S9.P2

Planning for GOES-R: Utilizing current technologies to prepare for GOES-R data assimilation and understand and apply its error information

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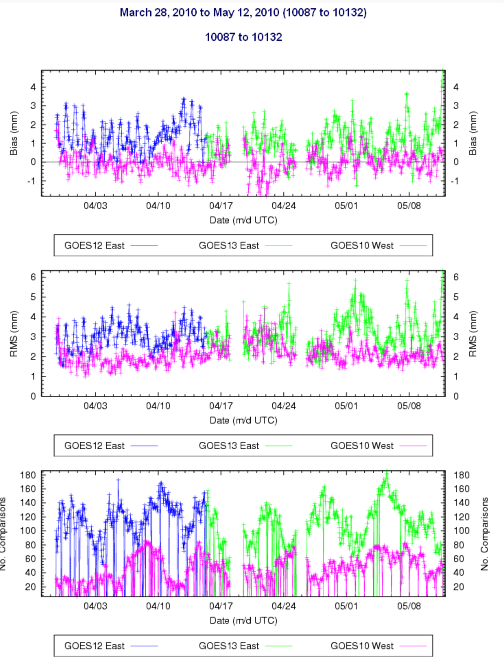
Themes

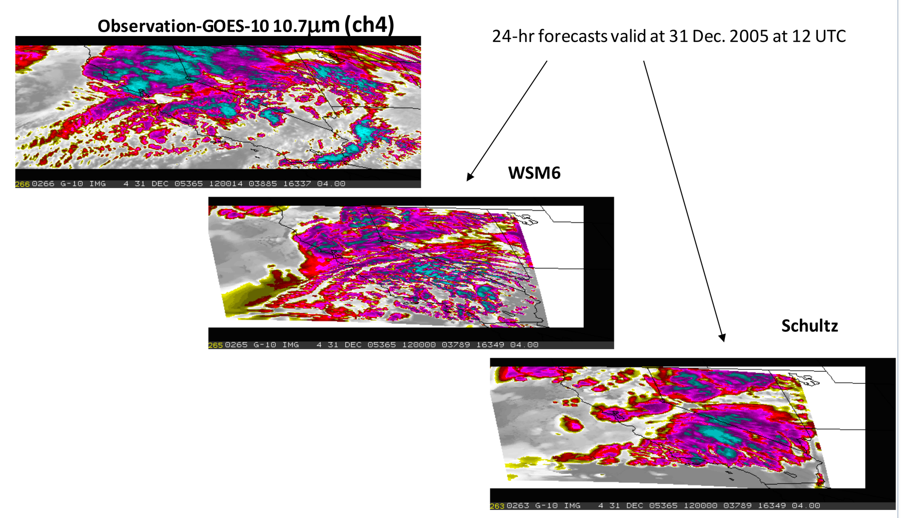
- Model interface
  - New metrics for microphysics assessment in models
  - Pathway for direct (including cloudy) radiance assimilation
- CRTM Applications
  - Bringing CRTM into STMAS (Space &Time Multiscale Analysis System) and LAPS, using STMAS to prototype approaches for GSI implementation
  - Expand to cloudy regions, then to partly cloudy regions.
  - STMAS 3DVAR /4DVAR cloudy radiance assimilation paves the way for GSI and eventual GSI/4DVAR follow-on.
  - CRTM STMAS gradient method to incorporate clear radiances
- Operational Products (ties here to AWG)
  - Validation of current and future products (stems back to prior talks and presentations on performance of GOES TPW since 2002). Desire to continue on into GOES-R era.
  - Detection of GOES sensor problems
  - Model first guess assessment, GFS better over water.
  - Explore horizontal gradient assimilation
  - SEVIRI proxy study for GOES-R moisture product

Assistance in GOES 12-13 Switchover

Envision Same with GOES R

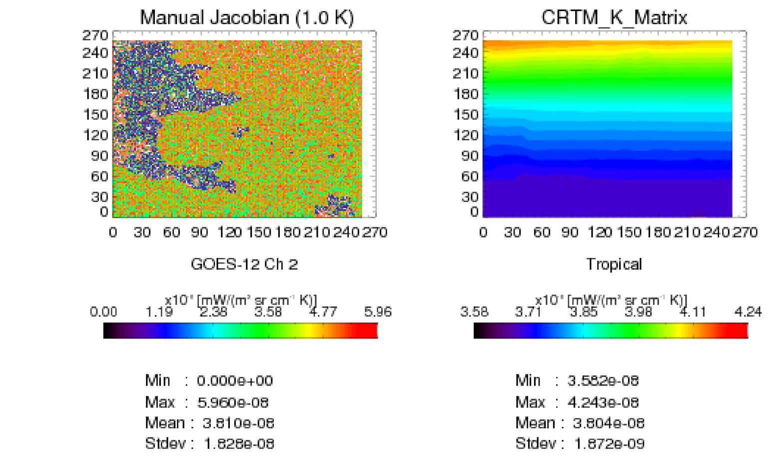


Model Interface – metrics for microphysics



Jankov, I. L. D. Grasso, M. Sengupta, P. J. Neiman, D. Zupanski, M. Zupanski, D. Lindsey, D. W. Hillger, D. L. Birkenheuer, R. Brummer and H. Yuan, 2010: An Evaluation of Five WRF-ARW Microphysics Schemes Using Synthetic GOES Imagery for an Atmospheric River Event Affecting the California Coast. Submitted to JHM.

Departure from CRTM (Jacobian/K-Matrix)



At 1.225 [hPa]

GOES Channel 2 (near IR)

Modification of DA functional to revisit cloud humidity enhancement – emphasis on scale, and cloud type

$$J = S_{SAT}\sum_{k=1}^{7}\frac{\mathrm{GT}(g_i)[\mathrm{R}(T,cq,o_3)_i - R_i^o]^2}{E_{SAT}^2} + \sum_{i=1}^{N}\frac{(1-c_i)^2}{E_{BACK}^2}$$

$$+ S_{GPS}\frac{\left(\sum_{i=1}^{N} c_i q_i - Q^{GPS}\right)^2}{E_{GPS}^2 L_{GPS}} + S_{sonde}\frac{\sum_{i=1}^{N}\left[\mathrm{RH}(T,p,cq)_i - RH_i^o\right]^2}{E_{sonde}^2 L_{sonde}}$$

$$+ S_d S_{GVAP}\sum_{j=1}^{3}\frac{\mathrm{G}(g)[\sum_{i=1}^{N}\frac{\Delta}{\Delta x}\mathrm{P}_{ji}(c_i q_i) - \frac{\Delta}{\Delta x}Q_j^{GVAP}]^2}{E_{xGVAP_j}^2 L_{GVAP}}$$

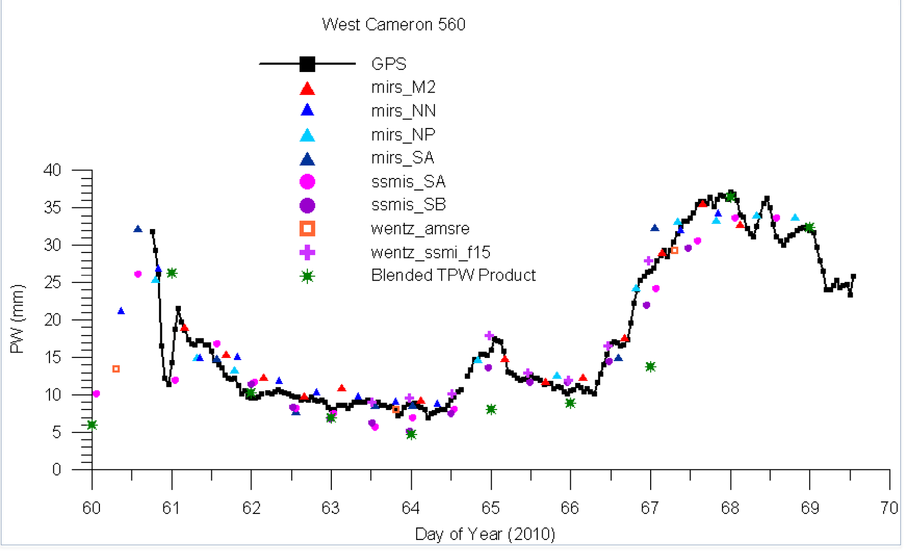
$$+ S_d S_{GVAP}\sum_{j=1}^{3}\frac{\mathrm{G}(g)[\sum_{i=1}^{N}\frac{\Delta}{\Delta y}\mathrm{P}_{ji}(c_i q_i) - \frac{\Delta}{\Delta y}Q_j^{GVAP}]^2}{E_{yGVAP_j}^2 L_{GVAP}}$$

$$+ S_{CLD}\sum_{i=1}^{N}\frac{\mathrm{g}_i[c_i q_i - q_s(t_i)]^2}{E_{CLD}^2}$$

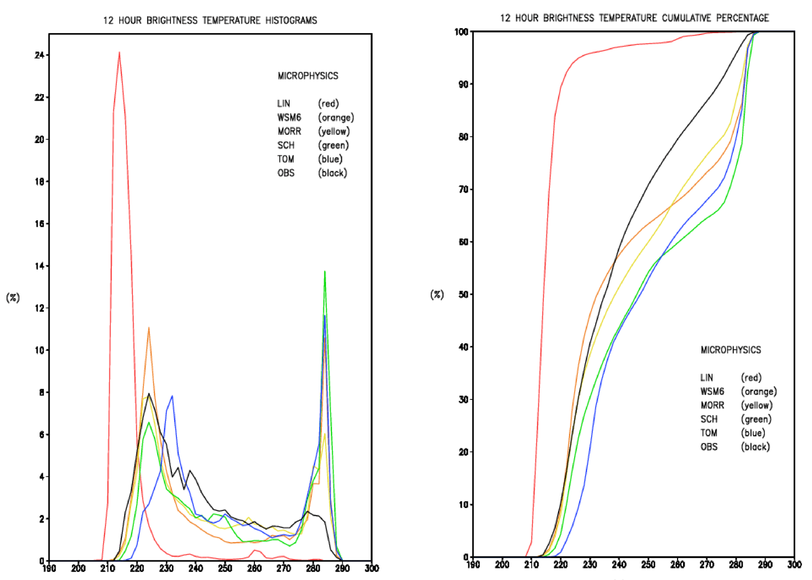
Overview

- Interactions with the Algorithm Working Group (AWG)
  - Conference calls, involving GPS (~every 2 weeks)
  - Concerns focus on retrieval science, forward radiance models, satellite health and checkout
  - Currently testing the Li algorithm over the operational Ma. Li is likely to be used in GOES-R
- CRTM related work
  - Continue Cal/Val with current GOES – extend into GOES-R system of the future
  - Improve GSI satellite bias correction (see companion poster)
  - Focus more on direct radiance assimilation with clear and cloudy radiances.
  - CRTM radiance output not matching observed clouds that well
    - Working with JCSDA on the radiance model, Jacobians and the K-matrix are checked out, working now on the surface and cloud top microphysics to see if we can use this for cloudy data assimilation
- GPS related activity
  - Use of GPS-PW for more than product assessment
    - Still feel it can improve the model first guess (use as a retrieval channel), use as an assimilation constraint
  - GPS useful for real-time product cal/val and possibly satellite cal/val
    - Discovering discrepancies between NESDIS LI and CIMSS Li algorithms
    - Potential to utilize the GOES bias corrections for a study against GSI satellite bias corrections
- GOES R proposal will be forthcoming the fall of 2011

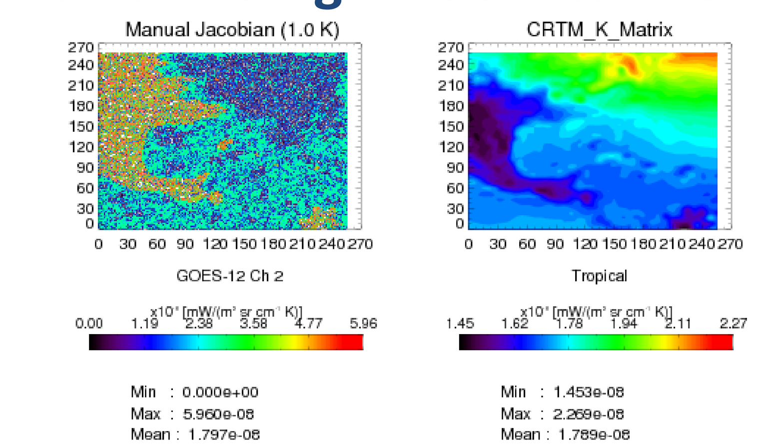
Water Vapor over Open Water Gulf Oil Platform Data (2 GPS sites)



Microphysics metrics from simulated imagery



Surface radiance "structures" observed at high altitudes in CRTM



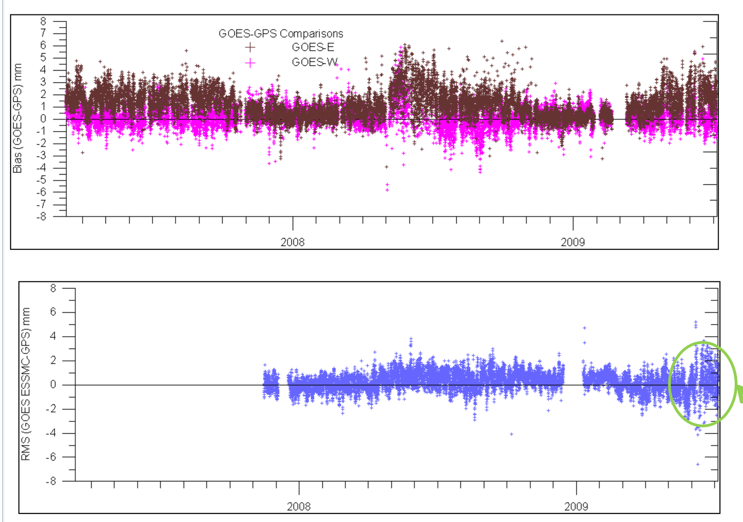
At 0.7071 [hPa]

GOES Channel 2 (near IR)

Cloud utilization enhancement

- LAPS system is now at 1km running 15min cycle time. Excellent platform for GOES R data testing against AWIPS data. LAPS/STMAS *being implemented on AWIPS-2 now*.
- Will be able to utilize full potential of satellite imagery (mainly relying on visible during daytime)
- GSI now incorporated into STMAS, development is now satellite focused (see other presentations, i.e., targeted assimilation and wavelet compression)
- Wish to share with NCEP and others when complete (GSI elements)
- Collocate GPS with upper level sites/use for calval (McMillin et al. paper)

Operational Products - validation



Current operational moisture product comparison

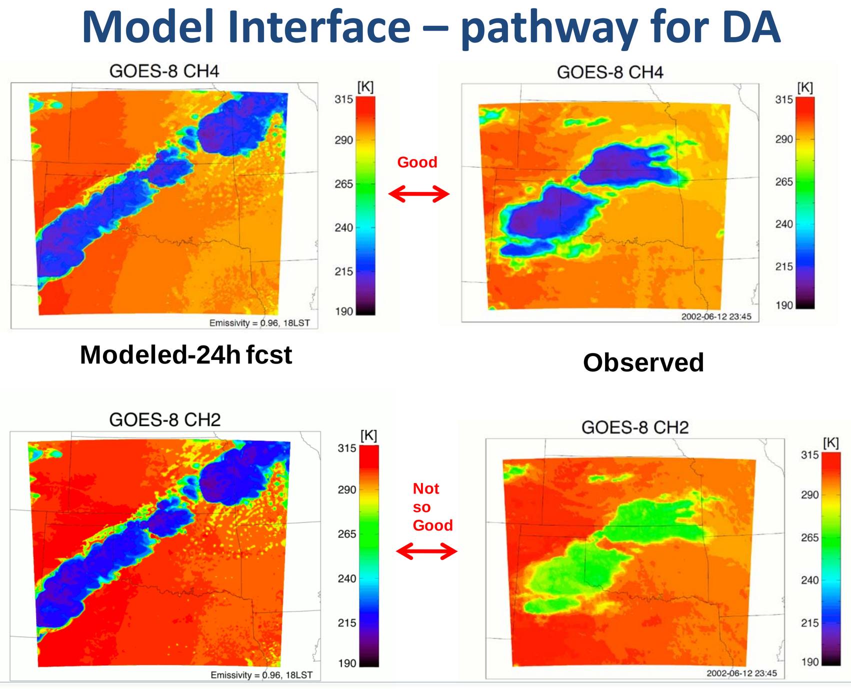
New CIMSS algorithm compares better to GPS

Detected problems with satellite sensor

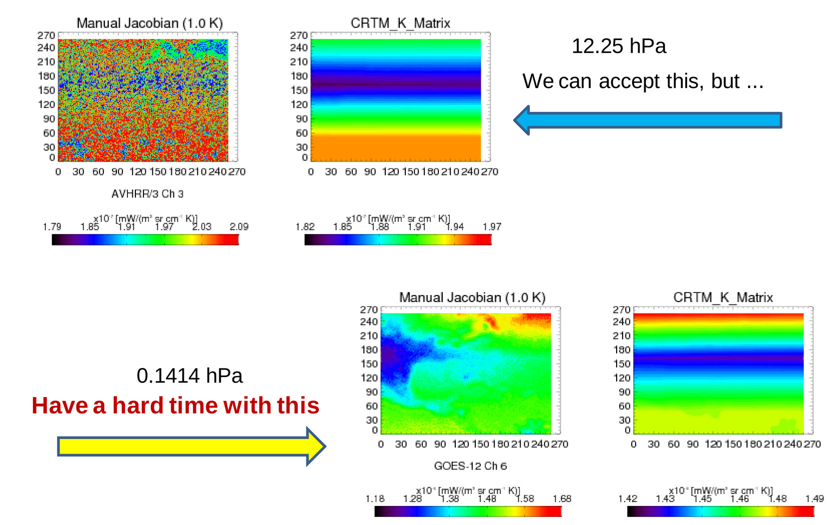
What does this plot tell us?

- Over the open water with well-understood microwave emissivity, the retrieved TPW is in good agreement with indpendent gound-based GPS-met observation.
- The GFS model uses this information over water and we believe is the reason the GFS is superior to the NAM when it comes to TPW (and water vapor in general).

Model Interface – pathway for DA



More "hard to explain" features discovered

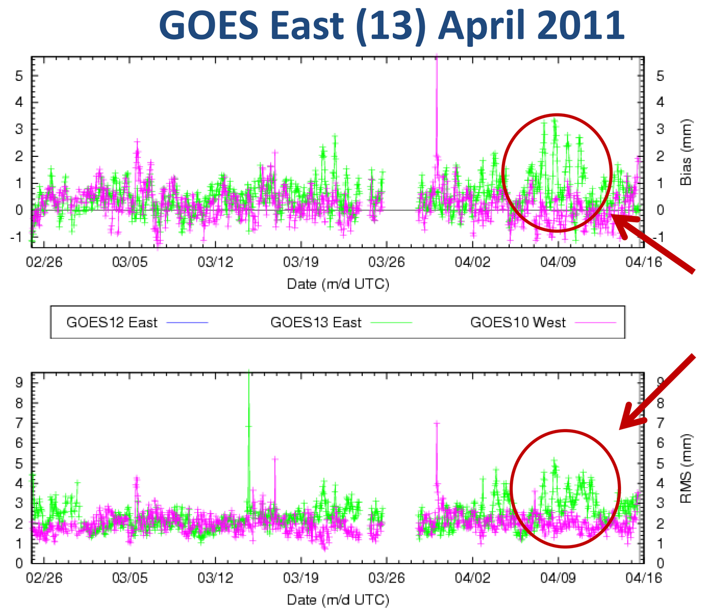


Summary – areas of current focus/future ideas

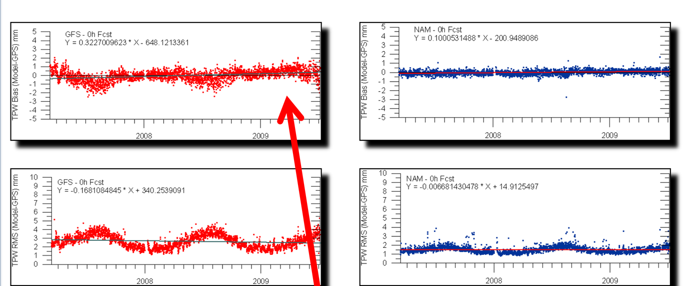
- Cloudy data assimilation
  - Utilize visible cloud data in analysis to a greater degree than currently assimilated
  - Accomplished groundwork for implementation
- CRTM validation – finished with minor questions remaining. Ready for STMAS implementation
- Model microphysics validation and improvements to either the physics or CRTM now possible with metrics in place
- Share strategic approaches on cloudy DA with GSI developers, GSI now integrated into STMAS development
- Examine the GSI satellite bias correction in terms of other bias correction methods used in other systems (e.g., retrievals) that are possibly superior. Transfer the information from these technologies to the GSI.

Validation – example 2

GOES East (13) April 2011



Operational Products – first guess



GFS time zero

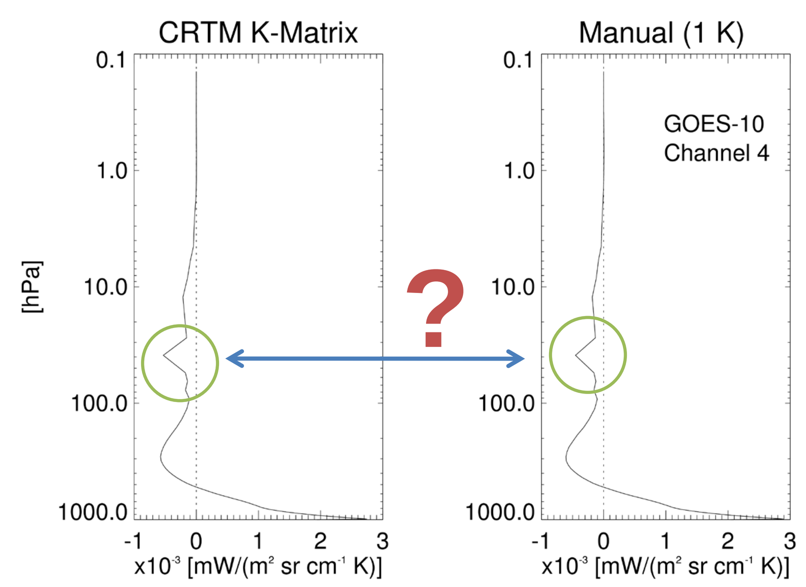
NAM time zero

Recommend fixing GFS or using different model for background like the NAM for CONUS retrievals.

Also consider using GPS data in retrieval processing as a constraint

GFS used for satellite retrieval initialization

Kmatrix profile problem?



Enhanced use of mesoscale satellite cloud image data in DA

- The most under-utilized data sets of current GOES – used in LAPS/STMAS, being improved for specific conditions – based on stability/cloud microphysics.
- Cloud variational minimization is being retested since problems have been re-assessed (next slide circled area).
- The Colorado, Windsor-tornado data set is providing an opportunity to examine cloud liquid water environment with GPS and satellite in one well-defined case. (Advantage is via microwave radiometer profile data)

Questions or Comments?

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