MINX Document 3

MINX – Overview and Plume Case Studies

David Nelson

Raytheon Company, Jet Propulsion Laboratory,
California Institute of Technology

May, 2012

Contents

Scientific motivation for MINX

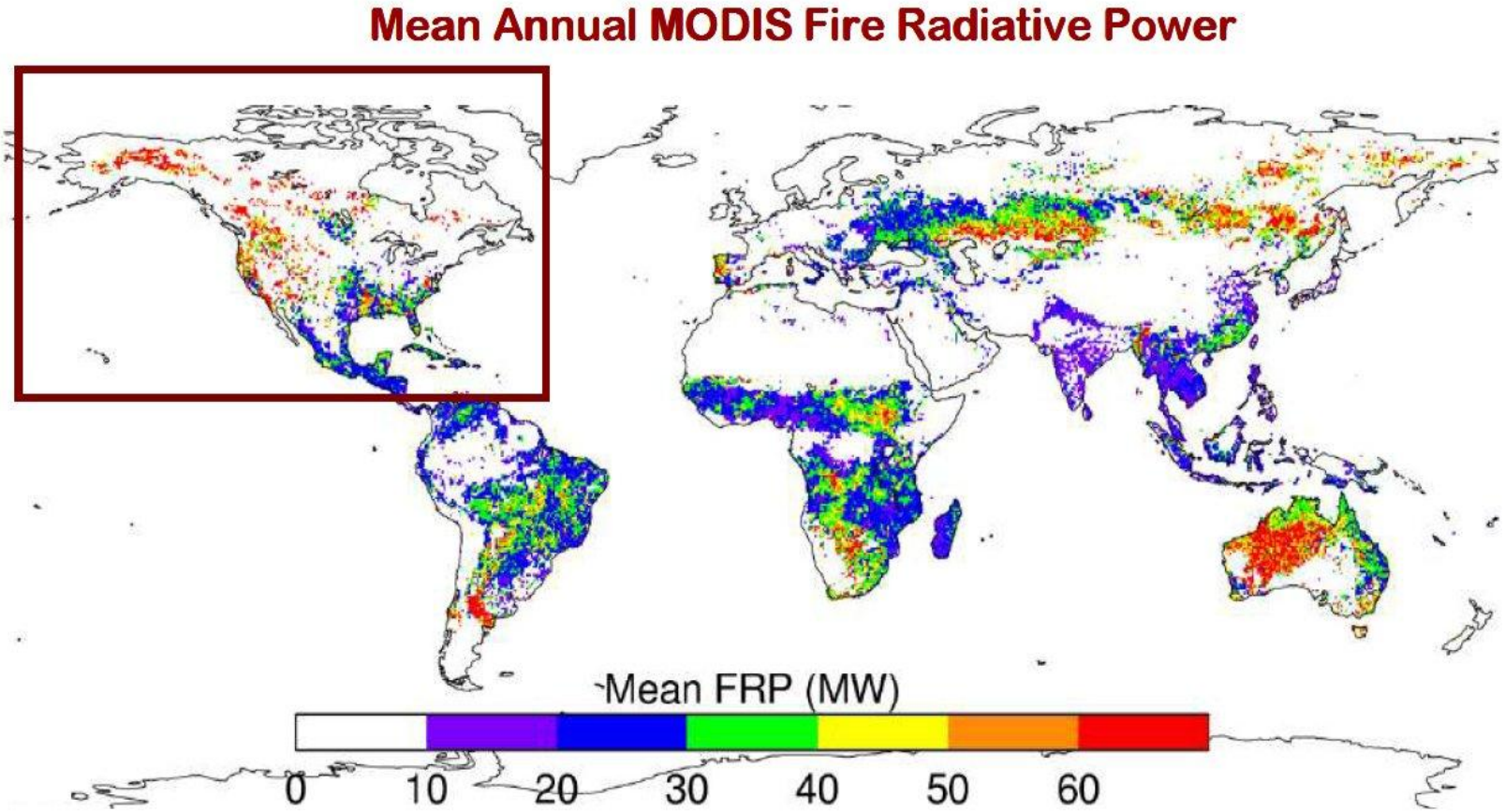
MISR Plume Project website

Animations and interpretations with MINX

- **Smoke plume over Alaska**
- **Dust in Taklamakan Basin**
- **Volcanic ash over Chile**
- **Snow storm in Antarctica**

Contents

Fires are a world-wide complex phenomenon



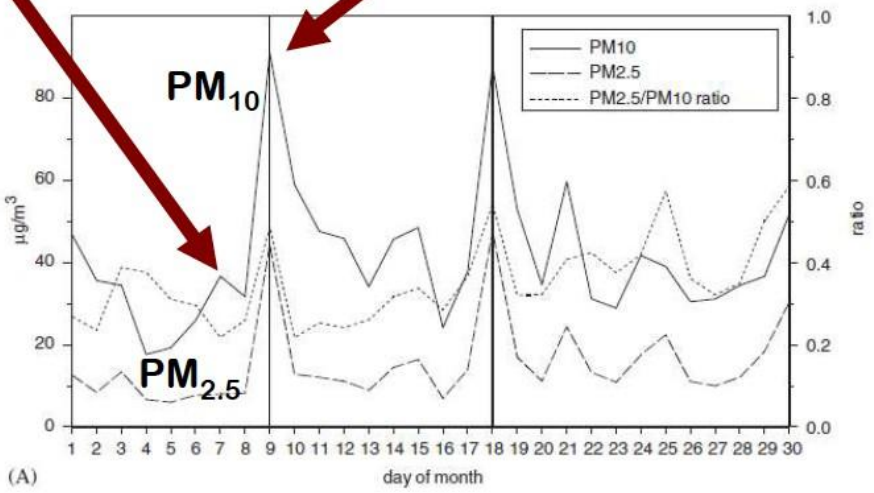
[*Giglio et al.*, 2006]

Courtesy of Maria Val Martin

Fire impacts regional air quality

June 2002 Hayman Fire over Colorado caused worst air quality ever in Denver

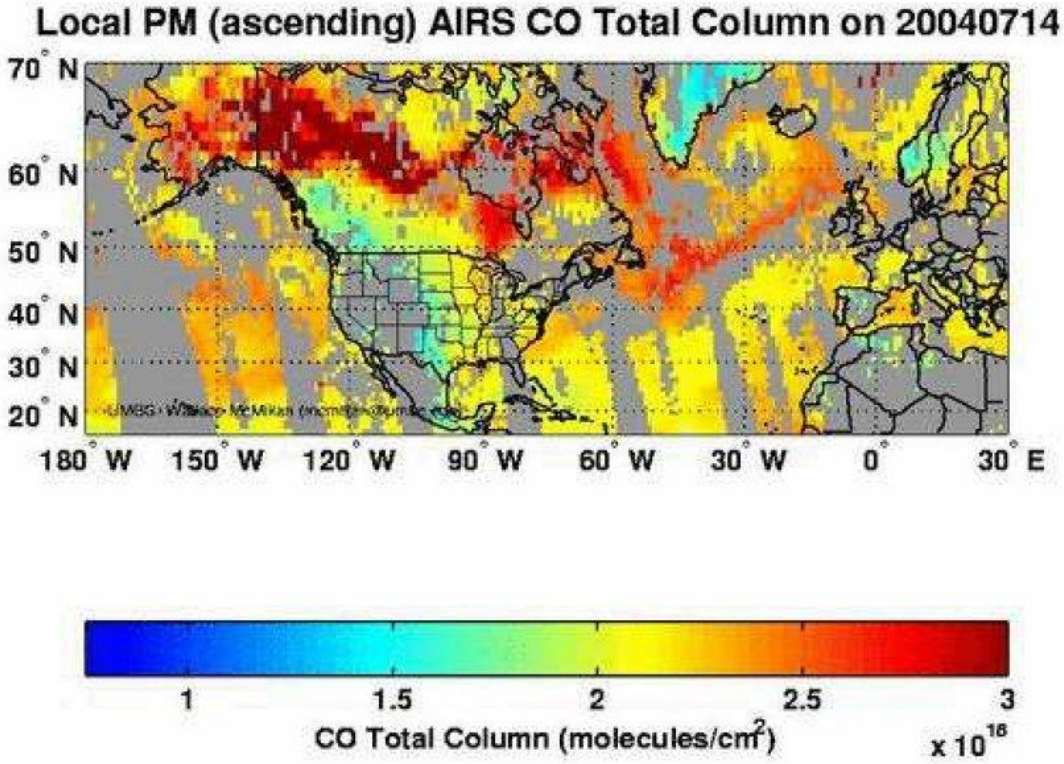
Daily mean $PM_{2.5}$ and PM_{10} in June



[*Vedal et al.*, 2006]

Courtesy of Maria Val Martin

Long-range transport of fire emissions



2004 Alaska fire emissions reached southern U.S. and Europe!!

[*e.g.*, *Val Martin et al.*, 2006; *Real et al.*, 2007; *Duck et al.*, 2007]

http://asl.umbc.edu/pub/mcmillan/www/index_INTEXA.html

Courtesy of Maria Val Martin

Scientific Motivation for MINX

- **In 2005, the EPA (Environmental Protection Agency) and NASA funded a proposal to develop an aerosol injection height climatology in support of studying forest fires, climate change and air quality.**
  - **Team scientists: Jennifer Logan (PI – Harvard), David Diner and Dominic Mazzoni (NASA-JPL), Ralph Kahn (NASA-GSFC)**
- **"The elevation at which aerosols are injected into the atmosphere has a strong influence on how the smoke is dispersed, and is a key input to aerosol transport models." (Kahn, et al, 2008)**
- **Aerosols that rise into the free troposphere can remain aloft longer and be transported farther than those that remain in the boundary layer.**
  - **Smoke can warm the atmosphere and enhance melting of snow and ice**
  - **Dust may carry pathogens**
  - **Volcanic eruptions can affect global transportation**

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Plume Project Website - 2

http://misr.jpl.nasa.gov/getData/accessData/MisrMinxPlumes/

MISR Plume Height Project

David Nelson, Cecelia Lawshe, Dominic Mazzoni, David Diner, Ralph Kahn

March, 2012 - see what's changed

(•) Wildfire smoke plumes ( ) Volcanic plumes

(click Project Areas to expand or collapse)

Project Area (Top Level)	Project Area (Secondary Level)	Date Added to Website	Images and Data
Africa			
	0 to 20 North, 2005	09/09/2009	View/Download
	0 to 20 North, 2006	09/09/2009	View/Download
Alaska Summer 2009			
ARCTAS Canada 2008			
Indonesia			
North America			
	2001	03/05/2012	View/Download
	2002	09/21/2007	View/Download
	2003	03/05/2012	View/Download
	2004	03/16/2009	View/Download
	2005	08/06/2008	View/Download
	2006	05/19/2008	View/Download
	2007	08/06/2008	View/Download
	2008	03/05/2012	View/Download
Siberia			
South America			
	Amazon Aug-Sept 2006	03/05/2012	View/Download
	Amazon Aug-Sept 2007	03/05/2012	View/Download
	Boliv-Parag Aug-Sept 2006	03/05/2012	View/Download
	Boliv-Parag Aug-Sept 2007	03/05/2012	View/Download
Southeast Asia			

Useful links:

- Product Description
- Product Labeling, Terms Used, and File Formats
- Data Quality Statement and Error Analysis
- Related Publications
- MISR
- MODIS

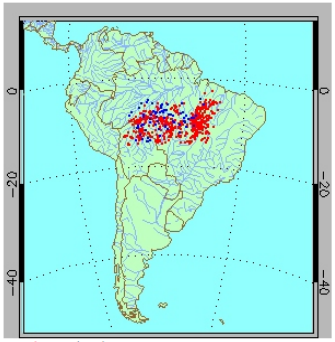
Project Area

MISR Plume Height Project

South America Amazon Aug-Sept 2007

Home Page

Created using the **MINX** software and **ColdFusion**
David Nelson, Cecelia Lawshe, Dominic Mazzoni, David Diner, Ralph Kahn



red = smoke plume
blue = smoke cloud

Date Plumes Processed: 03/05/2012
Number of orbits with plumes: 36
Number of plumes processed: 594
Number of plumes w/ wind-corr hts: 594
Number of plumes w/ power estimate: 579
Number of plumes w/ hts and power: 579
Total area of plumes: 95113 sq km
Total radiative power of plumes: 307354 MW
Median value of median plume top hts: 975 meters ASL
Median value of maximum plume top hts: 1253 meters ASL
Median # of data points/plume: 80
Median # of best-wind hts/plume: 34

View Plume Statistics by Time Interval
View and Retrieve Project Summary Files
View, Sort and Retrieve Raw Data Files

Orbits/Block Ranges	Date Acquired	# Plumes
040560 - B95-102	08/03/2007	8
040574 - B95-101	08/04/2007	16
040589 - B96-101	08/05/2007	10
040618 - B95-102	08/07/2007	16
040662 - B98-101	08/10/2007	2
040691 - B95-101	08/12/2007	12
040720 - B95-102	08/14/2007	20
040749 - B95-100	08/16/2007	15
040778 - B96-102	08/18/2007	33
040793 - B95-101	08/19/2007	20
040807 - B93-102	08/20/2007	29
040822 - B96-102	08/21/2007	18
040851 - B97-102	08/23/2007	21
040895 - B98-101	08/26/2007	4
040909 - B97-100	08/27/2007	20

Next slide

We gratefully acknowledge support from NASA and the EPA for this work. We also acknowledge contributions by the NASA Langley Atmospheric Science Data Center and Raytheon Company

Plume Project Website - 3

Plume Page

MISR Plume Height Project

South America
Amazon Aug-Sept 2007

Home Page - Project Area

Region Name	Region Type	Height ASL (km)	Direction (deg CW from N)	Total Power (MW)
040778 - B96 - SPWB1	Smoke Plume	1.69	286.0	99999.0
040778 - B96 - SPWB2	Smoke Plume	1.82	277.0	99999.0
040778 - B96 - SPWB3	Smoke Plume	0.95	293.0	99999.0
040778 - B96 - SPWB4	Smoke Plume	0.98	285.0	99999.0
040778 - B96 - SPWB5	Smoke Plume	1.39	281.0	99999.0
040778 - B97 - SPNB1	Smoke Cloud	1.85	99999.0	99999.0
040778 - B97 - SPWB1	Smoke Plume	1.13	287.0	1024.0
040778 - B97 - SPWB2	Smoke Plume	0.95	291.0	74.0
040778 - B97 - SPWB3	Smoke Plume	0.94	299.0	1161.0
040778 - B97 - SPWR1	Smoke Plume	1.27	295.0	1268.0
040778 - B97 - SPWR2	Smoke Plume	1.63	280.0	9092.0
040778 - B97 - SPWR4	Smoke Plume	1.68	272.0	4138.0
040778 - B98 - SPWB1	Smoke Plume	1.02	297.0	53.0
040778 - B98 - SPWB2	Smoke Plume	1.66	292.0	2076.0
040778 - B98 - SPWR1	Smoke Plume	0.88	291.0	751.0
040778 - B98 - SPWR2	Smoke Plume	1.24	268.0	2926.0
040778 - B98 - SPWR3	Smoke Plume	0.83	294.0	1439.0
040778 - B98 - SPWR4	Smoke Plume	1.42	283.0	1742.0
040778 - B98 - SPWR5	Smoke Plume	1.21	291.0	1094.0
040778 - B99 - SPNB1	Smoke Cloud	2.09	99999.0	99999.0
040778 - B99 - SPWB1	Smoke Plume	1.51	296.0	739.0
040778 - B99 - SPWB2	Smoke Plume	1.1	295.0	98.0
040778 - B100 - SPWB1	Smoke Plume	0.84	283.0	90.0
040778 - B100 - SPWB2	Smoke Plume	1.25	274.0	555.0

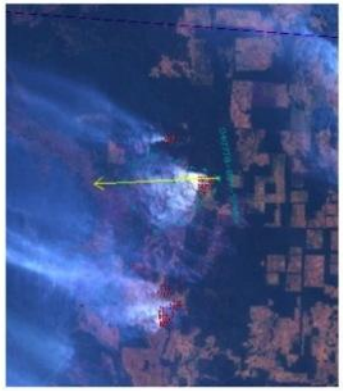
MISR Plume Height Project: South America - Amazon Aug-Sept 2007 ➡ Orbit 040778 - Block B97 ➡ SPWR4

View/Download Raw Data

⬅ Previous Region Next Region ➡

(Right-click any image and select "View Image" or "Copy Image" to view full-size or to save to your workplace.)

Nadir image w/ digitized region outline and name (cyan), wind direction (yellow) and MODIS fire pixels (red)

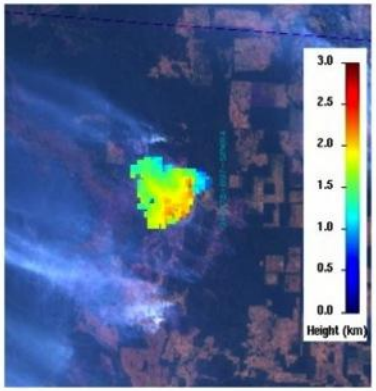


View raw ASCII data for current plume

Region Location in MISR block

MINX profiles and histograms are also archived on the website

Nadir Image w/ Color-Coded, Wind-Corrected Heights

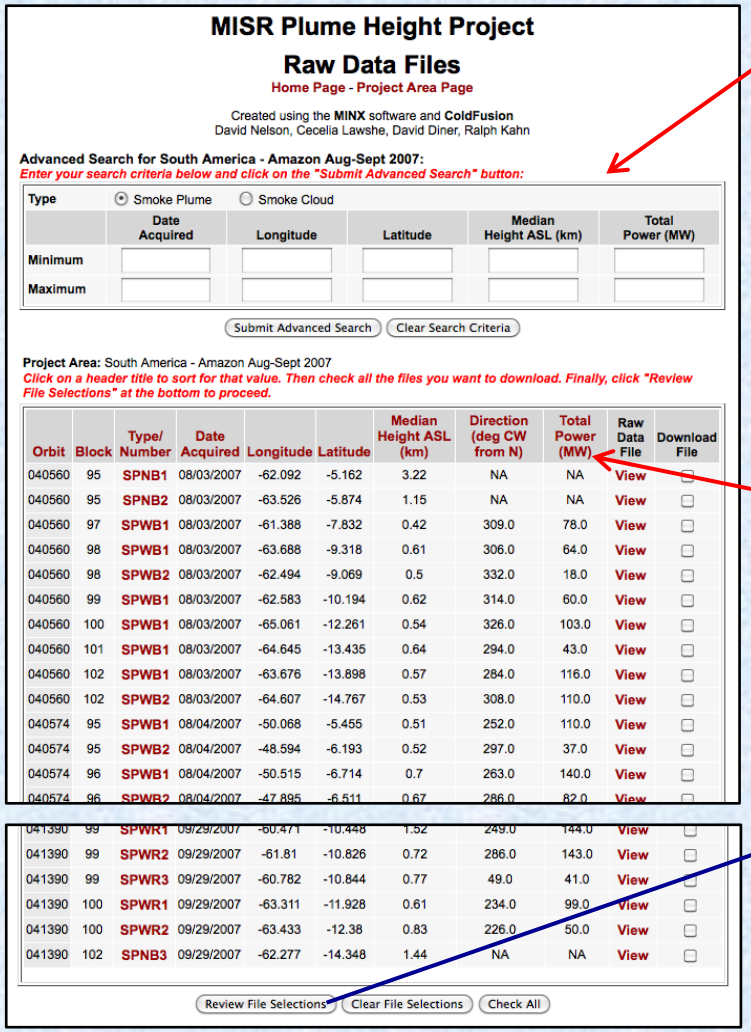


Camera Animation of Region

To see the full-size mpeg animation, or if your browser does not play the animation, right click this link.

Plume Project Website - 4

View, Sort and Retrieve Raw Data Files



MISR Plume Height Project

Raw Data Files

Home Page - Project Area Page

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David Nelson, Cecelia Lawshe, David Diner, Ralph Kahn

Advanced Search for South America - Amazon Aug-Sept 2007:
Enter your search criteria below and click on the "Submit Advanced Search" button:

Type	Smoke Plume / Smoke Cloud				
	Date Acquired	Longitude	Latitude	Median Height ASL (km)	Total Power (MW)
Minimum					
Maximum					

Submit Advanced Search | Clear Search Criteria

Project Area: South America - Amazon Aug-Sept 2007
Click on a header title to sort for that value. Then check all the files you want to download. Finally, click "Review File Selections" at the bottom to proceed.

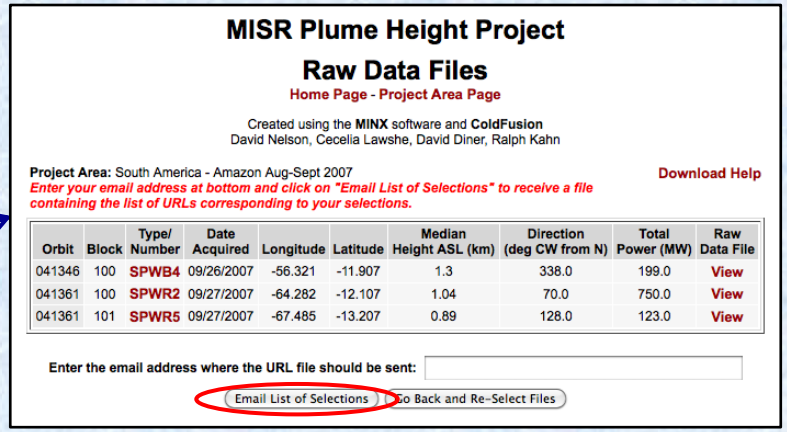
Orbit	Block	Type/ Number	Date Acquired	Longitude	Latitude	Median Height ASL (km)	Direction (deg CW from N)	Total Power (MW)	Raw Data File	Download File
040560	95	SPNB1	08/03/2007	-62.092	-5.162	3.22	NA	NA	View	
040560	95	SPNB2	08/03/2007	-63.526	-5.874	1.15	NA	NA	View	
040560	97	SPWB1	08/03/2007	-61.388	-7.832	0.42	309.0	78.0	View	
040560	98	SPWB1	08/03/2007	-63.688	-9.318	0.61	306.0	64.0	View	
040560	98	SPWB2	08/03/2007	-62.494	-9.069	0.5	332.0	18.0	View	
040560	99	SPWB1	08/03/2007	-62.583	-10.194	0.62	314.0	60.0	View	
040560	100	SPWB1	08/03/2007	-65.061	-12.261	0.54	326.0	103.0	View	
040560	101	SPWB1	08/03/2007	-64.645	-13.435	0.64	294.0	43.0	View	
040560	102	SPWB1	08/03/2007	-63.676	-13.898	0.57	284.0	116.0	View	
040560	102	SPWB2	08/03/2007	-64.607	-14.767	0.53	308.0	110.0	View	
040574	95	SPWB1	08/04/2007	-50.068	-5.455	0.51	252.0	110.0	View	
040574	95	SPWB2	08/04/2007	-48.594	-6.193	0.52	297.0	37.0	View	
040574	96	SPWB1	08/04/2007	-50.515	-6.714	0.7	263.0	140.0	View	
040574	96	SPWB2	08/04/2007	-47.895	-6.511	0.67	286.0	82.0	View	
041390	99	SPWR1	09/29/2007	-60.471	-10.448	1.52	249.0	144.0	View	
041390	99	SPWR2	09/29/2007	-61.81	-10.826	0.72	286.0	143.0	View	
041390	99	SPWR3	09/29/2007	-60.782	-10.844	0.77	49.0	41.0	View	
041390	100	SPWR1	09/29/2007	-63.311	-11.928	0.61	234.0	99.0	View	
041390	100	SPWR2	09/29/2007	-63.433	-12.38	0.83	226.0	50.0	View	
041390	102	SPNB3	09/29/2007	-62.277	-14.348	1.44	NA	NA	View	

Review File Selections | Clear File Selections | Check All

Advanced search parameters

- Any or all raw plume text files for a project area can be selected for downloading
- You will receive an email with a "cURL" file and instructions for downloading
- You must have the "curl" app to retrieve the data – it's standard with Macs – PC users can download a free copy

Click on column headers to sort



MISR Plume Height Project

Raw Data Files

Home Page - Project Area Page

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Project Area: South America - Amazon Aug-Sept 2007 — Download Help
Enter your email address at bottom and click on "Email List of Selections" to receive a file containing the list of URLs corresponding to your selections.

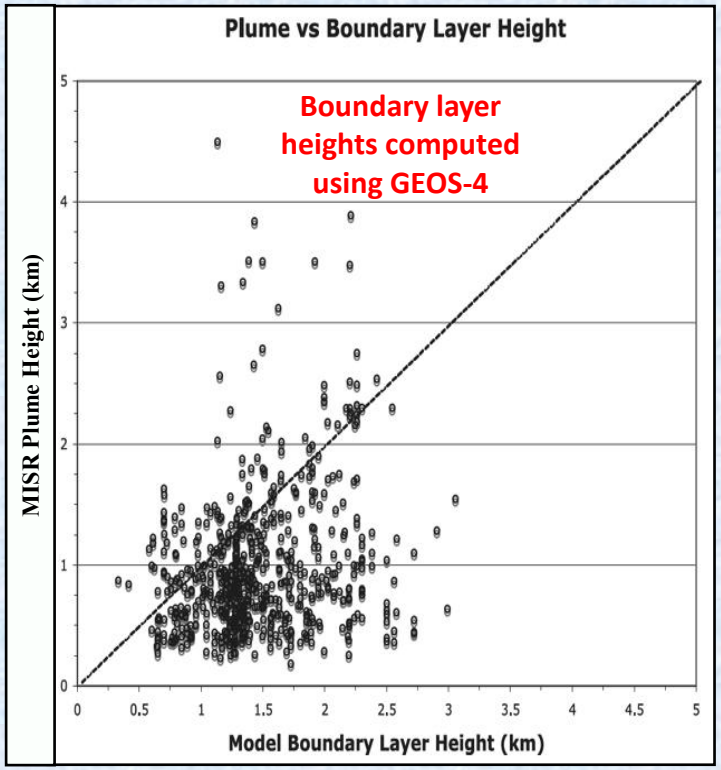
Orbit	Block	Type/ Number	Date Acquired	Longitude	Latitude	Median Height ASL (km)	Direction (deg CW from N)	Total Power (MW)	Raw Data File
041346	100	SPWB4	09/26/2007	-56.321	-11.907	1.3	338.0	199.0	View
041361	100	SPWR2	09/27/2007	-64.282	-12.107	1.04	70.0	750.0	View
041361	101	SPWR5	09/27/2007	-67.485	-13.207	0.89	128.0	123.0	View

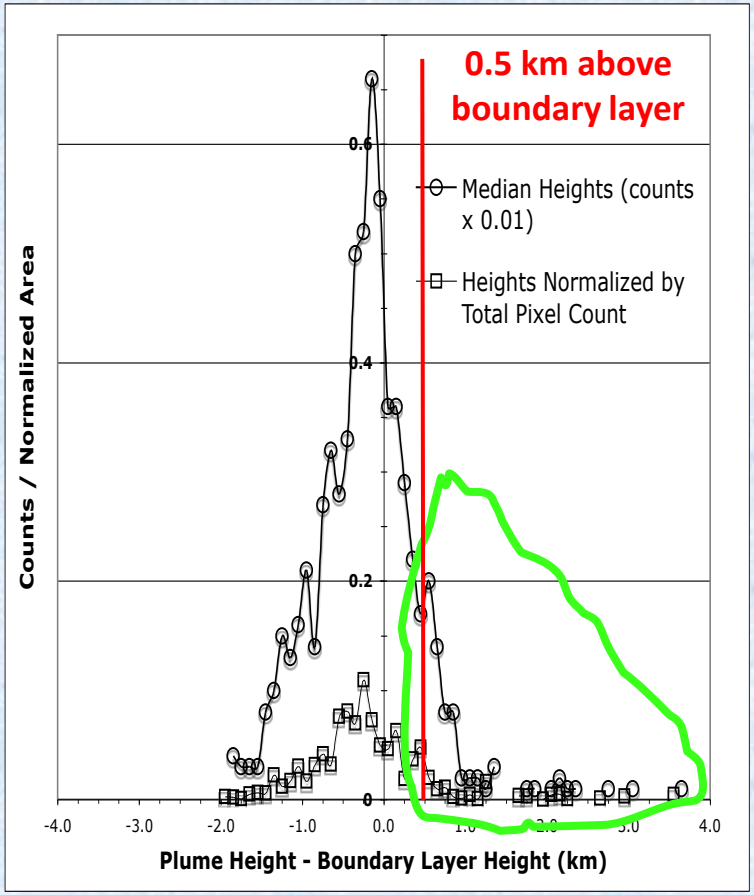
Enter the email address where the URL file should be sent:

Email List of Selections | Go Back and Re-Select Files

Alaska-Yukon Fire Plume Statistics, Summer 2004

- MINX found that at least 10% of wildfire smoke plumes reached the free troposphere. CALIOP concluded this was very rare
- CALIOP's swath width is ~ 4000 times narrower than MISR's suggesting that poor horizontal sampling is responsible

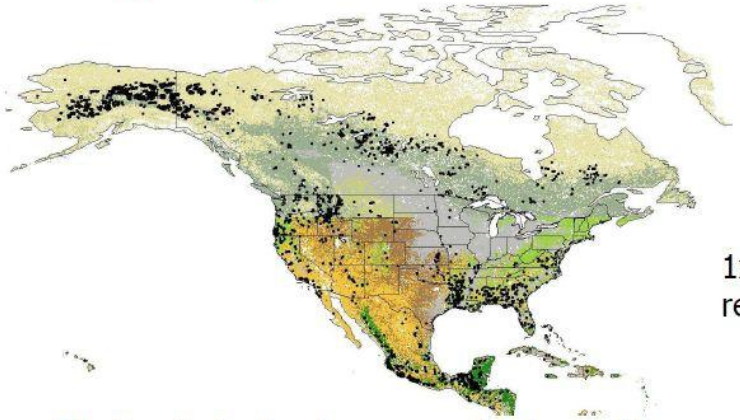




First science results from Plume Website data
R. Kahn, Y. Chen, D. Nelson et al., GRL 2008

Large variability in vertical injection heights

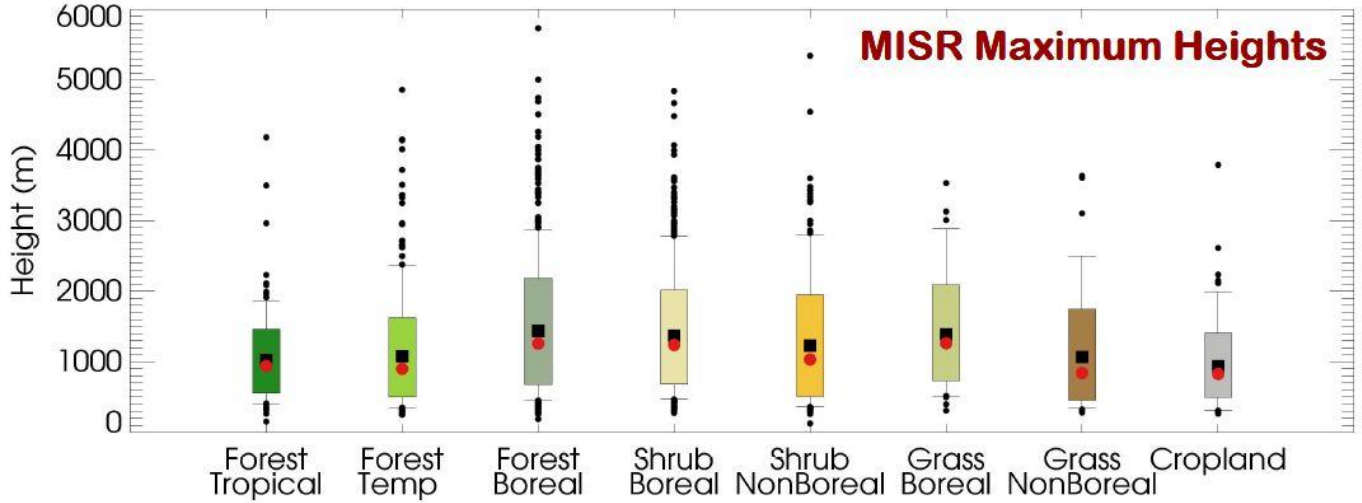
Ecological regions based on MODIS IGBP land cover map



1x1 km resolution

Cropland
Non-Boreal Grassland
Boreal Grassland
Non-Boreal Shrub
Boreal Shrub
Boreal Forest
Temperate Forest
Tropical Forest

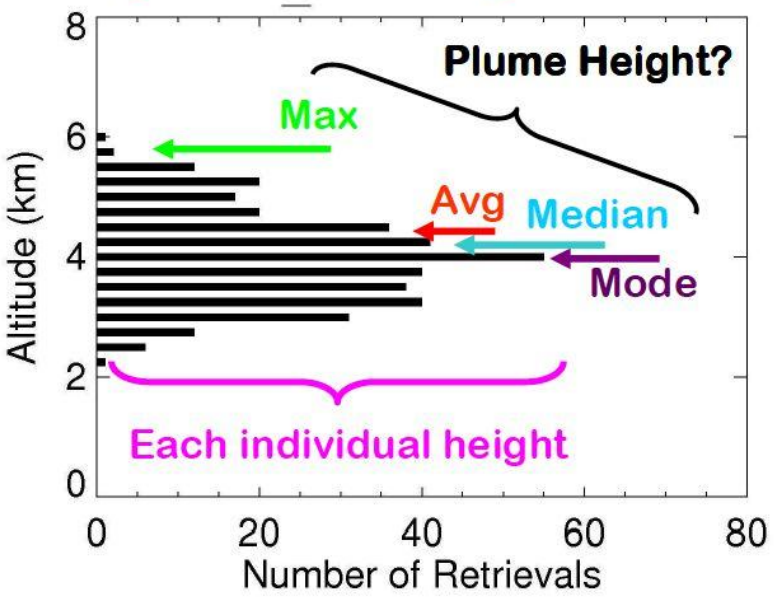
http://modis-land.gsfc.nasa.gov/landcover.htm



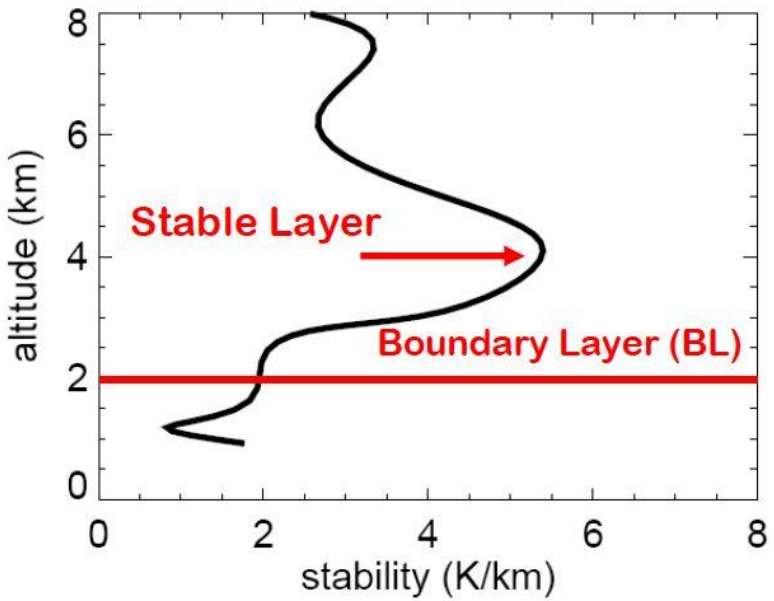
Courtesy of Maria Val Martin

Plume distribution, atmospheric conditions and fire properties

Histogram of Plume Height Retrievals



Atmospheric Stability Profile



- **Meteorological fields from GEOS**
- **Fire properties (size and power) from MODIS**

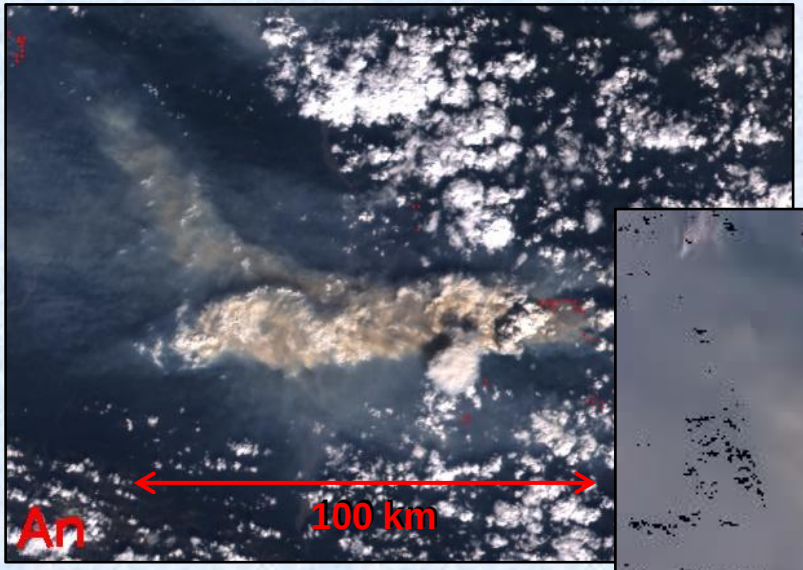
$$\text{Stability} = \frac{d\vartheta}{dz}, \text{ where } \vartheta = \mathrm{T}\left(\frac{\mathrm{P}_0}{\mathrm{P}}\right)^{R/c_p}$$

Courtesy of Maria Val Martin

Contents

Smoke Plumes - Alaska, USA

Orbit 24152, July 2, 2004

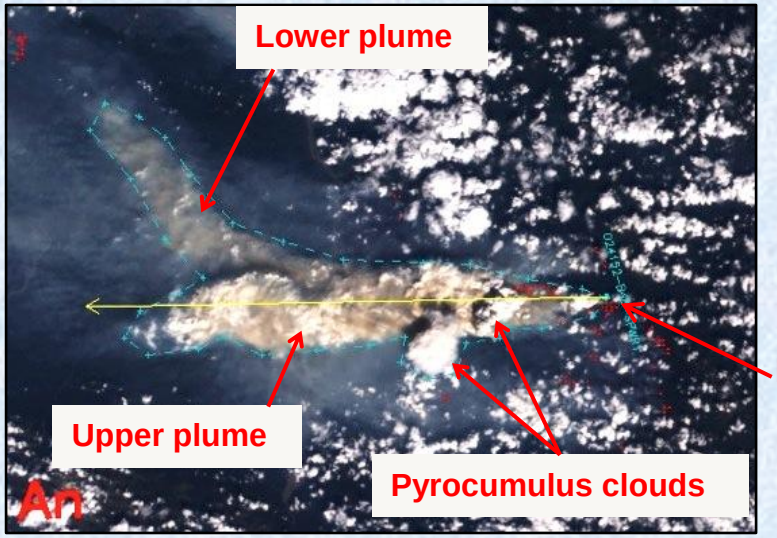


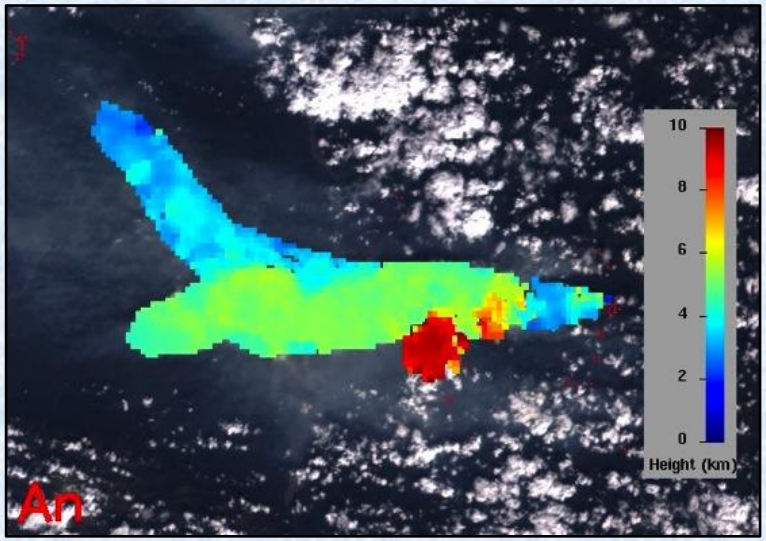
An image

Animation

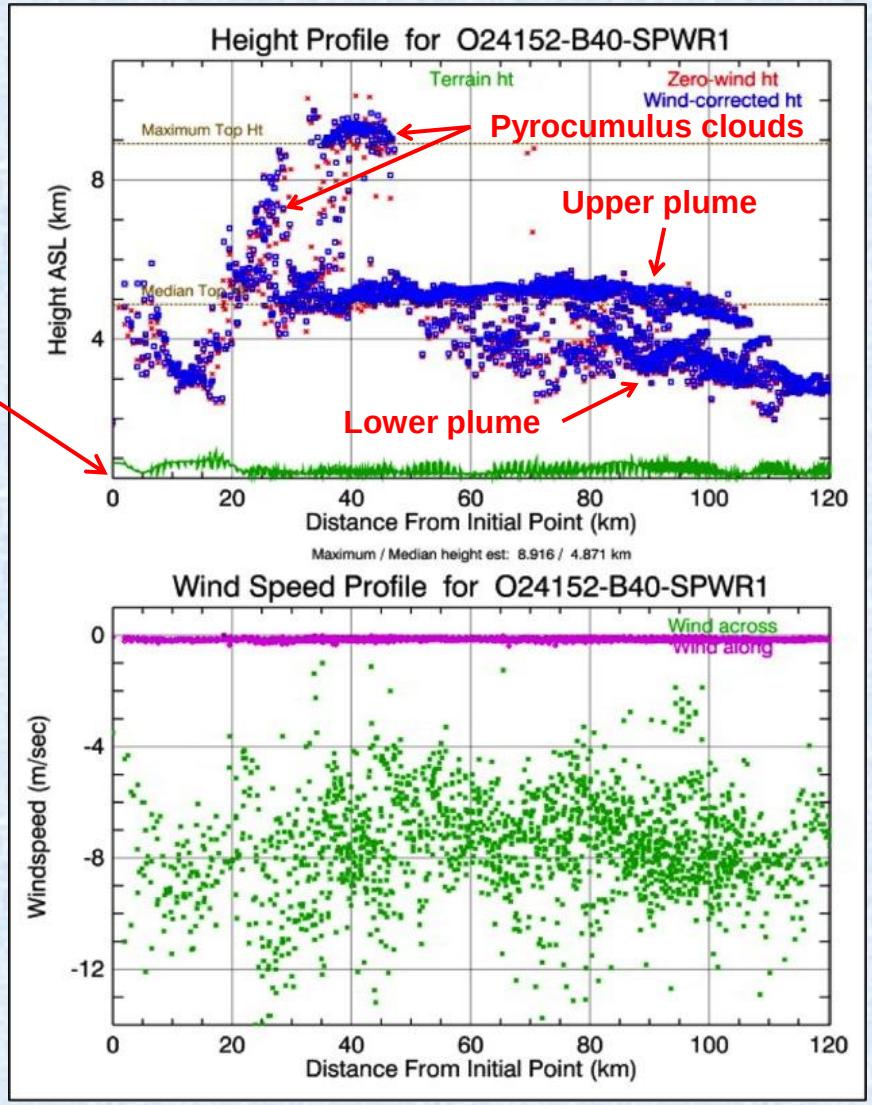
Hover over window then click arrow to start movie

Alaska Fire, July 2, 2004 (5054 MW)





Plume origin



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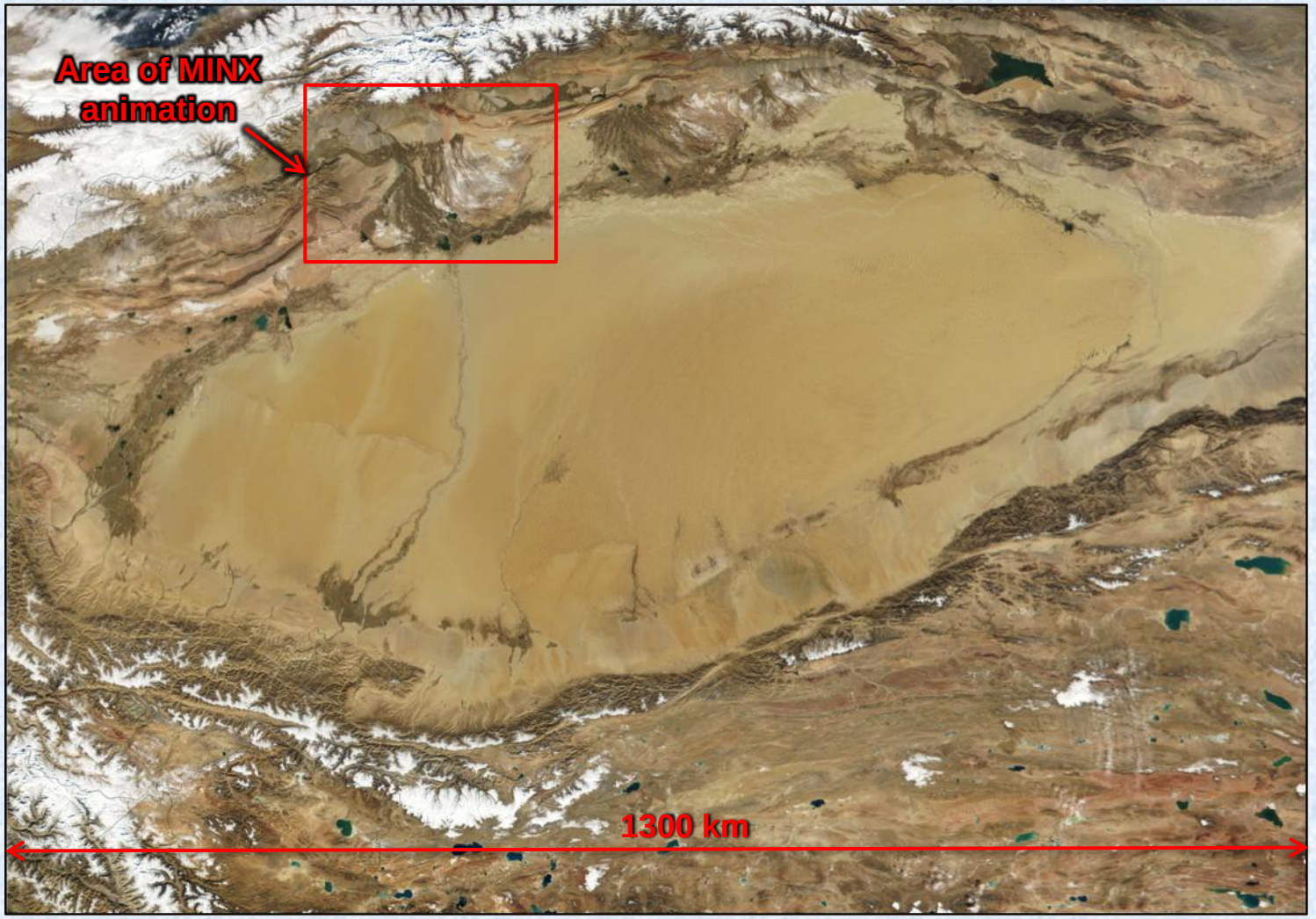
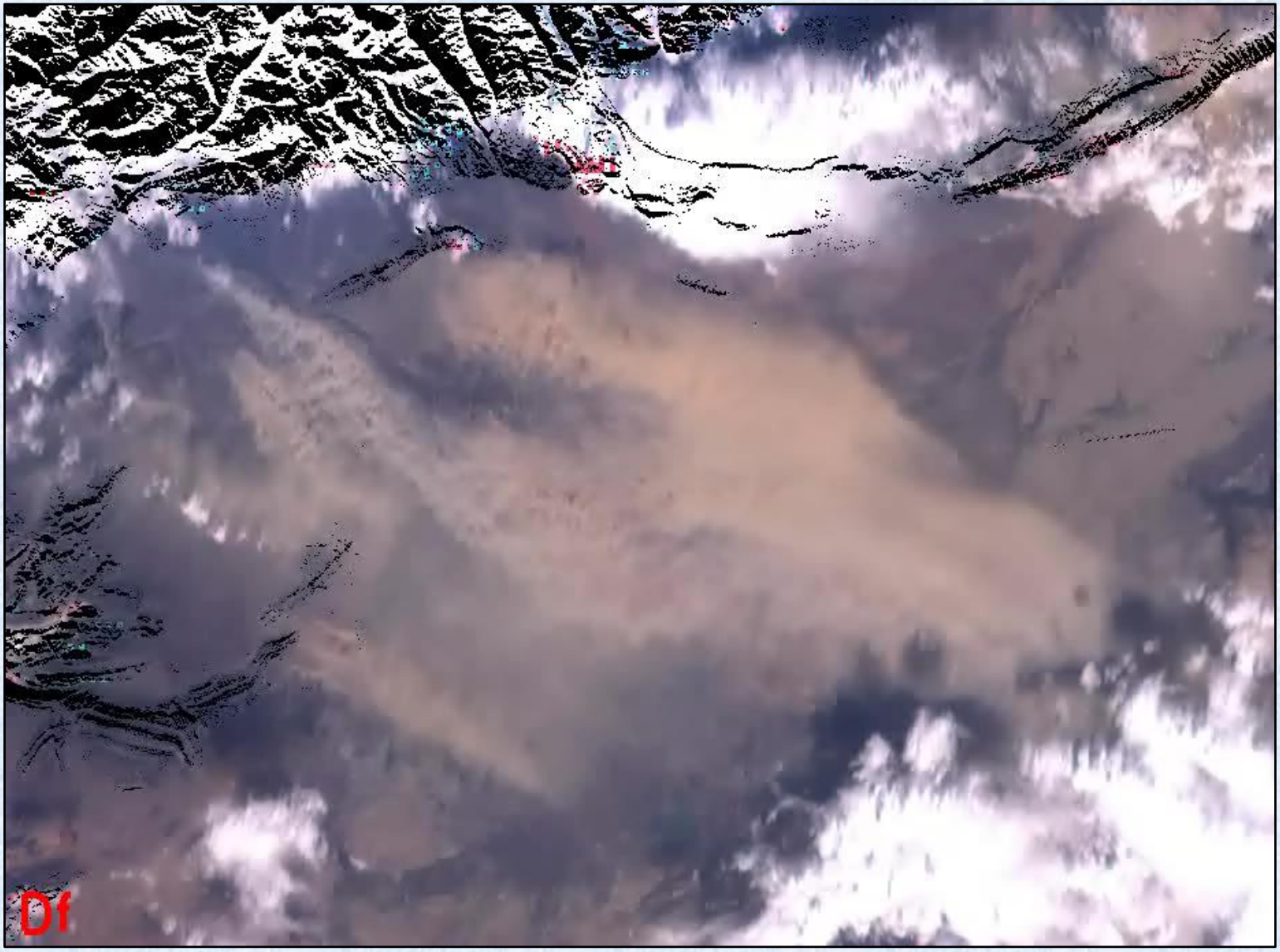
Dust Plumes - Taklamakan Desert in Tarim Basin

North of Tibetan Plateau (MODIS Image)

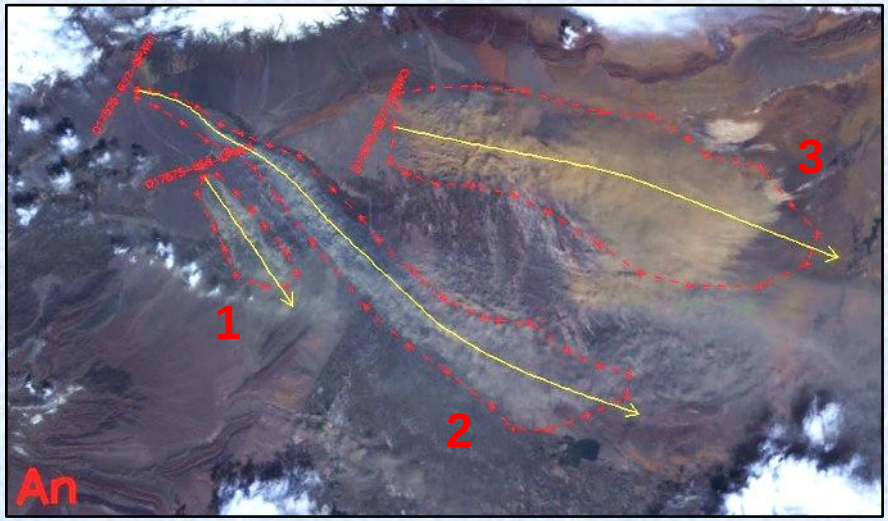


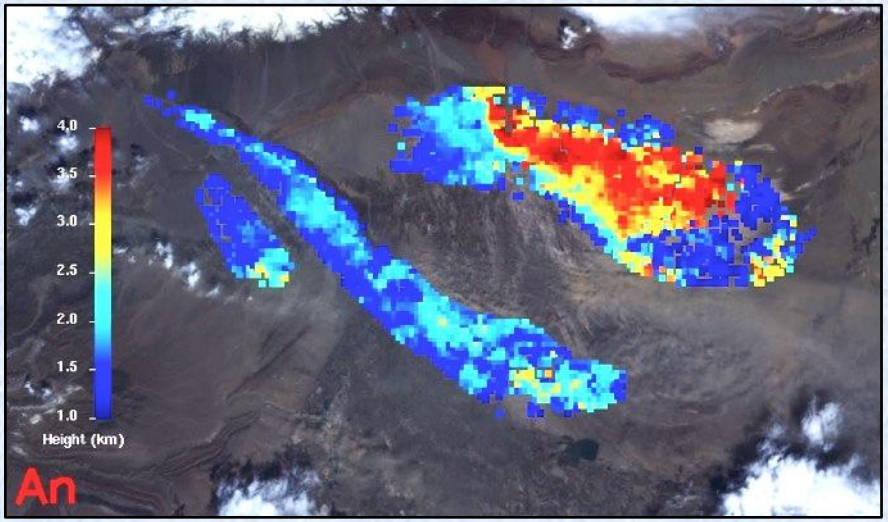
Taklamakan Dust – Orbit 17575 – April 8, 2003

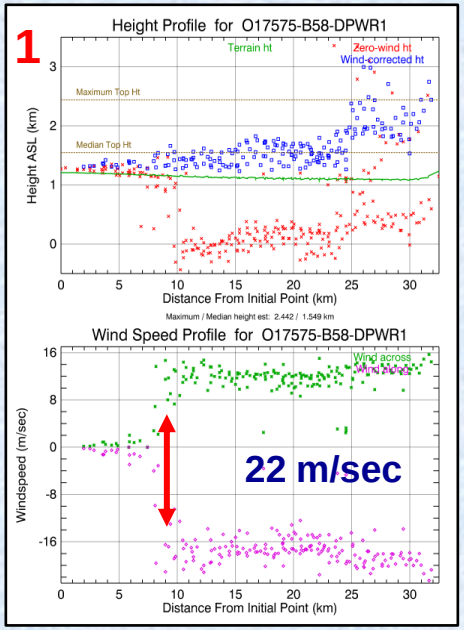


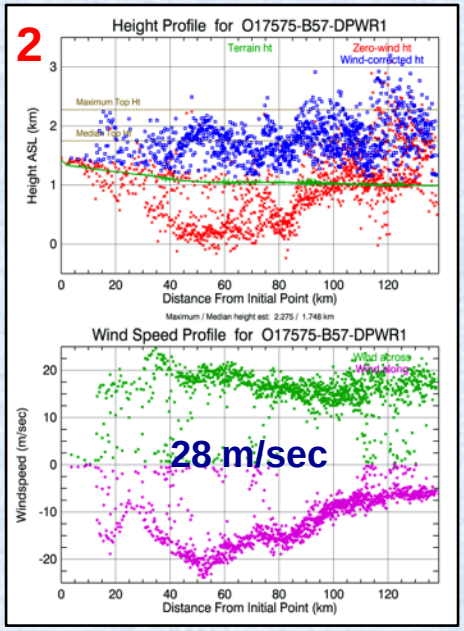
Hover over window then click arrow to start movie

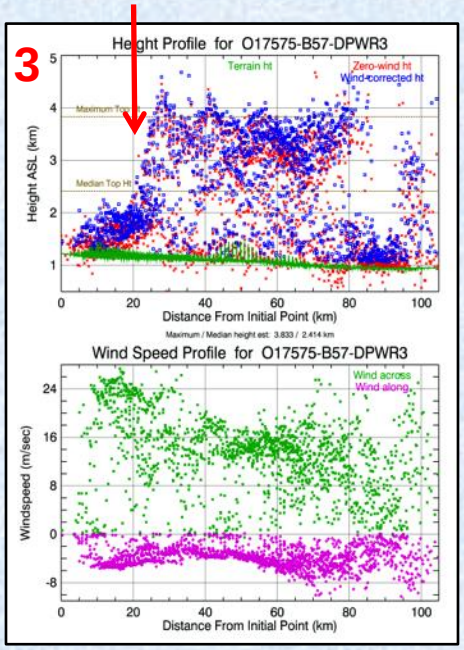
Taklamakan Dust – Orbit 17575 – April 8, 2003











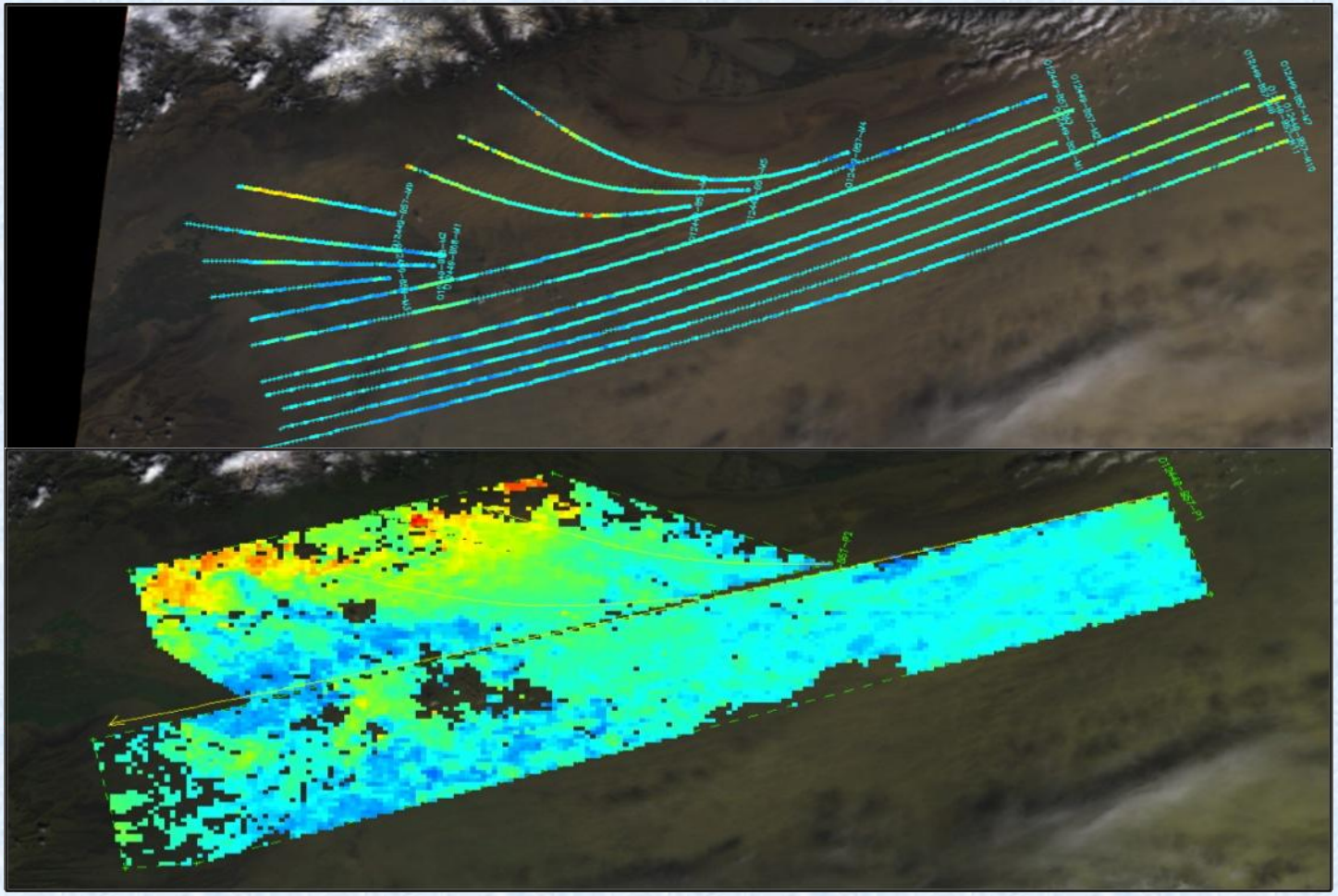
Several dust sources are linear - probably dry stream beds

Wind speed increases abruptly on plume 1

Dust rises about 3 km on plume 3

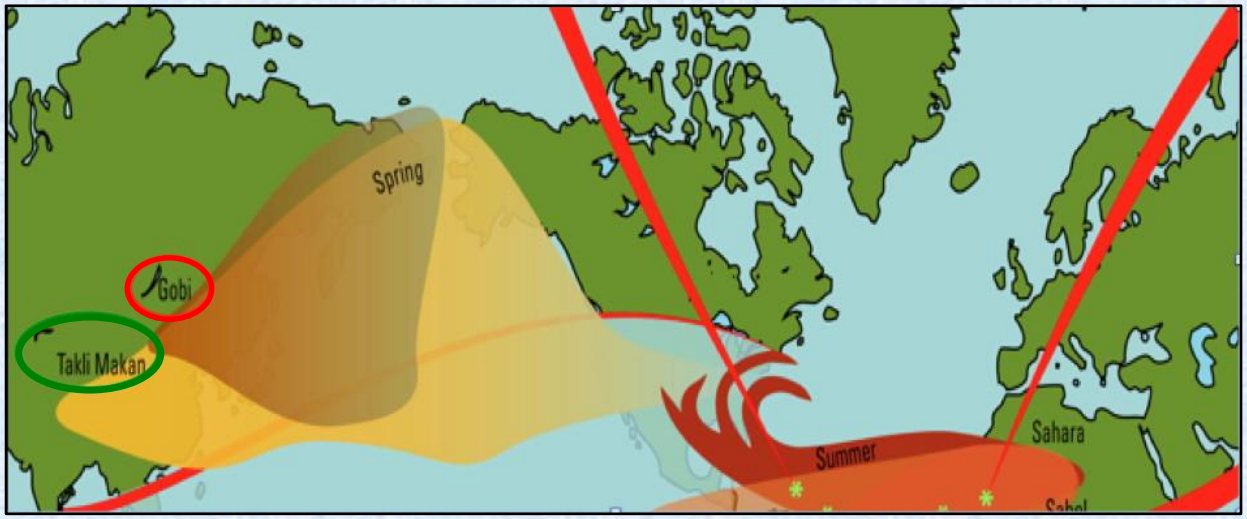
Taklamakan Desert

Digitizing Alternatives – Lines or Polygons

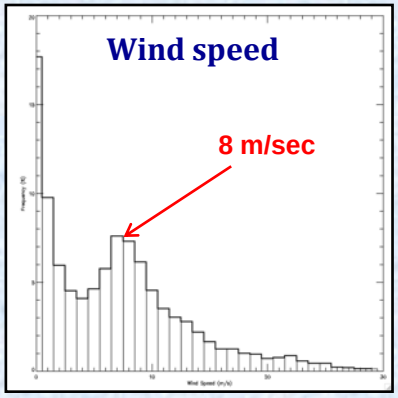


Courtesy of Michael Goetz, Olga Kalashnikova and Mike Garay, JPL, 2011

Taklamakan vs Gobi Dust Plume Heights and Wind Speeds



Taklamakan



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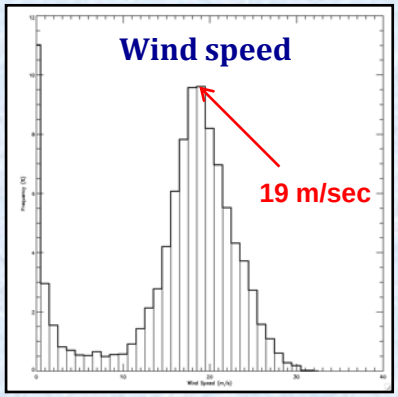

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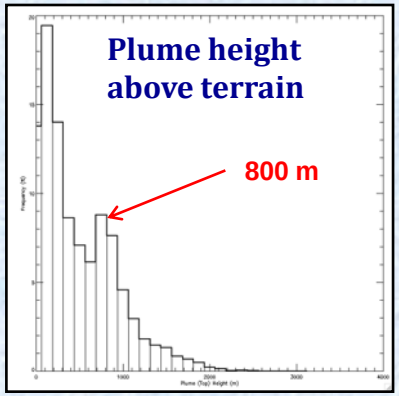

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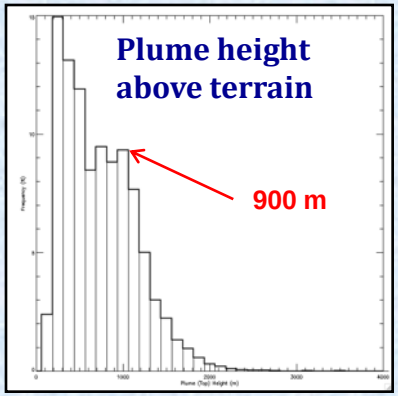

Courtesy of Michael Goetz, Olga Kalashnikova and Mike Garay, JPL, 2011

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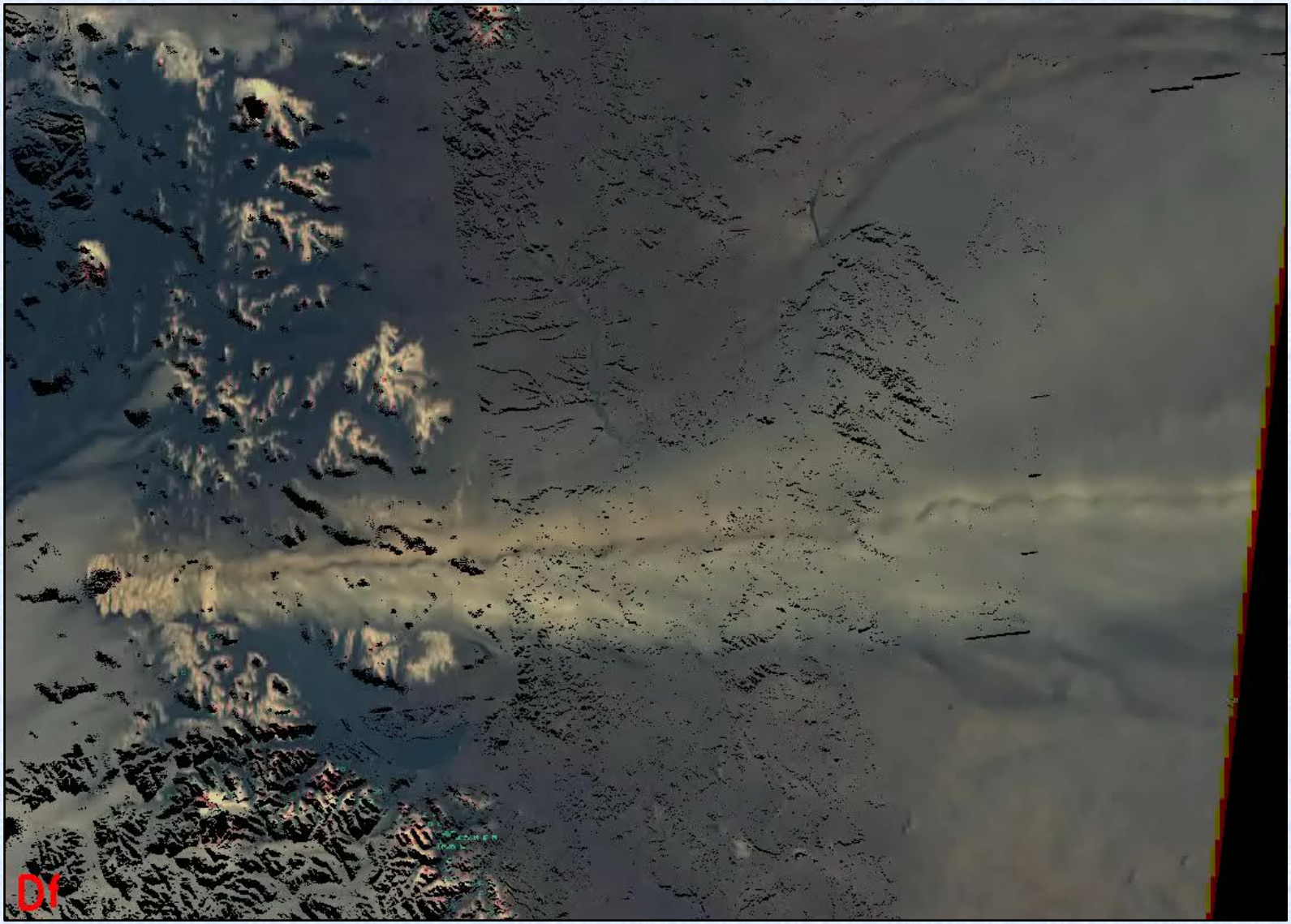
- **Volcanic ash over Chile**
- **Snow storm in Antarctica**

Volcanic Plumes - Puyehue-Cordon, Chile - June, 2011

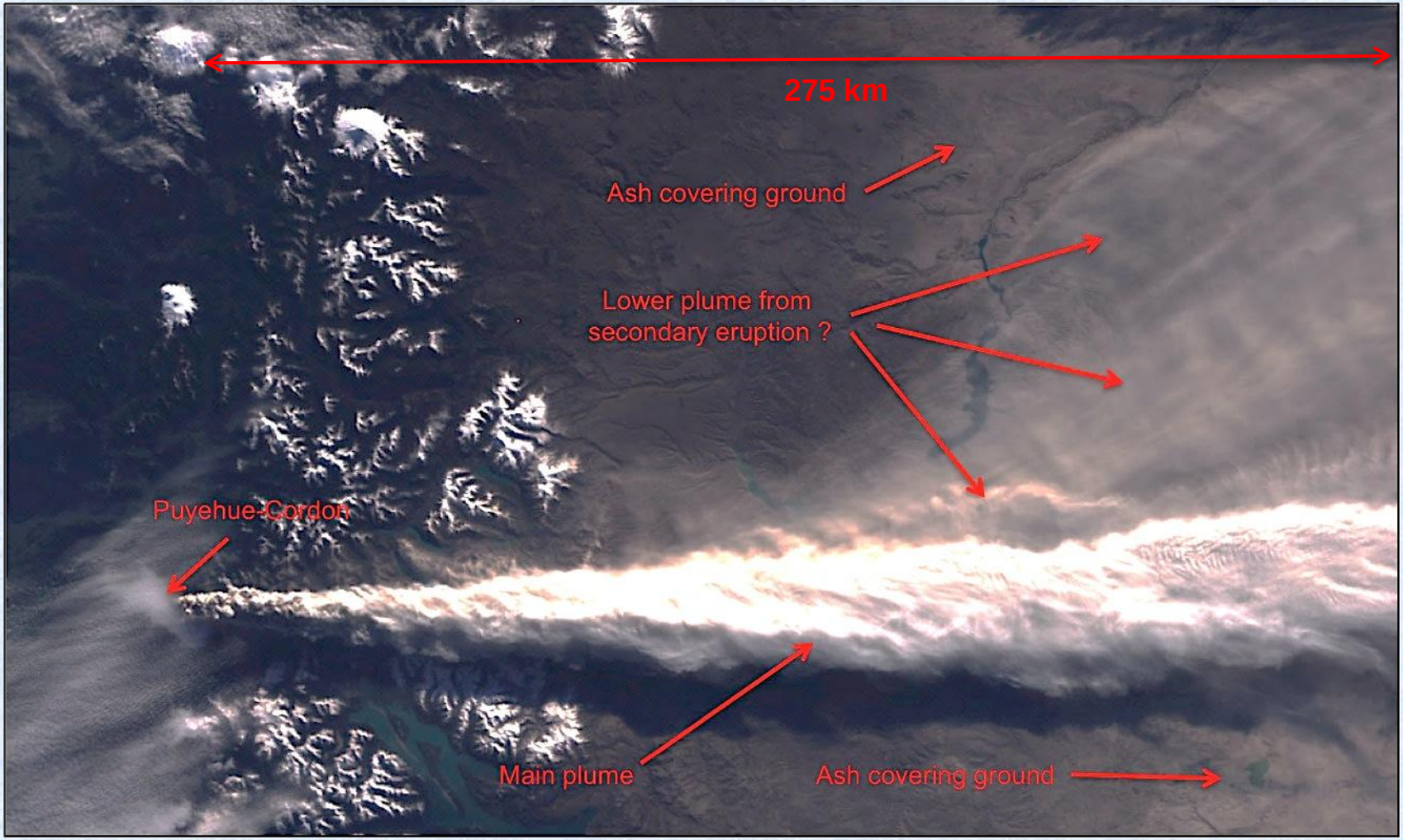
Puyehue-Cordon Eruption - Animation



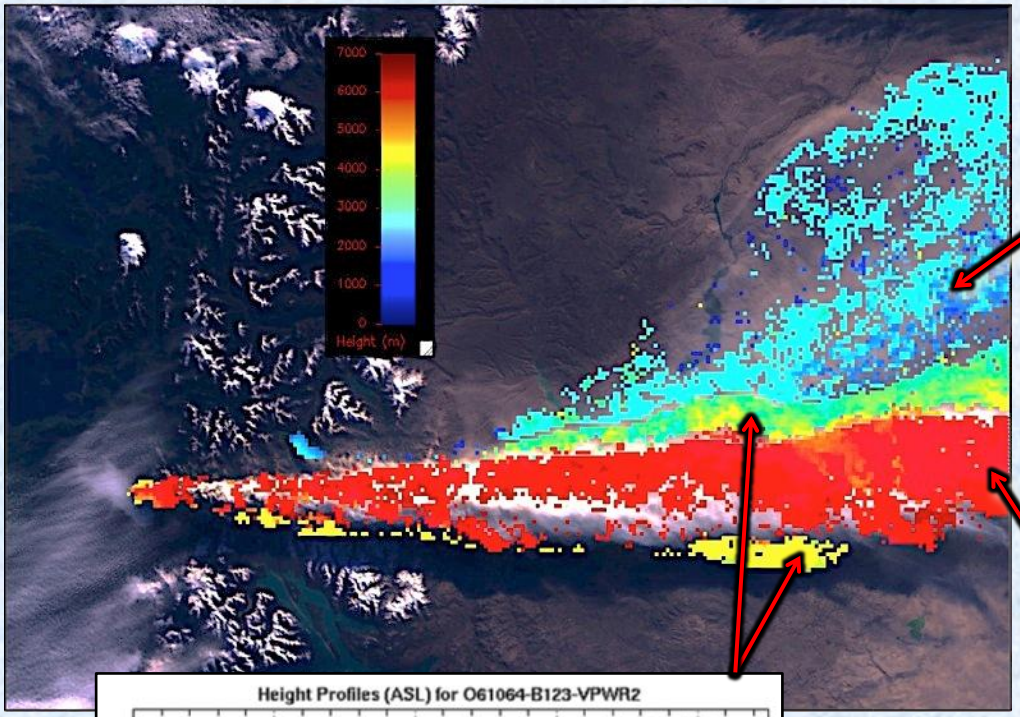
Hover over window then click arrow to start movie

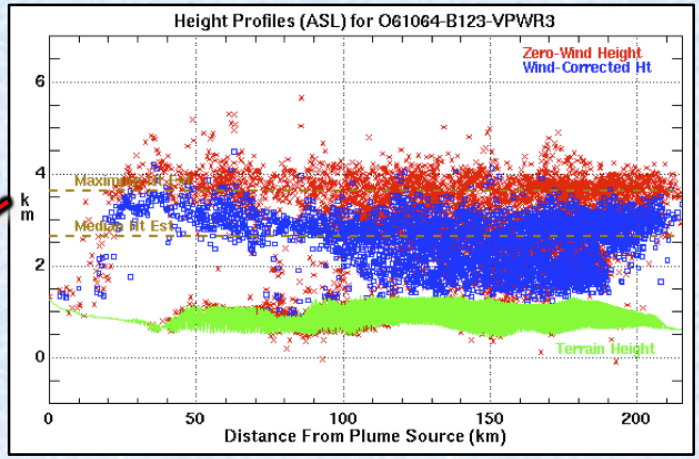
Puyehue-Cordon Eruption

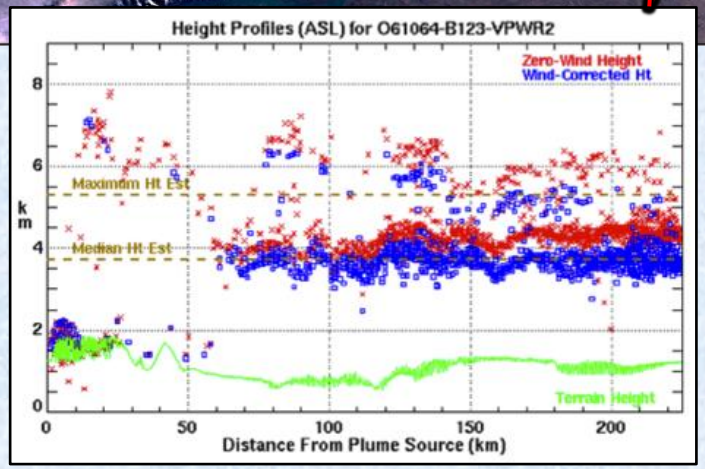
Orbit 61064 - June 11, 2011

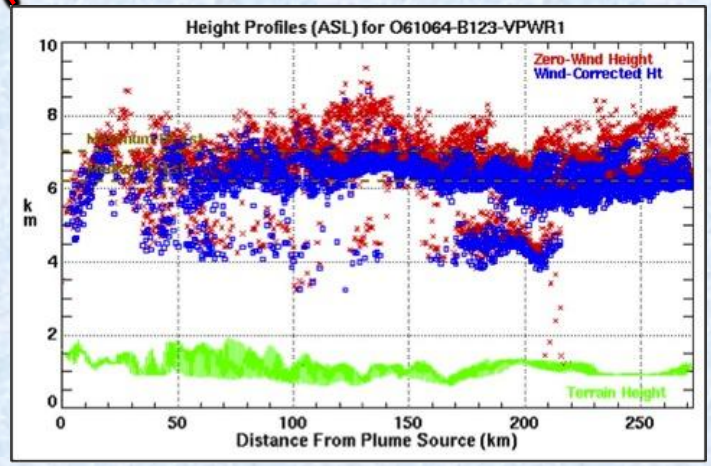


Puyehue-Cordon – Height Retrievals









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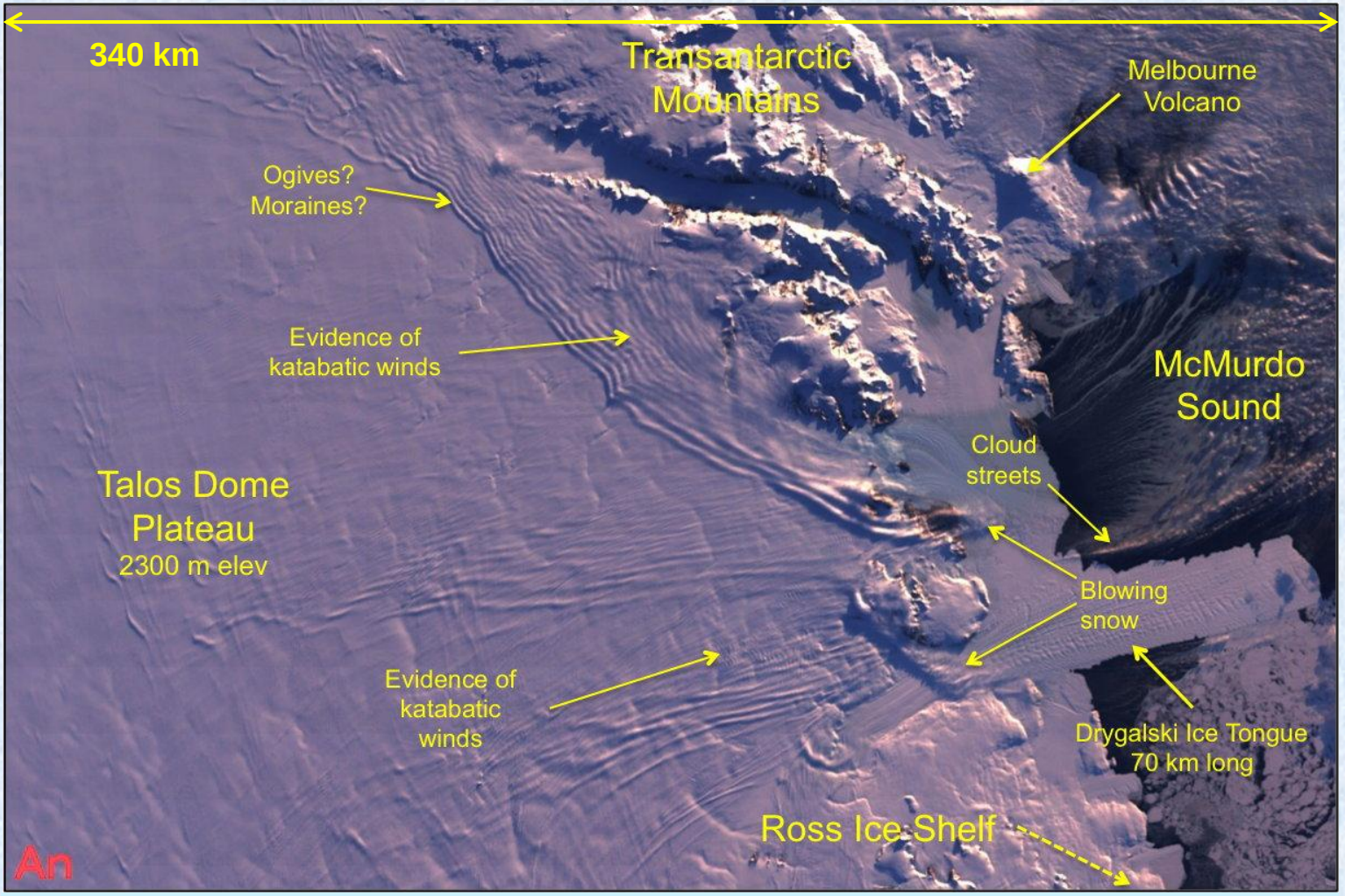
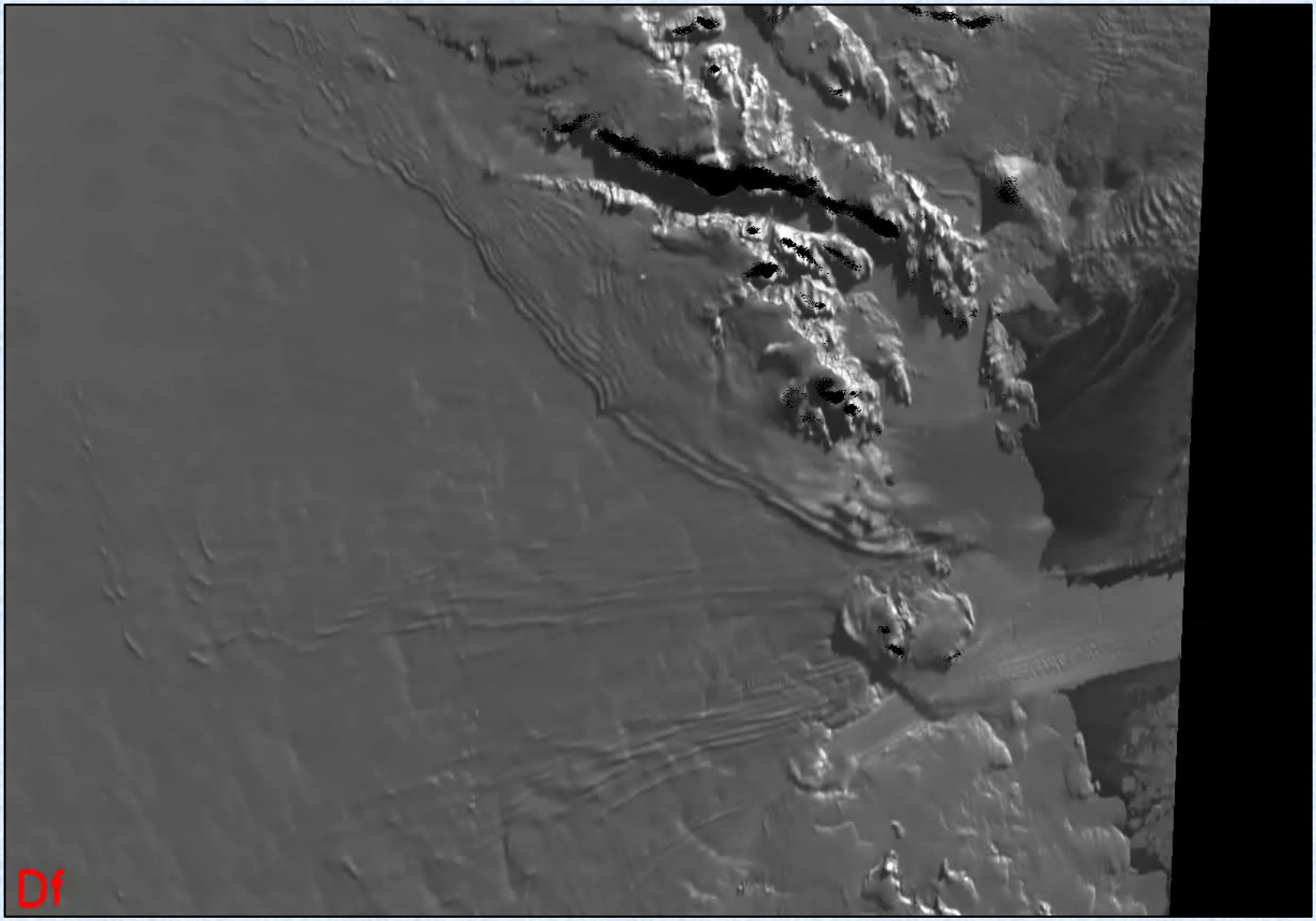
Snow Plumes - Antarctic Blizzard

Orbit 38671 - March, 2007



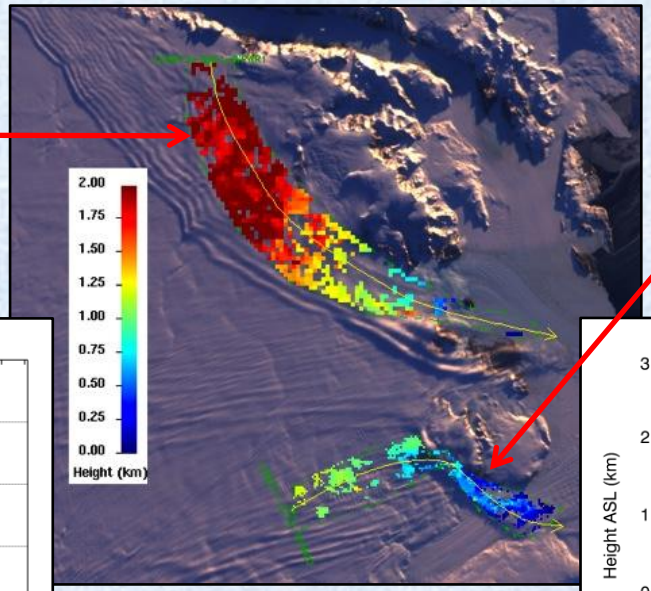
Antarctic Blizzard – Red-band Animation



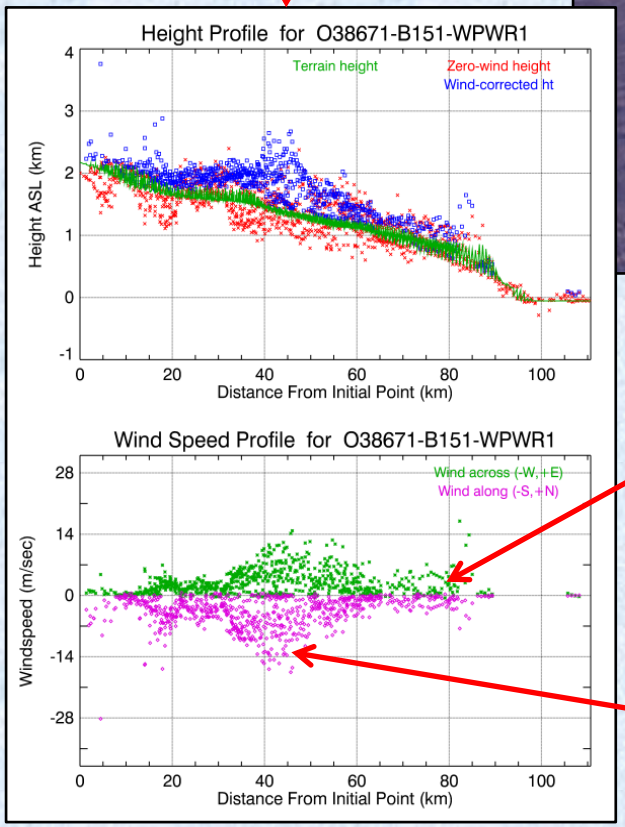
Hover over window then click arrow to start movie

Antarctic Blowing Snow - Height/Wind Retrievals

Snow drops 2 km, and is confined to glacial ridges

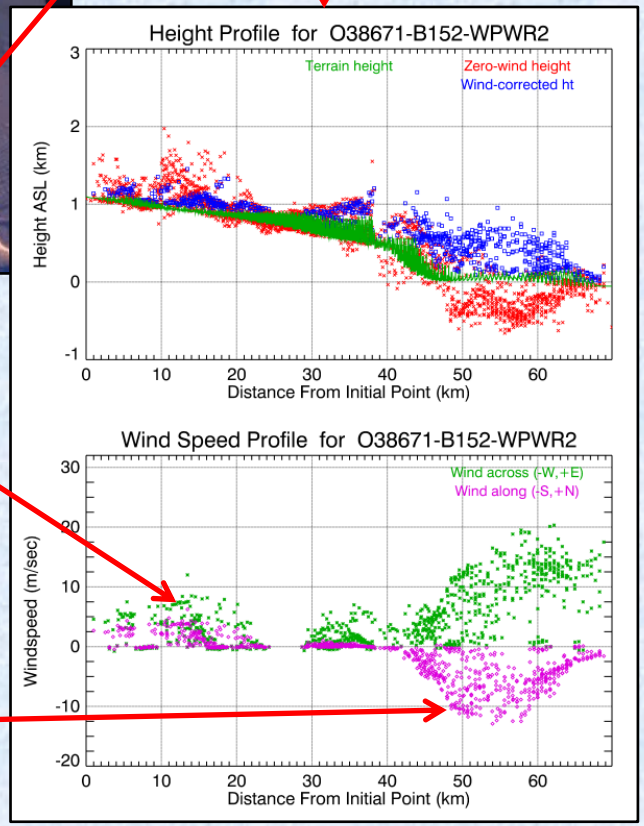


Snow drops 1 km, is diverted by mountain, and becomes airborne over David Glacier



When snow remains near the surface, wind speeds are low due to transport by saltation (< 8 m/sec ~= 30 km/hr)

When snow is airborne, wind speeds are higher (~ 22 m/sec ~= 80 km/hr)



References

- Val Martin, M., et al, 2009. “Vertical Transport of Wildfire Smoke over North America: Merging Satellite Observations and Models”, presentation to European Geosciences Union.
- MISR Plume Height Project website - http://www-misr.jpl.nasa.gov/getData/accessData/MisrMinxPlumes/