Investigating Height Assignment Type Errors in the NCEP Global Forecast System

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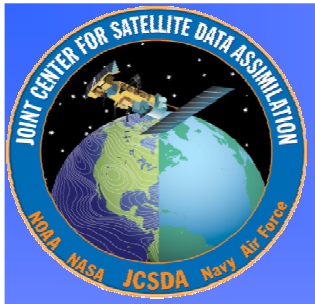

Outline

- Height Assignment types
- Definitions of Statistics used
  - Speed
  - Direction
- Height Assignment Statistics
  - Water Vapor Images
  - Infrared Images
- NCEP Future Work
- Comments and Conclusions

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Height Assignment Types

- CO2 Slicing
  - GOES-12 and beyond
  - Menzel et al 1983
- Water Vapor Intercept
  - Szejwach 1982
- Histogram
  - Nieman et al 1993
- IR Window
  - Nieman et al 1993
- Cloud Base
  - Le Marshall et al 1997

Wind Comparison Statistics

- Vector Difference

$$VD = \sqrt{(U_i - U_m)^2 + (V_i - V_m)^2}$$

- Mean Vector Difference

$$MVD = \frac{1}{N}\sum_{i=1}^{N}\left(\sqrt{(U_i - U_m)^2 + (V_i - V_m)^2}\right)$$

- Standard Deviation

$$SD = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left[(VD_i) - (MVD)\right]^2}$$

* Nieman et al 1997

i = observation, m = model

Wind Comparison Statistics

- Root Mean Square Error

$$RMSE = \sqrt{(MVD)^2 + (SD)^2}$$

- Normalized Root Mean Square Error

$$NRMSE = RMSE / \overline{Speed}$$

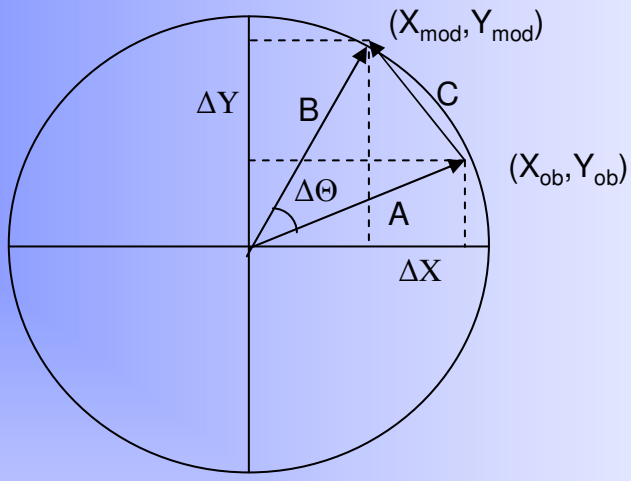
- Speed Bias

$$BIAS = \frac{1}{N} \sum_{i=1}^{N} \left(\sqrt{U_i^2 + V_i^2} - \sqrt{U_m^2 + V_m^2} \right)$$

* Nieman et al 1997

i = observation, m = model

New Directional Statistics



$$C^2 = A^2 + B^2 - 2AB\cos(\Delta\Theta)$$

- Directional RMSE

$$DRMSE = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N} C_i^2}$$

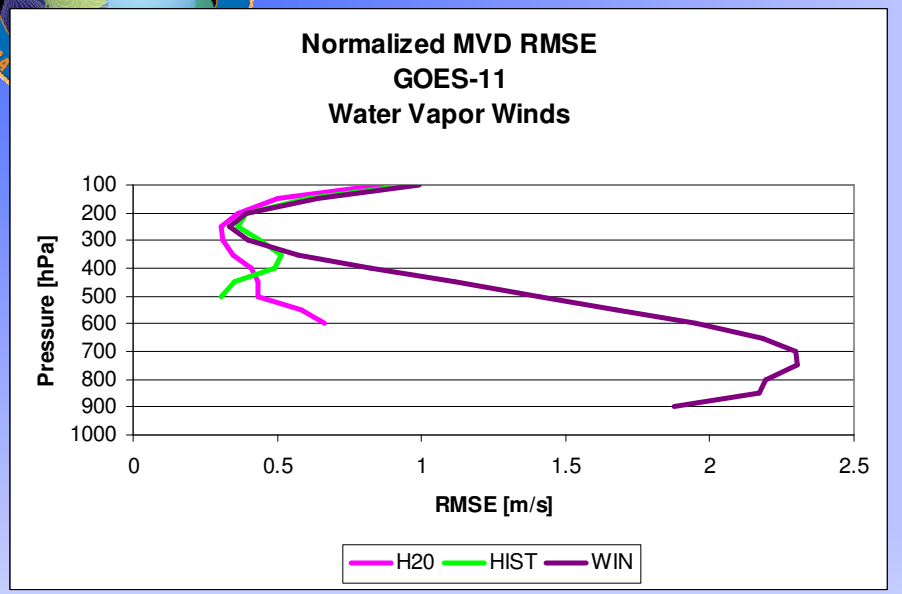
- Directional Bias

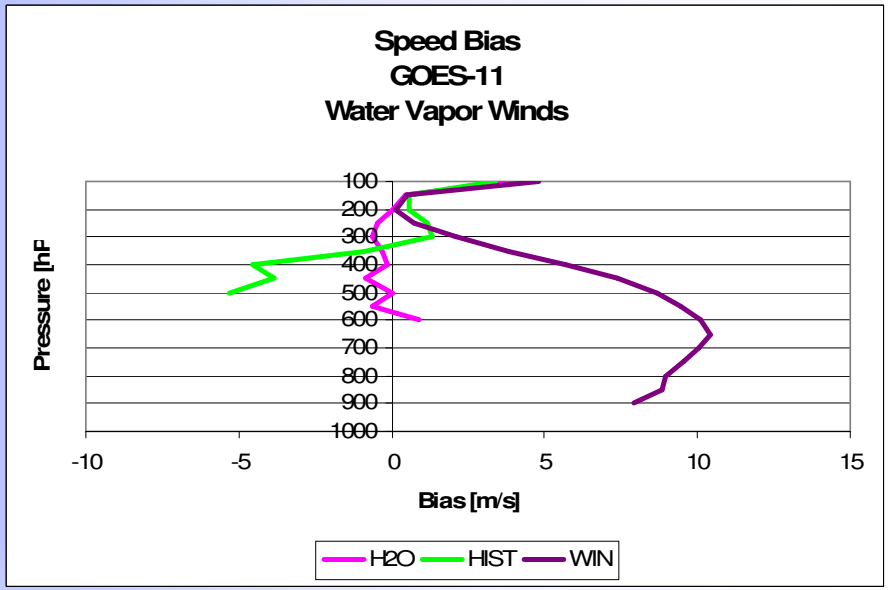
$$BIAS = \frac{1}{N}\sum_{i=1}^{N} C_i$$

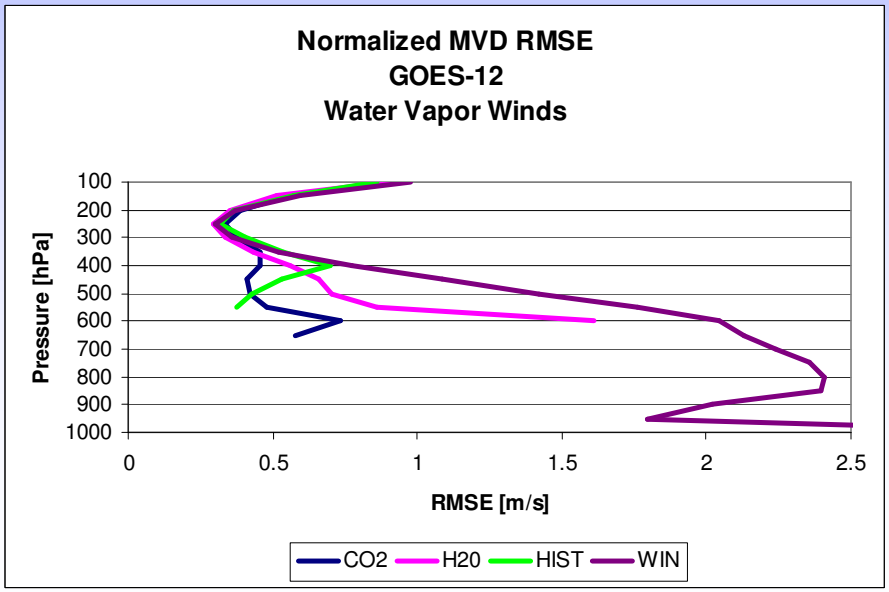
Height Assignment Statistics

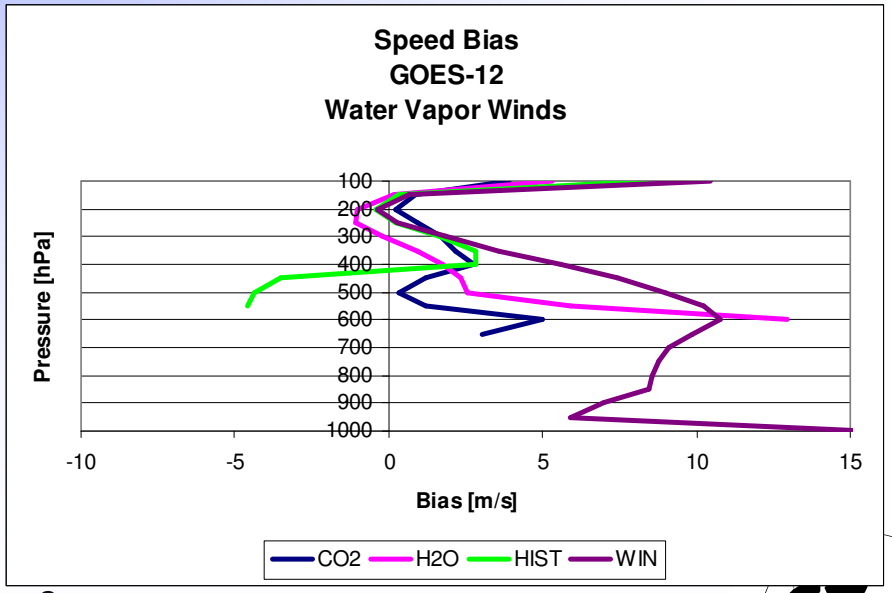
- Ocean only vectors used
- Monitored all height assignment types available for each observation.
- Separated by Satellite and Image type
  - GOES-11, GOES-12
  - Water Vapor winds, Cloud-Drift IR winds
- Combined two seasons
  - Days 1-20 in July and December 2009
- Stratified by Latitude
  - NH (20N – 60N)
  - Tropics (20N – 20S)
  - SH (20S – 60S)

Water Vapor Winds
Speed NRMSE and Bias

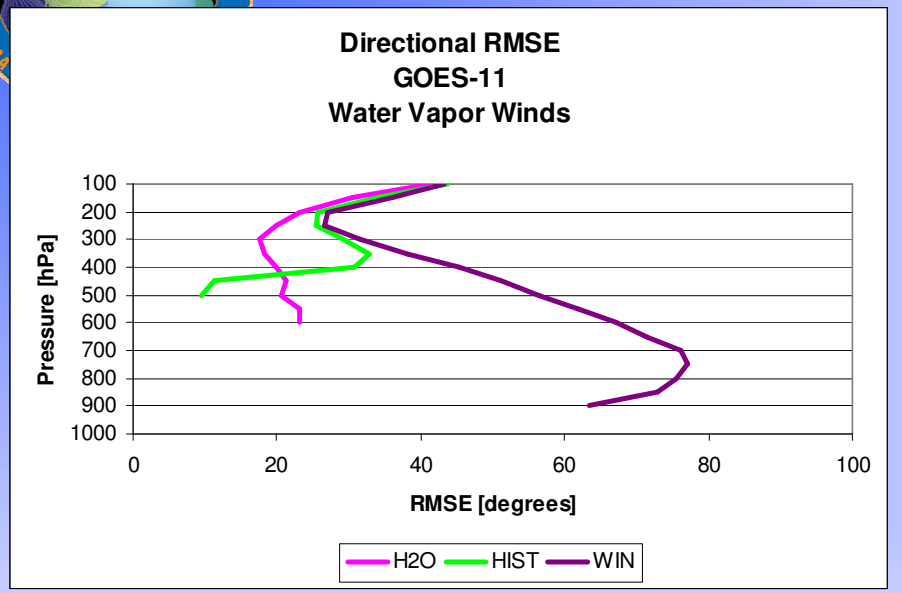


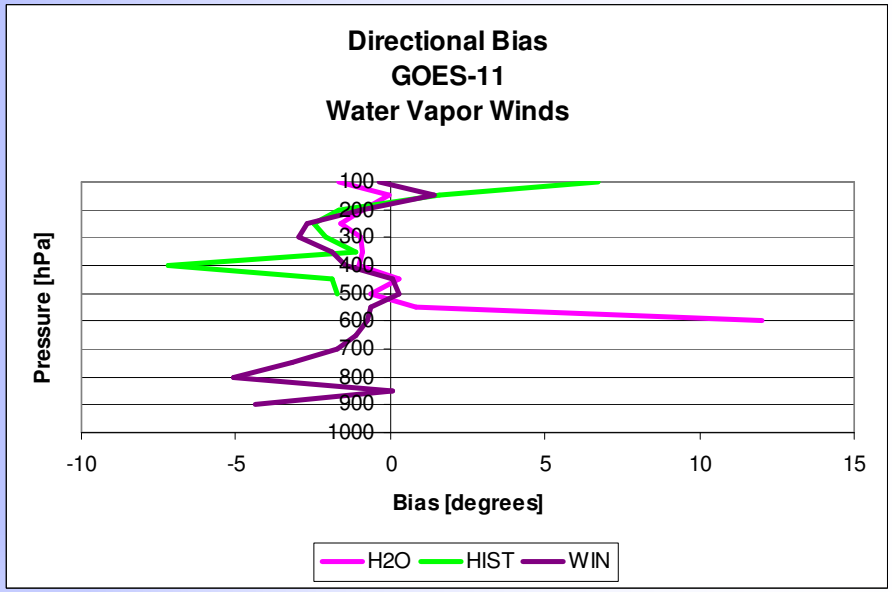


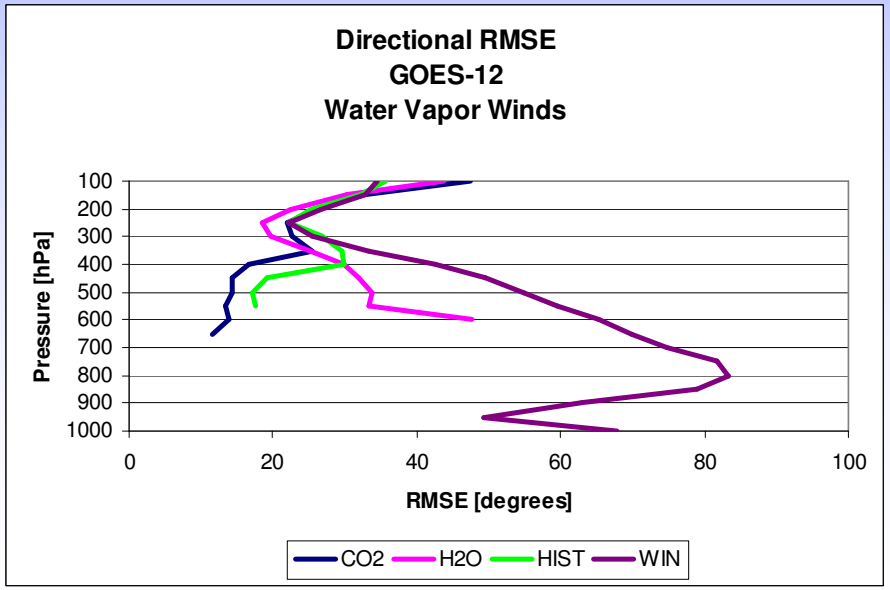


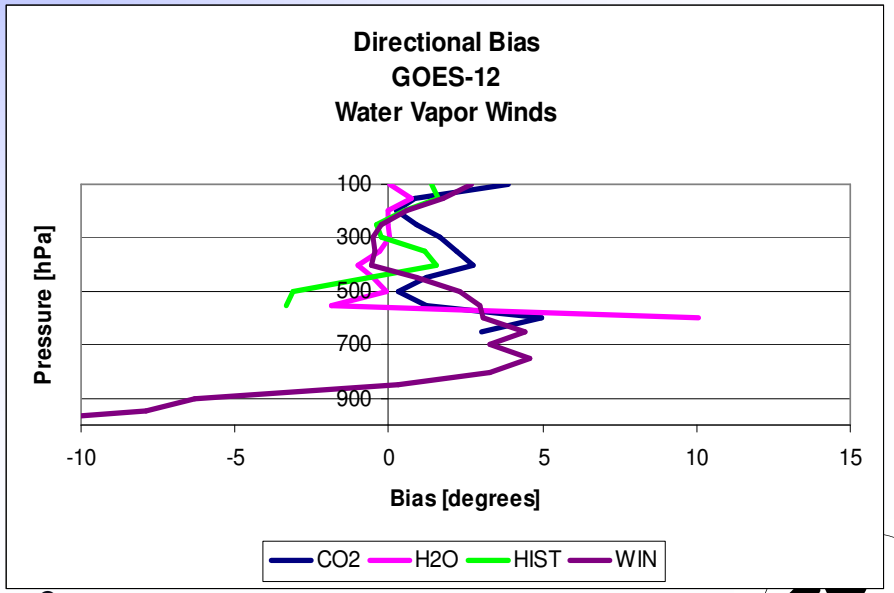


Water Vapor Winds
Directional RMSE and Bias

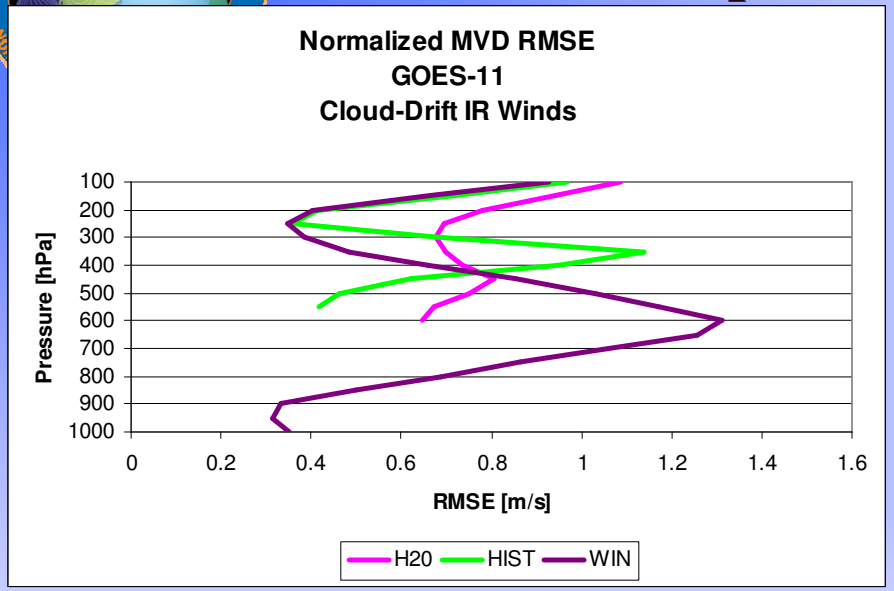


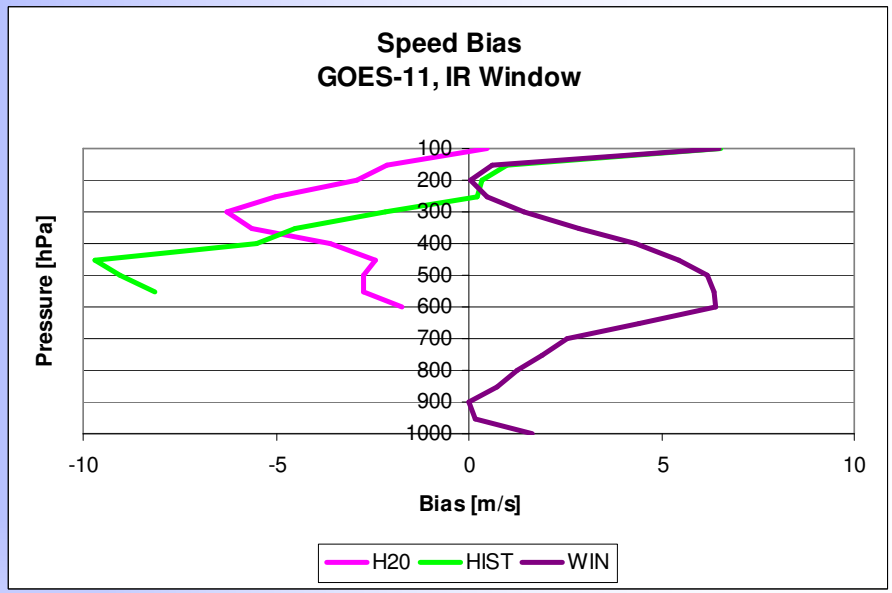


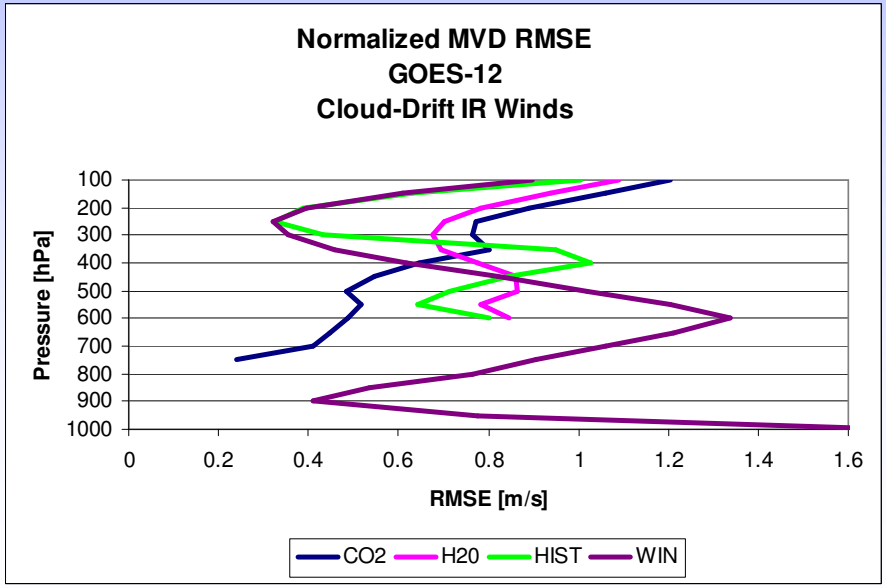


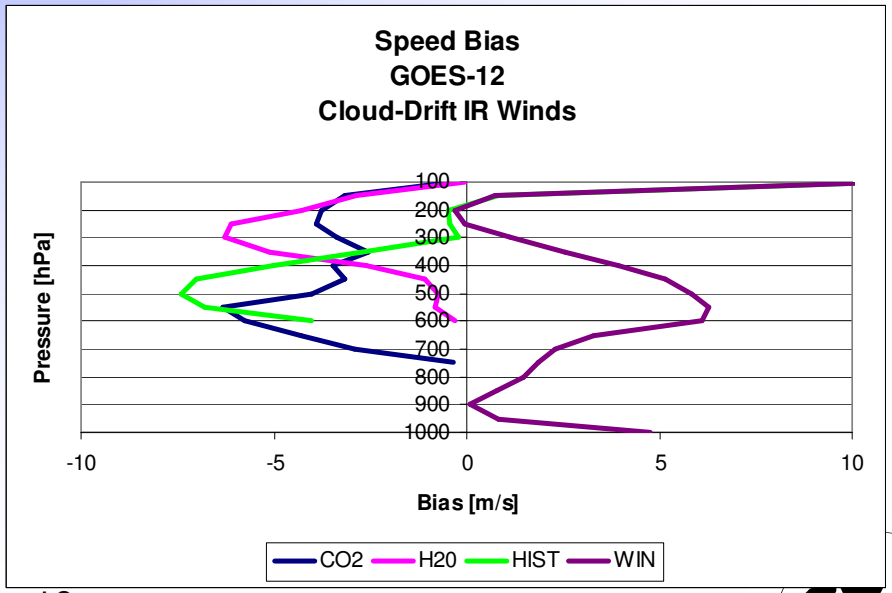


Cloud-Drift IR Winds
Speed NRMSE and Bias

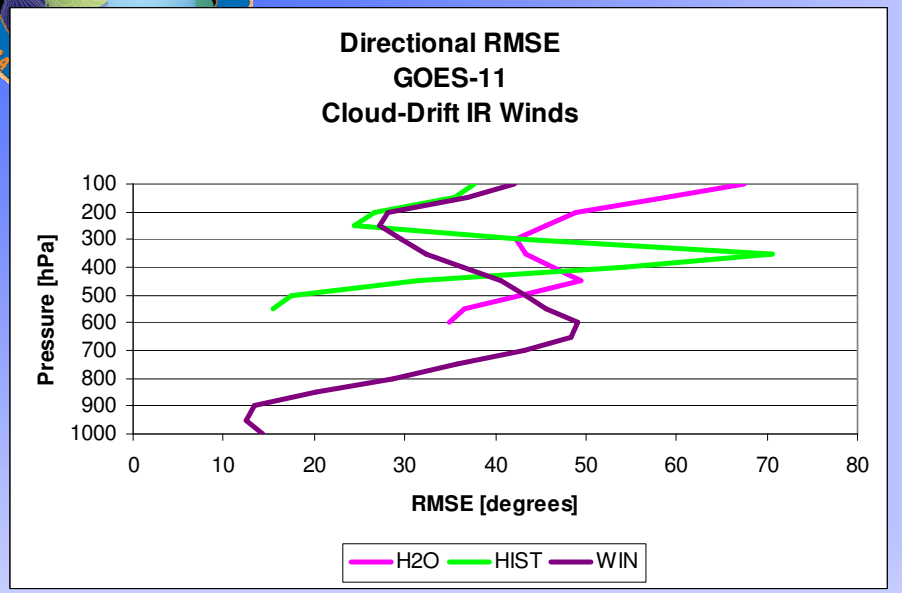


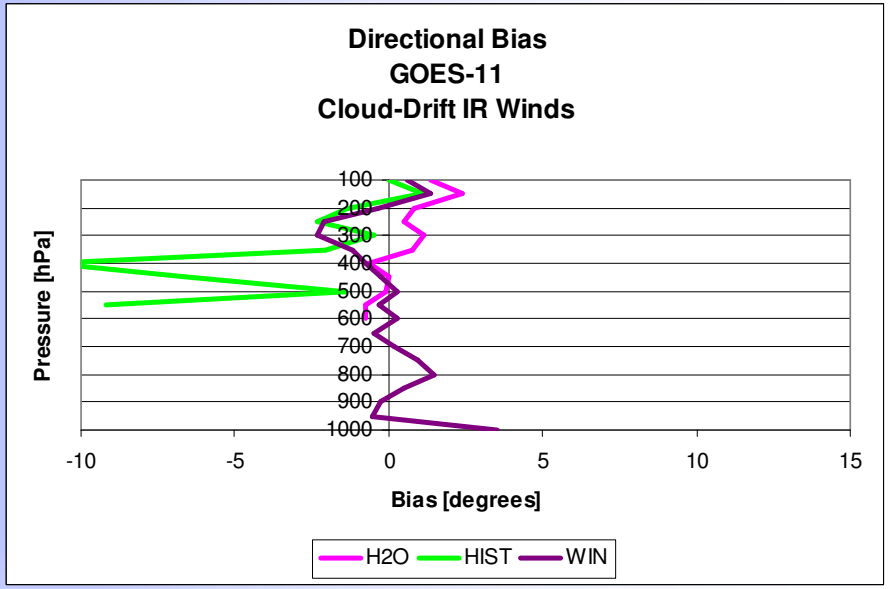


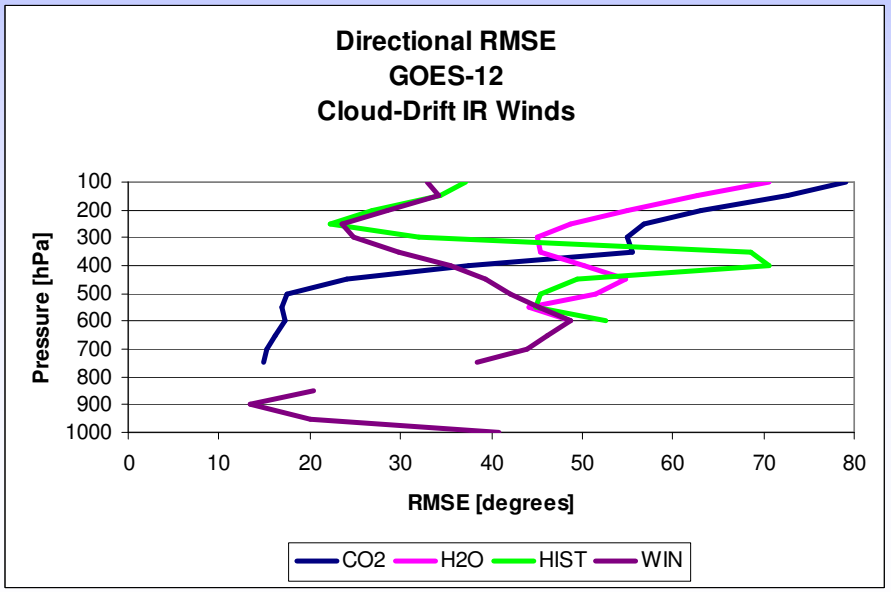


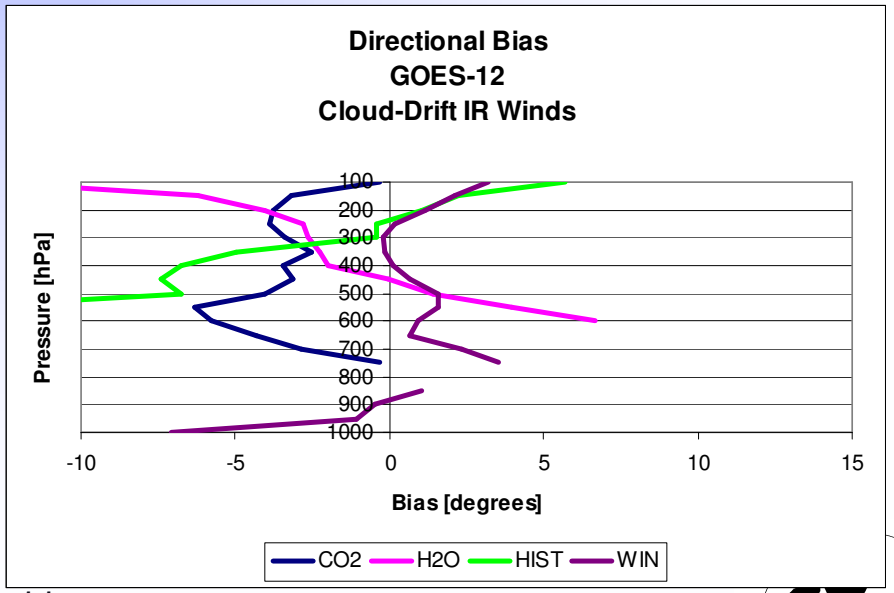


Cloud-Drift IR Winds
Directional RMSE and Bias

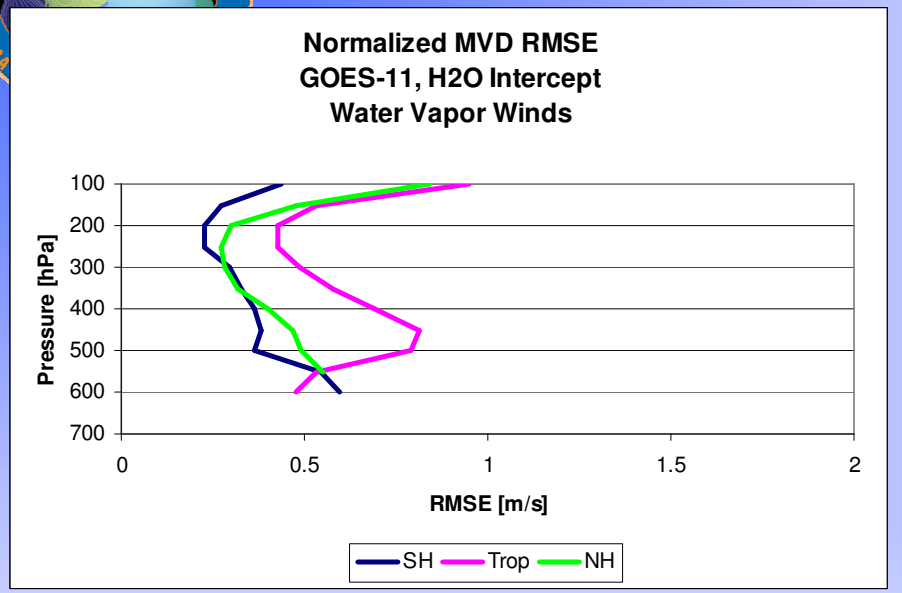


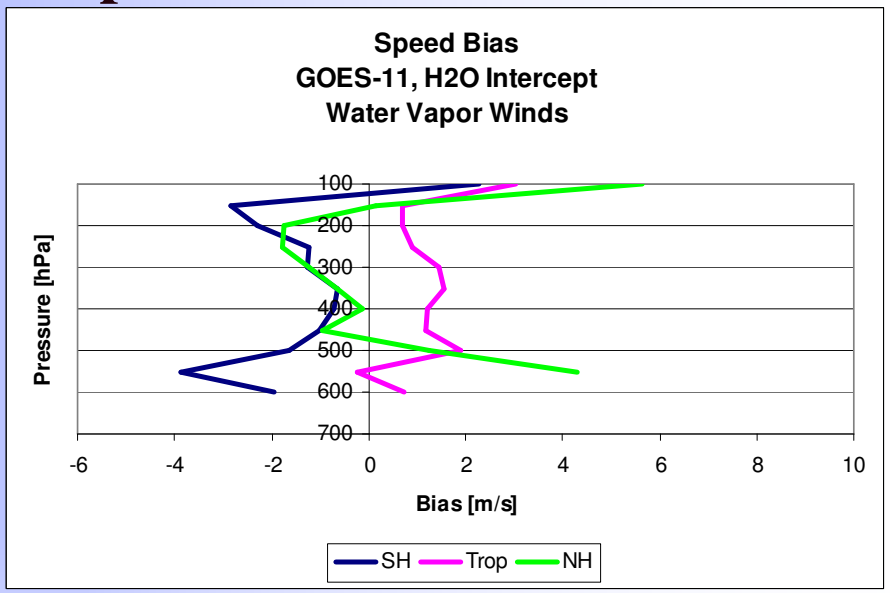


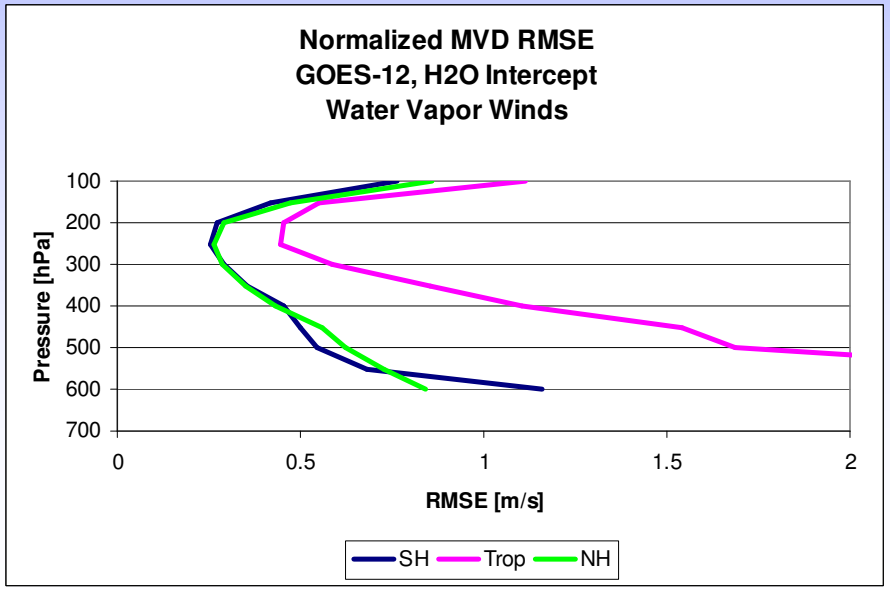


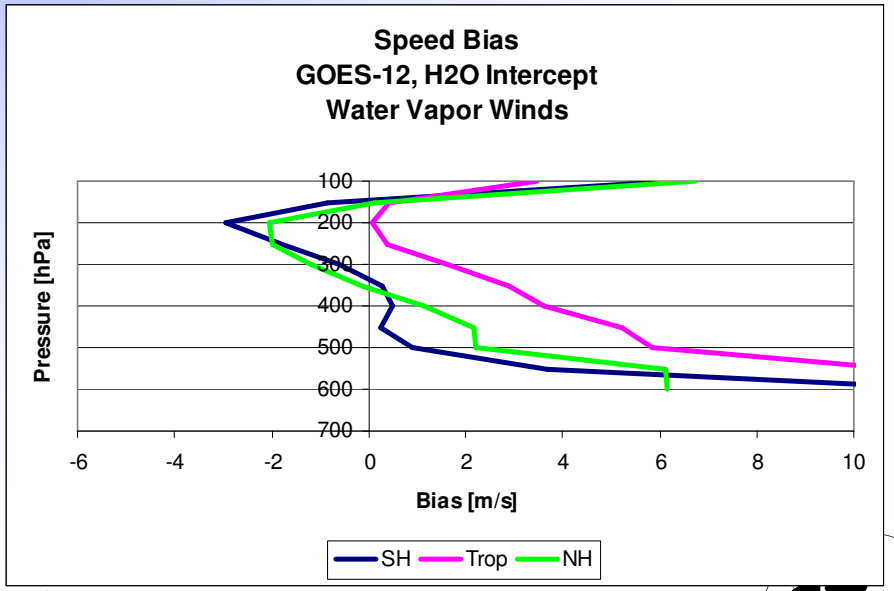


Latitude error dependence
Water Vapor Winds

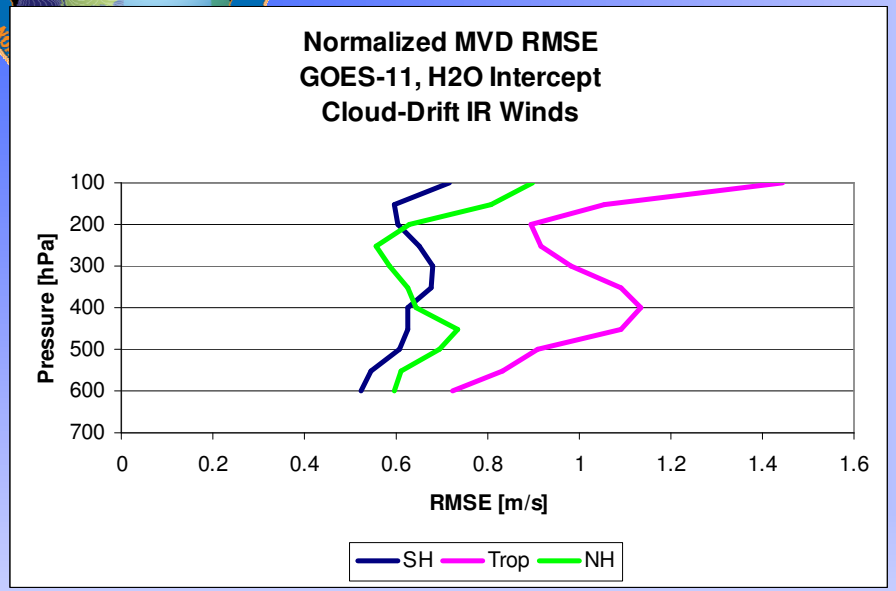


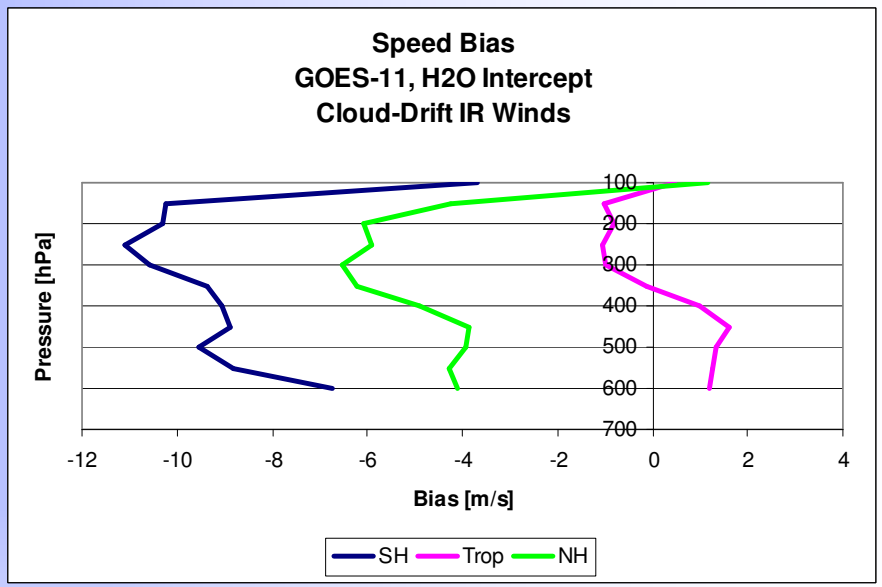


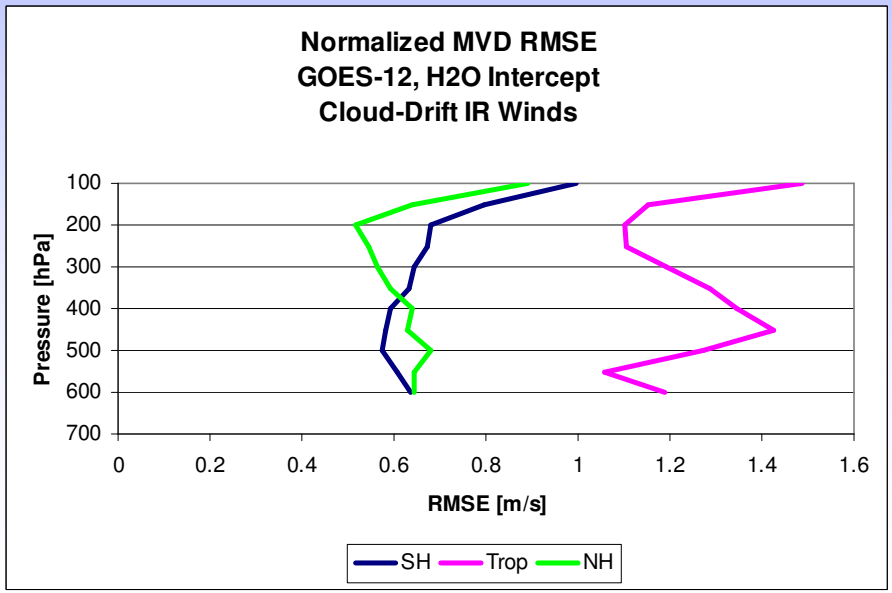


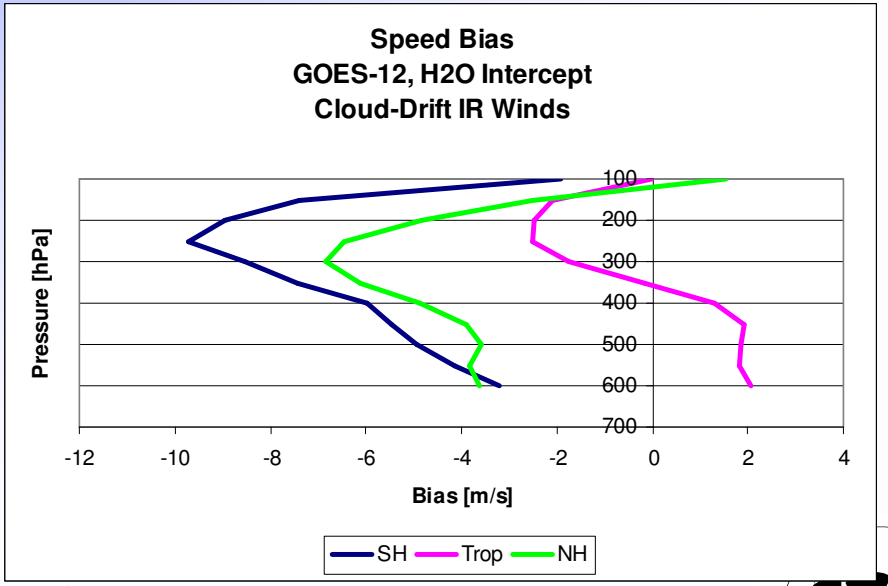


Latitude Error Dependence
Cloud-Drift IR Winds









NCEP Continuation Work

- Modify analysis code to process all height assignment types
- Generate O-B/O-A statistics for each height assignment type
- Derive assimilation techniques specific to height assignment type
  - Investigate QC techniques using multiple height assignments

Comments and Conclusions

- The cloud-drift IR winds have a slow speed bias not found in the water vapor winds.
  - Why, how can this be resolved?
- Are improvements possible to the CO2 and H2O intercept methods?
  - What are the upper and lower limits of the techniques?
- O-B errors in the tropics are greater than at mid-latitudes
  - This is a model problem. How can data providers help?
- Can other data providers include height assignment type in the BUFR file?

Questions ?

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