Cloud Retrieval and Nowcasting

Tom Auligné
Dongmei Xu, Jose Ruiz-Arias

National Center for Atmospheric Research
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Initialization of clouds in NWP models

Non-linear radiative transfer
Underdetermined problem
Complex balance
Significant model errors

Poor performance for Nowcasting
Retrieval of Cloud Fraction: Method (Auligné 2013a,b)

\[ R_{v}^{*k} / R_{v}^{\circ} \]

Vertical Level

Channel Number (LW band)

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)
Retrieval of Cloud Fraction

Real Observations

GEOS Cloud Mask
Cloud Nowcasting System with WRF

CRTM (clear)

T, Q

T_s, \varepsilon_s

MMR

Clear T_b

Cloud Columns

Interpolation to WRF grid

Obs

Rapid Update Cycling

Cloud Forecast

WRF (dynamics)

3D Cloud Fraction

Cloud Nowcasting System with WRF

CRTM (clear)

T, Q

T_s, \varepsilon_s

MMR

Clear T_b

Cloud Columns

Interpolation to WRF grid

Obs

Rapid Update Cycling

Cloud Forecast

WRF (dynamics)

3D Cloud Fraction
Rapid Update Cycling (1 hour)
15km horizontal resolution
Multi-sensor analysis/forecast of cloud fraction
Multi-sensor analysis/forecast of cloud fraction (age of information)
Multi-sensor combined analysis/forecast of cloud fraction
Validation with CloudSat
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!