Synergistic use of high spatial resolution imager and high spectral resolution sounder for atmospheric and cloud retrievals

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Best products will be realized from combinations of imager and sounder data!

Using MODIS/AIRS data to simulate ABI/HES system!

Better cloud detection and characterization, better spatial, etc

Better surface emissivity, better spectral, better accuracy, etc
What can we do for MODIS/AIRS synergistic retrieval?

- AIRS sub-pixel cloud detection and characterization using MODIS data

- MODIS products serve as the background information for sounder retrieval
MODIS classification mask at 1km resolution
Cloudy FOV

Clear mixed water/land (Milwaukee)

Clear Water

Clear Land

Cloudy FOV
What can we do for MODIS/AIRS synergistic retrieval?

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1DVAR algorithm for cloud retrieval (Li, Menzel and Schreiner 2001)

Observed AIRS Radiance Measurements

\[ J(X) = (R^m - R(X))^T E^{-1} [R^m - R(X)] + (X - X_B)^T B^{-1} [X - X_B] \]

Fast Cloudy Radiative Transfer Model: coupled

(1) Single-Scattering Cloud Model and
(2) AIRS Clear Sky Radiance Model – SARTA.
(3) Temperature/moisture profiles are from ECMWF.

\[ X = (CTP, ECA_1, ECA_2, ECA_3, ..., ECA_{10}, CPS, COT) \]

CTP: Cloud-Top Pressure
ECA: Effective Cloud Amount
CPS: Cloud Particle Size
COT: Cloud Optical Thickness at 0.55µm
Tropical atmosphere

ECA Sensitivity

CTP Sensitivity
Thin ice clouds
AIRS clear calculation with *ECMWF profile* versus cloudy observation
AIRS cloudy calculation with **MODIS CTP and ECA** versus cloudy observation

CTP=250, ECA=0.28
AIRS cloudy calculation with *AIRS CTP and ECA* versus cloudy observation

![Graph showing BT (K) against wavenumber with red and black lines: Observation and Calculation with AIRS CTP (251hPa) and ECA (0.23)](image)

**CTP=251, ECA=0.23**

![Graph showing Obs - Cal (K) against wavenumber with red line: AIRS retrieval uses MODIS product as background!](image)
AIRS cloudy calculation with *AIRS CTP, CPS, and COT* versus cloudy observation

CPS=47.56, COT=0.34
Thick ice clouds

MODIS Classification Mask

Legend:
- Water
- Land
- Mixed cld
- Mixed clr
- Low cld
- Mid cld
- High cld
- Mid cld
- Low cld
AIRS cloudy calculation with *ECMWF profile* versus cloudy observation.
AIRS cloudy calculation with *MODIS CTP and ECA* versus cloudy observation

*CTP=284, ECA=0.67*
AIRS cloudy calculation with *AIRS CTP and ECA* versus cloudy observation

CTP=258, ECA=0.70
AIRS cloudy calculation with *AIRS CTP, CPS, and COT* versus cloudy observation.

CPS = 33.90, COT = 1.62
AIRS Four Footprints Near Purcell, OK

MODIS Classification Mask

FOV3
FOV4
FOV2
FOV1
AIRS/MODIS/GOES CTP comparisons

MODIS at 5km

GOES at 10km

AIRS at 14km
RMS Residual with MODIS CTP and ECA

RMS (K)

Wavenumber (cm**-1)

AIRS NeDT

Residual with MODIS CTP and ECA
RMS Residual with AIRS CTP and ECA

AIRS NeDT
Summary

• MODIS data help AIRS sub-pixel cloud detection and characterization

• With MODIS products as the background, improved atmospheric and cloud parameters can be obtained from sounder radiance measurements

• Other
  – Improved imager SST products with sounder emissivity retrieval
  – Image product + sounder product => better imager product
Future work

• Synergistic use of MODIS/AIRS for retrieving the atmospheric profiles and cloud properties simultaneously

• Prepare ABI/HES retrieval system, MODIS/AIRS data will be used