# Cloud Physics Lidar on the Global Hawk

## HS3 Science Team Meeting
## NASA/Ames
## April 29-May 01, 2014


**Matthew McGill / GSFC**
**Dennis Hlavka / SSAI**
**Andrew Kupchock/ SSAI**
**Steve Palm / SSAI**
**Patrick Selmer / SSAI**
**Bill Hart / SSAI**



# Global Hawk CPL Data Products

## cpl.gsfc.nasa.gov/hs3_2013/hs3_2013_enter.htm

***Status of Data Products for HS3_13:***

- **Data processing is complete, with images and text files available on the web.**
- **Global Hawk flights are broken up into ~ 6hr segments for processing, with product files created for each.**
- **The NRB and OP binary files containing backscatter profiles, layer locations, and optical properties can be ordered from the web (at the bottom of each flight segment page).**
- **HDF5 files for attenuated total backscatter (ATB) and optical properties (OP) can be pulled from the Marshall Space Flight Center Archive FTP server or ordered from our web site.**
- **Data products are 1 second averages (~170 m horizontal X 30 m vertical) produced from the raw 10 hertz data.**

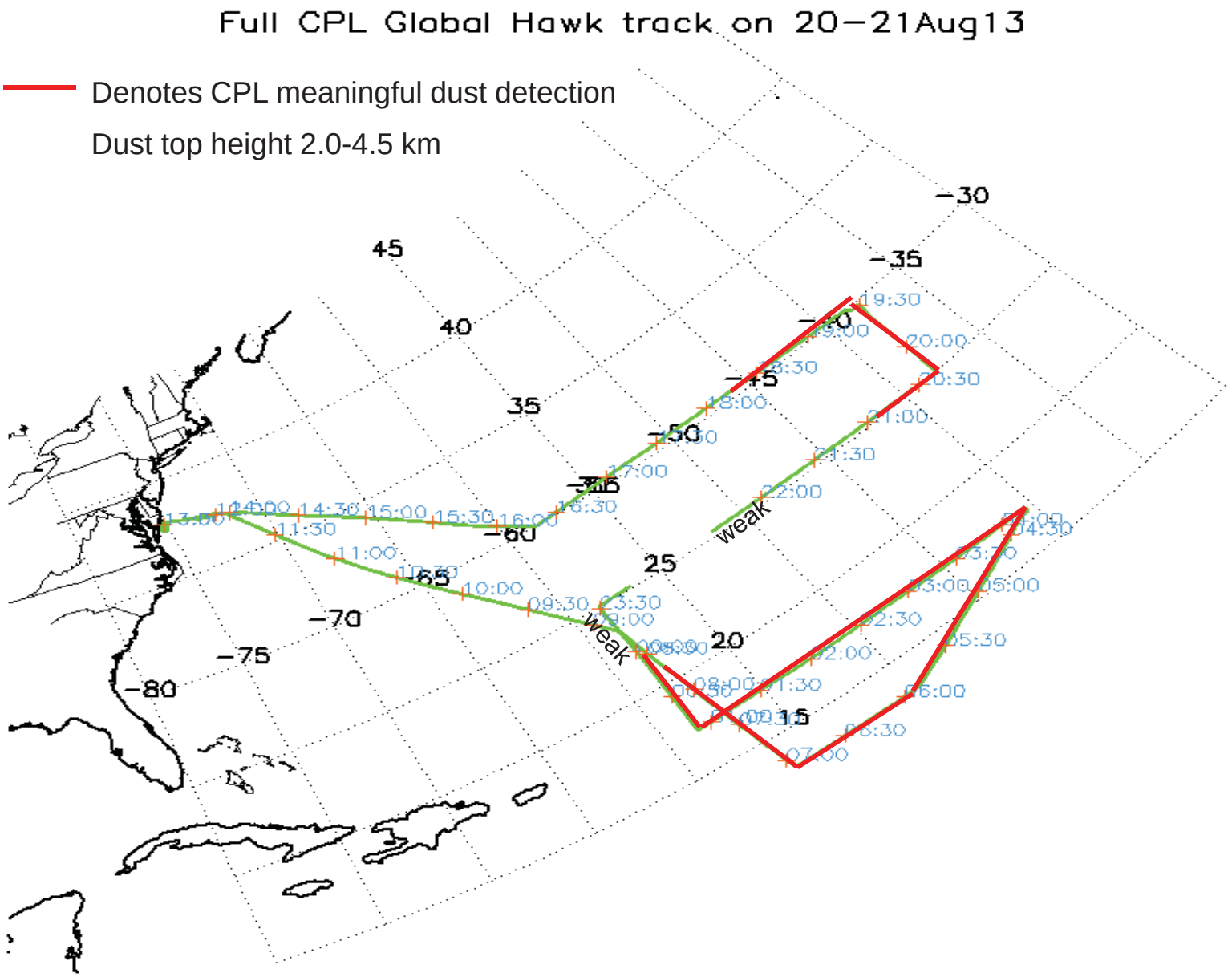
# Global Hawk CPL Data Products
## Marshall Space Flight Center Archive

***CPL Data Products at the Site:***

- **Three subdirectories under "cpl" directory:**
  **"HS3_2012", "HS3_2013", and "Read_Routines"**
- **The following files are available for each flight and year:**
  **a) CPL_ATB*.hdf5 (atten. total backscatter + layer loc.)**
  **b) CPL_OP*.hdf5 (optical properties + layer loc.)**
  **c) imgsum*.gif (summary ATB image for each segment)**
  **d) layers*.txt (layer locations)**
  **e) map*.gif (flight route for full flight and each segment)**
- **The Read_Routines directory contains IDL code to read the two HDF5 files.**

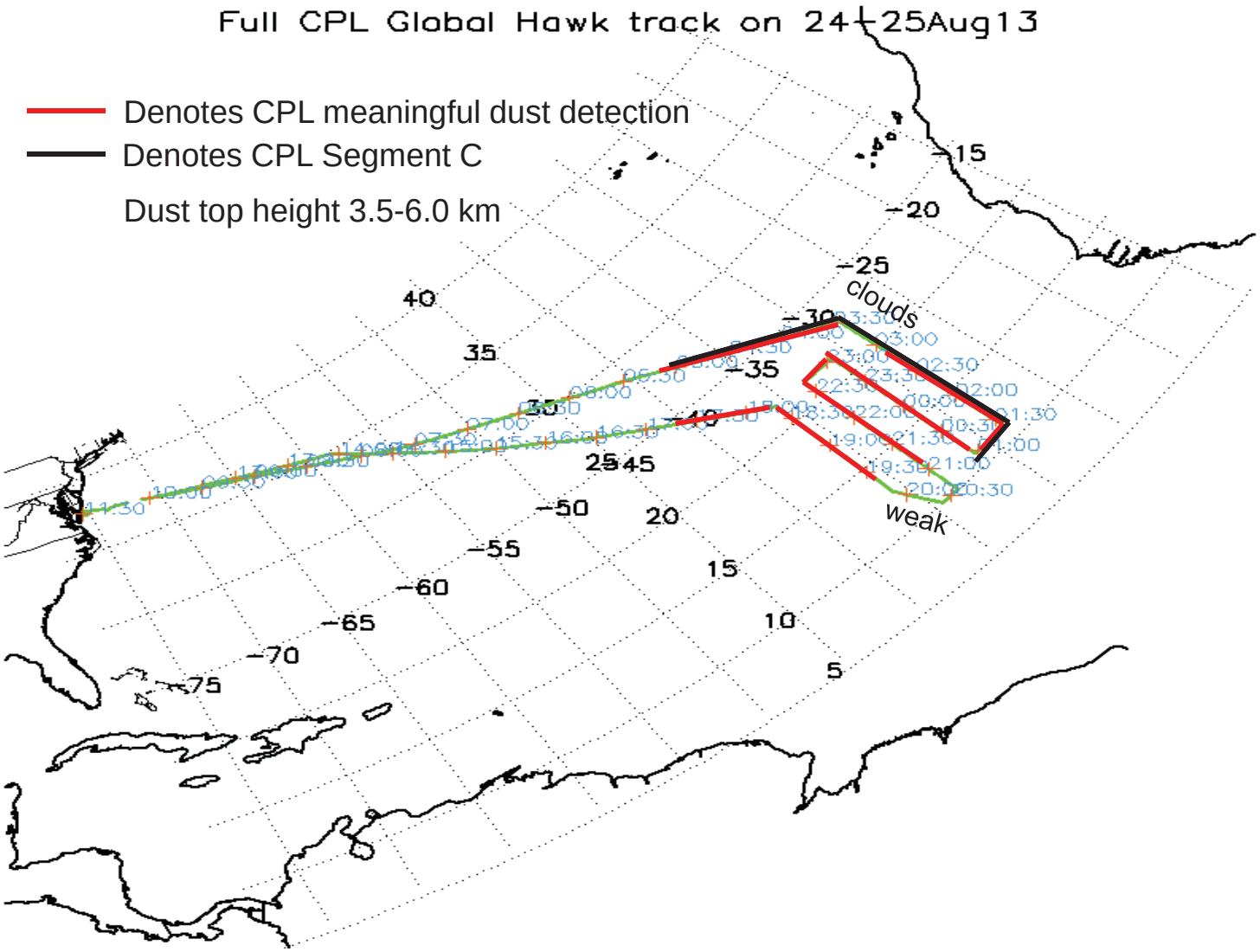
# HS3 CPL Products

## Saharan Air Layer Locations 08/20 – 8/21/13



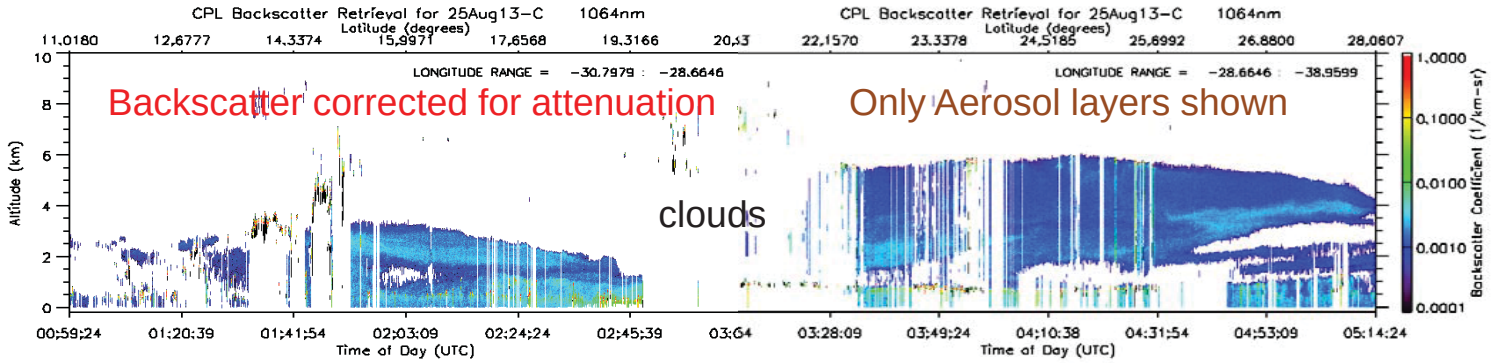
# HS3 CPL Products

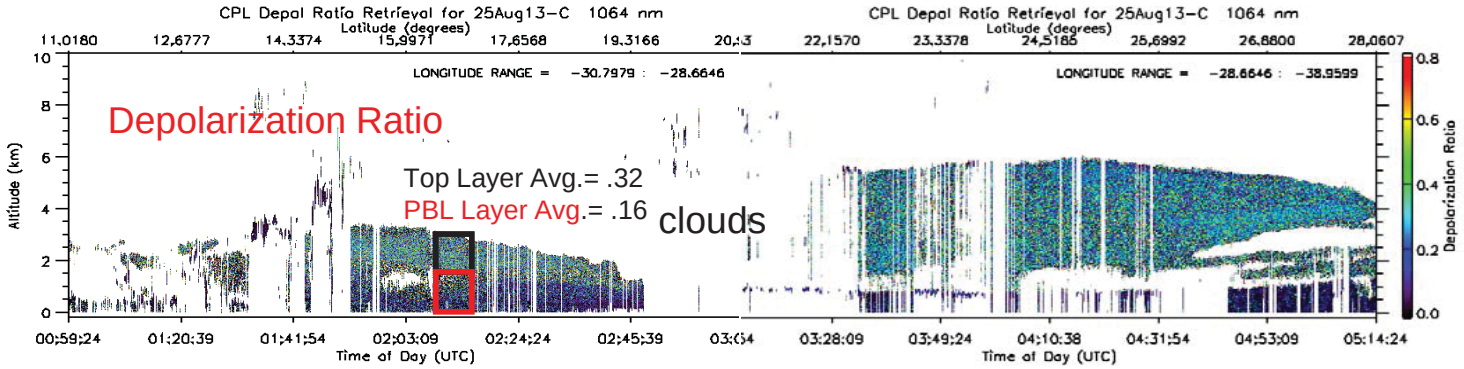
## Saharan Air Layer Locations 08/24 – 8/25/13

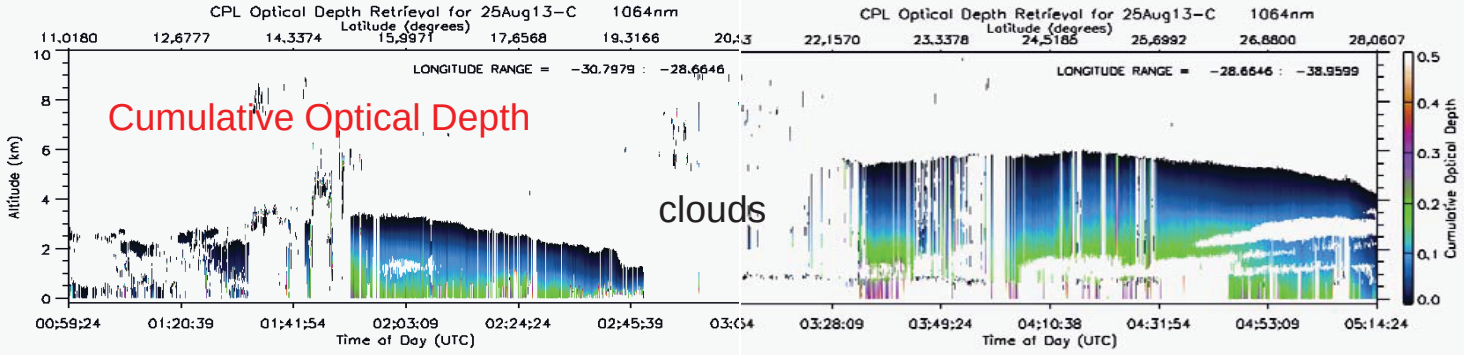


# HS3 CPL Products

## Saharan Air Layer 08/25/13 Segment C

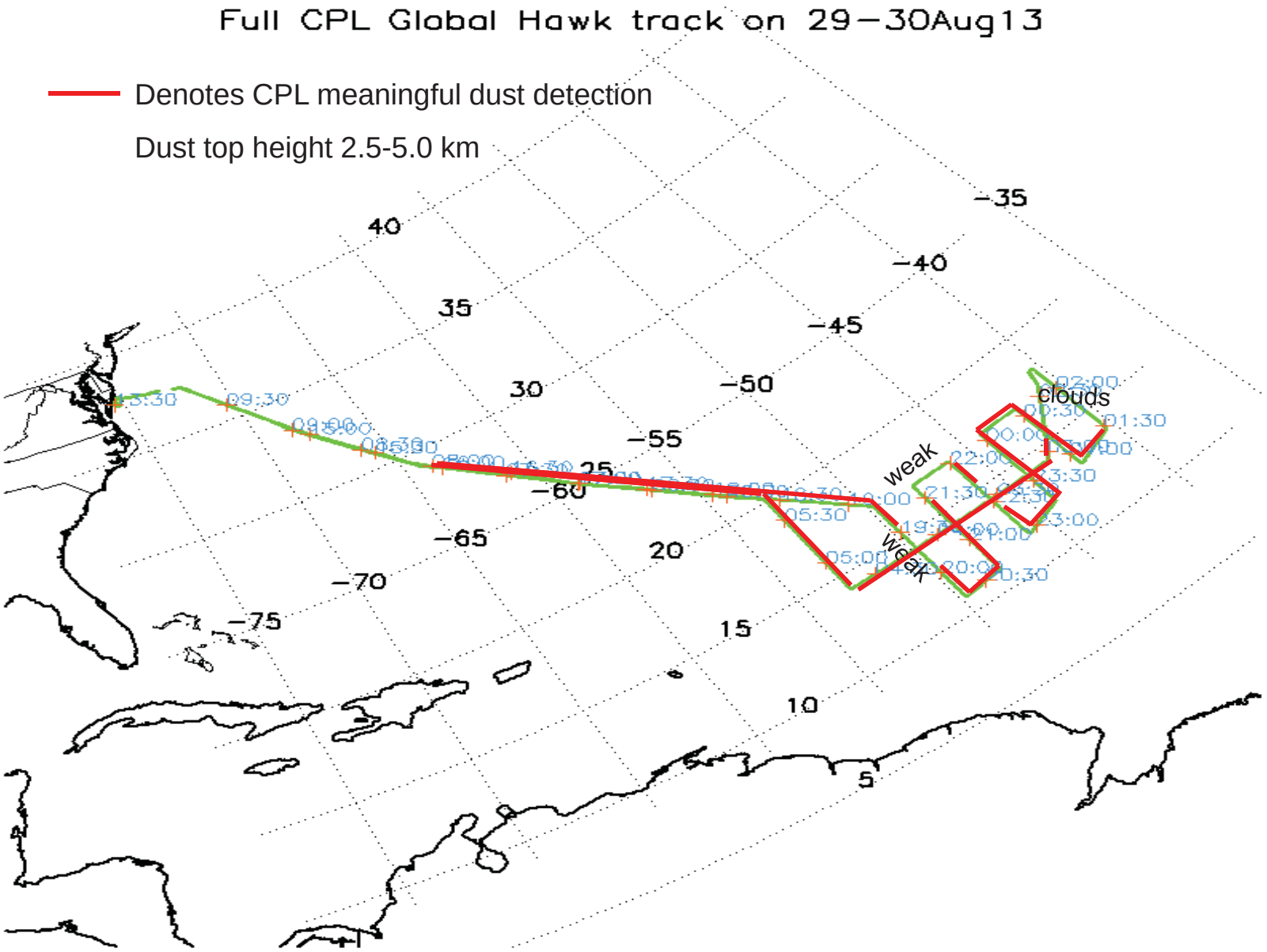


# HS3 CPL Products

## Saharan Air Layer Locations 08/29 – 8/30/13



# Global Hawk CPL
## Instrument and Product Status

***2014 Update:***

**1.The instrument/laser was successfully turned on after the ATTREX deployment to test and diagnose a laser issue. Suspect cables were returned to GSFC with one subsequently found to be damaged. A repaired cable will be brought to integration and we anticipate improved performance.**

**2.Both real-time and preliminary products are unchanged from last year.**

**3.As a default, we will save (and transfer to MTS) an image once every 5 minutes during flights, which covers the time span in one image, plus some overlap. During focus periods, we can increase that rate down to 1 minute.**

# Global Hawk CPL
## Real-time Products

**Examples of real-time displays:**

With Ku

Without Ku

# Global Hawk CPL

# ER-2 CPL Inter-comparison 23Sep12
# ER-2 westbound, Global Hawk westbound

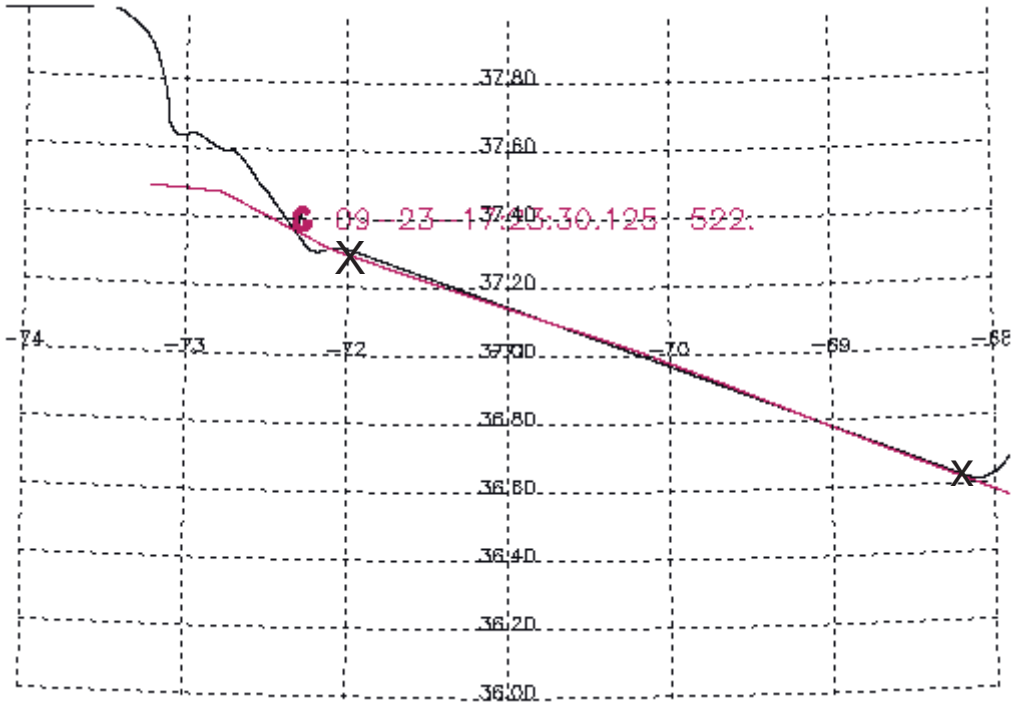
**Global Hawk: (Sortie 12207D)**
Segment Time> 16:47:24-17:20:23 utc
Segment Latitude> 36.61826 - 37.29256
Segment Longitude> -68.19118 - -71.97696

**ER-2 (Sortie 12924)**
Segment Time> 16:53:55-17:20:44 utc
Segment Latitude> 36.62517 - 37.30912
Segment Longitude> -68.19151 - -71.97642 (same direction)

**Exact Coincidence**
Time> 17:23:30.125 utc (3 minutes after end of segment)
Global Hawk Latitude/Longitude> 37.36726 / -72.33559
ER-2 Latitude/Longitude> 37.36649 / -72.32977

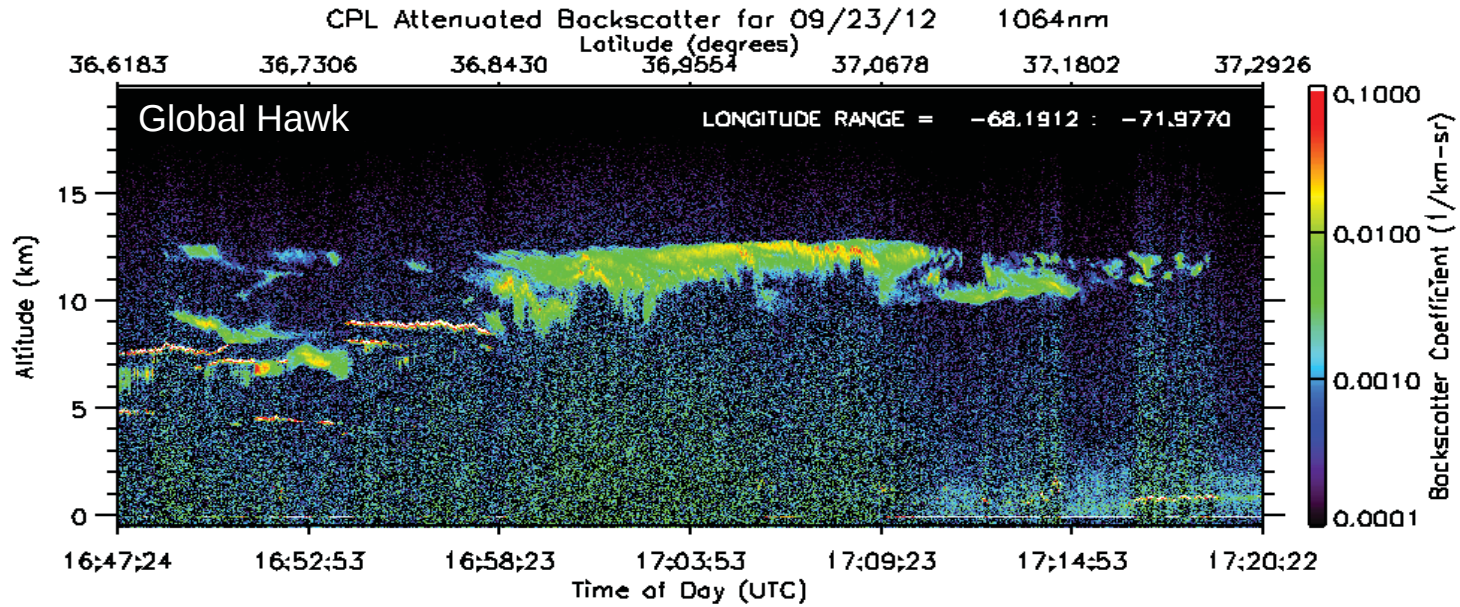
**Remarks:**
**Exact coincidence occurs after the segment ends during ER-2 crossover point.**
**At the eastern end of the coincidence, the two aircraft are ~6 minutes apart, improving to 0 minutes apart at the western end.**
**The whole segment is useful for comparison.**

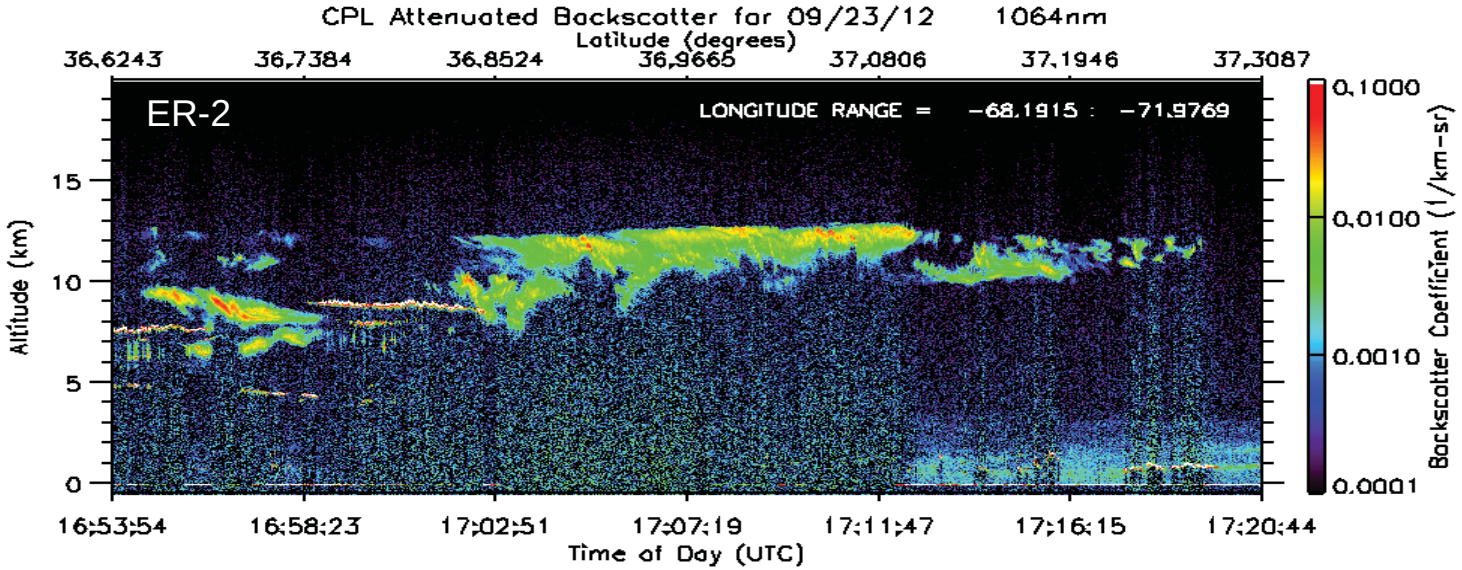
# ER-2 CPL Inter-comparison 23Sep12
# ER-2 westbound, Global Hawk westbound



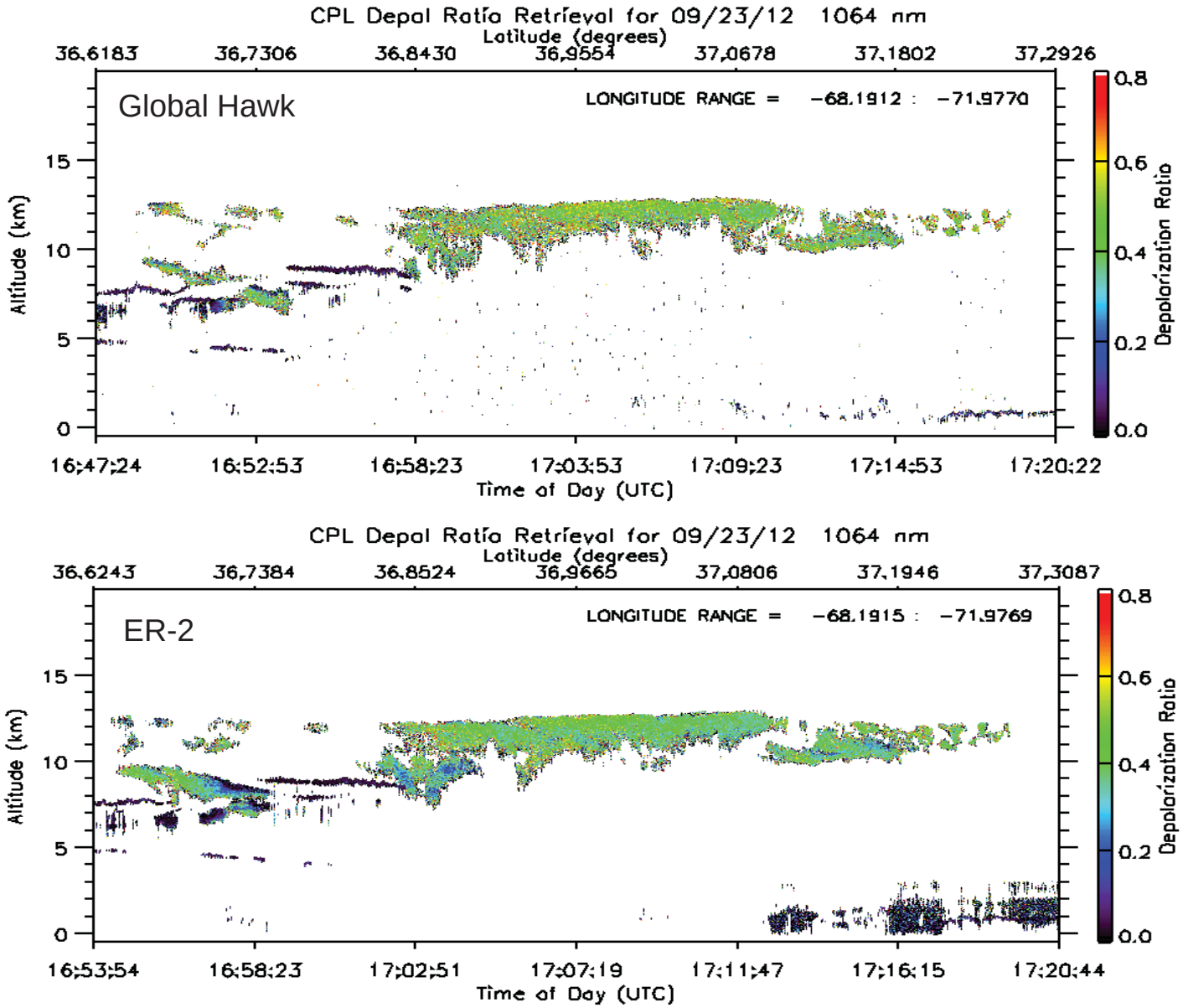

Global Hawk track (red)
ER-2 track (black)
Exact Coincidence (G)
Segment endpoints (X)

# ER-2 CPL Inter-comparison
# 1064 nm Attenuated Backscatter Profiles

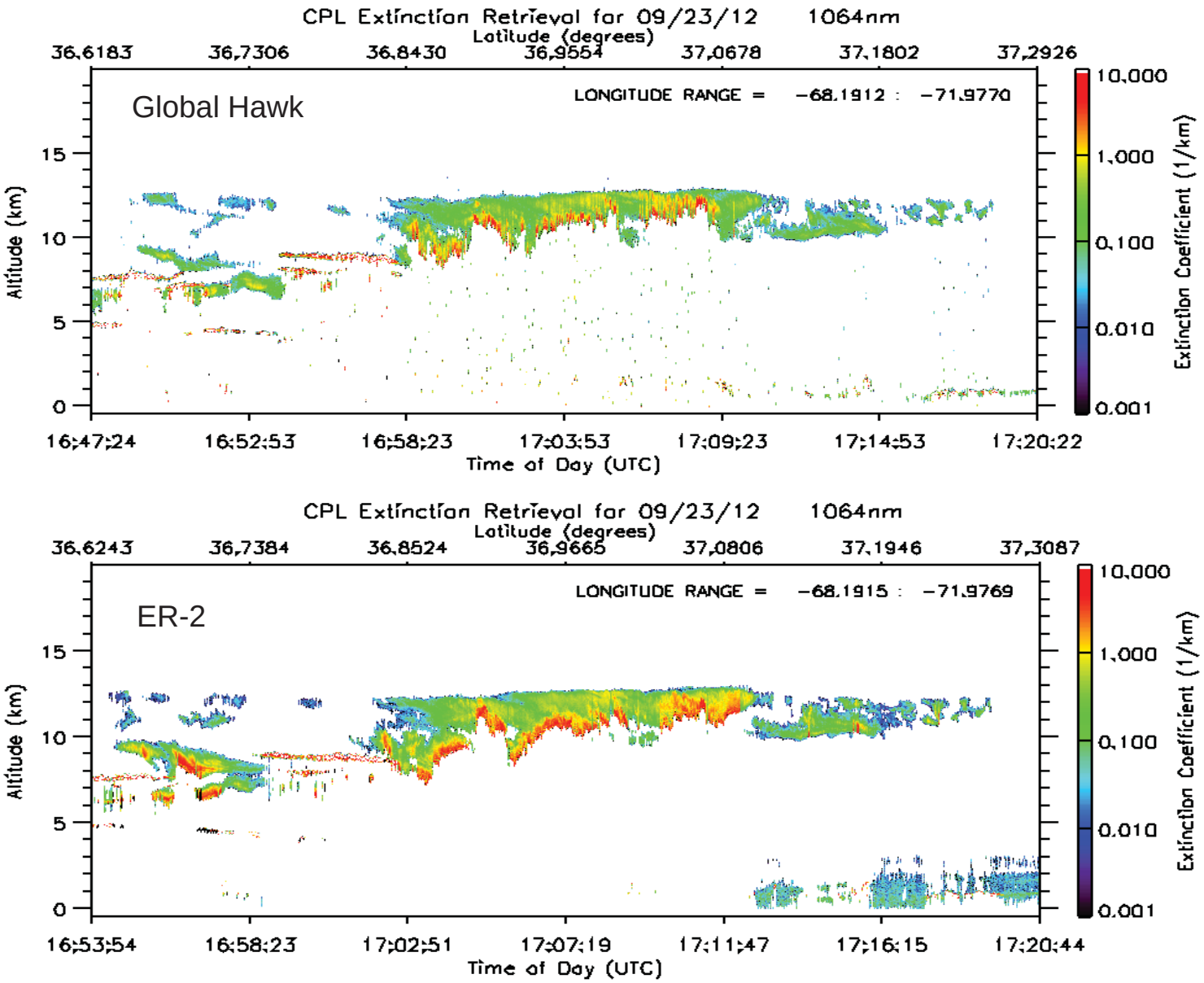


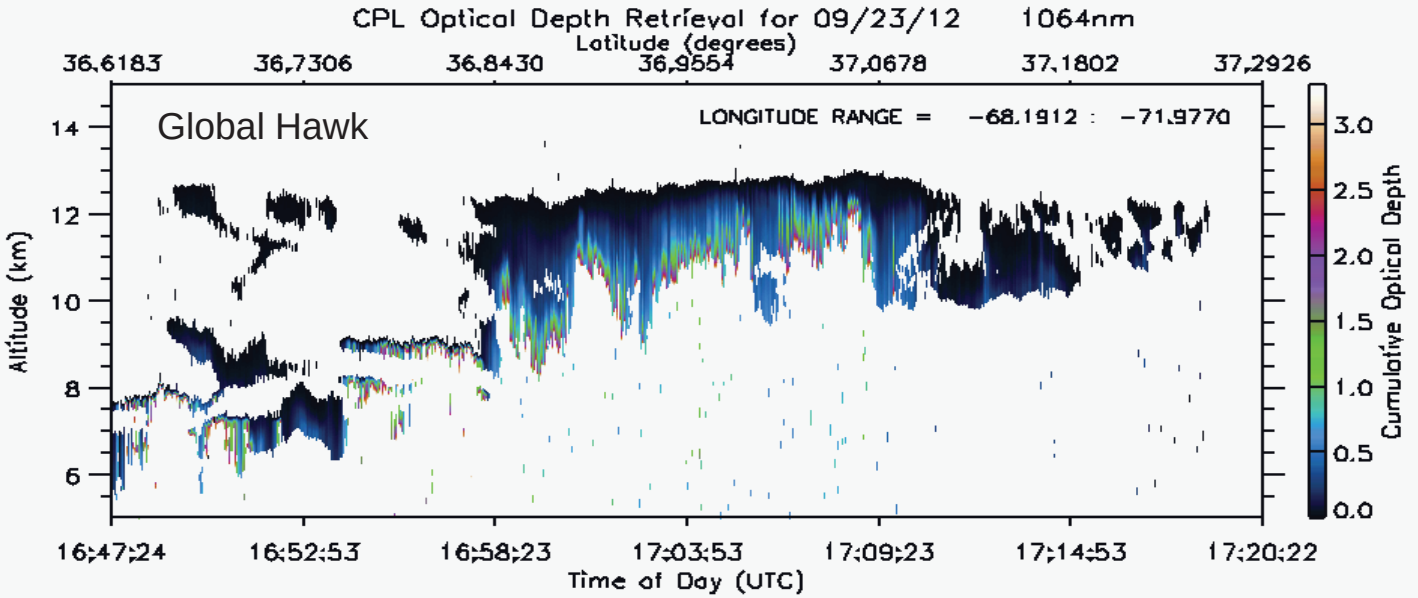
# ER-2 CPL Inter-comparison
# Depolarization Ratio Retrievals

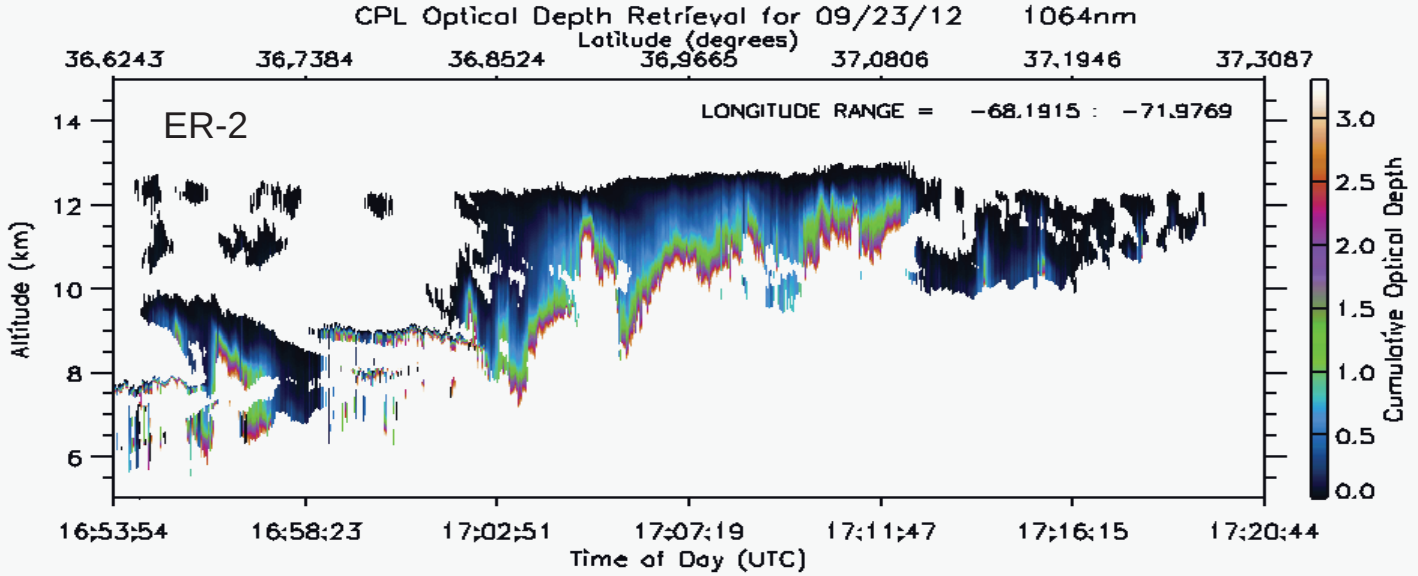


# ER-2 CPL Inter-comparison
# 1064 nm Extinction Profiles



# ER-2 CPL Inter-comparison
# 1064 nm Cumulative Optical Depth



# Global Hawk CPL Extras

**Global Hawk Instrumentation:**
Cloud Physics Lidar (CPL)

***Publications describing processing algorithms:***

McGill, M.J., D.L. Hlavka, W.D. Hart, E.J. Welton, and J.R. Campbell, "Airborne lidar measurements of aerosol optical properties during SAFARI-2000", *J. Geophys. Res.,* 108, doi: 10.1029/2002JD002370, 2003.

Yorks, J. E., M. McGill, D. Hlavka and W. Hart (2011), Statistics of Cloud Optical Properties from Airborne Lidar Measurements, *J. Atmos. Oceanic Technol*., 28, 869-883, doi:10.1175/2011JTECHA1507.1.

Yorks, J. E., D. L. Hlavka, M. A. Vaughan, M. J. McGill, W. D. Hart, S. Rodier, and R. Kuehn (2011), Airborne validation of cirrus cloud properties derived from CALIPSO lidar measurements: Spatial properties, *J. Geophys. Res*., 116, D19207, doi:10.1029/2011JD015942.

Hlavka, D. L., J. E. Yorks, S. Young, M. A. Vaughan, R. Kuehn, M. J. McGill, and S. Rodier (2012), Airborne validation of cirrus cloud properties derived from CALIPSO lidar measurements: Optical properties, submitted to *J. Geophys. Res.*.

***Publications describing data quality:***

McGill, M., D. Hlavka, W. Hart, J. Spinhirne, V. S. Scott, B. Schmid, 2002: The Cloud Physics Lidar: Instrument Description and Initial Measurement Results, Applied Optics, 41, No. 18, 3725-3734.

Schmid, B., J. Redemann, P.B. Russell, P.V. Hobbs, D.L. Hlavka, M.J. McGill, B.N. Holben, E.J. Welton, J. Campbell, O. Torres, R. Kahn, D.J. Diner, M.C. Helmlinger, D.A. Chu, C. Robles-Gonzalez, and G. de Leeuw, “Coordinated airborne, spaceborne, and ground-based measurements of massive, thick aerosol layers during the dry season in Southern Africa”, *J. Geophys. Res.*, 108, doi: 10.1029/2002JD002297, 2003.

Hlavka, D. L., S. P. Palm, W. D. Hart, J. D. Spinhirne, M. J. McGill, and E. J. Welton (2005), Aerosol and cloud optical depth from GLAS: Results and Verification for an October 2003 California fire smoke case, *Geophys. Res. Lett.*, 32, L22S07, doi:10.1029/2005GL023413.

# Global Hawk CPL Data Products

cpl.gsfc.nasa.gov/hs3_2012/hs3_2012_enter.htm

***Outline of CPL Data Products:***

**Global Hawk flights are broken up into ~ 6hr segments for processing, with two large binary files created for each:**

**Products produced from the NRB (normalized relative backscatter) binary file (within ~60 hours of landing):**

1. **Curtain plots of attenuated backscatter for full segment**
2. **Curtain plots of att. backscatter for each 30-minute slice**
3. **Layer boundaries for PBL, elevated aerosol layers, clouds**
4. **Depolarization ratio profiles (1064 nm) for ice/water phase**

**Products produced from the OP (optical properties) binary file (usually after the mission is over):**

1. **layer optical depth and column tot. (aerosol, cloud, total)**
2. **layer extinction-to-backscatter ratio (lidar ratio) used**
3. **extinction profiles inside identified layers**
4. **particulate backscatter profiles corrected for attenuation**
5. **Plots of extinction and optical depth for each 30-min. slice**