

Ozone Depletion in Filaments of the Arctic Polar Vortex, Observed the First Global Hawk Science Mission

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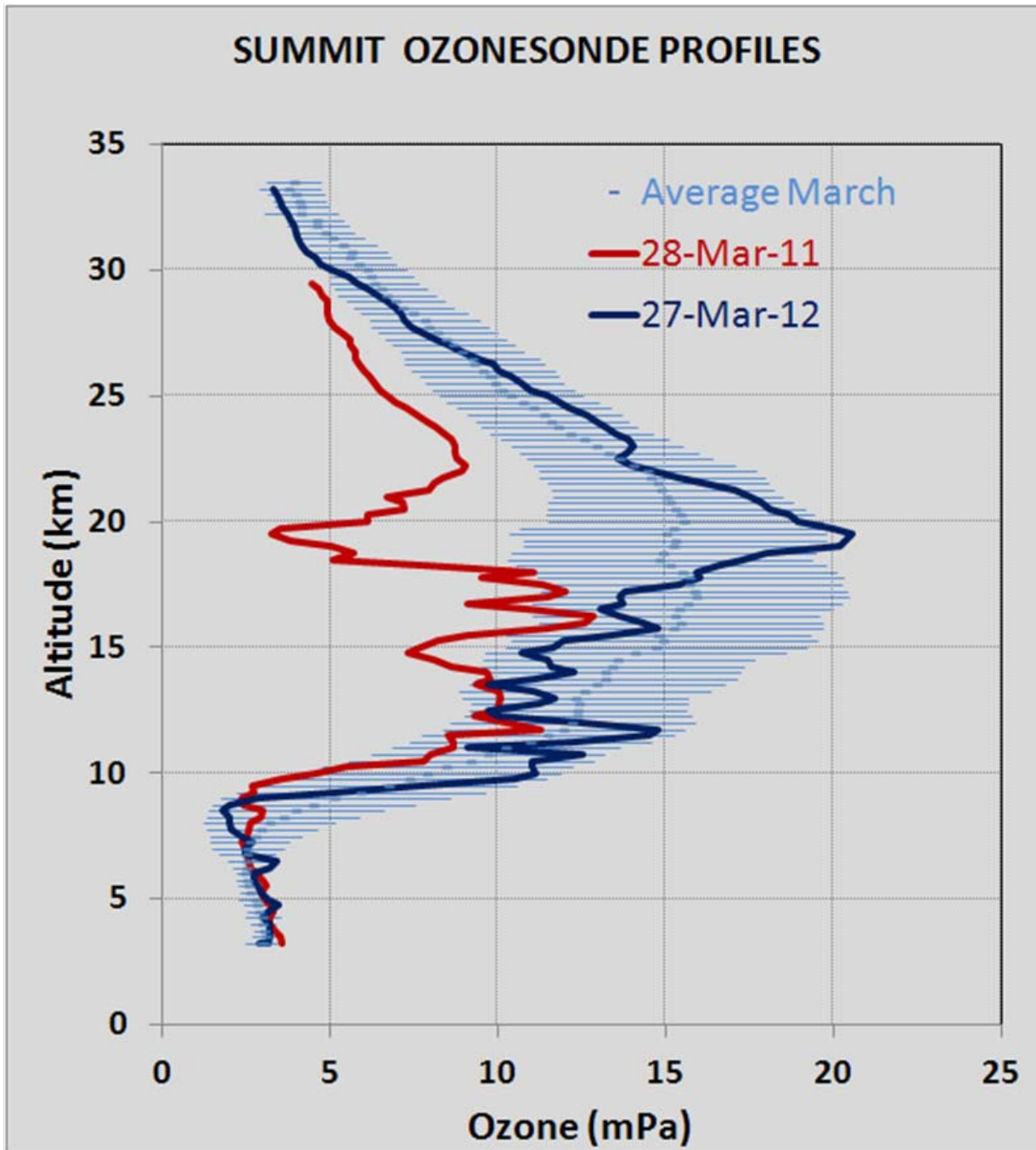
²CIRES, CU

³JPL

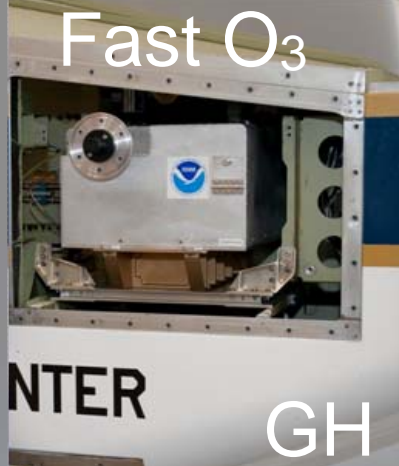
⁴NASA GSFC

⁵Harvard Univ.

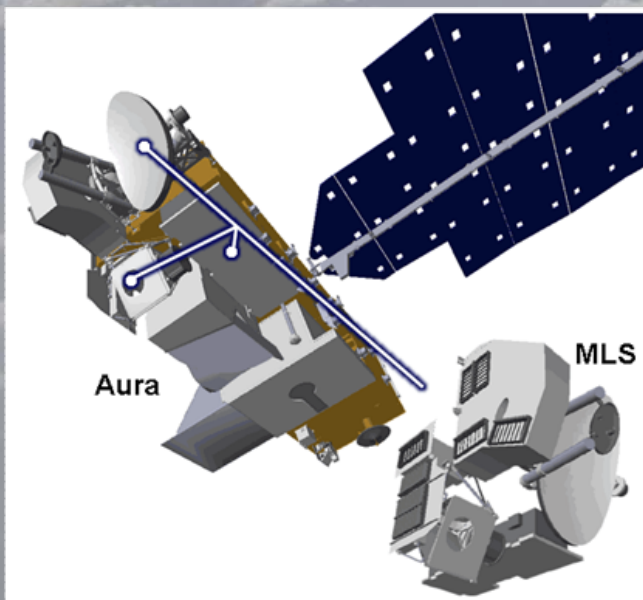
How can we measure polar O₃ loss? When it is not obvious as below?



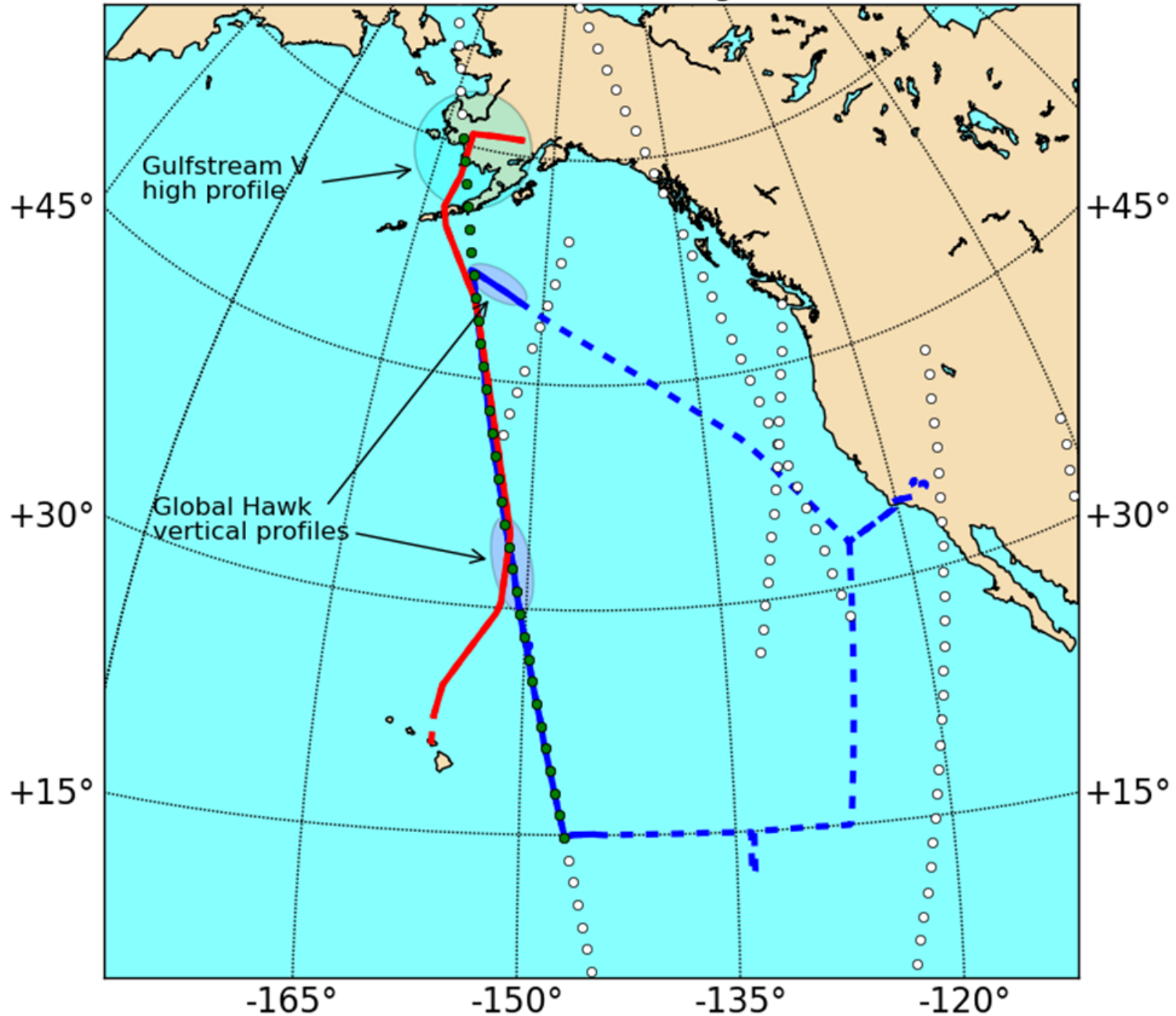
Unmanned Aircraft Systems (UAS), like Global Hawk, bridge the gap between ground based and satellite measurements.



How good are our UAS measurements?
Comparisons of Unmanned Global Hawk data vs
1. Manned NCAR HIAPER (Gulfstream-V).
2. MLS instrument on AURA satellite.

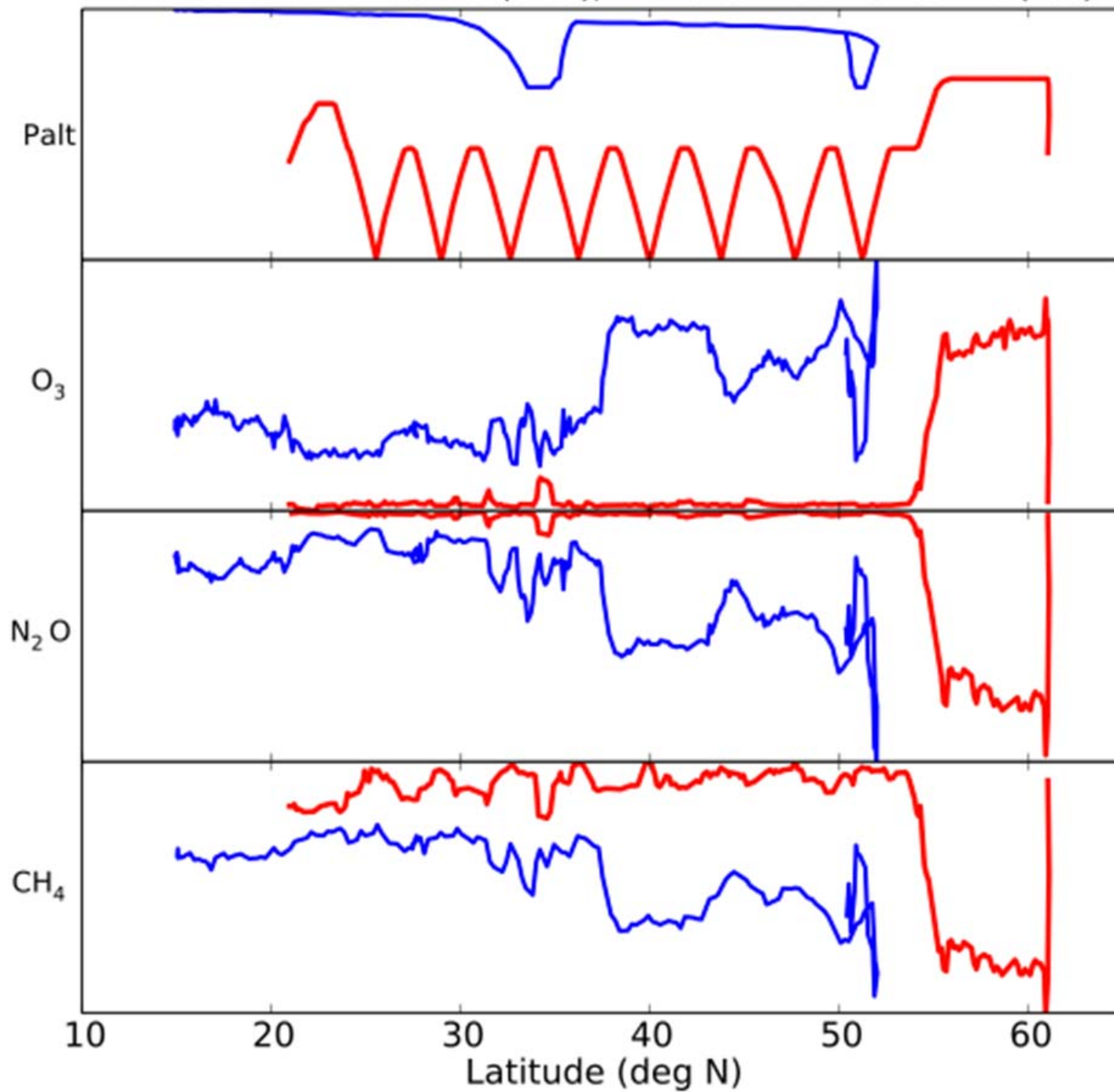


Aura-MLS Profile Locations from 2010-04-13,14 (circles)
with NASA Global Hawk track during GloPac RF02 (blue),
NSF/NCAR Gulfstream V track during HIPPO-3 RF09 (red)



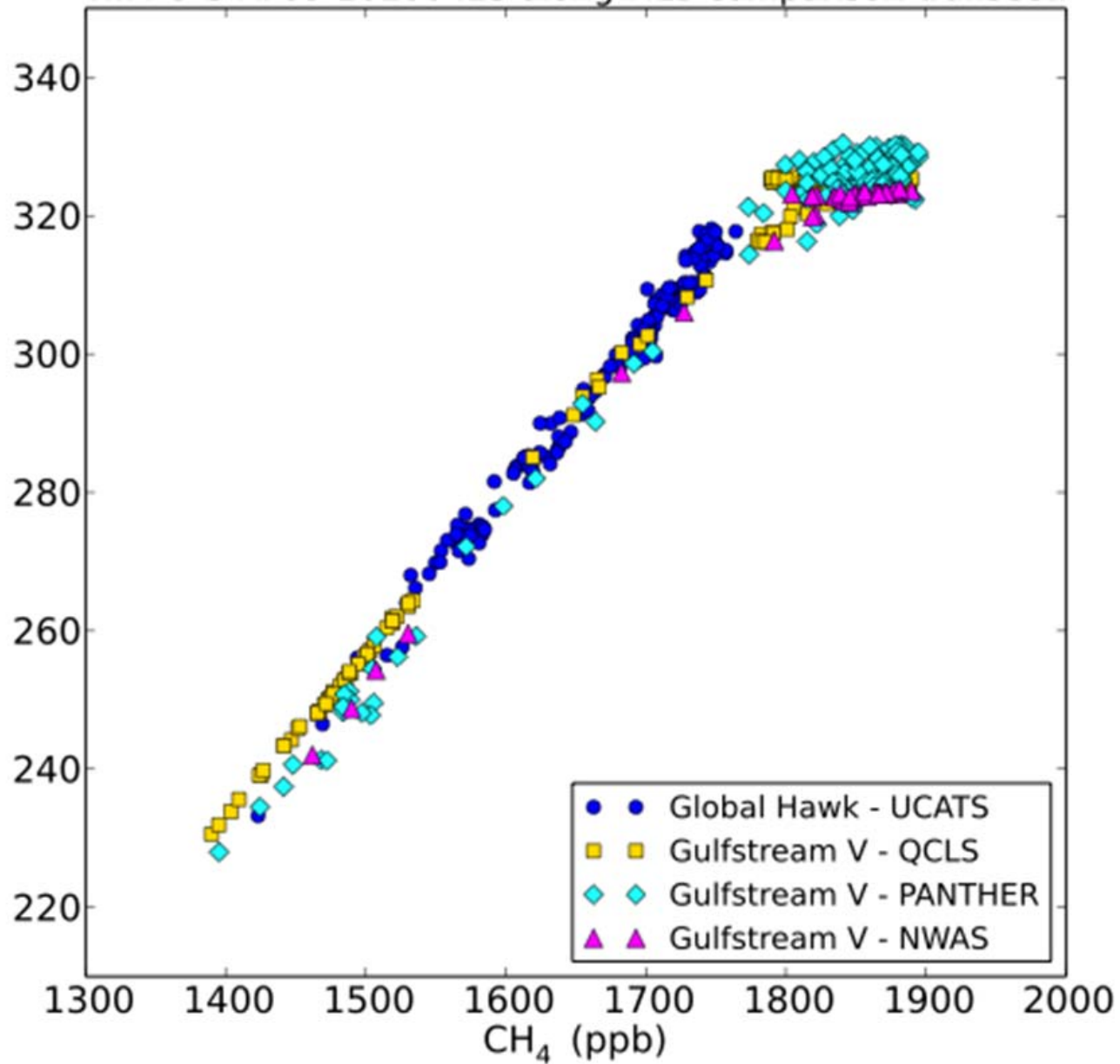
Aura pre-selection criteria: within 600 nmi, 6 hours of aircraft
Comparison transect highlighted green (MLS), solid (aircraft)

Aircraft data along MLS Comparison Transect
GloPac RF02-20100413 (blue), HIPPO-3 RF09-20100413 (red)



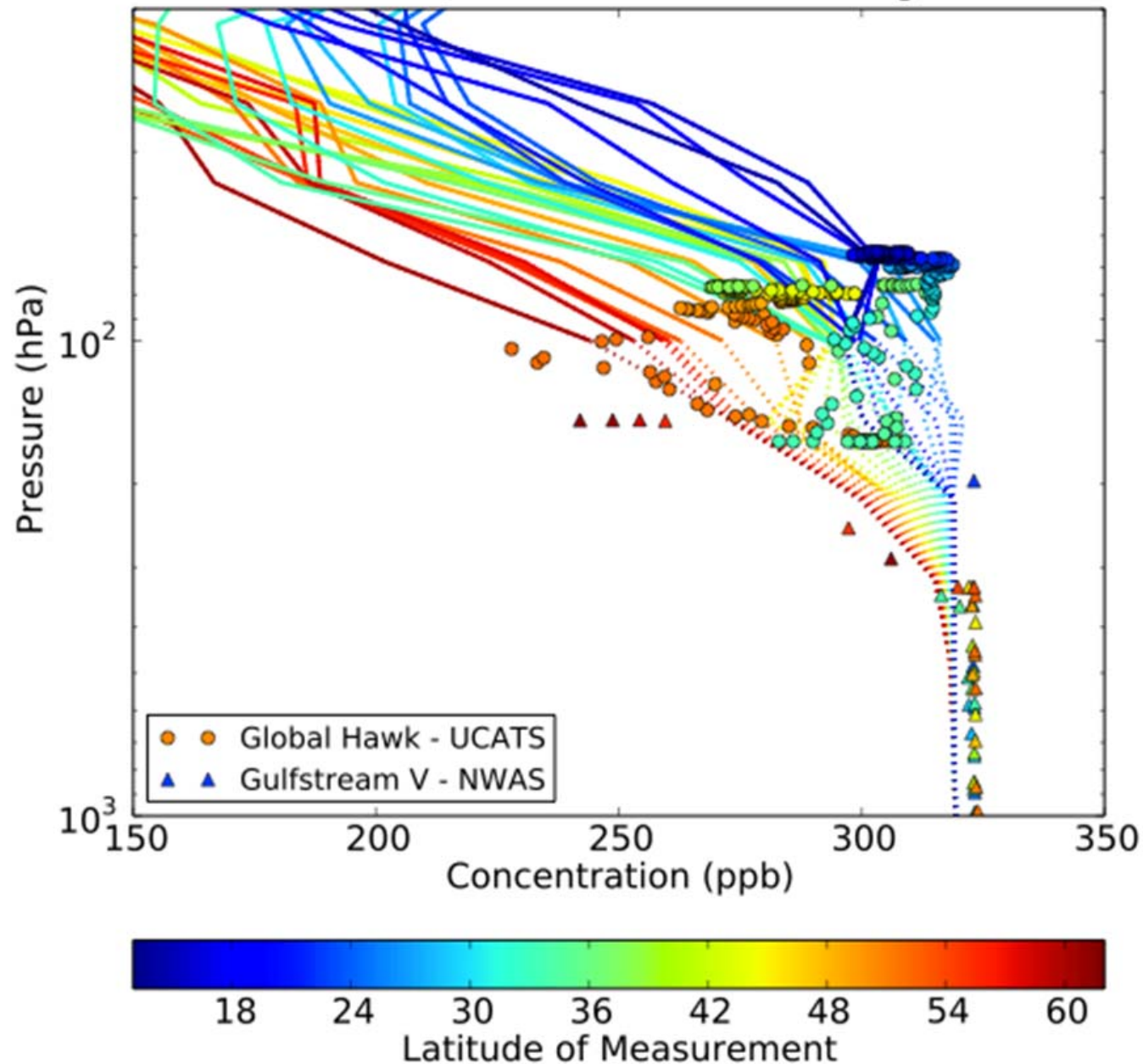
N₂O vs CH₄

Aircraft data from GloPac RF02-20100413 and
HIPPO-3 RF09-20100413 along MLS comparison transect.

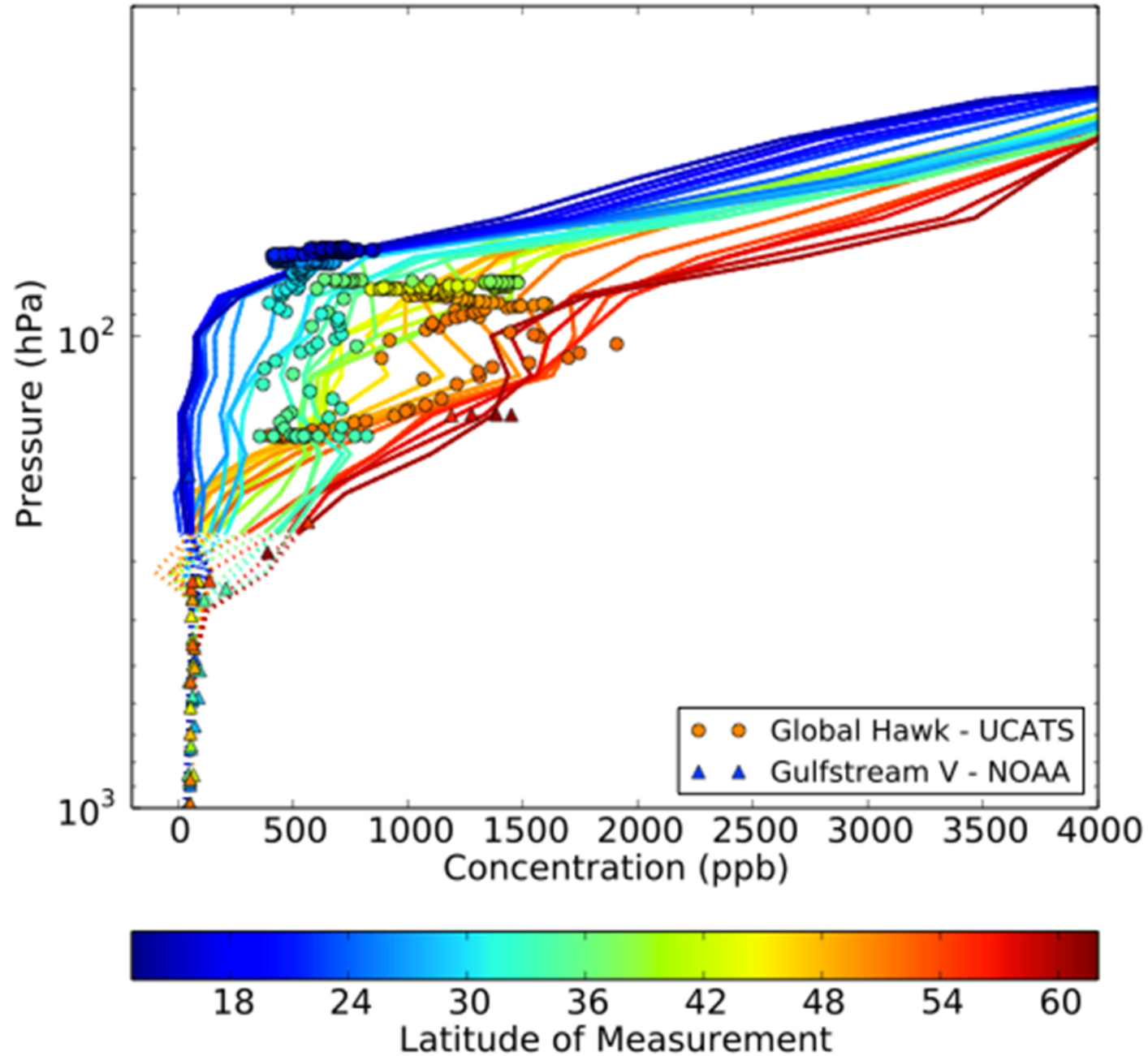


(1 Hz QCLS data presented as 1-minute averages)

Selected Aura-MLS N_2O Profiles from 2010-04-14 (Hour 0)
with N_2O measured from nearby NASA Global Hawk during
GloPac RF02 and NSF/NCAR Gulfstream V during HIPPO-3 RF09

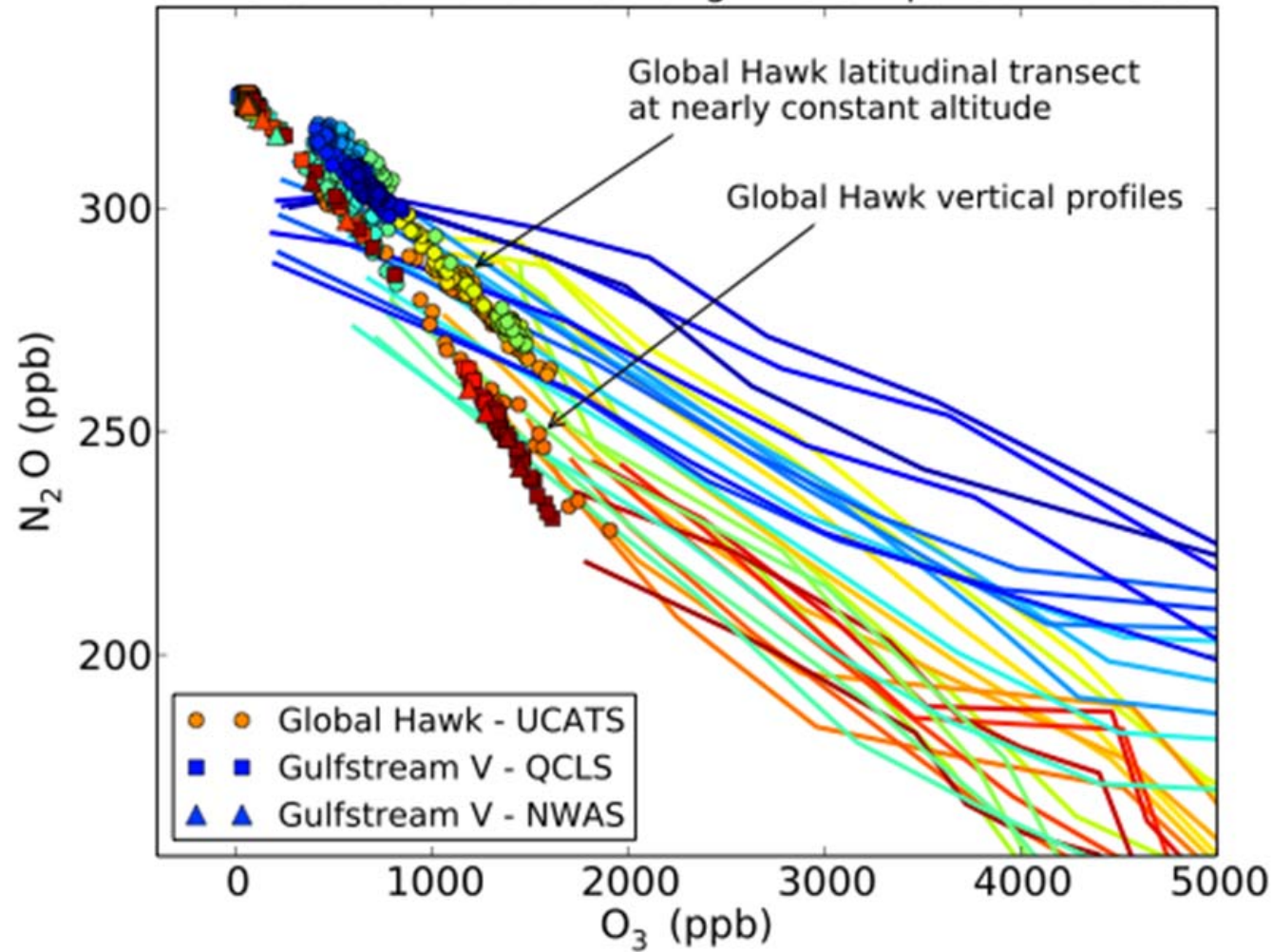


Selected Aura-MLS O₃ Profiles from 2010-04-14 (Hour 0)
with O₃ measured from nearby NASA Global Hawk during
GloPac RF02 and NSF/NCAR Gulfstream V during HIPPO-3 RF09



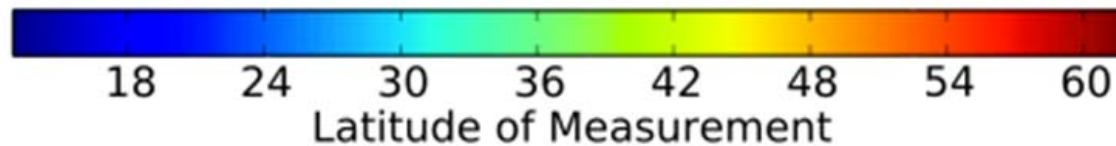
N_2O vs O_3

From selected MLS profiles (2010-04-14, hour 0)
and Aircraft data from GloPac RF02-20100413 and
HIPPO-3 RF09-20100413 along MLS comparison transect.



- Global Hawk - UCATS
- Gulfstream V - QCLS
- ▲ Gulfstream V - NWAS

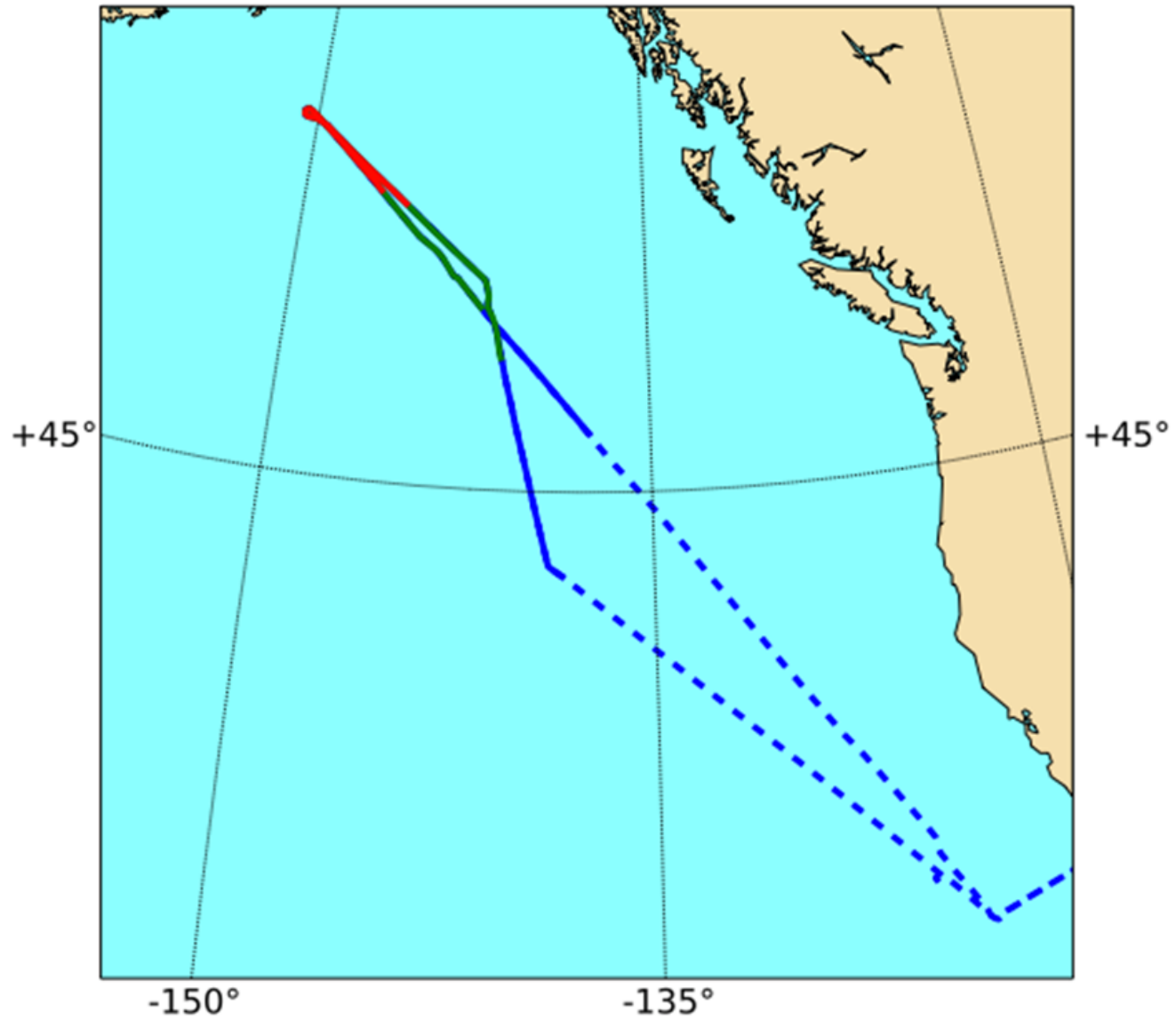
(1 Hz QCLS data presented as 1-minute averages)





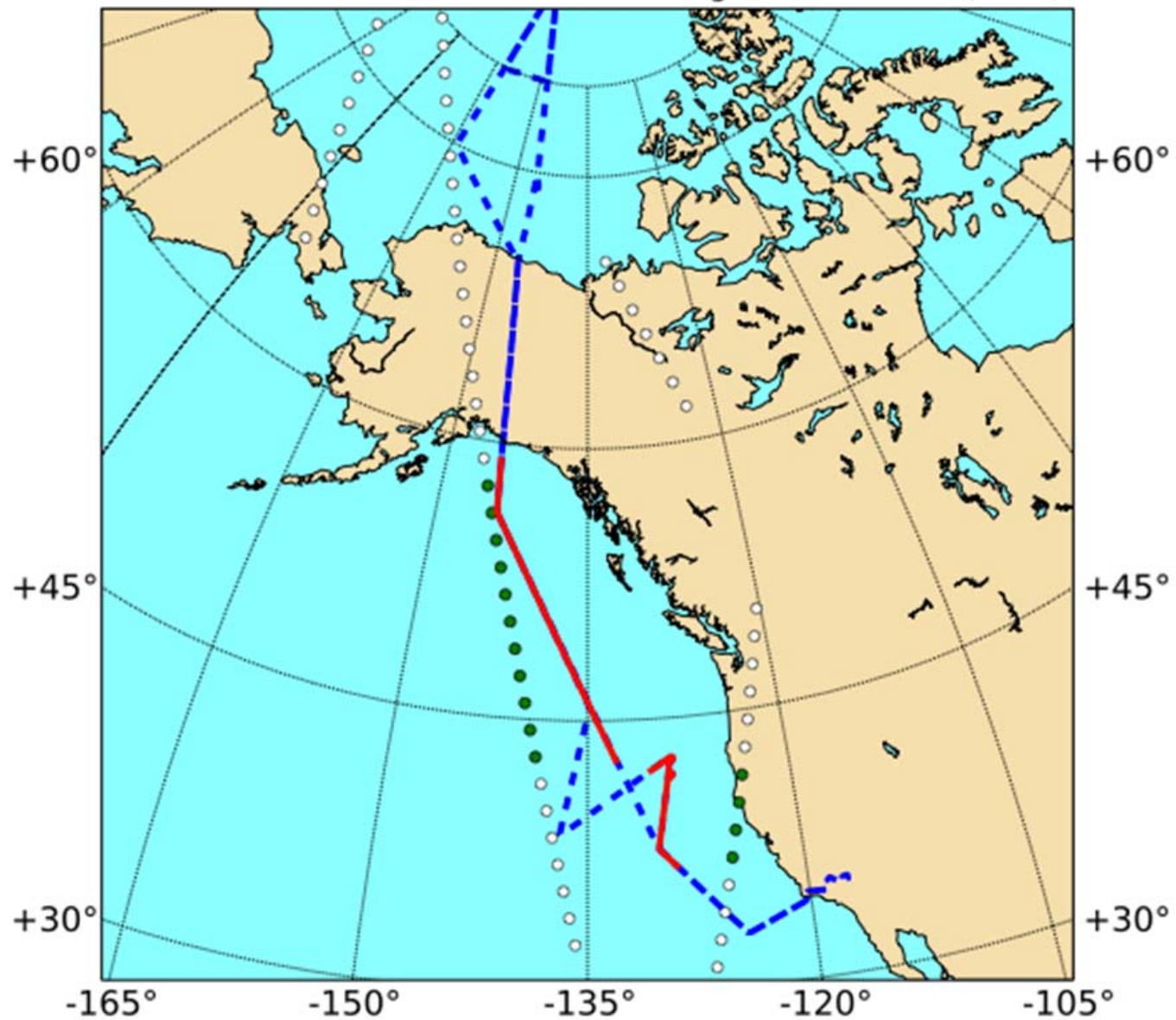
Ozone loss observed on 7 May

NASA Global Hawk track during GloPac RF01-20100407

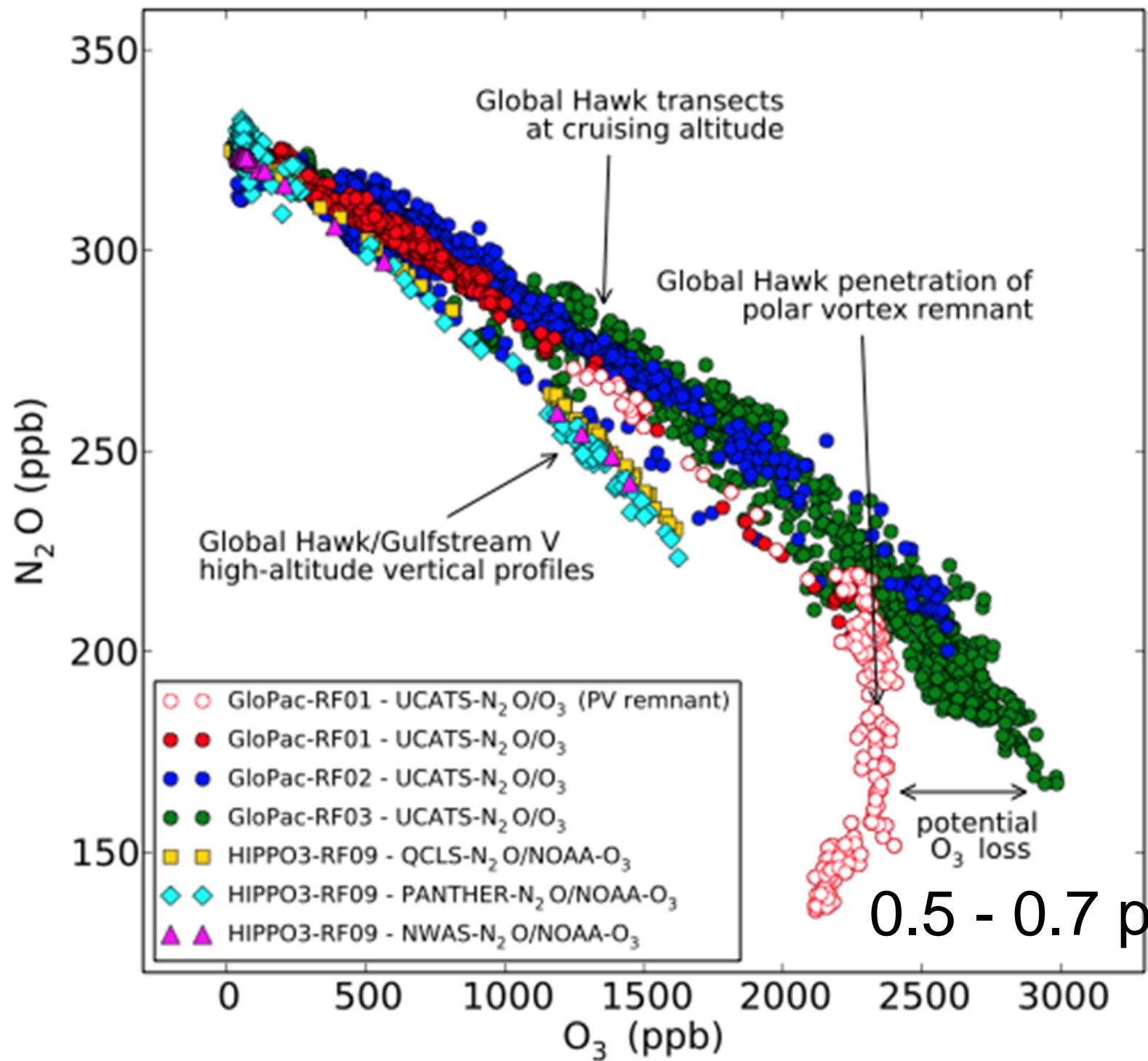


Region of stratospheric penetration highlighted solid.
Ozone-depleted stratospheric region highlighted green, red.

Aura-MLS Profile Locations from 2010-04-23,24 (circles)
with NASA Global Hawk track during GloPac RF03 (blue)

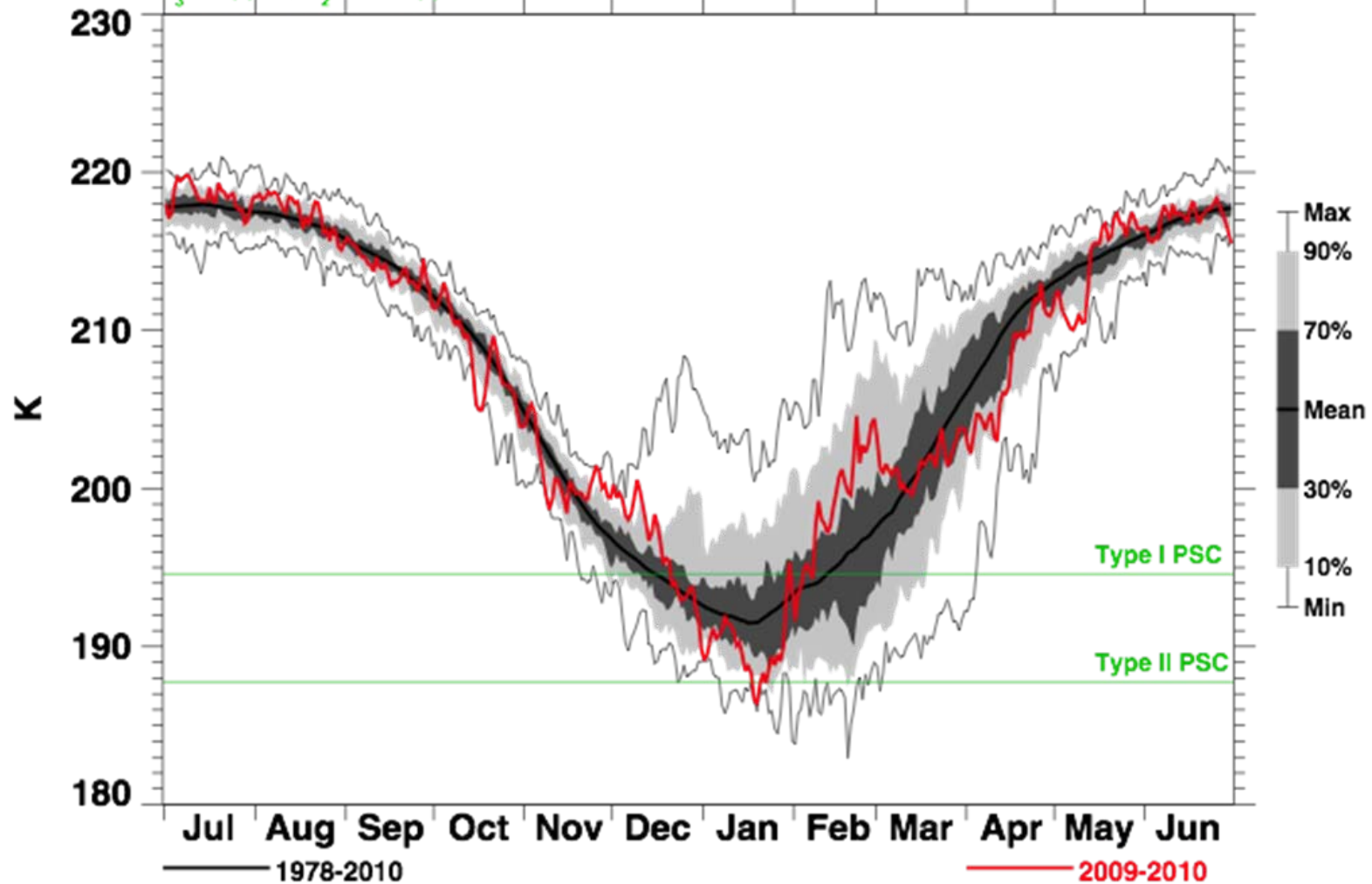


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Comparison transect highlighted green (MLS), solid red (aircraft)



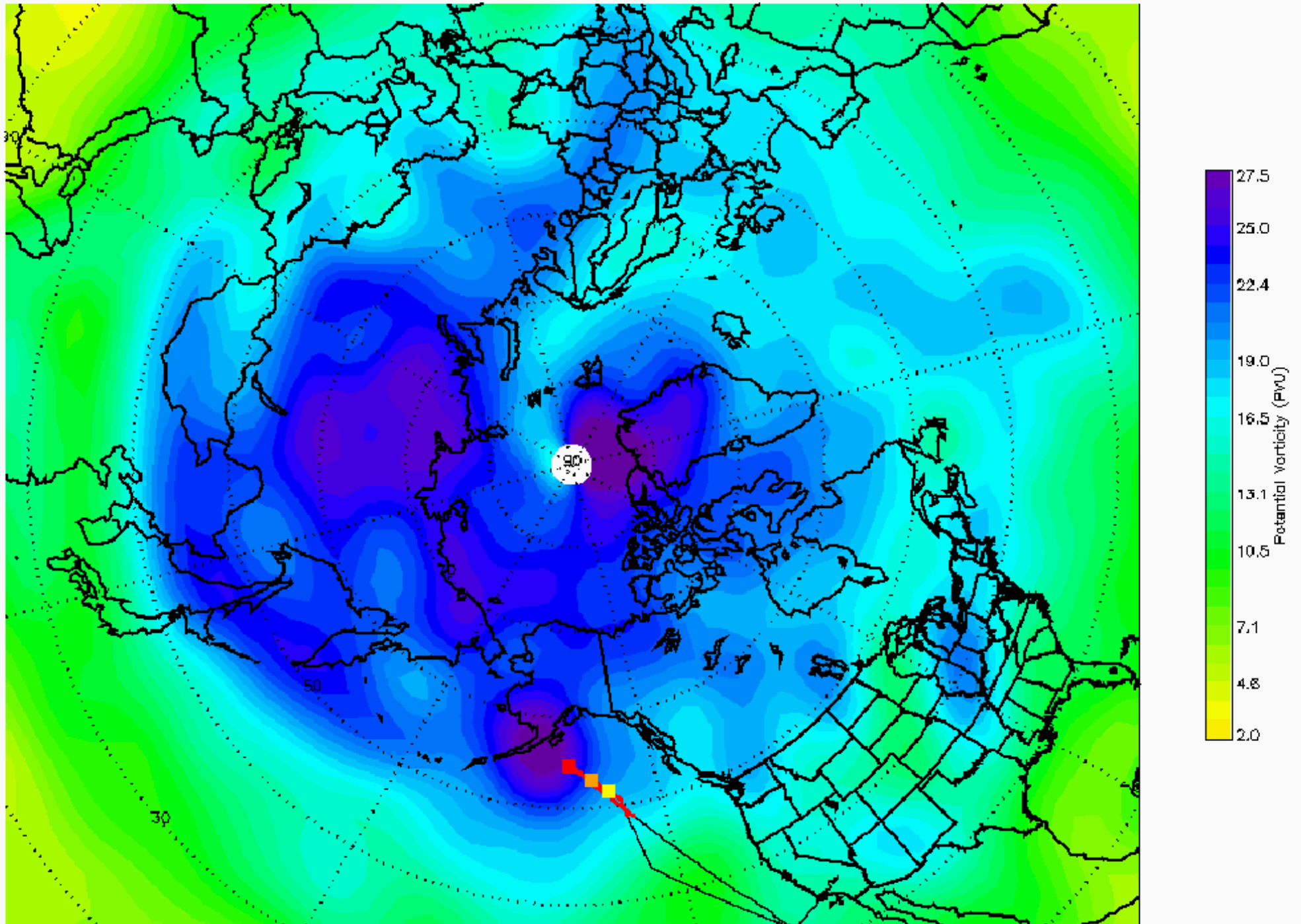
50-90°N Minimum Temperature 50 hPa MERRA

$\text{HNO}_3 = 6 \text{ ppbv}$, $\text{H}_2\text{O} = 4.5 \text{ ppmv}$

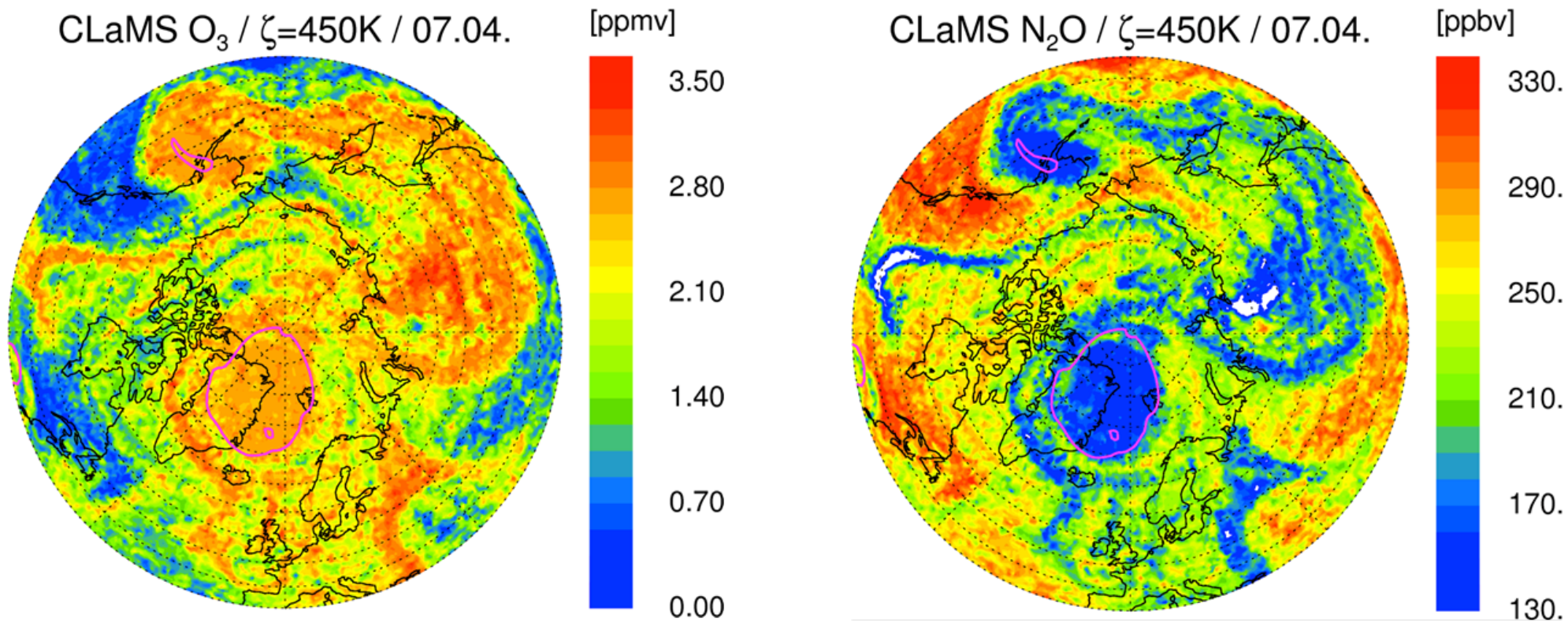


P. Newman (NASA), E. Nash (SSAI), S. Pawson (NASA)

NCEP reanalysis Daily Mean Potential Vorticity
Press = 70. hPa 20100407



CLaMS Model Simulation for 7 April 2010 (450K ~ 17 km)

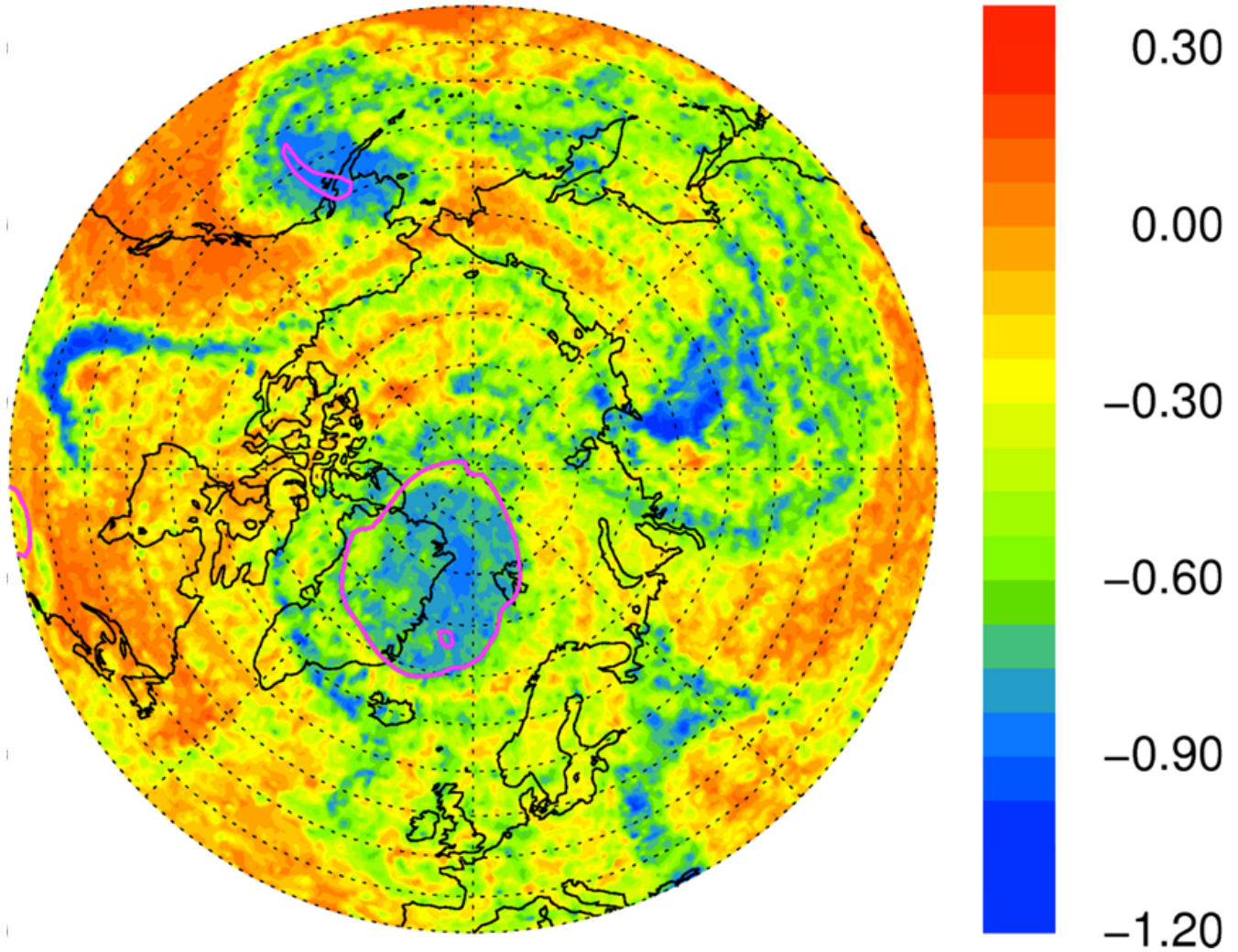


Courtesy of Jens-Uwe Grooss, Forschungszentrum Juelich

CLaMS Accumulated Ozone Loss since 1 Dec 2009

ΔO_3 (accum.) / $\zeta=450K$ / 07.04.

[ppmv]



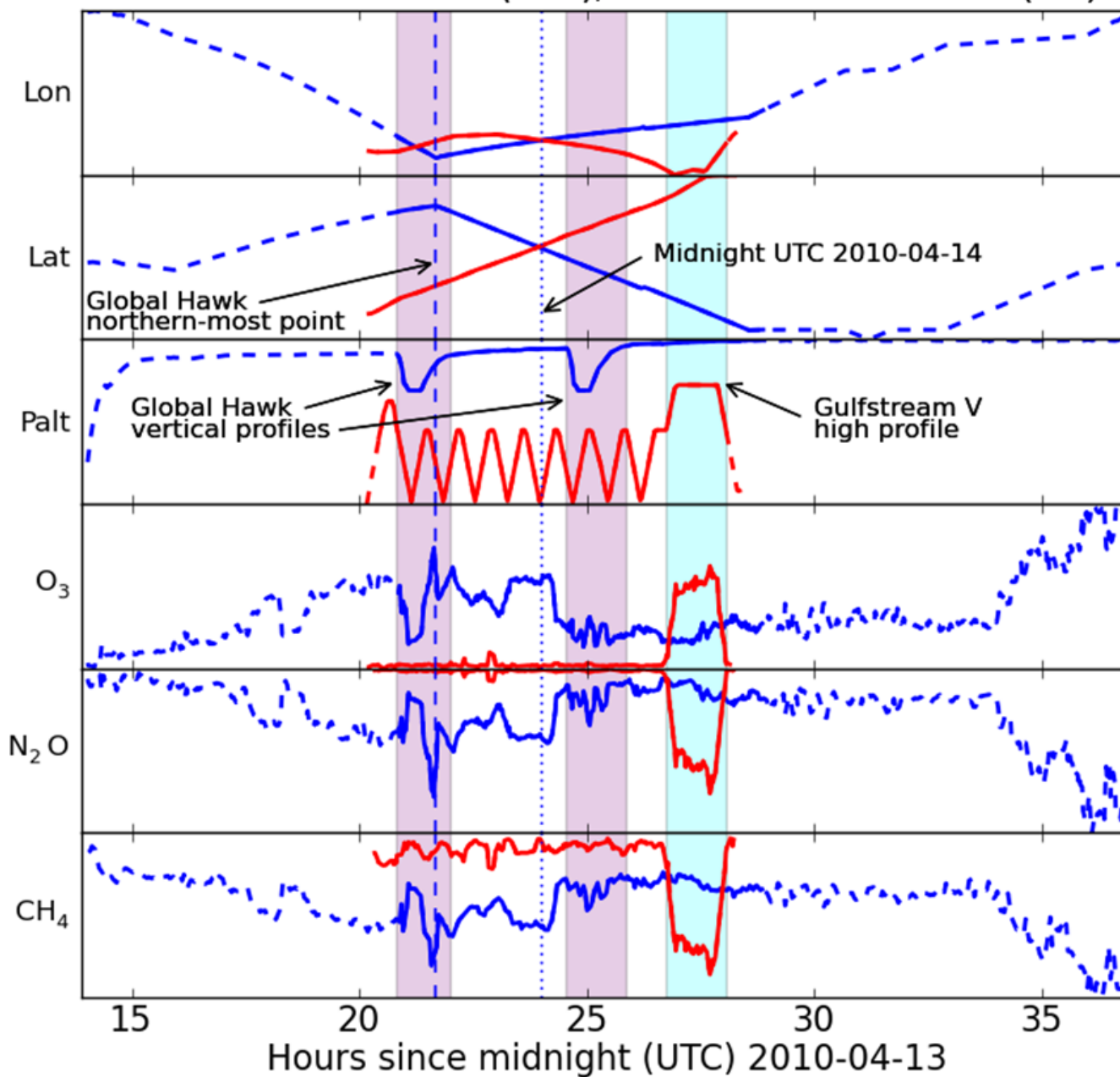
Conclusions

- Overflight of the Global Hawk over the GV during HIPPO/3 produced similar tracer-tracer relationships with structure.
- There was a good agreement of common tracers from different instruments on two aircraft and one satellite instrument.
- Breakup of the polar vortex with low ozone during HIPPO/3 and GloPac was observed in filaments.
- Agreement of ozone loss between ozone loss and model simulation.

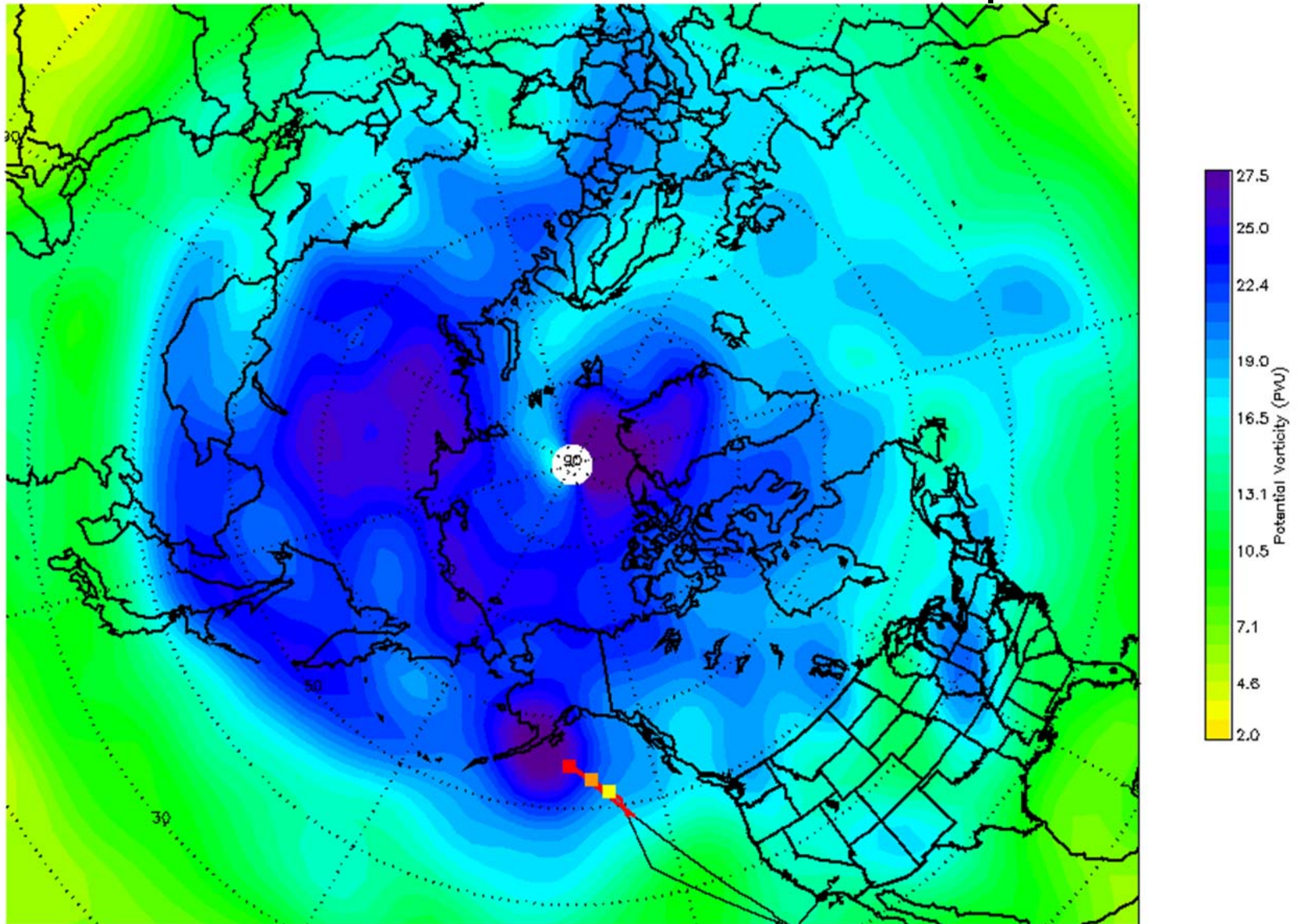
Extras

Aircraft Time Series Data

GloPac RF02-20100413 (blue), HIPPO-3 RF09-20100413 (red)



Comparison transect highlighted solid.



12 March 2010

NCEP reanalysis Daily Mean Potential Vorticity
Press = 70. hPa 20100312

