

14th Annual WRF Users' Workshop. June 24-28, 2013

Cloud Retrieval and Nowcasting

Tom Auligné

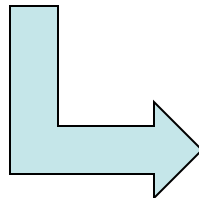
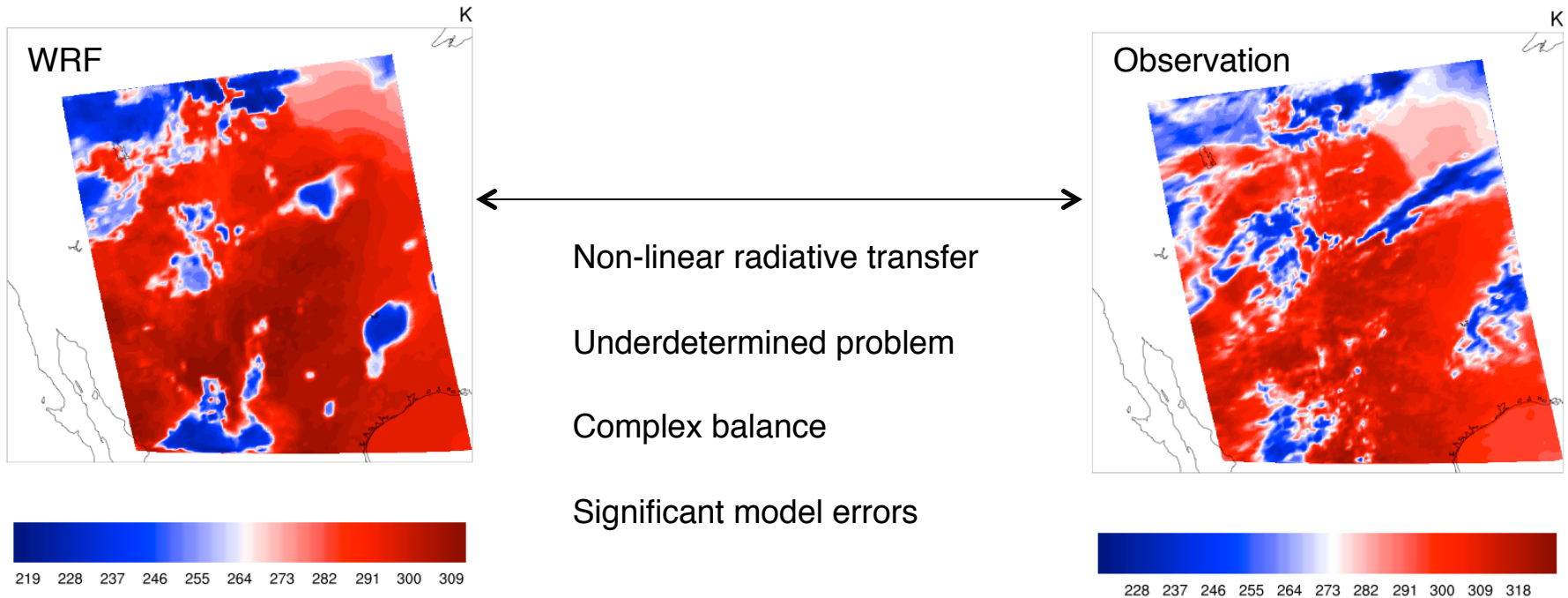
Dongmei Xu, Jose Ruiz-Arias

National Center for Atmospheric Research

Acknowledgment: Funding from Air Force Weather Agency

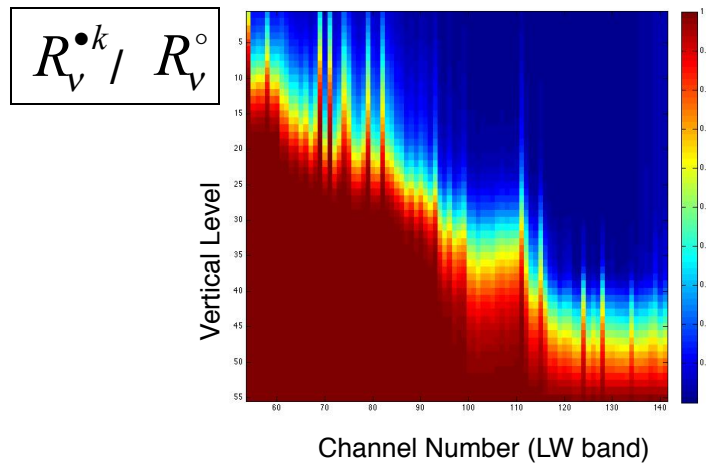


Initialization of clouds in NWP models



Poor performance for Nowcasting

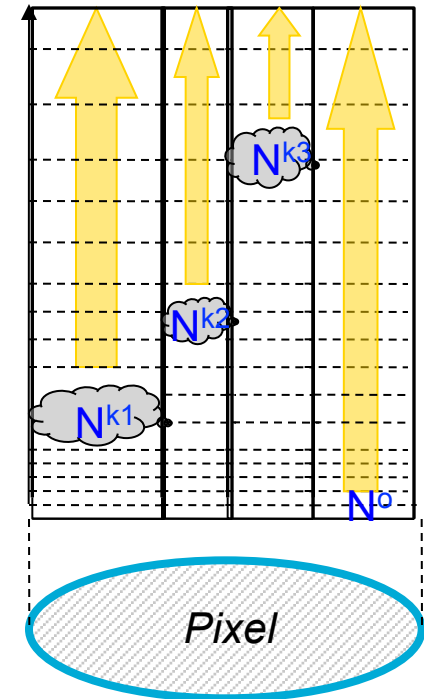
Retrieval of Cloud Fraction: Method (Auligné 2013a,b)



Multivariate Minimum Residual (MMR):

$$R_v^{Cld} = N^{\circ} R_v^{\circ} + \sum_{k=1}^n N^k R_v^{*k}$$

Cloud fractions N^k are adjusted **variationally** to fit observations



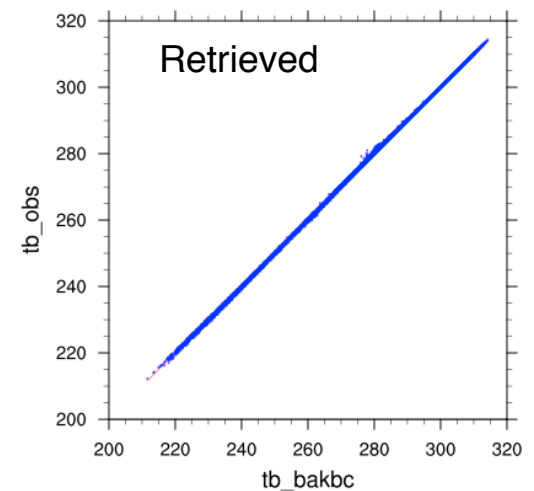
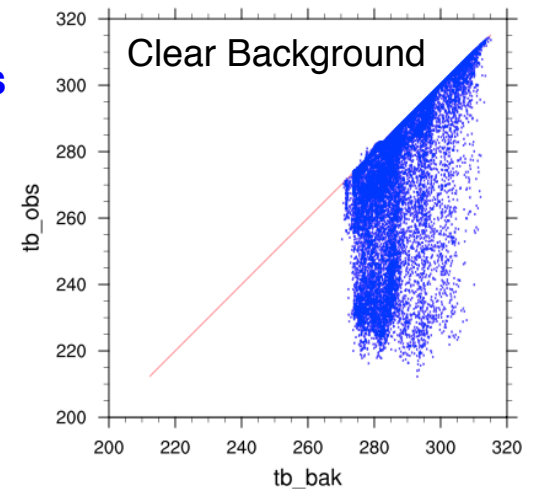
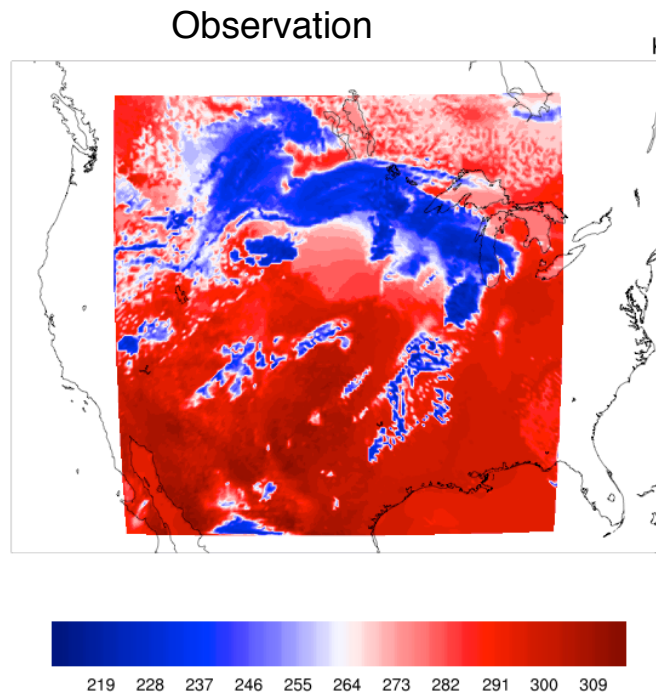
Validation with Synthetic Observations

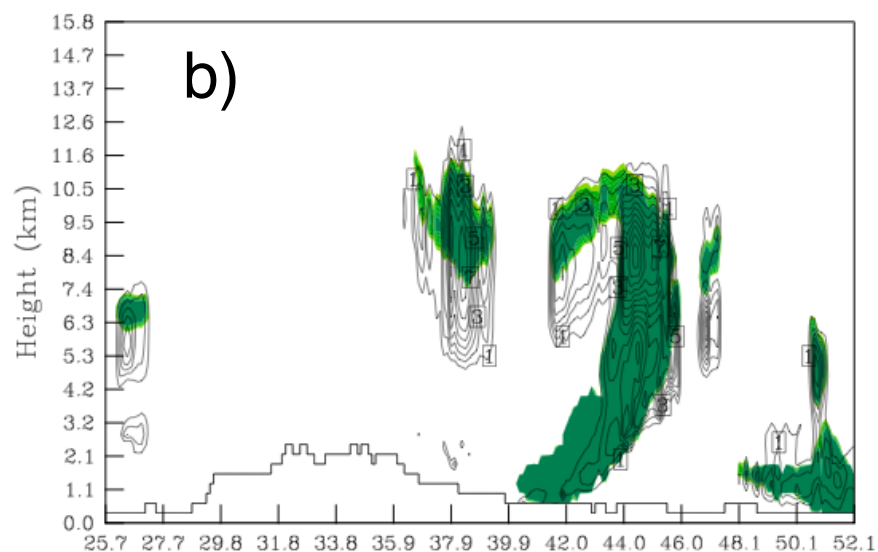
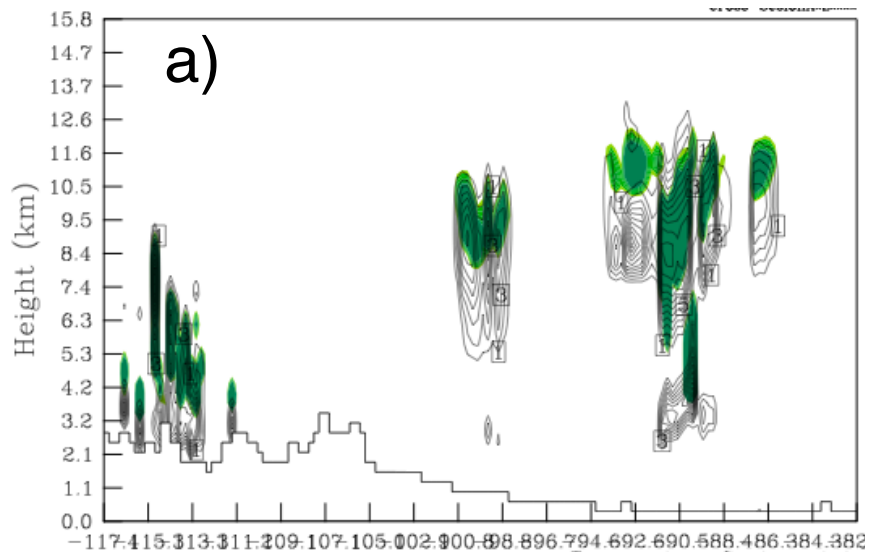
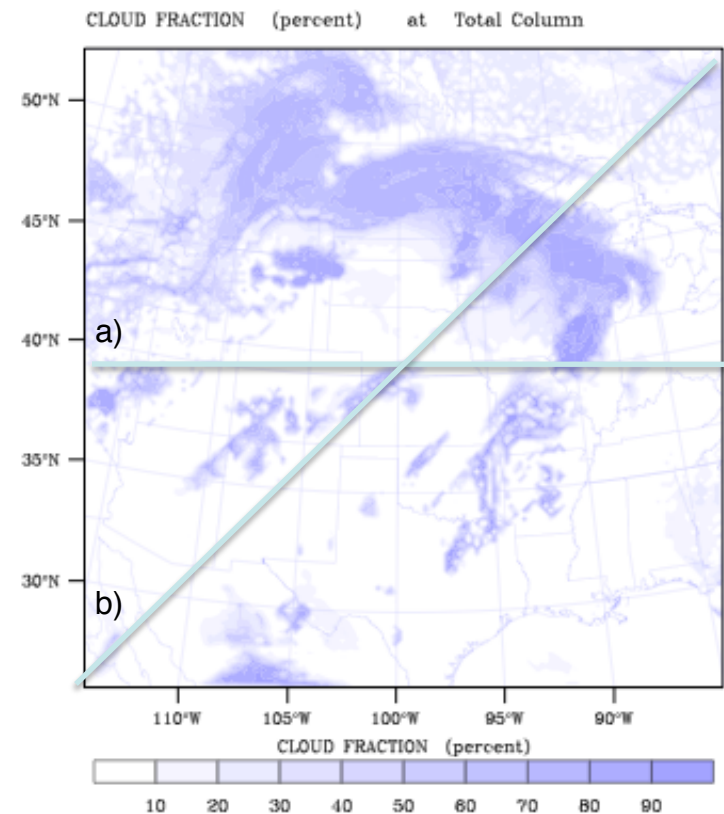
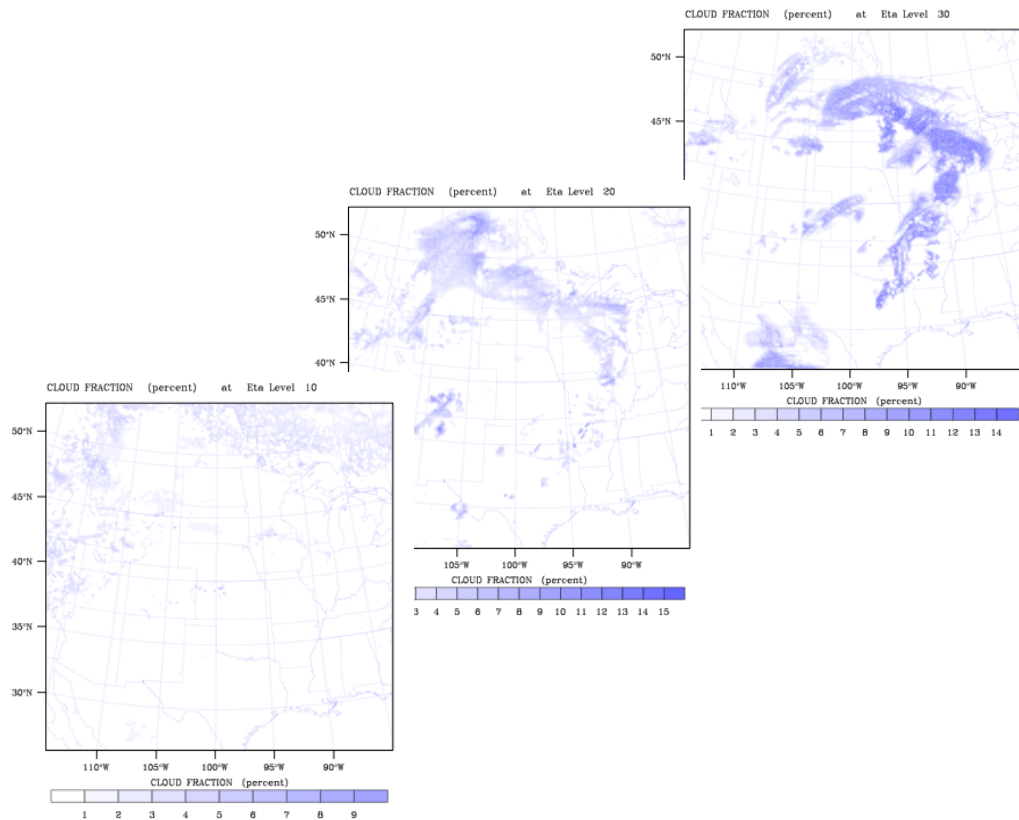
Truth = WRF forecast

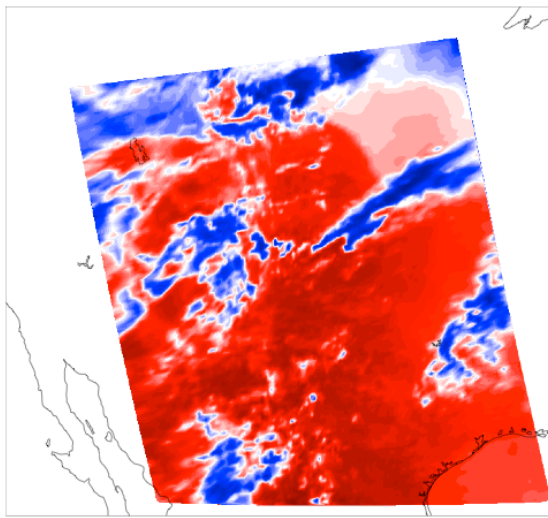
Radiative transfer: CRTM with **3D cloud microphysics**

Synthetic AIRS observations at every model grid point

Background: WRF (no clouds)

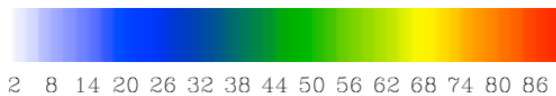
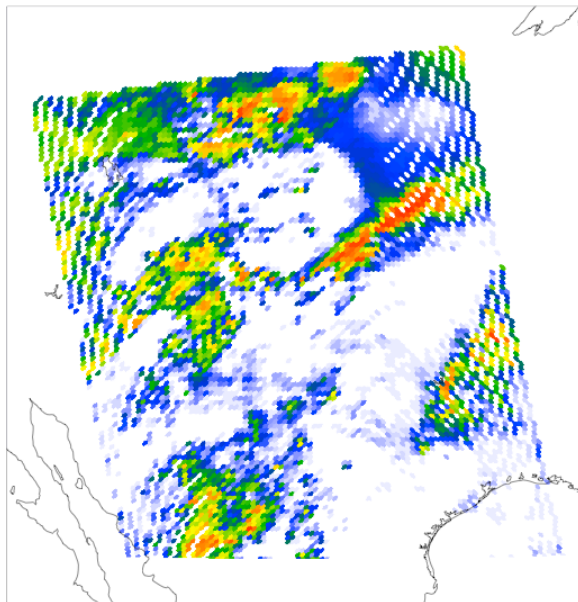




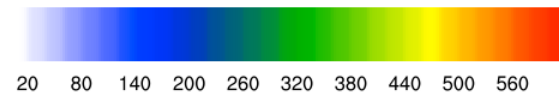
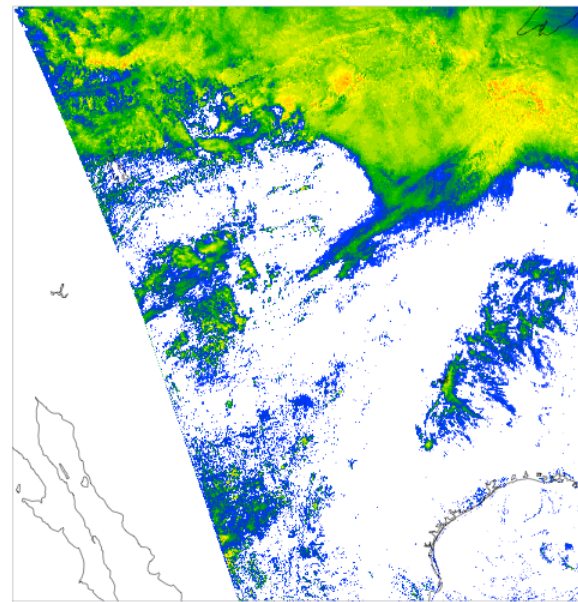


Real Observations

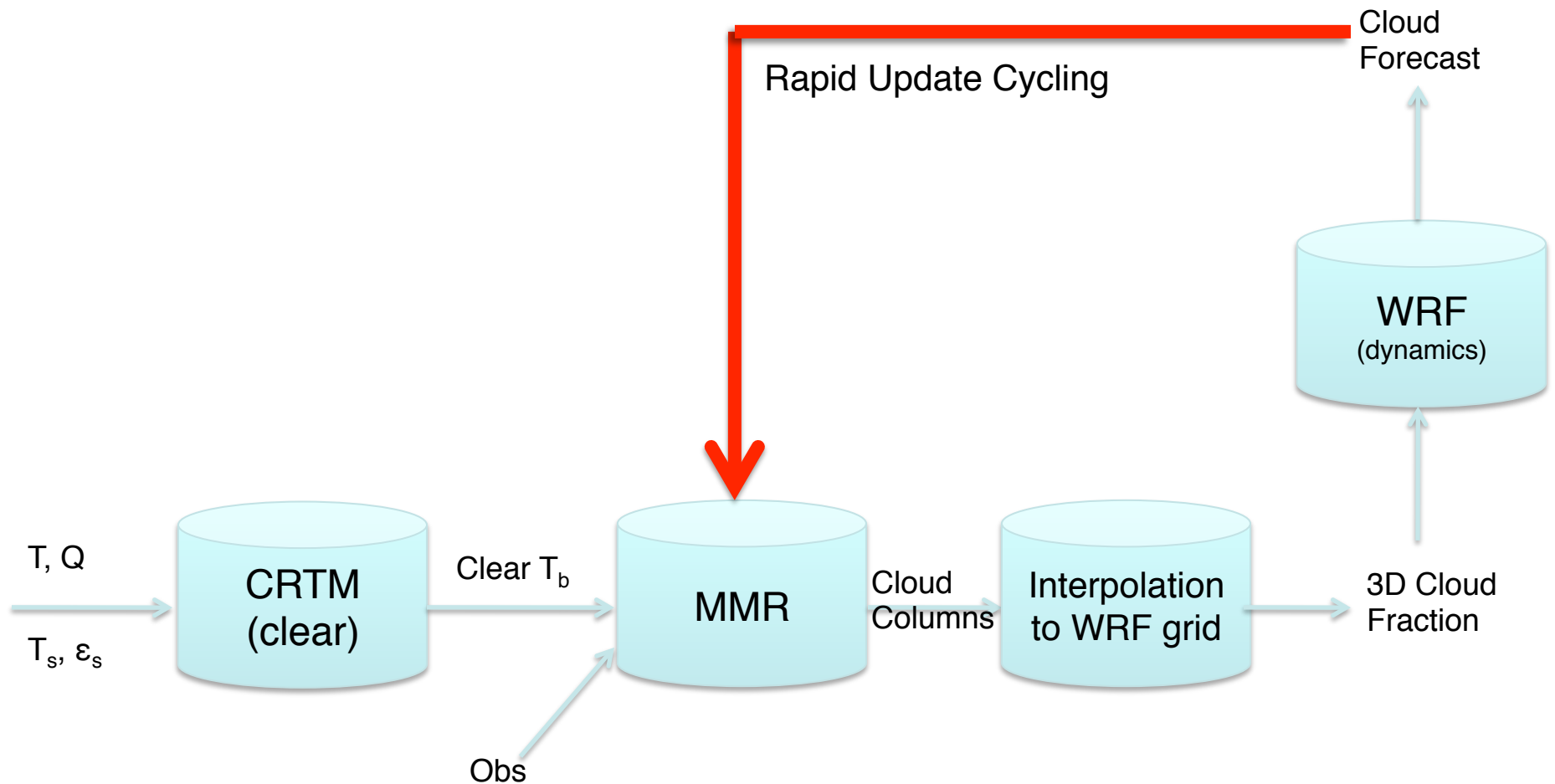
Retrieval of Cloud Fraction



GEOS Cloud Mask



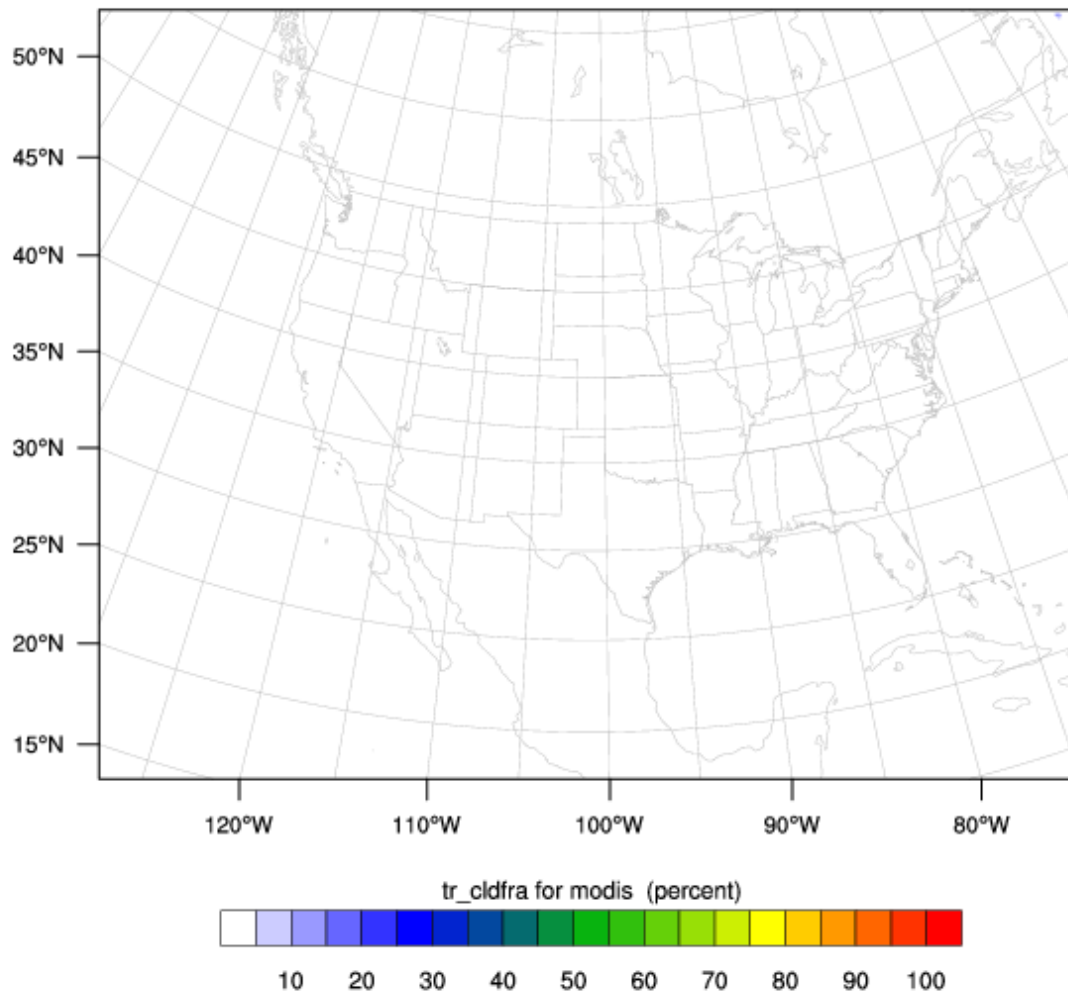
Cloud Nowcasting System with WRF



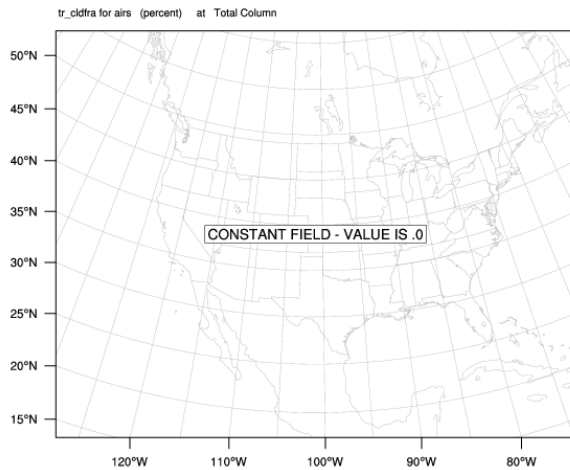
Rapid Update Cycling (1hour) 15km horizontal resolution

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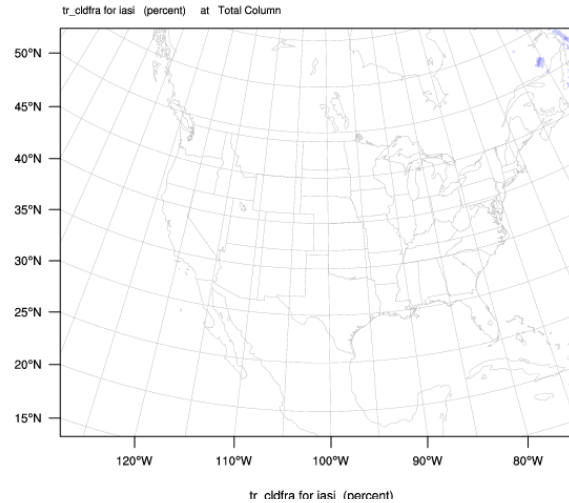
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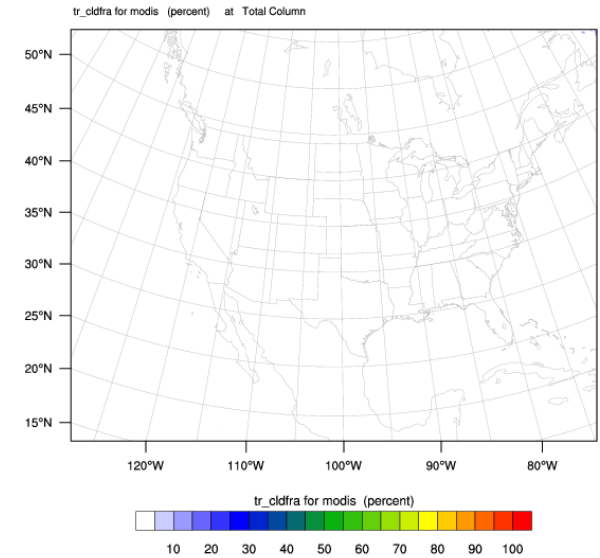
AIRS



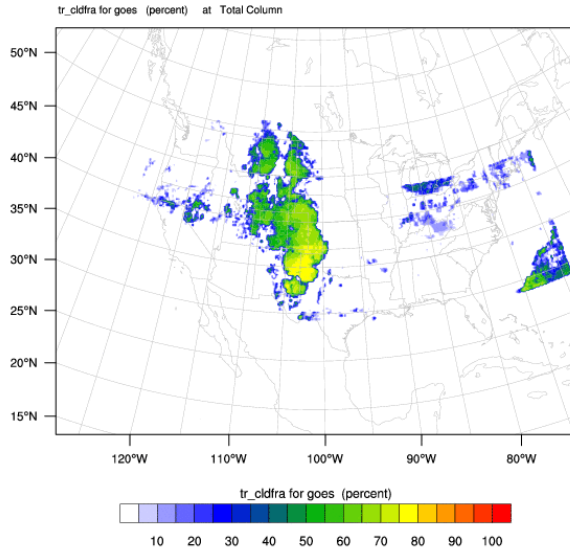
IASI



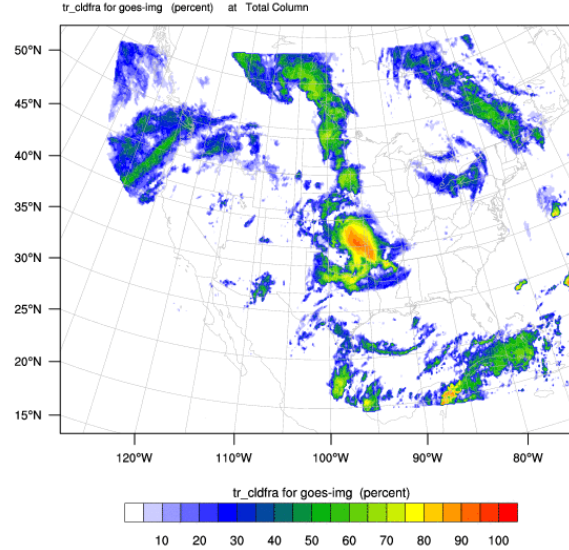
MODIS



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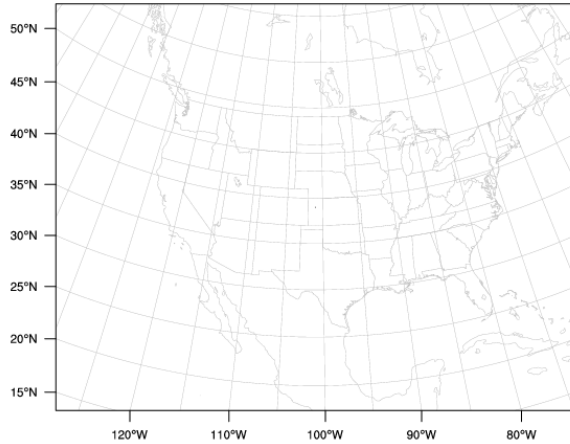
GOES Sounder



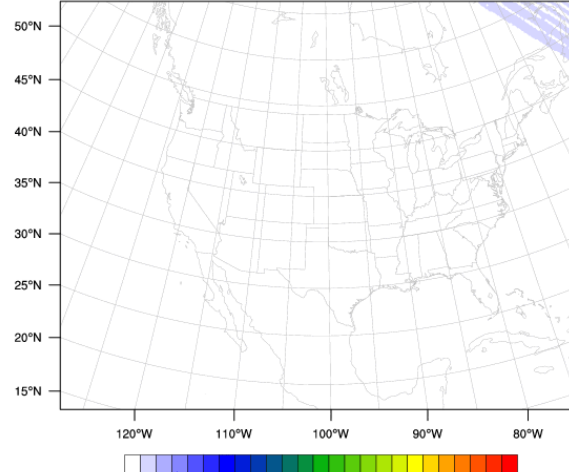
GOES Imager

Multi-sensor
analysis/forecast
of cloud fraction

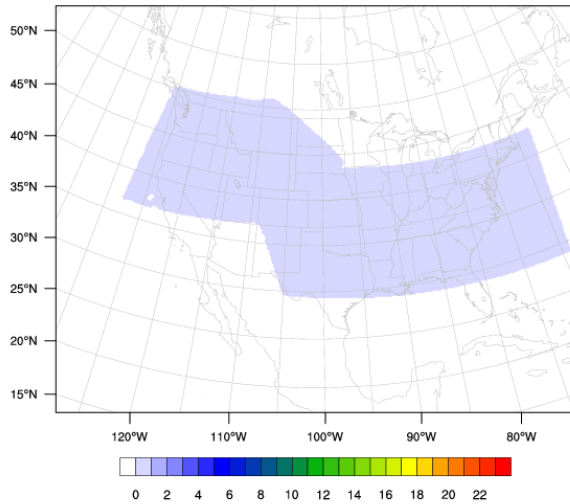
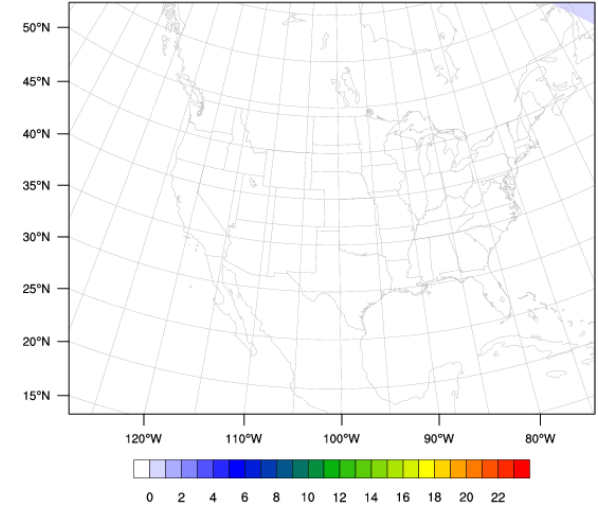
AIRS



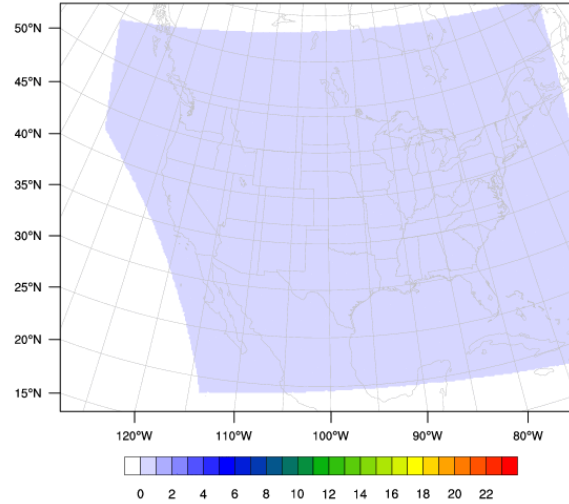
IASI



MODIS



GOES Sounder

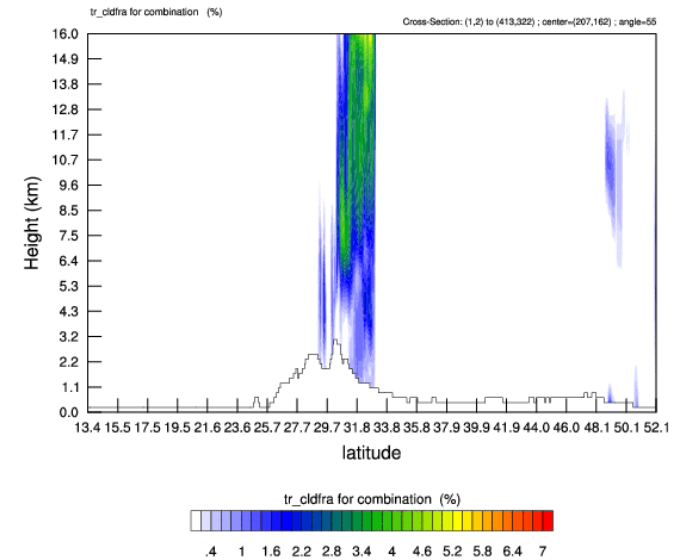
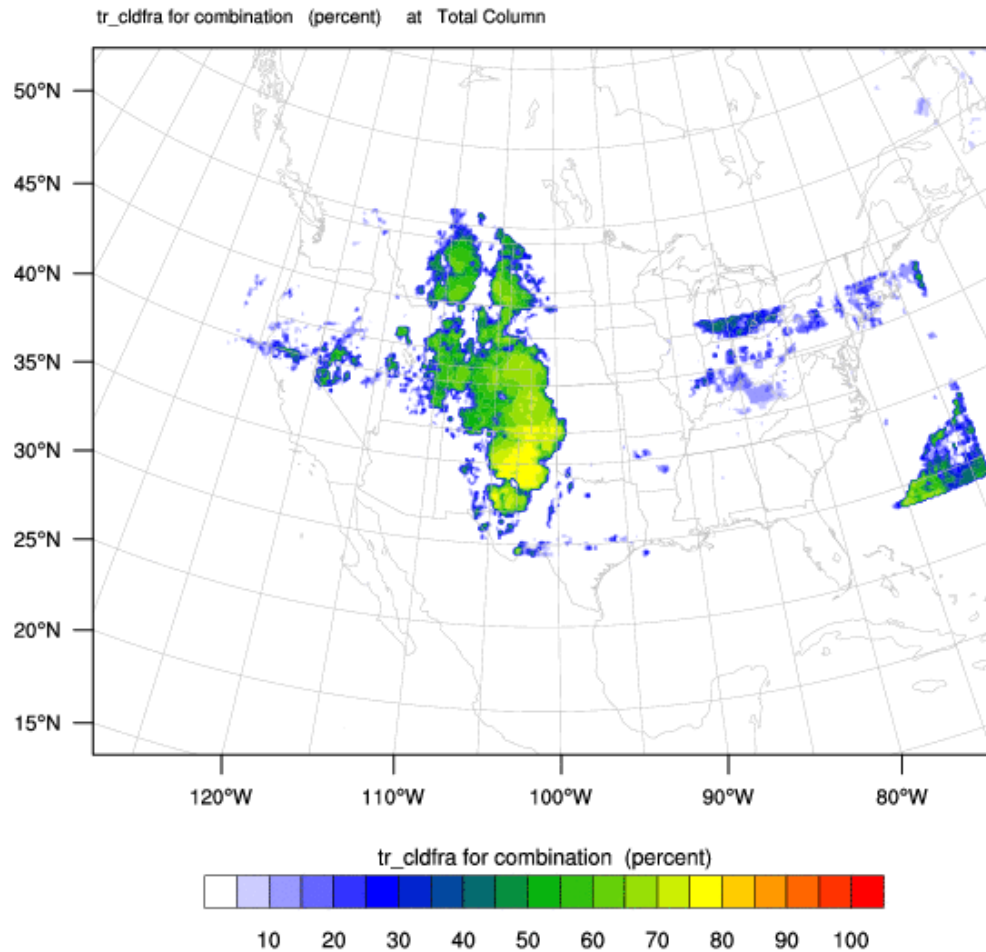


GOES Imager

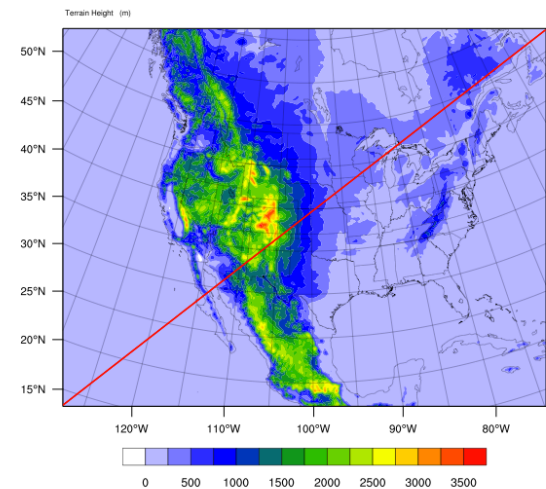
Multi-sensor
analysis/forecast
of cloud fraction
(age of information)

REAL-TIME WRF

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Valid: 2012-06-03_00:00:00

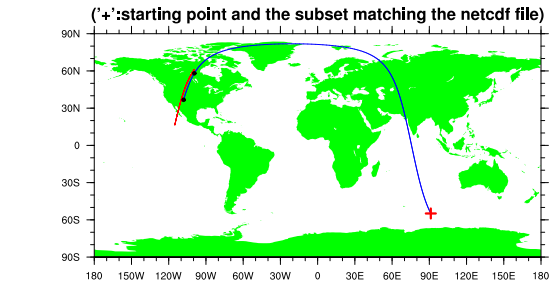


Vertical Cross Section

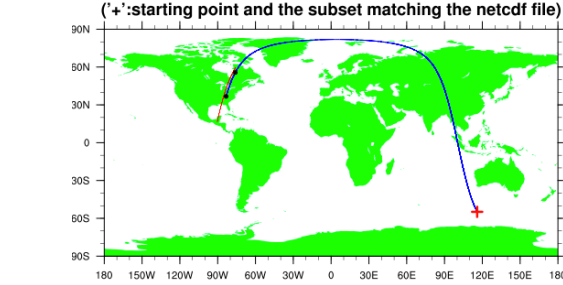
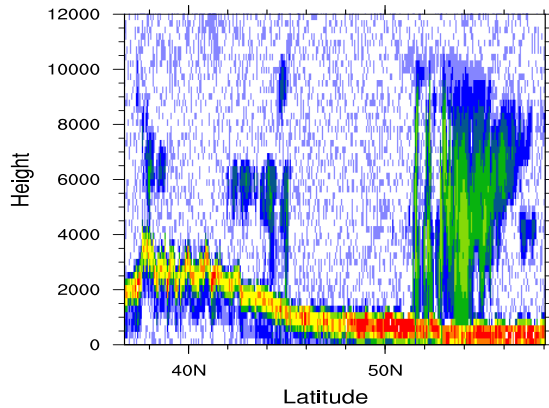


Multi-sensor **combined**
analysis/forecast of cloud fraction

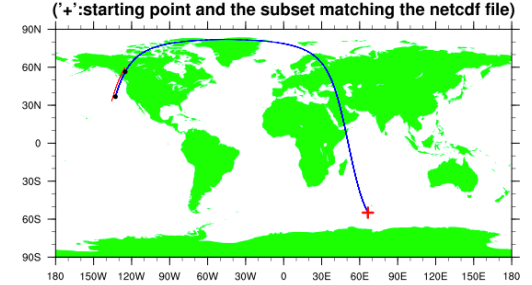
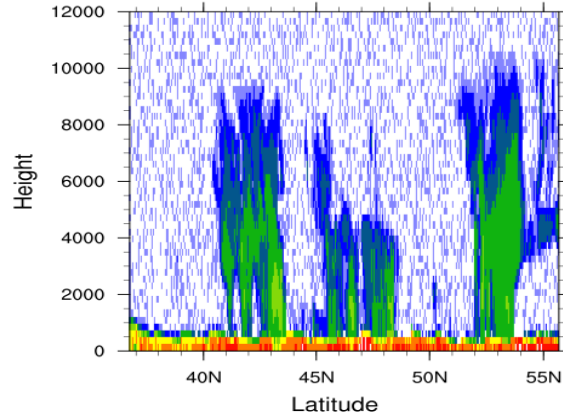
Validation with CloudSat



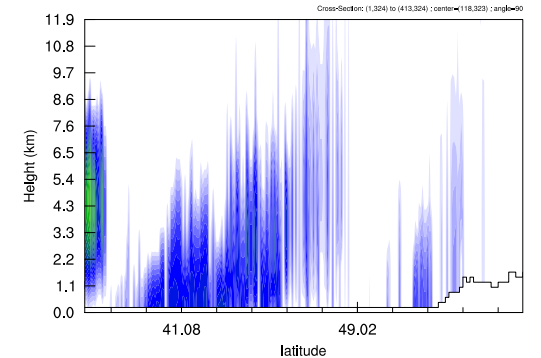
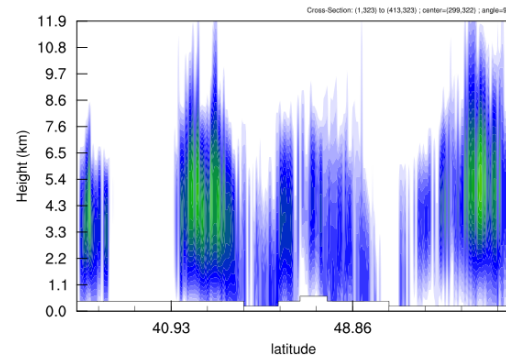
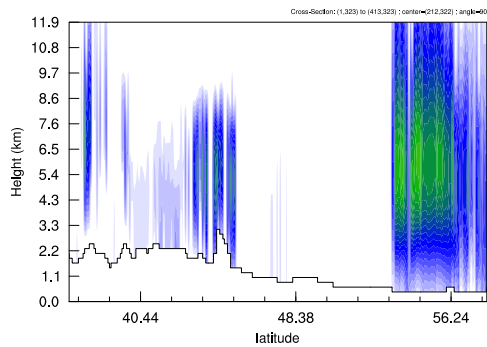
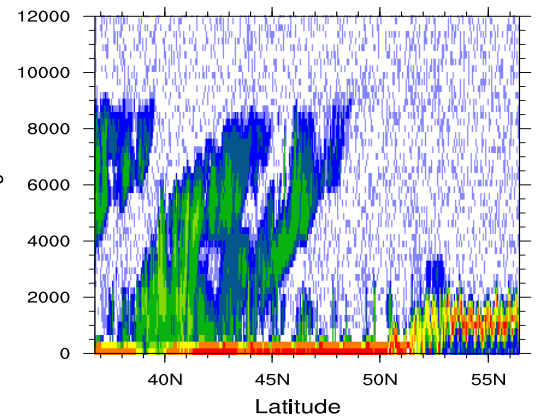
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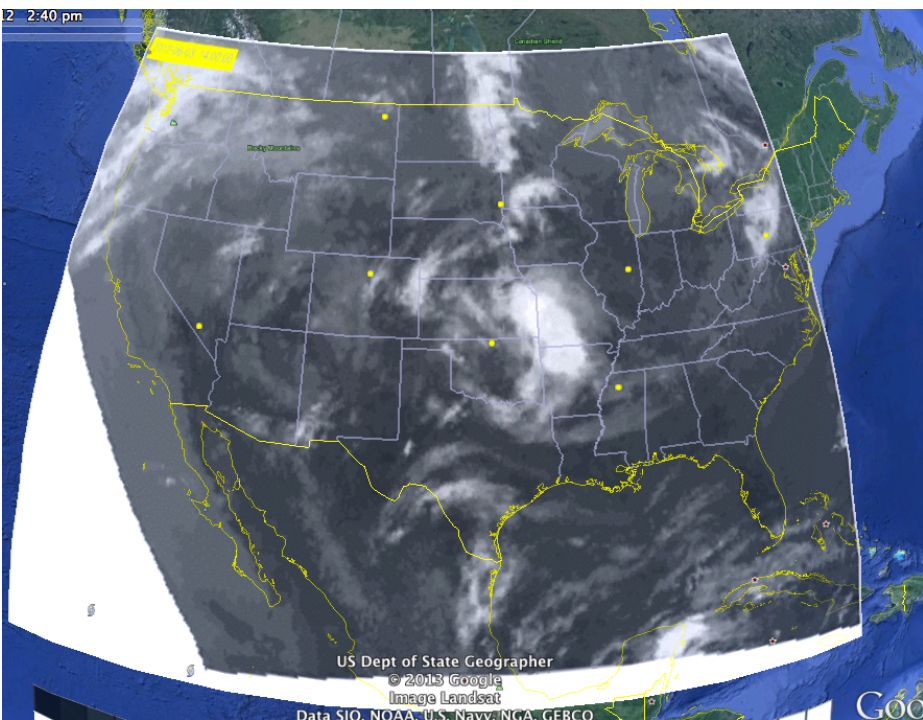


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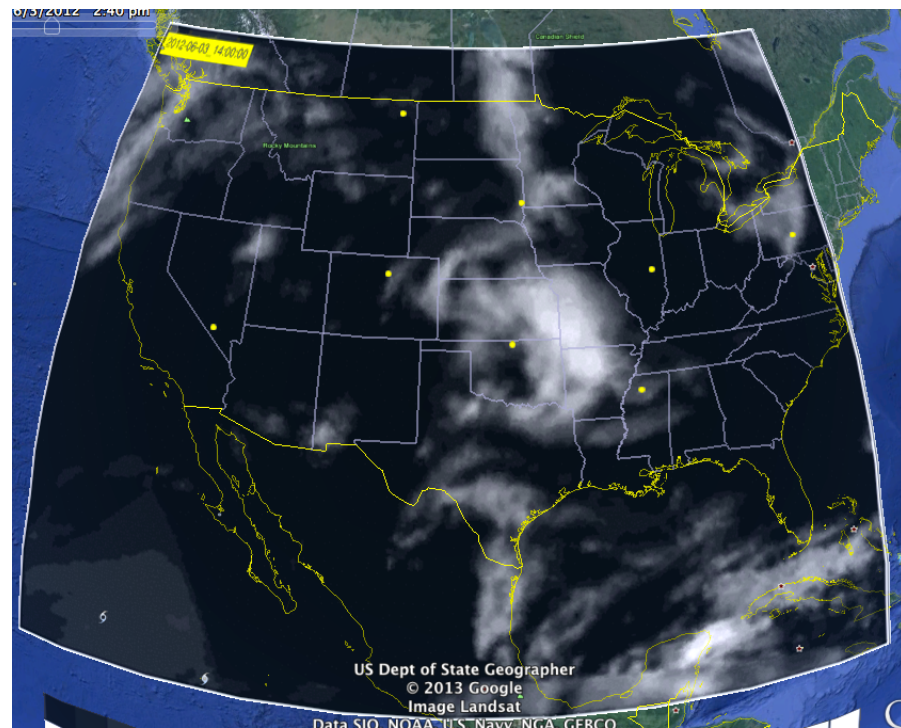
Observations

GOES Imager



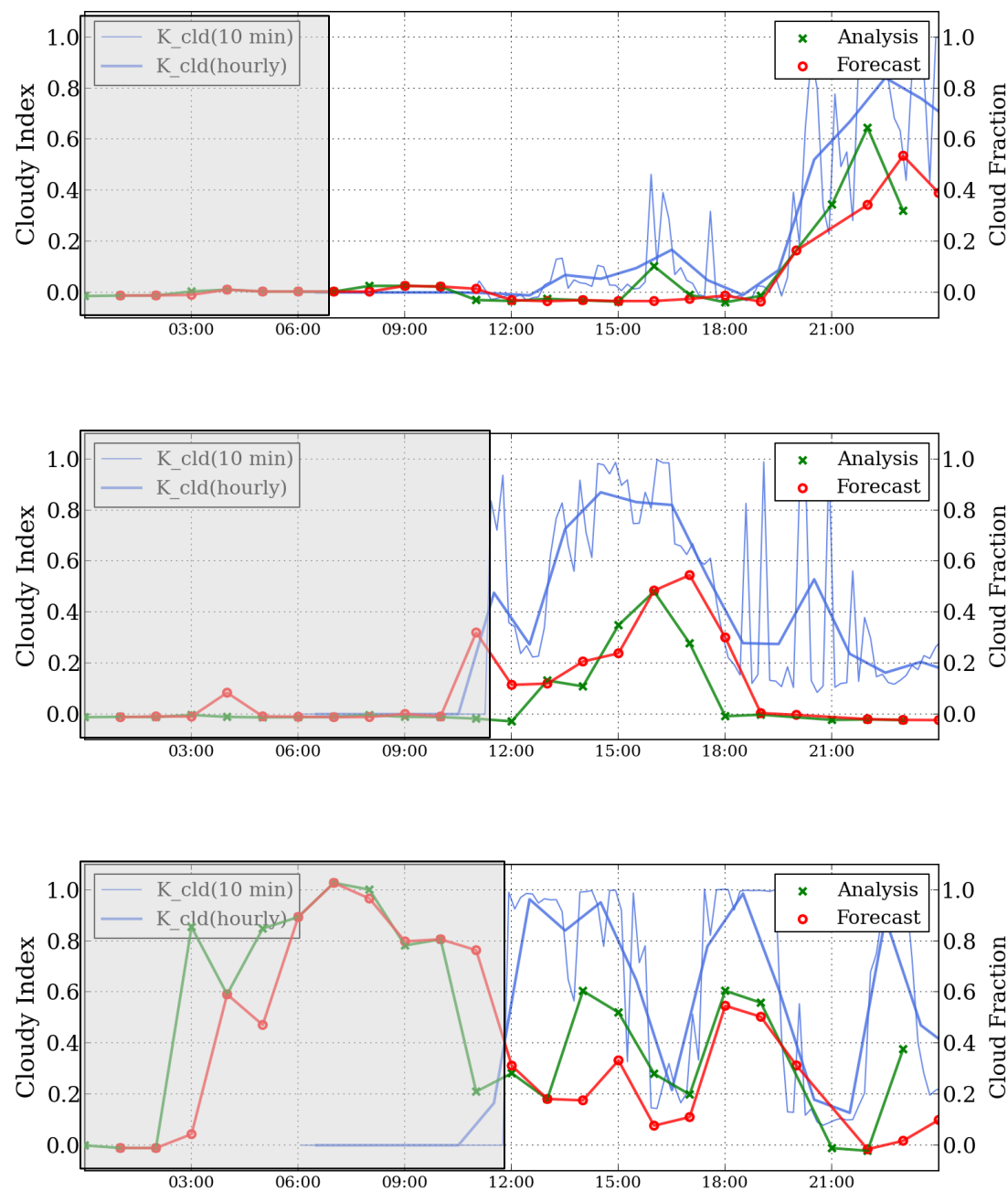
Forecast (1h)

Cloud Fraction



Rapid Update Cycling (every 1h)
15km horizontal resolution

SURFRAD Stations



Conclusions

Cloud Retrieval

- multi-layer cloud retrieval from satellite observations (MMR, Auligné 2013a,b)
- low computer cost (real-time)
- synergistic use of multiple sensors

Cloud Nowcasting

- dynamical transport via NWP model
- rapid-update cycling
- plans to cycle every 15min with WRF at 3km

Potential for Initialization of Microphysical Parameters

- empirical conversion to Q_c , Q_i
- pre-processing for ensemble/variational data assimilation

Thanks for your attention!