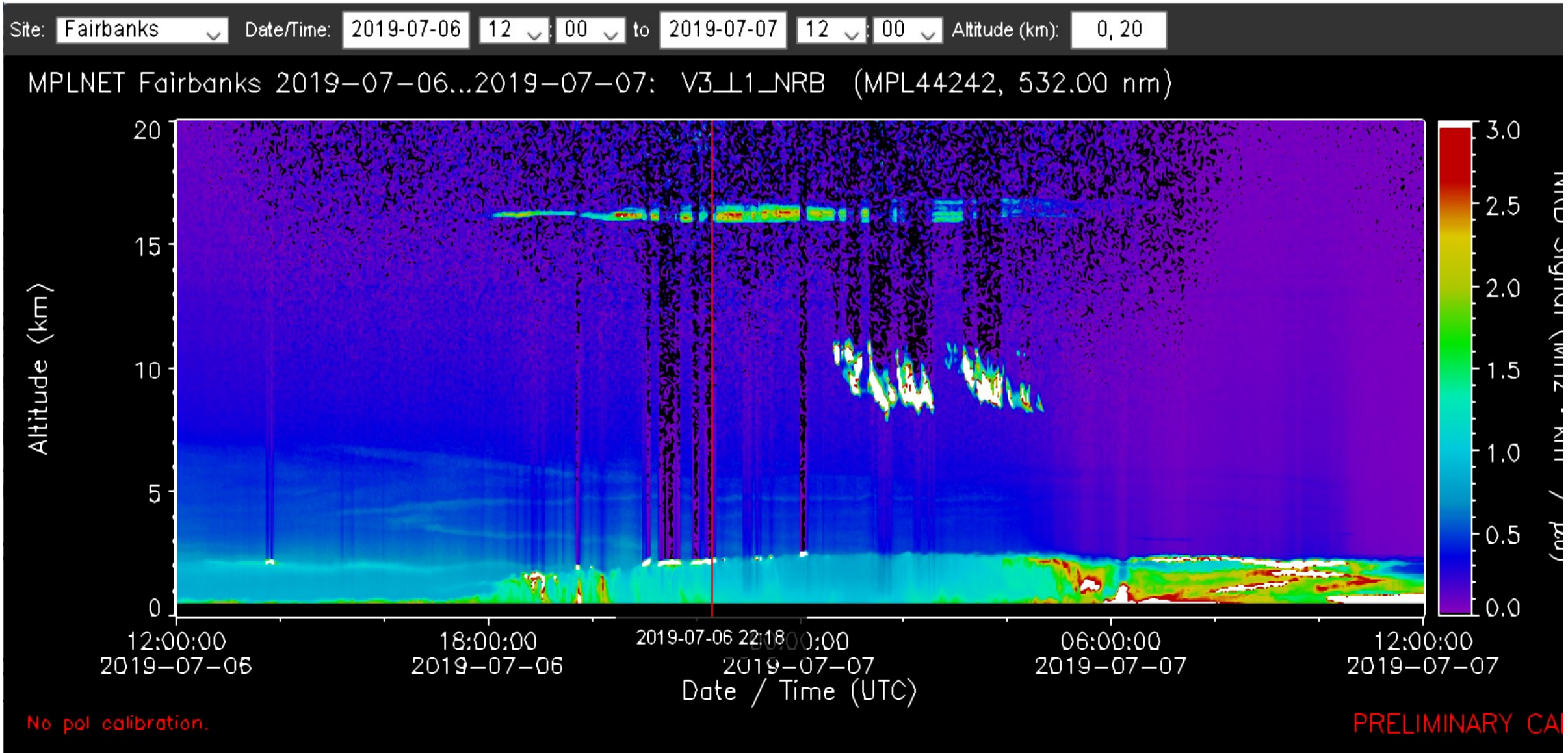
CMI (1)

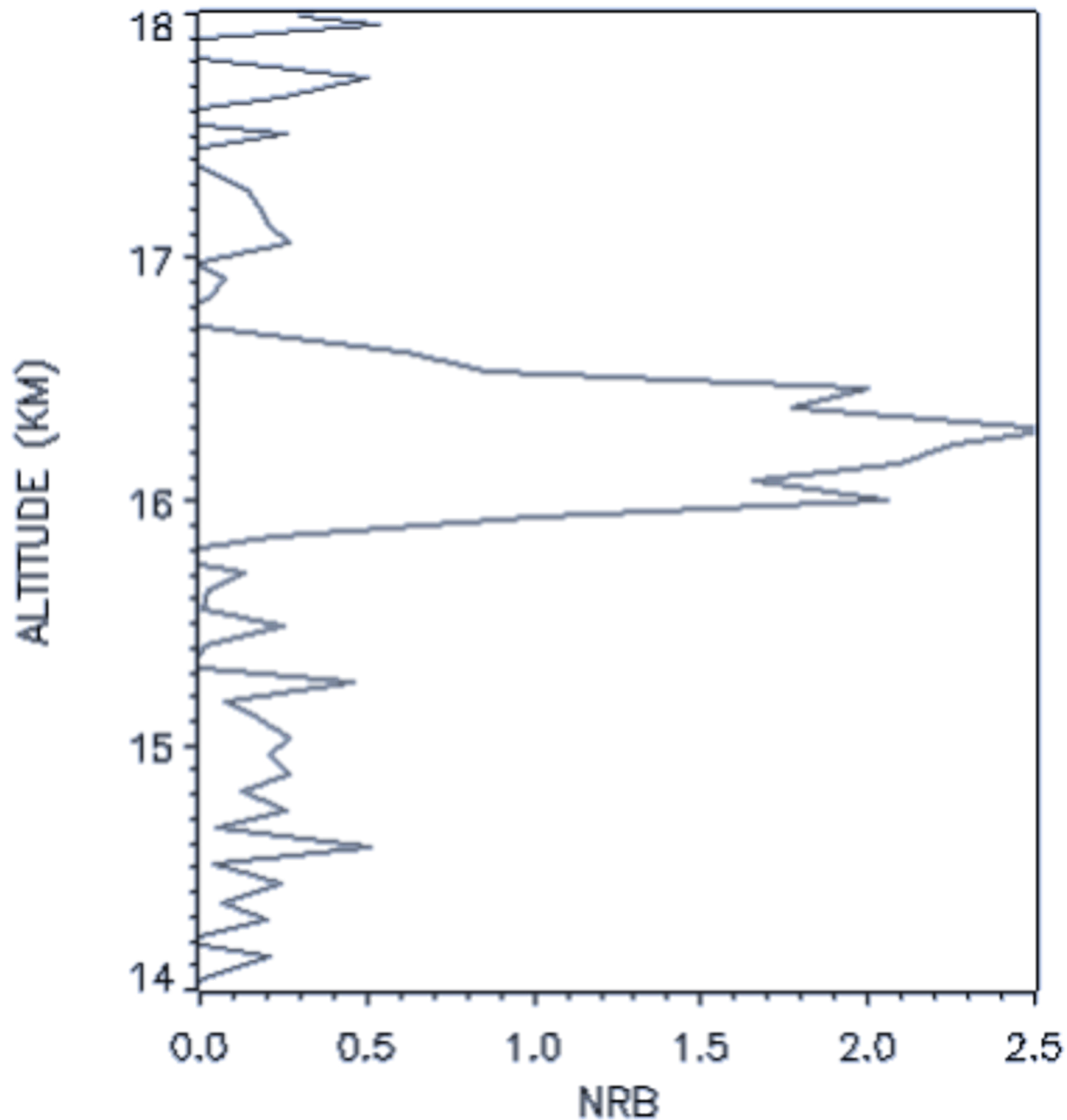
0.00 0.01 0.02 0.03 0.04 0.04





# Fairbanks lidar: 12 UTC 6 July – 12 UTC 7 July





**Fairbanks MicroPulse Lidar**

**Normalized Relative  
Backscatter.**

**00 UTC 7 July.**

**SSACC between 15.9-16.8 km.  
Peak backscatter ~16.4 km.**

# High-resolution radiosonde data from Fairbanks (PAFA)

**2 profiles:**

**1. 00z 7 July (SSACC)**

**2. 12z 7 July (post-SSACC)**

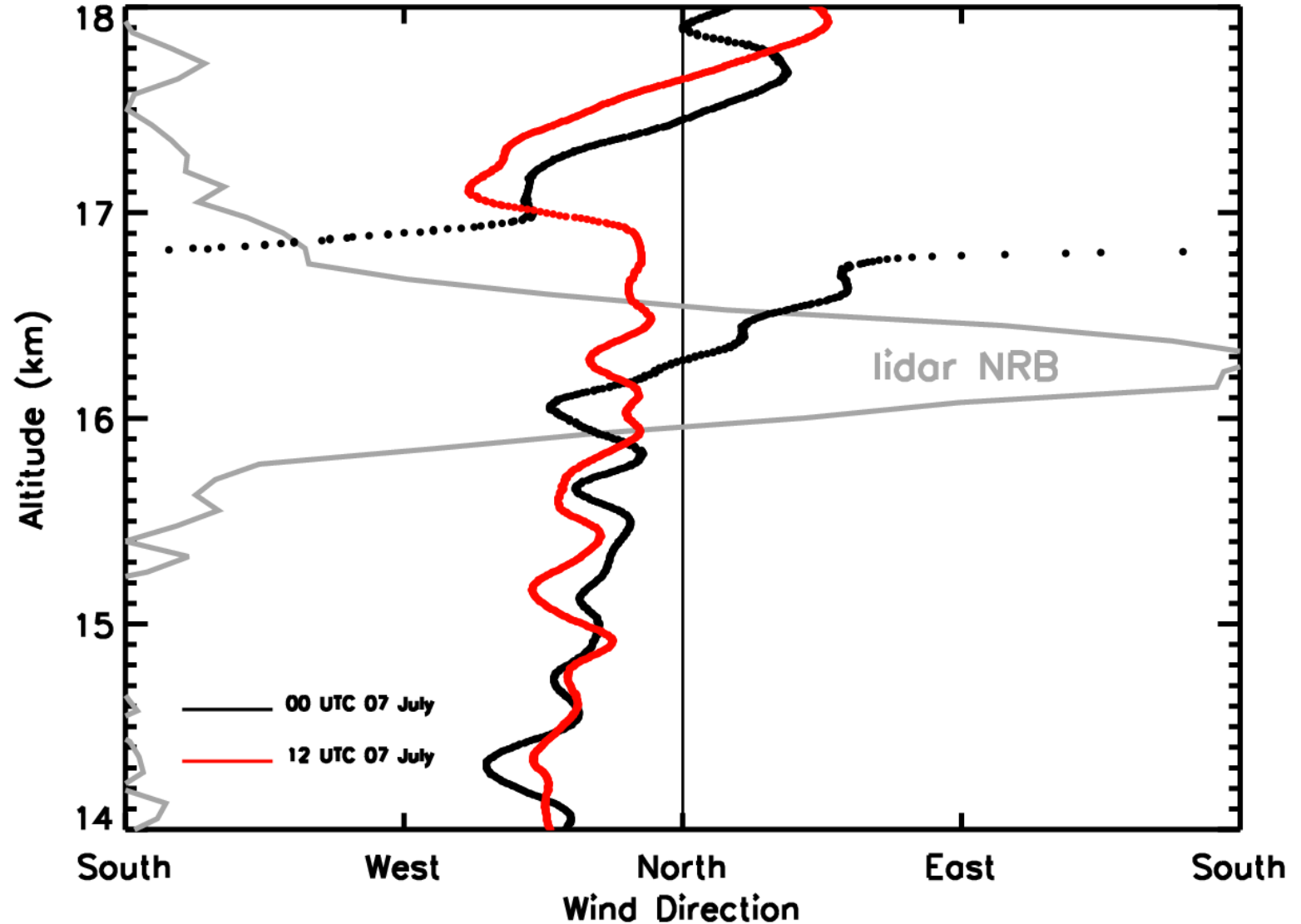
# RAOB Wind Direction Between 14-18 km

Mostly northwesterly  
up to 16 km.

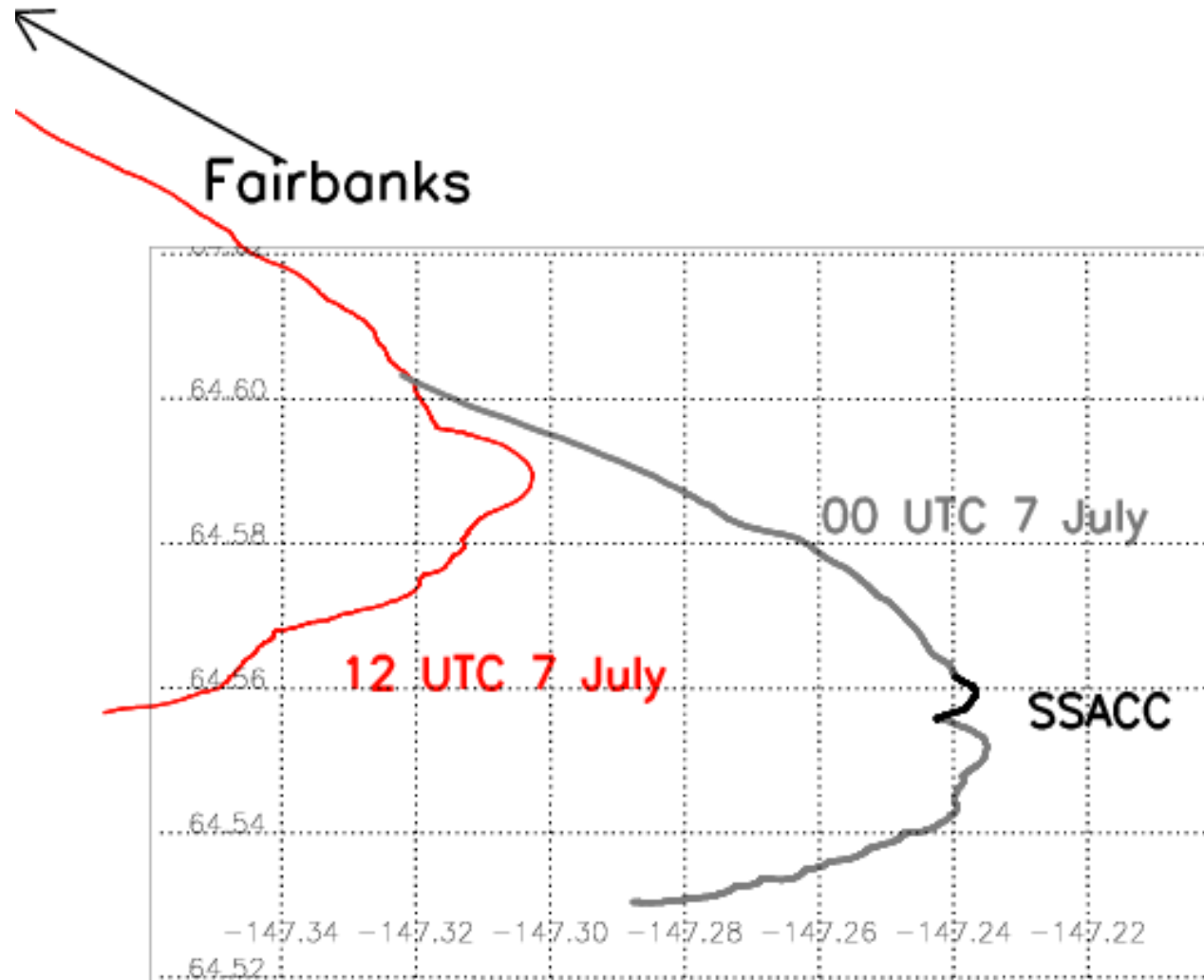
SSACC profile diverges  
significantly ~16-17km.

Complete 360° change.

Wind swings to NNE  
above SSACC.



# Zoom in on 00z 7 July GPS position. Balloon altitude: 12-20 km.



**Barrow: 1 day earlier**

PABR

5 July 23:50 UTC

OR\_ABI-L2-CMIPF-M6C04\_G17\_s20191862350339\_e20191862359406\_c20191862359454.nc (NetCDF file)

CMI (1)

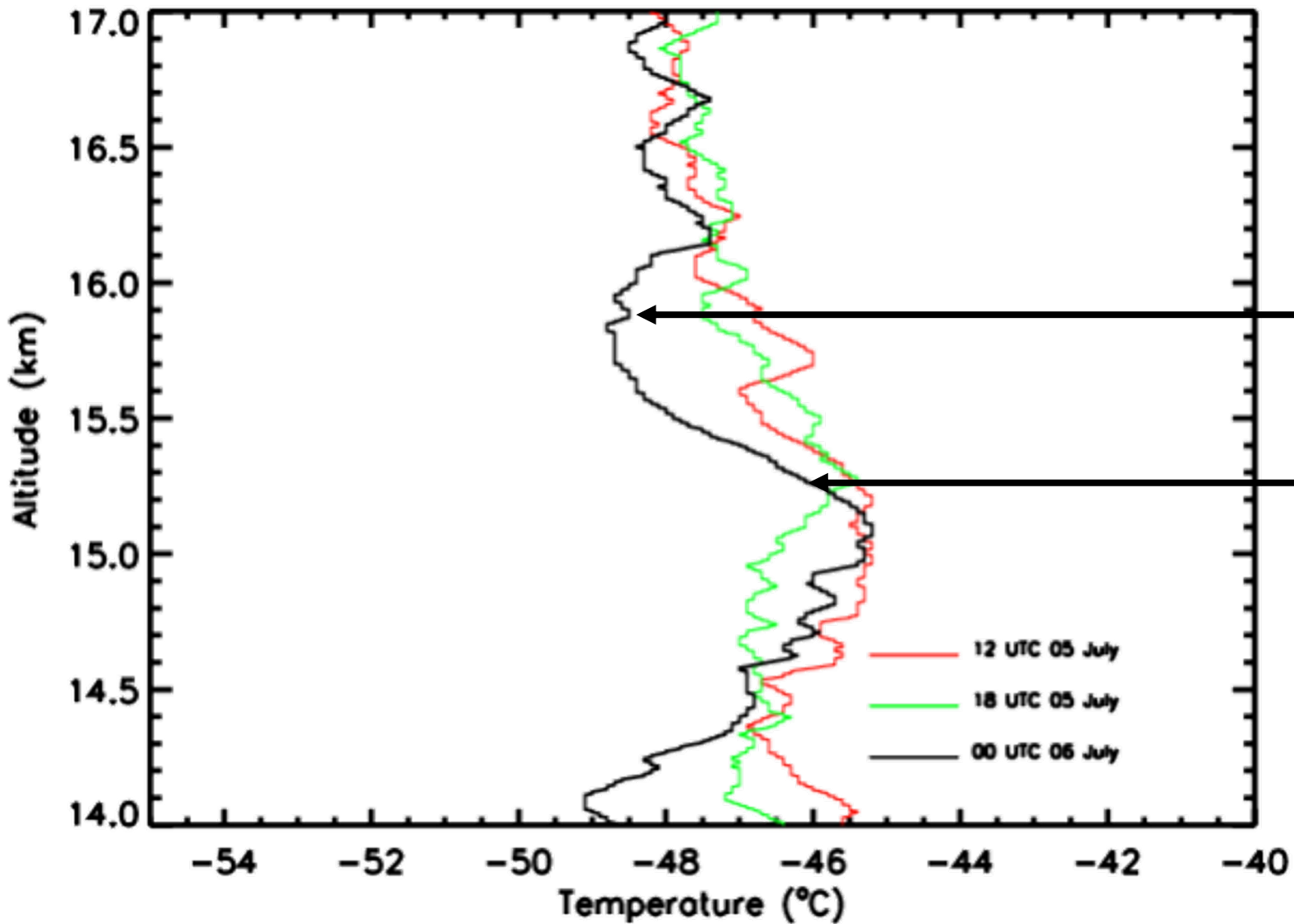
0.00 0.01 0.03 0.04 0.06 0.07







PABR 1-Second Radiosonde Temperature

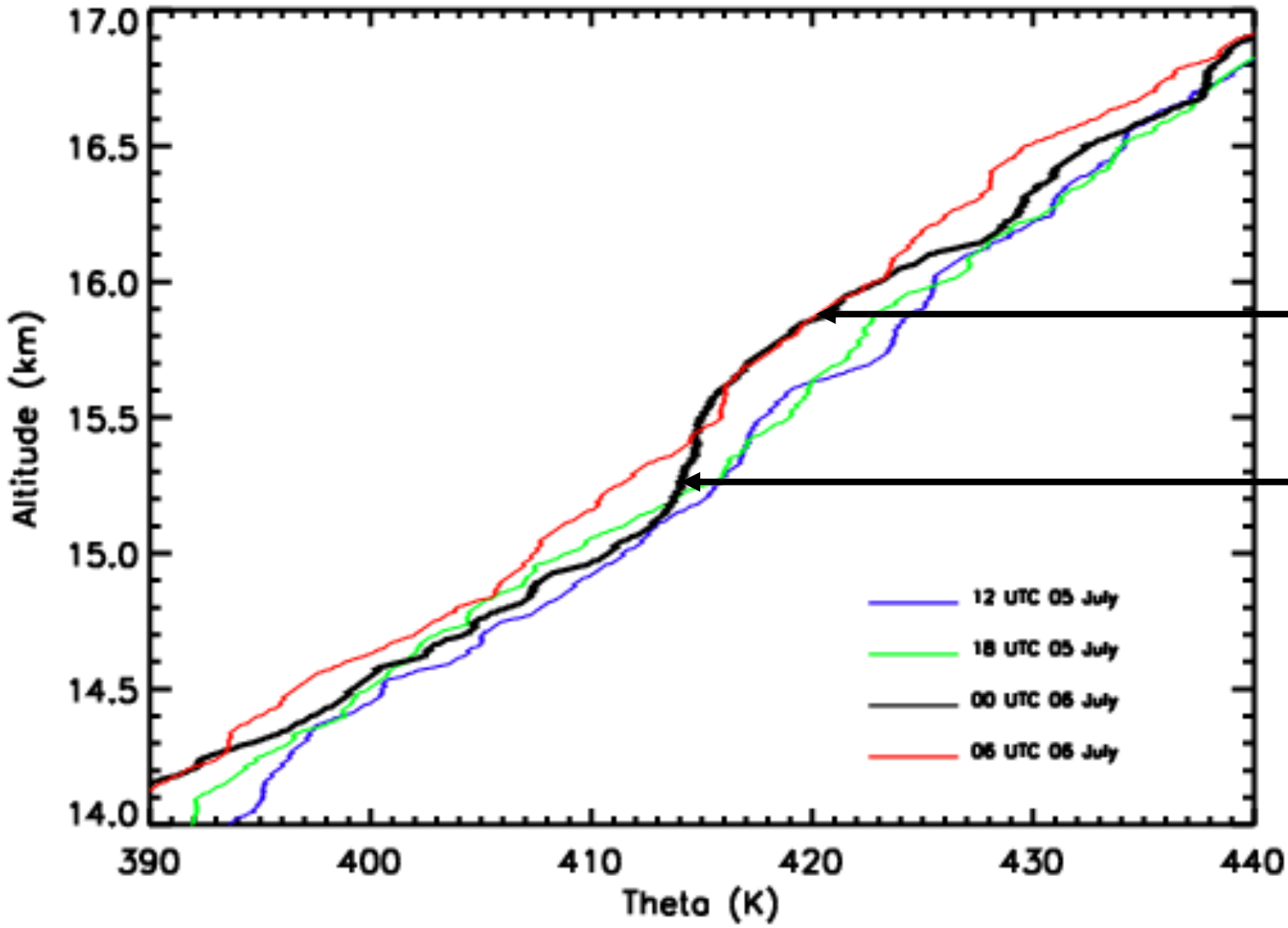


SL ALTITUDES (KM)

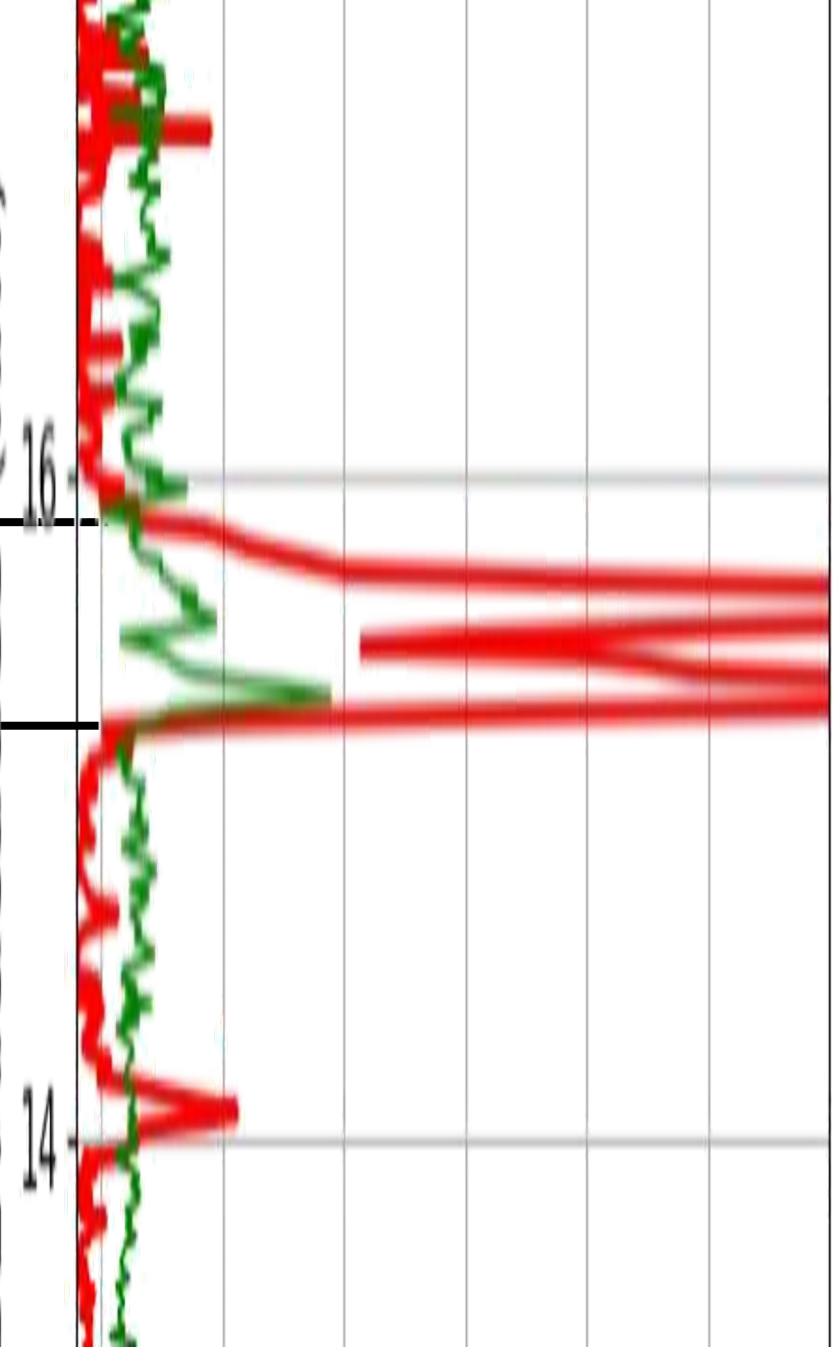
14

16

PABR 1-Second Radiosonde Theta



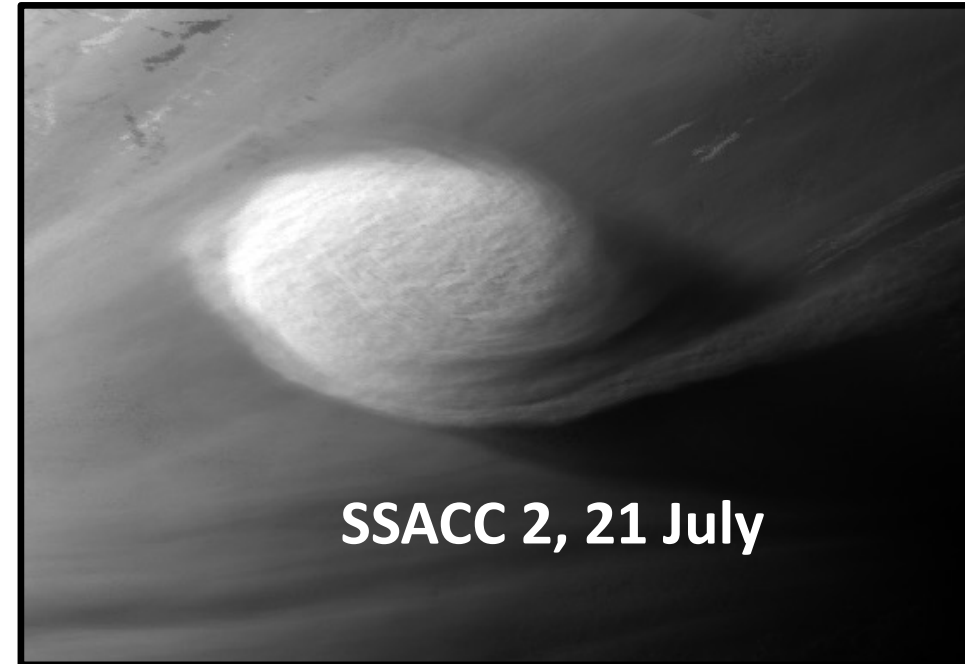
SL ALTITUDES (KM)



# Conclusions and Questions

- Raikoke SSACCs rose diabatically from 15-26 km (>250K)
- Anticyclonic circulations start as early as 25 June
- HR RAOBs deliver proof of plume circulation
- SSACC-related temperature perturbation

- ? How does this comport with historical volcanic clouds ?
- ? How well can models simulate Raikoke transport ?
- ? How do SSACCs and SWIRLS\* compare ?

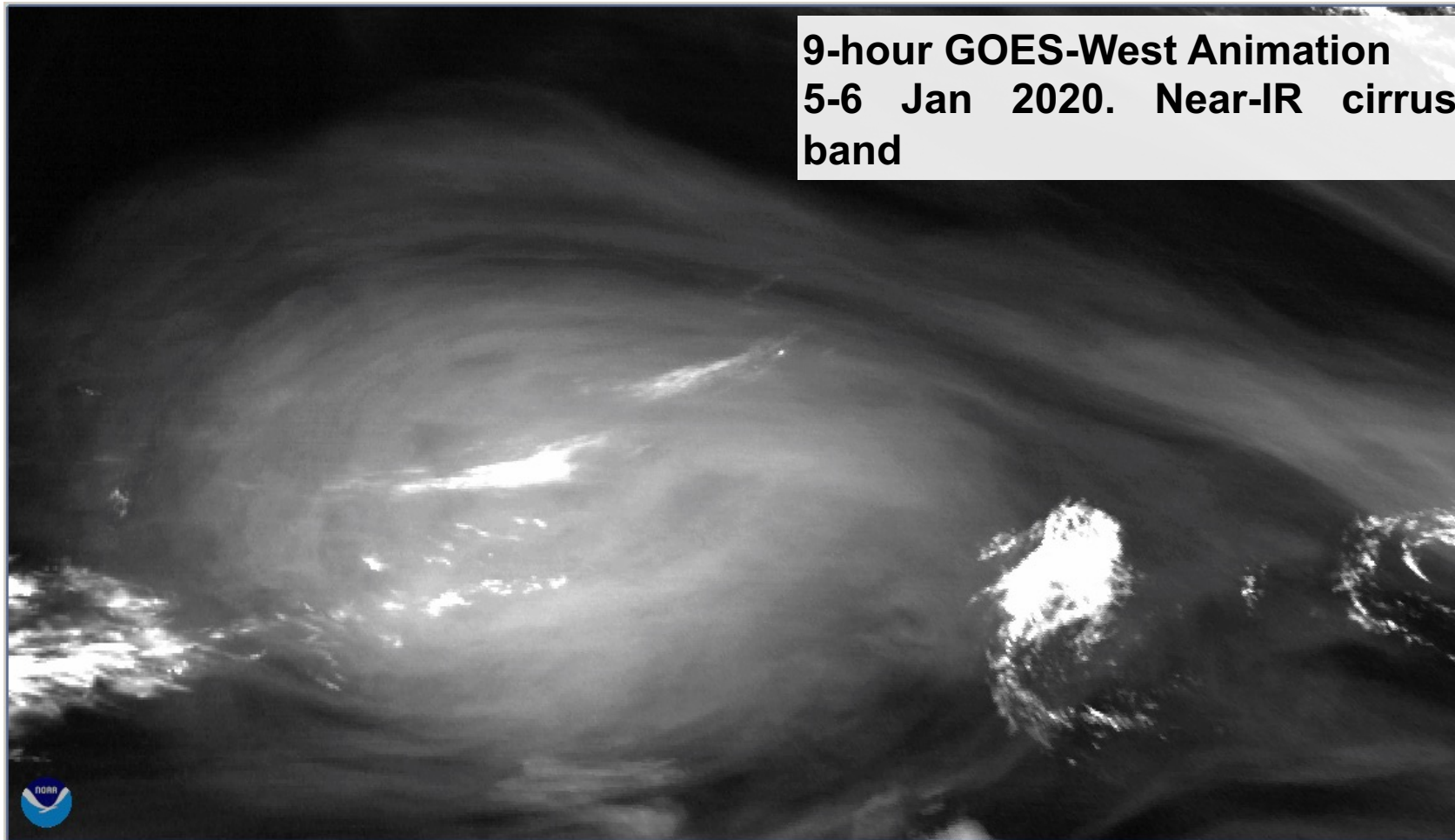


\* Smoke With Induced Rotation and Lofting

# Spinning Smoke: Australia pyroCb SWIRL

## Smoke With Induced Rotation & Lofting

South Pacific, 6 January 2020

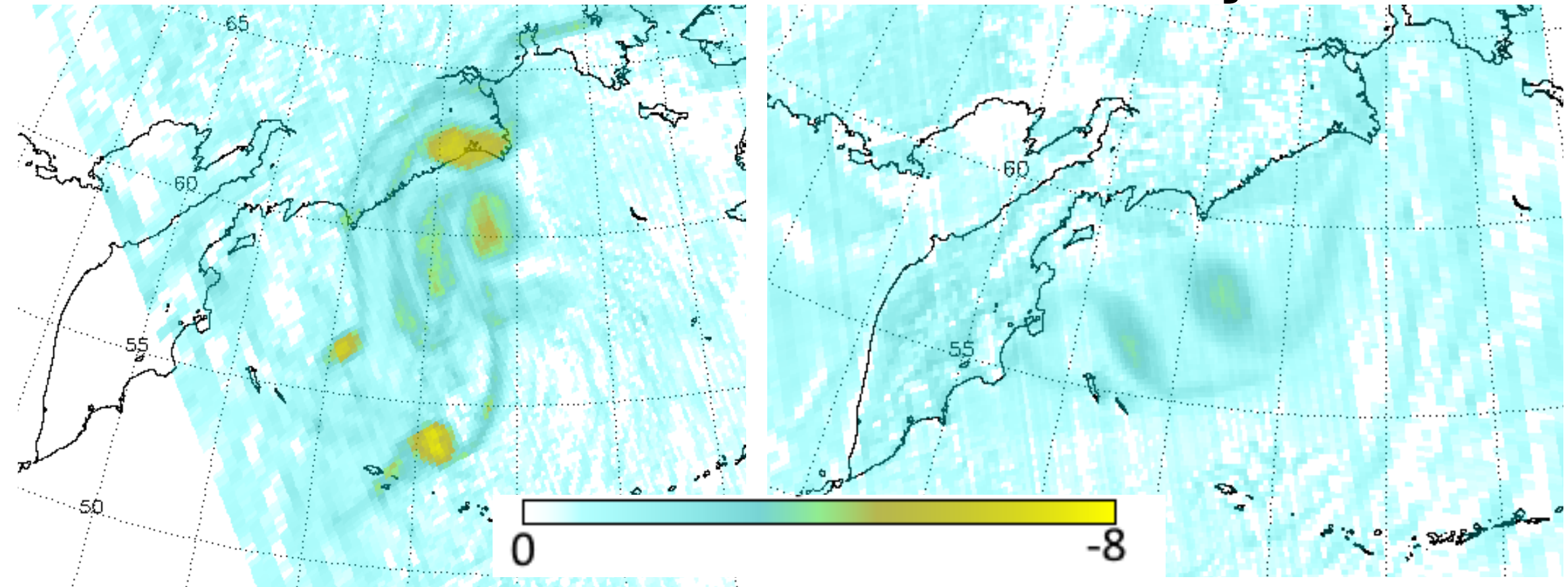


# Zooming in with OMPS UV Aerosol Index

- only negative values shown.
- Negative UVAI is a measure of scattering-aerosol optical depth

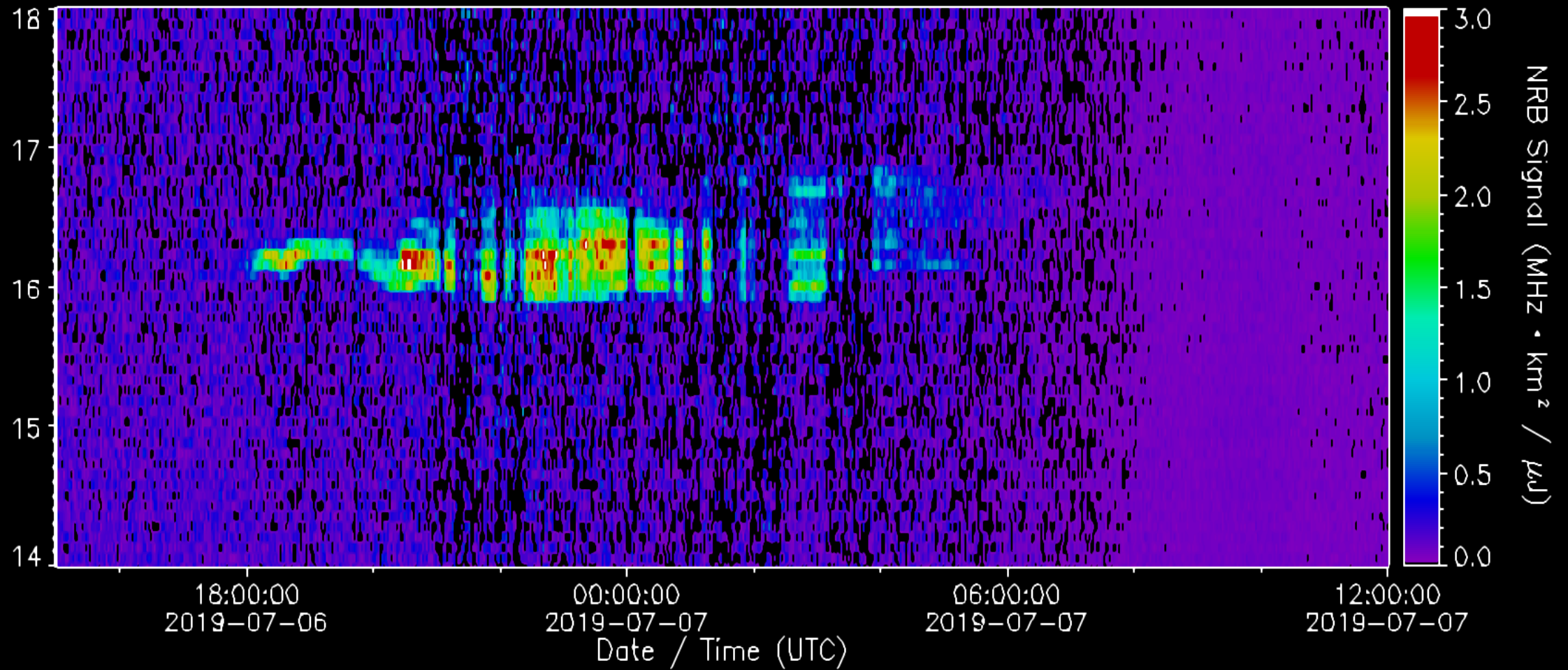
**25 June**

**3 July**



# Fairbanks MPL backscatter, 15z 6 July – 12z 7 July.

## SSACC in MPL beam between 18z 6 July and 6z 7 July



# **Plug 1 SSACC: Detailed lidar and radiosonde encounter**

Question: Does the balloon indicate any peculiar SSACC winds?

**Answer: Yes. From the upper portion of the plume to somewhat above, wind direction does a complete 360 deg. change.**

**The prevailing wind at plume altitude is NNW. This is also the case for just above and just below the plume. Going up, starting from about the middle altitude of the SSACC, winds rotate clockwise through the compass. The balloon traverses the SSACC in its southwestern quadrant. Local anticyclonic flow in this quadrant would nominally be a southeast wind. So the complete curl might make sense.**

# GOES West Ch 02 reflectance 21 July 2019, 0800z (twilight)

