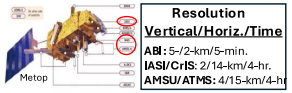
Improvements of Severe weather Prediction - A Proxy of Next Generation Satellite Sounding Observations

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Polar satellite infrared and microwave measurements are combined with geostationary satellite infrared measurements to create a real-time proxy of next generation high-resolution (e.g., 2-km / 30-min) satellite temperature, moisture, and wind sounding data. These soundings are derived using a GeoLeo Atmospheric Sounding System (GLASS) as described below. The soundings are assimilated into a 4-km resolution Weather Research and Forecasting (WRF) model, configured like NOAA's HRRR model to demonstrate improvements in the nowcasting and short-term (0 – 6 hour) forecasting of severe convective weather events (e.g., tornadoes).

Proxy Soundings From Fusion of Polar Sounder and Geostationary Imager Data

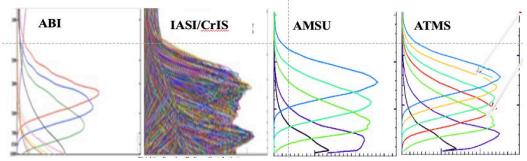




Resolution Vertical/Horiz./Time
ABI: 5-/2-km/5-min.
IASI/CrIS: 2/14-km/4-hr.
AMSU/ATMS: 4/15-km/4-hr

Data Characteristics
- Full Spectral Resolution
- Full Spatial Resolution
- Polar Hyperspectral Sounding (PHS) clear air above cloud
- MW sounding below cloud top
- 4-km Res, NWP WRF model
- Continuous 3-hr humidity data assimilation to diagnose winds
- 0- to 6- hour forecast cycle conducted every hour

Optimizing Vertical Resolution (Weighting Function Fusion)



GLASS Sounding Retrieval Process

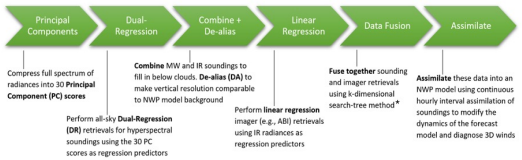
Dual Regression + De-Alias (DRDA)*
- **Alias =** Forecast Retrieval – Forecast Profile
- **DRDA Retrieval** = DR Retrieval – Alias

PHS IR, MW, and ABI Sounding Fusion

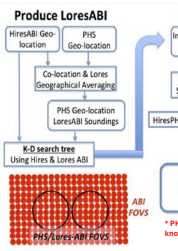
Fuse Leo & Geo Soundings to the highest resolution required to achieve the sounding footprint size and refresh rate desired.

A Simplified View of the Observation Retrieval & Data Fusion Technique (A. Leiband, NOAA)

Polar hyperspectral IR sounders + polar MW sounders + geostationary imagers



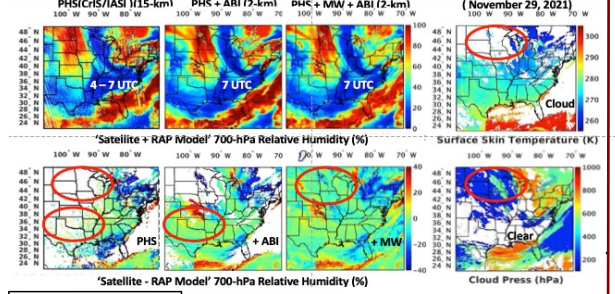
How ABI Acquires PHS Vertical Resolution



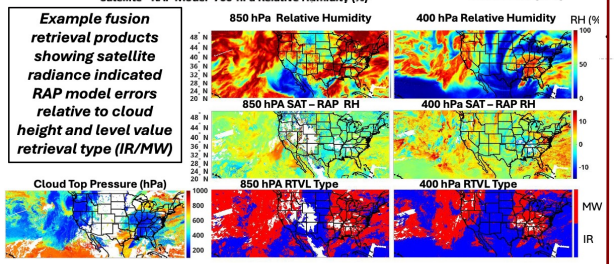
1. Start with ABI retrievals, where all the ABI retrievals within the polar footprint are averaged to match the horizontal resolution of the polar footprint. The results are Lores ABI retrievals.
2. Find the N=10 Lores ABI retrievals that most closely match (in space, time, and in profile T and RH values) the Hires (full horizontal resolution) ABI retrievals
3. Average the 10 PHS profiles corresponding to the 10 closet Lores profiles, weighted according to their sequence number (i.e., the closest profile getting the highest weight in the profile average)

HiresPHS(p) = PHSavg(p) + [HiresABI(p) – LoresABIavg(p)]

GLASS Retrieval Examples



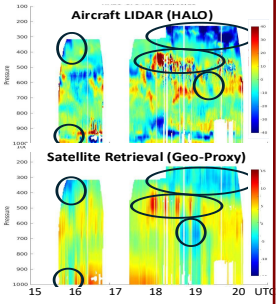
Example fusion retrieval products showing satellite radiance indicated RAP model errors relative to cloud height and level value retrieval type (IR/MW)



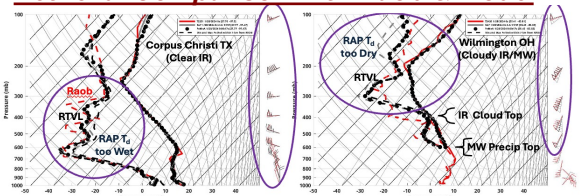
Example Retrieval Validation Result

GeoLeo Fusion (GeoXO Proxy) Retrievals Resolve High Spatial Resolution Moisture Features

Spatial resolution deficiencies in GFS Relative humidity (observation – model) are resolved by aircraft H_2O LIDAR (HALO) and satellite (GeoXO Proxy) profiles, the differences being due to the vertical resolution of the active LIDAR and passive radiance measurements shown for 2022-09-15 in the Vertical (hPa)/Time (hour) X-section (figure on the right).

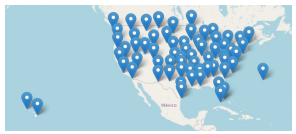


Retrieval Comparison with Raob & Model

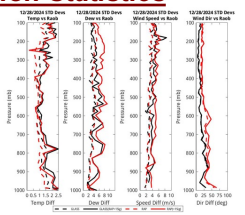


Polar Satellite IR & MW Profiles Fused with Geostationary Water Vapor & Wind Velocity Profiles Agree Better With Radiosonde Profiles Than the RAP Model Data Used in the Retrieval Process.

Radiosonde Validation Statistics



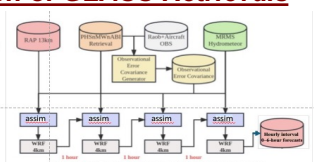
https://www.ssec.wisc.edu/hufusion/



NWP Assimilation of GLASS Retrievals

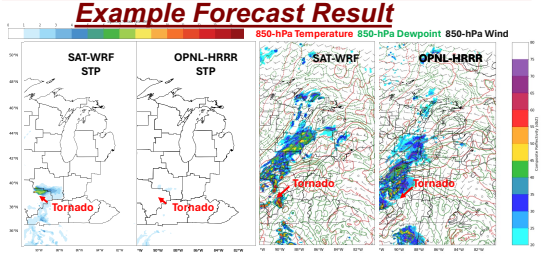
Horizontal and Vertical Motion is Diagnosed by the Quasi-Continuous Assimilation of High-Resolution Satellite Thermodynamic Profiles or Radiance Spectra

Forecast Model Primitive Equations of Motion Force the Model's Dynamical Processes (i.e., motion vectors) to Conform to the Spatial and Temporal Changes in the Thermodynamic Observations Being Assimilated.



2-km resolution moisture soundings are assimilated with other operational meteorological observations into a NOAA High-Resolution Rapid Refresh(HRRR) like 4-km grid-point spacing WRF model. Hourly continuous assimilation of 2-km resolution satellite soundings is performed to produce atmospheric state parameter fields, including winds, used to initialize WRF model 0-to-6-hour forecasts.

Example Forecast Result



5-hour forecast valid at 20240418 23-UTC initialized on 20240428-18-UTC

GeoLeo Fusion (GeoXO Proxy) Data Assimilated Forecast Predicts Tornado Conditions Missed by Operational HRRR Forecast

Example Wind Vortex Diagnosis

GeoLeo Fusion (GeoXO Proxy) Data-assimilated Forecast Produced Tornado Associated Wind Vortex

