



GLOW Participation in HARGLO-2: Results and Future Prospects

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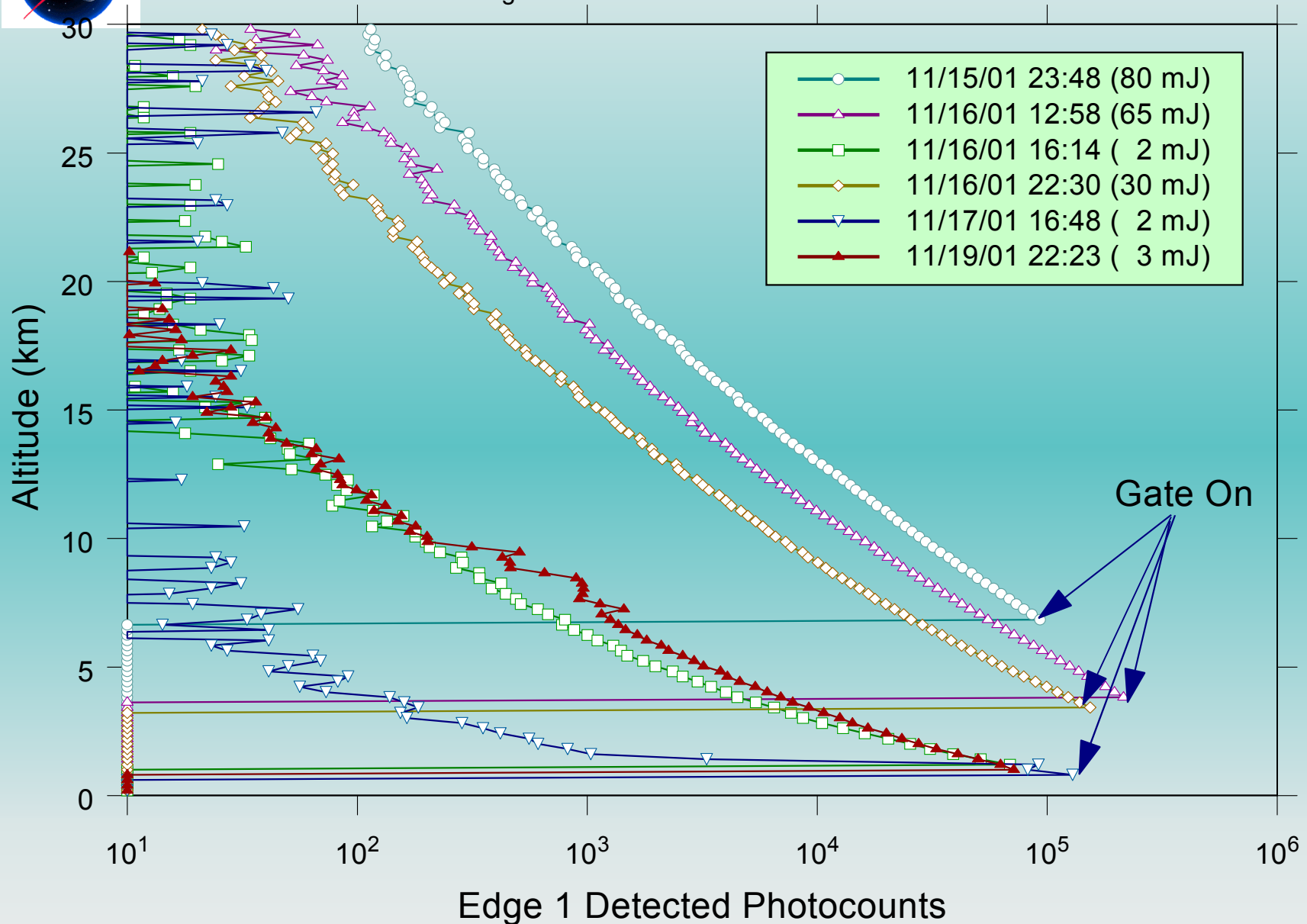
Outline

- Review GLOW operations during HARGLO-2
 - >27 hours of wind profiles obtained in 4 days of operations.
 - Coincident operation with HARLIE, SPANDAR, WFF rawinsondes.
 - Measurements gridded to common spatial (200 m vertical) and temporal resolution (30 minutes) to facilitate intercomparisons.
 - Transmitted laser energy varied to maximize coverage and overlap with HARLIE aerosol measurements.
 - Wind speed and direction derived from LOS winds measured at 4 azimuth angles (0,90,180,270 deg) and fixed elevation of 45 degrees. Vertical profile taken to complete scan sequence.
- Status of data analysis and intercomparisons
 - Example wind profiles and comparisons with sondes
 - Error analysis



HARGLO-2: GLOW Signal Levels

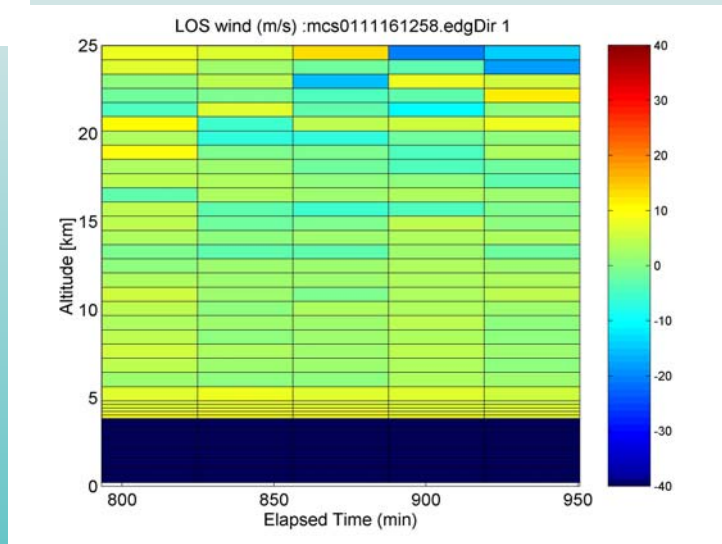
Edge Channel 1 PMT Detected Counts



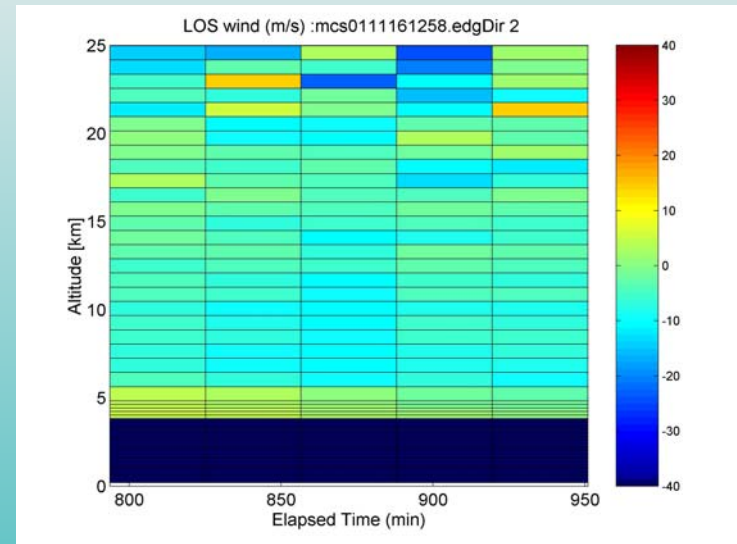


LOS Winds - Nov. 16, 2001 12:58 UT

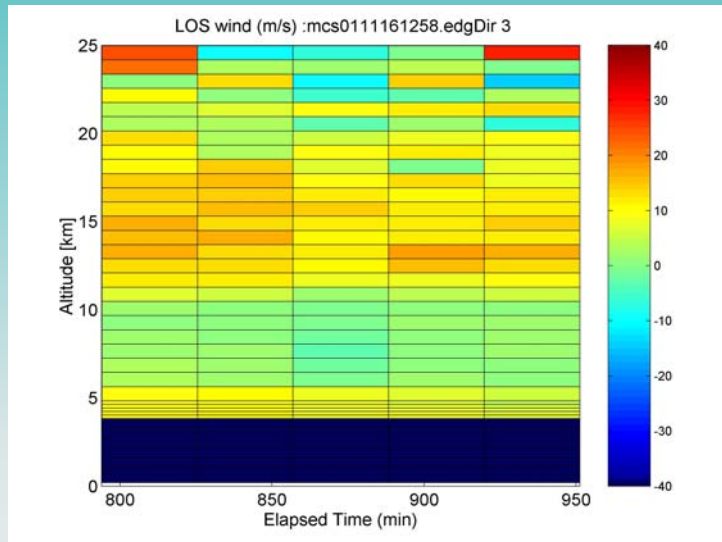
45 deg elevation; 5 min average per azimuth



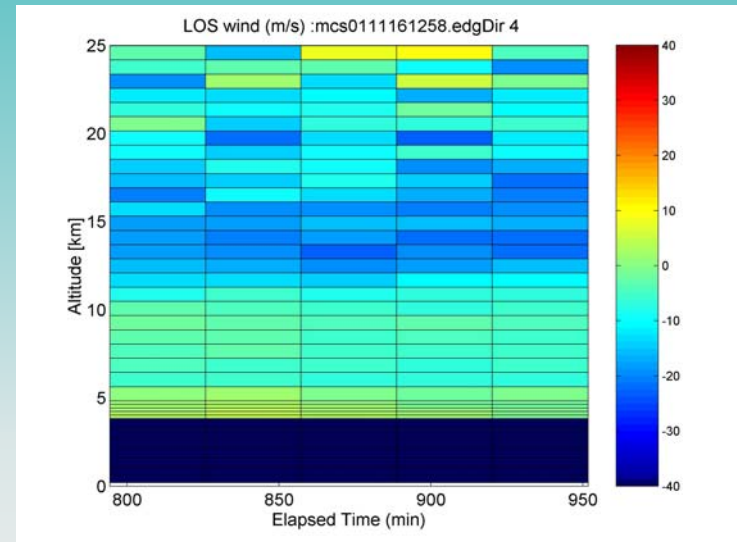
Azimuth = 0 deg



Azimuth = 180 deg



Azimuth = 270 deg



Azimuth = 90 deg



Measured signals Edg1 and Edg2 from are obtained from 4 azimuths N, S, W, E at elevation of Θ degrees. Given a sensitivity $Sens$ and the ratios

$$R_i = \frac{Edg\ 1_i}{Edg\ 2_i}; i = N, S, E, W$$

the wind speed v is given by

$$v = \sqrt{v_x^2 + v_y^2}$$

where

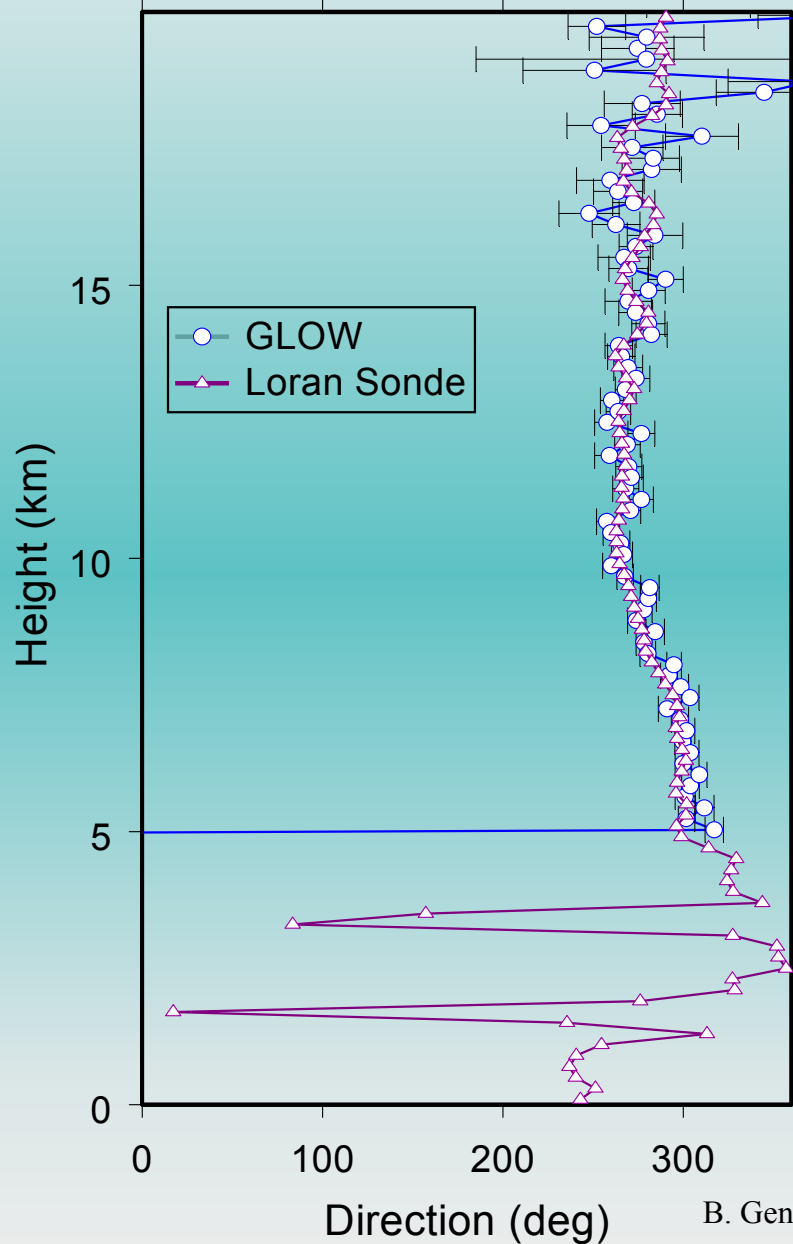
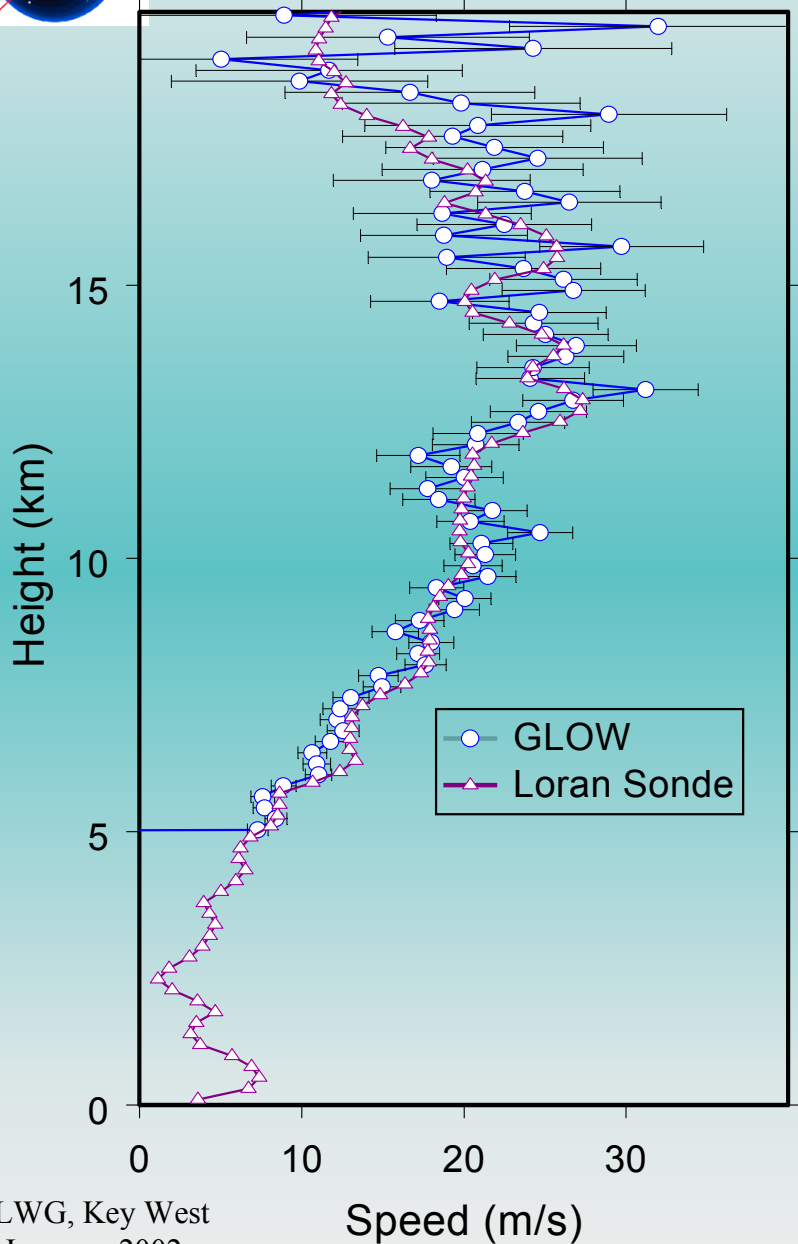
$$v_x = \frac{(R_W - R_E)}{(R_W + R_E)} * \frac{1}{Sens * \cos \Theta}$$

$$v_y = \frac{(R_N - R_S)}{(R_N + R_S)} * \frac{1}{Sens * \cos \Theta}$$



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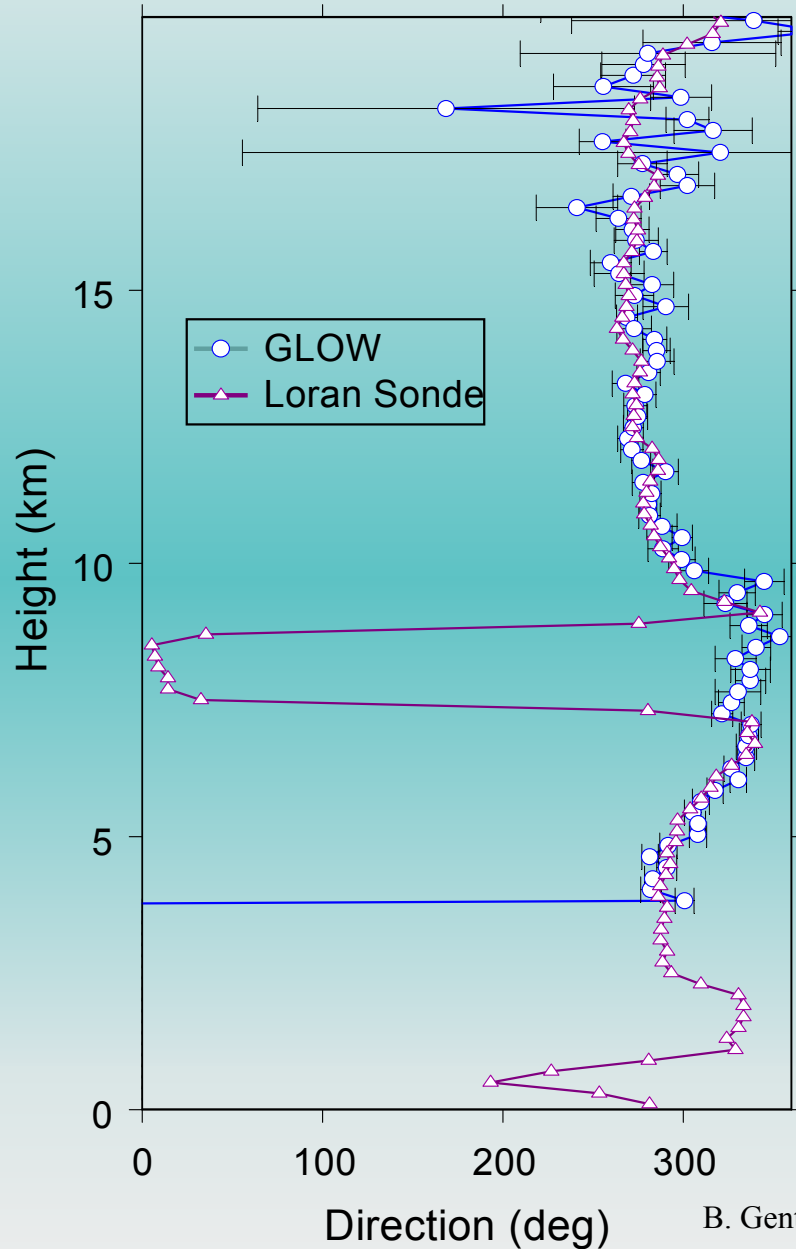
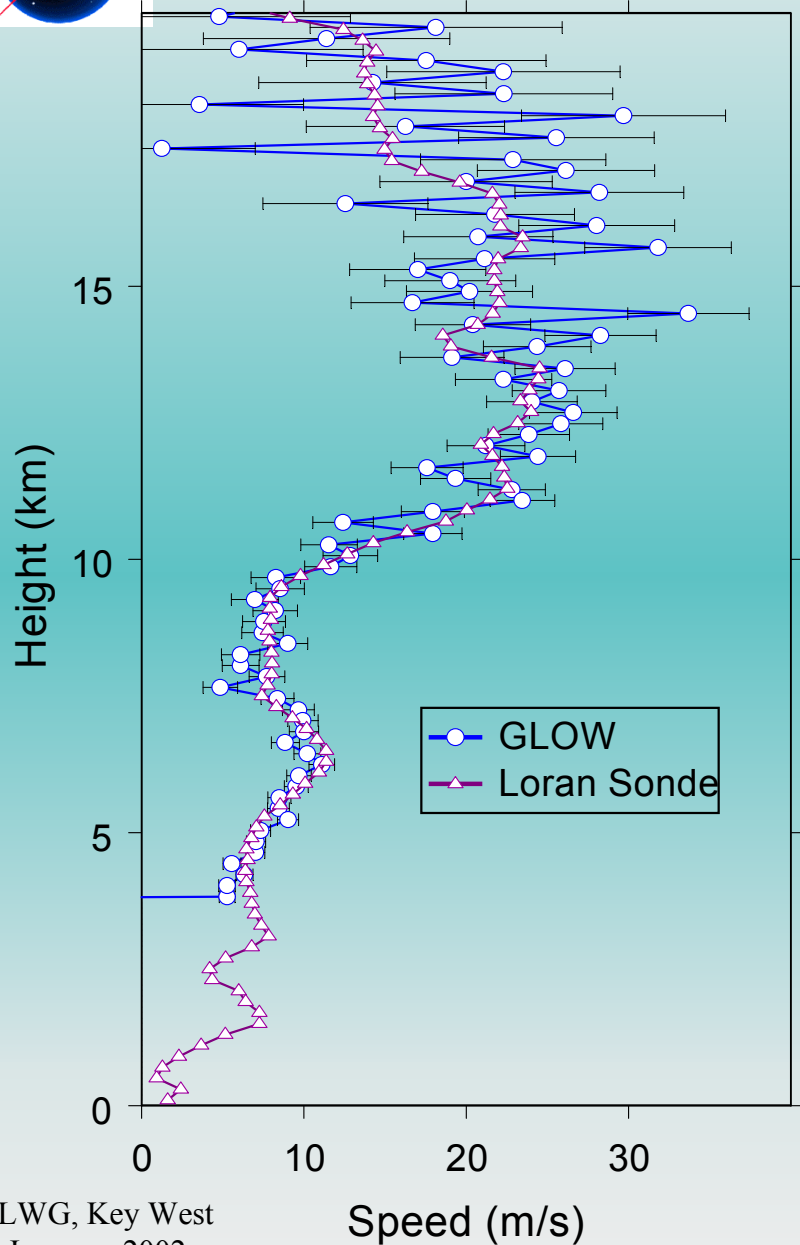
Profiles derived from 4 LOS; 5 min integration/LOS; 200 m vertical res

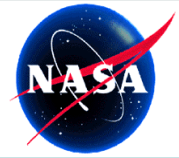




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Profiles derived from 4 LOS; 5 min integration/LOS; 200 m vertical res





Given component velocities v_x, v_y and their errors Δv_x and Δv_y , the error in the measured speed Δv , is given by

$$\Delta v^2 = \left(\frac{\partial v}{\partial v_x} \Delta v_x \right)^2 + \left(\frac{\partial v}{\partial v_y} \Delta v_y \right)^2$$

where

$$\frac{\partial v}{\partial v_x} = \frac{v_x}{v} \quad \text{and} \quad \frac{\partial v}{\partial v_y} = \frac{v_y}{v}$$

Assuming error in measured component velocities is dominated by the shot noise in the detected signals Edg1 and Edg2 gives

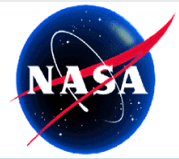
$$\Delta v_x = \frac{2R_W R_E}{(R_W + R_E)^2} * \frac{1}{Sens * \cos \Theta} * \sqrt{\frac{1}{Edg1_W} + \frac{1}{Edg2_W} + \frac{1}{Edg1_E} + \frac{1}{Edg2_W}}$$

and

$$\Delta v_y = \frac{2R_N R_S}{(R_N + R_S)^2} * \frac{1}{Sens * \cos \Theta} * \sqrt{\frac{1}{Edg1_N} + \frac{1}{Edg2_N} + \frac{1}{Edg1_S} + \frac{1}{Edg2_S}}$$

$$\Delta v^2 = \left(\frac{v_x}{v} * \frac{2R_W R_E}{(R_W + R_E)^2} * \frac{1}{Sens * \cos \Theta} \right)^2 * \left(\frac{1}{Edg1_W} + \frac{1}{Edg2_W} + \frac{1}{Edg1_E} + \frac{1}{Edg2_W} \right) + \dots$$

$$\left(\frac{v_y}{v} * \frac{2R_N R_S}{(R_N + R_S)^2} * \frac{1}{Sens * \cos \Theta} \right)^2 * \left(\frac{1}{Edg1_N} + \frac{1}{Edg2_N} + \frac{1}{Edg1_S} + \frac{1}{Edg2_S} \right)$$



Given the wind speed v and component velocities v_x, v_y
the wind direction Φ in radians is

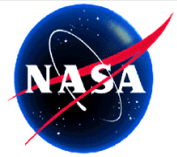
$$\Phi = \arcsin\left(\frac{v_y}{v}\right)$$

The error in direction $\Delta\Phi$ is

$$\Delta\Phi^2 = \left(\frac{\partial\Phi}{\partial v_x} \Delta v_x\right)^2 + \left(\frac{\partial\Phi}{\partial v_y} \Delta v_y\right)^2$$

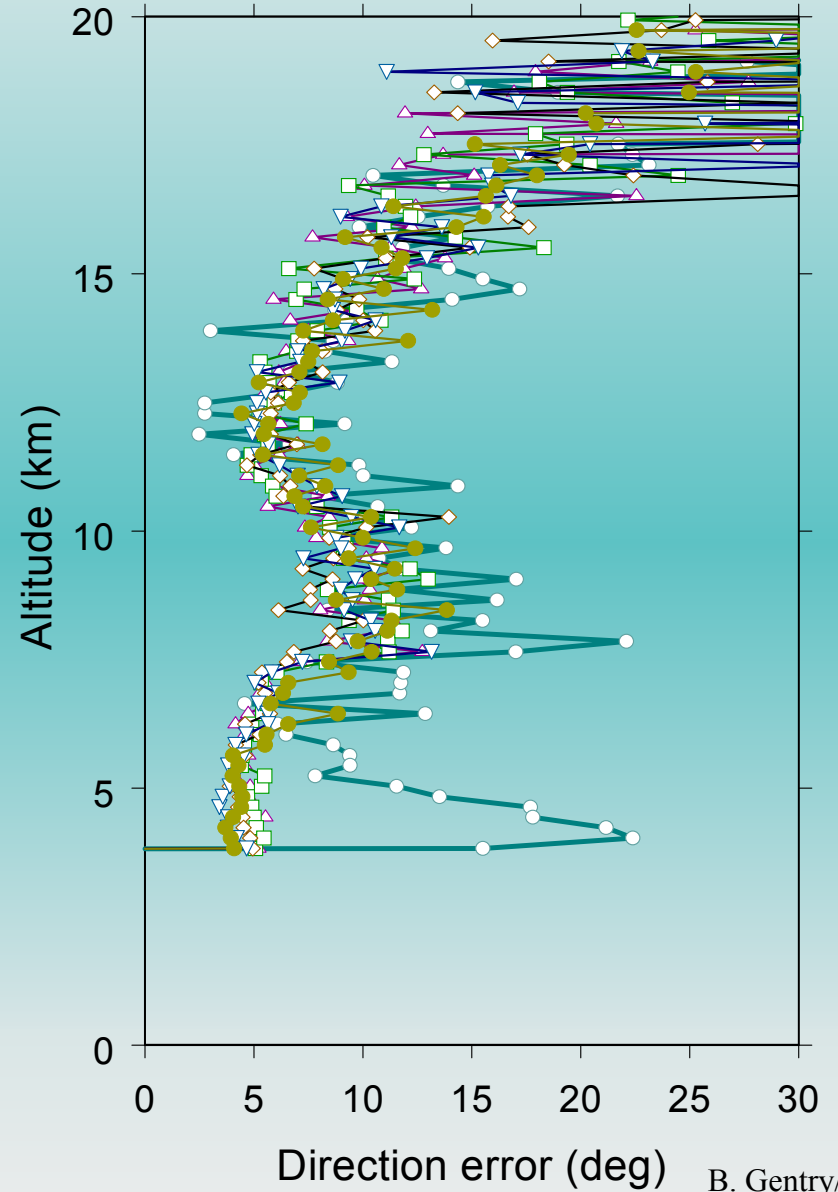
where Δv_x and Δv_y are the errors in the component velocities and

$$\frac{\partial\Phi}{\partial v_x} = \frac{1}{v_y} * \left(1 - \frac{v_x^2}{v^2}\right) \quad \text{and} \quad \frac{\partial\Phi}{\partial v_y} = \frac{-v_y}{v^2}$$



Wind Errors - mcs0111161258

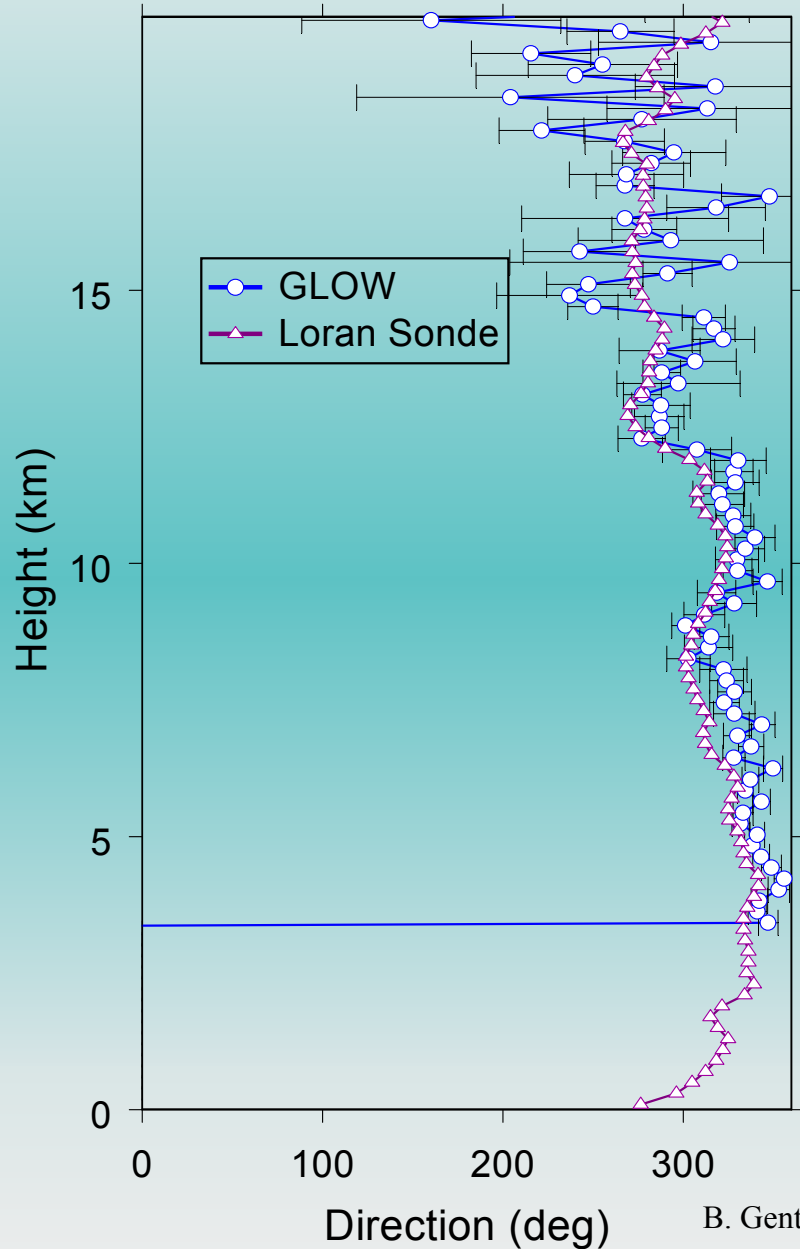
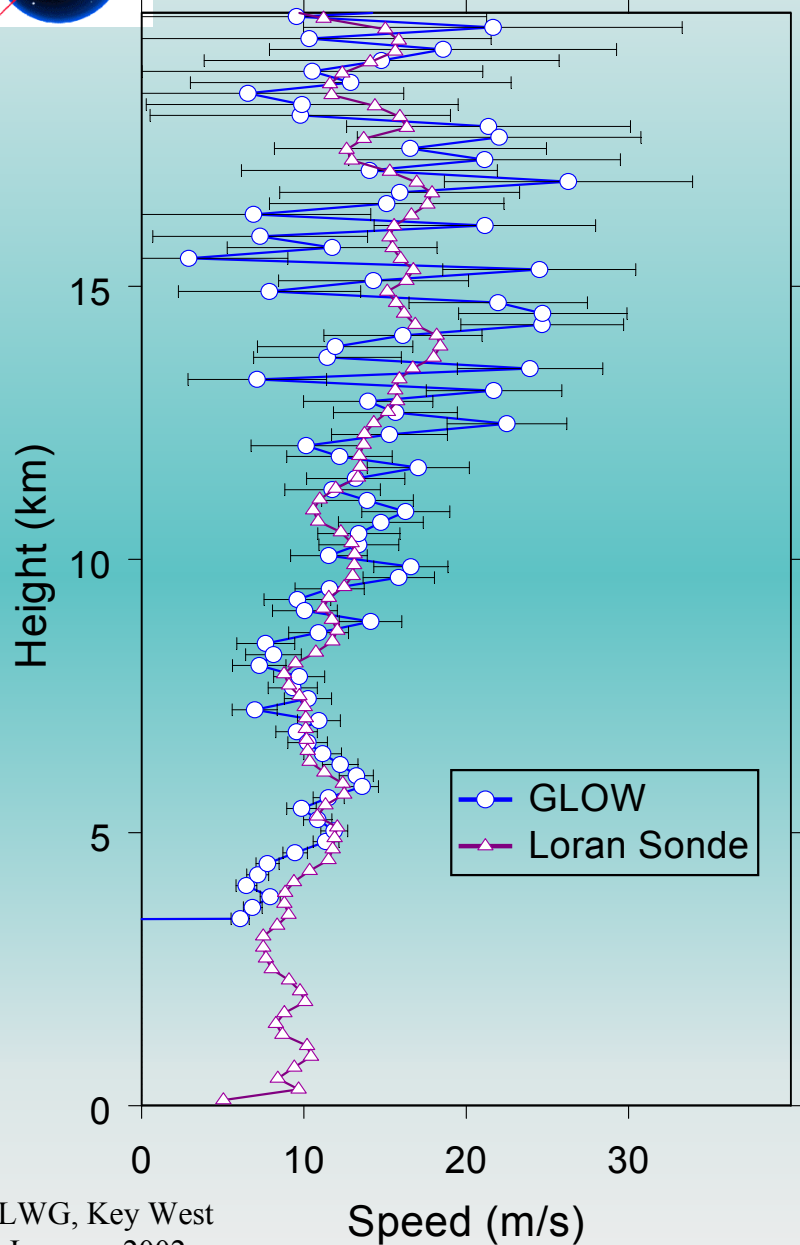
$\Delta z=200$ m





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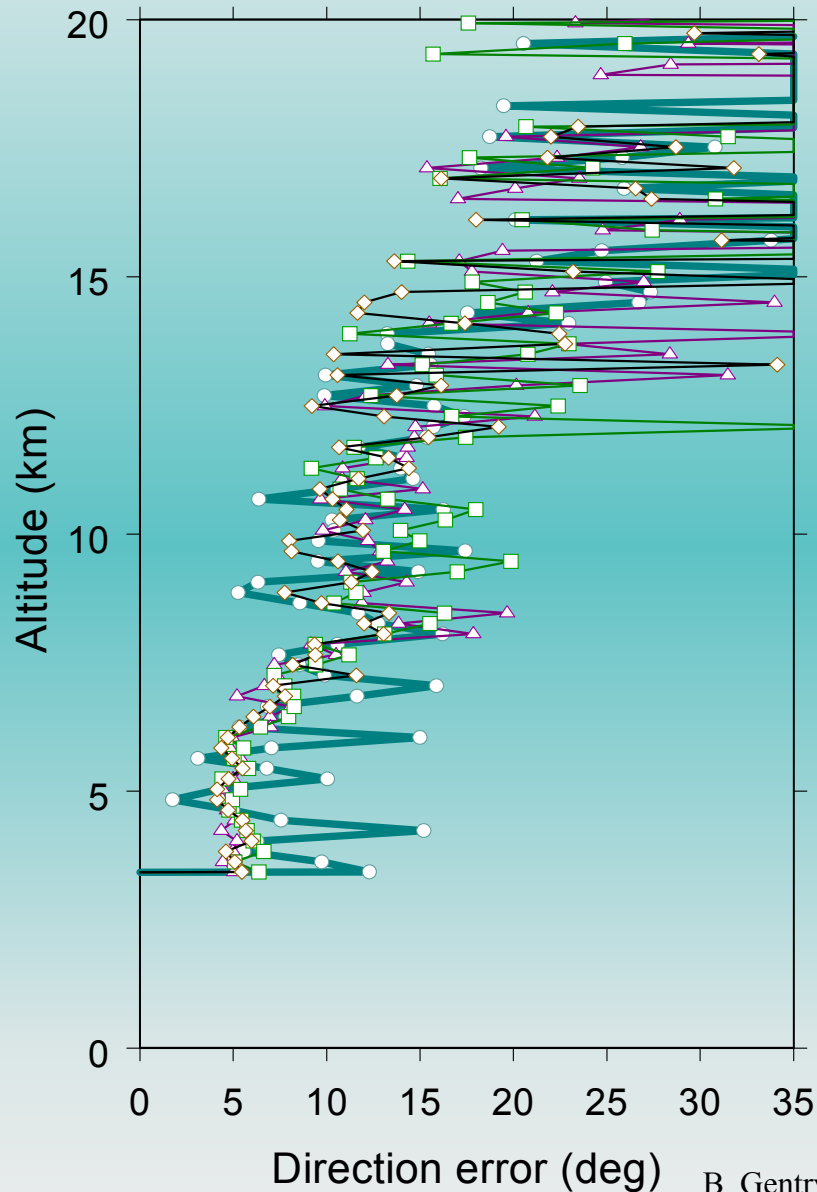
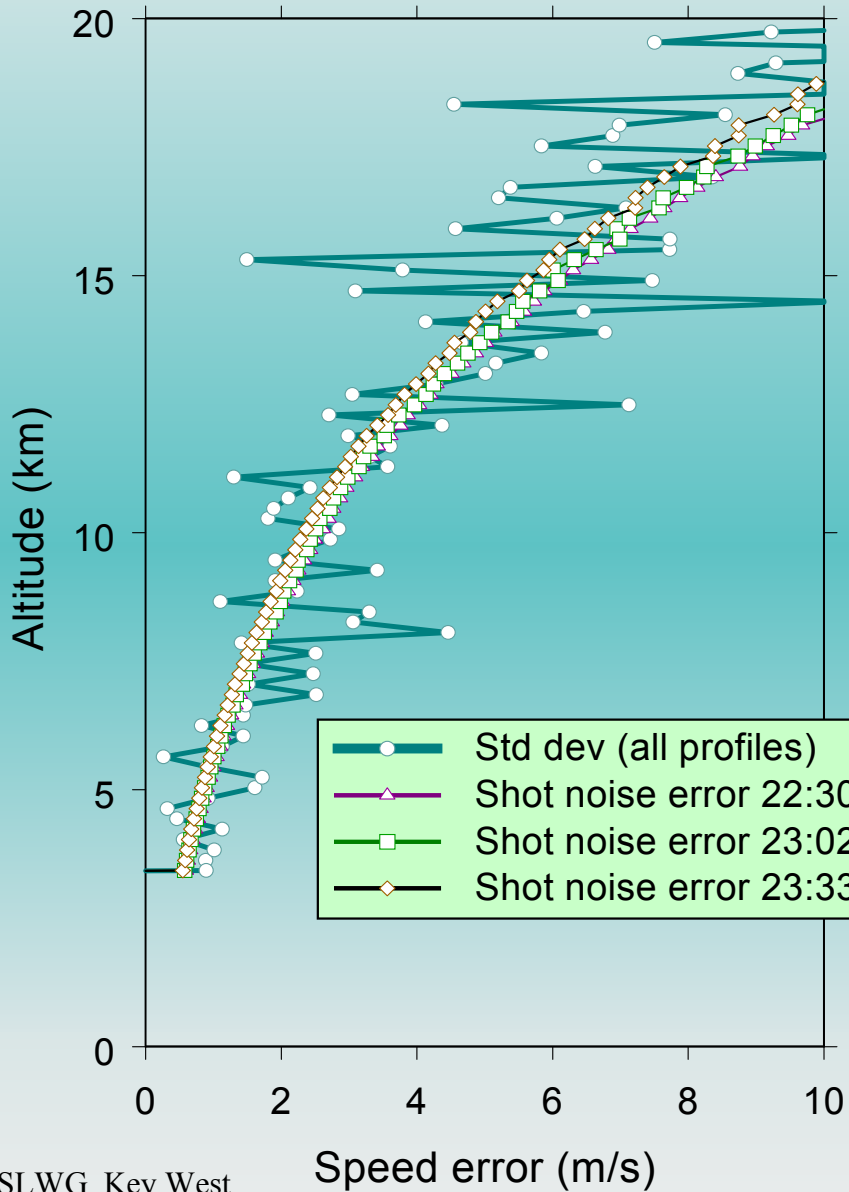
Profiles derived from 4 LOS; 5 min integration/LOS; 200 m vertical res

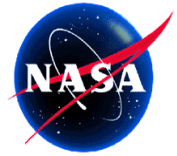




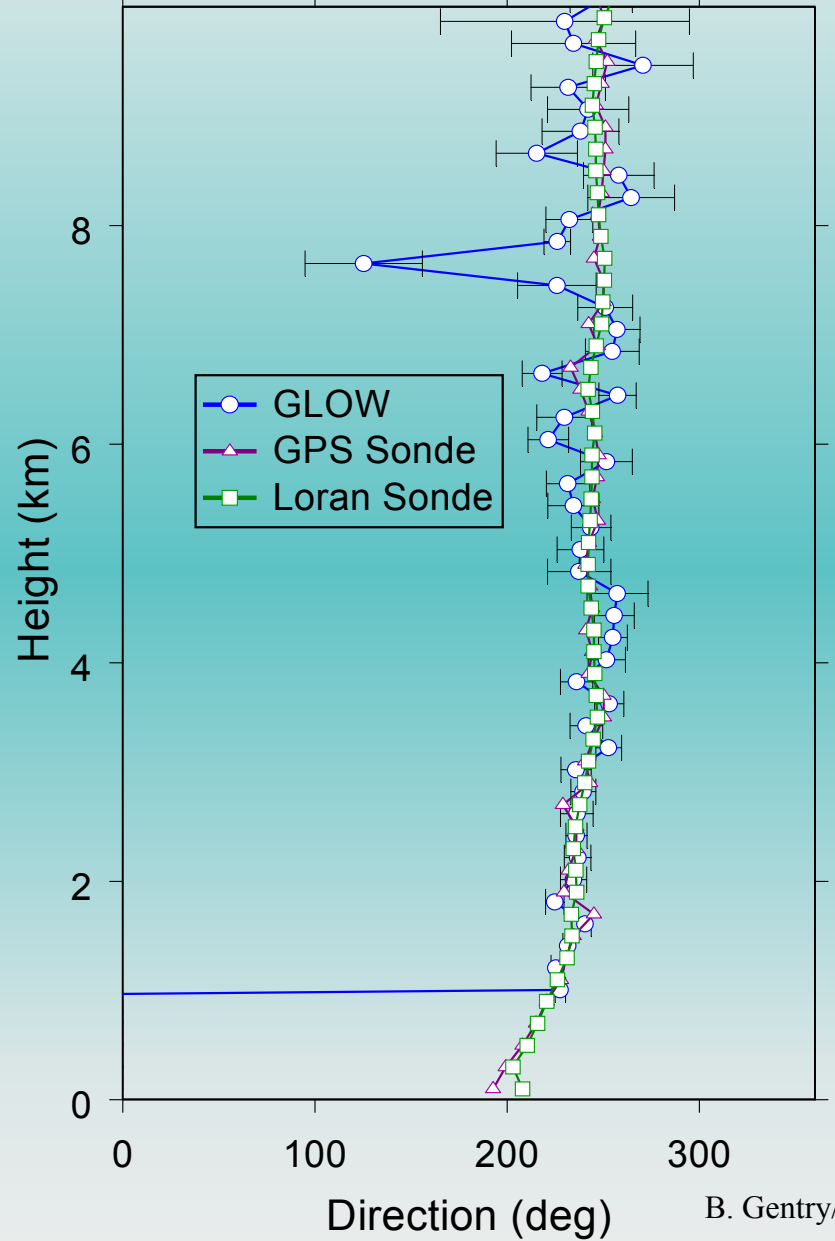
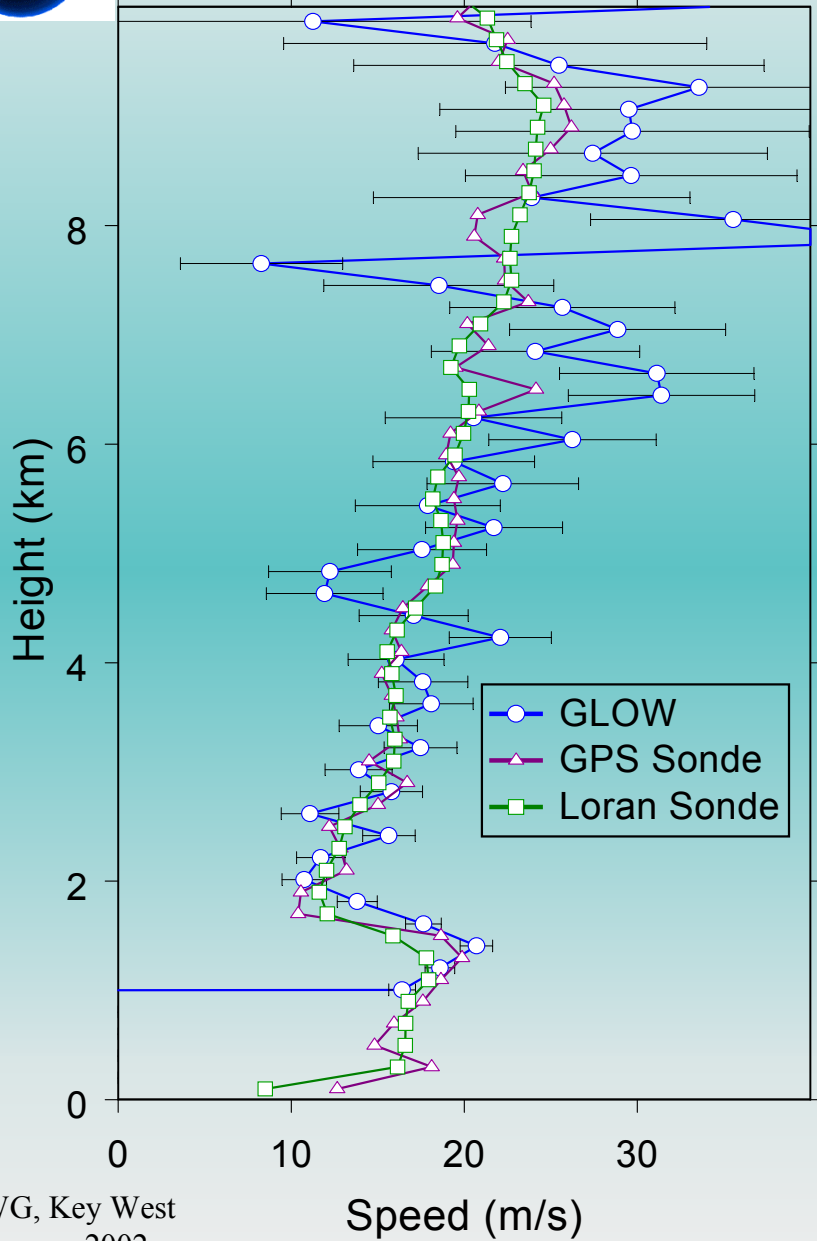
Wind Errors - mcs0111162231

$\Delta z=200$ m





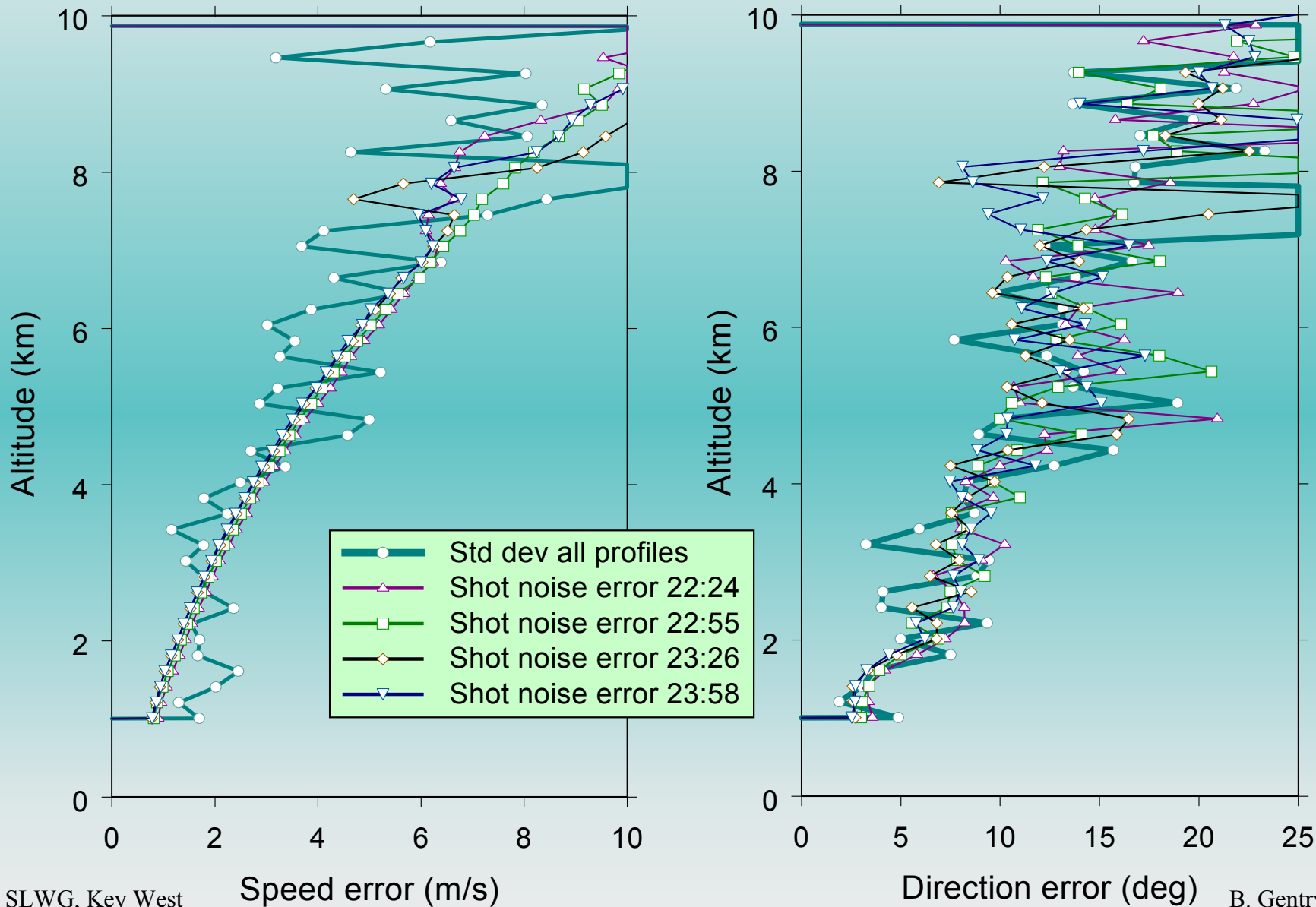
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Wind Errors - mcs0111192223

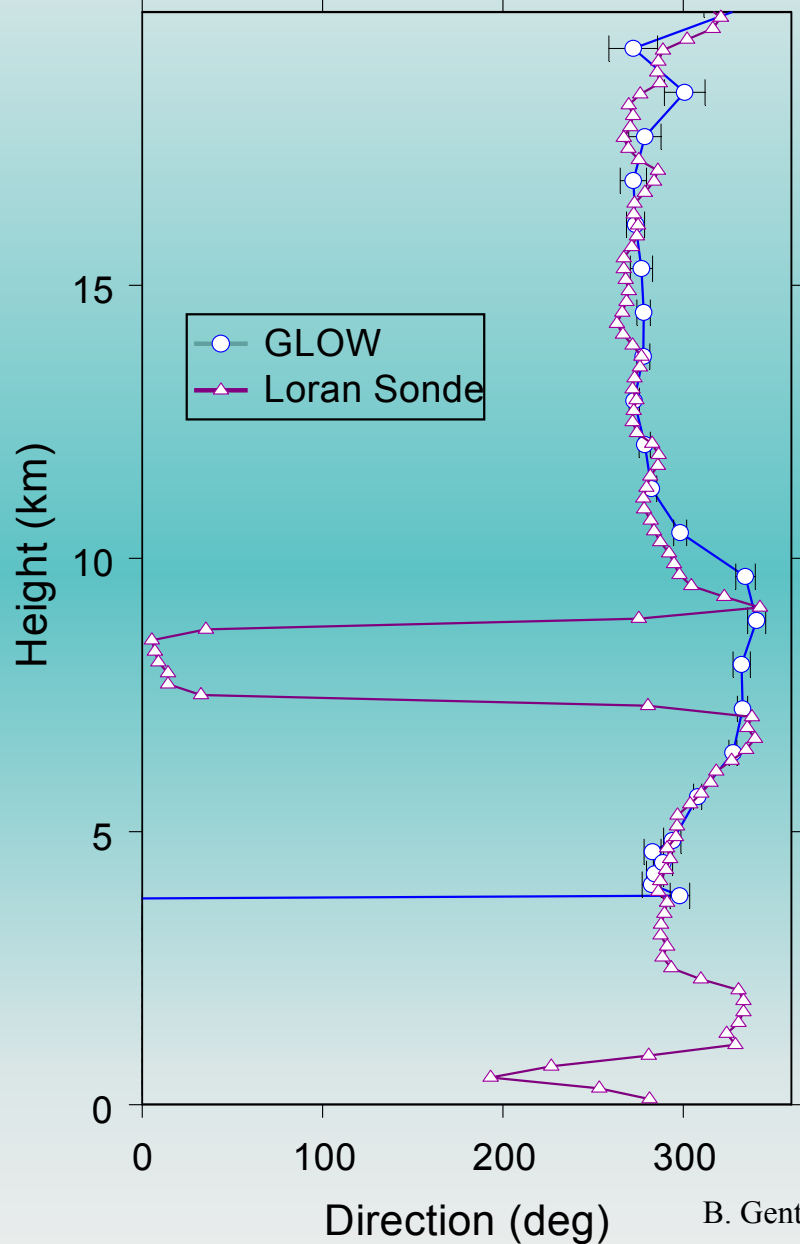
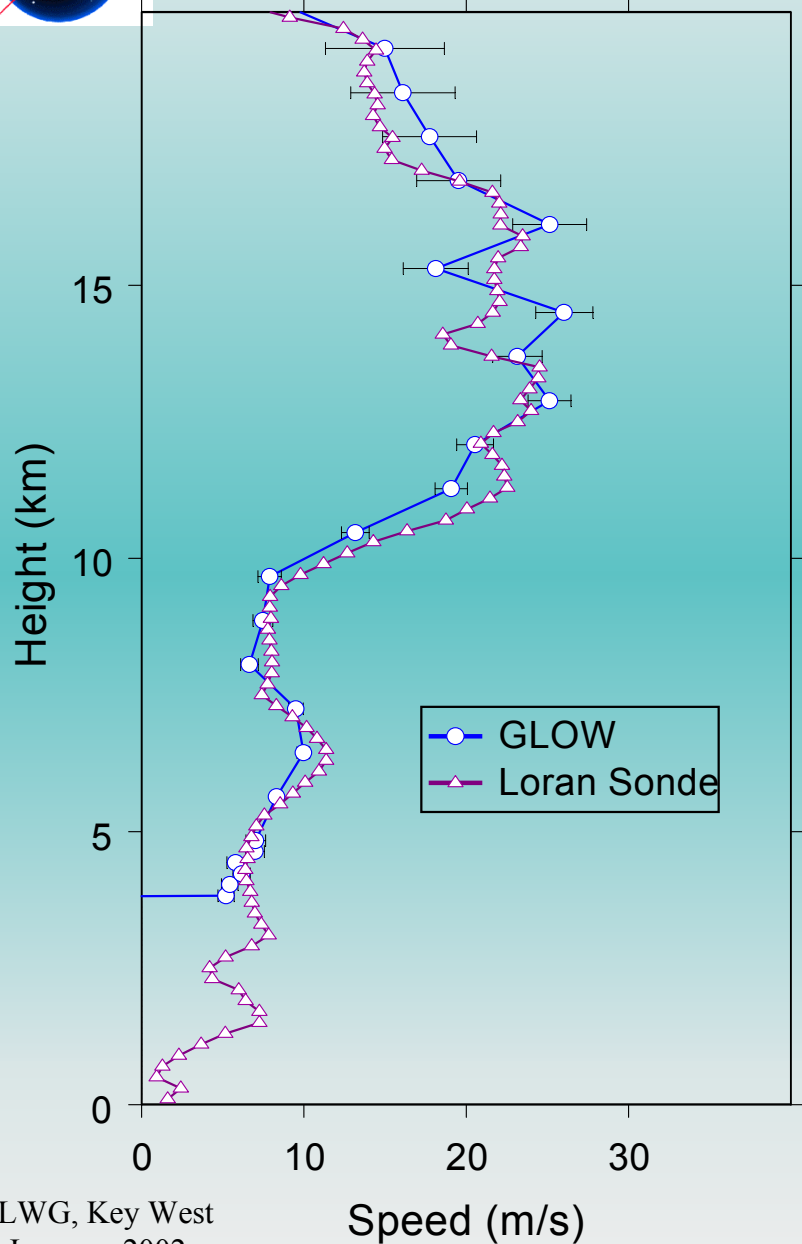
$\Delta z=200$ m

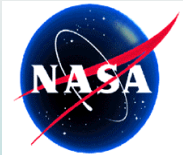




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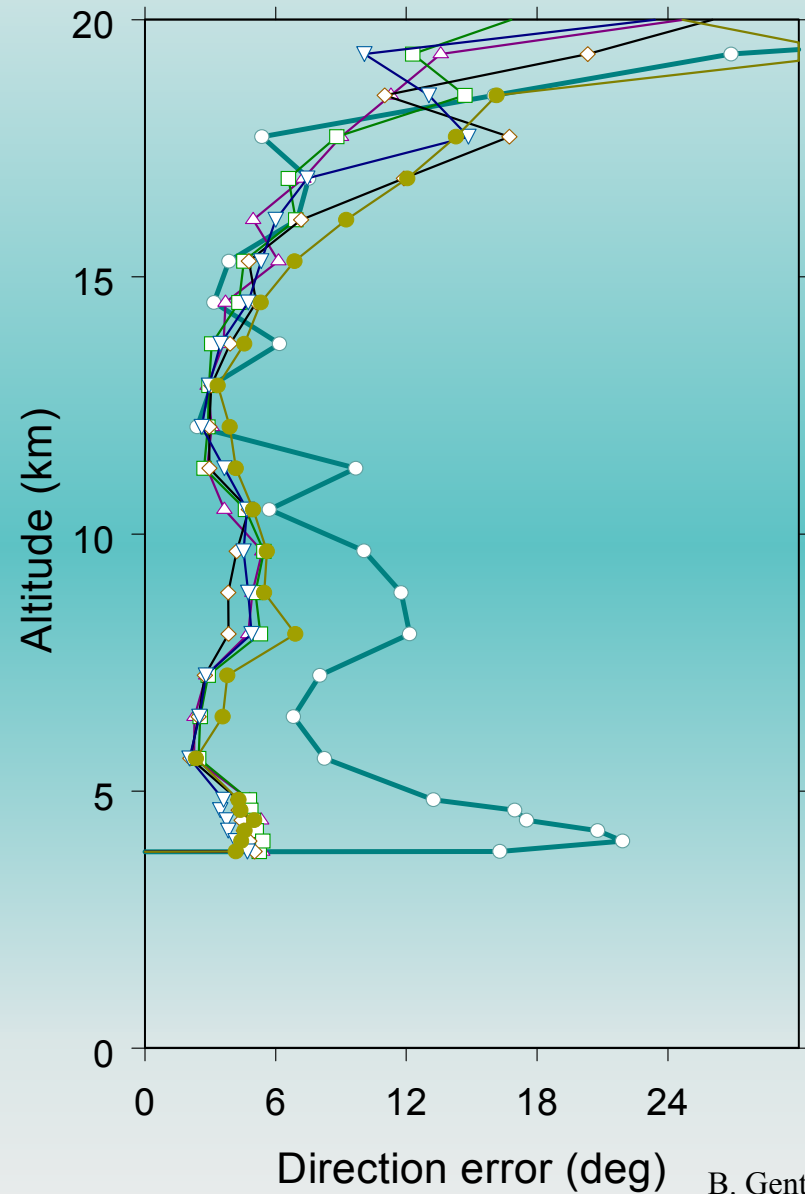
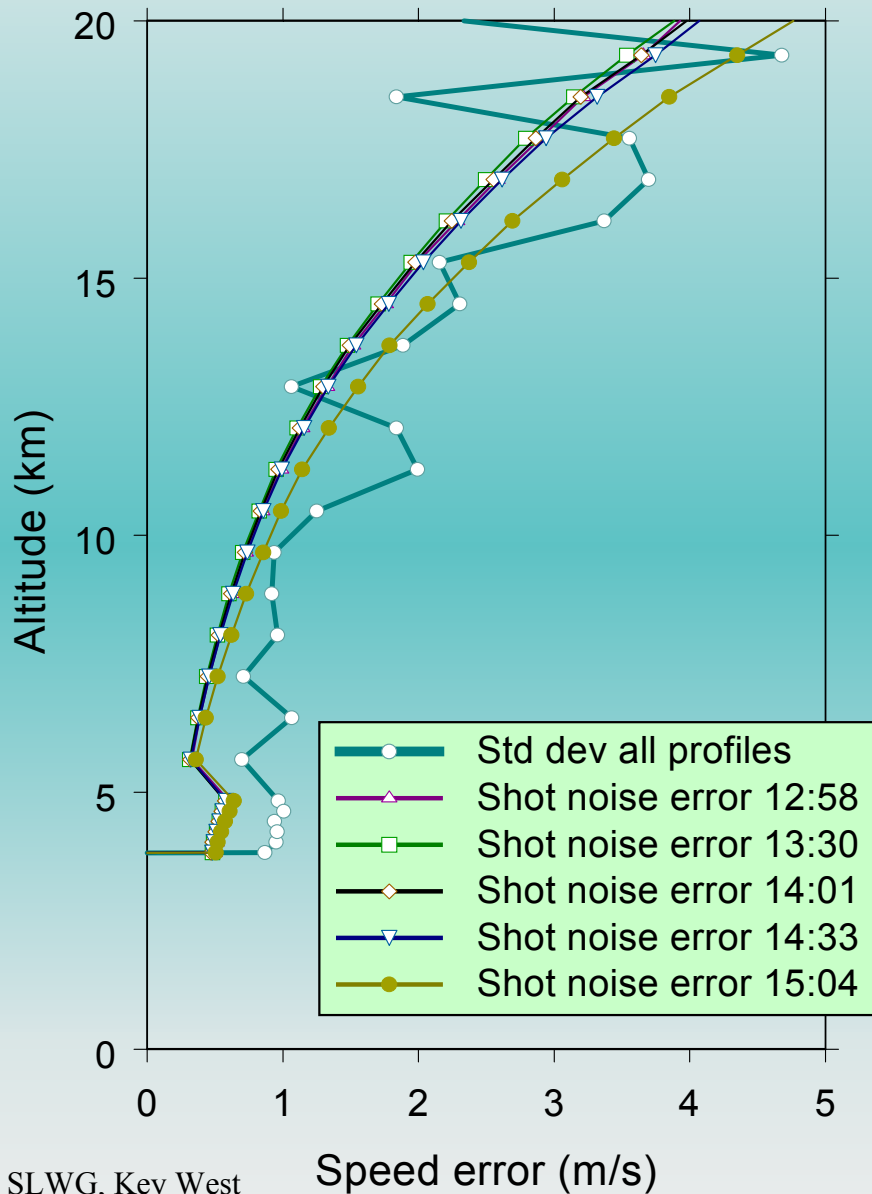
Profiles derived from 4 LOS; 5 min integration/LOS; 800 m vertical res





Wind Errors - mcs0111161258

$\Delta z=200$ m for $z<5$ km; $\Delta z=800$ m for $z>5$ km





Summary

- Analysis of GLOW wind measurement set to HARGLO common data grid completed.
- Initial intercomparisons with sondes show good agreement. Comparisons with HARLIE, SPANDAR will begin soon.
- Error analysis shows good agreement between statistically derived errors (1σ s.d.) and shot noise limited performance.
- Further analysis will continue using alternative averaging schemes.
- Future work includes continued validation and intercomparisons with other wind profilers (HARGLO-3?) perhaps as part of IHOP campaign in May-June.

- Acknowledgments: This research supported with funding from the Integrated Program Office and the NASA Earth Science and Technology Office (ESTO)